E45XN, E50XN, E55XN, E60XN, E65XN, E70XN (A268)
SERVICE MANUAL CONTENTS

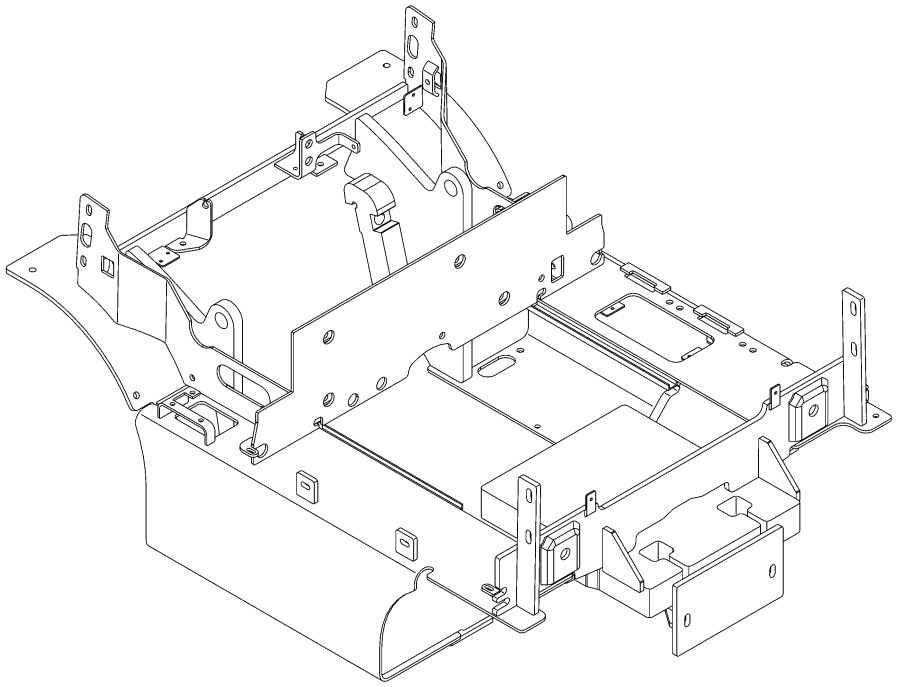
SECTION	PART NUMBER	SRM NUMBER	REV DATE
FRAME	1688870	0100 SRM 1342	08/18
OPERATOR'S CAB	4025482	0100 SRM 1446	09/14
AC MOTOR REPAIR	1696595	0620 SRM 1385	06/15
DRIVE AXLE, SPEED REDUCER, AND DIFFERENTIAL	1688871	1300 SRM 1366	08/16
STEERING AXLE	1688872	1600 SRM 1360	10/18
STEERING SYSTEM	1688873	1600 SRM 1363	09/14
BRAKE SYSTEM	1688874	1800 SRM 1359	03/12
HYDRAULIC SYSTEM	1688875	1900 SRM 1367	04/17
HYDRAULIC CLEANLINESS PROCEDURES	4075393	1900 SRM 1620	12/17
MAIN CONTROL VALVES	1688876	2000 SRM 1334	09/14
CYLINDER REPAIR (MAST S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564)	1688877	2100 SRM 1382	02/18
CYLINDER REPAIR (MAST S/N F507, F508, F562, F563)	4099650	2100 SRM 1668	02/18
WIRE HARNESS REPAIR	1580517	2200 SRM 1128	06/18
USER INTERFACE SUPERVISOR	1688878	2200 SRM 1335	01/18
USER INTERFACE SERVICE TECHNICIAN	1688879	2200 SRM 1336	07/18
ELECTRICAL SYSTEM	1688880	2200 SRM 1369	11/17
INDUSTRIAL BATTERY	899648	2240 SRM 0001	10/18
MAST REPAIR (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)	1688881	4000 SRM 1338	10/17
MAST REPAIR (S/N F507, F508, F562, F563)	4099655	4000 SRM 1669	10/17
METRIC AND INCH (SAE) FASTENERS	910442	8000 SRM 0231	09/18
PERIODIC MAINTENANCE	1688882	8000 SRM 1364	02/18
CAPACITIES AND SPECIFICATIONS	1688883	8000 SRM 1374	08/18
DIAGRAMS	1701941	8000 SRM 1384	06/16
DIAGNOSTIC TROUBLESHOOTING MANUAL	1688885	9000 SRM 1377	09/18

Service information for Cummins diesel engines can be ordered through the Hyster Literature Distribution Center.

PART NO. 1688862 (10/18)

FRAME

E2.2-3.5XN (E45-70XN) [A268];
E1.6-2.0XN (E30-40XN) [A269];
J2.2-3.5XN (J45-70XN) [A276];
J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) [A970];E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) [A099]



HYSTER

PART NO. 1688870

0100 SRM 1342

SAFETY PRECAUTIONS
MAINTENANCE AND REPAIR

- The Service Manuals are updated on a regular basis, but may not reflect recent design changes to the product. Updated technical service information may be available from your local authorized Hyster® dealer. Service Manuals provide general guidelines for maintenance and service and are intended for use by trained and experienced technicians. Failure to properly maintain equipment or to follow instructions contained in the Service Manual could result in damage to the products, personal injury, property damage or death.
- When lifting parts or assemblies, make sure all slings, chains, or cables are correctly fastened, and that the load being lifted is balanced. Make sure the crane, cables, and chains have the capacity to support the weight of the load.
- Do not lift heavy parts by hand, use a lifting mechanism.
- Wear safety glasses.
- DISCONNECT THE BATTERY CONNECTOR before doing any maintenance or repair on electric lift trucks. Disconnect the battery ground cable on internal combustion lift trucks.
- Always use correct blocks to prevent the unit from rolling or falling. See HOW TO PUT THE LIFT TRUCK ON BLOCKS in the **Operating Manual** or the **Periodic Maintenance** section.
- Keep the unit clean and the working area clean and orderly.
- Use the correct tools for the job.
- Keep the tools clean and in good condition.
- Always use **HYSTER APPROVED** parts when making repairs. Replacement parts must meet or exceed the specifications of the original equipment manufacturer.
- Make sure all nuts, bolts, snap rings, and other fastening devices are removed before using force to remove parts.
- Always fasten a DO NOT OPERATE tag to the controls of the unit when making repairs, or if the unit needs repairs.
- Be sure to follow the **WARNING** and **CAUTION** notes in the instructions.
- Gasoline, Liquid Petroleum Gas (LPG), Compressed Natural Gas (CNG), and Diesel fuel are flammable. Be sure to follow the necessary safety precautions when handling these fuels and when working on these fuel systems.
- Batteries generate flammable gas when they are being charged. Keep fire and sparks away from the area. Make sure the area is well ventilated.

NOTE: The following symbols and words indicate safety information in this manual:

WARNING

Indicates a hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION

Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury and property damage.

On the lift truck, the WARNING symbol and word are on orange background. The CAUTION symbol and word are on yellow background.

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This section is for the following models:

E2.2-3.5XN (E45-70XN) [A268];
E1.6-2.0XN (E30-40XN) [A269];
J2.2-3.5XN (J45-70XN) [A276];
J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) [A970];
E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) [A099]

"THE QUALITY KEEPERS"

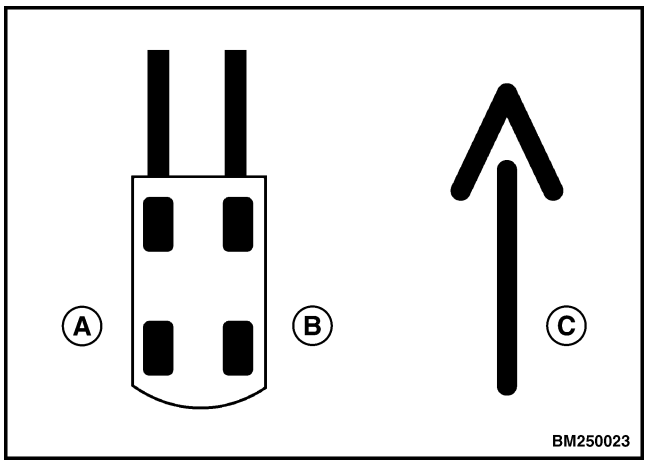
HYSTER APPROVED PARTS

General

DESCRIPTION

This section contains a description and service procedures for the parts of the frame. These parts include the frame, counterweight assembly, overhead guard, hood and seat assembly, access panels, and labels.

Throughout this section, forward will refer to travel in the direction of the forks and left and right will be determined by an operator sitting in the seat facing forward. See Figure 1.



A. LEFT SIDE
B. RIGHT SIDE
C. FORWARD TRAVEL

Figure 1. Truck Orientation

If a torque value is not specified, go to **Metric and Inch (SAE) Fasteners** 8000SRM0231 for torque values.

FRAME

The frame is a single weldment with mounts for:

- Counterweight
- Overhead guard
- Tilt cylinders
- Drive axle, or if equipped, transaxle
- Floor plate and pedals
- Side step and fender weldments
- Hood and seat assembly
- Front drop-in bulkhead for lift truck models E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

See Figure 2 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268)

See Figure 3 for lift truck models

- E1.6-2.0XN (E30-40XN) (A269)

See Figure 4 for lift truck models

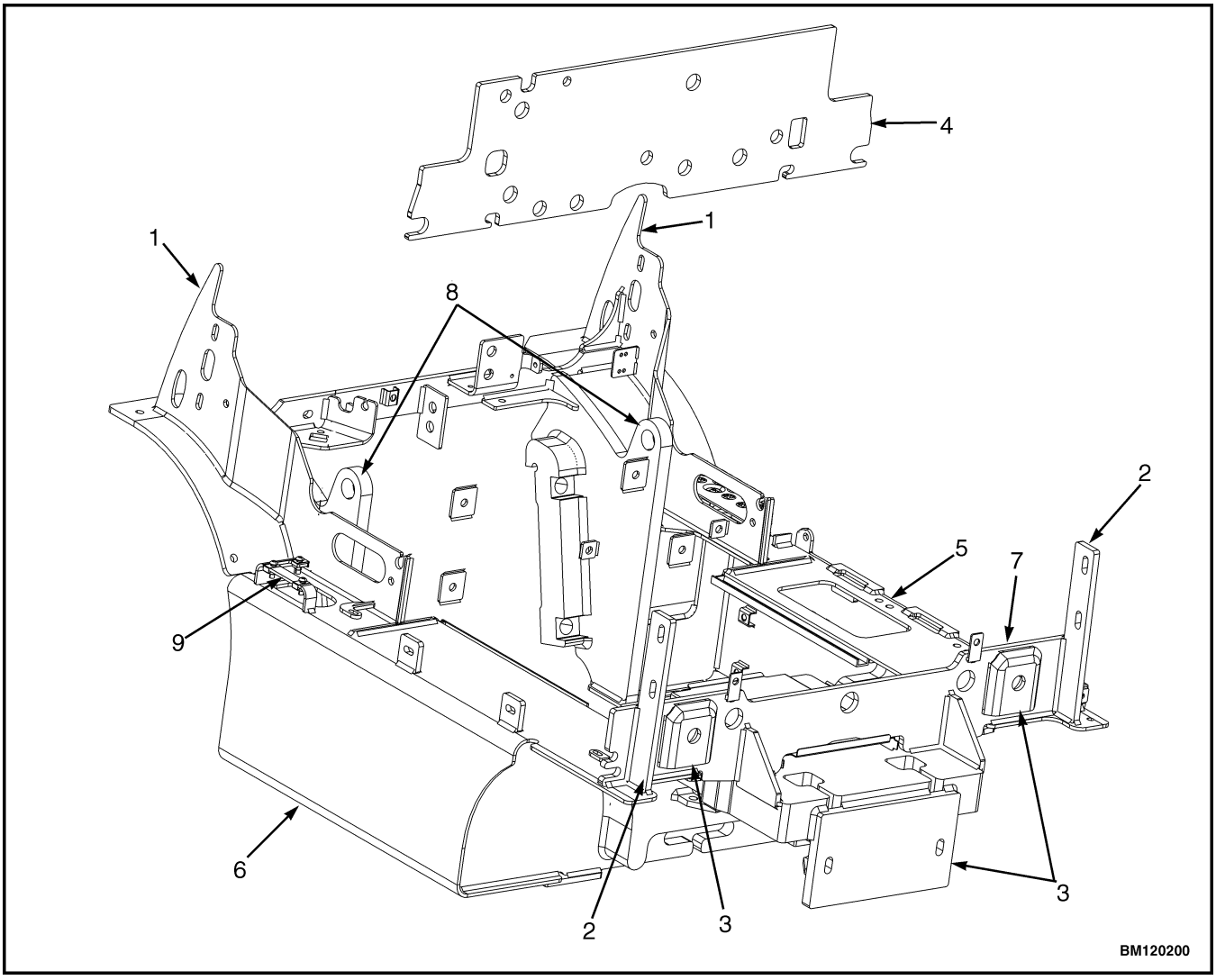
- J2.2-3.5XN (J45-70XN) (A276)

See Figure 5 for the following lift truck models not equipped with side battery removal

- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)
- See Figure 6 for the following lift truck models equipped with side battery removal
- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

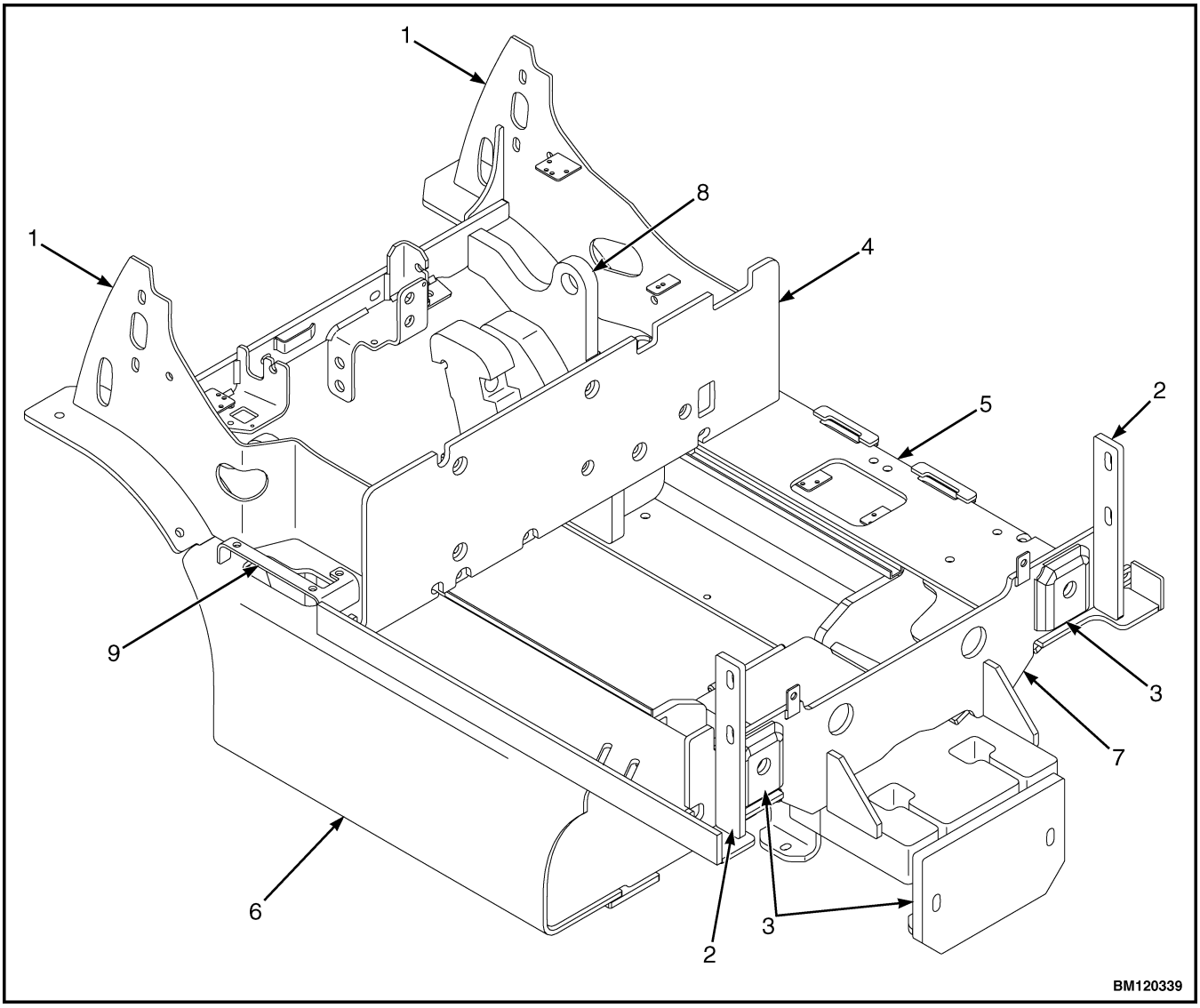
See Figure 7 for lift truck models

- E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)



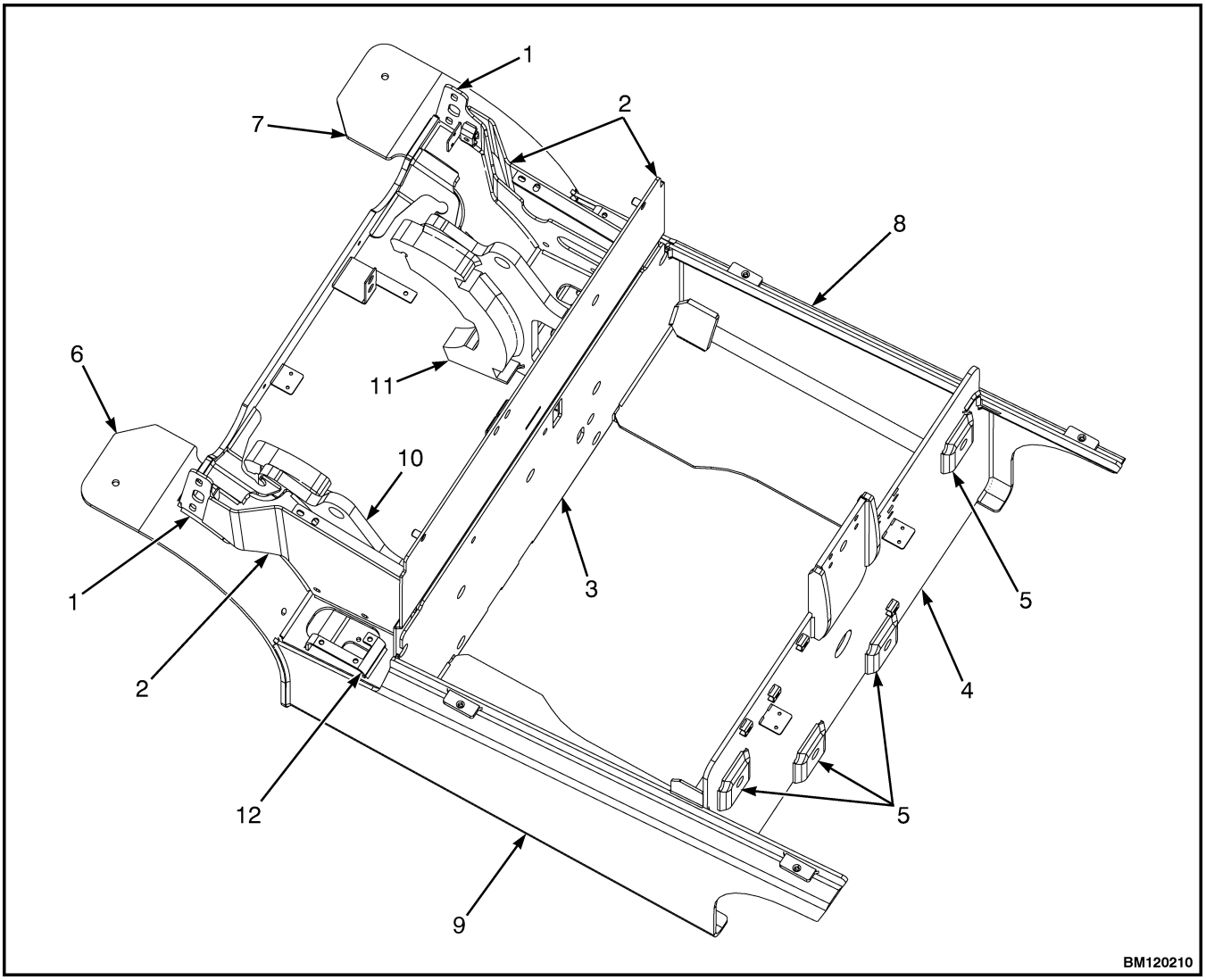
1. FRONT OVERHEAD GUARD MOUNTING BRACKET
2. REAR OVERHEAD GUARD MOUNTING BRACKET
3. COUNTERWEIGHT MOUNTING PLATE
4. FRONT BULKHEAD
5. RIGHT FRAME CHANNEL
6. LEFT FRAME CHANNEL
7. REAR BULKHEAD
8. TILT ANCHOR PLATE
9. SIDE STEP MOUNTING BRACKET

Figure 2. Frame Weldment for Lift Truck E2.2-3.5XN (E45-70XN) (A268)



1. FRONT OVERHEAD GUARD MOUNTING BRACKET
2. REAR OVERHEAD GUARD MOUNTING BRACKET
3. COUNTERWEIGHT MOUNTING PLATE
4. FRONT BULKHEAD
5. RIGHT FRAME CHANNEL
6. LEFT FRAME CHANNEL
7. REAR BULKHEAD
8. TILT ANCHOR PLATE
9. SIDE STEP MOUNTING BRACKET

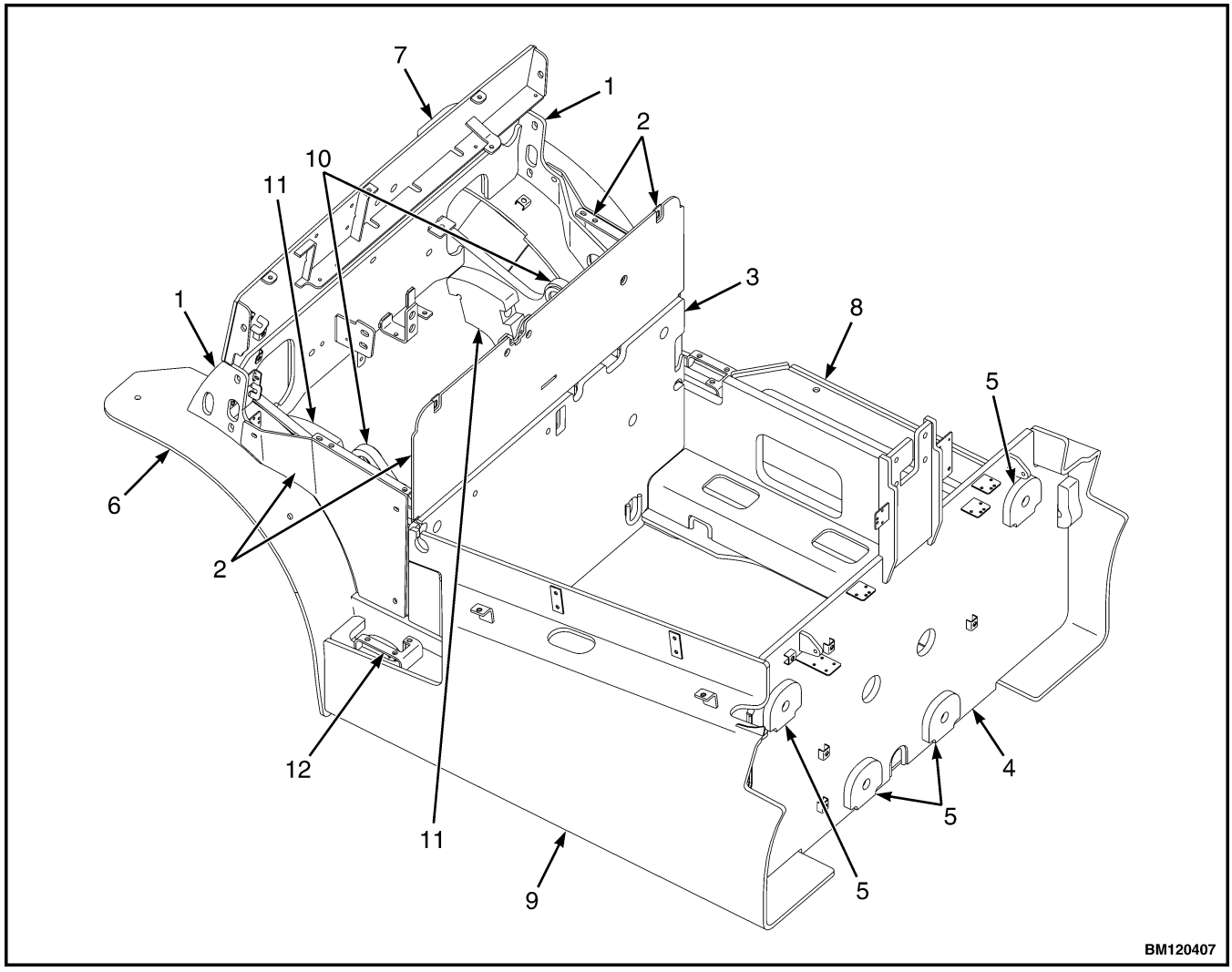
Figure 3. Frame Weldment for Lift Truck E1.6-2.0XN (E30-40XN) (A269)



NOTE: LIFT TRUCK W/OUT SIDE REMOVAL BATTERY SHOWN, LIFT TRUCK WITH SIDE REMOVAL BATTERY AND HINGED BATTERY DOOR SIMILAR.

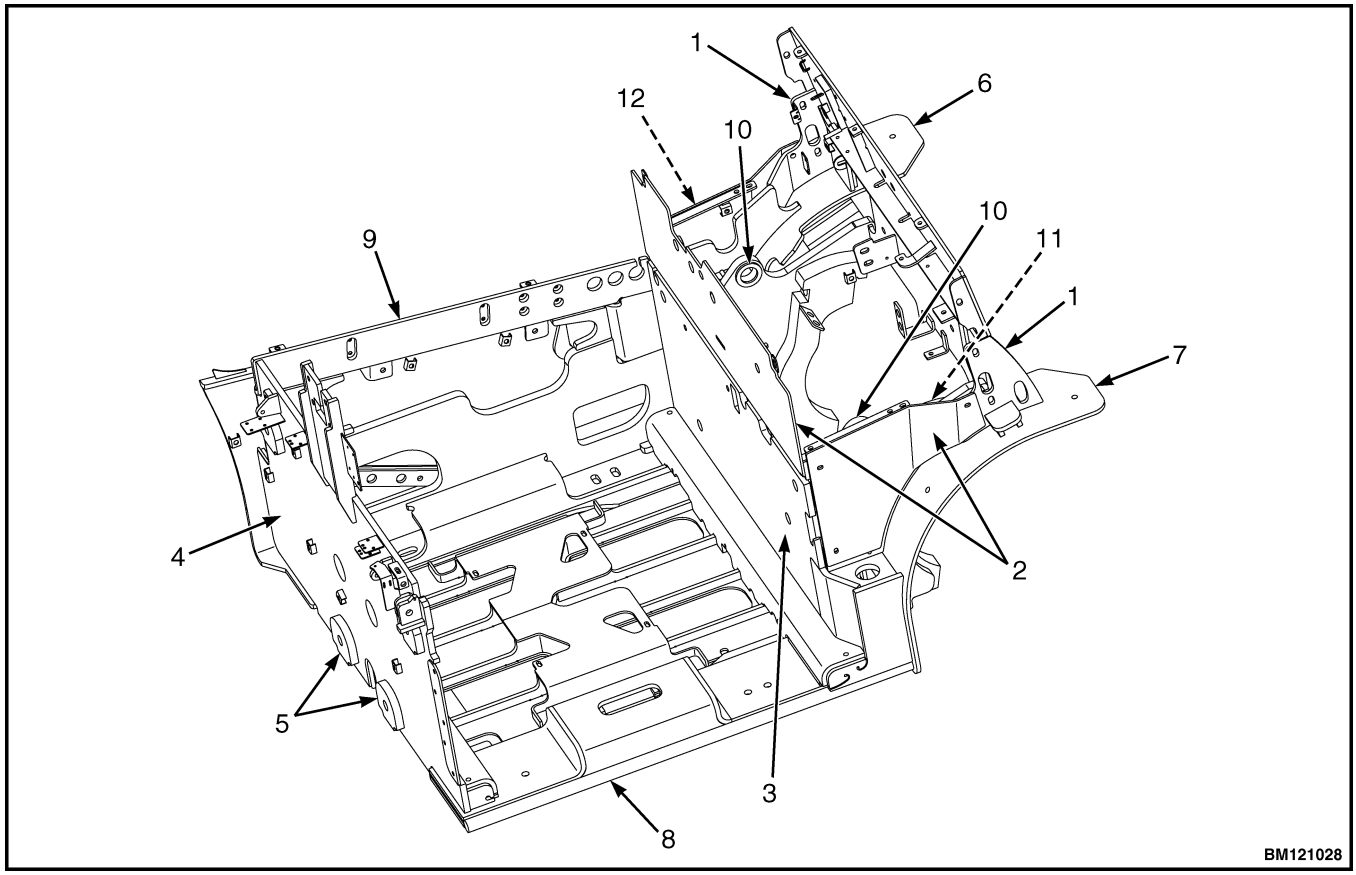
1. FRONT OVERHEAD GUARD MOUNTING BRACKET
2. OPERATOR MODULE PLATE
3. FRONT BULKHEAD
4. REAR BULKHEAD
5. COUNTERWEIGHT MOUNTING PLATE
6. LEFT FENDER
7. RIGHT FENDER
8. RIGHT FRAME CHANNEL
9. LEFT FRAME CHANNEL
10. TILT ANCHOR PLATE
11. DRIVE AXLE MOUNTS
12. SIDE STEP MOUNTING BRACKET

Figure 4. Frame Weldment for Lift Truck J2.2-3.5XN (J45-70XN) (A276)



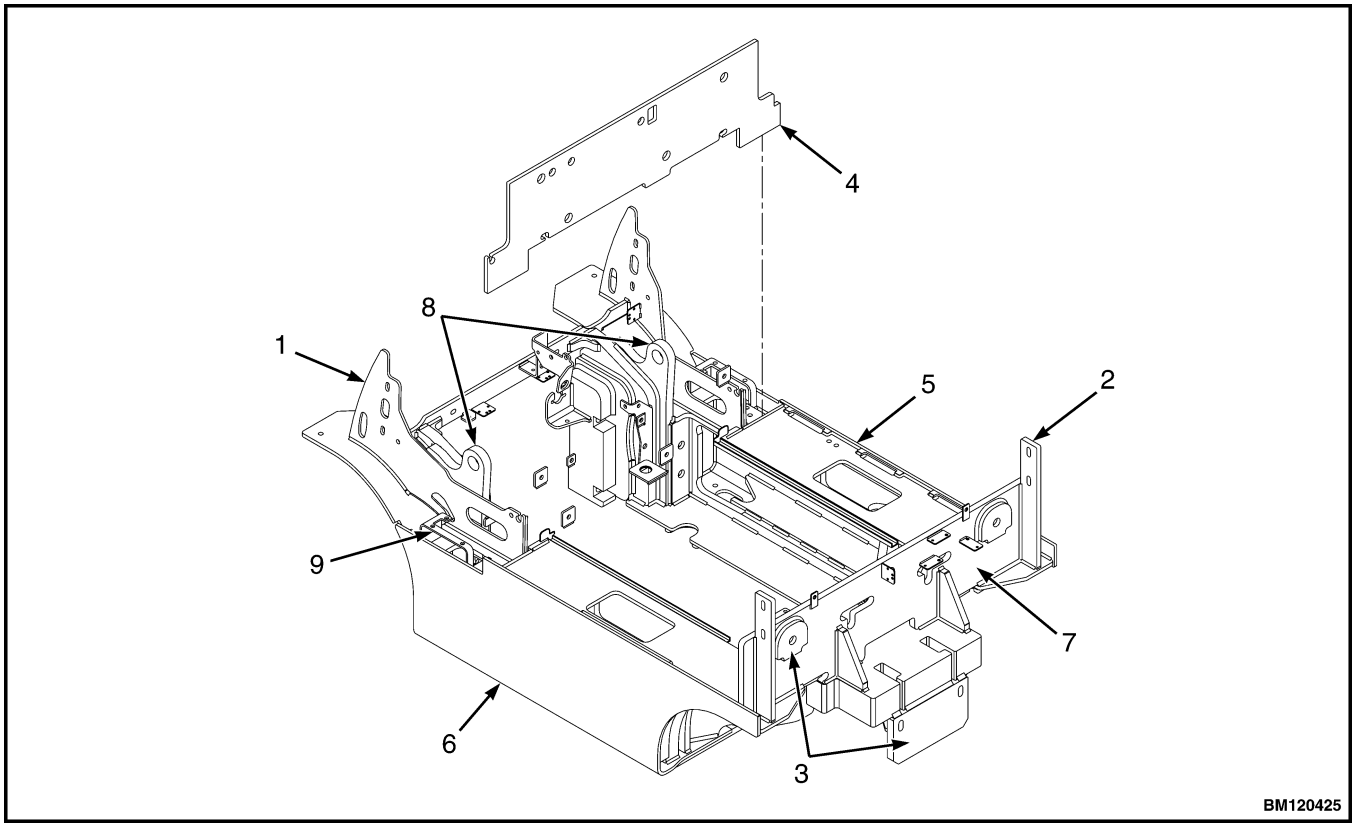
1. FRONT OVERHEAD GUARD MOUNTING BRACKET
2. OPERATOR MODULE PLATE
3. FRONT BULKHEAD
4. REAR BULKHEAD
5. COUNTERWEIGHT MOUNTING PLATE
6. LEFT FENDER
7. RIGHT FENDER
8. RIGHT FRAME CHANNEL
9. LEFT FRAME CHANNEL
10. TILT ANCHOR PLATE
11. DRIVE AXLE MOUNTS
12. SIDE STEP MOUNTING BRACKET

Figure 5. Frame Weldment for Lift Truck Without Side Battery RemovalJ4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)



1. FRONT OVERHEAD GUARD MOUNTING BRACKET
2. OPERATOR MODULE PLATE
3. FRONT BULKHEAD
4. REAR BULKHEAD
5. COUNTERWEIGHT MOUNTING PLATE
6. LEFT FENDER
7. RIGHT FENDER
8. RIGHT FRAME CHANNEL
9. LEFT FRAME CHANNEL
10. TILT ANCHOR PLATE
11. DRIVE AXLE MOUNTS
12. SIDE STEP MOUNTING BRACKET

Figure 6. Frame Weldment for Lift Truck With Side Battery RemovalJ4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)



1. FRONT OVERHEAD GUARD MOUNTING BRACKET
2. REAR OVERHEAD GUARD MOUNTING BRACKET
3. COUNTERWEIGHT MOUNTING PLATE
4. FRONT BULKHEAD
5. RIGHT FRAME CHANNEL
6. LEFT FRAME CHANNEL
7. REAR BULKHEAD
8. TILT ANCHOR PLATE
9. SIDE STEP MOUNTING BRACKET

Figure 7. Frame Weldment for Lift Trucks E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

The hydraulic and traction motor electronic controllers and contactors are located in the counterweight cavity for the following lift truck models

- E2.2-3.5XN (E45-70XN) (A268)
- E1.6-2.0XN (E30-40XN) (A269)
- E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

The hydraulic motor electronic controller and contactor are located in the counterweight cavity and the traction motor controller is attached to the front bulkhead for the following lift truck models

- J2.2-3.5XN (J45-70XN) (A276)
- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

NOTE: Lift truck models E2.2-3.5XN (E45-70XN) (A268) manufactured after June, 2012 are equipped with a removable floor plate that requires no tools to remove.

For all lift truck models covered in this **Service Manual**, the Vehicle Systems Manager (VSM) is either mounted on or near the front bulkhead underneath the floor mat and floor plate.

DISCHARGING THE CAPACITORS

WARNING

DO NOT make repairs or adjustments unless you have been properly trained and authorized to do so. Improper repairs and adjustments can create dangerous operating conditions. DO NOT operate a lift truck that needs repairs. Report the need for repairs to your supervisor immediately. If repair is necessary, attach a DO NOT OPERATE tag on the steering wheel and disconnect the battery.

Disconnect the battery and allow the capacitors to discharge before opening any compartment covers or inspecting or repairing the electrical system. DO NOT place tools on top of the battery. If a tool causes a short circuit, the high current flow from the battery can cause personal injury or property damage.

Some checks and adjustments are performed with the battery connected. DO NOT connect the battery until the procedure instructs you to do so. Never wear any metallic items on your fingers, arms, or neck. Metal items can accidentally make an electrical connection and cause injury.

Before performing any tests or adjustments, block the lift truck to prevent unexpected movement.

The capacitor in the transistor controller(s) can hold an electrical charge for about 10 seconds after the battery is disconnected. To prevent an electrical shock and personal injury, discharge the capacitor(s) before inspecting or repairing any component in the drive unit compartment. Make certain that the battery has been disconnected.

DO NOT short across the motor controller terminals with a screwdriver or jumper wire.

Make certain the Emergency-Disconnect switch has not been activated. This will isolate the controller and prevent the capacitors from discharging properly. The proper way to disconnect the battery is by separating the battery connectors.

1. Ensure the capacitors are discharged by performing Step 2 through Step 6 below.
2. Turn the key or keyless switch to the **OFF** position.
3. Disconnect the battery by separating the connectors.
4. Block the drive wheels to prevent the lift truck from moving.
5. Make sure the Emergency-Disconnect switch **HAS NOT** been activated. If the Emergency-Disconnect switch is activated, rotate the switch to the right until it pops up.
6. Press horn button. Wait 30 seconds to be sure capacitors are fully discharged.

RAPID CHARGE

All the lift trucks covered in this **Service Manual** may be equipped with an optional Basic Rapid Charge System. See Figure 8. Lift truck models J2.2-3.5XN (J45-70XN) (A276) and J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) may also be equipped with an optional Integrated (Quick Disconnect) Rapid Charge System. See Figure 9 or Figure 10.

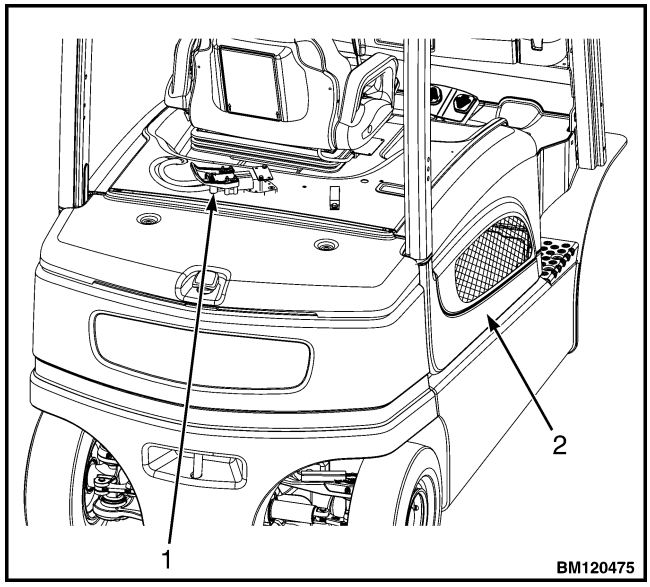
On lift trucks equipped with either Rapid Charge System, the battery is charged during operator breaks or when the lift truck is not being used. Both systems provide extended operation with a single battery. Connect or disconnect battery from the Rapid Charge System using the battery connectors.

Some of the features of the Basic Rapid Charge System include (see Figure 8):

- Battery connector externally mounted for easy access.
- Vented side covers for improved battery cooling.
- Requires rapid charge vented battery and sealed battery fan box with thermostat.

Some of the features of the Integrated (Quick Disconnect) Rapid Charge System include (see Figure 9 or Figure 10):

- Power cables from hood mounted connector are wired to the existing truck battery connections, eliminating the need to run cables from the battery to the top side of hood.
- The Integrated Rapid Charge System easily supports rapid, fast, and convenient charging.
- Cutouts in the battery compartment side panel are standard with the Integrated Rapid Charge System and help support vented tray batteries and batteries with side-mounted cooling fans.
- An interlock switch on the hood mounted connector housing door prevents truck from being operated during charging.

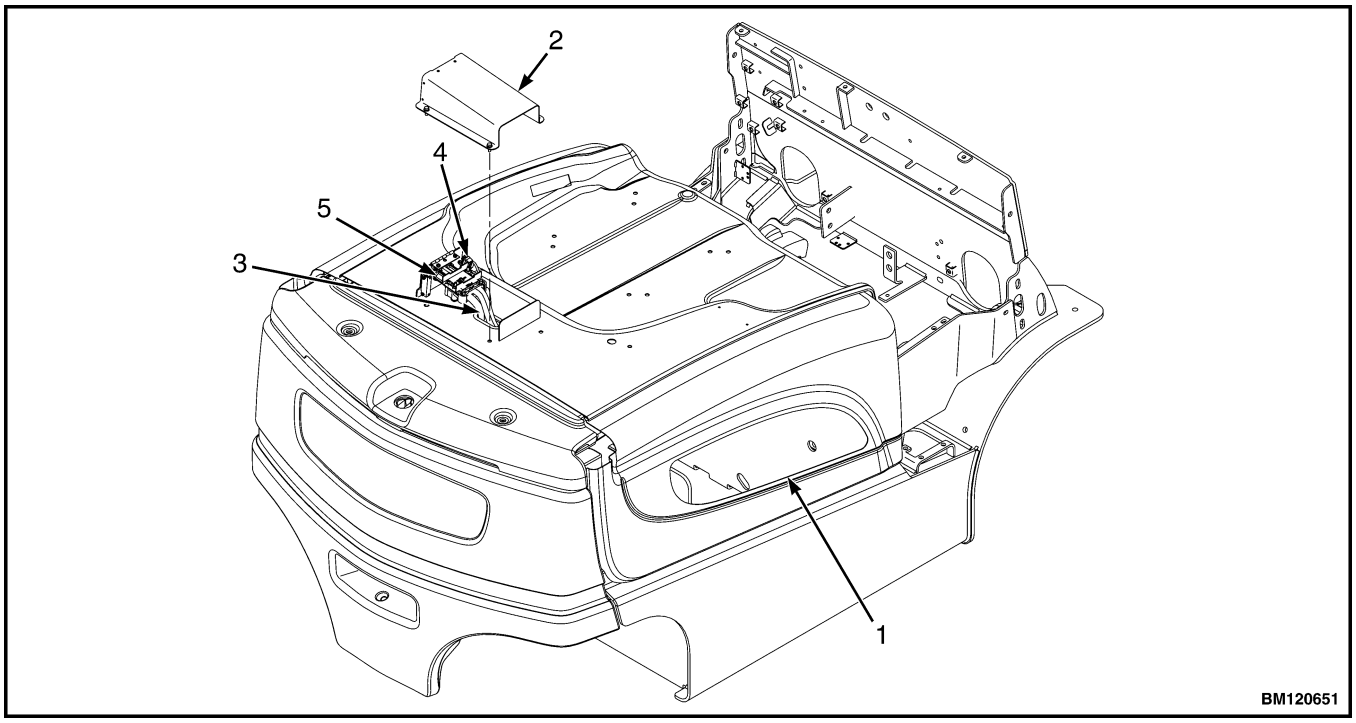


Legend for Figure 8.

NOTE: LIFT TRUCK MODELS J2.2-3.5XN (J45-70XN) (A276) SHOWN.

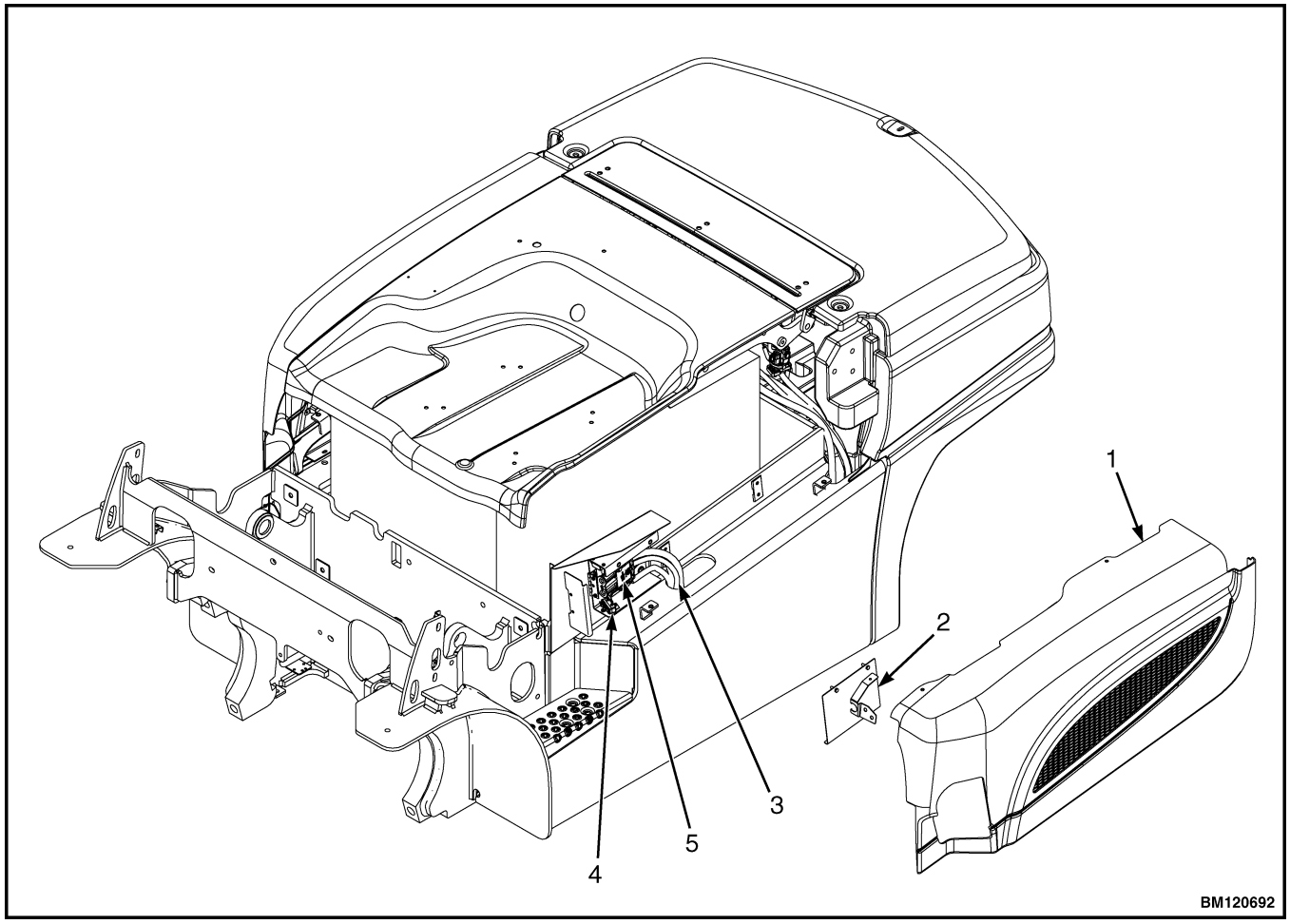
1. RAPID CHARGE CONNECTOR
2. VENTED SIDE COVER

Figure 8. Basic Rapid Charge System



1. SIDE PANEL CUTOUT
2. COVER
3. BATTERY CABLES
4. INTERLOCK SWITCH
5. BATTERY CONNECTOR

Figure 9. Integrated (Quick Connect) Rapid Charge System, Lift Truck Models J2.2-3.5XN (J45-70XN) (A276)



1. SIDE PANEL CUTOUT
2. COVER
3. BATTERY CABLES
4. INTERLOCK SWITCH
5. BATTERY CONNECTOR

Figure 10. Integrated (Quick Connect) Rapid Charge System, Lift Truck Models J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

GROUND TEST

NOTE: If the static discharge ground connection is not secured properly, it could lead to the possible failure of the traction motor and/or pump motor controller.

To ensure proper installation of seat assembly and associated bracketing, perform continuity test as described below:

1. Using an ohm meter, place a test lead at the armrest mounting bolt and another at the truck frame. The resistance needs to read 5 Ohms or less. See Figure 11.

2. If resistance is greater than 5 Ohms, double check installation of seat assembly, both ends of seat wiring harness, and wiring harness ground strap.

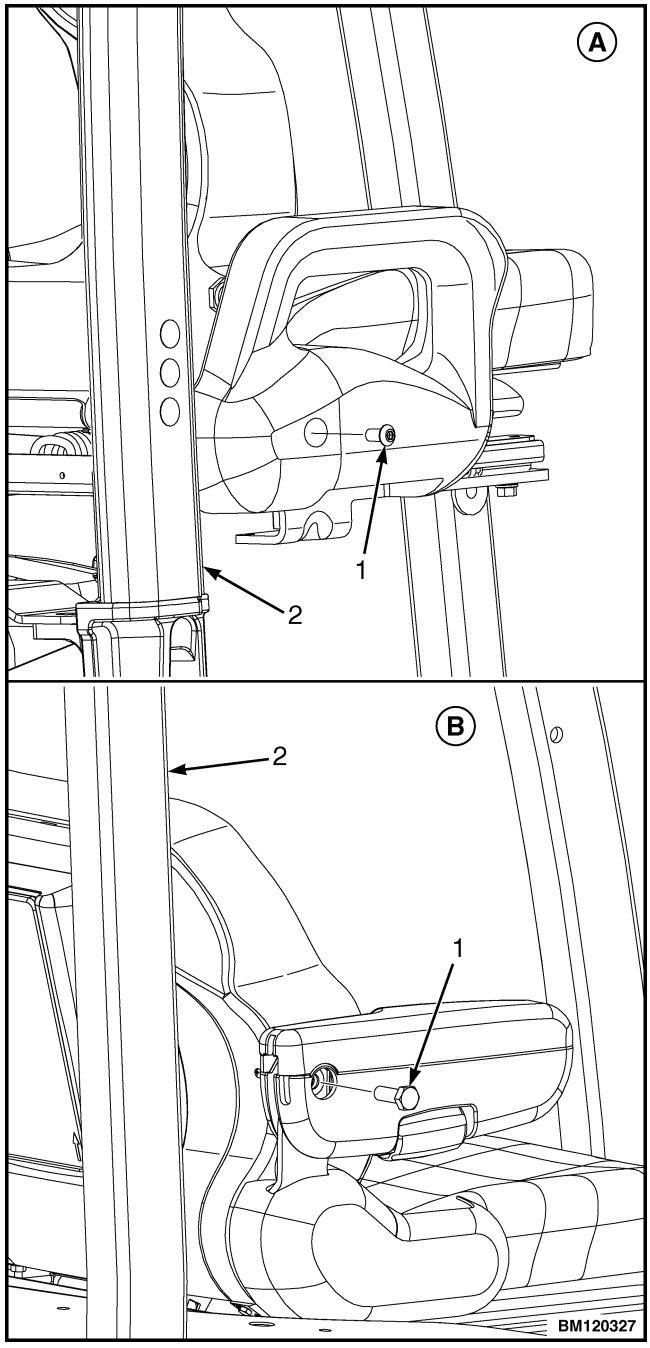


Figure 11. Ground Test

Legend for Figure 11.

A. ARMREST FOR LIFT TRUCK MODELS E45-70XN (A268), E30-40XN (A269), J45-70XN (A276), J80-120XN (A970), AND E80-120XN, E100XNS (A099)
B. ARMREST FOR LIFT TRUCK MODELS E2.2-3.5XN (A268), E1.6-2.0XN (A269), J2.2-3.5XN (A276), J4.0-5.0XN, J5.0-5.5XN6 (A970), AND E4.0-5.5XN, E5.0XNS (A099)

1. ARMREST BOLT
2. FRAME

Covers and Floor Plates

FOR LIFT TRUCK MODELS E2.2-3.5XN (E45-70XN) (A268)

Various covers and floor plates provide access to components during service and securely cover areas during normal operations.

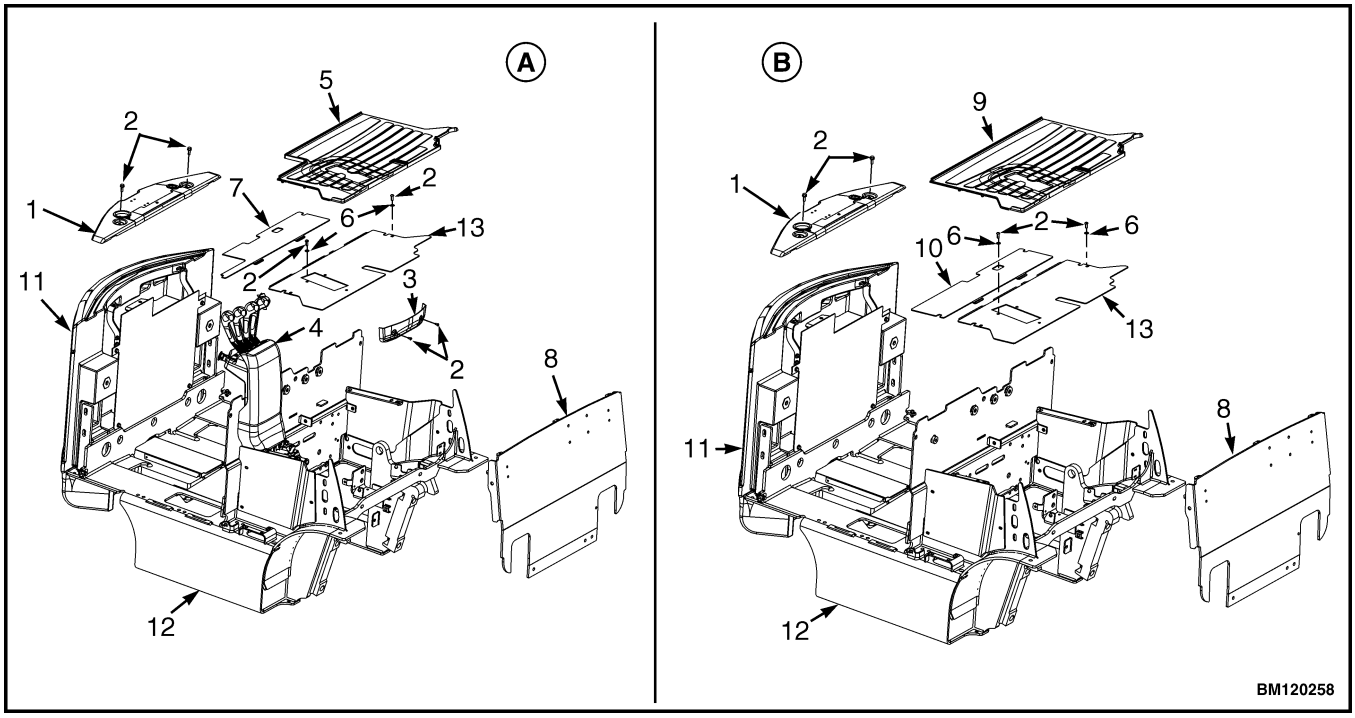
NOTE: Lift truck models E2.2-3.5XN (E45-70XN) (A268) manufactured after June, 2012 are equipped with a removable floor plate that requires no tools to remove.

1. Floor mat and floor plates in operator compartment allow access to traction motor, hydraulic pump and motor, service and parking brakes, and hydraulic control valve. The floor plate is fastened to the frame with capscrews and washers. The manual hydraulic floor plate and e-hydraulic floor plate hook onto the floor plate. See Figure 12.

2. Counterweight cover is attached to counterweight by two capscrews and allows access to electrical controllers. See Figure 12.

3. Manual hydraulic covers protect links during operation. For removal procedures for these covers see **Main Control Valves** 2000SRM1334. See Figure 12.

4. Hood latch cover is attached to bulkhead using two capscrews. See Figure 12.



A. MANUAL HYDRAULIC CONTROL LEVERS

1. COUNTERWEIGHT COVER
2. CAPSCREW
3. HOOD LATCH COVER*
4. MANUAL HYDRAULIC COVERS
5. MANUAL HYDRAULIC FLOOR MAT
6. WASHER
7. MANUAL HYDRAULIC FLOOR PLATE

B. E-HYDRAULIC CONTROL LEVERS

8. COWL
9. E-HYDRAULIC FLOOR MAT
10. E-HYDRAULIC FLOOR PLATE
11. COUNTERWEIGHT
12. FRAME
13. FLOOR PLATE

*Hood latch cover used on lift trucks equipped with either manual or E-Hydraulic control levers.

Figure 12. Covers and Floor Plates for Lift Truck Models E2.2-3.5XN (E45-70XN) (A268)

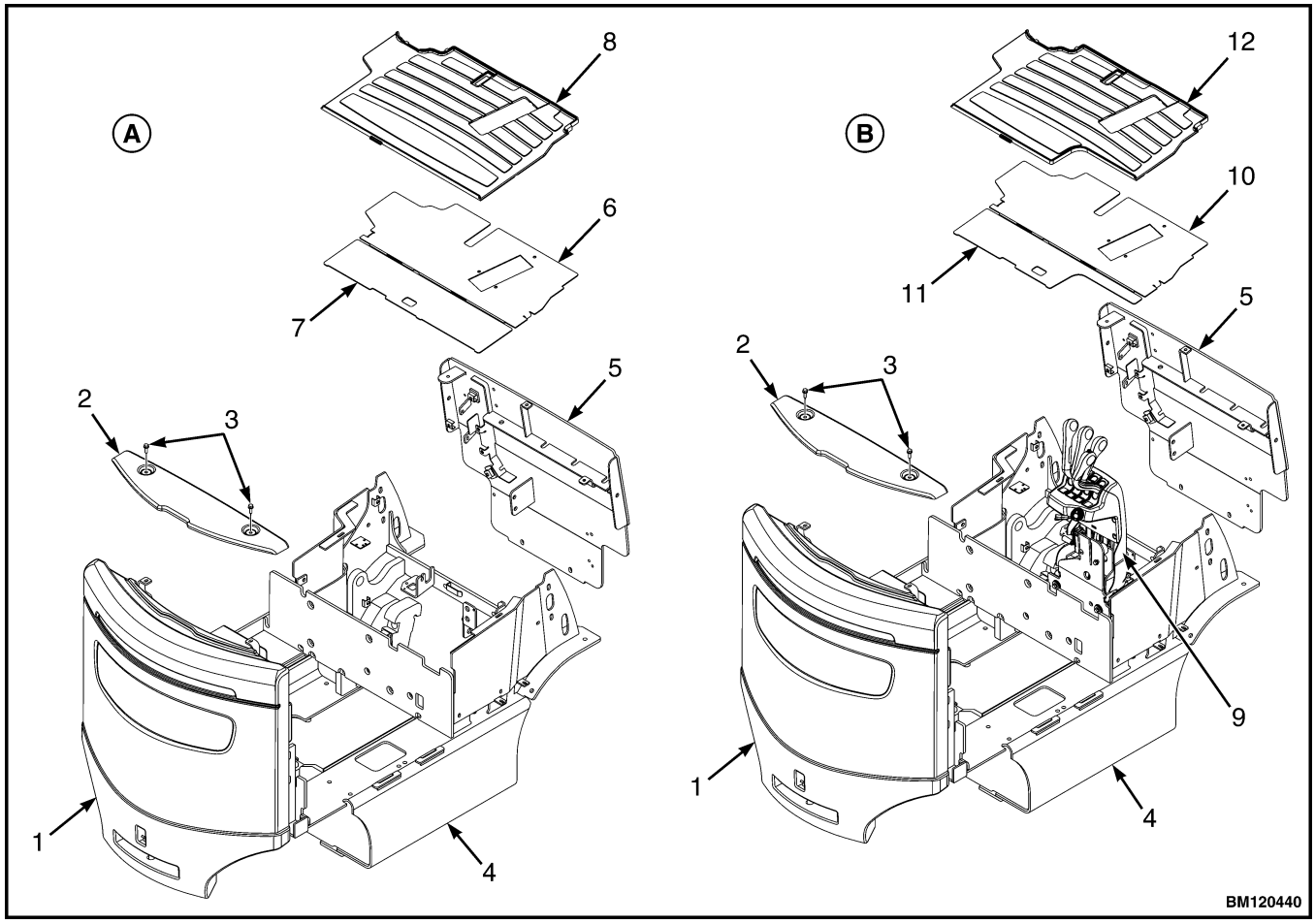
FOR LIFT TRUCK MODELS E1.6-2.0XN (E30-40XN) (A269)

Various covers and floor plates provide access to components during service and securely cover areas during normal operations.

1. Floor mat and floor plates in operator compartment allow access to traction motor, hydraulic pump and motor, service and parking brakes, and hydraulic control valve. The floor plate is fastened to the frame with capscrews and washers. The manual hydraulic floor plate and e-hydraulic floor plate hook onto the floor plate. See Figure 13.

2. Counterweight cover is attached to counterweight by two capscrews and allows access to electrical controllers. See Figure 13.

3. Manual hydraulic covers protect links during operation. For removal procedures for these covers see **Main Control Valves** 2000SRM1334. See Figure 13.



A. E-HYDRAULIC CONTROL LEVERS

B. MANUAL HYDRAULIC CONTROL LEVERS

1. COUNTERWEIGHT
2. COUNTERWEIGHT COVER
3. CAPSCREW
4. FRAME
5. COWL
6. E-HYDRAULIC FLOOR PLATE
7. E-HYDRAULIC FLOOR PLATE
8. E-HYDRAULIC FLOOR MAT
9. MANUAL HYDRAULIC COVERS
10. MANUAL HYDRAULIC FLOOR PLATE
11. MANUAL HYDRAULIC FLOOR PLATE
12. MANUAL HYDRAULIC FLOOR MAT

Figure 13. Covers and Floor Plates for Lift Truck Models E1.6-2.0XN (E30-40XN) (A269)

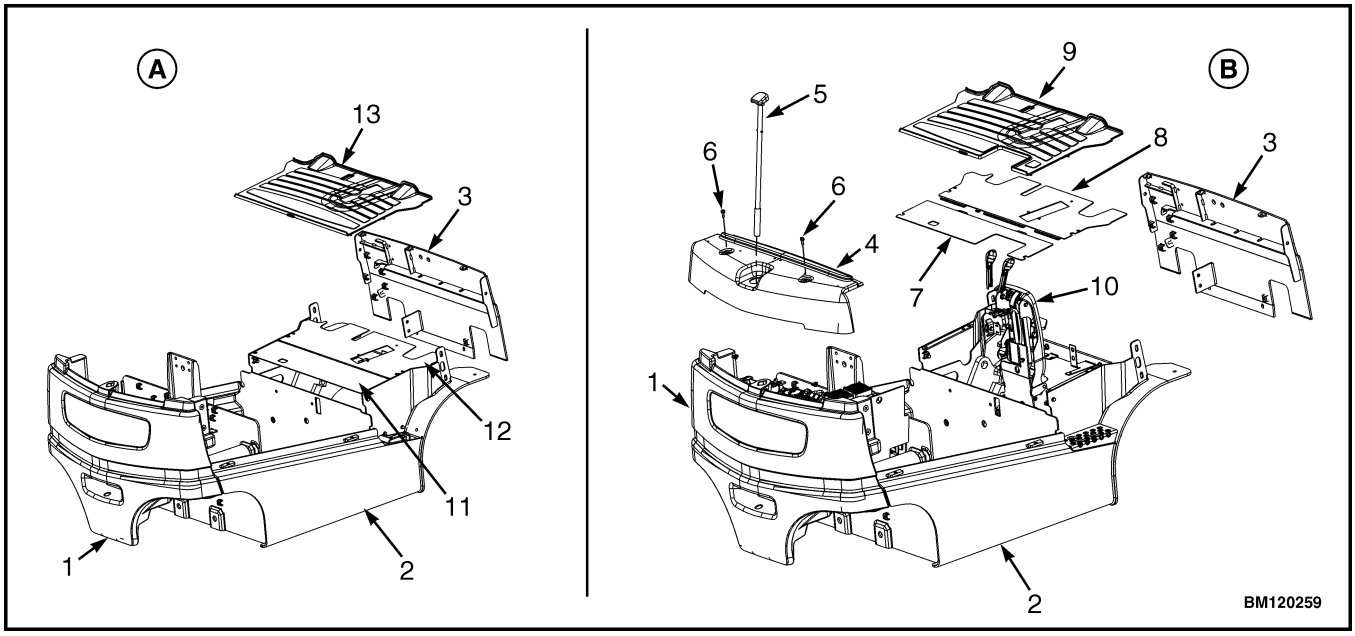
FOR LIFT TRUCK MODELS J2.2-3.5XN (J45-70XN) (A276)

Various covers and floor plates provide access to components during service and securely cover areas during normal operations.

1. Floor mat and floor plates in operator compartment allow access to service and parking brakes and hydraulic control valve. The floor plate is fastened to the frame with capscrews and washers. The manual hydraulic floor plate and e-hydraulic floor plate hook onto the floor plate. See Figure 14.

2. Counterweight cover is attached to counterweight by a tow pin and two capscrews. This cover allows access to electrical controllers, hydraulic pump and motor, and hydraulic tank. See Figure 14.

3. Manual hydraulic covers protect links during operation. For removal procedures for these covers see **Main Control Valves** 2000SRM1334. See Figure 14.



A. E-HYDRAULIC CONTROL LEVERS

1. COUNTERWEIGHT
2. FRAME
3. COWL
4. COUNTERWEIGHT COVER
5. TOW PIN
6. CAPSCREW
7. MANUAL HYDRAULIC FLOOR PLATE

B. MANUAL HYDRAULIC CONTROL LEVERS

8. MANUAL HYDRAULIC FLOOR PLATE
9. MANUAL HYDRAULIC FLOOR MAT
10. MANUAL HYDRAULIC COVERS
11. E-HYDRAULIC FLOOR PLATE
12. E-HYDRAULIC FLOOR PLATE
13. E-HYDRAULIC FLOOR MAT

Figure 14. Covers and Floor Plates for Lift Truck Models J2.2-3.5XN (J45-70XN) (A276)

FOR LIFT TRUCK MODELS J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

Various covers and floor plates provide access to components during service and securely cover areas during normal operations.

1. Floor mat and floor plates in operator compartment allow access to service brakes, hydraulic control valve, and traction motor electrical controller. The manual hydraulic floor plate and e-hydraulic floor plate hook onto the floor plate.

See Figure 15 for lift truck models

- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) manufactured before Nov, 2014

  See Figure 16 for lift truck models

- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) manufactured after Nov, 2014

  See Figure 17 for lift truck models

- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) equipped with optional side battery removal frame

2. Counterweight cover is attached to counterweight by three captive capscrews. This cover allows access to hydraulic pump electrical controller, hydraulic pump and motor, and hydraulic tank.

See Figure 15 for lift truck models

- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) manufactured before Nov, 2014

See Figure 16 for lift truck models

- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) manufactured after Nov, 2014

See Figure 17 for lift truck models

- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) equipped with optional side battery removal frame

3. Manual hydraulic covers protect links during operation. For removal procedures for these covers see **Main Control Valves** 2000SRM1334.

See Figure 15 for lift truck models

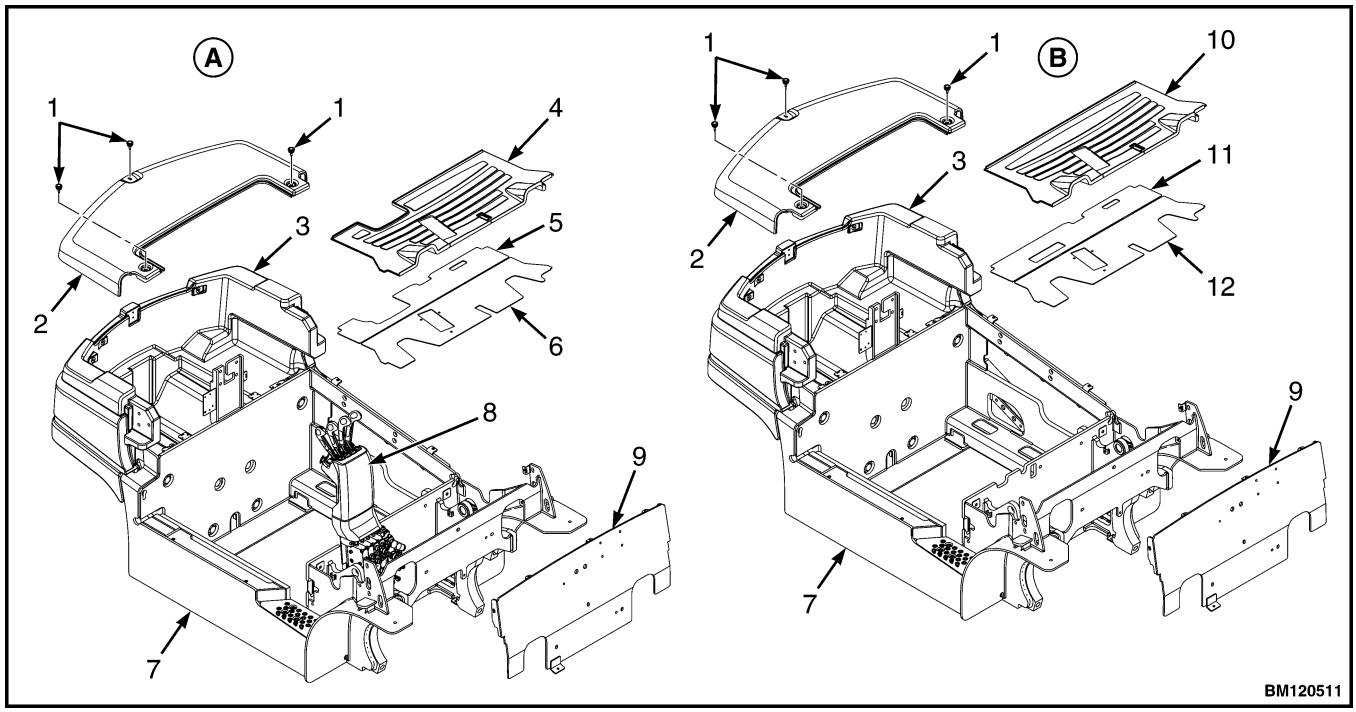
- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) manufactured before Nov, 2014

See Figure 16 for lift truck models

- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) manufactured after Nov, 2014

See Figure 17 for lift truck models

- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) equipped with optional side battery removal frame



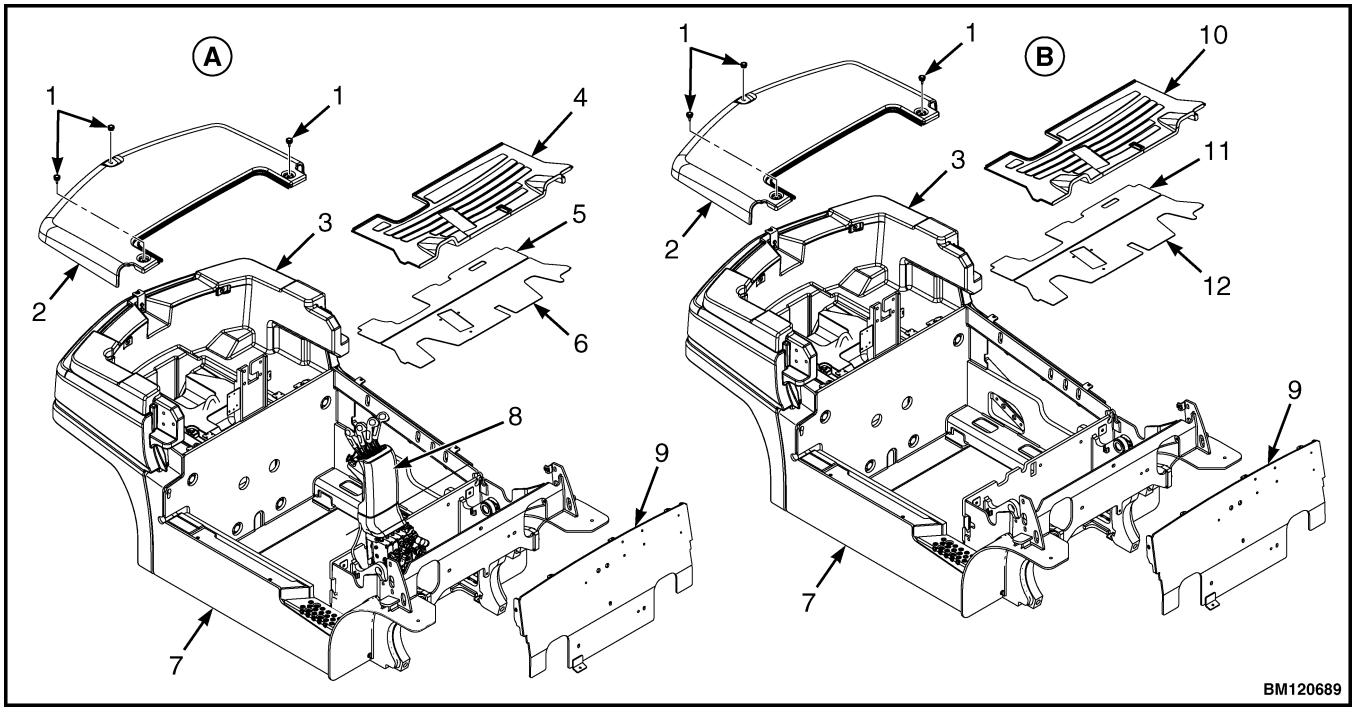
A. MANUAL HYDRAULIC CONTROL LEVERS

1. CAPTIVE CAPSCREW
2. COUNTERWEIGHT COVER
3. COUNTERWEIGHT
4. MANUAL HYDRAULIC FLOOR MAT
5. MANUAL HYDRAULIC FLOOR PLATE
6. MANUAL HYDRAULIC FLOOR PLATE

B. E-HYDRAULIC CONTROL LEVERS

7. FRAME
8. MANUAL HYDRAULIC COVERS
9. COWL
10. E-HYDRAULIC FLOOR MAT
11. E-HYDRAULIC FLOOR PLATE
12. E-HYDRAULIC FLOOR PLATE

Figure 15. Covers and Floor Plates for Lift Truck Models Manufactured Before Nov, 2014J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)



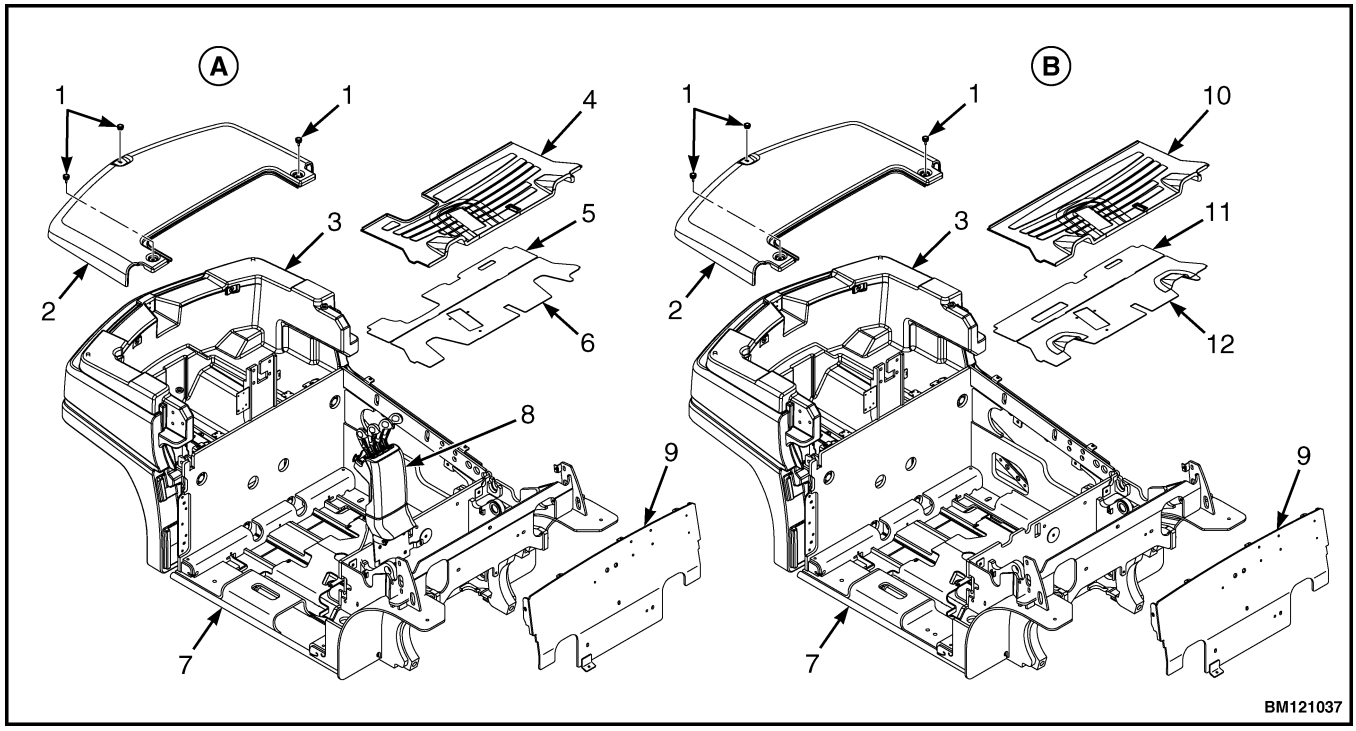
A. MANUAL HYDRAULIC CONTROL LEVERS

1. CAPTIVE CAPSCREW
2. COUNTERWEIGHT COVER
3. COUNTERWEIGHT
4. MANUAL HYDRAULIC FLOOR MAT
5. MANUAL HYDRAULIC FLOOR PLATE
6. MANUAL HYDRAULIC FLOOR PLATE

B. E-HYDRAULIC CONTROL LEVERS

7. FRAME
8. MANUAL HYDRAULIC COVERS
9. COWL
10. E-HYDRAULIC FLOOR MAT
11. E-HYDRAULIC FLOOR PLATE
12. E-HYDRAULIC FLOOR PLATE

Figure 16. Covers and Floor Plates for Lift Truck Models Manufactured After Nov, 2014J4.0-5.5XN (J80-120XN) (A970)



A. MANUAL HYDRAULIC CONTROL LEVERS

B. E-HYDRAULIC CONTROL LEVERS

1. CAPTIVE CAPSCREW
2. COUNTERWEIGHT COVER
3. COUNTERWEIGHT
4. MANUAL HYDRAULIC FLOOR MAT
5. MANUAL HYDRAULIC FLOOR PLATE
6. MANUAL HYDRAULIC FLOOR PLATE
7. FRAME
8. MANUAL HYDRAULIC COVERS
9. COWL
10. E-HYDRAULIC FLOOR MAT
11. E-HYDRAULIC FLOOR PLATE
12. E-HYDRAULIC FLOOR PLATE

Figure 17. Covers and Floor Plates for Lift Truck Models Equipped With Side Battery Removal OptionJ4.0-5.5XN (J80-120XN) (A970)

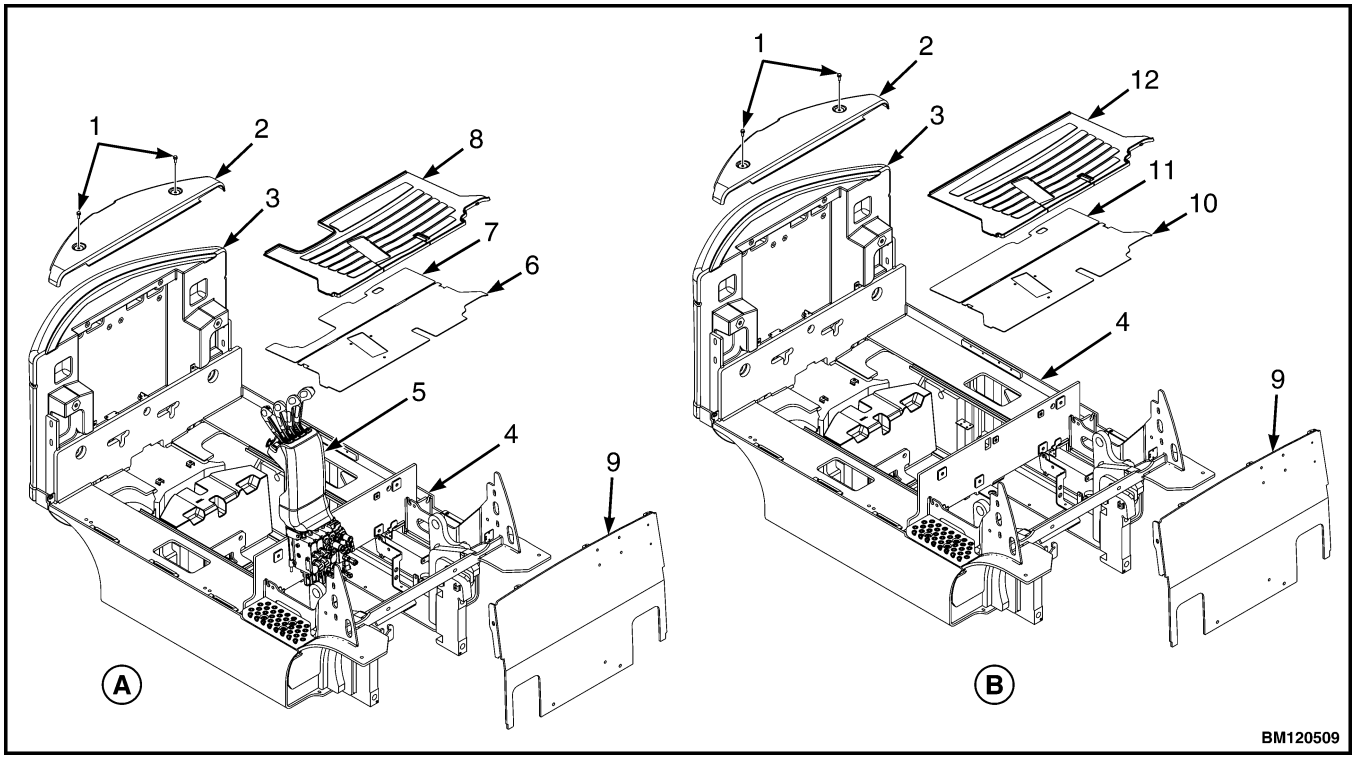
FOR LIFT TRUCK MODELS E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

Various covers and floor plates provide access to components during service and securely cover areas during normal operations.

1. Floor mat and floor plates in operator compartment allow access to traction motor, hydraulic pump and motor, service brakes, and hydraulic control valve. The manual hydraulic floor plate and e-hydraulic floor plate hook onto floor plate. See Figure 18.

2. Counterweight cover is attached to counterweight by two capscrews and allow access to electrical controllers. See Figure 18.

3. Manual hydraulic covers protect links during operation. For removal procedures for these covers see **Main Control Valves** 2000SRM1334. See Figure 18.



A. MANUAL HYDRAULIC CONTROL LEVERS

1. CAPSCREW
2. COUNTERWEIGHT COVER
3. COUNTERWEIGHT
4. FRAME
5. MANUAL HYDRAULIC COVERS
6. MANUAL HYDRAULIC FLOOR PLATE

B. E-HYDRAULIC CONTROL LEVERS

7. MANUAL HYDRAULIC FLOOR PLATE
8. MANUAL HYDRAULIC FLOOR MAT
9. COWL
10. E-HYDRAULIC FLOOR PLATE
11. E-HYDRAULIC FLOOR PLATE
12. E-HYDRAULIC FLOOR MAT

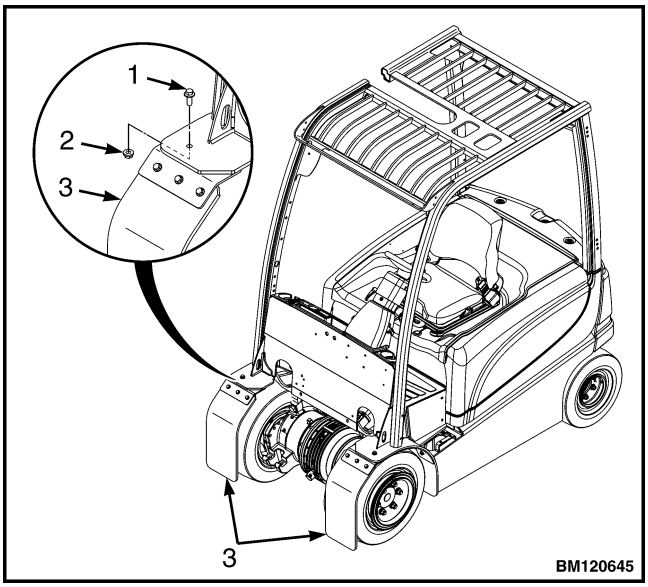
Figure 18. Covers and Floor Plates for Lift Truck Models E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

MUD GUARDS

Lift truck models equipped with mud guards will have mud guards attached to front fender extensions and suspended between drive wheels and carriage. The mud guards are not serviceable and should be replaced if damaged or no longer providing shielding from debris.

1. Set parking brake and turn key or keyless switch to **OFF** position.

2. Remove capscrew and nut from lift truck frame and fender extension. Discard mud guard. See Figure 19.



NOTE: STANDARD TREAD MUD GUARD SHOWN. WIDE TREAD MUD GUARD IS SIMILAR.

1. CAPSCREW
2. NUT
3. MUD GUARD

Figure 19. Mud Guards

3. Install new mud guard, capscrew, and nut into fender extension and frame. Tighten capscrew to 66 N•m (49 lbf ft).

Overhead Guard Replacement

REMOVE

For Lift Trucks E2.2-3.5XN (E45-70XN) (A268), E1.6-2.0XN (E30-40XN) (A269), and E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

WARNING

DO NOT operate lift truck without overhead guard correctly fastened to the lift truck frame.

WARNING

DO NOT weld, drill, grind, or cut the overhead guard for mounts of lights or accessories. The strength of the overhead guard can be reduced.

WARNING

PUTTING THE LIFT TRUCK ON BLOCKS

The lift truck must be put on blocks for some types of maintenance and repair. The removal of the mast, drive axle, battery, or counterweight assemblies will cause large changes in the center of gravity. When the lift truck is put on blocks, put additional blocks in the following positions:

> **If the mast and drive axle are removed, put blocks under the counterweight so the lift truck cannot fall backward.**
>
> **If the counterweight is removed, put blocks under the mast so that the lift truck cannot fall forward.**

Put the lift truck on blocks on a solid, even, and level surface. Verify the blocks or stands have enough capacity to hold the lift truck. Use additional blocks next to the tires as necessary to prevent movement of the lift truck.

Verify the lifting devices used during repairs can lift the weight of the parts and assemblies.

See the Operating Manual or one of the following service manuals for the procedure to put the lift truck on blocks.

See Periodic Maintenance 8000SRM1364 **for lift truck models**

- **E2.2-3.5XN (E45-70XN) (A268)**

See Periodic Maintenance 8000SRM1442 **for lift truck models**

- **E1.6-2.0XN (E30-40XN) (A269)**

See Periodic Maintenance 8000SRM1577 **for lift truck models**

- **E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)**

1. Remove battery from lift truck. See **How to Change Battery** in the **Operating Manual** or **Periodic Maintenance** manual above for procedures.

2. Remove hood and seat assembly from lift truck. See section **Hood and Seat Assembly Repair**, Remove for procedures.

3. Access to rear capscrews is from the battery compartment. Remove rear capscrews from rear overhead guard legs and plates.

   See Figure 20 for lift truck models

   - E2.2-3.5XN (E45-70XN) (A268)
   - E1.6-2.0XN (E30-40XN) (A269)

   See Figure 21 for lift truck models

   - E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

4. Remove front capscrews from front overhead guard legs and from the right and left plates.

   See Figure 20 for lift truck models

   - E2.2-3.5XN (E45-70XN) (A268)
   - E1.6-2.0XN (E30-40XN) (A269)

   See Figure 21 for lift truck models

   - E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

NOTE: Note routing of electrical wires prior to disconnecting.

NOTE: Tag electrical connectors during removal to aid in installation.

5. Tag and disconnect electrical wires that go through the legs of overhead guard.

NOTE: When overhead guard is lifted from frame assembly, make sure electrical wires move through holes in frame at the front and rear so that they are not damaged.

NOTE: On lift truck models E45-70XN (A268) and E30-40XN (A269) equipped with inboard tail lights, the rear lights are mounted inboard of the overhead guard, reducing the risk of damage to the lights. A protection shield above the lights also provides protection from above. The overhead guard will include mounting features for both inboard and outboard lights.

6. Using a lifting device, remove overhead guard from frame assembly.

See Figure 20 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268)
- E1.6-2.0XN (E30-40XN) (A269)

See Figure 21 for lift truck models

- E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

7. Remove capscrews and handle from overhead guard.

See Figure 20 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268)
- E1.6-2.0XN (E30-40XN) (A269)

See Figure 21 for lift truck models

- E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

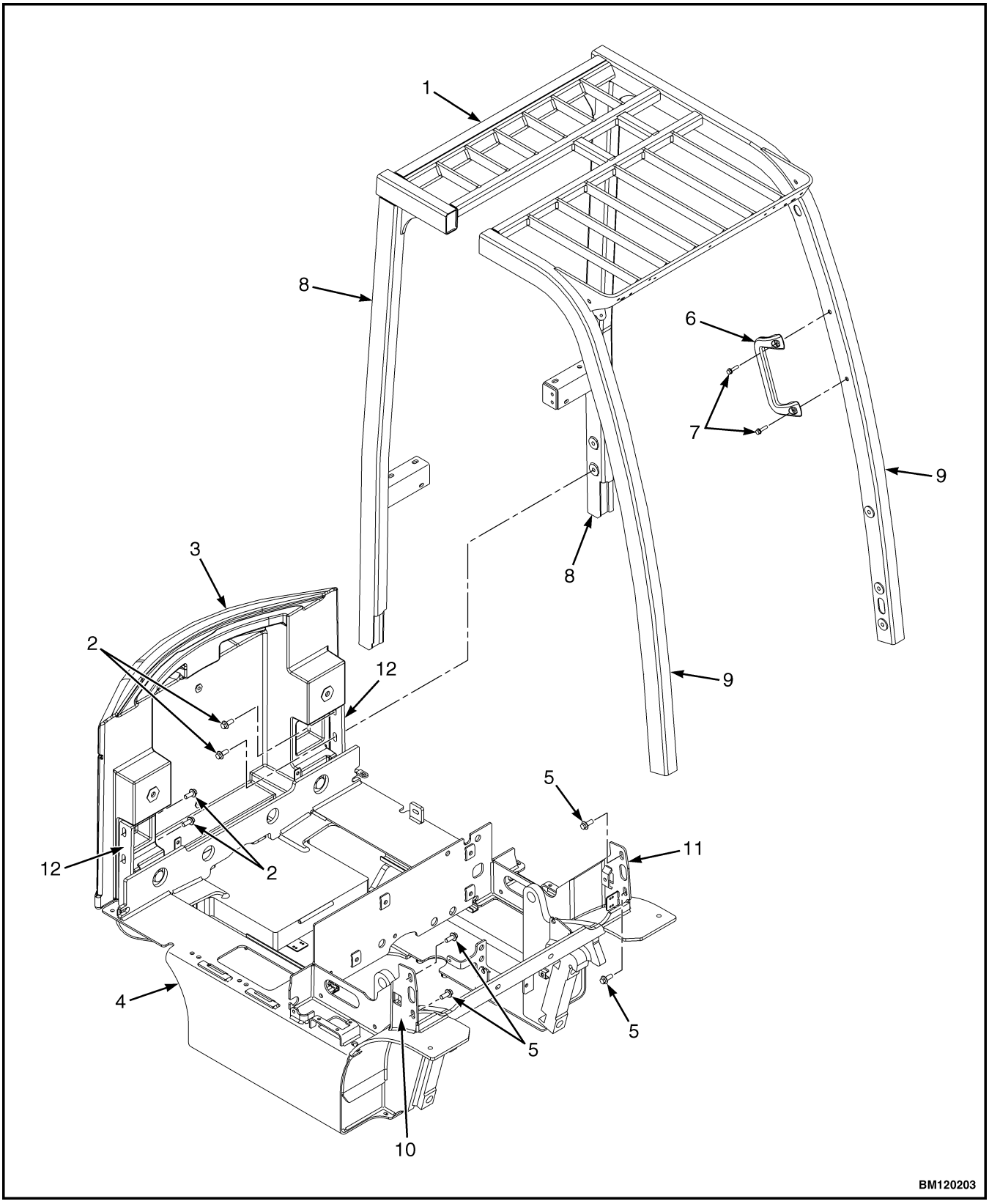


Figure 20. Overhead Guard and Counterweight for Lift Truck E2.2-3.5XN (E45-70XN) (A268) and E1.6-2.0XN (E30-40XN) (A269)

Legend for Figure 20.

1. OVERHEAD GUARD
2. REAR CAPSCREW
3. COUNTERWEIGHT
4. FRAME ASSEMBLY
5. FRONT CAPSCREW
6. HANDLE
7. CAPSCREW
8. REAR OVERHEAD GUARD LEG
9. FRONT OVERHEAD GUARD LEG
10. RIGHT PLATE
11. LEFT PLATE
12. PLATE

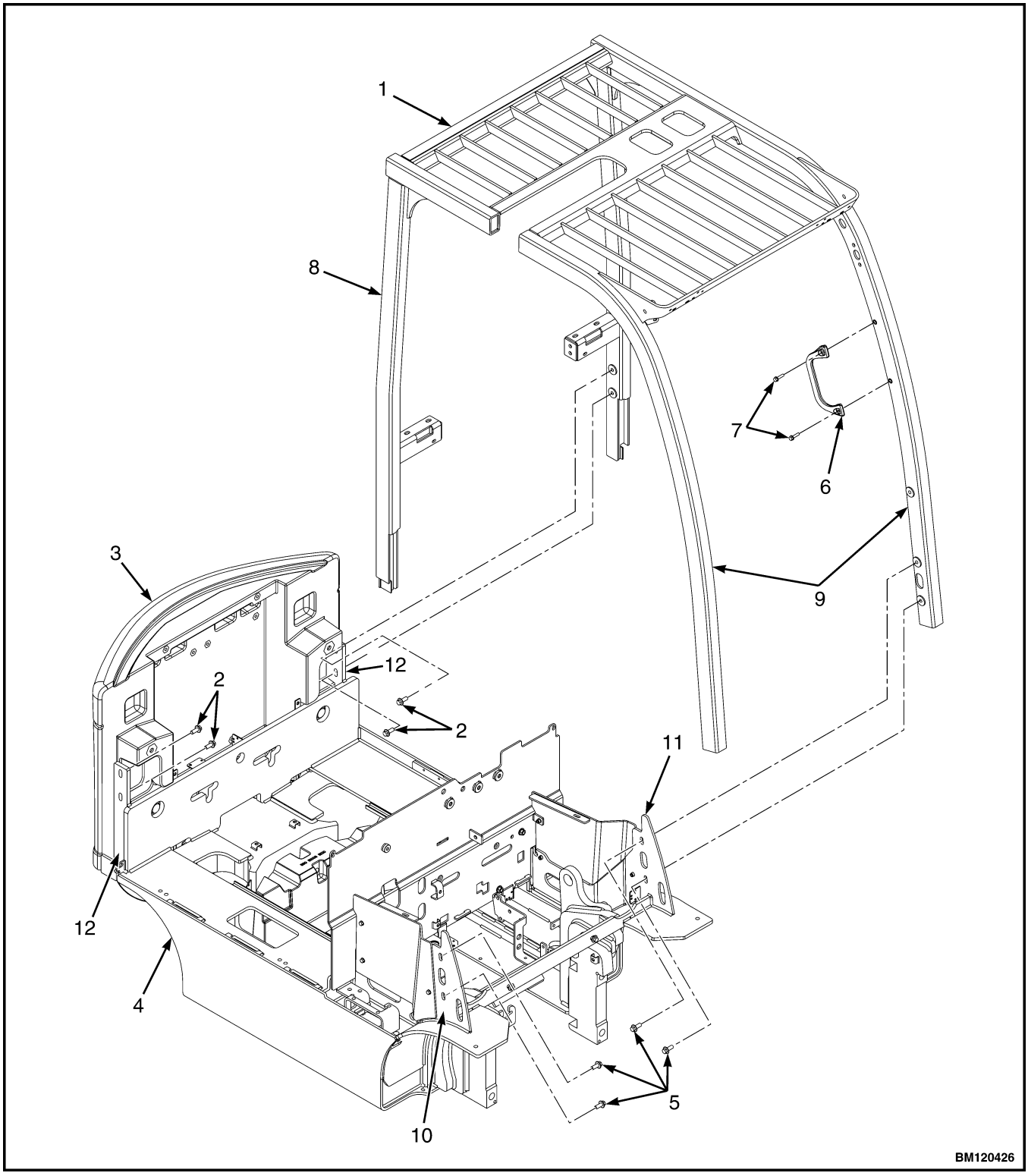


Figure 21. Overhead Guard and Counterweight for Lift Trucks E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

Legend for Figure 21.

1. OVERHEAD GUARD
2. REAR CAPSCREW
3. COUNTERWEIGHT
4. FRAME ASSEMBLY
5. FRONT CAPSCREW
6. HANDLE
7. CAPSCREW
8. REAR OVERHEAD GUARD LEG
9. FRONT OVERHEAD GUARD LEG
10. RIGHT PLATE
11. LEFT PLATE
12. PLATE

For Lift Truck Models J2.2-3.5XN (J45-70XN) (A276)

WARNING

DO NOT operate lift truck without overhead guard correctly fastened to the lift truck frame.

WARNING

DO NOT weld, drill, grind, or cut the overhead guard for mounts of lights or accessories. The strength of the overhead guard can be reduced.

WARNING

PUTTING THE LIFT TRUCK ON BLOCKS

The lift truck must be put on blocks for some types of maintenance and repair. The removal of the mast, drive axle, battery, or counterweight assemblies will cause large changes in the center of gravity. When the lift truck is put on blocks, put additional blocks in the following positions:

> **If the mast and drive axle are removed, put blocks under the counterweight so the lift truck cannot fall backward.**
>
> **If the counterweight is removed, put blocks under the mast so that the lift truck cannot fall forward.**

Put the lift truck on blocks on a solid, even, and level surface. Verify the blocks or stands have enough capacity to hold the lift truck. Use additional blocks next to the tires as necessary to prevent movement of the lift truck.

Verify the lifting devices used during repairs can lift the weight of the parts and assemblies.

See the Operating Manual or Periodic Maintenance 8000SRM1372**, for procedure to put lift truck on blocks.**

1. Remove tow pin, capscrews, washers, and counterweight cover from counterweight. See Figure 22.
2. Remove rear capscrews from rear overhead guard legs and counterweight. See Figure 22. Remove shims if present. See Figure 24.
3. Remove nuts and capscrews from hood crossmember and rear overhead guards legs. See Figure 22.
4. Remove capscrews and hose cover from cowl to allow access to front capscrews on left overhead guard leg. See Figure 22.
5. Remove color-coated screws and overhead guard leg covers from front overhead guard legs. See Figure 22.
6. Remove front capscrews from front overhead guard legs and cowl. See Figure 22.

NOTE: Note routing of electrical wires prior to disconnecting.

7. Tag and disconnect electrical wires that go through the legs of overhead guard.

NOTE: When overhead guard is lifted from fame, make sure electrical wires move through the holes in the frame at the front and rear so they are not damaged.

8. Using a lifting device, remove overhead guard from frame. See Figure 22.
9. Remove capscrews and handle from overhead guard. See Figure 22.

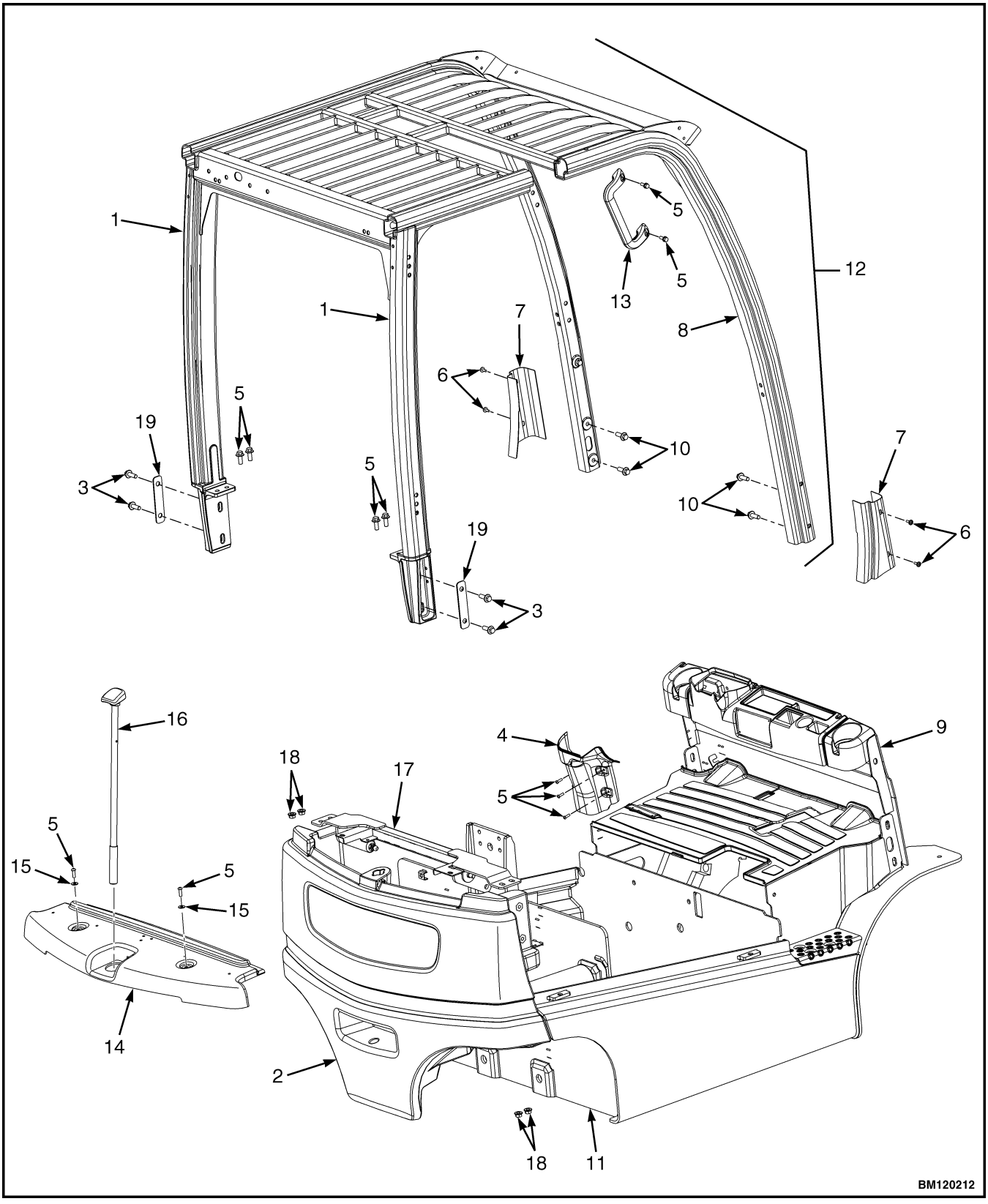


Figure 22. Overhead Guard for Lift Truck J2.2-3.5XN (J45-70XN) (A276)

Legend for Figure 22.

NOTE: LIFT TRUCK MANUFACTURED PRIOR TO NOVEMBER 2015 SHOWN, LIFT TRUCK MANUFACTURED AFTER NOVEMBER 2015 SIMILAR.

1. REAR OVERHEAD GUARD LEG
2. COUNTERWEIGHT
3. REAR CAPSCREW
4. HOSE COVER
5. CAPSCREW
6. COLOR-COATED SCREW
7. OVERHEAD GUARD LEG COVER
8. FRONT OVERHEAD GUARD LEG
9. COWL
10. FRONT CAPSCREW
11. FRAME
12. OVERHEAD GUARD
13. HANDLE
14. COUNTERWEIGHT COVER
15. WASHER
16. TOW PIN
17. HOOD CROSSMEMBER
18. NUT
19. OVERHEAD GUARD MOUNTING PLATE

For Lift Truck Models J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

WARNING

DO NOT operate lift truck without overhead guard correctly fastened to the lift truck frame.

WARNING

DO NOT weld, drill, grind, or cut the overhead guard for mounts for lights or accessories. The strength of the overhead guard can be reduced.

WARNING

PUTTING THE LIFT TRUCK ON BLOCKS

The lift truck must be put on blocks for some types of maintenance and repair. The removal of the mast, drive axle, battery, or counterweight assemblies will cause large changes in the center of gravity. When the lift truck is put on blocks, put additional blocks in the following positions:

If the mast and drive axle are removed, put blocks under the counterweight so the lift truck cannot fall backward.

If the counterweight is removed, put blocks under the mast so that the lift truck cannot fall forward.

Put the lift truck on blocks on a solid, even, and level surface. Verify the blocks or stands have enough capacity to hold the lift truck. Use additional blocks next to the tires as necessary to prevent movement of the lift truck.

Verify the lifting devices used during repairs can lift the weight of the parts and assemblies.

See the Operating Manual or Periodic Maintenance 8000SRM1541 **for procedure to put lift truck on blocks.**

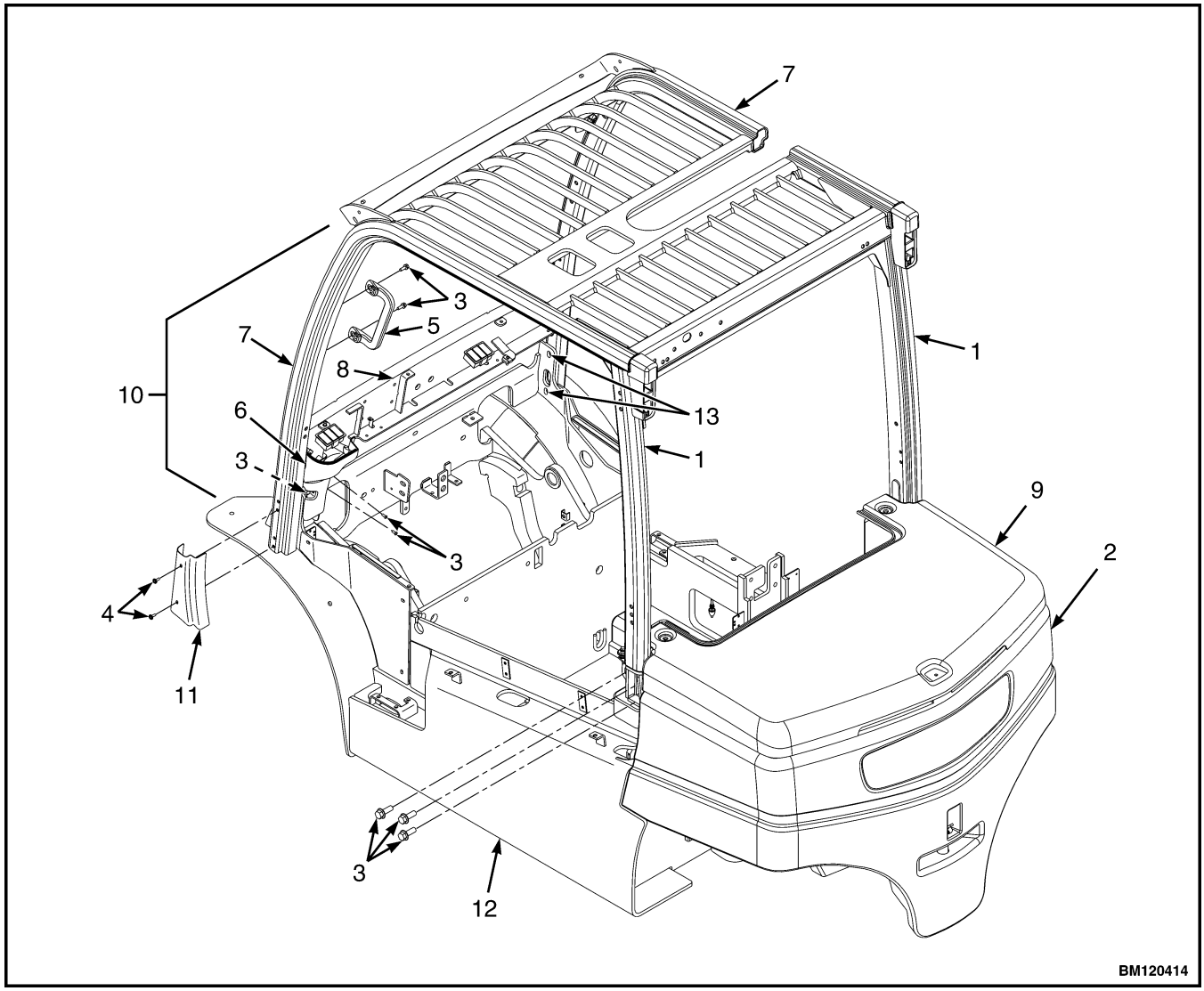
1. Remove three rear capscrews from each rear overhead guard legs and counterweight. See Figure 23.
2. Remove capscrews and hose cover from cowl to allow access to front capscrews on left overhead guard leg. See Figure 23.
3. Remove color-coated screws and overhead guard leg covers from front overhead guard legs. See Figure 23.
4. Remove front capscrews from front overhead guard legs and cowl. See Figure 23.

NOTE: Note routing of electrical wires prior to disconnecting.

5. Tag and disconnect electrical wires that go through the legs of overhead guard.

NOTE: When overhead guard is lifted from fame, make sure electrical wires move through the holes in the frame at the front and rear so they are not damaged.

6. Using a lifting device, remove overhead guard from frame. See Figure 23.
7. Remove capscrews and handle from overhead guard. See Figure 23.



1. REAR OVERHEAD GUARD LEG
2. COUNTERWEIGHT
3. CAPSCREW
4. COLOR-COATED SCREW
5. HANDLE
6. HOSE COVER
7. FRONT OVERHEAD GUARD LEG
8. COWL
9. COUNTERWEIGHT COVER
10. OVERHEAD GUARD
11. OVERHEAD GUARD LEG COVER
12. FRAME
13. FRONT CAPSCREW

Figure 23. Overhead Guard for Lift Truck J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

INSTALL

For Lift Trucks E2.2-3.5XN (E45-70XN) (A268), E1.6-2.0XN (E30-40XN) (A269), and E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

NOTE: Make sure electrical wires are routed as noted during removal to assure that wires do not get pinched.

1. Using a lifting device, install overhead guard onto frame assembly.
2. Connect electrical wires, as tagged during removal.
3. Install front capscrews into front overhead guard legs and the right and left plates. Tighten front capscrews to 66 N•m (49 lbf ft).

   See Figure 20 for lift truck models

   - E2.2-3.5XN (E45-70XN) (A268)
   - E1.6-2.0XN (E30-40XN) (A269)

   See Figure 21 for lift truck models

   - E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)
4. Install rear capscrews into rear overhead guard legs and plates. Tighten rear capscrews to 66 N•m (49 lbf ft).

   See Figure 20 for lift truck models

   - E2.2-3.5XN (E45-70XN) (A268)
   - E1.6-2.0XN (E30-40XN) (A269)

   See Figure 21 for lift truck models

   - E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)
5. Install hood and seat assembly onto lift truck. See section **Hood and Seat Assembly Repair**, Install for procedures.
6. Install battery into lift truck. See **How to Change Battery** in the **Operating Manual** or **Periodic Maintenance** manual for your lift truck.
7. Install handle and capscrews on overhead guard. Tighten capscrews to 25.2 N•m (18.5 lbf ft).

For Lift Truck Models J2.2-3.5XN (J45-70XN) (A276)

NOTE: Make sure electrical wires are routed as noted during removal to assure wires do not get pinched.

1. Using a lifting device, install overhead guard onto frame. See Figure 22.
2. Connect electrical wires, as tagged during removal.
3. Install front capscrews into front overhead guard legs and cowl. Tighten front capscrews to 66 N•m (49 lbf ft). See Figure 22.
4. Install overhead guard leg covers and color-coated screws onto front overhead guard legs. 66 N•m (49 lbf ft)See Figure 22.
5. Install hose cover and capscrews onto cowl. See Figure 22.
6. Install capscrews and nuts on rear overhead guard legs and hood crossmember. See Figure 22.
7. Install rear capscrews into rear overhead guard legs and counterweight. Tighten rear capscrews to 66 N•m (49 lbf ft). See Figure 22.

NOTE: If lift truck is equipped with optional horizontal battery removal feature, perform Step 8. If lift truck does not have optional horizontal battery removal feature, proceed to Step 9.

NOTE: The procedure in Step 8 is for left rear overhead guard leg.

8. Check and install shims as follows:

   a. Use a feeler gauge and check the gap between the rear overhead guard leg mount and the mating surface of the counterweight. See Figure 24.

   b. Insert feeler gauge between counterweight mating surface and rear overhead guard leg mating surface and in the center of the rear capscrews. See Figure 24.

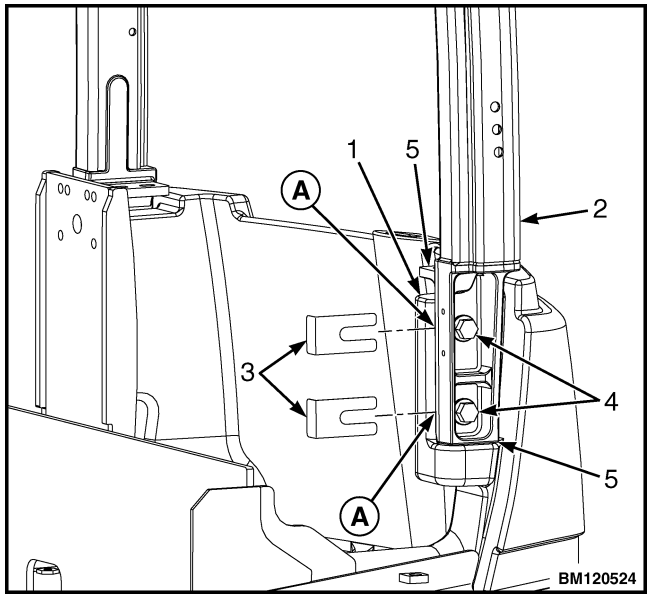


Figure 24. Measuring Gap and Installing Shims

Legend for Figure 24.

NOTE: LEFT SIDE SHOWN. SAME PROCEDURES APPLY TO RIGHT SIDE.

A. INSERT FEELER GAUGE HERE - AT CENTER OF CAPSCREW

1. COUNTERWEIGHT MATING SURFACE
2. REAR OVERHEAD GUARD LEG
3. SHIMS
4. REAR CAPSCREW
5. REAR OVERHEAD GUARD LEG MOUNTING SURFACE

c. If a gap exists, loosen rear overhead guard leg rear capscrews on both sides and install correct number and thickness of shims as shown in Table 1.

Table 1. Shim Selection

Gap Width At Capscrew	**Quantity and Shim Thickness** 0.5 mm (0.019 in.)	**Quantity and Shim Thickness** 1.0 mm (0.039 in.)
0.10 to 0.50 mm (0.004 to 0.019 in.)	1	0
0.51 to 1.00 mm (0.020 to 0.039 in.)	0	1
1.01 to 1.50 mm (0.040 to 0.059 in.)	1	1
1.51 to 2.00 mm (0.060 to 0.078 in.)	0	2
2.01 to 2.50 mm (0.079 to 0.098 in.)	1	2
2.51 to 3.00 mm (0.099 to 0.118 in.)	0	3
3.01 to 3.50 mm (0.119 to 0.137 in.)	1	3
NOTE: Apply shim selection in Table 1 to each gap at each capscrew. Measure twice (once at each capscrew) on each side to eliminate measurable gaps between rear overhead guard leg mounts and counterweight mating surface.		

d. If gap is smaller than the shim(s), use a tool between the overhead guard and counterweight to spread overhead guard and install shim.

e. Check to ensure rear overhead guard leg mounts rest on counterweight mating surface. If one side does not contact counterweight mating surface, check height of hood mounting surface. Adjust rear overhead guard leg that is not in contact with counterweight mating surface by raising or lowering the rear overhead guard leg to the same level as the hood mating surface.

f. After shims have been installed, torque rear capscrews on rear overhead guard leg to 66 N•m (49 lbf ft).

g. Install feeler gauge and recheck for gaps. If gaps exist, do procedures in Step 8 until no gaps exist. See Figure 24.

h. Perform Step a through Step g for right rear overhead guard leg.

9. Install counterweight cover, capscrews, washers, and tow pin onto counterweight. See Figure 22.

10. Install handle and capscrews onto overhead guard. Tighten capscrews to 19.2 N•m (14.16 lbf in).

For Lift Truck Models J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

NOTE: Make sure electrical wires are routed as noted during removal to assure wires do not get pinched.

1. Using a lifting device, install overhead guard onto frame. See Figure 23.

2. Connect electrical wires, as tagged during removal.

3. Install front capscrews into front overhead guard legs and cowl. Tighten front capscrews to 66 N•m (49 lbf ft). See Figure 23.

4. Install overhead guard leg covers and color-coated screws onto front overhead guard legs. See Figure 23.

5. Install hose cover and capscrews onto cowl. See Figure 23.

6. Install rear capscrews into rear overhead guard legs and counterweight. Tighten rear capscrews to 66 N•m (49 lbf ft). See Figure 23.

7. Install handle and capscrews onto overhead guard. Tighten capscrews to 19.2 N•m (14.16 lbf in).

Battery and Operator Restraint System Repair

GENERAL

The hood functions as part of the battery restraint system, completely covering the battery compartment. When correctly locked to frame, it will hold battery in battery compartment if an accident causes lift truck to tip over. Opening hood latch assembly unlocks hood from frame so hood can be raised for access to battery.

Battery Restraint System

WARNING

The battery must fit the battery compartment so that the battery restraint will operate correctly. A loose battery can cause serious injury and property damage if the lift truck tips over.

NOTE: Lift trucks are equipped with adjustable spacer plate(s) in the battery compartment.

1. Adjust spacer plate(s) to prevent battery from moving more than 13 mm (0.5 in.).

   See Figure 25 for lift truck models

   - E2.2-3.5XN (E45-70XN) (A268)

   See Figure 26 for lift truck models

   - E1.6-2.0XN (E30-40XN) (A269)

   See Figure 27 for lift truck models manufactured prior to June 2016

   - J2.2-3.5XN (J45-70XN) (A276)

   See Figure 28 for lift truck models manufactured after June 2016

   - J2.2-3.5XN (J45-70XN) (A276)

   See Figure 29 for lift truck models manufactured with hinged battery door

   - J2.2-3.5XN (J45-70XN) (A276)

   See Figure 30 for lift truck models

   - J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) equipped with standard battery removal system

   See Figure 31 for lift truck models

   - J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) equipped with side battery removal option with hinged battery door and battery tray

   See Figure 32 for lift truck models

   - J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) equipped with side battery removal option with drop-in door and rollers

   See Figure 33 for lift truck models

   - E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

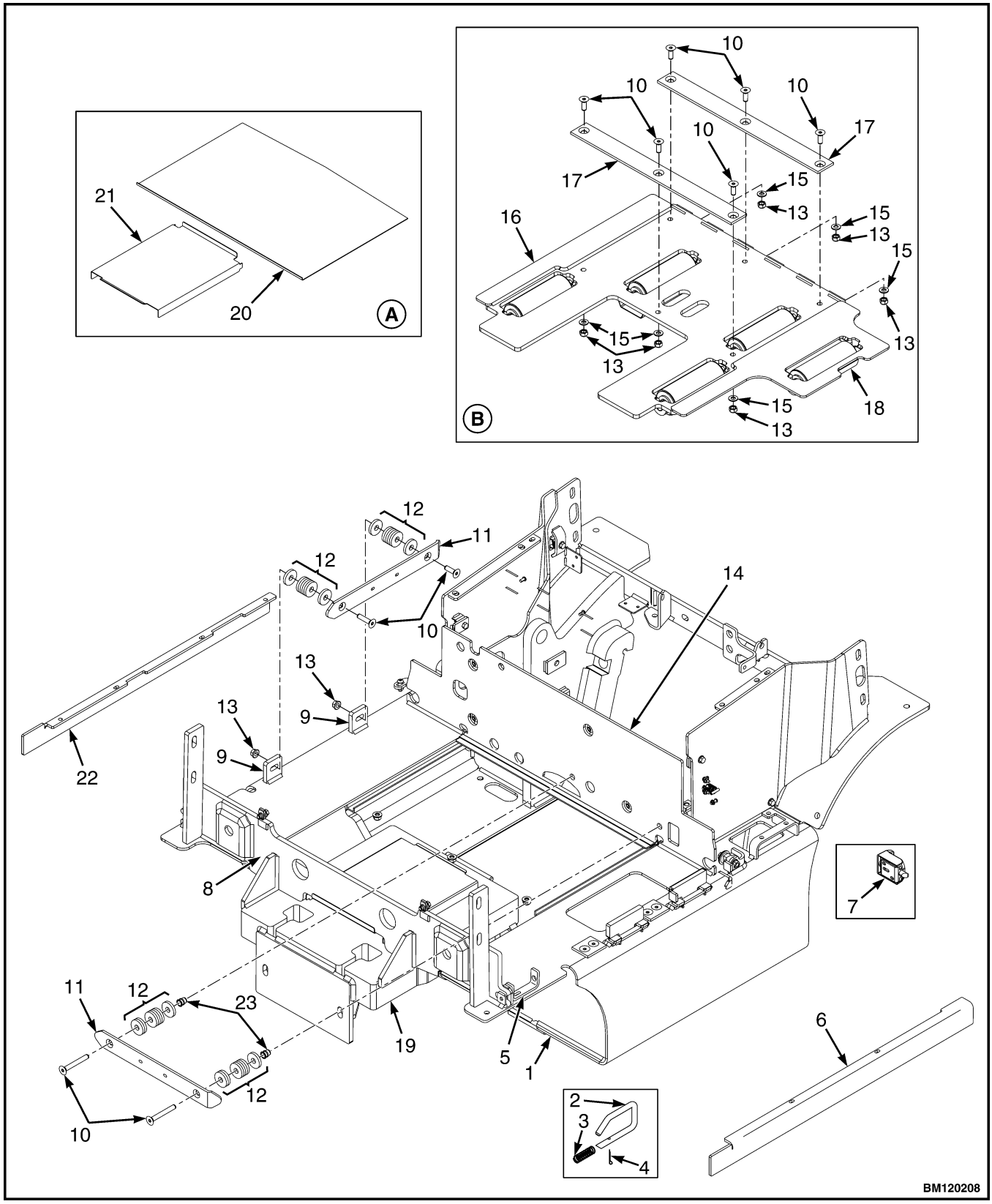


Figure 25. Battery Compartment for Lift Truck Models E2.2-3.5XN (E45-70XN) (A268)

Legend for Figure 25.

NOTE: BOTH STANDARD AND OPTIONAL VERSIONS SHOWN.

A. STANDARD COMPONENTS - VERTICAL BATTERY REMOVAL
B. OPTIONAL COMPONENTS - HORIZONTAL BATTERY REMOVAL

1. RIGHT FRAME CHANNEL
2. LATCH ROD
3. SPRING
4. SLOTTED PIN
5. LATCH PLATE
6. RIGHT PLATE
7. HOOD LATCH ASSEMBLY
8. REAR BULKHEAD
9. BRACKET
10. CAPSCREW
11. BATTERY SPACER PLATE
12. SPACER
13. NUT
14. FRONT BULKHEAD
15. WASHER
16. PLATE
17. BATTERY SLIDE PAD
18. ROLLER
19. PLATE
20. COVER
21. POWER CABLE COVER
22. LEFT PLATE
23. INSERT

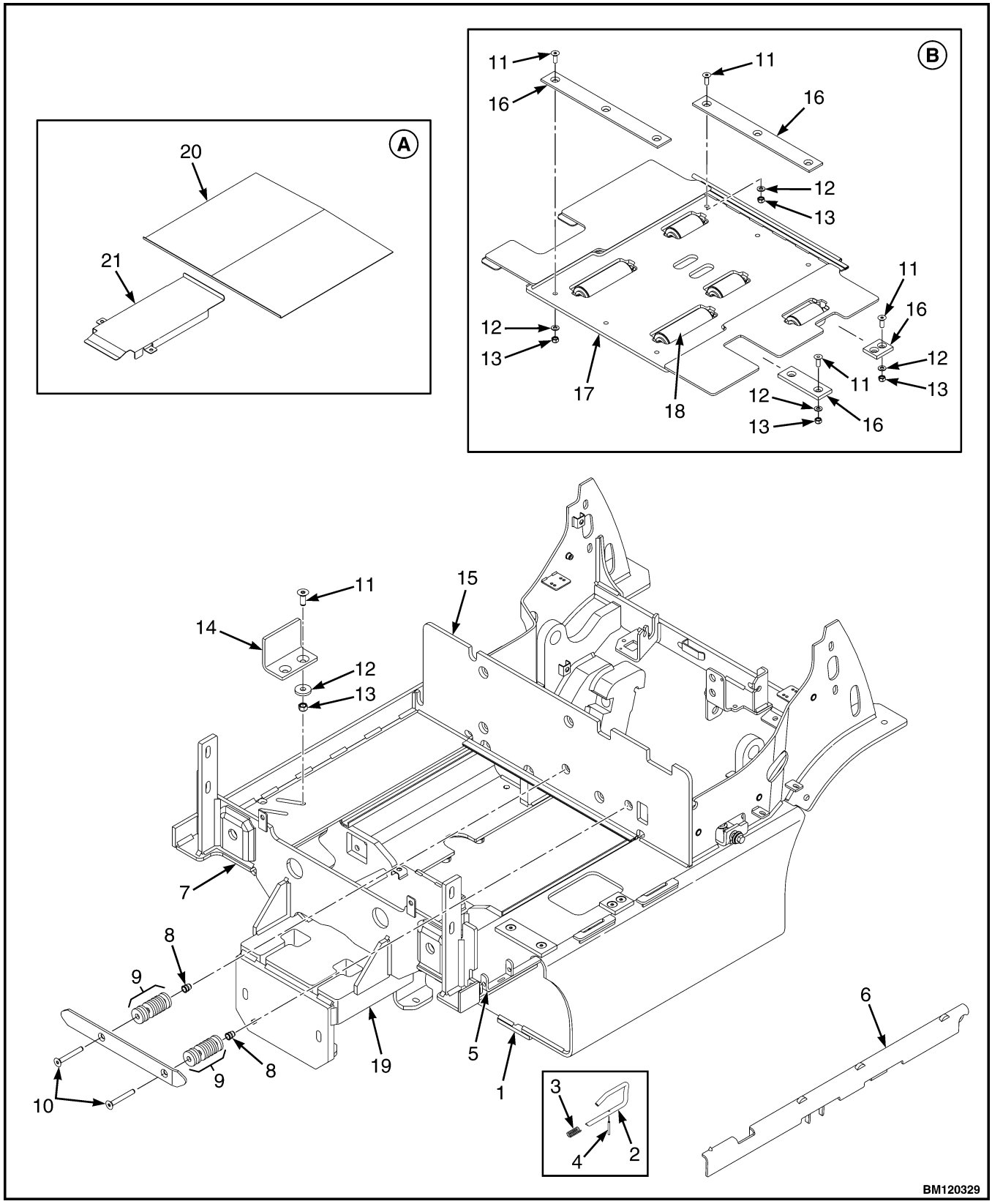


Figure 26. Battery Compartment for Lift Truck Models E1.6-2.0XN (E30-40XN) (A269)

Legend for Figure 26.

NOTE: BOTH STANDARD AND OPTIONAL VERSIONS SHOWN.

A. STANDARD COMPONENTS - VERTICAL BATTERY REMOVAL
B. OPTIONAL COMPONENTS - HORIZONTAL BATTERY REMOVAL

1. RIGHT FRAME CHANNEL
2. LATCH ROD
3. SPRING
4. SLOTTED PIN
5. LATCH PLATE
6. RIGHT PLATE
7. REAR BULKHEAD
8. INSERT
9. SPACER
10. BATTERY SPACER PLATE
11. CAPSCREW
12. WASHER
13. NUT
14. BRACKET
15. FRONT BULKHEAD
16. BATTERY SLIDE PLATE
17. PLATE
18. ROLLER
19. PLATE
20. COVER
21. POWER CABLE COVER

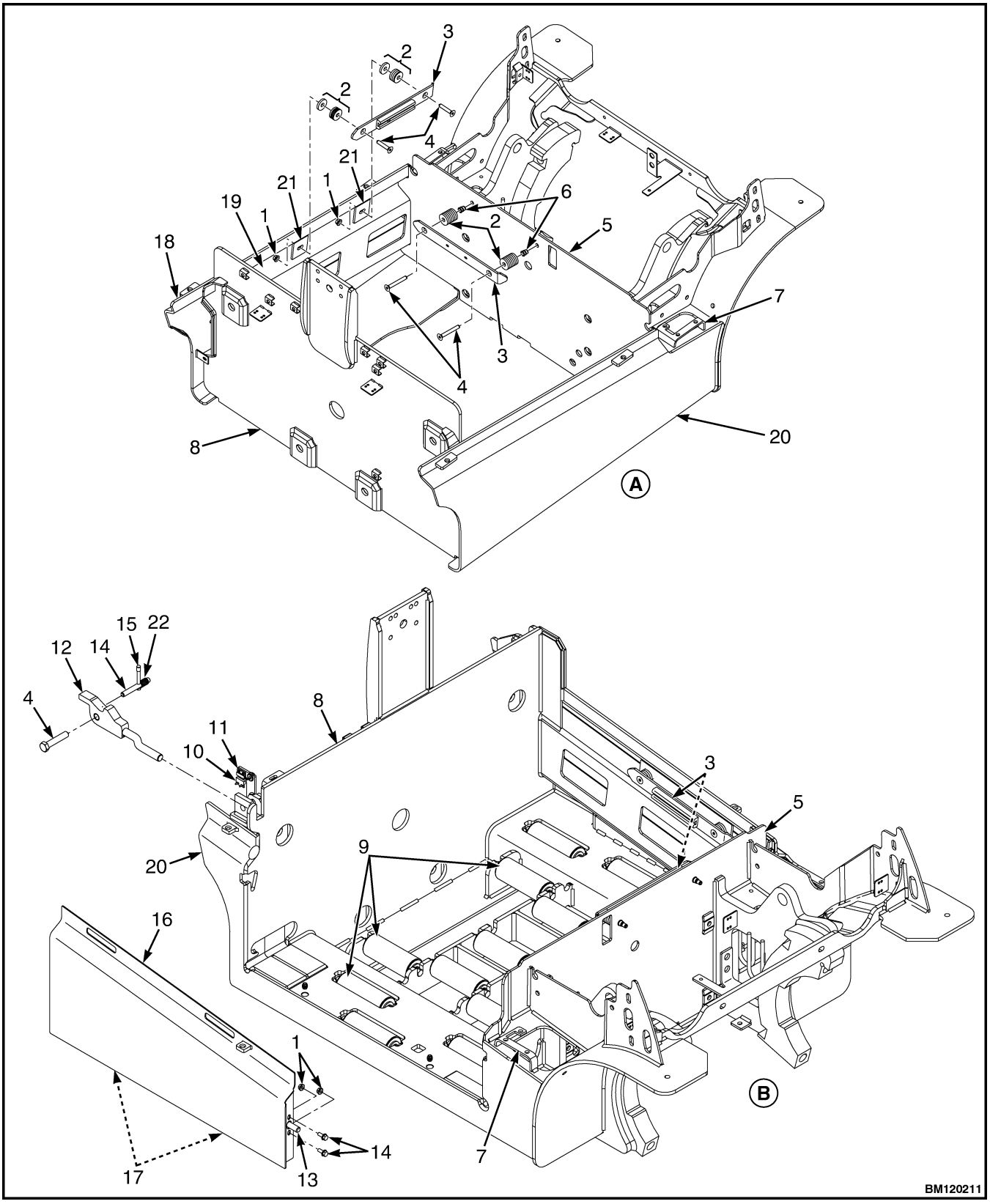


Figure 27. Battery Compartment for Lift Truck Models Manufactured Prior to June 2016J2.2-3.5XN (J45-70XN) (A276)

Legend for Figure 27.

NOTE: BOTH STANDARD AND OPTIONAL VERSIONS SHOWN.

NOTE: LIFT TRUCK MODEL MANUFACTURED PRIOR TO NOVEMBER 2015 SHOWN, LIFT TRUCKS MANUFACTURED AFTER NOVEMBER 2015 SIMILAR.

A. STANDARD COMPONENTS - VERTICAL BATTERY REMOVAL
B. OPTIONAL COMPONENTS - HORIZONTAL BATTERY REMOVAL

1. NUT
2. SPACER
3. BATTERY SPACER PLATE
4. CAPSCREW
5. FRONT BULKHEAD
6. INSERT
7. SIDE STEP MOUNTING BRACKET
8. REAR BULKHEAD
9. BATTERY ROLLERS
10. MAGNET
11. BATTERY GATE SWITCH
12. BATTERY RETENTION PLATE
13. BRACKET
14. PIN
15. LEVER
16. BATTERY GATE
17. BULLET ISOLATOR
18. LEFT FRAME CHANNEL
19. INNER FRAME CHANNEL
20. RIGHT FRAME CHANNEL
21. BATTERY SPACER PLATE MOUNTING BRACKET
22. SPRING

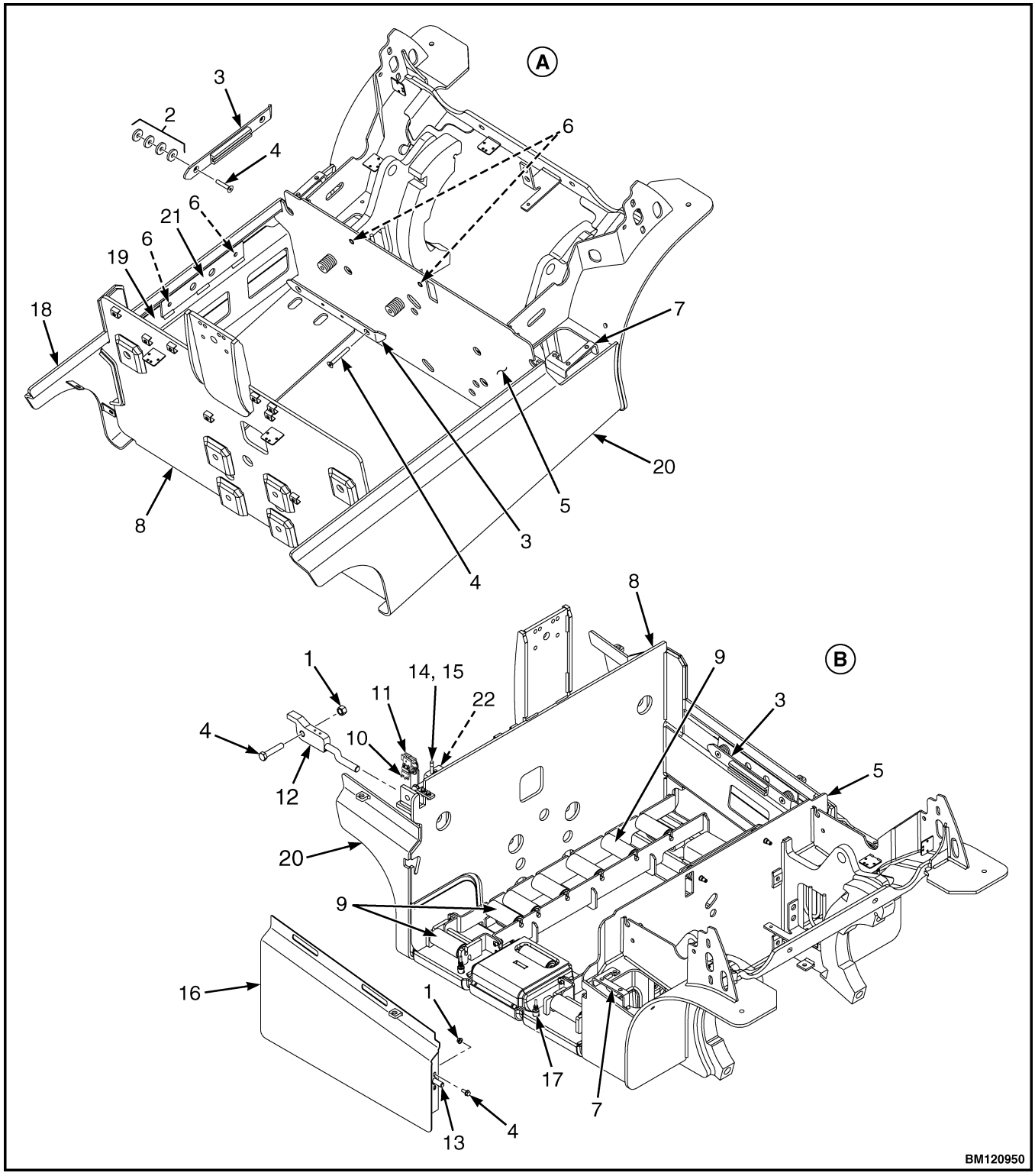


Figure 28. Battery Compartment for Lift Truck Models Manufactured After June 2016J2.2-3.5XN (J45-70XN) (A276)

Legend for Figure 28.

NOTE: BOTH STANDARD AND OPTIONAL VERSIONS SHOWN.

A. STANDARD COMPONENTS - VERTICAL BATTERY REMOVAL
B. OPTIONAL COMPONENTS - HORIZONTAL BATTERY REMOVAL

1. NUT
2. SPACER
3. BATTERY SPACER PLATE
4. CAPSCREW
5. FRONT BULKHEAD
6. INSERT
7. SIDE STEP MOUNTING BRACKET
8. REAR BULKHEAD
9. BATTERY ROLLERS
10. MAGNET
11. BATTERY GATE SWITCH
12. BATTERY RETENTION PLATE
13. BRACKET
14. PIN
15. LEVER
16. BATTERY GATE
17. BULLET ISOLATOR
18. LEFT FRAME CHANNEL
19. INNER FRAME CHANNEL
20. RIGHT FRAME CHANNEL
21. BATTERY SPACER PLATE MOUNTING BRACKET
22. SPRING

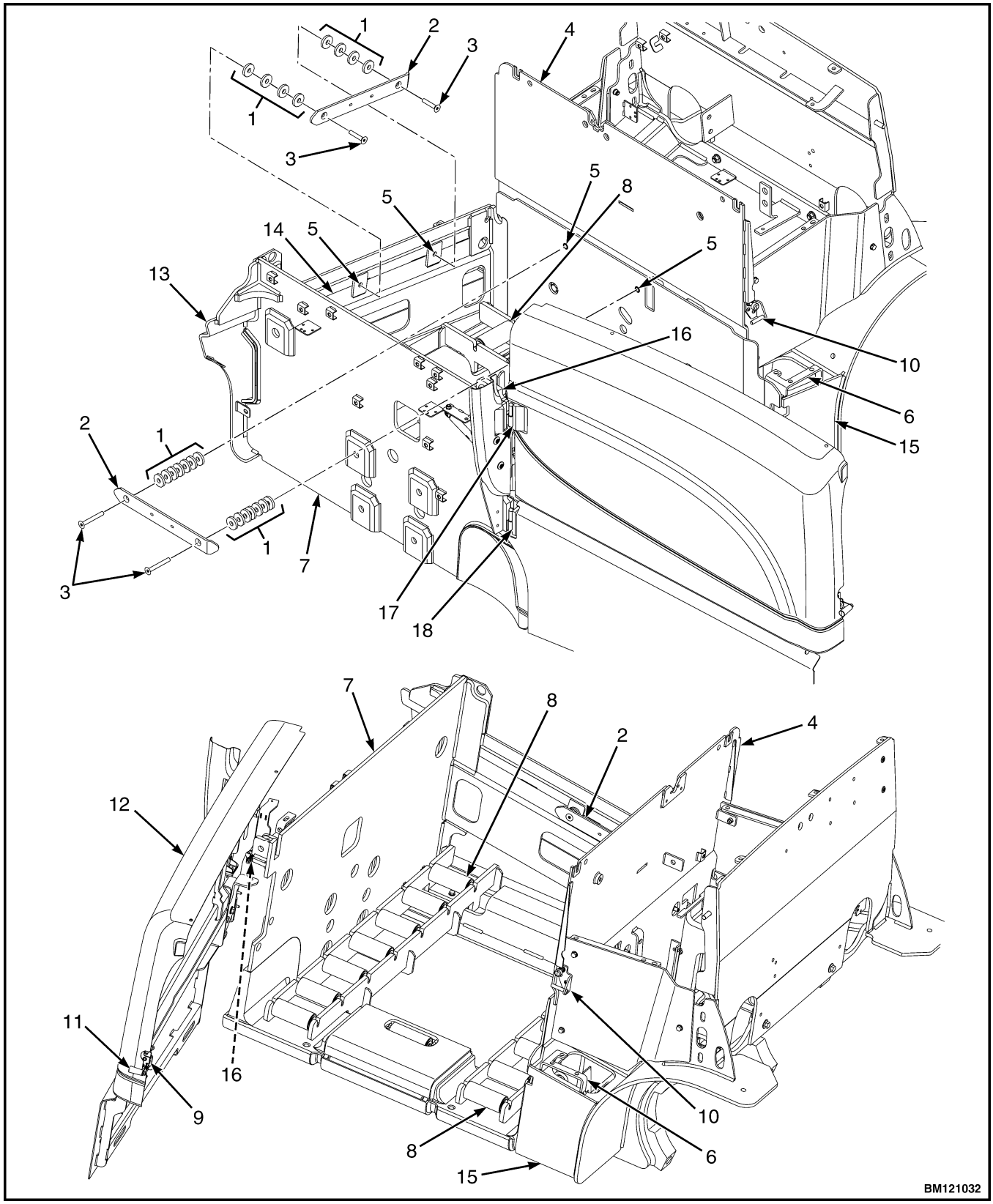
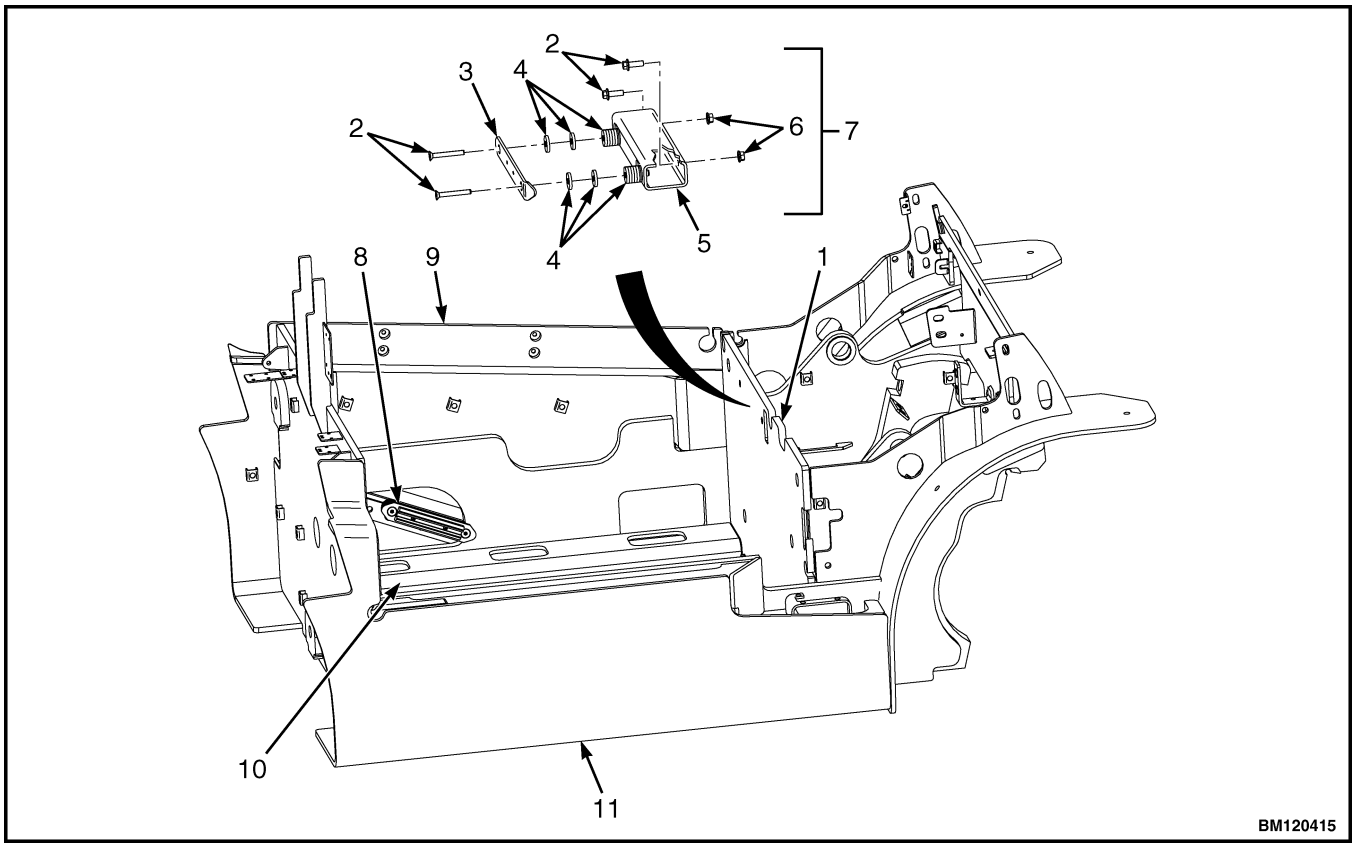


Figure 29. Battery Compartment for Lift Truck Models Manufactured with Hinged Battery DoorJ2.2-3.5XN (J45-70XN) (A276)

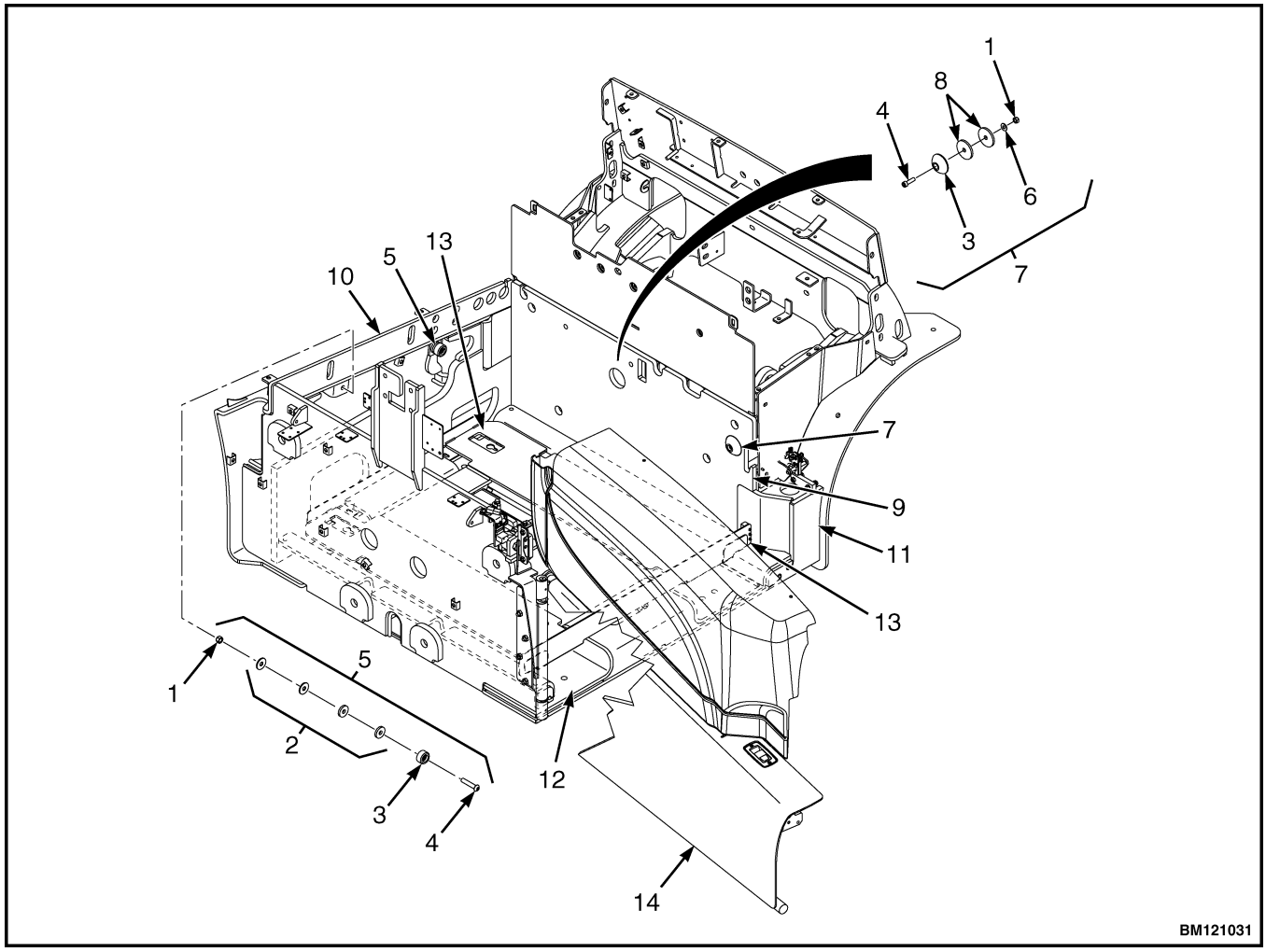
Legend for Figure 29.

1. SPACER
2. BATTERY SPACER PLATE
3. CAPSCREW
4. FRONT BULKHEAD
5. INSERT
6. SIDE STEP MOUNTING BRACKET
7. REAR BULKHEAD
8. FORK LIFT OUT TRAY
9. LATCH
10. STRIKER
11. RELEASE LEVER
12. BATTERY DOOR
13. LEFT FRAME CHANNEL
14. INNER FRAME CHANNEL
15. RIGHT FRAME CHANNEL
16. DOOR SPRING
17. UPPER HINGE
18. LOWER HINGE



1. FRONT BULKHEAD
2. CAPSCREW
3. BATTERY SPACER PLATE
4. SPACERS
5. BATTERY SPACER TUBE
6. NUT
7. FRONT BATTERY SPACER
8. SIDE BATTERY SPACER
9. LEFT FRAME CHANNEL
10. BATTERY TRAY
11. RIGHT FRAME CHANNEL

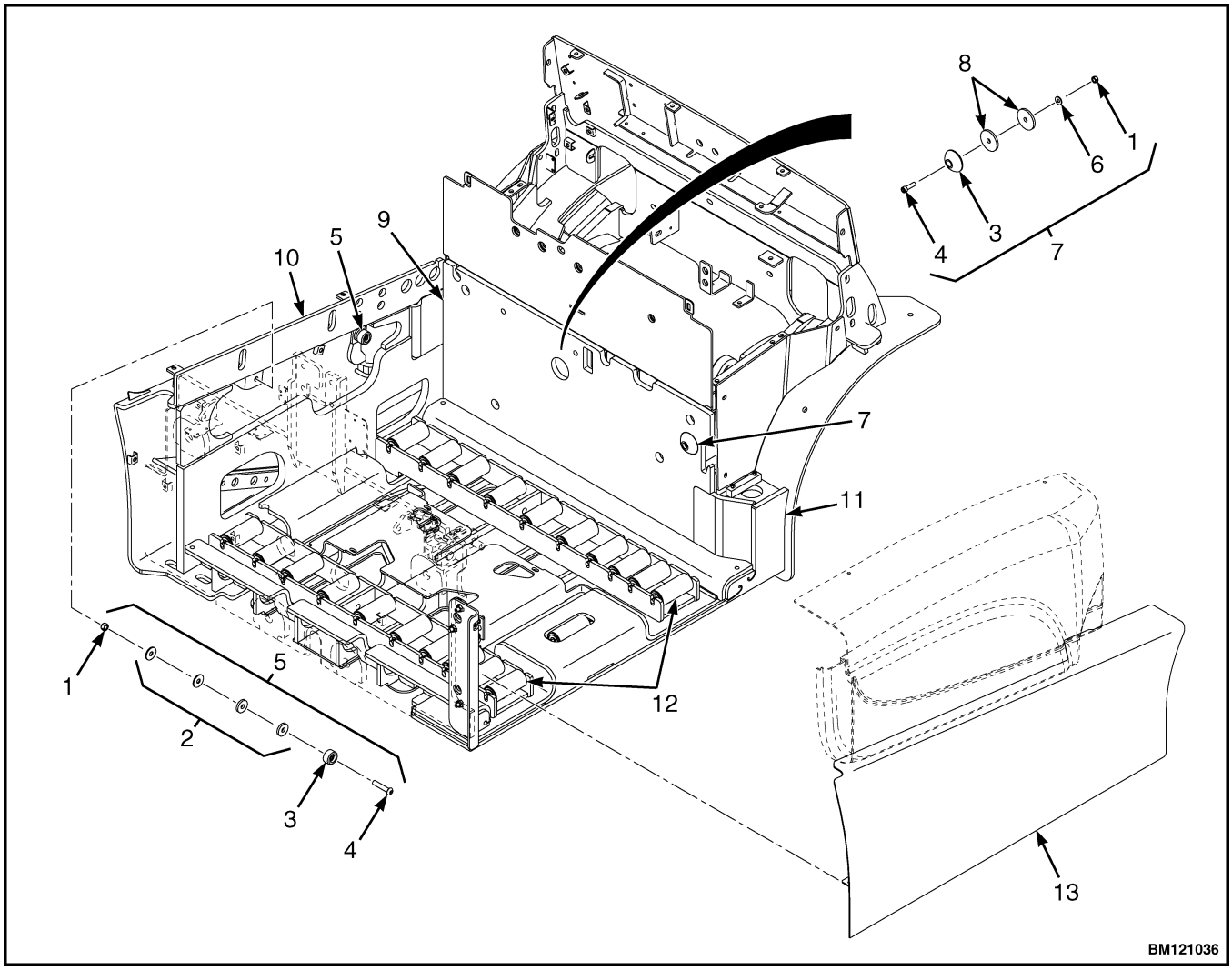
Figure 30. Battery Compartment for Lift Truck Models Equipped With Standard Battery Removal SystemJ4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)



1. NUT
2. SPACER*
3. NYLON SPACER
4. CAPSCREWS
5. SIDE BATTERY SPACER
6. WASHER
7. FRONT BATTERY SPACER
8. PLAIN SPACER
9. FRONT BULK HEAD
10. LEFT FRAME CHANNEL
11. RIGHT FRAME CHANNEL
12. FORK POCKETS
13. BATTERY TRAY
14. HINGED DOOR

*Spacer arrangement for lift truck models J80-120XN, J100XNL (A970) shown. Spacer arrangement for lift truck models J4.0-5.0XN, J5.0-5.5XN6 (A970) is similar.

Figure 31. Battery Compartment for Lift Truck Models Equipped With Side Battery Removal Option With Hinged Battery Door and Battery TrayJ4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)



1. NUT
2. SPACER
3. NYLON SPACER
4. CAPSCREWS
5. SIDE BATTERY SPACER
6. WASHER
7. FRONT BATTERY SPACER
8. PLAIN SPACERS
9. FRONT BULK HEAD
10. LEFT FRAME CHANNEL
11. RIGHT FRAME CHANNEL
12. ROLLERS
13. DROP-IN DOOR

Figure 32. Battery Compartment for Lift Truck Models Equipped With Side Battery Removal Option With Rollers and Drop-In Battery DoorJ80-120XN, J100XNL (A970)

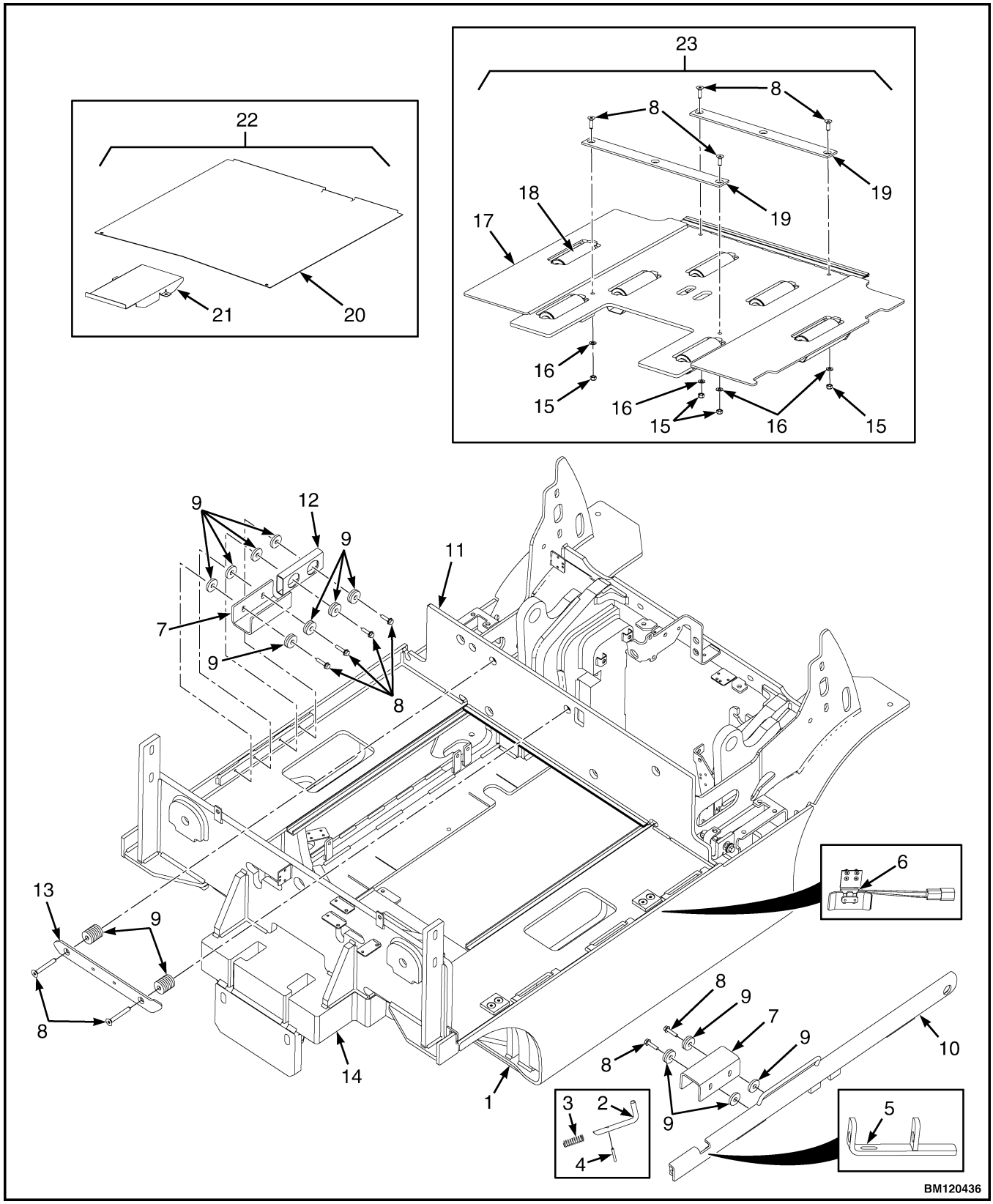


Figure 33. Battery Compartment for Lift Truck Models E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

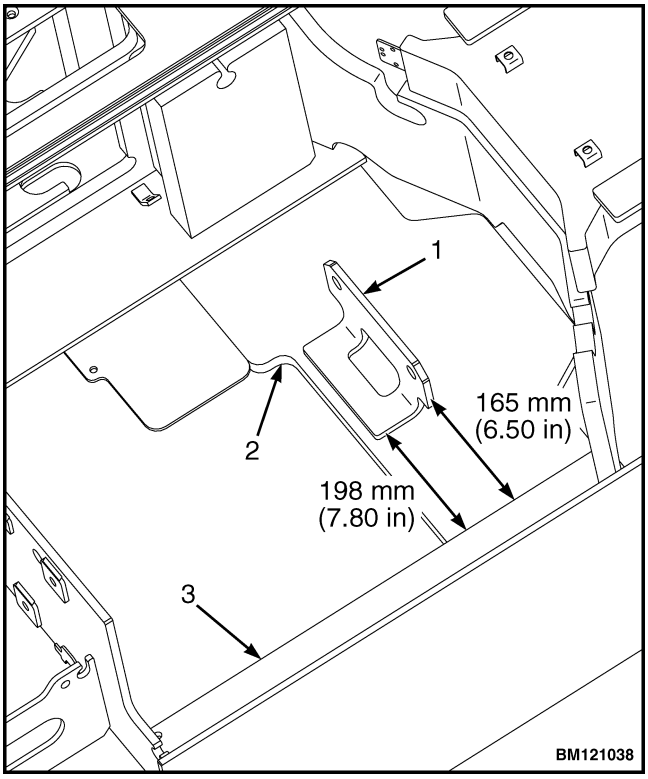
Legend for Figure 33.

1. RIGHT FRAME CHANNEL
2. LATCH ROD
3. SPRING
4. PIN
5. LATCH PLATE
6. REED SWITCH
7. BATTERY SPACER BRACKET
8. CAPSCREW
9. SPACERS
10. RIGHT PLATE
11. FRONT BULKHEAD
12. BATTERY SPACER TUBE
13. BATTERY SPACER PLATE
14. PLATE
15. NUT
16. WASHER
17. PLATE
18. ROLLER
19. BATTERY SLIDE PAD
20. COVER
21. POWER CABLE COVER
22. STANDARD COMPONENTS (VERTICAL BATTERY REMOVAL)
23. OPTIONAL COMPONENTS (HORIZONTAL BATTERY REMOVAL)

Auxiliary Counterweight Support Bracket for Lift Truck Model E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

Lift truck model E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099) is equipped with an Auxiliary counterweight support bracket. If that bracket should fail and need to be replaced a repair kit (part # 4186472) has been created. Follow the below procedure.

1. Remove battery from lift truck. See the **Operator's Manual** or **Periodic Maintenance** 8000SRM1577 for procedures.
2. Remove the battery roller tray from the lift truck to access the Auxiliary counterweight bracket located below the battery compartment. See the **Operator's Manual** or **Periodic Maintenance** 8000SRM1577 for procedures.
3. Disconnect power cables from the traction motor and hydraulic pump motor, and route them to the sides of the frame. See **AC Motor Repair** 0620SRM1385 for procedures.
4. Disconnect steering hoses from steer axle. See **Steering Axle** 1600SRM1360 for procedures.
5. Mark hoses as left hand and right hand to aid in installation. Cap and/or plug the fittings on the hoses and steer axle using items provided in service kit # 4186472, to prevent contamination during repair.
6. Remove counterweight from frame. See Counterweight Replacement for Lift Truck Models E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099) for procedures.
7. Cover hoses, power cables, and wiring harnesses with welding blanket.
8. Grind welds and remove remaining section of Auxiliary counterweight mounting bracket from frame.
9. Grind any remaining weld flush with the top surface of frame crossmember plate.
10. Grind paint from frame crossmember plate in area where new Auxiliary counterweight support bracket will be welded.
11. Position new Auxiliary counterweight mounting bracket onto frame crossmember plate as indicated in Figure 34.
12. Position upper portion of Auxiliary counterweight mounting bracket 165 mm (6.50 in.) from the inside edge of the left hand frame rail. Position lower portion of Auxiliary counterweight mounting bracket 198 mm (7.80 in.) from the inside edge of the left hand frame rail. See Figure 34.



1. AUXILIARY COUNTERWEIGHT MOUNTING BRACKET
2. FRAME CROSSMEMBER PLATE
3. LEFT HAND FRAME RAIL

Figure 34. Auxiliary Counterweight Bracket

NOTE: Prior to performing any welding repairs on lift truck refer to Welding Repairs module in the **Periodic Maintenance** 8000SRM1577 manual.

13. Ensure the mounting surfaces of the auxiliary counterweight mounting bracket and the frame crossmember plate are flush. Weld new auxiliary counterweight mounting bracket onto frame crossmember plate.

14. Remove any weld splatter.

15. Paint the new Auxiliary counterweight mounting bracket and the frame crossmember plate to match the existing frame color. See Painting Instructions.

16. Install counterweight onto frame. See Counterweight Replacement for Lift Truck Models E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099) for procedures.

17. Route steering hoses through the center opening in the new Auxiliary counterweight mounting bracket. Connect hoses to steer axle as noted during removal. See **Steering Axle** 1600SRM1360 for procedures.

18. Connect power cables onto the traction motor and hydraulic pump motor. See **AC Motor Repair** 0620SRM1385 for procedures.

19. Install battery roller tray into lift truck. See the **Operator's Manual** or **Periodic Maintenance** 8000SRM1577 for procedures.

20. Install battery into lift truck. See **Operator's Manual** or **Periodic Maintenance** 8000SRM1577 for procedures.

Operator Restraint System

The seat belt, hip restraint, seat, hood, seat rails, and hood latch are all part of the operator restraint system. Each item must be checked to make sure it is fastened correctly, functions correctly, and is in good condition. The operator restraint system helps the operator stay within the lift truck in case of a tip over.

1. Make sure seat is not loose on seat rails. Make sure seat rails are securely attached to seat spacer plates (see Figure 35) and mounting surface. The seat rails must lock securely in position, but move freely when unlocked.

See Figure 36 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268)

See Figure 37 for lift truck models

- E1.6-2.0XN (E30-40XN) (A269)

See Figure 38 and Figure 39 for lift truck models

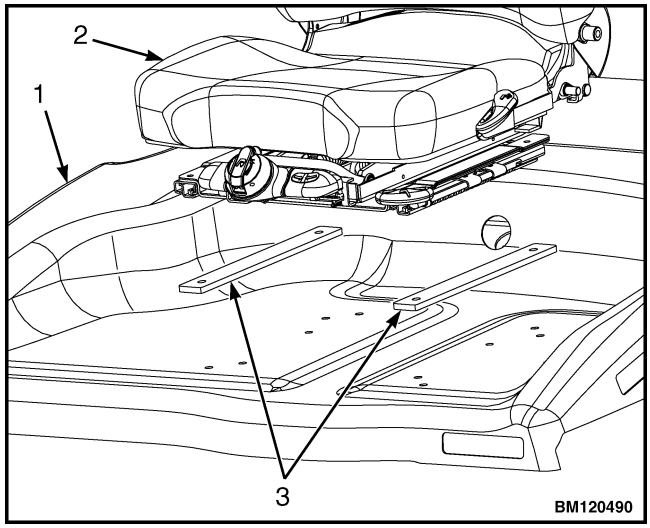
- J2.2-3.5XN (J45-70XN) (A276)

See Figure 40 for lift truck models

- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

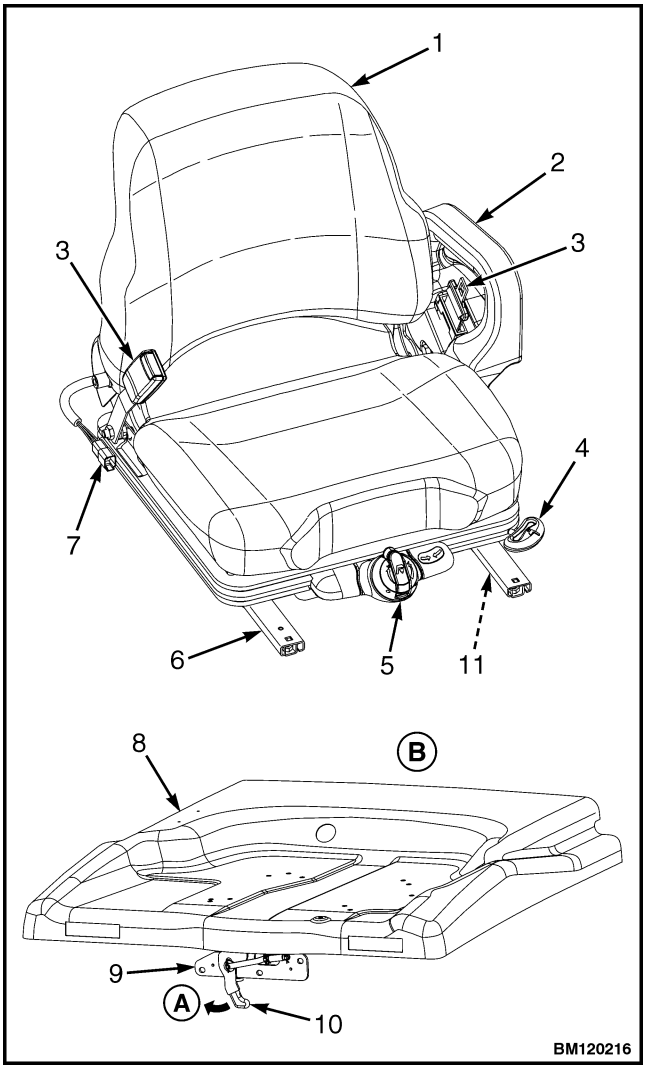
See Figure 41 for lift truck models

- E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)



1. HOOD
2. SEAT ASSEMBLY
3. SEAT SPACER PLATES

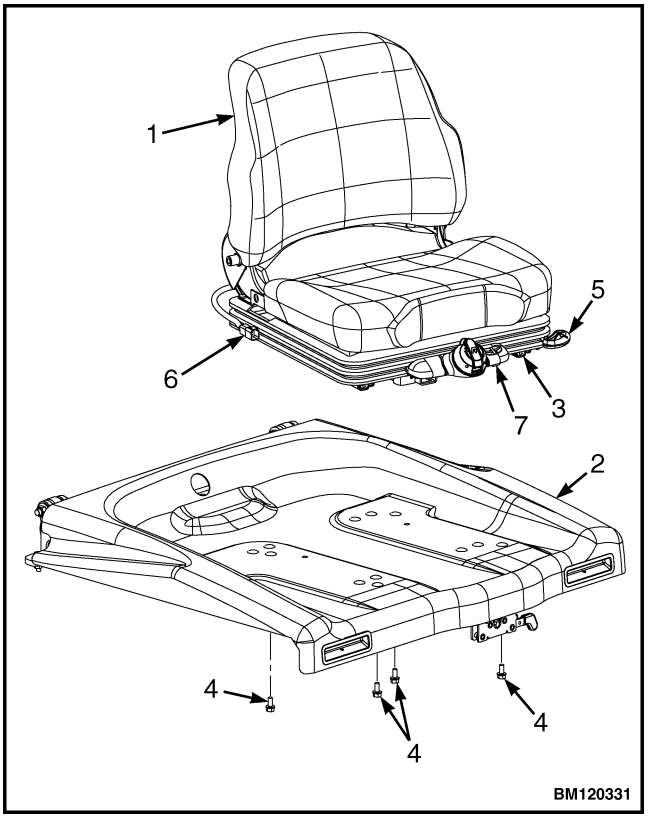
Figure 35. Seat Spacer Location



A. RELEASE DIRECTION
B. FRONT VIEW

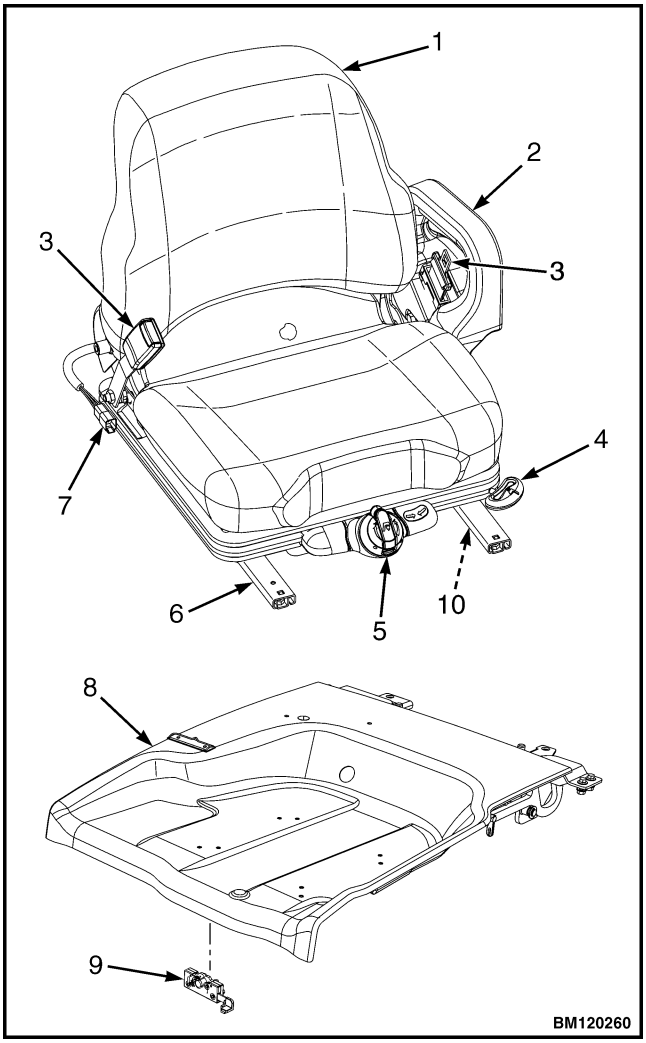
1. SEAT
2. HIP RESTRAINT
3. SEAT BELT AND MOUNT
4. FORWARD/BACKWARD LEVER
5. OPERATOR WEIGHT ADJUSTOR
6. SEAT RAIL
7. OPERATOR PRESENCE SYSTEM CONNECTOR
8. HOOD
9. HOOD LATCH ASSEMBLY
10. HOOD RELEASE HANDLE
11. STOP SCREWS

Figure 36. Hood and Seat Check for Lift Truck Models E2.2-3.5XN (E45-70XN) (A268)



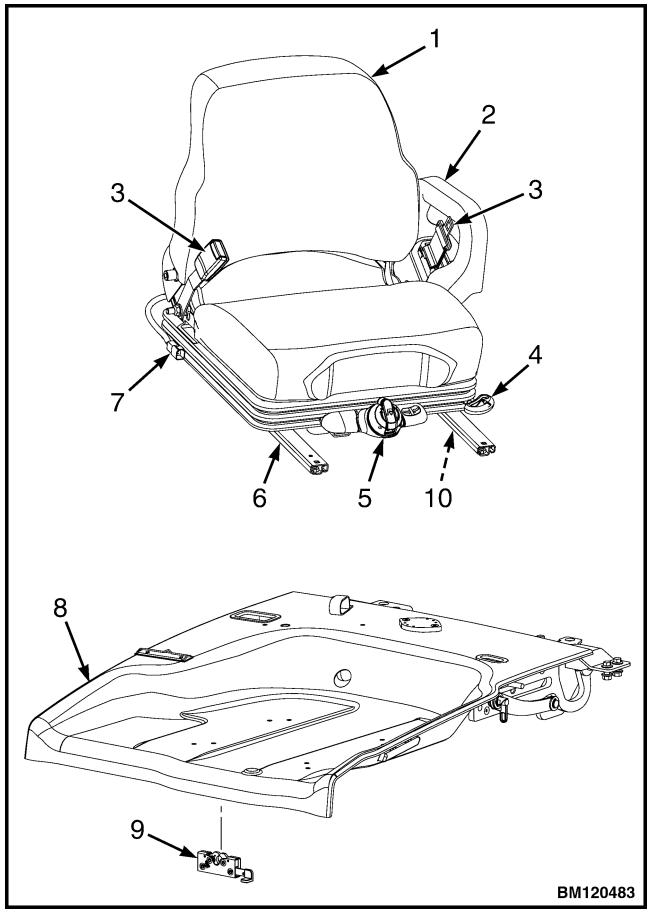
1. SEAT ASSEMBLY
2. HOOD
3. SEAT RAIL
4. CAPSCREW
5. FORWARD/BACKWARD LEVER
6. OPERATOR PRESENCE SYSTEM CONNECTOR
7. RIDE POSITION INDICATOR

Figure 37. Hood and Seat Check for Lift Truck Models E1.6-2.0XN (E30-40XN) (A269)



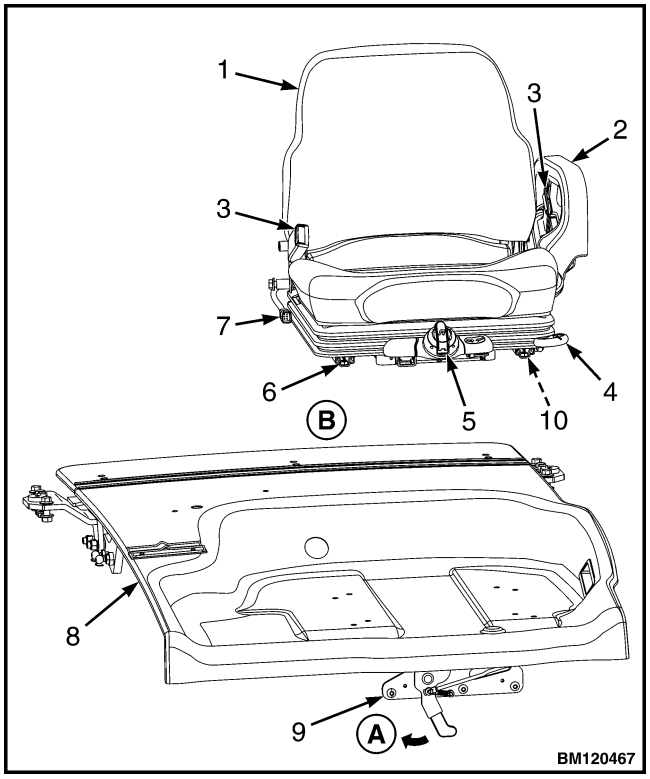
1. SEAT
2. HIP RESTRAINT
3. SEAT BELT AND MOUNT
4. FORWARD/BACKWARD LEVER
5. OPERATOR WEIGHT ADJUSTOR
6. SEAT RAIL
7. OPERATOR PRESENCE SYSTEM CONNECTOR
8. HOOD
9. HOOD LATCH ASSEMBLY
10. STOP SCREWS

Figure 38. Hood and Seat Check for Lift Truck Models Manufactured Prior to June, 2012J2.2-3.5XN (J45-70XN) (A276)



1. SEAT
2. HIP RESTRAINT
3. SEAT BELT AND MOUNT
4. FORWARD/BACKWARD LEVER
5. OPERATOR WEIGHT ADJUSTOR
6. SEAT RAIL
7. OPERATOR PRESENCE SYSTEM CONNECTOR
8. HOOD
9. HOOD LATCH ASSEMBLY
10. STOP SCREWS

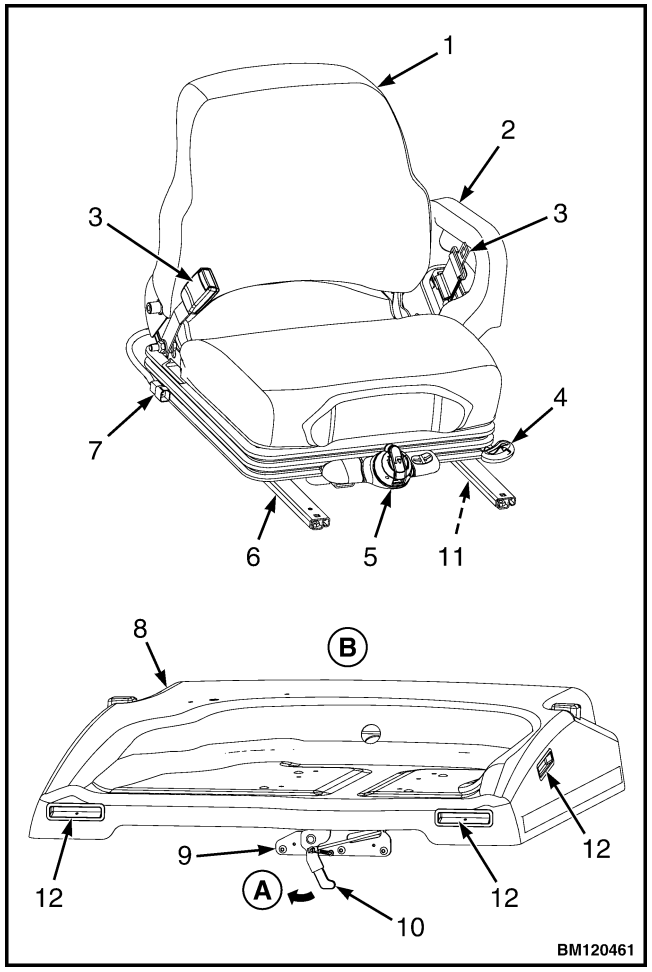
Figure 39. Hood and Seat Check for Lift Truck Models Manufactured After June, 2012J2.2-3.5XN (J45-70XN) (A276)



A. RELEASE DIRECTION
B. FRONT VIEW

1. SEAT
2. HIP RESTRAINT
3. SEAT BELT AND MOUNT
4. FORWARD/BACKWARD LEVER
5. OPERATOR WEIGHT ADJUSTOR
6. SEAT RAIL
7. OPERATOR PRESENCE SYSTEM CONNECTOR
8. HOOD
9. HOOD LATCH ASSEMBLY
10. STOP SCREWS

Figure 40. Hood and Seat Check for Lift Truck Models J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)



A. RELEASE DIRECTION
B. FRONT VIEW

1. SEAT
2. HIP RESTRAINT
3. SEAT BELT AND MOUNT
4. FORWARD/BACKWARD LEVER
5. OPERATOR WEIGHT ADJUSTOR
6. SEAT RAIL
7. OPERATOR PRESENCE SYSTEM CONNECTOR
8. HOOD
9. HOOD LATCH ASSEMBLY
10. HOOD RELEASE HANDLE
11. STOP SCREWS
12. HANDLE

Figure 41. Hood and Seat Check for Lift Truck Models E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

Emergency Locking Retractor (ELR)

NOTE: The seat belt may be either black or red.

When the ELR style seat belt is properly buckled across the operator, the belt will permit slight operator repositioning without activating the locking mechanism. If truck tips, travels off a dock, or comes to a sudden stop, the locking mechanism will be activated and hold operator's lower torso in the seat.

A seat belt that is damaged, worn, or does not operate properly will not provide protection when it is needed. The end of the belt must fasten correctly in the latch. The seat belt must be in good condition. Replace seat belt if it is damaged or worn.

See Figure 36 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268)

See Figure 37 for lift truck models

- E1.6-2.0XN (E30-40XN) (A269)

See Figure 38 and Figure 39 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276)

See Figure 40 for lift truck models

- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

See Figure 41 for lift truck models

- E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

NOTE: The following seat belt operation checks must be performed three times before replacing seat belt assembly:

- With hood closed and in locked position, pull seat belt slowly from retractor assembly. Make sure seat belt pulls out and retracts smoothly. If seat belt does not pullout of retractor assembly, the internal latch may be locked. Pull firmly on seat belt and hold for a moment to remove slack from the belt in the retractor. Release seat belt. Seat will retract and internal latch will unlock. If seat belt cannot be pulled from retractor assembly or belt will not retract, replace seat belt assembly.
- With hood closed and in locked position, pull seat belt with a sudden jerk. Make sure seat belt will not pull from retractor assembly. If seat belt can be pulled from retractor, when it is pulled with a sudden jerk, replace seat belt assembly.
- With hood in open position, make sure seat belt will not pull from retractor assembly. If seat belt can be pulled from retractor, with hood in open position, replace seat belt assembly.

E-Hydraulic Armrest Assembly Repair

For procedures to service and repair the E-Hydraulic armrest assembly, see **Electrical System** 2200SRM1369.

Hood and Seat Assembly Replacement

GENERAL FOR LIFT TRUCK MODELS E2.2-3.5XN (E45-70XN) (A268), E1.6-2.0XN (E30-40XN) (A269), AND E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

Hood Assembly

The hood is the platform for the seat assembly and is located above the battery. The hood is a welded steel assembly. Two hood hinges at the back attach to the overhead guard and prevent the hood from moving side to side. A latch assembly, on front bulkhead, locks hood closed during operation. The hood latch must be in good condition and properly secured before lift truck can be operated. If hood latch does not lock hood in closed position, lift truck must not be operated.

NOTE: Gas-controlled struts orientation varies between manufacturing dates.

On lift truck models E2.2-3.5XN (E45-70XN) (A268) and E1.6-2.0XN (E30-40XN) (A269), gas-controlled struts hold hood in the open position.

See Figure 42 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268) manufactured before June, 2012

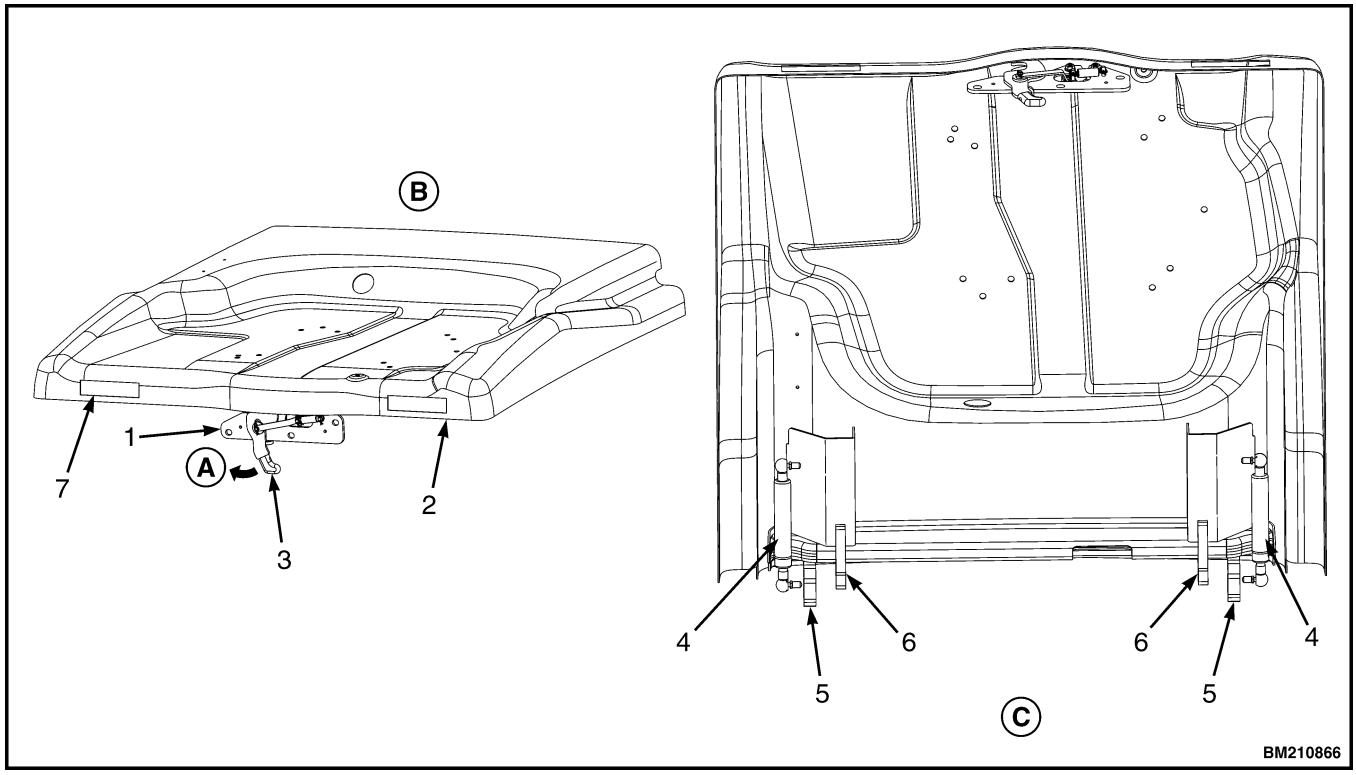
See Figure 43 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268) manufactured after June, 2012

See Figure 44 for lift truck models

- E1.6-2.0XN (E30-40XN) (A269)

Lift truck models E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099) can be equipped with either gas-controlled struts or coil springs that hold the hood in the open position. See Figure 45.

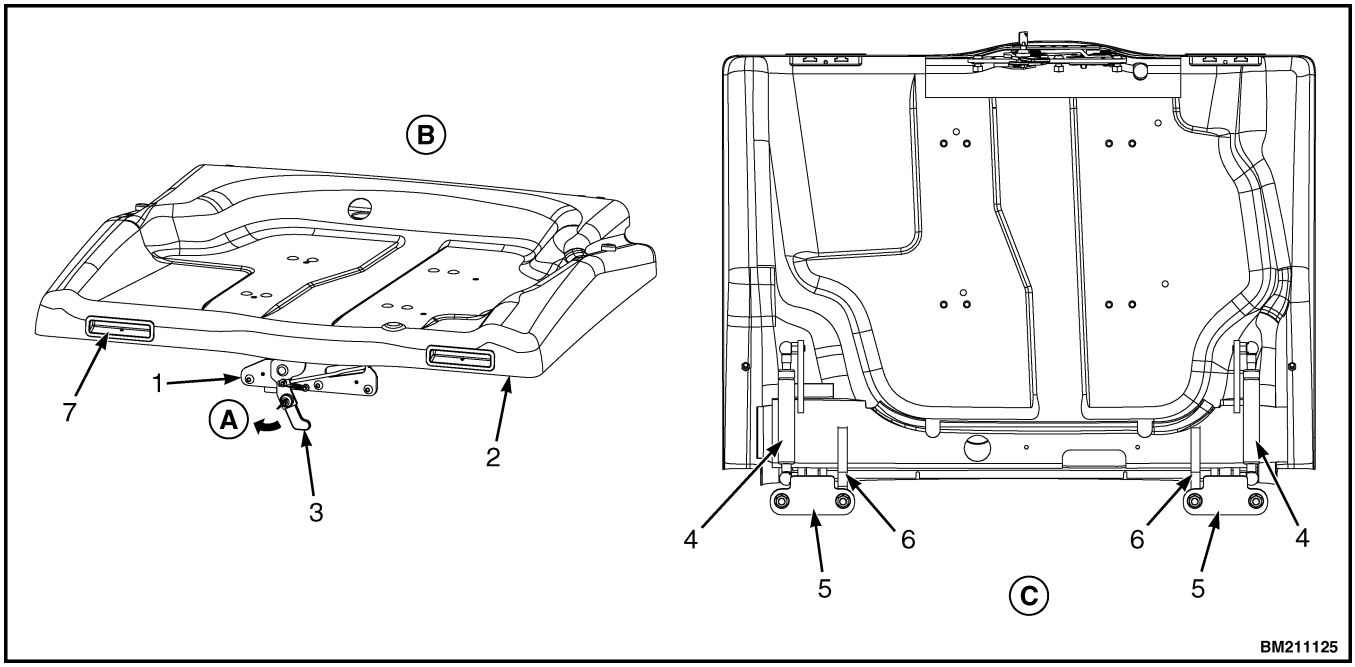


NOTE: 1015 mm (40 in.) HOOD SHOWN. OTHER SIZES SIMILAR.
NOTE: SEAT NOT SHOWN FOR CLARITY.

A. RELEASE DIRECTION
B. FRONT VIEW
C. BOTTOM VIEW

1. HOOD LATCH ASSEMBLY
2. HOOD
3. HOOD RELEASE LEVER
4. GAS-CONTROLLED STRUT
5. HOOD HINGE
6. BATTERY STOPPER
7. HANDLE

Figure 42. Hood and Latch Assembly, Lift Truck Models Manufactured Prior to June, 2012E2.2-3.5XN (E45-70XN) (A268)

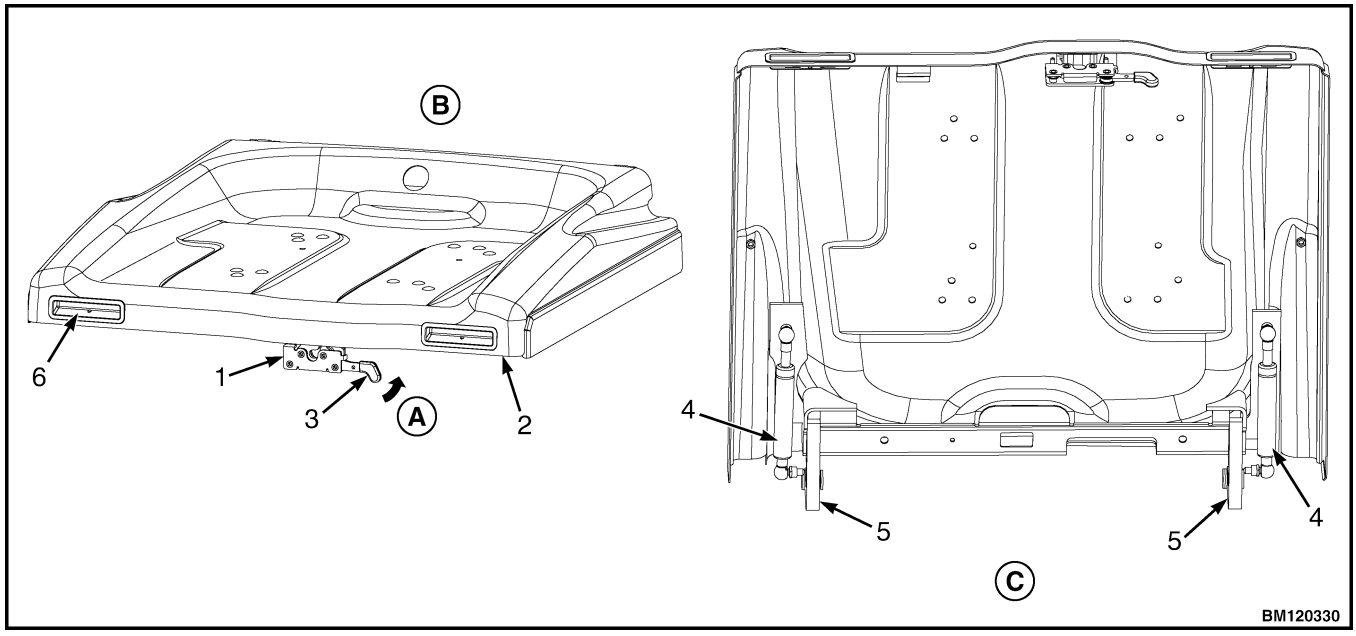


NOTE: 700 mm (27.6 in.) HOOD SHOWN. OTHER SIZES SIMILAR.
NOTE: SEAT NOT SHOWN FOR CLARITY.

A. RELEASE DIRECTION
B. FRONT VIEW
C. BOTTOM VIEW

1. HOOD LATCH ASSEMBLY
2. HOOD
3. HOOD RELEASE LEVER
4. GAS-CONTROLLED STRUT
5. HOOD HINGE
6. BATTERY STOPPER
7. HANDLE

Figure 43. Hood and Latch Assembly, Lift Truck Models Manufactured After June, 2012E2.2-3.5XN (E45-70XN) (A268)

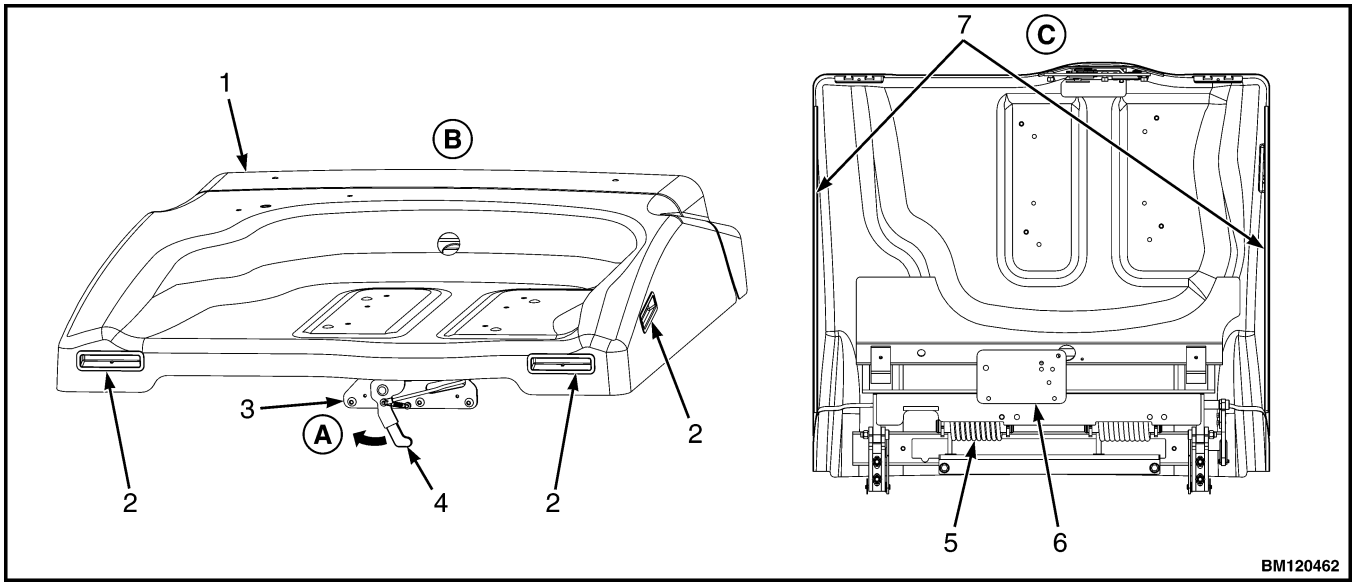


NOTE: SEAT NOT SHOWN FOR CLARITY.

A. RELEASE DIRECTION
B. FRONT VIEW
C. BOTTOM VIEW

1. HOOD LATCH ASSEMBLY
2. HOOD
3. HOOD RELEASE LEVER
4. GAS-CONTROLLED STRUT
5. HOOD HINGE
6. PLASTIC HANDLE

Figure 44. Hood and Latch Assembly, Lift Truck Models E1.6-2.0XN (E30-40XN) (A269)



NOTE: LIFT TRUCK MODELS E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099) EQUIPPED WITH COIL SPRINGS SHOWN.

A. RELEASE DIRECTION
B. FRONT VIEW
C. BOTTOM VIEW

1. HOOD
2. HANDLE
3. HOOD LATCH ASSEMBLY
4. HOOD RELEASE LEVER
5. COIL SPRING
6. BATTERY CONNECTOR PLATE
7. SIDE PLATE

Figure 45. Hood and Latch Assembly, Lift Truck Models E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

To open hood on lift trucks equipped with manual hydraulic control levers, the manual control levers and linkage assembly must be moved. To move the manual control levers and linkage assembly, pull latch handle up and allow manual hydraulic lever assembly to move forward and away from mounting plate on front bulkhead. Slide the seat all the way back. See Figure 46.

To open hood on lift trucks equipped with E-Hydraulic control levers, slide seat and armrest all the way back. See Figure 46.

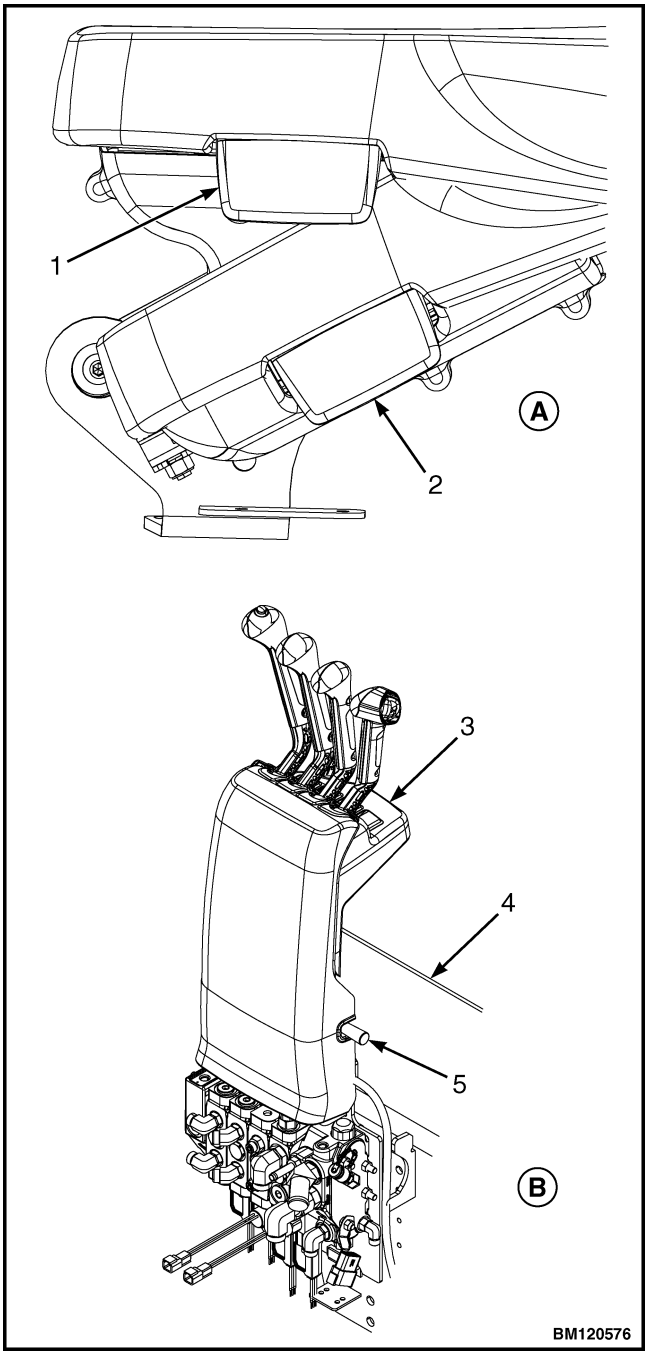


Figure 46. Hydraulic Control Levers Release Latches, Lift Trucks

Legend for Figure 46.

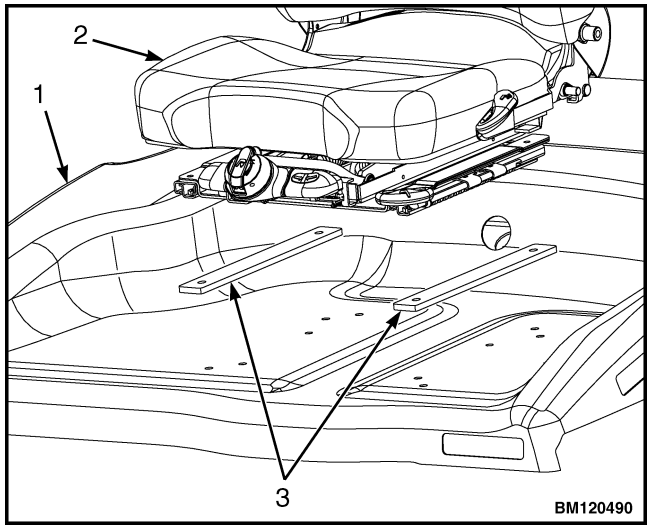
NOTE: MANUAL HYDRAULIC CONTROL LEVERS FOR LIFT TRUCK MODELS E2.2-3.5XN (E45-70XN) (A268) AND E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099) SHOWN. MANUAL HYDRAULIC CONTROL LEVERS FOR LIFT TRUCK MODELS E1.6-2.0XN (E30-40XN) (A269) ARE SIMILAR.

A. E-HYDRAULIC CONTROL LEVERS
B. MANUAL HYDRAULIC CONTROL LEVERS

1. HANDLE MOVES ARMREST FORWARD/ BACKWARD
2. HANDLE MOVE ARMREST UP/DOWN
3. MANUAL HYDRAULIC CONTROL LEVER AND LINKAGE ASSEMBLY
4. FRONT BULKHEAD
5. MANUAL HYDRAULIC CONTROL LEVER LATCH HANDLE (PULL UP TO MOVE FORWARD)

Seat Assembly

The seat assembly slides on seat rails that are fastened to seat spacers (see Figure 47) and hood by four capscrews. Make sure seat rails are not loose. Seat rails must lock tightly in position, but move freely when unlocked. Seat rails must be correctly fastened to hood. A forward/backward lever at the left front side of the base adjusts the seat either forward or backward.



1. HOOD
2. SEAT ASSEMBLY
3. SEAT SPACER PLATES

Figure 47. Seat Spacer Location

See Figure 48 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268)

See Figure 49 for lift truck models

- E1.6-2.0XN (E30-40XN) (A269)

See Figure 50 for lift truck models

- E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

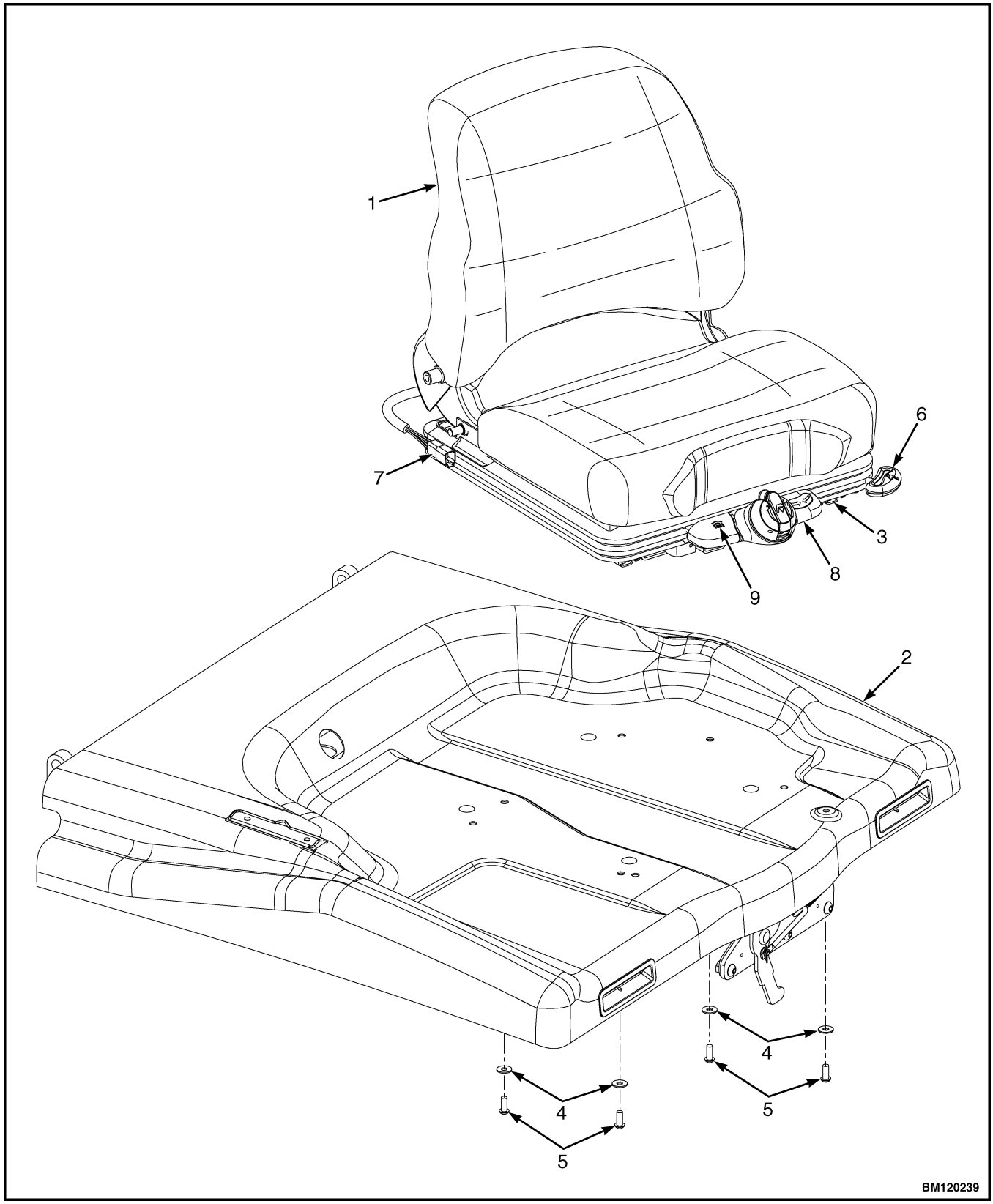
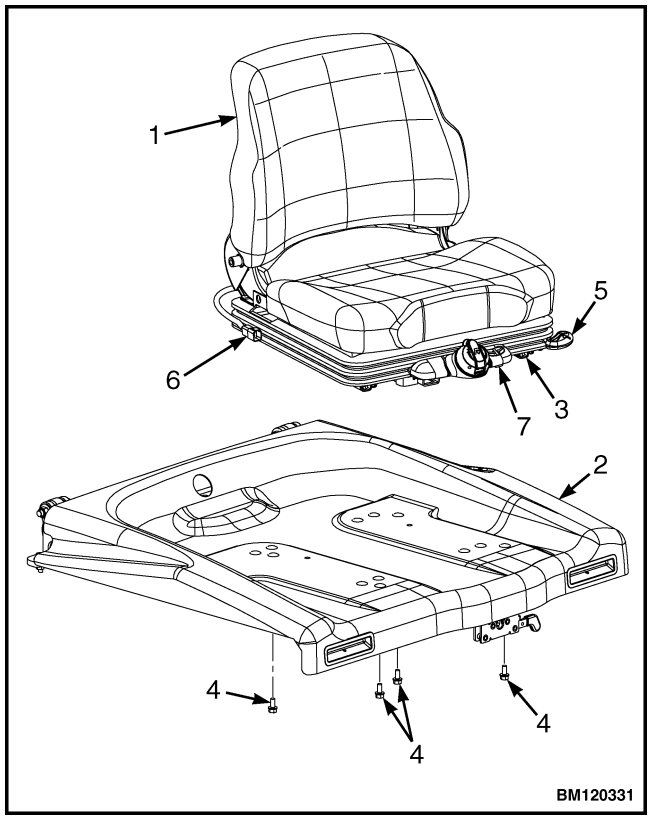


Figure 48. Seat, Lift Trucks E2.2-3.5XN (E45-70XN) (A268)

Legend for Figure 48.

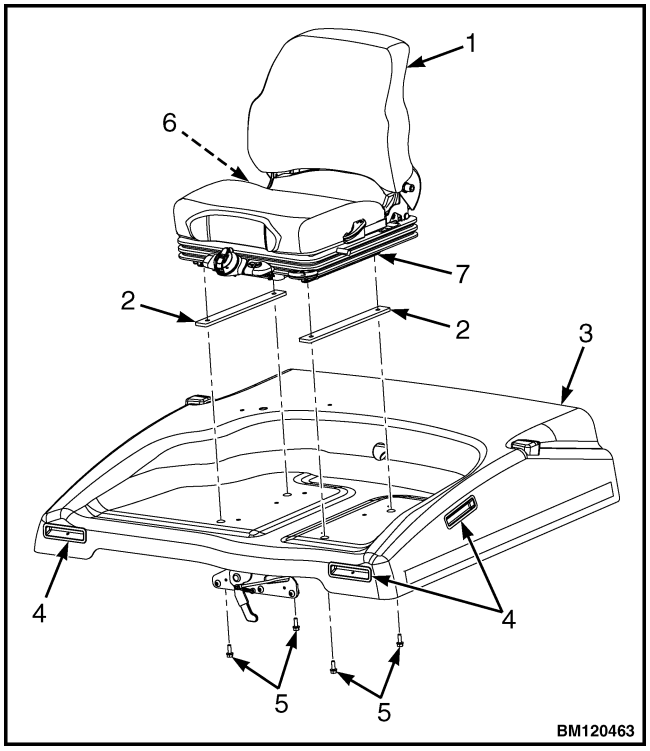
NOTE: FULL-SUSPENSION SWIVEL SEAT SHOWN.

1. SEAT ASSEMBLY
2. HOOD
3. SEAT RAIL
4. WASHER
5. CAPSCREW
6. FORWARD/BACKWARD LEVER
7. OPERATOR PRESENCE SYSTEM CONNECTOR
8. RIDE POSITION INDICATOR
9. SWIVEL LATCH RELEASE LEVER



1. SEAT ASSEMBLY
2. HOOD
3. SEAT RAIL
4. CAPSCREW
5. FORWARD/BACKWARD LEVER
6. OPERATOR PRESENCE SYSTEM CONNECTOR
7. RIDE POSITION INDICATOR

Figure 49. Seat, Lift Trucks E1.6-2.0XN (E30-40XN) (A269)



1. SEAT
2. SPACER
3. HOOD
4. HANDLE
5. CAPSCREW
6. OPERATOR PRESENCE SYSTEM CONNECTOR
7. SEAT RAIL

Figure 50. Seat, Lift Trucks E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

NOTE: Swivel seat not used on E1.6-2.0XN (E30-40XN) (A269) lift trucks.

Optional seats are available in cloth or vinyl with features such as full suspension and with the ability to swivel. All seats have a seat sensor installed in the bottom cushion that senses operator presence. When the operator is not on the seat, the seat sensor opens and interrupts the controller and stops lift truck operation.

See Figure 48 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268)

See Figure 49 for lift truck models

- E1.6-2.0XN (E30-40XN) (A269)

See Figure 50 for lift truck models

- E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

GENERAL FOR LIFT TRUCK MODELS J2.2-3.5XN (J45-70XN) (A276)

Hood Assembly

The hood is the platform for the seat assembly and is located above the battery. It functions as a battery restraint that completely covers the battery compartment. When correctly locked to frame, it will hold battery in battery compartment if an accident causes lift truck to tip over. The hood is a welded, steel assembly. Two hood hinges at the back attach to the counterweight. A latch assembly on the front bulkhead, locks hood closed during operation. Gas-controlled struts hold hood in the open position.

See Figure 52 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276) manufactured prior to June, 2012

See Figure 53 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276) manufactured after June, 2012

Opening the latch assembly unlocks hood from the frame so the hood can be raised to access the battery. The latch assembly must be in good condition and properly secured before lift truck can be operated. If hood latch assembly does not lock hood in the closed position, the lift truck must not be operated.

See Figure 52 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276) manufactured prior to June, 2012

See Figure 53 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276) manufactured after June, 2012

To open the hood on lift truck with manual hydraulics, the manual hydraulic control levers and linkage assembly must be moved: pull release lever up and allow manual hydraulic linkage and handles to move forward and away from mounting plate on front bulkhead. Slide the seat all the way back. If the latch assembly does not lock the hood in the closed position, the manual hydraulic levers and linkage assembly will not lock into position and the lift truck will not operate. See Figure 51.

To open hood on lift trucks equipped with E-Hydraulic control levers, slide seat and armrest all the way back. See Figure 51.

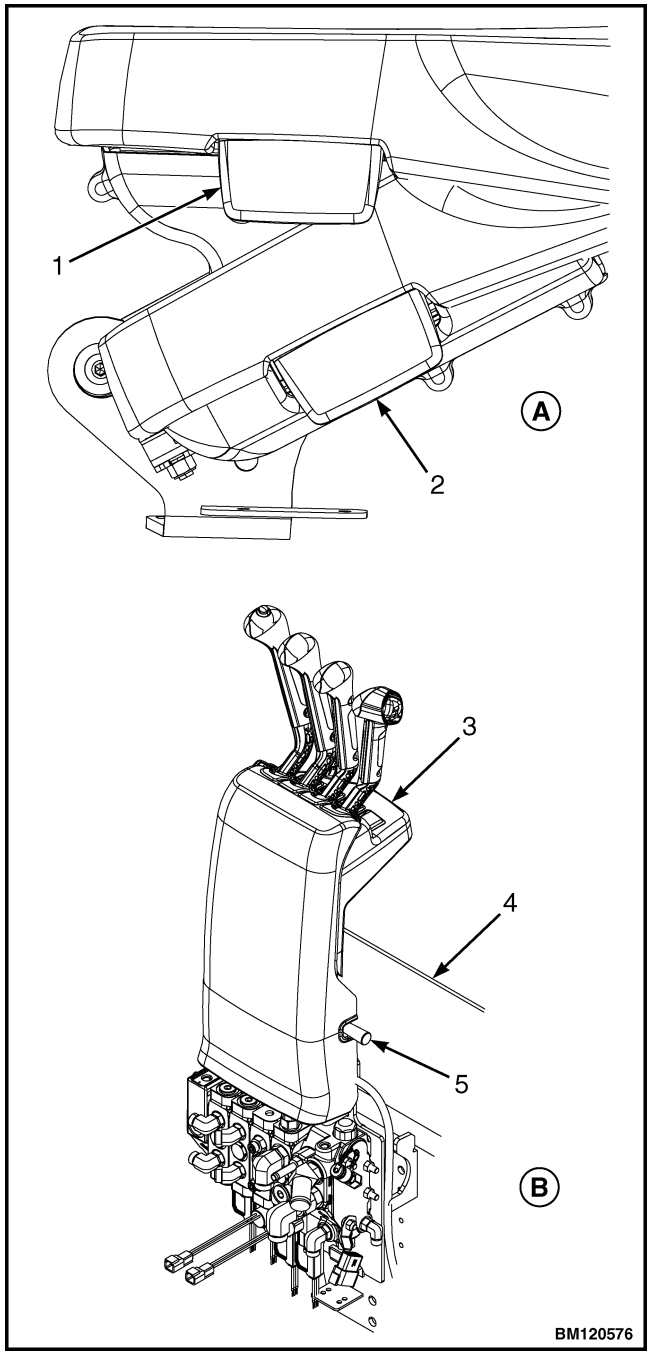
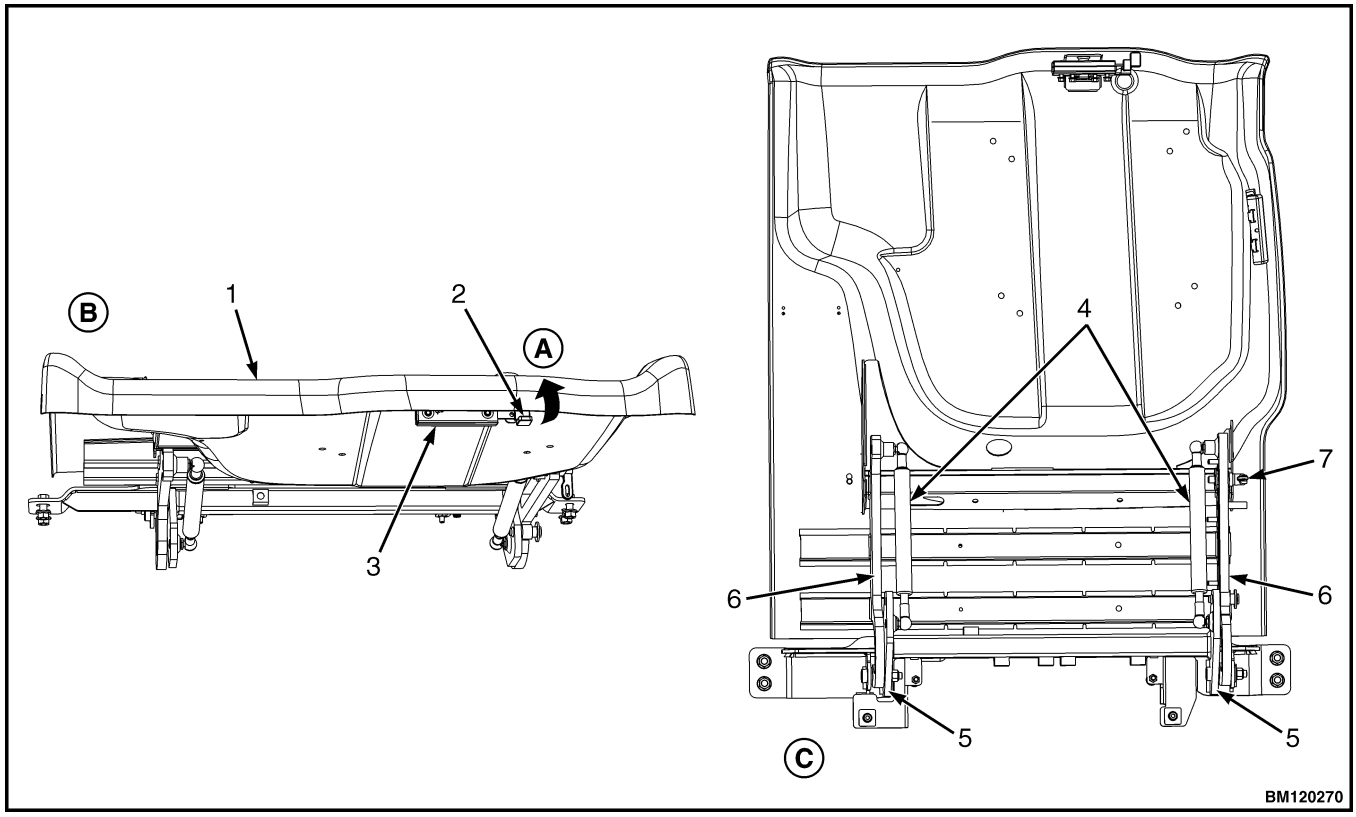


Figure 51. Hydraulic Control Levers Release Latches

Legend for Figure 51.

A. E-HYDRAULIC CONTROL LEVERS
B. MANUAL HYDRAULIC CONTROL LEVERS

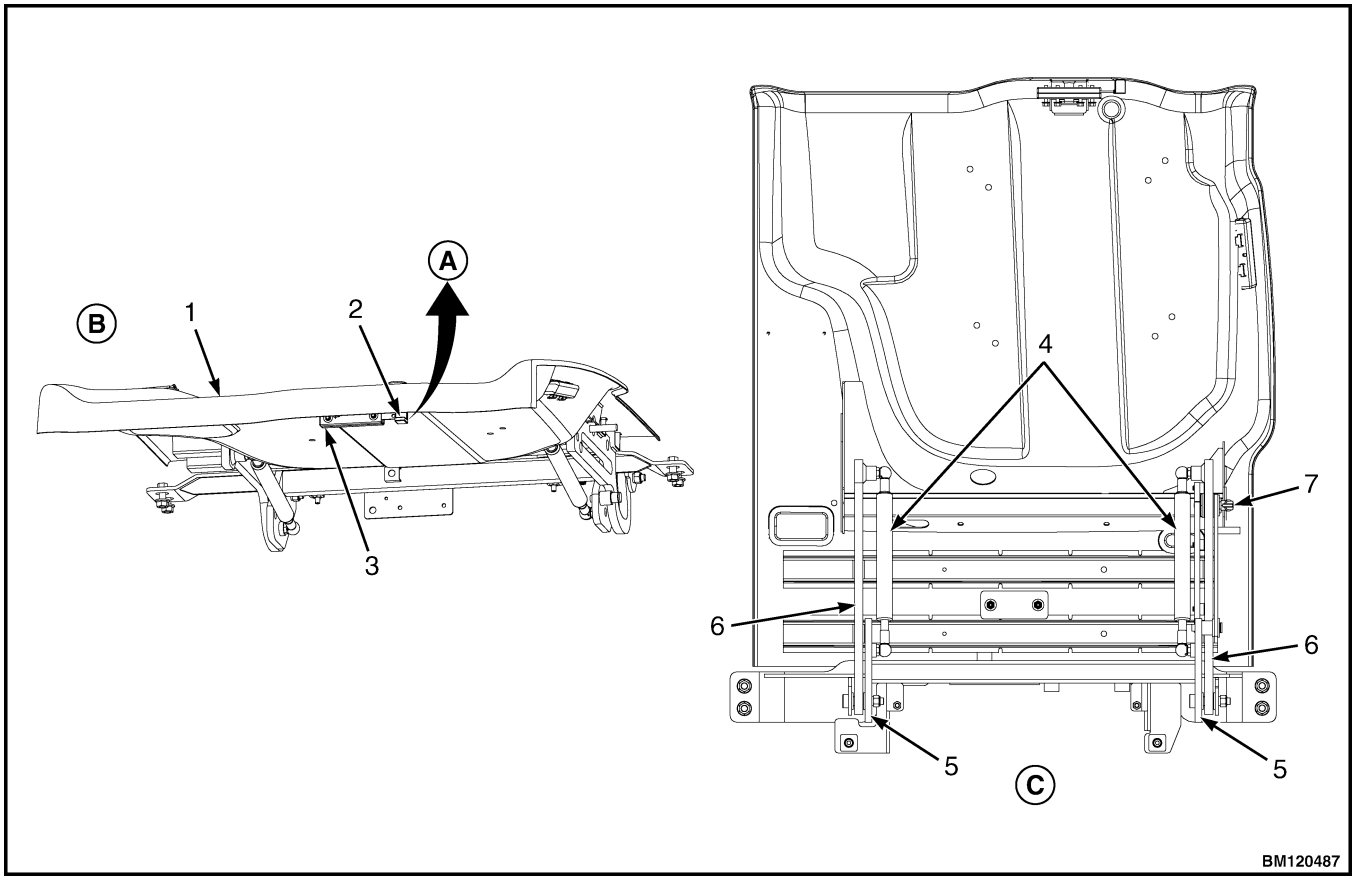
1. HANDLE MOVES ARMREST FORWARD/ BACKWARD
2. HANDLE MOVE ARMREST UP/DOWN
3. MANUAL HYDRAULIC CONTROL LEVER AND LINKAGE ASSEMBLY
4. FRONT BULKHEAD
5. MANUAL HYDRAULIC CONTROL LEVER LATCH HANDLE (PULL UP TO MOVE FORWARD)



A. RELEASE POSITION
B. FRONT VIEW
C. BOTTOM VIEW

1. HOOD
2. HOOD RELEASE HANDLE
3. HOOD LATCH ASSEMBLY
4. GAS SPRING
5. HOOD HINGE PLATE
6. HOOD HINGE ARM
7. LEVER

Figure 52. Hood and Hood Latch Arrangement, Lift Trucks Manufactured Prior to June, 2012



A. RELEASE POSITION
B. FRONT VIEW
C. BOTTOM VIEW

1. HOOD
2. HOOD RELEASE HANDLE
3. HOOD LATCH ASSEMBLY
4. GAS SPRING
5. HOOD HINGE PLATE
6. HOOD HINGE ARM
7. LEVER

Figure 53. Hood and Hood Latch Arrangement, Lift Trucks Manufactured After June, 2012

Seat Assembly

The seat assembly slides on seat rails that are fastened to spacer plates (see Figure 54) and hood by four capscrews. A lever at the left front side of the seat base controls the adjustment of the seat to the forward and backward positions. Optional seats are available in cloth or vinyl with features such as full suspension and with the ability to swivel. All seats have a seat switch (Operator Presence System) installed in the bottom cushion that senses the presence of the operator. When the operator is not on the seat, the seat switch opens and interrupts the motor controller and stops lift truck operation.

See Figure 55 for lift truck models

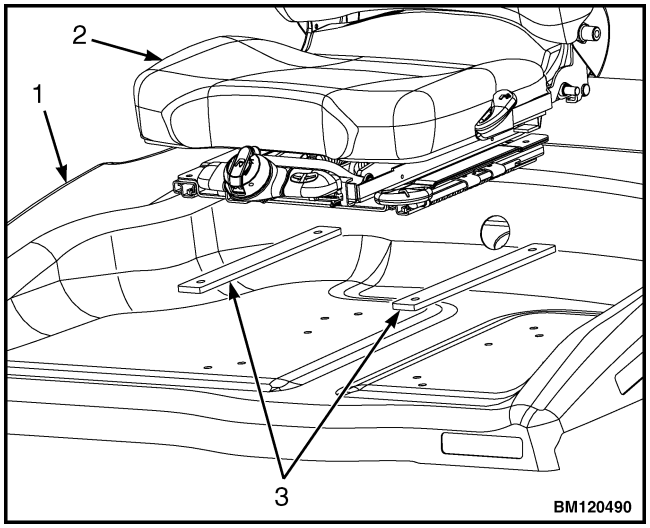
- J2.2-3.5XN (J45-70XN) (A276) manufactured prior to June, 2012

See Figure 56 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276) manufactured after June, 2012

The hood, seat belt, hip restraint brackets, seat, and seat rails are all parts of the operator restraint system. Checks and adjustments for the operator restraint system are described in the **Operating Manual** and **Periodic Maintenance** 8000SRM1372.

NOTE: The seat belt may be either black or red.



1. HOOD
2. SEAT ASSEMBLY
3. SEAT SPACER PLATES

Figure 54. Seat Spacer Location

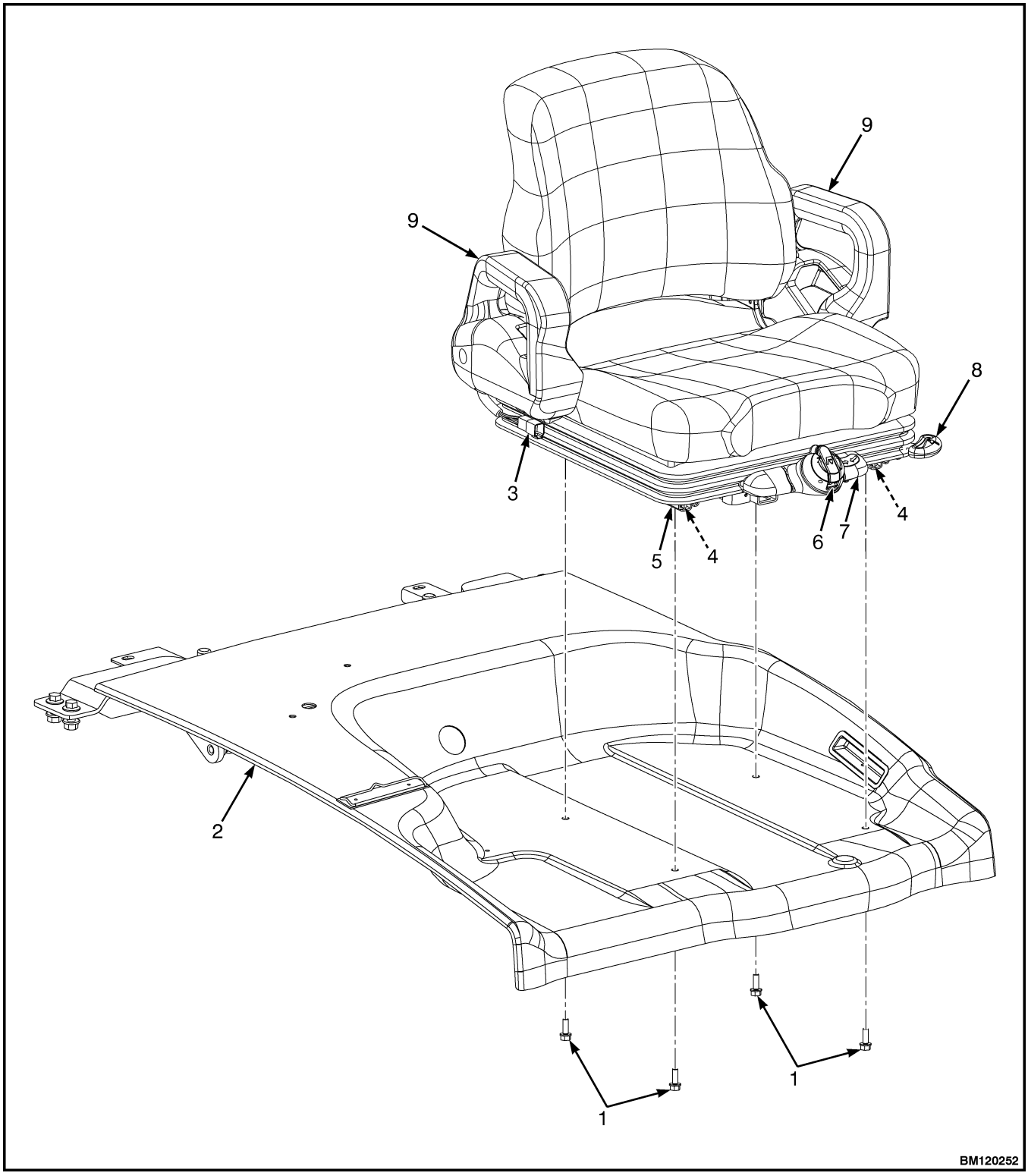


Figure 55. Seat Assembly, Lift Trucks Manufactured Prior to June, 2012

Legend for Figure 55.

NOTE: FULL SUSPENSION SEAT WITH MANUAL HYDRAULIC HIP RESTRAINTS SHOWN.

1. SEAT MOUNTING CAPSCREW
2. HOOD
3. OPERATOR PRESENCE SYSTEM CONNECTOR
4. SEAT MOUNTING NUT
5. SEAT RAIL
6. WEIGHT ADJUSTMENT KNOB
7. RIDE POSITION INDICATOR
8. FORWARD/BACKWARD LEVER
9. HIP RESTRAINT

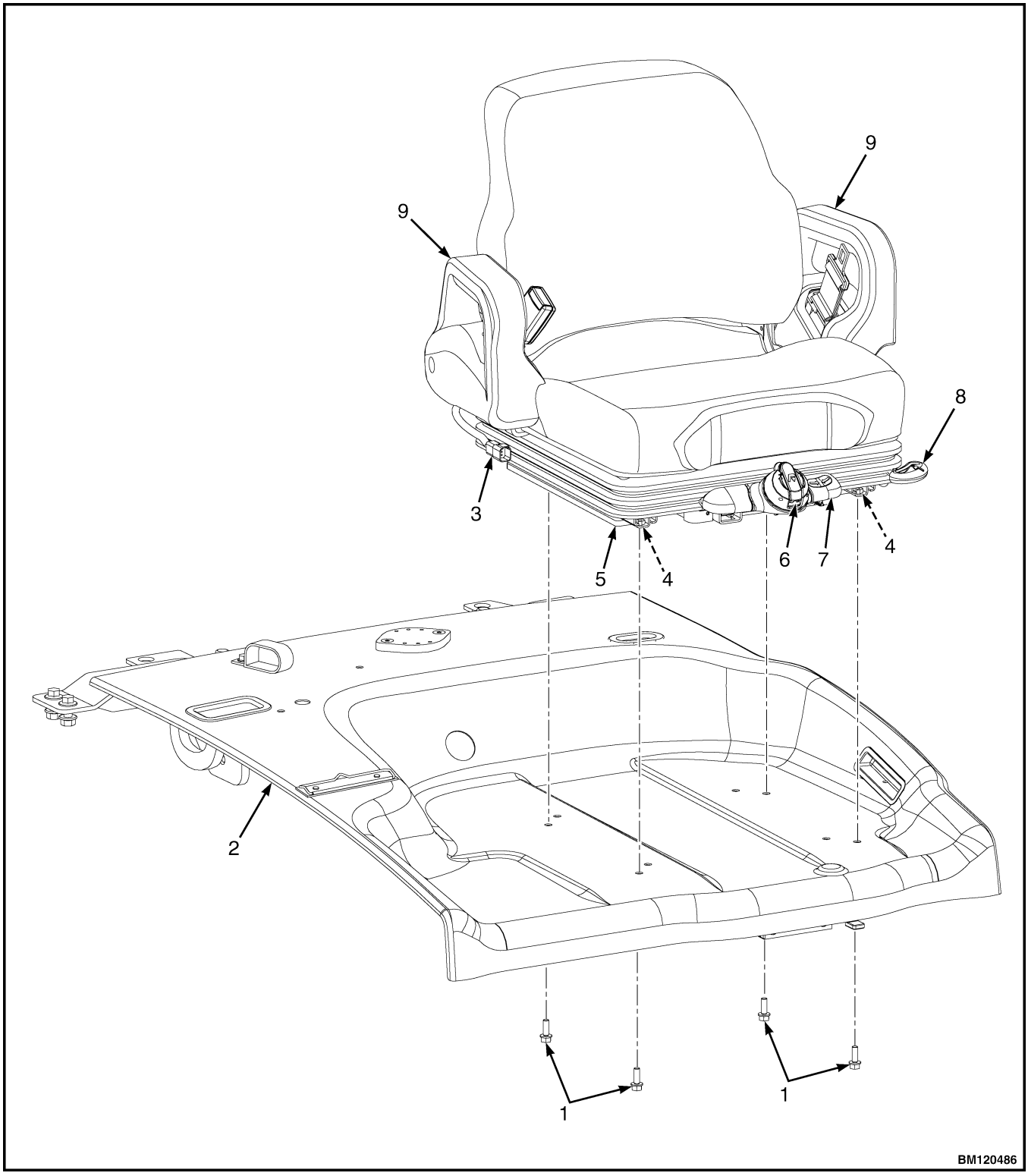


Figure 56. Seat Assembly, Lift Trucks Manufactured After June, 2012

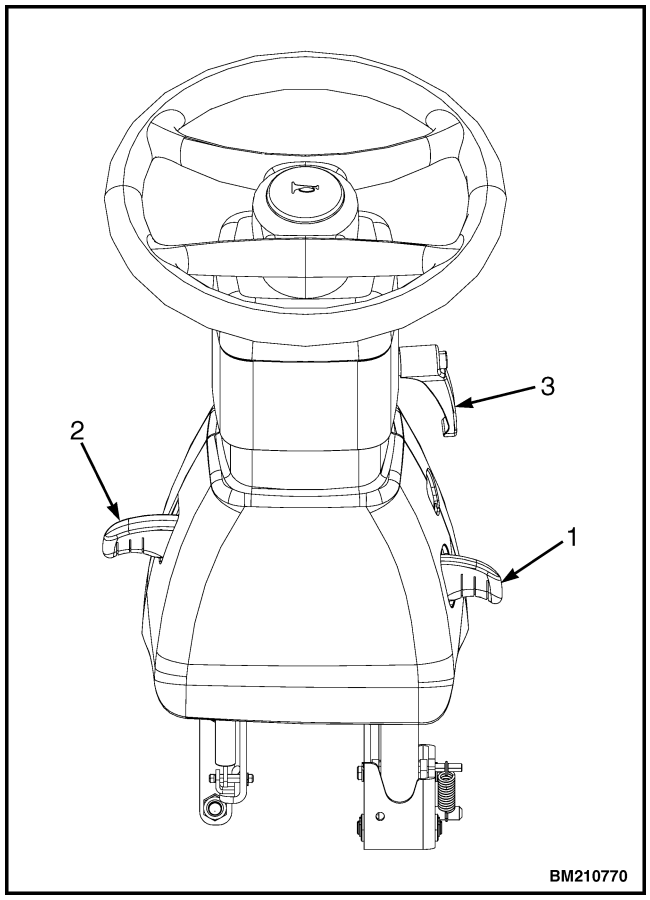
Legend for Figure 56.

NOTE: FULL SUSPENSION SEAT WITH MANUAL HYDRAULIC HIP RESTRAINTS SHOWN.

1. SEAT MOUNTING CAPSCREW
2. HOOD
3. OPERATOR PRESENCE SYSTEM CONNECTOR
4. SEAT MOUNTING NUT
5. SEAT RAIL
6. WEIGHT ADJUSTMENT KNOB
7. RIDE POSITION INDICATOR
8. FORWARD/BACKWARD LEVER
9. HIP RESTRAINT

Opening and Closing the Hood

1. Use the tilt memory lever (see Figure 57) and tilt the steering column all the way up.



NOTE: OPTIONAL TELESCOPIC STEERING COLUMN SHOWN.

1. TILT POSITION SENSOR
2. TILT MEMORY LEVER
3. TELESCOPIC COLUMN LOCKING HANDLE

Figure 57. Steering Column Levers

2. Slide the seat all the way back. Move the armrest all the way back if lift truck is equipped with E-Hydraulic control levers. See Figure 51.

3. If lift truck is equipped with manual hydraulic levers, release the latch for the manual hydraulic lever assembly and move the assembly to the forward position. See Figure 51.

Manual Hydraulic Control Levers

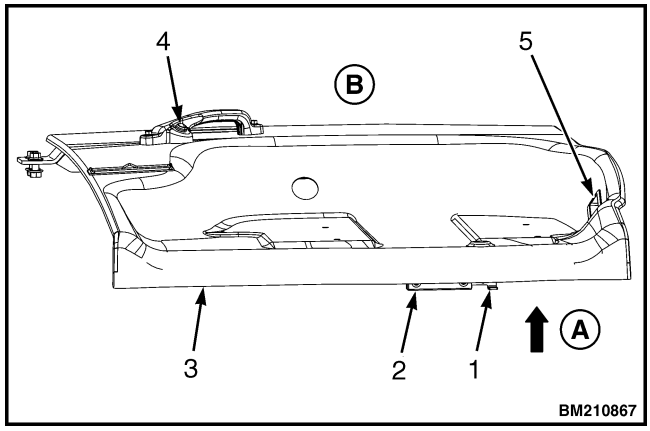
NOTE: The hood must be raised from the left side of the lift truck.

1. If lift truck is equipped with manual hydraulic control levers, open hood as follows:

a. Place hand under hood release lever and push hood release lever up to release hood latch assembly. See Figure 58.

b. Place hand in hood handle and raise hood all the way up.

c. To close the hood, lower hood until latch assembly touches latch striker. Push down on hood until it clicks once to lock. Try to lift hood up using the hood handle to make sure hood is securely latched. See Figure 58.



A. OPEN POSITION
B. FRONT VIEW

1. HOOD RELEASE LEVER
2. HOOD LATCH ASSEMBLY
3. HOOD
4. HOOD HORN BUTTON
5. HOOD HANDLE

Figure 58. Hood and Hood Handle Components

E-Hydraulic Mini-Levers

There are two ways to open and close the hood as described in Step 1 and Step 2 below.

1. To open and close the hood, perform the following:

a. Place hand in hood handle (see Figure 58) and raise hood to the first stop point. See Figure 59.

b. Turn lever to the right to the second stop. Lever will be horizontal to slot in plate. Raise hood to full upright position. See Figure 59.

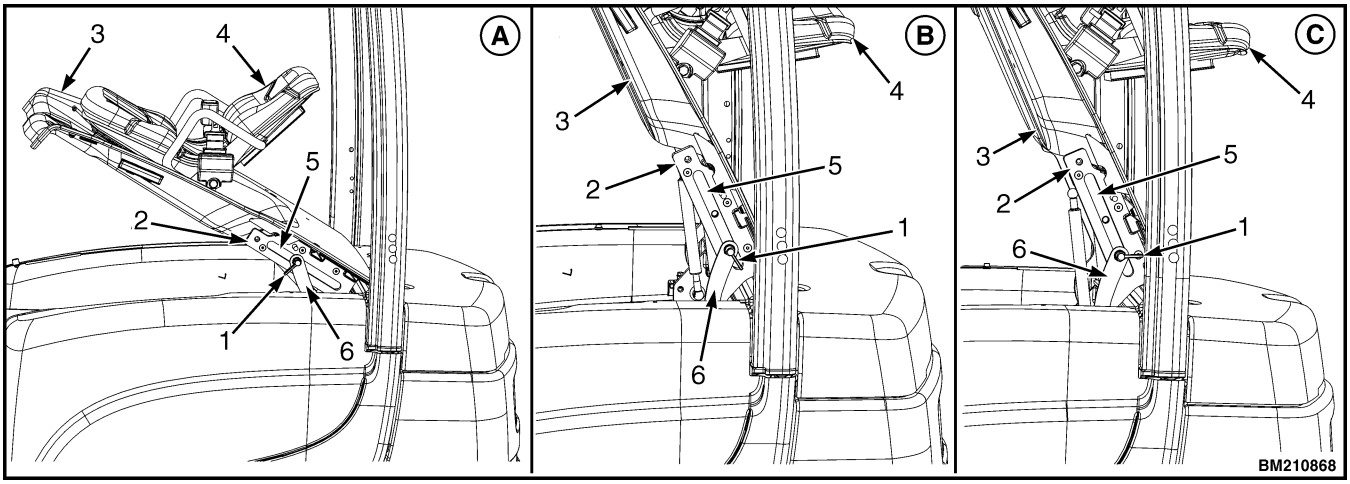
c. To close hood, lower hood to first stop point. Turn lever to left and close hood until bolt touches the striker. Push down on hood until it clicks once to lock. Try to lift hood up using hood handle to make sure hood is securely latched. See Figure 58.

See Figure 65 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276) manufactured prior to June, 2012

See Figure 66 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276) manufactured after June, 2012



NOTE: NON-SUSPENSION SEAT AND RAISED HOOD SHOWN.

A. HOOD RAISED TO FIRST STOP POINT
B. HOOD RAISED TO FULL UPRIGHT POSITION, LEVER TURNED TO SECOND STOP POINT (HORIZONTAL TO SLOT)
C. HOOD RAISED TO FULL UPRIGHT POSITION, LEVER TURNED TO THIRD STOP POINT (VERTICAL TO SLOT)

1. LEVER
2. PLATE
3. HOOD
4. SEAT
5. SLOT
6. LINK PLATE

Figure 59. Opening The Hood

2. To open and close the hood, perform the following:

a. Place hand in hood handle (see Figure 58) and raise hood to the first stop point. See Figure 59.

b. Turn lever to the right to the third stop. Lever will be vertical to slot in plate. Raise hood to full upright position. See Figure 59.

c. To close hood, lower hood down until the bolt touches the striker. Push down on hood until it clicks once to lock. Try to lift hood up using hood handle to make sure hood is securely latched. See Figure 58.

See Figure 65 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276) manufactured prior to June, 2012

See Figure 66 for lift truck models

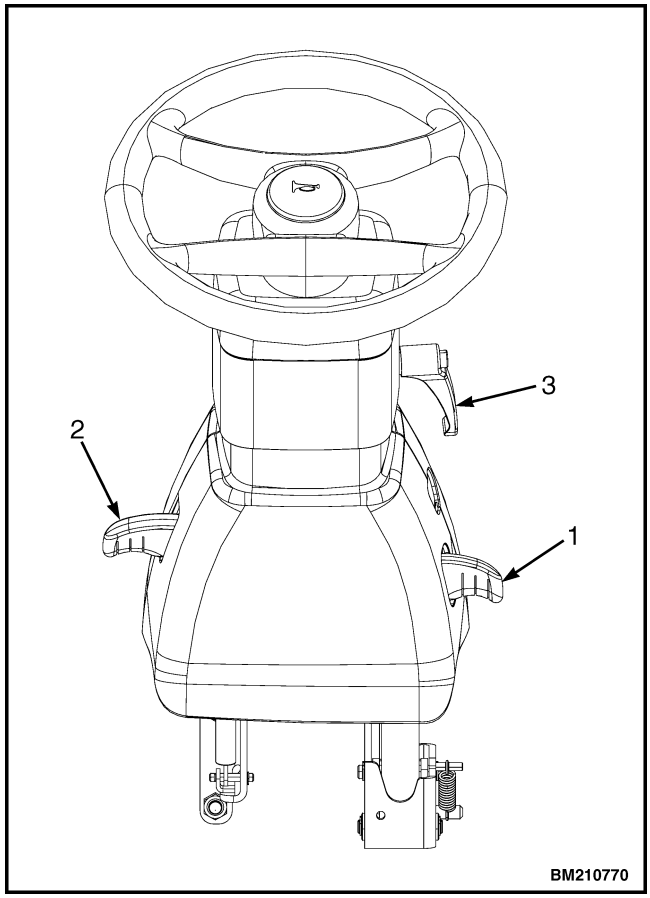
- J2.2-3.5XN (J45-70XN) (A276) manufactured after June, 2012

REMOVE

Lift Truck Models E2.2-3.5XN (E45-70XN) (A268) and E1.6-2.0XN (E30-40XN) (A269)

To raise the hood, perform the following:

1. Use the tilt memory lever and tilt the steering column all the way up. See Figure 60.



NOTE: OPTIONAL TELESCOPIC STEERING COLUMN SHOWN.

1. TILT POSITION LEVER
2. TILT MEMORY LEVER
3. TELESCOPIC COLUMN LOCKING HANDLE

Figure 60. Steering Column Tilt Memory Lever

2. Slide the seat all the way back, and if necessary, move the armrest all the way back if lift truck is equipped with E-Hydraulic control levers. See Figure 46.

3. If lift truck is equipped with manual hydraulic levers, pull the latch handle for the manual hydraulic lever assembly and move the manual hydraulic lever assembly to the forward position before raising the hood. See Figure 46.

CAUTION

Be careful while raising the hood. Injury to personnel may occur depending on lift truck overhead guard/cab height and hood configuration.

NOTE: Perform Step 4 for lift truck models E2.2-3.5XN (E45-70XN) (A268) .

NOTE: The hood can be raised from either side of the lift truck. Pull or push hood release lever. The hood release lever is spring loaded. Use a sling and crane to hold hood in up position.

4. From the left side of the lift truck, push the hood release lever out towards the right side of the truck to unlatch the hood. If hood is opened from right side of truck, pull hood release lever towards the right side of the truck to unlatch the hood. Place hand in handle provided and raise hood to the up position.

See Figure 42 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268) manufactured before June, 2012

See Figure 43 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268) manufactured after June, 2012

NOTE: Perform Step 5 for lift truck models E1.6-2.0XN (E30-40XN) (A269) .

NOTE: The hood can be raised from either side of the lift truck. The hood release lever is spring loaded. Use a sling and crane to hold hood in up position.

5. To raise hood, push hood release handle upwards to unlatch the hood. Place hands in plastic handle provided and raise hood to the up position. See Figure 44.

6. Remove the counterweight cover. See the Remove procedures in the section **Counterweight Replacement**.

7. Remove screws and latch cover from latch assembly.

See Figure 61 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268) manufactured before June, 2012

See Figure 62 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268) manufactured after June, 2012

See Figure 63 for lift truck models

- E1.6-2.0XN (E30-40XN) (A269)

NOTE: Perform Step 8 for lift truck models E2.2-3.5XN (E45-70XN) (A268) manufactured before June, 2012.

8. Remove nuts, capscrews, and latch assembly from front bulkhead. See Figure 61

NOTE: Perform Step 9 for lift truck models E2.2-3.5XN (E45-70XN) (A268) manufactured after June, 2012.

9. Remove nuts, button head capscrews, washers, and latch assembly from front bulkhead. See Figure 62.

NOTE: Perform Step 10 for lift truck models E1.6-2.0XN (E30-40XN) (A269) .

10. Remove capscrews and latch assembly from front bulkhead. See Figure 63.

NOTE: Tag electrical connectors during removal to aid in installation.

11. Disconnect battery connector.

NOTE: Perform Step 12 if lift truck is equipped with E-Hydraulics.

12. Tag and disconnect electrical connector for E-Hydraulic controller. See **Electrical System** 2200SRM1369 for procedures.

13. Tag and disconnect electrical connectors from emergency battery disconnect and hood and latch position switches. See **Electrical System** 2200SRM1369 for procedures.

14. Remove emergency battery disconnect switch if necessary. See **Electrical System** 2200SRM1369 for procedures.

NOTE: Perform Step 15 through Step 17 if removing seat assembly from hood.

15. Remove four capscrews and washers from hood, spacer plates, and rails.

    See Figure 48 for lift truck models

    - E2.2-3.5XN (E45-70XN) (A268)

    See Figure 49 for lift truck models

    - E1.6-2.0XN (E30-40XN) (A269)

16. Tag and disconnect operator presence system connector from main wire harness.

    See Figure 48 for lift truck models

    - E2.2-3.5XN (E45-70XN) (A268)

    See Figure 49 for lift truck models

    - E1.6-2.0XN (E30-40XN) (A269)

17. Remove seat assembly from hood.

NOTE: To remove seat from seat rails, perform Step 18.

18. Remove stop screws from seat rails, hold ride position indicator in the open position, and slide seat from seat rails.

    See Figure 36 for lift truck models

    - E2.2-3.5XN (E45-70XN) (A268)

    See Figure 37 for lift truck models

    - E1.6-2.0XN (E30-40XN) (A269)

NOTE: For Step 19 and Step 20, gas-controlled strut front end and back end to ball stud orientation may be reversed, depending on manufacturing date. Note orientation to aid in installation.

19. Remove locking clip from gas-controlled strut front end. Remove gas-controlled strut front end from ball stud on strut bracket. Remove ball stud, spacer, and O-ring from strut bracket.

    See Figure 61 for lift truck models

    - E2.2-3.5XN (E45-70XN) (A268) manufactured before June, 2012

    See Figure 62 for lift truck models

    - E2.2-3.5XN (E45-70XN) (A268) manufactured after June, 2012

    See Figure 63 for lift truck models

    - E1.6-2.0XN (E30-40XN) (A269)

20. Remove locking clip from gas-controlled strut back end. Remove gas-controlled strut back end from ball stud on hood hinge. Remove gas-controlled strut. Remove ball stud, spacer, and O-ring from hood hinge.

    See Figure 61 for lift truck models

    - E2.2-3.5XN (E45-70XN) (A268) manufactured before June, 2012

    See Figure 62 for lift truck models

    - E2.2-3.5XN (E45-70XN) (A268) manufactured after June, 2012

    See Figure 63 for lift truck models

    - E1.6-2.0XN (E30-40XN) (A269)

21. Repeat Step 19 and Step 20 for opposite gas-controlled strut.

22. Remove lifting device and close hood.

NOTE: Note placement of washers prior to removal to aid in installation.

23. Remove nuts, shoulder bolts, and washers from hood hinges and hood hinge arms.

See Figure 61 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268) manufactured before June, 2012

See Figure 62 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268) manufactured after June, 2012

See Figure 63 for lift truck models

- E1.6-2.0XN (E30-40XN) (A269)

24. Remove capscrews and flange nuts from hood hinge base plate and remove hood hinge base plate.

See Figure 61 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268) manufactured before June, 2012

See Figure 62 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268) manufactured after June, 2012

See Figure 63 for lift truck models

- E1.6-2.0XN (E30-40XN) (A269)

25. Using a lifting device, remove hood from lift truck.

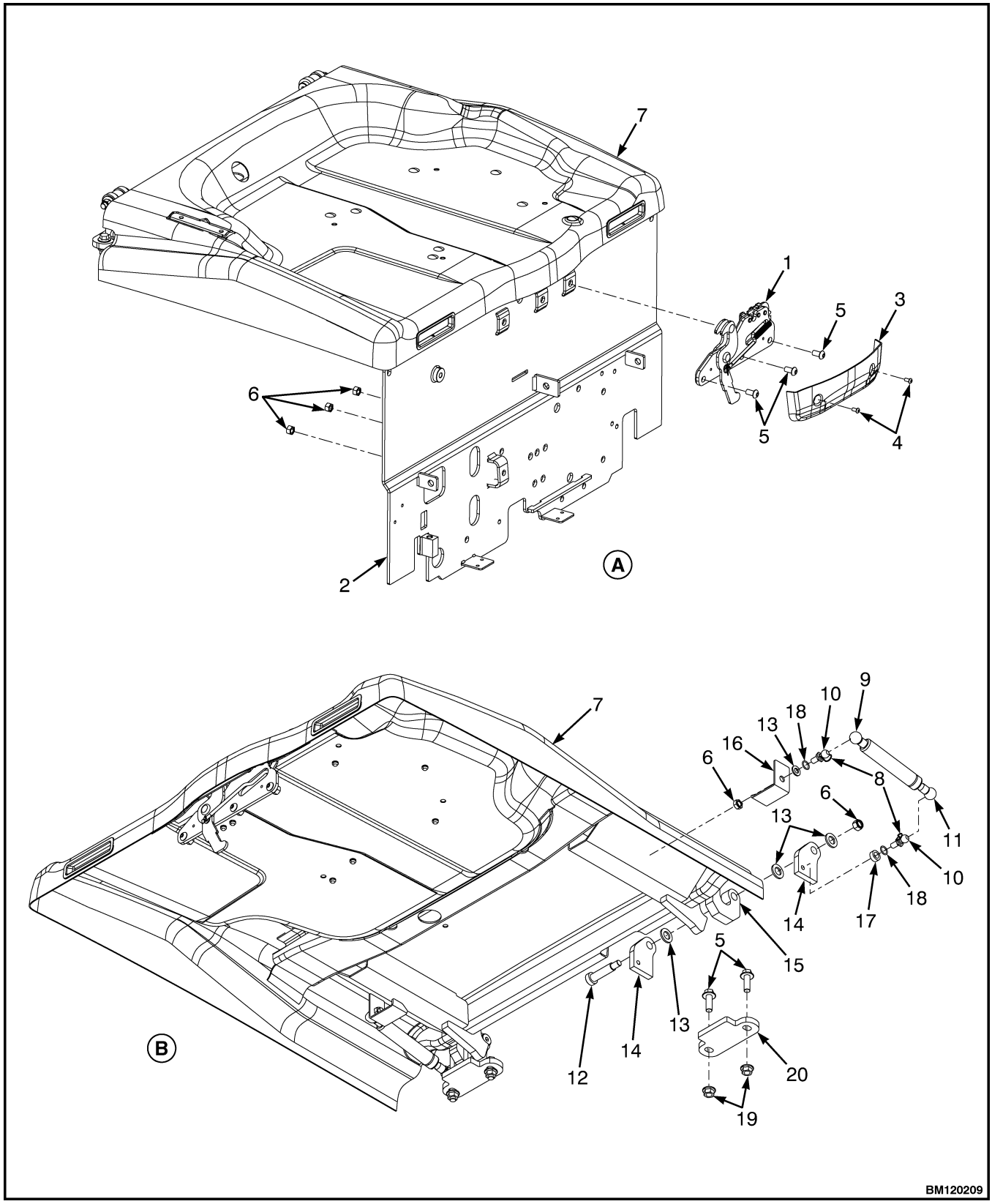


Figure 61. Hood and Latch, Lift Trucks Manufactured Prior to June, 2012E2.2-3.5XN (E45-70XN) (A268)

Legend for Figure 61.

NOTE: GAS-CONTROLLED STRUT ORIENTATION MAY BE DIFFERENT FROM SHOWN.

A. FRONT VIEW

1. LATCH ASSEMBLY
2. FRONT BULKHEAD
3. LATCH COVER
4. SCREW
5. CAPSCREW
6. NUT
7. HOOD
8. LOCKING CLIP
9. GAS-CONTROLLED STRUT FRONT END
10. BALL STUD

B. BOTTOM VIEW

11. GAS-CONTROLLED STRUT BACK END
12. SHOULDER BOLT
13. WASHER
14. HOOD HINGE
15. HOOD HINGE ARM
16. STRUT BRACKET
17. SPACER
18. O-RING
19. FLANGE NUT
20. HOOD HINGE BASE PLATE

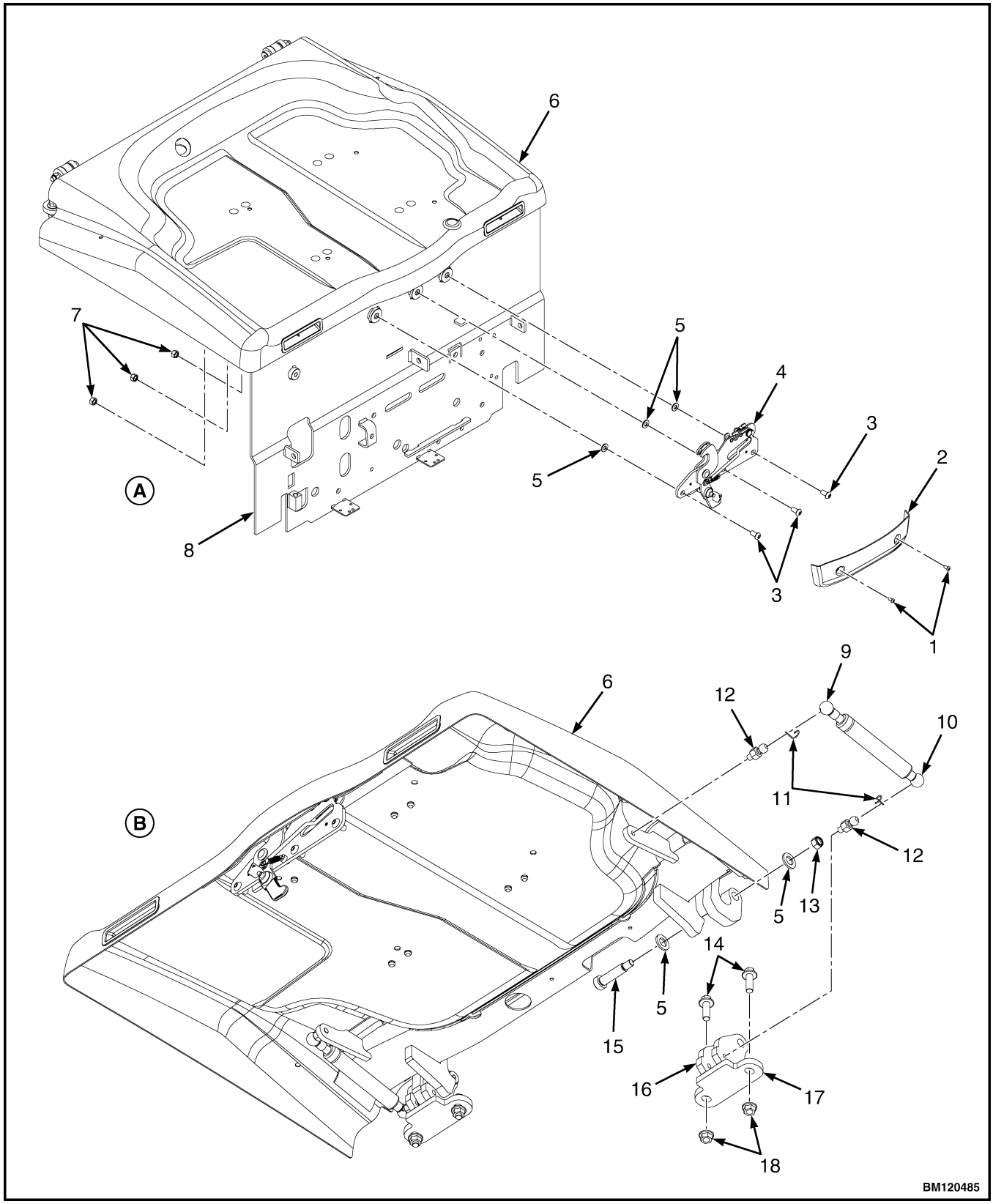


Figure 62. Hood and Latch, Lift Trucks Manufactured After June, 2012E2.2-3.5XN (E45-70XN) (A268)

Legend for Figure 62.

NOTE: GAS-CONTROLLED STRUT ORIENTATION MAY BE DIFFERENT FROM SHOWN.

A. FRONT VIEW

B. BOTTOM VIEW

1. SCREW
2. LATCH COVER
3. BUTTON HEAD CAPSCREW
4. LATCH ASSEMBLY
5. WASHER
6. HOOD
7. NUT
8. FRONT BULKHEAD
9. GAS-CONTROLLED STRUT FRONT END
10. GAS-CONTROLLED STRUT BACK END
11. LOCKING CLIP
12. BALL STUD
13. SPACER
14. CAPSCREW
15. SHOULDER BOLT
16. GAS STRUT BRACKET
17. HOOD HINGE BASE PLATE
18. SHOULDER NUT

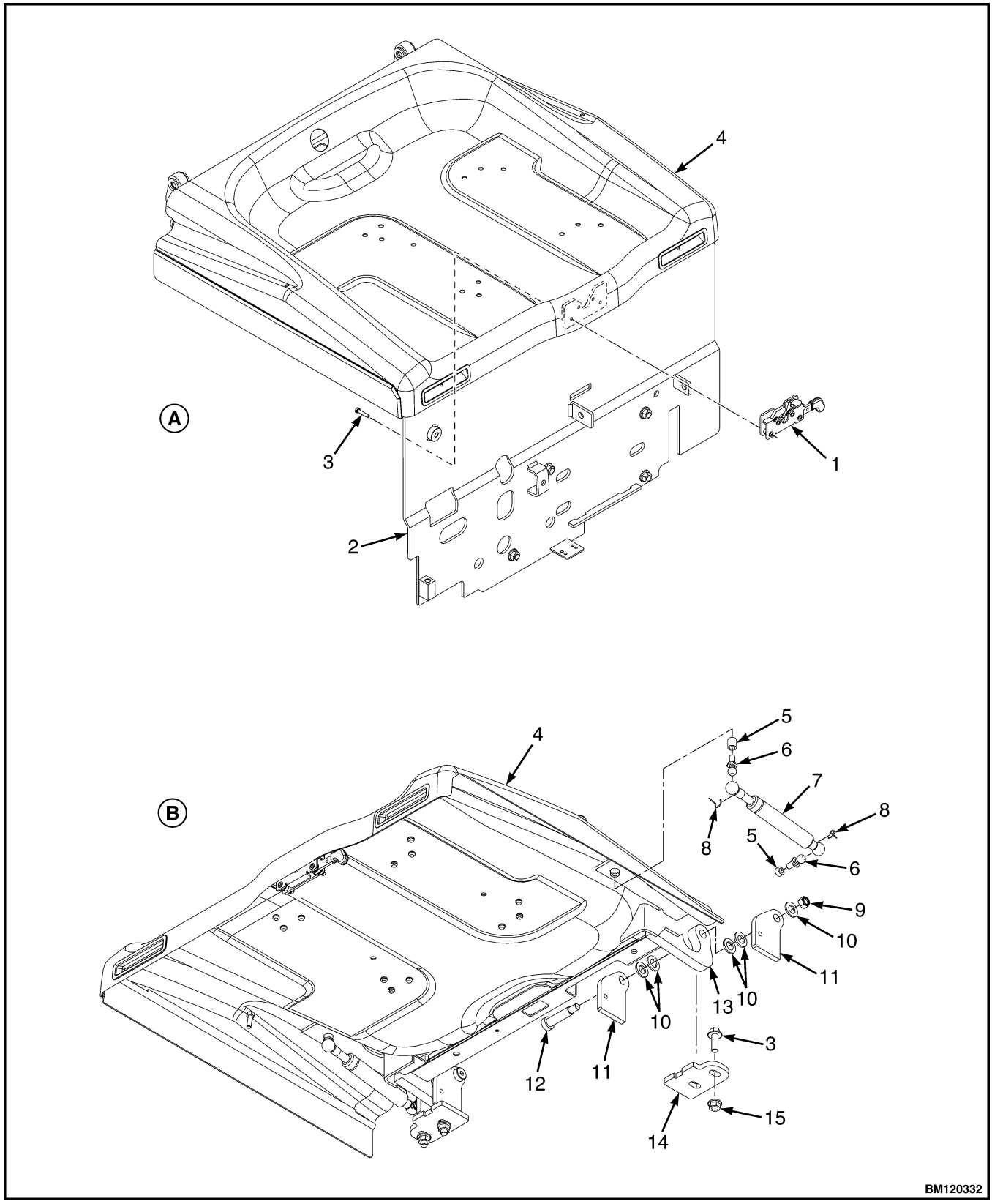


Figure 63. Hood and Latch, Lift Trucks E1.6-2.0XN (E30-40XN) (A269)

Legend for Figure 63.

NOTE: GAS-CONTROLLED STRUT ORIENTATION MAY BE DIFFERENT FROM SHOWN.

A. FRONT VIEW

1. LATCH ASSEMBLY
2. FRONT BULKHEAD
3. CAPSCREW
4. HOOD
5. SPACER
6. BALL STUD
7. GAS CONTROLLED STRUT
8. LOCKING CLIP

B. BOTTOM VIEW

9. NUT
10. WASHER
11. HOOD HINGE
12. SHOULDER BOLT
13. HOOD HINGE ARM
14. HOOD HINGE BASE PLATE
15. FLANGE NUT

Lift Truck Models E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

To raise the hood, perform the following:

1. Use the tilt memory lever and tilt the steering column all the way up. See Figure 60.

2. Slide the seat all the way back, and if necessary, move the armrest all the way back if lift truck is equipped with E-Hydraulic control levers. See Figure 46.

3. If lift truck is equipped with manual hydraulic levers, pull the latch handle for the manual hydraulic lever assembly and move the manual hydraulic lever assembly to the forward position before raising the hood. See Figure 46.

CAUTION

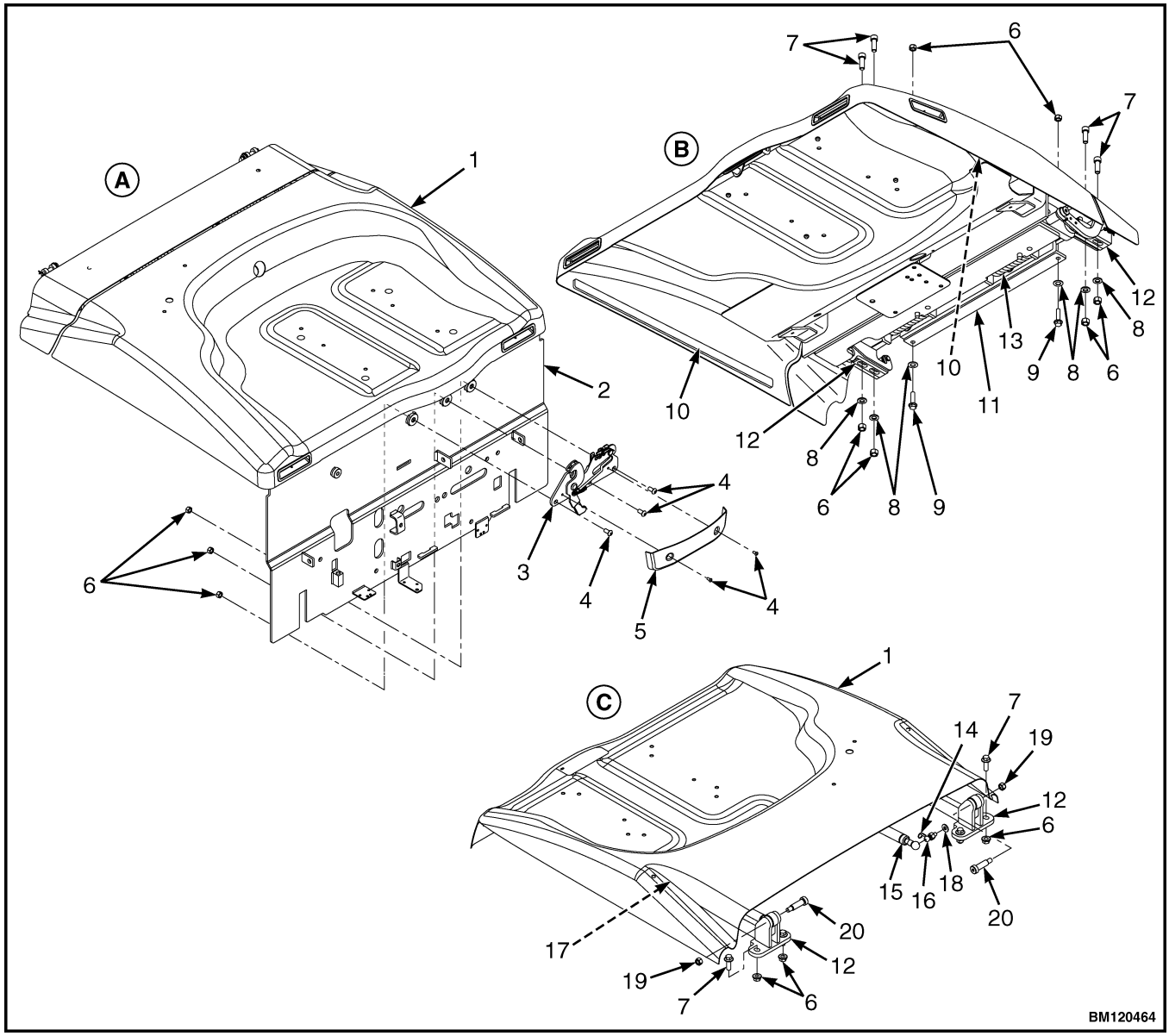
Be careful while raising the hood. Injury to personnel may occur depending on lift truck overhead guard/cab height and hood configuration.

NOTE: The hood can be raised from either side of the lift truck. Pull or push hood release lever. The hood release lever is spring loaded. Use a sling and crane to hold hood in up position.

4. From the left side of the lift truck, push the hood release lever out towards the right side of the truck to unlatch the hood. If hood is opened from right side of truck, pull hood release lever towards the right side of the truck to unlatch the hood. Place hand in handle provided and raise hood to the up position. See Figure 45.

5. Remove the counterweight cover. See the Remove procedures in the section **Counterweight Replacement**.

6. Remove screws and latch cover from latch assembly. See Figure 64.



A. FRONT VIEW
B. BOTTOM VIEW, LIFT TRUCKS EQUIPPED WITH COIL SPRINGS
C. REAR VIEW, LIFT TRUCKS EQUIPPED WITH GAS CONTROLLED STRUTS

1. HOOD
2. FRONT BULKHEAD
3. LATCH ASSEMBLY
4. SCREW
5. LATCH COVER
6. NUT
7. HINGE PLATE CAPSCREW
8. WASHER
9. SPRING CAPTURE BAR CAPSCREW
10. SIDE PLATE
11. SPRING CAPTURE BAR
12. HOOD HINGE PLATE
13. COIL SPRING
14. LOCKING CLIP
15. GAS CONTROLLED STRUT
16. BALL STUD
17. HOOD HINGE ARM
18. WASHER
19. LOCKNUT
20. SHOULDER BOLT

Figure 64. Hood and Latch, Lift Trucks E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

7. Remove nuts, capscrews, and latch assembly from front bulkhead. See Figure 64.

NOTE: Tag electrical connectors during removal to aid in installation.

8. Disconnect battery connector.

NOTE: Perform Step 9 if lift truck is equipped with E-Hydraulics.

9. Tag and disconnect electrical connector for E-Hydraulic controller. See **Electrical System** 2200SRM1369 for procedures.

10. Tag and disconnect electrical connectors from emergency battery disconnect and hood and latch position switches. See **Electrical System** 2200SRM1369 for procedures.

11. Remove emergency battery disconnect switch if necessary. See **Electrical System** 2200SRM1369 for procedures.

NOTE: Perform Step 12 through Step 14 if removing seat assembly from hood.

12. Remove four capscrews and washers from hood, spacer plates, and rails. See Figure 50.

13. Tag and disconnect operator presence system connector from main wire harness. See Figure 50.

14. Remove seat assembly from hood.

NOTE: To remove seat from seat rails, perform Step 15.

15. Remove stop screws from seat rails, hold ride position indicator in the open position, and slide seat from seat rails. See Figure 41.

NOTE: If lift truck is equipped with gas-controlled struts, perform Step 16 through Step 21. If lift truck is equipped with coil springs, go to Step 22.

16. Remove gas-controlled strut front end from ball stud. Remove ball stud from hood hinge arm. See Figure 64.

17. Remove locking clip from gas-controlled strut back end. Remove ball stud and washer from hood hinge plate. See Figure 64.

18. Repeat Step 16 and Step 17 for opposite gas-controlled strut.

19. Remove lifting device and close hood.

NOTE: Note placement of washers prior to removal to aid in installation.

20. Remove nuts, shoulder bolts, and washers from hood hinges and hood hinge arms. See Figure 64.

21. Remove capscrews and flange nuts from hood hinge base plate and remove hood hinge base plate. See Figure 64.

NOTE: Perform Step 22 and Step 23 if lift truck is equipped with coil springs.

22. Remove four capscrews and nuts from hinge plate. See Figure 64.

23. Remove two capscrews and nuts from spring capture bar. See Figure 64.

24. Using a lifting device, remove hood from lift truck.

Lift Truck Models J2.2-3.5XN (J45-70XN) (A276)

1. Open and raise hood to full upright position. See section Opening and Closing the Hood for procedures.

2. Remove capscrews and latch assembly from latch plate on front bulkhead.

   See Figure 65 for lift truck models

   - J2.2-3.5XN (J45-70XN) (A276) manufactured prior to June, 2012

   See Figure 66 for lift truck models

   - J2.2-3.5XN (J45-70XN) (A276) manufactured after June, 2012

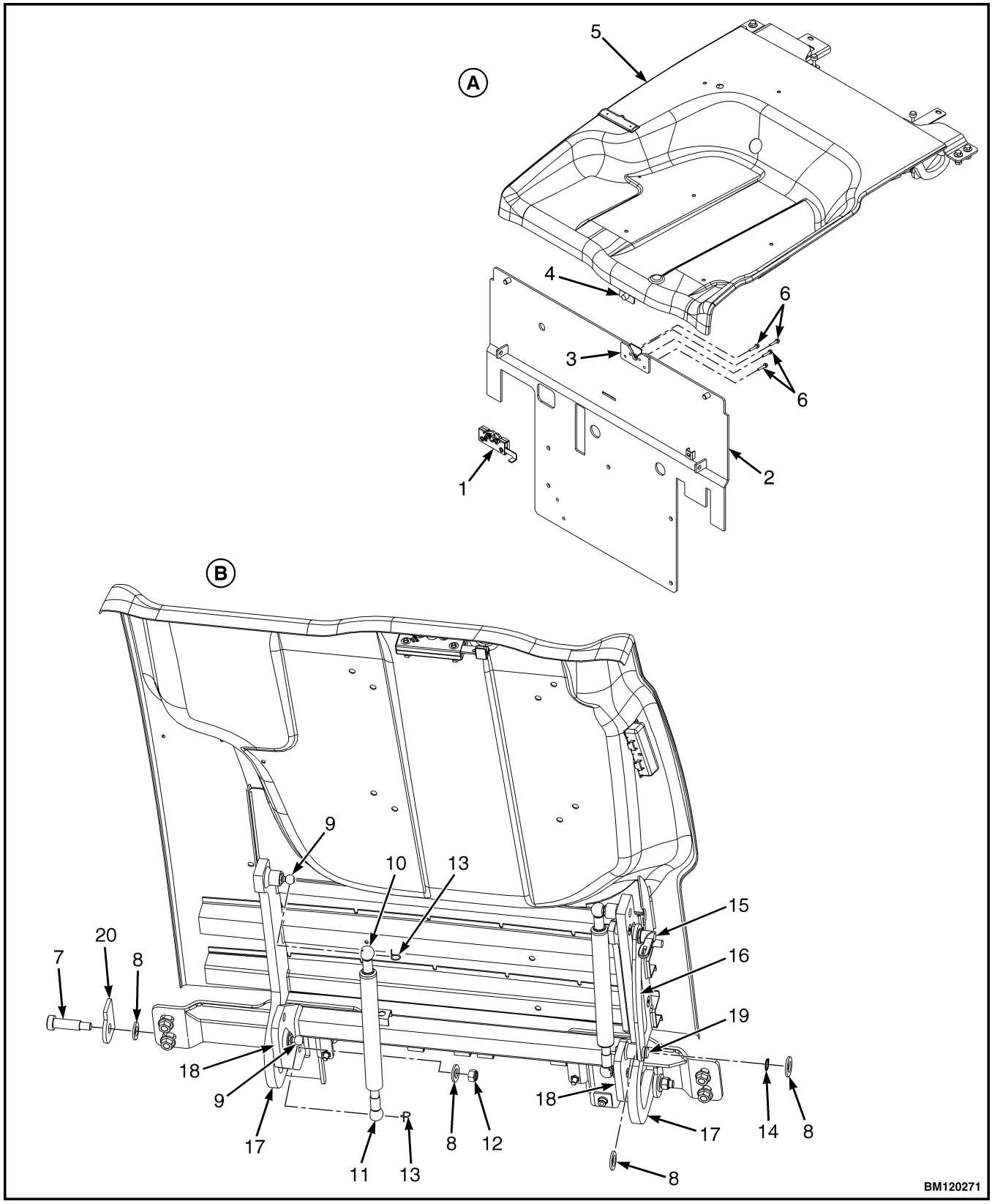


Figure 65. Hood and Latch, Lift Trucks Manufactured Prior to June, 2012

Legend for Figure 65.

A. SIDE VIEW

1. LATCH ASSEMBLY
2. FRONT BULKHEAD
3. LATCH PLATE
4. LATCH STRIKER
5. HOOD
6. CAPSCREW
7. SHOULDER BOLT
8. WASHER
9. BALL STUD
10. GAS CONTROLLED STRUT, FRONT END

B. BOTTOM VIEW

11. GAS CONTROLLED STRUT, BACK END
12. NUT
13. LOCKING CLIP
14. SNAP RING
15. LEVER
16. LINK PLATE
17. HOOD HINGE ARM
18. HOOD HINGE
19. PIN
20. PLATE

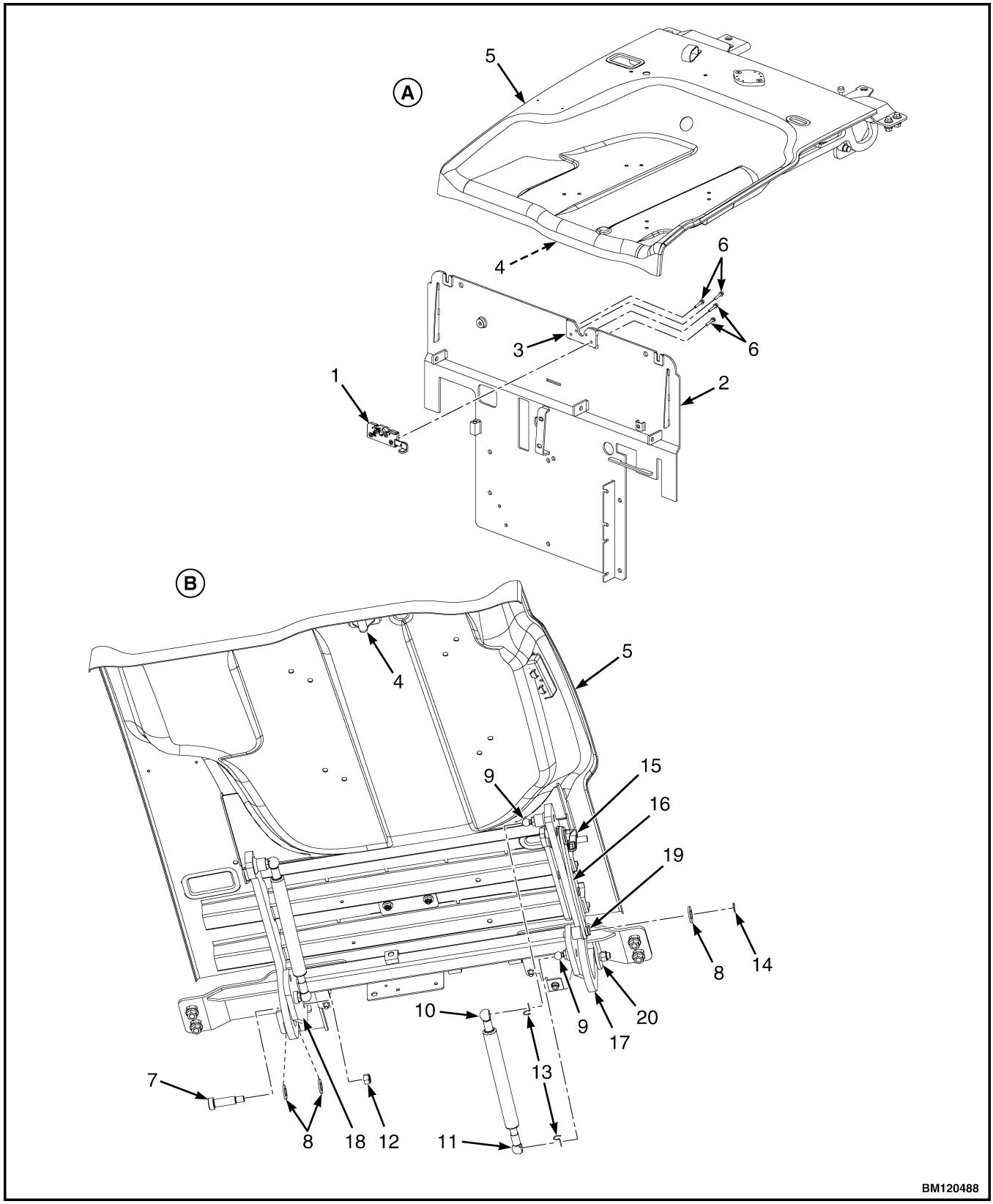


Figure 66. Hood and Latch, Lift Trucks Manufactured After June, 2012

Legend for Figure 66.

A. SIDE VIEW

1. LATCH ASSEMBLY
2. FRONT BULKHEAD
3. LATCH PLATE
4. LATCH STRIKER
5. HOOD
6. CAPSCREW
7. SHOULDER BOLT
8. WASHER
9. BALL STUD
10. GAS CONTROLLED STRUT, FRONT END

B. BOTTOM VIEW

11. GAS CONTROLLED STRUT, BACK END
12. NUT
13. LOCKING CLIP
14. SNAP RING
15. LEVER
16. LINK PLATE
17. HOOD HINGE ARM
18. HOOD HINGE
19. PIN
20. PLATE

NOTE: Tag electrical connectors during removal to aid in installation.

3. Disconnect battery connector.

NOTE: Perform Step 4 if lift truck is equipped with E-Hydraulics.

4. Tag and disconnect electrical connector for E-Hydraulic controller. See **Electrical System** 2200SRM1369 for procedures.

5. Tag and disconnect electrical connectors from emergency battery disconnect and hood and latch position switches. See **Electrical System** 2200SRM1369 for procedures.

6. Remove emergency battery disconnect switch if necessary. See **Electrical System** 2200SRM1369 for procedures.

NOTE: Perform Step 7 through Step 9 if removing seat assembly from hood.

7. Remove four capscrews and washers from hood and seat rails.

See Figure 55 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276) manufactured prior to June, 2012

See Figure 56 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276) manufactured after June, 2012

8. Tag and disconnect operator presence system connector from main wire harness.

See Figure 55 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276) manufactured prior to June, 2012

See Figure 56 for lift truck model

- J2.2-3.5XN (J45-70XN) (A276) manufactured after June, 2012

9. Remove seat assembly from hood.

NOTE: To remove seat from seat rails, perform Step 10.

10. Remove stop screws from seat rails, hold ride position indicator in open position, and slide seat from seat rails.

See Figure 38 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276) manufactured before June, 2012

See Figure 39 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276) manufactured after June, 2012

11. Remove locking clip from gas-controlled strut front end. Remove gas-controlled strut front end from ball stud and hood hinge arm.

See Figure 65 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276) manufactured prior to June, 2012

See Figure 66 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276) manufactured after June, 2012

12. Remove locking clip from gas-controlled strut back end. Remove gas-controlled strut back end from ball stud and hood hinge.

See Figure 65 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276) manufactured prior to June, 2012

See Figure 66 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276) manufactured after June, 2012

13. Repeat Step 11 and Step 12 for opposite gas-controlled strut.

14. Close hood. See Opening and Closing the Hood for procedures.

15. Remove counterweight cover. See Counterweight Replacement for Lift Truck Models E2.2-3.5XN (E45-70XN) (A268) and E1.6-2.0XN (E30-40XN) (A269) for procedures.

NOTE: Note placement of washers prior to removal to aid in installation.

16. Remove nuts, shoulder bolts, washers, and plates from hood hinges and hood hinge arms.

    See Figure 65 for lift truck models

    - J2.2-3.5XN (J45-70XN) (A276) manufactured prior to June, 2012

    See Figure 66 for lift truck models

    - J2.2-3.5XN (J45-70XN) (A276) manufactured after June, 2012

17. On left hood hinge, remove washers and snap ring from bottom of link plate. Remove bottom of link plate from pin.

    See Figure 65 for lift truck models

    - J2.2-3.5XN (J45-70XN) (A276) manufactured prior to June, 2012

    See Figure 66 for lift truck models

    - J2.2-3.5XN (J45-70XN) (A276) manufactured after June, 2012

18. Using a lifting device, remove hood from battery compartment.

INSTALL

Lift Truck Models E2.2-3.5XN (E45-70XN) (A268) and E1.6-2.0XN (E30-40XN) (A269)

1. Using a lifting device, position hood onto hinges and install washers, shoulder bolts, nuts, capscrews, and flange nuts as noted during removal.

   Tighten nuts.

   Nuts must be fully engaged with shoulder bolt and hood hinge arm assembly must be free to move.

   Add or subtract washers, if necessary, to allow hood hinge arm assembly to move freely when opening and closing hood.

   See Figure 61 for lift truck models

   - E2.2-3.5XN (E45-70XN) (A268) manufactured before June, 2012

   See Figure 62

   - E2.2-3.5XN (E45-70XN) (A268) manufactured after June, 2012

   See Figure 63 for lift truck models

   - E1.6-2.0XN (E30-40XN) (A269)

2. Open and close hood to check for proper clearance.

3. Raise hood and use a lifting device to support hood in the open position.

NOTE: For Step 4 and Step 5, gas-controlled strut front end and back end to ball stud orientation may be reversed, depending on manufacturing date. Install as noted during removal.

4. Install ball stud, spacer, and O-ring onto hood hinge. Install gas-controlled strut back end onto ball stud on hood hinge. Install locking clip on gas-controlled strut back end and ball stud.

   See Figure 61 for lift truck models

   - E2.2-3.5XN (E45-70XN) (A268) manufactured before June, 2012

   See Figure 62 for lift truck models

   - E2.2-3.5XN (E45-70XN) (A268) manufactured after June, 2012

   See Figure 63 for lift truck models

   - E1.6-2.0XN (E30-40XN) (A269)

5. Install ball stud, spacer, and O-ring onto strut bracket. Install gas-controlled strut front end onto ball stud on strut bracket. Install locking clip on gas-controlled strut front end and ball stud.

   See Figure 61 for lift truck models

   - E2.2-3.5XN (E45-70XN) (A268) manufactured before June, 2012

   See Figure 62 for lift truck models

   - E2.2-3.5XN (E45-70XN) (A268) manufactured after June, 2012

   See Figure 63 for lift truck models

   - E1.6-2.0XN (E30-40XN) (A269)

6. Repeat Step 4 and Step 5 for opposite gas-controlled strut. Close hood.

7. If seat rails were removed from seat assembly, hold ride position indicator in the open position and slide seat onto seat rails. Install stop screws.

   See Figure 36 for lift truck models

   - E2.2-3.5XN (E45-70XN) (A268)

   See Figure 37 for lift truck models

   - E1.6-2.0XN (E30-40XN) (A269)

8. If seat assembly has been removed from hood, position seat onto hood and install washers and capscrews into hood and seat rails.

   See Figure 48 for lift truck models

   - E2.2-3.5XN (E45-70XN) (A268)

   See Figure 49 for lift truck models

   - E1.6-2.0XN (E30-40XN) (A269)

NOTE: Remove tags as electrical connections are made.

9. Connect operator presence system connector to main wire harness.

   See Figure 48 for lift truck models

   - E2.2-3.5XN (E45-70XN) (A268)

   See Figure 49 for lift truck models

   - E1.6-2.0XN (E30-40XN) (A269)

10. Install hood and latch switches and emergency battery disconnect switch, if removed, and adjust as necessary. See **Electrical System** 2200SRM1369 for procedures.

11. Connect electrical wires, as tagged during removal, to emergency battery disconnect and hood and latch position switches. See **Electrical System** 2200SRM1369 for procedures.

12. If equipped, connect electrical connector for E-Hydraulic controller. See **Electrical System** 2200SRM1369 for procedures.

NOTE: Perform Step 13 for lift truck models E2.2-3.5XN (E45-70XN) (A268) manufactured before June, 2012.

13. Install nuts, capscrews, and latch assembly to front bulkhead. Install screws and latch cover to latch assembly.

NOTE: Perform Step 14 for lift truck models E2.2-3.5XN (E45-70XN) (A268) manufactured after June, 2012.

14. Install nuts, button head capscrews, washers, and latch assembly to front bulkhead. Install screws and latch cover to latch assembly.

15. Connect battery connector.

16. Close hood and remove lifting device.

17. Install counterweight cover. See the Install procedures in the section **Counterweight Replacement**.

18. If lift truck is equipped with manual hydraulic control levers, push manual hydraulic control lever assembly until it clicks into place.

Lift Truck Models E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

1. Using a lifting device, position hood onto hinges and install washers, shoulder bolts, nuts, capscrews, and flange nuts as noted during removal. See Figure 64.

   Tighten nuts.

   Nuts must be fully engaged with shoulder bolt and hood hinge arm assembly must be free to move.

   Add or subtract washers, if necessary, to allow hood hinge arm assembly to move freely when opening and closing hood.

2. Open and close hood to check for proper clearance.

3. Raise hood and use a lifting device to support hood in the open position.

NOTE: Perform Step 4 and Step 5 if lift truck is equipped with gas-controlled struts. If left truck is equipped with coil springs, perform Step 7 through Step 9.

4. Install gas-controlled strut back end onto ball stud on hood hinge. Install washer and locking clip on gas-controlled strut back end and ball stud. See Figure 64.

5. Install gas-controlled strut front end and ball stud on hood hinge arm. See Figure 64.

6. Repeat Step 4 and Step 5 for opposite gas-controlled strut. Close hood.

7. Slide spring ends into position on spring capture bar.

8. Install spring capture bar using two capscrews and nuts. See Figure 64.

9. Install hinge plate using four capscrew flange nuts. See Figure 64.

10. If seat rails were removed from seat assembly, hold ride position indicator in the open position and slide seat onto seat rails. Install stop screws. See Figure 41.

11. If seat assembly has been removed from hood, position seat onto hood and install washers and capscrews into hood and seat rails. See Figure 50.

NOTE: Remove tags as electrical connections are made.

12. Connect operator presence system connector to main wire harness. See Figure 50.

13. Install hood and latch switches and emergency battery disconnect switch, if removed, and adjust as necessary. See **Electrical System** 2200SRM1369 for procedures.

14. Connect electrical wires, as tagged during removal, to emergency battery disconnect and hood and latch position switches. See **Electrical System** 2200SRM1369 for procedures.

15. If equipped, connect electrical connector for E-Hydraulic controller. See **Electrical System** 2200SRM1369 for procedures.

16. Install nuts, capscrews, and latch assembly to front bulkhead. Install screws and latch cover to latch assembly.

17. Connect battery connector.

18. Close hood and remove lifting device.

19. Install counterweight cover. See the Install procedures in the section **Counterweight Replacement**.

20. If lift truck is equipped with manual hydraulic control levers, push manual hydraulic control lever assembly until it clicks into place.

Lift Truck Models J2.2-3.5XN (J45-70XN) (A276)

1. Using a lifting device, position hood onto hinges and install washers, shoulder bolts, nuts, and plates as noted during removal.

   Tighten nuts.

   Nuts must be fully engaged with shoulder bolt and hood hinge arm assembly must be free to move.

   Add or subtract washers, if necessary, to allow hood hinge arm assembly to move freely when opening and closing hood.

   See Figure 65 for lift truck models

   - J2.2-3.5XN (J45-70XN) (A276) manufactured prior to June, 2012

   See Figure 66 for lift truck models

   - J2.2-3.5XN (J45-70XN) (A276) manufactured after June, 2012

2. On left side of hood hinge, install washer and bottom of link plate to pin. Install other washer and snap ring to secure bottom of link plate to pin.

   See Figure 65 for lift truck models

   - J2.2-3.5XN (J45-70XN) (A276) manufactured prior to June, 2012

   See Figure 66 for lift truck models

   - J2.2-3.5XN (J45-70XN) (A276) manufactured after June, 2012

3. Open and close hood to check for proper clearance. See Opening and Closing the Hood for procedures.

4. Install counterweight cover. See Counterweight Replacement for Lift Truck Models E2.2-3.5XN (E45-70XN) (A268) and E1.6-2.0XN (E30-40XN) (A269) for procedures.

5. Raise hood. Install gas-controlled strut back end onto ball stud on hood hinge. Install locking clip on gas-controlled strut back end and ball stud.

   See Figure 65 for lift truck models

   - J2.2-3.5XN (J45-70XN) (A276) manufactured prior to June, 2012

   See Figure 66 for lift truck models

   - J2.2-3.5XN (J45-70XN) (A276) manufactured after June, 2012

6. Install gas-controlled strut front end onto ball stud on hood hinge arm. Install locking clip on gas-controlled strut front end and ball stud.

   See Figure 65 for lift truck models

   - J2.2-3.5XN (J45-70XN) (A276) manufactured prior to June, 2012

   See Figure 66 for lift truck models

   - J2.2-3.5XN (J45-70XN) (A276) manufactured after June, 2012

7. Repeat Step 5 and Step 6 for opposite gas-controlled strut.

8. If seat rails were removed from seat assembly, hold ride position indicator in the open position and slide seat onto seat rails. Install stop screws.

   See Figure 38 for lift truck models

   - J2.2-3.5XN (J45-70XN) (A276) manufactured before June, 2012

   See Figure 39 for lift truck models

   - J2.2-3.5XN (J45-70XN) (A276) manufactured after June, 2012

9. If seat assembly has been removed from hood, position seat onto hood and install capscrews and washers into hood and seat rails.

   See Figure 55 for lift truck models

   - J2.2-3.5XN (J45-70XN) (A276) manufactured prior to June, 2012

   See Figure 56 for lift truck model

   - J2.2-3.5XN (J45-70XN) (A276) manufactured after June, 2012

NOTE: Remove tags as electrical connections are made.

10. Connect operator presence system connector to main wire harness.

    See Figure 55 for lift truck models

    - J2.2-3.5XN (J45-70XN) (A276) manufactured prior to June, 2012

    See Figure 56 for lift truck model

    - J2.2-3.5XN (J45-70XN) (A276) manufactured after June, 2012

11. Install hood and latch switches and emergency battery disconnect switch, if removed, and adjust as necessary. See **Electrical System** 2200SRM1369 for procedures.

12. Connect electrical wires, as tagged during removal, to emergency battery disconnect and hood and latch position switches. See **Electrical System** 2200SRM1369 for procedures.

13. If equipped, connect electrical connector for E-Hydraulic controller. See **Electrical System** 2200SRM1369 for procedures.

14. Connect battery connector.

15. Install capscrews and latch assembly to latch plate on front bulkhead.

    See Figure 65 for lift truck models

    - J2.2-3.5XN (J45-70XN) (A276) manufactured prior to June, 2012

    See Figure 66 for lift truck models

    - J2.2-3.5XN (J45-70XN) (A276) manufactured after June, 2012

16. Close hood. See procedures in Opening and Closing the Hood. Make certain locking mechanism for hood is properly engaged.

17. If lift truck is equipped with manual hydraulic control levers, push manual hydraulic control lever assembly until it clicks into place.

GROUND TEST FOR LIFT TRUCK MODELS E2.2-3.5XN (E45-70XN) (A268), E1.6-2.0XN (E30-40XN) (A269), AND E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

If the static discharge ground connection is not secured properly it could lead to the possible failure of the traction and/or pump motor controllers. Perform Ground Test found in the General section of this **Service Manual** to ensure static discharge ground connection is properly secured.

GROUND TEST FOR LIFT TRUCK MODELS J2.2-3.5XN (J45-70XN) (A276)

If the static discharge ground connection is not secured properly it could lead to the possible failure of the traction and/or pump motor controllers. Perform Ground Test found in the General section of this **Service Manual** to ensure static discharge ground connection is properly secured.

Hood and Seat Assembly Replacement for Lift Truck Model J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

GENERAL

Hood Assembly

NOTE: Lift truck models J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) manufactured after May 2012, have a hood latch cover. See Figure 69.

The hood is the platform for the seat assembly and is located above the battery. It functions as a battery restraint that completely covers the battery compartment. When correctly locked to the frame, it will hold the battery in the battery compartment if an accident causes lift truck to tip over. The hood is a welded, steel assembly. Two hood hinges at the back attach to the counterweight. A latch assembly on the front bulkhead, locks the hood closed during operation. Gas-controlled struts hold hood in open position.

See Figure 68 for lift truck models

- J4.0-5.0XN (J80-100XN) (A970) manufactured before May 2012.

See Figure 69 for lift truck models

- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) manufactured after May 2012.

Opening the latch assembly unlocks hood from frame so the hood can be raised to access the battery. The latch assembly must be in good condition and properly secured before lift truck can be operated. If the hood latch assembly does not lock hood in closed position, the lift truck must not be operated.

See Figure 68 for lift truck models

- J4.0-5.0XN (J80-100XN) (A970) manufactured before May 2012.

See Figure 69 for lift truck models

- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) manufactured after May 2012.

To open the hood on lift truck with manual hydraulics, the manual hydraulic control levers and linkage assembly must be moved. Pull release lever up and allow manual hydraulic linkage and handles to move forward and away from mounting plate on front bulkhead. Slide the seat all the way back. If the latch assembly does not lock the hood in the closed position, the manual hydraulic levers and linkage assembly will not lock into position and the lift truck will not operate. See Figure 67.

To open hood on lift trucks equipped with E-Hydraulic control levers, slide seat and armrest all the way back. See Figure 67.

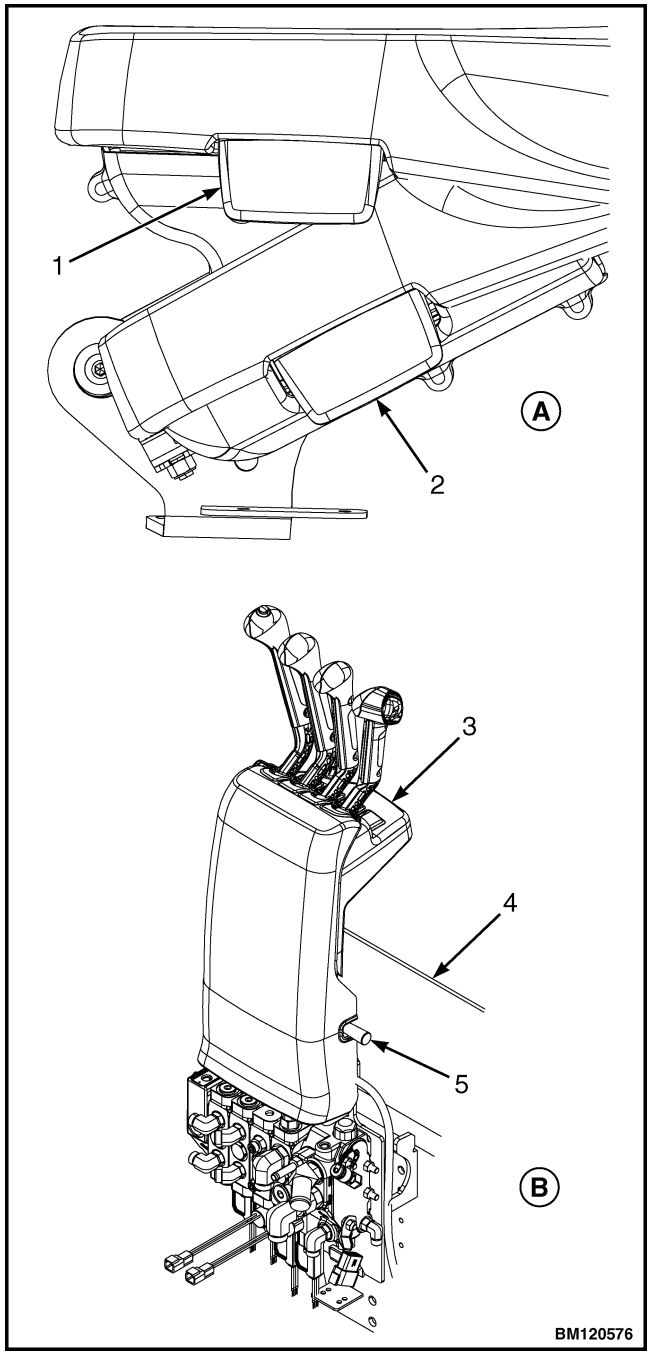
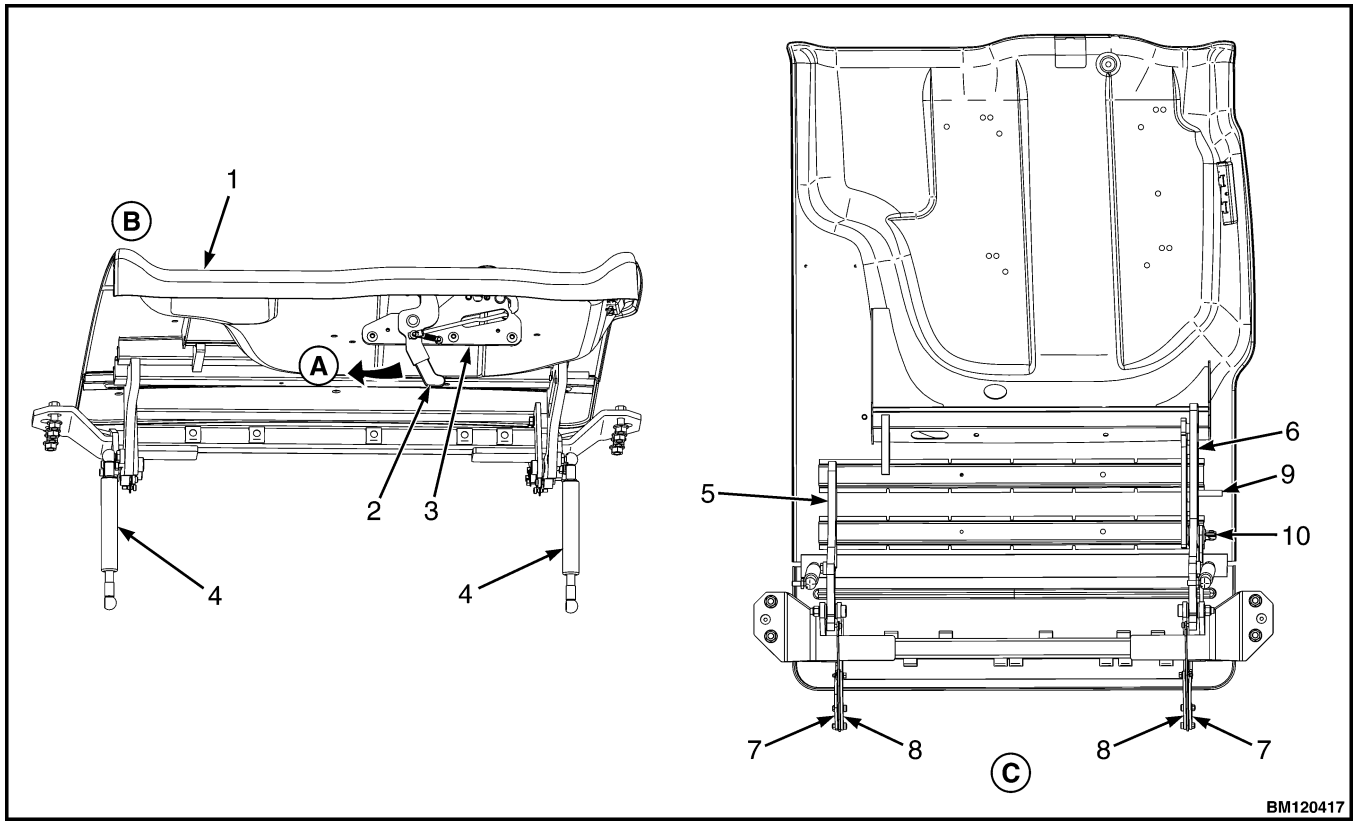


Figure 67. Hydraulic Control Levers Release Latches

Legend for Figure 67.

A. E-HYDRAULIC CONTROL LEVERS
B. MANUAL HYDRAULIC CONTROL LEVERS

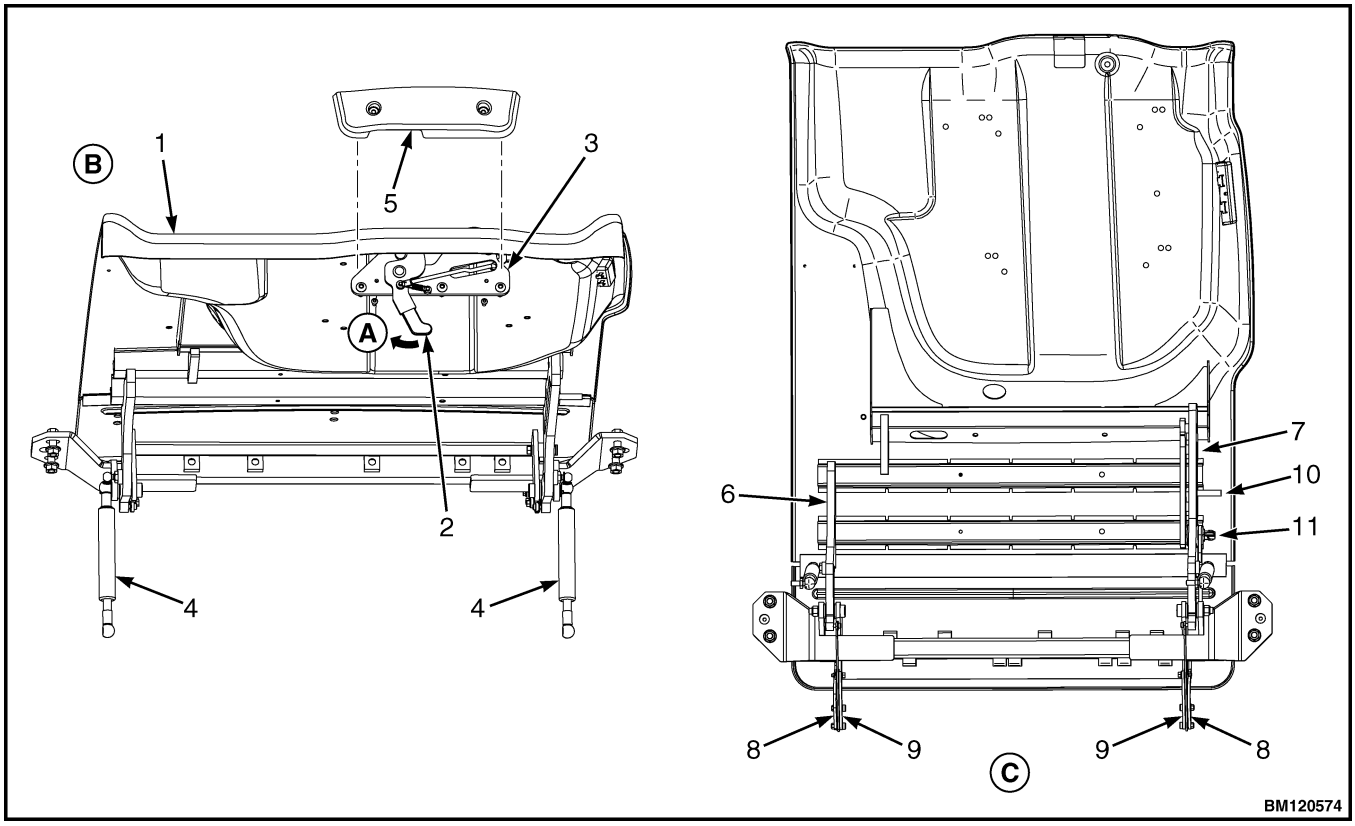
1. HANDLE MOVES ARMREST FORWARD/ BACKWARD
2. HANDLE MOVE ARMREST UP/DOWN
3. MANUAL HYDRAULIC CONTROL LEVER AND LINKAGE ASSEMBLY
4. FRONT BULKHEAD
5. MANUAL HYDRAULIC CONTROL LEVER LATCH HANDLE (PULL UP TO MOVE FORWARD)



A. OPEN POSITION
B. FRONT VIEW
C. BOTTOM VIEW

1. HOOD
2. HOOD RELEASE HANDLE
3. HOOD LATCH ASSEMBLY
4. GAS SPRING
5. RIGHT HINGE ARM
6. LEFT HINGE ARM
7. HOOD HINGE
8. SPACER
9. PIN
10. LEVER

Figure 68. Hood and Hood Latch Arrangement, Lift Trucks Manufactured Before May 2012J4.0-5.0XN (J80-100XN) (A970)



A. OPEN POSITION
B. FRONT VIEW
C. BOTTOM VIEW

1. HOOD
2. HOOD RELEASE HANDLE
3. HOOD LATCH ASSEMBLY
4. GAS SPRING
5. HOOD LATCH COVER
6. RIGHT HINGE ARM
7. LEFT HINGE ARM
8. HOOD HINGE
9. SPACER
10. PIN
11. LEVER

Figure 69. Hood and Hood Latch Arrangement, Lift Trucks Manufactured After May 2012J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

Seat Assembly

The seat assembly slides on seat rails that are fastened to hood by four capscrews. A lever at the left front side of the seat base controls the adjustment of seat to the forward and backward positions. Optional seats are available in cloth or vinyl with features such as full suspension and with the ability to swivel. All seats have a seat switch (Operator Presence System) installed in the bottom cushion that senses the presence of the operator. When the operator is not on the seat, the seat switch opens and interrupts the motor controller and stops lift truck operation. See Figure 70.

NOTE: The seat belt may be either black or red.

The hood, seat belt, hip restraint brackets, seat, and seat rails are all parts of the operator restraint system. Checks and adjustments for the operator restraint system are described in the **Operating Manual** and **Periodic Maintenance** 8000SRM1541.

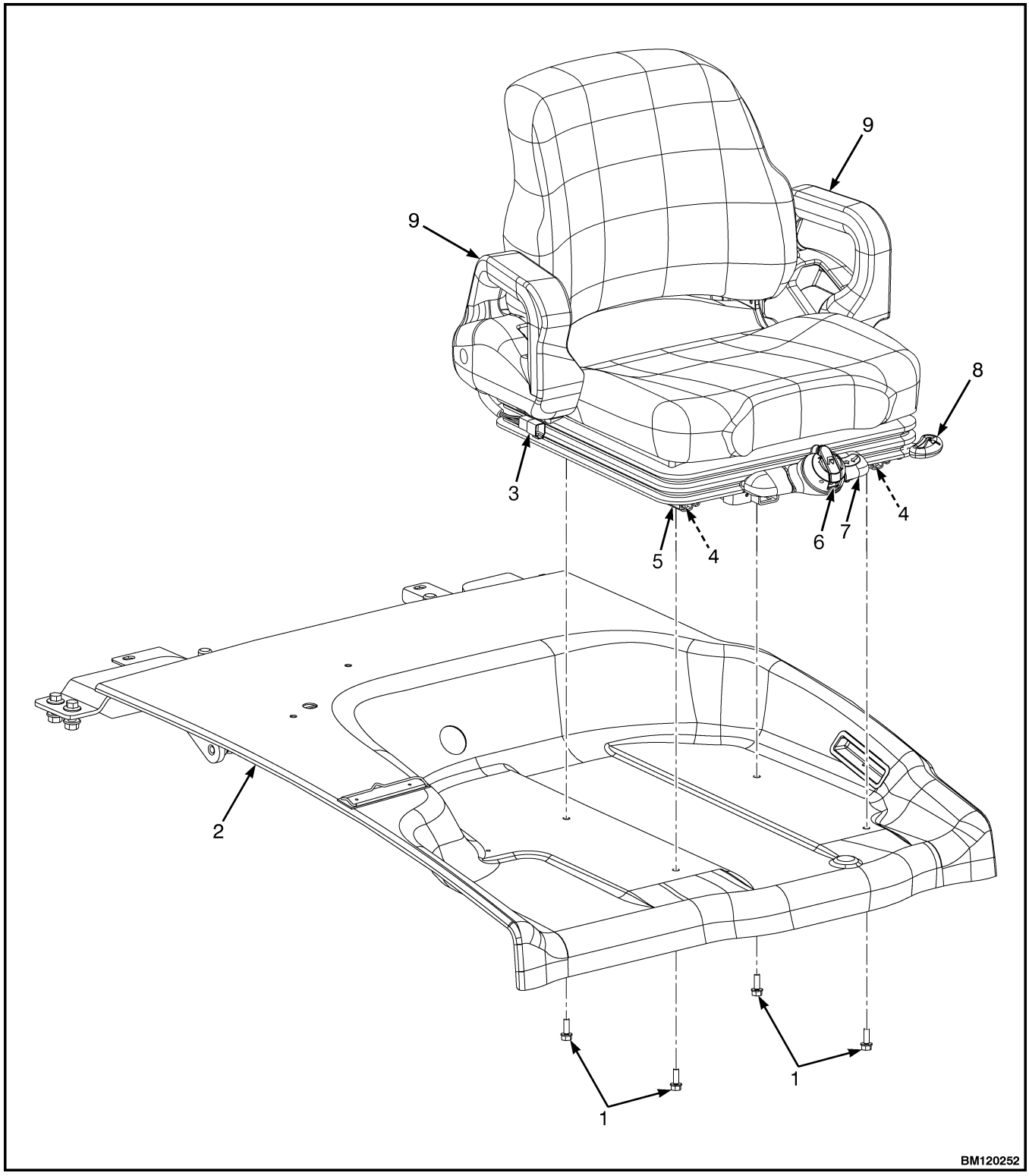


Figure 70. Seat Assembly

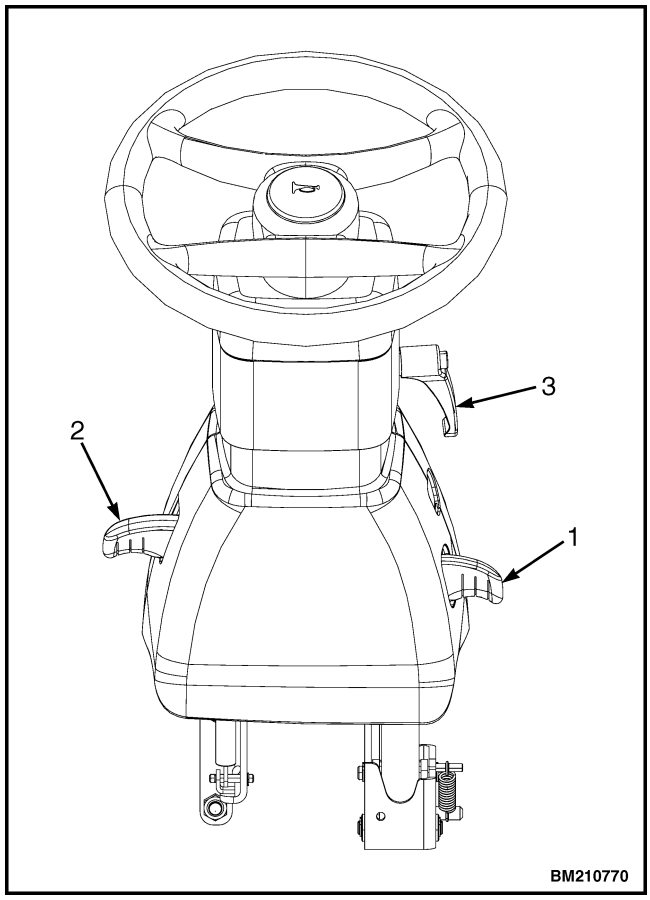
Legend for Figure 70.

NOTE: FULL SUSPENSION SEAT WITH MANUAL HYDRAULIC HIP RESTRAINTS SHOWN.

1. SEAT MOUNTING CAPSCREW
2. HOOD
3. OPERATOR PRESENCE SYSTEM CONNECTOR
4. SEAT MOUNTING NUT
5. SEAT RAIL
6. WEIGHT ADJUSTMENT KNOB
7. RIDE POSITION INDICATOR
8. FORWARD/BACKWARD LEVER
9. HIP RESTRAINT

Opening and Closing the Hood

1. Use the tilt memory lever (see Figure 71) and tilt the steering column all the way up.



NOTE: OPTIONAL TELESCOPIC STEERING COLUMN SHOWN.

1. TILT POSITION SENSOR
2. TILT MEMORY LEVER
3. TELESCOPIC COLUMN LOCKING HANDLE

Figure 71. Steering Column Levers

2. Slide the seat all the way back. Move the armrest all the way back if lift truck is equipped with E-Hydraulic control levers. See Figure 67.

3. If lift truck is equipped with manual hydraulic levers, release the latch for the manual hydraulic lever assembly and move the assembly to the forward position. See Figure 67.

Manual Hydraulic Control Levers

NOTE: The hood can be raised from either side of the lift truck. In the examples provided below, the hood is raised from the left side of the lift truck. If hood is raised from the right side of the lift truck, pull the hood release handle toward the right side of the lift truck to unlatch the hood.

1. If lift truck is equipped with manual hydraulic control levers, open the hood as follows:

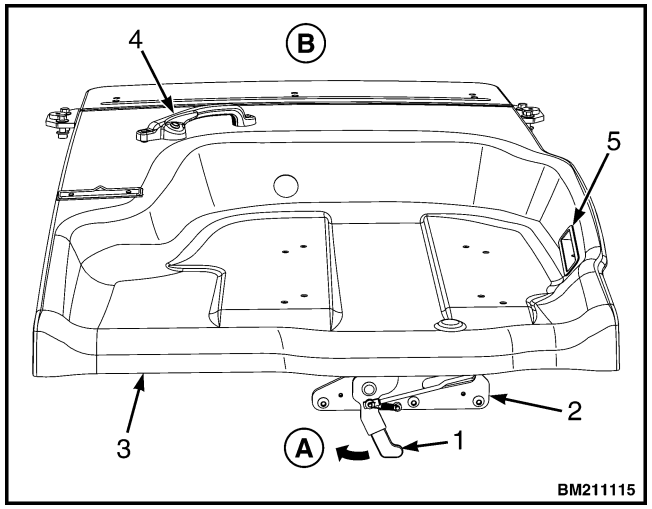
a. Place hand under hood release handle and push hood release lever toward the right side of lift truck to release hood latch assembly. See Figure 72.

CAUTION

Be careful while raising the hood. Injury to personnel may occur depending on lift truck overhead guard/cab height and hood configuration.

b. Place hand in hood handle and raise hood all the way up.

c. To close the hood, lower hood until the latch assembly touches the latch striker. Push down on hood until it clicks once to lock. Try to lift hood up using the hood handle to make sure hood is securely latched. The hood must be locked in the down position during lift truck operation. See Figure 72.



A. OPEN POSITION
B. FRONT VIEW

1. HOOD RELEASE HANDLE
2. HOOD LATCH ASSEMBLY
3. HOOD
4. HOOD HORN BUTTON
5. HOOD HANDLE

Figure 72. Hood and Hood Handle Components

E-Hydraulic Mini-Levers

NOTE: The hood can be raised from either side of the lift truck. In the examples provided below, the hood is raised from the left side of the lift truck. If hood is raised from the right side of the lift truck, pull the hood release handle toward the right side of the lift truck to unlatch the hood.

NOTE: Trucks equipped with E-hydraulics feature an intermediate hood opening position. There are two lever positions that disable the intermediate stop. See Figure 73.

1. To open and close the hood, perform the following:

a. Place hand under hood release handle and push hood release lever toward the right side of lift truck to release hood latch assembly. See Figure 72.

b. Place hand in hood handle (see Figure 72) and raise hood to the intermediate stop point.

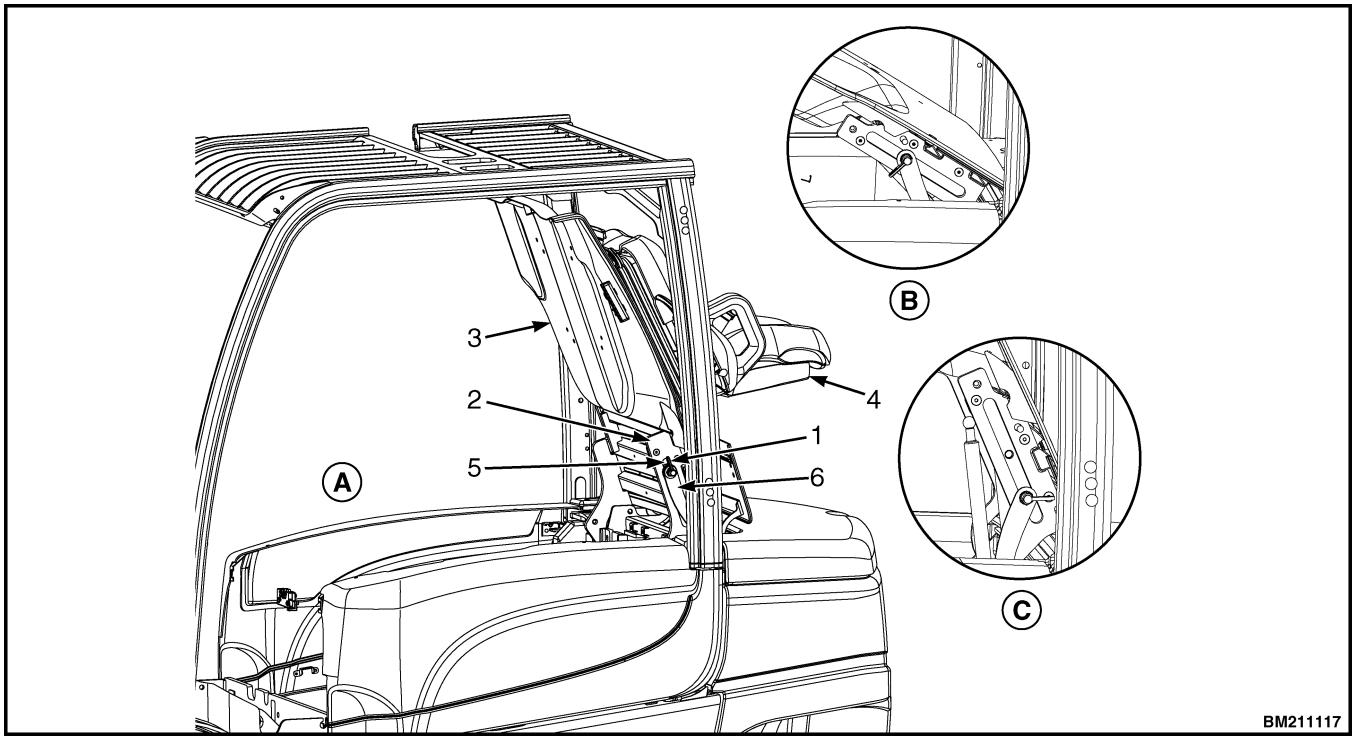
CAUTION

Be careful while raising the hood. Injury to personnel may occur depending on lift truck overhead guard/cab height and hood configuration.

c. Turn lever until it clicks. Lever will be vertically oriented. Raise hood to full upright position. See Figure 73.

NOTE: When closing the hood, the lever will automatically return to intermediate stop point position (down). To disable this, move lever clockwise until it is parallel to hinge slot.

2. To close hood, lower hood until latch touches the striker. Push down on hood until it clicks to lock. Try to lift hood up using hood handle to make sure hood is securely latched. The hood must be locked in the down position during lift truck operation.



NOTE: FULL SUSPENSION SEAT AND RAISED HOOD SHOWN.

A. HOOD RAISED TO FULL UPRIGHT POSITION, LEVER TURNED TO TEMPORARY DISABLING POSITION (HORIZONTAL TO SLOT)
B. HOOD RAISED TO INTERMEDIATE STOP POINT.
C. HOOD RAISED TO FULL UPRIGHT POSITION, LEVER TURNED TO PERMANENT DISABLING POSITION (VERTICAL SLOT)

1. LEVER
2. PLATE
3. HOOD
4. SEAT
5. HINGE SLOT
6. LINK PLATE

Figure 73. Opening The Hood Lift Trucks Equipped With E-Hydraulic Mini-Levers

REMOVE

1. Open and raise the hood to full upright position. See the section Opening and Closing the Hood for procedures.

2. For lift trucks manufactured before May 2012, remove spacers, nuts, and capscrews and remove latch assembly from front bulkhead. See Figure 74.

3. On lift trucks manufactured after May 2012:

a. Remove two capscrews and latch cover from latch assembly. See Figure 75.

b. Remove three nuts, capscrews, latch assembly, and spacers from front bulkhead.

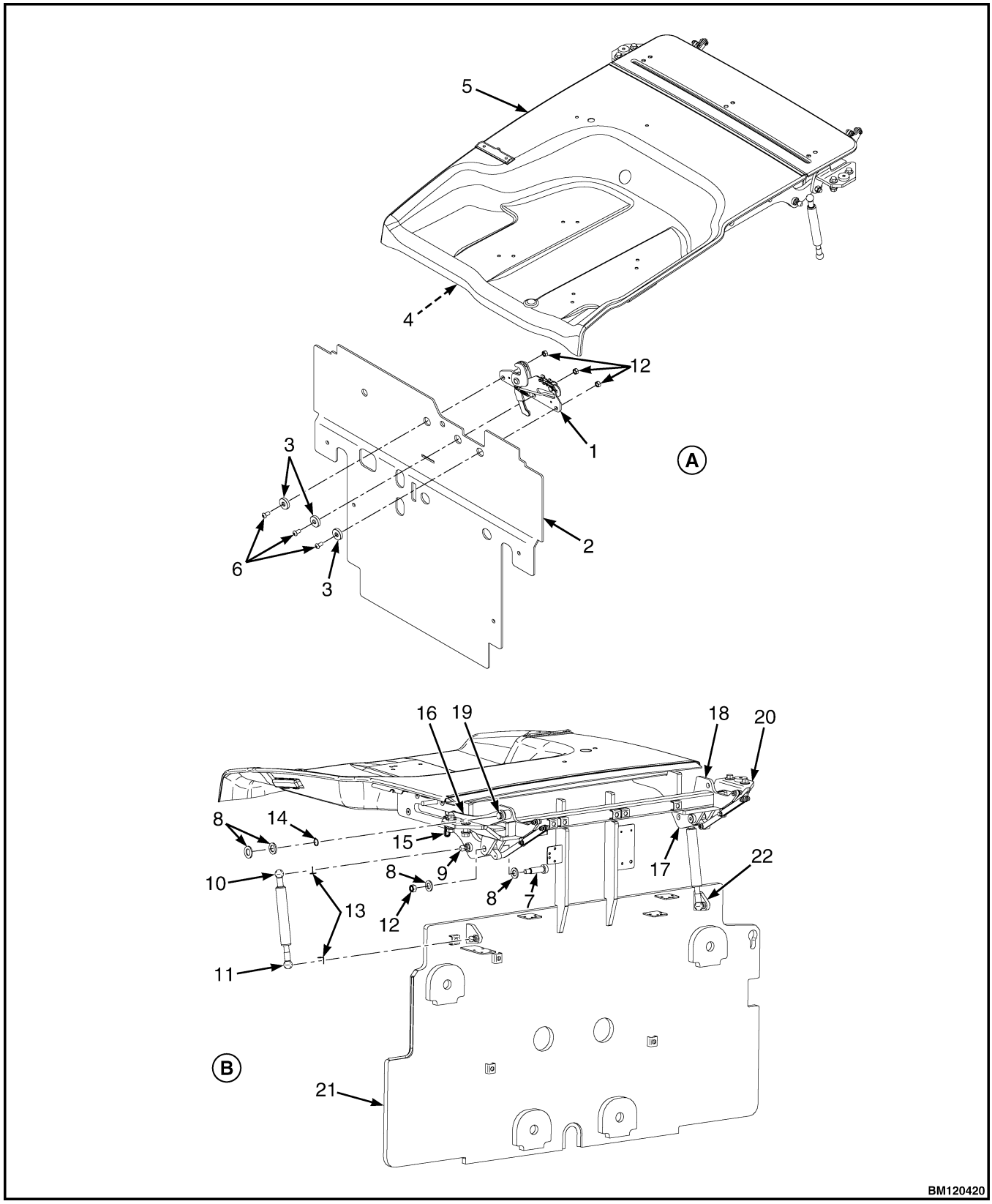


Figure 74. Hood and Latch, Lift Trucks Manufactured Before May 2012J4.0-5.0XN (J80-100XN) (A970)

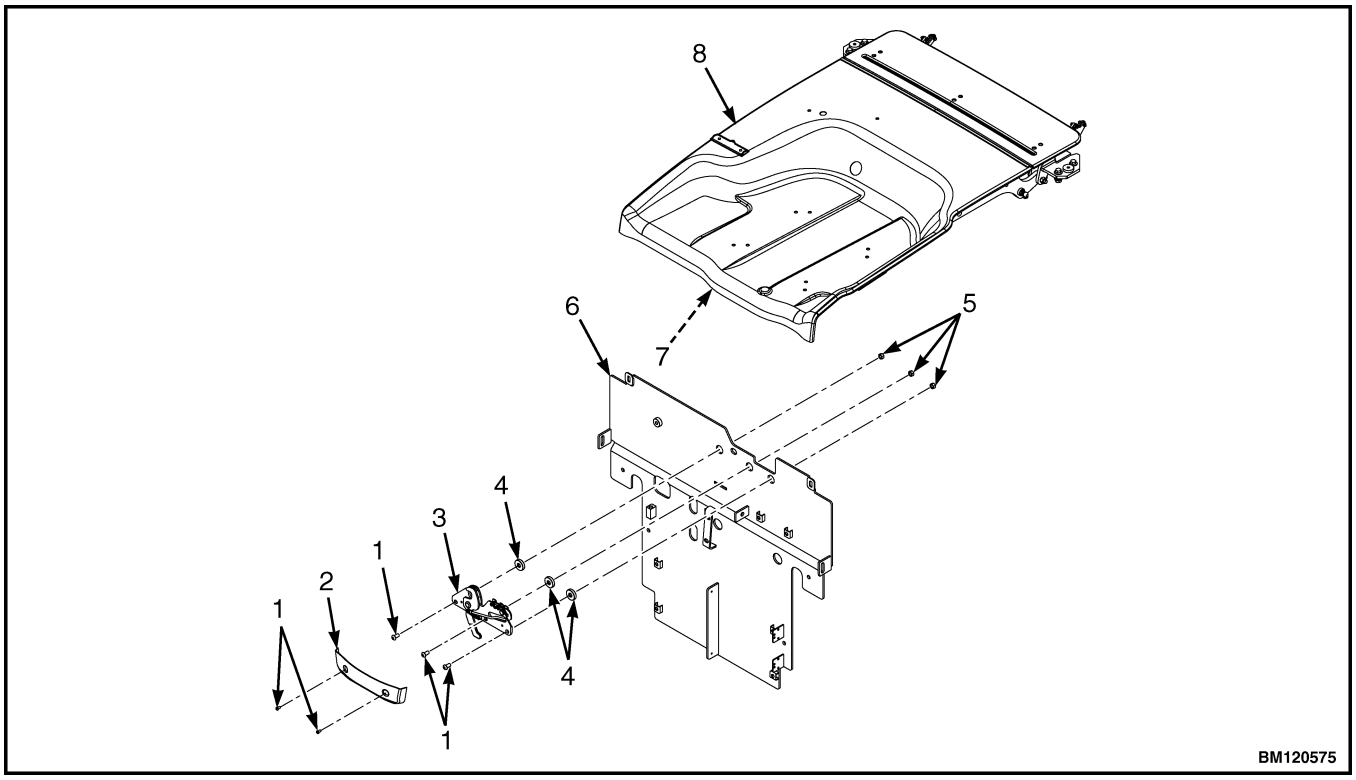
Legend for Figure 74.

NOTE: REAR VIEW OF LIFT TRUCKS EQUIPPED WITH E-HYDRAULIC CONTROLS SHOWN. REAR VIEW OF LIFT TRUCKS EQUIPPED WITH MANUAL HYDRAULIC CONTROLS IS SIMILAR.

A. SIDE VIEW

B. REAR VIEW

1. LATCH ASSEMBLY
2. FRONT BULKHEAD
3. SPACERS
4. LATCH STRIKER
5. HOOD
6. CAPSCREW
7. SHOULDER BOLT
8. WASHER
9. BALL STUD
10. GAS CONTROLLED STRUT, FRONT END
11. GAS CONTROLLED STRUT, BACK END
12. NUT
13. LOCKING CLIP
14. SNAP RING
15. LEVER
16. LINK PLATE
17. HOOD HINGE ARM
18. HOOD HINGE
19. PIN
20. PLATE
21. REAR BULKHEAD
22. MOUNTING PLATE



NOTE: SIDE VIEW SHOWN ABOVE. REAR VIEW IS THE SAME AS SHOWN IN FIGURE 74.

1. CAPSCREW
2. LATCH COVER
3. LATCH ASSEMBLY
4. SPACERS
5. NUT
6. FRONT BULKHEAD
7. LATCH STRIKER
8. HOOD

Figure 75. Hood and Latch, Lift Trucks Manufactured After May 2012J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

NOTE: Tag electrical connectors during removal to aid in installation.

4. Disconnect battery connector.

NOTE: Perform Step 5 if lift truck is equipped with E-Hydraulics.

5. Tag and disconnect electrical connector for E-Hydraulic controller. See **Electrical System** 2200SRM1369 for procedures.

6. Tag and disconnect electrical connectors from emergency battery disconnect and hood and latch position switches. See **Electrical System** 2200SRM1369 for procedures.

7. Remove emergency battery disconnect switch if necessary. See **Electrical System** 2200SRM1369 for procedures.

NOTE: Perform Step 8 through Step 10 if removing seat assembly from hood.

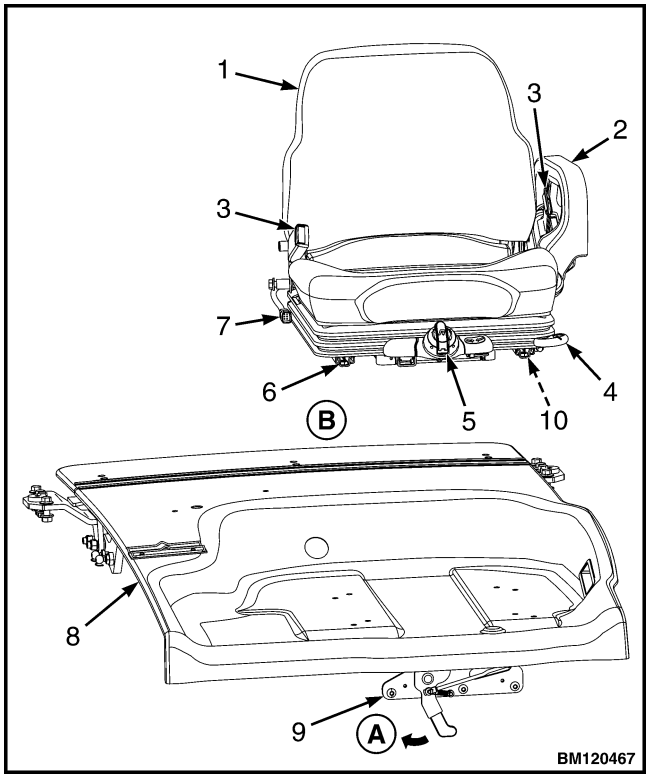
8. Remove four capscrews and washers from hood and seat rails. See Figure 70.

9. Tag and disconnect operator presence system connector from main wire harness. See Figure 70.

10. Remove seat assembly from hood.

NOTE: To remove seat from seat rails, perform Step 11.

11. Remove stop screws from seat rails, hold ride position indicator in the open position, and slide seat from seat rails. See Figure 76.



NOTE: HOOD LATCH COVER REMOVED FOR CLARITY.

A. OPEN POSITION
B. FRONT VIEW

1. SEAT
2. HIP RESTRAINT
3. SEAT BELT AND MOUNT
4. FORWARD/BACKWARD POSITION LEVER
5. OPERATOR WEIGHT ADJUSTOR
6. SEAT RAIL
7. OPERATOR PRESENCE SYSTEM CONNECTOR
8. HOOD
9. HOOD LATCH ASSEMBLY
10. STOP SCREWS

Figure 76. Seat Assembly

12. Remove locking clip from gas-controlled strut front end. Remove gas-controlled strut front end from ball stud and hood hinge arm. See Figure 74.

13. Remove locking clip from gas-controlled strut back end. Remove gas-controlled strut back end from ball stud and hood hinge. See Figure 74.

14. Repeat Step 12 and Step 13 for opposite gas-controlled strut.

15. Close hood. See the section Opening and Closing the Hood for procedures.

16. Remove counterweight cover. See the section Counterweight Replacement for Lift Truck Models J2.2-3.5XN (J45-70XN) (A276) and J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) for procedures.

NOTE: Note placement of washers prior to removal to aid in installation.

17. Remove nuts, shoulder bolts, washers, and plates from hood hinges and hood hinge arms. See Figure 74.

18. On left hood hinge, remove washers and snap ring from bottom of link plate. Remove bottom of link plate from pin. See Figure 74.

19. Using a lifting device, remove hood from lift truck frame.

INSTALL

1. Using a lifting device, position hood onto hinges and install washers, shoulder bolts, nuts, and plates as noted during removal. See Figure 74.

   Tighten nuts.

   Nuts must be fully engaged with shoulder bolt and hood hinge arm assembly must be free to move.

   Add or subtract washers, if necessary, to allow hood hinge arm assembly to move freely when opening and closing hood.

2. On left side of hood hinge, install washer and bottom of link plate to pin. Install other washer and snap ring to secure bottom of link plate to pin. See Figure 74.

3. Open and close hood to check for proper clearance. See section Opening and Closing the Hood for procedures.

4. Install counterweight cover. See section Counterweight Replacement for Lift Truck Models J2.2-3.5XN (J45-70XN) (A276) and J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) for procedures.

5. Raise hood. Install gas-controlled strut back end onto ball stud on hood hinge. Install locking clip on gas-controlled strut back end and ball stud. See Figure 74.

6. Install gas-controlled strut front end onto ball stud on hood hinge arm. Install locking clip on gas-controlled strut front end and ball stud. See Figure 74.

7. Repeat Step 5 and Step 6 for opposite gas-controlled strut.

8. If seat rails were removed from seat assembly, hold ride position indicator in the open position and slide seat onto seat rails. Install stop screws. See **Electrical System** 2200SRM1369 for procedures.

9. If seat assembly has been removed from hood, position seat onto hood and install capscrews and washers into hood and seat rails. See Figure 70.

NOTE: Remove tags as electrical connections are made.

10. Connect operator presence system connector to main wire harness. See Figure 70.

11. Install hood and latch switches and emergency battery disconnect switch, if removed, and adjust as necessary. See **Electrical System** 2200SRM1369 for procedures.

12. Connect electrical wires, as tagged during removal, to emergency battery disconnect and hood and latch position switches. See **Electrical System** 2200SRM1369 for procedures.

13. If equipped, connect electrical connector for E-Hydraulic controller. See **Electrical System** 2200SRM1369 for procedures.

14. Connect battery connector.

15. For lift trucks manufactured before May 2012, install capscrews, nuts, and spacers and latch assembly to front bulkhead. See Figure 74.

16. On lift trucks manufactured after May 2012, install capscrews, spacers, nuts, and latch assembly to front bulkhead. Install latch cover to latch assembly with two capscrews. See Figure 75.

17. Close hood. See procedures in Opening and Closing the Hood. Make certain locking mechanism for hood is properly engaged.

18. If lift truck is equipped with manual hydraulic control levers, push manual hydraulic control lever assembly until it clicks into place.

GROUND TEST

If the static discharge ground connection is not secured properly it could lead to the possible failure of the traction and/or pump motor controllers. Perform Ground Test found in the General section of this **Service Manual** to ensure static discharge ground connection is properly secured.

Master Cylinder Repair and Adjustment for 1.5-3.5T Cushion and 2.2-5.5T Pneumatic Lift Trucks

NOTE: For Lift Truck Models E2.2-3.5XN (E45-70XN) (A268), E1.6-2.0XN (E30-40XN) (A269), J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970), and J2.2-3.5XN (J45-70XN) (A276) .

For procedures on adjusting and repairing the master cylinder, see one of the following service manuals:

Brake System 1800SRM1359 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268)

Brake System 1800SRM1438 for lift truck models

- E1.6-2.0XN (E30-40XN) (A269)
- ERC22-35VG (ERC045-070VG) (A968)
- ERC16-20VA (ERC030-040VA) (A969)

Transaxle 1300SRM1539 for lift truck models

- J4.0-5.0XN (J80-100XN) (A970)
- ERP40-50VM (ERP080-100VM) (A985)

Transaxle 1300SRM1370 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276)
- ERP22-35VL (ERP045-070VL) (A976)

Master Cylinder Repair and Adjustment for 4.0-5.5T Cushion Lift Trucks

NOTE: For Lift Truck Models E4.0-5.5XN, E4.5XNS (E80-120XN, E100XNS) (A099)

Remove

1. Block front and rear sides of wheels to make sure lift truck cannot move.
2. Remove floor mat and floor plate from lift truck to access master cylinder.
3. Disconnect wire at brake sensor and bottom of master cylinder. Remove brake sensor. See Figure 77.

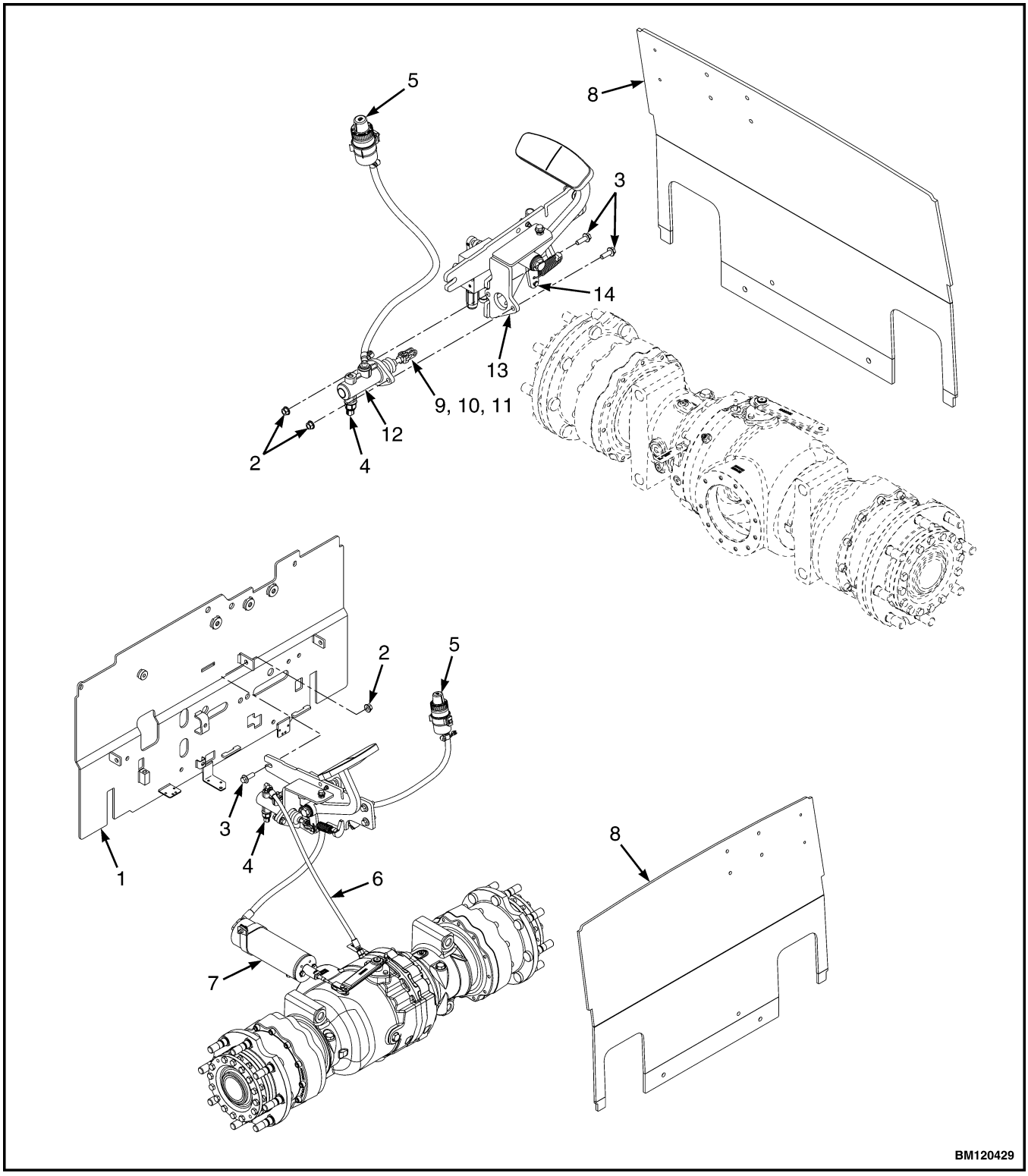


Figure 77. Master Cylinder and Brake Pedal for Lift Trucks E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

Legend for Figure 77.

1. BULKHEAD
2. NUT
3. CAPSCREW
4. BRAKE SENSOR
5. BRAKE RESERVOIR
6. SERVICE BRAKE HOSE
7. PARK BRAKE ACTUATOR
8. COWL
9. CLEVIS
10. PIN
11. COTTER PIN
12. MASTER CYLINDER
13. MOUNTING PLATE
14. PLATE

4. Disconnect brake reservoir level sensor switch from cowl harness.

5. Remove service brake hose from master cylinder. Plug master cylinder and tube to prevent foreign material from entering the brake system. See Figure 77.

NOTE: Perform Step 6 only if the tube is damaged.

6. Remove service brake hose from brake fitting. Plug fitting to prevent foreign material from entering the brake system. Lay tube assembly aside until ready for bench bleed. See Figure 77.

7. Remove cotter pin, washer, and pin from plate at bottom of brake pedal assembly.

8. Remove two nuts, two capscrews, and master cylinder from mounting plate. See Figure 77.

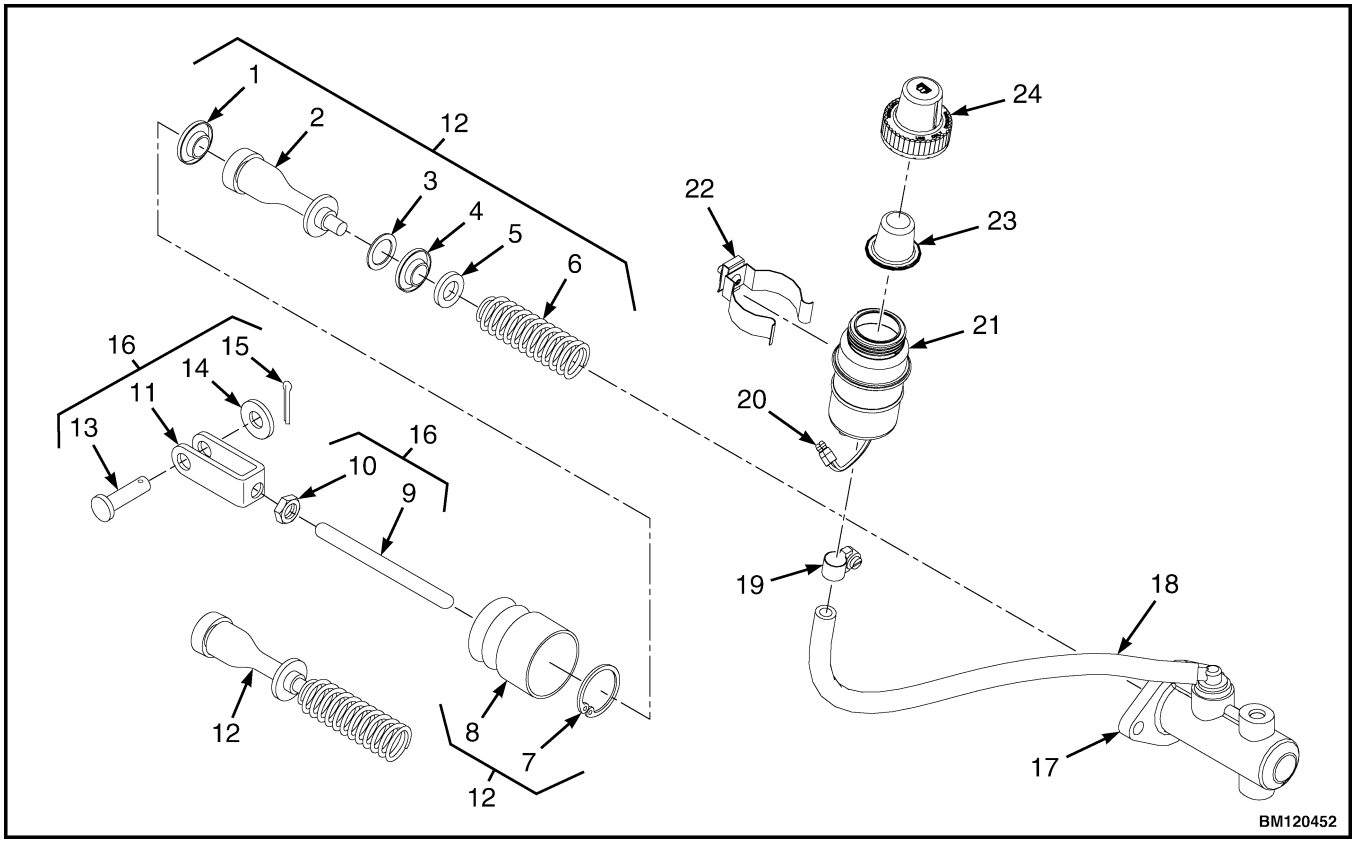
Disassemble

CAUTION

Disposal of lubricants and fluids must meet local environmental regulations.

1. Drain master cylinder into drain pan. Dispose of brake fluid.

2. Remove push rod and boot from cylinder. See Figure 78.



NOTE: ITEM 12, PISTON ASSEMBLY (INCLUDING ITEM 1 THROUGH 6) SHOULD **NOT** BE DISASSEMBLED. ILLUSTRATION CREATED FROM MANUFACTURER'S DOCUMENTATION.

1. SECONDARY CUP
2. PISTON
3. SPACER
4. PRIMARY CUP
5. RETAINER
6. SPRING
7. SNAP RING
8. BOOT
9. PUSH ROD
10. NUT
11. CLEVIS
12. PISTON ASSEMBLY
13. PIN
14. WASHER
15. COTTER PIN
16. REPAIR KIT
17. MASTER CYLINDER ASSEMBLY
18. HOSE
19. CLAMP
20. RESERVOIR LEVEL SENSOR SWITCH
21. RESERVOIR
22. RESERVOIR HOLDER
23. GASKET
24. CAP

Figure 78. Master Cylinder Assembly, Lift Trucks E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

WARNING

Use care when removing snap ring to avoid possible injury.

3. Remove snap ring from cylinder. See Figure 78.

CAUTION

When the piston is removed, make sure the cylinder bore and piston are not scratched or damaged.

NOTE: DO NOT disassemble piston assembly.

4. Remove piston assembly from cylinder.

5. Remove gasket and cap from reservoir. See Figure 78.

Clean

WARNING

DO NOT use an oil solvent to clean the master cylinder. Use Dexron® III transmission fluid from a sealed container only.

Clean components, paying particular attention to those areas highlighted in Figure 79 with Dexron® III transmission fluid from a sealed container only.

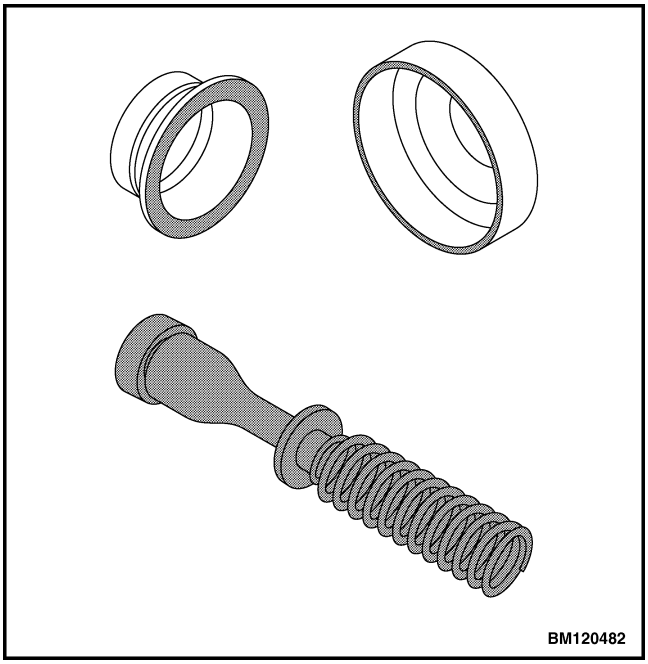


Figure 79. Cleaning Components

Inspect

NOTE: DO NOT disassemble piston assembly.

1. Inspect exterior of master cylinder assembly for damage. Replace master cylinder assembly if damaged.
2. Inspect bore of master cylinder for holes or scratches. Replace master cylinder assembly if damaged.

Assemble

CAUTION

When piston is installed, make sure the cylinder bore and piston are not scratched or damaged.

1. Install piston assembly into cylinder. See Figure 78.

WARNING

Use care when installing snap ring to avoid possible injury.

2. Install snap ring into cylinder. See Figure 78.
3. Install boot and push rod into cylinder. See Figure 78.

Bench Bleed Master Cylinder

NOTE: Master cylinder must be bench bled before installing it on lift truck.

1. Place master cylinder horizontally in a soft-jawed vise.
2. Remove plugs from service brake hose ends. Connect service brake hose to master cylinder.
3. Place other end of service brake hose in a clean container of transmission fluid.
4. Fill reservoir with Dexron III transmission fluid as needed.
5. Stroke master cylinder until all air is purged from master cylinder.
6. Install gasket and cap to reservoir. See Figure 78.

Install and Adjust

1. Remove plugs from service brake hose ends. Connect service brake hose to master cylinder.
2. Install master cylinder with service brake hose attached onto mounting plate using two capscrews and two nuts. Tighten capscrews to 38 N•m (28 lbf ft). See Figure 77.
3. Install pin, washer, cotter pin, and back of master cylinder onto plate at bottom of brake pedal assembly. See Figure 77.
4. Remove plug from brake fitting. Connect service brake hose onto brake fitting.
5. Install brake sensor. Tighten sensor to 23 to 28 N•m (203 to 247 lbf in). Connect wire to bottom of master cylinder. See Figure 77.

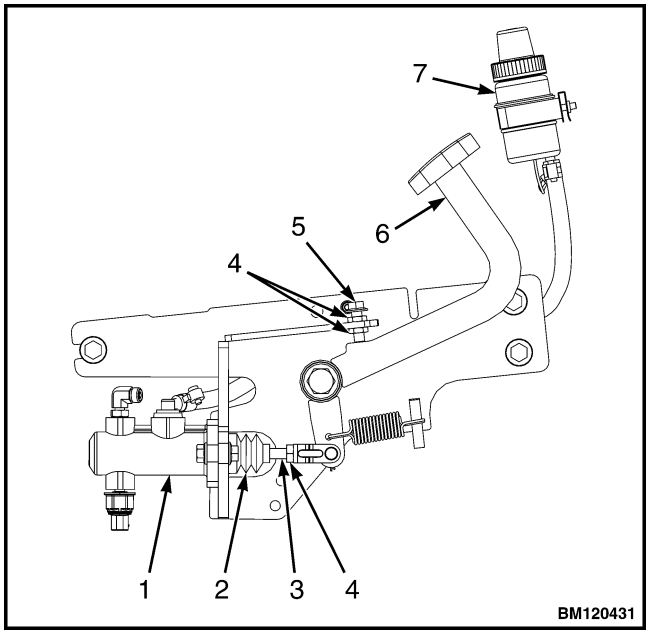
6. Connect reservoir level sensor switch to cowl harness.

7. Adjust brake pedal height to 92 mm (3.62 in.) by adjusting capscrew. Tighten locknuts. See Figure 80.

8. Adjust master cylinder per following procedure:

a. Loosen locknut on master cylinder push rod and adjust by turning push rod counterclockwise (as viewed from rear of lift truck) to remove all slack between master cylinder and brake pedal. Adjust push rod extension to 110 mm (4.3 in.). DO NOT allow rubber boot to be twisted while adjusting rod length. See Figure 80 and Figure 82, Brake Pedal Adjustment.

b. Turn push rod one-eighth turn clockwise (as viewed from rear of lift truck), allowing master cylinder to fully return when brake pedal is released. Tighten locknut to 18 N•m (159 lbf in). See Figure 80 and Figure 82, Brake Pedal Adjustment.



1. MASTER CYLINDER
2. RUBBER BOOT
3. PUSH ROD
4. LOCKNUT
5. CAPSCREW
6. BRAKE PEDAL
7. TANK RESERVOIR

Figure 80. Brake Pedal and Master Cylinder Adjustment

9. Flush with Dexron III transmission fluid and air bleed the system. See Bench Bleed Master Cylinder section for procedures.

10. Adjust fluid level until at MAX line on reservoir.

11. Verify that all connections are leak free.

12. Install floor plate and floor mat into lift truck.

13. Check adjustment of brake pedal as described in section Brake Pedal Components.

Brake Pedal Components

FOR LIFT TRUCK MODELS E2.2-3.5XN (E45-70XN) (A268), E1.6-2.0XN (E30-40XN) (A269), J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970), AND J2.2-3.5XN (J45-70XN) (A276)

For procedures dealing with brake pedal components, see one of the following service manuals:

Brake System 1800SRM1359 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268)

Brake System 1800SRM1438 for lift truck models

- E1.6-2.0XN (E30-40XN) (A269)
- ERC22-35VG (ERC045-070VG) (A968)
- ERC16-20VA (ERC030-040VA) (A969)

Transaxle 1300SRM1539 for lift truck models

- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)
- ERP40-50VM, ERP50-55VM6 (ERP080-120VM, ERP100VML) (A985)

Transaxle 1300SRM1370 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276)
- ERP22-35VL (ERP045-070VL) (A976)

FOR LIFT TRUCK MODELS E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

Remove

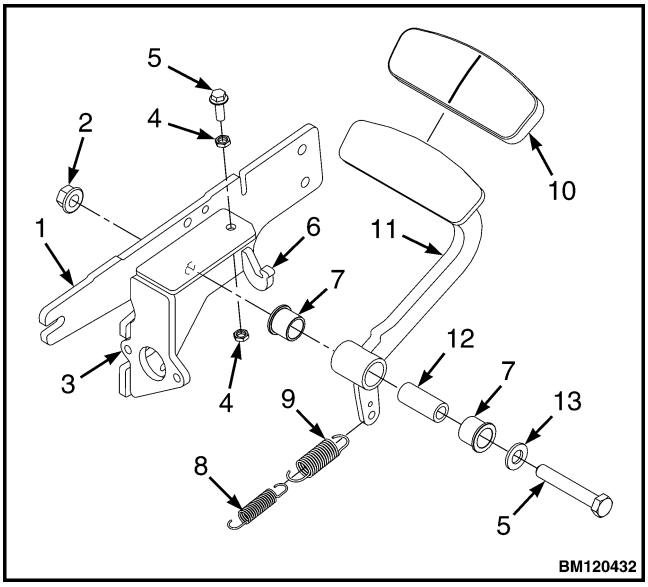
1. Block front and rear sides of wheels to make sure lift truck cannot move.
2. Remove floor mat and floor plate from lift truck.
3. Disconnect all electrical connections from master cylinder, brake fluid reservoir, and park brake valve. See Figure 77.

NOTE: Place a drain pan under the brake pedal assembly.

4. Disconnect hose from brake fluid reservoir and master cylinder at master cylinder and plug hose.
5. Disconnect hose from master cylinder to drive axle at master cylinder and plug hose. See Figure 77.
6. Disconnect hose assembly from park brake valve to actuator at park brake valve and plug hose.
7. Remove three flange nuts and capscrews and brake pedal assembly from lift truck. See Figure 77.

Disassemble

1. Remove outer and inner spring from spring anchor plate and crank plate. See Figure 81.
2. Remove cotter pin and rod end pin from clevis and crank plate.
3. Remove nuts and capscrews and master cylinder from master cylinder mounting plate. See Figure 81.
4. Remove the two fittings and pressure transducer from master cylinder.



1. BRAKE MOUNTING PLATE
2. NUT
3. MASTER CYLINDER MOUNTING PLATE
4. LOCK NUT
5. CAPSCREW
6. SPRING ANCHOR PLATE
7. FLANGED BUSHING
8. INNER SPRING
9. OUTER SPRING
10. BRAKE PAD
11. BRAKE PEDAL
12. TUBE
13. WASHER

Figure 81. Brake Pedal Assembly

Inspect

1. Inspect components for damage; replace if damaged.
2. Spring free length measurement should be 80 mm (3.15 in.) for both springs. Replace spring if length is beyond specifications.

Assemble

1. Install pressure transducer and two fittings to master cylinder. See Figure 81. Tighten pressure transducer to 23 to 28 N•m (204 to 247 lbf in).
2. Install master cylinder to master cylinder bracket using nuts and capscrews. Tighten nuts to 38 N•m (28 lbf ft). See Figure 81.
3. Install rod end pin and cotter pin in clevis and secure master cylinder to crank plate.
4. Insert inner spring inside outer spring and connect combined springs to crank plate and spring anchor plate.

Install

1. Using three flange nuts and capscrews, install brake pedal assembly to cowl. See Figure 77.
2. Unplug and connect actuator hose assembly to park brake valve.
3. Unplug and connect hose from drive axle to master cylinder. See Figure 77.
4. Unplug and connect hose from master cylinder to brake fluid reservoir.
5. Connect all electrical connections from master cylinder, brake fluid reservoir, and park brake valve. See Figure 77.
6. Install floor plate and floor mat into lift truck.
7. Remove blocks from front and rear sides of wheels.

BRAKE PEDAL ADJUSTMENT FOR LIFT TRUCK MODELS E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

Adjust brake pedal height to 92 mm (3.62 in.) by adjusting capscrews at the rear of the brake pedal assembly. Measurement is from the bottom of the brake pedal to the top of the bracket. Tighten locknuts after adjustment is completed. See Figure 82.

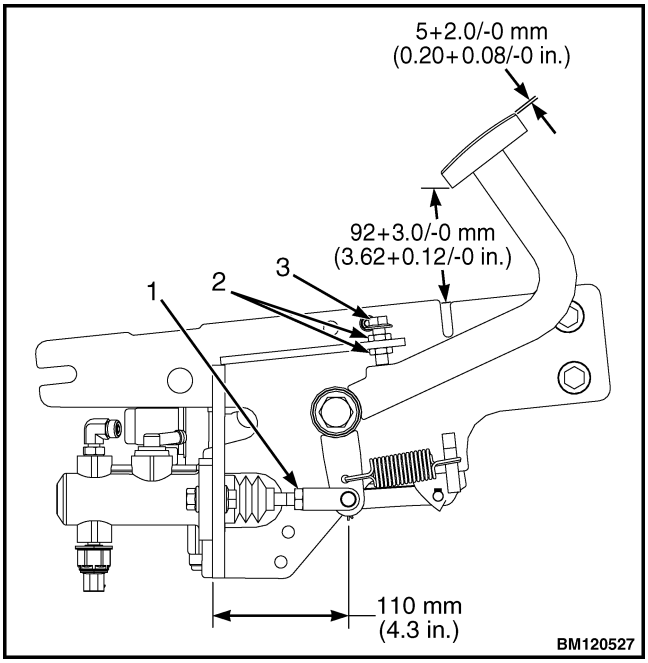


Figure 82. Brake Pedal Adjustment

Legend for Figure 82.

1. NUT
2. LOCK NUT
3. CAPSCREW

Brake System Air Removal

FOR LIFT TRUCK MODELS J2.2-3.5XN (J45-70XN) (A276) AND E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

NOTE: Lift truck models J2.2-3.5XN (J45-70XN) (A276) use (DOT 3) brake fluid in the master cylinder reservoir. Lift truck models E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099) use Dexron® III transmission fluid in the master cylinder reservoir.

There are two commonly used methods to remove air from the brake system. The preferred method is using a pressure bleed system. The other method is by applying pressure using brake pedal.

Using Pressure Bleed System

1. Fill master cylinder reservoir with (DOT 3) brake fluid for lift truck models J2.2-3.5XN (J45-70XN) (A276). or Dexron® III transmission fluid for lift truck models E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099) .
2. Remove bleeder cap.
3. Place one end of a rubber hose on bleeder screw of each wheel cylinder. Place other end of each hose into a clear container of fluid.
4. Connect a pressure bleeder to master cylinder reservoir.
5. Loosen bleeder screws at wheel cylinders one turn.

NOTE: While applying air pressure to pressure bleeder, check level of brake fluid in master cylinder reservoir. Make sure to maintain brake fluid at the correct level to avoid forcing more air into brake system.

6. Apply 34.5 kPa (5 psi) of air pressure to pressure bleeder, forcing fluid through lines until all air is removed from system. Close bleeder screws.
7. Install bleeder cap.
8. Check level of fluid in master cylinder reservoir. Fill reservoir to correct level.

Using Brake Pedal Pressure For Lift Truck Models J2.2-3.5XN (J45-70XN) (A276) and E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

1. Fill master cylinder reservoir with (DOT 3) brake fluid for lift truck models J2.2-3.5XN (J45-70XN) (A276) or Dexron® III transmission fluid for lift truck models E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099) .
2. Remove bleeder cap.
3. Place one end of a rubber hose on bleeder screw of wheel cylinder furthest from master cylinder. Place other end of each hose into a clear container of fluid.

NOTE: Check level of fluid in master cylinder reservoir during procedure. Make sure to maintain fluid at correct level.

4. Loosen bleeder screw at wheel cylinder one turn so that air can be removed from brake system. Slowly push brake pedal and hold it at the end of its stroke. Close the bleeder screw.
5. Repeat Step 4 until there are no air bubbles in container.
6. Install bleeder cap.
7. Repeat Step 1 through Step 4 and Step 6 for remaining wheel cylinder.
8. Check level of fluid in master cylinder reservoir. Fill reservoir to correct level.

FOR LIFT TRUCK MODELS E2.2-3.5XN (E45-70XN) (A268), E1.6-2.0XN (E30-40XN) (A269), AND J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

For procedures to remove air from the brake system, see one of the following service manuals

Brake System 1800SRM1359 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268)

Brake System 1800SRM1438 for lift truck models

- E1.6-2.0XN (E30-40XN) (A269)

Transaxle 1300SRM1539 for lift truck models

- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

Counterweight Replacement for Lift Truck Models E2.2-3.5XN (E45-70XN) (A268) and E1.6-2.0XN (E30-40XN) (A269)

If lift truck must be put on blocks for maintenance or repair, see **How to Put Lift Truck on Blocks** in **Operating Manual** or one of the following service manuals

Periodic Maintenance 8000SRM1364 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268)

Periodic Maintenance 8000SRM1442 for lift truck models

- E1.6-2.0XN (E30-40XN) (A269)

WARNING

The counterweight is very heavy. Make sure that the crane and lifting devices have enough lifting capacity to safely lift the counterweight. The weights of the counterweights are shown in

Table 2 for lift truck models

- **E2.2-3.5XN (E45-70XN) (A268)**

Table 3 for lift truck models

- **E1.6-2.0XN (E30-40XN) (A269)**

Table 2. Counterweights for Lift Truck E2.2-3.5XN (E45-70XN) (A268)

Model	(mm*)	Weight	+ 50 kg (110 lb) - 0 kg (0 lb)
E2.2XN (E45XN)	786	571 kg (1258 lb)	
E2.2-2.5XN (E45-50XN)	847		
E2.2XN (E45XN)	700	764 kg (1684 lb)	
E2.5XN (E50XN)	786		
E2.75XN (E55XN)	847		
E3.2XN (E65XN)	1015		
E2.5XN (E50XN)	700	948 kg (2090 lb)	
E3.0XN (E60XN)	847		
E3.2XN (E65XN)	933		
E3.5XN (E70XN)	1015		
*Approximate battery compartment lengths.			

Table 3. Counterweights for Lift Truck E1.6-2.0XN (E30-40XN) (A269)

Model	(mm*)	Weight	+ 50 kg (110 lb) - 0 kg (0 lb)
E1.6XN (E30XN)	700	489 kg (1078 lb)	
E1.8XN (E35XN)	700	605 kg (1334 lb)	
E2.0XN (E40XN)	700	754 kg (1662 lb)	
*Approximate battery compartment lengths.			

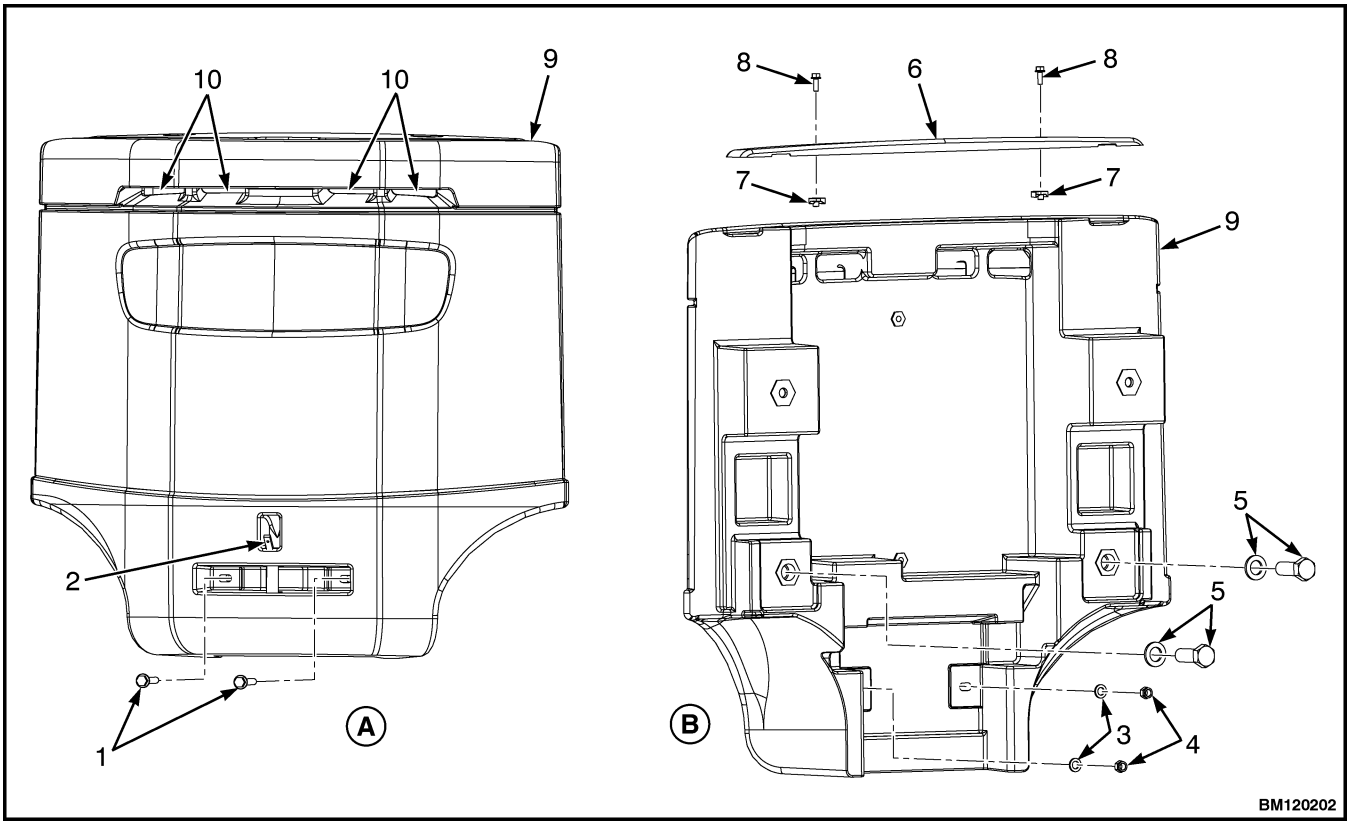
The counterweight normally is not removed for most repairs. Replacement of controller and contactors is easier with counterweight installed. The counterweight is fastened to frame with four capscrews.

See Figure 83 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268) manufactured prior to June, 2012
- and E1.6-2.0XN (E30-40XN) (A269) manufactured prior to June, 2012

See Figure 84 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268) manufactured after to June, 2012
- and E1.6-2.0XN (E30-40XN) (A269) manufactured after to June, 2012



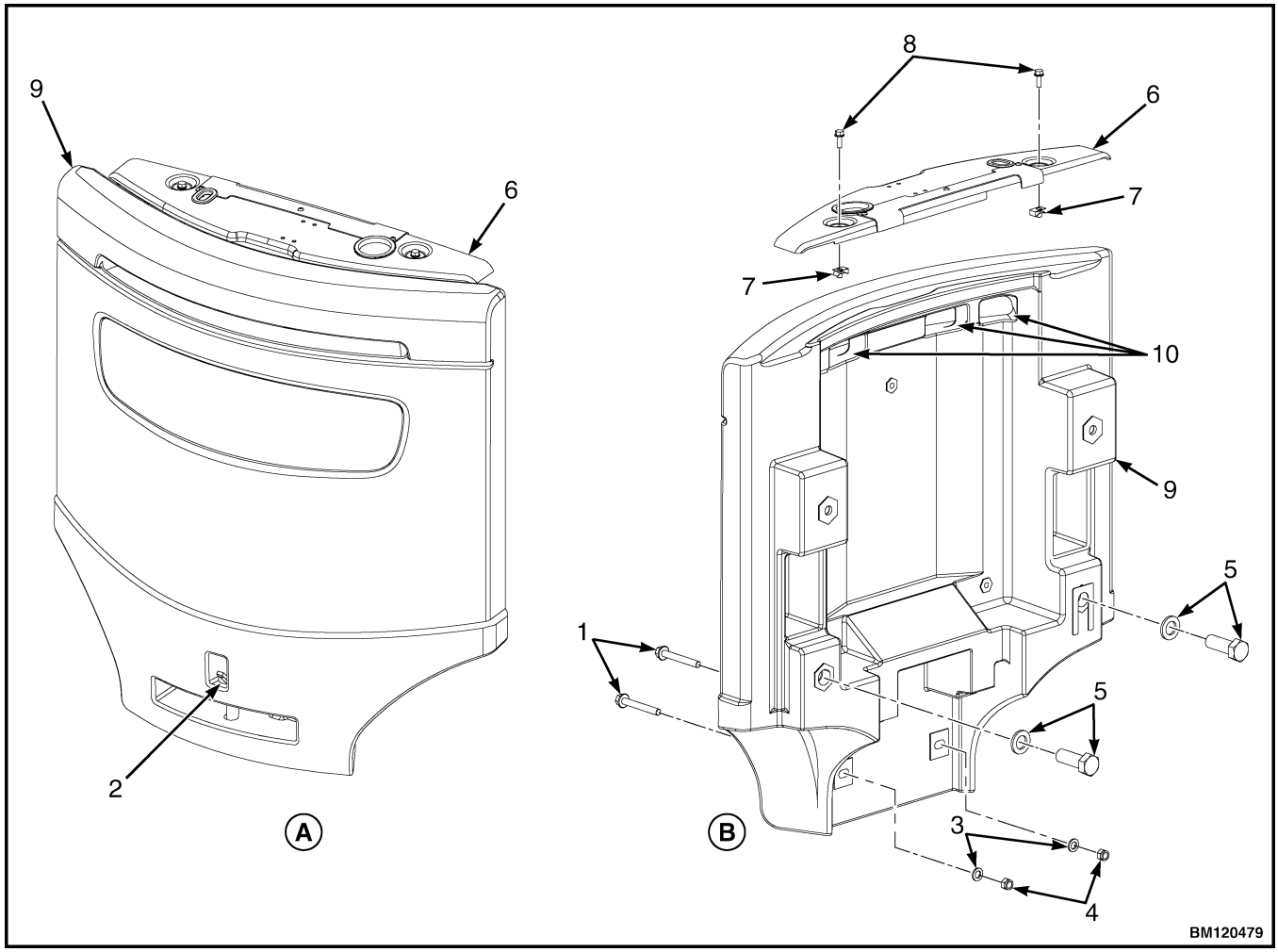
A. BACK VIEW SHOWN

1. LOWER CAPSCREW
2. TOW PIN
3. LOWER WASHER
4. LOWER NUT
5. UPPER CAPSCREW AND WASHER

B. FRONT VIEW SHOWN

6. COUNTERWEIGHT COVER
7. COVER NUT
8. COVER CAPSCREWS
9. COUNTERWEIGHT
10. SLOTS

Figure 83. Counterweight Assembly for Lift Truck Manufactured Prior to June, 2012E2.2-3.5XN (E45-70XN) (A268) and E1.6-2.0XN (E30-40XN) (A269)



A. BACK VIEW SHOWN

1. LOWER CAPSCREW
2. TOW PIN
3. LOWER WASHER
4. LOWER NUT
5. UPPER CAPSCREW AND WASHER

B. FRONT VIEW SHOWN

6. COUNTERWEIGHT COVER WITH RAPID CHARGE
7. COVER NUT
8. COVER CAPSCREWS
9. COUNTERWEIGHT
10. SLOTS

Figure 84. Counterweight Assembly for Lift Truck After June, 2012E2.2-3.5XN (E45-70XN) (A268) and E1.6-2.0XN (E30-40XN) (A269)

REMOVE

1. Disconnect battery connector.

2. Remove battery from lift truck. See **How to Change Battery** in **Operating Manual** or one of the following service manuals

Periodic Maintenance 8000SRM1364 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268)

Periodic Maintenance 8000SRM1442 for lift truck models

- E1.6-2.0XN (E30-40XN) (A269)

3. Remove overhead guard. See section **Overhead Guard Replacement**, Remove for procedures.

4. Remove top of counterweight cover from counterweight by removing two cover capscrews and cover nuts.

   See Figure 83 for lift truck models

   - E2.2-3.5XN (E45-70XN) (A268) manufactured prior to June, 2012
   - and E1.6-2.0XN (E30-40XN) (A269) manufactured prior to June, 2012

   See Figure 84 for lift truck models

   - E2.2-3.5XN (E45-70XN) (A268) manufactured after to June, 2012
   - and E1.6-2.0XN (E30-40XN) (A269) manufactured after to June, 2012

5. Remove controller cover. Remove controller, contactors, and other electronic components located in counterweight, see **Electrical System** 2200SRM1369.

WARNING

Make sure slings and crane have enough capacity to lift and hold counterweight.

See Table 2 for lift truck models

- **E2.2-3.5XN (E45-70XN) (A268)**

See Table 3 for lift truck models

- **E1.6-2.0XN (E30-40XN) (A269)**

6. Wrap two slings through slots in top of counterweight. Attach slings to crane.

   See Figure 83 for lift truck models

   - E2.2-3.5XN (E45-70XN) (A268) manufactured prior to June, 2012
   - and E1.6-2.0XN (E30-40XN) (A269) manufactured prior to June, 2012

   See Figure 84 for lift truck models

   - E2.2-3.5XN (E45-70XN) (A268) manufactured after to June, 2012
   - and E1.6-2.0XN (E30-40XN) (A269) manufactured after to June, 2012

7. From inside battery compartment, near bottom, remove upper capscrews and washers from counterweight and frame.

   See Figure 83 for lift truck models

   - E2.2-3.5XN (E45-70XN) (A268) manufactured prior to June, 2012
   - and E1.6-2.0XN (E30-40XN) (A269) manufactured prior to June, 2012

   See Figure 84 for lift truck models

   - E2.2-3.5XN (E45-70XN) (A268) manufactured after to June, 2012
   - and E1.6-2.0XN (E30-40XN) (A269) manufactured after to June, 2012

8. Remove lower capscrews, lower nuts, lower washers, and tow pin from counterweight and frame.

   See Figure 83 for lift truck models

   - E2.2-3.5XN (E45-70XN) (A268) manufactured prior to June, 2012
   - and E1.6-2.0XN (E30-40XN) (A269) manufactured prior to June, 2012

   See Figure 84 for lift truck models

   - E2.2-3.5XN (E45-70XN) (A268) manufactured after to June, 2012
   - and E1.6-2.0XN (E30-40XN) (A269) manufactured after to June, 2012

9. Using crane lift counterweight away from frame.

INSTALL

1. Using crane, lift counterweight into position on frame.

2. Install upper capscrews and washers, near bottom of battery compartment, into counterweight and frame. Tighten upper capscrews to 755 N•m (557 lbf ft).

   See Figure 83 for lift truck models

   - E2.2-3.5XN (E45-70XN) (A268) manufactured prior to June, 2012
   - and E1.6-2.0XN (E30-40XN) (A269) manufactured prior to June, 2012

   See Figure 84 for lift truck models

   - E2.2-3.5XN (E45-70XN) (A268) manufactured after to June, 2012
   - and E1.6-2.0XN (E30-40XN) (A269) manufactured after to June, 2012

3. Install lower capscrews, lower washers, and lower nuts, in tow pin area, into counterweight and frame. Install tow pin into counterweight. Tighten lower capscrews to 90 N•m (66 lbf ft).

   See Figure 83 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268) manufactured prior to June, 2012
- and E1.6-2.0XN (E30-40XN) (A269) manufactured prior to June, 2012

See Figure 84 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268) manufactured after to June, 2012
- and E1.6-2.0XN (E30-40XN) (A269) manufactured after to June, 2012

4. Disconnect and remove slings from counterweight.

5. Install controller, contactors, and other electronic components located in counterweight. Install controller cover onto counterweight. See **Electrical System** 2200SRM1369. Connect electrical connectors as tagged during removal.

6. Install counterweight cover, washers, and capscrews on counterweight.

See Figure 83 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268) manufactured prior to June, 2012
- and E1.6-2.0XN (E30-40XN) (A269) manufactured prior to June, 2012

See Figure 84 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268) manufactured after to June, 2012
- and E1.6-2.0XN (E30-40XN) (A269) manufactured after to June, 2012

7. Install overhead guard. See section **Overhead Guard Replacement**, Install for procedures.

8. Install battery into lift truck. See **How to Change Battery** in **Operating Manual** or one of the following service manuals

Periodic Maintenance 8000SRM1364 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268)

Periodic Maintenance 8000SRM1442 for lift truck models

- E1.6-2.0XN (E30-40XN) (A269)

9. Connect battery connector.

Counterweight Replacement for Lift Truck Models J2.2-3.5XN (J45-70XN) (A276) and J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

Put lift truck on blocks, see **How to Put Lift Truck on Blocks** in **Operating Manual** or one of the following service manuals

Periodic Maintenance 8000SRM1372 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276)

Periodic Maintenance 8000SRM1541 for lift truck models

- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

WARNING

The counterweight is heavy. Make sure that the crane and lifting devices have enough lifting capacity to safely lift the counterweight. The weights of the counterweights are shown in

Table 4 for lift truck models

- **J2.2-3.5XN (J45-70XN) (A276) manufactured prior to June 2016**

Table 5 for lift truck models

- **J2.2-3.5XN (J45-70XN) (A276) manufactured after June 2016**

Table 6 for lift trucks

- **J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)**

Table 4. Counterweights for Lift Truck Manufactured Prior to June 2016J2.2-3.5XN (J45-70XN) (A276)

Model	(mm*)	Weight	+ 50 kg (110 lb) - 0 kg (0 lb)
J2.2-2.5XN (J45-50XN)	717	725 kg (1598 lb)	
J3.0XN (J60XN)	861	801 kg (1766 lb)	
J3.5XN (J70XN)	861	1116 kg (2460 lb)	
*Approximate battery compartment lengths.			

Table 5. Counterweights for Lift Truck Manufactured After June 2016J2.2-3.5XN (J45-70XN) (A276)

Model	(mm*)	Weight	+ 50 kg (110 lb) - 0 kg (0 lb)
J2.2-2.5XN (J45-50XN)	717	736 kg (1623 lb)	
J3.0XN (J60XN)	861	812 kg (1790 lb)	
J3.5XN (J70XN)	861	1126 kg (2482 lb)	
*Approximate battery compartment lengths.			

Table 6. Counterweights for Lift Truck J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

Model	(mm*)	Weight	+ 50 kg (110 lb) - 0 kg (0 lb)
J4.0-4.5XN (J80-90XN)	859	1453 kg (3203 lb)	
J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL)	1006	2621 kg (5778 lb)	
*Approximate battery compartment lengths.			

The counterweight normally is not removed for most repairs. Replacement of controller and hydraulic components is easier with counterweight installed. The counterweight is fastened to rear bulkhead with mounting bolts.

See Figure 85 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276) manufactured prior to June, 2012

See Figure 86 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276) manufactured after June, 2012

See Figure 87 for lift truck model

- J2.2-3.5XN (J45-70XN) (A276) manufactured after November, 2015

See Figure 88 for lift truck model

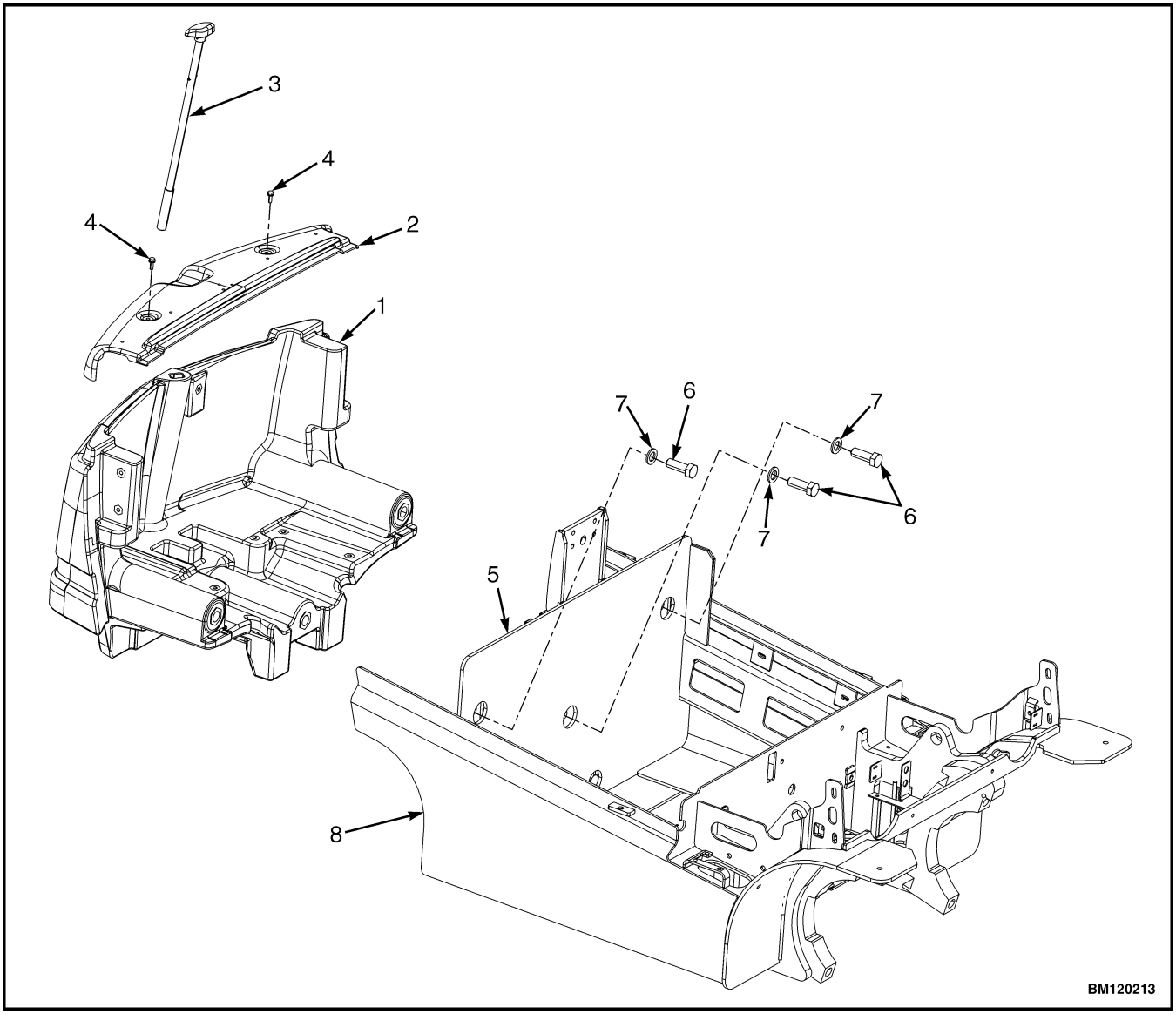
- J2.2-3.5XN (J45-70XN) (A276) manufactured after June, 2016

See Figure 89 for lift truck models

- J4.0-5.0XN (J80-100XN) (A970) manufactured before Nov, 2014

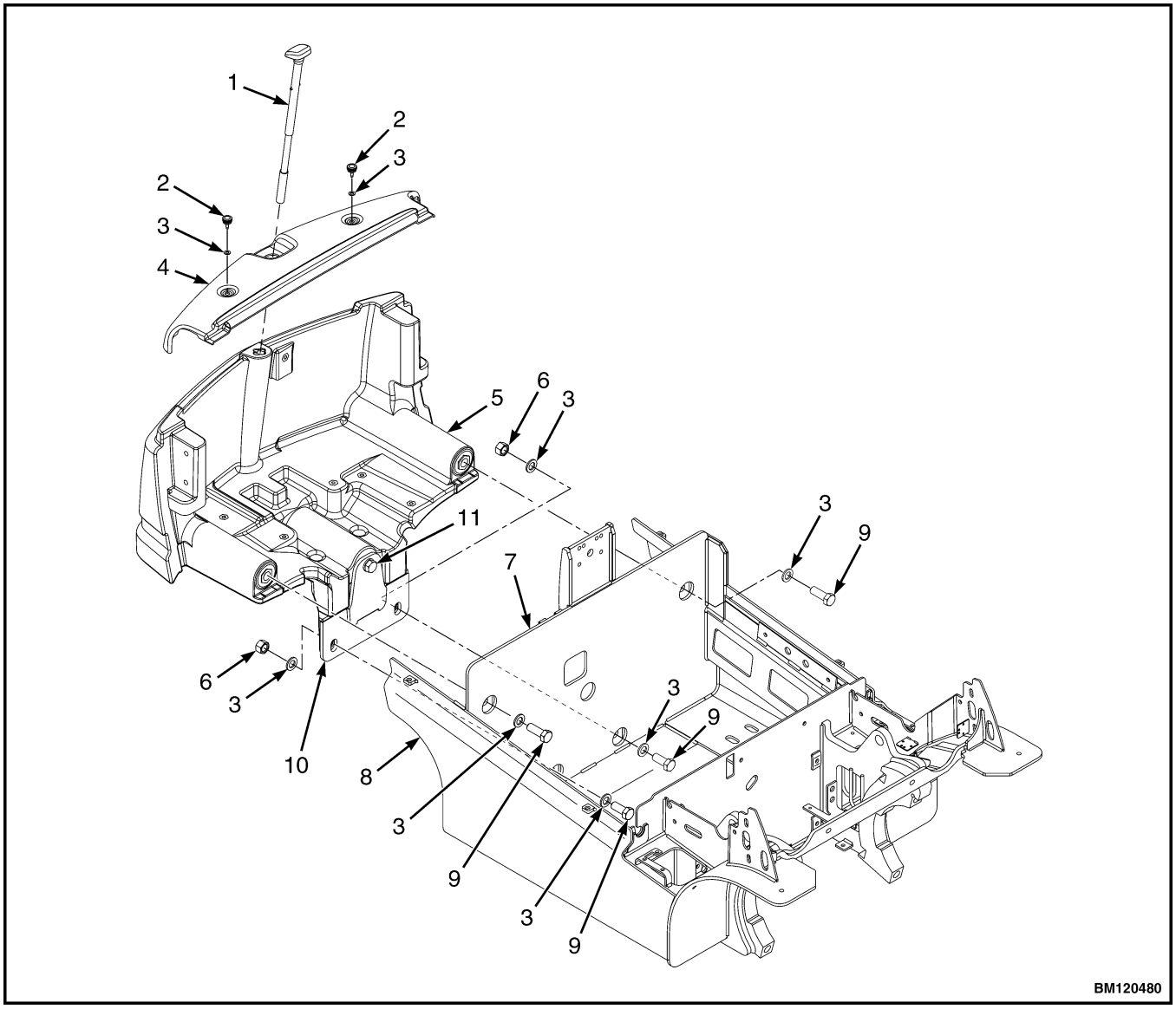
See Figure 90 for lift truck models

- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) manufactured after Nov, 2014



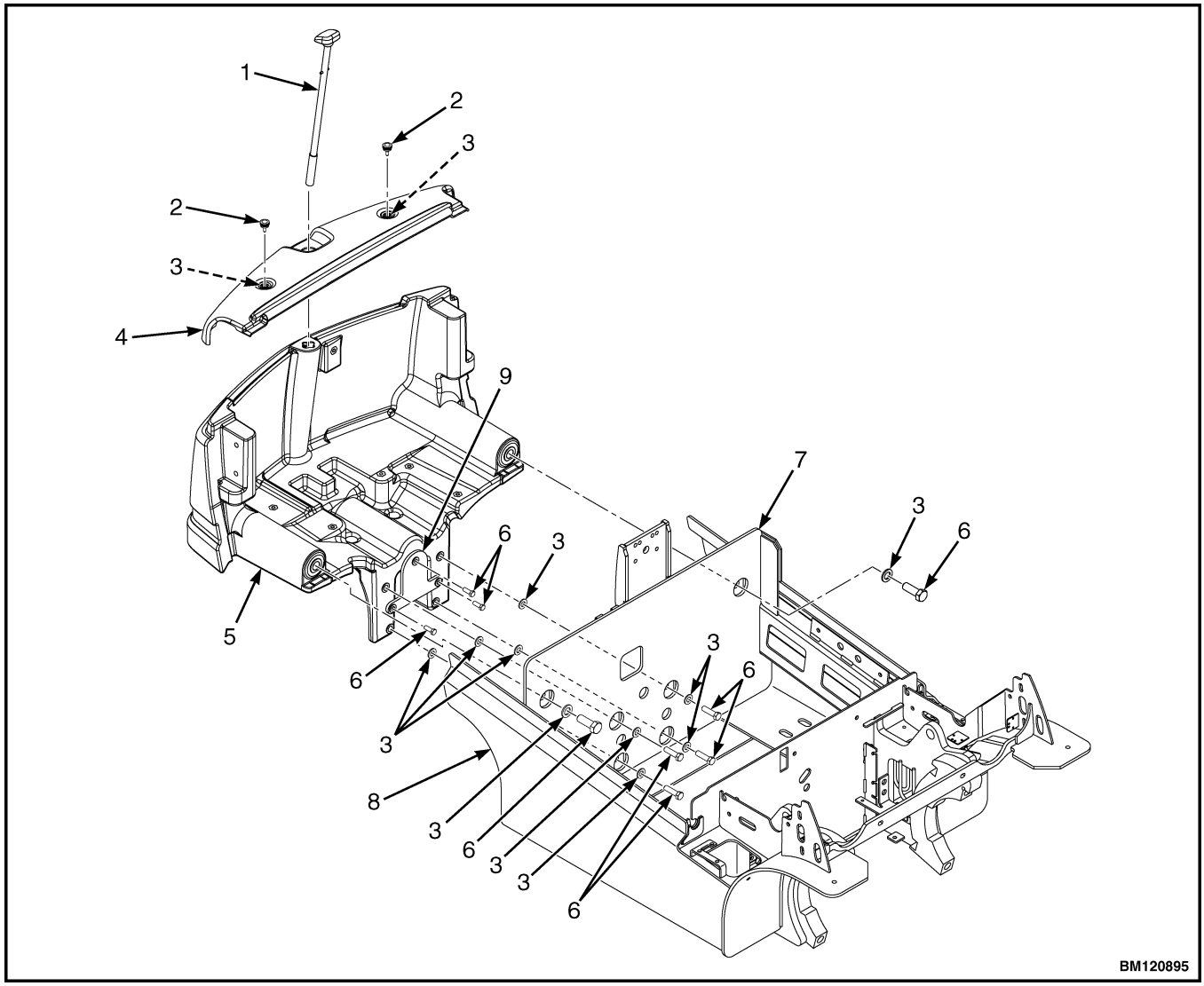
1. COUNTERWEIGHT
2. COUNTERWEIGHT COVER
3. TOW PIN
4. CAPSCREW
5. REAR BULKHEAD
6. MOUNTING BOLT
7. WASHER
8. FRAME

Figure 85. Counterweight Assembly for Lift Truck Manufactured Prior to June, 2012J2.2-3.5XN (J45-70XN) (A276)



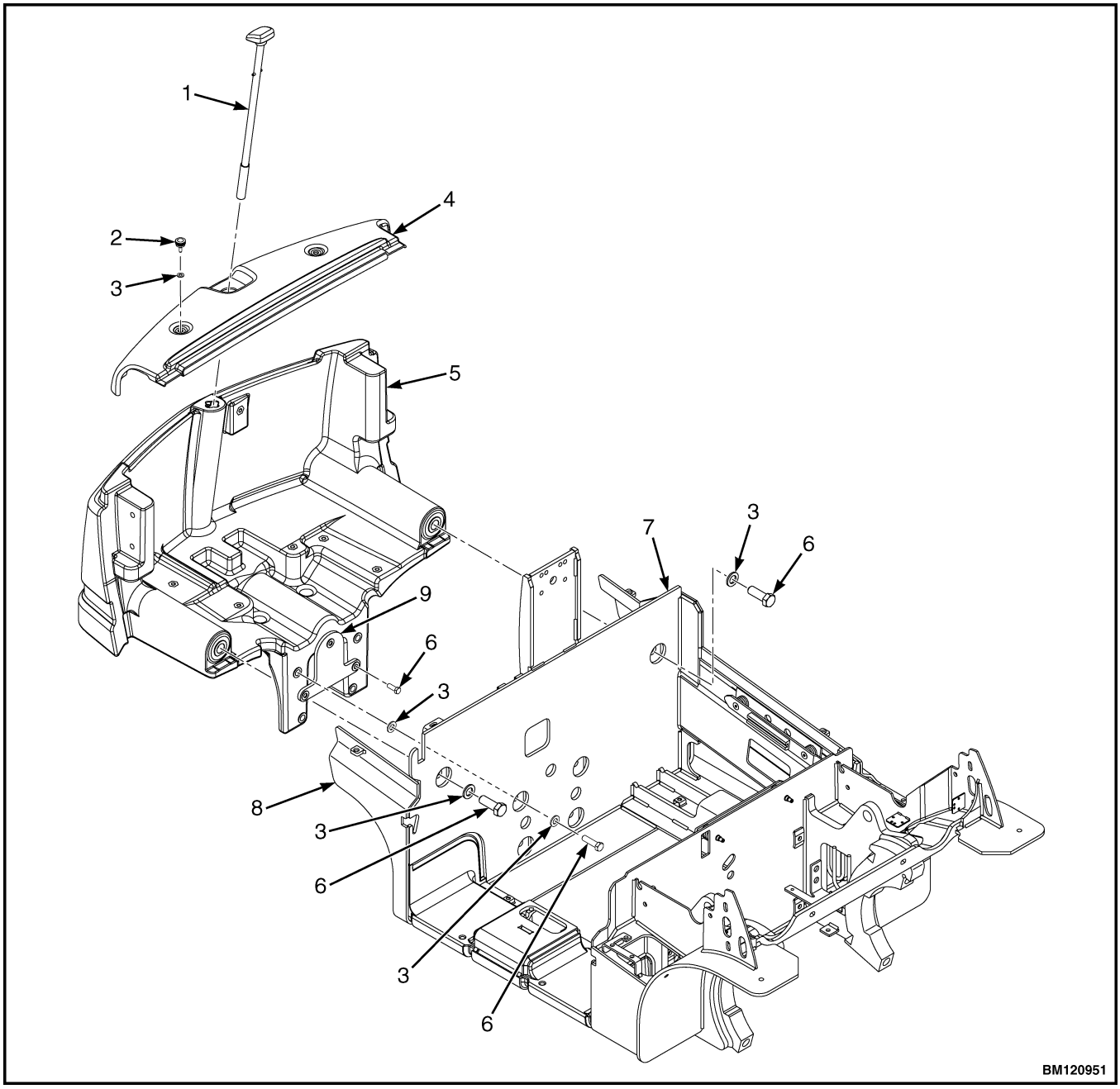
1. TOW PIN
2. CAPTURED THUMB SCREW
3. WASHER
4. COUNTERWEIGHT COVER
5. COUNTERWEIGHT
6. NUT
7. REAR BULKHEAD
8. FRAME
9. MOUNTING BOLT
10. BRACKET WELDMENT

Figure 86. Counterweight Assembly for Lift Truck Manufactured After June, 2012J2.2-3.5XN (J45-70XN) (A276)



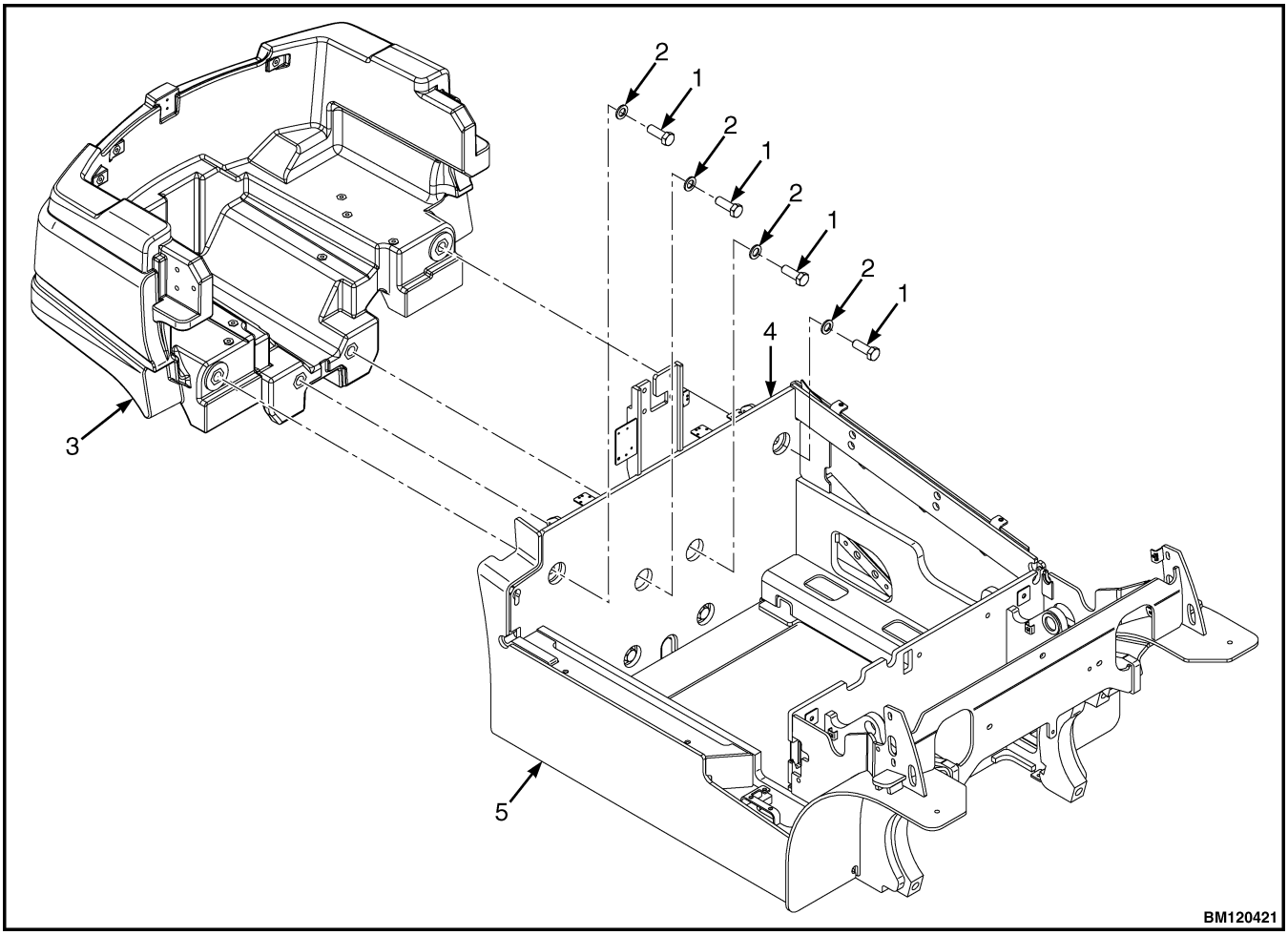
1. TOW PIN
2. CAPTURED THUMB SCREW
3. WASHER
4. COUNTERWEIGHT COVER
5. COUNTERWEIGHT
6. MOUNTING BOLT
7. REAR BULKHEAD
8. FRAME
9. BRACKET WELDMENT

Figure 87. Counterweight Assembly for Lift Truck Manufactured After November 2015J2.2-3.5XN (J45-70XN) (A276)



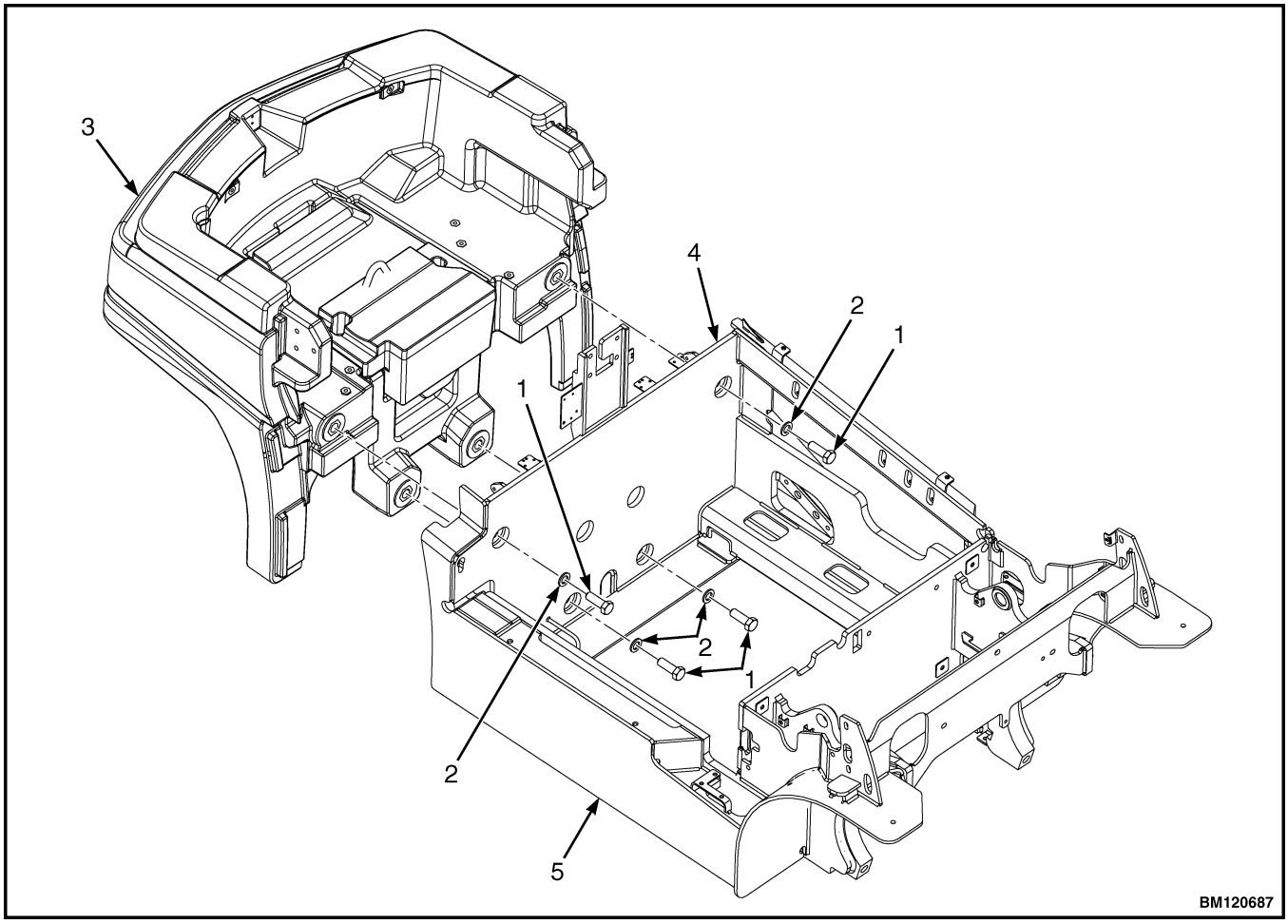
1. TOW PIN
2. CAPTURED THUMB SCREW
3. WASHER
4. COUNTERWEIGHT COVER
5. COUNTERWEIGHT
6. MOUNTING BOLT
7. REAR BULKHEAD
8. FRAME
9. BRACKET WELDMENT

Figure 88. Counterweight Assembly for Lift Truck Manufactured After June 2016J2.2-3.5XN (J45-70XN) (A276)



1. MOUNTING BOLT
2. WASHER
3. COUNTERWEIGHT
4. REAR BULKHEAD
5. FRAME

Figure 89. Counterweight Assembly for Lift Trucks with Short Wheel Base (SWB) Manufactured before Nov, 2014J4.0-5.0XN (J80-100XN) (A970)



1. MOUNTING BOLT
2. WASHER
3. COUNTERWEIGHT
4. REAR BULKHEAD
5. FRAME

Figure 90. Counterweight Assembly for Lift Trucks with Long Wheel Base (LWB) Manufactured after Nov, 2014J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

REMOVE

NOTE: Tag all electrical connectors during removal to aid in installation.

1. Disconnect battery connector.

2. Discharge capacitors as described in General section of this manual.

3. Remove battery from lift truck. See **How to Change Battery** in **Operating Manual** or one of the following service manuals

Periodic Maintenance 8000SRM1372 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276)

Periodic Maintenance 8000SRM1541 for lift truck models

- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

NOTE: Some lift trucks are equipped with cab panels. Be careful not to damage panels when removing overhead guard.

4. Remove overhead guard. See section Overhead Guard Replacement for procedures.

NOTE: Perform Step 5 for lift truck models J2.2-3.5XN (J45-70XN) (A276) , manufactured before June, 2012.

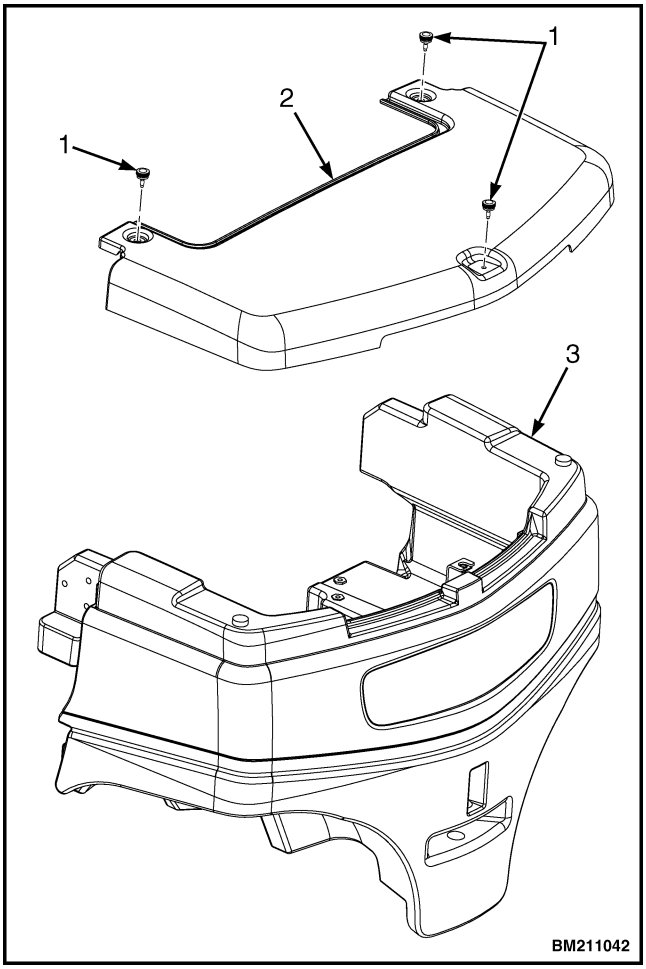
5. Remove tow pin, capscrews, washers, and counterweight cover from counterweight. See Figure 85.

NOTE: Perform Step 6 for lift truck models J2.2-3.5XN (J45-70XN) (A276) , manufactured after June, 2012.

6. Remove tow pin, captured thumb screws, washers, and counterweight cover from counterweight. See Figure 86 or Figure 87.

NOTE: Perform Step 7 for lift truck models J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) .

7. Remove mounting spacers and captive capscrews and remove counterweight cover from counterweight. See Figure 91.



1. CAPTIVE CAPSCREW
2. COUNTERWEIGHT COVER
3. COUNTERWEIGHT

Figure 91. Counterweight Cover Removal, Lift Truck Models J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

8. Remove hood and seat assembly. See Hood and Seat Assembly Replacement for procedures.

9. Remove controller, contactors, and other electronic components located in counterweight, see **Electrical System** 2200SRM1369.

NOTE: Tag all hydraulic lines during removal to aid in installation.

10. Remove hydraulic pump and motor assembly and hydraulic tank from counterweight. See **Hydraulic System** 1900SRM1367.

WARNING

Make sure lifting device has enough capacity to hold and lift counterweight.

See Table 4 for lift truck models

- **J2.2-3.5XN (J45-70XN) (A276) Manufactured Prior to June, 2016**

See Table 5 for lift truck models

- **J2.2-3.5XN (J45-70XN) (A276) Manufactured After June, 2016**

See Table 6 for lift truck models

- **J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)**

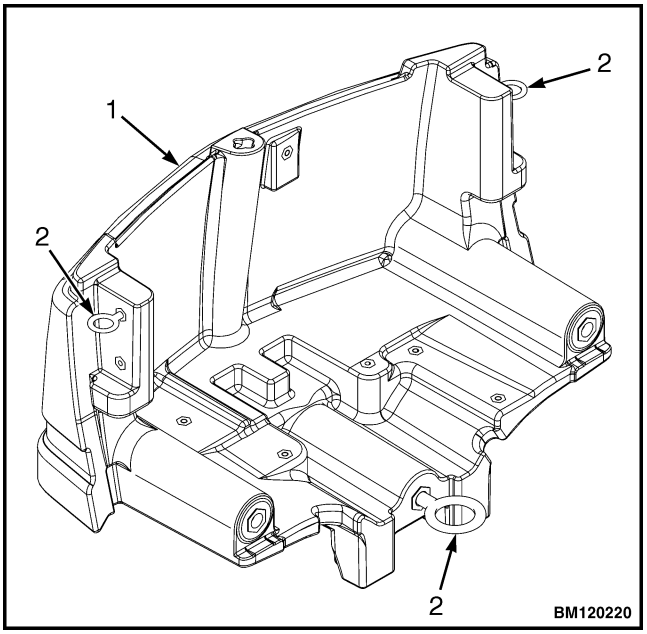
11. Install three or four eyebolts into counterweight and attach lifting device to eyebolts.

See Figure 92 and Figure 93 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276)

See Figure 94 and Figure 95 for lift truck models

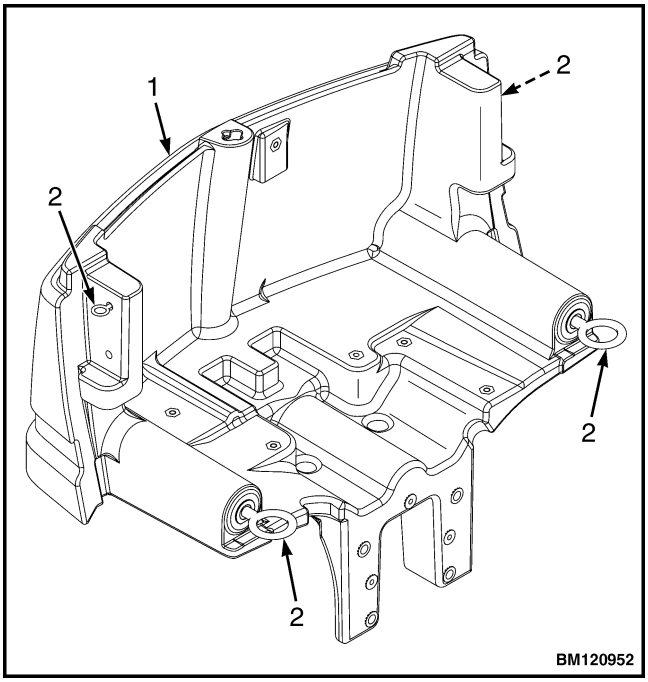
- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)



NOTE: COUNTERWEIGHT MANUFACTURED PRIOR TO NOVEMBER 2015 SHOWN. COUNTERWEIGHT MANUFACTURED AFTER NOVEMBER 2015 SIMILAR.

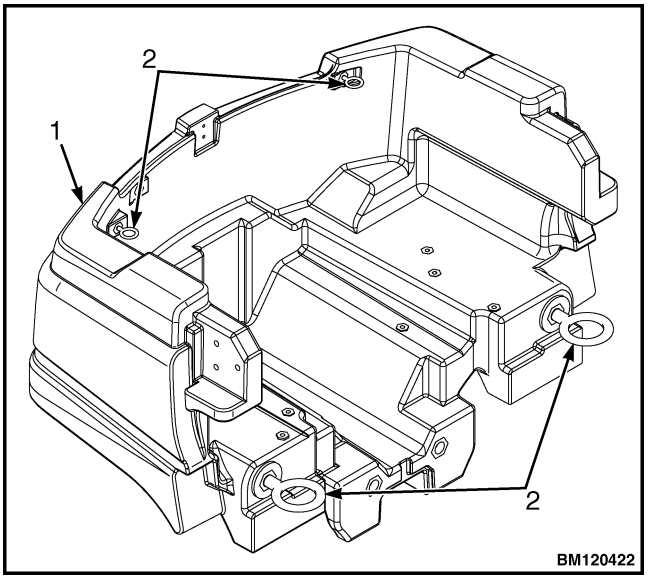
1. COUNTERWEIGHT
2. EYEBOLT

Figure 92. Counterweight Lift for Lift Truck Manufactured Prior to June, 2016J2.2-3.5XN (J45-70XN) (A276)



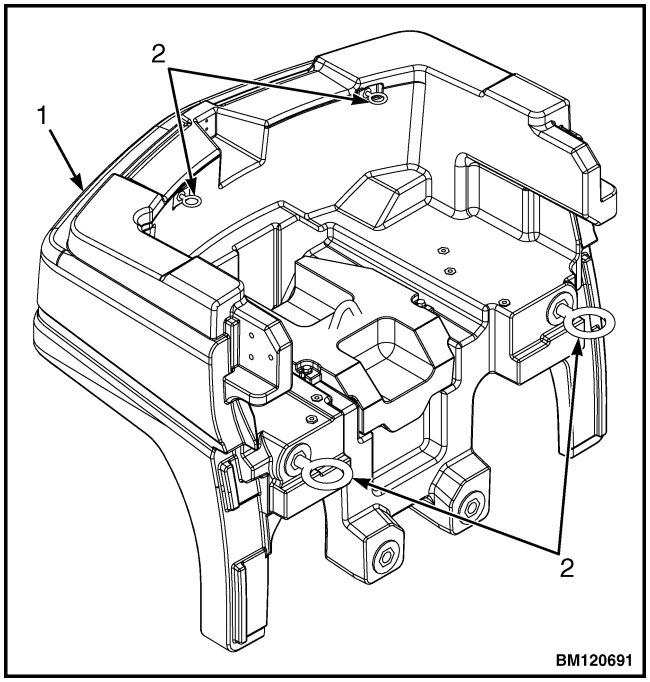
1. COUNTERWEIGHT
2. EYEBOLT

Figure 93. Counterweight Lift for Lift Truck Manufactured After June, 2016J2.2-3.5XN (J45-70XN) (A276)



1. COUNTERWEIGHT
2. EYEBOLT

Figure 94. Counterweight Lift for Lift Trucks Manufactured before Nov, 2014J4.0-5.0XN (J80-100XN) (A970)



1. COUNTERWEIGHT
2. EYEBOLT

Figure 95. Counterweight Lift for Lift Trucks Manufactured after Nov, 2014J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

12. Remove steering axle from counterweight. See **Steering Axle** 1600SRM1360.

NOTE: Perform Step 13 for lift truck models J2.2-3.5XN (J45-70XN) (A276) , manufactured before June, 2012.

13. Remove three mounting bolts and washers from rear bulkhead and counterweight. See Figure 85.

NOTE: Perform Step 14 for lift truck models J2.2-3.5XN (J45-70XN) (A276) , manufactured after June, 2012.

14. Remove four mounting bolts, two nuts, and six washers from rear bulkhead and counterweight. See Figure 86.

NOTE: Perform Step 15 for lift truck model J2.2-3.5XN (J45-70XN) (A276) , manufactured after November, 2015.

15. Remove six mounting bolts and six washers from rear bulkhead and counterweight. See Figure 87.

NOTE: Perform Step 16 for lift truck models J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) .

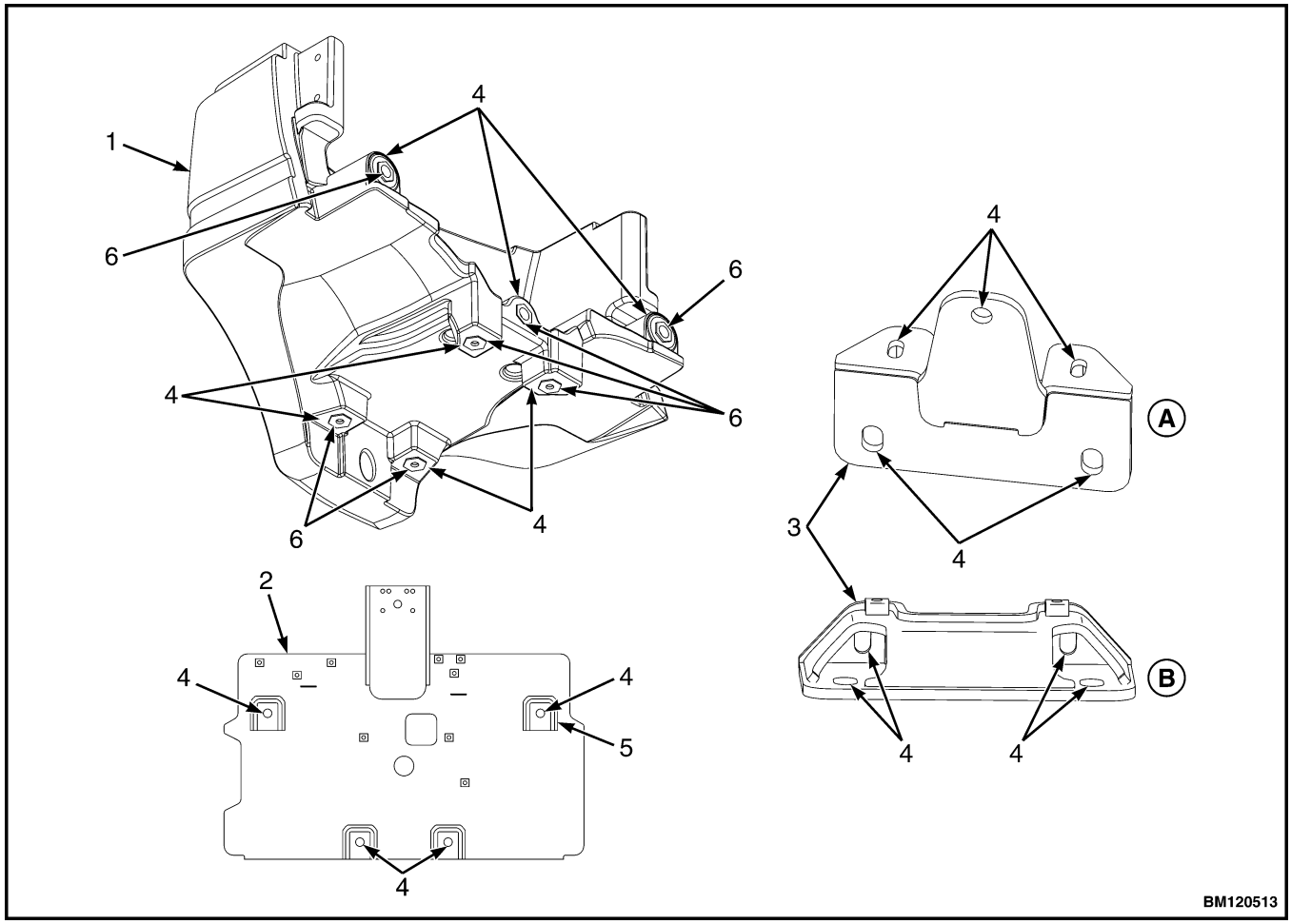
16. Remove four mounting bolts and washers from rear bulkhead and counterweight. See Figure 89 or Figure 90.

17. Using approved lifting device, pull counterweight slightly away from frame. Install eyebolt into center hole in counterweight and attach lifting device. Lift counterweight completely away from frame.

CLEAN AND INSPECT, LIFT TRUCK MODELS J2.2-3.5XN (J45-70XN) (A276)

1. Remove capscrew, washer and bracket weldment from bottom of counterweight. See Figure 86 or Figure 87.

2. Clean all mating surfaces of grease, grime, dirt, and other debris. See Figure 96 or Figure 97.

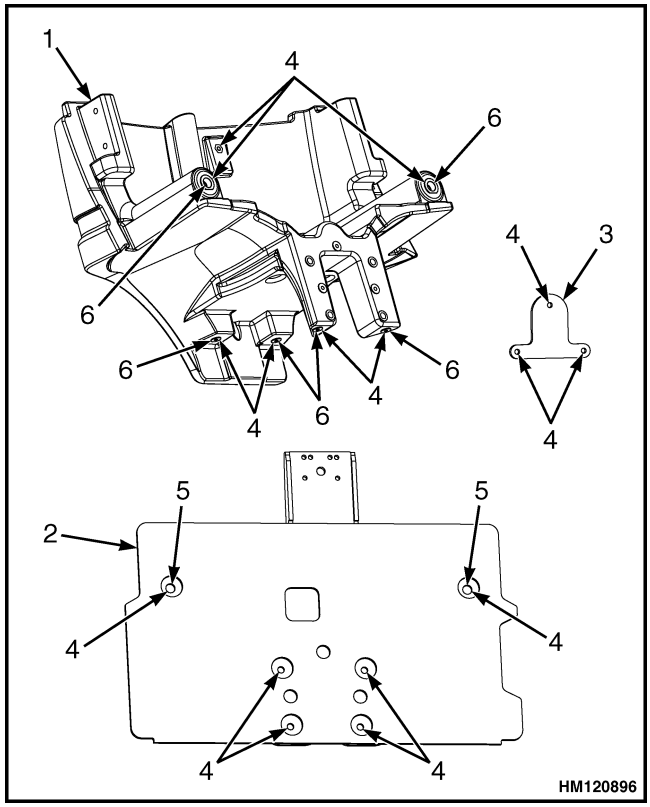


NOTE: COUNTERWEIGHT FOR LIFT TRUCK MODELS J2.2-3.5XN (J45-70XN) (A276) MANUFACTURED AFTER JUNE, 2012 SHOWN. CLEANING AND INSPECTION PROCEDURES FOR COUNTERWEIGHT FOR LIFT TRUCK MODELS J2.2-3.5XN (J45-70XN) (A276) MANUFACTURED BEFORE JUNE, 2012 ARE SIMILAR.

A. FRONT VIEW
B. BOTTOM VIEW

1. COUNTERWEIGHT
2. REAR BULKHEAD
3. BRACKET WELDMENT
4. MATING SURFACE
5. PAD
6. HEXAGON SURFACE

Figure 96. Counterweight Cleaning and Inspection, Manufactured After June, 2012



1. COUNTERWEIGHT
2. REAR BULKHEAD
3. BRACKET WELDMENT
4. MATING SURFACE
5. PAD
6. HEXAGON SURFACE

Figure 97. Counterweight Cleaning and Inspection, Manufactured After November, 2015

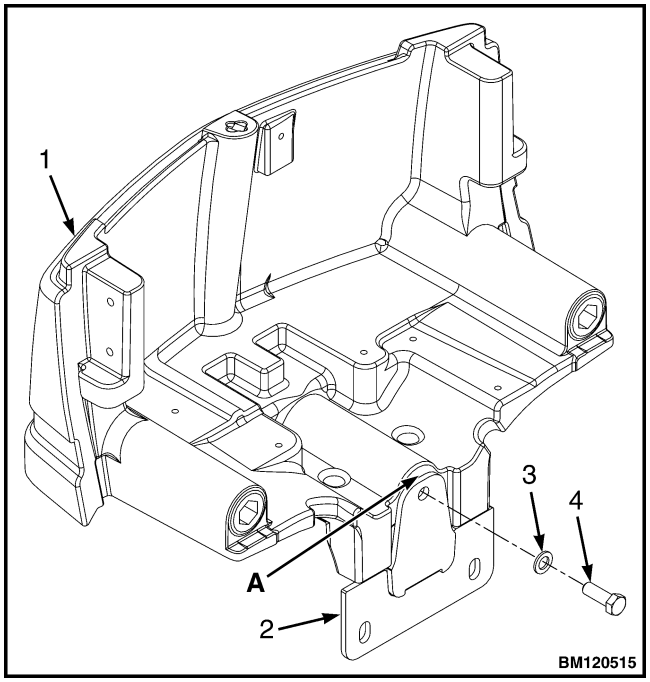
3. Inspect counterweight mounting holes to ensure that hexagon surfaces protrude past cast surfaces of the counterweight. See Figure 96.

INSTALL

NOTE: Perform Step 1 through Step 3 for lift truck models J2.2-3.5XN (J45-70XN) (A276) .

1. Install bracket weldment to counterweight. See Figure 98 or Figure 99. Tighten capscrew and washer to 755 N•m (557 lbf ft).

2. Make sure there is no gap between the counterweight and bracket weldment at location shown in Figure 98 or Figure 99.

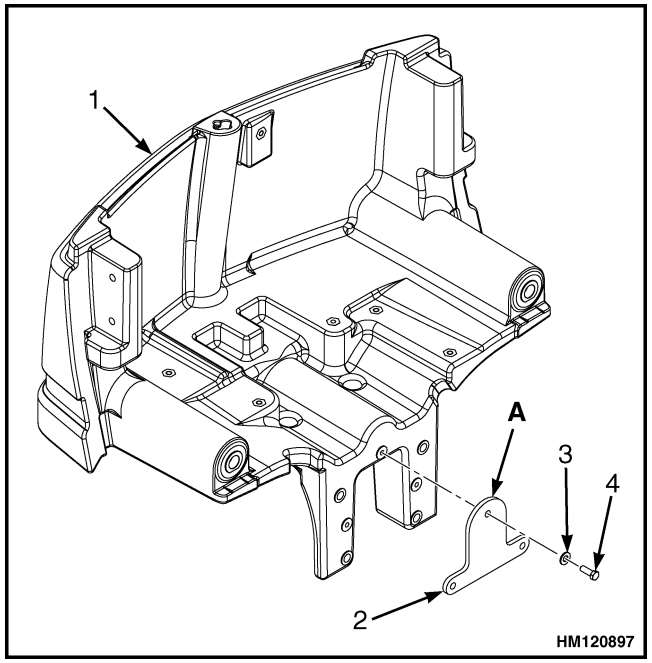


NOTE: COUNTERWEIGHT AND BRACKET WELDMENT FOR LIFT TRUCK MODELS J2.2-3.5XN (J45-70XN) (A276) MANUFACTURED AFTER JUNE, 2012 SHOWN. COUNTERWEIGHT AND BRACKET WELDMENT FOR LIFT TRUCK MODELS J2.2-3.5XN (J45-70XN) (A276) MANUFACTURED BEFORE JUNE, 2012 ARE SIMILAR.

A. NO GAP BETWEEN COUNTERWEIGHT AND BRACKET WELDMENT AT THIS LOCATION

1. COUNTERWEIGHT
2. BRACKET WELDMENT
3. WASHER
4. CAPSCREW

Figure 98. Counterweight Bracket Weldment, Install for Lift Trucks Manufactured After June, 2012



A. NO GAP BETWEEN COUNTERWEIGHT AND BRACKET WELDMENT AT THIS LOCATION

1. COUNTERWEIGHT
2. BRACKET WELDMENT
3. WASHER
4. CAPSCREW

Figure 99. Counterweight Bracket Weldment, Install for Lift Trucks Manufactured After November, 2012

NOTE: Make sure lifting mechanism has enough capacity to hold and lift counterweight.

3. Using approved lifting device, position counterweight to rear bulkhead. Detach lifting device from center eyebolt and remove eyebolt from center hole in counterweight. See Figure 92 or Figure 93.

4. For lift truck models J4.0-5.0XN (J80-100XN) (A970) , using approved lifting device, position counterweight to rear bulkhead. Detach lifting device from two lower eyebolts and remove eyebolts from holes in counterweight. See Figure 94 or Figure 95.

5. For lift trucks J2.2-3.5XN (J45-70XN) (A276) manufactured before June, 2012, install three washers and mounting bolts into rear bulkhead and counterweight. See Figure 85. Tighten mounting bolts to 755 N•m (557 lbf ft).

For lift trucks J2.2-3.5XN (J45-70XN) (A276) manufactured after June, 2012, install six washers, two nuts, and four mounting bolts into rear bulkhead and counterweight. See Figure 86. Tighten mounting bolts to 755 N•m (557 lbf ft).

For lift trucks J2.2-3.5XN (J45-70XN) (A276) manufactured after November, 2012, install six washers and six mounting bolts into rear bulkhead and counterweight. See Figure 87. Tighten mounting bolts to 755 N•m (557 lbf ft).

For lift trucks J2.2-3.5XN (J45-70XN) (A276) manufactured after June, 2016, install six washers and six mounting bolts into rear bulkhead and counterweight. See Figure 88. Tighten mounting bolts to 755 N•m (557 lbf ft).

6. For lift trucks J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) , install four mounting bolts and washers into rear bulkhead and counterweight. See Figure 89 or Figure 90. Tighten mounting bolts to 755 N•m (557 lbf ft).

7. Install steering axle onto counterweight. See **Steering Axle** 1600SRM1360.

8. Detach lifting device and remove two eyebolts from top of counterweight.

See Figure 92 or Figure 93 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276)

See Figure 94 for lift truck models

- J4.0-5.0XN (J80-100XN) (A970) manufactured before Nov, 2014

See Figure 90 for lift truck models

- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) manufactured after Nov, 2014

9. Install hydraulic tank and hydraulic pump and motor assembly. See **Hydraulic System** 1900SRM1367. Connect hydraulic lines as tagged during removal.

10. Install controller, contactors, and other electronic components located in counterweight, see **Electrical System** 2200SRM1369. Connect electrical connectors as tagged during removal.

11. Install hood and seat assembly. See section Hood and Seat Assembly Replacement and J2.2-3.5XN (J45-70XN) (A276) for procedures.

12. For lift truck models J2.2-3.5XN (J45-70XN) (A276) , install counterweight cover, capscrews, and tow pin onto counterweight.

See Figure 85 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276) manufactured prior to June, 2012

See Figure 86 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276) manufactured after June, 2012

See Figure 87 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276) manufactured after November, 2015

See Figure 88 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276) manufactured after June, 2016

13. For lift truck models J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) , install mounting spacers and capscrews and install counterweight cover to counterweight. See Figure 89 or Figure 90.

NOTE: For lift truck equipped with cab panels, be careful to not damage panels when installing overhead guard.

14. Install overhead guard. See section Overhead Guard Replacement for procedures.

15. Install battery into lift truck. See **How to Change Battery** in **Operating Manual** or one of the following service manuals

Periodic Maintenance 8000SRM1372 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276)

Periodic Maintenance 8000SRM1541 for lift truck models

- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

16. Connect battery connector.

Counterweight Replacement for Lift Truck Models E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

Put lift truck on blocks, see **How to Put Lift Truck on Blocks** in **Operating Manual** or in service manual **Periodic Maintenance** 8000SRM1577.

WARNING

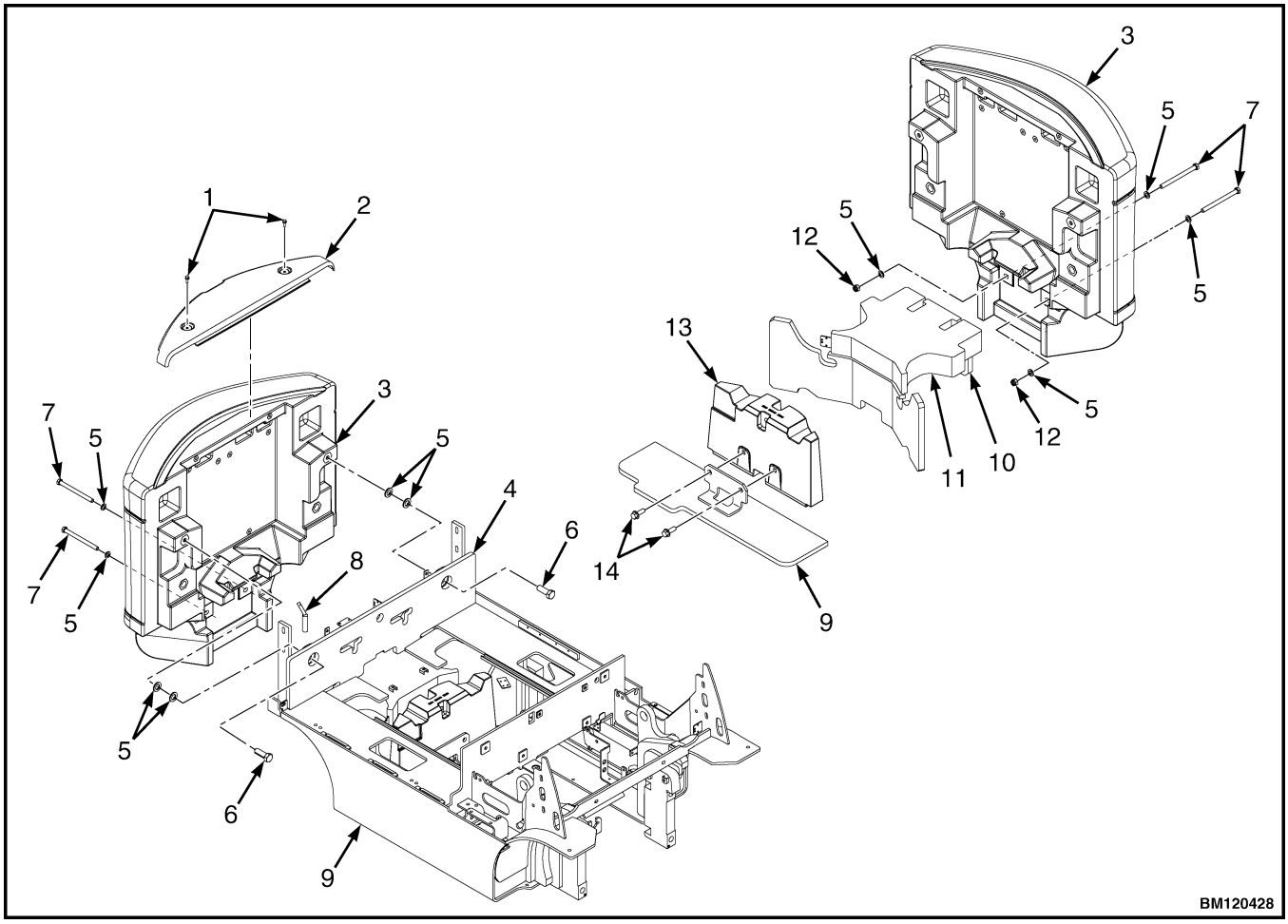
The counterweight is heavy. Make sure that the crane and lifting devices have enough lifting capacity to safely lift the counterweight. The weights of the counterweights are shown in Table 7.

Table 7. Counterweights for Lift Truck E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

Model	(mm*)	Sub-weight	Counterweight + 50 kg (110 lb) - 0 kg (0 lb)
E4.0XN (E80XN)	996 mm (39.2 in.)	145 kg (320 lb)	1316 kg (2901 lb)
E5.0XNS (E100XNS) (SWB)	996 mm (39.2 in.)	145 kg (320 lb)	2031 kg (4478 lb)
E5.0XN (E100XN)(LWB)	1156 mm (45.5 in.)	1316 kg (496 lb)	1316 kg (2901 lb)
E5.5XN (E120XN)	1156 mm (45.5 in.)	145 kg (320 lb)	2031 kg (4478 lb)
*Approximate battery compartment lengths.			

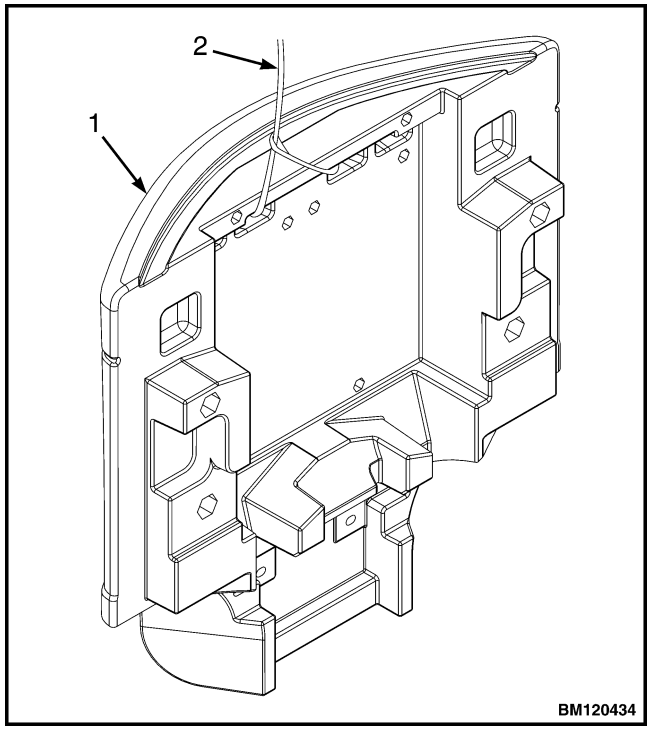
The counterweight normally is not removed for most repairs. Replacement of controller and hydraulic components is easier with counterweight installed.

The counterweight is fastened to rear bulkhead with mounting bolts. See Figure 100.



1. CAPSCREW
2. COUNTERWEIGHT COVER
3. COUNTERWEIGHT
4. REAR BULKHEAD
5. WASHER
6. UPPER MOUNTING BOLT
7. LOWER MOUNTING BOLT
8. TOW PIN
9. FRAME
10. COUNTERWEIGHT MOUNTING PLATE
11. STEERING AXLE MOUNTING PLATE
12. NUT
13. COUNTERWEIGHT SUB-CAST
14. CAPSCREW

Figure 100. Counterweight Assembly for Lift Trucks E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)



1. COUNTERWEIGHT
2. SLING

Figure 101. Remove and Install Counterweight for Lift Trucks E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

REMOVE

NOTE: Tag all electrical connectors during removal to aid in installation.

1. Disconnect battery connector.

2. Discharge capacitors as described in General section of this manual.

3. Remove battery from lift truck. See **How to Change Battery** in **Operating Manual** or in service manual **Periodic Maintenance** 8000SRM1577.

NOTE: Some lift trucks are equipped with cab panels. Be careful not to damage panels when removing overhead guard.

4. Remove overhead guard. See section Overhead Guard Replacement for procedures.

5. Remove tow pin, capscrews, washers, and counterweight cover from counterweight. See Figure 100.

6. Remove hood and seat assembly. See section Hood and Seat Assembly Replacement for procedures.

7. Remove controller, contactors, and other electronic components located in counterweight. See **Electrical System** 2200SRM1369 for procedures.

NOTE: Tag all hydraulic lines during removal to aid in installation.

8. Remove hydraulic pump and motor assembly and hydraulic tank from counterweight. See **Hydraulic System** 1900SRM1367 for procedures.

WARNING

Make sure lifting device has enough capacity to hold and lift counterweight. See Table 7.

9. Connect crane and sling around center of counterweight. See Figure 101.

10. Remove steering axle from counterweight. See **Steering Axle** 1600SRM1360 for procedures.

11. Remove two upper mounting bolts and washers from rear bulkhead and counterweight. See Figure 100.

12. Remove two lower mounting bolts, washers, nuts and counter weight from counterweight mounting plate. See Figure 100.

13. Using crane, pull counterweight slightly away from frame. Lift counterweight completely away from frame. See Figure 101.

INSTALL

NOTE: Make sure lifting device has enough capacity to lift and hold counterweight. See Table 7.

1. Using crane, position counterweight to rear bulkhead.

2. Install two upper mounting bolts and washers into rear bulkhead and counterweight. See Figure 100.

3. Install two lower mounting bolts, washers and nuts into counterweight mounting plate and counter weight. See Figure 100.

4. Tighten upper mounting bolts to 755 to 945 N•m (557 to 697 lbf ft).

5. Tighten lower mounting bolts to 250 to 280 N•m (184 to 207 lbf ft).

6. Detach sling from counterweight. See Figure 101.

7. Install steering axle onto counterweight. See **Steering Axle** 1600SRM1360 for procedures.

8. Install hydraulic tank and hydraulic pump and motor assembly. See **Hydraulic System** 1900SRM1367 for procedures. Connect hydraulic lines as tagged during removal.

9. Install controller, contactors, and other electronic components located in counterweight. See **Electrical System** 2200SRM1369 for procedures. Connect electrical connectors as tagged during removal.

10. Install hood and seat assembly. See section Hood and Seat Assembly Replacement for procedures.

11. Install counterweight cover, capscrews, and tow pin onto counterweight. See Figure 100.

NOTE: For lift trucks equipped with cab panels, be careful to not damage panels when installing overhead guard.

12. Install overhead guard. See Overhead Guard Replacement section of this manual.

13. Install battery into lift truck. See **How to Change Battery** in **Operating Manual** or in service manual **Periodic Maintenance** 8000SRM1577.

14. Connect battery connector.

Traction Motor Replacement for Lift Truck Models E2.2-3.5XN (E45-70XN) (A268) and E1.6-2.0XN (E30-40XN) (A269)

Remove

This procedure is for removal of the traction motor from under lift truck with the use of a floor jack. The traction motor can also be removed through the battery compartment. The lift truck must be on blocks with clearance for the floor jack and traction motor, if traction motor is removed from under lift truck.

See Figure 102 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268)

See Figure 103 for lift truck models

- E1.6-2.0XN (E30-40XN) (A269)

WARNING

PUTTING THE LIFT TRUCK ON BLOCKS

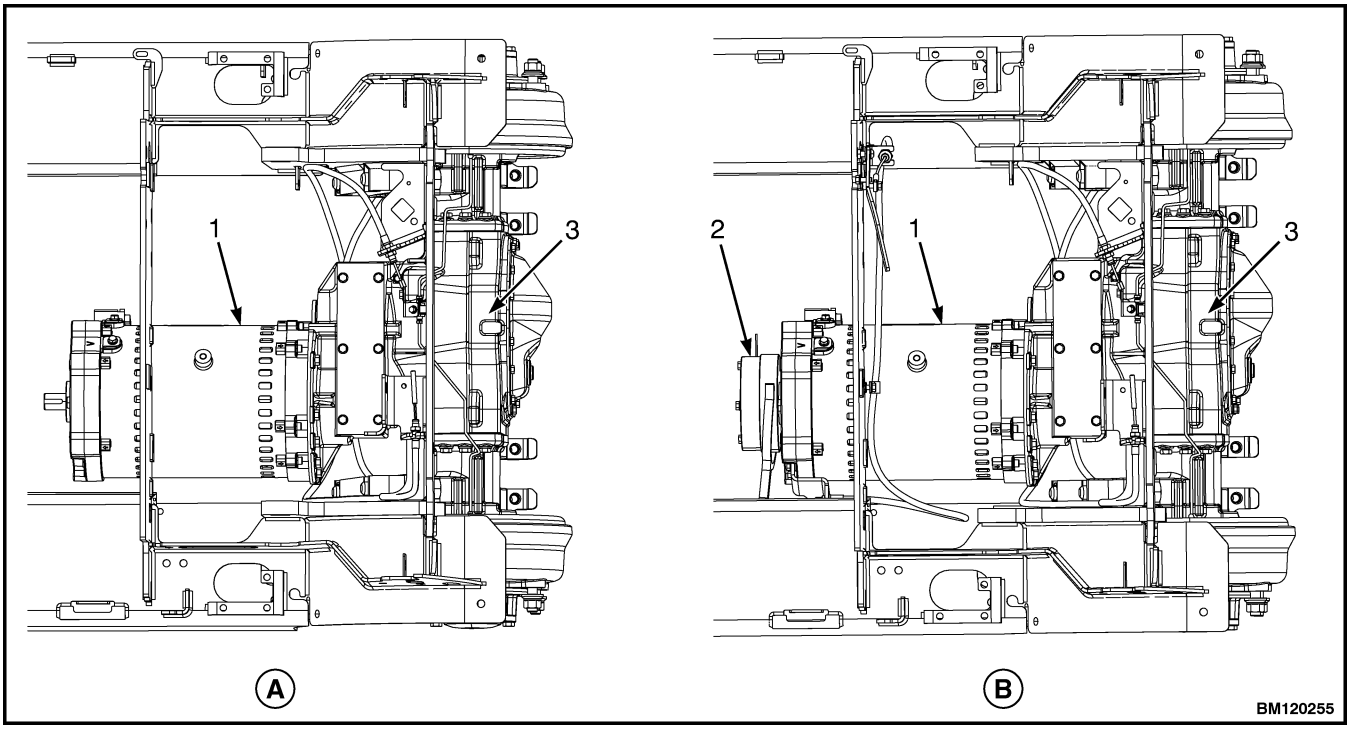
The lift truck must be put on blocks for many types of maintenance and repair. The removal of the mast, drive axle, battery, or counterweight assemblies will cause large changes in the center gravity. When the lift truck is put on blocks, put additional blocks in the following positions:

- **If the mast and drive axle are removed, put blocks under the counterweight so the lift truck cannot fall backward.**
- **If the counterweight is removed, put blocks under the mast so that the lift truck cannot fall forward.**

Put the lift truck on blocks on a solid, even, and level surface. Verify the blocks or stands have enough capacity to hold the lift truck. Use additional blocks next to the tires as necessary to prevent movement of the lift truck. Verify the lifting devices used during repairs can lift the weight of the parts and assemblies.

See Operating Manual or Periodic Maintenance manual for your lift truck.

NOTE: Some lift trucks have an automatic park brake on the armature shaft of the traction motor. The automatic park brake must be disconnected before traction motor is removed. See Figure 102.



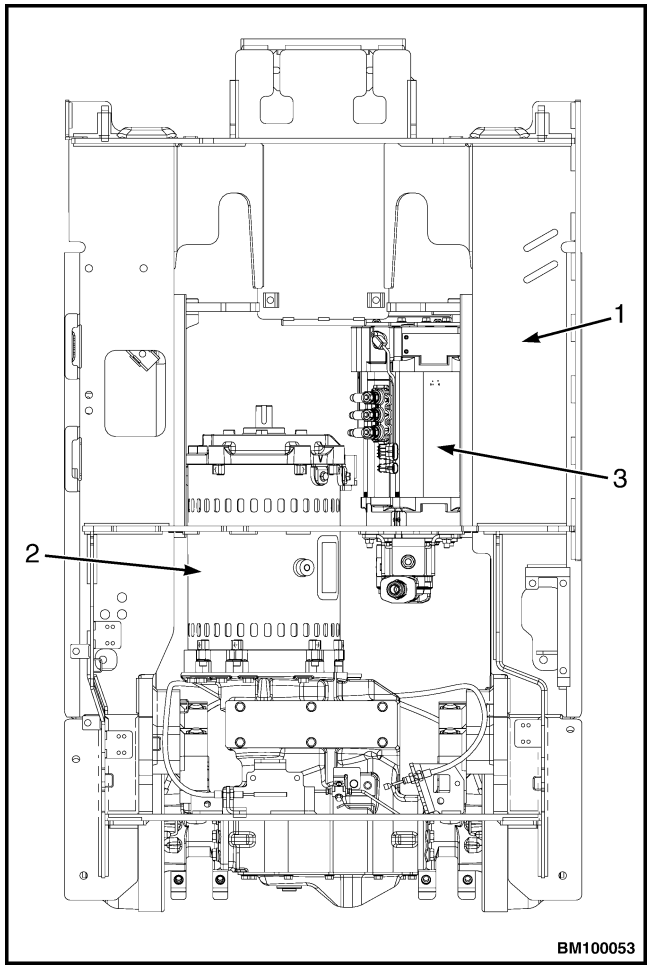
A. TRACTION MOTOR

B. TRACTION MOTOR WITH OPTIONAL AUTOMATIC PARK BRAKE

1. TRACTION MOTOR
2. AUTOMATIC PARKING BRAKE

3. DRIVE AXLE

Figure 102. Traction Motor, Lift Trucks E2.2-3.5XN (E45-70XN) (A268)



NOTE: OPTIONAL AUTOMATIC PARK BRAKE NOT SHOWN. SEE FIGURE 104.

1. FRAME
2. TRACTION MOTOR
3. HYDRAULIC PUMP MOTOR

Figure 103. Traction Motor, Lift Trucks E1.6-2.0XN (E30-40XN) (A269)

1. Remove battery from lift truck. See **How to Change Battery** in the **Operating Manual** or

See **Periodic Maintenance** 8000SRM1364 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268)

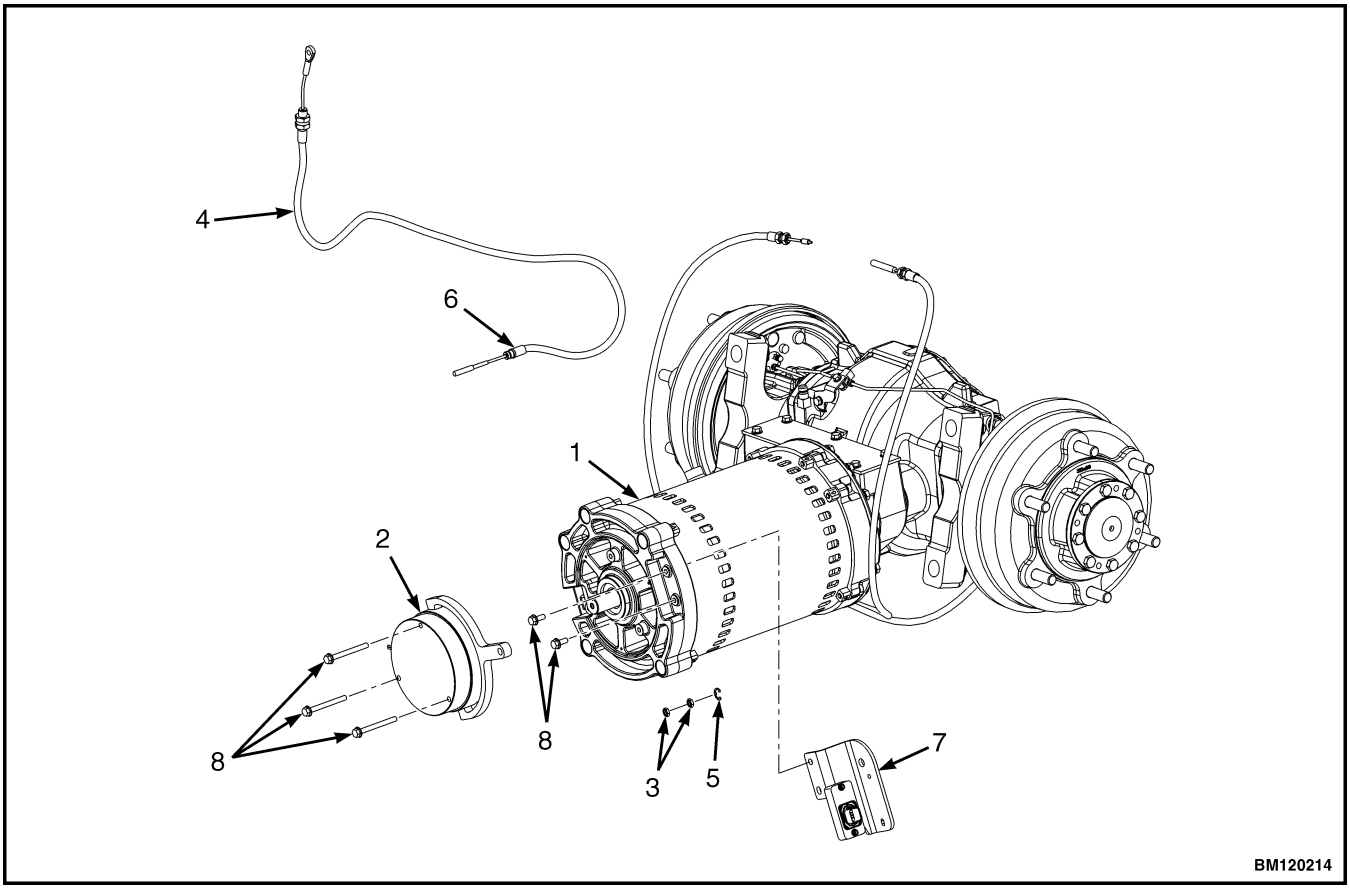
See **Periodic Maintenance** 8000SRM1442 for lift truck models

- E1.6-2.0XN (E30-40XN) (A269)

2. Remove covers or plates and optional rollers from bottom of battery compartment. See Battery and Operator Restraint System Repair section of this manual.

NOTE: Perform Step 3 and Step 4 if lift truck is equipped with an automatic park brake.

3. Remove jam-nuts and cable from automatic park brake. See Figure 104.



1. TRACTION MOTOR
2. AUTOMATIC PARK BRAKE
3. JAM-NUT
4. CABLE
5. E-RING
6. FITTING "D"
7. BRACKET PLATE
8. CAPSCREW

Figure 104. Automatic Park Brake and Traction Motor for Lift Trucks E2.2-3.5XN (E45-70XN) (A268) and E1.6-2.0XN (E30-40XN) (A269)

4. Remove e-ring, at fitting "D" on cable; remove cable from bracket plate. See Figure 104.

NOTE: Tag electrical connectors during removal to aid in installation.

5. Tag and disconnect speed and temperature sensor connectors from the terminals.

6. Tag and disconnect power cables from traction motor.

NOTE: Perform Step 7 only if lift truck is equipped with optional drip shield.

7. Remove capscrews and drip shield from frame, allowing access to traction motor. See Figure 105.

8. Position a floor jack under traction motor.

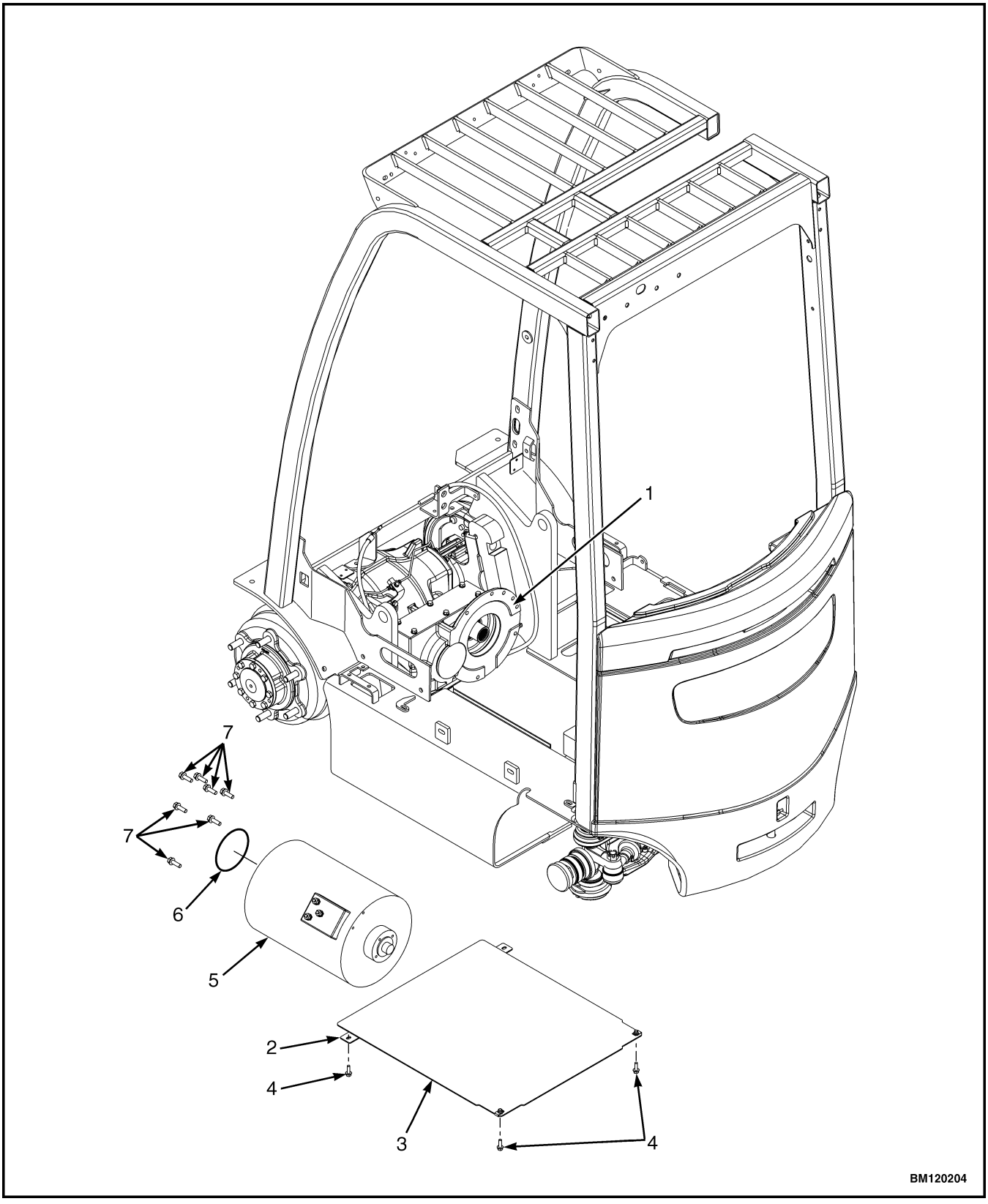


Figure 105. Traction Motor and Mounting Flange

Legend for Figure 105.

1. MOUNTING FLANGE FOR TRACTION MOTOR
2. BRACKET
3. DRIP SHIELD
4. CAPSCREWS
5. TRACTION MOTOR
6. O-RING
7. CAPSCREWS

NOTE: The traction motors are in different configurations for different applications of the lift trucks. Traction motors weigh approximately 90 to 140 kg (200 to 310 lb). Make sure floor jack has capacity to hold traction motor.

9. Remove three capscrews, equally spaced around mounting flange, from mounting flange and traction motor. See Figure 105.

10. Install three 76.2 mm (3 in.) threaded dowels into mounting flange and traction motor bolt holes at these positions.

11. Remove four remaining capscrews from mounting flange and traction motor. See Figure 105.

12. Use pry bar, as necessary, to separate mounting flange and traction motor. The dowels will support traction motor as it slides back, preventing any pressure on motor input sleeve.

NOTE: It is possible that traction motor will rotate during removal and lowering. Use a suitable strap to lock down traction motor when removing.

13. Slowly lower traction motor to level ground; adjust floor jack as needed for removal.

NOTE: Perform Step 14 and Step 15 if lift truck is equipped with an automatic park brake.

14. Remove capscrews and bracket plate from traction motor. See Figure 104.

15. Remove capscrews and automatic park brake from traction motor. See Figure 104.

16. Remove and discard O-ring from traction motor. See Figure 105.

Install

1. Install new O-ring onto traction motor.

NOTE: Perform Step 2 and Step 3 if lift truck is equipped with an automatic park brake.

2. Install automatic park brake and capscrews onto traction motor. See Figure 104.

3. Install bracket plate and capscrews on traction motor. See Figure 104.

NOTE: It is possible that the traction motor will rotate during installation and raising of floor jack. Use a suitable strap to lock down the traction motor when raising of floor jack.

4. Position traction motor beneath lift truck and slowly raise into frame. Adjust floor jack, as needed, during installation.

5. Align bolt holes in mounting flange and traction motor. Install three 76.2 mm (3 in.) threaded dowels, placed at equally spaced intervals, into mounting flange and traction motor for support.

6. Install four capscrews holding traction motor on mounting flange.

7. Remove threaded dowels and replace with three remaining capscrews. Tighten all capscrews to between 38 to 48 N•m (28 to 35 lbf ft).

8. Remove strap from traction motor. Remove floor jack from underneath lift truck.

9. Install drip shield and capscrews onto frame.

10. Remove lift truck from blocks.

11. Connect power cables to traction motor as tagged during removal.

12. Connect speed and temperature sensor connections to terminals as tagged during removal.

13. Connect any other hydraulic lines disconnected from main control valve during removal.

NOTE: Perform Step 14 and Step 15 if lift truck is equipped with an automatic park brake.

14. Install cable through bracket plate. Install e-ring on cable at fitting "D". See Figure 104.

15. Install cable and jam-nuts onto automatic park brake. See Figure 104.

16. Install covers or plates and optional rollers into bottom of battery compartment. See the Battery and Operator Restraint System Repair section of this manual.

17. Install battery into lift truck. See **How to Change Battery** in the **Operating Manual** or one of the following service manuals

    Periodic Maintenance 8000SRM1364 for lift truck models

    - E2.2-3.5XN (E45-70XN) (A268)

    Periodic Maintenance 8000SRM1442 for lift truck models

    - E1.6-2.0XN (E30-40XN) (A269)

Traction Motor Replacement for Lift Truck Models J2.2-3.5XN (J45-70XN) (A276) and J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

WARNING

PUTTING THE LIFT TRUCK ON BLOCKS

The lift truck must be put on blocks for many types of maintenance and repair. The removal of the mast, drive axle, battery, or counterweight assemblies will cause large changes in the center gravity. When the lift truck is put on blocks, put additional blocks in the following positions:

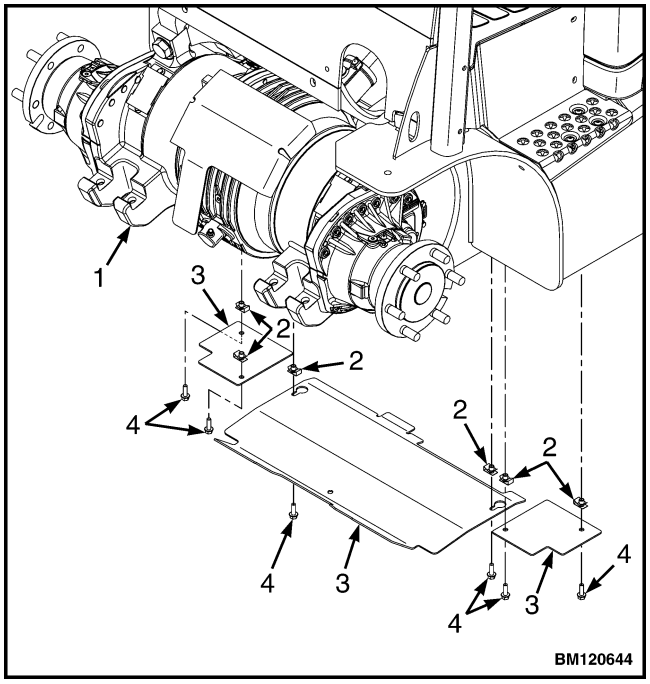
- **If the mast and drive axle are removed, put blocks under the counterweight so the lift truck cannot fall backward.**
- **If the counterweight is removed, put blocks under the mast so that the lift truck cannot fall forward.**

Put the lift truck on blocks on a solid, even, and level surface. Verify the blocks or stands have enough capacity to hold the lift truck. Use additional blocks next to the tires as necessary to prevent movement of the lift truck. Verify the lifting devices used during repairs can lift the weight of the parts and assemblies.

See Operating Manual or Periodic Maintenance manual for your lift truck.

NOTE: Perform Step 1 and Step 2 for lift truck models J2.2-3.5XN (J45-70XN) (A276) , equipped with sealed transaxle.

1. Remove six capscrews and drip shields from frame allowing access to transaxle. See Figure 106. Replace clip nuts with new clip nuts, if damaged.



1. SEALED TRANSAXLE
2. CLIP NUTS
3. DRIP SHIELDS
4. CAPSCREWS

Figure 106. Accessing Traction Motors

For repair or replacement of traction motor see

Transaxle 1300SRM1370 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276)

Transaxle 1300SRM1539 for lift truck models

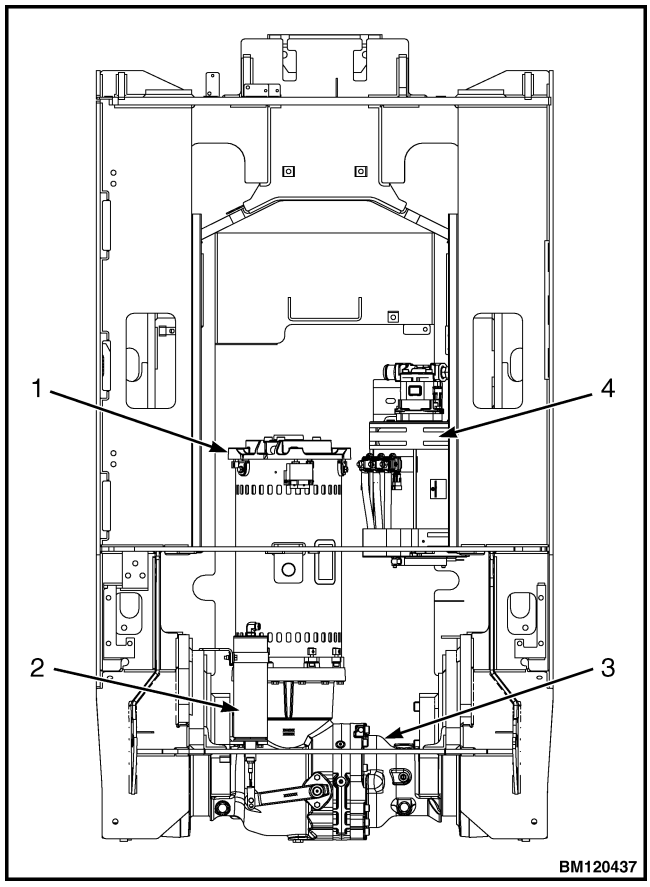
- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

2. Reinstall capscrews and drip shields in lift truck after repair and replacement procedures for traction motors has been performed.

Traction Motor Replacement for Lift Truck Models E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

Remove

This procedure is for removal of the traction motor from under lift truck with the use of a floor jack. The traction motor can also be removed through the battery compartment. The lift truck must be on blocks with clearance for the floor jack and traction motor, if traction motor is removed from under lift truck. See Figure 107.



1. TRACTION MOTOR
2. AUTOMATIC PARKING BRAKE ACTUATOR
3. DRIVE AXLE
4. HYDRAULIC MOTOR

Figure 107. Traction Motor, Lift Trucks E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

WARNING

PUTTING THE LIFT TRUCK ON BLOCKS

The lift truck must be put on blocks for many types of maintenance and repair. The removal of the mast, drive axle, battery, or counterweight assemblies will cause large changes in the center gravity. When the lift truck is put on blocks, put additional blocks in the following positions:

- **If the mast and drive axle are removed, put blocks under the counterweight so the lift truck cannot fall backward.**
- **If the counterweight is removed, put blocks under the mast so that the lift truck cannot fall forward.**

Put the lift truck on blocks on a solid, even, and level surface. Verify the blocks or stands have enough capacity to hold the lift truck. Use additional blocks next to the tires as necessary to prevent movement of the lift truck. Verify the lifting devices used during repairs can lift the weight of the parts and assemblies.

See Operating Manual or Periodic Maintenance 8000SRM1577 **for the procedure to put the lift truck on blocks.**

1. Remove battery from lift truck. See **How to Change Battery** in the **Operating Manual** or see **Periodic Maintenance** 8000SRM1577 for procedures.

2. Remove covers or plates and optional rollers from bottom of battery compartment. See section Battery and Operator Restraint System Repair in this manual for procedures.

NOTE: Tag electrical connectors during removal to aid in installation.

3. Tag and disconnect speed and temperature sensor connectors from the terminals.

4. Tag and disconnect power cables from traction motor.

NOTE: Perform Step 5 only if lift truck is equipped with optional drip shield.

5. Remove capscrews and drip shield from frame, allowing access to traction motor.

6. Position a floor jack under traction motor.

NOTE: The traction motors are in different configurations for different applications of the lift trucks. Traction motors weigh approximately 230 kg (507 lb). Make sure floor jack has capacity to hold traction motor.

7. Remove three capscrews, equally spaced around mounting flange, from mounting flange and traction motor. See Figure 108.

8. Install three 76.2 mm (3 in.) threaded dowels into mounting flange and traction motor bolt holes.

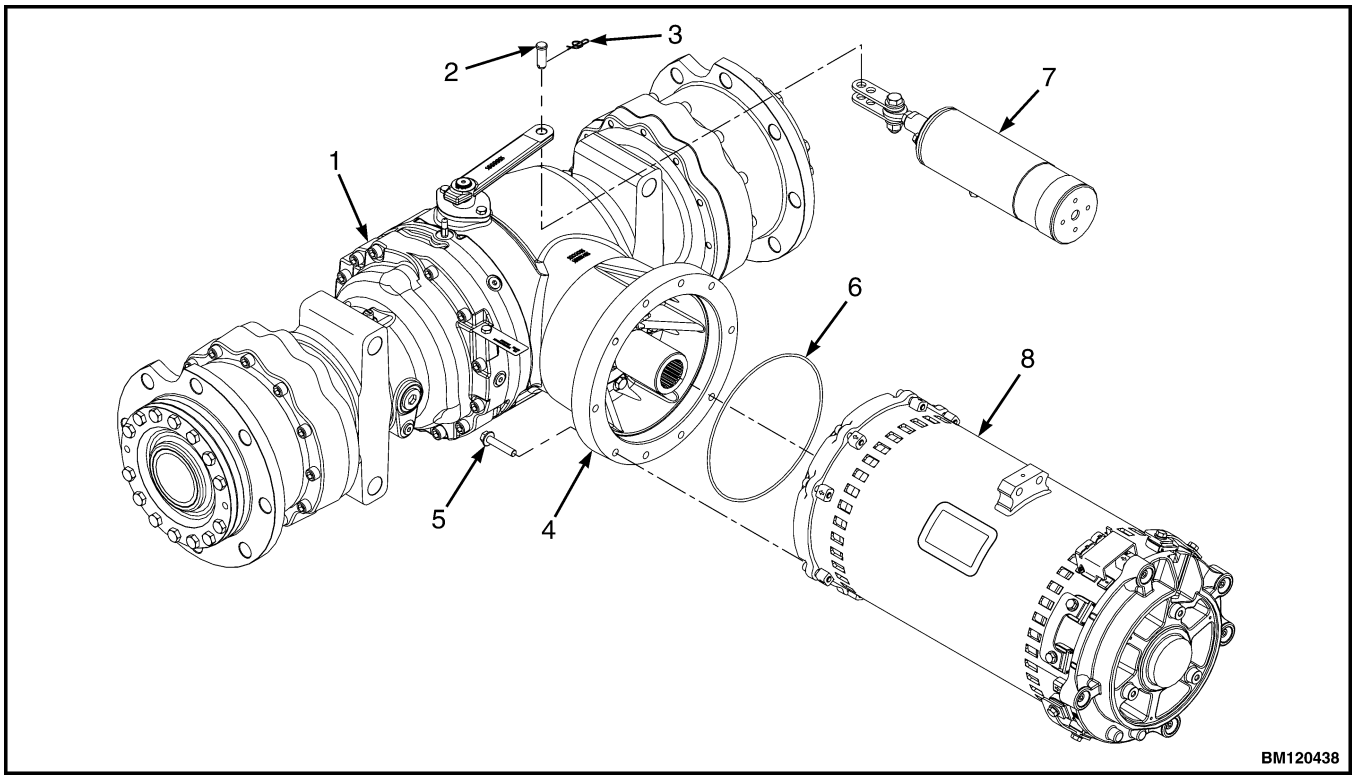
9. Remove seven remaining capscrews from mounting flange and traction motor. See Figure 108.

10. Use pry bar, as necessary, to separate mounting flange and traction motor. The dowels will support traction motor as it slides back, preventing any pressure on motor input sleeve.

NOTE: It is possible that traction motor will rotate during removal and lowering. Use a suitable strap to lock down traction motor when removing.

11. Slowly lower traction motor to level ground; adjust floor jack as needed for removal.

12. Remove and discard O-ring from traction motor. See Figure 108.



1. DRIVE AXLE
2. PIN
3. COTTER PIN
4. TRACTION MOTOR MOUNTING FLANGE
5. CAPSCREW
6. O-RING
7. AUTOMATIC PARK BRAKE ACTUATOR
8. TRACTION MOTOR

Figure 108. Traction Motor Mounting Flange and Automatic Park Brake Actuator, Lift Trucks E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

Install

1. Install new O-ring onto traction motor. See Figure 108.

NOTE: It is possible that the traction motor will rotate during installation and raising of floor jack. Use a suitable strap to lock down the traction motor when raising of floor jack.

2. Position traction motor beneath lift truck and slowly raise into frame. Adjust floor jack, as needed, during installation.
3. Align bolt holes in mounting flange and traction motor. See Figure 108.
4. Install seven capscrews holding traction motor on mounting flange.
5. Remove threaded dowels and replace with three remaining capscrews. Tighten all capscrews to between 38 to 48 N•m (28 to 35 lbf ft).
6. Remove strap from traction motor. Remove floor jack from underneath lift truck.
7. Install drip shield (if equipped) and capscrews onto frame.
8. Remove lift truck from blocks.
9. Connect power cables to traction motor as tagged during removal.
10. Connect speed and temperature sensor connections to terminals as tagged during removal.
11. Connect any other hydraulic lines disconnected from main control valve during removal.
12. Install covers or plates and optional rollers into bottom of battery compartment. See section Battery and Operator Restraint System Repair in this manual for procedures.
13. Install battery into lift truck. See the **Operating Manual** or **Periodic Maintenance** 8000SRM1577 for procedures.

Hydraulic Tank Inspection

INSPECT

WARNING

Special procedures must be followed when large leaks or other repairs are needed. All work must be done by authorized personnel. If the tank is cleaned inside of a building, make sure there is enough ventilation.

WARNING

DO NOT use tools that can make sparks, heat, or static electricity. The vapors in the tank can cause an explosion.

CAUTION

Additives may damage the hydraulic system. Before using additives, contact your local Hyster dealer.

Make a visual inspection of all sides of hydraulic tank.

See Figure 109 for lift truck models below with metal tank

- E2.2-3.5XN (E45-70XN) (A268)

See Figure 110 for lift truck models below with nylon tank

- E2.2-3.5XN (E45-70XN) (A268)

See Figure 111 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276)

See Figure 112 for lift truck models

- E1.6-2.0XN (E30-40XN) (A269)

See Figure 113 for lift truck models

- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

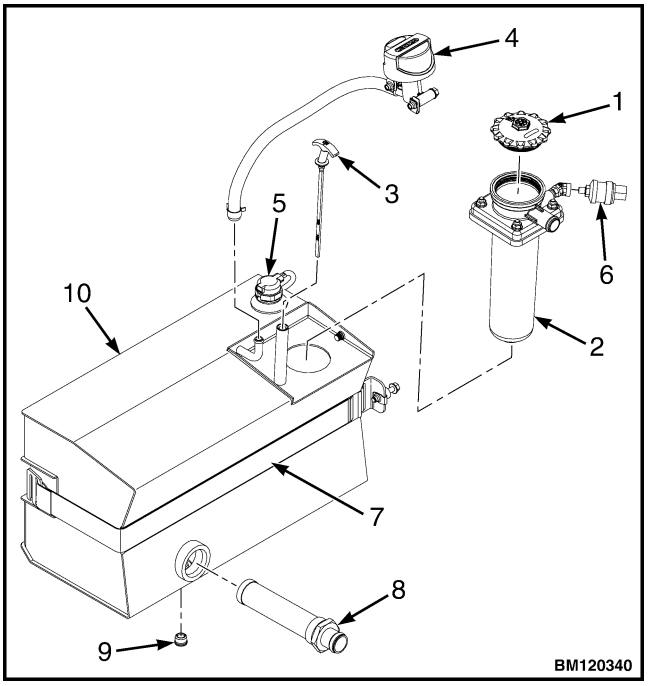
See Figure 114 for lift truck models

- E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

Inspect seams for cracks and leakage. Check for wet areas, accumulation of dirt, and loose or missing paint caused by leakage. Areas of hydraulic tank that are not easily seen can be checked with an

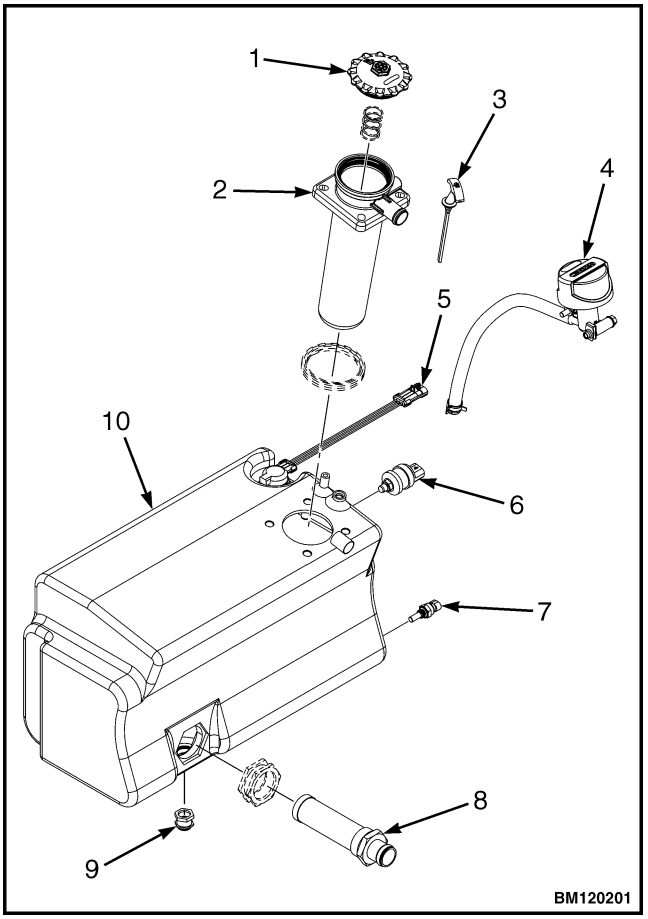
inspection mirror and a light that is approved for locations with flammable vapors.

The hydraulic tank is a steel fabricated drop-in or a molded nylon assembly, and can be removed from lift truck, if necessary, to check for leaks or for replacement. Repair or replace hydraulic tank if cracked or leaking. See **Hydraulic System** 1900SRM1367 for repair or replacement procedure.



1. FILL CAP
2. FILTER HOUSING
3. DIPSTICK
4. BREATHER FILTER
5. OPTIONAL LEVEL SENSOR
6. OPTIONAL FILTER PRESSURE SWITCH
7. RETAINING STRAP
8. SUCTION STRAINER W/O-RING
9. MAGNETIC PLUG W/O-RING
10. HYDRAULIC TANK

Figure 109. Metal Hydraulic Tank for Lift Truck E2.2-3.5XN (E45-70XN) (A268)



1. FILL CAP
2. FILTER HOUSING
3. DIPSTICK
4. BREATHER FILTER
5. OPTIONAL LEVEL SENSOR
6. OPTIONAL FILTER PRESSURE SWITCH
7. TEMPERATURE SENSOR
8. SUCTION STRAINER W/O-RING
9. MAGNETIC PLUG W/O-RING
10. HYDRAULIC TANK

Figure 110. Nylon Hydraulic Tank for Lift Truck E2.2-3.5XN (E45-70XN) (A268)

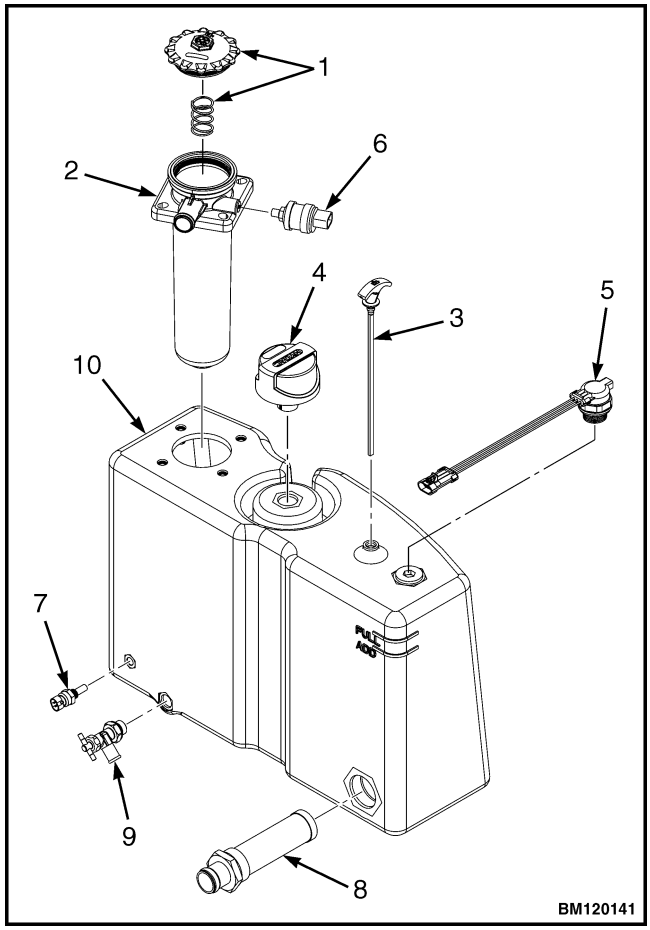
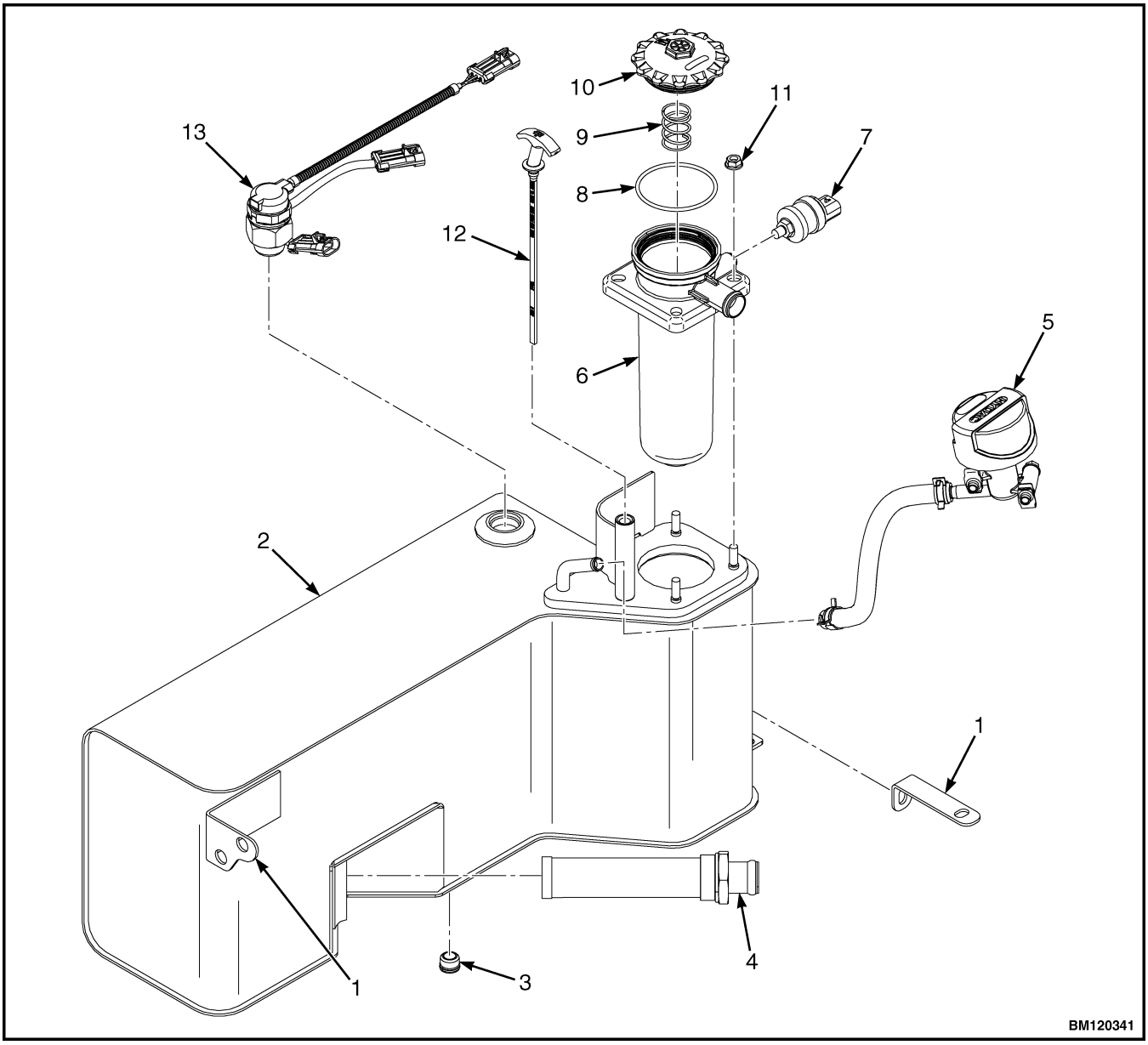


Figure 111. Hydraulic Tank for Lift Truck J2.2-3.5XN (J45-70XN) (A276)

Legend for Figure 111.

1. FILL CAP
2. FILTER HOUSING
3. DIPSTICK
4. BREATHER FILTER
5. LEVEL SENSOR
6. PRESSURE SWITCH
7. TEMPERATURE SENSOR
8. SUCTION STRAINER W/ O-RING
9. DRAIN VALVE
10. HYDRAULIC TANK



1. MOUNTING BRACKETS
2. HYDRAULIC TANK
3. MAGNETIC PLUG AND O-RING
4. SUCTION STAINER AND O-RING
5. BREATHER FILTER
6. FILTER HOUSING
7. FILTER PRESSURE SWITCH
8. O-RING SEAL
9. SPRING
10. FILL CAP
11. NUT
12. DIPSTICK
13. LEVEL SENSOR

Figure 112. Hydraulic Tank for Lift Truck Models E1.6-2.0XN (E30-40XN) (A269)

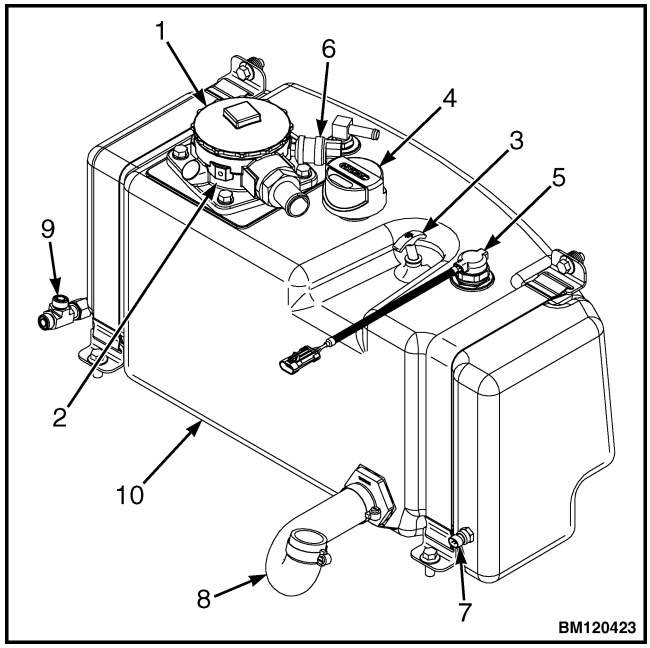
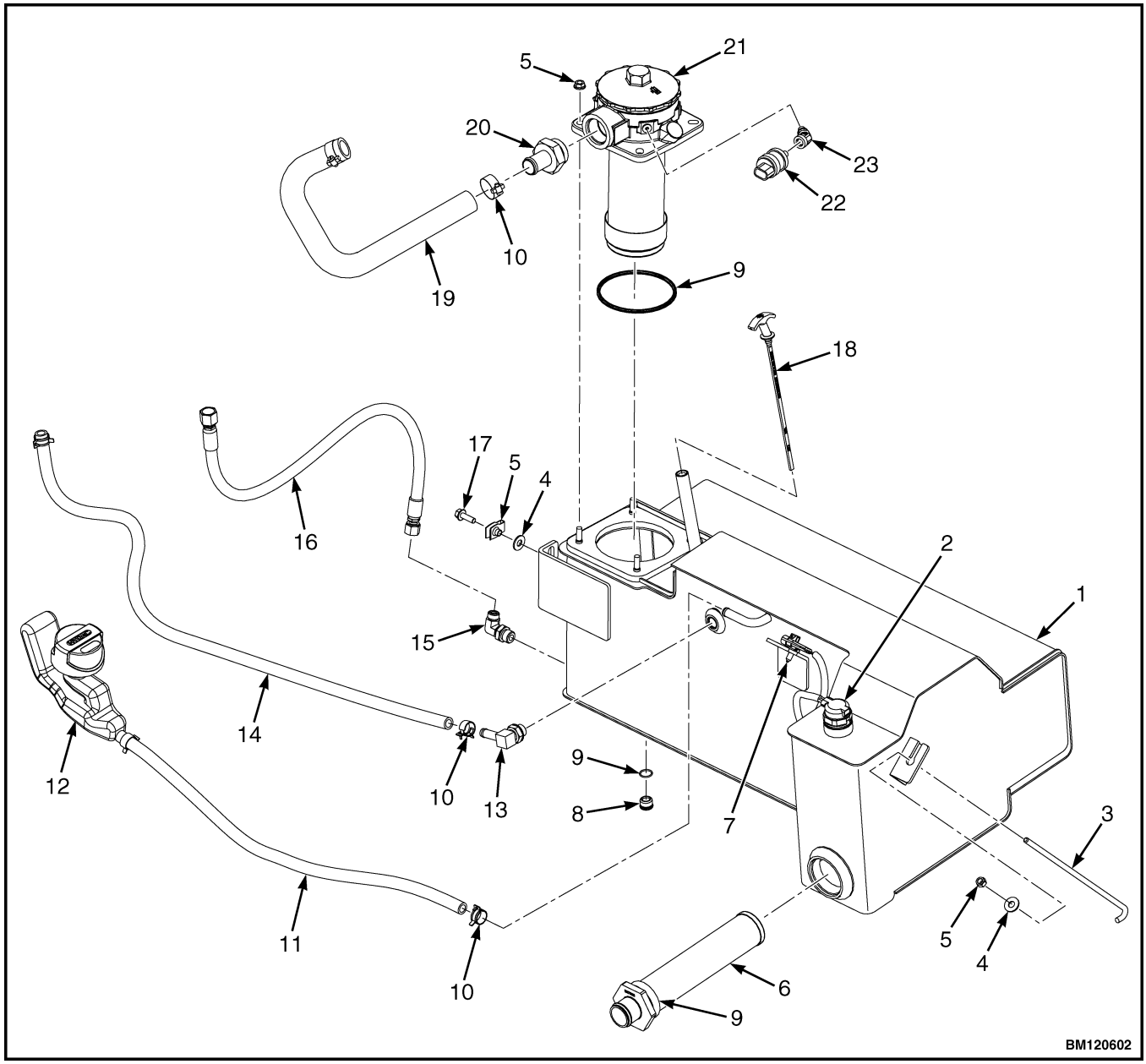


Figure 113. Hydraulic Tank for Lift Trucks J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

Legend for Figure 113.

1. FILL CAP
2. FILTER HOUSING
3. DIPSTICK
4. BREATHER FILTER
5. LEVEL SENSOR
6. PRESSURE SWITCH
7. TEMPERATURE SENSOR
8. SUCTION STRAINER W/ O-RING
9. DRAIN VALVE
10. HYDRAULIC TANK



1. HYDRAULIC TANK
2. HYDRAULIC TANK LEVEL SENSOR
3. RETENTION ROD
4. WASHER
5. NUT
6. SUCTION HOSE
7. MOUNTING CLIP
8. DRAIN PLUG
9. O-RING
10. CLAMP
11. BREATHER HOSE
12. BREATHER
13. VENT FITTING
14. VENT HOSE
15. BRAKE HOSE FITTING
16. BRAKE HOSE
17. CAPSCREW
18. DIPSTICK
19. RETURN LINE
20. FITTING
21. HYDRAULIC OIL FILTER
22. PRESSURE SENSOR
23. ADAPTER

Figure 114. Hydraulic Tank for Lift Trucks E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

CLEAN

See **Hydraulic System** 1900SRM1367 for hydraulic tank cleaning procedures.

Painting Instructions

WARNING

Always wear protection equipment (gloves, goggles, face shield, safety glasses, and a mask) if an electric sander is used or spraying paint, using either an aerosol can or spray gun.

WARNING

Always use solvents and paints in an area with ventilation. DO NOT use solvents or paints near heat, fire, or electrical equipment that can make sparks. Follow the manufacturer's instructions and cautions.

1. Remove all dirt from surface to be painted. Clean area to be painted. Use a solvent for painted surfaces to remove grease and oil before sanding. **DO NOT** use solvent on new paint. Make sure all oil and grease is removed.

2. Use sandpaper to remove top surface of the paint and rust from metal. All metal surfaces where paint is completely removed, must be painted. Use a primer. Apply primer before applying final coat of paint.

3. Protect all surfaces that will not be painted. See list of items in Figure 115.

CAUTION

DO NOT paint the pads, plastic covers or knobs, cables, labels, and information plates, or controls. Paint can make some assemblies not operate correctly.

4. Paint surfaces. Use the correct paint from your dealer for Hyster lift trucks. Follow directions on container. The correct arrangement of colors is shown in Figure 115.

WARNING

Make sure all labels are installed after painting is complete. Safety labels are installed on the lift truck to provide information about possible hazards. It is important that all safety labels are installed on the lift truck and can be read.

5. Check that all labels are installed in the correct locations on lift truck. See Safety Label Replacement. New labels are available from your dealer for Hyster lift trucks.

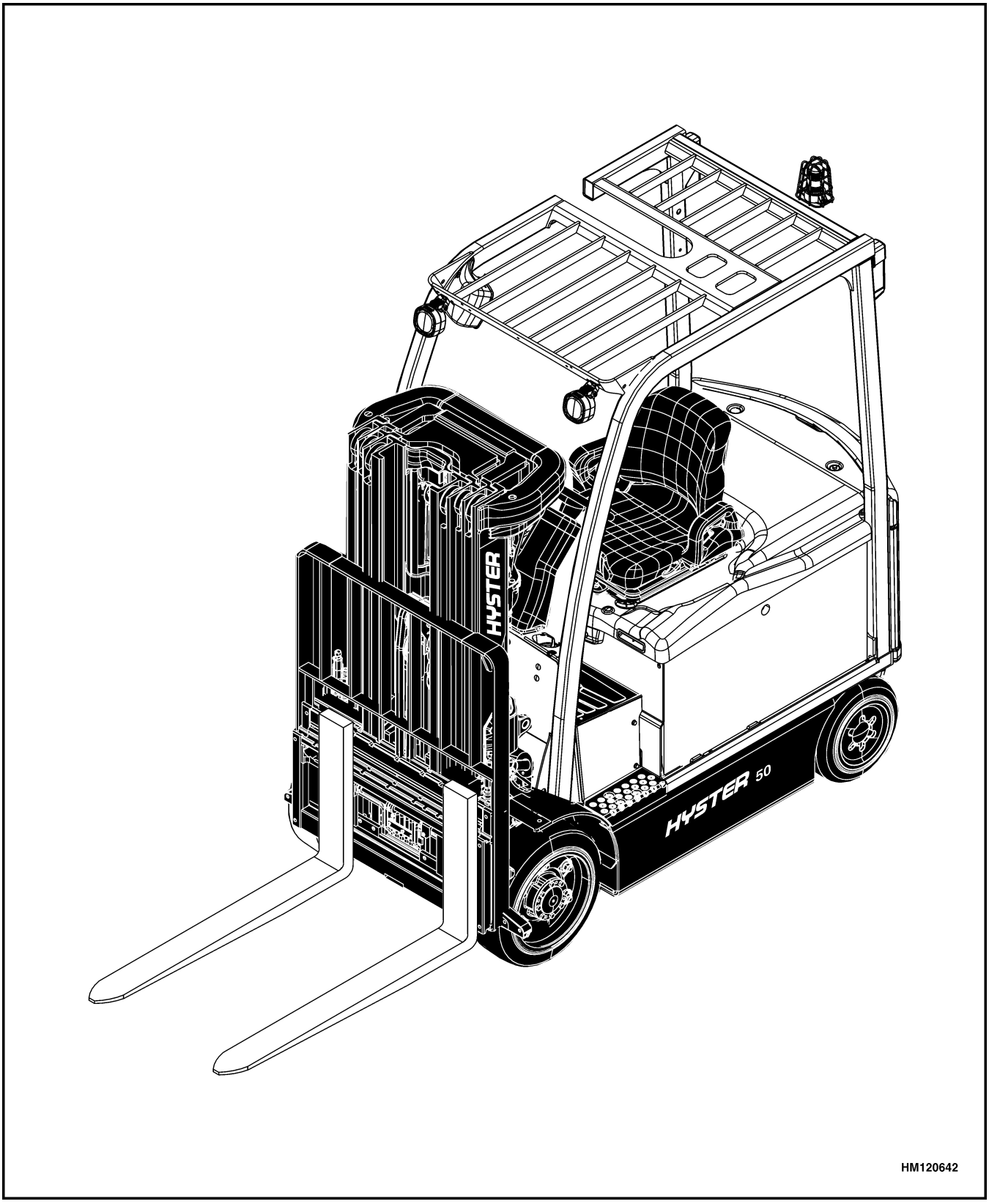


Figure 115. Color Arrangement

Legend for Figure 115.

NOTE: USE COLORS APPROVED BY HYSTER COMPANY. **DO NOT** PAINT THE FOLLOWING ITEMS: PEDAL PADS, LEVER KNOBS, INSTRUMENTS, STEERING WHEEL, SEAT ASSEMBLY AND SEAT RAILS, INFORMATION CASE AND COVER, TIRES, MAST CHAINS, AND HOSES, ALL LABELS AND INFORMATION PLATES, BATTERY CONNECTOR, PARKING BRAKE HANDLE, KEY SWITCH, CYLINDER RODS, ALL PLASTIC COVERS, AND STEERING COLUMN COVER.

NOTE: LIGHT AREAS = YELLOW; DARK AREAS = BLACK; AND FORKS = RED.

Safety Label Replacement

WARNING

Labels that have WARNINGS or CAUTIONS must be replaced if they are damaged. If a mast of a different size or an accessory carriage is installed, the capacity rating can change. Changes in the kind of drive tires can change the capacity rating. See a dealer for HYSTER lift trucks for a replacement Nameplate. The Nameplate information is a safety item and must be correct for the equipment and configuration of the lift truck.

NOTE: If labels or information plates are missing or are damaged, they must be replaced.

NOTE: Not all labels used on these lift truck models are shown in the following illustrations. See **Parts Manual** for a complete listing of all labels used on these lift trucks.

See Figure 116 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268)
- E1.6-2.0XN (E30-40XN) (A269)
- E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

See Figure 117 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268)
- E1.6-2.0XN (E30-40XN) (A269)

See Figure 118 for lift truck models

- E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

See Figure 119 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276)

See Figure 120 for lift truck models

- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

See Figure 121 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268)
- E1.6-2.0XN (E30-40XN) (A269)
- E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

See Figure 122 for lift truck models

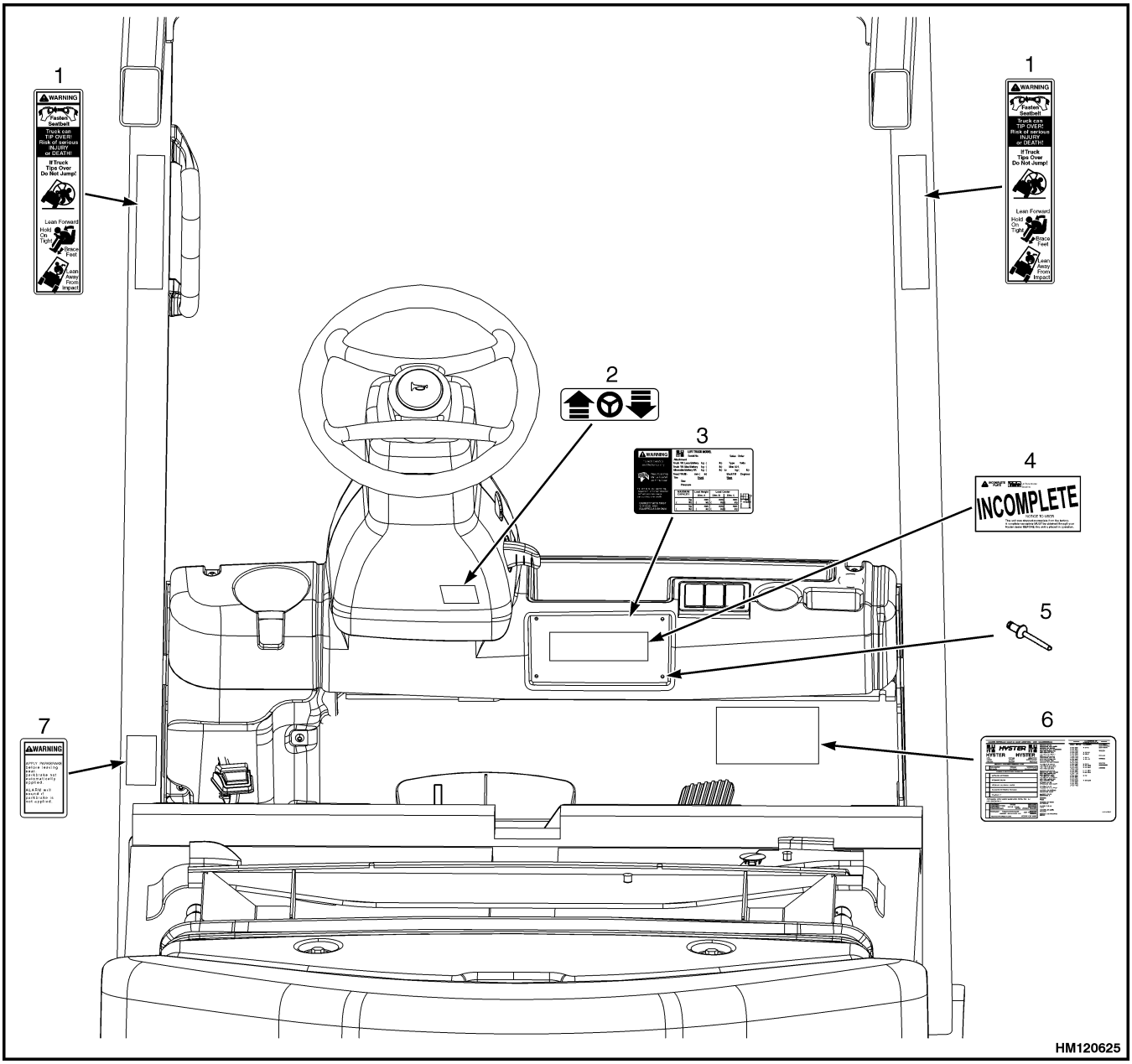
- J2.2-3.5XN (J45-70XN) (A276)
- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

See Figure 123 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276)
- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

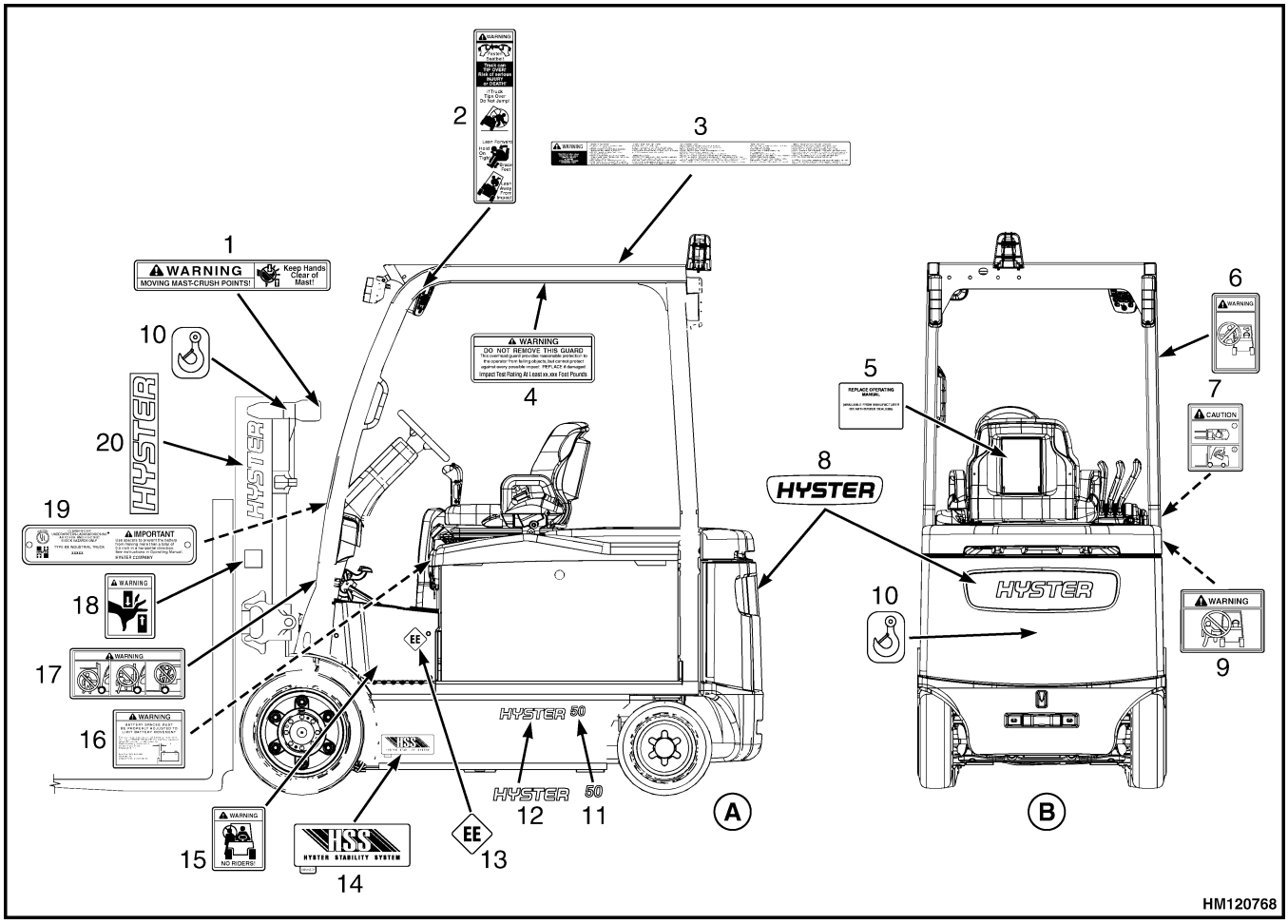
NOTE: The Nameplate is installed using rivets. The old rivets must be removed when installing a new Nameplate.

1. Before installing a new label, make sure surface is dry and has no oil or grease. **DO NOT** use solvent on new paint. Clean surface of old paint using a cleaning solvent.
2. Remove paper from back of label. **DO NOT** touch adhesive surface.
3. Carefully hold label in correct position above surface. The label cannot be moved after it touches surface. Put label onto surface. Make sure all air is removed from under label and corners and edges are tight.



1. OPERATOR RESTRAINT
2. TILT COLUMN
3. NAMEPLATE TAG
4. INCOMPLETE TRUCK NAMEPLATE
5. RIVET
6. PATENTS AND TRADEMARKS
7. PARKING BRAKE WARNING

Figure 116. Interior Labels for Lift Trucks E2.2-3.5XN (E45-70XN) (A268), E1.6-2.0XN (E30-40XN) (A269), and E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)



NOTE: SWIVEL SEAT NOT USED ON E1.6-2.0XN (E30-40XN) (A269) LIFT TRUCKS.

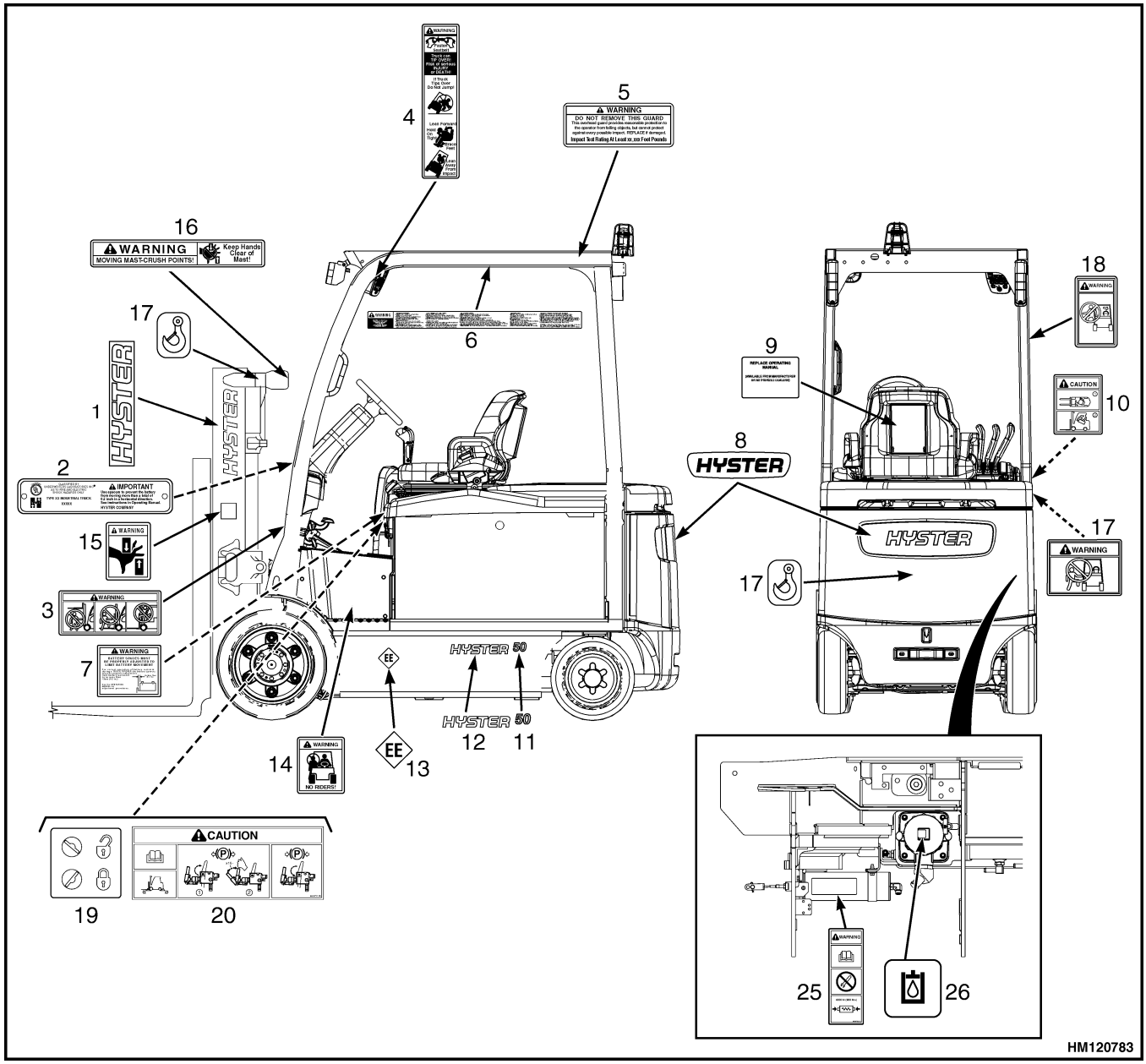
1. MAST WARNING
2. OPERATOR RESTRAINT
3. OPERATOR WARNING
4. OVERHEAD GUARD*
5. OPERATING MANUAL WARNING
6. NO EXIT
7. SWIVEL SEAT WARNING
8. HYSTER COUNTERWEIGHT LOGO
9. NO ENTRY
10. LIFTING EYE**
11. MODEL LABEL
12. HYSTER LOGO
13. OPTIONAL UL (TYPE EE)
14. STABILITY SYSTEM LABEL***
15. NO RIDERS
16. BATTERY SPACER
17. NO ONE ON OR UNDER FORKS
18. PINCH POINT
19. UL PLATE
20. VERTICAL HYSTER LOGO

*Right Side of Lift Truck

**Europe Only

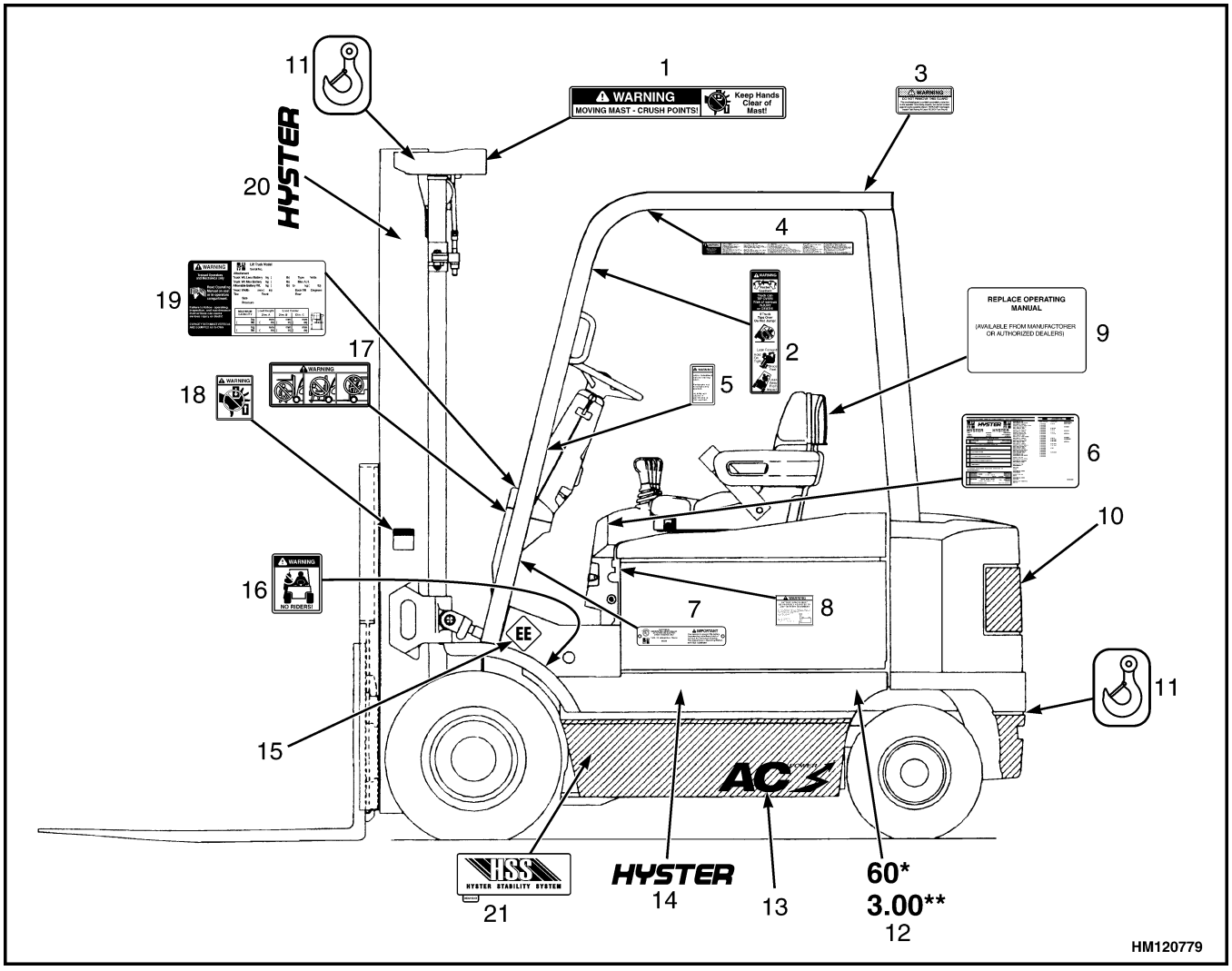
***Only on lift truck models E45-70XN (A268) and E30-40XN (A269) manufactured after June, 2012

Figure 117. Exterior Labels for Lift Trucks E2.2-3.5XN (E45-70XN) (A268) and E1.6-2.0XN (E30-40XN) (A269)



1. VERTICAL HYSTER LOGO
2. UL PLATE
3. NO ONE ON OR UNDER FORKS
4. OPERATOR RESTRAINT
5. OVERHEAD GUARD
6. OPERATOR WARNING
7. BATTERY SPACER
8. HYSTER COUNTERWEIGHT LOGO
9. OPERATING MANUAL WARNING
10. SWIVEL SEAT WARNING
11. MODEL LABEL
12. OPTIONAL UL (TYPE EE)
13. NO RIDERS
14. PINCH POINT
15. MAST WARNING
16. LIFTING EYE
17. NO ENTRY
18. NO EXIT
19. LOCK/UNLOCK
20. PARK BRAKE RELEASE
21. BULKHEAD
22. HOOD
23. RIGHT FRAME CHANNEL
24. PARK BRAKE ACTUATOR
25. PARK BRAKE ACTUATOR LABEL
26. HYDRAULIC OIL LABEL

Figure 118. Exterior Labels for Lift Trucks E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)



1. MAST WARNING LABEL
2. OPERATOR RESTRAINT
3. OVERHEAD GUARD TEST PLATE*
4. OPERATOR WARNING LABEL**
5. PARK BRAKE WARNING
6. PATENT PLATE
7. UL INSPECTION PLATE
8. BATTERY SPACER
9. OPERATORS MANUAL WARNING
10. HYSTER COUNTERWEIGHT LOGO (OPTIONAL)
11. LIFTING EYE***
12. MODEL LABEL
13. AC POWER LABEL***
14. HYSTER LOGO
15. FIRE SAFETY LABEL*
16. NO RIDERS
17. NO ONE ON OR UNDER FORKS
18. PINCH POINT
19. NAMEPLATE
20. VERTICAL HYSTER LOGO
21. STABILITY SYSTEM LABEL****

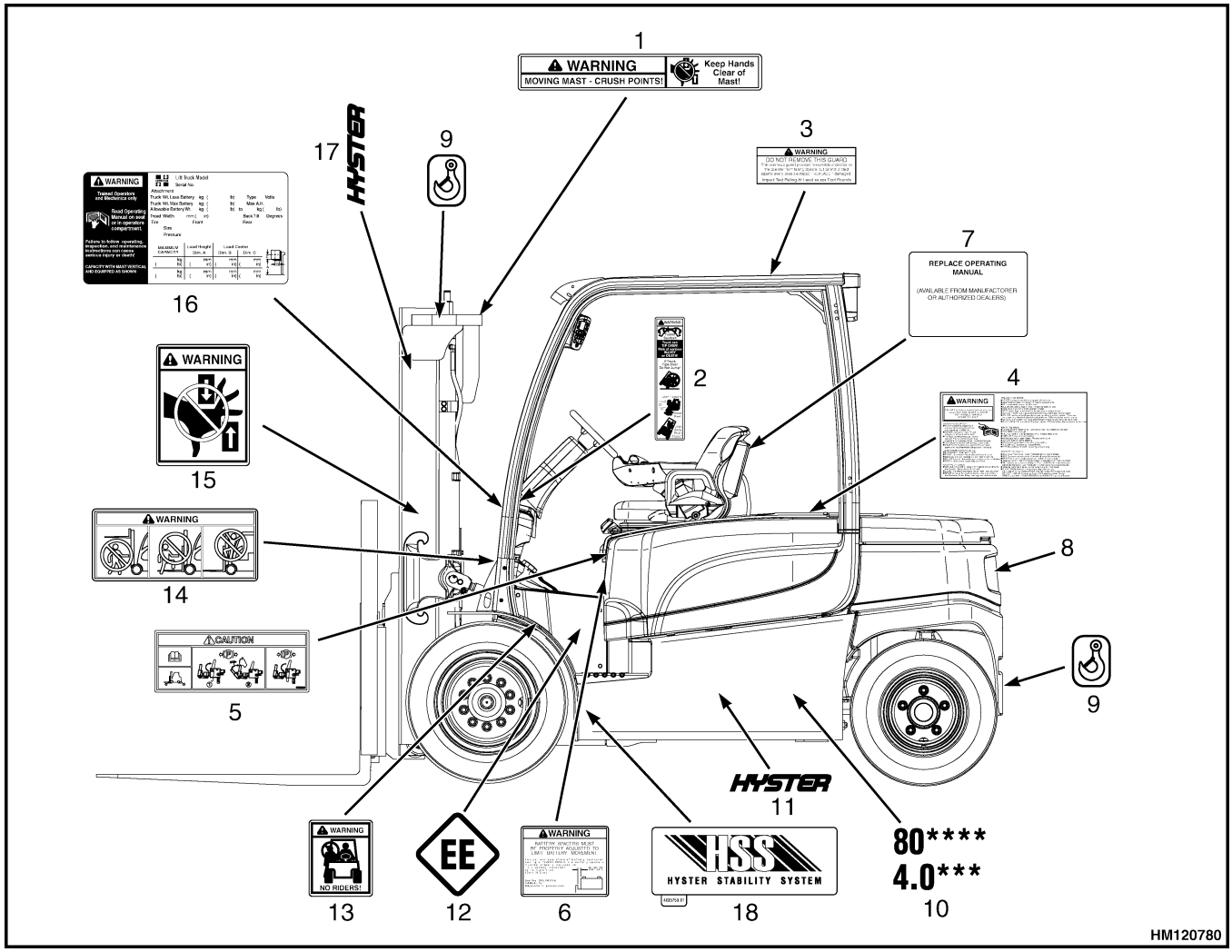
*Left Side of Lift Truck

**Right Side of Lift Truck

***Europe Only

****Only on lift truck models J45-70XN (A276) manufactured after June, 2012

Figure 119. Safety Labels for Lift Truck J2.2-3.5XN (J45-70XN) (A276)



1. MAST WARNING LABEL
2. OPERATOR RESTRAINT
3. OVERHEAD GUARD TEST PLATE*
4. OPERATOR WARNING LABEL**
5. AUTOMATIC PARKING BRAKE RELEASE CAUTION
6. BATTERY SPACER
7. OPERATORS MANUAL WARNING
8. HYSTER COUNTERWEIGHT LOGO (OPTIONAL)
9. LIFTING EYE***
10. MODEL LABEL
11. HYSTER LOGO
12. FIRE SAFETY LABEL*
13. NO RIDERS
14. NO ONE ON OR UNDER FORKS
15. PINCH POINT
16. NAMEPLATE
17. VERTICAL HYSTER LOGO
18. STABILITY SYSTEM LABEL*****

*Left Side of Lift Truck

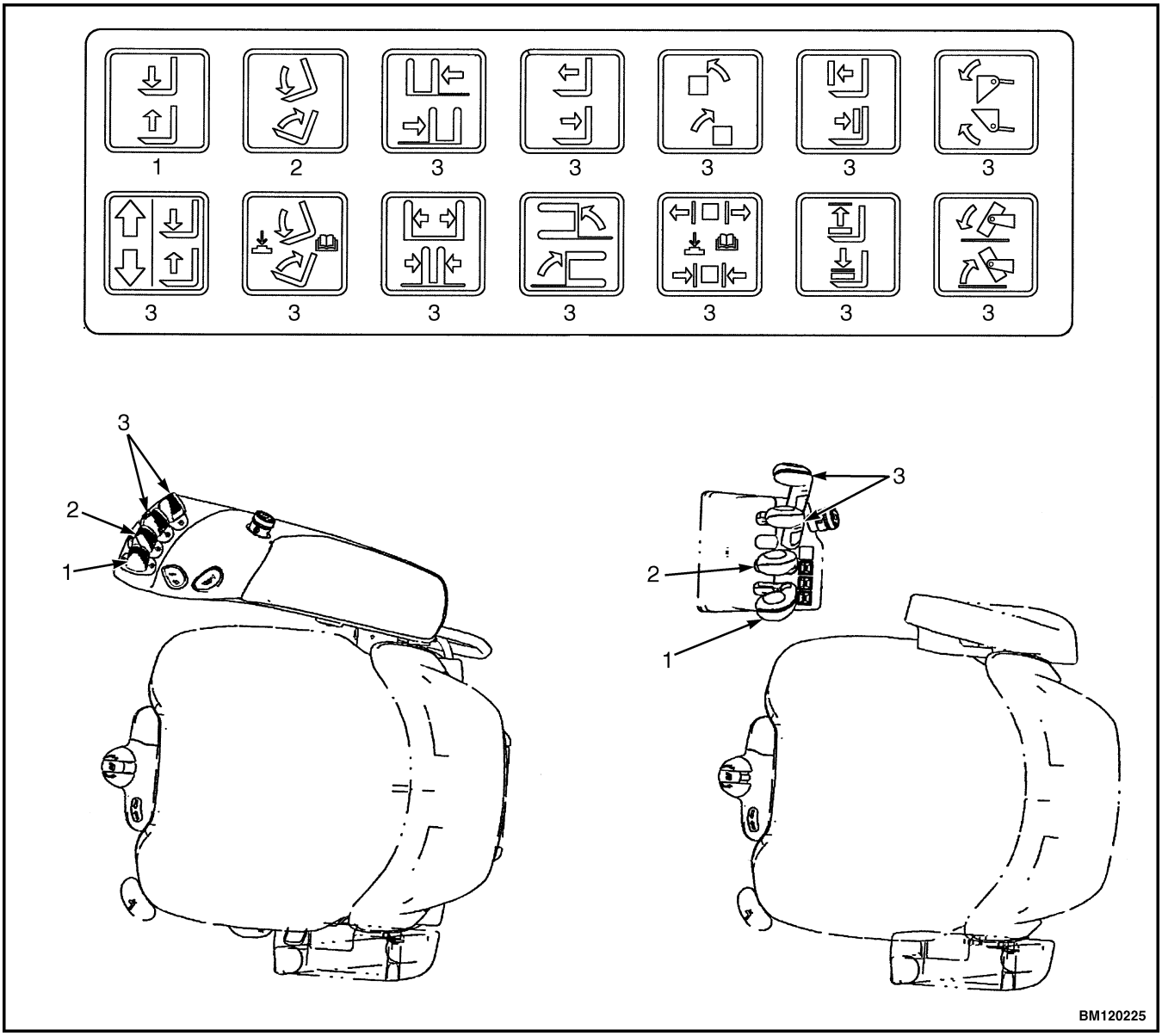
**Right Side of Lift Truck

***Europe Only

****US Only

*****Only on lift truck models J80-100XN (A970) manufactured after June, 2012

Figure 120. Safety Labels for Lift Trucks J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)



NOTE: SEAT AND LEVERS ONLY SHOWN FOR CLARITY.

1. LIFT/LOWER SYMBOL
2. TILT SYMBOL
3. AUX SYMBOLS

Figure 121. Labels - Mini and Manual Levers for Lift Trucks E2.2-3.5XN (E45-70XN) (A268), E1.6-2.0XN (E30-40XN) (A269) , and E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

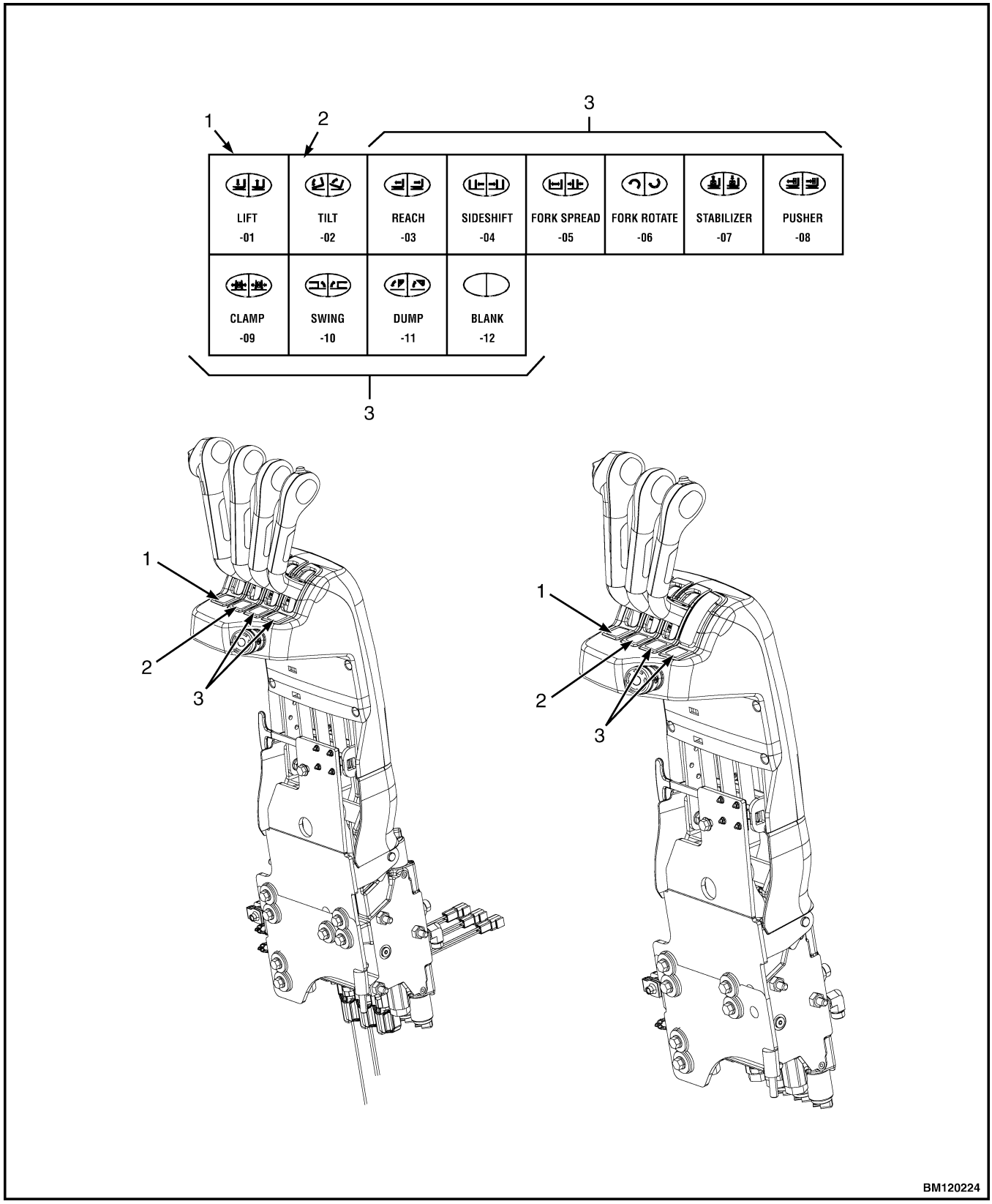
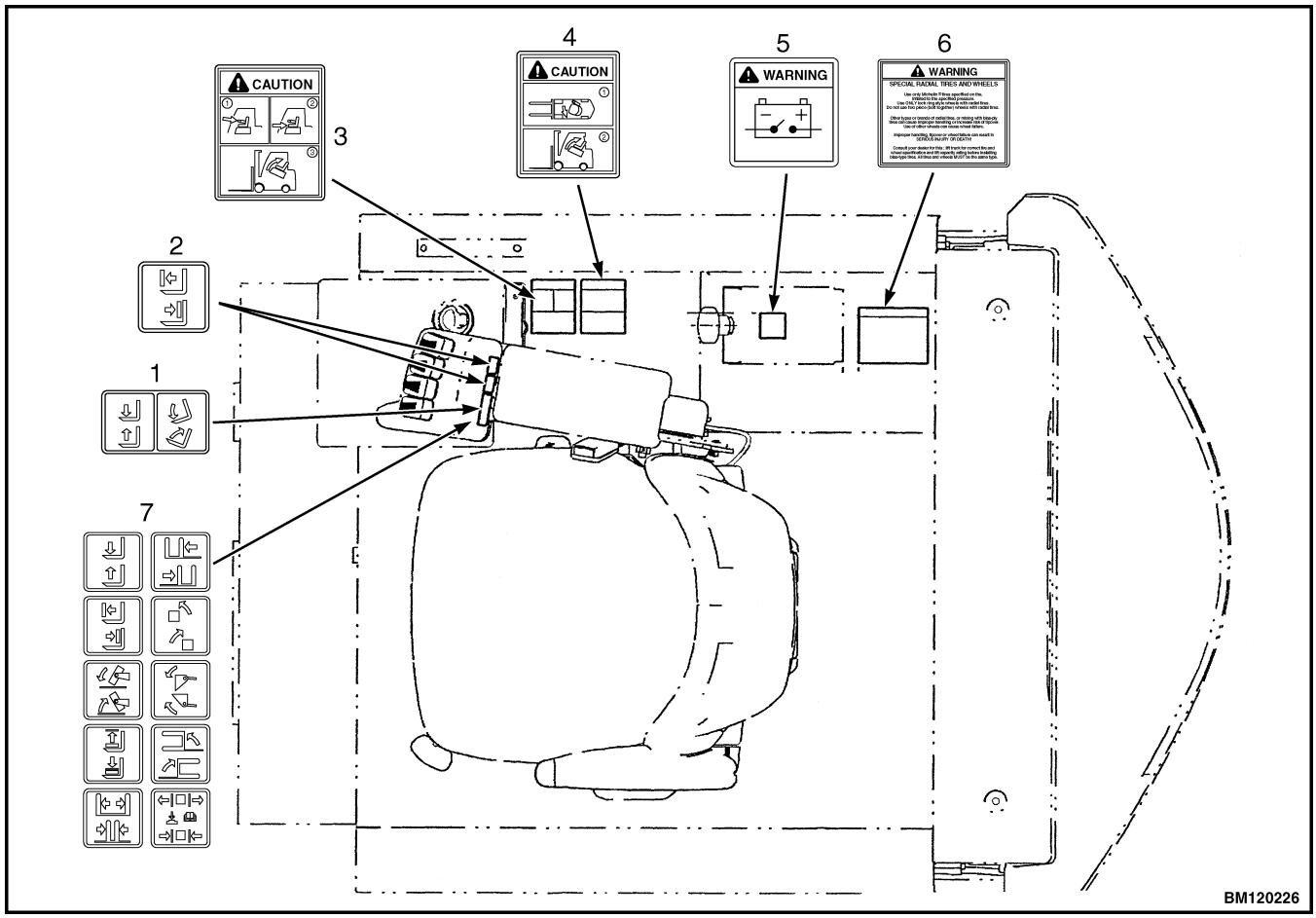


Figure 122. Labels - Manual Levers for Lift Truck J2.2-3.5XN (J45-70XN) (A276) and J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

Legend for Figure 122.

NOTE: 3-FUNCTION AND 4-FUNCTION MANUAL LEVERS SHOWN.

1. LIFT
2. TILT
3. AUXILIARY



NOTE: 4-FUNCTION MINI LEVERS SHOWN.

1. HOIST/TILT LABEL
2. REACH LABEL
3. "CAUTION" LABEL
4. SWIVEL SEAT CAUTION
5. BATTERY DISCONNECT
6. RADIAL TIRE WARNING
7. AUXILIARY LABEL

Figure 123. Labels - Mini Levers for Lift Truck J2.2-3.5XN (J45-70XN) (A276) and J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

Battery Specifications

Table 8. Model TrucksE2.2-3.5XN (E45-70XN) (A268)

Model	Minimum Compartment Size Length × Width	Battery Size Min/Max		Weight		Maximum Battery Height
		Length	Width	Minimum	Maximum	
E2.2XN-E2.5XN (E45 XN-E50XN)	695 x 987 mm (27.4 x 38.9 in.)	681 to 691 mm (26.8 to 27.2 in.)	978 to 983 mm (38.5 to 38.7 in.)	1050 kg (2314 lb)	1500 kg (3307 lb)	585 mm (23.0 in.)
E45XN-E50XN	781 x 987 mm (30.7 x 38.9 in.)	739/777 mm (29.1/30.6 in.)	978/983 mm (38.5/38.7 in.)	1150 kg (2535 lb)	1600 kg (3527 lb)	585 mm (23.0 in.)
E2.2XN-E3.0XN (E45 XN-E60XN)	842 x 987 mm (33.1 x 38.9 in.)	800/838 mm (31.5/32.9 in.)	978/983 mm (38.5/38.7 in.)	1317 kg (2903 lb)	1771 kg (3904 lb)	585 mm (23.0 in.)
E65XN	928 x 987 mm (36.5 x 38.9 in.)	900/924 mm (35.4/36.4 in.)	978/983 mm (38.5/38.7 in.)	1410 kg (3108 lb)	1860 kg (4100 lb)	585 mm (23.0 in.)
E3.2-3.5XN (E70XN)	1010 x 987 mm (39.8 x 38.9 in.)	1001/1006 mm (39.4/39.6 in.)	978/983 mm (38.5/38.7 in.)	1550 kg (3417 lb)	2000 kg (4409 lb)	585 mm (23.0 in.)

NOTE: Tolerances of the battery compartment are +3 and −0 mm (+0.12 and −0 in.). The battery size column shows the size range that will permit the battery to still fit into a battery compartment.

NOTE: Battery compartment length is front to back. Width is side to side. The "length" dimension of the battery must fit within the battery compartment front-to-back dimension with a clearance of 0 to 13 mm (0 to 0.5 in.) maximum. Battery width must fit within the battery compartment side-to-side dimension.

WARNING

The battery must fit the battery compartment so that the battery restraint system will operate correctly. Use only batteries with the correct length shown in this table. Adjust the spacer plate to prevent the battery from moving more than 13 mm (0.5 in.) forward or backward.

Table 9. Model TrucksE1.6-2.0XN (E30-40XN) (A269)

Model	Minimum Compartment Size Length × Width	Battery Size Min/Max		Weight		Maximum Battery Height
		Length	Width	Minimum	Maximum	
E1.6-2.0XN (E30-40XN)	700 x 909 mm (27.6 x 35.8 in.)	654 to 692 mm (25.7 to 27.2 in.)	784 to 907 mm (30.9 to 35.7 in.)	839 kg (1850 lb)	1132 kg (2495 lb)	585 mm (23.0 in.)

NOTE: Tolerances of the battery compartment are +3 and −0 mm (+0.12 and −0 in.). The battery size column shows the size range that will permit the battery to still fit into a battery compartment.

NOTE: Battery *compartment* length is front to back. Width is side to side. The **length** dimension of the battery must fit within the battery compartment front-to-back dimension with a clearance of 0 to 13 mm (0 to 0.5 in.) maximum. Battery width must fit within the battery compartment side-to-side dimension.

WARNING

The battery must fit the battery compartment so that the battery restraint system will operate correctly. Use only batteries with the correct length shown in this table. Adjust the spacer plate to prevent the battery from moving more than 13 mm (0.5 in.) forward or backward.

Table 10. Model TrucksE4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

Model	Minimum Compartment Size Length × Width	Battery Size Min/Max		Weight		Maximum Battery Height
		Length	Width	Minimum	Maximum	
E4.0-5.0XN, E5.0XNS (E80-90XN, E100XNS) (Short Wheel Base)	996 x 1174 mm (39.2 x 46.2 in.)	950 to 990 mm (37.4 to 38.9 in.)	950 to 1117 mm (37.4 to 44 in.)	1633 kg (3600 lb)	2177 kg (4800 lb)	585 mm (23.0 in.)
E5.0-5.5XN (E100-120XN) (Long Wheel Base)	1161 x 1174 mm (45.7 x 46.2 in.)	1115 to 1150 mm (43.9 to 45.3 in.)	950 to 1117 mm (37.4 to 44 in.)	1919 kg (4231 lb)	2517 kg (5549 lb)	585 mm (23.0 in.)

NOTE: Tolerances of the battery compartment are +3 and −0 mm (+0.12 and −0 in.). The battery size column shows the size range that will permit the battery to still fit into a battery compartment.

NOTE: Battery compartment length is front to back. Width is side to side. The "length" dimension of the battery must fit within the battery compartment front-to-back dimension with a clearance of 0 to 13 mm (0 to 0.5 in.) maximum. Battery width must fit within the battery compartment side-to-side dimension.

WARNING

The battery must fit the battery compartment so that the battery restraint system will operate correctly. Use only batteries with the correct length shown in this table. Adjust the spacer plate to prevent the battery from moving more than 13 mm (0.5 in.) forward or backward.

Table 11. Model Trucks Manufactured Prior to June, 2016J2.2-3.5XN (J45-70XN) (A276)

Model	Minimum Compartment Size Length × Width	Battery Size Min/Max		Weight		Maximum Battery Height
		Length	Width	Minimum	Maximum	
J2.2-2.5XN (J45-50XN)	717 x 1034 mm (28 x 40.7 in.)	708 to 711 mm (27.8 to 27.9 in.)	1025 to 1028 mm (40.4 to 40.5 in.)	1480 kg (3263 lb)	1636 kg (3607 lb)	782 to 786 mm (30.8 to 30.9 in.)
J2.5-3.5XN (J50-70XN)	861 x 1034 mm (34 x 41 in.)	852 to 855 mm (33.5 to 33.6 in.)	1025 to 1028 mm (40.4 to 40.5 in.)	1770 kg (3902 lb)	1956 kg (4312 lb)	782 to 786 mm (30.8 to 30.9 in.)

NOTE: Tolerances of the battery compartment are +3 and −0 mm (+0.12 and −0 in.). The battery size column shows the size range that will permit the battery to still fit into a battery compartment.

NOTE: Battery compartment length is front to back. Width is side to side. The "length" dimension of the battery must fit within the battery compartment front-to-back dimension with a clearance of 0 to 13 mm (0 to 0.5 in.) maximum. Battery width must fit within the battery compartment side-to-side dimension.

WARNING

The battery must fit the battery compartment so that the battery restraint system will operate correctly. Use only batteries with the correct length shown in this table. Adjust the spacer plate to prevent the battery from moving more than 13 mm (0.5 in.) forward or backward.

Table 12. Model Trucks Manufactured After June, 2016J2.2-3.5XN (J45-70XN) (A276)

Model	Minimum Compartment Size Length × Width	Battery Size Min/Max		Weight		Maximum Battery Height
		Length	Width	Minimum	Maximum	
J2.2-2.5XN (J45-50XN)	717 x 1034 mm (28 x 40.7 in.)	668 to 710 mm (26.3 to 27.9 in.)	1013 to 1063 mm (39.9 to 41.9 in.)	1656 kg (3651 lb)	1877 kg (4138 lb)	784 to 792 mm (30.9 to 31.2 in.)
J2.5-3.5XN (J50-70XN)	861 x 1034 mm (34 x 41 in.)	831 to 855 mm (32.0 to 33.6 in.)	1013 to 1063 mm (39.9 to 41.9 in.)	1744 kg (3845 lb)	1928 kg (4251 lb)	784 to 792 mm (30.9 to 31.2 in.)

NOTE: Tolerances of the battery compartment are +3 and −0 mm (+0.12 and −0 in.). The battery size column shows the size range that will permit the battery to still fit into a battery compartment.

NOTE: Battery compartment length is front to back. Width is side to side. The "length" dimension of the battery must fit within the battery compartment front-to-back dimension with a clearance of 0 to 13 mm (0 to 0.5 in.) maximum. Battery width must fit within the battery compartment side-to-side dimension.

WARNING

The battery must fit the battery compartment so that the battery restraint system will operate correctly. Use only batteries with the correct length shown in this table. Adjust the spacer plate to prevent the battery from moving more than 13 mm (0.5 in.) forward or backward.

Table 13. Model TrucksJ80-120XN, J100XNL (A970)

Model	Minimum Compartment Size Length × Width	Battery Size Min/Max		Weight		Maximum Battery Height
		Length	Width	Minimum	Maximum	
J80-120XN, J100XNL	1006 x 1037 mm (39.6 x 40.8 in.)	960 to 1000 mm (37.8 to 39.4 in.)	1013 to 1030 mm (39.8 to 40.6 in.)	2080 kg (4586 lb)	2440 kg (5379 lb)	798 mm (31.4 in.)
J80XN, J90XN	859 x 1037 mm (33.8 x 40.8 in.)	800 to 840 mm (31.5 to 33.1 in.)	1013 to 1030 mm (39.8 to 40.6 in.)	1991 kg (4389 lb)	2319 kg (5113 lb)	798 mm (31.4 in.)

NOTE: Tolerances of the battery compartment are +3 and −0 mm (+0.12 and −0 in.). The battery size column shows the size range that will permit the battery to still fit into a battery compartment.

NOTE: Battery compartment length is front to back. Width is side to side. The "length" dimension of the battery must fit within the battery compartment front-to-back dimension with a clearance of 0 to 13 mm (0 to 0.5 in.) maximum. Battery width must fit within the battery compartment side-to-side dimension.

WARNING

The battery must fit the battery compartment so that the battery restraint system will operate correctly. Use only batteries with the correct length shown in this table. Adjust the spacer plate to prevent the battery from moving more than 13 mm (0.5 in.) forward or backward.

Table 14. Model TrucksJ4.0-5.0XN, J5.0-5.5XN6 (A970)

Model	Minimum Compartment Size Length × Width	Battery Size Min/Max		Weight		Maximum Battery Height
		Length	Width	Minimum	Maximum	
J4.0-5.0XN, J5.0-5.5XN6	1006 x 1037 mm (39.6 x 40.8 in.)	960 to 1000 mm (37.8 to 39.4 in.)	1013 to 1030 mm (39.8 to 40.6 in.)	2070 kg (4564 lb)	2287 kg (5042 lb)	798 mm (31.4 in.)
J4.0XN, J4.5XN	859 x 1037 mm (33.8 x 40.8 in.)	800 to 855 mm (31.5 to 33.7 in.)	1013 to 1030 mm (39.8 to 40.6 in.)	1770 kg (3902 lb)	1956 kg (4312 lb)	798 mm (31.4 in.)

NOTE: Tolerances of the battery compartment are +3 and −0 mm (+0.12 and −0 in.). The battery size column shows the size range that will permit the battery to still fit into a battery compartment.

NOTE: Battery compartment length is front to back. Width is side to side. The "length" dimension of the battery must fit within the battery compartment front-to-back dimension with a clearance of 0 to 13 mm (0 to 0.5 in.) maximum. Battery width must fit within the battery compartment side-to-side dimension.

WARNING

The battery must fit the battery compartment so that the battery restraint system will operate correctly. Use only batteries with the correct length shown in this table. Adjust the spacer plate to prevent the battery from moving more than 13 mm (0.5 in.) forward or backward.

Torque Specifications for Lift Truck Models E2.2-3.5XN (E45-70XN) (A268) and E1.6-2.0XN (E30-40XN) (A269)

OVERHEAD GUARD

Front Overhead Guard Leg Capscrews
66 N•m (49 lbf ft)

Rear Overhead Guard Leg Capscrews
66 N•m (49 lbf ft)

Handle Capscrews
12 N•m (8.9 lbf ft)

COUNTERWEIGHT

Upper Capscrews
755 N•m (557 lbf ft)

Lower Capscrews
90 N•m (66 lbf ft)

TRACTION MOTOR

Traction Motor to Mounting Flange Capscrews
38 to 48 N•m (28 to 35 lbf ft)

Torque Specifications for Lift Truck J2.2-3.5XN (J45-70XN) (A276)

OVERHEAD GUARD

Front Overhead Guard Leg Capscrews
66 N•m (49 lbf ft)

Rear Overhead Guard Leg Capscrews
66 N•m (49 lbf ft)

Handle Capscrews
12 N•m (8.9 lbf ft)

COUNTERWEIGHT

Mounting Bolts
755 N•m (557 lbf ft)

Torque Specifications for Lift Truck J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

OVERHEAD GUARD

Front Overhead Guard Leg Capscrews
66 N•m (49 lbf ft)

Rear Overhead Guard Leg Capscrews
66 N•m (49 lbf ft)

Handle Capscrews
19.2 N•m (14.16 lbf ft)

COUNTERWEIGHT

Mounting Bolts
755 N•m (557 lbf ft)

Torque Specifications for Lift Truck E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

OVERHEAD GUARD

Front Overhead Guard Leg Capscrews
66 N•m (49 lbf in)

Rear Overhead Guard Leg Capscrews
66 N•m (49 lbf ft)

Handle Capscrews
12 N•m (8.9 lbf ft)

COUNTERWEIGHT

Upper Mounting Bolts
755 to 945 N•m (557 to 697 lbf ft)

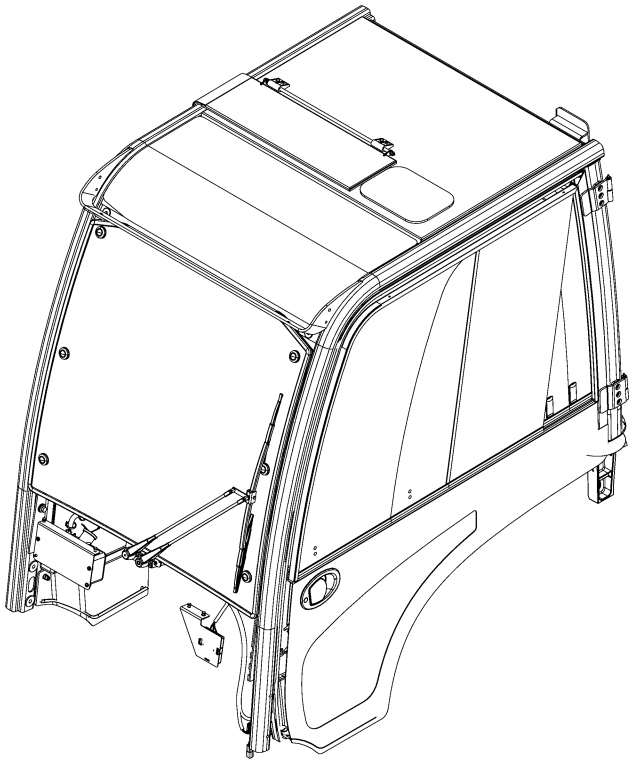
Lower Mounting Bolts
250 to 280 N•m (184 to 207 lbf ft)

Sub-Cast Mounting Capscrews
165 to 250 N•m (122 to 151 lbf ft)

NOTES

OPERATOR'S CAB

J2.2-3.5XN (J45-70XN) [A276];
J1.5-2.0XNT (J30-40XNT) [K160];
E2.2-3.5XN (E45-70XN) [A268];
J1.6-2.0XN (J30-40XN) [A935];
J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) [A970];
A1.3XNT, A1.5XNT [D203]



HYSTER

PART NO. 4025482

0100 SRM 1446

SAFETY PRECAUTIONS
MAINTENANCE AND REPAIR

- The Service Manuals are updated on a regular basis, but may not reflect recent design changes to the product. Updated technical service information may be available from your local authorized Hyster® dealer. Service Manuals provide general guidelines for maintenance and service and are intended for use by trained and experienced technicians. Failure to properly maintain equipment or to follow instructions contained in the Service Manual could result in damage to the products, personal injury, property damage or death.
- When lifting parts or assemblies, make sure all slings, chains, or cables are correctly fastened, and that the load being lifted is balanced. Make sure the crane, cables, and chains have the capacity to support the weight of the load.
- Do not lift heavy parts by hand, use a lifting mechanism.
- Wear safety glasses.
- DISCONNECT THE BATTERY CONNECTOR before doing any maintenance or repair on electric lift trucks. Disconnect the battery ground cable on internal combustion lift trucks.
- Always use correct blocks to prevent the unit from rolling or falling. See HOW TO PUT THE LIFT TRUCK ON BLOCKS in the **Operating Manual** or the **Periodic Maintenance** section.
- Keep the unit clean and the working area clean and orderly.
- Use the correct tools for the job.
- Keep the tools clean and in good condition.
- Always use **HYSTER APPROVED** parts when making repairs. Replacement parts must meet or exceed the specifications of the original equipment manufacturer.
- Make sure all nuts, bolts, snap rings, and other fastening devices are removed before using force to remove parts.
- Always fasten a DO NOT OPERATE tag to the controls of the unit when making repairs, or if the unit needs repairs.
- Be sure to follow the **WARNING** and **CAUTION** notes in the instructions.
- Gasoline, Liquid Petroleum Gas (LPG), Compressed Natural Gas (CNG), and Diesel fuel are flammable. Be sure to follow the necessary safety precautions when handling these fuels and when working on these fuel systems.
- Batteries generate flammable gas when they are being charged. Keep fire and sparks away from the area. Make sure the area is well ventilated.

NOTE: The following symbols and words indicate safety information in this manual:

WARNING

Indicates a hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION

Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury and property damage.

On the lift truck, the WARNING symbol and word are on orange background. The CAUTION symbol and word are on yellow background.

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This section is for the following models:

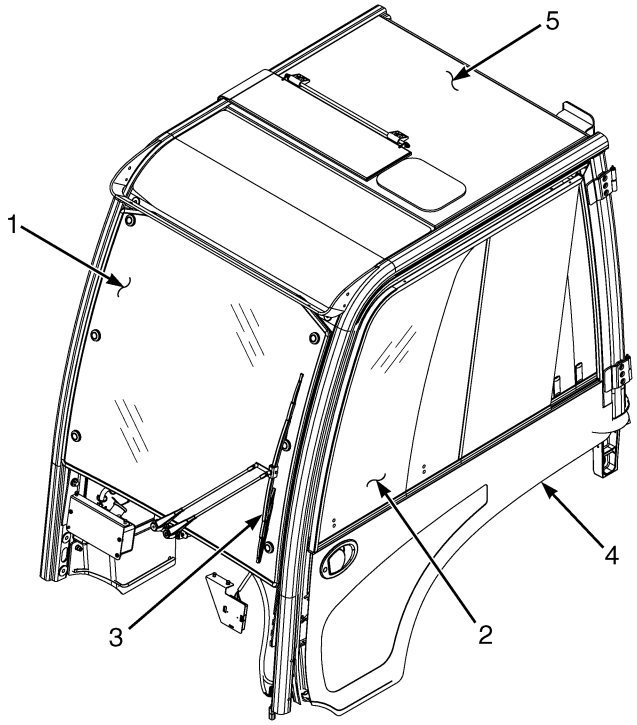
J2.2-3.5XN (J45-70XN) [A276];
J1.5-2.0XNT (J30-40XNT) [K160];
E2.2-3.5XN (E45-70XN) [A268];
J1.6-2.0XN (J30-40XN) [A935];
J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) [A970];
A1.3XNT, A1.5XNT [D203]

General

This **Service Manual** describes how the cab operates and includes replacement and repair instructions for the following cab components (see Figure 1):

- Front, rear, and cab door window panels
- Windshield wipers
- Roof liner
- Roof top panel
- Cab doors
- Cab heater
- Weather panels

Some of the described components are options that may not be present on each cab. The operation of the various switches and controls can be found in the **Operating Manual**.



1. FRONT WINDOW PANEL
2. DOOR WINDOW PANEL
3. WINDSHIELD WIPER
4. CAB DOOR
5. ROOF TOP PANEL

Figure 1. Operator's Cab

DISCHARGING THE CAPACITORS

WARNING

DO NOT make repairs or adjustments unless you have been properly trained and authorized to do so. Improper repairs and adjustments can create dangerous operating conditions. DO NOT operate a lift truck that needs repairs. Report the need for repairs to your supervisor immediately. If repair is necessary, attach a DO NOT OPERATE tag on the steering wheel and disconnect the battery.

Disconnect the battery and allow the capacitors to discharge before opening any compartment covers or inspecting or repairing the electrical system. DO NOT place tools on top of the battery. If a tool causes a short circuit, the high current flow from the battery can cause personal injury or property damage.

Some checks and adjustments are performed with the battery connected. DO NOT connect the battery until the procedure instructs you to do so. Never wear any metallic items on your fingers, arms, or neck. Metal items can accidentally make an electrical connection and cause injury.

Before performing any tests or adjustments, block the lift truck to prevent unexpected movement.

The capacitor in the transistor controller(s) can hold an electrical charge for about 10 seconds after the battery is disconnected. To prevent an electrical shock and personal injury, discharge the capacitor(s) before inspecting or repairing any component in the drive unit compartment. Make certain that the battery has been disconnected.

DO NOT short across the motor controller terminals with a screwdriver or jumper wire.

Make certain the Emergency-Disconnect switch has not been activated. This will isolate the controller and prevent the capacitors from discharging properly. The proper way to disconnect the battery is by separating the battery connectors.

Before performing work on the cab, the capacitors need to be discharged as described below:

1. Ensure the capacitors are discharged by performing Step 2 through Step 6 below.
2. Turn the key or keyless switch to the **OFF** position.
3. Disconnect the battery by separating the connectors.
4. Block the drive wheels to prevent the lift truck from moving.
5. Make sure the Emergency-Disconnect switch **HAS NOT** been activated. If the Emergency-Disconnect switch is activated, rotate the switch to the right until it pops up.
6. Press horn button. Wait 30 seconds to be sure capacitors are fully discharged.

Window Replacement

FRONT PANEL

Remove, Lift Truck Models J2.2-3.5XN (J45-70XN) (A276), J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970), J1.5-2.0XNT (J30-40XNT) K160), and J1.6-2.0XN (J30-40XN) (A935)

WARNING

All windows installed in the cab are made of safety glass. All replacement windows must be made of the correct material and must be made the correct thickness. Failure to have the correct material or thickness may cause the glass to break easily when struck and may cause personal injury.

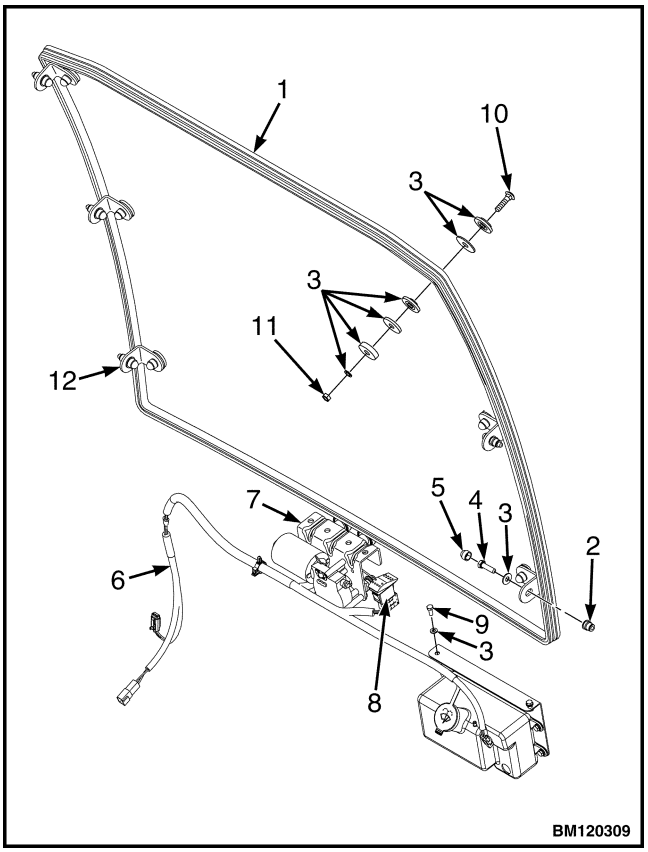
WARNING

Disconnect the battery before doing any work on the electrical system. Serious injury to personnel and/or damage to lift truck components can occur if battery is not disconnected.

Discharge capacitors as directed in the General section of this manual.

NOTE: In Step 1 and Step 2 note placement of components during removal to aid in installation.

1. Remove nut, bolt, and six washers from upper right hand corner of front window. See Figure 2.
2. Remove nut cover, nut, five washers, and screw from front window in five places. Remove front window from overhead guard. See Figure 3.



NOTE: OVERHEAD GUARD NOT SHOWN FOR CLARITY. WIPER KIT SHOWN NOT THE SAME ON ALL LIFT TRUCK MODELS.

1. FRONT WINDOW
2. INSERT
3. WASHER
4. SCREW
5. NUT COVER
6. WIRE HARNESS
7. WIPER KIT
8. SWITCH
9. CAPSCREW
10. BOLT
11. NUT
12. BRACKET

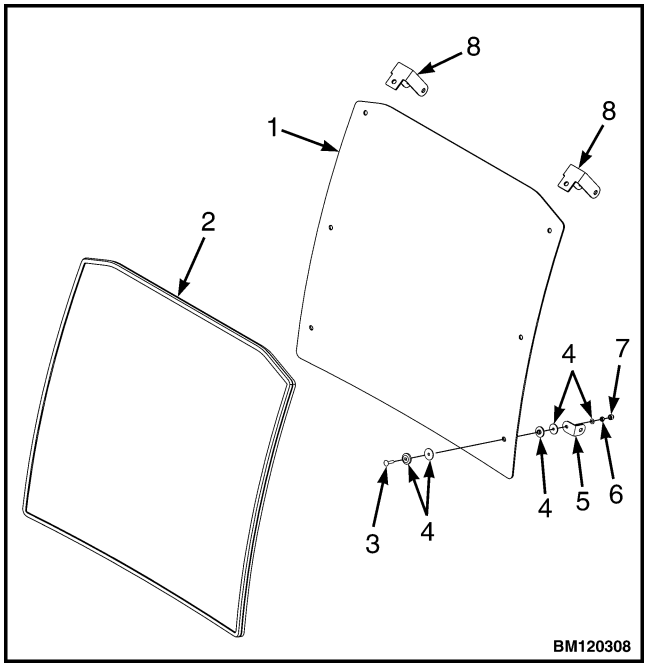
Figure 2. Front Panel and Wiper

3. Remove and discard seal from front window. See Figure 3.

NOTE: Perform Step 4 for the following lift truck models

- J2.2-3.5XN (J45-70XN) (A276)
- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

4. Remove light brackets from overhead guard, if equipped. See manual **Electrical System** 2200SRM1369 for procedures.



NOTE: OVERHEAD GUARD NOT SHOWN FOR CLARITY.

1. FRONT WINDOW
2. SEAL
3. SCREW
4. WASHER
5. BRACKET
6. NUT
7. NUT COVER
8. LIGHT BRACKET

Figure 3. Front Panel Assembly

Remove, Lift Truck Models A1.3XNT, A1.5XNT (D203)

WARNING

All windows installed in the cab are made of safety glass. All replacement windows must be made of the correct material and must be made the correct thickness. Failure to have the correct material or thickness may cause the glass to break easily when struck and may cause personal injury.

WARNING

Disconnect the battery before doing any work on the electrical system. Serious injury to personnel and/or damage to lift truck components can occur if battery is not disconnected.

Discharge capacitors as directed in the General section of this manual.

1. Move wiper blades away from front panel.
2. Remove inserts, wheel nuts, capscrews, and grab handle from mounting bracket on front panel frame. See Figure 4.
3. If equipped, remove light brackets from top of front panel frame. See **Electrical System** 2200SRM1524 for procedures.
4. Remove top two capscrews used to mount steering column. See Figure 5.
5. Remove six capscrews, nuts, front panel and front panel frame from lift truck. See Figure 5.

Clean

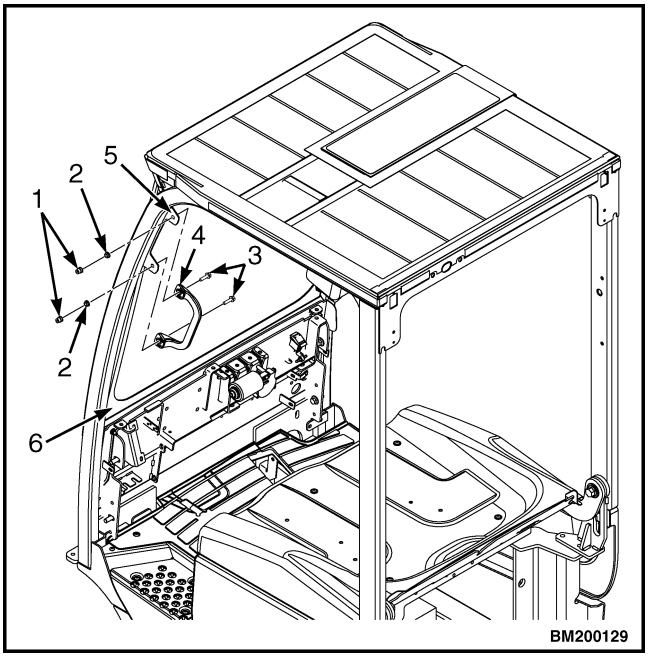
WARNING

Compressed air can move particles so that they cause injury to the user or to other personnel. Make sure that the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eyes.

1. Using compressed air, blow dirt and debris from components as needed.
2. Using a lint free cloth, wipe down front window and other components as needed.

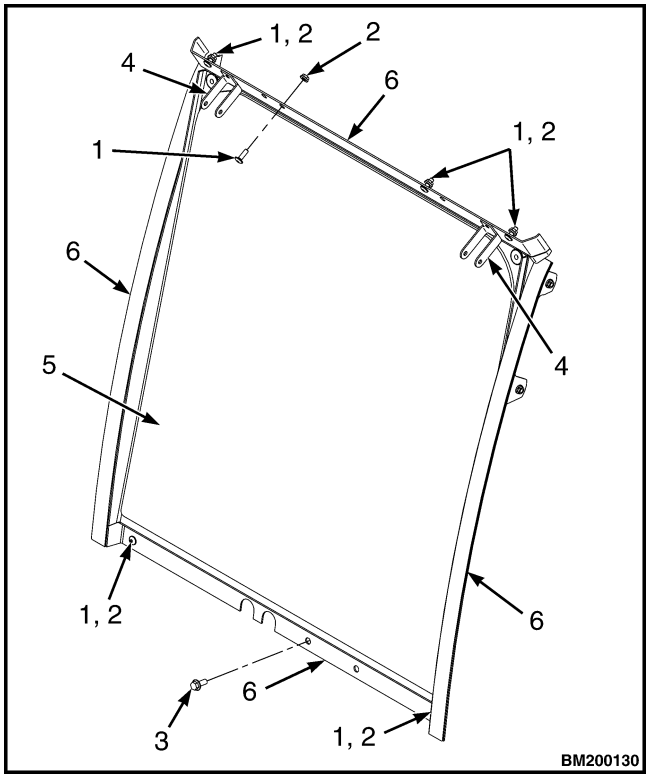
Inspect

1. Inspect front window for damage and cracks, replace if damaged.
2. For lift truck models A1.3XNT, A1.5XNT (D203), inspect front panel and steel frame for damage and cracks, replace if damaged.
3. Inspect components and hardware for cracks and defects. Replace as needed.



1. INSERT
2. WHEEL NUT
3. CAPSCREW
4. GRAB HANDLE
5. MOUNTING BRACKET
6. FRONT PANEL FRAME

Figure 4. Grab Handle, Remove and Install, Lift Truck Models A1.3XNT, A1.5XNT (D203)



1. CAPSCREW (FRONT PANEL AND FRAME)
2. NUT
3. CAPSCREW (STEERING COLUMN)
4. LIGHT BRACKET
5. FRONT PANEL
6. FRONT PANEL FRAME

Figure 5. Front Panel and Frame Components, Lift Truck Models A1.3XNT, A1.5XNT (D203)

Install, Lift Truck Models J2.2-3.5XN (J45-70XN) (A276), J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970), J1.5-2.0XNT (J30-40XNT) K160), and J1.6-2.0XN (J30-40XN) (A935)

1. Install seal on front window. See Figure 3.

NOTE: Perform Step 2 for the following lift truck models

- J2.2-3.5XN (J45-70XN) (A276)
- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

2. Install light brackets on overhead guard, if equipped. See section **Electrical System** 2200SRM1369 for procedures.

3. Install front window on overhead guard. Install two washers, screw, two washers, bracket, washer, nut, and nut cover on front window in five places. See Figure 3.

4. Install two washers, bolt, four washers, and nut on upper right hand corner of front window. See Figure 2.

Install, Lift Truck Models A1.3XNT, A1.5XNT (D203)

1. Install grab handle to mounting bracket on front panel frame using inserts, wheel nuts, and capscrews. See Figure 4.

NOTE: Apply liquid sealant, Hyster P/N 501702902, to capscrews prior to installation.

2. Install front panel and front panel frame to lift truck with six capscrews and nuts. Tighten capscrews to 19 N•m (168 lbf in). See Figure 5.

3. Install top two capscrews for steering column. See Figure 5.

4. If equipped, install light brackets from top of front panel frame. See **Electrical System** 2200SRM1524 for procedures.

5. Push wiper blades into position on the front panel.

REAR PANEL

Remove

1. Remove flange nut, cover, wiper arm, and wiper blade from wiper motor. See Figure 6.

2. Disconnect wiring harness from wiper motor and remove wiper motor from rear panel. See Figure 6.

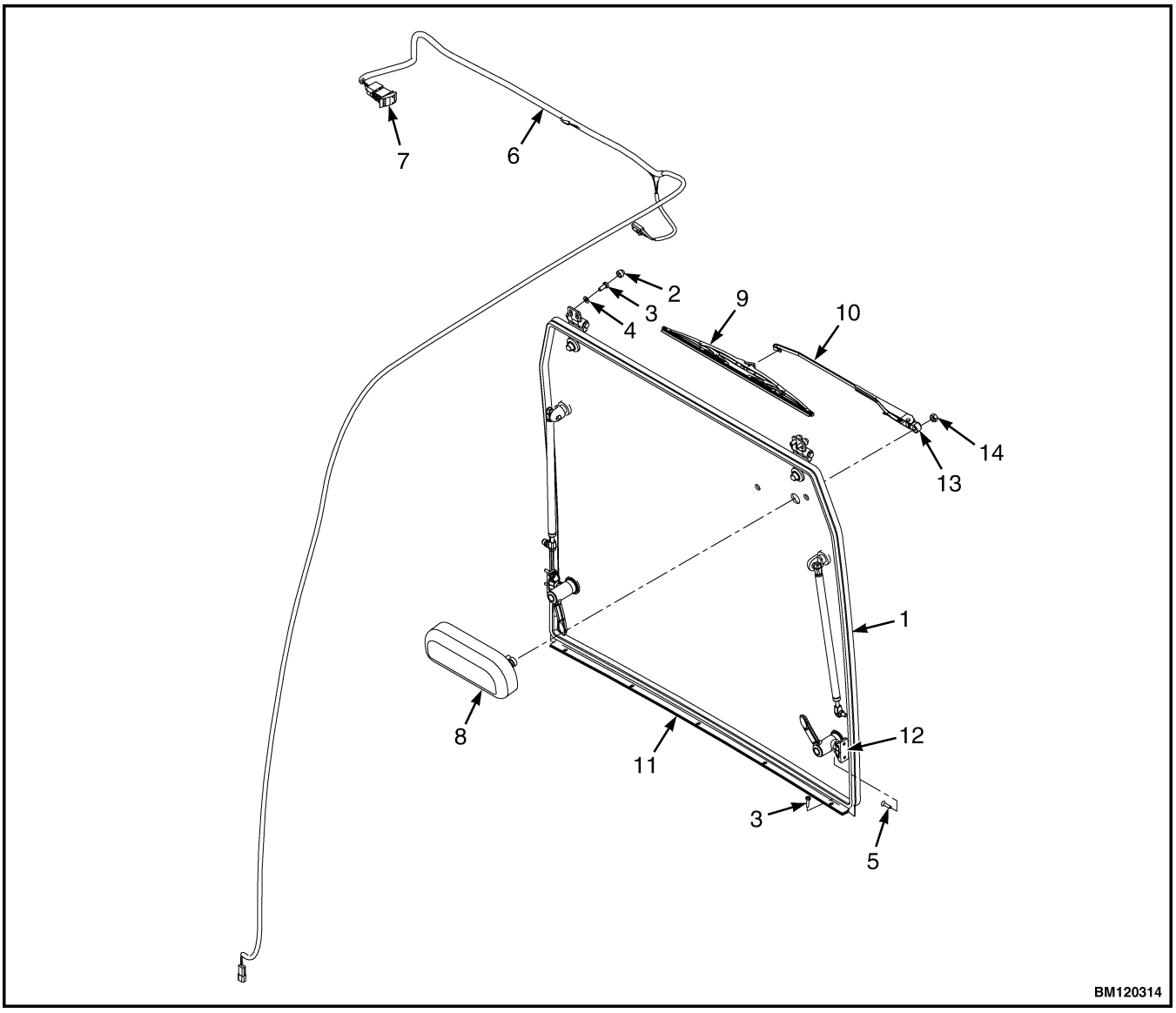
3. Remove two screws and latch from overhead guard legs in two places. See Figure 6.

4. Remove five capscrews and bracket from cab body. See Figure 6.

5. Disconnect gas spring from lower ball stud in two places. See Figure 7.

6. Remove cap, capscrew and washer from overhead guard and rear panel in two places. Remove rear panel from overhead guard. See Figure 6.

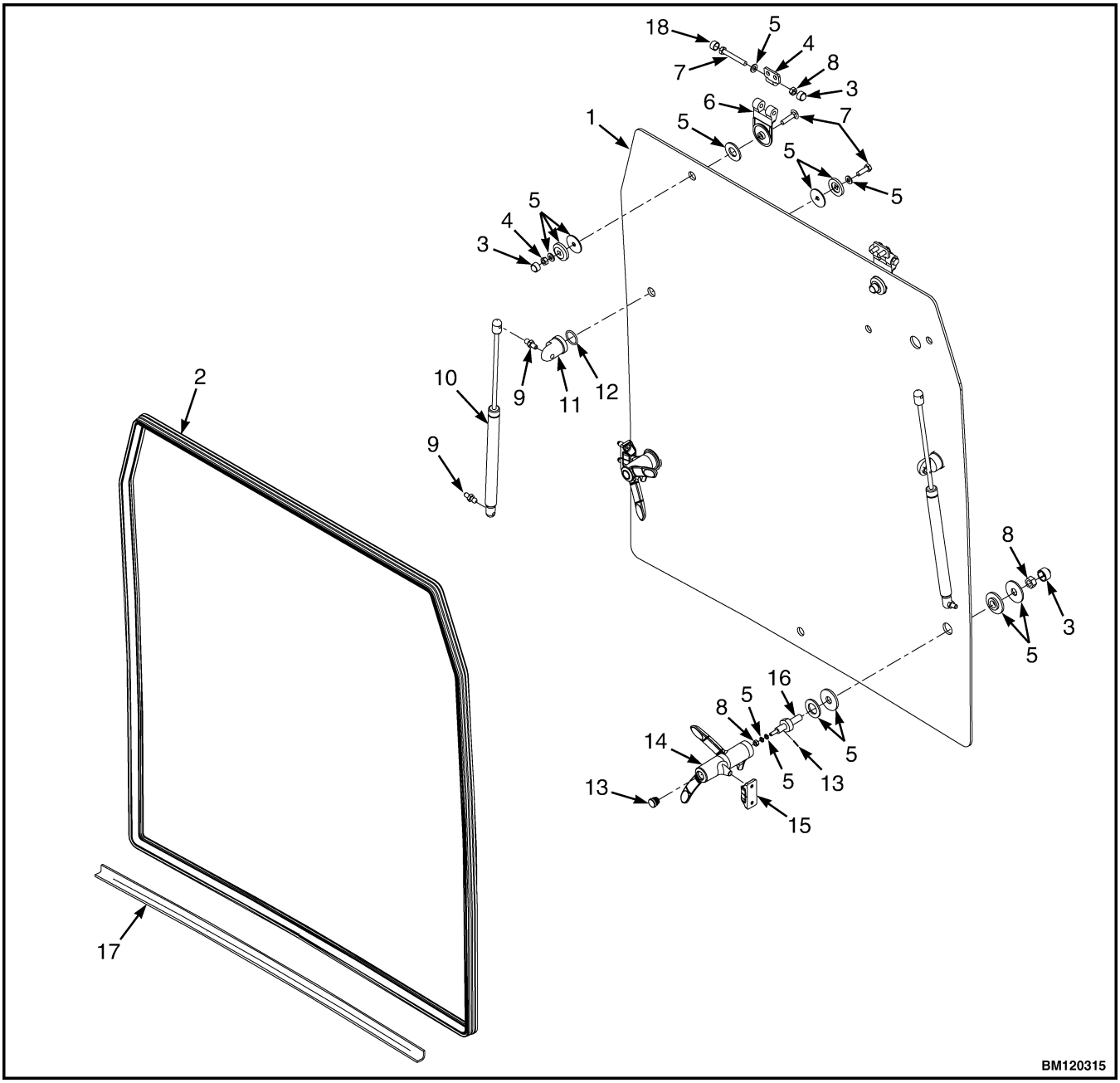
7. If damaged, remove ball stud from overhead guard leg in two places. See Figure 7.



NOTE: OVERHEAD GUARD NOT SHOWN FOR CLARITY.

1. REAR PANEL
2. CAP
3. CAPSCREW
4. WASHER
5. SCREW
6. WIRE HARNESS
7. SWITCH
8. WIPER MOTOR
9. WIPER BLADE
10. WIPER ARM
11. BRACKET
12. LATCH
13. COVER
14. FLANGE NUT

Figure 6. Rear Panel and Wiper Attachment



NOTE: OVERHEAD GUARD NOT SHOWN FOR CLARITY.

1. REAR PANEL
2. SEAL
3. NUT COVER
4. PLATE
5. WASHER
6. HINGE
7. SCREW
8. NUT
9. BALL STUD
10. GAS SPRING
11. KNOB
12. O-RING
13. PLUG
14. GRIP
15. LATCH
16. CONNECTOR
17. BRACKET
18. CAP

Figure 7. Rear Panel Assembly

8. Remove nut cover, nut, four washers, and hinge from rear panel in two places. See Figure 7.

9. Remove nut cover, nut, plate, washer, screw, and cap from hinge. Repeat for second hinge. See Figure 7.

10. Disconnect gas spring from upper ball stud on knob in two places. See Figure 7.

11. Remove ball stud from knob in two places. See Figure 7.

12. Remove screw, three washers, o-ring, and knob from rear panel in two places. See Figure 7.

13. Remove nut cover, nut, and two washers from connector on outside of rear panel. Repeat for opposite side. See Figure 7.

14. Remove plug, grip, nut, two washers, plug, connector, and two washers from inside of rear panel. Repeat for opposite side. See Figure 7.

15. Remove and discard seal from rear screen. See Figure 7.

Clean

WARNING

Compressed air can move particles so that they cause injury to the user or to other personnel. Make sure that the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eyes.

1. Using compressed air, blow dirt and debris from components as needed.

2. Using a lint free cloth, wipe down rear screen and other components as needed.

Inspect

1. Inspect components for cracks and defects. Replace as needed.

2. Inspect gas springs for proper travel and extension. Replace as necessary.

   a. Extended length; 735 mm (28.9 in.).

   b. Stroke length, 315 mm (12.4 in.).

   c. Resistance, 150 N (33.7 lbf).

3. Inspect wiper blade for cracks and tearing. Replace as needed.

Install

1. Install seal on rear screen. See Figure 7.

2. Install two washers, connector, plug, two washers, nut, grip, and plug on inside of rear panel. Repeat for opposite side. See Figure 7.

3. Install two washers, nut, and nut cover on connector on outside of rear panel. Repeat for opposite side. See Figure 7.

4. Install knob, O-ring, three washers, and screw on rear screen in two places. See Figure 7.

5. Install ball stud on knob in two places. See Figure 7.

6. Connect gas spring to upper ball stud on knob in two places. See Figure 7.

7. Install plate, washer, screw, nut, nut cover, and cap on hinge. Repeat for second hinge. See Figure 7.

8. Install washer, hinge, screw, three washers, nut, and nut cover on rear panel in two places. See Figure 7.

9. If removed, install ball stud on overhead guard leg in two places. See Figure 7.

10. Install rear panel on overhead guard. Install washer, capscrew, and cap on rear panel and overhead guard in two places. See Figure 6.

11. Connect gas spring to two lower ball stud in two places. See Figure 7.

12. Install bracket and five capscrews on cab body. See Figure 6.

13. Install latch and two screws on overhead guard legs in two places. See Figure 6.

14. Install rear wiper motor on rear panel and connect wiring harness to rear wiper motor. See Figure 6.

15. If removed, install wiper blade on wiper arm. See Figure 6.

16. Using a flange nut, install wiper arm and wiper blade on wiper motor. See Figure 6.

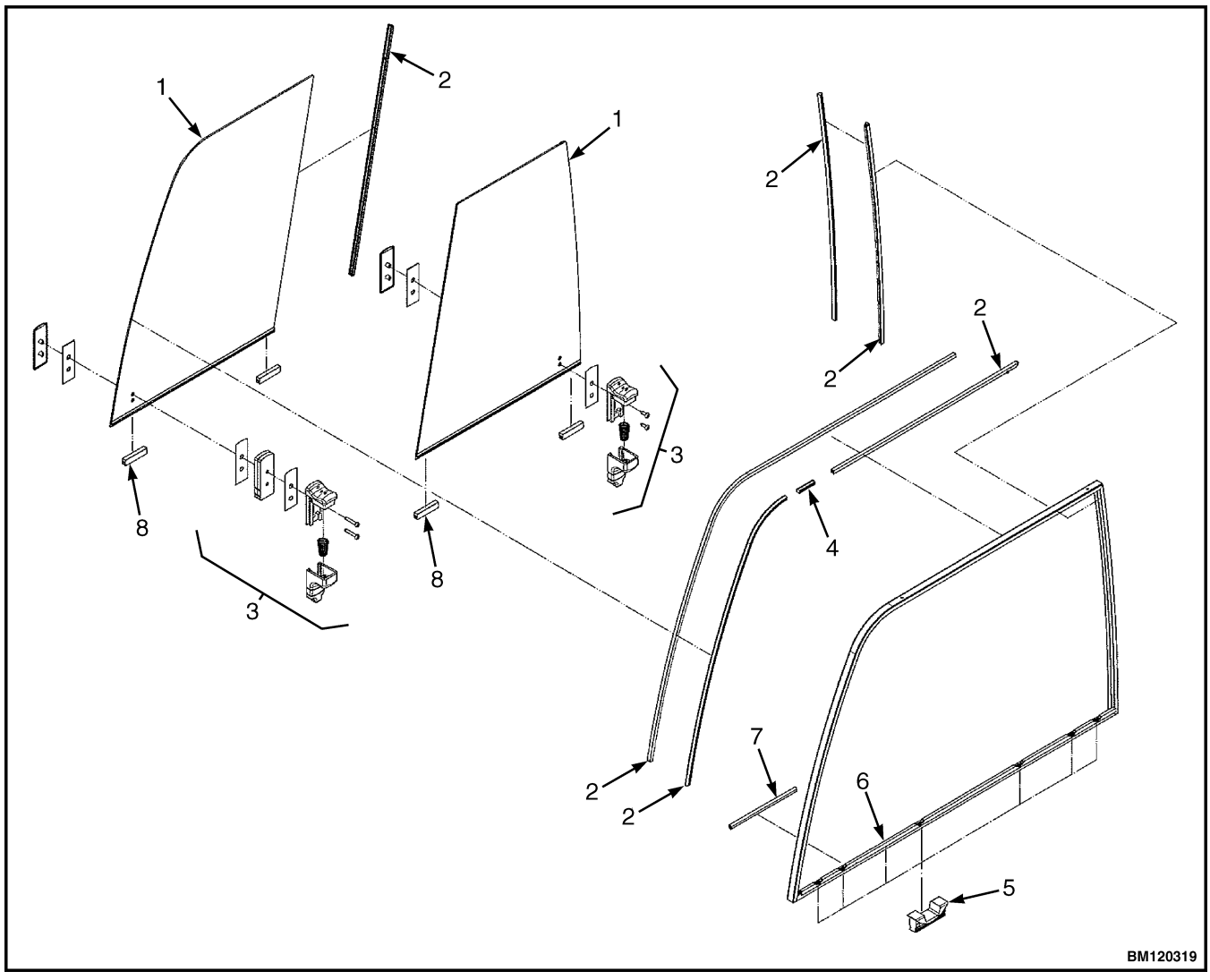
DOOR WINDOW

Disassemble Window

NOTE: If repair to non-sliding window is necessary, contact local glass repair shop.

NOTE: The following procedure applies to right and left doors with sliding windows.

1. Remove window frame and window assembly from door assembly. See Figure 8.
2. Remove two latches from two sliding windows. See Figure 8.
3. Remove two sliding windows from window frame. See Figure 8.
4. Remove and discard four guides from two sliding windows. See Figure 8.
5. Remove and discard seal from rear of sliding window. See Figure 8.



NOTE: RIGHT-HAND SIDE SHOWN.

1. SLIDING WINDOW
2. SEAL
3. LATCH
4. STRIP SEAL
5. CLIP
6. WINDOW FRAME
7. EDGE PROTECTOR
8. GUIDE

Figure 8. Window Components

6. Remove and discard five seals from window frame. See Figure 8.
7. Remove and discard strip seal from window frame. See Figure 8.
8. Remove and discard six clips from window frame. See Figure 8.
9. Remove and discard edge protector from window frame. See Figure 8.

Clean

WARNING

Compressed air can move particles so that they cause injury to the user or to other personnel. Make sure that the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eyes.

1. Using compressed air, blow dirt and debris from components as needed.
2. Using a lint free cloth, wipe down windows on both doors and other components as needed.

Inspect

1. Inspect all components and hardware for cracks and defects. Replace as needed.
2. Inspect latch assembly and hardware. Ensure proper operation.
3. Inspect windows for chips and cracks. Replace as necessary.

Assemble Window

NOTE: The following procedure applies to right and left doors.

1. Install edge protector and six clips on window frame. See Figure 8.
2. Install strip seal and five seals on window frame. See Figure 8.
3. Install seal on rear of sliding window. See Figure 8.
4. Install four guides on two sliding windows. See Figure 8.
5. Install two sliding windows on window frame. See Figure 8.
6. Install two latches to sliding windows. See Figure 8.
7. Install window frame and window assembly to door assembly. See Figure 8.

Window Wipers Replacement

FRONT WIPER ASSEMBLY

NOTE: Lift truck models E2.2-3.5XN (E45-70XN) (A268) are not equipped with windshield wiper and motor.

Remove, Lift Truck Models J2.2-3.5XN (J45-70XN) (A276), J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970), J1.5-2.0XNT (J30-40XNT) K160), and J1.6-2.0XN (J30-40XN) (A935)

1. Disconnect wire harness from wiper motor connector.

   See Figure 9 for lift truck models
   - J2.2-3.5XN (J45-70XN) (A276)

   See Figure 10 for lift truck models
   - J1.5-2.0XNT (J30-40XNT) (K160)
   - J1.6-2.0XN (J30-40XN) (A935)

   See Figure 11 for lift truck models
   - J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

2. Disconnect wire harness from washer pump connector.

   See Figure 9 for lift truck models
   - J2.2-3.5XN (J45-70XN) (A276)

   See Figure 10 for lift truck models
   - J1.5-2.0XNT (J30-40XNT) (K160)
   - J1.6-2.0XN (J30-40XN) (A935)

   See Figure 11 for lift truck models
   - J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

NOTE: Perform Step 3 and Step 4 for lift truck models J2.2-3.5XN (J45-70XN) (A276).

3. Disconnect hose (6) from connector (7). See Figure 9.

4. Remove two clamps (5), hose (6), and nozzle (4) from wiper arm. Set aside for installation. See Figure 9.

NOTE: Perform Step 5 for the following lift truck models

- J1.5-2.0XNT (J30-40XNT) (K160)
- J1.6-2.0XN (J30-40XN) (A935)

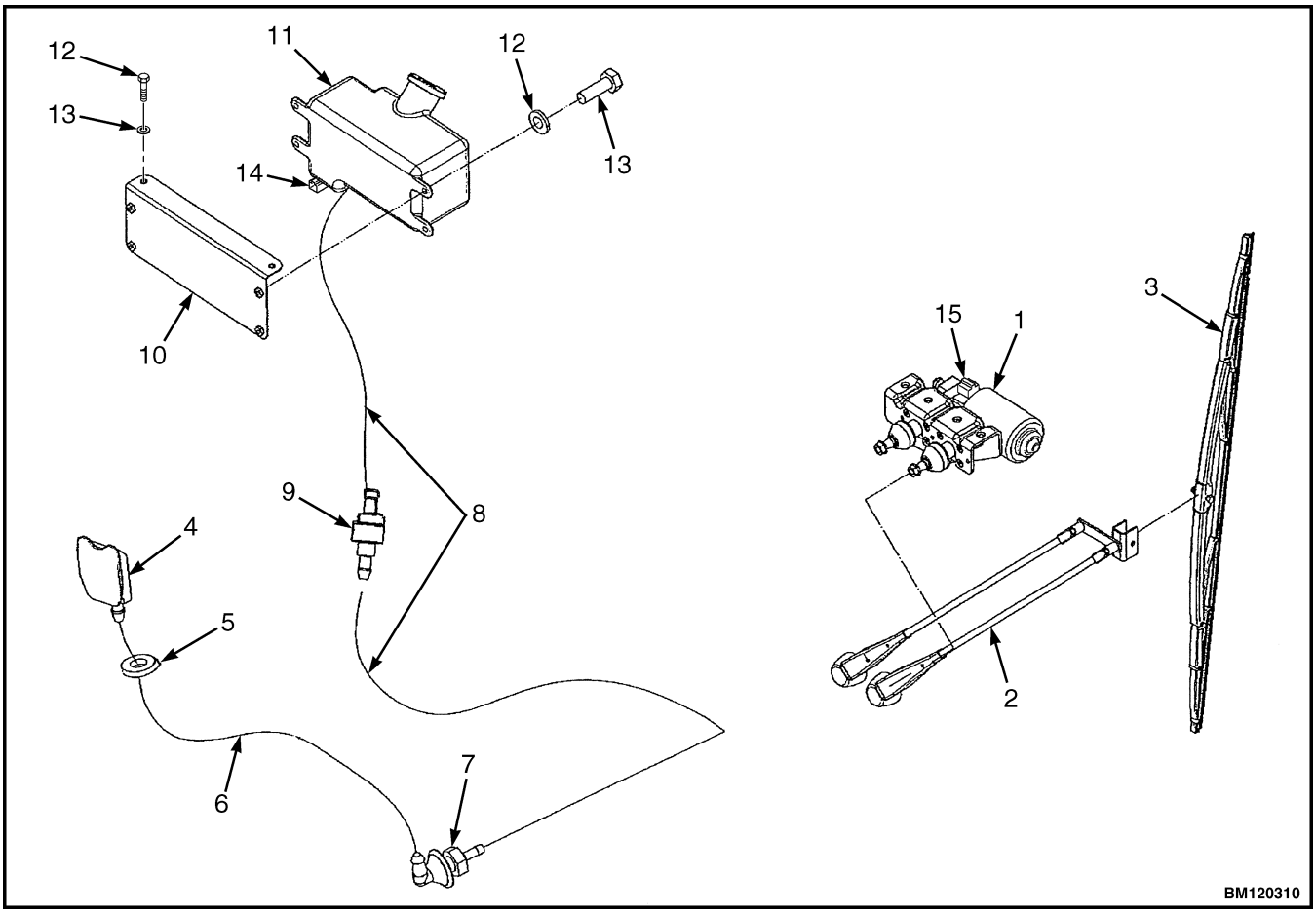
5. Disconnect hose (15) from connector (11). See Figure 10.

NOTE: Perform Step 6 and Step 7 for lift truck models J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970).

6. Disconnect hose (17) from connector (7). See Figure 11.

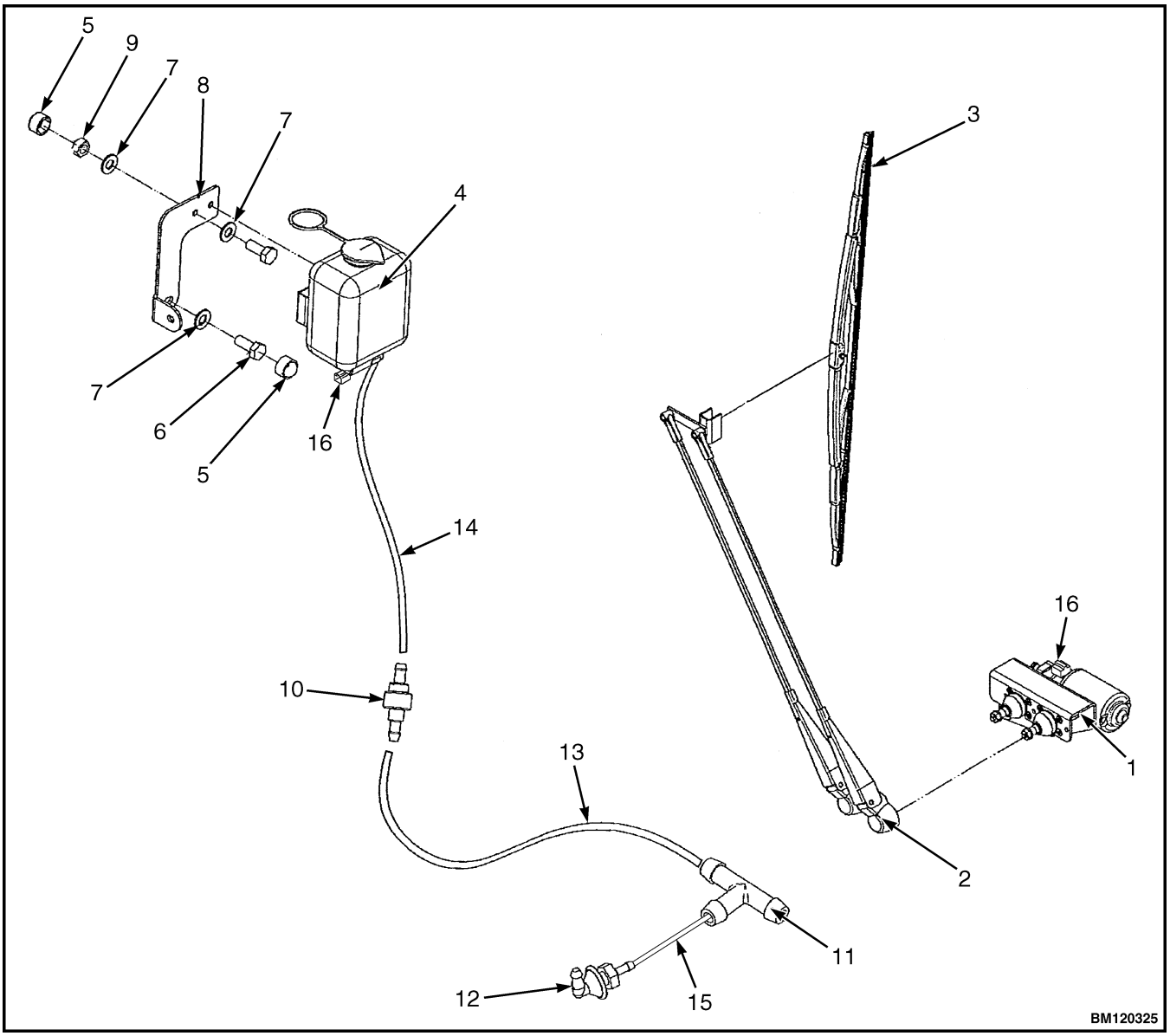
7. Disconnect hose from nozzle clip. Remove nozzle clip and nozzle from wiper arm. See Figure 11.

8. Remove two flange nuts, wiper arms, and wiper blade from wiper motor. See Figure 12.



1. WIPER MOTOR
2. WIPER ARM
3. WIPER BLADE
4. NOZZLE (CLIP)
5. CLAMP
6. HOSE
7. CONNECTOR (SPRAY NOZZLE)
8. HOSE
9. CHECK VALVE
10. BRACKET
11. RESERVOIR
12. WASHER
13. CAPSCREW
14. WASHER PUMP CONNECTOR
15. WIPER MOTOR CONNECTOR

Figure 9. Front Wiper Assembly for Lift Truck Models J2.2-3.5XN (J45-70XN) (A276)



1. WIPER MOTOR
2. WIPER ARM
3. WIPER BLADE
4. RESERVOIR
5. CAP
6. CAPSCREW
7. WASHER
8. BRACKET
9. NUT
10. CHECK VALVE
11. CONNECTOR
12. CHECK VALVE CONNECTOR
13. HOSE
14. HOSE
15. HOSE
16. WIRING CONNECTOR

Figure 10. Front Wiper Assembly for Lift Truck Models J1.5-2.0XNT (J30-40XNT) (K160) and J1.6-2.0XN (J30-40XN) (A935)

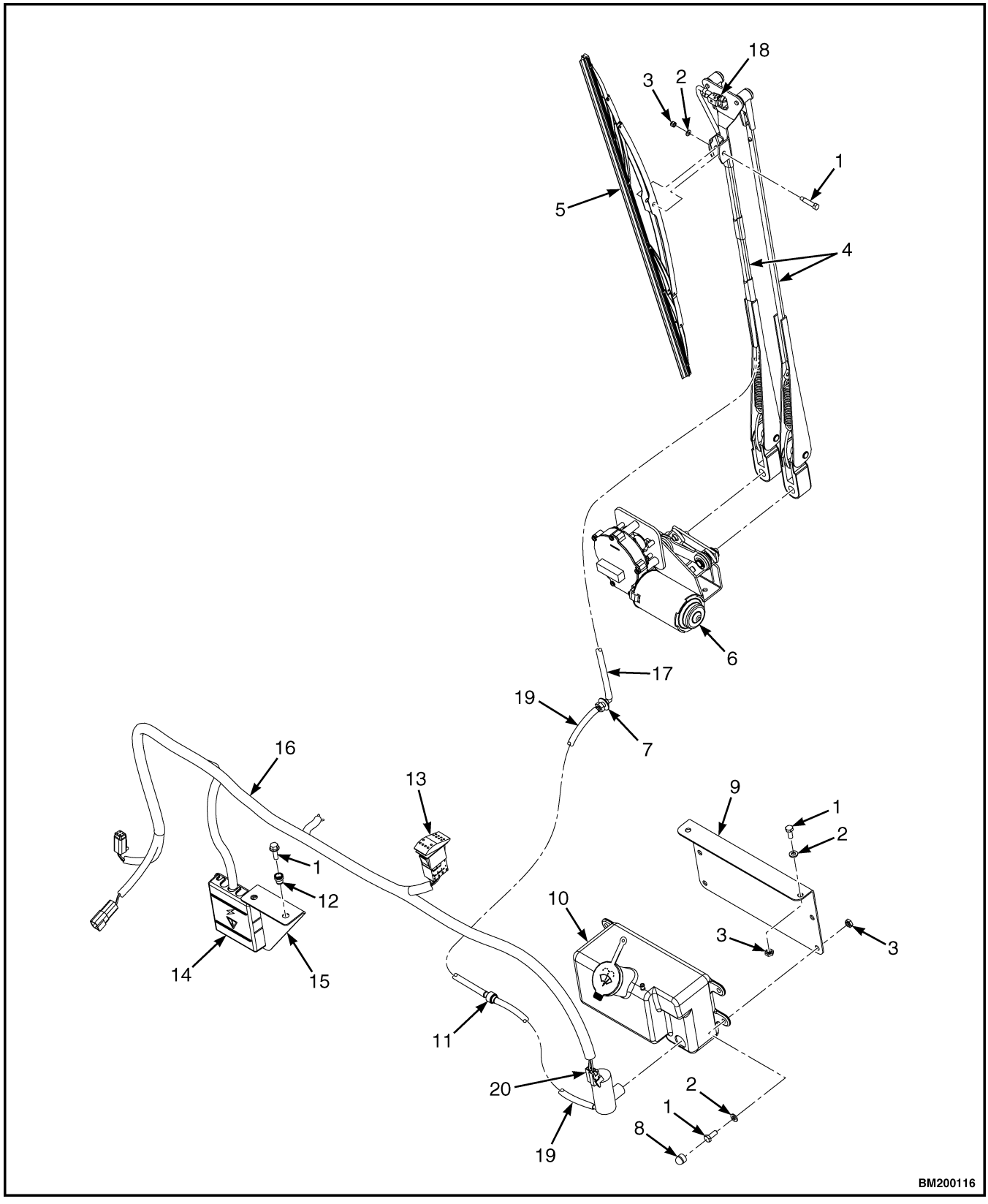
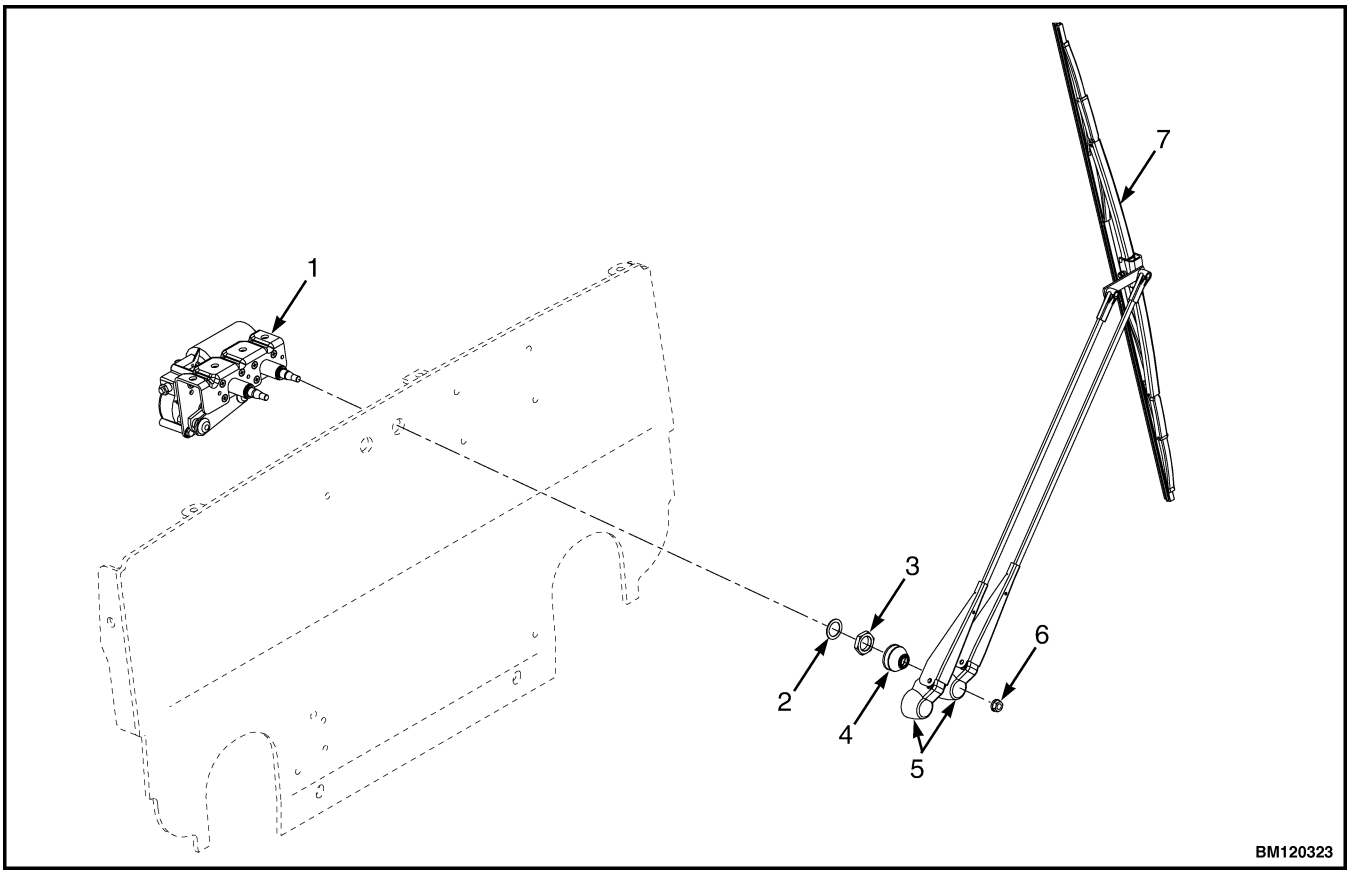


Figure 11. Front Wiper Assembly for Lift Truck Models J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

Legend for Figure 11

1. CAPSCREW
2. WASHER
3. NUT
4. WIPER ARM
5. WIPER BLADE
6. WIPER MOTOR
7. CONNECTOR (SPRAY NOZZLE)
8. CAP
9. RESERVOIR BRACKET
10. WASHER RESERVOIR
11. CHECK VALVE
12. INSERT
13. SWITCH
14. FUSES
15. FUSES MOUNTING BRACKET
16. WIRE HARNESS
17. HOSE
18. NOZZLE CLIP
19. HOSE
20. WASHER PUMP CONNECTOR



1. WIPER MOTOR
2. WASHER
3. NUT
4. NUT COVER
5. WIPER ARM
6. FLANGE NUTS
7. WIPER BLADE

Figure 12. Wiper Attachment

9. Remove wiper blade from wiper arm.

See Figure 9 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276)

See Figure 10 for lift truck models

- J1.5-2.0XNT (J30-40XNT) (K160)
- J1.6-2.0XN (J30-40XN) (A935)

See Figure 11 for lift truck models

- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

10. Remove two nut covers, two nuts, two washers, and wiper motor from lift truck. See Figure 12.

11. Disconnect hose from reservoir.

See Figure 9 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276)

See Figure 10 for lift truck models

- J1.5-2.0XNT (J30-40XNT) (K160)
- J1.6-2.0XN (J30-40XN) (A935)

See Figure 11 for lift truck models

- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

NOTE: Perform Step 12 and Step 13 for lift truck models J2.2-3.5XN (J45-70XN) (A276).

12. Remove two capscrews, two washers, and reservoir from cowl.

13. Remove four capscrews, washers, and reservoir from bracket. See Figure 9.

NOTE: Perform Step 14 for lift truck models

- J1.5-2.0XNT (J30-40XNT) (K160)
- J1.6-2.0XN (J30-40XN) (A935)

14. Remove three caps, three nuts, six washers, three capscrews, reservoir, and bracket from overhead guard leg. See Figure 10.

NOTE: Perform Step 15 and Step 16 for lift truck models J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970).

15. Remove two capscrews, washers, nuts, and reservoir from cowl. See Figure 11.

16. Remove caps, capscrews, washers, nuts, and reservoir from bracket. See Figure 11.

17. Disconnect and remove check valve. Set aside for installation.

See Figure 9 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276)

See Figure 10 for lift truck models

- J1.5-2.0XNT (J30-40XNT) (K160)
- J1.6-2.0XN (J30-40XN) (A935)

See Figure 11 for lift truck models

- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

NOTE: Perform Step 18 for lift truck models J2.2-3.5XN (J45-70XN) (A276).

18. Disconnect and remove connector from hose (8). Set hose aside for installation. See Figure 9.

NOTE: Perform Step 19 for lift truck models

- J1.5-2.0XNT (J30-40XNT) (K160)
- J1.6-2.0XN (J30-40XN) (A935)

19. Disconnect and remove connector (11) from hose (13). Set aside for installation. See Figure 10.

NOTE: Perform Step 20 for lift truck models J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970).

20. Disconnect and remove connector (7) from hose (19). See Figure 11.

Remove, Lift Truck Models A1.3XNT, A1.5XNT (D203)

1. Disconnect wire harness from wiper motor connector. See Figure 13.

2. Disconnect washer pump connector from washer reservoir. See Figure 13.

3. Disconnect hose (19) from connector (14). See Figure 13.

4. Disconnect hose from nozzle clip. Remove nozzle clip and nozzle from wiper arm. See Figure 13.

5. Remove two flange nuts, wiper arms, and wiper blade from wiper motor. See Figure 12.

6. Remove screw, nut, washer, and wiper blade from wiper arm. See Figure 13.

7. Remove two nut covers, two nuts, two washers, and wiper motor from lift truck. See Figure 12.

8. Disconnect hose from reservoir.

9. Remove two capscrews, washers, nuts, caps, and reservoir from mounting bracket on right front overhead guard leg.

10. Remove two capscrews, washers, nuts, caps, and reservoir from reservoir mounting bracket. See Figure 13.

11. Disconnect and remove check valve. Set aside for installation.

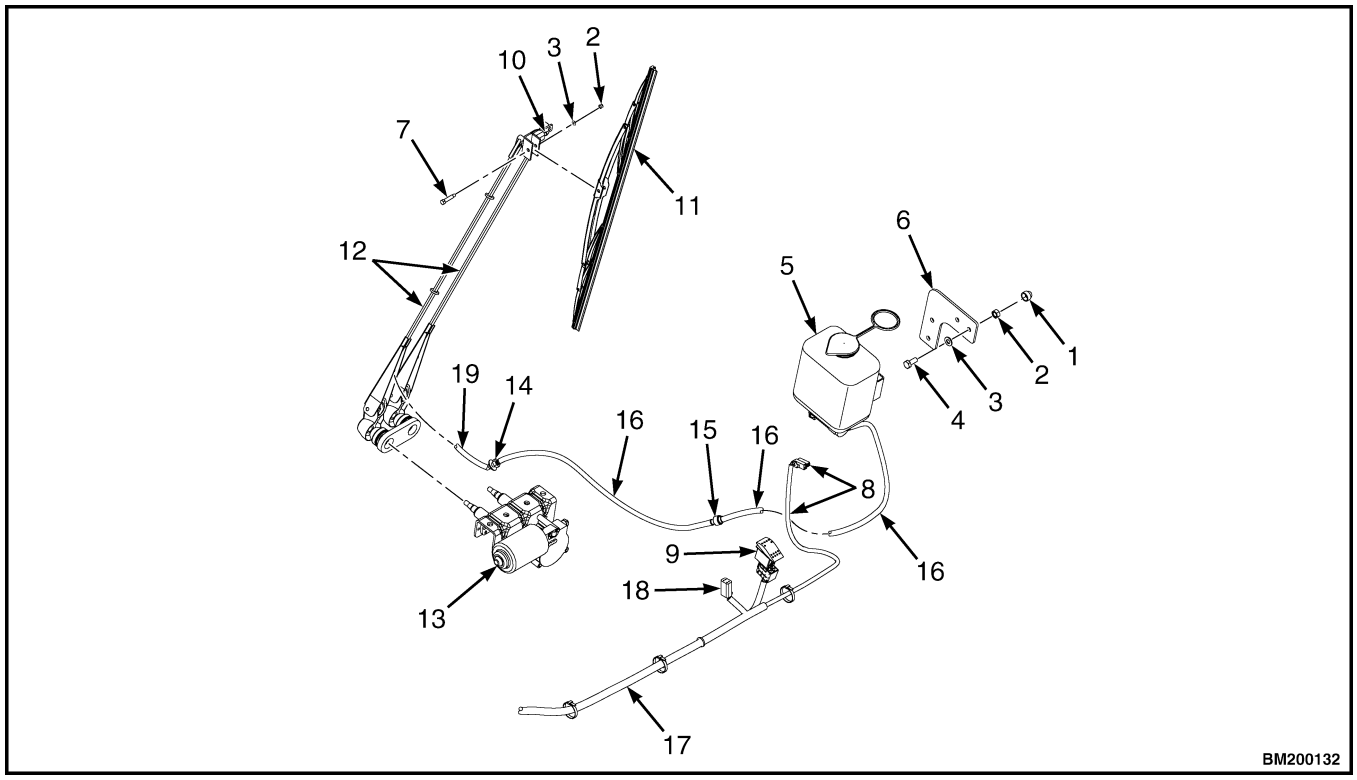
12. Disconnect and remove connector (14) from hose (16). See Figure 13.

Clean

WARNING

Compressed air can move particles so that they cause injury to the user or to other personnel. Make sure that the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the yes.

1. Using compressed air, clean outside of wiper motor, reservoir and wiper arms.



1. CAP
2. NUT
3. WASHER
4. CAPSCREW
5. WASHER RESERVOIR
6. WASHER RESERVOIR MOUNTING BRACKET
7. SCREW
8. WASHER PUMP CONNECTOR
9. SWITCH
10. NOZZLE CLIP
11. WIPER BLADE
12. WIPER ARM
13. WIPER MOTOR
14. CONNECTOR (SPRAY NOZZLE)
15. CHECK VALVE
16. HOSE
17. WIRE HARNESS
18. WIPER MOTOR CONNECTOR
19. HOSE

Figure 13. Front Wiper Assembly, Lift Truck Models A1.3XNT, A1.5XNT (D203)

Inspect

1. Inspect hoses for cracks and wear. Replace if damaged.
2. Check washer reservoir for leaks by filling with water and checking seams. Replace if leaking.
3. Inspect wiper blades for cracks and tearing. Replace as needed.

Install, Lift Truck Models J2.2-3.5XN (J45-70XN) (A276), J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970), J1.5-2.0XNT (J30-40XNT) (K160), and J1.6-2.0XN (J30-40XN) (A935)

NOTE: Perform Step 1 through Step 4 for lift truck model J2.2-3.5XN (J45-70XN) (A276).

1. Connect hose (8) to connector. See Figure 9.
2. Connect check valve into hose (8). Connect hose (8) to other end of check valve. See Figure 9.
3. Install reservoir, washers, and four capscrews on bracket. See Figure 9.
4. Using two washers and two capscrews, install reservoir on cowl.

NOTE: Perform Step 5 through Step 7 for lift truck models

- J1.5-2.0XNT (J30-40XNT) (K160)
- J1.6-2.0XN (J30-40XN) (A935)

5. Connect hose (13) to connector (11). See Figure 10.
6. Connect check valve to hose (13). Connect hose (14) to other end of check valve. See Figure 10.
7. Install bracket, pump, six washers, three capscrews, three nuts, and three caps on overhead guard leg. See Figure 10.

NOTE: Perform Step 8 through Step 11 for lift truck models J4.0-5.0XN (J80-100XN) (A970).

8. Connect hose (19) to connector (7). See Figure 11.
9. Connect check valve to hose.
10. Install reservoir to bracket using, four nuts, washers, capscrews, and caps. See Figure 11.
11. Using two nuts, washers, and capscrews, install reservoir to cowl.
12. Connect hose to reservoir.

    See Figure 9 for lift truck models
    - J2.2-3.5XN (J45-70XN) (A276)

    See Figure 10 for lift truck models
    - J1.5-2.0XNT (J30-40XNT) (K160)
    - J1.6-2.0XN (J30-40XN) (A935)

    See Figure 11 for lift truck models
    - J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

13. Using two washers, two nuts, and two caps, install wiper motor to lift truck. See Figure 12.
14. Install wiper blade on wiper arm.

    See Figure 9 for lift truck models
    - J2.2-3.5XN (J45-70XN) (A276)

    See Figure 10 for lift truck models
    - J1.5-2.0XNT (J30-40XNT) (K160)
    - J1.6-2.0XN (J30-40XN) (A935)

    See Figure 11 for lift truck models
    - J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

15. Using two flange nuts, install wiper arm and wiper blade on wiper motor.

    See Figure 9 for lift truck models
    - J2.2-3.5XN (J45-70XN) (A276)

    See Figure 10 for lift truck models
    - J1.5-2.0XNT (J30-40XNT) (K160)
    - J1.6-2.0XN (J30-40XN) (A935)

    See Figure 11 for lift truck models
    - J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

NOTE: Perform Step 16 and Step 17 for lift truck models J2.2-3.5XN (J45-70XN) (A276).

16. Install nozzle (4), hose (6), and two clamps (5) on wiper arm. See Figure 9.
17. Connect hose (6) to connector (7). See Figure 9.

NOTE: Perform Step 18 for lift truck models

- J1.5-2.0XNT (J30-40XNT) (K160)
- J1.6-2.0XN (J30-40XN) (A935)

18. Connect hose (15) to connector (11). See Figure 10.

NOTE: Perform Step 19 for lift truck models J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970).

19. Install nozzle clip and nozzle into wiper arm. Connect hose (17) to nozzle. See Figure 11.

20. Connect wire harness to wiper motor connector.

See Figure 9 for lift truck models

- J2.2-3.5XN (A276)

See Figure 10 for lift truck models

- J1.5-2.0XNT (J30-40XNT) (K160)
- J1.6-2.0XN (J30-40XN) (A935)

See Figure 11 for lift truck models

- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

21. Connect wire harness to washer pump connector.

See Figure 9 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276)

See Figure 10 for lift truck models

- J1.5-2.0XNT (J30-40XNT) (K160)
- J1.6-2.0XN (J30-40XN) (A935)

See Figure 11 for lift truck models

- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

Install, Lift Truck Models A1.3XNT, A1.5XNT (D203)

1. Connect hose (16) to connector (14). See Figure 13.

2. Connect check valve to hose.

3. Install reservoir to mounting bracket using two capscrews, nuts, washers, and caps. See Figure 13.

4. Using two capscrews, nuts, washers, and caps, install reservoir and mounting bracket to right overhead guard leg.

5. Connect hose to reservoir. See Figure 13.

6. Using two washers, two nuts, and two caps, install wiper motor to lift truck. See Figure 12.

7. Install wiper blade on wiper arm using screw, washer, and nut. See Figure 13.

8. Using two flange nuts, install wiper arm and wiper blade on wiper motor. See Figure 12.

9. Install nozzle clip and nozzle into wiper arm. Connect hose (19) to nozzle. See Figure 13.

10. Connect hose (19) to connector (14). See Figure 13.

11. Connect washer pump to washer reservoir.

12. Connect wire harness to wiper motor. See Figure 13.

Cab Component Repair

ROOF LINER

Remove

NOTE: Perform Step 1 for lift truck model J2.2-3.5XN (J45-70XN) (A276).

1. Remove seven caps, seven capscrews, and seven washers from roof liner. See Figure 14.

NOTE: Perform Step 2 for lift truck models

- J1.5-2.0XNT (J30-40XNT) (K160)
- J1.6-2.0XN (J30-40XN) (A935)

2. Remove seven capscrews and seven washers from roof liner. See Figure 15.

NOTE: Perform Step 3 for lift truck models J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970).

3. Remove eight capscrews and eight washers from roof liner. See Figure 16.

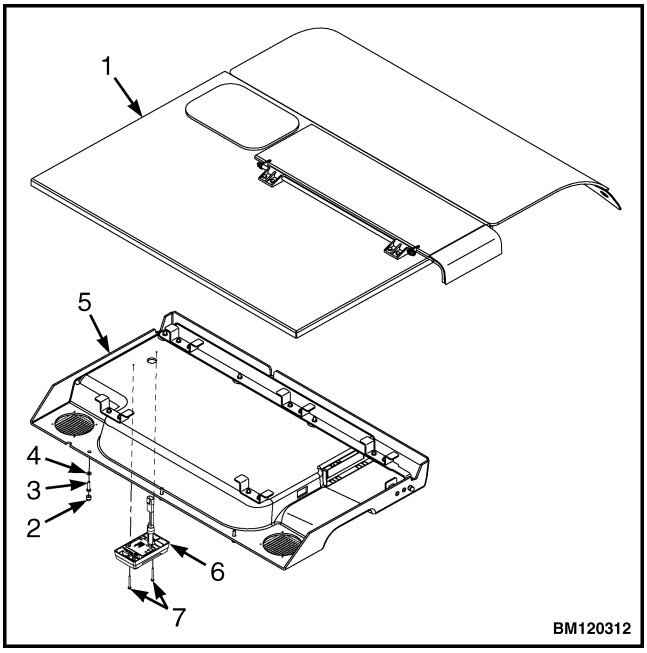
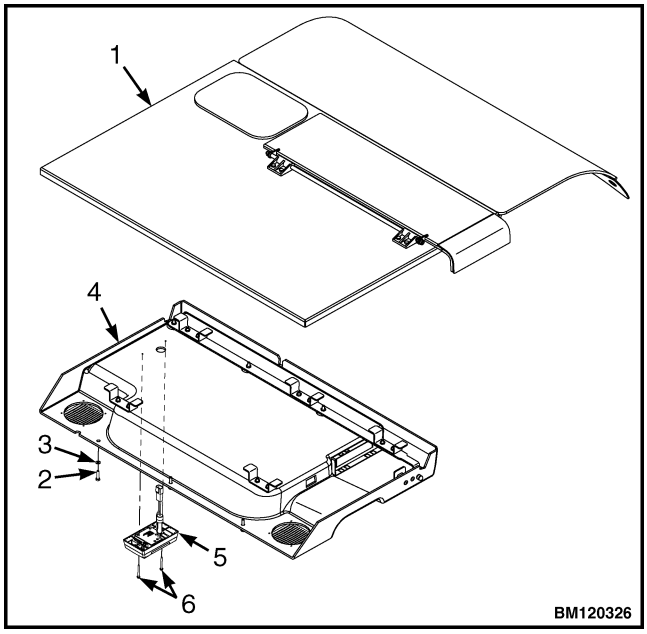


Figure 14. Roof Liner for Lift Truck Model J2.2-3.5XN (J45-70XN) (A276)

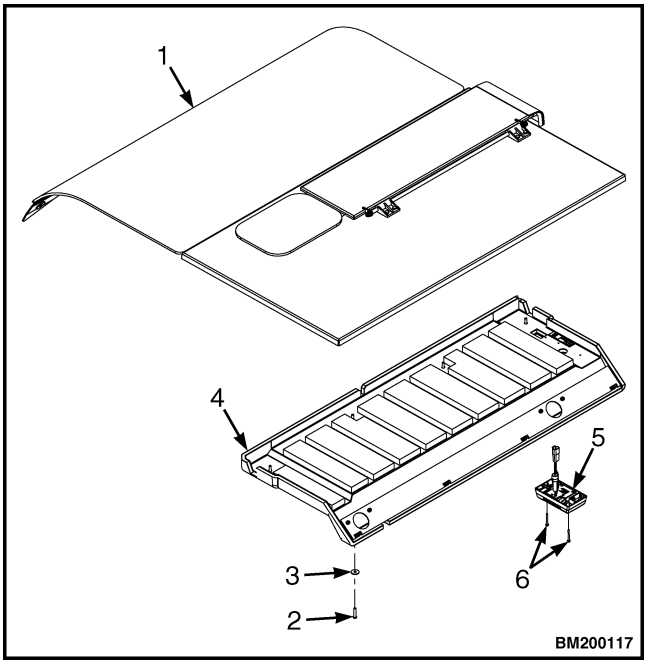
Legend for Figure 14

1. TOP PANEL
2. CAP
3. CAPSCREW
4. WASHER
5. ROOF LINER
6. DOME LIGHT
7. SCREW



1. TOP PANEL
2. CAPSCREW
3. WASHER
4. ROOF LINER
5. DOME LIGHT
6. SCREW

Figure 15. Roof Liner for Lift Truck Model J1.5-2.0XNT (J30-40XNT) (K160) and J1.6-2.0XN (J30-40XN) (A935)



1. TOP PANEL
2. CAPSCREW
3. WASHER
4. ROOF LINER
5. DOME LIGHT
6. SCREW

Figure 16. Roof Liner for Lift Truck Models J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

NOTE: Note position of wire harness and washer hose through notched cutout in rear of roof liner.

4. Disconnect dome light harness and rear wiper switch harness (if equipped).

5. Remove two screws and dome light from roof liner.

See Figure 14 for truck models

- J2.2-3.5XN (J45-70XN) (A276)

See Figure 15 for truck models

- J1.5-2.0XNT (J30-40XNT) (K160)
- J1.6-2.0XN (J30-40XN) (A935)

See Figure 16 for lift truck models

- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

6. Remove rear wiper switch from roof liner (if equipped).

7. Remove roof liner from overhead guard.

Clean

WARNING

Compressed air can move particles so that they cause injury to the user or to other personnel. Make sure that the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eyes.

1. Using compressed air, blow dirt and debris off of roof liner.

2. Using a lint free cloth, wipe down overhead guard.

Inspect

1. Inspect roof liner for cracks and defects. Replace as needed.

2. Inspect hardware for defects, replace as needed.

Install

1. Install roof liner on overhead guard.

2. Route wire harness and washer hose through notched cut out in rear of roof liner as noted during removal.

3. Install rear wiper switch to preformed cutout of roof liner (if equipped).

4. Using two screws, install dome light on roof liner.

See Figure 14 for truck models

- J2.2-3.5XN (J45-70XN) (A276)

See Figure 15 for truck models

- J1.5-2.0XNT (J30-40XNT) (K160)
- J1.6-2.0XN (J30-40XN) (A935)

See Figure 16 for lift truck models

- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

5. Connect dome light harness and rear wiper switch harness, if equipped.

NOTE: Perform Step 6 for lift truck model J2.2-3.5XN (J45-70XN) (A276).

6. Install seven washers, seven capscrews, and seven caps on roof liner. See Figure 14.

NOTE: Perform Step 7 for lift truck models

- J1.5-2.0XNT (J30-40XNT) (K160)
- J1.6-2.0XN (J30-40XN) (A935)

7. Install seven washers and seven capscrews on roof liner. See Figure 15.

NOTE: Perform Step 8 for lift truck models J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970).

8. Install eight washers and eight capscrews on roof liner. See Figure 16.

TOP PANEL

Remove, Lift Truck Models J2.2-3.5XN (J45-70XN) (A276), J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970), J1.5-2.0XNT (J30-40XNT) K160), and J1.6-2.0XN (J30-40XN) (A935)

NOTE: Perform Step 1 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276)
- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

1. Disconnect front light wiring. See section **Electrical System** 2200SRM1369, Lights, for proper procedures.

WARNING

All windows installed in the cab are made of safety glass. All replacement windows must be made of the correct material and must be the correct thickness. Failure to use the correct material or thickness may cause the glass to break easily when struck and may cause personal injury.

NOTE: Due to use of glue and RTV sealer, replacement of top screen is to be done only if damaged.

2. Remove and discard grommets from top panel assembly. See Figure 17.

3. Remove four nuts, four washers, four capscrews, and roof panel from top panel assembly. See Figure 17.

4. Remove and discard seal from screen. See Figure 17.

5. Remove two nuts, four washers, two hinges, and pin from screen. See Figure 17.

6. Remove two nut covers, two nuts, two washers, and plate from screen. See Figure 17.

7. Remove screw, spring, and grip from screen. See Figure 17.

8. Remove two nut covers, two nuts, two washers, and grip mounting plate from screen. See Figure 17.

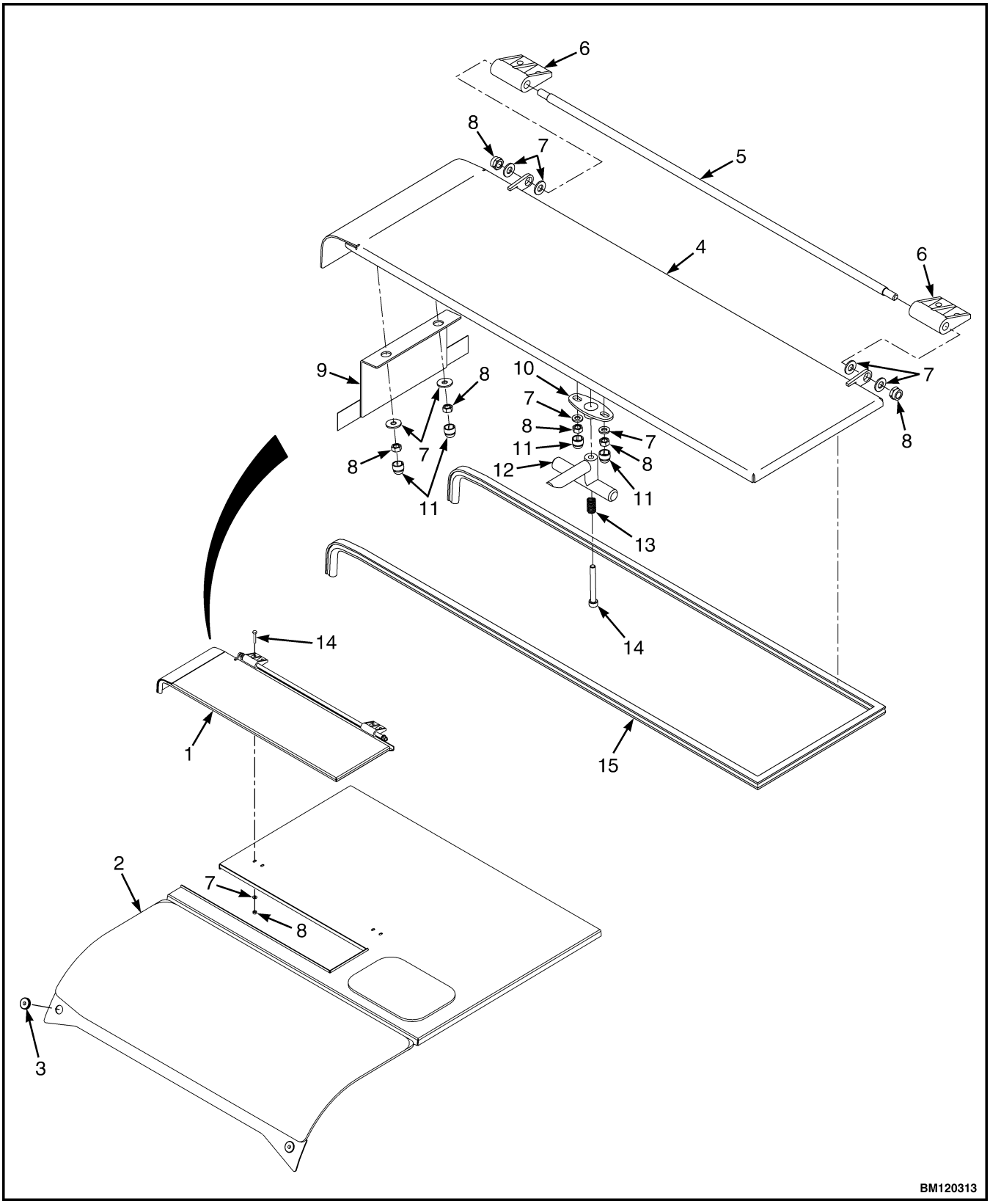


Figure 17. Top Panel

Legend for Figure 17

1. ROOF PANEL
2. TOP PANEL ASSEMBLY
3. GROMMET
4. SCREEN
5. PIN
6. HINGE
7. WASHER
8. NUT
9. PLATE
10. GRIP MOUNTING PLATE
11. NUT COVER
12. GRIP
13. SPRING
14. SCREW
15. SEAL

Remove, Lift Truck Models A1.3XNT, A1.5XNT (D203)

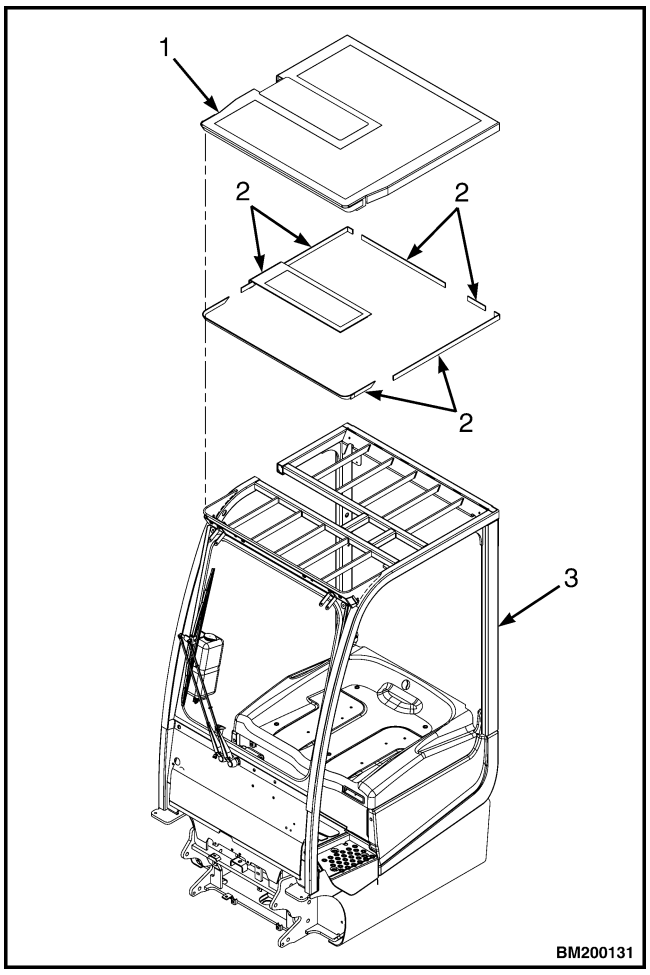
The top panel is attached to top of overhead guard using adhesive tape and pressing it on. See Figure 18.

WARNING

All windows installed in the cab are made of safety glass. All replacement windows must be made of the correct material and must be the correct thickness. Failure to use the correct material or thickness may cause the glass to break easily when struck and may cause personal injury.

NOTE: Due to use of glue and adhesive tape, replacement of top screen is to be done only if damaged.

1. Remove damaged top panel from lift truck. Pull top panel from overhead guard, using a cutting tool to remove glue and adhesive tape from overhead guard as top panel is pulled from overhead guard. See Figure 18.



1. TOP PANEL ASSEMBLY
2. ADHESIVE TAPE
3. OVERHEAD GUARD

Figure 18. Top Panel, Lift Truck Models A1.3XNT, A1.5XNT (D203)

Clean

WARNING

Compressed air can move particles so that they cause injury to the user or to other personnel. Make sure that the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the yes.

1. Using compressed air, blow dirt and debris from all components as needed.
2. Using warm soapy water, clean plastic, rubber, and vinyl components. Wipe dry with a lint free cloth.
3. For lift truck models A1.3XNT, A1.5XNT (D203), clean top of overhead guard to remove any glue residual from use of adhesive tape.

Inspect

1. Inspect hinges, rod, spring and grip for damage or cracks. Replace as needed.

Install, Lift Truck Models J2.2-3.5XN (J45-70XN) (A276), J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970), J1.5-2.0XNT (J30-40XNT) K160), and J1.6-2.0XN (J30-40XN) (A935)

1. Install grip mounting plate, two washers, two nuts, and two nut covers on screen. See Figure 17.
2. Install grip, spring, and screw on screen. See Figure 17.
3. Install plate, two washers, two nuts, and two nut covers on screen. See Figure 17.
4. Install pin, two hinges, four washers, and two nuts on screen. See Figure 17.
5. Install seal on screen. See Figure 17.
6. Install roof panel, four washers, four capscrews, and four nuts on top panel assembly. See Figure 17.
7. Install two grommets to top panel assembly. See Figure 17.

NOTE: Perform Step 8 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276)
- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

8. Install front light wiring. See section **Electrical System** 2200SRM1369, Lights, for proper procedures.

Install, Lift Truck Models A1.3XNT, A1.5XNT (D203)

1. Ensure overhead guard is clean and free of old adhesive tape and glue.
2. Peel off backing from adhesive tape and attach adhesive tape to all four sides of overhead guard. See Figure 18.
3. Position top panel above top of overhead guard. See Figure 18.
4. Press top panel onto top perimeter of overhead guard and adhesive tape, making sure all edges are aligned correctly.

Cab Door Assembly

DOOR ASSEMBLY

Remove

Lift Truck Models J2.2-3.5XN (J45-70XN) (A276) and J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

WARNING

The door assemblies are heavy, verify the lifting device being used during repairs can lift the weight of the parts and assembly.

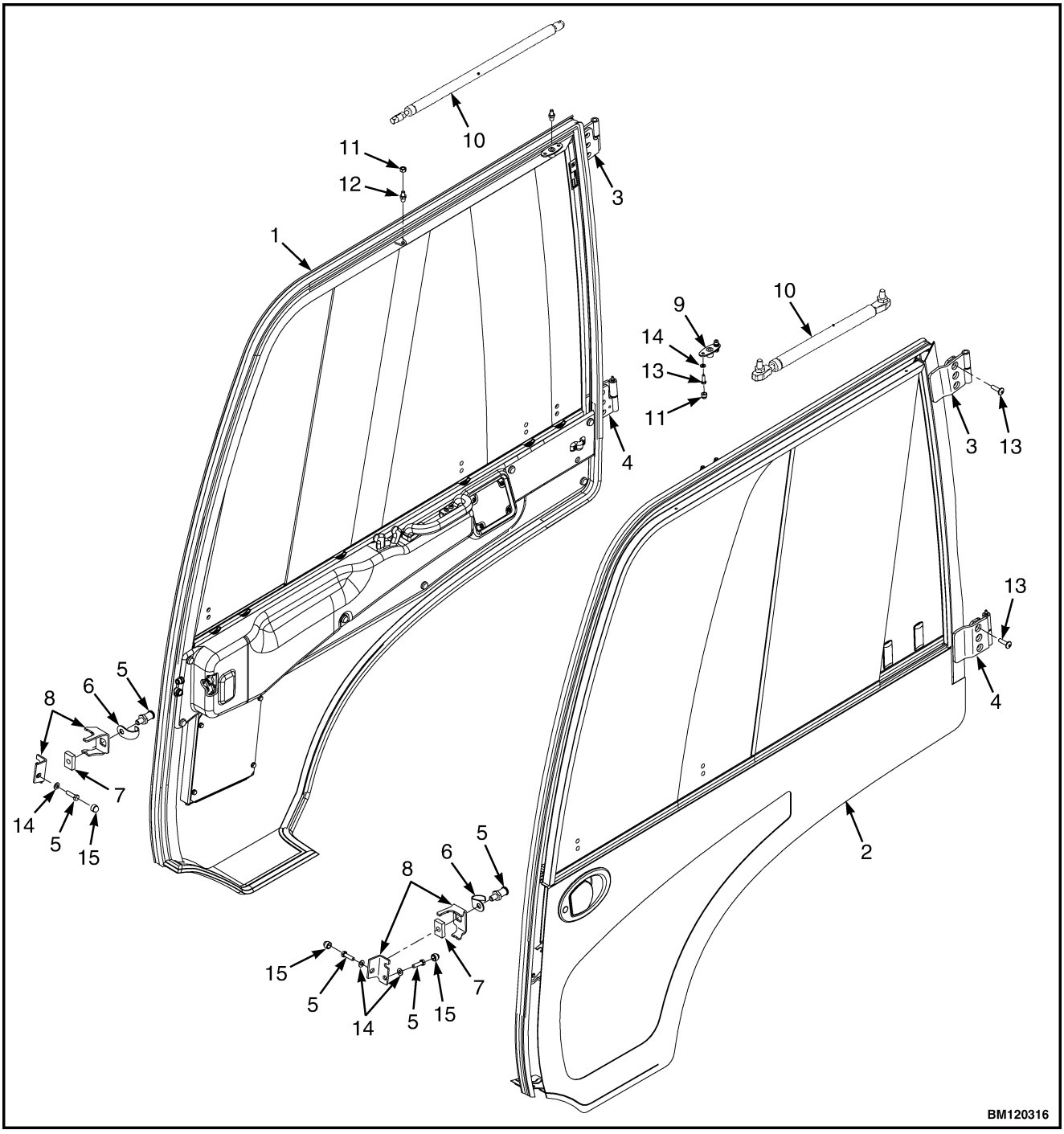
1. Disconnect gas spring from top of door assembly. See Figure 19.
2. Remove three capscrews from upper hinge. Remove three capscrews from lower hinge. See Figure 19.
3. Using a lifting device, remove door assembly from lift truck and set aside.
4. Remove three caps, three bolts, four washers, bolt, guard, striker, and block from front overhead guard leg. See Figure 19.
5. Remove gas spring from overhead guard.
6. Remove two caps, two capscrews, two washers, and bracket from overhead guard. See Figure 19.
7. Repeat Step 1 through Step 6 for opposite side.

Lift Truck Models J1.5-2.0XNT (J30-40XNT) (K160) and J1.6-2.0XN (J30-40XN) (A935)

WARNING

The door assemblies are heavy, verify the lifting device being used during repairs can lift the weight of the parts and assembly.

1. Disconnect gas spring from top of door assembly. See Figure 20.
2. Remove two screws from mounting plate and hinge in two places. Remove three bolts from mounting plate and overhead guard leg in two places. See Figure 20.
3. Using a lifting device, remove door assembly from lift truck and set aside.
4. Remove two caps, two capscrews, two washers, bolt, guard, bracket and block from front overhead guard leg. See Figure 20.
5. Remove gas spring from overhead guard.
6. Remove two caps, two capscrews, two washers, and bracket from overhead guard. See Figure 20.
7. Repeat Step 1 through Step 6 for opposite side.



1. DOOR ASSEMBLY (RH)
2. DOOR ASSEMBLY (LH)
3. HINGE (UPPER)
4. HINGE (LOWER)
5. BOLT
6. GUARD
7. BLOCK
8. STRIKER
9. BRACKET
10. GAS SPRING
11. NUT
12. BALL STUD
13. CAPSCREW
14. WASHER
15. CAP

Figure 19. Door Assembly for Lift Truck Model J2.2-3.5XN (J45-70XN) (A276) and J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

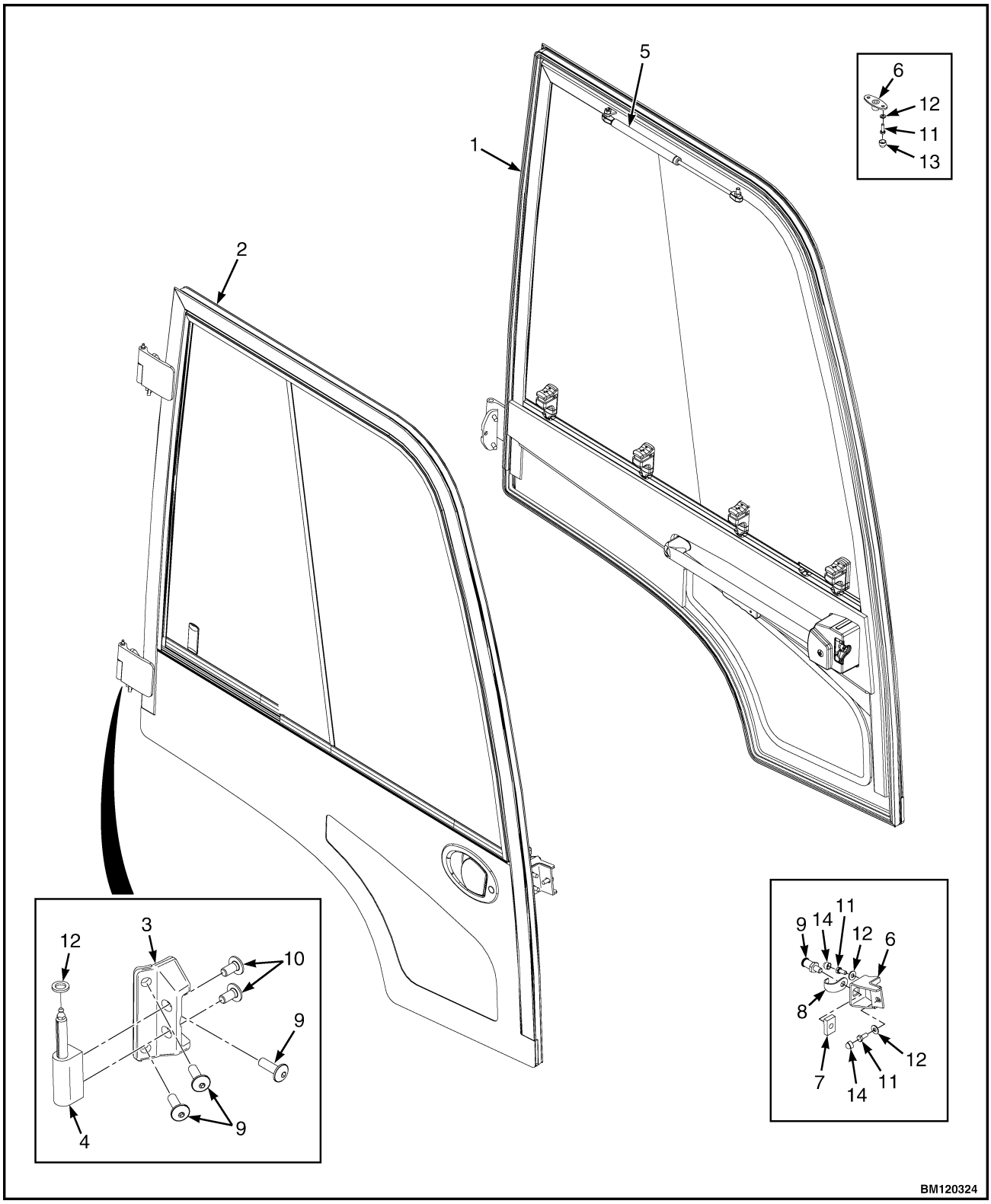


Figure 20. Door Assembly for Lift Truck Model J1.5-2.0XNT (J30-40XNT) (K160) and J1.6-2.0XN (J30-40XN) (A935)

Legend for Figure 20

1. DOOR ASSEMBLY
2. DOOR ASSEMBLY
3. MOUNTING PLATE
4. HINGE
5. GAS SPRING
6. BRACKET
7. BLOCK
8. GUARD
9. BOLT
10. SCREW
11. CAPSCREW
12. WASHER
13. CAP
14. CAP

Disassemble Left Door

NOTE: Perform Step 1 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276)
- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

1. Remove and discard two seals from door assembly. See Figure 21.

NOTE: Perform Step 2 for lift truck models

- J1.5-2.0XNT (J30-40XNT) (K160)
- J1.6-2.0XN (J30-40XN) (A935)

NOTE: Lift truck models J1.5-2.0XNT (J30-40XNT) (K160) and J1.6-2.0XN (J30-40XN) (A935) have a one piece seal around door assembly.

2. Remove and discard seal from door assembly. See Figure 21.

3. Remove screw, washer, lock plate cover, and plate from door assembly. See Figure 21.

4. Disconnect rod from latch. See Figure 21.

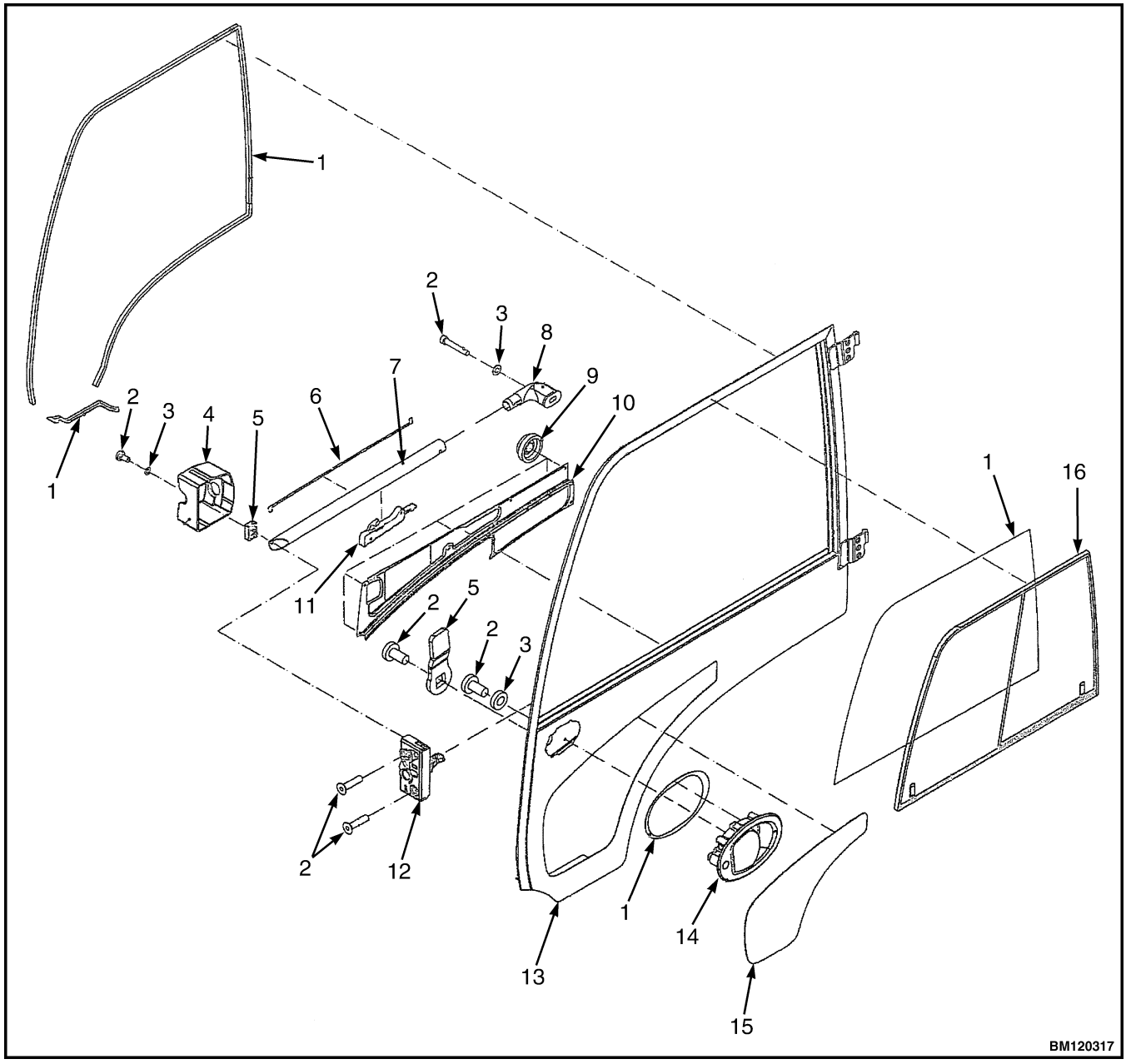
5. Remove screw, washer, door handle, tube, rod, and lock from door assembly. See Figure 21.

6. Remove seven fasteners and door cover from door assembly. See Figure 21.

7. Remove two screws and latch from door assembly. See Figure 21.

8. Remove screw and plate from grip. See Figure 21.

9. Remove two screws, two washers, seal, and grip from door assembly. See Figure 21.



1. SEAL
2. SCREW
3. WASHER
4. LOCK PLATE COVER
5. PLATE
6. ROD
7. TUBE
8. DOOR HANDLE
9. FASTENER
10. COVER (DOOR)
11. LOCK
12. LATCH
13. DOOR ASSEMBLY
14. GRIP
15. WINDOW
16. DOOR WINDOW

Figure 21. Left Door Components

Disassemble Right Door

NOTE: Perform Step 1 and Step 2 if lift truck is equipped with cab heater.

1. Remove eight screws and four washers from cab heater and heater control (if equipped). See Figure 23.
2. Disconnect wiring harness from cab heater and heater control. Remove cab heater and heater control from door assembly. See Figure 24.
3. Remove and discard two seals from door assembly. See Figure 22.
4. Remove four screws, four washers, and plate from door assembly. See Figure 22.
5. Remove four screws and cover from door assembly. See Figure 22.
6. Remove four screws, and handle from inside door assembly. See Figure 22.
7. Remove two screws and clamp from inside door assembly. See Figure 22.
8. Remove two screws, two washers, and plate from door assembly. See Figure 22.
9. Remove seven fasteners and cover from door assembly. See Figure 22.
10. Disconnect rod from latch. See Figure 22.
11. Remove two screws and latch from door assembly. See Figure 22.
12. Remove two screws, two washers, two nuts, rod, and lever from door assembly. See Figure 22.
13. Remove screw and plate from grip. See Figure 22.

NOTE: Perform Step 14 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276)
- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

14. Remove four screws, four washers, seal, and grip from door assembly. See Figure 22.

NOTE: Perform Step 15 for lift truck models

- J1.5-2.0XNT (J30-40XNT) (K160)
- J1.6-2.0XN (J30-40XN) (A935)

15. Remove three screws, three washers, seal, and grip from door assembly. See Figure 22.

Clean

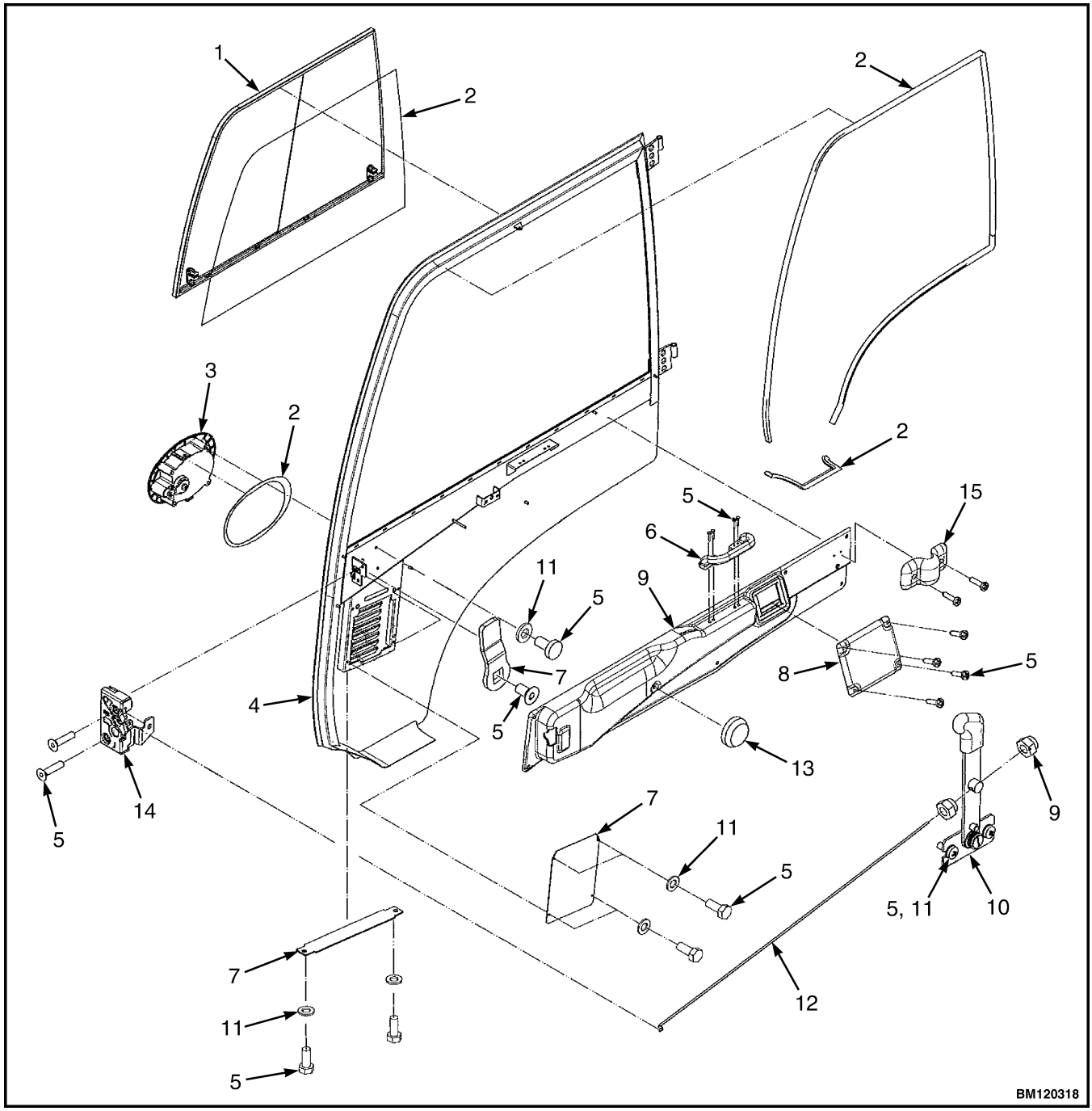
WARNING

Compressed air can move particles so that they cause injury to the user or to other personnel. Make sure that the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eyes.

1. Using compressed air, blow dirt and debris from components as needed.
2. Using a lint free cloth, wipe down components as needed.

Inspect

1. Inspect all components and hardware for cracks and defects. Replace as needed.
2. Inspect latch assembly and hardware. Ensure proper operation.
3. Inspect hinges and lubricate as necessary.
4. Inspect gas springs for proper travel and extension.
   a. Left door extended length 406 mm (16 in.). Right door extended length 880 mm (34.6 in.).
   b. Left door stroke 160 mm (6.3 in.). Right door stroke 393 mm (15.5 in.).
   c. Left door resistance 200 N (50 lbf). Right side resistance 200 N (50 lbf).



1. WINDOW
2. SEAL
3. GRIP
4. DOOR
5. SCREW
6. HANDLE
7. PLATE
8. COVER
9. NUT
10. LEVER
11. WASHER
12. ROD
13. FASTENER
14. LATCH
15. CLAMP

Figure 22. Right Door Components

Assemble Right Door

NOTE: Perform Step 1 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276)
- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

1. Install seal, grip, four washers, and four screws on door assembly. See Figure 22.

NOTE: Perform Step 2 for lift trucks

- J1.5-2.0XNT (J30-40XNT) (K160)
- J1.6-2.0XN (J30-40XN) (A935)

2. Install seal, grip, three washers, and three screws on door assembly. See Figure 22.
3. Install plate and screw on grip. See Figure 22.
4. Install lever, rod, two nuts, two washers, and two screws on door assembly. See Figure 22.
5. Install latch and two screws on door assembly. See Figure 22.
6. Attach rod to latch. See Figure 22.
7. Install cover and seven fasteners on door assembly. See Figure 22.
8. Install plate, two washers, and two screws on door assembly. See Figure 22.
9. Install clamp and two screws on door assembly. See Figure 22.
10. Install handle and four screws on door assembly. See Figure 22.
11. Install plate, four washers, and four screws on door assembly. See Figure 22.
12. Install cover and four screws on door assembly. See Figure 22.
13. Install two seals on door assembly. See Figure 22.

NOTE: Perform Step 14 and Step 15 if lift truck is equipped with cab heater.

14. Connect wiring to heater control and cab heater. See Figure 24.
15. Install heater control, cab heater, four washers and eight screws on door assembly. See Figure 23.

Assemble Left Door

1. Install seal, grip, two washers, and two screws on door assembly. See Figure 21.
2. Install plate and screw on grip. See Figure 21.
3. Install latch and two screws on door assembly. See Figure 21.
4. Install door cover and seven fasteners on door assembly. See Figure 21.
5. Install lock, rod, door handle, tube, washer, and screw onto door assembly. See Figure 21.
6. Connect rod onto door latch. See Figure 21.
7. Install plate, cover, washer, and screw on door assembly. See Figure 21.

NOTE: Perform Step 8 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276)
- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

8. Install two seals to door assembly. See Figure 21.

NOTE: Perform Step 9 for lift truck models

- J1.5-2.0XNT (J30-40XNT) (K160)
- J1.6-2.0XN (J30-40XN) (A935)

9. Install seal to door assembly. See Figure 21.

Install

Lift Truck Models J2.2-3.5XN (J45-70XN) (A276) and J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

NOTE: Use sealant, Hyster P/N 2064554 or equivalent, during installation of capscrews and bolts.

1. Install ball stud and screw onto door assembly. See Figure 19.
2. Install bracket, two washers, two capscrews, and two caps on overhead guard. See Figure 19.
3. Install gas spring on overhead guard. See Figure 19.
4. Install striker, block, guard, bolt, four washers, three bolts, and three caps on front overhead guard legs. See Figure 19.

5. Using a lifting device, lift door assembly in place and install six capscrews on overhead guard at rear of door. See Figure 19.

6. Repeat Step 1 through Step 5 for opposite side door installation.

Lift Truck Models J1.5-2.0XNT (J30-40XNT) (K160) and J1.6-2.0XN (J30-40XN) (A935)

1. Install bracket, two washers, two capscrews, and two caps on overhead guard. See Figure 20.

2. Install gas spring on overhead guard. See Figure 20.

3. Install striker, block, guard, bolt, two washers, two bolts, and two caps to front overhead guard legs. See Figure 20.

4. Using a lifting device, lift door assembly in place and install six bolts and four screws to hinge mounting plate on overhead guard legs at rear of door. See Figure 20.

5. Repeat Step 1 through Step 4 for opposite side door installation.

Cab Heater

CAB HEATER

Remove

1. Remove two screws and connector cover from cab heater. See Figure 23.

2. Disconnect wiring harness from cab heater. See Figure 23.

3. Remove four screws, four washers, and cab heater from door assembly. See Figure 23.

4. Remove two air filters from cab heater. See Figure 23.

5. Remove four screws and heater control from door assembly. See Figure 23.

6. Disconnect wire harness from heater control. See Figure 23.

NOTE: Step 7 does not apply to lift truck models J1.5-2.0XNT (K160) manufactured after November, 2014. For these models, go to Step 8.

7. Remove two nuts, two washers, and two capscrews from wire harness and plate located on hydraulic tank. See Figure 24.

   See Figure 26 for lift truck models J2.2-3.5XN (J45-70XN) (A276), equipped with Outdoor Protection/Wash-down package.

8. For lift truck models J1.5-2.0XNT (K160) manufactured after November, 2014, remove two nuts, two washers, and two screws from contactor mounting plate. Remove contactor mounting plate and contactor from plate weldment on counterweight. See Figure 25.

NOTE: Step 9 does not apply to lift truck models J1.5-2.0XNT (K160) manufactured after November, 2014. For these models, go to Step 10.

9. Remove two nuts, two washers, and two screws from contactor and plate located on hydraulic tank. See Figure 24.

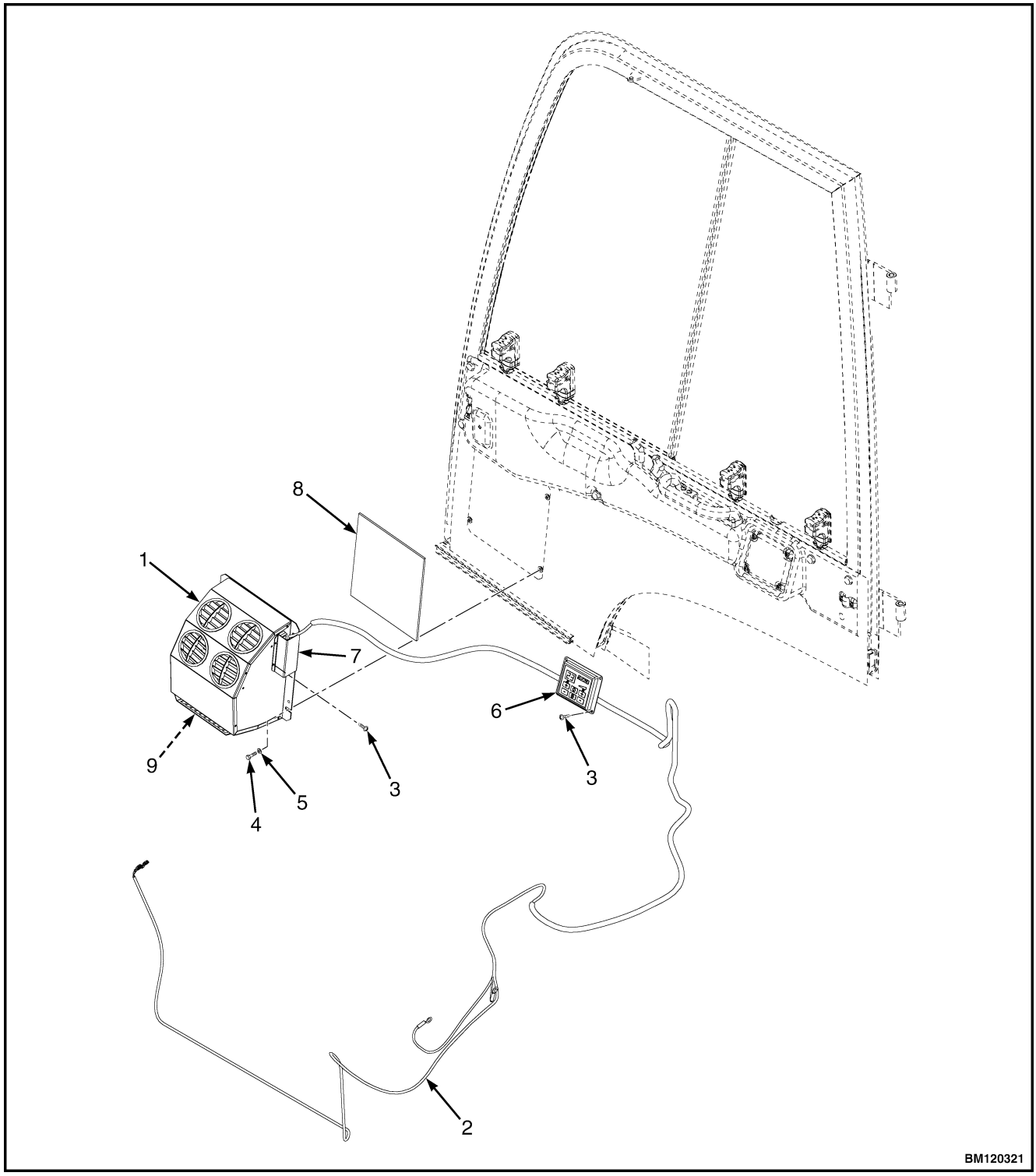
   See Figure 26 for lift truck models J2.2-3.5XN (J45-70XN) (A276), equipped with Outdoor Protection/Wash-down package.

10. For lift truck models J1.5-2.0XNT (K160) manufactured after November, 2014, remove two nuts, two washers, and two capscrews from contactor and contactor mounting plate located in counterweight cavity. See Figure 25.

11. Disconnect contactor from wire harness and remove from plate weldment.

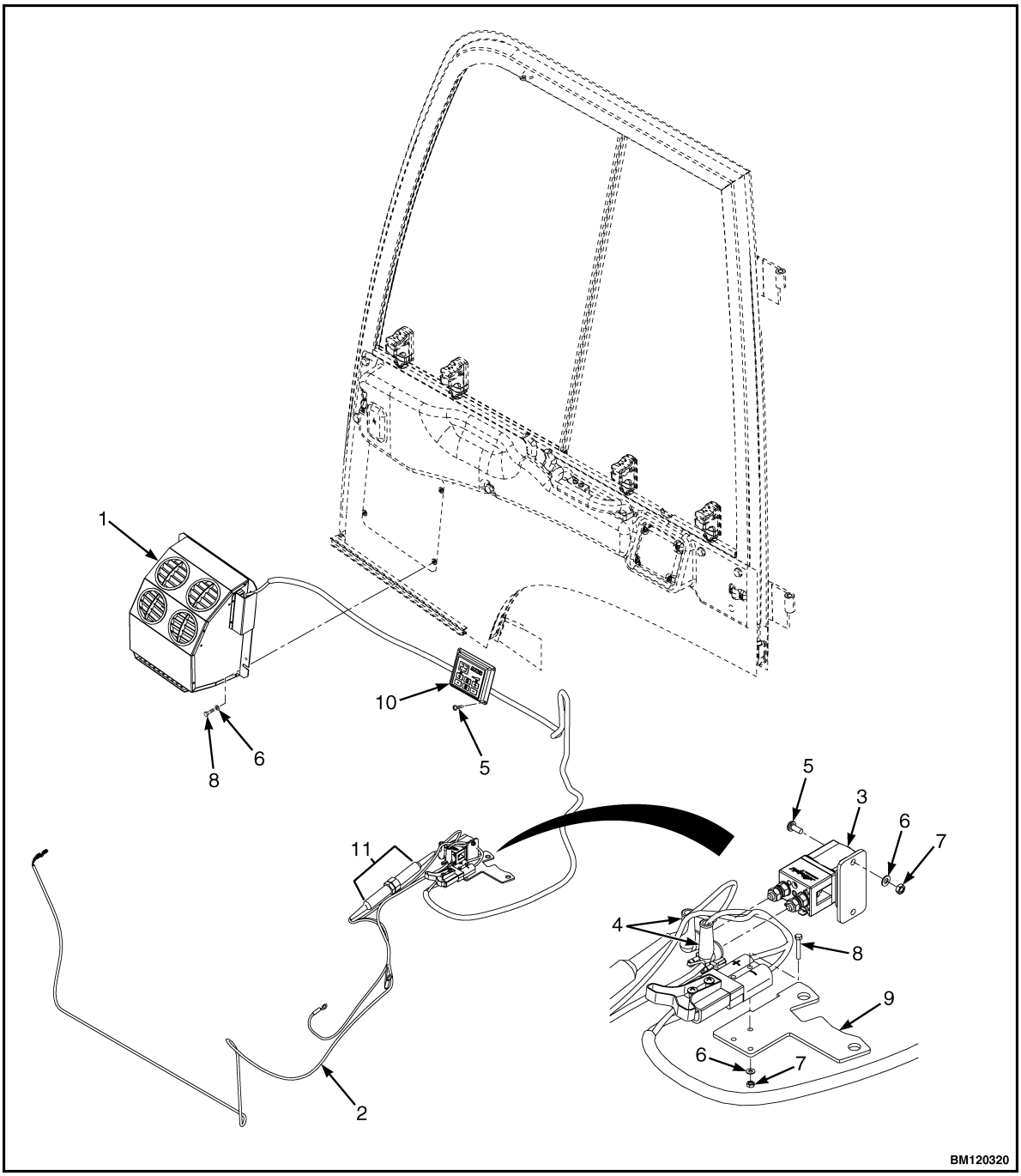
12. Remove wiring harness from lift truck.

NOTE: Perform Step 13 only if heater fan motor is inoperative prior to removing from lift truck.



1. CAB HEATER
2. WIRE HARNESS
3. SCREW
4. CAPSCREW
5. WASHER
6. CONTROL (HEATER)
7. CONNECTOR COVER
8. AIR FILTER
9. SECONDARY AIR FILTER

Figure 23. Cab Heater



1. CAB HEATER
2. WIRE HARNESS
3. CONTACTOR
4. BOOT
5. SCREW
6. WASHER
7. NUT
8. CAPSCREW
9. PLATE WELDMENT
10. HEATER CONTROL
11. FUSE HOLDER AND FUSE

Figure 24. Cab Heater Electrical, Lift Truck Models J1.5-2.0XNT (K160) Manufactured Before November, 2014, J2.2-3.5XN (J45-70XN) (A276) Without Outdoor Protection/Wash-Down Package, and J30-40XNT (K160), J1.6-2.0XN (J30-40XN) (A935), E2.2-3.5XN (E45-70XN) (A268), J5.0-5.5XN6 (J80-120XN, J100XNL) (A970), and A1.3XNT, A1.5XNT (D203)

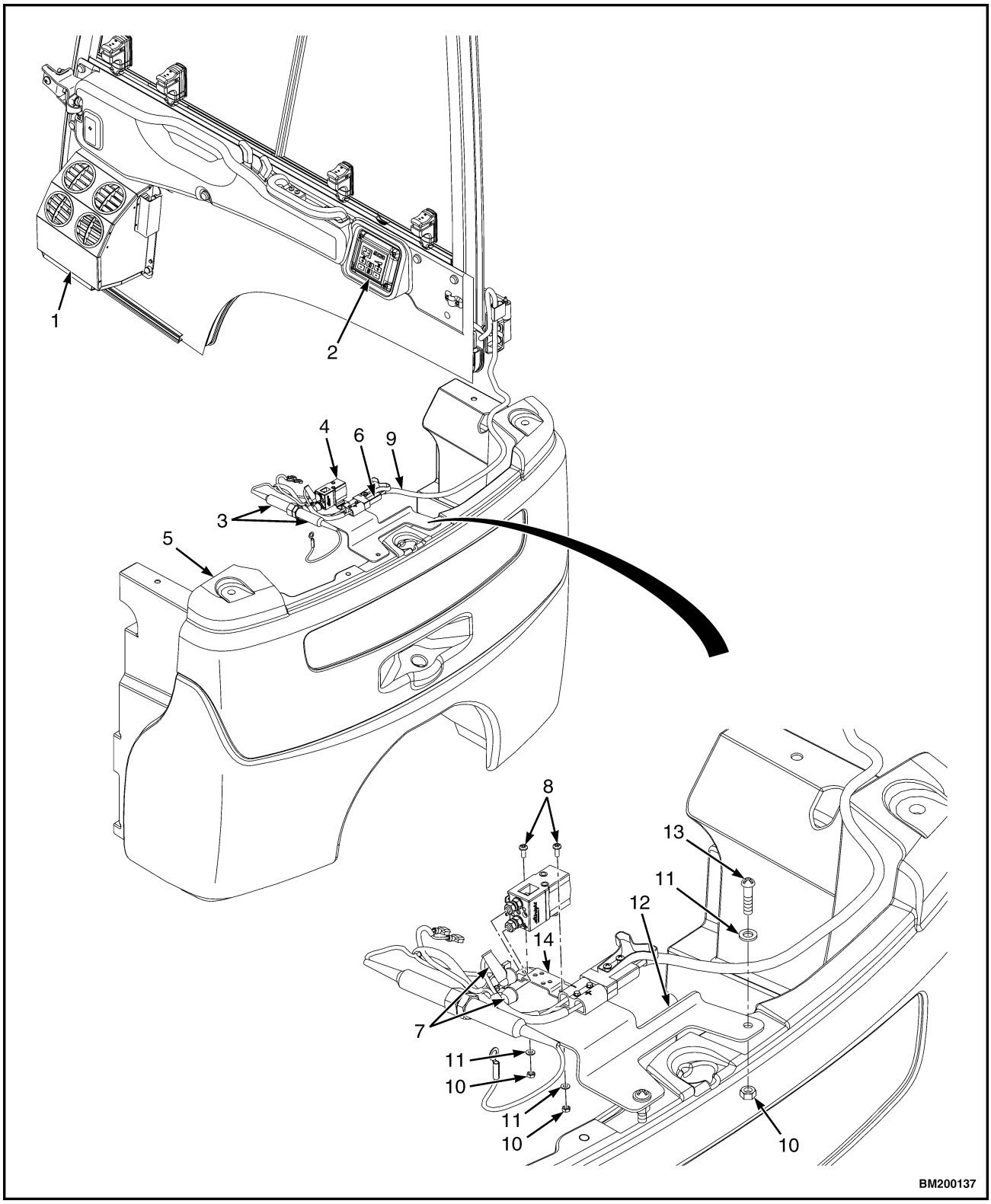
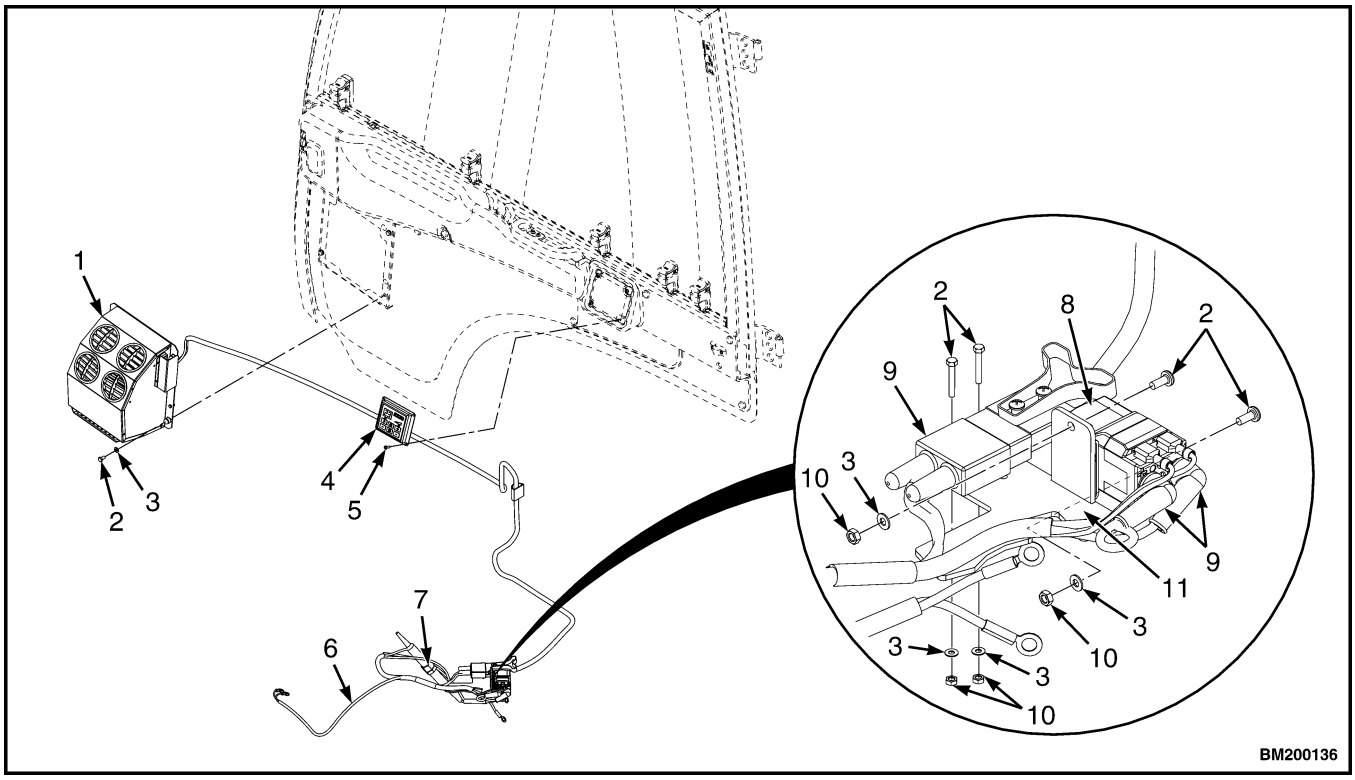


Figure 25. Cab Heater Electrical, Lift Truck Models J1.5-2.0XNT (K160) Manufactured After November, 2014

Legend for Figure 25

1. CAB HEATER
2. HEATER CONTROL
3. FUSE HOLDER AND FUSE
4. CONTACTOR
5. COUNTERWEIGHT
6. CONNECTOR
7. BOOT
8. SCREW
9. WIRE HARNESS
10. NUT
11. WASHER
12. PLATE WELDMENT
13. CAPSCREW
14. CONTACTOR MOUNTING PLATE



1. CAB HEATER
2. CAPSCREWS
3. WASHER
4. HEATER CONTROL
5. SCREW
6. WIRE HARNESS
7. FUSE HOLDER AND FUSE
8. CONTACTOR
9. BOOT
10. NUT
11. PLATE WELDMENT

Figure 26. Cab Heater Electrical Components For Lift Truck Models J2.2-3.5XN (J45-70XN) (A276) With Outdoor Protection/Wash-down Package

13. Remove 25 Amp fuse from fuse holder and inspect for broken element. Replace as necessary. See Figure 24.

See Figure 24 for lift truck models

- J1.5-2.0XNT (K160) manufactured before November, 2014
- J30-40XNT (K160)
- J1.6-2.0XN (J30-40XN) (A935)
- E2.2-3.5XN (E45-70XN) (A268)
- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)
- A1.3XNT, A1.5XNT (D203)
- J2.2-3.5XN (J45-70XN) (A276) without Outdoor Protection/Wash-down package

See Figure 25 for lift truck models

- J1.5-2.0XNT (K160) manufactured after November, 2014

See Figure 26 for lift truck models J2.2-3.5XN (J45-70XN) (A276), equipped with Outdoor Protection/Wash-down package.

Clean

WARNING

Compressed air can move particles so that they cause injury to the user or to other personnel. Make sure that the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eyes.

1. Using compressed air, blow dirt and debris from cab heater, heater control, air filters and all other components as necessary.
2. Using a lint free cloth, wipe down components as needed.

Inspect

1. Inspect components for damage and cracks. Replace as needed.
2. Inspect air filters after cleaning, replace as necessary.
3. Inspect wiring harness for damage and exposed wires. Replace as necessary.

Install

NOTE: Perform Step 1 only if Step 13 in Remove section was performed.

1. Install new 25 Amp fuse into fuse holder.

See Figure 24 for lift truck models

- J1.5-2.0XNT (K160) manufactured before November, 2014
- J30-40XNT (K160)
- J1.6-2.0XN (J30-40XN) (A935)
- E2.2-3.5XN (E45-70XN) (A268)
- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)
- A1.3XNT, A1.5XNT (D203)
- J2.2-3.5XN (J45-70XN) (A276) without Outdoor Protection/Wash-down package

See Figure 25 for lift truck models

- J1.5-2.0XNT (K160) manufactured after November, 2014

See Figure 26 for lift truck models J2.2-3.5XN (J45-70XN) (A276), equipped with Outdoor Protection/Wash-down package.

2. Install heater wiring harness on lift truck.
3. Connect wiring harness to contactor.

See Figure 24 for lift truck models

- J1.5-2.0XNT (K160) manufactured before November, 2014
- J30-40XNT (K160)
- J1.6-2.0XN (J30-40XN) (A935)
- E2.2-3.5XN (E45-70XN) (A268)
- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)
- A1.3XNT, A1.5XNT (D203)
- J2.2-3.5XN (J45-70XN) (A276) without Outdoor Protection/Wash-down package

See Figure 25 for lift truck models

- J1.5-2.0XNT (K160) manufactured after November, 2014

See Figure 26 for lift truck models J2.2-3.5XN (J45-70XN) (A276), equipped with Outdoor Protection/Wash-down package.

NOTE: Step 4 does not apply to lift truck models J1.5-2.0XNT (K160) manufactured after November, 2014. For these models, go to Step 5.

4. Install two capscrews, two washers and two nuts to contactor and plate located on hydraulic tank.

See Figure 24 for lift truck models

- J1.5-2.0XNT (K160) manufactured before November, 2014
- J30-40XNT (K160)
- J1.6-2.0XN (J30-40XN) (A935)
- E2.2-3.5XN (E45-70XN) (A268)
- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)
- A1.3XNT, A1.5XNT (D203)
- J2.2-3.5XN (J45-70XN) (A276) without Outdoor Protection/Wash-down package

See Figure 26 for lift truck models J2.2-3.5XN (J45-70XN) (A276), equipped with Outdoor Protection/Wash-down package.

5. For lift truck models J1.5-2.0XNT (K160) manufactured after November, 2014, install contactor to contactor mounting plate in counterweight cavity using two capscrews, two washers, and two nuts. See Figure 25.

NOTE: Step 6 does not apply to lift truck models J1.5-2.0XNT (K160) manufactured after November, 2014. For these models, go to Step 7.

6. Install two capscrews, two washers and two nuts to wire harness and plate located on hydraulic tank. See Figure 24.

See Figure 26 for lift truck models J2.2-3.5XN (J45-70XN) (A276), equipped with Outdoor Protection/Wash-down package.

7. For lift truck models J1.5-2.0XNT (K160) manufactured after November, 2014, install contactor and contactor mounting plate to plate weldment located on counterweight using remove two screws, two washers, and two nuts. See Figure 25.

8. Connect wiring harness on heater control. See Figure 23.

9. Using four screws, install heater control on door assembly. See Figure 23.

10. Install two air filters on cab heater. See Figure 23.

11. Using four screws and four washers, install cab heater on door assembly. See Figure 23.

12. Connect wiring harness on cab heater. See Figure 23.

13. Using two screws, install connector cover on cab heater. See Figure 23.

Troubleshooting

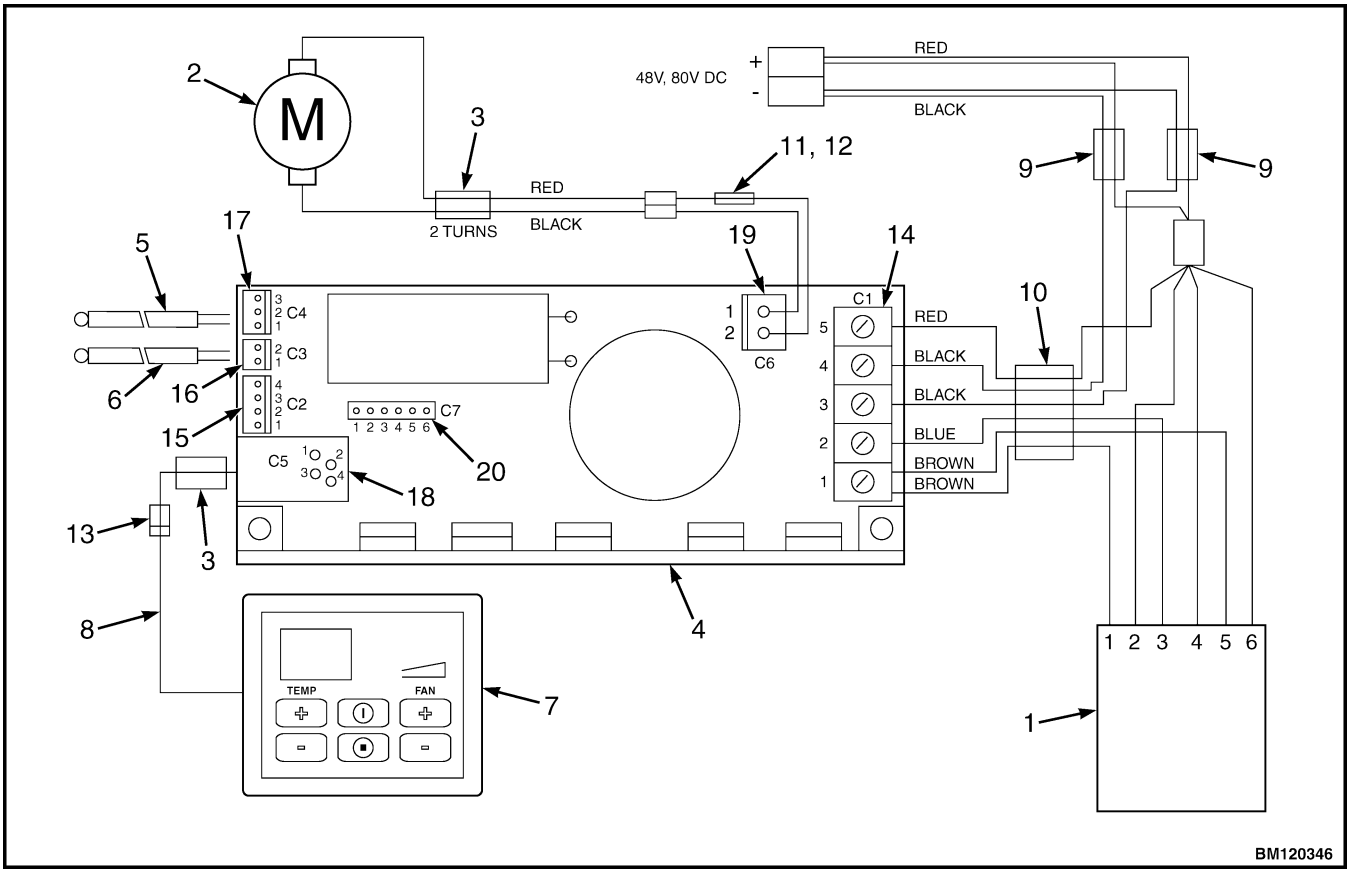
NOTE: If a malfunction disappears, heater will return to normal operation.

NOTE: For Error Codes 3 to 9; After five repeated errors of same kind, heater will turn off automatically and return to Standby Mode.

NOTE: For repair procedures, as directed by Error Code E0 through E9, refer to Figure 27 and Table 1 through Table 7.

Error Code	Error	Measure
E0	External keyswitch off	1. Check that the keyswitch is switched on. 2. Check that there is voltage to the keyswitch.
E1	Thermostat Sensor Error	1. Check the Printed Circuit Board (PCB) connector. 2. Inspect the sensor and sensor wiring for damage. 3. Replace the sensor.
E2	Overheat Protection Sensor Error	See Error Code E1.
E3	Overheat Protection Activated	1. Inspect heater outlets for debris or obstruction of air flow. 2. Clean the inlet air filter. 3. Inspect heater inlet for debris or obstruction of air flow.
E4	Max Temperature in the Cabin Achieved	Normal operating cabin temperature is 35°C (95°F). The heater will automatically turn off and back on again at a lower temperature. Inspect all air outlet louver's for proper directionality. Ensure all louver's are directing warm air away from heater inlet.

Error Code	Error	Measure
E5, E6	Fan Error; Current Consumption too high	The fan does not rotate smoothly or has stopped. Replace the fan.
E7	Fan Error; Current Consumption too low	Does the fan rotate? If no: 1. Check the fan in-line fuse. 2. Check the fan connections. 3. Check that there is voltage between the PCB and fan. 4. Check that the feed through capacitors are conducting. 5. Replace the fan. If yes: 1. Clean the inlet filter. 2. Check that there are no obstacles in the air inlet and air outlet.
E8	Voltage Too Low	1. Disconnect the power to the Heater for a minimum of seven seconds; connect again and test. 2. Battery voltage too low; charge lift truck battery.
E9	Voltage too High	Disconnect the power to the heater for a minimum of seven seconds; connect again and test.



1. HEATER ELEMENT
2. FAN
3. EMC FILTER
4. CONTROL BOARD
5. THERMOSTAT SENSOR
6. OVERHEAT SENSOR
7. CONTROL PANEL
8. WIRE
9. EMC FILTER
10. EMC FILTER
11. IN LINE FUSE
12. FUSE HOLDER
13. CONTROL PANEL CONTACT
14. C1 CONNECTOR
15. C2 CONNECTOR
16. C3 CONNECTOR
17. C4 CONNECTOR
18. C5 CONNECTOR
19. C6 CONNECTOR
20. C7 CONNECTOR

Figure 27. Cab Heater Wiring Schematic

Table 1. Connector C1

Pin #	Connector Function
1	Driver Low Power
2	Driver Full Power
3	Incoming Ground (-)
4	Incoming Ground (-)
5	Incoming Power (+)

Table 2. Connector C2

Pin #	Connector Function
1	+ 12 V
2	+ From Start Key
3	Control Output for Defroster
4	Ground (-)

Table 3. Connector C3

Pin #	Connector Function
1	Overheat Sensor (+5V)
2	Overheat Sensor (Sense)

Table 4. Connector C4

Pin #	Connector Function
1	Thermostat Sensor (+5V)
2	Thermostat Sensor (Sense)
3	Ground (-) Not Connected

Table 5. Connector C5

Pin #	Connector Function
1	+12V
2	RS485B
3	RS485A
4	Ground (-)

Table 6. Connector C6

Pin #	Connector Function
1	Fan -
2	Fan +

Table 7. Connector C7

Pin #	Connector Function
1-6	Programming Connector

Weather Panel Replacement for Lift Truck Model E2.2-3.5XN (E45-70XN) (A268)

REMOVE

WARNING

All windows installed in the cab are made of safety glass. All replacement windows must be made of the correct material and must be made the correct thickness. Failure to have the correct material or thickness may cause the glass to break easily when struck and may cause personal injury.

NOTE: Before replacing roof or front screen panel, remove all broken glass bits. Verify replacement glass is dry, clean, and free of grease.

Roof Panels

1. Remove nuts, washers, and "S" brackets from din bolts. See Figure 28.
2. Remove nuts, capscrews, washers, and roof mounting brackets from overhead guard canopy and roof panel. See Figure 28.
3. Remove nuts, capscrews, washers, and "U" brackets from panel plates and overhead guard. See Figure 28.

NOTE: The rear roof panel contains an access panel for the opening in the overhead guard, the access panel may be removed if necessary. Perform Step 4 through Step 6 to remove access panel.

4. Remove nuts, capscrews, and washers from hinges and plates. See Figure 29.
5. Remove access panel from rear roof panel. See Figure 29.
6. Remove nuts, washers, capscrews, and hinges from rear roof panel. See Figure 29.

Front Screen Panel

1. Remove nuts capscrews, washers, and front screen upper bracket from overhead guard canopy and front screen panel. See Figure 30.
2. Remove front screen panel from front screen lower brackets. See Figure 30.
3. Remove front screen upper seals from overhead guard. See Figure 30.

INSTALL

Front Screen Panel

1. Install front screen upper seals on overhead guard. See Figure 30.
2. Install front screen upper brackets. See Figure 30.
3. Install front screen panel into front screen lower brackets. See Figure 30.
4. Install front screen upper brackets, washers, capscrews, and nuts onto front screen panel and overhead guard canopy. See Figure 30.

Roof Panels

NOTE: Perform Step 1 and Step 2 if access panel was removed.

1. Install hinges, washers, capscrews, and nuts onto rear roof panel. See Figure 29.
2. Install access panel, washers, capscrews, and nuts onto hinges and plates. See Figure 29.
3. Install "U" brackets, washers, capscrews, and nuts on overhead guard and panel plates. See Figure 28.
4. Install roof mounting brackets, washers, capscrews, and nuts on roof panel and overhead guard canopy. See Figure 28.
5. Install "S" brackets, washers, and nuts onto din bolts. See Figure 28.

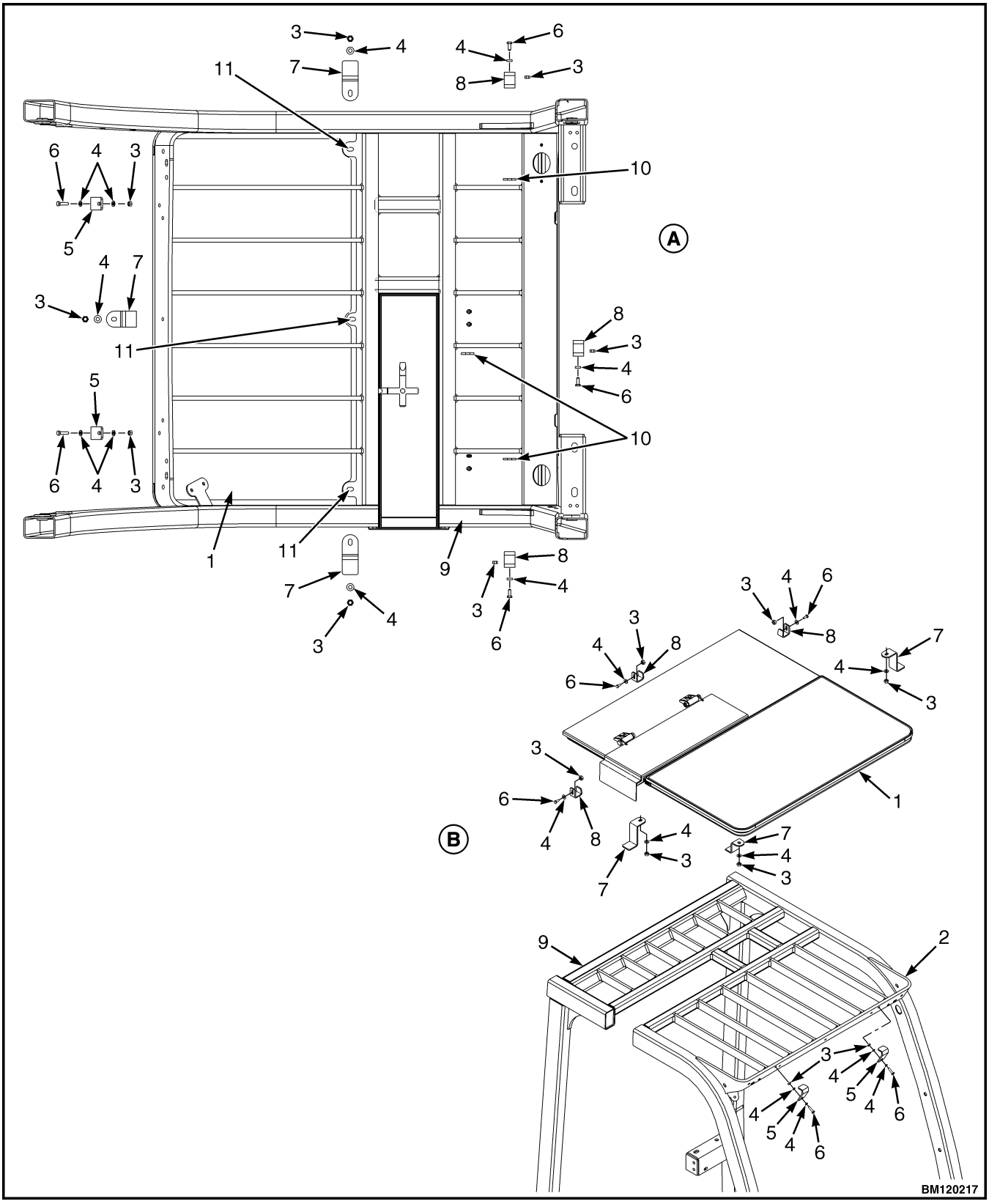


Figure 28. Roof Panels for Lift Truck E2.2-3.5XN (E45-70XN) (A268)

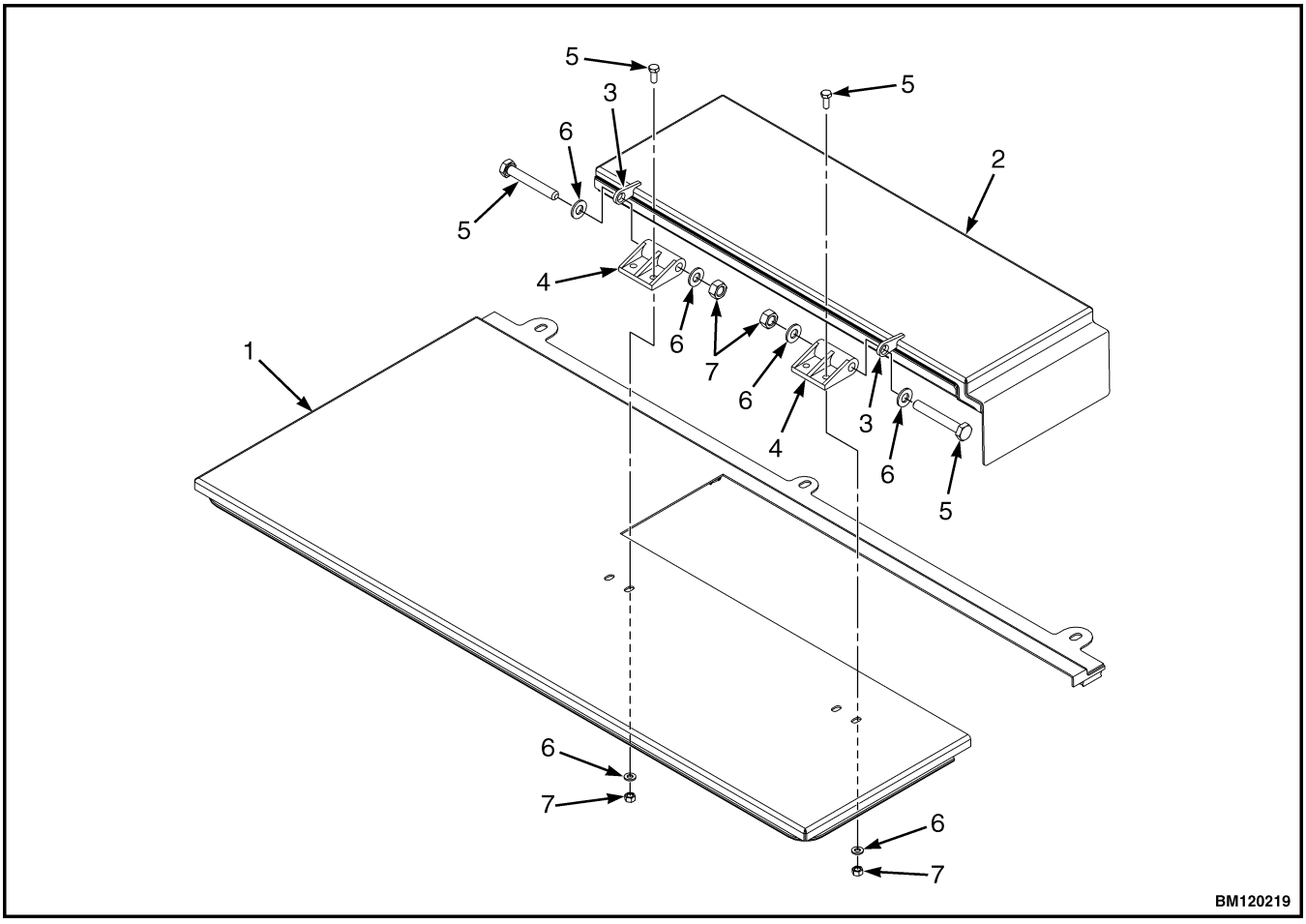
Legend for Figure 28

A. BOTTOM VIEW

1. ROOF PANEL
2. OVERHEAD GUARD CANOPY
3. NUT
4. WASHER
5. ROOF MOUNTING BRACKET
6. CAPSCREW

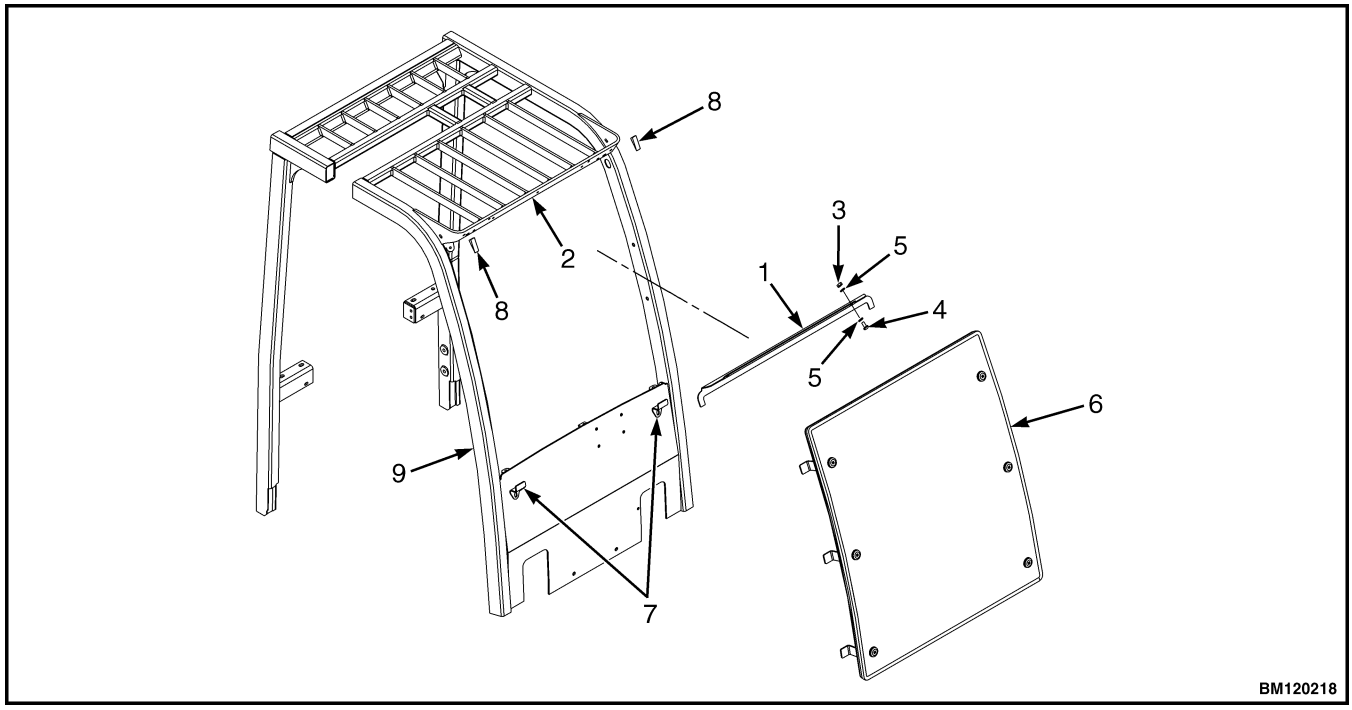
B. FRONT VIEW

7. "S" BRACKET
8. "U" BRACKET
9. OVERHEAD GUARD
10. PANEL PLATES
11. DIN BOLTS



1. REAR ROOF PANEL
2. ACCESS PANEL
3. PLATE
4. HINGE
5. CAPSCREW
6. WASHER
7. NUT

Figure 29. Rear Roof Panels for Lift Truck E2.2-3.5XN (E45-70XN) (A268)



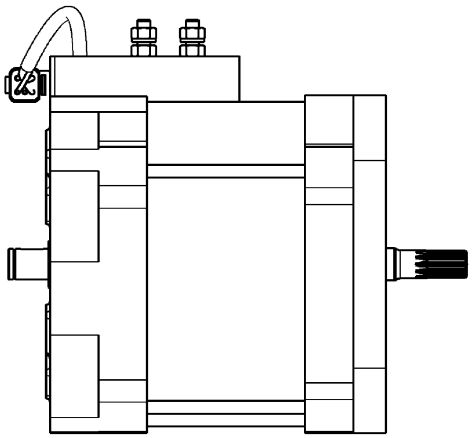
1. FRONT SCREEN UPPER BRACKET
2. OVERHEAD GUARD CANOPY
3. NUT
4. CAPSCREW
5. WASHER
6. FRONT SCREEN PANEL
7. FRONT SCREEN LOWER BRACKET
8. FRONT SCREEN UPPER SEAL
9. OVERHEAD GUARD

Figure 30. Front Screen Panel for Lift Truck E2.2-3.5XN (E45-70XN) (A268)

NOTES

AC MOTOR REPAIR

J1.5-2.0XNT (J30-40XNT) [K160];
J1.6-2.0XN (J30-40XN) [A935];
E2.2-3.5XN (E45-70XN) [A268];
E1.6-2.0XN (E30-40XN) [A269];
J2.2-3.5XN (J45-70XN) [A276];
E30-40HSD$_2$ [B219];
E30HSD$_3$, E35HSD$_3$, E40HSD$_3$ [C219];
J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) [A970];
E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) [A099]



HYSTER

PART NO. 1696595 0620 SRM 1385

SAFETY PRECAUTIONS
MAINTENANCE AND REPAIR

- The Service Manuals are updated on a regular basis, but may not reflect recent design changes to the product. Updated technical service information may be available from your local authorized Hyster® dealer. Service Manuals provide general guidelines for maintenance and service and are intended for use by trained and experienced technicians. Failure to properly maintain equipment or to follow instructions contained in the Service Manual could result in damage to the products, personal injury, property damage or death.
- When lifting parts or assemblies, make sure all slings, chains, or cables are correctly fastened, and that the load being lifted is balanced. Make sure the crane, cables, and chains have the capacity to support the weight of the load.
- Do not lift heavy parts by hand, use a lifting mechanism.
- Wear safety glasses.
- DISCONNECT THE BATTERY CONNECTOR before doing any maintenance or repair on electric lift trucks. Disconnect the battery ground cable on internal combustion lift trucks.
- Always use correct blocks to prevent the unit from rolling or falling. See HOW TO PUT THE LIFT TRUCK ON BLOCKS in the **Operating Manual** or the **Periodic Maintenance** section.
- Keep the unit clean and the working area clean and orderly.
- Use the correct tools for the job.
- Keep the tools clean and in good condition.
- Always use **HYSTER APPROVED** parts when making repairs. Replacement parts must meet or exceed the specifications of the original equipment manufacturer.
- Make sure all nuts, bolts, snap rings, and other fastening devices are removed before using force to remove parts.
- Always fasten a DO NOT OPERATE tag to the controls of the unit when making repairs, or if the unit needs repairs.
- Be sure to follow the **WARNING** and **CAUTION** notes in the instructions.
- Gasoline, Liquid Petroleum Gas (LPG), Compressed Natural Gas (CNG), and Diesel fuel are flammable. Be sure to follow the necessary safety precautions when handling these fuels and when working on these fuel systems.
- Batteries generate flammable gas when they are being charged. Keep fire and sparks away from the area. Make sure the area is well ventilated.

NOTE: The following symbols and words indicate safety information in this manual:

WARNING

Indicates a hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION

Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury and property damage.

On the lift truck, the WARNING symbol and word are on orange background. The CAUTION symbol and word are on yellow background.

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This section is for the following models:

J1.5-2.0XNT (J30-40XNT) [K160];
J1.6-2.0XN (J30-40XN) [A935];
E2.2-3.5XN (E45-70XN) [A268];
E1.6-2.0XN (E30-40XN) [A269];
J2.2-3.5XN (J45-70XN) [A276];
(E30-40HSD2) [B219];
(E30HSD3, E35HSD3, E40HSD3) [C219];
J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) [A970];
E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) [A099]

General

This section contains repair and maintenance procedures for the AC motors. Additional information concerning the motors may be more closely related to other systems and included in those sections. Sections that contain information regarding the motors include:

Electrical System 2200SRM1337 for lift truck models

- J1.5-2.0XNT (J30-40XNT) (K160)
- J1.6-2.0XN (J30-40XN) (A935)

Electrical System 2200SRM1369 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268)
- J2.2-3.5XN (J45-70XN) (A276)
- E1.6-2.0XN (E30-40XN) (A269)
- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)
- E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

Electrical System 2200SRM1414 for lift truck models

- E30-40HSD$_2$ (B219)

Electrical System 2200SRM2022 for lift truck models

- E30-40HSD$_3$ (C219)

Periodic Maintenance 8000SRM1373 for lift truck models

- J1.6-2.0XN (J30-40XN) (A935)

Periodic Maintenance 8000SRM1339 for lift truck models

- J1.5-2.0XNT (J30-40XNT) (K160)

Periodic Maintenance 8000SRM1364 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268)

Periodic Maintenance 8000SRM1372 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276)

Periodic Maintenance 8000SRM1418 for lift truck models

- E30-40HSD$_2$ (B219)

Periodic Maintenance 8000SRM2025 for lift truck models

- E30-40HSD$_3$ (C219)

Periodic Maintenance 8000SRM1442 for lift truck models

- E1.6-2.0XN (E30-40XN) (A269)

Periodic Maintenance 8000SRM1541

- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

Periodic Maintenance 8000SRM1577 for lift truck model

- E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

WARNING

DO NOT make repairs or adjustments unless you are properly trained and have authorization to do so. Repairs and adjustments that are not correct can create dangerous operating conditions. DO NOT operate a lift truck that needs repairs. Report the need for repairs to your supervisor immediately. If repair is necessary, attach a DO NOT OPERATE tag to the steering wheel and remove the key from the key switch.

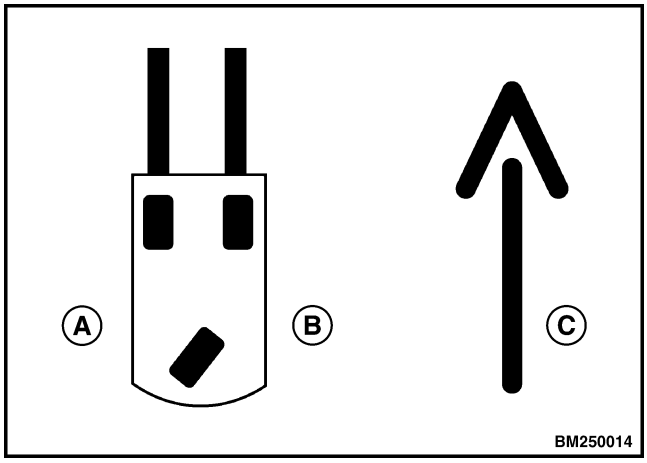
Throughout this section, forward will refer to travel in the direction of the forks and left and right will be determined by sitting in the seat facing forward. See Figure 1 or Figure 2. Troubleshooting information about the traction motors is available through on-board diagnostics and may be displayed on the dash display. Refer to one of the following sections for further explanation of dash display codes concerning the motors:

User Interface Service-Level Functions On-Board Dash Display =>s/n B219N02184L
2200SRM1417 for lift truck models

- E30-40HSD$_2$ (B219)

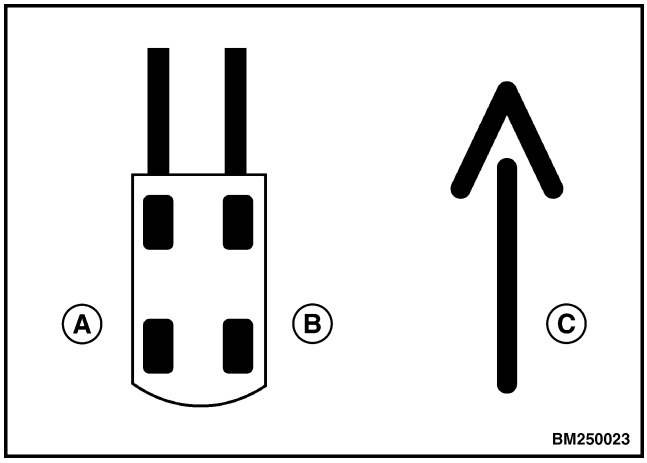
User Interface Service Technician
2200SRM1336 for lift truck models

- J1.6-2.0XN (J30-40XN) (A935)
- J1.5-2.0XNT (J30-40XNT) (K160)
- E2.2-3.5XN (E45-70XN) (A268)
- J2.2-3.5XN (J45-70XN) (A276)
- E1.6-2.0XN (E30-40XN) (A269)
- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)
- E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)



A. LEFT SIDE
B. RIGHT SIDE
C. FORWARD TRAVEL

Figure 1. Truck Orientation (Three-Wheel Models)



A. LEFT SIDE
B. RIGHT SIDE
C. FORWARD TRAVEL

Figure 2. Truck Orientation (Four-Wheel Models)

The traction motors are mounted onto the transaxle for the following lift truck models:

See Figure 3 for lift truck models

- J1.5-2.0XNT (J30-40XNT) (K160)
- J1.6-2.0XN (J30-40XN) (A935)

See Figure 6 for lift truck models

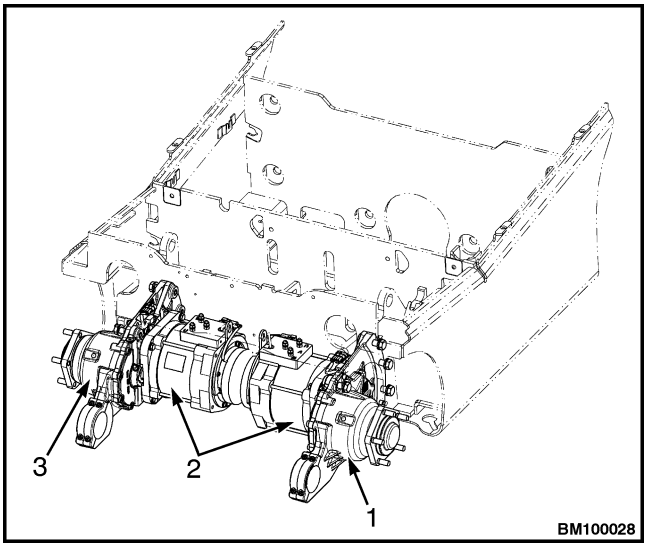
- J2.2-3.5XN (J45-70XN) (A276)

See Figure 7 for lift truck models

- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

See Figure 10 for lift truck model

- E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)



1. LEFT TRANSAXLE
2. TRACTION MOTOR
3. RIGHT TRANSAXLE

Figure 3. Traction Motors for Lift Truck J1.5-2.0XNT (J30-40XNT) (K160) and J1.6-2.0XN (J30-40XN) (A935)

For the lift truck models below, the hydraulic pump motor is mounted inside the counterweight.

- J1.5-2.0XNT (J30-40XNT) (K160)
- J1.6-2.0XN (J30-40XN) (A935)
- J2.2-3.5XN (J45-70XN) (A276)
- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

See Figure 4 for lift truck models

- J1.5-2.0XNT (K160) manufactured before November, 2014
- J30-40XNT (K160)
- J1.6-2.0XN (J30-40XN) (A935)

See Figure 5 for lift truck models

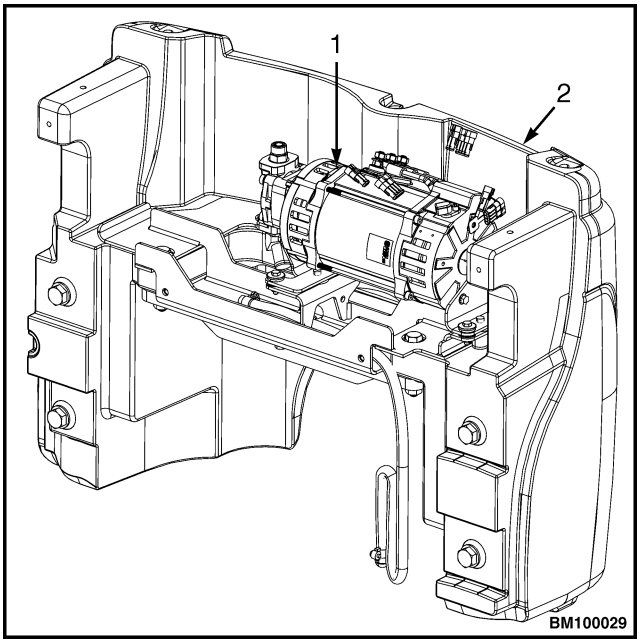
- J1.5-2.0XNT (K160) manufactured after November, 2014

See Figure 6 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276)

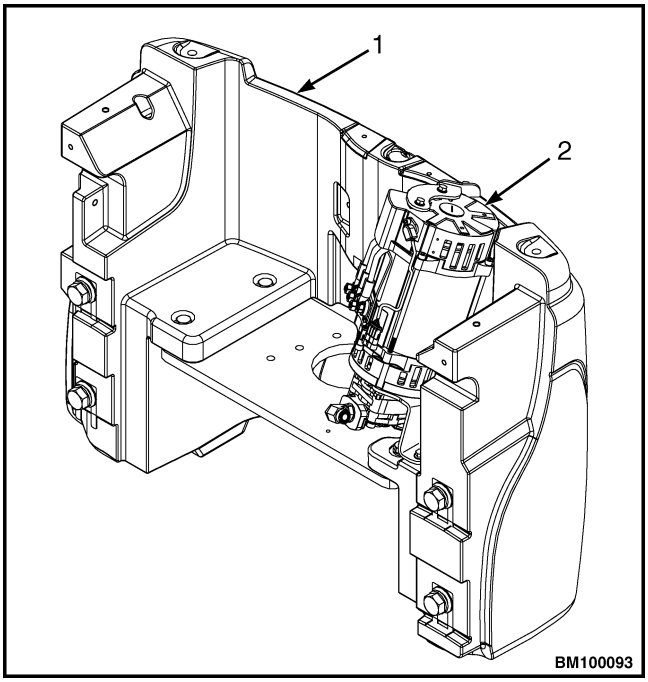
See Figure 7 for lift truck models

- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)



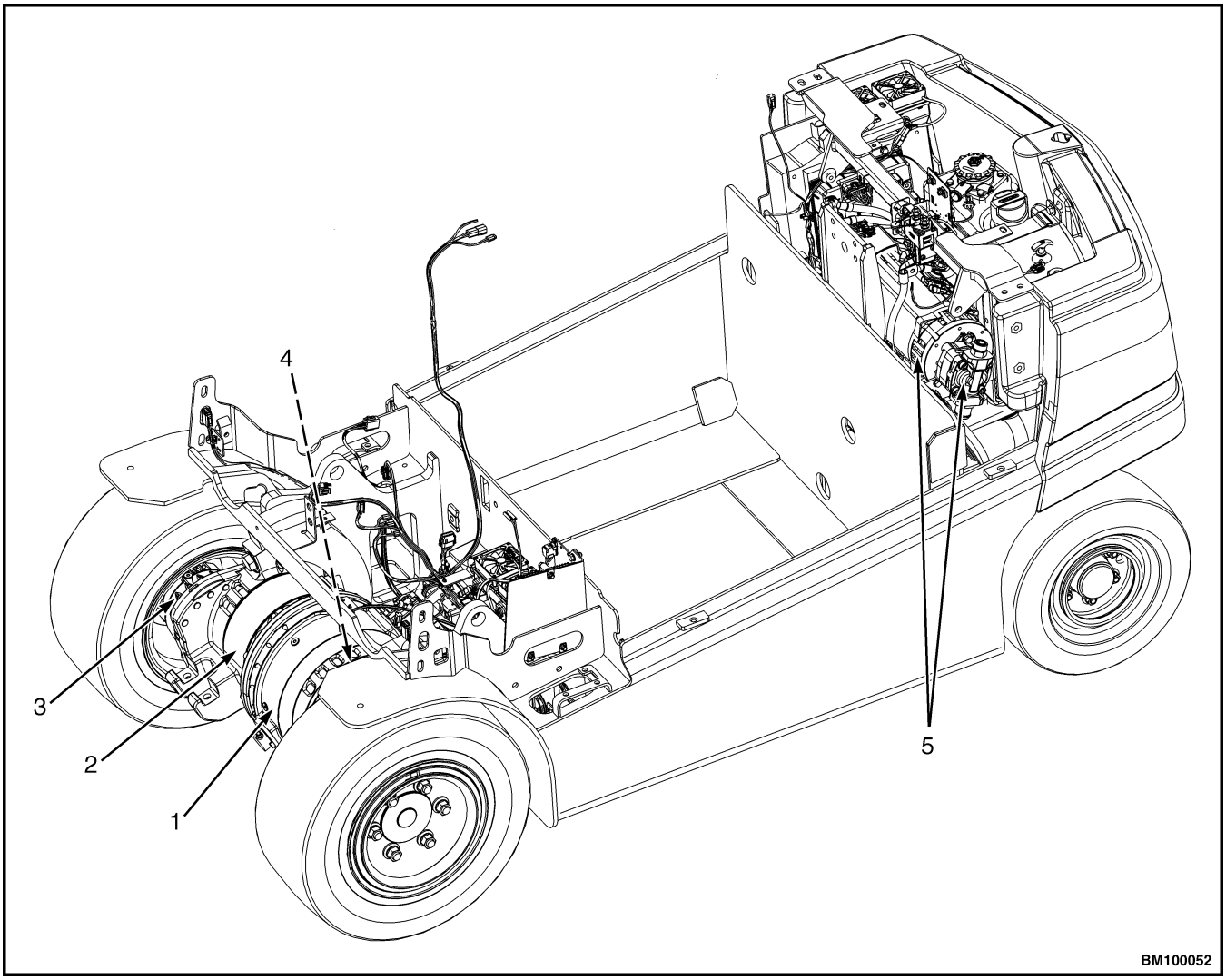
1. HYDRAULIC PUMP MOTOR
2. COUNTERWEIGHT

Figure 4. Hydraulic Motor for Lift Trucks J1.5-2.0XNT (K160) Manufactured Before November, 2014 and J30-40XNT (K160) and J1.6-2.0XN (J30-40XN) (A935)



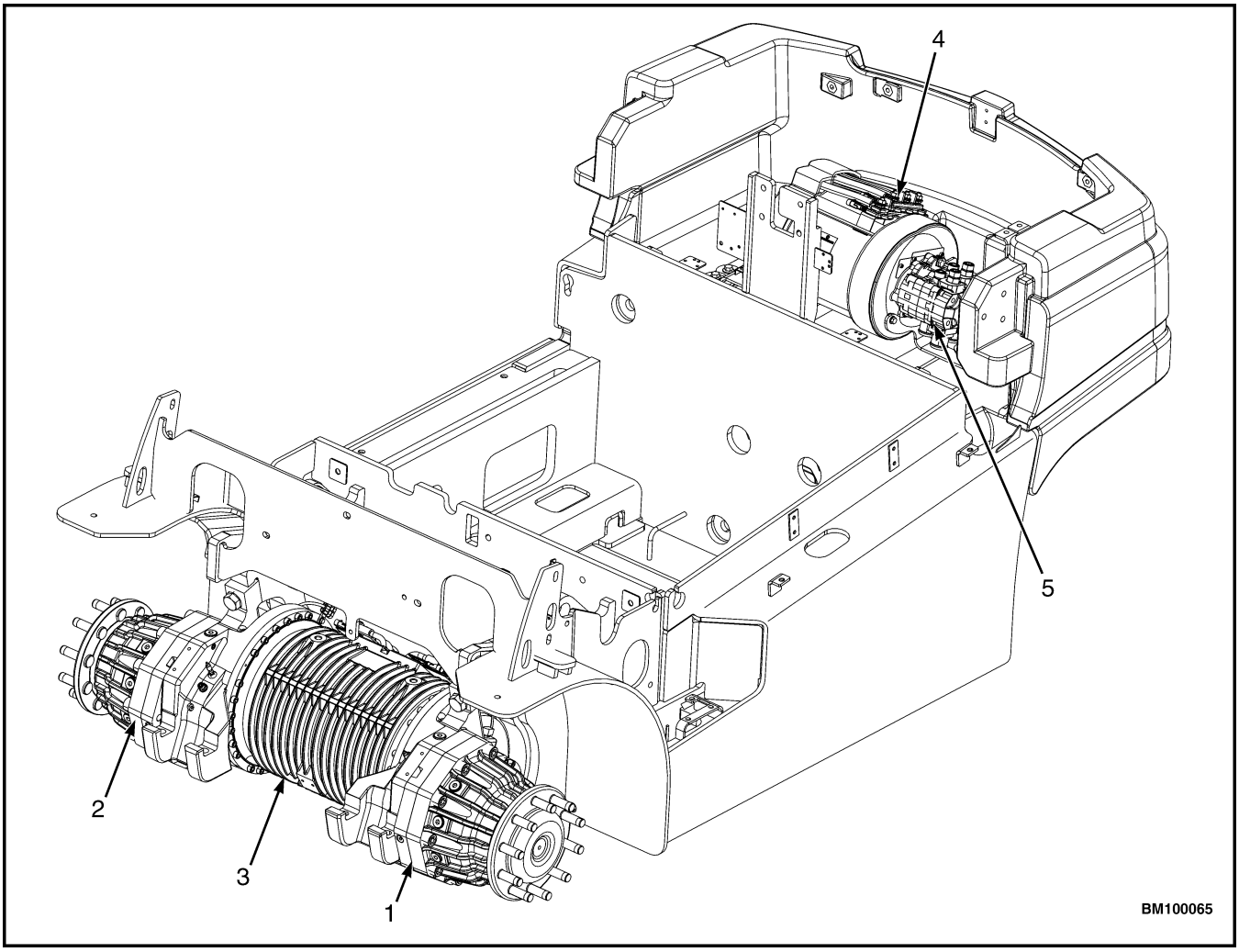
1. COUNTERWEIGHT
2. HYDRAULIC PUMP MOTOR

Figure 5. Hydraulic Motor for Lift Trucks J1.5-2.0XNT (K160) Manufactured After November, 2014



1. LEFT TRACTION MOTOR
2. RIGHT TRACTION MOTOR
3. RIGHT TRANSMISSION
4. LEFT TRANSMISSION
5. HYDRAULIC PUMP AND MOTOR

Figure 6. Traction Motor and Hydraulic Pump Motor for Lift Truck Models J2.2-3.5XN (J45-70XN) (A276)



1. LEFT TRANSMISSION
2. RIGHT TRANSMISSION
3. TRACTION MOTOR
4. HYDRAULIC MOTOR
5. HYDRAULIC PUMP

Figure 7. Traction and Hydraulic Pump Motor Locations, for Lift Truck Models J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

For lift truck models below, the traction motor is mounted under the frame to the drive axle.

- E2.2-3.5XN (E45-70XN) (A268)
- E1.6-2.0XN (E30-40XN) (A269)

See Figure 8 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268)

See Figure 9 for lift truck models

- E1.6-2.0XN (E30-40XN) (A269)

For lift truck models E2.2-3.5XN (E45-70XN) (A268) the hydraulic pump motor is mounted onto the frame beside the traction motor. See Figure 8.

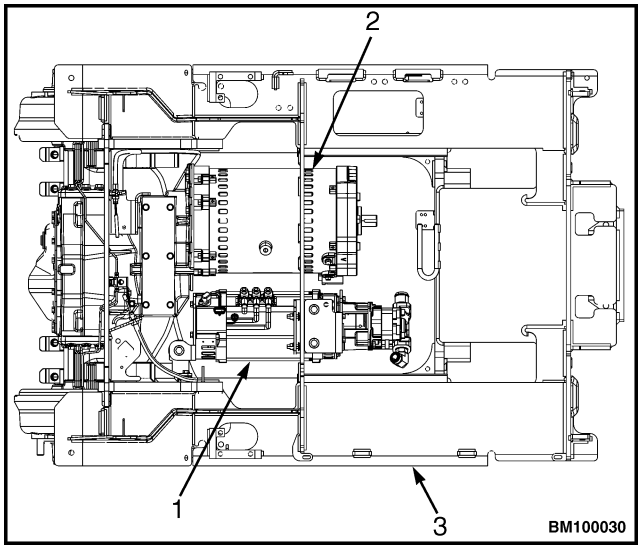
For lift truck models E1.6-2.0XN (E30-40XN) (A269) and E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099) the hydraulic pump motor is mounted onto the frame, opposite the traction motor.

See Figure 9 for lift truck model

- E1.6-2.0XN (E30-40XN) (A269)

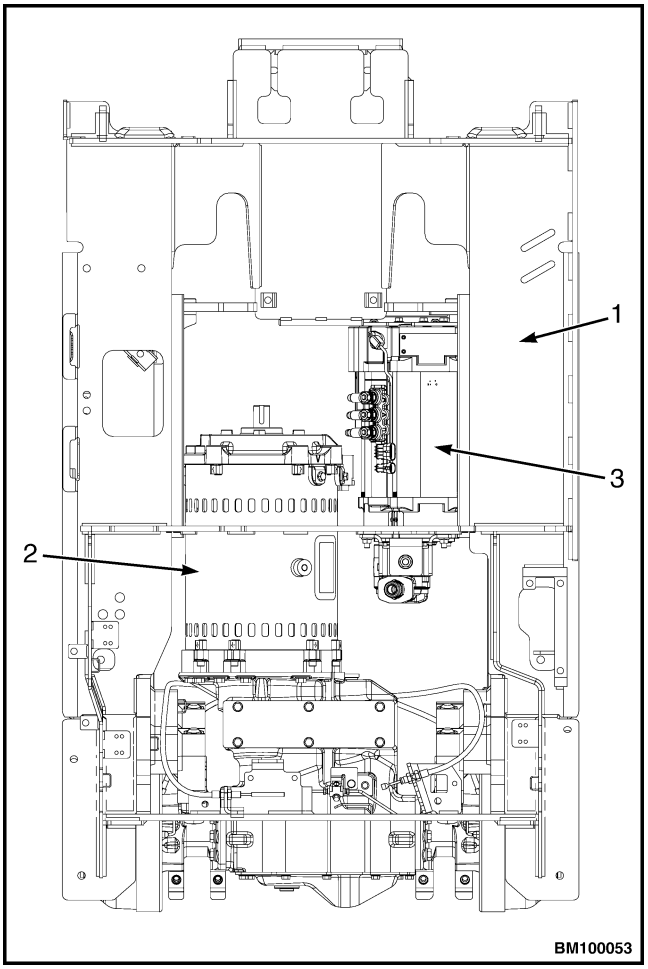
See Figure 10 for lift truck model

- E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)



1. HYDRAULIC PUMP MOTOR
2. TRACTION MOTOR
3. FRAME

Figure 8. Traction Motor and Hydraulic Pump Motor for Lift Truck E2.2-3.5XN (E45-70XN) (A268)

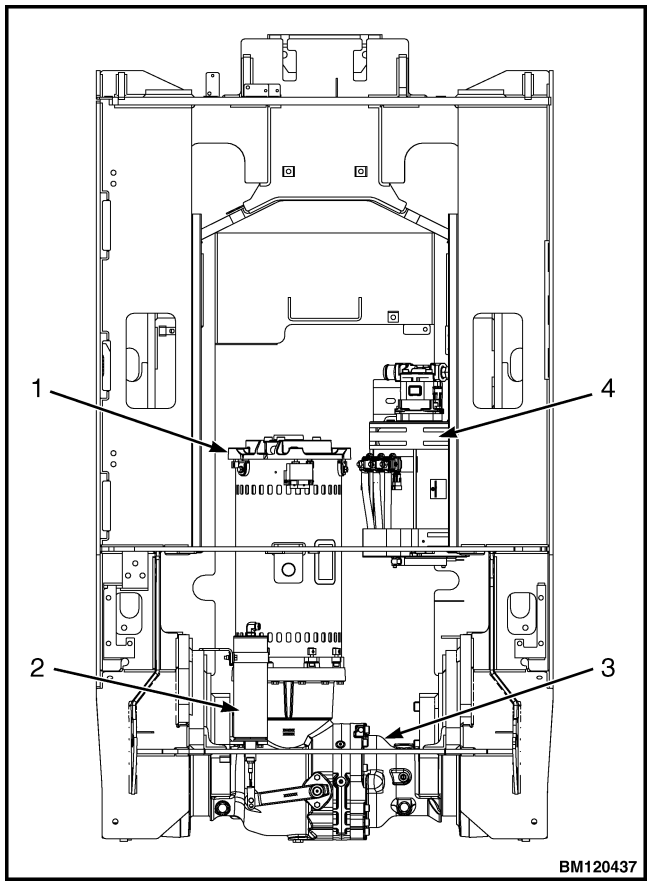


1. FRAME
2. TRACTION MOTOR
3. HYDRAULIC PUMP MOTOR

Figure 9. Traction Motor and Hydraulic Pump Motor for Lift Truck E1.6-2.0XN (E30-40XN) (A269)

For lift truck models below, the traction motors are mounted onto the transaxle and the hydraulic pump motor is mounted vertically to the front wall behind the front cover.

- E30-40HSD$_2$ (B219)



1. TRACTION MOTOR
2. AUTOMATIC PARK BRAKE ACTUATOR
3. DRIVE AXLE
4. HYDRAULIC MOTOR

Figure 10. Traction Motor and Hydraulic Pump Motor for Lift Truck Model E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

DISCHARGING THE CAPACITORS FOR LIFT TRUCK MODELS E30-40HSD$_2$ (B219), E30-40HSD$_3$ (C219)

WARNING

DO NOT make repairs or adjustments unless you have been properly trained and authorized to do so. Improper repairs and adjustments can create dangerous operating conditions. DO NOT operate a lift truck that needs repairs. Report the need for repairs to your supervisor immediately. If repair is necessary, attach a DO NOT OPERATE tag on the steering wheel and disconnect the battery.

Disconnect the battery and allow the capacitors to discharge before opening any compartment covers or inspecting or repairing the electrical system. DO NOT place tools on top of the battery. If a tool causes a short circuit, the high current flow from the battery can cause personal injury or property damage.

Some checks and adjustments are performed with the battery connected. DO NOT connect the battery until the procedure instructs you to do so. Never wear any metallic items on your fingers, arms, or neck. Metal items can accidentally make an electrical connection and cause injury.

Before performing any tests or adjustments, block the lift truck to prevent unexpected movement.

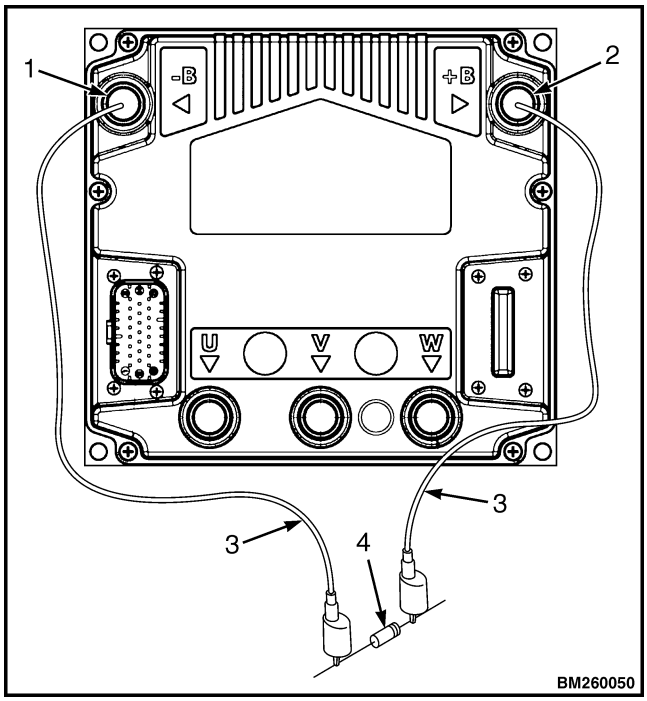
The capacitor in the transistor controller(s) can hold an electrical charge after the battery is disconnected. To prevent an electrical shock and personal injury, discharge the capacitor(s) before inspecting or repairing any component in the drive unit compartment. Make certain that the battery has been disconnected.

DO NOT short across the motor controller terminals with a screwdriver or jumper wire.

1. To avoid injury and prevent electrical shock, perform the following steps (Step 2 through Step 7 below) to discharge the capacitors before troubleshooting, making adjustments or repairs, or connecting or disconnecting a PC service tool.
2. Turn the key or keyless switch to the **OFF** position and **DISCONNECT THE BATTERY** by pushing forward on the battery disconnect lever.
3. Block the lift truck so the drive wheels are off the floor to prevent lift truck from moving.
4. Remove the electrical compartment cover to access the lift controller.

NOTE: The lift and traction controllers are wired parallel. Connecting the resistor across the lift controller will also discharge capacitors in the traction controllers if they are properly connected.

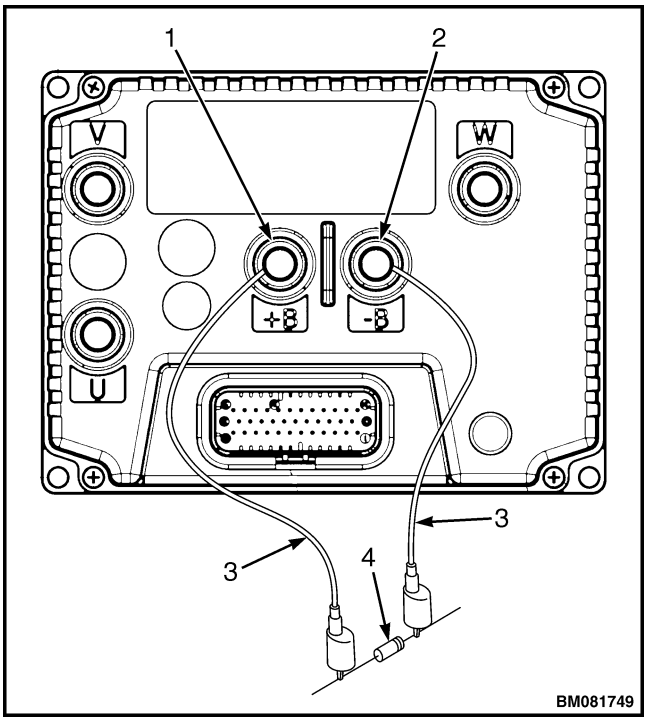
5. Discharge the capacitors in the controllers by connecting a 200-ohm, 2-watt resistor across the lift controller's negative (B-) and positive (B +) terminals. Wait at least 20 seconds to be sure that the capacitors are fully discharged. See Figure 11.



1. B- TERMINAL
2. B+ TERMINAL
3. JUMPER LEADS
4. 200-OHM, 2-WATT RESISTOR

Figure 11. Lift Controller

6. If necessary to discharge the traction controllers separately from the lift controller, connect a 200-ohm, 2-watt resistor across the controller's negative (B-) and positive (B+) terminals. Wait at least 20 seconds to be sure that the capacitors are fully discharged. Repeat for the other traction controller as necessary. See Figure 12.



1. B+ TERMINAL
2. B- TERMINAL
3. JUMPER LEADS
4. 200-OHM, 2-WATT RESISTOR

Figure 12. Traction Controller

7. Remove the resistor from the controller(s) and reinstall the covers before returning the lift truck to service.

DISCHARGING THE CAPACITORS (ALL OTHER MODELS)

WARNING

DO NOT make repairs or adjustments unless you have been properly trained and authorized to do so. Improper repairs and adjustments can create dangerous operating conditions. DO NOT operate a lift truck that needs repairs. Report the need for repairs to your supervisor immediately. If repair is necessary, attach a DO NOT OPERATE tag on the steering wheel and disconnect the battery.

Disconnect the battery and discharge the capacitors before opening any compartment covers or inspecting or repairing the electrical system. DO NOT place tools on top of the battery. If a tool causes a short circuit, the high current flow from the battery can cause personal injury or property damage.

Some checks and adjustments are performed with the battery connected. DO NOT connect the battery until the procedure instructs you to do so. Never wear any metallic items on your fingers, arms, or neck. Metal items can accidentally make an electrical connection and cause injury.

Before performing any tests or adjustments, block the lift truck to prevent unexpected movement.

The capacitors in the transistor controller(s) can hold an electrical charge for about 10 seconds after the battery is disconnected. To prevent an electrical shock and personal injury, discharge the capacitor(s) before inspecting or repairing any component in the drive unit compartment. Make certain that the battery has been disconnected.

DO NOT short across the motor controller terminals with a screwdriver or jumper wire.

Make certain the Emergency-Stop Switch has not been activated. This will isolate the controller and prevent the capacitors from discharging properly. The proper way to disconnect the battery is by separating the battery connectors.

1. Ensure the capacitors are discharged by performing Step 2 through Step 6 below.
2. Turn key or keyless switch to **OFF** position.
3. Disconnect the battery by separating the connectors.
4. Block drive wheels to prevent lift truck from moving.
5. Make sure the Emergency-Stop Switch **HAS NOT** been activated. If the Emergency-Stop Switch is activated, rotate the switch to the right until it pops up.
6. Press horn button. Wait 30 seconds to be sure capacitors are fully discharged.

Traction Motor Repair

FOR LIFT TRUCK MODELS J1.5-2.0XNT (J30-40XNT) (K160), J1.6-2.0XN (J30-40XN) (A935) AND E30-40HSD$_2$ (B219)

Remove

NOTE: The procedures described in this section apply to both right and left traction motors.

NOTE: Step 1 does not apply to E30-40HSD$_2$ (B219) lift truck models.

1. Disconnect manual release cable from parking brake.
2. Disconnect parking brake wire harness from main wire harness. See Figure 13.
3. Put lift truck on blocks so that the drive tires are suspended off the floor. See one of the following sections for procedures:

   Periodic Maintenance 8000SRM1339 for lift truck models
   - J1.5-2.0XNT (J30-40XNT) (K160)

   Periodic Maintenance 8000SRM1373 for lift truck models
   - J1.6-2.0XN (J30-40XN) (A935)

   Periodic Maintenance 8000SRM1418 for lift truck models
   - E30-40HSD$_2$ (B219)

4. Turn the key or keyless switch to **OFF** position and disconnect the battery.
5. Remove transaxle/traction motor/parking brake assembly from lift truck. See one of the following sections for removal instructions

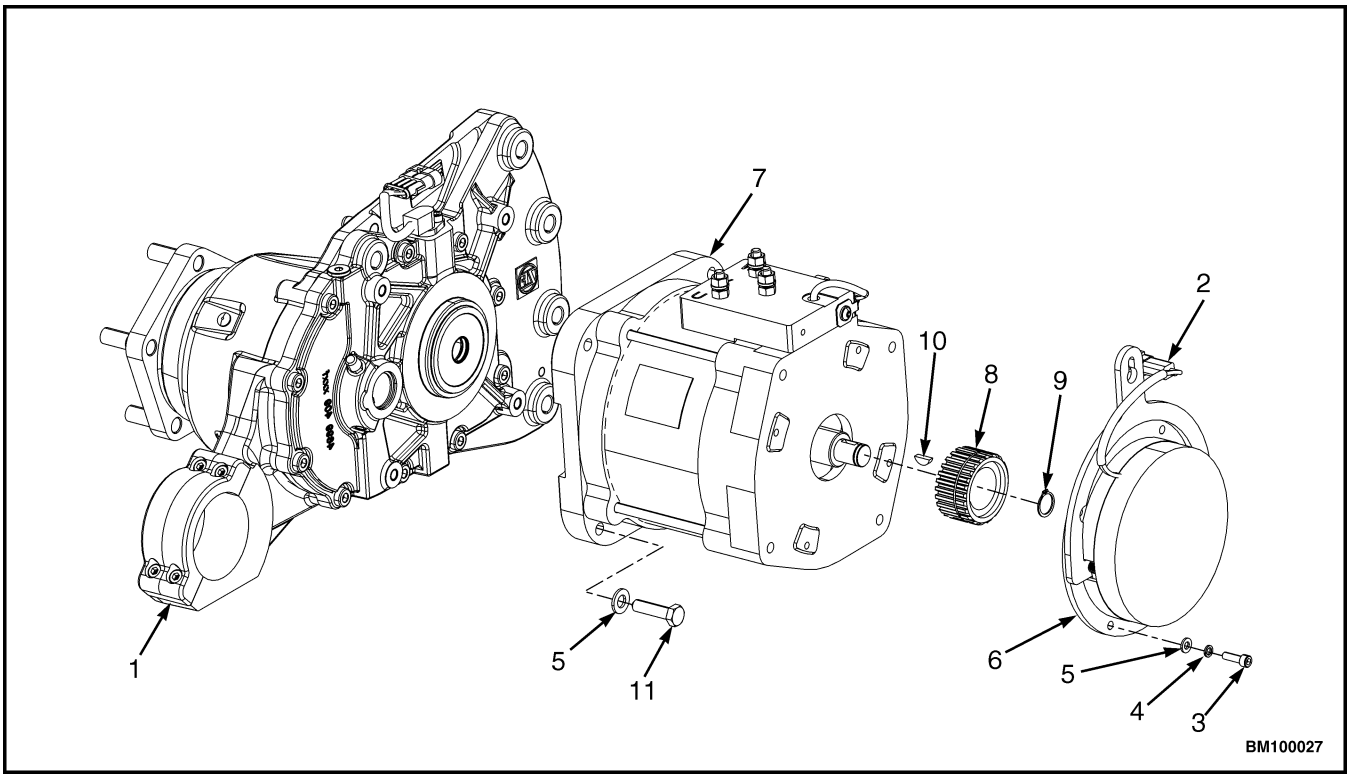
   Transaxle 1300SRM1330 for lift truck models
   - J1.5-2.0XNT (J30-40XNT) (K160)
   - J1.6-2.0XN (J30-40XN) (A935)

   Transaxle 1300SRM1411 for lift truck models
   - E30-40HSD$_2$ (B219)

6. Move transaxle/traction motor/parking brake assembly to a bench or other suitable work surface.

NOTE: Note placement and orientation of parking brake prior to removal to aid in installation.

7. Remove four socket head capscrews, lockwashers, washers and parking brake from traction motor shaft. See Figure 13.
8. Remove snap ring and splined hub from traction motor shaft; recover woodruff key. See Figure 13.



1. TRANSAXLE
2. PARKING BRAKE WIRE HARNESS
3. SOCKET HEAD CAPSCREW
4. LOCKWASHER
5. WASHER
6. PARKING BRAKE
7. TRACTION MOTOR
8. SPLINED HUB
9. SNAP RING
10. WOODRUFF KEY
11. TRACTION MOTOR MOUNTING CAPSCREW

Figure 13. Transaxle Assembly

WARNING

The traction motor weighs approximately 18.4 kg (40.6 lb). Make sure lifting device has enough lifting capacity to safely lift motor.

NOTE: Use an approved lifting device to hold and lift traction motor during removal.

9. Remove four traction motor mounting capscrews, washers, and traction motor from transaxle. See Figure 13.

Disassemble

1. Remove four socket-head capscrews and lockwashers from brake end head and transaxle end head. See Figure 14.

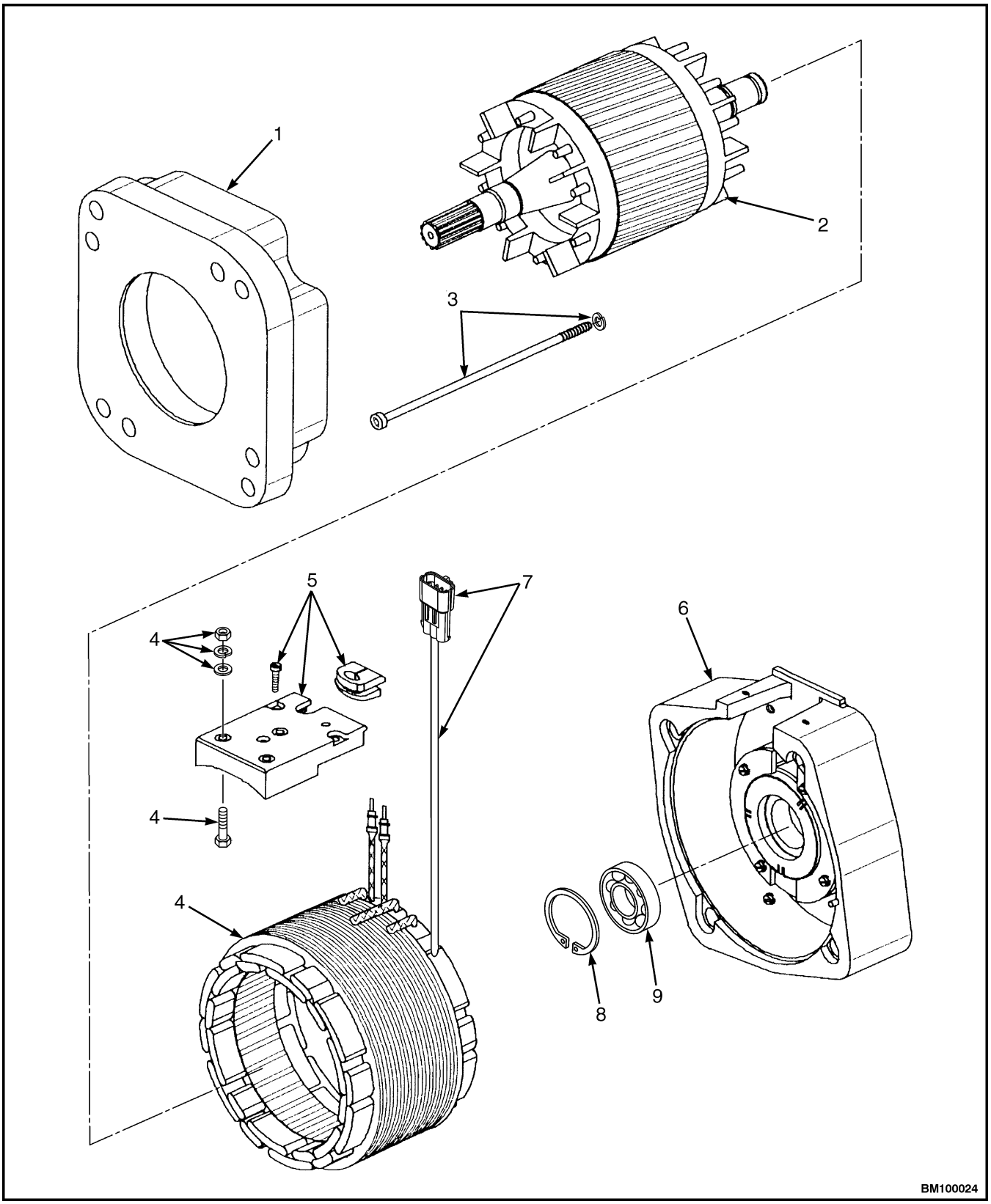


Figure 14. Traction Motor

Legend for Figure 14

1. TRANSAXLE END HEAD
2. ROTOR
3. SOCKET-HEAD CAPSCREW AND LOCK-WASHER
4. STATOR, TERMINALS, AND HARDWARE
5. CONNECTION PLATE, SCREW, AND GROM-MET
6. BRAKE END HEAD
7. TEMP SENSOR CONNECTOR AND WIRING HARNESS
8. SNAP RING
9. BEARING

NOTE: Carefully tap underside of brake end head with a soft hammer to loosen brake end head from stator.

2. Remove brake end head from stator and slide brake end head off rotor shaft. See Figure 14.

3. Remove rotor from stator. See Figure 14. Place stator brake end down on workbench.

NOTE: Carefully tap underside of transaxle end head with a soft hammer to loosen transaxle end head from stator.

4. Remove transaxle end head from stator. See Figure 14.

5. Remove snap ring from brake end head. See Figure 14.

6. Using bearing puller, carefully remove bearing from brake end head. See Figure 14.

NOTE: Perform Step 7 and Step 8 if connection plate is damaged and must be replaced.

7. Remove temp sensor wire harness from grommet. See Figure 14.

8. Remove screws, nuts, washers, grommet, and connection plate from stator. See Figure 14.

Electrical Connector Repair or Replacement

1. If necessary, electric brake connector (see Figure 13) may be repaired or replaced. See Deutsch Connectors section of **Wire Harness Repair** 2200SRM1128 manual for instructions.

2. If necessary, temp sensor connector (see Figure 14) may be repaired or replaced. See AMP Superseal 1.5 Connector Assemblies section of **Wire Harness Repair** 2200SRM1128 manual for instructions.

Clean

WARNING

Cleaning solvents can be flammable and toxic and can cause skin irritation. When using cleaning solvents, always follow the solvent manufacturer's recommended safety procedures.

1. Clean components with a clean cloth moistened with solvent and allow to thoroughly dry. DO NOT apply liquid solvent directly to stator windings.

Inspect

1. Inspect rotor and inside of stator for marks or grooves indicating contact between rotor and stator. Replace if damaged.

2. Check that the bearings roll smoothly and are not loose from excessive wear. Replace as necessary. Replace the bearings regardless of condition if motor has been subjected to thermal overload (see Step 3). In case of a catastrophic bearing failure, damage may result to other motor components and possibly to transaxle.

3. Check stator windings for signs of thermal overload. Signs of thermal overload are dark-stained, brittle, or burnt insulation. Thermal overload will shorten the life of the stator.

4. Check stator windings resistance as indicated below. To measure continuity between U, V, and W terminals of motor use a digital multimeter (DMM) set to Ohms.

a. Place one DMM probe on terminal U.

b. Place the other DMM probe on terminal V.

Meter must read less than 0.5 ohms. If the reading is more than 0.5 ohms, remove the cables from motor to inverter and measure again. If this reading is other than 0.5 ohm or less, the motor windings in the stator have burned open and the motor must be repaired or replaced.

c. Place one DMM probe on terminal V.

d. Place the other DMM probe on terminal W.

Meter must read less than 0.5 ohms. If the reading is more than 0.5 ohms, remove the cables from motor to inverter and measure again. If this reading is other than 0.5 ohm or less, the motor windings in the stator have burned open and the motor must be repaired or replaced.

e. Place one DMM probe on terminal W.

f. Place the other DMM probe on terminal U.

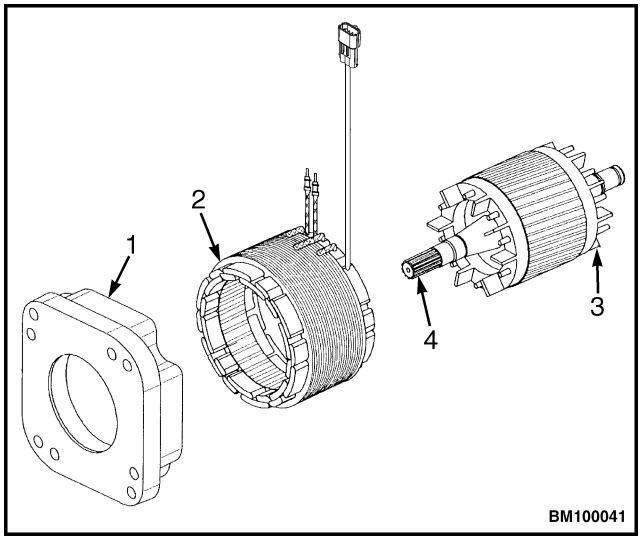
Meter must read less than 0.5 ohms. If the reading is more than 0.5 ohms, remove the cables from motor to inverter and measure again. If this reading is other than 0.5 ohm or less, the motor windings in the stator have burned open and the motor must be repaired or replaced.

NOTE: A likely cause of motor contamination may be from a damaged input bearing seal on the transaxle.

5. Check for signs of oil or other contaminants within the motor. If contaminants are present, locate source and take corrective action.

Assemble

1. Install transaxle end head onto stator. See Figure 15.



1. TRANSAXLE END HEAD
2. STATOR
3. ROTOR
4. DRIVE SPLINES

Figure 15. Transaxle End Head, Stator and Rotor

2. Install rotor into stator with drive splines protruding through transaxle end head. See Figure 15.

NOTE: Perform Step 3 through Step 5 if connection plate and hardware was removed.

3. If removed, install connection plate, grommet, washers, and nuts onto stator. See Figure 16.

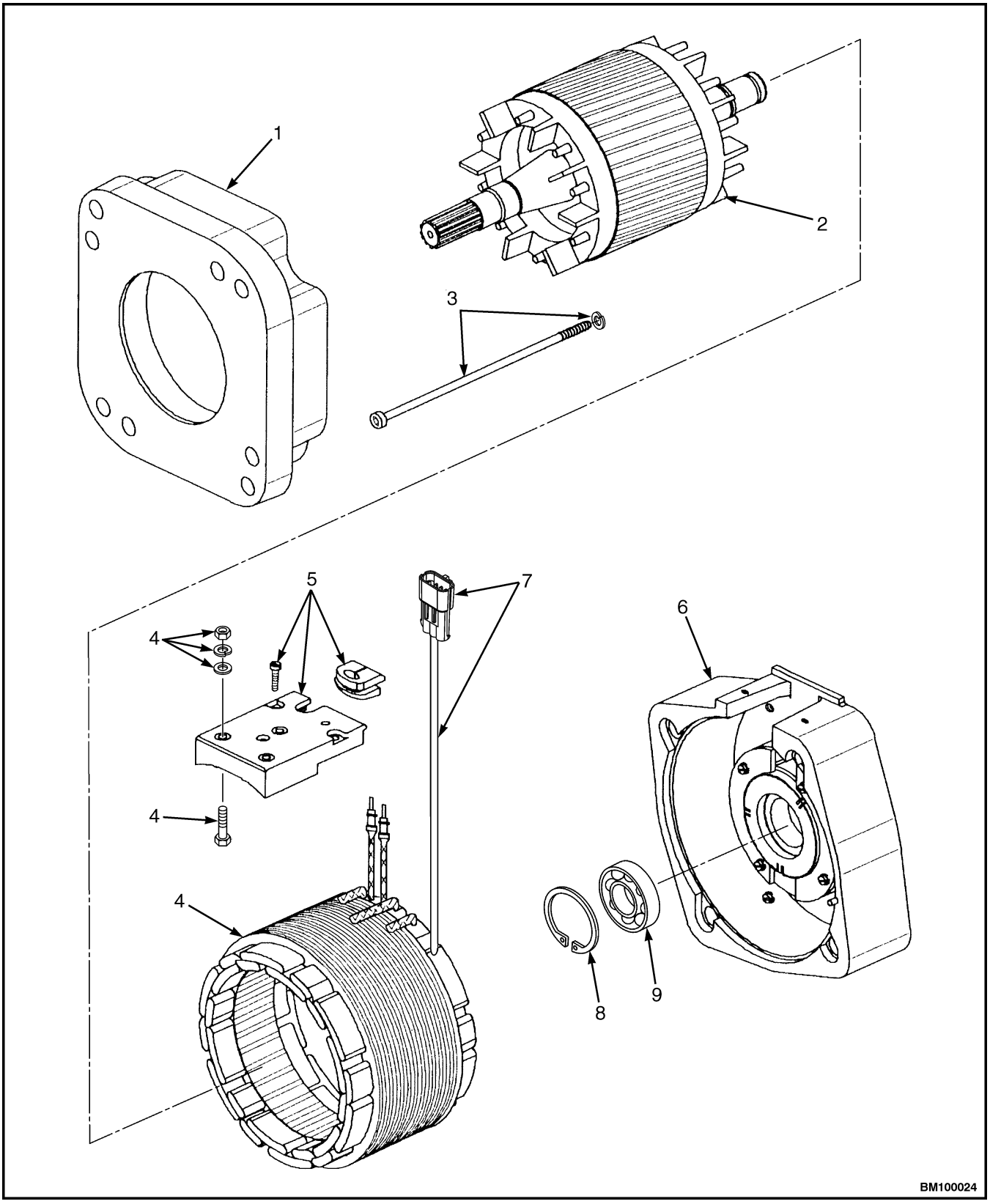


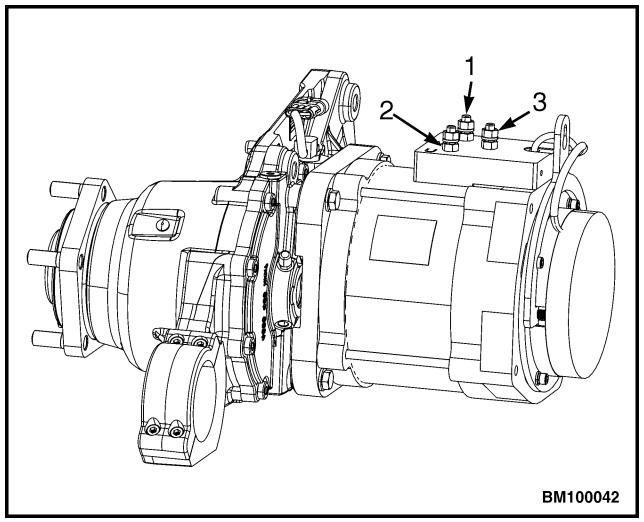
Figure 16. Traction Motor

Legend for Figure 16

1. TRANSAXLE END HEAD
2. ROTOR
3. SOCKET-HEAD CAPSCREW AND LOCK-WASHER
4. STATOR, TERMINALS, AND HARDWARE
5. CONNECTION PLATE, SCREW, AND GROM-MET
6. BRAKE END HEAD
7. TEMP SENSOR CONNECTOR AND WIRING HARNESS
8. SNAP RING
9. BEARING

NOTE: Terminal studs are located on top of connection plate.

4. Hold lower nut of terminal stud to prevent it from turning and tighten upper nut to 12 N•m (106 lbf in). See Figure 17.



1. TERMINAL STUD
2. LOWER NUT
3. UPPER NUT

Figure 17. Terminal Studs and Nuts

5. Insert temp sensor wire harness into grommet. See Figure 16.

CAUTION

Use an arbor press and a proper size driver when installing bearings to avoid damage to bearings and/or end shields. Press only on the outer race of the bearing.

6. Carefully install bearing into brake end head. See Figure 16.

7. Install snap ring into brake end head. See Figure 16.

8. Install brake end head onto rotor shaft and stator. See Figure 16.

9. Install four lockwashers and socket-head capscrews onto transaxle end head and brake end head. See Figure 16. Tighten capscrews to 14 to 16 N•m (124 to 142 lbf in).

Install

WARNING

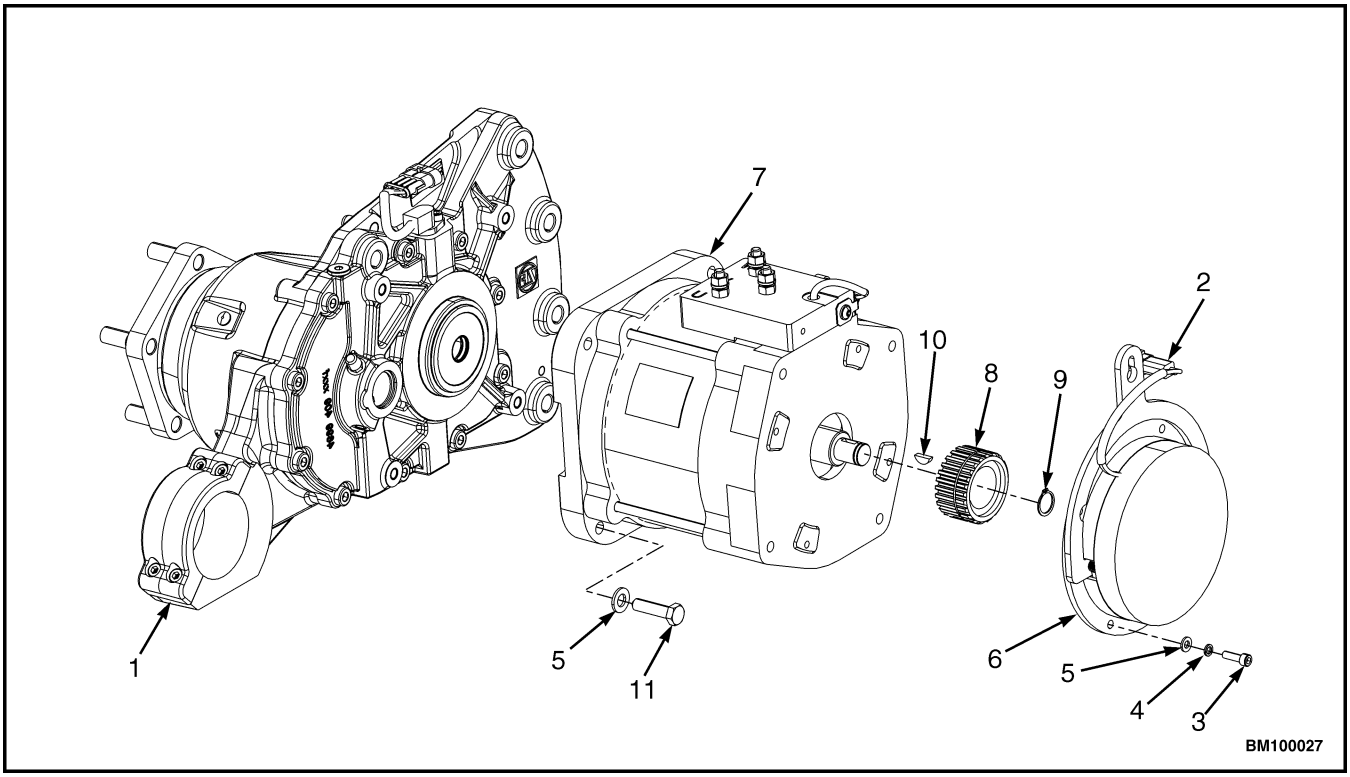
The traction motor weighs approximately 18.4 kg (40.6 lb). Make sure lifting device has enough lifting capacity to safely lift motor.

NOTE: Use an approved lifting device to lift and hold traction motor during install. Use caution when installing motor to transaxle not to damage transaxle shaft seal.

1. Apply Dexron III transmission fluid to drive splines of traction motor and install traction motor onto transaxle.

2. Apply Loctite® 271 to four traction motor mounting capscrews.

3. Install four washers and traction motor mounting capscrews into traction motor and transaxle. See Figure 18. Tighten capscrews to 48 N•m (35 lbf ft).



1. TRANSAXLE
2. PARKING BRAKE WIRE HARNESS
3. SOCKET-HEAD CAPSCREW
4. LOCKWASHER
5. WASHER
6. PARKING BRAKE
7. TRACTION MOTOR
8. SPLINED HUB
9. SNAP RING
10. WOODRUFF KEY
11. CAPSCREW

Figure 18. Transaxle Assembly

4. Install splined hub and woodruff key (with counterbore facing up) onto traction motor shaft. See Figure 18.

5. Install snap ring onto traction motor shaft. See Figure 18.

NOTE: Close clearances require parking brake to be installed after traction motor is installed to transaxle. Parking brake mechanical release arm must be in vertical position when installed.

6. Install parking brake onto splined hub. See Figure 18.

7. Install four washers, lockwashers, and socket-head capscrews into parking brake and brake end head of traction motor. See Figure 18.

8. Connect parking brake wire harness to main wiring harness. See Figure 18.

NOTE: Step 9 does not apply to E30-40HSD$_2$ (B219) lift truck models.

9. Connect manual release cable to parking brake.

10. Complete installation of transaxle into lift truck. See one of the following manuals for instructions:

    Transaxle 1300SRM1330 for lift truck models
    - J1.5-2.0XNT (J30-40XNT) (K160)
    - J1.6-2.0XN (J30-40XN) (A935)

    Transaxle 1300SRM1411 for lift truck models
    - E30-40HSD$_2$ (B219)

11. Lower the lift truck from the blocks. Refer to one of the following manuals for procedures:

    Periodic Maintenance 8000SRM1339 for lift truck models
    - J1.5-2.0XNT (J30-40XNT) (K160)

    Periodic Maintenance 8000SRM1373 for lift truck models
    - J1.6-2.0XN (J30-40XN) (A935)

    Periodic Maintenance 8000SRM1418 for lift truck models
    - E30-40HSD$_2$ (B219)

12. Connect battery connector and turn key or keyless switch to the **ON** position. Remove the blocks from the wheels. Test for proper operation.

FOR LIFT TRUCK E2.2-3.5XN (E45-70XN) (A268) AND E1.6-2.0XN (E30-40XN) (A269)

Remove

1. Remove traction motor from lift truck. See **Frame** 0100SRM1342 for instructions.

CAUTION

The traction motor can weigh as much as 136 kg (300 lb). To prevent injury, use a lifting device capable of lifting the assembly.

2. Place traction motor on level blocks on a flat surface with drive end pointing down. Remove floor jack.

Disassemble

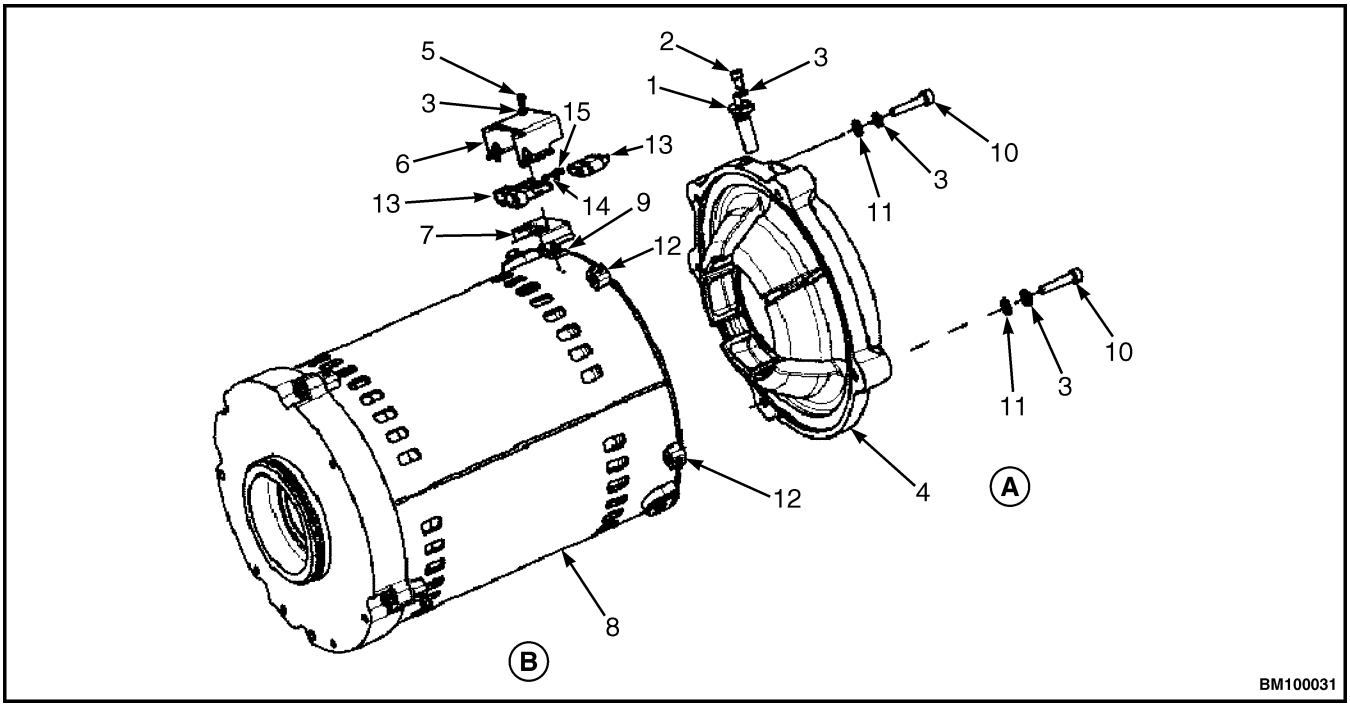
1. Remove capscrew M6, lockwasher, and speed sensor from non-drive end head. See Figure 19.

2. Remove long socket-head capscrew, lockwasher, sensor connector cover bracket, and sensor connector tab bracket from stator housing above sensor cable outlet. See Figure 19.

3. Remove five capscrews, lockwashers, and washers from stator Z-nuts and non-drive end head. See Figure 19.

4. Gently tap under non-drive end head and remove from stator housing. See Figure 19.

5. Pull sensor cable outlet from stator housing (see Figure 19) and disconnect speed sensor and temperature sensor connectors.



A. NON-DRIVE END

1. SPEED SENSOR
2. CAPSCREW M6
3. LOCKWASHER
4. NON-DRIVE END HEAD
5. LONG SOCKET-HEAD CAPSCREW
6. SENSOR CONNECTOR COVER BRACKET
7. SENSOR CONNECTOR TAB BRACKET
8. STATOR HOUSING

B. DRIVE END

9. SENSOR CABLE OUTLET
10. CAPSCREW
11. WASHER
12. STATOR Z-NUT
13. AMP SUPERSEAL TAB ASSEMBLY
14. TAB CONTACT
15. WIRE SEAL

Figure 19. Traction Motor Non-Drive End Head

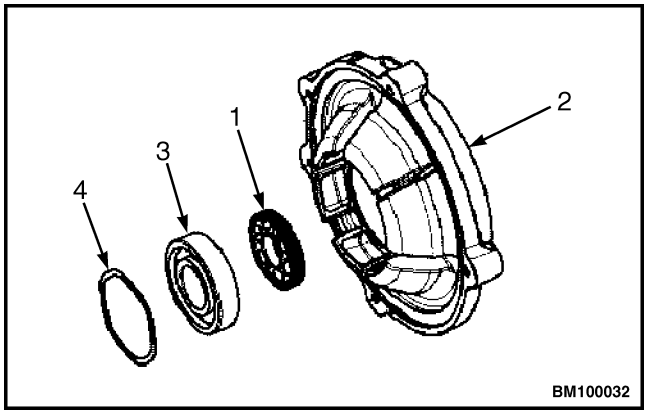
6. Using a bearing puller, remove and discard proximity sensor wheel from non-drive end head. See Figure 20.

NOTE: When replacing one bearing, it is strongly recommended to replace both bearings.

NOTE: Note orientation of bearing components during disassembly to aid in assembly.

7. Using bearing puller, remove bearing from non-drive end head. See Figure 20.

8. Remove bearing preload spring from non-drive end head. See Figure 20.



1. PROXIMITY SENSOR WHEEL
2. NON-DRIVE END HEAD
3. BEARING
4. BEARING PRELOAD SPRING

Figure 20. Traction Motor Non-Drive End Head Bearing

9. Remove three hex-head bolts, spring washers, terminal flags, terminal covers, terminal blocks, and special nuts from stator housing on non-drive end. See Figure 21.

10. Remove five capscrews, lockwashers, and washers from Z-nuts on stator housing and drive end head. See Figure 21.

11. Attach approved lifting device to stator housing and slowly lift straight up, removing it from rotor assembly and drive end head. See Figure 21.

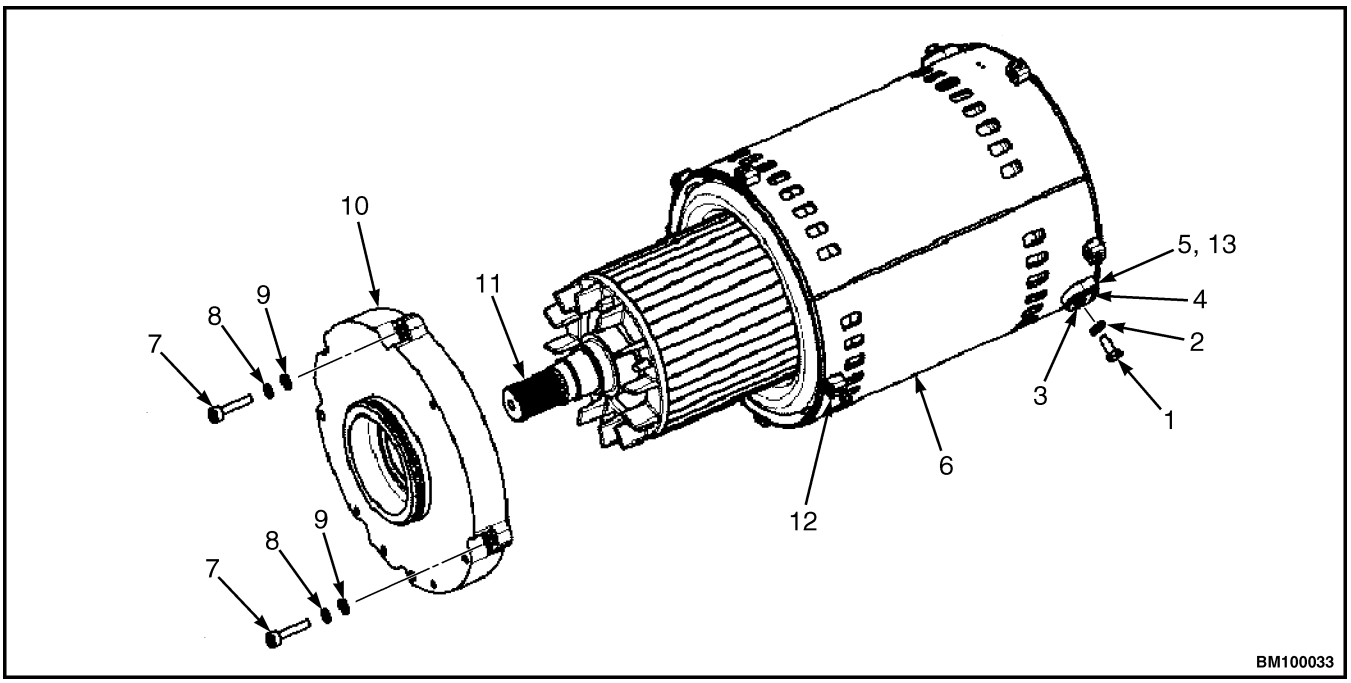
12. Screw lifting eye into threaded hole in end of rotor assembly. Attach approved lifting device and lift rotor assembly straight up from drive end head. See Figure 22.

NOTE: When replacing one bearing, it is strongly recommended to replace both bearings.

NOTE: Note orientation of bearing components prior to disassembly to aid in assembly.

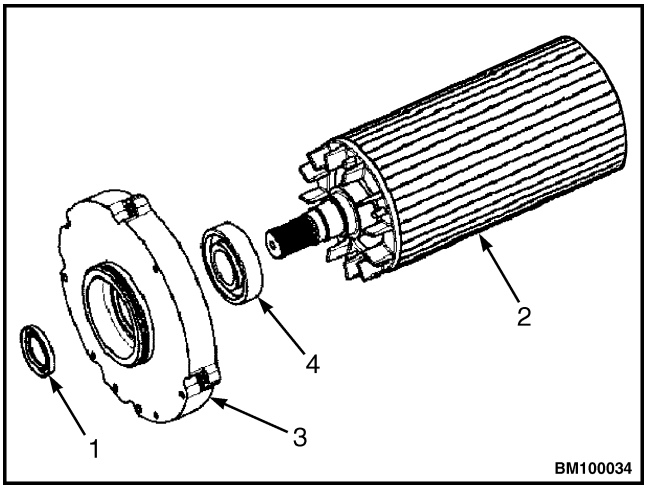
13. Using bearing puller, remove bearing from drive end head. See Figure 22.

14. Remove and discard shaft seal from drive end head. See Figure 22.



1. HEX-HEAD BOLT
2. SPRING WASHER
3. TERMINAL FLAG
4. TERMINAL COVER
5. TERMINAL BLOCK
6. STATOR HOUSING
7. CAPSCREW
8. LOCKWASHER
9. WASHER
10. DRIVE END HEAD
11. ROTOR ASSEMBLY
12. STATOR Z-NUT
13. SPECIAL NUT

Figure 21. Traction Motor Drive End Head



1. SHAFT SEAL
2. ROTOR ASSEMBLY
3. DRIVE END HEAD
4. BEARING

Figure 22. Traction Motor Rotor Assembly and Drive End Head

Electrical Connector Repair or Replacement

1. If necessary, AMP Superseal tab assembly, tab contact, and wire seal (see Figure 19) may be repaired or replaced. See AMP Superseal 1.5 Connector Assemblies section of **Wire Harness Repair** 2200SRM1128 manual for instructions.

Clean

WARNING

Cleaning solvents can be flammable and toxic and can cause skin irritation. When using cleaning solvents, always follow the solvent manufacturer's recommended safety procedures.

1. Clean components with a clean cloth moistened with solvent and allow to air dry. DO NOT apply liquid solvent directly to components.

Inspect

1. Inspect rotor assembly and inside of stator housing for marks or grooves indicating contact between rotor and stator. Replace if damaged.

2. Check that the bearings roll smoothly and are not loose from excessive wear. Replace as necessary. Replace the bearings regardless of condition if motor has been subjected to thermal overload (see Step 3). In case of a catastrophic bearing failure, damage may result to other motor components and possibly to transaxle.

3. Check stator windings for signs of thermal overload. Signs of thermal overload are dark-stained, brittle, or burnt insulation. Thermal overload will shorten the life of the stator.

4. Check motor windings resistance as indicated below. To measure continuity between U, V, and W terminals of motor use a digital multimeter (DMM) set to Ohms.

a. Place one DMM probe on terminal U.

b. Place the other DMM probe on terminal V.

Meter must read less than 0.5 ohms. If the reading is more than 0.5 ohms, remove the cables from motor to inverter and measure again. If this reading is other than 0.5 ohm or less, the motor windings in the stator have burned open and the motor must be repaired or replaced.

c. Place one DMM probe on terminal V.

d. Place the other DMM probe on terminal W.

Meter must read less than 0.5 ohms. If the reading is more than 0.5 ohms, remove the cables from motor to inverter and measure again. If this reading is other than 0.5 ohm or less, the motor windings in the stator have burned open and the motor must be repaired or replaced.

e. Place one DMM probe on terminal W.

f. Place the other DMM probe on terminal U.

Meter must read less than 0.5 ohms. If the reading is more than 0.5 ohms, remove the cables from motor to inverter and measure again. If this reading is other than 0.5 ohm or less, the motor windings in the stator have burned open and the motor must be repaired or replaced.

5. Check terminal flags for cracks or other damage. Replace if damaged.

6. Check for signs of oil or other contaminants within motor. If necessary, locate source of contaminants and take corrective action.

7. Inspect all other components and replace as necessary.

Assemble

1. Using a seal driver, install new shaft seal into drive end head. See Figure 22.

CAUTION

Use an arbor press and a proper size driver when installing bearings to avoid damage to bearings and/or end shields. Press only on the outer race of the bearing. Always replace bearings in sets.

2. Install bearing into drive end head as noted during disassembly. See Figure 22.

3. Screw lifting eye into threaded hole in the end of rotor assembly. Attach approved lifting device and lower rotor assembly onto drive end head. Ensure bearing is fully seated against drive end head. See Figure 22.

4. Remove lifting device and lifting eye from rotor assembly.

NOTE: Make sure holes for stator Z-nuts are aligned with capscrew holes.

5. Using approved lifting device, lower stator housing onto drive end head. See Figure 21.

6. Install five washers, lockwashers, and capscrews into drive end head and stator Z-nuts on stator housing. See Figure 21. Tighten capscrews to 25 to 30 N•m (18 to 22 lbf ft).

7. Install three special nuts, terminal blocks, terminal covers, terminal flags, spring washers, and hex-head bolts onto stator housing, non-drive end. See Figure 21.

8. Install bearing preload spring into non-drive end head. See Figure 20.

9. Install bearing into non-drive end head as noted during disassembly. See Figure 20.

10. Install new proximity sensor wheel into non-drive end head. See Figure 20.

11. Place sensor cable outlet into position on stator housing (see Figure 19). Connect proximity sensor and temperature sensor connectors to sensor cable outlet.

12. Install non-drive end head onto stator housing. See Figure 19.

13. Install five washers, lockwashers, and capscrews into non-drive end head and stator Z-nuts on stator housing. See Figure 19. Tighten capscrews to 25 to 30 N•m (18 to 22 lbf ft).

14. Install sensor connector tab bracket, sensor connector cover bracket, lockwasher, and long socket-head capscrew onto stator housing over sensor cable outlet. See Figure 19.

15. Install speed sensor, lockwasher, and capscrew M6 onto non-drive end head and stator housing. See Figure 19.

Install

1. Install traction motor onto drive axle. See **Frame** 0100SRM1342 for installation instructions.

FOR LIFT TRUCK J2.2-3.5XN (J45-70XN) (A276)

Remove

NOTE: The procedures described in this section apply to both right and left traction motors.

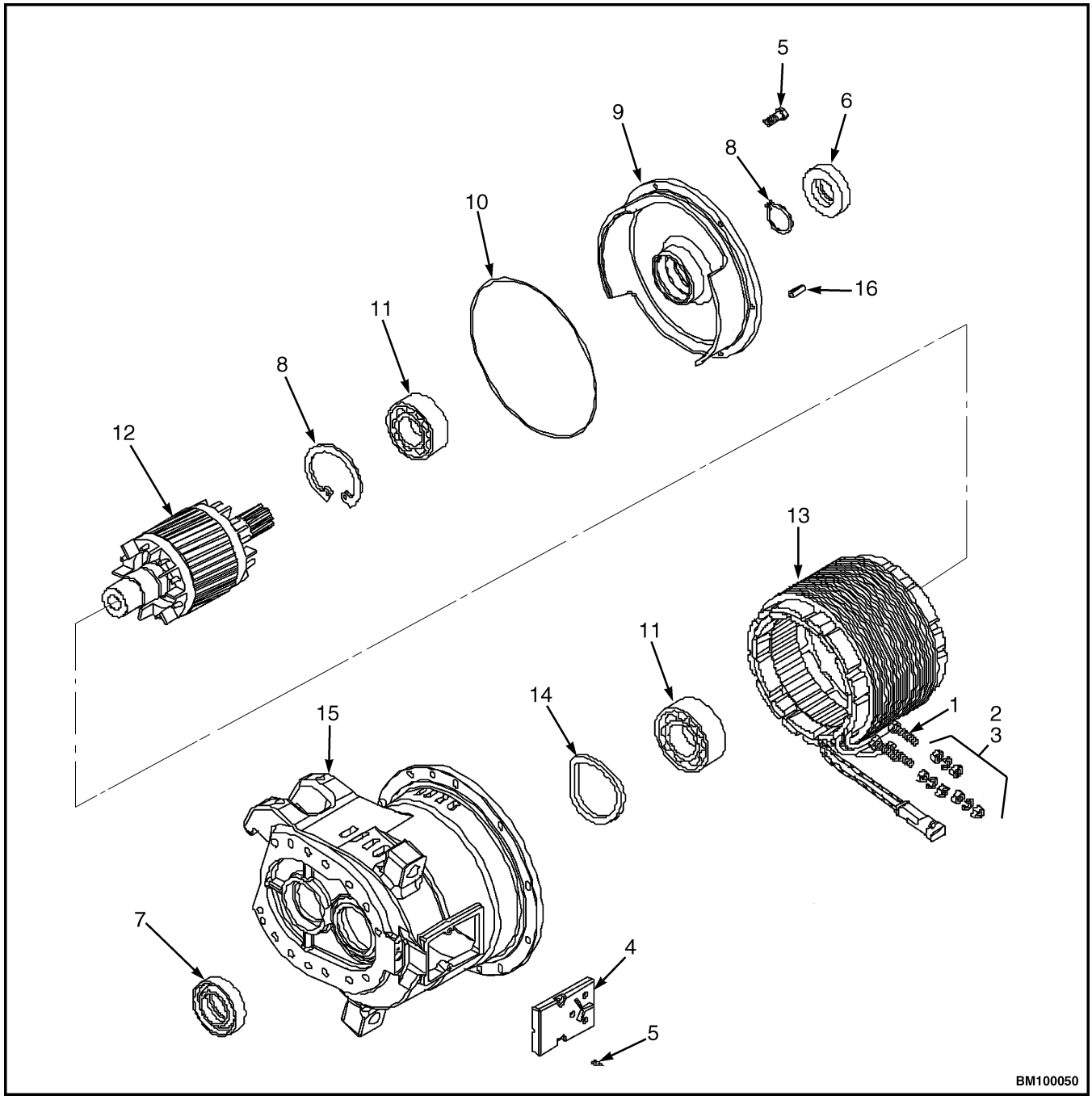
1. Remove transaxle assembly from lift truck. See **Transaxle** 1300SRM1370 for instructions.

2. Remove service and parking brake components from traction motor housings. See **Transaxle** 1300SRM1370 for instructions.

3. Remove the AC motor to be repaired from the output housing. See **Transaxle** 1300SRM1370 for instructions.

Disassemble

1. Remove nine nuts and washers from terminals on connection plate. See Figure 23.



1. TERMINAL
2. NUT
3. WASHER
4. CONNECTION PLATE
5. SCREW
6. FRONT SHAFT SEAL
7. REAR SHAFT SEAL
8. SNAP RING
9. BRAKE END BELL
10. O-RING
11. BEARING
12. ROTOR
13. STATOR
14. WAVE WASHER
15. STATOR HOUSING
16. DOWEL PINS

Figure 23. Traction Motor

2. Remove two screws and connection plate from stator housing. See Figure 23.

3. Remove and discard front shaft seal from brake end bell. See Figure 23.

4. Remove and discard rear shaft seal from stator housing. See Figure 23.

5. Remove snap ring from rotor at brake end bell. See Figure 23.

NOTE: Use threaded holes on the brake end bell to move the end bell away from the stator housing.

6. Remove six screws, dowel pins if present, and brake end bell from stator housing. Remove and discard O-ring. See Figure 23.

7. Remove snap ring from inside brake end bell. See Figure 23.

8. Carefully remove bearing from brake end bell. See Figure 23.

NOTE: Bearing will remain with rotor during removal.

9. Remove rotor from stator housing. See Figure 23.

10. Carefully remove bearing from rotor. See Figure 23.

11. Carefully remove stator from stator housing. See Figure 23. Take care not to damage power leads.

12. Remove wave washer from stator housing. See Figure 23.

Clean

WARNING

Cleaning solvents can be flammable and toxic and can cause skin irritation. When using cleaning solvents, always follow the solvent manufacturer's recommended safety procedures.

1. Clean components with a clean cloth moistened with solvent and allow to thoroughly dry. DO NOT apply liquid solvent directly to stator windings.

Inspect

1. Inspect rotor and inside of stator for marks or grooves indicating contact between rotor and stator. Replace if damaged.

2. Check that the bearings roll smoothly and are not loose from excessive wear. Replace as necessary. Replace the bearings regardless of condition if motor has been subjected to thermal overload (see Step 3). In case of a catastrophic bearing failure, damage may result to other motor components and possibly to transaxle.

3. Check stator windings for signs of thermal overload. Signs of thermal overload are dark-stained, brittle, or burnt insulation. Thermal overload will shorten the life of the stator.

4. Check motor windings resistance as indicated below. To measure continuity between U, V, and W terminals of motor use a digital multimeter (DMM) set to Ohms.

   a. Place one DMM probe on terminal U.

   b. Place the other DMM probe on terminal V.

   Meter must read less than 0.5 ohms. If the reading is more than 0.5 ohms, remove the cables from motor to inverter and measure again. If this reading is other than 0.5 ohm or less, the motor windings in the stator have burned open and the motor must be repaired or replaced.

   c. Place one DMM probe on terminal V.

   d. Place the other DMM probe on terminal W.

   Meter must read less than 0.5 ohms. If the reading is more than 0.5 ohms, remove the cables from motor to inverter and measure again. If this reading is other than 0.5 ohm or less, the motor windings in the stator have burned open and the motor must be repaired or replaced.

   e. Place one DMM probe on terminal W.

   f. Place the other DMM probe on terminal U.

Meter must read less than 0.5 ohms. If the reading is more than 0.5 ohms, remove the cables from motor to inverter and measure again. If this reading is other than 0.5 ohm or less, the motor windings in the stator have burned open and the motor must be repaired or replaced.

NOTE: A likely cause of motor contamination may be from a damaged input bearing seal on the transaxle.

5. Check for signs of oil or other contaminants within the motor. If contaminants are present, locate source and take corrective action.

Assemble

NOTE: The procedures described in this section apply to both right and left traction motors.

1. Install wave washer in stator housing. See Figure 23.
2. Carefully install stator into stator housing. See Figure 23. Take care not to damage power leads.

CAUTION

Use an arbor press and a proper size driver when installing bearings to rotor to avoid damage to bearing. Press only on the INNER race of the bearing. Always replace bearings in sets.

3. Install bearing onto rotor. See Figure 23.
4. Install rotor into stator and stator housing. See Figure 23.

CAUTION

Use an arbor press and a proper size driver when installing bearings to avoid damage to bearing. Press only on the OUTER race of the bearing. Always replace bearings in sets.

5. Install bearing into brake end bell. See Figure 23.
6. Install snap ring on inside brake end bell. See Figure 23.
7. Install new O-ring on the brake end bell. Install the brake end bell dowel pins and six screws into stator housing. Tighten the six screws to 23 N•m (204 lbf in). See Figure 23.
8. Install snap ring on rotor at brake end bell. See Figure 23.
9. Install new rear shaft seal into stator housing. See Figure 23.
10. Install new front shaft seal into brake end bell. See Figure 23.
11. Using two screws, install connection plate on stator housing. Tighten screws to 3 N•m (27 lbf in). See Figure 23.
12. Install nine nuts and washers on terminals on connection plate. Tighten bottom nuts to 8 N•m (71 lbf in). See Figure 23.

Install

NOTE: The procedures described in this section apply to both right and left traction motors.

1. Install repaired AC motor onto output housing. See **Transaxle** 1300SRM1370 for instructions.
2. Install parking brake and service brake components onto traction motor housings. See **Transaxle** 1300SRM1370 for instructions.
3. Install transaxle assembly onto lift truck. See **Transaxle** 1300SRM1370 for instructions.

FOR LIFT TRUCK E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

Remove

1. Remove traction motor from lift truck. See **Frame** 0100SRM1342 for instructions.

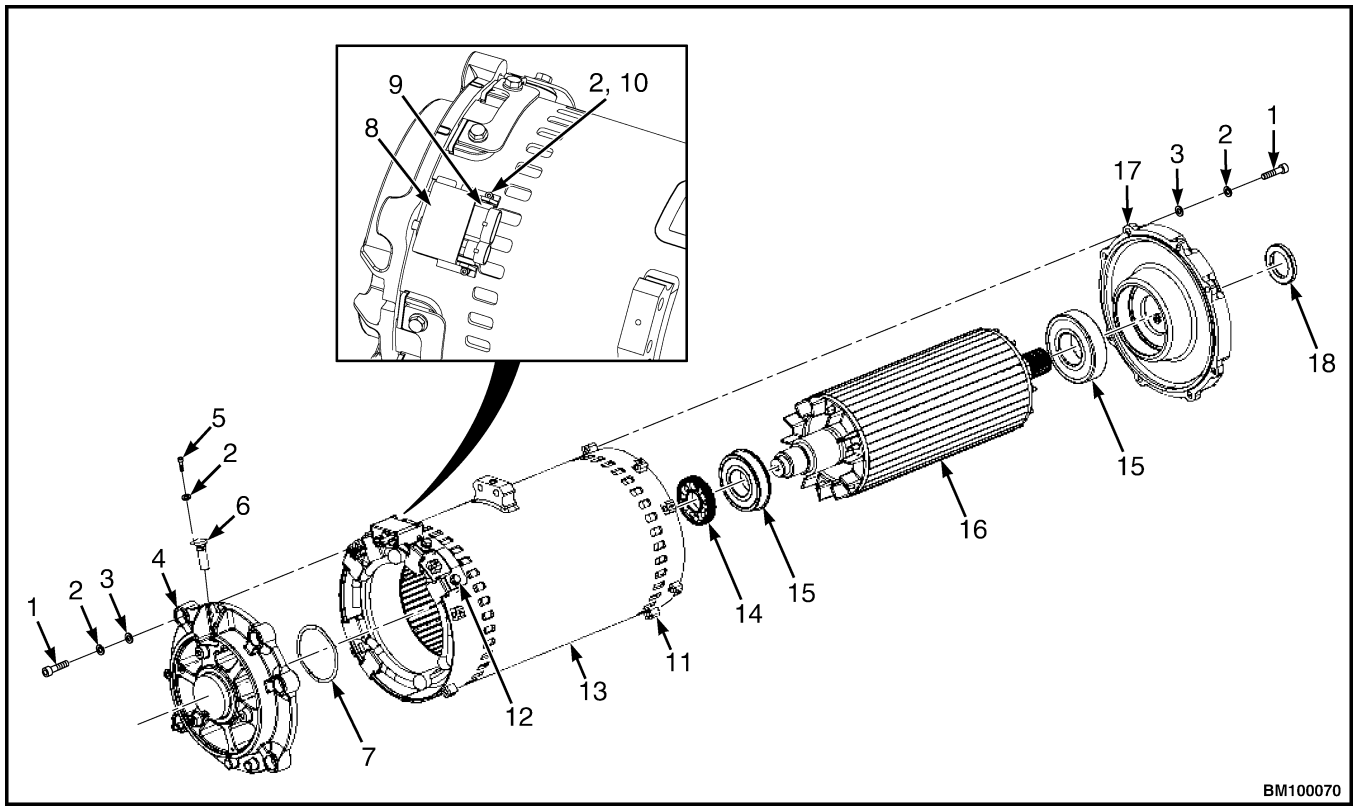
CAUTION

The traction motor can weigh as much as 230 kg (507 lb). To prevent injury, use a lifting device capable of lifting the assembly.

2. Place traction motor on level blocks on a flat surface with drive end pointing down. Remove floor jack.

Disassemble

1. Remove capscrew M6, lockwasher, and speed sensor from non-drive end head. See Figure 24.
2. Remove two socket-head capscrews, two lockwashers, sensor connector cover bracket, and sensor connector tab bracket from stator housing above sensor cable outlet. See Figure 24.
3. Remove five capscrews, lockwashers, and washers from stator Z-nuts and non-drive end head. See Figure 24.
4. Gently tap under non-drive end head and remove from stator housing. See Figure 24.
5. Pull sensor cable outlet from stator housing (see Figure 24) and disconnect speed sensor and temperature sensor connectors.



1. CAPSCREW
2. LOCKWASHER
3. WASHER
4. NON-DRIVE END HEAD
5. CAPSCREW M6
6. SPEED SENSOR
7. BEARING PRELOAD SPRING
8. SENSOR CONNECTOR COVER BRACKET
9. SENSOR CONNECTOR TAB BRACKET
10. LONG SOCKET-HEAD CAPSCREW
11. Z-NUT
12. TERMINAL BOLT
13. STATOR HOUSING
14. PROXIMITY SENSOR WHEEL
15. BEARING
16. ROTOR ASSEMBLY
17. DRIVE END HEAD
18. SHAFT SEAL

Figure 24. Traction Motor

6. Using a bearing puller, remove and discard proximity sensor wheel from non-drive end head. See Figure 24.

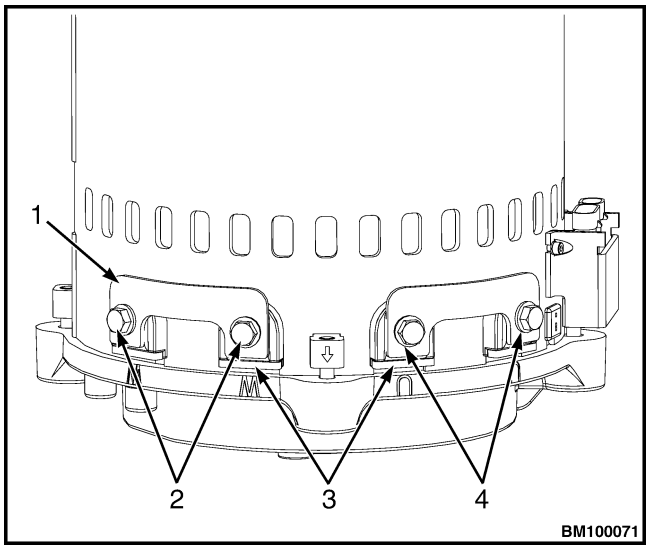
NOTE: When replacing one bearing, it is strongly recommended to replace both bearings.

NOTE: Note orientation of bearing components during disassembly to aid in assembly.

7. Using bearing puller, remove bearing from non-drive end head. See Figure 24.

8. Remove bearing preload spring from non-drive end head. See Figure 24.

9. Remove six terminal bolts, lockwashers, terminal covers, and terminal blocks from stator housing. See Figure 25.



1. TERMINAL COVER
2. TERMINAL BOLTS
3. TERMINAL BLOCKS
4. LOCK WASHER

Figure 25. Terminals

10. Remove five capscrews, lockwashers, and washers from Z-nuts on stator housing and drive end head. See Figure 24.

11. Attach approved lifting device to stator housing and slowly lift straight up, removing it from rotor assembly and drive end head. See Figure 24.

12. Screw lifting eye into threaded hole in end of rotor assembly. Attach approved lifting device and lift rotor assembly straight up from drive end head. See Figure 24.

NOTE: When replacing one bearing, it is strongly recommended to replace both bearings.

NOTE: Note orientation of bearing components prior to disassembly to aid in assembly.

13. Using bearing puller, remove bearing from drive end head. See Figure 24.

14. Remove and discard shaft seal from drive end head. See Figure 24.

Electrical Connector Repair or Replacement

1. If necessary, AMP Superseal tab assembly, tab contact, and wire seal (see Figure 24) may be repaired or replaced. See AMP Superseal 1.5 Connector Assemblies section of **Wire Harness Repair** 2200SRM1128 manual for instructions.

Clean

WARNING

Cleaning solvents can be flammable and toxic and can cause skin irritation. When using cleaning solvents, always follow the solvent manufacturer's recommended safety procedures.

1. Clean components with a clean cloth moistened with solvent and allow to air dry. DO NOT apply liquid solvent directly to components.

Inspect

1. Inspect rotor assembly and inside of stator housing for marks or grooves indicating contact between rotor and stator. Replace if damaged.

2. Check that the bearings roll smoothly and are not loose from excessive wear. Replace as necessary. Replace the bearings regardless of condition if motor has been subjected to thermal overload (see Step 3). In case of a catastrophic bearing failure, damage may result to other motor components and possibly to transaxle.

3. Check stator windings for signs of thermal overload. Signs of thermal overload are dark-stained, brittle, or burnt insulation. Thermal overload will shorten the life of the stator.

4. Check motor windings resistance as indicated below. To measure continuity between U, V, and W terminals of motor use a digital multimeter (DMM) set to Ohms.

a. Place one DMM probe on terminal U.

b. Place the other DMM probe on terminal V.

Meter must read less than 0.5 ohms. If the reading is more than 0.5 ohms, remove the cables from motor to inverter and measure again. If this reading is other than 0.5 ohm or less, the motor windings in the stator have burned open and the motor must be repaired or replaced.

c. Place one DMM probe on terminal V.

d. Place the other DMM probe on terminal W.

Meter must read less than 0.5 ohms. If the reading is more than 0.5 ohms, remove the cables from motor to inverter and measure again. If this reading is other than 0.5 ohm or less, the motor windings in the stator have burned open and the motor must be repaired or replaced.

e. Place one DMM probe on terminal W.

f. Place the other DMM probe on terminal U.

Meter must read less than 0.5 ohms. If the reading is more than 0.5 ohms, remove the cables from motor to inverter and measure again. If this reading is other than 0.5 ohm or less, the motor windings in the stator have burned open and the motor must be repaired or replaced.

5. Check terminal flags for cracks or other damage. Replace if damaged.

6. Check for signs of oil or other contaminants within motor. If necessary, locate source of contaminants and take corrective action.

7. Inspect all other components and replace as necessary.

Assemble

1. Using a seal driver, install new shaft seal into drive end head. See Figure 24.

CAUTION

Use an arbor press and a proper size driver when installing bearings to avoid damage to bearings and/or end shields. Press only on the outer race of the bearing. Always replace bearings in sets.

2. Install bearing into drive end head as noted during disassembly. See Figure 24.

3. Screw lifting eye into threaded hole in the end of rotor assembly. Attach approved lifting device and lower rotor assembly onto drive end head. Ensure bearing is fully seated against drive end head. See Figure 24.

4. Remove lifting device and lifting eye from rotor assembly.

NOTE: Make sure holes for stator Z-nuts are aligned with capscrew holes.

5. Using approved lifting device, lower stator housing onto drive end head. See Figure 24.

6. Install five washers, lockwashers, and capscrews into drive end head and stator Z-nuts on stator housing. See Figure 24. Tighten capscrews to 25 to 30 N•m (18 to 22 lbf ft).

7. Install six terminal bolts, lockwashers, terminal covers, and terminal blocks onto stator housing, non-drive end. Tighten terminal bolts to 23 to 25 N•m (17 to 18.5 lbf ft). See Figure 24.

8. Install bearing preload spring into non-drive end head. See Figure 24.

9. Install bearing into non-drive end head as noted during disassembly. See Figure 24.

10. Install new proximity sensor wheel into non-drive end head. See Figure 24.

11. Place sensor cable outlet into position on stator housing (see Figure 24). Connect proximity sensor and temperature sensor connectors to sensor cable outlet.

12. Install non-drive end head onto stator housing. See Figure 24.

13. Install five washers, lockwashers, and capscrews into non-drive end head and stator Z-nuts on stator housing. See Figure 24. Tighten capscrews to 25 to 30 N•m (18 to 22 lbf ft).

14. Install sensor connector tab bracket, sensor connector cover bracket, two lockwashers, and two socket-head capscrews onto stator housing over sensor cable outlet. See Figure 24.

15. Install speed sensor, lockwasher, and capscrew M6 onto non-drive end head and stator housing. See Figure 24.

Install

1. Install traction motor onto drive axle. See **Frame** 0100SRM1342 for installation instructions.

TRACTION MOTOR REPAIR FOR LIFT TRUCK J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

Remove

NOTE: Disconnect all electrical connections to the traction motor assembly prior to removal. The procedures described in this section apply to both right and left sides of the traction motor assembly. See **Transaxle** 1300SRM1539 for preparation of the lift truck for transaxle removal.

1. Remove the six upper nuts, six lock washers, and the lift truck power cables. See Figure 26.

2. Position power cables out of the way.

3. Remove transaxle assembly from lift truck. See **Transaxle** 1300SRM1539 for instructions.

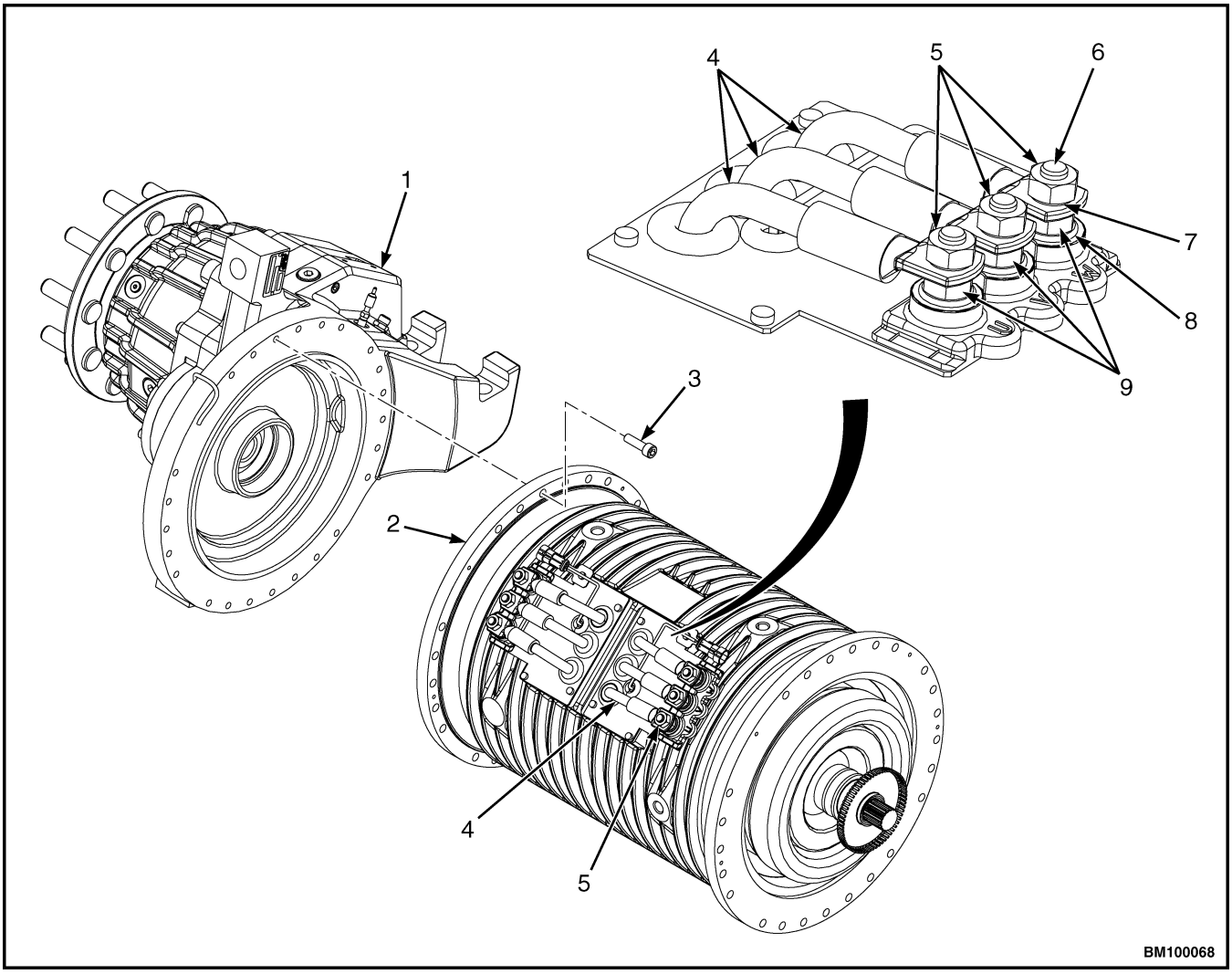
4. Remove service and parking brake components from traction motor housing. See **Transaxle** 1300SRM1539 for instructions.

5. Remove 24 capscrews holding the traction motor assembly to the gear box. See Figure 26.

6. Strike gear box and traction motor assembly joining surface with soft hammer to free traction motor assembly from the gear box.

7. Remove traction motor and dispose of properly.

NOTE: Remove dowel pins or leave in gear box if present.



1. GEAR BOX
2. TRACTION MOTOR ASSEMBLY
3. CAPSCREW
4. TRACTION MOTOR POWER CABLE
5. UPPER NUT
6. TRACTION MOTOR POWER TERMINAL
7. LOCK WASHER
8. WASHER
9. LOWER NUT

Figure 26. Traction Motor

Clean

WARNING

Cleaning solvents can be flammable and toxic and can cause skin irritation. When using cleaning solvents, always follow the solvent manufacturer's recommended safety procedures.

1. Clean components with a clean cloth moistened with solvent and allow to thoroughly dry. DO NOT apply liquid solvent directly to stator windings.

Install

NOTE: The procedures described in this section apply to both right and left traction motor assembly. The traction motors in this section are non-serviceable. The entire motor assembly must be replaced. See Figure 26.

1. If dowel pins were removed, install dowel pins and align with dowel holes.
2. Connect the traction motor assembly and the gear box.
3. Install 24 capscrews and tighten to 45 N•m (33 lbf ft). See Figure 26.
4. Install parkbrake and service brake components onto traction motor housing. See **Transaxle** 1300SRM1539 for instructions.
5. Install transaxle assembly into lift truck. See **Transaxle** 1300SRM1539 for instructions.
6. Tighten lower nuts on traction motor power terminals to 15 N•m (11 lbf ft). See Figure 26.
7. Place lift truck power cables onto traction motor power terminals.
8. Install 6 lock washers and 6 upper nuts onto traction motor power terminals. Tighten to 6 to 8 N•m (53 to 71 lbf in). See Figure 26.

Hydraulic Motor Repair

FOR LIFT TRUCKS J1.5-2.0XNT (J30-40XNT) (K160), J1.6-2.0XN (J30-40XN) (A935), AND E30-40HSD$_2$ (B219), E30-40HSD$_3$ (C219)

Remove

1. Remove hydraulic pump and motor assembly from lift truck. See one of the following manuals for removal instructions:

   Hydraulic System 1900SRM1333 for lift truck models

   - J1.5-2.0XNT (J30-40XNT) (K160)
   - J1.6-2.0XN (J30-40XN) (A935)

   Hydraulic System 1900SRM1413 for lift truck models

   - E30-40HSD$_2$ (B219)
   - E30-40HSD$_3$ (C219)

2. Place hydraulic pump and motor assembly on a clean work bench or other suitable surface.

3. Remove two capscrews and drive end bracket from hydraulic pump and motor assembly.

   See Figure 27 for lift truck models

   - J1.5-2.0XNT (K160) manufactured before November, 2014
   - J30-40XNT (K160)
   - JJ1.6-2.0XN (J30-40XN) (A935)
   - E30-40HSD$_2$ (B219), E30-40HSD$_3$ (C219)

   See Figure 28 for lift truck models

   - J1.5-2.0XNT (K160) manufactured after November, 2014

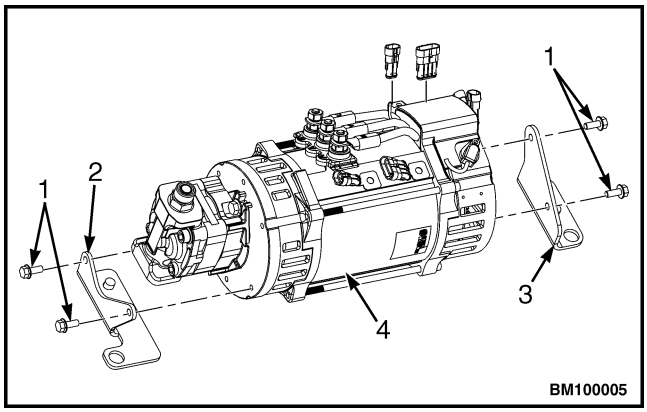
4. Remove two capscrews and terminal end bracket from hydraulic pump and motor assembly.

   See Figure 27 for lift truck models

   - J1.5-2.0XNT (K160) manufactured before November, 2014
   - J30-40XNT (K160)
   - JJ1.6-2.0XN (J30-40XN) (A935)
   - E30-40HSD$_2$ (B219), E30-40HSD$_3$ (C219)

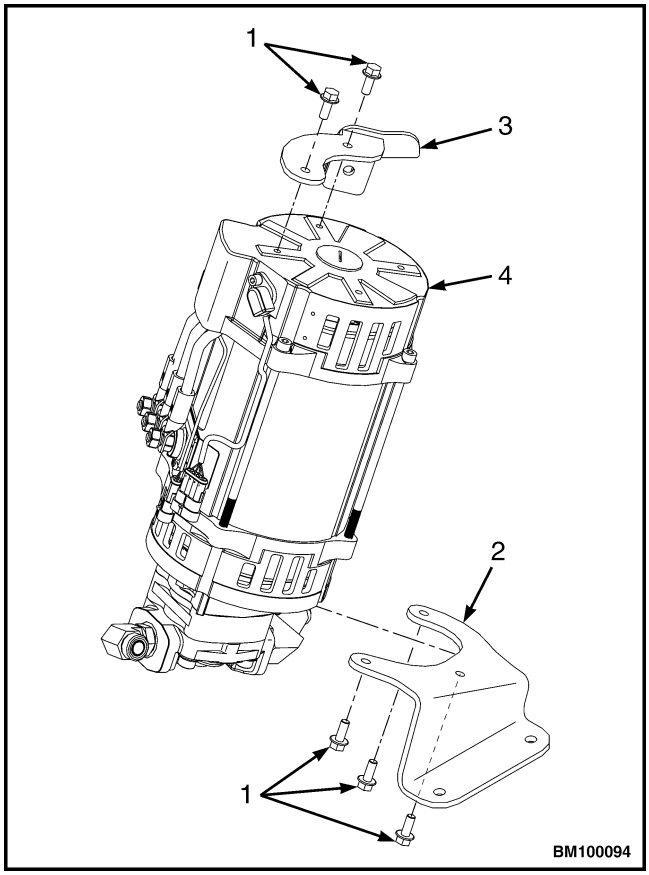
   See Figure 28 for lift truck models

   - J1.5-2.0XNT (K160) manufactured after November, 2014



1. CAPSCREWS
2. DRIVE END BRACKET
3. TERMINAL END BRACKET
4. HYDRAULIC PUMP AND MOTOR ASSEMBLY

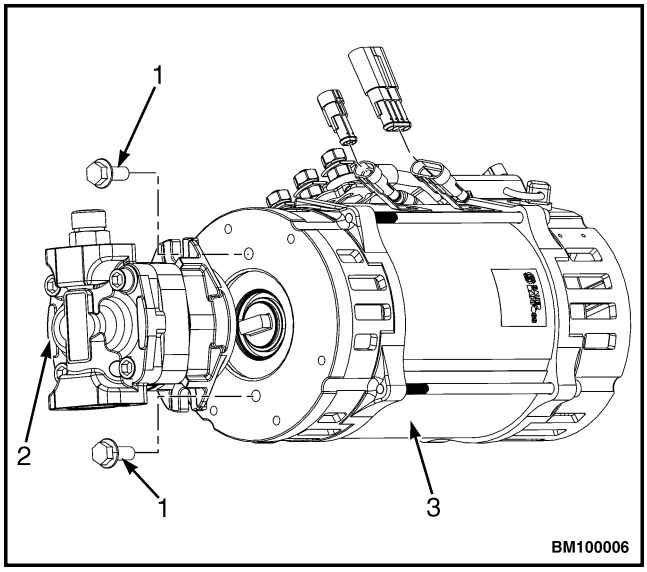
Figure 27. Hydraulic Pump and Motor Mounting, Lift Truck Models J1.5-2.0XNT (K160) Manufactured Before November, 2014 and J30-40XNT (K160), J1.6-2.0XN (J30-40XN) (A935), E30-40HSD$_3$ (C219), and E30-40HSD$_2$ (B219)



1. CAPSCREWS
2. DRIVE END BRACKET
3. TERMINAL END BRACKET
4. HYDRAULIC PUMP AND MOTOR ASSEMBLY

Figure 28. Hydraulic Pump and Motor Mounting, Lift Truck Models J1.5-2.0XNT (K160) Manufactured After November, 2014

5. Remove two capscrews retaining hydraulic pump to hydraulic motor. See Figure 29.



1. CAPSCREWS
2. HYDRAULIC PUMP
3. HYDRAULIC MOTOR

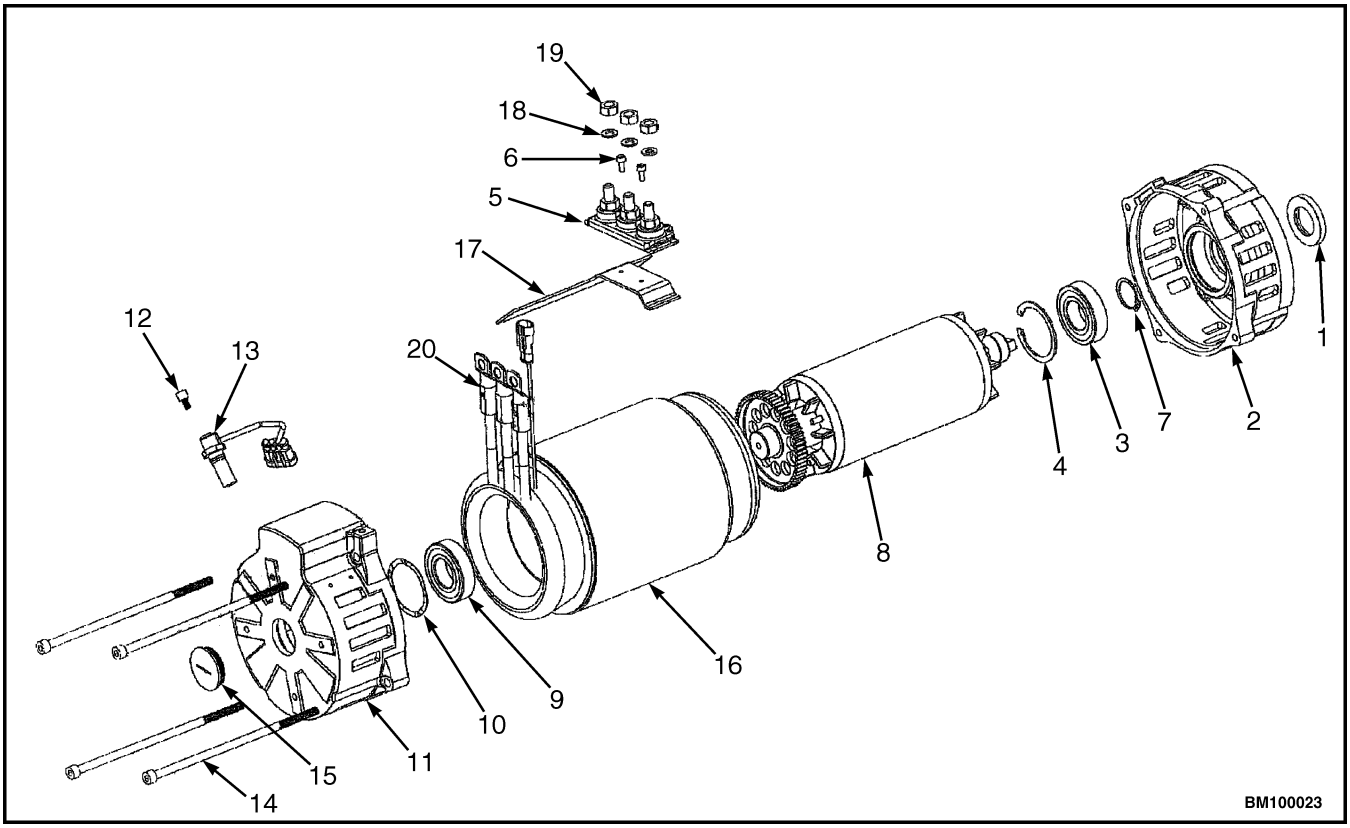
Figure 29. Hydraulic Pump to Hydraulic Motor

6. Remove hydraulic pump with drive coupling from hydraulic motor.

Disassemble

1. Place hydraulic motor in a vise with terminal posts on top and carefully clamp vise onto stator housing.

2. Remove hex nuts and disconnect power leads from terminal posts. See Figure 30.



1. SHAFT SEALING RING
2. DRIVE END SHIELD
3. DRIVE BALL BEARING
4. LOCKING RING
5. TERMINAL POST
6. CAPSCREW
7. SNAP RING
8. ROTOR
9. NON-DRIVE BALL BEARING
10. WAVED SPRING WASHER
11. NON-DRIVE END SHIELD
12. SENSOR SCREW
13. SPEED SENSOR
14. TIE ROD
15. CAP
16. STATOR HOUSING
17. TERMINAL POST BRACKET
18. SPRING WASHER
19. HEX NUT
20. POWER LEAD

Figure 30. Hydraulic Motor Components

3. Remove two capscrews, terminal posts, and terminal post bracket from stator housing. See Figure 30.

4. Remove four tie rods holding non-drive end shield and drive end shield to stator housing. See Figure 30.

CAUTION

Disposal of silicone sealant must meet local environmental regulations.

NOTE: Note threading position and orientation of power leads and thermal sensor connector wire through non-drive end shield during disassembly to aid in assembly.

NOTE: Silicone seal for power leads and thermal sensor connector wire must be broken prior to shield removal.

5. Remove non-drive end shield from stator housing. See Figure 30.

6. Using bearing puller, remove non-drive ball bearing from non-drive end shield. See Figure 30.

7. Remove waved spring washer from non-drive end shield. See Figure 30.

8. Remove stator housing from drive end shield and rotor. See Figure 30.

9. Remove shaft sealing ring from drive end shield and rotor. See Figure 30.

10. Remove rotor from drive end shield. See Figure 30.

11. Remove snap ring from drive end of rotor shaft. See Figure 30.

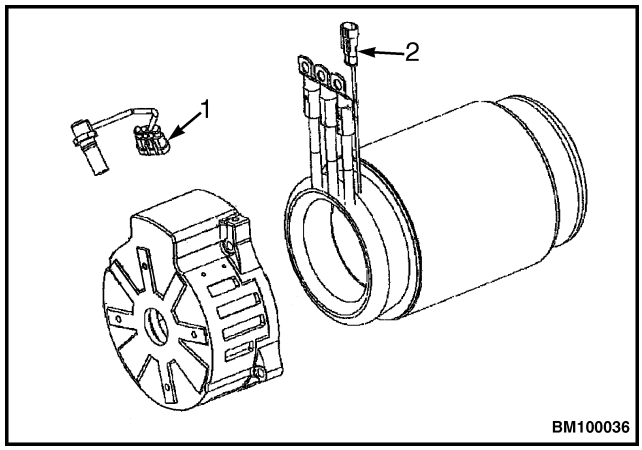
12. Using bearing puller, carefully remove drive end ball bearing from drive end shield. See Figure 30.

13. Remove locking ring from drive end shield. See Figure 30.

14. Remove cap from non-drive end shield. See Figure 30.

Electrical Connector Repair or Replacement

1. If necessary, speed sensor connector and/or thermal sensor connector may be repaired or replaced. See Figure 31. See AMP Superseal 1.5 Connector Assemblies section of **Wire Harness Repair** 2200SRM1128 manual for instructions.



1. SPEED SENSOR CONNECTOR
2. THERMAL SENSOR CONNECTOR

Figure 31. Electrical Connectors

2. Wire connections for speed sensor connector are shown in Table 1.

Table 1. Speed Sensor Connector

Pin	Wire Color	Description
1	Red	24V -0/+5
2	Blue	Signal B
3	White	Signal A
4	Black	Ground

3. Wire connections for thermal sensor connector are shown in Table 2.

Table 2. Thermal Sensor Connector

Pin	Wire Color	Description
1	Red	Positive
2	White	Negative

Clean

WARNING

Cleaning solvents can be flammable and toxic and can cause skin irritation. When using cleaning solvents, always follow the solvent manufacturer's recommended safety procedures.

1. Clean components with a clean cloth moistened with solvent and allow to air dry. DO NOT apply liquid solvent directly to components.

2. Check for signs of oil or other contaminants within motor. If necessary, locate source of contaminants and take corrective action.

3. Clean all joints, remove all foreign matter ad contaminants such as release agents, grease, oil, dust, water, protective coatings, old adhesives or sealants, and other substances which could affect silicone seal adhesion.

Inspect

1. Inspect rotor and inside of motor case for marks or grooves indicating contact between rotor and motor case. Replace if damaged.
2. Bearings should fit snugly where they ride on the shaft. If there is excessive wear, replace the bearing.
3. Check bearings for smooth operation. If a clean bearing does not roll smoothly, it must be replaced.
4. Check rotor windings for signs of thermal overload. Signs of thermal overload are dark-stained, brittle, or burnt insulation. Thermal overload will shorten the life of the stator housing.
5. Check motor windings resistance as indicated below. To measure continuity between U, V, and W terminals of motor use a digital multimeter (DMM) set to Ohms.
   a. Place one DMM probe on terminal U.
   b. Place the other DMM probe on terminal V.

      Meter must read less than 0.5 ohms. If the reading is more than 0.5 ohms, remove the cables from motor to inverter and measure again. If this reading is other than 0.5 ohm or less, the motor windings in the stator have burned open and the motor must be repaired or replaced.

   c. Place one DMM probe on terminal V.
   d. Place the other DMM probe on terminal W.

      Meter must read less than 0.5 ohms. If the reading is more than 0.5 ohms, remove the cables from motor to inverter and measure again. If this reading is other than 0.5 ohm or less, the motor windings in the stator have burned open and the motor must be repaired or replaced.

   e. Place one DMM probe on terminal W.
   f. Place the other DMM probe on terminal U.

      Meter must read less than 0.5 ohms. If the reading is more than 0.5 ohms, remove the cables from motor to inverter and measure again. If this reading is other than 0.5 ohm or less, the motor windings in the stator have burned open and the motor must be repaired or replaced.

Assemble

1. Install cap in non-drive end shield. See Figure 32.
2. Install locking ring in drive end shield. See Figure 32.

CAUTION

Use an arbor press and a proper size driver when installing bearings to avoid damage to bearings and/or end shields. Press only on the outer race of the bearing. Always replace bearings in sets.

3. Carefully install drive end ball bearing in drive end shield. See Figure 32.
4. Install snap ring onto drive end of rotor shaft. See Figure 32.
5. Install rotor in drive end shield. See Figure 32.
6. Install shaft sealing ring onto rotor and drive end shield. See Figure 32.
7. Install stator housing onto rotor and drive end shield. See Figure 32.
8. Install waved spring washer in non-drive end shield. See Figure 32.

CAUTION

Use an arbor press and a proper size driver when installing bearings to avoid damage to bearings and/or end shields. Press only on the outer race of the bearing. Always replace bearings in sets.

9. Carefully install non-drive end ball bearing in non-drive end shield. See Figure 32.

NOTE: Take care when routing power leads and thermal sensor through non-drive end shield as noted during disassembly.

NOTE: Ensure waved spring washer remains in position during non-drive end shield installation.

10. Install non-drive end shield onto stator housing. See Figure 32.

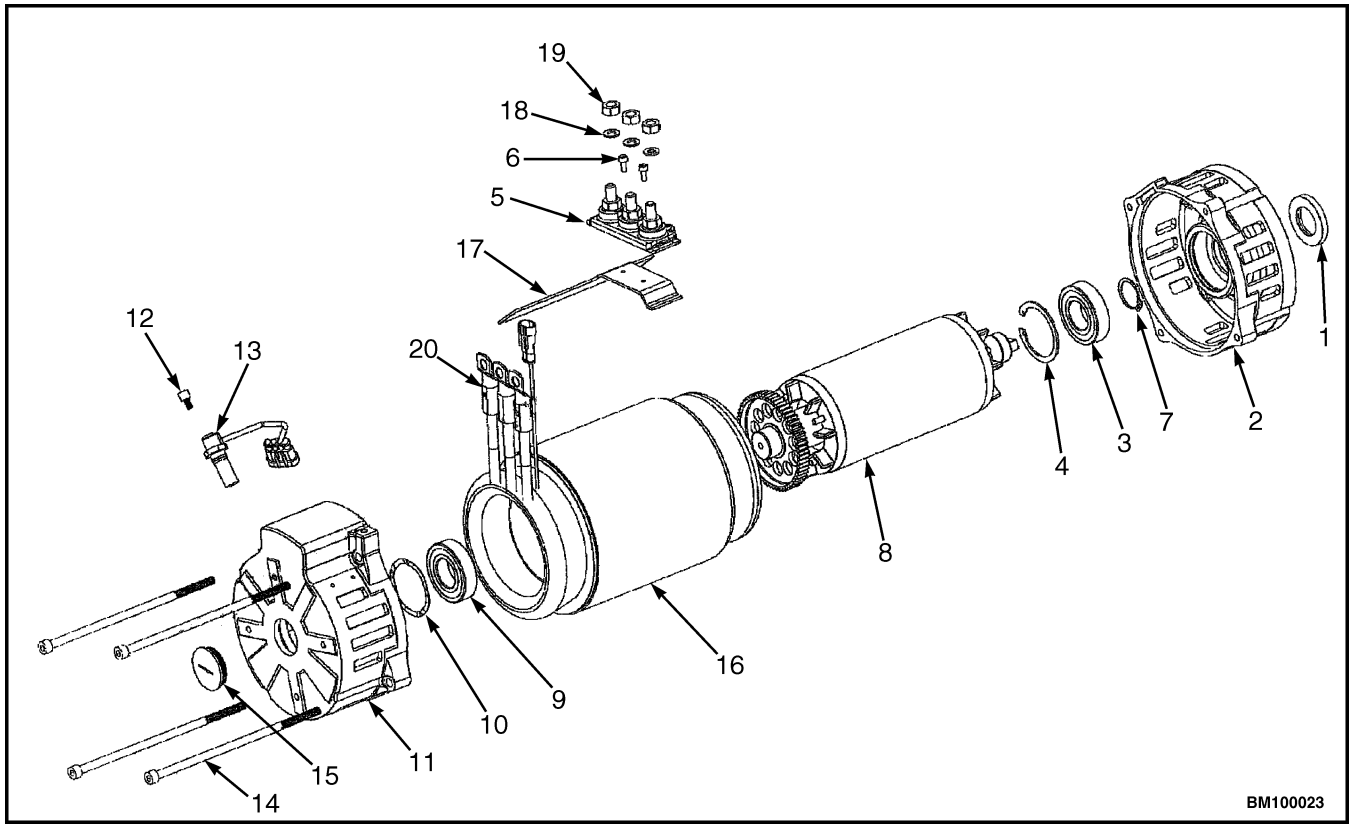
11. Apply neutral curing, high temperature silicone sealant, rated for at least 260°C (500°F), between stator housing and non-drive end shield to protect power leads and thermal sensor.

12. Install four tie rods in non-drive end shield and drive end shield, holding stator housing between shields. Tighten screws to 14 to 17 N•m (124 to 150 lbf in). See Figure 32.

13. Install terminal post bracket, terminal posts and two capscrews onto stator housing. See Figure 32.

14. Connect power leads to terminal posts.

15. Install hex nuts onto terminal posts. See Figure 32. Tighten hex nuts to 14 to 16 N•m (124 to 142 lbf in).



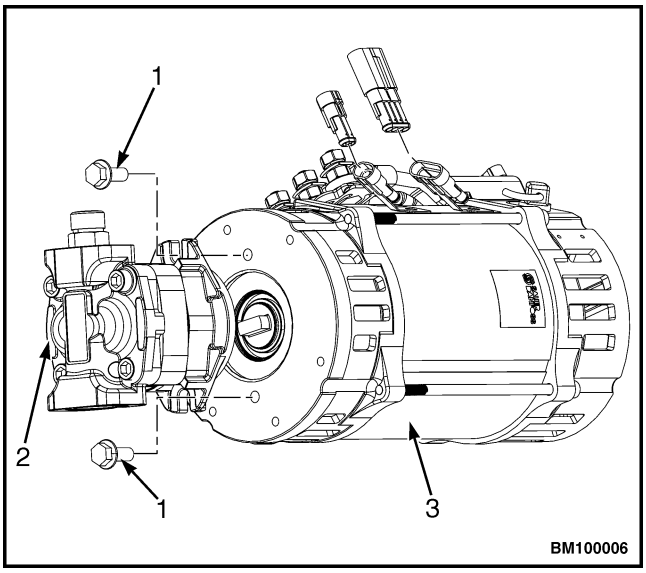
1. SHAFT SEALING RING
2. DRIVE END SHIELD
3. DRIVE BALL BEARING
4. LOCKING RING
5. TERMINAL POST
6. CAPSCREW
7. SNAP RING
8. ROTOR
9. NON-DRIVE BALL BEARING
10. WAVED SPRING WASHER
11. NON-DRIVE END SHIELD
12. SENSOR SCREW
13. SPEED SENSOR
14. TIE ROD
15. CAP
16. STATOR HOUSING
17. TERMINAL POST BRACKET
18. SPRING WASHER
19. HEX NUT
20. POWER LEAD

Figure 32. Hydraulic Motor Components

Install

1. Install drive coupling onto rotor. Install hydraulic pump over coupling onto hydraulic motor.

2. Apply Loctite 271 to two capscrews and install in hydraulic pump and hydraulic motor. See Figure 33. Tighten capscrews to 47 N•m (35 lbf ft).



1. CAPSCREW
2. HYDRAULIC PUMP
3. HYDRAULIC MOTOR

Figure 33. Hydraulic Pump to Hydraulic Motor

3. Install non-drive end bracket and two capscrews onto hydraulic pump and motor assembly.

   See Figure 34 for lift truck models

   - J1.5-2.0XNT (K160) manufactured before November, 2014
   - J30-40XNT (K160)
   - JJ1.6-2.0XN (J30-40XN) (A935)
   - E30-40HSD$_2$ (B219), E30-40HSD$_3$ (C219)

   See Figure 35 for lift truck models

   - J1.5-2.0XNT (K160) manufactured after November, 2014

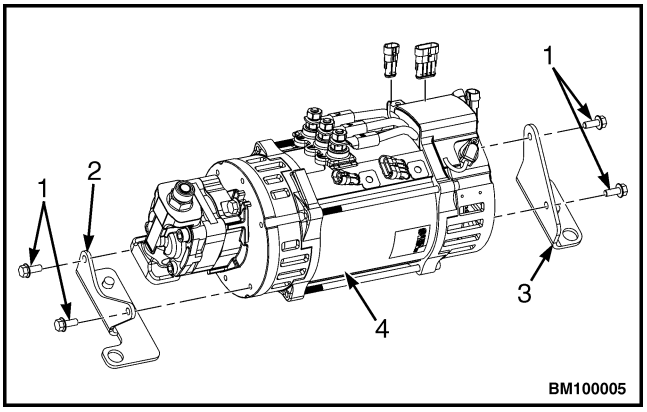
4. Install drive end bracket and two capscrews onto hydraulic pump and motor assembly.

   See Figure 34 for lift truck models

   - J1.5-2.0XNT (K160) manufactured before November, 2014
   - J30-40XNT (K160)
   - JJ1.6-2.0XN (J30-40XN) (A935)
   - E30-40HSD$_2$ (B219), E30-40HSD$_3$ (C219)

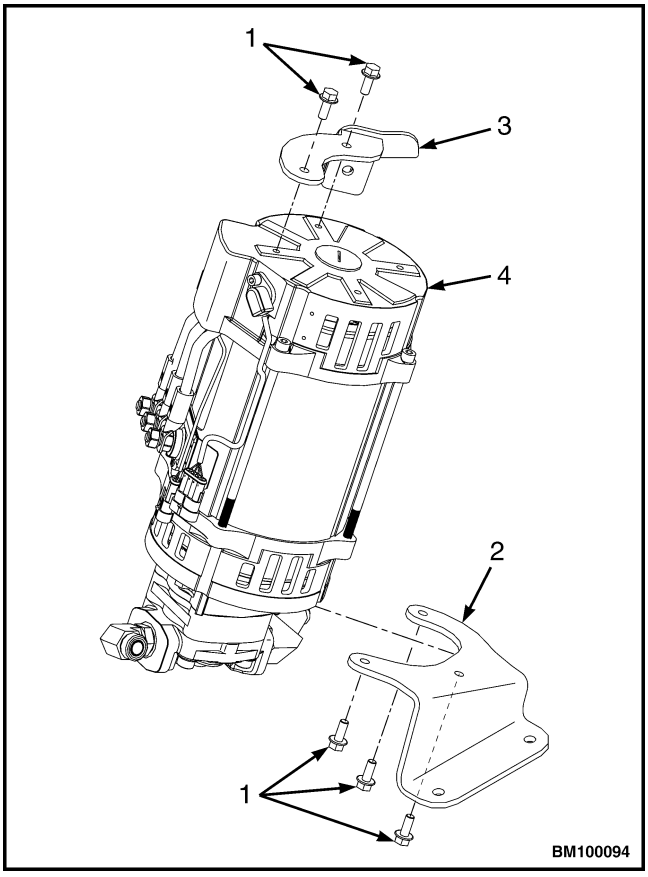
   See Figure 35 for lift truck models

   - J1.5-2.0XNT (K160) manufactured after November, 2014



1. CAPSCREW
2. DRIVE END BRACKET
3. NON-DRIVE END BRACKET
4. HYDRAULIC PUMP AND MOTOR ASSEMBLY

Figure 34. Hydraulic Pump and Motor Mounting, Lift Truck Models J1.5-2.0XNT (K160) Manufactured Before November, 2014 and J30-40XNT (K160), J1.6-2.0XN (J30-40XN) (A935), E30-40HSD$_3$ (C219), and E30-40HSD$_2$ (B219)



1. CAPSCREWS
2. DRIVE END BRACKET
3. TERMINAL END BRACKET
4. HYDRAULIC PUMP AND MOTOR ASSEMBLY

Figure 35. Hydraulic Pump and Motor Mounting, Lift Truck Models J1.5-2.0XNT (K160) Manufactured After November, 2014

5. Install hydraulic pump and motor assembly in counterweight. See one of the following manuals for installation instructions:

Hydraulic System 1900SRM1333 for lift truck models

- J1.5-2.0XNT (J30-40XNT) (K160)
- J1.6-2.0XN (J30-40XN) (A935)

Hydraulic System 1900SRM1413 for lift truck models

- E30-40HSD$_2$ (B219)
- E30-40HSD$_3$ (C219)

FOR LIFT TRUCK E2.2-3.5XN (E45-70XN) (A268)

Remove

1. Remove hydraulic pump and motor assembly from lift truck. See **Hydraulic System** 1900SRM1367 for removal instructions.

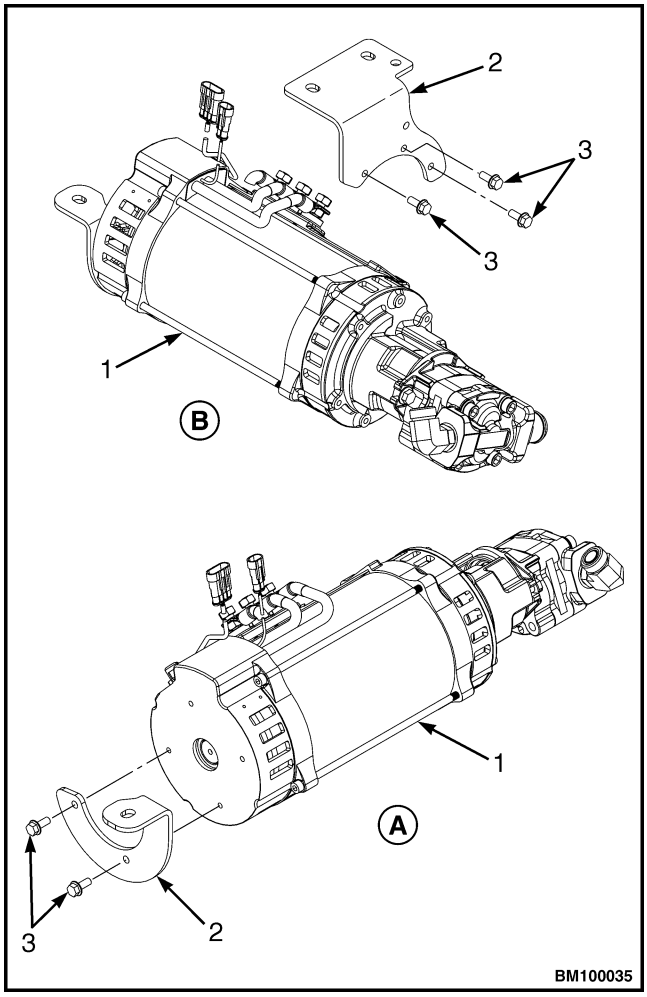
2. Place hydraulic pump and motor assembly on a clean workbench or other suitable surface.

3. Remove five capscrews and two motor mount brackets from hydraulic pump and motor assembly. See Figure 36.

NOTE: Note orientation of fitting and suction adapter during removal to aid in installation.

4. Remove fitting from pump. See Figure 37.

5. Remove suction adapter from pump. See Figure 37.



NOTE: STANDARD MOTOR ASSEMBLY SHOWN.

A. FRONT VIEW **B.** REAR VIEW

1. HYDRAULIC PUMP AND MOTOR ASSEMBLY
2. MOTOR MOUNT BRACKET
3. MOTOR MOUNT CAPSCREW

Figure 36. Motor Mount Brackets

NOTE: Note position of inlet and outlet ports of pump for correct alignment during installation.

6. Remove two capscrews fastening pump to motor. Carefully remove pump from motor. See Figure 37.

NOTE: Perform Step 7 for standard motor.

7. Loosen two setscrews in coupling. DO NOT lose two keys between coupling and shaft. Remove coupling from motor. See Figure 37.

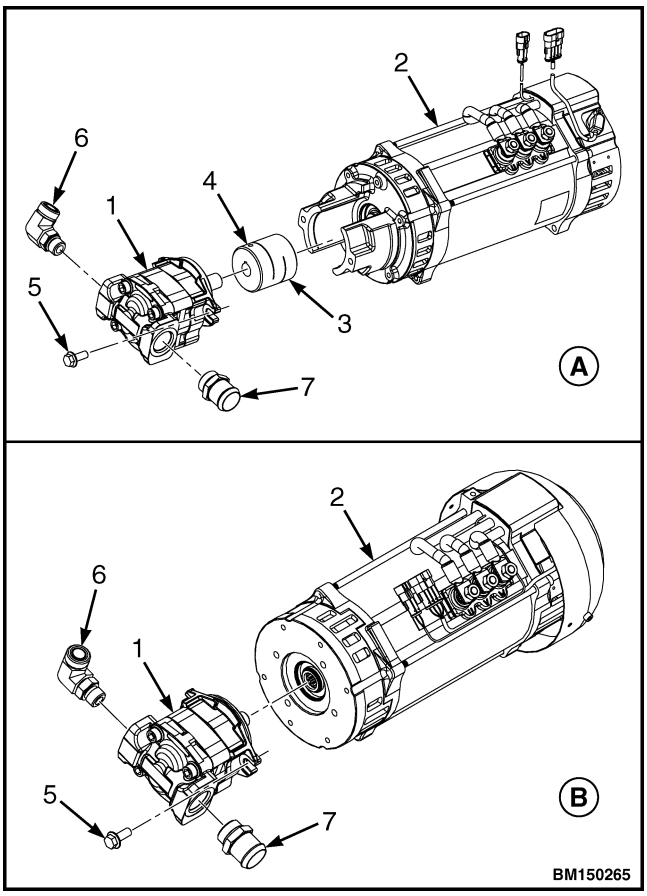


Figure 37. Pump and Motor Assembly

Legend for Figure 37

A. STANDARD MOTOR
B. ENHANCED MOTOR

1. PUMP
2. MOTOR
3. COUPLING
4. SETSCREW
5. CAPSCREW
6. FITTING
7. SUCTION ADAPTER

Disassemble

Standard Motor

1. Place motor in a vise with terminal posts on top and carefully clamp vise on stator housing.

2. Remove three hex nuts and spring washers from terminal posts. See Figure 38.

3. Disconnect power leads from terminal posts. See Figure 38.

4. Remove two screws, terminal posts, and terminal post bracket from stator housing. See Figure 38.

5. Remove four tie rods holding end shields to stator housing. See Figure 38.

6. Remove cap from non-drive end shield. Remove and discard O-ring from cap. See Figure 38.

CAUTION

Disposal of silicone sealant must meet local environmental regulations.

NOTE: Note threading position and orientation of power leads and thermal sensor connector wire through non-drive end shield during disassembly to aid in assembly.

NOTE: Silicone seal for power leads and thermal sensor connector wire must be broken prior to shield removal.

7. Remove non-drive end shield from stator housing. See Figure 38.
8. Using bearing puller, carefully remove non-drive end ball bearing from non-drive end shield. See Figure 38.
9. Remove O-ring seal from non-drive end shield. See Figure 38.
10. Remove waved spring washer from non-drive end shield. See Figure 38.
11. Remove capscrew and speed sensor from non-drive end shield. See Figure 38.
12. Remove drive end shield and rotor from stator housing. See Figure 38.
13. Remove woodruff key from drive end of rotor shaft. See Figure 38.
14. Remove snap ring from drive end of rotor. See Figure 38.
15. Remove rotor from drive end shield. See Figure 38.
16. Remove locking ring from drive end shield. See Figure 38.
17. Using bearing puller, carefully remove drive end ball bearing from drive end shield. See Figure 38.

Enhanced Motor

1. Place motor in a vise with terminal posts on top and carefully clamp vise on stator housing.
2. Remove three hex nuts and spring washers from terminal posts. See Figure 38.
3. Disconnect power leads from terminal posts. See Figure 38.
4. Remove two screws, terminal posts, bracket, and terminal post bracket from stator housing. See Figure 38.

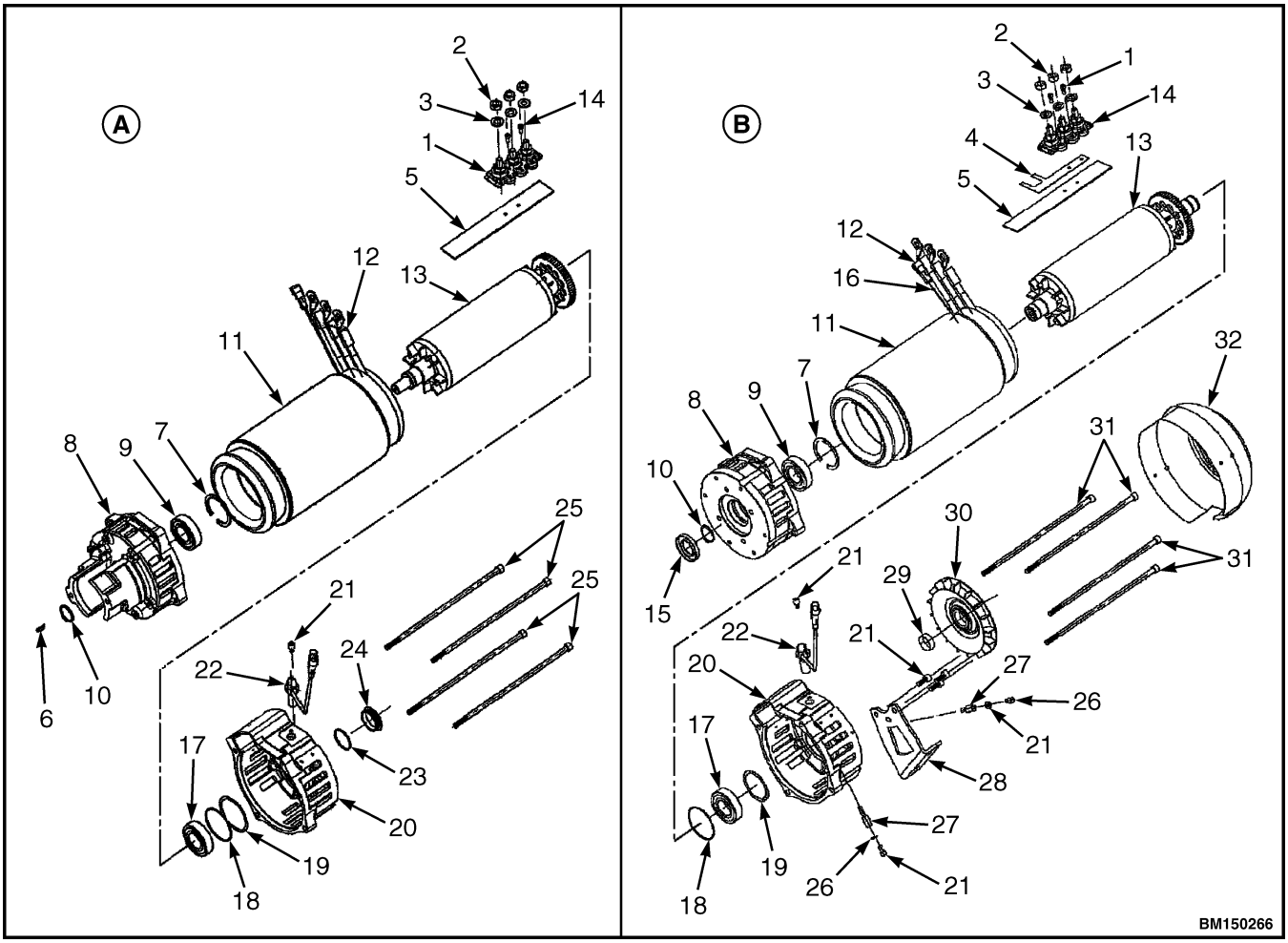
CAUTION

Disposal of silicone sealant must meet local environmental regulations.

NOTE: Note threading position and orientation of power leads and thermal sensor connector wire through non-drive end shield during disassembly to aid in assembly.

NOTE: Silicone seal for power leads and thermal sensor connector wire must be broken prior to shield removal.

5. Remove four capscrews, fan cover, four washers, and four spacers from non-drive end shield. See Figure 38.



A. STANDARD MOTOR

1. TERMINAL POST
2. HEX NUT
3. SPRING WASHER
4. BRACKET
5. TERMINAL POST BRACKET
6. WOODRUFF KEY
7. SNAP RING
8. DRIVE END SHIELD
9. DRIVE END BALL BEARING
10. LOCKING RING
11. STATOR HOUSING
12. POWER LEAD
13. ROTOR
14. SCREW
15. OIL SEAL
16. THERMAL SENSOR

B. ENHANCED MOTOR

17. NON-DRIVE END BALL BEARING
18. O-RING SEAL
19. WAVED SPRING WASHER
20. NON-DRIVE END SHIELD
21. CAPSCREW
22. SPEED SENSOR
23. O-RING
24. CAP
25. TIE ROD
26. WASHER
27. FAN COVER SPACER
28. MOUNTING BRACKET
29. RETAINING BUSHING
30. COOLING FAN
31. M8 X 270 SCREW
32. FAN COVER

Figure 38. Hydraulic Motor

6. Remove four M8 X 270 screws holding end shields to stator housing. See Figure 38.

7. Remove cooling fan from non-drive end shield. Remove retaining bushing from fan. See Figure 38.

8. Remove three capscrews and mounting bracket from non-drive end shield. See Figure 38.

9. Remove non-drive end shield from stator housing. See Figure 38.

10. Using bearing puller, carefully remove non-drive end ball bearing from non-drive end shield. See Figure 38.

11. Remove O-ring seal from non-drive end shield. See Figure 38.

12. Remove waved spring washer from non-drive end shield. See Figure 38.

13. Remove capscrew and speed sensor from non-drive end shield. See Figure 38.

14. Remove drive end shield and rotor from stator housing. See Figure 38.

15. Remove snap ring from drive end of rotor. See Figure 38.

16. Remove rotor from drive end shield. See Figure 38.

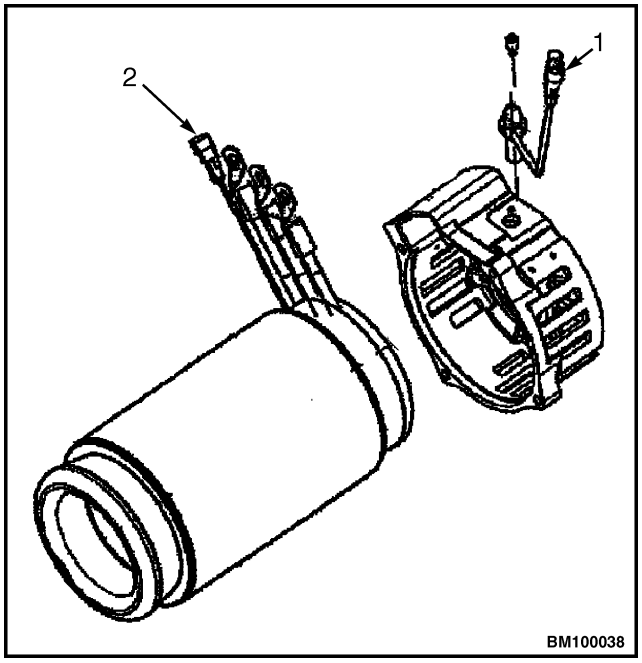
17. Remove oil seal from drive end shield. See Figure 38.

18. Remove locking ring from drive end shield. See Figure 38.

19. Using a bearing puller, carefully remove drive end ball bearing from drive end shield. See Figure 38.

Electrical Connector Repair or Replacement

1. If necessary, speed sensor connector and/or thermal sensor connector may be repaired or replaced. See Figure 39. See AMP Superseal 1.5 Connector Assemblies section of **Wire Harness Repair** 2200SRM1128 manual for instructions.

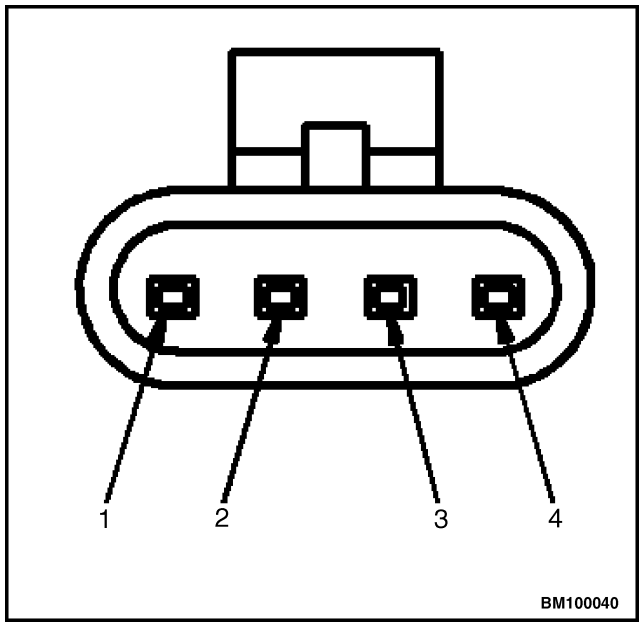


NOTE: STANDARD MOTOR SHOWN

1. SPEED SENSOR CONNECTOR
2. THERMAL SENSOR CONNECTOR

Figure 39. Electrical Connectors

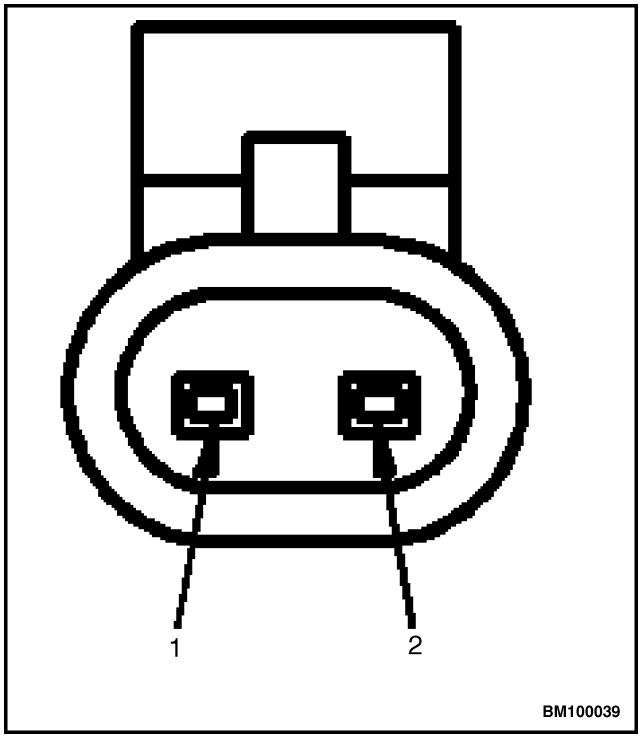
2. Connections for speed sensor connector are shown in Figure 40.



1. SUPPLY
2. SIGNAL B
3. SIGNAL A
4. GROUND

Figure 40. Speed Sensor Wire Connections

3. Connections for thermal sensor connector are shown in Figure 41.



1. GROUND
2. POSITIVE

Figure 41. Thermal Sensor Wire Connections

Clean

WARNING

Cleaning solvents can be flammable and toxic and can cause skin irritation. When using cleaning solvents, always follow the solvent manufacturer's recommended safety procedures.

1. Clean components with a clean cloth moistened with solvent and allow to thoroughly dry. DO NOT apply liquid solvent directly to rotor windings.
2. Check for signs of oil or other contaminants within the motor. If necessary, locate source of contaminants and take corrective action.
3. Clean all joints, remove all foreign matter and contaminants such as release agents, grease, oil, dust, water, protective coatings, old adhesives or sealants, and other substances which could affect silicone seal adhesion.

Inspect

1. Inspect rotor and inside motor case for marks or grooves indicating contact between rotor and motor case. Replace if damaged.
2. Bearings should fit snugly where they ride on the shaft. If there is excessive wear, replace bearing and/or shaft.
3. Check bearings for smooth operation. If a clean bearing does not roll smoothly, it must be replaced.
4. If equipped, check retaining bushing for damage. Replace if damaged.
5. Check rotor windings for signs of thermal overload. Signs of thermal overload are dark-stained, brittle, or burnt insulation. Thermal overload will shorten the life of the stator housing.
6. Check motor windings resistance as indicated below. To measure continuity between U, V, and W terminals of motor use a digital multimeter (DMM) set to Ohms.
   a. Place one DMM probe on terminal U.
   b. Place the other DMM probe on terminal V.

      Meter must read less than 0.5 ohms. If the reading is more than 0.5 ohms, remove the cables from motor to inverter and measure again. If this reading is other than 0.5 ohm or less, the motor windings in the stator have burned open and the motor must be repaired or replaced.

   c. Place one DMM probe on terminal V.
   d. Place the other DMM probe on terminal W.

      Meter must read less than 0.5 ohms. If the reading is more than 0.5 ohms, remove the cables from motor to inverter and measure again. If this reading is other than 0.5 ohm or less, the motor windings in the stator have burned open and the motor must be repaired or replaced.

   e. Place one DMM probe on terminal W.
   f. Place the other DMM probe on terminal U.

      Meter must read less than 0.5 ohms. If the reading is more than 0.5 ohms, remove the cables from motor to inverter and measure again. If this reading is other than 0.5 ohm or less, the motor windings in the stator have burned open and the motor must be repaired or replaced.

Assemble

Standard Motor

CAUTION

Use an arbor press and a proper size driver when installing bearings to avoid damage to bearings and/or end shields. Press only on the outer race of the bearing. Always replace bearings in sets.

1. Carefully install drive end ball bearing in drive end shield. See Figure 38.
2. Install locking ring in drive end shield. See Figure 38.
3. Install rotor in drive end shield. See Figure 38.

4. Install snap ring on drive end of rotor. See Figure 38.

5. Install woodruff key in drive end of rotor shaft. See Figure 38.

6. Install rotor and drive end shield in stator housing. See Figure 38.

7. Install speed sensor and capscrew onto non-drive end shield. See Figure 38.

8. Install waved spring washer in non-drive end shield. See Figure 38.

9. Install O-ring seal in non-drive end shield. See Figure 38.

CAUTION

Use an arbor press and a proper size driver when installing bearings to avoid damage to bearings and/or end shields. Press only on the outer race of the bearing. Always replace bearings in sets.

10. Carefully install non-drive end ball bearing in non-drive end shield. See Figure 38.

11. Install non-drive end shield on stator housing. See Figure 38.

12. Apply neutral curing, high temperature silicone sealant (rated for at least 260°C (500°F)) between stator housing and non-drive end shield to protect power leads and thermal sensor.

13. Install new O-ring on cap. Install cap in non-drive end shield. See Figure 38.

14. Install four tie rods to hold end shields to stator housing. See Figure 38.

15. Install terminal post bracket, terminal posts, and two screws on stator housing. See Figure 38.

16. Connect power leads to terminal posts. See Figure 38.

17. Install three spring washers and hex nuts on terminal posts. See Figure 38. Tighten hex nuts to 14 to 16 N•m (124 to 142 lbf in).

18. Carefully remove motor from vise and place on suitable work surface.

Enhanced Motor

CAUTION

Use an arbor press and a proper size driver when installing bearings to avoid damage to bearings and/or end shields. Press only on the outer race of the bearing. Always replace bearings in sets.

1. Carefully install drive end ball bearing in drive end shield. See Figure 38.

2. Install locking ring in drive end shield. See Figure 38.

3. Install oil seal in drive end shield. See Figure 38.

4. Install rotor in drive end shield. See Figure 38.

5. Install snap ring on drive end of rotor. See Figure 38.

6. Install rotor and drive end shield in stator housing. See Figure 38.

7. Install speed sensor and capscrew on non-drive end shield. See Figure 38.

8. Install waved spring washer in non-drive end shield. See Figure 38.

9. Install O-ring seal in non-drive end shield. See Figure 38.

CAUTION

Use an arbor press and a proper size driver when installing bearings to avoid damage to bearings and/or end shields. Press only on the outer race of the bearing. Always replace bearings in sets.

10. Carefully install non-drive end ball bearing in drive end shield. See Figure 38.

11. Install non-drive end shield on stator housing. See Figure 38.

12. Apply neutral curing, high temperature silicone sealant (rated for at least 260°C (500°F)) between stator housing and non-drive end shield to protect power leads and thermal sensor.

13. Install mounting bracket and three capscrews on non-drive end shield. See Figure 38.

14. Install retaining bushing into cooling fan. Install cooling fan in non-drive end shield. See Figure 38.

15. Install four M8 X 270 screws to hold end shields to stator housing. See Figure 38.

16. Install four spacers, four washers, fan cover, and four capscrews on non-drive end shield. See Figure 38.

17. Install terminal post bracket, bracket, terminal posts, and two screws on stator housing. See Figure 38.

18. Connect power leads to terminal posts. See Figure 38.

19. Install three spring washers and hex nuts to terminal posts. See Figure 38. Tighten hex nuts to 14 to 16 N•m (124 to 142 lbf in).

20. Carefully remove motor from vise and place on suitable work surface.

Install

1. Install keys onto motor shaft.

2. Install coupling onto pump shaft and motor shaft. See Figure 37.

3. Make sure the halves of the coupling are correctly engaged. Make sure setscrews that fasten coupling to shafts are 180° opposed. See Figure 37. Tighten setscrews to 11 to 13 N•m (97 to 115 lbf in).

4. Make sure pump is aligned to motor as marked during removal. Install two capscrews fastening pump to motor. See Figure 37. Tighten capscrews to 25 N•m (221 lbf in).

NOTE: Remove plugs from pump openings and install plugs in suction adapter and fitting after installation.

5. Install suction adapter onto hydraulic pump as noted during removal. See Figure 37. Tighten adapter to 91 to 100 N•m (67 to 74 lbf ft).

6. Install fitting onto hydraulic pump. See Figure 37. Tighten fitting to 49 to 59 N•m (36 to 44 lbf ft).

7. Install hydraulic pump and motor assembly in lift truck. See **Hydraulic System** 1900SRM1367 for instructions.

FOR LIFT TRUCK MODELS J2.2-3.5XN (J45-70XN) (A276) AND E1.6-E2.0XN (E30-40XN) (A269)

Remove

1. Remove hydraulic pump and motor assembly from lift truck. See **Hydraulic System** 1900SRM1367 for removal instructions.

2. Place hydraulic pump and motor assembly on a clean workbench or other suitable surface.

3. Remove the hydraulic pump and motor brackets. See **Hydraulic System** 1900SRM1367 for removal instructions.

Disassemble

1. Place motor in a vise with terminal posts on top and carefully clamp vise on stator housing.

2. Remove three hex nuts and lockwashers from terminal posts.

   See Figure 42 for lift truck models
   - J2.2-3.5XN (J45-70XN) (A276)

   See Figure 43 for lift truck models
   - E1.6-2.0XN (E30-40XN) (A269)

3. Disconnect power leads from terminal posts.

   See Figure 42 for lift truck models
   - J2.2-3.5XN (J45-70XN) (A276)

   See Figure 43 for lift truck models
   - E1.6-2.0XN (E30-40XN) (A269)

4. Remove two screws, terminal posts, and terminal post bracket and terminal strip from stator housing.

   See Figure 42 for lift truck models
   - J2.2-3.5XN (J45-70XN) (A276)

   See Figure 43 for lift truck models
   - E1.6-2.0XN (E30-40XN) (A269)

NOTE: Perform Step 5 for lift truck models J2.2-3.5XN (J45-70XN) (A276) only.

5. Remove three socket-head capscrews and fan cover from non drive end shield.

6. Remove four tie rods holding end shields to stator housing.

See Figure 42 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276)

See Figure 43 for lift truck models

- E1.6-2.0XN (E30-40XN) (A269)

CAUTION

Disposal of silicone sealant must meet local environmental regulations.

NOTE: during the performance of the following step, remove only a sufficient amount of sealing material to allow removal of the non-drive end shield.

7. Carefully remove silicone seal material from the non-drive end shield.

NOTE: Note threading position and orientation of power leads and thermal sensor connector wire through non-drive end shield during disassembly to aid in assembly.

8. Remove non-drive end shield from stator housing.

See Figure 42 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276)

See Figure 43 for lift truck models

- E1.6-2.0XN (E30-40XN) (A269)

9. Using bearing puller, carefully remove non-drive end ball bearing from rotor.

10. Remove wave washer, seal, retaining bushing and fan from the non-drive end shield. Discard the seal.

See Figure 42 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276)

See Figure 43 for lift truck models

- E1.6-2.0XN (E30-40XN) (A269)

11. Remove capscrew and speed sensor from non-drive end shield.

12. Remove drive end shield and rotor from stator housing.

See Figure 42 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276)

See Figure 43 for lift truck models

- E1.6-2.0XN (E30-40XN) (A269)

13. Remove and discard seal from the drive end shield.

See Figure 42 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276)

See Figure 43 for lift truck models

- E1.6-2.0XN (E30-40XN) (A269)

14. Remove lock ring, snap ring and drive end shield from the rotor.

See Figure 42 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276)

See Figure 43 for lift truck models

- E1.6-2.0XN (E30-40XN) (A269)

15. Using bearing puller, carefully remove drive end ball bearing from the rotor.

See Figure 42 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276)

See Figure 43 for lift truck models

- E1.6-2.0XN (E30-40XN) (A269)

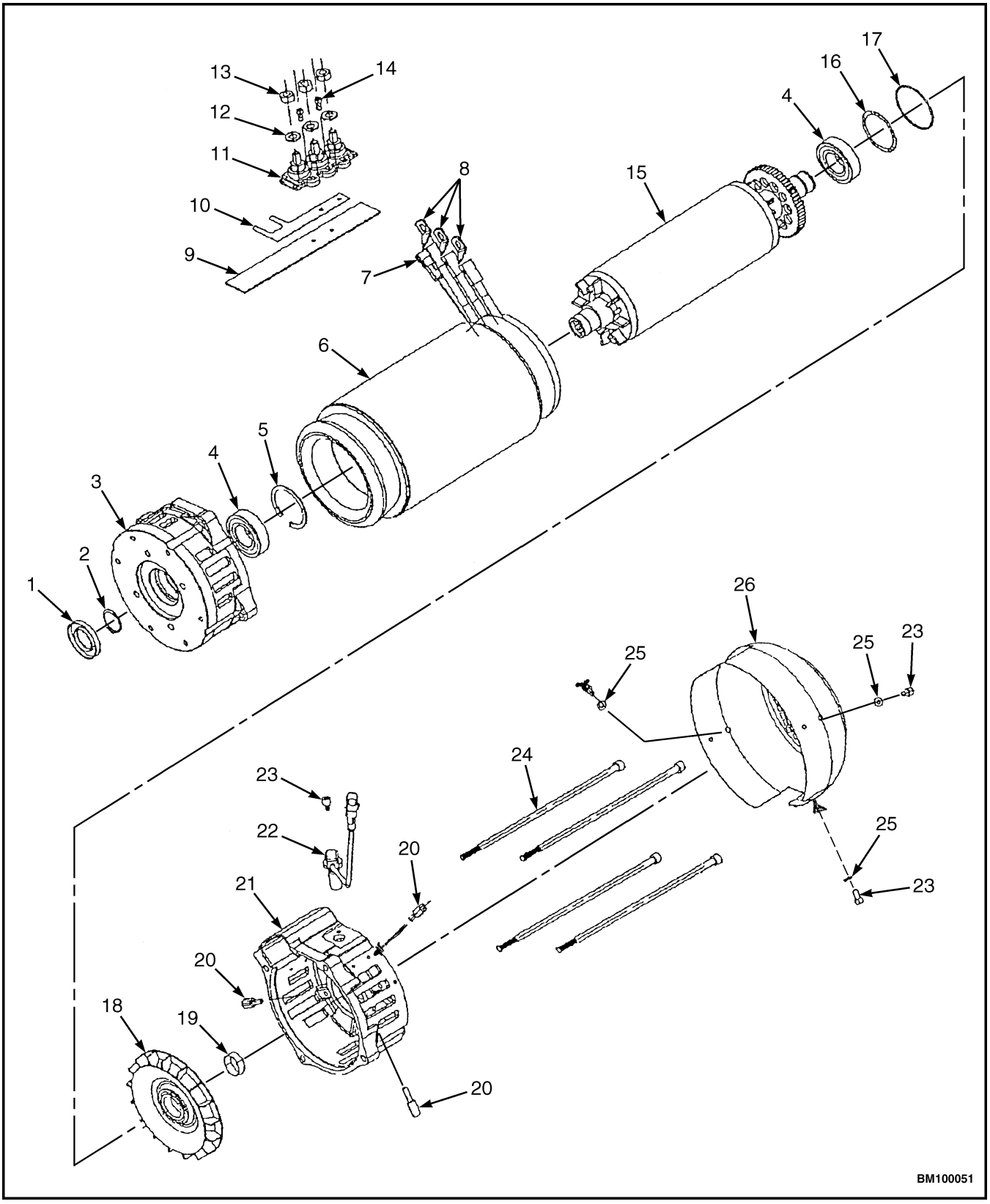


Figure 42. Hydraulic Motor, Lift Truck Models J2.2-3.5XN (J45-70XN) (A276)

Legend for Figure 42

1. SEAL
2. LOCK RING
3. DRIVE END SHIELD
4. BEARING
5. SNAP RING
6. STATOR HOUSING
7. THERMAL SENSOR
8. CONNECTOR
9. TERMINAL STRIP
10. TERMINAL POST BRACKET
11. TERMINAL POST
12. LOCKWASHER
13. HEX NUT
14. SCREW
15. ROTOR
16. WAVE WASHER
17. SEAL
18. FAN
19. RETAINING BUSHING
20. SPACER
21. NON-DRIVE END SHIELD
22. SPEED SENSOR
23. SOCKET-HEAD CAPSCREW
24. TIE ROD
25. WASHER
26. FAN COVER

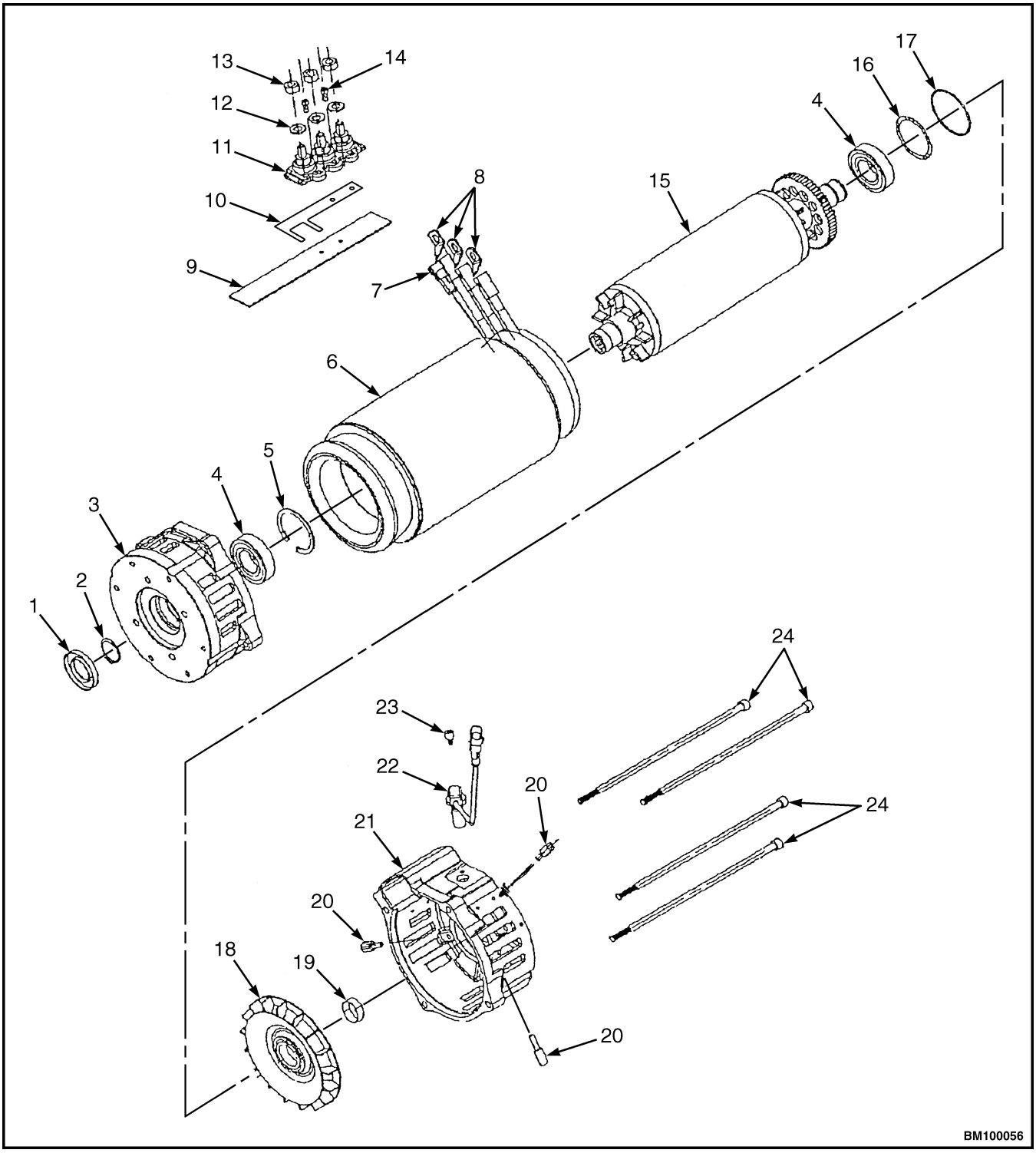


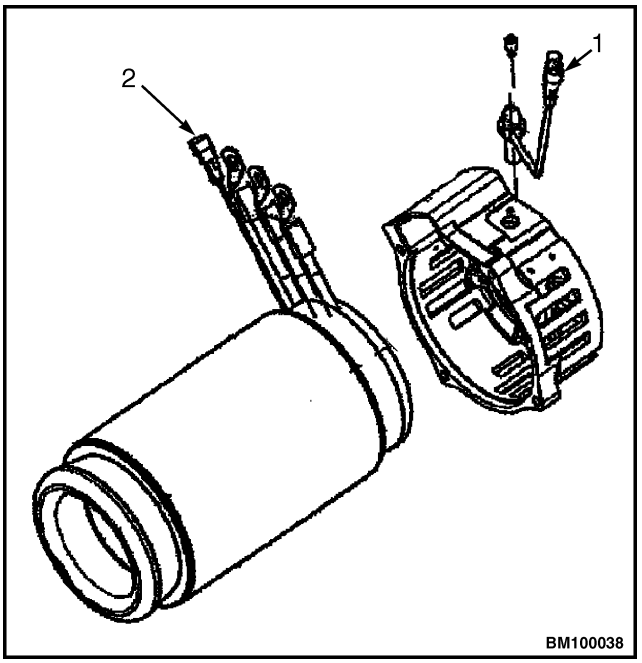
Figure 43. Hydraulic Motor, Lift Truck Models E1.6-2.0XN (E30-40XN) (A269)

Legend for Figure 43

1. SEAL
2. LOCK RING
3. DRIVE END SHIELD
4. BEARING
5. SNAP RING
6. STATOR HOUSING
7. THERMAL SENSOR
8. CONNECTOR
9. TERMINAL STRIP
10. TERMINAL POST BRACKET
11. TERMINAL POST
12. LOCKWASHER
13. HEX NUT
14. SCREW
15. ROTOR
16. WAVE WASHER
17. SEAL
18. FAN
19. RETAINING BUSHING
20. SPACER
21. NON-DRIVE END SHIELD
22. SPEED SENSOR
23. SOCKET-HEAD CAPSCREW
24. TIE ROD

Electrical Connector Repair or Replacement

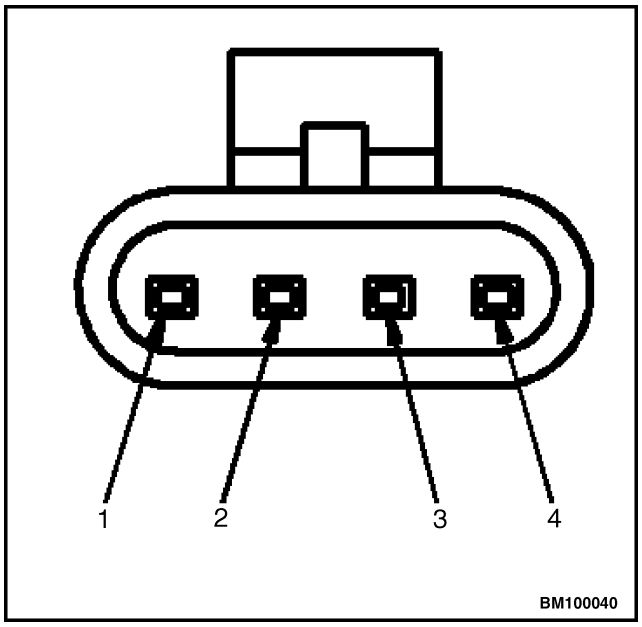
1. If necessary, speed sensor connector and/or thermal sensor connector may be repaired or replaced. See Figure 44. See AMP Superseal 1.5 Connector Assemblies section of **Wire Harness Repair** 2200SRM1128 manual for instructions.



1. SPEED SENSOR CONNECTOR
2. THERMAL SENSOR CONNECTOR

Figure 44. Electrical Connectors

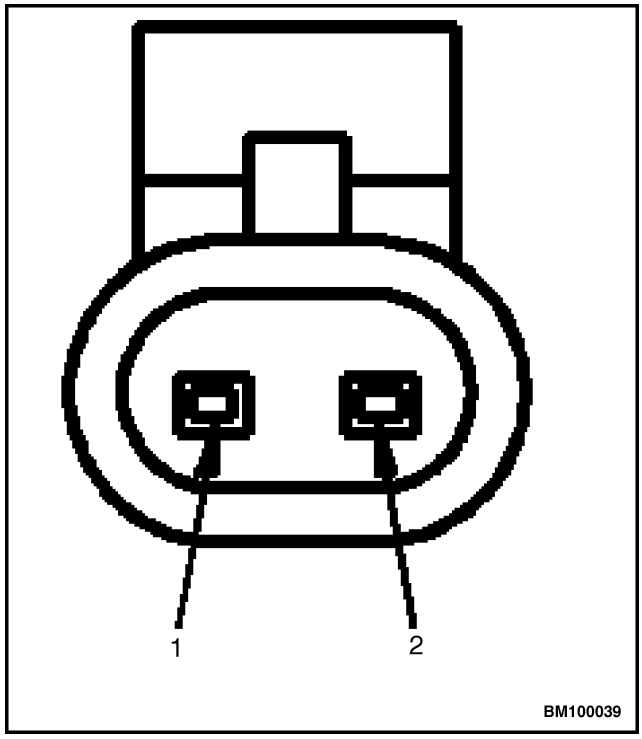
2. Connections for speed sensor connector are shown in Figure 45.



1. SUPPLY
2. SIGNAL B
3. SIGNAL A
4. GROUND

Figure 45. Speed Sensor Wire Connections

3. Connections for thermal sensor connector are shown in Figure 46.



1. GROUND 2. POSITIVE

Figure 46. Thermal Sensor Wire Connections

Clean

WARNING

Cleaning solvents can be flammable and toxic and can cause skin irritation. When using cleaning solvents, always follow the solvent manufacturer's recommended safety procedures.

1. Clean components with a clean cloth moistened with solvent and allow to thoroughly dry. DO NOT apply liquid solvent directly to rotor windings.
2. Check for signs of oil or other contaminants within the motor. If necessary, locate source of contaminants and take corrective action.
3. Clean all joints, remove all foreign matter and contaminants such as release agents, grease, oil, dust, water, protective coatings, old adhesives or sealants, and other substances which could affect silicone seal adhesion.

Inspect

1. Inspect rotor and inside motor case for marks or grooves indicating contact between rotor and motor case. Replace if damaged.
2. Bearings should fit snugly where they ride on the shaft. If there is excessive wear, replace bearing and/or shaft.
3. Check bearings for smooth operation. If a clean bearing does not roll smoothly, it must be replaced.
4. Check rotor windings for signs of thermal overload. Signs of thermal overload are dark-stained, brittle, or burnt insulation. Thermal overload will shorten the life of the stator housing.
5. Check motor windings resistance as indicated below. To measure continuity between U, V, and W terminals of motor use a digital multimeter (DMM) set to Ohms.
   a. Place one DMM probe on terminal U.
   b. Place the other DMM probe on terminal V.

      Meter must read less than 0.5 ohms. If the reading is more than 0.5 ohms, remove the cables from motor to inverter and measure again. If this reading is other than 0.5 ohm or less, the motor windings in the stator have burned open and the motor must be repaired or replaced.

   c. Place one DMM probe on terminal V.
   d. Place the other DMM probe on terminal W.

      Meter must read less than 0.5 ohms. If the reading is more than 0.5 ohms, remove the cables from motor to inverter and measure again. If this reading is other than 0.5 ohm or less, the motor windings in the stator have burned open and the motor must be repaired or replaced.

   e. Place one DMM probe on terminal W.
   f. Place the other DMM probe on terminal U.

      Meter must read less than 0.5 ohms. If the reading is more than 0.5 ohms, remove the cables from motor to inverter and measure again. If this reading is other than 0.5 ohm or less, the motor windings in the stator have burned open and the motor must be repaired or replaced.

Assemble

CAUTION

Use an arbor press and a proper size driver when installing bearings to avoid damage to bearings and/or rotor. Press only on the INNER race of the bearing. Always replace bearings in sets.

1. Using a press, carefully install drive end ball bearing onto the rotor.

   See Figure 42 for lift truck models
   - J2.2-3.5XN (J45-70XN) (A276)

   See Figure 43 for lift truck models
   - E1.6-2.0XN (E30-40XN) (A269)

2. Install drive end shield, snap ring, and lock ring on the rotor.

   See Figure 42 for lift truck models
   - J2.2-3.5XN (J45-70XN) (A276)

   See Figure 43 for lift truck models
   - E1.6-2.0XN (E30-40XN) (A269)

3. Install a new seal in the drive end shield.

   See Figure 42 for lift truck models
   - J2.2-3.5XN (J45-70XN) (A276)

   See Figure 43 for lift truck models
   - E1.6-2.0XN (E30-40XN) (A269)

4. Install drive end shield and rotor in stator housing.

   See Figure 42 for lift truck models
   - J2.2-3.5XN (J45-70XN) (A276)

   See Figure 43 for lift truck models
   - E1.6-2.0XN (E30-40XN) (A269)

5. Install speed sensor and capscrew in non-drive end shield.

   See Figure 42 for lift truck models
   - J2.2-3.5XN (J45-70XN) (A276)

See Figure 43 for lift truck models

- E1.6-2.0XN (E30-40XN) (A269)

6. Install new seal, wave washer, fan, and retaining bushing in the non-drive end shield. Discard the seal.

See Figure 42 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276)

See Figure 43 for lift truck models

- E1.6-2.0XN (E30-40XN) (A269)

CAUTION

Use an arbor press and a proper size driver when installing bearings to avoid damage to bearings and/or rotor. Press only on the INNER race of the bearing. Always replace bearings in sets.

7. Using a press, install non-drive end ball bearing onto the rotor.

See Figure 42 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276)

See Figure 43 for lift truck models

- E1.6-2.0XN (E30-40XN) (A269)

8. Install non-drive end shield onto stator housing and place power leads and thermal sensor in the orientation and position as noted during removal.

See Figure 42 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276)

See Figure 43 for lift truck models

- E1.6-2.0XN (E30-40XN) (A269)

9. Install four tie rods holding end shields to stator housing.

See Figure 42 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276)

See Figure 43 for lift truck models

- E1.6-2.0XN (E30-40XN) (A269)

NOTE: Perform Step 10 for lift truck models J2.2-3.5XN (J45-70XN) (A276) only.

10. Install fan cover and three socket-head capscrews on non drive end shield. See Figure 42.

11. Using two screws, install terminal strip, terminal post bracket, terminal posts onto stator housing.

See Figure 42 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276)

See Figure 43 for lift truck models

- E1.6-2.0XN (E30-40XN) (A269)

12. Connect power leads from terminal posts.

See Figure 42 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276)

See Figure 43 for lift truck models

- E1.6-2.0XN (E30-40XN) (A269)

13. Install three lockwashers and hex nuts onto terminal posts.

Tighten hex nuts to 14 to 16 N•m (124 to 142 lbf in). See Figure 42 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276)

Tighten hex nuts to 14 to 16 N•m (124 to 142 lbf in). See Figure 43 for lift truck models

- E1.6-2.0XN (E30-40XN) (A269)

14. Fill the area around the power leads and thermal sensor located on the non-drive end shield with neutral curing, high temperature silicone sealant (rated for at least 260°C (500°F).

Install

1. Place hydraulic motor assembly on a clean workbench or other suitable work surface.

2. Install the hydraulic pump and motor brackets. See **Hydraulic System** 1900SRM1367 for installation instructions.

3. Install hydraulic pump and motor assembly on the lift truck. See **Hydraulic System** 1900SRM1367 for installation instructions.

HYDRAULIC MOTOR REPAIR FOR 4.0-5.5T LIFT TRUCKS

This section covers the hydraulic motor repair procedures for lift truck models:

- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

- E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

Remove

1. Remove hydraulic pump and motor assembly from lift truck. See **Hydraulic System** 1900SRM1367 for removal instructions.
2. Place hydraulic pump and motor assembly on a clean workbench or other suitable surface.
3. Remove the hydraulic pump and motor brackets. See **Hydraulic System** 1900SRM1367 for removal instructions.

Disassemble

1. Place motor in a vise with terminal posts on top and carefully clamp vise on stator housing.
2. Remove three hex nuts and lockwashers from terminal posts. See Figure 47.
3. Disconnect terminal cables from terminal posts. See Figure 47.
4. Remove two screws, terminal posts, and terminal post bracket and terminal strip from stator housing. See Figure 47.
5. Remove two socket-head capscrews and fan cover from non drive end shield.
6. Remove four tie rods holding end shields to stator housing. See Figure 47.

CAUTION

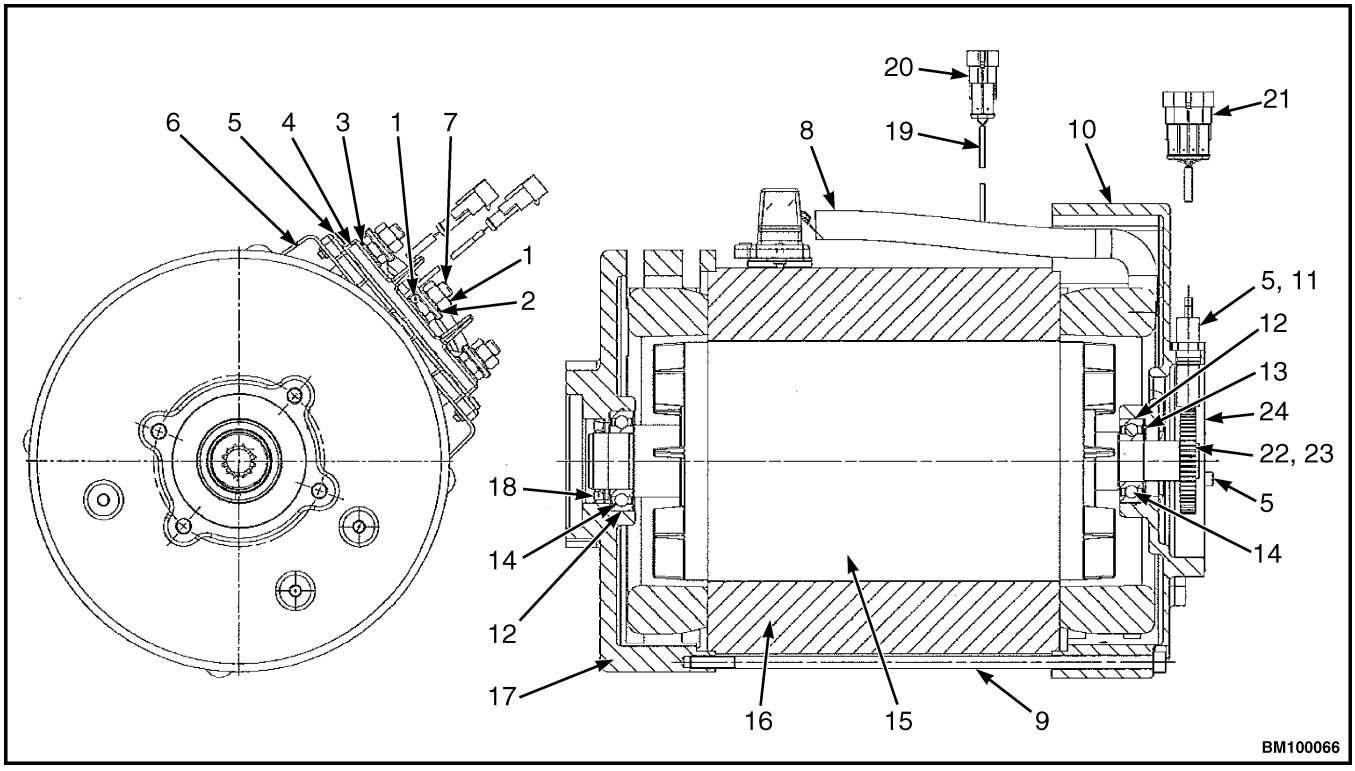
Disposal of silicone sealant must meet local environmental regulations.

NOTE: during the performance of the following step, remove only a sufficient amount of sealing material to allow removal of the non-drive end shield.

7. Carefully remove silicone seal material from the non-drive end shield.
8. Remove spur wheel and tolerance ring from rotor.

NOTE: Note threading position and orientation of power leads and thermal sensor connector wire through non-drive end shield during disassembly to aid in assembly.

9. Remove non-drive end shield from stator housing. See Figure 47.
10. Remove wave washer from the non-drive end shield. Discard the seal. See Figure 47.
11. Using bearing puller, carefully remove non-drive end ball bearing from rotor.
12. Remove capscrew and speed sensor from non-drive end shield.
13. Remove drive end shield and rotor from stator housing. See Figure 47.
14. Remove and discard seal from the drive end shield. See Figure 47.
15. Remove drive end shield from the rotor. See Figure 47.
16. Remove and discard O-ring from drive end shield.
17. Using bearing puller, carefully remove drive end ball bearing from the rotor. See Figure 47.



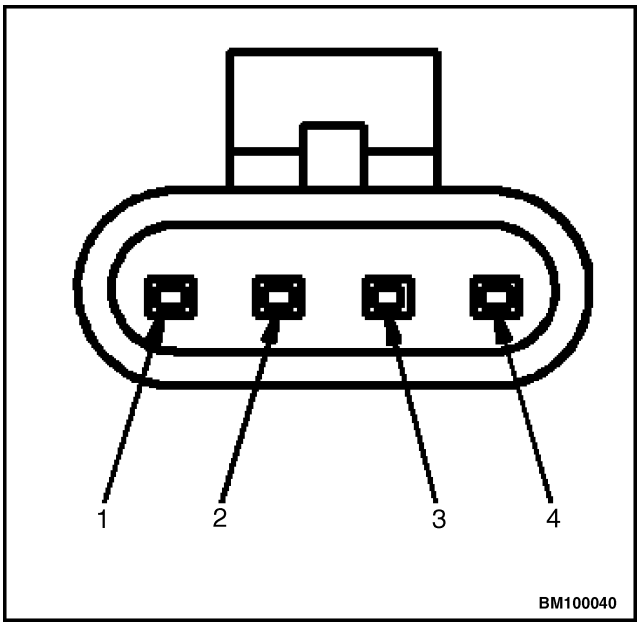
1. HEX NUT
2. LOCK WASHER
3. WASHER
4. TERMINAL
5. CYLINDER SCREW
6. TERMINAL BASE
7. HEX SCREW
8. TERMINAL CABLE
9. TIE ROD
10. NON-DRIVE END PLATE
11. SPEED SENSOR
12. O-RING
13. WAVE WASHER
14. BEARING
15. ROTOR
16. STATOR
17. DRIVE END SHIELD
18. SEAL
19. TEMPERATURE SENSOR
20. TEMPERATURE SENSOR CONNECTOR
21. SPEED SENSOR CONNECTOR
22. SPUR WHEEL
23. TOLERANCE RING
24. FAN COVER

Figure 47. Hydraulic Motor, Lift Truck Models J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) and E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

Electrical Connector Repair or Replacement

1. If necessary, speed sensor connector and/or thermal sensor connector may be repaired or replaced. See Figure 47. See AMP Superseal 1.5 Connector Assemblies section of **Wire Harness Repair** 2200SRM1128 manual for instructions.

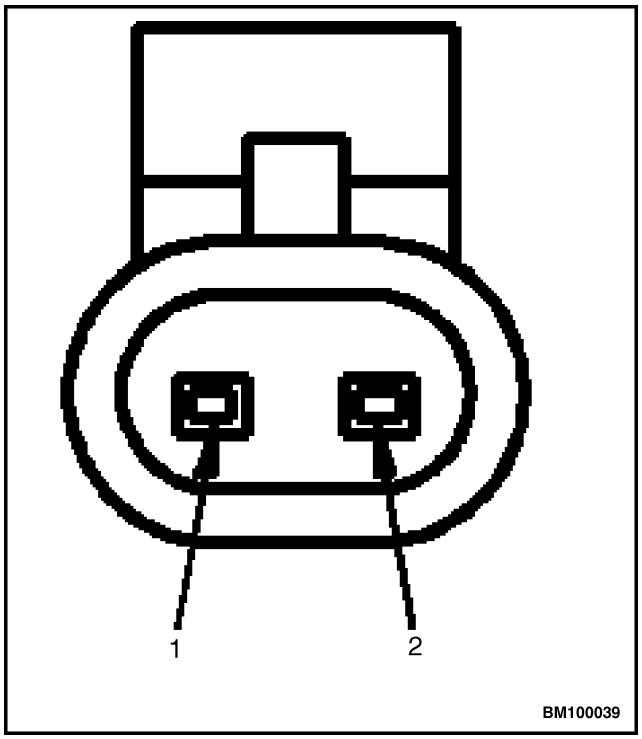
2. Connections for speed sensor connector are shown in Figure 48.



1. SUPPLY
2. SIGNAL B
3. SIGNAL A
4. GROUND

Figure 48. Speed Sensor Wire Connections

3. Connections for thermal sensor connector are shown in Figure 49.



1. GROUND
2. POSITIVE

Figure 49. Thermal Sensor Wire Connections

Clean

WARNING

Cleaning solvents can be flammable and toxic and can cause skin irritation. When using cleaning solvents, always follow the solvent manufacturer's recommended safety procedures.

1. Clean components with a clean cloth moistened with solvent and allow to thoroughly dry. DO NOT apply liquid solvent directly to rotor windings.
2. Check for signs of oil or other contaminants within the motor. If necessary, locate source of contaminants and take corrective action.
3. Clean all joints, remove all foreign matter and contaminants such as release agents, grease, oil, dust, water, protective coatings, old adhesives or sealants, and other substances which could affect silicone seal adhesion.

Inspect

1. Inspect rotor and inside motor case for marks or grooves indicating contact between rotor and motor case. Replace if damaged.
2. Bearings should fit snugly where they ride on the shaft. If there is excessive wear, replace bearing and/or shaft.
3. Check bearings for smooth operation. If a clean bearing does not roll smoothly, it must be replaced.
4. Check rotor windings for signs of thermal overload. Signs of thermal overload are dark-stained, brittle, or burnt insulation. Thermal overload will shorten the life of the stator housing.
5. Check motor windings resistance as indicated below. To measure continuity between U, V, and W terminals of motor use a digital multimeter (DMM) set to Ohms.

   a. Place one DMM probe on terminal U.

   b. Place the other DMM probe on terminal V.

   Meter must read less than 0.5 ohms. If the reading is more than 0.5 ohms, remove the cables from motor to inverter and measure again. If this reading is other than 0.5 ohm or less, the motor windings in the stator have burned open and the motor must be repaired or replaced.

   c. Place one DMM probe on terminal V.

   d. Place the other DMM probe on terminal W.

   Meter must read less than 0.5 ohms. If the reading is more than 0.5 ohms, remove the cables from motor to inverter and measure again. If this reading is other than 0.5 ohm or less, the motor windings in the stator have burned open and the motor must be repaired or replaced.

   e. Place one DMM probe on terminal W.

f. Place the other DMM probe on terminal U.

Meter must read less than 0.5 ohms. If the reading is more than 0.5 ohms, remove the cables from motor to inverter and measure again. If this reading is other than 0.5 ohm or less, the motor windings in the stator have burned open and the motor must be repaired or replaced.

Assemble

CAUTION

Use an arbor press and a proper size driver when installing bearings to avoid damage to bearings and/or rotor. Press only on the INNER race of the bearing. Always replace bearings in sets.

NOTE: Grease bearings with quality bearing grease.

1. Using a press, carefully Install drive end ball bearing onto the rotor. See Figure 47.
2. Install new O-ring in drive end shield.
3. Install drive end shield on the rotor. See Figure 47.
4. Install a new seal in the drive end shield. See Figure 47.
5. Install drive end shield and rotor in stator housing. See Figure 47.
6. Install speed sensor and capscrew in non-drive end shield. See Figure 47.
7. Install new seal and wave washer in the non-drive end shield. Discard the seal. See Figure 47.

CAUTION

Use an arbor press and a proper size driver when installing bearings to avoid damage to bearings and/or rotor. Press only on the INNER race of the bearing. Always replace bearings in sets.

NOTE: Grease bearings with quality bearing grease.

8. Using a press, install non-drive end ball bearing onto the rotor. See Figure 47.
9. Install non-drive end shield onto stator housing and place power leads and thermal sensor in the orientation and position as noted during removal. See Figure 47.
10. Install spur wheel and tolerance ring onto the rotor.
11. Install four tie rods holding end shields to stator housing. Tighten tie rods to 20 N•m (177 lbf in). See Figure 47.
12. Install fan cover and two socket-head capscrews on non drive end shield. See Figure 47.
13. Using two screws, install terminal strip, terminal post bracket, terminal posts onto stator housing. See Figure 47.
14. Connect power leads from terminal posts. See Figure 47
15. Install three washers and hex nuts onto terminal posts. Tighten hex nuts to 14 to 16 N•m (124 to 142 lbf in). See Figure 47.
16. Install lock three washers and hex nuts onto terminal posts. Tighten hex nuts to 14 to 16 N•m (124 to 142 lbf in). See Figure 47.
17. Fill the area around the power leads and thermal sensor located on the non-drive end shield with neutral curing, high temperature silicone sealant (rated for at least 260°C (500°F).

Install

1. Place hydraulic motor assembly on a clean workbench or other suitable work surface.
2. Install the hydraulic pump and motor brackets. See **Hydraulic System** 1900SRM1367 for installation instructions.
3. Install hydraulic pump and motor assembly on the lift truck. See **Hydraulic System** 1900SRM1367 for installation instructions.

Torque Specifications

TRACTION MOTOR FOR LIFT TRUCKS J1.5-2.0XNT (J30-40XNT) (K160) AND J1.6-2.0XN (J30-40XN) (A935)

Terminal Post Hex Nuts
14 to 16 N•m (124 to 142 lbf in)

Socket-Head Capscrews
14 to 16 N•m (124 to 142 lbf in)

Mounting Capscrews
48 N•m (35 lbf ft)

TRACTION MOTOR FOR LIFT TRUCK E2.2-3.5XN (E45-70XN) (A268), E1.6-2.0XN (E30-40XN) (A269), AND E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

End Head to Stator Housing Capscrews
25 to 30 N•m (18 to 22 lbf ft)

TRACTION MOTOR FOR LIFT TRUCK E30-40HSD$_2$ (B219), E30-40HSD$_3$ (C219)

Terminal Post Hex Nut
14 to 16 N•m (124 to 142 lbf in)

Socket-Head Capscrews
14 to 16 N•m (124 to 142 lbf in)

Mounting Capscrews
48 N•m (35 lbf ft)

HYDRAULIC MOTOR FOR LIFT TRUCKS J1.5-2.0XNT (J30-40XNT) (K160) AND J1.6-2.0XN (J30-40XN) (A935)

Tie Bar Screws
14 to 17 N•m (124 to 150 lbf in)

Terminal Post Hex Nuts
14 to 16 N•m (124 to 142 lbf in)

Pump to Motor Capscrews
47 N•m (35 lbf ft)

HYDRAULIC MOTOR FOR LIFT TRUCK E2.2-3.5XN (E45-70XN) (A268)

Terminal Post Hex Nuts
14 to 16 N•m (124 to 142 lbf in)

Setscrews
11 to 13 N•m (97 to 115 lbf in)

Pump to Motor Capscrews
25 N•m (221 lbf in)

Suction Adapter
91 to 100 N•m (67 to 74 lbf ft)

Fitting
49 to 59 N•m (36 to 44 lbf ft)

HYDRAULIC MOTOR FOR LIFT TRUCK J2.2-3.5XN (J45-70XN) (A276)

Terminal Post Hex Nuts (Lower)
14 to 16 N•m (124 to 142 lbf in)

Terminal Post Hex Nuts (Upper)
14 to 16 N•m (124 to 142 lbf in)

HYDRAULIC MOTOR FOR LIFT TRUCK E1.6-2.0XN (E30-40XN) (A269)

Terminal Post Hex Nuts (Lower)
14 to 16 N•m (124 to 142 lbf in)

Terminal Post Hex Nuts (Upper)
14 to 16 N•m (124 to 142 lbf in)

HYDRAULIC MOTOR FOR LIFT TRUCK E30-40HSD$_2$ (B219), E30-40HSD$_3$ (C219)

Tie Bar Screws
14 to 17 N•m (124 to 150 lbf in)

Terminal Post Hex Nuts
14 to 16 N•m (124 to 142 lbf in)

Pump to Motor Capscrews
47 N•m (35 lbf ft)

HYDRAULIC MOTOR FOR LIFT TRUCK J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) AND E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

Tie Bar Screws
20 N•m (177 lbf in)

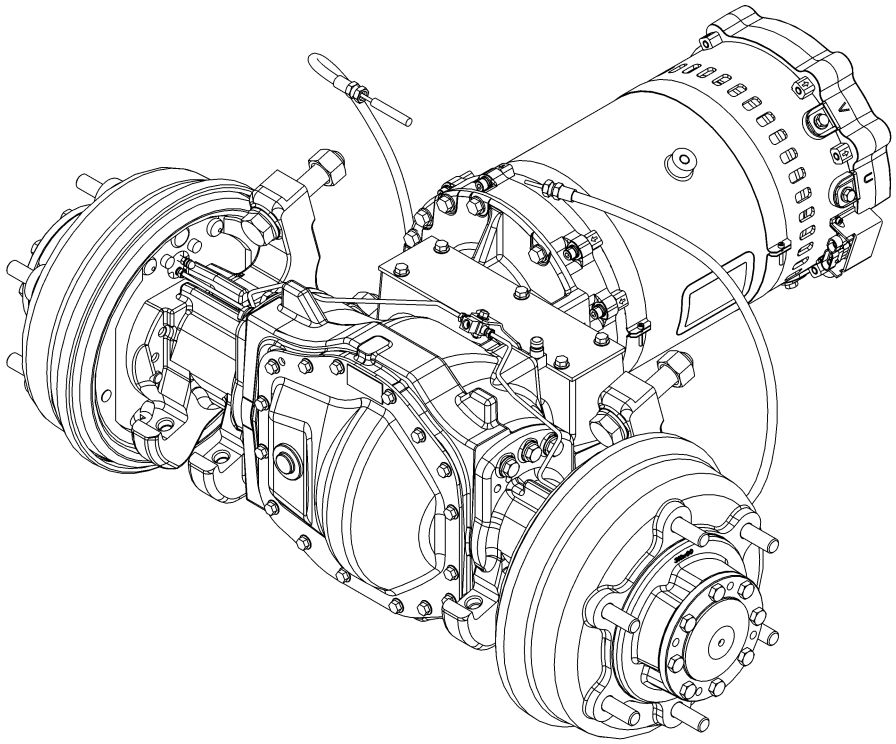
Suction Adapter
91 to 100 N•m (67 to 74 lbf ft)

Fitting
78 to 88 N•m (58 to 65 lbf ft)

NOTES

DRIVE AXLE, SPEED REDUCER, AND DIFFERENTIAL

E2.2-3.5XN (E45-70XN) [A268];
E1.6-2.0XN (E30-40XN) [A269]



HYSTER

PART NO. 1688871

1300 SRM 1366

SAFETY PRECAUTIONS
MAINTENANCE AND REPAIR

- The Service Manuals are updated on a regular basis, but may not reflect recent design changes to the product. Updated technical service information may be available from your local authorized Hyster® dealer. Service Manuals provide general guidelines for maintenance and service and are intended for use by trained and experienced technicians. Failure to properly maintain equipment or to follow instructions contained in the Service Manual could result in damage to the products, personal injury, property damage or death.
- When lifting parts or assemblies, make sure all slings, chains, or cables are correctly fastened, and that the load being lifted is balanced. Make sure the crane, cables, and chains have the capacity to support the weight of the load.
- Do not lift heavy parts by hand, use a lifting mechanism.
- Wear safety glasses.
- DISCONNECT THE BATTERY CONNECTOR before doing any maintenance or repair on electric lift trucks. Disconnect the battery ground cable on internal combustion lift trucks.
- Always use correct blocks to prevent the unit from rolling or falling. See HOW TO PUT THE LIFT TRUCK ON BLOCKS in the Operating Manual or the Periodic Maintenance section.
- Keep the unit clean and the working area clean and orderly.
- Use the correct tools for the job.
- Keep the tools clean and in good condition.
- Always use HYSTER APPROVED parts when making repairs. Replacement parts must meet or exceed the specifications of the original equipment manufacturer.
- Make sure all nuts, bolts, snap rings, and other fastening devices are removed before using force to remove parts.
- Always fasten a DO NOT OPERATE tag to the controls of the unit when making repairs, or if the unit needs repairs.
- Be sure to follow the WARNING and CAUTION notes in the instructions.
- Gasoline, Liquid Petroleum Gas (LPG), Compressed Natural Gas (CNG), and Diesel fuel are flammable. Be sure to follow the necessary safety precautions when handling these fuels and when working on these fuel systems.
- Batteries generate flammable gas when they are being charged. Keep fire and sparks away from the area. Make sure the area is well ventilated.

NOTE: The following symbols and words indicate safety information in this manual:

WARNING

Indicates a hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION

Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury and property damage.

On the lift truck, the WARNING symbol and word are on orange background. The CAUTION symbol and word are on yellow background.

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This section is for the following models:

E2.2-3.5XN (E45-70XN) [A268];
E1.6-2.0XN (E30-40XN) [A269]

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General

This section has the repair procedures for the drive axle/speed reducer/differential.

Drive Axle Repair

REMOVE

WARNING

PUTTING THE LIFT TRUCK ON BLOCKS

The lift truck must be put on blocks for some types of maintenance and repair. The removal of the mast, drive axle, battery, or counterweight assemblies will cause large changes in the center of gravity. When the lift truck is put on blocks, put additional blocks in the following positions:

- **If the mast and drive axle are removed, put blocks under the counterweight so the lift truck cannot fall backward.**
- **If the counterweight is removed, put blocks under the mast so that the lift truck cannot fall forward.**

Put the lift truck on blocks on a solid, even, and level surface. Verify the blocks or stands have enough capacity to hold the lift truck. Use additional blocks next to the tires as necessary to prevent movement of the lift truck. Verify the lifting devices used during repairs can lift the weight of the parts and assemblies.

See the Operating Manual or Periodic Maintenance section for your lift truck model, for the procedures to put the lift truck on blocks.

1. Place the lift truck on blocks. The procedure for placing the lift truck on blocks may be found in the Operating Manual or one of the following service manuals

   Periodic Maintenance 8000SRM1364 for lift truck models

   - E2.2-3.5XN (E45-70XN) (A268)

   Periodic Maintenance 8000SRM1442 for lift truck models

   - E1.6-2.0XN (E30-40XN) (A269)

2. Remove the battery from the lift truck. See How to Change Battery in the Operating Manual or

   Periodic Maintenance 8000SRM1364 for lift truck models

   - E2.2-3.5XN (E45-70XN) (A268)

   Periodic Maintenance 8000SRM1442 for lift truck models

   - E1.6-2.0XN (E30-40XN) (A269)

3. Remove the covers or plates and rollers from bottom of battery compartment. See Frame 0100SRM1342 for procedures.

4. Remove the mast assembly. See one of the following service manuals for procedures.

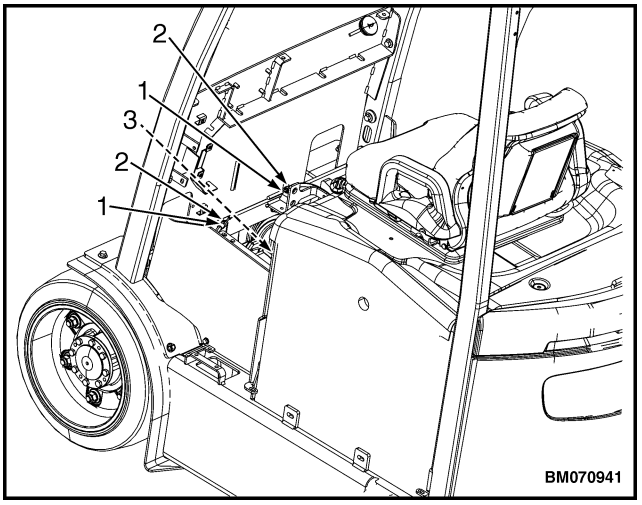
   Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564) 4000SRM1338 for lift truck models

   - E2.2-3.5XN (E45-70XN) (A268)

   Mast Repair (S/N B551, B555, and B559) 4000SRM1441 for lift truck models

   - E1.6-2.0XN (E30-40XN) (A269)

5. Disconnect the brake line connecting the master cylinder to the manifold located on top of the drive axle assembly. See Figure 1.



NOTE: LIFT TRUCK MODELS E2.2-3.5XN (E45-70XN) (A268) SHOWN. LIFT TRUCK MODELS E1.6-2.0XN (E30-40XN) (A269) ARE SIMILAR.

1. JAM NUT
2. PARKING BRAKE CABLE
3. BRAKE LINE

Figure 1. Brake Line Removal

6. Loosen the jam nuts and remove the parking brake cables from the brackets. See Figure 1.

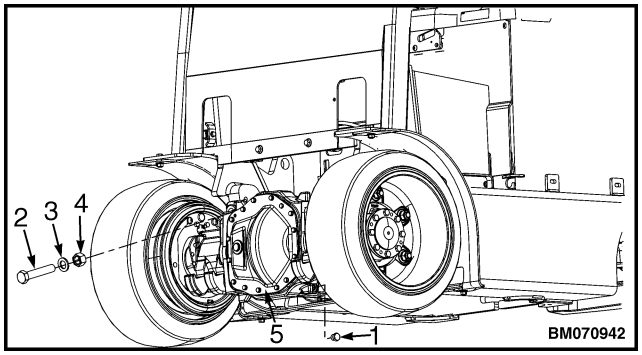
7. Remove the drain plug and drain the oil from the drive axle. See Figure 2.

NOTE: Tag electrical connectors during removal to aid in installation.

8. Tag and disconnect power cable from traction motor.

NOTE: Perform Step 9 only if lift truck is equipped with optional drip shield.

9. Remove capscrews, nuts, and drip shield from frame, allowing access to traction motor.



NOTE: DRIVE AXLE FOR LIFT TRUCK MODELS E2.2-3.5XN (E45-70XN) (A268) SHOWN. DRIVE AXLE FOR LIFT TRUCK MODELS E1.6-2.0XN (E30-40XN) (A269) IS SIMILAR.

1. DRAIN PLUG
2. AXLE MOUNTING BOLT
3. WASHER
4. NUT
5. DRIVE AXLE ASSEMBLY

Figure 2. Drive Axle

NOTE: Perform Step 10 if lift truck is equipped with an automatic park brake.

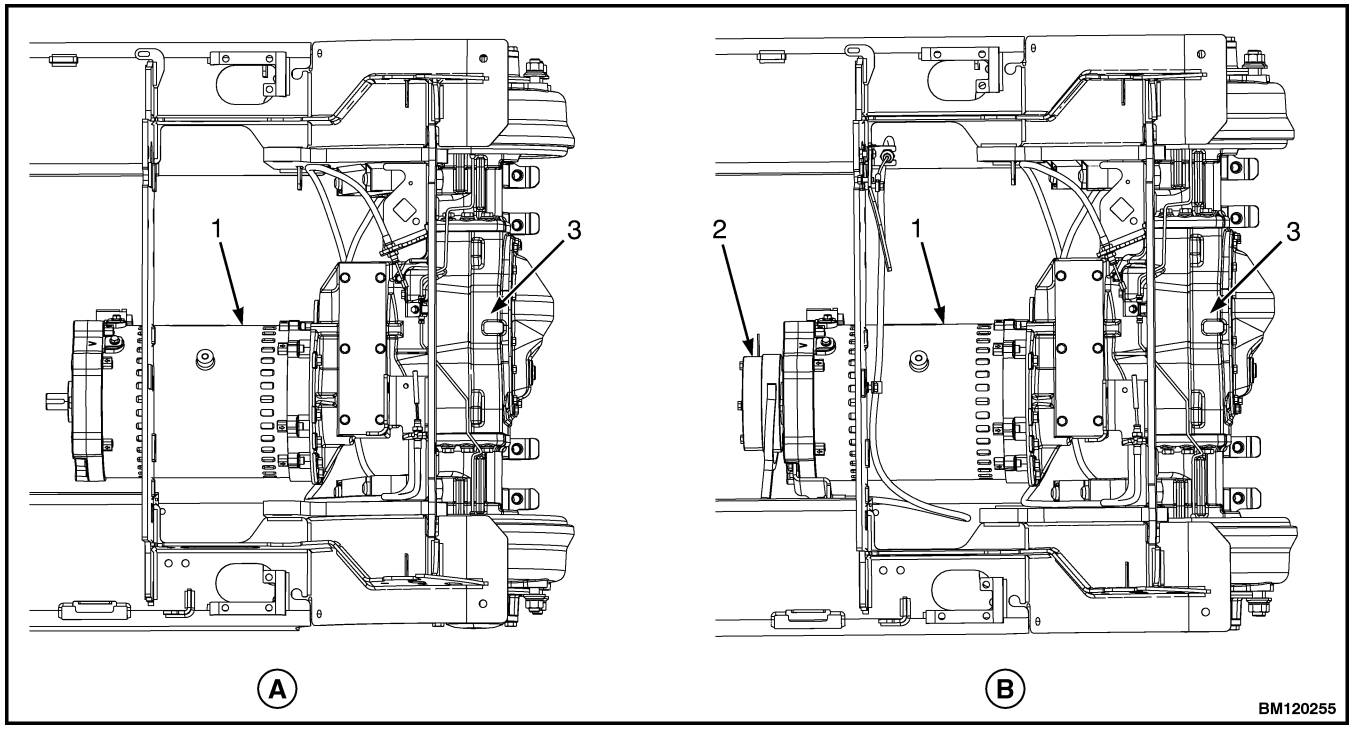
10. Disconnect automatic park brake from traction motor. See Figure 3.

See Brake System 1800SRM1359 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268)

See Brake System 1800SRM1438 for lift truck models

- E1.6-2.0XN (E30-40XN) (A269)



NOTE: TRACTION MOTOR ARRANGEMENT FOR LIFT TRUCK MODELS E2.2-3.5XN (E45-70XN) (A268) SHOWN. TRACTION MOTOR ARRANGEMENT FOR LIFT TRUCK MODELS E1.6-2.0XN (E30-40XN) (A269) IS SIMILAR.

A. TRACTION MOTOR

B. TRACTION MOTOR WITH OPTIONAL AUTOMATIC PARK BRAKE

1. TRACTION MOTOR
2. AUTOMATIC PARK BRAKE
3. DRIVE AXLE

Figure 3. Traction Motor

NOTE: In Step 11 and Step 12 make sure NOT to lift the tires off the surface.

NOTE: Use a lift truck to support drive axle and traction motor as a unit or use a transmission jack under the traction motor and a floor jack under the drive axle during removal.

11. Slide floor jack under the drive axle assembly differential. Raise floor jack until it supports the weight of the drive axle assembly.

NOTE: The traction motors are in different configurations for different applications of the lift trucks. Traction motors weigh approximately 90 to 140 kg (200 to 310 lb). Make sure transmission jack has capacity to hold traction motor.

12. Slide transmission jack under traction motor. Raise transmission jack until it supports the weight of the traction motor.

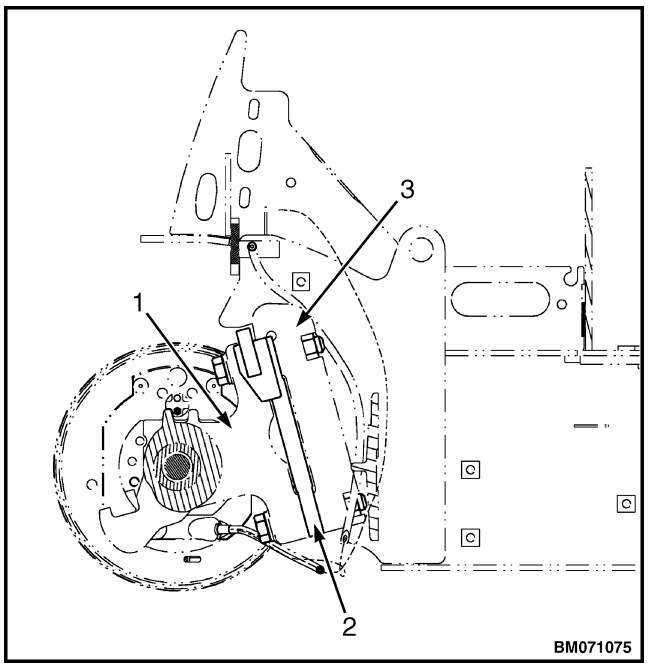
13. Remove the four axle mounting bolts, washers and nuts from the drive axle assembly. See Figure 2.

NOTE: Remove drive axle and traction motor as a single unit.

14. Roll the floor jack and transmission jack with drive axle and traction motor from underneath the lift truck.

NOTE: Forklift trucks with 4-Stage Quad Mast will have an optional spacer between the drive axle mount and the frame's mounting bracket.

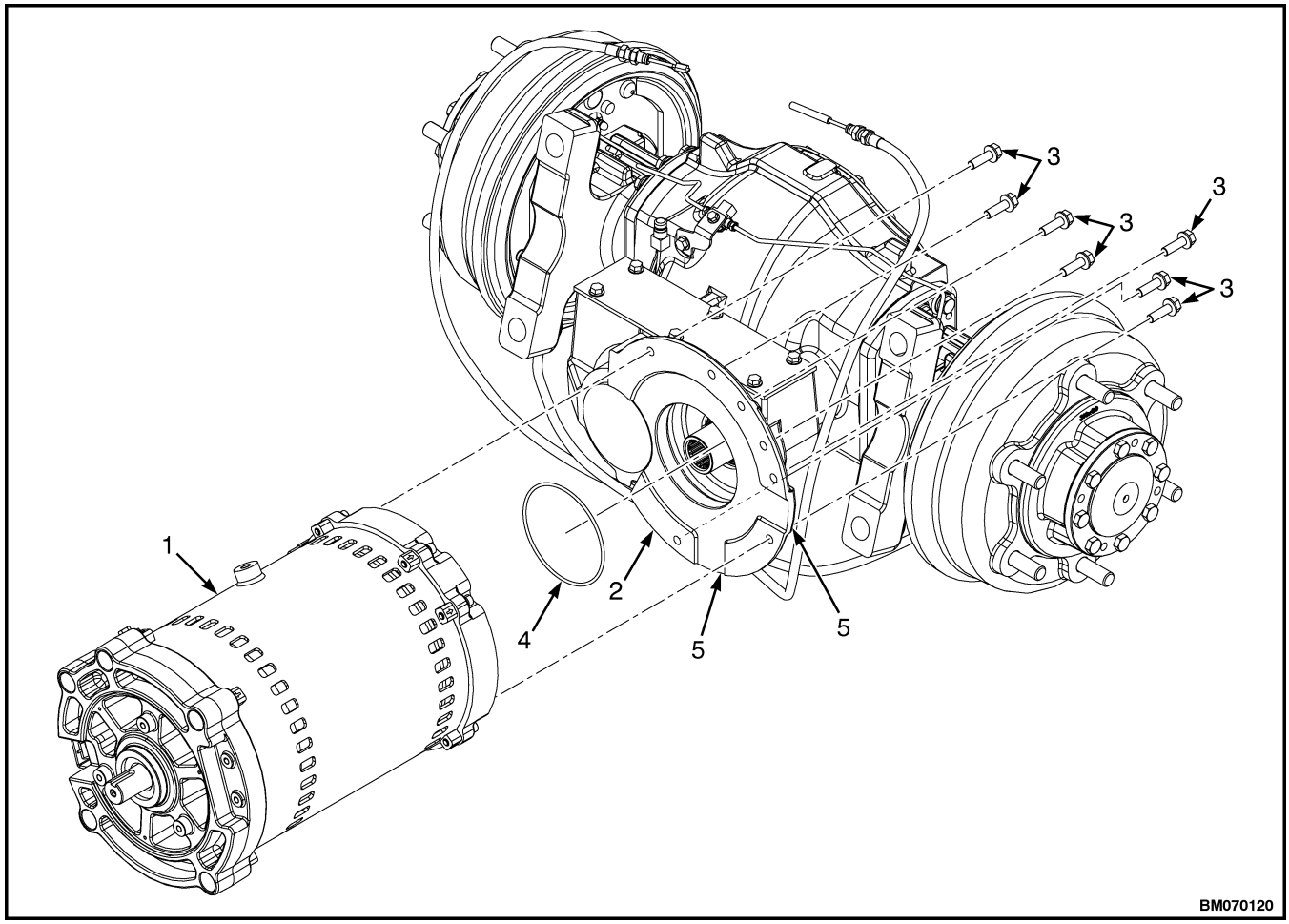
15. If lift truck is equipped with a 4-Stage Quad Mast, remove the spacer from the drive axle mount. Repeat for other side. See Figure 4.



1. DRIVE AXLE MOUNT
2. SPACER
3. FRAME MOUNTING BRACKET

Figure 4. Optional Spacer for 4-Stage Quad Mast

16. Remove capscrews from mounting flange and traction motor. See Figure 5.



NOTE: DRIVE AXLE AND TRACTION MOTOR ARRANGEMENT FOR LIFT TRUCK MODELS E2.2-3.5XN (E45-70XN) (A268) SHOWN. DRIVE AXLE AND TRACTION MOTOR ARRANGEMENT FOR LIFT TRUCK MODELS E1.6-2.0XN (E30-40XN) (A269) IS SIMILAR.

1. TRACTION MOTOR
2. MOUNTING FLANGE
3. CAPSCREW
4. O-RING
5. PRY POINT

Figure 5. Drive Axle and Traction Motor

17. Use pry bar, as necessary, to separate mounting flange and traction motor. See Figure 5.

18. Remove and discard O-ring from traction motor. See Figure 5. Set traction motor aside.

19. Use a lifting device to raise the drive axle enough to lift the wheels off the floor. Remove the floor jack from under the drive axle.

20. Place blocks under the center section assembly, and remove the lifting device.

21. Remove the wheels.

DISASSEMBLE

1. Remove capscrews, axle shaft, bearing locknut, bearing lock washer, wheel bearing washer, and hub assembly from the hanger assembly. Discard the bearing lock washer. See Figure 6.

2. Remove outer bearing cone from the hub. See Figure 6.

3. Remove the inner seal, inner bearing cone, and outer seal from the hub. Discard the inner and outer seals. See Figure 6.

NOTE: Locking feature of lock bolts is a ONE TIME ONLY. Be sure to discard lock bolts after removal.

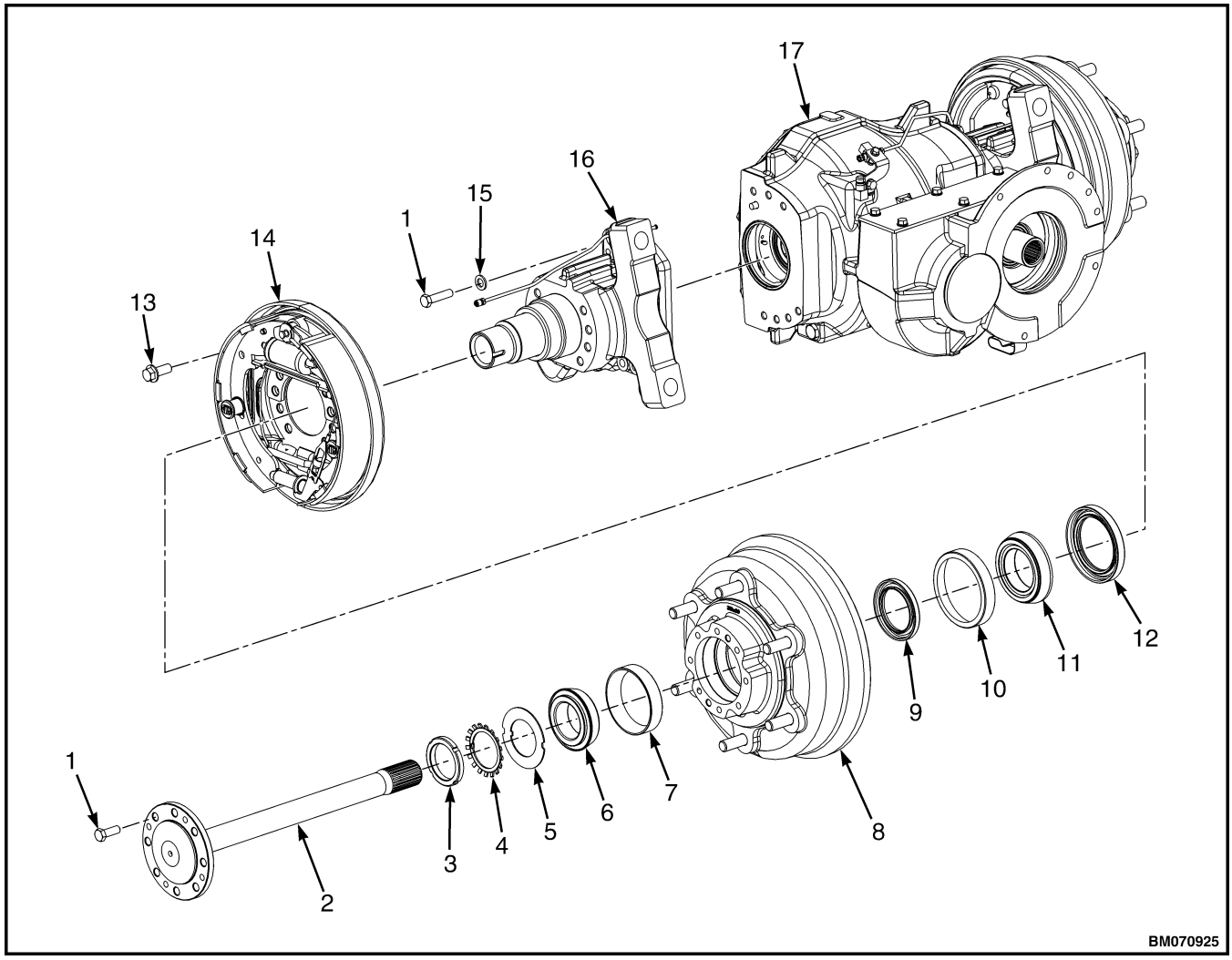
4. Remove eight lock bolts and brake assembly from the hanger assembly. See Figure 6. Discard the lock bolts.

NOTE: Perform Step 5 for lift truck models E2.2-3.5XN (E45-70XN) (A268).

5. Remove seven capscrews, seven washers, and the hanger assembly from the center section assembly. See Figure 6.

NOTE: Perform Step 6 for lift truck models E1.6-2.0XN (E30-40XN) (A269).

6. Remove six capscrews, six washers, and the hanger assembly from the center section assembly. See Figure 6.



NOTE: DRIVE AXLE ARRANGEMENT FOR LIFT TRUCK MODELS E2.2-3.5XN (E45-70XN) (A268) SHOWN. DRIVE AXLE ARRANGEMENT FOR LIFT TRUCK MODELS E1.6-2.0XN (E30-40XN) (A269) IS SIMILAR.

1. CAPSCREW
2. AXLE SHAFT
3. BEARING LOCKNUT
4. BEARING LOCK WASHER
5. WHEEL BEARING WASHER
6. OUTER BEARING CONE
7. OUTER BEARING CUP
8. HUB
9. OUTER SEAL
10. INNER BEARING CUP
11. INNER BEARING CONE
12. INNER SEAL
13. LOCK BOLT
14. BRAKE ASSEMBLY
15. WASHER
16. L.H. HANGER
17. CENTER SECTION ASSEMBLY

Figure 6. Drive Axle

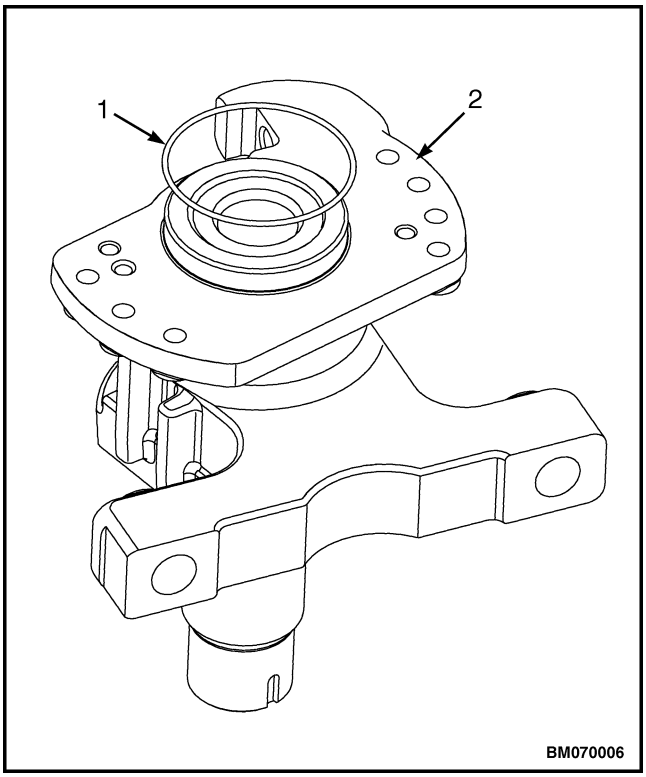
7. Remove and discard the O-ring from the hanger assembly.

See Figure 7 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268)

See Figure 8 for lift truck models

- E1.6-2.0XN (E30-40XN) (A269)



1. O-RING
2. HANGER ASSEMBLY

Figure 7. Hanger Assembly, Lift Truck Models E2.2-3.5XN (E45-70XN) (A268)

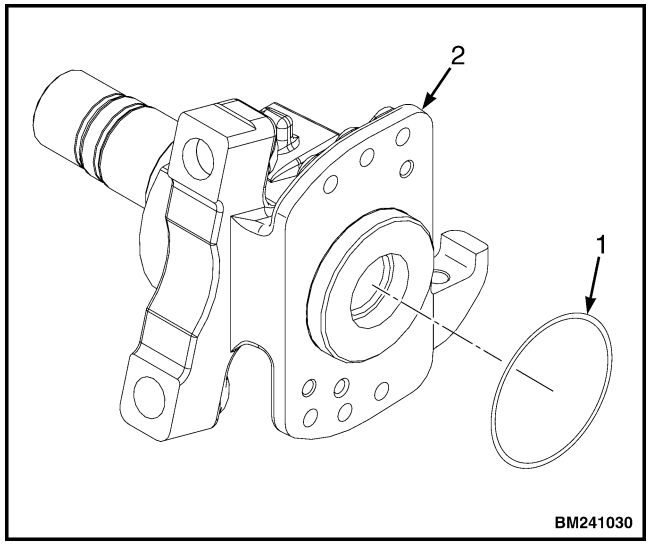
8. Repeat Step 1 through Step 7 for the opposite side.

CLEAN

WARNING

Cleaning solvents can be flammable and toxic and can cause skin irritation. When using cleaning solvents, always follow the solvent manufacturer's recommended safety precautions.

1. Clean all parts of the drive axle with solvent.



1. O-RING
2. HANGER ASSEMBLY

Figure 8. Hanger Assembly, Lift Truck Models E1.6-2.0XN (E30-40XN) (A269)

INSPECT

1. Inspect all components for damage. Replace or repair damaged components.

2. Inspect the bearings for damage or burned rollers. If any damage is found, remove the bearing cup from the wheel hub using a brass drift pin, and replace both the bearing cone and bearing cup.

ASSEMBLE

1. Install new O-ring on the hanger assembly.

See Figure 7 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268)

See Figure 8 for lift truck models

- E1.6-2.0XN (E30-40XN) (A269)

NOTE: Coat the threads of the capscrews with Loctite® 242 or equivalent prior to installation.

NOTE: Perform Step 2 and Step 3 for lift truck models E2.2-3.5XN (E45-70XN) (A268).

2. Install the hanger assembly, seven washers, and seven capscrews on the center section assembly. See Figure 6.

3. Tighten capscrews to 90 to 99 N•m (66 to 73 lbf ft) in the order shown in Figure 9.

NOTE: Perform Step 4 and Step 5 for lift truck models E1.6-2.0XN (E30-40XN) (A269).

4. Install the hanger assembly, six washers, and six capscrews on the center section assembly. See Figure 6.

5. Tighten capscrews to 90 to 108 N•m (66 to 80 lbf ft) in the order shown in Figure 10.

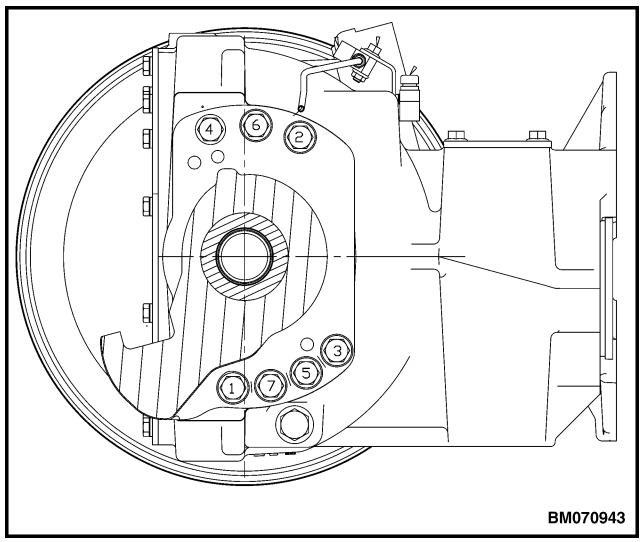


Figure 9. Mast Hanger Tightening Pattern, Lift Truck Models E2.2-3.5XN (E45-70XN) (A268)

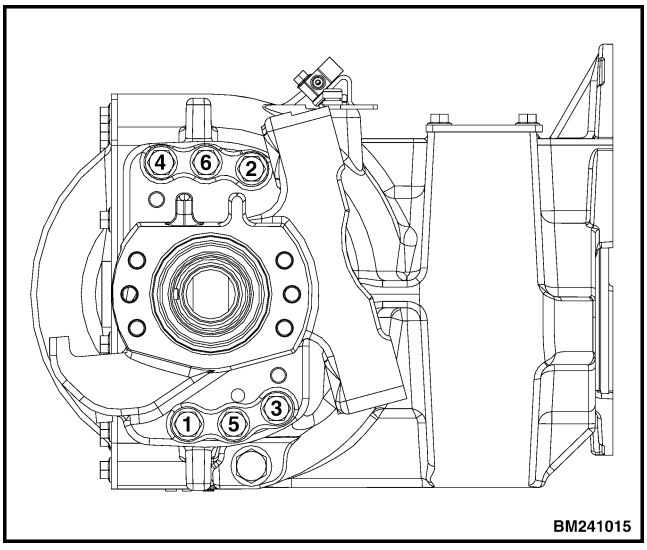


Figure 10. Mast Hanger Tightening Pattern, Lift Truck Models E1.6-2.0XN (E30-40XN) (A269)

NOTE: Be sure to use NEW lock bolts only.

NOTE: Perform Step 6 for lift truck models E2.2-3.5XN (E45-70XN) (A268).

6. Install the brake assembly and eight new lock bolts on the hangar assembly. See Figure 6.

Tighten the lock bolts to 255 to 306 N•m (188 to 226 lbf ft) in the order shown in Figure 11.

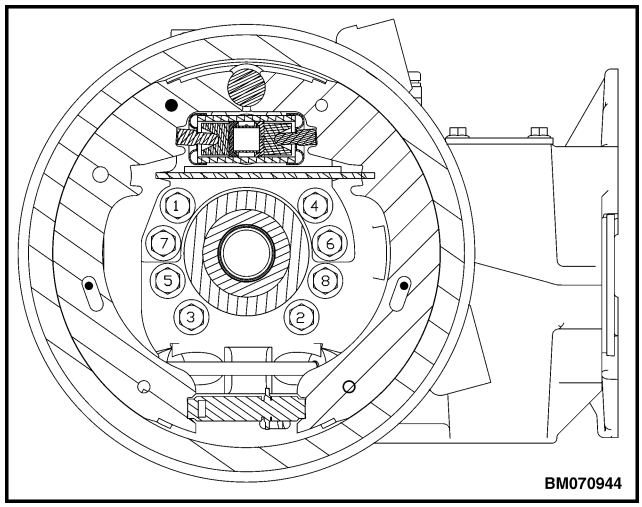


Figure 11. Brake Assembly Tightening Pattern, Lift Truck Models E2.2-3.5XN (E45-70XN) (A268)

NOTE: Perform Step 7 for lift truck models E1.6-2.0XN (E30-40XN) (A269).

7. Install brake assembly and six new lock bolts on the hangar assembly. See Figure 6.

Tighten the lock bolts to 152 to 167 N•m (112 to 123 lbf ft) in the order shown in Figure 12.

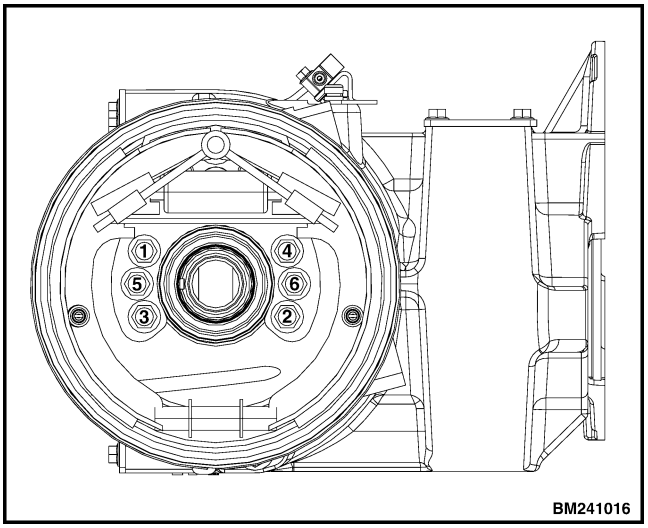


Figure 12. Brake Assembly Tightening Pattern, Lift Truck Models E1.6-2.0XN (E30-40XN) (A269)

8. If the bearing cones were removed, install new bearing cones in the hub. See Figure 6.

NOTE: Be sure to grease inner bearing cone properly prior to installation.

9. Install the new outer seal, inner bearing cup, inner bearing cone, and new inner seal in the hub. See Figure 6.

10. Install outer bearing cup into the hub. See Figure 6.

11. Install hub assembly, outer bearing cone, wheel bearing washer, new bearing lock washer, and bearing locknut, on the hanger assembly. See Figure 6.

12. Adjust the new wheel bearings as follows:

a. Align the bearing rollers by tightening the bearing locknut to 14 to 18 N•m (124 to 159 lbf in) and rotate the hub two revolutions in both directions.

b. For lift truck models E2.2-3.5XN (E45-70XN) (A268), seat wheel bearings by tightening bearing locknut to 175 to 215 N•m (129 to 159 lbf ft).

For lift truck models E1.6-2.0XN (E30-40XN) (A269), seat wheel bearings by tightening bearing locknut to 120 to 145 N•m (89 to 107 lbf ft).

c. Back off the bearing locknut to zero end play.

d. Preload the bearings by tightening the bearing locknut to 14 to 18 N•m (124 to 159 lbf in) and rotate the hub three complete revolutions in both directions.

e. Verify the bearing locknut torque to be 14 to 18 N•m (124 to 159 lbf in).

f. Repeat Step c through Step e until the final torque stabilizes at 14 to 18 N•m (124 to 159 lbf in).

13. To prevent the bearing locknut from loosening, bend the tangs of the bearing lock washer over the flats of the bearing locknut.

14. Apply a sealant, Hyster P/N 1584621 or 0264159, between axle shaft flange and hub.

Install axle shaft and eight capscrews into the axle assembly. Tighten capscrews in the order shown in Figure 13:

90 to 99 N•m (66 to 73 lbf ft) for lift truck models

- E2.2-3.5XN (E45-70XN) (A268)

90 to 108 N•m (66 to 80 lbf ft) for lift truck models

- E1.6-2.0XN (E30-40XN) (A269)

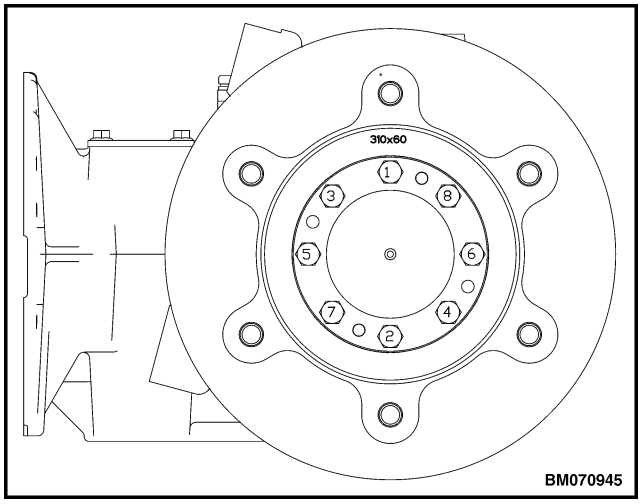
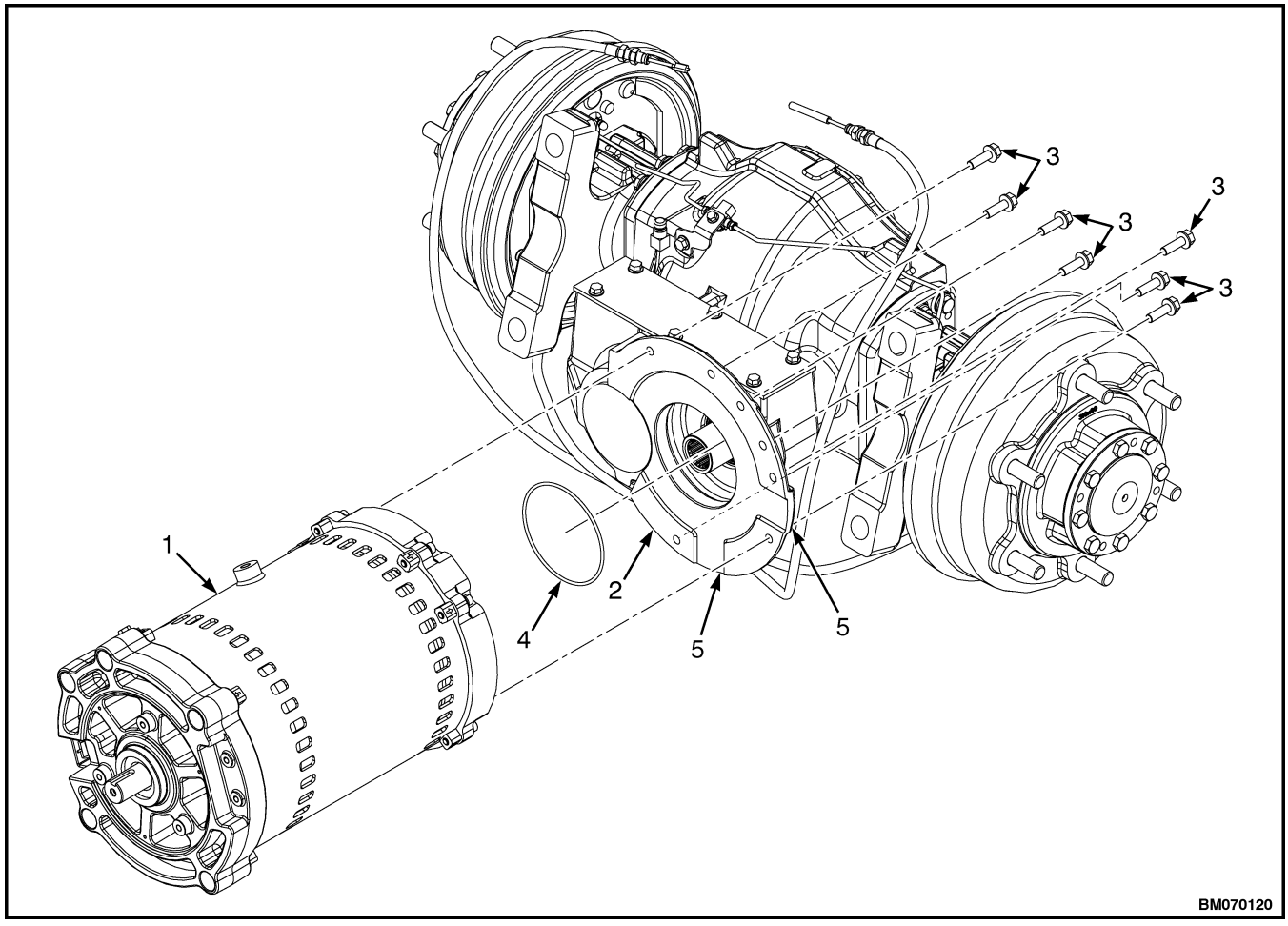


Figure 13. Axle Shaft Tightening Sequence

15. Repeat Step 1 through Step 14 for opposite side.

INSTALL

1. Install the wheels.
2. Raise the drive axle enough to allow the blocks to be removed from under center section assembly.
3. Raise drive axle and slide a floor jack under center section of drive axle. Raise floor jack until it supports the weight of the axle assembly.
4. Using transmission jack, position traction motor behind drive axle.
5. Install new O-ring onto traction motor. See Figure 14.



NOTE: DRIVE AXLE ARRANGEMENT FOR LIFT TRUCK MODELS E2.2-3.5XN (E45-70XN) (A268) SHOWN. DRIVE AXLE ARRANGEMENT FOR LIFT TRUCK MODELS E1.6-2.0XN (E30-40XN) (A269) IS SIMILAR.

1. TRACTION MOTOR
2. MOUNTING FLANGE
3. CAPSCREW
4. O-RING
5. PRY POINT

Figure 14. Drive Axle and Traction Motor

6. Align bolt holes in mounting flange and traction motor. Install capscrews holding traction motor onto mounting flange. See Figure 14. Tighten capscrews to 38 to 48 N•m (28 to 35 lbf ft).

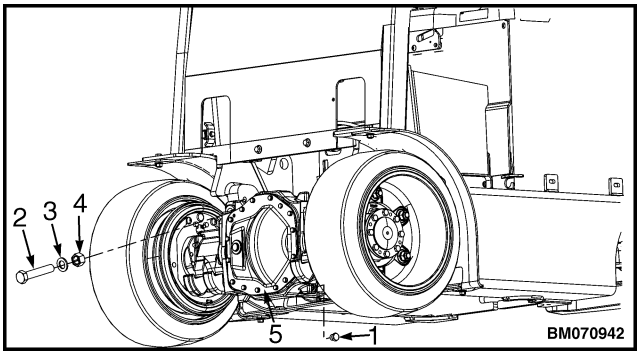
NOTE: Forklift trucks with 4-Stage Quad Mast will have an optional spacer between the drive axle mount and the frame's mounting bracket. The spacers top surface must make contact with the frame's drive axle mounting bracket. The drive axle's top surface must make contact with the frame's drive axle mounting bracket. See Figure 4.

7. If lift truck is equipped with a 4-Stage Quad Mast, install the spacer on the drive axle mount. Repeat for other side. See Figure 4.

NOTE: In the following step make sure tires stay on the surface.

8. Using floor jack and transmission jack, position drive axle and traction motor under lift truck and raise attaching position.

9. Install the four washers, axle mounting bolts, and nuts into drive axle assembly and frame. Tighten nuts to 755 to 830 N•m (557 to 612 lbf ft). See Figure 15.



NOTE: DRIVE AXLE ARRANGEMENT FOR LIFT TRUCK MODELS E2.2-3.5XN (E45-70XN) (A268) SHOWN. DRIVE AXLE ARRANGEMENT FOR LIFT TRUCK MODELS E1.6-2.0XN (E30-40XN) (A269) IS SIMILAR.

1. DRAIN PLUG
2. AXLE MOUNTING BOLT
3. WASHER
4. NUT
5. DRIVE AXLE ASSEMBLY

Figure 15. Drive Axle

10. Lower and remove floor jack from underneath lift truck.

11. Lower and remove transmission jack from underneath lift truck.

12. Tighten wheel nuts as specified below:

340 to 380 N•m (251 to 280 lbf ft) for lift truck models

- E2.2-3.5XN (E45-70XN) (A268)

155 to 175 N•m (114 to 129 lbf ft) for lift truck models

- E1.6-2.0XN (E30-40XN) (A269)

NOTE: Perform Step 13 if lift truck is equipped with an automatic park brake.

13. Connect automatic park brake to traction motor armature shaft.

See Brake System 1800SRM1359 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268)

See Brake System 1800SRM1438 for lift truck models

- E1.6-2.0XN (E30-40XN) (A269)

14. Connect hydraulic lines onto hydraulic tank.

NOTE: Remove tags after electrical connectors are installed.

15. Connect power cable to traction motor as tagged during removal.

NOTE: Perform Step 16 if lift truck is equipped with optional drip shield.

16. Install drip shield, capscrews, and nuts onto frame.

17. Install drain plug into drive axle and fill with oil. See Figure 15. See one of the following service manuals for oil type and quantity

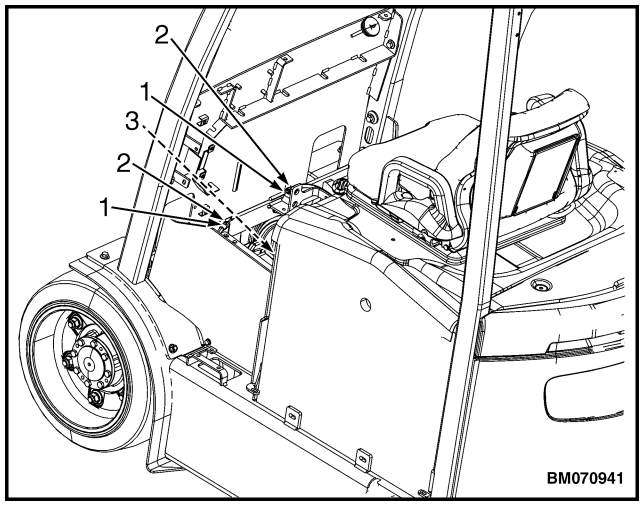
Periodic Maintenance 8000SRM1364 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268)

Periodic Maintenance 8000SRM1442 for lift truck models

- E1.6-2.0XN (E30-40XN) (A269)

18. Install parking brake cables into brackets and tighten jam nuts. See Figure 16.



NOTE: BRAKE LINES FOR LIFT TRUCK MODELS E2.2-3.5XN (E45-70XN) (A268) SHOWN. BRAKE LINES ARRANGEMENT FOR LIFT TRUCK MODELS E1.6-2.0XN (E30-40XN) (A269) IS SIMILAR.

1. JAM NUT
2. PARKING BRAKE CABLE
3. BRAKE LINE

Figure 16. Brake Line Installation

19. Adjust parking brake cables. See one of the following service manuals for procedures

Periodic Maintenance 8000SRM1364 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268)

Periodic Maintenance 8000SRM1442 for lift truck models

- E1.6-2.0XN (E30-40XN) (A269)

20. Connect brake line from master cylinder to manifold located on top of the drive axle assembly. See Figure 16.

21. Install the mast assembly. See one of the following service manuals for procedures.

Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564) 4000SRM1338 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268)

Mast Repair (S/N B551, B555, and B559) 4000SRM1441 for lift truck models

- E1.6-2.0XN (E30-40XN) (A269)

22. Install covers or plates and rollers into bottom of battery compartment. See Frame 0100SRM1342 for procedures.

23. Install the battery into the lift truck. See How to Change Battery in the Operating Manual or one of the following service manuals

Periodic Maintenance 8000SRM1364 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268)

Periodic Maintenance 8000SRM1442 for lift truck models

- E1.6-2.0XN (E30-40XN) (A269)

24. Remove lift truck from blocks. See Operators Manual or one of the following service manuals

Periodic Maintenance 8000SRM1364 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268)

Periodic Maintenance 8000SRM1442 for lift truck models

- E1.6-2.0XN (E30-40XN) (A269)

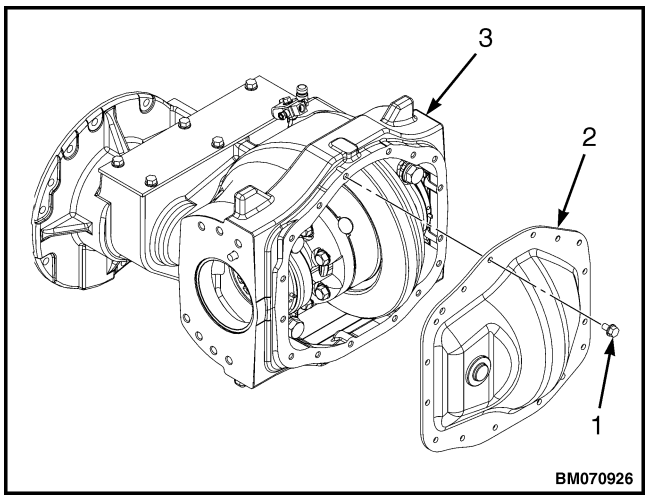
Differential Repair

REMOVE

For the following repair procedures, the drive axle must be removed and disassembled. Refer to the section Drive Axle Repair.

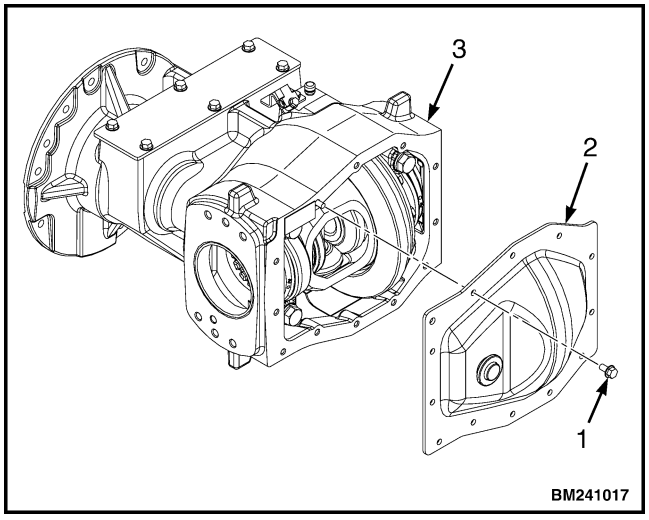
Differential Assembly From Center Section

STEP 1.
Remove capscrews and center section cover from the center section.



NOTE: DIFFERENTIAL ASSEMBLY FOR LIFT TRUCK MODELS E2.2-3.5XN (E45-70XN) (A268) SHOWN.

1. CAPSCREW
2. CENTER SECTION COVER
3. CENTER SECTION

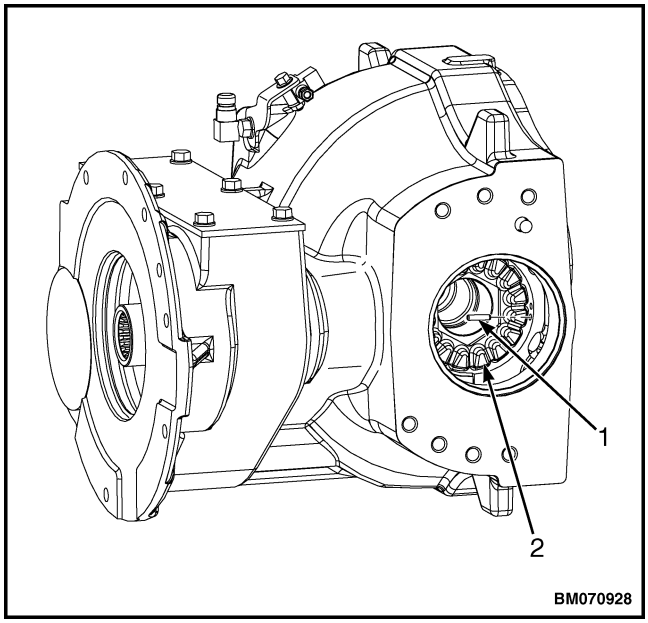


NOTE: DIFFERENTIAL ASSEMBLY FOR LIFT TRUCK MODELS E1.6-2.0XN (E30-40XN) (A269) SHOWN.

1. CAPSCREW
2. CENTER SECTION COVER
3. CENTER SECTION

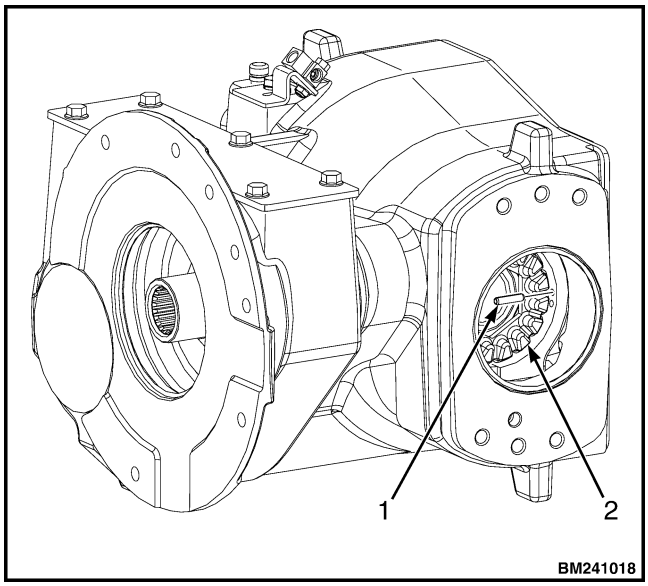
NOTE: Before working on the differential assembly, inspect the hypoid gear set for damage. If inspection shows no damage, the same gear set can be used again. Using a dial indicator, measure the backlash of the gear set and make a record of the dimension. See the procedures Ring Gear Backlash, Adjust and Gear Set, Tooth Contact Pattern Check.

STEP 2.
Remove spring pin. Using special tool, Hyster Part No. 1663599, loosen the differential retainer. See tool illustration below. If necessary, loosen the bearing cap capscrews to allow the differential retainer to turn freely.



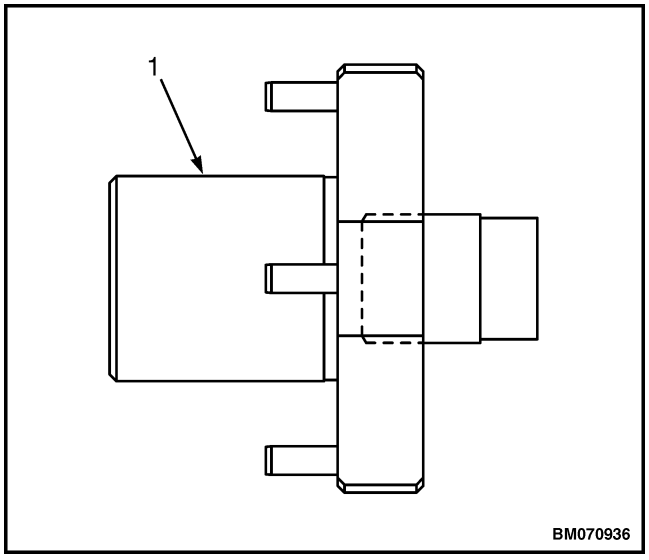
NOTE: DIFFERENTIAL ASSEMBLY FOR LIFT TRUCK MODELS E2.2-3.5XN (E45-70XN) (A268) SHOWN.

1. SPRING PIN
2. DIFFERENTIAL RETAINER



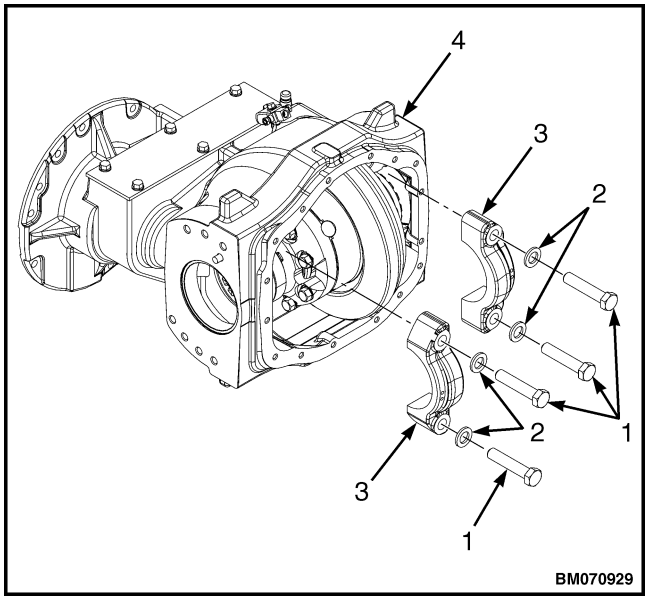
NOTE: DIFFERENTIAL ASSEMBLY FOR LIFT TRUCK MODELS E1.6-2.0XN (E30-40XN) (A269) SHOWN.

1. SPRING PIN
2. DIFFERENTIAL RETAINER



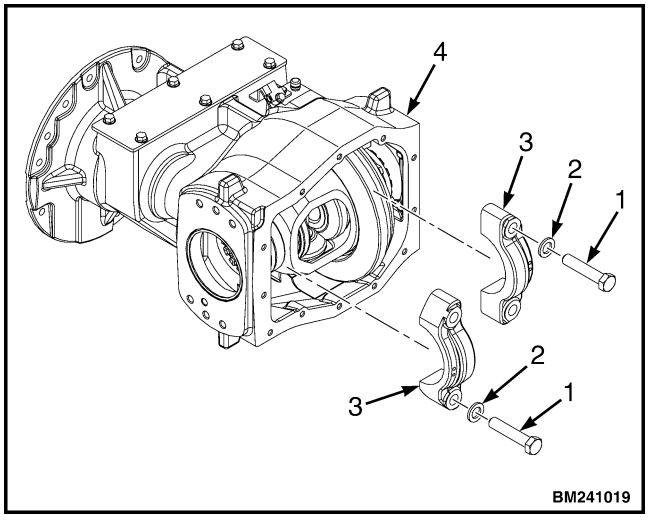
1. DIFFERENTIAL RETAINER SPECIAL TOOL

STEP 3.
Mark one differential carrier leg and bearing cap to correctly match the parts when assembling differential assembly. Mark the parts using a center punch and hammer. Remove capscrews, washers, and bearing caps.



NOTE: DIFFERENTIAL ASSEMBLY FOR LIFT TRUCK MODELS E2.2-3.5XN (E45-70XN) (A268) SHOWN.

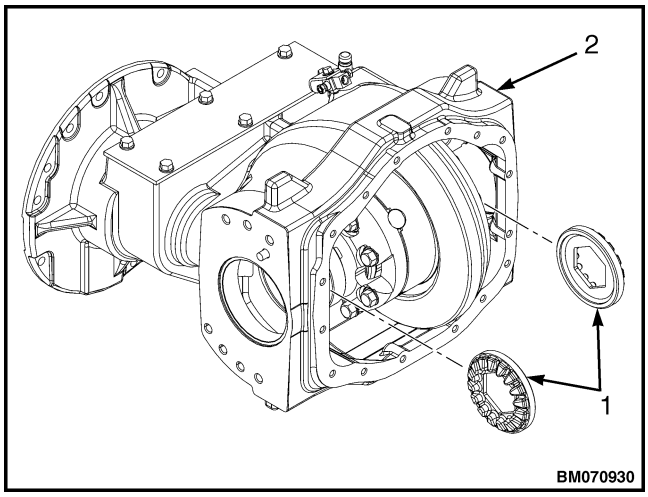
1. CAPSCREW
2. WASHER
3. BEARING CAP
4. CENTER SECTION



NOTE: DIFFERENTIAL ASSEMBLY FOR LIFT TRUCK MODELS E1.6-2.0XN (E30-40XN) (A269) SHOWN.

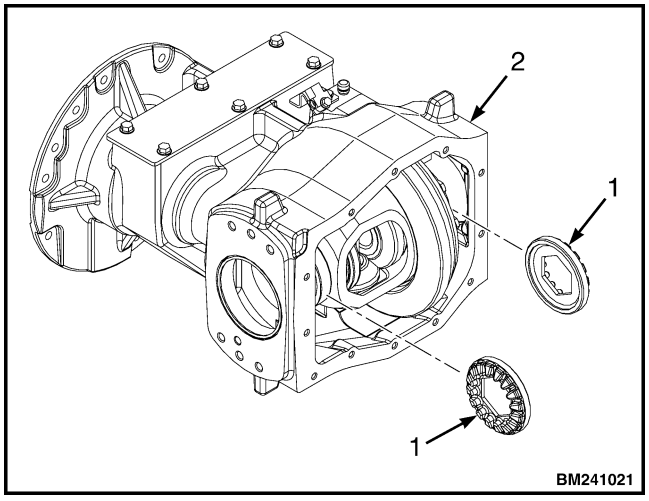
1. CAPSCREW
2. WASHER
3. BEARING CAP
4. CENTER SECTION

STEP 4.
Remove the differential retainers.



NOTE: DIFFERENTIAL ASSEMBLY FOR LIFT TRUCK MODELS E2.2-3.5XN (E45-70XN) (A268) SHOWN.

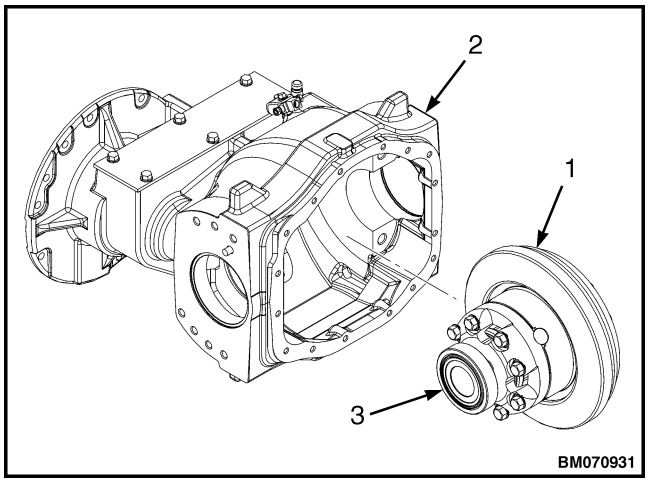
1. DIFFERENTIAL RETAINER
2. CENTER SECTION



NOTE: DIFFERENTIAL ASSEMBLY FOR LIFT TRUCK MODELS E1.6-2.0XN (E30-40XN) (A269) SHOWN.

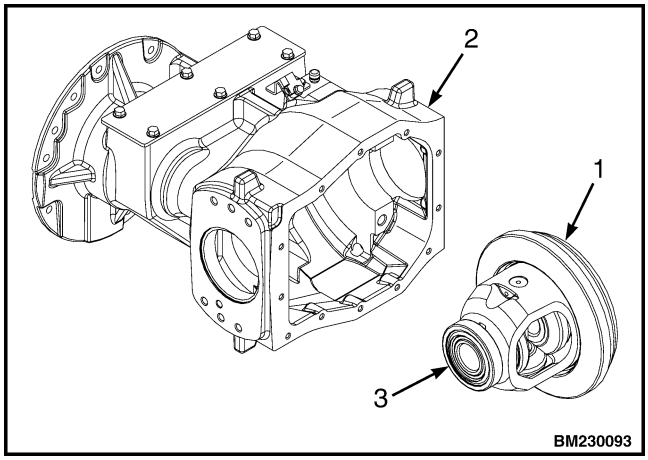
1. DIFFERENTIAL RETAINER
2. CENTER SECTION

STEP 5.
Remove the differential assembly.



NOTE: DIFFERENTIAL ASSEMBLY FOR LIFT TRUCK MODELS E2.2-3.5XN (E45-70XN) (A268) SHOWN.

1. DIFFERENTIAL ASSEMBLY
2. CENTER SECTION
3. TAPERED ROLLER BEARING AND CUP

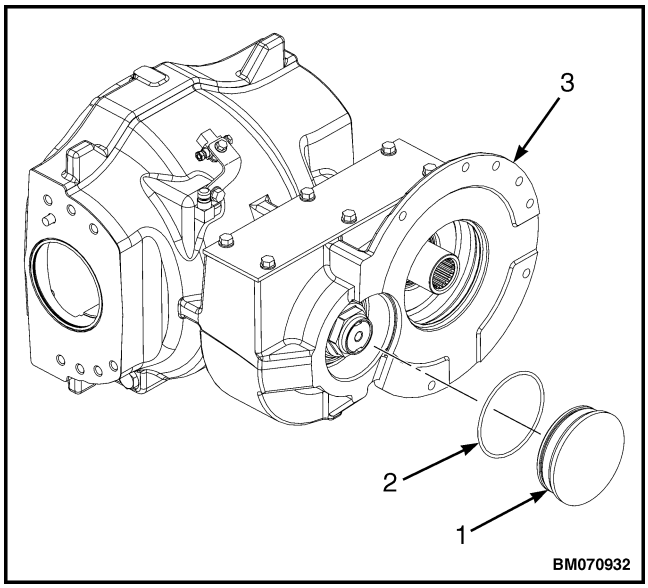


NOTE: DIFFERENTIAL ASSEMBLY FOR LIFT TRUCK MODELS E1.6-2.0XN (E30-40XN) (A269) SHOWN.

1. DIFFERENTIAL ASSEMBLY
2. CENTER SECTION
3. TAPERED ROLLER BEARING AND CUP

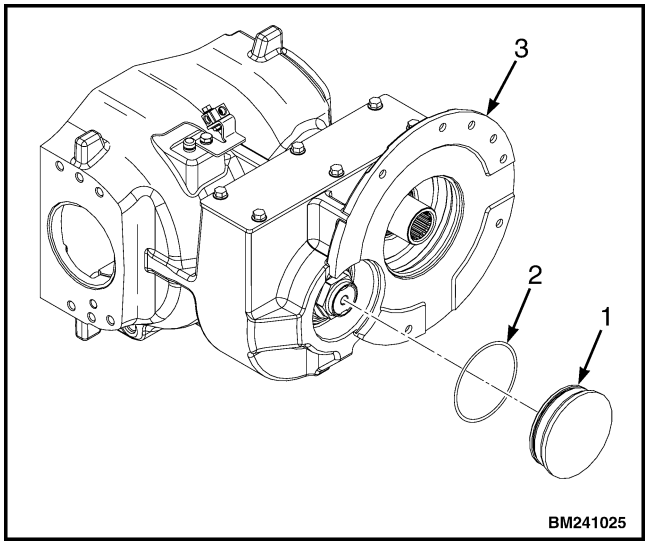
Drive Pinion, Pinion Gear, and Bearings From Center Section

STEP 1.
Remove the cover and O-ring from the center section. Discard the O-ring.



NOTE: DIFFERENTIAL ASSEMBLY FOR LIFT TRUCK MODELS E2.2-3.5XN (E45-70XN) (A268) SHOWN.

1. COVER
2. O-RING
3. CENTER SECTION



NOTE: DIFFERENTIAL ASSEMBLY FOR LIFT TRUCK MODELS E1.6-2.0XN (E30-40XN) (A269) SHOWN.

1. COVER
2. O-RING
3. CENTER SECTION

CAUTION

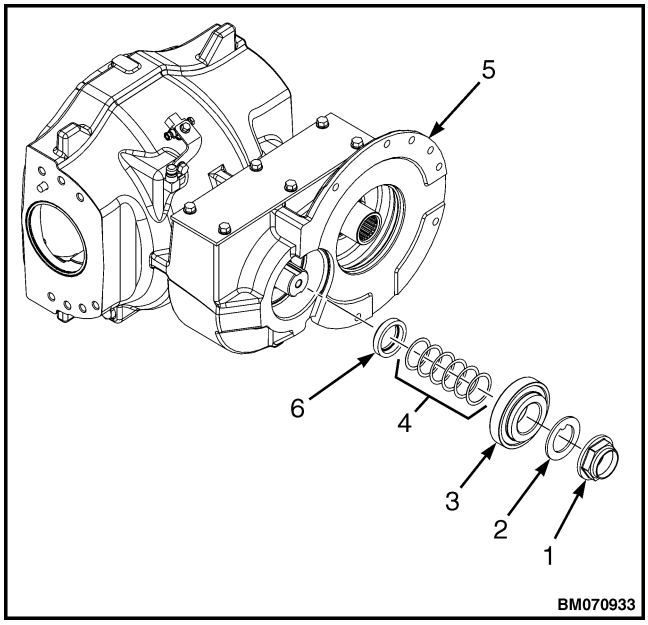
When removing the pinion nut, make sure the staked areas DO NOT touch the pinion threads. The staked areas can cause damage to the pinion threads, making the pinion unserviceable.

NOTE: When removing the pinion, be sure to retain the shims. Make note of the placement order, the number, and the thickness of the shims during removal to aid in installation.

STEP 2.
Using a small and flat chisel, unstake the pinion nut. Discard pinion nut.

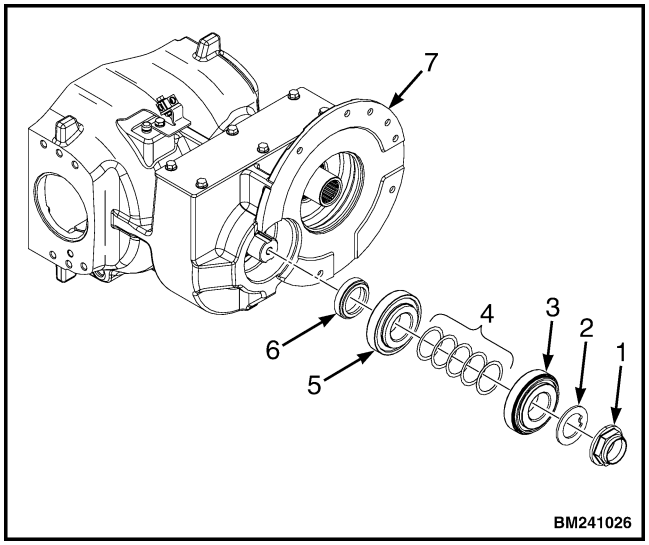
For lift truck models E2.2-3.5XN (E45-70XN) (A268), remove the pinion nut, pinion nut washer, tapered roller bearing, outer shims, and spacer from the center section.

For lift truck models E1.6-2.0XN (E30-40XN) (A269), remove the pinion nut, pinion nut washer, outer tapered roller bearing, outer shims, inner tapered roller bearing, and spacers from center section.



NOTE: DIFFERENTIAL ASSEMBLY FOR LIFT TRUCK MODELS E2.2-3.5XN (E45-70XN) (A268) SHOWN.

1. PINION NUT
2. PINION NUT WASHER
3. TAPERED ROLLER BEARING
4. OUTER SHIMS
5. CENTER SECTION
6. SPACER

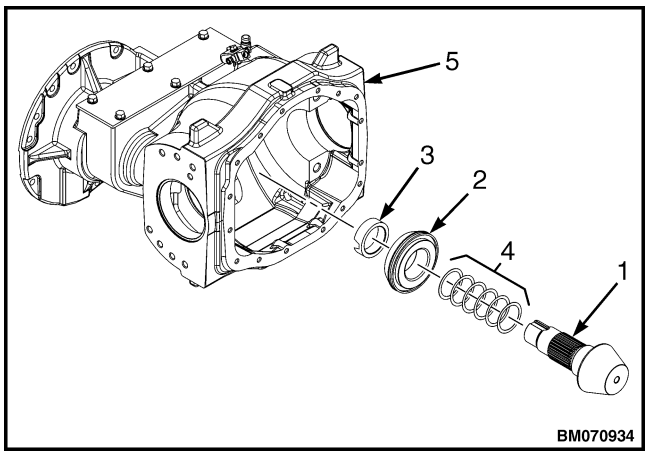


NOTE: DIFFERENTIAL ASSEMBLY FOR LIFT TRUCK MODELS E1.6-2.0XN (E30-40XN) (A269) SHOWN.

1. PINION NUT
2. PINION NUT WASHER
3. OUTER TAPERED ROLLER BEARING
4. OUTER SHIMS
5. INNER TAPERED ROLLER BEARINGS
6. SPACER
7. CENTER SECTION

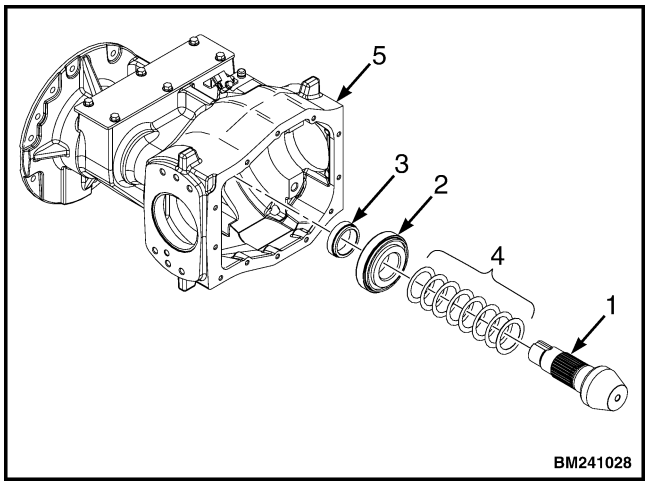
NOTE: Make note of the placement order, number and thickness of the shims during removal to aid in installation.

STEP 3.
Remove the pinion gear, inner shims, tapered roller bearing, and spacer from the center section.



NOTE: DIFFERENTIAL ASSEMBLY FOR LIFT TRUCK MODELS E2.2-3.5XN (E45-70XN) (A268) SHOWN.

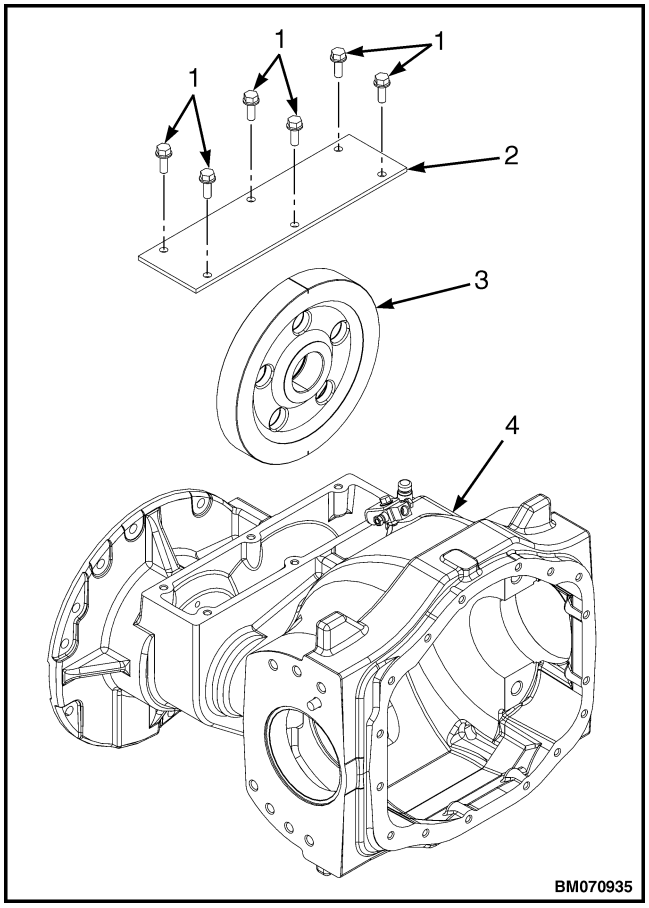
1. PINION GEAR
2. TAPERED ROLLER BEARING
3. SPACER
4. INNER SHIMS
5. CENTER SECTION



NOTE: DIFFERENTIAL ASSEMBLY FOR LIFT TRUCK MODELS E1.6-2.0XN (E30-40XN) (A269) SHOWN.

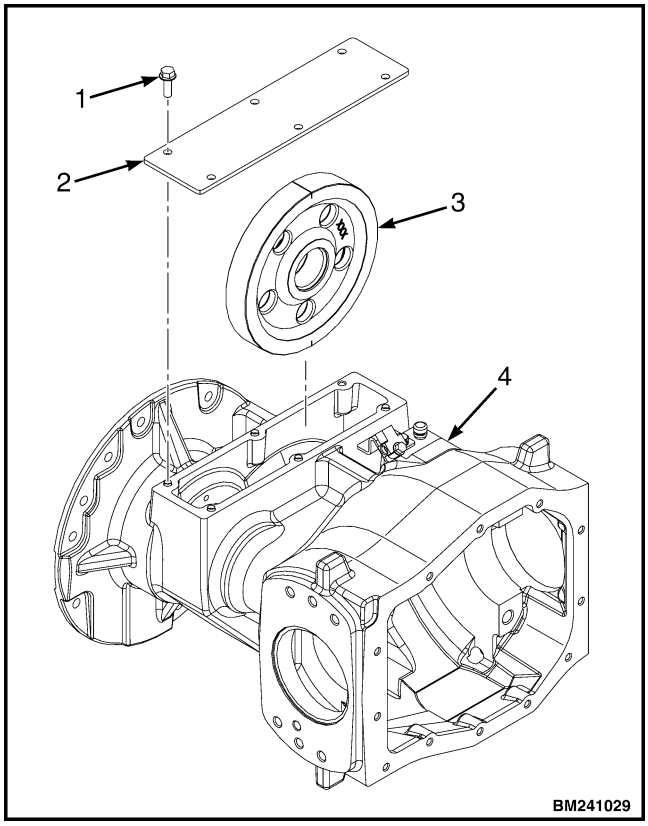
1. PINION GEAR
2. TAPERED ROLLER BEARING
3. SPACER
4. INNER SHIMS
5. CENTER SECTION

STEP 4.
Remove six capscrews, cover, and driven gear from the center housing.



NOTE: DIFFERENTIAL ASSEMBLY FOR LIFT TRUCK MODELS E2.2-3.5XN (E45-70XN) (A268) SHOWN.

1. CAPSCREWS
2. COVER
3. DRIVEN GEAR
4. CENTER HOUSING

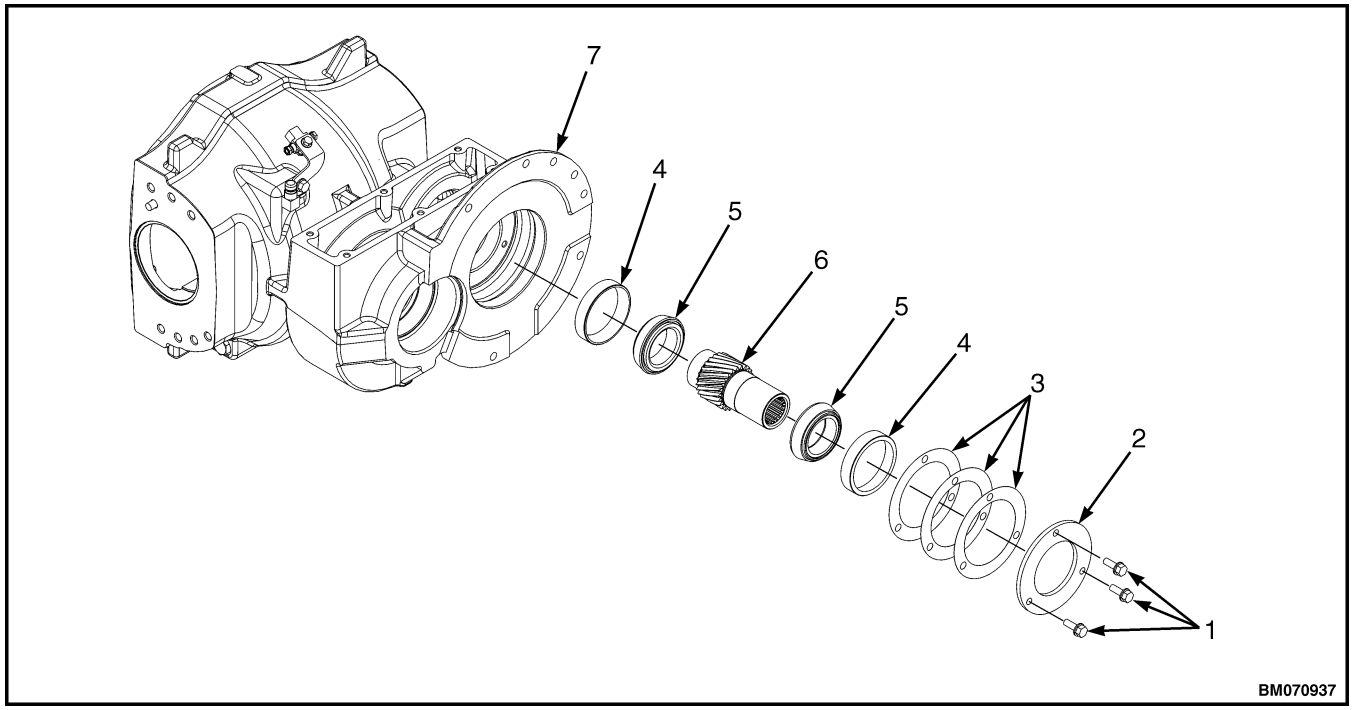


NOTE: DIFFERENTIAL ASSEMBLY FOR LIFT TRUCK MODELS E1.6-2.0XN (E30-40XN) (A269) SHOWN.

1. CAPSCREWS
2. COVER
3. DRIVEN GEAR
4. CENTER HOUSING

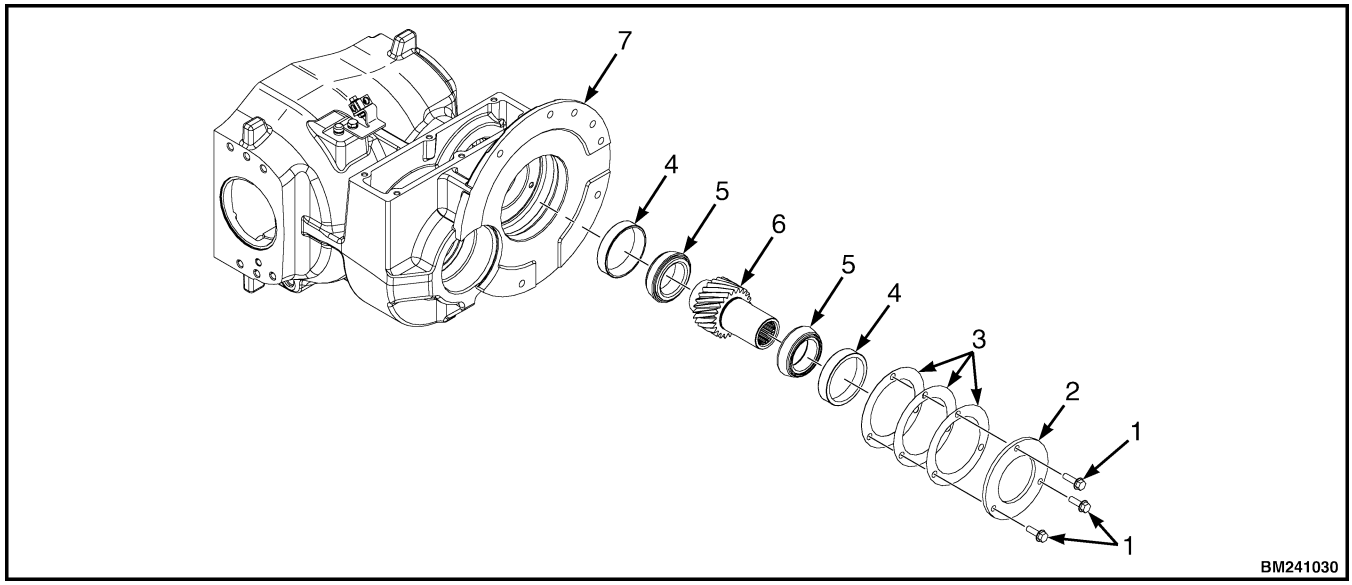
NOTE: Note the number of shims and thickness of the shim pack during removal to aid in installation.

STEP 5.
Remove capscrews, bearing retainer, shims, bearing cup, bearing cone, drive gear, bearing cone, and bearing cup from the center housing.



NOTE: DIFFERENTIAL ASSEMBLY FOR LIFT TRUCK MODELS E2.2-3.5XN (E45-70XN) (A268) SHOWN.

1. CAPSCREW
2. BEARING RETAINER
3. SHIMS
4. BEARING CUP
5. BEARING CONE
6. DRIVE GEAR
7. CENTER HOUSING



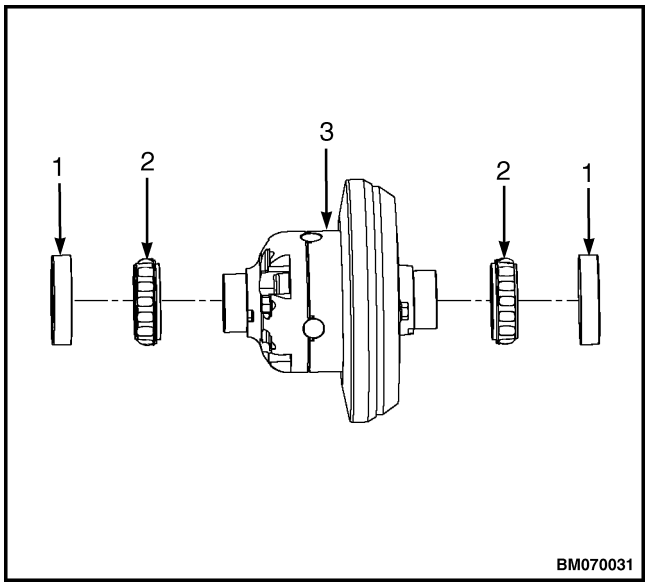
NOTE: DIFFERENTIAL ASSEMBLY FOR LIFT TRUCK MODELS E1.6-2.0XN (E30-40XN) (A269) SHOWN.

1. CAPSCREW
2. BEARING RETAINER
3. SHIMS
4. BEARING CUP
5. BEARING CONE
6. DRIVE GEAR
7. CENTER HOUSING

DISASSEMBLE

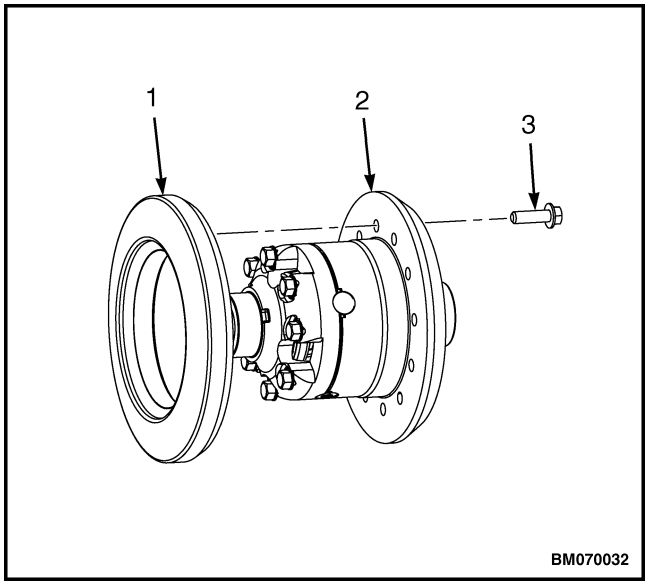
Differential Assembly, Lift Truck Models E2.2-3.5XN (E45-70XN) (A268)

STEP 1.
Using a bearing puller, remove the tapered roller bearings from the differential assembly. Remove bearing cups from center housing if bearings are damaged.



1. BEARING CUP
2. TAPERED ROLLER BEARING
3. DIFFERENTIAL ASSEMBLY

STEP 2.
Remove the capscrews retaining the ring gear to the differential assembly. Remove the ring gear.

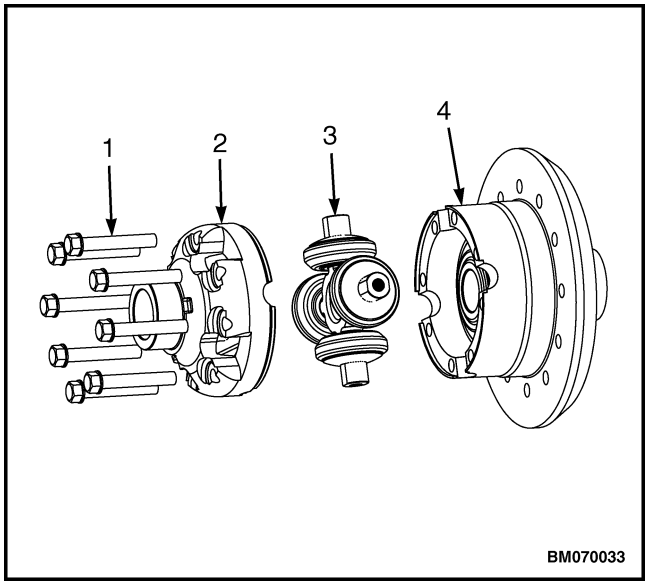


1. RING GEAR
2. DIFFERENTIAL ASSEMBLY
3. CAPSCREW

NOTE: Mark each side of the differential case halves before separating to ensure proper alignment at assembly.

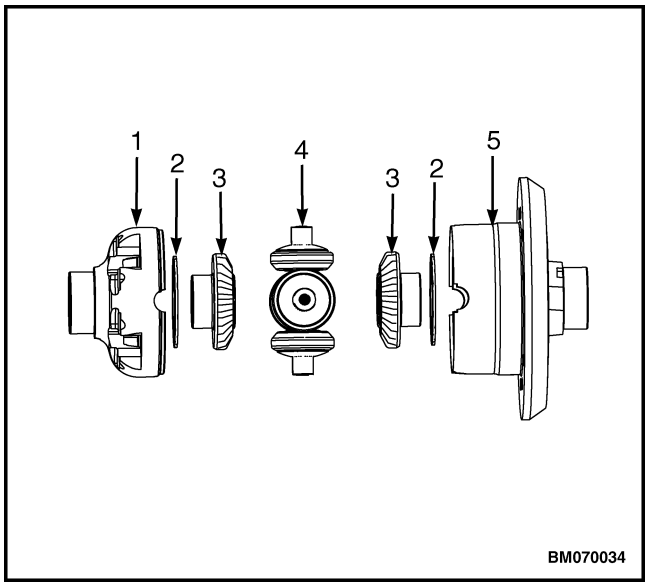
STEP 3.
Remove the capscrews from the differential and separate the differential case halves.

Inspect the differential case halves for wear or damage. If wear or damage is present, the entire differential assembly must be replaced.



1. CAPSCREW
2. DIFFERENTIAL CASE HALF
3. SPIDER ASSEMBLY
4. DIFFERENTIAL CASE HALF

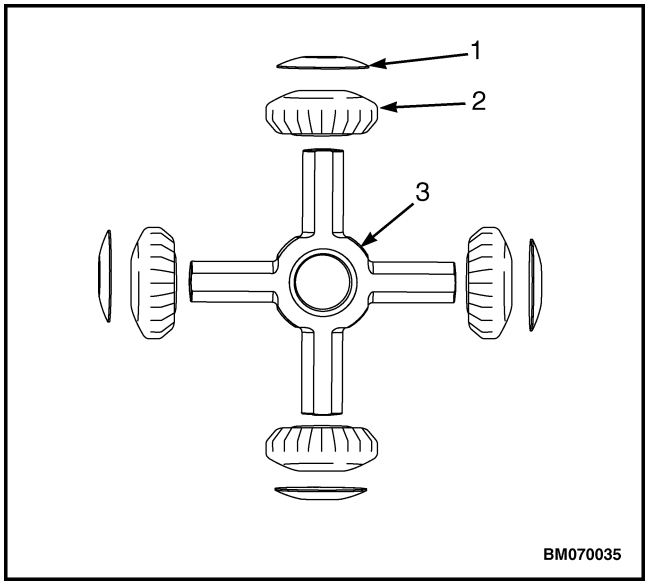
STEP 4.
Remove the spider assembly, side gears and thrust washers from the differential case halves.



1. DIFFERENTIAL CASE HALF
2. THRUST WASHER
3. SIDE GEAR
4. SPIDER ASSEMBLY
5. DIFFERENTIAL CASE HALF

STEP 5.
Remove the pinions and thrust washers from the spider.

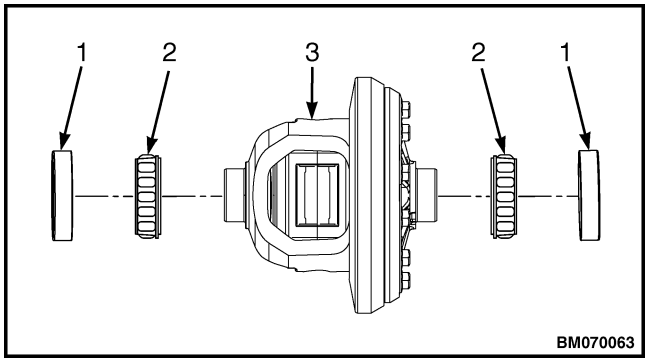
Inspect the spider for wear or damage. Replace as needed.



1. THRUST WASHER
2. PINION
3. SPIDER

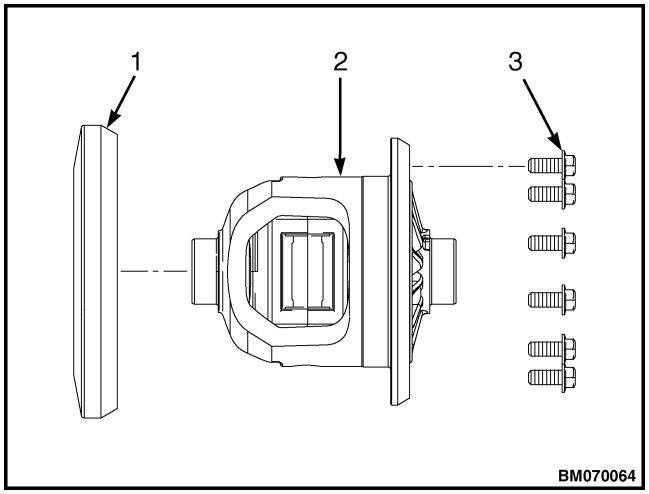
Differential Assembly, Lift Truck Models E1.6-2.0XN (E30-40XN) (A269)

STEP 1.
Using a bearing puller, remove the tapered roller bearings from the differential assembly. Remove bearing cups from center housing if bearings are damaged.



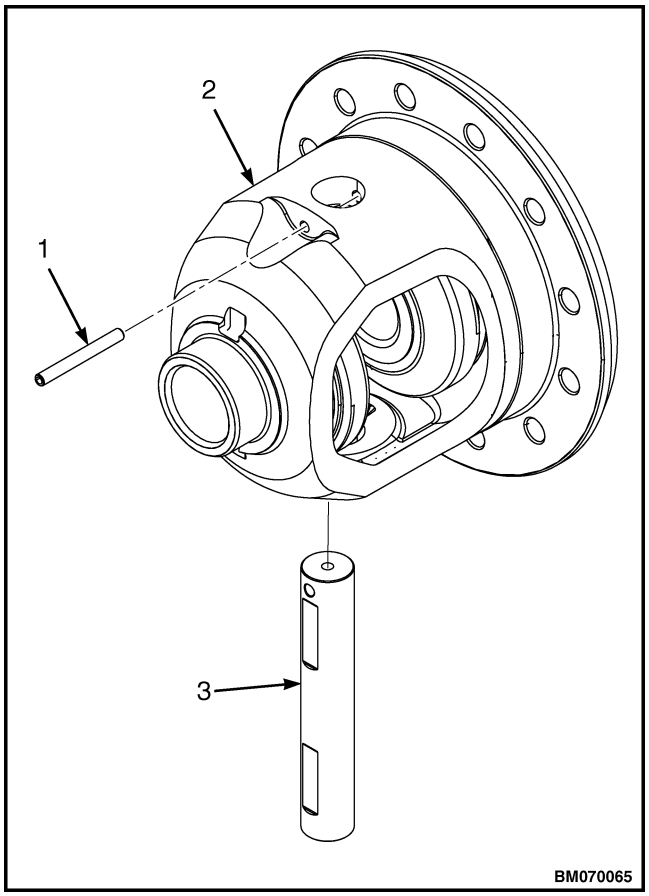
1. BEARING CUP
2. TAPERED ROLLER BEARING
3. DIFFERENTIAL ASSEMBLY

STEP 2.
Remove the capscrews retaining the ring gear to the differential assembly. Remove the ring gear.



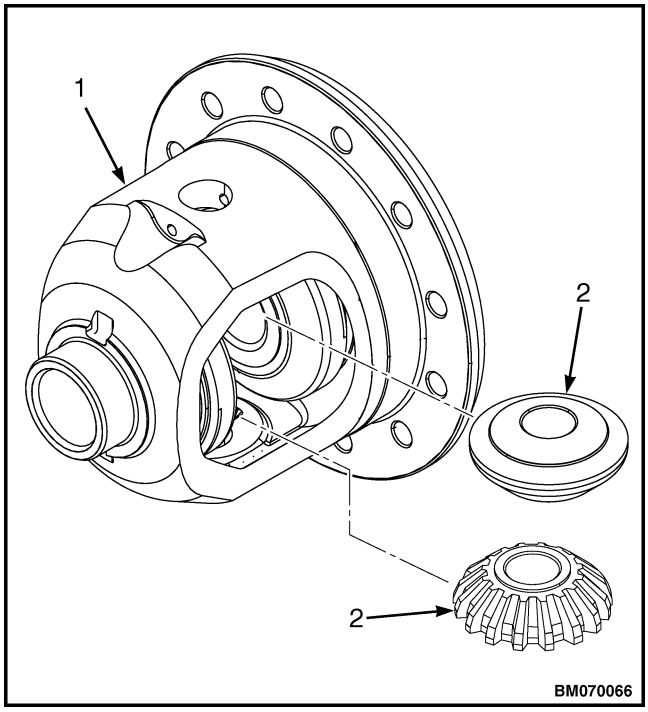
1. RING GEAR
2. DIFFERENTIAL ASSEMBLY
3. CAPSCREW

STEP 3.
Remove spring pin from carrier and pinion shaft. Discard spring pin. Remove shaft. Inspect shaft for wear. Replace as needed.



1. SPRING PIN
2. CARRIER
3. PINION SHAFT

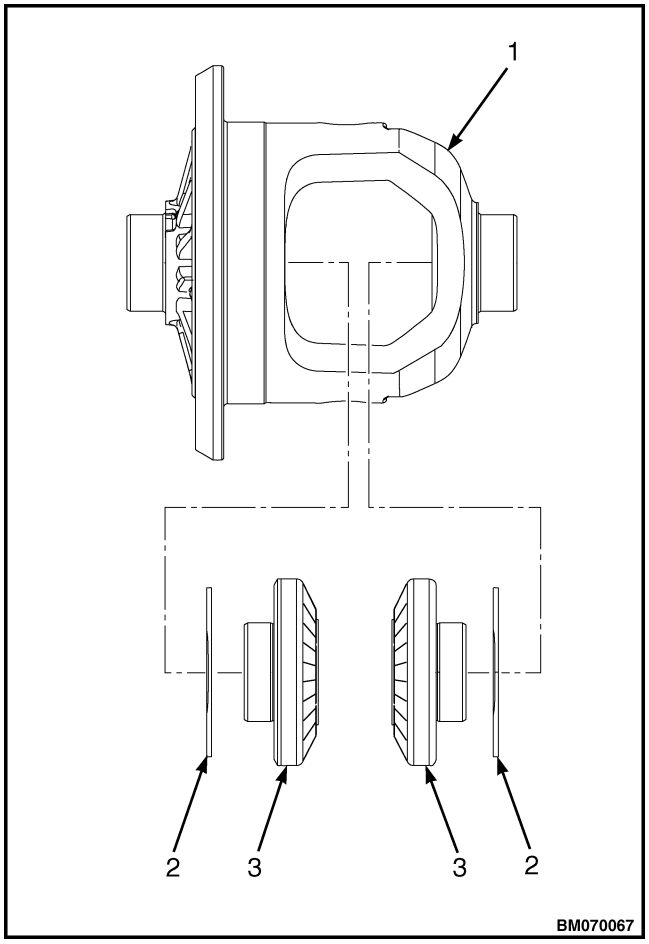
STEP 4.
Rotate the side gear until the pinion gears can be removed from the carrier. Remove pinion gears. Inspect pinion gears spherical washers for wear. Replace as needed.



1. CARRIER
2. PINION GEARS

STEP 5.
Remove the side gears and thrust washers from the carrier.

Inspect the carrier and side gears for wear or damage. Replace as needed.



1. CARRIER
2. THRUST WASHER
3. SIDE GEAR

CLEAN AND INSPECT

WARNING

Cleaning solvents can be flammable and toxic and can cause skin irritation. When using cleaning solvents, always follow the recommendations of the manufacturer.

WARNING

Compressed air can move particles so that they cause injury to the user or to other personnel. Make sure that the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eyes.

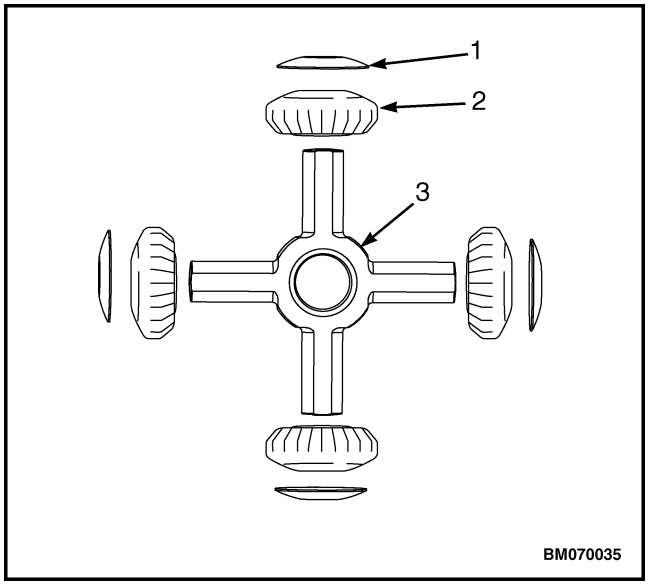
Clean and inspect the following parts of the differential:

- Drive axle
  - Clean the parts of the axle with solvent and dry with compressed air. Inspect all machined surfaces and bearings for wear and damage. Replace damaged parts.
- Tapered roller bearings
  - Inspect the cup, cone, rollers, and cage of all tapered roller bearings in the assembly. Replace bearings if there are signs of wear, cracks, or damage.
- Pinions and gears
  - Inspect the pinions and gears for wear or damage. Gears that are worn or damaged must be replaced.
- Main differential assembly
  - Inspect all parts of the main differential assembly for wear or damage. Parts that are damaged must be replaced.

ASSEMBLE

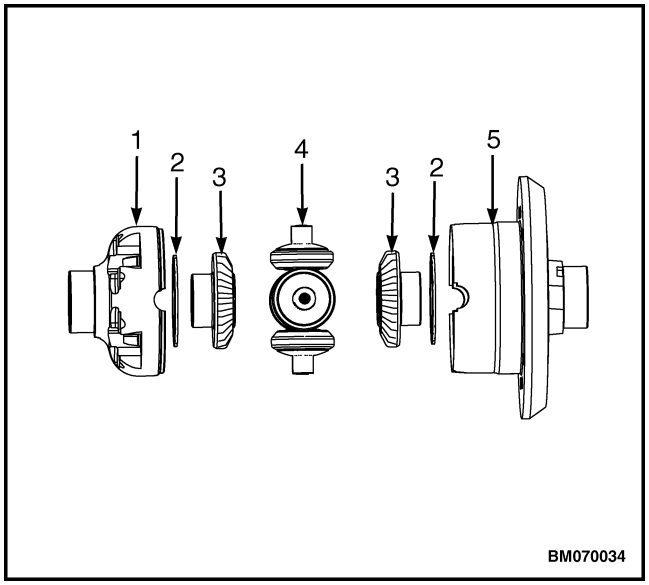
Differential Assembly, Lift Truck Models E2.2-3.5XN (E45-70XN) (A268)

STEP 1.
Lubricate both sides of the thrust washers with 80W - 90W gear lube. Install the pinions and thrust washers onto the spider.



1. THRUST WASHER
2. PINION
3. SPIDER

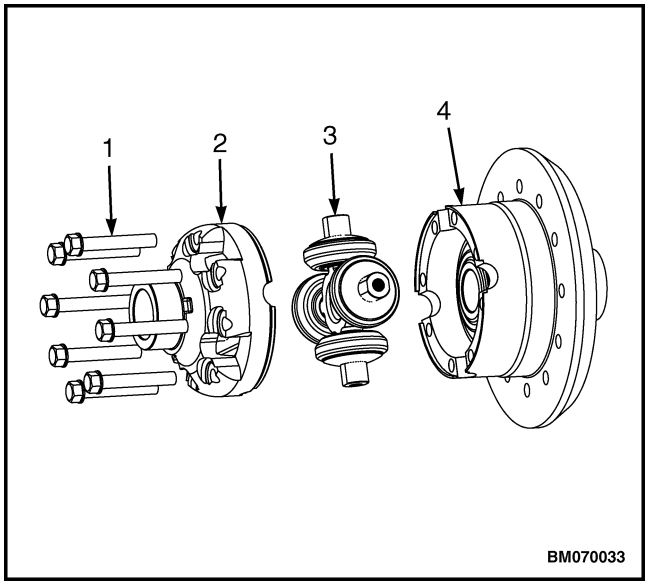
STEP 2.
Lubricate both sides of the thrust washers with 80W - 90W gear lube. Install the side gears and thrust washers into the differential halves.



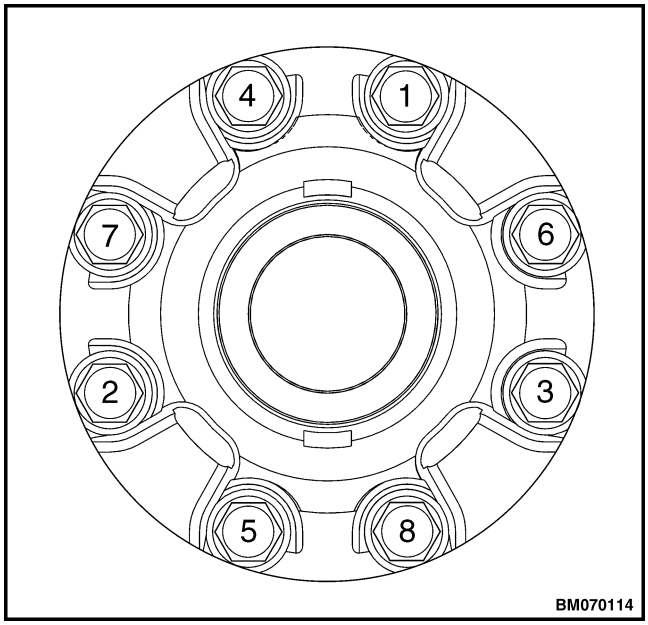
1. CASE HALF
2. THRUST WASHER
3. SIDE GEAR
4. SPIDER ASSEMBLY
5. CASE HALF

STEP 3.
Place the spider assembly into the case halves and assemble the case halves. Apply Loctite® 242 to the threads of the capscrews and install the capscrews. Tighten the capscrews in the sequence shown to 125 to 145 N•m (92 to 107 lbf ft).

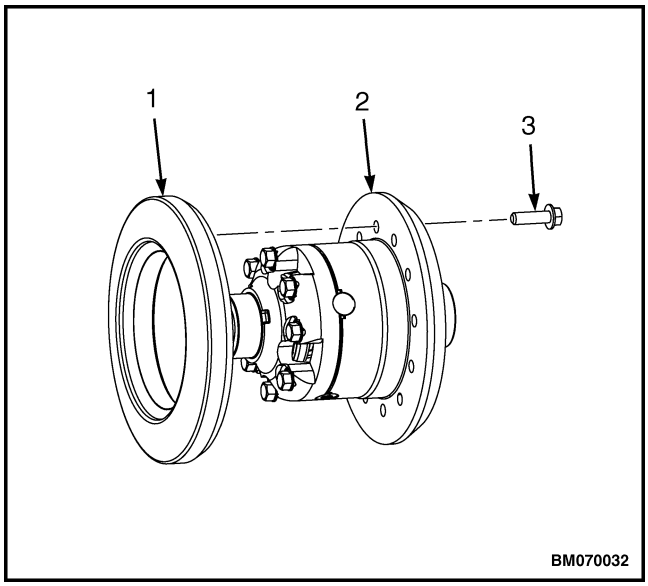
Make sure the backlash between the side and pinion gears is 0.15 to 0.25 mm (0.0059 to 0.0098 in.). If backlash exceeds 0.25 mm (0.0098 in.), verify case half does not have excessive wear. If excessive wear exists, replace differential assembly. See Ring Gear Backlash, Adjust and Gear Set, Tooth Contact Pattern Check for procedures.



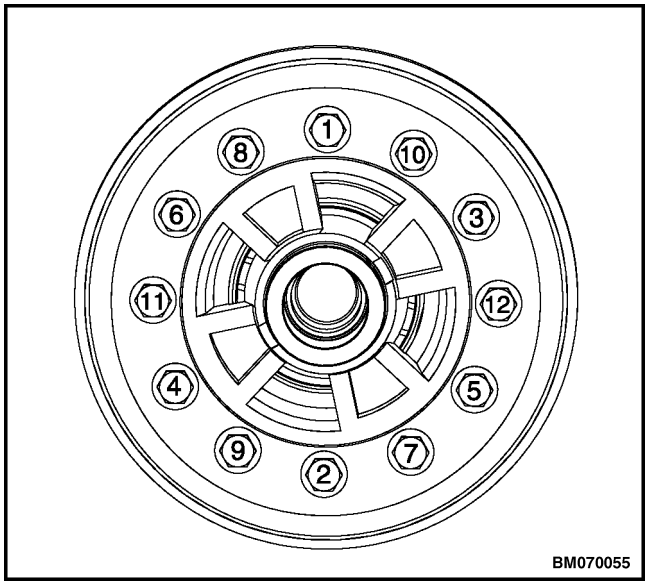
1. CAPSCREW
2. CASE HALF
3. SPIDER ASSEMBLY
4. CASE HALF



STEP 4.
Place the ring gear in position on the differential assembly and install capscrews. Tighten the capscrews in a cross/diagonal pattern, as shown, to 152 to 167 N•m (112 to 123 lbf ft).



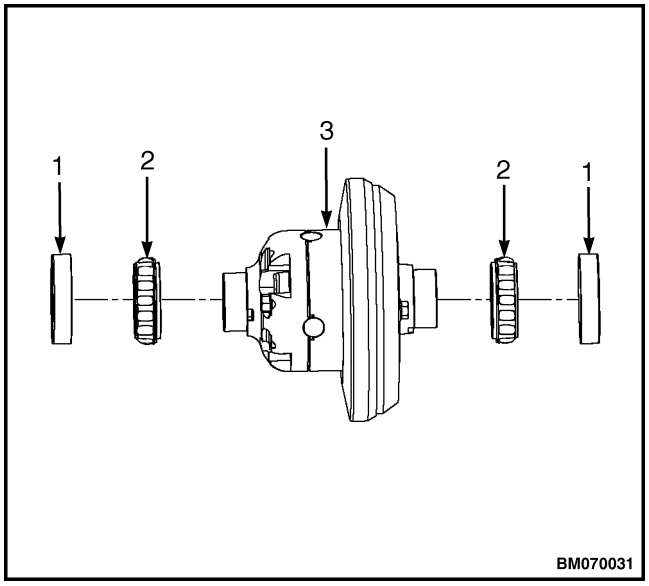
1. RING GEAR
2. DIFFERENTIAL ASSEMBLY
3. CAPSCREW



CAUTION

DO NOT damage the bearing rollers or cage when pressing the bearing cones onto the differential assembly. Press on the inner raceway of the cone.

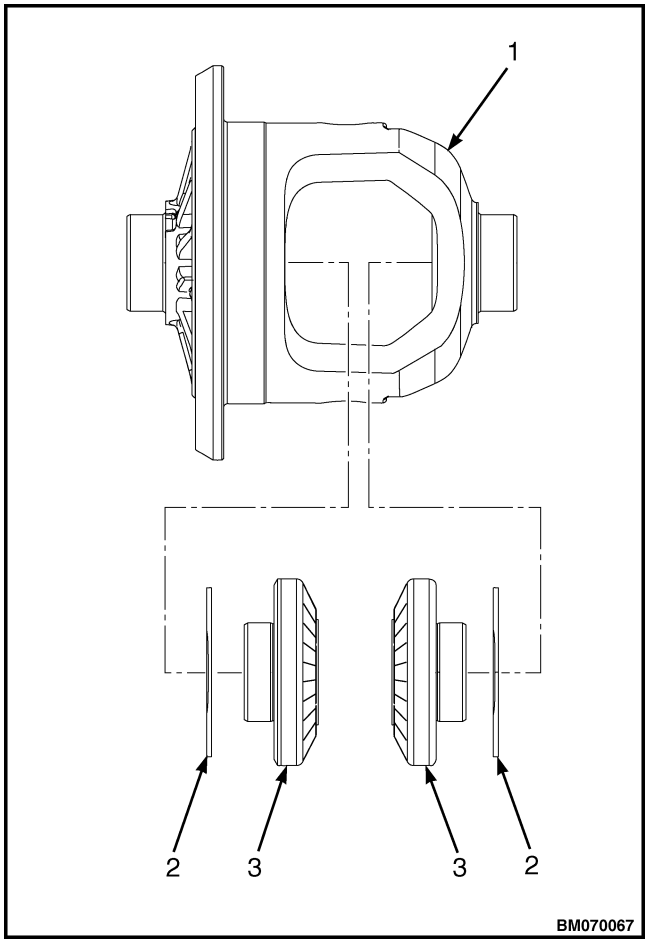
STEP 5.
Press the bearing cones onto the differential assembly. If removed, install the bearing cups into the center housing prior to differential assembly install.



1. BEARING CUP
2. TAPERED ROLLER BEARING
3. DIFFERENTIAL ASSEMBLY

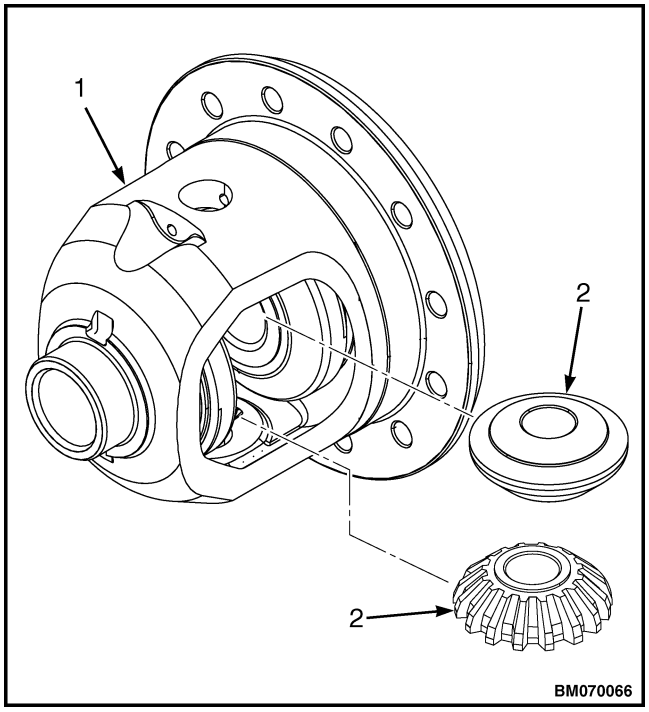
Differential Assembly, Lift Truck Models E1.6-2.0XN (E30-40XN) (A269)

STEP 1.
Lubricate both sides of the thrust washers with 80W - 90W gear lube. Install the side gears and thrust washers into the carrier.



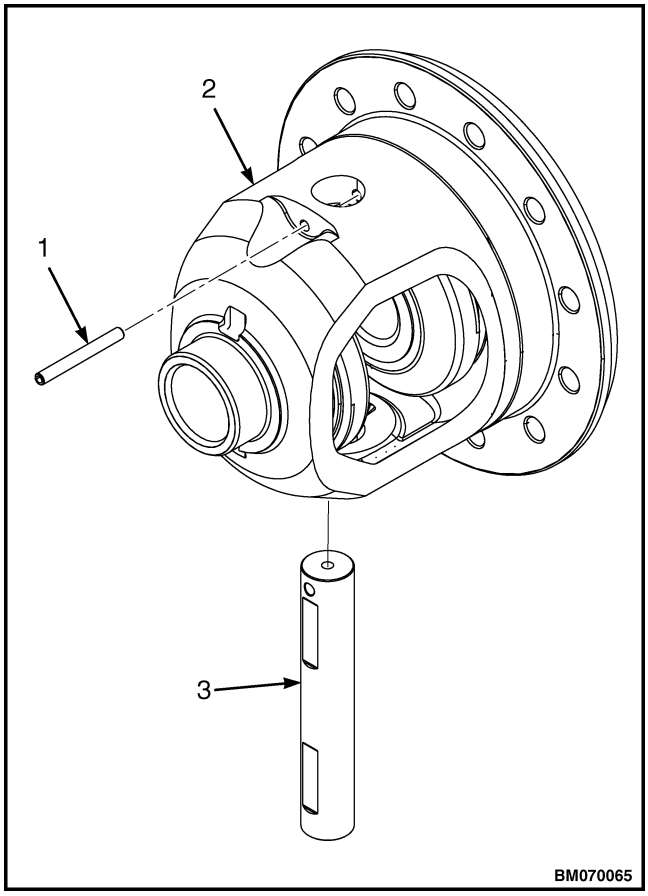
1. CARRIER
2. THRUST WASHER
3. SIDE GEAR

STEP 2.
Lubricate pinion gears with 80W - 90W gear lube. Install the pinion gears by rotating the side gears until the pinion gears are in position.



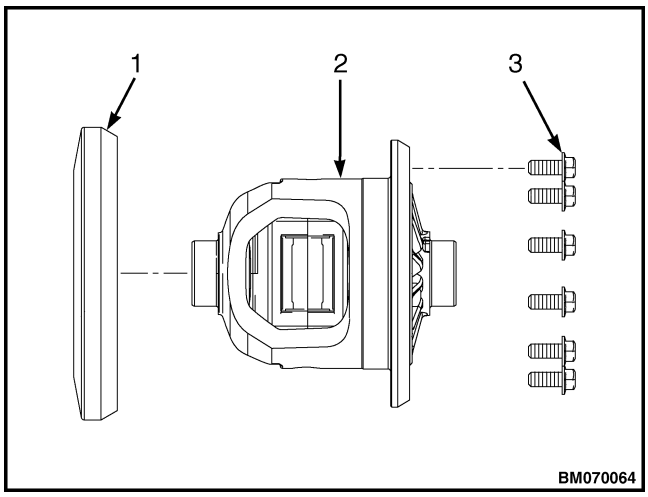
1. CARRIER
2. PINION GEARS

STEP 3.
Install the pinion shaft into the carrier, through the pinion gears. Install new spring pin into the carrier and pinion shaft.

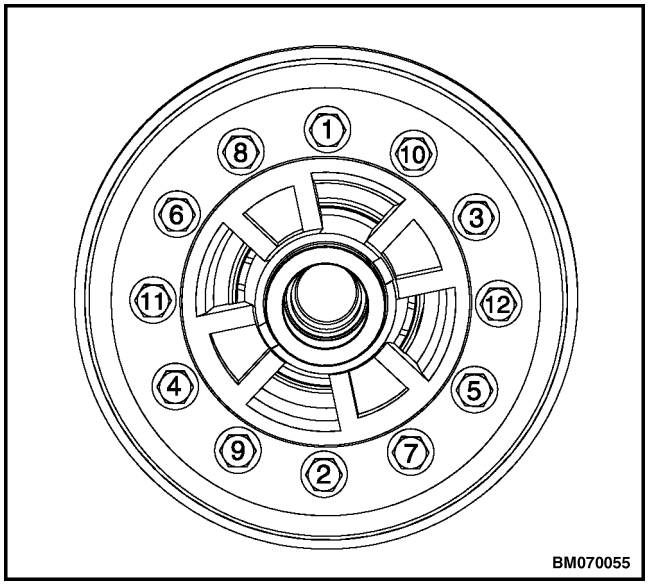


1. SPRING PIN
2. CARRIER
3. PINION SHAFT

STEP 4.
Place the ring gear in position on the differential assembly and install capscrews. Tighten capscrews in a cross/diagonal pattern to 152 to 167 N•m (112 to 123 lbf ft).



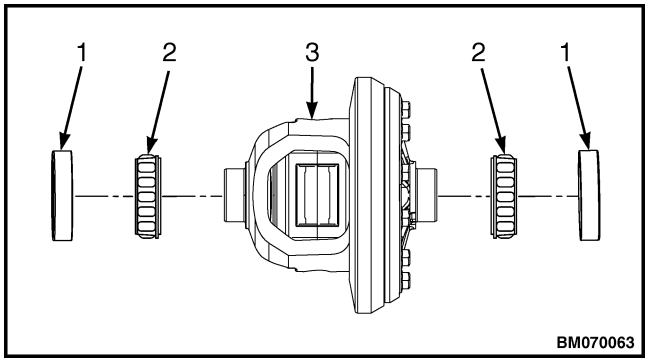
1. RING GEAR
2. DIFFERENTIAL ASSEMBLY
3. CAPSCREW



CAUTION

DO NOT damage the bearing rollers or cage when pressing the bearing cones onto the differential assembly. Press on the inner raceway of the cone.

STEP 5.
Press the bearing cones onto the differential assembly. If removed, install the bearing cups into the center housing prior to differential assembly install.



1. BEARING CUP
2. TAPERED ROLLER BEARING
3. DIFFERENTIAL ASSEMBLY

INSTALL

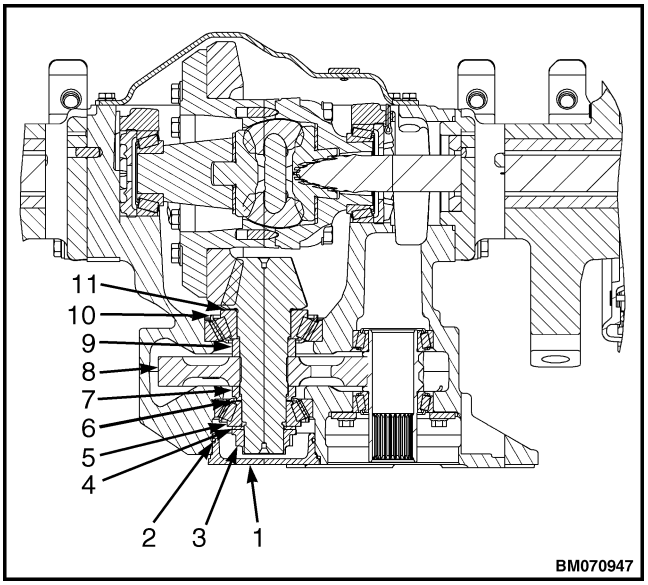
Pinion Inner Shim Set, Adjust Thickness (Depth of Pinion)

NOTE: Use this procedure if a new ring gear and pinion set is installed, or if the depth of the pinion has to be adjusted. See Ring Gear Backlash, Adjust and Gear Set, Tooth Contact Pattern Check for adjustment procedures.

NOTE: If replacing the center section, use a new standard shim set with nominal thickness of 1 mm (0.040 in.) for adjusting the depth of the pinion and a new standard shim set with nominal thickness of 1 mm (0.040 in.) for adjusting the preload. Perform the following procedure until the correct backlash and gear tooth contact pattern is achieved.

The pinion is adjusted using shims. If the same bearings, ring gear, and pinion are used, use the original shim set. See Figure 17. If a new bearings, ring gear, and pinion are used, adjust the pinion as described below.

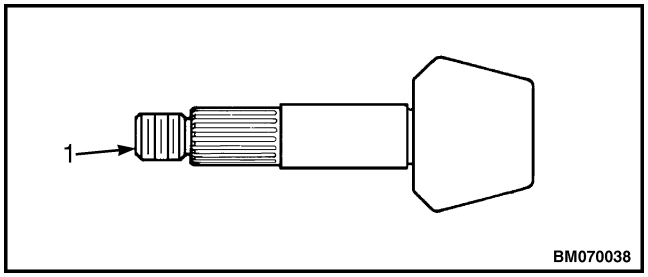
The correct shim set thickness can be found by using the original and new parts. Use the original shim set thickness and the pinion variation number on the original and new pinion. For the location and identification of the number, see Figure 18.



NOTE: SHIM SET FOR LIFT TRUCK MODELS E2.2-3.5XN (E45-70XN) (A268) SHOWN. SHIM SET FOR LIFT TRUCK MODELS E1.6-2.0XN (E30-40XN) (A269) IN SAME LOCATION.

1. CAP
2. O-RING
3. PINION NUT
4. PINION NUT WASHER
5. TAPERED ROLLER BEARING
6. OUTER SHIM SET (CONTROLS BEARING PRELOAD)
7. SPACER
8. DRIVEN GEAR
9. SPACER
10. TAPERED ROLLER BEARING
11. INNER SHIM SET (CONTROLS DEPTH OF PINION)

Figure 17. Shim Set Location



1. PINION VARIATION NUMBER

Figure 18. Pinion Variation Number

Find the correct thickness of the mounting distance (inner) shim set as follows:

1. Use a micrometer to measure the total thickness of the original shim set that was removed from under the pinion carrier. Make a note of the measurement for later use.

2. Check the pinion variation number for the original pinion. See Figure 18. If this number is a plus (+) value, subtract the value from the value in Step 1. If the pinion variation number is a minus (−) value, add the number to the value in Step 1. The number shown is in 0.00 × inch (+2 = +0.002 in.). The result is the standard thickness for a shim set.

NOTE: The value calculated in Step 2 is the thickness of the standard shim set, without a variation.

3. Check the pinion variation number for the new pinion. Add or subtract this number to the standard thickness value of Step 2. Add the number if the value is a plus (+) value. Subtract the number if the value is a minus (−) value. The result is the correct thickness for the new shim set. See the examples in Table 1.

NOTE: The value calculated in Step 3 is the thickness of the new shim set that will be installed. See the examples shown in Table 1.

Table 1. Pinion Variation Numbers Examples

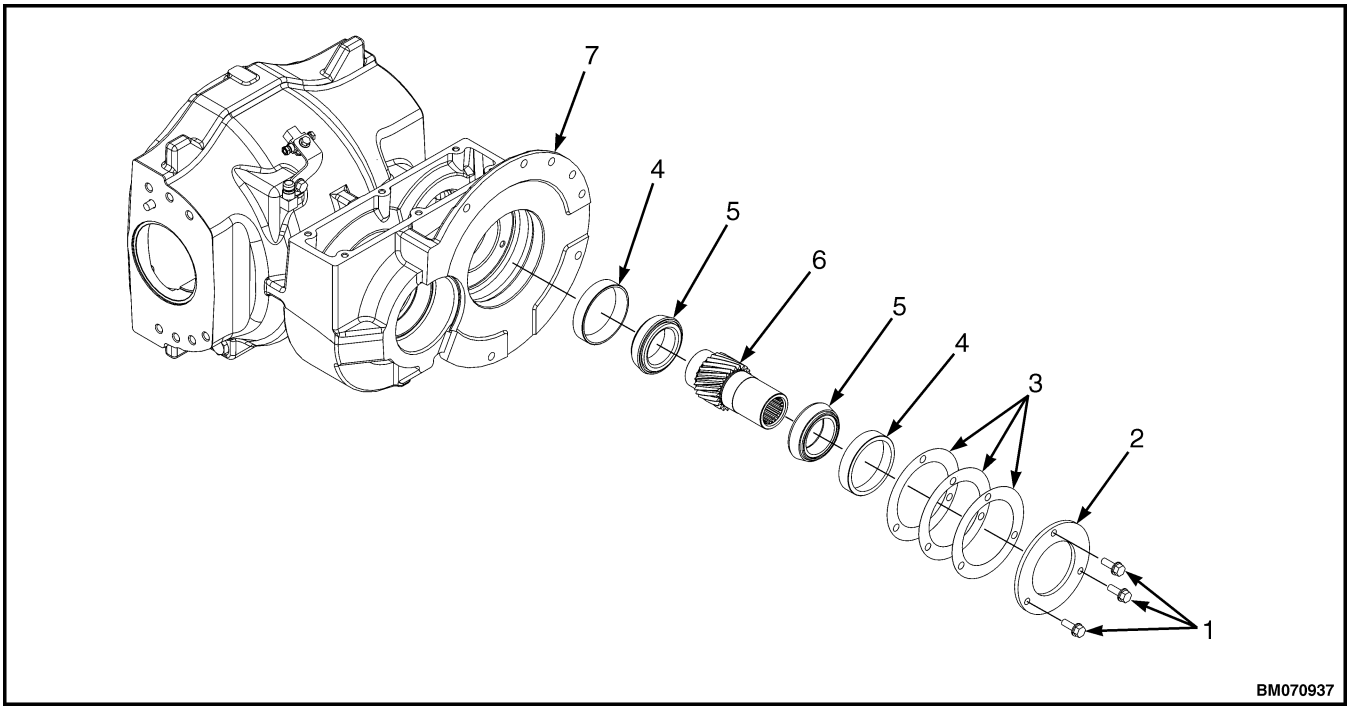
Examples		in.	mm
NOTE: The Pinion Variation Number is on the end of the pinion. See Figure 18.			
1.	Original Shim Set Thickness Original Pinion Variation Number = +2 in. (+0.05 mm)	0.030 −0.002	0.76 −0.05
	Standard Shim Set Thickness New Pinion Variation Number = +5 in. (+0.13 mm)	0.028 +0.005	0.71 +0.13
	New Shim Set Thickness =	0.033	0.84
2.	Original Shim Set Thickness Original Pinion Variation Number =−2 in. (−0.05 mm)	0.030 +0.002	0.76 +0.05
	Standard Shim Set Thickness New Pinion Variation Number = +5 in. (+0.13 mm)	0.032 +0.005	0.81 +0.13
	New Shim Set Thickness =	0.037	0.94
3.	Original Shim Set Thickness Original Pinion Variation Number = +2 in. (+0.05 mm)	0.030 −0.002	0.76 −0.05
	Standard Shim Set Thickness New Pinion Variation Number =−5 in. (−0.13 mm)	0.028 −0.005	0.71 −0.13
	New Shim Set Thickness =	0.023	0.58
4.	Original Shim Set Thickness Original Pinion Variation Number =−2 in. (−0.05 mm)	0.030 +0.002	0.76 +0.05
	Standard Shim Set Thickness New Pinion Variation Number =−5 in. (−0.13 mm)	0.032 −0.005	0.81 −0.13
	New Shim Set Thickness =	0.027	0.68

Drive Pinion, Pinion Gear, and Bearings Into Center Section

STEP 1.

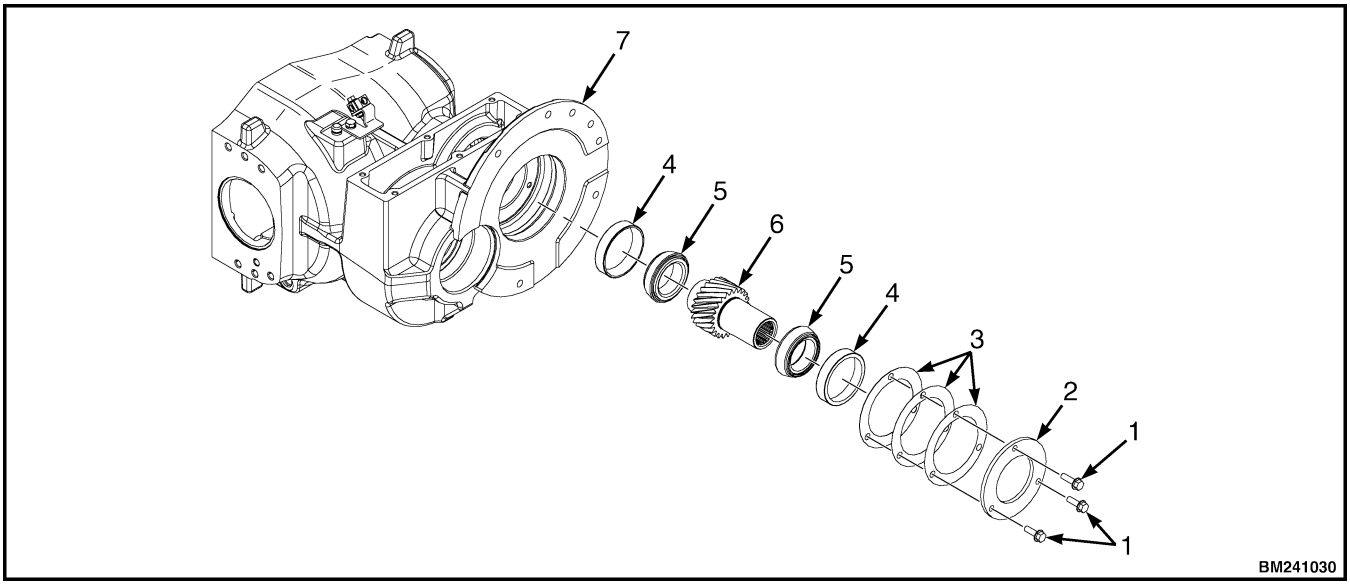
Install bearing cup, bearing cone, drive gear, bearing cone, bearing cup, shims, bearing retainer, and capscrews into center housing. Tighten capscrews to 19 to 23 N•m (168 to 204 lbf in).

Confirm there is zero end play with free rotation of drive gear.



NOTE: DIFFERENTIAL ASSEMBLY FOR LIFT TRUCK MODELS E2.2-3.5XN (E45-70XN) (A268) SHOWN.

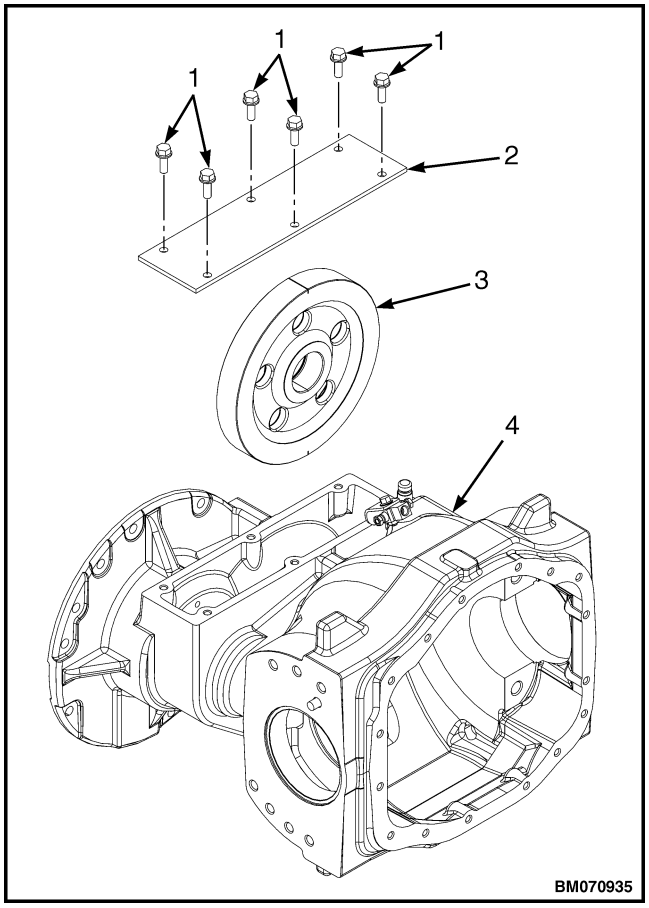
1. CAPSCREW
2. BEARING RETAINER
3. SHIMS
4. BEARING CUP
5. BEARING CONE
6. DRIVE GEAR
7. CENTER HOUSING



NOTE: DIFFERENTIAL ASSEMBLY FOR LIFT TRUCK MODELS E1.6-2.0XN (E30-40XN) (A269) SHOWN.

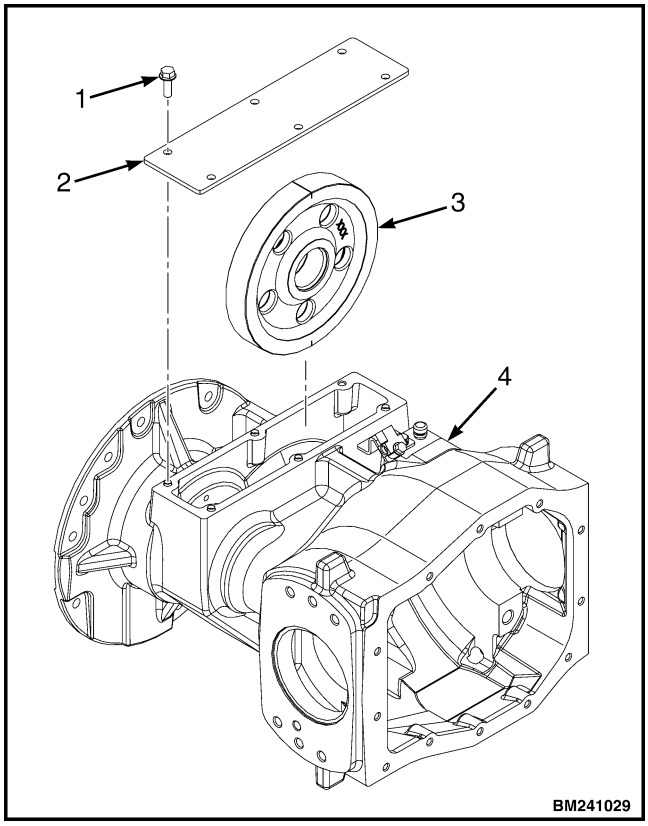
1. CAPSCREW
2. BEARING RETAINER
3. SHIMS
4. BEARING CUP
5. BEARING CONE
6. DRIVE GEAR
7. CENTER HOUSING

STEP 2.
Apply sealant, Hyster Part No. 1584621 or 0264159, on the mating surface of cover. Install driven gear, cover, and six capscrews into the center housing. Tighten capscrews to 19 to 23 N • m (168 to 204 lbf in).



NOTE: DIFFERENTIAL ASSEMBLY FOR LIFT TRUCK MODELS E2.2-3.5XN (E45-70XN) (A268) SHOWN.

1. CAPSCREWS
2. COVER
3. DRIVEN GEAR
4. CENTER HOUSING

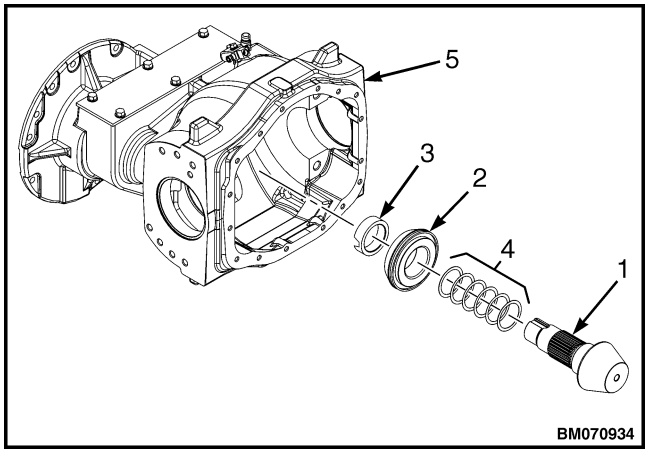


NOTE: DIFFERENTIAL ASSEMBLY FOR LIFT TRUCK MODELS E1.6-2.0XN (E30-40XN) (A269) SHOWN.

1. CAPSCREWS
2. COVER
3. DRIVEN GEAR
4. CENTER HOUSING

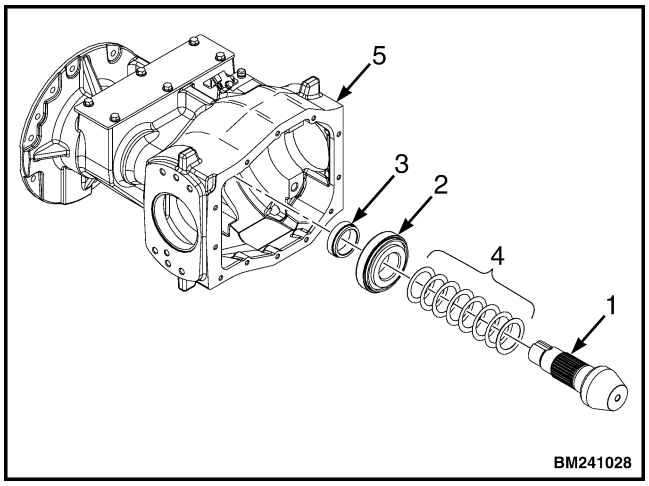
NOTE: Shims to be installed as noted during removal. If new shim set is installed, assemble thickest shim next to pinion gear. If three or more shims are required, place thinnest shim in the middle.

STEP 3.
Lubricate tapered roller bearing with 80W - 90W gear lube. Install mounting distance (inner) shims, determined in Pinion Inner Shim Set, Adjust Thickness (Depth of Pinion), spacer, and tapered roller bearing onto pinion gear creating the pinion assembly.



NOTE: DIFFERENTIAL ASSEMBLY FOR LIFT TRUCK MODELS E2.2-3.5XN (E45-70XN) (A268) SHOWN.

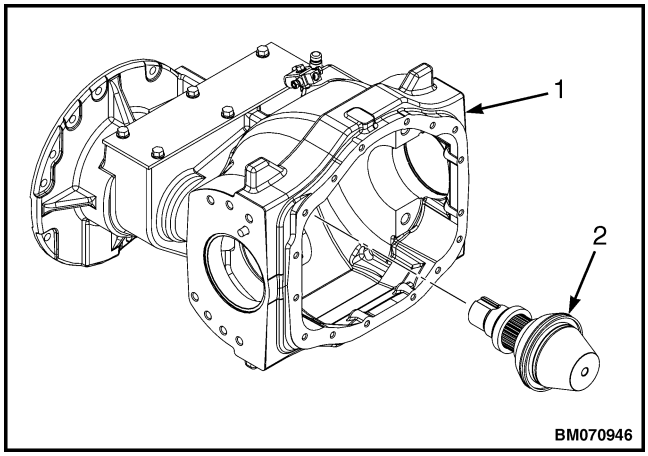
1. PINION GEAR
2. TAPERED ROLLER BEARING
3. SPACER
4. INNER SHIMS
5. CENTER SECTION



NOTE: DIFFERENTIAL ASSEMBLY FOR LIFT TRUCK MODELS E1.6-2.0XN (E30-40XN) (A269) SHOWN.

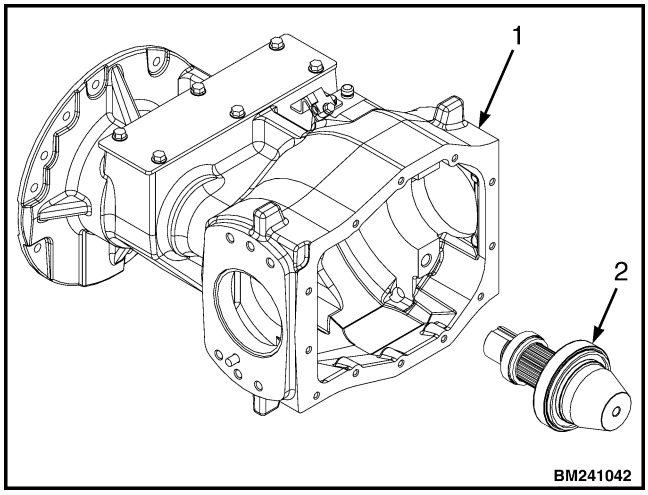
1. PINION GEAR
2. TAPERED ROLLER BEARING
3. SPACER
4. INNER SHIMS
5. CENTER SECTION

STEP 4.
Install pinion assembly into center section.



NOTE: DIFFERENTIAL ASSEMBLY FOR LIFT TRUCK MODELS E2.2-3.5XN (E45-70XN) (A268) SHOWN.

1. CENTER SECTION 2. PINION ASSEMBLY



NOTE: DIFFERENTIAL ASSEMBLY FOR LIFT TRUCK MODELS E1.6-2.0XN (E30-40XN) (A269) SHOWN.

1. CENTER SECTION 2. PINION ASSEMBLY

NOTE: Shims to be installed as noted during removal. If new shim set is installed, assemble thickest shim next to spacer and thinnest shim in the middle of the shims.

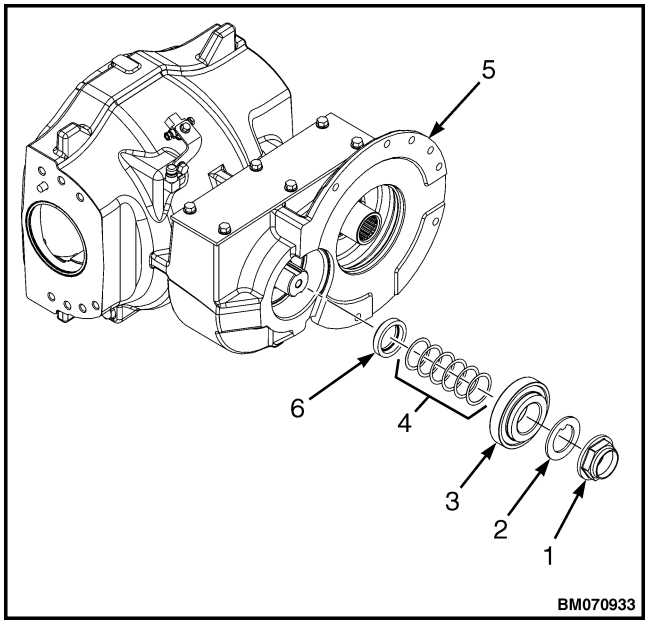
STEP 5.

For lift truck models E2.2-3.5XN (E45-70XN) (A268), lubricate tapered roller bearing with 80W - 90W gear lube. Install spacer, outer shims, tapered roller bearing, pinion nut washer, and pinion nut into center section.

For lift truck models E1.6-2.0XN (E30-40XN) (A269), lubricate inner and outer tapered roller bearings with 80W - 90W gear lube. Install spacer, outer shims, inner and outer tapered roller bearings, pinion nut washer, and pinion nut into center section.

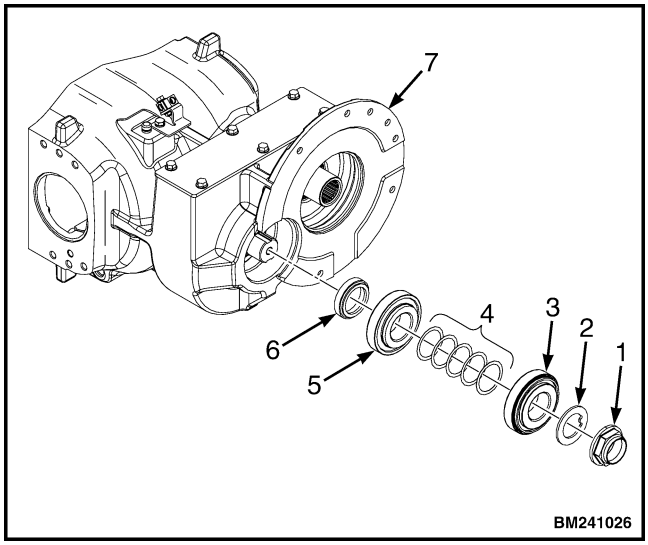
For all lift truck models:

- Tighten pinion nut to 530 to 645 N•m (391 to 476 lbf ft) to seat tapered roller bearing completely.
- Loosen pinion nut and retighten to 370 to 410 N•m (273 to 302 lbf ft).
- Rotate pinion two revolutions in each direction to ensure bearing seat.
- Verify pinion shaft rotating torque is 4 to 6 N•m (35 to 53 lbf in).
- Stake pinion nut with 8 mm (0.3 in.) spherical end punch until contacting bottom of groove in pinion shaft in two places.



NOTE: DIFFERENTIAL ASSEMBLY FOR LIFT TRUCK MODELS E2.2-3.5XN (E45-70XN) (A268) SHOWN.

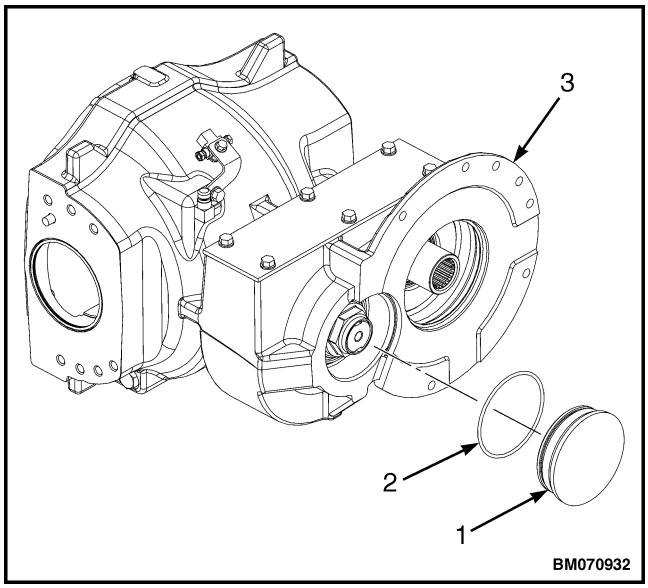
1. PINION NUT
2. PINION NUT WASHER
3. TAPERED ROLLER BEARING
4. OUTER SHIMS
5. CENTER SECTION
6. SPACER



NOTE: DIFFERENTIAL ASSEMBLY FOR LIFT TRUCK MODELS E1.6-2.0XN (E30-40XN) (A269) SHOWN.

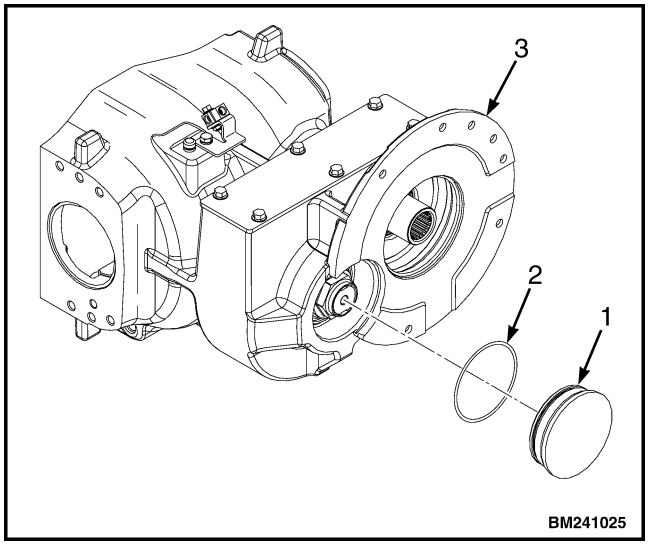
1. PINION NUT
2. PINION NUT WASHER
3. OUTER TAPERED ROLLER BEARING
4. OUTER SHIMS
5. INNER TAPERED ROLLER BEARINGS
6. SPACER
7. CENTER SECTION

STEP 6.
Lube new O-ring. Install O-ring onto cover. Install cover onto center section.



NOTE: DIFFERENTIAL ASSEMBLY FOR LIFT TRUCK MODELS E2.2-3.5XN (E45-70XN) (A268) SHOWN.

1. COVER
2. O-RING
3. CENTER SECTION



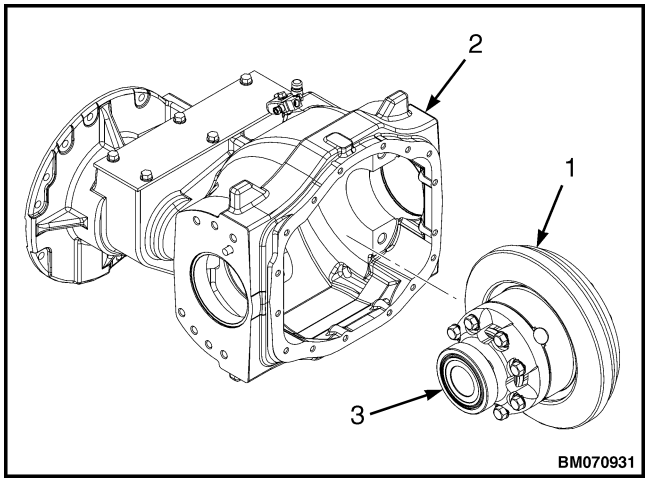
NOTE: DIFFERENTIAL ASSEMBLY FOR LIFT TRUCK MODELS E1.6-2.0XN (E30-40XN) (A269) SHOWN.

1. COVER
2. O-RING
3. CENTER SECTION

Differential Assembly Into Center Section

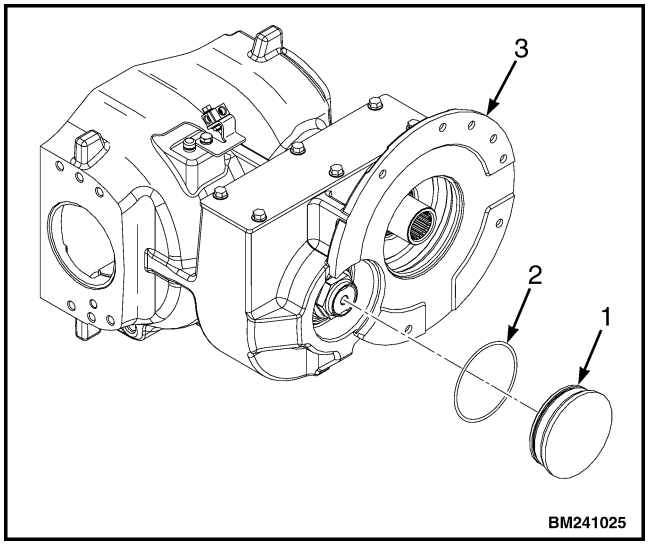
NOTE: Ensure bearing cups are installed in center section. Install new bearing cups if necessary.

STEP 1.
Install differential assembly into center section.



NOTE: DIFFERENTIAL ASSEMBLY FOR LIFT TRUCK MODELS E2.2-3.5XN (E45-70XN) (A268) SHOWN.

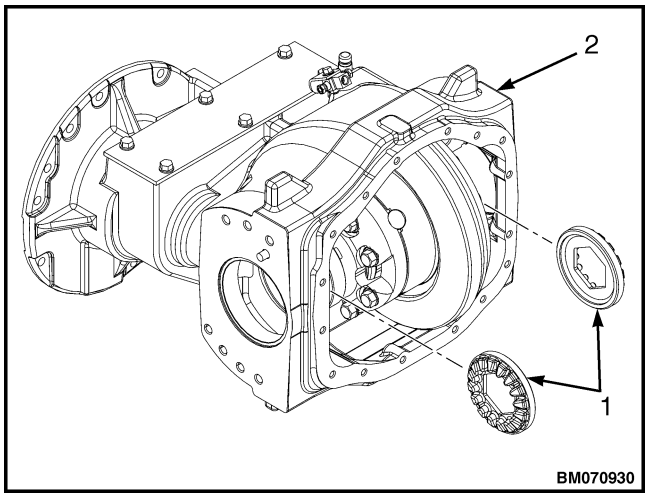
1. DIFFERENTIAL ASSEMBLY
2. CENTER SECTION
3. TAPERED ROLLER BEARING AND CUP



NOTE: DIFFERENTIAL ASSEMBLY FOR LIFT TRUCK MODELS E1.6-2.0XN (E30-40XN) (A269) SHOWN.

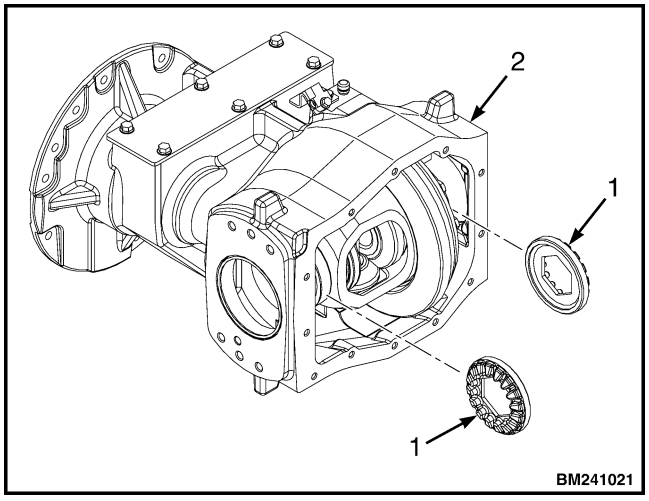
1. DIFFERENTIAL ASSEMBLY
2. CENTER SECTION
3. TAPERED ROLLER BEARING AND CUP

STEP 2.
Install differential retainers.



NOTE: DIFFERENTIAL ASSEMBLY FOR LIFT TRUCK MODELS E2.2-3.5XN (E45-70XN) (A268) SHOWN.

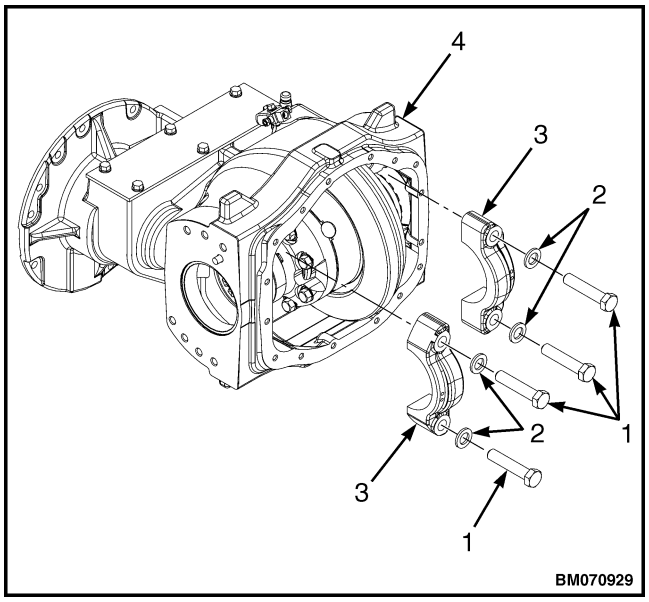
1. DIFFERENTIAL RETAINER
2. CENTER SECTION



NOTE: DIFFERENTIAL ASSEMBLY FOR LIFT TRUCK MODELS E1.6-2.0XN (E30-40XN) (A269) SHOWN.

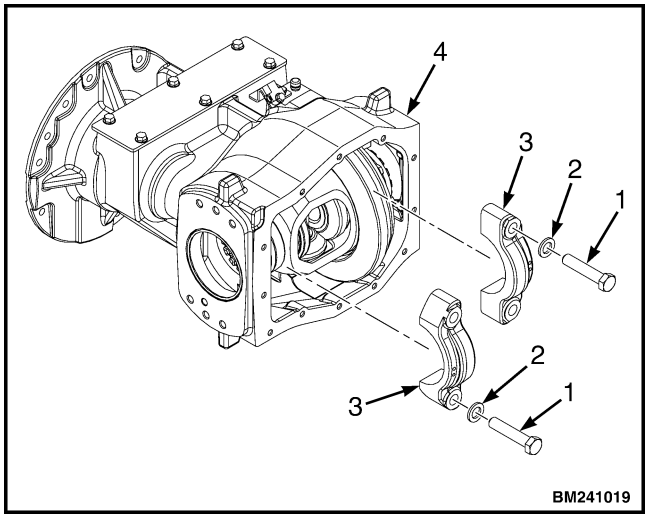
1. DIFFERENTIAL RETAINER
2. CENTER SECTION

STEP 3.
Install bearing caps, washers, and capscrews into center section. Make sure marks made on bearing cap and differential carrier leg during removal match up when assembling. Hand tighten capscrews only at this time.



NOTE: DIFFERENTIAL ASSEMBLY FOR LIFT TRUCK MODELS E2.2-3.5XN (E45-70XN) (A268) SHOWN.

1. CAPSCREW
2. WASHER
3. BEARING CAP
4. CENTER SECTION



NOTE: DIFFERENTIAL ASSEMBLY FOR LIFT TRUCK MODELS E1.6-2.0XN (E30-40XN) (A269) SHOWN.

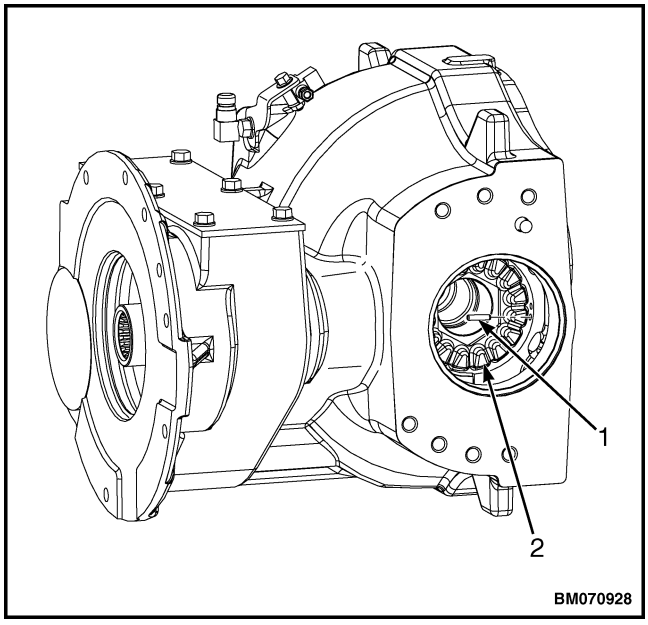
1. CAPSCREW
2. WASHER
3. BEARING CAP
4. CENTER SECTION

NOTE: Adjust backlash to original dimension recorded during removal. Backlash adjust to be done as indicated in Ring Gear Backlash, Adjust section of this manual.

STEP 4.
Using differential retainer special tool, Hyster Part No. 1663599, tighten the differential retainers as specified in Ring Gear Backlash, Adjust section. See tool illustration below.

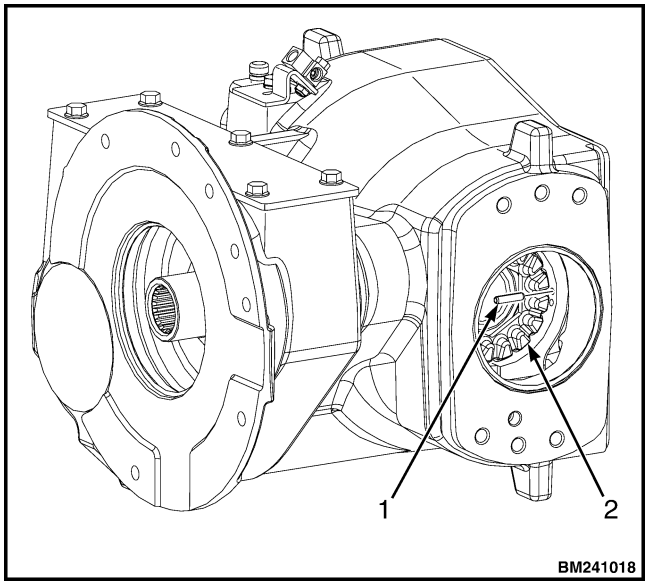
Tighten capscrews to 255 to 270 N•m (166 to 199 lbf ft).

Install differential assembly spring pins.



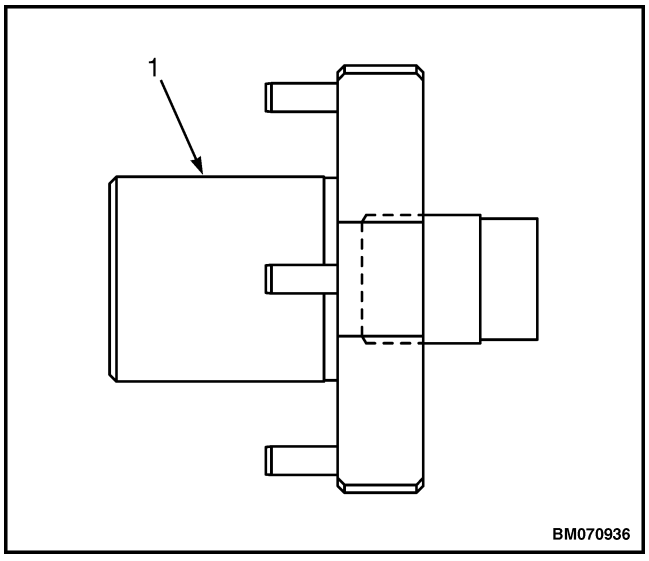
NOTE: DIFFERENTIAL ASSEMBLY FOR LIFT TRUCK MODELS E2.2-3.5XN (E45-70XN) (A268) SHOWN.

1. SPRING PIN
2. DIFFERENTIAL RETAINER



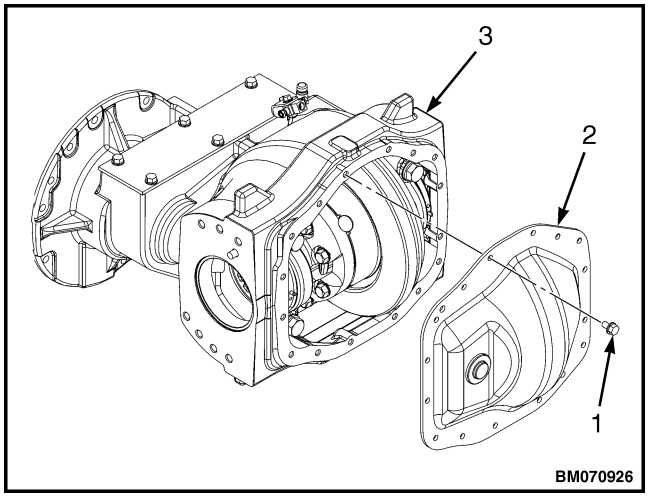
NOTE: DIFFERENTIAL ASSEMBLY FOR LIFT TRUCK MODELS E1.6-2.0XN (E30-40XN) (A269) SHOWN.

1. SPRING PIN
2. DIFFERENTIAL RETAINER



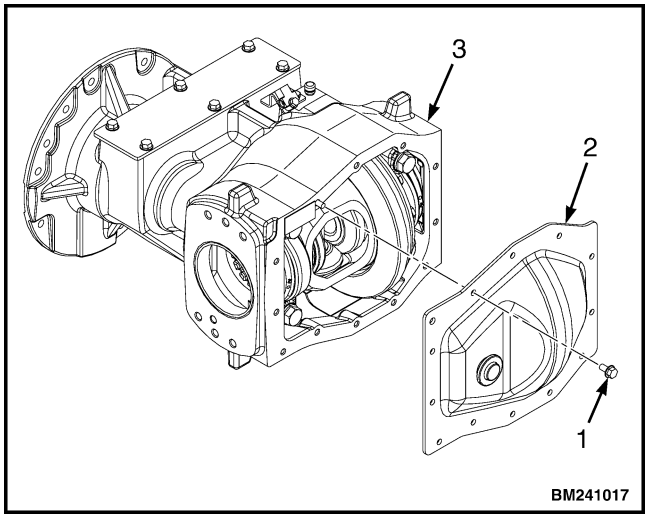
1. DIFFERENTIAL RETAINER SPECIAL TOOL

STEP 5.
Apply sealant, Hyster Part No. 1584621 or 0264159 on mating surface of cover. Install center section cover and capscrews on center section. Tighten capscrews to 19 to 23 N•m (168 to 204 lbf in).



NOTE: DIFFERENTIAL ASSEMBLY FOR LIFT TRUCK MODELS E2.2-3.5XN (E45-70XN) (A268) SHOWN.

1. CAPSCREW
2. CENTER SECTION COVER
3. CENTER SECTION



NOTE: DIFFERENTIAL ASSEMBLY FOR LIFT TRUCK MODELS E1.6-2.0XN (E30-40XN) (A269) SHOWN.

1. CAPSCREW
2. CENTER SECTION COVER
3. CENTER SECTION

Ring Gear Backlash, Adjust

NOTE: If the old gear set is installed, adjust the backlash to the setting that was measured before the differential assembly was disassembled.

NOTE: If a new gear set will be installed, adjust the backlash to 0.20 to 0.28 mm (0.008 to 0.011 in.).

1. Install a dial indicator on the mounting flange of the differential as shown in Figure 19.

2. Adjust the dial indicator so that the plunger or pointer is against the tooth surface. See Figure 19.

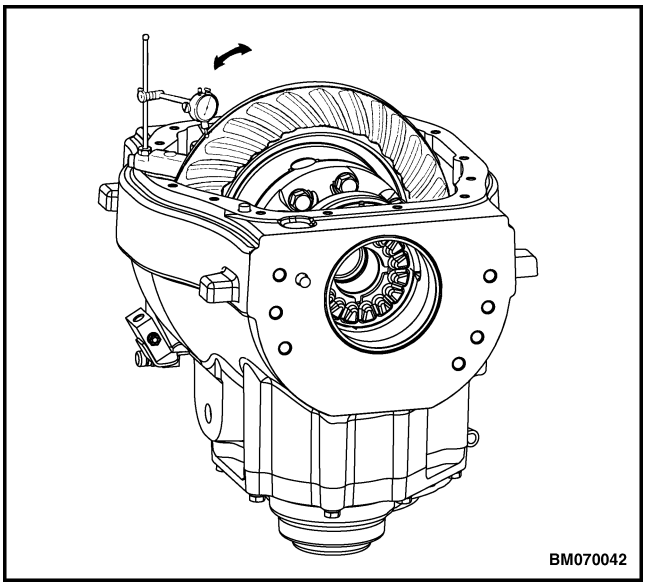


Figure 19. Gear Clearance Check

3. Adjust the indicator to zero.

4. Hold the drive pinion in position.

5. After reading the dial indicator, rotate the differential and ring gear a small amount in both directions, against the drive pinion teeth.

6. If the backlash reading is within specifications, 0.20 to 0.28 mm (0.008 to 0.011 in.), continue checking tooth contact patterns.

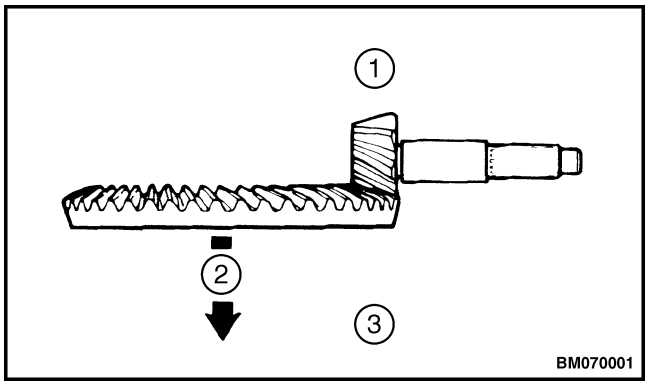
7. If the backlash reading is not within specifications, adjust backlash as needed. Continue onto Step 8 through Step 10.

8. Verify that the bearing cap capscrews are only finger tight.

NOTE: To increase backlash, move ring gear away from drive pinion. To decrease backlash, move ring gear toward drive pinion.

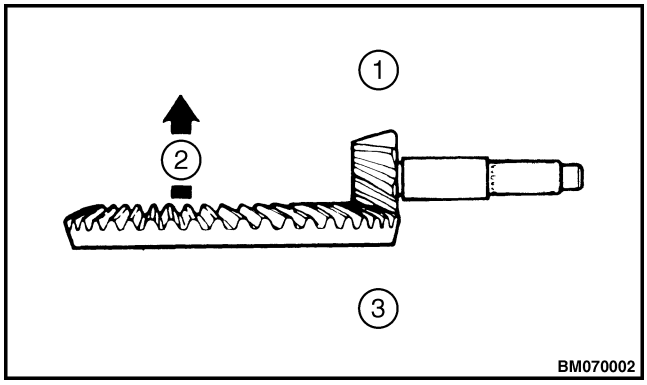
NOTE: When adjusting backlash, move the ring gear only. DO NOT move the drive pinion.

9. Loosen one bearing adjusting ring one notch, then tighten the opposite ring the same amount. See Figure 20 and Figure 21.



1. TIGHTEN RETAINER RING THIS SIDE
2. INCREASE BACKLASH
3. LOOSEN RETAINER RING THIS SIDE

Figure 20. Backlash Increase



1. LOOSEN RETAINER RING THIS SIDE
2. DECREASE BACKLASH
3. TIGHTEN RETAINER RING THIS SIDE

Figure 21. Backlash Decrease

10. Tighten the bearing cap capscrews to 225 to 270 N•m (166 to 199 lbf ft). Recheck the backlash.

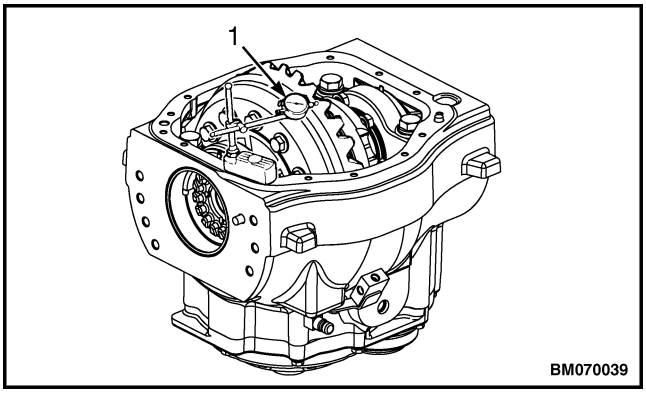
11. Repeat Step 2 through Step 10 until backlash is within 0.20 to 0.28 mm (0.008 to 0.011 in.).

12. Check the tooth contact pattern. See section Gear Set, Tooth Contact Pattern Check.

13. Check the ring gear runout. See section Ring Gear, Runout Check.

Ring Gear, Runout Check

1. Attach a dial indicator to the mounting flange of the differential assembly as shown in Figure 22.



1. DIAL INDICATOR

Figure 22. Ring Gear Runout Check

2. Adjust the dial indicator so that the plunger or pointer is against the back surface of the ring gear.

3. Set the indicator to zero.

4. Rotate the ring gear and check the dial indicator for the maximum needle movement. The maximum movement permitted is 0.20 mm (0.008 in.).

5. If the movement exceeds the maximum limit, remove the differential and ring gear assembly from the differential assembly and find the reason for the movement.

6. Install the differential and ring gear into the differential assembly after the parts are repaired or replaced.

Gear Set, Tooth Contact Pattern Check

NOTE: If the original gear set is installed, the backlash should be reset. If a new gear set is installed, adjust the retainer rings for 0.20 to 0.28 mm (0.008 to 0.011 in.) clearance. See section Ring Gear Backlash, Adjust for procedure. Refer to section Ring and Pinion Tooth Contact Adjustment.

Table 2. Ring and Pinion Tooth Contact Adjustment

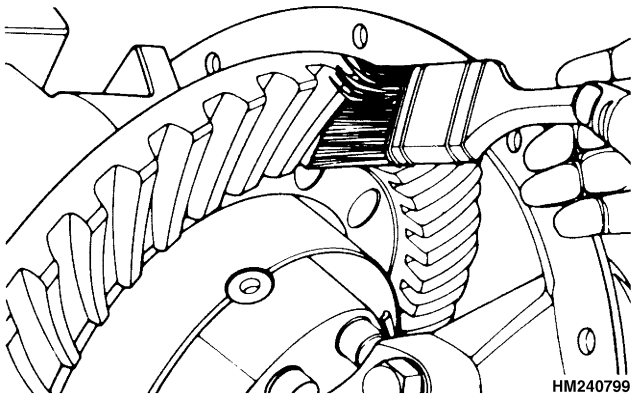
1. Apply a colored dye or grease to approximately 12 of the ring gear teeth.	
2. Rotate ring gear forward and backward so that the 12 gear teeth go past the drive six times to get to the contact patterns. Repeat if needed to get a clearer pattern.	
3. Check the tooth contact pattern on the ring gear. See Table 3 and Table 4. Make sure that the pattern is checked on the side of the tooth where the pinion applies the force in the forward direction.	

Table 3. Correct Tooth Contact

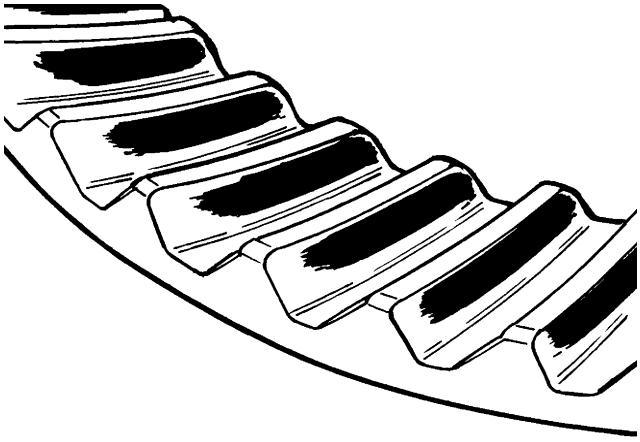
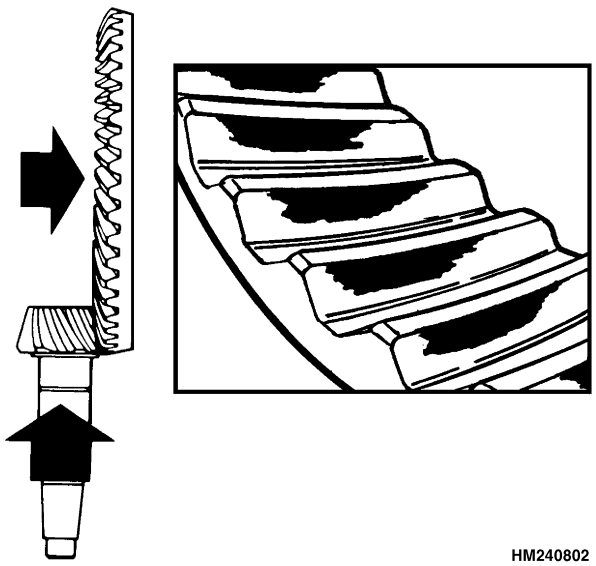
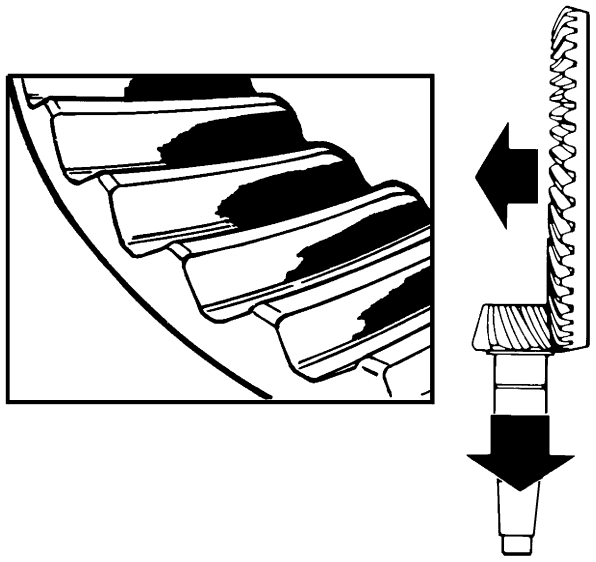
The contact area is the center between the top and bottom of the tooth. The contact area is toward the inner circumference of the ring gear.	**NOTE:** Normal pattern during adjustment shown. HM240800
The contact area is the center between the top and the bottom of the tooth. The contact area will be almost the full length of the tooth.	**NOTE:** Wear pattern from operation shown.  HM240801

Table 4. Incorrect Tooth Contact

The pinion is too far away from the center of the gear. Add shims to move pinion toward ring gear. Check that the clearance is correct. Some movement of ring gear away from pinion may be necessary.	 HM240802
The pinion is too close to the center of the ring gear. Remove shims to move pinion away from the ring gear. Check that the clearance is correct. Some movement of the ring gear toward the pinion may be necessary.	 HM240879

Assemble and install the drive axle. Refer to the section Drive Axle Repair.

Torque Specifications

LIFT TRUCK MODELS E2.2-3.5XN (E45-70XN) (A268)

Hanger Assembly to Center Section Housing Capscrews
90 to 99 N•m (66 to 73 lbf ft)

Brake Assembly to Axle Mount Capscrews
255 to 306 N•m (188 to 226 lbf ft)

Wheel Bearing Locknut
Initial 14 to 18 N•m (124 to 159 lbf in)
Bearing Seat 175 to 215 N•m (129 to 159 lbf ft)
Preload and Final 14 to 18 N•m (124 to 159 lbf in)

Axle Shaft Capscrews
90 to 99 N•m (66 to 73 lbf ft)

Drive Axle Mounting Bolts
755 to 830 N•m (557 to 612 lbf ft)

Differential Case Half Capscrews
125 to 145 N•m (92 to 107 lbf ft)

Differential/Ring Gear Assembly Capscrews
152 to 167 N•m (112 to 123 lbf ft)

Bearing Retainer Capscrews
19 to 23 N•m (168 to 204 lbf in)

Pinion Nut
Initial 530 to 645 N•m (391 to 476 lbf ft)
Final 370 to 410 N•m (273 to 302 lbf ft)

Pinion Shaft Rotating Torque
4 to 6 N•m (35 to 53 lbf in)

Bearing Cap Capscrew
225 to 270 N•m (166 to 199 lbf ft)

Center Section Cover Capscrews
19 to 23 N•m (168 to 204 lbf in)

LIFT TRUCK MODELS E1.6-2.0XN (E30-40XN) (A269)

Hanger Assembly to Center Section Housing Capscrews
90 to 108 N•m (66 to 80 lbf ft)

Brake Assembly to Axle Mount Capscrews
152 to 167 N•m (112 to 123 lbf ft)

Wheel Bearing Locknut
Initial 14 to 18 N•m (124 to 159 lbf in)
Bearing Seat 120 to 145 N•m (89 to 107 lbf ft)
Preload and Final 14 to 18 N•m (124 to 159 lbf in)

Axle Shaft Capscrews
90 to 108 N•m (66 to 80 lbf ft)

Drive Axle Mounting Bolts
755 to 830 N•m (557 to 612 lbf ft)

Differential/Ring Gear Assembly Capscrews
152 to 167 N•m (112 to 123 lbf ft)

Bearing Retainer Capscrews
19 to 23 N•m (168 to 204 lbf in)

Pinion Nut
Initial 530 to 645 N•m (391 to 476 lbf ft)
Final 370 to 410 N•m (273 to 302 lbf ft)

Pinion Shaft Rotating Torque
4 to 6 N•m (35 to 53 lbf in)

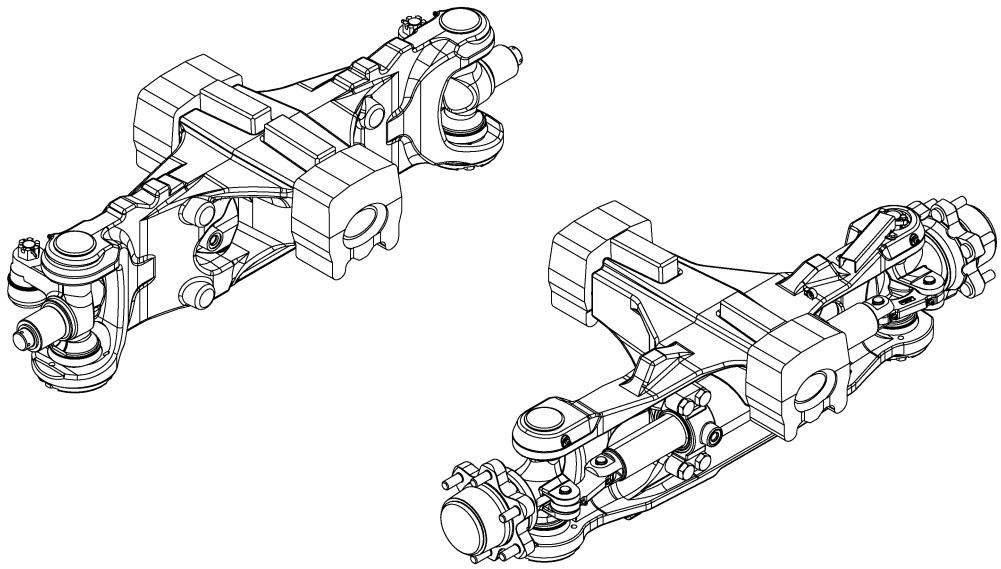
Bearing Cap Capscrew
225 to 270 N•m (166 to 199 lbf ft)

Center Section Cover Capscrews
19 to 23 N•m (168 to 204 lbf in)

NOTES

STEERING AXLE

E2.2-3.5XN (E45-70XN) [A268];
E1.6-2.0XN (E30-40XN) [A269];
J2.2-3.5XN (J45-70XN) [A276];
J1.6-2.0XN (J30-40XN) [A935];
J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) [A970];
E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) [A099]



HYSTER

PART NO. 1688872

1600 SRM 1360

SAFETY PRECAUTIONS
MAINTENANCE AND REPAIR

- When lifting parts or assemblies, make sure all slings, chains, or cables are correctly fastened, and that the load being lifted is balanced. Make sure the crane, cables, and chains have the capacity to support the weight of the load.
- Do not lift heavy parts by hand, use a lifting mechanism.
- Wear safety glasses.
- DISCONNECT THE BATTERY CONNECTOR before doing any maintenance or repair on electric lift trucks. Disconnect the battery ground cable on internal combustion lift trucks.
- Always use correct blocks to prevent the unit from rolling or falling. See HOW TO PUT THE LIFT TRUCK ON BLOCKS in the **Operating Manual** or the **Periodic Maintenance** section.
- Keep the unit clean and the working area clean and orderly.
- Use the correct tools for the job.
- Keep the tools clean and in good condition.
- Always use **HYSTER** ® **APPROVED** parts when making repairs. Replacement parts must meet or exceed the specifications of the original equipment manufacturer.
- Make sure all nuts, bolts, snap rings, and other fastening devices are removed before using force to remove parts.
- Always fasten a DO NOT OPERATE tag to the controls of the unit when making repairs, or if the unit needs repairs.
- Be sure to follow the **WARNING** and **CAUTION** notes in the instructions.
- Gasoline, Liquid Petroleum Gas (LPG), Compressed Natural Gas (CNG), and Diesel fuel are flammable. Be sure to follow the necessary safety precautions when handling these fuels and when working on these fuel systems.
- Batteries generate flammable gas when they are being charged. Keep fire and sparks away from the area. Make sure the area is well ventilated.

NOTE: The following symbols and words indicate safety information in this manual:

WARNING

Indicates a hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION

Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury and property damage.

On the lift truck, the WARNING symbol and word are on orange background. The CAUTION symbol and word are on yellow background.

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E1.6-2.0XN (E30-40XN) [A269];
J2.2-3.5XN (J45-70XN) [A276];
J1.6-2.0XN (J30-40XN) [A935];
J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) [A970];
E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) [A099]

"THE QUALITY KEEPERS"

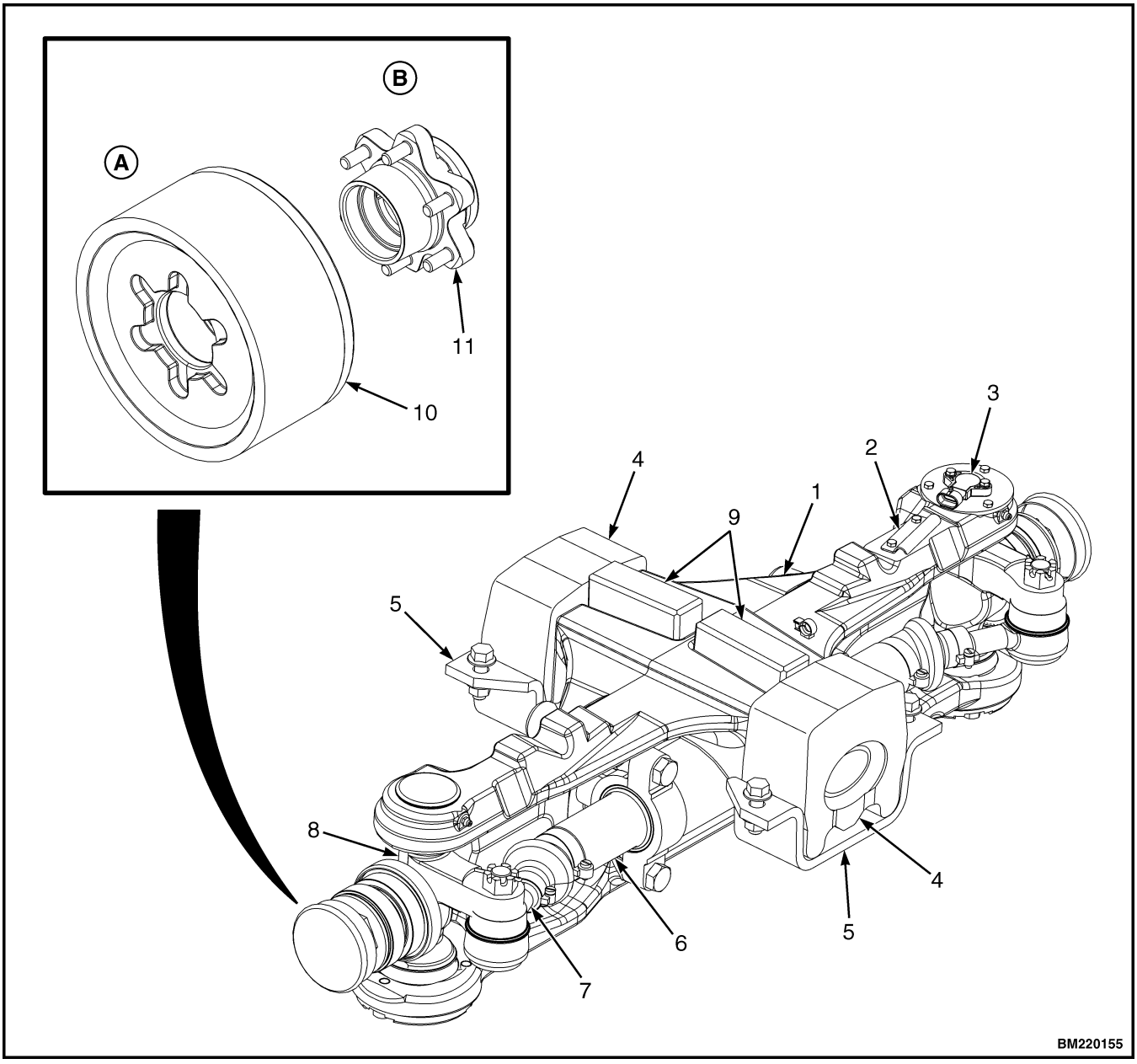
HYSTER APPROVED PARTS

General

This section has the description and repair procedures for the steering axle.

The steering axle assembly includes an axle frame, steering cylinder, two spindle assemblies, and two hub assemblies. The steering axle is articulated and is connected to the frame by center pivot mounts. The center pivot mounts permit the steering axle to move in the frame mount when the lift truck travels over rough surfaces. See Figure 1.

The end caps of the steering cylinder also serve as the axle mounts for the cylinder. The piston rod extends from both ends of the cylinder and is connected to the tie rods which are connected to the spindle assemblies.



NOTE: MOUNTS AND TIRES MAY BE DIFFERENT BETWEEN TRUCK MODELS.

A. CUSHION TRUCKS ONLY

B. PNEUMATIC TRUCKS ONLY

1. AXLE FRAME
2. STEERING DIRECTION SENSOR CABLE BRACKET
3. STEERING DIRECTION SENSOR
4. MOUNT
5. MOUNT BRACKET
6. STEERING CYLINDER
7. TIE ROD
8. SPINDLE ASSEMBLY
9. MOUNT
10. CUSHION TIRE WHEEL ASSEMBLY
11. PNEUMATIC HUB ASSEMBLY

Figure 1. Steering Axle

Steering Axle Assembly Repair

REMOVE E2.2-3.5XN (E45-70XN) (A268), E1.6-2.0XN (E30-40XN) (A269) AND E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

WARNING

PUTTING THE LIFT TRUCK ON BLOCKS

The lift truck must be put on blocks for some types of maintenance and repair. The removal of the mast, drive axle, battery, or counterweight assemblies will cause large changes in the center of gravity. When the lift truck is put on blocks, put additional blocks in the following positions:

- **If the mast and drive axle are removed, put blocks under the counterweight so the lift truck cannot fall backward.**
- **If the counterweight is removed, put blocks under the mast so that the lift truck cannot fall forward.**

Put the lift truck on blocks on a solid, even, and level surface. Verify the blocks or stands have enough capacity to hold the lift truck. Use additional blocks next to the tires as necessary to prevent movement of the lift truck. Verify the lifting devices used during repairs can lift the weight of the parts and assemblies.

See the Operating Manual or Periodic Maintenance section for your lift truck model, for the procedures to put the lift truck on blocks.

The steering axle can be removed without removing the counterweight.

1. Place the lift trucks on blocks. The procedure for placing the lift truck on blocks may be found in the **Operating Manual** or in one of the following service manuals:

   Periodic Maintenance 8000SRM1364 for lift truck models

   - E2.2-3.5XN (E45-70XN) (A268)

   Periodic Maintenance 8000SRM1442 for lift truck models

   - E1.6-2.0XN (E30-40XN) (A269)

   Periodic Maintenance 8000SRM1577 for lift truck models

   - E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

2. Slide floor jack under steering axle. Raise floor jack until it holds the weight of the axle assembly.

NOTE: Tag hydraulic lines prior to disconnecting from steering cylinder to aid in the correct connection of hydraulic lines during installation.

3. Disconnect hydraulic hoses at steering cylinder. Install plug fittings in cylinder and put caps on hydraulic hoses. Plug fittings will prevent spindles from turning as axle is removed from under the lift truck.

4. Remove four capscrews that fasten the mount brackets under the rubber mounts.

   See Figure 2 for lift truck models

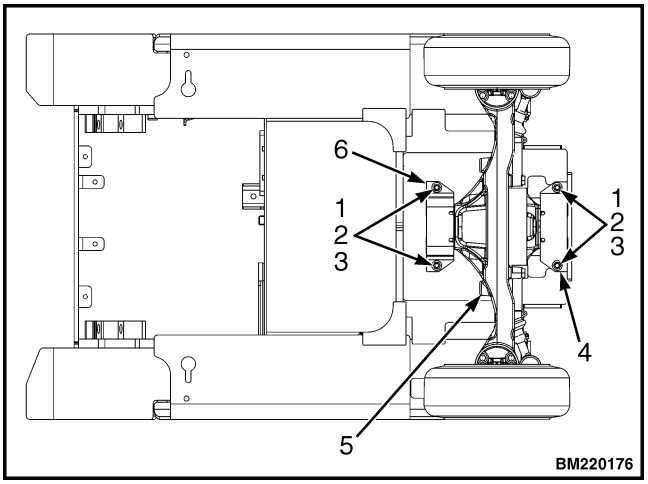
   - E2.2-3.5XN (E45-70XN) (A268)

   See Figure 3 for lift truck models

   - E1.6-2.0XN (E30-40XN) (A269)

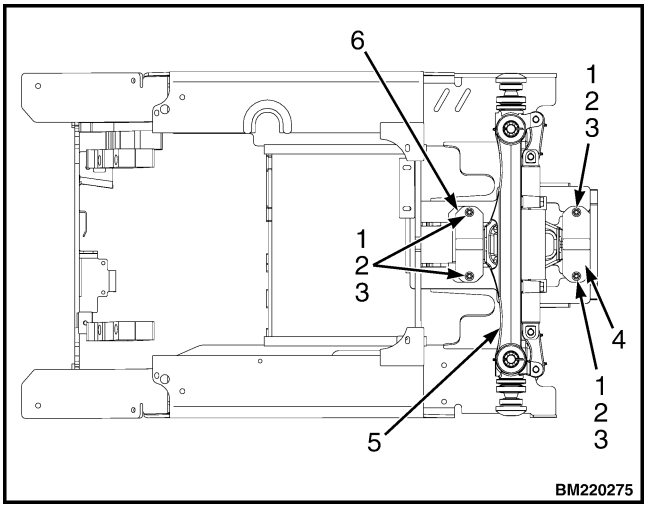
   See Figure 4 for lift truck models

   - E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)



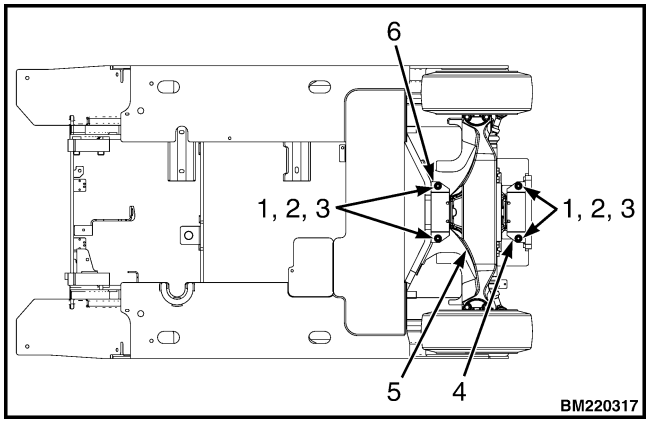
1. CAPSCREW
2. WASHER
3. NUT
4. REAR MOUNT BRACKET
5. STEER AXLE
6. FRONT MOUNT BRACKET

Figure 2. Steer Axle Removal E2.2-3.5XN (E45-70XN) (A268)



1. CAPSCREW
2. WASHER
3. NUT
4. REAR MOUNT BRACKET
5. STEER AXLE
6. FRONT MOUNT BRACKET

Figure 3. Steer Axle Removal E1.6-2.0XN (E30-40XN) (A269)



1. CAPSCREW
2. WASHER
3. NUT
4. REAR MOUNT BRACKET
5. STEER AXLE
6. FRONT MOUNT BRACKET

Figure 4. Steer Axle Removal E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

NOTE: The steering direction sensor is an optional feature on E2.2-3.5XN (E45-70XN) (A268), E1.6-2.0XN (E30-40XN) (A269) and E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099) lift trucks.

5. Carefully lower the floor jack enough to disconnect, if installed, steering direction sensor cable from the main wiring harness.

See Figure 5 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268)

See Figure 6 for lift truck models

- E1.6-2.0XN (E30-40XN) (A269)

See Figure 7 for lift truck models

- E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

6. Remove the steer axle from the under the lift truck.

DISASSEMBLE E2.2-3.5XN (E45-70XN) (A268), E1.6-2.0XN (E30-40XN) (A269) AND E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

1. Place steering axle on blocks so the wheels just touch the floor.

2. Remove hub cap, cotter pin, castle nut, and washer. Discard cotter pin.

See Figure 5 for lift truck models

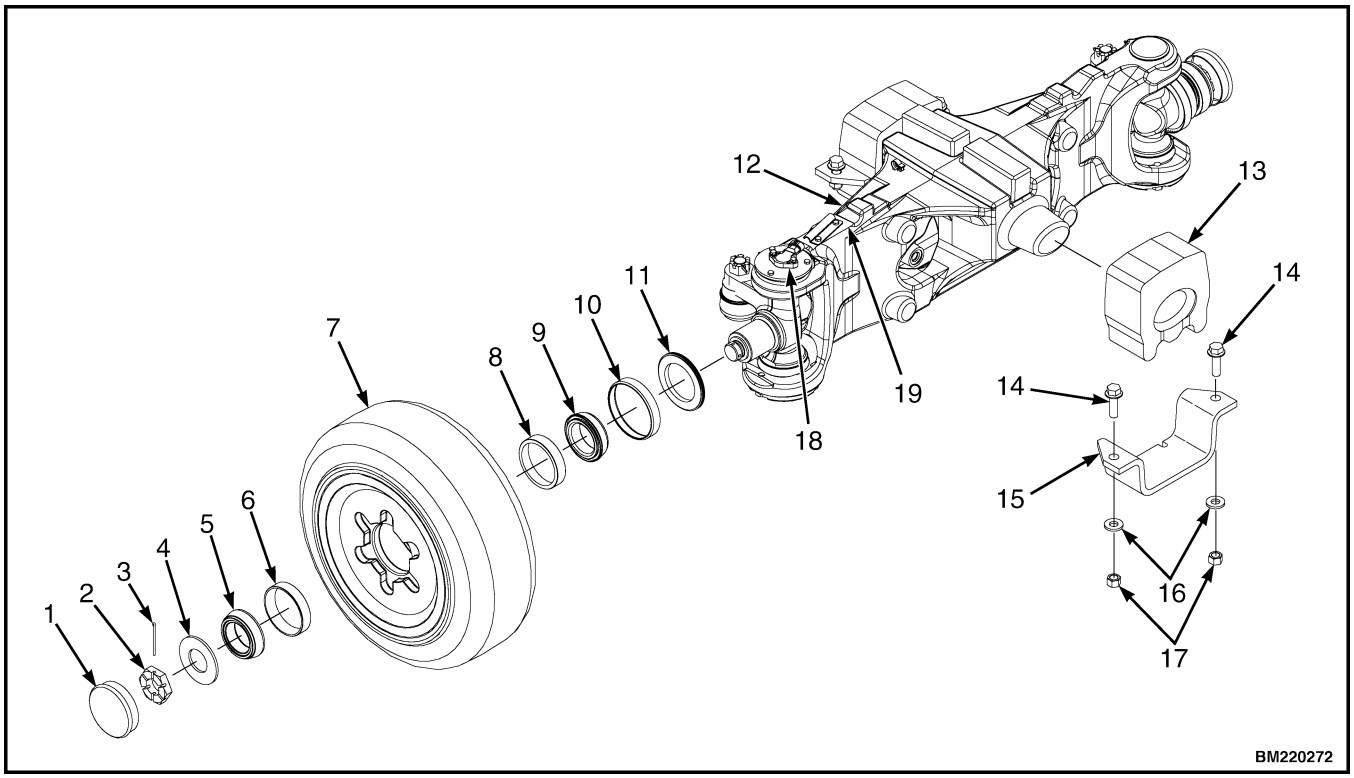
- E2.2-3.5XN (E45-70XN) (A268)

See Figure 6 for lift truck models

- E1.6-2.0XN (E30-40XN) (A269)

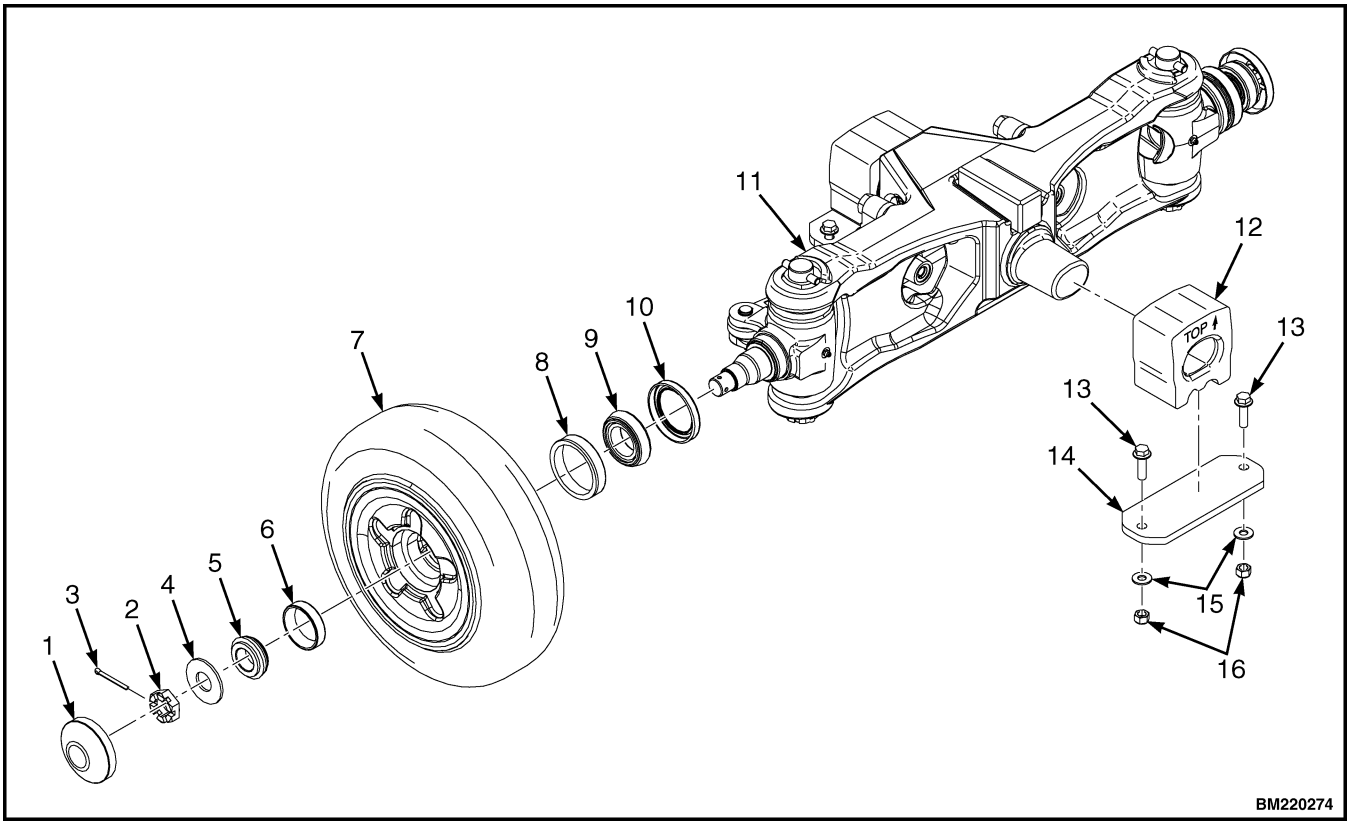
See Figure 7 for lift truck models

- E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)



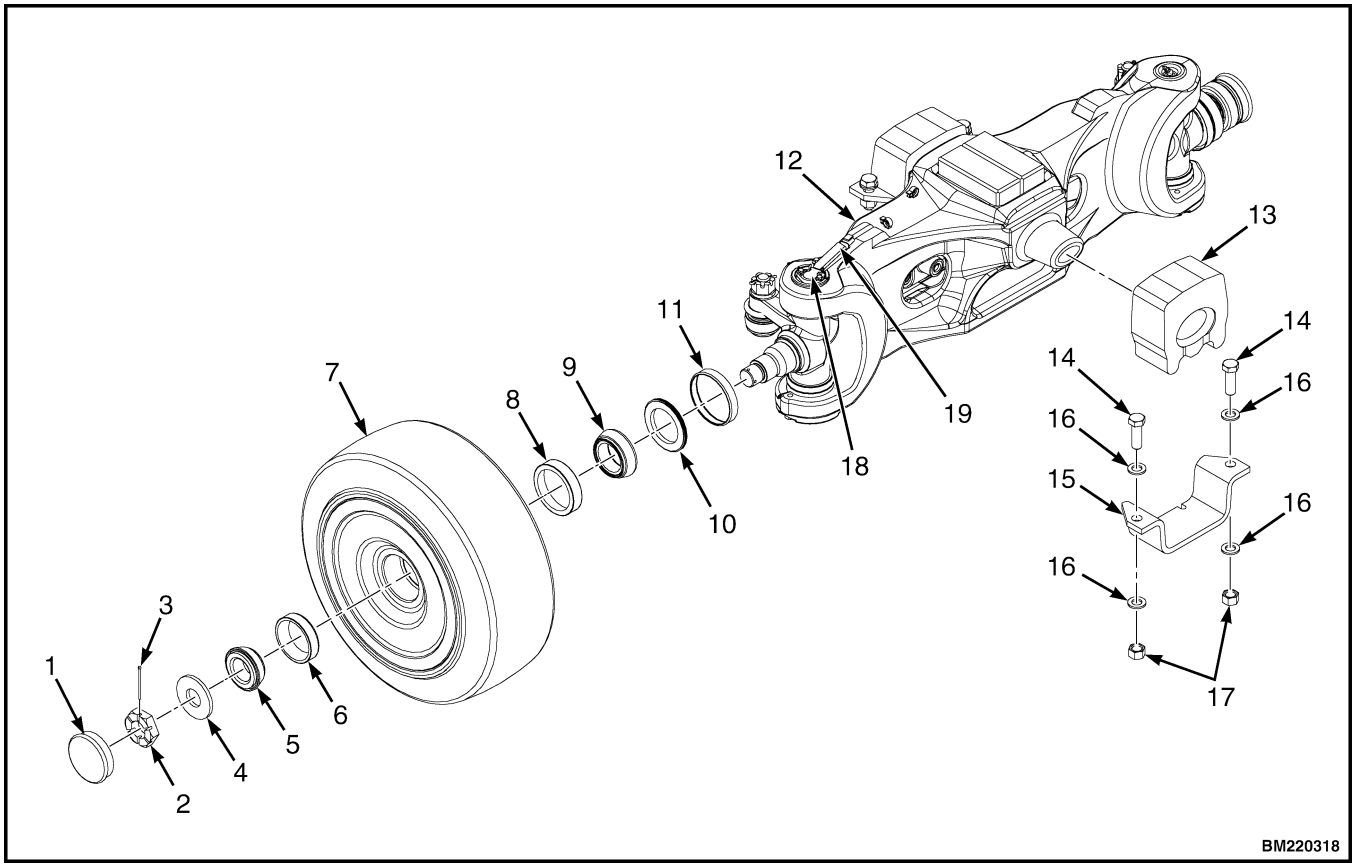
1. HUB CAP
2. CASTLE NUT
3. COTTER PIN
4. WASHER
5. OUTER BEARING CONE
6. OUTER BEARING CUP
7. SOLID TIRE WHEEL
8. INNER BEARING CUP
9. INNER BEARING CONE
10. WEAR RING
11. OIL SEAL
12. AXLE ASSEMBLY
13. MOUNT
14. CAPSCREW
15. BRACKET
16. WASHER
17. LOCKNUT
18. STEERING DIRECTION SENSOR
19. STEERING DIRECTION SENSOR CABLE BRACKET

Figure 5. Steering Axle Assembly for E2.2-3.5XN (E45-70XN) (A268)



1. HUB CAP
2. CASTLE NUT
3. COTTER PIN
4. WASHER
5. OUTER BEARING CONE
6. OUTER BEARING CUP
7. SOLID TIRE WHEEL
8. INNER BEARING CUP
9. INNER BEARING CONE
10. OIL SEAL
11. AXLE ASSEMBLY
12. MOUNT
13. CAPSCREW
14. BRACKET
15. WASHER
16. LOCKNUT

Figure 6. Steering Axle Assembly for E1.6-2.0XN (E30-40XN) (A269)



1. HUB CAP
2. CASTLE NUT
3. COTTER PIN
4. WASHER
5. OUTER BEARING CONE
6. OUTER BEARING CUP
7. SOLID TIRE WHEEL
8. INNER BEARING CUP
9. INNER BEARING CONE
10. WEAR RING
11. OIL SEAL
12. AXLE ASSEMBLY
13. MOUNT
14. CAPSCREW
15. BRACKET
16. WASHER
17. LOCKNUT
18. STEERING DIRECTION SENSOR
19. STEERING DIRECTION SENSOR CABLE BRACKET

Figure 7. Steering Axle Assembly for Lift Trucks E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

NOTE: Identify and tag the outer and inner bearing cones so they can be reassembled in their original locations.

3. Remove outer bearing cone from the wheel.

4. Remove wheel from spindle.

NOTE: For correct orientation during installation, note the position of the oil seal during removal.

NOTE: The wear ring may not be present on all steering axles.

5. Remove inner bearing cone, wear ring (if present) and oil seal from spindle.

See Figure 5 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268)

See Figure 6 for lift truck models

- E1.6-2.0XN (E30-40XN) (A269)

See Figure 7 for lift truck models

- E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

6. Remove the mounts from the axle assembly.

NOTE: Bearing cones are to be replaced as sets. If one bearing cone has been determined to be unserviceable, then both must be replaced.

7. If the bearing cones are to be replaced, remove the inner and outer bearing cups from the wheel using a brass drift pin.

8. Repeat Step 1 through Step 7 for the other wheel.

CLEAN

WARNING

Cleaning solvents can be flammable and toxic and can cause skin irritation. When using cleaning solvents, always follow the solvent manufacturer's recommended safety procedures.

WARNING

Compressed air is used for cleaning or drying purposes, or for clearing restrictions. Wear protective clothing (goggles/shield, gloves, etc.) to avoid injury to personnel.

1. Clean bearing cones by placing them in a wire basket and immersing in a container of fresh solvent. Agitate the bearing cones in the solvent to remove all traces of old lubricant.

2. Clean all remaining components, except the oil seals and mounts, with solvent.

3. Clean the oil seals and rubber mounts in warm soapy water. Rinse with clean warm water and allow to air dry.

4. After cleaning, dry bearing cones with compressed air. Take care to prevent spinning the bearing cones when using a compressed air jet.

5. Immediately wrap bearing cones in a lint-free cloth to protect them from dust and other foreign matter.

INSPECT

1. Inspect bearing cones for burned or damaged rollers. If either condition exists, replace both sets of bearing cones and bearing cups.

2. Inspect bearing cups for signs of overheating or scoring. If either condition exists, replace both sets of bearing cones and bearing cups.

3. Inspect the rubber mounts for signs of damage or cracking. Replace, if necessary.

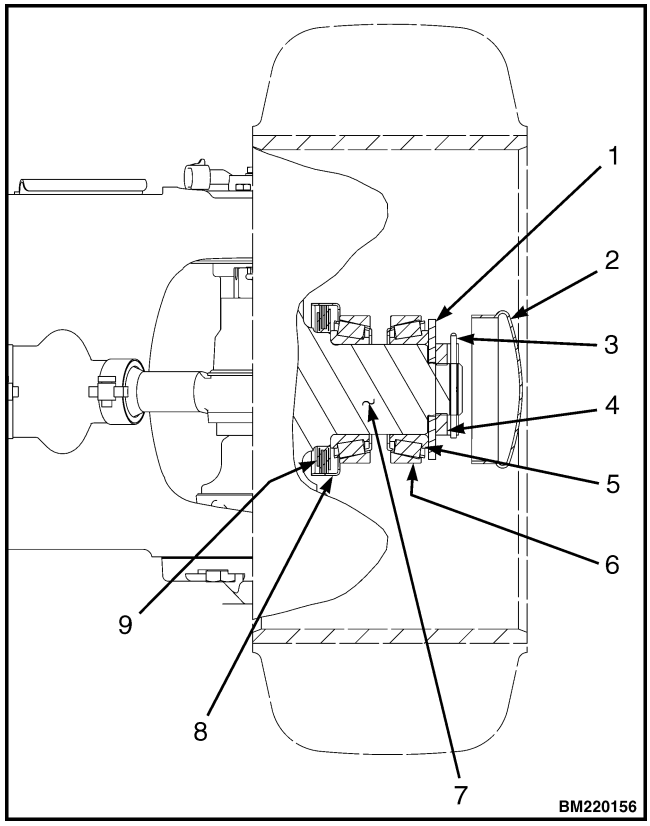
4. Inspect the oils seals and wear rings for any damage. Replace, if damaged.

5. Inspect spindle assemblies and tie rods for signs of damage. Replace, if necessary, in accordance with Spindle Repair and Tie Rod Replacement.

6. Inspect the remainder of the axle assembly for damage, and repair or replace as necessary.

ASSEMBLE E2.2-3.5XN (E45-70XN) (A268), E1.6-2.0XN (E30-40XN) (A269) AND E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

1. If bearing cups have been removed, use a press to install new bearing cups in wheel. See Figure 8.



1. WASHER
2. HUB CAP
3. COTTER PIN
4. CASTLE NUT
5. BEARING CONE
6. BEARING CUP
7. SPINDLE
8. WEAR RING
9. OIL SEAL

Figure 8. Bearing Arrangement for Lift Truck Models E2.2-3.5XN (E45-70XN) (A268), E1.6-2.0XN (E30-40XN) (A269) and E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

2. For specified lubricant see

Periodic Maintenance 8000SRM1364 for lift truck model

- E2.2-3.5XN (E45-70XN) (A268)

Periodic Maintenance 8000SRM1442 for lift truck model

- E1.6-2.0XN (E30-40XN) (A269)

Periodic Maintenance 8000SRM1577 for lift truck models

- E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

Verify bearings are filled with grease.

3. Install oil seal, as noted during removal, wear ring (if removed), and inner bearing cone on spindle.

CAUTION

DO NOT damage the seals during installation.

4. Carefully slide wheel onto spindle. Install outer bearing cone and install washer.

NOTE: Ensure that the washer is seated properly against the bearing cone and not against the shaft shoulder before tightening the castle nut.

NOTE: Perform Step 5 through Step 8 for lift truck models E2.2-3.5XN (E45-70XN) (A268) .

5. Install the castle nut as follows:
   a. Install and tighten the castle nut to seat the bearing, and back off completely.
   b. Tighten castle nut to 68 N•m (50 lbf ft) while rotating the wheel in both directions to properly seat the bearings.
   c. Loosen the castle nut 1/4 turn.
   d. Tighten nut to 3 N•m (27 lbf in).
   e. Pull on the wheel assembly to ensure that there is no end play. If there is excessive end play, reassemble washer and repeat Step a through Step c.
6. Install new cotter pin in castle nut. If cotter pin cannot be installed, tighten castle nut to the first alignment position where the cotter pin can be installed.
7. Install hub cap.
8. Repeat Step 1 through Step 7 for other wheel.

NOTE: Ensure that the washer is seated properly against the bearing cone and not against the shaft shoulder before tightening the castle nut.

NOTE: Perform Step 9 through Step 12 for lift truck models E1.6-2.0XN (E30-40XN) (A269) .

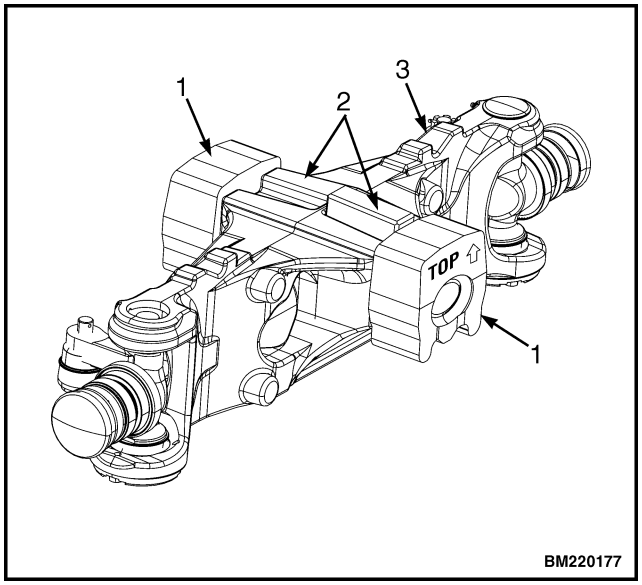
9. Install the castle nut as follows:
   a. Install and tighten the castle nut to seat the bearing, and back off completely.
   b. Tighten castle nut to 200 N•m (148 lbf ft) while rotating the wheel in both directions to properly seat the bearings.
   c. Loosen the castle nut 1/4 turn.
   d. Tighten nut to 12 N•m (106 lbf in).
   e. Pull on the wheel assembly to ensure that there is no end play. If there is excessive end play, reassemble washer and repeat Step a through Step c.
10. Install new cotter pin in castle nut. If cotter pin cannot be installed, tighten castle nut to the first alignment position where the cotter pin can be installed.
11. Install hub cap.
12. Repeat Step 1 through Step 4 and Step 9 through Step 11 for other wheel.

NOTE: Perform Step 13 through Step 15 for lift truck models E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099) .

13. Install the castle nut as follows:
   a. Install castle nut and tighten to 203 N•m (150 lbf ft) while rotating the wheel in both directions to properly seat the bearings.
   b. Back off castle nut until wheel turns freely with no end play. Torque should be less than 27 N•m (238 lbf in).
   c. If there is excessive end play, reassemble washer and repeat Step a and Step b.
   d. Re-torque castle nut to 34 N•m (25 lbf ft) and lock in place at first alignment position which occurs at or above 34 N•m (25 lbf ft).
   e. Install new cotter pin and bend one prong over castle nut. Bend other prong over spindle and cut flush with end of spindle.
14. Install hub cap.
15. Repeat Step 1 through Step 4 and Step 13 and Step 14 for other wheel.

INSTALL E2.2-3.5XN (E45-70XN) (A268)

1. Install rubber mounts and top mount(s) on axle. Verify that the face of rubber mount with the word "TOP" and the arrow (pointing up) is facing away from the steer axle. See Figure 9.



1. RUBBER MOUNT
2. TOP MOUNT
3. STEER AXLE

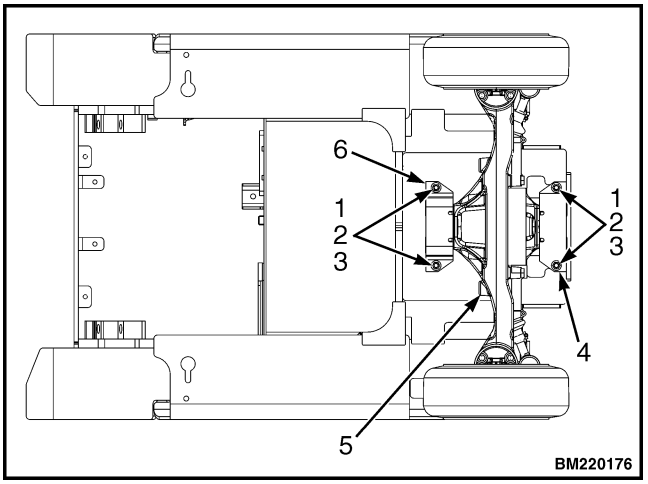
Figure 9. Mount Installation for Lift truck Model E2.2-3.5XN (E45-70XN) (A268)

2. Apply lubricant (that is approved for use with rubber) to rubber mount. The lubricant is used to ease assembly of the rubber mounts into lift truck frame and mount brackets.

3. Using a floor jack, position the steering axle under the frame.

4. If the lift truck is equipped with the steering direction sensor option, connect steering direction sensor cable to the main wiring harness. See Figure 5.

5. Lift the steer axle into position on the lift truck frame, and install the rear and front mount brackets, four washers, four capscrews, and four nuts. Tighten capscrews to 90 N•m (66 lbf ft). See Figure 10.



1. CAPSCREW
2. WASHER
3. NUT
4. REAR MOUNT BRACKET
5. STEER AXLE
6. FRONT MOUNT BRACKET

Figure 10. Steer Axle Installation for Lift Truck Model E2.2-3.5XN (E45-70XN) (A268)

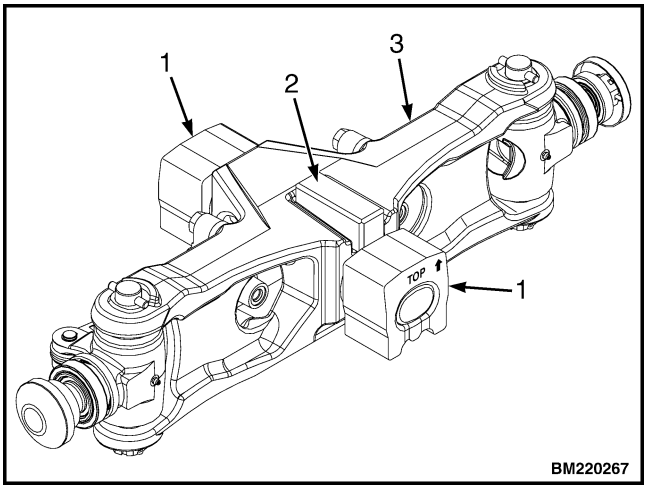
6. Remove plugs and caps and connect hydraulic lines to steering cylinder as noted during removal.

7. Remove the floor jack from under the lift truck, and remove the lift truck from the blocks.

8. Operate steering system to remove air from system. Turn steering wheel several times from one stop to the other. Check for hydraulic leaks.

INSTALL E1.6-2.0XN (E30-40XN) (A269)

1. Install rubber mounts and top mount(s) on axle. Verify that the face of rubber mount with the word "TOP" and the arrow (pointing up) is facing away from the steer axle. See Figure 11.



1. RUBBER MOUNT
2. TOP MOUNT
3. STEER AXLE

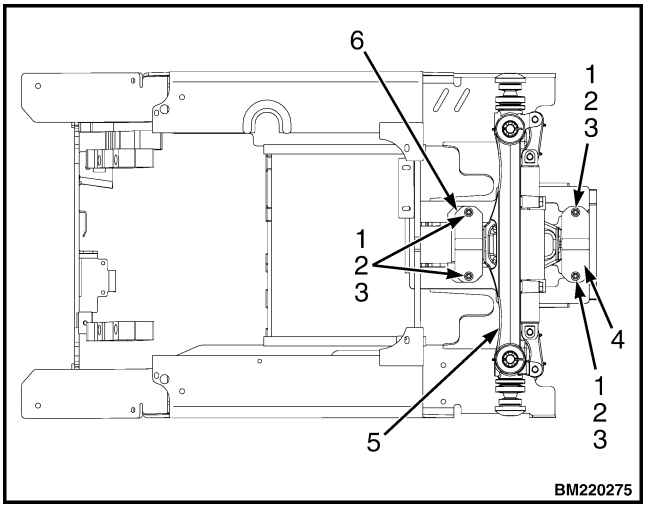
Figure 11. Mount Installation for Lift Truck Model E1.6-2.0XN (E30-40XN) (A269)

2. Apply lubricant (that is approved for use with rubber), to rubber mount. The lubricant is used to ease assembly of the rubber mounts into lift truck frame and mount brackets.

3. Using a floor jack, position the steering axle under the frame.

4. If the lift truck is equipped with the steering direction sensor option, connect steering direction sensor cable to the main wiring harness. See Figure 6.

5. Lift the steer axle into position on the lift truck frame, and install the rear and front mount brackets, four washers, four capscrews, and four nuts. Tighten capscrews to 41 to 49 N•m (30.2 to 36.1 lbf ft). See Figure 12.



1. CAPSCREW
2. WASHER
3. NUT
4. REAR MOUNT BRACKET
5. STEER AXLE
6. FRONT MOUNT BRACKET

Figure 12. Steer Axle Installation for Lift Truck Model E1.6-2.0XN (E30-40XN) (A269)

6. Remove plugs and caps and connect hydraulic lines to steering cylinder as noted during removal.

7. Remove the floor jack from under the lift truck, and remove the lift truck from the blocks.

8. Operate steering system to remove air from system. Turn steering wheel several times from one stop to the other. Check for hydraulic leaks.

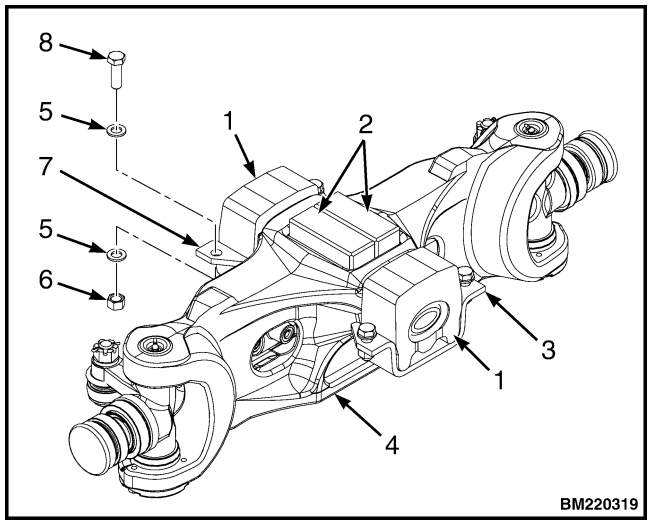
INSTALL E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

1. Install rubber mounts and top mount(s) on axle. Verify that the face of rubber mount with the word "TOP" and the arrow (pointing up) is facing away from the steer axle. See Figure 13.

2. Apply lubricant (that is approved for use with rubber) to rubber mount. The lubricant is used to ease assembly of the rubber mounts into lift truck frame and mount brackets.

3. Using a floor jack, position the steering axle under the frame.

4. If the lift truck is equipped with the steering direction sensor option, connect steering direction sensor cable to the main wiring harness. See Figure 7.



1. RUBBER MOUNT
2. TOP MOUNTS
3. REAR MOUNT BRACKET
4. STEER AXLE
5. WASHER
6. NUT
7. FRONT MOUNT BRACKET
8. CAPSCREW

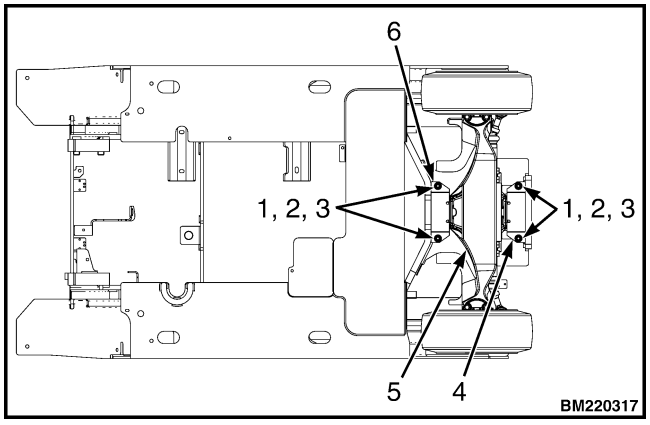
Figure 13. Mount Installation, Lift Trucks E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

5. Lift the steer axle into position on the lift truck frame, and install the rear and front mount brackets, eight washers, four capscrews, and four nuts. Tighten capscrews to 225 to 280 N•m (166 to 207 lbf ft). See Figure 14.

6. Remove plugs and caps and connect hydraulic lines to steering cylinder as noted during removal.

7. Remove the floor jack from under the lift truck, and remove the lift truck from the blocks.

8. Operate steering system to remove air from system. Turn steering wheel several times from one stop to the other. Check for hydraulic leaks.



1. CAPSCREW
2. WASHER
3. NUT
4. REAR MOUNT BRACKET
5. STEER AXLE
6. FRONT MOUNT BRACKET

Figure 14. Steer Axle Installation, Lift Trucks E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

REMOVE J2.2-3.5XN (J45-70XN) (A276) AND J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

WARNING

PUTTING THE LIFT TRUCK ON BLOCKS

The lift truck must be put on blocks for some types of maintenance and repair. The removal of the mast, drive axle, battery, or counterweight assemblies will cause large changes in the center of gravity. When the lift truck is put on blocks, put additional blocks in the following positions:

- **If the mast and drive axle are removed, put blocks under the counterweight so the lift truck cannot fall backward.**
- **If the counterweight is removed, put blocks under the mast so that the lift truck cannot fall forward.**

Put the lift truck on blocks on a solid, even, and level surface. Verify the blocks or stands have enough capacity to hold the lift truck. Use additional blocks next to the tires as necessary to prevent movement of the lift truck. Verify the lifting devices used during repairs can lift the weight of the parts and assemblies.

See the Operating Manual or Periodic Maintenance section for your lift truck model, for the procedures to put the lift truck on blocks.

The steering axle can be removed without removing the counterweight.

1. Remove the battery from the lift truck. The procedure for removing the battery may be found in the **Operating Manual** or in one of the following service manuals:

   Periodic Maintenance 8000SRM1372 for lift truck models

   - J2.2-3.5XN (J45-70XN) (A276)

   Periodic Maintenance 8000SRM1541 for lift truck models

   - J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

2. Place the lift trucks on blocks. The procedure for placing the lift truck on blocks may be found in the **Operating Manual** or in one of the following service manuals:

   Periodic Maintenance 8000SRM1372 for lift truck models

   - J2.2-3.5XN (J45-70XN) (A276)

   Periodic Maintenance 8000SRM1541 for lift truck models

   - J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

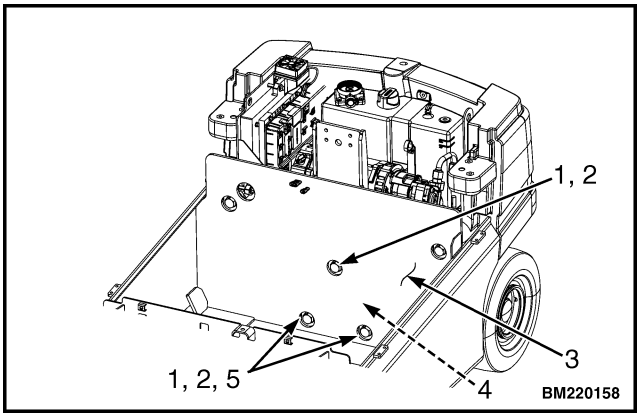
3. Slide floor jack under steering axle. Raise lifting device until it holds the weight of the axle assembly.

NOTE: Tag hydraulic lines prior to disconnecting from steering cylinder to aid in the correct connection of the hydraulic lines during installation.

4. Disconnect hydraulic lines at steering cylinder. Install plug fittings in cylinder and put caps on hydraulic lines. Plug fittings will prevent spindles from turning as axle is removed from under the lift truck.

NOTE: Perform Step 5 and Step 6 for lift truck model J2.2-3.5XN (J45-70XN) (A276) only.

5. Remove two lower nuts, capscrews, and washers from the battery box and front mount bracket. See Figure 15.



1. CAPSCREW
2. WASHER
3. BATTERY COMPARTMENT
4. FRONT MOUNT BRACKET
5. NUT

Figure 15. Steer Axle Replacement J2.2-3.5XN (J45-70XN) (A276)

6. Remove the top capscrew and washer from the battery box and front mount bracket. See Figure 15.

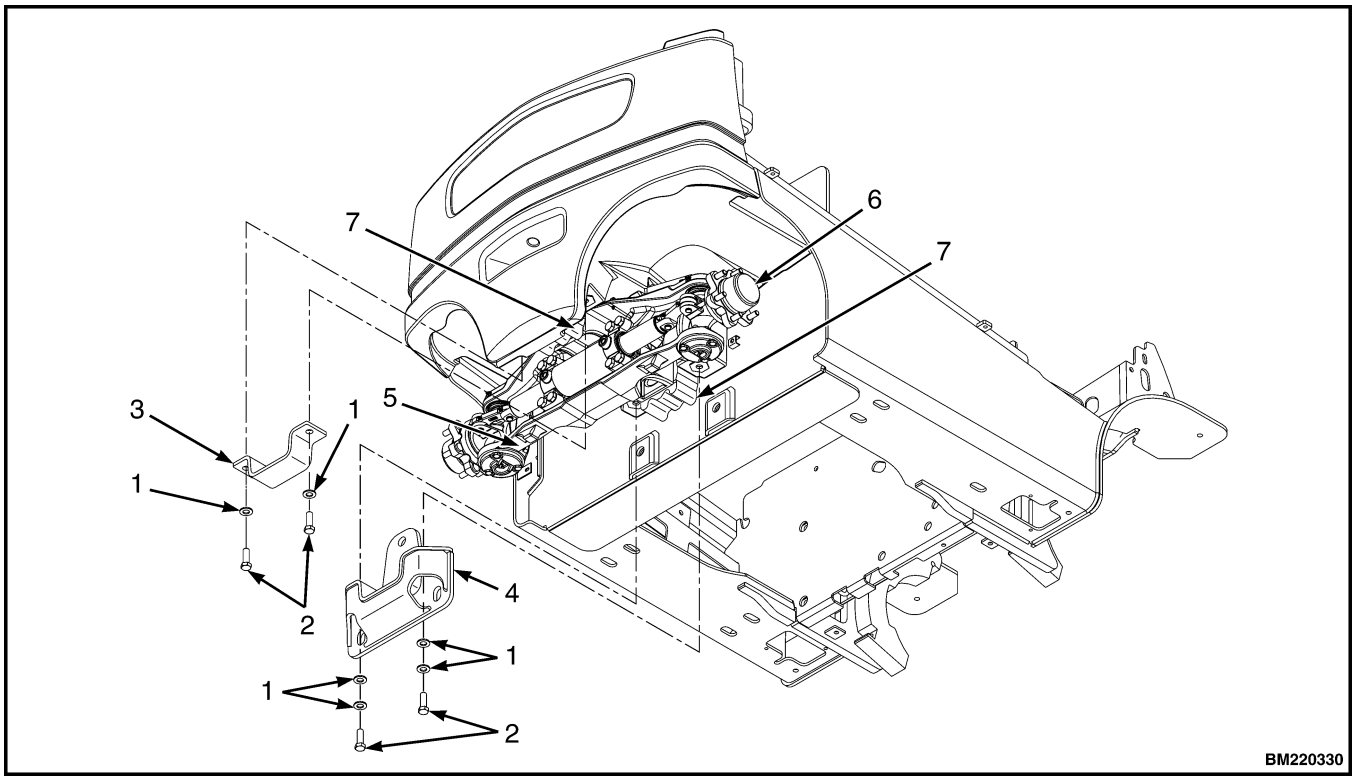
7. Remove two capscrews, washers, and rear mount bracket.

See Figure 16 or Figure 17 for lift truck model

- J2.2-3.5XN (J45-70XN) (A276)

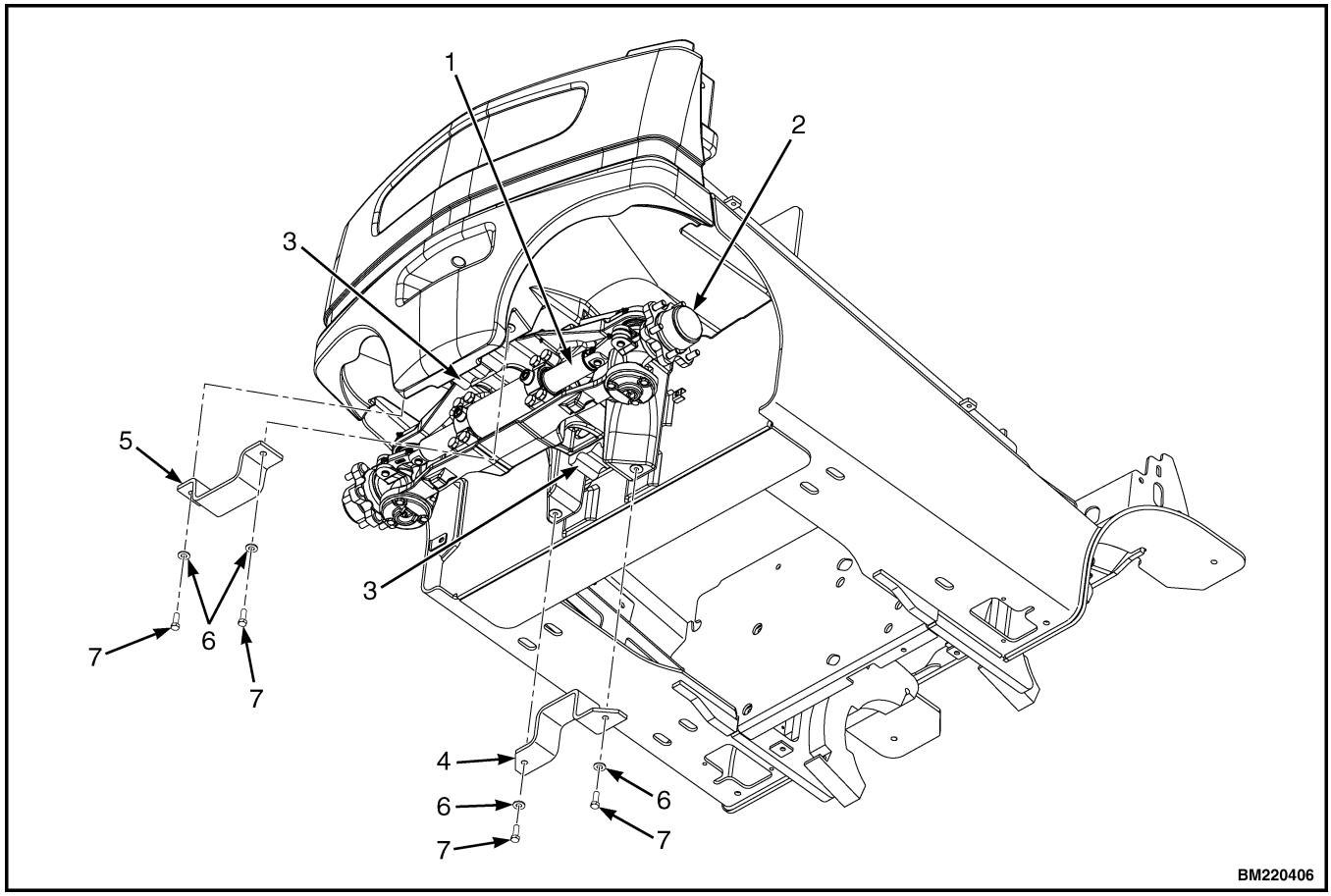
See Figure 18 for lift truck model

- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)



1. WASHER
2. CAPSCREW
3. REAR MOUNT BRACKET
4. FRONT MOUNT BRACKET
5. STEER AXLE
6. PNEUMATIC HUB
7. RUBBER MOUNTS

Figure 16. Steer Axle Removal for Lift Trucks Manufactured Prior to November, 2015J2.2-3.5XN (J45-70XN) (A276)



1. STEER AXLE
2. PNEUMATIC HUB
3. RUBBER MOUNTS
4. FRONT MOUNT BRACKET
5. REAR MOUNT BRACKET
6. WASHER
7. CAPSCREW

Figure 17. Steer Axle Removal for Lift Trucks Manufactured After November, 2015J2.2-3.5XN (J45-70XN) (A276)

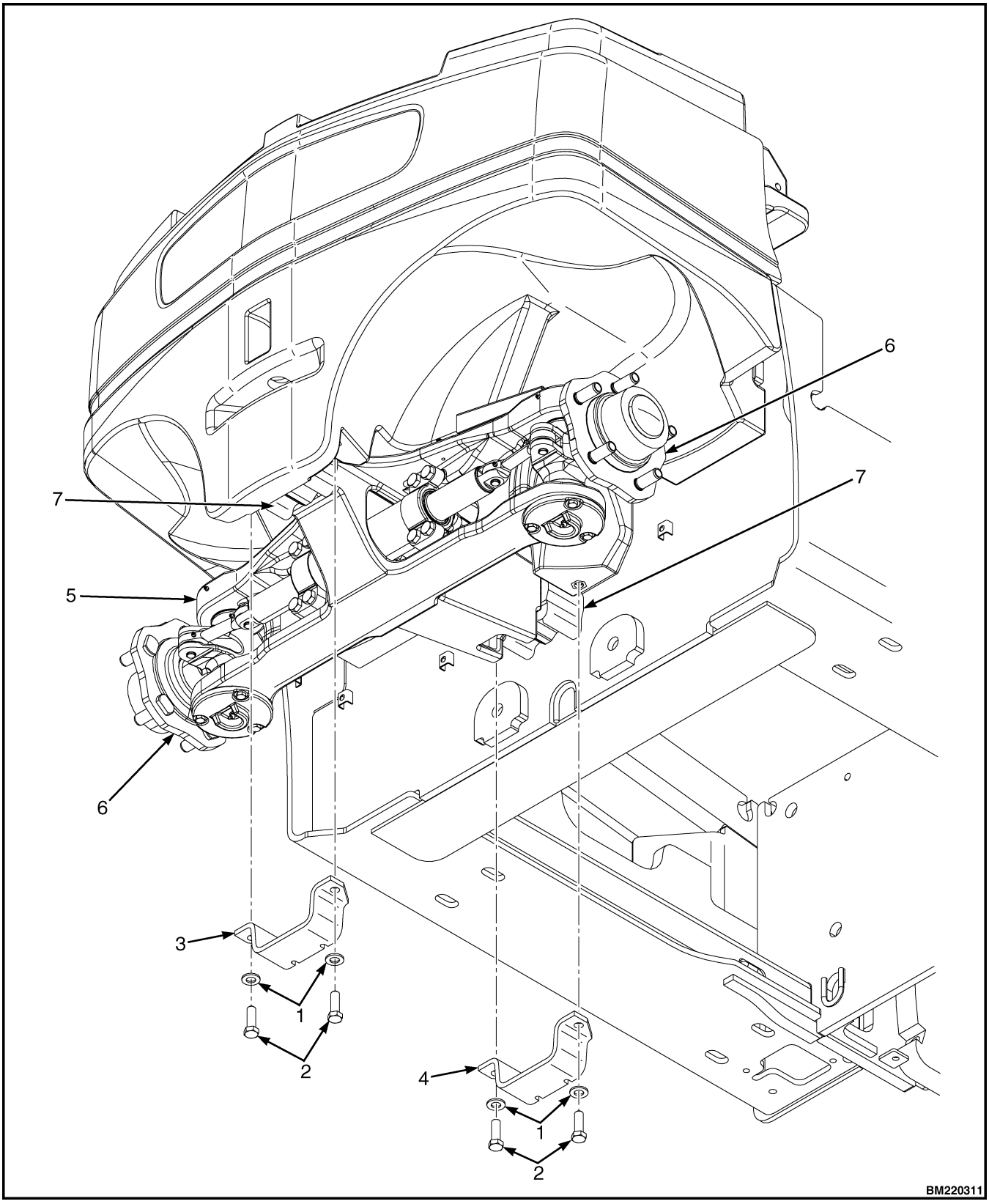


Figure 18. Steer Axle Removal J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

Legend for Figure 18.

1. WASHER
2. CAPSCREW
3. REAR MOUNT BRACKET
4. FRONT MOUNT BRACKET
5. STEER AXLE
6. PNEUMATIC HUB
7. RUBBER MOUNTS

NOTE: The front mount bracket may not be able to be removed until the steering axle is lowered during Step 9.

8. Remove two capscrews, washers, hydraulic hose mounting brackets, and front mount bracket from the counterweight.

See Figure 16 or Figure 17 for lift truck models

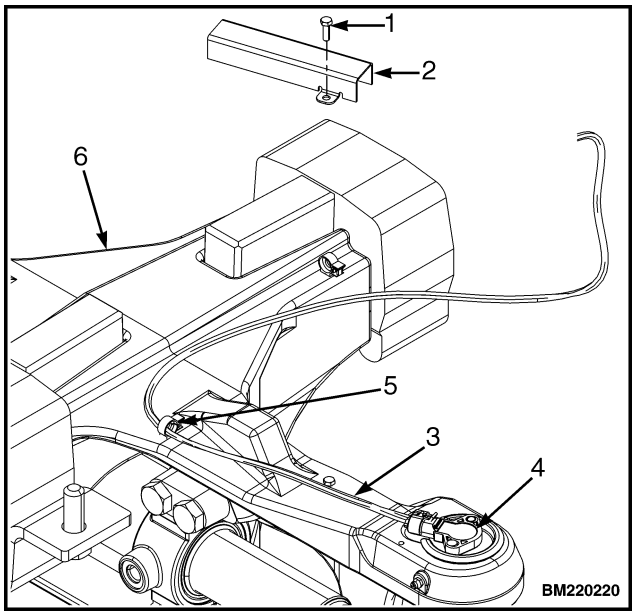
- J2.2-3.5XN (J45-70XN) (A276)

See Figure 18 for lift truck models

- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

NOTE: The steering direction sensor is standard on J2.2-3.5XN (J45-70XN) (A276) and J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) lift trucks.

9. Carefully lower the floor jack enough to remove capscrew and cover to disconnect steering direction sensor cable from the main wiring harness, and remove the main wiring harness from the conduit clip located on the steering axle. See Figure 19. Install cover and capscrew. Move the steer axle clear of the lift truck.



NOTE: MAJOR COMPONENTS NOT SHOWN FOR CLARITY. STEERING DIRECTION SENSOR FOR LIFT TRUCK MODELS J2.2-3.5XN (J45-70XN) (A276) SHOWN. STEERING DIRECTION SENSOR FOR LIFT TRUCK MODELS J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) IS SIMILAR.

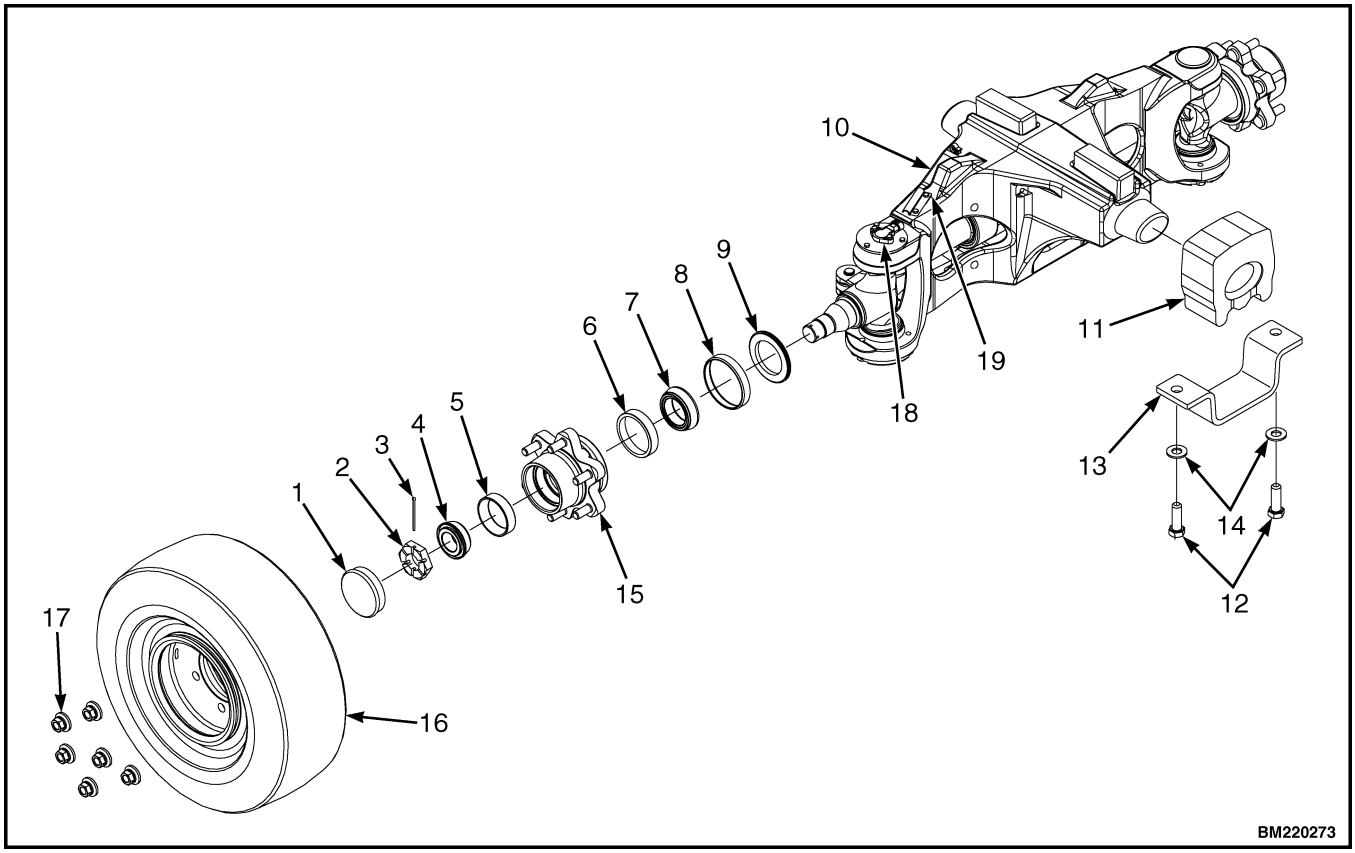
1. CAPSCREW
2. COVER
3. MAIN WIRING HARNESS
4. STEERING DIRECTION SENSOR
5. CONDUIT CLIP
6. STEERING AXLE

Figure 19. Main Wiring Harness Disconnect

DISASSEMBLE J2.2-3.5XN (J45-70XN) (A276) AND J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

1. Place steering axle on blocks so the wheels just touch the floor.

2. Remove six lug nuts and wheel from the pneumatic hub. See Figure 20.



NOTE: STEERING AXLE FOR LIFT TRUCK MODELS J2.2-3.5XN (J45-70XN) (A276) SHOWN. STEERING AXLE FOR LIFT TRUCK MODELS J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) IS SIMILAR.

1. HUB CAP
2. CASTLE NUT
3. COTTER PIN
4. OUTER BEARING CONE
5. OUTER BEARING CUP
6. INNER BEARING CUP
7. INNER BEARING CONE
8. WEAR RING
9. OIL SEAL
10. AXLE ASSEMBLY
11. MOUNT
12. CAPSCREW
13. BRACKET
14. WASHER
15. PNEUMATIC HUB
16. PNEUMATIC TIRE WHEEL
17. LUG NUTS
18. STEERING DIRECTION SENSOR
19. STEERING DIRECTION SENSOR CABLE BRACKET

Figure 20. Steering Axle Assemblies for J2.2-3.5XN (J45-70XN) (A276)

3. Remove hub cap, cotter pin, castle nut, and pneumatic hub from the spindle. Discard cotter pin.

NOTE: Identify and tag the outer and inner bearing cones so they can be reassembled in their original locations.

4. Remove the outer bearing cone from the pneumatic hub.

NOTE: Note the position of the oil seal during removal to ensure correct orientation during installation.

5. Remove the inner bearing cone and oil seal from the spindle assembly.

6. Remove the mounts from the axle assembly.

NOTE: Bearing cones are to be replaced as sets. If one bearing cone has been determined to be unserviceable, then both must be replaced.

7. If the bearing cones are to be replaced, remove the inner and outer bearing cups from the pneumatic hub using a brass drift pin.

8. Repeat Step 1 through Step 7 for the other wheel.

CLEAN

WARNING

Cleaning solvents can be flammable and toxic and can cause skin irritation. When using cleaning solvents, always follow the solvent manufacturer's recommended safety procedures.

WARNING

Compressed air is used for cleaning or drying purposes, or for clearing restrictions. Wear protective clothing (goggles/shield, gloves, etc.) to avoid injury to personnel.

1. Clean bearing cones by placing them in a wire basket and immersing in a container of fresh solvent. Agitate the bearing cones in the solvent to remove all traces of old lubricant.

2. Clean all remaining components, except the oil seals and mounts, with solvent.

3. Clean the oil seals and rubber mounts in warm soapy water. Rinse with clean warm water and allow to air dry.

4. After cleaning, dry bearing cones with compressed air. Take care to prevent spinning the bearing cones when using a compressed air jet.

5. Immediately wrap bearing cones in a lint-free cloth to protect them from dust and other foreign matter.

6. For lift truck models J2.2-3.5XN (J45-70XN) (A276) see **Frame** 0100SRM1342 for procedures to clean parts of the counterweight and bracket mounts before installing the steering axle.

INSPECT

1. Inspect bearing cones for burned or damaged rollers. If either condition exists, replace both sets of bearing cones and bearing cups.

2. Inspect bearing cups for signs of overheating or scoring. If either condition exists, replace both sets of bearing cones and bearing cups.

3. Inspect the rubber mounts for signs of damage or cracking. Replace, if necessary.

4. Inspect the oils seals and wear rings for any damage. Replace, if damaged.

5. Inspect spindle assemblies and tie rods for signs of damage. Replace, if necessary, in accordance with Spindle Repair and Tie Rod Replacement.

6. Inspect the remainder of the axle assembly for damage, and repair or replace as necessary.

7. For lift truck models J2.2-3.5XN (J45-70XN) (A276) see **Frame** 0100SRM1342 for procedures to inspect parts of the counterweight and bracket mounts before installing the steering axle.

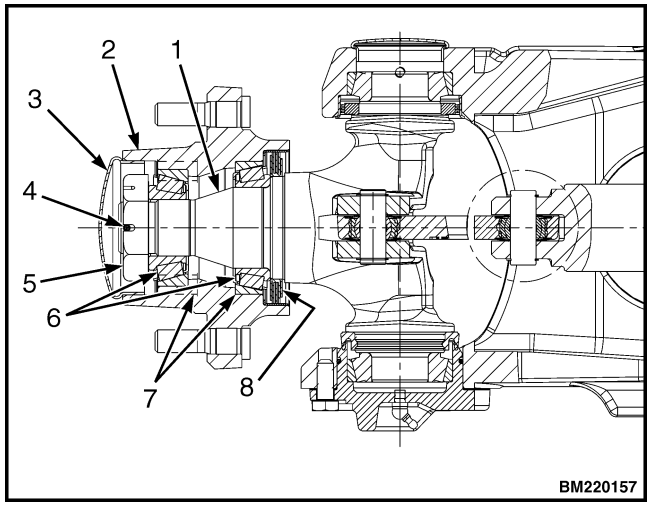
ASSEMBLE J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

1. If bearing cups have been removed, use a press to install new bearing cups in hub. See Figure 21.

2. Lubricate bearing cones with multipurpose grease. See **Periodic Maintenance** 8000SRM1541.

   Verify bearings are filled with grease.

3. Install oil seal, as noted during removal, and inner bearing cone on spindle.



1. SPINDLE
2. HUB
3. HUB CAP
4. COTTER PIN
5. CASTLE NUT
6. BEARING CONE
7. BEARING CUP
8. OIL SEAL

Figure 21. Bearing Arrangement for Lift Truck Models J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

CAUTION

DO NOT damage the seals during installation.

4. Carefully slide hub onto spindle. Install outer bearing cone and install washer.

NOTE: Ensure that the washer is seated properly against the bearing cone and not against the shaft shoulder before tightening the castle nut.

5. Tighten the castle nut as follows:

a. Install the castle nut and tighten to 200 N•m (147.5 lbf ft) while rotating the wheel in both directions to properly seat the bearings.

b. Back off the castle nut until wheel turns freely with no end play. Nut torque should be less than 15 N•m (133 lbf in).

c. Retorque castle nut to40 to 60 N•m (30 to 44 lbf ft).

d. Lock castle nut in place at first alignment position when new cotter pin can be installed.

e. Install cotter pin in castle nut.

6. Install hub cap.

7. Install wheel using six lug nuts.Tighten lug nuts to 610 to 680 N•m (450 to 502 lbf ft).

8. Repeat Step 1 through Step 7 for other wheel.

ASSEMBLE J2.2-3.5XN (J45-70XN) (A276)

NOTE: Ensure to pack wheel, spindle bearing, bearing cone roller and bearing cup with multipurpose grease.

1. If bearing cups have been removed, use a press to install new bearing cups in hub and lower bearing cap. See Figure 22 .

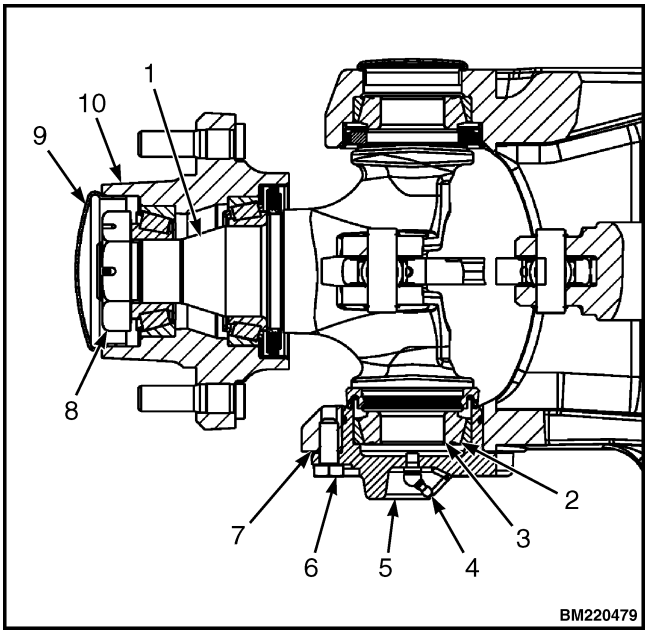
2. Lubricate bearing cones with multipurpose grease through fittings. See Figure 22, Figure 23, and **Periodic Maintenance** 8000SRM1372 .

Verify bearings are filled with grease.

CAUTION

DO NOT damage the seals during installation.

3. Install bearing cap into axle without shims.



1. SPINDLE
2. BEARING CUP
3. BEARING CONE
4. GREASE FITTING
5. BEARING CAP
6. CAPSCREW
7. SHIM (3)
8. SPINDLE NUT
9. HUB CAP
10. HUB ASSEMBLY

Figure 22. Bearing Arrangement for Lift Truck Models J2.2-3.5XN (J45-70XN) (A276)

4. Apply Loctite® to capscrews and tighten to 5-8 N•m (4-6 lbf ft).

5. Tap bearing cap lightly with a rubber mallet to ensure bearing races are seated. Re-torque the capscrews to 5-8 N•m (4-6 lbf ft).

6. Measure gap between housing and bearing cap at three locations around bearing cap. Place shims to match lowest of three measured gaps (±0.7mm).

7. Loosen capscrews completely and install shims. See Figure 22

8. Re-tighten capscrews to 44-55 N•m (32-40 lbf ft).

9. Ensure gap has closed to 0mm.

10. Ensure bearings are filled with grease. Add more grease if needed. See Figure 22 and Figure 23.

11. Ensure turning force of spindle is 48-101 N•m (35-74 lbf ft).

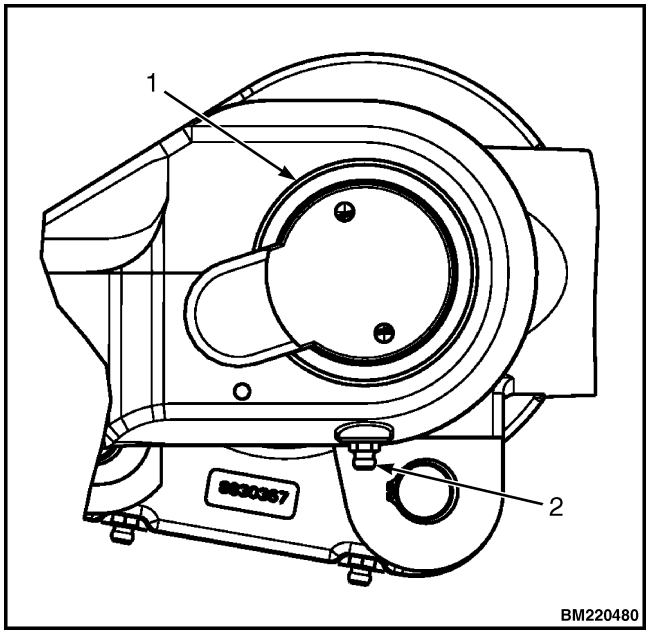
Wheel Bearing Adjustment J2.2-3.5XN (J45-70XN) (A276)

Follow steps below for bearing adjustments:

1. Torque spindle nuts in proper sequence to 200 N•m (147 lbf ft).
2. Loosen spindle nuts until wheel hub turns freely with no end play. At this point, wheel torque should be less than 15 N•m (11 lbf ft).
3. Re-torque spindle nuts in proper sequence to 15 N•m (11 lbf ft) and lock in place at nearest alignment position.

NOTE: Before installing the hub cap, apply lubricant to both mounting surfaces.

Hub cap must be aligned with machining of steer axle. Ensure hub cap is in contact with steering axle. See Figure 23



1. HUB CAP
2. GREASE FITTING

Figure 23. Hub Cap Alignment

INSTALL J2.2-3.5XN (J45-70XN) (A276) AND J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

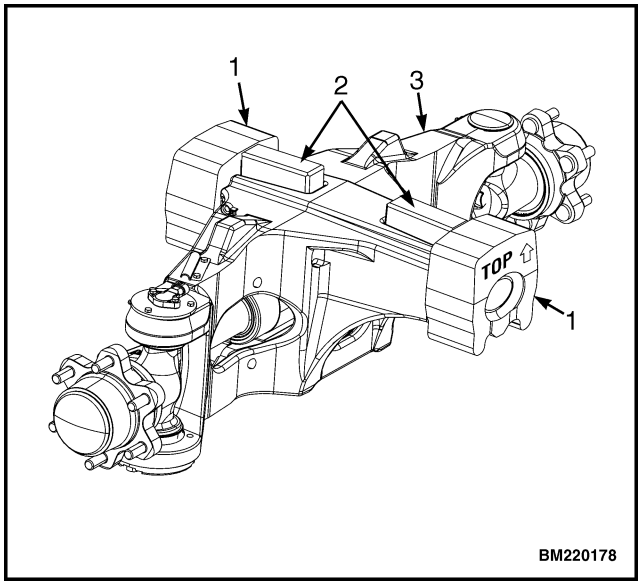
1. Install rubber mounts and top mount(s) on axle. Verify that the face of rubber mount with the word "TOP" and the arrow (pointing up) is facing away from the steer axle.

See Figure 24 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276)

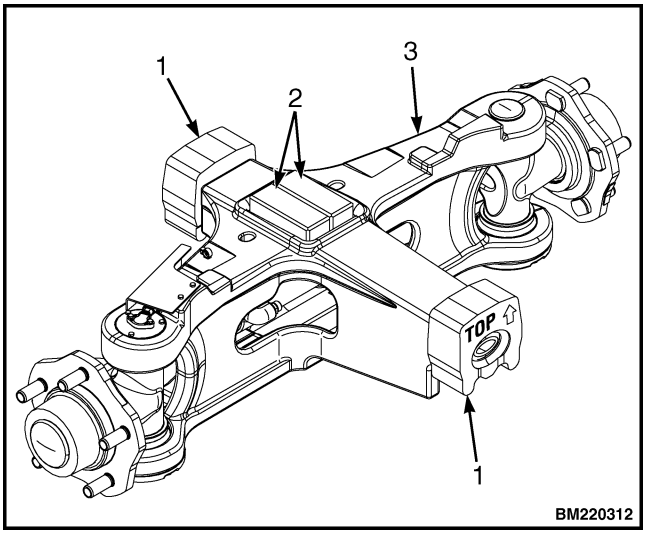
See Figure 25 for lift truck models

- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)



1. RUBBER MOUNT
2. TOP MOUNT
3. STEER AXLE

Figure 24. Mount Installation for Lift Truck Model J2.2-3.5XN (J45-70XN) (A276)



1. RUBBER MOUNT
2. TOP MOUNT
3. STEER AXLE

Figure 25. Mount Installation for Lift Truck Model J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

2. Apply lubricant, that is approved for use with rubber, to rubber mount. The lubricant is used to ease assembly of the rubber mounts into lift truck frame and mount brackets.

3. Using a floor jack, position the steering axle under the counterweight.

4. Raise the steering axle enough to connect steering direction sensor cable to the main wiring harness.

5. Install the steering direction sensor cable cover on the axle, and the main wiring harness into the conduit clips on the top of the axle. See Figure 20.

6. Lift the steer axle into position on the lift truck frame, and install the rear mount bracket, two washers, and two capscrews. Tighten capscrews to 225 to 280 N•m (166 to 207 lbf ft).

See Figure 26 or Figure 27 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276)

See Figure 28 for lift truck modelsJ4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

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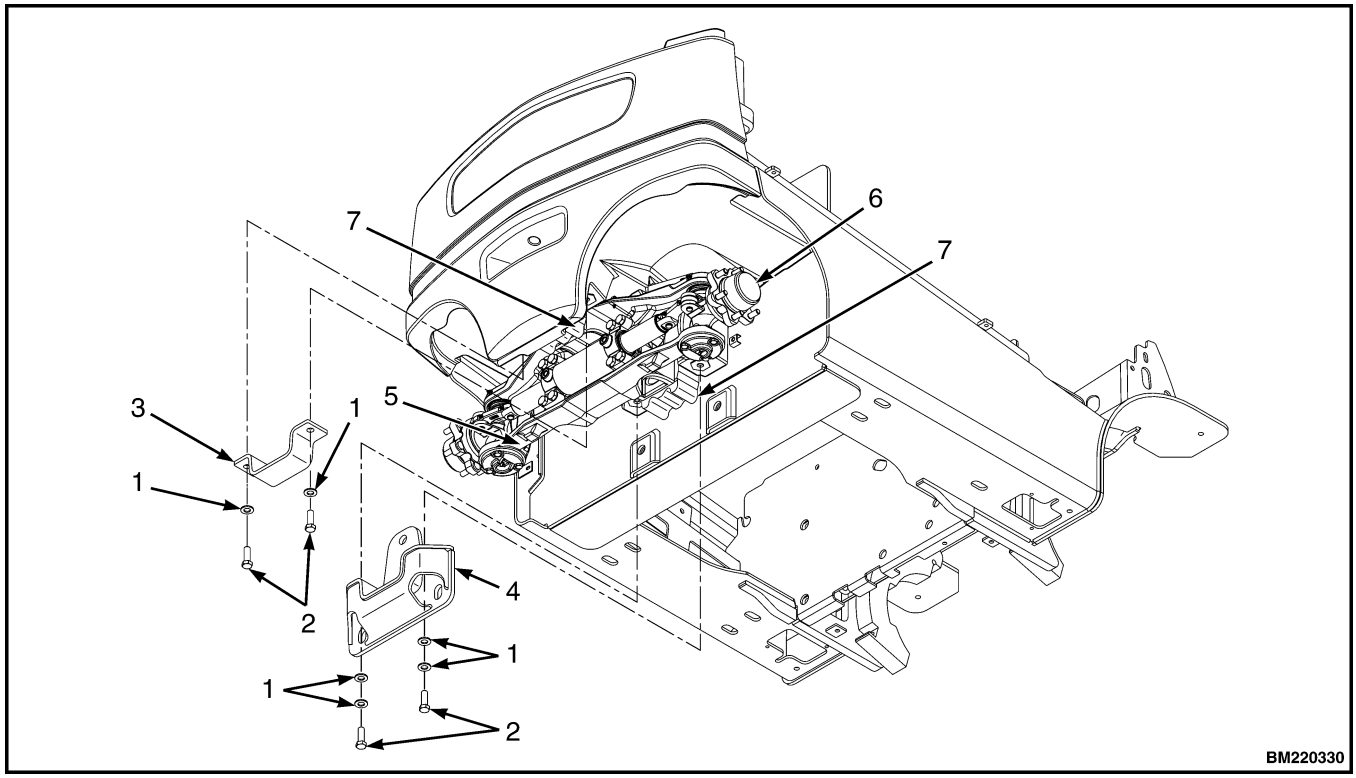
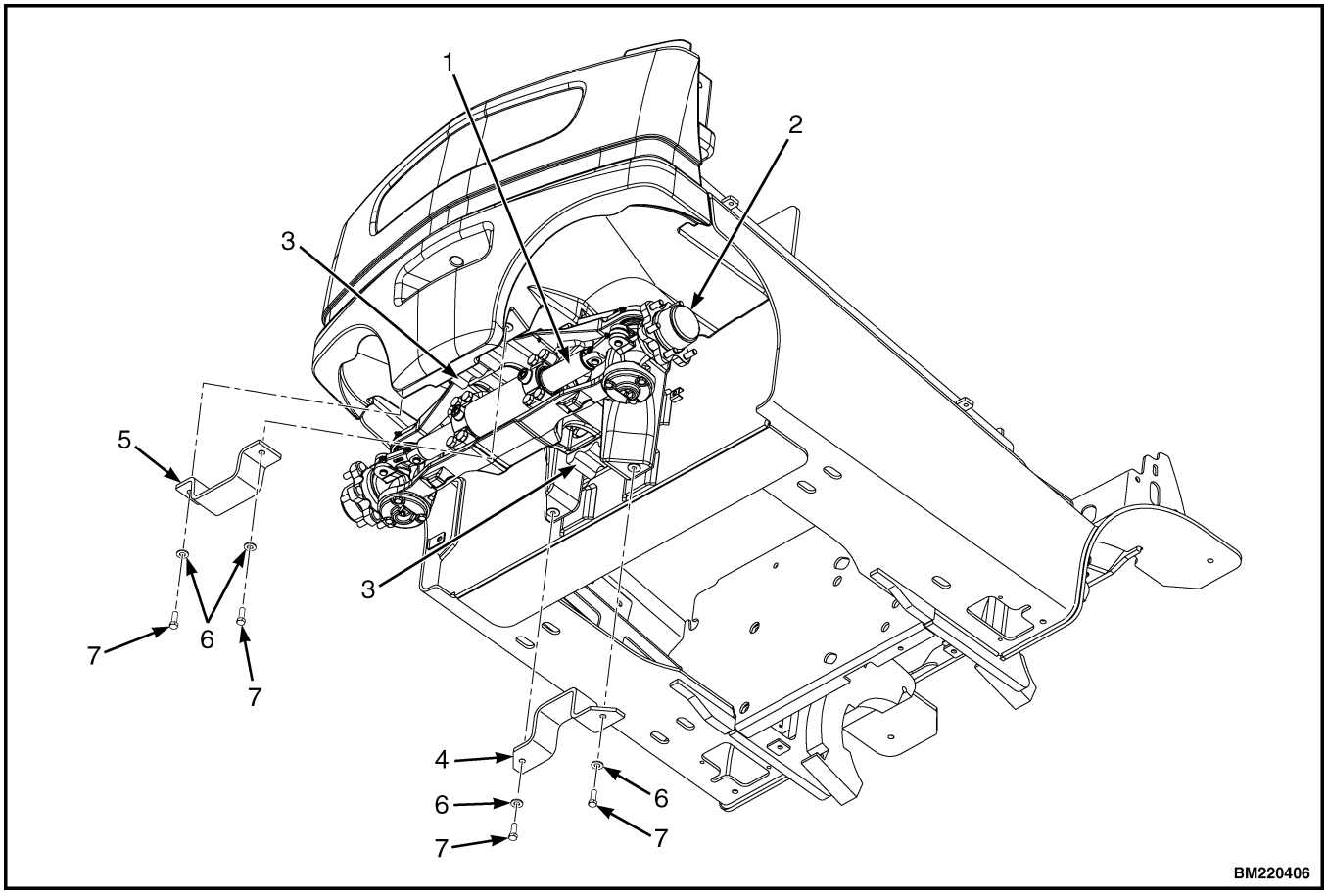


1. WASHER
2. CAPSCREW
3. REAR MOUNT BRACKET
4. FRONT MOUNT BRACKET
5. STEER AXLE
6. PNEUMATIC HUB
7. RUBBER MOUNTS

Figure 26. Steer Axle Installation for Lift Truck Model J2.2-3.5XN (J45-70XN) (A276)



1. STEER AXLE
2. PNEUMATIC HUB
3. RUBBER MOUNTS
4. FRONT MOUNT BRACKET
5. REAR MOUNT BRACKET
6. WASHER
7. CAPSCREW

Figure 27. Steer Axle Installation for Lift Trucks Manufactured After November, 2015J2.2-3.5XN (J45-70XN) (A276)

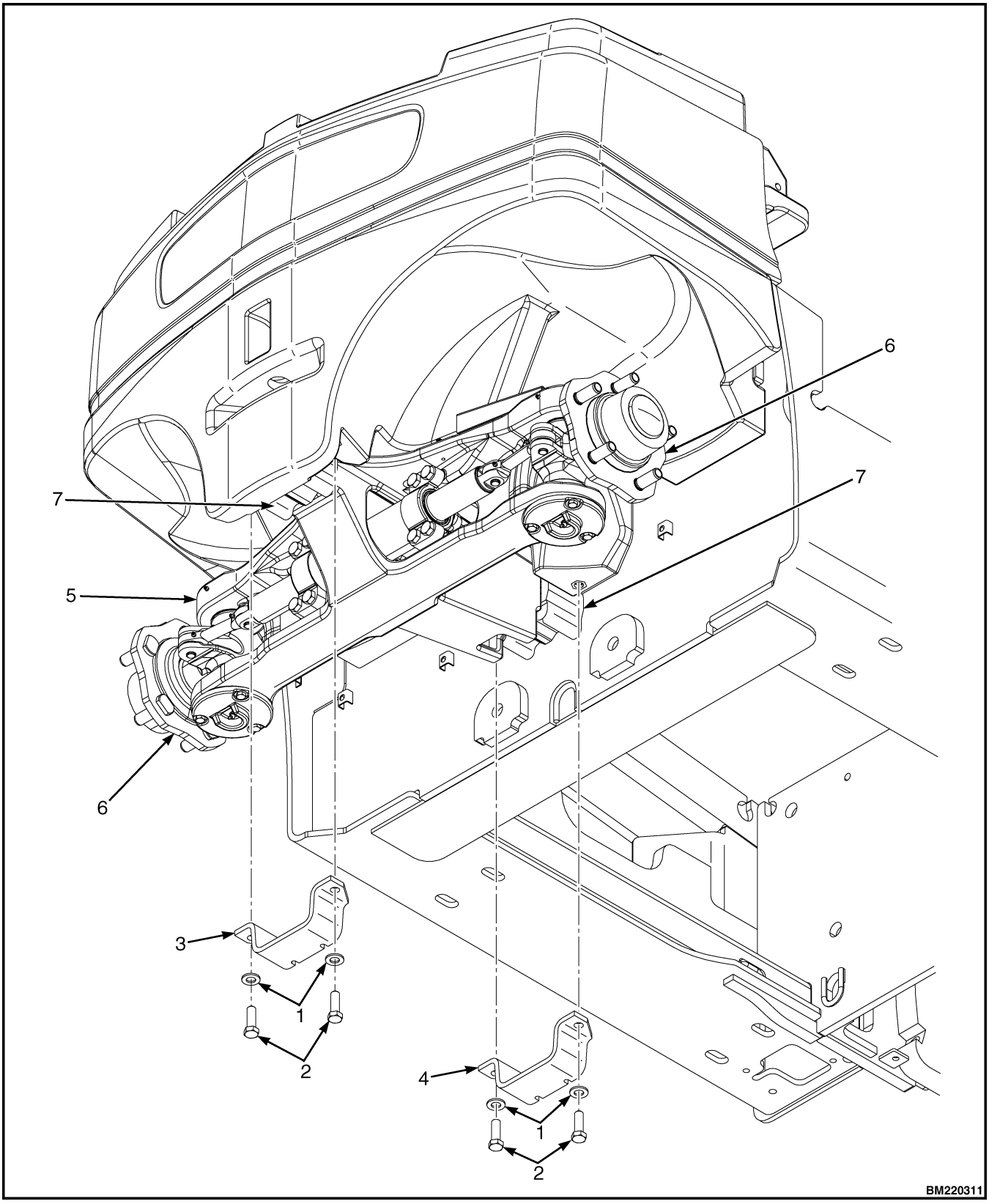


Figure 28. Steer Axle Installation J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

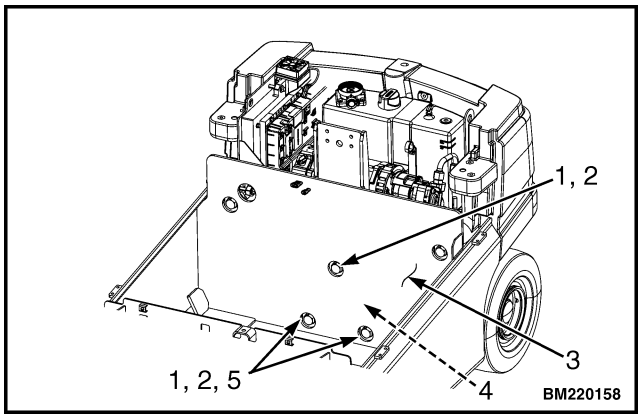
Legend for Figure 28.

1. WASHER
2. CAPSCREW
3. REAR MOUNT BRACKET
4. FRONT MOUNT BRACKET
5. STEER AXLE
6. PNEUMATIC HUB
7. RUBBER MOUNTS

NOTE: Perform Step 7 through Step 10 for lift truck models J2.2-3.5XN (J45-70XN) (A276) .

7. Using a jack, install the front mount bracket between the battery box and the front mount. Install steering hose brackets, two washers, and capscrews. Tighten capscrews 225 to 280 N•m (166 to 207 lbf ft). See Figure 26.

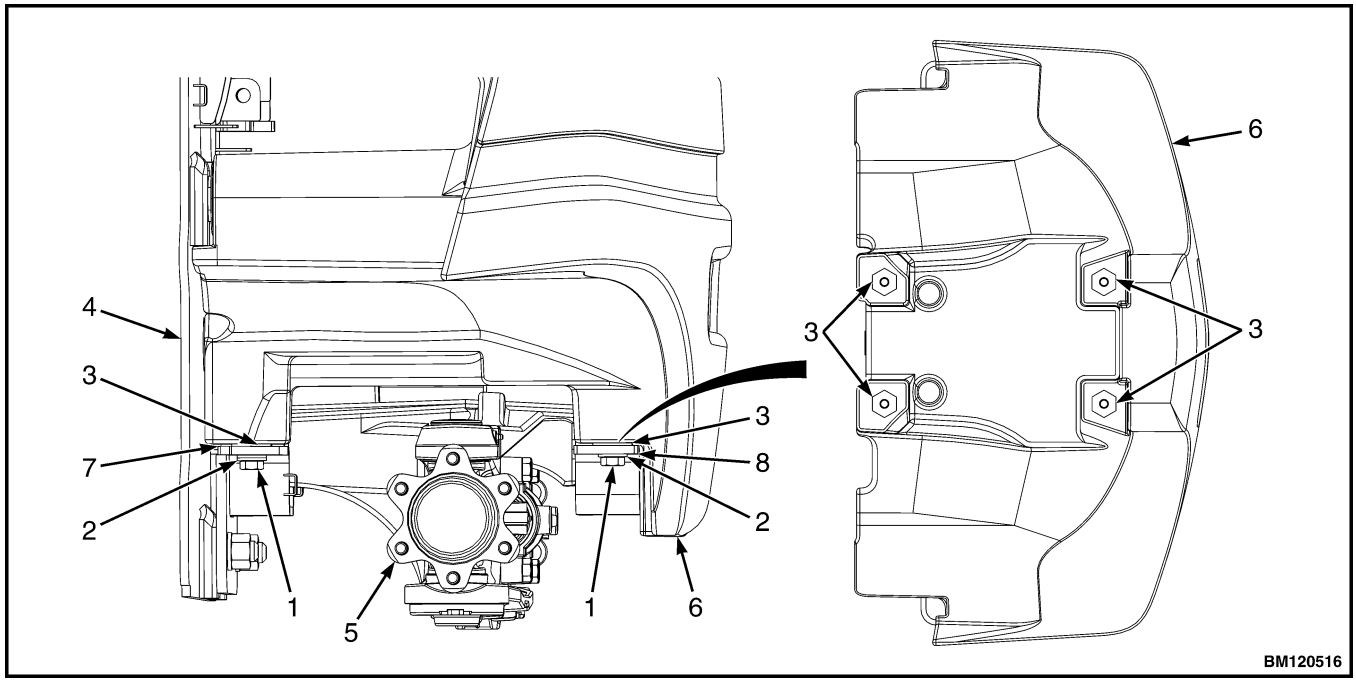
8. From inside the battery box install the top capscrew and washer. Tighten to 755 N•m (557 lbf ft). See Figure 29.



1. CAPSCREW
2. WASHER
3. BATTERY COMPARTMENT
4. FRONT MOUNT BRACKET
5. NUT

Figure 29. Steer Axle Replacement for Lift Truck Model J2.2-3.5XN (J45-70XN) (A276)

9. After the front and rear mount brackets have been installed, check to be sure there are no gaps between the front and rear mount brackets and the counterweight hexagon surfaces. See Figure 30.



NOTE: LIFT TRUCKS MANUFACTURED PRIOR TO NOVEMBER 2015 SHOWN, LIFT TRUCKS MANUFACTURED AFTER NOVEMBER 2015 SIMILAR.

1. CAPSCREW
2. WASHER
3. HEXAGON SURFACE
4. REAR BULKHEAD
5. STEERING AXLE
6. COUNTERWEIGHT
7. FRONT MOUNT BRACKET
8. REAR MOUNT BRACKET

Figure 30. Clearance Between Mounting Brackets

NOTE: Perform Step 10 for lift trucks manufactured prior to November, 2015.

10. From inside the battery box install the two lower capscrews, washers and nuts. Tighten nuts to 755 N•m (557 lbf ft). See Figure 29.

NOTE: Perform Step 11 for lift truck models J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) .

11. Using a jack, install two capscrews, washers, hydraulic hose mounting brackets, and front mount bracket to the counterweight. Tighten capscrews 225 to 280 N•m (166 to 207 lbf ft). See Figure 28.

12. Remove plugs and caps and connect hydraulic lines to steering cylinder as noted during removal.

13. Remove the floor jack from under the lift truck and remove the lift truck from the blocks.

14. Operate steering system to remove air from system. Turn steering wheel several times from one stop to the other. Check for hydraulic leaks.

REMOVE J1.6-2.0XN (J30-40XN) (A935)

WARNING

PUTTING THE LIFT TRUCK ON BLOCKS

The lift truck must be put on blocks for some types of maintenance and repair. The removal of the mast, drive axle, battery, or counterweight assemblies will cause large changes in the center of gravity. When the lift truck is put on blocks, put additional blocks in the following positions:

- **If the mast and drive axle are removed, put blocks under the counterweight so the lift truck cannot fall backward.**
- **If the counterweight is removed, put blocks under the mast so that the lift truck cannot fall forward.**

Put the lift truck on blocks on a solid, even, and level surface. Verify the blocks or stands have enough capacity to hold the lift truck. Use additional blocks next to the tires as necessary to prevent movement of the lift truck. Verify the lifting devices used during repairs can lift the weight of the parts and assemblies.

See the Operating Manual or Periodic Maintenance section for your lift truck model, for the procedures to put the lift truck on blocks.

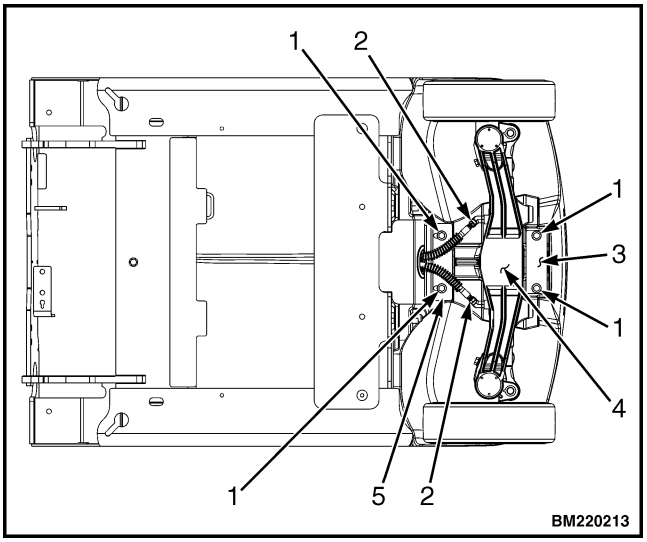
The steering axle can be removed without removing the counterweight.

1. Place the lift trucks on blocks. The procedure for placing the lift truck on blocks may be found in the **Operating Manual** or **Periodic Maintenance** 8000SRM1373.

2. Slide floor jack under steering axle. Raise floor jack until it holds the weight of the axle assembly.

3. Disconnect hydraulic hoses at steering cylinder. Install plug fittings in cylinder and put caps on hydraulic hoses. Plug fittings will prevent spindles from turning as axle is removed from under the lift truck.

4. Remove four capscrews that fasten the mount brackets under the rubber mounts. See Figure 31.



1. FLANGE HEAD CAPSCREW
2. HYDRAULIC HOSES
3. REAR MOUNT BRACKET
4. STEER AXLE
5. FRONT MOUNT BRACKET

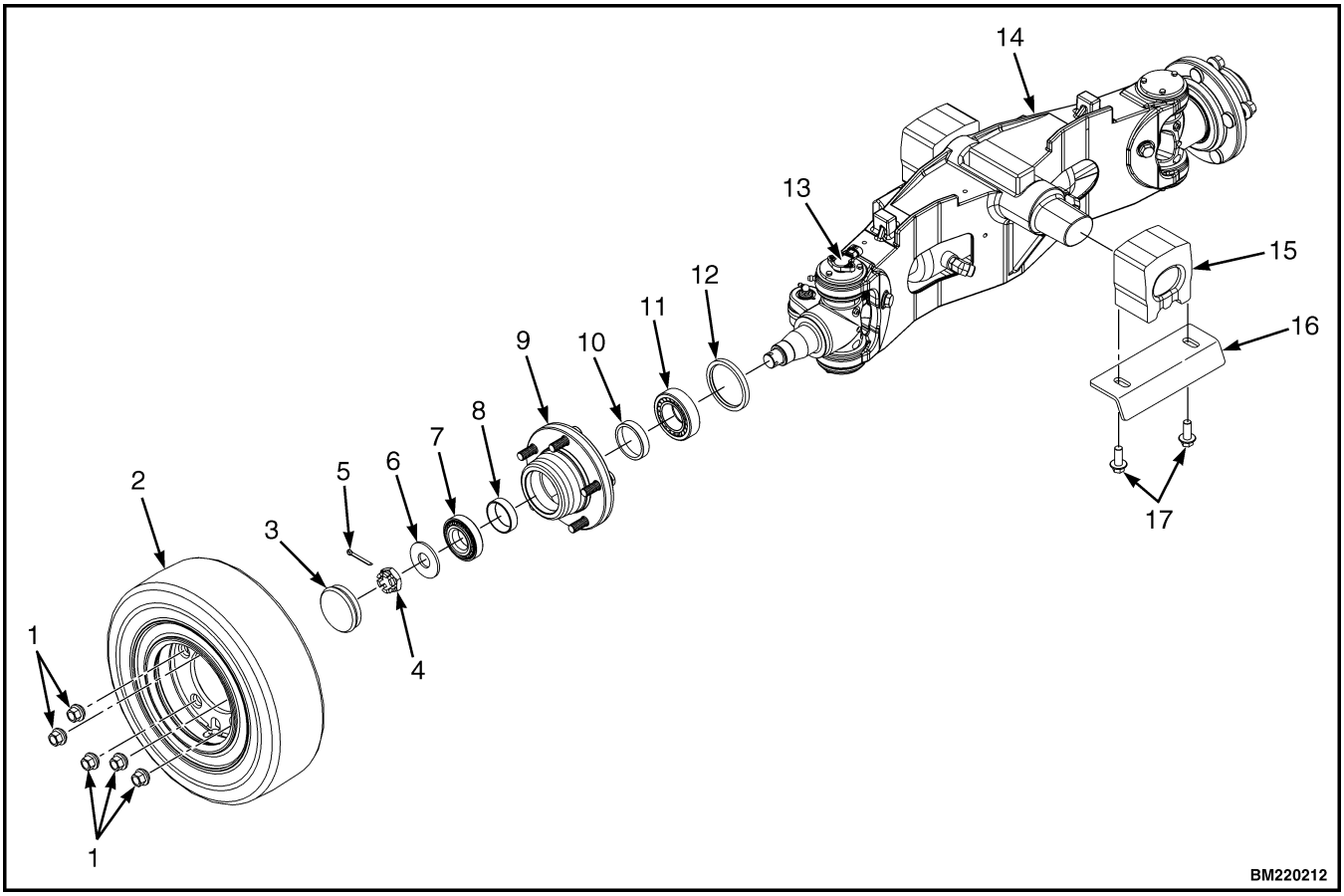
Figure 31. Steer Axle Removal J1.6-2.0XN (J30-40XN) (A935)

5. Carefully lower the floor jack enough to disconnect the steering direction sensor cable from the wiring harness. Remove the steer axle from the under the lift truck.

DISASSEMBLE J1.6-2.0XN (J30-40XN) (A935)

1. Place steering axle on blocks so the wheels just touch the floor.

2. Remove five lug nuts and wheel from the hub. See Figure 32.



1. LUG NUTS
2. WHEEL
3. HUB CAP
4. CASTLE NUT
5. COTTER PIN
6. WASHER
7. OUTER BEARING CONE
8. OUTER BEARING CUP
9. HUB
10. INNER BEARING CUP
11. INNER BEARING CONE
12. OIL SEAL
13. STEERING DIRECTION SENSOR
14. AXLE ASSEMBLY
15. MOUNT
16. BRACKET
17. FLANGE HEAD CAPSCREW

Figure 32. Steering Axle Assemblies for J1.6-2.0XN (J30-40XN) (A935)

3. Remove hub cap, cotter pin, castle nut, washer, and hub from the spindle. Discard cotter pin.

NOTE: Identify and tag the outer and inner bearing cones so they can be reassembled in their original locations.

4. Remove the outer bearing cone from the hub.

NOTE: Note the position of the oil seal during removal to ensure correct orientation during installation.

5. Remove the inner bearing cone and oil seal from the spindle assembly.

6. Remove the mounts from the axle assembly.

NOTE: Bearing cones are to be replaced as sets. If one bearing cone has been determined to be unserviceable, then both must be replaced.

7. If the bearing cones are to be replaced, remove the inner and outer bearing cups from the hub using a brass drift pin.

8. Repeat Step 1 through Step 7 for the other wheel.

CLEAN

WARNING

Cleaning solvents can be flammable and toxic and can cause skin irritation. When using cleaning solvents, always follow the solvent manufacturer's recommended safety procedures.

WARNING

Compressed air is used for cleaning or drying purposes, or for clearing restrictions. Wear protective clothing (goggles/shield, gloves, etc.) to avoid injury to personnel.

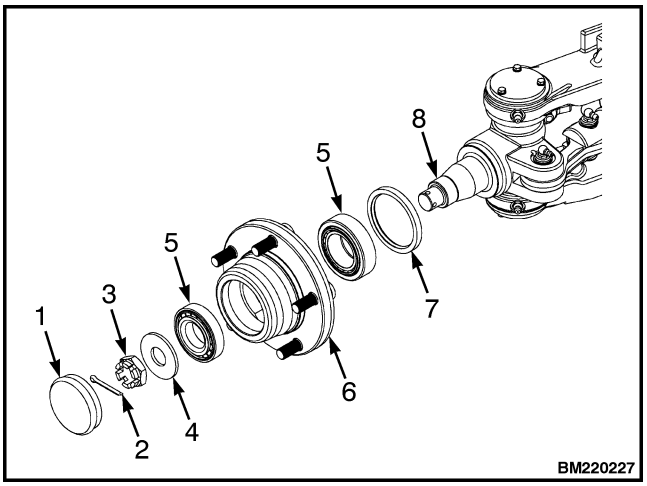
1. Clean bearing cones by placing them in a wire basket and immersing in a container of fresh solvent. Agitate the bearing cones in the solvent to remove all traces of old lubricant.
2. Clean all remaining components, except the oil seals and mounts, with solvent.
3. Clean the oil seals and rubber mounts in warm soapy water. Rinse with clean warm water and allow to air dry.
4. After cleaning, dry bearing cones with compressed air. Take care to prevent spinning the bearing cones when using a compressed air jet.
5. Immediately wrap bearing cones in a lint-free cloth to protect them from dust and other foreign matter.

INSPECT

1. Inspect bearing cones for burned or damaged rollers. If either condition exists, replace both sets of bearing cones and bearing cups.
2. Inspect bearing cups for signs of overheating or scoring. If either condition exists, replace both sets of bearing cones and bearing cups.
3. Inspect the rubber mounts for signs of damage or cracking. Replace, if necessary.
4. Inspect the oils seals and wear rings for any damage. Replace, if damaged.
5. Inspect spindle assemblies and tie rods for signs of damage. Replace, if necessary, in accordance with Spindle Repair and Tie Rod Replacement.
6. Inspect the remainder of the axle assembly for damage, and repair or replace as necessary.

ASSEMBLE J1.6-2.0XN (J30-40XN) (A935)

1. If bearing cups have been removed, use a press to install new bearing cups in hub. See Figure 33.
2. Lubricate bearing cones with multipurpose grease. See **Periodic Maintenance** 8000SRM1373 for specified lubricant. Verify bearings are filled with grease.
3. Install oil seal, as noted during removal, and inner bearing cone on spindle.



1. HUB CAP
2. COTTER PIN
3. CASTLE NUT
4. WASHER
5. BEARING
6. HUB
7. OIL SEAL
8. SPINDLE

Figure 33. Bearing Arrangement for Lift Truck Models J1.6-2.0XN (J30-40XN) (A935)

CAUTION

DO NOT damage the seals during installation.

4. Carefully slide hub onto spindle. Install outer bearing cone and install washer.

NOTE: Ensure that the washer is seated properly against the bearing cone.

5. Install the castle nut and tighten to 60 N•m (44 lbf ft) while rotating the wheel three times in both directions to properly seat the bearings. Loosen the castle nut and tighten nut to 20 N•m (177 lbf in).

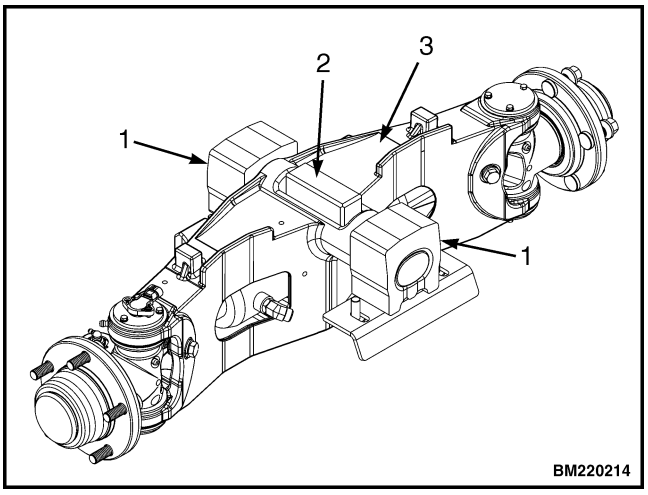
6. Install new cotter pin in castle nut. If cotter pin cannot be installed, tighten castle nut to the first alignment position where the cotter pin can be installed.

7. Install hub cap.

8. Repeat Step 1 through Step 7 for other wheel.

INSTALL J1.6-2.0XN (J30-40XN) (A935)

1. Install rubber mounts and top mount(s) on axle. Verify that the face of rubber mount with the word "TOP" and the arrow (pointing up) is facing away from the steer axle. See Figure 34.



1. RUBBER MOUNT
2. TOP MOUNT
3. STEER AXLE

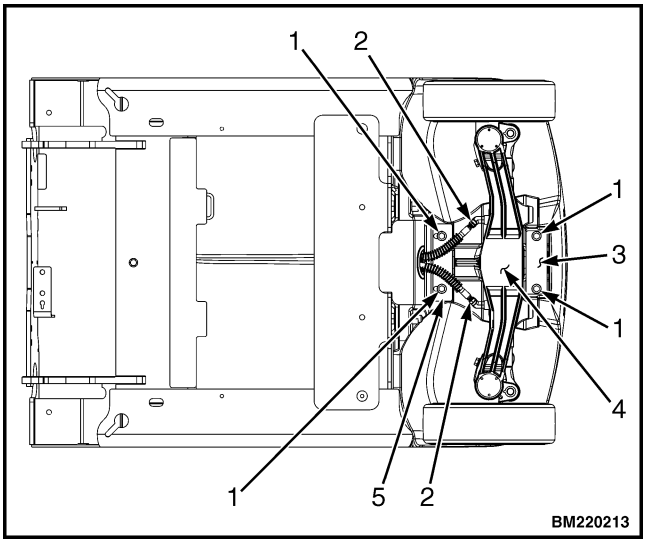
Figure 34. Mount Installation for Lift Truck Model J1.6-2.0XN (J30-40XN) (A935)

2. Apply lubricant (that is approved for use with rubber) to rubber mount. The lubricant is used to ease assembly of the rubber mounts into lift truck frame and mount brackets.

3. Using a floor jack, position the steering axle under the frame.

4. Raise the axle enough to connect steering direction sensor cable to the wiring harness.

5. Lift the steer axle into position on the lift truck frame. Install the rear and front mount brackets, and four flange head capscrews. Tighten capscrews to 90 N•m (66 lbf ft). See Figure 35.



1. FLANGE HEAD CAPSCREW
2. HYDRAULIC HOSES
3. REAR MOUNT BRACKET
4. STEER AXLE
5. FRONT MOUNT BRACKET

Figure 35. Steer Axle Installation J1.6-2.0XN (J30-40XN) (A935)

6. Remove plugs and caps and connect hydraulic lines to steering cylinder as noted during removal.

7. Remove the floor jack from under the lift truck, and remove the lift truck from the blocks.

8. Operate steering system to remove air from system. Turn steering wheel several times from one stop to the other. Check for hydraulic leaks.

Tie Rod Replacement

REMOVE E2.2-E3.5XN (E45-70XN) (A268) AND E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

WARNING

PUTTING THE LIFT TRUCK ON BLOCKS

The lift truck must be put on blocks for some types of maintenance and repair. The removal of the mast, drive axle, battery, or counterweight assemblies will cause large changes in the center of gravity. When the lift truck is put on blocks, put additional blocks in the following positions:

- **If the mast and drive axle are removed, put blocks under the counterweight so the lift truck cannot fall backward.**
- **If the counterweight is removed, put blocks under the mast so that the lift truck cannot fall forward.**

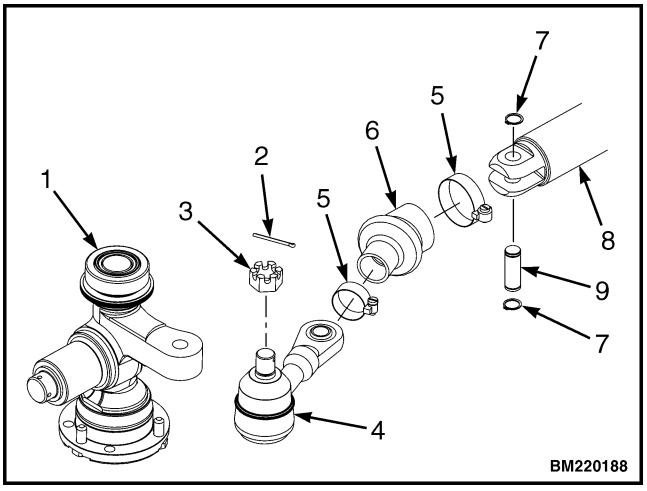
Put the lift truck on blocks on a solid, even, and level surface. Verify the blocks or stands have enough capacity to hold the lift truck. Use additional blocks next to the tires as necessary to prevent movement of the lift truck. Verify the lifting devices used during repairs can lift the weight of the parts and assemblies.

See the Operating Manual or Periodic Maintenance section for your lift truck model, for the procedures to put the lift truck on blocks.

1. Place the lift trucks on blocks. The procedure for placing the lift truck on blocks may be found in the **Operating Manual** or **Periodic Maintenance** for your lift truck.

2. Remove the wheel and bearings. See Steering Axle Assembly Repair.

3. Loosen two clamps and slide boot from the steering cylinder rod onto the tie rod end. See Figure 36.



1. SPINDLE ASSEMBLY
2. COTTER PIN
3. CASTLE NUT
4. TIE ROD
5. CLAMP
6. BOOT
7. SNAP RING
8. STEERING CYLINDER ROD
9. PIN

Figure 36. Tie Rod Removal for Lift Truck Model E2.2-E3.5XN (E45-70XN) (A268) and E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

NOTE: It may be necessary to use a brass drift pin to remove the pin connecting the tie rod end to the steering cylinder rod.

4. Remove snap ring and pin connecting the tie rod end to the steering cylinder rod.

5. Remove cotter pin and castle nut from the tie rod. Discard the cotter pin.

CAUTION

DO NOT hit the threads of the tie rod.

6. Using a puller, remove the tie rod from the spindle assembly.

7. If necessary to replace both tie rods, perform Step 1 through Step 6 for the other side of the steering axle.

CLEAN

CAUTION

DO NOT use cleaning solvent to clean the tie rod assembly as it will destroy any rubber components of the assembly.

Clean the tie rod assembly with warm soapy water. Rinse with clear warm water, and air dry completely.

INSPECT

Inspect the tie rod assembly for damage (i.e. damaged threads, bent rod etc.). If found to be damaged, replace the tie rod assembly.

INSTALL E2.2-E3.5XN (E45-70XN) (A268) AND E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

1. Install the tie rod assembly into the spindle assembly. See Figure 36.

NOTE: Perform Step 2 and Step 3 for lift trucks E2.2-E3.5XN (E45-70XN) (A268) .

2. Install the castle nut onto the tie rod assembly. Tighten to 163 N•m (120 lbf ft). See Figure 36.

3. Install new cotter pin in the castle nut. If the cotter pin cannot be installed, tighten the castle nut to the next position that will allow the cotter pin to be installed. Bend one end of the cotter pin around the castle nut to the left and the other to the right. See Figure 36.

NOTE: Perform Step 4 and Step 5 for lift trucks E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099) .

4. Install the castle nut onto the tie rod assembly. Tighten castle nut to 163 to 200 N•m (120 to 148 lbf ft) and advance the castle nut to the next slot in the nut to install cotter pin.

5. Install new cotter pin in castle nut. Bend one end of the cotter pin around castle nut to the left and the other to the right.

6. Place the tie rod end into the steering cylinder rod end.

7. Install the pin that connects the tie rod end to the steering cylinder rod, and install the snap ring on the pin.

8. Slide the boot over the tie rod end and steering cylinder rod. Tighten the clamps on both ends of the boot.

9. Install the bearings and wheel. See Steering Axle Assembly Repair.

10. If the tie rod was removed from the other side, repeat Step 1 through Step 9.

11. Remove the lift truck from blocks.

REMOVE E1.6-2.0XN (E30-40XN) (A269)

WARNING

PUTTING THE LIFT TRUCK ON BLOCKS

The lift truck must be put on blocks for some types of maintenance and repair. The removal of the mast, drive axle, battery, or counterweight assemblies will cause large changes in the center of gravity. When the lift truck is put on blocks, put additional blocks in the following positions:

- **If the mast and drive axle are removed, put blocks under the counterweight so the lift truck cannot fall backward.**
- **If the counterweight is removed, put blocks under the mast so that the lift truck cannot fall forward.**

Put the lift truck on blocks on a solid, even, and level surface. Verify the blocks or stands have enough capacity to hold the lift truck. Use additional blocks next to the tires as necessary to prevent movement of the lift truck. Verify the lifting devices used during repairs can lift the weight of the parts and assemblies.

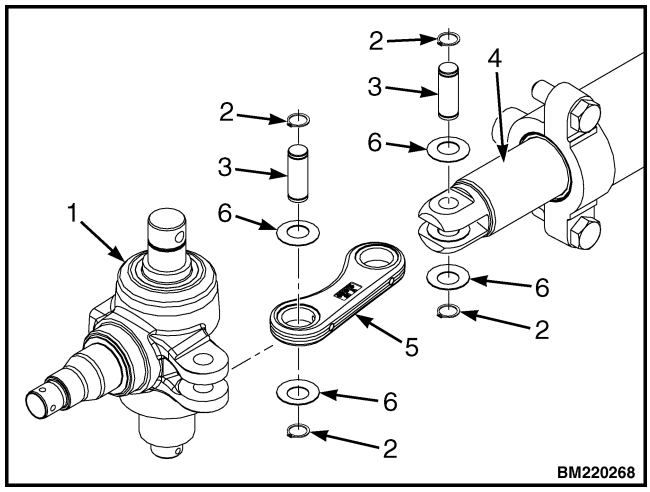
See the Operating Manual or Periodic Maintenance section for your lift truck model, for the procedures to put the lift truck on blocks.

1. Place the lift trucks on blocks. The procedure for placing the lift truck on blocks may be found in the **Operating Manual** or **Periodic Maintenance Manual** for your lift truck.

2. Remove the wheel and bearings. See Steering Axle Assembly Repair

NOTE: It may be necessary to use a brass drift pin to remove the pin connecting the tie rod end to the steering cylinder rod.

3. Remove two snap rings and pin connecting tie rod end to steering cylinder rod. See Figure 37.



1. SPINDLE ASSEMBLY
2. SNAP RING
3. PIN
4. STEERING CYLINDER ROD
5. TIE ROD
6. BELLEVILLE WASHER

Figure 37. Tie Rod Removal for Lift Truck Model E1.6-2.0XN (E30-40XN) (A269)

NOTE: It may be necessary to use a brass drift pin to remove the pin connecting tie rod end to spindle assembly.

4. Remove two snap rings and pin connecting tie rod end to spindle assembly. See Figure 37.

5. Remove tie rod and four belleville washers from spindle and steering cylinder rod. See Figure 37.

6. If necessary to replace both tie rods, perform Step 1 through Step 5 for the other side of the steering axle.

CLEAN

CAUTION

DO NOT use cleaning solvent to clean the tie rod assembly as it will destroy any rubber components of the assembly.

Clean the tie rod assembly with warm soapy water. Rinse with clear warm water, and air dry completely.

INSPECT

Inspect the tie rod assembly for damage (i.e. damaged threads, bent rod etc.). If found to be damaged, replace the tie rod assembly.

INSTALL E1.6-2.0XN (E30-40XN) (A269)

1. Install four belleville washers and tie rod on spindle assembly and steering cylinder rod. Figure 37.

2. Install pin and two snap rings connecting tie rod to spindle assembly. See Figure 37.

3. Install pin and two snap rings connecting tie rod to steering cylinder rod. See Figure 37.

4. Install bearings and wheel. See Steering Axle Assembly Repair.

5. If the tie rod was removed from the other side, repeat Step 1 through Step 4.

6. Remove the lift truck from blocks.

REMOVE J2.0-3.5XN (J45-70XN) (A276) AND J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

WARNING

PUTTING THE LIFT TRUCK ON BLOCKS

The lift truck must be put on blocks for some types of maintenance and repair. The removal of the mast, drive axle, battery, or counterweight assemblies will cause large changes in the center of gravity. When the lift truck is put on blocks, put additional blocks in the following positions:

- **If the mast and drive axle are removed, put blocks under the counterweight so the lift truck cannot fall backward.**
- **If the counterweight is removed, put blocks under the mast so that the lift truck cannot fall forward.**

Put the lift truck on blocks on a solid, even, and level surface. Verify the blocks or stands have enough capacity to hold the lift truck. Use additional blocks next to the tires as necessary to prevent movement of the lift truck. Verify the lifting devices used during repairs can lift the weight of the parts and assemblies.

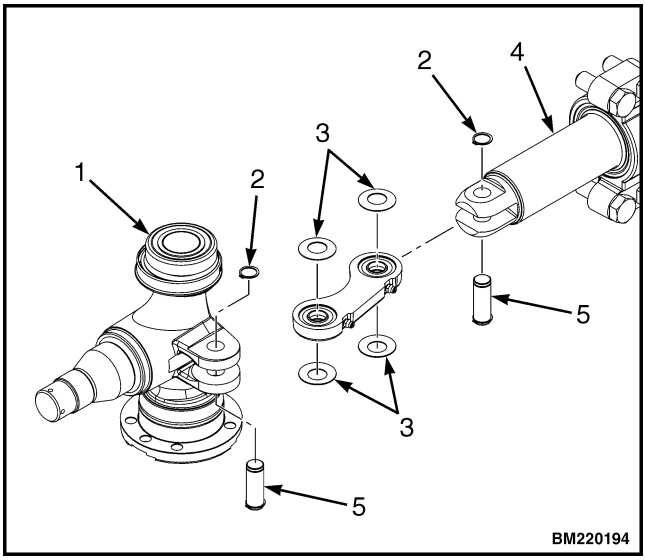
See the Operating Manual or Periodic Maintenance section for your lift truck model, for the procedures to put the lift truck on blocks.

1. Place the lift trucks on blocks. The procedure for placing the lift truck on blocks may be found in the **Operating Manual** or **Periodic Maintenance Manual** for your lift truck.

2. Remove the wheel and bearings. See Steering Axle Assembly Repair.

NOTE: It may be necessary to use a brass drift pin to remove the pin connecting the tie rod end to the steering cylinder rod and the pin connecting the tie rod end to the spindle.

3. Remove the snap ring and pin connecting the tie rod to the steering cylinder rod. See Figure 38.



NOTE: TIE ROD ASSEMBLY FOR LIFT TRUCK MODELS J2.2-3.5XN (J45-70XN) (A276) SHOWN. TIE ROD ASSEMBLY FOR LIFT TRUCK MODELS J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) IS SIMILAR.

1. SPINDLE ASSEMBLY
2. SNAP RING
3. BELLEVILLE WASHER
4. STEERING CYLINDER ROD
5. PIN

Figure 38. Tie Rod Removal for Lift Truck Models J2.2-3.5XN (J45-70XN) (A276) and J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

4. Remove the snap ring and pin connecting the tie rod to the spindle assembly. See Figure 38.

5. Remove the tie rod and belleville washers from the spindle and the steering cylinder rod.

6. Repeat Step 1 through Step 5 for the other side.

CLEAN

CAUTION

DO NOT use cleaning solvent to clean the tie rod assembly as it will destroy any rubber components of the assembly.

Clean the tie rod assembly with warm soapy water. Rinse with clear warm water, and air dry completely.

INSPECT

Inspect the tie rod assembly for damage (i.e. bent rod etc.). If found to be damaged, replace the tie rod assembly.

INSTALL J2.0-3.5XN (J45-70XN) (A276) AND J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

1. Install the tie rod and belleville washers in the spindle and the steering cylinder rod. See Figure 38.
2. Install the pin and snap ring connecting the tie rod to the spindle assembly. See Figure 38.
3. Install the pin and snap ring connecting the tie rod to the steering cylinder rod. See Figure 38.
4. Install the wheel and bearings. See Steering Axle Assembly Repair.
5. Repeat Step 1 through Step 4 for the other side.
6. Remove the lift truck from blocks.

REMOVE J1.6-2.0XN (J30-40XN) (A935)

WARNING

PUTTING THE LIFT TRUCK ON BLOCKS

The lift truck must be put on blocks for some types of maintenance and repair. The removal of the mast, drive axle, battery, or counterweight assemblies will cause large changes in the center of gravity. When the lift truck is put on blocks, put additional blocks in the following positions:

- **If the mast and drive axle are removed, put blocks under the counterweight so the lift truck cannot fall backward.**
- **If the counterweight is removed, put blocks under the mast so that the lift truck cannot fall forward.**

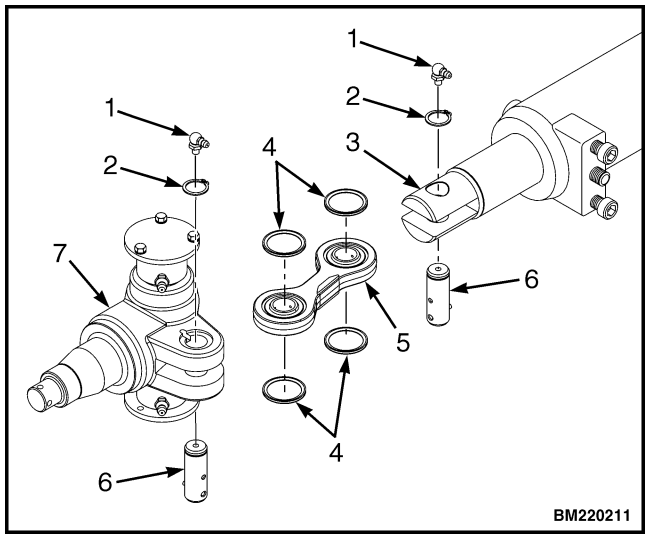
Put the lift truck on blocks on a solid, even, and level surface. Verify the blocks or stands have enough capacity to hold the lift truck. Use additional blocks next to the tires as necessary to prevent movement of the lift truck. Verify the lifting devices used during repairs can lift the weight of the parts and assemblies.

See the Operating Manual or Periodic Maintenance section for your lift truck model, for the procedures to put the lift truck on blocks.

1. Place the lift trucks on blocks. The procedure for placing the lift truck on blocks may be found in the **Operating Manual** or **Periodic Maintenance Manual** for your lift truck.
2. Remove the wheel and bearings. See Steering Axle Assembly Repair.

NOTE: It may be necessary to use a brass drift pin to remove the pin connecting the tie rod end to the steering cylinder rod and the pin connecting the tie rod end to the spindle.

3. Remove the snap ring and pin connecting the tie rod to the steering cylinder rod. See Figure 39.



1. LUBRICATION FITTING
2. SNAP RING SPINDLE ASSEMBLY
3. STEERING CYLINDER ROD
4. BELLEVILLE WASHER
5. TIE ROD
6. PIN
7. SPINDLE

Figure 39. Tie Rod Removal for Lift Truck Model J1.6-2.0XN (J30-40XN) (A935)

4. Remove the snap ring and pin connecting the tie rod to the spindle assembly. See Figure 39.
5. Remove the tie rod and belleville washers from the spindle and the steering cylinder rod.

6. Repeat Step 1 through Step 5 for the other side.

CLEAN

CAUTION

DO NOT use cleaning solvent to clean the tie rod assembly as it will destroy any rubber components of the assembly.

Clean the tie rod assembly with warm soapy water. Rinse with clear warm water, and air dry completely.

INSPECT

Inspect the tie rod assembly for damage (i.e. bent rod etc.). If found to be damaged, replace the tie rod assembly.

INSTALL J1.6-2.0XN (J30-40XN) (A935)

1. Install the tie rod and belleville washers in the spindle and the steering cylinder rod. See Figure 39.
2. Install the pin and snap ring connecting the tie rod to the spindle assembly. See Figure 39.
3. Install the pin and snap ring connecting the tie rod to the steering cylinder rod. See Figure 39.
4. Install the wheel and bearings. See Steering Axle Assembly Repair.
5. Repeat Step 1 through Step 4 for the other side.
6. Remove the lift truck from blocks.

Spindle Repair

REMOVE E2.2-3.5XN (E45-70XN) (A268) AND E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

WARNING

PUTTING THE LIFT TRUCK ON BLOCKS

The lift truck must be put on blocks for some types of maintenance and repair. The removal of the mast, drive axle, battery, or counterweight assemblies will cause large changes in the center of gravity. When the lift truck is put on blocks, put additional blocks in the following positions:

- **If the mast and drive axle are removed, put blocks under the counterweight so the lift truck cannot fall backward.**
- **If the counterweight is removed, put blocks under the mast so that the lift truck cannot fall forward.**

Put the lift truck on blocks on a solid, even, and level surface. Verify the blocks or stands have enough capacity to hold the lift truck. Use additional blocks next to the tires as necessary to prevent movement of the lift truck. Verify the lifting devices used during repairs can lift the weight of the parts and assemblies.

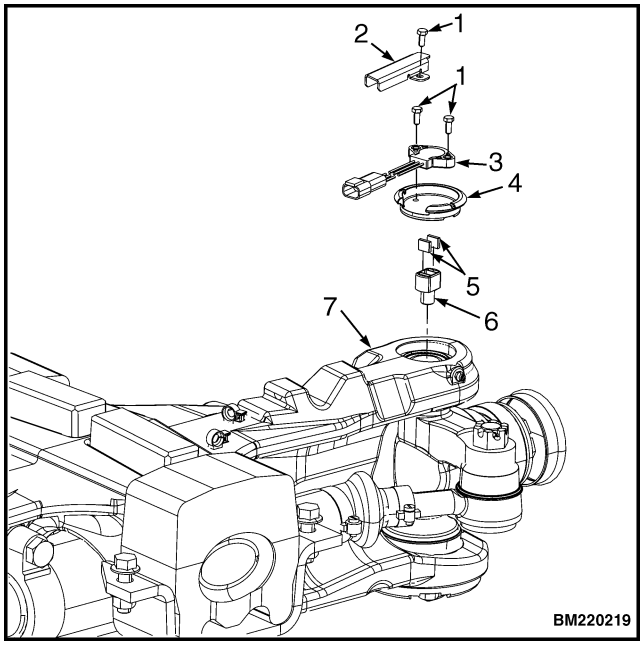
See the Operating Manual or Periodic Maintenance section for your lift truck model, for the procedures to put the lift truck on blocks.

1. Put the lift truck on blocks.
2. Remove the wheel and bearings. See Steering Axle Assembly Repair.
3. Disconnect the tie rod from the spindle assembly. See Tie Rod Replacement.

NOTE: Step 4 through Step 8 are to be performed if the spindle assembly on the right side is being repaired and the optional steering direction sensor is installed.

NOTE: If the optional steering direction sensor is not installed, go to Step 9.

4. Remove the capscrew and cover from the steer axle. See Figure 40.



1. CAPSCREW
2. COVER
3. STEERING DIRECTION SENSOR
4. GREASE CAP
5. MAGNET
6. MAGNET CARRIER
7. STEER AXLE

Figure 40. Steering Direction Sensor for Lift Truck Model E2.2-3.5XN (E40-70XN) (A268) and E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

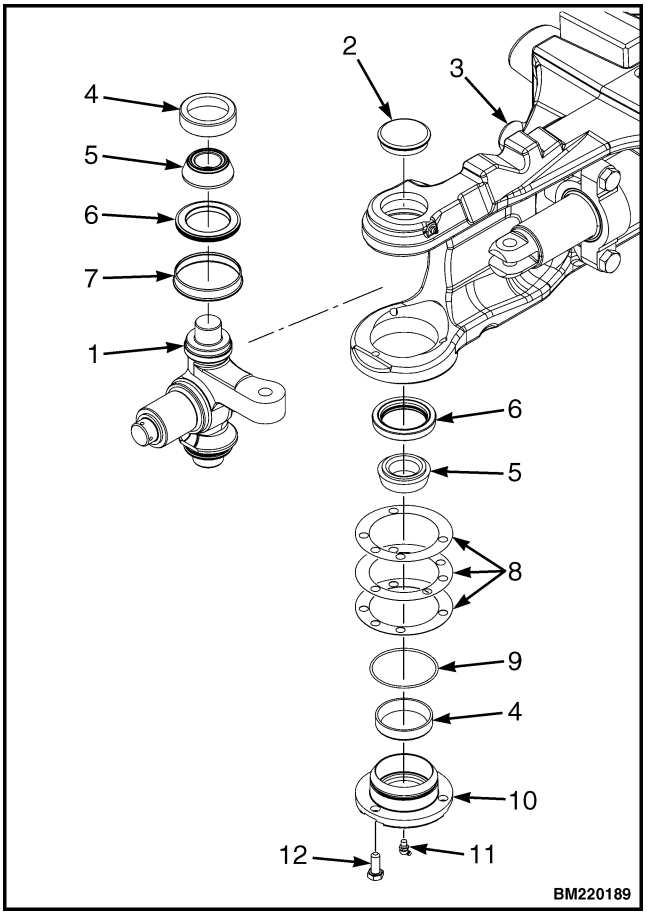
5. Disconnect the steering direction sensor wiring harness from the main wiring harness.

6. Remove two capscrews and steering direction sensor from the grease cap.

7. Remove the grease cap from the steer axle.

8. Remove the two magnets and magnet carrier from the steering axle.

9. Remove grease cap from top of steering axle. See Figure 41.



1. SPINDLE LH
2. GREASE CAP
3. STEERING AXLE
4. BEARING CUP
5. BEARING CONE
6. SEAL
7. WEAR RING
8. SHIMS
9. O-RING
10. BEARING CAP
11. LUBRICATION FITTING
12. CAPSCREWS

Figure 41. Spindle Repair E2.2-3.5XN (E40-70XN) (A268) and E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

NOTE: Note the thickness of the shims during removal to aid in installation.

10. Remove three capscrews, bearing cap, and shims from the bottom of the steering axle. See Figure 41.

11. Tilt the spindle and lift from the steering axle.

12. Remove the wear sleeve from the steering axle.

13. Repeat Step 2, Step 3 and Step 9 through Step 12 for the other spindle.

DISASSEMBLE E2.2-3.5XN (E45-70XN) (A268) AND E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

1. Remove and discard O-ring from the bearing cap. See Figure 41.

2. Remove bearing cone, and seal from top of the spindle. Discard seal.

3. Remove bearing cone, and seal from bottom of the spindle. Discard seal.

CLEAN

WARNING

Cleaning solvents can be flammable and toxic and can cause skin irritation. When using cleaning solvents, always follow the solvent manufacturer's recommended safety procedures.

WARNING

Compressed air is used for cleaning or drying purposes, or for clearing restrictions. Wear protective clothing (goggles/shield, gloves, etc.) to avoid injury to personnel.

1. Clean bearings by placing them in a wire basket and immersing in a container of fresh solvent. Agitate the bearings in the solvent to remove all traces of old lubricant.

2. After cleaning the bearings, dry them with clean compressed air. Take care to prevent spinning the bearings when using a compressed air jet.

3. Immediately wrap bearings in a lint-free cloth to protect them from dust and other foreign matter.

4. Clean the spindle with solvent and air dry with compressed air.

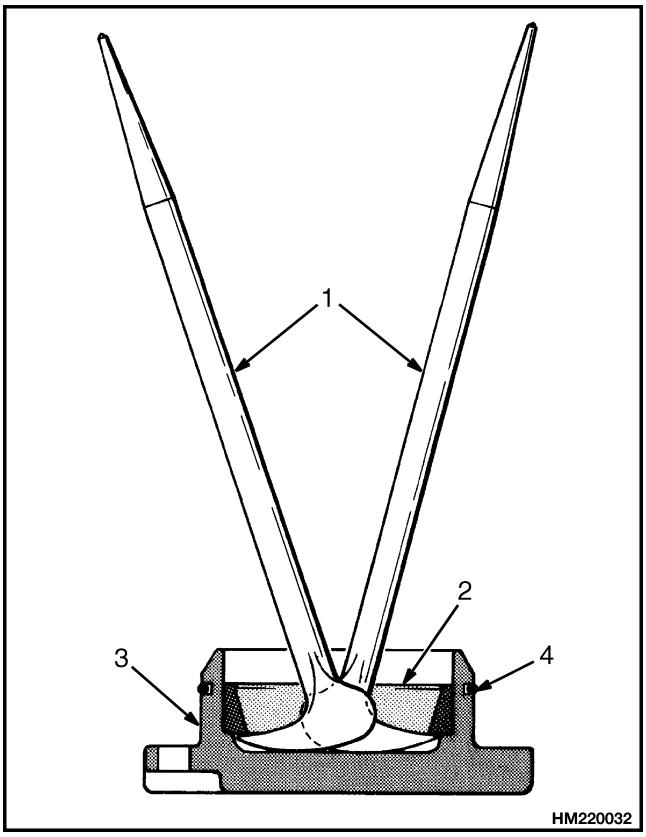
5. Clean the wear ring using warm soapy water and dry with a lint free cloth.

INSPECT

1. Inspect for loose, missing, cracked, burned or damaged hardware.

2. If upper bearing is found to be damaged, remove the bearing cup from the axle using a hammer and brass drift pin.

3. If lower bearing is found to be damaged, remove the bearing cup from the bearing cap as shown in Figure 42.



1. PRY BAR
2. BEARING CUP
3. BEARING CAP
4. O-RING

Figure 42. Bearing Removal

4. Inspect all parts for dents, holes, bends, burrs, rust, corrosion, or marred finish.

5. Replace any damaged parts.

ASSEMBLE E2.2-3.5XN (E45-70XN) (A268) AND E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

1. If upper bearing cup was removed, using a press install new bearing cup into the axle.

2. If lower bearing was removed, using a press install new bearing cup in the bearing cap.

NOTE: Coat all seals and O-rings with multipurpose grease prior to installation.

3. Install new seals on the top and bottom of spindle.

4. Pack each bearing cone with multipurpose grease, and install the bearing cones on top and bottom of spindle.

INSTALL E2.2-3.5XN (E45-70XN) (A268) AND E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

1. Install wear sleeve into steering axle. See Figure 41.

2. Tilt the spindle and install the spindle in the steering axle.

3. Install the bearing cap without the shims. See Figure 41. Install capscrews and tighten to 22 to 27.5 N•m (16 to 20 lbf ft). Measure the clearance between the bearing cap and the axle. Remove the bearing cap and install enough shims to give a preload of 0.00 to 0.13 mm (0.000 to 0.005 in.).

NOTE: Perform Step 4 for lift truck models E2.2-3.5XN (E45-70XN) (A268) .

4. Install bearing cap and capscrews. Tighten the capscrews to 44 to 55 N•m (32 to 41 lbf ft).

NOTE: Perform Step 5 for lift truck models E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099) .

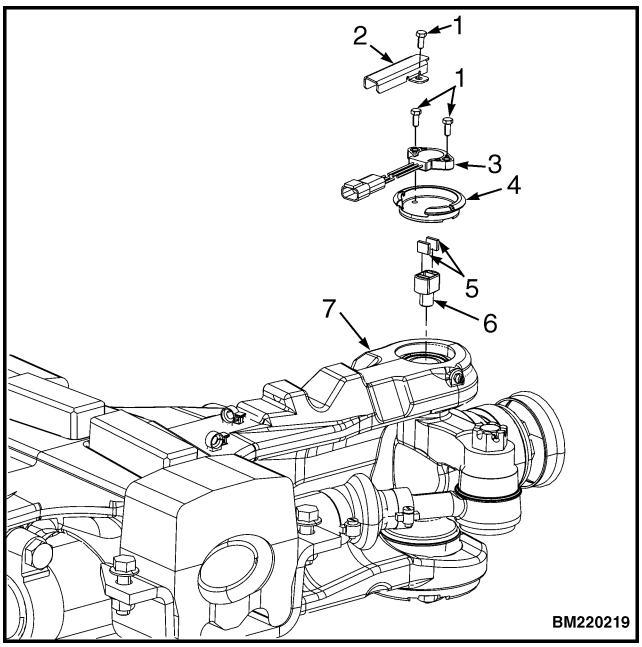
5. Coat capscrew threads with Loctite® 242 or equivalent. Install bearing cap and capscrews. Tighten capscrews to 52 N•m (38 lbf ft).

NOTE: If the optional steering direction sensor is not installed, perform Step 6, and Step 12 through Step 15.

NOTE: Step 7 through Step 15 are to be performed if the spindle assembly on the left side is being repaired and the optional steering direction sensor is installed.

6. Install grease cap on the top of the steering axle. See Figure 41.

7. Install magnet carrier and two magnets into the steering axle. See Figure 43.



1. CAPSCREW
2. COVER
3. STEERING DIRECTION SENSOR
4. GREASE CAP
5. MAGNET
6. MAGNET CARRIER
7. STEER AXLE

Figure 43. Steering Direction Sensor for Lift Truck Model E2.2-3.5XN (E45-70XN) (A268)

8. Install grease cap in the steer axle with the notch toward the grease fitting ±5°.

9. Using two capscrews, install steering direction sensor on grease cap.

10. Connect steering direction sensor wiring harness to main wiring harness.

11. Install cover and capscrew on steer axle.

12. Connect the tie rod to the spindle assembly. See Tie Rod Replacement.

13. Install bearings and wheel. See Steering Axle Assembly Repair.

14. If required, repeat the procedure for the other spindle.

15. Remove the lift truck from the blocks.

REMOVE E1.6-2.0XN (E30-40XN) (A269)

WARNING

PUTTING THE LIFT TRUCK ON BLOCKS

The lift truck must be put on blocks for some types of maintenance and repair. The removal of the mast, drive axle, battery, or counterweight assemblies will cause large changes in the center of gravity. When the lift truck is put on blocks, put additional blocks in the following positions:

- **If the mast and drive axle are removed, put blocks under the counterweight so the lift truck cannot fall backward.**
- **If the counterweight is removed, put blocks under the mast so that the lift truck cannot fall forward.**

Put the lift truck on blocks on a solid, even, and level surface. Verify the blocks or stands have enough capacity to hold the lift truck. Use additional blocks next to the tires as necessary to prevent movement of the lift truck. Verify the lifting devices used during repairs can lift the weight of the parts and assemblies.

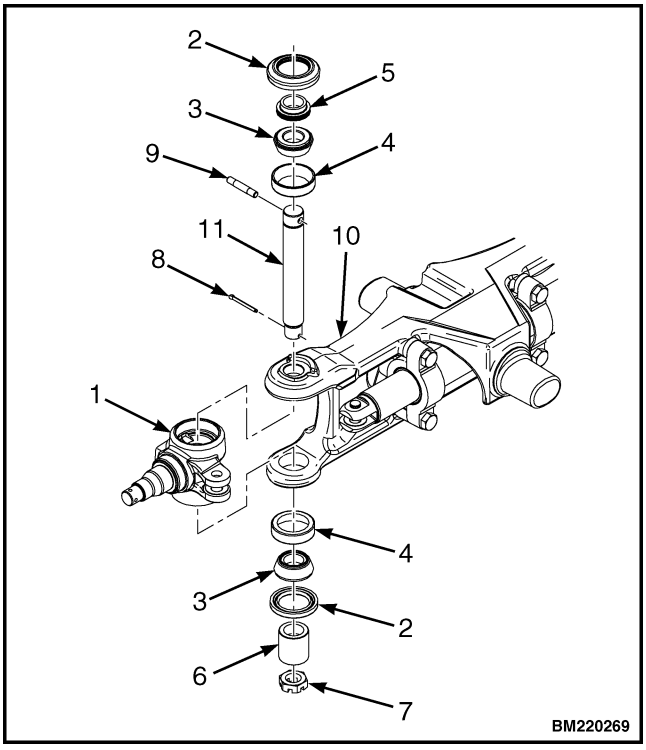
See the Operating Manual or Periodic Maintenance section for your lift truck model, for the procedures to put the lift truck on blocks.

1. Put the lift truck on blocks.

2. Remove the wheel and bearings. See Steering Axle Assembly Repair.

3. Disconnect the tie rod from the spindle assembly. See Tie Rod Replacement.

4. Remove cotter pin, slotted nut, and sleeve from spindle. Figure 44.



1. SPINDLE ASSEMBLY
2. SEAL
3. BEARING CONE
4. BEARING CUP
5. SPACER
6. SLEEVE
7. SLOTTED NUT
8. COTTER PIN
9. PIN
10. STEERING AXLE
11. KINGPIN

Figure 44. Spindle Repair E1.6-2.0XN (E30-40XN) (A269)

5. Remove pin from kingpin. See Figure 44.

6. Tilt the spindle assembly and lift from the steering axle. See Figure 44.

7. Repeat Step 2 through Step 6 for the other spindle.

DISASSEMBLE E1.6-2.0XN (E30-40XN) (A269)

1. Remove and discard seal from bottom of spindle. See Figure 44.

2. Remove and discard seal from top of spindle. See Figure 44.

3. Remove spacer from top of spindle. See Figure 44.

4. Remove upper and lower bearing cones from spindle. See Figure 44.

5. Remove kingpin from spindle. See Figure 44.

CLEAN

WARNING

Cleaning solvents can be flammable and toxic and can cause skin irritation. When using cleaning solvents, always follow the solvent manufacturer's recommended safety procedures.

WARNING

Compressed air is used for cleaning or drying purposes, or for clearing restrictions. Wear protective clothing (goggles/shield, gloves, etc.) to avoid injury to personnel.

1. Clean bearings by placing them in a wire basket and immersing in a container of fresh solvent. Agitate the bearings in the solvent to remove all traces of old lubricant.

2. After cleaning the bearings, dry them with clean compressed air. Take care to prevent spinning the bearings when using a compressed air jet.

3. Immediately wrap bearings in a lint-free cloth to protect them from dust and other foreign matter.

4. Clean the spindle with solvent and air dry with compressed air.

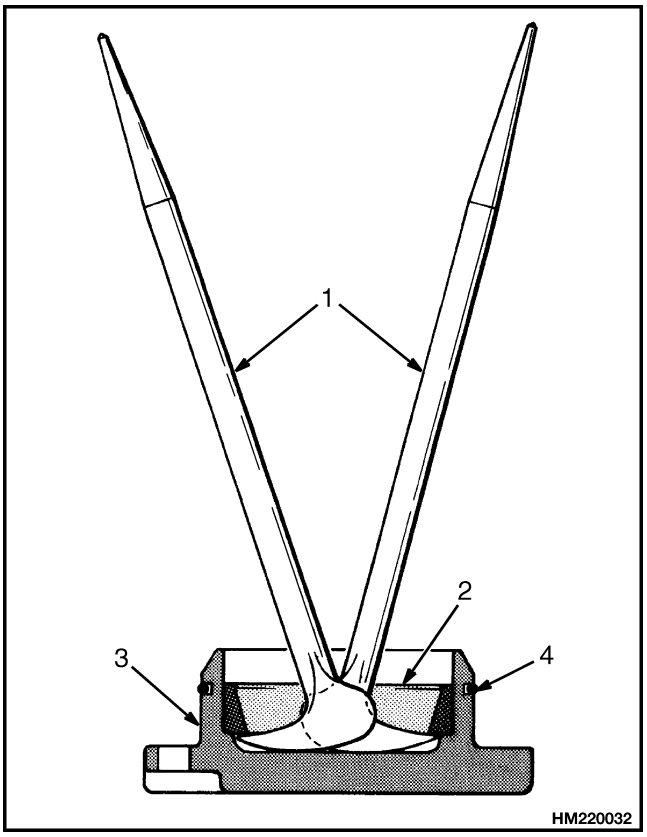
5. Clean the wear ring using warm soapy water and dry with a lint free cloth.

INSPECT

1. Inspect for loose, missing, cracked, burned or damaged hardware.

2. If upper bearing is found to be damaged, remove the bearing cup from the axle using a hammer and brass drift pin.

3. If lower bearing is found to be damaged, remove the bearing cup from the bearing cap as shown in Figure 45.



1. PRY BAR
2. BEARING CUP
3. BEARING CAP
4. O-RING

Figure 45. Bearing Removal

4. Inspect all parts for dents, holes, bends, burrs, rust, corrosion, or marred finish.

5. Replace any damaged parts.

ASSEMBLE E1.6-2.0XN (E30-40XN) (A269)

1. If upper bearing cup was removed, using a press install the new bearing cup in spindle.

2. If lower bearing cup was removed, using a press install new bearing cup in spindle.

3. Install kingpin in spindle. See Figure 44.

4. Install upper and lower bearing cones on spindle. See Figure 44.

5. Install spacer on spindle. See Figure 44.

NOTE: Coat all seals and O-rings with multipurpose grease prior to installation.

6. Install new seals on the top and bottom of the spindle. See Figure 44.

7. If necessary, repeat Step 1 through Step 6 for opposite side.

INSTALL E1.6-2.0XN (E30-40XN) (A269)

1. Tilt the spindle assembly and install the spindle in the steering axle.

2. Install pin on kingpin. See Figure 44.

3. Install sleeve, slotted nut, and cotter pin on spindle. See Figure 44.

4. Connect the tie rod to the spindle assembly. See Tie Rod Replacement.

5. Install bearings and wheel. See Steering Axle Assembly Repair.

6. If required, repeat the procedure for the other spindle.

7. Remove the lift truck from the blocks.

REMOVE J2.2-3.5XN (J45-70XN) (A276) AND J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

WARNING

PUTTING THE LIFT TRUCK ON BLOCKS

The lift truck must be put on blocks for some types of maintenance and repair. The removal of the mast, drive axle, battery, or counterweight assemblies will cause large changes in the center of gravity. When the lift truck is put on blocks, put additional blocks in the following positions:

- **If the mast and drive axle are removed, put blocks under the counterweight so the lift truck cannot fall backward.**
- **If the counterweight is removed, put blocks under the mast so that the lift truck cannot fall forward.**

Put the lift truck on blocks on a solid, even, and level surface. Verify the blocks or stands have enough capacity to hold the lift truck. Use additional blocks next to the tires as necessary to prevent movement of the lift truck. Verify the lifting devices used during repairs can lift the weight of the parts and assemblies.

See the Operating Manual or Periodic Maintenance section for your lift truck model, for the procedures to put the lift truck on blocks.

1. Put the lift truck on blocks.

2. Remove the wheel and bearings. See Steering Axle Assembly Repair.

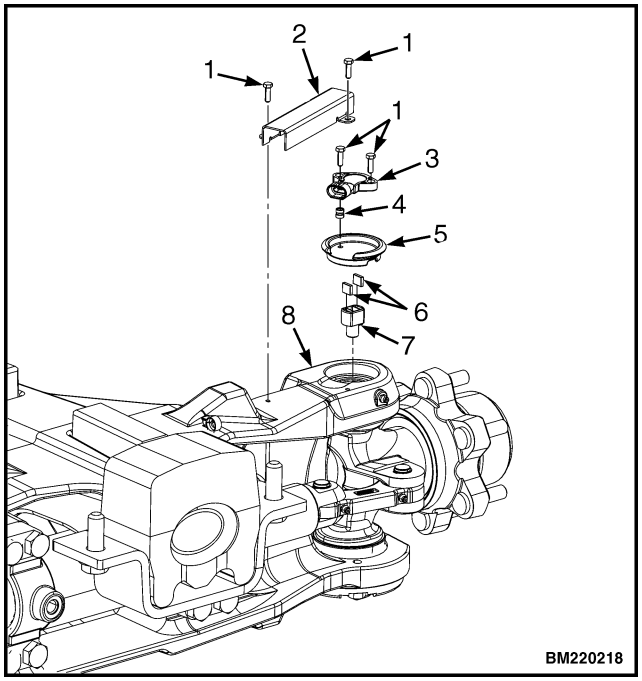
3. Disconnect the tie rod from the spindle assembly. See Tie Rod Replacement.

NOTE: Step 4 through Step 9 are to be performed if the kingpin assembly on the left side is being repaired.

4. Remove capscrew and cover from the steer axle.

5. Disconnect the wiring harness from the steering direction sensor.

6. Remove two capscrews and steering direction sensor from the steer axle. See Figure 46.



NOTE: STEERING DIRECTION SENSOR FOR LIFT TRUCK MODELS J2.2-3.5XN (J45-70XN) (A276) SHOWN. STEERING DIRECTION SENSOR FOR LIFT TRUCK MODELS J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) IS SIMILAR.

1. CAPSCREW
2. COVER
3. STEERING DIRECTION SENSOR
4. INSERT
5. GREASE CAP
6. MAGNET
7. MAGNET CARRIER
8. STEER AXLE

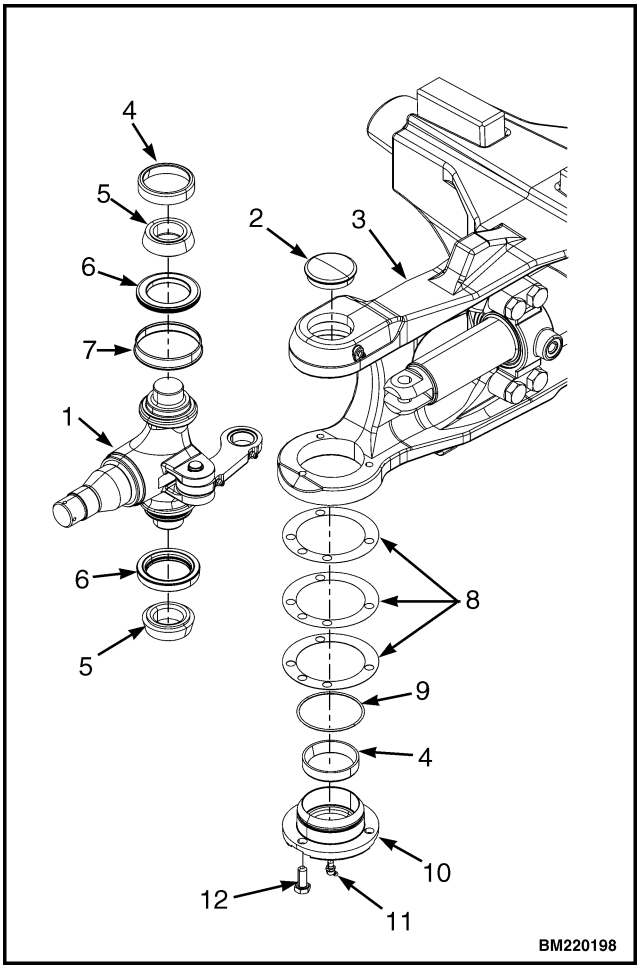
Figure 46. Steering Direction Sensor for Lift Truck Models J2.2-3.5XN (J45-70XN) (A276) and J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

7. Remove the insert from the steering direction sensor.

8. Remove the grease cap from the steer axle.

9. Remove the magnets and magnet carrier from the steer axle.

10. Remove grease cap from top of steer axle above spindle. See Figure 47.



NOTE: SPINDLE ASSEMBLY FOR LIFT TRUCK MODELS J2.2-3.5XN (J45-70XN) (A276) SHOWN. SPINDLE ASSEMBLY FOR LIFT TRUCK MODELS J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) IS SIMILAR.

1. SPINDLE LH
2. GREASE CAP
3. STEERING AXLE
4. BEARING CUP
5. BEARING CONE
6. SEAL
7. WEAR RING
8. SHIMS
9. O-RING
10. BEARING CAP
11. LUBRICATION FITTING
12. CAPSCREWS

Figure 47. Spindle Repair for Lift Truck Models J2.2-3.5XN (J45-70XN) (A276) and J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

NOTE: Note the thickness of the shims during removal to aid in installation.

11. Remove three capscrews, bearing cap, and shims from the bottom of the steering axle. See Figure 47.

12. Tilt the spindle and lift from the steering axle.

13. Remove the wear sleeve from the steering axle.

14. Repeat Step 2 through Step 13 for the other spindle.

DISASSEMBLE J2.2-3.5XN (J45-70XN) (A276) AND J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

1. Remove and discard the O-ring from the bearing cap. See Figure 47.

2. Remove bearing cone and seal from the top of the spindle. Discard seal.

3. Remove bearing cone and seal from the bottom of the spindle. Discard seal.

CLEAN

WARNING

Cleaning solvents can be flammable and toxic and can cause skin irritation. When using cleaning solvents, always follow the solvent manufacturer's recommended safety procedures.

WARNING

Compressed air is used for cleaning or drying purposes, or for clearing restrictions. Wear protective clothing (goggles/shield, gloves, etc.) to avoid injury to personnel.

1. Clean bearings by placing them in a wire basket and immersing in a container of fresh solvent. Agitate the bearings in the solvent to remove all traces of old lubricant.

2. After cleaning the bearings, dry them with clean compressed air. Take care to prevent spinning the bearings when using a compressed air jet.

3. Immediately wrap bearings in a lint-free cloth to protect them from dust and other foreign matter.

4. Clean the spindle with solvent and air dry with compressed air

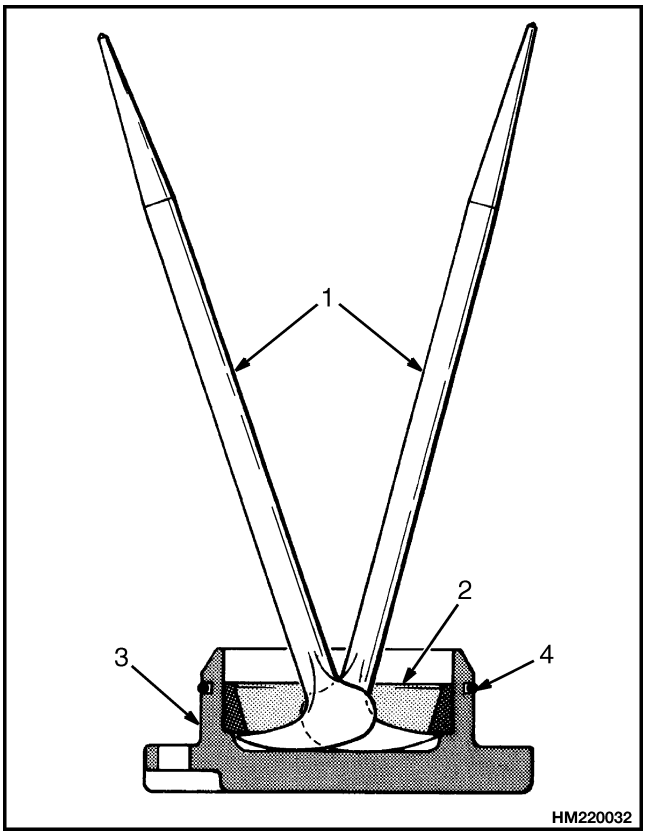
5. Clean the wear ring using warm soapy water and dry with a lint free cloth.

INSPECT

1. Inspect for loose, missing, cracked, burned or damaged hardware.

2. If upper bearing is found to be damaged, remove the bearing cup from the axle using a hammer and brass drift pin.

3. If lower bearing is found to be damaged, remove the bearing cup from the bearing cap as shown in Figure 48.



1. PRY BAR
2. BEARING CUP
3. BEARING CAP
4. O-RING

Figure 48. Bearing Removal

4. Inspect all parts for dents, holes, bends, burrs, rust, corrosion, or marred finish.

5. Replace any damaged parts.

ASSEMBLE J2.2-3.5XN (J45-70XN) (A276)

NOTE: Pack bearing cone with multipurpose grease prior to installing.

1. If upper bearing cup was removed, using a press install new bearing cup into the axle.

NOTE: Coat all seals and O-rings with multipurpose grease prior to installation.

2. Install new seal on top of spindle.

NOTE: Pack bearing cone with multipurpose grease prior to installing.

3. If lower bearing cup was removed, using a press install new bearing cone and bearing cup on the spindle.

INSTALL J2.2-3.5XN (J45-70XN) (A276)

1. Install wear sleeve into steering axle. See Figure 47.

2. Tilt spindle and install spindle in the steering axle.

3. Apply multipurpose grease to bearing's rollers and cup.

4. Install bearing cap into steering axle without shims. Install and tighten capscrews to 5 to 8 N•m (3.7 to 5.9 lbf ft).

5. Strike bearing cap with rubber mallet to ensure bearing races are seated.Re-tighten capscrews to 5 to 8 N•m (3.7 to 5.9 lbf ft).

6. Measure clearance between bearing cap and axle. Prepare shims to match lowest clearance gap (±0.07 mm (0.003 in.)).

7. Loosen capscrews completely and install shims. Re-install and tighten capscrews to 44 to 55 N•m (32 to 41 lbf ft).

NOTE: If performing install procedures on the right side of steer axle, go to Step 11; otherwise perform Step 10 and then go to Step 17.

8. Install grease cap on the top of the steering axle. See Figure 47.

9. Install magnet carrier and magnets into the steer axle. See Figure 46.

10. Install grease cap into steer axle with the notch toward grease fitting within ±5°.

11. Install insert into steering direction sensor.

12. Install steering direction sensor and two capscrews into steer axle.

13. Connect wiring harness to steering direction sensor.

14. Install cover and capscrew on steer axle

15. Connect tie rod to spindle assembly. See Tie Rod Replacement.

16. Install bearings and wheel. See Steering Axle Assembly Repair.

17. If required, repeat procedure for the other spindle.

18. Remove lift truck from the blocks.

ASSEMBLE J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

1. If upper bearing cup was removed, using a press install new bearing cup into the axle.

2. If lower bearing cup was removed, using a press install new bearing cup in the bearing cap.

NOTE: Coat all seals and O-rings with multipurpose grease prior to installation.

3. Install new seals on top and bottom of spindle.

4. Pack each bearing cone with multipurpose grease, and install bearing cones on top and bottom of spindle.

INSTALL J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

1. Install wear sleeve into steering axle. See Figure 47.

2. Tilt spindle and install spindle in the steering axle.

3. Install the bearing cap without shims. See Figure 47. Install capscrews and tighten 22 to 27.5 N•m (16 to 20 lbf ft). Measure clearance between bearing cap and axle. Remove bearing cap and install enough shims to give a preload of 0.00 to 0.13 mm (0.000 to 0.005 in.).

4. Install bearing cap and capscrews. Tighten capscrews 44 to 55 N•m (32 to 41 lbf ft).

NOTE: If performing install procedures on the right side of steer axle, go to ; otherwise perform Step 5 and then go to Step 12.

5. Install grease cap on the top of the steering axle. See Figure 47.

6. Install magnet carrier and magnets into the steer axle. See Figure 46.

7. Install grease cap into steer axle with the notch toward grease fitting within ±5°.

8. Install insert into steering direction sensor.

9. Install steering direction sensor and two capscrews into steer axle.

10. Connect wiring harness to steering direction sensor.

11. Install cover and capscrew on steer axle

12. Connect tie rod to spindle assembly. See Tie Rod Replacement.

13. Install bearings and wheel. See Steering Axle Assembly Repair.

14. If required, repeat procedure for the other spindle.

15. Remove lift truck from the blocks.

REMOVE J1.6-2.0XN (J30-40XN) (A935)

WARNING

PUTTING THE LIFT TRUCK ON BLOCKS

The lift truck must be put on blocks for some types of maintenance and repair. The removal of the mast, drive axle, battery, or counterweight assemblies will cause large changes in the center of gravity. When the lift truck is put on blocks, put additional blocks in the following positions:

- **If the mast and drive axle are removed, put blocks under the counterweight so the lift truck cannot fall backward.**
- **If the counterweight is removed, put blocks under the mast so that the lift truck cannot fall forward.**

Put the lift truck on blocks on a solid, even, and level surface. Verify the blocks or stands have enough capacity to hold the lift truck. Use additional blocks next to the tires as necessary to prevent movement of the lift truck. Verify the lifting devices used during repairs can lift the weight of the parts and assemblies.

See the Operating Manual or Periodic Maintenance section for your lift truck model, for the procedures to put the lift truck on blocks.

1. Put the lift truck on blocks.

2. Remove the wheel and bearings. See Steering Axle Assembly Repair.

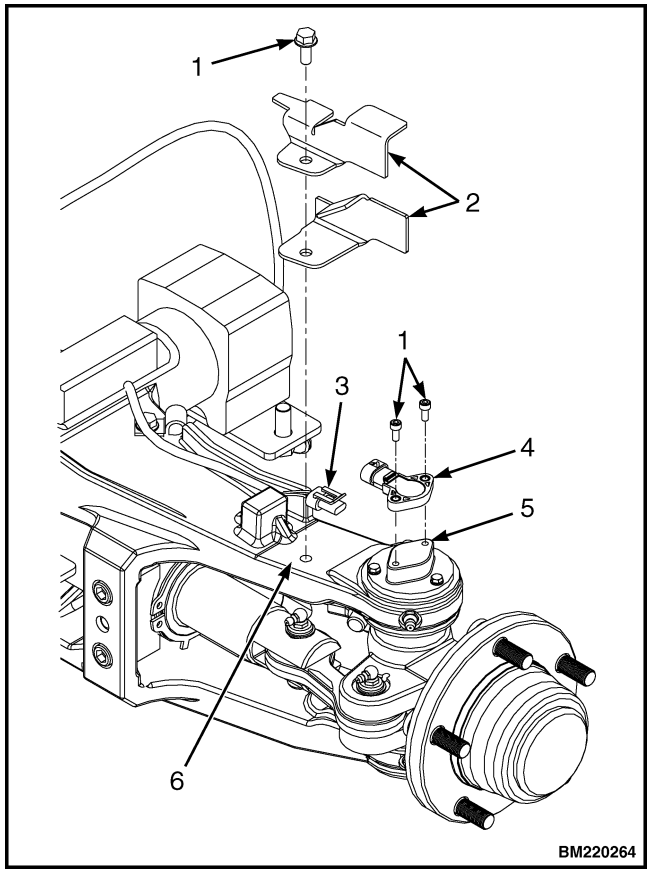
3. Disconnect the tie rod from the spindle. See Tie Rod Replacement.

NOTE: Step 4 and Step 6 are to be performed if the kingpin assembly on the right side is being repaired.

4. Remove capscrew and two plates from steering axle. See Figure 49.

5. Disconnect steering axle wiring harness from the steering direction sensor. See Figure 49.

6. Remove two capscrews and steering direction sensor from kingpin cover. See Figure 49.



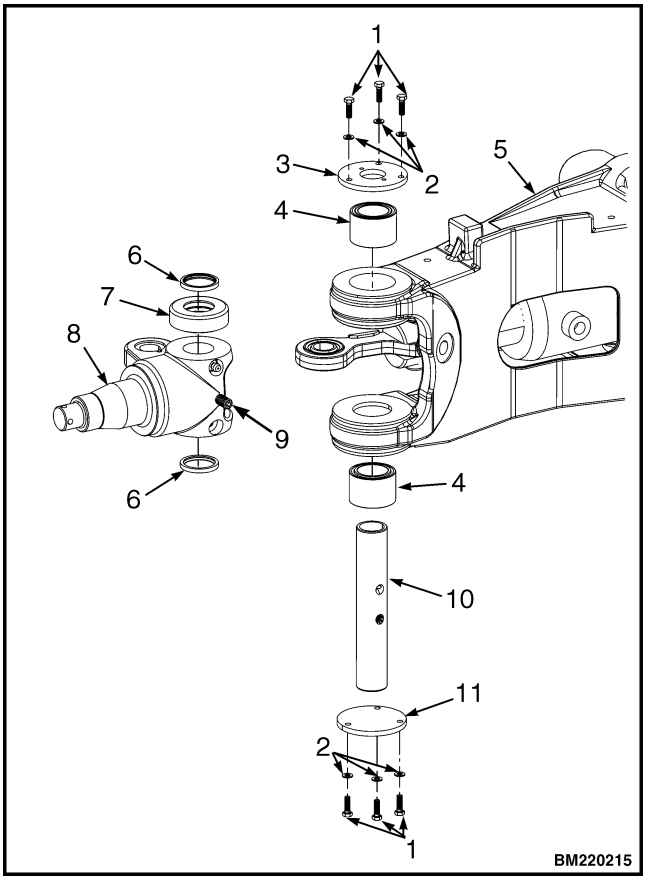
NOTE: RIGHT HAND SPINDLE SHOWN.

1. CAPSCREW
2. PLATE
3. STEERING AXLE WIRING HARNESS
4. STEERING DIRECTION SENSOR
5. KIN PIN COVER
6. STEERING AXLE

Figure 49. Steering Direction Sensor for Lift Truck Model J1.6-2.0XN (J30-40XN) (A935)

DISASSEMBLE J1.6-2.0XN (J30-40XN) (A935)

1. Remove three capscrews, three washers and the upper kingpin cover from the steering axle. See Figure 50.



1. CAPSCREW
2. WASHER
3. UPPER KINGPIN COVER
4. NEEDLE BEARING
5. STEERING AXLE
6. KINGPIN SEAL
7. THRUST BEARING
8. SPINDLE
9. GRUB SCREW.
10. KINGPIN
11. LOWER KINGPIN COVER

Figure 50. Spindle Repair J1.6-2.0XN (J30-40XN) (A935)

2. Remove three capscrews, washers, and the lower kingpin cover from the steering axle.

3. Remove the grub screw and kingpin from the spindle.

4. Remove the thrust bearing from between the steering axle and spindle.

5. Remove the spindle from the steering axle.

6. Remove the needle bearings from the steering axle.

7. Remove and discard the kingpin seals from the steering axle.

CLEAN

WARNING

Cleaning solvents can be flammable and toxic and can cause skin irritation. When using cleaning solvents, always follow the solvent manufacturer's recommended safety procedures.

WARNING

Compressed air is used for cleaning or drying purposes, or for clearing restrictions. Wear protective clothing (goggles/shield, gloves, etc.) to avoid injury to personnel.

1. Clean bearings by placing them in a wire basket and immersing in a container of fresh solvent. Agitate the bearings in the solvent to remove all traces of old lubricant.

2. After cleaning the bearings, dry them with clean compressed air.

3. Immediately wrap bearings in a lint-free cloth to protect them from dust and other foreign matter.

4. Clean the spindle and kingpin with solvent and air dry with compressed air.

INSPECT

1. Inspect bearings for any damage. (i.e. burned or corroded bearings). If any damage is found, replace the bearings.

2. Inspect the kingpin for straightness by placing a ruler or other known true straight edge along the length of the kingpin. Replace the kingpin if found to be bent.

3. Inspect all other parts for, burrs, rust, corrosion, or marred finish.

4. Replace any damaged parts.

5. If removed, inspect the steering direction sensor and its attaching parts for damage. If damaged, replace either the steering direction sensor or the damaged parts.

ASSEMBLE J1.6-2.0XN (J30-40XN) (A935)

NOTE: Coat kingpin seals with multipurpose grease prior to installation.

1. Install new kingpin seals into steering axle. See Figure 50

2. Coat needle bearings with multipurpose grease and install needle bearings into steering axle.

3. Install the spindle into steering axle.

4. Fill thrust bearing with multipurpose grease, and install thrust bearing between the steering axle and spindle.

NOTE: There is an indentation in the kingpin for the installation of the grub screw. While performing Step 5, ensure that the indentation is lined up on the grub screw hole in the spindle.

5. Coat the kingpin with multipurpose grease, and install the kingpin in the steering axle and spindle assembly.

6. Install and tighten the grub screw in the spindle. Check the kingpin to ensure there is no vertical movement.

7. Install the lower kingpin cover, three capscrews, and washers on the steering axle.

8. Install the upper kingpin cover, three capscrews, and washers on the steering axle.

INSTALL J1.6-2.0XN (J30-40XN) (A935)

NOTE: Step 1 and Step 3 are to be performed if the kingpin assembly on the right side is being repaired.

1. Install the steering direction sensor and two capscrews in kingpin cover. See Figure 49.

2. Connect steering axle wiring harness to steering direction sensor. See Figure 49.

3. Install two plates and capscrew to steering axle. See Figure 49.

4. Connect the tie rod to the spindle assembly. See Tie Rod Replacement.

5. Install the wheel. See Steering Axle Assembly Repair.

6. If required, repeat the procedure for the other spindle.

Steering Cylinder Repair

REMOVE E2.2-E3.5XN (E45XN-70XN) (A268) AND J2.2-3.5XN (J45-70XN) (A276)

NOTE: The end caps of the steering cylinder are held in the shell by the installation of cylinder mount capscrews into the axle frame. To prevent oil leaks at the caps, hold the caps on the shell during removal.

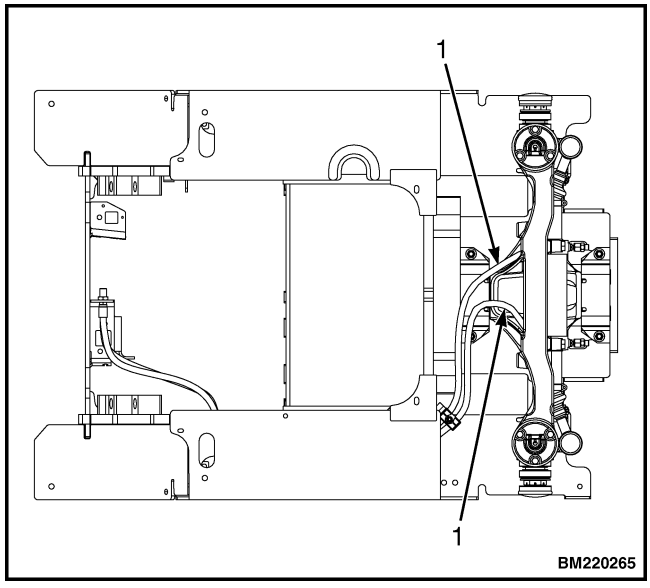
1. Disconnect and tag hydraulic lines at steering cylinder. Install plugs in fittings on steering cylinder and put caps on hydraulic lines.

   See Figure 51 for lift truck models

   - E2.2-3.5XN (E45-70XN) (A268)

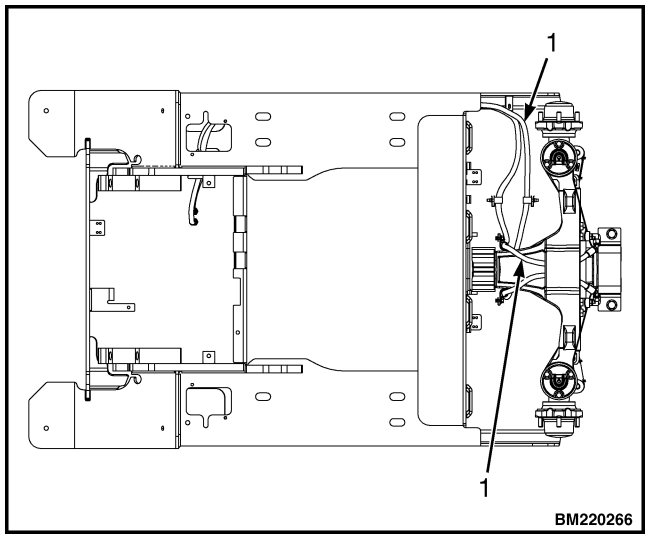
   See Figure 52 for lift truck models

   - J2.2-3.5XN (J45-70XN) (A276)



1. HYDRAULIC HOSE

Figure 51. Steering Cylinder Hoses for Lift Truck Model E2.2-3.5XN (E45-70XN) (A268)

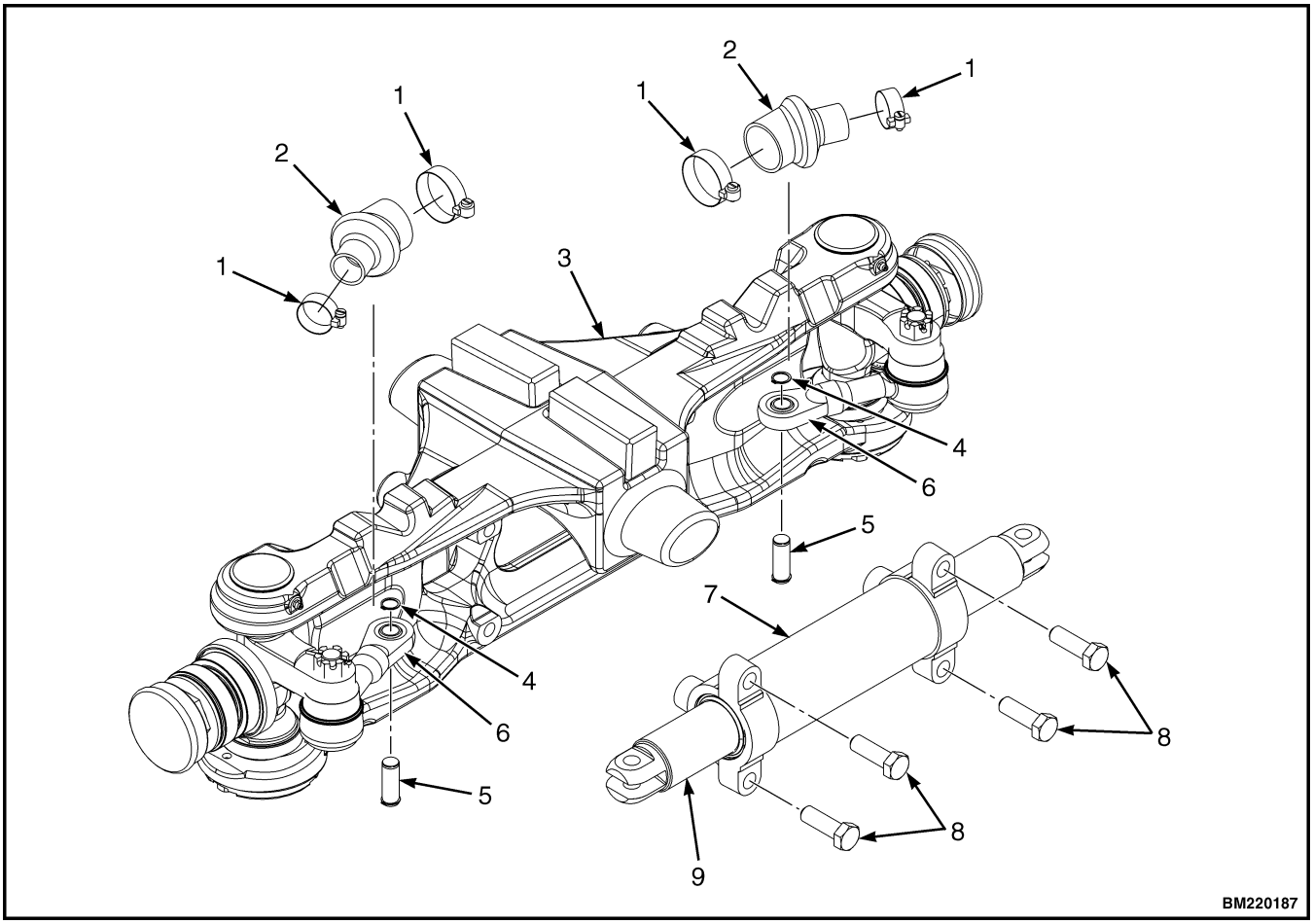


1. HYDRAULIC HOSE

Figure 52. Steering Cylinder Hoses for Lift Truck Model J2.2-3.5XN (J45-70XN) (A276)

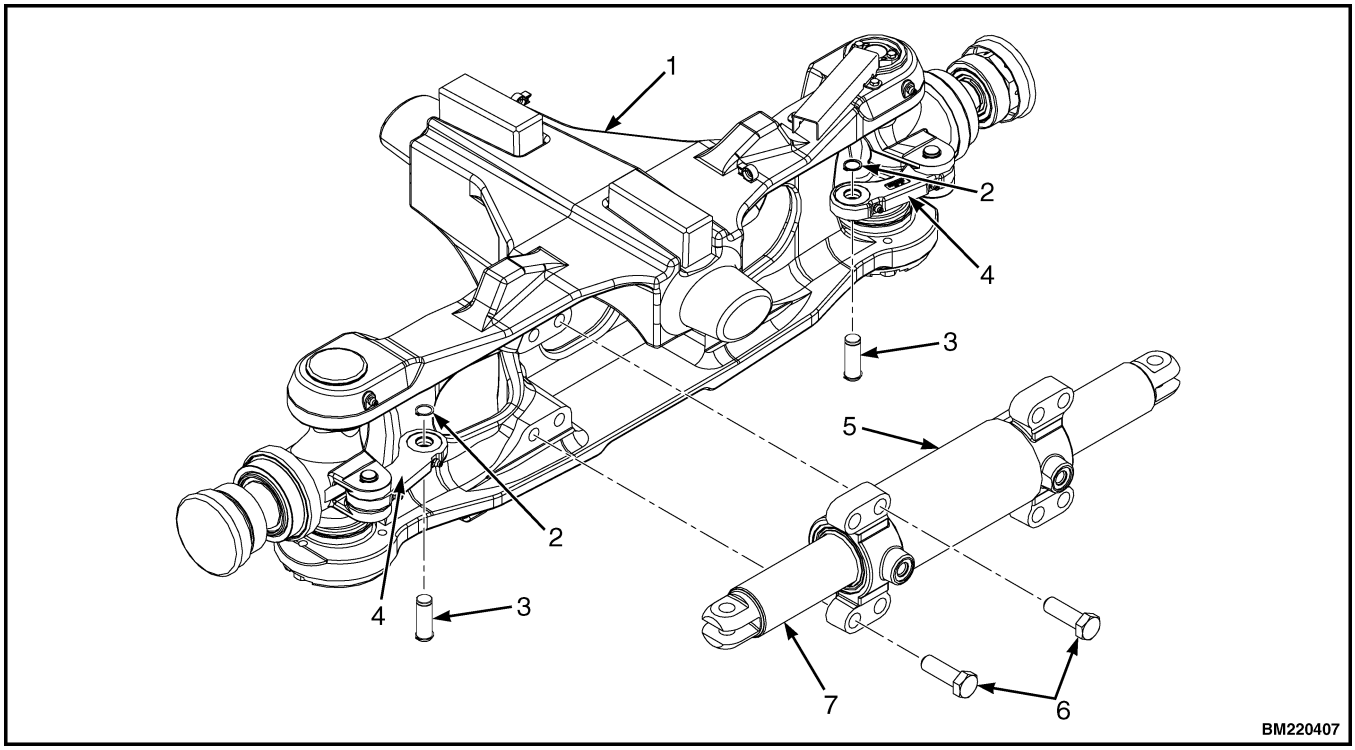
NOTE: Perform Step 2 for lift trucks manufactured prior to November, 2015.

2. Loosen four clamps and move two boots from the tie rods to the steering cylinder rod. See Figure 53.



1. CLAMP
2. BOOT
3. STEERING AXLE
4. SNAP RING
5. PIN
6. TIE ROD
7. STEERING CYLINDER
8. CAPSCREW
9. STEERING CYLINDER ROD

Figure 53. Steering Cylinder Removal for Lift Truck Models J2.2-3.5XN (J45-70XN) (A276) Manufactured Prior to November, 2015 and E2.2-E3.5XN (E45XN-70XN) (A268)



1. STEERING AXLE
2. SNAP RING
3. PIN
4. TIE ROD
5. STEERING CYLINDER
6. CAPSCREW
7. STEERING CYLINDER ROD

Figure 54. Steering Cylinder Removal for Lift Truck Models J2.2-3.5XN (J45-70XN) (A276) Manufactured After November, 2015 and E2.2-3.5XN (E45-70XN) (A268)

WARNING

The steering cylinder weighs 13.7 kg (30 lb), and to prevent possible injury, may require two people to remove the steering cylinder from the steering axle.

NOTE: Perform Step 3 for lift trucks manufactured prior to November, 2015.

3. Remove two snap rings, two pins, four capscrews, and steering cylinder from the steering axle and tie rods. See Figure 53.

WARNING

The steering cylinder weighs 13.7 kg (30 lb), and to prevent possible injury, may require two people to remove the steering cylinder from the steering axle.

NOTE: Perform Step 4 for lift trucks manufactured after November, 2015.

4. Remove two snap rings, two pins, eight capscrews, and steering cylinder from the steering axle and tie rods. See Figure 54.

NOTE: Perform Step 5 for lift trucks manufactured prior to November, 2015.

5. Remove two boots and four clamps from the steering cylinder rod.

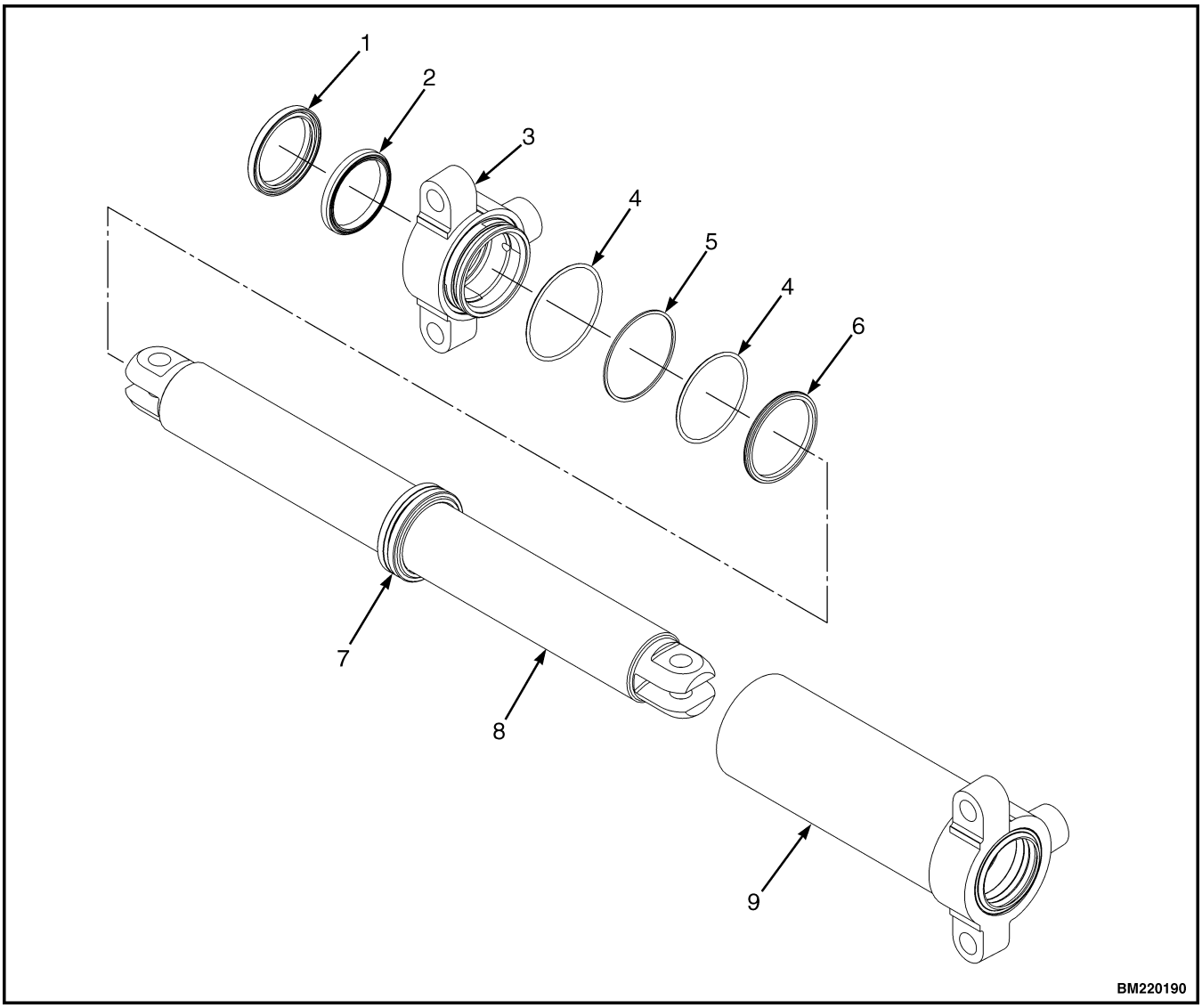
CAUTION

Disposal of lubricants and fluids must meet local environmental regulations.

6. Hold end of steering cylinder over a container. Remove plug for hydraulic fitting from each end cap. Push rod toward end of shell that is over container. Oil will drain from cylinder. Repeat procedure for other end.

DISASSEMBLE E2.2-E3.5XN (E45XN-70XN) (A268) AND J2.2-3.5XN (J45-70XN) (A276)

1. Remove one end cap from cylinder shell and slide off of cylinder rod. See Figure 55.
2. Remove the rod wiper, seal, O-ring, backup ring, and O-ring from the end cap. Discard rod wiper, seal, and O-rings. See Figure 55.



1. ROD WIPER
2. SEAL
3. END CAP
4. O-RING
5. BACKUP RING
6. PISTON SEAL
7. PISTON
8. CYLINDER ROD
9. CYLINDER SHELL

Figure 55. Steering Cylinder Disassembly

3. Pull cylinder rod out of cylinder shell, to prevent possible damage to the cylinder shell, keep cylinder rod centered in cylinder shell during removal. See Figure 55.

4. Remove and discard piston seal from the piston. See Figure 55.

5. Repeat Step 1 and Step 2 for the opposite end cap.

CLEAN

WARNING

Cleaning solvents can be flammable and toxic and can cause skin irritation. When using cleaning solvents, always follow the solvent manufacturer's recommended safety procedures.

WARNING

Compressed air is used for cleaning or drying purposes, or for clearing restrictions. Wear protective clothing (goggles/shield, gloves, etc.) to avoid injury to personnel.

Clean all metal parts in solvent. Dry with compressed air.

INSPECT

1. Inspect cylinder rod for grooves or damage. Remove small scratches with fine emery cloth.

2. Inspect cylinder bore for damage.

3. Inspect end caps for cracks.

ASSEMBLE E2.2-E3.5XN (E45XN-70XN) (A268) AND J2.2-3.5XN (J45-70XN) (A276)

1. Coat seals, rod wipers, and O-rings with packing lubricant Hyster P/N 186061 prior to installation.

CAUTION

DO NOT damage the O-rings, seals, or wipers during installation.

2. Install new O-ring, backup ring, O-ring, seal, and wiper on both end caps. See Figure 55.

3. Install one end cap on cylinder shell. See Figure 55.

4. Install new piston seal on piston. See Figure 55.

5. Carefully slide cylinder rod into cylinder shell and end cap. Keep cylinder rod aligned in center of shell during installation so the parts are not damaged.

6. Install remaining end cap into cylinder shell. Install plugs in hydraulic fittings on end caps.

INSTALL E2.2-E3.5XN (E45XN-70XN) (A268) AND J2.2-3.5XN (J45-70XN) (A276)

NOTE: Perform Step 1 for lift trucks manufactured prior November, 2015.

1. Hold end caps and install steering cylinder on steering axle using four capscrews. Tighten capscrews 225 to 280 N•m (166 to 206 lbf ft). See Figure 53.

NOTE: Perform Step 2 for lift trucks manufactured after November, 2015.

2. Hold end caps and install steering cylinder on steering axle using eight capscrews. Tighten capscrews 225 to 280 N•m (166 to 206 lbf ft). See Figure 54.

3. Install two clamps and one boot on each end of the cylinder rod. See Figure 53.

4. Install tie rods into the steering cylinder ends.

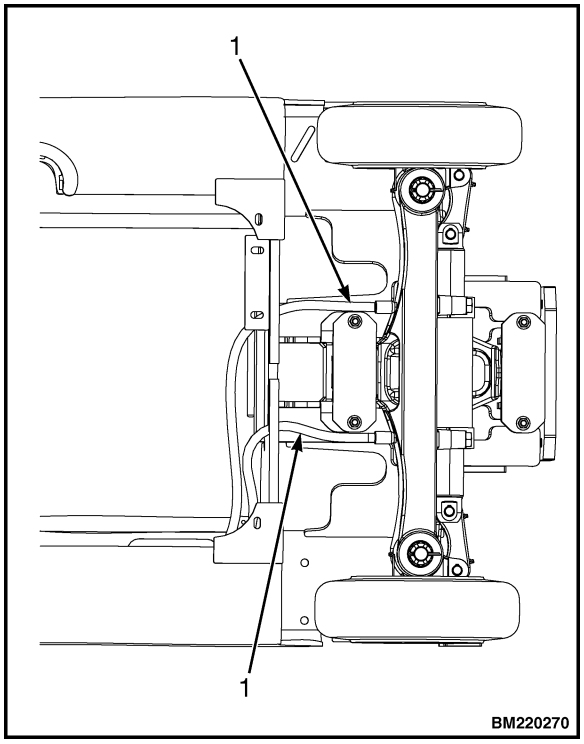
5. Install two pins into the steering cylinder rod/tie rod combination and install a snap ring on each pin. Move the rubber covers over each tie rod/steering cylinder rod combination and tighten clamps.

6. Remove plugs and caps and connect hydraulic lines as tagged during removal, to steering cylinder. Operate steering system to remove air from cylinders and system. Turn steering wheel several times from one stop to the other. Check that the steer cylinder operates lock to lock.

REMOVE E1.6-2.0XN (E30-40XN) (A269)

NOTE: The end caps of the steering cylinder are held in the shell by the installation of cylinder mount capscrews into the axle frame. To prevent oil leaks at the caps, hold the caps on the shell during removal.

1. Disconnect and tag hydraulic lines at steering cylinder. Install plugs in fittings on steering cylinder and put caps on hydraulic lines. See Figure 56.



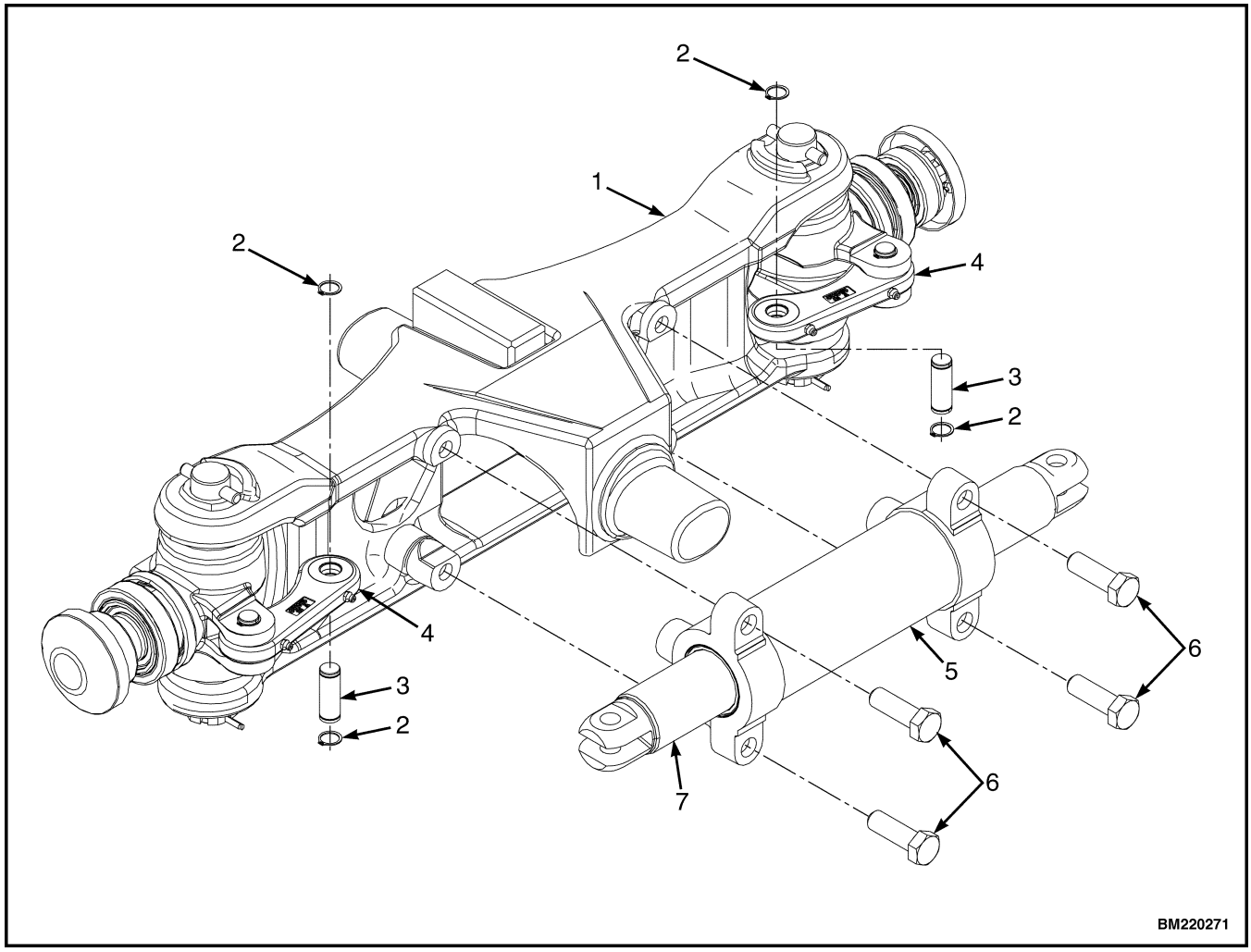
1. HYDRAULIC HOSE

Figure 56. Steering Cylinder Hoses for Lift Truck Model E1.6-2.0XN (E30-40XN) (A269)

WARNING

The steering cylinder weighs 13.7 kg (30 lb), and to prevent possible injury, may require two people to remove the steering cylinder from the steering axle.

2. Remove four snap rings, two pins, four capscrews, and steering cylinder from the steering axle and tie rods. See Figure 57.



1. STEERING AXLE
2. SNAP RING
3. PIN
4. TIE ROD
5. STEERING CYLINDER
6. CAPSCREW
7. STEERING CYLINDER ROD

Figure 57. Steering Cylinder for Lift Truck Models E1.6-2.0XN (E30-40XN) (A269)

CAUTION

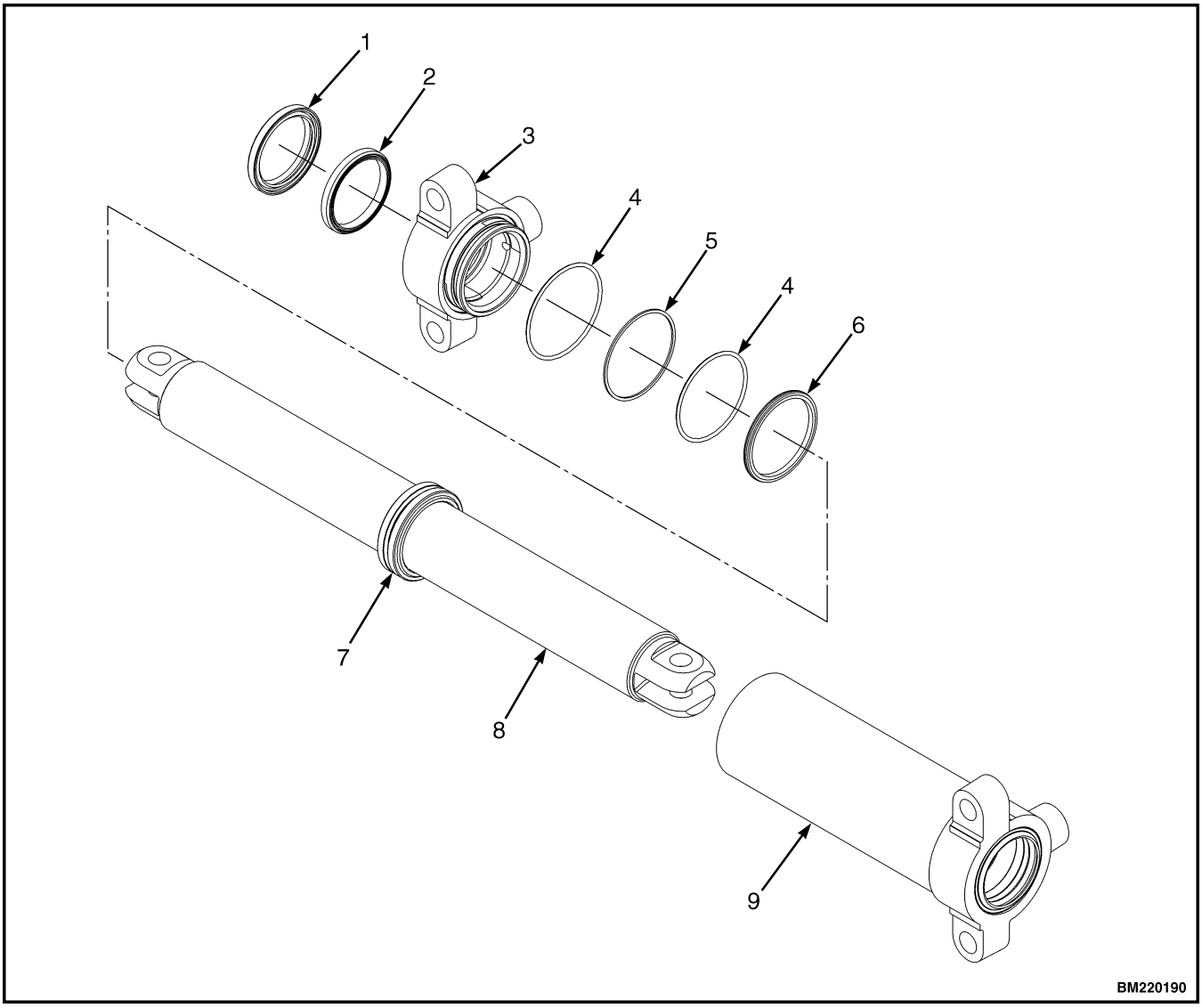
Disposal of lubricants and fluids must meet local environmental regulations.

3. Hold end of steering cylinder over a container. Remove plug for hydraulic fitting from each end cap. Push rod toward end of shell that is over container. Oil will drain from cylinder. Repeat procedure for other end.

DISASSEMBLE E1.6-2.0XN (E30-40XN) (A269)

1. Remove one end cap from cylinder shell and slide off of cylinder rod. See Figure 58.

2. Remove the rod wiper, seal, O-ring, backup ring, and O-ring from the end cap. Discard rod wiper, seal, and O-rings. See Figure 58.



1. ROD WIPER
2. SEAL
3. END CAP
4. O-RING
5. BACKUP RING
6. PISTON SEAL
7. PISTON
8. CYLINDER ROD
9. CYLINDER SHELL

Figure 58. Steering Cylinder Disassembly

3. Pull cylinder rod out of cylinder shell. To prevent possible damage to the cylinder shell, keep cylinder centered in cylinder shell during removal.

4. Remove and discard piston seal from the piston.

5. Repeat Step 1 and Step 2 for the opposite end cap.

CLEAN

WARNING

Cleaning solvents can be flammable and toxic and can cause skin irritation. When using cleaning solvents, always follow the solvent manufacturer's recommended safety procedures.

WARNING

Compressed air is used for cleaning or drying purposes, or for clearing restrictions. Wear protective clothing (goggles/shield, gloves, etc.) to avoid injury to personnel.

Clean all metal parts in solvent. Dry with compressed air.

INSPECT

1. Inspect cylinder rod for grooves or damage. Remove small scratches with fine emery cloth.
2. Inspect cylinder bore for damage.
3. Inspect end caps for cracks.

ASSEMBLE E1.6-2.0XN (E30-40XN) (A269)

1. Coat seals, rod wipers, and O-rings with packing lubricant Hyster P/N 186061 prior to installation.

CAUTION

DO NOT damage the O-rings, seals, or wipers during installation.

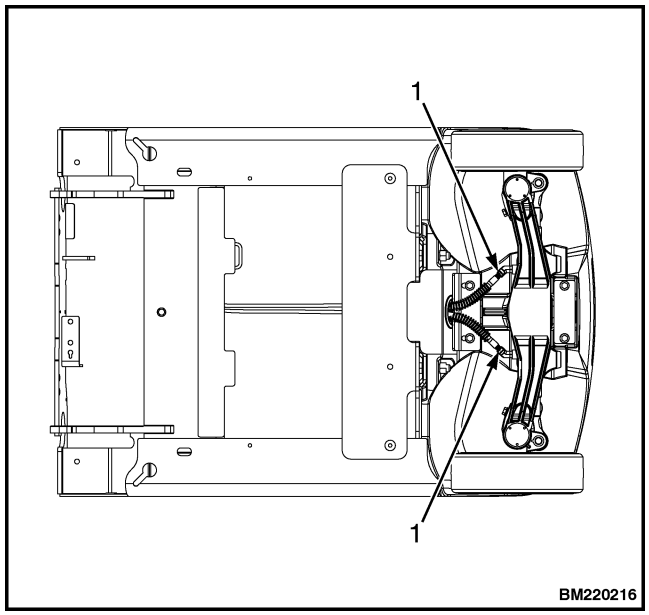
2. Install new O-ring, backup ring, O-ring, seal, and wiper on both end caps. See Figure 58.
3. Install one end cap on cylinder shell. See Figure 58.
4. Install new piston seal on piston. See Figure 58.
5. Carefully slide cylinder rod into cylinder shell and end cap. Keep cylinder rod aligned in center of shell during installation so the parts are not damaged.
6. Install remaining end cap into cylinder shell. Install plugs in hydraulic fittings on end caps.

INSTALL E1.6-2.0XN (E30-40XN) (A269)

1. Hold end caps and install steering cylinder on steering axle using four capscrews. Tighten capscrews to 225 to 280 N•m (166 to 206 lbf ft). See Figure 57.
2. Install tie rods into the steering cylinder ends. See Figure 57.
3. Install two pins into steering cylinder rod and tie rod combination. Install two snap rings on each pin.
4. Remove plugs and caps and connect hydraulic lines as tagged during removal, to steering cylinder. Operate steering system to remove air from cylinders and system. Turn steering wheel several times from one stop to the other. Check that the steer cylinder operates lock to lock.

REMOVE J1.6-2.0XN (J30-40XN) (A935)

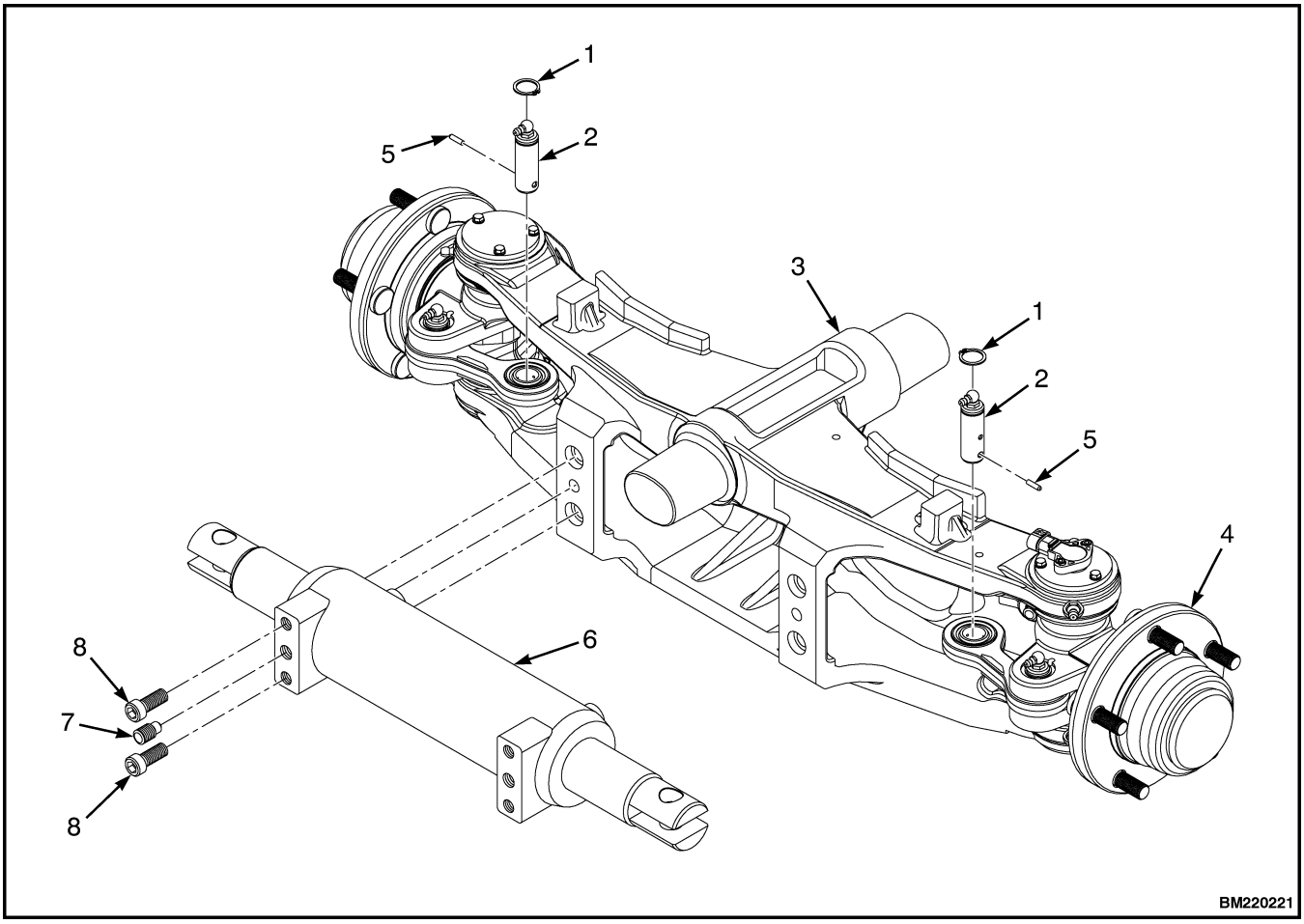
1. Disconnect and tag hydraulic lines at the steering cylinder. See Figure 59. Install plugs in the cylinder fittings and caps on the hydraulic lines to prevent possible contamination.



1. HYDRAULIC HOSE

Figure 59. Steering Cylinder Hose Removal J1.6-2.0XN (J30-40XN) (A935)

2. Remove two dowel pins, two snap rings, two pins, four socket head screws, and two grub screws. To remove the steering cylinder, rotate one of the hubs out of the way and pull the steering cylinder from the steer axle frame. See Figure 60.



1. SNAP RING
2. PIN
3. STEER AXLE FRAME
4. HUB
5. DOWEL
6. STEERING CYLINDER
7. GRUB SCREW
8. SOCKET HEAD SCREWS

Figure 60. Steering Cylinder Removal J1.6-2.0XN (J30-40XN) (A935)

CAUTION

Disposal of lubricants and fluids must meet local environmental regulations.

3. While holding one end of the steering cylinder over a suitable container, remove the plug from the fitting and push the rod toward the end over the container. This will push any fluid on that end of the cylinder out and into the container. Repeat for the opposite end.

DISASSEMBLE J1.6-2.0XN (J30-40XN) (A935)

1. Remove the snap ring from the collar. See Figure 61.

2. Push the collar into the cylinder shell approximately 25.4 mm (1 in.) and remove the split ring from the cylinder shell.

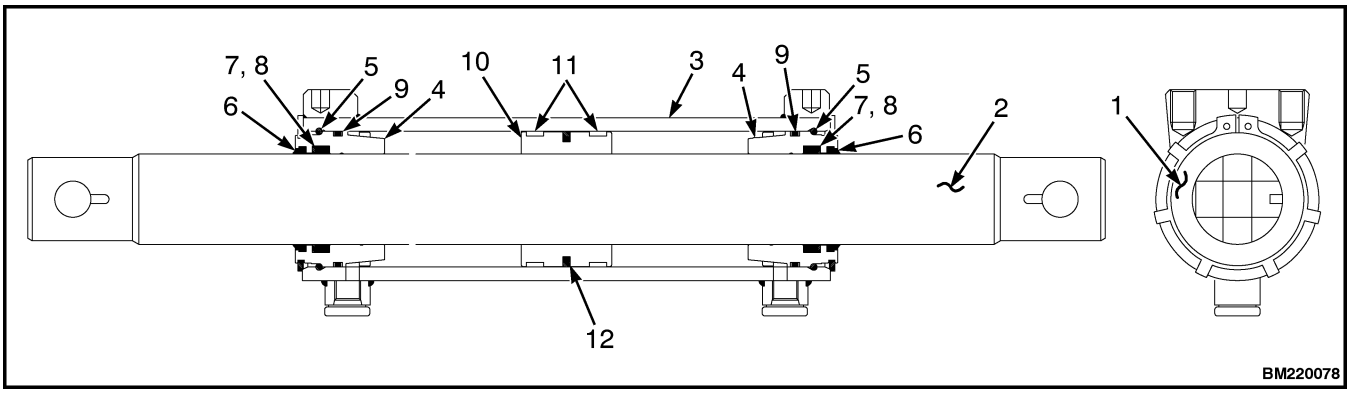
3. To remove the collar from the cylinder shell pull the cylinder rod until the piston pushes the collar from the cylinder shell.

4. Repeat Step 1 through Step 3 to remove the collar from the opposite end of the steer cylinder.

5. Remove and discard the rod wiper, inner seal, outer seal, and backup ring from each collar. See Figure 61.

6. Remove the cylinder rod from the cylinder shell using care not to allow the cylinder rod end to come in contact with the inner surface of the cylinder shell possibly scoring the inner surface.

7. Remove and discard two wear rings and the piston seal from the piston. See Figure 61.



1. SNAP RING
2. CYLINDER ROD
3. CYLINDER SHELL
4. COLLAR
5. SPLIT RING
6. ROD WIPER
7. INNER SEAL
8. BACKUP RING
9. OUTER SEAL
10. PISTON
11. WEAR RING
12. PISTON SEAL

Figure 61. Steering Cylinder Repair

CLEAN

WARNING

Cleaning solvents can be flammable and toxic and can cause skin irritation. When using cleaning solvents, always follow the solvent manufacturer's recommended safety procedures.

WARNING

Compressed air is used for cleaning or drying purposes, or for clearing restrictions. Wear protective clothing (goggles/shield, gloves, etc.) to avoid injury to personnel.

Clean all metal parts in solvent. Dry with compressed air.

INSPECT

1. Inspect cylinder rod for grooves or damage. Remove small scratches with fine emery cloth.

2. Inspect cylinder bore for damage.

3. Inspect collars for damage.

ASSEMBLE J1.6-2.0XN (J30-40XN) (A935)

1. Coat seals, rod wipers, and O-rings with packing lubricant Hyster P/N 186061 prior to installation.

CAUTION

Do not damage the O-rings, seals, or wipers during installation.

2. Install two new wear rings and a new piston seal on the piston. See Figure 61.

3. Install the cylinder rod in the cylinder shell using care not to allow the cylinder rod end to come in contact with the inner surface of the cylinder shell possibly scoring the inner surface.

4. Install a new backup ring, outer seal, inner seal, and rod wiper on each collar. See Figure 61.

5. Install the collar on the cylinder rod and push the collar about 25.4 mm (1 in.) from the cylinder shell end and install the split ring in the cylinder shell.

6. Use the rod to push the collar back to the end of the cylinder shell enough to allow installation of the snap ring. Install the snap ring on the collar with the snap ring plier tabs at the top of the cylinder shell.

7. Repeat Step 5 and Step 6 to install the collar into the opposite end of the steering cylinder. See Figure 61.

INSTALL J1.6-2.0XN (J30-40XN) (A935)

1. Rotate one of the hubs out of the way and install the steering cylinder on the steer axle frame. See Figure 60.

2. Install four socket head screws and two grub screws in steering cylinder and steer axle frame. Tighten socket head and grub screws to 130 N•m (95 lbf ft).

3. Connect the tie rod to the steering cylinder rod with a pin and dowel. Figure 60.

4. Repeat Step 3 for opposite side tie rod.

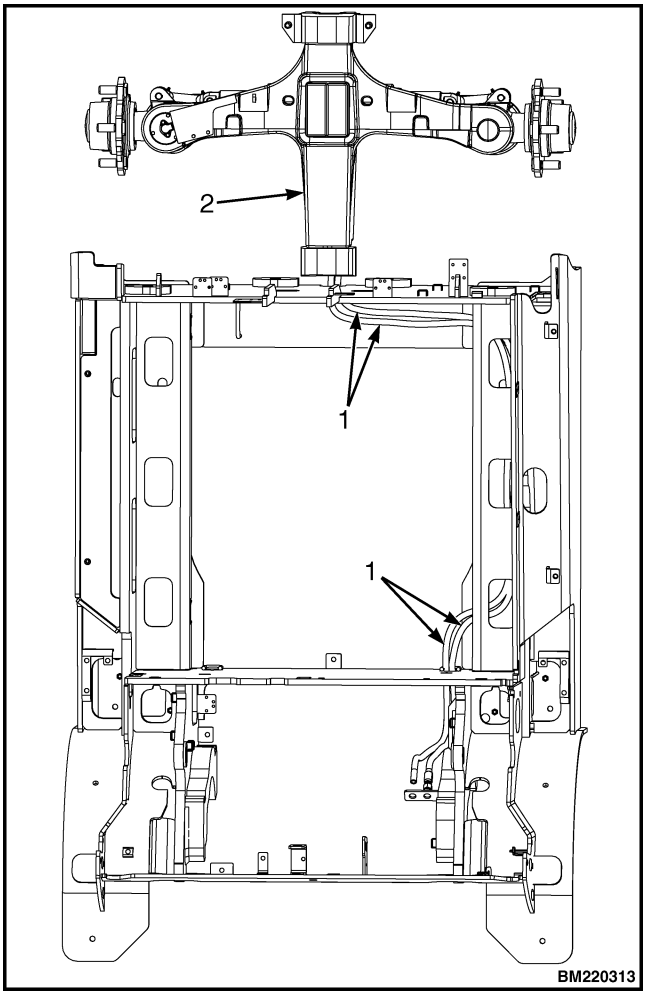
5. Connect the hydraulic hoses to the steering cylinder as tagged during removal.

6. Operate the steering system to remove air from the steering system and steering cylinder. Check that the steering cylinder operates from stop to stop by turning the steering wheel several times from one stop to the other.

REMOVE J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

NOTE: The end caps of the steering cylinder are held in the shell by the installation of cylinder mount capscrews into the axle frame. To prevent oil leaks at the caps, hold the caps on the shell during removal.

1. Disconnect and tag hydraulic lines at steering cylinder. Install plugs in fittings on steering cylinder and put caps on hydraulic lines. See Figure 62.



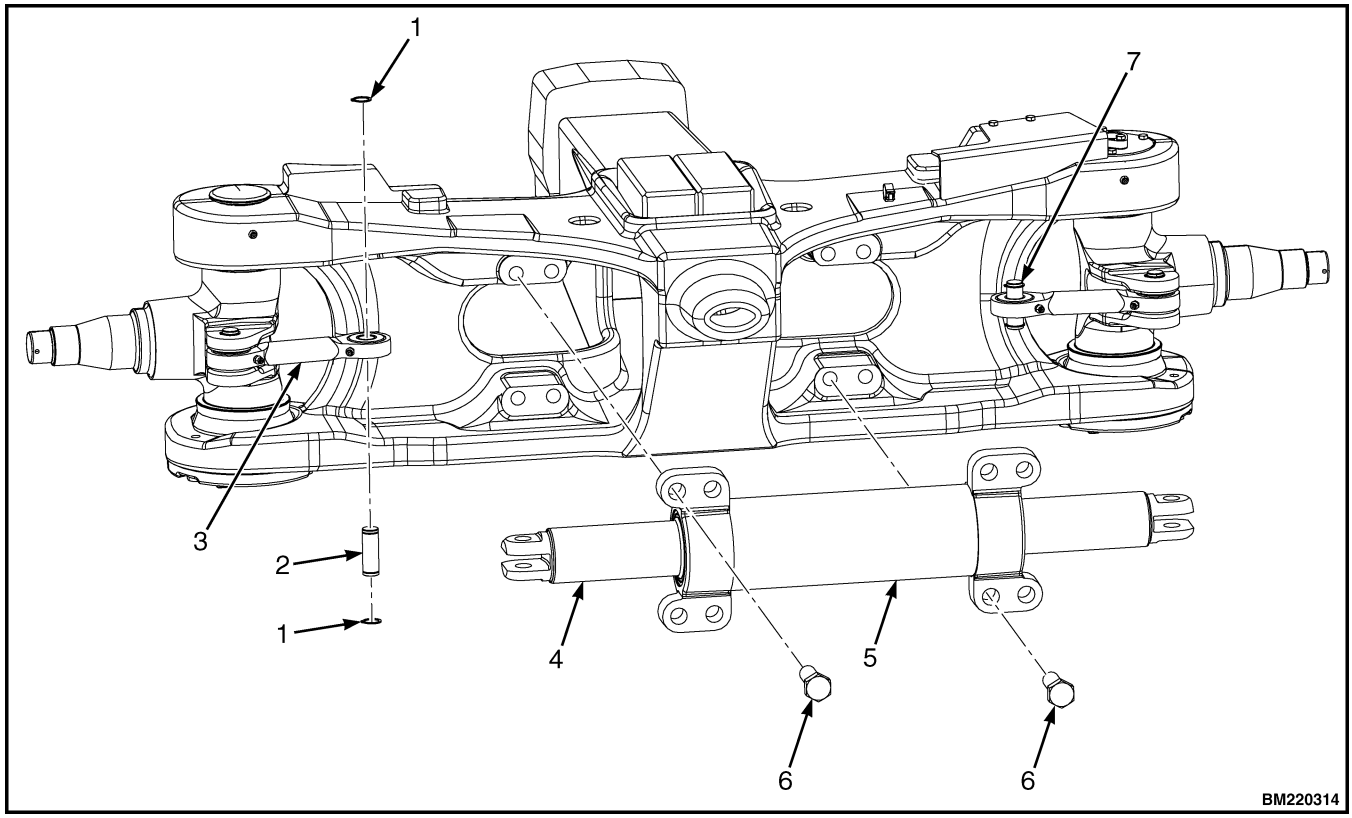
1. HYDRAULIC HOSE
2. STEERING AXLE

Figure 62. Steering Cylinder Hoses for Lift Truck Model J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

WARNING

The steering cylinder is heavy. To prevent possible injury, two people may be required to remove the steering cylinder from the steering axle.

2. Remove four snap rings, two pins, eight capscrews, and steering cylinder from the steering axle and tie rods. See Figure 63.



1. SNAP RING
2. PIN
3. TIE ROD
4. STEERING CYLINDER ROD
5. STEERING CYLINDER
6. CAPSCREW
7. PIN AND SNAP RINGS

Figure 63. Steering Cylinder Removal for Lift Truck Models J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

CAUTION

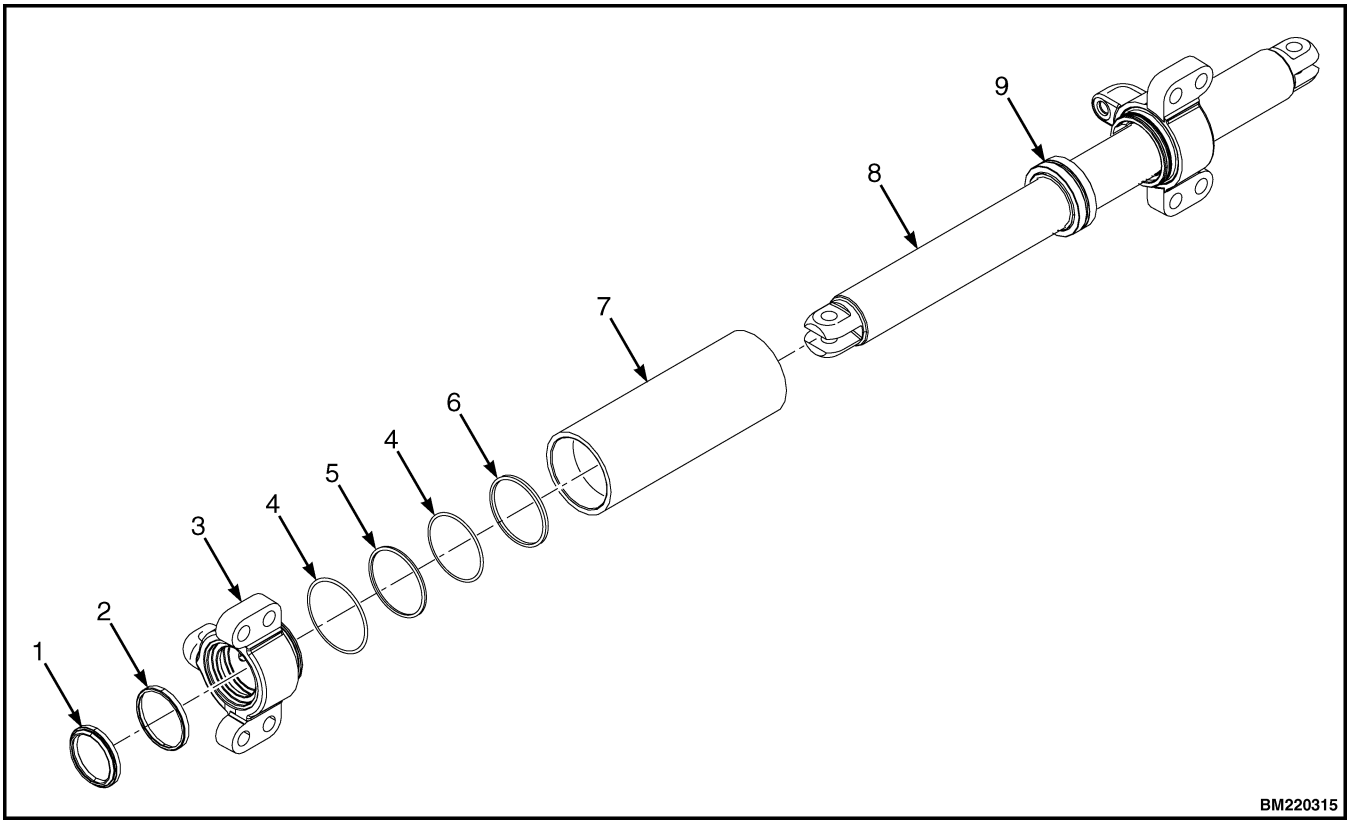
Disposal of lubricants and fluids must meet local environmental regulations.

3. Hold end of steering cylinder over a container. Remove plug for hydraulic fitting from each end cap. Push rod toward end of shell that is over container. Oil will drain from cylinder. Repeat procedure for other end.

DISASSEMBLE J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

1. Remove one end cap from cylinder shell and slide off of cylinder rod. See Figure 64.

2. Remove the rod wiper, seal, O-ring, backup ring, and O-ring from the end cap. Discard rod wiper, seal, and O-rings. See Figure 64.



1. ROD WIPER
2. SEAL
3. END CAP
4. O-RING
5. BACKUP RING
6. PISTON SEAL
7. CYLINDER SHELL
8. CYLINDER ROD
9. PISTON

Figure 64. Steering Cylinder Disassembly

3. Pull cylinder rod out of cylinder shell, to prevent possible damage to the cylinder shell, keep cylinder rod centered in cylinder shell during removal. See Figure 64.

4. Remove and discard piston seal from the piston. See Figure 64.

5. Repeat Step 1 and Step 2 for the opposite end cap.

CLEAN

WARNING

Cleaning solvents can be flammable and toxic and can cause skin irritation. When using cleaning solvents, always follow the solvent manufacturer's recommended safety procedures.

WARNING

Compressed air is used for cleaning or drying purposes, or for clearing restrictions. Wear protective clothing (goggles/shield, gloves, etc.) to avoid injury to personnel.

Clean all metal parts in solvent. Dry with compressed air.

INSPECT

1. Inspect cylinder rod for grooves or damage. Remove small scratches with fine emery cloth.

2. Inspect cylinder bore for damage.

3. Inspect end caps for cracks.

ASSEMBLE J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

1. Coat seals, rod wipers, and O-rings with packing lubricant Hyster P/N 186061 prior to installation.

CAUTION

DO NOT damage the O-rings, seals, or wipers during installation.

2. Install new O-ring, backup ring, O-ring, seal, and wiper on both end caps. See Figure 64.

3. Install one end cap on cylinder shell. See Figure 64.

4. Install new piston seal on piston. See Figure 64.

5. Carefully slide cylinder rod into cylinder shell and end cap. Keep cylinder rod aligned in center of shell during installation so the parts are not damaged.

6. Install remaining end cap into cylinder shell. Install plugs in hydraulic fittings on end caps.

INSTALL J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

1. Hold end caps and install steering cylinder on steering axle using eight capscrews. Tighten capscrews 225 to 280 N•m (166 to 206 lbf ft). See Figure 63.

2. Install tie rods into the steering cylinder ends.

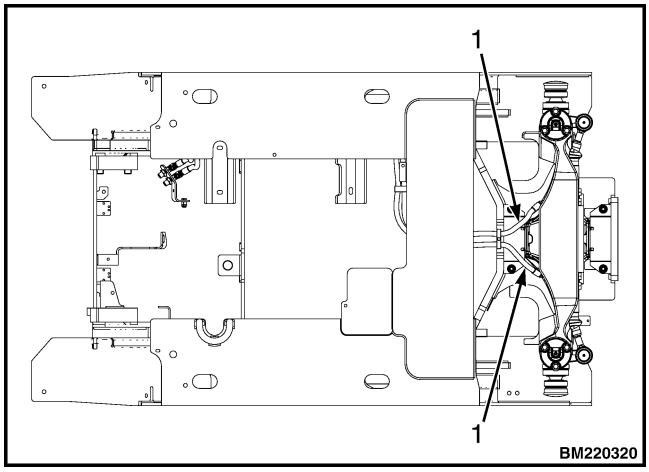
3. Install two pins into the steering cylinder rod/tie rod combination and install two snap rings on each pin. See Figure 63.

4. Remove plugs and caps and connect hydraulic lines as tagged during removal, to steering cylinder. Operate steering system to remove air from cylinders and system. Turn steering wheel several times from one stop to the other. Check that the steer cylinder operates lock to lock.

REMOVE E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

1. The end caps of the steering cylinder are held in the shell by the installation of cylinder mount capscrews into the axle frame. To prevent oil leaks at the caps, hold the caps on the shell during removal.

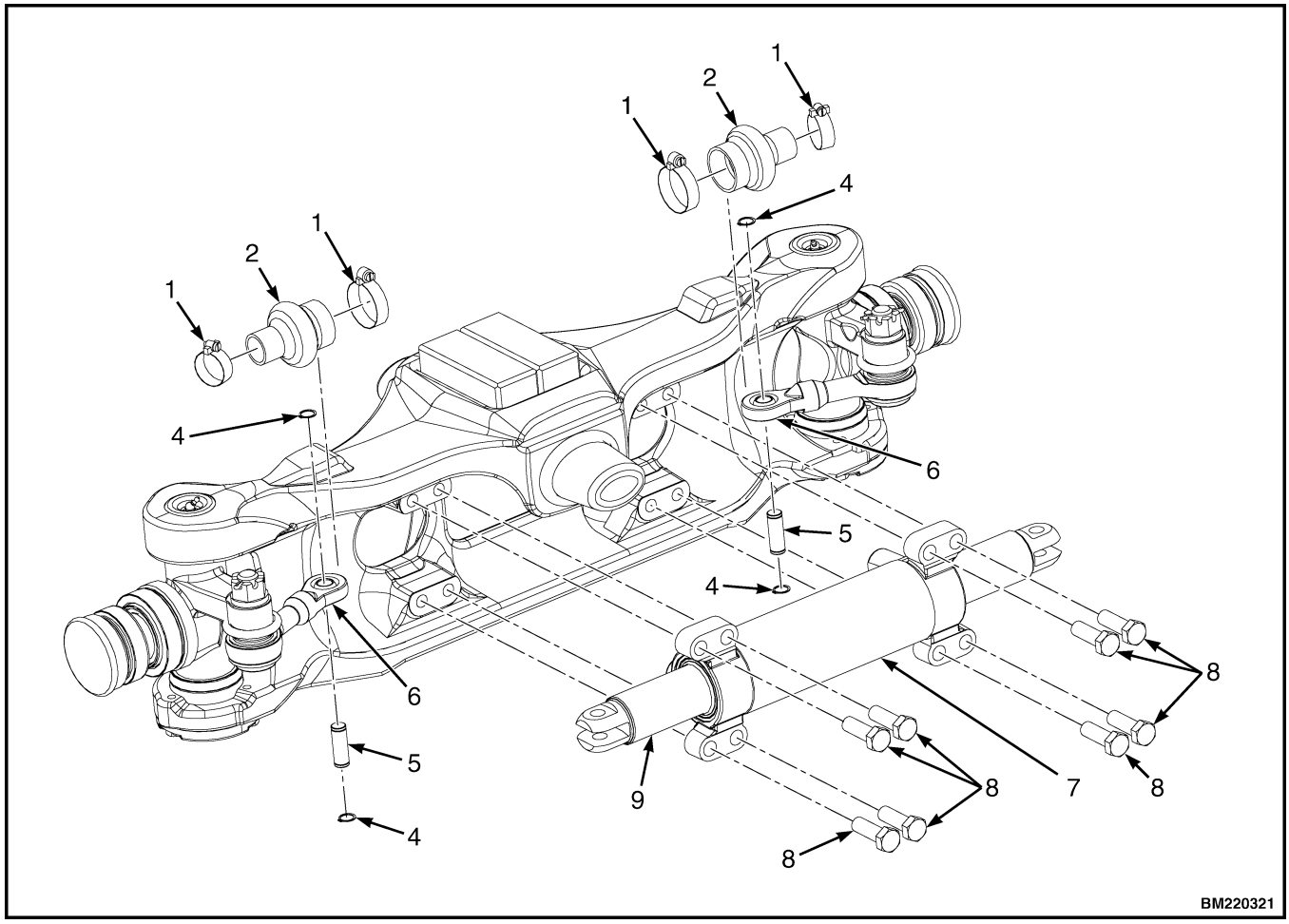
   Disconnect and tag hydraulic lines at steering cylinder. Install plugs in fittings on steering cylinder and put caps on hydraulic lines. See Figure 65.



1. HYDRAULIC HOSE

Figure 65. Steering Cylinder Hoses for Lift Trucks E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

2. Loosen four clamps and move two boots from the tie rods to the steering cylinder rod. See Figure 66.



1. CLAMP
2. BOOT
3. STEERING AXLE
4. SNAP RING
5. PIN
6. TIE ROD
7. STEERING CYLINDER
8. CAPSCREW
9. STEERING CYLINDER ROD

Figure 66. Steering Cylinder Removal, Lift Truck Models E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

WARNING

The steering cylinder weighs 17.1 kg (38 lb), To prevent possible injury, two people may be required to remove the steering cylinder from the steering axle.

3. Remove two snap rings, two pins, eight capscrews, and steering cylinder from the steering axle and tie rods. See Figure 66.

4. Remove two boots and four clamps from the steering cylinder rod.

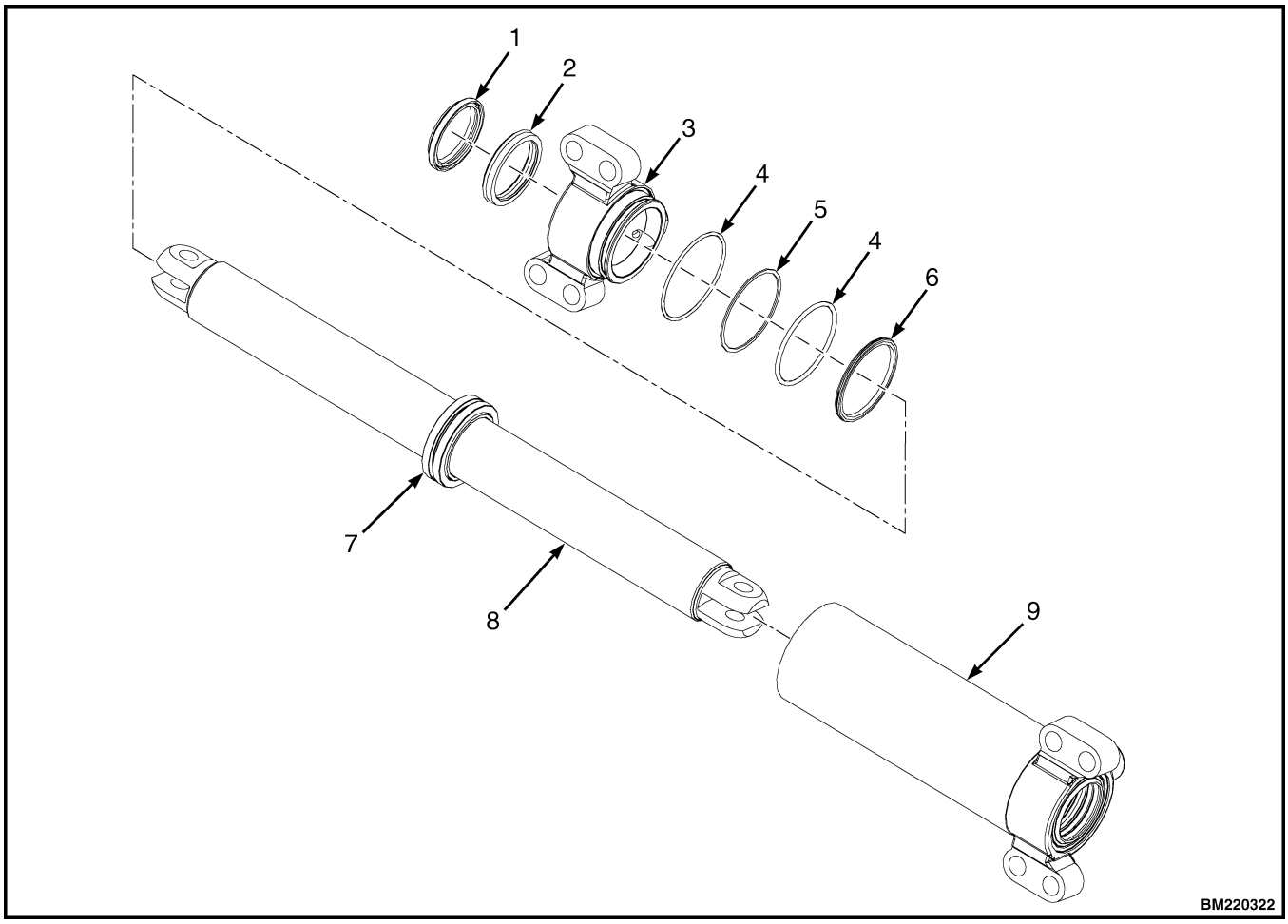
CAUTION

Disposal of lubricants and fluids must meet local environmental regulations.

5. Hold end of steering cylinder over a container. Remove plug for hydraulic fitting from each end cap. Push rod toward end of shell that is over container. Oil will drain from cylinder. Repeat procedure for other end.

DISASSEMBLE E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

1. Remove one end cap from cylinder shell and slide off of cylinder rod. See Figure 67.
2. Remove the rod wiper, seal, O-ring, backup ring, and O-ring from the end cap. Discard rod wiper, seal, and O-rings. See Figure 67.



1. ROD WIPER
2. SEAL
3. END CAP
4. O-RING
5. BACKUP RING
6. PISTON SEAL
7. PISTON
8. CYLINDER ROD
9. CYLINDER SHELL

Figure 67. Steering Cylinder Disassembly

3. Pull cylinder rod out of cylinder shell, to prevent possible damage to the cylinder shell, keep cylinder rod centered in cylinder shell during removal. See Figure 67.
4. Remove and discard piston seal from the piston.
5. Repeat Step 1 through Step 4 for the opposite end cap.

CLEAN

WARNING

Cleaning solvents can be flammable and toxic and can cause skin irritation. When using cleaning solvents, always follow the solvent manufacturer's recommended safety procedures.

WARNING

Compressed air can move particles so that they cause injury to the user or to other personnel. Make sure that the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eyes.

Clean all metal parts in solvent and dry with compressed air.

INSPECT

1. Inspect cylinder rod for grooves or damage. Remove small scratches with fine emery cloth.
2. Inspect cylinder bore for damage.
3. Inspect end caps for cracks.

ASSEMBLE E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

1. Coat the internal surfaces of the cylinder shell with anti-rust compound (Rust Veto 377 or equivalent). See Figure 67.
2. Coat seals, rod wipers, and O-rings with packing lubricant (Hyster P/N 186061) prior to installation.

CAUTION

DO NOT damage the O-rings, seals, or wipers during installation.

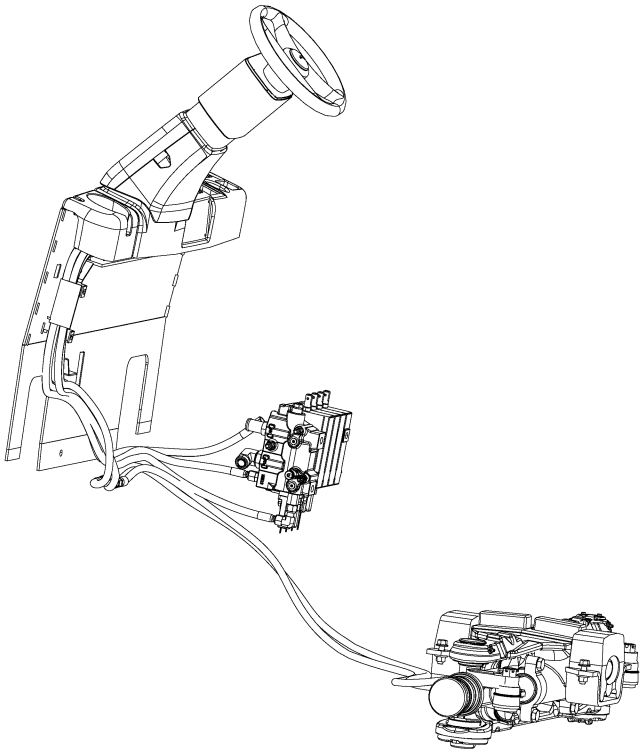
3. Install new O-ring, backup ring, O-ring, seal, and wiper on both end caps. See Figure 67.
4. Install one end cap on cylinder shell.
5. Install new piston seal on piston. See Figure 67.
6. Carefully slide cylinder rod into cylinder shell and end cap. Keep cylinder rod aligned in center of shell during installation so the parts are not damaged.
7. Install remaining end cap into cylinder shell.
8. Install plugs in hydraulic fittings on end caps.

INSTALL E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

1. Hold end caps and install steering cylinder on steering axle using eight capscrews.
2. Tighten capscrews 225 N•m (166 lbf ft) See Figure 66.
3. Install two clamps and one boot on each end of the cylinder rod. See Figure 66.
4. Install tie rods into the steering cylinder ends.
5. Install two pins into the steering cylinder rod/tie rod combination and install a snap ring on each pin. Move the rubber covers over each tie rod/steering cylinder rod combination and tighten clamps.
6. Remove plugs and caps and connect hydraulic lines as tagged during removal, to steering cylinder. Operate steering system to remove air from cylinders and system. Turn steering wheel several times from one stop to the other. Check that the steer cylinder operates lock to lock.

STEERING SYSTEM

E2.2-3.5XN (E45-70XN) [A268];
E1.6-2.0XN (E30-40XN) [A269];
J2.2-3.5XN (J45-70XN) [A276];
J1.6-2.0XN (J30-40XN) [A935];
J4.0-5.0XN, J5.0-5.5XN6
(J80-120XN, J100XNL) [A970];
E4.0-5.5XN, E5.0XNS
(E80-120XN, E100XNS) [A099]



HYSTER

PART NO. 1688873

1600 SRM 1363

SAFETY PRECAUTIONS
MAINTENANCE AND REPAIR

- The Service Manuals are updated on a regular basis, but may not reflect recent design changes to the product. Updated technical service information may be available from your local authorized Hyster® dealer. Service Manuals provide general guidelines for maintenance and service and are intended for use by trained and experienced technicians. Failure to properly maintain equipment or to follow instructions contained in the Service Manual could result in damage to the products, personal injury, property damage or death.
- When lifting parts or assemblies, make sure all slings, chains, or cables are correctly fastened, and that the load being lifted is balanced. Make sure the crane, cables, and chains have the capacity to support the weight of the load.
- Do not lift heavy parts by hand, use a lifting mechanism.
- Wear safety glasses.
- DISCONNECT THE BATTERY CONNECTOR before doing any maintenance or repair on electric lift trucks. Disconnect the battery ground cable on internal combustion lift trucks.
- Always use correct blocks to prevent the unit from rolling or falling. See HOW TO PUT THE LIFT TRUCK ON BLOCKS in the **Operating Manual** or the **Periodic Maintenance** section.
- Keep the unit clean and the working area clean and orderly.
- Use the correct tools for the job.
- Keep the tools clean and in good condition.
- Always use **HYSTER APPROVED** parts when making repairs. Replacement parts must meet or exceed the specifications of the original equipment manufacturer.
- Make sure all nuts, bolts, snap rings, and other fastening devices are removed before using force to remove parts.
- Always fasten a DO NOT OPERATE tag to the controls of the unit when making repairs, or if the unit needs repairs.
- Be sure to follow the **WARNING** and **CAUTION** notes in the instructions.
- Gasoline, Liquid Petroleum Gas (LPG), Compressed Natural Gas (CNG), and Diesel fuel are flammable. Be sure to follow the necessary safety precautions when handling these fuels and when working on these fuel systems.
- Batteries generate flammable gas when they are being charged. Keep fire and sparks away from the area. Make sure the area is well ventilated.

NOTE: The following symbols and words indicate safety information in this manual:

WARNING

Indicates a hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION

Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury and property damage.

On the lift truck, the WARNING symbol and word are on orange background. The CAUTION symbol and word are on yellow background.

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This section is for the following models:

E2.2-3.5XN (E45-70XN) [A268];
E1.6-2.0XN (E30-40XN) [A269];
J2.2-3.5XN (J45-70XN) [A276];
J1.6-2.0XN (J30-40XN) [A935];
J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) [A970];
E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) [A099]

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"THE QUALITY KEEPERS"

HYSTER APPROVED PARTS

General

This section has the description, disassembly, assembly, checks, adjustments, and repair of the steering system, the steering housing, and the steering control unit. Additional information on parts of the steering system can be found in the following service manual sections for your lift truck: **Steering Axle** 1600SRM1360, for all lift truck models in this manual.

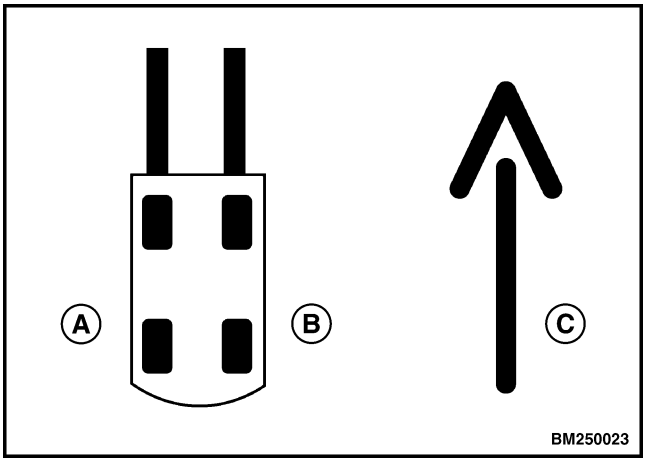
Hydraulic System 1900SRM1367 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268)
- J2.2-3.5XN (J40-70XN) (A276)
- E1.6-2.0XN (E30-40XN) (A269)
- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)
- E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

Hydraulic System 1900SRM1333 for lift truck models

- J1.6-2.0XN (J30-40XN) (A935)

Throughout this section, forward will refer to travel in the direction of the forks and left and right determined by an operator sitting in the seat facing forward. See Figure 1.



A. LEFT SIDE
B. RIGHT SIDE
C. FORWARD TRAVEL

Figure 1. Truck Orientation

DISCHARGING THE CAPACITORS

WARNING

DO NOT make repairs or adjustments unless you have been properly trained and authorized to do so. Improper repairs and adjustments can create dangerous operating conditions. DO NOT operate a lift truck that needs repairs. Report the need for repairs to your supervisor immediately. If repair is necessary, attach a DO NOT OPERATE tag on the steering wheel and disconnect the battery.

Disconnect the battery and allow the capacitors to discharge before opening an compartment covers or inspecting or repairing the electrical system. DO NOT place tool on top of the battery. If a tool causes a short circuit, the high current flow from the battery can cause personal injury and property damage.

Some checks and adjustments are performed with the battery connected. DO NOT connect the battery until the procedure instructs you to do so. Never wear any metallic items on your fingers, arms, or neck. Metal items can accidentally make an electrical connection and cause injury

Before performing any tests or adjustment, block the lift truck to prevent unexpected movement.

The capacitor in the transistor controller(s) can hold an electrical charge for about 10 seconds after the battery is disconnected. To prevent an electrical shock and personal injury, discharge the capacitor(s) before inspecting or repairing any component in the drive unit compartment. Make certain that the battery has been disconnected.

DO NOT short across the motor controller terminals with a screwdriver or jumper wire.

Make certain the Emergency-Stop switch has not been activated. This will isolate the controller and prevent the capacitors from discharging properly. The proper way to disconnect the battery is by separating the battery connectors.

1. Ensure the capacitors are discharged by performing Step 2 through Step 6 below.
2. Turn key or keyless switch to **OFF** position.
3. Disconnect the battery by separating the connectors.
4. Block drive wheels to prevent lift truck from moving.
5. Make sure the Emergency-Stop switch **HAS NOT** been activated. If the Emergency-Stop switch is activated, rotate the switch to the right until it pops up.
6. Press horn button. Wait 30 seconds to be sure capacitors are fully discharged.

Steering Control Unit (SCU) Repair

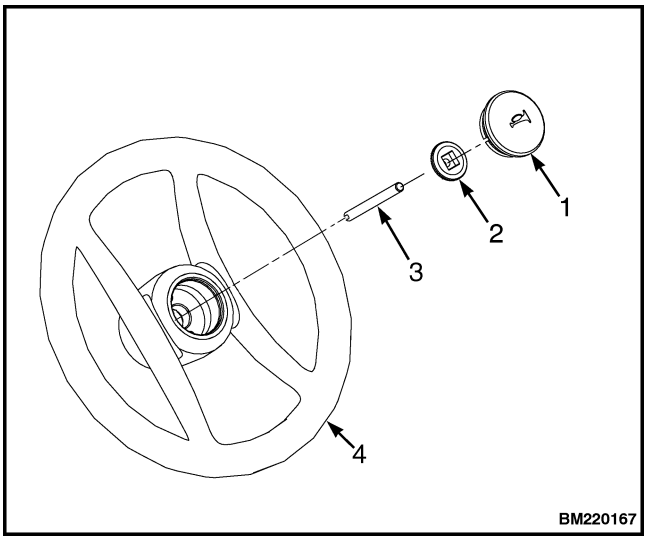
REMOVE

NOTE: Unless otherwise specified, the following steps apply to both fixed and telescopic steering columns.

1. Disconnect the battery connector.
2. Discharge capacitors, for procedures see **General** section of this manual.

NOTE: Tag all electrical connectors during removal to aid in installation.

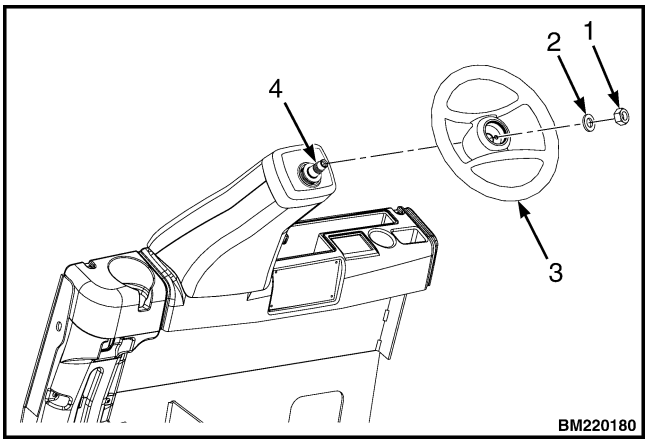
3. Remove horn button, nut, and rod from steering wheel. See Figure 2.



1. HORN BUTTON
2. NUT
3. ROD
4. STEERING WHEEL

Figure 2. Horn Button Assembly and Electrical Connections

4. Remove hex nut, washer (if equipped) and steering wheel from steering column. If necessary, use puller tool to remove steering wheel. See Figure 3.

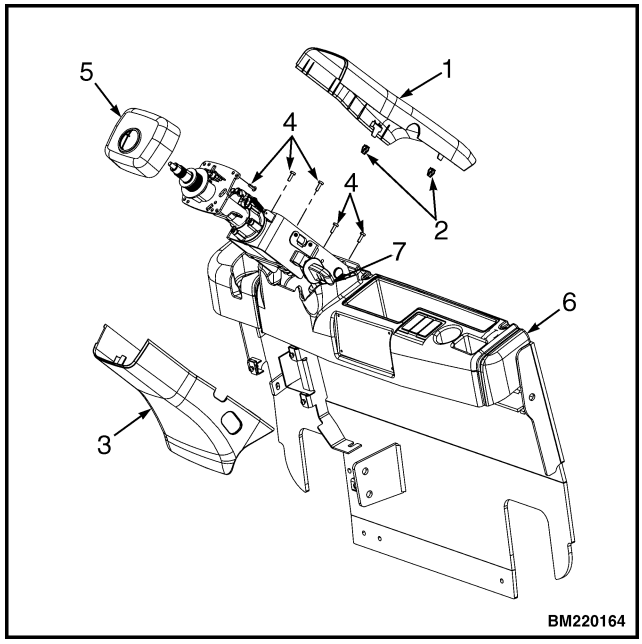


1. HEX NUT
2. WASHER
3. STEERING WHEEL
4. STEERING COLUMN

Figure 3. Steering Wheel

NOTE: Follow Step 5 through Step 8 for fixed steering column. See Figure 6 for lift trucks with automatic parking brakes.

5. Remove steering column upper cover by pressing from both sides near the bottom and pulling up. Clips should remain attached. See Figure 4.
6. Remove four capscrews and steering column lower cover. See Figure 4.
7. Remove four capscrews and steering column top cover. See Figure 4.



1. STEERING COLUMN UPPER COVER
2. CLIP
3. STEERING COLUMN LOWER COVER
4. CAPSCREW
5. STEERING COLUMN TOP COVER
6. DASH PANEL
7. TILT ADJUST LEVER

Figure 4. Fixed Steering Column Covers

8. Remove capscrews from dash panel and cowl plate. Lift dash panel over fixed steering column, maneuvering it past tilt adjust lever.

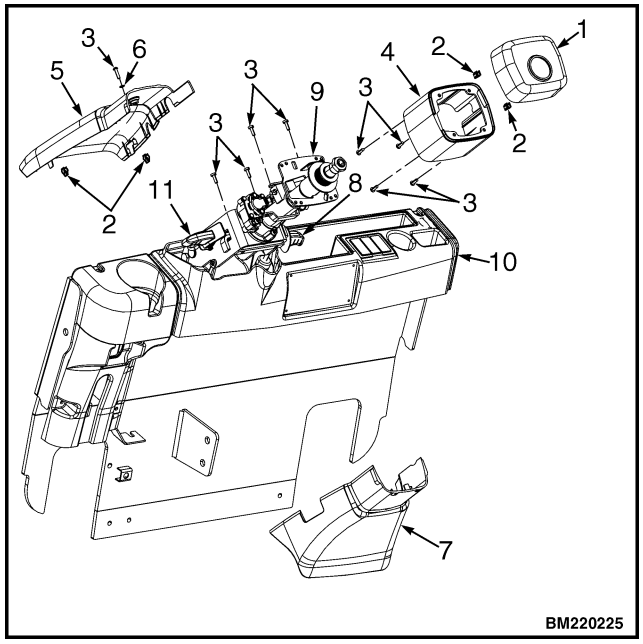
NOTE: Follow Step 9 through Step 13 for telescopic steering column.

9. Remove steering column top cover by pressing from both sides and pulling up. Clips should remain attached. See Figure 5.

10. Telescope steering column to the fully **UP** position, then remove four capscrews and steering column telescoping cover. See Figure 5.

11. Remove capscrew and washer; press steering column upper cover from both sides and pull up. Clips should remain attached. See Figure 5.

12. Remove four capscrews and steering column lower cover. Maneuver steering column lower cover around tilt memory lever. See Figure 5.



1. STEERING COLUMN TOP COVER
2. CLIP
3. CAPSCREW
4. STEERING COLUMN TELESCOPING COVER
5. STEERING COLUMN UPPER COVER
6. WASHER
7. STEERING COLUMN LOWER COVER
8. TILT ADJUST LEVER
9. TELESCOPIC STEERING COLUMN
10. DASH PANEL
11. TILT MEMORY LEVER

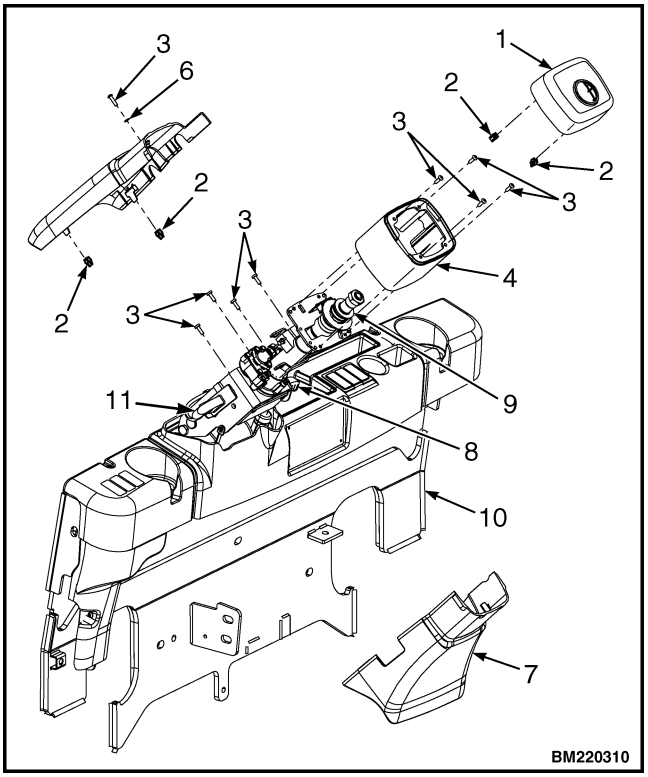
Figure 5. Telescopic Steering Column Covers

13. Remove capscrews from dash panel and cowl plate. Lift dash panel over telescopic steering column, maneuvering it past the tilt memory lever, tilt adjust lever, and column locking lever.

NOTE: Tag all hoses and fittings during removal to aid in installation. Tags on hoses and fittings should reflect the letter sequence on the steering control unit end cover.

NOTE: Install plugs at all hose ports and hose ends to prevent foreign material from entering hydraulic system.

14. Remove steering column top cover by pressing from both sides and pulling up. Clips should remain attached. See Figure 6.

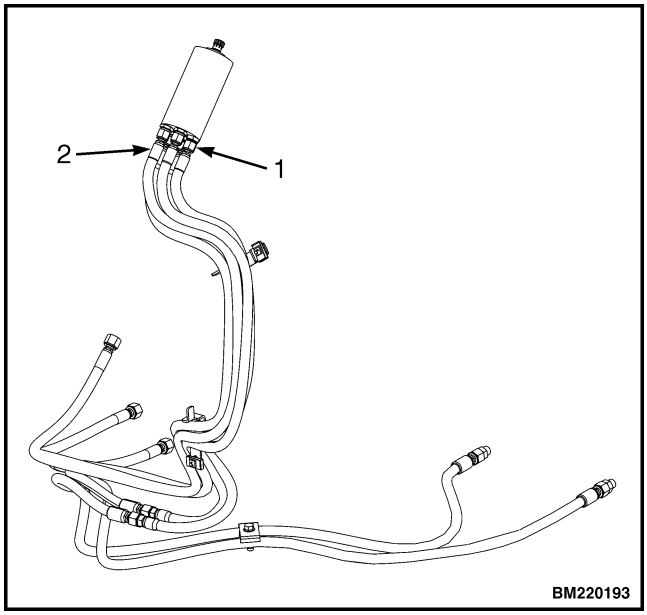


1. STEERING COLUMN TOP COVER
2. CLIP
3. CAPSCREW
4. STEERING COLUMN TELESCOPING COVER
5. STEERING COLUMN UPPER COVER
6. WASHER
7. STEERING COLUMN LOWER COVER
8. TILT ADJUST LEVER
9. TELESCOPIC STEERING COLUMN
10. DASH PANEL
11. TILT MEMORY LEVER

Figure 6. Steering Column Covers with Automatic Parking Brake

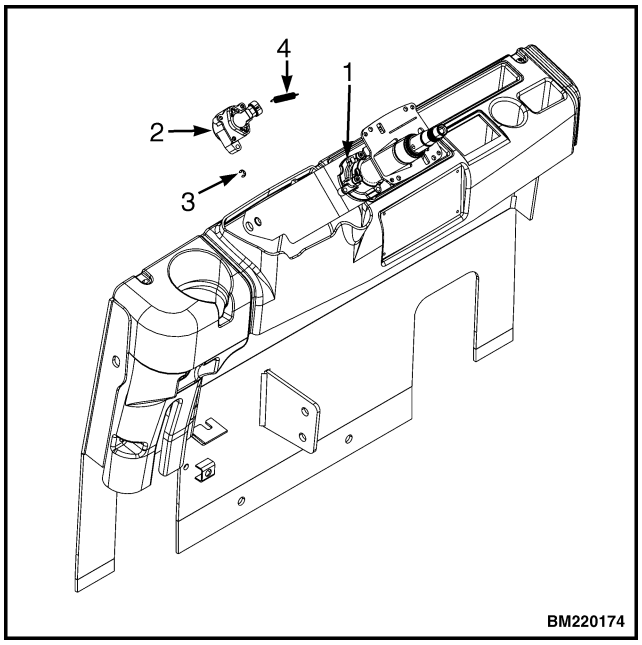
Disconnect the hydraulic hoses from the steering control unit fittings. See Figure 7. Set the hydraulic hoses aside to prevent possible damage.

15. Remove spring, e-ring and steering direction sensor from steering column. See Figure 8.



1. STEERING CONTROL UNIT FITTING
2. HYDRAULIC HOSE

Figure 7. Hydraulic Hose Connections



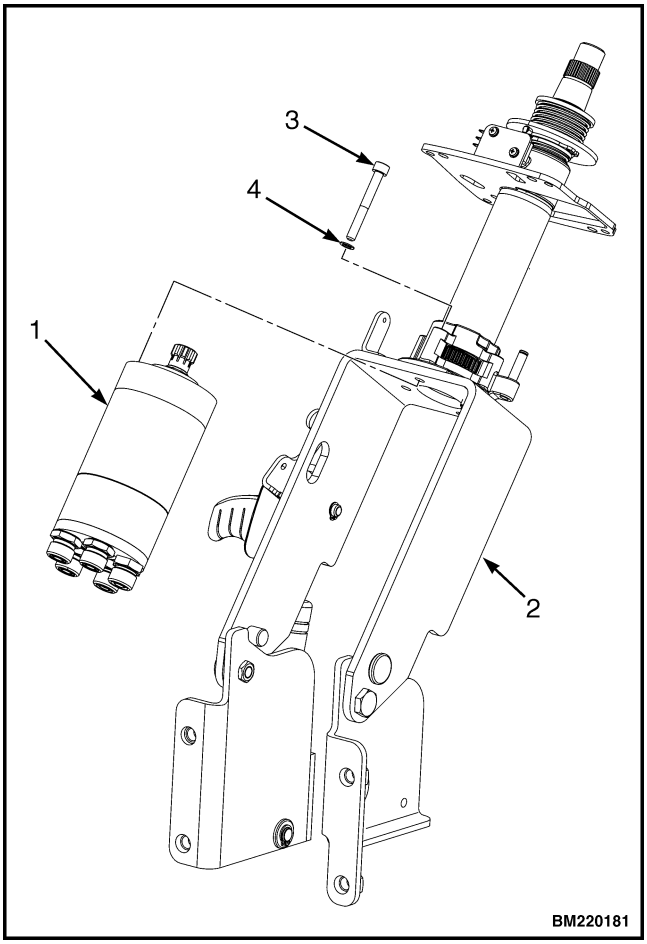
1. STEERING COLUMN
2. STEERING DIRECTION SENSOR
3. E-RING
4. SPRING

Figure 8. Steering Direction Sensor

NOTE: Perform Step 16 for lift trucks equipped with synchronous steering.

16. Disconnect wiring harness from synchronous steering valve kit. See Figure 10.

17. Remove capscrews, washers, and steering control unit from tilt base bracket. See Figure 9.



1. STEERING CONTROL UNIT
2. TILT BASE BRACKET
3. CAPSCREW
4. WASHER

Figure 9. Steering Control Unit

DISASSEMBLE

NOTE: For lift truck model J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) and E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099), see Figure 12. For all other lift truck models, see Figure 11.

1. Place the steering control unit (SCU) into a soft jaw vise with the splined shaft facing down.

NOTE: Perform Step 2 and Step 3 for lift trucks equipped with synchronous steering.

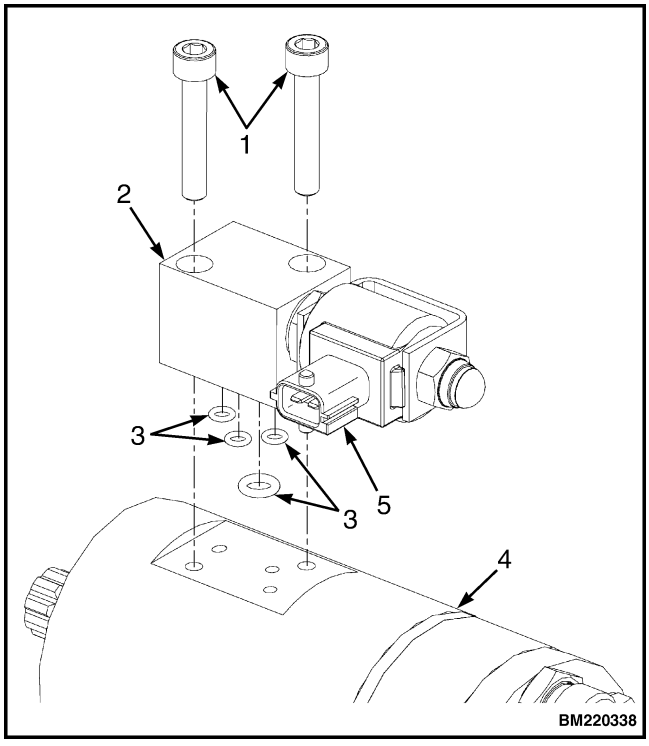
2. Remove two Allen head capscrews and synchronous steering valve kit from SCU. See Figure 10.

3. Remove and discard four O-ring from manifold. See Figure 10.

4. Remove hydraulic fittings and O-rings from SCU housing. Discard O-rings.

5. Remove checkball, ball stop, and emergency steering ball. Rotate SCU 90 degrees sideways in the vise.

6. Remove the end cover, spacer, gear housing, gear, distributor plate, and O-rings from SCU. Discard O-rings.



1. ALLEN HEAD CAPSCREWS
2. SYNCHRONOUS STEERING VALVE KIT
3. O-RING
4. STEERING CONTROL UNIT WITH SYNCHRONOUS STEERING
5. WIRE HARNESS CONNECTOR

Figure 10. Synchronous Steering Valve Kit

7. Remove the cardan shaft from spool assembly.

8. Remove the spool assembly from SCU housing.

NOTE: Note positioning of thrust washers on either side of the thrust bearing in the thrust bearing assembly during Step 9.

9. Remove the thrust bearing assembly from the shaft end of spool assembly.

10. Remove the retaining ring from spool assembly.

11. Press the cross pin out of spool assembly.

12. Press the spool from the sleeve and remove spring set from spool.

13. Remove the shaft seals from SCU housing. Discard seals.

CLEAN

WARNING

Cleaning solvents can be flammable and toxic and can cause skin irritation. When using cleaning solvents, always follow the solvent manufacturer's recommended safety precautions.

WARNING

Compressed air can move particles so that they cause injury to the user or to other personnel. Make sure that the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eyes.

Clean all parts in solvent. Dry parts with compressed air. Do not dry parts with a cloth. Make sure all surfaces are free of scratches and sharp edges.

INSPECT

1. Check all components for damage. Replace component if damage is found.

NOTE: Apply thread locker LOXEAL 83-55 thread locker or equivalent to tilt pin before assembly.

ASSEMBLE

WARNING

An improperly assembled steering control unit can cause uncontrollable steering wheel rotation when lift truck power is turned ON. This can cause serious injury to personnel. Be sure steering control unit is operating properly before handling the steering wheel.

NOTE: For lift truck J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) and E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099), see Figure 12. For all other lift truck models, see Figure 11.

1. Using a seal installer, install new shaft seals in SCU housing.

2. Install the spool into sleeve with key slots opposite each other.

3. Insert the curved springs between the flat springs. Install spring set into spool assembly.

NOTE: The retaining ring must be able to rotate unimpeded by the springs.

4. Center the springs in spool assembly and install retaining ring over sleeve.

5. Install the cross pin into spool assembly.

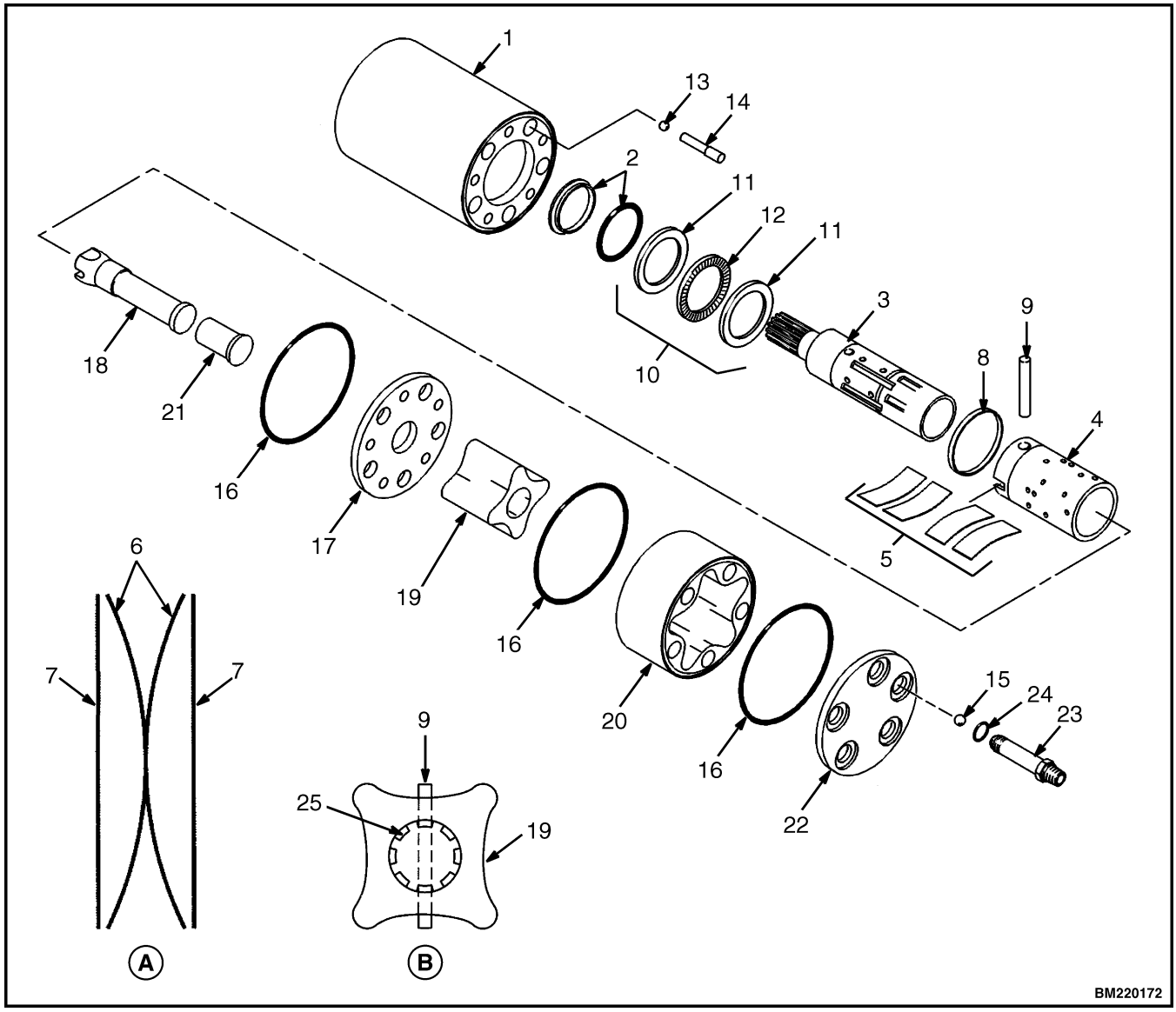
NOTE: Thrust bearing assembly consists of two thrust washers and a single thrust bearing.

6. Install the thrust bearing assembly, as noted during removal, on the shaft end of spool assembly.

7. Place the SCU housing in a soft jawed vise in the horizontal position. Install the spool assembly into housing while holding cross pin in a horizontal position.

8. Rotate SCU housing to the vertical position and rotate the spool so that the cross pin in the spool is pointed to the "P" port position.

9. Install the emergency steering ball, ball stop, and check ball in the "P" port.



NOTE: STEERING CONTROL UNIT (SCU) WITHOUT SYNCHRONOUS STEERING SHOWN. SCU WITH SYNCHRONOUS STEERING IS SIMILAR.

A. SPRING SET ARRANGEMENT

B. CARDAN SHAFT GEAR TEETH

1. STEERING CONTROL UNIT HOUSING
2. SHAFT SEALS
3. SPOOL
4. SLEEVE
5. SPRING SET
6. CURVED SPRING
7. FLAT SPRING
8. RETAINING RING
9. CROSS PIN
10. THRUST BEARING ASSEMBLY
11. THRUST WASHER
12. THRUST BEARING
13. EMERGENCY STEERING BALL
14. BALL STOP
15. CHECK BALL
16. O-RING
17. DISTRIBUTOR PLATE
18. CARDAN SHAFT
19. GEAR
20. GEAR HOUSING
21. SPACER
22. END COVER
23. HYDRAULIC FITTING
24. O-RING
25. GEAR TEETH

Figure 11. Low Pressure Steering Control Unit

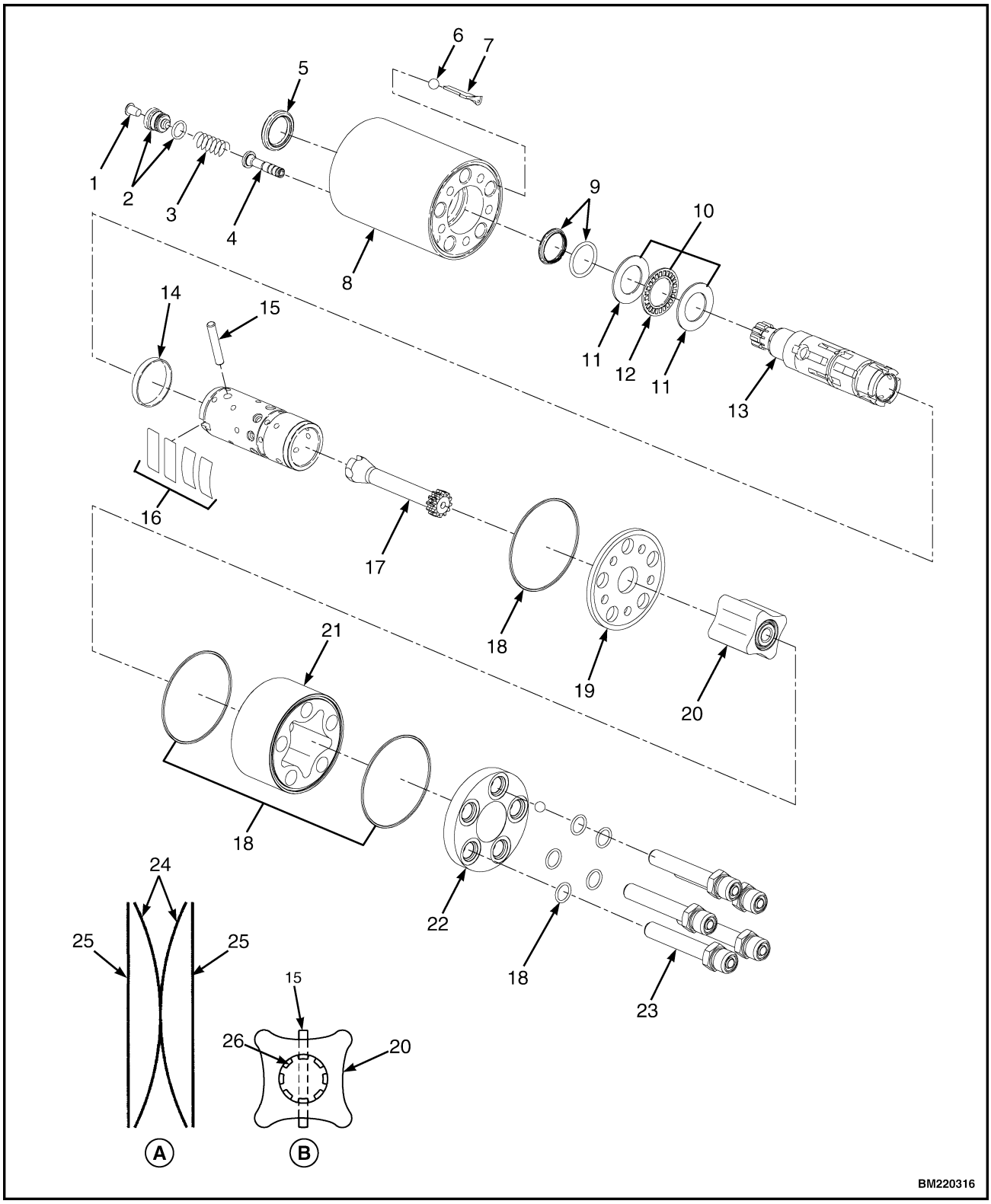


Figure 12. Steering Control Unit for J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) and E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

Legend for Figure 12

NOTE: STEERING CONTROL UNIT (SCU) WITHOUT SYNCHRONOUS STEERING SHOWN. SCU WITH SYNCHRONOUS STEERING IS SIMILAR.

A. SPRING SET ARRANGEMENT

1. CAP
2. ADJUSTING SCREW ASSEMBLY
3. SPRING
4. RELIEF VALVE
5. DUST SEAL RING
6. CHECK BALL
7. BALL STOP
8. STEERING CONTROL UNIT HOUSING
9. SHAFT SEALS
10. THRUST BEARING ASSEMBLY
11. THRUST WASHER
12. THRUST BEARING
13. SPOOL

B. CARDAN SHAFT GEAR TEETH

14. RETAINING RING
15. CROSS PIN
16. SET OF SPRINGS
17. CARDAN SHAFT
18. O-RING
19. DISTRIBUTOR PLATE
20. GEAR
21. GEAR HOUSING
22. END COVER
23. HYDRAULIC FITTING
24. INNER SPRING
25. OUTER SPRING
26. GEAR TEETH

10. Install new O-ring on SCU housing and place distributor plate with holes properly aligned.

11. Install the cardan shaft and rotate it until it is engaged with the cross pin in the spool assembly and the teeth of the gear end are aligned as shown in item B of Figure 11 and Figure 12

12. Install the gear onto cardan shaft.

13. Install new O-rings onto gear housing, install gear housing onto distributor plate, making sure the holes are properly aligned.

14. Place the spacer over cardan shaft and install end cover with "P" hole lined up with "P" port in SCU housing.

15. Install new O-rings and hydraulic fittings on SCU housing. Tighten the fittings to 30 ±3 N•m (266 ±27 lbf in) in a cross pattern.

NOTE: Perform Step 16 and Step 17 for lift trucks equipped with synchronous steering.

16. Install four new O-rings into synchronous steering valve kit. See Figure 10.

17. Install two Allen head capscrews and synchronous steering valve kit onto steering control unit. See Figure 10.

INSTALL

1. Install steering control unit, washers, and capscrews onto tilt base bracket. See Figure 9.

NOTE: Perform Step 2 for lift trucks equipped with synchronous steering.

2. Connect wiring harness to synchronous steering valve kit. See Figure 10.

3. Install steering direction sensor, e-ring, and spring onto steering column. See Figure 8.

WARNING

The hydraulic hoses must be connected to the correct ports or the steering system will not operate as expected, which can cause damage or personal injury. Make sure the hoses are identified and connected correctly.

NOTE: Remove tags from hoses and fittings after installation.

4. Remove caps and plugs. Connect hydraulic hoses to steering control unit fittings, as tagged during removal. See Figure 7.

NOTE: Follow Step 5 through Step 8 for fixed steering column.

5. Maneuver dash panel down over fixed steering column past tilt adjust lever and attach to cowl plate with capscrews.

NOTE: Remove all tags from electrical wiring after installation.

6. Install steering column lower cover and four capscrews. See Figure 4.

7. Install steering column top cover and four capscrews. See Figure 4.

NOTE: Check that clips are attached to steering column covers prior to installation. Replace clips if damaged or missing.

8. Install steering column upper cover by pressing from both sides and pushing against lower cover until snapped in place. See Figure 4.

NOTE: Follow Step 9 through Step 13 for telescopic steering column.

9. Maneuver dash panel down over telescopic steering column past column locking lever, tilt adjust lever, and tilt memory lever. Attach dash panel to cowl plate with capscrews.

10. Install steering column lower cover into place around tilt adjust lever, and fasten in position with four capscrews. See Figure 5.

NOTE: Check that clips are attached to steering column covers prior to installation. Replace clips if damaged or missing.

11. Install steering column upper cover by pressing from both sides and down against lower cover until snapped into place. Fasten in position with washer and capscrew. See Figure 5.

12. Install steering column telescoping cover and four capscrews. See Figure 5.

13. Install steering column top cover by pressing from both sides and pushing down until snapped in place. See Figure 5.

14. Install steering wheel and hex nut on steering column. Tighten nut to 40 to 54 N•m (30 to 40 lbf ft). See Figure 3.

15. Install rod, nut, and horn button in steering wheel. See Figure 2.

16. Connect the battery connector.

Steering Wheel and Fixed Steering Column Assembly Repair

REMOVE

NOTE: The fixed steering column position can be adjusted up or down for different operators and is held in place by cylinder pressure and the pivot shaft.

NOTE: The upper end of the steering column has splines for the steering wheel. The lower end of the steering column has splines to engage the steering control unit.

NOTE: This procedure is for the removal of all components of the steering column assembly. Perform only those steps of the procedure necessary to remove the required component.

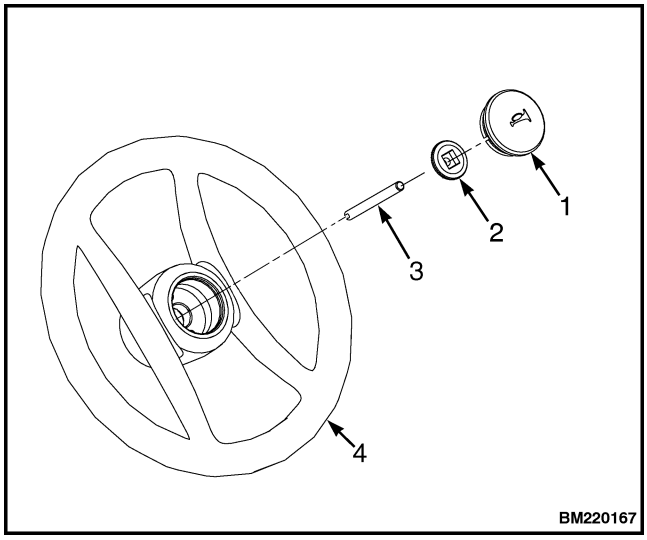
NOTE: For quick access to steer column components perform Step 1 through Step 5.

NOTE: Tag all electrical connectors during removal to aid in installation.

1. Disconnect the battery connector.

2. Discharge capacitors, for procedures see **General** section of this manual.

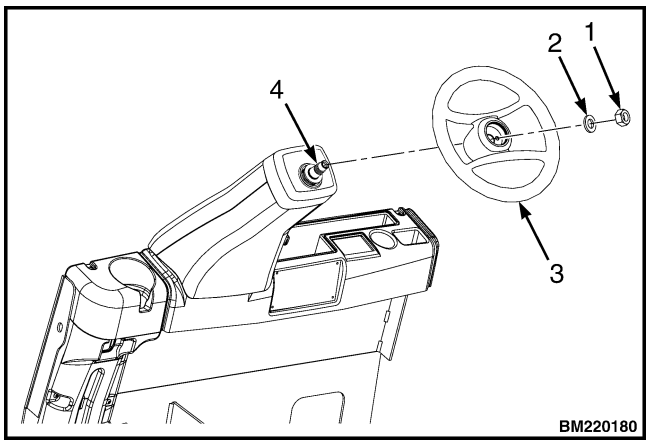
3. Remove horn button, nut, and rod from steering wheel. See Figure 13.



1. HORN BUTTON
2. NUT
3. ROD
4. STEERING WHEEL

Figure 13. Horn Button Assembly and Electrical Connections

4. Remove hex nut, washer (if equipped) and steering wheel from steering column. If necessary, use puller tool to remove steering wheel. See Figure 14.



1. HEX NUT
2. WASHER
3. STEERING WHEEL
4. STEERING COLUMN

Figure 14. Steering Wheel

5. Remove steering column upper cover by pressing from both sides near the bottom and pulling up. Clips should remain attached. See Figure 15.

6. Remove four capscrews and steering column lower cover. See Figure 15.

7. Remove four capscrews and steering column top cover. See Figure 15.

8. Remove three capscrews from dash panel and cowl plate. Lift dash panel over fixed steering column, maneuvering it past the tilt adjust lever. See Figure 16.

NOTE: Tag all hoses and fittings during removal to aid in installation.

NOTE: Install plugs at all hose ports and hose ends to prevent foreign material from entering the hydraulic system.

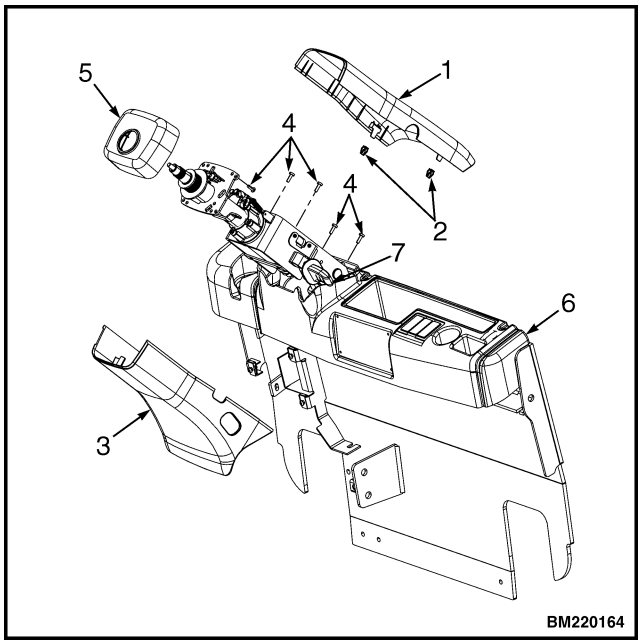
9. Disconnect the hydraulic hoses from the steering control unit fittings. See Figure 17. Set the hydraulic hoses aside to prevent possible damage.

10. Remove spring, e-ring, and steering direction sensor from the steering column. See Figure 18.

11. Remove capscrews, washers, and steering control unit from tilt base bracket. See Figure 19.

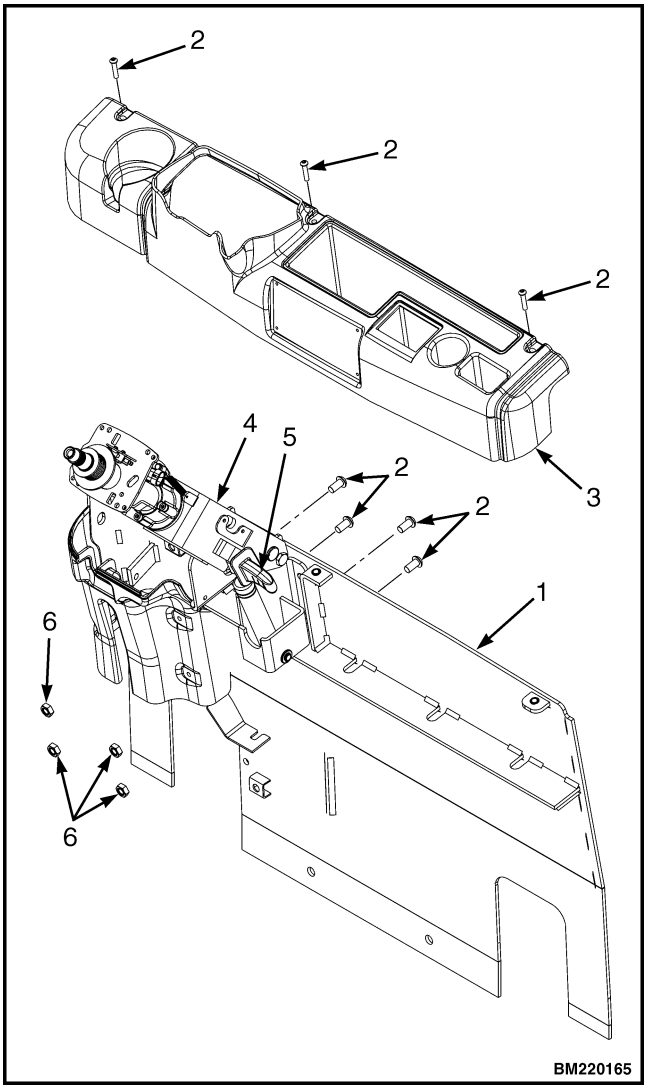
NOTE: Ensure electrical wires and hydraulic hoses are not damaged when steering column is removed.

12. Remove nuts, capscrews and fixed steering column from cowl plate. See Figure 16.



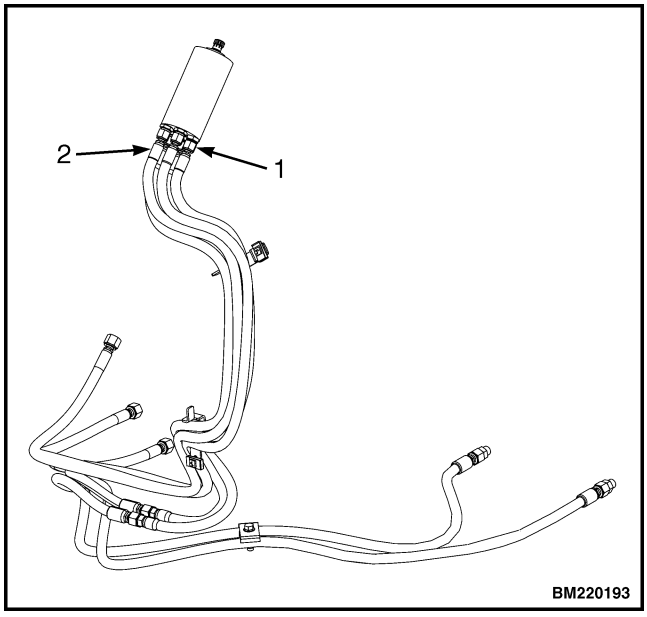
1. STEERING COLUMN UPPER COVER
2. CLIP
3. STEERING COLUMN LOWER COVER
4. CAPSCREW
5. STEERING COLUMN TOP COVER
6. DASH PANEL
7. TILT ADJUST LEVER

Figure 15. Fixed Steering Column Covers



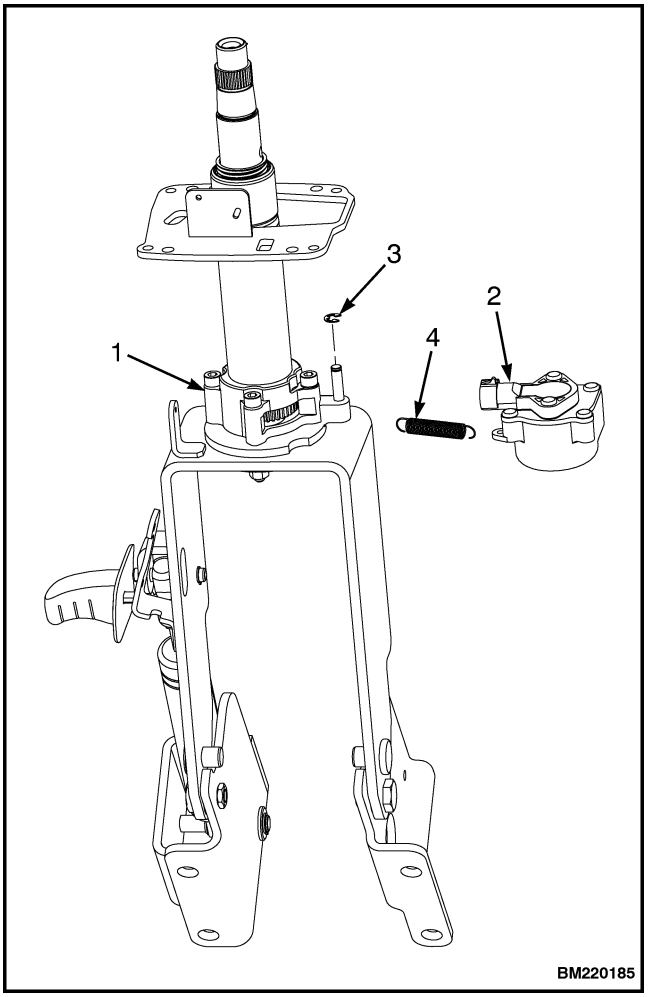
1. COWL PLATE
2. CAPSCREW
3. DASH PANEL
4. FIXED STEERING COLUMN
5. TILT ADJUST LEVER
6. NUT

Figure 16. Fixed Steering Column Attachment



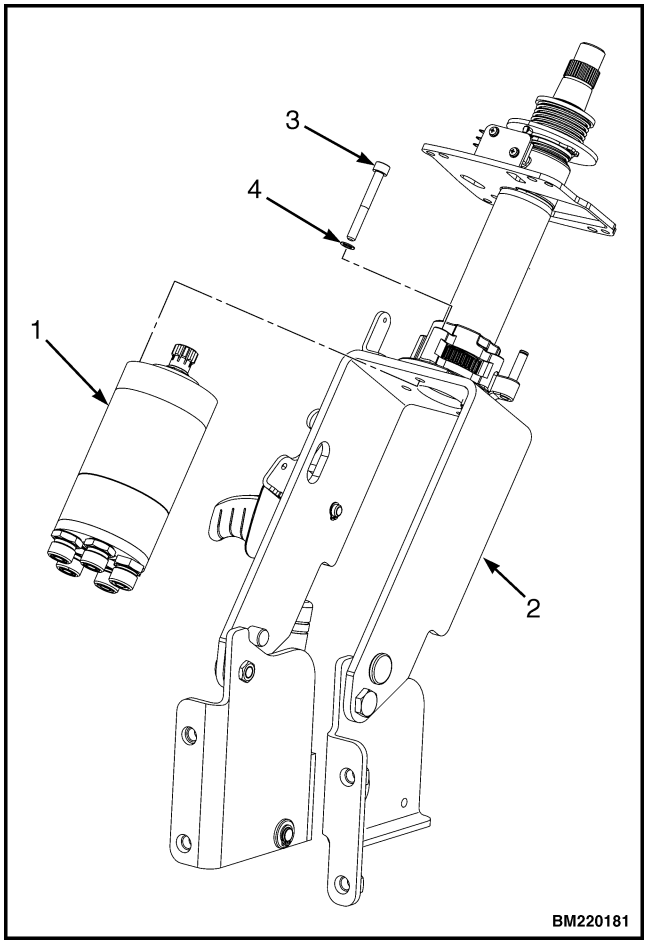
1. STEERING CONTROL UNIT FITTINGS
2. HYDRAULIC HOSE

Figure 17. Hydraulic Hose Connections



1. STEERING COLUMN
2. STEERING DIRECTION SENSOR
3. E-RING
4. SPRING

Figure 18. Steering Direction Sensor



1. STEERING CONTROL UNIT
2. TILT BASE BRACKET
3. CAPSCREW
4. WASHER

Figure 19. Steering Control Unit

DISASSEMBLE

NOTE: Perform only those steps below necessary for the repair or replacement required.

NOTE: Note position and orientation of components during disassembly to aid in assembly.

1. Remove pin, retaining ring, spring, switch contact washer, and snap ring from fixed steering column. See Figure 20.

2. Remove capscrews, washers, tapped plate, and horn switch from horn switch plate. See Figure 20.

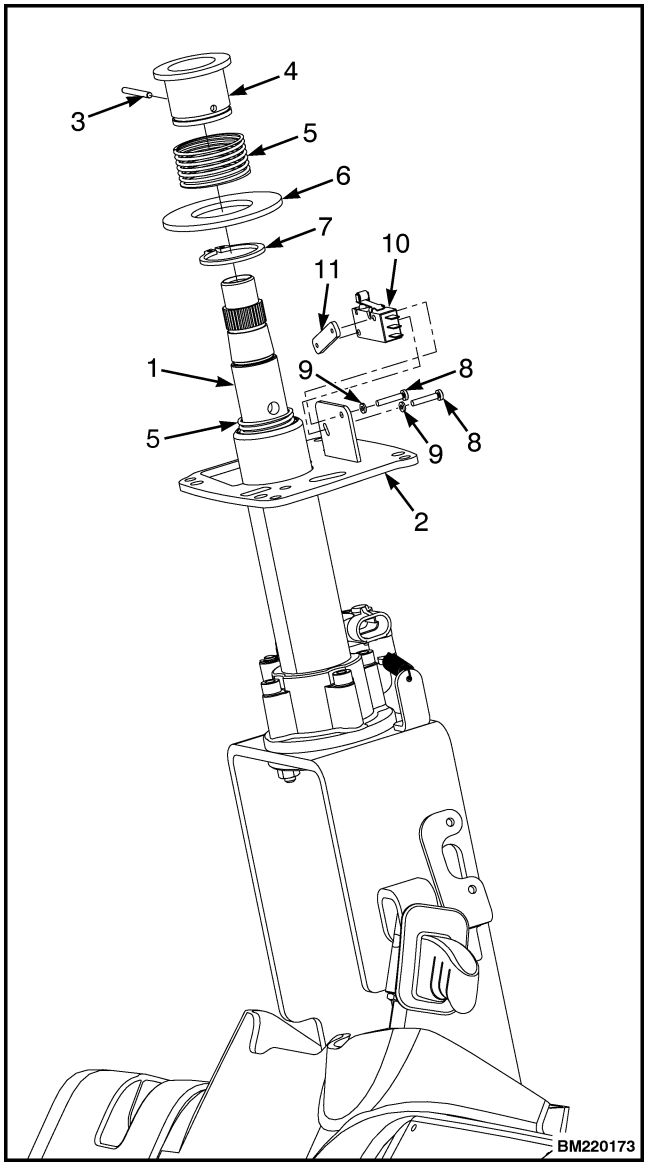
WARNING

Be careful when removing or installing snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers, and wear eye and face protection during removal or installation.

NOTE: Note position of snap rings during disassembly to aid in assembly.

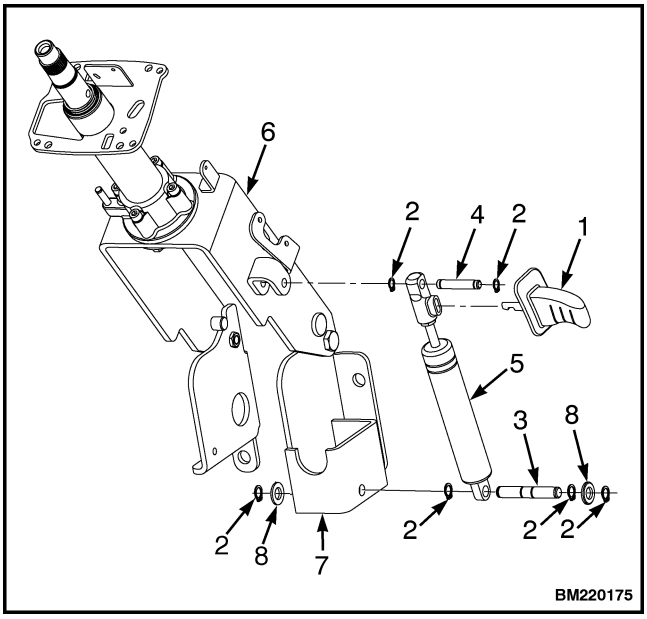
3. Remove tilt adjust lever, snap rings, pivot, pin, collars, and tilt adjust cylinder from tilt base bracket and tilt bracket. See Figure 21.

4. Remove tilt pin, bushing, nut and tilt base bracket from mount bracket and tilt bracket. See Figure 22.



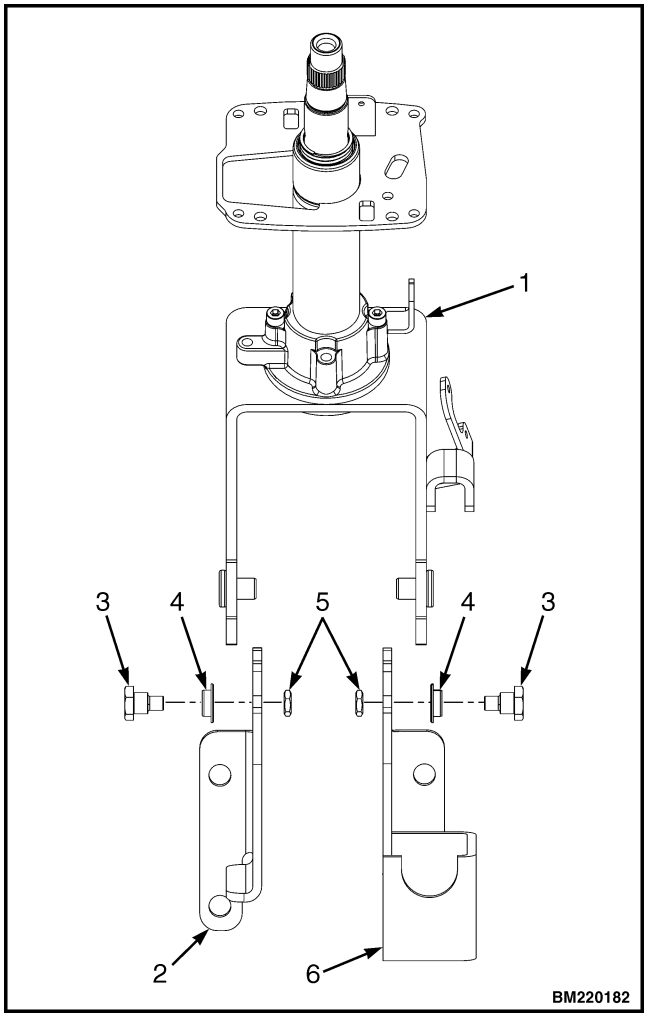
1. FIXED STEERING COLUMN
2. HORN SWITCH PLATE
3. PIN
4. RETAINING RING
5. SPRING
6. SWITCH CONTACT WASHER
7. SNAP RING
8. CAPSCREW
9. WASHER
10. HORN SWITCH
11. TAPPED PLATE

Figure 20. Horn Switch



1. TILT ADJUST LEVER
2. SNAP RING
3. PIVOT
4. PIN
5. TILT ADJUST CYLINDER
6. TILT BASE BRACKET
7. TILT BRACKET
8. COLLAR

Figure 21. Tilt Adjust Lever and Cylinder



1. TILT BASE BRACKET
2. MOUNT BRACKET
3. TILT PIN
4. BUSHING
5. NUT
6. TILT BRACKET

Figure 22. Brackets - Steering Column

CLEAN

WARNING

Cleaning solvents can be flammable and toxic and can cause skin irritation. When using cleaning solvents, always follow the solvent manufacturer's recommended safety procedures.

WARNING

Compressed air is used for cleaning or drying purposes, or for clearing restrictions. Wear protective clothing (goggles/shield, gloves, etc.) to avoid injury to personnel.

1. Use cleaning solvent to clean metal components only, do not use on any component that has plastic or rubber parts. Dry with compressed air.
2. Clean plastic or rubber components using warm soapy water and wipe dry with a lint free cloth.

INSPECT

1. Check all components for damage. Replace damaged components.

ASSEMBLE

NOTE: Apply thread locker LOXEAL 83-55 thread locker or equivalent to tilt pin before assembly.

1. Assemble tilt base bracket onto mount bracket and tilt bracket with bushings, tilt pins, and nuts. See Figure 22.

WARNING

Be careful when removing or installing snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers, and wear eye and face protection during removal or installation.

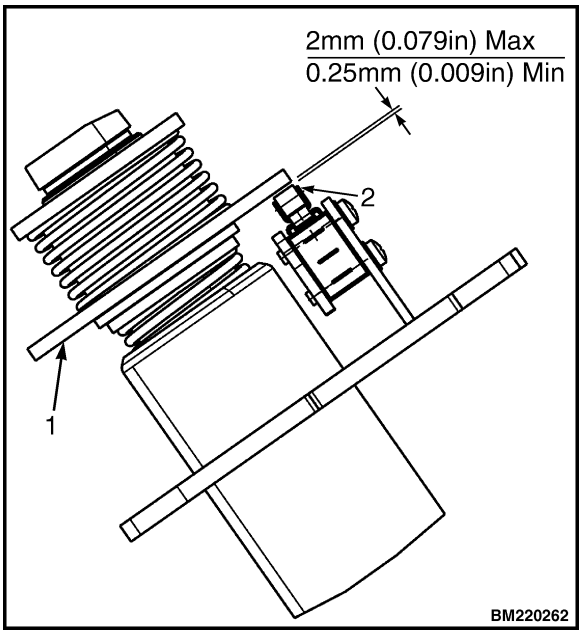
NOTE: Ensure snap rings are positioned correctly to hold the cylinder in place.

2. With tilt adjust cylinder end inside tilt bracket, insert pivot through tilt bracket holes and cylinder end; install collars and snap rings. See Figure 21.
3. Insert pin through tilt base bracket holes and top end of tilt adjust cylinder; install snap rings and tilt adjust lever. See Figure 21.
4. Install steering direction sensor, e-ring, and spring to steering column. See Figure 18.
5. Assemble horn switch, tapped plate, washers, and capscrews; attach to horn switch plate as noted during disassembly. See Figure 20.
6. Measure gap between switch contact washer and horn switch. If gap does not meet specification shown in Figure 23 adjust as required.
7. Install snap ring, switch contact washer, spring, retaining ring, and pin on fixed steering column. See Figure 20.

INSTALL

NOTE: Ensure electrical wires and hydraulic hoses are not damaged during installation.

1. Install fixed steering column, capscrews, and nuts onto cowl plate. Tighten capscrews to 52 N•m (38 lbf ft). See Figure 16.
2. Install steering control unit, washers, and capscrews onto tilt base bracket. See Figure 19.



1. SWITCH CONTACT WASHER
2. HORN SWITCH

Figure 23. Horn Switch Gap

WARNING

The hydraulic hoses must be connected to the correct ports or the steering system will not operate as expected, which can cause damage or personal injury. Make sure the hoses are identified and connected correctly.

NOTE: Remove tags from hoses and fittings after installation.

3. Remove plugs from hose ports and hose ends. Connect hydraulic hoses to steering control unit fittings, as tagged in removal. See Figure 17.

4. Maneuver dash panel down over fixed steering column past tilt adjust lever and attach onto cowl plate with capscrews. See Figure 16.

NOTE: Ensure the lower steering column cover is pushed into the steering column top cover as far as possible before tightening capscrews.

5. Install steering column lower cover and four capscrews. See Figure 15.

NOTE: Check that clips are attached to steering column covers prior to installation. Replace clips if damaged or missing.

6. Install steering column top cover and four capscrews. See Figure 15.

7. Install steering column upper cover by pressing from both sides and pushing against lower cover until snapped in place. See Figure 15.

8. Install steering wheel, hex nut and washer (if equipped) on steering column. Tighten nut 40 to 54 N•m (30 to 40 lbf ft). See Figure 14.

9. Install rod, nut, and horn button in steering wheel. See Figure 13.

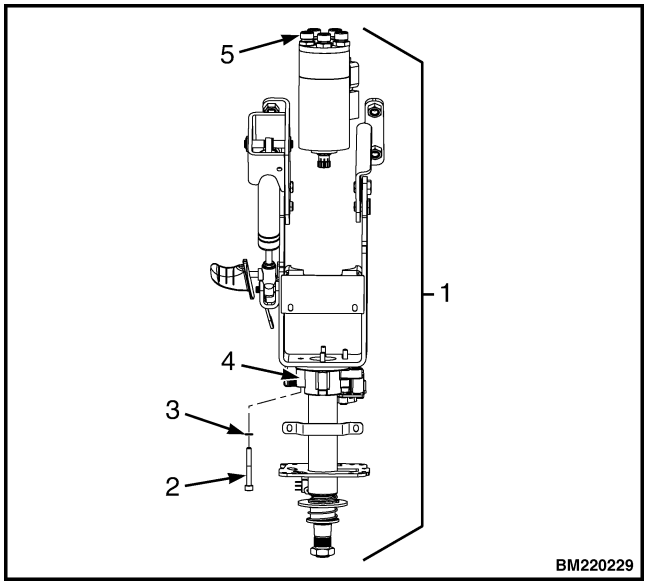
10. Connect battery connector.

GEAR REPLACEMENT FOR LIFT TRUCKS BUILT PRIOR TO OCTOBER, 2008

1. Follow steps outlined in Remove section, then perform steps below.

2. Place steering column upside down in stand.

3. Remove four capscrews and washers from pump mount and steering control unit (SCU). See Figure 24.



1. FIXED STEERING COLUMN
2. CAPSCREW
3. WASHER
4. PUMP MOUNT
5. STEERING CONTROL UNIT (SCU)

Figure 24. Fixed Steering Column SCU Remove/ Install

4. Remove steering control unit (SCU) from tilt base bracket. See Figure 24.

NOTE: The column shaft is not easily removed due to the location of the snap ring holding the shaft under the upper bearing. The best way to remove the gear is to split the gear using a hammer and chisel, allowing it to slide off.

5. Remove lower snap ring. See Figure 25.

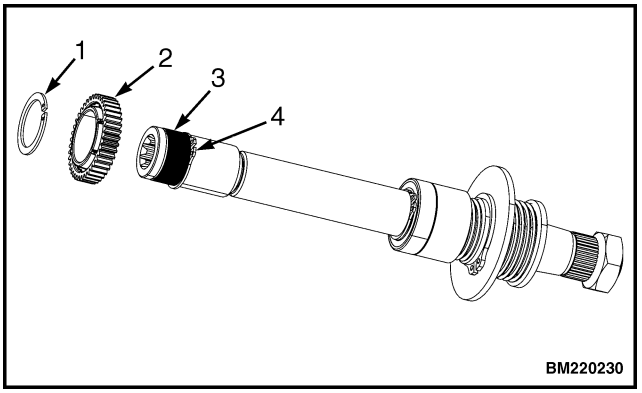
6. Split column gear using hammer and chisel. Remove and discard gear. See Figure 25.

7. Using a press, install new column gear. Press gear onto knurled shaft until against upper snap ring. See Figure 25.

8. Remove any displaced material from snap ring groove area.

9. Install lower snap ring. See Figure 25.

10. Install steering control unit (SCU) onto tilt base bracket. See Figure 24.



NOTE: STEERING COLUMN PLATES, BRACKETS, AND MOUNT FIXTURES NOT SHOWN FOR CLARITY.

1. LOWER SNAP RING
2. COLUMN GEAR
3. KNURLED SHAFT
4. UPPER SNAP RING

Figure 25. Column Gear

11. Install four washers and capscrews onto pump mount and steering control unit (SCU). See Figure 24.

12. Return steering column to upright position.

13. Follow steps outlined in Install section to complete steering column installation.

Steering Wheel and Telescopic Column Assembly Repair

REMOVE

NOTE: The telescopic steering column is optional on the following lift trucks:

- E2.2-3.5XN (E45-70XN) (A268)
- E1.6-2.0XN (E30-40XN) (A269)
- J2.2-3.5XN (J45-70XN) (A276)
- J1.6-2.0XN (J30-40XN) (A935)
- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)
- E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

NOTE: The telescopic steering column position can be adjusted up, down, forward, and back for different operators. The column is held in position by locking tilt cylinder pressure, a pivot, and column locking lever.

NOTE: The upper end of the steering shaft has splines for the steering wheel. The lower end of the steering shaft has splines to engage the steering control unit.

NOTE: This procedure is for the removal of all components of the telescopic steering column assembly. Perform only those steps of the procedure necessary to remove the required component.

NOTE: For quick access to steer column perform Step 1 through Step 7.

NOTE: Tag all electrical connectors during removal to aid in installation.

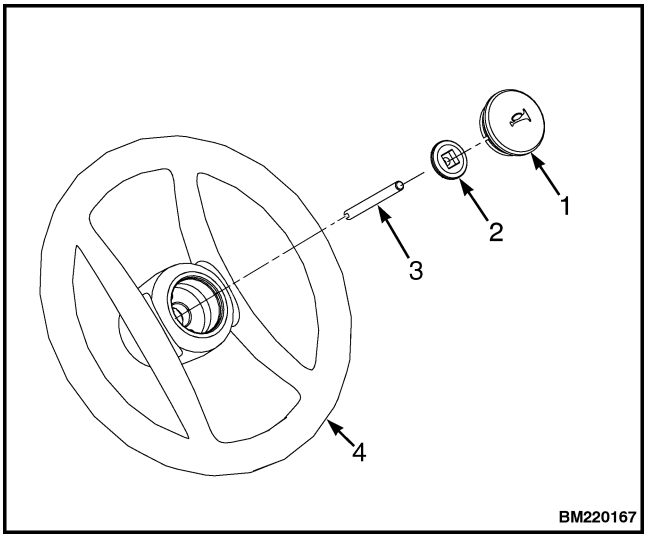
1. Disconnect the battery connector.

2. Discharge capacitors, for procedures see **General** section of this manual.

3. Remove horn button, nut, and rod from steering wheel. See Figure 26.

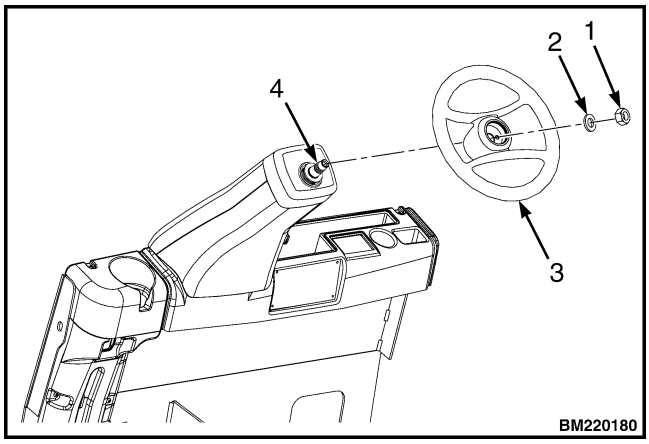
4. Remove hex nut, washer (if equipped) and steering wheel from steering column. If necessary use puller tool to remove steering wheel. See Figure 27.

5. Remove steering column top cover by pressing from both sides and pulling up. Clips should remain attached. See Figure 28.



1. HORN BUTTON
2. NUT
3. ROD
4. STEERING WHEEL

Figure 26. Horn Button Assembly and Electrical Connections



1. HEX NUT
2. WASHER
3. STEERING WHEEL
4. STEERING COLUMN

Figure 27. Steering Wheel

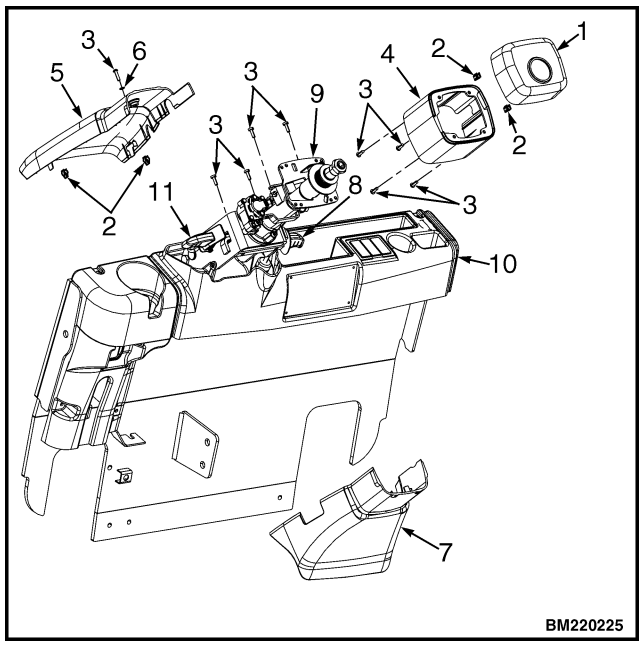
6. Remove capscrews and steering column telescoping cover. See Figure 28.

7. Remove capscrew and washer; press steering column upper cover from both sides and pull up. Clips should remain attached; remove fold-over nut from upper bracket. See Figure 28.

8. Remove capscrews, steering column lower cover, upper bracket, and lower bracket. Steering column lower cover to be maneuvered around tilt memory lever. See Figure 28.

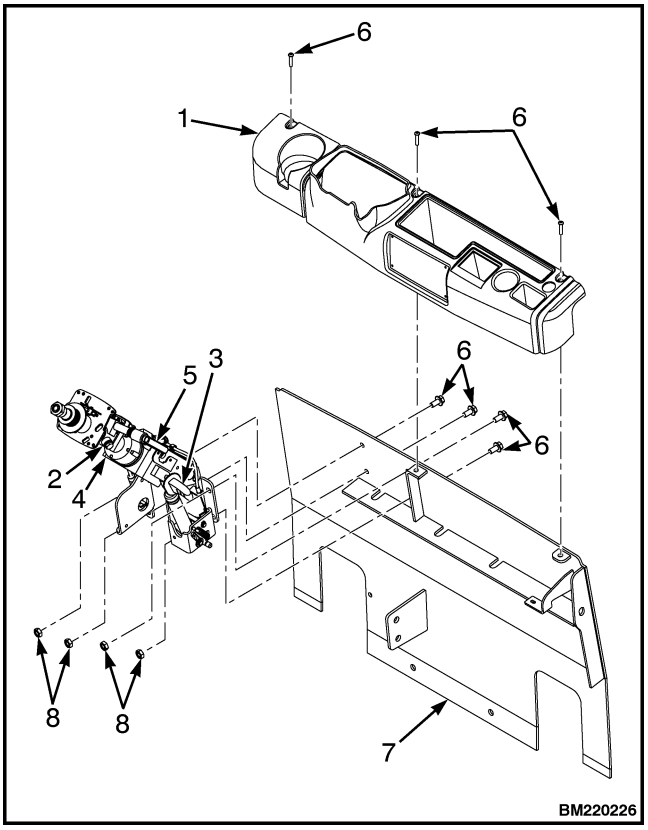
9. Remove capscrews from dash panel and cowl plate. Lift dash panel over telescopic steering column, maneuvering it past the tilt memory lever, adjust lever, and column locking knob. See Figure 29.

NOTE: Tag all hoses and fittings during disassembly to aid in assembly. Tags on hoses and fittings should reflect letter squence on steering control unit end cover.



1. STEERING COLUMN TOP COVER
2. CLIP
3. CAPSCREW
4. STEERING COLUMN TELESCOPING COVER
5. STEERING COLUMN UPPER COVER
6. WASHER
7. STEERING COLUMN LOWER COVER
8. TILT ADJUST LEVER
9. TELESCOPIC STEERING COLUMN
10. DASH PANEL
11. TILT MEMORY LEVER

Figure 28. Telescopic Steering Column Covers



1. DASH PANEL
2. TELESCOPIC STEERING COLUMN
3. TILT ADJUST LEVER
4. TILT MEMORY LEVER
5. COLUMN LOCKING LEVER
6. CAPSCREW
7. COWL PLATE
8. NUT

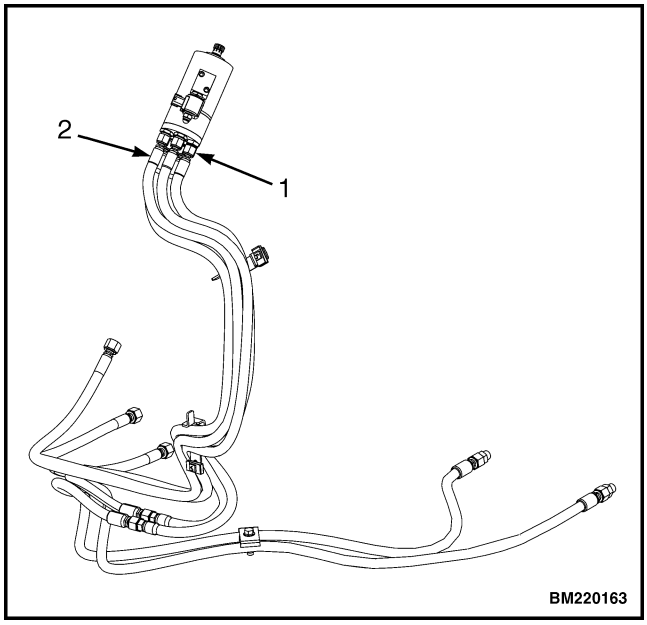
Figure 29. Telescopic Steering Column Attachment

NOTE: Insert plugs at all hose ports and hose ends to prevent foreign material from entering the hydraulic system.

10. Disconnect hydraulic hoses from steering control unit fittings. See Figure 30. Set the hydraulic hoses aside to prevent possible damage.

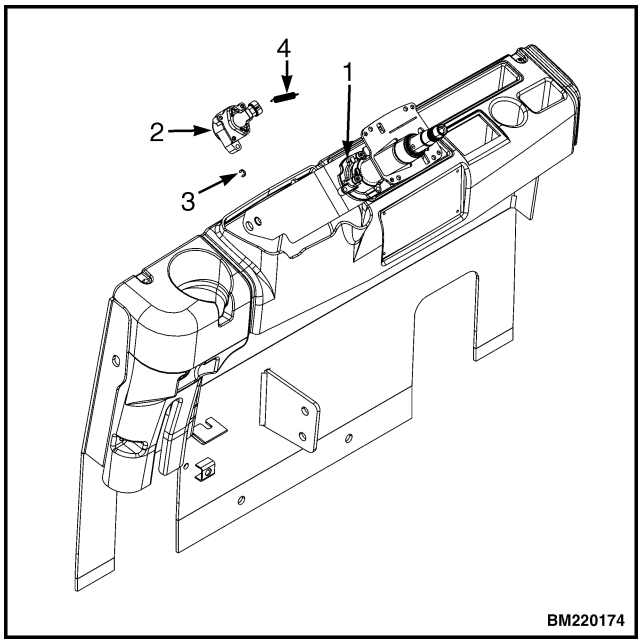
11. Remove spring, e-ring, and steering direction sensor from steering column. See Figure 31.

12. Remove capscrews, washers, and steering control unit from tilt base bracket. See Figure 32.



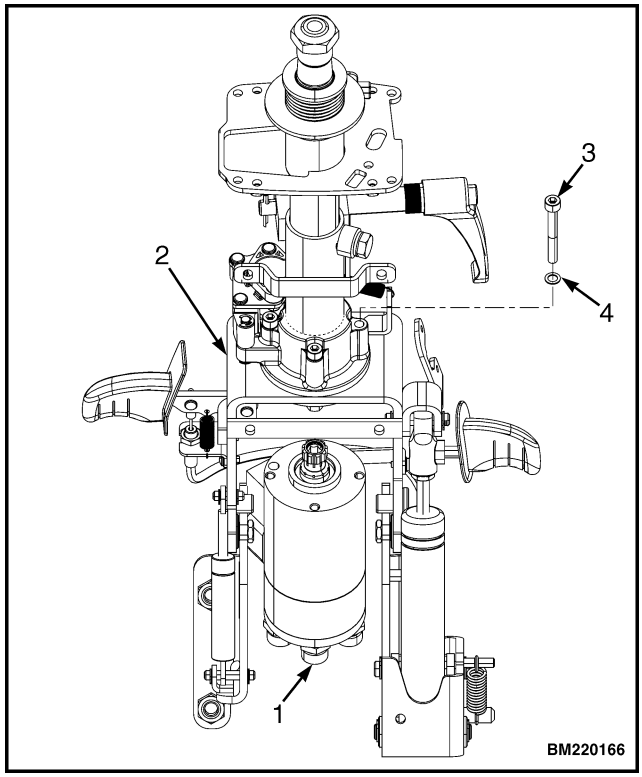
1. STEERING CONTROL UNIT FITTING
2. HYDRAULIC HOSE

Figure 30. Hydraulic Hose Connections



1. STEERING COLUMN
2. STEERING POSITION SENSOR
3. E-RING
4. SPRING

Figure 31. Steering Position Sensor



1. STEERING CONTROL UNIT
2. TILT BASE BRACKET
3. CAPSCREW
4. WASHER

Figure 32. Steering Control Unit

NOTE: Ensure electrical wires and hydraulic hoses are not damaged when telescopic steering column is removed.

13. Remove nuts, capscrews, and telescopic steering column assembly from cowl plate. See Figure 29.

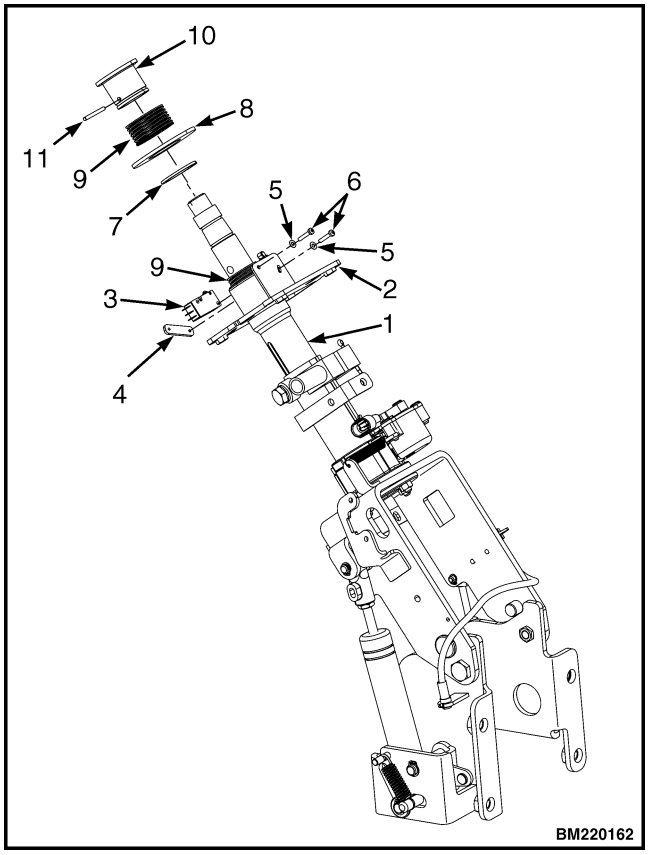
DISASSEMBLE

NOTE: Only perform those steps below necessary for required repair or replacement.

NOTE: Note placement and orientation of components prior to disassembly to aid in assembly.

1. Remove pin, retaining ring, spring, switch contact washer, and snap ring from telescopic steering column. See Figure 33.

2. Remove capscrews, washers, tapped plate, and horn switch from the horn switch plate. See Figure 33.



1. TELESCOPIC STEERING COLUMN
2. HORN SWITCH PLATE
3. HORN SWITCH
4. TAPPED PLATE
5. WASHER
6. CAPSCREW
7. SNAP RING
8. SWITCH CONTACT WASHER
9. SPRING
10. RETAINING RING
11. PIN

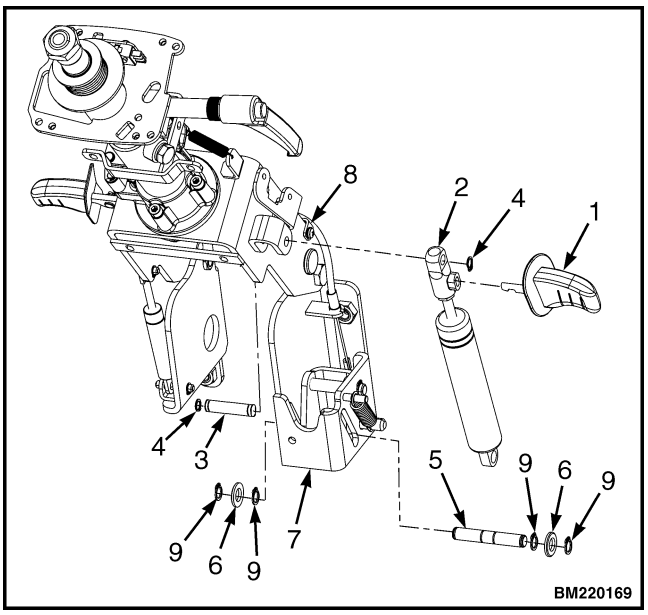
Figure 33. Horn Switch

WARNING

Be careful when removing or installing snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers, and wear eye and face protection during removal or installation.

NOTE: Note placement of snap rings during disassembly to aid in assembly.

3. Remove tilt adjust lever, upper snap rings, pin, lower snap rings, collar, pivot, and tilt adjust cylinder from the tilt base bracket and tilt bracket. See Figure 34.



1. TILT ADJUST LEVER
2. TILT ADJUST CYLINDER
3. PIN
4. UPPER SNAP RING
5. PIVOT
6. COLLAR
7. TILT BRACKET
8. TILT BASE BRACKET
9. LOWER SNAP RING

Figure 34. Tilt Adjust Cylinder - Telescopic Steering Column

4. Remove cotter pin and column locking lever from pinch blocks on telescopic steering column. See Figure 35.

5. Disassemble the cylinder, cable assembly, and adjust lever as indicated below:

NOTE: Note position of cable assembly during disassembly to aid in assembly.

a. Disconnect cable assembly from tilt memory release lever and remove from anchor bracket. See Figure 36.

b. Remove spring from anchor bracket and tilt memory release lever. See Figure 36.

c. Remove screws, washers, and anchor bracket from tilt base bracket. See Figure 36.

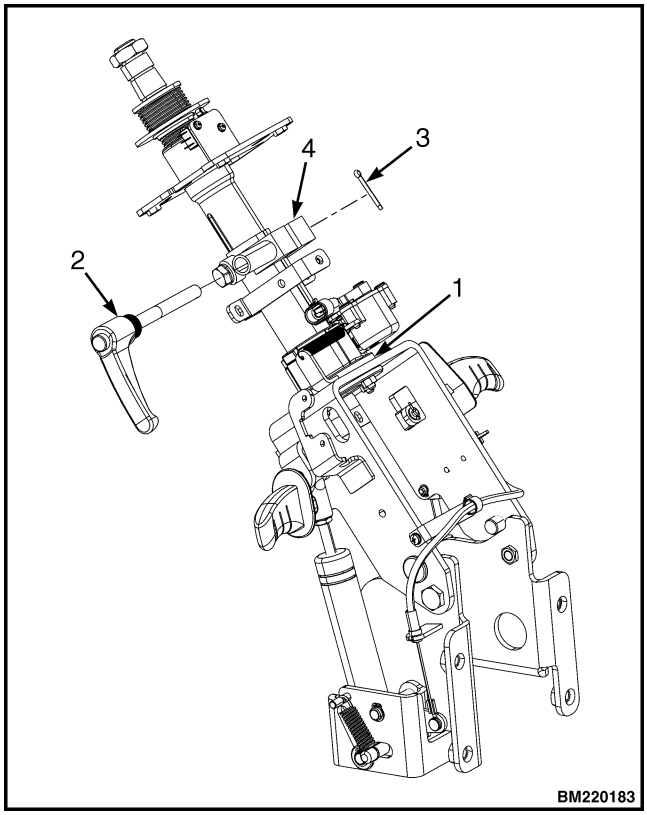
d. Remove pivot pin, washer, and cotter pin and remove tilt memory lever from tilt base bracket. See Figure 36.

e. Remove e-ring, cable anchor pin, and cable assembly from tilt memory bracket. See Figure 37.

f. Remove snap rings and lower pin from mount bracket and lift cylinder end. See Figure 38.

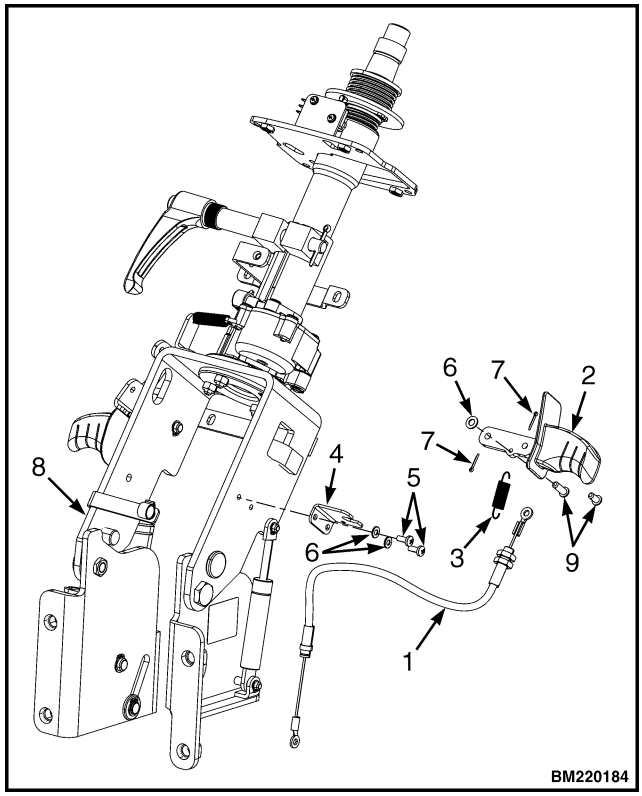
g. Remove snap rings and upper pin from tilt base bracket and lift cylinder end; remove lift cylinder. See Figure 38.

6. Remove nuts, tilt pins, bushings, and tilt base bracket from mount bracket and tilt memory bracket. See Figure 39.



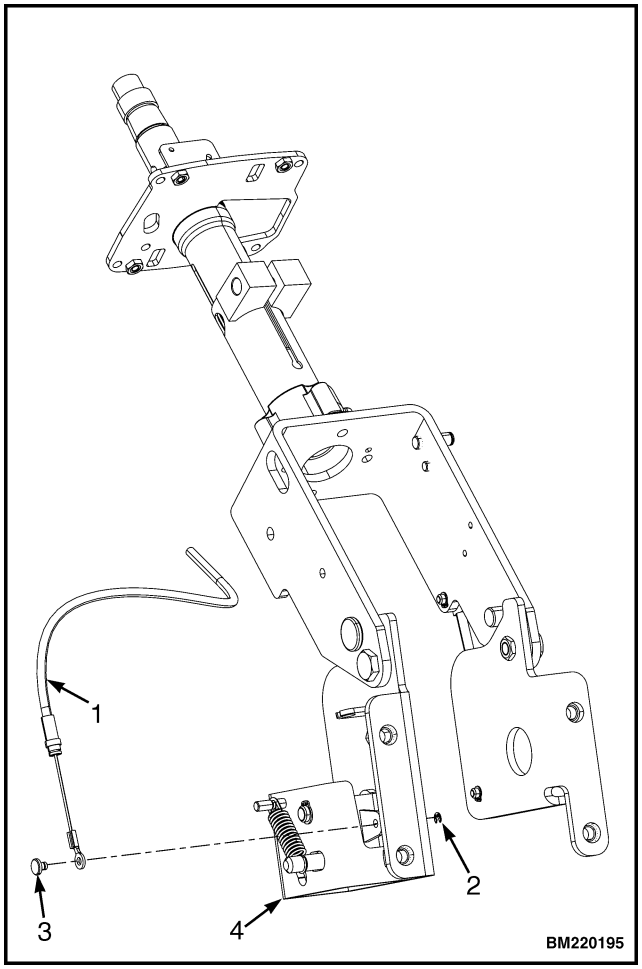
1. TELESCOPIC STEERING COLUMN
2. COLUMN LOCKING LEVER
3. COTTER PIN
4. PINCH LEVER

Figure 35. Column Locking Lever



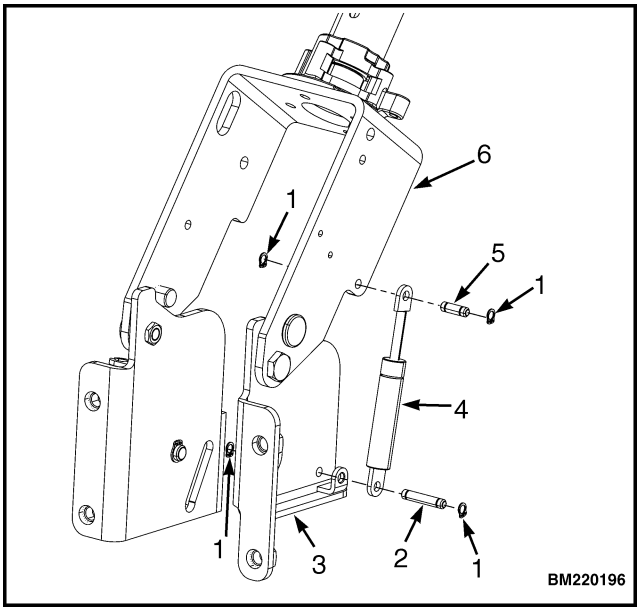
1. CABLE ASSEMBLY
2. TILT MEMORY LEVER
3. SPRING
4. ANCHOR BRACKET
5. SCREW
6. WASHER
7. COTTER PIN
8. TILT BASE BRACKET
9. PIVOT PIN

Figure 36. Tilt Memory Lever



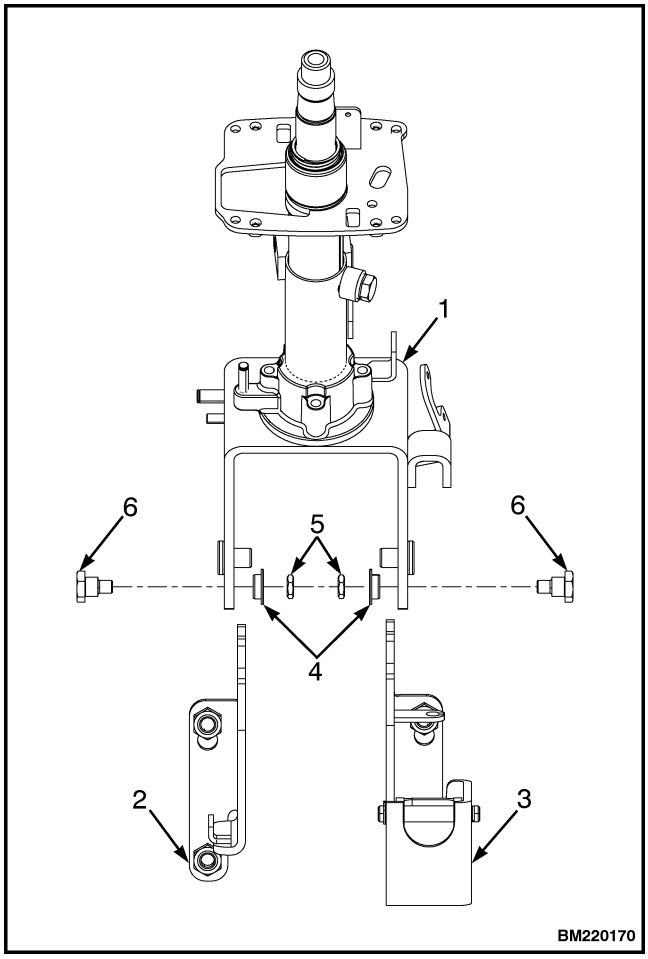
1. CABLE ASSEMBLY
2. E-RING
3. CABLE ANCHOR PIN
4. TILT MEMORY BRACKET

Figure 37. Tilt Memory Release Cable



1. SNAP RING
2. LOWER PIN
3. MOUNT BRACKET
4. LIFT CYLINDER
5. UPPER PIN
6. TILT BASE BRACKET

Figure 38. Telescopic Adjust Cylinder



1. TILT BASE BRACKET
2. MOUNT BRACKET
3. TILT BRACKET
4. BUSHING
5. NUT
6. TILT PIN

Figure 39. Brackets - Telescopic Steering Column

CLEAN

WARNING

Cleaning solvents can be flammable and toxic and can cause skin irritation. When using cleaning solvents, always follow the solvent manufacturer's recommended safety procedures.

WARNING

Compressed air is used for cleaning or drying purposes, or for clearing restrictions. Wear protective clothing (goggles/shield, gloves, etc.) to avoid injury to personnel.

1. Use cleaning solvent to clean metal components only, do not use on any component that has plastic or rubber parts. Dry with compressed air.
2. Clean plastic or rubber components using warm soapy water and wipe dry with a lint free cloth.

INSPECT

1. Check all components for damage. Replace damaged components.

ASSEMBLE

NOTE: Apply thread locker LOXEAL 83-55 thread locker or equivalent to tilt pin before assembly.

1. Assemble tilt base bracket onto mount bracket and tilt bracket with bushings, tilt pins, and nuts. See Figure 39.
2. Assemble lift cylinder, cable assembly, and lever as indicated below:
   a. Attach cable assembly to the upper and lower connection points using anchor pins and e-ring. See Figure 37.

WARNING

Be careful when removing or installing snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers, and wear eye and face protection during removal or installation.

   b. Attach lift cylinder into mount bracket by inserting lower pin through bracket holes and lift cylinder end; install snap rings. See Figure 38.
   c. While compressing lift cylinder upright, insert upper pin through tilt base bracket holes and lift cylinder end; install snap rings. See Figure 38.
   d. Install anchor bracket, washers, and screws on tilt base bracket. See Figure 36.
   e. Install adjust lever to tilt base bracket using pivot pin, washer, and cotter pin. See Figure 36.
   f. Install spring between adjust lever and anchor bracket. See Figure 36.
   g. Position cable assembly into anchor bracket, as noted during disassembly. See Figure 36.
   h. With the lower end of the cable (non lever end) properly connected to the assembly, install the threaded end of the cable to the cable support bracket using the cable hex nut. The nut should have a final torque of 16 N•m (142 lbf in) applied. Install the cable eyelet to the lever with the small clevis pin and e-clip. See Figure 36. When properly adjusted, there should not be tension on the cable when the lever is in the relaxed position.

   On the other end of the cable, the large pin with the return spring should have full travel in the pin slot as the lever is actuated. Finally, with the column positioned toward the front of the truck, the cable must not uncouple from the lower base.

3. Install column locking lever through pinch blocks and insert cotter pin. See Figure 35.

WARNING

Be careful when removing or installing snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers, and wear eye and face protection during removal or installation.

NOTE: Ensure snap rings are positioned correctly to hold cylinder in position.

4. With tilt cylinder bottom inside tilt memory bracket, insert pivot through bracket holes and cylinder end; install collars and snap rings. See Figure 34.

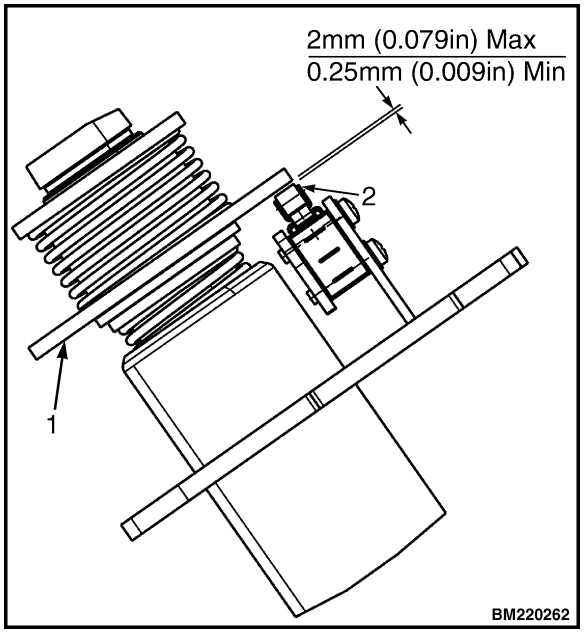
5. Insert pin through tilt base bracket holes and top end of tilt cylinder; install snap rings and tilt lever. See Figure 34.

6. Install steering direction sensor, e-ring, and spring on steering column. See Figure 31.

7. Assemble horn switch, tapped plate, washers, and capscrews; attach to horn switch plate. See Figure 33.

8. Install snap ring, switch contact washer, spring, retaining ring, and pin on telescopic steering column. See Figure 33.

9. Measure gap between switch contact washer and horn switch. If gap does not meet specification shown in Figure 40 adjust as required.



1. SWITCH CONTACT WASHER
2. HORN SWITCH

Figure 40. Horn Switch Gap

INSTALL

NOTE: Ensure electrical wires and hydraulic hoses are not damaged during installation.

1. Install telescopic steering column, capscrews, and nuts onto cowl plate. Tighten capscrews to 52 N•m (38 lbf ft). See Figure 29.

2. Install steering control unit, capscrews, and washers into tilt base bracket. See Figure 32.

WARNING

The hydraulic hoses must be connected to the correct ports or the steering system will not operator as expected, which can cause damage or personal injury. Make sure the hoses are identified and connected correctly.

NOTE: Remove tags from hoses and fittings after installation.

3. Remove plugs from hose ports and hose ends. Connect hydraulic hoses to steering control unit fittings, as tagged during removal. See Figure 30.

4. Maneuver dash panel down over telescopic steering column past column locking lever, tilt memory lever, and tilt lever; attach to cowl plate with capscrews. See Figure 29.

NOTE: Check that clips are attached to steering column covers prior to installation. Replace clips if damaged or missing.

5. Maneuver steering column lower cover around tilt memory lever; install upper bracket, lower bracket, and capscrews. See Figure 28.

6. Install steering column telescoping cover and capscrews. See Figure 28.

7. Install steering column upper cover and clips; squeeze both sides and push down until snapped into place. See Figure 28.

8. Install steering wheel, washer (if equipped) and hex nut on steering column. Tighten nut to 40 to 54 N•m (30 to 40 lbf ft). See Figure 27.

9. Connect horn electrical wires; tighten setscrews; install rod, nut, and horn button in steering wheel. See Figure 26.

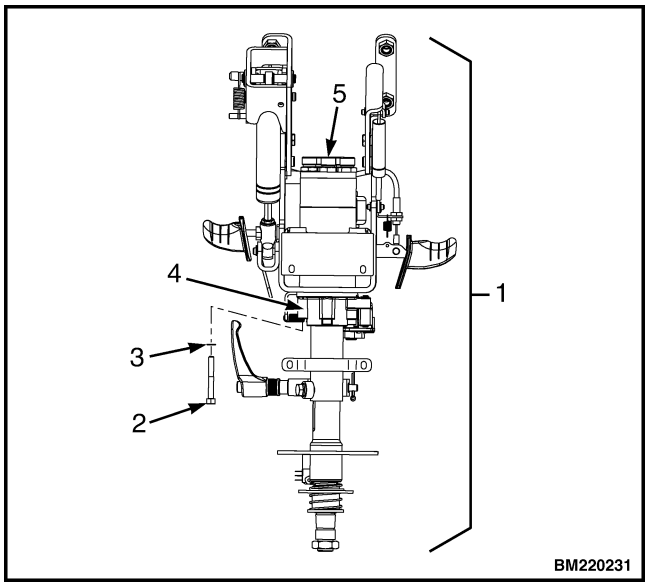
10. Connect battery connector.

GEAR REPLACEMENT FOR LIFT TRUCKS BUILT PRIOR TO OCTOBER, 2008

STEP 1.
Follow steps in Remove section, then continue with steps below.

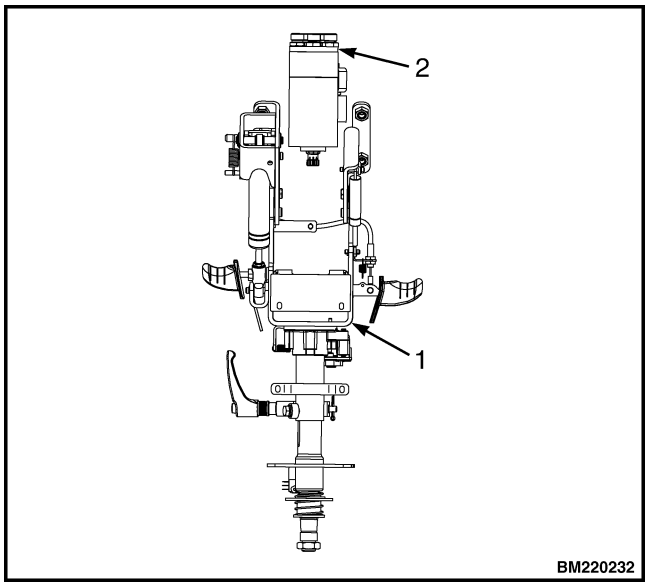
STEP 2.
Place steering column upside down in a stand.

STEP 3.
Remove four capscrews and washers from pump mount and steering control unit.



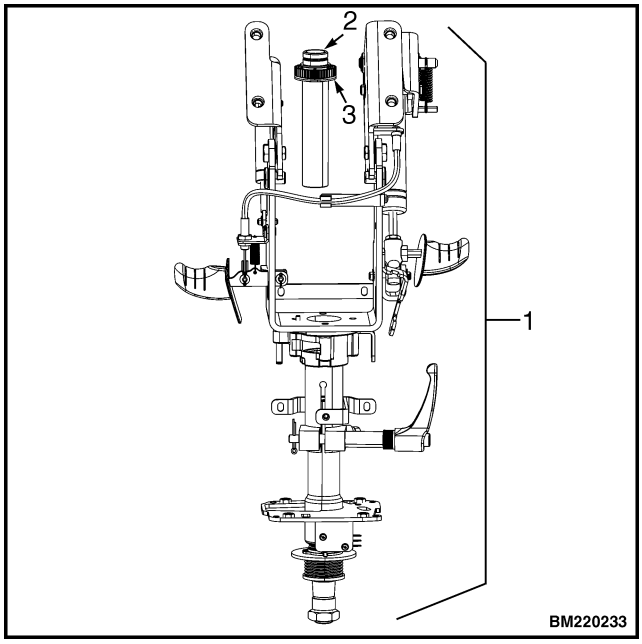
1. TELESCOPIC STEERING COLUMN
2. CAPSCREW
3. WASHER
4. PUMP MOUNT
5. STEERING CONTROL UNIT

STEP 4.
Remove steering control unit from tilt base bracket.



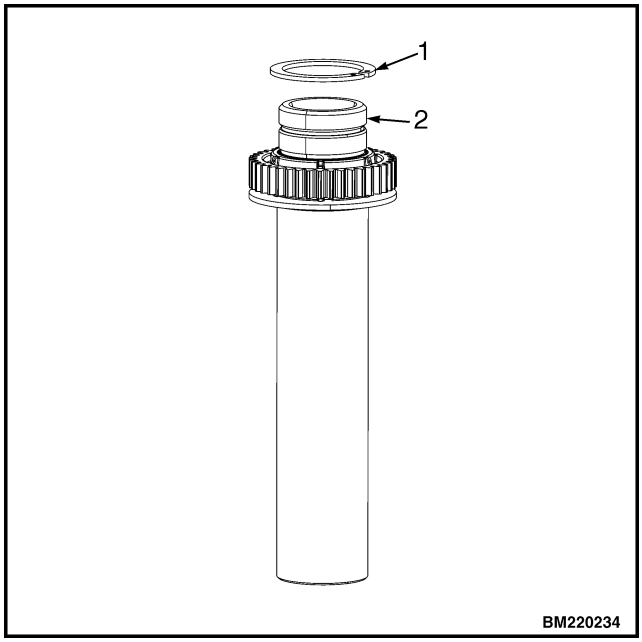
1. TILT BASE BRACKET
2. STEERING CONTROL UNIT

STEP 5.
Remove tube with column gear from telescopic steering column.



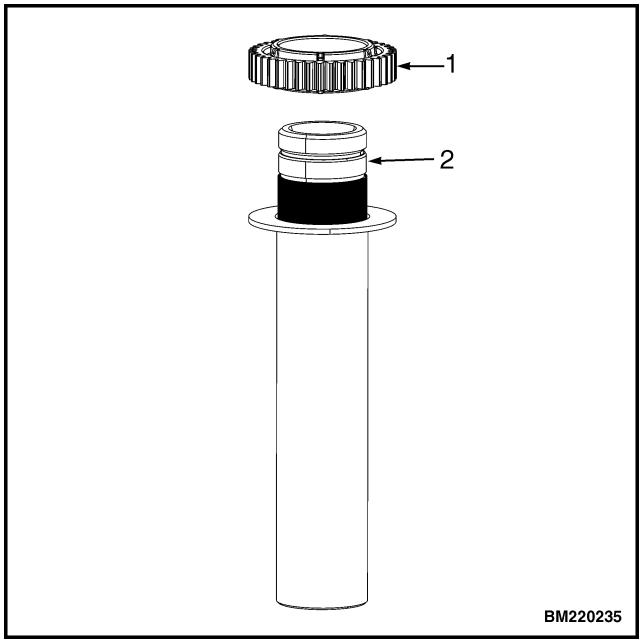
1. TELESCOPIC STEERING COLUMN
2. TUBE
3. COLUMN GEAR

STEP 6.
Remove lower snap ring from tube.



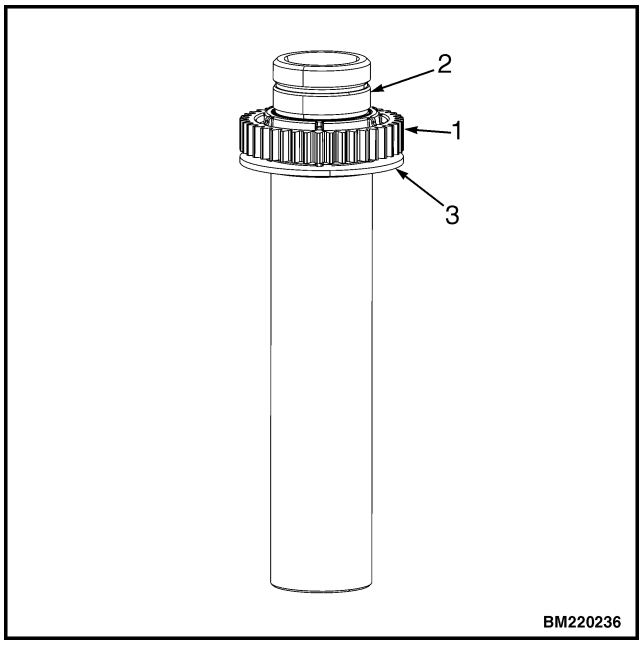
1. LOWER SNAP RING
2. TUBE

STEP 7.
Remove and discard column gear from tube.



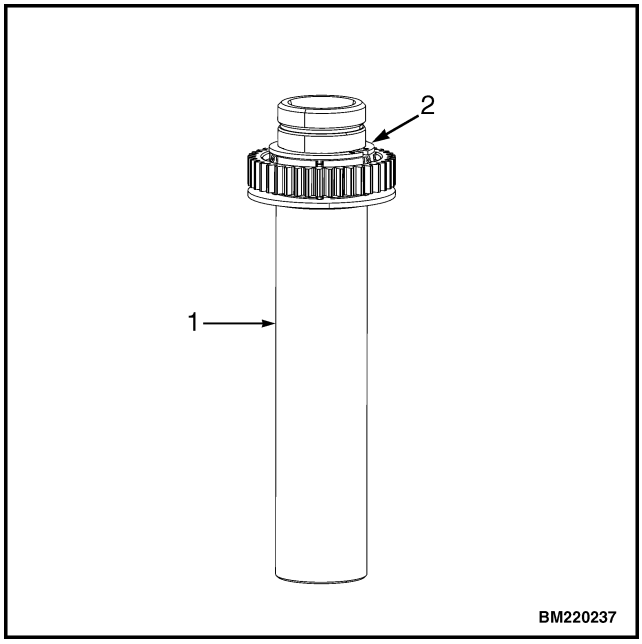
1. COLUMN GEAR
2. TUBE

STEP 8.
Install new column gear onto tube until it contacts washer.



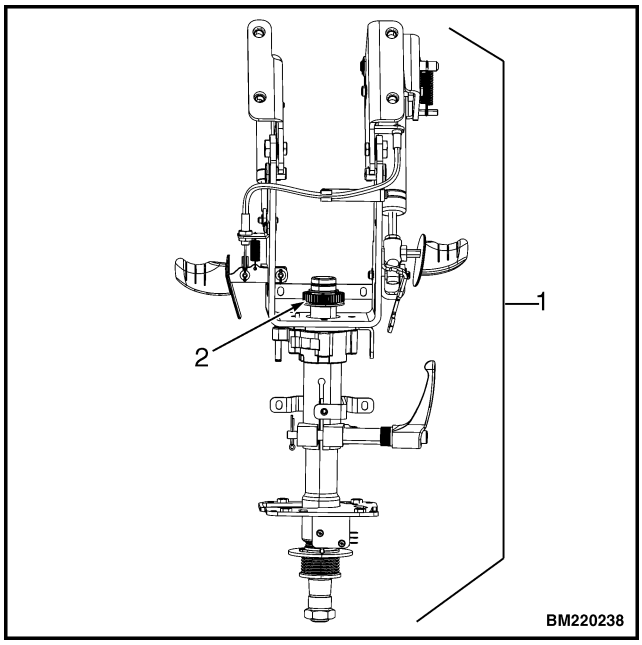
1. COLUMN GEAR
2. TUBE
3. WASHER

STEP 9.
Remove any displaced plastic material from snap ring groove and install lower snap ring onto tube.



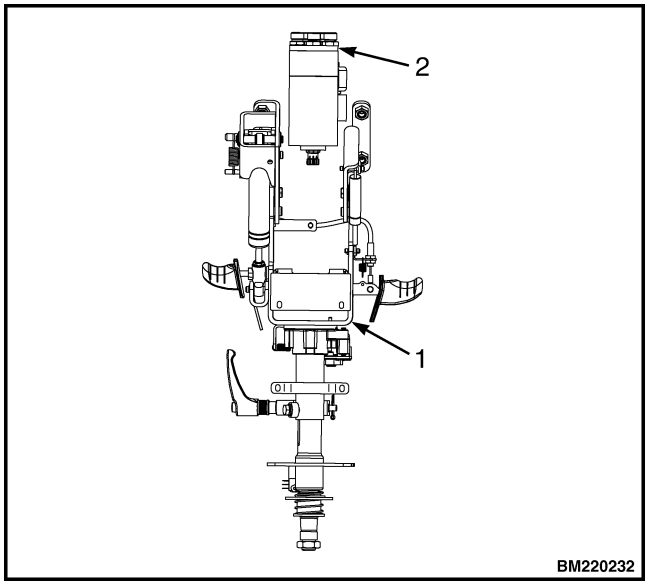
1. TUBE WITH COLUMN GEAR
2. LOWER SNAP RING

STEP 10.
Install tube with column gear into telescopic steering column.



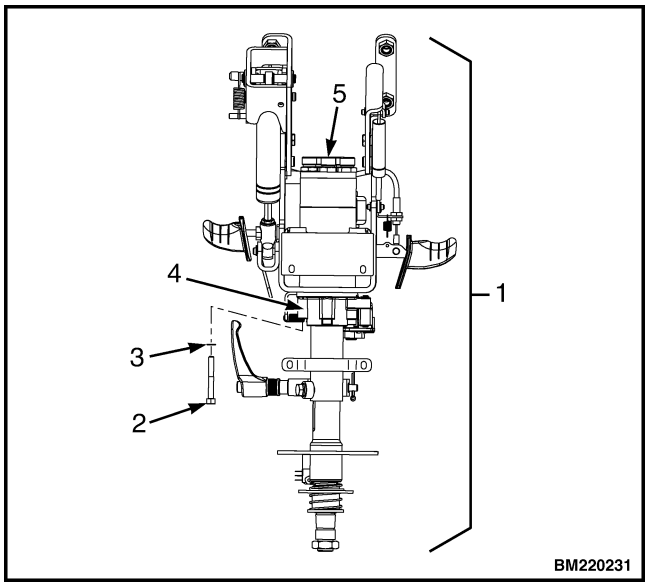
1. TELESCOPIC STEERING COLUMN
2. TUBE WITH COLUMN GEAR

STEP 11.
Install steering control unit onto tilt base bracket.



1. TILT BASE BRACKET
2. STEERING CONTROL UNIT

STEP 12.
Install four washers and capscrews onto pump mount and steering control unit.



1. SHIPPING FLANGE
2. SCREW
3. NUT

STEP 13.
Return steering column to upright position.

STEP 14.
Follow steps in Install section to complete installation.

Torque Specifications

STEERING CONTROL UNIT

Fittings and Special Screws
30 ±3 N•m (266 ±27 lbf in)

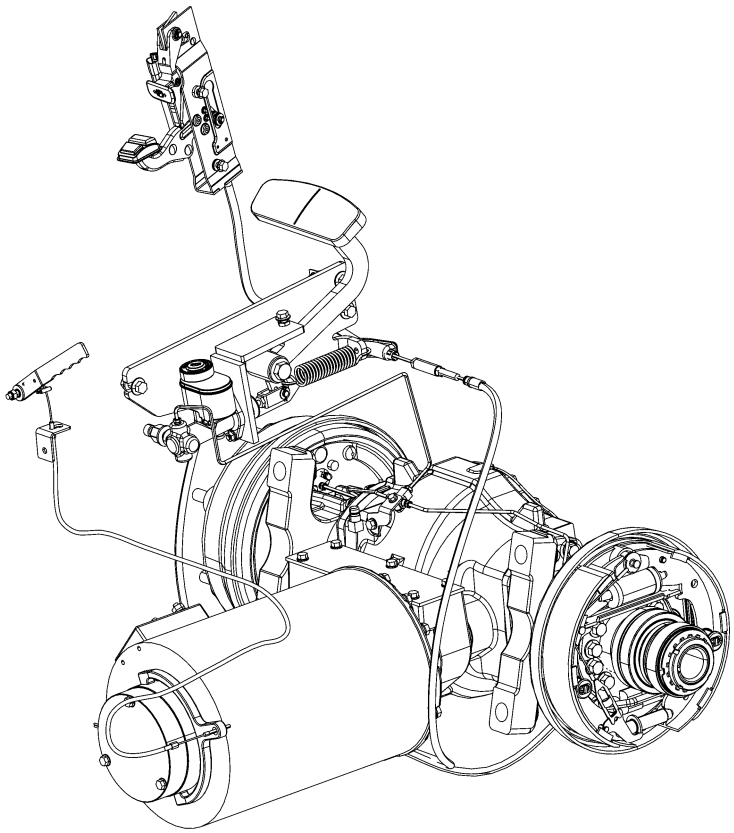
STEERING COLUMN

Steering Wheel Hex Nut
40 to 54 N•m (30 to 40 lbf ft)

Cowl Attachment
52 N•m (38 lbf ft)

BRAKE SYSTEM

E2.2-3.5XN (E45-70XN) [A268]



HYSTER

PART NO. 1688874

1800 SRM 1359

SAFETY PRECAUTIONS
MAINTENANCE AND REPAIR

- When lifting parts or assemblies, make sure all slings, chains, or cables are correctly fastened, and that the load being lifted is balanced. Make sure the crane, cables, and chains have the capacity to support the weight of the load.
- Do not lift heavy parts by hand, use a lifting mechanism.
- Wear safety glasses.
- DISCONNECT THE BATTERY CONNECTOR before doing any maintenance or repair on electric lift trucks. Disconnect the battery ground cable on internal combustion lift trucks.
- Always use correct blocks to prevent the unit from rolling or falling. See HOW TO PUT THE LIFT TRUCK ON BLOCKS in the **Operating Manual** or the **Periodic Maintenance** section.
- Keep the unit clean and the working area clean and orderly.
- Use the correct tools for the job.
- Keep the tools clean and in good condition.
- Always use **HYSTER APPROVED** parts when making repairs. Replacement parts must meet or exceed the specifications of the original equipment manufacturer.
- Make sure all nuts, bolts, snap rings, and other fastening devices are removed before using force to remove parts.
- Always fasten a DO NOT OPERATE tag to the controls of the unit when making repairs, or if the unit needs repairs.
- Be sure to follow the **WARNING** and **CAUTION** notes in the instructions.
- Gasoline, Liquid Petroleum Gas (LPG), Compressed Natural Gas (CNG), and Diesel fuel are flammable. Be sure to follow the necessary safety precautions when handling these fuels and when working on these fuel systems.
- Batteries generate flammable gas when they are being charged. Keep fire and sparks away from the area. Make sure the area is well ventilated.

NOTE: The following symbols and words indicate safety information in this manual:

WARNING

Indicates a hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION

Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury and property damage.

On the lift truck, the WARNING symbol and word are on orange background. The CAUTION symbol and word are on yellow background.

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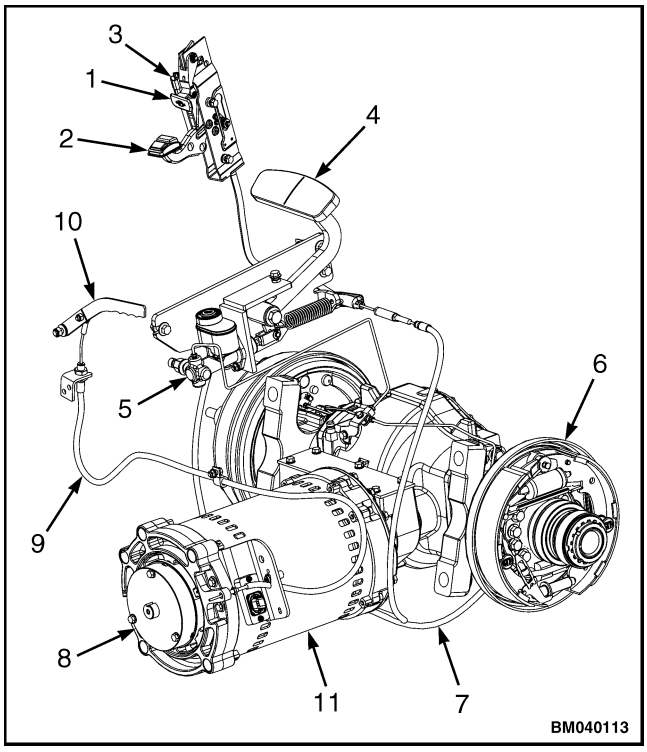
This section is for the following models:

E2.2-3.5XN (E45-70XN) [A268]

General

DRY BRAKE SYSTEM

This section has service procedures for the dry brake system. The dry brake system includes the following parts: park brake, service brakes, master cylinder, and automatic park brake. The park brake assembly contains a release handle, pedal, position sensor and cable. The service brake assembly contains the brake pedal, master cylinder, brake assembly (attached to wheel), and park brake cables. The automatic park brake assembly contains the brake (attached to the traction motor), cable, and handle.



1. PARK BRAKE RELEASE HANDLE
2. PARK BRAKE PEDAL
3. BRAKE POSITION SENSOR (RIGHT-HAND SIDE)
4. BRAKE PEDAL
5. MASTER CYLINDER
6. BRAKE ASSEMBLY
7. PARK BRAKE CABLES
8. AUTOMATIC PARK BRAKE ASSEMBLY
9. AUTOMATIC PARK BRAKE CABLE
10. AUTOMATIC PARK BRAKE RELEASE HANDLE
11. TRACTION MOTOR

Figure 1. Brake System

Service Brakes Repair (Dry Brake)

REMOVE AND DISASSEMBLE

WARNING

Brake linings can contain dangerous fibers. Breathing the dust from these brake linings is a cancer or lung disease hazard. Do not create dust! Do not clean brake parts with compressed air or by brushing. Use vacuum equipment approved for brake dust or follow the cleaning procedure in this section. When the brake drums are removed, do not create dust.

Do not sand, grind, chisel, hammer, or change linings in any way that will create dust. Any changes to brake linings must be done in a restricted area with special ventilation. Protective clothing and a respirator must be used.

WARNING

PUTTING THE LIFT TRUCK ON BLOCKS

The lift truck must be put on blocks for some types of maintenance and repair. The removal of the mast, drive axle, battery, or counterweight assemblies will cause large changes in the center of gravity. When the lift truck is put on blocks, put additional blocks in the following positions:

- **If the mast and drive axle are removed, put blocks under the counterweight so the lift truck cannot fall backward.**
- **If the counterweight is removed, put blocks under the mast so that the lift truck cannot fall forward.**

Put the lift truck on blocks on a solid, even, and level surface. Verify the blocks or stands have enough capacity to hold the lift truck. Use additional blocks next to the tires as necessary to prevent movement of the lift truck. Verify the lifting devices used during repairs can lift the weight of the parts and assemblies.

See the Operating Manual or Periodic Maintenance section for your lift truck model, for the procedures to put the lift truck on blocks.

NOTE: Perform only those steps necessary for repair or replacement.

1. Remove the battery from the lift truck. The procedure for removing the battery may be found in the **Operating Manual** or **Periodic Maintenance** 8000 SRM 1364.
2. Remove the capscrews that hold the axle shaft to the hub. Remove the axle shaft.
3. Bend the lock plate tabs to release the nut.
4. Remove the nut, lock plate, wheel bearing washer, and bearing cone from the wheel.

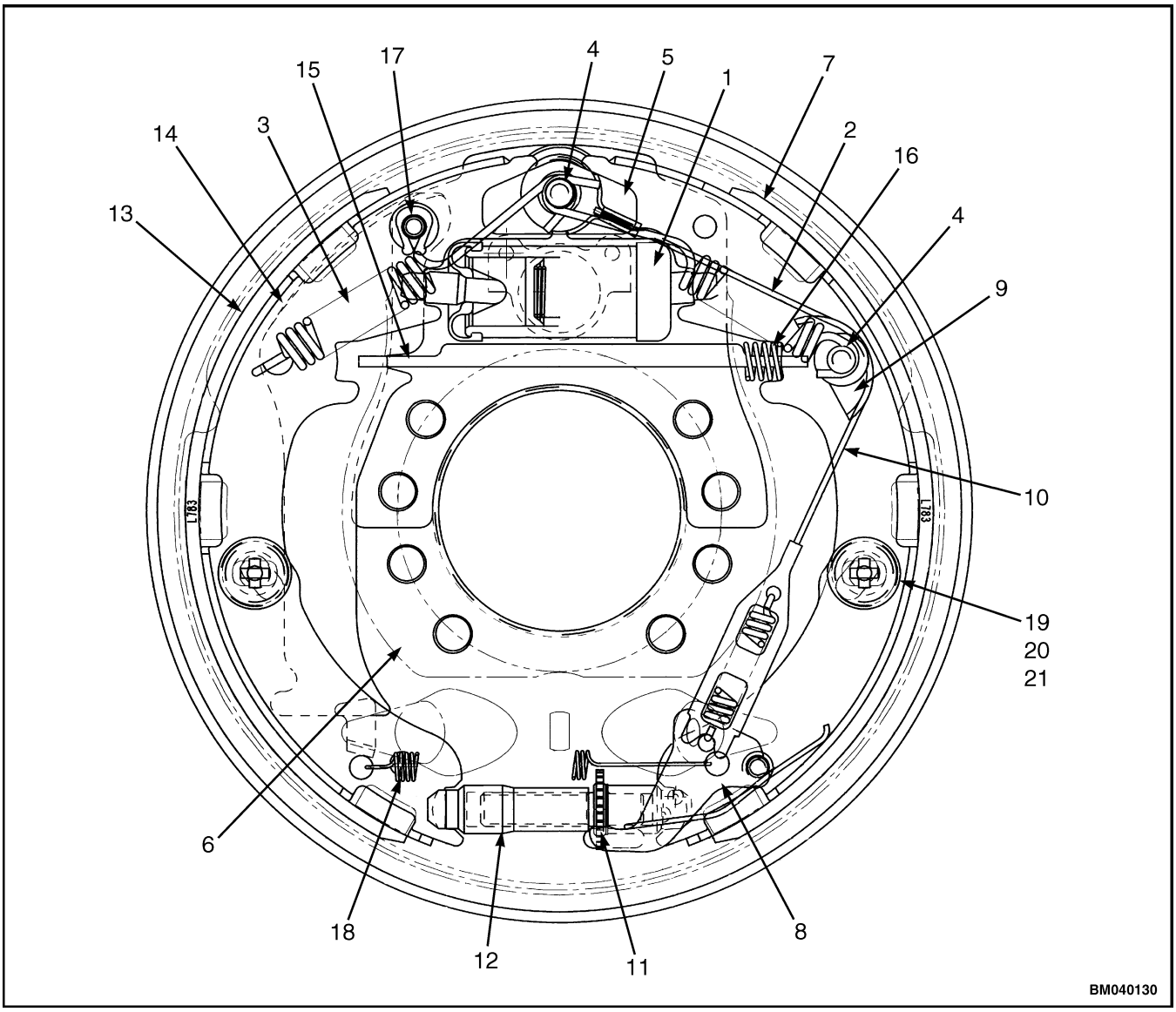
WARNING

When the brake shoes are removed, do not create dust in the air. See the Clean procedure in this section.

5. Pull the wheel assembly from the lift truck. If the wheel assembly cannot be removed easily, use a small screwdriver to push the adjustor actuator away from the adjustor wheel. Use a brake adjustment tool or a screwdriver to turn the adjustor wheel to loosen the brake shoes. Remove the hub and drum assembly. Do not damage the grease seal when removing the hub.
6. Remove the inner and outer seal from hub. Remove the inner and outer bearings from hub. See Figure 8.

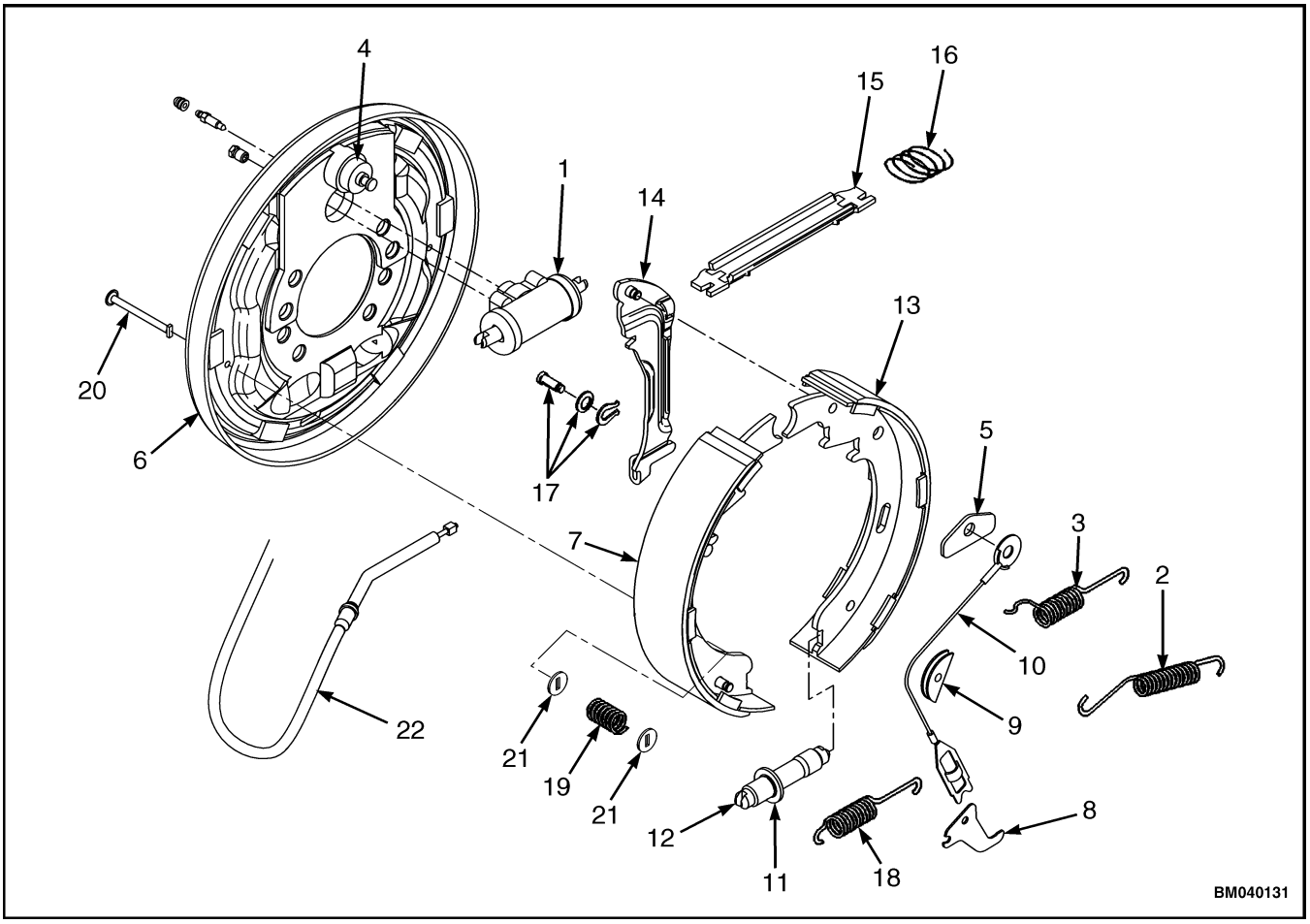
NOTE: Note arrangement of brake parts during disassembly to aid in assembly.

7. Remove the return springs with spring pliers from the anchor. See Figure 2 and Figure 3.
8. Remove the retaining pins, retaining washers, and springs that hold the brake shoes to the back plate. See Figure 2 and Figure 3.
9. Disengage the adjustor actuator link from the lever. Remove the adjustor actuator link, washer, and pivot plate. Remove the anchor guide.
10. Move the brake shoes away from each other to disengage the brake shoes from the wheel cylinder. Disconnect the parking brake lever from the parking brake cable as the brake assembly is removed from the back plate. The parking brake lever has a hook that engages the parking brake cable.



1. WHEEL CYLINDER
2. RETURN SPRING
3. RETURN SPRING
4. ANCHOR
5. ANCHOR GUIDE
6. BACK PLATE
7. SECONDARY BRAKE SHOE
8. LEVER
9. PIVOT PLATE
10. ADJUSTOR ACTUATOR LINK
11. ADJUSTOR ACTUATOR WHEEL
12. ADJUSTOR ASSEMBLY
13. PRIMARY BRAKE SHOE
14. PARKING BRAKE LEVER
15. PARKING BRAKE LINK
16. PARKING BRAKE SPRING
17. PIVOT PIN, RETAINING RING, AND SPRING WASHER
18. ADJUSTOR ACTUATOR SPRING
19. SPRING
20. RETAINING PIN
21. RETAINING WASHER

Figure 2. Brake Assembly (Left-Hand Shown)



NOTE: RIGHT-HAND BRAKE ASSEMBLY SHOWN.

1. WHEEL CYLINDER
2. RETURN SPRING
3. RETURN SPRING
4. ANCHOR
5. ANCHOR GUIDE
6. BACK PLATE
7. SECONDARY BRAKE SHOE
8. LEVER
9. PIVOT PLATE
10. ADJUSTOR ACTUATOR LINK
11. ADJUSTOR ACTUATOR WHEEL
12. ADJUSTOR ASSEMBLY
13. PRIMARY BRAKE SHOE
14. PARKING BRAKE LEVER
15. PARKING BRAKE LINK
16. PARKING BRAKE SPRING
17. PIVOT PIN, RETAINING RING, AND SPRING WASHER
18. ADJUSTOR ACTUATOR SPRING
19. SPRING
20. RETAINING PIN
21. RETAINING WASHER
22. PARKING BRAKE CABLE

Figure 3. Service Brake Parts

NOTE: The adjustor wheel for the left brake is not the same as the adjustor wheel for the right brake. The adjustor wheel for the left brake has left-hand threads.

11. Remove the parking brake link and spring if they are still engaged with brake shoes. The parking brake link and spring will often fall from the brake assembly when the brake assembly is removed from the back plate. The adjustor assembly will also disengage from the brake shoes after the brake assembly is removed. See Figure 2 and Figure 3.

12. Remove the adjustor actuator spring from the adjustor assembly. Remove the adjustor assembly from the brake shoe.

13. Use a screwdriver or small pry bar to move apart the ends of the retainer. Remove the spring washer, retaining ring, and pivot pin to remove the parking brake lever from the brake shoe.

NOTE: Perform Step 14 through Step 16 if backing plate or wheel cylinder require service.

14. Disconnect the brake line from the wheel cylinder. Remove the capscrews that hold the wheel cylinder to the back plate and remove the wheel cylinder.

15. Disconnect parking brake cable from back plate (see Figure 14). Remove lock bolts from back plate (see Figure 3) and remove back plate from drive axle.

16. Remove the push rods, dust covers, pistons, cups, and spring from the wheel cylinder body. See Figure 4.

17. If damaged, remove pressure bleeder from wheel cylinder body.

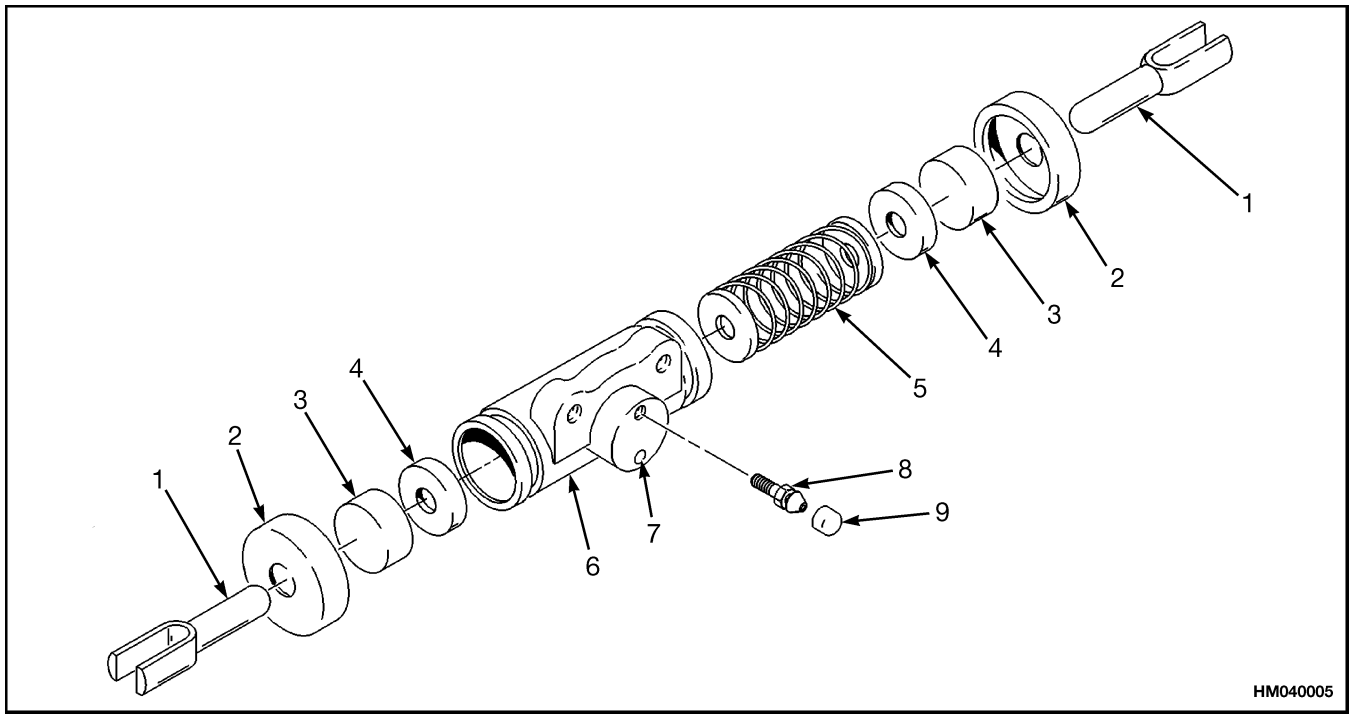
CLEAN

WARNING

DO NOT use an oil solvent to clean the master cylinder, wheel cylinder, or brake linings. Use a solvent approved for cleaning of brake parts. Do not permit oil or grease in the brake fluid or on the brake linings. Oil and grease will cause damage and leaks in the seals of a brake system. The brakes will not operate correctly if oil, grease, or brake fluid is on the brake linings.

Cleaning solvents can be flammable and toxic and can cause skin irritation. When using cleaning solvents, always follow the safety instructions of the solvent manufacturer.

1. DO NOT release dust from the brake linings into the air when the brake drum is removed.



1. PUSH ROD (2)
2. DUST COVER (2)
3. PISTON (2)
4. CUP (2)
5. SPRING
6. WHEEL CYLINDER BODY
7. INLET PORT
8. PRESSURE BLEEDER
9. DUST COVER

Figure 4. Wheel Cylinder

2. Use a solvent approved for cleaning of brake parts to wet the brake lining dust. Follow the instructions and cautions of the manufacturer for the use of the solvent. If a solvent spray is used, spray at a distance so that the dust is not released into the air.

3. When the brake lining dust is wet, clean the parts. Put any cloth or towels in a plastic bag or an airtight container while they are still wet. Put a DANGEROUS FIBERS warning label on the plastic bag or airtight container.

CAUTION

Do not permit oil or grease on the brake linings. Use a brake cleaning fluid as necessary to clean linings that will not be replaced.

4. Any cleaning cloths that will be washed must be cleaned so that fibers are not released into the air.

INSPECT

1. Inspect the bore of the wheel cylinder for holes or scratches. Replace the wheel cylinder assembly if there is any damage.

2. Inspect the return springs for wear and damage. Inspect the back plate for wear where the brake shoes touch the back plate. Remove any grooves or replace a worn or damaged back plate.

WARNING

The brake shoes on both wheels must be replaced if any shoe is damaged. The brake performance on both ends of an axle must be equal, or the lift truck can be difficult to steer when the brakes are applied.

3. Inspect the brake shoes for cracks or damage. If the linings or shoes are worn or damaged, replace the brake shoes. Maximum wear is to within 1 mm (0.039 in.) of contact with the rivets, or the metal shoe on bonded linings. Brake shoes must be replaced in complete sets. Inspect the brake drums for cracks or damage. Replace any damaged parts.

4. Inspect the brake drum for deep grooves or other damage.

NOTE: On lift truck, E2.2-3.5XN (E45-70XN) (A268), if grooves must be removed from the brake drums, do not grind more than 1.5 mm (0.060 in.) from the internal diameter of the brake drum. The maximum limit of the internal diameter of the brake drum is 312 mm (12.28 in.). If the internal diameter is larger than the limit, replace the brake drum.

5. The teeth of the adjustor actuator wheel must not be worn. The adjustor actuator wheel must turn freely. Check the adjustor links for damage.

6. Make sure the parking brake cables are in good condition.

7. Check the grease seals and the surfaces of the seals for wear or damage.

ASSEMBLE AND INSTALL

1. If removed, install back plate to drive axle. Tighten lock bolts to 255 to 306 N•m (188 to 226 lbf ft) and in the sequence shown in Figure 5.

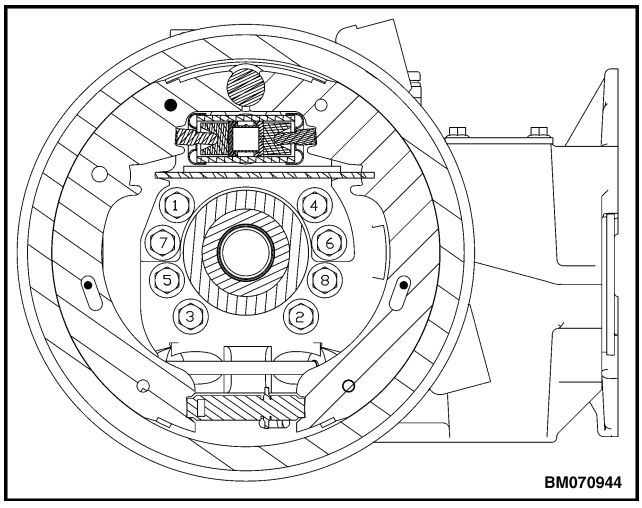


Figure 5. Back Plate Installation

2. If the wheel cylinder is disassembled for repair, assemble the wheel cylinder. See Figure 4. Use only **HYSTER APPROVED** parts.

3. Install the wheel cylinder on the back plate and tighten the two capscrews to 18 to 27 N•m (13 to 20 lbf ft). Connect the brake line to the wheel cylinder.

4. Install the parking brake lever. Use the pivot pin, spring washer, and retaining ring to fasten the parking brake lever to the brake shoe. Close the ends of the retaining ring to fasten the pivot pin in position. See Figure 3.

5. Fasten the adjustor actuator spring to the adjustor assembly and the brake shoe.

6. Put antiseize compound on the threads of the adjustor wheel. Turn the adjustor wheel into the adjustor nut so that the adjustor assembly is in its shortest position. This action permits the brake drum to be easily installed over the brake shoes. See Figure 2 and Figure 3.

WARNING

The threads of the adjustor wheel are not the same for each side. If the adjustor assemblies are installed on the wrong side, the brake shoe clearance will increase each time the brakes are applied. The adjustor wheel for the right brake has right-hand threads. The adjustor wheel for the left brake has left-hand threads.

7. Install the adjustor assembly between the two brake shoes. Make sure the adjustor actuator wheel is toward the rear of the lift truck. Move the brake shoes apart so that the adjustor assembly is held in position and the adjustor actuator spring is in tension.

8. Lubricate the back plate with a small amount of lithium grease where the brake shoes touch. Install the brake shoes on the anchor and engage the push rods of the wheel cylinder. Engage the parking brake lever in the slot in the parking brake cable as the brake shoes are installed on the back plate.

9. Install one of the retaining pins that hold the brake shoes through the back plate. Install first retaining washer, spring, then second retaining washer onto retaining pin. Rotate the retaining pin 90 degrees. Make sure the retaining pin is in the correct position.

10. Install the parking brake link, and parking brake between the parking brake lever and the brake shoe.

11. Install second retaining pin through the back plate, holding the brake shoes. Install first retaining washer, spring, second retaining washer onto retaining pin. Rotate the retaining pin 90 degrees. Make sure the parking brake link and parking brake spring are correctly engaged after the both retaining pins are installed.

12. Install the anchor guide on the anchor.

13. Install the pivot plate on its anchor.

14. Lubricate the adjustor actuator link where it slides in the pivot plate groove.

15. Fasten the adjustor actuator link to the adjustor assembly and put the cable around the pivot plate. Raise the adjustor assembly against the spring tension and connect the adjustor actuator link to the anchor.

CAUTION

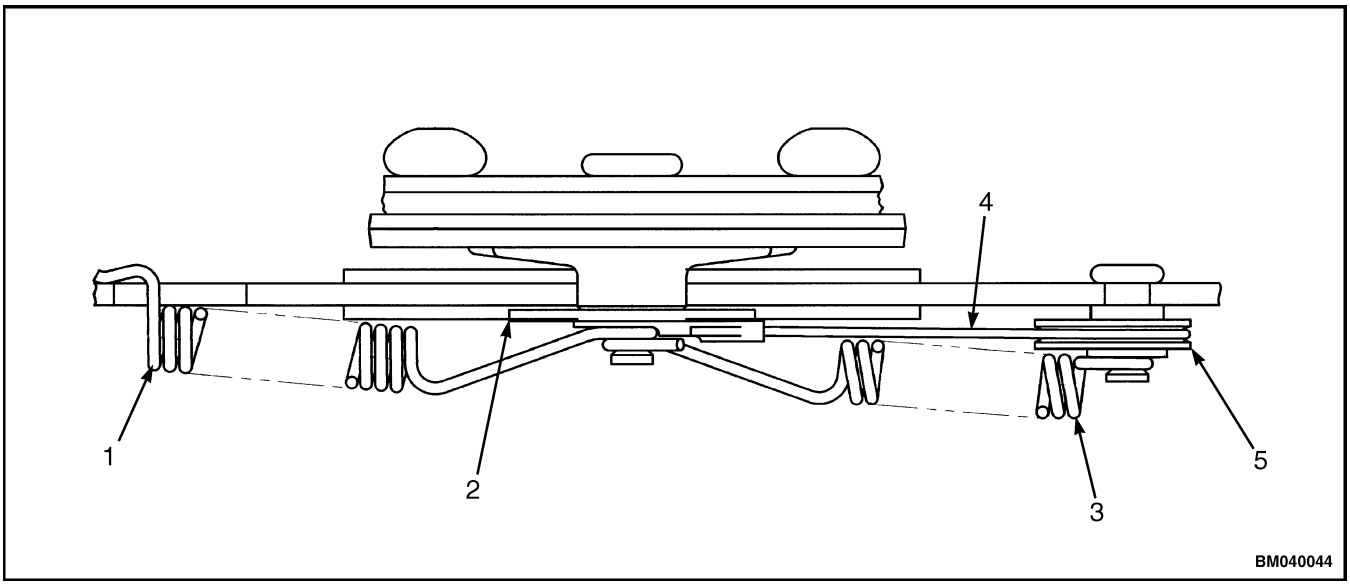
Be sure to install the white return spring first and then the black return spring. See Figure 7. Improper assembly can result in brake failure and/or component damage.

NOTE: The shape of the return springs permits them to be installed correctly in only one position. The arrangement of the return springs on the anchors is shown in Figure 6 and Figure 7.

16. Using the correct tools, install the return springs as follows: see Figure 7.

    a. Install the white spring.

    b. Install the black spring.



1. RETURN SPRING
2. ANCHOR GUIDE
3. RETURN SPRING
4. ADJUST ACTUATOR LINK
5. PIVOT PLATE

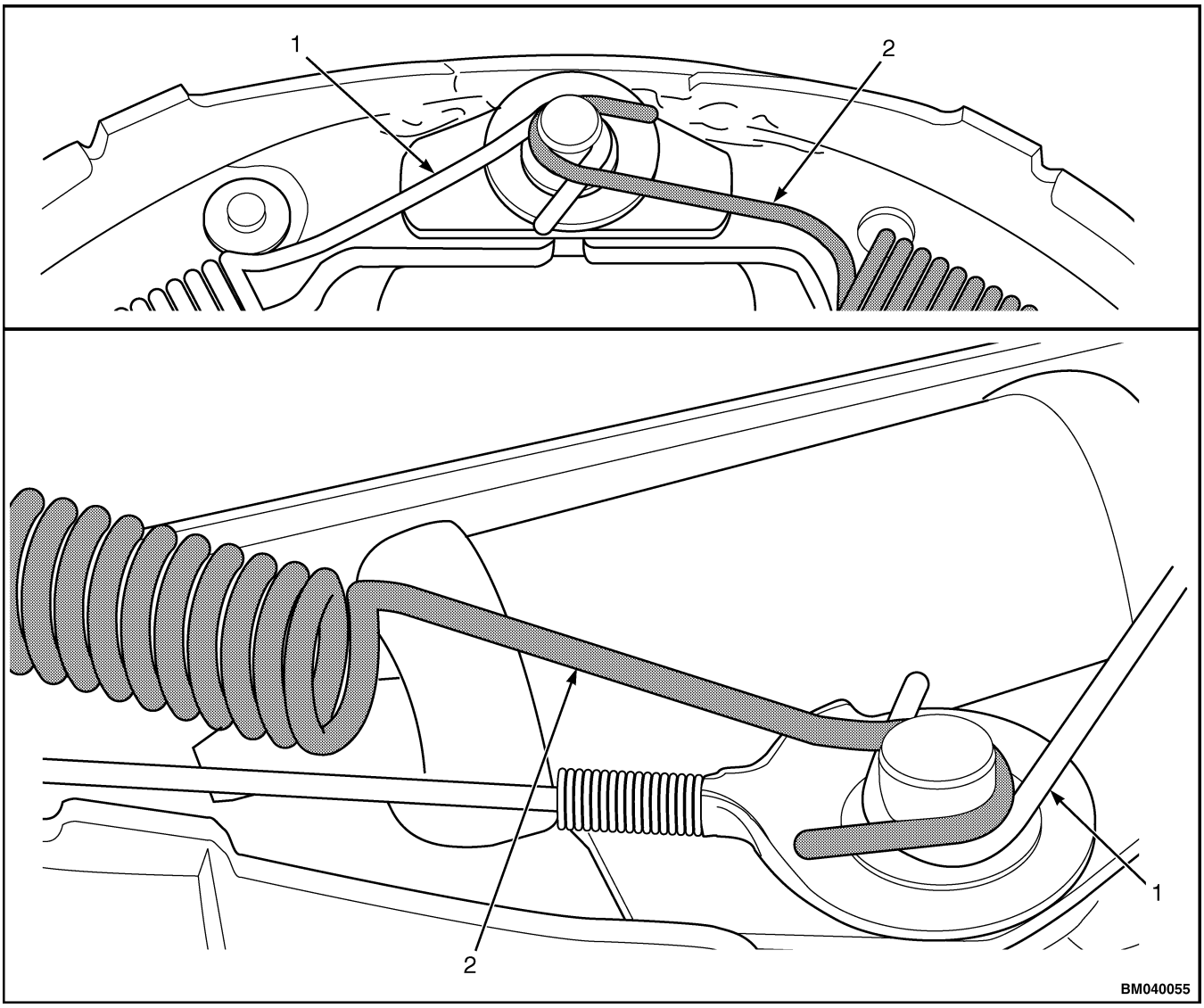
Figure 6. Return Springs

NOTE: Seal and bearings are to be installed flush with the hub. Seal is to be installed with no grease or oil on outside surface.

17. Clean the bearings and lubricate them with wheel bearing grease. Install the bearings and seals in the brake drum. Install the assembly on the axle housing. See Figure 8 and Figure 9.

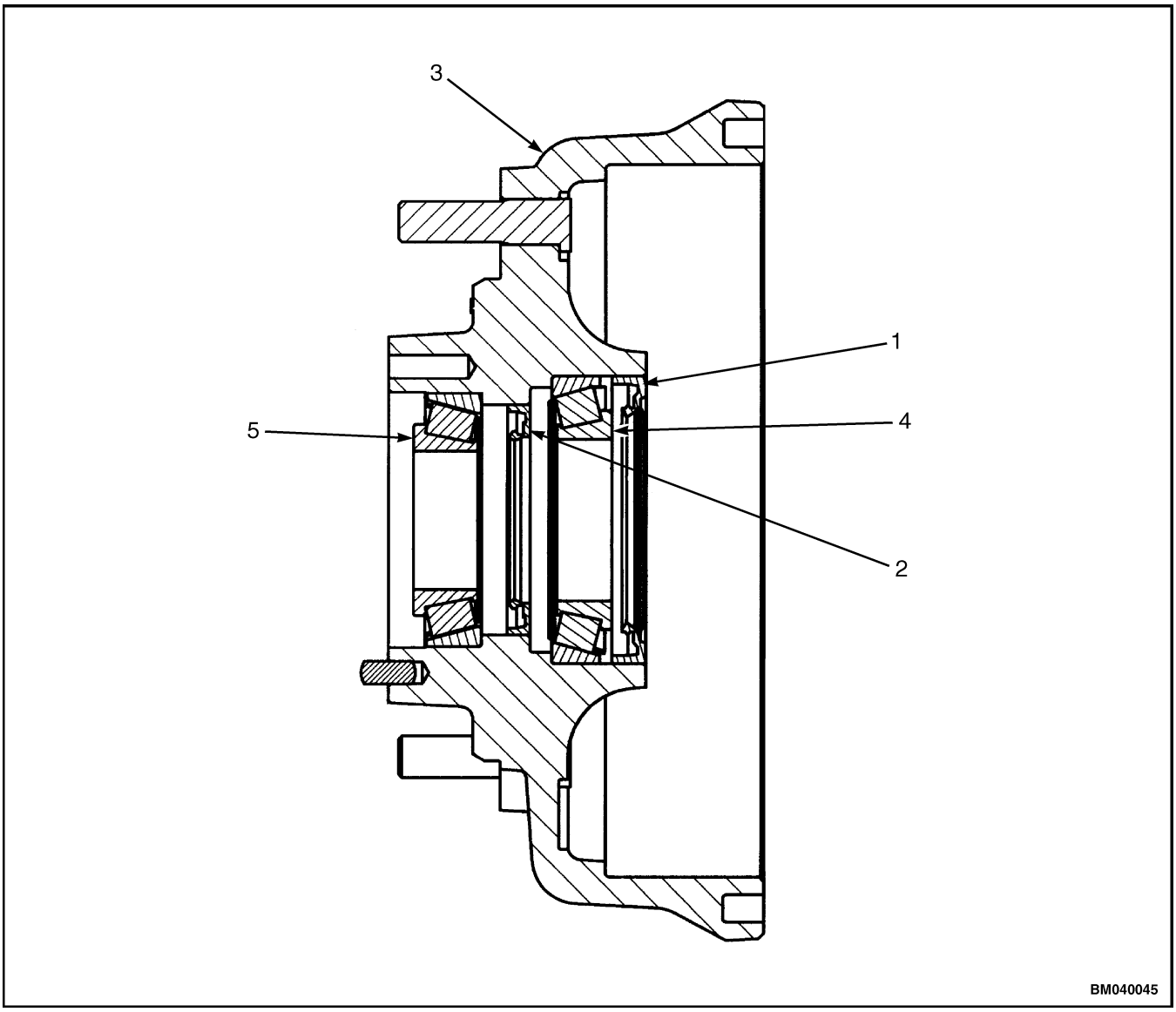
NOTE: To prevent damage to the inner grease seal when installing the hub, the hub and drum assembly can be temporarily fastened to the wheel. Align the height of the axle housing with hub bearings. Slide the wheel toward the axle housing. Install the outer bearing and nut.

18. Install the washer, lock plate and wheel adjustment nut. To align the bearing rollers, tighten the wheel adjustment nut to 14 to 18 N•m (10 to 13 lbf ft) and rotate the hub 2 revolutions in both directions. To seat the wheel bearings, tighten the wheel adjustment nut to 175 to 215 N•m (129 to 159 lbf ft). Back off the wheel adjustment nut to zero end play. Preload the wheel bearings by tightening the wheel adjustment nut to 14 to 18 N•m (10 to 13 lbf in). Rotate the hub 3 complete revolutions in both directions. Verify the wheel adjustment nut torque is 14 to 18 N•m (10 to 13 lbf ft) and that the torque stabilizes at that specification.



1. WHITE SPRING
2. BLACK SPRING

Figure 7. Proper Installation of Return Springs



1. INNER SEAL
2. OUTER SEAL
3. BRAKE DRUM
4. INNER BEARING
5. OUTER BEARING

Figure 8. Grease Seals and Bearing Locations

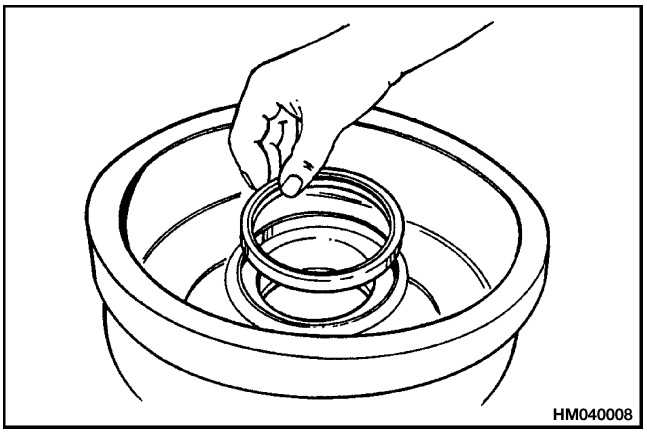
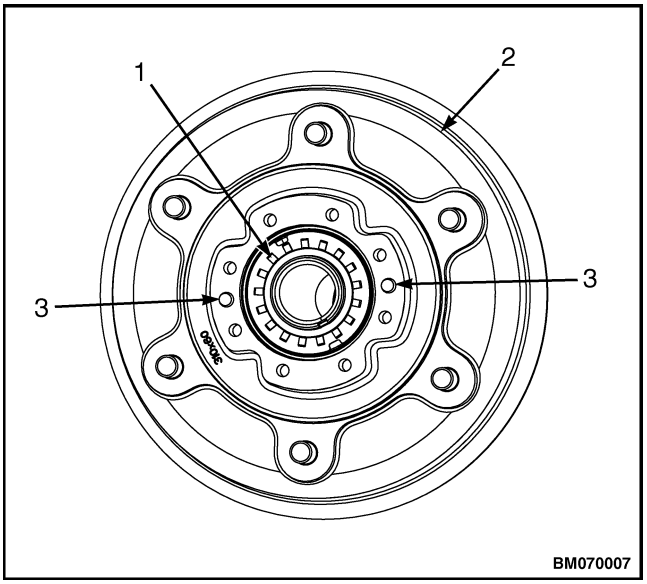


Figure 9. Inner Grease Seal Installation

19. Bend the lock plate tabs over the lock nut. See Figure 10.



1. LOCK PLATE
2. HUB/BRAKE DRUM ASSEMBLY
3. DOWEL PIN

Figure 10. Lock Plate

CAUTION

If there is too much clearance, the automatic adjustors will not operate. If the clearance is too small, the automatic adjustor cannot turn the adjustor wheel to increase the clearance, and the adjustor wheel will not turn until the brake shoes wear. If the adjustor wheel does not move for a long operating period, the adjustor link can wear a spot on the adjustor wheel so that it will not turn correctly.

NOTE: If the brake shoes were not replaced, loosen the adjustor wheel approximately 20 teeth.

20. Adjust the clearance of the brake shoes. Put a brake adjustment tool or a screwdriver through the slot in the back plate. Use the tool to rotate the adjustor wheel. The actuator for the adjustor wheel will only permit rotation in one direction. Turn the adjustor wheel until the brake shoes have expanded against the brake drum and the hub will not turn. Use a small screwdriver to lift the actuator away from the adjustor wheel and turn the adjustor wheel approximately 20 teeth in the opposite direction. The brakes will adjust to the correct clearance when they are applied while the lift truck is traveling in the reverse direction.

21. Put liquid sealant, Hyster Part Number 264159, on the flange of the axle shaft. Install the axle shaft and capscrews. Tighten the capscrews in cross pattern to a torque specified below:

a. Tighten between 90 to 99 N•m (66 to 73 lbf ft). See Figure 11.

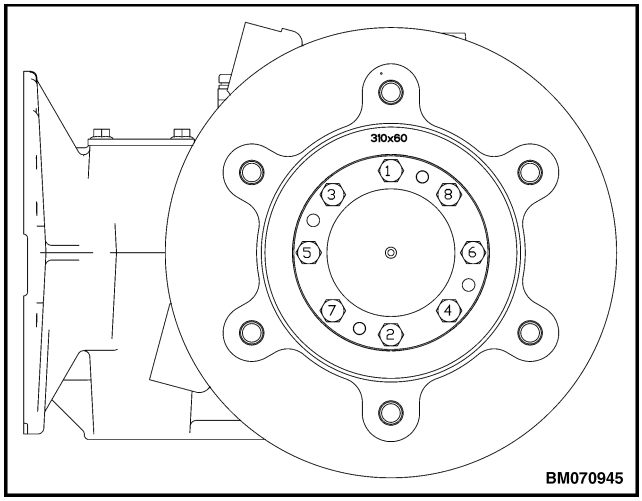


Figure 11. Axle Shaft Tightening Sequence

ADJUST

NOTE: The service brakes must be adjusted before the parking brake can be adjusted. See **Parking Brake Repair** section for the correct adjustment of the parking brake.

1. Remove the air from the brake hydraulic system. See **Brake System Air Removal**.
2. Install the wheel on the hub. Tighten the wheel nuts to 340 to 380 N•m (251 to 280 lbf ft).
3. Install battery.
4. Turn lift truck power **ON** and tilt the mast backward to remove the blocks. Push on the brake pedal. The pedal must not touch the floor plate. Move the lift truck in **REVERSE** and push on the brake pedal to permit adjusting mechanism to operate. Repeat this operation several times.

Parking Brake Repair

REMOVE AND DISASSEMBLE

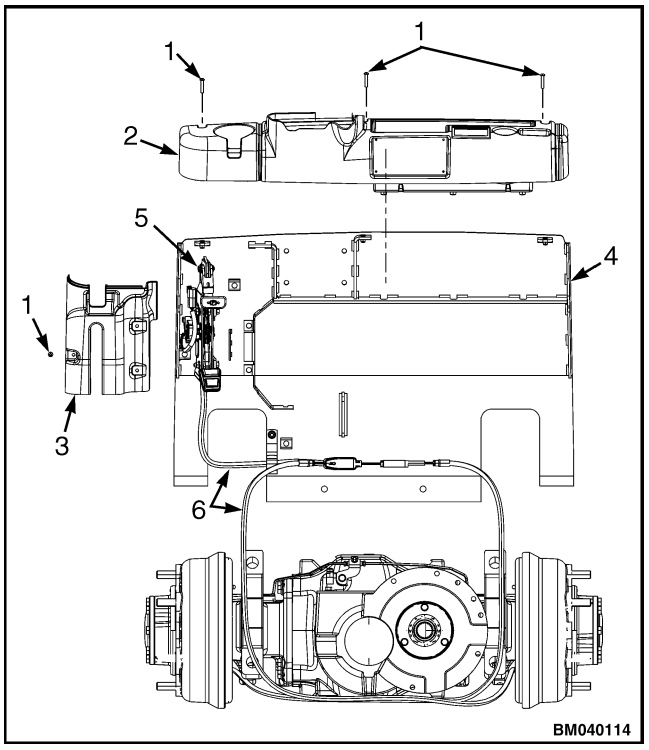
1. Block front and rear sides of wheels to make sure lift truck cannot move.
2. Remove battery from the lift truck. The procedure for removing the battery may be found in the **Operating Manual** or **Periodic Maintenance** 8000 SRM 1364.
3. Park brake to be released.

NOTE: Perform only those steps below necessary for required repair or replacement.

4. Remove three capscrews and dash panel. See Figure 12.
5. Remove three capscrews and park brake cover from cowl. See Figure 12.

NOTE: Tag electrical wiring during removal to aid in installation.

6. Disconnect brake position sensor cable from cowl harness. See Figure 13.
7. Remove two capscrews, two lockwashers, and brake position sensor from park brake assembly; discard lockwashers. See Figure 13.



1. CAPSCREW
2. DASH PANEL
3. PARK BRAKE COVER
4. COWL
5. PARK BRAKE ASSEMBLY
6. PARK BRAKE CABLES

Figure 12. Brakes - Covers and Cables

8. Remove two nuts, two capscrews, two washers, and park brake assembly from mounting plate attached to cowl. See Figure 13.

9. Remove front cable from park brake assembly and clevis. See Figure 14.

10. Remove front cable from clip. See Figure 14.

NOTE: Cables are routed left to right for right-hand park brake cable and right to left for left-hand park brake cable facing the front of lift truck as shown in Figure 14.

11. Disconnect the left-hand brake cable from front cable by loosening nut and removing cable tension adjust fitting. See Figure 14.

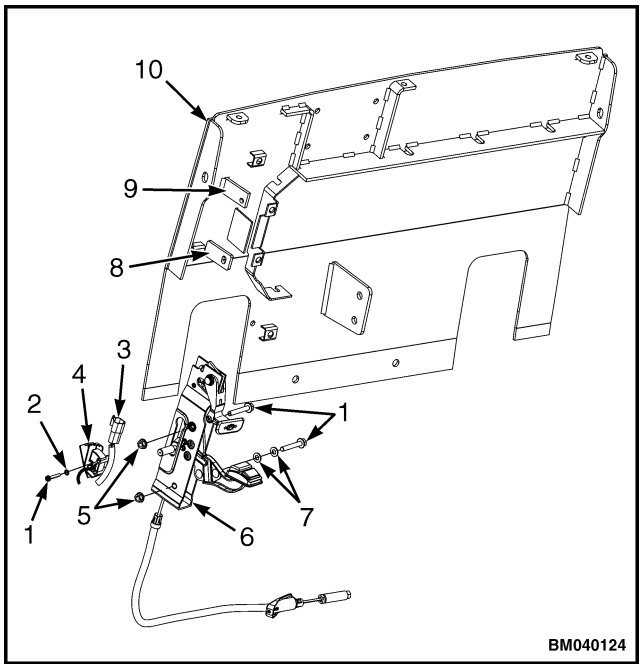
12. Disconnect the right-hand brake cable from front cable by removing strand end fitting from conduit reaction bracket. See Figure 14.

NOTE: Perform Step 13 through Step 18 only if inspection reveals left-hand park brake cable must be replaced.

NOTE: Perform Step 13 through Step 20 only if inspection reveals right-hand park brake cable must be replaced.

NOTE: The service brake assembly must be removed from the axle tube before the parking brake cable can be removed from the back plate of the service brake.

13. Remove capscrews that hold axle shaft to hub. Remove axle shaft.



1. CAPSCREW
2. LOCKWASHER
3. BRAKE POSITION SENSOR CABLE
4. BRAKE POSITION SENSOR
5. NUT
6. PARK BRAKE ASSEMBLY
7. WASHER
8. MOUNTING PLATE
9. PLATE
10. COWL

Figure 13. Park Brake Assembly

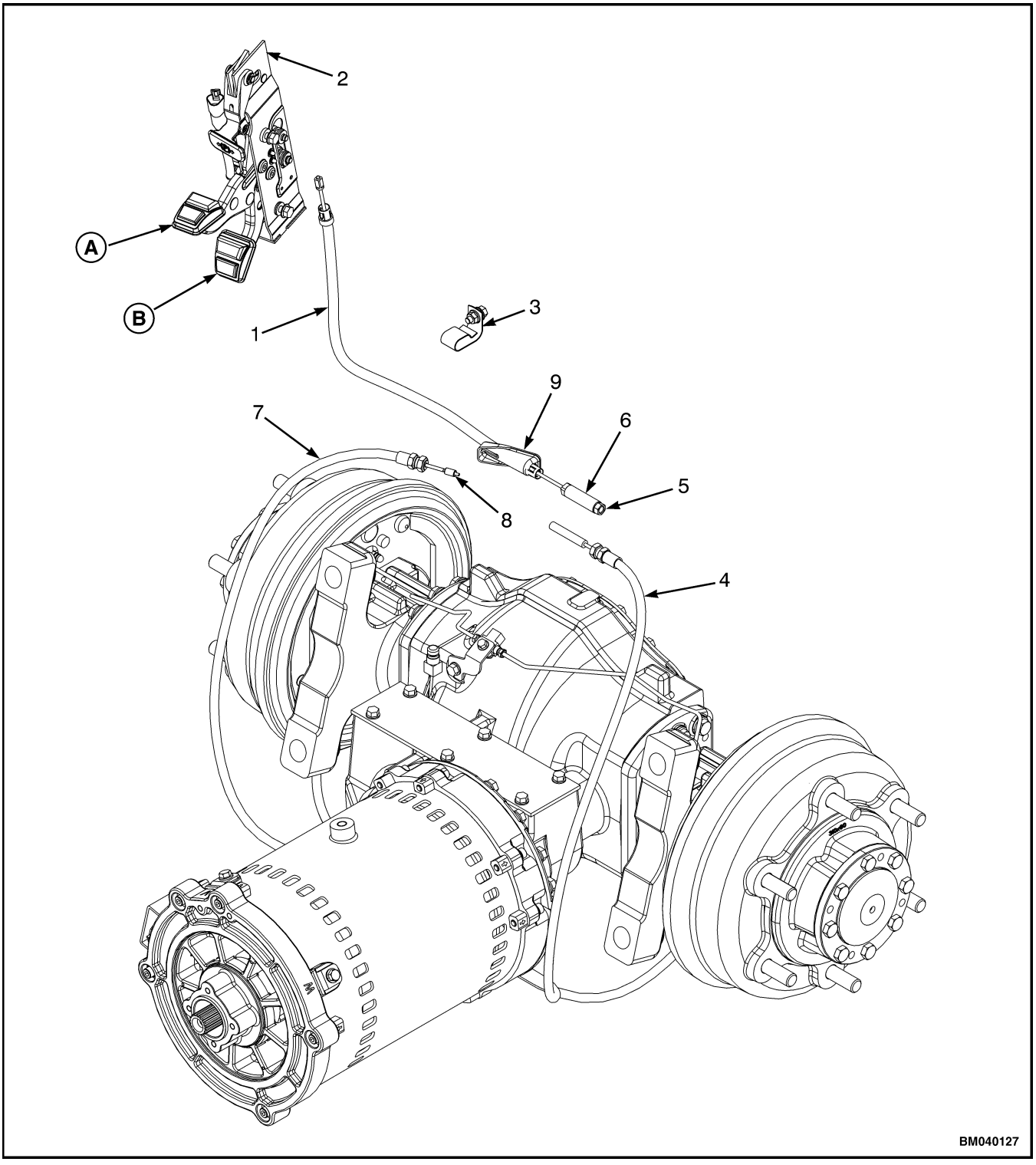


Figure 14. Park Brake Cables

Legend for Figure 14

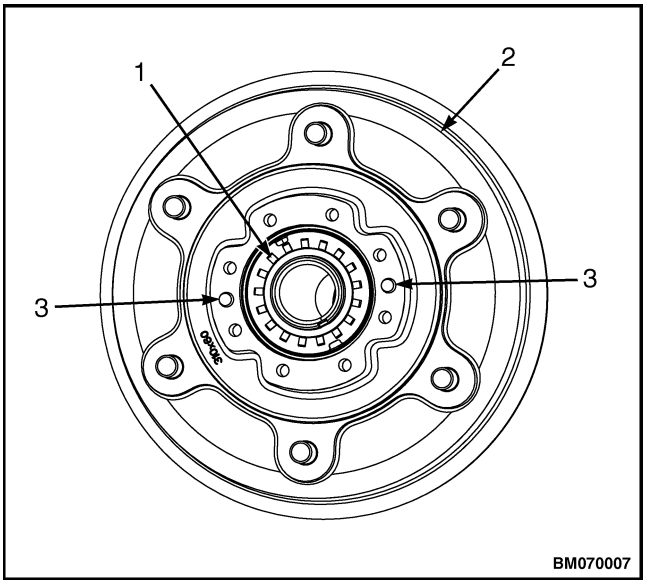
A. RELEASED POSITION

1. FRONT CABLE
2. PARK BRAKE ASSEMBLY
3. CLIP
4. LEFT-HAND PARK BRAKE CABLE
5. NUT

B. APPLIED POSITION

6. TENSION ADJUST FITTING
7. RIGHT-HAND PARK BRAKE CABLE
8. STRAND END FITTING
9. CONDUIT REACTION BRACKET

14. Bend lock plate tabs to release nut. See Figure 15.



1. LOCK PLATE
2. HUB/BRAKE DRUM ASSEMBLY
3. DOWEL PIN

Figure 15. Lock Plate

15. Remove nut, lock plate, wheel bearing washer, and bearing cone from wheel.

16. Pull wheel assembly from lift truck. If wheel assembly cannot be removed easily, use a small screwdriver to move adjustor assembly away from wheel. Use a brake adjustment tool or small screwdriver to turn adjustor actuator wheel to loosen brake shoes. Remove hub and drum assembly. Do not damage grease seal when removing hub.

17. Remove snap ring and park brake cable from back plate.

18. Remove park brake cable, from front end of frame, by loosening two jam-nuts and removing end cable fitting from bracket.

19. Disconnect end fitting connected to front cable.

20. Remove right-hand cable from clip attached to drive axle housing.

INSPECT

1. Check park brake assembly for damage to ratchet teeth, pawl, and sliding components. Replace park brake assembly if there is damage.

2. Check brake position sensor, brake position sensor cable, and front cable for damage. Replace items if damaged.

3. Inspect park brake cables for damage. Replace cable if damage is found.

ASSEMBLE AND INSTALL

NOTE: Perform Step 1 through Step 3 below only if park brake cables are replaced.

1. Install end cable fittings onto brackets attached to lower end of frame for both park brake cables and tighten four jam-nuts. See Figure 14.

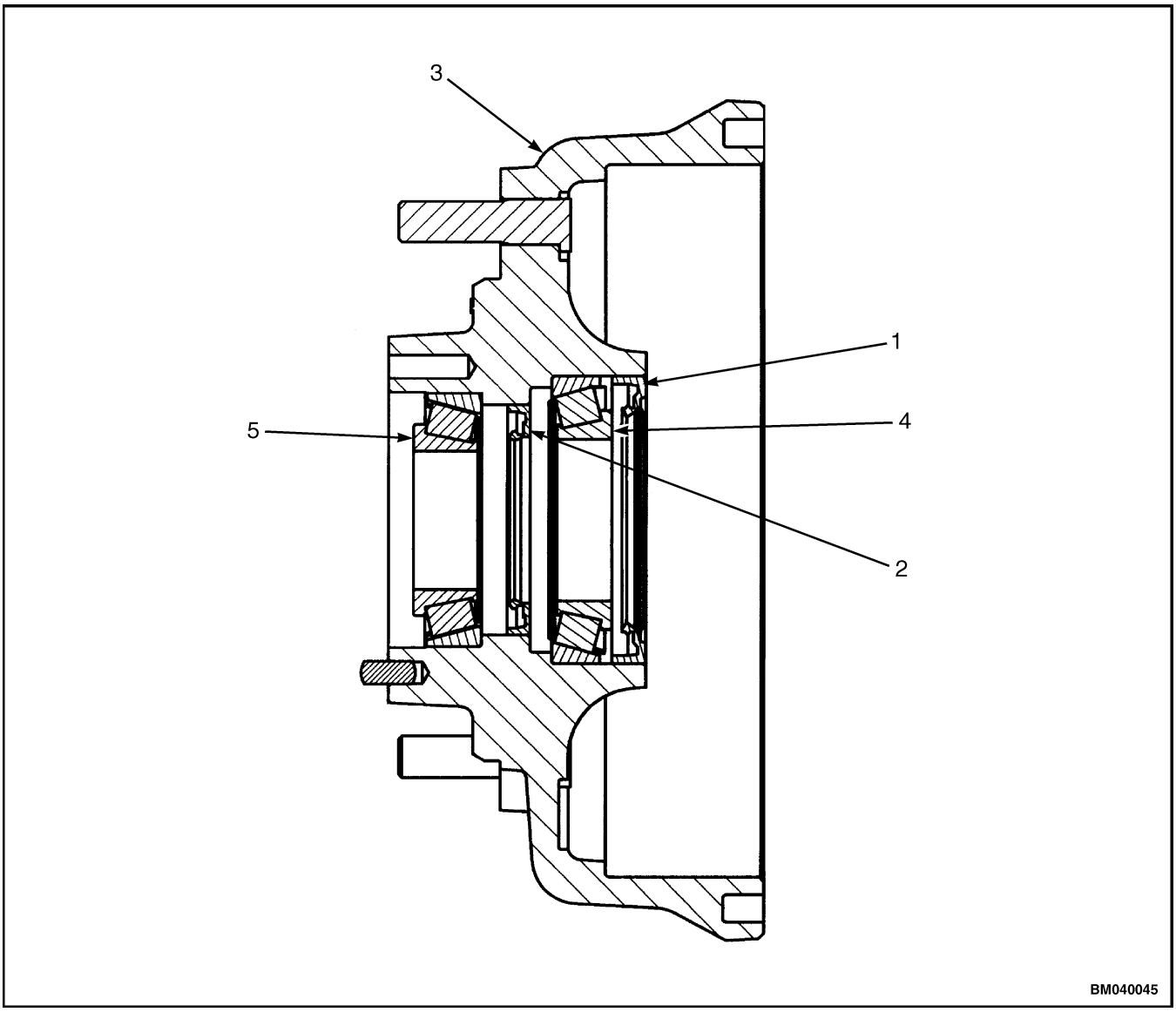
2. Route right-hand park brake cable through clip attached below drive axle housing.

NOTE: The parking brake cables must be installed in the back plate before the service brake is installed. A snap ring holds the sheath of the parking brake cable in the back plate of the service brake.

3. Install parking brake cable in back plate and install snap ring that holds the sheath of parking brake cable in the back plate.

NOTE: Seal and bearings are to be installed flush with the hub. Seal is to be installed with no grease or oil on outside surface.

4. Clean bearings and lubricate them with wheel bearing grease. Install bearings and seals into brake drum. Install assembly on axle housing. See Figure 16 and Figure 17.



1. INNER SEAL
2. OUTER SEAL
3. BRAKE DRUM
4. INNER BEARING
5. OUTER BEARING

Figure 16. Grease Seals and Bearing Locations

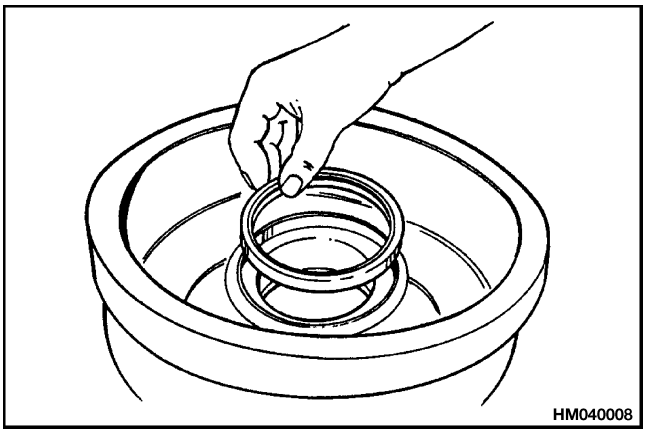


Figure 17. Inner Grease Seal Installation

NOTE: To prevent damage to the inner grease seal when installing the hub, the hub and drum assembly can be temporarily fastened to the wheel. Align the height of the axle housing with hub bearings. Put grease under the wheel and slide the wheel toward the axle housing. Install the outer bearing and nut.

5. Install washer, lock plate, and wheel adjustment nut. To align bearing rollers, tighten wheel adjustment nut to 14 to 18 N•m (10 to 13 lbf ft) and rotate hub 2 revolutions in both directions. To seat wheel bearings, tighten wheel adjustment nut to 175 to 215 N•m (129 to 159 lbf ft). Back off wheel adjustment nut to zero end play. Preload wheel bearings by tightening wheel adjustment nut to 14 to 18 N•m (10 to 13 lbf ft) Rotate hub 3 complete revolutions in both directions. Verify wheel adjustment nut torque is 14 to 18 N•m (10 to 13 lbf ft) and that torque stabilized at specification.

6. Connect cable tension fitting to threaded end fitting on left-hand cable. Tighten nut against cable tension fitting. See Figure 14.

7. Connect strand end fitting of right-hand cable to conduit reaction bracket. See Figure 14.

8. Route front cable through clip. See Figure 14.

9. Assemble front brake cable and clevis. See Figure 14.

10. Install front brake cable end fitting through clevis slot and snap this cable fitting onto park brake assembly. See Figure 14.

11. Install park brake assembly, two washers, two capscrews and two nuts to mounting plate and plate attached to cowl. See Figure 13.

12. Connect brake position sensor cable to cowl harness.

13. Install park brake cover and three capscrews to the cowl plate. See Figure 12.

14. Install dash panel and three capscrews to cowl plate. See Figure 12.

NOTE: The park brake release handle should be able to return freely to its original position after brake release actuation without any binding.

15. Engage parking brake.

16. Remove blocks from front and rear sides of wheels.

ADJUST

1. With part brake cables assembled and park brake assembly in release position (see Figure 14), apply an initial load of 382.5 N (86 lbf) to park brake pedal. Adjust cable tension adjustor fitting and secure with jam-nut to take up slack.

2. Check park brake tension while lift truck is on 15% grade with rated load. Make adjustment to park brake cable tension if required, tighten adjustor fitting and jam-nut to secure adjustments.

Master Cylinder Repair

REMOVE

1. Block front and rear sides of wheels to make sure lift truck cannot move.
2. Remove floor mat and floor plates from lift truck to access master cylinder.

NOTE: Tag all electrical connections prior to removal to aid in installation.

3. Disconnect wire at brake sensor and bottom of master cylinder. Remove brake sensor. See Figure 18.
4. Disconnect reservoir level sensor switch from cowl harness.
5. Remove tube assembly from master cylinder. Plug master cylinder and tube to prevent foreign material from entering the brake system. See Figure 18.

NOTE: Perform the following step only if the tube is damaged.

6. Remove tube assembly from brake fitting. Plug fitting to prevent foreign material from entering the brake system. Lay tube assembly aside until ready for bench bleed. See Figure 18.
7. Remove cotter pin, washer, and pin from plate at bottom of brake pedal assembly. See Figure 18.
8. Remove two nuts, two capscrews and master cylinder from mounting plate. See Figure 18.

DISASSEMBLE

CAUTION

Disposal of lubricants and fluids must meet local environmental regulations.

1. Drain master cylinder into drain pan. Dispose of brake fluid.
2. Remove push rod and boot from cylinder. See Figure 19.

WARNING

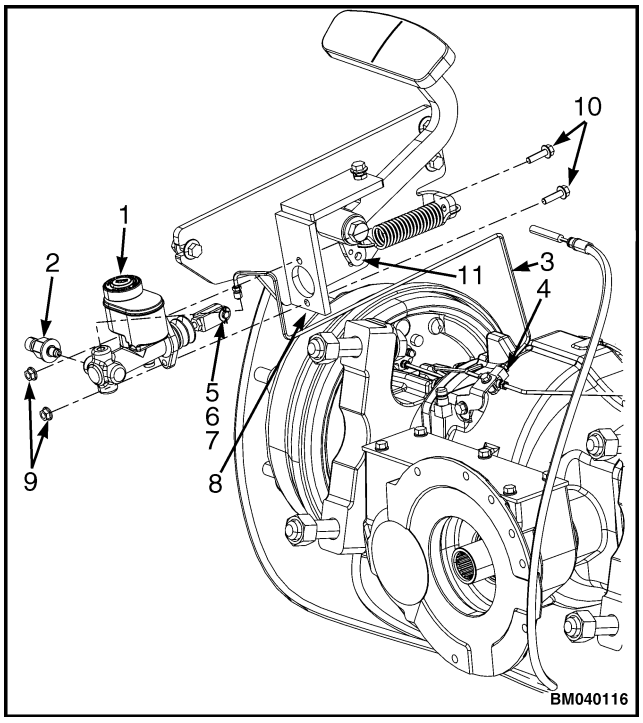
Use care when removing snap ring to avoid possible injury.

3. Remove snap ring from cylinder. See Figure 19.

CAUTION

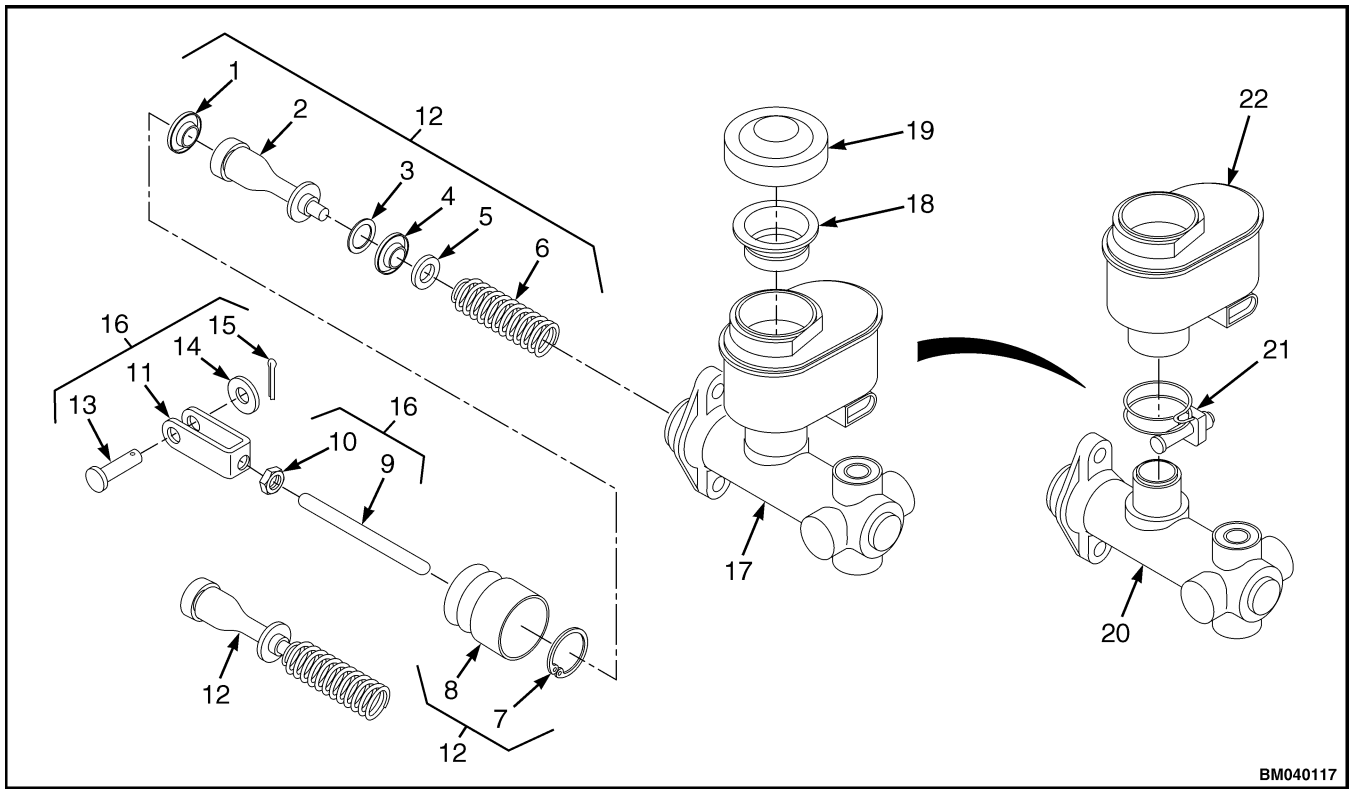
When the piston is removed, make sure the cylinder bore and piston are not scratched or damaged.

4. Remove piston assembly from cylinder. See Figure 19.
5. Remove gasket and cap from reservoir. See Figure 19.



1. MASTER CYLINDER
2. BRAKE SENSOR
3. TUBE ASSEMBLY
4. BRAKE FITTING
5. COTTER PIN
6. WASHER
7. PIN
8. MOUNTING PLATE
9. NUT
10. CAPSCREW
11. PLATE

Figure 18. Master Cylinder



NOTE: ITEM 12, PISTON ASSEMBLY (INCLUDES ITEM 1 THROUGH 6), SHOULD **NOT** BE DISASSEMBLED. ILLUSTRATION CREATE FROM MANUFACTURER'S DOCUMENTATION.

1. SECONDARY CUP
2. PISTON
3. SPACER
4. PRIMARY CUP
5. RETAINER
6. SPRING
7. SNAP RING
8. BOOT
9. PUSH ROD
10. NUT
11. CLEVIS
12. PISTON ASSEMBLY
13. PIN
14. WASHER
15. COTTER PIN
16. REPAIR KIT
17. MASTER CYLINDER ASSEMBLY
18. GASKET
19. CAP
20. CYLINDER
21. CLAMP
22. RESERVOIR

Figure 19. Master Cylinder Assembly

CLEAN

⚠ CAUTION

DO NOT use an oil solvent to clean the master cylinder. Use alcohol or DOT3 brake fluid only.

1. Clean components paying particular attention to those areas highlighted in Figure 20 with alcohol or DOT3 brake fluid only.

INSPECT

1. Inspect exterior of master cylinder assembly for damage. Replace assembly if damaged.
2. Inspect bore of master cylinder for holes or scratches. Replace master cylinder assembly if damaged.

NOTE: DO NOT disassemble piston assembly.

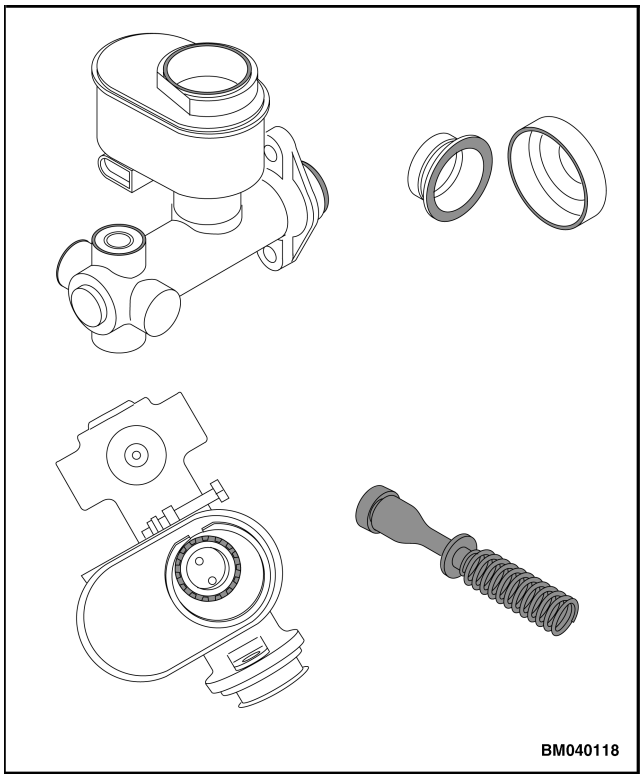


Figure 20. Cleaning Components

ASSEMBLE

CAUTION

When piston is installed, make sure the cylinder bore and piston are not scratched or damaged.

1. Install piston assembly into cylinder. See Figure 19.

WARNING

Use care when installing snap ring to avoid possible injury.

2. Install snap ring into cylinder. See Figure 19.
3. Install boot and push rod into cylinder. See Figure 19.

BENCH BLEED MASTER CYLINDER

NOTE: Master cylinder must be bench bled before installing it on lift truck.

1. Place master cylinder, horizontally, in a soft-jawed vise.
2. Remove plugs from tube assembly ends. Connect tube assembly to master cylinder.
3. Place the other end of tube assembly in a clear container of brake fluid.
4. Fill reservoir with (DOT 3) brake fluid, as needed.
5. Stroke master cylinder until all air is purged from master cylinder.
6. Install gasket and cap to reservoir. See Figure 19.

INSTALL AND ADJUST

1. Remove plugs from master cylinder and tube assembly. Install tube assembly to master cylinder. See Figure 18.
2. Install master cylinder with tube assembly attached, two capscrews, and two nuts onto mounting plate. Tighten nuts to 19 N•m (168 lbf in). See Figure 18.
3. Install pin, washer, cotter pin and the back of master cylinder onto plate at the bottom of brake pedal assembly. See Figure 18.
4. Remove plug from brake fitting. Install tube assembly into brake fitting. See Figure 18.
5. Install brake sensor. Tighten to 23 to 28 N•m (203 to 247 lbf in). Connect wire from sensor to bottom of master cylinder. See Figure 18.
6. Connect reservoir level sensor switch to cowl harness.
7. Adjust brake pedal height to 79 mm (3 in.) by adjusting capscrew. Tighten locknuts. See Figure 21.

8. Adjust master cylinder per following procedure:

   a. Loosen locknut on master cylinder push rod and adjust by turning push rod counterclockwise (as viewed from rear of lift truck) to remove all slack between master cylinder and brake pedal. Do not allow rubber boot to be twisted while adjusting the rod length. See Figure 21.

   b. Turn push rod one-eighth turn clockwise (as viewed from rear of lift truck) allowing master cylinder to fully return when brake pedal is released. Tighten locknut to 15 to 17 N•m (133 to 150 lbf in). See Figure 21.

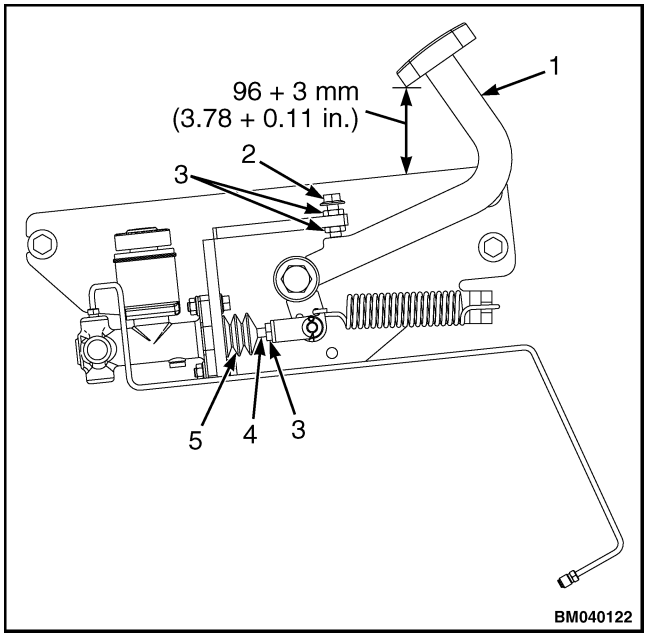
9. Flush with (DOT3) brake fluid and air bleed system. See section of this manual.

10. Adjust fluid level until at MAX line on reservoir.

11. Verify all connections are leak-free.

12. Install floor plates and floor mat to lift truck.

13. Check adjustment of brake pedal as described in section of this manual.



1. BRAKE PEDAL
2. CAPSCREW
3. LOCKNUT
4. PUSH ROD
5. RUBBER BOOT

Figure 21. Brake Pedal and Master Cylinder Adjustment

Brake Pedal Components

REMOVE

1. Block front and rear sides of wheel to make sure lift truck cannot move.

2. Remove floor mat and floor plates from lift truck.

3. Remove tube assembly from master cylinder. Plug master cylinder and tube assembly to prevent foreign material from entering brake system. See Figure 22.

4. Disconnect wire at brake sensor and bottom of master cylinder.

5. Disconnect reservoir level sensor switch from cowl harness.

6. Remove nut and capscrew from bracket and plate attached to bulkhead; remove two nuts and two capscrews from bracket and plate attached to cowl. Remove bracket with brake pedal assembly and master cylinder. See Figure 22.

7. Remove cotter pin, washer, and pin from plate at bottom of brake pedal assembly. See Figure 22.

8. Remove two nuts, two capscrews, and master cylinder from mounting plate. See Figure 22.

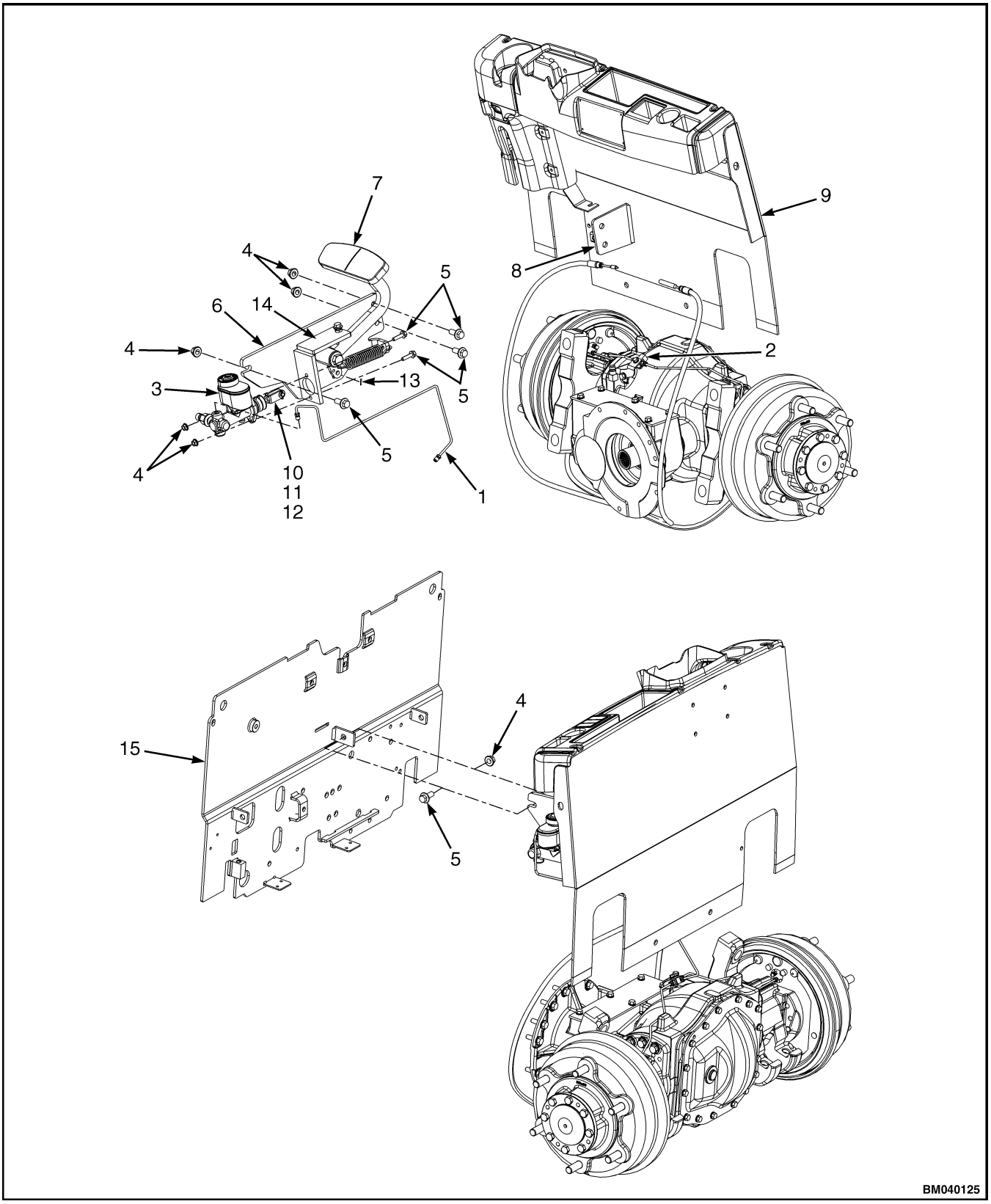


Figure 22. Brake Pedal

Legend for Figure 22

1. TUBE ASSEMBLY
2. BRAKE FITTING
3. MASTER CYLINDER
4. NUT
5. CAPSCREW
6. BRACKET
7. BRAKE PEDAL ASSEMBLY
8. PLATE
9. COWL
10. CLEVIS
11. WASHER
12. PIN
13. COTTER PIN
14. MOUNTING PLATE
15. BULKHEAD
16. PLATE

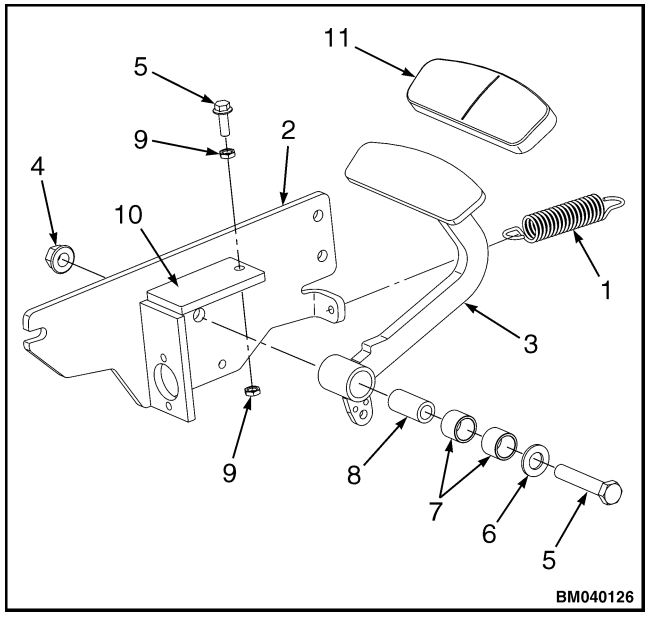
DISASSEMBLE

1. Disconnect spring from bracket and brake pedal assembly. See Figure 23.

2. Remove capscrew and two lock nuts from mount bracket. See Figure 23.

3. Remove nut, capscrew, washer, two bushings, tube, and brake pedal from bracket. See Figure 23.

4. Remove brake pad from brake pedal. See Figure 23.



1. SPRING
2. BRACKET
3. BRAKE PEDAL
4. NUT
5. CAPSCREW
6. WASHER
7. BUSHING
8. TUBE
9. LOCKNUT
10. MOUNT BRACKET
11. BRAKE PAD

Figure 23. Brake Pedal Assembly

INSPECT

1. Inspect components for damage; replace if damaged.

2. Spring free length measurement should be 133 to 160 mm (5 to 6 in.). Replace spring if length is beyond specification.

ASSEMBLE

1. Assemble brake pedal and brake pad. See Figure 23.

2. Assemble brake pedal, two bushings, tube, washer, capscrew, and nut on bracket. See Figure 23. Tighten capscrew to 165 N•m (122 lbf ft).

3. Assemble two locknuts and one capscrew on mount bracket. See Figure 23.

4. Adjust brake pedal height to 79 mm (3 in.) by adjusting capscrew. Measurement between bottom of brake pedal and top of bracket. After adjustment, tighten locknuts.

5. Connect spring to brake pedal and bracket. See Figure 23.

INSTALL

1. Install master cylinder, two capscrews, and two nuts onto mounting plate. Tighten nuts to 19 N•m (14 lbf ft). See Figure 22.

2. Install pin, washer, and cotter pin onto plate at bottom of brake pedal assembly. See Figure 22.

3. Install bracket, brake pedal assembly, master cylinder, two capscrews and two nuts onto plate attached to cowl; install capscrew, nut, and bracket onto plate attached to bulkhead. See Figure 22.

4. Connect brake sensor wire to sensor on master cylinder.

5. Connect reservoir level sensor switch to cowl harness.

6. Remove plugs from master cylinder and tube assembly; install tube assembly onto master cylinder. See Figure 22.

7. Install floor plates and floor mat.

8. Remove blocks from front and rear sides of wheels.

Automatic Park Brake

GENERAL

The automatic park brake is optional. This brake is attached to the traction motor. The automatic park brake activates at zero speed. If the driver leaves the seat a switch notifies the operating software and the lift truck will slow to a stop. When the lift truck is stopped for a period longer than two seconds, the park brake will apply automatically. When the accelerator is applied the brake will release. The manual override is a handle attached to the cable and for use when the lift truck has no power. The brake is in the applied position when the handle rests against the mechanical stop. The brake is manually released by pulling the handle upright.

REMOVE

WARNING

PUTTING THE LIFT TRUCK ON BLOCKS

The lift truck must be put on blocks for some types of maintenance and repair. The removal of the mast, drive axle, battery, or counterweight assemblies will cause large changes in the center of gravity. When the lift truck is put on blocks, put additional blocks in the following positions:

- **If the mast and drive axle are removed, put blocks under the counterweight so the lift truck cannot fall backward.**
- **If the counterweight is removed, put blocks under the mast so that the lift truck cannot fall forward.**

Put the lift truck on blocks on a solid, even, and level surface. Verify the blocks or stands have enough capacity to hold the lift truck. Use additional blocks next to the tires as necessary to prevent movement of the lift truck. Verify the lifting devices used during repairs can lift the weight of the parts and assemblies.

See the Operating Manual or Periodic Maintenance section for your lift truck model, for the procedures to put the lift truck on blocks.

Remove the battery from the lift truck. The procedure for removing the battery may be found in the **Operating Manual** or **Periodic Maintenance** 8000 SRM 1364.

NOTE: Note placement and orientation of parts during removal to aid in installation.

NOTE: Tag electrical connections during removal to aid in installation.

1. Remove floor mat and floor plates.

Manual Release Handle

1. Remove nut, two disc springs, two washers, capscrew, and handle from bulkhead. See Figure 24.

2. Remove nut, capscrew, bushing, and handle from ring terminal of cable. See Figure 24.

3. Loosen two jam-nuts, remove cable from bracket at fitting "F". See Figure 24.

4. Remove nut, capscrew, clamp, and cable from bulkhead. Remove clamp from cable. See Figure 24.

5. Remove two jam-nuts and cable from automatic park brake. See Figure 24.

6. Remove e-ring, at fitting "D" on cable; remove cable from bracket plate. See Figure 24.

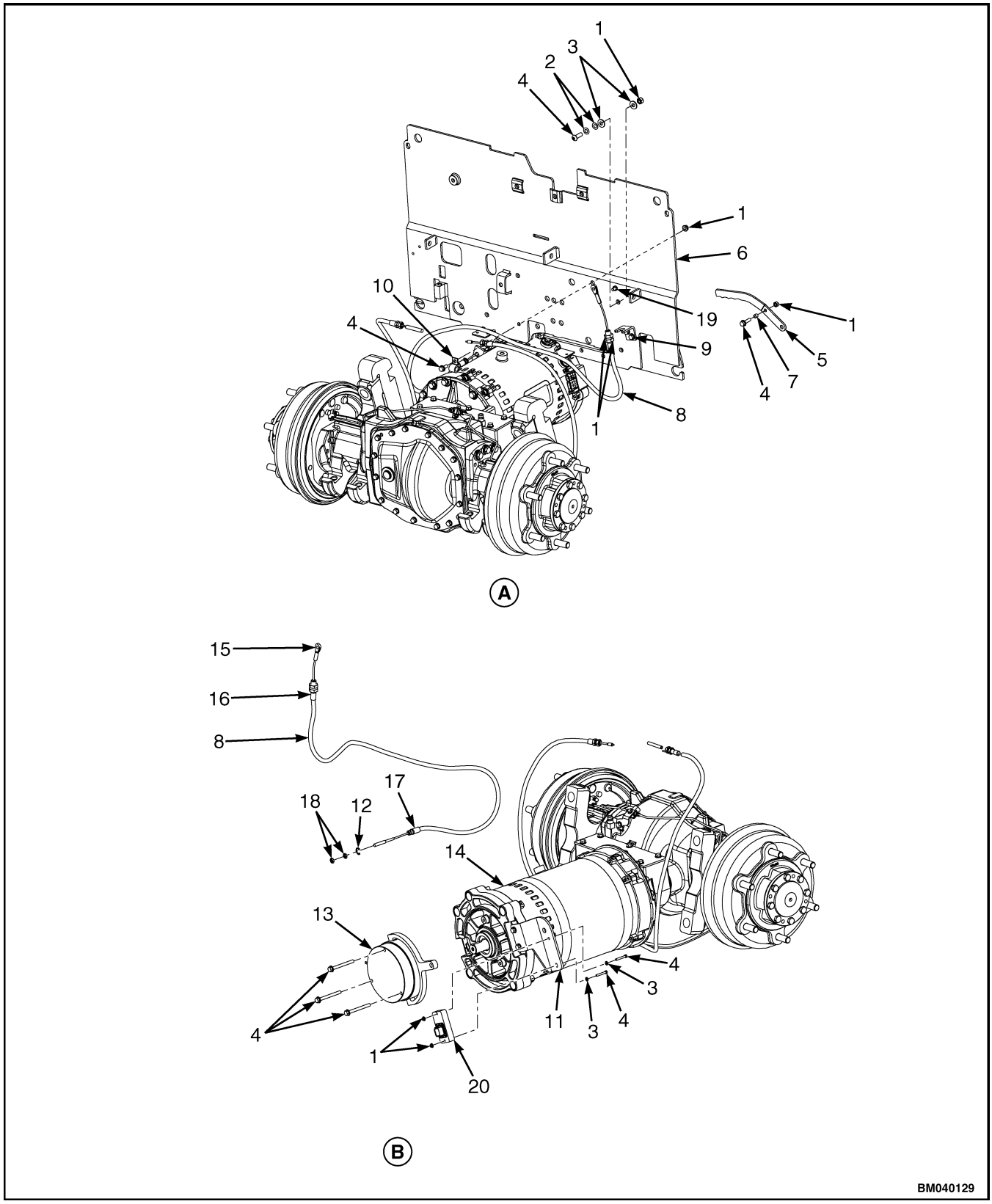


Figure 24. Automatic Park Brake

Legend for Figure 24

A. AUTOMATIC PARK BRAKE HANDLE

1. NUT
2. DISC SPRING
3. WASHER
4. CAPSCREW
5. HANDLE
6. BULKHEAD
7. BUSHING
8. CABLE
9. BRACKET
10. CLAMP

B. AUTOMATIC PARK BRAKE AND CABLE

11. BRACKET PLATE
12. E-RING
13. AUTOMATIC PARK BRAKE
14. TRACTION MOTOR
15. RING TERMINAL
16. FITTING "F"
17. FITTING "D"
18. JAM-NUT
19. MECHANICAL STOP
20. MODULE

Automatic Park Brake Assembly

NOTE: The automatic park brake assembly fits very tightly on the traction motor and is not easily removed. If necessary, rock assembly as it is pulled from motor spline.

1. Remove three capscrews and automatic park brake from traction motor. See Figure 24.

Automatic Park Brake Module

NOTE: Tag electrical connections at removal to aid in installation.

1. Disconnect module connector from wire harness.

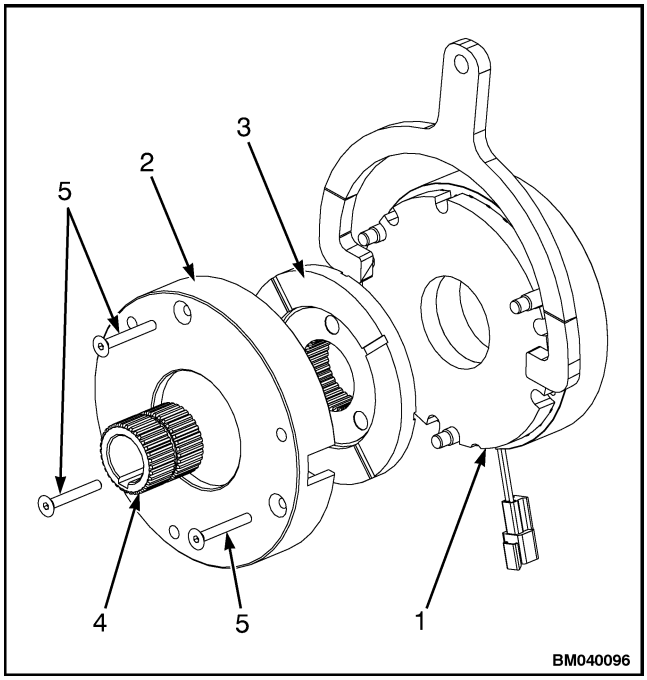
2. Remove two nuts, module, two capscrews, and two washers from bracket plate. See Figure 24.

DISASSEMBLE

NOTE: Friction disc replacement required when brake will not release.

1. Remove three screws, flange, and hub from armature. See Figure 25.

2. Remove and discard friction disc from armature. See Figure 25.



1. ARMATURE
2. FLANGE
3. FRICTION DISC
4. HUB
5. SCREW

Figure 25. Park Brake Assembly

CLEAN AND INSPECT

WARNING

Cleaning solvents can be flammable and toxic and can cause skin irritation. When using cleaning solvents, always follow the safety instructions of the solvent manufacturer.

CAUTION

Use only a dry rag when cleaning brake assembly surfaces. DO NOT use any lubricants, otherwise brake torque will be reduced.

1. Clean brake assembly components. Pay special attention to friction faces of flange and armature.
2. Clean remaining components if needed.
3. Inspect all parts for wear or damage. Replace if worn or damaged.

ASSEMBLE

1. Install new friction disc onto armature. See Figure 25.
2. Install flange, hub, and three screws to armature. See Figure 25. Tighten screws to 9 N•m (80 lbf in).

INSTALL

Automatic Park Brake Module

1. Install two washers, two capscrews, module, and two nuts onto bracket plate. See Figure 24.
2. Connect module connector to wire harness as tagged during removal.

Manual Release Handle

1. Install cable, fitting "D", to bracket-plate. Install e-ring to cable. See Figure 24.
2. Install cable with two jam-nuts to automatic park brake as noted during removal. See Figure 24.
3. Install clamp, cable, capscrew and nut to bulkhead. See Figure 24.
4. Install cable, fitting "F", to bracket; tighten two jam-nuts. See Figure 24.
5. Install bushing, ring terminal of cable, capscrew, and nut on handle. See Figure 24.
6. Install handle, two disc springs, capscrew, two washers, and nut to bulkhead. See Figure 24.

Automatic Park Brake Assembly

NOTE: Apply Loctite® 270 or equivalent to capscrews prior to installation.

1. Apply manual release. Install automatic park brake and three capscrews to traction motor. See Figure 24.

ADJUSTMENTS

1. Set automatic park brake handle to released position. Adjust cable assembly using jam-nuts at fitting "F" so brake is completely released.
2. Release handle to rest against mechanical stop and check that the brake is applied and holds a rated load on 15% grade.
3. Replace brake assembly if it does not hold or when lift truck system indicates change needed.

Service Brakes Adjustment (Dry Brake)

BRAKE ADJUST

The following procedure is for newly-installed brake shoes. If the lift truck has been operated for more than 25 hours and has correct pedal height, the brakes normally will not need adjustment.

1. See the procedure **How to Put Lift Truck on Blocks** in the **Operator's Manual** or **Periodic Maintenance** 8000 SRM 1364. Put lift truck on blocks so the drive wheels can be removed. Remove drive wheels.
2. Use an adjust tool to rotate the adjust wheel so that the teeth of the wheel move downward. This adjustment expands the brake shoes. Adjust the brake shoes so that the brake drum will not rotate.

NOTE: If the brake shoes were not replaced, loosen the adjust wheel approximately 20 teeth.

3. Push the automatic adjust lever away from the adjust wheel with a small screwdriver. Use the adjust tool to loosen the adjust wheel approximately 20 teeth (new brake shoes).
4. Install the drive wheels. Remove that lift truck from the blocks. Operate the lift truck in **FORWARD** and **REVERSE** directions. Stop the lift truck 10 times in each direction. This procedure causes the brake shoes to wear a small amount and fit the brake drum better.

Parking Brake Adjustment

1. With part brake cables assembled and park brake assembly in release position (see Figure 26), apply an initial load of 382.5 N (86 lbf) to park brake pedal. Adjust cable tension adjustor fitting and secure with jam-nut to take up slack.
2. Check the park brake tension while lift truck is on 15% grade with rated load. Make adjustment to park brake cable tension if required, tighten adjust fitting and jam-nut to secure adjustments.

Legend for Figure 26

A. RELEASE POSITION

1. FRONT CABLE
2. PARK BRAKE ASSEMBLY
3. CLIP
4. LEFT-HAND PARK BRAKE CABLE
5. NUT

B. APPLIED POSITION

6. TENSION ADJUST FITTING
7. RIGHT-HAND PARK BRAKE CABLE
8. STRAND END FITTING
9. CONDUIT REACTION BRACKET

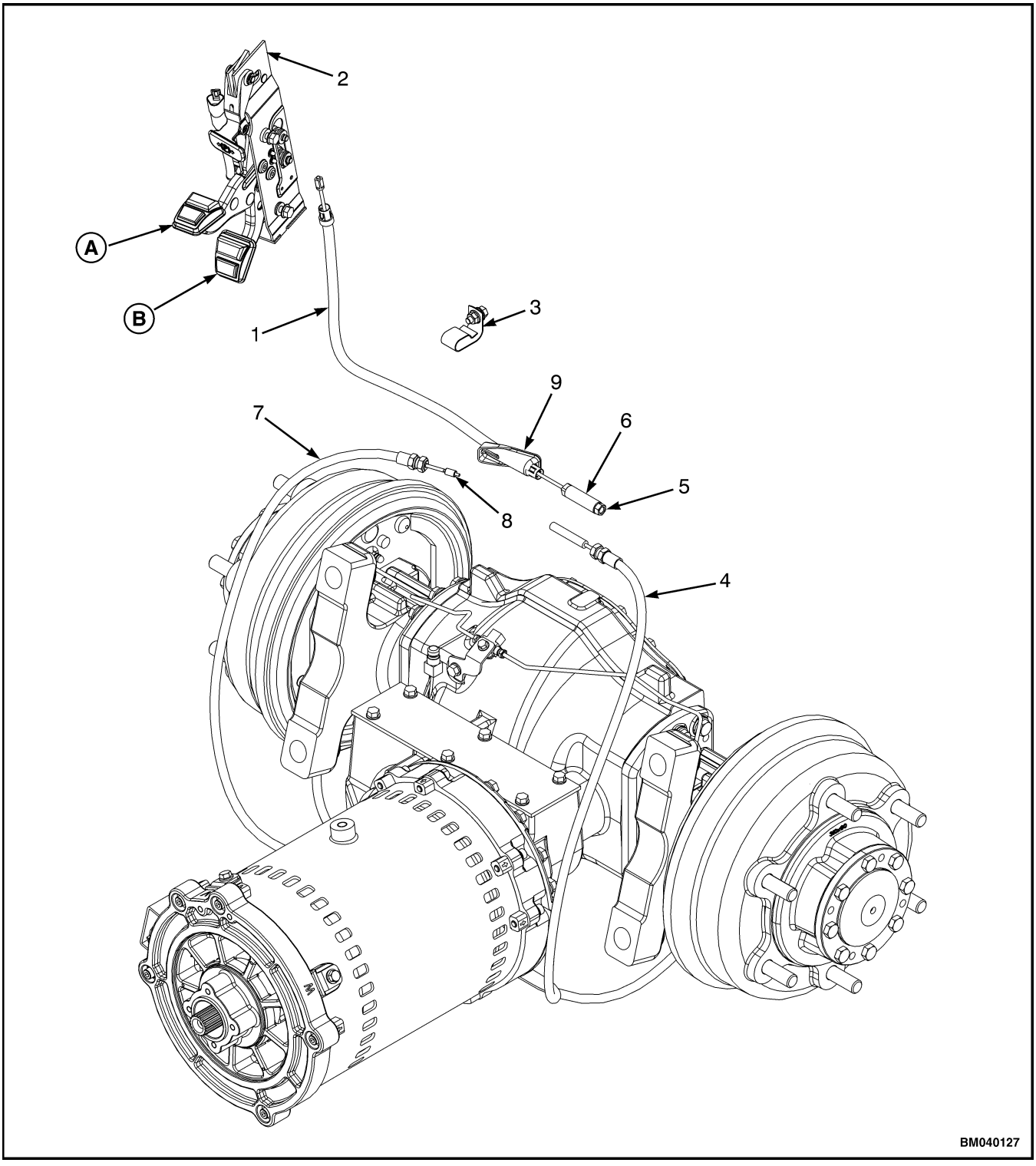


Figure 26. Park Brake Cables

Brake System Air Removal

BRAKE SYSTEM AIR REMOVAL

There are two commonly used methods to remove air form the brake system. The preferred method is using a pressure bleed system. The other method is by applying pressure using the brake pedal.

USING PRESSURE BLEED SYSTEM

WARNING

On lift trucks with dry brake drive axles, only use SAE J-1703 (DOT 3) brake fluid in the master cylinder.

NOTE: Adjust the service brakes before the air is removed from the brake system.

1. Fill the brake fluid reservoir with brake fluid.
2. Remove bleeder cap.
3. Place one end of a robber hose on the bleeder screw of each wheel cylinder. Place the other end of each hose into a clear container of brake fluid.
4. Connect a pressure bleeder to the brake fluid reservoir.
5. Loosen the bleeder screws at the wheel cylinders one turn.

NOTE: While applying air pressure to the pressure bleeder, check the level of the brake fluid in the master cylinder reservoir. Make sure to maintain the brake fluid at the correct level to avoid forcing more air into the brake system.

6. Apply 34.5 kPa (5 psi) of air pressure to the pressure bleeder, forcing fluid through the lines until all air is removed from the system. Close the bleeder screws.
7. Install bleeder cap.
8. Check the level of the brake fluid in the master cylinder reservoir. Fill the brake fluid reservoir to the correct level.

USING BRAKE PEDAL PRESSURE

WARNING

On lift trucks with dry brake drive axles, only use SAE J-1703 (DOT 3) brake fluid in the master cylinder.

NOTE: Adjust the service brakes before the air is removed from the brake system.

1. Fill the brake fluid reservoir with brake fluid.
2. Remove bleeder cap.
3. Place one end of a rubber hose on the bleeder screw of the wheel cylinder furthest from the master cylinder. Place the other end of the hose into a clear container of brake fluid.

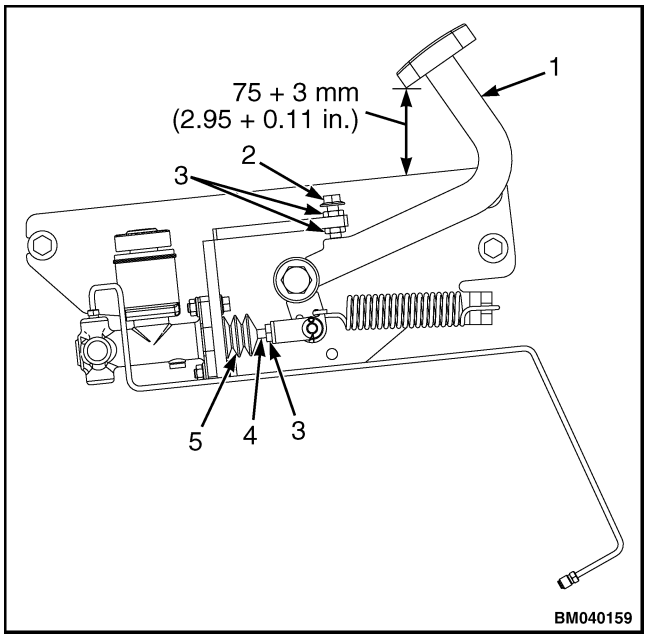
NOTE: Check the level of the brake fluid in the master cylinder reservoir during the procedure. Make sure to maintain the brake fluid at the correct level.

4. Loosen the bleeder screw at the wheel cylinder one turn so that the air can be removed from the brake system. Slowly push the brake pedal and hold it at the end of its stroke. Close the bleeder screw.
5. Repeat Step 4 until there are no air bubbles in the container.
6. Install bleeder cap.
7. Repeat Step 1 through Step 4 and Step 6 for the remaining wheel cylinder.
8. Check the level of the brake fluid in the master cylinder reservoir. Fill the brake fluid reservoir to the correct level.

Brake Pedal Adjustment

BRAKE PEDAL ADJUSTMENT

Adjust pedal height to 75 +3 mm (2.95 +0.11 in.) by adjusting capscrew at the rear of the pedal assembly. Measurement is from the bottom of the brake pedal to the top of the bracket. Tighten locknuts. See Figure 27.



1. BRAKE PEDAL
2. CAPSCREW
3. LOCKNUT
4. MASTER CYLINDER PUSH ROD
5. RUBBER BOOT

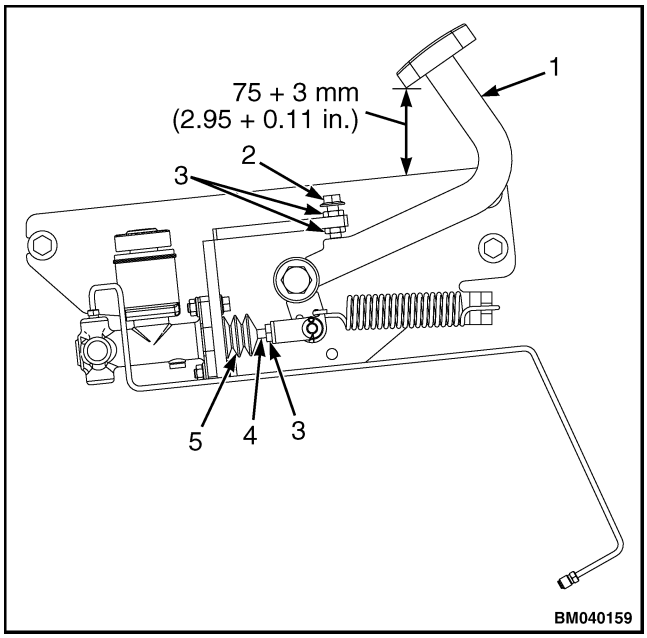
Figure 27. Brake Pedal and Master Cylinder Adjustment

Master Cylinder Adjustment

ADJUST PUSH ROD

1. Loosen locknut on master cylinder push rod and adjust by turning push rod counterclockwise (as viewed from rear of lift truck) to remove all slack between master cylinder and brake pedal. Do not allow rubber boot to be twisted while adjusting the rod length. See Figure 28.

2. Turn push rod one-eighth turn clockwise allowing master cylinder to fully return when brake pedal is released. Tighten locknut to 15 to 17 N•m (133 to 150 lbf in). See Figure 28.



1. BRAKE PEDAL
2. CAPSCREW
3. LOCKNUT
4. MASTER CYLINDER PUSH ROD
5. RUBBER BOOT

Figure 28. Brake Pedal and Master Cylinder Adjustment

Parking Brake Not Applied Switch Test

The Parking Brake Not Applied system is actuated by a combination of two switches, one attached to the parking brake mechanism and the other is the seat switch. These switches actuate an audible buzzer on the instrument cluster. When the operator leaves the seat for more than two seconds without applying the parking brake, the buzzer will be continuous for 20 seconds. The buzzer operates whether the key switch is **ON** or **OFF**.

Torque Specifications

Back Plate to Axle Lock Bolts
255 to 306 N•m (188 to 226 lbf ft)

Wheel Cylinder to Back Plate Capscrews
18 to 27 N•m (13 to 20 lbf ft)

Drive Axle Shaft Capscrews
90 to 99 N•m (66 to 73 lbf ft)

Wheel Adjustment Nut - Align Bearing Rollers
14 to 18 N•m (10 to 13 lbf ft)

Wheel Adjustment Nut - Seat Wheel Bearings
175 to 215 N•m (129 to 159 lbf ft)

Wheel Adjustment Nut - Preload Wheel Bearings
14 to 18 N•m (10 to 13 lbf ft)

Master Cylinder to Mounting Plate Nuts
19 N•m (168 lbf in)

Brake Sensor to Master Cylinder
23 to 28 N•m (204 to 248 lbf in)

Master Cylinder Push Rod Locknut
15 to 17 N•m (133 to 150 lbf in)

Brake Pedal Assembly to Bracket Capscrew
165 N•m (122 lbf ft)

Brake Pedal Adjustment Lock Nut
15 to 17 N•m (133 to 150 lbf in)

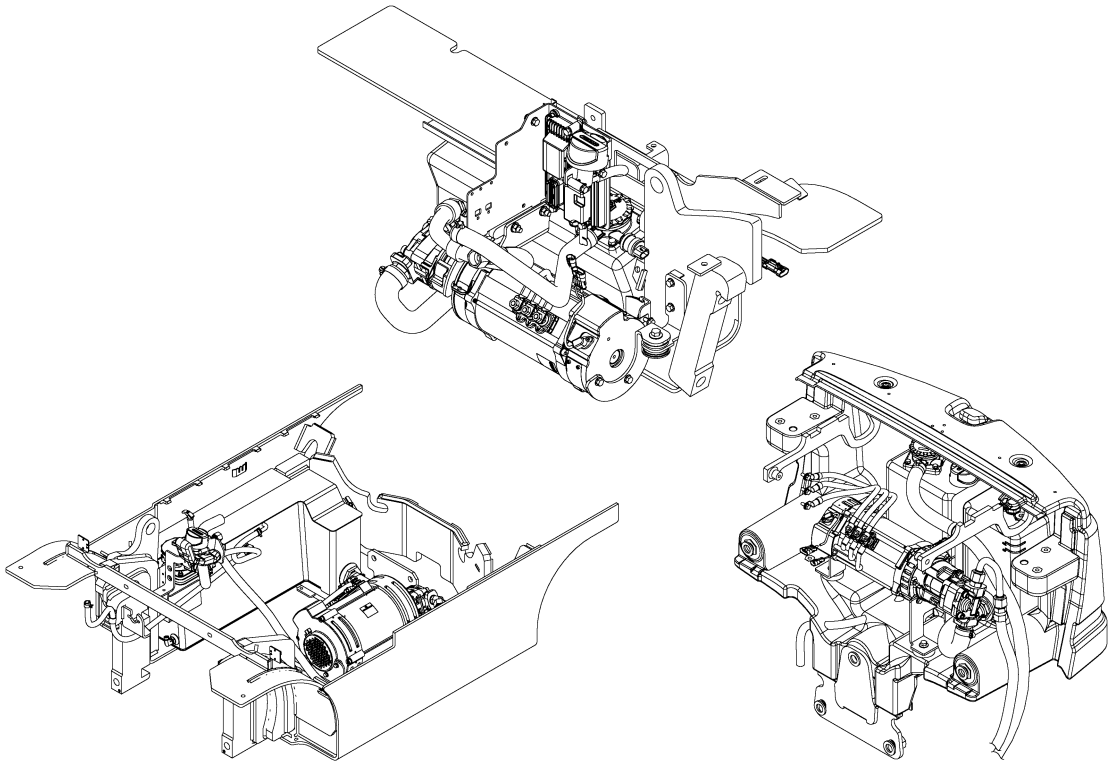
NOTES

HYSTER TECHNICAL PUBLICATIONS

1800 SRM 1359 3/12 (12/10)(7/10)(9/08) Printed in U.S.A.

HYDRAULIC SYSTEM

E2.2-3.5XN (E45-70XN) [A268];
E1.6-2.0XN (E30-40XN) [A269];
J2.2-3.5XN (J45-70XN) [A276];
J4.0-5.0XN, J5.0-5.5XN6
(J80-120XN, J100XNL) [A970];
E4.0-5.5XN, E5.0XNS
(E80-120XN, E100XNS) [A099]



HYSTER

PART NO. 1688875

1900 SRM 1367

SAFETY PRECAUTIONS
MAINTENANCE AND REPAIR

- The Service Manuals are updated on a regular basis, but may not reflect recent design changes to the product. Updated technical service information may be available from your local authorized Hyster® dealer. Service Manuals provide general guidelines for maintenance and service and are intended for use by trained and experienced technicians. Failure to properly maintain equipment or to follow instructions contained in the Service Manual could result in damage to the products, personal injury, property damage or death.
- When lifting parts or assemblies, make sure all slings, chains, or cables are correctly fastened, and that the load being lifted is balanced. Make sure the crane, cables, and chains have the capacity to support the weight of the load.
- Do not lift heavy parts by hand, use a lifting mechanism.
- Wear safety glasses.
- DISCONNECT THE BATTERY CONNECTOR before doing any maintenance or repair on electric lift trucks. Disconnect the battery ground cable on internal combustion lift trucks.
- Always use correct blocks to prevent the unit from rolling or falling. See HOW TO PUT THE LIFT TRUCK ON BLOCKS in the **Operating Manual** or the **Periodic Maintenance** section.
- Keep the unit clean and the working area clean and orderly.
- Use the correct tools for the job.
- Keep the tools clean and in good condition.
- Always use **HYSTER APPROVED** parts when making repairs. Replacement parts must meet or exceed the specifications of the original equipment manufacturer.
- Make sure all nuts, bolts, snap rings, and other fastening devices are removed before using force to remove parts.
- Always fasten a DO NOT OPERATE tag to the controls of the unit when making repairs, or if the unit needs repairs.
- Be sure to follow the **WARNING** and **CAUTION** notes in the instructions.
- Gasoline, Liquid Petroleum Gas (LPG), Compressed Natural Gas (CNG), and Diesel fuel are flammable. Be sure to follow the necessary safety precautions when handling these fuels and when working on these fuel systems.
- Batteries generate flammable gas when they are being charged. Keep fire and sparks away from the area. Make sure the area is well ventilated.

NOTE: The following symbols and words indicate safety information in this manual:

WARNING

Indicates a hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION

Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury and property damage.

On the lift truck, the WARNING symbol and word are on orange background. The CAUTION symbol and word are on yellow background.

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E2.2-3.5XN (E45-70XN) [A268];
E1.6-2.0XN (E30-40XN) [A269];
J2.2-3.5XN (J45-70XN) [A276];
J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) [A970];
E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) [A099]

"THE QUALITY KEEPERS"

HYSTER APPROVED PARTS

General

This section describes repairs, checks, and adjustments for the hydraulic pump and hydraulic tank including hydraulic filter and breather replacement. Repair procedures for related systems can be found in the following sections:

Main Control Valves 2000SRM1334 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268)
- J2.2-3.5XN (J45-70XN) (A276)
- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)
- E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

Main Control Valves 2000SRM1439 for lift truck models

- E1.6-2.0XN (E30-40XN) (A269)

Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564) 4000SRM1338 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268)
- J2.2-3.5XN (J45-70XN) (A276)

Mast Repair (S/N B551, B555, and B559) 4000SRM1441 for lift truck models

- E1.6-2.0XN (E30-40XN) (A269)

Mast Repair (S/N A626-27, A751-52, B590-91, and B749-54) 4000SRM1540 for lift truck models

- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

Mast Repairs (S/N A551, A555, A559, A751, A752, B586, B587, B588, B590, B591, B749, B750, B751, B752, and B754) 4000SRM1576 for lift truck model

- E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564) 2100SRM1382 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268)
- J2.2-3.5XN (J45-70XN) (A276)
- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)
- E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

Cylinder Repair (Mast S/N B551, B555, B559) 2100SRM1440 for lift truck models

- E1.6-2.0XN (E30-40XN) (A269)

The service manuals below are for all lift truck models covered in this manual

- **Steering System** 1600SRM1363
- **Steering Axle** 1600SRM1360
- **AC Motor Repair** 0620SRM1385

DISCHARGING THE CAPACITORS

WARNING

DO NOT make repairs or adjustments unless you have been properly trained and authorized to do so. Improper repairs and adjustments can create dangerous operating conditions. DO NOT operate a lift truck that needs repairs. Report the need for repairs to you supervisor immediately. If repair is necessary, attach a DO NOT OPERATE tag on the steering wheel and disconnect the battery.

Disconnect the battery and allow the capacitors to discharge before opening any compartments covers or inspecting or repairing the hydraulic system. DO NOT place tools on top of the battery. If a tool causes a short circuit, the high current flow from the battery can cause personal injury or property damage.

Some checks and adjustments are performed with the battery connected. DO NOT connect the battery until the procedure instructs you to do so. Never wear any metallic items on your fingers, arms, or neck. Metal items can accidentally make an electrical connection and cause injury.

Before performing any tests or adjustment, block the lift truck to prevent unexpected movement.

The capacitor in the transistor controller(s) can hold an electrical charge for about 10 seconds after the battery is disconnected. To prevent an electrical shock and personal injury, discharge the capacitor(s) before inspecting or repairing any component in the drive unit compartment. Make certain that the battery has been disconnected.

DO NOT short across the motor controller terminals with a screwdriver or jumper wire.

Make certain the Emergency Disconnect Switch has not been activated. This will isolate the controller and prevent the capacitors from discharging properly. The proper way to disconnect the battery is by separating the battery connectors.

1. Ensure the capacitors are discharged by performing Step 2 through Step 6 below.
2. Turn the key or keyless switch to the **OFF** position.
3. Disconnect the battery by separating the connectors.
4. Block drive wheels to prevent lift truck from moving.
5. Make sure the Emergency Disconnect Switch **HAS NOT** been activated. If the Emergency Disconnect Switch is activated, rotate the switch to the right until it pops up.
6. Press horn button. Wait 30 seconds to be sure capacitors are fully discharged.

Hydraulic Pump and Motor

REMOVE

WARNING

PUTTING THE LIFT TRUCK ON BLOCKS

The lift truck must be put on blocks for some types of maintenance and repair. The removal of the mast, drive axle, battery, or counterweight assemblies will cause large changes in the center of gravity. When the lift truck is put on blocks, put additional blocks in the following positions:

- **If the mast and drive axle are removed, put blocks under the counterweight so the lift truck cannot fall backward.**
- **If the counterweight is removed, put blocks under the mast so that the lift truck cannot fall forward.**

Put the lift truck on blocks on a solid, even, and level surface. Verify the blocks or stands have enough capacity to hold the lift truck. Use additional blocks next to the tires as necessary to prevent movement of the lift truck. Verify the lifting devices used during repairs can lift the weight of the parts and assemblies.

See the Operating Manual or Periodic Maintenance section for your lift truck model, for the procedures to put the lift truck on blocks.

CAUTION

DO NOT permit dirt to enter the hydraulic system during the steps of this procedure. Dirt can cause damage to the components of the hydraulic system.

Never operate the hydraulic pump without oil in the hydraulic system. The operation of the hydraulic pump without oil will damage the pump.

1. Place lift truck on blocks. See **Operating Manual** or one of the following sections

   Periodic Maintenance 8000SRM1364 for lift truck models

   - E2.2-3.5XN (E45-70XN) (A268)

   Periodic Maintenance 8000SRM1442 for lift truck models

   - E1.6-2.0XN (E30-40XN) (A269)

   Periodic Maintenance 8000SRM1372 for lift truck models

   - J2.2-3.5XN (J45-70XN) (A276)

   Periodic Maintenance 8000SRM1541 for lift truck models

   - J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

   Periodic Maintenance 8000SRM1577 for lift truck model

   - E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

2. Discharge capacitors as specified in Discharging the Capacitors in **General** section of this manual.

Lift Truck Models E2.2-3.5XN (E45-70XN) (A268)

1. Remove the battery from the lift truck. The procedure for removing the battery may be found in the **Operating Manual** or **Periodic Maintenance** 8000SRM1364.

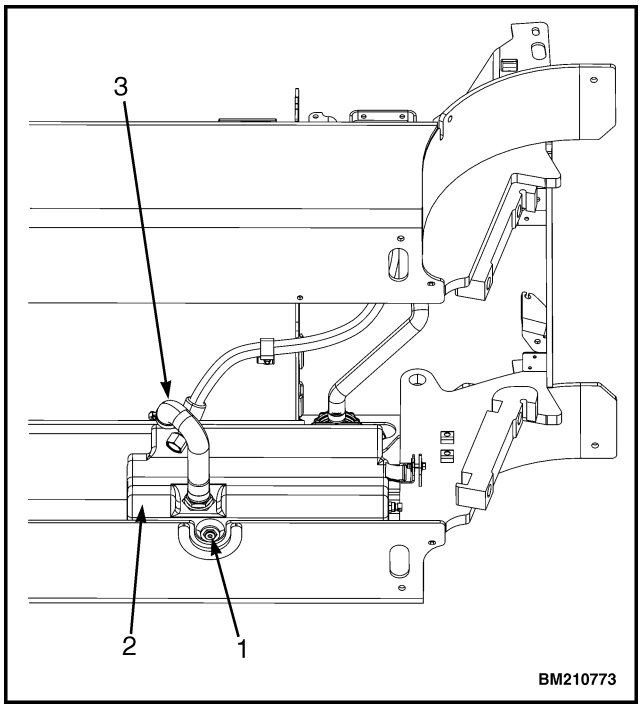
2. Remove battery plate.

3. Install a container, with a capacity of 33 liter (35 qt) for nylon tank or 35 liter (37 qt) for metal tank, under drain plug of hydraulic tank. Remove drain plug and drain hydraulic oil. See Figure 1.

NOTE: Tag hoses and electrical connections during removal to aid in installation.

NOTE: Plug hoses and pump openings to prevent foreign material from entering hydraulic system.

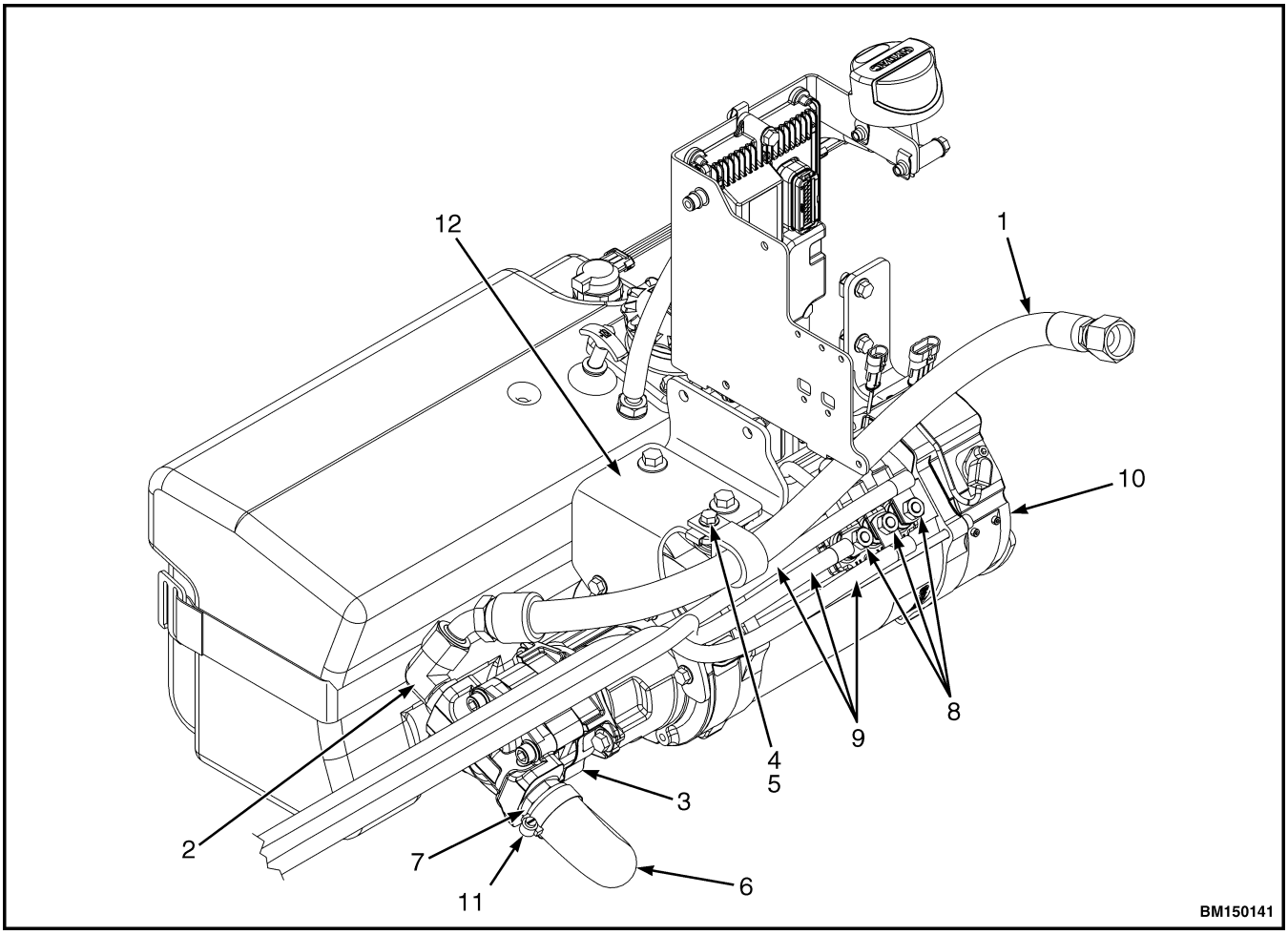
4. Remove capscrew and clamp, securing pressure line hose that runs from control valve to pump pressure port, from motor support bracket. See Figure 2.



NOTE: MAJOR COMPONENTS OF HYDRAULIC SYSTEM REMOVED FOR CLARITY.

1. HYDRAULIC OIL DRAIN PLUG
2. HYDRAULIC TANK
3. SUCTION HOSE

Figure 1. Drain Hydraulic Oil From Lift Truck Models E2.2-3.5XN (E45-70XN) (A268)



NOTE: STANDARD MOTOR SHOWN.

1. PRESSURE LINE HOSE
2. FITTING
3. HYDRAULIC PUMP
4. CAPSCREW
5. CLAMP
6. SUCTION HOSE
7. SUCTION ADAPTER
8. NUT
9. POWER CABLES
10. MOTOR
11. HOSE CLAMP
12. MOTOR SUPPORT BRACKET

Figure 2. Hydraulic Pump and Motor Connections for Lift Truck Models E2.2-3.5XN (E45-70XN) (A268)

5. Disconnect pressure line hose at fitting and move aside to prevent damage. See Figure 2.

6. Loosen hose clamp at suction adapter end of suction hose and move it up suction hose until suction adapter is cleared. Tighten hose clamp enough to keep suction hose and hose clamp together.

7. Disconnect suction hose from suction adapter. See Figure 2. Plug adapter and suction hose.

CAUTION

Disposal of lubricants and fluids must meet local environmental regulations.

8. Ensure hydraulic oil has completely drained from hydraulic tank, replace drain plug, and cap all open ports. Remove container with used hydraulic oil.

9. With lift truck on blocks, position floor jack under pump and motor to support both at the same time.

NOTE: Tag electrical connections during removal to aid in installation.

10. Remove three nuts and disconnect three power cables from motor. Lay power cables aside to prevent damage. See Figure 2.

11. Disconnect temperature and speed sensor connectors from wire harness.

12. Remove motor mount bolt, nut, and snubbing washer from motor mount bracket and motor support bracket at front of pump and motor assembly. See "A" of Figure 3.

13. Remove motor mount bolts, nuts, and snubbing washers from motor mount bracket and motor support bracket at rear of pump and motor assembly. See "B" of Figure 3.

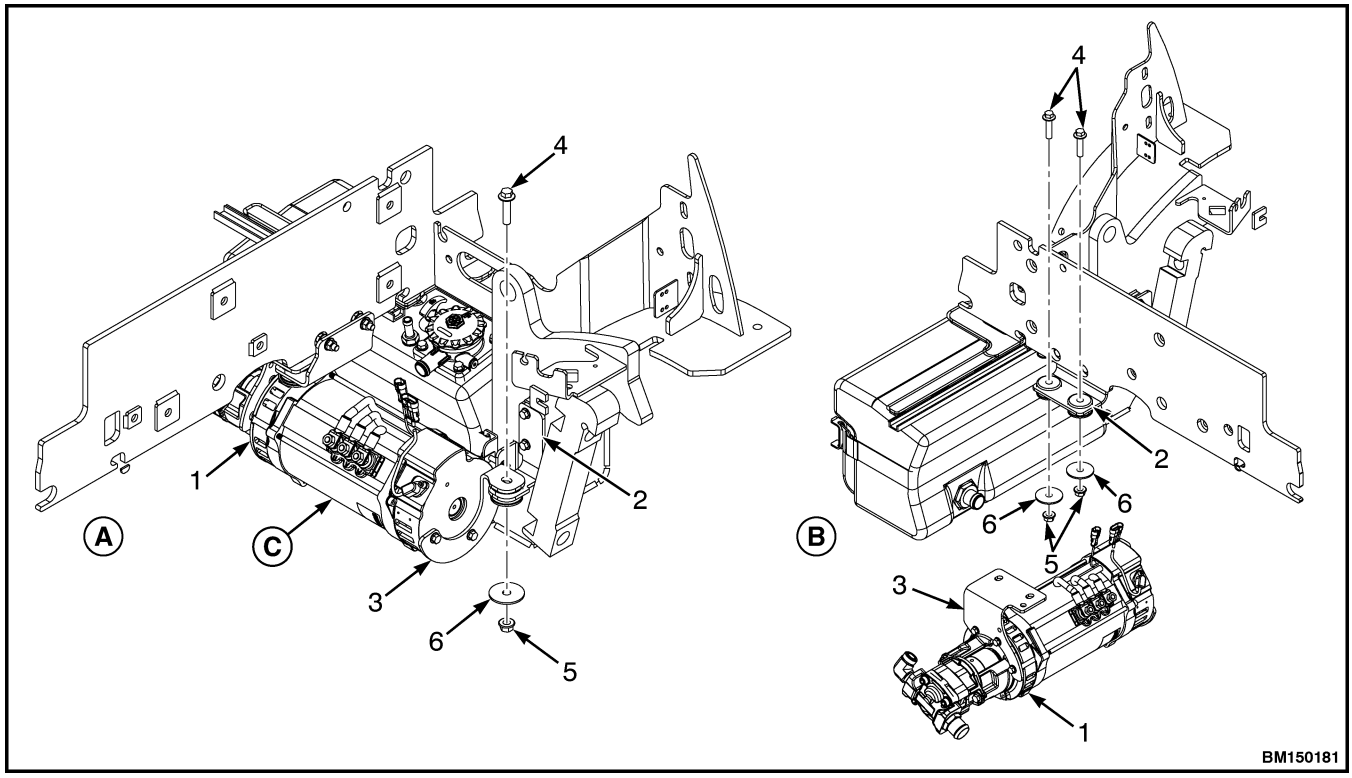
14. With all connections and mounting bolts removed from the pump and motor assembly, raise floor jack slightly and maneuver pump and motor assembly toward rear of lift truck until free of all obstructions.

15. Lower pump and motor assembly and remove from lift truck.

16. Remove fitting from hydraulic pump. See Figure 4.

NOTE: Note orientation of suction adapter during disassembly to aid in assembly.

17. Remove suction adapter from hydraulic pump. See Figure 4.

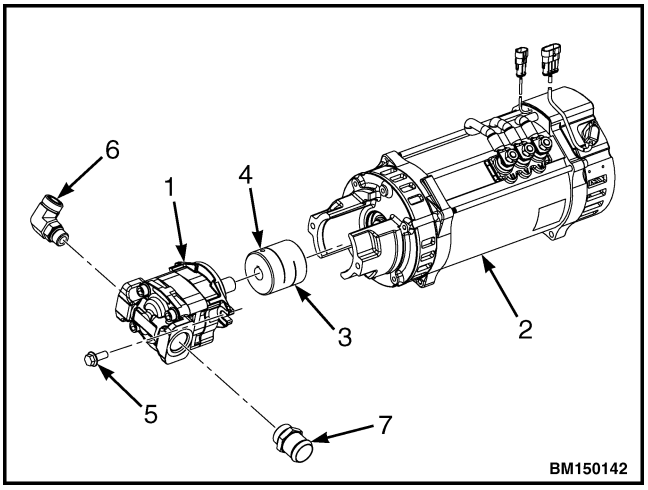


NOTE: MAJOR COMPONENTS OF FRAME NOT SHOWN FOR CLARITY. STANDARD MOTOR SHOWN.

A. FRONT VIEW
B. REAR VIEW
C. FLOOR JACK PLACEMENT

1. PUMP AND MOTOR ASSEMBLY
2. MOTOR SUPPORT BRACKET
3. MOTOR MOUNT BRACKET
4. MOTOR MOUNT BOLT
5. NUT
6. SNUBBING WASHER

Figure 3. Pump and Motor Support for Lift Truck Models E2.2-3.5XN (E45-70XN) (A268)



NOTE: STANDARD MOTOR SHOWN.

1. HYDRAULIC PUMP
2. MOTOR
3. COUPLING
4. SETSCREW
5. CAPSCREW
6. FITTING
7. SUCTION ADAPTER

Figure 4. Hydraulic Pump and Motor Assembly for Lift Truck Models E2.2-3.5XN (E45-70XN) (A268)

NOTE: Note position of inlet and outlet ports of pump for correct alignment during installation.

18. Remove two capscrews and pump from motor. See Figure 4.

Lift Truck Models E1.6-2.0XN (E30-40XN) (A269)

1. Remove the battery from the lift truck. The procedure for removing the battery may be found in the **Operating Manual** or **Periodic Maintenance** 8000SRM1442.

2. Remove battery plate.

3. Install a container, with a capacity of 30.0 liter (32 qt), under drain plug of hydraulic tank. Remove drain plug and drain hydraulic oil. See Figure 5.

NOTE: Tag hoses and electrical connections during removal to aid in installation.

NOTE: Plug hoses and pump openings to prevent foreign material from entering hydraulic system.

4. Disconnect control valve fitting, securing pressure line hose that runs from control valve to pump pressure port. See Figure 6.

5. Disconnect pressure line hose at pump pressure port fitting and move aside to prevent damage. See Figure 6.

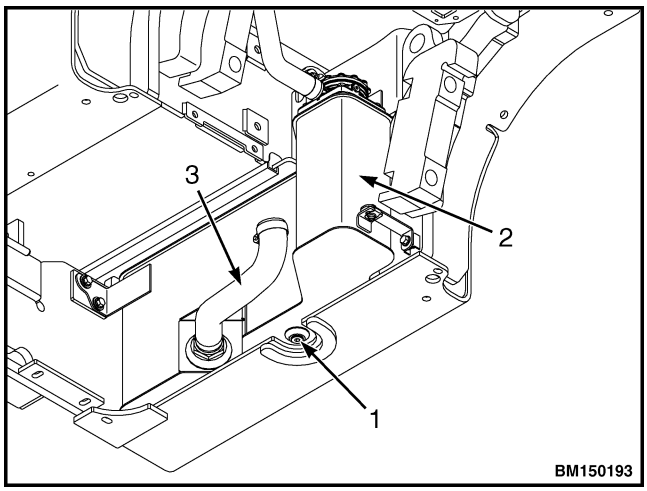
6. Loosen hose clamp at suction adapter end of suction hose and move it down suction hose until suction adapter is cleared. Tighten hose clamp enough to keep suction hose and hose clamp together.

7. Disconnect suction hose from suction adapter. See Figure 6. Plug adapter and suction hose.

CAUTION

Disposal of lubricants and fluids must meet local environmental regulations.

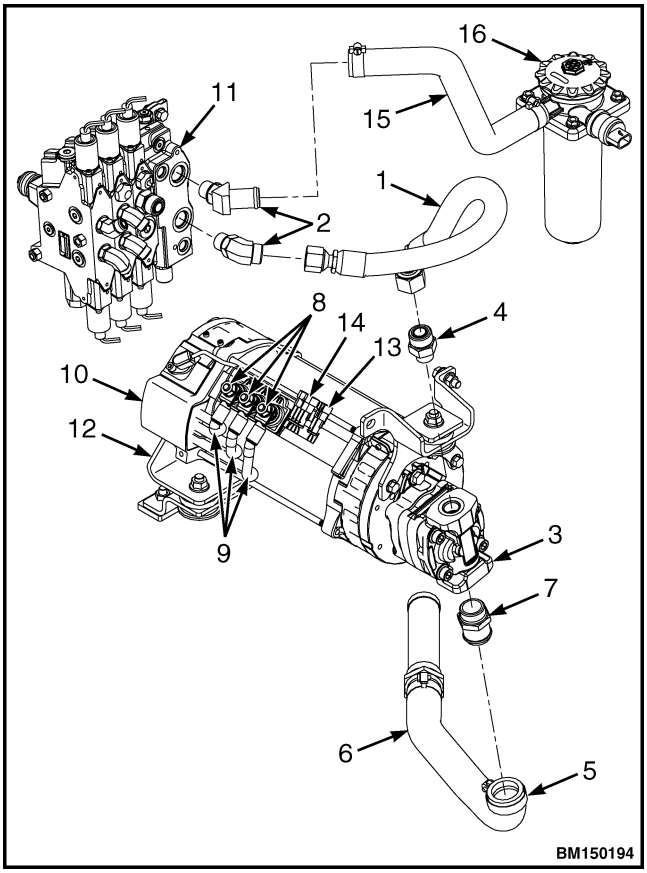
8. Ensure hydraulic oil has completely drained from hydraulic tank, replace drain plug, and cap all open ports. Remove container with used hydraulic oil.



NOTE: MAJOR COMPONENTS OF HYDRAULIC SYSTEM REMOVED FOR CLARITY.

1. HYDRAULIC OIL DRAIN PLUG
2. HYDRAULIC TANK
3. SUCTION HOSE

Figure 5. Drain Hydraulic Oil From Lift Truck Models E1.6-2.0XN (E30-40XN) (A269)



NOTE: MAJOR COMPONENTS OF HYDRAULIC SYSTEM AND ELECTRICAL WIRING HARNESS REMOVED FOR CLARITY.

1. PRESSURE LINE HOSE
2. CONTROL VALVE FITTING
3. HYDRAULIC PUMP
4. PUMP PRESSURE PORT FITTING
5. CLAMP
6. SUCTION HOSE
7. SUCTION ADAPTER
8. NUT
9. POWER CABLES
10. MOTOR
11. CONTROL VALVE
12. MOTOR SUPPORT BRACKET
13. TEMPERATURE SENSOR CONNECTOR
14. SPEED SENSOR CONNECTOR
15. RETURN LINE
16. HYDRAULIC FILTER

Figure 6. Hydraulic Pump and Motor Connections for Lift Truck Models E1.6-2.0XN (E30-40XN) (A269)

9. With lift truck on blocks, position floor jack under pump and motor to support both at the same time.

NOTE: Tag electrical connections during removal to aid in installation.

10. Remove three nuts and disconnect three power cables from motor. Lay power cables aside to prevent damage. See Figure 6.

11. Disconnect temperature and speed sensor connectors from wire harness. See Figure 6.

12. Remove two nuts, two motor mount bolts, motor support bracket, and motor mount from front motor mount bracket. See Figure 7.

13. Remove two nuts, two motor mount bolts, and two snubbing washers from motor mount bracket and motor support bracket at rear of pump and motor assembly. See Figure 7.

14. With all connections and mounting bolts removed from the pump and motor assembly, raise floor jack slightly and maneuver pump and motor assembly toward rear of lift truck until free of all obstructions.

15. Lower pump and motor assembly and remove from lift truck.

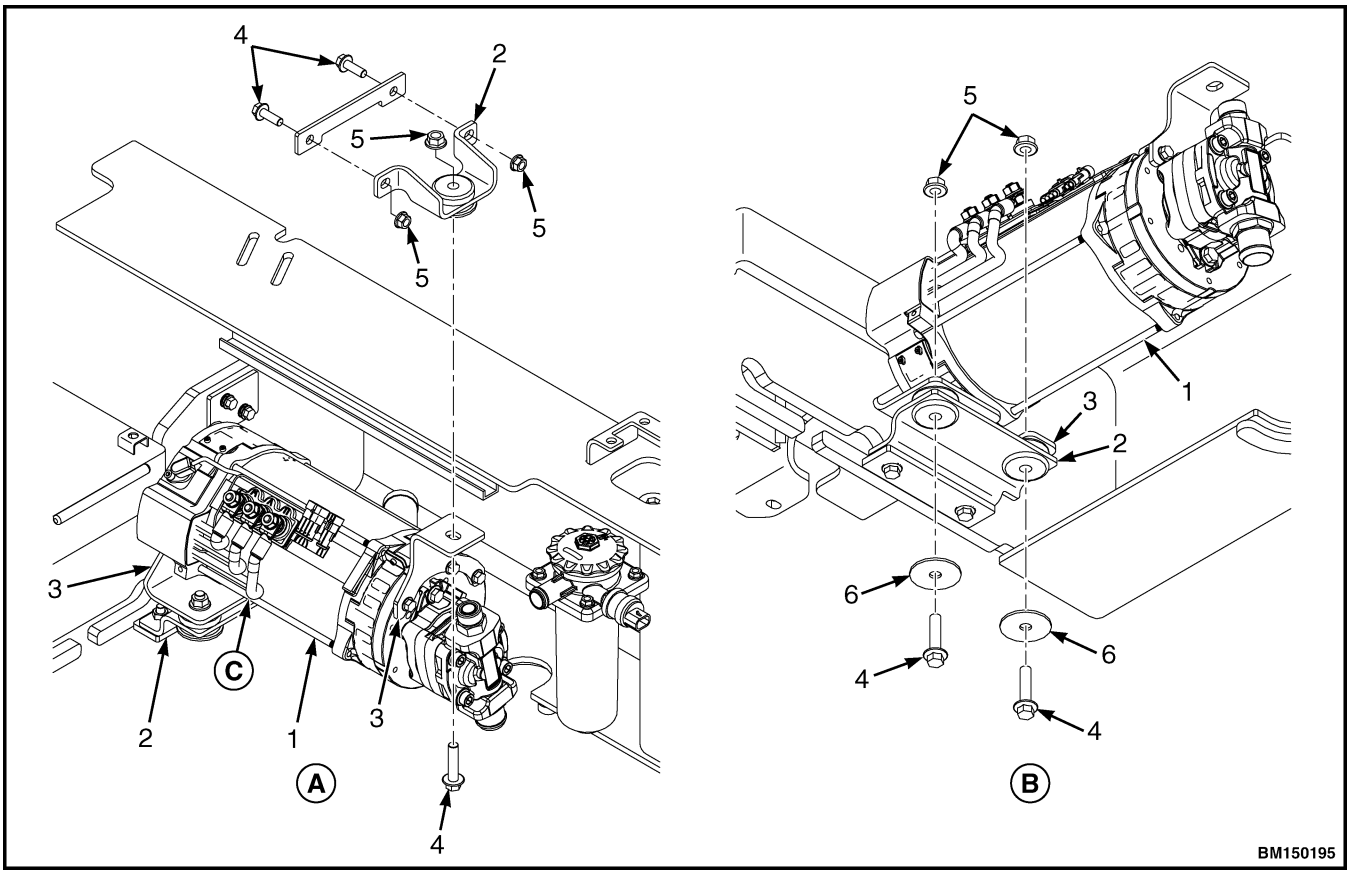
16. Remove fitting from hydraulic pump. See Figure 8.

NOTE: Note orientation of suction adapter during disassembly to aid in assembly.

17. Remove suction adapter from hydraulic pump. See Figure 8.

NOTE: Note position of inlet and outlet ports of pump for correct alignment during installation.

18. Remove two capscrews and pump from motor. See Figure 8.

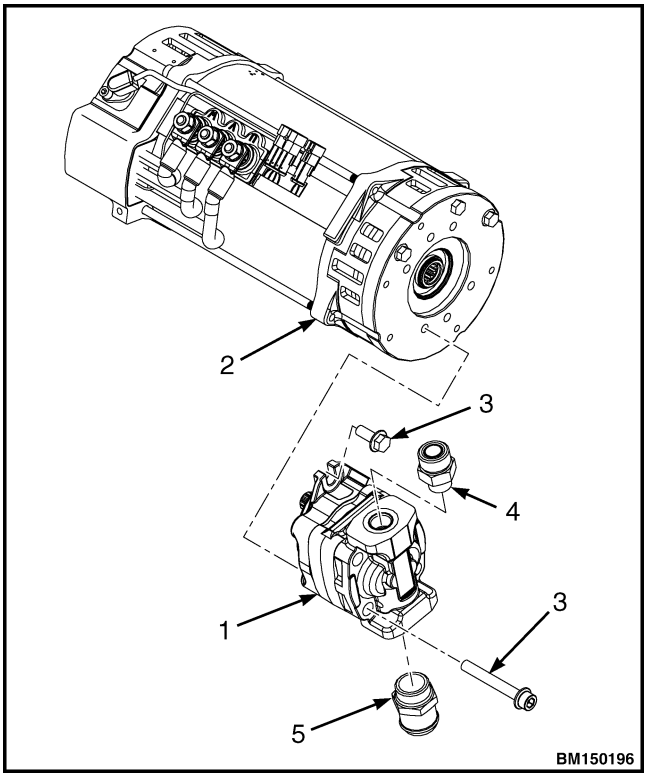


NOTE: MAJOR COMPONENTS OF FRAME NOT SHOWN FOR CLARITY.

A. FRONT VIEW
B. REAR VIEW
C. FLOOR JACK PLACEMENT

1. PUMP AND MOTOR ASSEMBLY
2. MOTOR SUPPORT BRACKET
3. MOTOR MOUNT BRACKET
4. MOTOR MOUNT BOLT
5. NUT
6. SNUBBING WASHER

Figure 7. Pump and Motor Support for Lift Truck Models E1.6-2.0XN (E30-40XN) (A269)



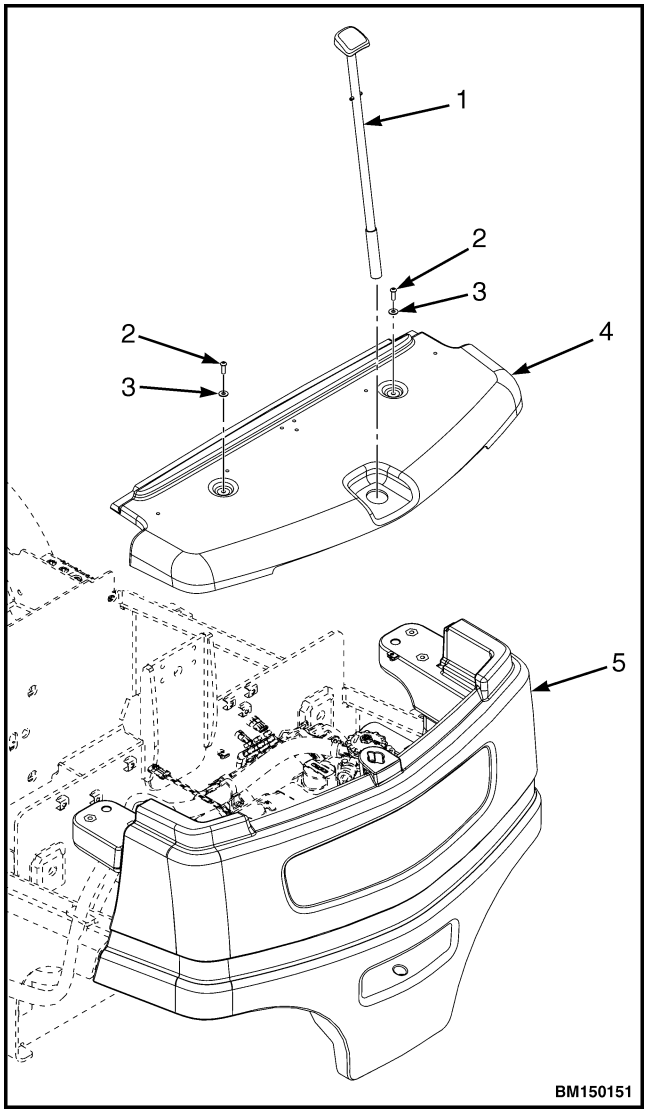
1. HYDRAULIC PUMP
2. MOTOR
3. CAPSCREW
4. FITTING
5. SUCTION ADAPTER

Figure 8. Hydraulic Pump and Motor Assembly for Lift Truck Models E1.6-2.0XN (E30-40XN) (A269)

Lift Truck Models J2.2-3.5XN (J45-70XN) (A276)

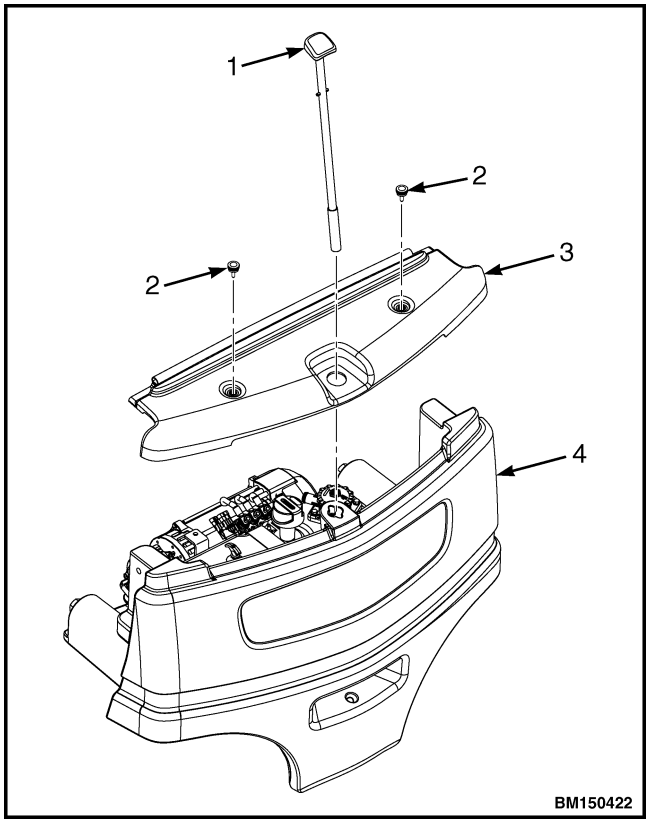
1. Install a container, with a capacity of 33 liter (35 qt) under drain hose beneath lift truck. Open drain valve and empty hydraulic tank.

2. Remove tow pin from counterweight and counterweight cover. See Figure 9 or Figure 10.



1. TOW PIN
2. CAPSCREW
3. WASHER
4. COUNTERWEIGHT COVER
5. COUNTERWEIGHT

Figure 9. Counterweight Cover for Lift Truck Models J2.2-3.5XN (J45-70XN) (A276) Manufactured Prior to November, 2015



1. TOW PIN
2. KNOB SCREW
3. COUNTERWEIGHT COVER
4. COUNTERWEIGHT

Figure 10. Counterweight Cover for Lift Truck Model J2.2-3.5XN (J45-70XN) (A276)ERP22-35VL (ERP045-070VL) (A976) Manufactured After November, 2015

NOTE: If removing counterweight cover does not allow enough room for pump and motor assembly to be moved, the hood and hood support crossmember will need to be removed. See **Operating Manual** or **Frame** 0100SRM1342, Hood and Seat Assembly Replacement for procedures.

3. Remove two capscrews, two washers, and counterweight cover from counterweight. See Figure 9 or Figure 10.

NOTE: Tag electrical connections during removal to aid in installation.

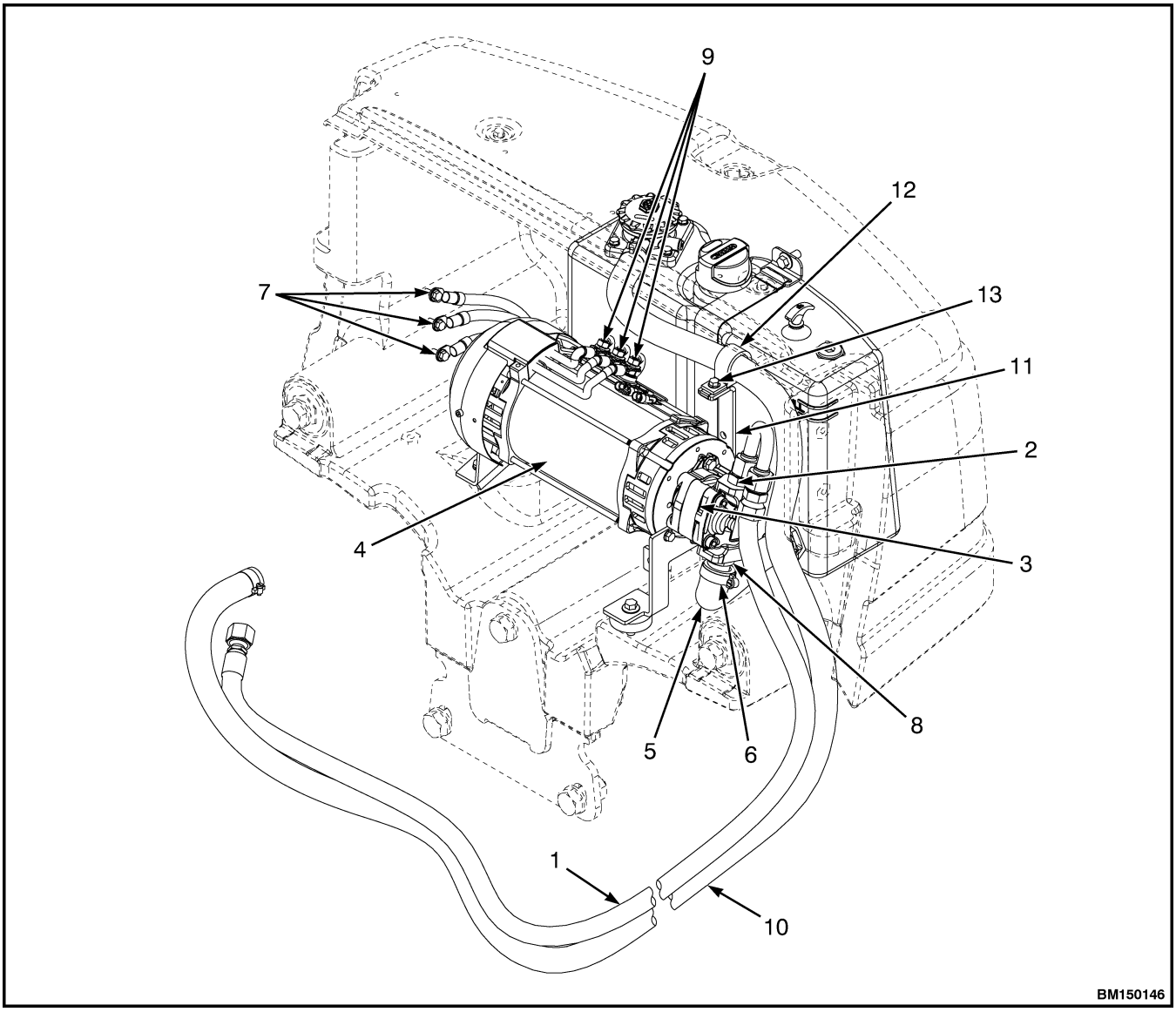
4. Remove three nuts and disconnect three power cables from motor. Lay power cables aside to prevent damage. See Figure 11 or Figure 12.

5. Remove capscrew, clamp, and return line hose from motor mount bracket. See Figure 11 or Figure 12. Move return line hose aside to prevent damage.

NOTE: Tag hoses, adapters, and fittings during removal to aid in installation.

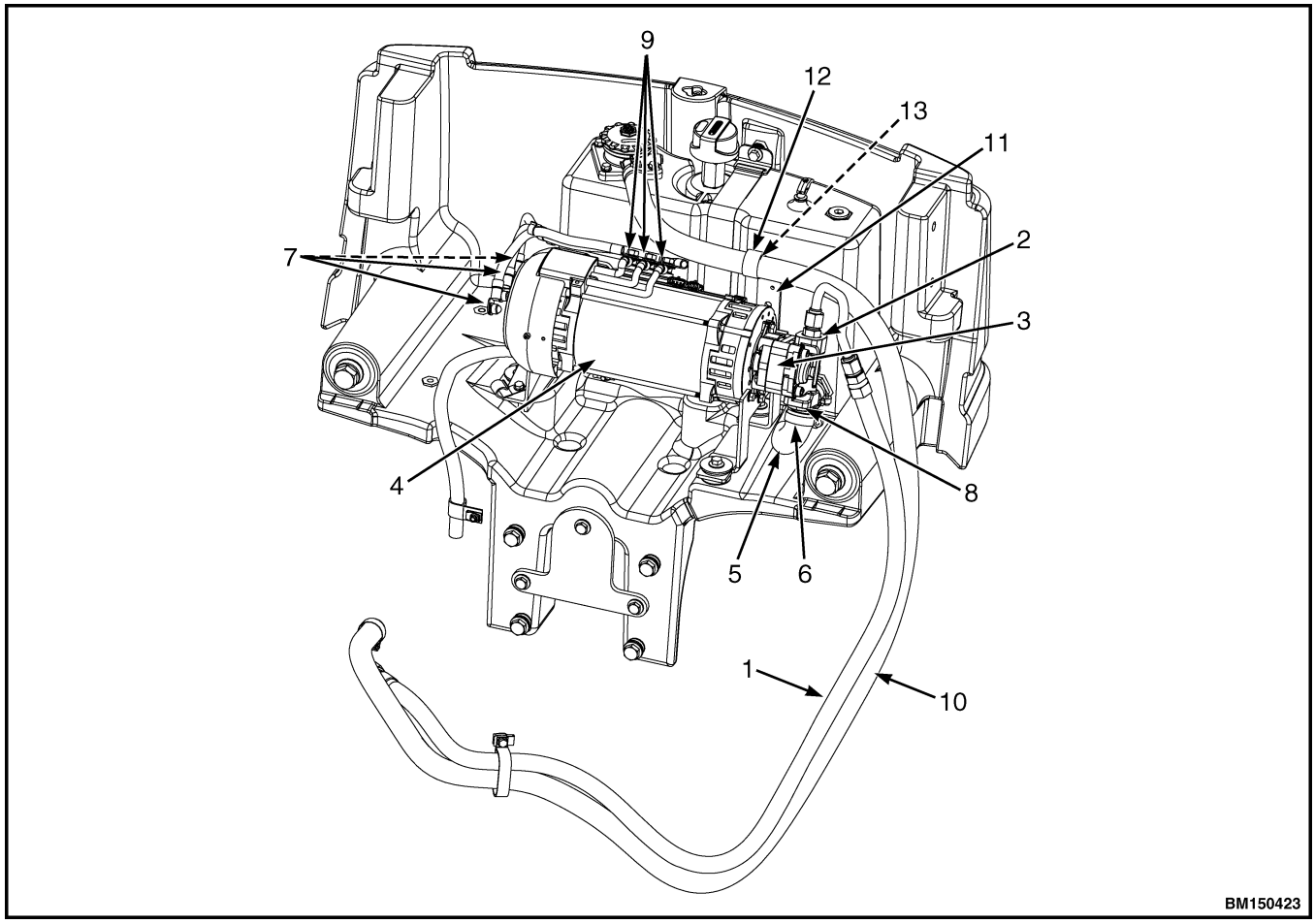
NOTE: Plug hoses and pump openings to prevent foreign material from entering the hydraulic system.

6. Disconnect pressure line hose from fitting. Plug fitting and pressure line hose. See Figure 11, Figure 12, and Figure 13.



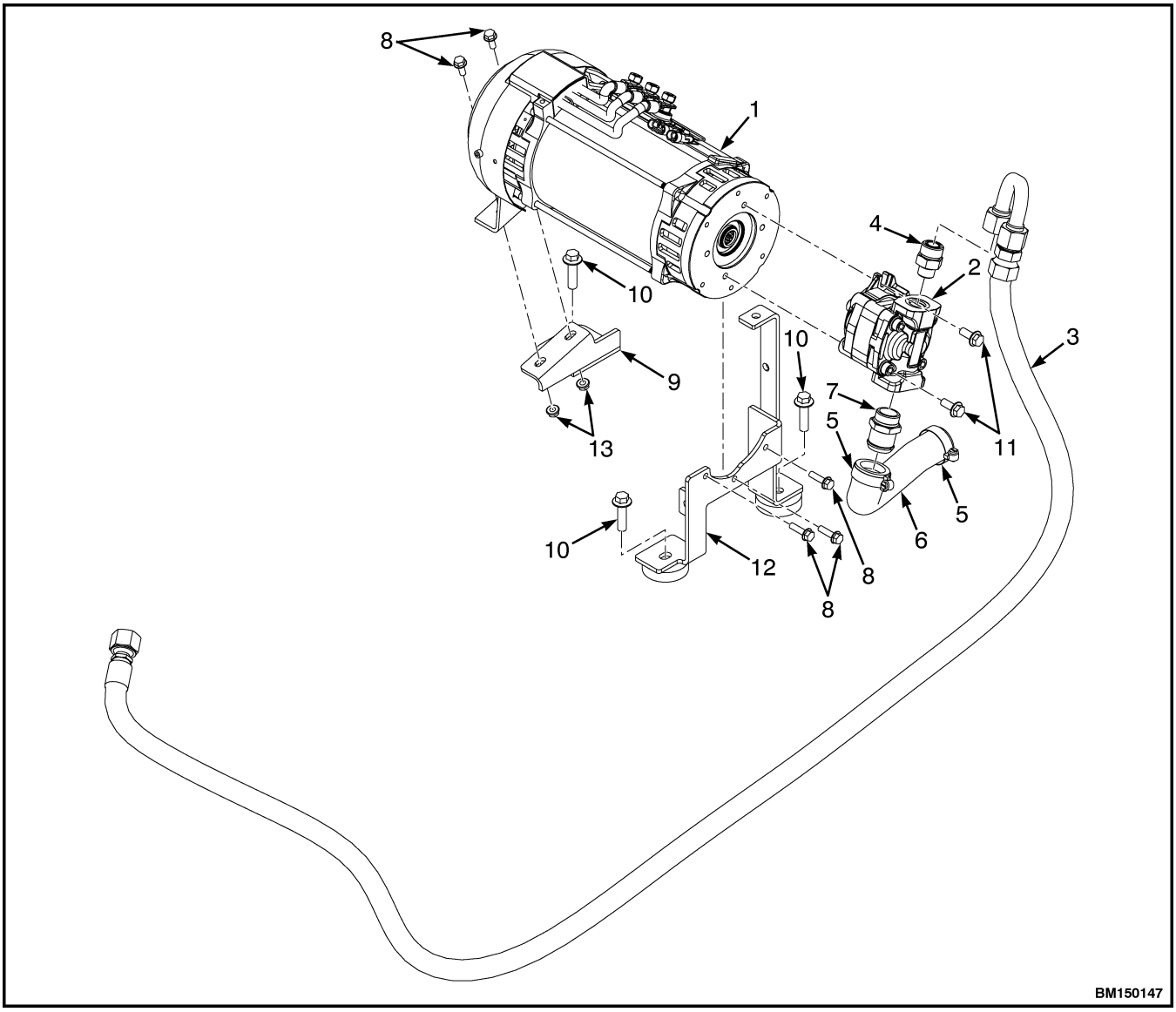
1. PRESSURE LINE HOSE
2. FITTING
3. HYDRAULIC PUMP
4. MOTOR
5. SUCTION HOSE
6. HOSE CLAMP
7. POWER CABLE
8. SUCTION ADAPTER
9. NUT
10. RETURN LINE HOSE
11. MOTOR MOUNT BRACKET
12. CLAMP
13. CAPSCREW

Figure 11. Pump and Motor Connections for Lift Truck Models J2.2-3.5XN (J45-70XN) (A276) Manufactured Prior to November, 2015



1. PRESSURE LINE HOSE
2. FITTING
3. HYDRAULIC PUMP
4. MOTOR
5. SUCTION HOSE
6. HOSE CLAMP
7. POWER CABLE
8. SUCTION ADAPTER
9. NUT
10. RETURN LINE HOSE
11. MOTOR MOUNT BRACKET
12. CLAMP
13. CAPSCREW

Figure 12. Pump and Motor Connections for Lift Truck Models J2.2-3.5XN (J45-70XN) (A276) Manufactured After November, 2015



1. MOTOR
2. HYDRAULIC PUMP
3. PRESSURE LINE HOSE
4. FITTING
5. HOSE CLAMP
6. SUCTION HOSE
7. SUCTION ADAPTER
8. CAPSCREW
9. MOTOR MOUNT BRACKET
10. MOUNTING CAPSCREW
11. CAPSCREW
12. PUMP END MOTOR MOUNT BRACKET
13. NUT

Figure 13. Hydraulic Pump and Motor Assembly for Lift Truck Models J2.2-3.5XN (J45-70XN) (A276)

7. Loosen and move hose clamp up suction hose until suction adapter end is cleared, tighten hose clamp enough to keep suction hose and hose clamp together.

8. Disconnect suction hose from suction adapter. See Figure 11, Figure 12, and Figure 13. Plug suction adapter and suction hose.

CAUTION

Disposal of lubricants and fluids must meet local environmental regulations.

9. Ensure that hydraulic fluid has drained from the tank and close drain valve. Remove container with used hydraulic oil.

NOTE: Make sure crane and sling have the lifting capacity of 50.0 kg (110.0 lb) or more.

10. Once all connector wires and hoses have been disconnected from pump and motor assembly, connect crane and sling around center of hydraulic pump and motor assembly. Raise crane to support the assembly. See Figure 14.

11. Remove one mounting capscrew from motor mount bracket and counterweight on right side of lift truck, as viewed from front. See Figure 13.

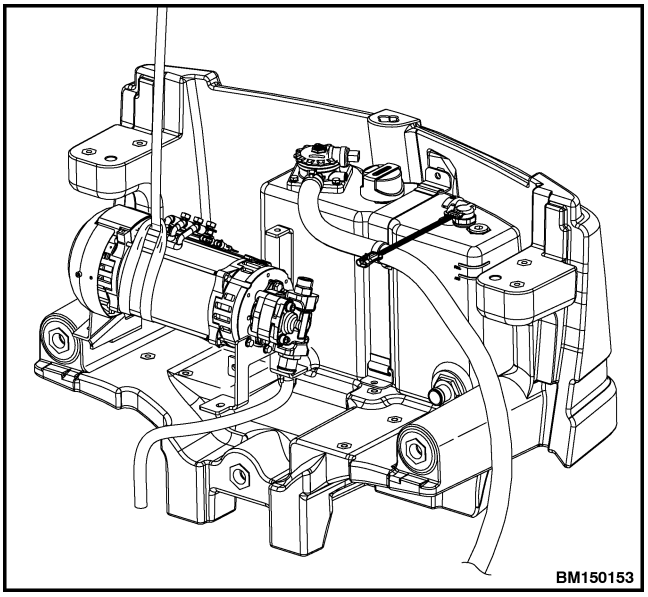


Figure 14. Sling and Crane

12. Remove two mounting capscrews from pump end motor mount bracket and counterweight on left side of lift truck, as viewed from front. See Figure 13.

NOTE: **DO NOT** damage hoses, electrical connectors, or assembly during removal.

13. Using sling and crane, carefully lift pump and motor assembly from counterweight. See Figure 14.

14. Remove three capscrews and pump end motor mount bracket from motor. See Figure 13.

15. Remove two nuts, two capscrews and motor mount bracket from opposite end of motor. See Figure 13.

16. Remove fitting from hydraulic pump. See Figure 13.

NOTE: Note orientation of adapter during disassembly to aid in assembly.

17. Remove suction adapter from hydraulic pump. See Figure 13.

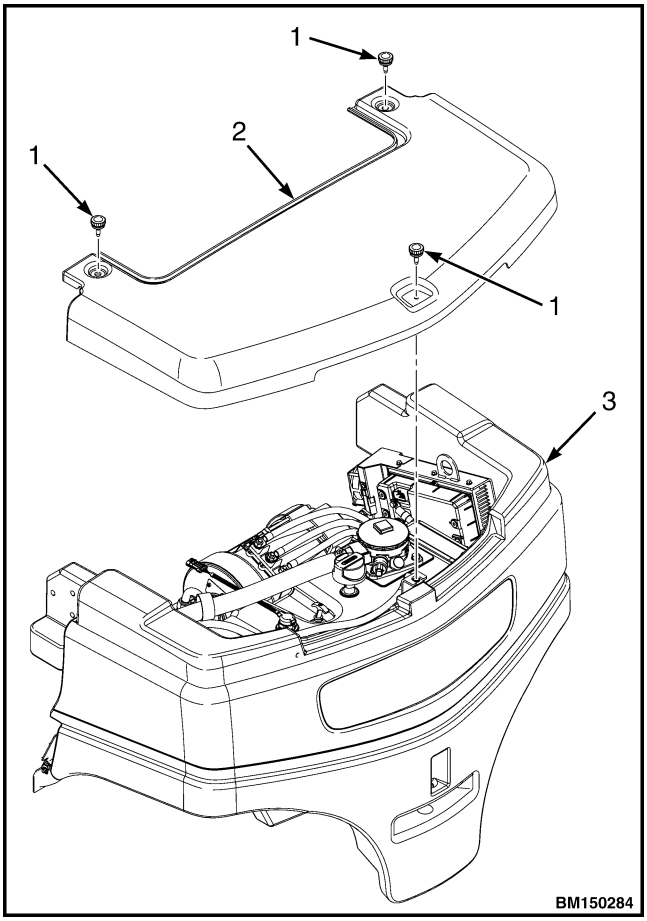
18. Remove two capscrews and pump from motor. See Figure 13.

Lift Truck Models J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

1. Install a container, with a capacity of 57.0 liter (60.2 qt) under drain hose beneath lift truck. Open drain valve and empty hydraulic tank.

NOTE: If removing counterweight cover does not allow enough room for pump and motor assembly to be moved, the hood and hood support crossmember will need to be removed. See **Operating Manual** or **Frame** 0100SRM1342, Hood and Seat Assembly Replacement for procedures.

2. Remove three capscrews and counterweight cover from counterweight. See Figure 15.



1. CAPSCREW
2. COUNTERWEIGHT COVER
3. COUNTERWEIGHT

Figure 15. Counterweight Cover for Lift Truck Models J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

NOTE: Tag electrical connections during removal to aid in installation.

3. Remove three nuts and disconnect three power cables from motor. Lay power cables aside to prevent damage. See Figure 16 or Figure 17.

4. Remove capscrew, clamp, and return line hose from motor mount bracket (see Figure 16 or Figure 17). Move return line hose aside to prevent damage.

NOTE: Tag hoses, adapters, and fittings during removal to aid in installation.

NOTE: Plug hoses and pump openings to prevent foreign material from entering the hydraulic system.

5. Disconnect pressure line hose from fitting. Plug fitting and pressure line hose. See Figure 16, Figure 17, and Figure 18.

6. Loosen and move hose clamp up suction hose until suction adapter end is cleared, tighten hose clamp enough to keep suction hose and hose clamp together.

7. Disconnect suction hose from suction adapter. Plug suction adapter and suction hose. See Figure 16, Figure 17, and Figure 18.

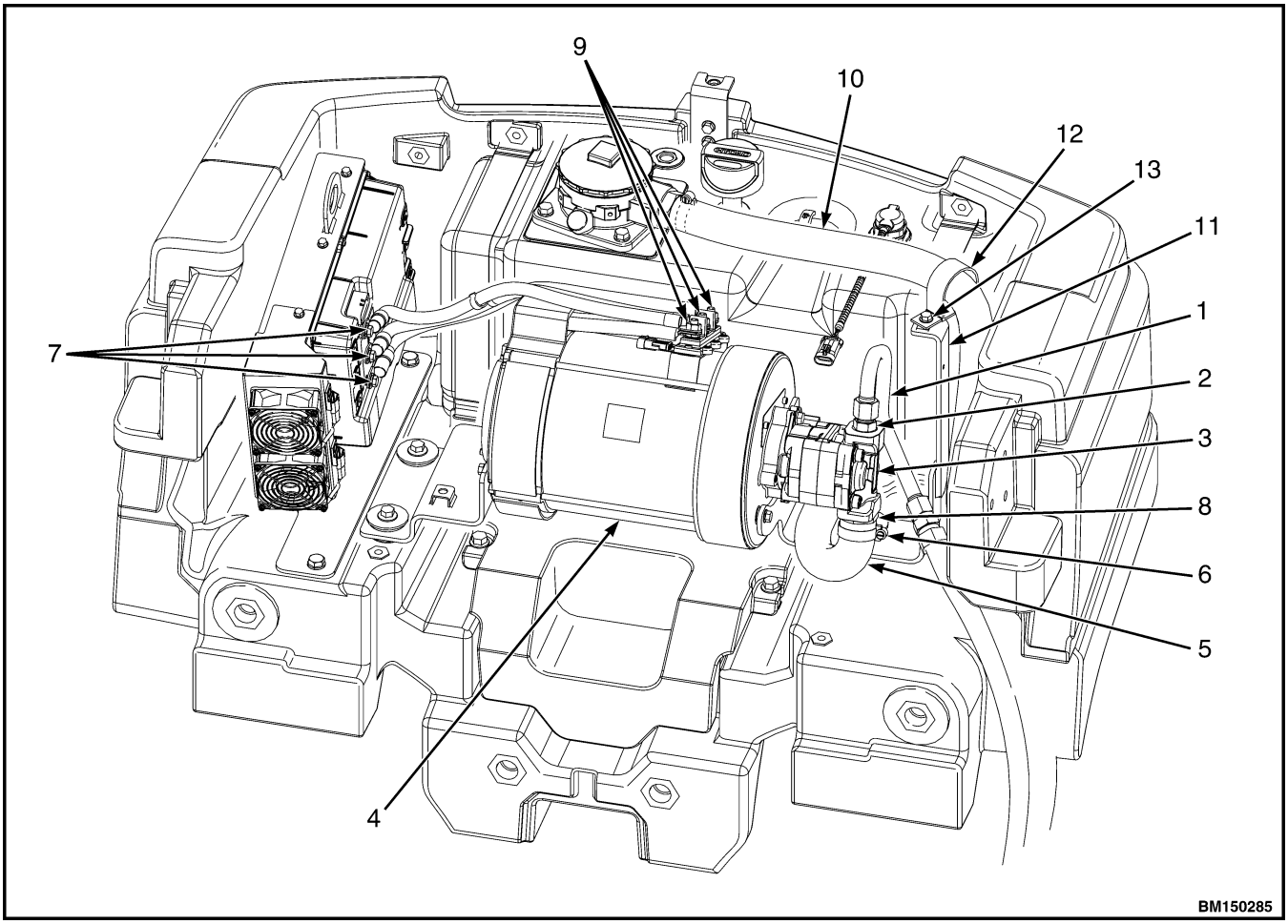
CAUTION

Disposal of lubricants and fluids must meet local environmental regulations.

8. Ensure that hydraulic fluid has drained from the tank and close drain valve. Remove container with used hydraulic oil.

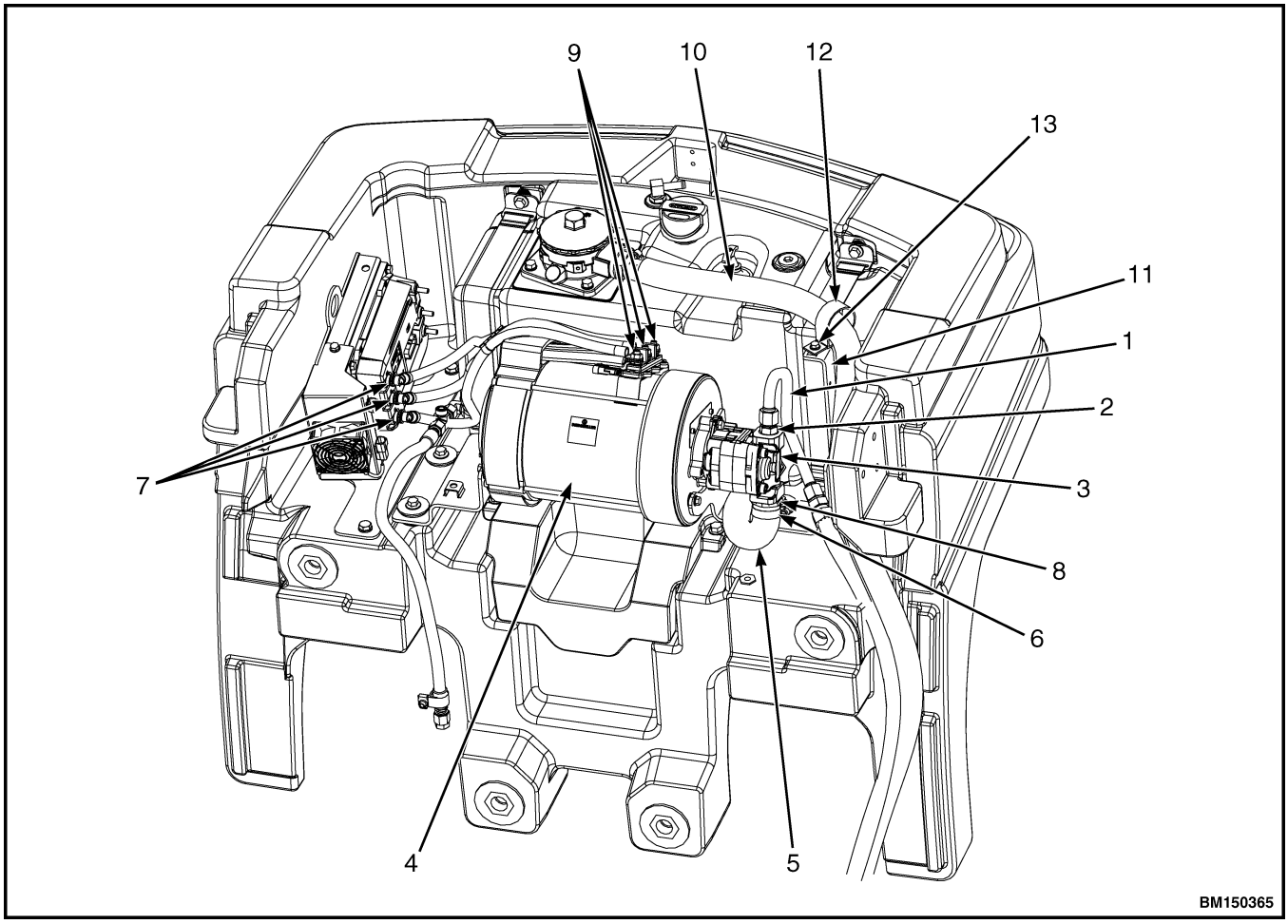
NOTE: Make sure crane and sling have the lifting capacity of 50.0 kg (110.0 lb) or more.

9. Once all connector wires and hoses have been disconnected from pump and motor assembly, connect crane and sling around center of hydraulic pump and motor assembly. Raise crane to support the assembly. See Figure 19.



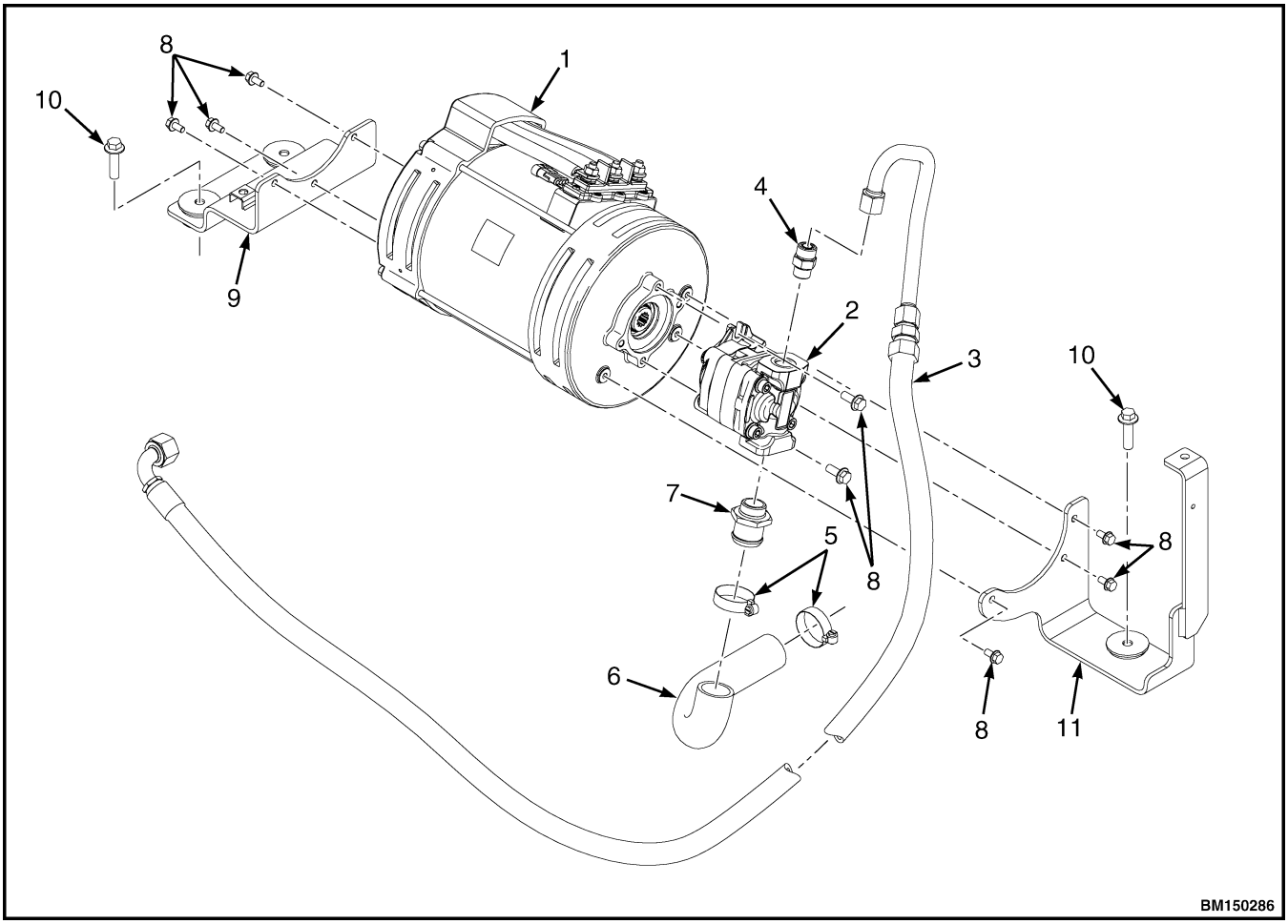
1. PRESSURE LINE HOSE
2. FITTING
3. HYDRAULIC PUMP
4. MOTOR
5. SUCTION HOSE
6. HOSE CLAMP
7. POWER CABLE
8. SUCTION ADAPTER
9. NUT
10. RETURN LINE HOSE
11. MOTOR MOUNT BRACKET
12. CLAMP
13. CAPSCREW

Figure 16. Short Wheel Base (SWB) Pump and Motor Connections for Lift Truck Models J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)



1. PRESSURE LINE HOSE
2. FITTING
3. HYDRAULIC PUMP
4. MOTOR
5. SUCTION HOSE
6. HOSE CLAMP
7. POWER CABLE
8. SUCTION ADAPTER
9. NUT
10. RETURN LINE HOSE
11. MOTOR MOUNT BRACKET
12. CLAMP
13. CAPSCREW

Figure 17. Long Wheel Base (LWB) Pump and Motor Connections for Lift Truck Models J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)



1. MOTOR
2. HYDRAULIC PUMP
3. PRESSURE LINE HOSE
4. FITTING
5. HOSE CLAMP
6. SUCTION HOSE
7. SUCTION ADAPTER
8. CAPSCREW
9. MOTOR MOUNT BRACKET
10. MOUNTING CAPSCREW
11. PUMP END MOTOR MOUNT BRACKET

Figure 18. Hydraulic Pump and Motor Assembly for Lift Truck Models J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

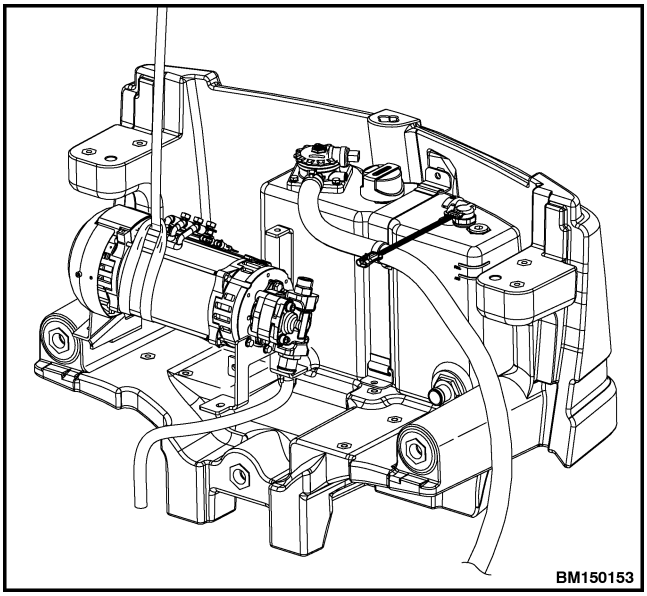


Figure 19. Sling and Crane

10. Remove one mounting capscrew from motor mount bracket and counterweight on right side of lift truck, as viewed from front. See Figure 18.

11. Remove two mounting capscrews from pump end motor mount bracket and counterweight on left side of lift truck, as viewed from front. See Figure 18.

NOTE: **DO NOT** damage hoses, electrical connectors, or assembly during removal.

12. Using sling and crane, carefully lift pump and motor assembly from counterweight. See Figure 19.

13. Remove three capscrews and pump end motor mount bracket from motor. See Figure 18.

14. Remove three capscrews and motor mount bracket from opposite end of motor. See Figure 18.

15. Remove fitting from hydraulic pump. See Figure 18.

NOTE: Note orientation of adapter during disassembly to aid in assembly.

16. Remove suction adapter from hydraulic pump. See Figure 18.

17. Remove two capscrews and pump from motor. See Figure 18.

Lift Truck Model E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

1. Remove battery from lift truck. The procedure for removing the battery may be found in the **Operators Manual** or **Periodic Maintenance** 8000SRM1577.

2. Remove the battery plate.

3. Install a container, with a capacity of 62.0 liter (66 qt) under drain plug of hydraulic tank.

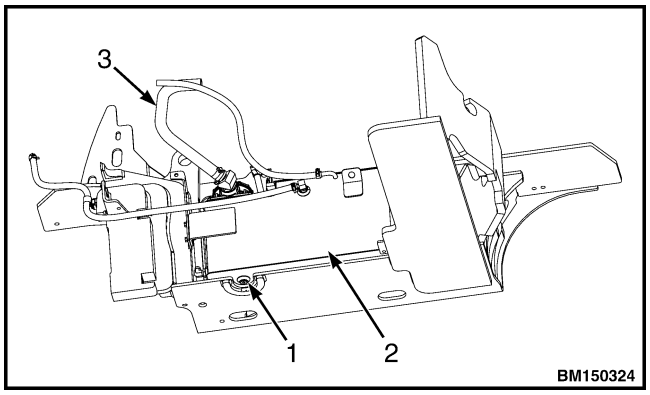
4. Remove drain plug and drain hydraulic oil. See Figure 20.

NOTE: Tag hoses and electrical connections during removal to aid in installation.

NOTE: Plug hoses and pump openings to prevent foreign material from entering hydraulic system.

5. Disconnect pressure line hose at fitting and move aside to prevent damage. See Figure 21.

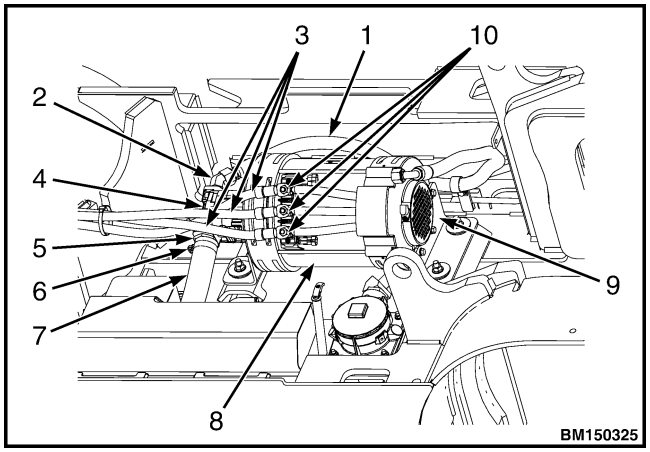
6. Disconnect all electrical connections from motor.



NOTE: MAJOR COMPONENTS OF HYDRAULIC SYSTEM REMOVED FOR CLARITY.

1. HYDRAULIC OIL DRAIN PLUG
2. HYDRAULIC TANK
3. SUCTION HOSE

Figure 20. Drain Hydraulic Oil From Lift Truck Models E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)



1. PRESSURE LINE HOSE
2. FITTING
3. POWER CABLES
4. HYDRAULIC PUMP
5. SUCTION ADAPTER
6. HOSE CLAMP
7. SUCTION HOSE
8. MOTOR
9. MOTOR SUPPORT BRACKET
10. NUT

Figure 21. Hydraulic Pump and Motor Connections for Lift Truck Model E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

7. Loosen hose clamp at suction adapter end of suction hose and move it up suction hose until suction adapter is cleared. Tighten hose clamp enough to keep suction hose and clamp together.

8. Disconnect suction hose from suction adapter. See Figure 21 . Plug suction adapter and suction hose.

CAUTION

Disposal of lubricants and fluids must meet local environmental regulations.

9. Ensure hydraulic oil has completely drained from hydraulic tank, replace drain plug, and cap all open ports. Remove container with used hydraulic oil.

NOTE: Make sure crane and sling have the lifting capacity of 96 kg (211 lb) or more.

10. Once all connector wires and hoses have been disconnected from pump and motor assembly, connect crane and sling around center of hydraulic pump and motor assembly. Raise crane to support the assembly. See Figure 22.

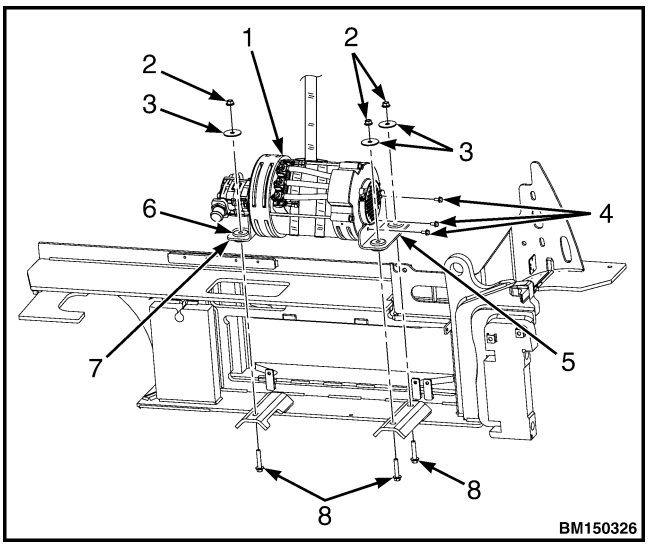
11. Remove two nuts, two washers and two capscrews from right hand side motor mount.

12. Remove nut, washer and capscrew from left hand side motor mount.

NOTE: DO NOT damage hoses, electrical connectors, or assembly during removal.

13. Using sling and crane, carefully lift pump and motor assembly from counterweight. See Figure 22.

14. Using the crane and sling, place pump and motor assembly on a suitable work area and flat surface.



NOTE: SOME FRAME COMPONENTS NOT SHOWN FOR CLARITY.

1. PUMP AND MOTOR ASSEMBLY
2. NUT
3. WASHER
4. MOTOR MOUNT CAPSCREWS
5. RIGHT HAND SIDE MOTOR MOUNT
6. ISOLATOR
7. LEFT HAND SIDE MOTOR MOUNT
8. CAPSCREW

Figure 22. Sling and Crane

15. Remove the sling and crane.

16. Remove three motor mount capscrews from right hand side motor mount.

17. Remove three motor mount capscrews from left hand side motor mount.

18. Remove fitting from hydraulic pump. See Figure 23.

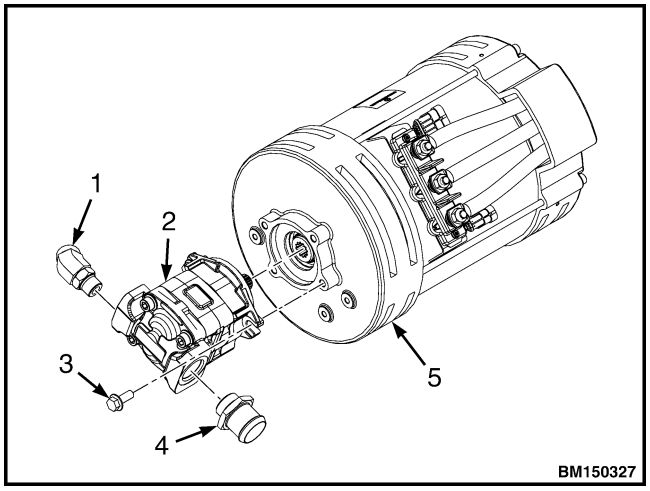
NOTE: Note orientation of adapter during disassembly to aid in assembly.

NOTE: Mark motor housing and hydraulic pump orientation to aid in installation.

19. Remove suction adapter from hydraulic pump. See Figure 23.

20. Remove two capscrews and pump from motor. See Figure 23.

21. Remove hydraulic pump from motor.



1. FITTING
2. HYDRAULIC PUMP
3. CAPSCREW
4. SUCTION ADAPTER
5. MOTOR

Figure 23. Hydraulic Pump and Motor Assembly for Lift Truck Model E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

DISASSEMBLE

Lift Truck Models E2.2-3.5XN (E45-70XN) (A268), E1.6-2.0XN (E30-40XN) (A269)E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

NOTE: This section is for the hydraulic pump only; for motor disassembly see **AC Motor Repair** 0620SRM1385.

1. Loosen two setscrews in coupling. DO NOT lose two keys between coupling and shaft. Remove coupling from pump. See Figure 4.

NOTE: If the pump is held in a vise for disassembly, make sure vise does not hold pump too tightly and cause distortion of pump body. The O-ring surface of the outlet port can also be damaged.

NOTE: Make careful notes of the location and orientation of the parts and seals during disassembly. Some of the parts are similar but not exactly the same. It can be difficult to make an identification if parts are mixed.

NOTE: Place an alignment mark on each section of the pump body to aid in assembly.

2. Remove key and clip from pump. DO NOT lose key. See Figure 24.

3. Remove snap ring from mounting flange. See Figure 24.

4. Remove four flange head screws holding pump together. See Figure 24.

5. Remove oil seal and discard. See Figure 24.

6. Carefully remove mounting flange from housing. See Figure 24.

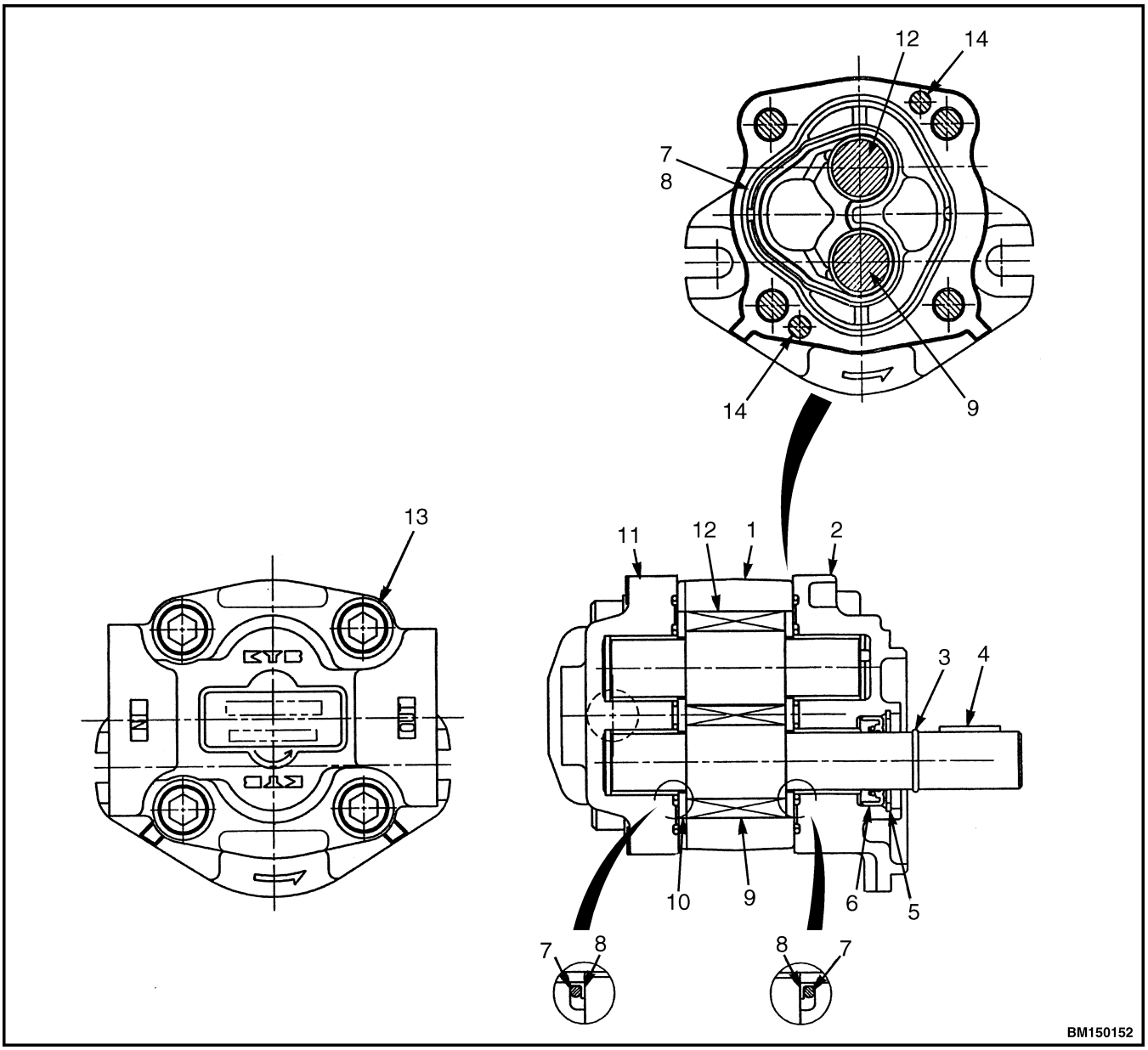
7. Remove seal plate and backup seal from mounting flange or housing. Discard seal plate and backup seal. See Figure 24.

8. Carefully remove housing. See Figure 24.

9. Remove drive gear and driven gear. See Figure 24.

10. Remove side plate from cover plate. See Figure 24.

11. Remove seal plate and backup seal from housing or cover plate. See Figure 24. Discard seal plate and backup seal.



1. HOUSING
2. MOUNTING FLANGE
3. CLIP
4. KEY
5. SNAP RING
6. OIL SEAL
7. SEAL PLATE
8. BACKUP SEAL
9. DRIVE GEAR
10. SIDE PLATE
11. COVER PLATE
12. DRIVEN GEAR
13. FLANGE HEAD SCREW
14. DOWEL PIN

Figure 24. Hydraulic Pump for Lift Truck Models E2.2-3.5XN (E45-70XN) (A268), E1.6-2.0XN (E30-40XN) (A269)E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

Lift Truck Models J2.2-3.5XN (J45-70XN) (A276)

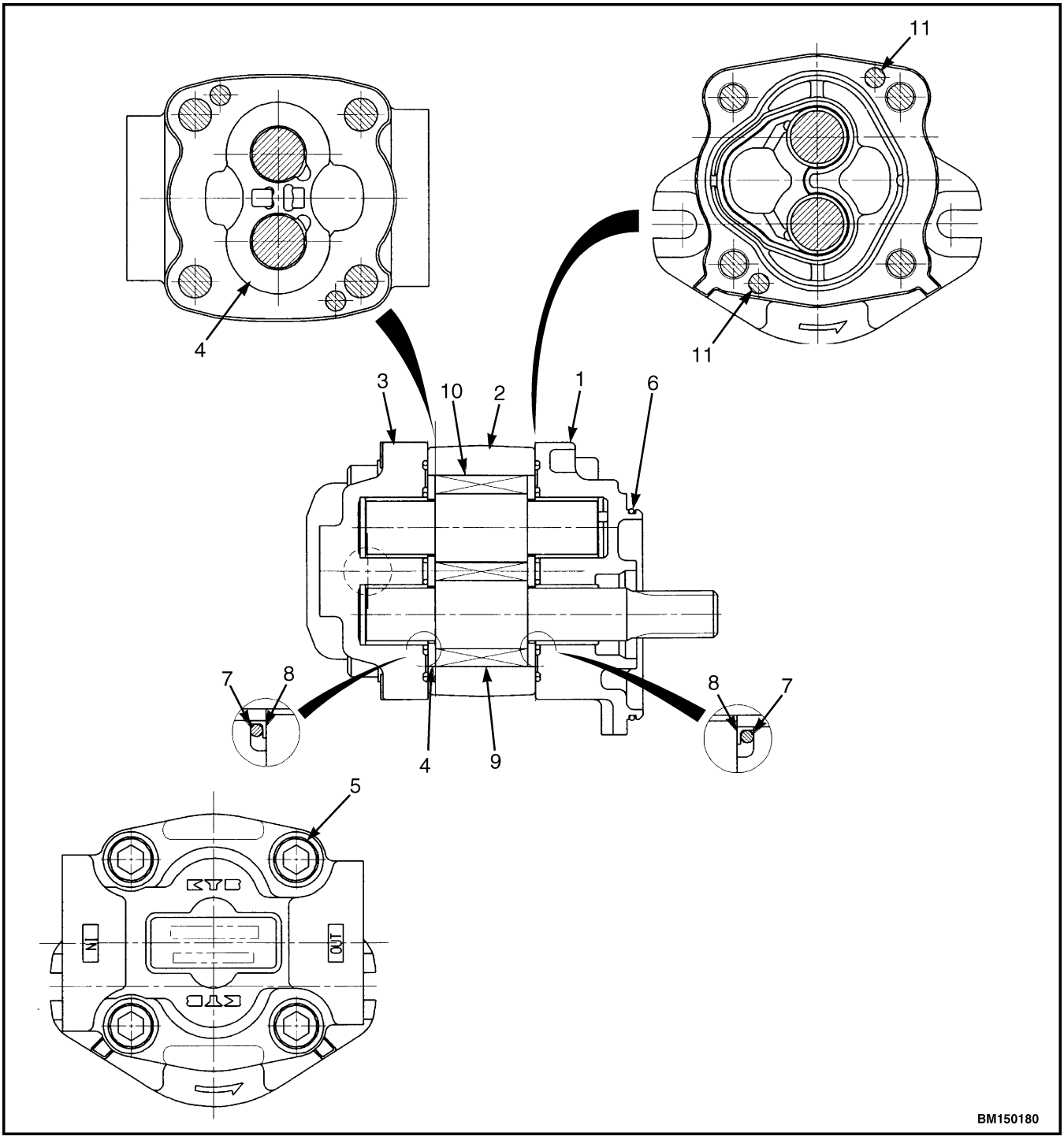
NOTE: This section is for the hydraulic pump only; for motor disassembly see **AC Motor Repair** 0620SRM1385.

NOTE: If the pump is held in a vise for disassembly, make sure vise does not hold pump too tightly and cause distortion of pump body. The O-ring surface of the outlet port can also be damaged.

NOTE: Make careful notes of the location and orientation of the parts and seals during disassembly. Some of the parts are similar but not exactly the same. It can be difficult to make an identification if parts are mixed.

NOTE: Place an alignment mark on each section of the pump body to aid in assembly.

1. Remove four flange head screws holding pump together. See Figure 25.
2. Remove and discard O-ring from mounting flange. See Figure 25.
3. Carefully remove mounting flange from gear plate. See Figure 25.
4. Remove and discard seal plate and backup seal from mounting flange or gear plate. See Figure 25.
5. Carefully remove gear plate from cover. See Figure 25.
6. Remove drive gear and driven gear form gear plate. See Figure 25.
7. Remove side plate from cover. See Figure 25.
8. Remove and discard backup seal and seal plate from cover. See Figure 25.



1. MOUNTING FLANGE
2. GEAR PLATE
3. COVER
4. SIDE PLATE
5. FLANGE HEAD SCREW
6. O-RING
7. SEAL PLATE
8. BACKUP SEAL
9. DRIVE GEAR
10. DRIVEN GEAR
11. DOWEL PIN

Figure 25. Hydraulic Pump for Lift Truck Models J2.2-3.5XN (J45-70XN) (A276)

Lift Truck Models J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

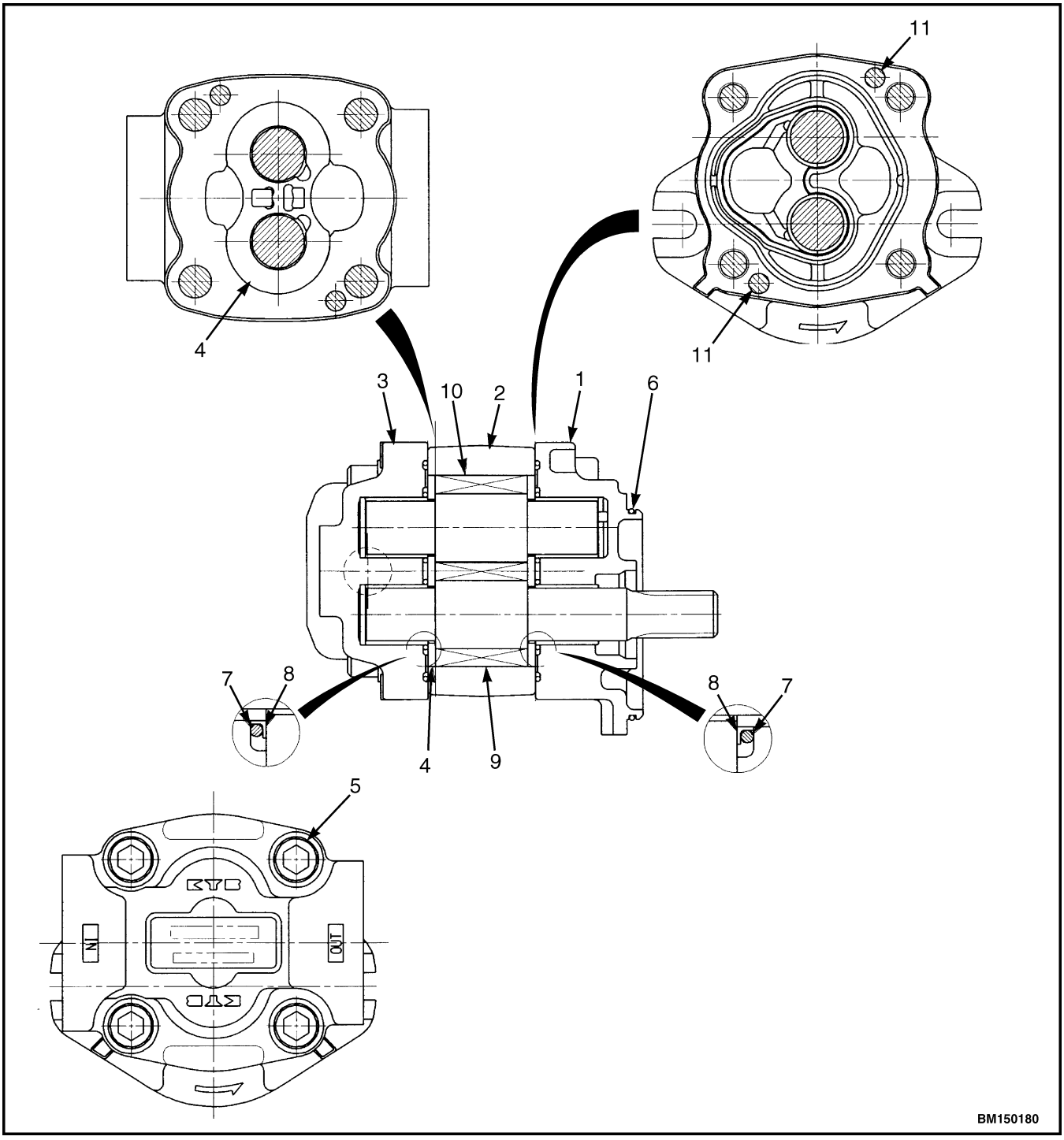
NOTE: This section is for the hydraulic pump only; for motor disassembly see **AC Motor Repair** 0620SRM1385.

NOTE: If the pump is held in a vise for disassembly, make sure vise does not hold pump too tightly and cause distortion of pump body. The O-ring surface of the outlet port can also be damaged.

NOTE: Make careful notes of the location and orientation of the parts and seals during disassembly. Some of the parts are similar but not exactly the same. It can be difficult to make an identification if parts are mixed.

NOTE: Place an alignment mark on each section of the pump body to aid in assembly.

1. Remove four flange head screws holding pump together. See Figure 26.
2. Remove and discard O-ring from mounting flange. See Figure 26.
3. Carefully remove mounting flange from gear plate. See Figure 26.
4. Remove and discard seal plate and backup seal from mounting flange or gear plate. See Figure 26.
5. Carefully remove gear plate from cover. See Figure 26.
6. Remove drive gear and driven gear form gear plate. See Figure 26.
7. Remove side plate from cover. See Figure 26.
8. Remove and discard backup seal and seal plate from cover. See Figure 26.



1. MOUNTING FLANGE
2. GEAR PLATE
3. COVER
4. SIDE PLATE
5. FLANGE HEAD SCREW
6. O-RING
7. SEAL PLATE
8. BACKUP SEAL
9. DRIVE GEAR
10. DRIVEN GEAR
11. DOWEL PIN

Figure 26. Hydraulic Pump for Lift Truck Models J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

INSPECT

NOTE: Some pump bodies will show gear marks where gears rotate because of the small clearances between parts. These gear marks **DO NOT** indicate a worn or damage pump, unless the pump will not supply the volume and pressure shown in Table 1 in the **Specifications** section in the back of this manual.

Check pump components for wear and damage. Seals and O-rings to be discarded, replaced with new.

If pump gears or shaft are worn or damaged, replace pump.

If present, inspect coupling. If the cushion material has pieces missing or has distortion, replace coupling.

CLEAN

WARNING

Cleaning solvents can be flammable and toxic, can cause skin irritation. When using cleaning solvents, always follow the recommendations of the manufacturer.

WARNING

Compressed air can move particles so that they cause injury to the user or to other personnel. Make sure that the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eyes.

Clean all components in solvent. Dry components with compressed air. **DO NOT** dry components with a cloth. Make sure all surfaces are free of scratches and sharp edges.

ASSEMBLE

Lift Truck Models E2.2-3.5XN (E45-70XN) (A268), E1.6-2.0XN (E30-40XN) (A269)E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

NOTE: This section is for the hydraulic pump only; for motor assembly see **AC Motor Repair** 0620SRM1385.

NOTE: Install new seals during assembly.

1. Make sure internal parts of pump are clean. Lubricate parts with clean hydraulic oil as they are installed.
2. Install new backup seal and new seal plate on cover plate. See Figure 24.
3. Install side plate on cover plate. See Figure 24. Make sure backup seal and seal plate do not move out of correct position.
4. Install housing onto cover plate. See Figure 24.
5. Install driven gear and drive gear in housing. See Figure 24.
6. Install new backup seal and new seal plate on housing. See Figure 24.
7. Carefully install mounting flange onto housing. See Figure 24. Make sure backup seal and seal plate do not move out of correct position.
8. Install new oil seal on mounting flange. See Figure 24.
9. Install four flange head screws into cover plate to hold pump together. See Figure 24. Make sure marks made during disassembly are aligned. Tighten screws to 88 to 98 N·m (65 to 72 lbf ft).
10. Install snap ring on mounting flange. See Figure 24.
11. Install clip and key onto pump shaft. See Figure 24.
12. Install key onto motor shaft.

Lift Truck Models J2.2-3.5XN (J45-70XN) (A276)

NOTE: This section is for the hydraulic pump only; for motor assembly see **AC Motor Repair** 0620SRM1385.

NOTE: Install new O-ring, backup seals, and seal plates during assembly.

1. Make sure internal parts are clean. Lubricate parts with clean hydraulic oil as they are installed.

2. Install new seal plate and backup seal onto cover. See Figure 25.
3. Install side plate on cover. Make sure seal plate and backup seal DO NOT move from correct position. See Figure 25.
4. Install driven gear and drive gear in gear plate. See Figure 25.
5. Install gear plate on cover. See Figure 25.
6. Install new backup seal and seal plate on gear plate. See Figure 25.
7. Install mounting flange on gear plate. Make sure backup seal and seal plate DO NOT move from correct position. See Figure 25.
8. Install four flange head screws through cover and gear plate into mounting flange. Tighten screws to 88 to 98 N•m (65 to 72 lbf ft). See Figure 25.
9. Install new O-ring on mounting flange. See Figure 25.

Lift Truck Models J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

NOTE: This section is for the hydraulic pump only; for motor assembly see **AC Motor Repair** 0620SRM1385.

NOTE: Install new O-ring, backup seals, and seal plates during assembly.

1. Make sure internal parts are clean. Lubricate parts with clean hydraulic oil as they are installed.
2. Install new seal plate and backup seal onto cover. See Figure 26.
3. Install side plate on cover. Make sure seal plate and backup seal DO NOT move from correct position. See Figure 26.
4. Install driven gear and drive gear in gear plate. See Figure 26.
5. Install gear plate on cover. See Figure 26.
6. Install new backup seal and seal plate on gear plate. See Figure 26.
7. Install mounting flange on gear plate. Make sure backup seal and seal plate DO NOT move from correct position. See Figure 26.
8. Install four flange head screws through cover and gear plate into mounting flange. Tighten screws to 88 to 98 N•m (65 to 72 lbf ft). See Figure 26.
9. Install new O-ring on mounting flange. See Figure 26.

INSTALL

Lift Truck Models E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

1. Install hydraulic pump onto motor. See Figure 23.
2. Make sure pump is aligned to motor as marked during disassembly. Install cpascrews that fasten pump to motor and tighten to 25 N•m (221 lbf in). See Figure 23.

NOTE: Remove plugs from pump openings and install plugs into suction adapter and fitting after installation.

3. Install suction adapter into hydraulic pump as noted during disassembly. Tighten to 91 to 100 N•m (67 to 74 lbf ft). See Figure 23.
4. Install fitting into hydraulic pump. Tighten to 78 to 88 N•m (58 to 65 lbf ft). See Figure 23.
5. Install the right hand side motor mount using three motor mount capscrews and tighten to 19 N•m (168 lbf in).
6. Install the left hand side motor mount using three motor mount capscrews and tighten to 19 N•m (168 lbf in).
7. Attach sling and crane to pump and motor assembly and maneuver the pump and motor assembly over the frame.

NOTE: **DO NOT** damage hoses, electrical connections or assembly during installation.

8. Lower pump and motor assembly into position in the frame. See Figure 22.
9. Using three nuts, three washers and three capscrews, install the pump and motor assembly. See Figure 22.

10. Tighten capscrews to 60 to 70 N•m (44 to 52 lbf ft).

11. After securing pump and motor assembly to mounting brackets, remove sling and crane to allow access for component connections.

12. Connect all electrical connections to motor.

NOTE: Remove tags from electrical connectors after installation.

13. Connect three power cables and install three nuts to motor as tagged during removal. Tighten nuts to 24 N•m (212 lbf in). See Figure 21. Power cable terminals must not rotate when installed and torqued.

NOTE: Remove plugs from adapter and fitting as installation is made.

14. Connect suction hose to adapter. Move hose clamp to hold suction hose on suction adapter and tighten hose clamp. See Figure 21.

15. Connect pressure line hose to fitting. See Figure 21.

CAUTION

DO NOT fill tank above FULL mark on dipstick. If tank is too full, oil will come out breather during operations.

16. Fill hydraulic tank with hydraulic oil, 62 liter (66 qt). See Add Hydraulic Oil section for procedure.

17. Remove lift truck from blocks. See **Operating Manual** or **Periodic Maintenance** 8000SRM1577 for procedures.

18. Install battery plate.

19. Attach a tag line to temporarily power lift truck. Operate hydraulic system by tilting mast forward and backward pressurizing hydraulic system. Check all lines and connections for leaks. Remove tag line from lift truck.

20. Install battery into lift truck. See **Operators Manual** or **Periodic Maintenance** 8000SRM1577 for procedures.

Lift Truck Models E2.2-3.5XN (E45-70XN) (A268)

1. Install coupling onto pump shaft and motor shaft as pump is aligned to motor. See Figure 4.

2. Make sure the halves of the coupling are correctly engaged. Make sure setscrews that fasten coupling to shafts are 180° opposed. Tighten setscrews to 11 to 13 N•m (97 to 115 lbf in). See Figure 4.

3. Make sure pump is aligned to motor as marked during disassembly. Install capscrews that fasten pump to motor and tighten to 25 N•m (221 lbf in). See Figure 4.

NOTE: Remove plugs from pump openings and install plugs into suction adapter and fitting after installation.

4. Install suction adapter onto hydraulic pump as noted during disassembly. Tighten to 91 to 100 N•m (67 to 74 lbf ft). See Figure 4.

5. Install fitting onto hydraulic pump. Tighten to 49 to 59 N•m (36 to 44 lbf ft). See Figure 4.

NOTE: DO NOT damage hoses, electrical connections or assembly during installation.

6. Using floor jack, place pump and motor assembly in position under lift truck. Maneuver past any obstructions and raise pump and motor into mounting position.

7. Install snubbing washers, mounting bolts, and nuts onto motor mount bracket and motor support bracket at rear of pump and motor assembly. Tighten mounting bolts to 60 to 70 N•m (44 to 51 lbf ft). See "B" of Figure 3.

8. Install snubbing washer, mounting bolt, and nut onto motor mount bracket and motor support bracket at front of pump and motor assembly. Tighten mounting bolt to 60 to 70 N•m (44 to 51 lbf ft). See "A" of Figure 3.

9. After securing pump and motor assembly to mounting brackets, remove floor jack to allow access for component connections.

10. Connect speed and temperature sensor connectors to wire harness.

NOTE: Remove tags from electrical connections and hoses after installation.

11. Connect three power cables and install three nuts to motor as tagged during removal. See Figure 2. Tighten nuts to 24 N•m (212 lbf in). Power cable terminals must not rotate when installed and torqued.

NOTE: Remove plugs from suction adapter and fitting as installation is made.

12. Connect suction hose to suction adapter. Move hose clamp to hold suction hose on suction adapter and tighten hose clamp. See Figure 2.

13. Connect pressure line hose to fitting. See Figure 2.

14. Install pressure line hose, clamp, and capscrew onto motor support bracket. See Figure 2.

CAUTION

DO NOT fill tank above FULL mark on dipstick. If tank is too full, oil will come out breather during operations.

15. Fill hydraulic tank with hydraulic oil until level reaches **FULL** mark on dipstick. See Add Hydraulic Oil section for procedure.

16. Remove lift truck from blocks. See **Operating Manual** or **Periodic Maintenance** 8000SRM1364.

17. Install battery plate.

18. Attach a tag line to temporarily power lift truck. Operate hydraulic system by tilting mast forward and backward pressurizing hydraulic system. Check all lines and connections for leaks. Remove tag line from lift truck.

19. Install battery into lift truck. See the **Operating Manual** or **Periodic Maintenance** 8000SRM1364 for procedures.

Lift Truck Models E1.6-2.0XN (E30-40XN) (A269)

1. Make sure pump is aligned to motor as marked during disassembly. Install two capscrews to fasten pump to motor. Tighten capscrews to 25 N•m (221 lbf in). See Figure 8.

NOTE: Remove plugs from pump openings and install plugs into suction adapter and fitting after installation.

2. Install suction adapter onto hydraulic pump as noted during disassembly. Tighten adapter to 91 to 100 N•m (67 to 74 lbf ft). See Figure 8.

3. Install fitting onto hydraulic pump. Tighten to 49 to 59 N•m (36 to 44 lbf ft). See Figure 8.

NOTE: DO NOT damage hoses, electrical connections or assembly during installation.

4. Using floor jack, place pump and motor assembly in position under lift truck. Maneuver past any obstructions and raise pump and motor into mounting position.

5. Install two snubbing washers, two motor mounting bolts, and two nuts onto motor mount bracket and motor support bracket at rear of pump and motor assembly. Tighten mounting bolts to 60 to 70 N•m (44 to 51 lbf ft). See Figure 7.

6. Install two nuts, two motor mount bolts, motor support bracket, and motor mount to front of pump and motor assembly. See Figure 7. Tighten mounting bolts to 60 to 70 N•m (44 to 51 lbf ft).

7. After securing pump and motor assembly to mounting brackets, remove floor jack to allow access for component connections.

8. Connect speed and temperature sensor connectors to wire harness.

NOTE: Remove tags from electrical connections and hoses after installation.

9. Connect three power cables and install three nuts to motor as tagged during removal. See Figure 6. Tighten nuts to 14 to 16 N•m (124 to 142 lbf in). Power cable terminals must not rotate when installed and torqued.

NOTE: Remove plugs from suction adapter and fitting as installation is made.

10. Connect suction hose to suction adapter. Move hose clamp to hold suction hose on suction adapter and tighten hose clamp. See Figure 6.

11. Connect pressure line hose to fitting. See Figure 6.

12. Install pressure line hose, clamp, and capscrew onto motor support bracket.

CAUTION

DO NOT fill tank above FULL mark on dipstick. If tank is too full, oil will come out of breather during operations.

13. Fill hydraulic tank with hydraulic oil until level reaches **FULL** mark on dipstick. See Add Hydraulic Oil section for procedure.

14. Remove lift truck from blocks. See **Operating Manual** or **Periodic Maintenance** 8000SRM1442 for procedures.

15. Install battery plate.

16. Attach a tag line to temporarily power lift truck. Operate hydraulic system by tilting mast forward and backward and pressurizing hydraulic system. Check all lines and connections for leaks. Remove tag line from lift truck.

17. Install battery into lift truck. See **Operating Manual** or **Periodic Maintenance** 8000SRM1442 for procedures.

Lift Truck Models J2.2-3.5XN (J45-70XN) (A276)

1. Install hydraulic pump and two capscrews onto motor. See Figure 13.

2. Install suction adapter into hydraulic pump as noted during disassembly. See Figure 13.

3. Install fitting into hydraulic pump. See Figure 13.

4. Install two capscrews and two nuts into motor mount bracket and motor. See Figure 13.

5. Install three capscrews into pump end motor mount bracket and motor. See Figure 13.

NOTE: DO NOT damage hoses, electrical connections or assembly during installation.

6. Using sling and crane, carefully lower pump and motor assembly onto motor mounts in counterweight. See Figure 14.

7. Install two mounting capscrews into pump end motor mount bracket and counterweight on left side of lift truck, as viewed from front. See Figure 13.

8. Install one mounting capscrew into motor mount bracket and counterweight on right side of lift truck, as viewed from front. See Figure 13.

9. Remove sling and crane after making sure pump and motor assembly is secure.

NOTE: Remove plugs from adapter and fitting as installation is made.

NOTE: Remove tags from hoses as installation is made.

10. Connect suction hose to adapter. Move hose clamp to hold suction hose on suction adapter and tighten hose clamp. See Figure 13.

11. Connect pressure line hose to fitting. See Figure 13.

12. Install clamp, return line hose, and capscrew onto motor mount bracket. See Figure 11 or Figure 12.

NOTE: Remove tags from electrical connectors after installation. For lift trucks manufactured after October, 2013 and equipped with Outdoor Protection/ Washdown Package, spray power cable terminals with rust inhibitor-ignition sealer.

13. Connect three power cables and install three nuts to motor as tagged during removal. Tighten nuts to 24 N·m (212 lbf in). See Figure 11 or Figure 12. Power cable terminals must not rotate when installed and torqued.

CAUTION

DO NOT fill tank above FULL mark on dipstick. If tank is too full, oil will come out breather during operations.

14. Fill hydraulic tank with hydraulic oil until level reaches **FULL** mark on dipstick. See Add Hydraulic Oil section for procedure.

15. Remove lift truck from blocks. See **Operating Manual** or **Periodic Maintenance** 8000SRM1372 for procedures.

16. Install counterweight cover, two washers, and two capscrews onto counterweight. See Figure 9 or Figure 10.

17. Install tow pin to counterweight cover and counterweight. See Figure 9 or Figure 10 .

18. Operate hydraulic system by tilting mast forward and backward pressurizing hydraulic system. Check all lines and connections for leaks.

Lift Truck Models J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

1. Install hydraulic pump and two capscrews onto motor. See Figure 18.

2. Install suction adapter into hydraulic pump as noted during disassembly. See Figure 18.

3. Install fitting into hydraulic pump. See Figure 18.

4. Install three capscrews into motor mount bracket and motor. See Figure 18.

5. Install three capscrews into pump end motor mount bracket and motor. See Figure 18.

NOTE: **DO NOT** damage hoses, electrical connections or assembly during installation.

6. Using sling and crane, carefully lower pump and motor assembly onto motor mounts in counterweight. See Figure 19.

7. Install two mounting capscrews into pump end motor mount bracket and counterweight on left side of lift truck, as viewed from front. See Figure 18.

8. Install one mounting capscrew into motor mount bracket and counterweight on right side of lift truck, as viewed from front. See Figure 18.

9. Remove sling and crane after making sure pump and motor assembly is secure.

NOTE: Remove plugs from adapter and fitting as installation is made.

NOTE: Remove tags from hoses as installation is made.

10. Connect suction hose to adapter. Move hose clamp to hold suction hose on suction adapter and tighten hose clamp. See Figure 18.

11. Connect pressure line hose to fitting. See Figure 18.

12. Install clamp, return line hose, and capscrew onto motor mount bracket. See Figure 16 or Figure 17.

NOTE: Remove tags from electrical connectors after installation.

13. Connect three power cables and install three nuts to motor as tagged during removal. Tighten nuts to 24 N•m (212 lbf in). See Figure 11. Power cable terminals must not rotate when installed and torqued.

CAUTION

DO NOT fill tank above FULL mark on dipstick. If tank is too full, oil will come out breather during operations.

14. Fill hydraulic tank with hydraulic oil until level reaches **FULL** mark on dipstick. See Add Hydraulic Oil section for procedure.

15. Remove lift truck from blocks. See **Operating Manual** or **Periodic Maintenance** 8000SRM1541 for procedures.

16. Install counterweight cover, two washers, and two capscrews onto counterweight. See Figure 15.

17. Install tow pin to counterweight cover and counterweight. See Figure 15.

18. Operate hydraulic system by tilting mast forward and backward pressurizing hydraulic system. Check all lines and connections for leaks.

Hydraulic Tank

REMOVE

WARNING

PUTTING THE LIFT TRUCK ON BLOCKS

The lift truck must be put on blocks for some types of maintenance and repair. The removal of the mast, drive axle, battery, or counterweight assemblies will cause large changes in the center of gravity. When the lift truck is put on blocks, put additional blocks in the following positions:

- **If the mast and drive axle are removed, put blocks under the counterweight so the lift truck cannot fall backward.**
- **If the counterweight is removed, put blocks under the mast so that the lift truck cannot fall forward.**

Put the lift truck on blocks on a solid, even, and level surface. Verify the blocks or stands have enough capacity to hold the lift truck. Use additional blocks next to the tires as necessary to prevent movement of the lift truck. Verify the lifting devices used during repairs can lift the weight of the parts and assemblies.

See the Operating Manual or Periodic Maintenance section for your lift truck model, for the procedures to put the lift truck on blocks.

1. Put lift truck on blocks. See the **Operating Manual** or **Periodic Maintenance Manual** for your specific lift truck model for procedures.
2. Discharge capacitors as specified in Discharging the Capacitors in **General** section of this manual.

Lift Truck Models E2.2-3.5XN (E45-70XN) (A268)

1. Remove battery. See the **Operating Manual** or **Periodic Maintenance** 8000SRM1364 for procedures.
2. Remove battery plate.

WARNING

Hydraulic oil is hot after system operation and can cause burns. DO NOT disconnect any hydraulic hoses until the oil in the system is cool.

CAUTION

DO NOT permit dirt to enter the hydraulic system during the steps of this procedures. Dirt can cause damage to the components of the hydraulic system.

CAUTION

Disposal of lubricants and fluids must meet local environmental regulations.

3. Put drain pan, with capacity of 33 liter (35 qt) for nylon tank or 35 liter (37 qt) for metal tank, beneath the lift truck.
4. Remove drain plug and allow hydraulic tank to empty.

   For lift trucks equipped with a nylon tank, see Figure 27.

   For lift trucks equipped with a metal tank, see Figure 28.
5. Remove hydraulic pump and motor. See Hydraulic Pump and Motor, Remove section for procedures.

NOTE: For inspection, clean, and replacement procedures for breather see Breather Clean and Inspect section of this manual.

NOTE: Perform steps below for lift trucks equipped with nylon tank.

6. Loosen hose clamp on breather hose and move it up hose until past flanged end of fitting. Tighten hose clamp to keep hose and clamp together.
7. Remove breather hose from breather fitting on hydraulic tank. See Figure 27.

NOTE: Perform steps below for lift trucks equipped with metal tank.

8. Loosen hose clamp on breather hose and move it up until past flanged end of tube. Tighten hose clamp to keep hose and clamp together.

9. Remove breather hose from breather tube on hydraulic tank. See Figure 28.

10. Loosen hose clamp on return line at hydraulic filter housing. Move hose clamp on return line and tighten to keep hose clamp and return line together.

For lift trucks equipped with a nylon tank, see Figure 27.

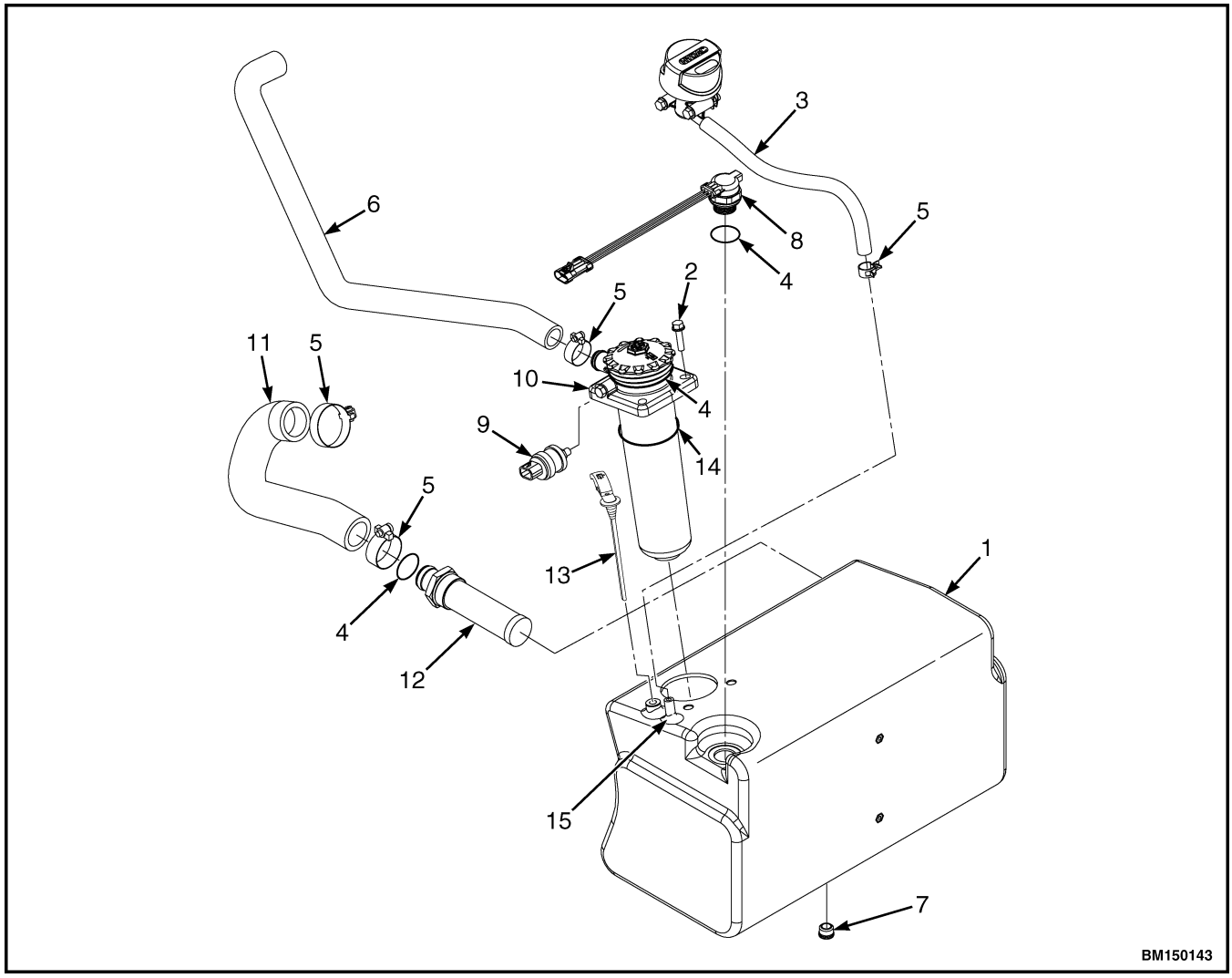
For lift trucks equipped with a metal tank, see Figure 28.

11. Remove return line from hydraulic filter housing and set aside to prevent damage. Cap both return line and hydraulic filter housing to prevent contamination.

12. Remove capscrew and tank retention strap from mounting bracket on truck frame. See Figure 29.

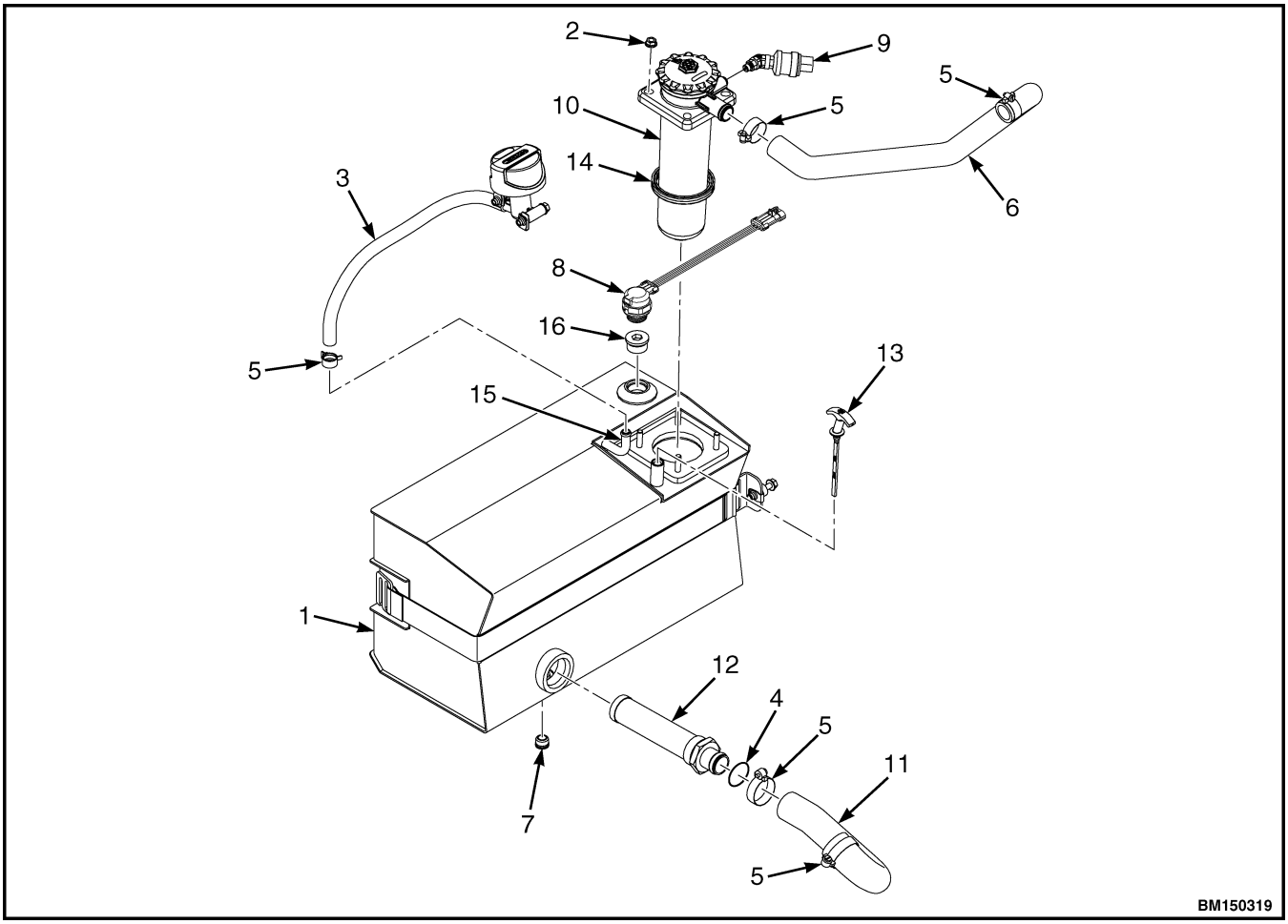
13. Remove tank retention strap from around hydraulic tank. See Figure 29.

14. After ensuring all components have been disconnected, remove hydraulic tank from lift truck.



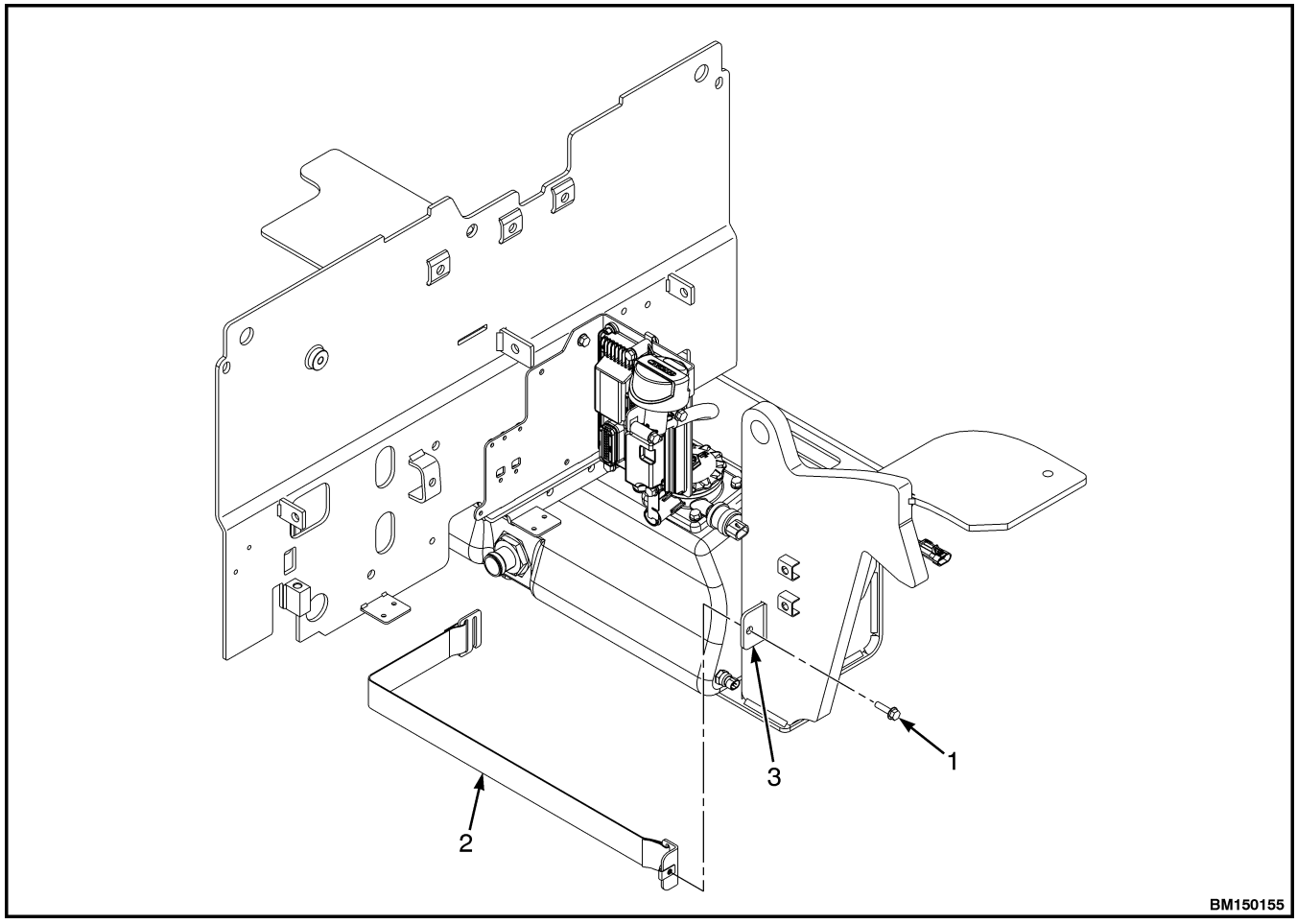
1. NYLON HYDRAULIC TANK
2. CAPSCREW
3. BREATHER HOSE
4. O-RING
5. HOSE CLAMP
6. RETURN LINE
7. DRAIN PLUG
8. TANK LEVEL SENSOR
9. PRESSURE SWITCH
10. HYDRAULIC FILTER HOUSING
11. SUCTION HOSE
12. SUCTION STRAINER
13. DIPSTICK
14. QUAD SEAL
15. BREATHER FITTING

Figure 27. Nylon Hydraulic Tank and Components



1. METAL HYDRAULIC TANK
2. NUT
3. BREATHER HOSE
4. O-RING
5. HOSE CLAMP
6. RETURN LINE
7. DRAIN PLUG
8. OPTIONAL TANK LEVEL SENSOR
9. OPTIONAL PRESSURE SWITCH
10. HYDRAULIC FILTER HOUSING
11. SUCTION HOSE
12. SUCTION STRAINER
13. DIPSTICK
14. QUAD SEAL
15. BREATHER TUBE
16. TANK LEVEL SENSOR PLUG

Figure 28. Metal Hydraulic Tank and Components



NOTE: MAJOR COMPONENTS NOT SHOWN FOR CLARITY. METAL TANK IS SHOWN, NYLON TANK RETENTION IS SIMILAR.

1. CAPSCREW
2. TANK RETENTION STRAP
3. MOUNTING BRACKET

Figure 29. Tank Retention for Lift Truck Models E2.2-3.5XN (E45-70XN) (A268)

Lift Truck Models E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

1. Remove battery. See the **Operating Manual** or **Periodic Maintenance** 8000SRM1577 for procedures.
2. Remove battery plate.

WARNING

Hydraulic oil is hot after system operation and can cause burns. DO NOT disconnect any hydraulic hoses until the oil in the system is cool.

CAUTION

DO NOT permit dirt to enter the hydraulic system during the steps of this procedures. Dirt can cause damage to the components of the hydraulic system.

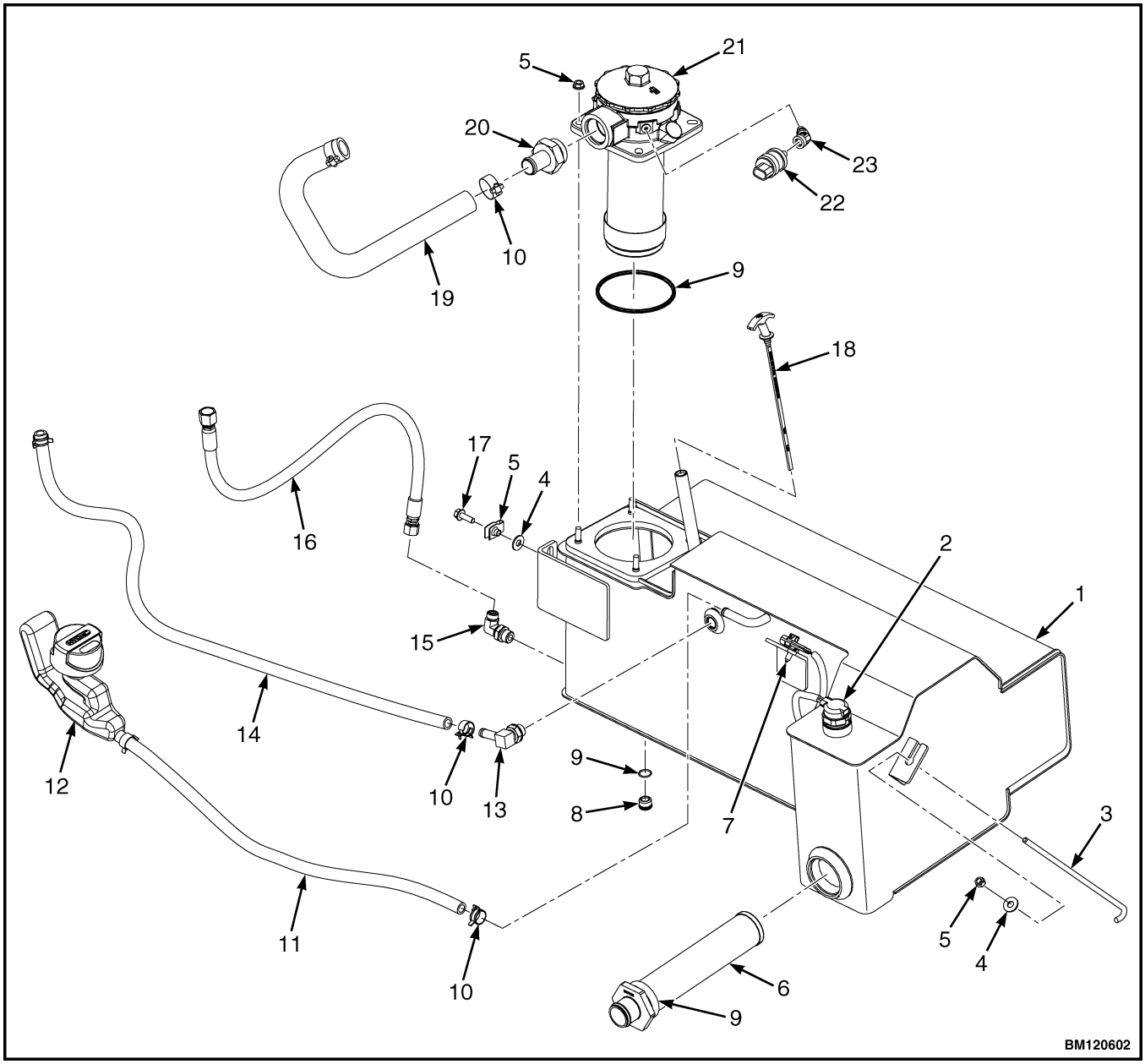
CAUTION

Disposal of lubricants and fluids must meet local environmental regulations.

3. Put drain pan, with capacity of 62 liter (66 qt) beneath the lift truck.
4. Remove drain plug and allow hydraulic tank to empty. See Figure 30.
5. Remove hydraulic pump and motor. See Hydraulic Pump and Motor, Remove section for procedures.

NOTE: For inspection, clean, and replacement procedures for breather see Breather Clean and Inspect section of this manual.

6. Disconnect all electrical connections from tank sensor.
7. Loosen hose clamp on breather hose and move it up hose until past flanged end of tube. Tighten hose clamp to keep hose and clamp together. See Figure 30.
8. Remove breather hose from breather tube on hydraulic tank. See Figure 30.
9. Loosen hose clamp on vent hose and move it up until past flanged end of tube. Tighten hose clamp to keep hose and clamp together. See Figure 30.
10. Remove vent hose from vent fitting on hydraulic tank. See Figure 30.
11. Loosen hose clamp on return line at hydraulic filter housing. Move hose clamp on return line and tighten to keep hose clamp and return line together. See Figure 30.
12. Remove return line from hydraulic filter housing and set aside to prevent damage. Cap both return line and hydraulic filter housing to prevent contamination.
13. Loosen hose clamp on suction line at tank. Move hose clamp on suction and tighten to keep hose clamp and suction line together. See Figure 30.
14. Remove suction line from tank and set aside to prevent damage. Cap both suction line an tank to prevent contamination.
15. Loosen brake hose from brake hose fitting in tank. See Figure 30.
16. Remove brake hose from brake hose fitting in tank and set aside to prevent damage. Cap brake hose.
17. Remove two capscrews and two washers from mounting brackets on truck frame. See Figure 30.
18. Remove nut and washer from retention rod. See Figure 30.
19. Remove retention rod from hydraulic tank and frame.
20. Slide a floor jack or transmission jack under lift truck.
21. After ensuring all components have been disconnected, maneuver hydraulic tank onto floor jack or transmission jack and remove tank from lift truck.



1. HYDRAULIC TANK
2. HYDRAULIC TANK LEVEL SENSOR
3. RETENTION ROD
4. WASHER
5. NUT
6. SUCTION HOSE
7. MOUNTING CLIP
8. DRAIN PLUG
9. O-RING
10. CLAMP
11. BREATHER HOSE
12. BREATHER
13. VENT FITTING
14. VENT HOSE
15. BRAKE HOSE FITTING
16. BRAKE HOSE
17. CAPSCREW
18. DIPSTICK
19. RETURN LINE
20. FITTING
21. HYDRAULIC OIL FILTER
22. PRESSURE SENSOR
23. ADAPTER

Figure 30. Hydraulic Tank and Components for Lift Truck Model E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

Lift Truck Models E1.6-2.0XN (E30-40XN) (A269)

WARNING

Hydraulic oil is hot after system operation and can cause burns. DO NOT disconnect any hydraulic hoses until oil in the system is cool.

CAUTION

DO NOT permit dirt to enter the hydraulic system during the steps of this procedure. Dirt can cause damage to the components of the hydraulic system.

Never operate the hydraulic pump without oil in the hydraulic system. The operation of the hydraulic pump without oil will damage the pump.

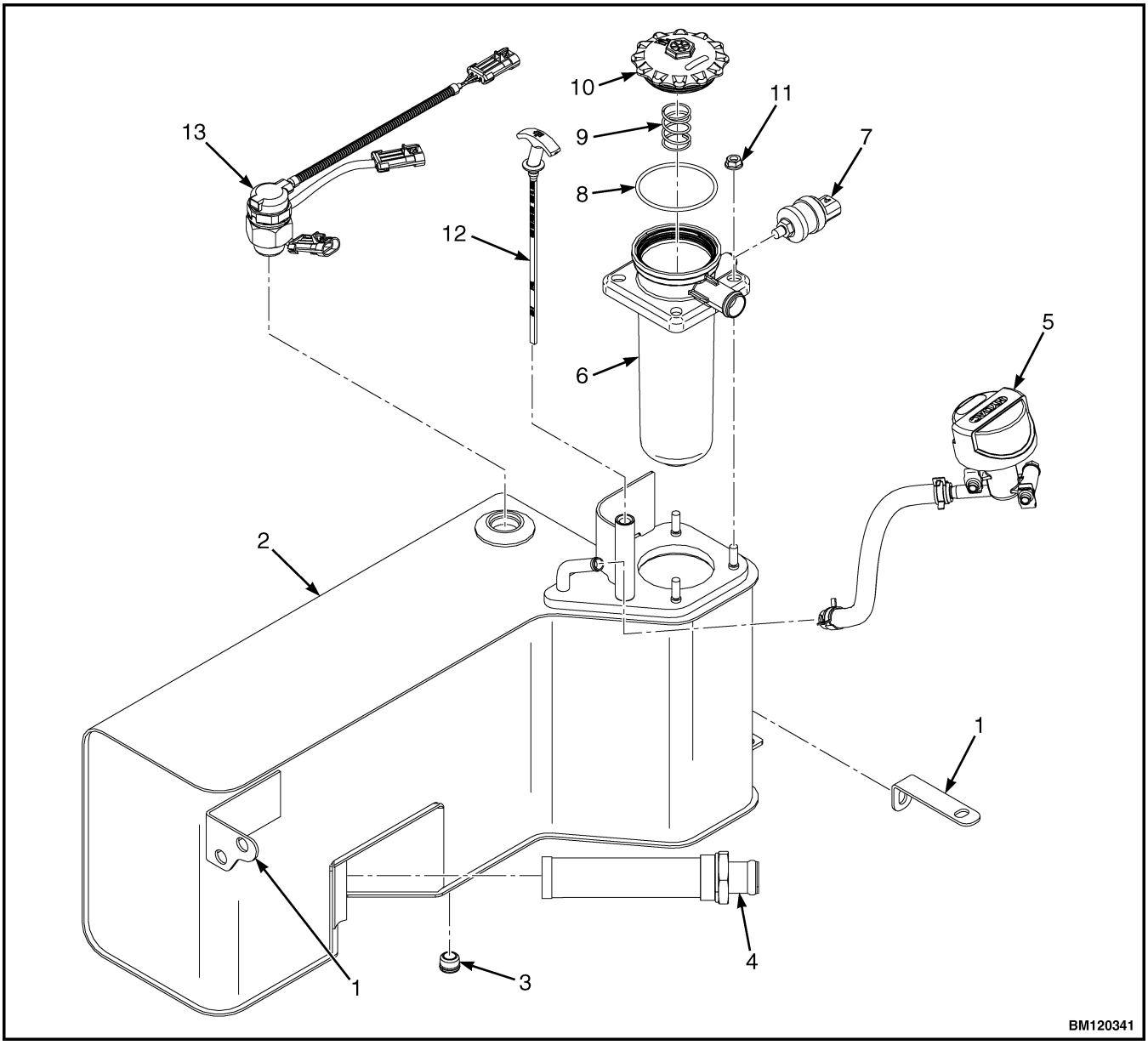
CAUTION

Disposal of lubricants and fluids must meet local environmental regulations.

1. Place a drain pan, with capacity of 30 liter (32 qt) beneath the lift truck. See Figure 31.
2. Remove drain plug and allow hydraulic tank to empty.
3. Remove floor plate and floor mat.
4. Remove Hydraulic Pump and Motor. See section Hydraulic Pump and Motor for procedures.
5. Loosen hose clamp on breather hose. Move clamp up breather hose until it is past the tube end. Tighten hose clamp to keep breather hose and hose clamp together. See Figure 31.

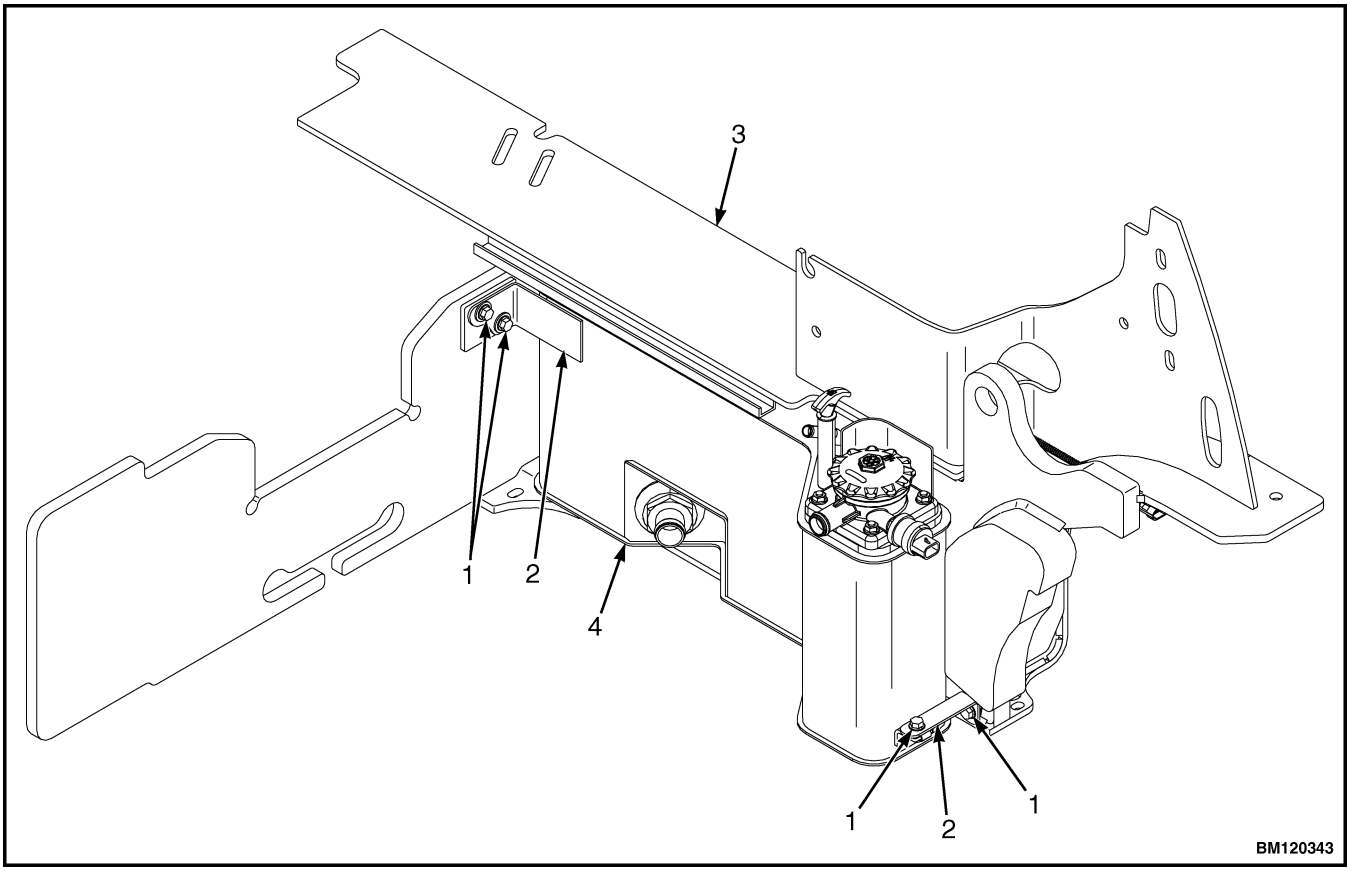
NOTE: For inspection, cleaning, and replacement procedures for the hydraulic tank breather, see the section Breather Clean and Inspect in this manual.

6. Remove breather hose from tube on hydraulic tank. See Figure 31.
7. Loosen hose clamp on return line at hydraulic filter housing. Move hose clamp on return line and tighten to keep hose clamp and return line together. See Figure 31.
8. Remove return line from hydraulic filter housing and set aside to prevent damage. Cap both return line and hydraulic filter housing to prevent contamination. See Figure 31.
9. Remove four capscrews and mounting brackets from lift truck frame. See Figure 32.
10. After ensuring all components have been disconnected, remove hydraulic tank from lift truck.



1. MOUNTING BRACKETS
2. HYDRAULIC TANK
3. MAGNETIC PLUG AND O-RING
4. SUCTION STAINER AND O-RING
5. BREATHER
6. FILTER HOUSING
7. FILTER PRESSURE SWITCH
8. O-RING SEAL
9. SPRING
10. FILL CAP
11. NUT
12. DIPSTICK
13. LEVEL SENSOR

Figure 31. Hydraulic Tank and Components for Lift Truck Models E1.6-2.0XN (E30-40XN) (A269)



NOTE: MAJOR COMPONENTS NOT SHOWN FOR CLARITY.

1. CAPSCREW
2. MOUNTING BRACKET
3. LEFT FRAME CHANNEL
4. HYDRAULIC TANK

Figure 32. Hydraulic Tank Retention for Lift Truck E1.6-2.0XN (E30-40XN) (A269)

Lift Truck Models J2.2-3.5XN (J45-70XN) (A276)

1. Remove battery. See **Operating Manual** or **Periodic Maintenance** 8000SRM1372 for procedures.

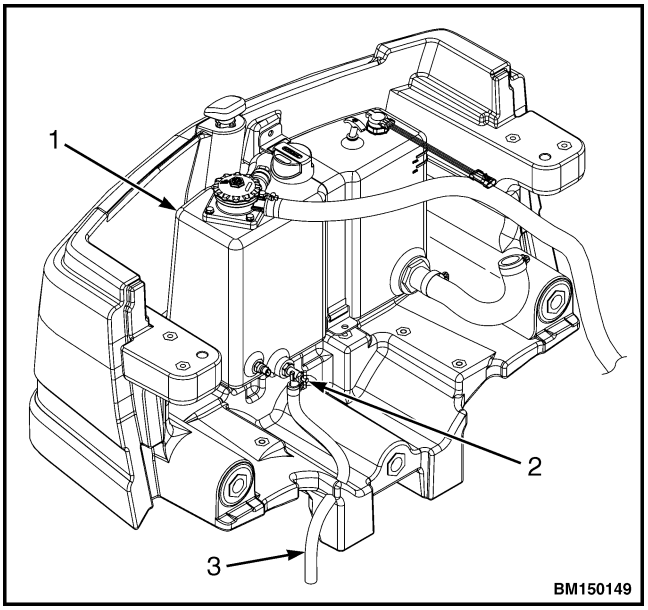
2. Remove hydraulic pump and motor as described in Hydraulic Pump and Motor section of this manual.

3. Put drain pan with capacity of approximately 33.0 liter (35.0 qt) under drain hose beneath the lift truck.

CAUTION

Disposal of lubricants and fluids must meet local environmental regulations.

4. Open drain valve, hydraulic oil will run through drain hose, emptying hydraulic tank. When oil has completely drained, close drain valve. See Figure 33.



NOTE: HYDRAULIC PUMP AND MOTOR NOT SHOWN FOR CLARITY.

NOTE: LIFT TRUCK MANUFACTURED PRIOR TO NOVEMBER, 2015 SHOWN, LIFT TRUCK MANUFACTURED AFTER NOVEMBER, 2015 SIMILAR.

1. HYDRAULIC TANK
2. DRAIN VALVE
3. DRAIN HOSE

Figure 33. Drain Hydraulic Oil From Lift Truck Models J2.2-3.5XN (J45-70XN) (A276)

5. Remove capscrew, clamp, and return line from motor bracket. See Figure 34.

NOTE: Tag hoses, adapters, and fittings during removal to aid in installation.

6. Loosen hose clamp on return line and move it on return line until flanged end of hydraulic filter housing is cleared; tighten hose clamp to keep return line and hose clamp together.

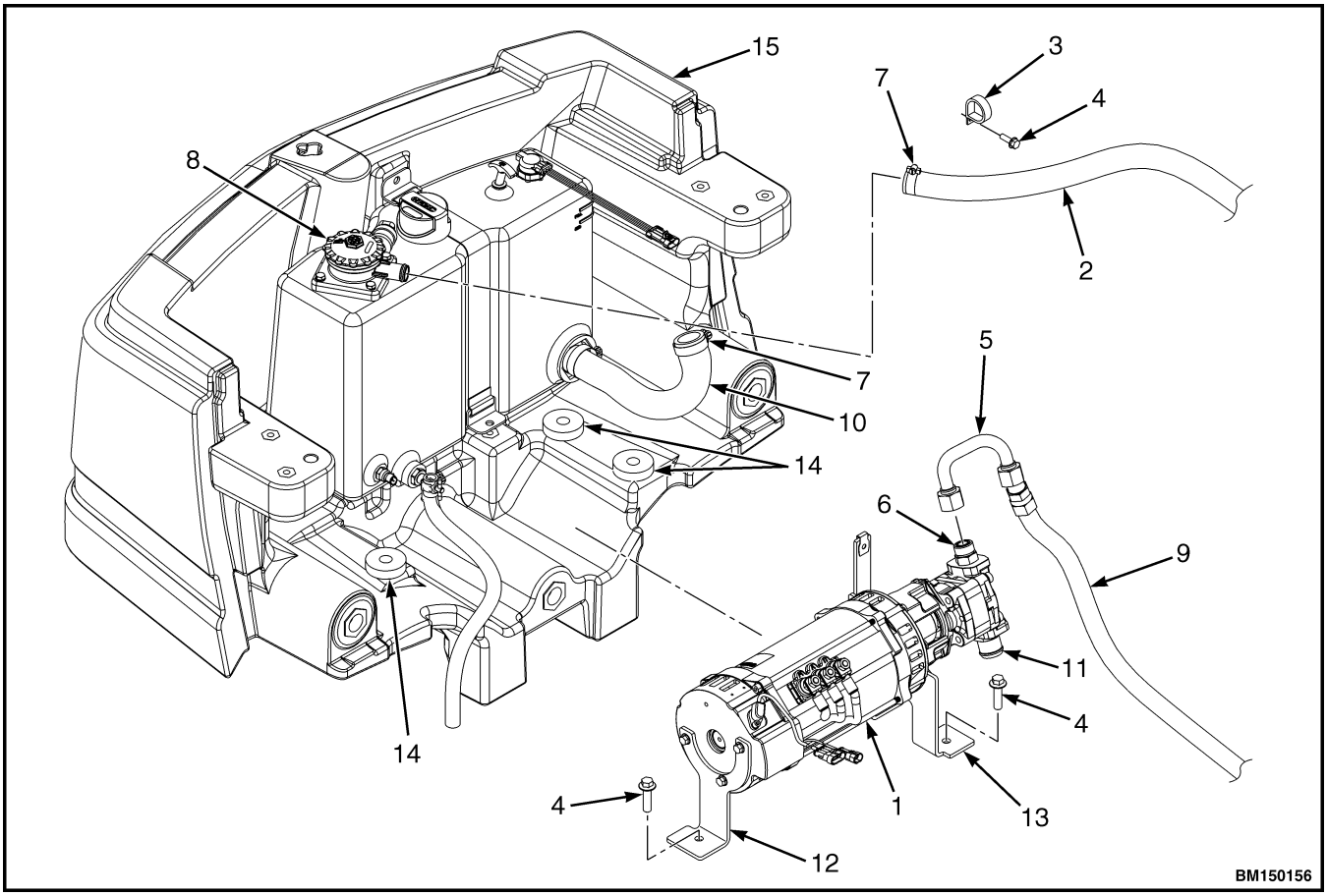
NOTE: Plug hoses, tank openings, and pump openings to prevent foreign material from entering hydraulic system.

7. Disconnect return line from hydraulic filter housing (see Figure 34). Plug return line and hydraulic filter housing opening. Move return line aside to prevent damage.

8. Disconnect tube assembly from fitting (see Figure 34). Plug fitting and tube assembly. Move tube assembly and pressure hose aside to prevent damage.

9. Remove two capscrews and tank retention strap from counterweight and hydraulic tank.

10. Remove hydraulic tank from counterweight.



NOTE: LIFT TRUCK MANUFACTURED PRIOR TO NOVEMBER, 2015 SHOWN, LIFT TRUCK MANUFACTURED AFTER NOVEMBER, 2015 SIMILAR.

1. PUMP AND MOTOR
2. RETURN LINE
3. CLAMP
4. CAPSCREW
5. TUBE ASSEMBLY
6. FITTING
7. HOSE CLAMP
8. HYDRAULIC FILTER HOUSING
9. PRESSURE HOSE
10. SUCTION HOSE
11. ADAPTER
12. MOTOR MOUNT BRACKET
13. MOTOR BRACKET
14. MOUNT
15. COUNTERWEIGHT

Figure 34. Pump and Motor for Lift Truck Models J2.2-3.5XN (J45-70XN) (A276)

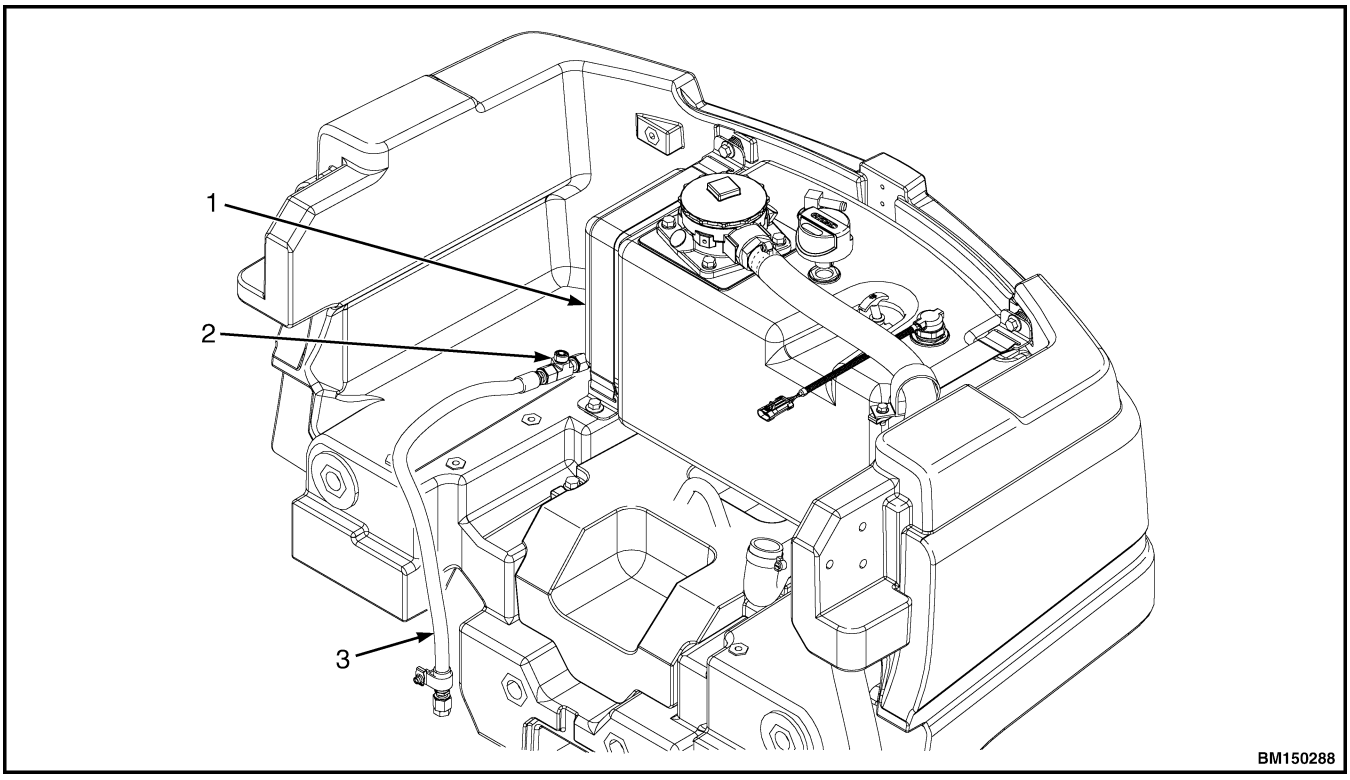
Lift Truck Models J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

1. Remove battery. See **Operating Manual** or **Periodic Maintenance** 8000SRM1541 for procedures.
2. Remove hydraulic pump and motor as described in Hydraulic Pump and Motor section of this manual.
3. Put drain pan with capacity of approximately 57.0 liter (60.2 qt) under drain hose beneath the lift truck.

CAUTION

Disposal of lubricants and fluids must meet local environmental regulations.

4. Open drain valve, hydraulic oil will run through drain hose, emptying hydraulic tank. When oil has completely drained, close drain valve. See Figure 35.



NOTE: HYDRAULIC PUMP AND MOTOR NOT SHOWN FOR CLARITY.

1. HYDRAULIC TANK
2. DRAIN VALVE
3. DRAIN HOSE

Figure 35. Drain Hydraulic Oil From Lift Truck Models J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

5. Remove capscrew, clamp, and return line from motor bracket. See Figure 36.

NOTE: Tag hoses, adapters, and fittings during removal to aid in installation.

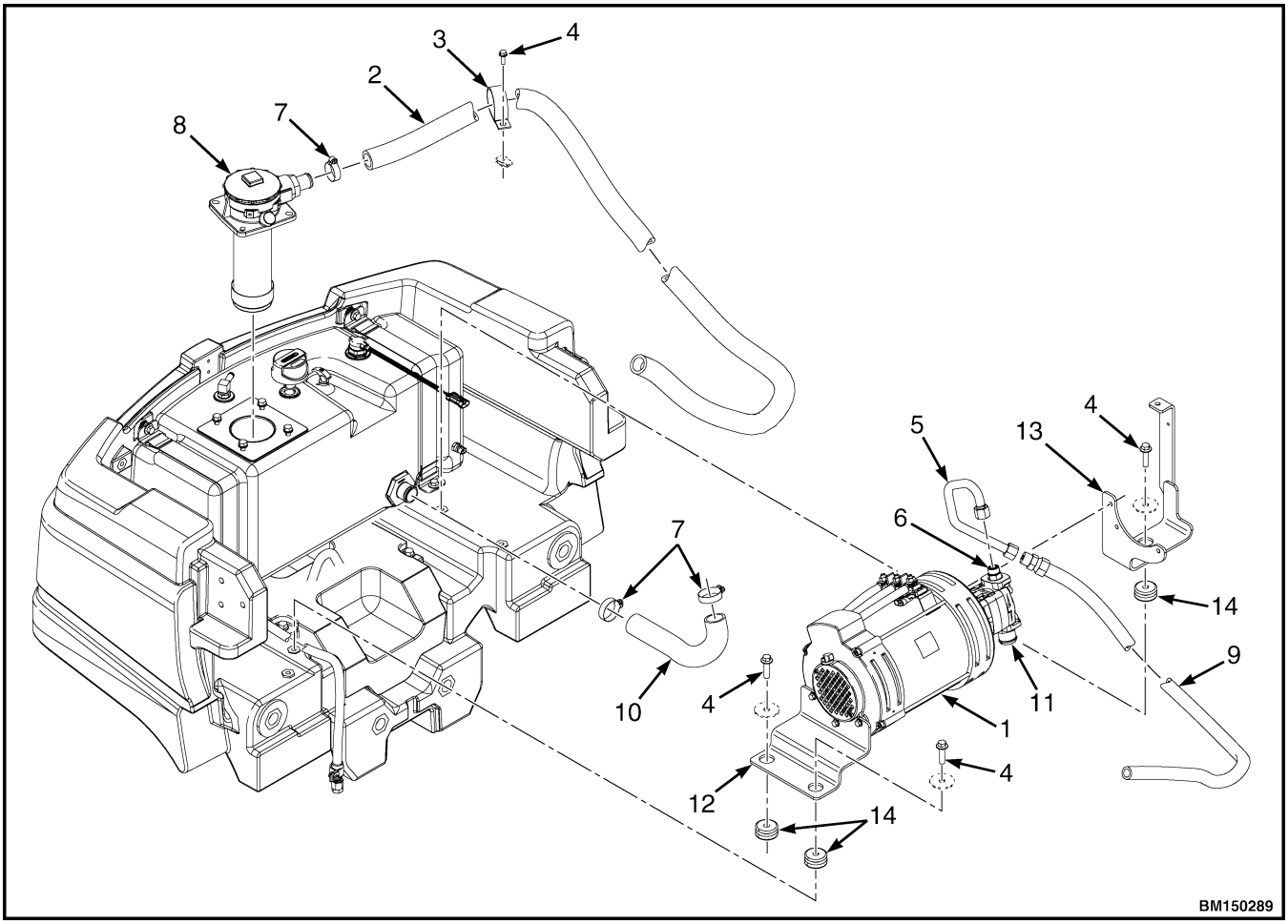
6. Loosen hose clamp on return line and move it on return line until flanged end of hydraulic filter housing is cleared; tighten hose clamp to keep return line and hose clamp together.

NOTE: Plug hoses, tank openings, and pump openings to prevent foreign material from entering hydraulic system.

7. Disconnect return line from hydraulic filter housing (see Figure 36). Plug return line and hydraulic filter housing opening. Move return line aside to prevent damage.

8. Disconnect tube assembly from fitting (see Figure 36). Plug fitting and tube assembly. Move tube assembly and pressure hose aside to prevent damage.

9. Remove two capscrews and tank retention strap from counterweight and hydraulic tank.



1. PUMP AND MOTOR
2. RETURN LINE
3. CLAMP
4. CAPSCREW
5. TUBE ASSEMBLY
6. FITTING
7. HOSE CLAMP
8. HYDRAULIC FILTER HOUSING
9. PRESSURE HOSE
10. SUCTION HOSE
11. ADAPTER
12. MOTOR MOUNT BRACKET
13. MOTOR BRACKET
14. MOUNT

Figure 36. Pump and Motor for Lift Truck Models J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

10. Remove hydraulic tank from counterweight.

DISASSEMBLE

NOTE: Perform only those steps below required for repair or replacement.

Lift Truck Models E2.2-3.5XN (E45-70XN) (A268)

NOTE: Perform step below for lift trucks equipped with nylon tank.

1. Remove breather fitting from hydraulic tank and replace with plug. Discard O-ring. See Figure 27.

NOTE: Perform step below for lift trucks equipped with metal tank.

2. Remove breather tube from hydraulic tank and replace with plug. See Figure 28.

NOTE: Perform the following step if lift truck is equipped with tank level sensor.

3. Remove tank level sensor from hydraulic tank. Discard O-ring. Replace tank level sensor with plug.

For lift trucks equipped with a nylon tank, see Figure 27.

For lift trucks equipped with a metal tank, see Figure 28.

4. Remove gauge from hydraulic filter housing.

NOTE: Perform the following step if lift truck is equipped with pressure switch.

5. Remove pressure switch from hydraulic filter housing.

For lift trucks equipped with a nylon tank, see Figure 27.

For lift trucks equipped with a metal tank, see Figure 28.

NOTE: Perform step below for lift trucks equipped with nylon tank.

6. Remove four capscrews and hydraulic filter housing from hydraulic tank. Discard quad seal. Replace hydraulic filter housing with plug. See Figure 27.

NOTE: Perform step below for lift trucks equipped with metal tank.

7. Remove four nuts and hydraulic filter housing from hydraulic tank. Discard quad seal. Replace hydraulic filter housing with plug. See Figure 28.

8. Remove hydraulic filter element from hydraulic filter housing. See Hydraulic Filter Replacement for procedure.

9. Loosen hose clamp on suction hose and move it on suction hose until past flanged end of suction strainer. Tighten hose clamp to keep suction hose and hose clamp together.

For lift trucks equipped with a nylon tank, see Figure 27.

For lift trucks equipped with a metal tank, see Figure 28.

10. Remove suction hose from suction strainer.

For lift trucks equipped with a nylon tank, see Figure 27.

For lift trucks equipped with a metal tank, see Figure 28.

11. Remove suction strainer from hydraulic tank. Discard O-ring. Replace suction strainer with plug.

For lift trucks equipped with a nylon tank, see Figure 27.

For lift trucks equipped with a metal tank, see Figure 28.

12. Remove dipstick from hydraulic tank. Discard O-ring. Replace dipstick with plug.

For lift trucks equipped with a nylon tank, see Figure 27.

For lift trucks equipped with a metal tank, see Figure 28.

Lift Truck Models E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

1. Plug breather tube. See Figure 30.

NOTE: Mark fitting position on tank to ensure proper angle alignment during install.

2. Remove vent fitting and replace with plug. See Figure 30.

3. Remove brake hose fitting and replace with plug. See Figure 30.

NOTE: Perform the following step if lift truck is equipped with tank level sensor.

4. Remove tank level sensor from hydraulic tank. Discard O-ring. Replace tank level sensor with plug. See Figure 30.

5. If equipped, remove gauge from hydraulic filter housing.

NOTE: Perform the following step if lift truck is equipped with pressure switch.

6. Remove pressure switch from hydraulic filter housing. See Figure 30.

7. Remove four nuts and hydraulic filter housing from hydraulic tank. Discard quad seal. Replace hydraulic filter housing with plug. See Figure 30.

8. Remove hydraulic filter element from hydraulic filter housing. See Hydraulic Filter Replacement for procedure.

9. Remove suction strainer from hydraulic tank. Discard O-ring. Replace suction strainer with plug. See Figure 30.

10. Remove dipstick from hydraulic tank. Discard O-ring. Replace dipstick with plug. See Figure 30.

Lift Truck Models E1.6-2.0XN (E30-40XN) (A269)

1. Remove hydraulic tank level sensor as follows:

   a. Remove three capscrews and remove step from left side of frame. See Figure 37.

   b. Disconnect hydraulic tank level sensor from hydraulic tank

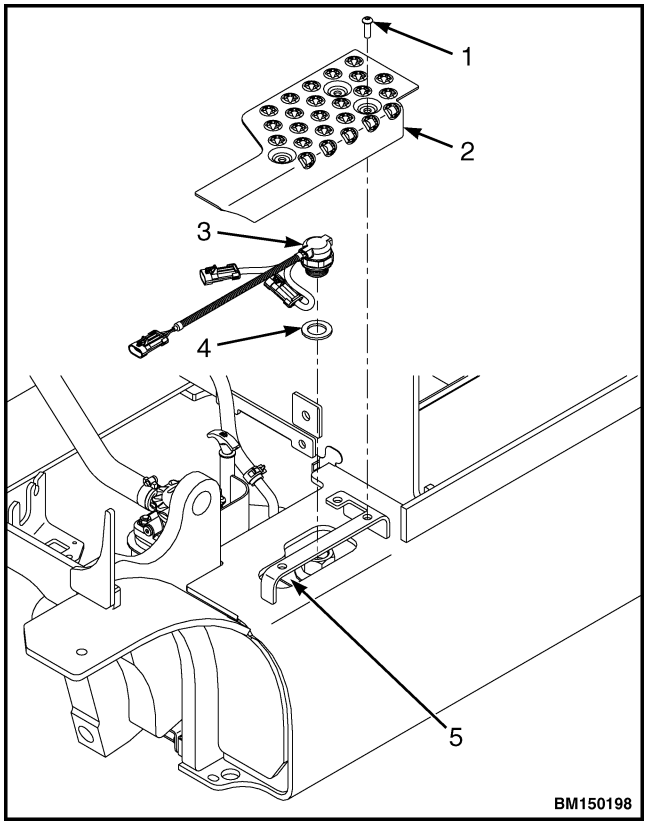
   c. Unscrew and remove hydraulic tank level sensor from hydraulic tank. Discard O-ring. Replace hydraulic tank level sensor with plug. See Figure 37.

2. Remove pressure switch from hydraulic filter housing. See Figure 31.

3. Remove four capscrews and hydraulic filter housing from hydraulic tank. Discard quad seal. See Figure 31.

4. Replace hydraulic filter housing with plug.

5. Remove hydraulic filter element from hydraulic filter housing. See Hydraulic Filter Replacement for procedure.



1. CAPSCREW
2. STEP
3. HYDRAULIC TANK LEVEL SENSOR
4. O-RING
5. HYDRAULIC TANK

Figure 37. Hydraulic Tank Level Sensor for Lift Truck Models E1.6-2.0XN (E30-40XN) (A269)

6. Loosen hose clamp on suction hose and move it on suction hose until past flanged end of suction strainer. Tighten hose clamp to keep suction hose and hose clamp together. See Figure 31.

7. Remove suction hose from suction strainer.

8. Remove suction strainer from hydraulic tank. Discard O-ring. Replace suction strainer with plug. See Figure 31.

9. Remove dipstick from hydraulic tank. Discard O-ring. Replace dipstick with plug.

Lift Truck Models J2.2-3.5XN (J45-70XN) (A276)

1. Loosen hose clamp on suction hose and move it on suction hose past flanged end of suction strainer. Tighten hose clamp to keep suction hose and hose clamp together. See Figure 38.

2. Remove suction hose from suction strainer. See Figure 38.

3. Remove suction strainer from hydraulic tank. Discard O-ring. Replace suction strainer with plug. See Figure 38.

4. Loosen hose clamp on drain hose and move it on drain hose until past flanged end of drain valve. Tighten hose clamp to keep drain hose and hose clamp together. See Figure 38.

5. Make sure drain valve is closed. Remove drain hose from drain valve. See Figure 38.

6. Remove temperature sensor from hydraulic tank. Replace temperature sensor with plug. See Figure 38.

7. Remove fitting from hydraulic tank and replace with plug. See Figure 38.

NOTE: Perform the following step if lift truck is equipped with tank level sensor.

8. Remove tank level sensor from hydraulic tank. Discard O-ring. Replace tank level sensor with plug. See Figure 38.

9. Remove breather from hydraulic tank. Discard O-ring. Replace breather with plug. See Figure 38. For procedures on cleaning breather, see Breather Clean and Inspect section.

10. Remove gauge from hydraulic filter housing. Replace gauge with plug.

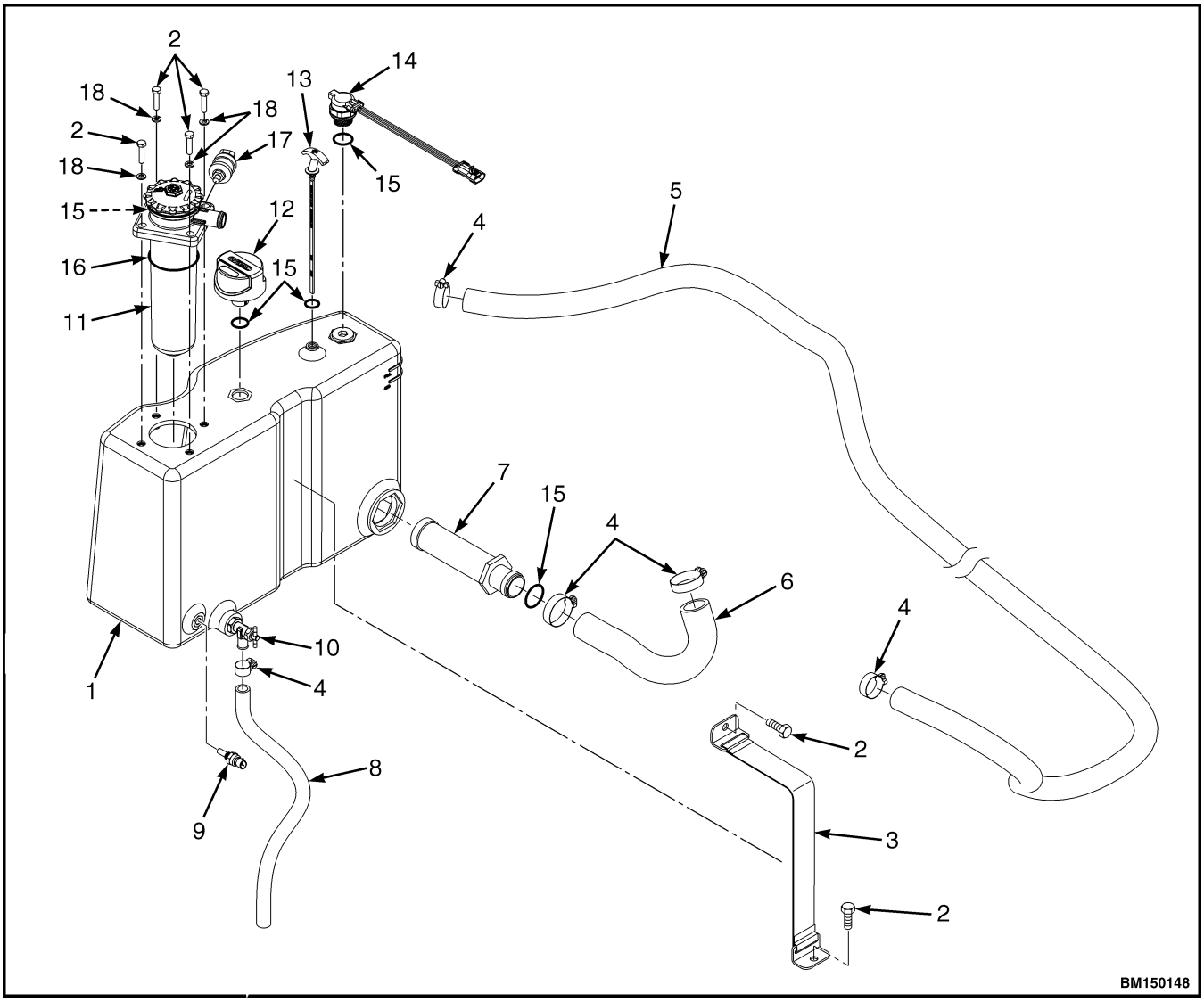
NOTE: Perform the following step only if lift truck is equipped with pressure switch.

11. Remove pressure switch from hydraulic filter housing. Replace pressure switch with plug. See Figure 38.

12. Remove four capscrews, four lockwashers, and hydraulic filter housing from hydraulic tank. Discard quad ring. Replace hydraulic filter housing with plug. See Figure 38.

13. Remove dipstick from hydraulic tank. Discard O-ring. Replace dipstick with plug. See Figure 38.

14. Remove drain valve from hydraulic tank and replace with plug. See Figure 38.



1. HYDRAULIC TANK
2. CAPSCREW
3. TANK RETENTION STRAP
4. HOSE CLAMP
5. RETURN LINE
6. SUCTION HOSE
7. SUCTION STRAINER
8. DRAIN HOSE
9. TEMPERATURE SENSOR
10. DRAIN VALVE
11. HYDRAULIC FILTER HOUSING
12. BREATHER
13. DIPSTICK
14. TANK LEVEL SENSOR
15. O-RING
16. QUAD RING
17. PRESSURE SWITCH
18. LOCKWASHER

Figure 38. Hydraulic Tank and Components for Lift Truck Models J2.2-3.5XN (J45-70XN) (A276)

Lift Truck Models J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

1. Loosen hose clamp on suction hose and move it on suction hose past flanged end of suction strainer. Tighten hose clamp to keep suction hose and hose clamp together. See Figure 39.
2. Remove suction hose from suction strainer. See Figure 39.
3. Remove suction strainer from hydraulic tank. Discard O-ring. Replace suction strainer with plug. See Figure 39.
4. Loosen hose clamp on drain hose and move it on drain hose until past flanged end of drain valve. Tighten hose clamp to keep drain hose and hose clamp together. See Figure 39.
5. Make sure drain valve is closed. Remove drain hose from drain valve. See Figure 39.
6. Remove temperature sensor from hydraulic tank. Replace temperature sensor with plug. See Figure 39.
7. Remove fitting from hydraulic tank. See Figure 39. Replace fitting with plug.

NOTE: Perform the following step if lift truck is equipped with tank level sensor.

8. Remove tank level sensor from hydraulic tank. Discard O-ring. Replace tank level sensor with plug. See Figure 39.
9. Remove breather from hydraulic tank. Discard O-ring. Replace breather with plug. See Figure 39. For procedures on cleaning breather, see Breather Clean and Inspect section.
10. Remove gauge from hydraulic filter housing. Replace gauge with plug.

NOTE: Perform the following step only if lift truck is equipped with pressure switch.

11. Remove pressure switch from hydraulic filter housing. Replace pressure switch with plug. See Figure 39.
12. Remove four capscrews, four lockwashers, and hydraulic filter housing from hydraulic tank. Discard quad ring. Replace hydraulic filter housing with plug. See Figure 39.
13. Remove dipstick from hydraulic tank. Discard O-ring. Replace dipstick with plug. See Figure 39.
14. Remove drain valve from hydraulic tank and replace with plug. See Figure 39.

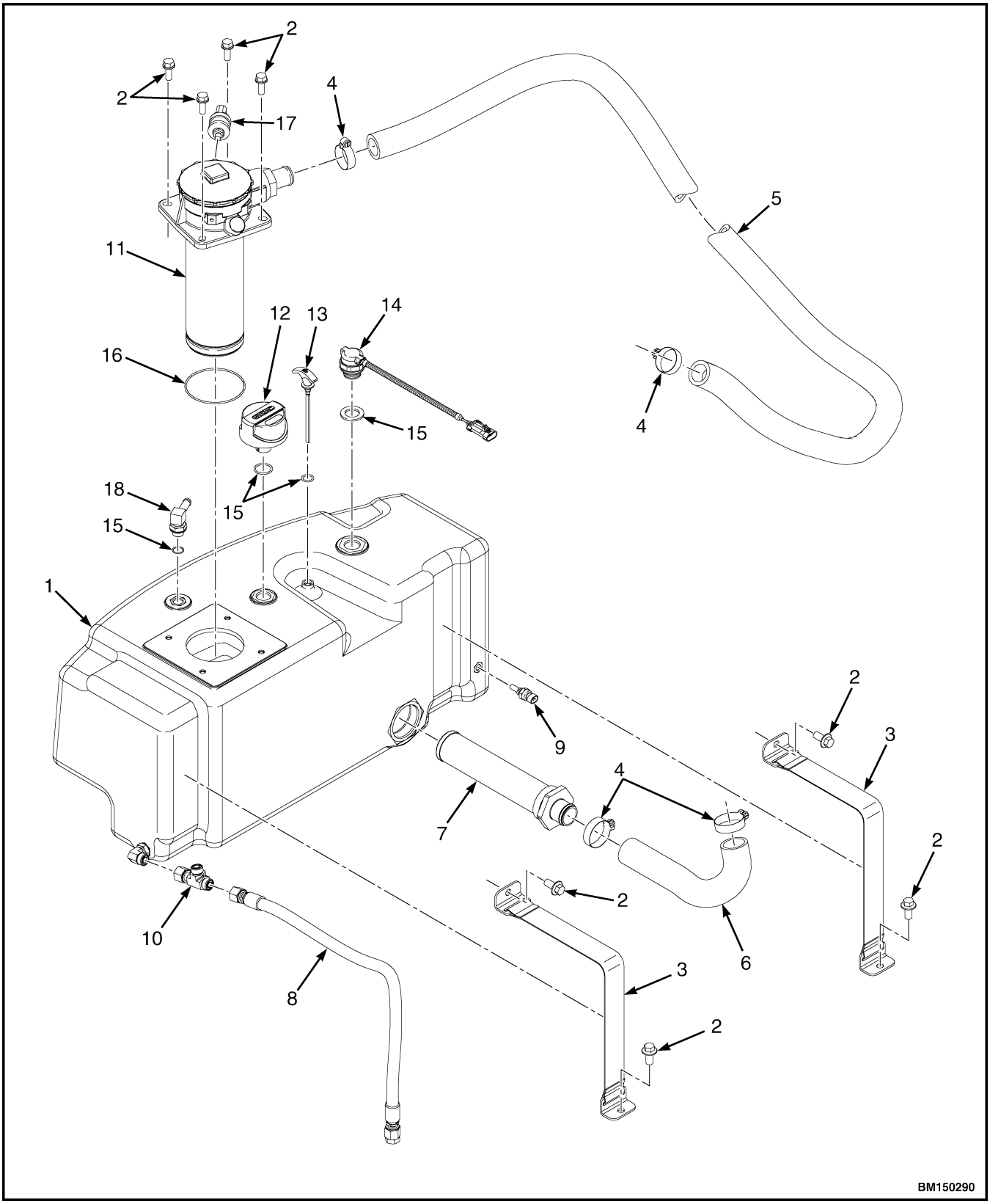


Figure 39. Hydraulic Tank and Components for Lift Truck Models J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

Legend for Figure 39

1. HYDRAULIC TANK
2. CAPSCREW
3. TANK RETENTION STRAP
4. HOSE CLAMP
5. RETURN LINE
6. SUCTION HOSE
7. SUCTION STRAINER
8. DRAIN HOSE
9. TEMPERATURE SENSOR
10. DRAIN VALVE
11. HYDRAULIC FILTER HOUSING
12. BREATHER
13. DIPSTICK
14. TANK LEVEL SENSOR
15. O-RING
16. QUAD RING
17. PRESSURE SWITCH
18. FITTING

CLEAN

WARNING

When cleaning the tank, DO NOT use solutions that make dangerous gasses at normal temperatures or when heated. Wear eye and face protection. Protect the body from burns.

WARNING

At operating temperature, the hydraulic oil is HOT. DO NOT permit the hot oil to touch the skin and cause a burn.

WARNING

Compressed air can move particles so that they cause injury to the user or to other personnel. Make sure that the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eyes.

WARNING

If hydraulic tank is cleaned inside of a building, make sure there is enough ventilation. Serious injury can result if there is not adequate ventilation.

Steam Method

Use the following procedure to clean the tank with steam:

When cleaning with steam, use a hose with a minimum diameter of 19 mm (0.75 in.). Control the pressure of the steam by a valve installed at the nozzle of the hose. If a metal nozzle is used, it must be made of material that does not make sparks.

1. Fill tank 1/4 full with solution of water and sodium bicarbonate (baking soda) or sodium carbonate. Mix 0.5 kg (1 lb) per 4 liter (1 gal) of water.
2. Mix solution in tank using air pressure. Make sure all surfaces of the tank are flushed with solution. Drain tank.
3. Remove tank plugs. Put steam into tank until tank does not have odors and is hot. Steam vapors must come from all openings.
4. Flush inside of tank with boiling water. Make sure all loose material is removed from inside of tank.
5. Inspect inside of tank, if it is not clean, repeat Step 3 and Step 4, then make another inspection. When making inspections, use a light that is approved for locations with flammable vapors.
6. Put plugs in all openings of tank. Wait 15 minutes, then remove the inlet and outlet plugs. Test a sample of the vapor with a combustible gas detector. If the amount of flammable vapors is above the lower flammable limit, repeat cleaning procedures.

Chemical Method

If tank cannot be cleaned with steam, use the following procedure:

1. Mix a solution of water and trisodium phosphate or a cleaning compound with an alkali base. Follow instructions given by manufacturer.
2. Fill tank with cleaning solution. Use compressed air to mix solution in tank.

3. Drain tank. Flush inside of tank with boiling water. Make sure all cleaning compound is removed.

4. Inspect inside of tank, if it is not clean, repeat Step 1 through Step 3, then make another inspection. When making inspections, use a light that is approved for locations with flammable vapors.

5. Put plugs in all openings of tank. Wait 15 minutes, then remove the inlet and outlet plugs. Test a sample of the vapor with a combustible gas detector. If the amount of flammable vapors is above the lower flammable limit, repeat cleaning procedures.

INSPECT

1. Make a visual inspection of all sides of the tank. Inspect welds, on metal tanks, for cracks and leakage, check for wet areas, accumulation of dirt, and loose or missing paint caused by leakage. Areas not easily seen can be checked with an inspection mirror and a light that is approved for locations with flammable vapors.

   Repairs for leaks in the metal hydraulic tanks can require special procedures described in the next paragraphs. The most common cause of leaks is from rust caused by the moisture of condensation. Drain any water out of the tank by removing drain plug and letting tank drain until there is no water in oil.

Small Leaks, Repair

NOTE: Use the following procedure to seal small leaks in metal tanks.

1. Use steam to clean area around leak. Remove all paint and dirt around leak.

WARNING

DO NOT use tools that can make sparks, heat, or static electricity. The vapors in the tank can cause an explosion.

2. Apply Loctite® 290 to leak. Follow instructions of manufacturer.

Large Leaks, Repair

NOTE: Use the following procedure to seal large leaks in metal tanks.

1. Use one of the procedures described under Clean, to clean and prepare tank for repairs.

2. Use acceptable welding practices to repair tank. See the American National Standard, *Safety In Welding and Cutting* AWS Z 49.1 - 1999.

Additional Methods for Metal Tank Repair

If nitrogen gas or carbon dioxide gas is available, prepare tank for welding using these gases. See the manual *Safe Practices for Welding and Cutting Containers that Have Held Combustibles* by the American Welding Society, F4.1 - 1999. If these gases are not available, another method using water can be used as follows:

1. Fill tank with water to just below the point where the work will be done. Make sure the space above the level of the water has a vent.

2. Use acceptable welding practices to repair the tank. See the American National Standard, *Safety In Welding and Cutting* AWS Z 49.1 - 1999.

ASSEMBLE

NOTE: Perform only those steps below required for repair or replacement.

NOTE: Remove plugs as components are assembled with hydraulic tank.

Lift Truck Models E2.2-3.5XN (E45-70XN) (A268)

1. Install drain plug into hydraulic tank. Tighten drain plug to 40 N•m (30 lbf ft).

   For lift trucks equipped with a nylon tank, see Figure 27.

   For lift trucks equipped with a metal tank, see Figure 28.

2. Lubricate new O-ring with clean hydraulic fluid and install onto suction strainer. Install suction strainer into hydraulic tank. Tighten suction strainer to 135 N•m (100 lbf ft).

   For lift trucks equipped with a nylon tank, see Figure 27.

   For lift trucks equipped with a metal tank, see Figure 28.

NOTE: Perform step below for lift trucks equipped with nylon tank.

3. Lubricate new quad seal with clean hydraulic oil and install on hydraulic filter housing. Install hydraulic filter housing and four capscrews into hydraulic tank. Tighten capscrews to 10 N•m (89 lbf in). See Figure 27.

NOTE: Perform step below for lift trucks equipped with metal tank.

4. Lubricate new quad seal with clean hydraulic oil and install on hydraulic filter housing. Install hydraulic filter housing and four nuts onto hydraulic tank. Tighten nuts to 15 N•m (133 lbf in). See Figure 28.

NOTE: Perform the following step if lift truck is equipped with pressure switch.

5. Install pressure switch onto hydraulic filter housing. Tighten pressure switch to 25 N•m (221 lbf in).

   For lift trucks equipped with a nylon tank, see Figure 27.

   For lift trucks equipped with a metal tank, see Figure 28.

6. Install gauge onto hydraulic filter housing.

NOTE: Perform step below for lift trucks equipped with nylon tank.

7. Lubricate new O-ring with clean hydraulic oil and install onto breather fitting. Install breather fitting into hydraulic tank. Tighten fitting to 4 to 7 N•m (35 to 62 lbf in). See Figure 27.

NOTE: Perform step below for lift trucks equipped with metal tank.

8. Install breather tube into hydraulic tank. See Figure 28.

NOTE: Perform the following step if lift truck is equipped with tank level sensor.

9. Lubricate new O-ring with clean hydraulic oil and install on tank level sensor. Install tank level sensor into hydraulic tank. Tighten tank level sensor to 45 N•m (33 lbf ft).

   For lift trucks equipped with a nylon tank, see Figure 27.

   For lift trucks equipped with a metal tank, see Figure 28.

10. Install suction hose onto suction strainer. Move hose clamp to hold suction hose on suction strainer and tighten hose clamp.

    For lift trucks equipped with a nylon tank, see Figure 27.

    For lift trucks equipped with a metal tank, see Figure 28.

11. Lubricate new O-ring with clean hydraulic oil and install on dipstick. Install dipstick into hydraulic tank, oriented toward filter housing.

    For lift trucks equipped with a nylon tank, see Figure 27.

    For lift trucks equipped with a metal tank, see Figure 28.

Lift Truck Models E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

1. Install drain plug into hydraulic tank. Tighten drain plug to 40 N•m (30 lbf ft). See Figure 30.

2. Lubricate new O-ring with clean hydraulic fluid and install onto suction strainer. Install suction strainer into hydraulic tank. Tighten suction strainer to 135 N•m (100 lbf ft). See Figure 30.

3. Lubricate new quad seal with clean hydraulic oil and install on hydraulic filter housing. Install hydraulic filter housing and four nuts onto hydraulic tank. Tighten nuts to 15 N•m (133 lbf in). See Figure 30.

NOTE: Perform the following step if lift truck is equipped with pressure switch.

4. Install pressure switch onto hydraulic filter housing. Tighten pressure switch to 25 N•m (221 lbf in). See Figure 30.

5. If equipped, install gauge onto hydraulic filter housing.

6. Remove plug from breather tube on hydraulic tank. See Figure 30.

7. Remove plug from vent fitting port. Install vent fitting and tighten to 40 to 43 N•m (30 to 32 lbf ft). See Figure 30.

8. Remove plug from brake hose fitting port. Install brake hose fitting and tighten to 68 to 78 N•m (50 to 58 lbf ft). See Figure 30.

NOTE: Perform the following step if lift truck is equipped with tank level sensor.

9. Lubricate new O-ring with clean hydraulic oil and install on tank level sensor. Install tank level sensor into hydraulic tank. Tighten tank level sensor to 4 to 7 N•m (35 to 62 lbf in). See Figure 30.

10. Lubricate new O-ring with clean hydraulic oil and install on dipstick. Install dipstick into hydraulic tank, oriented toward filter housing. See Figure 30.

Lift Truck Models E1.6-2.0XN (E30-40XN) (A269)

1. Install drain plug onto bottom of hydraulic tank. See Figure 31. Tighten drain plug to 40 N•m (30 lbf ft).

2. Install new O-ring onto dipstick. Install dipstick into hydraulic tank. See Figure 31.

3. Lubricate new O-ring with clean hydraulic oil and install onto suction strainer. Install suction strainer into hydraulic tank. Tighten suction strainer to 135 N•m (100 lbf ft) See Figure 31.

4. Install hydraulic filter element into hydraulic filter housing. See section Hydraulic Filter Replacement for procedures.

5. Lubricate new quad seal with clean hydraulic oil and install onto hydraulic filter housing. See Figure 31.

6. Install hydraulic filter housing and four capscrews into hydraulic tank. Tighten capscrews to 15 N•m (133 lbf in). See Figure 31.

7. Install pressure switch onto hydraulic filter housing. Tighten pressure switch to 25 N•m (221 lbf in). See Figure 31.

8. Perform the following to install hydraulic tank level sensor:

   a. Lubricate new O-ring with clean hydraulic oil and install on hydraulic tank level sensor. Install hydraulic tank level sensor into hydraulic tank. Tighten hydraulic tank level sensor to 4 to 7 N•m (35 to 62 lbf in). See Figure 37.

   b. Connect hydraulic tank level sensor to wire harness.

   c. Install step onto left side of frame using three capscrews. See Figure 37.

Lift Truck Models J2.2-3.5XN (J45-70XN) (A276)

1. Lubricate new quad seal with clean hydraulic oil and install on hydraulic filter housing. Install hydraulic filter housing, four lockwashers, and four capscrews into hydraulic tank. See Figure 38. Tighten capscrews to 10 N•m (89 lbf in).

2. Install gauge onto hydraulic filter housing.

NOTE: Perform the following step if lift truck is equipped with pressure switch.

3. Install pressure switch onto hydraulic filter housing. Tighten pressure switch to 25 N•m (221 lbf in). See Figure 38.

4. Lubricate new O-ring with clean hydraulic oil and install on breather. Install breather onto hydraulic tank. Tighten breather to 10 N•m (89 lbf in). See Figure 38.

5. Lubricate new O-ring with clean hydraulic oil and install on fitting. Install fitting into hydraulic tank. Tighten fitting to 45 N•m (33 lbf ft).

NOTE: Perform the following step if lift truck is equipped with tank level sensor.

6. Lubricate new O-ring with clean hydraulic oil and install on tank level sensor. Install tank level sensor into hydraulic tank. Tighten tank level sensor to 4 to 7 N•m (35 to 62 lbf in). See Figure 38.

7. Install temperature sensor into hydraulic tank. Tighten temperature sensor to 19 to 21 N•m (168 to 186 lbf in). See Figure 38.

8. Install drain valve onto hydraulic tank. Tighten drain valve to 40 N•m (30 lbf ft). See Figure 38.

9. Install drain hose onto drain valve. Move hose clamp to hold drain hose on drain valve and tighten hose clamp. See Figure 38.

10. Lubricate new O-ring with clean hydraulic oil and install on suction strainer. Install suction strainer into hydraulic tank. Tighten suction strainer to 135 N•m (100 lbf ft). See Figure 38.

11. Lubricate new O-ring with clean hydraulic oil and install on dipstick. Install dipstick into hydraulic tank. See Figure 38.

Lift Truck Models J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

1. Lubricate new quad seal with clean hydraulic oil and install on hydraulic filter housing. Install hydraulic filter housing, four lockwashers, and four capscrews into hydraulic tank. Tighten capscrews to 10 N•m (89 lbf in). See Figure 39.

2. Install gauge onto hydraulic filter housing.

NOTE: Perform the following step if lift truck is equipped with pressure switch.

3. Install pressure switch onto hydraulic filter housing. Tighten pressure switch to 25 N•m (221 lbf in). See Figure 39.

4. Lubricate new O-ring with clean hydraulic oil and install on breather. Install breather onto hydraulic tank. Tighten breather to 10 N•m (89 lbf in). See Figure 39.

5. Lubricate new O-ring with clean hydraulic oil and install on fitting. Install fitting into hydraulic tank. Tighten fitting to 45 N•m (33 lbf ft).

NOTE: Perform the following step if lift truck is equipped with tank level sensor.

6. Lubricate new O-ring with clean hydraulic oil and install on tank level sensor. Install tank level sensor into hydraulic tank. Tighten tank level sensor to 4 to 7 N•m (35 to 62 lbf in). See Figure 39.

7. Install temperature sensor into hydraulic tank. Tighten temperature sensor to 19 to 21 N•m (168 to 186 lbf in). See Figure 39.

8. Install drain valve onto hydraulic tank. Tighten drain valve to 40 N•m (30 lbf ft). See Figure 39.

9. Install drain hose onto drain valve. Move hose clamp to hold drain hose on drain valve and tighten hose clamp. See Figure 39.

10. Lubricate new O-ring with clean hydraulic oil and install on suction strainer. Install suction strainer into hydraulic tank. Tighten suction strainer to 135 N•m (100 lbf ft). See Figure 39.

11. Lubricate new O-ring with clean hydraulic oil and install on dipstick. Install dipstick into hydraulic tank. See Figure 39.

INSTALL

Lift Truck Models E2.2-3.5XN (E45-70XN) (A268)

1. Install hydraulic tank in lift truck.

2. Wrap tank retention strap around hydraulic tank and install capscrew to hold strap to mounting bracket on truck frame. See Figure 29.

NOTE: Perform step below for lift trucks equipped with nylon tank.

3. Install breather hose onto breather fitting. Move hose clamp over flanged end of fitting and tighten. See Figure 27.

NOTE: Perform step below for lift truck equipped with metal tank.

4. Install breather hose onto breather tube. Move hose clamp over flanged end of tube and tighten. See Figure 28.

5. Install hydraulic filter element into hydraulic filter housing. See Hydraulic Filter Replacement section of this manual for procedure.

6. Install return line onto hydraulic filter housing. Move hose clamp on return line over end of hydraulic filter housing port and tighten.

   For lift trucks equipped with a nylon tank, see Figure 27.

   For lift trucks equipped with a metal tank, see Figure 28.

7. Install hydraulic pump and motor. See Hydraulic Pump and Motor, Install section of this manual for procedures.

8. Fill hydraulic tank with hydraulic oil. See Add Hydraulic Oil section of this manual for procedure.

CAUTION

Disposal of lubricants and fluids must meet local environmental regulations.

9. Remove container and dispose of hydraulic oil.

10. Remove lift truck from blocks. See **Operating ManualPeriodic Maintenance** 8000SRM1364 for procedure to remove lift truck from blocks.

11. Install battery plate.

12. Attach a tag line to temporarily power lift truck. Operate hydraulic system by tilting mast forward and backward pressurizing hydraulic system. Check all lines and connections for leaks. Remove tag line from lift truck.

13. Install battery. The procedure for installing the battery may be found in the **Operating Manual** or **Periodic Maintenance** 8000SRM1364.

Lift Truck Models E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

1. Place hydraulic tank onto lift jack of transmission jack.

2. Roll lift jack or transmission jack under lift truck.

3. Raise lift jack or transmission jack and hydraulic tank into lift truck and maneuver hydraulic tank into position inside lift truck's frame.

4. Secure hydraulic tank to lift truck's frame by installing two capscrews and two washers to one side of the hydraulic tank. See Figure 30.

5. Install retention rod into frame and into bracket on hydraulic tank. See Figure 30.

6. Install washer and nut onto retention rod. See Figure 30.

7. Once hydraulic tank has been secured in lift truck, remove lift jack or transmission jack from under lift truck.

8. Install brake hose onto brake hose fitting. Tighten hose end. See Figure 30.

9. Loosen clamp on vent hose.

10. Install vent hose onto vent hose fitting. Move hose clamp on vent hose over end of vent hose fitting and tighten. See Figure 30.

11. Loosen clamp on breather hose.

12. Install breather hose onto breather tube. Move hose clamp on breather hose over end of breather tube and tighten. See Figure 30.

13. Loosen hose clamp on suction hose.

14. Install suction hose onto strainer in hydraulic tank. Move hose clamp on suction hose over end of strainer in hydraulic tank and tighten. See Figure 30.

15. Install hydraulic filter element into hydraulic filter housing. See Hydraulic Filter Replacement section of this manual for procedure.

16. Loosen hose clamp on return line.

17. Install return line onto hydraulic filter housing. Move hose clamp on return line over end of hydraulic filter housing port and tighten. See Figure 30.

18. Reconnect all electrical connections.

19. Install hydraulic pump and motor. See Hydraulic Pump and Motor, Install section of this manual for procedures.

20. Fill hydraulic tank with hydraulic oil. See Add Hydraulic Oil section of this manual for procedure.

CAUTION

Disposal of lubricants and fluids must meet local environmental regulations.

21. Remove container and dispose of hydraulic oil.

22. Remove lift truck from blocks. See **Operating ManualPeriodic Maintenance** 8000SRM1577 for procedure to remove lift truck from blocks.

23. Install battery plate.

24. Attach a tag line to temporarily power lift truck. Operate hydraulic system by tilting mast forward and backward pressurizing hydraulic system. Check all lines and connections for leaks. Remove tag line from lift truck.

25. Install battery. The procedure for installing the battery may be found in the **Operating Manual** or **Periodic Maintenance** 8000SRM1577.

Lift Truck Models E1.6-2.0XN (E30-40XN) (A269)

1. Install hydraulic tank in left channel of lift truck. See Figure 32.

2. Install two mounting brackets and four capscrews to hydraulic tank and frame channel. See Figure 32.

3. Install return line onto hydraulic filter housing. Move hose clamp on return line over end of hydraulic filter housing port and tighten. See Figure 31.

4. Install hydraulic breather hose onto fitting. Move hose clamp to tube end of fitting and tighten. See Figure 31.

5. Install hydraulic pump and motor. See the section Hydraulic Pump and Motor for procedures.

6. Install floor plate and floor mat.

7. Add hydraulic oil to tank. See the section Add Hydraulic Oil for procedures.

CAUTION

Disposal of lubricants and fluids must meet local environmental regulations.

8. Remove container and dispose of hydraulic oil.

9. Remove lift truck from blocks. See the **Operating Manual** or service manual **Periodic Maintenance** 8000SRM1442 for procedures.

10. Operate hydraulic system by tilting mast forward and backward, to pressurize the hydraulic system. Check all lines and connections for leaks.

Lift Truck Models J2.2-3.5XN (J45-70XN) (A276)

1. Install hydraulic tank onto counterweight.

2. Wrap tank retention strap around hydraulic tank and install two capscrews holding strap to counterweight. See Figure 38. Tighten capscrews until 10 mm (0.4 in.) gap is obtained between counterweight and strap end.

NOTE: Remove plugs from hoses, adapter, and fitting as connections are made.

3. Install hydraulic pump and motor as described in Hydraulic Pump and Motor section of this manual.

4. Install suction hose onto suction strainer. Move hose clamp to hold suction hose on suction strainer and tighten hose clamp. See Figure 38.

5. Connect tube assembly onto fitting. See Figure 34.

6. Install return line, clamp, and capscrew onto motor bracket. See Figure 34.

7. Connect return line to hydraulic filter housing. Move hose clamp to hold return line on hydraulic filter housing and tighten clamp. See Figure 34.

8. Install hydraulic filter element into hydraulic filter housing. See Hydraulic Filter Replacement section for procedures.

9. Fill hydraulic tank with hydraulic oil. See Add Hydraulic Oil section for procedure.

10. Remove lift truck from blocks. See **Operating Manual** or **Periodic Maintenance** 8000SRM1372 for procedures.

11. Attach a tag line to temporarily power lift truck. Operate hydraulic system by tilting mast forward and backward pressurizing hydraulic system. Check all lines and connections for leaks. Remove tag line from lift truck.

12. Install battery. See **Operating Manual** or **Periodic Maintenance** 8000SRM1372 for procedures.

Lift Truck Models J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

1. Install hydraulic tank onto counterweight.

2. Wrap two tank retention straps around hydraulic tank and install four capscrews holding strap to counterweight. See Figure 39. Tighten capscrews until 10 mm (0.4 in.) gap is obtained between counterweight and strap end.

NOTE: Remove plugs from hoses, adapter, and fitting as connections are made.

3. Install hydraulic pump and motor as described in Hydraulic Pump and Motor section of this manual.

4. Install suction hose onto suction strainer. Move hose clamp to hold suction hose on suction strainer and tighten hose clamp. See Figure 39.

5. Connect tube assembly onto fitting. See Figure 36.

6. Install return line, clamp, and capscrew onto motor bracket. See Figure 36.

7. Connect return line to hydraulic filter housing. Move hose clamp to hold return line on hydraulic filter housing and tighten clamp. See Figure 36.

8. Install hydraulic filter element into hydraulic filter housing. See Hydraulic Filter Replacement section for procedures.

9. Fill hydraulic tank with hydraulic oil. See Add Hydraulic Oil section for procedure.

10. Remove lift truck from blocks. See **Operating Manual** or **Periodic Maintenance** 8000SRM1541 for procedures.

11. Attach a tag line to temporarily power lift truck. Operate hydraulic system by tilting mast forward and backward pressurizing hydraulic system. Check all lines and connections for leaks. Remove tag line from lift truck.

12. Install battery. See **Operating Manual** or **Periodic Maintenance** 8000SRM1541 for procedures.

HYDRAULIC FILTER REPLACEMENT

NOTE: Ensure filter housing head is protected to prevent foreign material from entering hydraulic system by cleaning around it prior to removal.

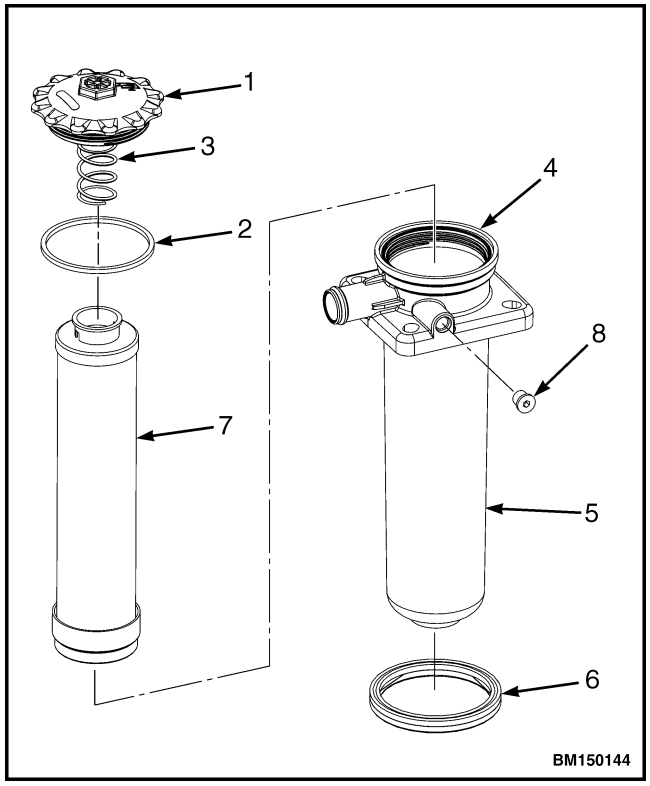
1. Remove lid with spring and gasket from head. Use socket or wrench if unable to remove lid by hand. Discard gasket. See Figure 40.

NOTE: Have container large enough to hold the filter assembly and allow for final hydraulic oil draining.

2. Remove hydraulic filter element from hydraulic filter housing and place into container. See Figure 40.

NOTE: Perform Step 3 through Step 5 only if head is damaged.

3. Inspect filter housing head, if damaged remove four capscrews and hydraulic filter housing from hydraulic tank. Discard quad seal (see Figure 40). Plug hole to prevent dirt from entering hydraulic tank.



NOTE: THE FILTER HOUSING HEAD AND HYDRAULIC FILTER HOUSING ARE ONE PIECE; DIFFERENTIATION MADE FOR SERVICE PURPOSES ONLY. THE SPRING REMAINS ATTACHED TO THE LID.

1. LID
2. GASKET
3. SPRING
4. FILTER HOUSING HEAD
5. HYDRAULIC FILTER HOUSING
6. QUAD SEAL
7. HYDRAULIC FILTER ELEMENT
8. PLUG

Figure 40. Hydraulic Filter

4. Lubricate new quad seal with clean hydraulic oil and install on new hydraulic filter housing.

5. Install new hydraulic filter housing and four capscrews into hydraulic tank. Tighten capscrews to 10 N•m (86 lbf in).

CAUTION

Additives may damage the hydraulic system. Before using additives, contact your local dealer.

6. Fill hydraulic tank with hydraulic oil to replenish oil lost with filter element. See the Add Hydraulic Oil section for procedure.

7. Install new hydraulic filter element into hydraulic filter housing.

8. Lubricate new gasket with clean hydraulic oil and install on lid. See Figure 40.

9. Inspect spring and lid; if worn or damaged, replace with new part. See **Parts Manual** if new part is required.

10. Install lid onto hydraulic filter housing. See Figure 40. Tighten lid to 13.6 N•m (120 lbf in).

11. Operate hydraulic system and check hydraulic lines and connections for leaks. Turn off key switch and recheck hydraulic oil level in hydraulic tank. Add oil, if necessary.

BREATHER CLEAN AND INSPECT

Lift Truck Models E2.2-3.5XN (E45-70XN) (A268) and E1.6-2.0XN (E30-40XN) (A269)

1. Remove floor mats and floor plates for access to breather.

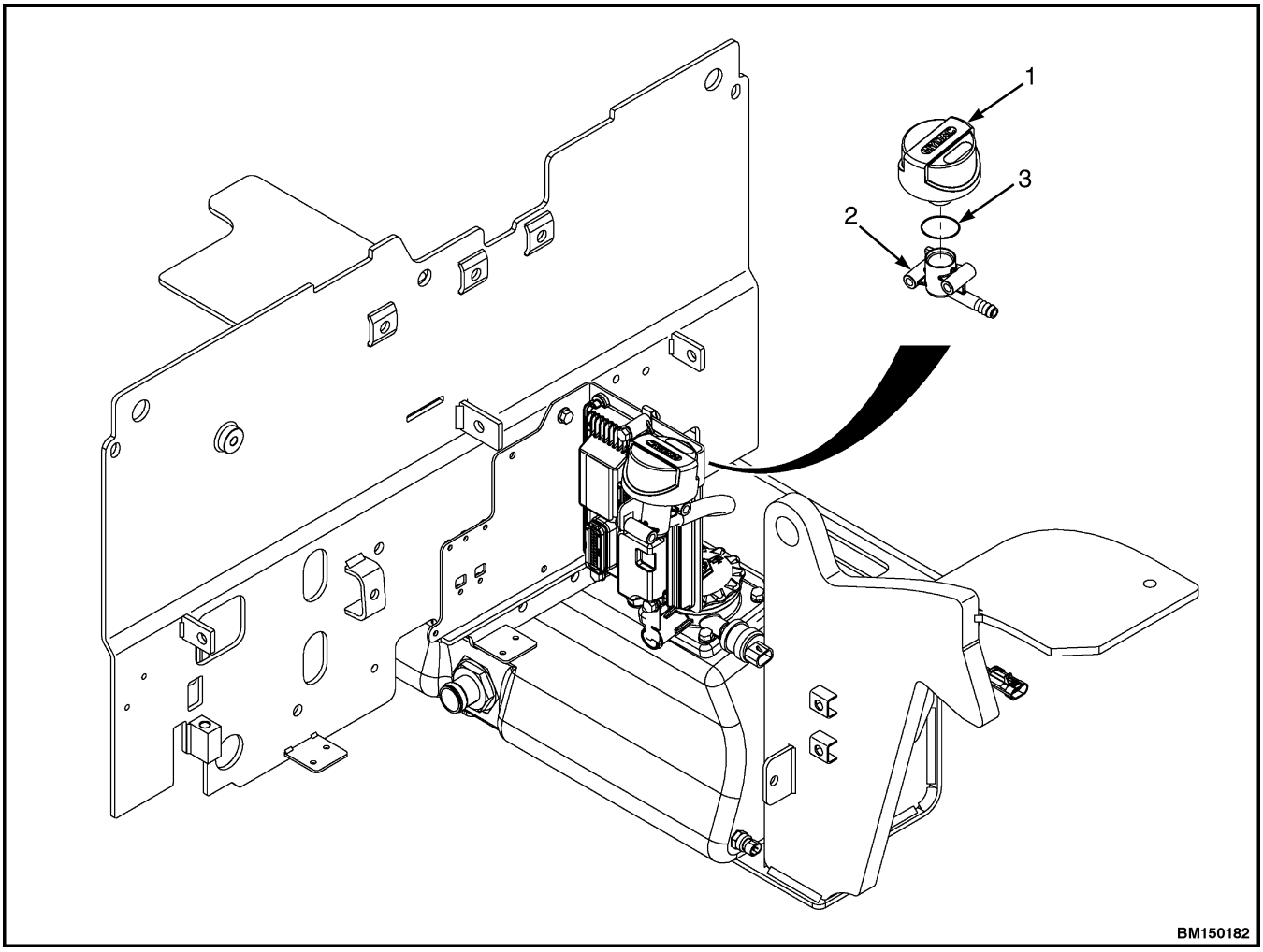
2. Remove breather from breather adapter. Discard O-ring. Plug breather adapter to prevent foreign material from entering hydraulic system.

See Figure 41 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268)

See Figure 42 for lift truck models

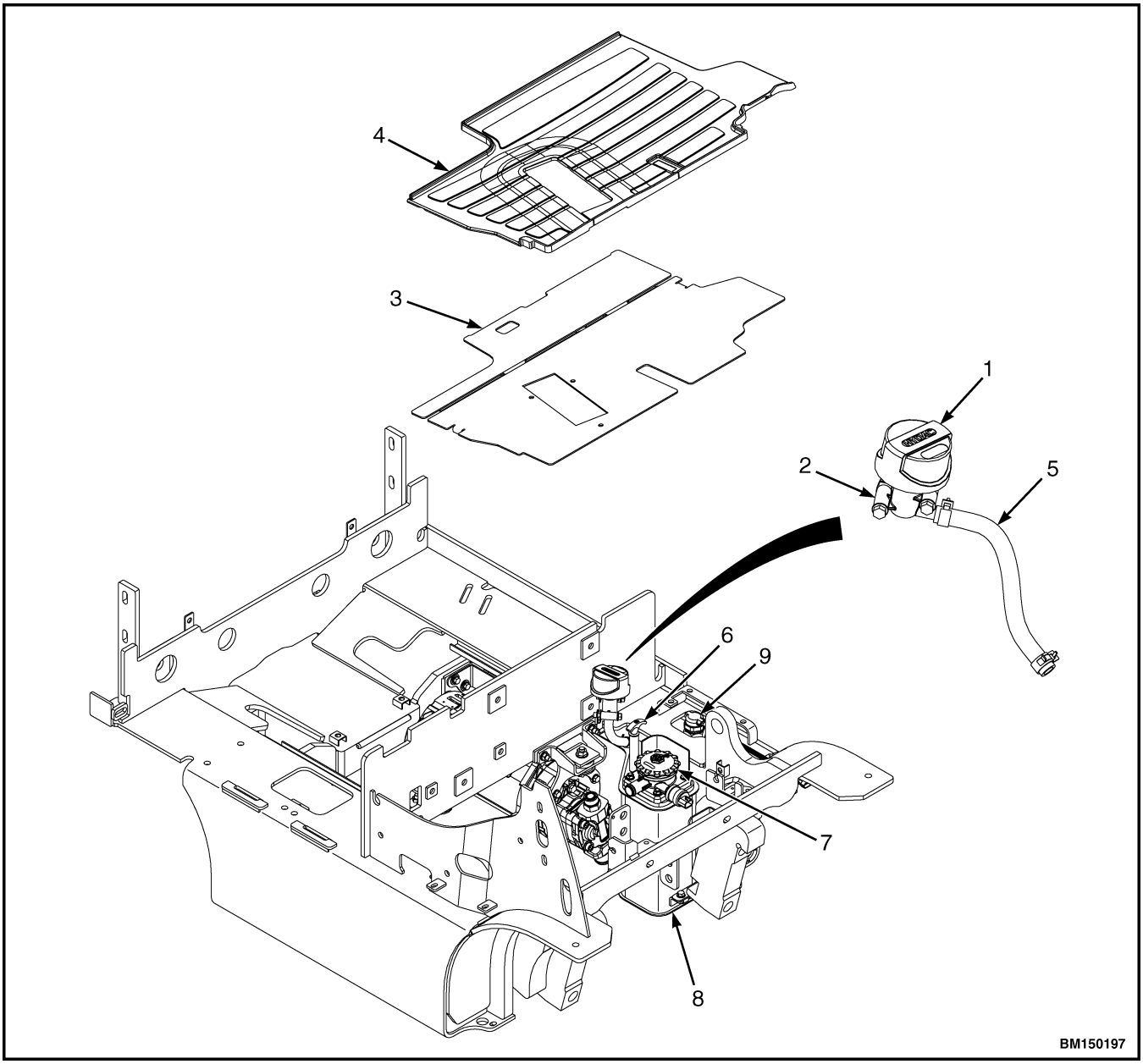
- E1.6-2.0XN (E30-40XN) (A269)



NOTE: METAL TANK SHOWN, NYLON TANK SIMILAR.

1. BREATHER
2. BREATHER ADAPTER
3. O-RING

Figure 41. Breather, Lift Truck Models E2.2-3.5XN (E45-70XN) (A268)



1. HYDRAULIC BREATHER
2. HYDRAULIC BREATHER ADAPTER
3. FLOOR PLATE
4. FLOOR MAT
5. HYDRAULIC BREATHER HOSE
6. DIPSTICK
7. HYDRAULIC OIL FILTER
8. HYDRAULIC TANK
9. HYDRAULIC TANK LEVEL SENSOR

Figure 42. Hydraulic Breather and Oil Fill for Lift Truck Models E1.6-2.0XN (E30-40XN) (A269)

WARNING

Cleaning solvents can be flammable and toxic, and can cause skin irritation. When using cleaning solvents, always follow the recommendations of the manufacturer.

WARNING

Compressed air can move particles so that they cause injury to the user or to other personnel. Make sure that the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eyes.

3. Wash breather in solvent and use compressed air to dry.
4. Inspect breather for wear or damage. Replace if damaged. See **Parts Manual** if new part is required.
5. Lubricate new O-ring with clean hydraulic oil and install on breather.

NOTE: Remove plugs during installation.

6. Install breather onto breather adapter.

   See Figure 41 for lift truck models
   - E2.2-3.5XN (E45-70XN) (A268)

   See Figure 42 for lift truck models
   - E1.6-2.0XN (E30-40XN) (A269)

7. Install floor plate and floor mats.

Lift Truck Models E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

1. Remove floor mats and floor plates for access to breather.
2. Remove breather from surge tank. Discard O-ring. Plug surge tank to prevent foreign material from entering hydraulic system. See Figure 30.

WARNING

Cleaning solvents can be flammable and toxic, and can cause skin irritation. When using cleaning solvents, always follow the recommendations of the manufacturer.

WARNING

Compressed air can move particles so that they cause injury to the user or to other personnel. Make sure that the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eyes.

3. Wash breather in solvent and use compressed air to dry.
4. Inspect breather for wear or damage. Replace if damaged. See **Parts Manual** if new part is required.
5. Lubricate new O-ring with clean hydraulic oil and install on breather.

NOTE: Remove plugs during installation.

6. Install breather onto surge tank. See Figure 30.
7. Install floor plate and floor mats.

Lift Truck Models J2.2-3.5XN (J45-70XN) (A276)

1. Remove tow pin from counterweight cover.
2. Remove two capscrews, two washers, and counterweight cover from counterweight.
3. Remove breather from hydraulic tank. Discard O-ring. Plug hydraulic tank to prevent foreign material from entering hydraulic system. See Figure 38.

WARNING

Cleaning solvents can be flammable and toxic, and can cause skin irritation. When using cleaning solvents, always follow the recommendations of the manufacturer.

WARNING

Compressed air can move particles so that they cause injury to the user or to other personnel. Make sure that the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eyes.

4. Wash breather in solvent and use compressed air to dry.

5. Inspect breather for wear or damage. Replace if damaged. See **Parts Manual** if new part is required.

6. Lubricate new O-ring with clean hydraulic oil and install on breather. See Figure 38.

NOTE: Remove plugs during installation.

7. Install breather on hydraulic tank.

8. Install counterweight cover, two washers, and two capscrews onto counterweight.

9. Install tow pin into counterweight cover and counterweight.

Lift Truck Models J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

1. Remove three capscrews and counterweight cover from counterweight.

2. Remove breather from hydraulic tank. Discard O-ring. See Figure 39. Plug hydraulic tank to prevent foreign material from entering hydraulic system.

WARNING

Cleaning solvents can be flammable and toxic, and can cause skin irritation. When using cleaning solvents, always follow the recommendations of the manufacturer.

WARNING

Compressed air can move particles so that they cause injury to the user or to other personnel. Make sure that the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eyes.

3. Wash breather in solvent and use compressed air to dry.

4. Inspect breather for wear or damage. Replace if damaged. See **Parts Manual** if new part is required.

5. Lubricate new O-ring with clean hydraulic oil and install on breather. See Figure 39.

NOTE: Remove plugs during installation.

6. Install breather on hydraulic tank.

7. Install counterweight cover and three capscrews onto counterweight.

HYDRAULIC OIL COOLER FOR LIFT TRUCK MODELS J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

1. Hydraulic oil cooler is an add-on option. See **Parts Manual** for components.

ADD HYDRAULIC OIL

Lift Truck Models E2.2-3.5XN (E45-70XN) (A268)

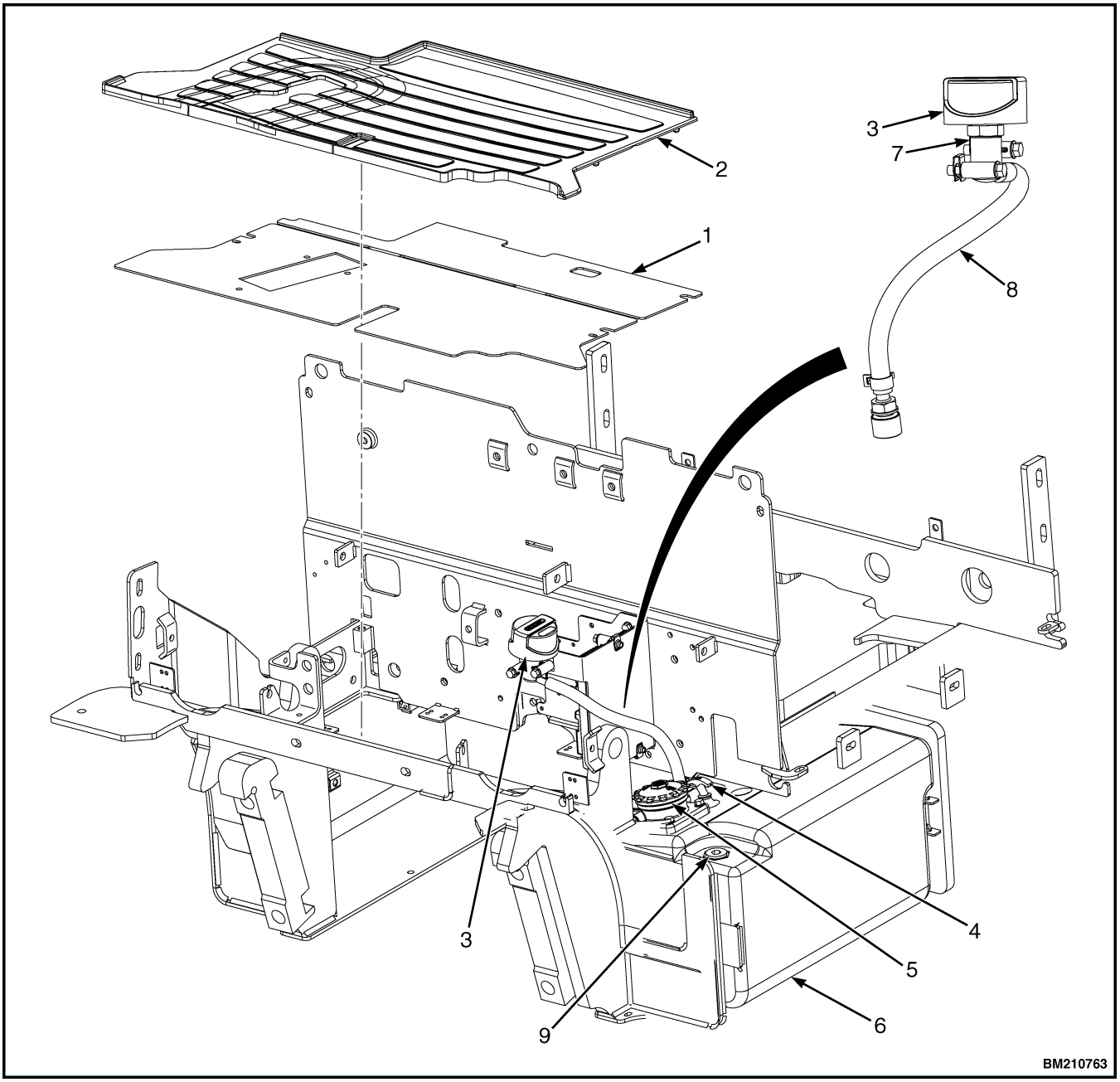
CAUTION

If hydraulic oil is white or milky, ALL hydraulic oil must be drained and replaced.

CAUTION

DO NOT fill tank above the FULL mark on dipstick. If tank is too full, oil will come out the breather during operation.

1. **If filling the tank with filtered oil:** remove hydraulic tank level sensor or tank level sensor plug and fill hydraulic tank with hydraulic oil. **If filling the tank with non-filtered oil:** remove hydraulic oil filter lid and fill tank through filter element. See **Periodic Maintenance** 8000SRM1364 for specified hydraulic oil. See Figure 43.



1. FLOOR PLATE
2. FLOOR MAT
3. BREATHER
4. DIPSTICK
5. HYDRAULIC OIL FILTER
6. HYDRAULIC TANK
7. HYDRAULIC BREATHER ADAPTER
8. HYDRAULIC BREATHER HOSE
9. HYDRAULIC TANK LEVEL SENSOR PLUG

Figure 43. Add Hydraulic Oil, Lift Truck Models E2.2-3.5XN (E45-70XN) (A268)

Lift Truck Models E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

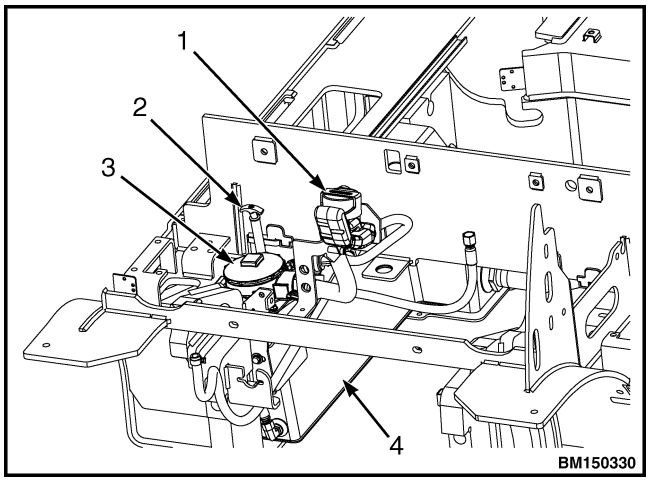
CAUTION

If hydraulic oil is white or milky, ALL hydraulic oil must be drained and replaced.

CAUTION

DO NOT fill tank above the FULL mark on dipstick. If tank is too full, oil will come out the breather during operation.

1. **If filling the tank with filtered oil:** remove hydraulic tank level sensor or tank level sensor plug and fill hydraulic tank with hydraulic oil. See Figure 30. **If filling the tank with non-filtered oil:** remove hydraulic oil filter lid and fill tank through filter element. See Figure 44. See **Periodic Maintenance** 8000SRM1577 for specified hydraulic oil.



1. BREATHER
2. DIPSTICK
3. HYDRAULIC OIL FILTER HOUSING
4. HYDRAULIC TANK

Figure 44. Add Hydraulic Oil, Lift Truck Models E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

Lift Truck Models E1.6-2.0XN (E30-40XN) (A269)

CAUTION

If hydraulic oil is white or milky, ALL hydraulic oil must be drained and replaced.

CAUTION

DO NOT fill tank above the FULL mark on dipstick. If tank is too full, oil will come out the breather during operation.

1. **If filling tank with filtered oil:** remove hydraulic tank level sensor or tank level sensor plug and fill hydraulic tank with hydraulic oil. **If filling tank with non-filtered oil:** remove hydraulic oil filter lid and fill tank through the filter element. See the **Operating Manual** or service manual **Periodic Maintenance** 8000SRM1442 for specified hydraulic oil. See Figure 42.

Lift Truck Models J2.2-3.5XN (J45-70XN) (A276)

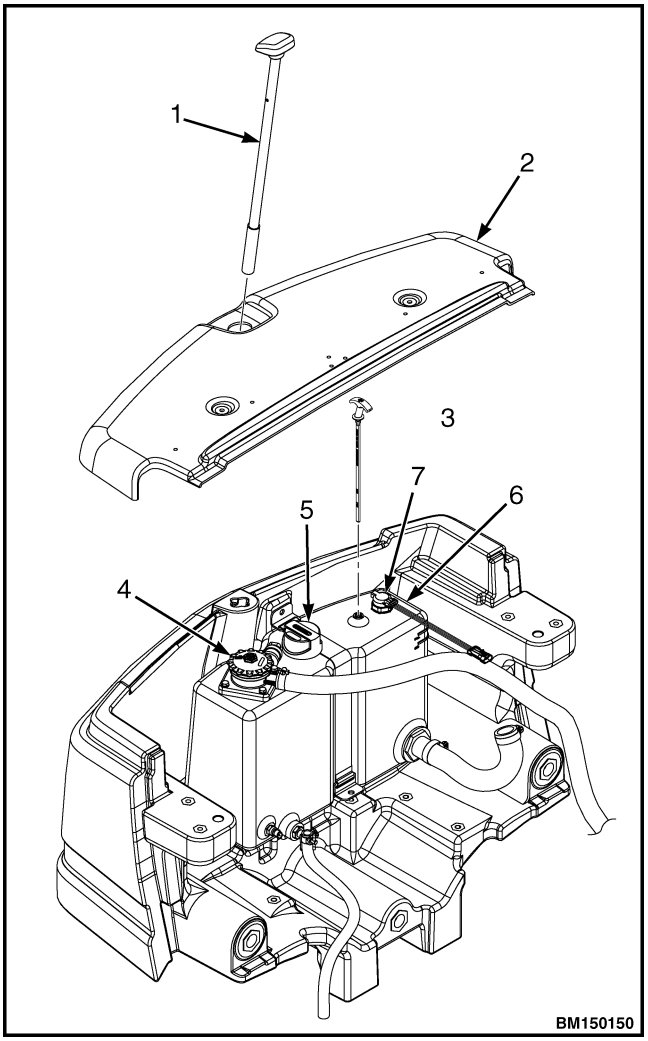
CAUTION

If hydraulic oil is white or milky, ALL hydraulic oil must be drained and replaced.

CAUTION

DO NOT fill tank above the FULL mark on dipstick. If tank is too full, oil will come out the breather during operation.

1. **If filling tank with filtered oil:** remove hydraulic tank level sensor or tank level sensor plug and fill hydraulic tank with hydraulic oil. **If filling tank with non-filtered oil:** remove hydraulic oil filter lid and fill tank through the filter element. See **Periodic Maintenance** 8000SRM1372 for specified hydraulic oil. See Figure 45.



NOTE: LIFT TRUCK MANUFACTURED PRIOR TO NOVEMBER, 2015 SHOWN. LIFT TRUCKS MANUFACTURED AFTER NOVEMBER, 2015 SIMILAR.

1. TOW PIN
2. COUNTERWEIGHT COVER
3. DIPSTICK
4. HYDRAULIC FILTER HOUSING
5. BREATHER
6. HYDRAULIC TANK
7. HYDRAULIC TANK LEVEL SENSOR

Figure 45. Add Hydraulic Oil, Lift Truck Models J2.2-3.5XN (J45-70XN) (A276)

Lift Truck Models J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

CAUTION

If hydraulic oil is white or milky, ALL hydraulic oil must be drained and replaced.

CAUTION

DO NOT fill tank above the FULL mark on dipstick. If tank is too full, oil will come out the breather during operation.

1. **If filling the tank with filtered oil:** remove the hydraulic tank level sensor of tank level sensor plug and fill hydraulic tank with hydraulic oil. **If filling the tank with non-filtered oil:** remove hydraulic oil filter land fill the tank through the filter element. See **Periodic Maintenance** 8000SRM1541 for specified hydraulic oil. See Figure 46.

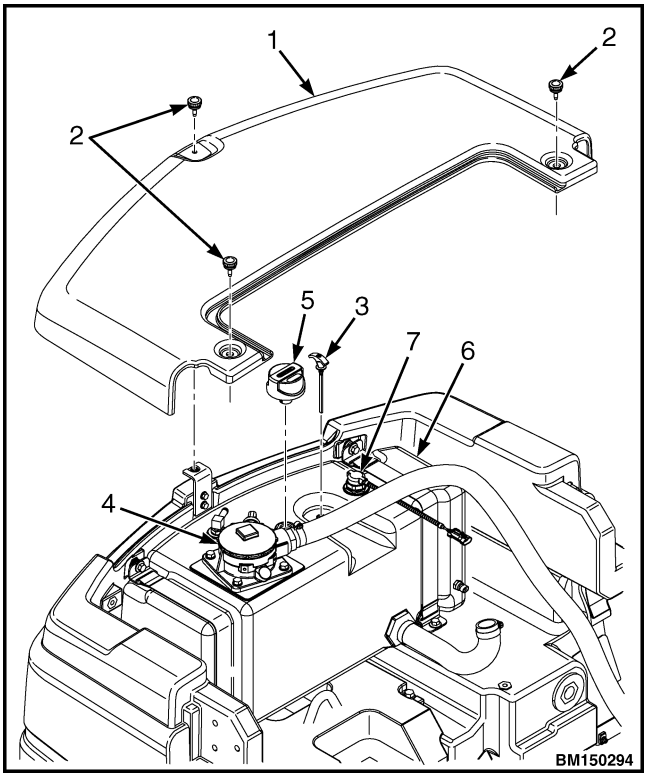


Figure 46. Add Hydraulic Oil, Lift Truck Models J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

Legend for Figure 46

1. COUNTERWEIGHT COVER
2. CAPSCREW
3. DIPSTICK
4. HYDRAULIC FILTER HOUSING
5. BREATHER
6. HYDRAULIC TANK
7. HYDRAULIC TANK LEVEL SENSOR

Steer Accumulator Replacement

NOTE: The information in this section applies to lifts trucks manufactured **before** October, 2013 and lift trucks not equipped with optional synchronous steering feature.

REMOVE

1. Block front and rear sides of wheels to make sure lift truck cannot move.

2. Remove floor mat and floor plates from lift truck.

NOTE: Note orientation of steer supply fitting prior to removal to aid in install.

3. Disconnect steer accumulator hose from main control valve steer supply fitting. Remove steer supply fitting from main control valve port; remove and discard O-ring from fitting. Plug port to prevent foreign material from entering hydraulic system.

See Figure 47 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268)
- J2.2-3.5XN (J45-70XN) (A276), manufactured before September, 2012 or after June, 2015
- J4.0-5.0XN (J80-100XN) (A970), manufactured before November, 2014

See Figure 48 for lift truck model

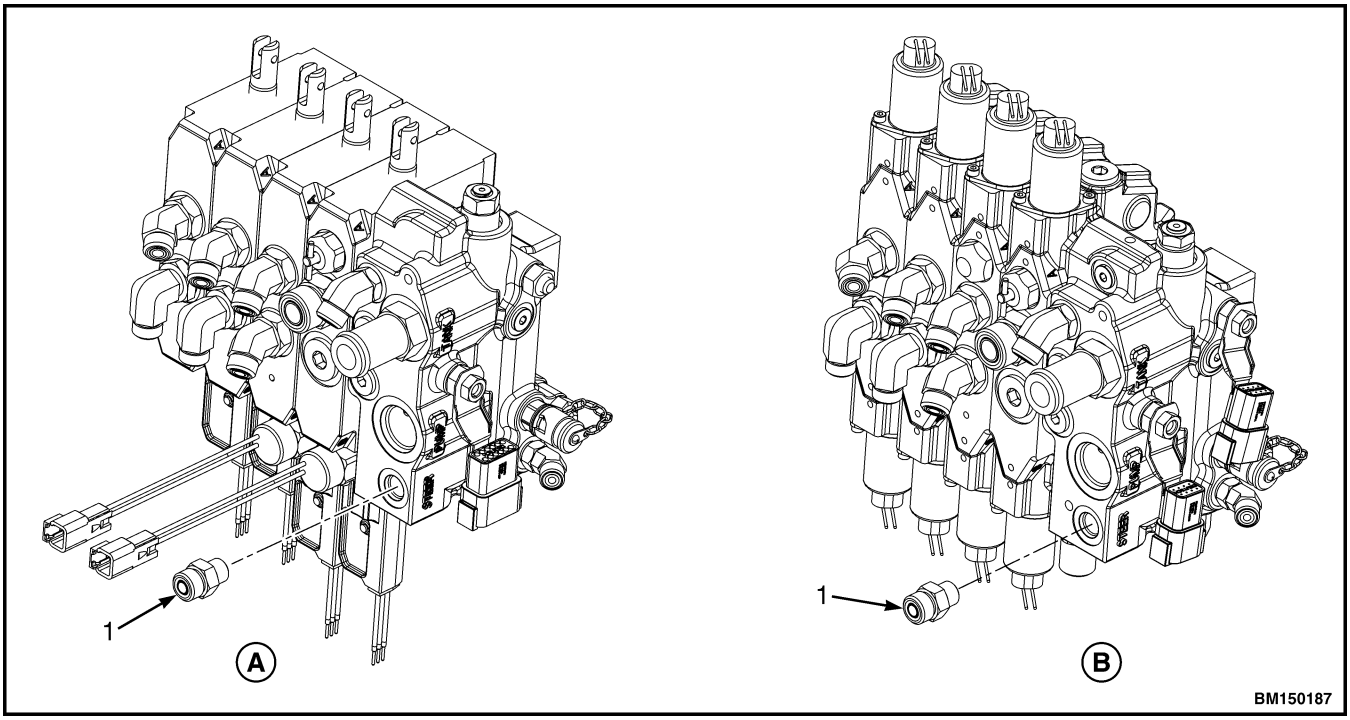
- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970), manufactured after November, 2014

See Figure 49 for lift truck models

- E1.6-2.0XN (E30-40XN) (A269)

See Figure 50 for lift truck model

- E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)



A. MANUAL CONTROL VALVE

B. E-HYDRAULIC CONTROL VALVE

1. STEER SUPPLY FITTING

Figure 47. Steer Accumulator Control Valve Connection, Lift Truck Models E2.2-3.5XN (E45-70XN) (A268), J2.2-3.5XN (J45-70XN) (A276) Manufactured Before September, 2012 or After June, 2015, and J4.0-5.0XN (J80-100XN) (A970) Manufactured before November, 2014

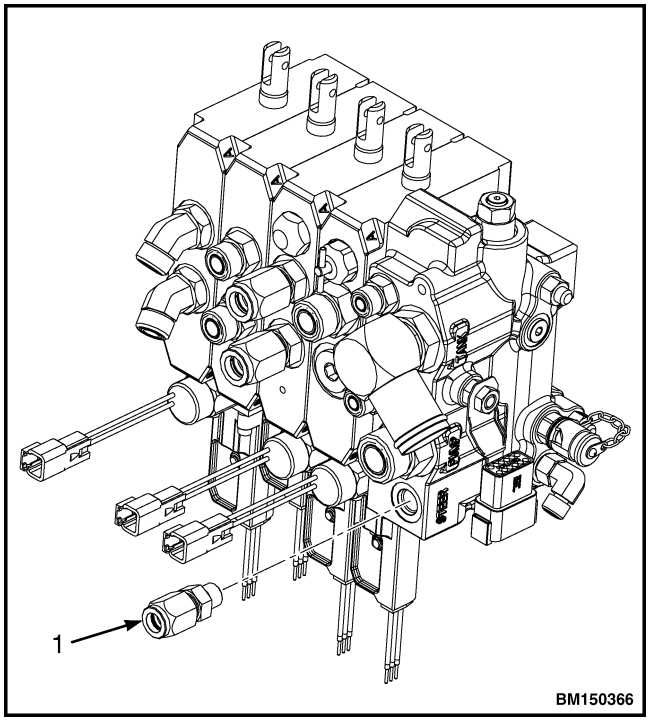
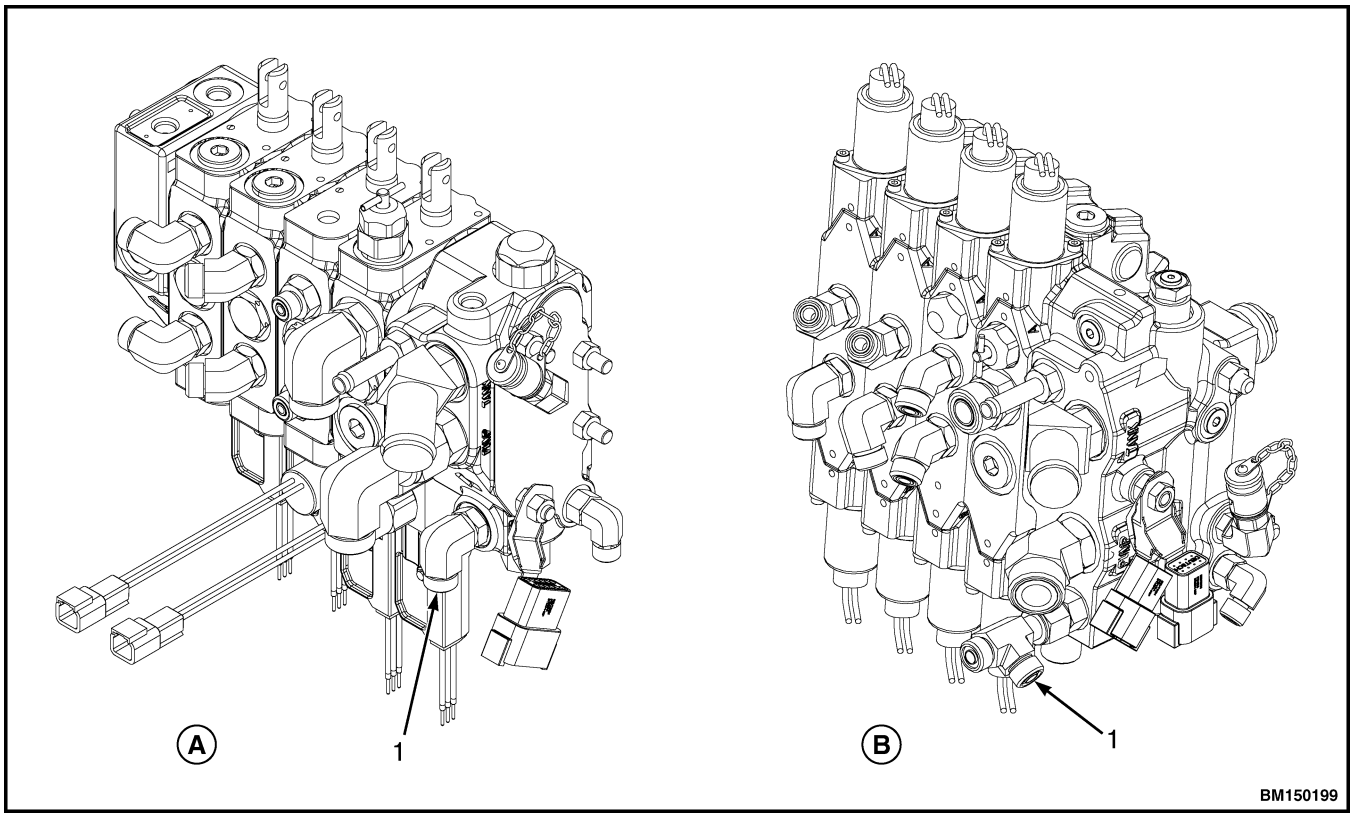


Figure 48. Steer Accumulator Control Valve Connection, Lift Truck Models J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) Manufacutred After November, 2014

Legend for Figure 48

1. STEER SUPPLY FITTING

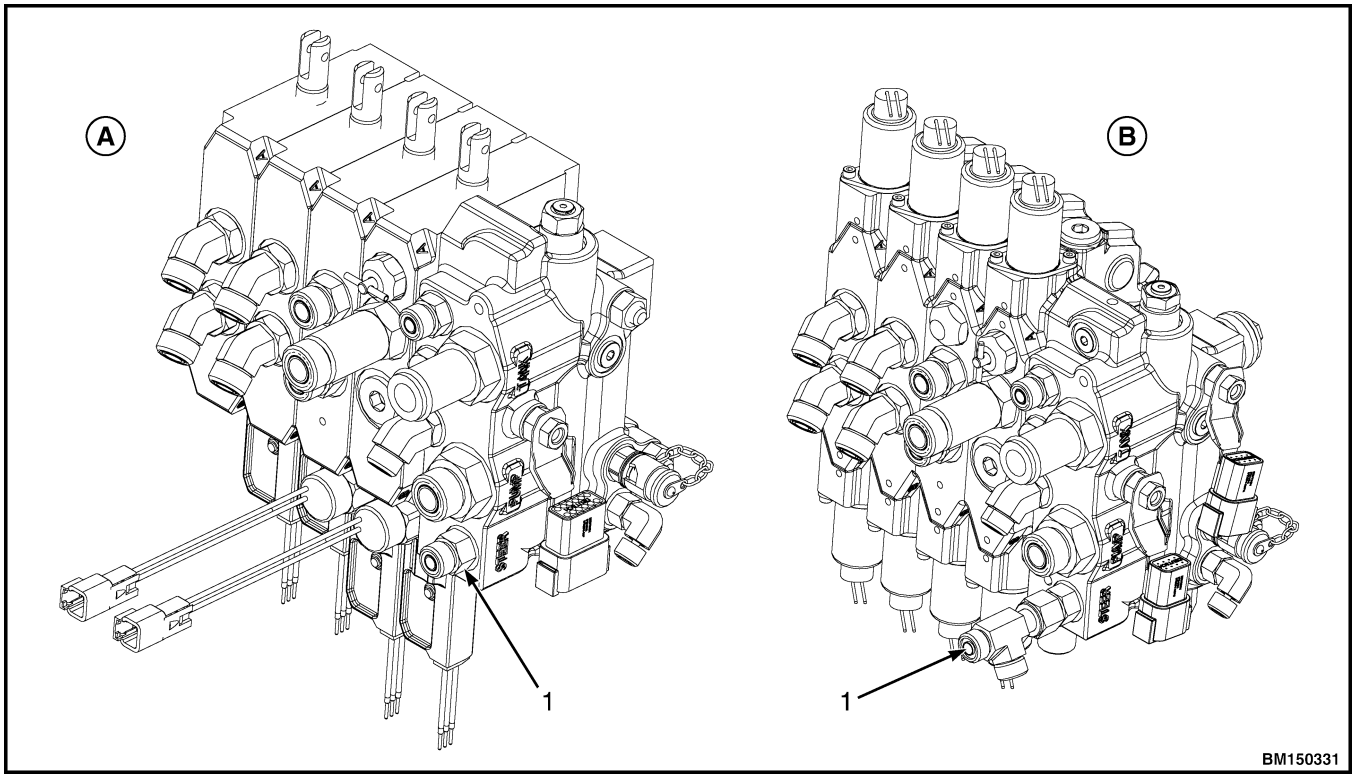


A. MANUAL CONTROL VALVE

B. E-HYDRAULIC CONTROL VALVE

1. STEER SUPPLY FITTING

Figure 49. Steer Accumulator Control Valve Connection, Lift Truck Models E1.6-2.0XN (E30-40XN) (A269)



A. MANUAL CONTROL VALVE

B. E-HYDRAULIC CONTROL VALVE

1. STEER SUPPLY FITTING

Figure 50. Steer Accumulator Control Valve Connection, Lift Truck Model E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

4. Remove two nuts, two capscrews, and steer accumulator with clamps from bracket.

See Figure 51 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268)
- J2.2-3.5XN (J45-70XN) (A276), manufactured before September, 2012 or after June, 2015

See Figure 52 for lift truck models

- E1.6-2.0XN (E30-40XN) (A269)

See Figure 53 for lift truck models

- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

See Figure 54 for lift truck models

- E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

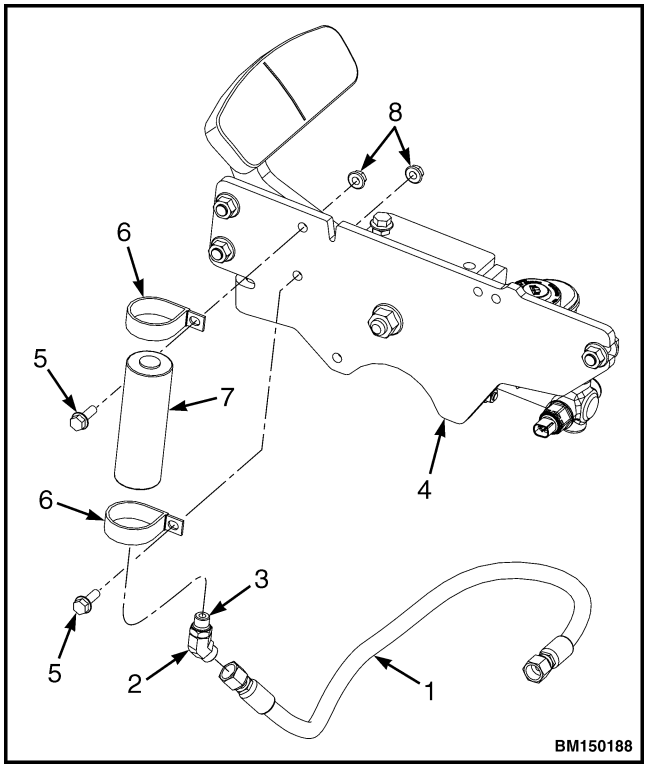
5. Disconnect steer accumulator hose from steer accumulator fitting.

6. Remove steer accumulator fitting from bottom of steer accumulator.

7. Remove and discard O-ring from steer accumulator fitting.

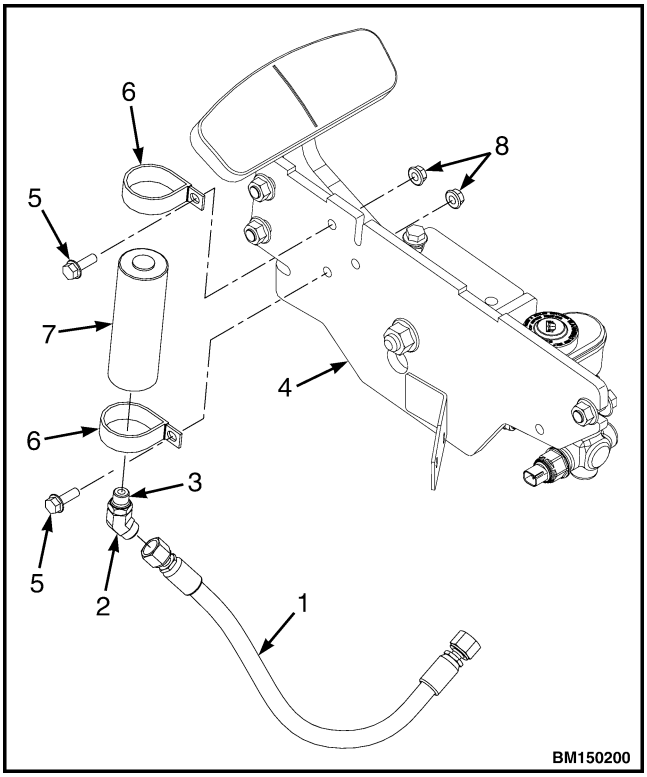
NOTE: Steer accumulator is **NOT** rechargeable.

8. Remove two clamps from steer accumulator. Discard steer accumulator.



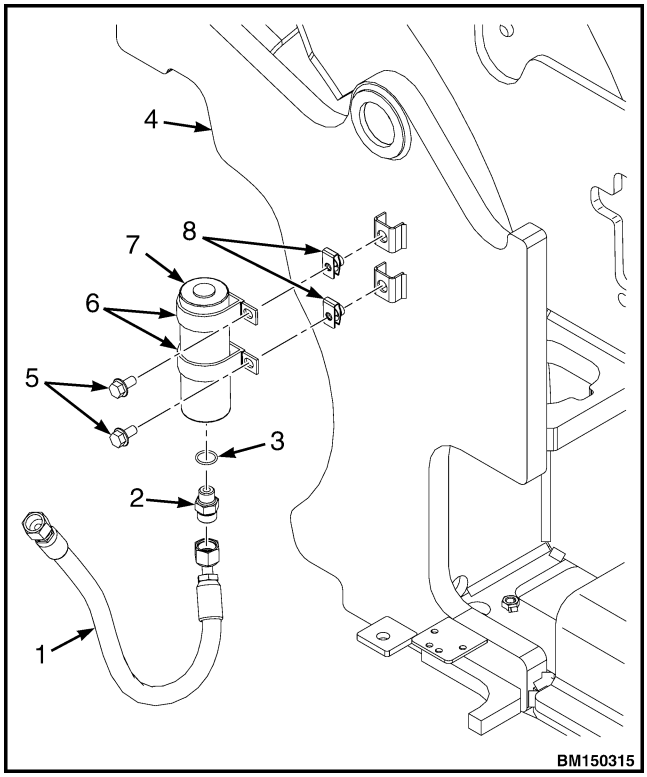
1. STEER ACCUMULATOR HOSE
2. STEER ACCUMULATOR FITTING
3. O-RING
4. BRACKET
5. CAPSCREW
6. CLAMP
7. STEER ACCUMULATOR
8. NUT

Figure 51. Steer Accumulator, Lift Truck Models E2.2-3.5XN (E45-70XN) (A268) and J2.2-3.5XN (J45-70XN) (A276) Manufactured Before September, 2012 or After June, 2015



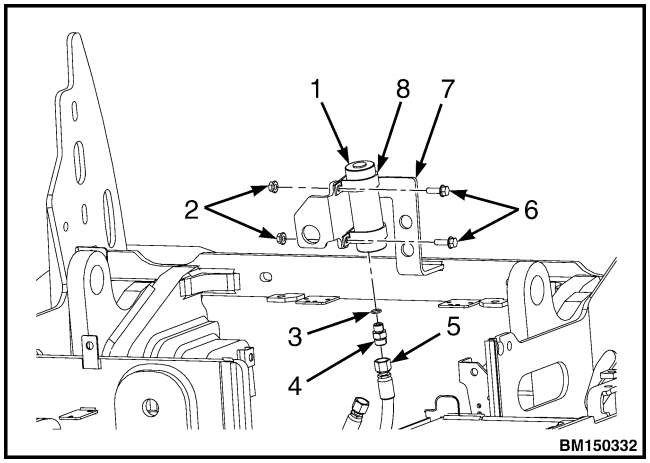
1. STEER ACCUMULATOR HOSE
2. STEER ACCUMULATOR FITTING
3. O-RING
4. BRACKET
5. CAPSCREW
6. CLAMP
7. STEER ACCUMULATOR
8. NUT

Figure 52. Steer Accumulator, Lift Truck Models E1.6-2.0XN (E30-40XN) (A269)



1. STEER ACCUMULATOR HOSE
2. STEER ACCUMULATOR FITTING
3. O-RING
4. BRACKET
5. CAPSCREW
6. CLAMP
7. STEER ACCUMULATOR
8. NUT

Figure 53. Steer Accumulator, Lift Truck Models J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)



1. STEER ACCUMULATOR
2. NUT
3. O-RING
4. STEER ACCUMULATOR FITTING
5. STEER ACCUMULATOR HOSE
6. CAPSCREW
7. BRACKET
8. CLAMP

Figure 54. Steer Accumulator, Lift Truck Model E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

INSTALL

1. Install two clamps onto new steer accumulator.

See Figure 51 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268)
- J2.2-3.5XN (J45-70XN) (A276), manufactured before September, 2012 or after June, 2015

See Figure 52 for lift truck models

- E1.6-2.0XN (E30-40XN) (A269)

See Figure 53 for lift truck models

- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

See Figure 54 for lift truck model

- E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

2. Install new O-ring onto steer accumulator fitting.

3. Install steer accumulator fitting into bottom of steer accumulator.

4. Install steer accumulator with clamps, two capscrews, and two nuts onto bracket. Tighten nuts to 25 N•m (221 lbf in).

5. Connect steer accumulator hose to steer accumulator fitting.

6. Install new O-ring onto steer supply fitting; install steer supply fitting into main control valve port as noted during removal.

See Figure 47 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268)
- J2.2-3.5XN (J45-70XN) (A276), manufactured before September, 2012 or after June, 2015
- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970), manufactured before November, 2014

See Figure 49 for lift truck models

- E1.6-2.0XN (E30-40XN) (A269)

See Figure 48 for lift truck models

- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970), manufactured after November, 2014

See Figure 50 for lift truck model

- E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

7. Connect steer accumulator hose to steer supply fitting.

8. Install floor plates and floor mat into lift truck.

9. Remove blocks from front and rear sides of wheels.

Specifications for Lift Truck E2.2-3.5XN (E45-70XN) (A268)

TANK CAPACITY

Dipstick FULL Mark - Nylon Tank
33.0 liter (35.0 qt)

Dipstick FULL Mark - Metal Tank
35.0 liter (37.0 qt)

Table 1. Hydraulic Pump Motor

Pump Displacement	Relief Pressure	Max. Peak Pressure	Speed	Voltage
19 CC	20.6 MPa (2988 psi)	24.5 MPa (3553 psi)	300 to 3000 RPM	36/48 and 72/80 Volts

Specifications for Lift Truck E1.6-2.0XN (E30-40XN) (A269)

TANK CAPACITY

30.0 liter (32.0 qt)

Dipstick FULL Mark

Table 2. Hydraulic Pump Motor

Pump Displacement	Relief Pressure	Max. Peak Pressure	Speed	Voltage
22 CC	20.6 MPa (2988 psi)	24.5 MPa (3553 psi)	300 to 3000 RPM	36/48 Volts

Specifications for Lift Truck J2.2-3.5XN (J45-70XN) (A276)

TANK CAPACITY

33.0 liter (35.0 qt)

Dipstick FULL Mark

Table 3. Hydraulic Pump Motor

Pump Displacement	Relief Pressure	Max. Peak Pressure	Speed	Voltage
19 CC	20.6 MPa (2988 psi)	24.5 MPa (3553 psi)	300 to 3000 RPM	72/80 Volts
20 CC	20.6 MPa (2988 psi)	25.4 MPa (3684 psi)	600 to 3000 RPM	72/80 Volts

Specifications for Lift Truck J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

TANK CAPACITY

57.0 liter (60.2 qt)

Dipstick FULL Mark

Table 4. Hydraulic Pump Motor

Pump Displacement	Relief Pressure	Max. Peak Pressure	Speed	Voltage
33 CC	20.6 MPa (2988 psi)	24.5 MPa (3553 psi)	300 to 3000 RPM	72/80 Volts

Specifications for Lift Truck E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

TANK CAPACITY

62.0 liter (65.5 qt)

Dipstick FULL Mark

Table 5. Hydraulic Pump Motor

Pump Displacement	Relief Pressure	Max. Peak Pressure	Speed	Voltage
33 CC	20.6 MPa (2988 psi)	24.5 MPa (3553 psi)	300 to 3000 RPM	72/80 Volts

Torque Specifications for Lift Truck E2.2-3.5XN (E45-70XN) (A268)

HYDRAULIC PUMP AND MOTOR

Pump Flange Head Screws
88 to 98 N•m (65 to 72 lbf ft)

Setscrews
11 to 13 N•m (97 to 115 lbf in)

Pump to Motor Capscrews
25 N•m (221 lbf in)

Suction Hose Adapter to Hydraulic Pump
91 to 100 N•m (67 to 74 lbf ft)

Pressure Line Fitting to Hydraulic Pump
49 to 59 N•m (36 to 44 lbf ft)

Motor Mount Capscrews
12 N•m (106 lbf in)

Motor Power Cable Nuts
24 N•m (212 lbf in)

HYDRAULIC TANK

Drain Plug
40 N•m (30 lbf ft)

Temperature Sensor
19 to 21 N•m (168 to 186 lbf in)

Suction Strainer
135 N•m (100 lbf ft)

Filter Housing Capscrews
10 N•m (86 lbf in)

Fitting
45 N•m (33 lbf ft)

Tank Level Sensor
4 to 7 N•m (35 to 62 lbf in)

Pressure Switch
25 N•m (221 lbf in)

Breather Adapter Mounting Capscrews
25 N•m (221 lbf in)

Torque Specifications for Lift Truck E1.6-2.0XN (E30-40XN) (A269)

HYDRAULIC PUMP AND MOTOR

Pump Flange Head Screws
88 to 98 N•m (65 to 72 lbf ft)

Pump to Motor Capscrews
25 N•m (221 lbf in)

Suction Hose Adapter to Hydraulic Pump
91 to 100 N•m (67 to 74 lbf ft)

Pressure Line Fitting to Hydraulic Pump
49 to 59 N•m (36 to 44 lbf ft)

Motor to Mounting Bracket Capscrews
19 N•m (168 lbf in)

Motor Power Cable Nuts
14 to 16 N•m (124 to 142 lbf in)

Motor Mounting Bolts
60 to 70 N•m (44 to 52 lbf ft)

HYDRAULIC TANK

Drain Plug
40 N•m (30 lbf ft)

Suction Strainer
135 N•m (100 lbf ft)

Filter Housing Capscrews
15 N•m (133 lbf in)

Tank Level Sensor Fitting
45 N•m (33 lbf ft)

Tank Level Sensor
4 to 7 N•m (35 to 62 lbf in)

Pressure Switch
25 N•m (221 lbf in)

Breather Adapter Mounting Capscrews
25 N•m (221 lbf in)

Torque Specifications for Lift Truck J2.2-3.5XN (J45-70XN) (A276)

HYDRAULIC PUMP AND MOTOR

Pump Flange Head Screws
88 to 98 N•m (65 to 72 lbf ft)

Pump to Motor Capscrews
25 N•m (221 lbf in)

Suction Hose Adapter to Hydraulic Pump
91 to 100 N•m (67 to 74 lbf ft)

Pressure Line Fitting to Hydraulic Pump
49 to 59 N•m (36 to 44 lbf ft)

Motor to Pump End Motor Mount Bracket
19 N•m (168 lbf in)

Motor Power Cable Nuts
24 N•m (212 lbf in)

HYDRAULIC TANK

Drain Valve
40 N•m (30 lbf ft)

Temperature Sensor
19 to 21 N•m (168 to 186 lbf in)

Suction Strainer
135 N•m (100 lbf ft)

Filter Housing Capscrews
10 N•m (86 lbf in)

Fitting
45 N•m (33 lbf ft)

Tank Level Sensor
4 to 7 N•m (35 to 62 lbf in)

Breather
10 N•m (89 lbf in)

Pressure Switch
4 to 7 N•m (35 to 61 lbf in)

Torque Specifications for Lift Truck J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

HYDRAULIC PUMP AND MOTOR

Pump Flange Head Screws
88 to 98 N•m (65 to 72 lbf ft)

Pump to Motor Capscrews
25 N•m (221 lbf in)

Suction Hose Adapter to Hydraulic Pump
91 to 100 N•m (67 to 74 lbf ft)

Pressure Line Fitting to Hydraulic Pump
78 to 88 N•m (58 to 65 lbf ft)

Motor to Pump End Motor Mount Bracket
19 N•m (168 lbf in)

Motor Power Cable Nuts
24 N•m (212 lbf in)

Motor Mount Bracket to Counterweight
60 to 70 N•m (44 to 52 lbf ft)

HYDRAULIC TANK

Temperature Sensor
19 to 21 N•m (168 to 186 lbf in)

Suction Strainer
135 N•m (100 lbf ft)

Filter Housing Capscrews
15 N•m (133 lbf in)

Fitting
40 N•m (30 lbf ft)

Tank Level Sensor Fitting
45 N•m (33 lbf ft)

Tank Level Sensor
4 to 7 N•m (35 to 62 lbf in)

Breather
10 N•m (89 lbf in)

Pressure Switch
12 N•m (106 lbf in)

Torque Specifications for Lift Truck E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

HYDRAULIC PUMP AND MOTOR

Pump to Motor Capscrews
25 N•m (221 lbf in)

Suction Hose Adapter to Hydraulic Pump
91 to 100 N•m (67 to 74 lbf ft)

Motor to Mount Bracket Capscrews
19 N•m (168 lbf in)

Motor Mount Bracket to Frame Capscrews
60 to 70 N•m (44 to 52 lbf in)

Power Cable Nuts
24 N•m (212 lbf in)

High Pressure Fitting to Hydraulic Pump
78 to 88 N•m (58 to 65 lbf ft)

HYDRAULIC TANK

Drain Plug
40 N•m (30 lbf ft)

Suction Strainer
135 N•m (100 lbf ft)

Hydraulic Filter Housing Nuts
15 N•m (133 lbf in)

Pressure Switch
25 N•m (221 lbf in)

Vent Fitting to Hydraulic Tank
40 to 43 N•m (30 to 32 lbf ft)

Brake Hose Fitting to Hydraulic Tank
68 to 78 N•m (50 to 58 lbf ft)

Hydraulic Tank Level Sensor
4 to 7 N•m (35 to 62 lbf in)

NOTES

HYDRAULIC CLEANLINESS PROCEDURES

HYSTER

PART NO. 4075393

1900 SRM 1620

SAFETY PRECAUTIONS
MAINTENANCE AND REPAIR

- The Service Manuals are updated on a regular basis, but may not reflect recent design changes to the product. Updated technical service information may be available from your local authorized Hyster® dealer. Service Manuals provide general guidelines for maintenance and service and are intended for use by trained and experienced technicians. Failure to properly maintain equipment or to follow instructions contained in the Service Manual could result in damage to the products, personal injury, property damage or death.
- When lifting parts or assemblies, make sure all slings, chains, or cables are correctly fastened, and that the load being lifted is balanced. Make sure the crane, cables, and chains have the capacity to support the weight of the load.
- Do not lift heavy parts by hand, use a lifting mechanism.
- Wear safety glasses.
- DISCONNECT THE BATTERY CONNECTOR before doing any maintenance or repair on electric lift trucks. Disconnect the battery ground cable on internal combustion lift trucks.
- Always use correct blocks to prevent the unit from rolling or falling. See HOW TO PUT THE LIFT TRUCK ON BLOCKS in the **Operating Manual** or the **Periodic Maintenance** section.
- Keep the unit clean and the working area clean and orderly.
- Use the correct tools for the job.
- Keep the tools clean and in good condition.
- Always use **HYSTER APPROVED** parts when making repairs. Replacement parts must meet or exceed the specifications of the original equipment manufacturer.
- Make sure all nuts, bolts, snap rings, and other fastening devices are removed before using force to remove parts.
- Always fasten a DO NOT OPERATE tag to the controls of the unit when making repairs, or if the unit needs repairs.
- Be sure to follow the **WARNING** and **CAUTION** notes in the instructions.
- Gasoline, Liquid Petroleum Gas (LPG), Compressed Natural Gas (CNG), and Diesel fuel are flammable. Be sure to follow the necessary safety precautions when handling these fuels and when working on these fuel systems.
- Batteries generate flammable gas when they are being charged. Keep fire and sparks away from the area. Make sure the area is well ventilated.

NOTE: The following symbols and words indicate safety information in this manual:

WARNING

Indicates a hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION

Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury and property damage.

On the lift truck, the WARNING symbol and word are on orange background. The CAUTION symbol and word are on yellow background.

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This section is for the following models:

Proper Flushing after Major Hydraulic Repairs

INTRODUCTION

Hyster lift truck operators/owners sometimes blame component quality for failures of costly hydraulic pumps and control valves when in fact these failures are cause by system contamination. There are several potential causes for the system contamination:

- Improper fluid flushing after a repair is completed.
- In an effort to minimize downtime, a technician may not complete a thorough clean up procedure.
- The technician may not have the ability to remove contaminants from the hydraulic system after completing repairs.
- The technician may not have any visibility of the oil cleanliness level before or after necessary repairs.

With proper equipment, having instant visibility to oil cleanliness and the ability to remove fluid contaminants is feasible. Technicians will be able to accomplish successful repairs and thoroughly clean the system utilizing filter caddies combined with sponge launchers. Hydraulic pumps and control valves will operate as designed and reach their intended life expectancy.

THE PHASES OF WEAR

Wear starts the day the lift truck is put into operation. See Table 1. Some wear can be detected through condition-based maintenance practices and some are undetectable. While lift trucks operate normally as they get older, some wear becomes visible during standard maintenance practices. Oil analysis provides the opportunity to determine potential areas of concern. At this point in the wear phase, it is possible to keep the system operating normally and allow the components to survive. When the system reaches the point of no return, it means that too much wear has occurred and component replacement or an overhaul becomes the only solution. The service technician's task is to monitor the systems and modify them when contamination or wear is detected. This can be accomplished with condition based maintenance practices and the use of conditioning units like the filter caddy discussed below. A well-designed oil analysis program should enable these common problems to be detected before a flush is required. When successful, nothing more than an oil change may be required. The effectiveness in catching common flush precursors depends on oil samples being taken at the optimum frequency and the proper use of laboratory screening tests.

Table 1. Phases of Wear

<table>
<tr><td colspan="5">⇒⇒⇒⇒⇒⇒⇒TIME⇒⇒⇒⇒⇒⇒⇒</td></tr>
<tr><td>Operating Normal</td><td>Operating Normal</td><td>Some Symptoms Appear</td><td>Performance Issues</td><td>Failure</td></tr>
<tr><td rowspan="3">Non detectable wear</td><td rowspan="2">Some wear detectable through fluid analysis</td><td colspan="3">Point of no return ⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒</td></tr>
<tr><td>Visible wear, changes in behavior</td><td>Very visible symptoms and wear</td><td>Forensics</td></tr>
<tr><td colspan="4">Objective is to increase the operating time with non detectable wear through standard maintenance practices, including conditioning units (filter caddy) and an oil analysis program.</td></tr>
</table>

CAUSES OF HYDRAULIC SYSTEM FAILURE

Industry statistics show that 70-80% of hydraulic failure are not caused by design flaws, but by contaminants, water, or lubricant degradation.

Contaminants are produced in different ways:

1 Introduced through poor maintenance and service procedures.
   - Introduced when adding fluids.
   - When replacing failed components.
   - Poor shop cleanliness, dirty spare parts storage, dirty rags.

2 Ingression of contamination.
   - Leaky cylinder wiper seals.
   - Reservoir vents with poorly maintained breather filters.

3 Generated internally due to wear and part failure.

4 Chemical reactions between the lubricant additives, water, air, heat, and metallic particles.

Contaminants are not limited to solid particles. Air, water and high temperatures are also contaminants. Chemical reactions between lubricant additives and water can produce chemical sub-products that could be corrosive to vital components inside the hydraulic system. These same chemical reactions could also destroy oil film strength where it is most needed.

Hydraulic systems on Hyster lift trucks are designed to provide many years of trouble free service. However, there may be times when the system's internal environment, in which the hydraulic components work, has been altered by some contaminant or contaminants that are not detected in time and the system's own filtration mechanism is unable to handle. Preventative maintenance programs that include scheduled oil analysis can detect these system changes.

The second series of events occur when the technician, not aware of the micro-world on which the hydraulic system is so dependent, limits corrective actions to replacing the most affected component and oil from the reservoir. This leaves behind millions of destructive particles lodged in lines, valves, coolers and crevices. The results are premature failure of the main component and even greater levels of contamination.

PROGRESSION OF CONTAMINANT CAUSED HYDRAULIC SYSTEM FAILURE

High contaminant particle counts tend to erode soft metals and increase wear on all moving parts. Also, chemical reactions between additives and water or incompatible oils cause etching. Etching reduces pump efficiency and increases internal leaks, which causes high temperatures. High temperatures reduce oil additive life and destroy further ability of the lubricant to separate parts in motion.

Metallic particles act as catalysts that contribute to rapid oxidation of the lubricant. The destructive pattern has begun and total failure of the most active components is probable.

After the failure of a major component (pump or cylinder) millions of metallic particles, as well as fibers and contaminated oil, settle in every corner of the hydraulic system. **Replacing the oil from the reservoir accomplishes only one-third of the process required to restore the system.**

HYDRAULIC SYSTEM FLUSHING TECHNIQUES

Techniques for flushing hydraulic systems vary in cost and complexity. Before discussing some of these methods, let's first distinguish between **Flushing the Fluid** and **Flushing the System**.

- The objective of **Flushing the Fluid**, commonly referred to as Fluid Conditioning, is to eliminate contaminants such as particles and water. This is usually accomplished using a filter caddy or by diverting system flow through an external fluid-conditioning tool.
- The objective of **Flushing the System** is to eliminate sludge, varnish, debris and contaminated or degraded fluid from the reservoir, conductor walls, other component internal surfaces and system dead spots.

The technique or combination of techniques selected will depend on the type of system and its size, your reliability objectives for the equipment and the reason for the flush.

Double Oil and Filter Change

CAUTION

There is risk of secondary failures in steering control units and control valves if residual contaminants are not removed from the system.

NOTE: This procedure should only be used for lightly contaminated systems or degraded fluid and not for systems that have experienced major component failures.

NOTE: The installation of large volumes of new oil and disposal of the contaminated oil can be costly. If the oil is not degraded, this is a waste of oil since it is contaminated but not degraded. The filter caddy can be used to "condition the fluid" by removing the particles and water.

This technique involves an initial oil drain and filter change, which removes a large percentage of contaminants and degraded fluid. The system is then filled with pre-filtered oil and the fluid circulated at low pressure until operating temperature is reached, each hydraulic function has been operated three full cycles, and the fluid has been turned over at least five times.

The oil is drained, system refilled with filtered oil and the filters changed a second time. After the fluid has been circulated, each circuit operated three full cycles, and the system warmed to operating temperature, an appropriate oil sample should be taken to determine the success of the flush.

Mechanical Cleaning

The use of mechanical cleaning after a major pump or cylinder failure must be incorporated in the flushing strategy. This involves the use of a pneumatic projectile gun and sponge projectiles to clean tubes and hoses. It also involves disassembly of other components for cleaning using brushes and clean solvents. It is essential that the reservoir is mechanically cleaned to remove residual contamination particles.

Mechanical cleaning is labor intensive, but is the most effective method for restoring the system to reliable operation after major mechanical failure.

Cleaning of Components

The question of how to deal with system components arises when considering a hydraulic system flush.

Plumbing should be cleaned in isolation from pumps, valves and actuators. These can be cleaned while still installed in the equipment as discussed in the following sections. The decision to disassemble and mechanically clean components will depend on the type of equipment, your reliability objectives and the reason for the flush. Once the conductors and components have been cleaned and clean oil is installed, valves and actuators can be gradually included in the flushing circuit as the process proceeds.

HOW TO CLEAN TUBES AND HOSES

The use of sponge projectiles is very effective in cleaning tubes and hoses. The hoses and tubes can be cleaned while installed in the truck after a major component failure. The sponge projectiles clean hoses and tubes regardless of their length and angles. The sponge projectiles are shot with compressed air and travel at high speed, pushing residual oil and contaminants out. The hoses and tubes can be cleaned to levels unattainable by conventional methods. See Figure 1. Without the sponge projectile, the hose could not have been cleaned. This tool can minimize replacement costs of additional components caused by secondary contamination failures.

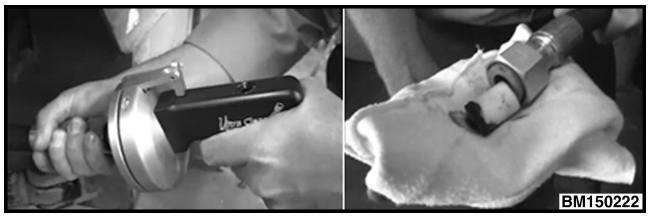


Figure 1. Sponge Projectile Tool

FILTER CADDY

Flushing the system is the total cleaning of the hydraulic system, which means actually removing all the oil, components, and cleaning or repairing them as required. Hoses and tubes are cleaned as described in the previous section. It is essential that the reservoir is mechanically cleaned to remove residual contamination particles. The reservoir suction screen and breather must be replaced.

Hydraulic cylinders must be cleaned and filled with clean oil to eliminate as much air as possible. Elimination of air avoids micro-dieseling. Micro-dieseling is combustion just like a diesel engine and occurs when hydraulic oil is compressed at high pressure in the presence of air or air bubbles. Micro-dieseling can burn the oil (turns oil blackish) and damage hoses and cylinders internally. Cylinders should not be extended to the end-stops or system relief pressure until the air in the system has been flushed.

Once the hydraulic system has been overhauled and all components cleaned and installed, the hydraulic reservoir needs to be refilled with filtered oil. The filter caddy (Figure 2 or Figure 3) is then used to clean the reservoir oil until a predetermined level of oil cleanliness is achieved. This operation is not possible without a filter caddy. The caddy insures that the reservoir and reservoir oil are clean before the pump is turned.

Next, the pump needs to be bled or the case filled with filtered oil. Only then can the hydraulic system be put into operation. The most critical part of the start-up procedure is when the hydraulic pump is turned for the first time.

Filter caddies are not capable of removing all contaminants from the hydraulic system. As previously explained, hidden particles in the most secluded areas of the hydraulic system make it impossible for any filter caddy to reach into all areas of complex hydraulic systems. However, a filter caddy is an essential tool once the system has been completely disassembled, cleaned and assembled.

Figure 2. Portable Filter Caddy

Figure 3. Hand Held Filter Caddy

START-UP PROCEDURE FOR CLEANED SYSTEM

When the reservoir fluid in a hydraulic system has been cleaned to the target cleanliness level, the hydraulic system is ready for start-up. Initially, the system is operated at low speed and relief valves are adjusted to the lowest possible pressure (see the individual truck service procedures for specifics of adjusting relief valves). In addition, individual circuits are looped to isolate cylinders and sensitive valves during initial system start-up. Due to the length of the auxiliary lines, the **A** and **B** port auxiliary hoses should be looped at the carriage end to insure the full length gets flushed.

By activating the hydraulic pump to start pumping oil slowly through the main valve the remaining particles still in crevices, valves and fluid conductors are brought back to the reservoir and the return filter. Once the cleanliness is assured, the rest of the operating components on the hydraulic system are progressively actuated with loops eliminated. Progressively actuate each circuit, starting with the auxiliary circuit, tilt circuit, lift circuit, and lastly the steering circuit. To flush the individual cylinder circuits, they must be operated stop-to-stop for at least five stroke cycles without load.

CONTAMINATED OIL COOLERS

In the case of major component failures, the metal chips and debris collected in oil coolers make it impossible to clean them to a safe level. The cooler

must be replaced. In contaminated units where a massive failure has **NOT OCCURRED**, the oil coolers can be flushed, assuring a safe cleanliness level. The filter caddy would be ideal for this fluid conditioning task.

ADDITIONAL FILTER CADDY FUNCTIONS

Filter caddying as described in the previous section, takes part in the final step of recuperating a hydraulic system after a major component failure. Filter caddies are useful for additional service procedures:

- Transferring and pre-filling new oil from storage when filling hydraulic reservoir.
- Conditioning the hydraulic fluid (cleaning the fluid already in the system).
    - Certain hydraulic system contaminations make it impractical to clean and one needs to determine the benefits of using a caddy filter. For example, to clean oil that is heavily contaminated (to the level of ISO 24/23/20) makes no sense if the condition of the additive package is already degraded. Therefore, before conditioning fluid, check condition of the additive package through oil analysis.

HOW TO HANDLE DIFFERENT FLUIDS

Special care is needed when handling different types of oil. Mixing oils of a different nature, such as hydraulic oil and tractor hydraulic fluids, is not recommended.

The additive concentrations and types are different. Tractor fluids have EP additives that are not fully compatible with AW additives from hydraulic oils. Mixing oils brings changes of viscosity and the possible loss of oil film strength. Oil additives tend to fight over polar surfaces, increasing production of soft metals.

When using a filter caddy with different oils, it is a recommended practice to have different sets of hydraulic filters for use with different oil types. The filter caddy operator should switch to a different filter set matched to the oil type being filtered. Store the alternate filters in properly identified plastic bags that protect them from contamination.

WATER REMOVAL FILTERS

Some water removal filters are made of water absorbent material. They can also act as particle removal units, but their primary function is to remove free water. Most oils have some level of water content, especially those containing calcium additives. Monitoring water content and having a water removal filter permanently installed is a recommended practice. This keeps water content in the range considered acceptable.

Fluid Conditioning and System Flushing Procedures

OPERATION OF THE FILTER CADDY

WARNING

Read the safety messages in the operating manual of the filter caddy. Follow these warnings and instructions carefully. Review them frequently. Be sure all operators of the filter caddy understand every safety message. Replace safety labels immediately if missing or damaged.

The filter caddy is designed to remove particulate contamination in fluid powered systems. The filter caddy is an oil filtering system that captures contaminant particles using a high performance filter(s). The filter caddy can also be equipped with an optional water removal filter that can be used in place of one of the standard filters to remove free water. The filter caddy can also be used to transfer fluid from an oil drum to the truck reservoir, or to condition the fluid (clean up fluid) already in the truck reservoir as part of a preventive maintenance program.

Filter Caddy operation

WARNING

The Mobile Filtration System is designed for the transfer and filtering of hydraulic and lubrication oils only. It is not to be used for highly volatile fluids such as gasoline or paint thinners. Failure to follow this warning could lead to death or serious injury.

CAUTION

Never start or run a dry pump. Allowing the pump to run without fluid flowing through it will greatly reduce pump life. During fluid transfer operation it is critical that the pump inlet stay submerged in fluid. Failure to do so will cause galling, seizing or destructive wear between the rotors, end plates and casting.

CAUTION

The maximum operating temperature for the filter caddy is 65°C (150°F). Higher operating temperatures could lead to hose damage.

CAUTION

The 1½ HP electric motor draws 12.6/6.3 amps at 115/230 volts, 60 Hz at full load. Starting current is approximately 88/44 amps at 115/230 volts, 60 Hz. A proper circuit breaker should be installed to protect the motor and meet national and local electric codes. Recommended size for an extension cable is 12-3 conductor with a maximum length of 25 feet.

NOTE: Minimal repair service is generally required on filter caddies. It is recommended that any failed parts be replaced with new parts. See the unit manual for parts list.

NOTE: Below are summarized instructions for operating the filter caddy. See the filter caddy operating manual for full details.

NOTE: All safety procedures associated with the operation of electrical powered equipment must be observed.

1. On a new unit, prime the suction hose to insure the pump does not run dry. Pumps that are allowed to run dry will not be covered by warranty.

2. Place the suction hose into the fluid to be filtered or transferred. Place the discharge hose into the machinery reservoir or waste container depending on desired operation. Ensure that the wands are secured to avoid possible fluid loss.

3. Ensure selector switch is in **OFF** position. Check that the power source being utilized complies with the requirements of the filtration cart motor before actual hook-up. To energize the unit, connect to appropriate electrical outlet.

4. Switch on the Mobile Filtration System's motor. Visually check that the fluid is actually being pumped through the filter unit and out of the outlet hose.

FLUID CONDITIONING PROCEDURE

Fluid Conditioning is used to eliminate contaminants such as particles and water as part of a preventive maintenance program. Fluid conditioning can be accomplished using a filter caddy. It is usually done in response to a Fluid Analysis Report that shows higher than normal

contaminant particle counts or high water content and can be done as long as the additives have not degraded. If the water content is high, install a water removal filter on the filter caddy. If the additives have degraded, the system fluid needs to be drained and replaced with new fluid. Fluid conditioning does not address significant contamination that results from major component failures that have spread contamination throughout the system. See System Flushing Procedure below if there has been a major component failure.

NOTE: Wand positioning is an important part of maximizing the cleaning speed of the filter caddy. In order to ensure the proper cleaning of the reservoir fluid, position the ends of both the inlet and the outlet hose or tube as far apart as possible inside the reservoir.

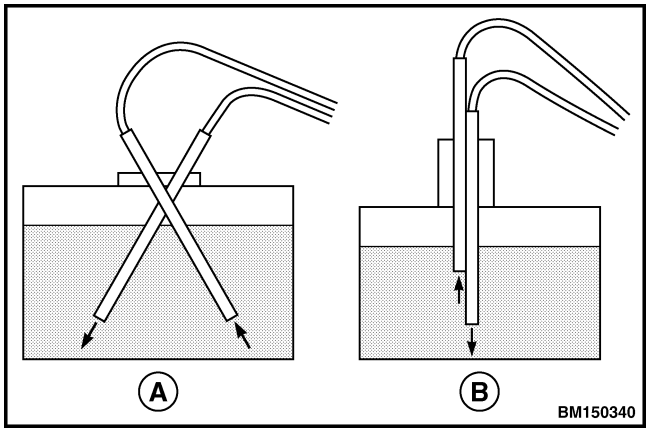
1. Remove the filter housing cap, filter element, and element bowl to allow full access to the reservoir interior.

2. Position the filter wands inside the reservoir per the following guideline:

   - The best situation occurs when the reservoir has a large but short opening. That way the wands can be crossed and separated to create turbulence throughout the reservoir and filter the fluid faster. When the reservoir opening is smaller and has a long or narrow opening, the wands have to be offset at different heights. See Figure 4. In this orientation, the flow and cleaning speed will be lower than the widely separated tubes.

Filter Caddy Start-Up

After set up is complete, the filter caddy is now ready for start-up and cleaning of the reservoir fluid.



A. CROSSED CONFIGURATION
B. OFFSET CONFIGURATION

Figure 4. Filter Station Wand Configuration

1. Run the reservoir cleaning process for the time outlined in Table 2. Different filter machines have different flow rates, requiring different run times to achieve the required cleanliness. If not utilizing one of the listed filter units, see the operating manual for the flow rate and filter Beta rating of your filter caddy to determine if the run time needs to be adjusted upward. Reduced flow rates, lower filter Beta ratings, and fewer filters in series require longer flushing times.

2. After the run time has been completed, install the filter element bowl, a new filter element, and filter housing cap.

3. The system is now ready to start.

4. Operate the individual hydraulic functions until the system is up to operating temperature (50°C (120°F)).

5. Take an oil sample from designated test port and send off for analysis.

6. Return lift truck to service.

7. Review oil analysis report to insure fluid has been sufficiently cleaned. Repeat conditioning sequence if required.

SYSTEM FLUSHING PROCEDURE

System flushing is used to eliminate sludge, varnish, debris, contaminated or degraded fluid from conductor walls and other internal surfaces,

and system dead spots after a major component failure. The use of mechanical cleaning after a major component failure (pump or cylinder), must be incorporated in the flushing strategy. This involves the use of a pneumatic gun and sponge projectiles to clean tubes and hoses. It also involves disassembly of other components for cleaning using brushes and clean solvents.

Mechanical cleaning is labor intensive but is the most effective method for restoring the system to reliable operation in cases of major component failure. **Reservoirs, hoses, tubes and cylinders must be cleaned prior to filling the system with oil and flushing the system**.

Before proceeding with the component cleaning procedure, drain all fluid from the system and then proceed to clean the components as outlined below. Failure to do so may result in damage to the pump(s) or other components on start-up. On large systems where it may be cost prohibitive to change the fluid, the fluid can be removed from the reservoir and pumped into a clean storage container with the filter caddy. It can then be filtered to the target ISO cleanliness, then returned after the reservoir cleaning is complete (this assumes the fluid is not already degraded).

Component Cleaning Procedure

NOTE: The following steps outline the basic procedures for cleaning a heavily contaminated system after a major component failure. The technique or combination of techniques employed will depend on size and type of system, your reliability objectives for the equipment and the reason for the flush.

Reservoir Cleaning Procedure

1. Ensure absolute cleanliness in all work procedures.
2. Clean the top of the filter housing, cap, and surrounding reservoir surface to avoid adding any additional contaminant to the hydraulic reservoir.

NOTE: It is an acceptable alternative to perform Step 5 prior to Step 3.

3. Remove the filter housing cap, filter element, and element bowl to allow full access to the reservoir interior.

CAUTION

Dispose of fluids in accordance with local environmental regulations.

4. Utilize the filter caddy to pump fluid from the reservoir to a storage container for disposal.
5. Drain and remove all residual oil from reservoir.
6. Remove and discard the suction strainer.
7. Remove and discard the reservoir breather.
8. Clean the reservoir to ensure it is free of metallic debris and other containments.
9. Clean all accumulated metallic particles from the magnetic plug and reinstall.
10. Install new reservoir breather.
11. Install new suction strainer.
12. Cover the reservoir openings until ready to perform flushing operation.

Cylinder Cleaning Procedure

1. Ensure absolute cleanliness in all work procedures.
2. Before loosening fittings and components, clean the external surfaces using industrial, residue free wipes.
3. Cover all connecting hose and cylinder openings immediately with protective caps in order to prevent dirt and debris from penetrating the system.
4. Disassemble the cylinder and wash all parts with filtered petroleum based solvent to remove contamination particles. Pay particular attention to cleaning seal grooves, and gland nut and port threads. See the **Cylinder Repair** manual for your specific lift truck.
5. Install new seal kits. See the **Cylinder Repair** manual for your specific lift truck.

6. Fill the cylinder with filtered hydraulic fluid. This displaces the air and reduces the risk of air compression inside the cylinder that can cause dieseling during initial pressurization at start-up. Dieseling will result in damage to the cylinder and seals.

7. Plug all ports and reinstall in the truck. See the **Cylinder Repair** manual for your specific lift truck.

Hose and Tube Cleaning Procedure

WARNING

Compressed air can move particles so that they cause injury to the user or to other personnel. Make sure that the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eyes.

CAUTION

Disposal of contaminated sponge projectiles must meet local environmental regulations.

NOTE: A sponge projectile launcher cannot be use to clean pump suction line hoses with spring wire inserts. These suction lines must be removed and flushed with clean solvent.

A handheld sponge projectile launcher can be used to quickly and efficiently remove contaminated oil and contamination particles from hoses and tubes without removing them from the lift truck. The required air supply for the projectile launcher consists of the following:

- 5.5 to 7.5 bar (80 to 110 psi)
- 1/2" ID air hose to ensure 55 SCFM (1.6 m3/min) air flow
- A 5 micron filter, pressure regulator, and pressure gage

Dirty, moisture laden air will add contamination to the hoses and tubes.

Consult the Ultra Clean Owner's manual for detailed recommendations for the required air pressure and supply line size.

1. Closely inspect hoses and replace any that are suspect.

2. Disconnect each end of the hose and tube assembly to be cleaned.

3. Place one end of the hose/tube assembly into the catcher bucket.

4. Install the appropriate sized nozzle on the launcher and place the sponge projectile into the launcher.

5. Place the projectile launcher at the opposite end of the hose/tube assembly.

6. Launch the sponge projectile through the hose/tube assembly.

7. The first projectile will remove the residual oil from the hose/tube assembly.

8. Launch additional sponge projectiles through the hose/tube assembly until all oil and contaminants are removed and the projectiles come out clean. Generally, four to six projectiles should be enough. Wipe off the nozzle each time to eliminate potential contaminants.

9. Check the catcher bucket each time to ensure that the projectile has been discharged into the bucket and has not been trapped inside the hose/tube.

10. Prior to launching the final projectile and reconnecting the hose/tube assembly, wipe off each end of the assembly to remove any accumulated oil or visible contaminants.

Valve Cleaning Procedure

NOTE: This procedure is a general outline. The exact procedure will depend on the valves in the system. More complex systems will require more valves to be cleaned.

1. Ensure absolute cleanliness in all work procedures.

NOTE: Make note of position and setting of valve prior to disassembly to help in resetting after flushing is complete.

2. **Primary Relief Valve:** Disassemble the relief valve assembly, clean all parts, reassemble, and leave setting at low pressure for initial flushing operation.

3. **Unloader and Spool Valve (if applicable) :** Remove and clean all parts. Some assemblies may not contain these components.

NOTE: Make note of position and setting of valve prior to disassembly to help in resetting after flushing is complete.

4. **Secondary Relief Valve:** Disassemble the relief valve assembly, clean all parts, reassemble, and leave setting at low pressure for initial flushing operation.

5. **Steering Priority Spool:** Remove, clean all parts, ensure all orifices are clean and reinstall.

6. Remove the screened fittings from the **L** (left) and **R** (right) steering control unit ports and flush to remove any accumulated contamination particles.

Front-End Attachment Cleaning Procedure

NOTE: The cleaning procedure below should also be utilized when transferring a previously used attachment to a new truck with a clean hydraulic system to prevent contaminating the new system.

1. Ensure absolute cleanliness in all work procedures.

2. Flush cylinders and refill with filtered oil.

3. Clean hoses and tubes.

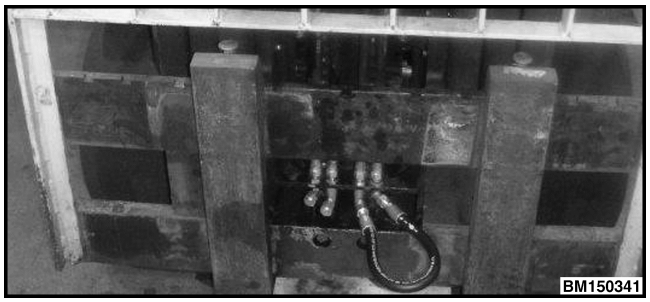
System Flushing Procedure

Once the hydraulic system has been overhauled and all components cleaned and installed, the hydraulic reservoir needs to be refilled with filtered oil. The filter caddy is then used to clean the reservoir oil until a predetermined level of oil cleanliness is achieved. This operation is not possible without a filter caddy. The caddy insures that the reservoir and reservoir oil are clean before the pump is turned.

Next, the pump needs to be bled or the case filled with filtered oil. Only then can the hydraulic system be put into operation. The most critical part of the start-up procedure is when the hydraulic pump is turned for the first time.

NOTE: Wand positioning is an important part of maximizing the cleaning speed of the filter caddy. In order to ensure proper cleaning of the reservoir fluid, position the ends of both the inlet and the outlet hose or tube as far apart as possible.

1. Loop the steering, auxiliary, and tilt circuits to exclude the cylinders during the initial flushing operation. This will allow the fluid to flow through continuously to clear the air from the system and keep from recontaminating the cylinders just cleaned. See Figure 5.
   - Steering lines should be looped at the steer axle end.
   - Tilt lines should be looped at tilt cylinder end.
   - Auxiliary lines should be looped at the carriage end.



NOTE: THIS IMAGE IS AN EXAMPLE OF WHAT THE LOOPING PROCEDURE WILL LOOK LIKE.

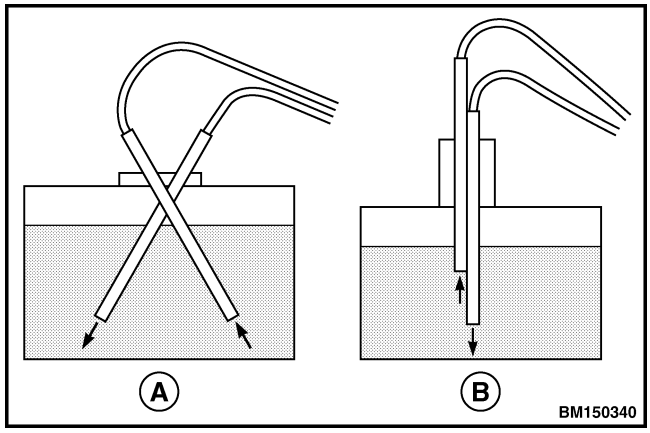
Figure 5. Hydraulic Hose Looping

2. Clean the top of the filter housing, cap, and surrounding reservoir surface to avoid adding any additional contaminants to the hydraulic reservoir.

3. Remove the filter housing cap, filter element, and element basket to allow full access to the reservoir.

4. Fill the reservoir with filtered oil using the filter caddy or a barrel pump to transfer oil from the storage barrel.

5. Position the filter station wands inside the reservoir per the following guideline:
   - The best situation occurs when the reservoir has a large but short opening. That way the wands can be crossed and separated to create turbulence throughout the reservoir and filter the fluid faster. When the reservoir opening is smaller and has a long or narrow opening, the wands have to be offset at different heights, see Figure 6. In this orientation, the flow and cleaning speed will be slower than the widely separated tubes.



A. CROSSED CONFIGURATION
B. OFFSET CONFIGURATION

Figure 6. Filter Station Wand Configuration

Filter Caddy Start-Up

After setup is complete, the filter caddy is now ready for start-up and cleaning of the reservoir fluid.

- Run the reservoir cleaning process for the time outlined in Table 2. Different filter machines have different flow rates, requiring different run times to achieve the required cleanliness.

System Start-Up and Flushing

Once components are clean and the fluid in the reservoir has been flushed clean the system is ready to start.

1. Install the filter element bowl, a new filter element, and filter housing cap.

2. On pumps with a flooded inlet (pump inlet is below the reservoir fluid level) carefully loosen the intake line to allow the trapped air to escape. This ensures that the line is full of fluid so the pump will have immediate lubrication.

3. On units fitted with variable displacement pumps with an external case drain line, fill the pump case with filtered hydraulic fluid through the highest case drain port and reconnect the case drain line. Failure to do so will result in damage to the pump through inadequate lubrication at start-up.

4. Confirm the reservoir is above the minimum level.

5. Ensure all hydraulic controls are in neutral so there is no load on the system.

6. Start the system and run unloaded at lowest possible speed.
   - On lift trucks equipped with a fixed displacement system, allow the system to run unloaded for 10 minutes to flush any remaining particles still in the main valve circuit back to the filter. Inspect for leaks and check reservoir level.

NOTE: Perform Step 7 on lift trucks equipped with a variable displacement pump (VDP).

7. Bleed the LS (load sensing) pilot line by carefully loosening the pilot line fitting at the pump to allow trapped air to escape.
   - On lift trucks equipped with a VDP, the pump will not flow unless there is a demand from the control levers. Fully actuate and hold the last auxiliary lever (third or fourth lever). Allow the system to run unloaded for ten minutes to flush any remaining particles still in the main valve circuit back to the filter. Inspect for leaks and check reservoir level.
8. With the circuits still looped (cylinders not connected), progressively operate each hydraulic function in the following order to flush out any remaining particles and majority of the air in each circuit. First at low speed (low pressure), then at high speed (high flow).
   - Auxiliary 3- Set auxiliary speed at ten for highest flow rate on EH valves.
   - Auxiliary 4- Set auxiliary speed at ten for highest flow rate on EH valves.
   - Tilt
   - Lift
   - Steering
9. Shut off system, remove circuit loops and connect cylinders.
10. With the cylinders now connected, operate the individual hydraulic functions in the same sequence as above for at least five complete stroke cycles each until all air is expelled and all actuators operate smoothly. Stroke cylinders slowly taking care not to develop high pressure at the end of stroke which can cause dieseling.
11. With system at operating temperature, 50°C (120°F), check and adjust all relief valve settings to specification and set the auxiliary speed setting to match auxiliary requirements. See the **Capacities and Specifications Manual** for your lift truck model.
12. Functionally test all circuits under load.
13. Check reservoir fluid level, fill to correct level with filtered fluid.
14. Take an oil sample from the designated test port and send off for analysis.
15. Return lift truck to service.
16. After fifty hours of operation, take an oil sample from the designated test port and send off for analysis to verify the system is operating at the target cleanliness level.

Reservoir Fluid Cleaning Times

Cleaning times can be affected by various factors. The reasons for this include:

- The filter caddy is cavitating.
- The return wand is not submerged in fluid and is generating air bubbles.
- The filter tower has not been purged.
- Too much fluid turbulence in reservoir.
- The oil is too cold.
- The oil is heavily contaminated with water and particles.

The following table has been developed to provide an estimate of the cleaning times required with the filter caddy.

NOTE: See Hydraulic Cleanliness Service Gram for further information on the filter caddies.

Table 2. Reservoir Flushing Times

Reservoir Flushing Time - Minutes			
Hydraulic Reservoir Capacity	OF7 Hand Held Filter Caddy 15 liter/min (4 gal/min) Flow Capacity (See Figure 2)	OFCD Portable Filter Caddy 53 liter/min (14 gal/min) Flow Capacity (See Figure 3)	Target ISO Cleanliness
Less than 42 liter (11 gal)	40	10	@ Start-Up after reservoir flush = ISO 18/15/12

Table 2. Reservoir Flushing Times (Continued)

42 to 80 liter (11 to 21 gal)	80	20	@ Stabilization at 50 operating hours = ISO 20/17/14 10

DEALING WITH DIFFERENT FLUID TYPES

WARNING

The filter caddy is designed for the transfer and filtering of hydraulic and lubrication oils only! It is not to be used for highly volatile fluids such as gasoline or paint thinners. Failure to follow this warning may lead to death or serious injury.

Cleaning Procedure After Switching Fluids (Cross Contamination Flushing)

1. Prepare an empty waste oil container (five gallon bucket), as well as a top-off container (five gallon container) for fluid removed from the hydraulic system.
2. Insert suction wand into reservoir and place return wand into the waste container.
3. Replace existing particle filter with those of the fluid in the machine (if the filter caddy has HCE-102 Tractor Hydraulic Oil filters and machine uses HCE-140 Hydraulic Oil, then install filters used with HCE-140 oil).
4. Run the filter caddy until the waste container is filled with about four gallons of fluid.
5. Remove return wand from waste container, wipe it clean, and insert into reservoir.
6. Position wands in the correct orientation and begin reservoir filtration until desired cleanliness level has been achieved.
7. Cycle machine hydraulic functions.
8. Resume reservoir filtration.

Filter Caddy Maintenance

See the filter caddy **Operating Manual** for detailed instructions.

No maintenance operations should be carried out while the unit is running. Before starting any other maintenance operations, ensure that the system is shut down and disconnected from the electrical power source. System pressure can be contained in the unit for some time after it has been disconnected.

Servicing the Strainer

Under normal operating conditions, the strainer should be removed from the line, cleaned and re-installed after every one hundred hours of operation. The strainer should be cleaned more often however, if the fluid is heavily contaminated.

DC Motor

The motor should be inspected at regular intervals (every five hundred hours of operation or every three months, whichever occurs first). Keep the motor clean and the ventilation openings clear.

Hydraulic Oil Sampling Method and Procedure

HYDRAULIC OIL SAMPLING METHOD

Objective

Document a structured oil sampling method for taking fluid samples from field vehicles.

Maximize Data Density in the sample.

Determine level of wear particles.

Understand status of additive deletion.

Determine cleanliness and dryness of fluid.

Establish physical and chemical properties of oil, contamination, and mechanical wear. Oil life and service intervals are determined by degradation due to oxidation and additive depletion.

General Guidelines

WARNING

The lift truck must be put on blocks for some types of maintenance and repair.

The surface must be solid, even, and level when the lift truck is put on blocks. Make sure any blocks used to support the lift truck are solid, one-piece units.

WARNING

When operating the lift truck with the hood open, be aware of the hazard from the fan, pulleys and belts. Failure to recognize these moving components could lead to serious injury.

WARNING

At operating temperature, the hydraulic oil is HOT. DO NOT permit the hot oil to touch the skin and cause a burn.

Due to the extreme sensitivity to external contamination of an oil sample, the utmost care and diligence must be exercised while performing oil sampling. The measured cleanliness of a hydraulic fluid sample depends on how and where (in the hydraulic system) the sample is extracted. Follow the procedure carefully and consistently each time a sample is taken.

1. Refer to Hydraulic Cleanliness Service Gram for kits specifically designated for Hydraulic Oil Analysis.

2. Use the same analysis laboratory for all similar fluid samples in order to maintain consistent results for each sample program. There are differences in results from laboratory to laboratory, no matter how reputable.

3. Consistent use of the same laboratory will provide a historical record of sample results. Trending of these results provides the ability to identify significant changes in oil condition.

4. Analysis Reports should include the following information:
   - Spectrographic analysis - Wear Metals
   - Viscosity
   - FT-IR spectroscopy - Additive condition, oxidation, TAN, fluid mixing
   - Particle counts per ISO 4406-1999
   - Water Content (% or PPM (parts per million))

5. Follow the described method for sampling in all cases to avoid contamination of the sample.

6. Minimize Data Variability.
   - Consistent sampling process produces uniform, consistent, and representative information.
   - DO NOT allow contaminant to enter the sample from outside the oil.
   - Use the same location for each sample. Not all sample locations will produce the same data.

7. The recommended frequency for hydraulic fluid samples is:
   - Every 500 hours and just prior to all oil and filter changes. Once the effects of the operating conditions have on the oil are understood, it may be possible to extend the sampling frequency.
   - High operating temperatures and severe operating conditions shorten the life of oil. For machines operating in severe duty applications with high hydraulic oil temperatures or operating in highly contaminated environments, we recommend taking oil samples every 500 hours.
   - Within one operational hour of major system service, then at 100 hours, and every 500 hours thereafter.
   - Significant changes in the system fluid condition reported by the analysis will dictate a repeat sample to validate results prior to taking corrective actions.

8. Document all hydraulic component failures or hydraulic system service performed that might have introduced contamination or new oil into the system since the last oil sample was taken.

Synopsis

1. Analysis Reports

   Spectrographic analysis

   - is used to finely measure parts per million by weight (PPM) of various elements contained in sampled oil. The process measures the concentration of wear metals, contaminant metals and additive metals in a lubricant.
     - It can identify the concentration of individual metal or alloy of a particle. Its size limit is about 8 microns or smaller, so it is blind to the larger particles that can often signal pending failure.

- Spectrographic limits are an instrument limitation. The size limitation depends on the particle types and instrumentation used.
- Spectrographic Analysis and Particle Count Analysis form an efficient partnership in identifying the concentration of small and large particles in the oil and the total fluid contamination level.

Viscosity

- is the most important physical property of oil. Viscosity determination provides a specific number to compare to the recommended oil in service. An abnormal viscosity (± 15%) is usually indicative of a problem. Standard ISO VG 46 hydraulic oil should have a viscosity between 41 and 51.

Fourier Transform Infrared (FT-IR) Spectrometer

- Measures the chemical composition of a lubrcant.

- Every compound has a unique infrared signature. Using a FT-IR Spectrometer, the key signature points in a spectrum of a specific lubricant are monitored. These signatures are usually common contaminants and degradation by-products unique for a particular lubricant.
- Molecular analysis of hydraulic fluids by FT-IR spectroscopy produces direct information on molecular species on interest, including additives, fluid breakdown products and external contamination. The infrared spectrum of used oil is compared to a baseline spectrum of new oil. Levels of oxidation, nitration and sulfate by-products are reported along with soot, water and glycol.

Particle Counts

- Measures the size and quantity of particles in a lubricant. Use whenever Hyster provides recommended lubricant cleanliness levels and for any system where oil cleanliness is directly related to longer lubricant life, decreased equipment wear or improved equipment performance.

- The analysis report will show the actual number of particles by size category and by the ISO code per ISO 4406-1999. The ISO code reports 3 particle size categories: ≥ 4 microns / ≥ 6 microns / ≥ 14 microns
- Use whenever Hyster provides recommended lubricant cleanliness levels and for any system where oil cleanliness is directly related to longer lubricant life, decreased equipment wear or improved equipment performance.

Water Content

- The Karl Fischer Test quantifies the amount of water in lubricant.

- Results are reported as % water or PPM (1% = 10,000 PPM).
- Water seriously damages the lubricating properties of oil and promotes component corrosion, Increased water concentrations indicate possible condensation, coolant leaks, or leaks around the seals.

2. All equipment or components of equipment requiring oil will vary in performance and wear rates from one application to another, depending on the nature and extent of their use, their exposure to adverse operating conditions, their age, how often the oil was changed, etc. Unless a sharp increase in an important element is detected, it is inadvisable to rely on a single test. Repeated sampling on a regular schedule is required to establish trending which will enable the technician to identify significant changes in the system.

3. It is important to know the target fluid cleanliness level specified for the system. Unless otherwise stated, Hyster hydraulic systems have a target cleanliness of ISO 20/17/14. See the **Periodic Maintenance Manual** for your specific lift truck.

4. Although the 3 code ISO system is used for all manufacturing cleanliness requirements, for hydraulic oil samples taken in the field, only the last two ISO particle counts need to be monitored. As an example, 20/17/14 is stated as simply --/17/14. Unless otherwise stated in the **Periodic Maintenance Manual**, target oil cleanliness levels for field oil samples are ISO --/15/12 for initial fill oil, and ISO --/17/14 for oil in service.

As previously stated, the Particle Count test is used in partnership with the Spectrographic Analysis to monitor the total contamination levels in the oil. Trending the concentration of small and large particles indicates the severity of system wear.

Hydraulic Oil Analysis Report Guidelines

Unless otherwise stated in the **Periodic Maintenance Manual** for your specific lift truck, see Table 3 for the hydraulic oil cleanliness guidelines and Table 4 for the water content guidelines.

Table 3. Hydraulic Oil Cleanliness Guidelines

Oil Type	Initial Fill Oil	Target Cleanliness for Hydraulic Oil in Service	Maximum Particle Counts for Oil in Service
HCE-140, HCE-141, 1614025	ISO --/15/12	ISO --/17/14	ISO --/18/15
HCE-102	ISO --/15/12	ISO --/17/14	ISO --/18/15

Table 4. Hydraulic Oil Water Content Guidelines

Water Content	Status	Recommended Action
≤ 0.05% (≤ 500 PPM)	Normal	None Required
> 0.05% to < 0.1% (>500 to <1000 PPM)	Alert	Use filter caddy to remove water.
≥ 0.1% (≥ 1000 PPM)	Immediate Action Required	Use filter caddy to remove water or replace fluid. Determine and eliminate source of water ingression.

Sampling Conditions

1. All samples should be taken with the system at normal operating temperature; the hydraulic fluid at 50°C (120°F) or greater. Operate all hydraulic functions repeatedly just prior to taking a sample.
2. The system must be running when taking a sample.
3. Thoroughly flush sampling valves and sampling devices.
4. Maintain sample bottles in a clean environment.
5. Sample at proper frequency.
6. Record operating hours on machine and oil hours.
7. Record oil brand and type.
8. Send samples immediately to laboratory.

Equipment

NOTE: Refer to Hydraulic Cleanliness Service Gram for complete information regarding available Hydraulic Cleanliness Service Kits.

1. A factory installed zero-leak quick-disconnect fitting (Hyster P/N 2061646) is installed on the control valve of 1-8 ton capacity products at the recommended sampling location.

   Sampling port conversion kits for other units without factory installed sample ports may be available from the **NMHG Parts Distribution Center**.

   Oil sampling directly from the reservoir with a sampling pump is an alternative but results may be unreliable due to oil flow stratification and inconsistent probe location.
2. Utilize hydraulic sampling valve kit available from **NMHG Parts Distribution Center**. It includes a connection line, fitting and a valve to open and close flow through the quick disconnect fittings.
3. Utilize hydraulic oil analysis kits available from **NMHG Parts Distribution Center**.

SAMPLING PROCEDURE

Hydraulic Oil Sampling

CAUTION

Wear safety glasses when collecting oil samples.

1. Operate lift truck long enough to bring oil up to operating temperature and evenly distribute contaminants throughout the system. Operate all hydraulic functions for a minimum of three cycles. Run the system at elevated speeds and steer lock to lock, lift to full height and lower fully, tilt full forward and full back, and cycle any attachment for at least one minute each. Assure oil temperature in sump has reached at least 50°C (120°F) prior to initiating the following procedure.

   ICE Truck - run the engine at high idle speed.

   Electric Truck - run the pump motor at high lift speed.

2. To avoid contaminating the sample:

   Clean your hands or wear clean nitrile gloves.

   Leave sample container closed until just before you are ready to take sample.

   When cap is off bottle, hold bottle in your hand with opening facing down, and do not set the cap or open bottle down on a workbench, truck surface, or in your pocket.

   Do not touch sample bottle with sampling line.

   Try to sample in an enclosed area - doors closed to reduce drafts that may carry contaminants. Do not take a sample in an area where someone is grinding, cutting, sweeping, or creating dust of any kind.

   Return fluid back into the system by running it into dipstick tube. Do not run fluid into a waste pan when flushing the sample tube.

NOTE: Due to the design of manual control valve on some trucks, the sample port flow at idle can be quite low. It may be necessary to elevate engine speeds in order to obtain a steady stream of oil. On these units, run the engine at the minimum speed that provides a steady oil stream from the test port.

3. When taking oil sample:

   ICE Truck

   - run engine at idle.

   Electric Truck

   - run pump motor at tilt speed.

   open the valve and flush the sampling line by following oil back into the sump through the dipstick tube for at least one minute.

4. To take the sample; open the sample bottle, hold the nozzle over the sample bottle **without touching the nozzle on the sample bottle** and collect 50 to 100 ml (2 to 4 oz) of oil. Close the valve and immediately seal the sample container. Leave some head space in the bottle to facilitate agitation at the analysis laboratory.

Sample Labeling

Sample labels should include the following minimum information:

- Date and time of sample
- System sampled, e.g. hydraulic system
- Equipment reference, e.g. truck serial number
- Operating hours on machine and hours on oil
- Fluid manufacturer and type (example - Mobile DTE 25)

Results Documentation

1. Send samples immediately for analysis.

2. Send samples to the same laboratory for analysis to maintain consistent results for trending comparison.

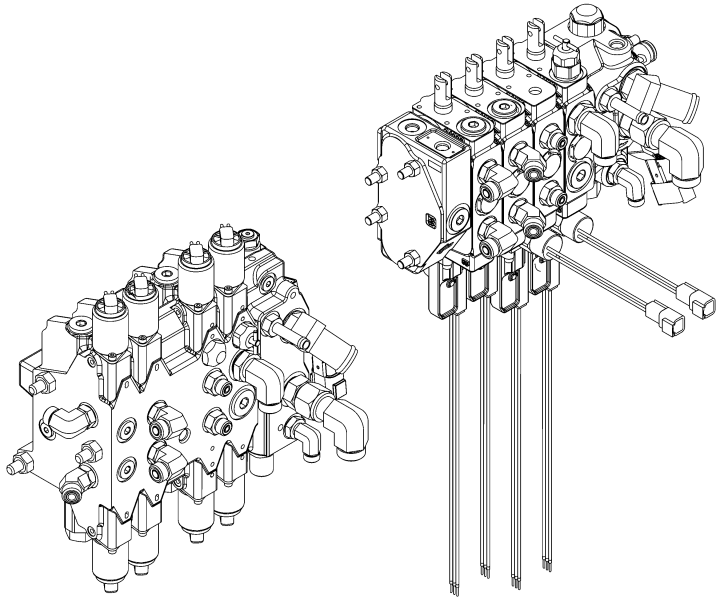
3. Laboratory analysis reports should be retained in the Analysis Laboratories on-line database and vehicle service log for future reference.

NOTES

MAIN CONTROL VALVES

(MANUAL AND E-HYDRAULIC VALVES)

J1.5-2.0XNT (J30-40XNT) [K160];
J1.6-2.0XN (J30-40XN) [A935];
E2.2-3.5XN (E45-70XN) [A268];
J2.2-3.5XN (J45-70XN) [A276];
J4.0-5.0XN, J5.0-5.5XN6
(J80-120XN, J100XNL) [A970];
E4.0-5.5XN, E5.0XNS
(E80-120XN, E100XNS) [A099]



HYSTER

PART NO. 1688876

2000 SRM 1334

SAFETY PRECAUTIONS
MAINTENANCE AND REPAIR

- The Service Manuals are updated on a regular basis, but may not reflect recent design changes to the product. Updated technical service information may be available from your local authorized Hyster® dealer. Service Manuals provide general guidelines for maintenance and service and are intended for use by trained and experienced technicians. Failure to properly maintain equipment or to follow instructions contained in the Service Manual could result in damage to the products, personal injury, property damage or death.
- When lifting parts or assemblies, make sure all slings, chains, or cables are correctly fastened, and that the load being lifted is balanced. Make sure the crane, cables, and chains have the capacity to support the weight of the load.
- Do not lift heavy parts by hand, use a lifting mechanism.
- Wear safety glasses.
- DISCONNECT THE BATTERY CONNECTOR before doing any maintenance or repair on electric lift trucks. Disconnect the battery ground cable on internal combustion lift trucks.
- Always use correct blocks to prevent the unit from rolling or falling. See HOW TO PUT THE LIFT TRUCK ON BLOCKS in the **Operating Manual** or the **Periodic Maintenance** section.
- Keep the unit clean and the working area clean and orderly.
- Use the correct tools for the job.
- Keep the tools clean and in good condition.
- Always use **HYSTER APPROVED** parts when making repairs. Replacement parts must meet or exceed the specifications of the original equipment manufacturer.
- Make sure all nuts, bolts, snap rings, and other fastening devices are removed before using force to remove parts.
- Always fasten a DO NOT OPERATE tag to the controls of the unit when making repairs, or if the unit needs repairs.
- Be sure to follow the **WARNING** and **CAUTION** notes in the instructions.
- Gasoline, Liquid Petroleum Gas (LPG), Compressed Natural Gas (CNG), and Diesel fuel are flammable. Be sure to follow the necessary safety precautions when handling these fuels and when working on these fuel systems.
- Batteries generate flammable gas when they are being charged. Keep fire and sparks away from the area. Make sure the area is well ventilated.

NOTE: The following symbols and words indicate safety information in this manual:

WARNING

Indicates a hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION

Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury and property damage.

On the lift truck, the WARNING symbol and word are on orange background. The CAUTION symbol and word are on yellow background.

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This section is for the following models:

J1.5-2.0XNT (J30-40XNT) [K160];
J1.6-2.0XN (J30-40XN) [A935];
E2.2-3.5XN (E45-70XN) [A268];
J2.2-3.5XN (J45-70XN) [A276];
J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) [A970];
E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) [A099]

"THE QUALITY KEEPERS"

HYSTER APPROVED PARTS

General

LIFT TRUCKS J1.5-2.0XNT (J30-40XNT) (K160) AND J1.6-2.0XN (J30-40XN) (A935)

This section contains the description and repair procedures for both manual (controlled manually) and e-hydraulic (controlled electronically) main control valves used in the hydraulic system for this series of lift trucks. Each body section of the main control valve is made of cast grey iron; the spools within inlet, lift, tilt, and auxiliary sections are different for each function.

The operator presence solenoid (OPS) has a spring loaded plunger which holds the spool in neutral position when no electrical power is supplied to solenoid coil.

The position sensor monitors spool movement and produces a variable output signal utilized by the vehicle systems manager (VSM) to regulate hydraulic pump flow.

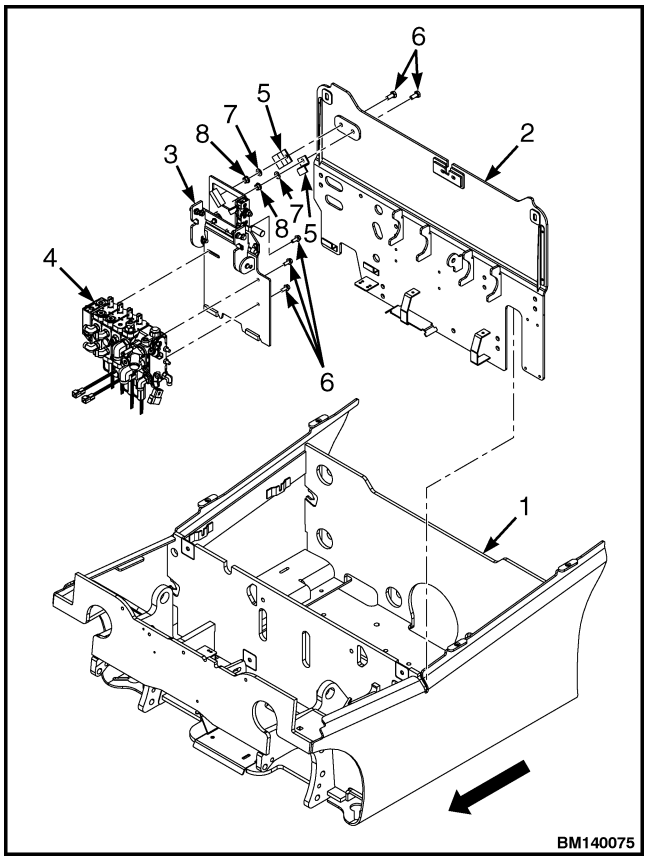
The control valves are mounted to a mounting bracket using washers, capscrews and nuts. The mounting bracket is then attached to the front bulkhead.

See Figure 1 for lift trucks below equipped with manual hydraulics

- J1.5-2.0XNT (J30-40XNT) (K160)
- J1.6-2.0XN (J30-40XN) (A935)

See Figure 2 for lift truck below equipped with e-hydraulics

- J1.5-2.0XNT (J30-40XNT) (K160)
- J1.6-2.0XN (J30-40XN) (A935)

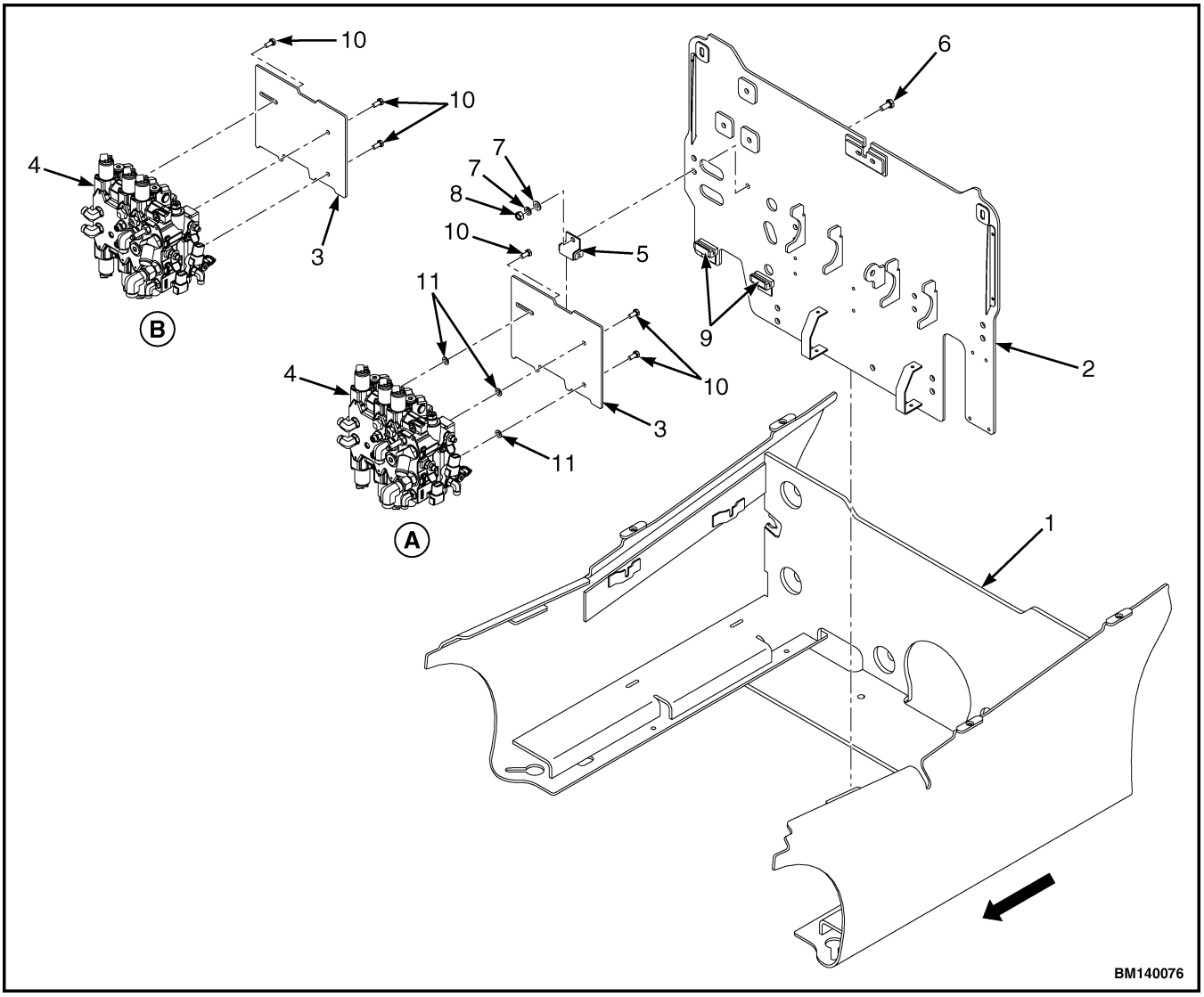


NOTE: MAJOR COMPONENTS NOT SHOWN FOR CLARITY.

NOTE: ARROW POINTS TOWARD FRONT OF LIFT TRUCK.

1. FRAME
2. FRONT BULKHEAD
3. MOUNTING BRACKET
4. MANUAL CONTROL VALVE
5. BRACKET
6. CAPSCREW
7. WASHER
8. NUT

Figure 1. Manual Control Valve Mounting for Lift Truck J1.5-2.0XNT (J30-40XNT) (K160) and J1.6-2.0XN (J30-40XN) (A935)



NOTE: MAJOR COMPONENTS NOT SHOWN FOR CLARITY.

NOTE: ARROW POINTS TOWARD FRONT OF LIFT TRUCK.

NOTE: NEWER LIFT TRUCK MODELS DO NOT HAVE WASHERS (ITEM #11) BETWEEN THE MOUNTING BRACKET AND CONTROL VALVE.

A. MOUNTING ARRANGEMENT, OLDER LIFT TRUCK MODELS

B. MOUNTING ARRANGEMENT, NEWER LIFT TRUCK MODELS

1. FRAME
2. FRONT BULKHEAD
3. MOUNTING BRACKET
4. E-HYDRAULIC CONTROL VALVE
5. BRACKET
6. M10 CAPSCREW
7. WASHER
8. NUT
9. HOLDING BRACKET
10. M8 CAPSCREW
11. WASHER

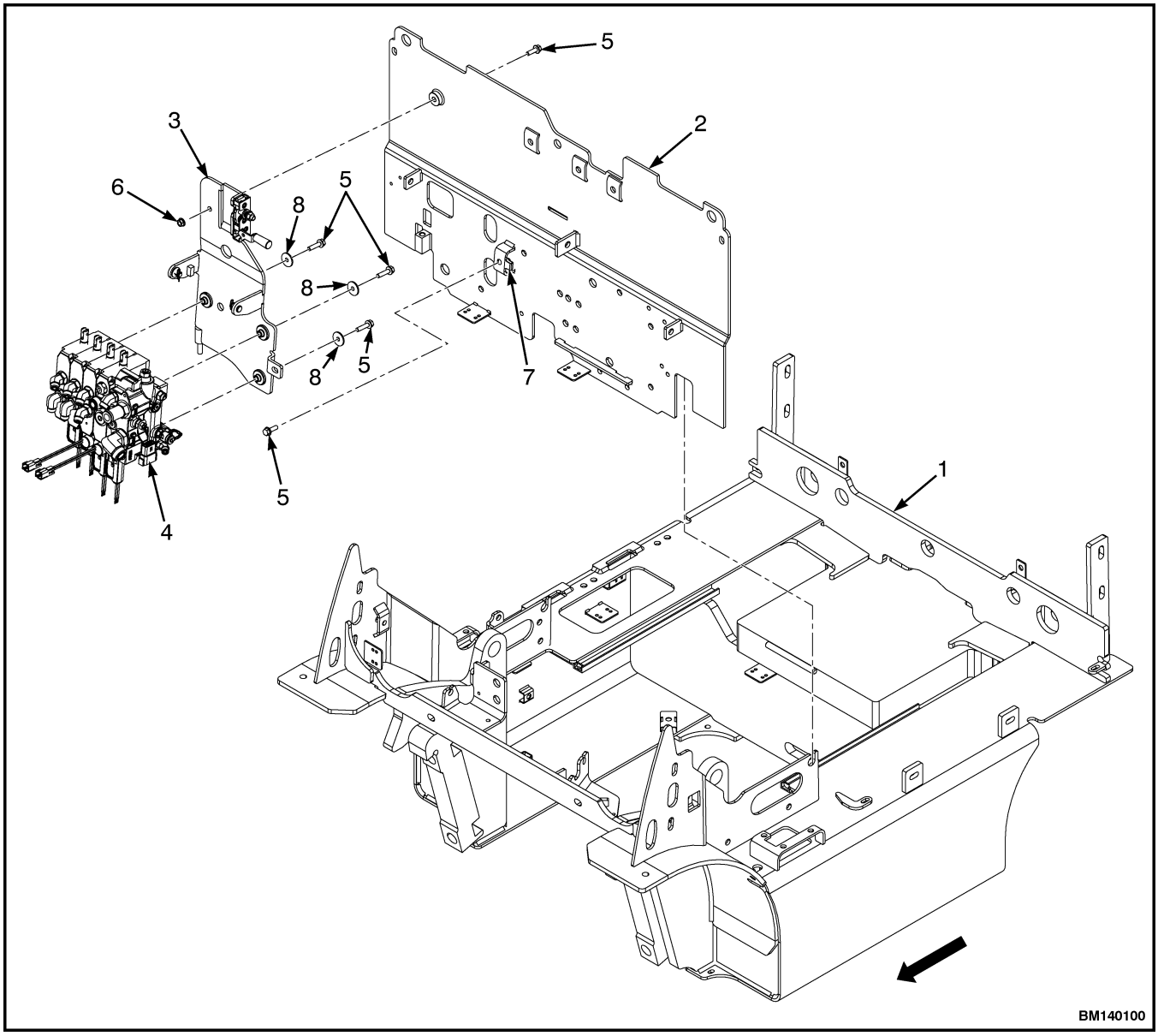
Figure 2. E-Hydraulic Control Valve Mounting for Lift Truck J1.5-2.0XNT (J30-40XNT) (K160) and J1.6-2.0XN (J30-40XN) (A935)

LIFT TRUCKS E2.2-3.5XN (E45-70XN) (A268), J2.2-3.5XN (J45-70XN) (A276), AND J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

This section contains the description and repair procedure for both manual (controlled manually) and e-hydraulic (controlled electronically) main control valves used in this series of lift trucks.

The manual control valve is mounted to a mounting bracket using isolators, capscrews, and washers. The mounting bracket is then attached to the front bulkhead using capscrews, nut, and clip nuts. Each body section of the manual control valve is made of grey cast iron; the inlet, lift, tilt, and auxiliary sections contain spools. The spools are different for each function. See Figure 3.

The e-hydraulic control valve is mounted to a mounting bracket using washers, capscrews, and nuts. The mounting bracket is then attached to the front bulkhead using brackets, capscrews, washers, and nuts. See Figure 4.



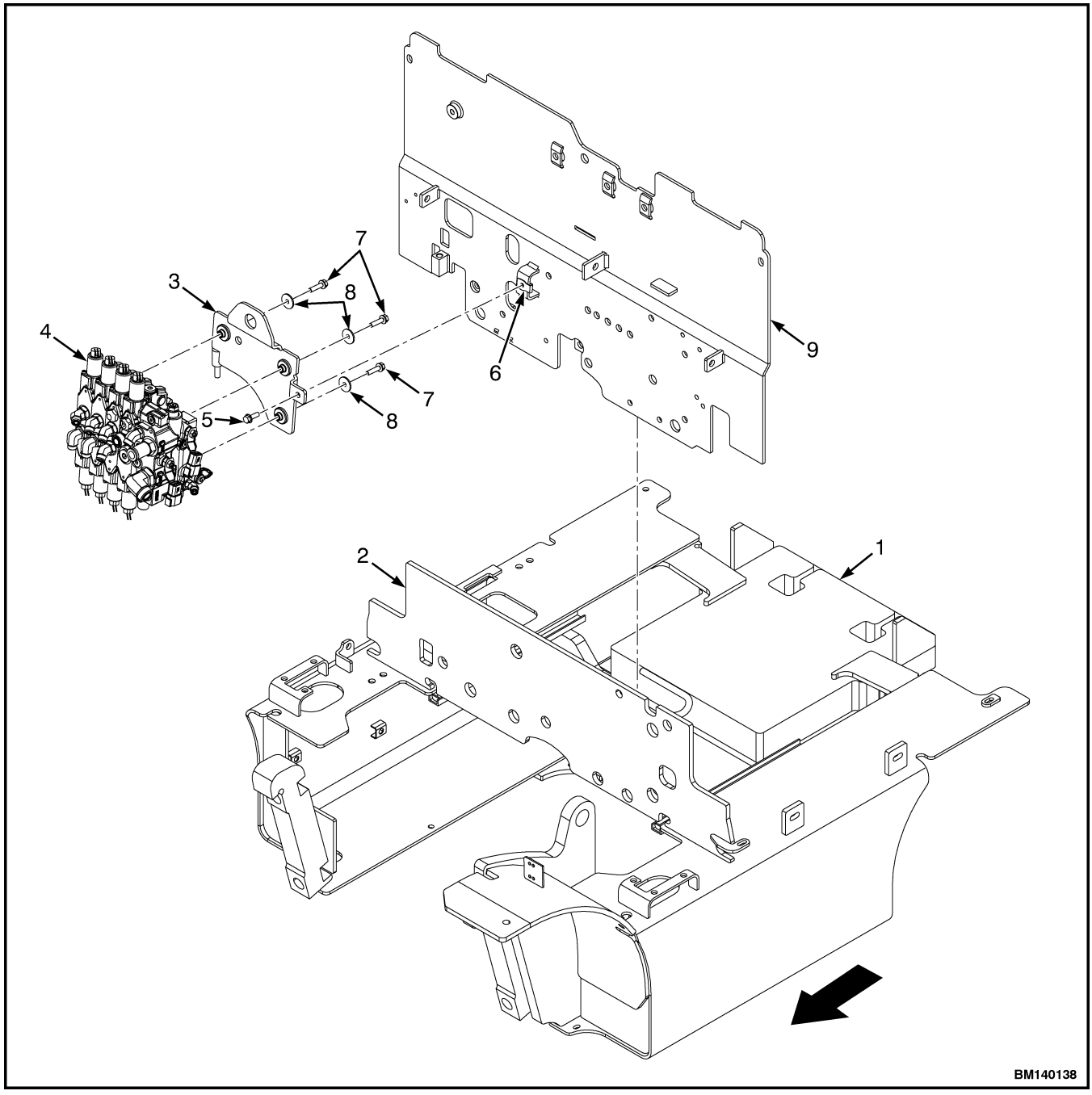
NOTE: CONTROL VALVE MANUFACTURED PRIOR TO OCTOBER, 2012 SHOWN.

NOTE: MAJOR COMPONENTS NOT SHOWN FOR CLARITY.

NOTE: ARROW POINTS TOWARD FRONT OF LIFT TRUCK.

1. FRAME
2. FRONT BULKHEAD
3. MOUNTING BRACKET
4. MANUAL CONTROL VALVE
5. CAPSCREW
6. NUT
7. CLIP NUT
8. SPECIAL WASHER

Figure 3. Manual Control Valve Mounting for Lift Truck E2.2-3.5XN (E45-70XN) (A268), J2.2-3.5XN (J45-70XN) (A276), and J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)



NOTE: MAJOR COMPONENTS NOT SHOWN FOR CLARITY.

NOTE: ARROW POINTS TOWARD FRONT OF LIFT TRUCK.

1. FRAME
2. FRONT BULKHEAD
3. VALVE MOUNTING BRACKET
4. E-HYDRAULIC CONTROL VALVE
5. MOUNTING CAPSCREW
6. CLIP NUT
7. CAPSCREW
8. SPECIAL WASHER
9. BULKHEAD

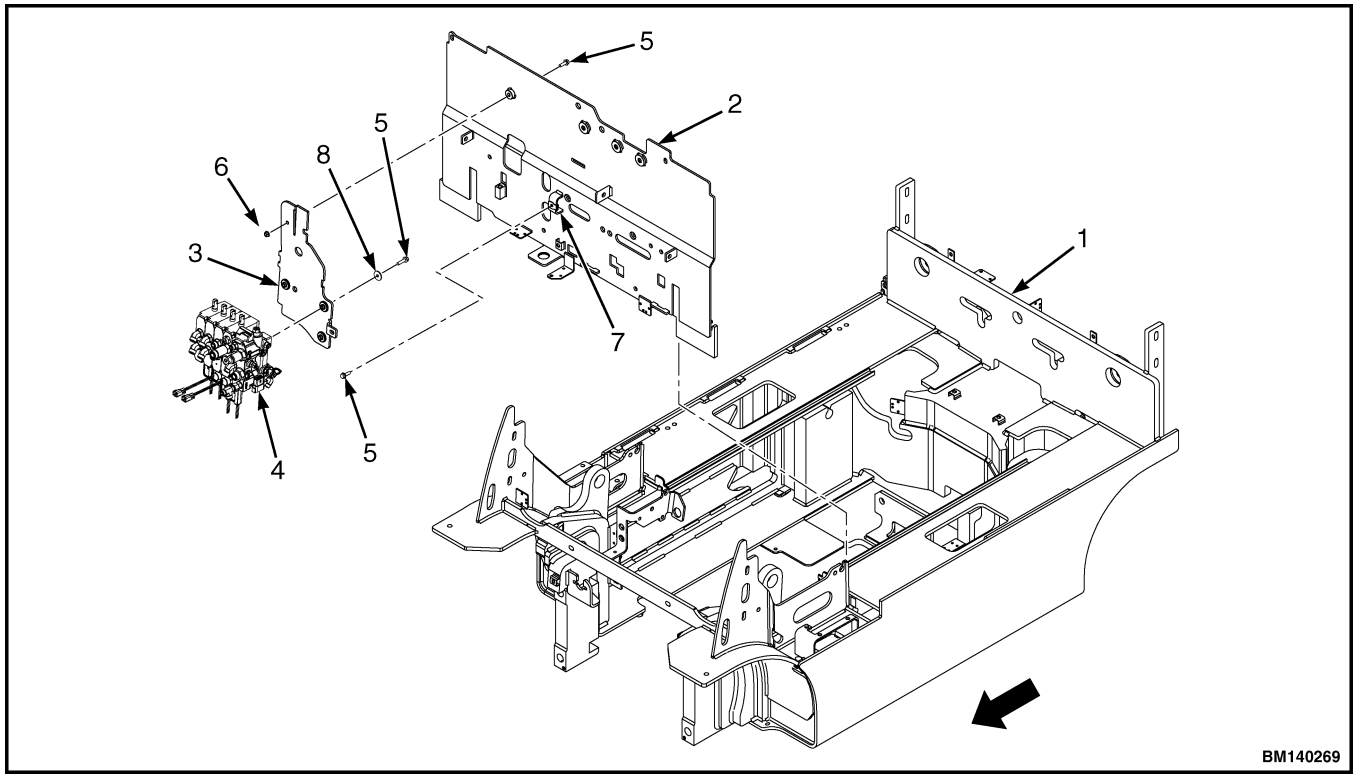
Figure 4. E-Hydraulic Control Valve Mounting for Lift Truck E2.2-3.5XN (E45-70XN) (A268), J2.2-3.5XN (J45-70XN) (A276), and J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

LIFT TRUCK E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

This section contains the description and repair procedure for both manual (controlled manually) and e-hydraulic (controlled electronically) main control valves used in this series lift truck.

The manual control valve is mounted to a mounting bracket using isolators, capscrews, and washers. The mounting bracket is then attached to the front bulkhead using capscrews, nuts, and clip nuts. Each body section of the manual control valve is made of grey cast iron; the inlet, lift, tilt, and auxiliary section contain spools. The spools are different for each function. See Figure 5.

The e-hydraulic control valve is mounted to a mounting bracket using washers, capscrews, and nuts. The mounting bracket is then attached to the front bulkhead using brackets, capscrews, washers, isolators, and nuts. See Figure 6.



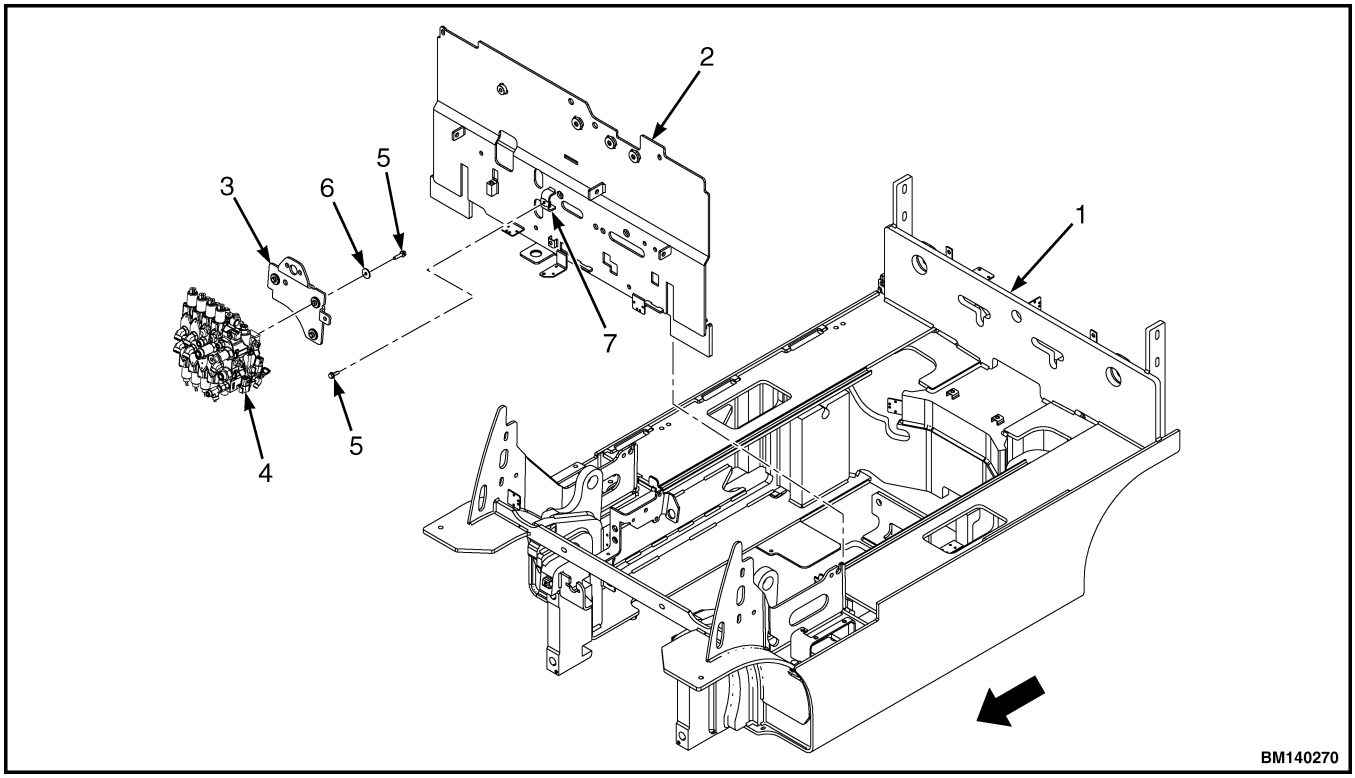
NOTE: CONTROL VALVE MANUFACTURED PRIOR TO OCTOBER, 2012 SHOWN.

NOTE: MAJOR COMPONENTS NOT SHOWN FOR CLARITY.

NOTE: ARROW POINTS TOWARD FRONT OF LIFT TRUCK.

1. FRAME
2. FRONT BULKHEAD
3. MOUNTING BRACKET
4. MANUAL CONTROL VALVE
5. CAPSCREW
6. NUT
7. CLIP NUT
8. SPECIAL WASHER

Figure 5. Manual Control Valve Mounting for Lift Truck E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)



NOTE: MAJOR COMPONENTS NOT SHOWN FOR CLARITY.

NOTE: ARROW POINTS TOWARD FRONT OF LIFT TRUCK.

1. FRAME
2. FRONT BULKHEAD
3. MOUNTING BRACKET
4. E-HYDRAULIC CONTROL VALVE
5. CAPSCREW
6. SPECIAL WASHER
7. CLIP NUT

Figure 6. E-Hydraulic Control Valve Mounting for Lift Truck E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

DISCHARGING THE CAPACITORS

WARNING

DO NOT make repairs or adjustments unless you have been properly trained and authorized to do so. Improper repairs and adjustments can create dangerous operating conditions. DO NOT operate a lift truck that needs repairs. Report the need for repairs to your supervisor immediately. If repair is necessary, attach a DO NOT OPERATE tag on the steering wheel and disconnect the battery.

Disconnect the battery and allow the capacitors to discharge before opening an compartment covers or inspecting or repairing the electrical system. DO NOT place tool on top of the battery. If a tool causes a short circuit, the high current flow from the battery can cause personal injury and property damage.

Some checks and adjustments are performed with the battery connected. DO NOT connect the battery until the procedure instructs you to do so. Never wear any metallic items on your fingers, arms, or neck. Metal items can accidentally make an electrical connection and cause injury

Before performing any tests or adjustment, block the lift truck to prevent unexpected movement.

The capacitor in the transistor controller(s) can hold an electrical charge for about 10 seconds after the battery is disconnected. To prevent an electrical shock and personal injury, discharge the capacitor(s) before inspecting or repairing any component in the drive unit compartment. Make certain that the battery has been disconnected.

DO NOT short across the motor controller terminals with a screwdriver or jumper wire.

Make certain the Emergency Disconnect switch has not been activated. This will isolate the controller and prevent the capacitors from discharging properly. The proper way to disconnect the battery is by separating the battery connectors.

1. Ensure the capacitors are discharged by performing Step 2 through Step 6 below.
2. Turn key or keyless switch to **OFF** position.
3. Disconnect the battery by separating the connectors.
4. Block drive wheels to prevent lift truck from moving.
5. Make sure the Emergency Disconnect switch **HAS NOT** been activated. If the Emergency Disconnect switch is activated, rotate the switch to the right until it pops up.
6. Press the horn button. Wait 30 seconds to be sure capacitors are fully discharged.

Manual Hydraulic Control Valve Repair for 1.5-2.0T Trucks

REMOVE

Beginning Steps

WARNING

Before making repairs to the control valve or its linkage, fully lower all parts of the mast and tilt it fully forward. This action will prevent the mast from lowering suddenly when hydraulic lines are disconnected.

NOTE: Only perform those steps below necessary for required repair or replacement.

1. Lower mast and tilt forward.
2. Remove battery from lift truck. See **How to Change Battery** in **Operating Manual** or

   Periodic Maintenance 8000SRM1339 for lift truck models

   - J1.5-2.0XNT (J30-40XNT) (K160)

   Periodic Maintenance 8000SRM1373 for lift truck models

   - J1.6-2.0XN (J30-40XN) (A935)
3. Discharge capacitors by following steps shown in Discharging the Capacitors in **General** section of this manual.
4. Remove floor mats and floor plates.

WARNING

Hydraulic oil is hot after system operation and can cause burns. DO NOT disconnect any hydraulic hoses until the oil in the system is cool.

CAUTION

Electrical components to be shielded from hydraulic oil drips if they are below hydraulic valve and lines.

NOTE: Tag hydraulic lines during removal to aid in installation.

5. Put a drain pan under the area of the hydraulic valve. Disconnect hydraulic lines from manual control valve. Cap hydraulic lines and manual control valve fittings.
6. Disconnect position sensor electrical connector from manual hydraulic wire harness. See Figure 7.
7. Disconnect OPS solenoids from manual hydraulic wire harness. See Figure 7.

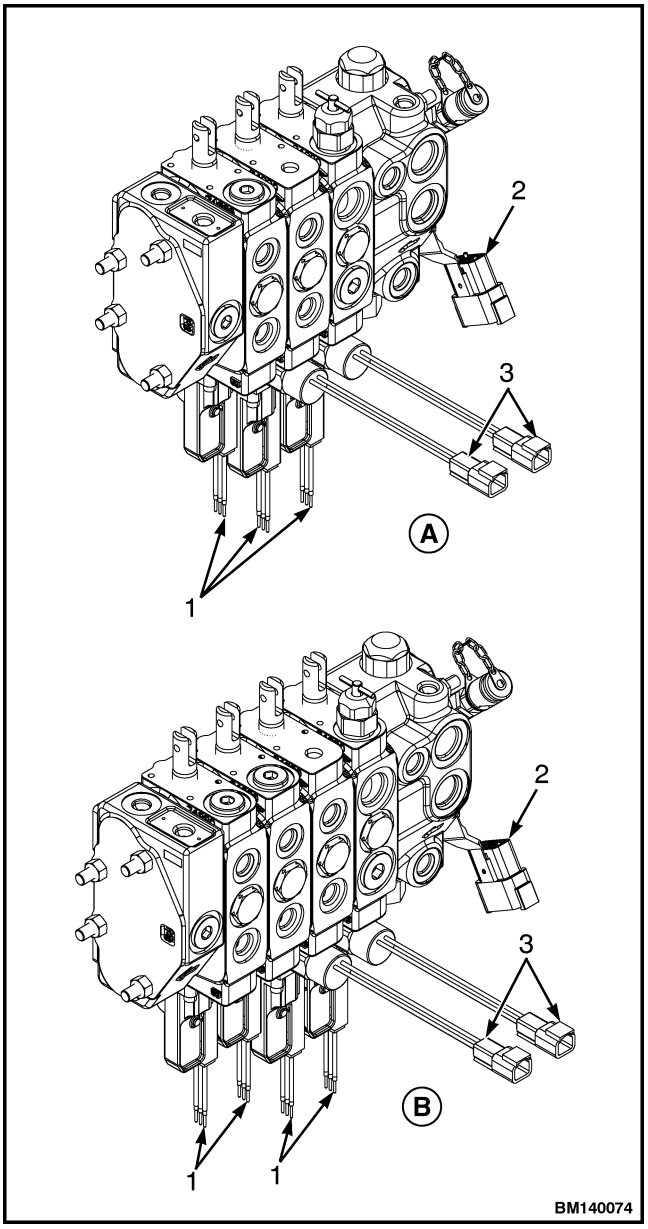


Figure 7. Manual Control Valve Electrical Connections

Legend for Figure 7

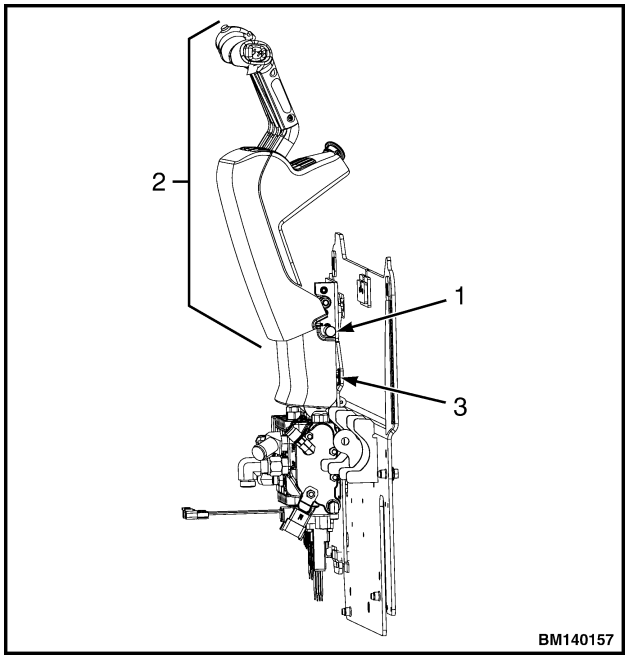
A. 3-FUNCTION MANUAL CONTROL VALVE
B. 4-FUNCTION MANUAL CONTROL VALVE

1. POSITION SENSOR WIRES
2. POSITION SENSOR ELECTRICAL CONNECTOR
3. OPS SOLENOID

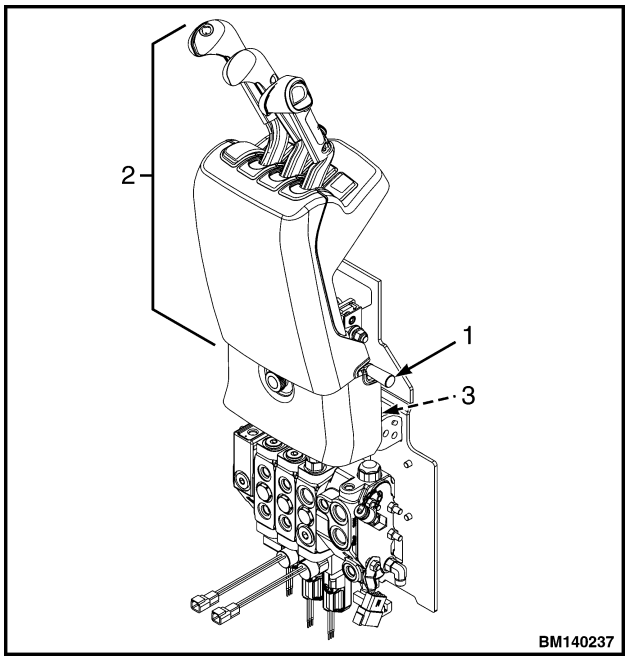
Disassemble Covers, Links, and Levers

NOTE: Original and updated illustrations shown in STEP 1, STEP 6, and STEP 13 through STEP 16.

STEP 1.
Pull latch handle and allow manual hydraulic linkage and levers to move forward away from mounting plate.

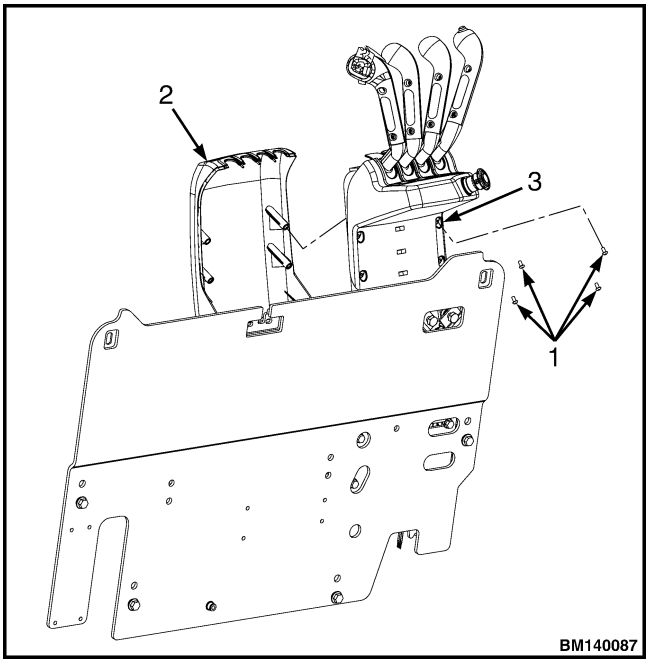


1. LATCH HANDLE
2. MANUAL HYDRAULIC LINKAGE AND LEVERS
3. MOUNTING PLATE



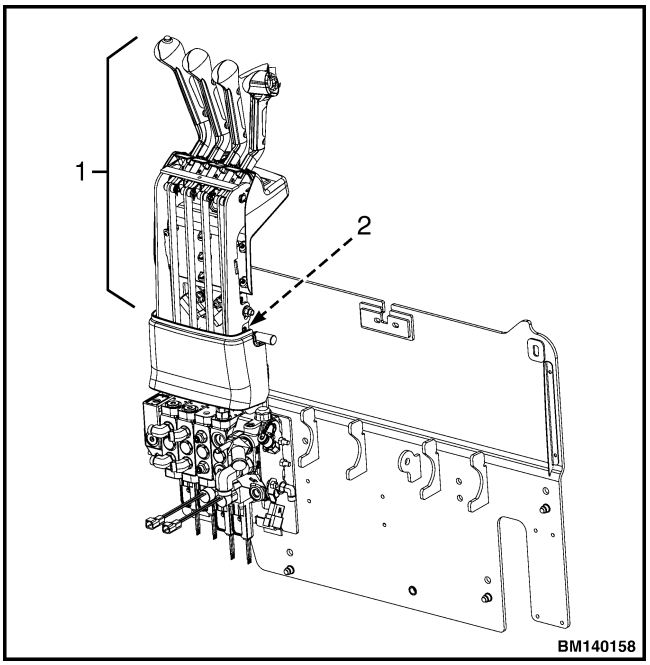
1. LATCH HANDLE
2. MANUAL HYDRAULIC LINKAGE AND LEVERS
3. MOUNTING PLATE

STEP 2.
Remove four button-head capscrews and upper front cover from rear cover.



1. BUTTON-HEAD CAPSCREW
2. UPPER FRONT COVER
3. REAR COVER

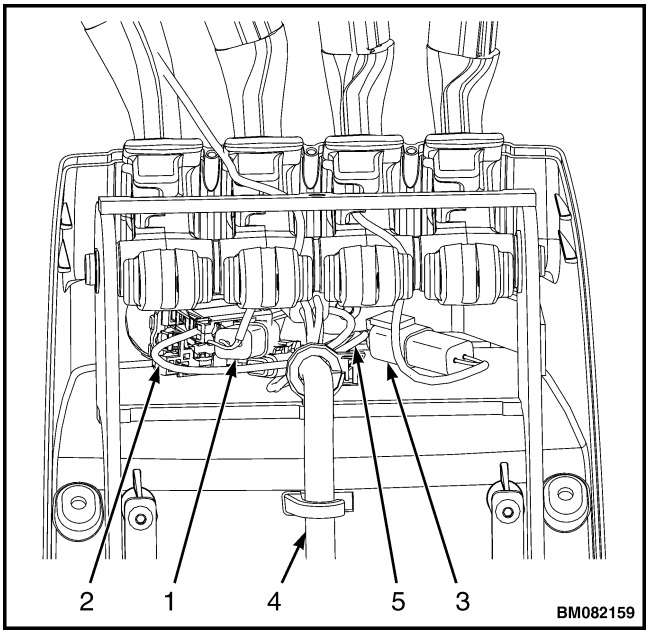
STEP 3.
Push manual hydraulic linkage and handles upright until secured against mounting plate.



1. MANUAL HYDRAULIC LINKAGE AND HANDLES
2. MOUNTING PLATE

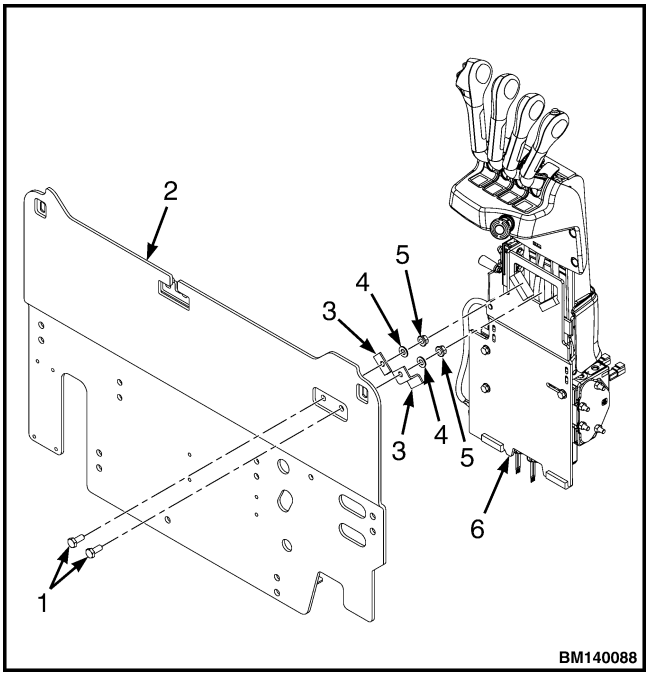
STEP 4.
Tag and disconnect manual hydraulic wire harness from clamp button connector, emergency disconnect switch connector, and direction control switch connector.

Lift truck models J30-40XNT (K160) and J30-40XN (A935) manufactured after November, 2014, can be equipped with a Return to Set Tilt (RTST) option on the tilt lever. Tag and disconnect manual hydraulic wire harness from clamp button connector, emergency disconnect switch connector, direction control switch connector, and RTST switch connector.



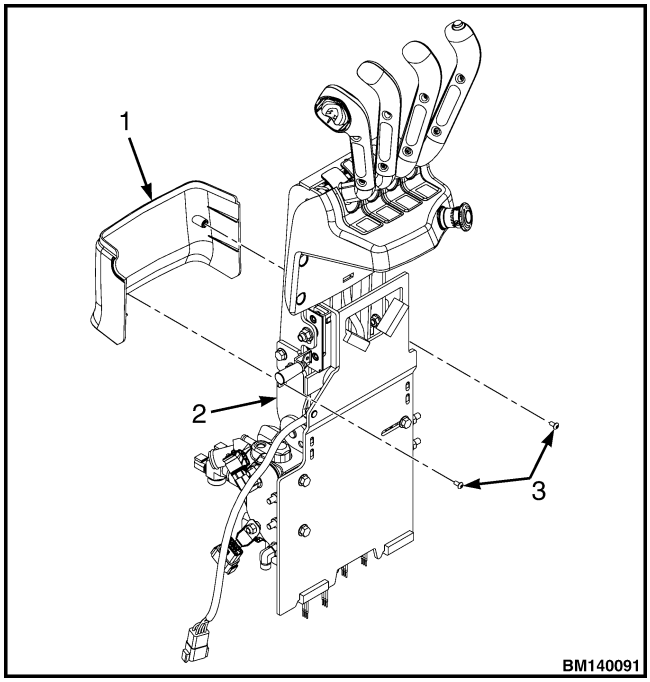
1. CLAMP BUTTON CONNECTOR
2. EMERGENCY DISCONNECT SWITCH CONNECTOR
3. RETURN TO SET TILT SWITCH CONNECTOR
4. MANUAL CONTROL VALVE WIRE HARNESS
5. DIRECTION CONTROL SWITCH CONNECTOR

STEP 5.
Remove two nuts, two washers, two brackets, and two capscrews from mounting plate and front bulkhead.

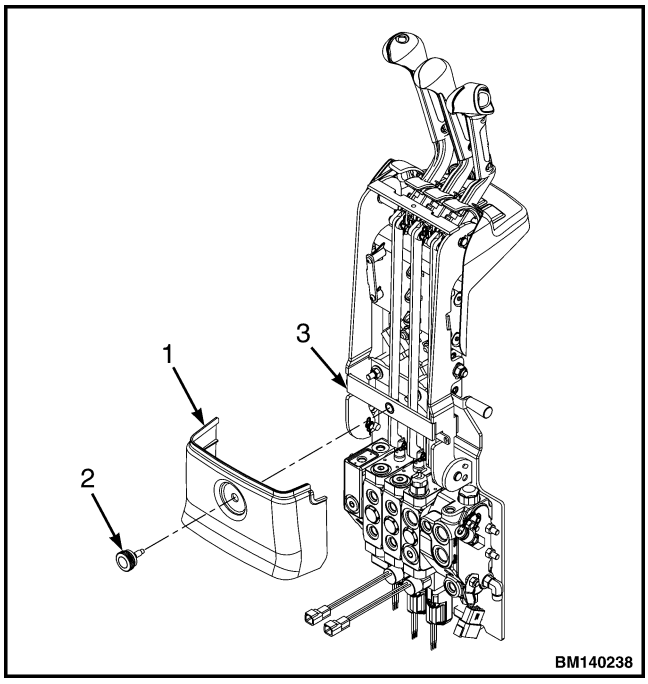


1. CAPSCREW
2. FRONT BULKHEAD
3. BRACKET
4. WASHER
5. NUT
6. MOUNTING PLATE

STEP 6.
Remove two button-head capscrews and lower cover from lower frame plate or remove captive screw and lower cover from plate.

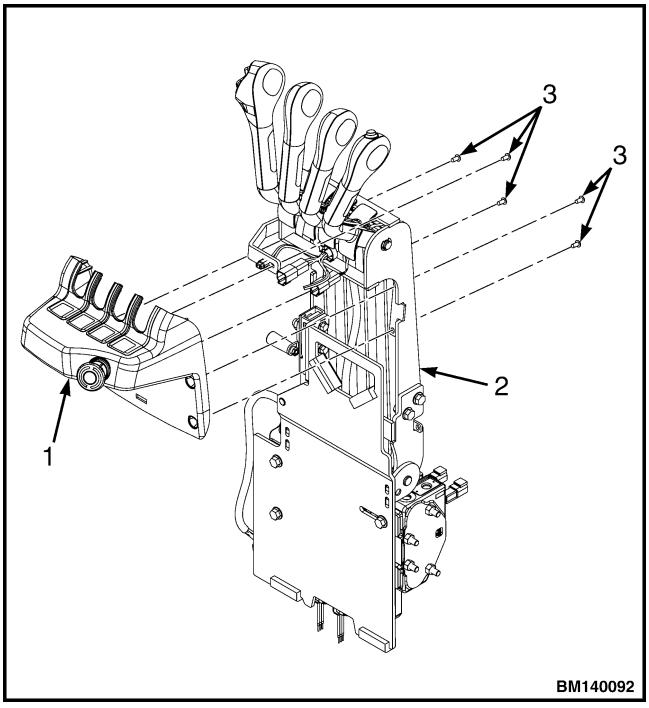


1. LOWER COVER
2. LOWER FRAME PLATE
3. BUTTON-HEAD CAPSCREW



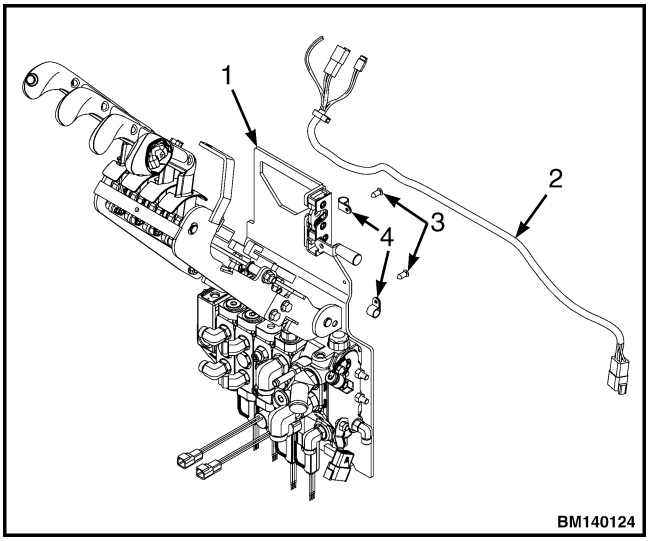
1. LOWER COVER
2. CAPTIVE SCREW
3. PLATE

STEP 7.
Remove five button-head capscrews and rear cover from upper bracket.



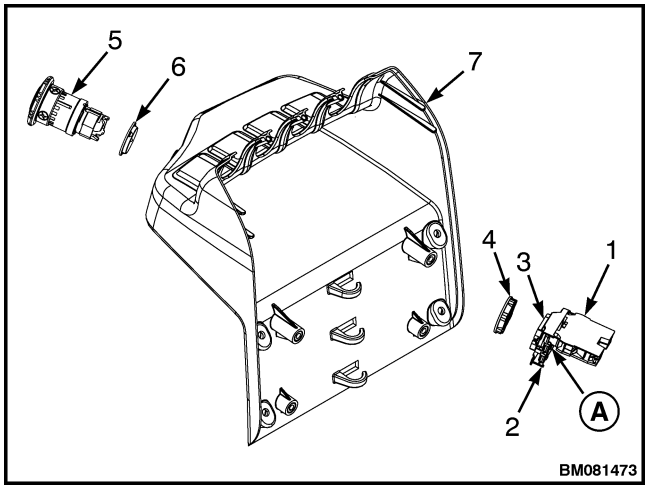
1. REAR COVER
2. UPPER BRACKET
3. BUTTON-HEAD CAPSCREW

STEP 8.
Remove two capscrews and two clamps from manual hydraulics wire harness and mounting plate. Move manual hydraulics wire harness aside to avoid damage.



1. MOUNTING PLATE
2. MANUAL HYDRAULICS WIRE HARNESS
3. CAPSCREW
4. CLAMP

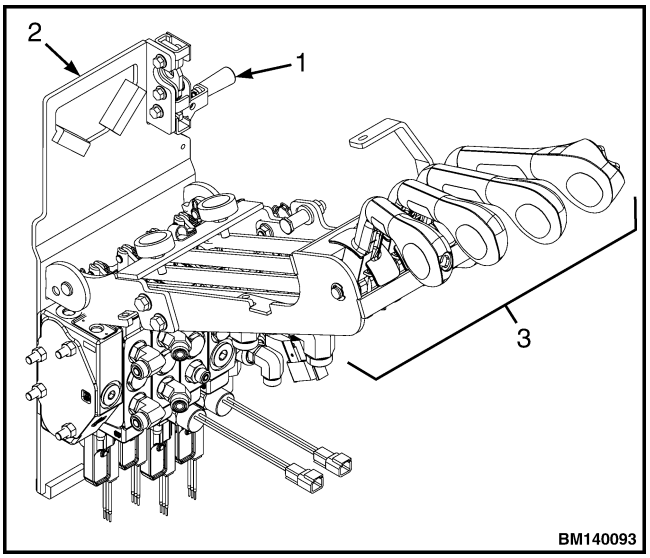
STEP 9.
Disconnect emergency disconnect switch from manual hydraulic wire harness and remove from rear cover. See **Electrical System** 2200SRM1337 for procedure.



A. INSERT SCREWDRIVER HERE

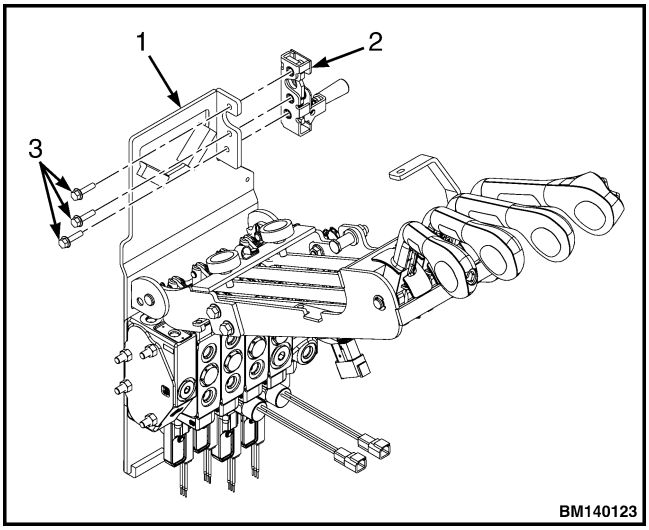
1. SWITCH
2. SWITCH ADAPTER
3. LOCK
4. NUT
5. EMERGENCY DISCONNECT SWITCH
6. WASHER
7. REAR COVER
8. HOLE

STEP 10.
Pull latch handle up and allow manual hydraulic linkage and handles to move forward away from mounting plate.



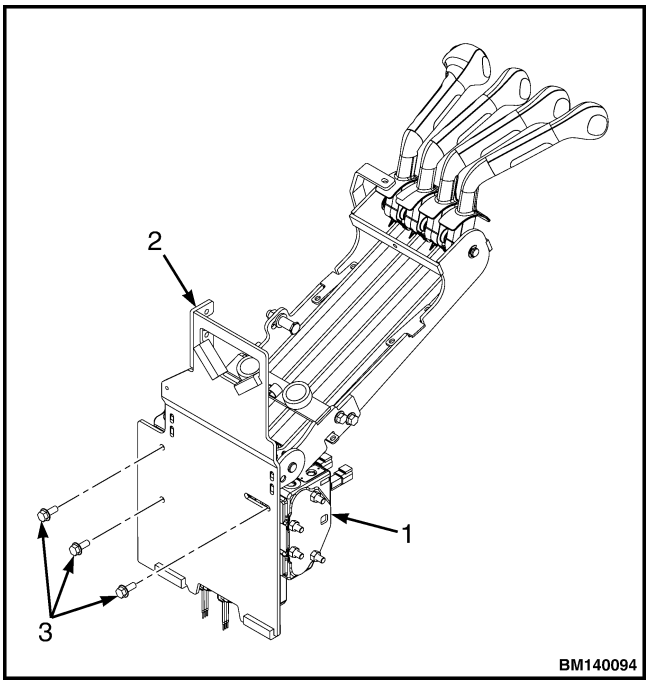
1. LATCH HANDLE
2. MOUNTING PLATE
3. MANUAL HYDRAULIC LINKAGE AND HANDLES

STEP 11.
Remove three capscrews and latch assembly from mounting plate.



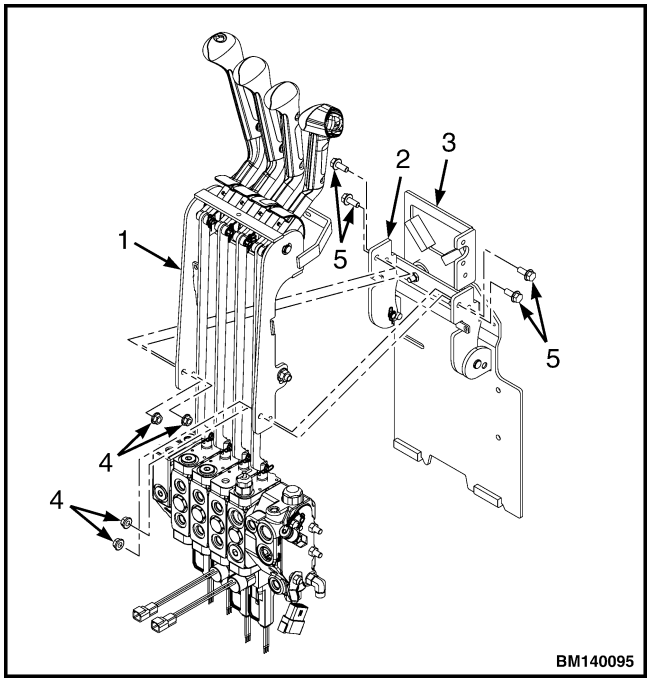
1. MOUNTING PLATE
2. LATCH ASSEMBLY
3. CAPSCREW

STEP 12.
Remove three hex capscrews from mounting plate and manual control valve.

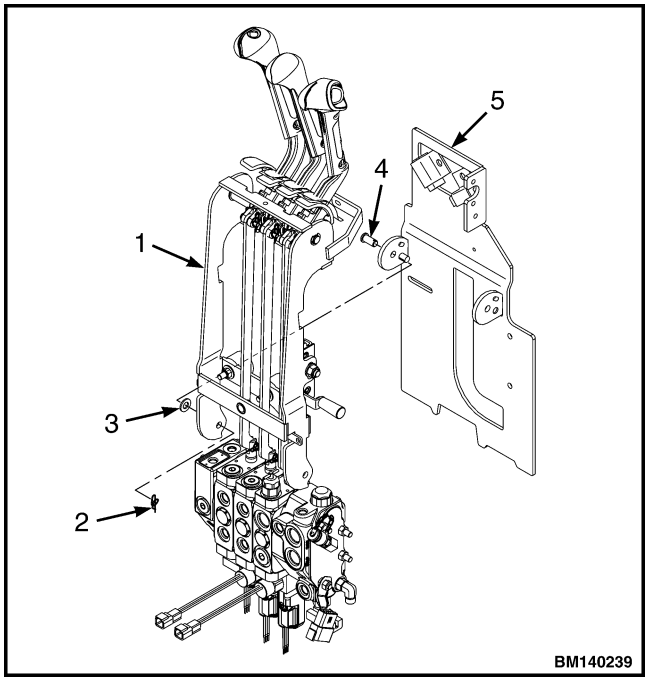


1. MANUAL CONTROL VALVE
2. MOUNTING PLATE
3. HEX CAPSCREW

STEP 13.
Remove four nuts, four capscrews, and lower frame plate with mounting bracket from upper bracket or remove locking ring cotter pin, rod end pin, nylon washer, and mounting bracket from upper bracket.

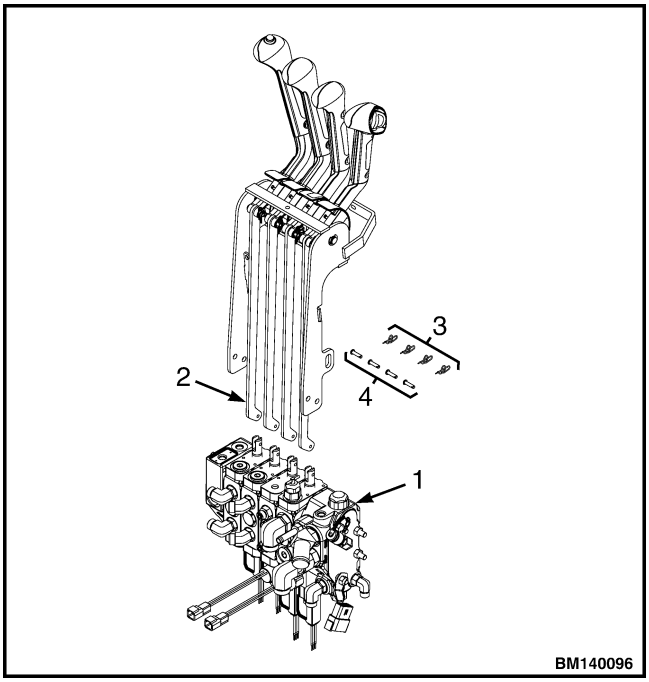


1. UPPER BRACKET
2. LOWER FRAME PLATE
3. MOUNTING BRACKET
4. NUT
5. CAPSCREW

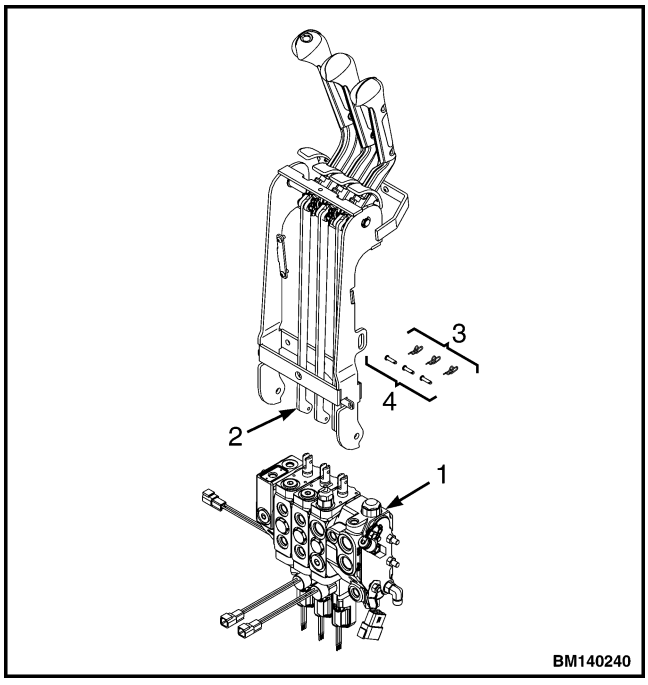


1. UPPER BRACKET
2. LOCKING RING COTTER PIN
3. NYLON WASHER
4. ROD END PIN
5. MOUNTING BRACKET

STEP 14.
Remove locking ring cotter pin, rod end pin, and link from manual control valve. Repeat for all links. Discard locking ring cotter pin.

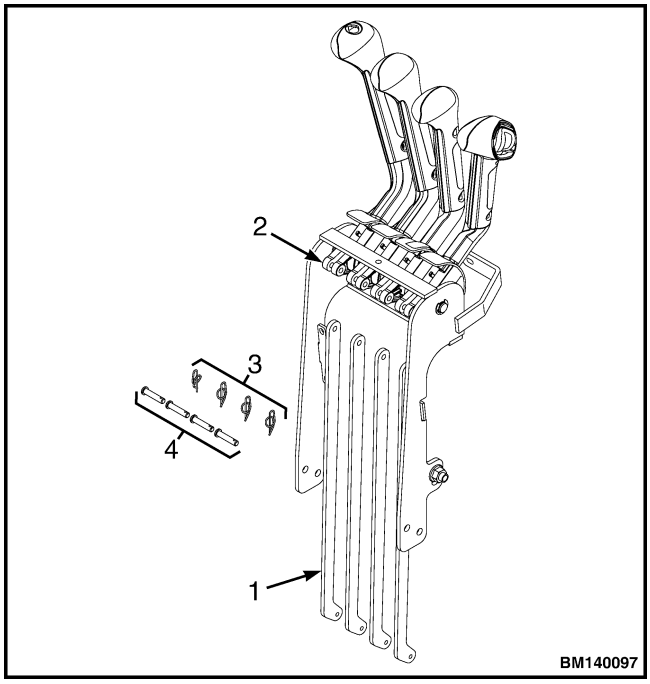


1. MANUAL CONTROL VALVE
2. LINK
3. LOCKING RING COTTER PIN
4. ROD END PIN

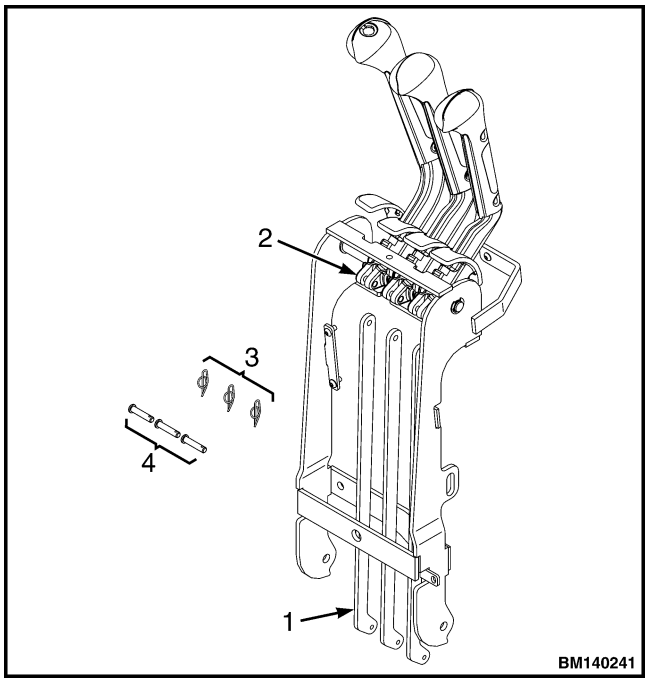


1. MANUAL CONTROL VALVE
2. LINK
3. LOCKING RING COTTER PIN
4. ROD END PIN

STEP 15.
Remove locking ring cotter pin, clevis pin, and link from levers. Repeat for all links. Discard locking ring cotter pin.

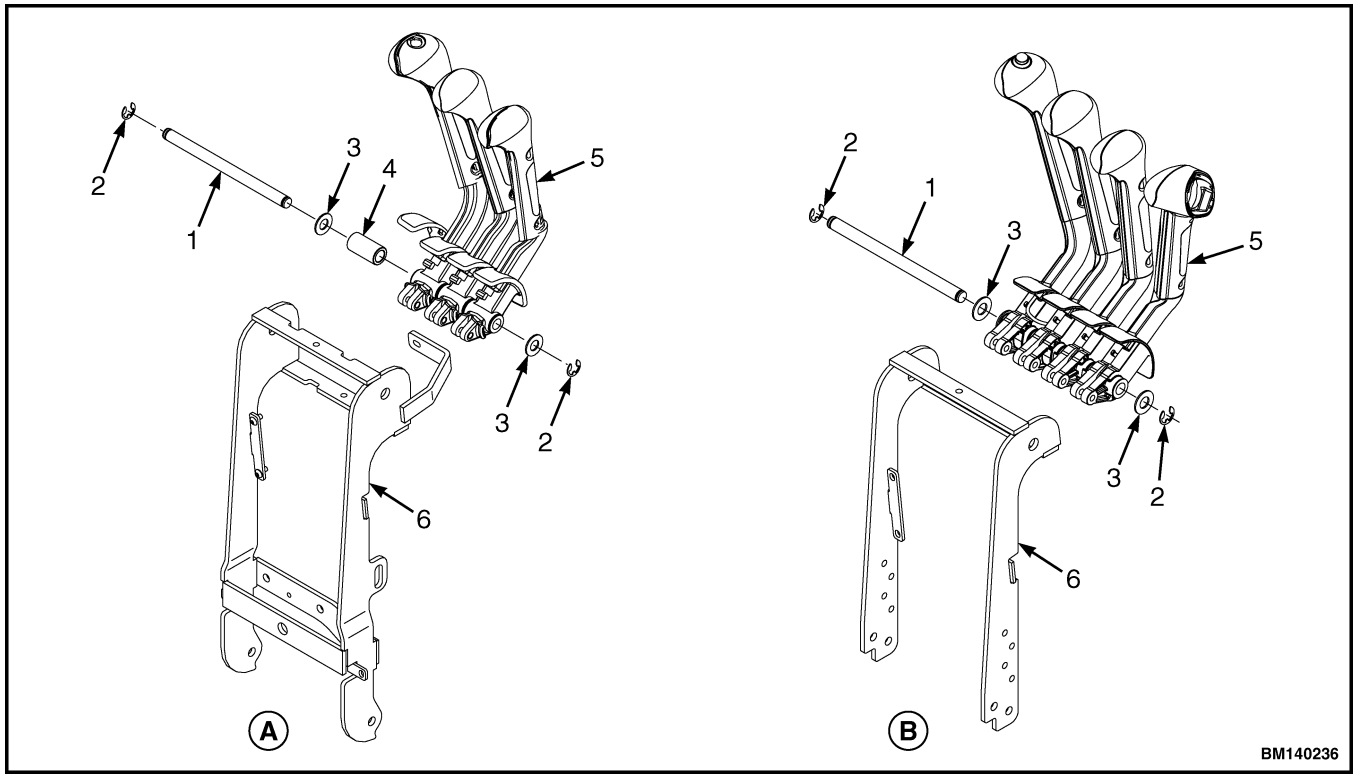


1. LINK
2. LEVER
3. LOCKING RING COTTER PIN
4. CLEVIS PIN



1. LINK
2. LEVER
3. LOCKING RING COTTER PIN
4. CLEVIS PIN

STEP 16.
Remove e-clip at both ends of pivot pin. Slide pivot pin from levers and upper bracket, removing nylon washers, lever spacer if present, and levers.



A. 3-FUNCTION LEVERS

1. PIVOT PIN
2. E-CLIP
3. WASHER

B. 4-FUNCTION LEVERS

4. LEVER SPACER
5. LEVER
6. UPPER BRACKET

DISASSEMBLE HANDLES AND LEVERS

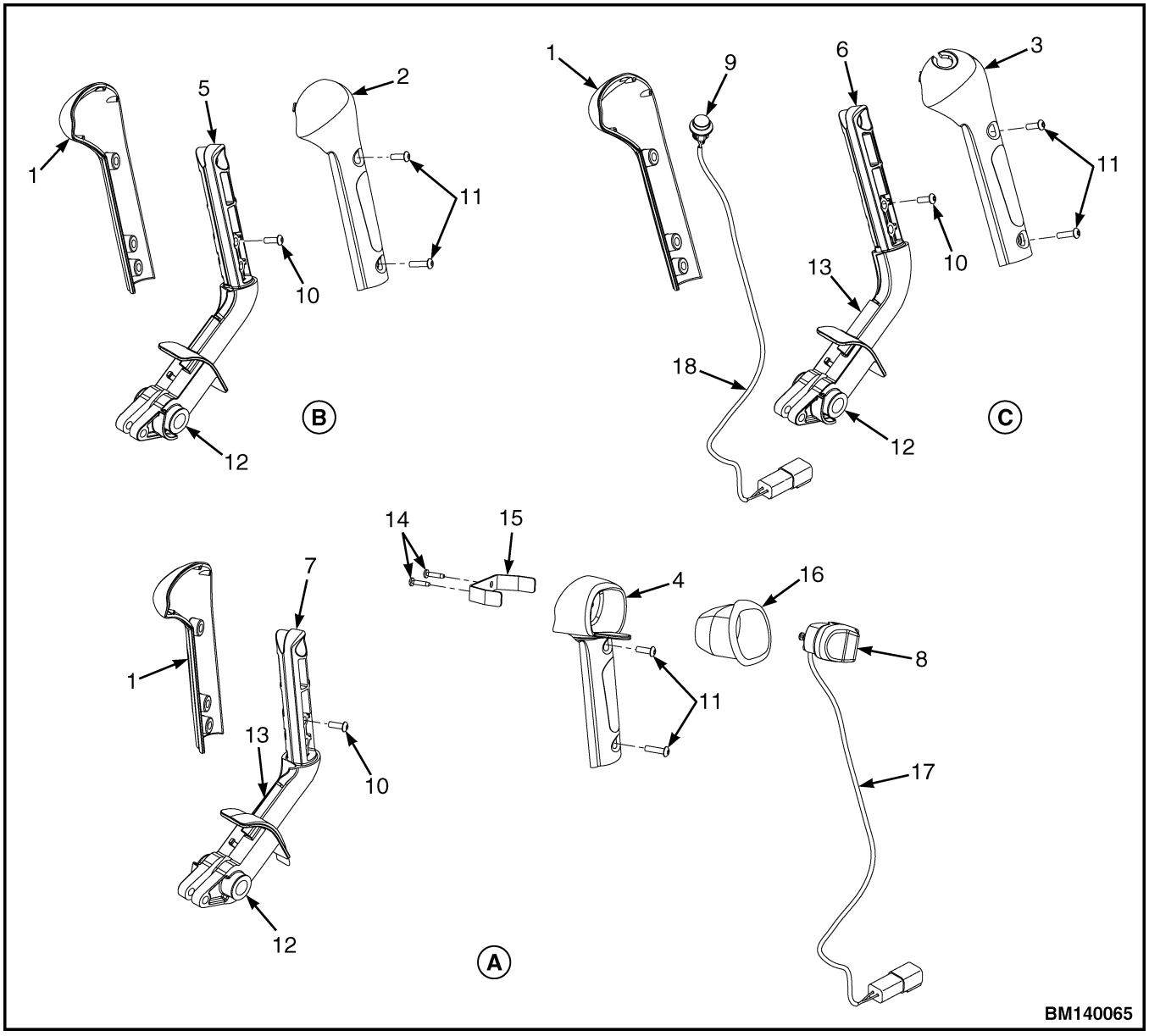
NOTE: If necessary, handles can be disassembled. Perform Step 1 through Step 4 for lift/lower handle for lift truck equipped with Direction Control Switch (DCS) handle, Step 5 and Step 6 for lift/lower, tilt, aux 1, and aux 2 handles, and Step 7 through Step 10 for aux handle with dual function for lift trucks equipped with clamping function or lift truck models J30-40XNT (K160) and J30-40XN (A935) manufactured after November, 2014 and equipped with Return to Set Tilt (RTST) option

NOTE: Handles described in Step 1 through Step 4 and Step 7 through Step 10 are optional.

1. Remove two outer capscrews and lift/lower with DCS handle from manual lift/lower lever. See Figure 8.

2. Remove one inner capscrew and palm side grip handle from manual lift lever. See Figure 8.

3. Remove DCS cable from cable track. See Figure 8.



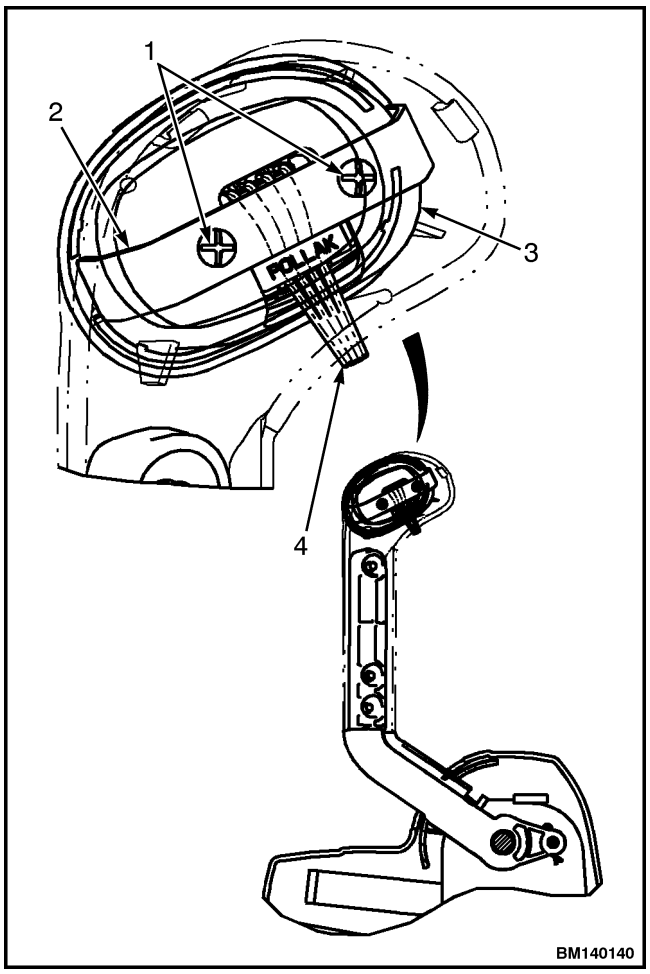
NOTE: ONLY LIFT TRUCK MODELS J30-40XNT (K160) AND J30-40XN (A935) MANUFACTURED AFTER NOVEMBER, 2014 CAN BE EQUIPPED WITH RETURN TO SET TILT (RTST) OPTION.

A. LIFT/LOWER WITH DCS
B. LIFT/LOWER, TILT, AUX 1, AUX 2
C. AUX WITH DUAL FUNCTION OR TILT HANDLE WITH RETURN TO SET TILT

1. PALM SIDE GRIP HANDLE
2. FINGER SIDE HANDLE
3. CLAMP/RTST SWITCH HANDLE
4. LIFT/LOWER WITH DCS HANDLE
5. MANUAL TILT OR AUX 1 LEVER
6. MANUAL AUX 2 LEVER
7. MANUAL LIFT/LOWER LEVER
8. DIRECTIONAL CONTROL SWITCH (DCS)
9. CLAMPING PUSH-BUTTON/RETURN TO SET TILT PUSH-BUTTON
10. INNER CAPSCREW
11. OUTER CAPSCREW
12. BUSHING
13. CABLE TRACK
14. SCREW
15. DCS RETAINER
16. DCS CUP
17. DCS CABLE
18. PUSH-BUTTON CABLE

Figure 8. Manual Hydraulic Control Handles

4. Remove two screws, DCS retainer, DCS cup, and Direction Control Switch from lift/lower with DCS handle. See Figure 8 and Figure 9.



1. SCREW
2. DCS RETAINER
3. DCS CUP
4. DCS CABLE

Figure 9. Directional Control Switch

5. Remove two outer capscrews and finger side handle from manual tilt or aux 1 lever. See Figure 8.

6. Remove one inner capscrew and palm side grip handle from manual tilt or aux 1 lever. See Figure 8.

7. For lift truck models J30-40XNT (K160) and J30-40XN (A935) manufactured after November, 2014 and equipped with RTST button option, remove push-button cable from cable track. See Figure 8.

8. Remove two outer capscrews and clamp switch handle from manual aux 2 lever. See Figure 8.

9. Remove one inner capscrew and palm side grip handle from manual aux 2 lever. See Figure 8.

10. Remove push-button cable from cable track. See Figure 8.

11. Remove bushings from levers. See Figure 8.

DISASSEMBLE MANUAL CONTROL VALVE

CAUTION

All power must be disconnected from valve, mast lowered, and hydraulic lines de-pressurized prior to servicing.

Before any disassembly, all interfaces, joints, and recesses must be cleaned of residue and dirt to avoid contaminating internal components.

CAUTION

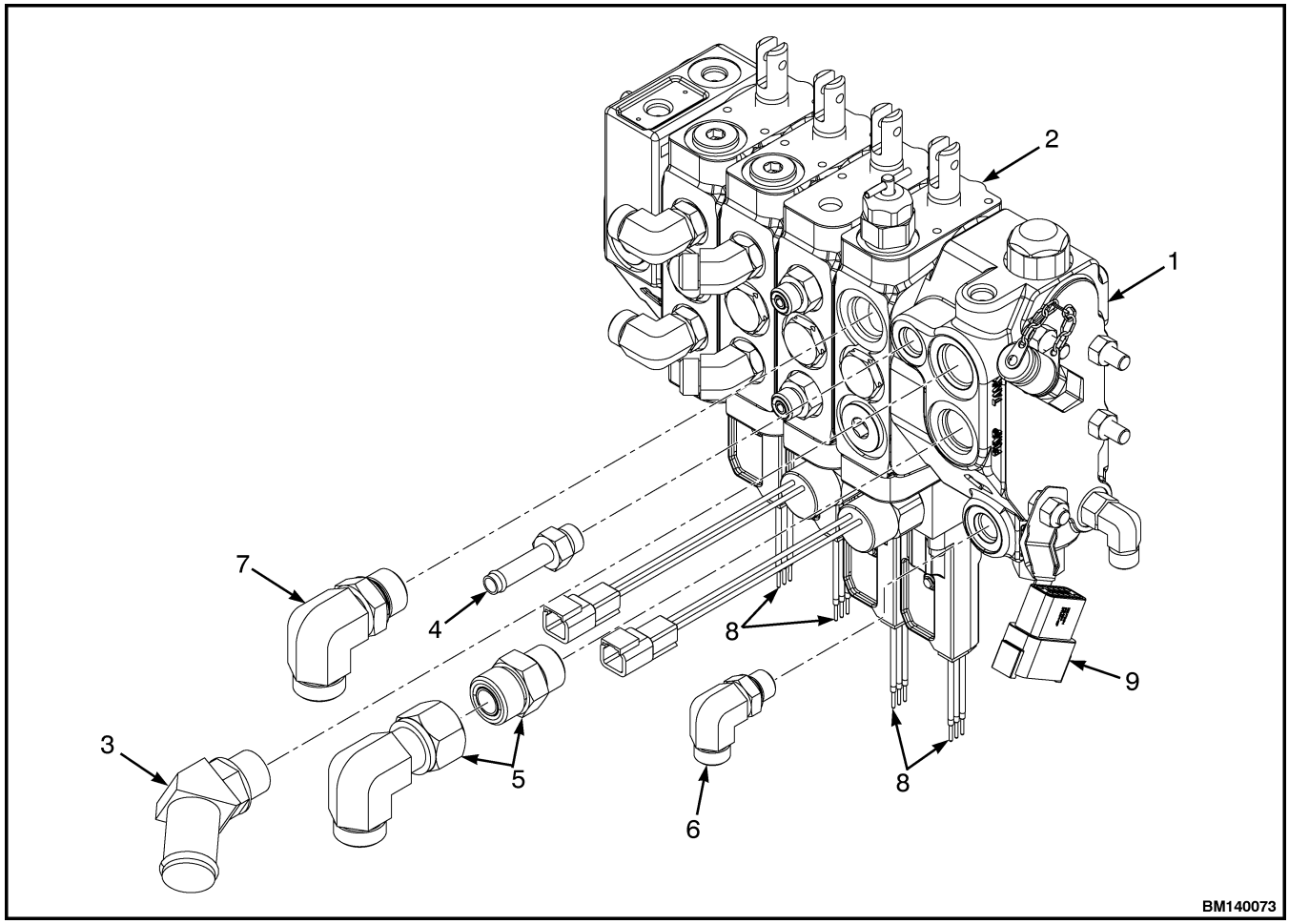
If O-rings are to be replaced between two sections that have a hydraulic oil leak, replace all O-rings between all sections. This eliminates the possibility of a subsequent oil leak or possible damage to another O-ring.

NOTE: Disassemble the manual control valve only as necessary for repairs. Most repairs to the manual control valve will be to replace O-rings and seals. Spools and valve sections are not serviceable individually and must be replaced as a complete valve section with spool.

NOTE: Note placement and orientation of fittings prior to disassembly to aid in assembly.

NOTE: Lift truck models J1.5-2.0XNT (K160) manufactured after November, 2014 do not have any hydraulic hoses and connections for the steering function. These lift truck models are equipped with E-Steering (Electronic Steering) and steering function is done electronically.

1. For lift truck models J1.5-2.0XNT (K160) manufactured before November, 2014 and J30-40XNT (K160) and J1.6-2.0XN (J30-40XN) (A935) lift truck models, remove inlet fitting, return line fitting, steer supply line fitting, steer return line fitting, and lift/lower fitting from inlet and lift section ports. See Figure 10.



NOTE: 4-FUNCTION MANUAL CONTROL VALVE SHOWN.

1. INLET SECTION
2. LIFT SECTION
3. RETURN LINE FITTING
4. STEER RETURN LINE FITTING
5. INLET FITTING
6. STEER SUPPLY LINE FITTING
7. LIFT/LOWER FITTING
8. POSITION SENSOR WIRES
9. POSITION SENSOR ELECTRICAL CONNECTOR

Figure 10. Manual Control Valve Fittings, Inlet and Lift Sections, Lift Truck Models J1.5-2.0XNT (K160) Manufactured Before November, 2014 and J30-40XNT (K160) and J1.6-2.0XN (J30-40XN) (A935)

2. For lift trucks J1.5-2.0XNT (K160) manufactured after November, 2014, remove inlet flitting, return line fitting, and lift/lower fitting from inlet and lift section ports. See Figure 11.

3. Tag and disconnect position sensor wires from position sensor electrical connector.

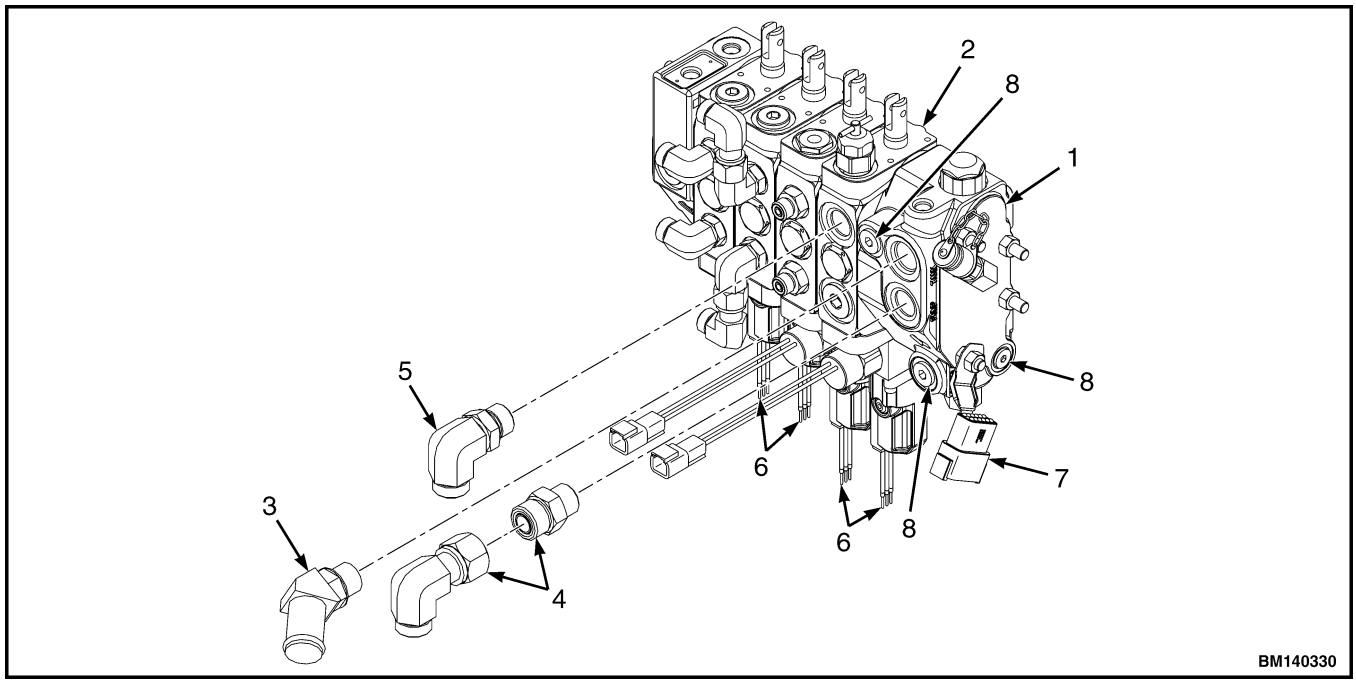
4. Remove tilt fittings, 3-function auxiliary fittings, and 4-function auxiliary fittings from tilt, auxiliary, and dual auxiliary sections.

See Figure 12 for lift truck models

- J1.5-2.0XNT (K160) manufactured before November, 2014
- J30-40XNT (K160) and J1.6-2.0XN (J30-40XN) (A935)

See Figure 13 for lift truck models

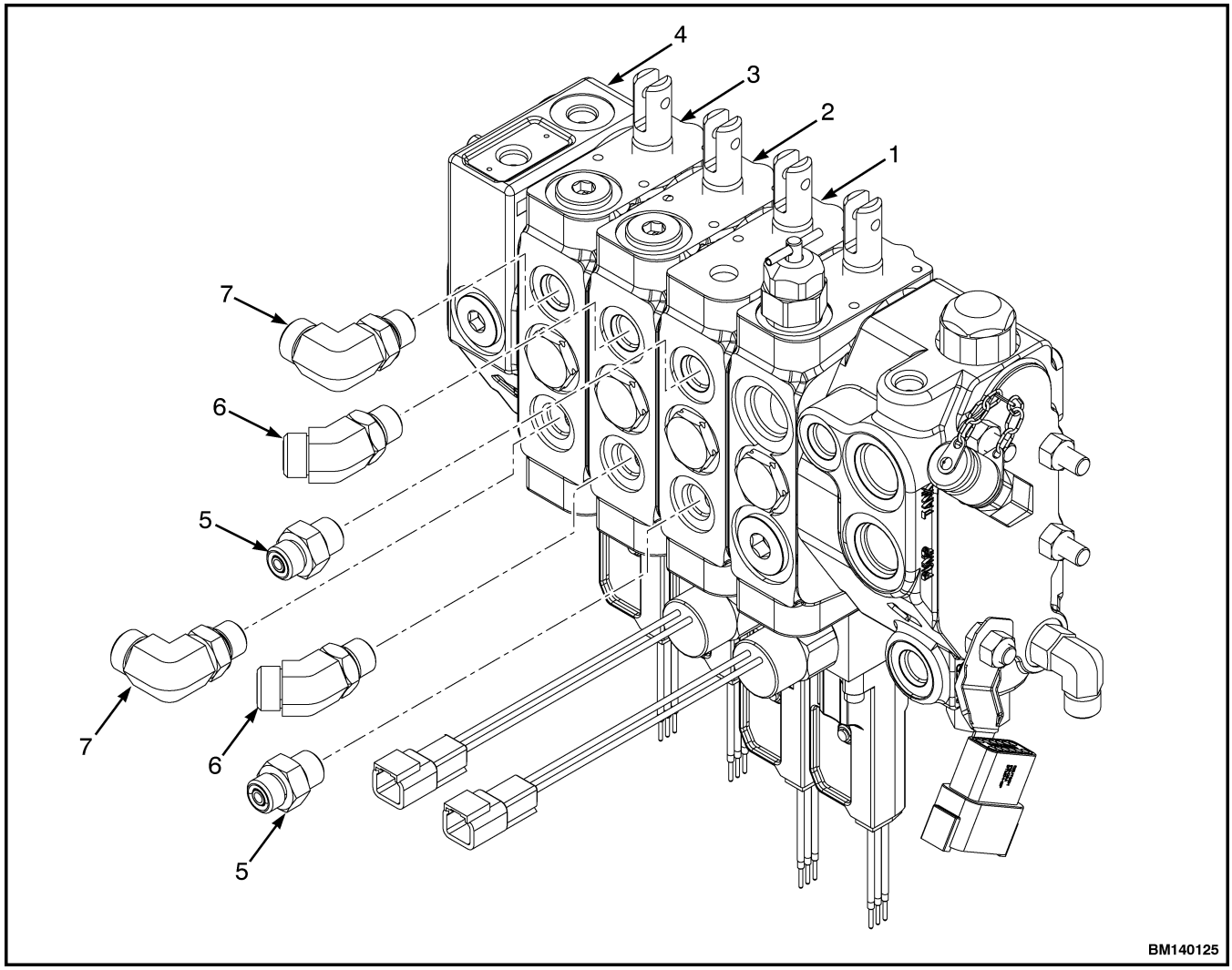
- J1.5-2.0XNT (K160) manufactured after November, 2014



NOTE: 4-FUNCTION MANUAL CONTROL VALVE SHOWN.

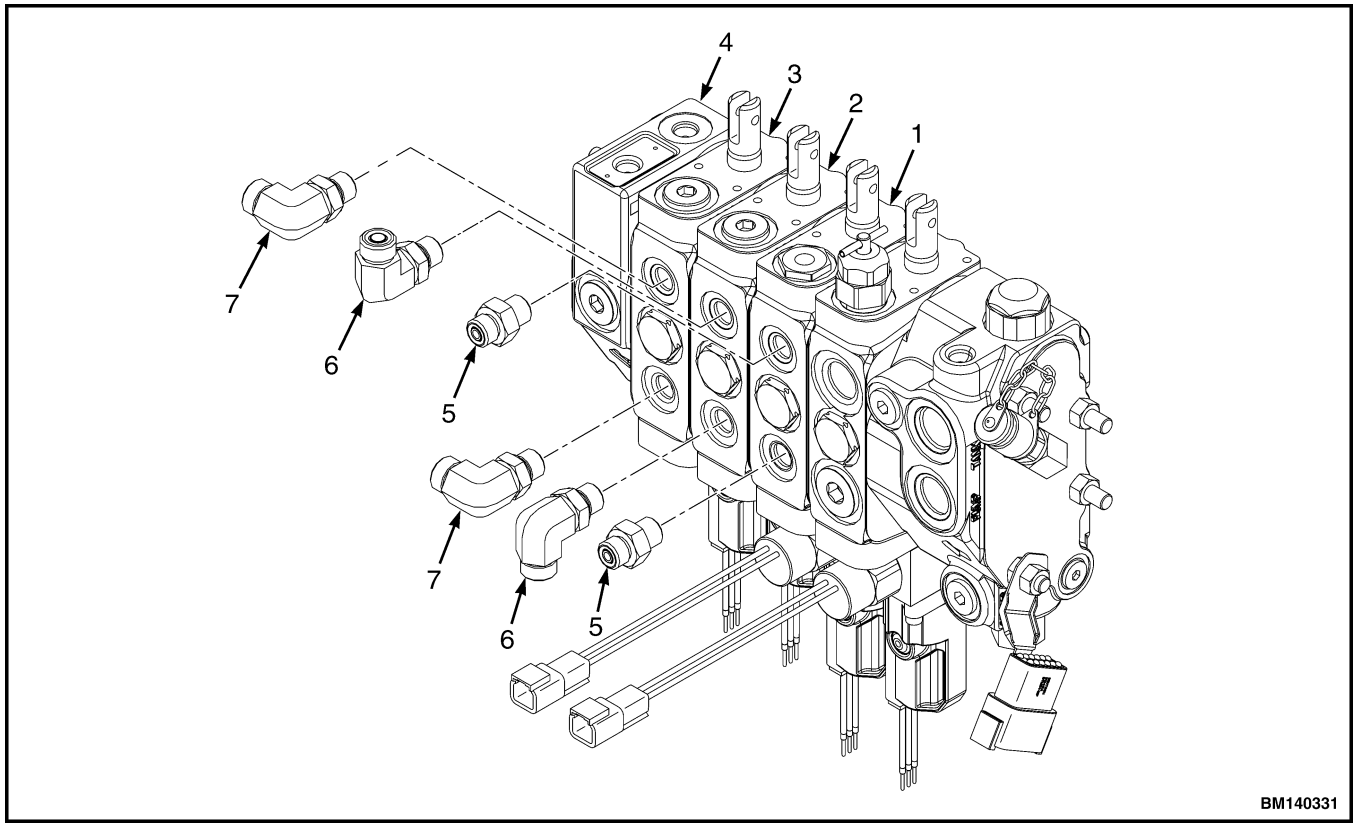
1. INLET SECTION
2. LIFT SECTION
3. PRESSURE LINE FITTING
4. INLET FITTING
5. LIFT/LOWER FITTING
6. POSITION SENSOR WIRES
7. POSITION SENSOR ELECTRICAL CONNECTOR
8. PLUG

Figure 11. Manual Control Valve Fittings, Inlet and Lift Sections, Lift Truck Models J1.5-2.0XNT (K160) Manufactured After November, 2014



1. TILT SECTION
2. AUXILIARY SECTION
3. DUAL AUXILIARY SECTION
4. OUTLET SECTION
5. TILT FITTINGS
6. 3-FUNCTION AUXILIARY FITTING
7. 4-FUNCTION AUXILIARY FITTING

Figure 12. Manual Control Valve Fittings, Tilt and Auxiliary Sections, Lift Truck Models J1.5-2.0XNT (K160) Manufactured Before November, 2014 and J30-40XNT (K160) and J1.6-2.0XN (J30-40XN) (A935)



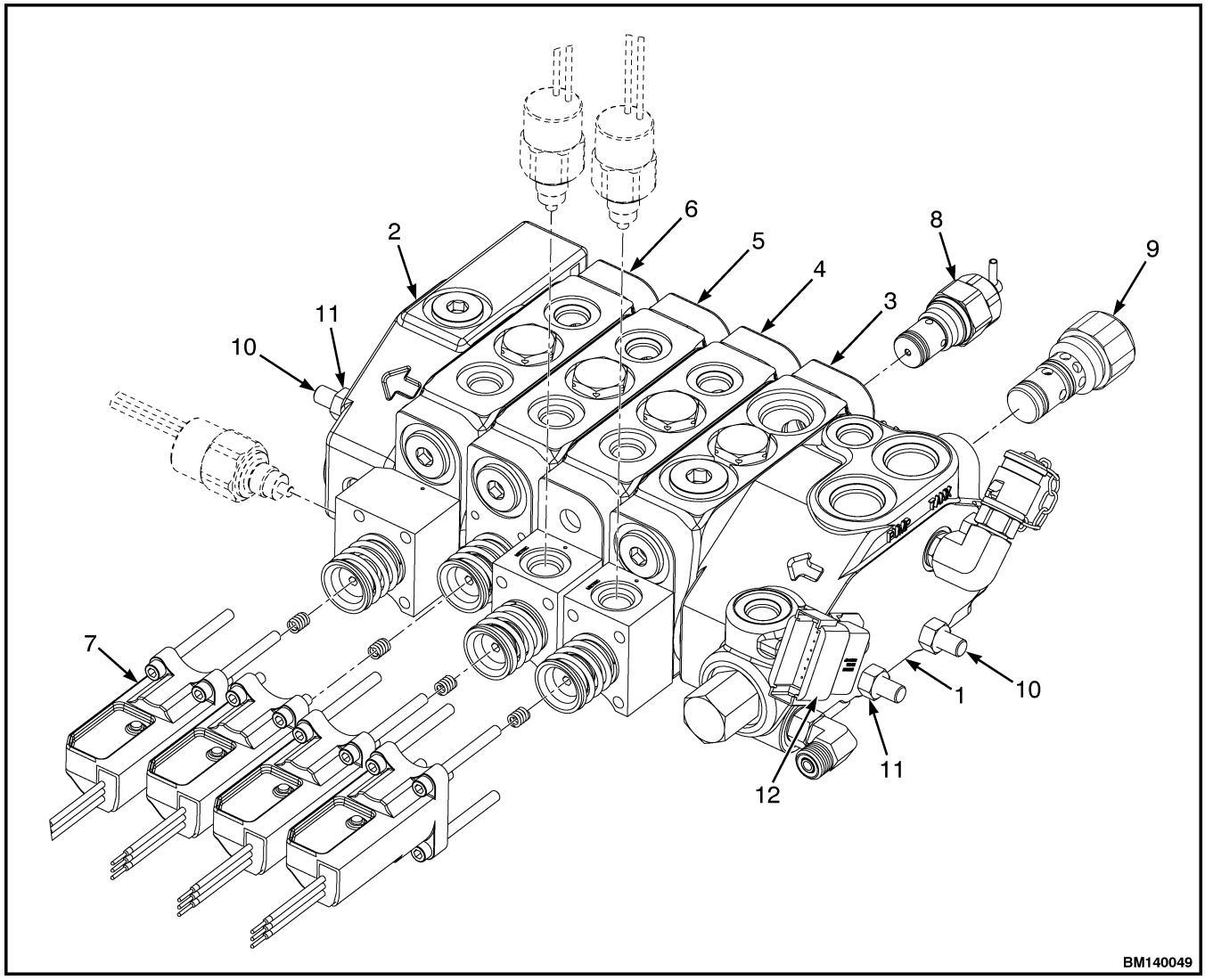
1. TILT SECTION
2. AUXILIARY SECTION
3. DUAL AUXILIARY SECTION
4. OUTLET SECTION
5. TILT FITTINGS
6. 3-FUNCTION AUXILIARY FITTING
7. 4-FUNCTION AUXILIARY FITTING

Figure 13. Manual Control Valve Fittings, Tilt and Auxiliary Sections, Lift Truck Models J1.5-2.0XNT (K160) Manufactured After November, 2014

5. Remove nuts from tie rods on outlet section side of manual control valve. See Figure 14.

NOTE: Note which tie rod has the position sensor electrical connector attached prior to disassembly to aid in assembly.

6. Remove nut and position sensor electrical connector from tie rod on inlet side of manual control valve. See Figure 14.



NOTE: MANUAL CONTROL VALVE SECTIONS FOR LIFT TRUCKS J1.5-2.0XNT (K160) MANUFACTURED BEFORE NOVEMBER, 2014 AND J30-40XNT (K160) AND J1.6-2.0XN (J30-40XN) (A935) SHOWN. MANUAL CONTROL VALVE SECTIONS FOR LIFT TRUCKS J1.5-2.0XNT (K160) MANUFACTURED AFTER NOVEMBER, 2014 ARE SIMILAR.

1. INLET SECTION
2. OUTLET SECTION
3. LIFT SECTION
4. TILT SECTION
5. AUXILIARY SECTION
6. AUXILIARY WITH SOLENOID SECTION
7. POSITION SENSOR
8. MANUAL LOWERING VALVE
9. PRIMARY RELIEF VALVE
10. TIE ROD
11. NUT
12. POSITION SENSOR ELECTRICAL CONNECTOR

Figure 14. Manual Control Valve Sections

7. Remove each section from tie rods starting with outlet section, followed by auxiliary with solenoid section if present, auxiliary section, tilt section, lift section, and finally the inlet section. See Figure 15.

NOTE: Note placement of section seals in retaining grooves prior to removal to aid in installation.

8. Remove and discard section seals from retaining grooves of all manual control valve sections. See Figure 16 and Figure 18.

9. Remove plug from outlet section. See Figure 17.

NOTE: Perform Step 10 for tilt section.

10. If equipped, remove optional work port relief valve from tilt section. Remove and discard O-rings and backup ring from relief valve. See Figure 16.

NOTE: Perform Step 11 for lift section.

11. Remove manual lowering valve from lift section. Remove and discard O-rings and backup ring from valve. See Figure 16.

NOTE: Step 12 does not apply to lift truck models J1.5-2.0XNT (K160) manufactured after November, 2014.

12. Remove steering load sense fitting from inlet section. Remove and discard O-rings from steering load sense fitting. See Figure 18.

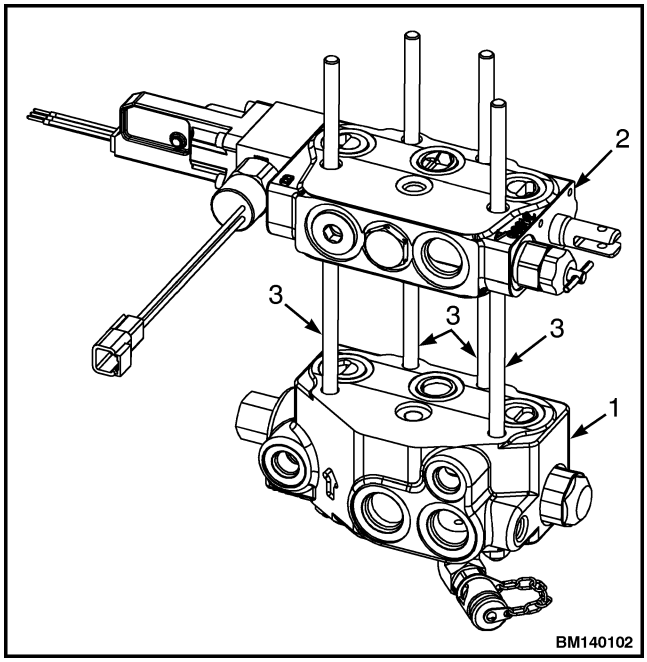
13. Remove plug from inlet section. Remove and discard O-ring from plug. See Figure 18.

14. Remove primary relief valve from inlet section. Remove and discard O-rings and backup rings from primary relief valve. See Figure 18.

15. Remove diagnostic and elbow fittings from inlet section. Remove and discard O-ring from elbow fitting. See Figure 18.

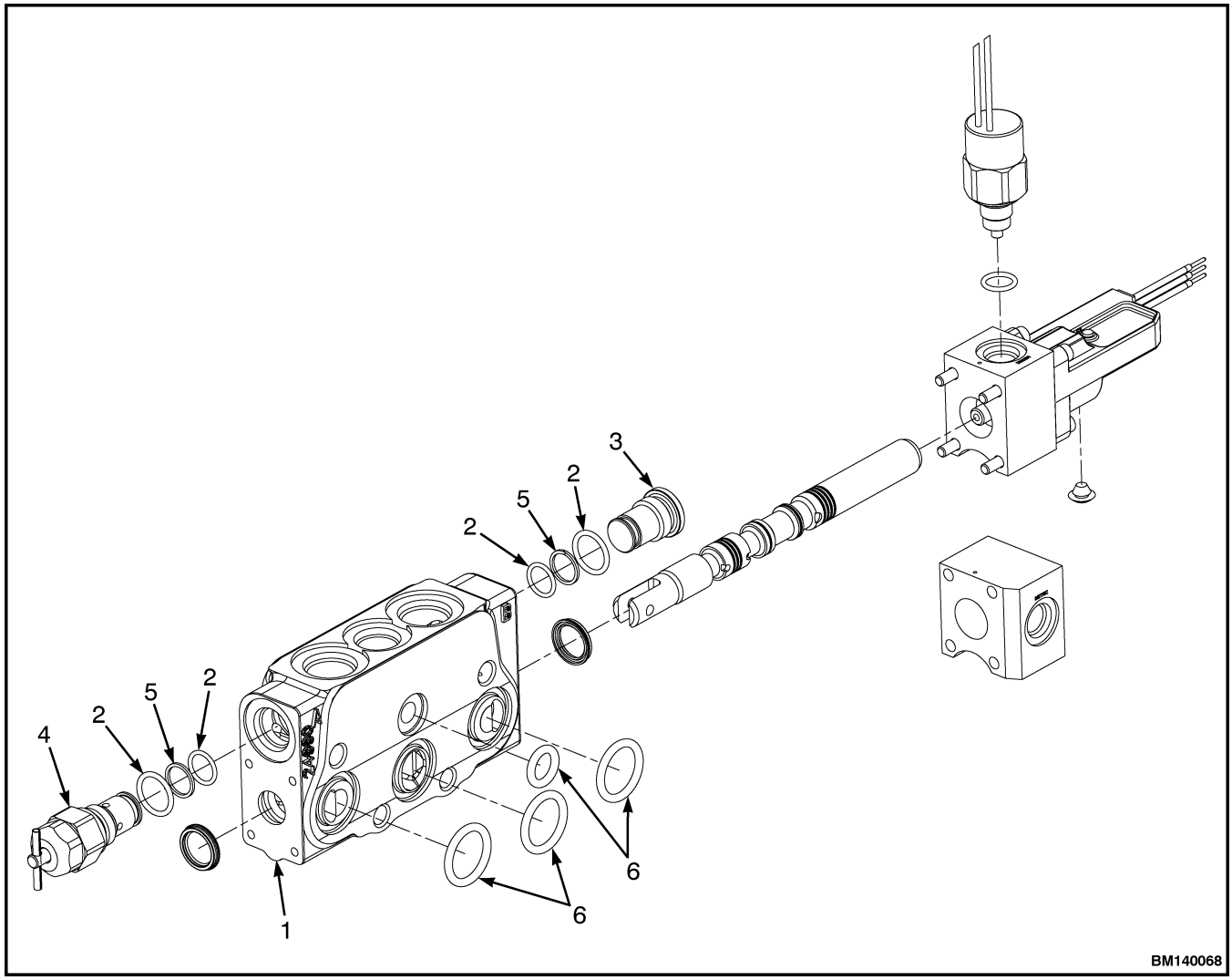
SPOOL SEAL REPLACEMENT

1. Remove OPS solenoid from lift, tilt, and auxiliary with solenoid sections. See Figure 19 and Figure 20.



1. INLET SECTION
2. LIFT SECTION
3. TIE ROD

Figure 15. Manual Control Valve - Sections and Tie Rods

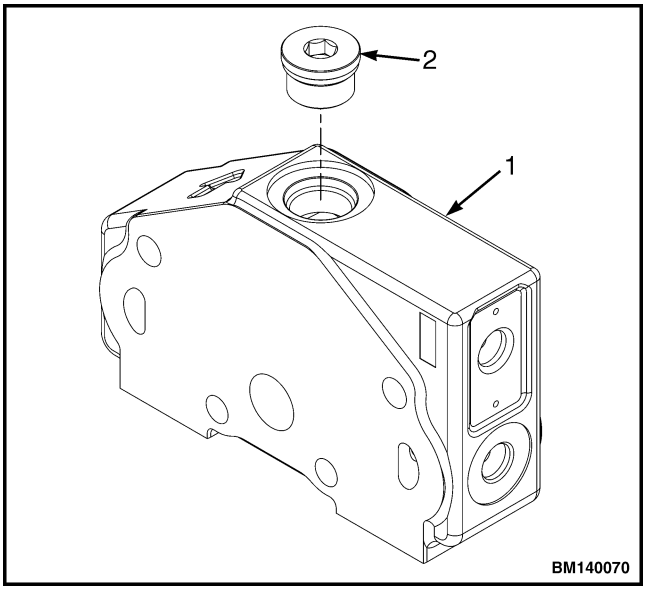


NOTE: VALVE SECTION BODY FOR LIFT, TILT, AND AUXILIARY SECTIONS ARE VISUALLY THE SAME.

NOTE: SPOOL, POSITION SENSOR, AND SOLENOID SHOWN PER MANUFACTURER'S DOCUMENTATION.

1. LIFT/TILT/AUXILIARY SECTION BODY
2. O-RING
3. OPTIONAL WORK PORT RELIEF VALVE
4. MANUAL LOWERING VALVE
5. BACKUP RING
6. SECTION SEAL

Figure 16. Lift/Tilt/Auxiliary Sections Manual Control Valve



1. OUTLET SECTION
2. PLUG

Figure 17. Outlet Section of Manual Control Valve

NOTE: **DO NOT** lose spring at end of position sensor. See Figure 19.

2. Remove capscrews and position sensor from spool lock body on lift section, tilt section, and auxiliary with solenoid section. See Figure 19, Figure 20, and Figure 22.

3. Remove position sensor from spool lock body. See Figure 19.

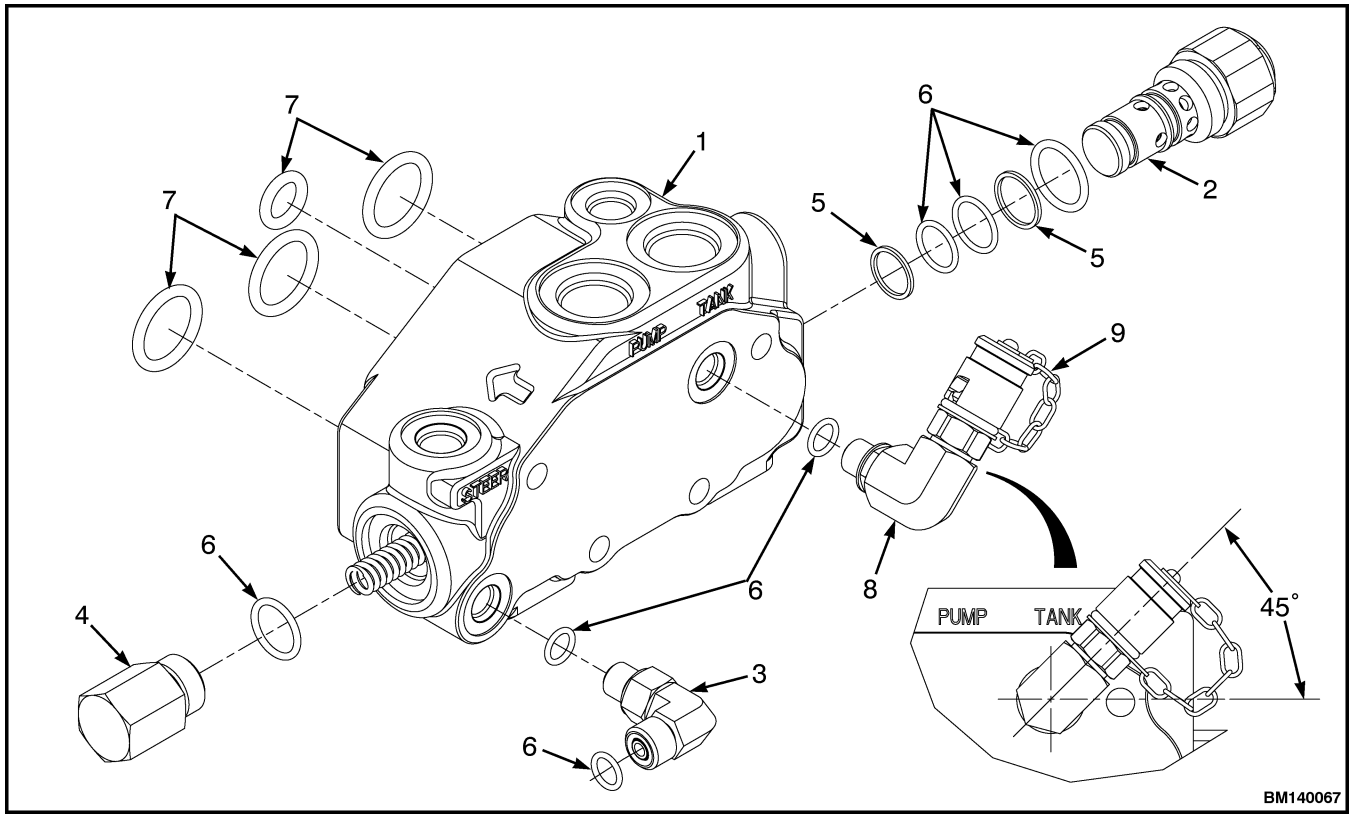
NOTE: If working on tilt section, use caution not to lose small spool and spring inside main spool and held in place with spool lock extension.

4. Using screwdriver or pin, hold spool clevis and remove spool lock extension from spool assembly. See Figure 20.

5. Pull spool assembly far enough out of the section body to expose spool seal on clevis end of section body. See Figure 20.

NOTE: Lubricate new spool seal with clean hydraulic oil prior to installation.

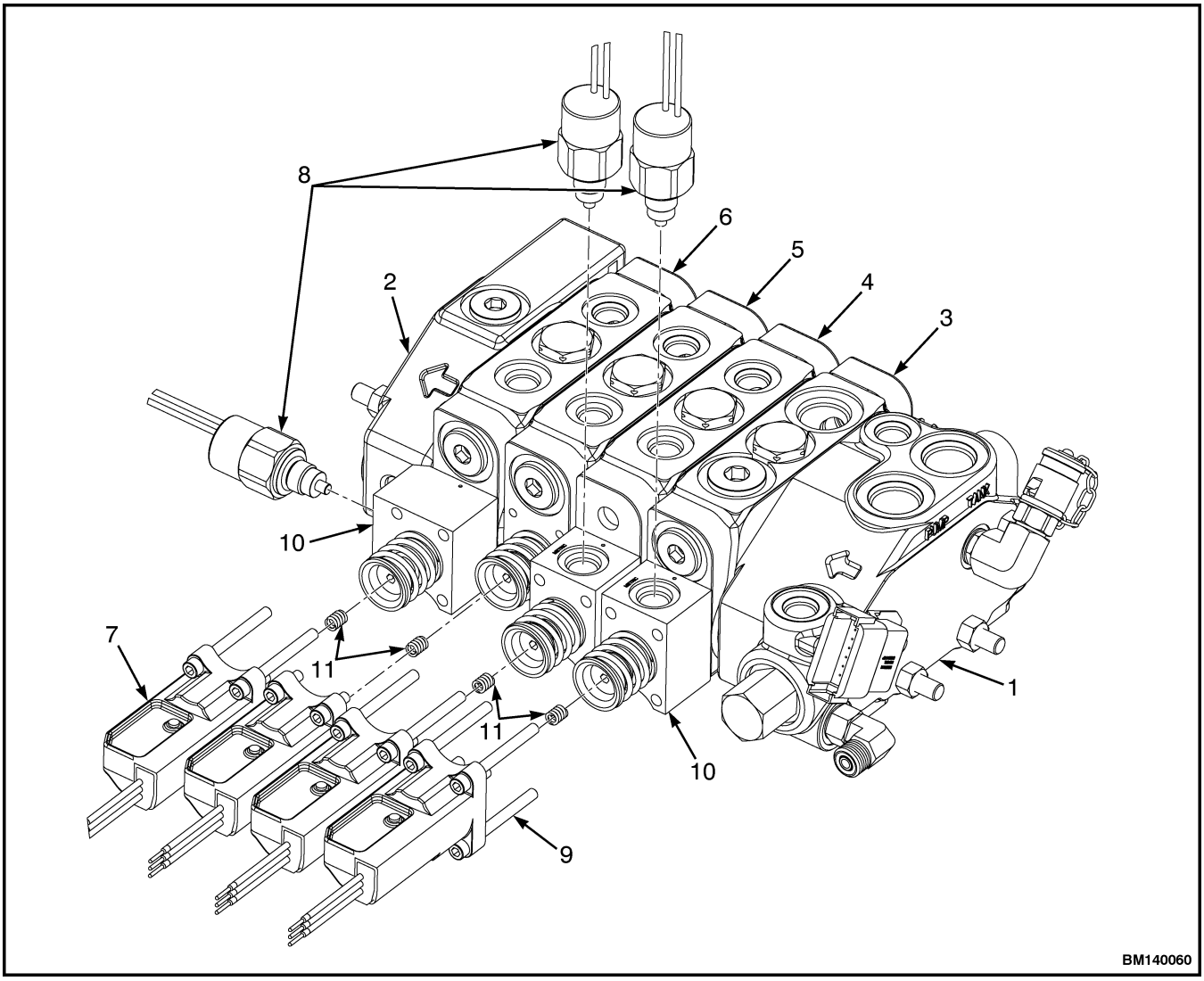
6. Using O-ring pick or similar device remove and discard spool seal from spool assembly. Lightly lubricate new spool seal and install into section body. U cup side of seal to be facing inward toward the section body. See Figure 21.



1. INLET SECTION
2. PRIMARY RELIEF VALVE
3. STEERING LOAD SENSE FITTING*
4. PLUG
5. BACKUP RING
6. O-RING
7. SECTION SEAL
8. ELBOW FITTING
9. DIAGNOSTIC FITTING (SHOWN IN PUMP PRESSURE GAUGE PORT)

* LIFT TRUCKS J1.5-2.0XNT (K160) MANUFACTURED AFTER NOVEMBER, 2014 NOT EQUIPPED WITH STEERING LOAD SENSE FITTING, BUT WILL HAVE A PLUG INSTEAD.

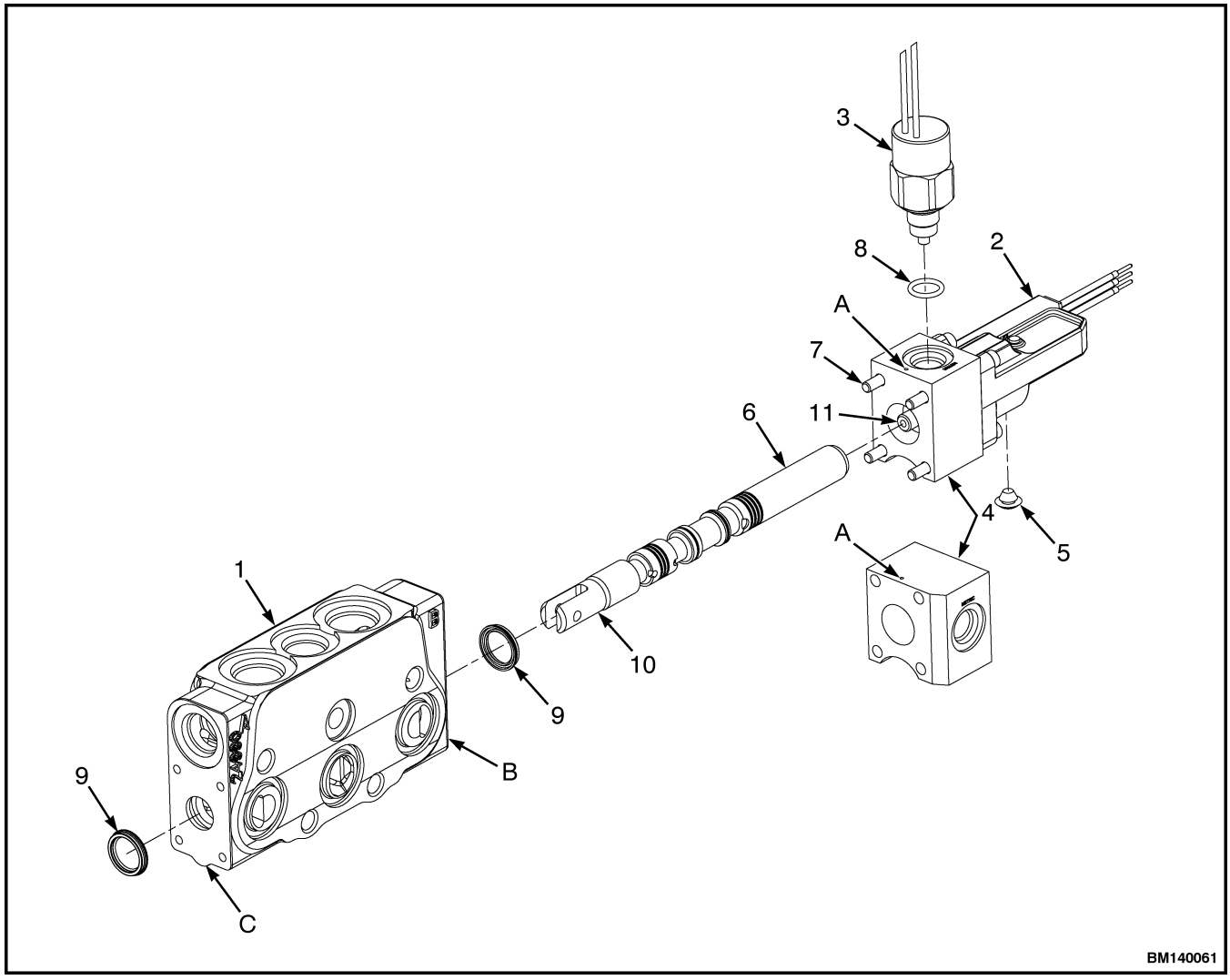
Figure 18. Inlet section of Manual Control Valve



NOTE: MANUAL CONTROL VALVE FOR LIFT TRUCKS J1.5-2.0XNT (K160) MANUFACTURED BEFORE NOVEMBER, 2014 AND J30-40XNT (K160) AND J1.6-2.0XN (J30-40XN) (A935) SHOWN. POSITION SENSOR AND OPS SOLENOID FOR MANUAL CONTROL VALVE FOR LIFT TRUCKS J1.5-2.0XNT (K160) MANUFACTURED AFTER NOVEMBER, 2014 ARE IN SAME POSITION.

1. INLET SECTION
2. OUTLET SECTION
3. LIFT SECTION
4. TILT SECTION
5. AUXILIARY SECTION
6. AUXILIARY WITH SOLENOID SECTION
7. POSITION SENSOR
8. OPS SOLENOID
9. CAPSCREW
10. SPOOL LOCK BODY
11. SPRING

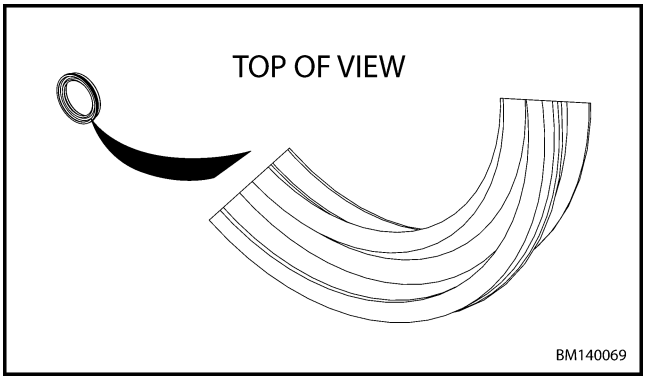
Figure 19. Position Sensor and OPS Solenoid



A. ORIENTATION DOT
B. OPS END
C. CLEVIS END

1. LIFT/TILT/AUXILIARY SECTION BODY
2. POSITION SENSOR
3. OPS SOLENOID
4. SPOOL LOCK BODY
5. CHECK VALVE
6. SPOOL ASSEMBLY
7. CAPSCREW
8. O-RING
9. SPOOL SEAL
10. SPOOL CLEVIS
11. SPOOL LOCK EXTENSION

Figure 20. Spool and Sensor



CAUTION

To ensure proper assembly, lip of spool seal should point "in" toward valve housing on both ends.

Figure 21. Spool Seal Installation

7. Carefully run your finger around exposed edge of seal. You should have a smooth precise ridge with no kinks or twists.

CAUTION

Pulling the spool's meter edges across the spool seals can result in damaging the spool seal.

8. Slide spool assembly back into section body to keep spool seal in place.

9. Push spool assembly into section body far enough to expose the spool seal on OPS end of section body.

NOTE: Lubricate new spool seal with clean hydraulic oil prior to installation.

10. Using O-ring pick or similar device remove and discard spool seal from spool assembly. Lightly lubricate new spool seal and install onto spool assembly. U cup side of seal to be facing inward toward the section body. See Figure 21.

CAUTION

Pulling the spool's meter edges across the spool seals can result in damaging the spool seal.

11. Slide spool assembly back into section body to keep spool seal in place.

12. Carefully run your finger around exposed edge of seal. You should have a smooth precise ridge with no kinks or twists.

NOTE: Perform Step 13 for tilt section.

13. Install small spool and spring inside spool assembly to be held in position by spool extension. See Figure 20 and Figure 19.

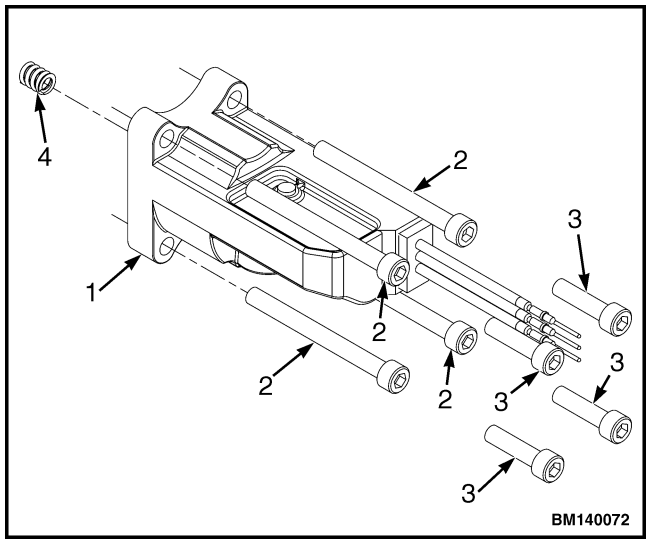
CAUTION

Spool lock body must be placed with orientation dot up and toward section body for correct fit. If not installed correctly damage to manual control valve may result.

14. Install spool extension and spool lock body onto spool assembly. See Figure 20 and Figure 19.

NOTE: Apply Loctite® 262 on capscrew threads prior to installation.

15. Install spring, position sensor, and capscrews onto lift section, tilt section, and auxiliary with OPS section. See Figure 22. Tighten capscrews to 4.7 N•m (42 lbf in).



1. POSITION SENSOR
2. CAPSCREW FOR SECTIONS WITH SPOOL LOCKS
3. CAPSCREW FOR SECTIONS WITHOUT SPOOL LOCKS
4. SPRING

Figure 22. Position Sensor Assembly

16. Install O-ring on OPS solenoid. See Figure 20.

17. Install OPS solenoid into spool lock body on lift, tilt, and auxiliary with solenoid sections. See Figure 19.

CLEAN

WARNING

Cleaning solvents can be flammable and toxic and cause skin irritation. When using cleaning solvents, always follow the solvent manufacturer's recommended safety procedures.

WARNING

Compressed air can move particles so they cause injury to the user or to other personnel. Make sure the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eyes.

1. Clean only metal components of manual control valve with solvent and dry using compressed air.

2. Clean all threaded components with denatured alcohol and dry using compressed air.

3. Clean rubber or plastic components with warm soapy water and dry with a lint free cloth. DO NOT submerge components with electrical connections in water.

INSPECT

1. Check spools and bores for wear or damage. If damaged, entire section must be replaced. Make sure spool moves freely within bore.

2. Inspect check valves and relief valves for damage. Replace if damaged.

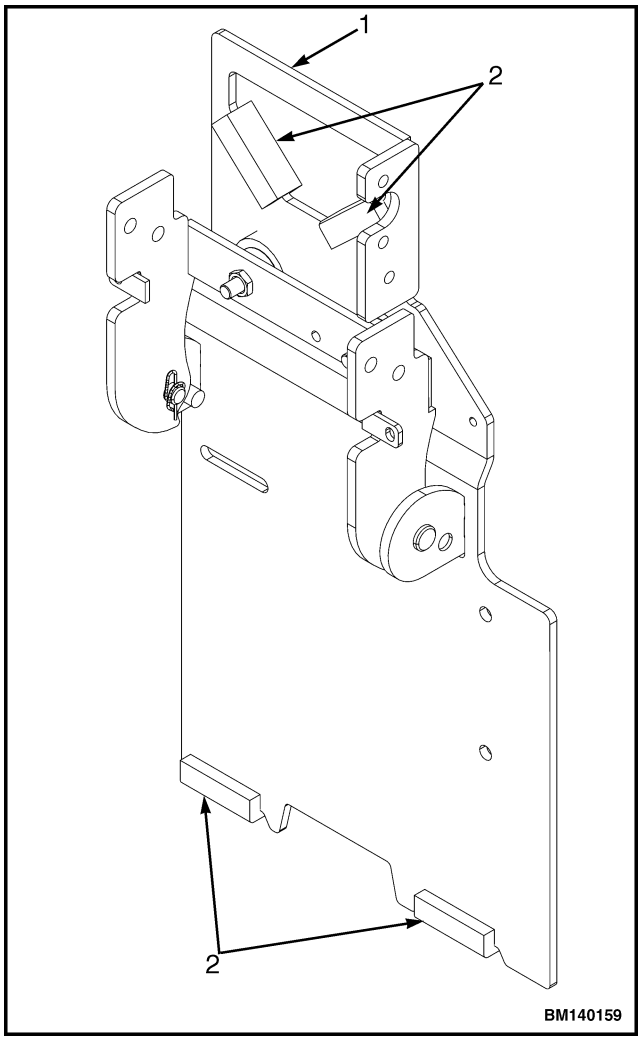
3. Inspect solenoids and position sensors for damage. Replace if damaged.

4. Inspect threaded components to ensure absence of oil or solvent residue.

5. Inspect handles, levers, bushings, and linkages for damage. Replace if damaged.

6. Inspect rubber channels on mounting plate. See Figure 23.

7. Inspect all other components for damage. Replace if damaged.



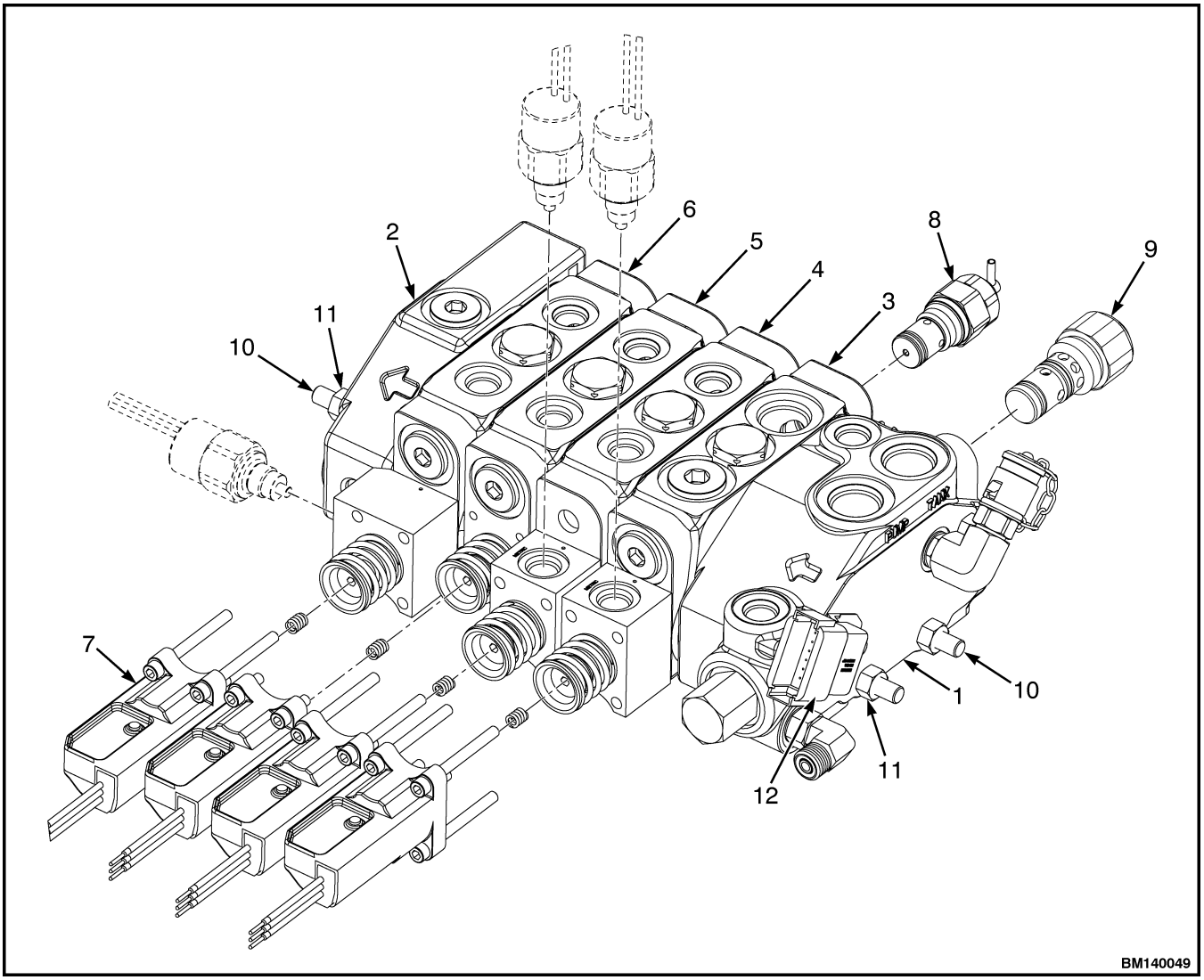
1. MOUNTING PLATE
2. RUBBER CHANNEL

Figure 23. Rubber Channels

ASSEMBLE MANUAL CONTROL VALVE

NOTE: Tie rod ends should protrude one to two threads beyond the edge of the nut.

1. Install position sensor electrical connector and nut onto tie rod as noted during disassembly. See Figure 24.



NOTE: MANUAL CONTROL VALVE SECTIONS FOR LIFT TRUCKS J1.5-2.0XNT (K160) MANUFACTURED BEFORE NOVEMBER, 2014 AND J30-40XNT (K160) AND J1.6-2.0XN (J30-40XN) (A935) SHOWN. MANUAL CONTROL VALVE SECTIONS FOR LIFT TRUCKS J1.5-2.0XNT (K160) MANUFACTURED AFTER NOVEMBER, 2014 ARE SIMILAR.

1. INLET SECTION
2. OUTLET SECTION
3. LIFT SECTION
4. LIT SECTION
5. AUXILIARY SECTION
6. AUXILIARY WITH SOLENOID SECTION
7. POSITION SENSOR
8. MANUAL LOWERING VALVE
9. PRIMARY RELIEF VALVE
10. TIE ROD
11. NUT
12. POSITION SENSOR ELECTRICAL CONNECTOR

Figure 24. Manual Control Valve Sections

2. Make sure position sensor electrical connector is at the correct angle, as shown in Figure 25.

3. Insert tie rod end without nut through inlet section tie rod holes. Repeat for all four tie rods.

4. Lay inlet section with machined surface facing up as shown in Figure 26.

NOTE: **DO NOT** lubricate section seals.

5. Install new section seals into section retaining grooves on inlet section, as noted during disassembly. See Figure 26.

6. Install lift section onto tie rods and against inlet section. See Figure 27.

7. Install new section seals into section retaining grooves on lift section, as noted during disassembly. See Figure 28.

8. Install tilt section onto tie rods and against lift section. See Figure 27 for example.

9. Install new section seals into section retaining grooves on tilt section, as noted during disassembly. See Figure 28.

10. Install auxiliary section onto tie rods and against tilt section. See Figure 27 for example.

11. Install section seals into section retaining grooves on auxiliary section. See Figure 28.

NOTE: Perform Step 12 and Step 13 if control valve is equipped with an auxiliary with solenoid section. If not, go to Step 14.

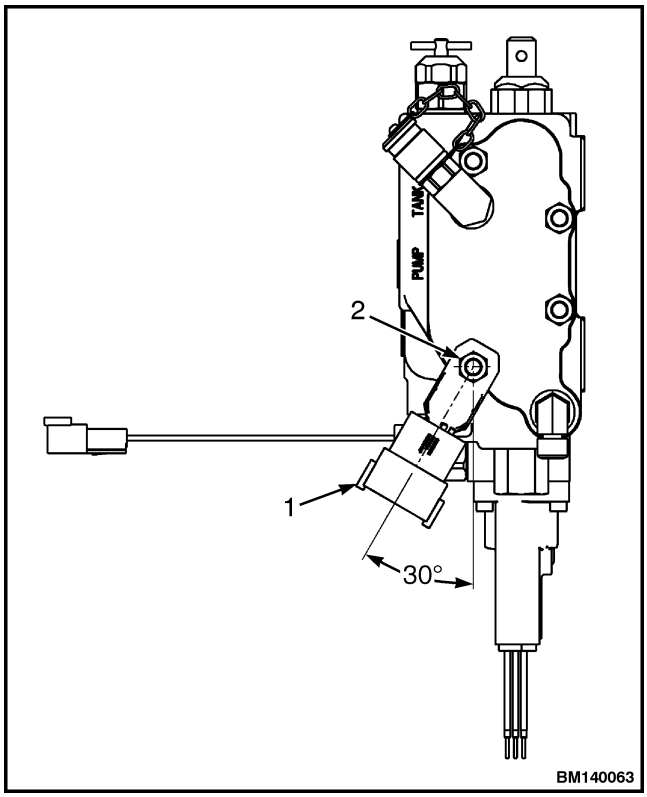
12. Install auxiliary with solenoid section onto tie rods and against auxiliary section. See Figure 27 for example.

13. Install section seals into section retaining grooves on auxiliary with solenoid section, as noted during disassembly. See Figure 28.

14. Install outlet section onto tie rods and against auxiliary or auxiliary with solenoid section. See Figure 27 for example.

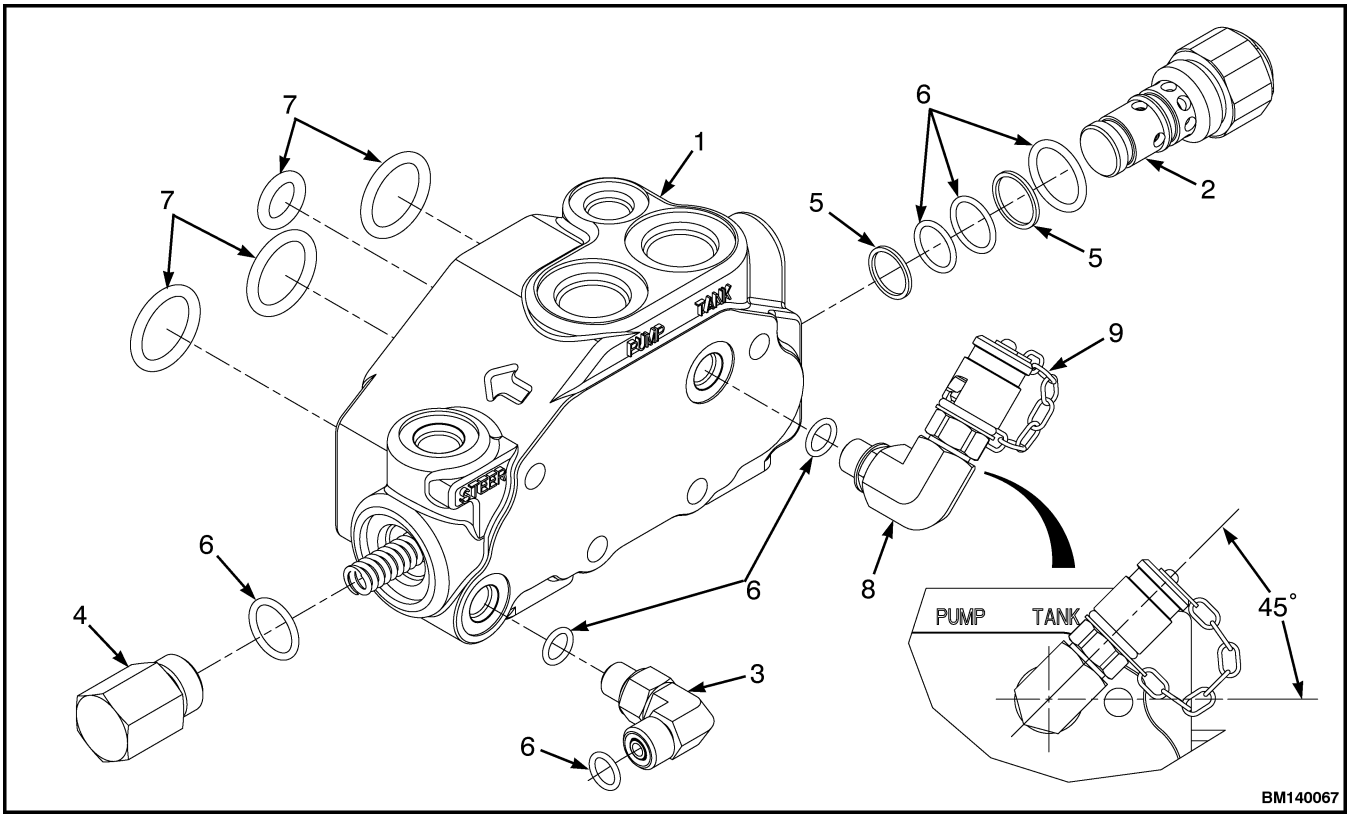
NOTE: Tie rod ends should protrude one to two threads beyond the edge of the nut.

15. Install nuts onto tie rods on outlet section side. See Figure 29. Hand tighten nuts only at this time.



1. POSITION SENSOR ELECTRICAL CONNECTOR
2. NUT

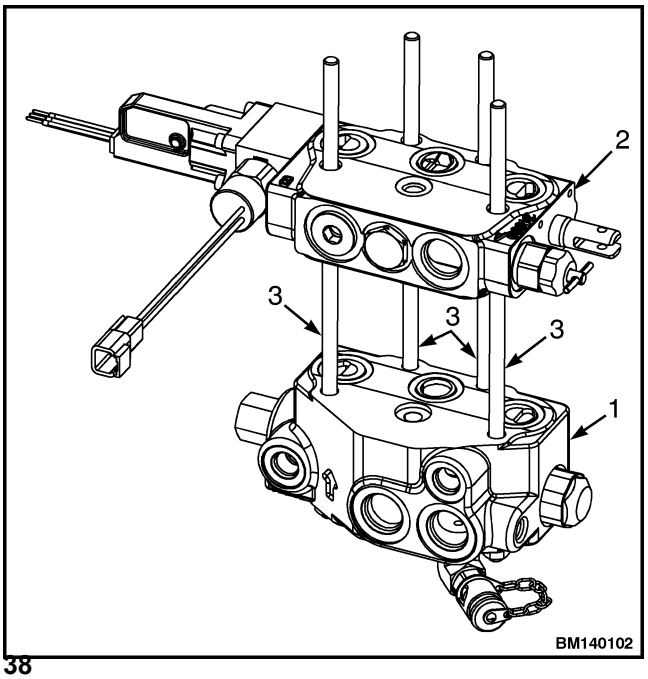
Figure 25. Position Sensor Electrical Connector



1. INLET SECTION
2. PRIMARY RELIEF VALVE
3. STEERING LOAD SENSE FITTING*
4. PLUG
5. BACKUP RING
6. O-RING
7. SECTION SEAL
8. ELBOW FITTING
9. DIAGNOSTIC FITTING (SHOWN IN PUMP PRESSURE GAUGE PORT)

* LIFT TRUCKS J1.5-2.0XNT (K160) MANUFACTURED AFTER NOVEMBER, 2014 NOT EQUIPPED WITH STEERING LOAD SENSE FITTING, BUT WILL HAVE A PLUG INSTEAD.

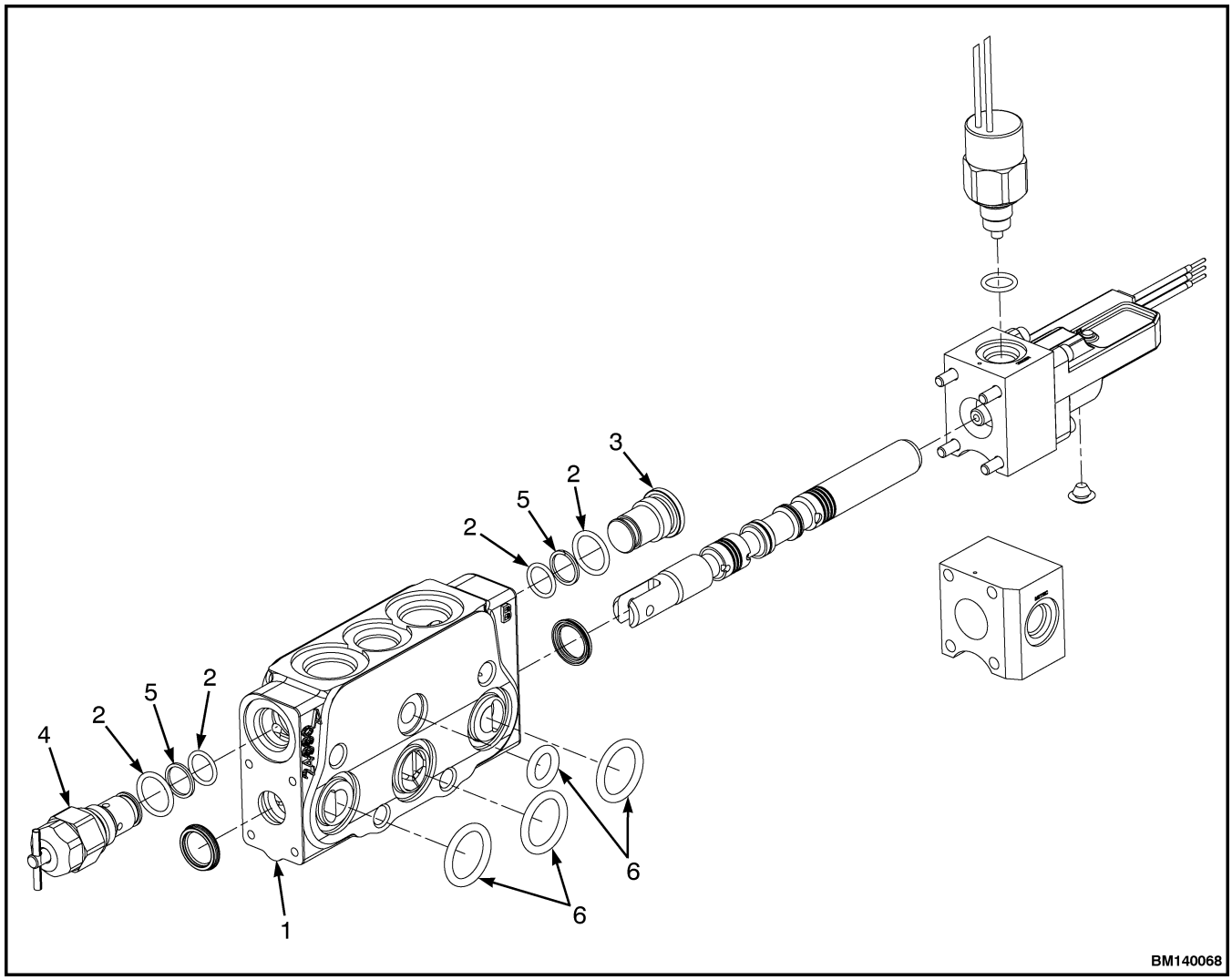
Figure 26. Inlet Section of Manual Control Valve



Legend for Figure 27

1. INLET SECTION
2. LIFT SECTION
3. TIE ROD

Figure 27. Manual Control Valve - Sections and Tie Rods

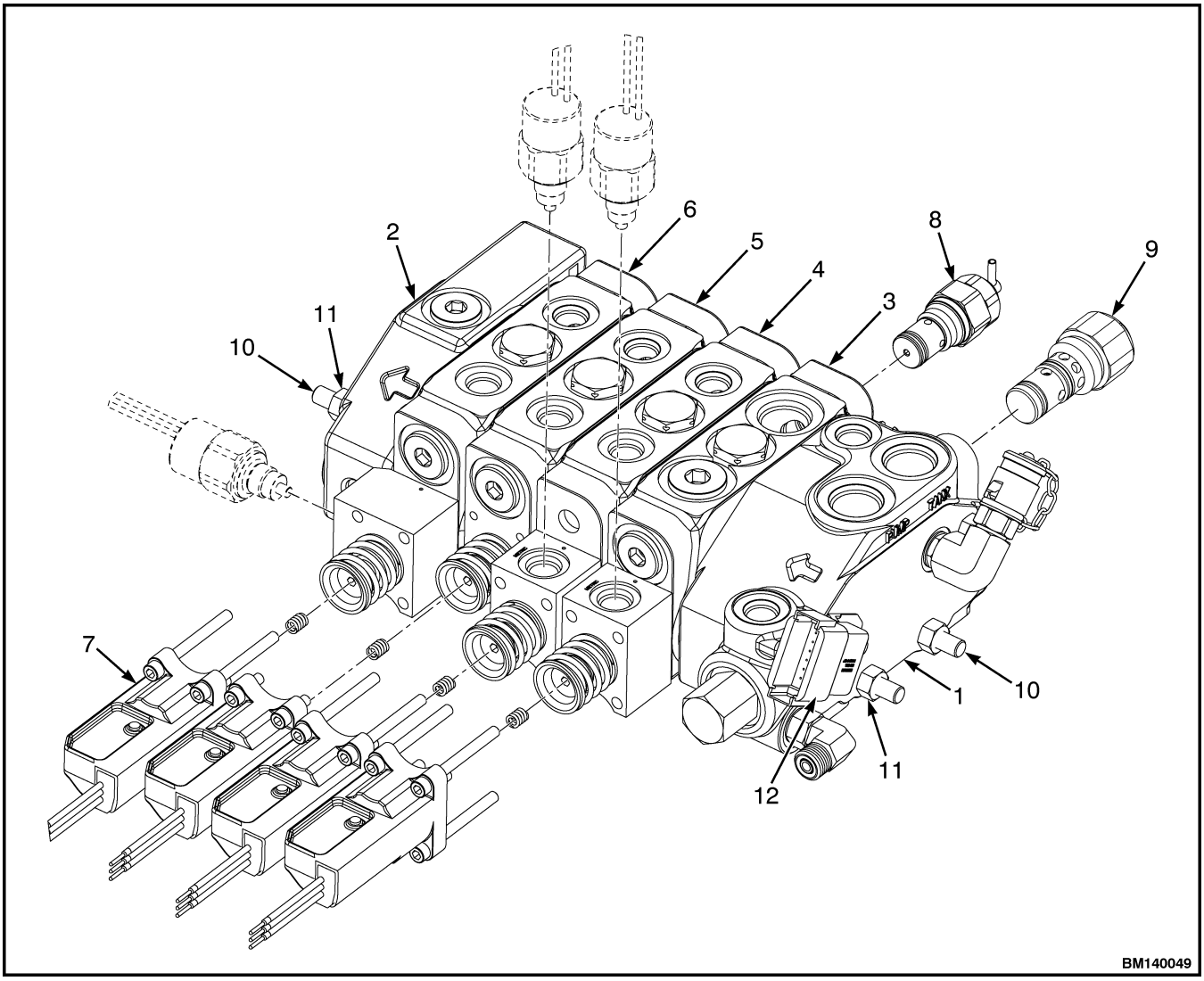


NOTE: VALVE SECTION BODY FOR LIFT, TILT, AND AUXILIARY SECTIONS ARE VISUALLY THE SAME.

NOTE: SPOOL, POSITION SENSOR AND SOLENOID SHOWN PER MANUFACTURERS DOCUMENTATION.

1. LIFT/TILT/AUXILIARY SECTION BODY
2. O-RING
3. OPTIONAL WORK PORT RELIEF VALVE
4. MANUAL LOWERING VALVE
5. BACKUP RING
6. SECTION SEAL

Figure 28. Lift/Tilt/Auxiliary Sections, Manual Control Valve



NOTE: MANUAL CONTROL VALVE SECTIONS FOR LIFT TRUCKS J1.5-2.0XNT (K160) MANUFACTURED BEFORE NOVEMBER, 2014 AND J30-40XNT (K160) AND J1.6-2.0XN (J30-40XN) (A935) SHOWN. MANUAL CONTROL VALVE SECTIONS FOR LIFT TRUCKS J1.5-2.0XNT (K160) MANUFACTURED AFTER NOVEMBER, 2014 ARE SIMILAR.

1. INLET SECTION
2. OUTLET SECTION
3. LIFT SECTION
4. TILT SECTION
5. AUXILIARY SECTION
6. AUXILIARY WITH SOLENOID SECTION
7. POSITION SENSOR
8. MANUAL LOWERING VALVE
9. TIE ROD
10. NUT
11. POSITION SENSOR ELECTRICAL CONNECTOR

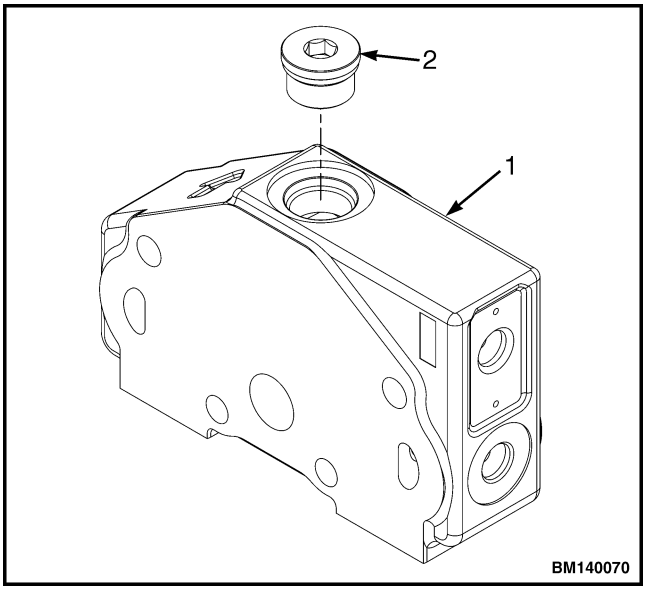
Figure 29. Manual Control Valve Sections

CAUTION

If the proper torque is not applied to the nuts on the tie rods, the valve spools may bind or stick and section seals may extrude.

16. Turn manual control valve until work ports are facing up, and tighten ALL tie rod nuts to 20.3 ± 1.4 N•m (179.7 ± 12.4 lbf in).

17. Install plug in outlet section. See Figure 30. Tighten plug to 26 N•m (19 lbf ft).



1. OUTLET SECTION
2. PLUG

Figure 30. Outlet Section of Manual Control Valve

NOTE: Perform Step 18 if manual control valve is equipped with auxiliary with solenoid section.

18. Install 4-function auxiliary fittings into auxiliary with solenoid section.

See Figure 31 for lift truck models

- J1.5-2.0XNT (K160) manufactured before November, 2014
- J30-40XNT (K160) and J1.6-2.0XN (J30-40XN) (A935)

See Figure 32 for lift truck models

- J1.5-2.0XNT (K160) manufactured after November, 2014

19. Install 3-function auxiliary fittings into auxiliary section.

See Figure 31 for lift truck models

- J1.5-2.0XNT (K160) manufactured before November, 2014
- J30-40XNT (K160) and J1.6-2.0XN (J30-40XN) (A935)

See Figure 32 for lift truck models

- J1.5-2.0XNT (K160) manufactured after November, 2014

NOTE: Lubricate new backup rings and O-rings with clean hydraulic oil prior to installation.

NOTE: Perform Step 20 and Step 21 for tilt section.

20. If equipped, install new backup ring and O-rings onto optional work port relief valve. Install optional work port relief valve into tilt section. See Figure 28. Tighten optional work port relief valve to 26 N•m (19 lbf ft).

21. Install tilt fittings into tilt sections.

NOTE: Perform Step 22 and Step 23 for lift section.

22. Install new backup ring and O-rings onto manual lowering valve. Install manual lowering valve into lift section as shown in Figure 28. Tighten manual lowering valve to 26 N•m (19 lbf ft).

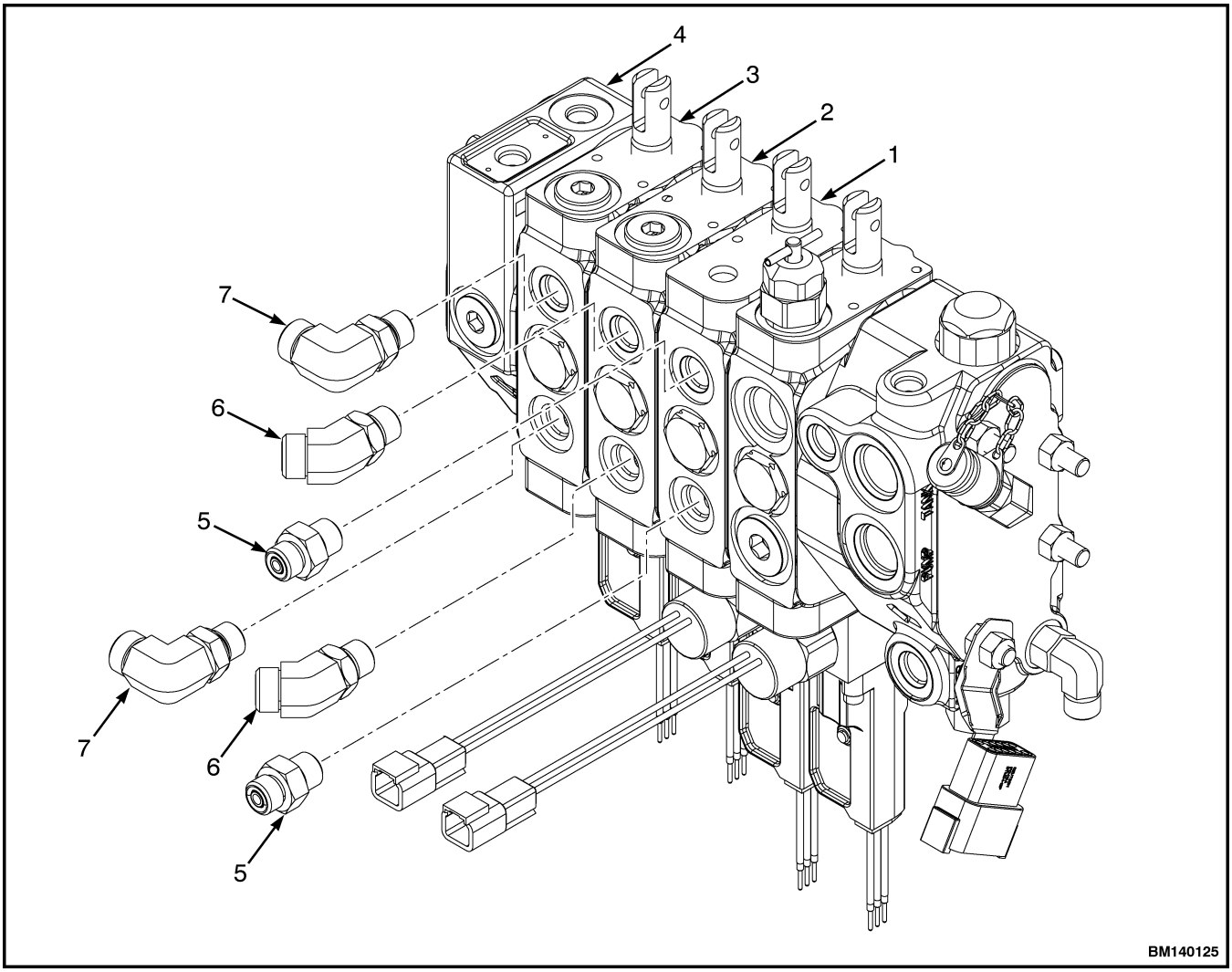
23. Install lift/lower fitting into lift section.

See Figure 33 for lift truck models

- J1.5-2.0XNT (K160) manufactured before November, 2014
- J30-40XNT (K160) and J1.6-2.0XN (J30-40XN) (A935)

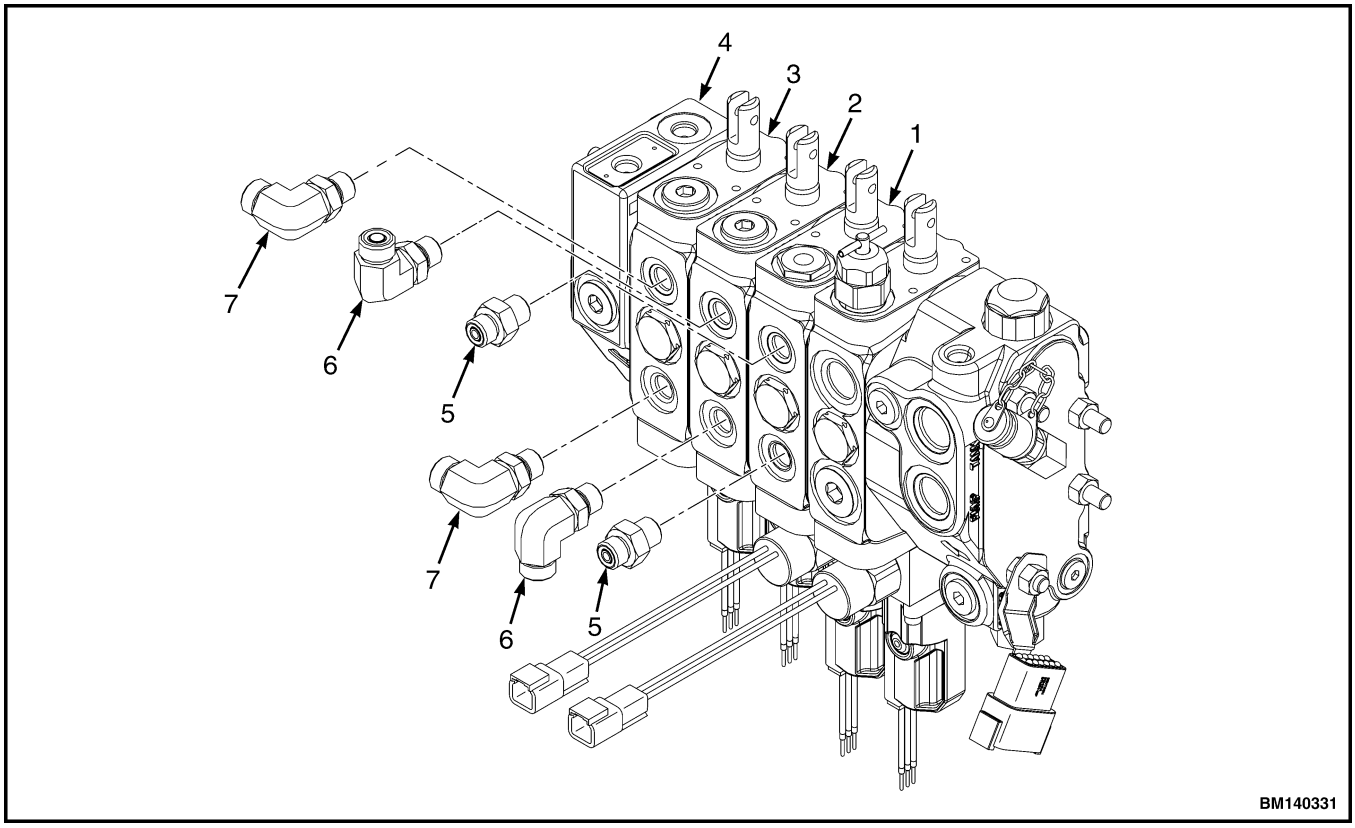
See Figure 34 for lift truck models

- J1.5-2.0XNT (K160) manufactured after November, 2014



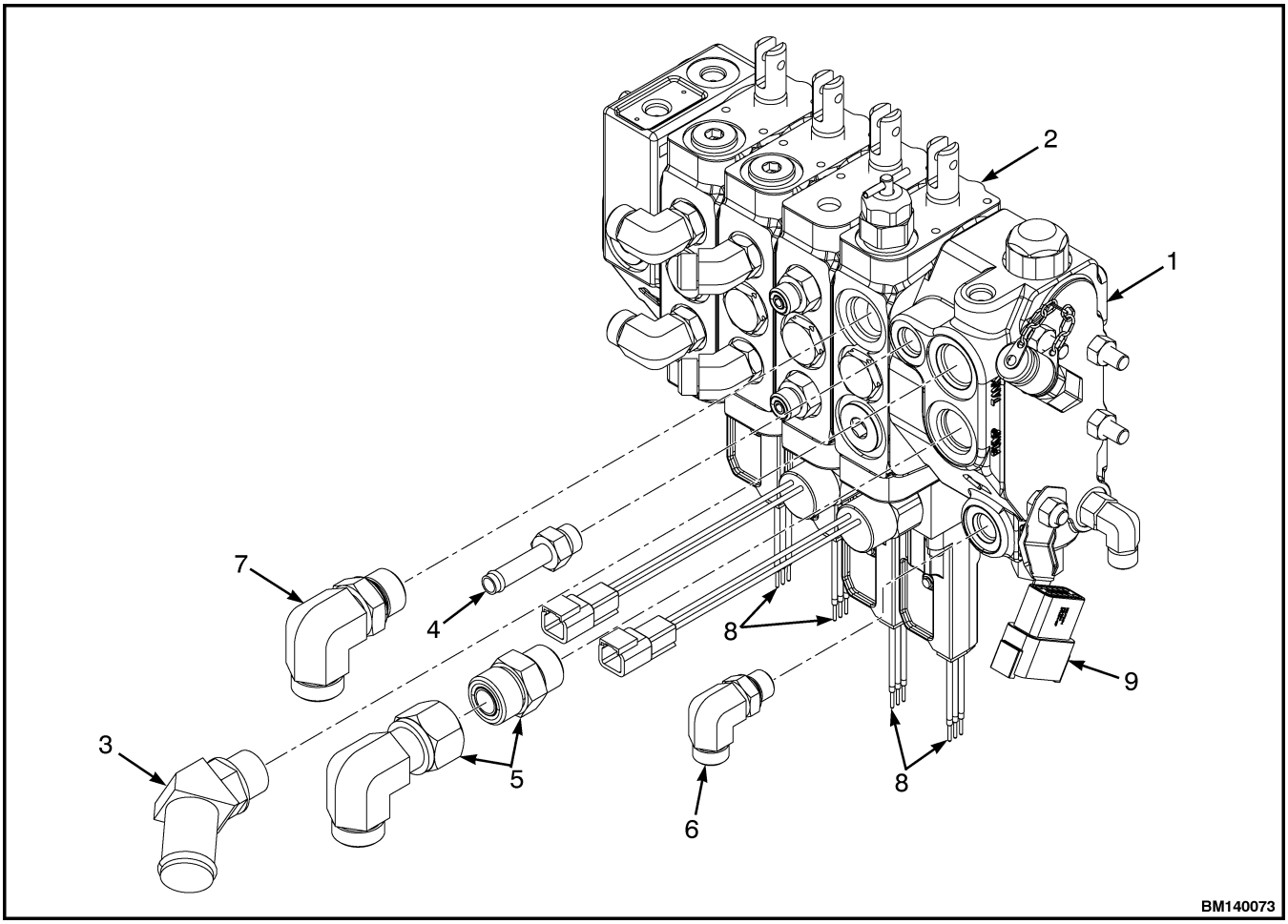
1. TILT SECTION
2. AUXILIARY SECTION
3. FIRST AUXILIARY SECTION
4. OUTLET SECTION
5. TILT FITTINGS
6. 3-FUNCTION FITTING
7. 4-FUNCTION FITTING

Figure 31. Manual Control Valve Fittings, Tilt and Auxiliary Sections, Lift Truck Models J1.5-2.0XNT (K160) Manufactured Before November, 2014 and J30-40XNT (K160) and J1.6-2.0XN (J30-40XN) (A935)



1. TILT SECTION
2. AUXILIARY SECTION
3. DUAL AUXILIARY SECTION
4. OUTLET SECTION
5. TILT FITTINGS
6. 3-FUNCTION AUXILIARY FITTING
7. 4-FUNCTION AUXILIARY FITTING

Figure 32. Manual Control Valve Fittings, Tilt and Auxiliary Sections, Lift Truck Models J1.5-2.0XNT (K160) Manufactured After November, 2014



NOTE: 4-FUNCTION MANUAL CONTROL VALVE SHOWN.

1. INLET SECTION
2. LIFT SECTION
3. RETURN LINE FITTING
4. STEER RETURN LINE FITTING
5. INLET FITTING
6. STEER SUPPLY LINE FITTING
7. LIFT/LOWER FITTING
8. POSITION SENSOR WIRES
9. POSITION SENSOR ELECTRICAL CONNECTOR

Figure 33. Manual Control Valve Fittings, Inlet and Lift Sections, Lift Truck Models Lift Truck Models J1.5-2.0XNT (K160) Manufactured Before November, 2014 and J30-40XNT (K160) and J1.6-2.0XN (J30-40XN) (A935)

NOTE: Perform Step 24 through Step 28 for inlet section.

NOTE: Step 24 does not apply to lift trucks J1.5-2.0XNT (K160) manufactured after November, 2014.

24. Install new O-rings onto steering load sense fitting. Install steering load sense fitting into inlet section as shown in Figure 26. Tighten steering load sense fitting to 16 N•m (142 lbf in).

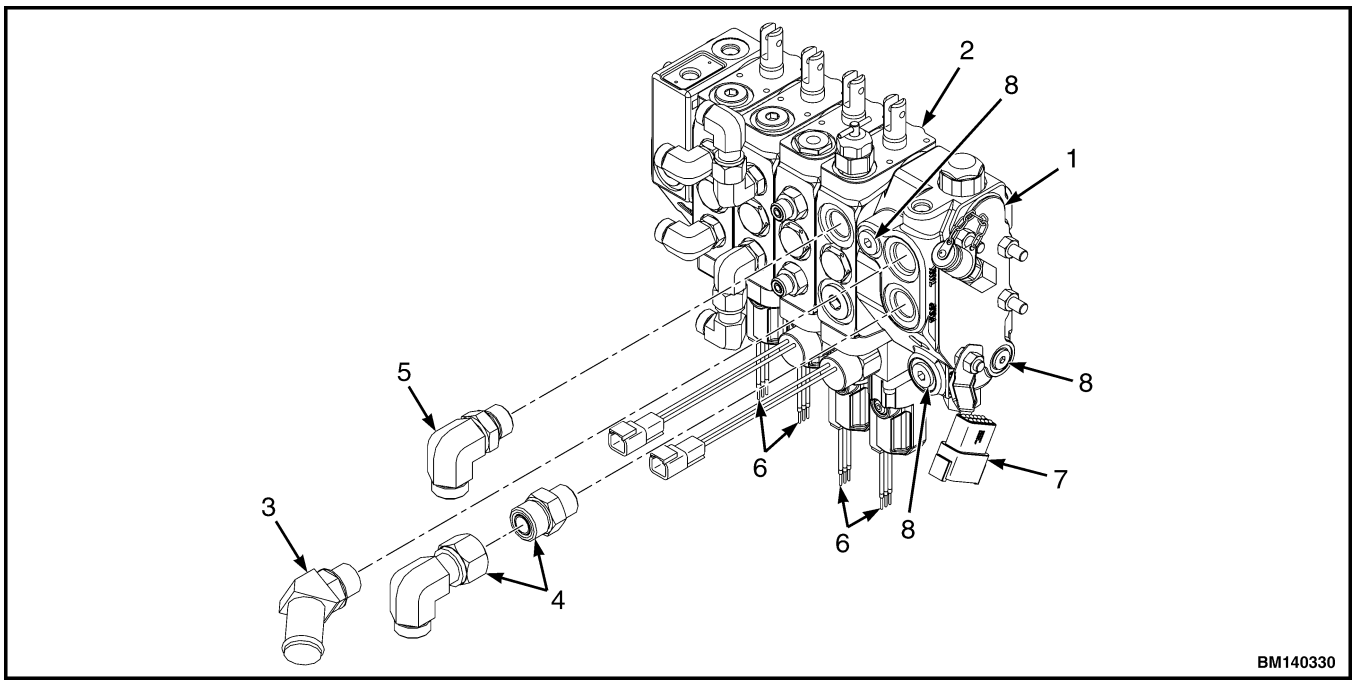
25. Install new backup rings and O-rings on primary relief valve. Install primary relief valve into inlet section as shown in Figure 26. Tighten primary relief valve to 27 N•m (20 lbf ft).

26. Install new O-ring on plug. Install plug into inlet section. Tighten plug to 45 N•m (33 lbf ft). See Figure 26.

27. Install new O-ring on elbow fitting. Install elbow fitting into inlet section and tighten to 16 N•m (142 lbf in). Install diagnostic fitting onto elbow fitting. See Figure 26.

NOTE: Step 28 does not apply to lift trucks J1.5-2.0XNT (K160) manufactured after November, 2014.

28. Install steer supply line fitting, steer return line fitting, inlet fitting, and return line fitting into inlet section ports. See Figure 33.



NOTE: 4-FUNCTION MANUAL CONTROL VALVE SHOWN.

1. INLET SECTION
2. LIFT SECTION
3. PRESSURE LINE FITTING
4. INLET FITTING
5. LIFT/LOWER FITTING
6. POSITION SENSOR WIRES
7. POSITION SENSOR ELECTRICAL CONNECTOR
8. PLUG

Figure 34. Manual Control Valve Fittings, Inlet and Lift Sections, Lift Truck Models J1.5-2.0XNT (K160) Manufactured After November, 2014

ASSEMBLE HANDLES AND LEVERS

NOTE: If levers and handles have been disassembled, perform Step 2 through Step 4 for aux handle with dual function for lift trucks equipped with clamping function; perform Step 5 through Step 7 for lift, tilt, tilt with Return To Set Tilt (RTST), aux 1, and aux 2 handles; perform Step 8 through Step 14 for lift/lower with Direction Control Switch (DCS) handles.

NOTE: Table 1 indicates installed handle positions. Optional handles and levers are described in Step 2 through Step 5 and Step 8 through Step 14.

1. Install bushings into levers. See Figure 35.
2. Route push-button cable through cable track on manual aux 2 lever. See Figure 35.
3. Install palm side handle and one inner capscrew on manual aux 2 lever. See Figure 35.

NOTE: Ensure clamping push-button is in correct position on clamp switch handle during assembly.

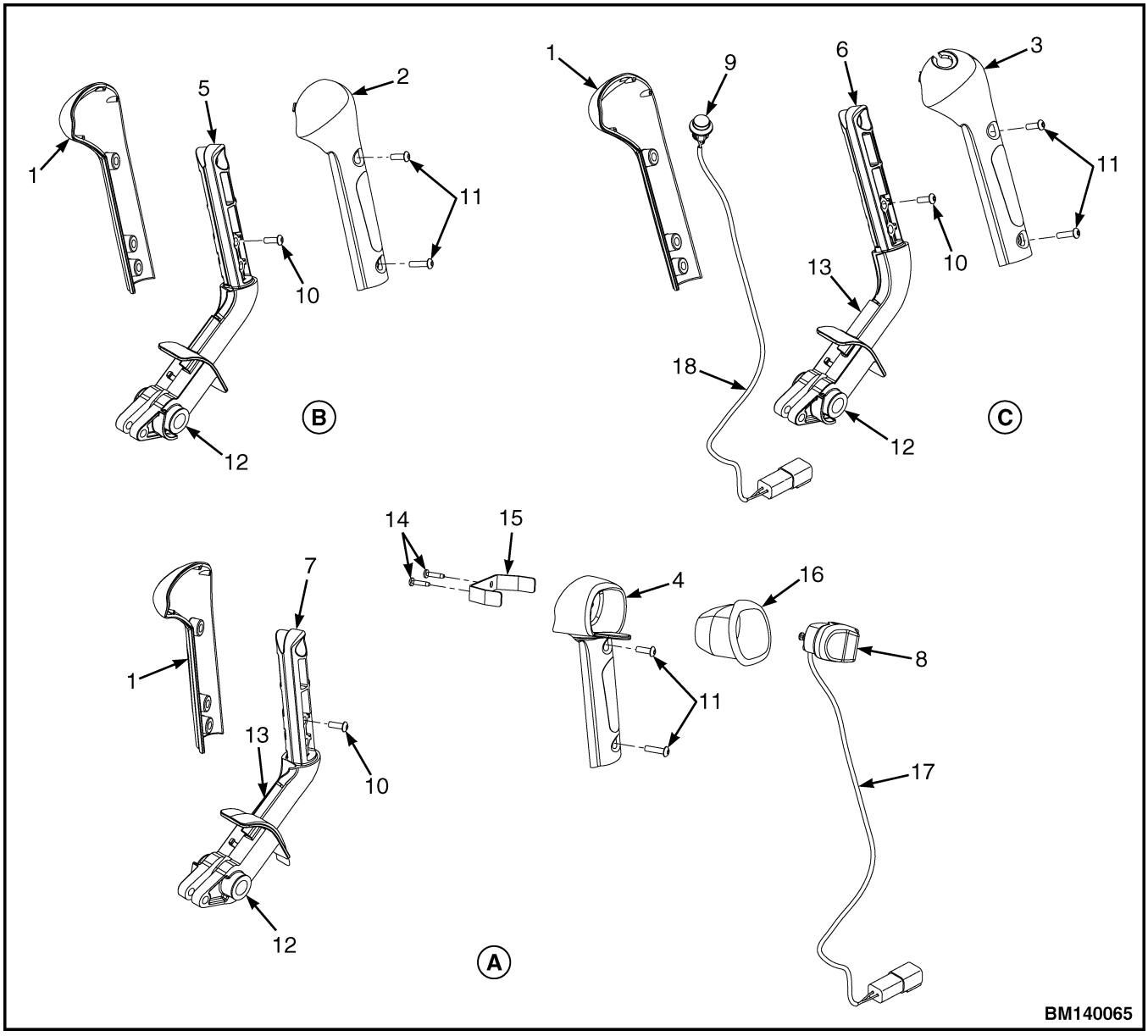
4. Install clamp switch handle and two outer capscrews on manual aux 2 lever. See Figure 35. Tighten outer capscrews to 1.35 to 1.65 N•m (11.9 to 14.6 lbf in).

NOTE: Ensure Return To Set Tilt push-button is in correct position on tilt switch handle during assembly.

5. Lift truck models J30-40XNT (K160) and J30-40XN (A935) manufactured after November, 2014 and equipped with RTST option, route push-button cable through cable track on manual tilt lever. See Figure 35.
6. Install palm side handle and one inner capscrew on manual tilt or aux 1 lever. See Figure 35.
7. Install finger side handle and two outer capscrews on manual tilt or aux 1 lever. See Figure 35. Tighten outer capscrews to 1.35 to 1.65 N•m (11.9 to 14.6 lbf in).
8. Install directional control switch into DCS cup. See Figure 35.
9. Install DCS cup and directional control switch into lift/lower with DCS handle. See Figure 35 and Figure 36.
10. Install DCS retainer onto back side of DCS cup, inside lift/lower with DCS handle. See Figure 35 and Figure 36.
11. Install two screws through retainer and DCS cup into Direction Control Switch. See Figure 35 and Figure 36.
12. Route DCS cable through cable track on manual lift/lower lever. See Figure 35.
13. Install palm side handle and one capscrew on manual lift/lower lever. See Figure 35.
14. Install lift/lower with DCS handle and two outer capscrews on manual lift/lower lever. See Figure 35. Tighten outer capscrews to 1.35 to 1.65 N•m (11.9 to 14.6 lbf in).

Table 1. Handle Options

3-Function		4-Function	
Handle Position	**Option**	**Handle Position**	**Option**
1	None	1	None
1	Lift/lower with DCS	1	Lift/lower with DCS
2	Tilt with RTST	2	Tilt with RTST
3	None	4	None
3	Aux with dual function	4	Aux with dual function



A. LIFT/LOWER WITH DCS
B. LIFT, TILT, AUX 1, AUX 2
C. AUX HANDLE WITH DUAL FUNCTION OR TILT HANDLE WITH RTST

1. PALM SIDE GRIP HANDLE
2. FINGER SIDE HANDLE
3. CLAMP SWITCH HANDLE/TILT HANDLE WITH RTST SWITCH
4. LIFT/LOWER WITH DCS HANDLE
5. MANUAL TILT OR AUX 1 LEVER
6. MANUAL AUX 2 LEVER
7. MANUAL LIFT/LOWER LEVER
8. DIRECTIONAL CONTROL SWITCH (DCS)
9. CLAMPING PUSH-BUTTON/RTST PUSH-BUTTON
10. INNER CAPSCREW
11. OUTER CAPSCREW
12. BUSHING
13. CABLE TRACK
14. SCREW
15. DCS RETAINER
16. DCS CUP
17. DCS CABLE
18. PUSH-BUTTON CABLE

Figure 35. Manual Hydraulic Control Handles

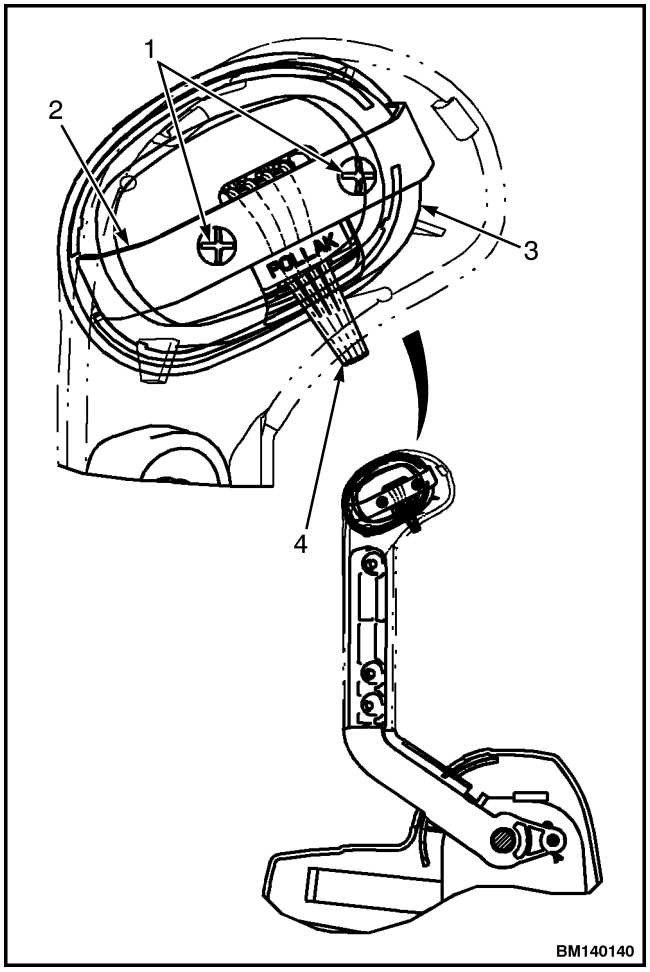


Figure 36. Directional Control Switch

Legend for Figure 36

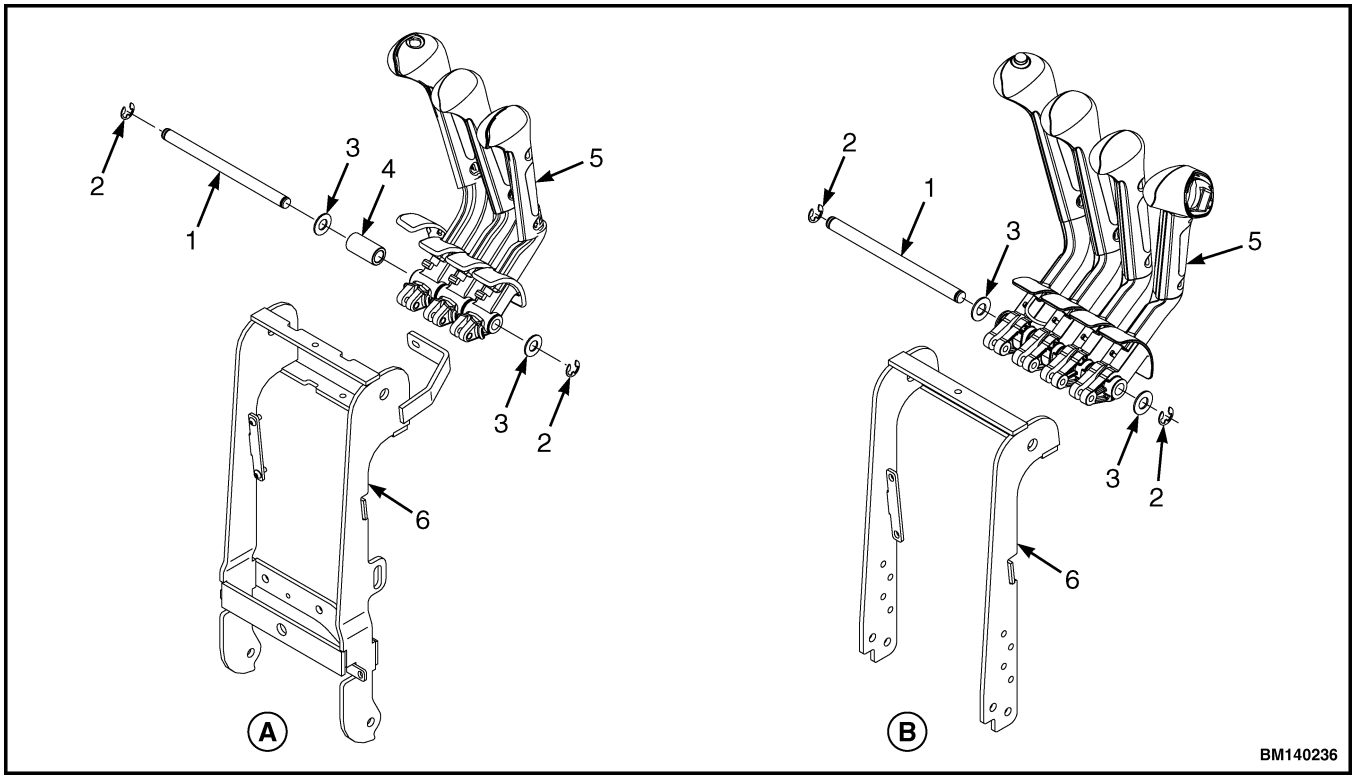
1. SCREW
2. DCS RETAINER
3. DCS CUP
4. DCS CABLE

INSTALL

Install Covers, Links, and Levers

NOTE: Update illustrations shown in STEP 1 through STEP 4, and STEP 10.

STEP 1.
Slide pivot pin through one side of upper bracket, nylon washer, lever spacer if required, levers, nylon washer, and out the other side of upper bracket. Install e-clip onto each end of pivot pin holding levers to upper bracket.



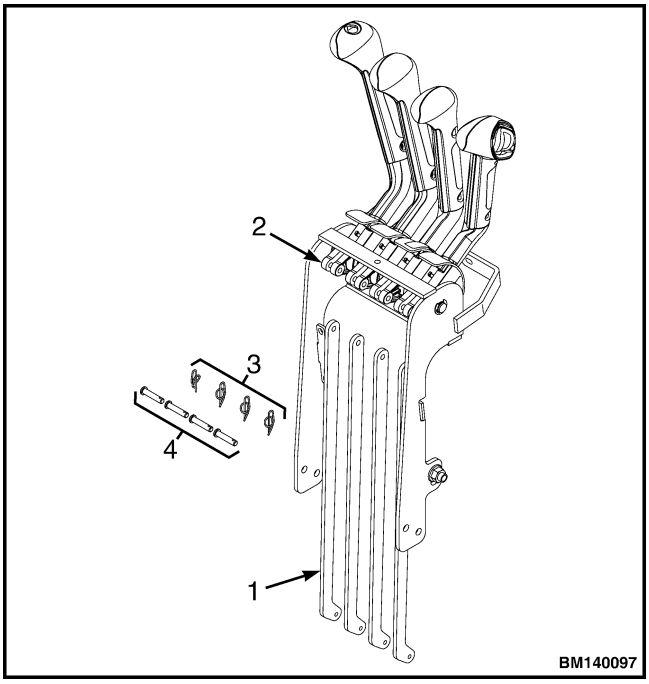
A. 3-FUNCTION LEVERS

1. PIVOT PIN
2. E-CLIP
3. WASHER

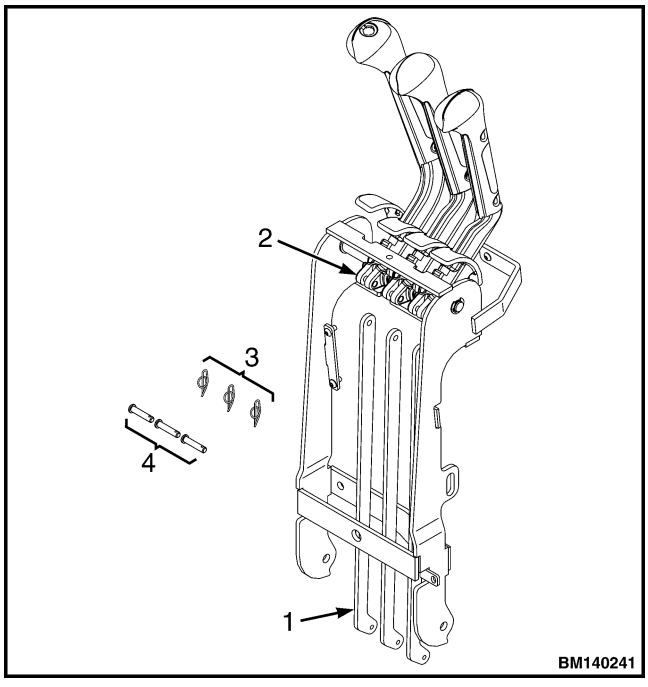
B. 4-FUNCTION LEVERS

4. LEVER SPACER
5. LEVER
6. UPPER BRACKET

STEP 2.
Install link, clevis pin, and new locking ring cotter pin onto lever, Repeat for all links.

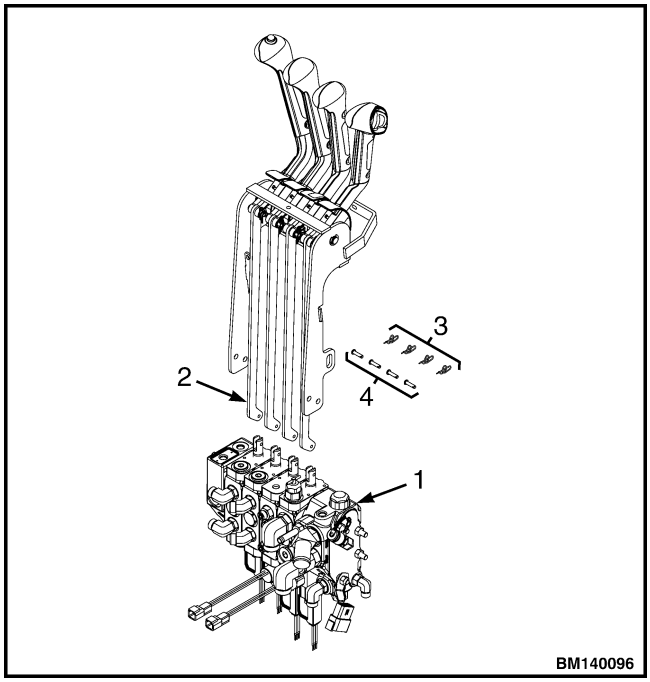


1. LINK
2. LEVER
3. LOCKING RING COTTER PIN
4. CLEVIS PIN

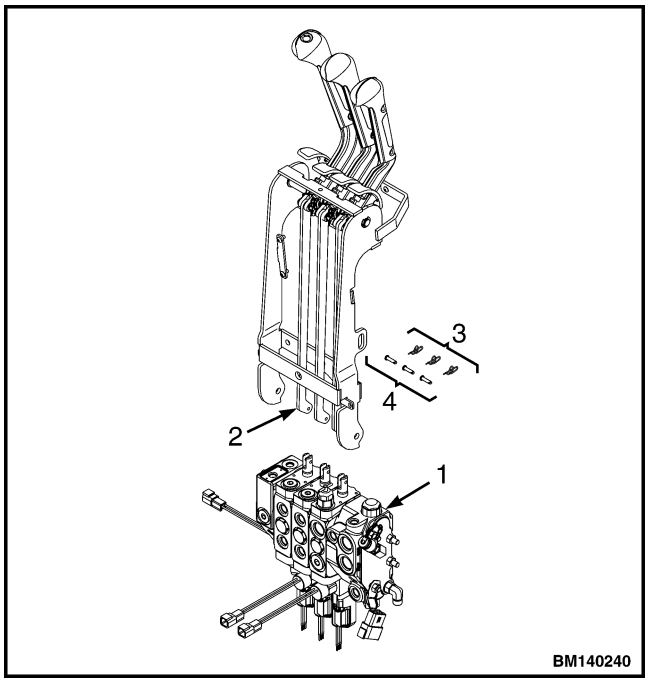


1. LINK
2. LEVER
3. LOCKING RING COTTER PIN
4. CLEVIS PIN

STEP 3.
Install link, rod end pin, and new locking ring cotter pin onto manual control valve. Repeat for all links.



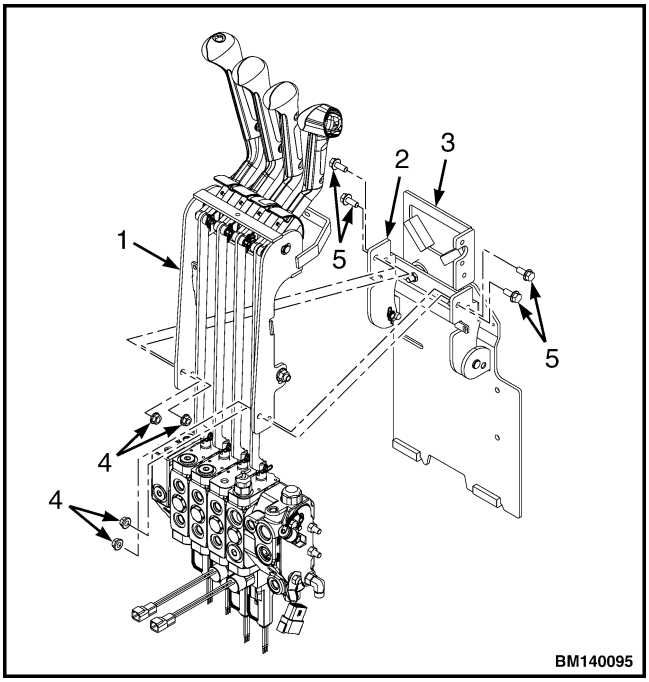
1. MANUAL CONTROL VALVE
2. LINK
3. LOCKING RING COTTER PIN
4. ROD END PIN



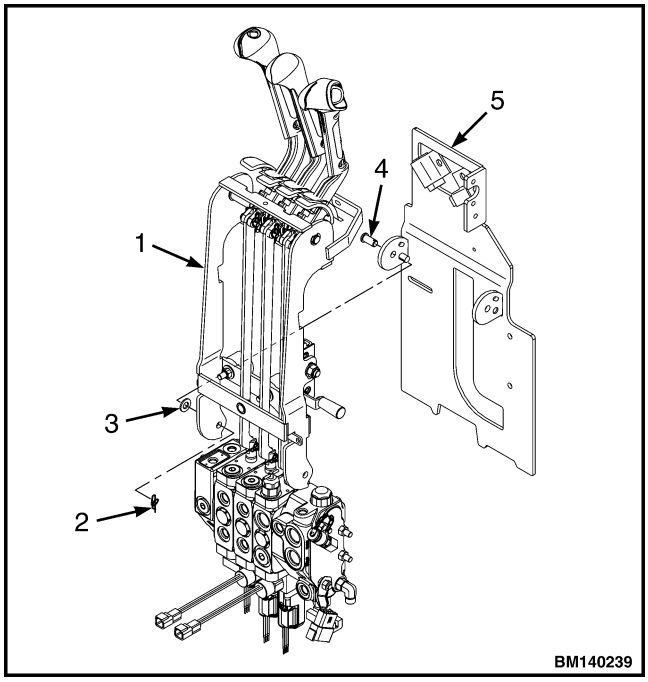
1. MANUAL CONTROL VALVE
2. LINK
3. LOCKING RING COTTER PIN
4. ROD END PIN

STEP 4.

Install lower frame plate with mounting bracket, four capscrews, and four nuts onto upper bracket or install mounting bracket, rod end pin, nylon washer, and locking ring cotter pin on upper bracket.

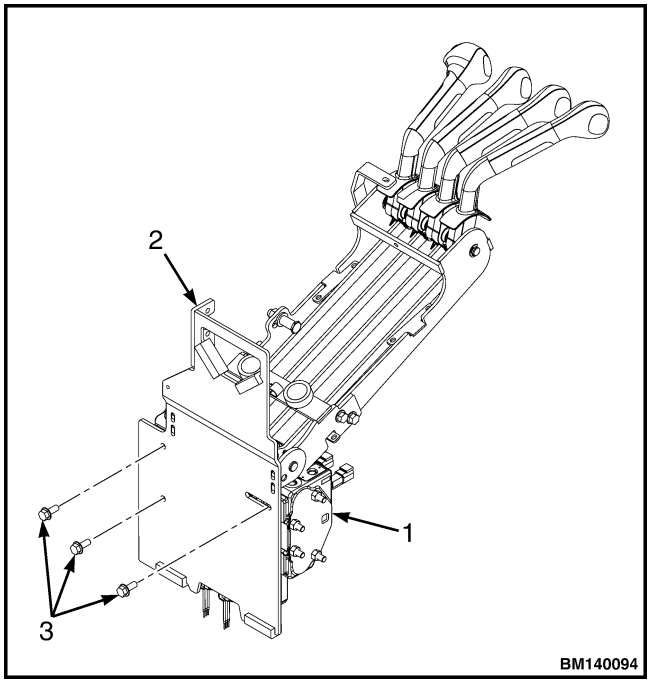


1. UPPER BRACKET
2. LOWER FRAME PLATE
3. MOUNTING BRACKET
4. NUT
5. CAPSCREW



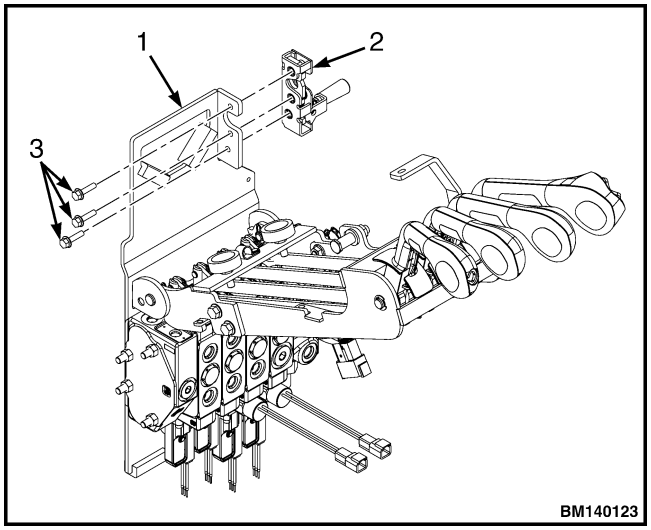
1. UPPER BRACKET
2. LOCKING RING COTTER PIN
3. NYLON WASHER
4. ROD END PIN
5. MOUNTING BRACKET

STEP 5.
Install three hex capscrews into mounting plate and manual control valve.



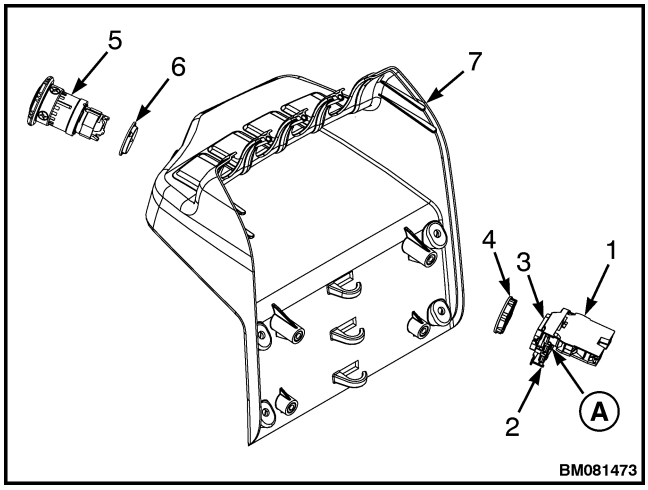
1. MANUAL CONTROL VALVE
2. MOUNTING PLATE
3. HEX CAPSCREW

STEP 6.
Install latch assembly and three capscrews onto mounting plate.



1. MOUNTING PLATE
2. LATCH ASSEMBLY
3. CAPSCREW

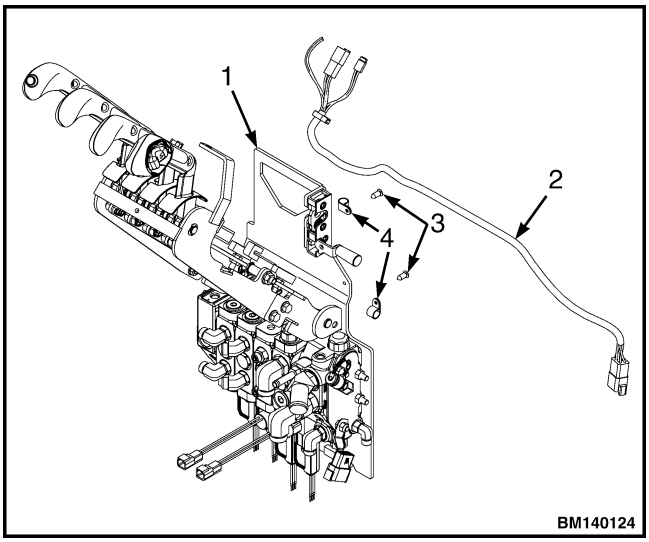
STEP 7.
Install emergency disconnect switch into rear cover. See **Electrical System** 2200SRM1337 for procedure.



A. INSERT SCREWDRIVER HERE

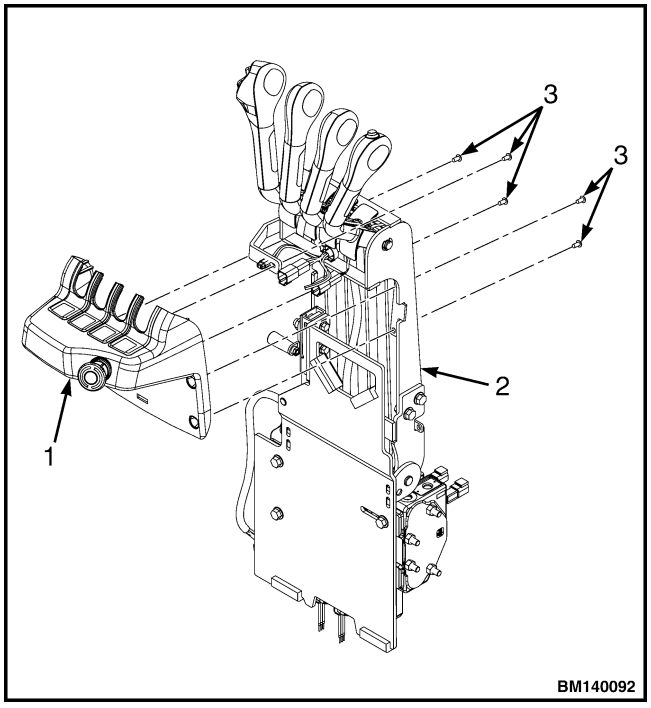
1. SWITCH
2. SWITCH ADAPTER
3. LOCK
4. NUT
5. EMERGENCY DISCONNECT SWITCH
6. WASHER
7. REAR COVER
8. HOLE

STEP 8.
Install two clamps and two capscrews on manual hydraulic wire harness and mounting plate. Route manual hydraulic wire harness and confirm it will not be crushed when moving lever assembly fore and aft. Place connectors inside rear cover.



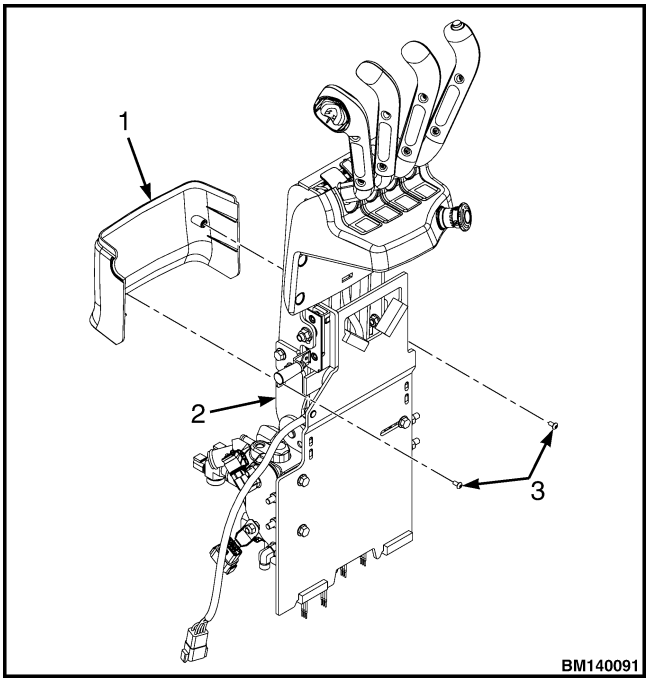
1. MOUNTING PLATE
2. MANUAL HYDRAULICS WIRE HARNESS
3. CAPSCREW
4. CLAMP

STEP 9.
Install rear cover and four button-head capscrews onto upper bracket.

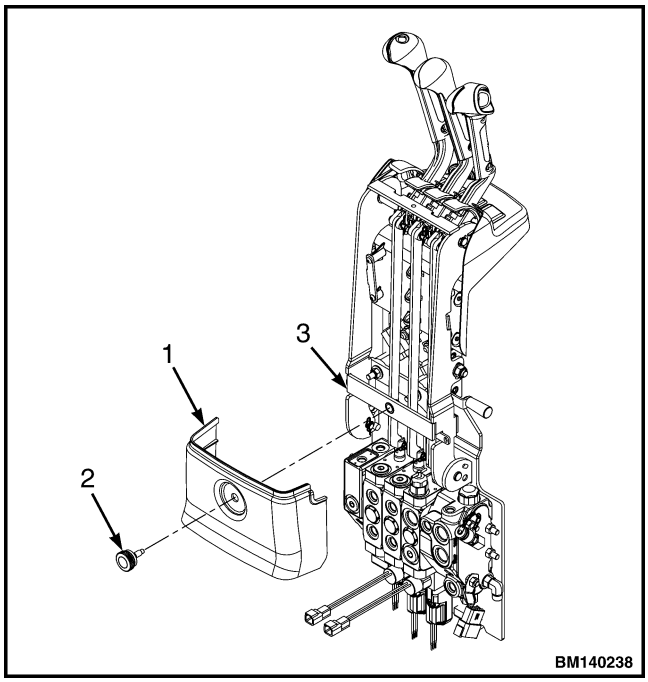


1. REAR COVER
2. UPPER BRACKET
3. BUTTON-HEAD CAPSCREW

STEP 10.
Install lower cover and two button-head capscrews onto lower frame plate or install lower cover and captive screw on plate.

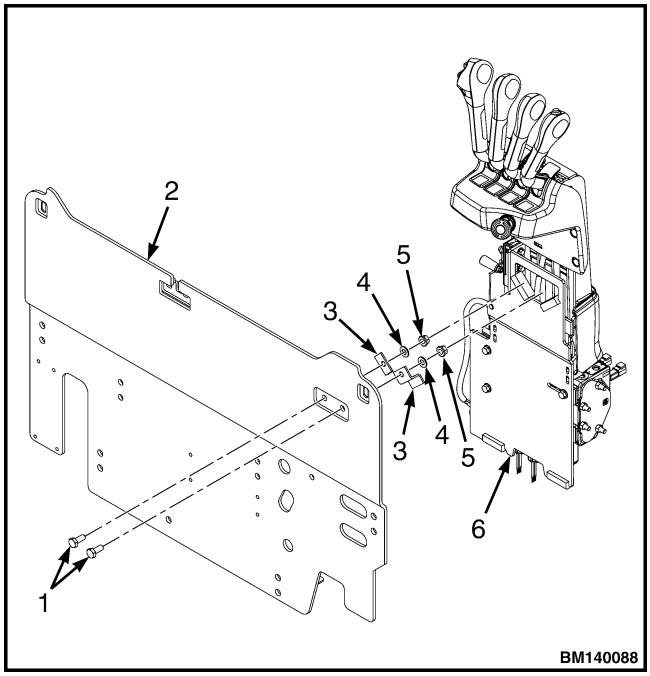


1. LOWER COVER
2. LOWER FRAME PLATE
3. BUTTON-HEAD CAPSCREW



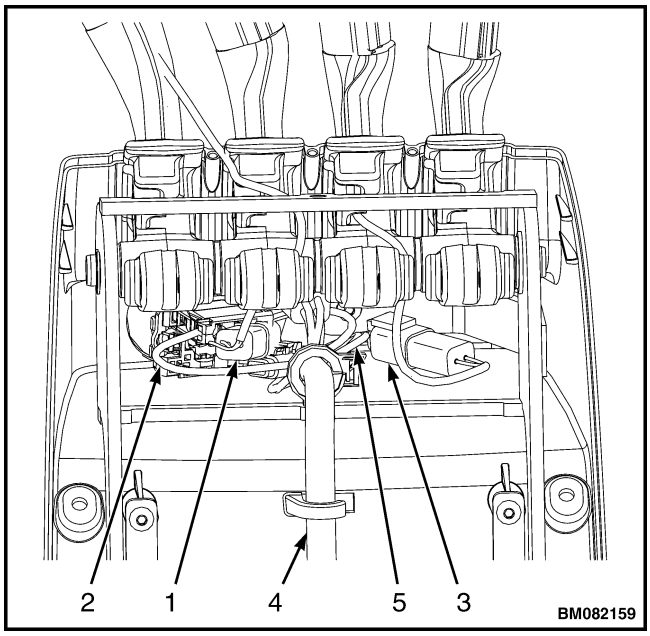
1. LOWER COVER
2. CAPTIVE SCREW
3. PLATE

STEP 11.
Install two brackets, two washers, two hex capscrews, and two nuts onto front bulkhead and mounting plate.



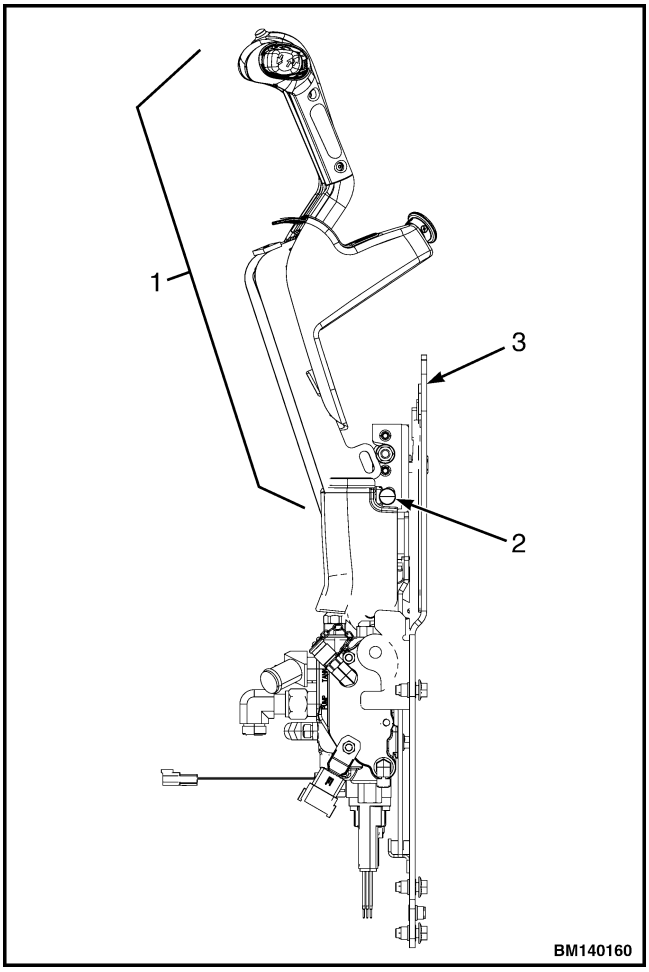
1. HEX CAPSCREW
2. FRONT BULKHEAD
3. BRACKET
4. WASHER
5. NUT
6. MOUNTING PLATE

STEP 12.
Connect manual hydraulics wire harness, as tagged during disassembly, to clamp button connector, emergency disconnect switch connector, and direction control switch connector. Lift truck models J30-40XNT (K160) and J30-40XN (A935) manufactured after November, 2014, can be equipped with a Return to Set Tilt (RTST) option on the tilt lever. If lift truck has this option, connect the RTST switch connector.



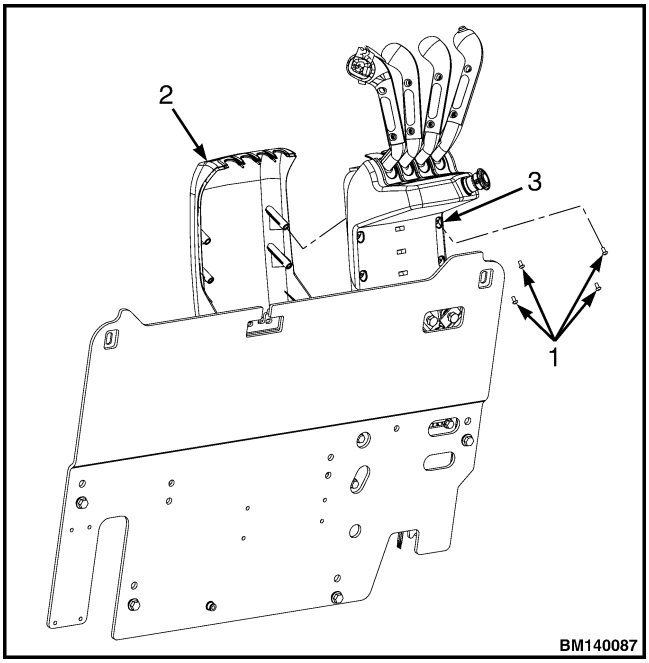
1. CLAMP BUTTON CONNECTOR
2. EMERGENCY DISCONNECT SWITCH CONNECTOR
3. RETURN TO SET TILT SWITCH CONNECTOR
4. MANUAL CONTROL VALVE WIRE HARNESS
5. DIRECTION CONTROL SWITCH CONNECTOR

STEP 13.
Pull latch handle and allow manual hydraulic linkage and handles to move forward away from mounting plate.



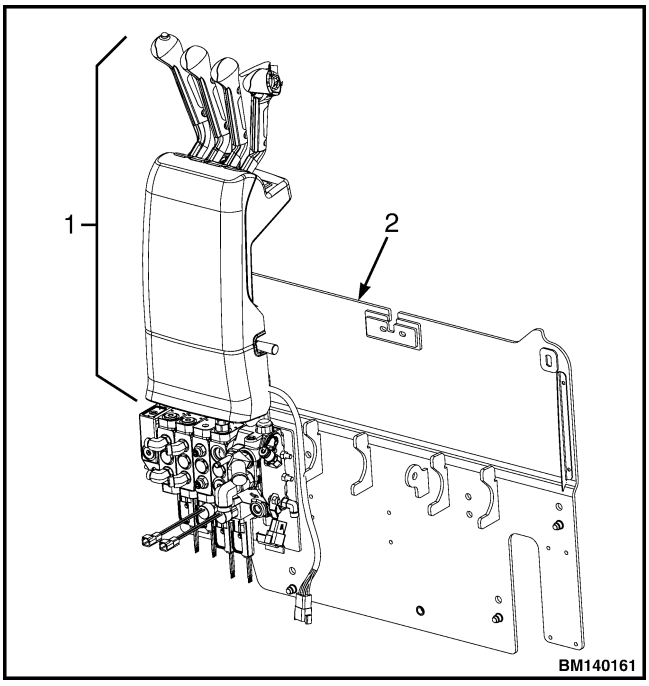
1. MANUAL HYDRAULIC LINKAGE AND HANDLES
2. LATCH HANDLE
3. MOUNTING PLATE

STEP 14.
Install upper front cover and four button-head capscrews onto rear cover.



1. UPPER FRONT COVER
2. BUTTON-HEAD CAPSCREW
3. REAR COVER

STEP 15.
Pull manual hydraulic linkage and handles upright until secured against mounting plate.



1. MANUAL HYDRAULIC LINKAGE AND HANDLES
2. MOUNTING PLATE

Ending Steps

1. Connect position sensor wires to rear of position sensor connector as tagged during removal. See Table 2 and Figure 37.
2. Connect position sensor connector to manual hydraulic wire harness. See Figure 37.
3. Connect spool lock solenoids to manual hydraulic wire harness. See Figure 37.
4. Raise manual hydraulic linkage and handles to upright position and secure latch. See Figure 38.
5. Connect hydraulic lines to fittings as tagged during removal.

CAUTION

Disposal of lubricants and fluids must meet local environmental regulations.

6. Dispose of drain pan contents.
7. Install floor plates and floor mats.
8. Install battery into lift truck. See **How to Change Battery** in **Operating Manual** or

   Periodic Maintenance 8000SRM1339 for lift truck models

   - J1.5-2.0XNT (J30-40XNT) (K160)

   Periodic Maintenance 8000SRM1373 for lift truck models

   - J1.6-2.0XN (J30-40XN) (A935)
9. Turn lift truck **ON**; operate hydraulic functions; check for leaks.
10. Calibrate manual control valve as outlined in section Calibration Procedure in this manual.

Table 2. Position Sensor Connector Pin Layout

PIN	SOCKET	PIN	SOCKET	PIN	SOCKET
PIN 1	SPOOL 1 POS	**PIN 5**	SPOOL 1 OUTPUT	**PIN 12**	SPOOL 1 NEG
PIN 2	SPOOL 2 POS	**PIN 6**	SPOOL 2 OUTPUT	**PIN 11**	SPOOL 2 NEG
PIN 3	SPOOL 3 POS	**PIN 7**	SPOOL 3 OUTPUT	**PIN 10**	SPOOL 3 NEG
PIN 4	SPOOL 4 POS	**PIN 8**	SPOOL 4 OUTPUT	**PIN 9**	SPOOL 4 NEG

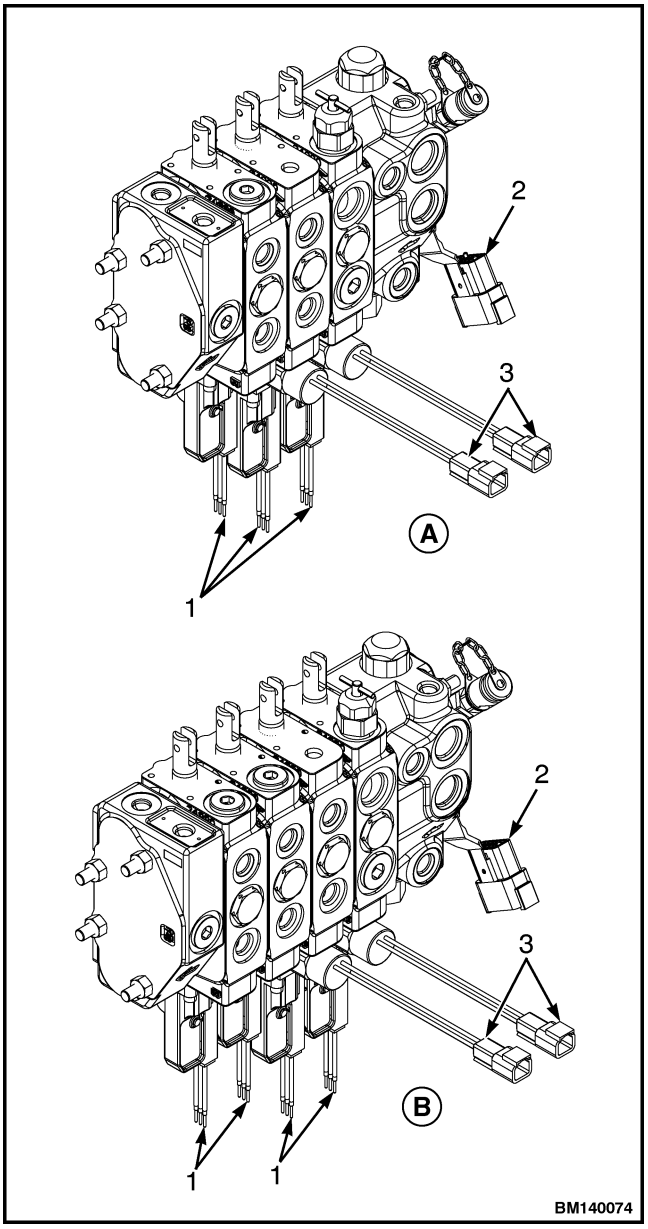
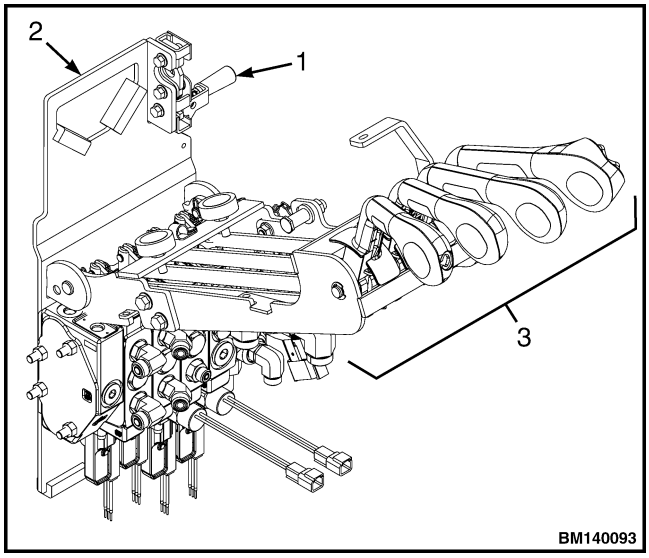


Figure 37. Manual Control Valve Electrical Connections

Legend for Figure 37

A. 3-FUNCTION MANUAL CONTROL VALVE
B. 4-FUNCTION MANUAL CONTROL VALVE

1. POSITION SENSOR WIRES
2. POSITION SENSOR ELECTRICAL CONNECTOR
3. OPS SOLENOID



1. LATCH HANDLE
2. MOUNTING PLATE
3. MANUAL HYDRAULIC LINKAGE AND HANDLES

Figure 38. Latch

Manual Hydraulic Control Valve Repair for 2.0-3.5T Trucks and 4.0-5.0T Pneumatic Trucks

REMOVE

WARNING

Before making repairs to the control valve or its linkage, fully lower all parts of the mast and tilt it fully forward. These actions will prevent the mast from lowering suddenly when hydraulic lines are disconnected.

NOTE: Only perform the steps below necessary for required repair or replacement.

1. Lower mast and tilt forward.
2. Remove battery from lift truck. See the **Operating Manual** or one of the following service manuals

   Periodic Maintenance 8000SRM1364 for lift truck models
   - E2.2-3.5XN (E45-70XN) (A268)

   Periodic Maintenance 8000SRM1372 for lift truck models
   - J2.2-3.5XN (J45-70XN) (A276)

   Periodic Maintenance 8000SRM1541 for lift truck models
   - J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)
3. Discharge capacitors by following steps shown in Discharging the Capacitors in **General** section of this manual.
4. Remove floor mats and floor plates.

WARNING

Hydraulic oil is hot after system operation and can cause burns. DO NOT disconnect any hydraulic hoses until the oil in the system is cool.

CAUTION

For lift truck E2.2-3.5XN (E45-70XN) (A268), electrical components must be shielded from hydraulic oil drips if they are below hydraulic valve and lines.

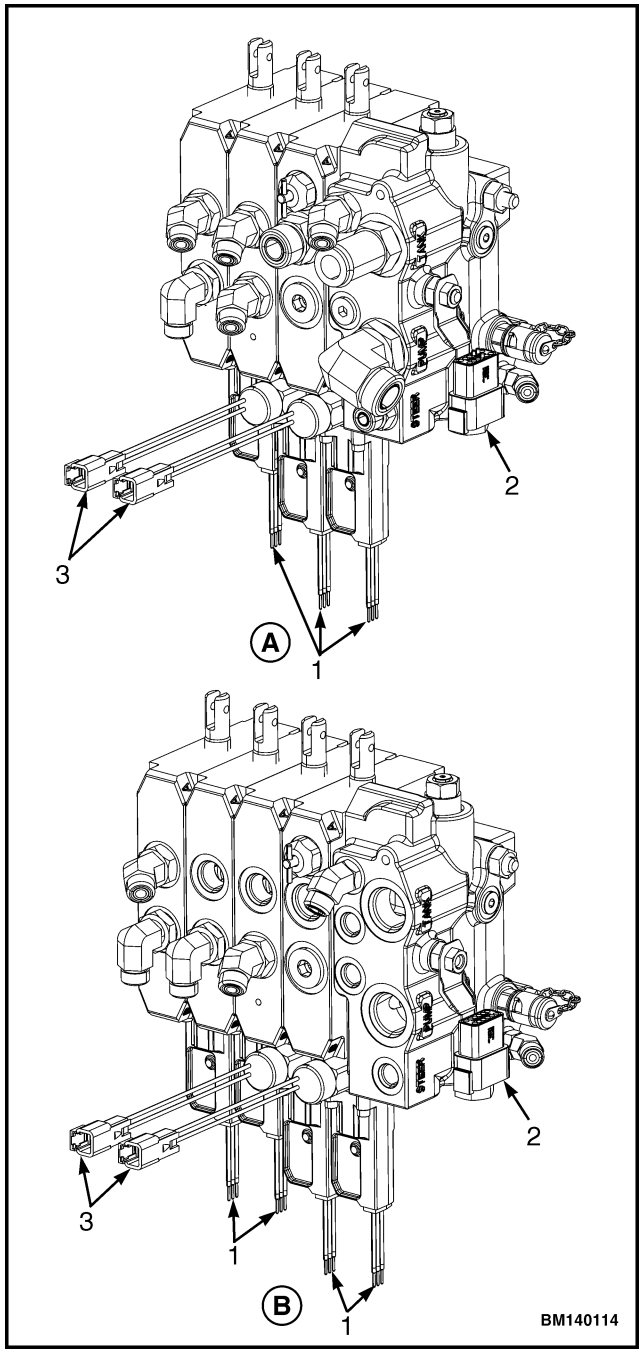
NOTE: Tag hydraulic hoses during removal to aid in installation.

5. Put a drain pan under the area of the control valve assembly. Disconnect hydraulic hoses from control valve fittings. Cap hydraulic hoses and control valve fittings.
6. Disconnect position sensor electrical connector from manual hydraulic wire harness.

   See Figure 39 for the following lift truck models manufactured before October, 2012
   - E2.2-3.5XN (E45-70XN) (A268)
   - J2.2-3.5XN (J45-70XN) (A276)
   - J4.0-5.0XN (J80-100XN) (A970)

   See Figure 40 for the following lift truck models manufactured after October, 2012
   - E2.2-3.5XN (E45-70XN) (A268)
   - J2.2-3.5XN (J45-70XN) (A276)
   - J4.0-5.0XN (J80-100XN) (A970)

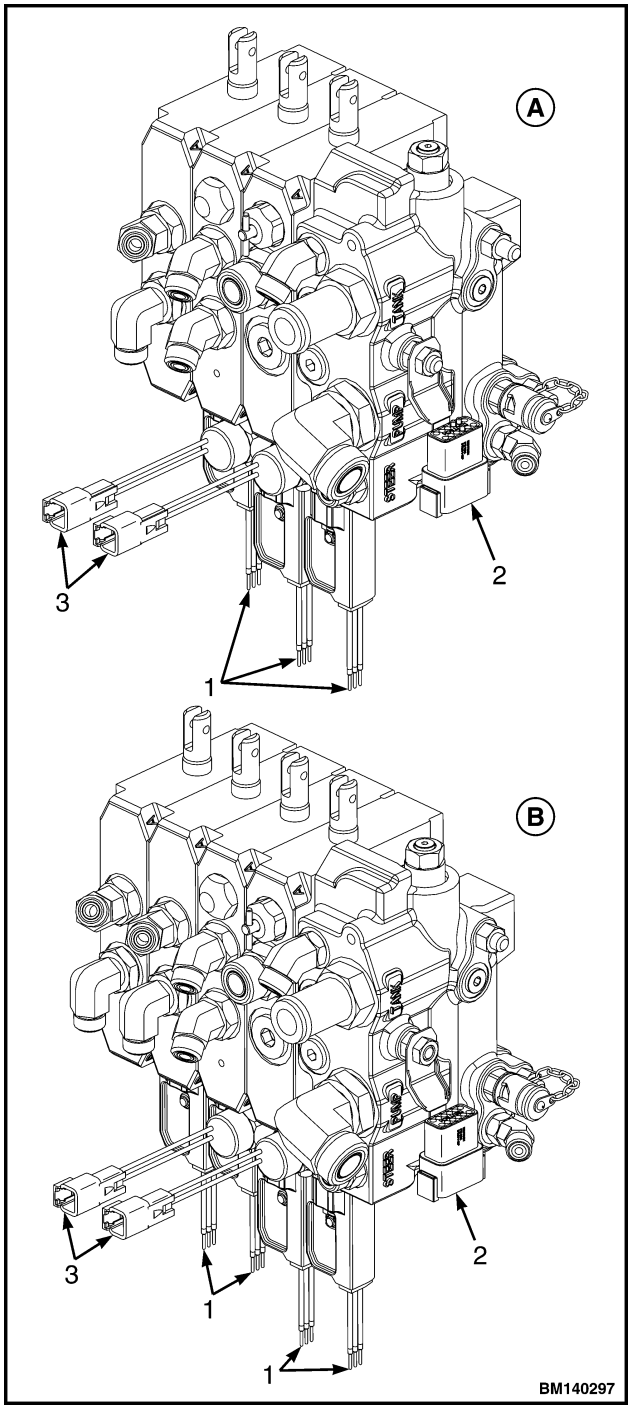
   See Figure 41 for the following lift truck models manufactured after November, 2014
   - J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)
7. Disconnect OPS solenoids from manual hydraulic wire harness.



A. 3-FUNCTION MANUAL CONTROL VALVE
B. 4-FUNCTION MANUAL CONTROL VALVE

1. POSITION SENSOR WIRES
2. POSITION SENSOR ELECTRICAL CONNECTOR
3. OPS SOLENOID

Figure 39. Manual Control Valve Electrical Connections, Manufactured Before October, 2012



A. 3-FUNCTION MANUAL CONTROL VALVE
B. 4-FUNCTION MANUAL CONTROL VALVE

1. POSITION SENSOR WIRES
2. POSITION SENSOR ELECTRICAL CONNECTOR
3. OPS SOLENOID

Figure 40. Manual Control Valve Electrical Connections, Manufactured After October, 2012

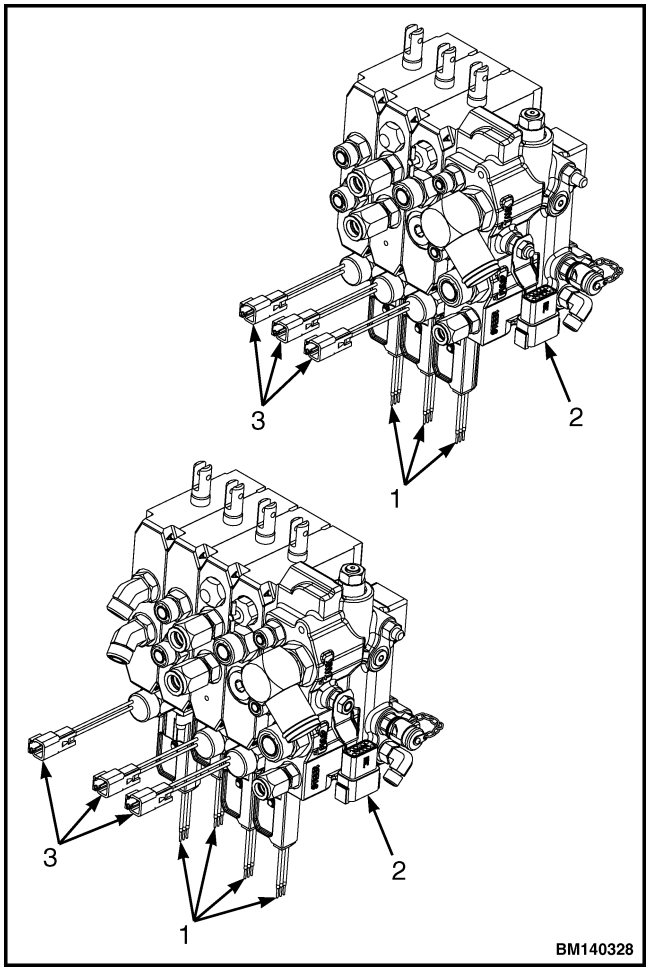


Figure 41. Manual Control Valve Electrical Connections, Lift Truck Models J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) Manufactured After November, 2014

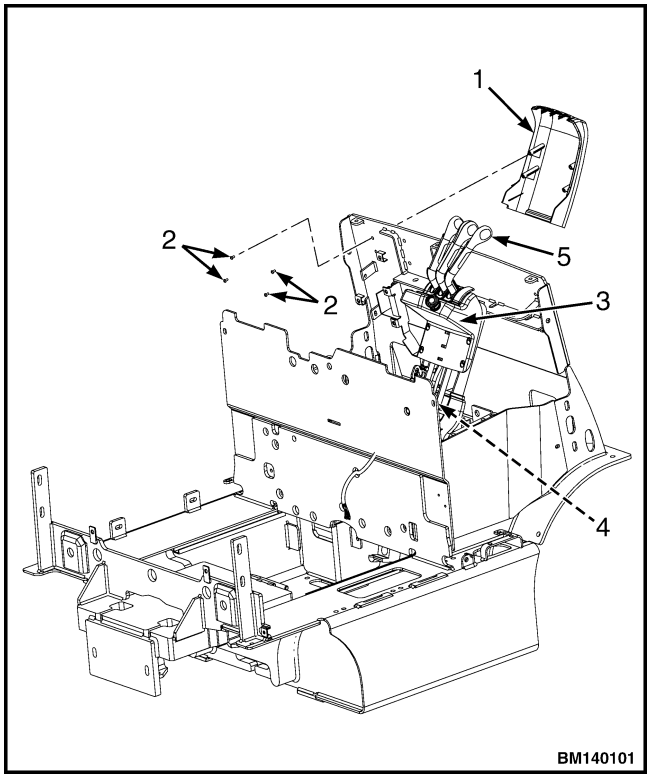
Legend for Figure 41

A. 3-FUNCTION MANUAL CONTROL VALVE
B. 4-FUNCTION MANUAL CONTROL VALVE

1. POSITION SENSOR WIRES
2. POSITION SENSOR ELECTRICAL CONNECTOR
3. OPS SOLENOID

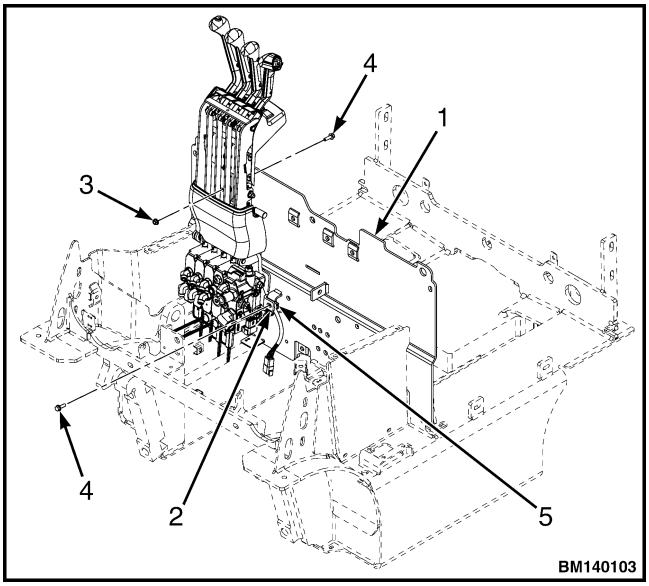
Remove Control Valve

STEP 1.
Pull latch handle, tilt manual hydraulic linkage and handles forward, and remove four button-head capscrews and upper front cover from rear cover.



1. UPPER FRONT COVER
2. BUTTON-HEAD CAPSCREW
3. REAR COVER
4. LATCH HANDLE
5. MANUAL HYDRAULIC LINKAGE AND HANDLES

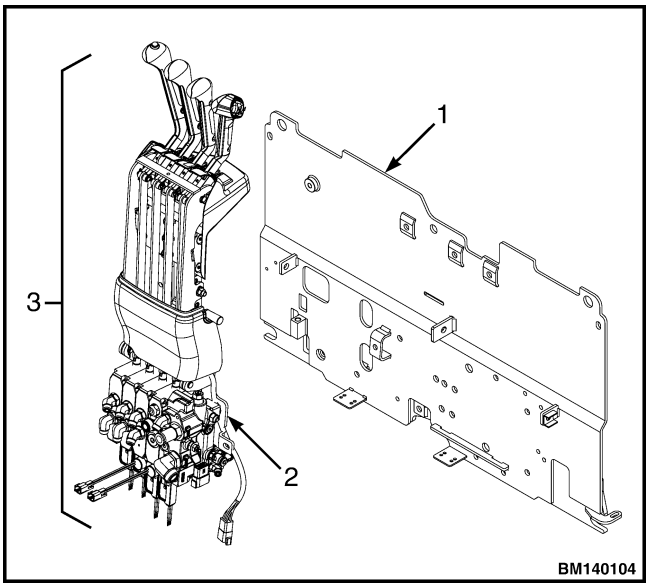
STEP 2.
Remove nut and capscrews, and clip-nut from mounting plate and front bulkhead.



NOTE: CONTROL VALVE MANUFACTURED BEFORE OCTOBER, 2012 SHOWN.

1. FRONT BULKHEAD
2. MOUNTING PLATE
3. NUT
4. CAPSCREW
5. CLIP-NUT

STEP 3.
Lift mounting plate with attached components away from front bulkhead and out of lift truck.



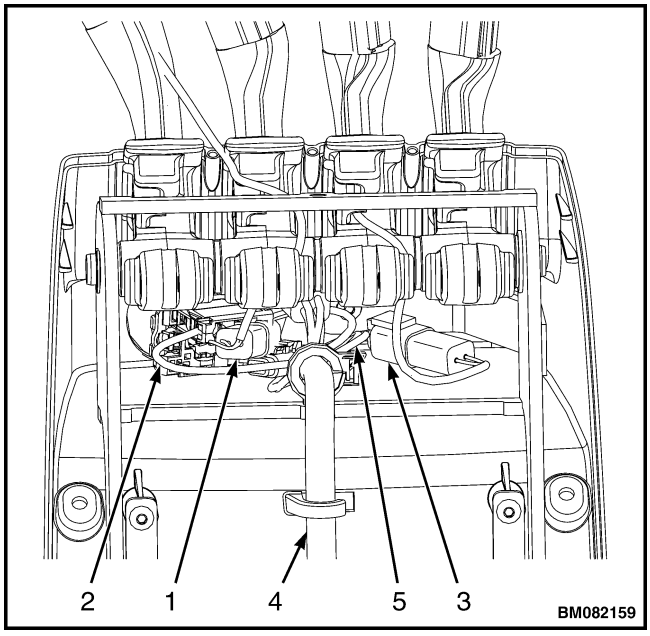
NOTE: CONTROL VALVE MANUFACTURED BEFORE OCTOBER, 2012 SHOWN.

1. FRONT BULKHEAD
2. MOUNTING PLATE
3. ATTACHED COMPONENTS

STEP 4.

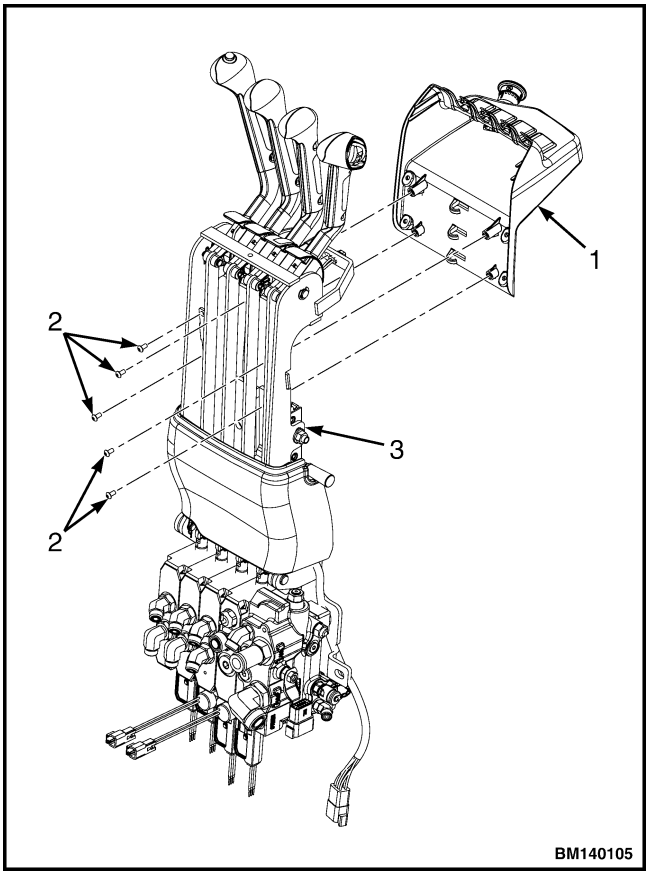
Disconnect manual hydraulic wire harness from clamp button connector, emergency disconnect switch connector, and direction control switch connector.

Lift truck models E45-70XN (A268) manufactured after November, 2014 can be equipped with an optional Return To Set Tilt (RTST) button connector on the tilt lever. If lift truck is equipped with this option, disconnect manual wire harness from RTST button connector.



1. CLAMP BUTTON CONNECTOR
2. EMERGENCY DISCONNECT SWITCH CONNECTOR
3. RETURN TO SET TILT SWITCH CONNECTOR
4. MANUAL CONTROL VALVE WIRE HARNESS
5. DIRECTION CONTROL SWITCH CONNECTOR

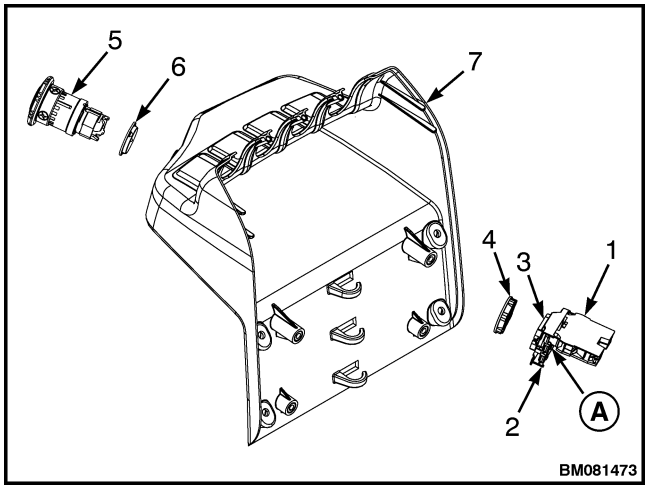
STEP 5.
Remove five button-head capscrews and rear cover from upper bracket.



NOTE: CONTROL VALVE MANUFACTURED BEFORE OCTOBER, 2012 SHOWN.

1. REAR COVER
2. BUTTON-HEAD CAPSCREW
3. UPPER BRACKET

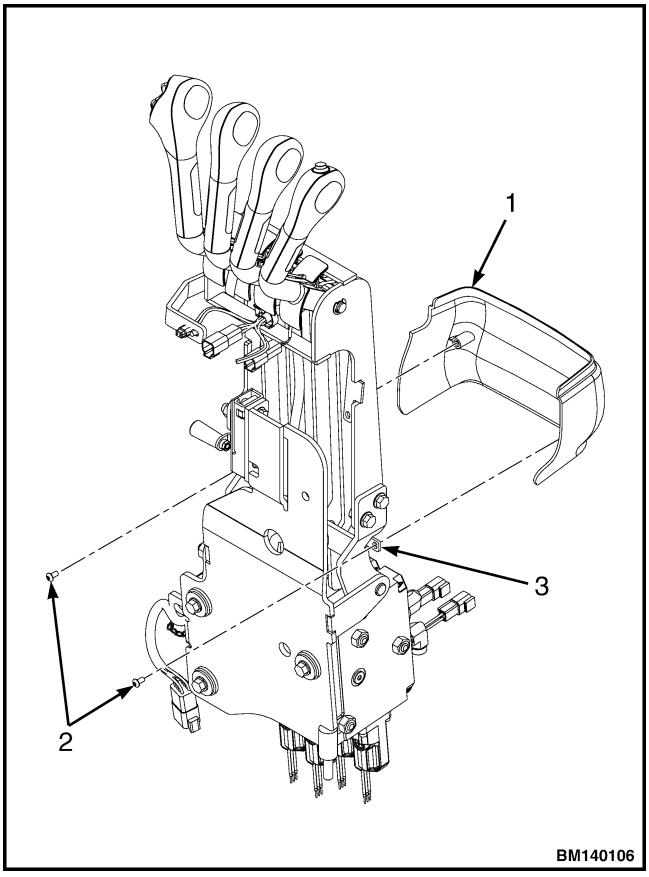
STEP 6.
Remove emergency disconnect switch from rear cover. See **Electrical System** 2200SRM1369 for procedure.



A. INSERT SCREWDRIVER HERE

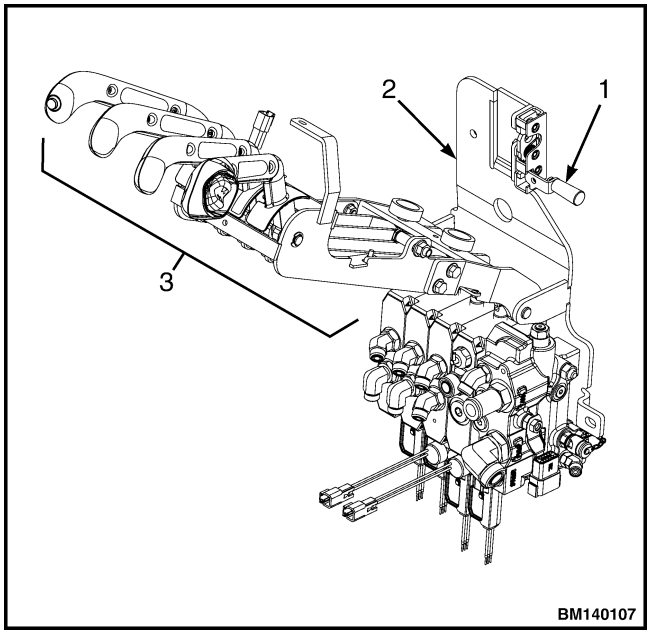
1. SWITCH
2. SWITCH ADAPTER
3. LOCK
4. NUT
5. EMERGENCY DISCONNECT BUTTON
6. BUSHING
7. UPPER REAR COVER
8. HOLE

STEP 7.
Remove two button-head capscrews and lower cover from lower bracket.



1. LOWER COVER
2. BUTTON-HEAD CAPSCREW
3. LOWER BRACKET

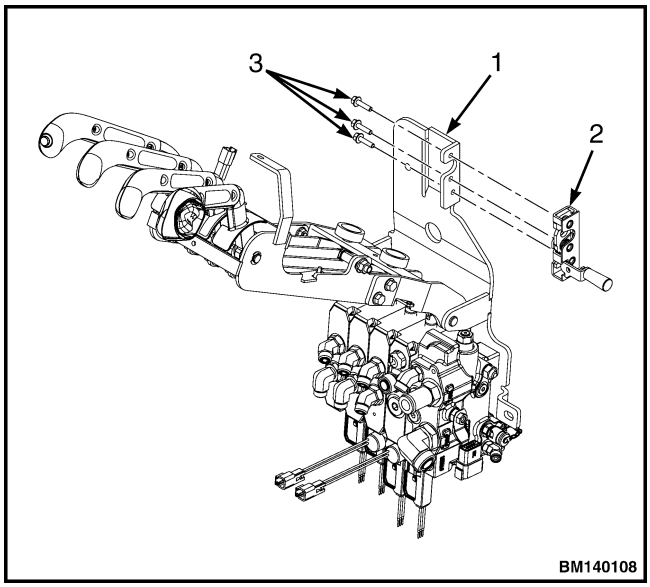
STEP 8.
Pull latch handle up an allow manual hydraulic linkage and handles to move forward away from mounting plate.



NOTE: CONTROL VALVE MANUFACTURED BEFORE OCTOBER, 2012 SHOWN.

1. LATCH HANDLE
2. MOUNTING PLATE
3. HYDRAULIC LINKAGE AND HANDLES

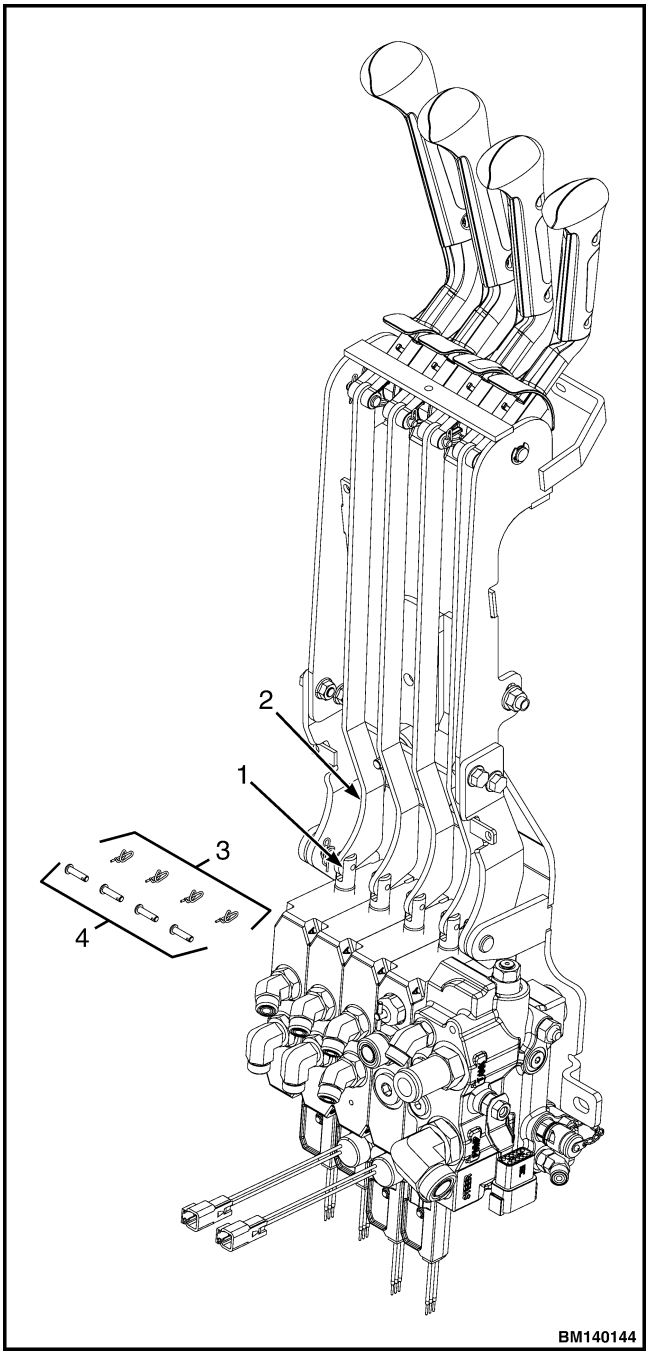
STEP 9.
Remove three capscrews and latch assembly from mounting plate.



NOTE: CONTROL VALVE MANUFACTURED BEFORE OCTOBER, 2012 SHOWN.

1. MOUNTING PLATE
2. LATCH ASSEMBLY
3. CAPSCREW

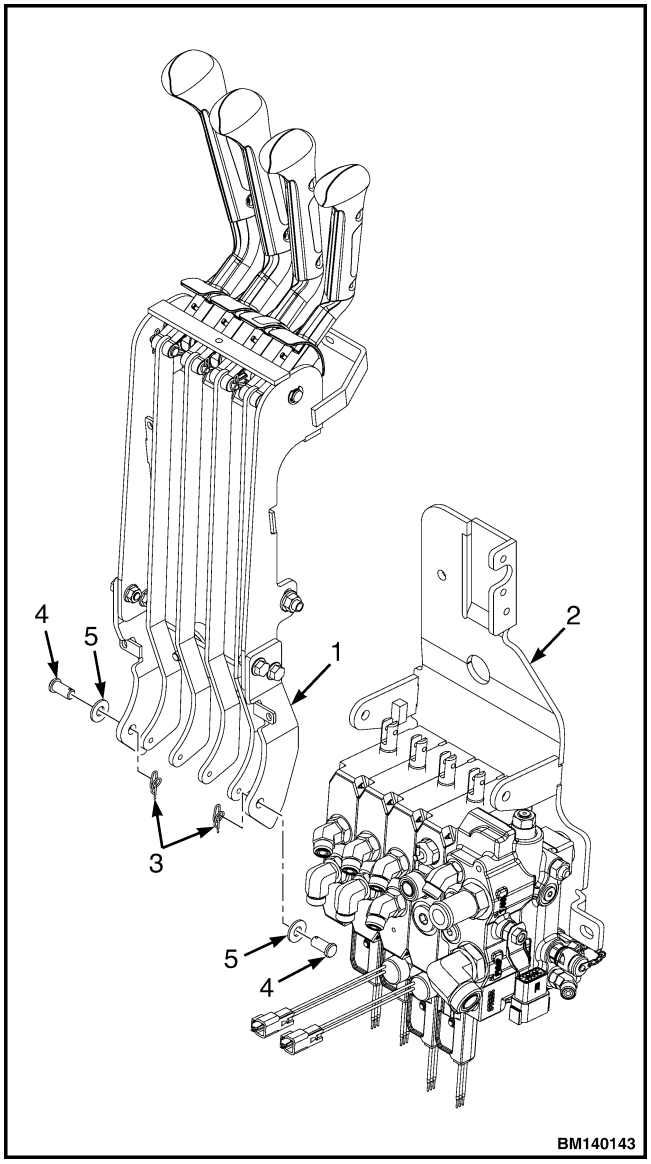
STEP 10.
Remove locking ring cotter pins, rod end pins and links from clevis' at top of manual control valve sections.



NOTE: CONTROL VALVE MANUFACTURED BEFORE OCTOBER, 2012 SHOWN.

1. CLEVIS
2. LINK
3. LOCKING RING COTTER PIN
4. ROD END PIN

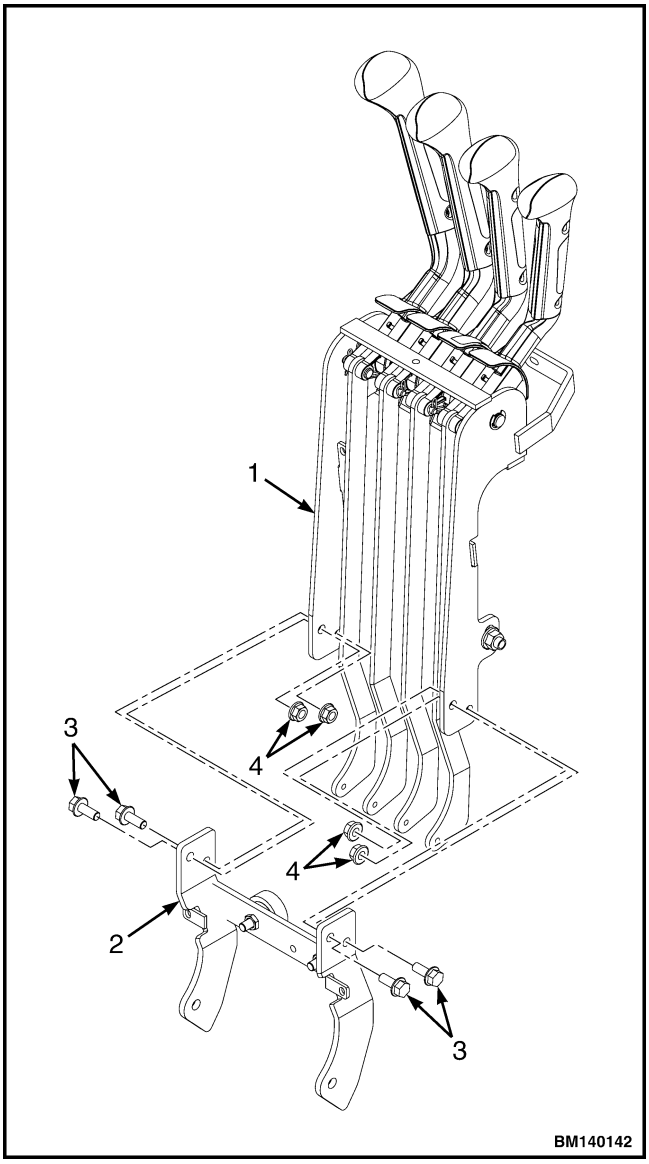
STEP 11.
Remove two locking ring cotter pins, two rod end pins, two nylon washers, and mounting bracket from lower bracket.



NOTE: CONTROL VALVE MANUFACTURED BEFORE OCTOBER, 2012 SHOWN.

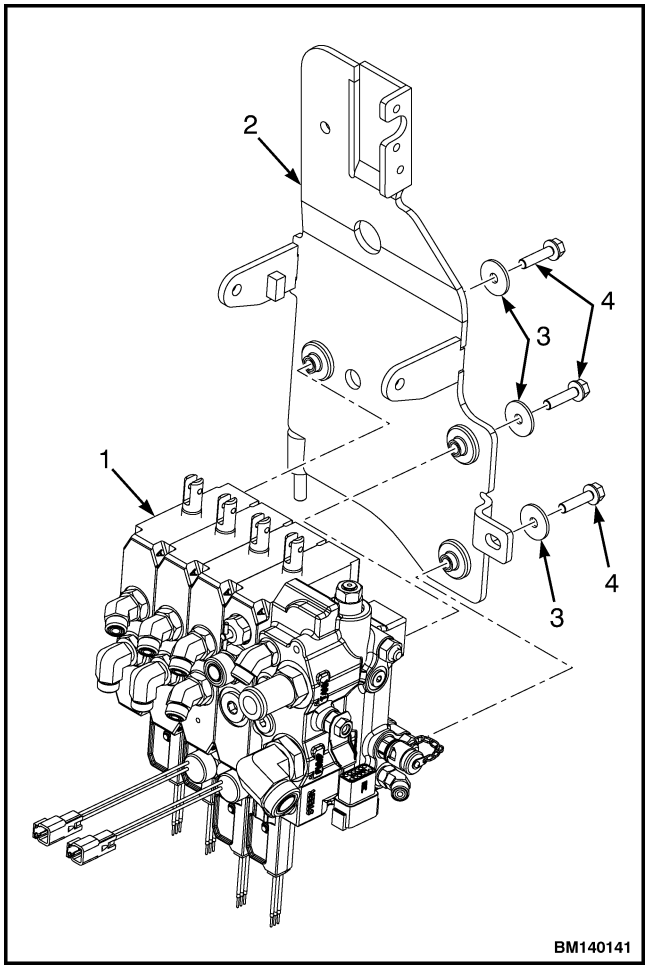
1. LOWER BRACKET
2. MOUNTING BRACKET
3. LOCKING RING COTTER PIN
4. ROD END PIN
5. NYLON WASHER

STEP 12.
Remove four nuts, four capscrews and lower bracket from upper bracket.



1. UPPER BRACKET
2. LOWER BRACKET
3. CAPSCREW
4. NUT

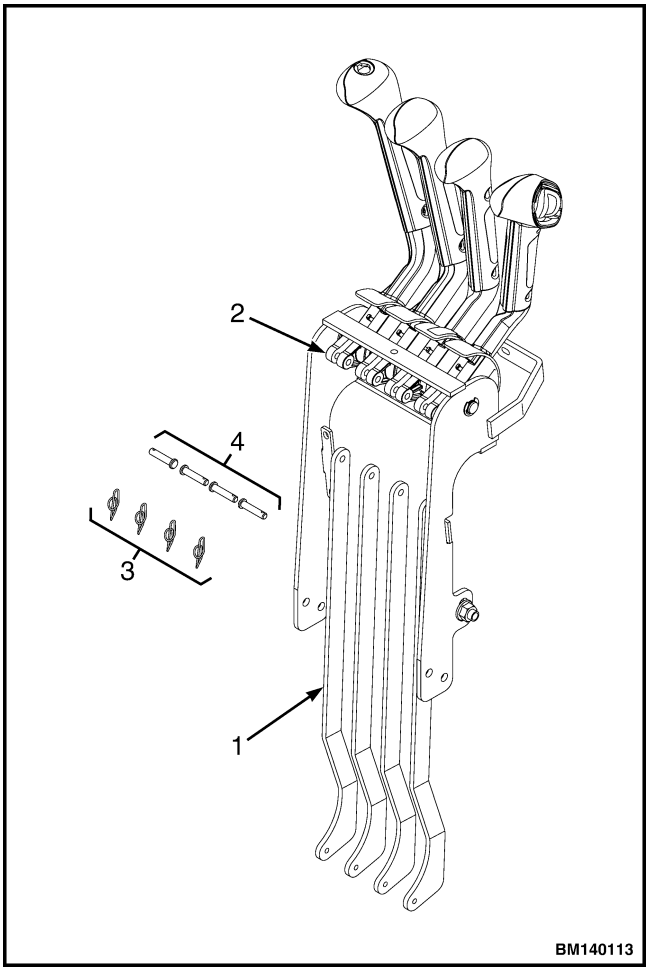
STEP 13.
Remove three capscrews, three special washers, and manual control valve from mounting bracket



NOTE: CONTROL VALVE MANUFACTURED BEFORE OCTOBER, 2012 SHOWN.

1. MANUAL CONTROL VALVE
2. MOUNTING BRACKET
3. SPECIAL WASHER
4. CAPSCREW

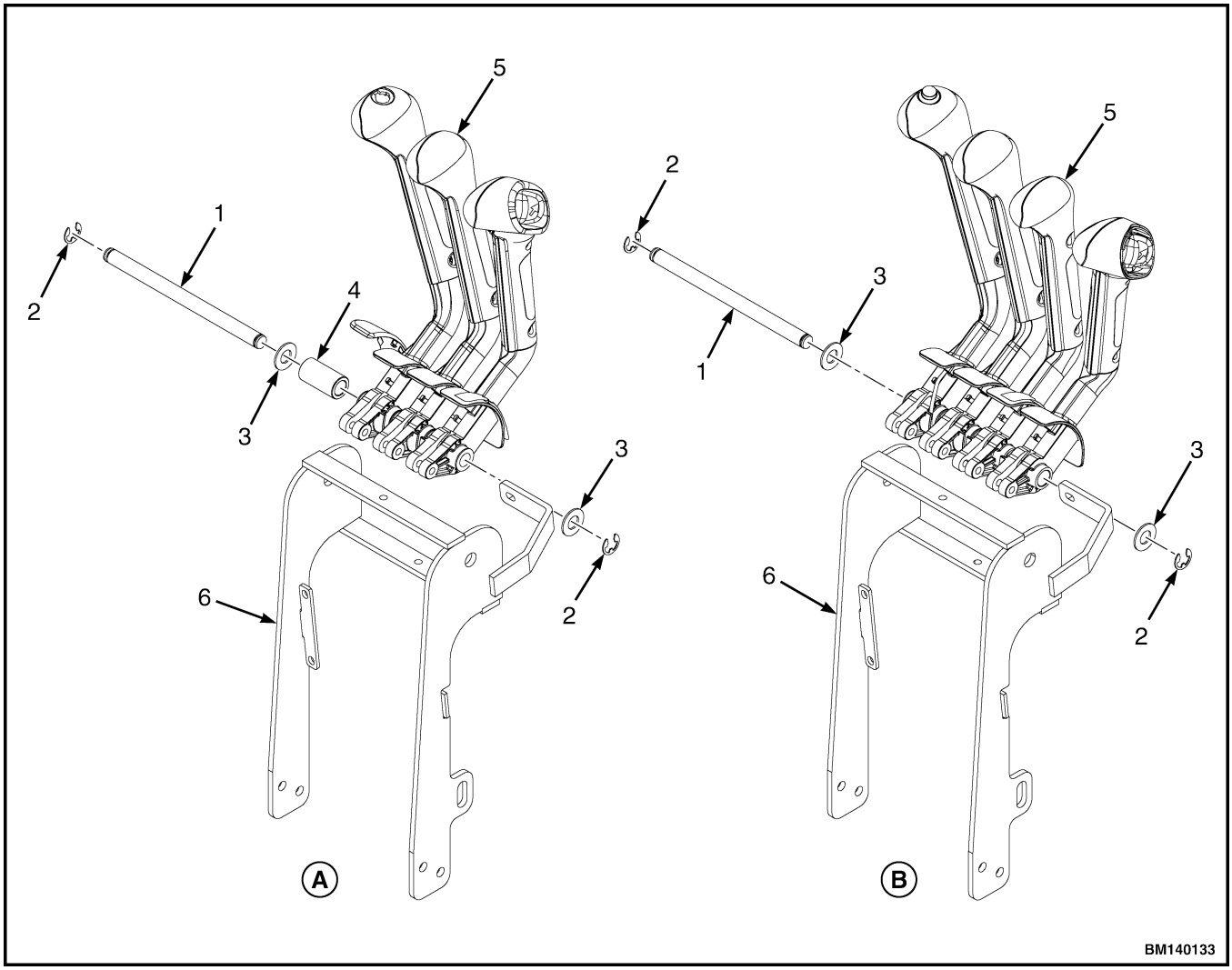
STEP 14.
Remove locking ring cotter pins, clevis pins, and links from levers. Discard locking ring cotter pins.



1. LINK
2. LEVER
3. LOCKING RING COTTER PIN
4. CLEVIS PIN

STEP 15.

Remove e-clip at both ends of pivot pin. Slide pivot pin from levers and upper bracket. Remove nylon washers, lever spacer if present, and levers from upper bracket.



A. 3-FUNCTION LEVERS

1. PIVOT PIN
2. E-CLIP
3. WASHER

B. 4-FUNCTION LEVERS

4. LEVER SPACER
5. LEVER
6. UPPER BRACKET

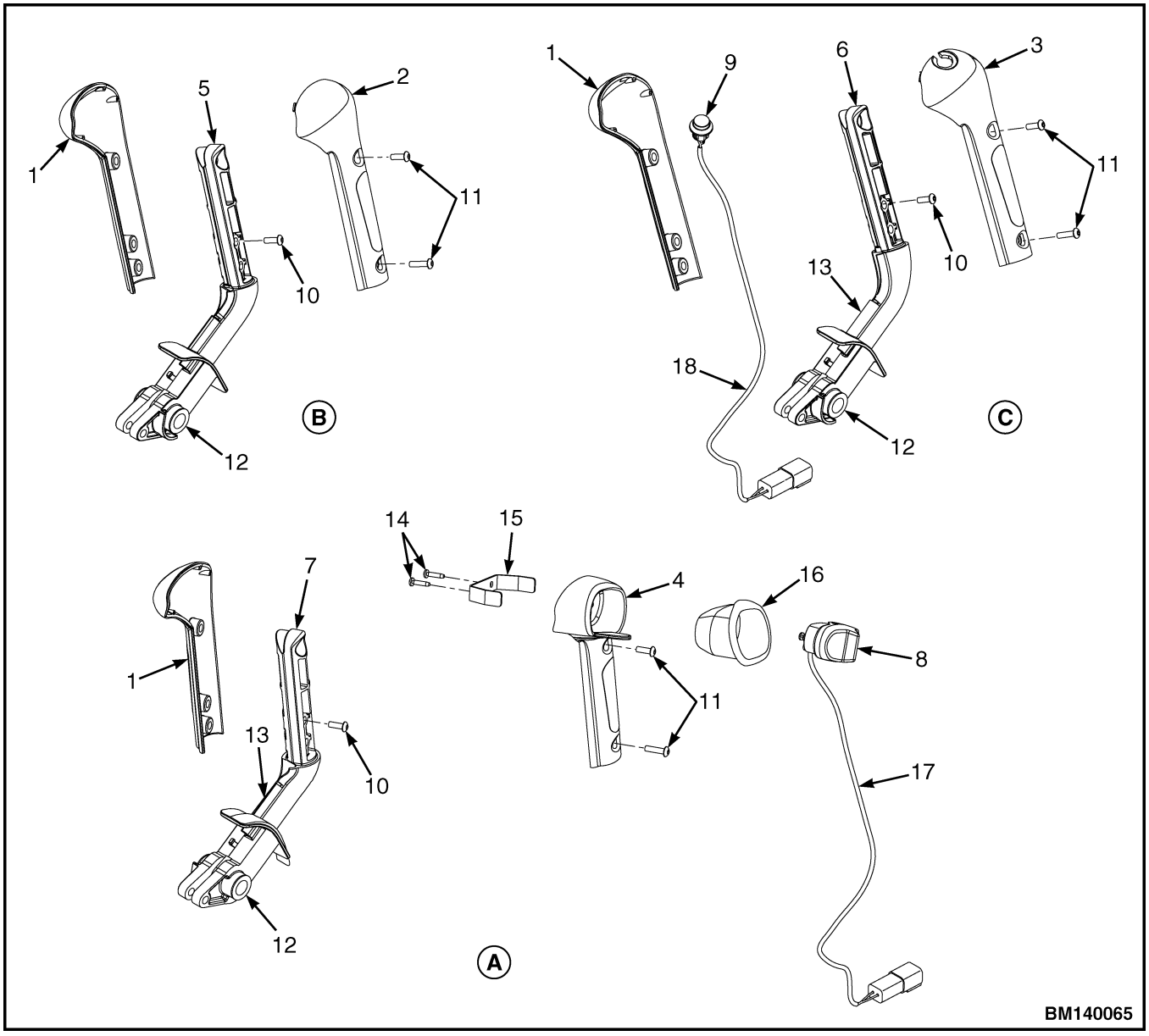
DISASSEMBLE HANDLES AND LEVERS

NOTE: Follow procedure for disassembling links and brackets before disassembling handles.

NOTE: If necessary, handles can be disassembled. Perform Step 1 through Step 4 for lift/lower handle for lift truck equipped with Direction Control Switch (DCS) handle, Step 5 through Step 7 for lift/lower, tilt, tilt with RTST, aux 1, and aux 2 handles, and Step 8 through Step 10 for aux handle with dual function for lift trucks equipped with clamping function.

NOTE: Handles described in Step 1 through Step 4 and Step 7 through Step 10 are optional.

1. Remove two outer capscrews and lift/lower with DCS handle from manual lift/lower lever. See Figure 42.
2. Remove one inner capscrew and palm side grip handle from manual lift lever. See Figure 42.
3. Remove DCS cable from cable track. See Figure 42.
4. Remove two screws, DCS retainer, DCS cup, and Direction Control Switch from lift/lower with DCS handle. See Figure 42 and Figure 43.
5. Remove two outer capscrews and finger side handle from manual tilt or aux 1 lever. See Figure 42.
6. Remove one inner capscrew and palm side grip handle from manual tilt or aux 1 lever. See Figure 42.
7. For lift truck models E45-70XN (A268) manufactured after November, 2014 and equipped with RTST option, remove push-button cable from cable track. See Figure 42.
8. Remove two outer capscrews and clamp switch handle from manual aux 2 lever. See Figure 42.
9. Remove one inner capscrew and palm side grip handle from manual aux 2 lever. See Figure 42.
10. Remove push-button cable from cable track. See Figure 42.
11. Remove bushings from levers. See Figure 42.

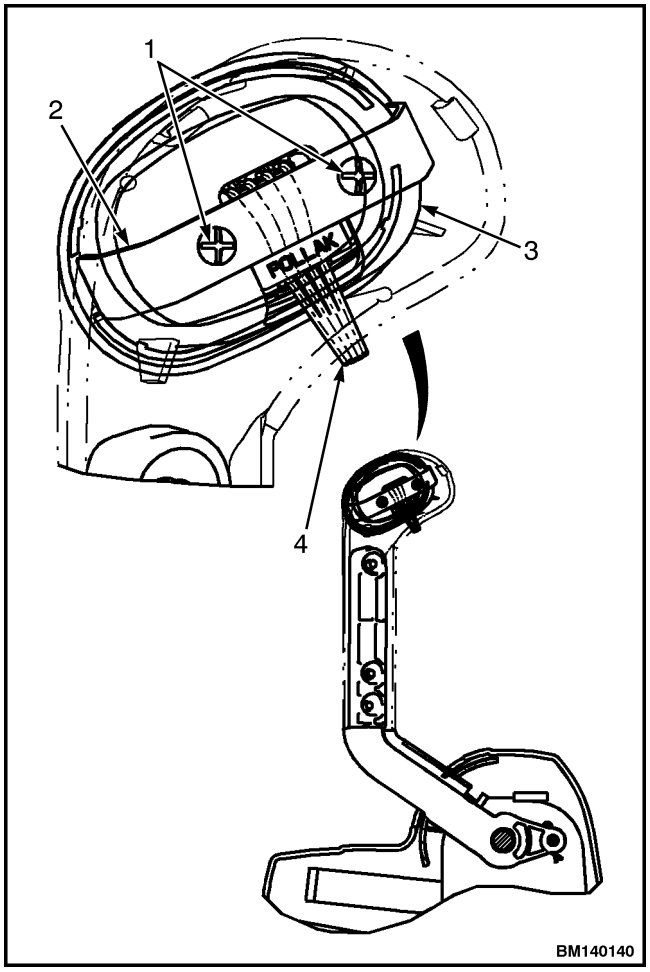


NOTE: ONLY LIFT TRUCK MODELS E45-70XN (A268) MANUFACTURED AFTER NOVEMBER, 2014, CAN BE EQUIPPED WITH OPTIONAL RTST BUTTON ON TILT LEVER.

A. LIFT/LOWER WITH DCS
B. LIFT/LOWER, TILT, AUX 1, AUX 2
C. AUX WITH DUAL FUNCTION/TILT HANDLE WITH RETURN TO SET TILT (RTST)

1. PALM SIDE GRIP HANDLE
2. FINGER SIDE HANDLE
3. CLAMP/RTST SWITCH HANDLE
4. LIFT/LOWER WITH DCS HANDLE
5. MANUAL TILT OR AUX 1 LEVER
6. MANUAL AUX 2 LEVER
7. MANUAL LIFT/LOWER LEVER
8. DIRECTIONAL CONTROL SWITCH (DCS)
9. CLAMPING/RTST PUSH-BUTTON
10. INNER CAPSCREW
11. OUTER CAPSCREW
12. BUSHING
13. CABLE TRACK
14. SCREW
15. DCS RETAINER
16. DCS CUP
17. DCS CABLE
18. PUSH-BUTTON CABLE

Figure 42. Manual Hydraulic Control Handles



1. SCREW
2. DCS RETAINER
3. DCS CUP
4. DCS CABLE

Figure 43. Directional Control Switch

DISASSEMBLE MANUAL CONTROL VALVE

Disassemble Valve

CAUTION

All power must be disconnected from valve, mast lowered, and hydraulic lines de-pressurized prior to servicing.

Before any disassembly, all interfaces, joints, and recesses must be cleaned of residue and dirt to avoid contaminating internal components.

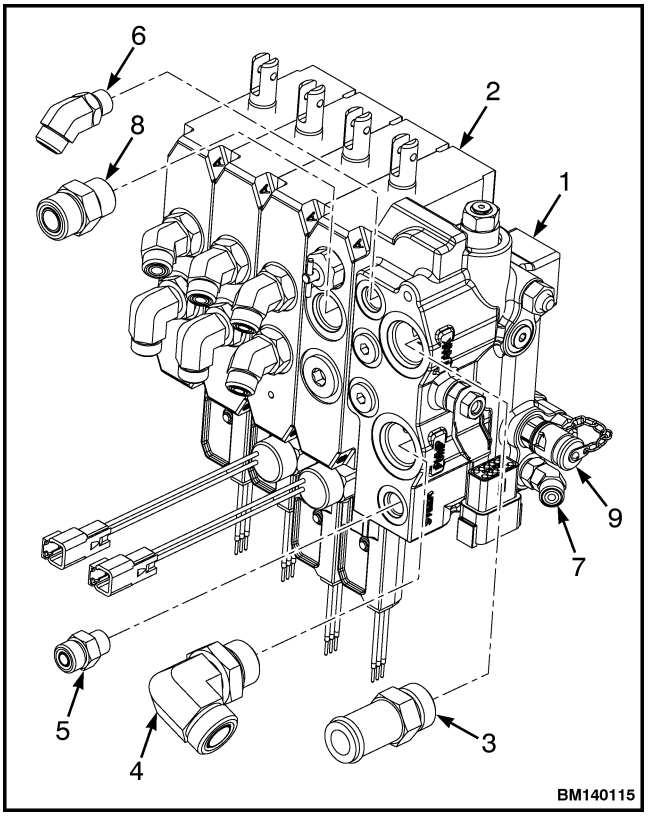
CAUTION

If O-rings are to be replaced between two sections that have a hydraulic oil leak, replace all O-rings between all sections. This eliminates the possibility of subsequent oil leak or possible damage to another O-ring.

NOTE: Disassemble the manual control valve only as necessary for repairs. Most repairs to the manual control valve will be to replace O-rings and seals. Spools and valve sections are not serviceable individually, and must be replaced as a complete valve section with spool.

NOTE: Note placement and orientation of fittings prior to disassembly to aid in assembly.

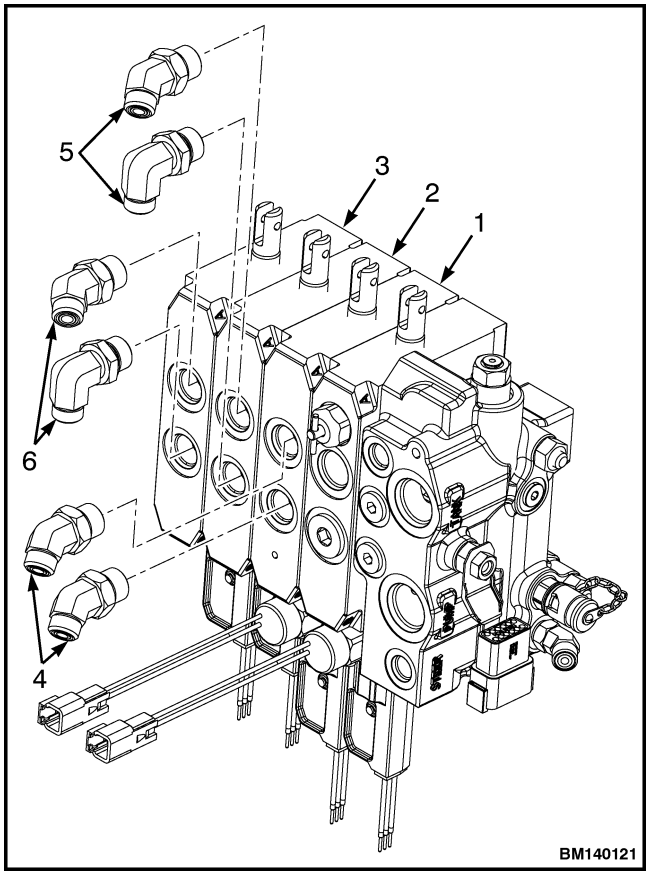
1. Remove return line fitting, pressure line fitting, steer supply fitting, steer return fitting, steer load sense fitting, and hoist line fitting from inlet and lift sections of manual control valve. Remove and discard all O-rings from fittings. See Figure 44.



NOTE: 4-FUNCTION MANUAL CONTROL VALVE MANUFACTURED BEFORE OCTOBER, 2012 SHOWN.

1. INLET SECTION
2. LIFT SECTION
3. RETURN LINE FITTING
4. PRESSURE LINE FITTING
5. STEER SUPPLY FITTING
6. STEER RETURN FITTING
7. STEER LOAD SENSE FITTING
8. HOIST LINE FITTING
9. DIAGNOSTIC FITTING (SHOWN IN PUMP PRESSURE GAUGE PORT)

Figure 44. Manual Control Valve Fittings, Inlet and Lift Sections



NOTE: 4-FUNCTION MANUAL CONTROL VALVE MANUFACTURED BEFORE OCTOBER, 2012 SHOWN.

1. TILT SECTION
2. OPTIONAL AUXILIARY SECTION
3. AUXILIARY SECTION
4. TILT LINE FITTING
5. OPTIONAL AUXILIARY FITTING
6. AUXILIARY FITTING

Figure 45. Manual Control Valve Fittings, Tilt and Auxiliary Sections

NOTE: 3-Function manual control valve does not contain optional auxiliary section.

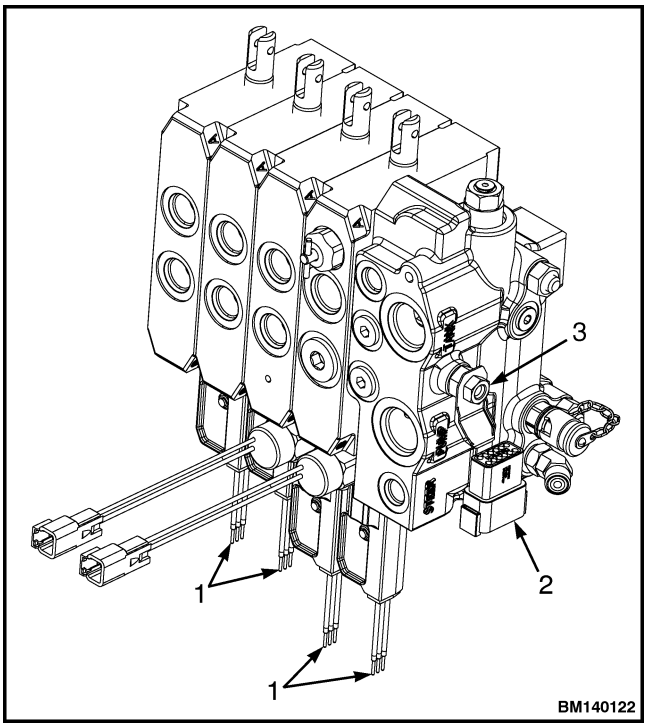
2. Remove tilt line fittings, optional auxiliary, and auxiliary fittings from tilt, optional auxiliary, and auxiliary sections. Remove and discard all O-rings from fittings. See Figure 45.

NOTE: Tag position sensor wires during disassembly to aid in assembly.

3. Disconnect position sensor wires from position sensor electrical connector. See Figure 46.

4. Remove nut and position sensor electrical connector from tie rod on inlet side of manual control valve. See Figure 46.

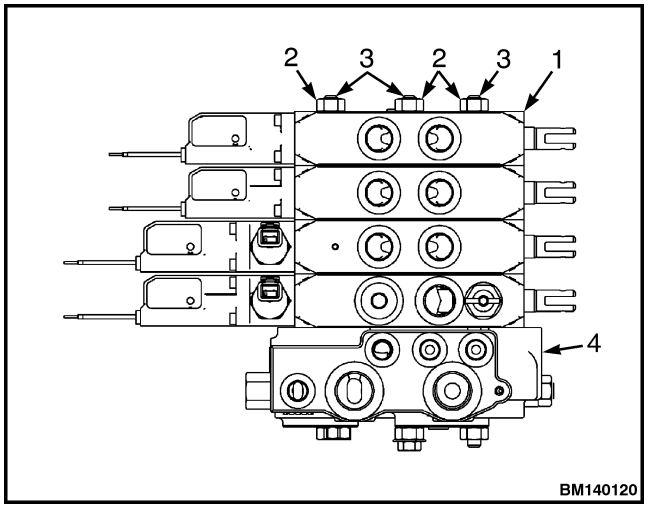
5. Place manual control valve with inlet section on work surface and auxiliary section pointing upward. See Figure 47.



NOTE: CONTROL VALVE MANUFACTURED BEFORE OCTOBER, 2012 SHOWN.

1. POSITION SENSOR WIRE
2. POSITION SENSOR ELECTRICAL CONNECTOR
3. NUT

Figure 46. Position Sensor Wires and Connector



NOTE: CONTROL VALVE MANUFACTURED BEFORE OCTOBER, 2012 SHOWN.

1. AUXILIARY SECTION
2. NUT
3. TIE ROD
4. INLET SECTION

Figure 47. Auxiliary Section Tie Rods and Nuts

6. Remove nuts from tie rods on auxiliary section side of manual control valve. See Figure 47.

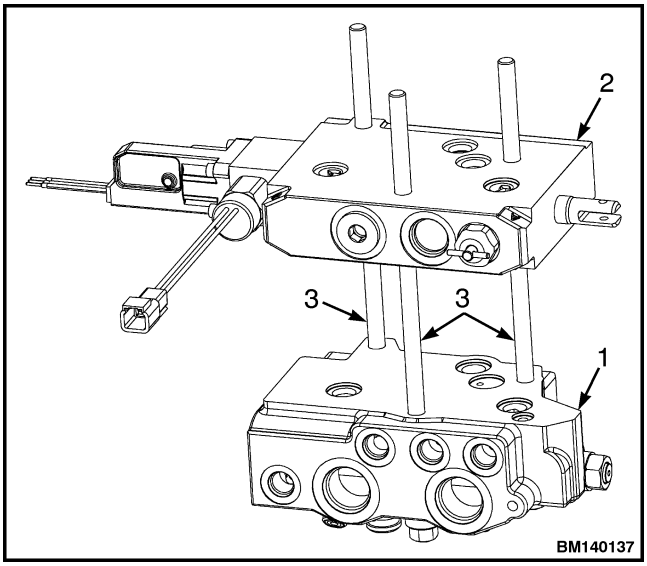
CAUTION

Care must be taken to ensure section seals do not become dislodged during disassembly, they can become wedged into holes which will result in problems during assembly.

7. Remove each section from tie rods starting with auxiliary section, followed by optional auxiliary section if present, tilt section, lift section, and finally the inlet section. See Figure 48 for example.

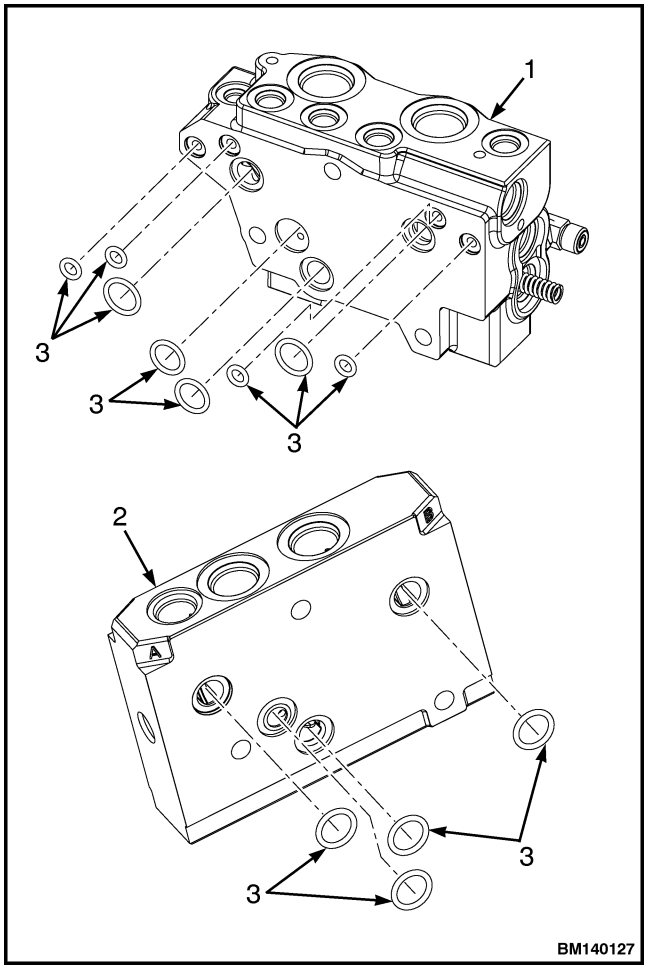
NOTE: Note placement of section seals in retaining grooves prior to removal to aid in installation.

8. Remove and discard section seals from retaining grooves of all manual control valve sections. See Figure 49.



1. INLET SECTION
2. LIFT SECTION
3. TIE ROD

Figure 48. Manual Control Valve - Sections and Tie Rods

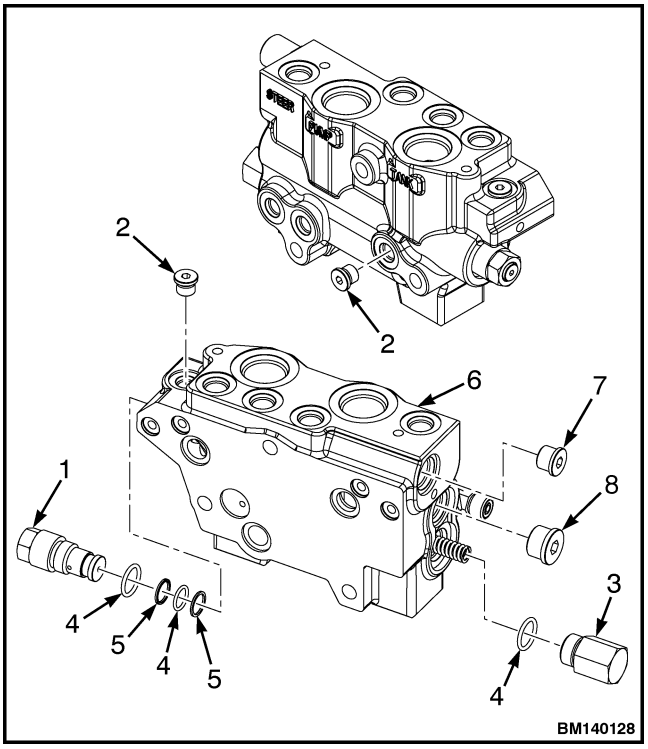


1. INLET SECTION BODY
2. LIFT/TILT/AUXILIARY SECTION BODY
3. SECTION SEAL

Figure 49. Manual Control Valve Section Seals

Disassemble Inlet Section

1. Remove primary relief valve, compensator plug, small port plugs, medium port plug, and large port plug from inlet section body. Remove and discard O-rings and backup rings from primary relief valve and compensator plug. See Figure 50.



1. PRIMARY RELIEF VALVE
2. SMALL PORT PLUG
3. COMPENSATOR PLUG
4. O-RING
5. BACKUP RING
6. INLET SECTION BODY
7. MEDIUM PORT PLUG
8. LARGE PORT PLUG

Figure 50. Inlet Section Body

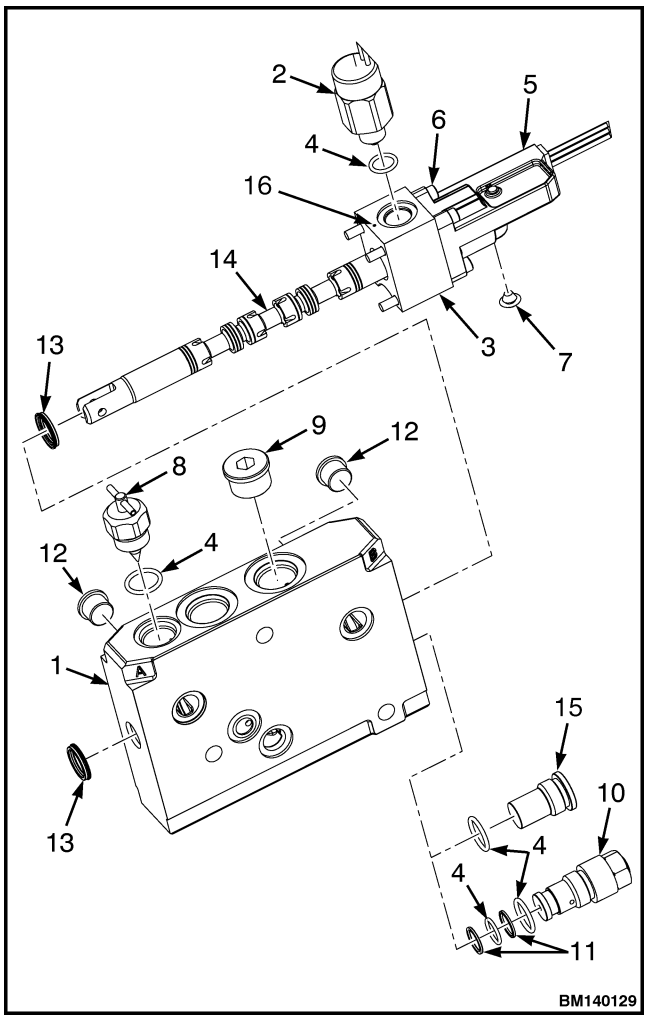
Disassemble Lift, Tilt, and Auxiliary Sections

NOTE: Prior to disassembly, all interfaces, joints, and recesses must be cleaned of residue and dirt to avoid contaminating internal components.

NOTE: Note placement and orientation of springs during disassembly to aid in assembly

NOTE: Perform steps Step 1 and Step 2 if section is equipped with OPS solenoid.

1. Remove OPS solenoid from spool lock body. Remove and discard O-ring from solenoid. See Figure 51.

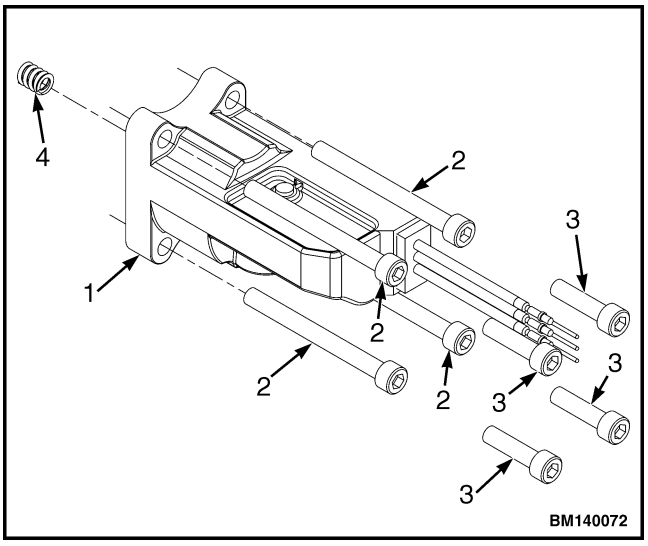


1. LIFT/TILT/AUXILIARY SECTION BODY
2. OPS SOLENOID
3. SPOOL LOCK BODY
4. O-RING
5. POSITION SENSOR
6. CAPSCREW
7. CHECK VALVE
8. MANUAL LOWERING VALVE
9. LIFT PORT PLUG-SHORT
10. SECONDARY RELIEF VALVE
11. BACKUP RING
12. AUXILIARY PORT PLUG
13. SPOOL SEAL
14. SPOOL
15. LIFT PORT PLUG-LONG

Figure 51. Lift, Tilt, and Auxiliary Section Body

NOTE: **DO NOT** lose springs.

2. Remove capscrews, position sensor, spring, and spool lock body from section body. See Figure 52.



1. POSITION SENSOR ASSEMBLY
2. CAPSCREW - WITH SPOOL LOCKS
3. CAPSCREW - WITHOUT SPOOL LOCKS
4. SPRING

Figure 52. Position Sensor Assembly

NOTE: Perform steps Step 3 and Step 4 for lift section.

3. Remove manual lowering valve from lift section body. Remove and discard O-ring from manual lowering valve. See Figure 51.

4. Remove lift port plug-short and lift port plug-long from lift section body. Remove and discard O-ring from lift port plug-long. See Figure 51.

NOTE: Perform step Step 5 for tilt section.

5. Remove secondary relief valve from tilt section body. Remove and discard O-rings and backup rings from secondary relief valve. See Figure 51.

NOTE: Perform step Step 6 for auxiliary section.

6. Remove auxiliary port plugs from auxiliary section body. See Figure 51.

7. Remove any remaining port plugs. Remove and discard O-rings, if present, from port plugs.

8. If spool seal for any valve section requires replacement, see Spool Seal Replacement section.

SPOOL SEAL REPLACEMENT

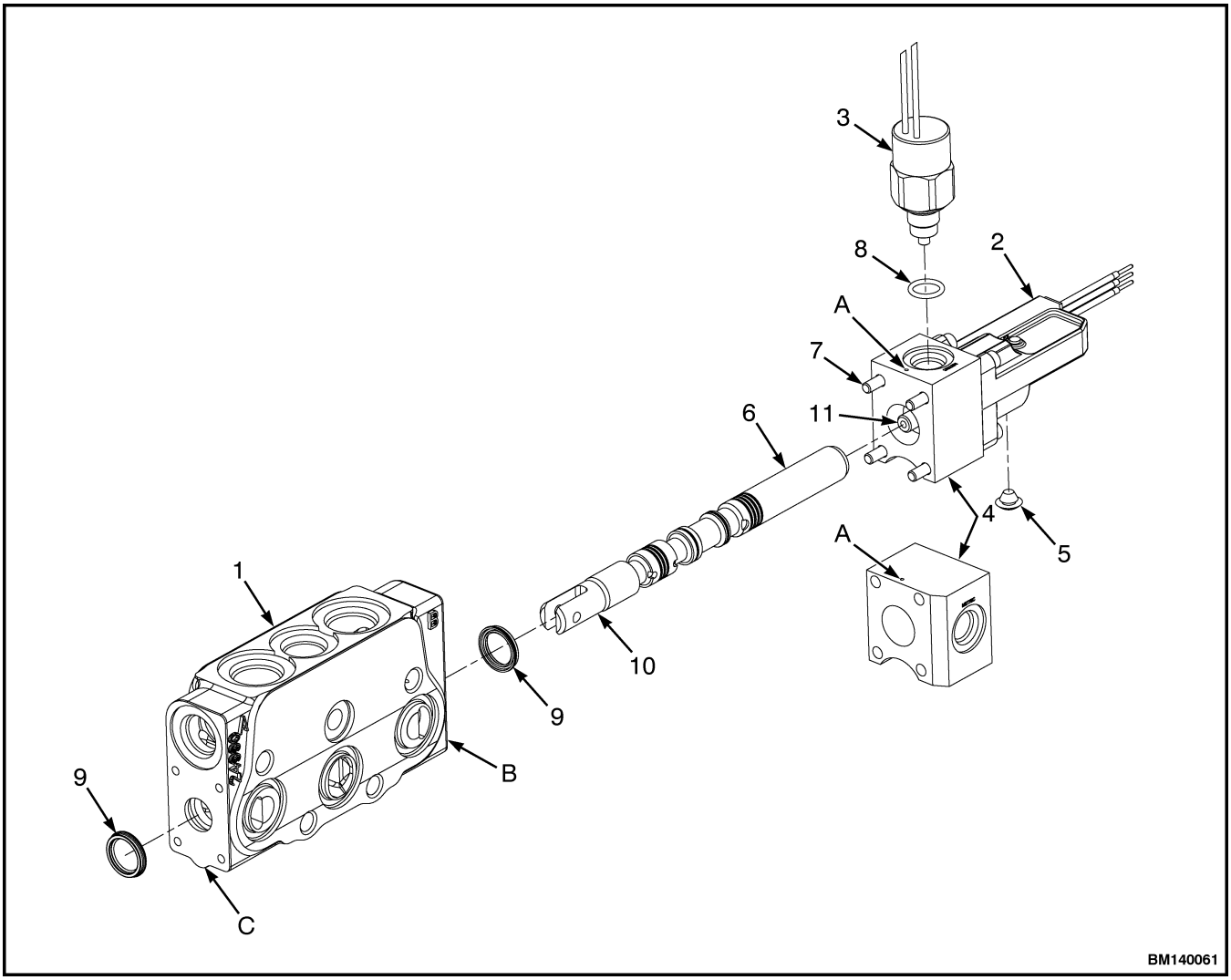
NOTE: If working on tilt section, use caution not to lose small spool and spring inside main spool and held in place with spool lock extension.

1. Using screwdriver or pin, hold spool clevis and remove spool lock extension from spool assembly. See Figure 53.

2. Pull spool assembly far enough out of section body to expose spool seal on clevis end of section body. See Figure 53.

NOTE: Lubricate new spool seal with clean hydraulic oil prior to installation.

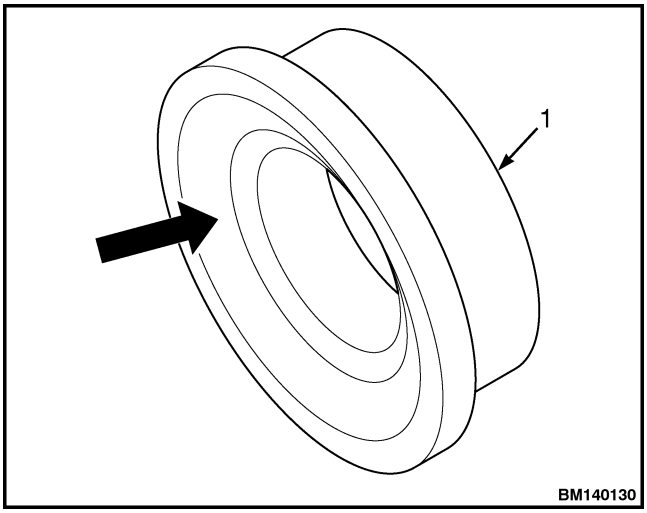
3. Using O-ring pick or similar device remove and discard spool seal from spool assembly. Lightly lubricate new spool seal and install into grooves in section body. See Figure 54.



A. ORIENTATION DOT
B. OPS END
C. CLEVIS END

1. LIFT/TILT/AUXILIARY SECTION BODY
2. POSITION SENSOR
3. OPS SOLENOID
4. SPOOL LOCK BODY
5. CHECK VALVE
6. SPOOL ASSEMBLY
7. CAPSCREW
8. O-RING
9. SPOOL SEAL
10. SPOOL CLEVIS
11. SPOOL LOCK EXTENSION

Figure 53. Lift/Tilt/Auxiliary Sections Manual Control Valve



CAUTION

To ensure proper assembly, lip of spool seal should point "in" toward section body.

1. SPOOL SEAL

Figure 54. Spool Seal Installation

4. Carefully run your finger around exposed edge of seal. You should have a smooth, precise ridge with no kinks or twists.

CAUTION

Pulling the spools meter edges across the spool seals can result in damage to the spool seal.

5. Slide spool assembly back into section body to keep spool seal in place.

6. Push spool assembly into section body far enough to expose the spool seal on OPS end of section body.

NOTE: Lubricate new spool seal with clean hydraulic oil prior to installation.

7. Using O-ring pick or similar device remove and discard spool seal from spool assembly. Lightly lubricate new spool seal and install onto spool assembly. See Figure 54.

CAUTION

Pulling the spools meter edges across the spool seals can result in damage to the spool seal.

8. Slide spool assembly back into section body to keep spool seal in place.

9. Carefully run your finger around expose edge of seal. You should have a smooth, precise ridge with no kinks or twists.

NOTE: Perform Step 10 for tilt section.

10. Install small spool and spring inside spool assembly to be held in position by spool extension. See Figure 53.

CLEAN

WARNING

Cleaning solvents can be flammable and toxic and cause skin irritation. When using cleaning solvents, always follow the solvent manufacturer's recommended safety procedures.

WARNING

Compressed air can move particles so they cause injury to the user or to other personnel. Make sure the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eyes.

1. Clean only metal components of manual control valve with solvent and dry using compressed air.

2. Clean all threaded components with denatured alcohol and dry using compressed air.

3. Clean rubber or plastic components with warm soapy water and dry with a lint free cloth. DO NOT submerge components with electrical connections in water.

INSPECT

1. Check spools and bores for wear or damage. If damaged, entire section must be replaced. Make sure spool moves freely within bore.
2. Inspect check valves and relief valves for damage. Replace if damaged.
3. Inspect solenoids and position sensors for damage. Replace if damaged.
4. Inspect threaded components to ensure absence of oil or solvent residue.
5. Inspect handles, levers, bushings, and linkages for damage. Replace if damaged.
6. Inspect all other components for damage. Replace if damaged.

ASSEMBLE MANUAL CONTROL VALVE

Assemble Lift, Tilt, and Auxiliary Sections

NOTE: Perform Step 1 for auxiliary section(s).

1. Install auxiliary port plug into auxiliary section body. See Figure 55. Tighten auxiliary port plug to 14 N•m (124 lbf in).

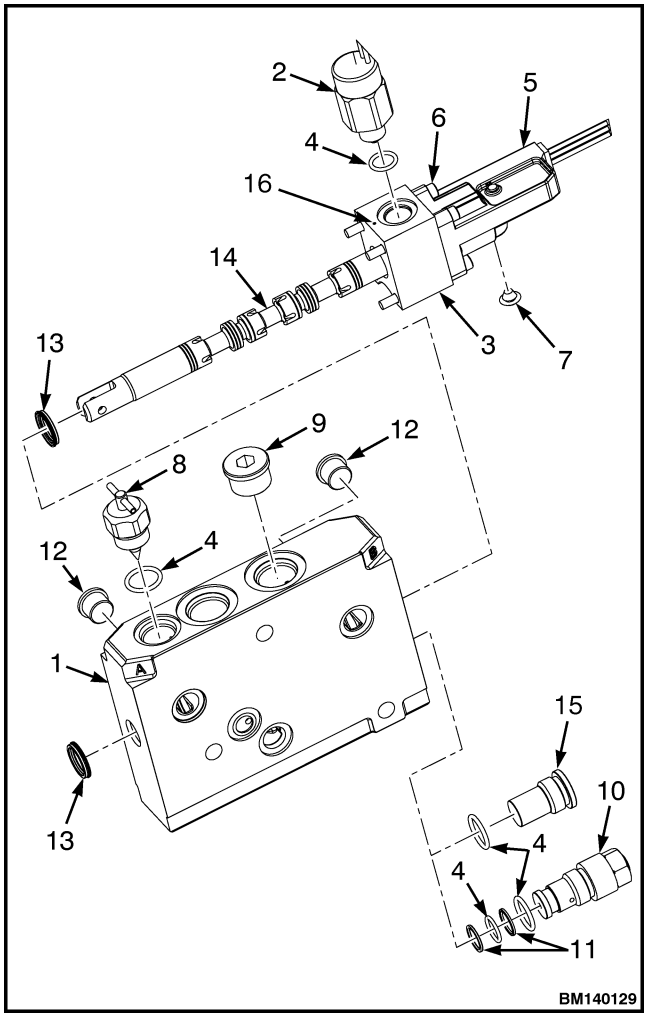
NOTE: Perform Step 2 for tilt section.

NOTE: Lubricate O-rings and backup rings with clean hydraulic oil prior to installation.

2. Install new O-rings and backup rings onto secondary relief valve. Install secondary relief valve into tilt section body. See Figure 55. Tighten secondary relief valve to 27 N•m (20 lbf ft).

NOTE: Perform Step 3 through Step 5 for lift section.

3. Install new O-ring onto lift port plug-long. Install lift port plug-long into lift section body. See Figure 55. Tighten lift port plug-long to 27 N•m (20 lbf ft).



1. LIFT/TILT/AUXILIARY SECTION BODY
2. OPS SOLENOID
3. SPOOL LOCK BODY
4. O-RING
5. POSITION SENSOR
6. CAPSCREW
7. CHECK VALVE
8. MANUAL LOWERING VALVE
9. LIFT PORT PLUG-SHORT
10. SECONDARY RELIEF VALVE
11. BACKUP RING
12. AUXILIARY PORT PLUG
13. SPOOL SEAL
14. SPOOL
15. LIFT PORT PLUG-LONG

Figure 55. Lift, Tilt, and Auxiliary Section Body

4. Install lift port plug-short into lift section body. See Figure 55. Tighten lift port plug-short to 54 N•m (40 lbf ft).

5. Install new O-ring onto manual lowering valve. Install manual lowering valve into lift section body. See Figure 55. Tighten manual lowering valve to 54 N•m (40 lbf ft).

CAUTION

Spool lock body must be placed with orientation dot up and toward section body for correct fit. If not installed correctly damage to manual control valve may result.

NOTE: Perform Step 6 and Step 7 if section is equipped with OPS solenoid.

NOTE: Apply Loctite® 262 to capscrew threads prior to installation.

NOTE: Install spring as noted during disassembly.

6. Install spool lock body, position sensor, and capscrews to section body. See Figure 56. Tighten capscrews to 4.7 N•m (42 lbf in).

7. Install new O-ring onto OPS solenoid. Install OPS solenoid into spool lock body. See Figure 55. Tighten OPS solenoid to 7.5 N•m (66 lbf in).

Assemble Inlet Section

NOTE: Lubricate new O-rings and backup rings with clean hydraulic oil prior to installation.

1. Install new O-rings and backup rings onto primary relief valve. Install primary relief valve to inlet section body. See Figure 57. Tighten primary relief valve to 27 N•m (20 lbf ft).

2. Install new O-ring onto compensator plug. Install compensator plug to inlet section body. See Figure 57. Tighten compensator plug to 47 N•m (35 lbf ft).

3. Install small port plugs to inlet section body. See Figure 57. Tighten small port plugs to 13.5 N•m (119 lbf in).

4. Install medium port plug to inlet section body. See Figure 57. Tighten medium port plug to 65 N•m (48 lbf ft).

5. Install large port plug to inlet section body. See Figure 57. Tighten large port plug to 60 to 72 N•m (44 to 53 lbf ft).

Assemble Valve

1. Install a nut on one end of each tie rod and hand-tighten only at this time. Thread opposite end through inlet section tie rod holes. See Figure 58.

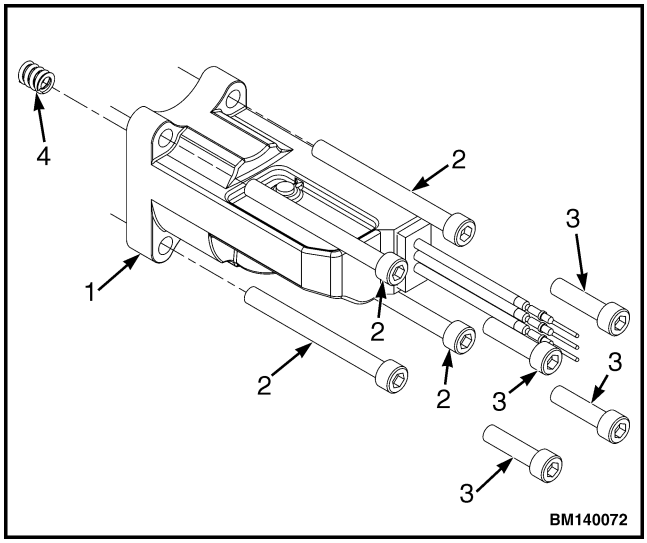
2. Place inlet section with machined surface facing up as shown in Figure 58.

NOTE: **DO NOT** lubricate section seals prior to installation. Lubricants on these seals can distort valve body, resulting in spool bind.

3. Install section seals into retaining grooves of inlet section as noted during disassembly. See Figure 59.

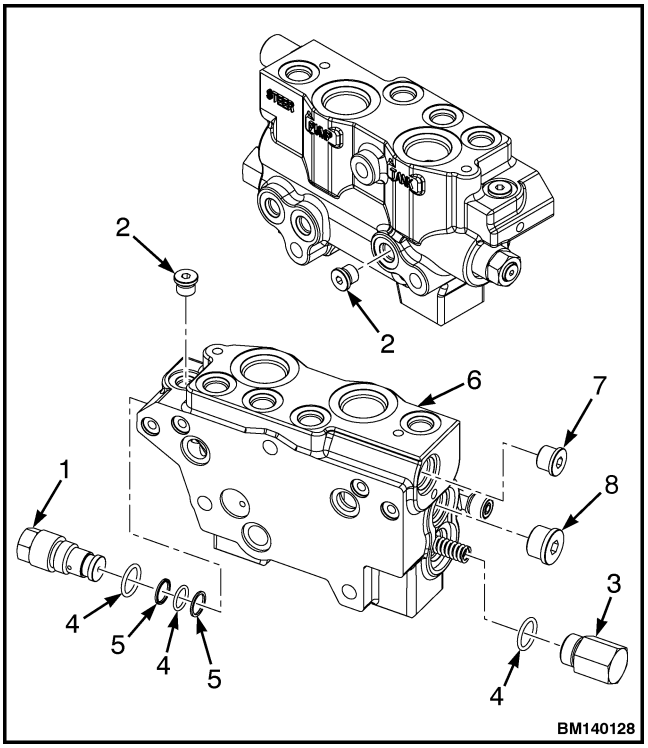
4. Install lift section over tie rods and against inlet section. See Figure 60.

5. Install section seals into retaining grooves of lift section as noted during disassembly. See Figure 59.



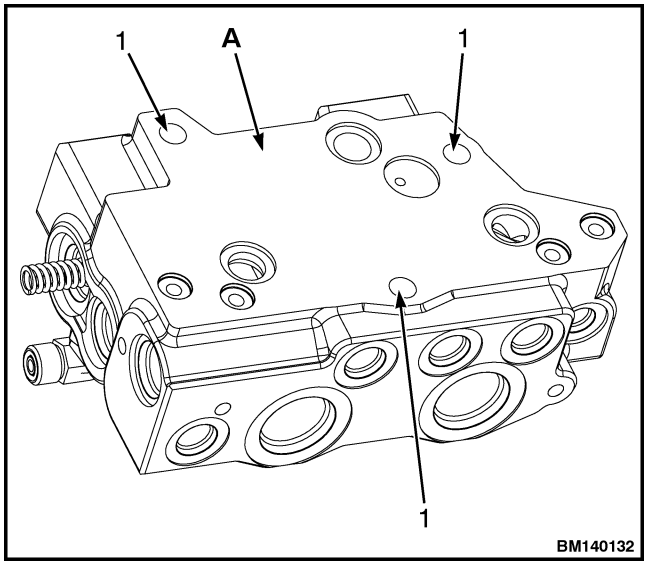
1. POSITION SENSOR ASSEMBLY
2. CAPSCREW WITH SPOOL LOCKS
3. CAPSCREW WITHOUT SPOOL LOCKS
4. SPRING

Figure 56. Position Sensor Assembly



1. PRIMARY RELIEF VALVE
2. SMALL PORT PLUG
3. COMPENSATOR PLUG
4. O-RING
5. BACKUP RING
6. INLET SECTION BODY
7. MEDIUM PORT PLUG
8. LARGE PORT PLUG

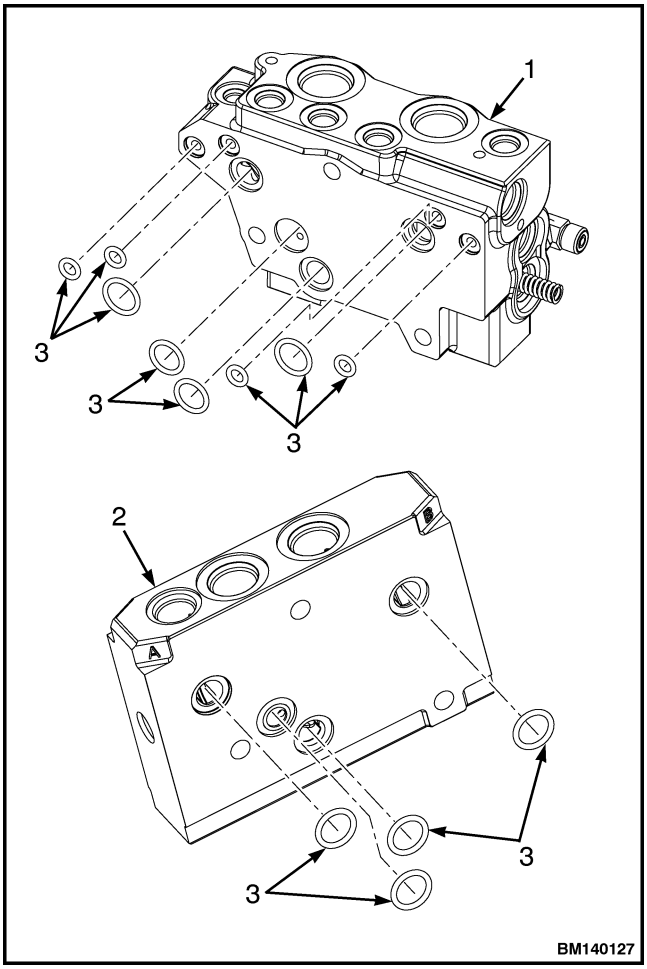
Figure 57. Inlet Section Body



A. MACHINED FACE

1. TIE ROD HOLE

Figure 58. Manual Control Valve Inlet Section Machined Face



1. INLET SECTION BODY
2. LIFT/TILT/AUXILIARY SECTION BODY
3. SECTION SEAL

Figure 59. Manual Control Valve Section Seals

6. Install tilt section over tie rods and against lift section. See Figure 60 for example.

7. Install section seals into retaining grooves of tilt section as noted during disassembly. See Figure 59.

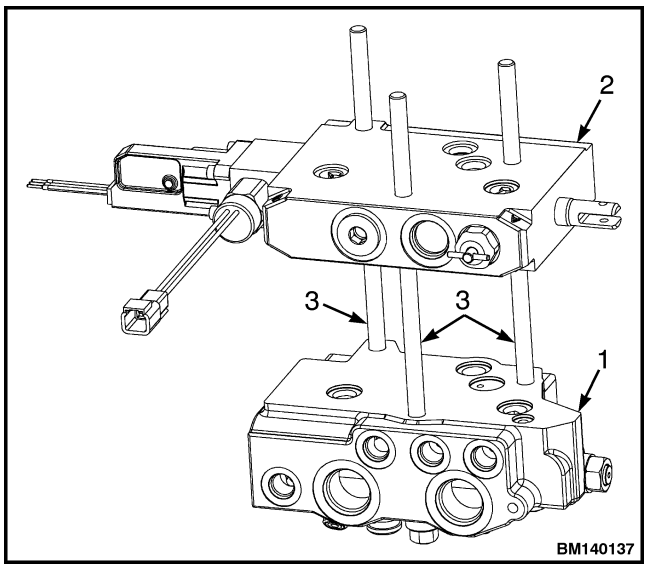
NOTE: 3-Function manual control valve is not equipped with a optional auxiliary section.

8. Install optional auxiliary section over tie rods and against tilt section. See Figure 60 for example.

9. Install section seals into retaining grooves of optional auxiliary section as noted during disassembly. See Figure 59.

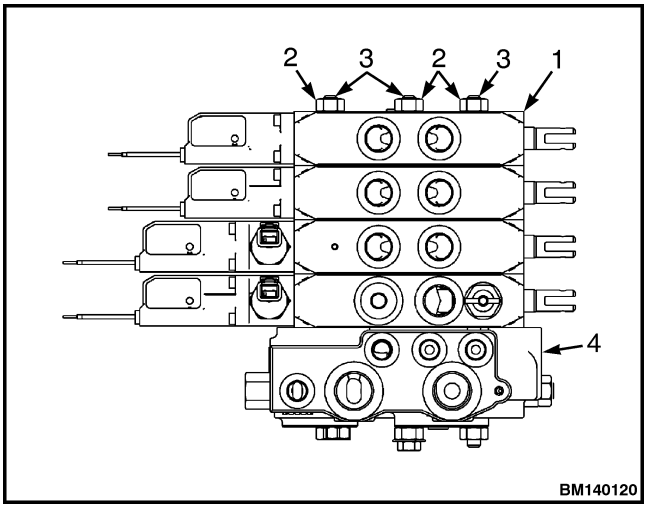
10. Install auxiliary section over tie rods and against optional auxiliary or tilt section. See Figure 60 for example.

11. Install a nut onto end of each tie rod and hand-tighten only at this time. See Figure 61.



1. INLET SECTION
2. LIFT SECTION
3. TIE ROD

Figure 60. Manual Control Valve - Sections and Tie Rods



NOTE: CONTROL VALVE MANUFACTURED BEFORE OCTOBER, 2012 SHOWN.

1. AUXILIARY SECTION
2. NUT
3. TIE ROD
4. INLET SECTION

Figure 61. Auxiliary Section Tie Rods and Nuts

CAUTION

If proper value of torque is not applied to the nuts on the tie rods, the valve spools may bind or stick and section seals may extrude.

12. Reposition manual control valve with work ports facing up, then tighten eight nuts on tie rods to 20.3 ± 1.4 N•m (179.7 ± 12.4 lbf in).

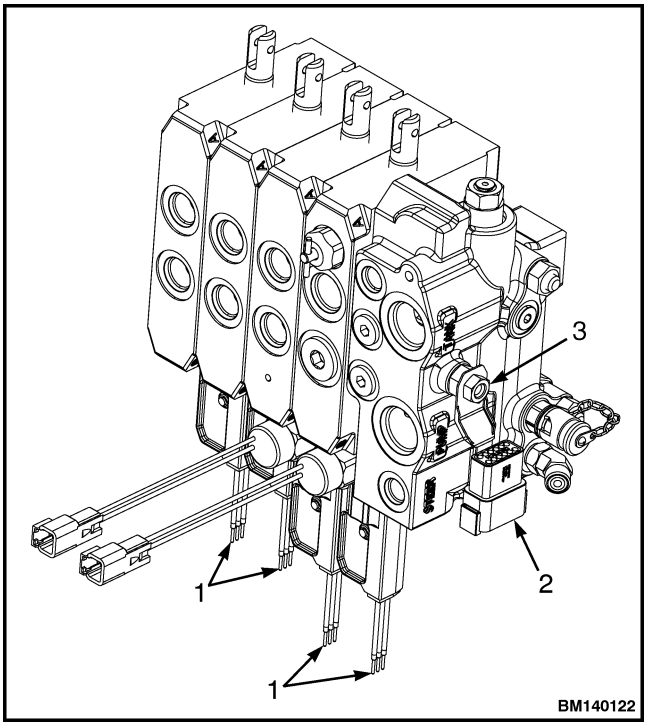
NOTE: Tie rods to extend beyond nuts for one to two threads.

13. Install position sensor electrical connector onto tie rod. Apply thread locker to tie rod threads and install (jam) nut onto tie rod on inlet side of manual control valve. See Figure 62. Tighten (jam) nut to 18 to 20 N•m (156 to 180 lbf in).

14. Connect position sensor wires to back of position sensor electrical connector as tagged during disassembly. See Table 3 and Figure 62.

Table 3. Position Sensor Electrical Connector Pin Layout

PIN	SOCKET	PIN	SOCKET	PIN	SOCKET
PIN 1	SPOOL 1 POS	**PIN 5**	SPOOL 1 OUTPUT	**PIN 12**	SPOOL 1 NEG
PIN 2	SPOOL 2 POS	**PIN 6**	SPOOL 2 OUTPUT	**PIN 11**	SPOOL 2 NEG
PIN 3	SPOOL 3 POS	**PIN 7**	SPOOL 3 OUTPUT	**PIN 10**	SPOOL 3 NEG
PIN 4	SPOOL 4 POS	**PIN 8**	SPOOL 4 OUTPUT	**PIN 9**	SPOOL 4 NEG



NOTE: CONTROL VALVE MANUFACTURED BEFORE OCTOBER, 2012 SHOWN.

1. POSITION SENSOR WIRE
2. POSITION SENSOR ELECTRICAL CONNECTOR
3. (JAM) NUT

Figure 62. Position Sensor Wires and Connector

NOTE: Lubricate new O-rings with clean hydraulic oil prior to installation.

15. Install new O-rings onto auxiliary fittings. Install auxiliary fittings into auxiliary section as noted during disassembly.

See Figure 63 for lift truck models

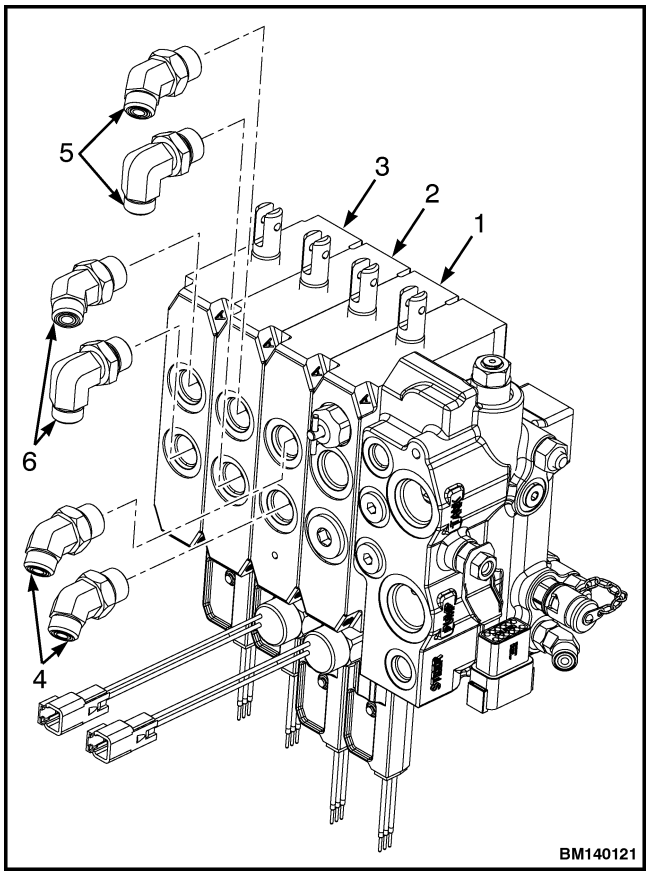
- E2.2-3.5XN (E45-70XN) (A268)
- J2.2-3.5XN (J45-70XN) (A276)
- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

See Figure 64 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268)

See Figure 65 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276)
- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)



NOTE: CONTROL VALVE MANUFACTURED BEFORE OCTOBER, 2012 SHOWN.

NOTE: 4-FUNCTION MANUAL CONTROL VALVE SHOWN.

1. TILT SECTION
2. OPTIONAL AUXILIARY SECTION
3. AUXILIARY SECTION
4. TILT LINE FITTING
5. OPTIONAL AUXILIARY FITTING
6. AUXILIARY FITTING

Figure 63. Manual Control Valve Fittings - Tilt and Auxiliary Sections

NOTE: 3-Function manual control valve does not contain optional auxiliary section.

16. Install new O-rings onto optional auxiliary fittings. Install optional auxiliary fittings into optional auxiliary section as noted during disassembly.

See Figure 63 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268)
- J2.2-3.5XN (J45-70XN) (A276)
- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

See Figure 64 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268)

See Figure 65 for lift truck models

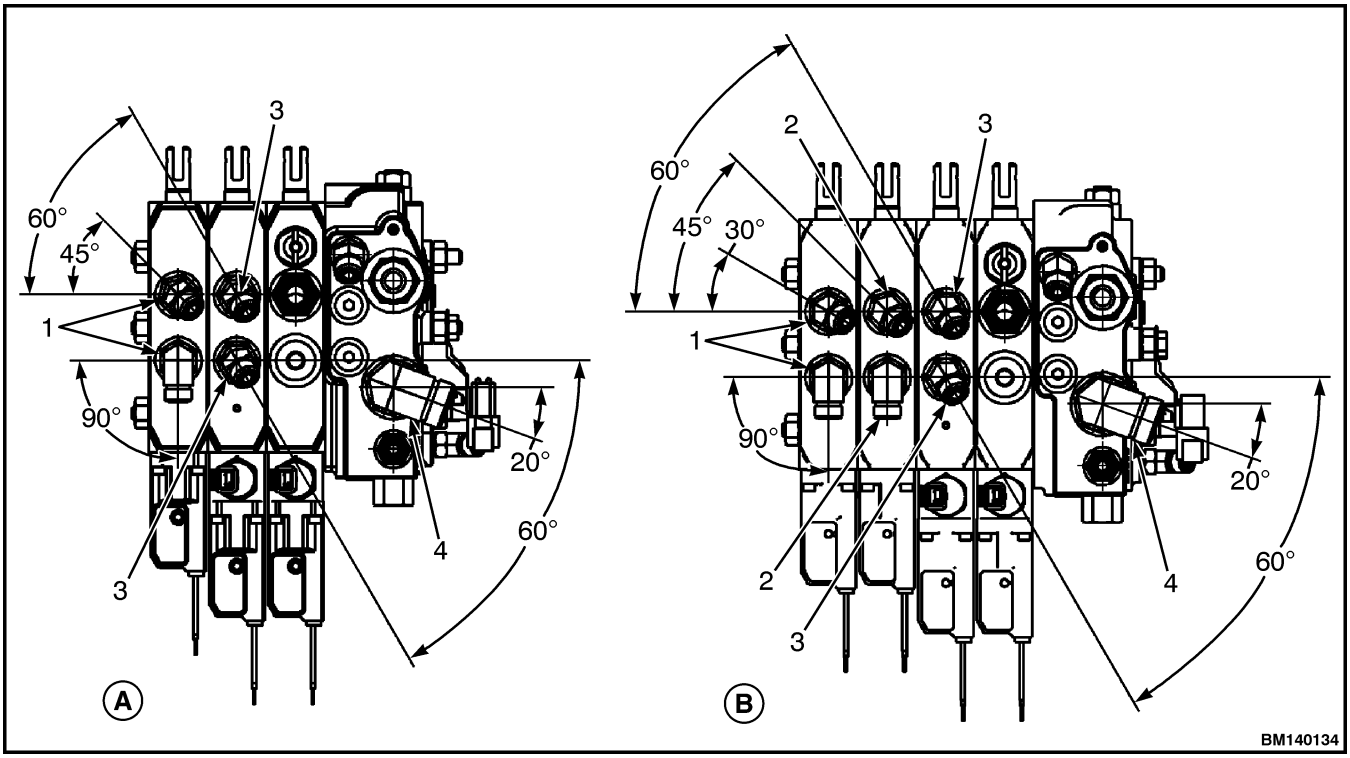
- J2.2-3.5XN (J45-70XN) (A276)
- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

for fitting placement and orientation.

17. Install new O-rings onto tilt line fittings. Install tilt line fittings into tilt section as noted during disassembly.

See Figure 63 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268)
- J2.2-3.5XN (J45-70XN) (A276)
- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)



NOTE: CONTROL VALVE MANUFACTURED BEFORE OCTOBER, 2012 SHOWN.

A. 3-FUNCTION MANUAL CONTROL VALVE

1. AUXILIARY FITTING
2. OPTIONAL AUXILIARY FITTING

B. 4-FUNCTION MANUAL CONTROL VALVE

3. TILT LINE FITTING
4. PRESSURE LINE FITTING

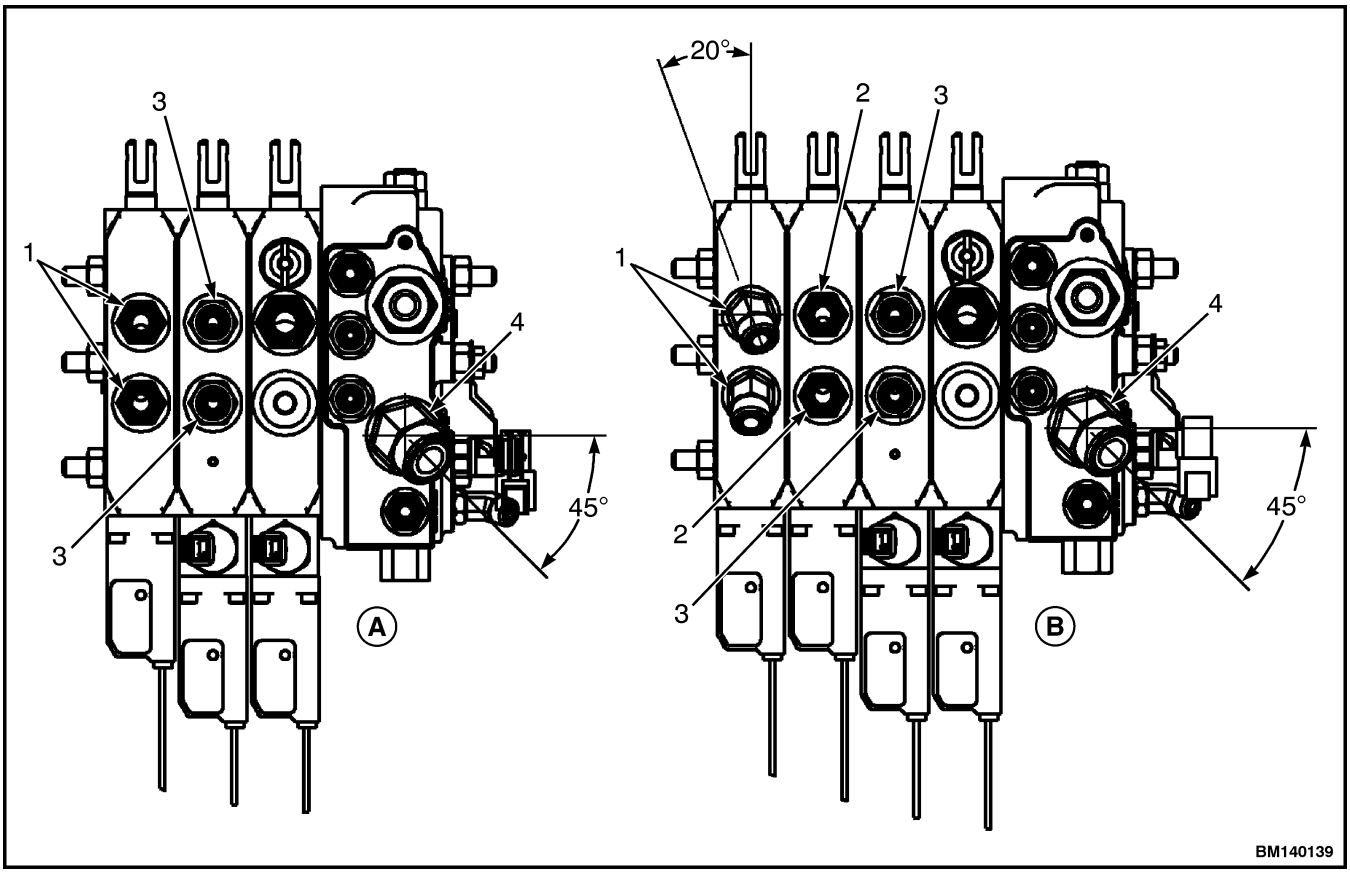
Figure 64. Fitting Orientation 1 for Lift Truck E2.2-3.5XN (E45-70XN) (A268)

See Figure 64 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268)

See Figure 65 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276)
- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)



NOTE: CONTROL VALVE MANUFACTURED BEFORE OCTOBER, 2012 SHOWN.

A. 3-FUNCTION MANUAL CONTROL VALVE

B. 4-FUNCTION MANUAL CONTROL VALVE

1. AUXILIARY FITTING
2. OPTIONAL AUXILIARY FITTING
3. TILT LINE FITTING
4. PRESSURE LINE FITTING

Figure 65. Fitting Orientation 1 for Lift Trucks J2.2-3.5XN (J45-70XN) (A276) and J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

18. Install new O-ring onto hoist line fitting. Install hoist line fitting into lift section as noted during disassembly. See Figure 66.

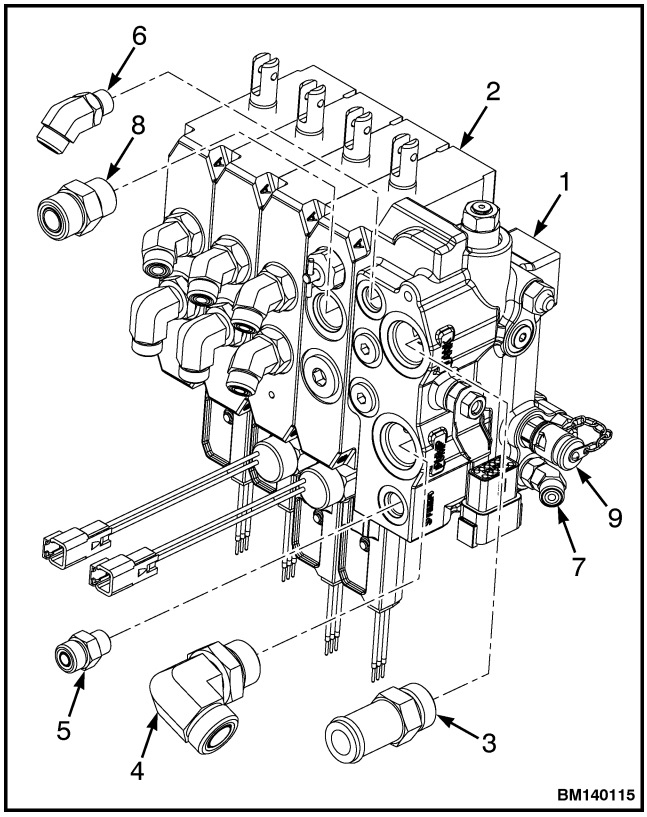
19. Install new O-rings onto steer return fitting, return line fitting, and steer supply fitting. Install steer return fitting, return line fitting, and steer supply fitting into inlet section as noted during disassembly. See Figure 66.

20. Install new O-ring onto pressure line fitting. Install pressure line fitting into inlet section as noted during disassembly. See Figure 66.

21. Install new O-ring onto diagnostic fitting. Install diagnostic fitting into inlet section as noted during disassembly. See Figure 66. Tighten diagnostic fitting to 16 N•m (142 lbf in).

NOTE: Steer load sense fitting contains special internal features and **CANNOT** be replaced with standard hydraulic fitting.

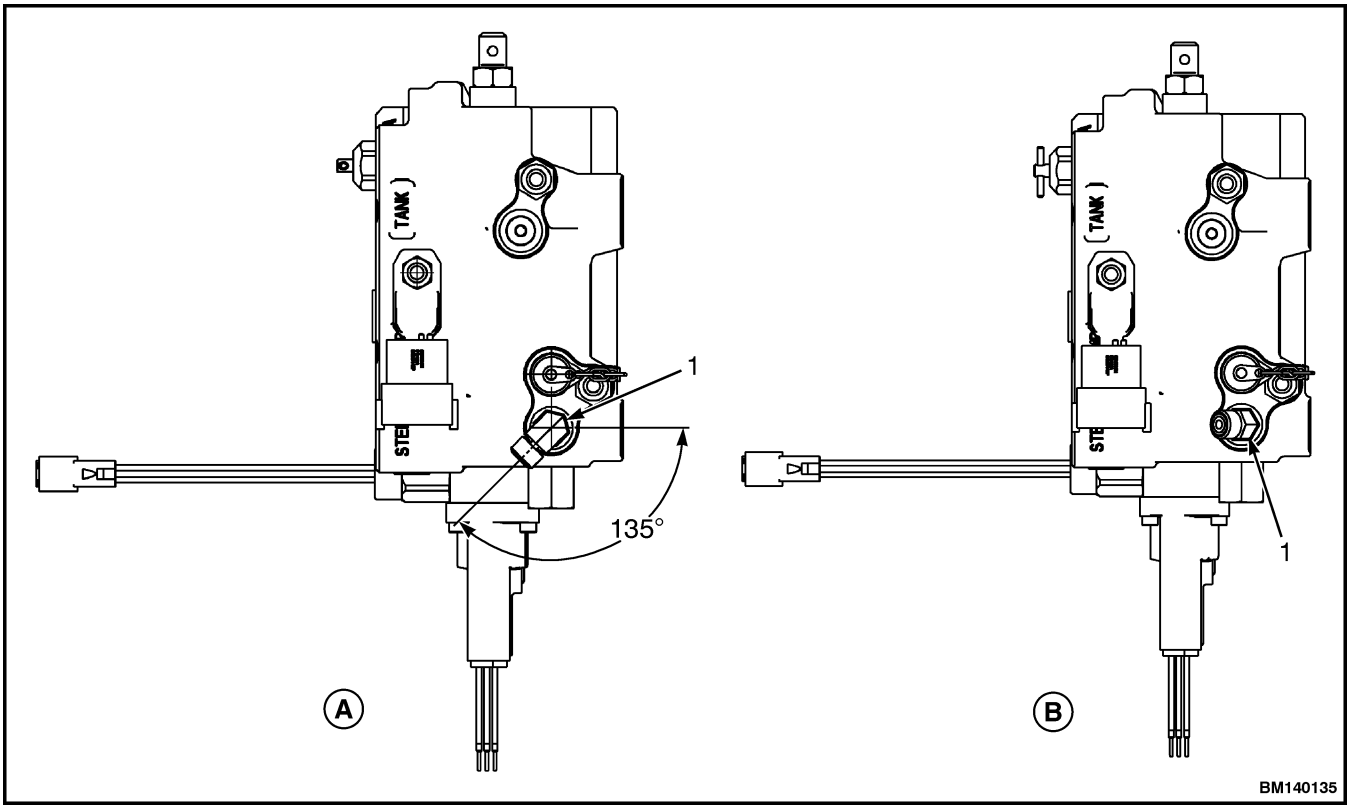
22. Install new O-ring onto steer load sense fitting. Install steer load sense fitting into inlet section as noted during disassembly. See Figure 66 and Figure 67. Tighten steer load sense fitting to 16 N•m (142 lbf in).



NOTE: 4-FUNCTION MANUAL CONTROL VALVE MANUFACTURED BEFORE OCTOBER, 2012 SHOWN.

1. INLET SECTION
2. LIFT SECTION
3. RETURN LINE FITTING
4. PRESSURE LINE FITTING
5. STEER SUPPLY FITTING
6. STEER RETURN FITTING
7. STEER LOAD SENSE FITTING
8. HOIST LINE FITTING
9. DIAGNOSTIC FITTING (SHOWN IN PUMP PRESSURE GAUGE PORT)

Figure 66. Manual Control Valve Fittings, Inlet and Lift Sections



A. 90° ADAPTER

B. 45° ADAPTER

1. STEER LOAD SENSE FITTING

Figure 67. Fitting Orientation 2

ASSEMBLE HANDLES AND LEVERS

NOTE: If levers and handles have been disassembled, perform Step 2 through Step 4 for aux handle with dual function for lift trucks equipped with clamping function; perform Step 5 through Step 7 for lift, tilt, tilt with RTST, aux 1, and aux 2 handles; perform Step 8 through Step 14 for lift/lower with Direction Control Switch (DCS) handles.

NOTE: Table 4 indicates installed handle positions. Optional handles and levers are described in Step 2 through Step 5 and Step 8 through Step 14.

1. Install bushings into levers. See Figure 68.
2. Route push-button cable through cable track on manual aux 2 lever. See Figure 68.
3. Install palm side handle and one inner capscrew on manual aux 2 lever. See Figure 68.

NOTE: Ensure clamping push-button is in correct position on clamp switch handle during assembly.

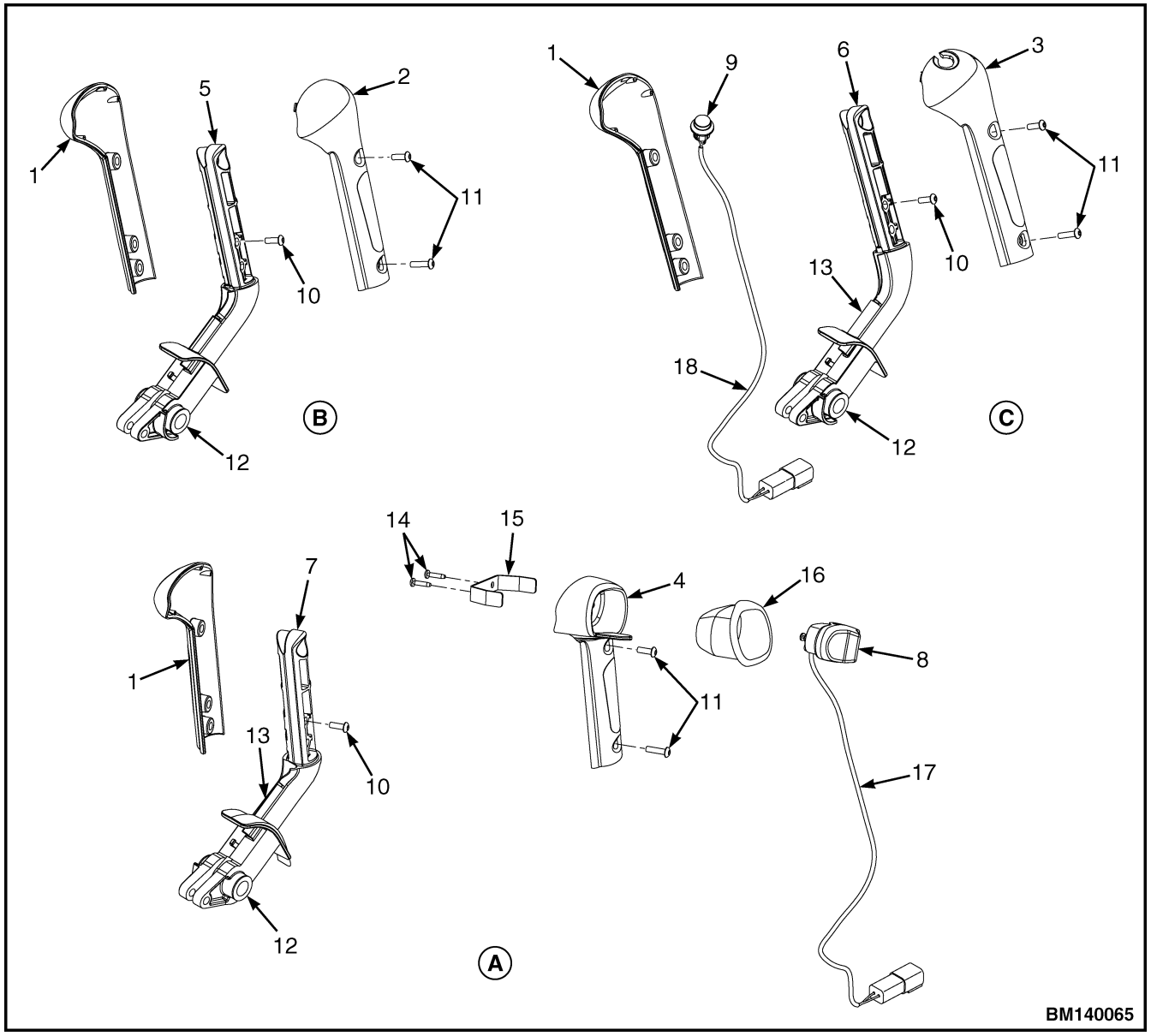
4. Install clamp switch handle and two outer capscrews on manual aux 2 lever. See Figure 68. Tighten outer capscrews to 1.35 to 1.65 N•m (11.9 to 14.6 lbf in).

NOTE: Ensure Return To Set Tilt push-button is in correct position on tilt switch handle during assembly.

5. Lift truck models E45-70XN (A268) manufactured after November, 2014 and equipped with RTST option, route push-button cable through cable track on manual tilt lever. See Figure 68.
6. Install palm side handle and one inner capscrew on manual tilt or aux 1 lever. See Figure 68.
7. Install finger side handle and two outer capscrews on manual tilt or aux 1 lever. See Figure 68. Tighten outer capscrews to 1.35 to 1.65 N•m (11.9 to 14.6 lbf in).
8. Install directional control switch into DCS cup. See Figure 68.
9. Install DCS cup and directional control switch into lift/lower with dcs handle. See Figure 68 and Figure 69.
10. Install DCS retainer onto back side of DCS cup, inside lift/lower with dcs handle. See Figure 68 and Figure 69.
11. Install two screws through retainer and DCS cup into directional control switch. See Figure 68 and Figure 69.
12. Route DCS cable through cable track on manual lift/lower lever. See Figure 68.
13. Install palm side handle and one capscrew on manual lift/lower lever. See Figure 68.
14. Install lift/lower with dcs handle and two outer capscrews on manual lift/lower lever. See Figure 68. Tighten outer capscrews to 1.35 to 1.65 N•m (11.9 to 14.6 lbf in).

Table 4. Handle Options

3-Function		4-Function	
Handle Position	**Option**	**Handle Position**	**Option**
1	None	1	None
1	Lift/lower with DCS	1	Lift/lower with DCS
2	Tilt with Return To Set Tilt	2	Tilt with Return To Set Tilt
3	None	4	None
3	Aux with dual function	4	Aux with dual function



NOTE: ONLY LIFT TRUCK MODELS E45-70XN (A268) MANUFACTURED AFTER NOVEMBER, 2014, CAN BE EQUIPPED WITH OPTIONAL RTST BUTTON ON TILT LEVER.

A. LIFT/LOWER WITH DCS
B. LIFT, TILT, AUX 1, AUX 2
C. AUX HANDLE WITH DUAL FUNCTION OR TILT HANDLE WITH RETURN TO SET TILT (RTST)

1. PALM SIDE GRIP HANDLE
2. FINGER SIDE HANDLE
3. CLAMP SWITCH HANDLE/RTST SWITCH HANDLE
4. LIFT/LOWER WITH DCS HANDLE
5. MANUAL TILT OR AUX 1 LEVER
6. MANUAL AUX 2 LEVER
7. MANUAL LIFT/LOWER LEVER
8. DIRECTIONAL CONTROL SWITCH (DCS)
9. CLAMPING PUSH-BUTTON/RTST PUSH-BUTTON
10. INNER CAPSCREW
11. OUTER CAPSCREW
12. BUSHING
13. CABLE TRACK
14. SCREW
15. DCS RETAINER
16. DCS CUP
17. DCS CABLE
18. PUSH-BUTTON CABLE

Figure 68. Manual Hydraulic Control Handles

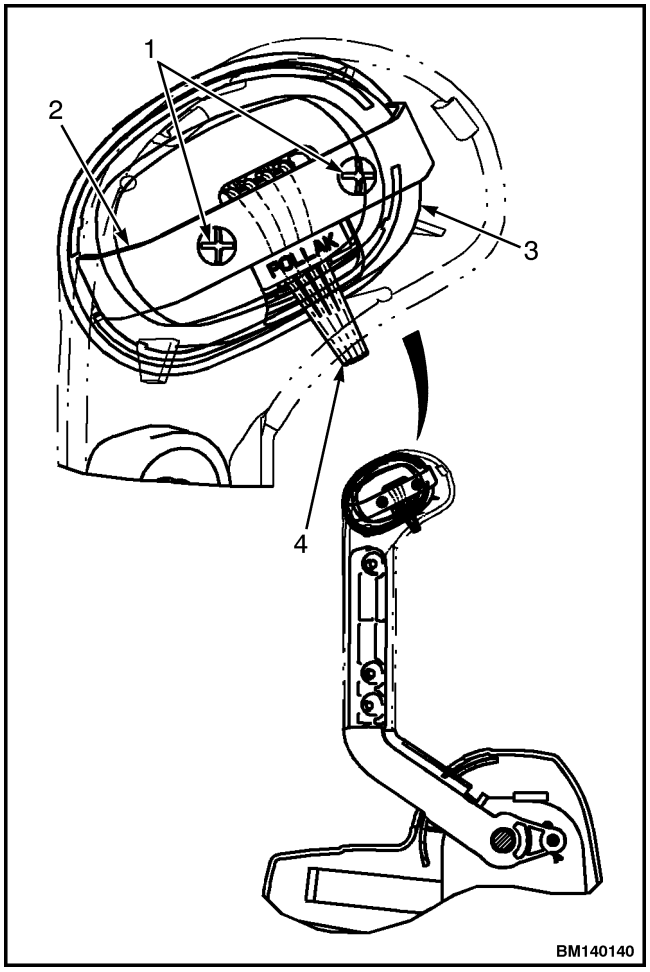


Figure 69. Directional Control Switch

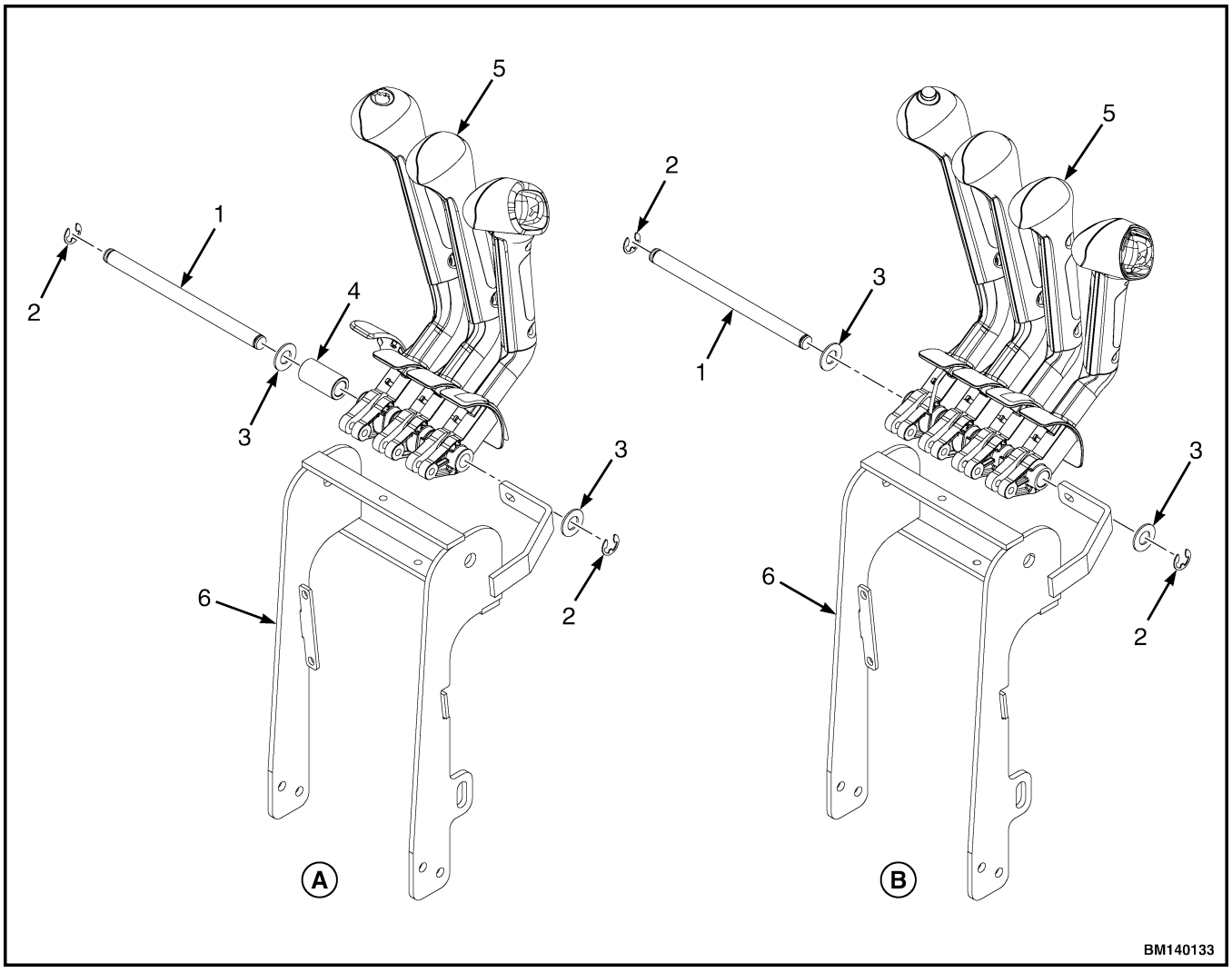
Legend for Figure 69

1. SCREW
2. DCS RETAINER
3. DCS CUP
4. DCS CABLE

INSTALL

Install Control Valve

STEP 1.
Slide pivot pin through side of upper bracket. Install one nylon washer, lever spacer if required, levers, and one nylon washer. Slide pivot pin out the other side of upper bracket. Install e-clip onto each end of pivot pin holding levers to upper bracket.



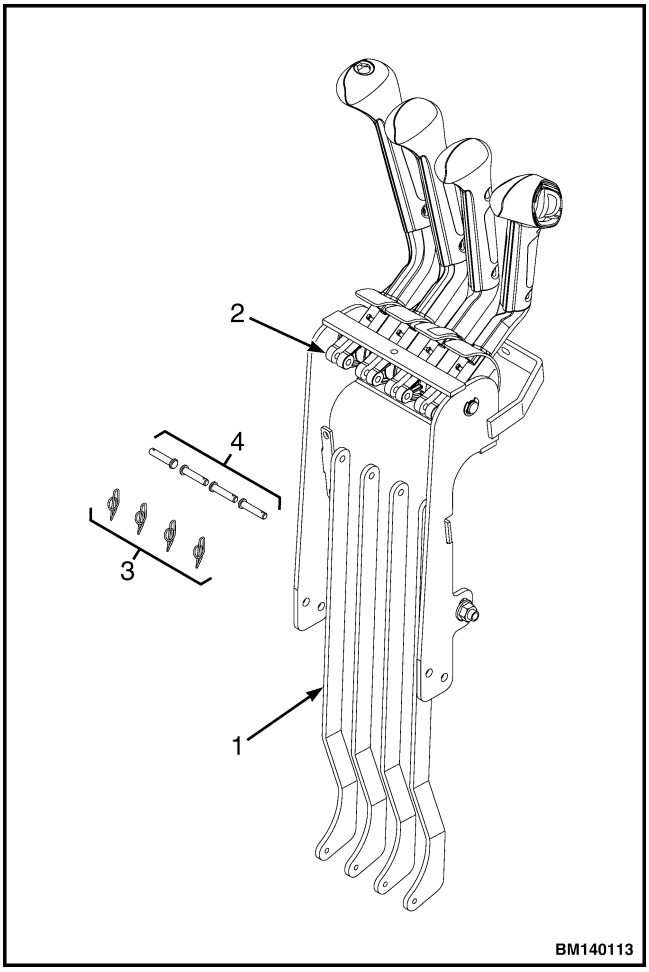
A. 3-FUNCTION LEVERS

1. PIVOT PIN
2. E-CLIP
3. NYLON WASHER

B. 4-FUNCTION LEVERS

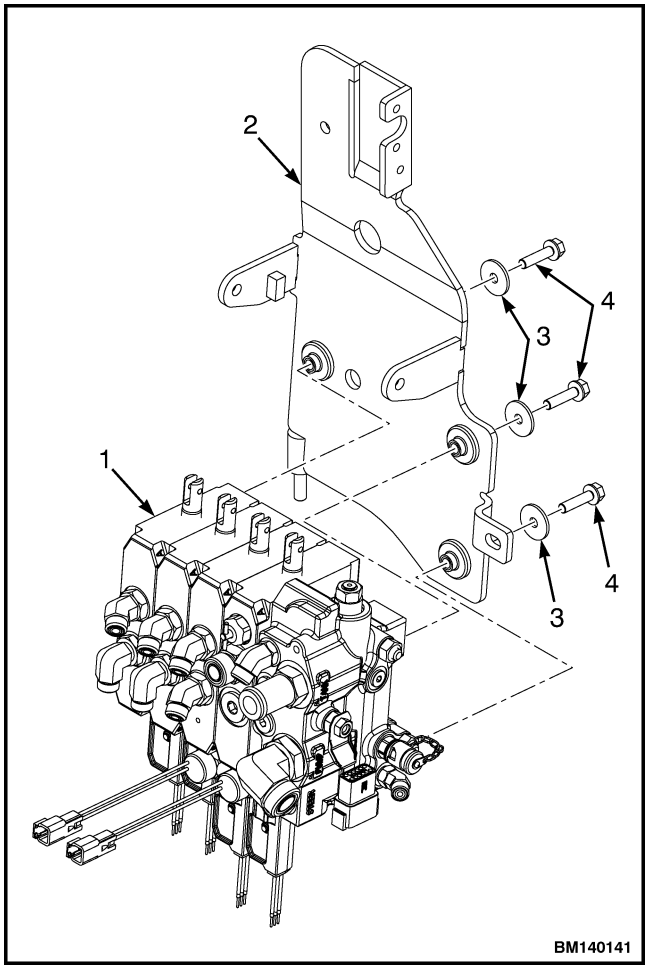
4. LEVER SPACER
5. LEVER
6. UPPER BRACKET

STEP 2.
While holding link in lever slot, install clevis pin through lever and link, then install new locking ring cotter pin through clevis pin. Repeat for all links.



1. LINK
2. LEVER
3. LOCKING RING COTTER PIN
4. CLEVIS PIN

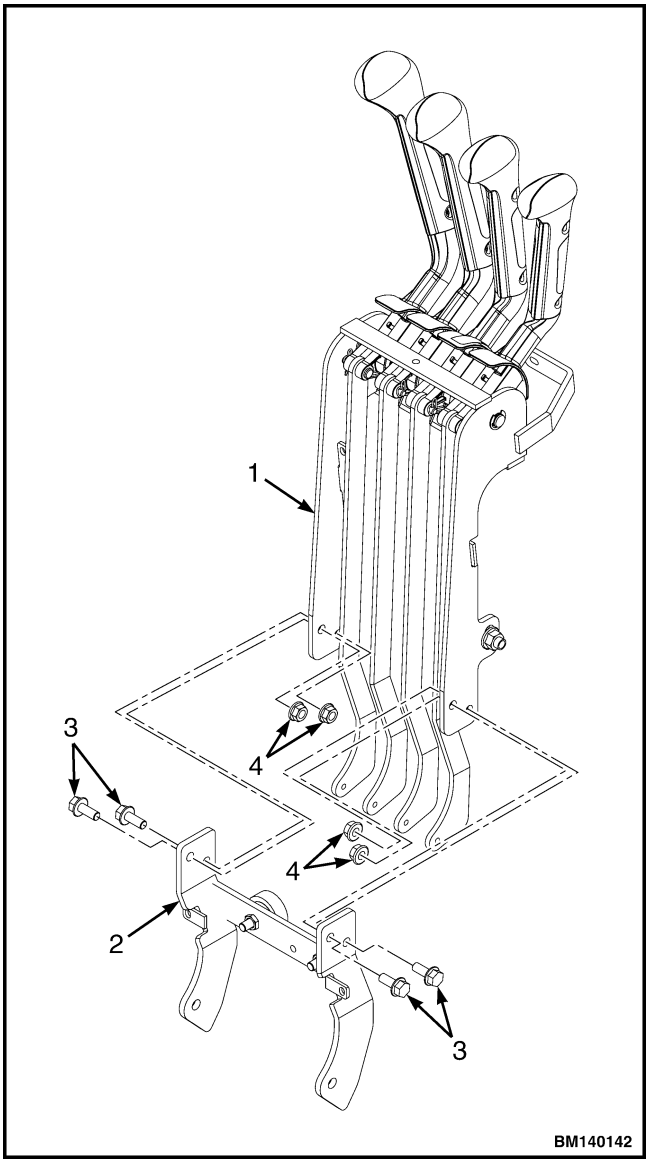
STEP 3.
Install manual control valve, three special washers, and three capscrews onto mounting bracket.



NOTE: CONTROL VALVE MANUFACTURED BEFORE OCTOBER, 2012 SHOWN.

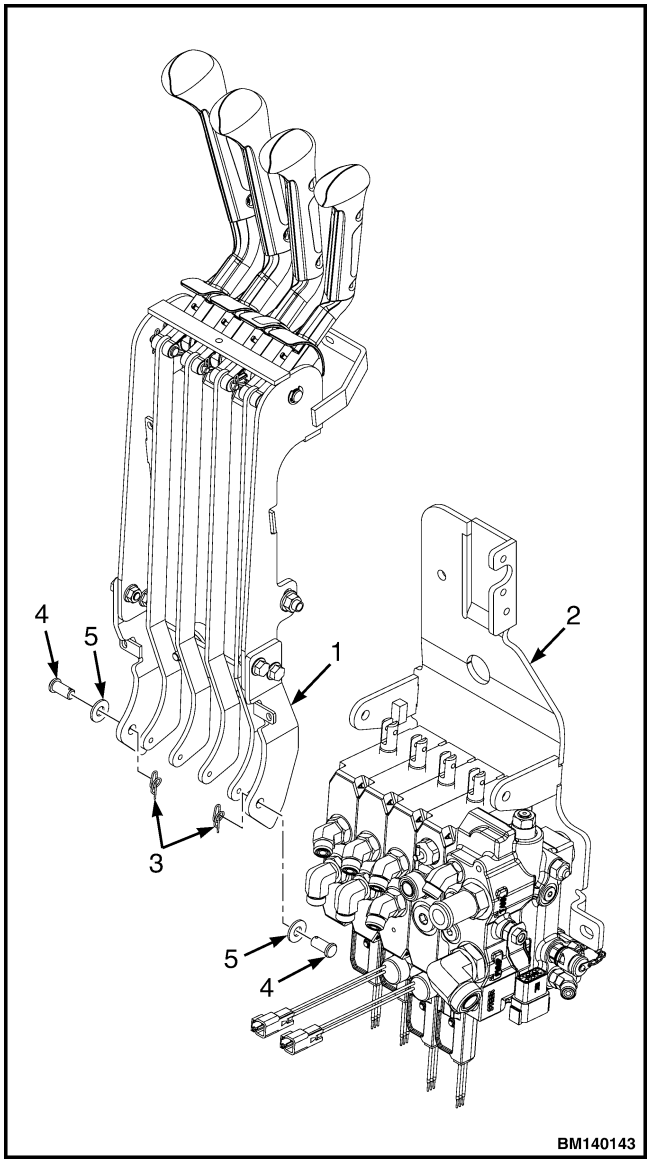
1. MANUAL CONTROL VALVE
2. MOUNTING BRACKET
3. SPECIAL WASHER
4. CAPSCREW

STEP 4.
Install lower bracket, four capscrews, and four nuts onto upper bracket.



1. UPPER BRACKET
2. LOWER BRACKET
3. CAPSCREW
4. NUT

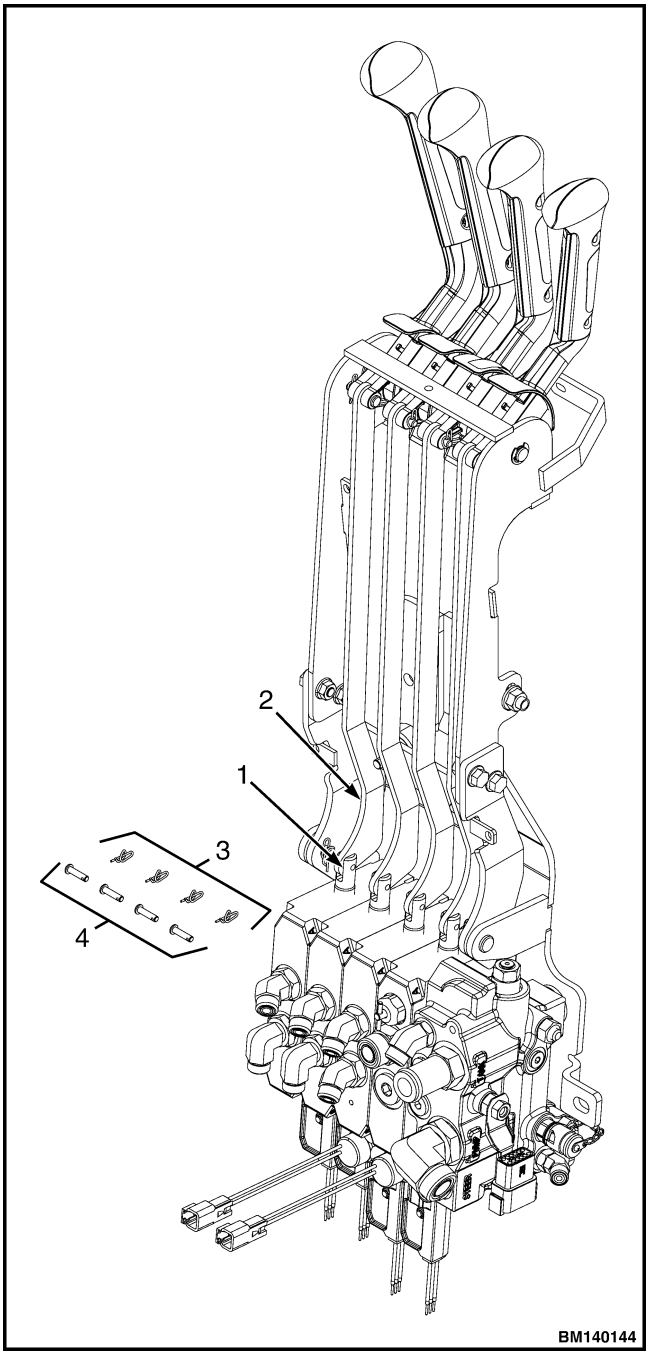
STEP 5.
Install mounting bracket, two nylon washers, two rod end pins, and two locking ring cotter pins onto lower bracket.



NOTE: CONTROL VALVE MANUFACTURED BEFORE OCTOBER, 2012 SHOWN.

1. LOWER BRACKET
2. MOUNTING BRACKET
3. LOCKING RING COTTER PIN
4. ROD END PIN
5. NYLON WASHER

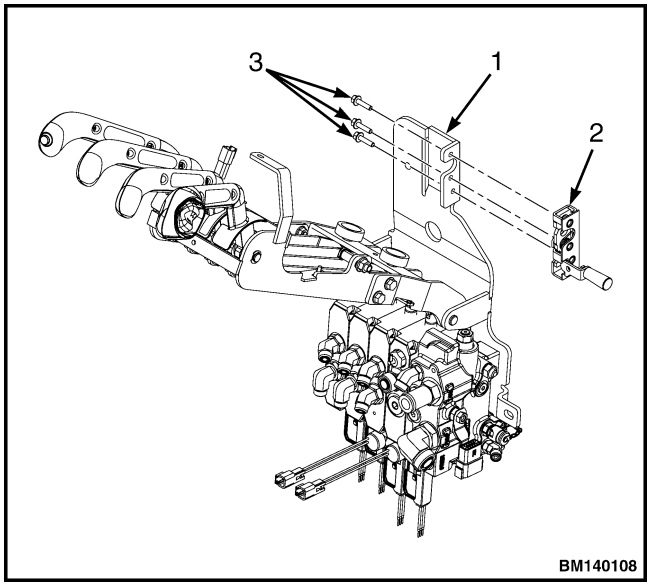
STEP 6.
Install links, rod end pins, and locking ring cotter pins into clevis' at top of manual control valve sections.



NOTE: CONTROL VALVE MANUFACTURED BEFORE OCTOBER, 2012 SHOWN.

1. CLEVIS
2. LINK
3. LOCKING RING COTTER PIN
4. ROD END PIN

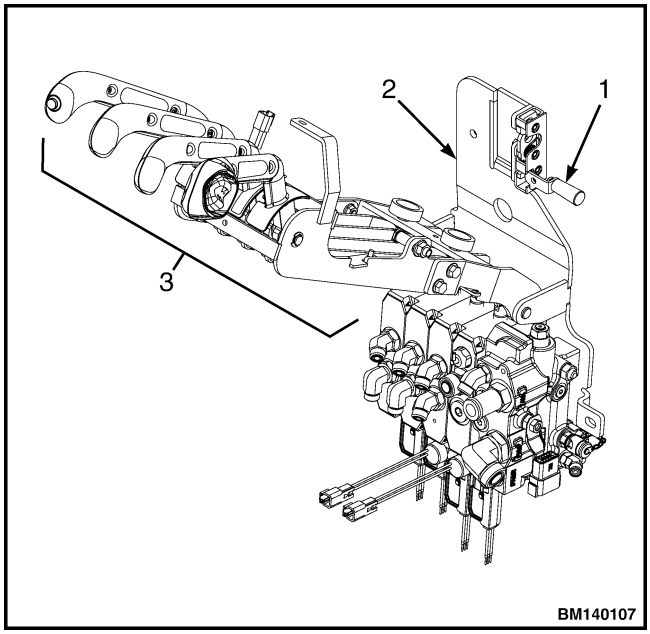
STEP 7.
Install latch assembly and three capscrews onto mounting bracket.



NOTE: CONTROL VALVE MANUFACTURED BEFORE OCTOBER, 2012 SHOWN.

1. MOUNTING BRACKET
2. LATCH ASSEMBLY
3. CAPSCREW

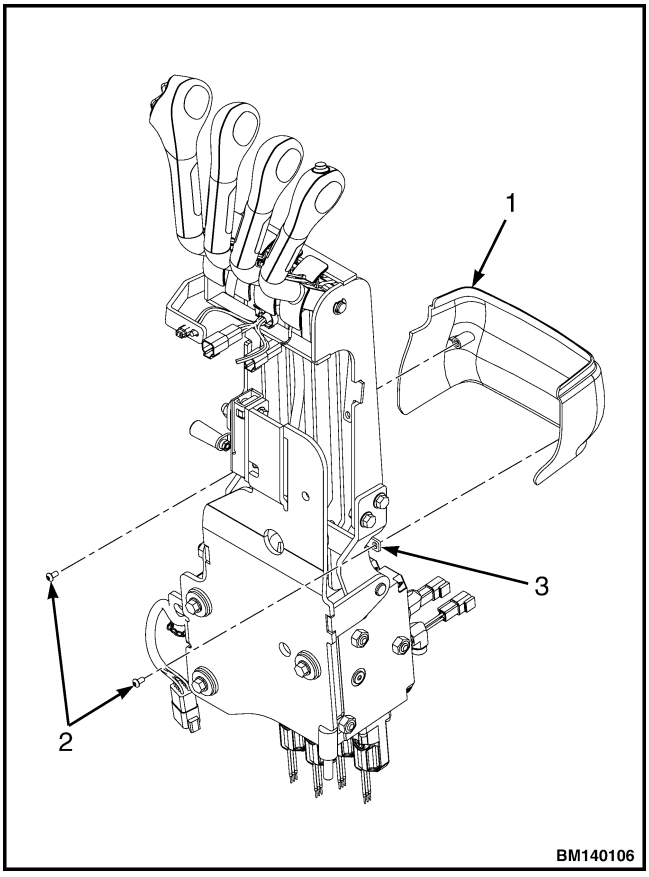
STEP 8.
Raise hydraulic linkage and handles upright against mounting bracket. Apply thread locker to the threads of the latch handle and ensure latch handle fastens securely.



NOTE: CONTROL VALVE MANUFACTURED BEFORE OCTOBER, 2012 SHOWN.

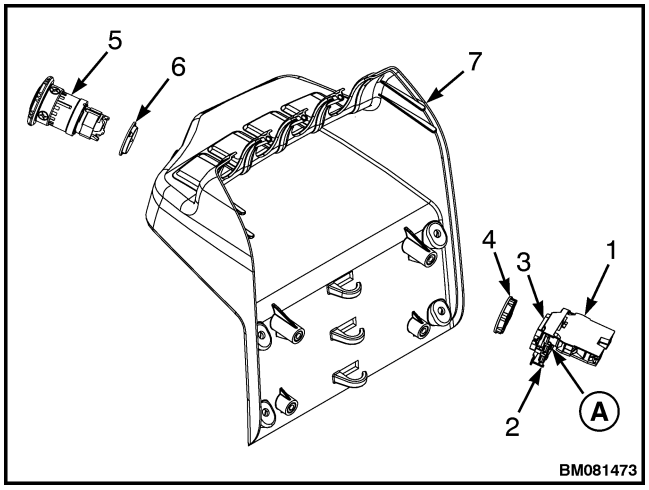
1. LATCH HANDLE
2. MOUNTING BRACKET
3. HYDRAULIC LINKAGE AND HANDLES

STEP 9.
Install lower cover and two button-head capscrews onto lower bracket. Tighten capscrews to 2.82 to 3.16 N•m (24.95 to 27.97 lbf in).



1. LOWER COVER
2. BUTTON-HEAD CAPSCREW
3. LOWER BRACKET

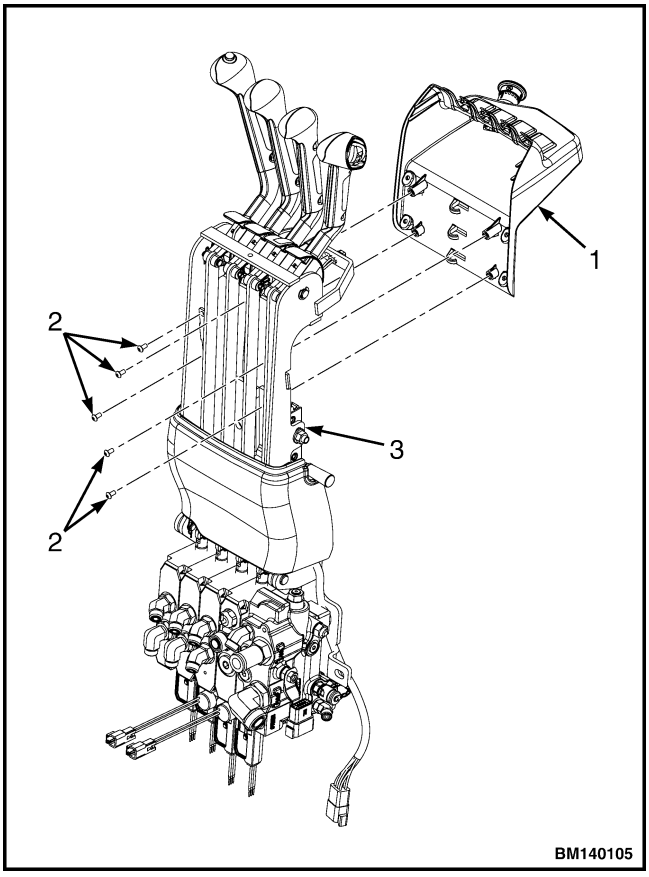
STEP 10.
Install emergency disconnect switch into rear cover. See **Electrical System** 2200SRM1369 for procedures.



A. INSERT SCREWDRIVER HERE

1. SWITCH
2. SWITCH ADAPTER
3. LOCK
4. NUT
5. EMERGENCY DISCONNECT BUTTON
6. BUSHING
7. UPPER REAR COVER
8. HOLE

STEP 11.
Install rear cover and five button-head capscrews onto upper bracket. Tighten capscrews to 1.35 to 1.65 N•m (11.95 to 14.60 lbf in).

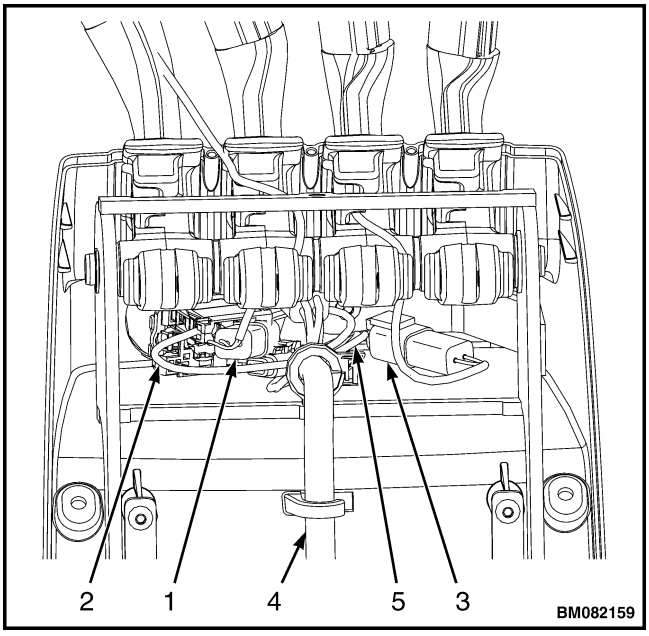


NOTE: CONTROL VALVE MANUFACTURED BEFORE OCTOBER, 2012 SHOWN.

1. REAR COVER
2. BUTTON-HEAD CAPSCREW
3. UPPER BRACKET

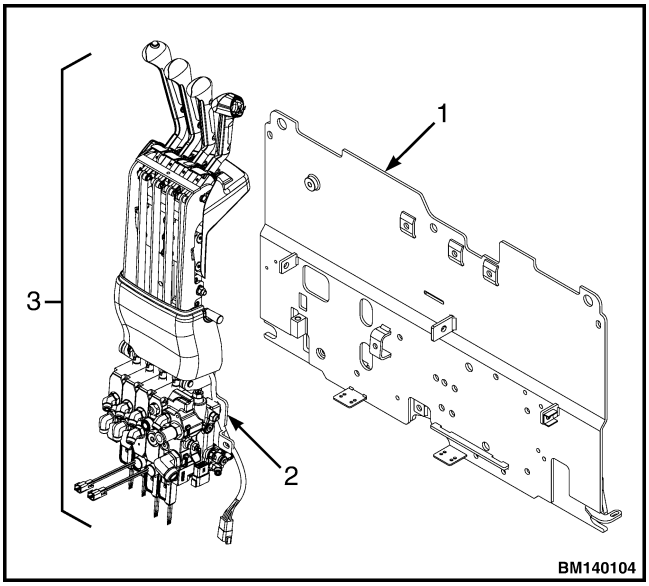
STEP 12.
Connect manual hydraulic wire harness to direction control switch connector, emergency disconnect switch connector, and clamp button connector.

Lift truck models E45-70XN (A268) manufactured after November, 2014, can be equipped with Return To Set Tilt (RTST) option. If equipped, connect manual hydraulic wire harness to RTST switch connector.



1. CLAMP BUTTON CONNECTOR
2. EMERGENCY DISCONNECT SWITCH CONNECTOR
3. RETURN TO SET TILT SWITCH CONNECTOR
4. MANUAL CONTROL VALVE WIRE HARNESS
5. DIRECTION CONTROL SWITCH CONNECTOR

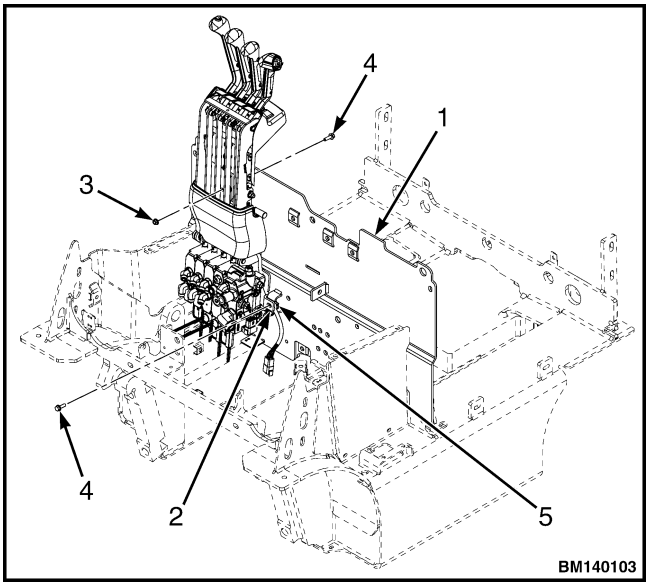
STEP 13.
Install mounting bracket with attached components onto front bulkhead in lift truck.



NOTE: CONTROL VALVE MANUFACTURED BEFORE OCTOBER, 2012 SHOWN.

1. FRONT BULKHEAD
2. MOUNTING BRACKET
3. ATTACHED COMPONENTS

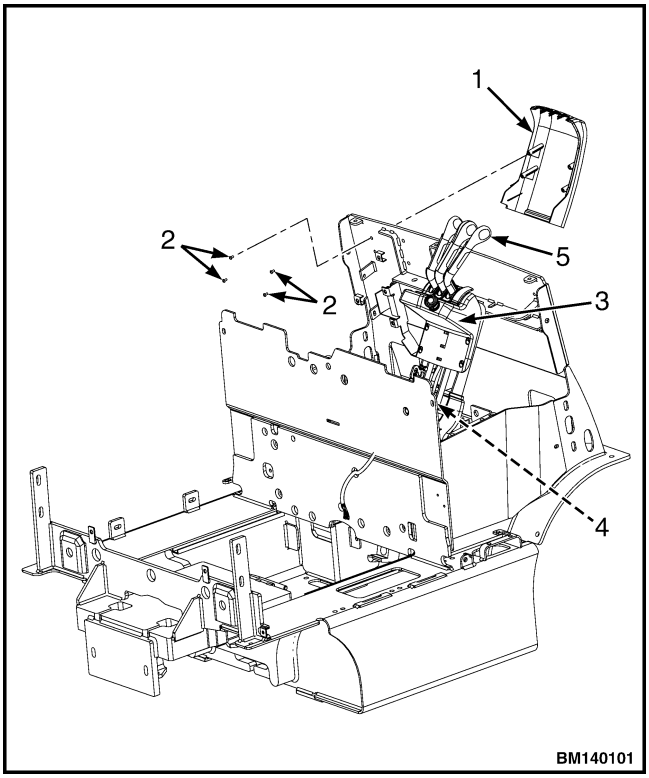
STEP 14.
Install clip nut, capscrews, and nut onto front bulkhead and mounting bracket.



NOTE: CONTROL VALVE MANUFACTURED BEFORE OCTOBER, 2012 SHOWN.

1. FRONT BULKHEAD
2. MOUNTING BRACKET
3. NUT
4. CAPSCREW
5. CLIP NUT

STEP 15.
Install upper front cover and four button-head capscrews onto rear cover. Tighten capscrews to 2.82 to 3.16 N•m (24.96 to 27.97 lbf in). Pull manual hydraulic linkage and handles upright and secure with latch handle.



1. UPPER FRONT COVER
2. BUTTON-HEAD CAPSCREW
3. REAR COVER

Ending Steps

1. Connect spool lock solenoids to manual hydraulic wire harness. See Figure 39, Figure 40, or Figure 41.

2. Connect position sensor connector to manual hydraulic wire harness. See Figure 39, Figure 40, or Figure 41.

CAUTION

Disposal of lubricants and fluids must meet local environmental regulations.

NOTE: Remove caps from hydraulic hoses and control valve fittings as connections are made.

3. Connect hydraulic hoses to control valve fittings as tagged during removal. Dispose of drain pan contents.

4. Install floor plates and floor mats.

5. Install battery into lift truck. See **How to Change Battery** in **Operating Manual** or

Periodic Maintenance 8000SRM1364 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268)

Periodic Maintenance 8000SRM1372 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276)

Periodic Maintenance 8000SRM1541 for lift truck models

- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

6. Turn lift truck **ON**, operate hydraulic functions, then check for leaks.

7. Calibrate manual control valve as outlined in Calibration Procedure.

Manual Hydraulic Control Valve Repair for 4.0-5.5T Cushion Trucks

REMOVE

WARNING

Before making repairs to the control valve or its linkage, fully lower all parts of the mast and tilt it fully forward. These actions will prevent the mast from lowering suddenly when hydraulic lines are disconnected.

NOTE: Only perform the steps below necessary for required repair or replacement.

1. Lower mast and tilt forward.
2. Remove battery from lift truck. See the **Operating Manual** or the following service manuals **Periodic Maintenance** 8000SRM1577.
3. Discharge capacitors by following steps shown in Discharging the Capacitors in **General** section of this manual.
4. Remove floor mats and floor plates.

WARNING

Hydraulic oil is hot after system operation and can cause burns.

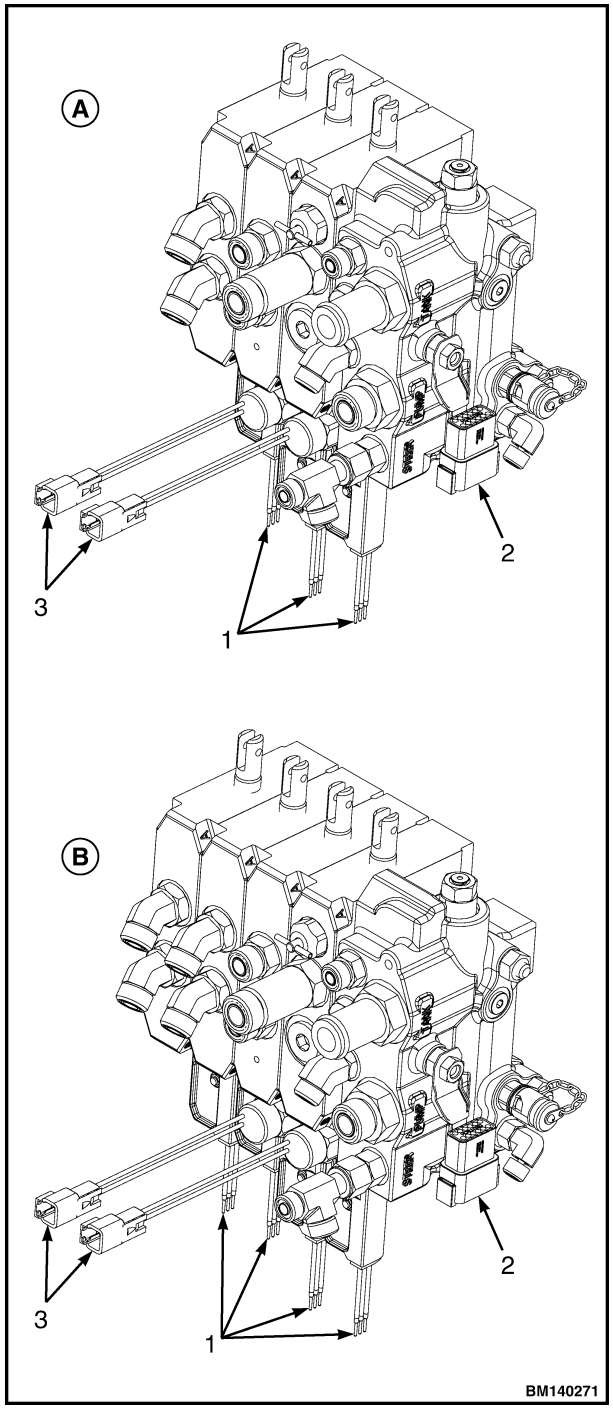
DO NOT disconnect any hydraulic hoses until the oil in the system is cool.

CAUTION

Electrical components must be shielded from hydraulic oil drips if they are below hydraulic valve and lines.

NOTE: Tag hydraulic hoses during removal to aid in installation.

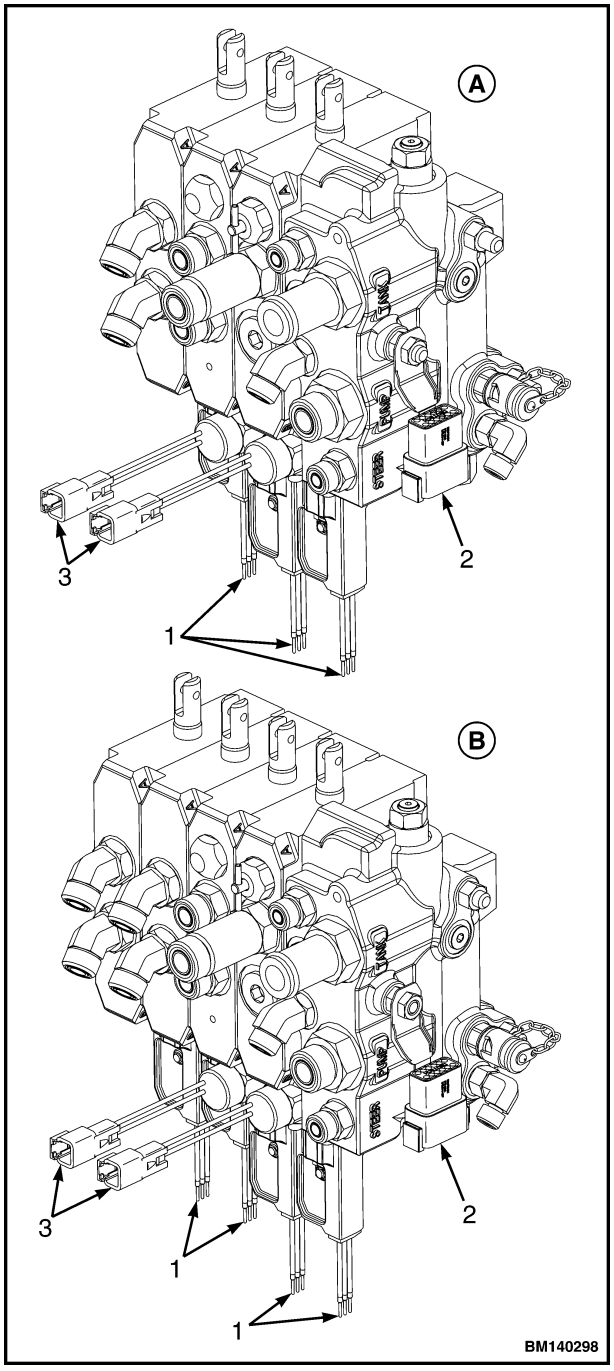
5. Put a drain pan under the area of the control valve assembly. Disconnect hydraulic hoses from control valve fittings. Cap hydraulic hoses and control valve fittings.
6. Disconnect position sensor electrical connector from manual hydraulic wire harness. See Figure 70 or Figure 71.
7. Disconnect OPS solenoids from manual hydraulic wire harness. See Figure 70 or Figure 71.



A. 3-FUNCTION MANUAL CONTROL VALVE
B. 4-FUNCTION MANUAL CONTROL VALVE

1. POSITION SENSOR WIRES
2. POSITION SENSOR ELECTRICAL CONNECTOR
3. OPS SOLENOID

Figure 70. Manual Control Valve Electrical Connections Manufactured Before October, 2012



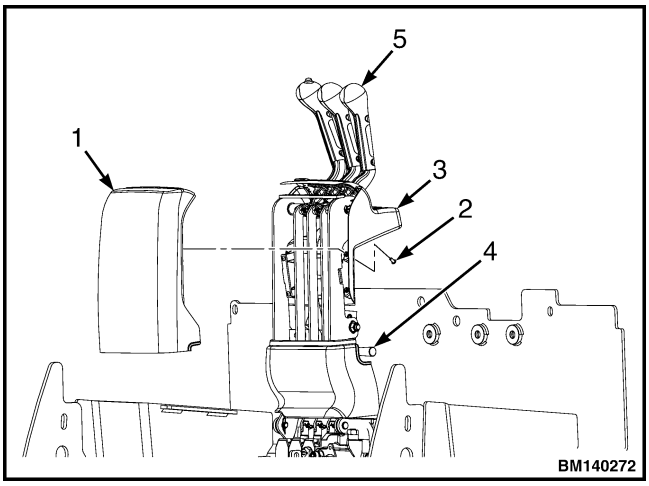
A. 3-FUNCTION MANUAL CONTROL VALVE
B. 4-FUNCTION MANUAL CONTROL VALVE

1. POSITION SENSOR WIRES
2. POSITION SENSOR ELECTRICAL CONNECTOR
3. OPS SOLENOID

Figure 71. Manual Control Valve Electrical Connections Manufactured After October, 2012

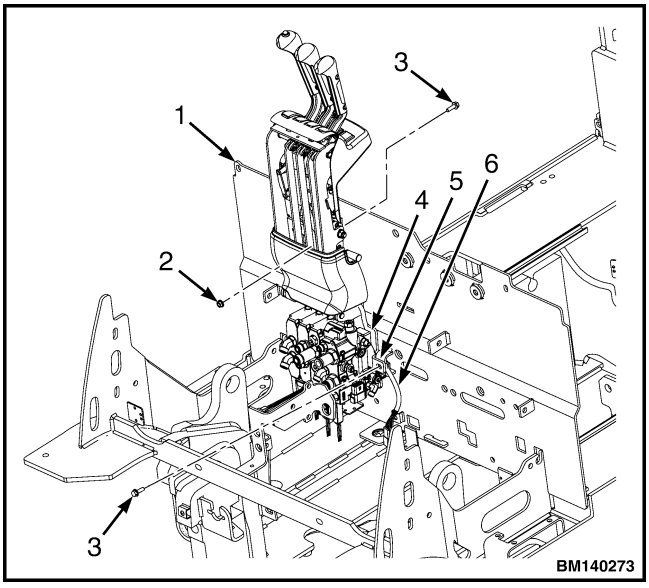
Remove Control Valve

STEP 1.
Pull latch handle, tilt manual hydraulic linkage and handles forward, and remove four button-head capscrews and upper front cover from rear cover.



1. UPPER FRONT COVER
2. BUTTON-HEAD CAPSCREW
3. REAR COVER
4. LATCH HANDLE
5. MANUAL HYDRAULIC LINKAGE AND HANDLES

STEP 2.
Remove nut and capscrews, and clip-nut from mounting plate and front bulkhead.

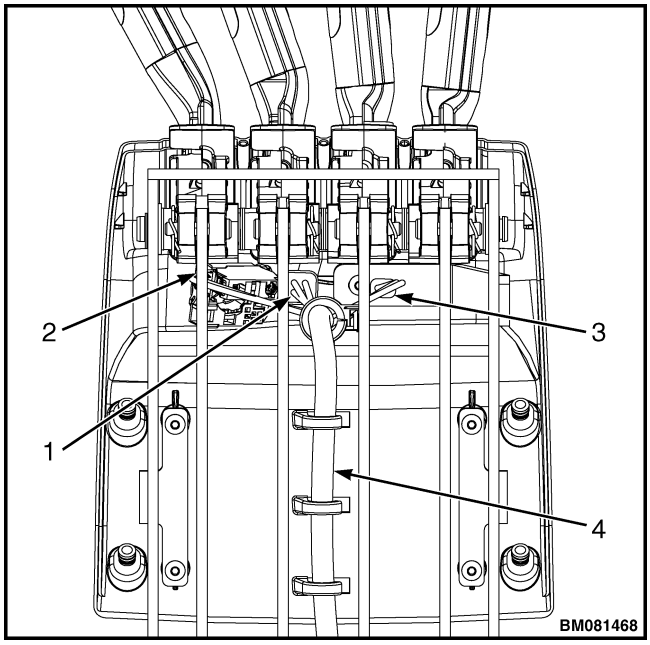


NOTE: CONTROL VALVE MANUFACTURED BEFORE OCTOBER, 2012 SHOWN.

1. FRONT BULKHEAD
2. NUT
3. CAPSCREW
4. MOUNTING PLATE
5. CLIP-NUT
6. WIRE HARNESS

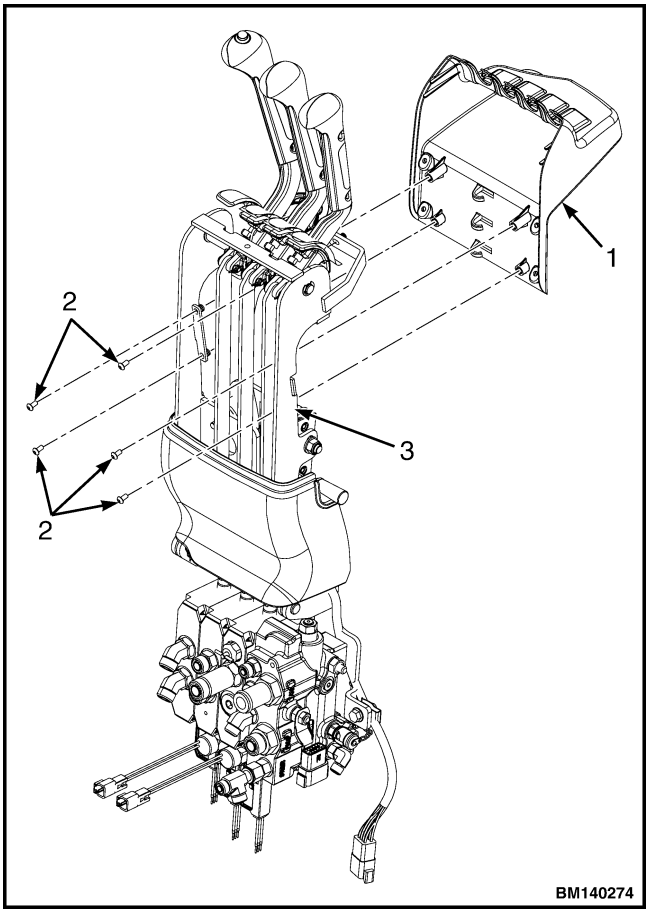
STEP 3.
Lift mounting plate with attached components away from front bulkhead and out of lift truck.

STEP 4.
Disconnect manual hydraulic wire harness from clamp button connector, emergency disconnect switch connector, and direction control switch connector.



1. CLAMP BUTTON CONNECTOR
2. EMERGENCY DISCONNECT SWITCH CONNECTOR
3. DIRECTION CONTROL SWITCH CONNECTOR
4. MANUAL HYDRAULICS WIRE HARNESS

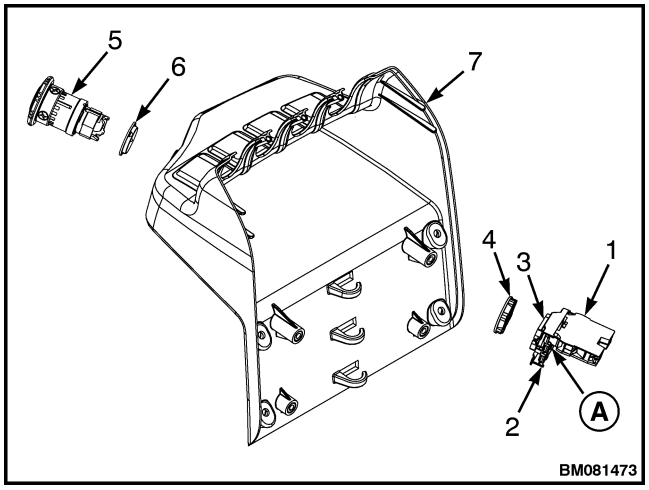
STEP 5.
Remove five button-head capscrews and rear cover from upper bracket.



NOTE: CONTROL VALVE MANUFACTURED BEFORE OCTOBER, 2012 SHOWN.

1. REAR COVER
2. BUTTON-HEAD CAPSCREW
3. UPPER BRACKET

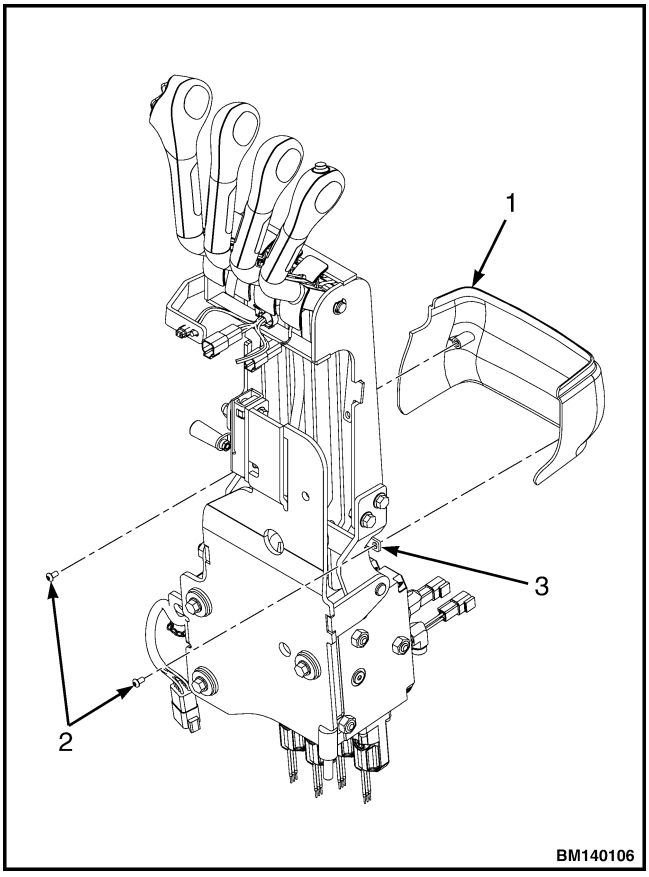
STEP 6.
Remove emergency disconnect switch from rear cover. See **Electrical System** 2200SRM1369 for procedure.



A. INSERT SCREWDRIVER HERE

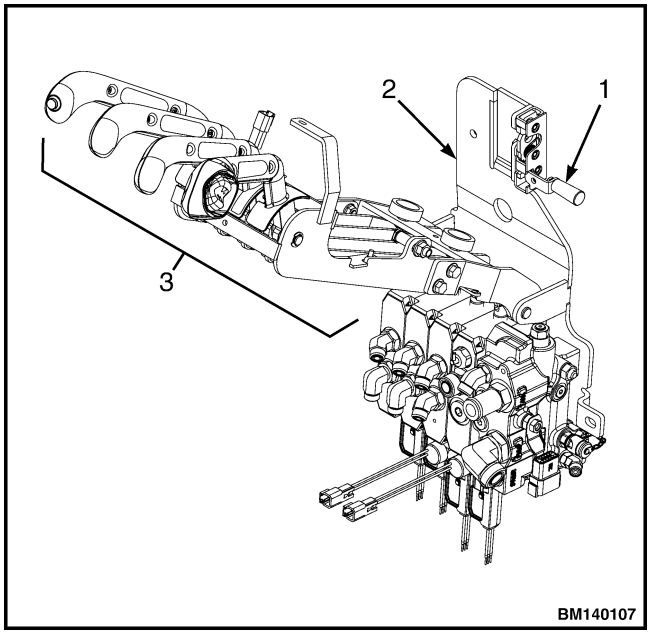
1. SWITCH
2. SWITCH ADAPTER
3. LOCK
4. NUT
5. EMERGENCY DISCONNECT BUTTON
6. BUSHING
7. UPPER REAR COVER HOLE

STEP 7.
Remove two button-head capscrews and lower cover from lower bracket.



1. LOWER COVER
2. BUTTON-HEAD CAPSCREW
3. LOWER BRACKET

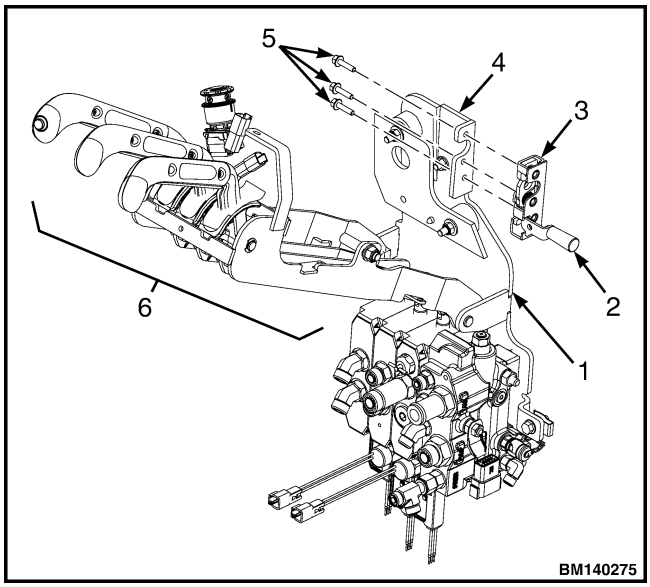
STEP 8.
Pull latch handle up an allow manual hydraulic linkage and handles to move forward away from mounting plate.



NOTE: CONTROL VALVE MANUFACTURED BEFORE OCTOBER, 2012 SHOWN.

1. LATCH HANDLE
2. MOUNTING PLATE
3. HYDRAULIC LINKAGE AND HANDLES

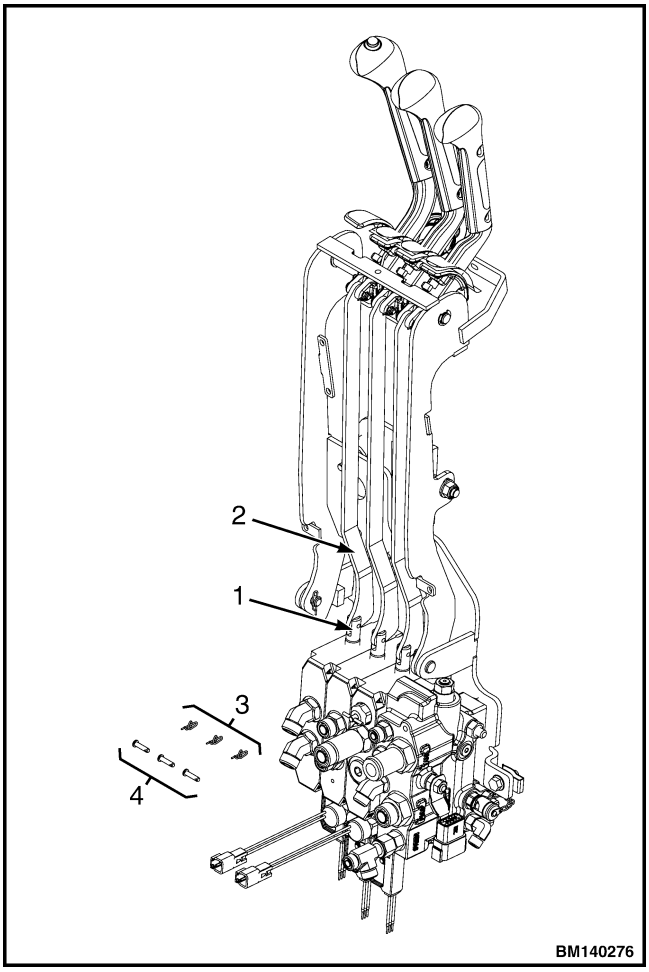
STEP 9.
Remove three capscrews and latch assembly from mounting plate.



NOTE: CONTROL VALVE MANUFACTURED BEFORE OCTOBER, 2012 SHOWN.

1. CONTROL VALVE MOUNTING PLATE
2. LATCH HANDLE
3. LATCH ASSEMBLY
4. LATCH ASSEMBLY MOUNTING PLATE
5. CAPSCREW
6. HYDRAULIC LINKAGE AND HANDLE

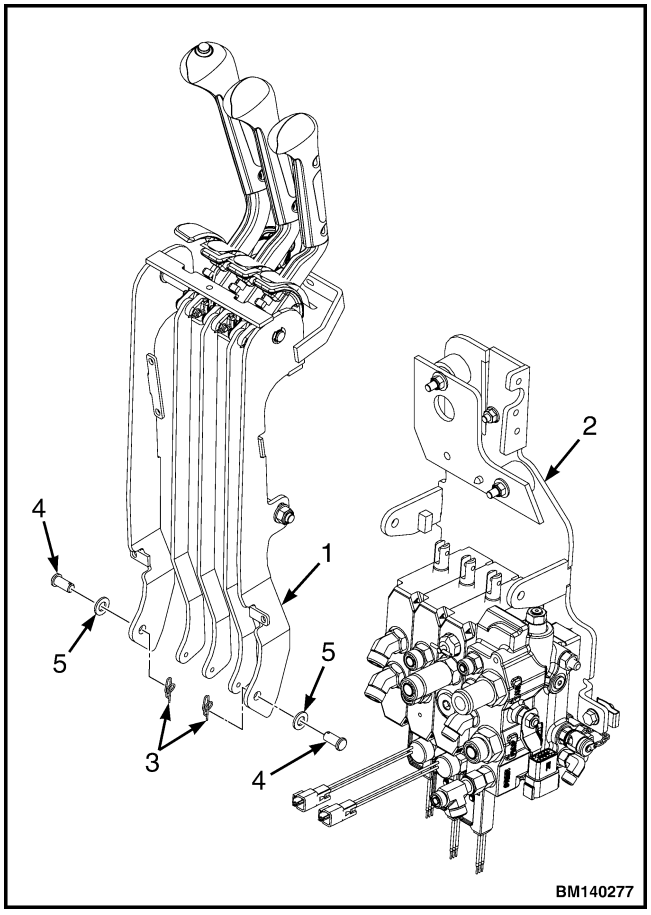
STEP 10.
Remove locking ring cotter pins, rod end pins and links from clevis' at top of manual control valve sections.



NOTE: CONTROL VALVE MANUFACTURED BEFORE OCTOBER, 2012 SHOWN.

1. CLEVIS
2. LINK
3. LOCKING RING COTTER PIN
4. ROD END PIN

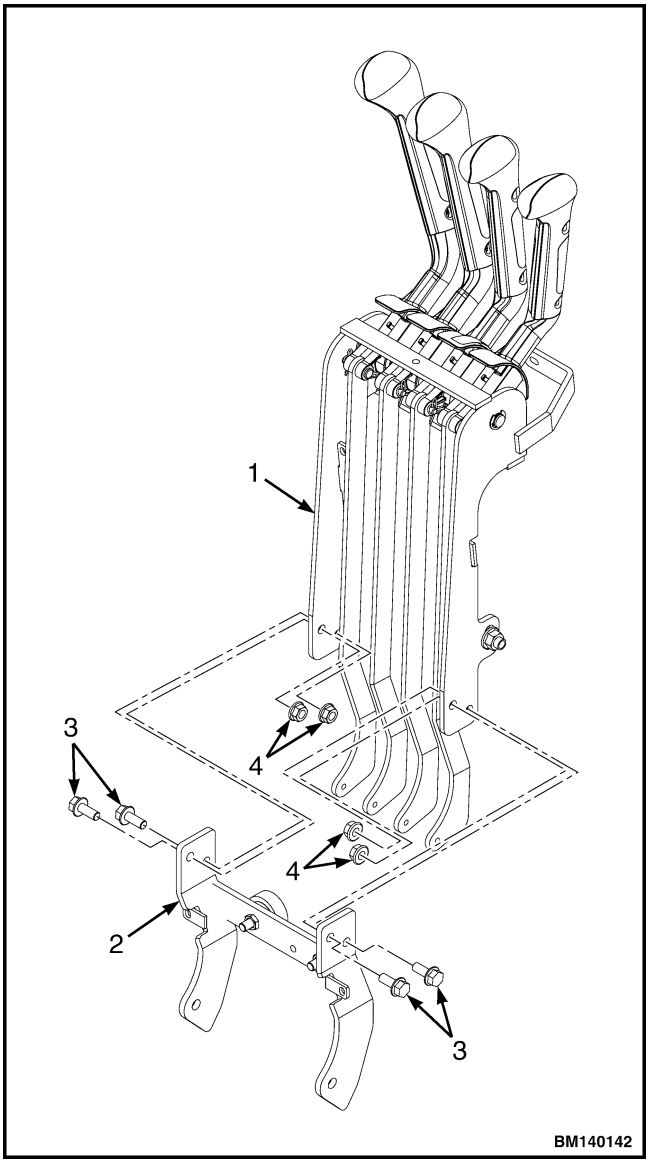
STEP 11.
Remove two locking ring cotter pins, two rod end pins, two nylon washers, and mounting bracket from lower bracket.



NOTE: CONTROL VALVE MANUFACTURED BEFORE OCTOBER, 2012 SHOWN.

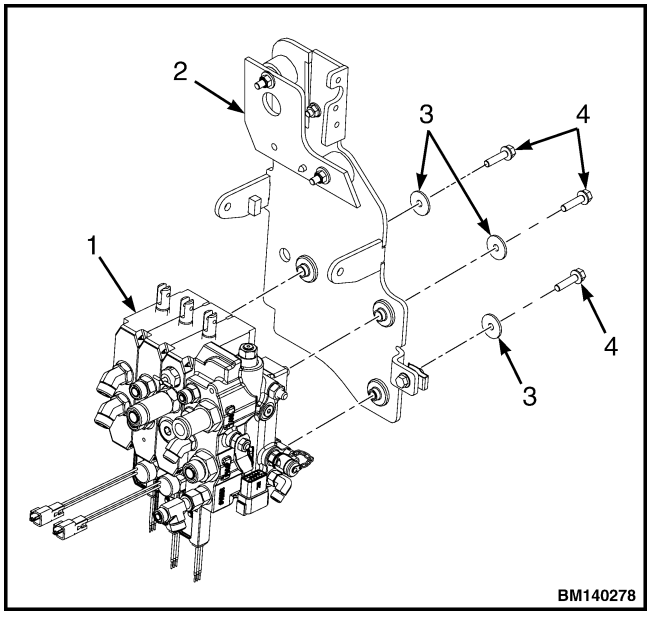
1. LOWER BRACKET
2. MOUNTING BRACKET
3. LOCKING RING COTTER PIN
4. ROD END PIN
5. NYLON WASHER

STEP 12.
Remove four nuts, four capscrews and lower bracket from upper bracket.



1. UPPER BRACKET
2. LOWER BRACKET
3. CAPSCREW
4. NUT

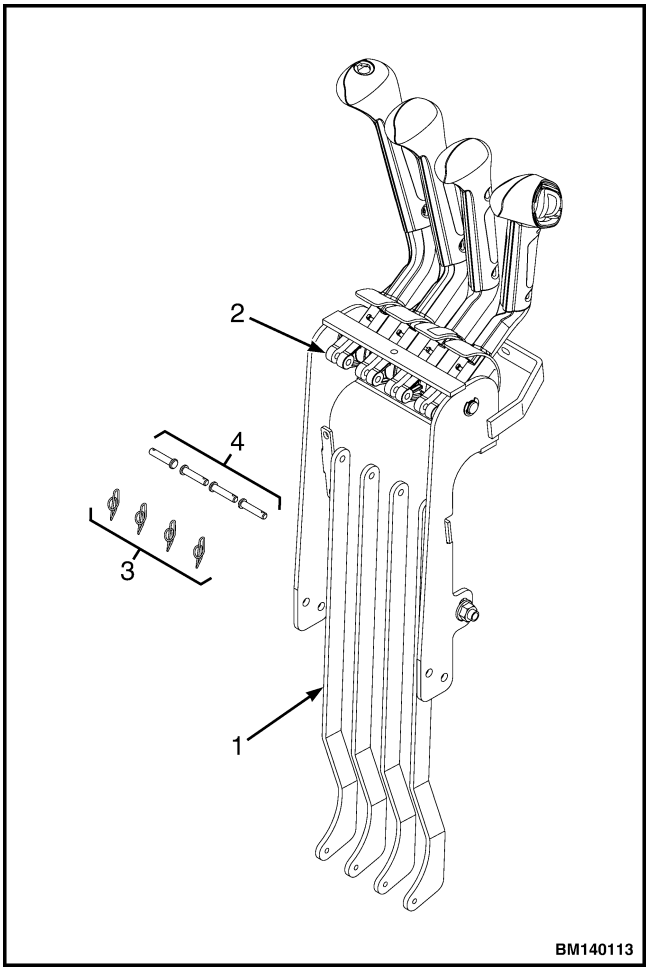
STEP 13.
Remove three capscrews, three special washers, and manual control valve from mounting bracket



NOTE: CONTROL VALVE MANUFACTURED BEFORE OCTOBER, 2012 SHOWN.

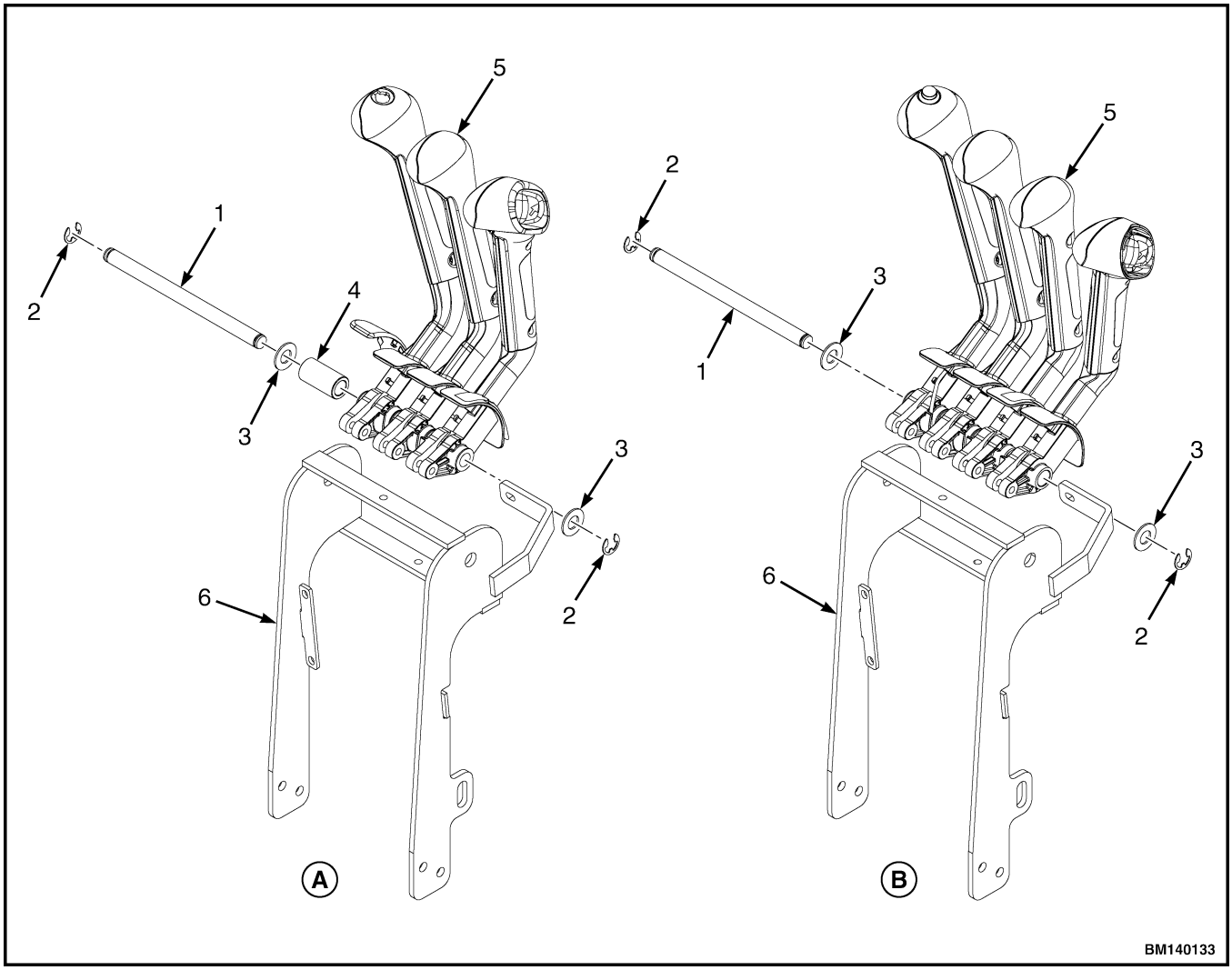
1. MANUAL CONTROL VALVE
2. MOUNTING BRACKET
3. SPECIAL WASHER
4. CAPSCREW

STEP 14.
Remove locking ring cotter pins, clevis pins, and links from levers. Discard locking ring cotter pins.



1. LINK
2. LEVER
3. LOCKING RING COTTER PIN
4. CLEVIS PIN

STEP 15.
Remove e-clip at both ends of pivot pin. Slide pivot pin from levers and upper bracket. Remove nylon washers, lever spacer if present, and levers from upper bracket.



A. 3-FUNCTION LEVERS

1. PIVOT PIN
2. E-CLIP
3. WASHER

B. 4-FUNCTION LEVERS

4. LEVER SPACER
5. LEVER
6. UPPER BRACKET

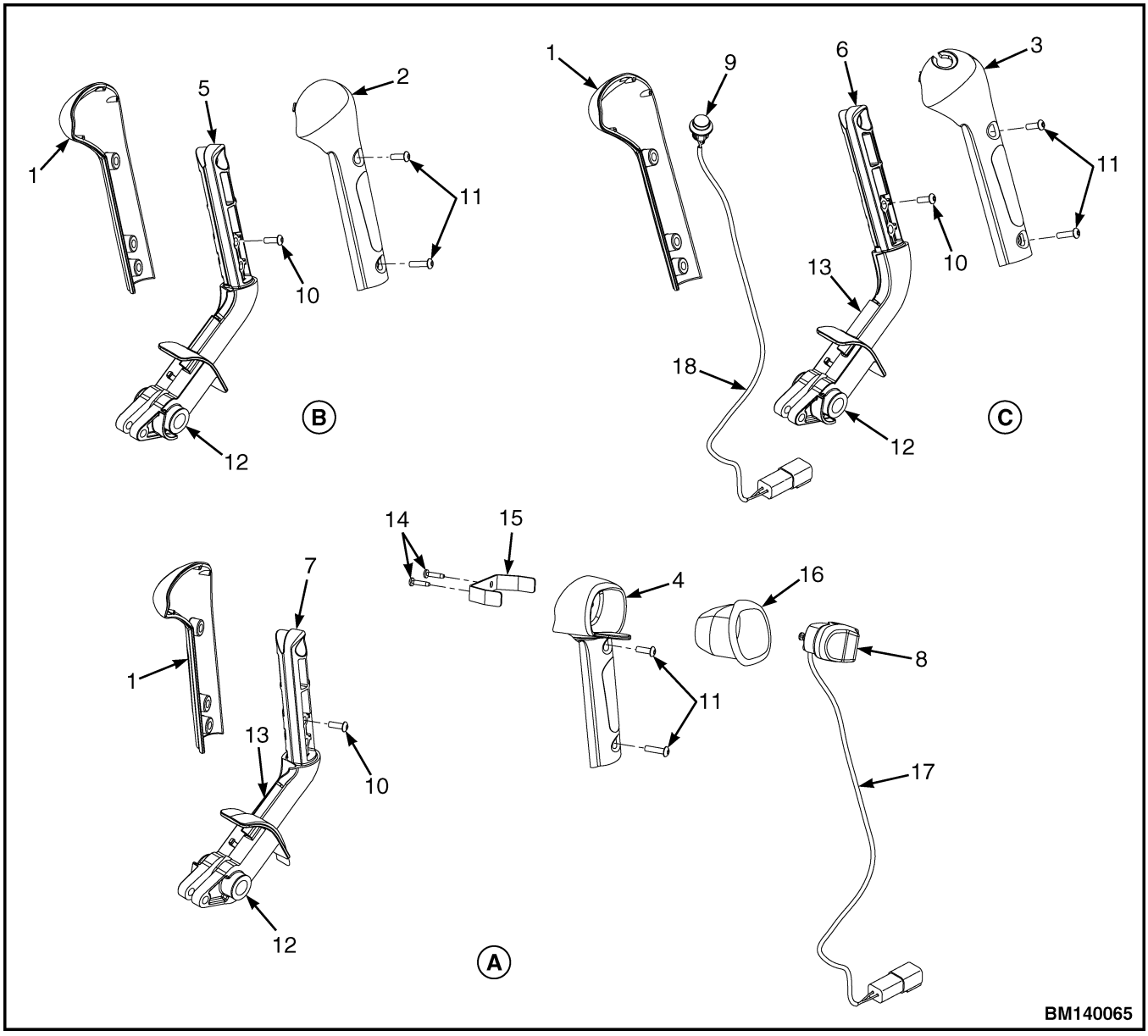
DISASSEMBLE HANDLES AND LEVERS

NOTE: Follow procedure for disassembling links and brackets before disassembling handles.

NOTE: If necessary, handles can be disassembled. Perform Step 1 through Step 4 for lift/lower handle for lift truck equipped with Direction Control Switch (DCS) handle, Step 5 and Step 6 for lift/lower, tilt, aux 1, and aux 2 handles, and Step 7 through Step 9 for aux handle with dual function for lift trucks equipped with clamping function.

NOTE: Handles described in Step 1 through Step 4 and Step 7 through Step 9 are optional.

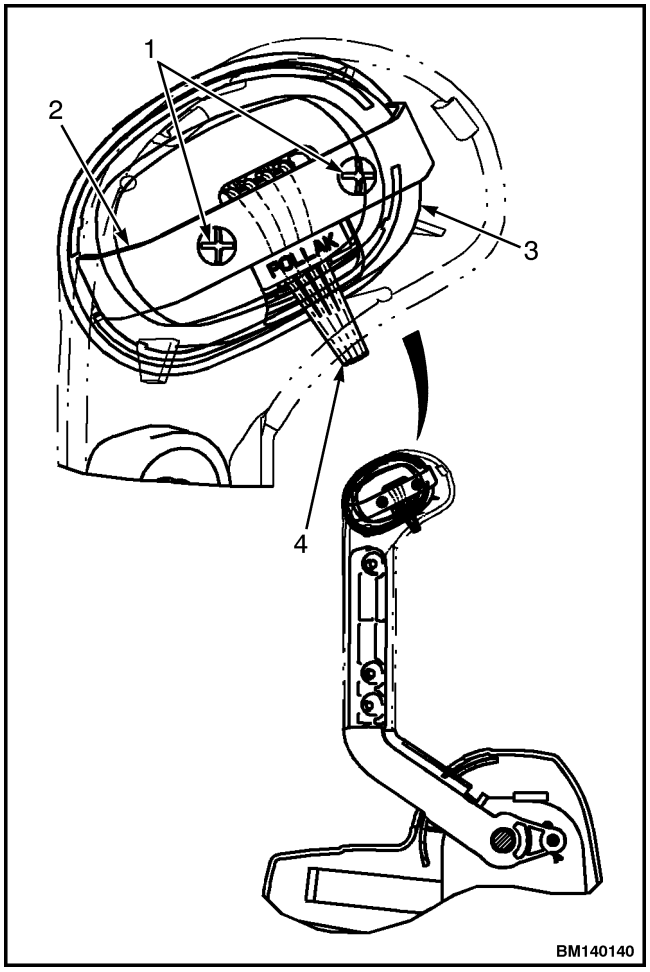
1. Remove two outer capscrews and lift/lower with DCS handle from manual lift/lower lever. See Figure 72.
2. Remove one inner capscrew and palm side grip handle from manual lift lever. See Figure 72.
3. Remove DCS cable from cable track. See Figure 72.
4. Remove two screws, DCS retainer, DCS cup, and Direction Control Switch from lift/lower with DCS handle. See Figure 72 and Figure 73.
5. Remove two outer capscrews and finger side handle from manual tilt or aux 1 lever. See Figure 72.
6. Remove one inner capscrew and palm side grip handle from manual tilt or aux 1 lever. See Figure 72.
7. Remove two outer capscrews and clamp switch handle from manual aux 2 lever. See Figure 72.
8. Remove one inner capscrew and palm side grip handle from manual aux 2 lever. See Figure 72.
9. Remove push-button cable from cable track. See Figure 72.
10. Remove bushings from levers. See Figure 72.



A. LIFT/LOWER WITH DCS
B. LIFT/LOWER, TILT, AUX 1, AUX 2
C. AUX WITH DUAL FUNCTION

1. PALM SIDE GRIP HANDLE
2. FINGER SIDE HANDLE
3. CLAMP SWITCH HANDLE
4. LIFT/LOWER WITH DCS HANDLE
5. MANUAL TILT OR AUX 1 LEVER
6. MANUAL AUX 2 LEVER
7. MANUAL LIFT/LOWER LEVER
8. DIRECTIONAL CONTROL SWITCH (DCS)
9. CLAMPING PUSH-BUTTON
10. INNER CAPSCREW
11. OUTER CAPSCREW
12. BUSHING
13. CABLE TRACK
14. SCREW
15. DCS RETAINER
16. DCS CUP
17. DCS CABLE
18. PUSH-BUTTON CABLE

Figure 72. Manual Hydraulic Control Handles



1. SCREW
2. DCS RETAINER
3. DCS CUP
4. DCS CABLE

Figure 73. Directional Control Switch

DISASSEMBLE MANUAL CONTROL VALVE

Disassemble Valve

CAUTION

All power must be disconnected from valve, mast lowered, and hydraulic lines de-pressurized prior to servicing.

Before any disassembly, all interfaces, joints, and recesses must be cleaned of residue and dirt to avoid contaminating internal components.

CAUTION

If O-rings are to be replaced between two sections that have a hydraulic oil leak, replace all O-rings between all sections. This eliminates the possibility of subsequent oil leak or possible damage to another O-ring.

NOTE: Disassemble the manual control valve only as necessary for repairs. Most repairs to the manual control valve will be to replace O-rings and seals. Spools and valve sections are not serviceable individually, and must be replaced as a complete valve section with spool.

NOTE: Note placement and orientation of fittings prior to disassembly to aid in assembly.

1. Remove return line fitting, pressure line fitting, steer supply fitting, steer return fitting, steer load sense fitting, and hoist line fitting from inlet and lift sections of manual control valve. Remove and discard all O-rings from fittings. See Figure 74.

NOTE: 3-Function manual control valve does not contain optional auxiliary section.

2. Remove tilt line fittings, optional auxiliary, and auxiliary fittings from tilt, optional auxiliary, and auxiliary sections. Remove and discard all O-rings from fittings. See Figure 74.

NOTE: Tag position sensor wires during disassembly to aid in assembly.

3. Disconnect position sensor wires from position sensor electrical connector. See Figure 75.

4. Remove nut and position sensor electrical connector from tie rod on inlet side of manual control valve. See Figure 75.

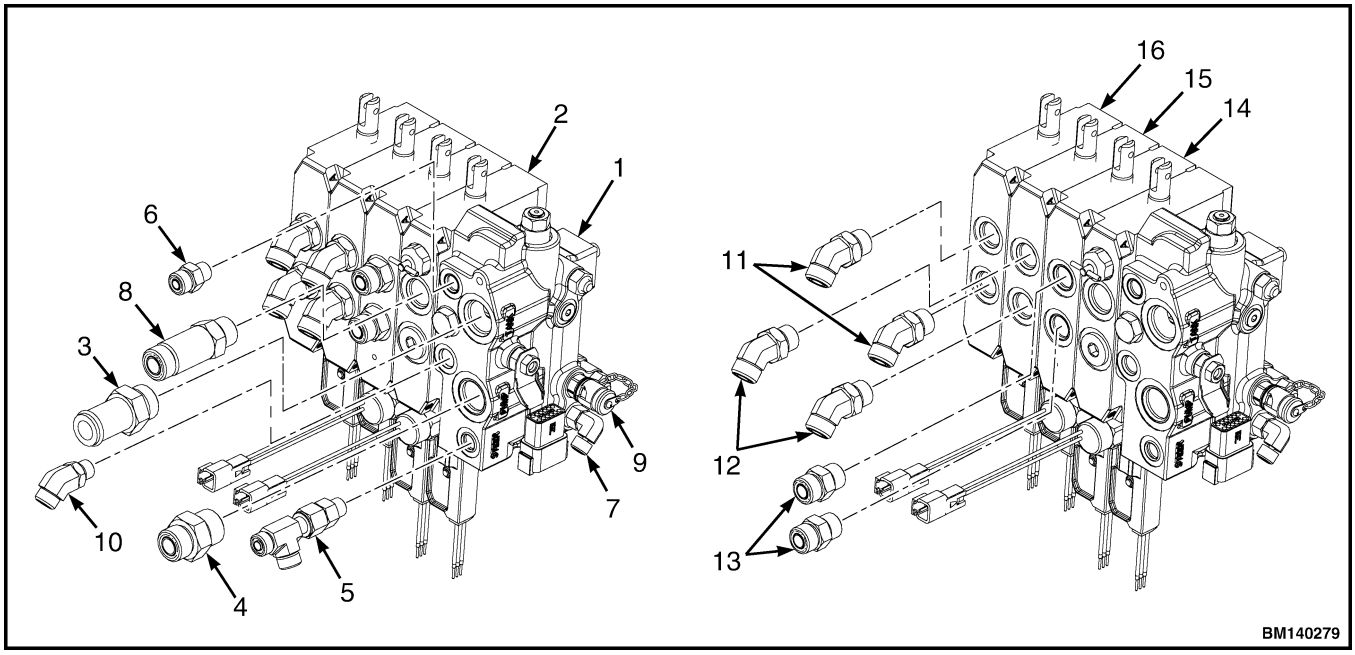
5. Place manual control valve with inlet section on work surface and auxiliary section pointing upward. See Figure 76.

6. Remove nuts from tie rods on auxiliary section side of manual control valve. See Figure 76.

CAUTION

Care must be taken to ensure section seals do not become dislodged during disassembly, they can become wedged into holes which will result in problems during assembly.

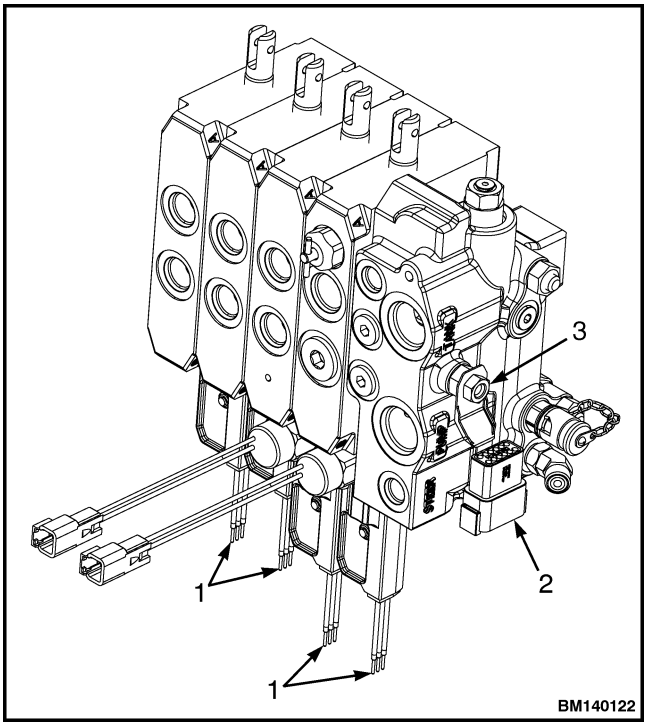
7. Remove each section from tie rods starting with auxiliary section, followed by optional auxiliary section if present, tilt section, lift section, and finally the inlet section. See Figure 77 for example.



NOTE: 4-FUNCTION MANUAL CONTROL VALVE MANUFACTURED BEFORE OCTOBER, 2012 SHOWN.

1. INLET SECTION
2. LIFT SECTION
3. RETURN LINE FITTING
4. PRESSURE LINE FITTING
5. STEER SUPPLY FITTING
6. STEER RETURN FITTING
7. STEER LOAD SENSE FITTING
8. HOIST LINE FITTING
9. DIAGNOSTIC FITTING (SHOWN IN PUMP PRESSURE GAUGE PORT)
10. BRAKE SUPPLY FITTING
11. AUXILIARY FITTING
12. OPTIONAL AUXILIARY FITTING
13. TILT LINE FITTING
14. TILT SECTION
15. OPTIONAL AUXILIARY SECTION
16. AUXILIARY SECTION

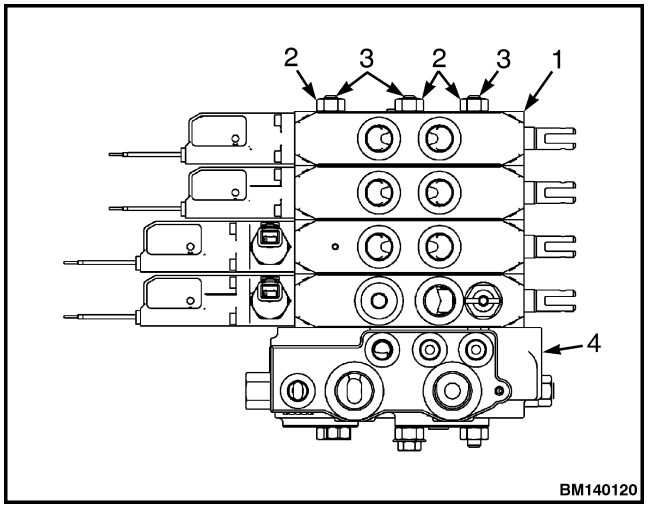
Figure 74. Manual Control Valve Fittings, Inlet, Lift, Tilt and Auxiliary Sections



NOTE: CONTROL VALVE MANUFACTURED BEFORE OCTOBER, 2012 SHOWN.

1. POSITION SENSOR WIRE
2. POSITION SENSOR ELECTRICAL CONNECTOR
3. NUT

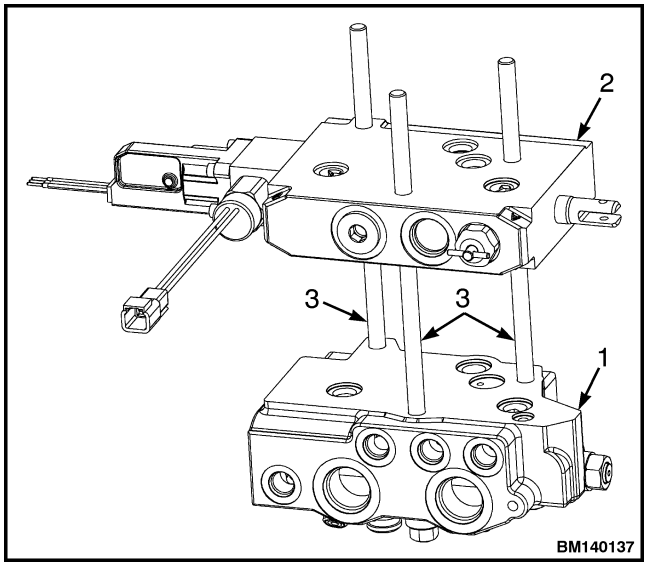
Figure 75. Position Sensor Wires and Connector



NOTE: CONTROL VALVE MANUFACTURED BEFORE OCTOBER, 2012 SHOWN.

1. AUXILIARY SECTION
2. NUT
3. TIE ROD
4. INLET SECTION

Figure 76. Auxiliary Section Tie Rods and Nuts

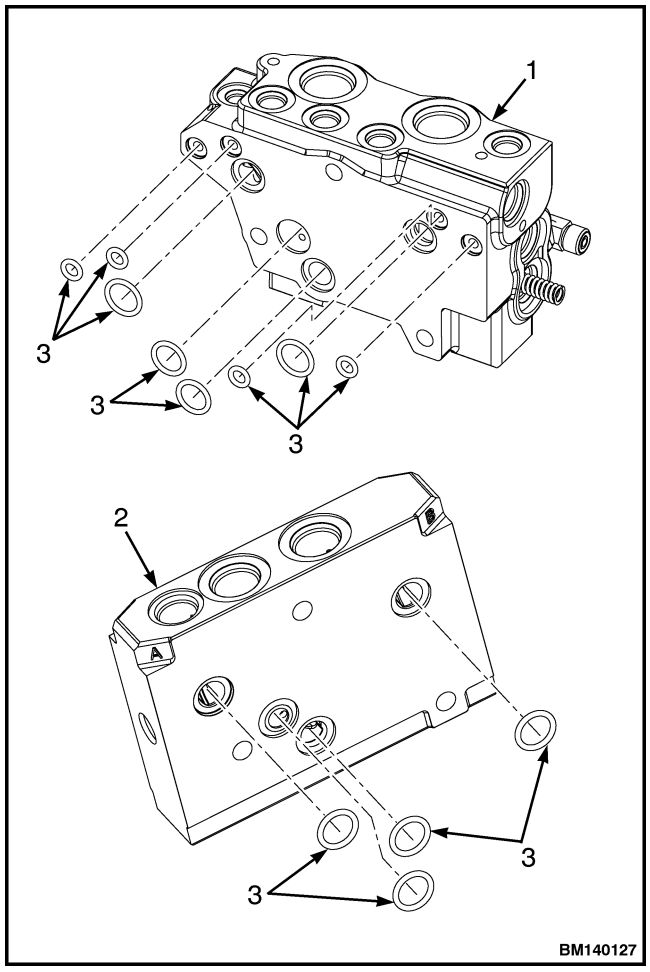


1. INLET SECTION
2. LIFT SECTION
3. TIE ROD

Figure 77. Manual Control Valve - Sections and Tie Rods

NOTE: Note placement of section seals in retaining grooves prior to removal to aid in installation.

8. Remove and discard section seals from retaining grooves of all manual control valve sections. See Figure 78.

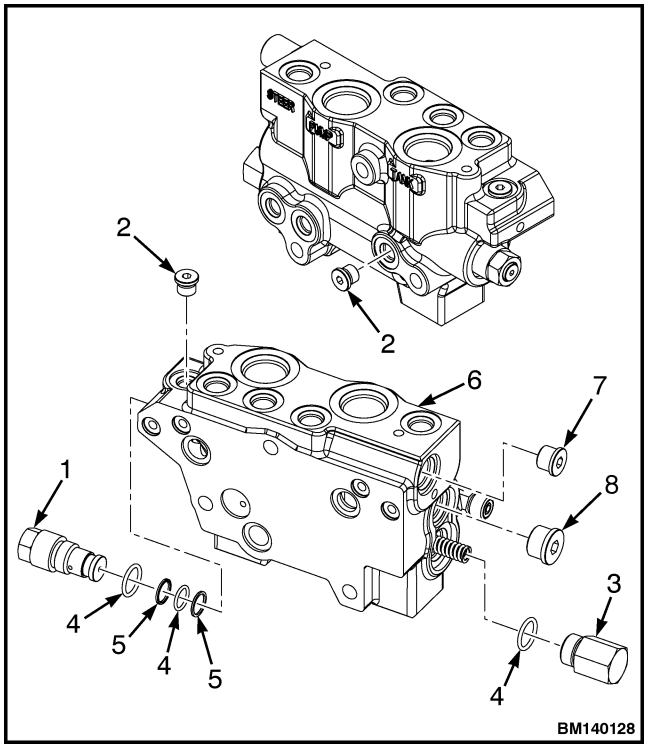


1. INLET SECTION BODY
2. LIFT/TILT/AUXILIARY SECTION BODY
3. SECTION SEAL

Figure 78. Manual Control Valve Section Seals

Disassemble Inlet Section

1. Remove primary relief valve, compensator plug, small port plugs, medium port plug, and large port plug from inlet section body. Remove and discard O-rings and backup rings from primary relief valve and compensator plug. See Figure 79.



1. PRIMARY RELIEF VALVE
2. SMALL PORT PLUG
3. COMPENSATOR PLUG
4. O-RING
5. BACKUP RING
6. INLET SECTION BODY
7. MEDIUM PORT PLUG
8. LARGE PORT PLUG

Figure 79. Inlet Section Body

Disassemble Lift, Tilt, and Auxiliary Sections

NOTE: Prior to disassembly, all interfaces, joints, and recesses must be cleaned of residue and dirt to avoid contaminating internal components.

NOTE: Note placement and orientation of springs during disassembly to aid in assembly

NOTE: Perform Step 1 and Step 2 if section is equipped with OPS solenoid.

1. Remove OPS solenoid from spool lock body. Remove and discard O-ring from solenoid. See Figure 80.

NOTE: **DO NOT** lose springs.

2. Remove capscrews, position sensor, spring, and spool lock body from section body. See Figure 81.

NOTE: Perform Step 3 and Step 4 for lift section.

3. Remove manual lowering valve from lift section body. Remove and discard O-ring from manual lowering valve. See Figure 80.

4. Remove lift port plug-short and lift port plug-long from lift section body. Remove and discard O-ring from lift port plug-long. See Figure 80.

NOTE: Perform Step 5 for tilt section.

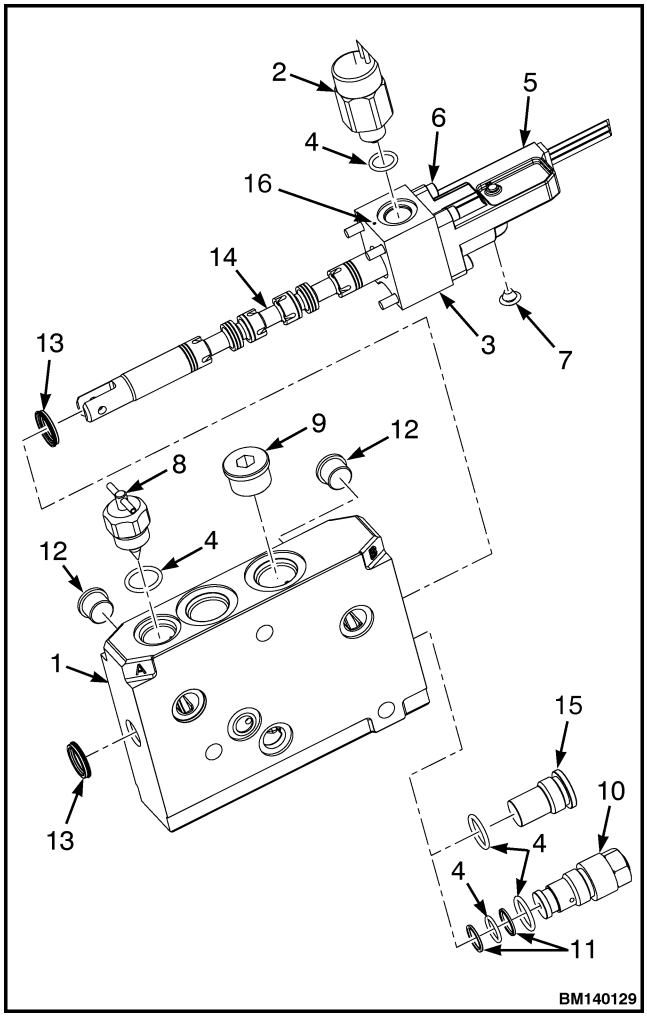
5. Remove secondary relief valve from tilt section body. Remove and discard O-rings and backup rings from secondary relief valve. See Figure 70.

NOTE: Perform Step 6 for auxiliary section.

6. Remove auxiliary port plugs from auxiliary section body. See Figure 80.

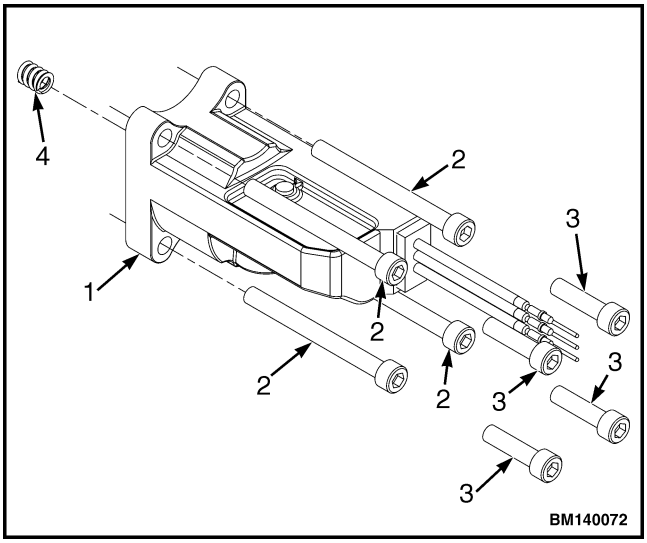
7. Remove any remaining port plugs. Remove and discard O-rings, if present, from port plugs.

8. If spool seal for any valve section requires replacement, see Spool Seal Replacement section.



1. LIFT/TILT/AUXILIARY SECTION BODY
2. OPS SOLENOID
3. SPOOL LOCK BODY
4. O-RING
5. POSITION SENSOR
6. CAPSCREW
7. CHECK VALVE
8. MANUAL LOWERING VALVE
9. LIFT PORT PLUG-SHORT
10. SECONDARY RELIEF VALVE
11. BACKUP RING
12. AUXILIARY PORT PLUG
13. SPOOL SEAL
14. SPOOL
15. LIFT PORT PLUG-LONG

Figure 80. Lift, Tilt, and Auxiliary Section Body



1. POSITION SENSOR ASSEMBLY
2. CAPSCREW - WITH SPOOL LOCKS
3. CAPSCREW - WITHOUT SPOOL LOCKS
4. SPRING

Figure 81. Position Sensor Assembly

SPOOL SEAL REPLACEMENT

NOTE: If working on tilt section, use caution not to lose small spool and spring inside main spool and held in place with spool lock extension.

1. Using screwdriver or pin, hold spool clevis and remove spool lock extension from spool assembly. See Figure 82.

2. Pull spool assembly far enough out of section body to expose spool seal on clevis end of section body. See Figure 82.

NOTE: Lubricate new spool seal with clean hydraulic oil prior to installation.

3. Using O-ring pick or similar device remove and discard spool seal from spool assembly. Lightly lubricate new spool seal and install into grooves in section body. See Figure 83.

4. Carefully run your finger around expose edge of seal. You should have a smooth, precise ridge with no kinks or twists.

CAUTION

Pulling the spools meter edges across the spool seals can result in damage to the spool seal.

5. Slide spool assembly back into section body to keep spool seal in place.

6. Push spool assembly into section body far enough to expose the spool seal on OPS end of section body.

NOTE: Lubricate new spool seal with clean hydraulic oil prior to installation.

7. Using O-ring pick or similar device remove and discard spool seal from spool assembly. Lightly lubricate new spool seal and install onto spool assembly. See Figure 83.

CAUTION

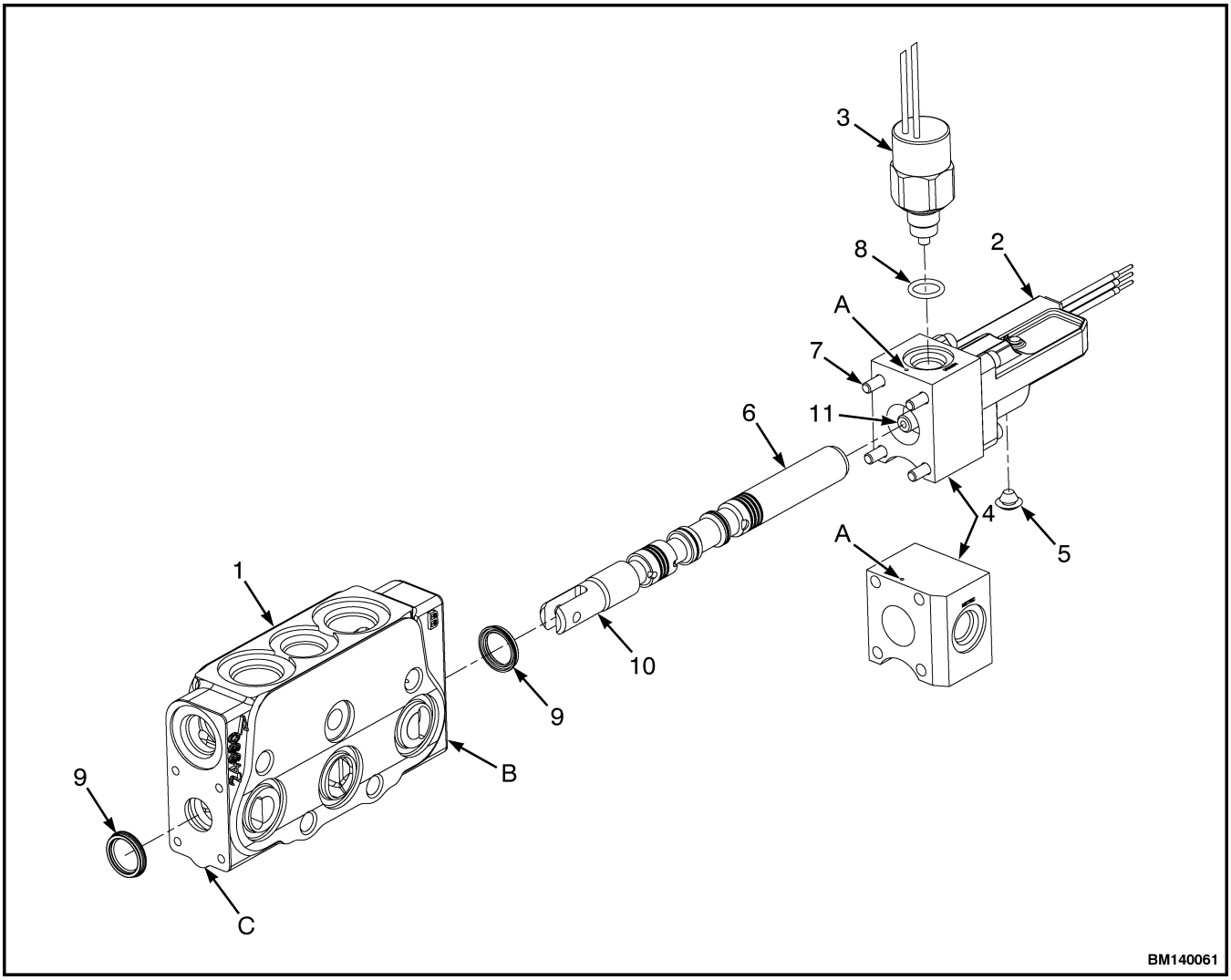
Pulling the spools meter edges across the spool seals can result in damage to the spool seal.

8. Slide spool assembly back into section body to keep spool seal in place.

9. Carefully run your finger around exposed edge of seal. You should have a smooth, precise ridge with no kinks or twists.

NOTE: Perform Step 10 for tilt section.

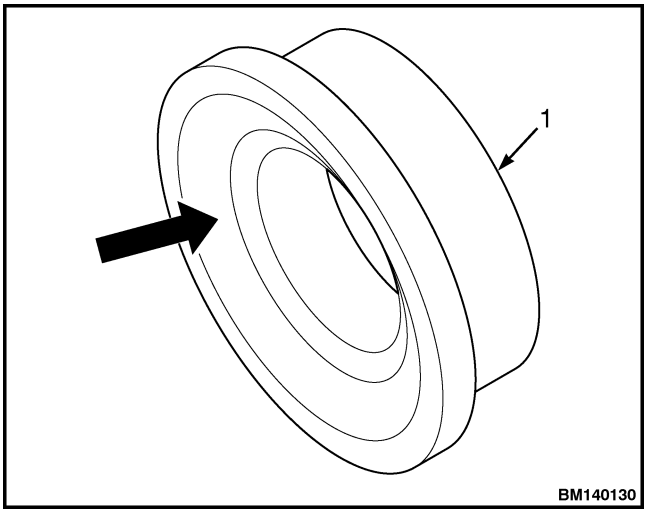
10. Install small spool and spring inside spool assembly to be held in position by spool extension. See Figure 82.



A. ORIENTATION DOT
B. OPS END
C. CLEVIS END

1. LIFT/TILT/AUXILIARY SECTION BODY
2. POSITION SENSOR
3. OPS SOLENOID
4. SPOOL LOCK BODY
5. CHECK VALVE
6. SPOOL ASSEMBLY
7. CAPSCREW
8. O-RING
9. SPOOL SEAL
10. SPOOL CLEVIS
11. SPOOL LOCK EXTENSION

Figure 82. Lift/Tilt/Auxiliary Sections Manual Control Valve



CAUTION

To ensure proper assembly, lip of spool seal should point "in" toward section body.

1. SPOOL SEAL

Figure 83. Spool Seal Installation

CLEAN

WARNING

Cleaning solvents can be flammable and toxic and cause skin irritation. When using cleaning solvents, always follow the solvent manufacturer's recommended safety procedures.

WARNING

Compressed air can move particles so they cause injury to the user or to other personnel. Make sure the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eyes.

1. Clean only metal components of manual control valve with solvent and dry using compressed air.
2. Clean all threaded components with denatured alcohol and dry using compressed air.
3. Clean rubber or plastic components with warm soapy water and dry with a lint free cloth. DO NOT submerge components with electrical connections in water.

INSPECT

1. Check spools and bores for wear or damage. If damaged, entire section must be replaced. Make sure spool moves freely within bore.
2. Inspect check valves and relief valves for damage. Replace if damaged.
3. Inspect solenoids and position sensors for damage. Replace if damaged.
4. Inspect threaded components to ensure absence of oil or solvent residue.
5. Inspect handles, levers, bushings, and linkages for damage. Replace if damaged.
6. Inspect all other components for damage. Replace if damaged.

ASSEMBLE MANUAL CONTROL VALVE

Assemble Lift, Tilt, and Auxiliary Sections

NOTE: Perform Step 1 for auxiliary section(s).

1. Install auxiliary port plug into auxiliary section body. See Figure 84. Tighten auxiliary port plug to 14 N•m (124 lbf in).

NOTE: Perform Step 2 for tilt section.

NOTE: Lubricate O-rings and backup rings with clean hydraulic oil prior to installation.

2. Install new O-rings and backup rings onto secondary relief valve. Install secondary relief valve into tilt section body. See Figure 84. Tighten secondary relief valve to 27 N•m (20 lbf ft).

NOTE: Perform Step 3 through Step 5 for lift section.

3. Install new O-ring onto lift port plug-long. Install lift port plug-long into lift section body. See Figure 84. Tighten lift port plug-long to 27 N•m (20 lbf ft).
4. Install lift port plug-short into lift section body. See Figure 84. Tighten lift port plug-short to 54 N•m (40 lbf ft).

5. Install new O-ring onto manual lowering valve. Install manual lowering valve into lift section body. See Figure 84. Tighten manual lowering valve to 54 N•m (40 lbf ft).

CAUTION

Spool lock body must be placed with orientation dot up and toward section body for correct fit. If not installed correctly damage to manual control valve may result.

NOTE: Perform Step 6 and Step 7 if section is equipped with OPS solenoid.

NOTE: Apply Loctite® 262 to capscrew threads prior to installation.

NOTE: Install spring as noted during disassembly.

6. Install spool lock body, position sensor, and capscrews to section body. See Figure 85. Tighten capscrews to 4.7 N•m (42 lbf in).

7. Install new O-ring onto OPS solenoid. Install OPS solenoid into spool lock body. See Figure 84. Tighten OPS solenoid to 7.5 N•m (66 lbf in).

Assemble Inlet Section

NOTE: Lubricate new O-rings and backup rings with clean hydraulic oil prior to installation.

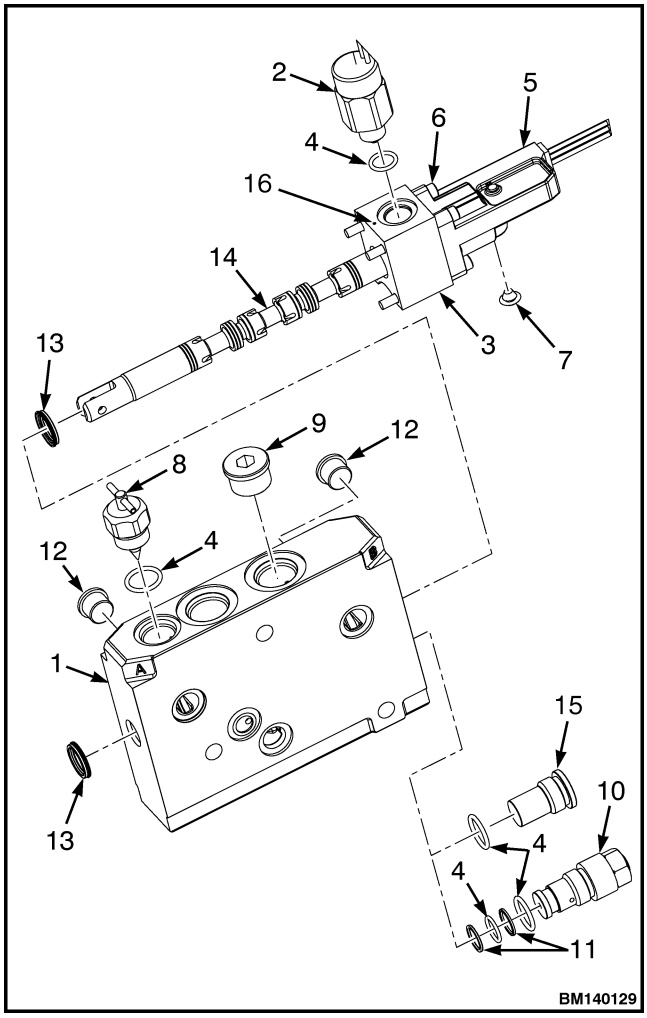
1. Install new O-rings and backup rings onto primary relief valve. Install primary relief valve to inlet section body. See Figure 86. Tighten primary relief valve to 27 N•m (20 lbf ft).

2. Install new O-ring onto compensator plug. Install compensator plug to inlet section body. See Figure 86. Tighten compensator plug to 47 N•m (35 lbf ft).

3. Install small port plugs to inlet section body. See Figure 86. Tighten small port plugs to 13.5 N•m (119 lbf in).

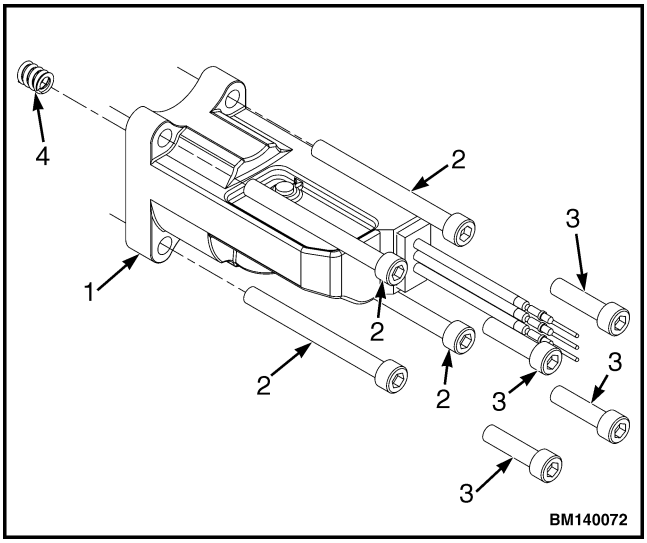
4. Install medium port plug to inlet section body. See Figure 86. Tighten medium port plug to 65 N•m (48 lbf ft).

5. Install large port plug to inlet section body. See Figure 86. Tighten large port plug to 60 to 72 N•m (44 to 53 lbf ft).



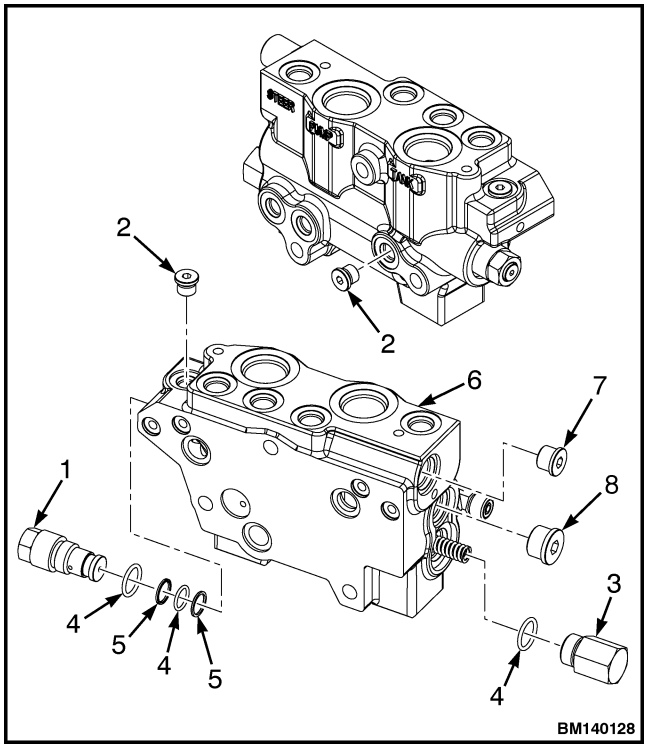
1. LIFT/TILT/AUXILIARY SECTION BODY
2. OPS SOLENOID
3. SPOOL LOCK BODY
4. O-RING
5. POSITION SENSOR
6. CAPSCREW
7. CHECK VALVE
8. MANUAL LOWERING VALVE
9. LIFT PORT PLUG-SHORT
10. SECONDARY RELIEF VALVE
11. BACKUP RING
12. AUXILIARY PORT PLUG
13. SPOOL SEAL
14. SPOOL
15. LIFT PORT PLUG-LONG

Figure 84. Lift, Tilt, and Auxiliary Section Body



1. POSITION SENSOR ASSEMBLY
2. CAPSCREW WITH SPOOL LOCKS
3. CAPSCREW WITHOUT SPOOL LOCKS
4. SPRING

Figure 85. Position Sensor Assembly

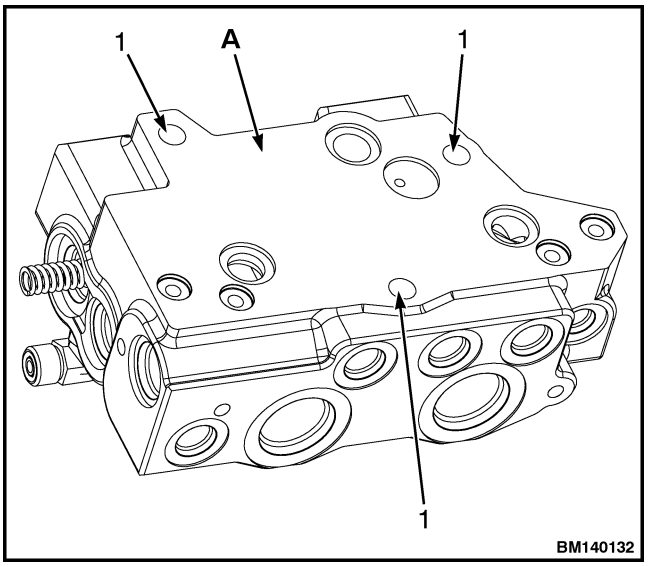


1. PRIMARY RELIEF VALVE
2. SMALL PORT PLUG
3. COMPENSATOR PLUG
4. O-RING
5. BACKUP RING
6. INLET SECTION BODY
7. MEDIUM PORT PLUG
8. LARGE PORT PLUG

Figure 86. Inlet Section Body

Assemble Valve

1. Install a nut on one end of each tie rod and hand-tighten only at this time. Thread opposite end through inlet section tie rod holes. See Figure 87.



A. MACHINED FACE

1. TIE ROD HOLE

Figure 87. Manual Control Valve Inlet Section Machined Face

2. Place inlet section with machined surface facing up as shown in Figure 87.

NOTE: **DO NOT** lubricate section seals prior to installation. Lubricants on these seals can distort valve body, resulting in spool bind.

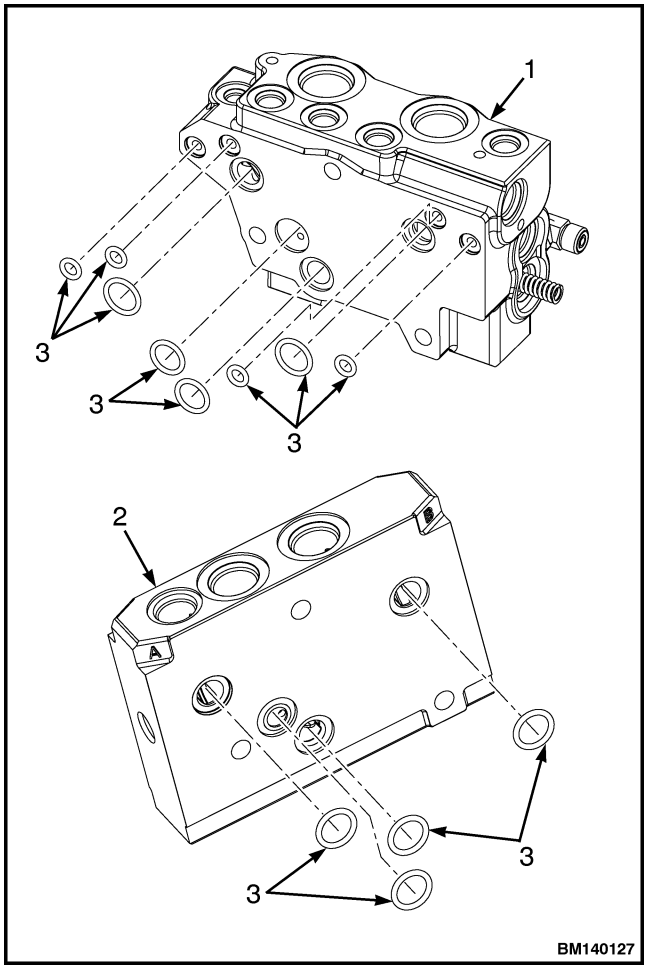
3. Install section seals into retaining grooves of inlet section as noted during disassembly. See Figure 88.

4. Install lift section over tie rods and against inlet section. See Figure 89.

5. Install section seals into retaining grooves of lift section as noted during disassembly. See Figure 88.

6. Install tilt section over tie rods and against lift section. See Figure 89 for example.

7. Install section seals into retaining grooves of tilt section as noted during disassembly. See Figure 88.



1. INLET SECTION BODY
2. LIFT/TILT/AUXILIARY SECTION BODY
3. SECTION SEAL

Figure 88. Manual Control Valve Section Seals

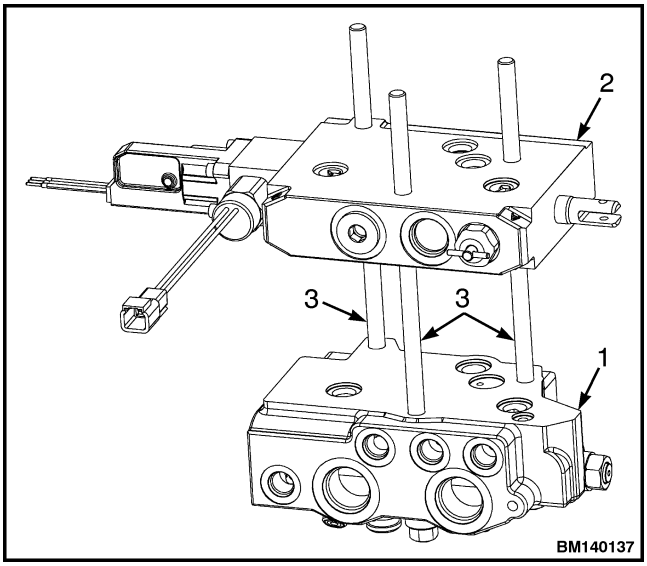
NOTE: 3-Function manual control valve is not equipped with a optional auxiliary section.

8. Install optional auxiliary section over tie rods and against tilt section. See Figure 89 for example.

9. Install section seals into retaining grooves of optional auxiliary section as noted during disassembly. See Figure 88.

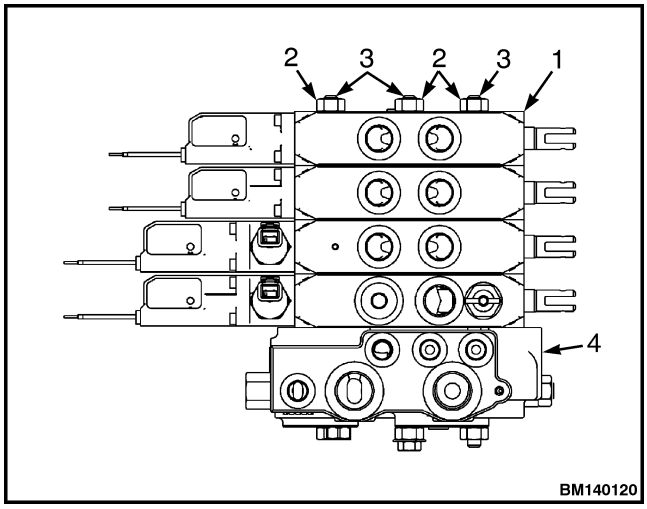
10. Install auxiliary section over tie rods and against optional auxiliary or tilt section. See Figure 89 for example.

11. Install a nut onto end of each tie rod and hand-tighten only at this time. See Figure 90.



1. INLET SECTION
2. LIFT SECTION
3. TIE ROD

Figure 89. Manual Control Valve - Sections and Tie Rods



NOTE: CONTROL VALVE MANUFACTURED BEFORE OCTOBER, 2012 SHOWN.

1. AUXILIARY SECTION
2. NUT
3. TIE ROD
4. INLET SECTION

Figure 90. Auxiliary Section Tie Rods and Nuts

CAUTION

If proper value of torque is not applied to the nuts on the tie rods, the valve spools may bind or stick and section seals may extrude.

12. Reposition manual control valve with work ports facing up, then tighten eight nuts on tie rods to 20.3 ± 1.4 N•m (179.7 ± 12.4 lbf in).

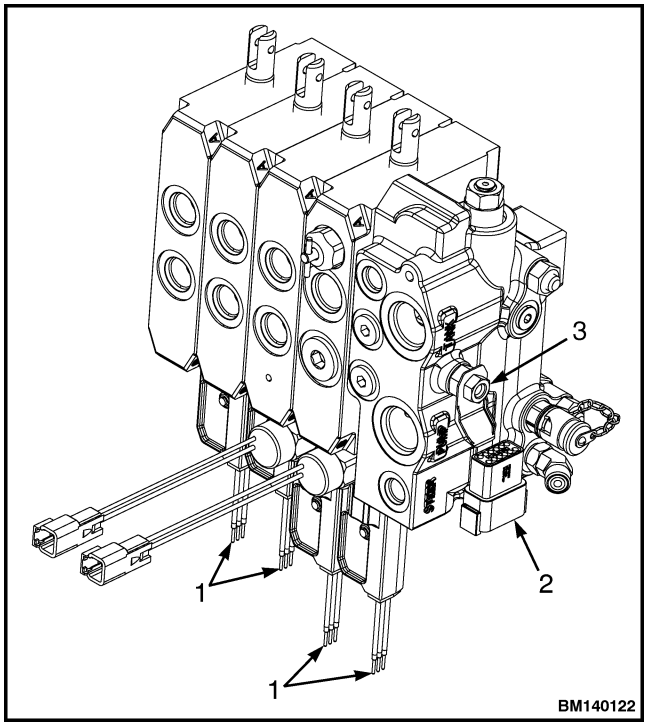
NOTE: Tie rods to extend beyond nuts for one to two threads.

13. Install position sensor electrical connector and nut onto tie rod on inlet side of manual control valve. See Figure 91. Tighten nut to 18 to 20 N•m (156 to 180 lbf in).

14. Connect position sensor wires to back of position sensor electrical connector as tagged during disassembly. See Table 5 and Figure 91.

NOTE: Lubricate new O-rings with clean hydraulic oil prior to installation.

15. Install new O-rings onto auxiliary fittings. Install auxiliary fittings into auxiliary section as noted during disassembly. See Figure 92 and Figure 93.



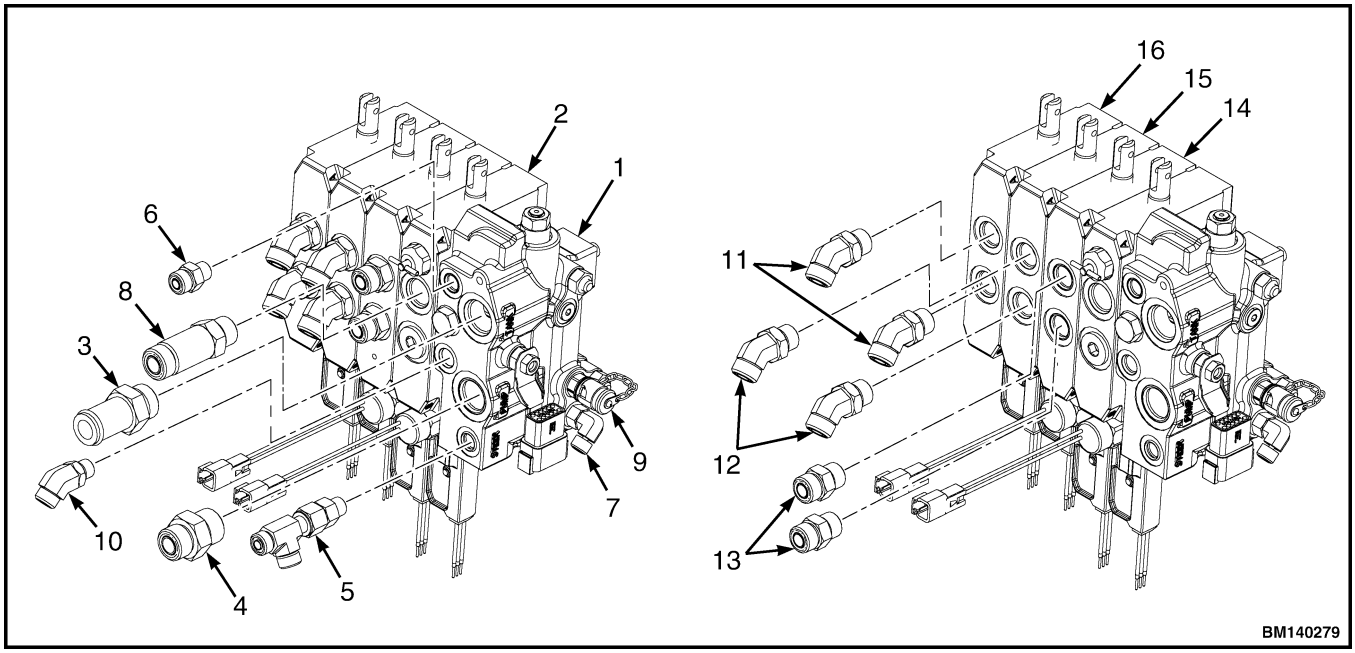
NOTE: CONTROL VALVE MANUFACTURED BEFORE OCTOBER, 2012 SHOWN.

1. POSITION SENSOR WIRE
2. POSITION SENSOR ELECTRICAL CONNECTOR
3. NUT

Figure 91. Position Sensor Wires and Connector

Table 5. Position Sensor Electrical Connector Pin Layout

PIN	SOCKET	PIN	SOCKET	PIN	SOCKET
PIN 1	SPOOL 1 POS	**PIN 5**	SPOOL 1 OUTPUT	**PIN 12**	SPOOL 1 NEG
PIN 2	SPOOL 2 POS	**PIN 6**	SPOOL 2 OUTPUT	**PIN 11**	SPOOL 2 NEG
PIN 3	SPOOL 3 POS	**PIN 7**	SPOOL 3 OUTPUT	**PIN 10**	SPOOL 3 NEG
PIN 4	SPOOL 4 POS	**PIN 8**	SPOOL 4 OUTPUT	**PIN 9**	SPOOL 4 NEG



NOTE: 4-FUNCTION MANUAL CONTROL VALVE MANUFACTURED BEFORE OCTOBER, 2012 SHOWN.

1. INLET SECTION
2. LIFT SECTION
3. RETURN LINE FITTING
4. PRESSURE LINE FITTING
5. STEER SUPPLY FITTING
6. STEER RETURN FITTING
7. STEER LOAD SENSE FITTING
8. HOIST LINE FITTING
9. DIAGNOSTIC FITTING (SHOWN IN PUMP PRESSURE GAUGE PORT)
10. BRAKE SUPPLY FITTING
11. AUXILIARY FITTING
12. OPTIONAL AUXILIARY FITTING
13. TILT LINE FITTING
14. TILT SECTION
15. OPTIONAL AUXILIARY SECTION
16. AUXILIARY SECTION

Figure 92. Manual Control Valve Fittings - Tilt and Auxiliary Sections

NOTE: 3-Function manual control valve does not contain optional auxiliary section.

16. Install new O-rings onto optional auxiliary fittings. Install optional auxiliary fittings into optional auxiliary section as noted during disassembly. See Figure 92 and Figure 93 for fitting placement and orientation.

17. Install new O-rings onto tilt line fittings. Install tilt line fittings into tilt section as noted during disassembly. See Figure 92 and Figure 93.

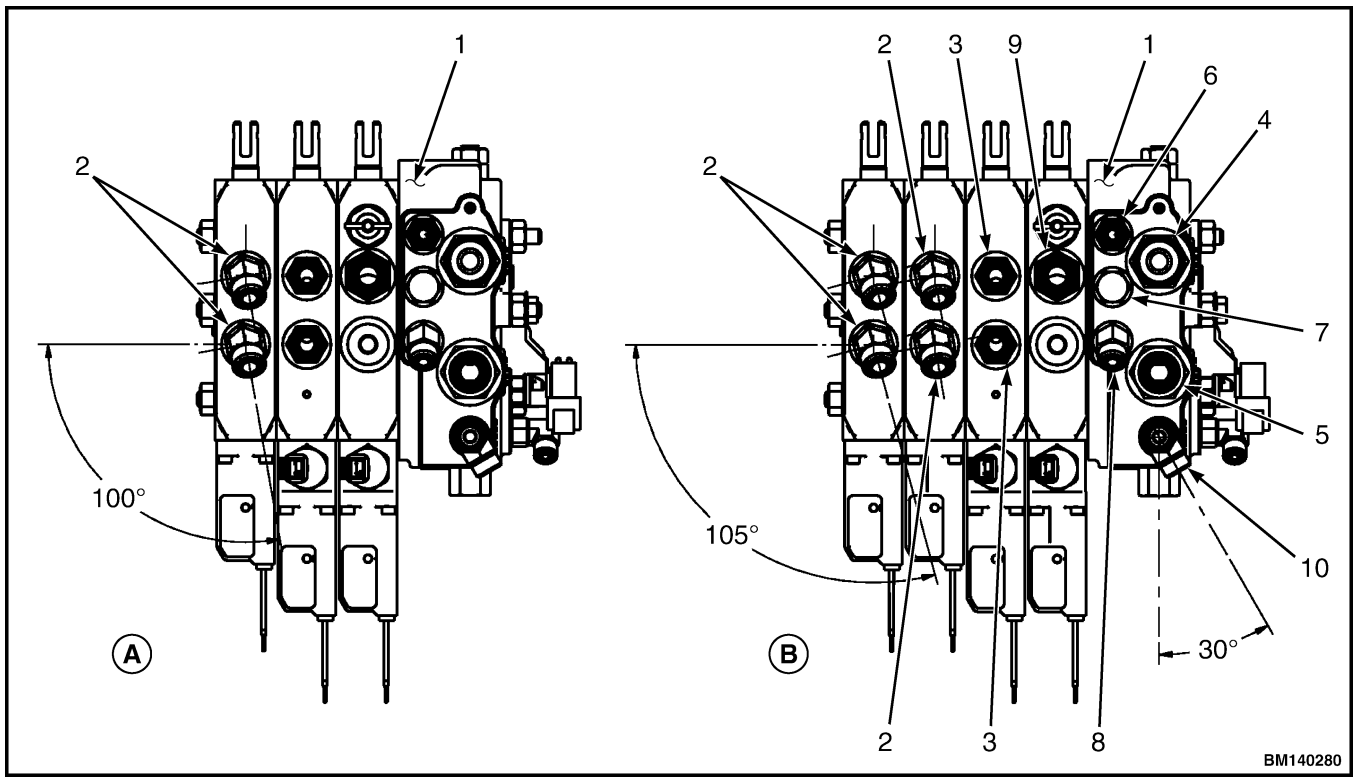
18. Install new O-ring onto hoist line fitting. Install hoist line fitting into lift section as noted during disassembly. See Figure 93.

19. Install new O-rings onto steer return fitting, return line fitting, and steer supply fitting. Install steer return fitting, return line fitting, and steer supply fitting into inlet section as noted during disassembly. See Figure 93.

20. Install new O-ring onto pressure line fitting. Install pressure line fitting into inlet section as noted during disassembly. See Figure 93.

21. Install new O-ring onto diagnostic fitting. Install diagnostic fitting into inlet section as noted during disassembly. See Figure 93. Tighten diagnostic fitting to 16 N•m (142 lbf in).

NOTE: Steer load sense fitting contains special internal features and **CANNOT** be replaced with standard hydraulic fitting.



NOTE: CONTROL VALVE MANUFACTURED BEFORE OCTOBER, 2012 SHOWN.

A. 3-FUNCTION MANUAL CONTROL VALVE

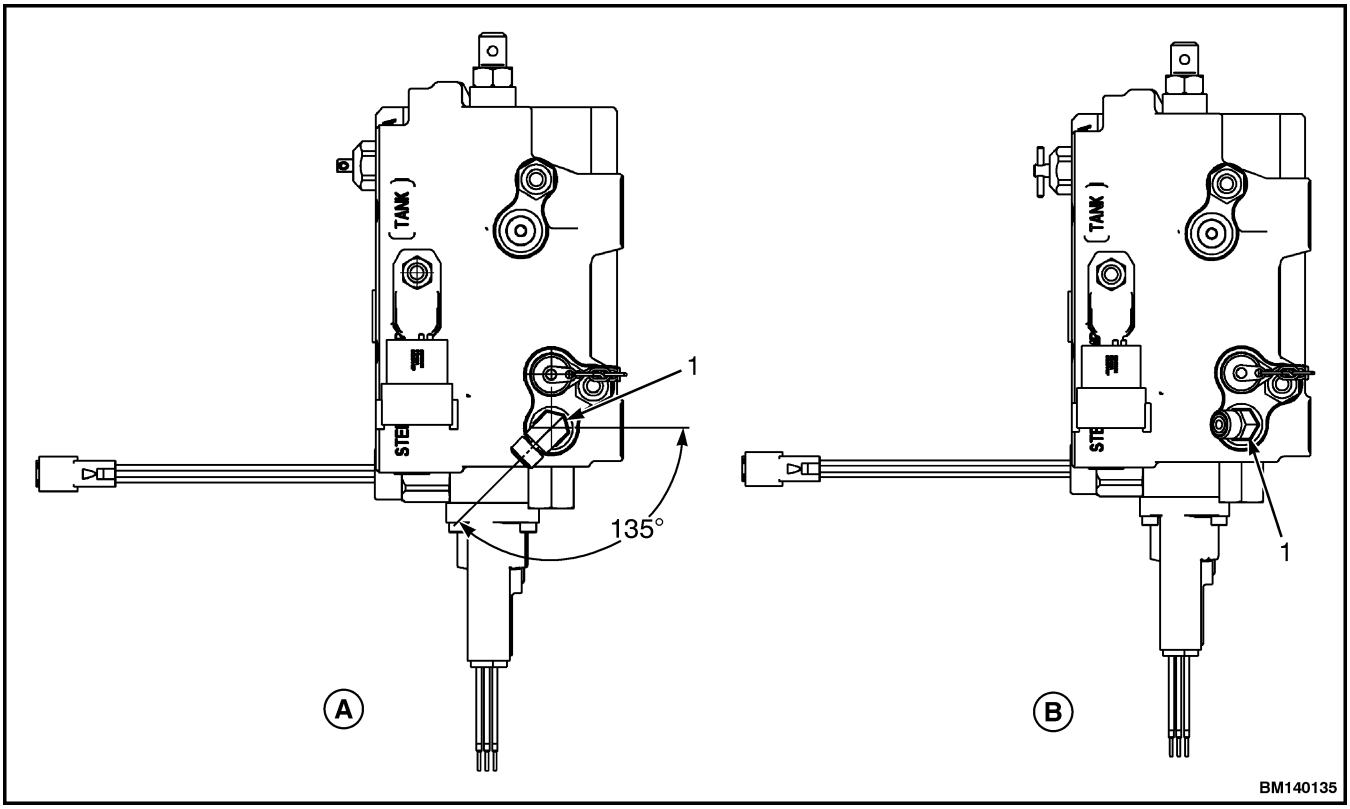
1. INLET SECTION
2. AUXILIARY FITTING
3. TILT LINE FITTING
4. RETURN LINE FITTING
5. PRESSURE LINE FITTING

B. 4-FUNCTION MANUAL CONTROL VALVE

6. STEER RETURN FITTING
7. PLUG
8. BRAKE SUPPLY FITTING
9. HOIST LINE FITTING
10. STEER SUPPLY FITTING

Figure 93. Fitting Orientation 1

22. Install new O-ring onto steer load sense fitting. Install steer load sense fitting into inlet section as noted during disassembly. See Figure 93 and Figure 94. Tighten steer load sense fitting to 16 N•m (142 lbf in).



A. 90° ADAPTER

B. 45° ADAPTER

1. STEER LOAD SENSE FITTING

Figure 94. Fitting Orientation 2

ASSEMBLE HANDLES AND LEVERS

NOTE: If levers and handles have been disassembled, perform Step 2 through Step 4 for aux handle with dual function for lift trucks equipped with clamping function; perform Step 5 and Step 6 for lift, tilt, aux 1, and aux 2 handles; perform Step 7 through Step 13 for lift/lower with Direction Control Switch (DCS) handles.

NOTE: Table 6 indicates installed handle positions. Optional handles and levers are described in Step 2 through Step 4 and Step 7 through Step 13.

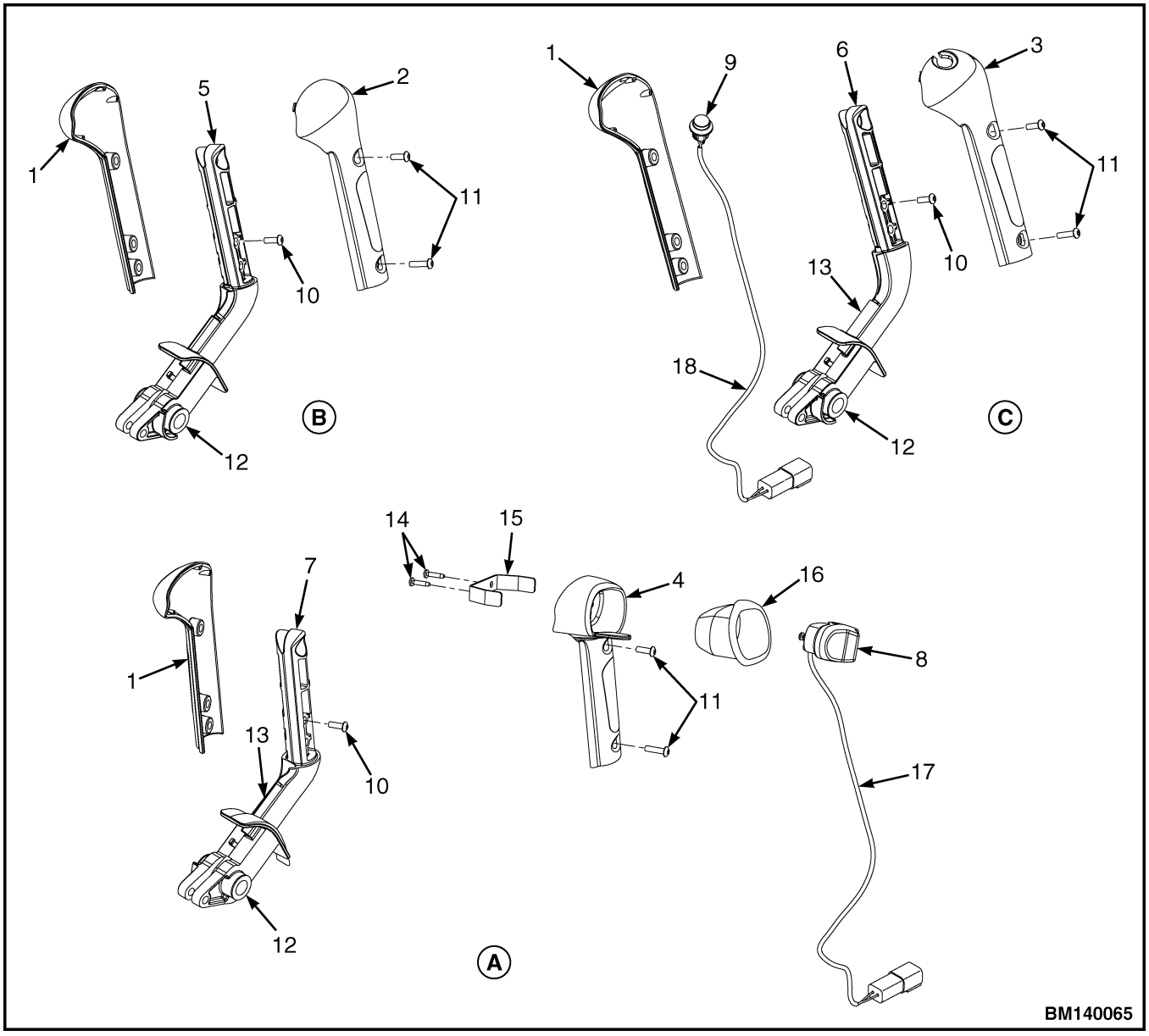
1. Install bushings into levers. See Figure 95.
2. Route push-button cable through cable track on manual aux 2 lever. See Figure 95.
3. Install palm side handle and one inner capscrew on manual aux 2 lever. See Figure 95.

NOTE: Ensure clamping push-button is in correction position on clamp switch handle during assembly.

4. Install clamp switch handle and two outer capscrews on manual aux 2 lever. See Figure 95. Tighten outer capscrews to 1.35 to 1.65 N•m (11.9 to 14.6 lbf in).
5. Install palm side handle and one inner capscrew on manual tilt or aux 1 lever. See Figure 95.
6. Install finger side handle and two outer capscrews on manual tilt or aux 1 lever. See Figure 95. Tighten outer capscrews to 1.35 to 1.65 N•m (11.9 to 14.6 lbf in).
7. Install directional control switch into DCS cup. See Figure 95.
8. Install DCS cup and directional control switch into lift/lower with dcs handle. See Figure 96 and Figure 69.
9. Install DCS retainer onto back side of DCS cup, inside lift/lower with dcs handle. See Figure 95 and Figure 96.
10. Install two screws through retainer and DCS cup into directional control switch. See Figure 95 and Figure 96.
11. Route DCS cable through cable track on manual lift/lower lever. See Figure 95.
12. Install palm side handle and one capscrew on manual lift/lower lever. See Figure 95.
13. Install lift/lower with dcs handle and two outer capscrews on manual lift/lower lever. See Figure 95. Tighten outer capscrews to 1.35 to 1.65 N•m (11.9 to 14.6 lbf in).

Table 6. Handle Options

3-Function		4-Function	
Handle Position	**Option**	**Handle Position**	**Option**
1	None	1	None
1	Lift/lower with DCS	1	Lift/lower with DCS
3	None	4	None
3	Aux with dual function	4	Aux with dual function



A. LIFT/LOWER WITH DCS
B. LIFT, TILT, AUX 1, AUX 2
C. AUX HANDLE WITH DUAL FUNCTION

1. PALM SIDE GRIP HANDLE
2. FINGER SIDE HANDLE
3. CLAMP SWITCH HANDLE
4. LIFT/LOWER WITH DCS HANDLE
5. MANUAL TILT OR AUX 1 LEVER
6. MANUAL AUX 2 LEVER
7. MANUAL LIFT/LOWER LEVER
8. DIRECTIONAL CONTROL SWITCH (DCS)
9. CLAMPING PUSH-BUTTON
10. INNER CAPSCREW
11. OUTER CAPSCREW
12. BUSHING
13. CABLE TRACK
14. SCREW
15. DCS RETAINER
16. DCS CUP
17. DCS CABLE
18. PUSH-BUTTON CABLE

Figure 95. Manual Hydraulic Control Handles

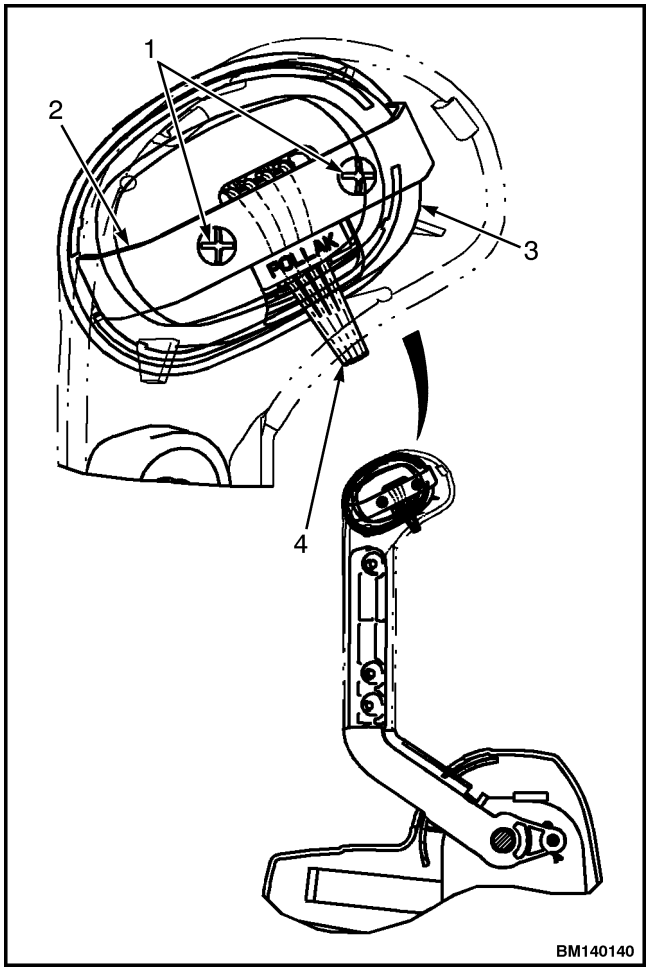


Figure 96. Directional Control Switch

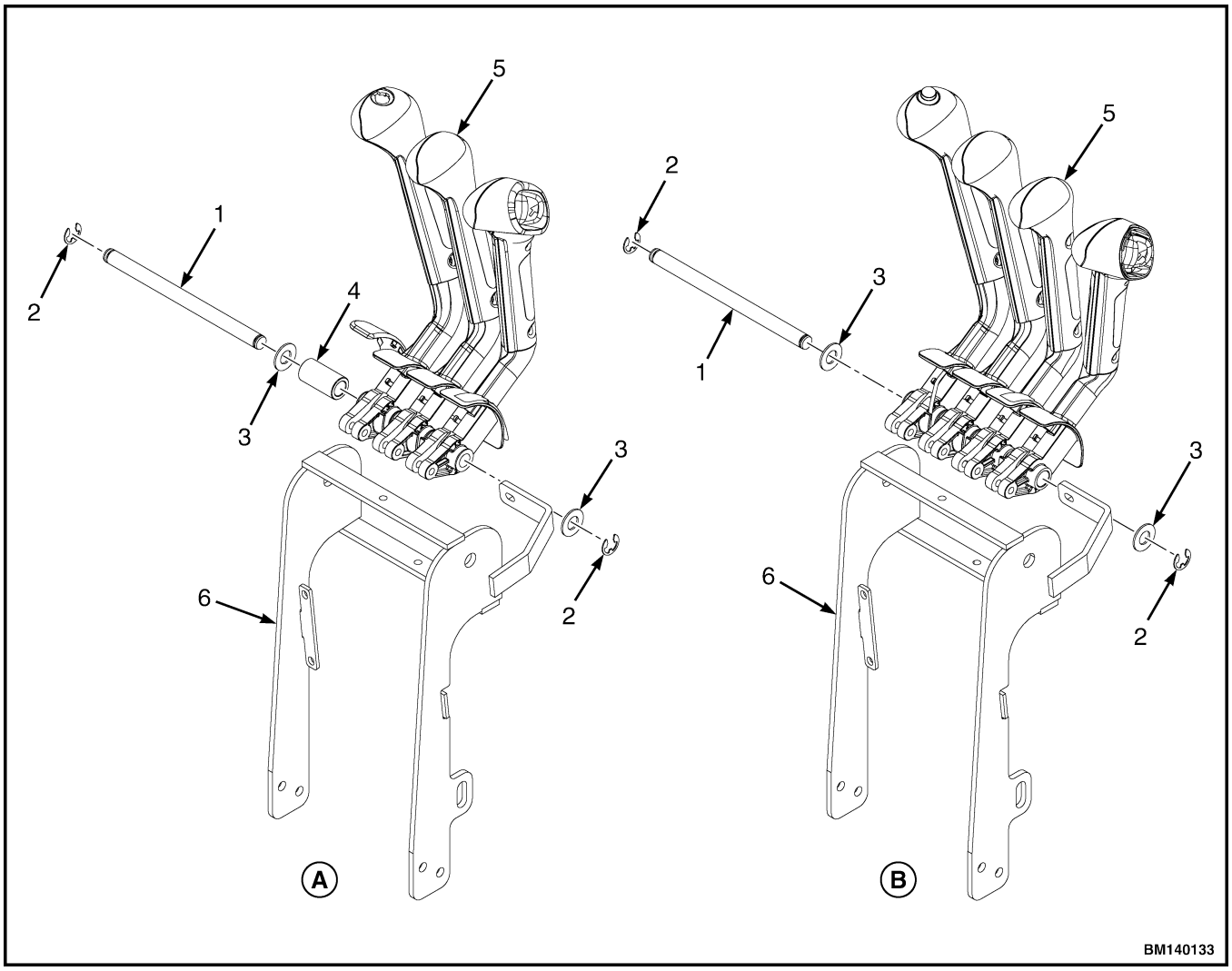
Legend for Figure 96

1. SCREW
2. DCS RETAINER
3. DCS CUP
4. DCS CABLE

INSTALL

Install Control Valve

STEP 1.
Slide pivot pin through side of upper bracket. Install one nylon washer, lever spacer if required, levers, and one nylon washer. Slide pivot pin out the other side of upper bracket. Install e-clip onto each end of pivot pin holding levers to upper bracket.



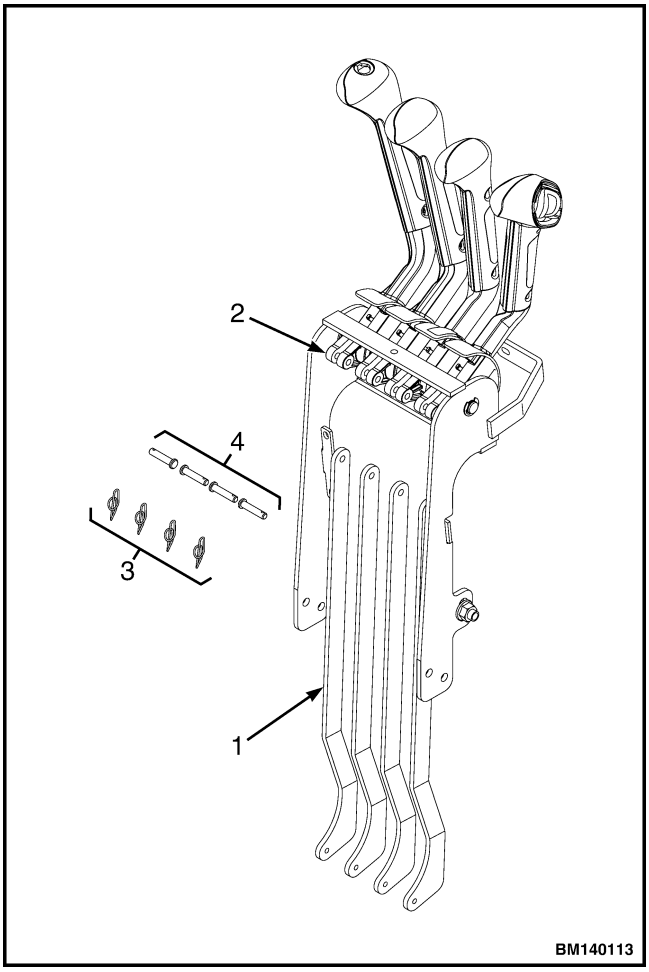
A. 3-FUNCTION LEVERS

1. PIVOT PIN
2. E-CLIP
3. NYLON WASHER

B. 4-FUNCTION LEVERS

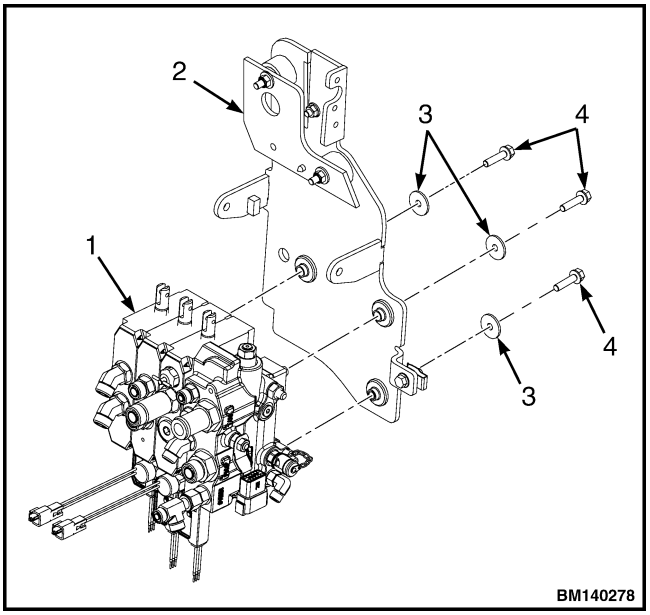
4. LEVER SPACER
5. LEVER
6. UPPER BRACKET

STEP 2.
While holding link in lever slot, install clevis pin through lever and link, then install new locking ring cotter pin through clevis pin. Repeat for all links.



1. LINK
2. LEVER
3. LOCKING RING COTTER PIN
4. CLEVIS PIN

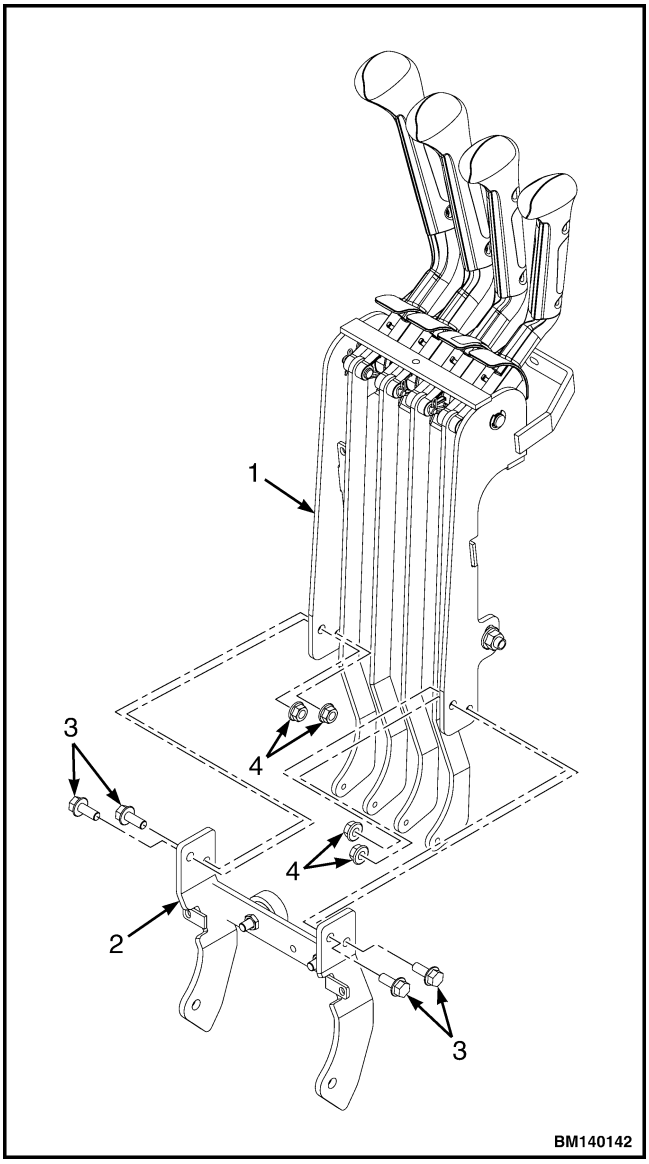
STEP 3.
Install manual control valve, three special washers, and three capscrews onto mounting bracket.



NOTE: CONTROL VALVE MANUFACTURED BEFORE OCTOBER, 2012 SHOWN.

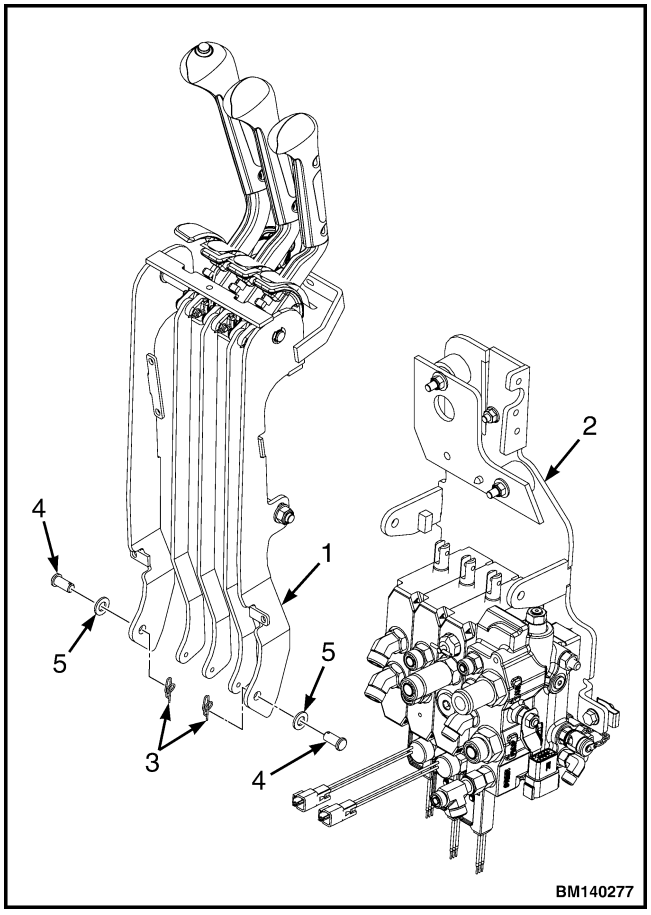
1. MANUAL CONTROL VALVE
2. MOUNTING BRACKET
3. SPECIAL WASHER
4. CAPSCREW

STEP 4.
Install lower bracket, four capscrews, and four nuts onto upper bracket.



1. UPPER BRACKET
2. LOWER BRACKET
3. CAPSCREW
4. NUT

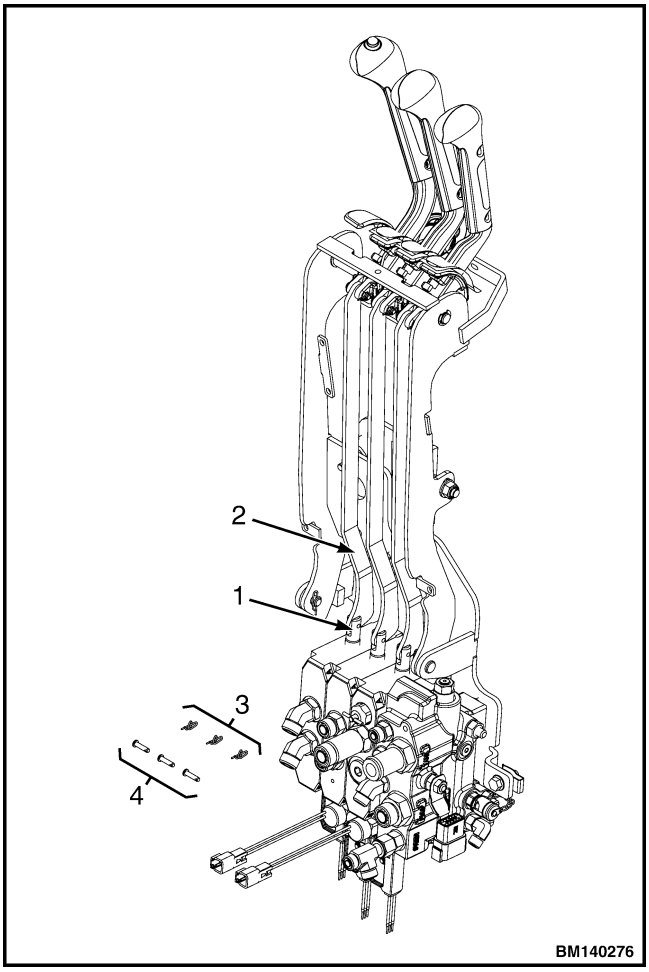
STEP 5.
Install mounting bracket, two nylon washers, two rod end pins, and two locking ring cotter pins onto lower bracket.



NOTE: CONTROL VALVE MANUFACTURED BEFORE OCTOBER, 2012 SHOWN.

1. LOWER BRACKET
2. MOUNTING BRACKET
3. LOCKING RING COTTER PIN
4. ROD END PIN
5. NYLON WASHER

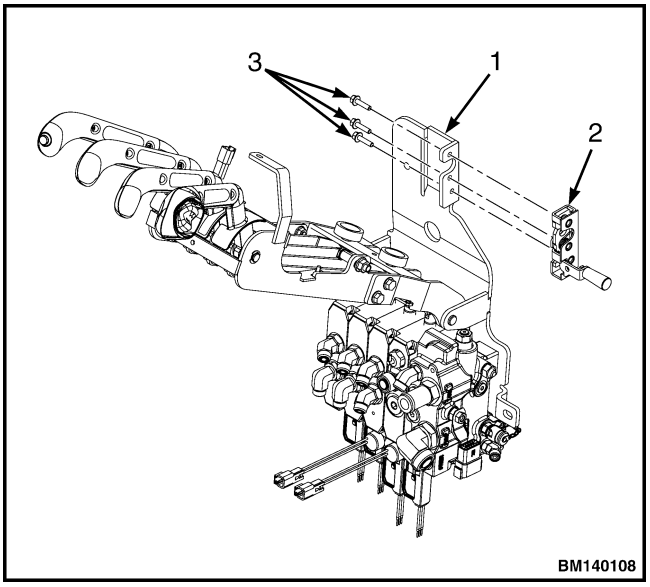
STEP 6.
Install links, rod end pins, and locking ring cotter pins into clevis' at top of manual control valve sections.



NOTE: CONTROL VALVE MANUFACTURED BEFORE OCTOBER, 2012 SHOWN.

1. CLEVIS
2. LINK
3. LOCKING RING COTTER PIN
4. ROD END PIN

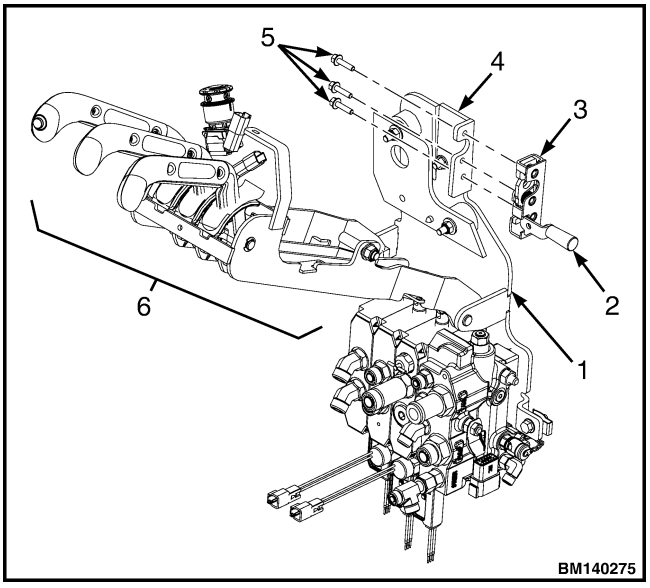
STEP 7.
Install latch assembly and three capscrews onto mounting bracket.



NOTE: CONTROL VALVE MANUFACTURED BEFORE OCTOBER, 2012 SHOWN.

1. MOUNTING BRACKET
2. LATCH ASSEMBLY
3. CAPSCREW

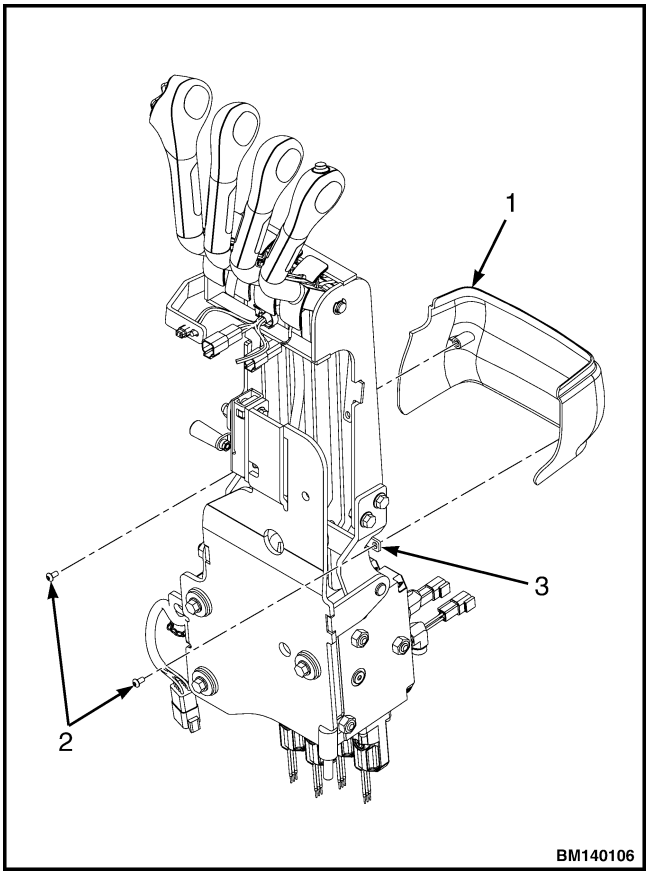
STEP 8.
Raise hydraulic linkage and handles upright against mounting bracket. Ensure latch handle fastens securely.



NOTE: CONTROL VALVE MANUFACTURED BEFORE OCTOBER, 2012 SHOWN.

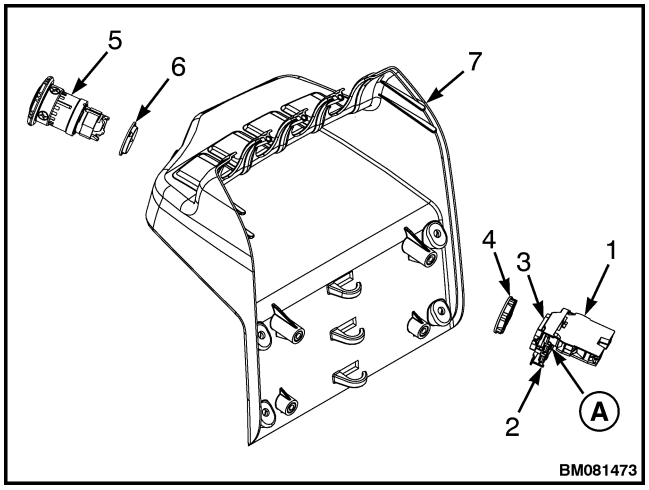
1. CONTROL VALVE MOUNTING PLATE
2. LATCH HANDLE
3. LATCH ASSEMBLY
4. LATCH ASSEMBLY MOUNTING PLATE
5. CAPSCREW
6. HYDRAULIC LINKAGE AND HANDLES

STEP 9.
Install lower cover and two button-head capscrews onto lower bracket. Tighten capscrews to 2.82 to 3.16 N•m (24.95 to 27.97 lbf in).



1. LOWER COVER
2. BUTTON-HEAD CAPSCREW
3. LOWER BRACKET

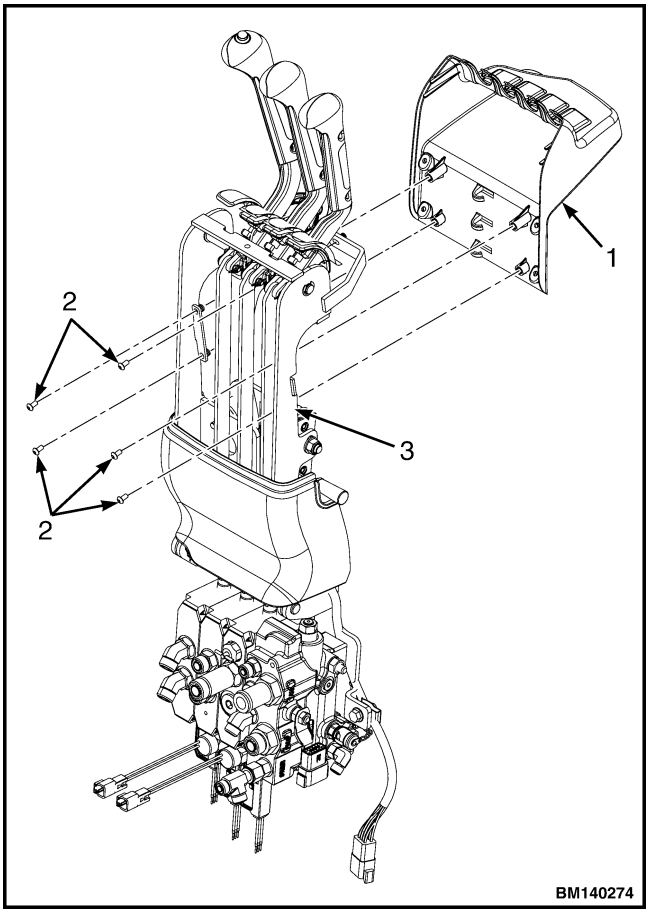
STEP 10.
Install emergency disconnect switch into rear cover. See **Electrical System** 2200SRM1369 for procedures.



A. INSERT SCREWDRIVER HERE

1. SWITCH
2. SWITCH ADAPTER
3. LOCK
4. NUT
5. EMERGENCY DISCONNECT BUTTON
6. BUSHING
7. UPPER REAR COVER HOLE

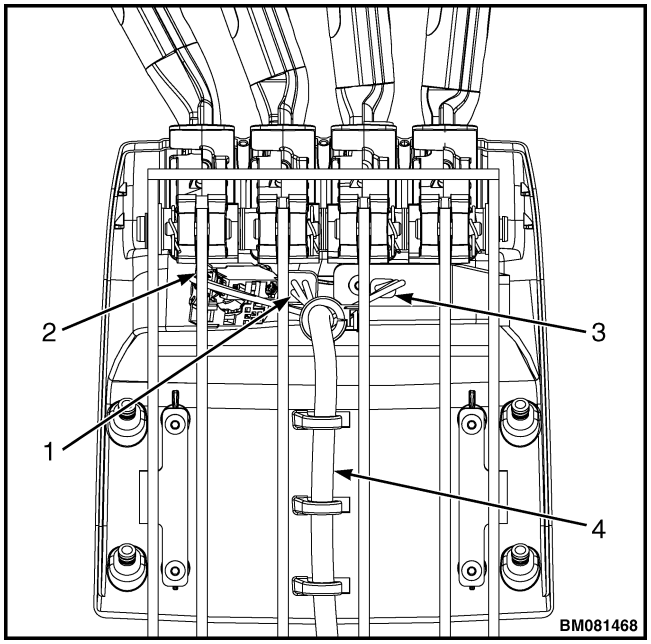
STEP 11.
Install rear cover and five button-head capscrews onto upper bracket. Tighten capscrews to 1.35 to 1.65 N•m (11.95 to 14.60 lbf in).



NOTE: CONTROL VALVE MANUFACTURED BEFORE OCTOBER, 2012 SHOWN.

1. REAR COVER
2. BUTTON-HEAD CAPSCREW
3. UPPER BRACKET

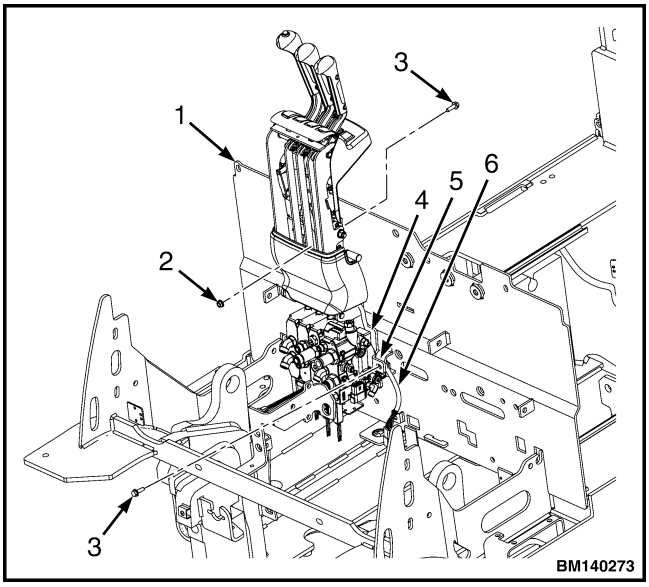
STEP 12.
Connect manual hydraulic wire harness to direction control switch connector, emergency disconnect switch connector, and clamp button connector.



1. CLAMP BUTTON CONNECTOR
2. EMERGENCY DISCONNECT SWITCH CONNECTOR
3. DIRECTION CONTROL SWITCH CONNECTOR
4. MANUAL HYDRAULICS WIRE HARNESS

STEP 13.
Install mounting bracket with attached components onto front bulkhead in lift truck.

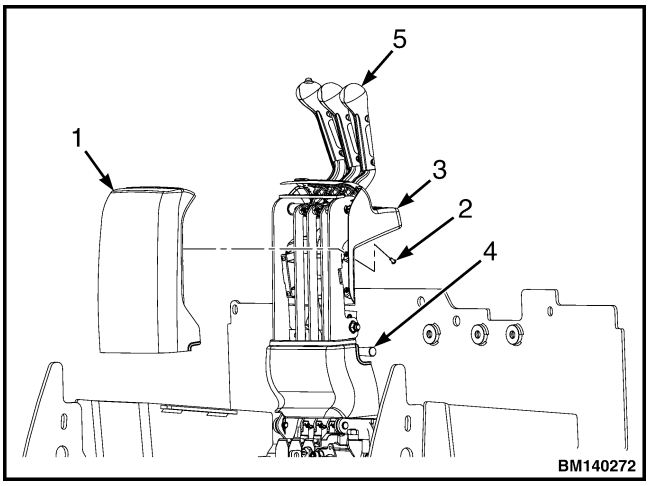
STEP 14.
Install clip nut, capscrews, and nut onto front bulkhead and mounting bracket.



NOTE: CONTROL VALVE MANUFACTURED BEFORE OCTOBER, 2012 SHOWN.

1. FRONT BULKHEAD
2. MOUNTING PLATE
3. NUT
4. CAPSCREW
5. CLIP NUT

STEP 15.
Install upper front cover and four button-head capscrews onto rear cover. Tighten capscrews to 2.82 to 3.16 N•m (24.96 to 27.97 lbf in). Pull manual hydraulic linkage and handles upright and secure with latch handle.



1. UPPER FRONT COVER
2. BUTTON-HEAD CAPSCREW
3. REAR COVER
4. LATCH HANDLE
5. MANUAL HYDRAULIC LINKAGE AND HANDLES

Ending Steps

1. Connect spool lock solenoids to manual hydraulic wire harness. See Figure 70 or Figure 71.
2. Connect position sensor connector to manual hydraulic wire harness. See Figure 70 or Figure 71.

CAUTION

Disposal of lubricants and fluids must meet local environmental regulations.

NOTE: Remove caps from hydraulic hoses and control valve fittings as connections are made.

3. Connect hydraulic hoses to control valve fittings as tagged during removal. Dispose of drain pan contents.
4. Install floor plates and floor mats.
5. Install battery into lift truck. See **How to Change Battery** in **Operating Manual** or **Periodic Maintenance** 8000SRM1577.
6. Turn lift truck **ON**, operate hydraulic functions, then check for leaks.
7. Calibrate manual control valve as outlined in Calibration Procedure .

E-Hydraulic Control Valve Repair for 1.5-2.0T Trucks

REMOVE

WARNING

Before making repairs to the control valve, fully lower all parts of the mast and tilt it fully forward. This action will prevent the mast from lowering suddenly when hydraulic lines are disconnected.

NOTE: Only perform those steps below necessary for required repair or replacement.

1. Lower mast and tilt forward.
2. Remove battery from lift truck. See **How to Change Battery** in **Operating Manual** or

   Periodic Maintenance 8000SRM1339 for lift trucks

   - J1.5-2.0XNT (J30-40XNT) (K160)

   Periodic Maintenance 8000SRM1373 for lift trucks

   - J1.6-2.0XN (J30-40XN) (A935)
3. Discharge capacitors by following steps shown in Discharging the Capacitors in **General** section of this manual.
4. Remove floor mats and floor plates.

WARNING

Hydraulic oil is hot after system operation and can cause burns. DO NOT disconnect any hydraulic hoses until the oil in the system is cool.

NOTE: Tag hydraulic lines during removal to aid in installation.

5. Put a drain pan under the area of the hydraulic control assembly. Disconnect hydraulic lines from E-hydraulic control assembly. Cap hydraulic lines.

NOTE: Note placement and orientation of fittings prior to removal to aid in installation.

NOTE: Note placement of O-rings on fittings prior to removal to aid in installation.

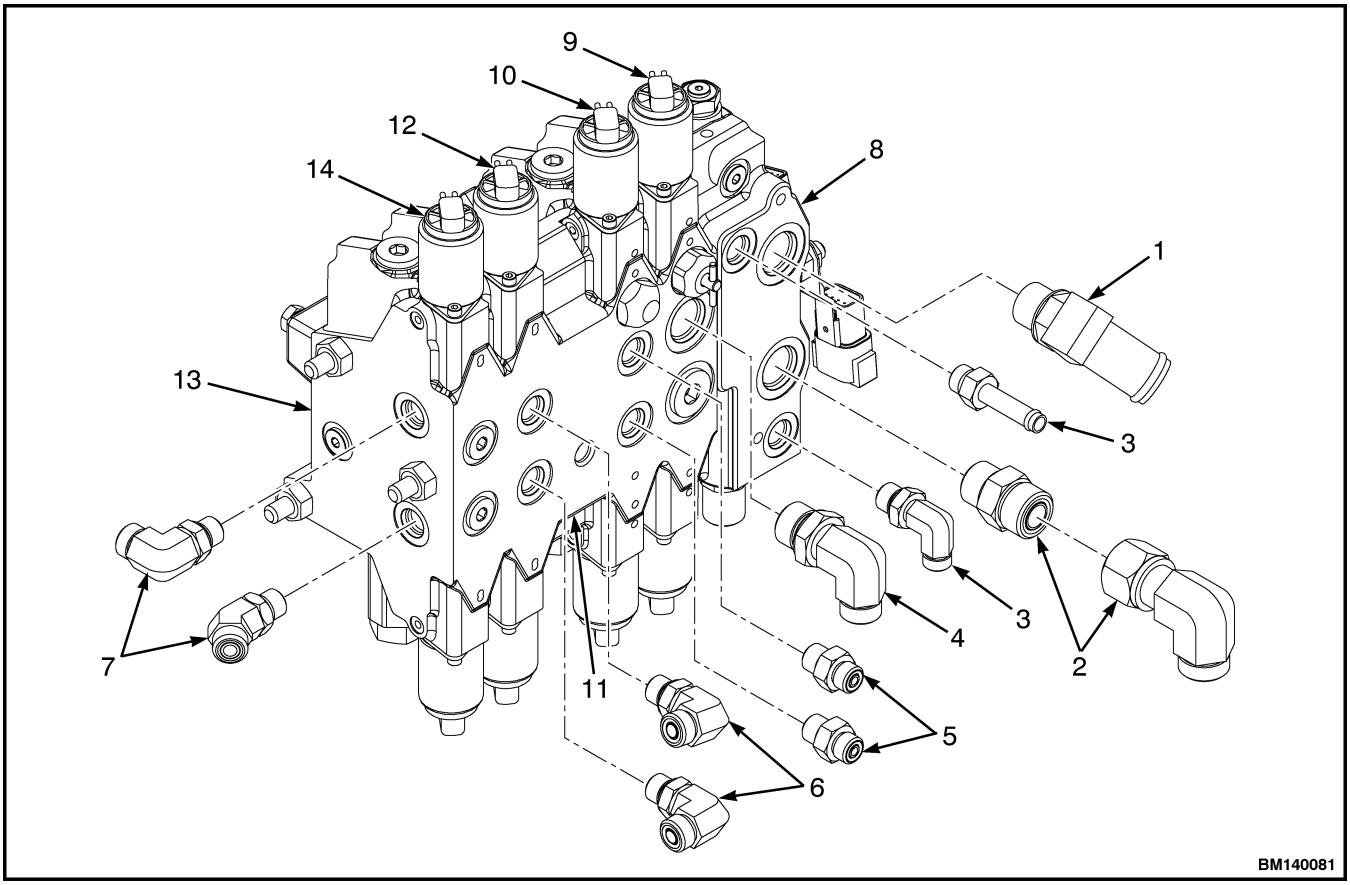
6. Remove fittings from inlet, lift, tilt, and auxiliary section(s). Remove and discard O-rings from fittings.

   See Figure 97 for lift truck models

   - J1.5-2.0XNT (K160) manufactured before November, 2014
   - J30-40XNT (K160) and J1.6-2.0XN (J30-40XN) (A935)

   See Figure 98 for lift truck models

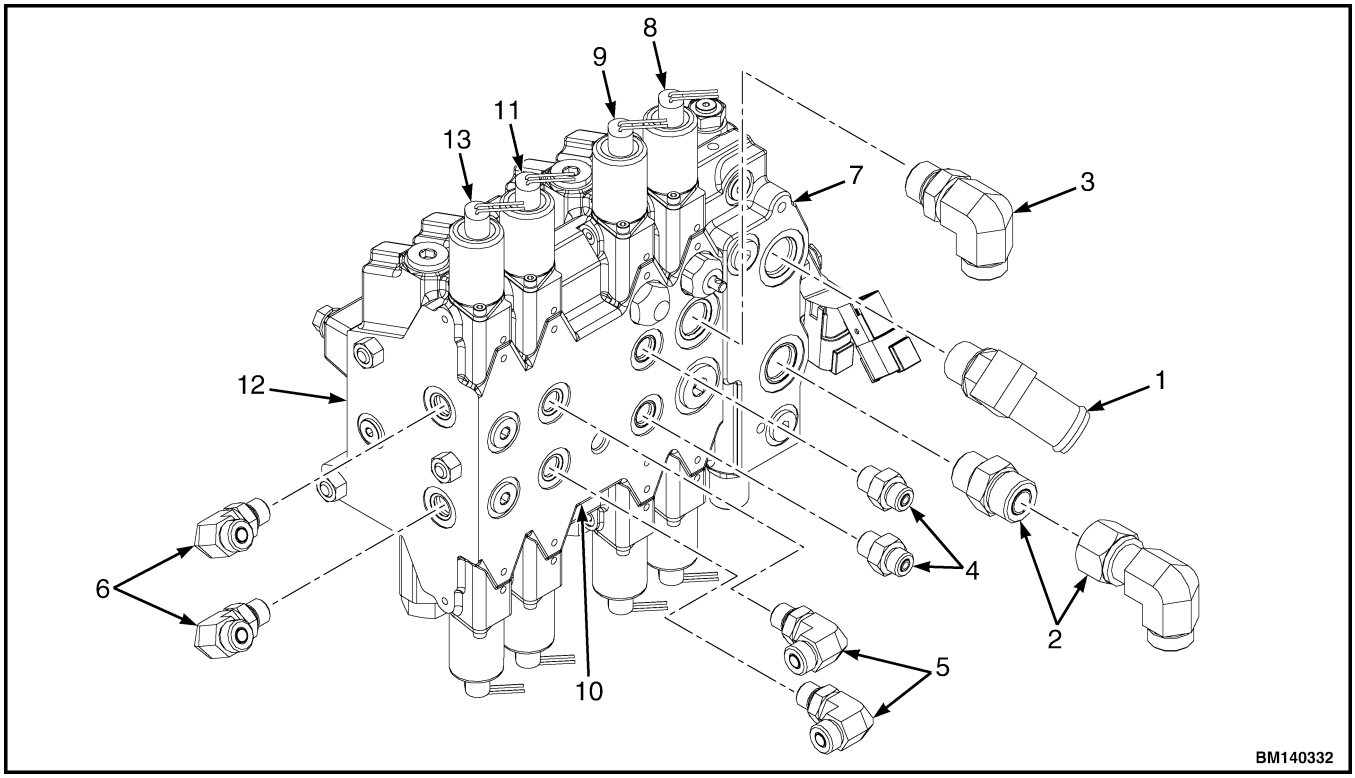
   - J1.5-2.0XNT (K160) manufactured after November, 2014



NOTE: 4-FUNCTION CONTROL VALVE SHOWN.

1. RETURN LINE FITTING
2. INLET FITTING
3. STEER RETURN FITTING
4. LIFT/LOWER FITTING
5. TILT FITTING
6. 3-FUNCTION AUXILIARY FITTING
7. 4-FUNCTION AUXILIARY FITTING
8. INLET SECTION
9. LIFT SECTION
10. TILT SECTION
11. SPACER SECTION
12. FIRST AUXILIARY SECTION (OPTIONAL)
13. OUTLET COVER
14. SECOND AUXILIARY SECTION

Figure 97. E-Hydraulic Control Valve Fittings, Lift Truck Models J1.5-2.0XNT (K160) Manufactured Before November, 2014 and J30-40XNT (K160) and J1.6-2.0XN (J30-40XN) (A935)



NOTE: 4-FUNCTION CONTROL VALVE SHOWN.

1. RETURN LINE FITTING
2. INLET FITTING
3. LIFT/LOWER FITTING
4. TILT FITTING
5. 3-FUNCTION AUXILIARY FITTING
6. 4-FUNCTION AUXILIARY FITTING
7. INLET SECTION
8. LIFT SECTION
9. TILT SECTION
10. SPACER SECTION
11. FIRST AUXILIARY SECTION (OPTIONAL)
12. OUTLET COVER
13. SECOND AUXILIARY SECTION

Figure 98. E-Hydraulic Control Valve Fittings, Lift Truck Models J1.5-2.0XNT (K160) Manufactured After November, 2014

NOTE: Step 7 does not apply to lift truck models J1.5-2.0XNT (K160) manufactured after November, 2014

7. Remove steer load sense fitting from inlet section. See Figure 99.

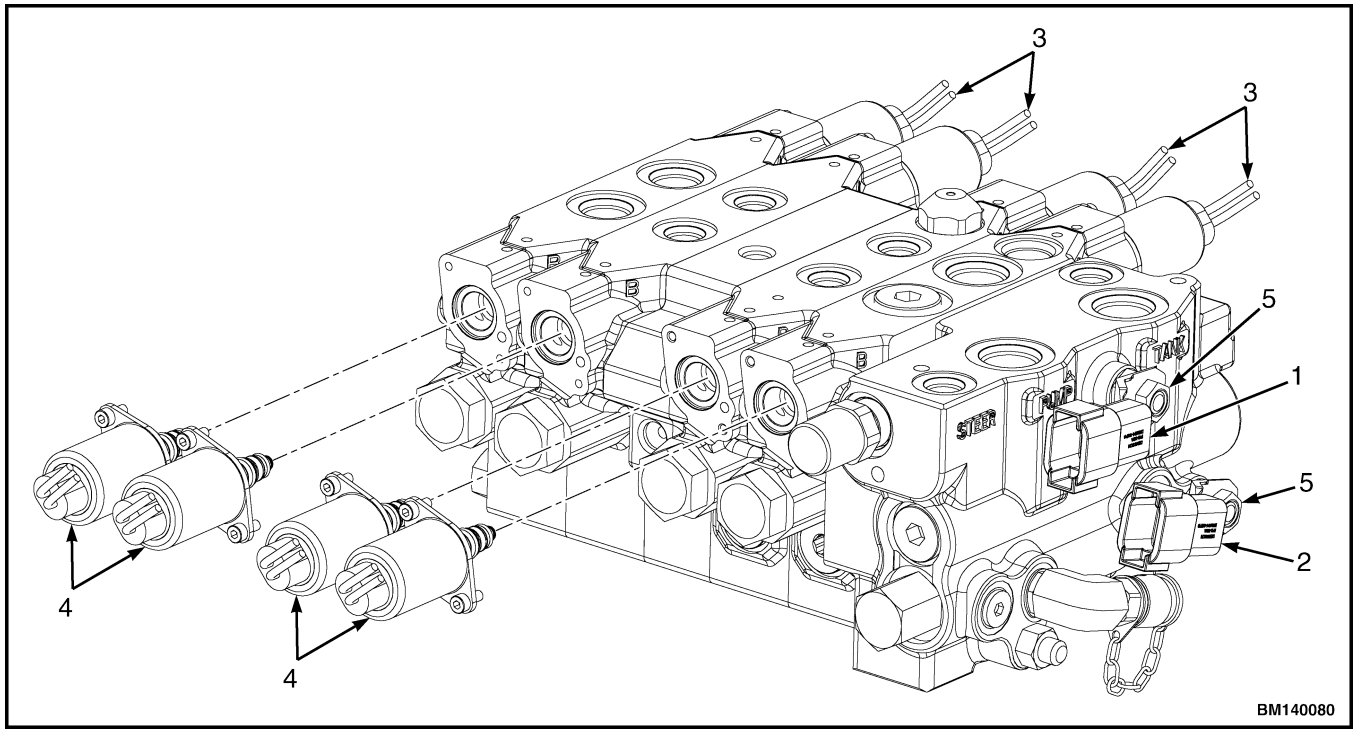
8. Disconnect upper solenoid connector from e-hydraulic main wire harness.

See Figure 99 for lift truck models

- J1.5-2.0XNT (K160) manufactured before November, 2014
- J30-40XNT (K160) and J1.6-2.0XN (J30-40XN) (A935)

See Figure 100 for lift truck models

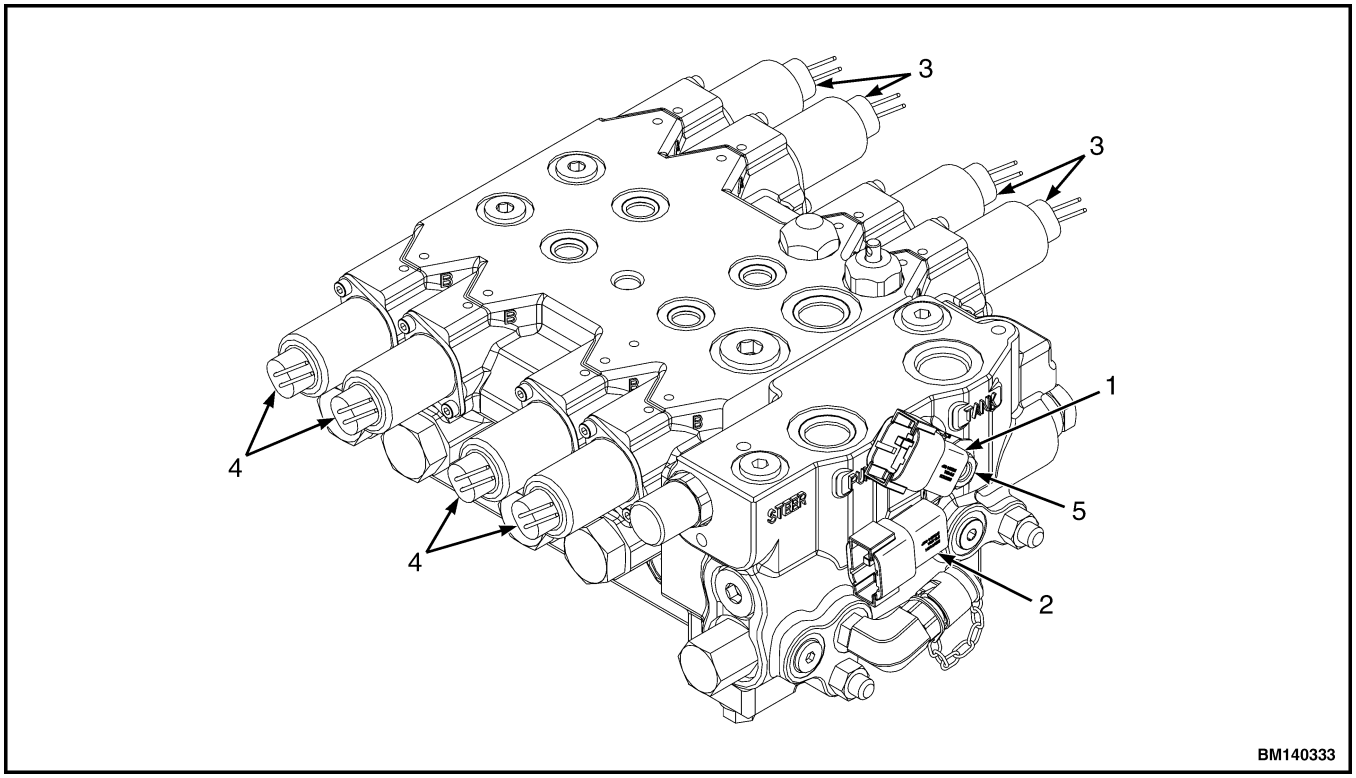
- J1.5-2.0XNT (K160) manufactured after November, 2014



NOTE: 4-FUNCTION E-HYDRAULIC CONTROL VALVE SHOWN.

1. LOWER SOLENOID CONNECTOR
2. UPPER SOLENOID CONNECTOR
3. UPPER SOLENOID WIRE
4. LOWER SOLENOID WIRE
5. JAM NUT
6. STEER LOAD SENSE FITTING

Figure 99. Solenoid Wires and Connectors, Lift Truck Models J1.5-2.0XNT (K160) Manufactured Before November, 2014 and J30-40XNT (K160) and J1.6-2.0XN (J30-40XN) (A935)



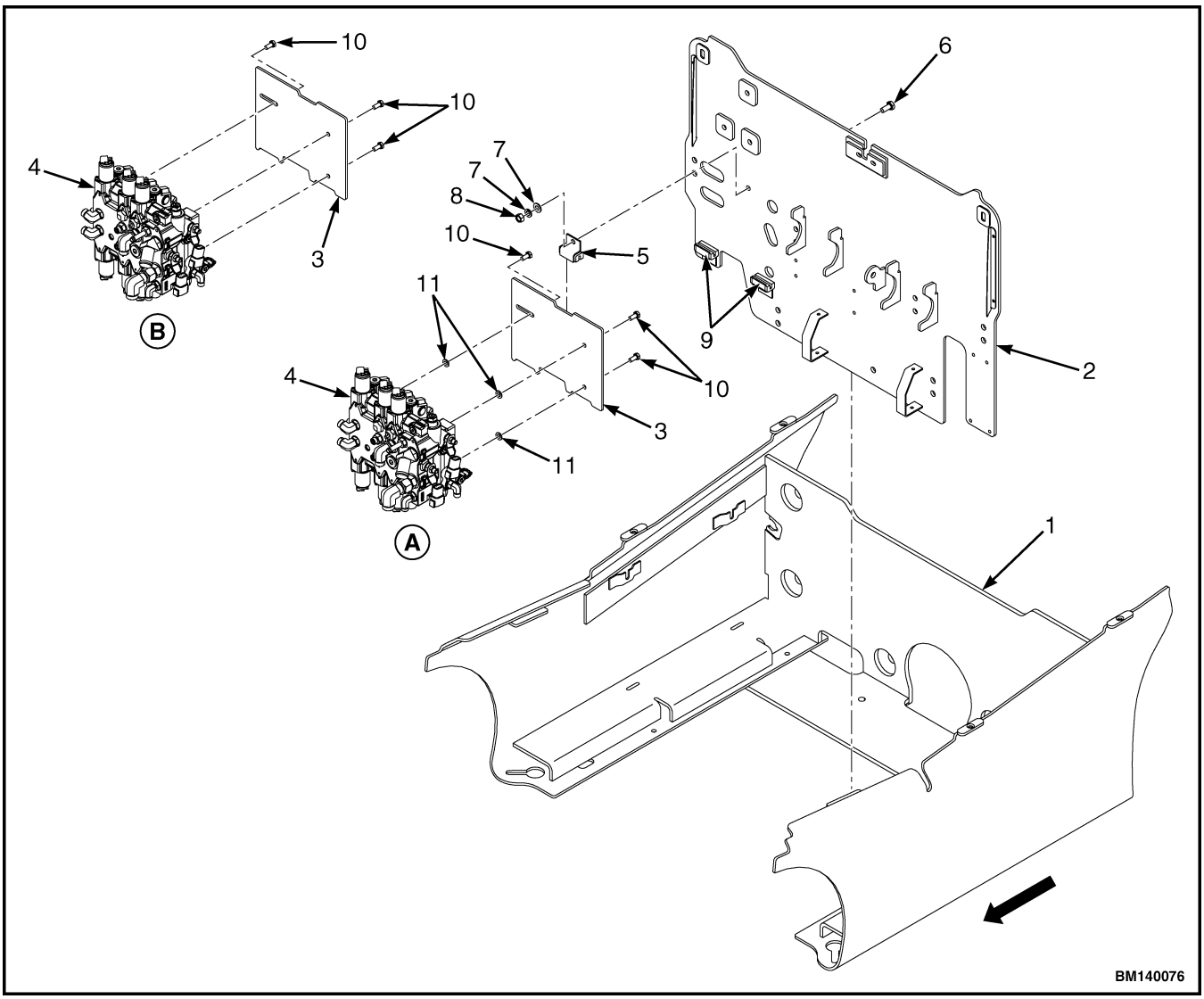
NOTE: 4-FUNCTION E-HYDRAULIC CONTROL VALVE SHOWN.

1. LOWER SOLENOID CONNECTOR
2. UPPER SOLENOID CONNECTOR
3. UPPER SOLENOID WIRE
4. LOWER SOLENOID WIRE
5. JAM NUT

Figure 100. Solenoid Wires and Connectors, Lift Truck Models J1.5-2.0XNT (K160) Manufactured After November, 2014

9. Disconnect lower solenoid connector from e-hydraulic main wire harness.

10. Remove nut, washers, M10 capscrew, and bracket from mounting bracket and front bulkhead. See Figure 101.



NOTE: ARROW POINTING TO FRONT OF LIFT TRUCK.

NOTE: NEWER LIFT TRUCK MODELS DO NOT HAVE WASHERS (ITEM #11) BETWEEN THE MOUNTING BRACKET AND CONTROL VALVE.

A. MOUNTING ARRANGEMENT, OLDER LIFT TRUCK MODELS

B. MOUNTING ARRANGEMENT, NEWER LIFT TRUCK MODELS

1. FRAME
2. FRONT BULKHEAD
3. MOUNTING BRACKET
4. E-HYDRAULIC CONTROL VALVE
5. BRACKET
6. M10 CAPSCREW
7. WASHER
8. NUT
9. HOLDING BRACKET
10. M8 CAPSCREW
11. WASHER

Figure 101. E-Hydraulic Control Valve Mounting

11. Lift mounting bracket, with E-hydraulic control valve attached, up and out of holding brackets on front bulkhead. See Figure 101.

NOTE: Newer lift truck models do not have washers (11, Figure 101) between the mounting bracket and control valve)

12. Remove three M8 capscrews, mounting bracket, and three washers from E-hydraulic control valve. See Figure 101.

NOTE: Tag solenoid wires during removal to aid in installation.

13. Disconnect upper solenoid wires from upper solenoid connector.

See Figure 99 for lift truck models

- J1.5-2.0XNT (K160) manufactured before November, 2014
- J30-40XNT (K160) and J1.6-2.0XN (J30-40XN) (A935)

See Figure 100 for lift truck models

- J1.5-2.0XNT (K160) manufactured after November, 2014

14. Disconnect lower solenoid wires from lower solenoid connector.

DISASSEMBLE

NOTE: Disassemble the e-hydraulic control valve only as necessary for repairs. Most repairs to the e-hydraulic control valve will be to replace O-rings and seals. Spools and valve sections are not serviceable individually and must be replaced as a complete valve section with spool.

NOTE: The 3-function E-hydraulic control valve is not equipped with a first auxiliary section.

1. Remove lower solenoid assemblies from the lift, tilt, and auxiliary sections.

See Figure 102 for lift truck models

- J1.5-2.0XNT (K160) manufactured before November, 2014
- J30-40XNT (K160) and J1.6-2.0XN (J30-40XN) (A935)

See Figure 103 for lift truck models

- J1.5-2.0XNT (K160) manufactured after November, 2014

2. Remove upper solenoid assembly from lift, tilt, and auxiliary sections.

3. Remove nuts from tie rods on outlet side of E-hydraulic control valve. See Figure 104 and Figure 105.

4. Remove outlet cover from tie rods and second auxiliary section.

5. Remove each section from tie rods and adjacent section starting with the second auxiliary section, followed by the first auxiliary section if present, the spacer section if present, the tilt section, and the lift section. See Figure 107 for example.

NOTE: Note placement of jam nuts and solenoid connectors on tie rods prior to removal to aid in installation.

6. Remove two jam nuts, upper solenoid connector, and lower solenoid connector from tie rods and inlet section.

See Figure 99 and Figure 104 for lift truck models

- J1.5-2.0XNT (K160) manufactured before November, 2014
- J30-40XNT (K160) and J1.6-2.0XN (J30-40XN) (A935)

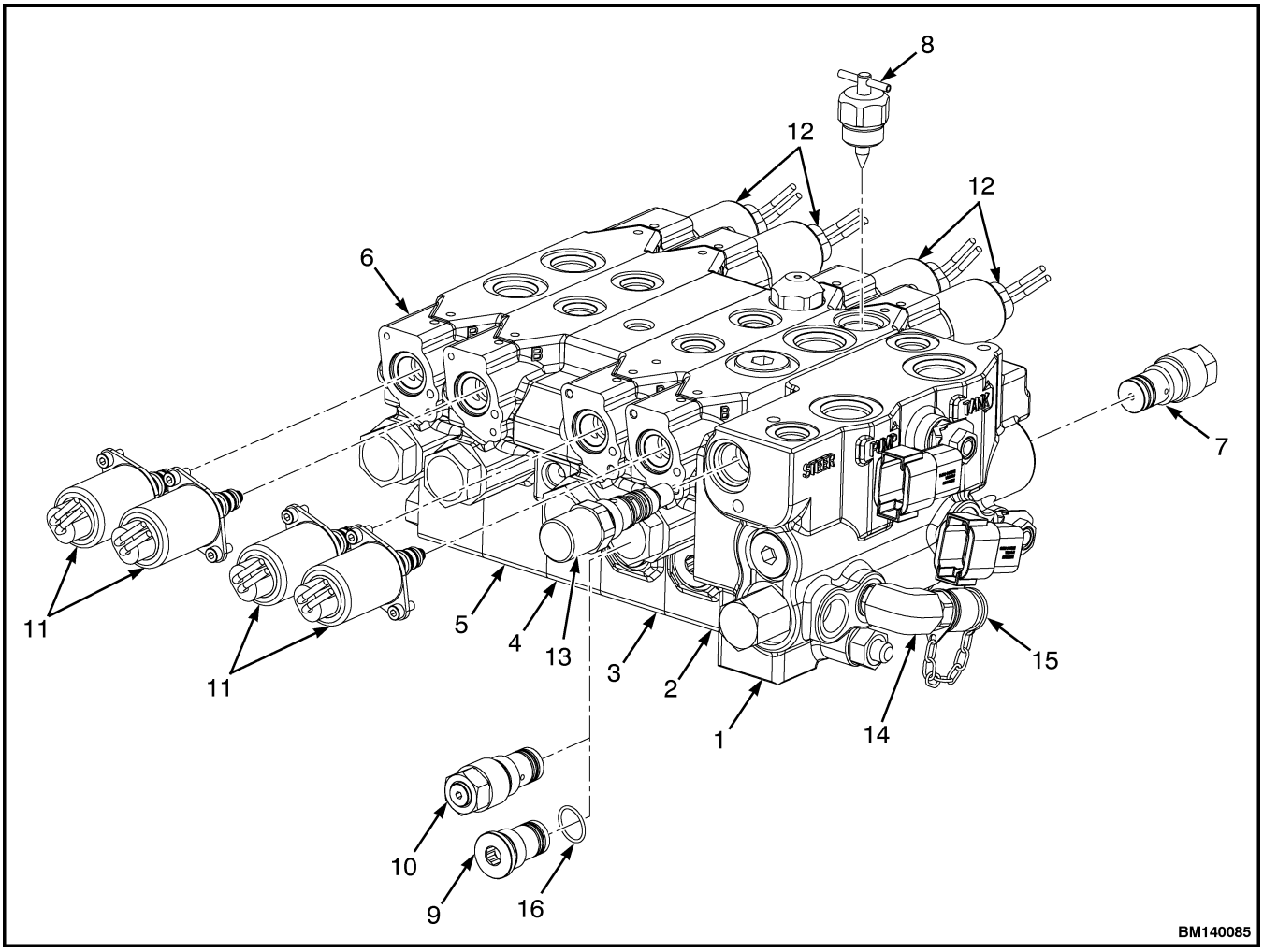
See Figure 100 and Figure 104 for lift truck models

- J1.5-2.0XNT (K160) manufactured after November, 2014

7. Remove tie rods from inlet section. See Figure 105.

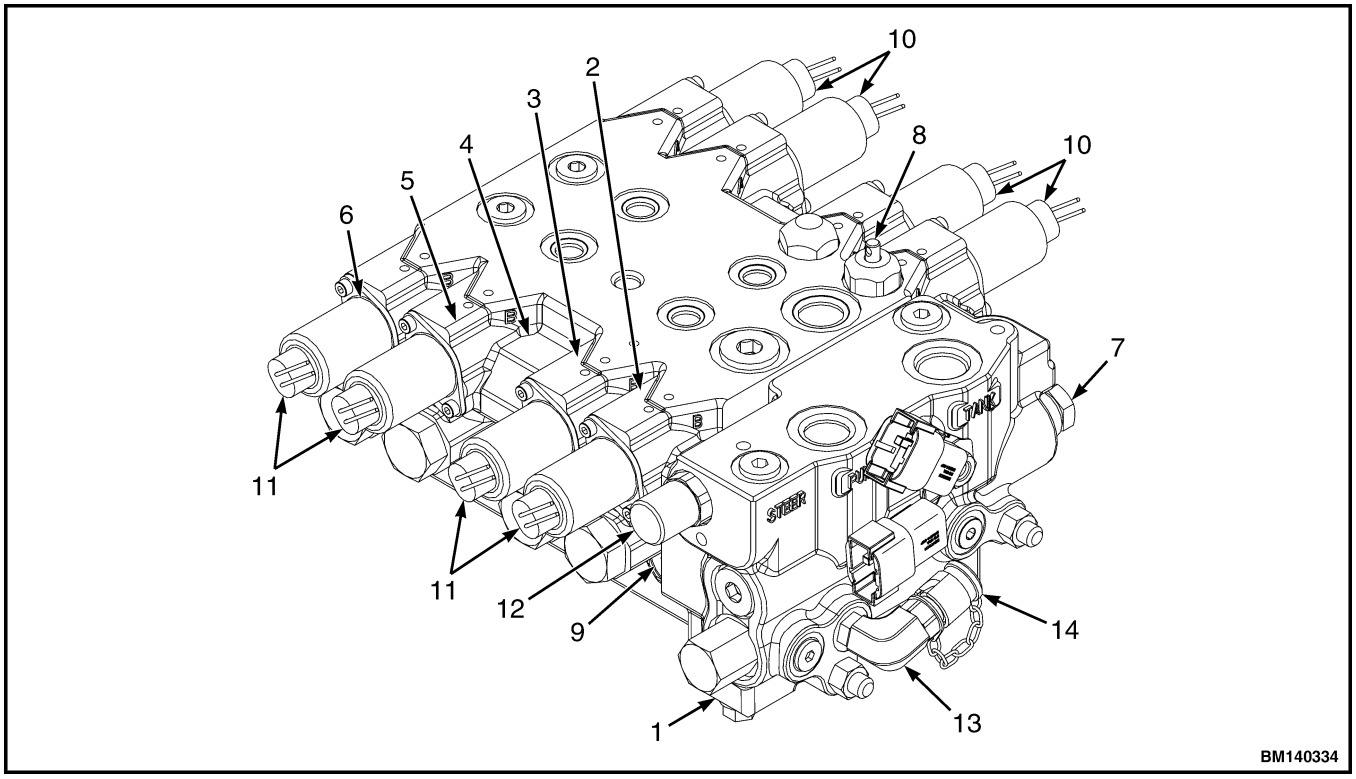
NOTE: Note placement of section seals in retaining grooves prior to removal to aid in installation.

8. Remove and discard section seals from retaining grooves of all sections. See Figure 108 and Figure 109.



1. INLET SECTION
2. LIFT SECTION
3. TILT SECTION
4. SPACER SECTION (OPTIONAL)
5. FIRST AUXILIARY SECTION (OPTIONAL)
6. SECOND AUXILIARY SECTION
7. PRIMARY RELIEF VALVE
8. MANUAL LOWERING VALVE
9. COMPENSATOR PLUG
10. OPTIONAL SECONDARY RELIEF VALVE
11. LOWER SOLENOID ASSEMBLY
12. UPPER SOLENOID ASSEMBLY
13. PILOT CARTRIDGE
14. ELBOW FITTING
15. DIAGNOSTIC FITTING (SHOWN IN PUMP PRESSURE GAUGE PORT)
16. O-RING

Figure 102. E-Hydraulic Control Valve, Lift Truck Models J1.5-2.0XNT (K160) Manufactured Before November, 2014 and J30-40XNT (K160) and J1.6-2.0XN (J30-40XN) (A935)



1. INLET SECTION
2. LIFT/LOWER SECTION
3. TILT SECTION
4. SPACER SECTION (OPTIONAL)
5. FIRST AUXILIARY SECTION (OPTIONAL)
6. SECOND AUXILIARY SECTION
7. PRIMARY RELIEF VALVE
8. MANUAL LOWERING VALVE
9. COMPENSATOR PLUG (OPTIONAL) OR OPTIONAL SECONDARY RELIEF VALVE
10. UPPER SOLENOID ASSEMBLY
11. LOWER SOLENOID ASSEMBLY
12. PILOT CARTRIDGE
13. ELBOW FITTING
14. DIAGNOSTIC FITTING (SHOWN IN PUMP PRESSURE GAUGE PORT)

Figure 103. E-Hydraulic Control Valve, Lift Truck Models J1.5-2.0XNT (K160) Manufactured After November, 2014

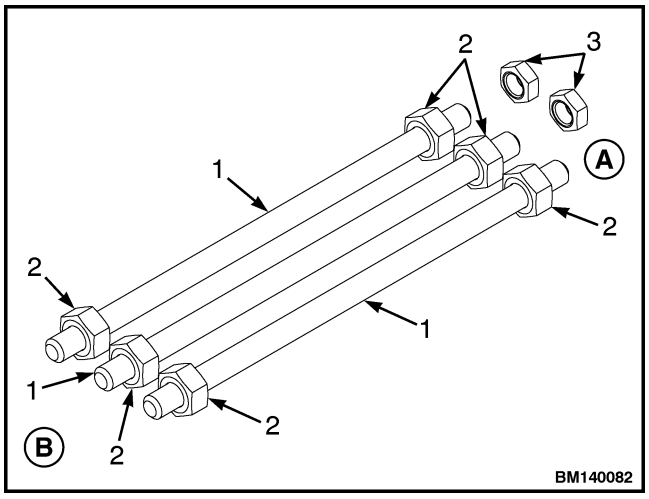
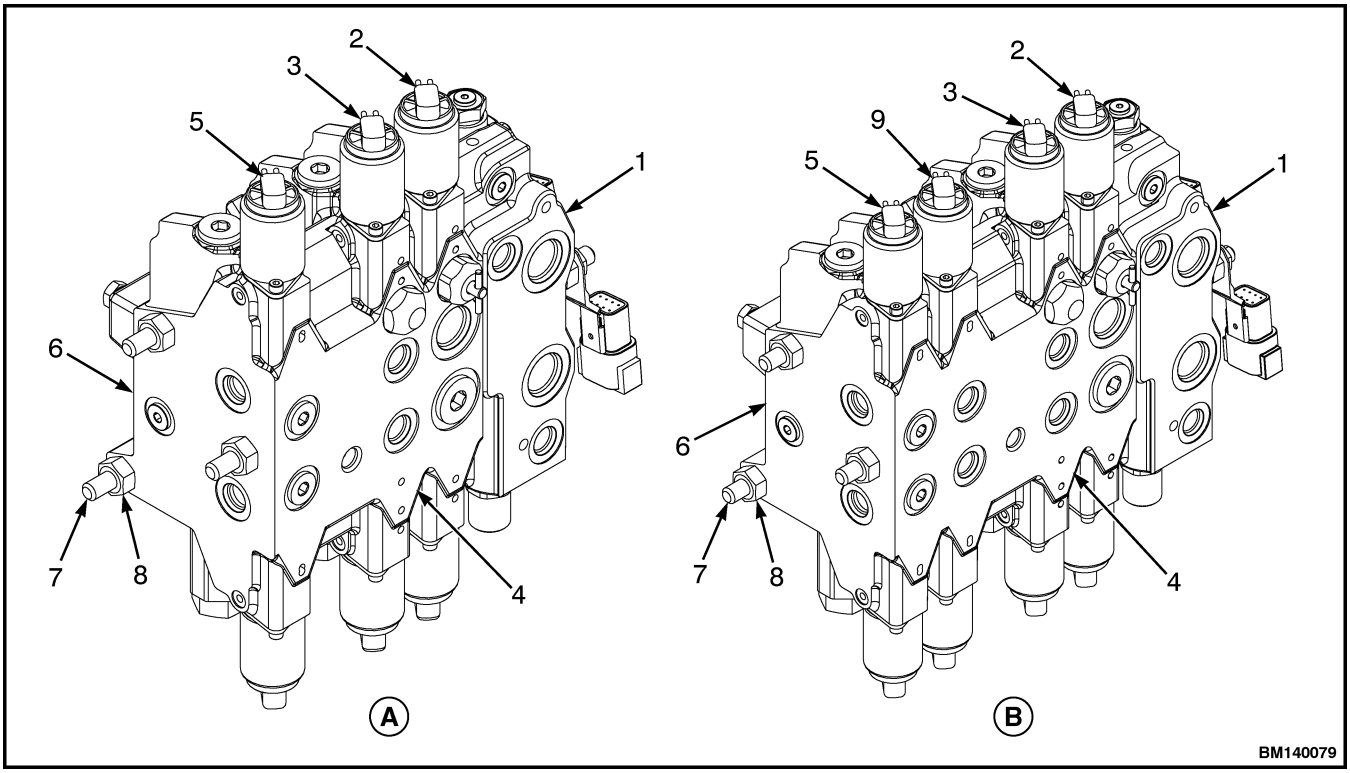


Figure 104. Tie Rods and Nuts for E-Hydraulic Control Valve

Legend for Figure 104

A. INLET SIDE
B. OUTLET SIDE

1. TIE ROD
2. NUT
3. JAM NUT



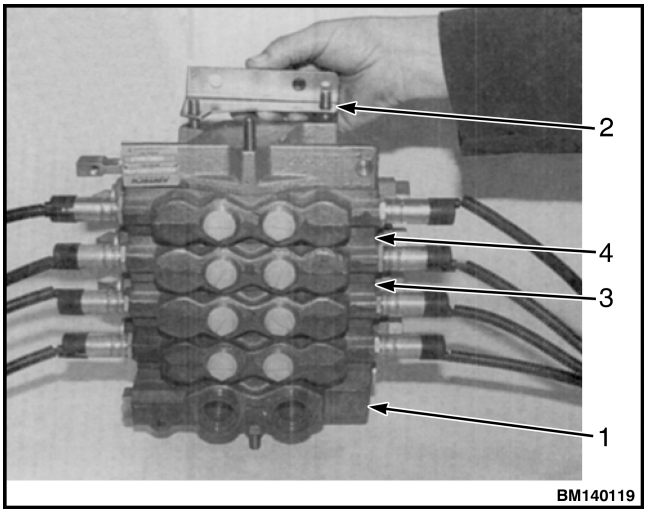
A. 3 FUNCTION CONTROL VALVE

1. INLET SECTION
2. LIFT SECTION
3. TILT SECTION
4. SPACER SECTION
5. SECOND AUXILIARY SECTION

B. 4 FUNCTION CONTROL VALVE

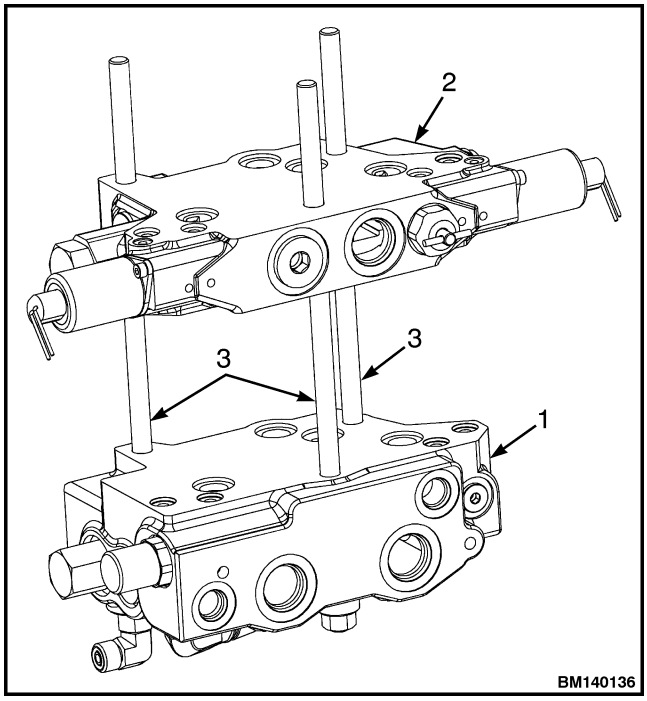
6. OUTLET CAP
7. TIE ROD
8. NUT
9. FIRST AUXILIARY SECTION (OPTIONAL)

Figure 105. E-Hydraulic Control Valve Sections



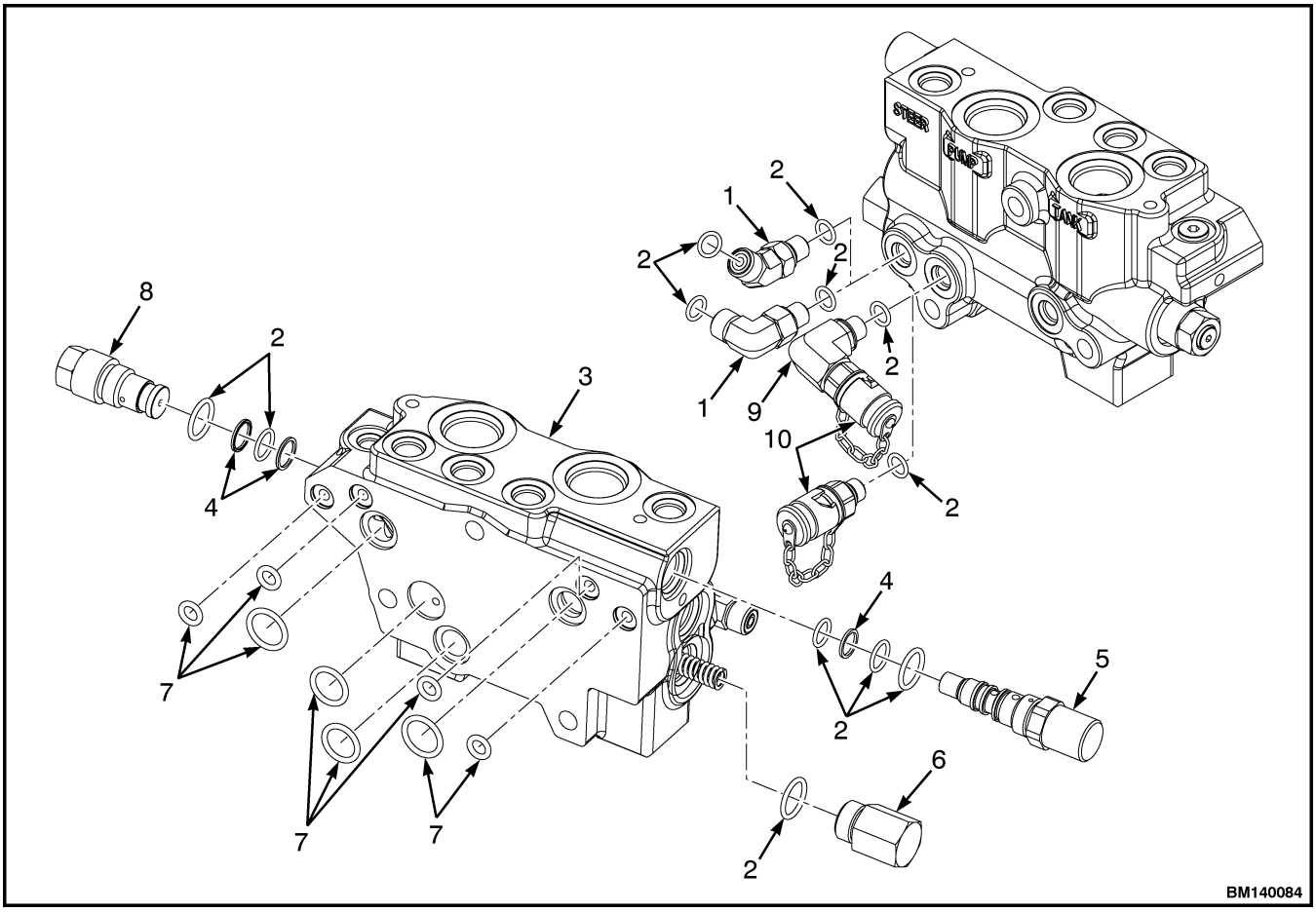
1. INLET SECTION
2. OUTLET COVER
3. FIRST AUXILIARY SECTION (OPTIONAL)
4. SECOND AUXILIARY SECTION

Figure 106. E-Hydraulic Control Valve



1. INLET SECTION
2. LIFT SECTION
3. TIE ROD

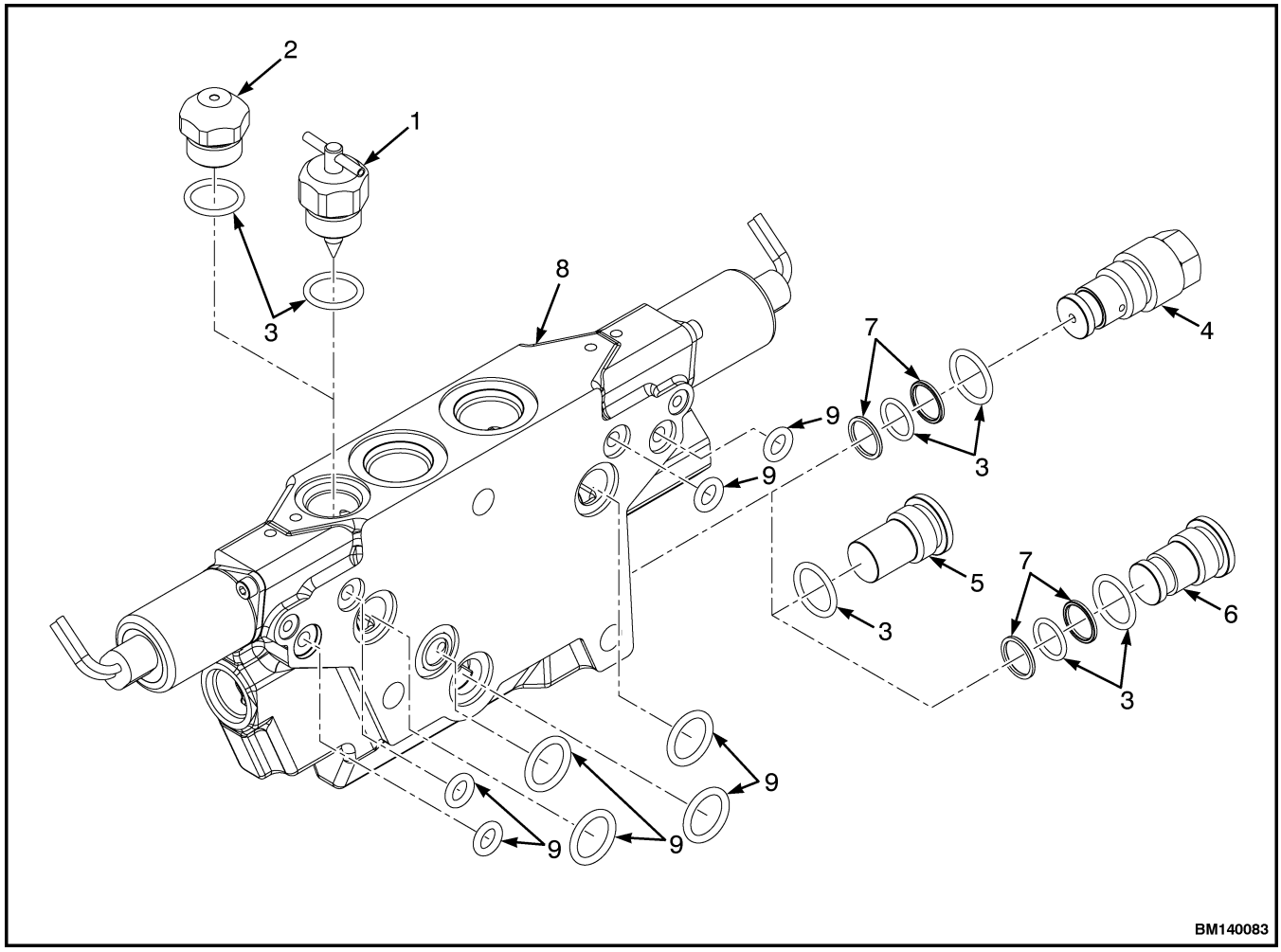
Figure 107. E-Hydraulic Control Valve - Sections and Tie Rods



NOTE: E-HYDRAULIC CONTROL VALVES FOR LIFT TRUCK MODELS J1.5-2.0XNT (K160) MANUFACTURED AFTER NOVEMBER, 2014 DO NOT HAVE A STEER LOAD SENSE FITTING. THIS PART OF THE VALVE IS COVERED WITH A PLUG.

1. STEER LOAD SENSE FITTING
2. O-RING
3. INLET SECTION BODY
4. BACKUP RING
5. PILOT CARTRIDGE
6. COMPENSATOR PLUG
7. SECTION SEAL
8. PRIMARY RELIEF VALVE
9. ELBOW FITTING
10. DIAGNOSTIC FITTING (SHOWN IN PUMP PRESSURE GAUGE PORT)

Figure 108. Inlet Section E-Hydraulic Control Valve



NOTE: SPACER SECTION NOT ILLUSTRATED.

1. MANUAL LOWERING VALVE
2. PORT OPTION PLUG
3. O-RING
4. OPTIONAL SECONDARY RELIEF VALVE
5. LIFT SECTION PLUG
6. TILT SECTION PLUG
7. BACKUP RING
8. LIFT/TILT/AUXILIARY SECTION BODY
9. SECTION SEAL

Figure 109. Lift/Tilt/Auxiliary Sections E-Hydraulic Control Valve

9. Remove pilot cartridge from inlet section. Remove and discard O-rings from pilot cartridge.

See Figure 102 for lift truck models

- J1.5-2.0XNT (K160) manufactured before November, 2014
- J30-40XNT (K160) and J1.6-2.0XN (J30-40XN) (A935)

See Figure 103 for lift truck models

- J1.5-2.0XNT (K160) manufactured after November, 2014

10. Remove primary relief valve from inlet section. Remove and discard O-rings and backup ring from primary relief valve.

11. If required, remove elbow fitting and diagnostic fitting from inlet section. Remove and discard O-ring from elbow fitting.

12. Remove manual lowering valve from lift section. Remove and discard O-ring from manual lowering valve.

13. Remove compensator plug from tilt section. Remove and discard O-ring from compensator plug.

See Figure 102 for lift truck models

- J1.5-2.0XNT (K160) manufactured before November, 2014
- J30-40XNT (K160) and J1.6-2.0XN (J30-40XN) (A935)

See Figure 103 for lift truck models

- J1.5-2.0XNT (K160) manufactured after November, 2014

14. Remove optional secondary relief valve from tilt section. Remove and discard O-rings and backup rings from optional secondary relief valve.

NOTE: Perform the following step if steer load sense fitting has not been removed from inlet section.

15. Remove steer load sense fitting from inlet section. Remove and discard O-rings from steer load sense fitting. See Figure 108.

16. Remove lift section plug from lift section. Remove and discard O-ring from lift section plug. See Figure 109.

NOTE: Perform the following step only if the tilt section plug is installed.

17. Remove tilt section plug from tilt section. Remove and discard O-rings and backup rings from tilt section plug. See Figure 109.

CLEAN

WARNING

Cleaning solvents can be flammable and toxic and cause skin irritation. When using cleaning solvents, always follow the solvent manufacturer's recommended safety procedures.

WARNING

Compressed air can move particles so they cause injury to the user or to other personnel. Make sure the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eyes.

1. Clean only metal components of E-hydraulic control valve with solvent and dry using compressed air. Avoid getting solvent in electrical connectors.

2. Clean all threaded components with denatured alcohol and dry using compressed air.

3. Clean rubber or plastic components with warm soapy water and dry with a lint free cloth.

INSPECT

1. Inspect section bodies for damage. Replace if damaged.

2. Inspect threaded components to ensure absence of oil or solvent residue.

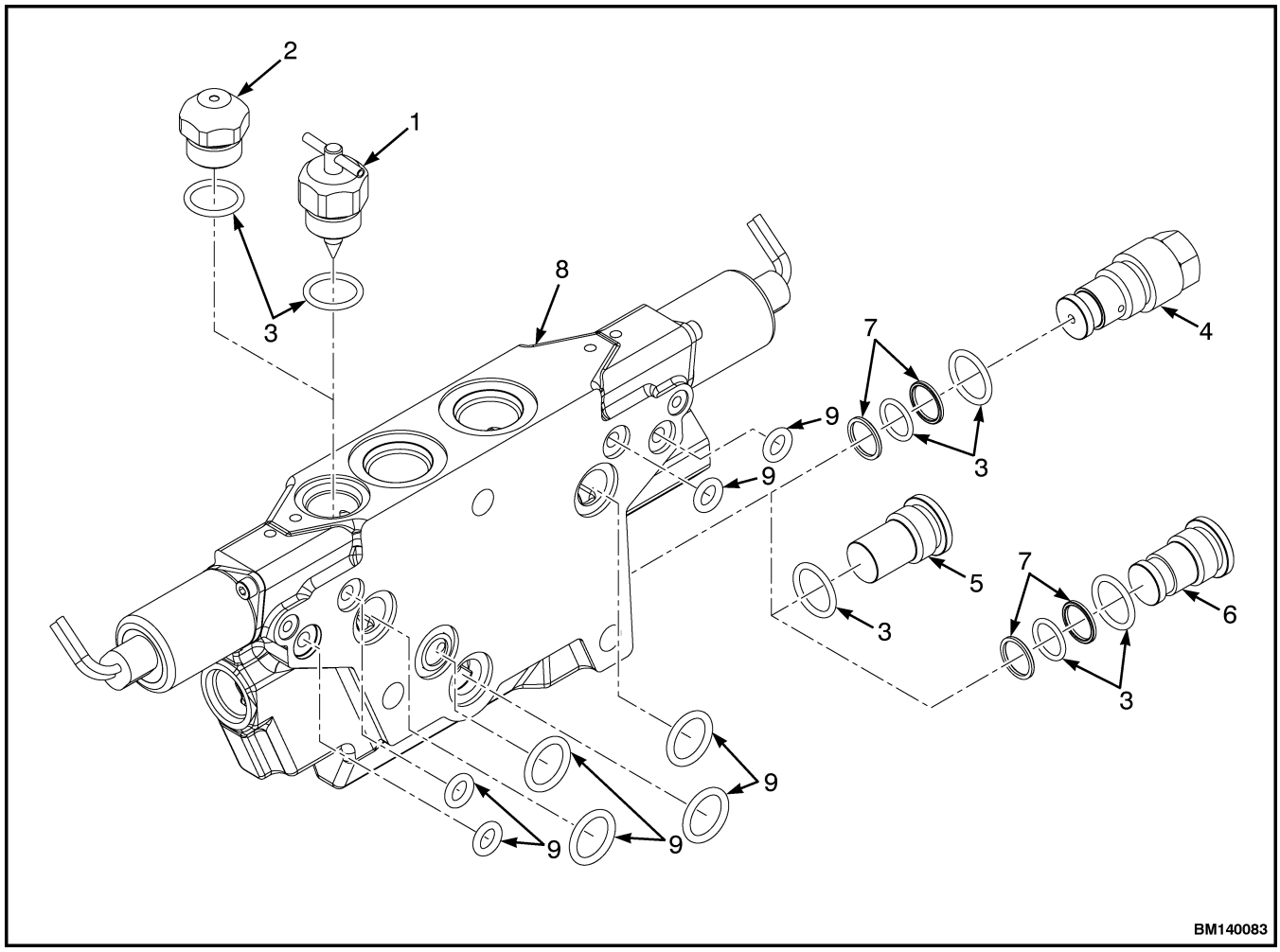
3. Inspect all other components for damage. Replace if damaged.

ASSEMBLE

NOTE: Lubricate all new O-rings and backup rings with hydraulic oil prior to installation. **DO NOT** lubricate section seals.

NOTE: Perform the following step if E-hydraulic control valve is **NOT** equipped with secondary relief valve.

1. Install new O-rings and backup rings onto tilt section plug. Install tilt section plug into tilt section. See Figure 110. Tighten tilt section plug to 27 N•m (20 lbf ft).
2. Install O-rings and backup rings onto optional secondary relief valve. Install optional secondary relief valve into tilt section. See Figure 110. Tighten optional secondary relief valve to 27 N•m (20 lbf ft).
3. Install new O-ring onto port option plug. Install port option plug into tilt section. See Figure 110. Tighten port option plug to 54 N•m (40 lbf ft).
4. Install new O-ring onto lift section plug. Install lift section plug into lift section. See Figure 110. Tighten lift section plug to 27 N•m (20 lbf ft).



1. MANUAL LOWERING VALVE
2. PORT OPTION PLUG
3. O-RING
4. OPTIONAL SECONDARY RELIEF VALVE
5. LIFT SECTION PLUG
6. TILT SECTION PLUG
7. BACKUP RING
8. LIFT/TILT/AUXILIARY SECTION BODY
9. SECTION SEAL

Figure 110. Lift/Tilt/Auxiliary Section of E-Hydraulic Control Valve

5. Install new O-ring onto manual lowering valve. Install manual lowering valve into lift section. See Figure 110. Tighten manual lowering valve to 54 N•m (40 lbf ft).

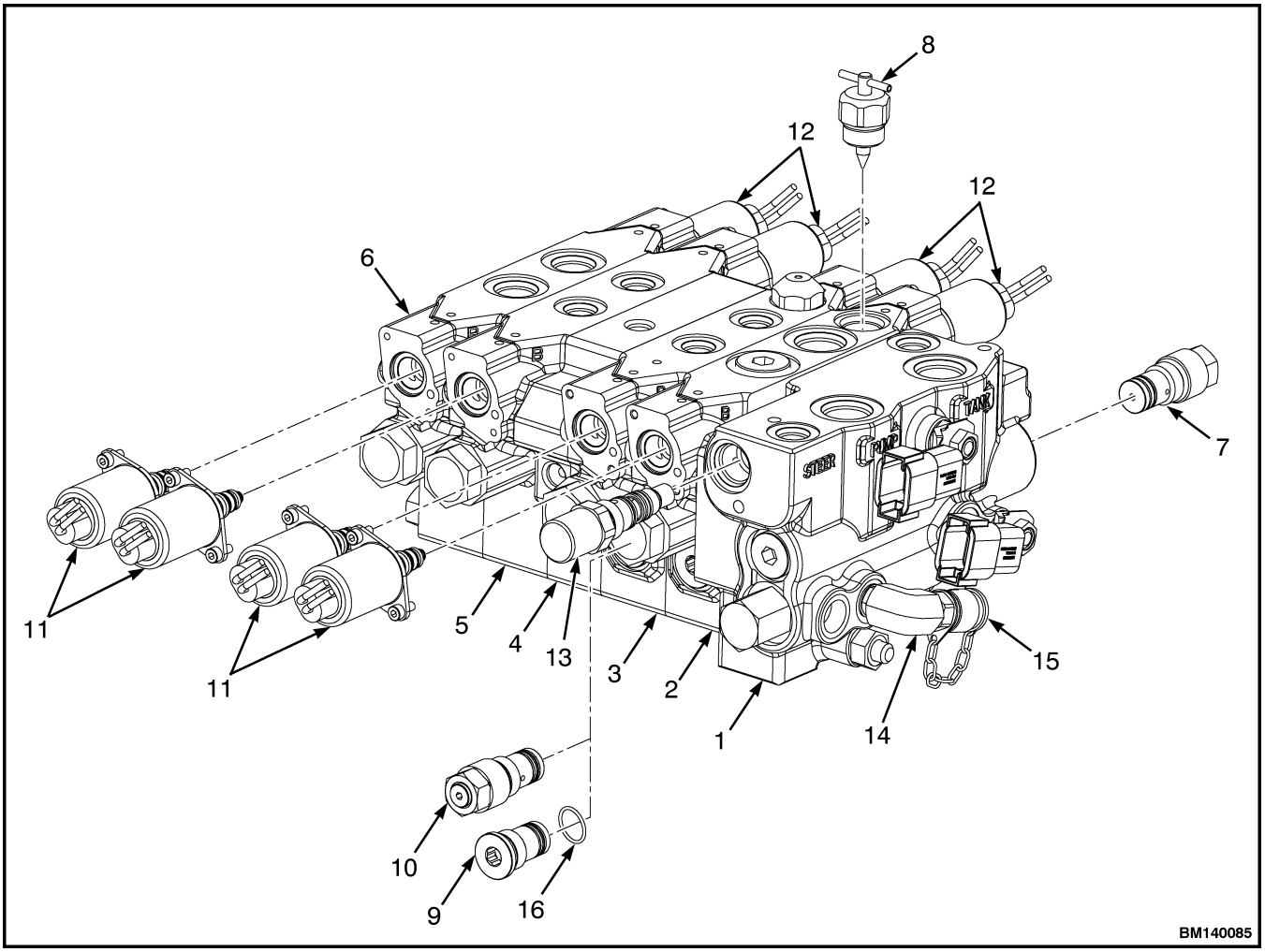
6. If removed, install diagnostic fitting onto elbow fitting. Install O-ring onto elbow fitting, then install elbow fitting into inlet section. Tighten elbow fitting to 16 N•m (142 lbf in).

See Figure 111 for lift truck models

- J1.5-2.0XNT (K160) manufactured before November, 2014
- J30-40XNT (K160) and J1.6-2.0XN (J30-40XN) (A935)

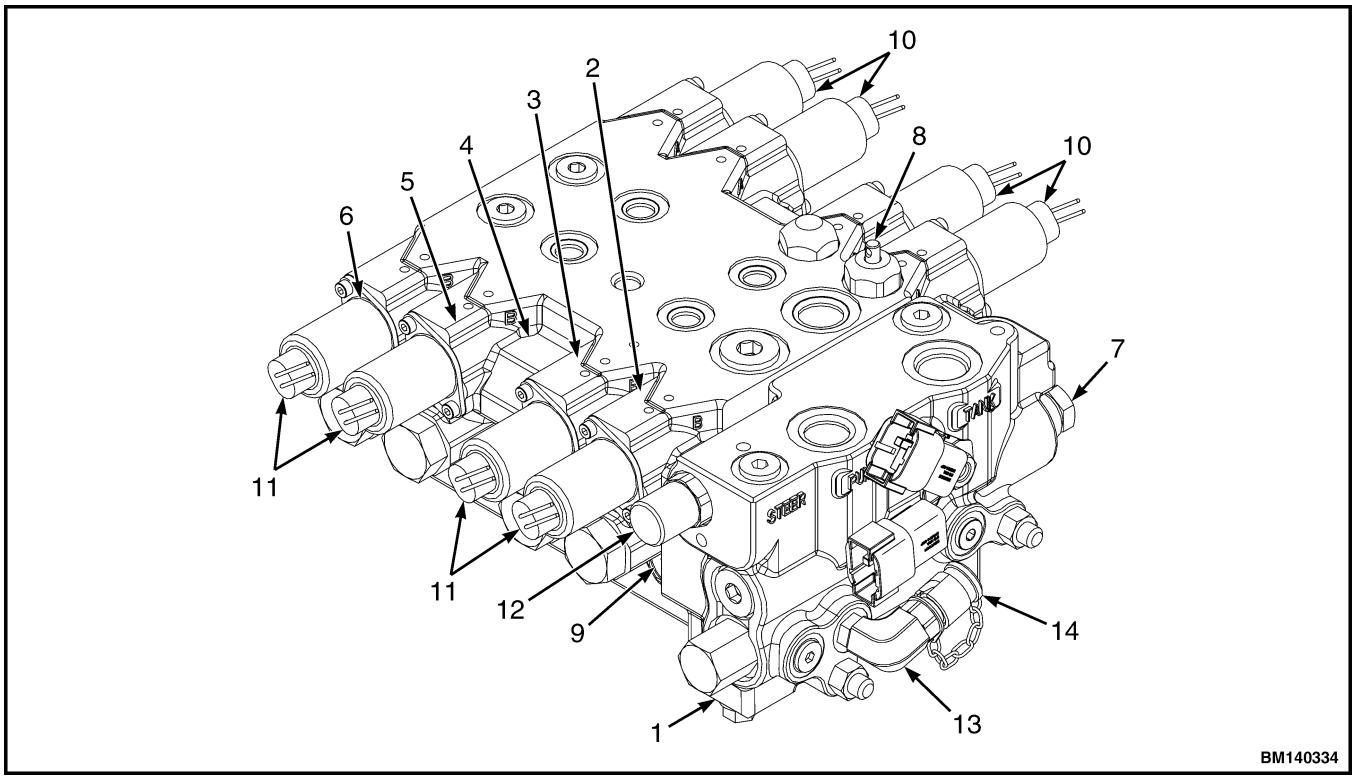
See Figure 112 for lift truck models

- J1.5-2.0XNT (K160) manufactured after November, 2014



1. INLET SECTION
2. LIFT SECTION
3. TILT SECTION
4. SPACER SECTION (OPTIONAL)
5. FIRST AUXILIARY SECTION (OPTIONAL)
6. SECTION AUXILIARY SECTION
7. PRIMARY RELIEF VALVE
8. MANUAL LOWERING VALVE
9. COMPENSATOR PLUG
10. OPTIONAL SECONDARY RELIEF VALVE
11. LOWER SOLENOID ASSEMBLY
12. UPPER SOLENOID ASSEMBLY
13. PILOT CARTRIDGE
14. ELBOW FITTING
15. DIAGNOSTIC FITTING (SHOWN IN PUMP PRESSURE GAUGE PORT)
16. O-RING

Figure 111. E-Hydraulic Control Valve, Lift Truck Models J1.5-2.0XNT (K160) Manufactured Before November, 2014 and J30-40XNT (K160) and J1.6-2.0XN (J30-40XN) (A935)



1. INLET SECTION
2. LIFT/LOWER SECTION
3. TILT SECTION
4. SPACER SECTION (OPTIONAL)
5. FIRST AUXILIARY SECTION (OPTIONAL)
6. SECOND AUXILIARY SECTION
7. PRIMARY RELIEF VALVE
8. MANUAL LOWERING VALVE
9. COMPENSATOR PLUG (OPTIONAL) OR OPTIONAL SECONDARY RELIEF VALVE
10. UPPER SOLENOID ASSEMBLY
11. LOWER SOLENOID ASSEMBLY
12. PILOT CARTRIDGE
13. ELBOW FITTING
14. DIAGNOSTIC FITTING (SHOWN IN PUMP PRESSURE GAUGE PORT)

Figure 112. E-Hydraulic Control Valve, Lift Truck Models J1.5-2.0XNT (K160) Manufactured After November, 2014

NOTE: Step 7 does not apply to lift truck models J1.5-2.0XNT (K160) manufactured after November, 2014.

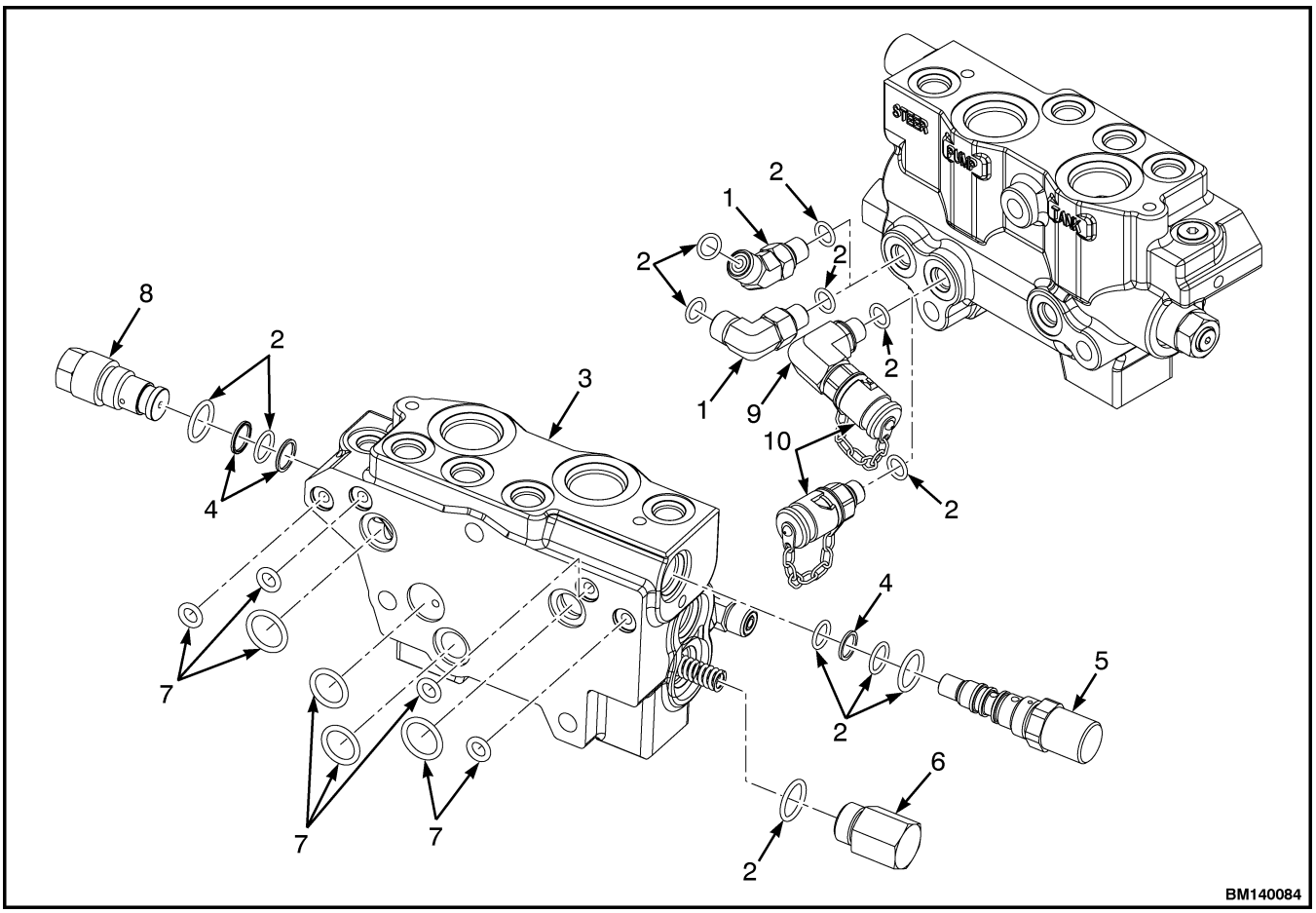
7. Install new O-rings onto steer load sense fitting. Install steer load sense fitting into inlet section. See Figure 113. Tighten steer load sense fitting to 16 N•m (142 lbf in).

8. Install new O-rings and backup rings onto pilot cartridge. Install pilot cartridge into inlet section. See Figure 113. Tighten pilot cartridge to 65 N•m (48 lbf ft).

9. Install new O-rings onto primary relief valve. Install primary relief valve into inlet section. See Figure 113. Tighten primary relief valve to 27 N•m (20 lbf ft).

10. If removed, install nuts on inlet side of tie rods. See Figure 114. Hand tighten nuts only at this time.

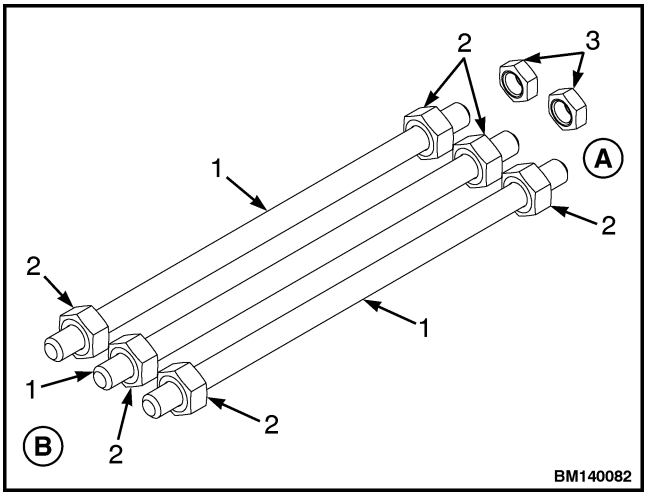
11. Install tie rod end without nut through inlet section. See Figure 115 for example.



NOTE: E-HYDRAULIC CONTROL VALVES FOR LIFT TRUCK MODELS J1.5-2.0XNT (K160) MANUFACTURED AFTER NOVEMBER, 2014 DO NOT HAVE A STEER LOAD SENSE FITTING. THIS PART OF THE VALVE IS COVERED WITH A PLUG.

1. STEER LOAD SENSE FITTING
2. O-RING
3. INLET SECTION BODY
4. BACKUP RING
5. PILOT CARTRIDGE
6. COMPENSATOR PLUG
7. SECTION SEAL
8. PRIMARY RELIEF VALVE
9. ELBOW FITTING
10. DIAGNOSTIC FITTING (SHOWN IN PUMP PRESSURE GAUGE PORT)

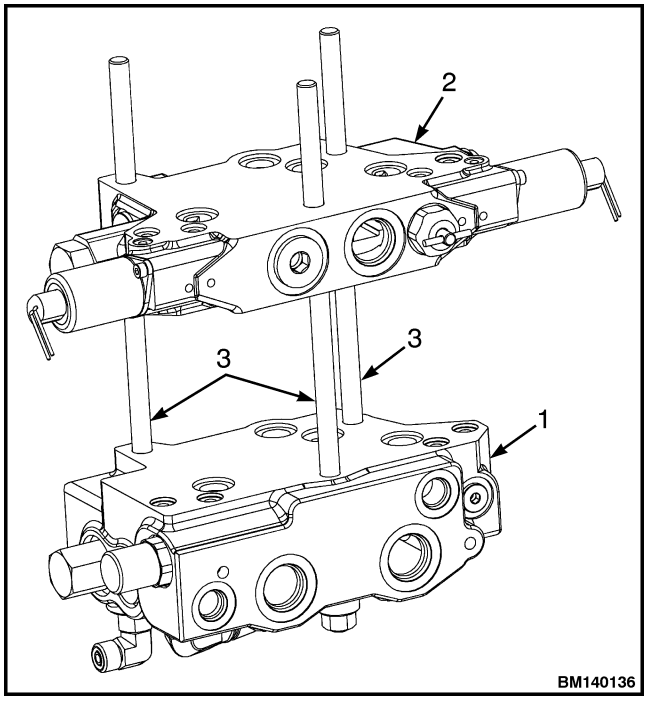
Figure 113. Inlet Section E-Hydraulic Control Valve



A. INLET SIDE
B. OUTLET SIDE

1. TIE ROD
2. NUT
3. JAM NUT

Figure 114. Tie Rods and Nuts for E-Hydraulic Control Valve



1. INLET SECTION
2. LIFT SECTION
3. TIE ROD

Figure 115. E-Hydraulic Control Valve - Sections and Tie Rods

12. Install upper solenoid connector, lower solenoid connector, and two jam nuts, as noted during disassembly, onto tie rod ends. Make sure upper and lower solenoid connectors are installed at the correct angles. Hand tighten jam nuts to hold connectors onto inlet section.

See Figure 116 for lift truck models

- J1.5-2.0XNT (K160) manufactured before November, 2014
- J30-40XNT (K160) and J1.6-2.0XN (J30-40XN) (A935)

See Figure 117 for lift truck models

- J1.5-2.0XNT (K160) manufactured after November, 2014

NOTE: DO NOT lubricate section seals.

13. Install section seals into retaining grooves in inlet section face. See Figure 113.

14. Install lift section onto tie rods against inlet section. See Figure 115 for example.

15. Install section seals into retaining grooves in lift section face. See Figure 110.

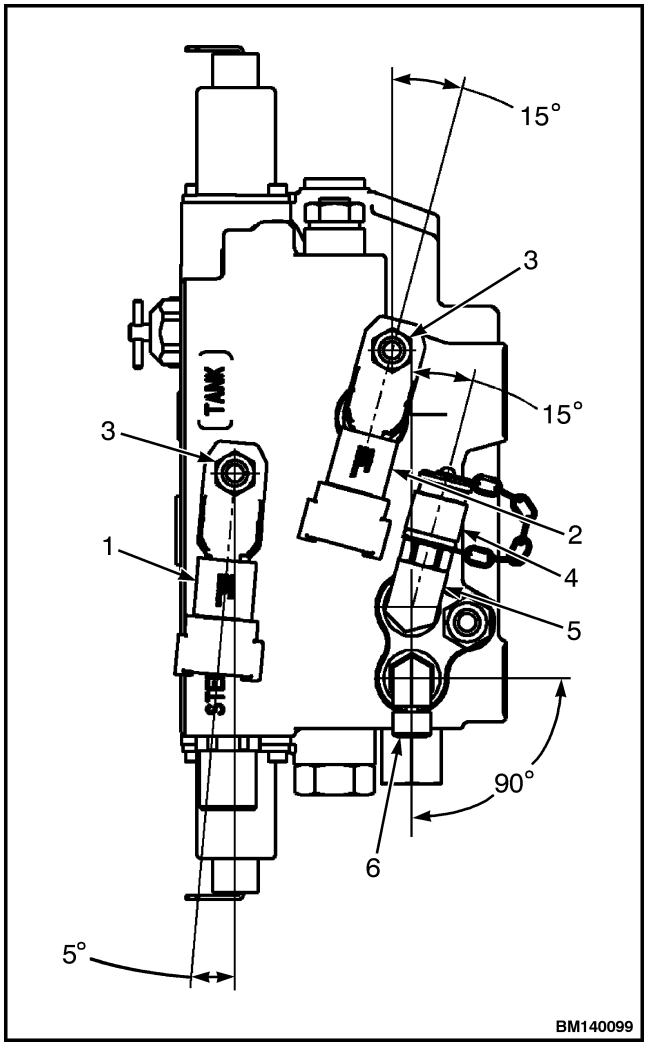
16. Install tilt section onto tie rods against lift section. See Figure 115 for example.

17. Install section seals into retaining grooves in tilt section face. See Figure 110.

NOTE: Perform Step 18 and Step 19 if E-hydraulic control valve is equipped with spacer section.

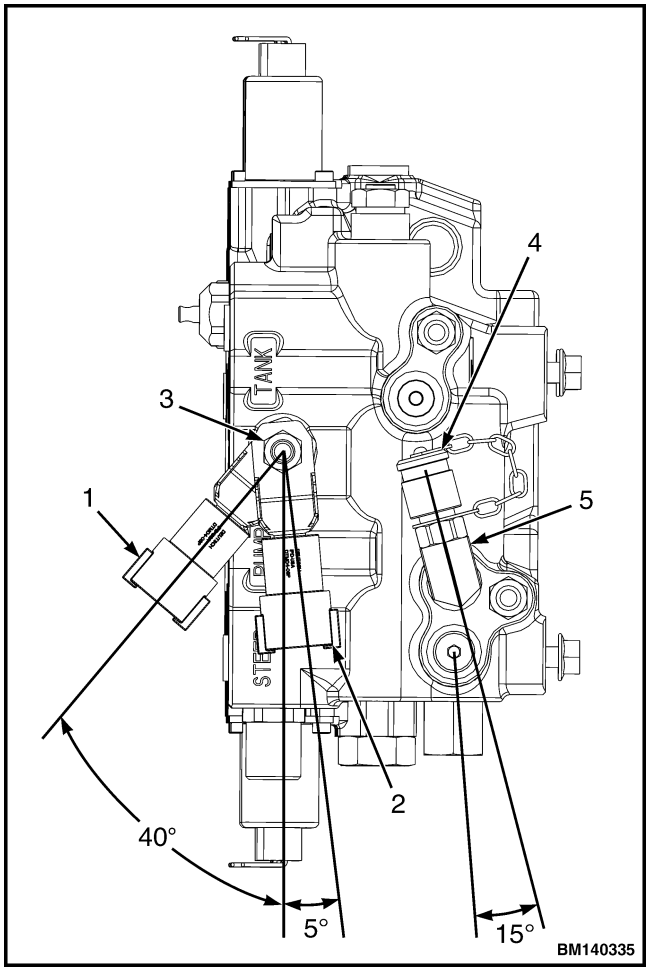
18. Install spacer section onto tie rods against tilt section. See Figure 115 for example.

19. Install section seals into retaining grooves on spacer section face.



1. UPPER SOLENOID CONNECTOR
2. LOWER SOLENOID CONNECTOR
3. JAM NUT
4. DIAGNOSTIC FITTING (SHOWN IN PUMP PRESSURE GAUGE PORT)
5. ELBOW FITTING
6. STEER LOAD SENSE FITTING

Figure 116. E-Hydraulic Solenoid Connectors, Lift Truck Models J1.5-2.0XNT (K160) Manufactured Before November, 2014 and J30-40XNT (K160) and J1.6-2.0XN (J30-40XN) (A935)



1. UPPER SOLENOID CONNECTOR
2. LOWER SOLENOID CONNECTOR
3. JAM NUT
4. DIAGNOSTIC FITTING (SHOWN IN PUMP PRESSURE GAUGE PORT)
5. ELBOW FITTING

Figure 117. E-Hydraulic Solenoid Connectors, Lift Truck Models J1.5-2.0XNT (K160) Manufactured After November, 2014

NOTE: Perform Step 20 and Step 21 if E-hydraulic control valve is equipped with a first auxiliary section.

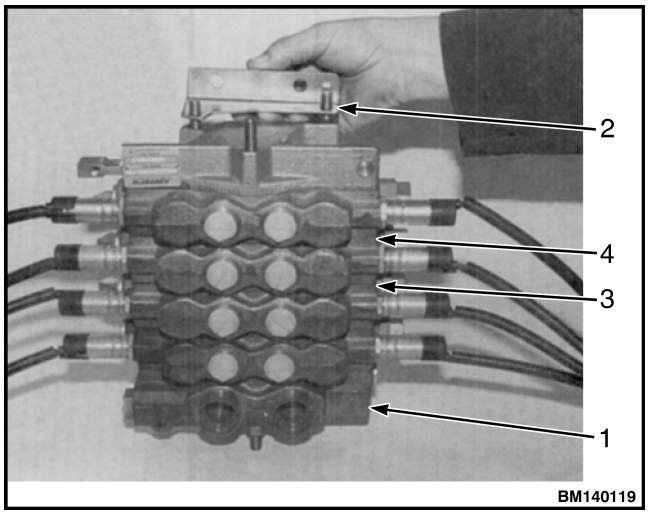
20. Install first auxiliary section onto tie rods against spacer section. See Figure 115 for example.

21. Install section seals into retaining grooves on first auxiliary section face. See Figure 110.

22. Install second auxiliary section onto tie rods against spacer section or first auxiliary section. See Figure 115 for example.

23. Install section seals into retaining grooves on second auxiliary section face. See Figure 110.

24. Install outlet cap onto tie rods against second auxiliary section. See Figure 118.



1. INLET SECTION
2. OUTLET COVER
3. FIRST AUXILIARY SECTION (OPTIONAL)
4. SECOND AUXILIARY SECTION

Figure 118. E-Hydraulic Control Valve

25. Install nuts on tie rods on outlet side of E-hydraulic control valve. See Figure 114. Hand tighten nuts only at this time.

NOTE: Tie rods should extend one or two threads past nuts on both sides.

26. After ensuring tie rods are completely through all sections of E-hydraulic control valve tighten nuts to 20.3 ± 1.4 N•m (179.7 ± 12.4 lbf in).

27. Tighten jam nuts to 7 to 11 N•m (62 to 97 lbf in) keeping connectors at the correct angle, as shown in:

Figure 116 for lift truck models

- J1.5-2.0XNT (K160) manufactured before November, 2014
- J30-40XNT (K160) and J1.6-2.0XN (J30-40XN) (A935)

Figure 117 for lift truck models

- J1.5-2.0XNT (K160) manufactured after November, 2014

28. Install upper solenoid assemblies into lift, tilt, and auxiliary sections. Tighten upper solenoid assembly to 5 N•m (48 lbf in).

29. Install lower solenoid assemblies into lift, tilt, and auxiliary sections. Tighten lower solenoid assembly to 5 N•m (48 lbf in).

See Figure 111 for lift truck models

- J1.5-2.0XNT (K160) manufactured before November, 2014
- J30-40XNT (K160) and J1.6-2.0XN (J30-40XN) (A935)

See Figure 112 for lift truck models

- J1.5-2.0XNT (K160) manufactured after November, 2014

INSTALL

1. Connect lower solenoid wires to lower solenoid connector as tagged during removal. See Table 7 and see:

Figure 119 for lift truck models

- J1.5-2.0XNT (K160) manufactured before November, 2014
- J30-40XNT (K160) and J1.6-2.0XN (J30-40XN) (A935)

Figure 120 for lift truck models

- J1.5-2.0XNT (K160) manufactured after November, 2014

Table 7. Lower Solenoid Connector Pin Layout

Pin	Socket	Pin	Socket
PIN 8	1B NEG	**PIN 1**	1B POS
PIN 7	2B NEG	**PIN 2**	2B POS
PIN 6	3B NEG	**PIN 3**	3B POS
PIN 5	4B NEG	**PIN 4**	4B POS

2. Connect upper solenoid wires to upper solenoid connector as tagged during removal. See Table 8 and see:

Figure 119 for lift truck models

- J1.5-2.0XNT (K160) manufactured before November, 2014
- J30-40XNT (K160) and J1.6-2.0XN (J30-40XN) (A935)

Figure 120 for lift truck models

- J1.5-2.0XNT (K160) manufactured after November, 2014

Table 8. Upper Solenoid Connector Pin Layout

Pin	Socket	Pin	Socket
PIN 8	1A NEG	**PIN 1**	1A POS
PIN 7	2A NEG	**PIN 2**	2A POS
PIN 6	3A NEG	**PIN 3**	3A POS
PIN 5	4A NEG	**PIN 4**	4A POS

NOTE: Newer lift truck models do not have washers (11, Figure 121) between the mounting bracket and control valve).

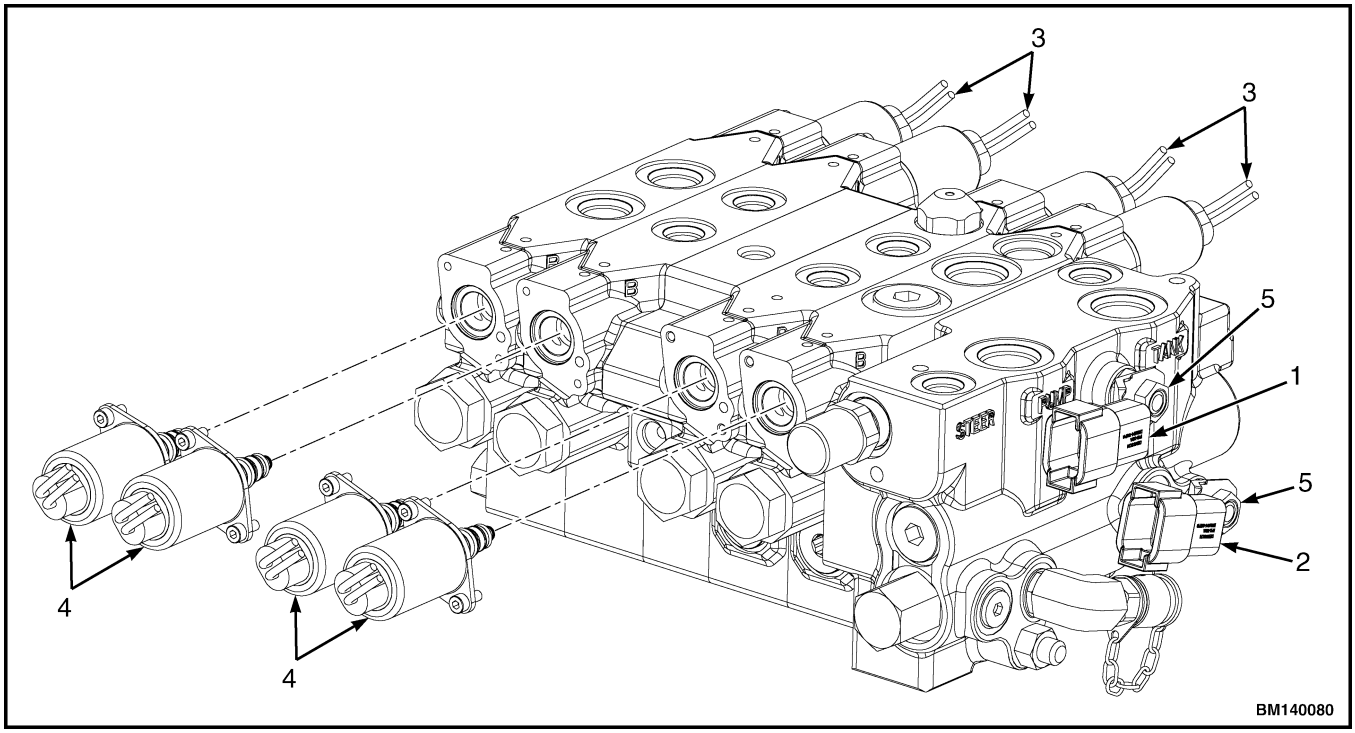
3. Install three washers, mounting bracket, and three M8 capscrews onto E-hydraulic control valve. See Figure 121.

4. Install mounting bracket, with E-hydraulic control valve attached, into holding brackets on front bulkhead. See Figure 121.

5. Install bracket, M10 capscrew, washers, and nut onto mounting bracket and front bulkhead. See Figure 121.

6. Connect lower solenoid connector to wire harness.

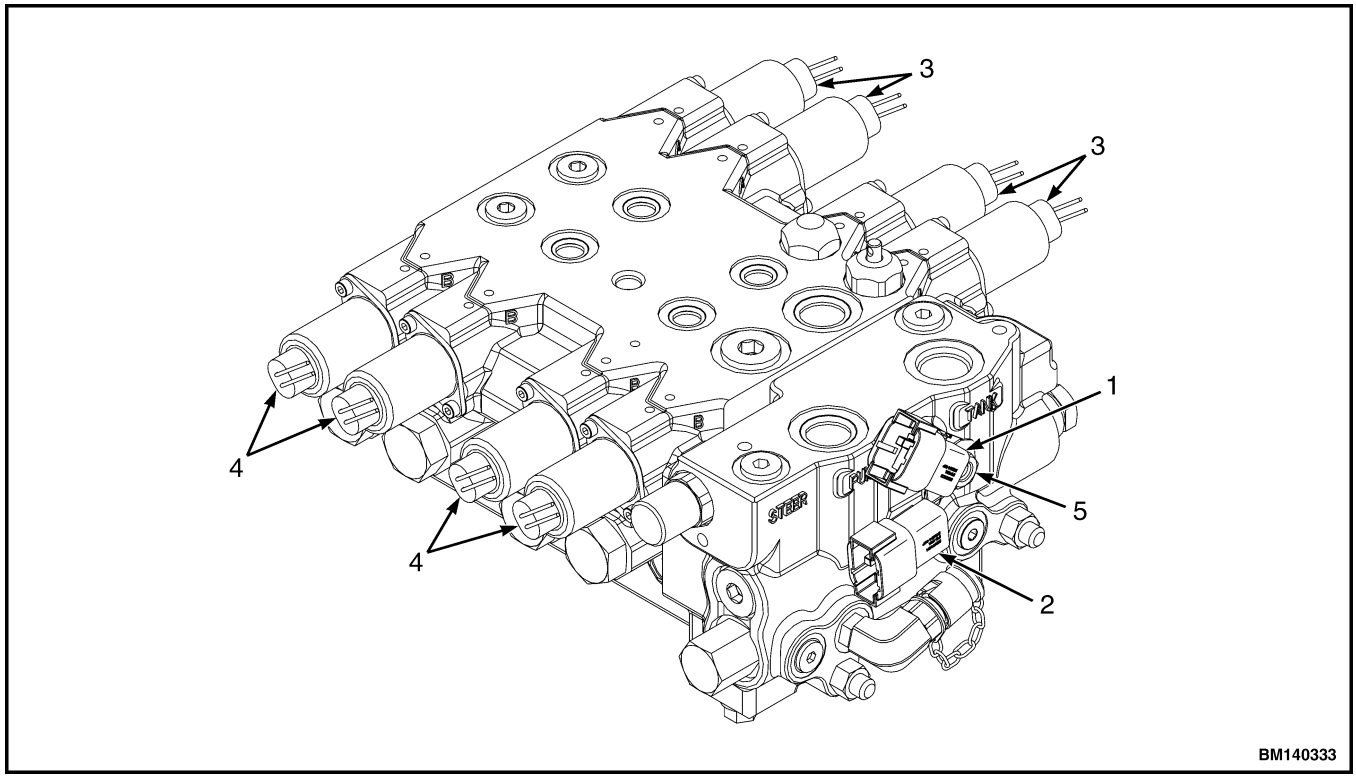
7. Connect upper solenoid connector to wire harness.



NOTE: 4-FUNCTION E-HYDRAULIC CONTROL VALVE SHOWN.

1. LOWER SOLENOID CONNECTOR
2. UPPER SOLENOID CONNECTOR
3. UPPER SOLENOID WIRE
4. LOWER SOLENOID WIRE
5. JAM NUT
6. STEER LOAD SENSE FITTING

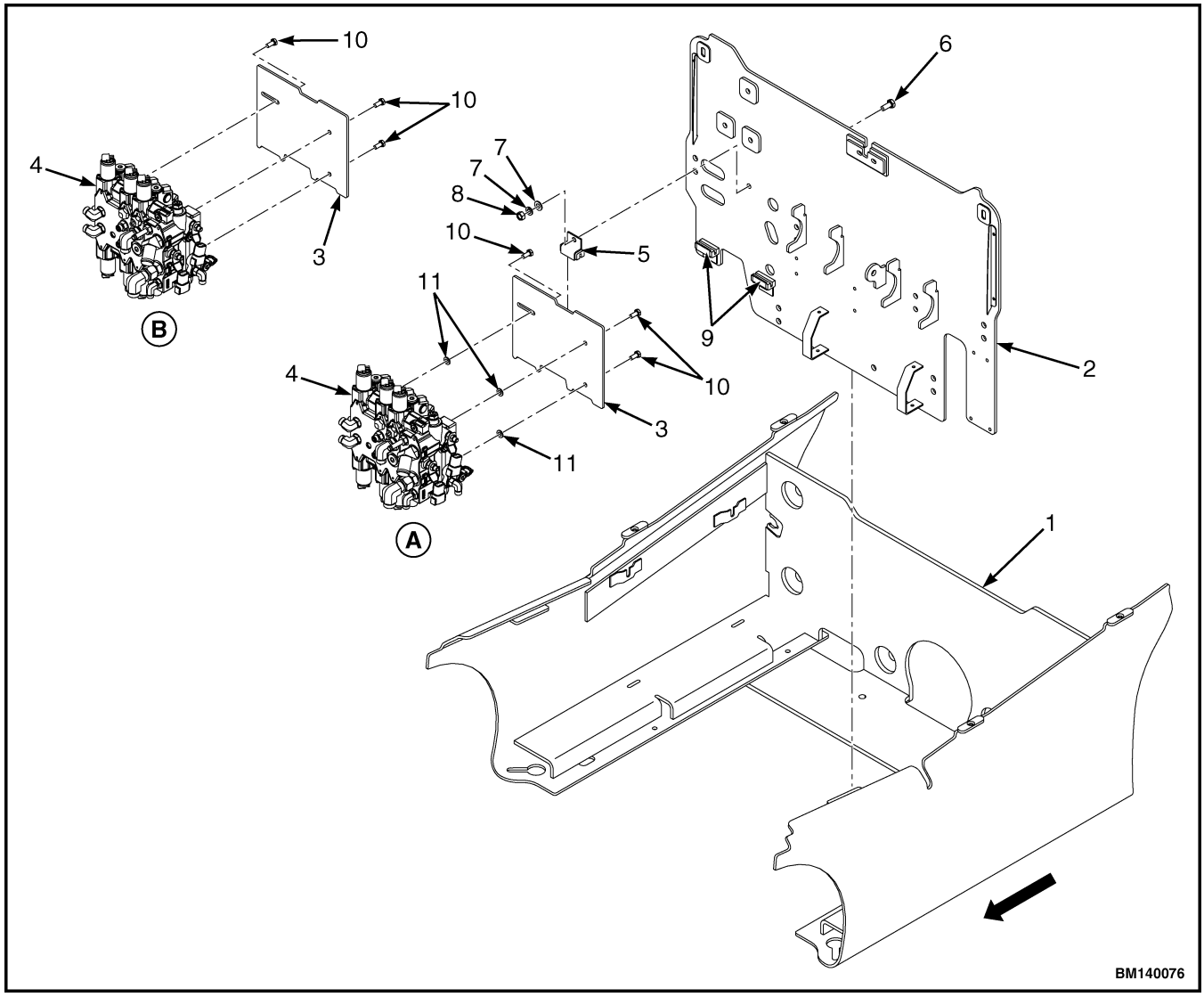
Figure 119. Solenoid Wires and Connectors, Lift Truck Models J1.5-2.0XNT (K160) Manufactured Before November, 2014 and J30-40XNT (K160) and J1.6-2.0XN (J30-40XN) (A935)



NOTE: 4-FUNCTION E-HYDRAULIC CONTROL VALVE SHOWN.

1. LOWER SOLENOID CONNECTOR
2. UPPER SOLENOID CONNECTOR
3. UPPER SOLENOID WIRE
4. LOWER SOLENOID WIRE
5. JAM NUT

Figure 120. Solenoid Wires and Connectors, Lift Truck Models J1.5-2.0XNT (K160) Manufactured After November, 2014



NOTE: ARROW POINTING TO FRONT OF LIFT TRUCK.

NOTE: NEWER LIFT TRUCK MODELS DO NOT HAVE WASHERS (ITEM #11) BETWEEN THE MOUNTING BRACKET AND CONTROL VALVE.

A. MOUNTING ARRANGEMENT, OLDER LIFT TRUCK MODELS

B. MOUNTING ARRANGEMENT, NEWER LIFT TRUCK MODELS

1. FRAME
2. FRONT BULKHEAD
3. MOUNTING BRACKET
4. E-HYDRAULIC CONTROL VALVE
5. BRACKET
6. M10 CAPSCREW
7. WASHER
8. NUT
9. HOLDING BRACKET
10. M8 CAPSCREW
11. WASHER

Figure 121. E-Hydraulic Control Valve Mounting

NOTE: Lubricate O-rings with clean hydraulic oil prior to installation.

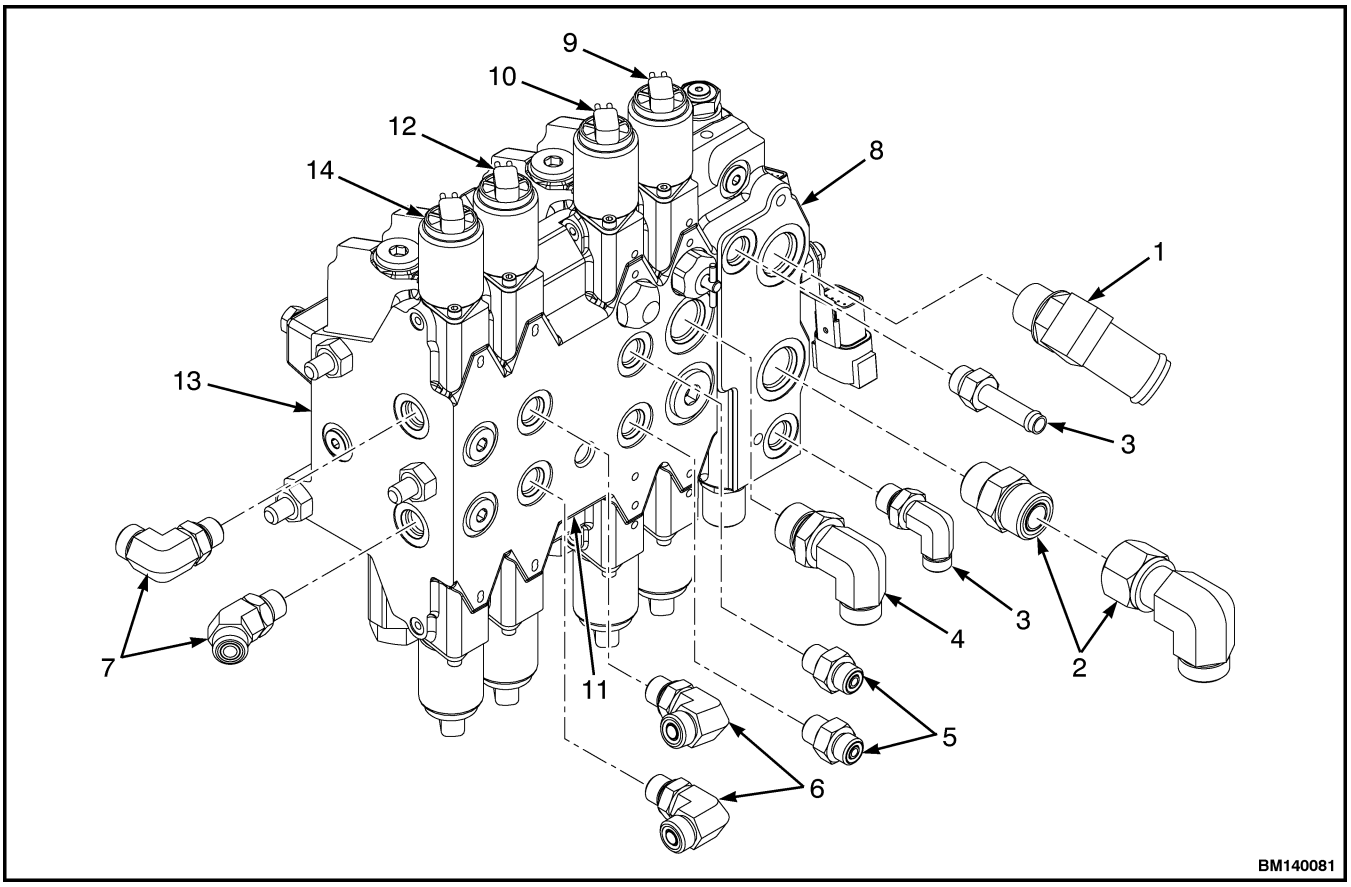
8. Lubricate new O-rings and install on return line fitting, inlet fitting, steer return fitting, tilt fittings, lift/lower fittings, and auxiliary fittings.

See Figure 122 for lift truck models

- J1.5-2.0XNT (K160) manufactured before November, 2014
- J30-40XNT (K160) and J1.6-2.0XN (J30-40XN) (A935)

See Figure 123 for lift truck models

- J1.5-2.0XNT (K160) manufactured after November, 2014



NOTE: 4-FUNCTION CONTROL VALVE SHOWN.

1. RETURN LINE FITTING
2. INLET FITTING
3. STEER FITTING
4. LIFT/LOWER FITTING
5. TILT FITTING
6. 3-FUNCTION AUXILIARY FITTING
7. 4-FUNCTION AUXILIARY FITTING
8. INLET SECTION
9. LIFT SECTION
10. TILT SECTION
11. SPACER SECTION
12. FIRST AUXILIARY SECTION (OPTIONAL)
13. OUTLET COVER
14. SECOND AUXILIARY SECTION

Figure 122. E-Hydraulic Control Valve Fittings, Lift Truck Models J1.5-2.0XNT (K160) Manufactured Before November, 2014 and J30-40XNT (K160) and J1.6-2.0XN (J30-40XN) (A935)

NOTE: Perform Step 9 for E-hydraulic control valve equipped with both first and second auxiliary sections.

9. Install auxiliary fittings into second auxiliary section as noted during removal.

NOTE: Perform Step 10 for E-hydraulic control valve equipped with second auxiliary section.

10. Install auxiliary fittings into second auxiliary section as noted during removal.

11. Install tilt fittings into tilt section as noted during removal.

12. Install lift/lower fittings into lift section as noted during removal.

See Figure 122 for lift truck models

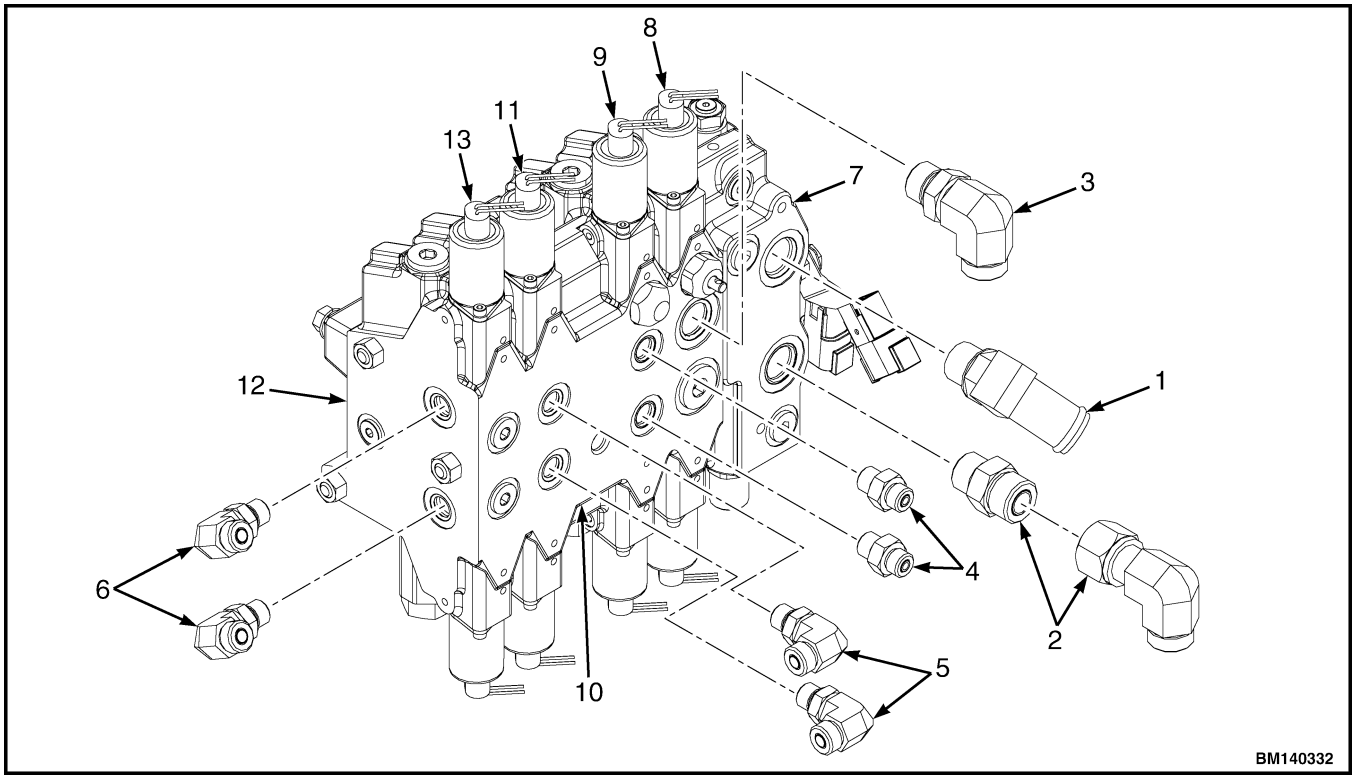
- J1.5-2.0XNT (K160) manufactured before November, 2014
- J30-40XNT (K160) and J1.6-2.0XN (J30-40XN) (A935)

See Figure 123 for lift truck models

- J1.5-2.0XNT (K160) manufactured after November, 2014

NOTE: Step 13 does not apply to lift truck models J1.5-2.0XNT (K160) manufactured after November, 2014.

13. Install steer fittings into inlet section as noted during removal. See Figure 122.



NOTE: 4-FUNCTION CONTROL VALVE SHOWN.

1. RETURN LINE FITTING
2. INLET FITTING
3. LIFT/LOWER FITTING
4. TILT FITTING
5. 3-FUNCTION AUXILIARY FITTING
6. 4-FUNCTION AUXILIARY FITTING
7. INLET SECTION
8. LIFT SECTION
9. TILT SECTION
10. SPACER SECTION
11. FIRST AUXILIARY SECTION (OPTIONAL)
12. OUTLET COVER
13. SECOND AUXILIARY SECTION

Figure 123. E-Hydraulic Control Valve Fittings, Lift Truck Models J1.5-2.0XNT (K160) Manufactured After November, 2014

14. Install inlet fitting into inlet section as noted during removal. Tighten fitting to 16 N•m (142 lbf in). See Figure 122.

15. Install return line fitting into inlet section as noted during removal.

See Figure 122 for lift truck models

- J1.5-2.0XNT (K160) manufactured before November, 2014
- J30-40XNT (K160) and J1.6-2.0XN (J30-40XN) (A935)

See Figure 123 for lift truck models

- J1.5-2.0XNT (K160) manufactured after November, 2014

NOTE: Remove caps from hydraulic lines as they are connected.

16. Connect hydraulic lines to fittings as tagged during removal.

CAUTION

Disposal of lubricants and fluids must meet local environmental regulations.

17. Dispose of drain pan contents.

18. Check hydraulic oil level; refill system as needed. For procedures, see

Periodic Maintenance 8000SRM1339 for lift trucks

- J1.5-2.0XNT (J30-40XNT) (K160)

Periodic Maintenance 8000SRM1373 for lift trucks

- J1.6-2.0XN (J30-40XN) (A935)

19. Install floor plates and floor mats.

20. Install battery. See **How to Change Battery** in **Operating Manual** or

Periodic Maintenance 8000SRM1339 for lift trucks

- J1.5-2.0XNT (J30-40XNT) (K160)

Periodic Maintenance 8000SRM1373 for lift trucks

- J1.6-2.0XN (J30-40XN) (A935)

21. Connect battery connectors.

22. Operate hydraulic functions, then check for leaks.

23. Perform procedures outlined in Calibration Procedure section of this manual.

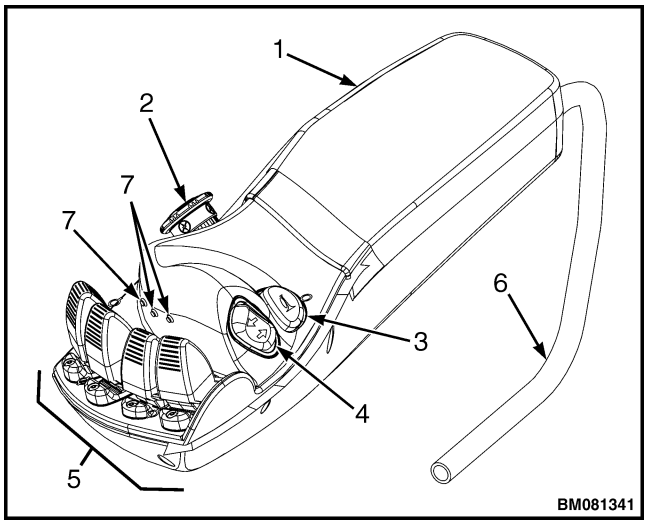
E-HYDRAULIC CONTROLS

E-hydraulic controls for the lift truck are part of the mini-lever module (MLM) installed on an armrest. The emergency disconnect switch is mounted on the outside of the armrest and connected to the MLM wire harness. Mounting for a direction control switch (optional) has been provided on the armrest and will connect to the MLM wire harness. The horn button is mounted on the inside of the armrest and connected to the MLM wire harness. The MLM wire harness is routed beside the seat and connects to the main wire harness. See Figure 124.

Mini-levers are available in single function or dual function. See Figure 125 for examples.

Replace E-Hydraulic Control Components

1. For procedures to replace the armrest, emergency disconnect switch, horn button, direction control switch, and mini-levers see **Electrical System** 2200SRM1337.



1. ARMREST
2. EMERGENCY DISCONNECT SWITCH
3. HORN BUTTON
4. DIRECTION CONTROL SWITCH (OPTIONAL)
5. MINI-LEVER
6. MLM WIRE HARNESS
7. MOMENTARY BUTTON (OPTIONAL)

Figure 124. E-Hydraulic Controls

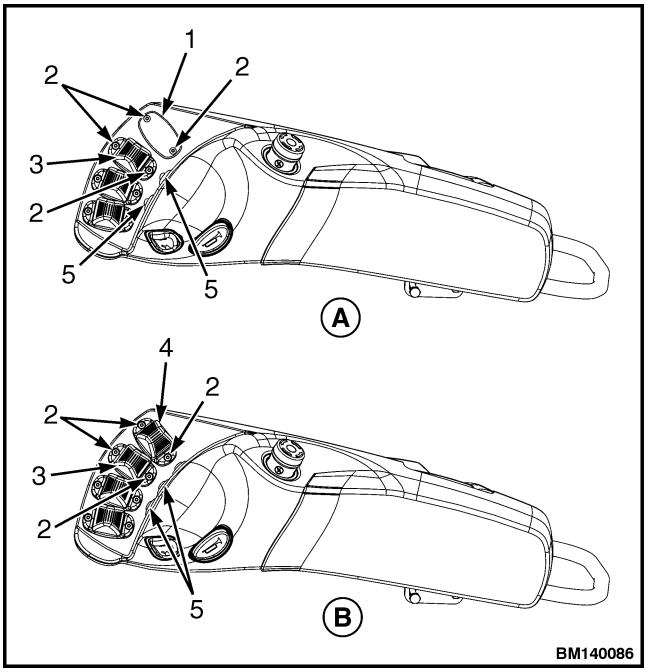


Figure 125. Mini-Levers and Armrest

Legend for Figure 125

A. 3-FUNCTION MINI-LEVER MODULE
B. 4-FUNCTION MINI-LEVER MODULE

1. BLANK
2. CAPSCREW
3. AUX 1 LEVER
4. AUX 2 LEVER
5. MOMENTARY BUTTON (OPTIONAL)

E-Hydraulic Control Valve Repair for 2.0-3.5T Trucks and 4.0-5.0T Pneumatic Trucks

REMOVE

Initial Steps

WARNING

Before making repairs to the control valve, fully lower all parts of the mast and tilt it fully forward. This action will prevent the mast from lowering suddenly when hydraulic lines are disconnected.

NOTE: Only perform those steps below necessary for required repair or replacement.

1. Lower mast and tilt forward.
2. Remove battery from lift truck. See **How to Change Battery** in **Operating Manual** or

   Periodic Maintenance 8000SRM1364 for lift truck

   - E2.2-3.5XN (E45-70XN) (A268)

   Periodic Maintenance 8000SRM1372 for lift truck

   - J2.2-3.5XN (J45-70XN) (A276)

   Periodic Maintenance 8000SRM1541 for lift truck

   - J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

3. Discharge capacitors by following steps shown in Discharging the Capacitors in **General** section of this manual.
4. Remove floor mats and floor plates.

WARNING

Hydraulic oil is hot after system operation and can cause burns. DO NOT disconnect any hydraulic hoses until the oil in the system is cool.

CAUTION

For Lift Truck E2.2-3.5XN (E45-70XN) (A268) electrical components must be shielded from hydraulic oil drips if they are below hydraulic valve and lines.

NOTE: Tag hydraulic lines during removal to aid in installation.

5. Put a drain pan under the area of the hydraulic control assembly. Disconnect hydraulic lines from E-hydraulic control assembly. Cap hydraulic lines.

Fitting Removal for Lift Truck E2.2-3.5XN (E45-70XN) (A268)

NOTE: Note placement and orientation of fittings prior to removal to aid in installation. Note placement of O-rings on fittings prior to removal to aid in installation.

1. Remove return line fitting, inlet fitting, steer fittings from inlet section. Remove and discard O-rings from fittings. See Figure 126.
2. Remove steer load sense fitting from inlet section. Remove and discard O-rings from fitting. See Figure 126.
3. Remove lift/lower fitting from lift section. See Figure 126.
4. Remove tilt fittings from tilt section. See Figure 126.

NOTE: Perform Step 5 if E-hydraulic control valve is equipped with first auxiliary section.

5. Remove first auxiliary fittings from first auxiliary section. See Figure 126.

NOTE: Perform Step 5 and Step 6 if E-hydraulic control valve is equipped with first and second auxiliary sections.

6. Remove second auxiliary fittings from second auxiliary section. See Figure 126.

Fitting Removal for Lift Truck J2.2-3.5XN (J45-70XN) (A276) and J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

NOTE: Note placement and orientation of fittings prior to removal to aid in installations. Note place of O-rings on fittings prior to removal to aid in installation.

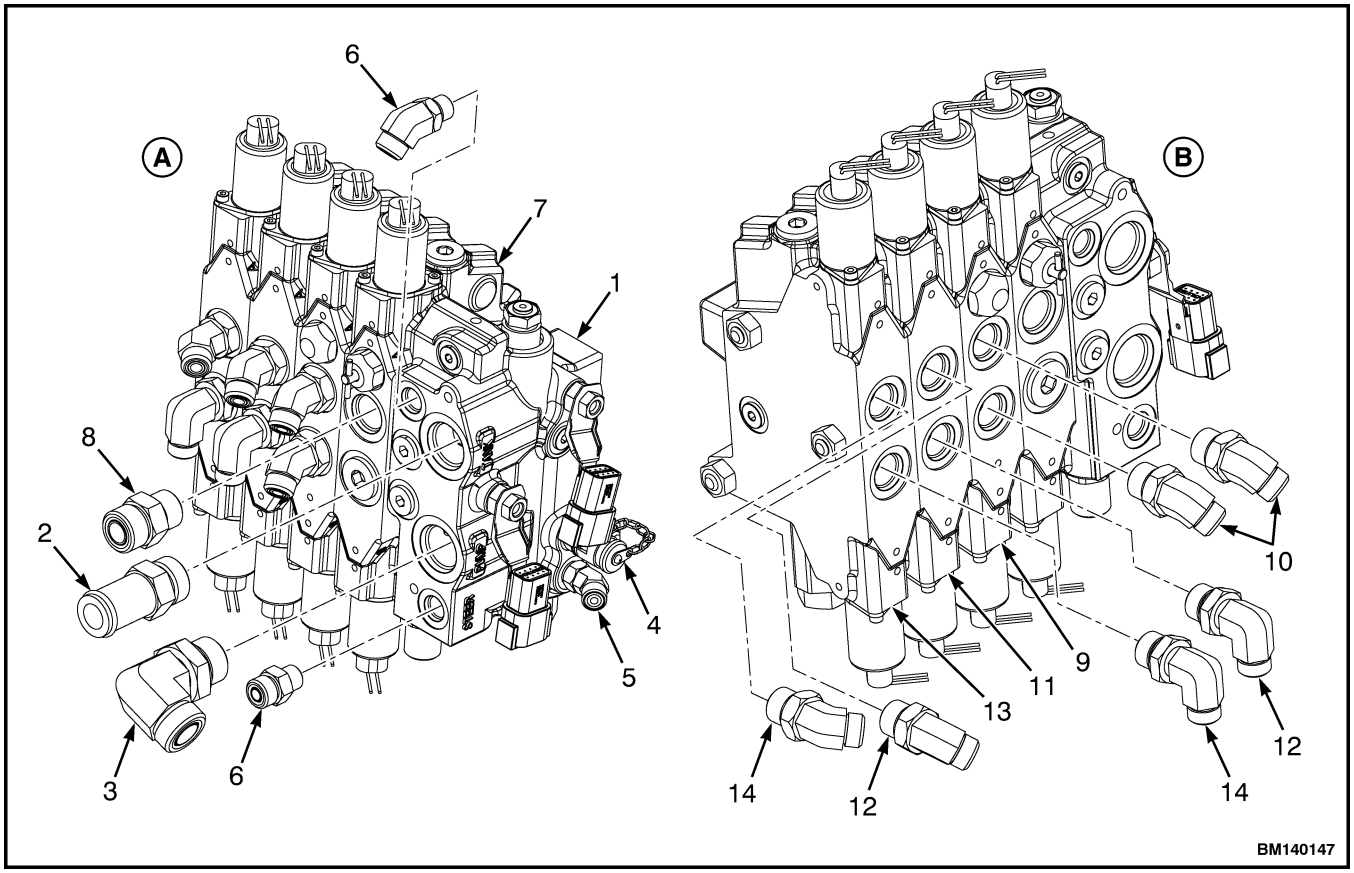
1. Remove return line fitting, inlet fitting, steer fittings, and park brake fittings from inlet section. Remove and discard O-rings from fittings. See Figure 127 or Figure 128.
2. Remove steer load sense fitting from inlet section. Remove and discard O-ring from fitting. See Figure 127 or Figure 128.
3. Remove lift/lower fitting from lift section. Remove and discard O-ring from fitting. See Figure 127 or Figure 128.
4. Remove tilt fittings from tilt section. Remove and discard O-rings from fittings. See Figure 127 or Figure 128.

NOTE: Perform Step 5 if E-hydraulic control valve is equipped with first auxiliary section.

5. Remove first auxiliary fittings from first auxiliary section. Remove and discard O-rings from fittings. See Figure 127 or Figure 128.

NOTE: Perform Step 5 and Step 6 if E-hydraulic control valve is equipped with first and second auxiliary sections.

6. Remove second auxiliary fittings from second auxiliary section. Remove and discard O-rings from fittings. See Figure 127 or Figure 128.



NOTE: 4-FUNCTION CONTROL VALVE SHOWN.

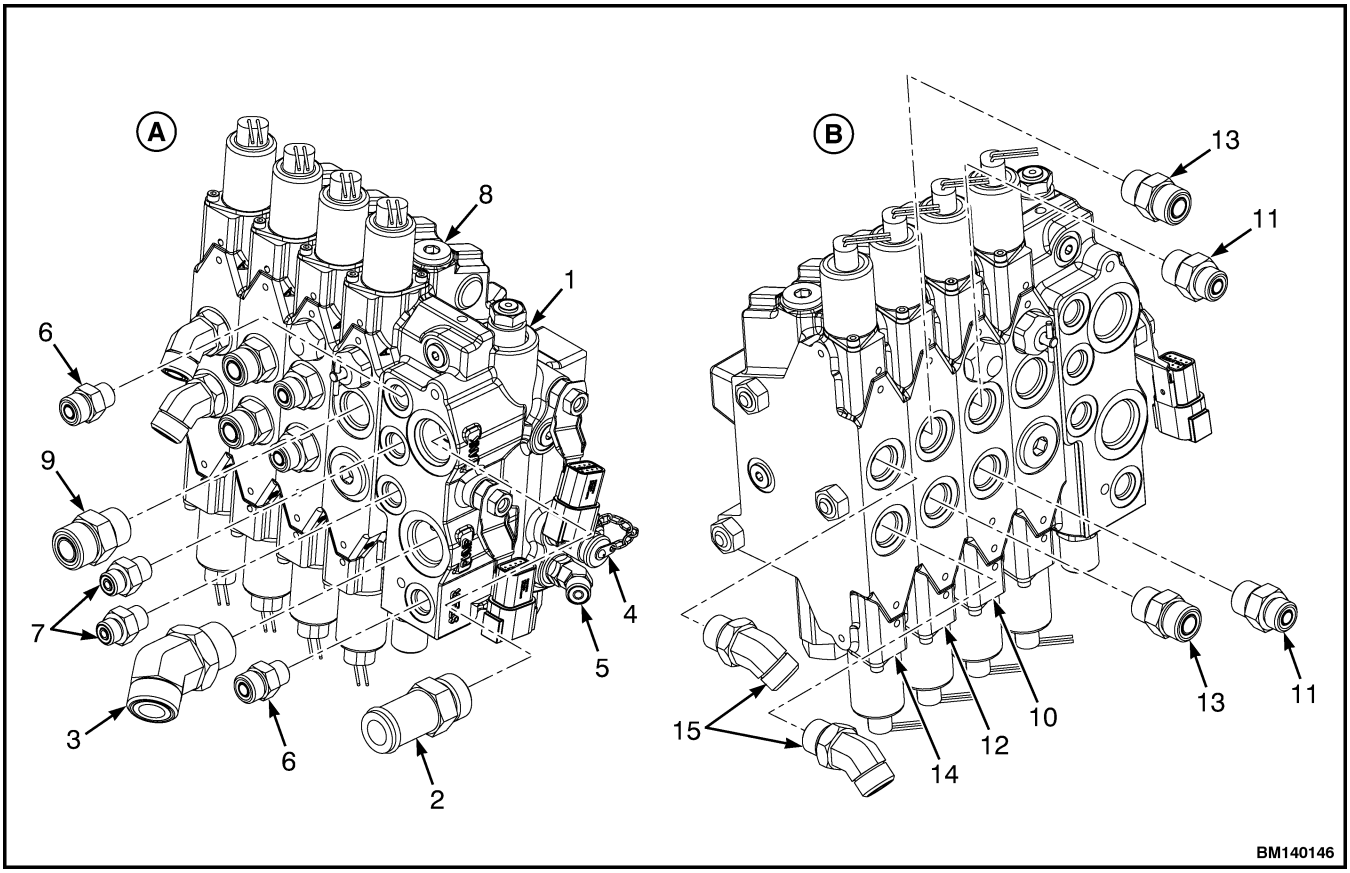
A. INLET AND LIFT SECTION FITTINGS

1. INLET SECTION
2. RETURN LINE FITTING
3. INLET FITTING
4. DIAGNOSTIC FITTING (SHOWN IN PUMP PRESSURE GAUGE PORT)
5. STEER LOAD SENSE FITTING
6. STEER FITTING
7. LIFT SECTION

B. TILT AND AUXILIARY SECTION FITTINGS

8. LIFT/LOWER FITTING
9. TILT SECTION
10. TILT FITTING
11. FIRST AUXILIARY SECTION (OPTIONAL)
12. FIRST AUXILIARY FITTING
13. SECOND AUXILIARY SECTION
14. SECOND AUXILIARY FITTING

Figure 126. E-Hydraulic Control Valve Fittings for Lift Truck E2.2-3.5XN (E45-70XN) (A268)



NOTE: 4-FUNCTION CONTROL VALVE SHOWN.

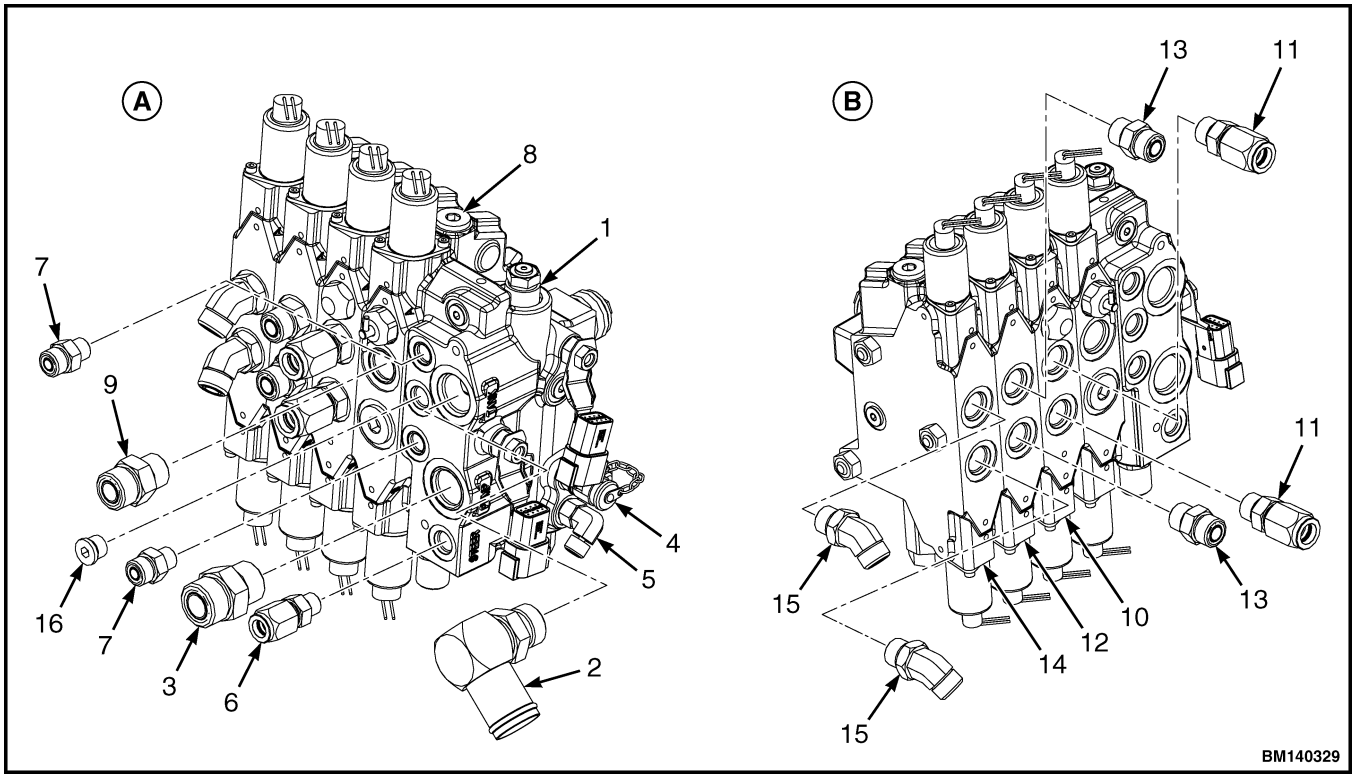
A. INLET AND LIFT SECTION FITTINGS

1. INLET SECTION
2. RETURN LINE FITTING
3. INLET FITTING
4. DIAGNOSTIC FITTING (SHOWN IN PUMP PRESSURE GAUGE PORT)
5. STEER LOAD SENSE FITTING
6. STEER FITTING
7. PARK BRAKE FITTING
8. LIFT SECTION

B. TILT AND AUXILIARY SECTION FITTINGS

9. LIFT/LOWER FITTING
10. TILT SECTION
11. TILT LINE FITTING
12. FIRST AUXILIARY SECTION
13. FIRST AUXILIARY FITTING
14. SECOND AUXILIARY SECTION
15. SECOND AUXILIARY FITTING

Figure 127. E-Hydraulic Control Valve Fittings for Lift Truck J2.2-3.5XN (J45-70XN) (A276) and J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)



NOTE: 4-FUNCTION CONTROL VALVE SHOWN.

A. INLET AND LIFT SECTION FITTINGS

1. INLET SECTION
2. RETURN LINE FITTING
3. INLET FITTING
4. DIAGNOSTIC FITTING (SHOWN IN PUMP PRESSURE GAUGE PORT)
5. STEER LOAD SENSE FITTING
6. STEER FITTING
7. PARK BRAKE FITTING
8. LIFT SECTION

B. TILT AND AUXILIARY SECTION FITTINGS

9. LIFT/LOWER FITTING
10. TILT SECTION
11. TILT LINE FITTING
12. FIRST AUXILIARY SECTION
13. FIRST AUXILIARY FITTING
14. SECOND AUXILIARY SECTION
15. SECOND AUXILIARY FITTING
16. PLUG

Figure 128. E-Hydraulic Control Valve Fittings for Lift Truck J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) Manufactured After November, 2014

Electrical Disconnect and Control Valve Dismount

1. Disconnect upper solenoid electrical connector from e-hydraulic main wire harness. See Figure 129.
2. Disconnect lower solenoid electrical connector from e-hydraulic main wire harness. See Figure 129.
3. Remove mounting capscrew and valve mounting bracket, with E-hydraulic control valve, from clip nut and bulkhead. See Figure 130.
4. Remove three capscrews, three special washers, and valve mounting bracket from E-hydraulic control valve. See Figure 130.

NOTE: Tag upper solenoid wires during removal to aid in installation.

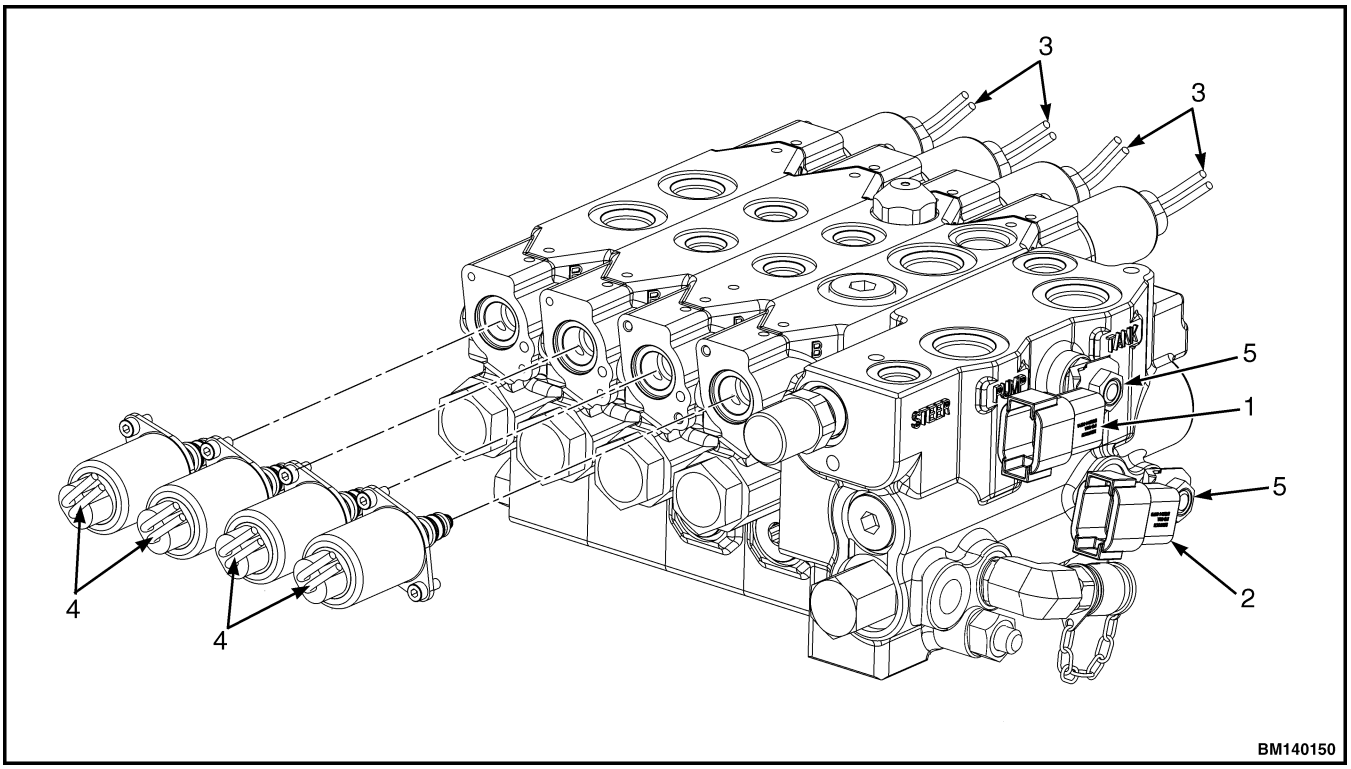
5. Disconnect upper solenoid wires from upper solenoid electrical connector. See Figure 129.

NOTE: Tag lower solenoid wires during removal to aid in installation.

6. Disconnect lower solenoid wires from lower solenoid electrical connector. See Figure 129.

NOTE: Note placement of (jam) nuts and solenoid connectors on tie rods prior to removal to aid in installation.

7. Remove two (jam) nuts, upper solenoid electrical connector, and lower solenoid electrical connector from tie rods on inlet section side. See Figure 129.

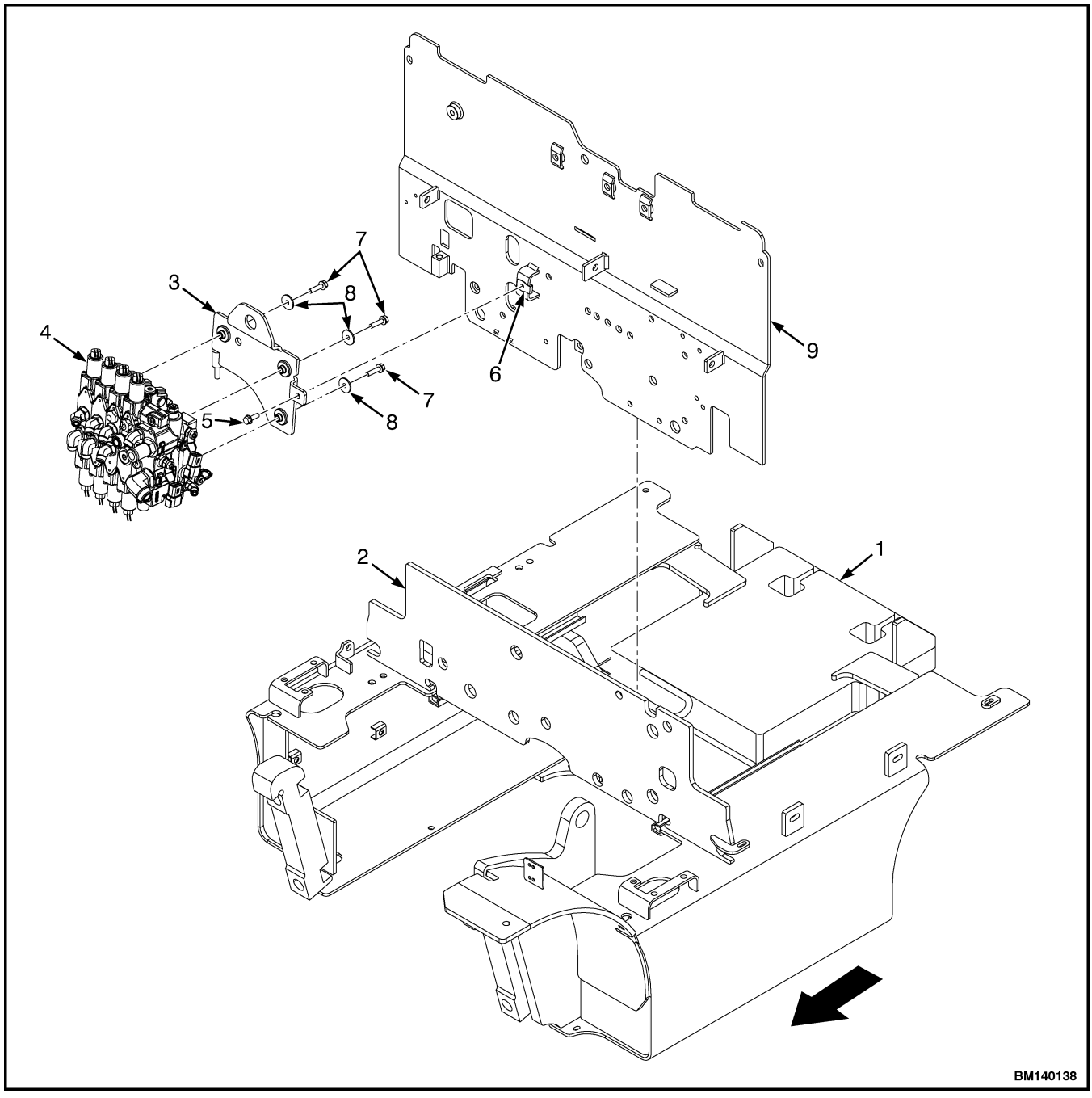


NOTE: 4-FUNCTION E-HYDRAULIC CONTROL VALVE SHOWN.

NOTE: BRAKE PORTS NOT SHOWN FOR WET BRAKE DRIVE AXLE.

1. LOWER SOLENOID ELECTRICAL CONNECTOR
2. UPPER SOLENOID ELECTRICAL CONNECTOR
3. UPPER SOLENOID WIRE
4. LOWER SOLENOID WIRE
5. (JAM) NUT

Figure 129. Solenoid Wires and Connectors



NOTE: FRAME AND FRONT BULKHEAD SHOWN ONLY FOR VALVE PLACEMENT PURPOSES.

NOTE: ARROW POINTING TO FRONT OF LIFT TRUCK.

1. FRAME
2. FRONT BULKHEAD
3. VALVE MOUNTING BRACKET
4. E-HYDRAULIC CONTROL VALVE
5. MOUNTING CAPSCREW
6. CLIP NUT
7. CAPSCREW
8. SPECIAL WASHER
9. BULKHEAD

Figure 130. E-Hydraulic Control Valve Mounting

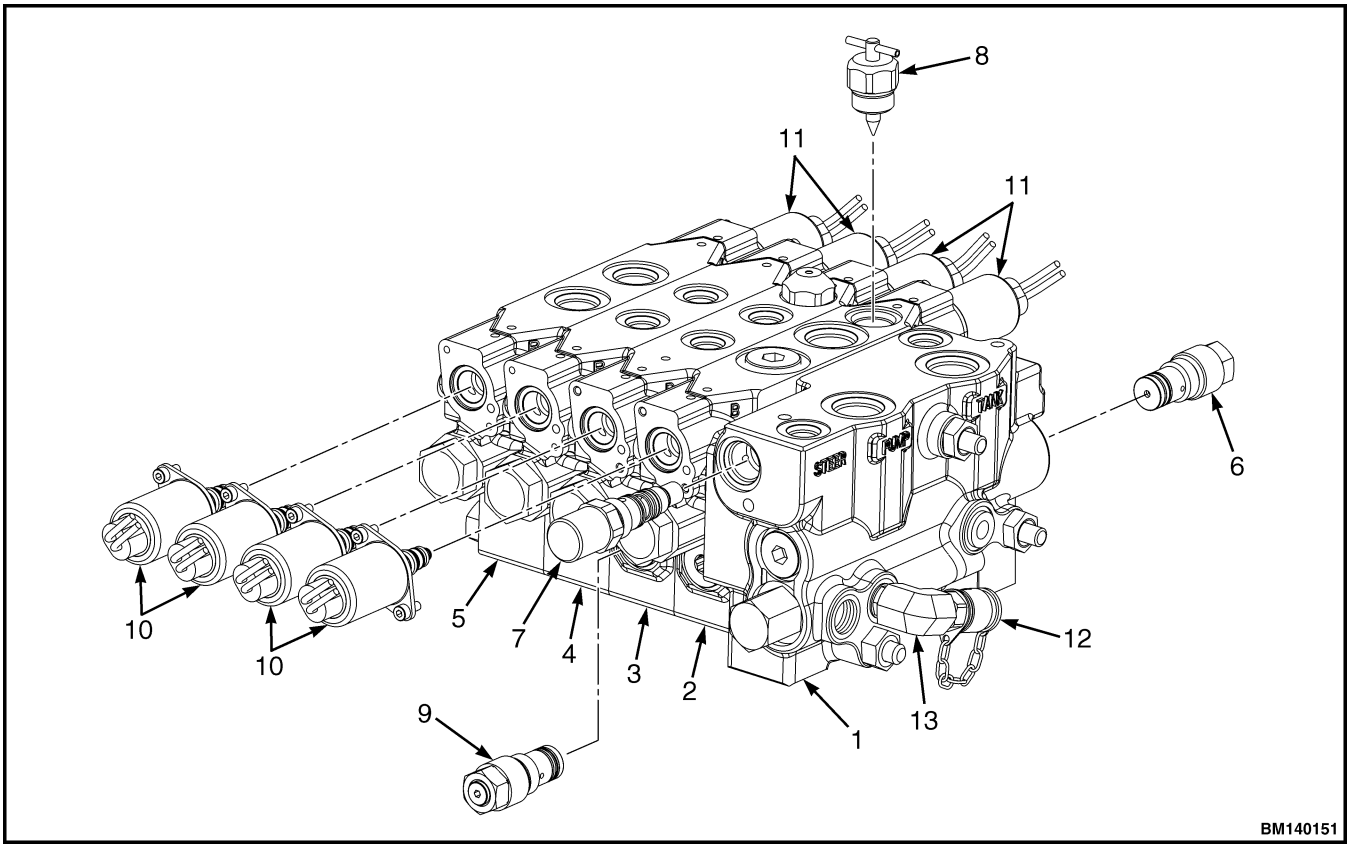
DISASSEMBLE

NOTE: The 3-function E-hydraulic control valve is **not** equipped with a first auxiliary section.

1. Remove lower solenoid from the lift, tilt, and auxiliary sections. See Figure 131.
2. Remove upper solenoid from lift, tilt, and auxiliary sections. See Figure 131.
3. Remove nuts from tie rods on outlet side of E-hydraulic control valve. See Figure 132.
4. Remove two jam nuts, upper solenoid connector, and lower solenoid connector from tie rods on inlet side. See Figure 129.

NOTE: Note placement of section seals in retaining grooves of each section prior to removal to aid in installation.

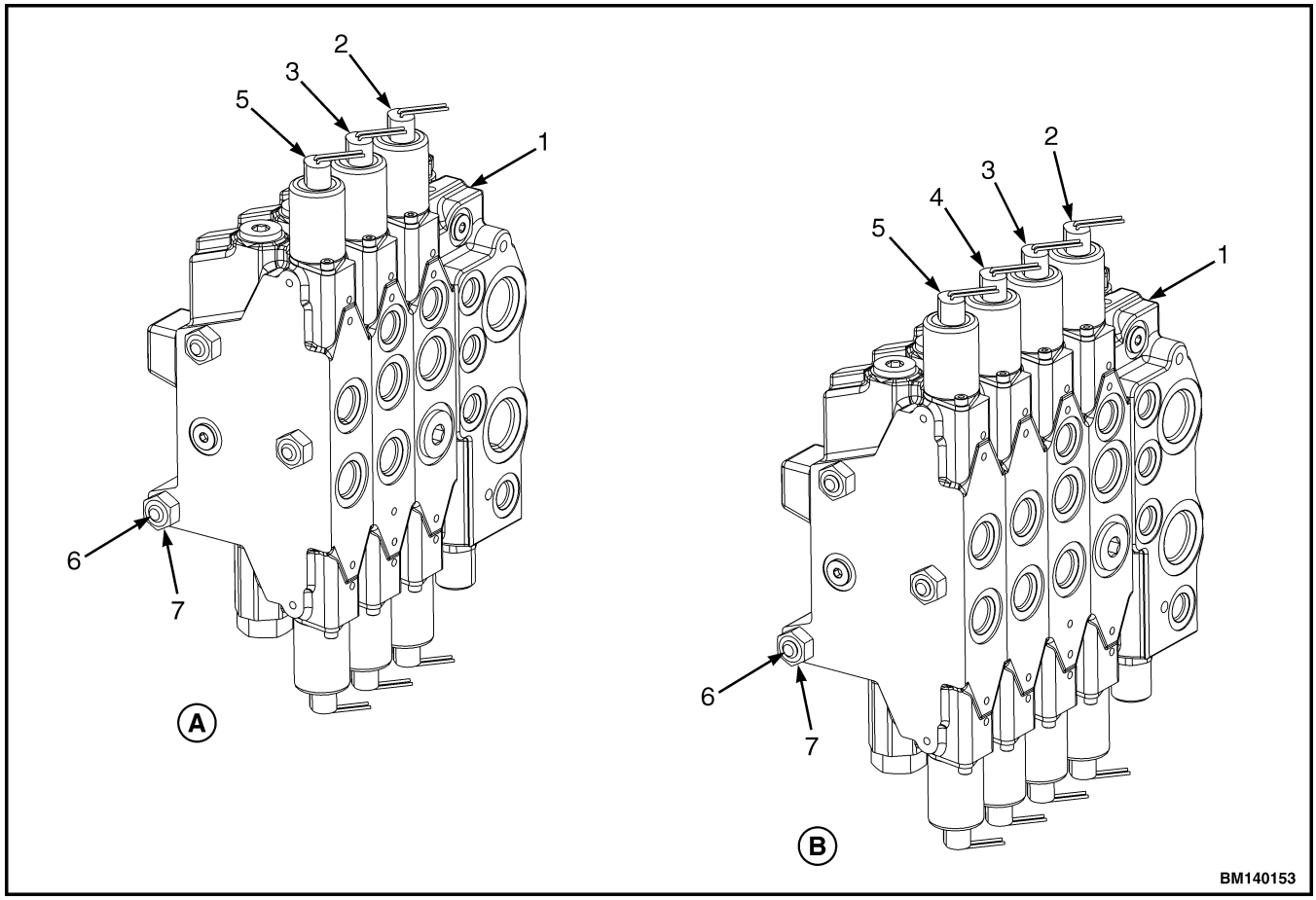
5. Remove each section from tie rods and adjacent section starting with the second auxiliary section, followed by the first auxiliary section if present, the tilt section, and the lift section. See Figure 133 for example.
6. Remove tie rods from inlet section. See Figure 133.
7. Remove and discard section seals from retaining grooves of all sections. See Figure 134 and Figure 135.



NOTE: BRAKE PORTS NOT SHOWN FOR WET BRAKE DRIVE AXLE.

1. INLET SECTION
2. LIFT SECTION
3. TILT SECTION
4. FIRST AUXILIARY SECTION (OPTIONAL)
5. SECOND AUXILIARY SECTION
6. PRIMARY RELIEF VALVE
7. PILOT CARTRIDGE
8. MANUAL LOWERING VALVE
9. SECONDARY RELIEF VALVE
10. LOWER SOLENOID
11. UPPER SOLENOID
12. DIAGNOSTIC FITTING (SHOWN IN PUMP PRESSURE GAUGE PORT)
13. ELBOW FITTING

Figure 131. E-Hydraulic Control Valve



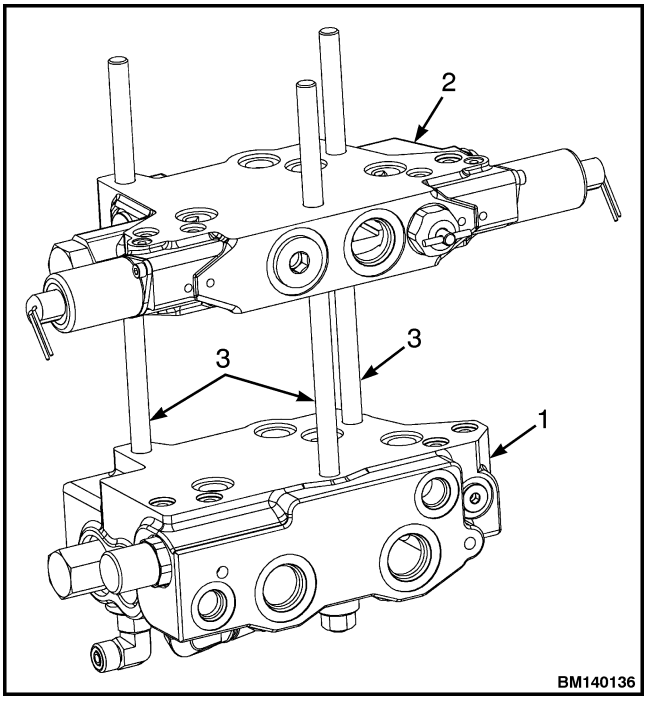
A. 3 FUNCTION E-HYDRAULIC CONTROL VALVE

1. INLET SECTION
2. LIFT SECTION
3. TILT SECTION
4. FIRST AUXILIARY SECTION (OPTIONAL)

B. 4 FUNCTION E-HYDRAULIC CONTROL VALVE

5. SECOND AUXILIARY SECTION
6. TIE ROD
7. NUT

Figure 132. E-Hydraulic Control Valve Sections



NOTE: BRAKE PORTS NOT SHOWN FOR WET BRAKE DRIVE AXLE.

1. INLET SECTION
2. LIFT SECTION
3. TIE ROD

Figure 133. E-Hydraulic Control Valve - Sections and Tie Rods

8. Remove pilot cartridge from inlet section. Remove and discard O-rings from pilot cartridge. See Figure 131 and Figure 134.

9. Remove primary relief valve from inlet section. Remove and discard O-rings and backup ring from primary relief valve. See Figure 131 and Figure 134.

10. Remove compensator plug from inlet section. Remove and discard O-ring from plug. See Figure 134.

11. Remove elbow fitting and diagnostic fitting from inlet section. Remove and discard O-ring from elbow fitting. See Figure 134.

12. Remove manual lowering valve from lift section. Remove and discard O-ring from valve. See Figure 135.

13. Remove lift section plug from lift section. Remove and discard O-ring from plug. See Figure 135.

14. Remove port option plug from tilt section. Remove and discard O-ring from plug. See Figure 135.

15. Remove secondary relief valve or tilt section plug from tilt section. Remove and discard O-rings and backup rings from valve or plug. See Figure 135.

CLEAN

WARNING

Cleaning solvents can be flammable and toxic and cause skin irritation. When using cleaning solvents, always follow the solvent manufacturer's recommended safety procedures.

WARNING

Compressed air can move particles so they cause injury to the user or to other personnel. Make sure the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eyes.

1. Clean only metal components of E-hydraulic control valve with solvent and dry using compressed air. Avoid getting solvent in electrical connectors.

2. Clean all threaded components with denatured alcohol and dry using compressed air.

3. Clean rubber or plastic components with warm soapy water and dry with a lint free cloth.

INSPECT

1. Inspect section bodies for damage. Replace if damaged.

2. Inspect threaded components to ensure absence of oil or solvent residue.

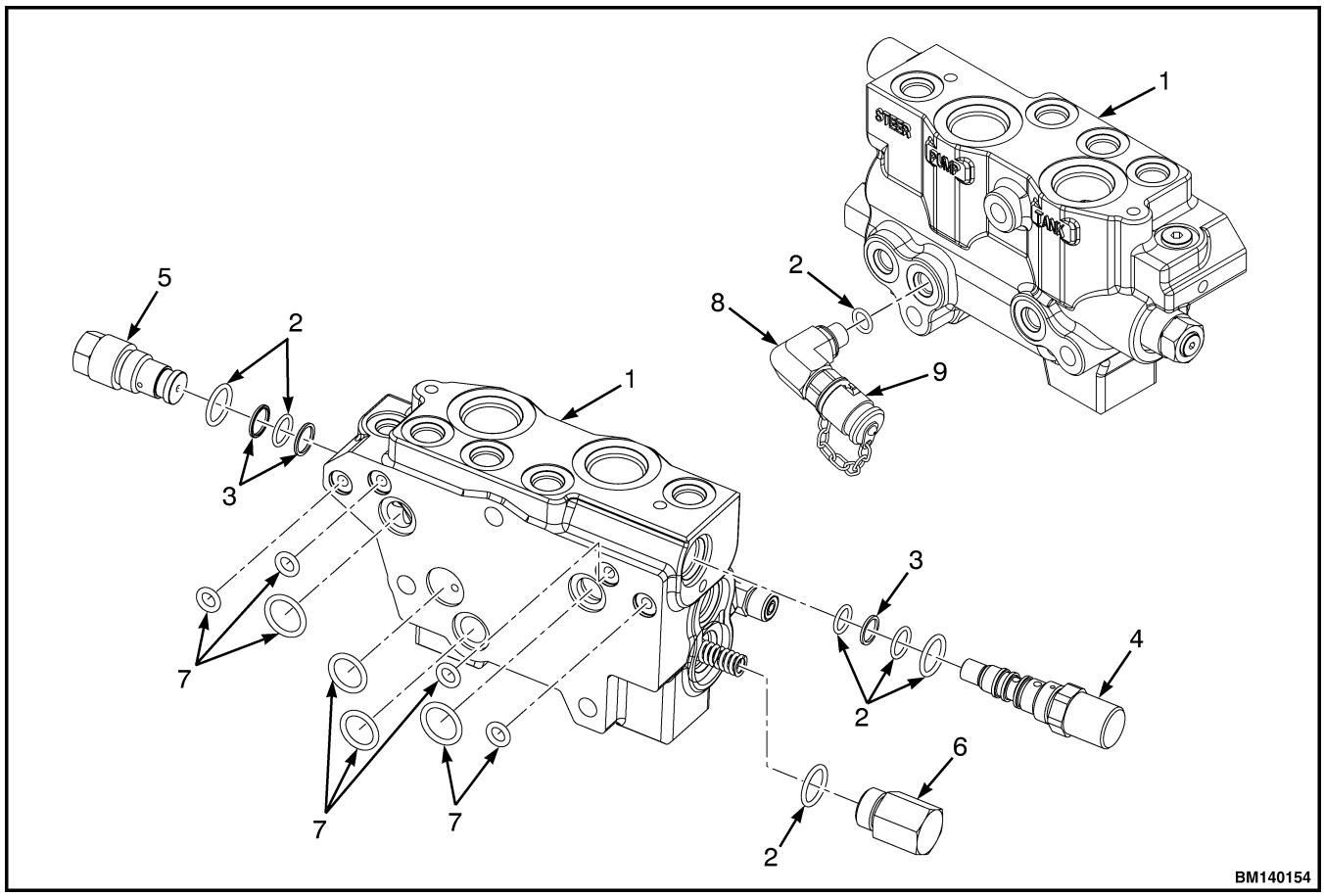
3. Inspect all other components for damage. Replace if damaged.

ASSEMBLE

NOTE: Lubricate all new O-rings and backup rings with clean hydraulic oil prior to installation. **DO NOT** lubricate section seals.

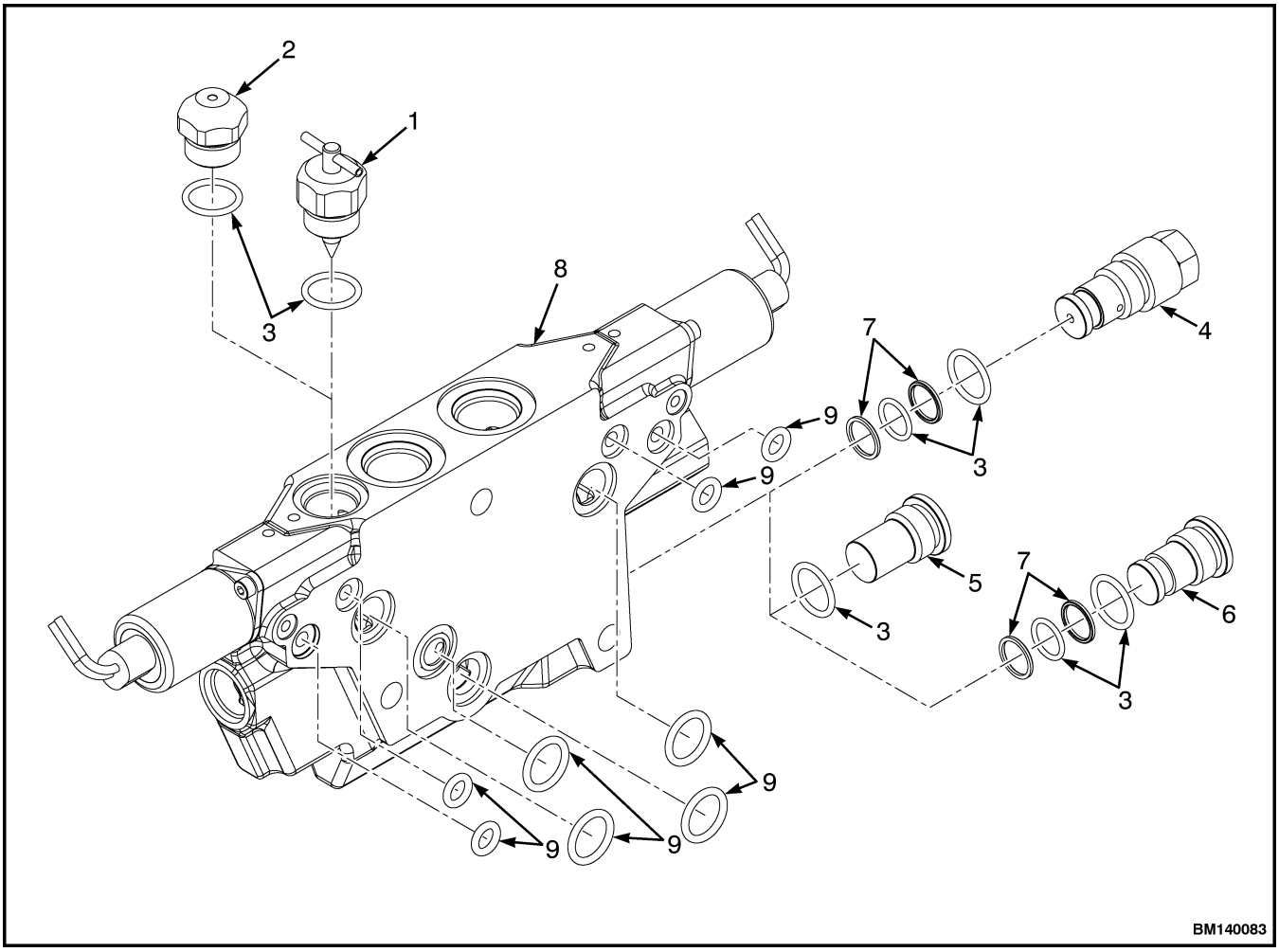
NOTE: Perform Step 1 if E-hydraulic control valve is **NOT** equipped with secondary relief valve.

1. Install new O-rings, new backup rings, and tilt section plug into tilt section. See Figure 136. Tighten tilt section plug to 27 N•m (20 lbf ft).
2. Install O-rings, new backup rings, and secondary relief valve into tilt section. See Figure 136. Tighten secondary relief valve to 27 N•m (20 lbf ft).
3. Install new O-ring and port option plug onto tilt section. See Figure 136. Tighten port option plug to 54 N•m (40 lbf ft).
4. Install new O-ring and lift section plug onto lift section. See Figure 136. Tighten lift section plug to 27 N•m (20 lbf ft).
5. Install new O-ring and manual lowering valve onto lift section. See Figure 136. Tighten manual lowering valve to 54 N•m (40 lbf ft).
6. Install new O-ring onto elbow fitting. Install diagnostic fitting onto elbow fitting. Install elbow fitting into inlet section. See Figure 137. Tighten elbow fitting to 16 N•m (142 lbf in).



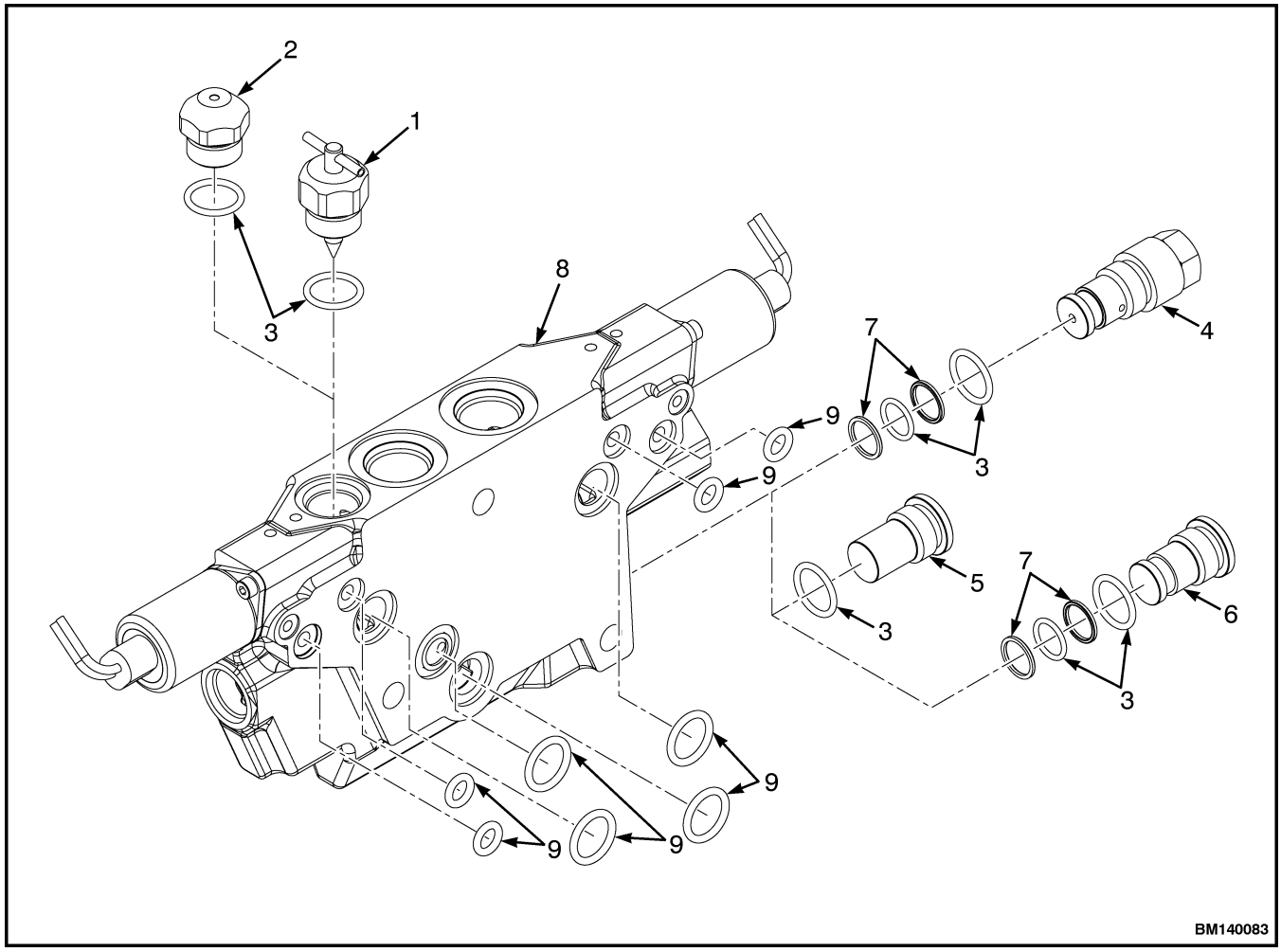
1. INLET SECTION
2. O-RING
3. BACKUP RING
4. PILOT CARTRIDGE
5. PRIMARY RELIEF VALVE
6. COMPENSATOR PLUG
7. SECTION SEAL
8. ELBOW FITTING
9. DIAGNOSTIC FITTING (SHOWN IN PUMP PRESSURE GAUGE PORT)

Figure 134. Inlet Section E-Hydraulic Control Valve



1. MANUAL LOWERING VALVE
2. PORT OPTION PLUG
3. O-RING
4. SECONDARY RELIEF VALVE
5. LIFT SECTION PLUG
6. TILT SECTION PLUG
7. BACKUP RING
8. LIFT/TILT/AUXILIARY SECTION
9. SECTION SEAL

Figure 135. Lift/Tilt/Auxiliary Sections E-Hydraulic Control Valve



1. MANUAL LOWERING VALVE
2. PORT OPTION PLUG
3. O-RING
4. SECONDARY RELIEF VALVE
5. LIFT SECTION PLUG
6. TILT SECTION PLUG
7. BACKUP RING
8. LIFT/TILT/AUXILIARY SECTION
9. SECTION SEAL

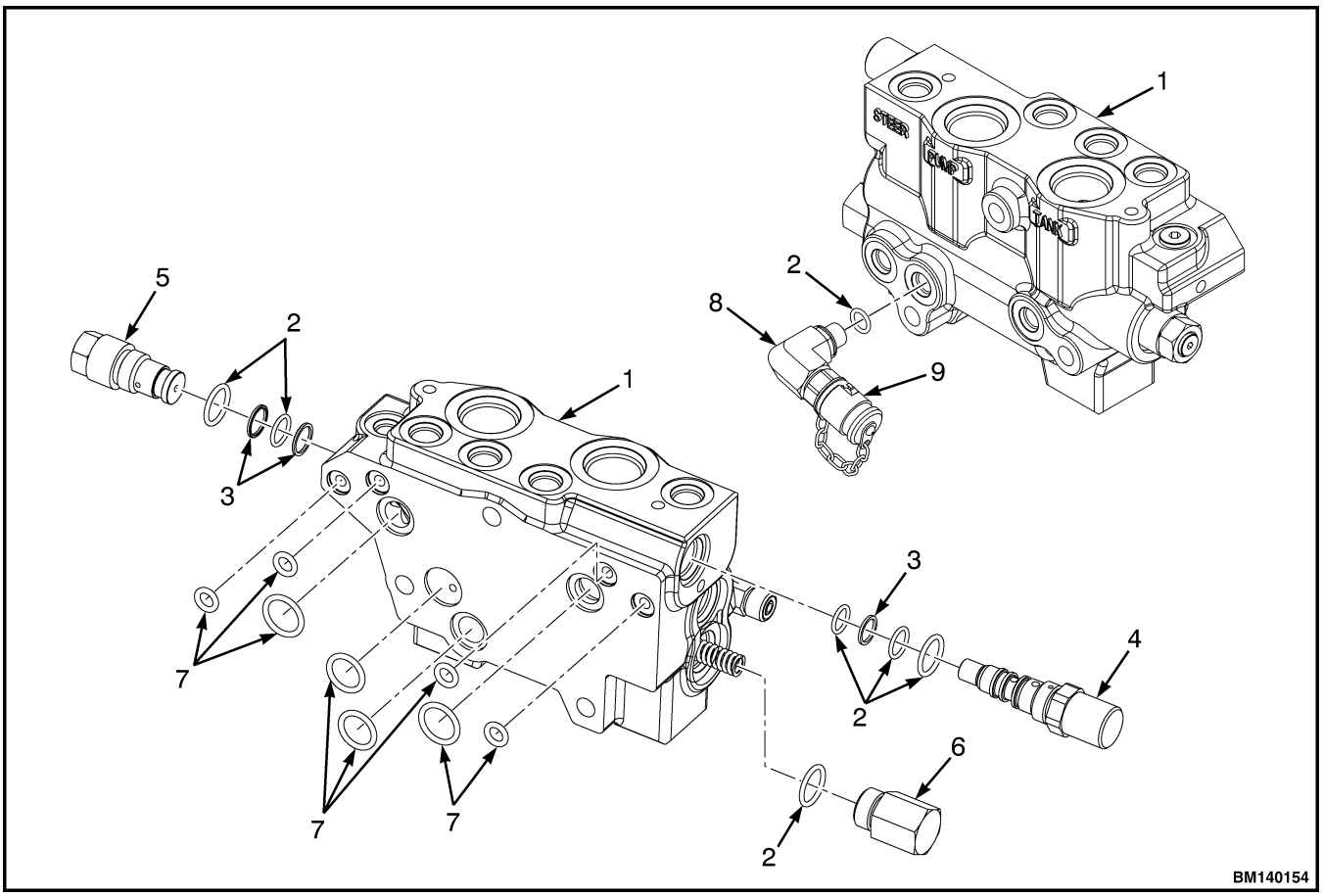
Figure 136. Lift/Tilt/Auxiliary Sections - E-Hydraulic Control Valve

7. Install new O-ring onto compensator plug. Install compensator plug into inlet section. See Figure 137.

8. Install new O-rings and backup rings onto primary relief valve. Install primary relief valve into inlet section. See Figure 137. Tighten primary relief valve to 27 N•m (20 lbf ft).

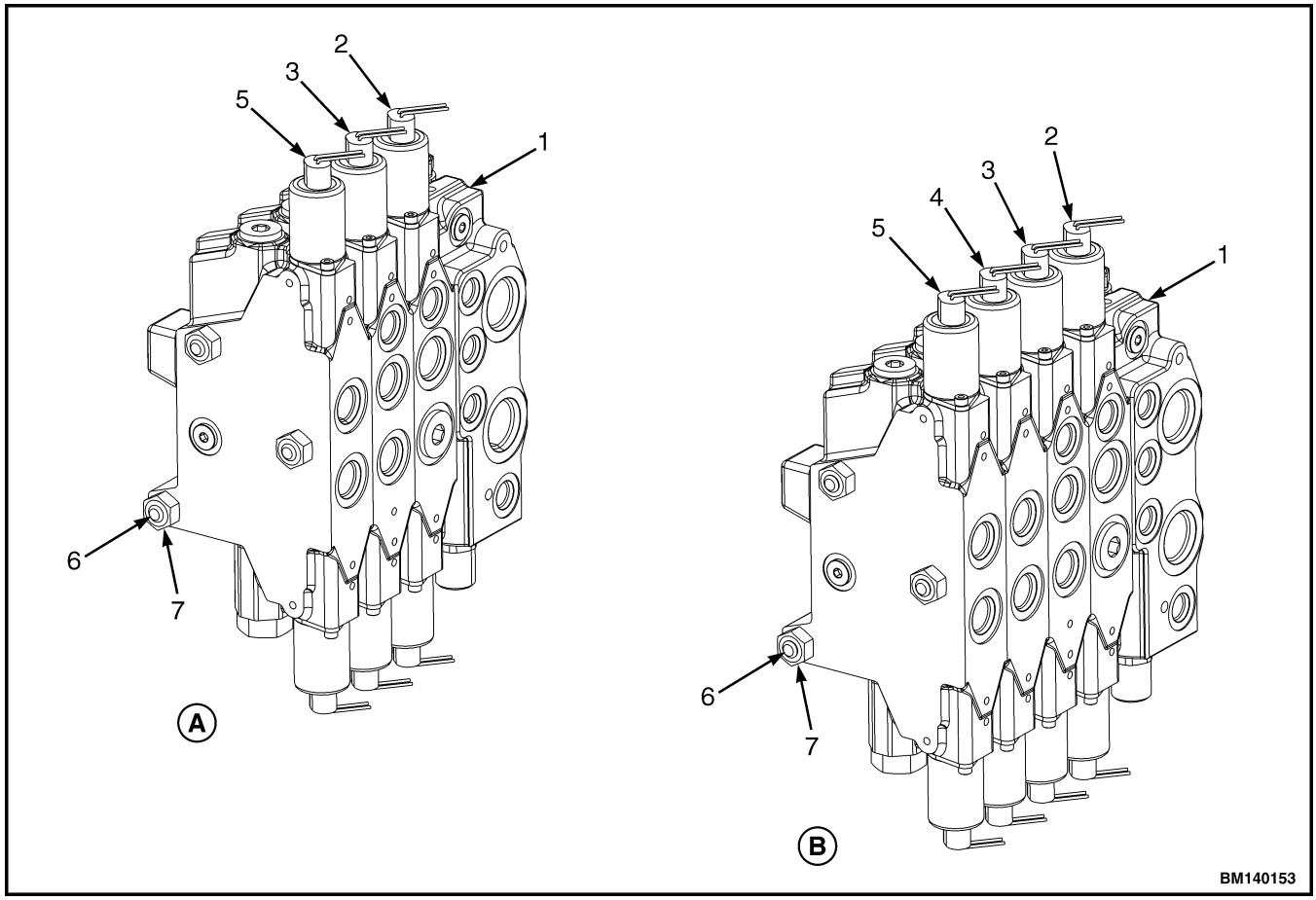
9. Install new O-rings and new backup rings onto pilot cartridge. Install pilot cartridge into inlet section. See Figure 137. Tighten pilot cartridge to 65 N•m (48 lbf ft).

10. If removed, install nuts on inlet side of tie rods. See Figure 138. Hand tighten nuts only at this time.



1. INLET SECTION
2. O-RING
3. BACKUP RING
4. PILOT CARTRIDGE
5. PRIMARY RELIEF VALVE
6. COMPENSATOR PLUG
7. SECTION SEAL
8. ELBOW FITTING
9. DIAGNOSTIC FITTING (SHOWN IN PUMP PRESSURE GAUGE PORT)

Figure 137. Inlet Section - E-Hydraulic Control Valve



A. 3-FUNCTION E-HYDRAULIC CONTROL VALVE

1. INLET SECTION
2. LIFT SECTION
3. TILT SECTION
4. FIRST AUXILIARY SECTION (OPTIONAL)

B. 4-FUNCTION E-HYDRAULIC CONTROL VALVE

5. SECOND AUXILIARY SECTION
6. TIE ROD
7. NUT

Figure 138. E-Hydraulic Control Valve Sections

11. Install tie rod end without nut through inlet section. See Figure 133 for example.

12. Apply thread locker to tie rod ends. Install upper solenoid connector and (jam) nut, as noted during disassembly, onto tie rod end. See Figure 140.

13. Position upper solenoid electrical connector as shown in Figure 141 and hand tighten (jam) nut.

14. Install lower solenoid electrical connector and (jam) nut, as noted during disassembly, onto tie rod end. See Figure 140.

15. Position lower solenoid electrical connector as shown in Figure 141 and hand tighten jam nut.

NOTE: **DO NOT** lubricate section seals.

16. Install section seals into retaining grooves in inlet section face. See Figure 137.

17. Install lift section onto tie rods against inlet section. See Figure 139 for example.

18. Install section seals into retaining grooves in lift section face. See Figure 136.

19. Install tilt section onto tie rods against lift section. See Figure 139 for example.

20. Install section seals into retaining grooves in tilt section face. See Figure 136.

NOTE: The 3-function E-hydraulic control valve is **not** equipped with a first auxiliary section.

21. Install first auxiliary section onto tie rods against tilt section. See Figure 139 for example.

22. Install section seals into retaining grooves on first auxiliary section face. See Figure 136.

23. Install second auxiliary section onto tie rods against first auxiliary section. See Figure 139 for example.

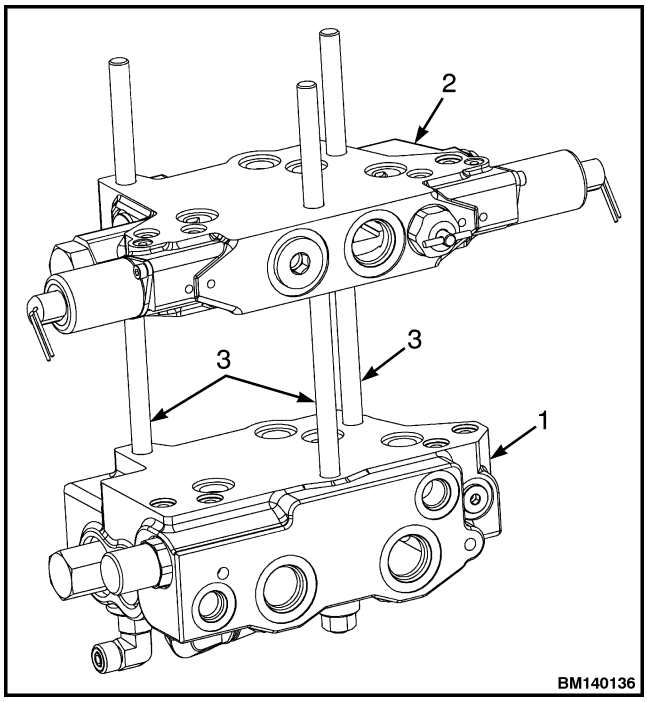
24. Install nuts on tie rods on outlet side of E-hydraulic control valve. See Figure 138. Hand tighten nuts only at this time.

NOTE: Tie rods to extend one or two threads beyond nut on each end.

25. After ensuring tie rods are completely through all sections of E-hydraulic control valve tighten nuts on both inlet and outlet side to 20.3 ± 1.4 N•m (179.7 ± 12.4 lbf in).

26. Tighten (jam) nuts to 7 to 11 N•m (62 to 97 lbf in) keeping connectors at the correct angle, as shown in Figure 141.

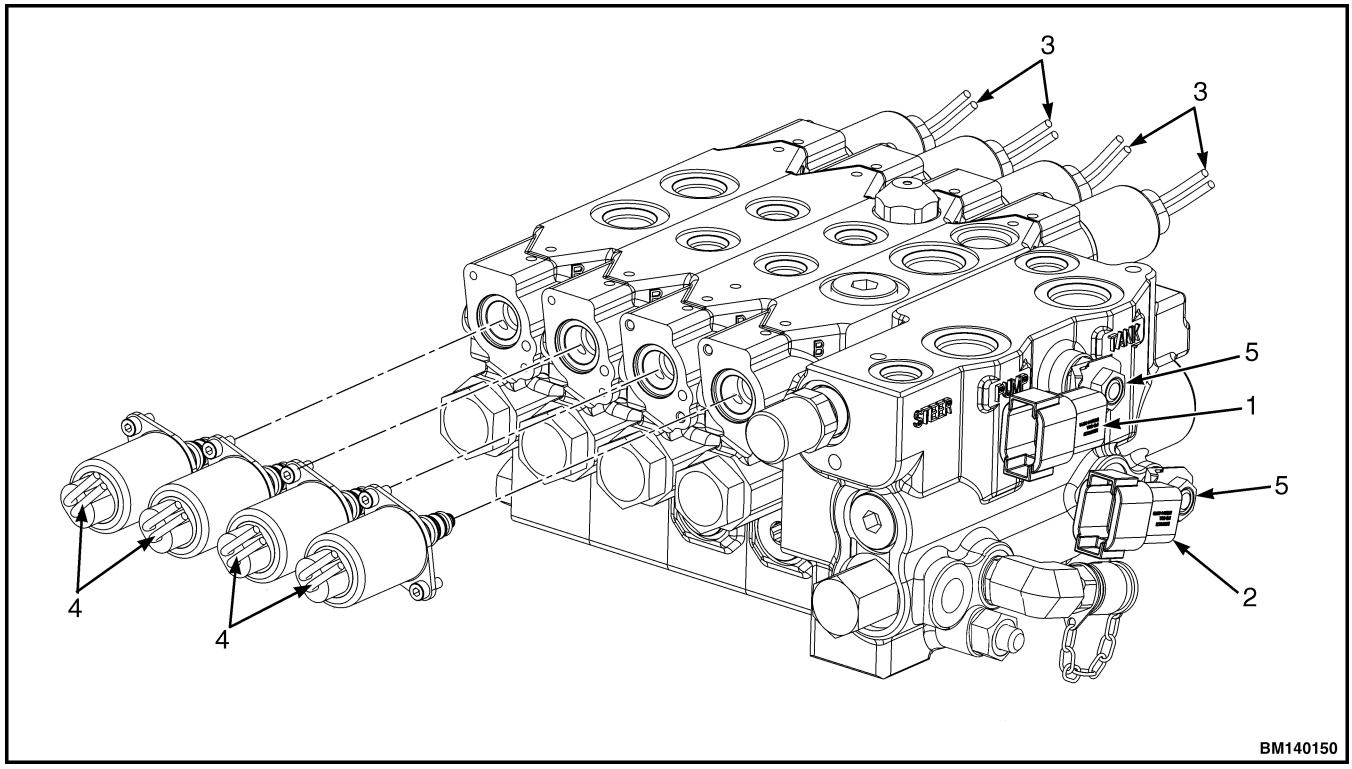
27. Install upper solenoid into lift, tilt, and auxiliary sections. See Figure 142. Tighten upper solenoids to 5 N•m (48 lbf in).



NOTE: BRAKE PORTS NOT SHOWN FOR WET BRAKE DRIVE AXLE.

1. INLET SECTION
2. LIFT SECTION
3. TIE ROD

Figure 139. E-Hydraulic Control Valve - Sections and Tie Rods

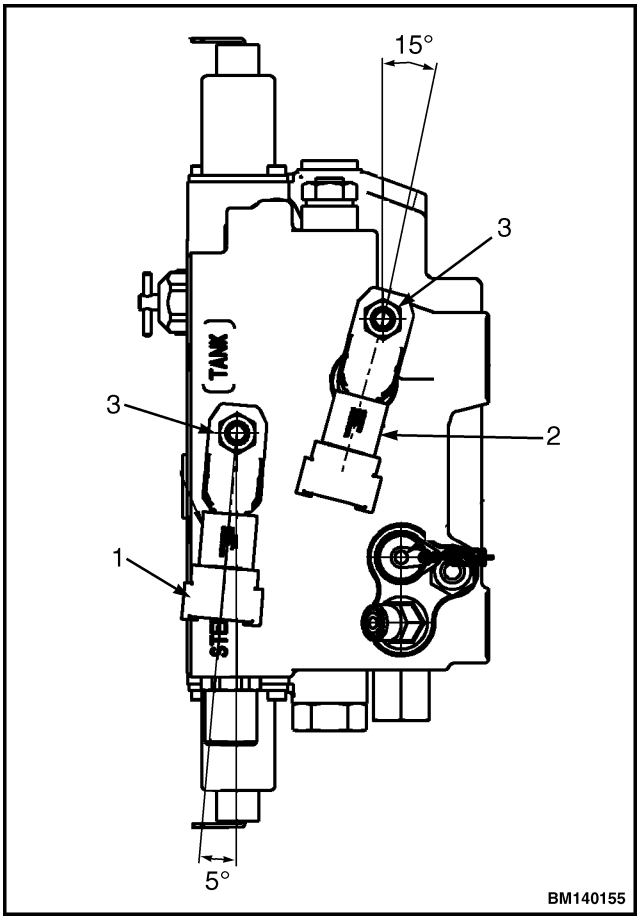


NOTE: 4-FUNCTION E-HYDRAULIC CONTROL VALVE SHOWN.

NOTE: BRAKE PORTS NOT SHOWN FOR WET BRAKE DRIVE AXLE.

1. LOWER SOLENOID ELECTRICAL CONNECTOR
2. UPPER SOLENOID ELECTRICAL CONNECTOR
3. UPPER SOLENOID WIRE
4. LOWER SOLENOID WIRE
5. (JAM) NUT

Figure 140. Solenoid Wires and Connectors



1. UPPER SOLENOID ELECTRICAL CONNECTOR
2. LOWER SOLENOID ELECTRICAL CONNECTOR
3. (JAM) NUT

Figure 141. E-Hydraulic Solenoid Electrical Connectors

28. Install lower solenoid into lift, tilt, dual auxiliary, and auxiliary sections. See Figure 142. Tighten lower solenoids to 5 N•m (48 lbf in).

INSTALL

Electrical Connect and Control Valve Mount

1. Connect lower solenoid wires to lower solenoid connector as tagged during removal. See Table 9 and Figure 140.

Table 9. Lower Solenoid Connector Pin Layout

Pin	Socket	Pin	Socket
PIN 8	1B NEG	**PIN 1**	1B POS
PIN 7	2B NEG	**PIN 2**	2B POS
PIN 6	3B NEG	**PIN 3**	3B POS
PIN 5	4B NEG	**PIN 4**	4B POS

2. Connect upper solenoid wires to upper solenoid connector as tagged during removal. See Table 10 and Figure 140.

Table 10. Upper Solenoid Connector Pin Layout

Pin	Socket	Pin	Socket
PIN 8	1A NEG	**PIN 1**	1A POS
PIN 7	2A NEG	**PIN 2**	2A POS
PIN 6	3A NEG	**PIN 3**	3A POS
PIN 5	4A NEG	**PIN 4**	4A POS

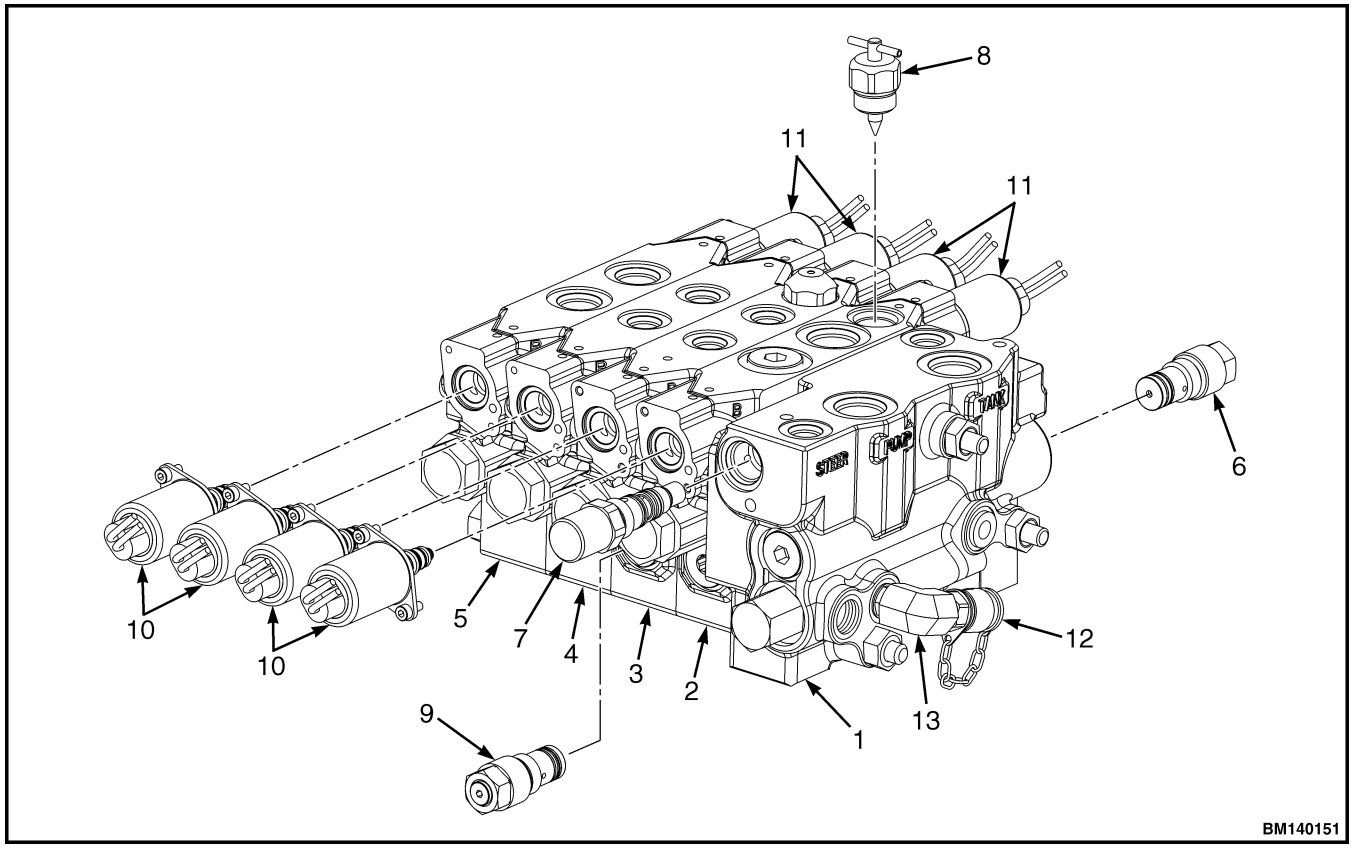
3. Install three special washers, valve mounting bracket, and three capscrews onto E-hydraulic control valve. See Figure 143.

4. Install clip nut onto bulkhead. See Figure 143.

5. Install valve mounting bracket, with E-hydraulic control valve attached, onto bulkhead. Install mounting capscrew into clip nut and bulkhead. See Figure 143.

6. Connect upper solenoid electrical connector to e-hydraulic main wire harness.

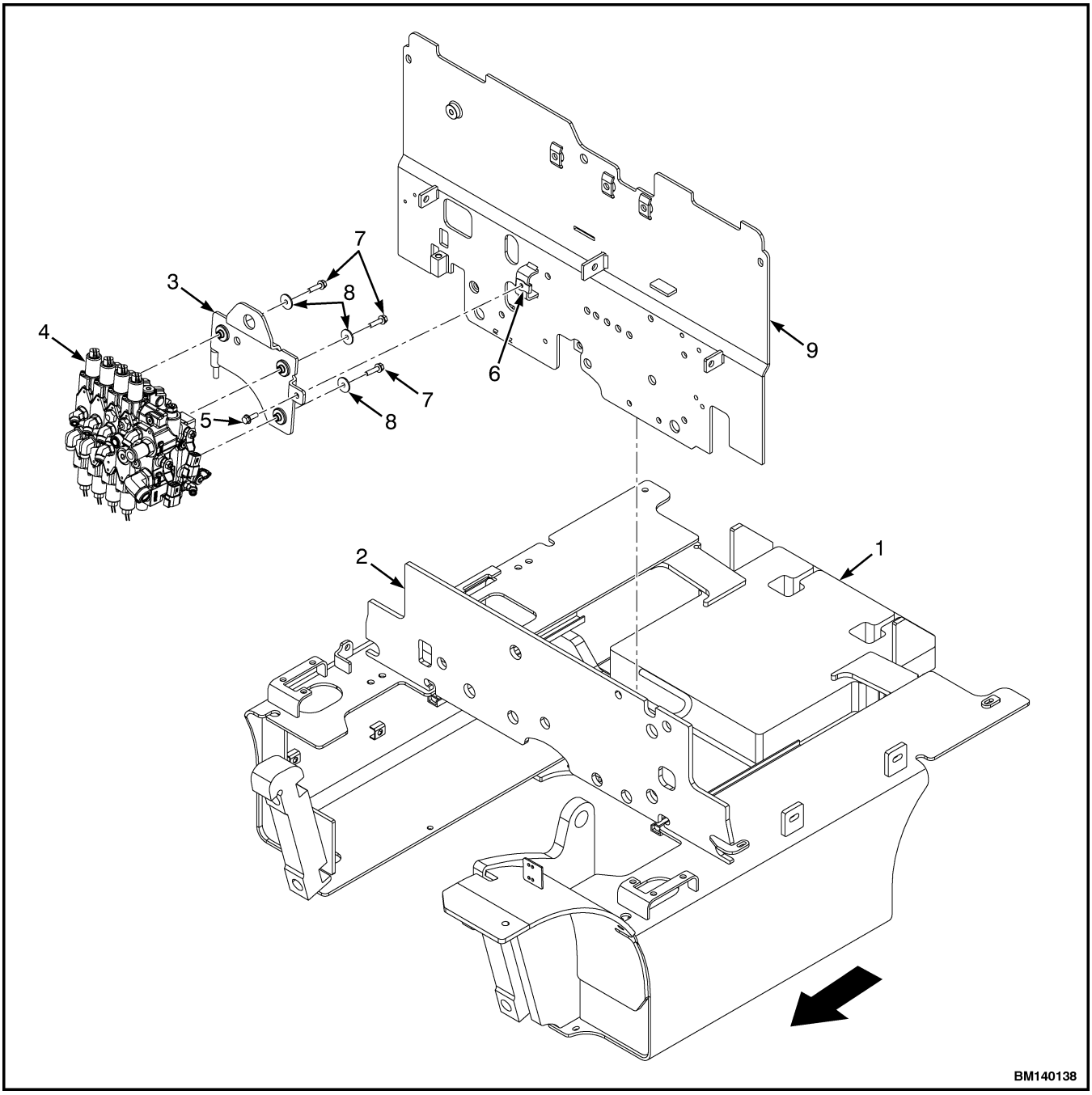
7. Connect lower solenoid electrical connector to e-hydraulic main wire harness.



NOTE: BRAKE PORTS NOT SHOWN FOR WET BRAKE DRIVE AXLE.

1. INLET SECTION
2. LIFT SECTION
3. TILT SECTION
4. FIRST AUXILIARY SECTION (OPTIONAL)
5. SECOND AUXILIARY SECTION
6. PRIMARY RELIEF VALVE
7. PILOT CARTRIDGE
8. MANUAL LOWERING VALVE
9. SECONDARY RELIEF VALVE
10. LOWER SOLENOID
11. UPPER SOLENOID
12. DIAGNOSTIC FITTING (SHOWN IN PUMP PRESSURE GAUGE PORT)
13. ELBOW FITTING

Figure 142. E-Hydraulic Control Valve



NOTE: FRAME AND FRONT BULKHEAD SHOWN ONLY FOR VALVE PLACEMENT PURPOSES.

NOTE: ARROW POINTING TO FRONT OF LIFT TRUCK.

1. FRAME
2. FRONT BULKHEAD
3. VALVE MOUNTING BRACKET
4. E-HYDRAULIC CONTROL VALVE
5. MOUNT CAPSCREW
6. CLIP NUT
7. CAPSCREW
8. SPECIAL WASHER
9. BULKHEAD

Figure 143. E-Hydraulic Control Valve Mounting

Fitting Installation for Lift Truck E2.2-3.5XN (E45-70XN) (A268)

NOTE: Lubricate new O-rings with clean hydraulic oil prior to installation.

1. Install new O-rings onto 4th function fittings. Install 4th function fittings into auxiliary section. See Figure 144.

NOTE: Perform Step 2 if control valve is equipped with first auxiliary section.

2. Install new O-rings onto first auxiliary fittings. Install first auxiliary fittings into first auxiliary section. See Figure 144.
3. Install new O-rings onto tilt fittings. Install tilt fittings into tilt section. See Figure 144.
4. Install new O-ring onto lift/lower fitting. Install lift/lower fitting into lift section. See Figure 144.
5. Install new O-ring onto steer load sense fitting. Install steer load sense fitting into inlet section. See Figure 144.
6. Install new O-rings onto steer fittings. Install steer fittings into inlet section. See Figure 144.
7. Install new O-ring onto inlet fitting. Install inlet fitting into inlet section. See Figure 144.
8. Install new O-ring onto return line fitting. Install return line fitting into inlet section. See Figure 144.

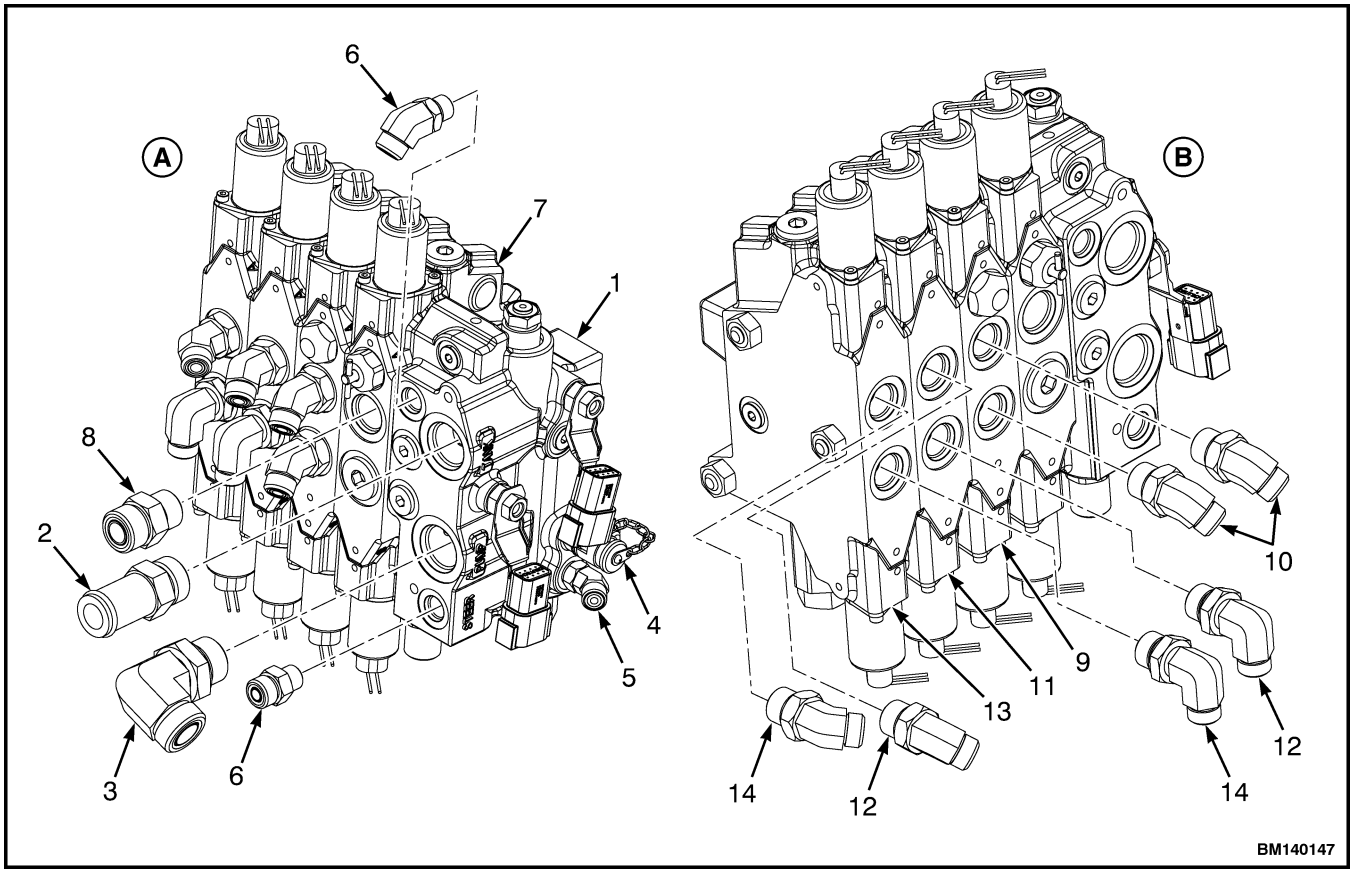
Fitting Installation for Lift Truck J2.2-3.5XN (J45-70XN) (A276) and J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

NOTE: Lubricate new O-rings with clean hydraulic oil prior to installation.

1. Install new O-rings onto second auxiliary fittings. Install second auxiliary fittings into second auxiliary section. See Figure 145.

NOTE: Perform Step 2 if control valve is equipped with dual auxiliary section.

2. Install new O-rings onto 3rd function auxiliary fittings. Install 3rd function auxiliary fittings into dual auxiliary section. See Figure 145.
3. Install new O-rings onto tilt fittings. Install tilt fittings into tilt section. See Figure 145.
4. Install new O-ring onto lift/lower fitting. Install lift/lower fitting into lift section. See Figure 145.
5. Install new O-rings onto steer load sense fitting. Install steer load sense fitting into inlet section. See Figure 145.
6. Install new O-rings onto park brake fittings. Install park brake fittings into inlet section. See Figure 145.
7. Install new O-rings onto steer fittings. Install steer fittings into inlet section. See Figure 145.
8. Install new O-ring onto inlet fitting. Install inlet fitting into inlet section. See Figure 145.
9. Install new O-ring onto return line fitting. Install return line fitting into inlet section. See Figure 145.



NOTE: 4-FUNCTION CONTROL VALVE SHOWN.

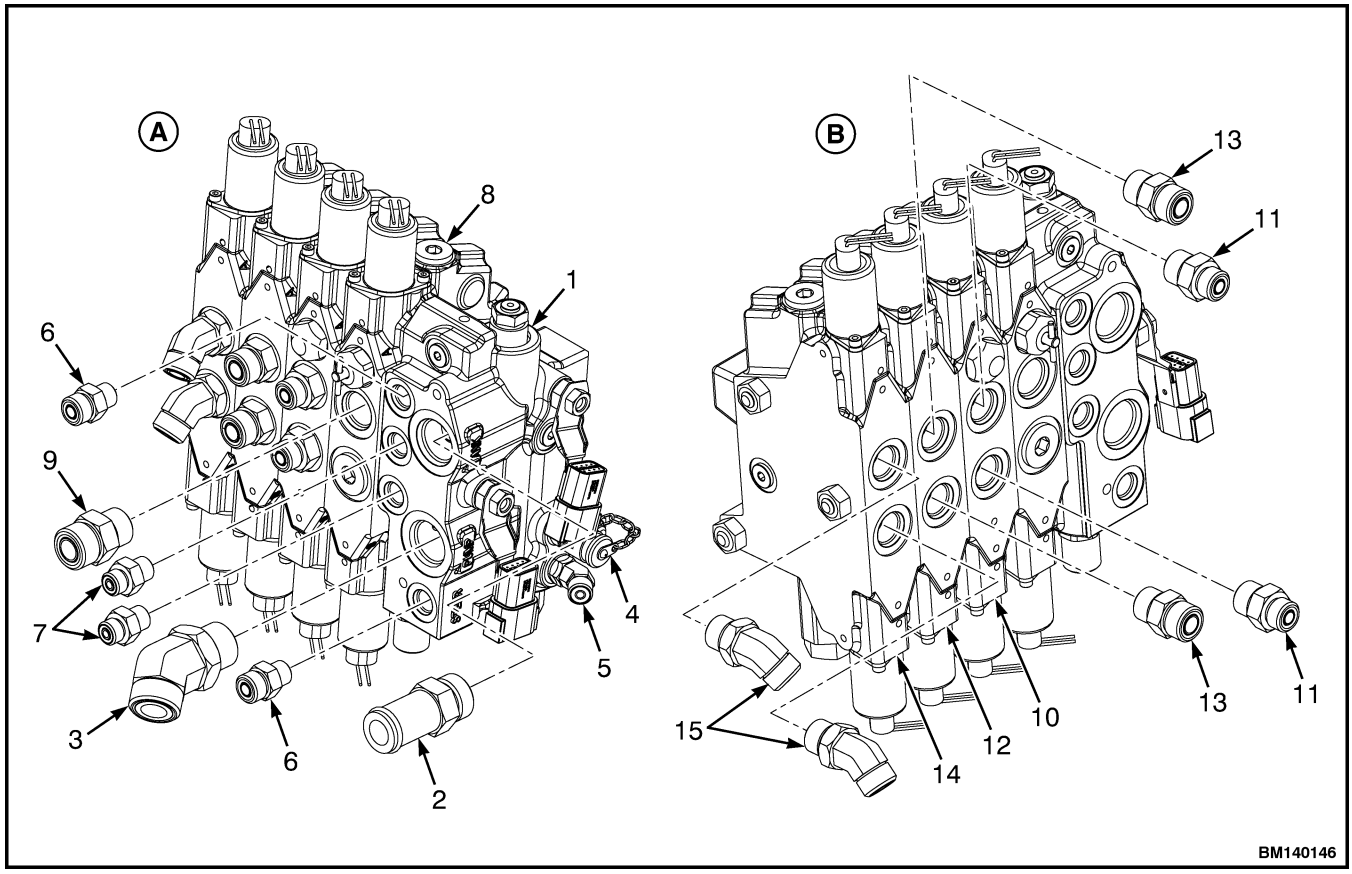
A. INLET AND LIFT SECTION FITTINGS

1. INLET SECTION
2. RETURN LINE FITTING
3. INLET FITTING
4. DIAGNOSTIC FITTING (SHOWN IN PUMP PRESSURE GAUGE PORT)
5. STEER LOAD SENSE FITTING
6. STEER FITTING
7. LIFT SECTION

B. TILT AND AUXILIARY SECTION FITTINGS

8. LIFT/LOWER FITTING
9. TILT SECTION
10. TILT FITTING
11. FIRST AUXILIARY SECTION (OPTIONAL)
12. FIRST AUXILIARY FITTING
13. SECOND AUXILIARY SECTION
14. SECOND AUXILIARY FITTING

Figure 144. E-Hydraulic Control Valve Fittings for Lift Truck E2.2-3.5XN (E45-70XN) (A268)



NOTE: 4-FUNCTION CONTROL VALVE SHOWN.

A. INLET AND LIFT SECTION FITTINGS

1. INLET SECTION
2. RETURN LINE FITTING
3. INLET FITTING
4. DIAGNOSTIC FITTING (SHOWN IN PUMP PRESSURE GAUGE PORT)
5. STEER LOAD SENSE FITTING
6. STEER FITTING
7. PARK BRAKE FITTING
8. LIFT SECTION

B. TILT AND AUXILIARY SECTION FITTINGS

9. LIFT/LOWER FITTING
10. TILT SECTION
11. TILT LINE FITTING
12. FIRST AUXILIARY SECTION
13. FIRST AUXILIARY FITTING
14. SECOND AUXILIARY SECTION
15. SECOND AUXILIARY FITTING

Figure 145. E-Hydraulic Control Valve Fittings for Lift Truck J2.2-3.5XN (J45-70XN) (A276) and J4.0-5.0XN (J80-100XN) (A970)

Ending Steps

NOTE: Remove caps from hydraulic lines as they are connected to appropriate fitting.

1. Connect hydraulic lines to fittings as tagged during removal.

CAUTION

Disposal of lubricants and fluids must meet local environmental regulations.

2. Dispose of drain pan contents.
3. Check hydraulic oil level; refill system as needed. For type of oil required and fill procedures, see

   Periodic Maintenance 8000SRM1364 for lift truck
   - E2.2-3.5XN (E45-70XN) (A268)

   Periodic Maintenance 8000SRM1372 for lift truck
   - J2.2-3.5XN (J45-70XN) (A276)

   Periodic Maintenance 8000SRM1541 for lift truck
   - J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

4. Install floor plates and floor mats.
5. Install battery. See **How to Change Battery** in **Operating Manual** or

   Periodic Maintenance 8000SRM1364 for lift truck
   - E2.2-3.5XN (E45-70XN) (A268)

   Periodic Maintenance 8000SRM1372 for lift truck
   - J2.2-3.5XN (J45-70XN) (A276)

   Periodic Maintenance 8000SRM1541 for lift truck
   - J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

6. Connect battery connectors.
7. Operate hydraulic functions, then check for leaks.
8. Perform procedures outlined in Calibration Procedure section of this manual.

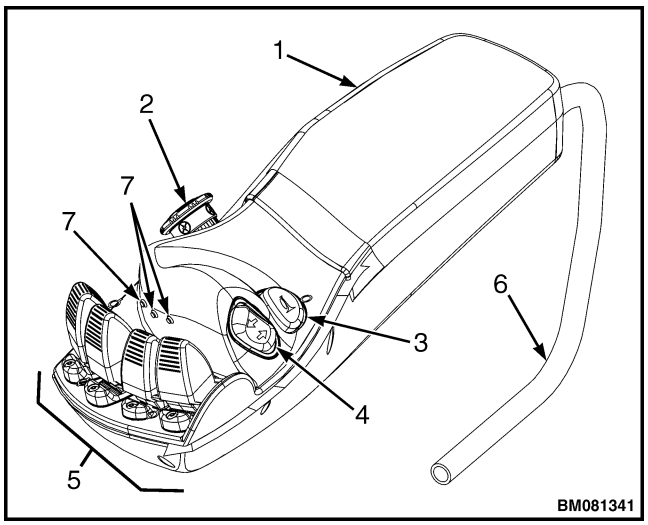
E-HYDRAULIC CONTROLS

E-hydraulic controls for the lift truck are part of the mini-lever module (MLM) installed on an armrest. An emergency disconnect switch is mounted on the outside of the armrest and connected to the MLM wire harness. Mounting for a direction control switch (optional) has been provided on the armrest and will connect to the MLM wire harness. The horn button is mounted on the inside of the armrest and connected to the MLM wire harness. The MLM wire harness is routed beside the seat and connects to the main wire harness. See Figure 146.

Mini-levers are available in single function or dual function. See Figure 147 for examples.

Replace E-Hydraulic Control Components

1. For procedures to replace the armrest, emergency disconnect switch, horn button, direction control switch, and mini-levers see **Electrical System** 2200SRM1369.



1. ARMREST
2. EMERGENCY DISCONNECT SWITCH
3. HORN BUTTON
4. DIRECTION CONTROL SWITCH (OPTIONAL)
5. MINI-LEVER
6. MLM WIRE HARNESS
7. MOMENTARY BUTTON (OPTIONAL)

Figure 146. E-Hydraulic Controls

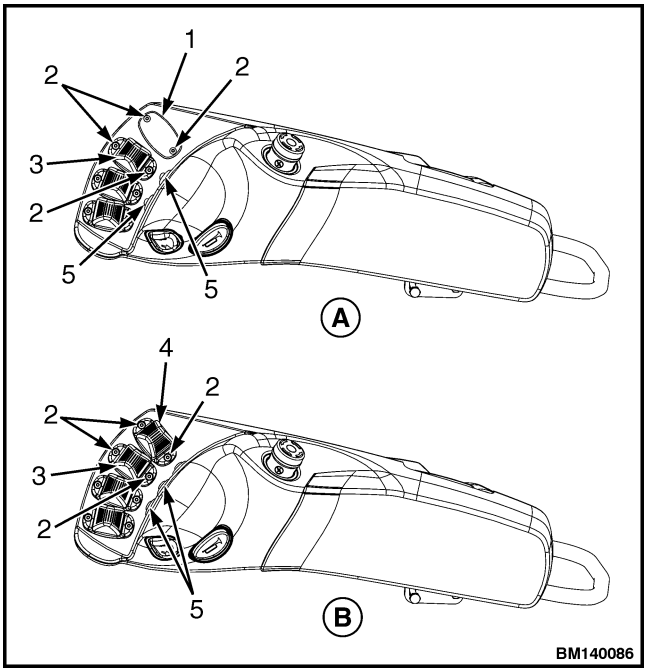


Figure 147. Mini-Levers and Armrest

Legend for Figure 147

A. 3-FUNCTION MINI-LEVER MODULE
B. 4-FUNCTION MINI-LEVER MODULE

1. BLANK
2. CAPSCREW
3. AUX 1 LEVER
4. AUX 2 LEVER
5. MOMENTARY BUTTON (OPTIONAL)

E-Hydraulic Control Valve Repair for 4.0-5.5T Cushion Trucks

REMOVE

Initial Steps

WARNING

Before making repairs to the control valve, fully lower all parts of the mast and tilt it fully forward. This action will prevent the mast from lowering suddenly when hydraulic lines are disconnected.

NOTE: Only perform those steps below necessary for required repair or replacement.

1. Lower mast and tilt forward.
2. Remove battery from lift truck. See **How to Change Battery** in **Operating Manual** or **Periodic Maintenance** 8000SRM1577.
3. Discharge capacitors by following steps shown in Discharging the Capacitors in **General** section of this manual.
4. Remove floor mats and floor plates.

WARNING

Hydraulic oil is hot after system operation and can cause burns. DO NOT disconnect any hydraulic hoses until the oil in the system is cool.

CAUTION

Electrical components must be shielded from hydraulic oil drips if they are below hydraulic valve and lines.

NOTE: Tag hydraulic lines during removal to aid in installation.

5. Put a drain pan under the area of the hydraulic control assembly. Disconnect hydraulic lines from E-hydraulic control assembly. Cap hydraulic lines.

Fitting Removal

NOTE: Note placement and orientation of fittings prior to removal to aid in installations. Note place of O-rings on fittings prior to removal to aid in installation.

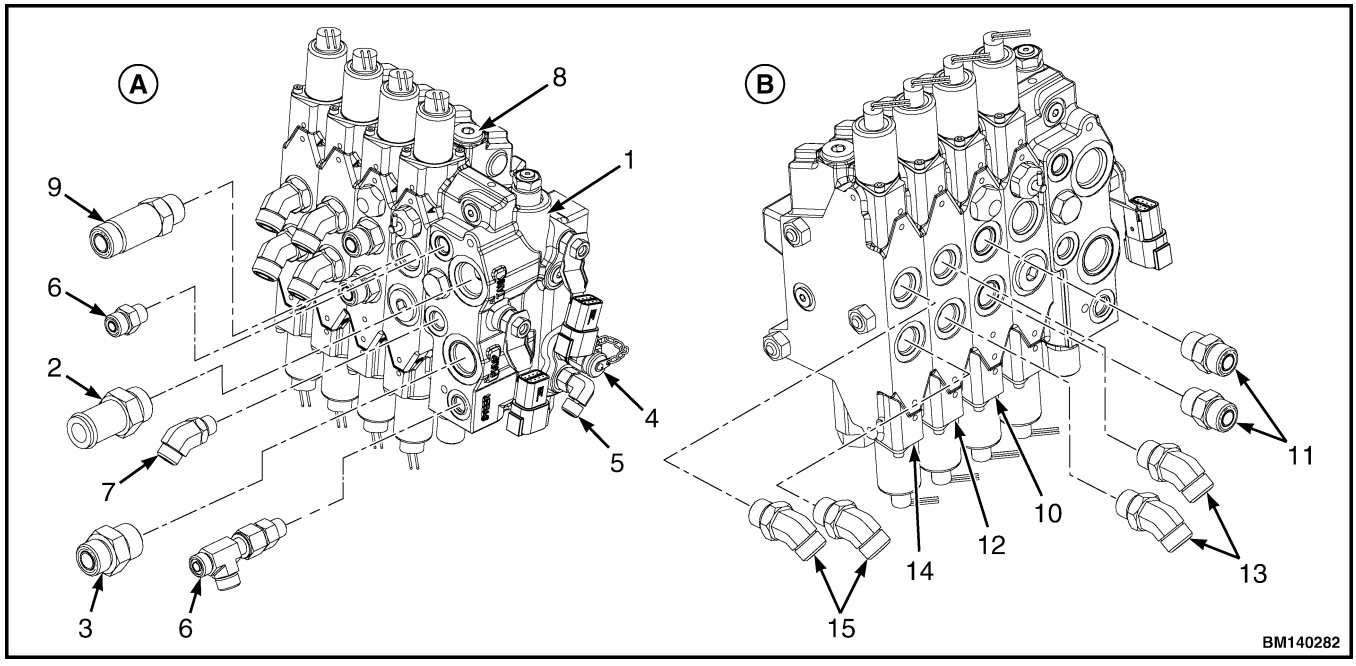
1. Remove return line fitting, inlet fitting, steer fittings, and park brake fittings from inlet section. Remove and discard O-rings from fittings. See Figure 148.
2. Remove steer load sense fitting from inlet section. Remove and discard O-ring from fitting. See Figure 148.
3. Remove lift/lower fitting from lift section. Remove and discard O-ring from fitting. See Figure 148.
4. Remove tilt fittings from tilt section. Remove and discard O-rings from fittings. See Figure 148.

NOTE: Perform Step 5 if E-hydraulic control valve is equipped with first auxiliary section.

5. Remove first auxiliary fittings from first auxiliary section. Remove and discard O-rings from fittings. See Figure 148.

NOTE: Perform Step 5 and Step 6 if E-hydraulic control valve is equipped with first and second auxiliary sections.

6. Remove second auxiliary fittings from second auxiliary section. Remove and discard O-rings from fittings. See Figure 148.



NOTE: 4-FUNCTION CONTROL VALVE SHOWN.

A. INLET AND LIFT SECTION FITTINGS

1. INLET SECTION
2. RETURN LINE FITTING
3. INLET FITTING
4. DIAGNOSTIC FITTING (SHOWN IN PUMP PRESSURE GAUGE PORT)
5. STEER LOAD SENSE FITTING
6. STEER FITTING
7. BRAKE SUPPLY FITTING
8. STEERING RETURN FITTING

B. TILT AND AUXILIARY SECTION FITTINGS

9. LIFT/LOWER FITTING
10. LIFT/LOWER SECTION
11. TILT FITTINGS
12. FIRST AUXILIARY FITTINGS (OPTIONAL)
13. TILT SECTION
14. FIRST AUXILIARY SECTION
15. SECOND AUXILIARY SECTION
16. SECOND AUXILIARY FITTINGS

Figure 148. E-Hydraulic Control Valve Fittings

Electrical Disconnect and Control Valve Dismount

1. Disconnect upper solenoid electrical connector from e-hydraulic main wire harness. See Figure 149.
2. Disconnect lower solenoid electrical connector from e-hydraulic main wire harness. See Figure 149.
3. Remove mounting capscrew and valve mounting bracket, with E-hydraulic control valve, from clip nut and bulkhead. See Figure 150.
4. Remove three capscrews, three special washers, and valve mounting bracket from E-hydraulic control valve. See Figure 150.

NOTE: Tag upper solenoid wires during removal to aid in installation.

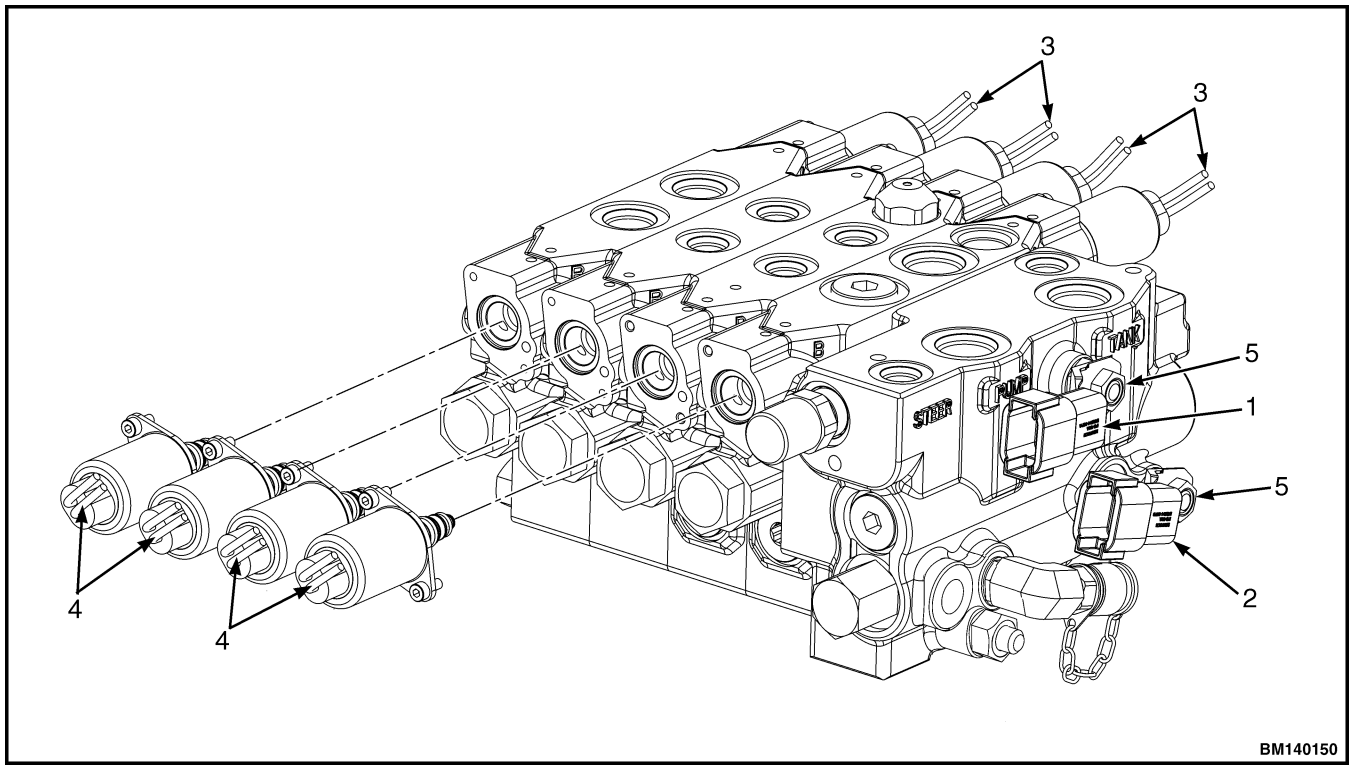
5. Disconnect upper solenoid wires from upper solenoid electrical connector. See Figure 149.

NOTE: Tag lower solenoid wires during removal to aid in installation.

6. Disconnect lower solenoid wires from lower solenoid electrical connector. See Figure 149.

NOTE: Note placement of jam nuts and solenoid connectors on tie rods prior to removal to aid in installation.

7. Remove two jam nuts, upper solenoid electrical connector, and lower solenoid electrical connector from tie rods on inlet section side. See Figure 149.

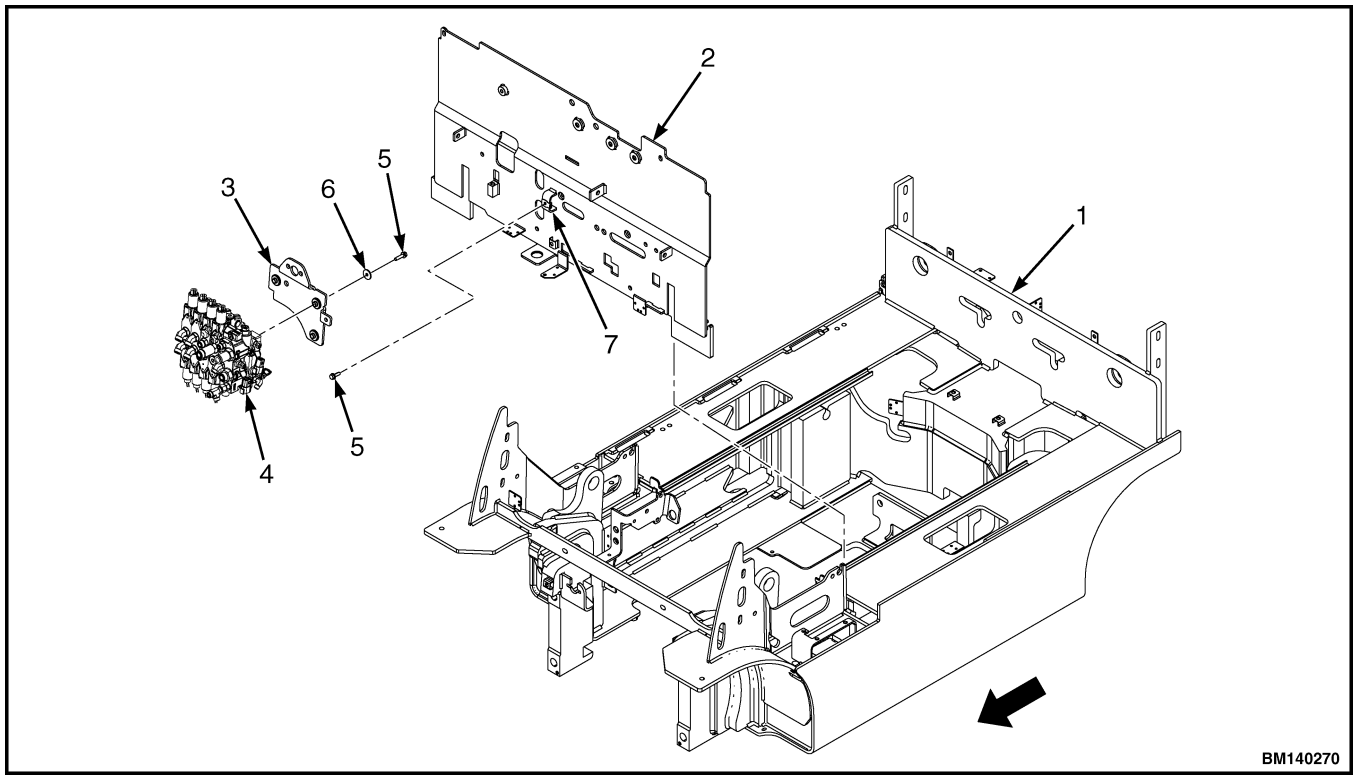


NOTE: 4-FUNCTION E-HYDRAULIC CONTROL VALVE SHOWN.

NOTE: BRAKE PORTS NOT SHOWN FOR WET BRAKE DRIVE AXLE.

1. LOWER SOLENOID ELECTRICAL CONNECTOR
2. UPPER SOLENOID ELECTRICAL CONNECTOR
3. UPPER SOLENOID WIRE
4. LOWER SOLENOID WIRE
5. JAM NUT

Figure 149. Solenoid Wires and Connectors



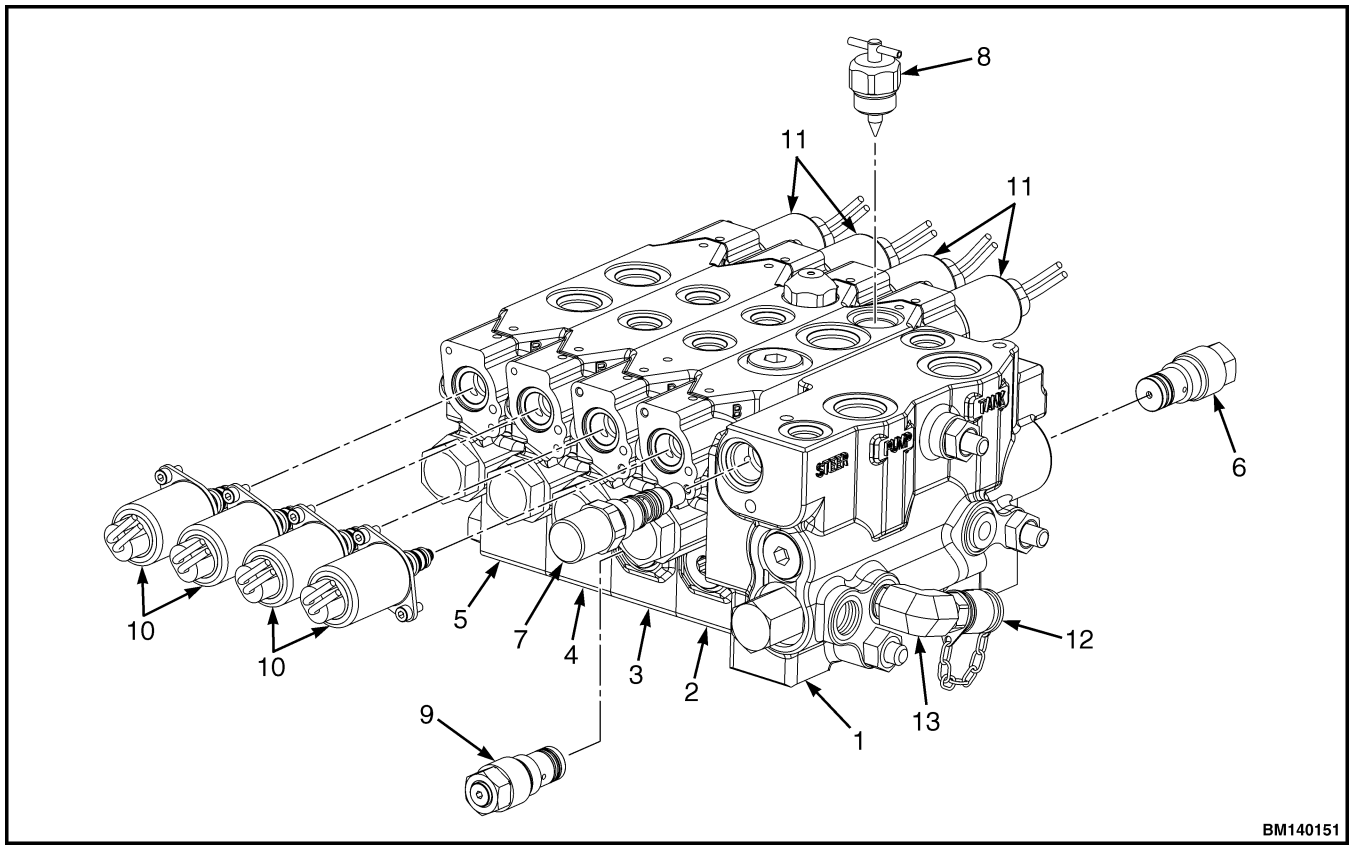
1. FRAME
2. FRONT BULKHEAD
3. MOUNTING BRACKET
4. E-HYDRAULIC CONTROL VALVE
5. CAPSCREW
6. SPECIAL WASHER
7. CLIP NUT

Figure 150. E-Hydraulic Control Valve Mounting

DISASSEMBLE

NOTE: The 3-function E-hydraulic control valve is **not** equipped with a first auxiliary section.

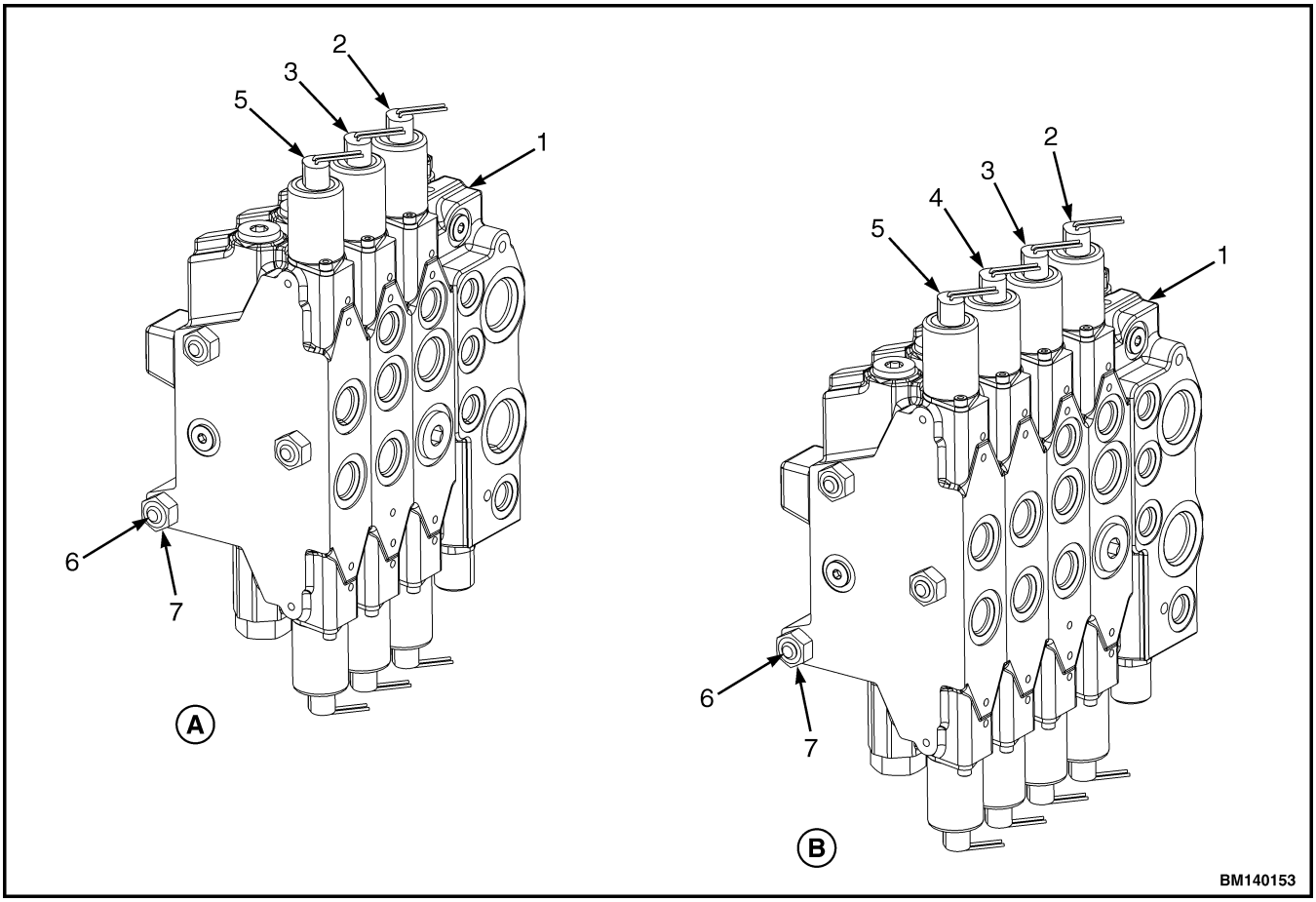
1. Remove lower solenoid from the lift, tilt, and auxiliary sections. See Figure 151.
2. Remove upper solenoid from lift, tilt, and auxiliary sections. See Figure 151.
3. Remove nuts from tie rods on outlet side of E-hydraulic control valve. See Figure 152.
4. Remove two jam nuts, upper solenoid connector, and lower solenoid connector from tie rods on inlet side. See Figure 149.



NOTE: BRAKE PORTS NOT SHOWN FOR WET BRAKE DRIVE AXLE.

1. INLET SECTION
2. LIFT SECTION
3. TILT SECTION
4. FIRST AUXILIARY SECTION (OPTIONAL)
5. SECOND AUXILIARY SECTION
6. PRIMARY RELIEF VALVE
7. PILOT CARTRIDGE
8. MANUAL LOWERING VALVE
9. SECONDARY RELIEF VALVE
10. LOWER SOLENOID
11. UPPER SOLENOID
12. DIAGNOSTIC FITTING (SHOWN IN PUMP PRESSURE GAUGE PORT)
13. ELBOW FITTING

Figure 151. E-Hydraulic Control Valve



A. 3 FUNCTION E-HYDRAULIC CONTROL VALVE

1. INLET SECTION
2. LIFT SECTION
3. TILT SECTION
4. FIRST AUXILIARY SECTION (OPTIONAL)

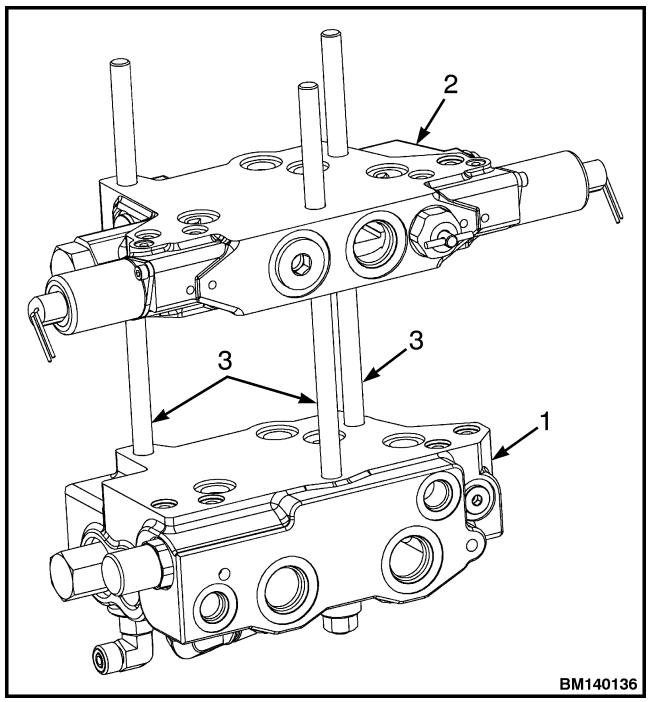
B. 4 FUNCTION E-HYDRAULIC CONTROL VALVE

5. SECOND AUXILIARY SECTION
6. TIE ROD
7. NUT

Figure 152. E-Hydraulic Control Valve Sections

NOTE: Note placement of section seals in retaining grooves of each section prior to removal to aid in installation.

5. Remove each section from tie rods and adjacent section starting with the second auxiliary section, followed by the first auxiliary section if present, the tilt section, and the lift section. See Figure 153 for example.



NOTE: BRAKE PORTS NOT SHOWN FOR WET BRAKE DRIVE AXLE.

1. INLET SECTION
2. LIFT SECTION
3. TIE ROD

Figure 153. E-Hydraulic Control Valve - Sections and Tie Rods

6. Remove tie rods from inlet section. See Figure 153.

7. Remove and discard section seals from retaining grooves of all sections. See Figure 154 and Figure 155.

8. Remove pilot cartridge from inlet section. Remove and discard O-rings from pilot cartridge. See Figure 151 and Figure 154.

9. Remove primary relief valve from inlet section. Remove and discard O-rings and backup ring from primary relief valve. See Figure 151 and Figure 154.

10. Remove compensator plug from inlet section. Remove and discard O-ring from plug. See Figure 154.

11. Remove elbow fitting and diagnostic fitting from inlet section. Remove and discard O-ring from elbow fitting. See Figure 154.

12. Remove manual lowering valve from lift section. Remove and discard O-ring from valve. See Figure 155.

13. Remove lift section plug from lift section. Remove and discard O-ring from plug. See Figure 155.

14. Remove port option plug from tilt section. Remove and discard O-ring from plug. See Figure 155.

15. Remove secondary relief valve or tilt section plug from tilt section. Remove and discard O-rings and backup rings from valve or plug. See Figure 155.

CLEAN

WARNING

Cleaning solvents can be flammable and toxic and cause skin irritation. When using cleaning solvents, always follow the solvent manufacturer's recommended safety procedures.

WARNING

Compressed air can move particles so they cause injury to the user or to other personnel. Make sure the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eyes.

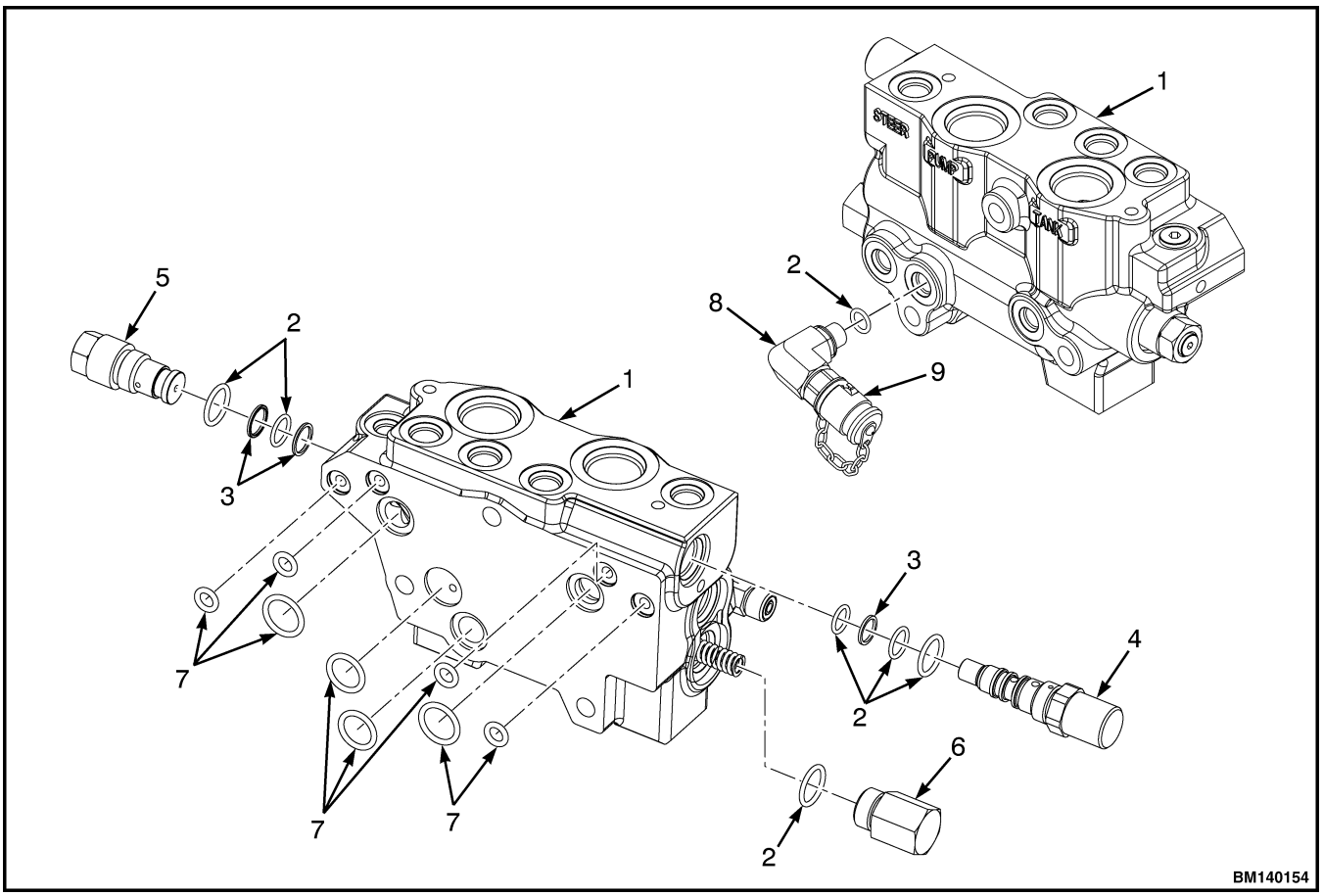
1. Clean only metal components of E-hydraulic control valve with solvent and dry using compressed air. Avoid getting solvent in electrical connectors.

2. Clean all threaded components with denatured alcohol and dry using compressed air.

3. Clean rubber or plastic components with warm soapy water and dry with a lint free cloth.

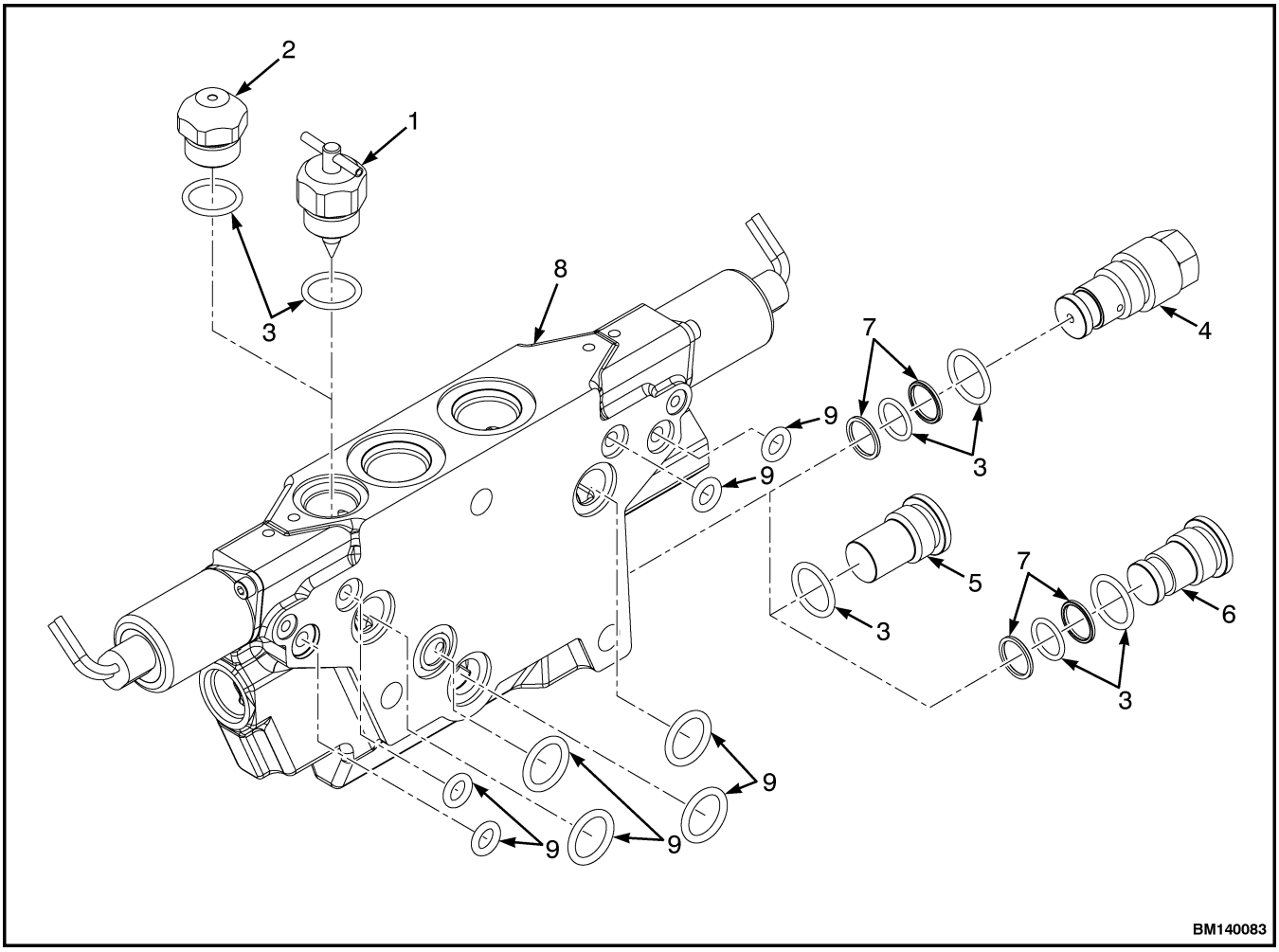
INSPECT

1. Inspect section bodies for damage. Replace if damaged.
2. Inspect threaded components to ensure absence of oil or solvent residue.
3. Inspect all other components for damage. Replace if damaged.



1. INLET SECTION
2. O-RING
3. BACKUP RING
4. PILOT CARTRIDGE
5. PRIMARY RELIEF VALVE
6. COMPENSATOR PLUG
7. SECTION SEAL
8. ELBOW FITTING
9. DIAGNOSTIC FITTING (SHOWN IN PUMP PRESSURE GAUGE PORT)

Figure 154. Inlet Section E-Hydraulic Control Valve



1. MANUAL LOWERING VALVE
2. PORT OPTION PLUG
3. O-RING
4. SECONDARY RELIEF VALVE
5. LIFT SECTION PLUG
6. TILT SECTION PLUG
7. BACKUP RING
8. LIFT/TILT/AUXILIARY SECTION
9. SECTION SEAL

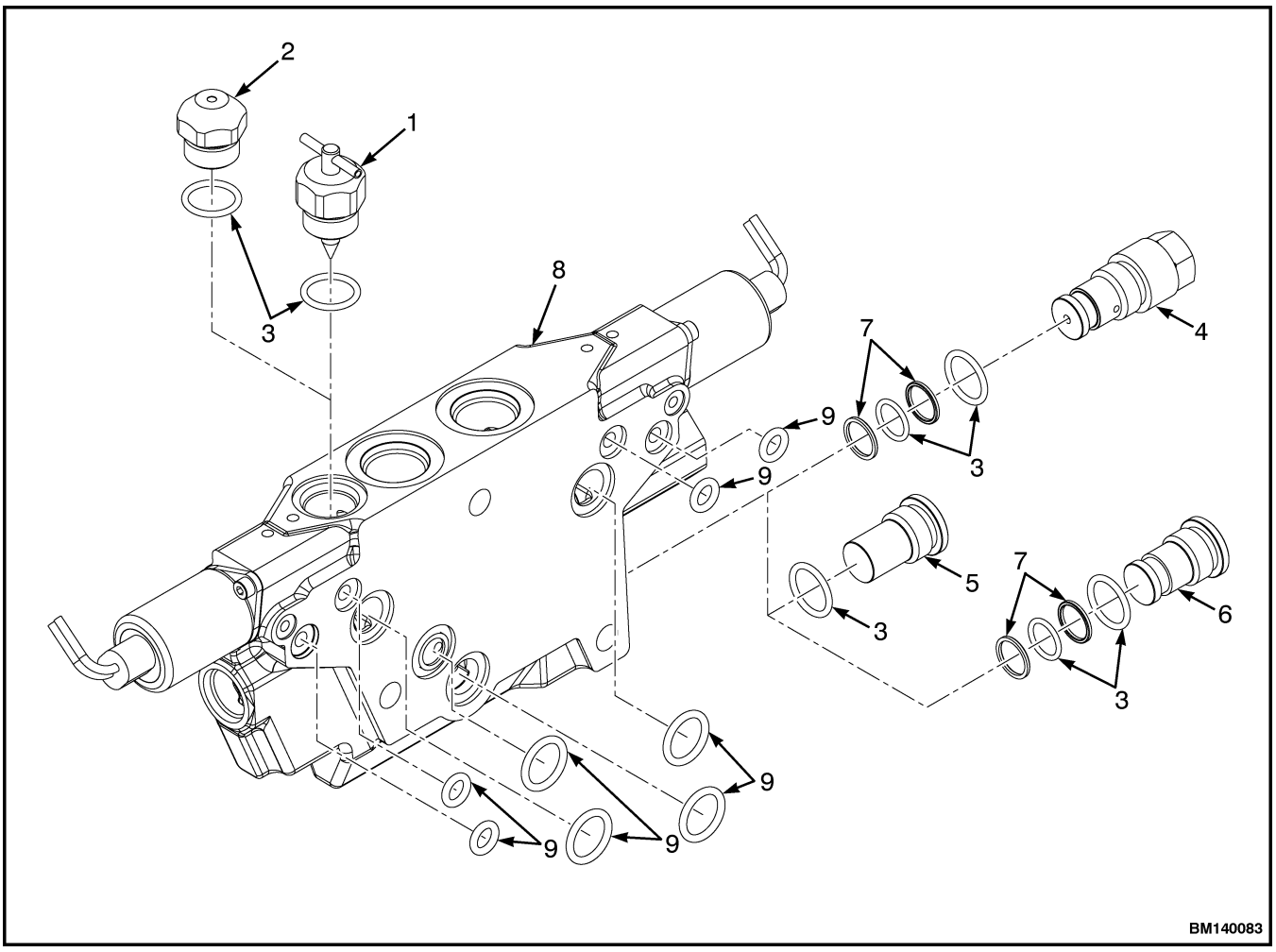
Figure 155. Lift/Tilt/Auxiliary Sections E-Hydraulic Control Valve

ASSEMBLE

NOTE: Lubricate all new O-rings and backup rings with clean hydraulic oil prior to installation. **DO NOT** lubricate section seals.

NOTE: Perform Step 1 if E-hydraulic control valve is **NOT** equipped with secondary relief valve.

1. Install new O-rings, new backup rings, and tilt section plug into tilt section. See Figure 156. Tighten tilt section plug to 27 N•m (20 lbf ft).
2. Install O-rings, new backup rings, and secondary relief valve into tilt section. See Figure 156. Tighten secondary relief valve to 27 N•m (20 lbf ft).
3. Install new O-ring and port option plug onto tilt section. See Figure 156. Tighten port option plug to 54 N•m (40 lbf ft).



1. MANUAL LOWERING VALVE
2. PORT OPTION PLUG
3. O-RING
4. SECONDARY RELIEF VALVE
5. LIFT SECTION PLUG
6. TILT SECTION PLUG
7. BACKUP RING
8. LIFT/TILT/AUXILIARY SECTION
9. SECTION SEAL

Figure 156. Lift/Tilt/Auxiliary Sections - E-Hydraulic Control Valve

4. Install new O-ring and lift section plug onto lift section. See Figure 156. Tighten lift section plug to 27 N•m (20 lbf ft).

5. Install new O-ring and manual lowering valve onto lift section. See Figure 156. Tighten manual lowering valve to 54 N•m (40 lbf ft).

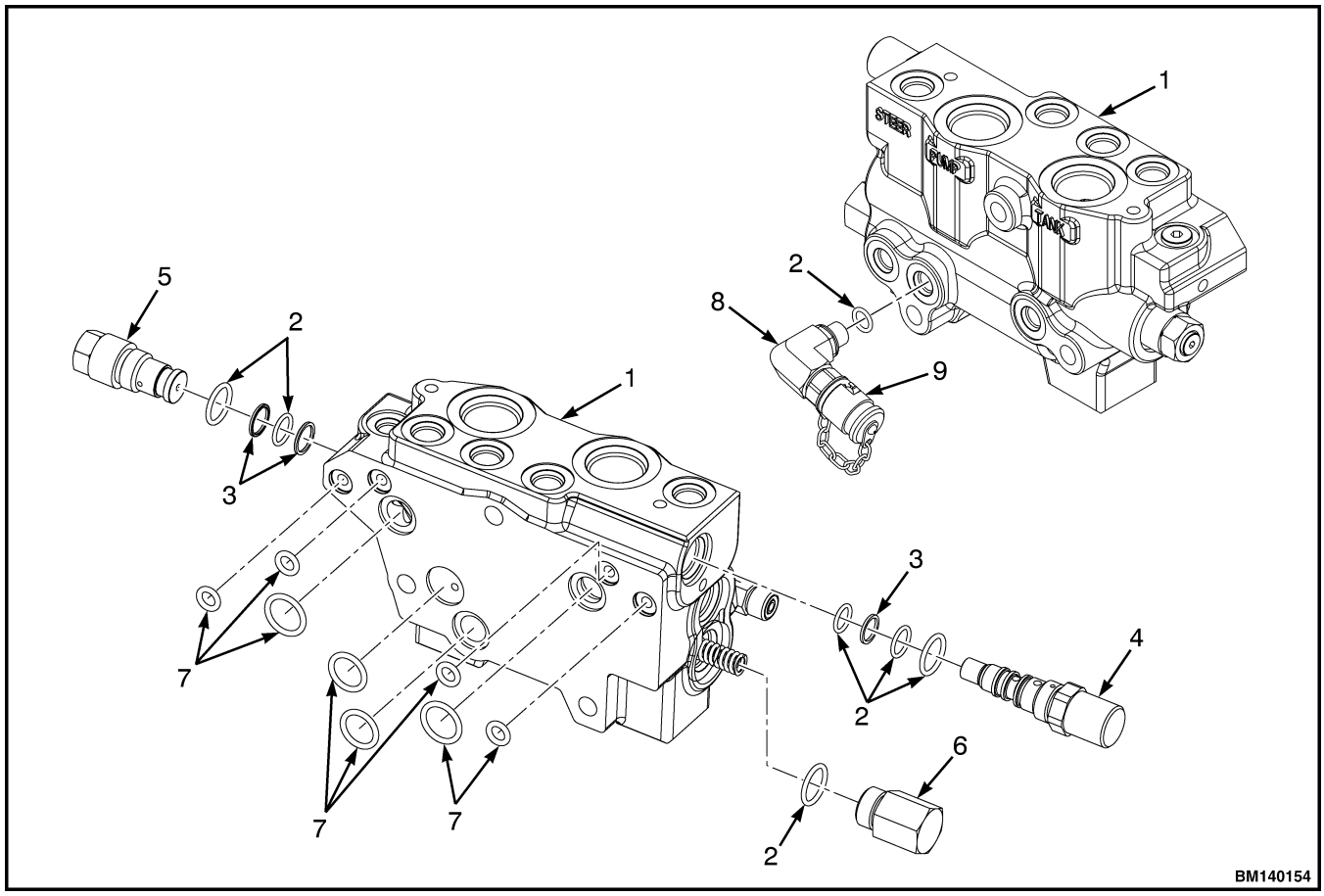
6. Install new O-ring onto elbow fitting. Install diagnostic fitting onto elbow fitting. Install elbow fitting into inlet section. See Figure 157. Tighten elbow fitting to 16 N•m (142 lbf in).

7. Install new O-ring onto compensator plug. Install compensator plug into inlet section. See Figure 157.

8. Install new O-rings and backup rings onto primary relief valve. Install primary relief valve into inlet section. See Figure 157. Tighten primary relief valve to 27 N•m (20 lbf ft).

9. Install new O-rings and new backup rings onto pilot cartridge. Install pilot cartridge into inlet section. See Figure 157. Tighten pilot cartridge to 65 N•m (48 lbf ft).

10. If removed, install nuts on inlet side of tie rods. See Figure 158. Hand tighten nuts only at this time.



1. INLET SECTION
2. O-RING
3. BACKUP RING
4. PILOT CARTRIDGE
5. PRIMARY RELIEF VALVE
6. COMPENSATOR PLUG
7. SECTION SEAL
8. ELBOW FITTING
9. DIAGNOSTIC FITTING (SHOWN IN PUMP PRESSURE GAUGE PORT)

Figure 157. Inlet Section - E-Hydraulic Control Valve

11. Install tie rod end without nut through inlet section. See Figure 159 for example.

12. Install upper solenoid electrical connector and jam nut, as noted during disassembly, onto tie end. See Figure 160.

13. Position upper solenoid electrical connector as shown in Figure 161 and hand tighten jam nut.

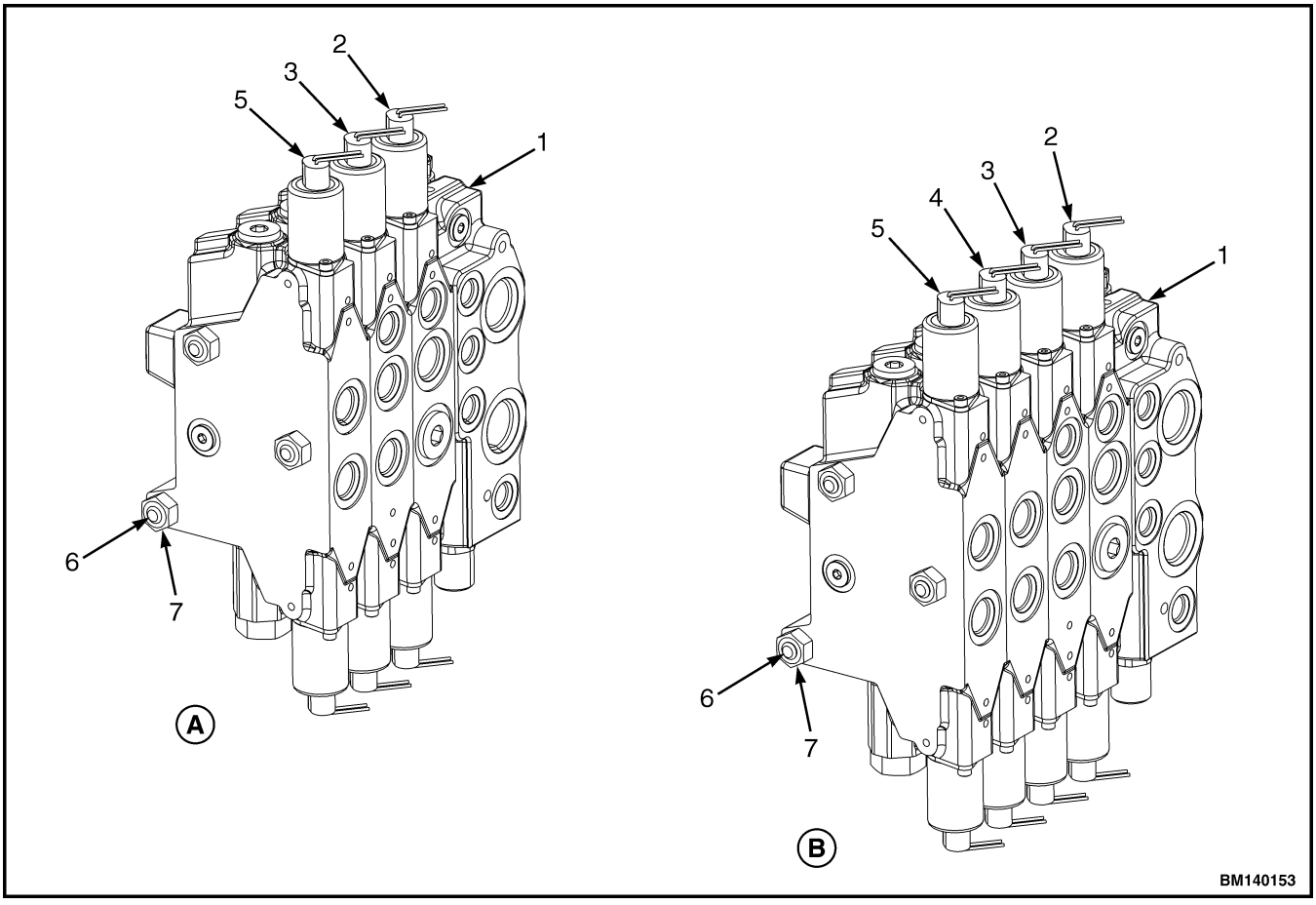
14. Install lower solenoid electrical connector and jam nut, as noted during disassembly, onto tie rod end. See Figure 160.

15. Position lower solenoid electrical connector as shown in Figure 161 and hand tighten jam nut.

NOTE: **DO NOT** lubricate section seals.

16. Install section seals into retaining grooves in inlet section face. See Figure 157.

17. Install lift section onto tie rods against inlet section. See Figure 159 for example.



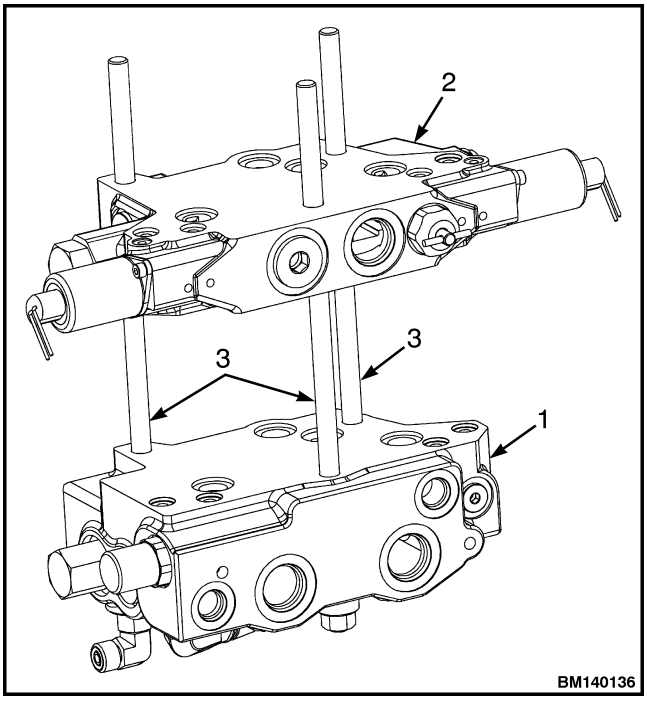
A. 3-FUNCTION E-HYDRAULIC CONTROL VALVE

1. INLET SECTION
2. LIFT SECTION
3. TILT SECTION
4. FIRST AUXILIARY SECTION (OPTIONAL)

B. 4-FUNCTION E-HYDRAULIC CONTROL VALVE

5. SECOND AUXILIARY SECTION
6. TIE ROD
7. NUT

Figure 158. E-Hydraulic Control Valve Sections



1. INLET SECTION
2. LIFT SECTION
3. TIE ROD

Figure 159. E-Hydraulic Control Valve - Sections and Tie Rods

18. Install section seals into retaining grooves in lift section face. See Figure 156.

19. Install tilt section onto tie rods against lift section. See Figure 159 for example.

20. Install section seals into retaining grooves in tilt section face. See Figure 156.

NOTE: The 3-function E-hydraulic control valve is **not** equipped with a first auxiliary section.

21. Install first auxiliary section onto tie rods against tilt section. See Figure 159 for example.

22. Install section seals into retaining grooves on first auxiliary section face. See Figure 156.

23. Install second auxiliary section onto tie rods against first auxiliary section. See Figure 159 for example.

24. Install nuts on tie rods on outlet side of E-hydraulic control valve. See Figure 158. Hand tighten nuts only at this time.

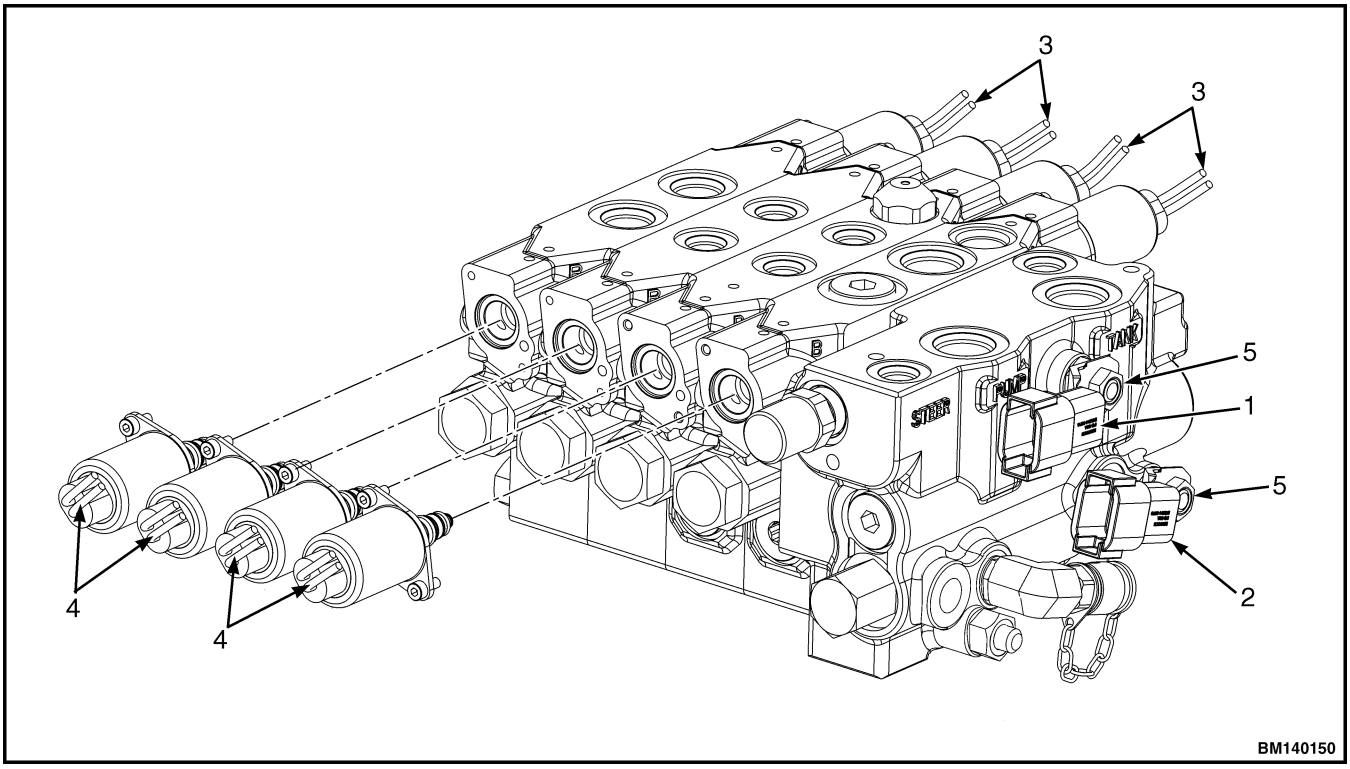
NOTE: Tie rods to extend one or two threads beyond nut on each end.

25. After ensuring tie rods are completely through all sections of E-hydraulic control valve tighten nuts on both inlet and outlet side to 20.3 ± 1.4 N•m (179.7 ± 12.4 lbf in).

26. Tighten jam nuts to 7 to 11 N•m (62 to 97 lbf in) keeping connectors at the correct angle, as shown in Figure 161.

27. Install upper solenoid into lift, tilt, and auxiliary sections. See Figure 162. Tighten upper solenoids to 5 N•m (48 lbf in).

28. Install lower solenoid into lift, tilt, dual auxiliary, and auxiliary sections. See Figure 162. Tighten lower solenoids to 5 N•m (48 lbf in).



NOTE: 4-FUNCTION E-HYDRAULIC CONTROL VALVE SHOWN.

1. LOWER SOLENOID ELECTRICAL CONNECTOR
2. UPPER SOLENOID ELECTRICAL CONNECTOR
3. UPPER SOLENOID WIRE
4. LOWER SOLENOID WIRE
5. JAM NUT

Figure 160. Solenoid Wires and Connectors

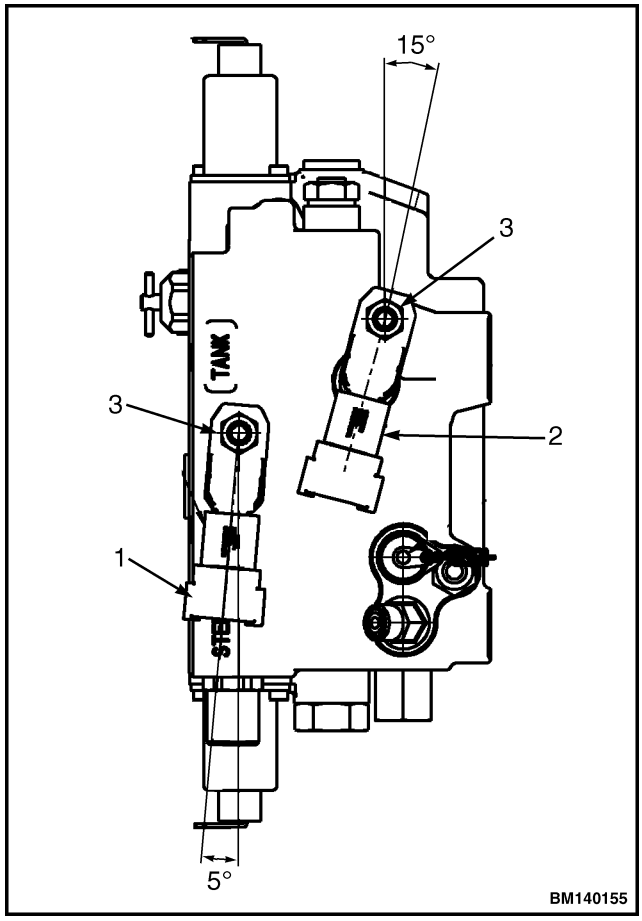
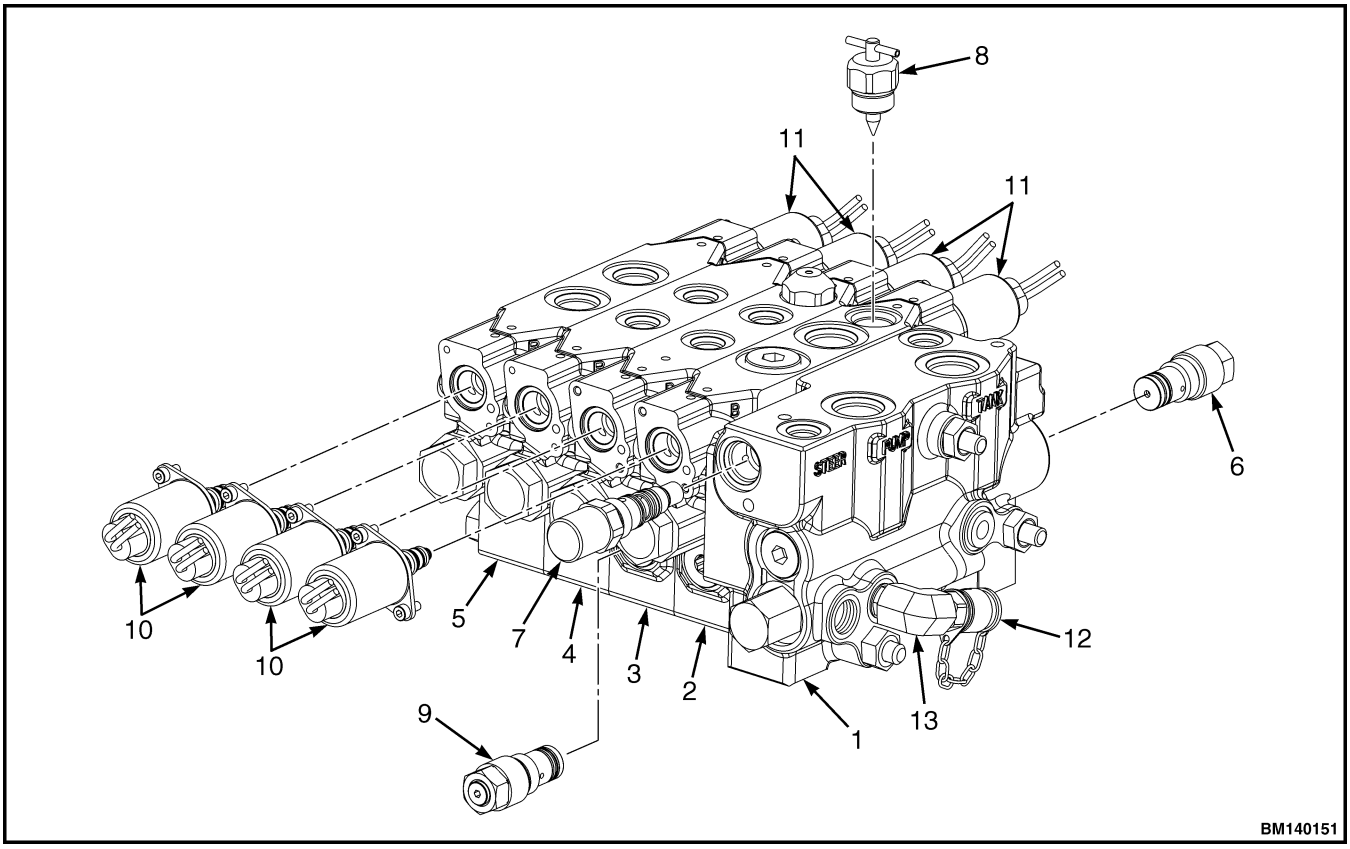


Figure 161. E-Hydraulic Solenoid Electrical Connectors

Legend for Figure 161

1. UPPER SOLENOID ELECTRICAL CONNECTOR
2. LOWER SOLENOID ELECTRICAL CONNECTOR
3. JAM NUT



1. INLET SECTION
2. LIFT SECTION
3. TILT SECTION
4. FIRST AUXILIARY SECTION (OPTIONAL)
5. SECOND AUXILIARY SECTION
6. PRIMARY RELIEF VALVE
7. PILOT CARTRIDGE
8. MANUAL LOWERING VALVE
9. SECONDARY RELIEF VALVE
10. LOWER SOLENOID
11. UPPER SOLENOID
12. DIAGNOSTIC FITTING (SHOWN IN PUMP PRESSURE GAUGE PORT)
13. ELBOW FITTING

Figure 162. E-Hydraulic Control Valve

INSTALL

Electrical Connect and Control Valve Mount

1. Connect lower solenoid wires to lower solenoid connector as tagged during removal. See Table 11 and Figure 160.

Table 11. Lower Solenoid Connector Pin Layout

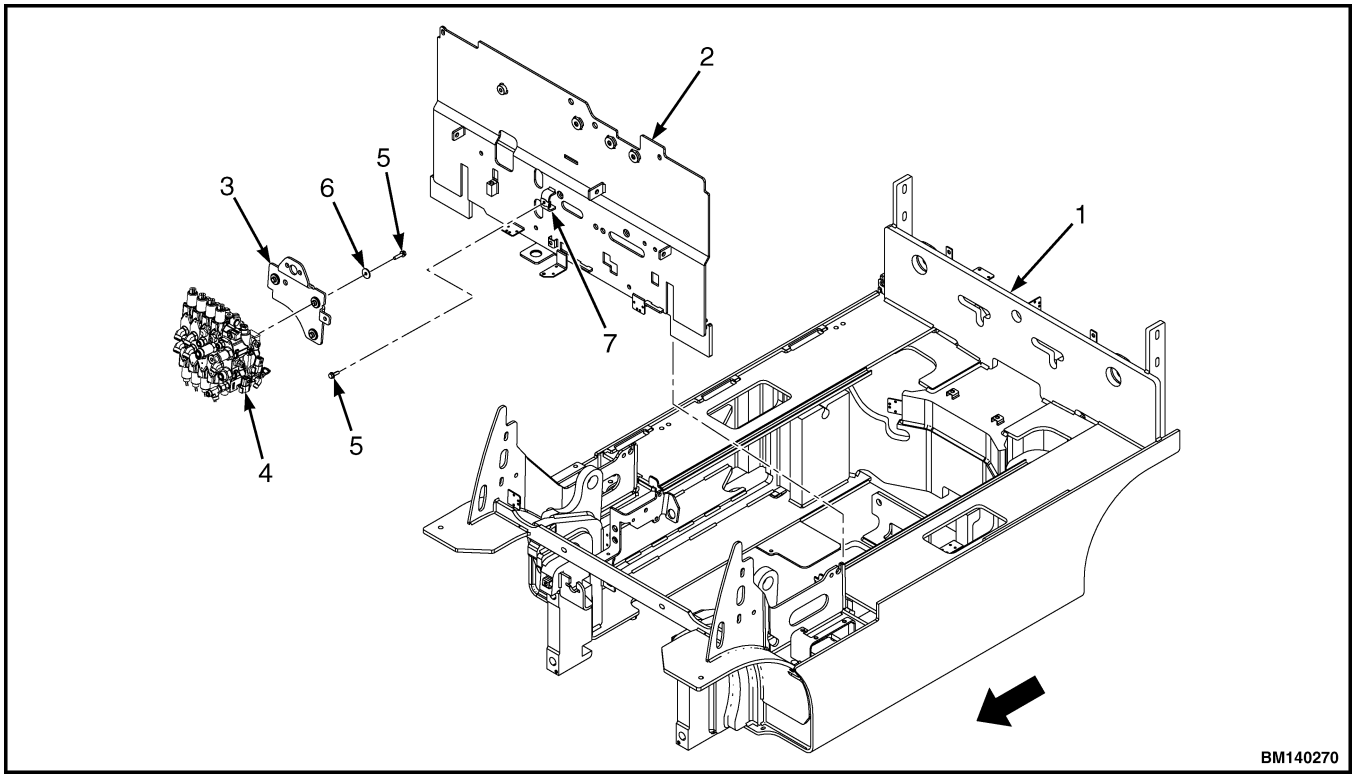
Pin	Socket	Pin	Socket
PIN 8	1B NEG	**PIN 1**	1B POS
PIN 7	2B NEG	**PIN 2**	2B POS
PIN 6	3B NEG	**PIN 3**	3B POS
PIN 5	4B NEG	**PIN 4**	4B POS

2. Connect upper solenoid wires to upper solenoid connector as tagged during removal. See Table 12 and Figure 160.

Table 12. Upper Solenoid Connector Pin Layout

Pin	Socket	Pin	Socket
PIN 8	1A NEG	**PIN 1**	1A POS
PIN 7	2A NEG	**PIN 2**	2A POS
PIN 6	3A NEG	**PIN 3**	3A POS
PIN 5	4A NEG	**PIN 4**	4A POS

3. Install three special washers, valve mounting bracket, and three capscrews onto E-hydraulic control valve. See Figure 163.
4. Install clip nut onto bulkhead. See Figure 163.
5. Install valve mounting bracket, with E-hydraulic control valve attached, onto bulkhead. Install mounting capscrew into clip nut and bulkhead. See Figure 163.



1. FRAME
2. FRONT BULKHEAD
3. MOUNTING BRACKET
4. E-HYDRAULIC CONTROL VALVE
5. CAPSCREW
6. CLIP NUT

Figure 163. E-Hydraulic Control Valve Mounting

6. Connect upper solenoid electrical connector to e-hydraulic main wire harness.

7. Connect lower solenoid electrical connector to e-hydraulic main wire harness.

Fitting Installation

NOTE: Lubricate new O-rings with clean hydraulic oil prior to installation.

1. Install new O-rings onto second auxiliary fittings. Install second auxiliary fittings into second auxiliary section. See Figure 164.

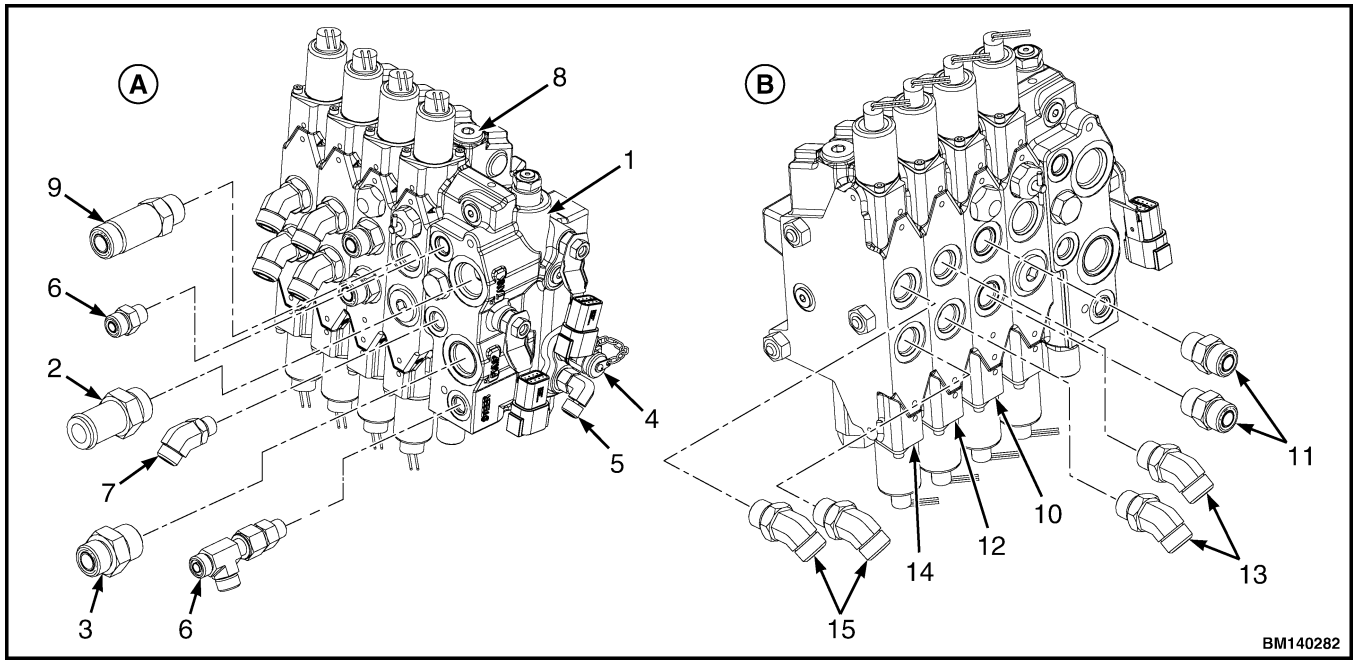
NOTE: Perform Step 2 if control valve is equipped with dual auxiliary section.

2. Install new O-rings onto 3rd function auxiliary fittings. Install 3rd function auxiliary fittings into dual auxiliary section. See Figure 164.

3. Install new O-rings onto tilt fittings. Install tilt fittings into tilt section. See Figure 164.

4. Install new O-ring onto lift/lower fitting. Install lift/lower fitting into lift section. See Figure 164.

5. Install new O-rings onto steer load sense fitting. Install steer load sense fitting into inlet section. See Figure 164.



NOTE: 4-FUNCTION CONTROL VALVE SHOWN.

A. INLET AND LIFT SECTION FITTINGS

1. INLET SECTION
2. RETURN LINE FITTING
3. INLET FITTING
4. DIAGNOSTIC FITTING (SHOWN IN PUMP PRESSURE GAUGE PORT)
5. STEER LOAD SENSE FITTING
6. STEER FITTING
7. BRAKE SUPPLY FITTING
8. STEERING RETURN FITTING

B. TILT AND AUXILIARY SECTION FITTINGS

9. LIFT/LOWER FITTING
10. LIFT/LOWER SECTION
11. TILT FITTINGS
12. FIRST AUXILIARY FITTINGS (OPTIONAL)
13. TILT SECTION
14. FIRST AUXILIARY SECTION
15. SECOND AUXILIARY SECTION
16. SECOND AUXILIARY FITTINGS

Figure 164. E-Hydraulic Control Valve Fittings

6. Install new O-rings onto park brake fittings. Install park brake fittings into inlet section. See Figure 164.

7. Install new O-rings onto steer fittings. Install steer fittings into inlet section. See Figure 164.

8. Install new O-ring onto inlet fitting. Install inlet fitting into inlet section. See Figure 164.

9. Install new O-ring onto return line fitting. Install return line fitting into inlet section. See Figure 164.

Ending Steps

NOTE: Remove caps from hydraulic lines as they are connected to appropriate fitting.

1. Connect hydraulic lines to fittings as tagged during removal.

CAUTION

Disposal of lubricants and fluids must meet local environmental regulations.

2. Dispose of drain pan contents.

3. Check hydraulic oil level; refill system as needed. For type of oil required and fill procedures, see **Periodic Maintenance** 8000SRM1577.

4. Install floor plates and floor mats.

5. Install battery. See **How to Change Battery** in **Operating Manual** or **Periodic Maintenance** 8000SRM1577.

6. Connect battery connectors.

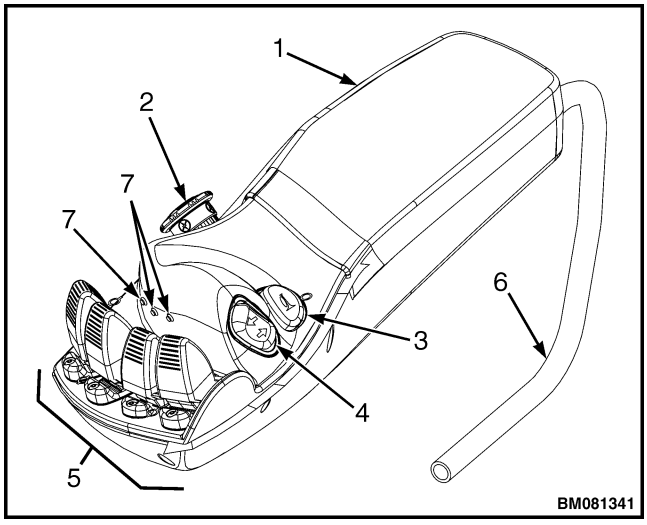
7. Operate hydraulic functions, then check for leaks.

8. Perform procedures outlined in section of this manual.

E-HYDRAULIC CONTROLS

E-hydraulic controls for the lift truck are part of the mini-lever module (MLM) installed on an armrest. An emergency disconnect switch is mounted on the outside of the armrest and connected to the MLM wire harness. Mounting for a direction control switch (optional) has been provided on the armrest and will connect to the MLM wire harness. The horn button is mounted on the inside of the armrest and connected to the MLM wire harness. The MLM wire harness is routed beside the seat and connects to the main wire harness. See Figure 165.

Mini-levers are available in single function or dual function. See Figure 166 for examples.



1. ARMREST
2. EMERGENCY DISCONNECT SWITCH
3. HORN BUTTON
4. DIRECTION CONTROL SWITCH (OPTIONAL)
5. MINI-LEVER
6. MLM WIRE HARNESS
7. MOMENTARY BUTTON (OPTIONAL)

Figure 165. E-Hydraulic Controls

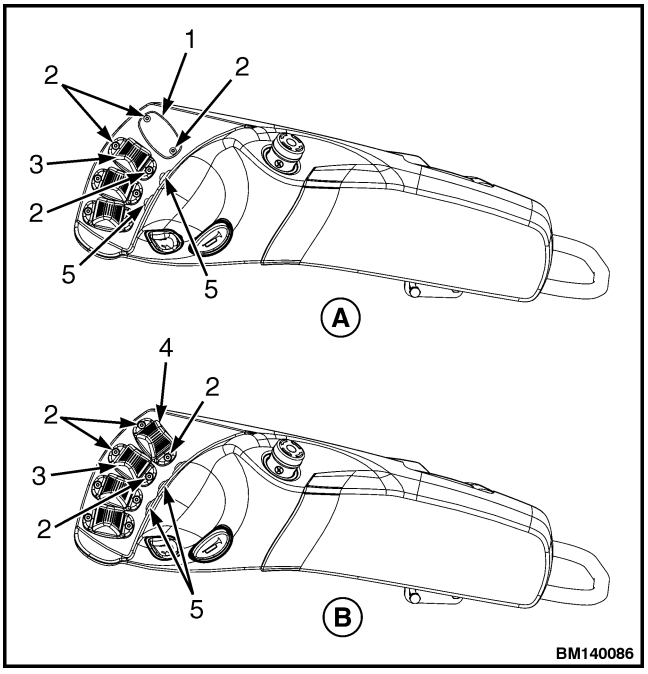


Figure 166. Mini-Levers and Armrest

Legend for Figure 166

A. 3-FUNCTION MINI-LEVER MODULE
B. 4-FUNCTION MINI-LEVER MODULE

1. BLANK
2. CAPSCREW
3. AUX 1 LEVER
4. AUX 2 LEVER
5. MOMENTARY BUTTON (OPTIONAL)

Replace E-Hydraulic Control Components

1. For procedures to replace the armrest, emergency disconnect switch, horn button, direction control switch, and mini-levers see **Electrical System** 2200SRM1369.

Checks and Adjustments for 1.5-2.0T Lift Trucks

MANUAL CONTROL VALVE

This section contains checks and adjustment procedures for lift truck models J1.5-2.0XNT (J30-40XNT) (K160) and J1.6-2.0XN (J30-40XN) (A935) .

Primary Relief Valve

1. Remove cap from diagnostic fitting. See Figure 167.

2. Install 200 bar (3000 psi) pressure gauge into diagnostic fitting installed in Pump Pressure Gauge Port.

3. Run lift truck to ensure hydraulic oil temperature has stabilized at 65 to 70°C (150 to 160°F).

4. Raise mast enough for forks to clear when tilted fully forward.

5. Tilt forks either forward or backward until they reach end of travel and record pressure reading. Pressure should be 179 ±5 bar (2600 ±75 psi).

6. If pressure is outside of range, replace primary relief valve as follows:

a. Lower forks to ground, turn lift truck **OFF**.

b. Remove primary relief valve cartridge from inlet section and replace with new primary relief valve cartridge.

c. Repeat Step 3 through Step 5 to verify new primary relief valve is set correctly.

d. Lower forks to ground and turn lift truck **OFF**.

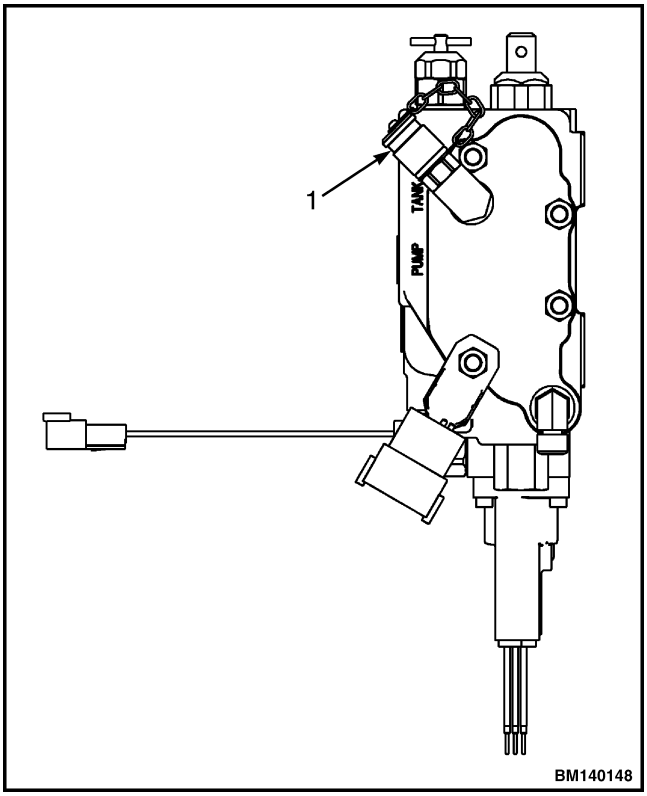
7. Remove pressure gauge from diagnostic fitting and replace cap.

Optional Auxiliary Port Relief Valve

NOTE: If lift truck is equipped with optional work port relief valve follow this procedure.

NOTE: The optional work port relief valve is externally screw-adjustable.

1. Install a 200 bar (3000 psi) pressure gauge into diagnostic fitting installed in Pump Pressure Gauge Port.



1. DIAGNOSTIC FITTING WITH CAP (SHOWN IN PRESSURE GAUGE PORT)

Figure 167. Manual Control Valve Pressure Gauge Port

2. Run lift truck to ensure hydraulic oil temperature has stabilized at 49°C (120°F).

3. Raise mast enough for forks to clear when tilted fully forward.

4. Perform auxiliary function as required to reach end of stroke and record pressure reading. Verify that the pressure matches required pressure range for attachment.

5. If pressure is out of range, adjust optional work port relief valve screw adjustment as directed below:

a. Turn screw adjustment **CLOCKWISE** to increase pressure setting.

b. Turn screw adjustment **COUNTERCLOCKWISE** to decrease pressure setting.

c. Lower forks to ground and turn lift truck **OFF**.

CAUTION

Hydraulic oil is hot after system operation and can cause burns. Allow lift truck to cool down sufficiently prior to any work that may expose hydraulic fluid.

6. Remove pressure gauge from diagnostic fitting and replace cap.

E-HYDRAULIC CONTROL VALVE

Primary Relief Valve

NOTE: Primary relief valve is not externally adjustable.

1. Remove cap from diagnostic fitting.

See Figure 168 for lift truck models

- J1.5-2.0XNT (K160) manufactured before November, 2014
- J30-40XNT (K160) and J1.6-2.0XN (J30-40XN) (A935)

See Figure 169 for lift truck models

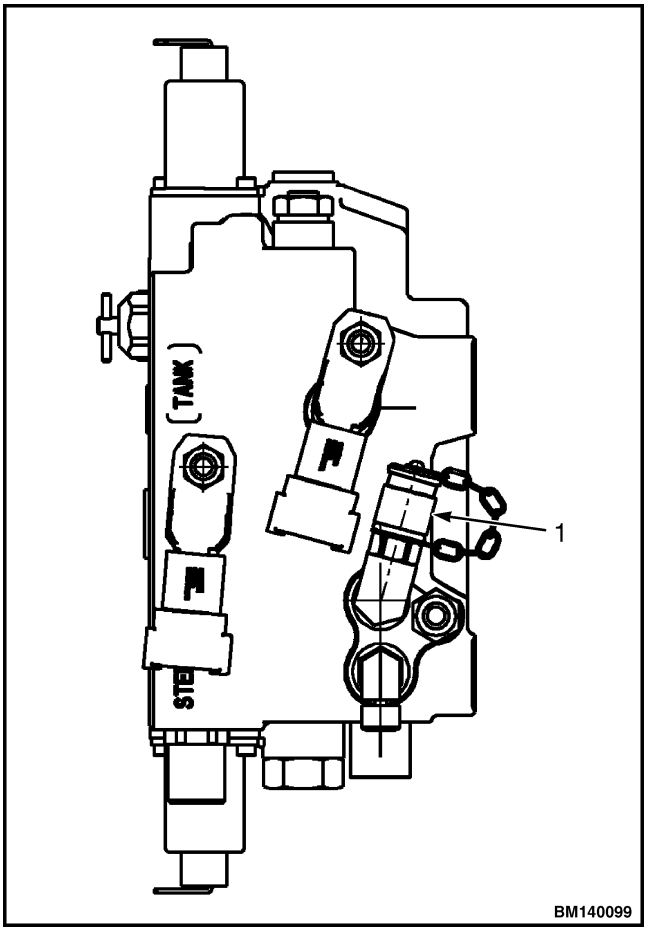
- J1.5-2.0XNT (K160) manufactured after November, 2014

2. Install 200 bar (3000 psi) pressure gauge into diagnostic fitting installed in Pump Pressure Gauge Port.

3. Run lift truck to ensure hydraulic oil temperature has stabilized at 65 to 70°C (150 to 160°F).

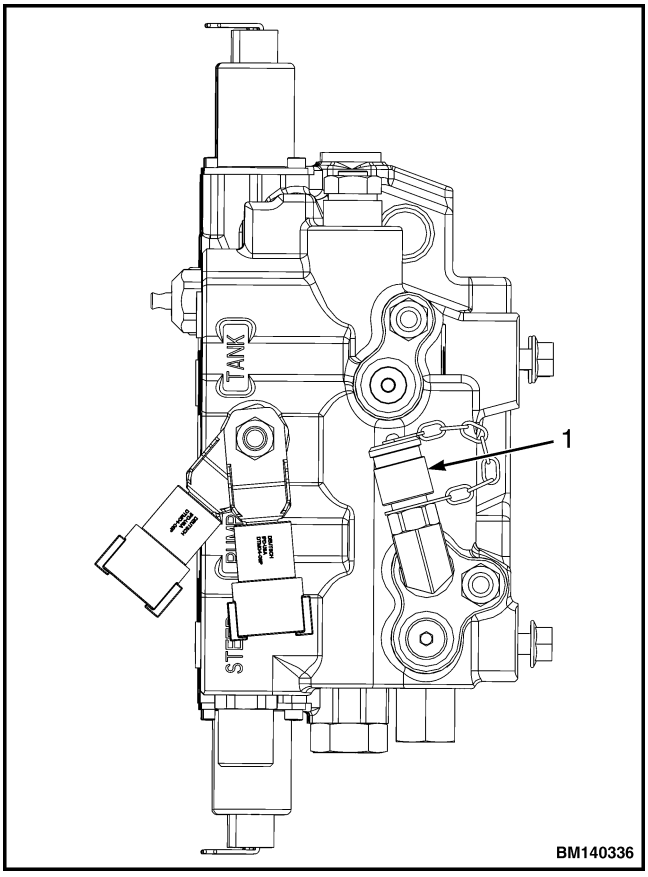
4. Raise mast enough for forks to clear when tilted fully forward.

5. Tilt forks either forward or backward until they reach end of travel and record pressure reading. Pressure should be 179 ±5 bar (2600 ±75 psi).



1. DIAGNOSTIC FITTING WITH CAP (SHOWN IN PUMP PRESSURE GAUGE PORT)

Figure 168. E-Hydraulic Control Valve Pressure Gauge Port, Lift Truck Models J1.5-2.0XNT (K160) Manufactured Before November, 2014 and J30-40XNT (K160) and J1.6-2.0XN (J30-40XN) (A935)



1. DIAGNOSTIC FITTING WITH CAP (SHOWN IN PUMP PRESSURE GAUGE PORT)

Figure 169. E-Hydraulic Control Valve Pressure Gauge Port, Lift Truck Models J1.5-2.0XNT (K160) Manufactured After November, 2014

6. If pressure is outside of range, replace primary relief valve as directed below:

   a. Lower forks to ground, turn lift truck **OFF**.

CAUTION

Hydraulic oil is hot after system operation and can cause burns. Allow lift truck to cool down sufficiently prior to any work that may expose hydraulic fluid.

   b. Replace primary relief valve cartridge with new one.

   c. Repeat Step 3 through Step 5 to verify new primary relief valve is set correctly.

   d. Lower forks to ground and turn lift truck **OFF**.

7. Remove pressure gauge from diagnostic fitting and replace cap.

Optional Secondary Port Relief Valve

NOTE: If lift truck is equipped with optional secondary relief valve follow this procedure.

NOTE: The optional secondary relief valve is externally screw-adjustable.

1. Install a 200 bar (3000 psi) pressure gauge into diagnostic fitting installed in the Pump Pressure Gauge Port.

2. Run lift truck to ensure hydraulic oil temperature has stabilized at 49°C (120°F).

3. Raise mast enough for forks to clear when tilted fully forward.

4. Perform auxiliary function as required to reach end of stroke and record pressure reading. Verify that the pressure matches the intended set pressure range for the attachment.

5. If pressure is out of range, adjust optional secondary relief valve screw adjustment as directed below:

   a. Turn screw adjustment **CLOCKWISE** to increase pressure setting.

   b. Turn screw adjustment **COUNTERCLOCKWISE** to decrease pressure setting.

   c. Lower forks to ground and turn lift truck **OFF**.

6. Remove pressure gauge from diagnostic fitting and replace cap.

HYDRAULIC SYSTEM AIR REMOVAL

1. Remove cap from diagnostic fitting.

   See Figure 167 for lift trucks equipped with manual control valve.

   See Figure 168 for the following lift trucks equipped with an E-Hydraulic control valve

   - J1.5-2.0XNT (K160) manufactured before November, 2014
   - J30-40XNT (K160) and J1.6-2.0XN (J30-40XN) (A935)

   See Figure 169 for the following lift trucks equipped with an E-Hydraulic control valve

   - J1.5-2.0XNT (K160) manufactured after November, 2014

2. Install 200 bar (3000 psi) pressure gauge into diagnostic fitting installed in Pump Pressure Gauge Port.

3. Turn lift truck **ON**; make sure lift truck is in neutral and park brake is set.

NOTE: Step 4 is required warm up for service. This is to ensure that the fluid temperature is optimal for calibrations.

4. Activate tilt at relief pressure until the hydraulic fluid temperature is 50 to 65°C (122 to 149°F).

NOTE: Perform Step 5 and Step 6 for hoist valve air bleed. This is required if the carriage moves slightly (approximately 25.4 mm (1 in.)) alternating between lifting and lowering.

5. Activate lift control from neutral to full lift and back to neutral at a rate of one to two times per second. Repeat until lift function is operating smoothly with no unexpected or sudden mast movements.

6. Lift carriage to maximum height and run over hydraulic relief for 15 to 30 seconds.

NOTE: Perform Step 7 for cylinder air bleed. This is required if the cylinders have not been previously cycled, or if the lift function is not operating smoothly.

7. Cycle function completely two or three times; repeat if necessary.

It is not necessary to turn the lift truck **ON** or **OFF** if you are performing other procedures.

Checks and Adjustments 2.0-5.5T Lift Trucks

MANUAL CONTROL VALVE

This section covers the checks and adjustmnets for lift truck models E2.2-3.5XN (E45-70XN) (A268), J2.2-3.5XN (J45-70XN) (A276), J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970), and E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099).

External Leakage

1. If leaking between sections, loosen mounting bolts, loosen tie rod nuts and re-torque tie rod nuts to 19 to 21 N•m (168 to 192 lbf in). Tighten mounting bolts and check for leaks. If leakage continues, replace section seals, see **Assemble Manual Control Valve** section in this manual.

2. If relief cartridges, lowering valves, plugs, or fittings are leaking, tighten to measurements indicated in **Assemble Manual Control Valve** section of this manual. If leakage continues, replace O-rings.

Primary Relief Cartridge

1. Remove cap and install pressure gauge capable of reading 250 bar (3625 psi) on diagnostic fitting installed in the Pump Pressure Gauge Port. See Figure 170.

2. Run lift truck to ensure oil temperature has stabilized to 65 to 70°C (150 to 160°F).

3. Ensure that there is clearance to fully extend the mast.

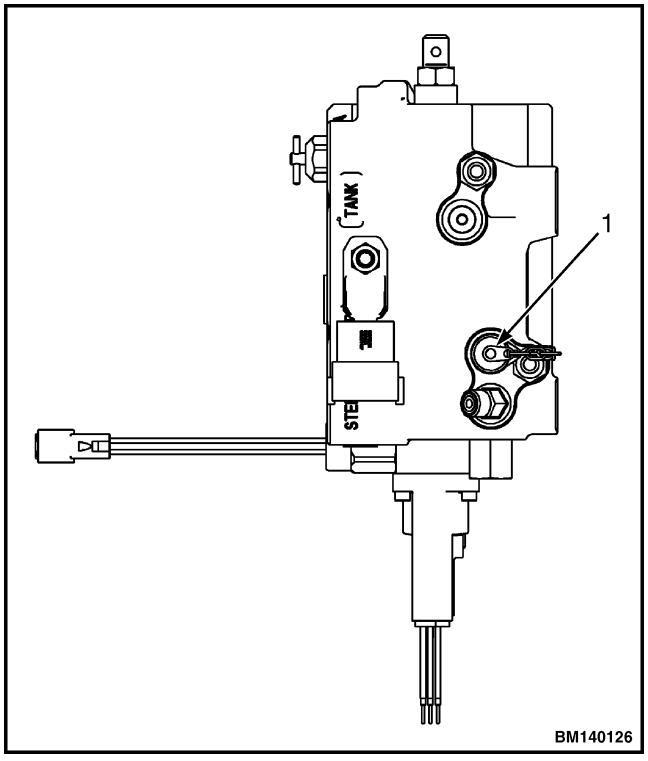
4. Actuate lift function as required to reach end of stroke and record pressure reading. See Table 13 for pressure specifications.

5. If pressure is outside of range, follow these procedures to adjust primary relief valve cartridges:

   a. Remove plug at end of large hex of cartridge and insert hex wrench into adjustment plug.

   b. Turning adjustment plug **CLOCKWISE** increases spring compression (higher pressure setting); turning adjustment plug **COUNTERCLOCKWISE** decreases spring compressions (lower pressure setting).

6. Lower forks to the ground and turn **OFF** lift truck.



1. DIAGNOSTIC FITTING WITH CAP (SHOWN IN PUMP PRESSURE GAUGE PORT)

Figure 170. Manual Control Valve Pressure Gauge Port

CAUTION

Hydraulic fluid may be hot, allow lift truck to cool down sufficiently prior to any work that may expose hydraulic fluid.

7. To replace primary relief valve, unscrew cartridge from inlet cover and replace with new cartridge. See **Parts Manual** for replacement part information.

8. Repeat Step 3 through Step 6 to verify new primary relief valve is set properly.

9. Remove pressure gauge and replace cap on diagnostic fitting.

Secondary Relief Valve

NOTE: The secondary relief valve is externally screw-adjustable.

1. Install a 200 bar (3000 psi) pressure gauge into diagnostic fitting installed in the Pump Pressure Gauge Port. See Figure 170.

2. Run lift truck to ensure hydraulic oil temperature has stabilized at 49°C (120°F).

3. Raise mast enough for forks to clear when tilted fully forward.

4. Actuate tilt or auxiliary function as required to reach end of stroke and record pressure reading. Pressure should read approximately 165 ±5 bar (2400 ±75 psi).

5. If pressure is out of range, adjust secondary relief valve screw adjustment as directed below:

   a. Turn screw adjustment **CLOCKWISE** to increase pressure setting.

   b. Turn screw adjustment **COUNTERCLOCKWISE** to decrease pressure setting.

   c. Lower forks to ground and turn lift truck **OFF**.

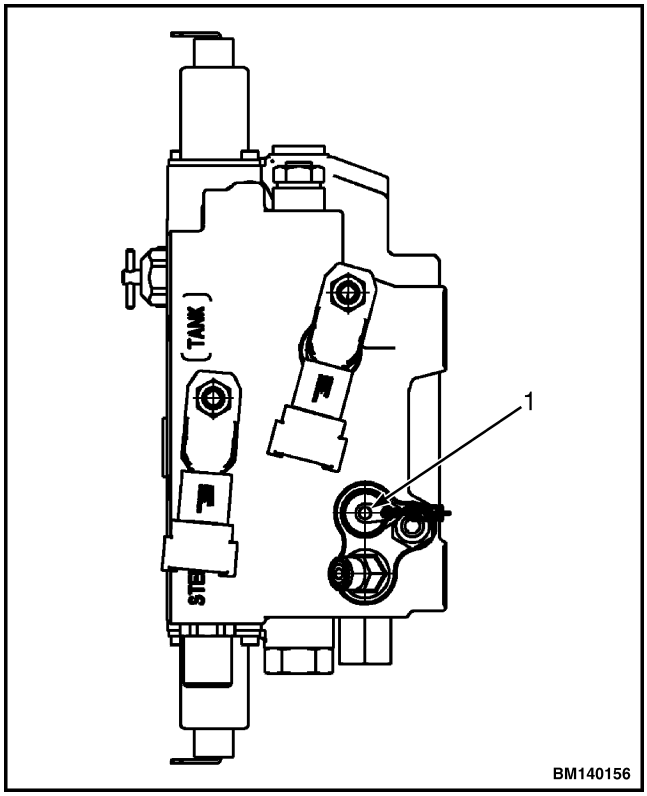
6. Remove pressure gauge from diagnostic fitting and replace cap.

E-HYDRAULIC CONTROL VALVE

Primary Relief Valve

NOTE: Primary relief valve is not externally adjustable.

1. Remove cap from diagnostic fitting installed in the Pump Pressure Gauge Port. See Figure 171.



1. DIAGNOSTIC FITTING WITH CAP (SHOWN PUMP PRESSURE GAUGE PORT)

Figure 171. E-Hydraulic Control Valve Pressure Gauge Port

2. Install a 250 bar (3625 psi) pressure gauge into diagnostic fitting.

3. Run lift truck to ensure hydraulic oil temperature has stabilized at 65 to 75°C (150 to 160°F).

4. Actuate lift function as required to reach end of stroke and record pressure reading.
5. See Table 13 for pressure specifications.
6. If pressure is outside of range, replace primary relief valve as directed below:
   a. Lower forks to ground, turn lift truck **OFF**.

CAUTION

Hydraulic oil is hot after system operation and can cause burns. Allow lift truck to cool down sufficiently prior to any work that may expose hydraulic fluid.

   b. Replace primary relief valve with new one.
   c. Repeat Step 3 through Step 5 to verify new primary relief valve is set correctly.
   d. Lower forks to ground, turn lift truck **OFF**.
7. Remove pressure gauge from diagnostic fitting and replace cap.

Secondary Relief Valve

1. Remove cap from diagnostic fitting installed in the Pump Pressure Gauge Port. See Figure 171.
2. Install a 200 bar (3000 psi) pressure gauge into diagnostic fitting.
3. Run lift truck to ensure hydraulic oil temperature has stabilized at 65 to 75°C (150 to 160°F).
4. Raise mast enough for forks to clear when tilted fully forward.
5. Actuate auxiliary function as required to reach end of stroke and record pressure reading. Pressure should read approximately 165 ±5 bar (2400 ±75 psi).
6. If pressure is out of range, adjust secondary relief valve screw as indicated below.
   a. Turn screw adjustment **CLOCKWISE** to increase pressure setting.
   b. Turn screw adjust **COUNTERCLOCKWISE** to decrease pressure setting.
   c. After adjustment, repeat Step 3 through Step 5 to verify pressure.
   d. Lower forks to ground and turn lift truck **OFF**.
7. Remove pressure gauge from diagnostic fitting and replace cap.

PPRV Pilot Pressure Test

This test is to determine if Pilot Pressure Reducing Valve (PPRV) is hydraulically supplying correct pressure to move the valve spool in E-Valve. This test should be done after confirming that the PPRV solenoid is getting correct current and that Pilot Supply pressure has been checked.

Table 13. Pressure Specifications

Model	Control Valve	Pressure
E2.2-3.0XN (E45-60XN) (A268) J2.2-3.0XN (J40-60XN) (A276)	3-Function	219 bar (3176 psi)
E3.0-3.5XN (E60-70XN) (A268) J3.0-3.5XN (J60-70XN) (A276)	4-Function	240 bar (3481 psi)
J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) E4.0-5.5XN(E80-120XN) (A099)	3-Function	220 bar (3191 psi)
J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) E4.0-5.5XN (E80-120XN) (A099)	4-Function	220 bar (3191 psi)

Table 14. Test Specifications

Oil Temperature	50 to 65°C (122 to 150°F)
Minimum Pilot Pressure 1.5 amps at 12 volts	1000 kPa (145 psi)

Table 15. Service Tools

Pilot Pressure "A" Test Plug (Smaller)	Hyster P/N 4009065
Pilot Pressure "B" Test Plug (Larger)	Hyster P/N 0197668
Pilot Pressure Test Gauge	0 to 7.0 MPa (0 to 1000 psi)
Pilot Supply Test Gauge	0 to 7.0 MPa (0 to 1000 psi)
Pilot Supply Test Port Size	SAE #4 O-ring Port (7/16 - 20 UNF)

NOTE: Check that pump RPM is at correct speed for all functions with no load on forks. See section

Capacities and Specifications 8000SRM1374 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268)

Capacities And Specifications 8000SRM1375 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276)

Capacities and Specifications 8000SRM1542 for lift truck models

- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

Capacities and Specifications 8000SRM1578 for lift truck model

- E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

NOTE: If all functions are lower flow than expected or none at all, then check the Pilot Supply pressure setting according to Table 14.

NOTE: A functioning solenoid valve will make a clicking sound when current is applied. This clicking can also be felt but solenoids may be too hot to touch if truck has been operating.

1. Check actuating current at solenoid while shifting appropriate MLM lever by using Display Switch Cluster (DSC) display. If no reading, DSC will display a Diagnostic Trouble Code (DTC). See **Diagnostic Troubleshooting Manual** 9000SRM1377.

WARNING

Hot hydraulic oil can cause serious burns to skin. DO NOT touch hydraulic components or oil during test. Make sure hydraulic oil has cooled to safe temperature before installing or removing test equipment.

WARNING

Hydraulic oil under pressure can be injected into the skin. Lower forks to ground and relieve all circuit pressure before removing test plugs from valve.

2. Lower forks to ground and remove key from display. Apply park brake and disconnect battery.

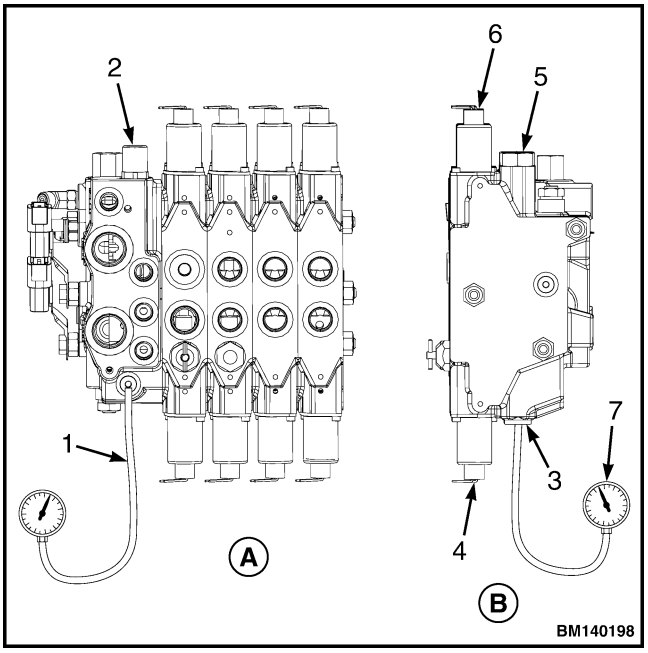
CAUTION

DO NOT permit dirt or other contaminants to enter the hydraulic system. Disconnected hoses, tubes, open valves, cylinder fittings, and ports should be protected with clean caps or plugs.

NOTE: The Pilot Supply Pressure gauge is shown as an additional gauge to use if pilot pressure is low.

3. Remove floor mat and floor plates. Unplug foot pedal connector.

4. Install pilot pressure test plug(s) into section with suspected faulty solenoid valve and install pilot pressure test gauge. See Figure 172.



NOTE: CONTROL VALVE IS SHOWN UPSIDE DOWN.

A. FRONT SIDE VIEW
B. RIGHT SIDE VIEW

1. PILOT SUPPLY TEST PORT WITH GAUGE
2. PILOT SUPPLY CARTRIDGE VALVE WITH TAMPERPROOF CAP
3. AUXILIARY 4A PLUG (SMALLER), SEE TABLE 15
4. AUXILIARY 4A SOLENOID
5. AUXILIARY 4B PLUG (LARGER), SEE TABLE 15
6. AUXILIARY 4B SOLENOID
7. PILOT PRESSURE TEST PORT WITH GAUGE

Figure 172. PPRV Pilot Pressure Test

5. Reconnect battery. Insert key into display and turn to **ON** position while sitting on seat.

6. Operate hydraulic system until oil temperature is at test specifications. See Table 14.

7. Shift MLM lever of test function and hold over relief. Check gauge reading when relief valve is open. Measure current flow to solenoid using DSC display. Compare to specifications.

NOTE: The PPRV is not repairable except for cleaning or replacing solenoid valve.

8. If pressure is not within specifications, check pressure reading on Pilot Supply Test Port gauge and compare to Table 14.

If Pilot Supply pressure is okay, remove PPRV and inspect for the following:

- Plugged inlet screen on PPRV
- Failed sealing ring on PPRV
- Sticking valve

9. Turn key to **OFF** position, disconnect battery, remove test equipment, and reinstall original port plugs onto control valve.

HYDRAULIC SYSTEM AIR REMOVAL

1. Install hydraulic valve pressure gauge as indicated in External Leakage

2. Turn lift truck **ON**; make sure lift truck is in neutral and park brake is set.

NOTE: Step 3 is required warm up for service. This is to ensure that the fluid temperature is optimal for calibrations.

3. Activate tilt at relief pressure until the hydraulic fluid temperature is 50 to 65°C (122 to 149°F).

NOTE: Perform Step 4 and Step 5 for hoist valve air bleed. This is required if the carriage moves slightly (approximately 25.4 mm (1 in.)) alternating between lifting and lowering.

4. Activate lift control from neutral to full lift and back to neutral at a rate of one to two times per second. Repeat until lift function is operating smoothly with not uncommanded mast movements.

5. Lift carriage to maximum height and run over hydraulic relief for 15 to 30 seconds.

NOTE: Perform Step 6 for cylinder air bleed. This is required if the cylinders have not been previously cycled, or if the lift function is not operating smoothly.

6. Cycle function completely two or three times; repeat if necessary.

It is not necessary to turn the lift truck **ON** or **OFF** if you are performing other procedures.

Position Sensor and OPS Check and Adjustment

POSITION SENSOR

NOTE: The position sensors are calibrated to the lift trucks's electronics and **must** be re-calibrated if they are removed or adjusted.

1. Check sensors to verify they are working properly. See Table 16 for correct wiring.

Table 16. Position Sensor Wiring

Wire Color	Purpose
Red Wire	Input, 5 VDC
Black Wire	Ground
White Wire	Output

a. With power supplied to the sensor, record sensor output voltages and compare to Table 17.

Table 17. Sensor Power Check

Spool Position	Sensor Output
Neutral	2.5 ±0.3 volts
Spool In	0.5 ±0.1 volts
Spool Out	4.5 ±0.1 volts

b. If outputs are out of tolerance, replace position sensor and re-calibrate. See Calibration Procedure section in this manual.

(OPS) OPERATOR PRESENCE SOLENOID

NOTE: The OPS is a simple on-off solenoid, and has no adjustments. With no power provided, the plunger is extended as shown in Figure 173.

1. Mark each connector and solenoid location prior to removal to aid in installation.

a. Disconnect solenoid connector and remove solenoid from spool lock body.

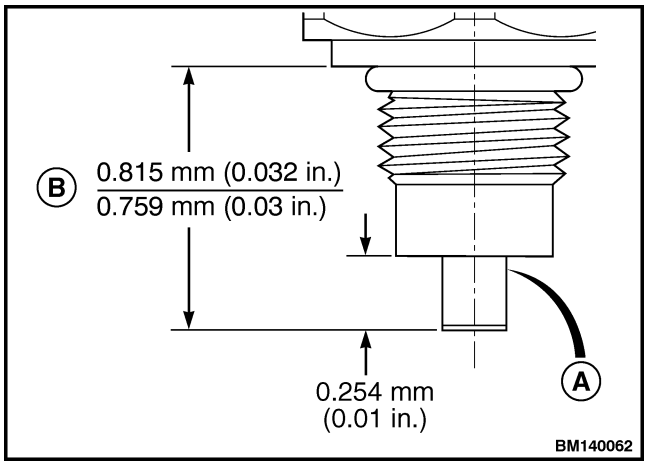
b. Measure pin length from solenoid as shown in Figure 173.

c. Measure resistance across the connector terminals.

(1) Acceptable resistance: 29.8 to 36.6 Ohms @ 25°C (77°F).

d. Power solenoid 10 times with 24VDC and verify pin retractions into solenoid. Plunger to be fully retracted into housing or protrude a maximum of 0.254 mm (0.01 in.) from housing.

e. Replace solenoid if any of these measurements are out of specification.



A. EXTENDED PLUNGER
B. PIN LENGTH

Figure 173. Solenoid Measurements

MANUAL CONTROL VALVE RE-CALIBRATION

Removal and installation of position sensors require manual control valve to be re-calibrated. See Calibration Procedure section of this manual.

Calibration Procedure

CONTROL VALVE

1. Turn key or keyless switch to **ON** position.
2. Lift forks approximately 25 cm (10 in.) off the ground.

NOTE: If lift truck is equipped with a roll clamp or similar front-end equipment, use momentary button and/or detent switches during calibration as in normal operation.

3. Center all auxiliary functions of the truck to allow for movement in both directions of each function.

NOTE: Perform Step 4 through Step 6 if password option is enabled.

4. From the operator screen, on the display, scroll to the right one screen to the password entry screen.
5. Enter password.
6. Press **Enter Key** (*).
7. From the operator screen, scroll to the right three times to the calibrations screen. See Figure 174.
8. Press **Enter Key** (*).
9. Scroll down once to the Valve Threshold Submenu.
10. Press **Enter Key** (*).
11. The display will prompt a hydraulic input for function 1 in the A (lower) direction until the forks begin to "creep".
12. Slowly move the function 1 control lever forward (lower).
13. While still holding the control lever, press **Enter Key** (*) when forks begin to creep in the A (lower) direction.
14. The display will prompt a hydraulic input for function 1 in the B (raise) direction until the forks begin to "creep".
15. Slowly move the function 1 control lever backward (raise).
16. While still holding the control lever, press **Enter Key** (*) when forks begin to creep in the B (raise) direction.
17. The Display will repeat Step 11 through Step 16 for the remaining functions. (indicated by a non-zero setting for the maximum flow rate).
18. Display will transition back to Calibrations Maintenance Menu List.
19. Calibration is complete.
20. Turn power **OFF**, wait 10 seconds, then turn power **ON**.

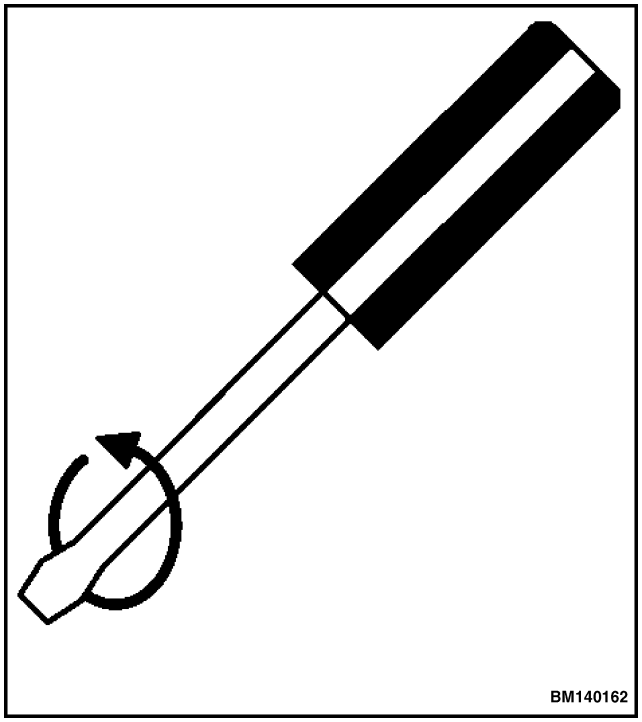


Figure 174. Calibrations Screen

Torque Specifications for 1.5-2.0T Lift Trucks

MANUAL HYDRAULIC CONTROL VALVE

Tie Rod Nuts
20.3 ± 1.4 N•m (179.7 ± 12.4 lbf in)

Elbow Fitting, Inlet Section
16 N•m (142 lbf in)

Primary Relief Valve
27 N•m (20 lbf ft)

Manual Lowering Valve
26 N•m (19 lbf ft)

Optional Work Port Relief Valve
26 N•m (19 lbf ft)

Spool Lock Solenoid
7 N•m (62 lbf in)

Steering Load Sense Fitting
16 N•m (142 lbf in)

Lift trucks J1.5-2.0XNT (K160) manufactured after November, 2014, not equipped with a steering load sense fitting.

Plug, Inlet Section
45 N•m (33 lbf ft)

Plug, Outlet Section
26 N•m (19 lbf ft)

Position Sensor Capscrews
4.7 N•m (42 lbf in)

MANUAL CONTROL VALVE HANDLES AND LEVERS

Outer Capscrews
1.35 to 1.65 N•m (11.9 to 14.6 lbf in)

E-HYDRAULIC CONTROL VALVE

Tie Rod Nuts
20.3 ± 1.4 N•m (179.7 ± 12.4 lbf in)

Jam Nuts
7 to 11 N•m (62 to 97 lbf in)

Elbow Fitting, Inlet Section
16 N•m (142 lbf in)

Compensator Plug
47 N•m (35 lbf ft)

Primary Relief Valve
27 N•m (20 lbf ft)

Pilot Cartridge
65 N•m (48 lbf ft)

Plug, Lift Section
27 N•m (20 lbf ft)

Manual Lowering Valve
54 N•m (40 lbf ft)

Port Option Plug, Tilt Section
54 N•m (40 lbf ft)

Plug, Tilt Section
27 N•m (20 lbf ft)

Optional Secondary Relief Valve
27 N•m (20 lbf ft)

Steer Load Sense Fitting
16 N•m (142 lbf in)

Lift trucks J1.5-2.0XNT (K160) manufactured after November, 2014, not equipped with a steering load sense fitting.

Solenoid
5 N•m (48 lbf in)

Torque Specifications for 2.2-5.5T Lift Trucks

MANUAL HYDRAULIC CONTROL VALVE

Tie Rod Nuts
20.3 ± 1.4 N•m (179.7 ± 12.4 lbf in)

Position Sensor Connector Nut
18 to 20 N•m (156 to 180 lbf in)

Steer Load Sense Fitting
16 N•m (142 lbf in)

Diagnostic Fitting
16 N•m (142 lbf in)

Primary Relief Valve
27 N•m (20 lbf ft)

Compensator Plug
47 N•m (35 lbf ft)

Small Port Plugs, Inlet Section
13.5 N•m (119 lbf in)

Medium Port Plugs, Inlet Section
65 N•m (48 lbf ft)

Large Port Plugs, Inlet Section
60 to 72 N•m (44 to 53 lbf ft)

Manual Lowering Valve
54 N•m (40 lbf ft)

Port Plug-Long, Lift Section
27 N•m (20 lbf ft)

Port Plug-Short, Lift Section
54 N•m (40 lbf ft)

Secondary Relief Valve
27 N•m (20 lbf ft)

Port Plugs, Auxiliary Section
14 N•m (124 lbf in)

Position Sensor Capscrews
4.7 N•m (42 lbf in)

OPS Solenoid
7.5 N•m (66 lbf in)

MANUAL CONTROL VALVE HANDLES AND LEVERS

Outer Capscrews
1.36 to 1.65 N•m (11.9 to 14.6 lbf in)

MANUAL CONTROL VALVE COVERS

Lower Cover Capscrews
2.82 to 3.16 N•m (24.95 to 27.97 lbf in)

Front Cover Capscrews
2.82 to 3.16 N•m (24.95 to 27.97 lbf in)

Rear Cover Capscrews
1.35 to 1.65 N•m (11.9 to 14.6 lbf in)

E-HYDRAULIC CONTROL VALVE

Tie Rod Nuts
20.3 ± 1.4 N•m (179.7 ± 12.4 lbf in)

Connector Jam Nuts
7 to 11 N•m (62 to 97 lbf in)

Solenoids
5 N•m (48 lbf in)

Pilot Cartridge
65 N•m (45 lbf ft)

Primary Relief Valve
27 N•m (20 lbf ft)

Elbow Fitting
16 N•m (142 lbf in)

Manual Lowering Valve
54 N•m (40 lbf ft)

Lift Section Plug
27 N•m (20 lbf ft)

Port Option Plug, Tilt Section
54 N•m (40 lbf ft)

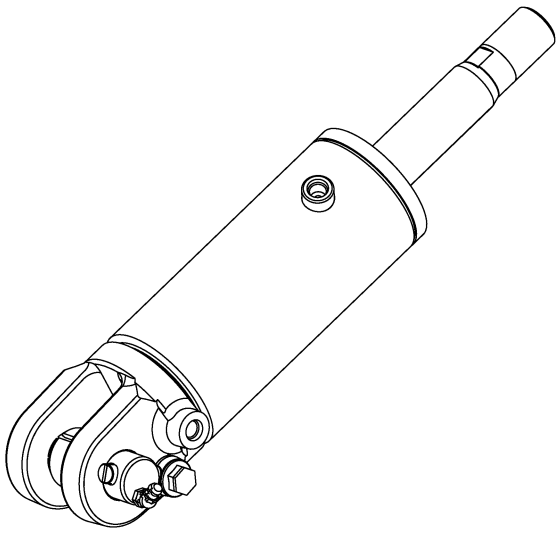
Optional Secondary Relief Cartridge
27 N•m (20 lbf ft)

Tilt Section Plug
27 N•m (20 lbf ft)

CYLINDER REPAIR

(MAST S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564)

E2.2-3.5XN (E45-70XN) [A268];
J2.2-3.5XN (J45-70XN) [A276];
J1.5-2.0XNT (J30-40XNT) [K160];
J1.6-2.0XN (J30-40XN) [A935];
J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) [A970];
E30-40HSD$_2$ [B219];
E30HSD$_3$, E35HSD$_3$, E40HSD$_3$ [C219];
E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) [A099]



HYSTER

PART NO. 1688877

2100 SRM 1382

SAFETY PRECAUTIONS
MAINTENANCE AND REPAIR

- The Service Manuals are updated on a regular basis, but may not reflect recent design changes to the product. Updated technical service information may be available from your local authorized Hyster® dealer. Service Manuals provide general guidelines for maintenance and service and are intended for use by trained and experienced technicians. Failure to properly maintain equipment or to follow instructions contained in the Service Manual could result in damage to the products, personal injury, property damage or death.
- When lifting parts or assemblies, make sure all slings, chains, or cables are correctly fastened, and that the load being lifted is balanced. Make sure the crane, cables, and chains have the capacity to support the weight of the load.
- Do not lift heavy parts by hand, use a lifting mechanism.
- Wear safety glasses.
- DISCONNECT THE BATTERY CONNECTOR before doing any maintenance or repair on electric lift trucks. Disconnect the battery ground cable on internal combustion lift trucks.
- Always use correct blocks to prevent the unit from rolling or falling. See HOW TO PUT THE LIFT TRUCK ON BLOCKS in the **Operating Manual** or the **Periodic Maintenance** section.
- Keep the unit clean and the working area clean and orderly.
- Use the correct tools for the job.
- Keep the tools clean and in good condition.
- Always use **HYSTER APPROVED** parts when making repairs. Replacement parts must meet or exceed the specifications of the original equipment manufacturer.
- Make sure all nuts, bolts, snap rings, and other fastening devices are removed before using force to remove parts.
- Always fasten a DO NOT OPERATE tag to the controls of the unit when making repairs, or if the unit needs repairs.
- Be sure to follow the **WARNING** and **CAUTION** notes in the instructions.
- Gasoline, Liquid Petroleum Gas (LPG), Compressed Natural Gas (CNG), and Diesel fuel are flammable. Be sure to follow the necessary safety precautions when handling these fuels and when working on these fuel systems.
- Batteries generate flammable gas when they are being charged. Keep fire and sparks away from the area. Make sure the area is well ventilated.

NOTE: The following symbols and words indicate safety information in this manual:

WARNING

Indicates a hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION

Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury and property damage.

On the lift truck, the WARNING symbol and word are on orange background. The CAUTION symbol and word are on yellow background.

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This section is for the following models:

E2.2-3.5XN (E45-70XN) [A268];
J2.2-3.5XN (J45-70XN) [A276];
J1.5-2.0XNT (J30-40XNT) [K160];
J1.6-2.0XN (J30-40XN) [A935];
J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) [A970];
($E30\text{-}40HSD_2$) [B219];
($E30HSD_3$, $E35HSD_3$, $E40HSD_3$) [C219];
E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) [A099]

"THE QUALITY KEEPERS"

HYSTER APPROVED PARTS

Safety Procedures When Working Near Mast

The following procedures MUST be used when inspecting or working near the mast. Additional precautions and procedures can be required when repairing or removing the mast.

WARNING

Mast parts are heavy and can move. Distances between parts are small. Serious injury or death can result if part of the body is hit by parts of the mast or the carriage.

- **Never put any part of the body into or under the mast or carriage unless all parts are completely lowered or a safety chain is installed. Also make sure that the power is OFF and the key is removed. Put a DO NOT OPERATE tag in the operator's compartment. Disconnect the battery and put a tag or lock on the battery connector.**
- **Be careful of the forks. When the mast is raised, the forks can be at a height to cause an injury.**
- **DO NOT climb on the mast or lift truck at any time. Use a ladder or personnel lift to work on the mast.**
- **DO NOT use blocks to support the mast weldments nor to restrain their movement.**
- **Mast repairs require disassembly and removal of parts and can require removal of the mast or carriage. Follow the repair procedures in this section.**

WHEN WORKING NEAR THE MAST ALWAYS:

- **Lower the mast and carriage completely. Push the lift/lower control lever forward and make sure there is no movement in the mast. Make sure that all parts of the mast that move are fully lowered.**

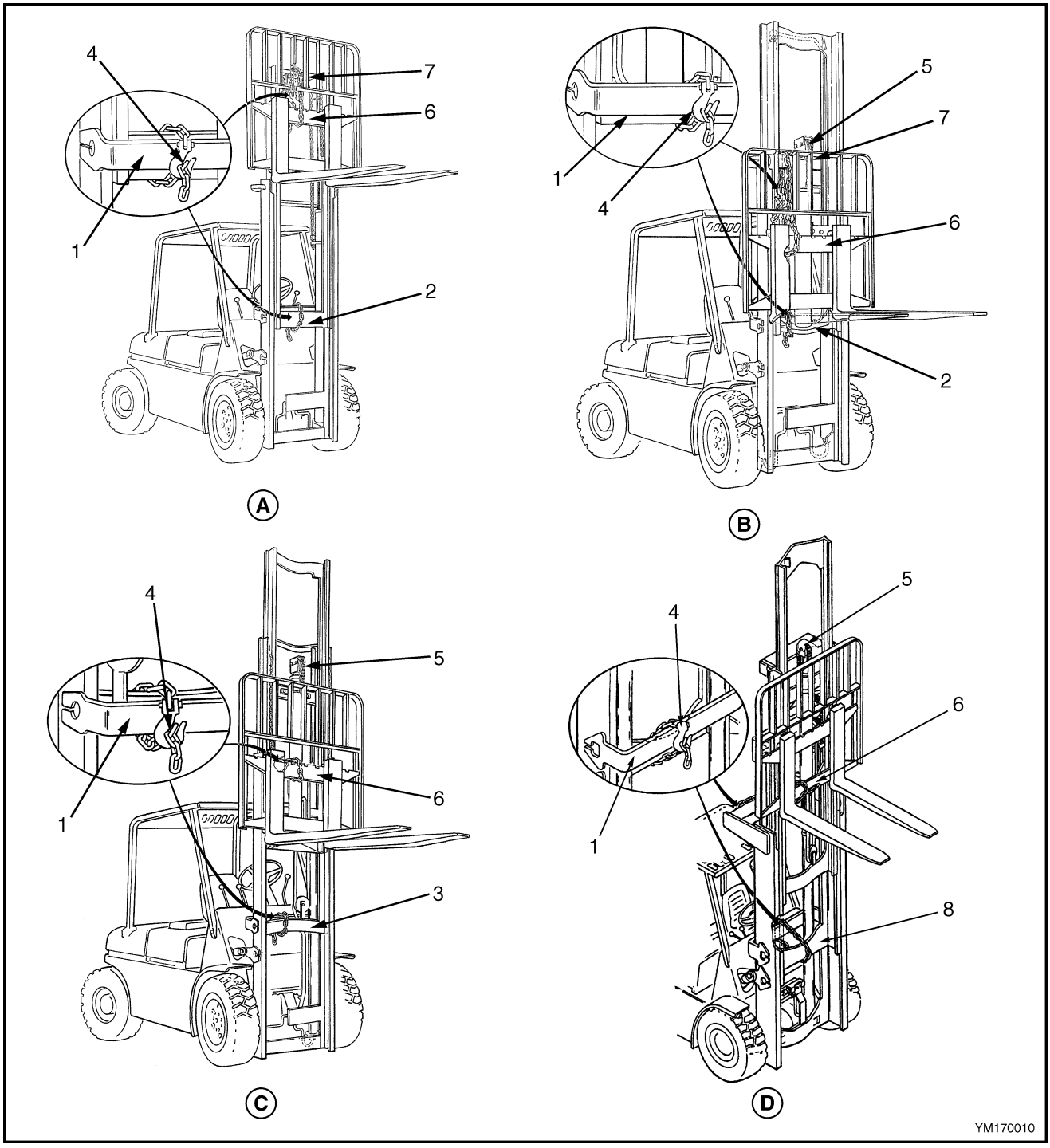
  OR

- **If parts of the mast must be in a raised position, install a safety chain to restrain the moving parts of the mast. Connect moving parts to a part that does not move. Follow these procedures:**

1. Put mast in vertical position.
2. Raise mast to align bottom crossmember of weldment that moves in outer weldment with crossmember on outer weldment. On the two-stage and free-lift mast, the moving part is the inner weldment. On the three-stage mast, it is the intermediate weldment. On the four-stage mast, it is the first intermediate weldment. See Figure 1.
3. Use a 3/8-inch (minimum) safety chain with a hook to fasten the crossmembers together so the movable member cannot lower. Put hook on back side of mast. Make sure hook is completely engaged with a link in the chain. Make sure safety chain does not touch lift chains or chain sheaves, tubes, hoses, fittings, or other parts on the mast.
4. Lower mast until there is tension in safety chain and free-lift cylinder (two-stage full free-lift, three-stage, and four-stage) is completely retracted. If running, turn the power **OFF**. Apply the parking brake. Install a **DO NOT REMOVE** tag on the safety chain(s).
5. Install another safety chain (3/8-in. minimum) between the top or bottom crossmember of the carriage bar and a crossmember on the outer weldment.
6. After lowering or restraining the mast, shut off the power, and remove key.

NOTE: Place a **DO NOT OPERATE** tag in the operator's compartment.

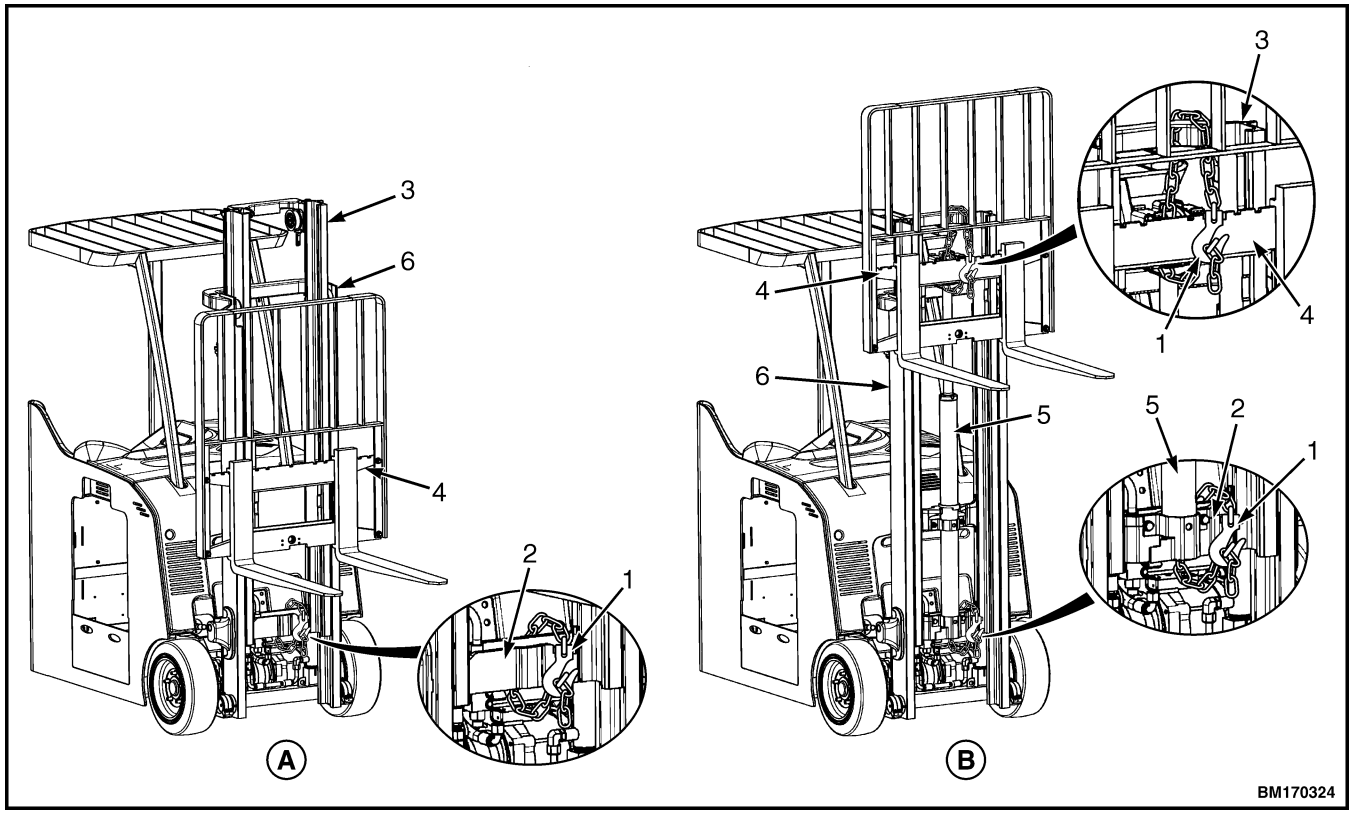
7. Disconnect battery and put a tag or lock on battery connector.



A. TWO-STAGE LFL MAST
B. TWO-STAGE FFL MAST
C. THREE-STAGE FFL MAST
D. FOUR-STAGE FFL MAST

1. OUTER WELDMENT
2. INNER WELDMENT
3. INTERMEDIATE WELDMENT
4. HOOK
5. FREE-LIFT CYLINDER
6. CARRIAGE BAR
7. CROSSMEMBER
8. FIRST INTERMEDIATE WELDMENT

Figure 1. Safety Chaining the Mast (Sit-Down Lift Trucks)



NOTE: TWO-STAGE MASTS SHOWN. FOR THREE-STAGE MAST, ALIGN THE CROSSEMEMBER OF INTERMEDIATE WELDMENT ALONG WITH INNER AND OUTER WELDMENTS WHEN CHAINING THE MAST.

A. LIMITED FREE-LIFT MAST

B. FULL FREE-LIFT MAST

1. SAFETY CHAIN AND HOOK
2. MAST CROSSMEMBERS ALIGNED
3. INNER WELDMENT
4. CARRIAGE (TOP BAR)
5. FREE-LIFT CYLINDER
6. OUTER WELDMENT

Figure 2. Safety Chaining the Masts (Stand-Up Lift Trucks)

General

CAUTION

Before working on any components of the hydraulic system, see Hydraulic Cleanliness Procedures 1900SRM1620 **for procedures to prevent dirt and debris from entering the hydraulic system and cause damage.**

This section contains repair procedures for tilt cylinders, main lift cylinders, free-lift cylinders, sideshift cylinders, and fork positioner cylinders. The number and the design of the parts can be different, but the operation of the cylinders is the same.

Description

This manual covers many different types of cylinders. Each cylinder will be described in detail.

Tilt cylinders are fastened between the frame of the lift truck and the outer weldment of the mast to change the angle of the mast and forks.

Two single-stage main lift cylinders and a free-lift cylinder are used to raise the carriage and extend the mast weldments.

The two main lift cylinders are installed at the back of the outer mast. The base of each lift cylinder sits on a mount at the bottom crossmember of the outer mast. The top of each main lift cylinder rod fits into a guide on the top crossmember of the inner mast. The free-lift cylinder is installed in the inner mast. Each of the lift cylinders has an internal lowering control valve. A single external lowering control valve is connected by tubing and hoses to all the lift cylinders.

NOTE: On lift truck models E2.2-3.5XN (E45-70XN) (A268), J2.2-3.5XN (J45-70XN) (A276), and J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) and E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099) there are two free-lift chains and chain sheaves.

On lift truck models J1.5-2.0XNT (J30-40XNT) (K160), J1.6-2.0XN (J30-40XN) (A935), E30-40HSD$_2$ (B219), and E30-40HSD$_3$ (C219) there is one free-lift chain and chain sheave. The description below applies to all trucks.

The free-lift chains connect at one end of the mid-crossmember of the inner mast. Chain sheaves are installed on a crosshead on the rod of the free-lift cylinder. The chains then go over sheaves on the crosshead and connect to the carriage.

Tilt Cylinder Repair for 1.0-2.0T Trucks

This section outlines the tilt cylinder repair procedures for lift truck models J1.5-2.0XNT (J30-40XNT) (K160), J1.6-2.0XN (J30-40XN) (A935), E30-40HSD$_2$ (B219), and E30-40HSD$_3$ (C219).

REMOVE

WARNING

Before removing the tilt cylinder(s), tilt the mast forward. Use a chain to hold the mast to the frame and prevent the mast from moving forward.

WARNING

DO NOT push the anchor pins out of the rod end with your fingers. DO NOT permit the tilt cylinder(s) to drop and cause damage.

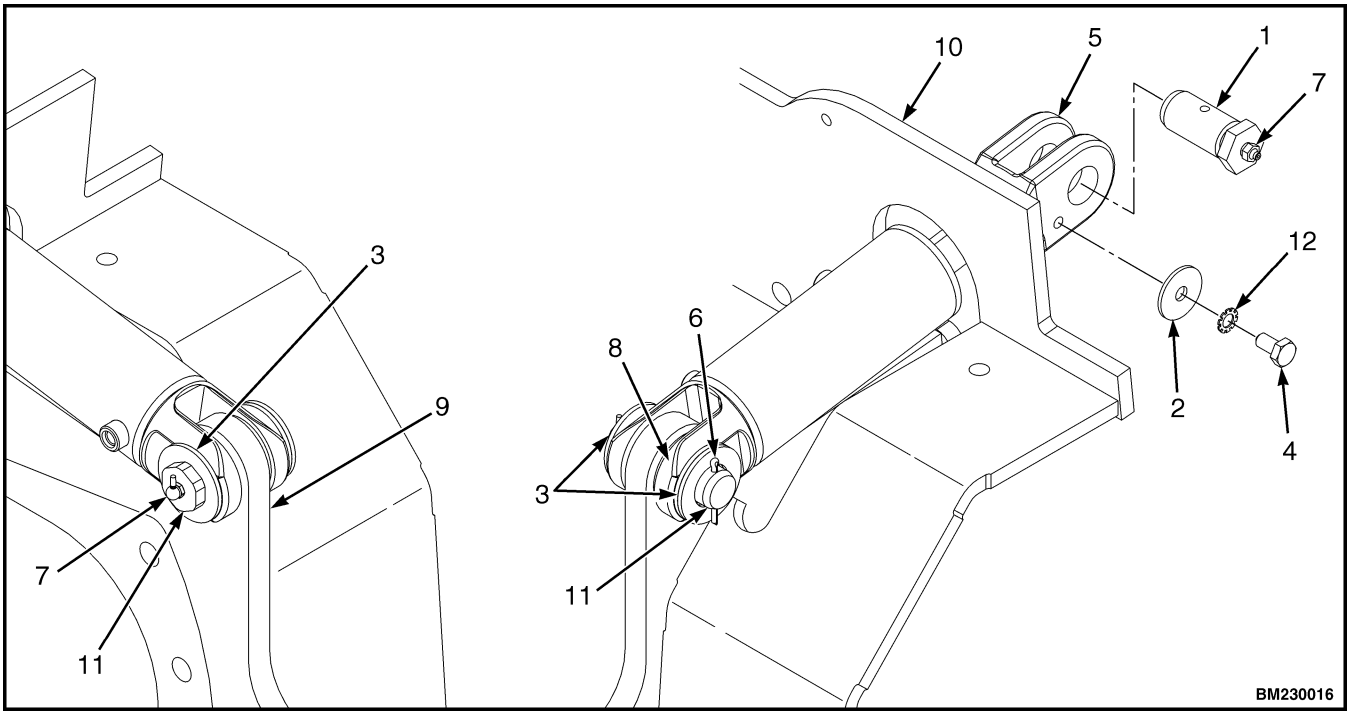
1. At the mast, remove capscrew, lock washer, and special washer. Using drift pin or similar tool remove rod end pin from rod end and tilt anchor.

   See Figure 3 for lift truck models

   - J1.5-2.0XNT (J30-40XNT) (K160)
   - J1.6-2.0XN (J30-40XN) (A935)

   See Figure 4 for lift truck models

   - E30-40HSD$_2$ (B219), E30-40HSD$_3$ (C219)



NOTE: RIGHT TILT CYLINDER SHOWN.

1. ROD END PIN
2. SPECIAL WASHER
3. WASHER
4. CAPSCREW
5. ROD END
6. COTTER PIN
7. LUBE FITTING
8. BUSHING
9. MOUNTING PLATE
10. FRONT CROSSMEMBER
11. ANCHOR PIN
12. LOCK WASHER EXTERNAL TOOTH

Figure 3. Tilt Cylinder Connections, Lift Truck Models J1.5-2.0XNT (J30-40XNT) (K160) and J1.6-2.0XN (J30-40XN) (A935)

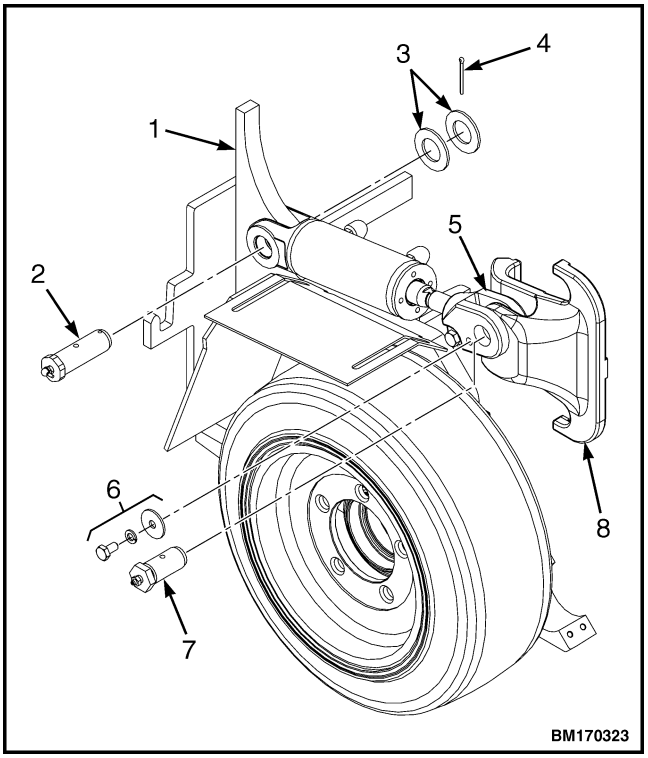


Figure 4. Tilt Cylinder Connections, Lift Truck Models E30-40HSD$_2$ (B219), E30-40HSD$_3$ (C219)

Legend for Figure 4.

NOTE: RIGHT TILT CYLINDER SHOWN.

1. MOUNTING PLATE (FRAME)
2. ANCHOR PIN (WITH GREASE FITTING)
3. SHIMS
4. COTTER PIN
5. ROD END
6. CAPSCREW, LOCKWASHER, AND SPECIAL WASHER
7. ROD END PIN (WITH GREASE FITTING)
8. TILT MOUNTING FLANGE (MAST)

2. Stroke tilt cylinder to the full back tilt position.

NOTE: Lift truck models J1.5-2.0XNT (K160) and J1.6-2.0XN (A935) equipped with a mast that has a lift height of 5 m (16 ft) are equipped with a hydraulic flow control valve to restrict tilt speed. See Figure 5.

3. Disconnect hydraulic line at tilt cylinder. Install cap on hydraulic line and in cylinder port.

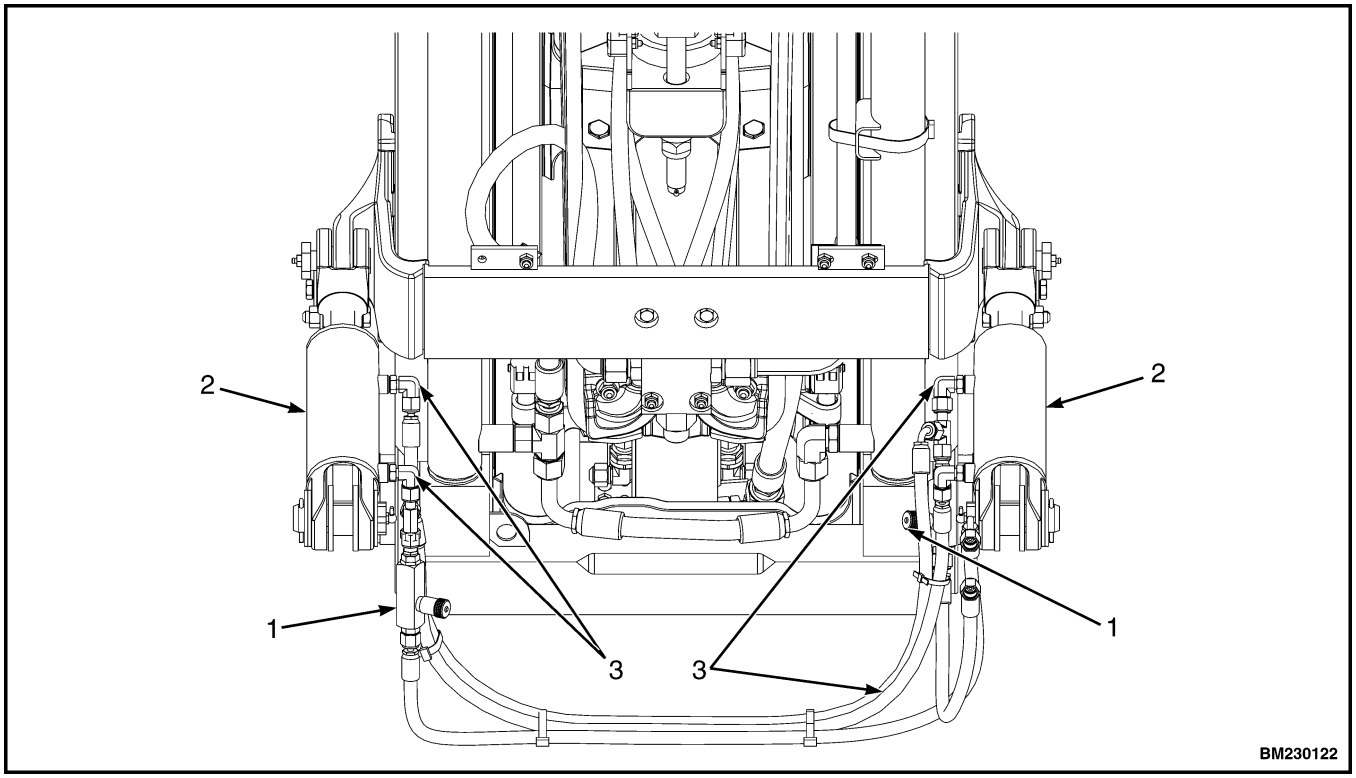
4. Remove cotter pin and two washers from anchor pin. Discard cotter pin. See Figure 3.

5. Remove anchor pin and washer using drift pin or similar tool from rod end and mounting plate. See Figure 3.

6. Using a lifting device, remove tilt cylinder from lift truck.

7. Remove washer. See Figure 3.

8. Repeat Step 1 through Step 7 for opposite tilt cylinder.



1. HYDRAULIC FLOW CONTROL VALVE (TILT SPEED RESTRICTOR)
2. TILT CYLINDER
3. HYDRAULIC LINE

Figure 5. Tilt Speed Restrictor

DISASSEMBLE

NOTE: The following steps have detailed disassembly instructions. Perform only those steps required to repair tilt cylinder.

NOTE: Note position of rod end and number of turns used to remove it from rod.

1. Place tilt cylinder in a soft jaw vise. Remove nut, washer, capscrew, and rod end. See Figure 6. If equipped, remove tilt spacer from rod. See Figure 7.

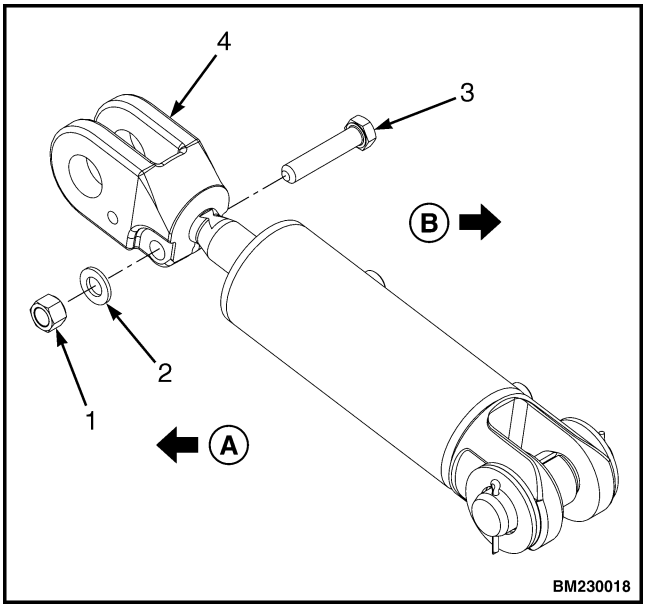


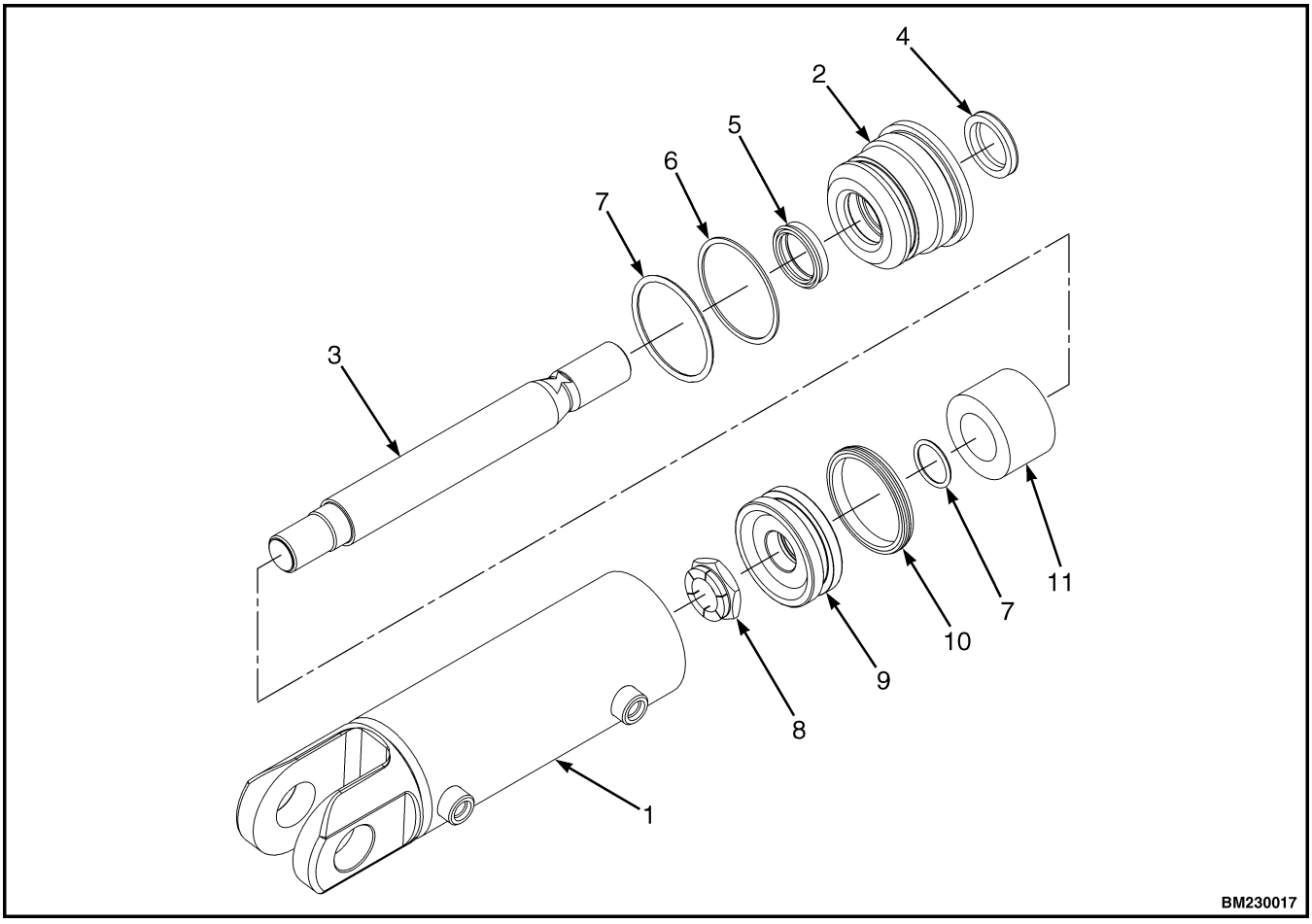
Figure 6. Rod End

Legend for Figure 6.

A. OUTBOARD SIDE OF ROD END
B. INBOARD SIDE OF ROD END

1. NUT
2. WASHER
3. CAPSCREW
4. ROD END

2. Using a pin-type spanner wrench, remove gland from tilt cylinder. Remove rod and piston assembly from shell. See Figure 7.



1. SHELL
2. GLAND
3. ROD
4. ROD WIPER
5. ROD SEAL
6. BACKUP RING
7. O-RING
8. LOCK NUT
9. PISTON
10. PISTON SEAL
11. SPACER

Figure 7. Tilt Cylinder

NOTE: To prevent damage to sealing surfaces, use brass tools when removing seals and O-rings.

3. Remove and discard rod wiper, rod seal, backup ring, and O-ring from gland. See Figure 7.

4. Place rod in a soft jawed vise and remove lock nut and piston from rod. See Figure 7.

5. Remove and discard O-ring and piston seal from piston. See Figure 7.

6. Remove spacer from rod. See Figure 7.

INSPECT

Inspect gland for damage to threads and seal surfaces. If damaged, replace gland.

Inspect piston for any damage to seal surfaces. If damaged, replace piston.

Inspect rod for damage to rod surface and ensure rod is not bent. If damaged, replace rod.

Inspect inner surface of shell for damage. If damaged, replace tilt cylinder.

Inspect bushings for damage. These bushings are in the frame and mast tilt cylinder connection points. If damaged, replace bushings.

CLEAN

WARNING

Cleaning solvents can be flammable and toxic and can cause skin irritation. When using cleaning solvents, always follow the solvent manufacturer's recommended safety procedures.

Compressed air can move particles so they cause injury to the user or to other personnel. Make sure the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eyes.

CAUTION

DO NOT allow cleaning solvent to come in contact with rubber components, as it will damage those components.

Clean all metal parts in solvent and dry with compressed air.

ASSEMBLE

NOTE: To prevent damage to sealing surfaces, use brass tools when installing seals and O-rings.

NOTE: Lubricate new rod seal, piston seal, O-rings, and backup ring with clean hydraulic oil before installation.

1. Install new piston seal and O-ring on piston. See Figure 7.

2. Place rod in a soft jaw vise and install spacer onto rod. See Figure 7.

NOTE: Perform following step only if piston was removed from rod.

3. With rod still in soft jaw vise, lube the threads of the lock nut with hydraulic oil. Install piston and lock nut onto rod and tighten lock nut to 163-190 N•m (120-140 lbf ft). See Figure 7.

4. Install new rod wiper, rod seal, backup ring, and O-ring on gland. See Figure 7.

5. Install rod and piston assembly into shell. Using pin-type spanner wrench, install gland onto tilt cylinder. Tighten gland to 163-190 N•m (120-140 lbf ft).

6. Place cylinder in a soft-jaw vise and install tilt spacer, if equipped, and rod end on rod as noted during removal. Lubricate threads on capscrew with lubricant, Hyster Part No. 186061 . Install capscrew in rod end so that capscrew head is on the inboard side of rod end. Install washer and nut on capscrew. Washer and nut must be on the outboard side of rod end. See Figure 6. Tighten nut to 90 N•m (66 lbf ft).

7. Repeat above steps for remaining tilt cylinder.

INSTALL

1. Using lifting device, place tilt cylinder in mounting position on lift truck frame.

2. Install washer and rod end onto mounting plate. See Figure 3.

3. Install washer on anchor pin. Install anchor pin into rod end and mounting plate. See Figure 3.

4. Install two washers and new cotter pin onto anchor pin. See Figure 3.

5. Connect hydraulic lines to tilt cylinder. Slowly stroke cylinder until rod holes line up with mast tilt anchor holes.

6. Position rod end pin head to outboard side of lift truck. Install special washer, rod end pin, washer, and capscrew to rod end and tilt anchor. See Figure 3. Tighten capscrew to 38 N•m (28 lbf ft).

7. Repeat above steps for remaining tilt cylinder.

8. Remove chain holding mast to lift truck frame.

WARNING

DO NOT put hands between cylinder rod end and mast. Serious injury can occur.

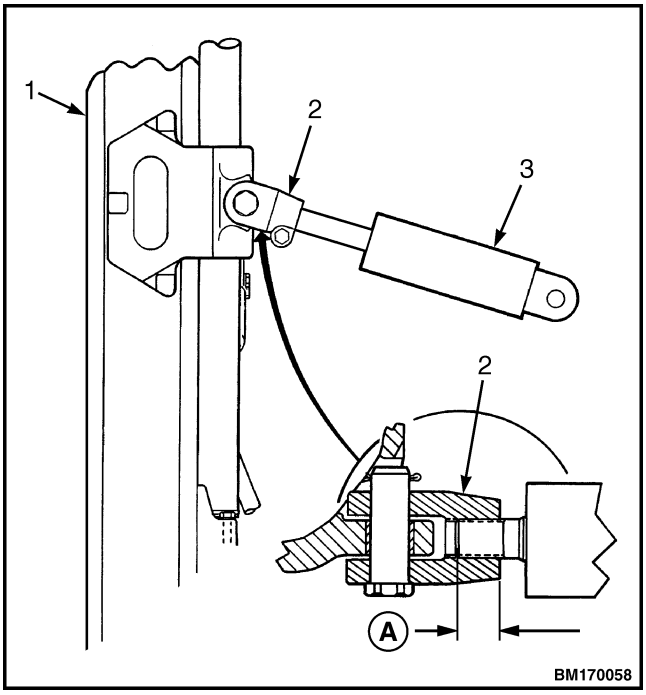
9. Operate tilt cylinders. Check for correct operation and leakage. Adjust tilt cylinders.

TILT CYLINDERS, ADJUST

WARNING

When tilt cylinders have tilt limit spacers, make sure they are installed during installation procedures. Without the tilt limit spacers, the mast can tilt too much and cause an accident or serious injury.

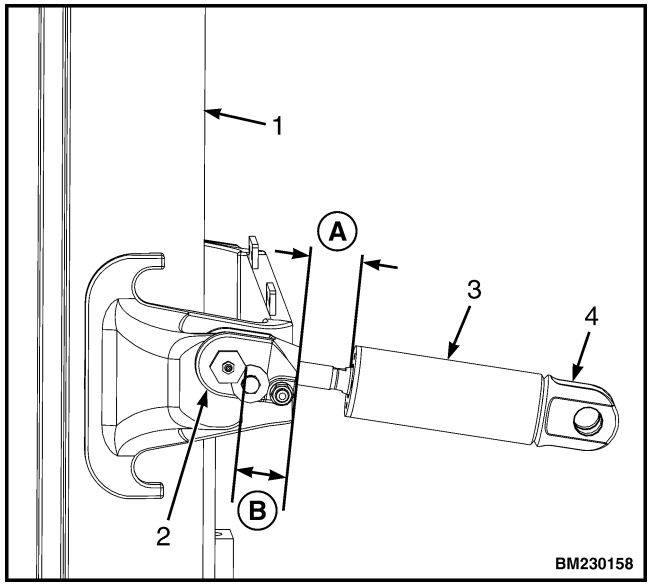
Check the tilt cylinder stroke by **SLOWLY** tilting the mast fully forward and backward several times. Both tilt cylinders must stop their stroke at the same time. Adjust the rod ends as shown in Figure 8. There must be no twist in mast weldments.



A. 32 mm (1.25 in.)

1. MAST
2. ROD END
3. TILT CYLINDER

Figure 8. Tilt Cylinder Adjustments, Lift Truck Models Manufactured Before December, 2015 and Lift Truck Models J1.5-2.0XNT (J30-40XNT) (K160) and J1.6-2.0XN (J30-40XN) (A935) E30-40HSD$_2$ (B219) and E30-40HSD$_3$ (C219)



A. 27 mm (1.10 in.)
B. 32 mm (1.25 in.)

1. MAST
2. ROD END
3. TILT CYLINDER
4. TRUCK END

Figure 9. Tilt Cylinder Adjustments, Lift Truck Models Manufactured After December, 2015J1.5-2.0XNT (J30-40XNT) (K160) and J1.6-2.0XN (J30-40XN) (A935)

NOTE: Perform Step 1 for lift truck models J1.5-2.0XNT (J30-40XNT) (K160) and J1.6-2.0XN (J30-40XN) (A935) manufactured before December, 2015 and for lift truck models E30-40HSD$_2$ (B219) and E30-40HSD$_3$ (C219) .

1. Adjust the stroke of tilt cylinders **WITHOUT** tilt limit spacers as follows:

Adjust the rod ends to 32 mm (1.25 in.). See Figure 8.

Slowly tilt the mast backward until one cylinder rod stops. On the opposite cylinder, loosen the capscrew on the rod end. Measure the distance from the end of the cylinder to the back end of the rod end. Use a wrench to turn the cylinder rod **IN** until the dimension start to decrease, then stop. Repeat this procedure until both cylinder rods stop at the same position within 1 mm (0.04 in.). After adjustments are complete, tighten nuts on rod end to 90 N•m (66 lbf ft).

Tilt mast fully backward and measure tilt angle. See the Nameplate for tilt angles. If necessary, adjust both rod ends equally for the correct angle.

NOTE: Perform Step 2 for lift truck models J1.5-2.0XNT (J30-40XNT) (K160) and J1.6-2.0XN (J30-40XN) (A935) manufactured after December, 2015.

2. Adjust the stroke of tilt cylinders **WITHOUT** tilt limit spacers as follows:

Adjust the rod ends to 32 mm (1.25 in.). See Figure 9.

Slowly tilt the mast backward until one cylinder rod stops. On the opposite cylinder, loosen the capscrew on the rod end. Measure the distance from the end of the cylinder to the back end of the rod end. Use a wrench to turn the cylinder rod **IN** until the dimension start to decrease, then stop. Repeat this procedure until both cylinder rods stop at the same position within 1 mm (0.04 in.). After adjustments are complete, tighten nuts on rod end to 90 N•m (66 lbf ft).

Tilt mast fully backward and measure tilt angle. See the Nameplate for tilt angles. If necessary, adjust both rod ends equally to the correct angle. The tilt angle must not exceed 27 mm (1.10 in.) as shown in Figure 9.

TILT CYLINDERS LEAK CHECK

WARNING

Never allow anyone under a raised carriage. DO NOT put any part of your body in or through the lift mechanism unless all parts of the mast are completely lowered and the key switch or keyless switch is turned OFF.

DO NOT try to find hydraulic leaks by putting your hand on hydraulic components under pressure. Hydraulic oil can be injected into the body by the pressure.

1. Put a capacity load on the forks. If the mast slowly tilts forward when the control valve is in the **NEUTRAL** position, there are leaks inside the hydraulic system. The maximum speed that the mast is allowed to tilt forward when there are internal leaks in the lift system is 0.50 degree in one minute. The maximum speed is measured when the hydraulic oil is 49°C (120°F).

2. If the leak rate is greater than these specifications, remove the load from the mast. Install a gate valve between the port at the front of the tilt cylinder and the hydraulic line. Put the load on the forks again. Close the gate valve. If the mast tilts forward faster than 0.5 degrees per minute, the cylinder seals are leaking. Be sure to check both tilt cylinders.
3. If the mast does not move, open the gate valve and check for movement again. If the mast moves forward when the gate valve is open, check for leaks in the hydraulic lines or fittings. If no leaks are found, the main control valve may have a defect. Remove the load from the forks.

Tilt Cylinder Repair for 2.0-5.5T Trucks

This section outlines the tilt cylinder repair procedures for lift truck models E2.2-3.5XN (E45-70XN) (A268), J2.2-3.5XN (J45-70XN) (A276), J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970), and E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099).

REMOVE

WARNING

Before removing the tilt cylinder(s), tilt the mast forward. Use a chain to hold the mast to the frame to prevent the mast from moving forward.

WARNING

DO NOT push the anchor pins out of the rod end with your fingers. DO NOT permit the tilt cylinders to drop and cause damage.

NOTE: Only lift truck models J2.2-3.5XN (J45-70XN) (A276) and J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) may be equipped with optional boot on the tilt cylinder. See Figure 11.

1. At the mast end, remove capscrew and retainer from anchor pin. Using a drift pin or similar tool, push anchor pin out of rod end.

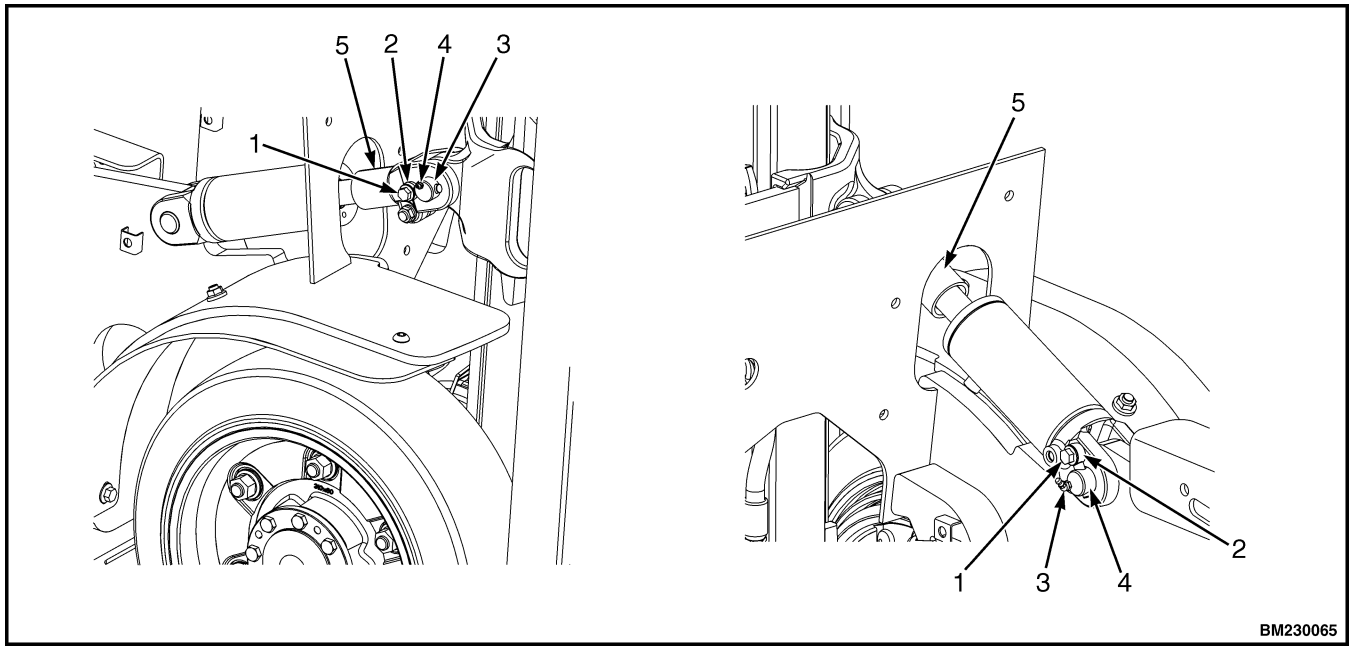
   See Figure 10 for tilt cylinders NOT equipped with optional boot

   See Figure 11 for lift truck models J2.2-3.5XN (J45-70XN) (A276) and J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) equipped with tilt cylinder with optional boot.
2. Stroke tilt cylinder to the full back tilt position.
3. Disconnect hydraulic line at tilt cylinder. Install cap on hydraulic line and in cylinder port.

WARNING

DO NOT push the anchor pins out of the rod end with your fingers. DO NOT permit the tilt cylinders to drop and cause damage.

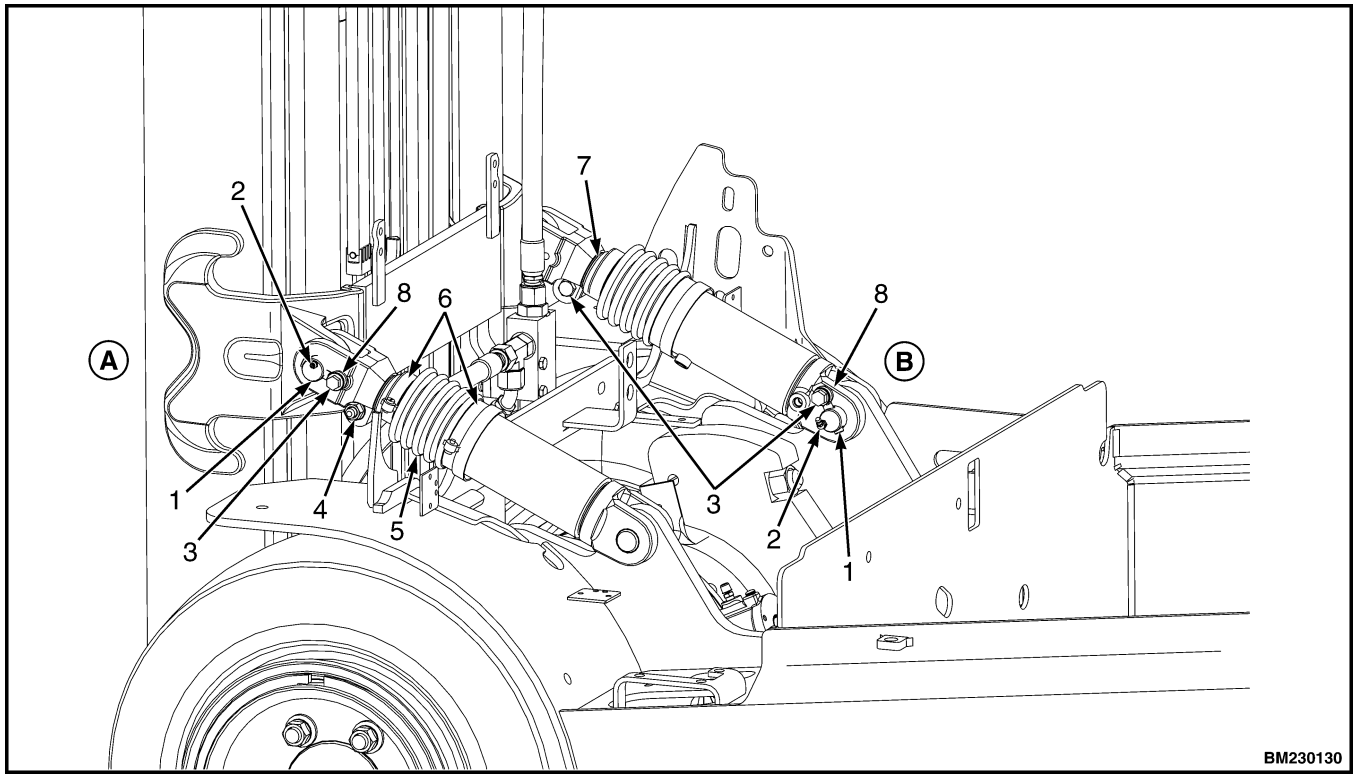
4. Use a lifting device to hold tilt cylinder. At the truck end, remove capscrew and retainer from anchor pin. Using a drift pin or similar tool, push anchor pin out of lift truck frame.
5. Using lifting device, remove tilt cylinder from lift truck.
6. If necessary, repeat Step 1 through Step 5 for opposite tilt cylinder.



NOTE: HYDRAULIC HOSES ARE SHOWN DISCONNECTED FOR CLARITY.

1. CAPSCREW
2. RETAINER
3. LUBRICATION FITTING
4. ANCHOR PIN
5. TILT SPACER

Figure 10. Tilt Cylinder Removal, Tilt Cylinder Without Boot



NOTE: HYDRAULIC HOSES AND OTHER COMPONENT PARTS OMITTED FOR CLARITY.

A. MAST END
B. TRUCK END

1. ANCHOR PIN
2. GREASE FITTING
3. CAPSCREW
4. NUT
5. BOOT
6. CLAMP
7. SPACER
8. RETAINER

Figure 11. Tilt Cylinder Removal, Tilt Cylinder With Boot, Lift Truck Models Manufactured After November, 2014 and J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) J2.2-3.5XN (J45-70XN) (A276)

DISASSEMBLE

NOTE: The following steps have detailed disassembly instructions. Perform only those steps required to repair the tilt cylinder.

NOTE: Note position of rod end and number of turns used to remove it from rod.

1. Place tilt cylinder in a soft jaw vise.

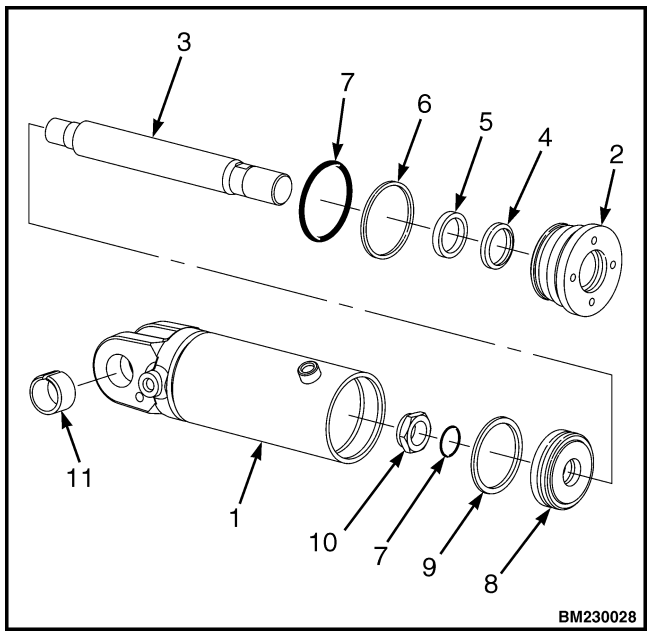
a. Tilt cylinder not equipped with optional boot: Remove rod end and, if equipped, tilt spacer from rod. See Figure 10.

b. Tilt cylinder equipped with optional boot: Remove rod end and, if equipped, shim(s). Remove two clamps and boot from tilt cylinder. Remove tilt spacer from rod. See Figure 11.

2. Using a pin-type spanner wrench, remove gland from rod and shell. Remove rod and piston assembly from shell.

NOTE: To prevent damage to sealing surfaces, use brass tools when removing seals and O-rings.

3. Remove and discard O-ring, backup ring, seal, and rod wiper from gland. See Figure 12.



1. SHELL
2. GLAND
3. ROD
4. ROD WIPER
5. SEAL
6. BACKUP RING
7. O-RING
8. PISTON
9. PISTON SEAL
10. NUT
11. BUSHING

Figure 12. Tilt Cylinder

NOTE: Perform Step 4 only if piston or rod has been damaged.

4. Place rod in a soft-jaw vise and remove nut and piston from rod. See Figure 12.

5. Remove and discard O-ring and piston seal from piston. See Figure 12.

INSPECT

Inspect gland for damage to threads and seal surfaces. If damaged, replace gland.

Inspect piston for any damage to seal surfaces. If damaged, replace piston.

Inspect rod for damage to rod surface and ensure that rod is not bent. If damaged, replace rod.

Inspect inner surface of cylinder tube for damage. If damaged, replace tilt cylinder assembly.

Inspect bushings for damage. These bushings are in the frame and mast tilt cylinder connection points. If damaged, replace bushings.

If lift truck is equipped with optional boot on tilt cylinder, inspect the boot and clamps. If worn or damaged, replace with new parts.

CLEAN

WARNING

Cleaning solvents can be flammable and toxic and can cause skin irritation. When using cleaning solvents, always follow the solvent manufacturer's recommended safety procedures.

Compressed air can move particles so they cause injury to the user or to other personnel. Make sure the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eyes.

CAUTION

DO NOT allow cleaning solvent to come in contact with rubber components, as it will damage those components.

Clean all metal parts in solvent and dry with compressed air.

ASSEMBLE

NOTE: To prevent damage to sealing surfaces, use brass tools when installing seals and O-rings.

NOTE: Lubricate new seals, O-rings, and rings with clean hydraulic oil before installation.

1. Install new piston seal and O-ring on the piston. See Figure 12.

NOTE: Perform Step 2 only if piston was removed from rod.

2. Place rod in a soft-jaw vise and lube the threads of the nut with hydraulic oil. Install piston and nut on rod.

Tighten nut to
170 to 220 N•m (125 to 162 lbf ft) on lift truck models

- E2.2-2.5XN (E45-55XN) (A268)
- J2.2-2.5XN (J45-50XN) (A276)

Tighten nut to
320 to 400 N•m (236 to 295 lbf ft) on lift truck models

- E3.0-3.5XN (E60-70XN) (A268)
- J3.0-3.5XN (J60-70XN) (A276)

  Tighten nut to
  400 to 440 N•m (295 to 325 lbf ft) on lift truck models

- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)
- E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

3. Install new rod wiper, seal, backup ring, and O-ring on gland. See Figure 12.

4. Install rod and piston assembly into shell. Using a pin-type spanner, install gland onto rod in shell.

Tighten gland to
170 to 237 N•m (125 to 175 lbf ft) for lift truck models

- E2.2-2.5XN (E45-55XN) (A268)
- J2.2-2.5 (J45-55XN) (A276)

Tighten gland to
400 to 500 N•m (295 to 370 lbf ft) for lift truck models

- E3.0-3.5XN (E60-70XN) (A268)
- J3.0-3.5XN (J60-70XN) (A276)
- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)
- E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

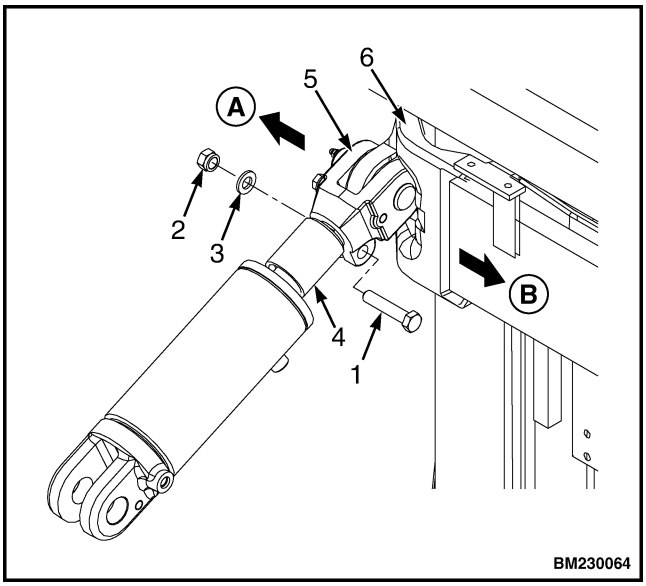
5. Place cylinder in a soft-jaw vise.

a. Tilt cylinder not equipped with boot: Install tilt spacer, if equipped, and rod end on rod as noted during removal. See Figure 10. Lubricate threads on capscrew with lubricant, Hyster Part No. 186061 . Install capscrew in rod end so that capscrew head is on the inboard side of rod end. Install washer and nut on capscrew. Washer and nut must be on the outboard side of rod end. See Figure 13.

Tighten nut to 90 N•m (66 lbf ft) for lift truck models

- E2.2-3.5XN (E45-70XN) (A268)
- J2.2-3.5XN (J450-70XN) (A276)
- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)
- E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

b. Tilt cylinder equipped with optional boot: Install tilt spacer tight against rod end. Install tilt cylinder boot with air holes on the bottom. Secure tilt cylinder boot to tilt cylinder and tilt spacer using two clamps. See Figure 11. Install rod end on rod as noted during removal. Lubricate threads on capscrew with lubricant, Hyster Part No. 186061 . Install capscrew in rod end so that capscrew head is on the inboard side of rod end. Install washer and nut on capscrew. Washer and nut must be on the outboard side of rod end. See Figure 13. Tighten nut to 90 N•m (66 lbf ft).



NOTE: LEFT TILT CYLINDER SHOWN. TILT CYLINDER WITHOUT OPTIONAL BOOT SHOWN. LIFT TRUCK MODELS J2.2-3.5XN (J450-70XN) (A276) EQUIPPED WITH OPTIONAL BOOT ON TILT CYLINDER INSTALLED IN SAME WAY.

A. OUTBOARD SIDE OF ROD END
B. INBOARD SIDE OF ROD END

1. CAPSCREW
2. NUT
3. WASHER
4. TILT SPACER
5. ROD END
6. MAST END MOUNT

Figure 13. Rod End Installation

6. Repeat above steps for other tilt cylinder.

INSTALL

1. Using a lifting device, place cylinder in mounting position on lift truck frame. Install anchor pin. Install retainer and capscrew. Lubricate threads on bolt that secures rod end to piston with lubricant, Hyster Part No. 186061 . Install washer and nut on bolt that secures the rod end.

   Tighten nut to 38 N•m (28 lbf ft) for lift truck models

   - E2.2-3.5XN (E45-70XN) (A268)
   - J2.2-3.5XN (J450-70XN) (A276)

   Tighten nut to 66 to 73 N•m (49 to 54 lbf ft) for lift truck models

   - J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

   Tighten nut to 68 N•m (50 lbf ft) for lift truck model

   - E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

   See Figure 10 for tilt cylinders not equipped with optional boot

   See Figure 11 for lift truck models J2.2-3.5XN (J45-70XN) (A276) equipped with tilt cylinder with optional boot.

2. Connect hydraulic lines to tilt cylinder. Slowly stroke cylinders until rod holes line up with mast tilt anchor holes.

3. Install anchor pin and retainer on tilt anchor.

4. Repeat above steps for remaining tilt cylinder.

5. Remove chain holding mast to lift truck frame.

WARNING

DO NOT put hands between the cylinder rod end and the mast. Serious injury can occur.

6. Operate tilt cylinders. Check for correct operation and leakage. For lift truck models J2.2-3.5XN (J45-70XN) (A276) and J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) equipped with tilt cylinder with optional boot, check that there is no slippage at boot collars when mast tilts forward and backward. Adjust tilt cylinders. See Tilt Cylinders, Adjust.

TILT CYLINDERS, ADJUST

WARNING

When the tilt cylinders have tilt limit spacers, make sure they are installed during installation procedures. Without the tilt limit spacers, the mast can tilt too much and cause an accident or serious injury.

Check tilt cylinder stroke by slowly tilting mast fully forward and backward several times. Both tilt cylinders must stop their stroke at the same time. Adjust rod ends as shown in illustrations below. There must be no twist in mast weldments.

See Figure 14 for lift truck models

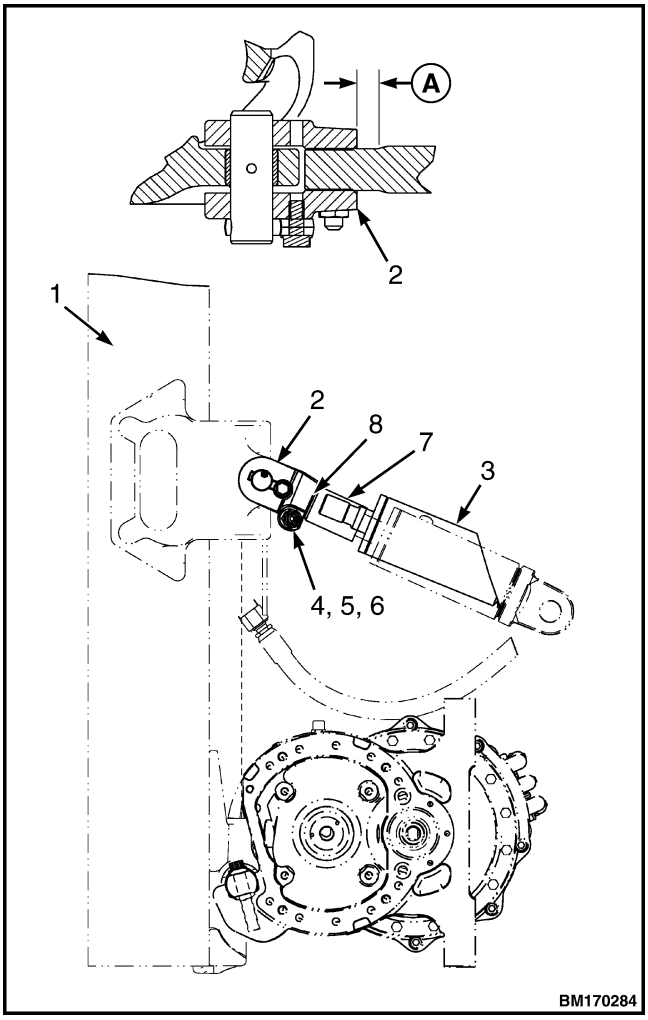
- E2.2-3.5XN (E45-70XN) (A268)
- J2.2-3.5XN (J45-70XN) (A276)

See Figure 15 for lift truck models

- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

See Figure 16 for lift truck models

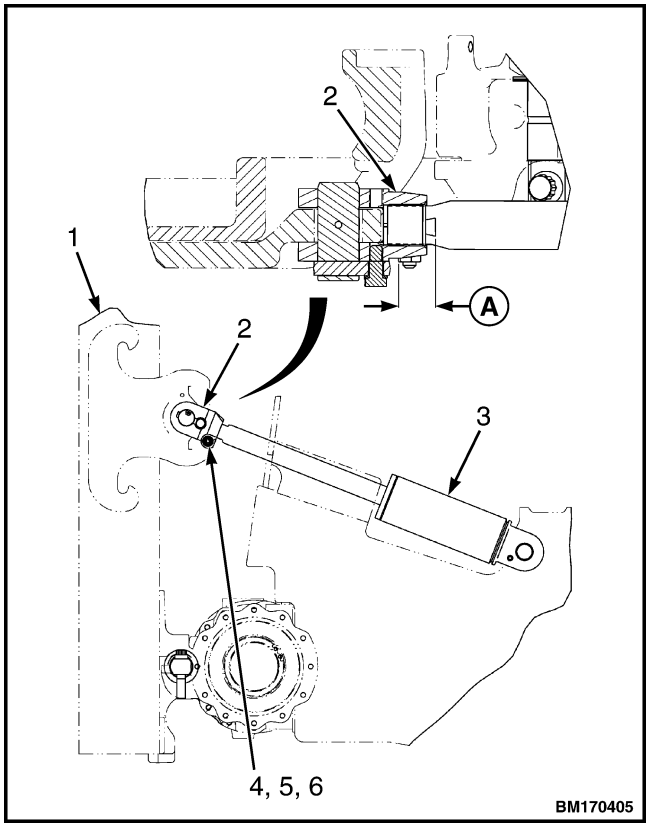
- E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)



A. DIMENSION A = 15 mm (0.60 in.)

1. MAST
2. ROD END
3. TILT CYLINDER
4. WASHER
5. CAPSCREW
6. NUT
7. TILT LIMIT SPACER
8. SHIMS

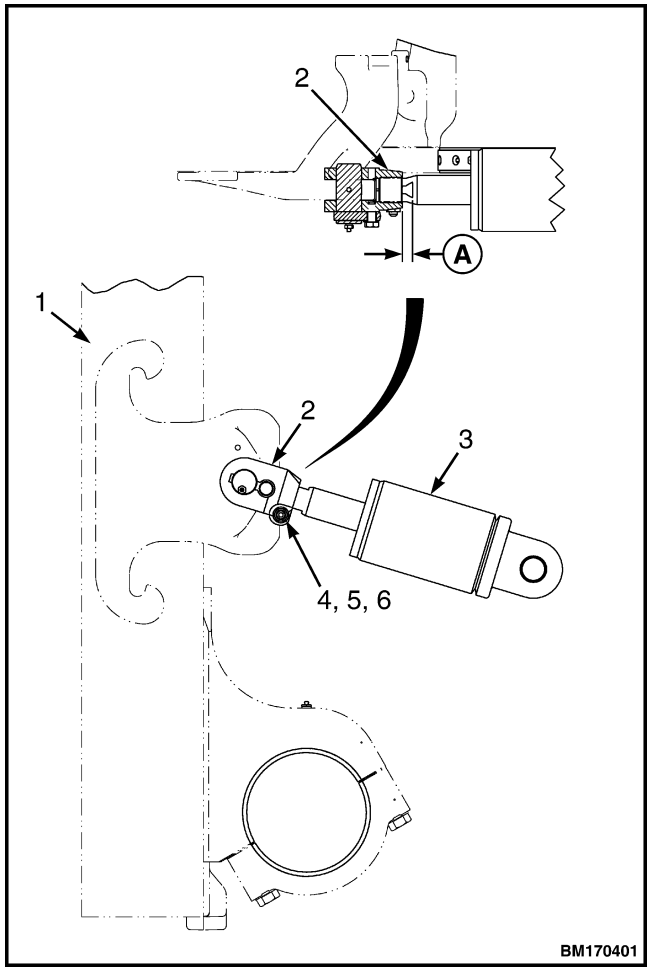
Figure 14. Tilt Cylinder Adjustments for Lift Truck Models and E2.2-3.5XN (E45-70XN) (A268) J2.2-3.5XN (J45-70XN) (A276)



A. DIMENSION A = 15 mm (0.60 in.)

1. MAST
2. ROD END
3. TILT CYLINDER
4. WASHER
5. CAPSCREW
6. NUT

Figure 15. Tilt Cylinder Adjustments for Lift Truck Models J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)



A. DIMENSION A = 15 mm (0.60 in.)

1. MAST
2. ROD END
3. TILT CYLINDER
4. WASHER
5. CAPSCREW
6. NUT

Figure 16. Tilt Cylinder Adjustments for Lift Truck Models E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

1. Adjust the stroke of the tilt cylinders **WITHOUT** tilt limit spacers as follows:

a. Adjust rod ends to 15 mm (0.6 in.).

b. Slowly tilt mast backward until one cylinder rod stops. On the opposite cylinder, loosen capscrews on rod end. Measure the distance from the end of the cylinder to the back end of the rod end. Use a wrench and turn the cylinder rod **IN** until the dimension starts to decrease, then stop. Repeat this procedure until both cylinder rods stop at the same position within 0.5 mm (0.02 in.).

After adjustments are complete, tighten nuts on rod ends to 90 N•m (66 lbf ft) for lift truck models

- E2.2-3.5XN (E45-70XN) (A268)
- J2.2-3.5XN (J450-70XN) (A276)
- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)
- E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

c. Tilt mast fully backward and measure tilt angle. See the Nameplate for tilt angles. If necessary, adjust both rod ends equally for the correct angle.

NOTE: Dimension A cannot exceed 20 mm (0.79 in.).

NOTE: Dimension A cannot exceed 25 mm (0.98 in.) for lift truck model

- E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

2. Adjust the stroke of the tilt cylinders **WITH** tilt limit spacers as follows:

a. Adjust rod ends to 15 mm (0.6 in.) for all tilt cylinders as shown:

See Figure 14 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268)
- J2.2-3.5XN (J45-70XN) (A276)

See Figure 15 for lift truck models

- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

See Figure 16 for lift truck models

- E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

b. Slowly tilt mast forward until one cylinder rod stops. On the opposite cylinder, loosen capscrews on rod end. Use a wrench and turn the cylinder rod **IN** as necessary. Repeat this procedure until both cylinder rods stop at the same position within 0.5 mm (0.02 in.).

c. Slowly tilt mast backward until one rod end just contacts the spacer. Add shims to fill the gap at the opposite rod end until both rod ends contact the spacers within 0.5 mm (0.02 in.).

d. After adjustments are complete, tighten nuts on rod ends to

90 N • m (66 lbf ft) for lift truck models

- E2.2-3.5XN (E45-70XN) (A268)
- J2.2-3.5XN (J450-70XN) (A276)
- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)
- E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

e. Tilt mast fully backward and measure the tilt angle. See the nameplate for tilt angles. If necessary, add an equal number of shims to both rods for the correct angle.

NOTE: Dimension A cannot exceed 20 mm (0.79 in.).

NOTE: Dimension A cannot exceed 25 mm (0.98 in.) for lift truck model

- E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

TILT CYLINDER LEAK CHECK

WARNING

Never allow anyone under a raised carriage. DO NOT put any part of your body in or through the lift mechanism unless all parts of the mast are completely lowered and the key switch or keyless switch is turned OFF.

DO NOT try to find hydraulic leaks by putting your hand on hydraulic components under pressure. Hydraulic oil can be injected into the body by the pressure.

1. Put a capacity load on the forks. Use a safety chain to hold the load to the carriage. Raise the load approximately 2.5 m (8 ft). Put the mast in a vertical position.

2. Measure the distance that the tilt cylinder rod extends from the shell. Check the distance the rod moves in five or ten minutes. See Table 1.

Table 1. Movement Rates (Maximum) for Tilt Cylinders, Lift Truck Models E2.2-3.5XN (E45-70XN) (A268), J2.2-3.5XN (J45-70XN) (A276), and J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

Hydraulic Oil Temperature/Mast Tilt Rate									
20°C (68°F)		30°C (86°F)		40°C (104°F)		50°C (122°F)		60°C (140°F)	
mm/min	in./min	mm/min	in./min	mm/min	in./min	mm/min	in./min	mm/min	in./min
0.88	0.035	1.32	0.05	2.56	0.10	4.14	0.16	5.99	0.24

3. If the tilt rate is greater than the specifications, lower the mast and remove the load from the forks. Install a valve between the port at the front of the tilt cylinder and the hydraulic line. The valve must be able to completely shut off the flow of hydraulic oil. Put the load on the forks again. Close the valve. Tilt the mast forward just past the vertical position. If the mast continues to tilt **SLOWLY** forward, the seals on the piston are leaking.

4. If the mast does not move, open the valve and check the movement again. If the mast moves forward when the gate valve is open, check for leaks in the hydraulic lines and fittings. If no leaks are found, the main control valve may be worn or damaged. Remove the load from the forks when the checks are complete.

Lift Cylinder Repair for Lift Truck Model J1.5XNT (K160)

MAIN LIFT CYLINDER

Remove

WARNING

Before working on or near the mast, see Safety Procedures When Working Near Mast.

NOTE: The following procedures are for removal of lift cylinders with mast installed on lift truck.

NOTE: Except as noted, the following procedures are for removal of both lift cylinders.

1. Remove the carriage as described in the carriage removal procedures located in the section **Mast Repair (S/N A270, A271, A272)** 4000SRM1386 or **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405.

2. Raise and chain the mast as instructed in Safety Procedures When Working Near Mast section. The mast **must be chained** before proceeding to the next step in this procedure.

Main Lift Cylinders - Two-Stage FFL Mast

NOTE: Perform the following step for right-hand lift cylinder only.

1. Remove fitting at top of cylinder. See Figure 17.

WARNING

Be careful when removing or installing snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers, and wear eye and face protection during removal or installation.

2. Remove snap ring, washer, and shims at top of cylinder. See Figure 17.

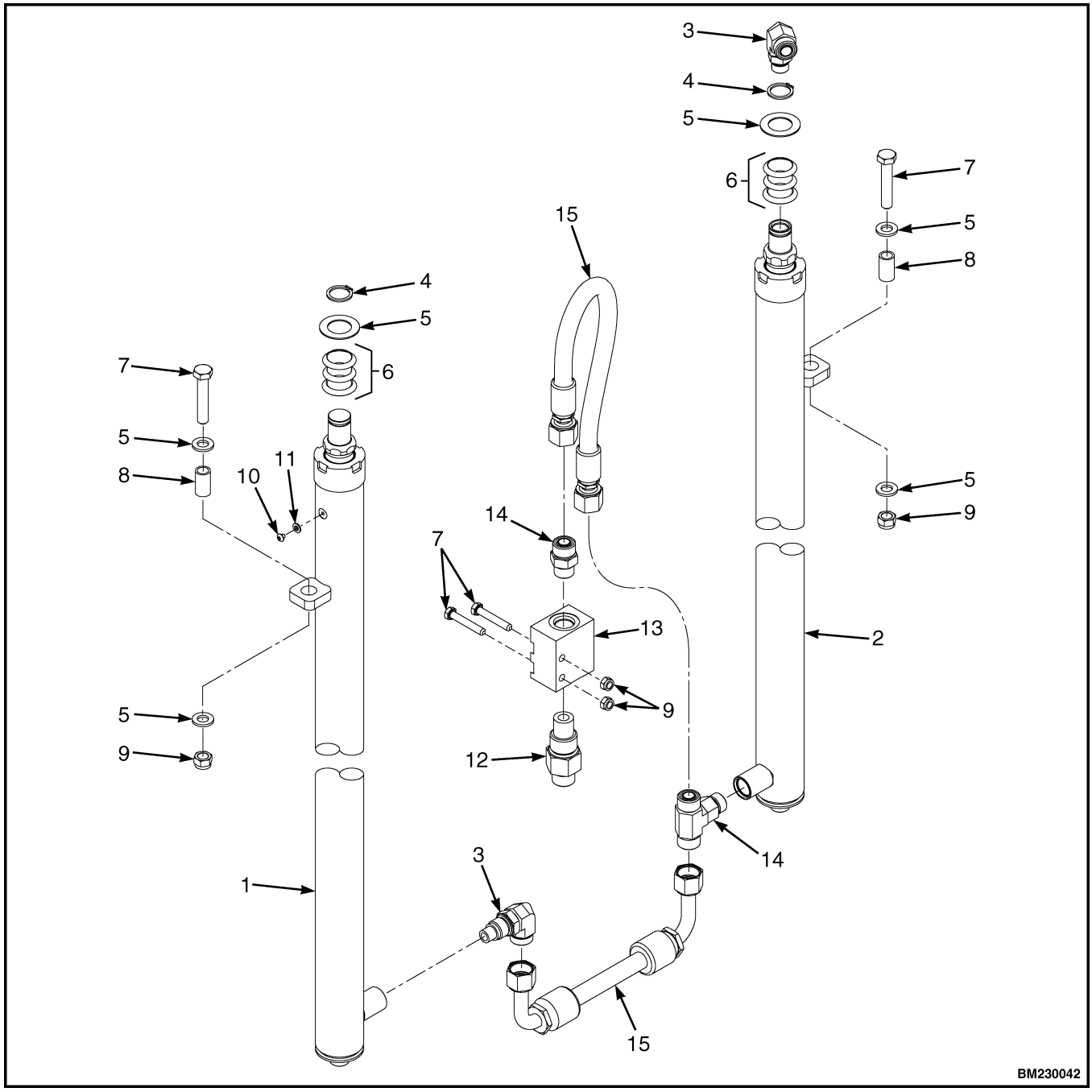


Figure 17. Main Lift Cylinder Installation

Legend for Figure 17.

NOTE: CROSSMEMBER REMOVED FOR CLARITY.
NOTE: TWO-STAGE FFL MAIN LIFT CYLINDER SHOWN.

1. LEFT-HAND MAIN LIFT CYLINDER
2. RIGHT HAND MAIN LIFT CYLINDER
3. FITTING WITH O-RING
4. SNAP RING
5. WASHER
6. SHIMS
7. CAPSCREW
8. SPACER
9. NUT
10. FILL SCREW
11. SEAL
12. LOWERING CONTROL VALVE
13. LOWERING CONTROL HOUSING
14. FITTING
15. HOSE ASSEMBLY

WARNING

Hydraulic oil is hot after system operation and can cause burns. DO NOT disconnect any hydraulic hoses until the oil in the system is cool.

3. Put a drain pan under the area of the hydraulic fittings. Disconnect hydraulic lines at the cylinder, drain oil, and cap hydraulic lines and cylinder ports.

4. Remove nut, spacer, capscrew, and washer at mounting plate. See Figure 17.

5. Using a lifting device, remove lift cylinder from mast.

6. Remove tube assembly from top of the right-hand cylinder.

NOTE: Raise the mast high enough for the bottom of the cylinder to clear the crossmember on the outer mast weldment and push the rod back into the cylinder being removed.

Left-Hand Main Lift Cylinder - Three-Stage FFL Mast

1. Put drain pan underneath area of hydraulic fittings.

2. Remove two nuts, two capscrews, and clamp from tube mounting plate. See Figure 18.

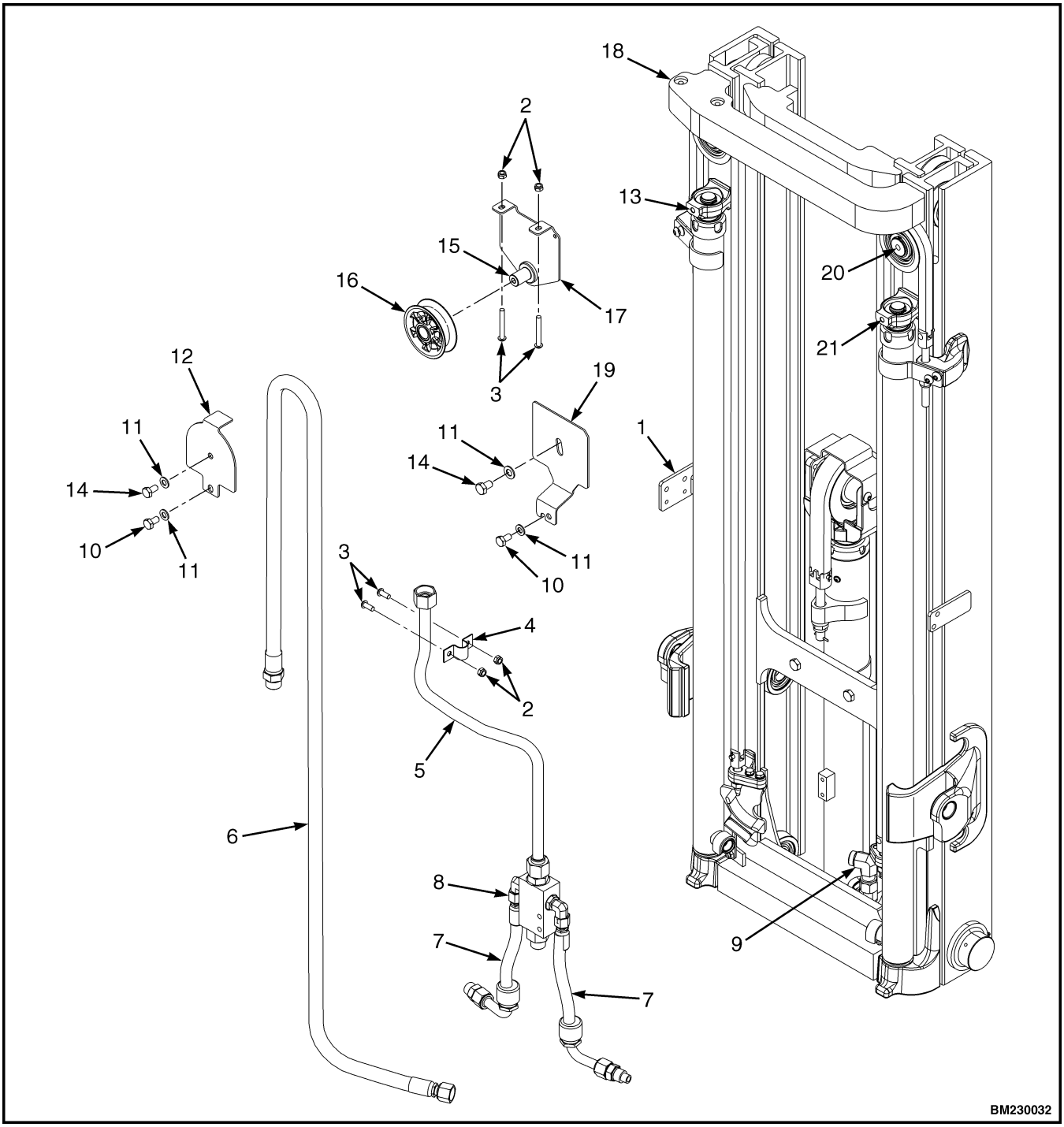


Figure 18. Main Lift Cylinders, Three-Stage FFL Mast

Legend for Figure 18.

NOTE: HEADER HOSES AND OUTER MAST CROSSMEMBERS REMOVED FOR CLARITY.

1. TUBE MOUNTING PLATE
2. NUT
3. CAPSCREW
4. CLAMP
5. TUBE ASSEMBLY
6. FREE-LIFT HOSE
7. HYDRAULIC LINE
8. LOWERING CONTROL
9. FREE-LIFT CYLINDER FITTING
10. BOTTOM CAPSCREW
11. WASHER
12. HOSE SHEAVE COVER PLATE
13. LEFT-HAND CYLINDER MOUNT BRACKET
14. TOP CAPSCREW
15. FREE-LIFT SHEAVE STUBSHAFT
16. HOSE SHEAVE
17. FREE-LIFT SHEAVE MOUNTING BRACKET
18. INNER MAST TOP CROSSMEMBER
19. CHAIN SHEAVE COVER PLATE
20. CHAIN STUBSHAFT
21. RIGHT-HAND CYLINDER MOUNT BRACKET

WARNING

Hydraulic oil is hot after system operation and can cause burns. DO NOT disconnect any hydraulic hoses until the oil in the system is cool.

3. Disconnect tube assembly from the top of free-lift hose. See Figure 18.

NOTE: Note position of hydraulic line, lowering control, and tube assembly prior to disconnecting hydraulic line to aid in installation.

NOTE: Steps Step 4 through Step 11 must be performed before starting to remove the main lift cylinder to allow access to the main lift cylinder.

4. Disconnect hydraulic line at cylinder and drain oil from cylinder. Cap hydraulic line and cylinder port.

5. Move hydraulic line, lowering control, and tube assembly aside to prevent damage during lift cylinder removal.

6. Disconnect free-lift hose from free-lift cylinder fitting. Cap free-lift hose and free-lift cylinder fitting. See Figure 18.

7. Remove bottom capscrew and washer from hose sheave cover plate and cylinder mount bracket. See Figure 18.

8. Remove top capscrew, washer, and hose sheave cover plate from free-lift sheave stubshaft. See Figure 18.

9. Remove free-lift hose from hose sheave and free-lift sheave bracket. See Figure 18.

10. Remove hose sheave from free-lift sheave stubshaft. See Figure 18.

11. Remove two nuts, two capscrews, and free-lift sheave mounting bracket from inner mast top crossmember. See Figure 18.

WARNING

Be careful when removing or installing snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers, and wear eye and face protection during removal or installation.

12. Remove snap ring and washer from top of lift cylinder. See Figure 19.

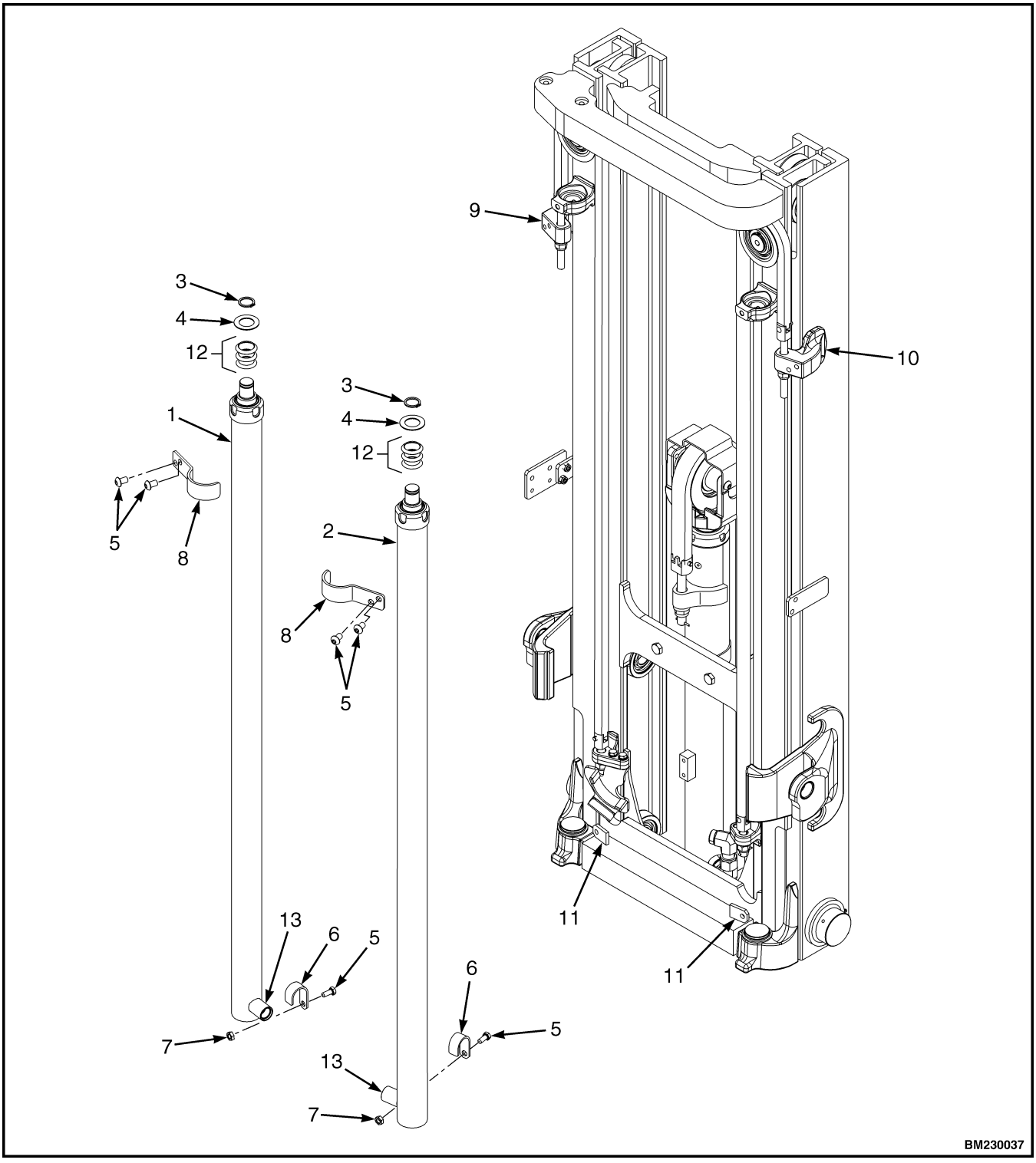


Figure 19. Main Lift Cylinders Three-Stage FFL Mast for Lift Truck J1.5XNT (K160)

Legend for Figure 19.

1. LEFT-HAND MAIN LIFT CYLINDER
2. RIGHT-HAND MAIN LIFT CYLINDER
3. SNAP RING
4. WASHER
5. CAPSCREW
6. CLAMP
7. NUT
8. CYLINDER RESTRAINT BRACKET
9. LEFT-HAND CHAIN ANCHOR BRACKET
10. RIGHT-HAND CHAIN ANCHOR BRACKET
11. PLATE
12. SHIMS
13. CYLINDER PORT

13. Remove two capscrews and cylinder restraint bracket from chain anchor bracket. See Figure 19.

14. Disconnect main lift chain at chain anchor bracket.

15. Remove capscrew, nut, and clamp from cylinder port and plate. See Figure 19.

16. Using lifting device, remove lift cylinder from mast.

NOTE: Note quantity of shims prior to removal to aid in installation.

17. Remove shims from top of lift cylinder. See Figure 19.

Right-Hand Main Lift Cylinder - Three-Stage FFL Mast

1. Remove bottom capscrew and washer from chain sheave cover plate and cylinder mount bracket. See Figure 18.

2. Remove top capscrew, washer, and chain sheave cover plate from chain stubshaft. See Figure 18.

WARNING

Hydraulic oil is hot after system operation and can cause burns. DO NOT disconnect any hydraulic hoses until the oil in the system is cool.

3. Put a drain pan underneath area of hydraulic fittings. Disconnect hydraulic line at cylinder and drain oil from cylinder. Cap hydraulic line and cylinder port.

WARNING

Be careful when removing or installing snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers, and wear eye and face protection during removal or installation.

4. Remove snap ring and washer from top of lift cylinder. See Figure 19.

5. Remove two capscrews and cylinder restraint bracket from chain anchor bracket. See Figure 19.

6. Disconnect main lift chain at chain anchor bracket.

7. Remove capscrew, nut, and clamp from cylinder port and plate. See Figure 19.

8. Using lifting device, remove lift cylinder from mast.

9. Remove shims from top of lift cylinder. See Figure 19.

Main Lift Cylinder - Two-Stage LFL Mast

1. Remove bottom capscrew and washer from chain sheave cover plate and cylinder mount bracket. See Figure 20.

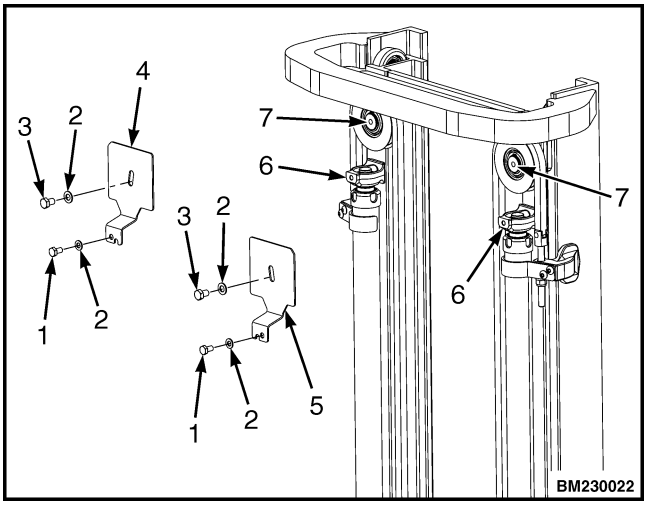


Figure 20. Cover Plates Two-Stage LFL Mast for Lift Truck J1.5XNT (K160)

Legend for Figure 20.

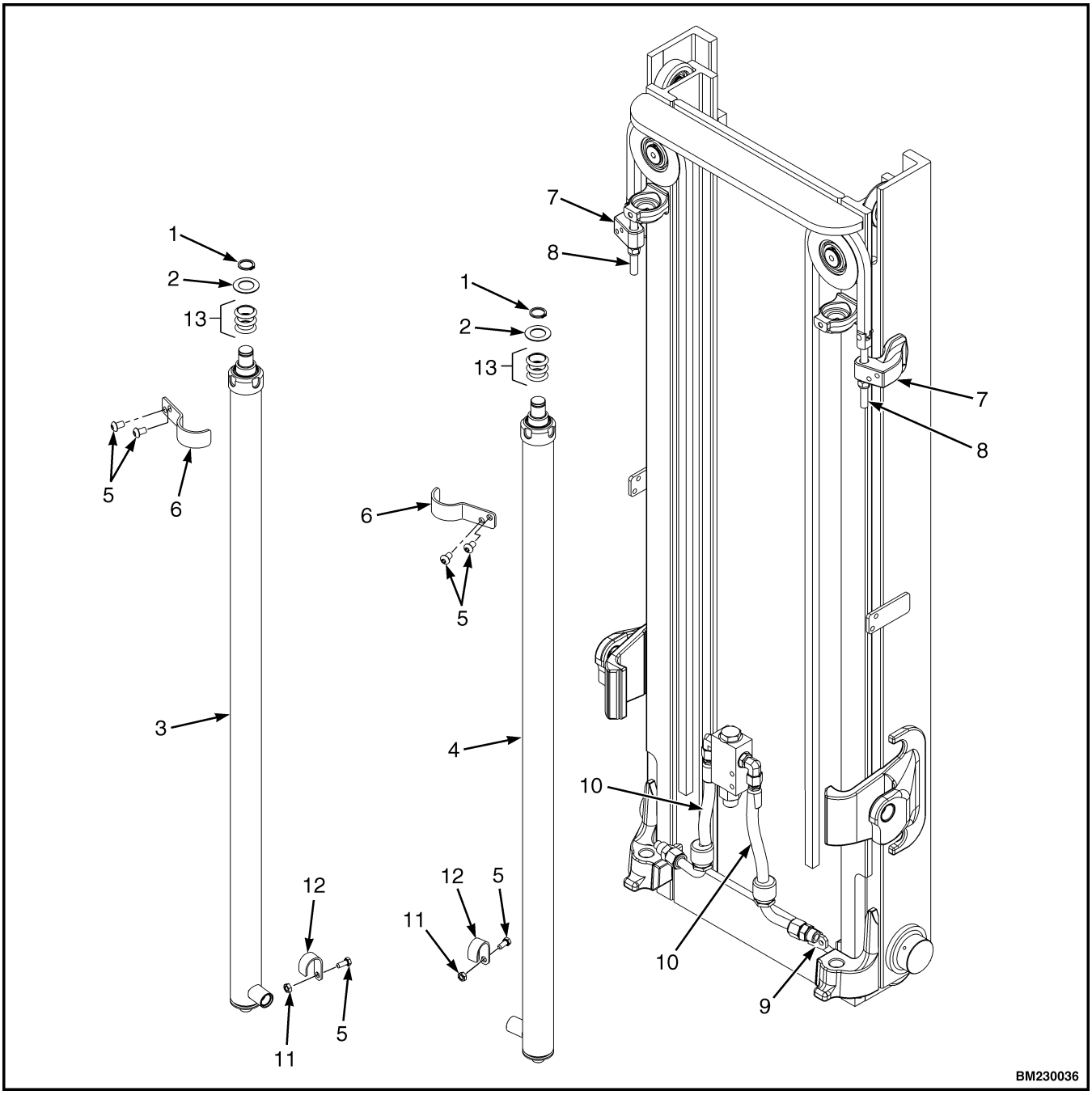
1. BOTTOM CAPSCREW
2. WASHER
3. TOP CAPSCREW
4. LEFT-HAND CHAIN SHEAVE COVER PLATE
5. RIGHT-HAND CHAIN SHEAVE COVER PLATE
6. CYLINDER MOUNT BRACKET
7. CHAIN STUBSHAFT

2. Remove top capscrew, washer, and chain sheave cover plate from chain stubshaft. See Figure 20.

WARNING

Be careful when removing or installing snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers, and wear eye and face protection during removal or installation.

3. Remove snap ring and washer from top of lift cylinder. See Figure 21.



NOTE: OUTER MAST CROSSMEMBERS REMOVED FOR CLARITY.

1. SNAP RING
2. WASHER
3. LEFT-HAND MAIN LIFT CYLINDER
4. RIGHT-HAND MAIN LIFT CYLINDER
5. CAPSCREW
6. CYLINDER RESTRAINT BRACKET
7. CHAIN ANCHOR BRACKET
8. MAIN LIFT CHAIN
9. PLATE
10. HYDRAULIC LINE
11. NUT
12. CLAMP
13. SHIMS

Figure 21. Main Lift Cylinders Two-Stage LFL Mast for Lift Truck J1.5XNT (K160)

WARNING

Hydraulic oil is hot after system operation and can cause burns. DO NOT disconnect any hydraulic hoses until the oil in the system is cool.

4. Put a drain pan under the area of the hydraulic fittings. Disconnect hydraulic line at cylinder and drain oil from cylinder. Cap hydraulic line and cylinder port.

5. Remove two capscrews and cylinder restraint bracket from chain anchor bracket. See Figure 21.

6. Disconnect main lift chain at chain anchor bracket. See Figure 21.

7. Remove capscrew, nut, and clamp from lift cylinder and plate. See Figure 21.

8. Using a lifting device, remove lift cylinder from mast.

NOTE: Note number of shims prior to removal to aid in installation.

9. Remove shims from top of lift cylinder. See Figure 21.

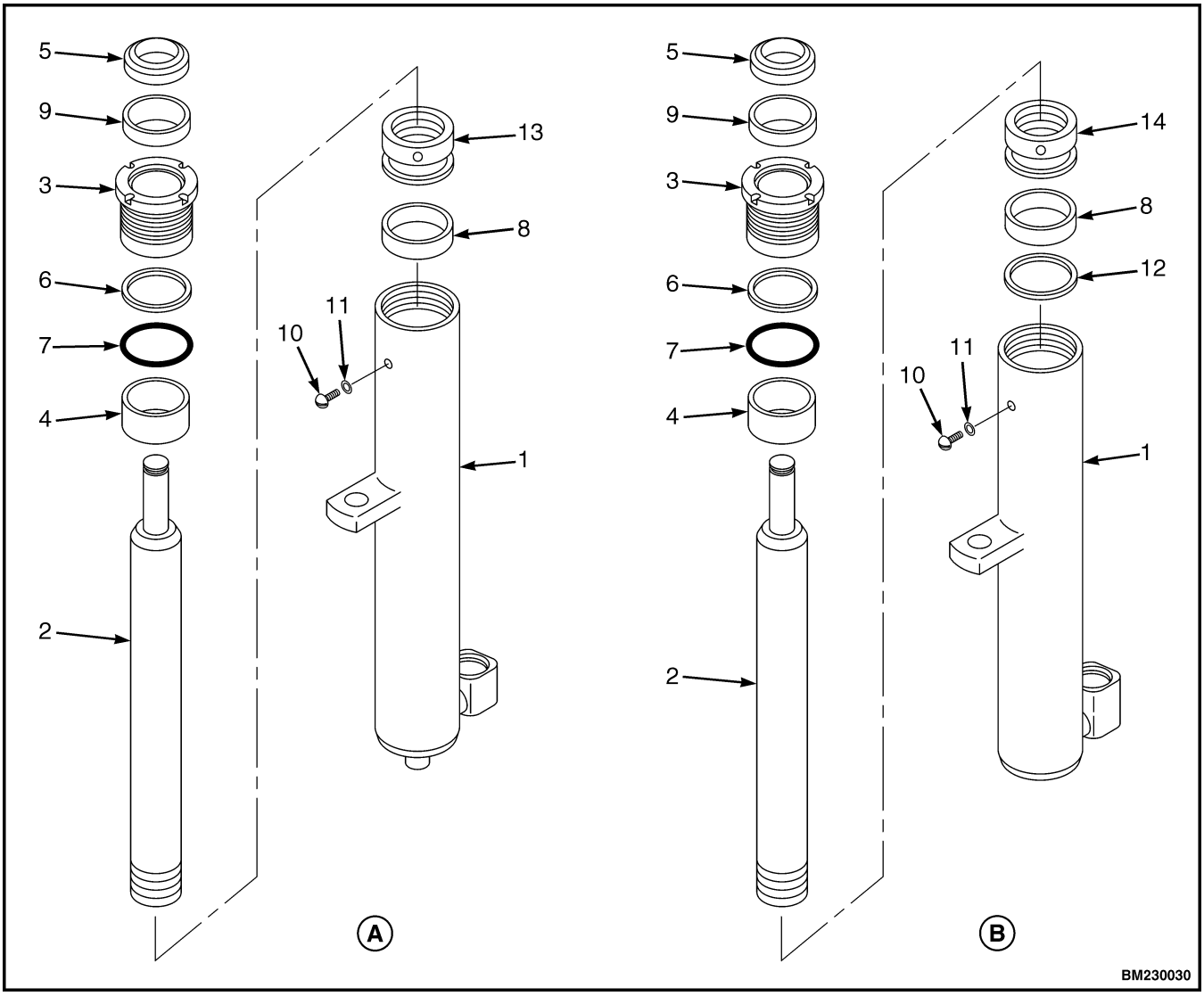
10. Repeat Step 1 through Step 9 for opposite lift cylinder.

Disassemble

Main Lift Cylinders - Two-Stage FFL Mast

1. Loosen gland with spanner wrench.

2. Remove gland from rod and shell. See Figure 22.



A. RIGHT-HAND CYLINDER

1. SHELL
2. ROD
3. GLAND
4. SPACER
5. ROD WIPER
6. BACKUP RING
7. O-RING

B. LEFT-HAND CYLINDER

8. WEAR RING
9. ROD SEAL
10. CAPSCREW
11. SEAL
12. PISTON RING
13. RIGHT-HAND PISTON
14. LEFT-HAND PISTON

Figure 22. Main Lift Cylinder Two-Stage FFL Mast

3. Remove rod and piston assembly from shell. See Figure 22. Drain any remaining hydraulic oil into drain pan.

NOTE: To prevent damage to sealing surfaces, use brass tools when removing seals and O-rings.

4. Remove and discard rod wiper, rod seal, backup ring, and O-ring from gland. See Figure 22.

5. Remove spacer, if installed, from rod. See Figure 22.

NOTE: Perform the following step for right-hand Main Lift Cylinder.

6. Remove and discard wear ring from piston. See Figure 22.

NOTE: Perform the following step for Left-Hand Main Lift Cylinder.

7. Remove piston ring and wear ring from piston. Discard wear ring. See Figure 22.

NOTE: Perform the following step only if piston is damaged.

8. Remove piston from rod. See Figure 22.

9. Remove capscrew and seal from shell. Discard seal. See Figure 22.

Main Lift Cylinder - Three-Stage FFL Mast

1. Loosen gland with spanner wrench.

2. Remove gland from rod and shell. See Figure 23.

3. Remove rod and piston assembly from shell. See Figure 23. Drain any remaining hydraulic oil into drain pan.

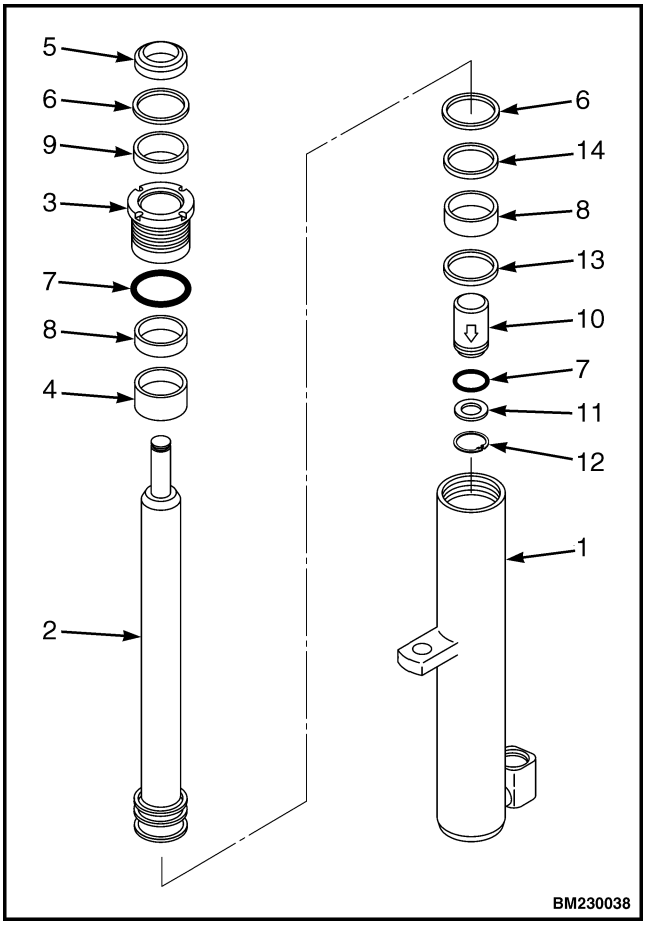
NOTE: To prevent damage to sealing surfaces, use brass tools when removing seals and O-rings.

4. Remove and discard rod wiper, backup ring, rod seal, O-ring, and wear ring from gland. See Figure 23.

5. Remove spacer, if installed, from rod.

6. Remove piston ring, wear ring, seal, and backup ring from piston. See Figure 23. Discard wear ring rod seal, and backup ring.

7. Remove snap ring, washer, and check valve from piston base. Remove and discard O-ring from check valve. See Figure 23.



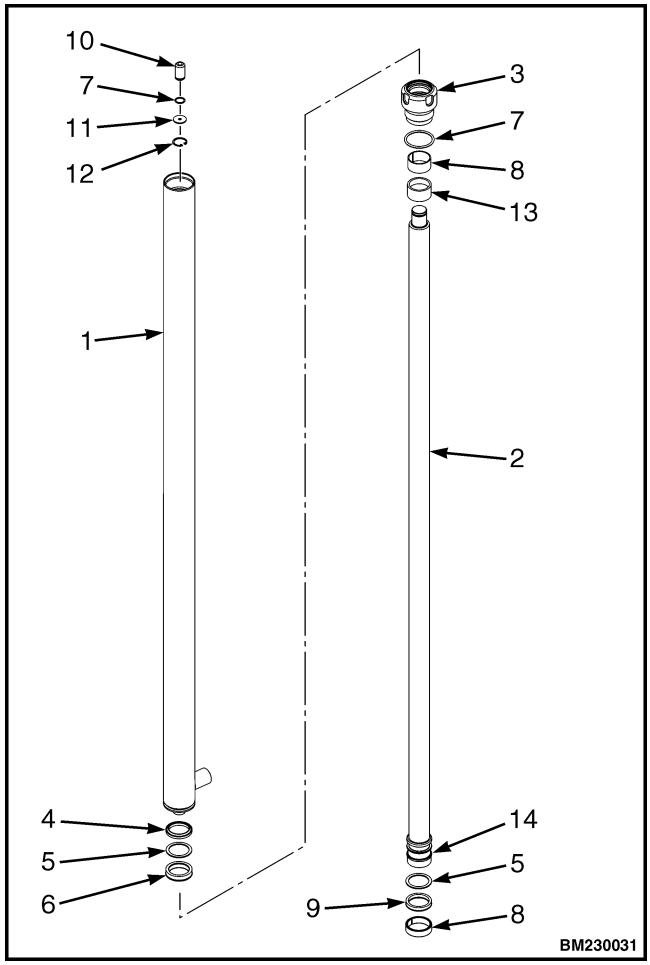
1. SHELL
2. ROD
3. GLAND
4. SPACER
5. ROD WIPER
6. BACKUP RING
7. O-RING
8. WEAR RING
9. ROD SEAL
10. CHECK VALVE
11. WASHER
12. SNAP RING
13. PISTON RING
14. SEAL

Figure 23. Main Lift Cylinder Three-Stage FFL Mast

Main Lift Cylinder - Two-Stage LFL Mast

1. Loosen gland with spanner wrench.

2. Remove gland from rod and shell. See Figure 24.



1. SHELL
2. ROD
3. GLAND
4. ROD WIPER
5. BACKUP RING
6. ROD SEAL
7. O-RING
8. WEAR RING
9. SEAL
10. CHECK VALVE
11. WASHER
12. SNAP RING
13. SPACER
14. PISTON

Figure 24. Main Lift Cylinder Two-Stage LFL Mast

3. Remove rod and piston assembly from shell. Remove piston assembly from the rod. See Figure 24. Drain any remaining hydraulic oil into drain pan.

NOTE: To prevent damage to sealing surfaces, use brass tools when removing seals and O-rings.

4. Remove and discard rod wiper, backup ring, rod seal, O-ring, and wear ring. See Figure 24.

5. Remove spacer, if installed, from rod. See Figure 24.

6. Remove and discard backup ring, seal, and wear ring from piston. See Figure 24.

WARNING

Be careful when removing or installing snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers and wear eye and face protection during removal or installation.

7. Remove snap ring, washer, and check valve. Remove and discard O-ring from check valve. See Figure 24.

Clean

WARNING

Cleaning solvents can be flammable and toxic and can cause skin irritation. When using cleaning solvents, always follow the solvent manufacturer's recommended safety procedures.

Compressed air can move particles so they cause injury to the user or to other personnel. Make sure the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eyes.

CAUTION

DO NOT allow cleaning solvent to come in contact with rubber components, as it will damage those components.

Clean all metal parts in solvent and dry with compressed air.

Inspect

Inspect gland for damage to threads and seal surfaces. If damaged, replace gland.

Inspect piston for any damage to seal surfaces. If damaged, replace piston on two-stage FFL or rod and piston assembly on three-stage FFL and two-stage LFL main lift cylinders.

Inspect rod for damage to rod surface and ensure that the rod is not bent. If damaged, replace rod.

Inspect inner surface of cylinder tube for damage. If damaged, replace cylinder assembly.

Assemble

Main Lift Cylinder - Two-Stage FFL Mast

1. Lubricate all internal parts of the lift cylinder with clean hydraulic oil. Use new O-rings, seals, and wear rings for installation.

NOTE: Perform the following step only if piston was removed from rod.

2. Install piston onto rod. Tighten piston to 170 to 200 N•m (125 to 148 lbf ft).

NOTE: Perform the following step for right-hand main lift cylinder.

3. Install wear ring onto piston. See Figure 22.

NOTE: Perform the following step for left-hand main lift cylinder.

4. Install wear ring and piston ring onto piston. See Figure 22.

5. Install spacer, if removed, onto rod. See Figure 22.

CAUTION

A difficult and important step in assembling lift cylinders is the correct installation of the seals. Most lift cylinder maintenance is cause by seal leaks. DO NOT damage any parts during assembly.

NOTE: To prevent damage to sealing surfaces, use brass tools when installing seals and O-rings.

6. Install new backup ring, O-ring, rod seal, and rod wiper onto gland. See Figure 22.

7. Install rod and piston assembly into shell. See Figure 22.

NOTE: To prevent possible damage to rod and piston assembly, use care while installing gland.

8. Install gland onto rod in shell. Tighten gland to 340 to 410 N•m (250 to 300 lbf ft). See Figure 22.

9. Install seal and capscrew into shell. Tighten capscrew to 6.0 to 8.0 N•m (53 to 71 lbf in). See Figure 22.

Main Lift Cylinder - Three-Stage FFL Mast

1. Lubricate all internal parts of the lift cylinder with clean hydraulic oil. Use new O-rings, seals, and wear rings for installation.

NOTE: To prevent damage to sealing surfaces, use brass tools when installing seals and O-rings.

2. Install new O-ring onto check valve. See Figure 23.

WARNING

Be careful when removing or installing snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers, and wear eye and face protection during removal or installation.

3. Install check valve, washer, and snap ring into piston base. See Figure 23.

CAUTION

A difficult and important step in assembling lift cylinders is the correct installation of the seals. Most lift cylinder maintenance is caused by seal leaks. DO NOT damage any parts during assembly.

4. Install new backup ring, rod seal, wear ring, and piston ring onto piston. See Figure 23.

5. Install spacer, if required, onto rod. See Figure 23.

6. Install new O-ring, wear ring, rod seal, backup ring, and rod wiper on gland. See Figure 23.

7. Install rod and piston assembly into shell. See Figure 23.

NOTE: To prevent possible damage to rod and piston assembly, use care while installing gland.

8. Install gland on rod in shell. Tighten gland to 340 to 410 N•m (250 to 300 lbf ft). See Figure 23.

Main Lift Cylinder - Two-Stage LFL Mast

1. Lubricate all internal parts of the lift cylinder with clean hydraulic oil. Use O-rings, seals, and wear rings.

NOTE: To prevent damage to sealing surfaces, use brass tools when installing seals and O-rings.

2. Install new O-ring on check valve. See Figure 24.

WARNING

Be careful when removing or installing snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers and wear eye and face protection during removal or installation.

3. Install check valve, washer, and snap ring into piston base. See Figure 24.

4. Install new backup ring, seal, and wear ring on piston. See Figure 24.

5. Install spacer, if removed, onto rod.

6. Install new O-ring, wear ring, rod seal, backup ring, and rod wiper on gland. See Figure 24.

7. Install rod and piston assembly into shell. See Figure 24.

NOTE: To prevent possible damage to rod and piston assembly, use care while installing gland.

8. Install gland onto rod in shell. Tighten gland to 340 to 410 N•m (250 to 300 lbf ft). See Figure 24.

Install

NOTE: Except as noted, the following procedures are for installation of both lift cylinders.

Main Lift Cylinder - Two-Stage FFL Mast

WARNING

Before working on or near the mast, see Safety Procedures When Working Near Mast.

NOTE: The following procedures are for the installation of lift cylinders with the mast installed on lift truck.

1. Using a lifting device, install lift cylinder on mast.

NOTE: Mast must be raised for bottom of cylinder to clear outer mast crossmember.

2. Install spacer, washer, capscrew, and nut at mounting plate. Tighten nut to 40 N•m (30 lbf ft). See Figure 17.

3. Uncap hydraulic lines and cylinder ports. Connect hydraulic lines at cylinder.

WARNING

Be careful when removing or installing snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers, and wear eye and face protection during removal or installation.

NOTE: One washer and one snap ring required at top of each main lift cylinder.

4. Install shims, if removed, washer, and snap ring at top of cylinder. See Figure 17.

NOTE: Perform following step for right-hand lift cylinder.

5. Install fitting at top of cylinder. See Figure 17. Connect hydraulic line at fitting.

CAUTION

Disposal of lubricants and fluids must meet local environmental regulations.

6. Remove drain pan from below hydraulic fitting area and dispose of contents.

Left-Hand Main Lift Cylinder - Three-Stage FFL Mast

WARNING

Before working on or near the mast, see Safety Procedures When Working Near Mast.

NOTE: The following procedures are for the installation of lift cylinders with the mast installed on lift truck. The mast **must be chained** before proceeding to the next step in this procedure.

1. Install shims, as noted during removal, at top of lift cylinder. See Figure 19.

2. Using a lifting device, install lift cylinder onto mast.

NOTE: Mast must be raised for bottom of cylinder to clear outer mast crossmember.

3. Install clamp, capscrew, and nut onto cylinder port and plate. Tighten nut to 25 N•m (18 lbf ft). See Figure 19.

4. Connect main lift chain at chain anchor bracket. Use new cotter pin and bend both legs of cotter pin a minimum of 90 degrees against chain anchor pin to secure lift chain to chain anchor.

5. Install cylinder restraint bracket and two capscrews onto chain anchor bracket. Tighten capscrews to 52 N•m (38 lbf ft). See Figure 19.

WARNING

Be careful when removing or installing snap rings. These snap rings come loose during removal or installation with enough force to cause an injury. Always use the correct ring pliers, and wear eye and face protection during removal or installation.

NOTE: One washer and snap ring required at top of each main lift cylinder.

6. Install washer and snap ring at top of lift cylinder. See Figure 19.

NOTE: Nut to be at top of mast crossmember.

7. Install free-lift sheave mounting bracket, two capscrews, and two nuts on inner mast top crossmember. See Figure 18. Tighten nut to 25 N•m (18 lbf ft).

8. Install hose sheave onto free-lift sheave stubshaft. See Figure 18.

9. Install free-lift hose on free-lift sheave bracket and hose sheave. See Figure 18.

10. Install hose sheave cover plate, washer and top capscrew onto free-lift sheave stubshaft. DO NOT tighten top capscrew. See Figure 18.

11. Install washer and bottom capscrew onto hose sheave cover plate and cylinder mount bracket. See Figure 18.

12. Tighten bottom capscrew to 38 N•m (28 lbf ft).

13. Tighten top capscrew to 38 N•m (28 lbf ft).

14. Remove caps from free-lift cylinder fitting and free-lift hose. Connect free-lift hose to free-lift cylinder fitting.

NOTE: Make sure tube assembly, lowering control and hydraulic line are in position, as noted during removal, prior to connecting hydraulic line.

15. Remove caps from hydraulic line and cylinder port. Connect hydraulic line to cylinder port.

16. Connect tube assembly to free-lift hose. See Figure 18.

17. Install clamp, two capscrews, and two nuts on tube mounting plate. See Figure 18. Tighten nuts to 25 N•m (18 lbf ft).

CAUTION

Disposal of lubricants and fluids must meet local environmental regulations.

18. Remove drain pan from below hydraulic fitting area and dispose of contents.

Right-Hand Main Lift Cylinder - Three-Stage FFL Mast

WARNING

Before working on or near the mast, see Safety Procedures When Working Near Mast.

NOTE: The following procedures are for the installation of lift cylinders with the mast installed on lift truck. The mast **must be chained** before proceeding to the next step in this procedure.

1. Install shims, as noted during removal, at top of lift cylinder. See Figure 19.

2. Using a lifting device, install lift cylinder onto mast.

NOTE: Mast must be raised for bottom of cylinder to clear outer mast crossmember.

3. Install clamp, capscrew, and nut onto cylinder port and plate. Tighten nut to 25 N•m (18 lbf ft). See Figure 19.

4. Connect main lift chain at chain anchor bracket. Use new cotter pin and bend both legs of cotter pin a minimum of 90° degrees against chain anchor pin to secure lift chain to chain anchor.

5. Install cylinder restraint bracket and two capscrews onto chain anchor bracket. Tighten capscrews to 52 N•m (38 lbf ft). See Figure 19.

WARNING

Be careful when removing or installing snap rings. These snap rings come loose during removal or installation with enough force to cause an injury. Always use the correct ring pliers, and wear eye and face protection during removal or installation.

NOTE: One washer and one snap ring required at top of each main lift cylinder.

6. Install washer and snap ring at top of lift cylinder. See Figure 19.

7. Remove caps from hydraulic line and cylinder port. Connect hydraulic line to cylinder port.

NOTE: Chain sheave cover plate to be installed with chamfer outboard. Use mounting slot as needed for fit.

8. Install chain sheave cover plate, washer, and top capscrew onto chain stubshaft. DO NOT tighten top capscrew. See Figure 18.

9. Install washer and bottom capscrew on chain sheave cover plate and cylinder mount bracket. See Figure 18.

10. Tighten bottom capscrew to 38 N•m (28 lbf ft).

11. Tighten top capscrew to 72 N•m (53 lbf ft).

CAUTION

Disposal of lubricants and fluids must meet local environmental regulations.

12. Remove drain pan from beneath hydraulic fitting area and dispose of contents.

Main Lift Cylinder - Two-Stage LFL Mast

WARNING

Before working on or near the mast, see Safety Procedures When Working Near Mast.

NOTE: The following procedures are for the installation of lift cylinders with the mast installed on lift truck.

1. Install shims, as noted during removal, onto top of lift cylinder. See Figure 21. The mast **must be chained** before proceeding to the next step in this procedure.

2. Using a lifting device, install lift cylinder onto mast. Extend rod out of lift cylinder.

NOTE: Mast must be raised for bottom of cylinder to clear outer mast crossmember.

WARNING

Be careful when removing or installing snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers, and wear eye and face protection during removal or installation.

3. Install washer and snap ring onto top of lift cylinder. See Figure 21.

NOTE: Nut to be toward back of lift truck.

4. Install clamp, capscrew, and nut onto cylinder and plate. See Figure 21. Tighten nut to 19 N•m (14 lbf ft).

5. Connect main lift chain at chain anchor bracket. See Figure 21. Use new cotter pin and bend both legs of cotter pin a minimum of 90° degrees against chain anchor pin to secure lift chain to chain anchor.

6. Install cylinder restraint bracket and two capscrews. See Figure 21. Tighten capscrews to 52 N•m (38 lbf ft).

7. Remove caps from hydraulic line and cylinder port. Connect hydraulic line to cylinder port. See Figure 21. Extend rod out of lift cylinder.

NOTE: Chain sheave cover plate to be oriented with chamfer outboard. Use mounting slot as needed for fit.

8. Install chain sheave cover plate, washer, and top capscrew onto chain stubshaft. See Figure 20. DO NOT tighten top capscrew.

9. Install washer and bottom capscrew onto chain sheave cover plate and cylinder mount bracket. See Figure 20.

10. Tighten bottom capscrew to 38 N•m (28 lbf ft).

11. Tighten top capscrew to 72 N•m (53 lbf ft).

CAUTION

Disposal of lubricants and fluids must meet local environmental regulations.

12. Remove drain pan from beneath hydraulic fitting area and dispose of contents.

13. Repeat Step 1 through Step 12 for opposite lift cylinder.

System Air Bleed Procedures

NOTE: The procedures for bleeding air out of the lift cylinders apply only to lift trucks equipped with a two-stage FFL mast. Trucks equipped with a three or four-stage FFL mast or two-stage LFL mast do not need to have air bled out of the lift cylinders.

1. Remove the air from main lift cylinders as described below. See Figure 25, Two-Stage FFL shown.

   a. Loosen capscrew two turns to permit oil to flow around threads of capscrew.

   b. With forks unloaded, raise carriage using hydraulic control. Raise carriage 300 mm (12 in.) and then stop for 10 seconds to reduce the pressure in the cylinder. Repeat this procedure until the oil flowing from around the threads is free of air bubbles.

   c. Stop carriage at the top of the cylinder stroke. Tighten capscrew to 5.5 to 6.5 N•m (49 to 58 lbf in).

All Main Lift Cylinders

1. Use a lifting device to lower the inner mast weldment (two-stage) or intermediate mast weldment (three-stage) onto the lift cylinder.

NOTE: Mast must be raised for bottom of cylinder to clear outer mast crossmember.

2. Install carriage as described in carriage installation procedures located in the section **Mast Repair (S/N A270, A271, A272)** 4000SRM1386 or **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405.

3. Adjust lift cylinders as specified in section **Mast Repair (S/N A270, A271, A272)** 4000SRM1386 or **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405.

Lift Cylinder Repair for 1.5-2.0T Trucks

This section outlines the lift cylinder repair procedures for lift truck models J1.6-2.0XNT (J30-40XNT) (K160), J1.6-2.0XN (J30-40XN) (A935), E30-40HSD$_2$ (B219), and E30-40HSD$_3$ (C219).

MAIN LIFT CYLINDER

Remove

WARNING

Before working on or near the mast, see Safety Procedures When Working Near Mast.

NOTE: The following procedures are for the removal of lift cylinders with the mast installed on lift truck.

NOTE: Except as noted, the following procedures are for removal of both lift cylinders.

1. Remove the carriage as described in the carriage removal procedures located in one of the following **Service Manuals:**

   Mast Repair (S/N A270, A271, A272) 4000SRM1386 for lift truck models

   - J1.6-2.0XNT (K160)
   - J1.6-2.0XN (A935)

- E30-40HSD$_3$ (C219)

Mast Repair (S/N C661, C662, C663, C665) 4000SRM1405 for lift truck models

- J1.6-2.0XNT (J30-40XNT) (K160)
- J1.6-2.0XN (J30-40XN) (A935)
- E30-40HSD$_2$ (B219)
- E30-40HSD$_3$ (C219)

NOTE: Perform Step 2 for lift trucks equipped with Two-Stage FFL, Three-Stage FFL, and Two-Stage LFL masts.

Perform Step 3 for lift truck equipped with Four-Stage FFL mast.

2. Raise and chain the mast as instructed in Safety Procedures When Working Near Mast section. The mast **must be chained** before proceeding to the next step in this procedure.

3. Remove mast from lift truck as described in **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405

Two-Stage FFL

NOTE: Perform the following step for right-hand lift cylinder only.

1. Remove fitting at top of cylinder. See Figure 25.

WARNING

Be careful when removing or installing snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers, and wear eye and face protection during removal or installation.

2. Remove snap ring, washer, and shims at top of cylinder. See Figure 25.

WARNING

Hydraulic oil is hot after system operation and can cause burns. DO NOT disconnect any hydraulic hoses until the oil in the system is cool.

3. Put a drain pan under the area of the hydraulic fittings. Disconnect hydraulic lines at the cylinder and drain oil from cylinder. Cap hydraulic lines and cylinder ports.

4. Remove nut, spacer, capscrew, and washer at mounting plate. See Figure 25.

5. Disconnect main lift chain at mount.

NOTE: Raise the mast high enough for the bottom of the lift cylinder to clear the crossmember on the outer mast weldment and push the rod back into the cylinder being removed.

6. Using a lifting device, remove lift cylinder from mast.

Three-Stage FFL

WARNING

Be careful when removing or installing snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers, and wear eye and face protection during removal or installation.

1. Remove snap ring, washer, and shims, if installed, from top of cylinder. See Figure 25.

WARNING

Hydraulic oil is hot after system operation and can cause burns. DO NOT disconnect any hydraulic hoses until the oil in the system is cool.

2. Put a drain pan under the area of the hydraulic fittings. Disconnect hydraulic lines at cylinder and drain oil from cylinder. Cap hydraulic lines and cylinder ports.

3. Remove nut, spacer, capscrew, and washer at mounting plate. See Figure 25.

4. Disconnect main lift chain at mount.

5. Using a lifting device, remove lift cylinder from mast.

NOTE: Raise the mast high enough for the bottom of the cylinder to clear the crossmember on the outer mast weldment and push the rod back into the cylinder being removed.

6. Repeat Step 1 through Step 5 for opposite cylinder.

Two-Stage LFL

WARNING

Be careful when removing or installing snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers, and wear eye and face protection during removal or installation.

1. Remove snap ring and shims from top of cylinder. See Figure 25.

WARNING

Hydraulic oil is hot after system operation and can cause burns. DO NOT disconnect any hydraulic hoses until the oil in the system is cool.

2. Put a drain pan under the area of the hydraulic fittings. Disconnect hydraulic line at cylinder and drain oil from cylinder. Cap hydraulic lines and cylinder ports.

3. Remove nut, two washers, spacer, and capscrew at mounting plate. See Figure 25.

4. Disconnect main lift chain at mount.

5. Using a lifting device, remove lift cylinder from mast.

NOTE: Raise the mast high enough for the bottom of the cylinder to clear the crossmember on the outer mast weldment and push the rod back into the cylinder being removed.

6. Repeat Step 1 through Step 5 for opposite lift cylinder.

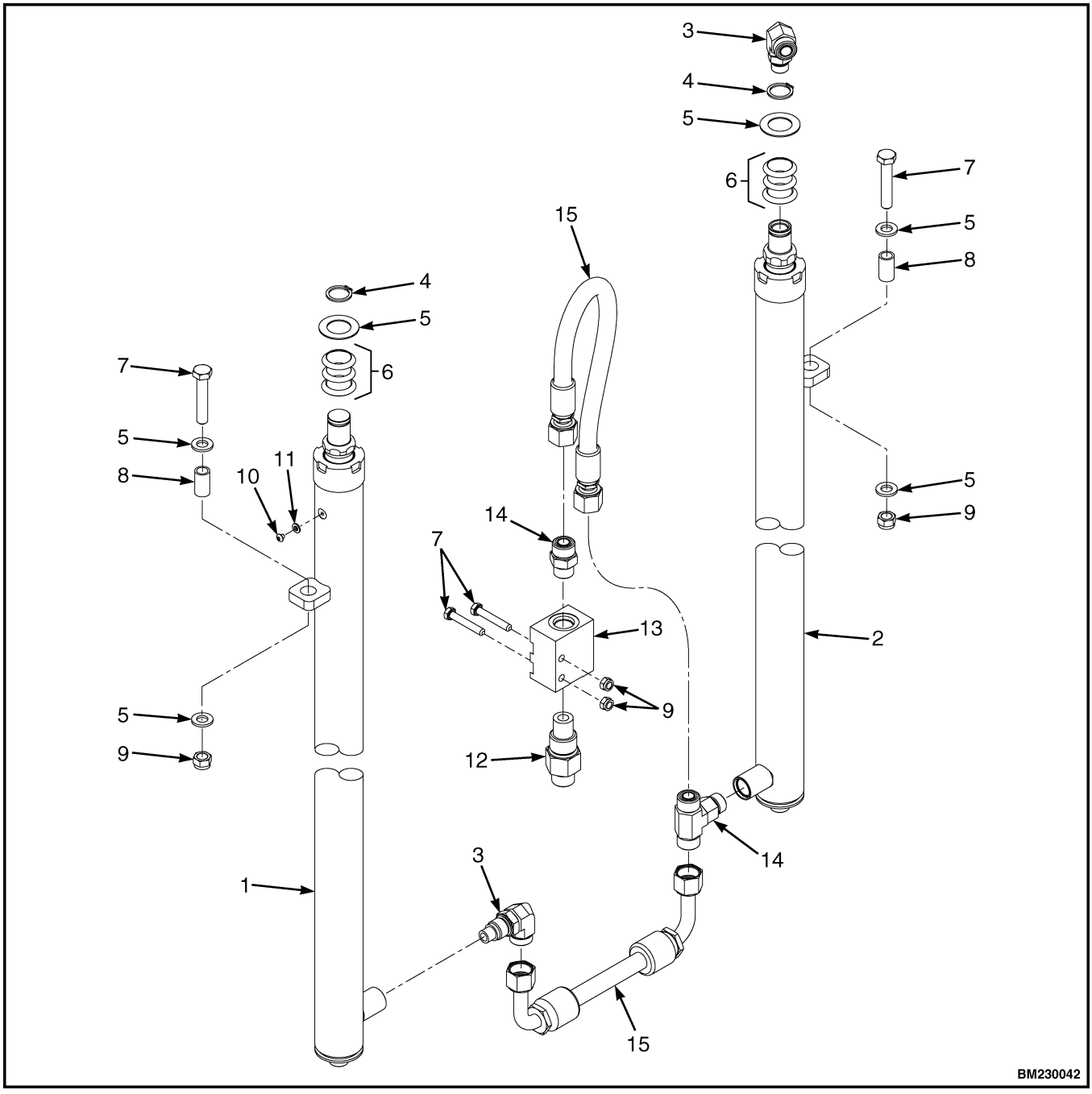


Figure 25. Main Lift Cylinder - Two-Stage FFL, Three-Stage FFL, and Two-Stage LFL Masts

Legend for Figure 25.

NOTE: CROSSMEMBER REMOVED FOR CLARITY.
NOTE: TWO-STAGE FFL MAIN LIFT CYLINDER SHOWN.

1. LEFT-HAND MAIN LIFT CYLINDER
2. RIGHT HAND MAIN LIFT CYLINDER
3. FITTING WITH O-RING
4. SNAP RING
5. WASHER
6. SHIMS
7. CAPSCREW
8. SPACER
9. NUT
10. FILL SCREW
11. SEAL
12. LOWERING CONTROL VALVE
13. LOWERING CONTROL HOUSING
14. FITTING
15. HOSE ASSEMBLY

Four-Stage FFL

1. Insert 5 x 10 cm (2 x 4 in.) wood block between lower crossmembers of outer and outer intermediate masts to prevent movement out the bottom of mast assembly. See Figure 26.

2. Lay mast assembly face down on wood blocks as shown in Figure 26. Ensure mast assembly is level, and inner masts move freely.

WARNING

Hydraulic oil is hot after system operation and can cause burns. DO NOT disconnect any hydraulic hoses until the oil in the system is cool.

3. Place drain pan under the area of the hydraulic fittings. Disconnect cylinder supply hoses from special long fittings. See Figure 26.

4. Remove special long fitting from cylinder inlet ports and install plugs. See Figure 26.

WARNING

Be careful when removing or installing snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers, and wear eye and face protection during removal or installation.

5. Remove snap ring from top of left-hand cylinder rod. See Figure 26.

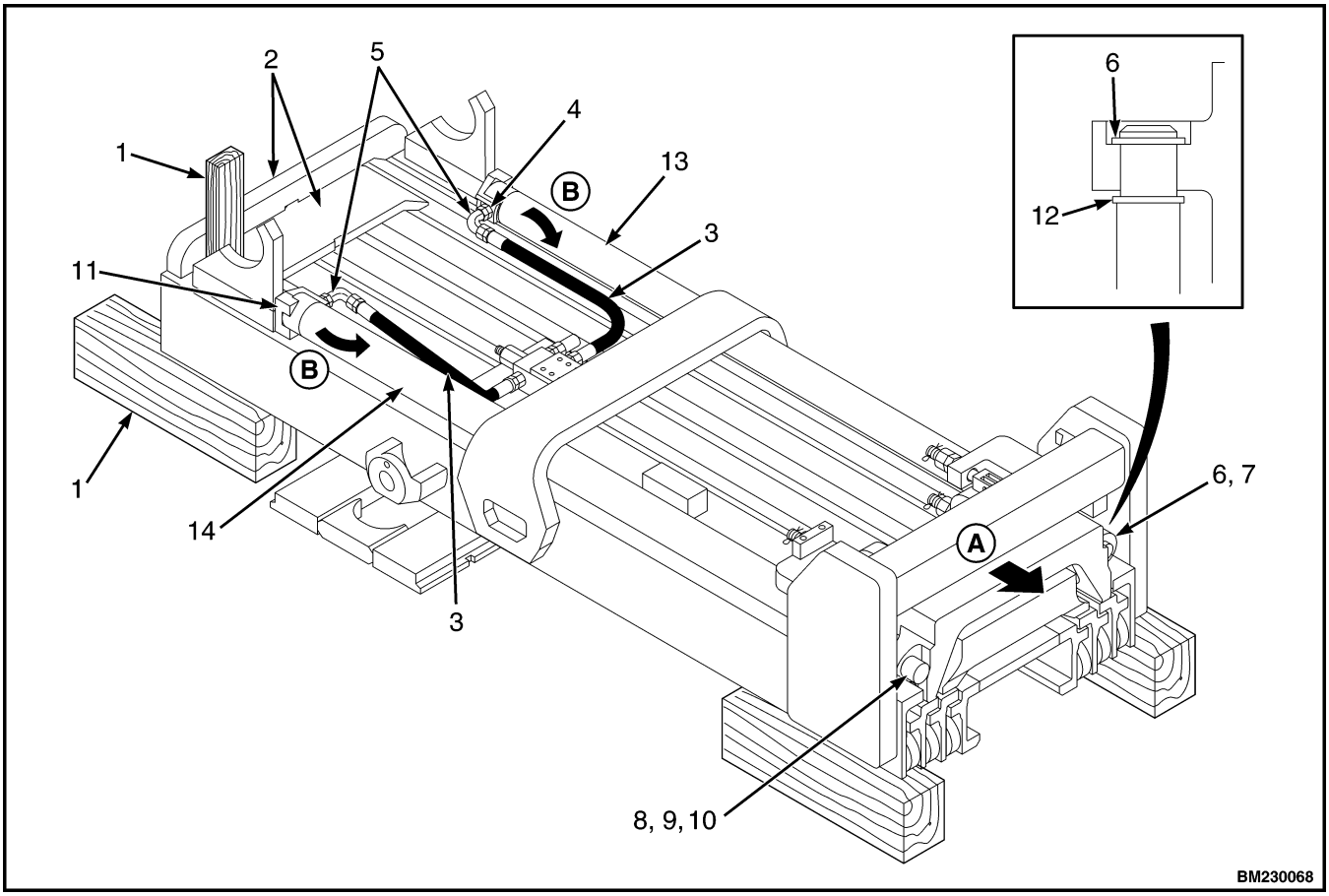
6. Remove fitting and tube from top of right-hand cylinder rod. See Figure 26.

7. Pull inner, inner intermediate, and outer intermediate masts from outer mast 30 to 60 cm (1 to 2 ft) and disengage cylinder rods from outer intermediate mast.

8. Lift cylinders from mounting boss of outer mast and angle inward. Remove cylinders through sides of the masts.

NOTE: Note number of shims at top of each rod to aid in installation.

9. Remove shims, if present, from tops of cylinders.



A. MAST PULL DIRECTION

B. CYLINDER REMOVAL DIRECTION

1. WOOD BLOCK
2. CROSSMEMBER
3. HOSE
4. CYLINDER INLET PORT
5. SPECIAL LONG FITTING
6. SNAP RING
7. LEFT-HAND CYLINDER ROD
8. TUBE
9. FITTING
10. RIGHT-HAND CYLINDER ROD
11. MOUNTING BOSS
12. SHIM
13. LEFT-HAND CYLINDER
14. RIGHT-HAND CYLINDER

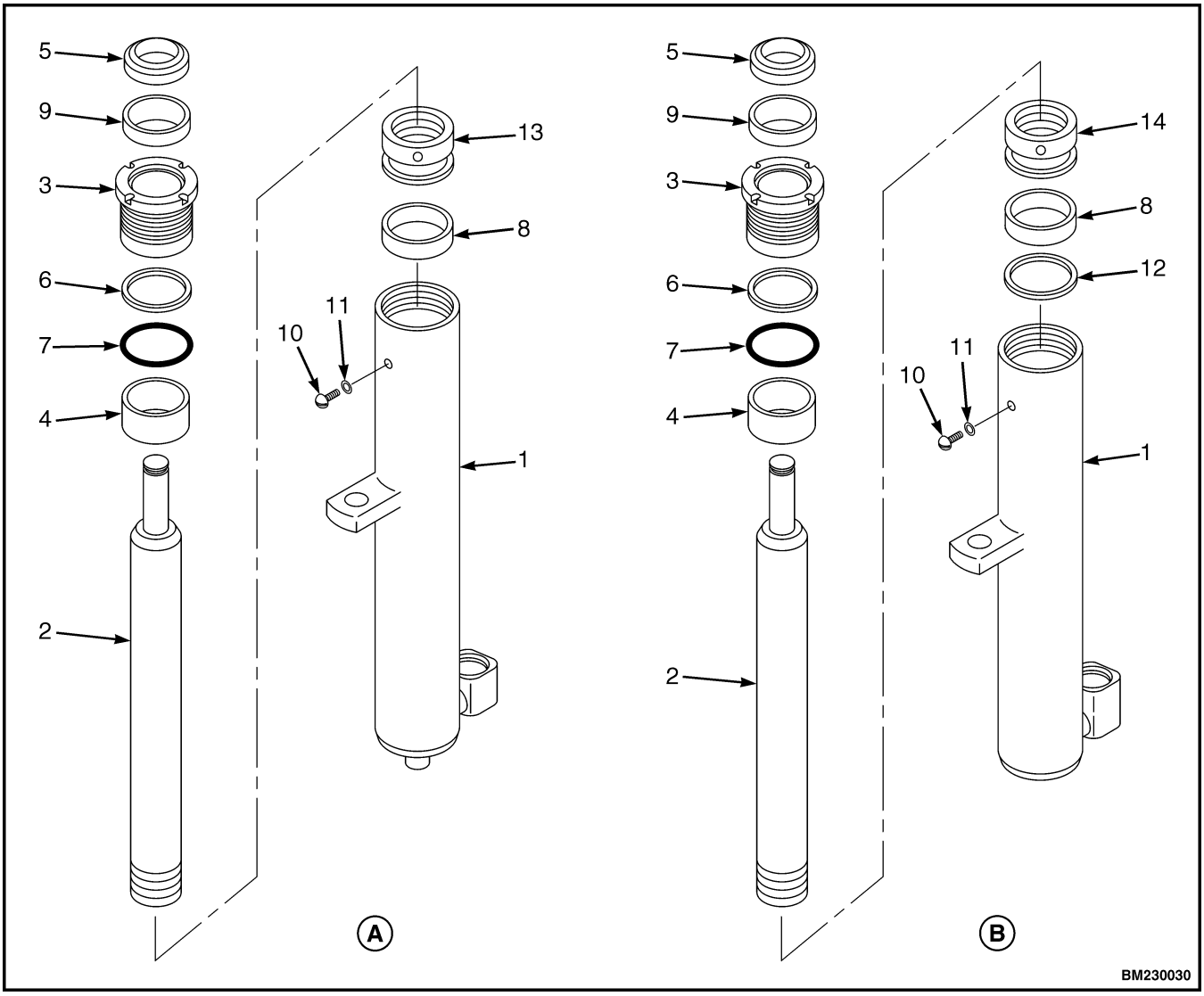
Figure 26. Main Lift Cylinders, Four-Stage FFL Mast

Disassemble

Two-Stage FFL

1. Loosen gland with spanner wrench.

2. Remove gland from rod and shell. See Figure 27.



A. RIGHT-HAND CYLINDER

1. SHELL
2. ROD
3. GLAND
4. SPACER
5. ROD WIPER
6. BACKUP RING

B. LEFT-HAND CYLINDER

7. O-RING
8. WEAR RING
9. ROD SEAL
10. CAPSCREW
11. SEAL
12. PISTON RING

Figure 27. Main Lift Cylinder, Two-Stage FFL Mast

3. Remove rod and piston assembly from shell. See Figure 27. Drain any remaining hydraulic oil into drain pan.

NOTE: To prevent damage to sealing surfaces, use brass tools when removing seals and O-rings.

4. Remove and discard rod wiper, rod seal, backup ring, and O-ring from gland. See Figure 27.

5. Remove spacer, if installed, from rod. See Figure 27.

NOTE: Perform the following step for right-hand Main Lift Cylinder.

6. Remove and discard wear ring from piston. See Figure 27.

NOTE: Perform the following step for Left-Hand Main Lift Cylinder.

7. Remove piston ring and wear ring from piston. Discard wear ring. See Figure 27.

NOTE: Perform the following step only if piston is damaged.

8. Remove piston from rod. See Figure 27.

9. Remove capscrew and seal from shell. Discard seal. See Figure 27.

Three-Stage FFL

1. Loosen gland with spanner wrench.

2. Remove gland from rod and shell. See Figure 28.

3. Remove rod and piston assembly from shell. See Figure 28. Drain any remaining hydraulic oil into drain pan.

NOTE: To prevent damage to sealing surfaces, use brass tools when removing seals and O-rings.

4. Remove and discard rod wiper, backup ring, rod seal, wear ring, and O-ring from gland. See Figure 28.

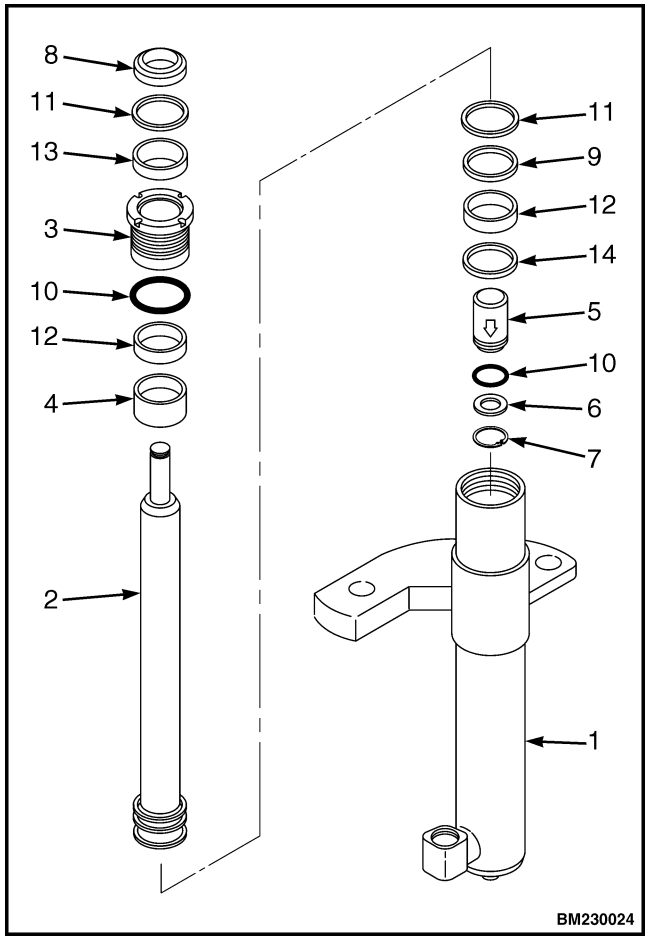
5. Remove spacer, if installed, from rod. See Figure 28.

6. Remove piston ring, wear ring, seal, and backup ring from piston. Discard wear ring, seal, and backup ring. See Figure 28.

WARNING

Be careful when removing or installing snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers and wear eye and face protection during removal or installation.

7. Remove snap ring, washer, and check valve from piston base. Remove and discard O-ring from check valve. See Figure 28.



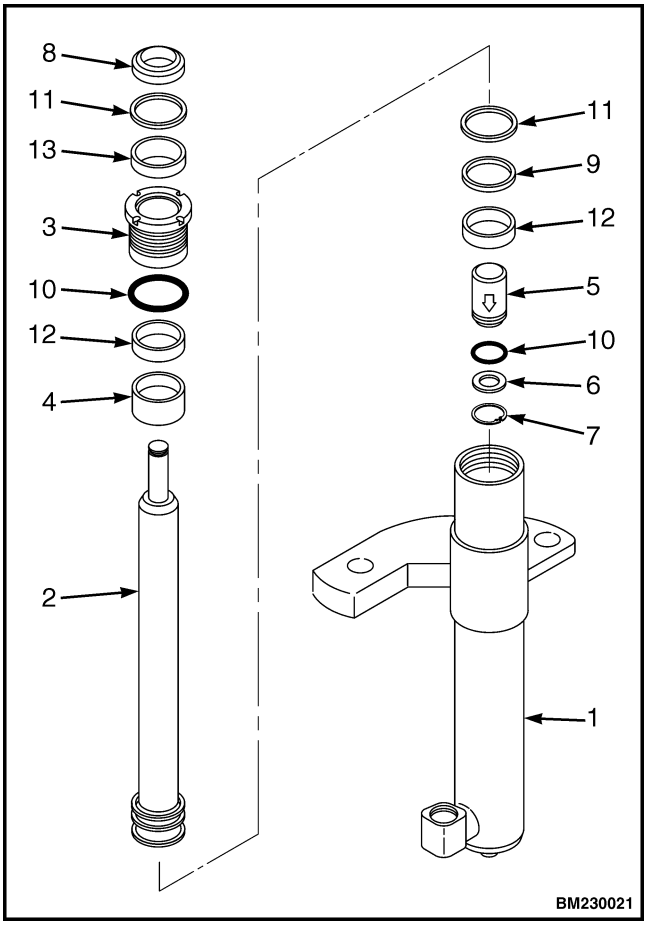
1. SHELL
2. ROD
3. GLAND
4. SPACER
5. CHECK VALVE
6. WASHER
7. SNAP RING
8. ROD WIPER
9. SEAL
10. O-RING
11. BACKUP RING
12. WEAR RING
13. ROD SEAL
14. PISTON RING

Figure 28. Main Lift Cylinder, Three-Stage FFL Mast

Two-Stage LFL

1. Loosen gland with spanner wrench.

2. Remove gland from rod and shell. See Figure 29.



1. SHELL
2. ROD
3. GLAND
4. SPACER
5. CHECK VALVE
6. WASHER
7. SNAP RING
8. ROD WIPER
9. SEAL
10. O-RING
11. BACKUP RING
12. WEAR RING
13. ROD SEAL

Figure 29. Main Lift Cylinder, Two-Stage LFL Mast

3. Remove rod and piston assembly from shell. See Figure 29. Drain any remaining hydraulic oil into drain pan.

NOTE: To prevent damage to sealing surfaces, use brass tools when removing seals and O-rings.

4. Remove and discard rod wiper, backup ring, rod seal, wear ring, and O-ring from gland. See Figure 29.

5. Remove spacer, if installed, from rod. See Figure 29.

6. Remove and discard wear ring, seal, and backup ring from piston See Figure 29.

WARNING

Be careful when removing or installing snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers and wear eye and face protection during removal or installation.

7. Remove snap ring, washer, and check valve from piston base. Remove and discard O-ring from check valve. See Figure 29.

Four-Stage FFL

NOTE: Perform Step 1 through Step 9 for right-hand Main Lift Cylinder.

Perform Step 10 through Step 18 for Left-Hand Main Lift Cylinder.

1. Using spanner wrench, remove gland from rod end and shell. See Figure 30.

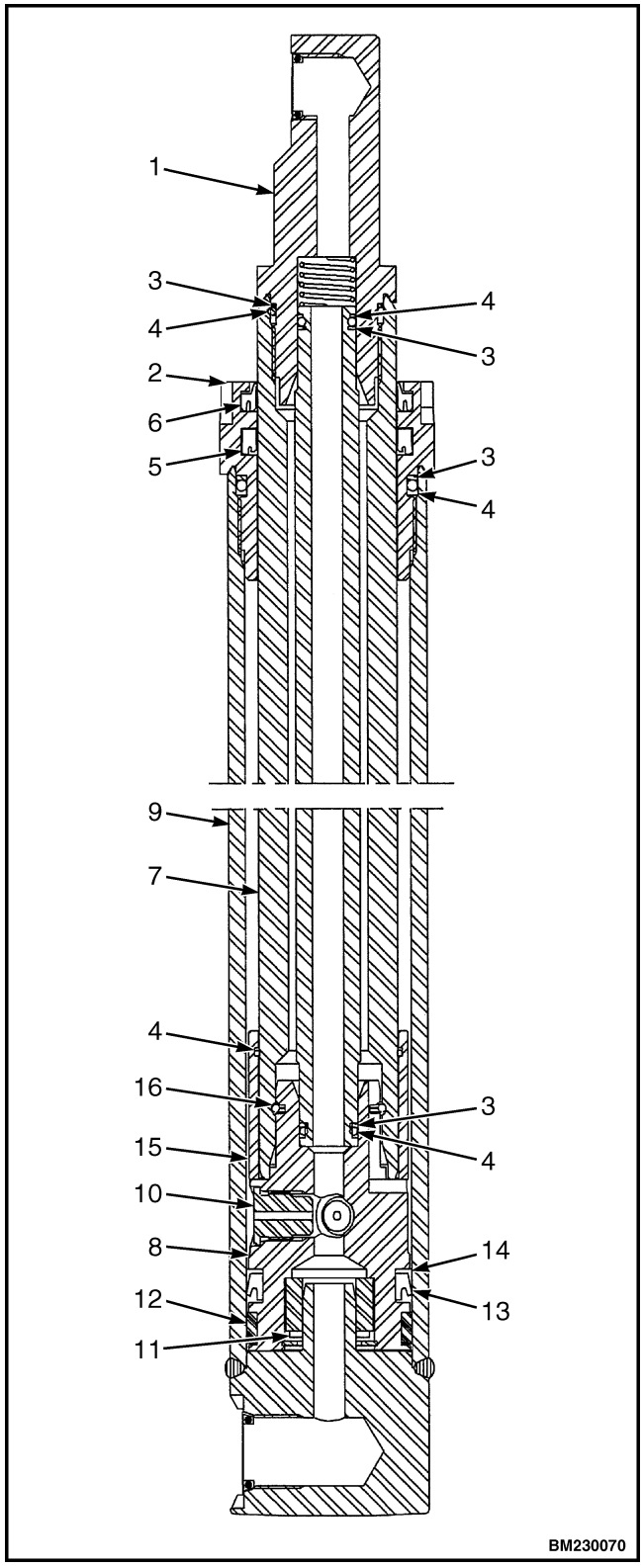


Figure 30. Right-Hand Main Lift Cylinder, Four-Stage FFL Mast

Legend for Figure 30.

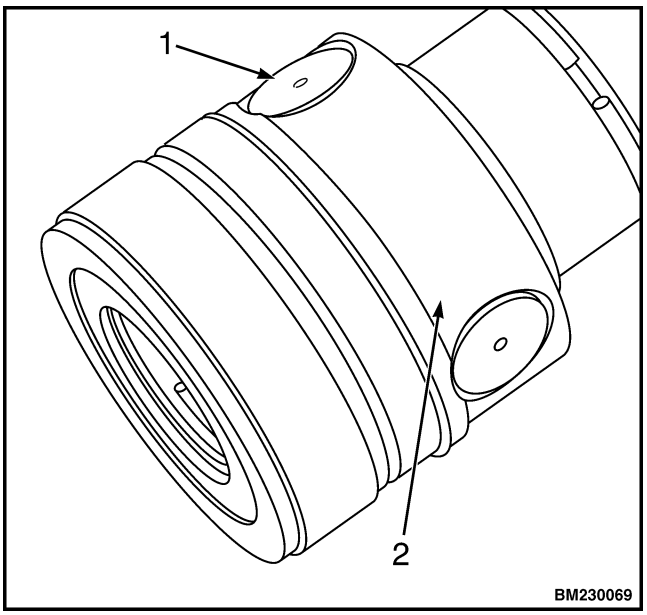
1. ROD END
2. GLAND
3. BACKUP RING
4. O-RING
5. ROD SEAL
6. WIPER
7. ROD
8. PISTON
9. SHELL
10. CHECK VALVE
11. CUSHION SLEEVE
12. WEAR RING
13. PISTON SEAL
14. NYLON RING
15. SPACER
16. WIRE RING

NOTE: Note orientation of seals prior to disassembly to aid in assembly.

2. Remove and discard backup rings, O-rings, rod seal, and wiper from gland. See Figure 30.

3. Remove rod and piston assembly from shell. See Figure 30. Drain any remaining hydraulic oil into drain pan.

4. Remove three check valves from piston. See Figure 31.



1. CHECK VALVE
2. PISTON

Figure 31. Right-Hand Main Lift Cylinder, Piston Check Valve

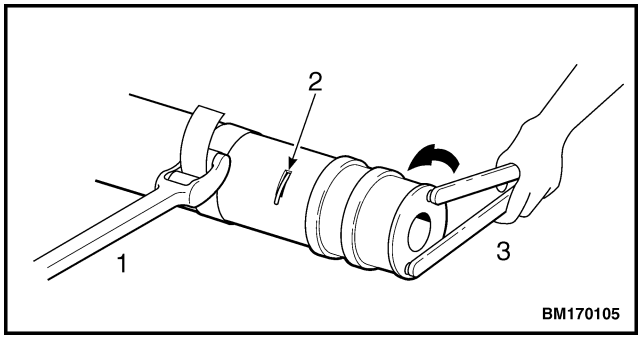
5. Place rod and piston assembly into soft jaw vise. Using strap wrench and spanner wrench, remove piston from rod as specified below:

a. Turn piston until circlip end is visible through hole. See Figure 32.

b. Pull circlip end out of hole. See Figure 32.

c. Turn piston to feed circlip out. Discard circlip. See Figure 32.

d. Pull piston from rod.



1. STRAP WRENCH
2. CIRCLIP
3. SPANNER WRENCH

Figure 32. Piston Removal

6. Remove cushion sleeve from bottom of piston. See Figure 30.

7. Remove O-ring and spacer, if present, from rod. Discard O-ring. See Figure 30.

8. Using spanner wrench, remove rod end from rod. Remove and discard O-rings and backup rings from rod. See Figure 30.

NOTE: Note orientation of seals prior to disassembly to aid in assembly.

9. Remove and discard ware ring, seal, nylon ring, spacer, and wire ring from piston. See Figure 30.

NOTE: Perform Step 10 through Step 18 for left-hand main lift cylinder.

10. Using spanner wrench, remove gland from rod and shell. See Figure 33.

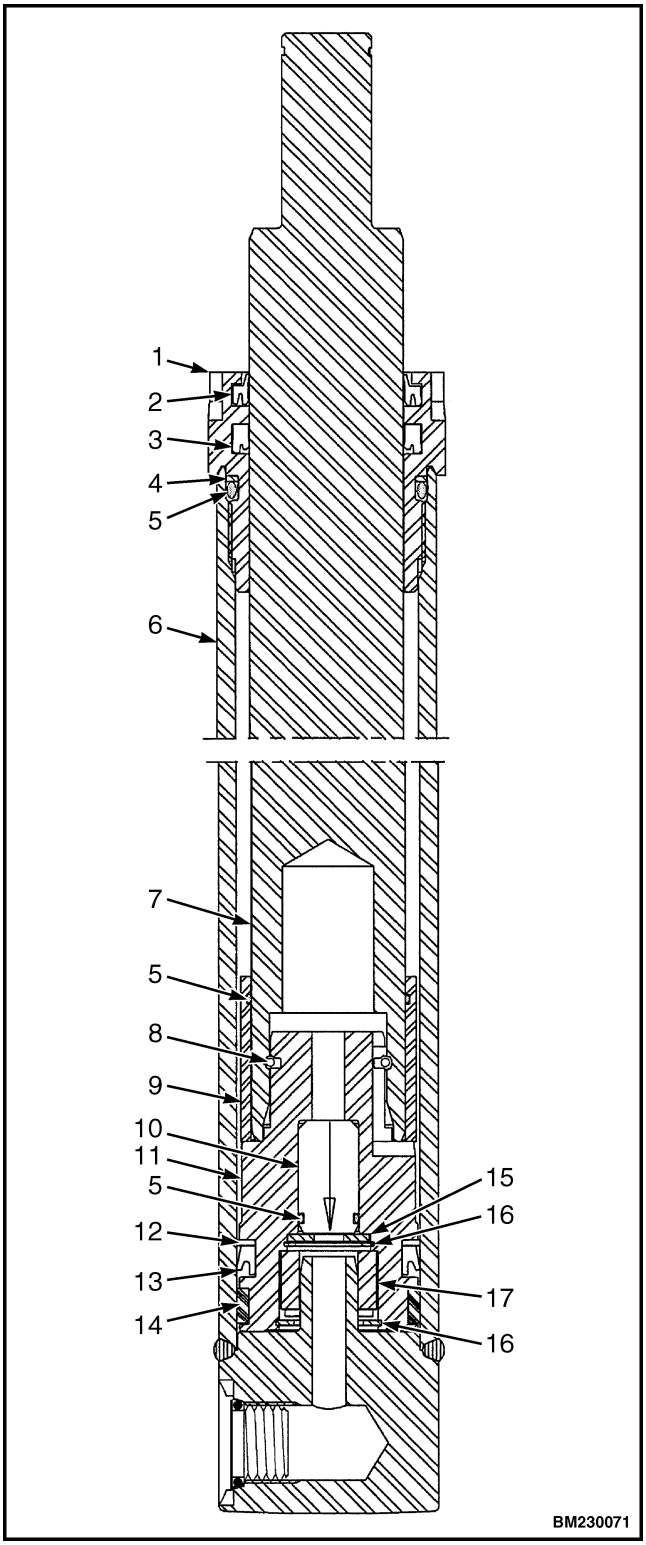


Figure 33. Left-Hand Main Lift Cylinder, Four-Stage FFL Mast

Legend for Figure 33.

1. GLAND
2. WIPER
3. U-CUP SEAL
4. BACKUP RING
5. O-RING
6. SHELL
7. ROD
8. WIRE RING
9. SPACER
10. CONTROL VALVE
11. PISTON
12. NYLON RING
13. PISTON SEAL
14. WEAR RING
15. WASHER
16. CIRCLIP
17. CUSHION SLEEVE

NOTE: Note orientation of seals prior to disassemble to aid in assembly.

11. Remove and discard wiper, U-cup seal, backup ring, and O-ring from gland. See Figure 33.

12. Remove rod and piston assembly from shell. Drain any remaining hydraulic oil into drain pan.

13. Remove O-ring and spacer from rod. Discard O-ring. See Figure 33.

14. Place rod and piston assembly into soft-jawed vise. Using spanner wrench, remove piston from rod. See Figure 33.

15. Remove circlip and cushion sleeve from bottom of piston. Discard circlip. See Figure 33.

16. Remove and discard wear ring, piston seal, nylon ring, and wire ring from piston. See Figure 33.

17. Remove circlip, washer, and control valve from piston. Discard circlip. See Figure 33.

18. Remove and discard O-ring from control valve. See Figure 33.

Clean

WARNING

Cleaning solvents can be flammable and toxic and can cause skin irritation. When using cleaning solvents, always follow the solvent manufacturer's recommended safety procedures.

Compressed air can move particles so they cause injury to the user or to other personnel. Make sure the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eyes.

CAUTION

DO NOT allow cleaning solvent to come in contact with rubber components, as it will damage those components.

Clean all metal parts in solvent and dry with compressed air.

Inspect

Inspect gland for damage to threads and seal surfaces. If damaged, replace gland.

Inspect piston for any damage to seal surfaces. If damaged, replace piston on two-stage FFL and four-stage FFL or rod and piston assembly on three-stage FFL and two-stage LFL main lift cylinders.

Inspect rod for damage to rod surface and ensure that the rod is not bent. If damaged, replace rod.

Inspect inner surface of cylinder tube for damage. If damaged, replace cylinder assembly.

For four-stage FFL right-hand main lift cylinder, inspect check valves for missing O-rings or damage. Replace O-rings if missing or check valve if damaged.

Assemble

Two-Stage FFL

1. Lubricate all internal parts of the lift cylinder with clean hydraulic oil. Use new O-rings, seals, and wear rings for installation.

NOTE: Perform the following step only if piston was removed from rod.

2. Install piston onto rod. Tighten piston to 170 to 200 N•m (125 to 148 lbf ft).

NOTE: Perform the following step for right-hand main lift cylinder.

3. Install wear ring onto piston. See Figure 27.

NOTE: Perform the following step for left-hand main lift cylinder.

4. Install wear ring and piston ring onto piston. See Figure 27.

5. Install spacer, if removed, onto rod. See Figure 27.

CAUTION

A difficult and important step in assembling lift cylinders is the correct installation of the seals. Most lift cylinder maintenance is cause by seal leaks. DO NOT damage any parts during assembly.

NOTE: To prevent damage to sealing surfaces, use brass tools when installing seals and O-rings.

6. Install new backup ring, O-ring, rod seal, and rod wiper onto gland. See Figure 27.

7. Install rod and piston assembly into shell. See Figure 27.

NOTE: To prevent possible damage to rod and piston assembly, use care while installing gland.

8. Install gland onto rod in shell. Tighten gland to 340 to 410 N•m (250 to 300 lbf ft). See Figure 27.

9. Install seal and capscrew into shell. Tighten capscrew to 6.0 to 8.0 N•m (53 to 71 lbf in). See Figure 27.

Three-Stage FFL

1. Lubricate all internal parts of the lift cylinder with clean hydraulic oil. Use new O-rings, seals, and wear rings for installation.

NOTE: To prevent damage to sealing surfaces, use brass tools when installing seals and O-rings.

2. Install new O-ring onto check valve. See Figure 28.

WARNING

Be careful when removing or installing snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers, and wear eye and face protection during removal or installation.

3. Install check valve, washer, and snap ring into piston base. See Figure 28.

CAUTION

A difficult and important step in assembling lift cylinders is the correct installation of the seals. Most lift cylinder maintenance is caused by seal leaks. DO NOT damage any parts during assembly.

4. Install new backup ring, seal, and wear ring onto piston. See Figure 28.

5. Install spacer, if required, onto rod. See Figure 28.

6. Install new O-ring, wear ring, rod seal, backup ring, and rod wiper on gland. See Figure 28.

7. Install rod and piston assembly into shell. See Figure 28.

NOTE: To prevent possible damage to rod and piston assembly, use care while installing gland.

8. Install gland on rod in shell. Tighten gland to 340 to 410 N•m (250 to 300 lbf ft). See Figure 28.

Two-Stage LFL

1. Lubricate all internal parts of the lift cylinder with clean hydraulic oil. Use new O-rings, seals, and wear rings.

NOTE: To prevent damage to sealing surfaces, use brass tools when installing seals and O-rings

2. Install new O-ring on check valve. See Figure 29.

WARNING

Be careful when removing or installing snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers and wear eye and face protection during removal or installation.

3. Install check valve, washer, and snap ring into piston base. See Figure 29.

4. Install new backup ring, seal, and wear ring onto piston. See Figure 29.

5. Install spacer, if removed, onto rod. See Figure 29.

6. Install rod and piston assembly into shell. See Figure 29.

7. Install new O-ring, wear ring, rod seal, backup ring, and rod wiper on gland. See Figure 29.

NOTE: To prevent possible damage to rod and piston assembly, use care while installing gland.

8. Install gland onto rod in shell. Tighten gland to 340 to 410 N•m (250 to 300 lbf ft). See Figure 29.

Four-Stage FFL

NOTE: Perform Step 1 through Step 10 for right-hand Main Lift Cylinder.

Perform Step 11 through Step 19 for Left-Hand Main Lift Cylinder.

NOTE: Lubricate new rings and seals with clean hydraulic oil prior to assembly.

1. Install wire ring, spacer, nylon ring, piston seal, and wear ring onto piston as noted during disassembly. See Figure 30.

2. Install new backup rings and O-rings onto rod. See Figure 30.

3. Install spacer, if present, and new O-ring onto rod. See Figure 30.

NOTE: Apply Loctite™ 242 or equivalent to rod end threads prior to assembly.

4. Install rod end onto rod. See Figure 30. Tighten rod end to 68 N•m (50 lbf ft).

5. Install cushion sleeve into bottom of piston. See Figure 30.

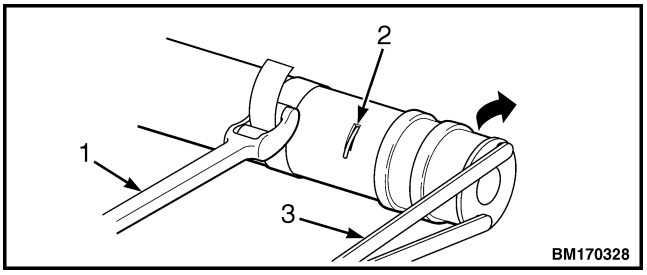
NOTE: Apply Loctite™ 242 or equivalent to piston threads prior to assembly.

6. Install piston onto rod as specified below:

   a. Install new circlip onto piston. See Figure 34.

   b. Install piston onto rod. See Figure 34.

   c. Tighten piston to 68 N•m (50 lbf ft).



1. STRAP WRENCH
2. CIRCLIP
3. SPANNER WRENCH

Figure 34. Piston Installation

7. Install three check valves into piston. See Figure 31.

8. Install rod and piston assembly into shell. See Figure 30.

NOTE: Lubricate new rings and seals with hydraulic oil prior to installation. Be sure to install rod seal as noted during disassembly.

9. Install new wiper, rod seal, O-rings, and backup rings onto gland. See Figure 30.

NOTE: Apply Loctite™ 242 or equivalent to gland threads prior to assembly.

10. Install gland onto rod end and shell. See Figure 30. Tighten gland to 68 N•m (50 lbf ft).

NOTE: Perform Step 11 through Step 19 for left-hand main lift cylinder.

NOTE: Lubricate new rings and seals with hydraulic oil prior to installation.

11. Install new O-ring onto control valve. See Figure 33.

12. Install control valve, washer, and new circlip into piston. See Figure 33.

13. Install new wire ring, nylon ring, piston seal, and war ring onto piston. See Figure 33.

14. Install cushion sleeve and new circlip into bottom of piston. See Figure 33.

NOTE: Apply Loctite™ 242 or equivalent to gland threads prior to assembly.

15. Install piston onto rod. See Figure 33. Tighten piston to 68 N•m (50 lbf ft).

NOTE: Lubricate new rings and seals with hydraulic oil prior to installation.

16. Install spacer and new O-ring onto rod. See Figure 33.

17. Install rod and piston assembly into shell.

18. Install new O-ring, backup ring, U-cup seal, and wiper onto gland. See Figure 33.

NOTE: Apply Loctite™ 242 or equivalent to gland threads prior to assembly.

19. Install gland onto rod and shell. See Figure 33. Tighten gland to 68 N•m (50 lbf ft).

Install

NOTE: Except as noted, the following procedures are for installation of both lift cylinders.

Two-Stage FFL

WARNING

Before working on or near the mast, see Safety Procedures When Working Near Mast.

NOTE: The following procedures are for the installation of lift cylinders with the mast installed on lift truck.

1. Using a lifting device, install lift cylinder on mast. The mast **must be chained** before proceeding to the next step in this procedure.

2. Install spacer, washer, capscrew, and nut at mounting plate. Tighten nut to 40 N•m (30 lbf ft). See Figure 25.

CAUTION

Disposal of lubricants and fluids must meet local environmental regulations.

3. Uncap hydraulic lines and cylinder ports. Connect hydraulic lines at cylinder.

WARNING

Be careful when removing or installing snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers, and wear eye and face protection during removal or installation.

NOTE: One washer and snap ring are required at top of each main lift cylinder.

4. Install shims, if removed, washer, and snap ring at top of cylinder. See Figure 25.

NOTE: Perform Step 5 and Step 6 for right-hand lift cylinder only.

5. Install fitting at top of cylinder. See Figure 25.

6. Connect hydraulic line to fitting.

CAUTION

Disposal of lubricants and fluids must meet local environmental regulations.

7. Remove drain pan from beneath hydraulic fitting area and dispose of contents.

System Air Bleed Procedures

NOTE: The procedures for bleeding air out of the lift cylinders apply only to lift trucks equipped with a two-stage FFL mast. Trucks equipped with a three or four-stage FFL mast or two-stage LFL mast do not need to have air bled out of the lift cylinders.

1. Remove the air from main lift cylinders as described below. See Figure 25.

   a. Loosen capscrew two turns to permit oil to flow around threads of capscrew.

   b. With forks unloaded, raise carriage using hydraulic control. Raise carriage 300 mm (12 in.) and then stop for 10 seconds to reduce the pressure in the cylinder. Repeat this procedure until the oil flowing from around the threads is free of air bubbles.

   c. Stop carriage at the top of the cylinder stroke. Tighten capscrew to 6.0 to 8.0 N•m (53 to 71 lbf in).

Three-Stage FFL Mast

WARNING

Before working on or near the mast, see Safety Procedures When Working Near Mast.

NOTE: The following procedures are for the installation of lift cylinders with the mast installed on lift truck.

1. Using a lifting device install lift cylinder onto mast. The mast **must be chained** before proceeding to the next step in this procedure.
2. Connect main lift chain at mount. Use new cotter pin and bend both legs of cotter pin a minimum of 90 degrees against chain anchor pin to secure lift chain to chain anchor.
3. Install spacer, washer, capscrew, and nut at mounting plate. See Figure 25. Tighten nut to 40 N•m (30 lbf ft).
4. Uncap hydraulic lines and cylinder ports. Connect hydraulic line at cylinder.

WARNING

Be careful when removing or installing snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers, and wear eye and face protection during removal or installation.

NOTE: One washer and snap ring are required at top of each main lift cylinder.

5. Install shims, if removed, washer, and snap ring at top of cylinder. See Figure 25.

CAUTION

Disposal of lubricants and fluids must meet local environmental regulations.

6. Remove drain pan from beneath hydraulic fitting area and dispose of contents.

Two-Stage LFL

WARNING

Before working on or near the mast, see Safety Procedures When Working Near Mast.

NOTE: The following procedures are for the installation of lift cylinders with the mast installed on lift truck.

1. Using a lifting device, install lift cylinder onto mast. The mast **must be chained** before proceeding to the next step in this procedure.
2. Connect main lift chain at mount. Use new cotter pin and bend both legs of cotter pin a minimum of 90° degrees against chain anchor pin to secure lift chain to chain anchor.
3. Install spacer, two washers, capscrew, and nut at mounting plate. Tighten nut to 40 N•m (30 lbf ft). See Figure 25.
4. Uncap hydraulic lines and cylinder ports. Connect hydraulic lines at cylinder.

WARNING

Be careful when removing or installing snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers, and wear eye and face protection during removal or installation.

NOTE: One washer and snap ring are required at top of each main lift cylinder.

5. Install shims, if removed, washer, and snap ring at top of cylinder. See Figure 25.

CAUTION

Disposal of lubricants and fluids must meet local environmental regulations.

6. Remove drain pan from beneath hydraulic fitting area and dispose of contents.

Four-Stage FFL

NOTE: Main lift cylinders install with mast removed from lift truck.

1. Install shims onto tops of cylinders as noted during removal. See Figure 26.
2. Install cylinder through sides of masts and onto mounting boss.
3. Engage cylinder rods with outer intermediate mast. Push outer intermediate, inner intermediate, and inner masts into working position.

WARNING

Be careful when removing or installing snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers, and wear eye and face protection during removal or installation.

4. Install snap ring onto top of left hand cylinder rod. See Figure 26.
5. Install tube and fitting onto top of right-hand cylinder rod. See Figure 26.
6. Remove plugs and install special long fittings into cylinder inlet ports. See Figure 26.
7. Connect cylinder supply hoses to special long fittings. See Figure 26.
8. Ensure inner masts move freely.
9. Remove wood block from low crossmembers of outer intermediate and outer masts. See Figure 26.

CAUTION

Disposal of lubricants and fluids must meet local environmental regulations.

10. Remove drain pan and dispose of contents.

Mast and Carriage Install for Two-Stage FFL, Three-Stage FFL, and Two-Stage LFL

1. Use a lifting device to lower the inner mast weldment (two-stage) or intermediate mast weldment (three-stage) onto the lift cylinder.
2. Install carriage as described in carriage installation procedures located in the following **Service Manuals:**

   Mast Repair (S/N A270, A271, A272) 4000SRM1386 for lift truck models
   - J1.6-2.0XNT (K160)
   - J1.6-2.0XN (A935)
   - E30-40HSD$_3$ (C219)

   Mast Repair (S/N C661, C662, C663, C665) 4000SRM1405 for lift truck models
   - J1.6-2.0XNT (J30-40XNT) (K160)
   - J1.6-2.0XN (J30-40XN) (A935)
   - E30-40HSD$_2$ (B219)
   - E30-40HSD$_3$ (C219)
3. Adjust lift cylinders as specified in section

   Mast Repair (S/N A270, A271, A272) 4000SRM1386 for lift truck models
   - J1.6-2.0XNT (K160)
   - J1.6-2.0XN (A935)
   - E30-40HSD$_3$ (C219)

   Mast Repair (S/N C661, C662, C663, C665) 4000SRM1405 for lift truck models
   - J1.6-2.0XNT (J30-40XNT) (K160)
   - J1.6-2.0XN (J30-40XN) (A935)
   - E30-40HSD$_2$ (B219)
   - E30-40HSD$_3$ (C219)

Mast and Carriage Installation for Four-Stage FFL

1. Use a lifting device to position mast onto lift truck. Install mast. See section **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405.
2. Install carriage as described in section **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405.

3. Adjust lift cylinders as specified in section **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405.

Lift Cylinder Repair for 2.0-3.5T Trucks

This section outlines the lift cylinder repair procedures for lift truck models E2.2-3.5XN (E45-70XN) (A268) and J2.2-3.5XN (J45-70XN) (A276) .

MAIN LIFT CYLINDERS

Remove

WARNING

Before working on or near the mast, see Safety Procedures When Working Near Mast.

NOTE: The following procedures are for the removal of lift cylinders with the mast installed on lift truck.

NOTE: Except as noted, the following procedures are for removal of both lift cylinders.

1. Remove the carriage as described in the carriage removal procedures located in the section **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338.

Two-Stage FFL

1. Raise and chain the mast as instructed in Safety Procedures When Working Near Mast section. The mast **must be chained** before proceeding to the next step in this procedure.

WARNING

Be careful when removing or installing snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers, and wear eye and face protection during removal or installation.

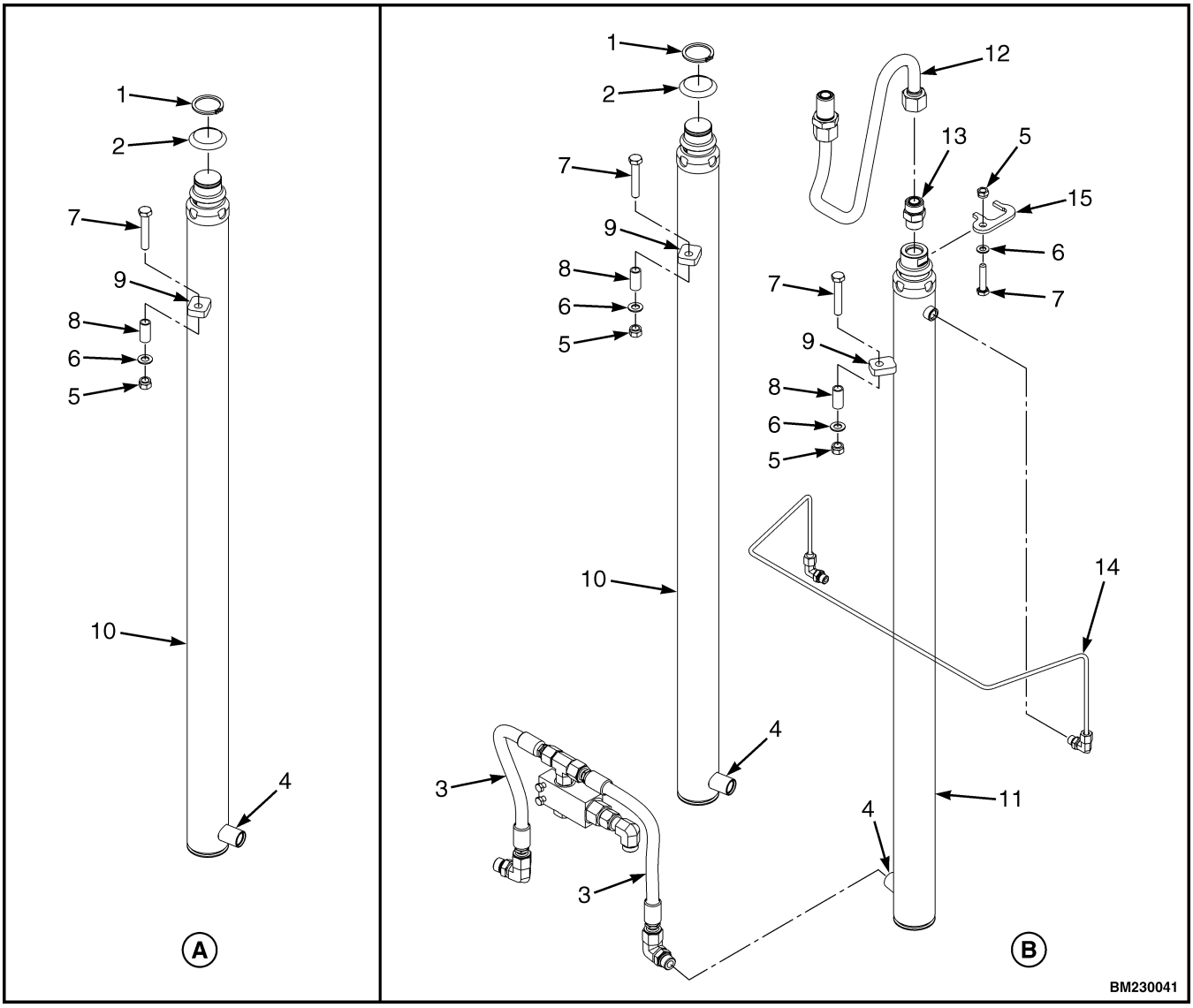
2. Remove snap ring and shims at top of cylinder. Remove tube assembly from the top of the left-hand cylinder. See Figure 35.

WARNING

Hydraulic oil is hot after system operation and can cause burns. DO NOT disconnect any hydraulic hoses until the oil in the system is cool.

3. Put a drain pan under the area of the hydraulic fittings. Disconnect hydraulic lines at lift cylinder and drain oil. See Figure 35. Cap hydraulic lines and cylinder ports.

4. Remove nut, washer, capscrew, and spacer at mounting plate. See Figure 35.



NOTE: BALANCE LINE IS USED ON FOUR-STAGE FFL MAST ONLY. MASTS REMOVED FOR CLARITY.

A. TWO AND THREE-STAGE FFL. TYPICAL FOR BOTH RIGHT-HAND AND LEFT-HAND CYLINDERS ON TWO AND THREE-STAGE MASTS.
B. FOUR-STAGE FFL

1. SNAP RING
2. SHIM
3. HYDRAULIC LINE
4. CYLINDER PORT
5. NUT
6. WASHER
7. CAPSCREW
8. SPACER
9. MOUNTING PLATE
10. LEFT-HAND MAIN LIFT CYLINDER
11. RIGHT-HAND MAIN LIFT CYLINDER
12. TUBE ASSEMBLY
13. STRAIGHT FITTING
14. BALANCE LINE
15. KEEPER

Figure 35. Main Lift Cylinders Installation

NOTE: After the cylinder has been completely disconnected from the mast, the mast needs to be raised high enough for the bottom of the cylinder to clear the crossmember on the outer mast weldment. The cylinder being removed needs to have the rod retracted into the cylinder.

5. Using a lifting device, remove main lift cylinder from mast.

Three-Stage FFL

1. Raise and chain the mast as instructed in Safety Procedures When Working Near Mast section. The mast **must be chained** before proceeding to the next step in this procedure.

WARNING

Be careful when removing or installing snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers, and wear eye and face protection during removal or installation.

2. Remove snap ring and shims at top of cylinder. See Figure 35.

WARNING

Hydraulic oil is hot after system operation and can cause burns. DO NOT disconnect any hydraulic hoses until the oil in the system is cool.

3. Put a drain pan under the area of the hydraulic fittings. Disconnect hydraulic lines at lift cylinder and drain oil. See Figure 35. Cap hydraulic lines and cylinder ports.

4. Remove nut, washer, capscrew and spacer at mounting plate. See Figure 35.

5. Disconnect main lift chain at mount.

NOTE: Raise the mast high enough for the bottom of the cylinder to clear the crossmember on the outer mast weldment and push the rod back into the cylinder being removed.

6. Using a lifting device, remove lift cylinder from mast.

Four-Stage FFL

1. Raise and chain the mast as instructed in Safety Procedures When Working Near Mast section. The mast **must be chained** before proceeding to the next step in this procedure.

WARNING

Be careful when removing or installing snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers, and wear eye and face protection during removal or installation.

2. On left-hand lift cylinder, remove snap ring from top of cylinder. See Figure 35.

WARNING

Hydraulic oil is hot after system operation and can cause burns. DO NOT disconnect any hydraulic hoses until the oil in the system is cool.

3. Put a drain pan under the area of the hydraulic fittings. Disconnect hydraulic lines at lift cylinders and drain oil. See Figure 35. Cap hydraulic lines and cylinder ports.

4. On right-hand lift cylinder, disconnect tube assembly from straight fitting at top of cylinder. See Figure 35. Cap tube assembly.

5. On right-hand lift cylinder, remove nut, keeper, capscrew, and washer from cylinder mount of intermediate mast section. See Figure 35.

6. Disconnect balance line from both cylinders. See Figure 35.

7. Remove nut, washer, capscrew, and spacer at mounting plate. See Figure 35

NOTE: Raise the mast high enough for the bottom of the cylinder to clear the crossmember on the outer mast weldment and push the rod back into the cylinder being removed.

8. Using a lifting device, remove lift cylinder from mast. Keep shims from top of left-hand cylinder with cylinder.

Two-Stage LFL

1. Raise and chain the mast as instructed in Safety Procedures When Working Near Mast section.

WARNING

Be careful when removing or installing snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers, and wear eye and face protection during removal or installation.

2. Remove snap ring and shims at top of cylinder. See Figure 35.

WARNING

Hydraulic oil is hot after system operation and can cause burns. DO NOT disconnect any hydraulic hoses until the oil in the system is cool.

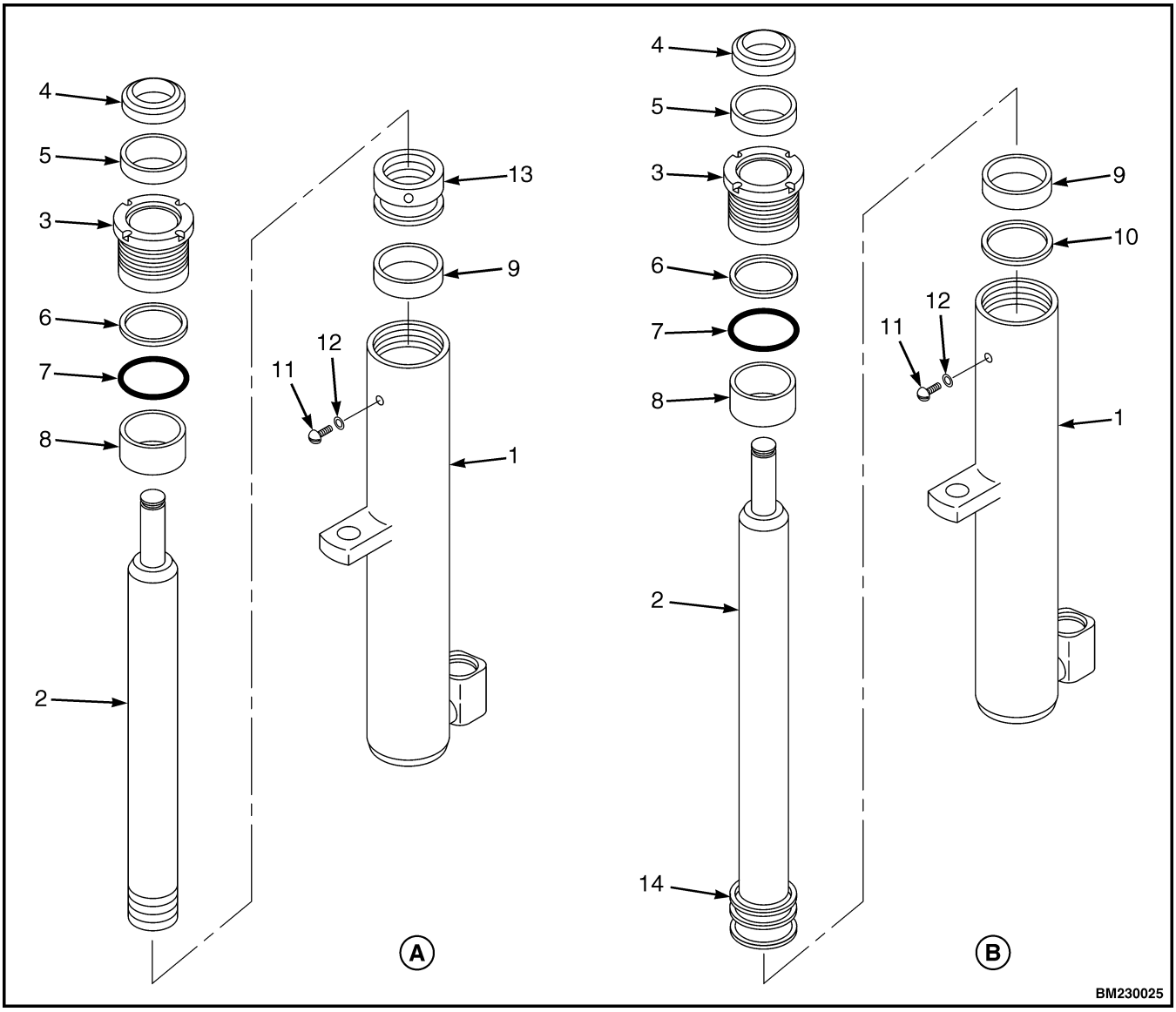
3. Put a drain pan under the area of the hydraulic fittings. Disconnect hydraulic lines at lift cylinder and drain oil. See Figure 35. Cap hydraulic lines and cylinder ports.
4. Remove nut, washer, spacer, and capscrew at mounting plate. See Figure 35.
5. Disconnect main lift chain at mount.
6. Using a lifting device, remove main lift cylinder from mast.

NOTE: Raise the mast high enough for the bottom of the cylinder to clear the crossmember on the outer mast weldment and push the rod back into the cylinder being removed.

Disassemble

Two-Stage FFL

1. Loosen gland with spanner wrench.
2. Remove gland from rod and shell. See Figure 36.



A. LEFT-HAND CYLINDER

1. SHELL
2. ROD
3. GLAND
4. ROD WIPER
5. ROD SEAL
6. BACKUP RING
7. O-RING

B. RIGHT-HAND CYLINDER

8. SPACER
9. WEAR RING
10. PISTON RING ®. H. ONLY)
11. CAPSCREW
12. WASHER-SEAL
13. LEFT-HAND PISTON
14. RIGHT-HAND PISTON

Figure 36. Main Lift Cylinder - Two-Stage Mast FFL

3. Remove rod and piston assembly from shell. See Figure 36. Drain any remaining hydraulic oil into drain pan.

NOTE: To prevent damage to sealing surfaces, use brass tools when removing seals and O-rings.

4. Remove and discard rod wiper, rod seal, backup ring, and O-ring from gland. See Figure 36.

5. Remove spacer, if installed, from rod. See Figure 36.

NOTE: Perform Step 6 for right-hand lift cylinders. Perform Step 7 for left-hand lift cylinders.

6. Remove wear ring, and piston ring from piston end of rod. Discard wear ring. See Figure 36.

7. Remove and discard wear ring from piston end of rod. See Figure 36.

8. Remove capscrew and seal. Discard seal. See Figure 36.

NOTE: Perform the following step only if the piston is damaged.

9. Remove piston from rod using spanner wrench. See Figure 36.

Three-Stage FFL

1. Loosen gland with spanner wrench.

2. Remove gland from rod and shell. See Figure 37.

3. Remove rod and piston assembly from shell. See Figure 37. Drain any remaining hydraulic oil into drain pan.

NOTE: To prevent damage to sealing surfaces, use brass tools when removing seals and O-rings.

4. Remove and discard rod wiper, backup ring, rod seal, O-ring, and wear ring from gland. See Figure 37.

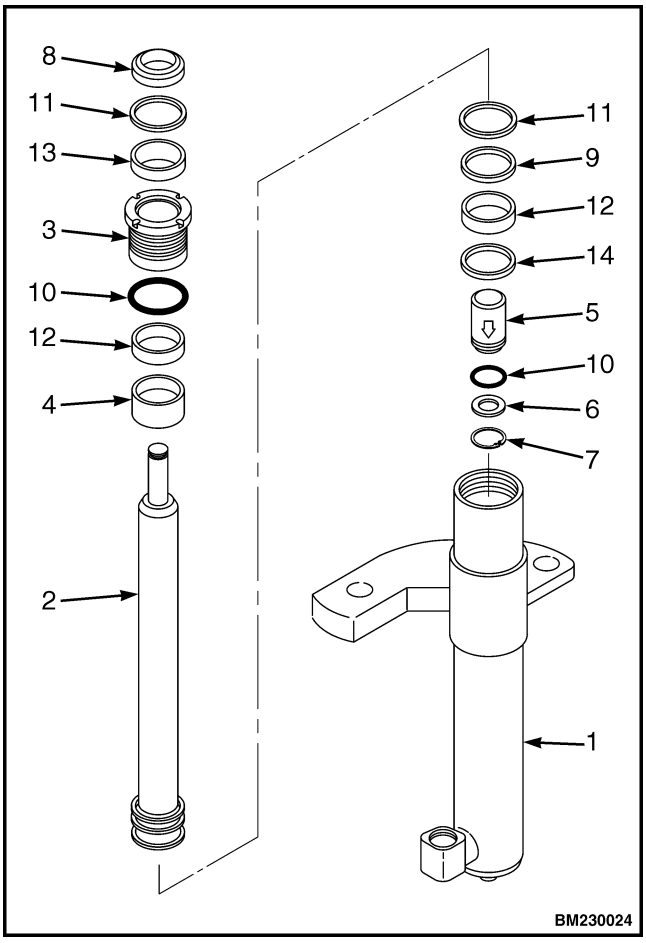
5. Remove spacer, if installed, from rod. See Figure 37.

6. Remove piston ring, wear ring, seal, and backup ring from piston. See Figure 37. Discard wear ring, seal and backup ring.

WARNING

Be careful when removing or installing snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers, and wear eye and face protection during removal or installation.

7. Remove snap ring, washer, and check valve from piston base. Remove and discard O-ring from check valve. See Figure 37.



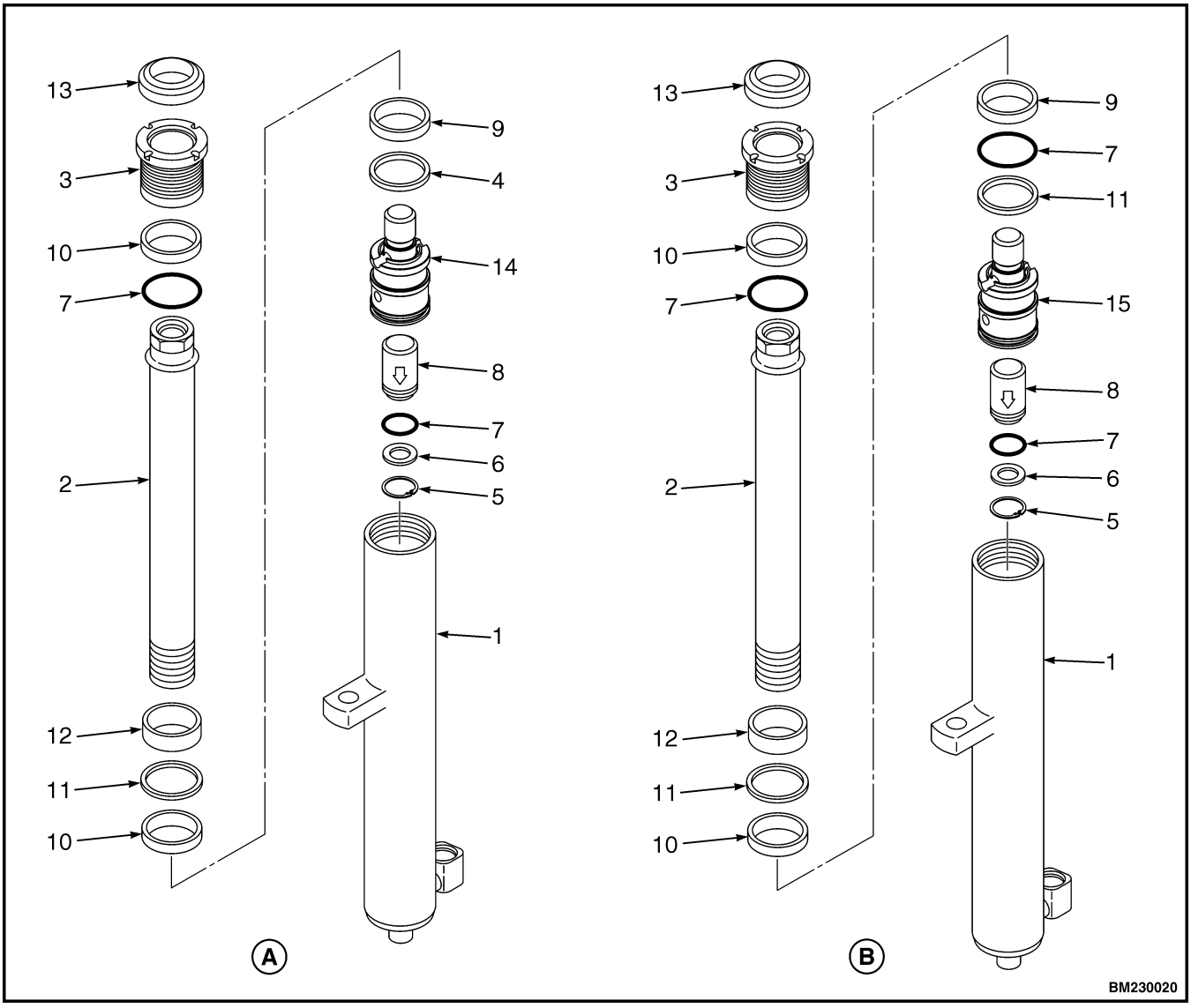
1. SHELL
2. ROD
3. GLAND
4. SPACER
5. CHECK VALVE
6. WASHER
7. SNAP RING
8. ROD WIPER
9. SEAL
10. O-RING
11. BACKUP RING
12. WEAR RING
13. ROD SEAL
14. PISTON RING

Figure 37. Right and Left Main Lift Cylinders Three-Stage Mast

Four-Stage FFL

1. Loosen gland with spanner wrench.

2. Remove gland from rod and shell. See Figure 38.



A. LEFT-HAND CYLINDER

1. SHELL
2. ROD
3. GLAND
4. PISTON RING
5. SNAP RING
6. WASHER
7. O-RING
8. CHECK VALVE

B. RIGHT-HAND CYLINDER

9. WEAR RING
10. ROD SEAL
11. BACKUP RING
12. SPACER
13. ROD WIPER
14. LEFT-HAND PISTON
15. RIGHT-HAND PISTON

Figure 38. Main Lift Cylinder For Four-Stage Mast

NOTE: To prevent damage to sealing surfaces, use brass tools when removing seals and O-rings.

3. Remove and discard rod wiper, rod seal, and O-ring, from gland. See Figure 38.

4. Remove rod and piston assembly from shell.

5. Remove spacer, backup ring, rod seal, and wear ring from piston. Discard backup ring, rod seal, and wear ring. See Figure 38.

NOTE: Perform Step 6 for left-hand cylinder and Step 7 for right-hand cylinder.

6. Remove piston ring from piston. See Figure 38.

7. Remove and discard O-ring and backup ring from piston. See Figure 38.

NOTE: Perform the following step only if the piston is damaged.

8. Remove piston from rod using spanner wrench. See Figure 38.

WARNING

Be careful when removing or installing snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers, and wear eye and face protection during removal or installation.

9. Remove snap ring, washer, and check valve from piston base. Remove and discard O-ring from check valve. See Figure 38.

Two-Stage LFL

1. Loosen gland with spanner wrench.

2. Remove gland from rod and shell. See Figure 39.

3. Remove rod and piston assembly from shell. Drain any remaining hydraulic oil into drain pan.

NOTE: To prevent damage to sealing surfaces, use brass tools when removing seals and O-rings.

4. Remove and discard rod wiper, backup ring, rod seal, O-ring, and wear ring from gland. See Figure 39.

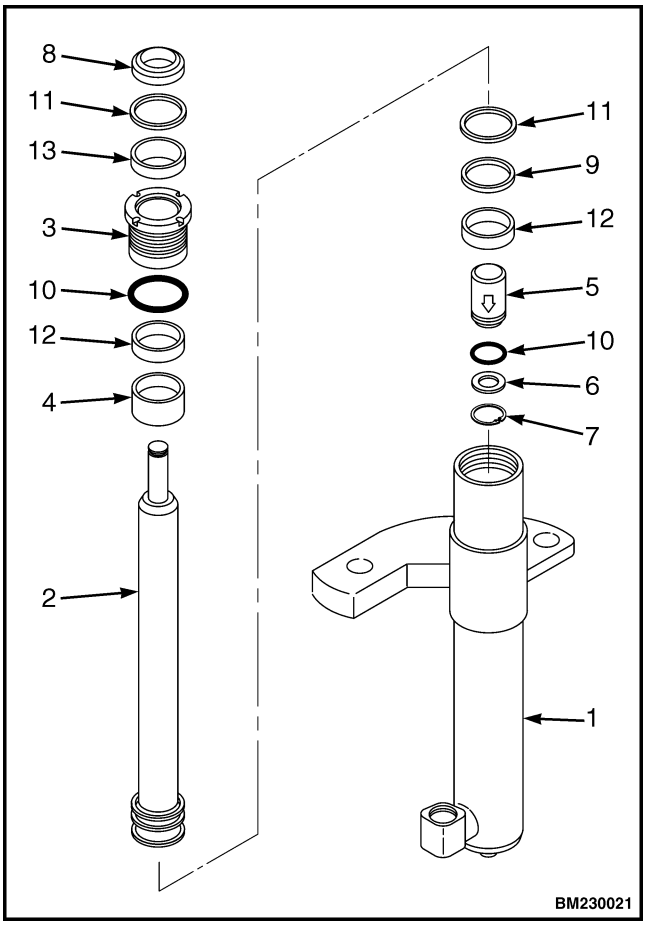
5. Remove spacer from rod. See Figure 39.

6. Remove and discard wear ring, seal, and backup ring from piston. See Figure 39.

WARNING

Be careful when removing or installing snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers, and wear eye and face protection during removal or installation.

7. Remove snap ring, washer, and check valve from piston base. Remove and discard O-ring from check valve. See Figure 39.



1. SHELL
2. ROD
3. GLAND
4. SPACER
5. CHECK VALVE
6. WASHER
7. SNAP RING
8. ROD WIPER
9. SEAL
10. O-RING
11. BACKUP RING
12. WEAR RING
13. ROD SEAL

Figure 39. Limited Free-Lift Cylinder Two-Stage Mast LFL

Clean

WARNING

Cleaning solvents can be flammable and toxic and can cause skin irritation. When using cleaning solvents, always follow the solvent manufacturer's recommended safety procedures.

Compressed air can move particles so they cause injury to the user or to other personnel. Make sure the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eyes.

CAUTION

DO NOT allow cleaning solvent to come in contact with rubber components, as it will damage those components.

Clean all metal parts in solvent and dry with compressed air.

Inspect

Inspect gland for damage to threads and seal surfaces. If damaged, replace gland.

Inspect piston for damage to seal surfaces. If damaged, replace piston on two and four-stage FFL main lift cylinders, replace rod and piston assembly on three-stage FFL and two-stage LFL main lift cylinders.

Inspect rod for damage to rod surface and ensure that rod is not bent. If damaged, replace rod.

Inspect inner surface of cylinder tube for damage. If damaged, replace lift cylinder assembly.

Assemble

Two-Stage FFL

1. Lubricate all internal parts of the lift cylinder with clean hydraulic oil. Use new O-rings, seals, and wear rings.

NOTE: Perform the following step if the piston was removed from the rod.

2. Install piston onto rod. Tighten piston to 170 to 200 N•m (125 to 148 lbf ft).

NOTE: Perform Step 3 for right-hand lift cylinders. Perform Step 4 for left-hand lift cylinders.

CAUTION

A difficult and important step in assembling lift cylinders is the correct installation of the seals. Most lift cylinder maintenance is caused by seal leaks. DO NOT damage any parts during assembly.

NOTE: To prevent damage to sealing surfaces, use brass tools when installing seals and O-rings.

3. Install spacer, new wear ring, and piston ring onto piston. See Figure 36.

4. Install spacer and new wear ring onto piston. See Figure 36.

5. Install new backup ring, O-ring, rod seal, and rod wiper on gland. See Figure 36.

6. Install rod and piston assembly into shell. See Figure 36.

NOTE: To prevent possible damage to rod and piston assembly, use care while installing gland.

7. Install gland onto rod in shell. See Figure 36. Tighten gland to 340 to 410 N•m (250 to 300 lbf ft).

CAUTION

Additives may damage the hydraulic system. Before using additives, contact your local Hyster dealer.

8. Pour 150 cc (5 oz) hydraulic oil into cylinder through the capscrew hole. This oil provides a hydraulic cushion when cylinder reaches the top of its stroke. Install washer-seal and capscrew. See Figure 36. Tighten capscrew to 6.0 to 8.0 N•m (53 to 71 lbf in).

Three-Stage FFL

1. Lubricate all internal parts of lift cylinder with clean hydraulic oil. Use new O-rings, seals, and wear rings.

WARNING

Be careful when removing or installing snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers, and wear eye and face protection during removal or installation.

NOTE: To prevent damage to sealing surfaces, use brass tools when installing seals and O-rings.

2. Install new O-ring on check valve. Install check valve, washer, and snap ring into base of piston. Make sure arrow on check valve is toward piston base. See Figure 37.

CAUTION

A difficult and important step in assembling lift cylinder is the correct installation of the seals. Most lift cylinder maintenance is caused by seal leaks. DO NOT damage any parts during assembly.

3. Install new backup ring, seal, wear ring, and piston ring on piston. See Figure 37.

4. Install spacer, if removed, onto rod. See Figure 37.

5. Install new wear ring, O-ring, rod seal, backup ring, and rod wiper onto gland. See Figure 37.

6. Install rod and piston assembly into shell.

NOTE: To prevent possible damage to rod and piston assembly, use care while installing gland.

7. Install gland onto rod in shell. Tighten gland to 340 to 410 N•m (250 to 300 lbf ft).

Four-Stage FFL

1. Lubricate all internal parts of lift cylinder with clean hydraulic oil. Use new O-rings, seals, backup rings, and wear rings.

NOTE: Perform the following step for the right-hand cylinder only.

2. Install backup ring and O-ring onto piston. See Figure 38.

NOTE: Perform the following step only if piston was removed from rod.

3. Install piston onto rod. Tighten piston to 170 to 200 N•m (125 to 148 lbf ft).

NOTE: Perform the following step for left hand cylinder only.

4. Install piston ring onto piston. See Figure 38.

NOTE: To prevent damage to sealing surfaces, use brass tools when installing seals and O-rings.

5. Install new O-ring onto check valve.

WARNING

Be careful when removing or installing snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers, and wear eye and face protection during removal or installation.

6. Install check valve, washer, and snap ring in piston base. Make sure arrow on check valve is toward piston base. See Figure 38.

CAUTION

A difficult and important step in assembling lift cylinders is the correct installation of the seals. Most lift cylinder maintenance is caused by seal leaks. DO NOT damage any parts during assembly.

7. Install wear ring, rod seal, backup ring, and spacer onto piston. See Figure 38.

8. Install rod and piston assembly into shell.

9. Install new O-ring, rod seal, and rod wiper onto gland. See Figure 38.

NOTE: To prevent possible damage to rod and piston assembly, use care while installing gland.

10. Install gland onto rod in shell. Tighten gland to 340 to 410 N•m (250 to 300 lbf ft).

Two-Stage LFL

1. Lubricate all internal parts of the lift cylinder with clean hydraulic oil. Use new O-rings, seals, backup rings, and wear rings.

NOTE: To prevent damage to sealing surfaces, use brass tools when installing seals and O-rings.

2. Install new O-ring on check valve. See Figure 39.

WARNING

Be careful when removing or installing snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers, and wear eye and face protection during removal or installation.

3. Install check valve, washer, and snap ring into piston base. Make sure arrow on check valve is toward piston base. See Figure 39.

CAUTION

A difficult and important step in assembling lift cylinders is the correct installation of the seals. Most lift cylinder maintenance is caused by seal leaks. DO NOT damage any parts during assembly.

4. Install backup ring, seal, and wear ring onto piston. See Figure 39.

5. Install spacer onto rod. See Figure 39.

6. Install wear ring, O-ring, rod seal, backup ring, and rod wiper onto gland. See Figure 39.

7. Install rod and piston assembly into shell.

NOTE: To prevent damage to the rod and piston assembly, use care while installing gland.

8. Install gland onto rod and in shell. Tighten gland to 340 to 410 N•m (250 to 300 lbf ft). See Figure 39.

Install

NOTE: Except as noted, the following procedures are for installation of both lift cylinders.

Two-Stage FFL

1. Using lifting device, install lift cylinder in mount at bottom of outer mast.

NOTE: After the cylinder has been completely disconnected from the mast, raise the mast high enough for the bottom of the cylinder to clear the crossmember on the outer mast weldment and push the rod back into the cylinder being removed.

2. Install spacer, capscrew, washer, and nut at mounting plate. See Figure 35. Tighten nut to 40 N•m (30 lbf ft).

3. Use lifting device to lower the inner mast onto lift cylinder. Connect tube assembly to top of left lift cylinder. Install shims and snap ring at top of lift cylinder. See Figure 35.

4. Uncap hydraulic lines and cylinder ports. Connect hydraulic lines to cylinder ports. See Figure 35.

CAUTION

Disposal of lubricants and fluids must meet local environmental regulations.

5. Dispose of drain pan contents.

6. Connect main lift chains and adjust as specified in section **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338.

System Air Bleed Procedures

NOTE: The procedures for bleeding air out of the lift cylinders apply only to lift trucks equipped with a two-stage FFL mast. Trucks equipped with a three or four-stage FFL mast or two-stage LFL mast do not need to have air bled out of the lift cylinders.

1. Remove the air from main lift cylinders as described below. See Figure 36, Two-Stage FFL shown.

   a. Loosen capscrew two turns to permit oil to flow around threads of capscrew.

   b. With forks unloaded, raise carriage using hydraulic control. Raise carriage 300 mm (12 in.) and then stop for 10 seconds to reduce the pressure in the cylinder. Repeat this procedure until the oil flowing from around the threads is free of air bubbles.

   c. Stop carriage at the top of the cylinder stroke. Tighten capscrew to 6.0 to 8.0 N•m (53 to 71 lbf in).

Three-Stage FFL

1. Using lifting device, install lift cylinder in mount at the bottom of the outer mast.

NOTE: Raise the mast high enough for the bottom of the cylinder to clear the crossmember on the outer mast weldment and push the rod back into the cylinder being removed.

2. Install spacer, capscrew, washer, and nut at mounting plate. See Figure 35. Tighten nut to 40 N•m (30 lbf ft).

3. Use lifting device to lower intermediate mast onto lift cylinder. Install shim and snap ring at top of lift cylinder. See Figure 35.

4. Reconnect main lift chain to chain anchor.

5. Install new cotter pin with cotter pin hole positioned toward the inside mast. Bend both legs of cotter pin against chain anchor pin to secure lift chain to chain anchor.

6. Uncap hydraulic lines and cylinder ports. Connect hydraulic lines to cylinder ports. See Figure 35.

CAUTION

Disposal of lubricants and fluids must meet local environmental regulations.

7. Dispose of drain pan contents.

8. Connect main lift chains and adjust as specified in section **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338.

Four-Stage FFL

1. Using lifting device, install lift cylinder in mount at the bottom of the outer mast section.

NOTE: Raise the mast high enough for the bottom of the cylinder to clear the crossmember on the outer mast weldment and push the rod back into the cylinder being removed.

2. Install spacer, capscrew, washer, and nut at mounting plate. See Figure 35. Tighten nut to 40 N•m (30 lbf ft).

3. Use lifting device to lower mast onto lift cylinder.

WARNING

Be careful when removing or installing snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers, and wear eye and face protection during removal or installation.

4. On left-hand cylinder, install shim(s) and snap ring at top of cylinder. See Figure 35.

5. On right-hand cylinder, install keeper, washer, capscrew, and nut to cylinder mount of intermediate mast. See Figure 35. Tighten nut to 33 N•m (24 lbf ft).

6. Connect main lift chains and adjust as specified in section **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338.

7. On right-hand cylinder, uncap tube assembly and connect to straight fitting at top of cylinder. See Figure 35.

8. Uncap hydraulic lines and cylinder ports. Connect the hydraulic lines at cylinder ports. See Figure 35.

9. Install balance line between main lift cylinders. See Figure 35.

CAUTION

Disposal of lubricants and fluids must meet local environmental regulations.

10. Dispose of drain pan contents.

Two-Stage LFL

1. Using lifting device, install lift cylinder in mount at the bottom of the outer mast.

NOTE: Raise the mast high enough for the bottom of the cylinder to clear the crossmember on the outer mast weldment and push the rod back into the cylinder being removed.

2. Install spacer, capscrew, washer, and nut at mounting plate. See Figure 35. Tighten nut to 40 N•m (30 lbf ft).

WARNING

Be careful when removing or installing snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers, and wear eye and face protection during removal or installation.

3. Use lifting device to lower the inner mast onto lift cylinder. Install shim and snap ring at top of lift cylinder. See Figure 35.

4. Uncap hydraulic lines and cylinder ports. Connect the hydraulic lines to cylinder ports. See Figure 35.

CAUTION

Disposal of lubricants and fluids must meet local environmental regulations.

5. Dispose of drain pan contents.

6. Connect main lift chains and adjust as specified in section **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338.

Lift Cylinder Repair for 4.0-5.5T Trucks

This section outlines the lift cylinder repair procedures for lift truck models J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) and E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099).

MAIN LIFT CYLINDERS

Remove

WARNING

Before working on or near the mast, see Safety Procedures When Working Near Mast.

NOTE: The following procedures are for the removal of lift cylinders with the mast installed on lift truck.

NOTE: Except as noted, the following procedures are for removal of both lift cylinders.

1. Remove the carriage as described in the carriage removal procedures. See section **Mast Repair (S/N A626-27, A751-52, B590-91, and B749-54)** 4000SRM1540.

See the section **Mast Repairs (S/N A551, A555, A559, A751, A752, B586, B587, B588, B590, B591, B749, B750, B751, B752, and B754)** 4000SRM1576 for lift truck model

- E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

Two-Stage FFL

1. Raise and chain the mast as instructed in Safety Procedures When Working Near Mast section. The mast **must be chained** before proceeding to the next step in this procedure.

WARNING

Be careful when removing or installing snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers, and wear eye and face protection during removal or installation.

2. Remove snap ring, shims, and washer at top of cylinder. Remove tube assembly from the top of the left-hand cylinder. See Figure 40.

WARNING

Hydraulic oil is hot after system operation and can cause burns. DO NOT disconnect any hydraulic hoses until the oil in the system is cool.

3. Put a drain pan under the area of the hydraulic fittings. Disconnect hydraulic lines at lift cylinder and drain oil. See Figure 40. Cap hydraulic lines and cylinder ports.

4. Remove two washers, two capscrews and bracket from mast. See Figure 40.

NOTE: After the cylinder has been completely disconnected from the mast, the mast needs to be raised high enough for the bottom of the cylinder to clear the crossmember on the outer mast weldment. The cylinder being removed needs to have the rod retracted into the cylinder.

5. Using a lifting device, remove main lift cylinder from mast.

Three-Stage FFL

1. Raise and chain the mast as instructed in Safety Procedures When Working Near Mast section. The mast **must be chained** before proceeding to the next step in this procedure.

WARNING

Be careful when removing or installing snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers, and wear eye and face protection during removal or installation.

2. Remove snap ring, shims, and washer at top of cylinder. Remove tube assembly from side of cylinder. See Figure 40.

WARNING

Hydraulic oil is hot after system operation and can cause burns. DO NOT disconnect any hydraulic hoses until the oil in the system is cool.

3. Put a drain pan under the area of the hydraulic fittings. Disconnect hydraulic lines at lift cylinder and drain oil. See Figure 40. Cap hydraulic lines and cylinder ports.

4. Remove two washers, two capscrews and bracket from mast. See Figure 40.

5. Disconnect main lift chain at mount.

NOTE: Raise the mast high enough for the bottom of the cylinder to clear the crossmember on the outer mast weldment and push the rod back into the cylinder being removed.

6. Using a lifting device, remove lift cylinder from mast.

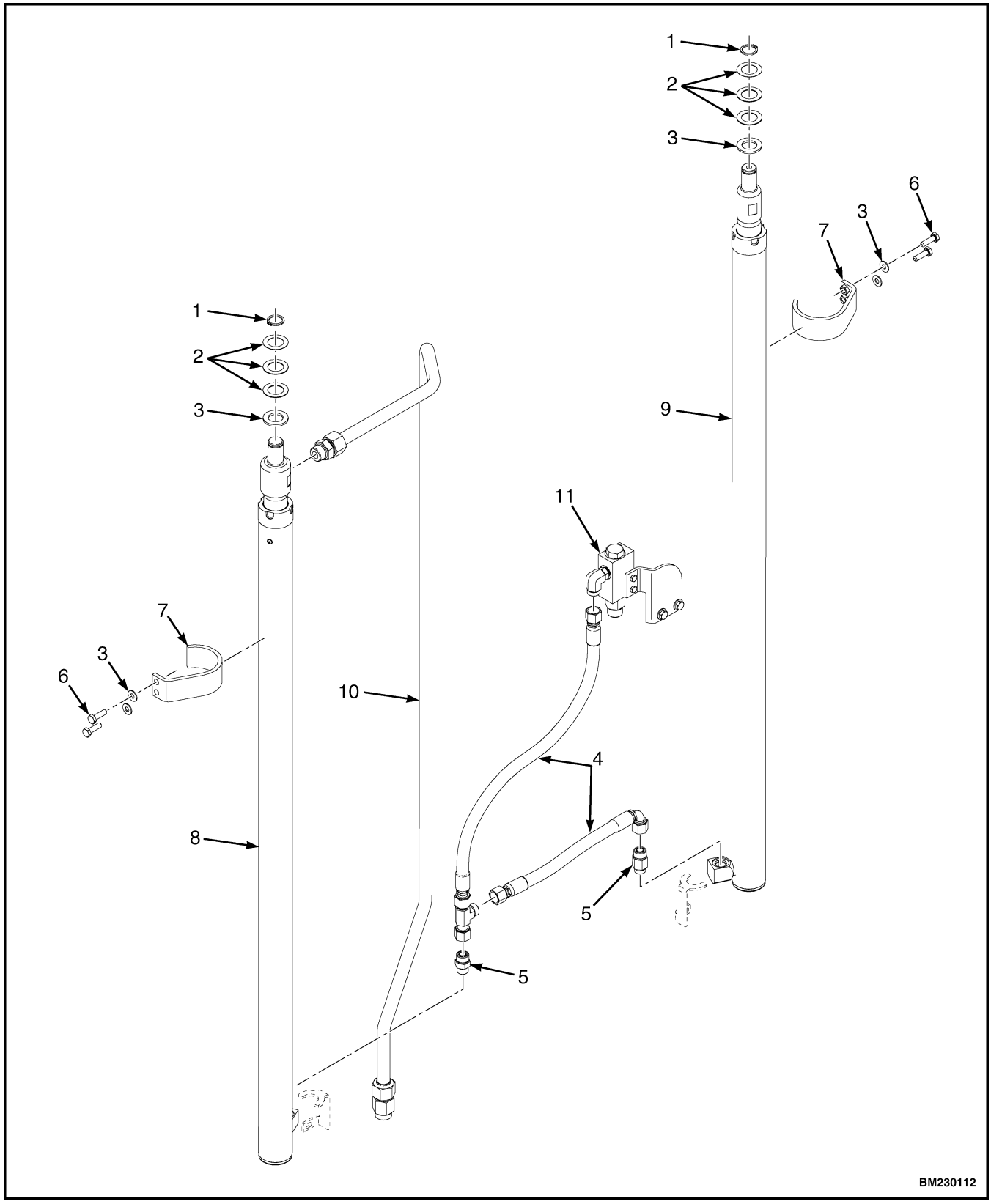


Figure 40. Main Lift Cylinders Installation

Legend for Figure 40.

NOTE: TWO STAGE FFL SHOWN, THREE STAGE FFL SIMILAR. MASTS REMOVED FOR CLARITY.

1. SNAP RING
2. SHIM
3. WASHER
4. HYDRAULIC LINE
5. CYLINDER PORT
6. CAPSCREW
7. BRACKET
8. LEFT-HAND MAIN LIFT CYLINDER
9. RIGHT-HAND MAIN LIFT CYLINDER
10. TUBE ASSEMBLY
11. LOWERING CONTROL HOUSING/VALVE

Two-Stage LFL

1. Raise and chain the mast as instructed in Safety Procedures When Working Near Mast section.

WARNING

Be careful when removing or installing snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers, and wear eye and face protection during removal or installation.

2. Remove snap ring and shims at top of cylinder. Remove tube assembly from side of cylinder. See Figure 40.

WARNING

Hydraulic oil is hot after system operation and can cause burns. DO NOT disconnect any hydraulic hoses until the oil in the system is cool.

3. Put a drain pan under the area of the hydraulic fittings. Disconnect hydraulic lines at lift cylinder and drain oil. See Figure 40. Cap hydraulic lines and cylinder ports.

4. Remove two washers, two capscrews and bracket from mast. See Figure 40.

5. Disconnect main lift chain at mount.

6. Using a lifting device, remove main lift cylinder from mast.

NOTE: Raise the mast high enough for the bottom of the cylinder to clear the crossmember on the outer mast weldment and push the rod back into the cylinder being removed.

Disassemble

Two-Stage FFL

1. Loosen gland with spanner wrench.

2. Remove gland from rod and shell. See Figure 41.

3. Remove rod and piston assembly from shell. See Figure 41. Drain any remaining hydraulic oil into drain pan.

NOTE: To prevent damage to sealing surfaces, use brass tools when removing seals and O-rings.

4. Remove and discard rod wiper, rod seal, backup ring, and O-ring from gland. See Figure 41.

5. Remove spacer, if installed, from rod. See Figure 41.

NOTE: Perform Step 6 for right-hand lift cylinders. Perform Step 7 for left-hand lift cylinders.

6. Remove wear ring, and piston ring from piston end of rod. Discard wear ring. See Figure 41.

7. Remove and discard wear ring from piston end of rod. See Figure 41.

8. Remove capscrew and washer seal. Discard seal. See Figure 41.

NOTE: Perform the following step only if the piston is damaged.

9. Remove piston from rod using spanner wrench. See Figure 41.

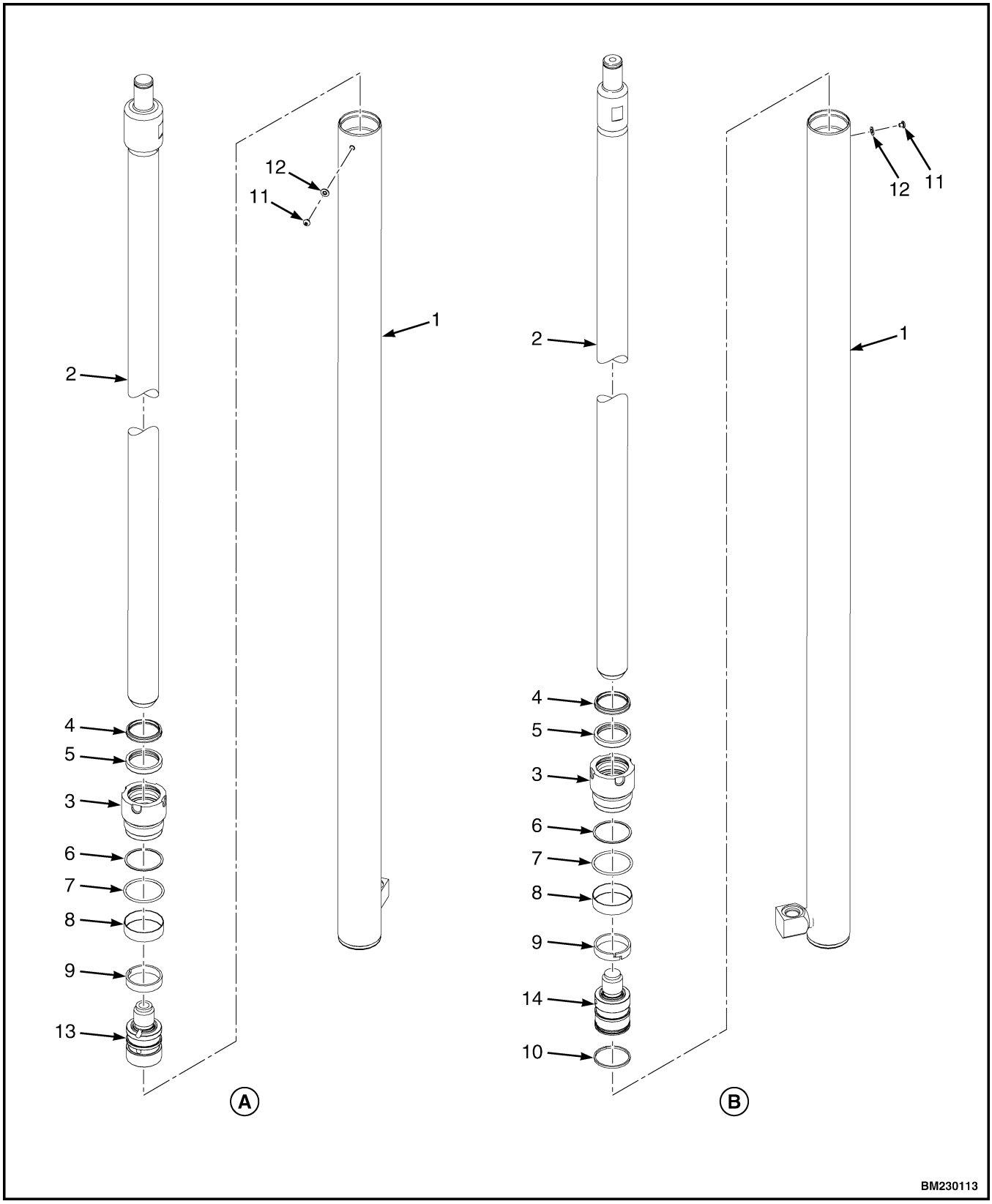


Figure 41. Right and Left Main Lift Cylinders - Two-Stage Mast FFL

Legend for Figure 41.

A. LEFT-HAND CYLINDER

1. SHELL
2. ROD
3. GLAND
4. ROD WIPER
5. ROD SEAL
6. BACKUP RING
7. O-RING

B. RIGHT-HAND CYLINDER

8. SPACER (OPTIONAL)
9. WEAR RING
10. PISTON RING ®. H. ONLY)
11. CAPSCREW
12. WASHER-SEAL
13. LEFT-HAND PISTON
14. RIGHT-HAND PISTON

Three-Stage FFL

1. Loosen gland with spanner wrench.

2. Remove gland from rod and shell. See Figure 42.

3. Remove rod and piston assembly from shell. See Figure 42. Drain any remaining hydraulic oil into drain pan.

NOTE: To prevent damage to sealing surfaces, use brass tools when removing seals and O-rings.

4. Remove and discard rod wiper, backup ring, seal, O-ring, and wear ring from gland. See Figure 42.

5. Remove spacer, if installed, from rod. See Figure 42.

6. Remove backup ring, piston ring, and wear ring, from piston. See Figure 42. Discard backup ring piston ring and wear ring.

WARNING

Be careful when removing or installing snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers, and wear eye and face protection during removal or installation.

7. Remove snap ring from piston. See Figure 42.

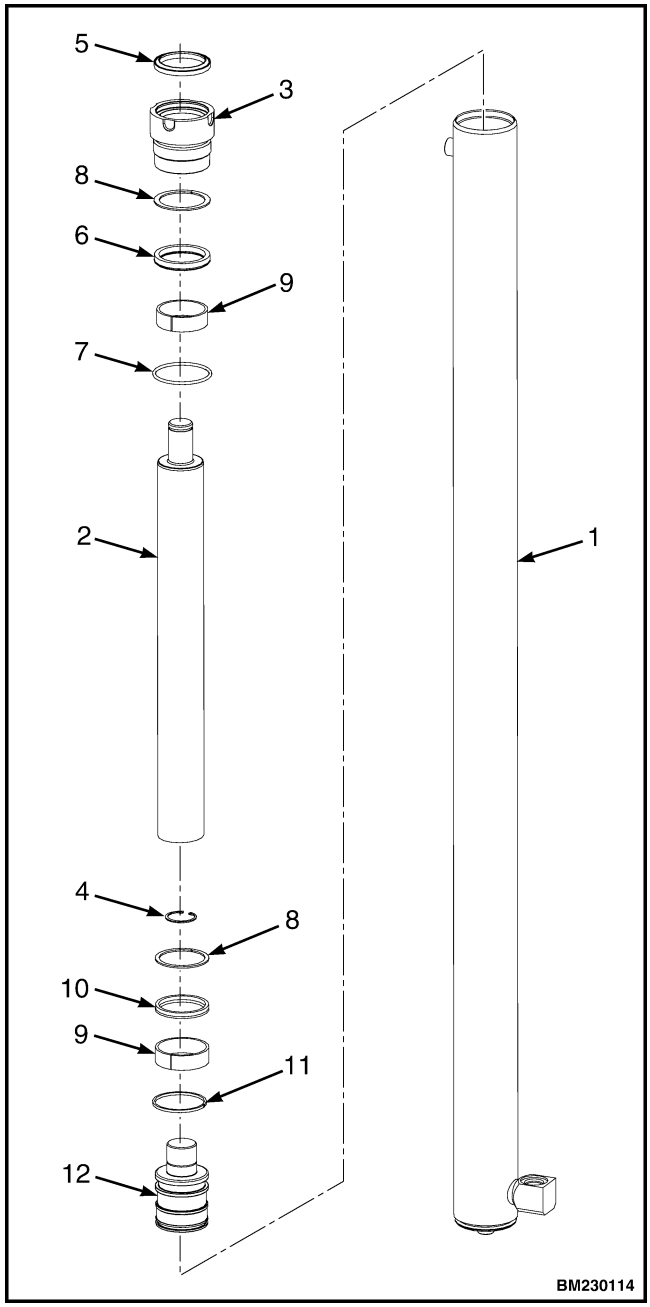


Figure 42. Main Lift Cylinder - RH/LH Three-Stage Mast

Legend for Figure 42.

1. SHELL
2. ROD
3. GLAND
4. SNAP RING
5. ROD WIPER
6. SEAL
7. O-RING
8. BACKUP RING
9. WEAR RING
10. ROD SEAL
11. PISTON RING
12. PISTON

Two-Stage LFL

1. Loosen gland with spanner wrench.

2. Remove gland from rod and shell. See Figure 43.

3. Remove rod and piston assembly from shell. Drain any remaining hydraulic oil into drain pan.

NOTE: To prevent damage to sealing surfaces, use brass tools when removing seals and O-rings.

4. Remove and discard rod wiper, backup ring, seal, O-ring, and wear ring from gland. See Figure 43.

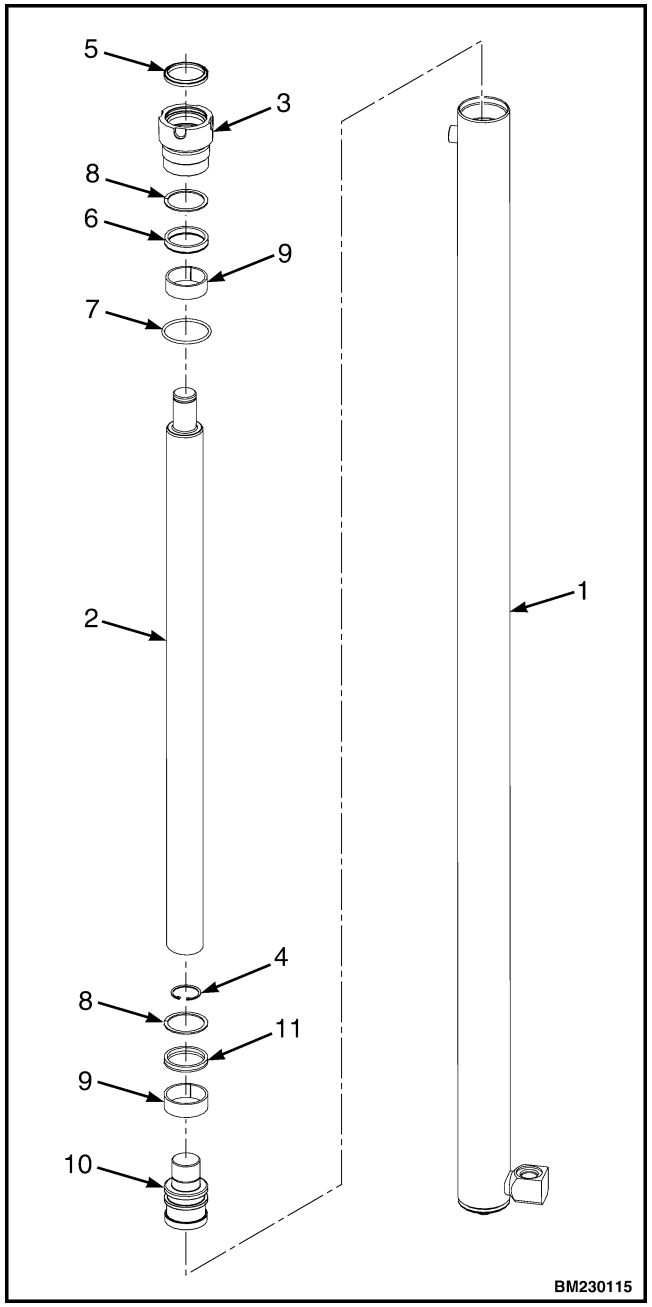
5. Remove spacer from rod. See Figure 43.

6. Remove backup ring, piston ring, and wear ring, from piston. See Figure 43. Discard backup ring piston ring and wear ring.

WARNING

Be careful when removing or installing snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers, and wear eye and face protection during removal or installation.

7. Remove snap ring from piston. See Figure 43.



1. SHELL
2. ROD
3. GLAND
4. SNAP RING
5. ROD WIPER
6. SEAL
7. O-RING
8. BACKUP RING
9. WEAR RING
10. PISTON

Figure 43. Limited Free-Lift Cylinder Two-Stage Mast LFL

Clean

WARNING

Cleaning solvents can be flammable and toxic and can cause skin irritation. When using cleaning solvents, always follow the solvent manufacturer's recommended safety procedures.

Compressed air can move particles so they cause injury to the user or to other personnel. Make sure the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eyes.

CAUTION

DO NOT allow cleaning solvent to come in contact with rubber components, as it will damage those components.

Clean all metal parts in solvent and dry with compressed air.

Inspect

Inspect gland for damage to threads and seal surfaces. If damaged, replace gland.

Inspect piston for damage to seal surfaces. If damaged, replace piston on two and four-stage FFL main lift cylinders, replace rod and piston assembly on three-stage FFL and two-stage LFL main lift cylinders.

Inspect rod for damage to rod surface and ensure that rod is not bent. If damaged, replace rod.

Inspect inner surface of cylinder tube for damage. If damaged, replace lift cylinder assembly.

Assemble

Two-Stage FFL

1. Lubricate all internal parts of the lift cylinder with clean hydraulic oil. Use new O-rings, seals, and wear rings.

NOTE: Perform the following step if the piston was removed from the rod.

2. Install piston onto rod. Tighten piston to 170 to 200 N•m (125 to 148 lbf ft).

NOTE: Perform Step 3 for right-hand lift cylinders. Perform Step 4 for left-hand lift cylinders.

CAUTION

A difficult and important step in assembling lift cylinders is the correct installation of the seals. Most lift cylinder maintenance is caused by seal leaks. DO NOT damage any parts during assembly.

NOTE: To prevent damage to sealing surfaces, use brass tools when installing seals and O-rings.

3. Install spacer, new wear ring, and piston ring onto piston. See Figure 41.

4. Install spacer and new wear ring onto piston. See Figure 41.

5. Install new backup ring, O-ring, rod seal, and rod wiper on gland. See Figure 41.

6. Install rod and piston assembly into shell. See Figure 41.

NOTE: To prevent possible damage to rod and piston assembly, use care while installing gland.

7. Install gland onto rod in shell. See Figure 41. Tighten gland to 340 to 410 N•m (250 to 300 lbf ft).

CAUTION

Additives may damage the hydraulic system. Before using additives, contact your local Hyster dealer.

8. Pour 150 cc (5 oz) hydraulic oil into cylinder through the capscrew hole. This oil provides a hydraulic cushion when cylinder reaches the top of its stroke. Install washer-seal and capscrew. See Figure 41. Tighten capscrew to 6.0 to 8.0 N•m (53 to 71 lbf in).

Three-Stage FFL

1. Lubricate all internal parts of lift cylinder with clean hydraulic oil. Use new O-rings, seals, and wear rings.

WARNING

Be careful when removing or installing snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers, and wear eye and face protection during removal or installation.

NOTE: To prevent damage to sealing surfaces, use brass tools when installing seals and O-rings.

2. Install snap ring onto piston. See Figure 42.

CAUTION

A difficult and important step in assembling lift cylinder is the correct installation of the seals. Most lift cylinder maintenance is caused by seal leaks. DO NOT damage any parts during assembly.

3. Install new backup ring, piston ring, and wear ring on piston. See Figure 42.

4. Install spacer, if removed, onto rod. See Figure 42.

5. Install new wear ring, O-ring, seal, backup ring, and rod wiper onto gland. See Figure 42.

6. Install rod and piston assembly into shell.

NOTE: To prevent possible damage to rod and piston assembly, use care while installing gland.

7. Install gland onto rod in shell. Tighten gland to 400 to 475 N•m (295 to 350 lbf ft).

Two-Stage LFL

1. Lubricate all internal parts of the lift cylinder with clean hydraulic oil. Use new O-rings, seals, backup rings, and wear rings.

NOTE: To prevent damage to sealing surfaces, use brass tools when installing seals and O-rings.

2. Install new O-ring on check valve. See Figure 43.

WARNING

Be careful when removing or installing snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers, and wear eye and face protection during removal or installation.

3. Install snap ring onto piston. See Figure 43.

CAUTION

A difficult and important step in assembling lift cylinders is the correct installation of the seals. Most lift cylinder maintenance is caused by seal leaks. DO NOT damage any parts during assembly.

4. Install wear ring, piston ring, and backup ring onto piston. See Figure 43.

5. Install spacer onto rod. See Figure 43.

6. Install wear ring, O-ring, seal, backup ring, and rod wiper onto gland. See Figure 43.

7. Install rod and piston assembly into shell.

NOTE: To prevent damage to the rod and piston assembly, use care while installing gland.

8. Install gland onto rod and in shell. Tighten gland to 340 to 410 N•m (250 to 300 lbf ft). See Figure 43.

Install

NOTE: Except as noted, the following procedures are for installation of both lift cylinders.

Two-Stage FFL

1. Using lifting device, install lift cylinder in mount at bottom of outer mast.

NOTE: After the cylinder has been completely disconnected from the mast, raise the mast high enough for the bottom of the cylinder to clear the crossmember on the outer mast weldment and push the rod back into the cylinder being removed.

2. Install bracket, two capscrews, and two washers to mast. See Figure 40. Tighten nut to 33 N•m (24 lbf ft).

3. Use lifting device to lower the inner mast onto lift cylinder. Connect tube assembly to top of left lift cylinder. Install shims and snap ring at top of lift cylinder. See Figure 40.

4. Uncap hydraulic lines and cylinder ports. Connect hydraulic lines to cylinder ports. See Figure 40.

CAUTION

Disposal of lubricants and fluids must meet local environmental regulations.

5. Dispose of drain pan contents.

6. Connect main lift chains and adjust as specified. See section **Mast Repair (S/N A626-27, A751-52, B590-91, and B749-54)** 4000SRM1540 for procedures.

   See the section **Mast Repairs (S/N A551, A555, A559, A751, A752, B586, B587, B588, B590, B591, B749, B750, B751, B752, and B754)** 4000SRM1576 for lift truck model

   - E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

System Air Bleed Procedures

NOTE: The procedures for bleeding air out of the lift cylinders apply only to lift trucks equipped with a two-stage FFL mast. Trucks equipped with a three or four-stage FFL mast or two-stage LFL mast do not need to have air bled out of the lift cylinders.

1. Remove the air from main lift cylinders as described below. See Figure 41, Two-Stage FFL shown.

   a. Loosen capscrew two turns to permit oil to flow around threads of capscrew.

   b. With forks unloaded, raise carriage using hydraulic control. Raise carriage 300 mm (12 in.) and then stop for 10 seconds to reduce the pressure in the cylinder. Repeat this procedure until the oil flowing from around the threads is free of air bubbles.

   c. Stop carriage at the top of the cylinder stroke. Tighten capscrew to 6.0 to 8.0 N•m (53 to 71 lbf in).

Three-Stage FFL

1. Using lifting device, install lift cylinder in mount at the bottom of the outer mast.

NOTE: Raise the mast high enough for the bottom of the cylinder to clear the crossmember on the outer mast weldment and push the rod back into the cylinder being removed.

2. Install bracket, two capscrews and two washers to mast. See Figure 40. Tighten nut to 33 N•m (24 lbf ft).

3. Use lifting device to lower intermediate mast onto lift cylinder. Install shim and snap ring at top of lift cylinder. See Figure 40.

4. Reconnect main lift chain to chain anchor.

5. Install new cotter pin with cotter pin hole positioned toward the inside mast. Bend both legs of cotter pin against chain anchor pin to secure lift chain to chain anchor.

6. Uncap hydraulic lines and cylinder ports. Connect hydraulic lines to cylinder ports. See Figure 40.

CAUTION

Disposal of lubricants and fluids must meet local environmental regulations.

7. Dispose of drain pan contents.

8. Connect main lift chains and adjust as specified. See section **Mast Repair (S/N A626-27, A751-52, B590-91, and B749-54)** 4000SRM1540 for procedures.

   See the section **Mast Repairs (S/N A551, A555, A559, A751, A752, B586, B587, B588, B590, B591, B749, B750, B751, B752, and B754)** 4000SRM1576 for lift truck model

   - E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

Two-Stage LFL

1. Using lifting device, install lift cylinder in mount at the bottom of the outer mast.

NOTE: Raise the mast high enough for the bottom of the cylinder to clear the crossmember on the outer mast weldment and push the rod back into the cylinder being removed.

2. Install bracket, two capscrews and two washers to mast. See Figure 40. Tighten nut to 33 N•m (24 lbf ft).

WARNING

Be careful when removing or installing snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers, and wear eye and face protection during removal or installation.

3. Use lifting device to lower the inner mast onto lift cylinder. Install shim and snap ring at top of lift cylinder. See Figure 40.

4. Uncap hydraulic lines and cylinder ports. Connect the hydraulic lines to cylinder ports. See Figure 40.

CAUTION

Disposal of lubricants and fluids must meet local environmental regulations.

5. Dispose of drain pan contents.

6. Connect main lift chains and adjust as specified. See section **Mast Repair (S/N A626-27, A751-52, B590-91, and B749-54)** 4000SRM1540 for procedures.

   See the section **Mast Repairs (S/N A551, A555, A559, A751, A752, B586, B587, B588, B590, B591, B749, B750, B751, B752, and B754)** 4000SRM1576 for lift truck model

   - E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

Free Lift Cylinder Repair for Lift Truck Model J1.5XNT (K160)

FREE-LIFT CYLINDER

Remove

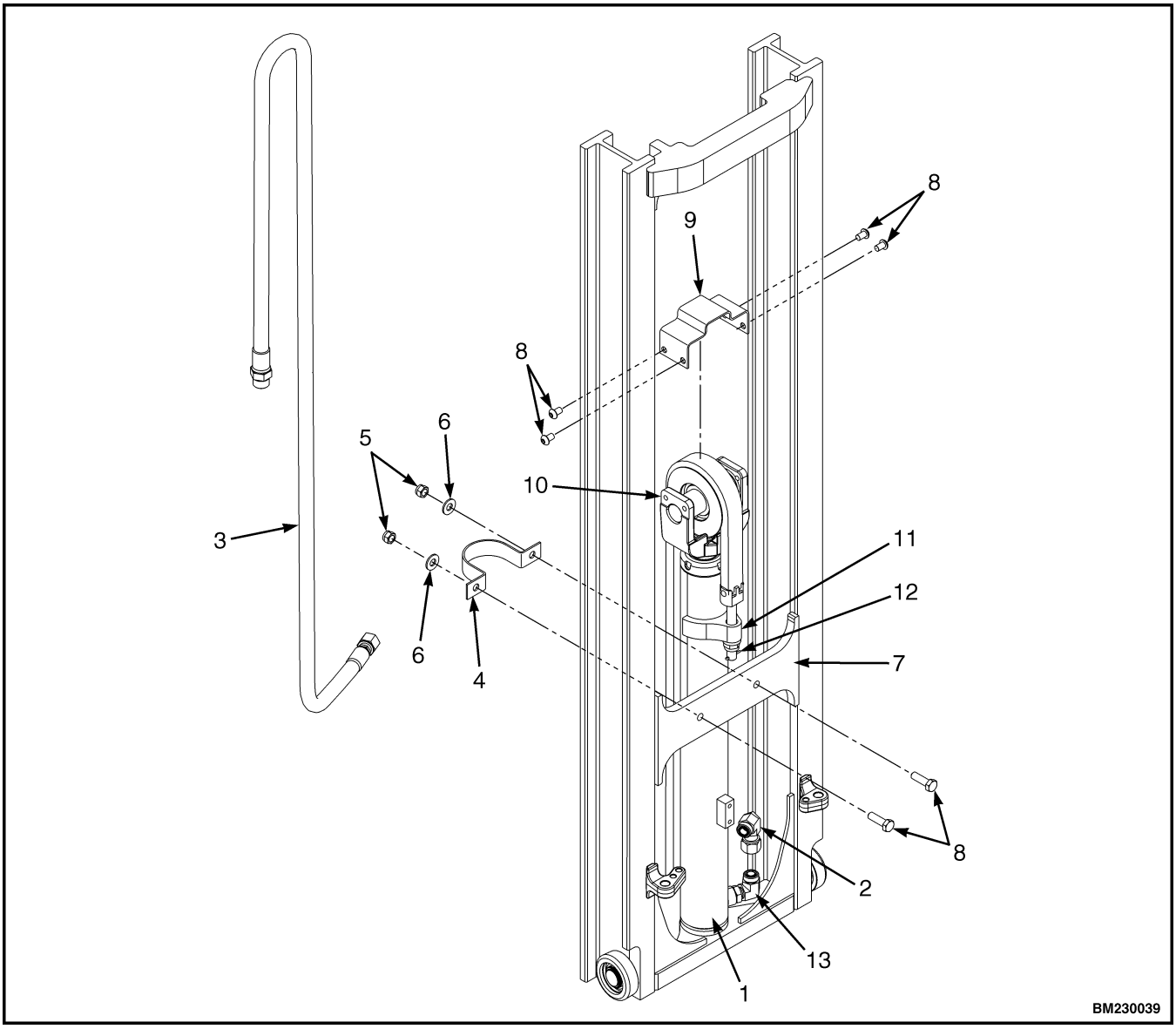
1. Remove the carriage as described in the carriage removal procedures in the section **Mast Repair (S/N A270, A271, A272)** 4000SRM1386.

Three-Stage FFL Mast

WARNING

Hydraulic oil is hot after system operation and can cause burns. DO NOT disconnect any hydraulic hoses until the oil in the system is cool.

1. Put a drain pan under the area of the hydraulic fittings. Disconnect free-lift hose at fitting and cap free-lift hose. Drain oil from cylinder. See Figure 44.
2. Remove fitting from flow valve. See Figure 44.
3. Remove flow valve from free-lift cylinder. Drain hydraulic oil from cylinder. See Figure 44. Cap cylinder.
4. Remove four capscrews and chain guard bracket from crosshead. See Figure 44.
5. Remove two nuts, two washers, cylinder mounting bracket, and two capscrews from inner mast crossmember. See Figure 44.
6. Remove pin to disconnect lift chain from chain support plate. See Figure 44.
7. Remove chain from chain sheave.
8. Using a lifting device, remove free-lift cylinder from mast.

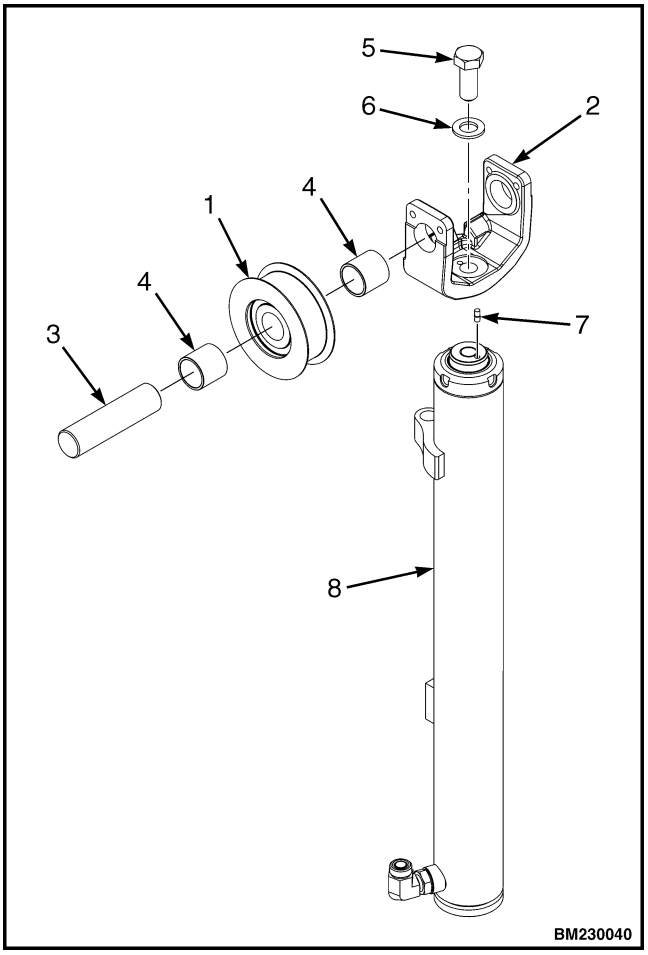


NOTE: OUTER MAST AND CROSSMEMBERS REMOVED FOR CLARITY

1. FREE-LIFT CYLINDER
2. FITTING
3. FREE-LIFT HOSE
4. CYLINDER MOUNTING BRACKET
5. NUT
6. WASHER
7. INNER MAST CROSSMEMBER
8. CAPSCREW
9. CHAIN GUARD BRACKET
10. CROSSHEAD
11. CHAIN SUPPORT PLATE
12. PIN
13. FLOW VALVE

Figure 44. Free-Lift Cylinder - Three-Stage FFL Mast

9. Remove crosshead pin, two bushings, and chain sheave from crosshead. See Figure 45.



1. CHAIN SHEAVE
2. CROSSHEAD
3. CROSSHEAD PIN
4. BUSHING
5. CAPSCREW
6. WASHER
7. PIN
8. FREE-LIFT CYLINDER

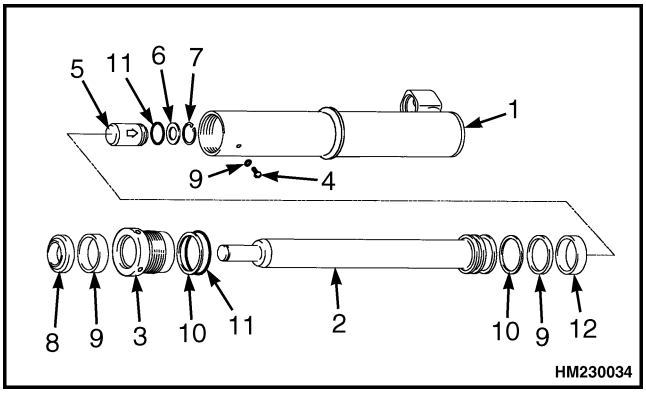
Figure 45. Crosshead - Three-Stage FFL Mast

10. Remove capscrew, washer, crosshead, and pin from free-lift cylinder. See Figure 45.

Disassemble

1. Loosen gland with spanner wrench.

2. Remove gland from rod and shell. See Figure 46.



1. SHELL
2. ROD
3. GLAND
4. SCREW
5. CHECK VALVE
6. WASHER
7. SNAP RING
8. ROD WIPER
9. SEAL
10. BACKUP RING
11. O-RING
12. WEAR RING

Figure 46. Free-Lift Cylinder - Three-Stage FFL Mast

3. Remove rod and piston assembly from shell. Drain any remaining hydraulic oil into drain pan.

NOTE: To prevent damage to sealing surfaces, use brass tools when removing seals and O-rings.

4. Remove and discard rod wiper, seal, O-ring, and backup ring from gland. See Figure 46.

WARNING

Be careful when removing or installing snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers, and wear eye and face protections during removal or installation.

5. Remove snap ring, washer, and check valve from piston base. Remove and discard O-ring from check valve. See Figure 46.

6. Remove and discard wear ring, seal, and backup ring from piston. See Figure 46.

7. Remove screw and seal from shell. Discard seal. See Figure 46.

Clean

WARNING

Cleaning solvents can be flammable and toxic and can cause skin irritation. When using cleaning solvents, always follow the solvent manufacturer's recommended safety procedures.

Compressed air can move particles so they cause injury to the user or to other personnel. Make sure the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eyes.

CAUTION

DO NOT allow cleaning solvent to come in contact with rubber components, as it will damage those components.

Clean all metal parts in solvent and dry with compressed air.

Inspect

Inspect gland for damage to threads and seal surfaces. If damaged, replace gland.

Inspect piston for damage to seal surfaces. If damaged, replace rod and piston assembly.

Inspect rod for damage to rod surface and ensure that rod is not bent. If damaged, replace rod.

Inspect inner surface of cylinder tube for damage. If damaged, replace cylinder assembly.

Assemble

1. Lubricate all internal parts of the free-lift cylinder with clean hydraulic oil. Use new O-rings, seals, and wear rings.

NOTE: To prevent damage to sealing surfaces, use brass tools when installing seals and O-rings.

2. Install new O-ring onto check valve. See Figure 46.

WARNING

Be careful when removing or installing snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers, and wear eye and face protection during removal or installation.

3. Install check valve, washer and snap ring into piston base. Make sure arrow on check valve is toward piston base. See Figure 46.

4. Install new backup ring, seal, and wear ring onto piston. See Figure 46.

5. Install new seal, rod wiper, backup ring, and O-ring onto gland. See Figure 46.

6. Install rod and piston assembly into shell. See Figure 46.

NOTE: To prevent possible damage to the rod and piston assembly, use care when installing gland.

7. Install gland onto rod in shell. Tighten gland to 475 to 540 N•m (350 to 400 lbf ft). See Figure 46.

8. Add 100 cc (3 oz) of hydraulic oil into cylinder through screw hole. This oil provides a hydraulic cushion when cylinder reaches the top of its stroke. Install seal and screw. See Figure 46.

Install

1. Install pin, crosshead, washer, and capscrew onto free-lift cylinder. See Figure 45.

2. Install pin, chain sheave, two bushings, and crosshead pin into crosshead. See Figure 45.

3. Using lifting device, install free-lift cylinder onto mast.

4. Install chain onto chain sheave.

5. Connect lift chain to chain support plate by installing pin. See Figure 44.

6. Install cylinder mount bracket, two capscrews, two washers, and two nuts onto free-lift cylinder and inner mast crossmember. Nuts are to be toward front of lift truck. See Figure 44. Tighten capscrews to 82 N•m (60 lbf ft).

7. Install chain guard bracket and four capscrews on crosshead. See Figure 44. Tighten capscrews to 52 N•m (38 lbf ft).

8. Uncap cylinder and install flow valve onto free-lift cylinder. See Figure 44.

9. Install fitting onto flow valve. See Figure 44.

CAUTION

Disposal of lubricants and fluids must meet local environmental regulations.

10. Uncap free-lift hose and connect free-lift hose to fitting. Discard drain pan contents.

11. Install carriage as described in section **Mast Repair (S/N A270, A271, A272)** 4000SRM1386.

Free Lift Cylinder Repair for 1.5-2.0T Trucks

This section outlines the free lift cylinder repair procedures for lift truck models J1.6-2.0XNT (J30-40XNT) (K160), J1.6-2.0XN (J30-40XN) (A935), E30-40HSD$_2$ (B219), and E30-40HSD$_3$ (C219)

FREE-LIFT CYLINDER

Remove

1. Remove the carriage as described in the carriage removal procedures in **Service Manual**:

   Mast Repair (S/N A270, A271, A272) 4000SRM1386 for the lift truck models listed below

   - J1.6-2.0XNT (K160)
   - J1.6-2.0XN (A935)
   - E30-40HSD$_3$ (C219)

   Mast Repair (S/N C661, C662, C663, C665) 4000SRM1405 for the lift truck models listed below

   - J1.6-2.0XNT (J30-40XNT) (K160)
   - J1.6-2.0XN (J30-40XN) (A935)
   - E30-40HSD$_2$ (B219)
   - E30-40HSD$_3$ (C219)

Two and Three-Stage FFL Mast

WARNING

Hydraulic oil is hot after system operation and can cause burns. DO NOT disconnect any hydraulic hoses until the oil in the system is cool.

1. Put a drain pan under the area of the hydraulic fittings. Disconnect hydraulic line at free-lift cylinder and drain oil from cylinder. Cap hydraulic line and cylinder port.

2. Remove four capscrews and chain guard from top of free-lift cylinder. See Figure 47.

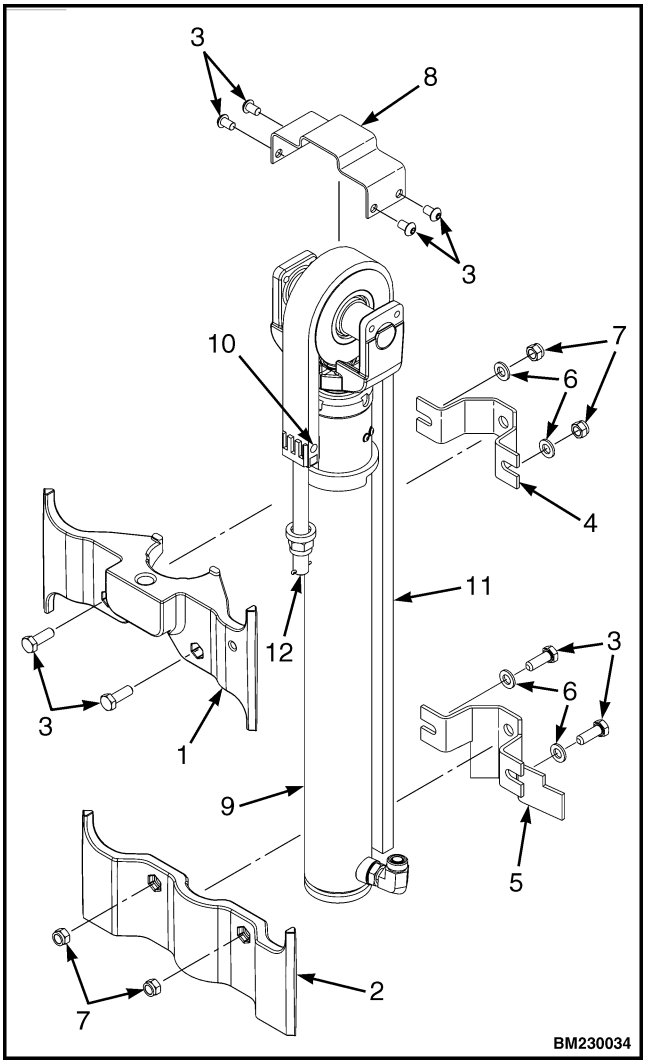


Figure 47. Free-Lift Cylinder - Two and Three-Stage FFL Mast

Legend for Figure 47.

NOTE: MASTS REMOVED FOR CLARITY - TWO-STAGE FFL SHOWN.

1. INNER MAST MIDDLE CROSSMEMBER
2. INNER MAST BOTTOM CROSSMEMBER
3. CAPSCREW
4. CYLINDER GUARD BRACKET
5. BRACKET
6. WASHER
7. NUT
8. CHAIN GUARD
9. FREE-LIFT CYLINDER
10. PIN
11. CHAIN
12. CHAIN ANCHOR

3. Remove two nuts, two washers, cylinder guard bracket, and two capscrews from inner mast middle crossmember. See Figure 47.

4. Remove two capscrews, two washers, bracket and two nuts from inner mast bottom crossmember. See Figure 47.

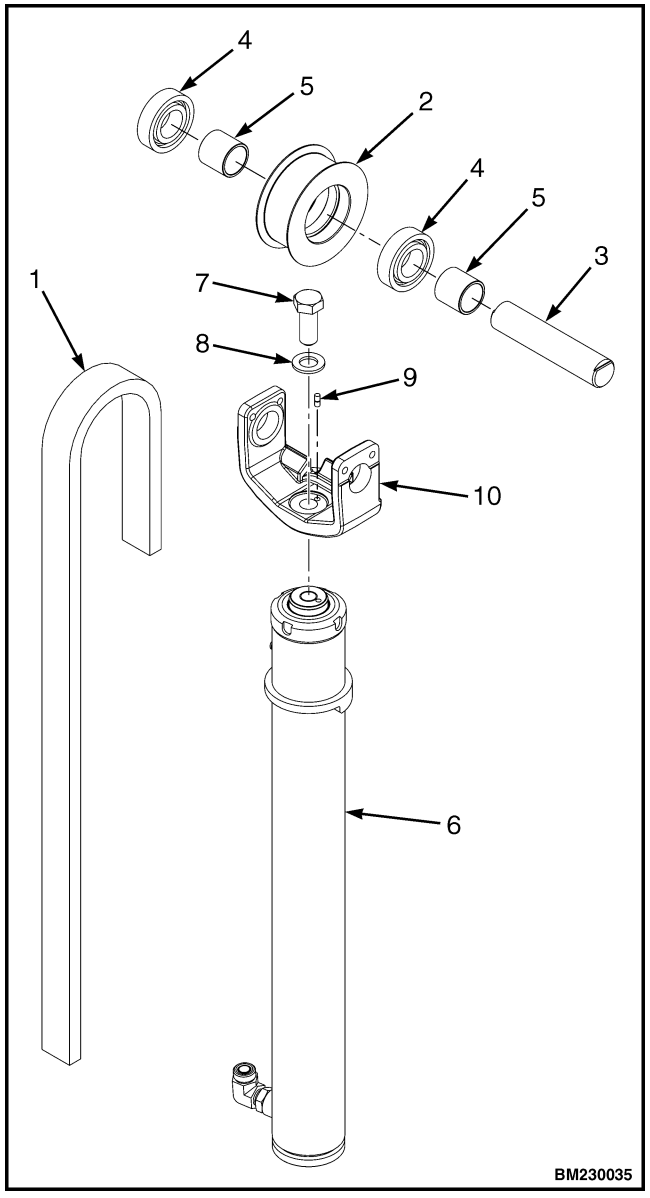
5. Disconnect pin and chain from chain anchor. See Figure 47.

6. Remove chain from chain sheave. See Figure 48.

7. Using a lift device remove free-lift cylinder from mast.

8. Remove crosshead pin, two spacers, and chain sheave with bearings from crosshead. See Figure 48.

9. Remove capscrew, washer, pin, and crosshead from free-lift cylinder. See Figure 48.



1. CHAIN
2. CHAIN SHEAVE
3. CROSSHEAD PIN
4. BEARING
5. SPACER
6. FREE-LIFT CYLINDER
7. CAPSCREW
8. WASHER
9. PIN
10. CROSSHEAD

Figure 48. Crosshead - Two and Three-Stage FFL Mast

Four-Stage FFL Mast

WARNING

Mast parts are heavy and can shift. Distances between parts are small. Serious injury or death can result if part of the body is hit by parts of the mast or the carriage.

Be sure that all lifting devices are suitable and of adequate capacity to lift the mast and components.

WARNING

Hydraulic oil is hot after system operation and can cause burns. DO NOT disconnect any hydraulic lines of the system until the oil for the system is cool and the pressure is relieved.

NOTE: Perform Step 1 through Step 9 if mast is on lift truck.

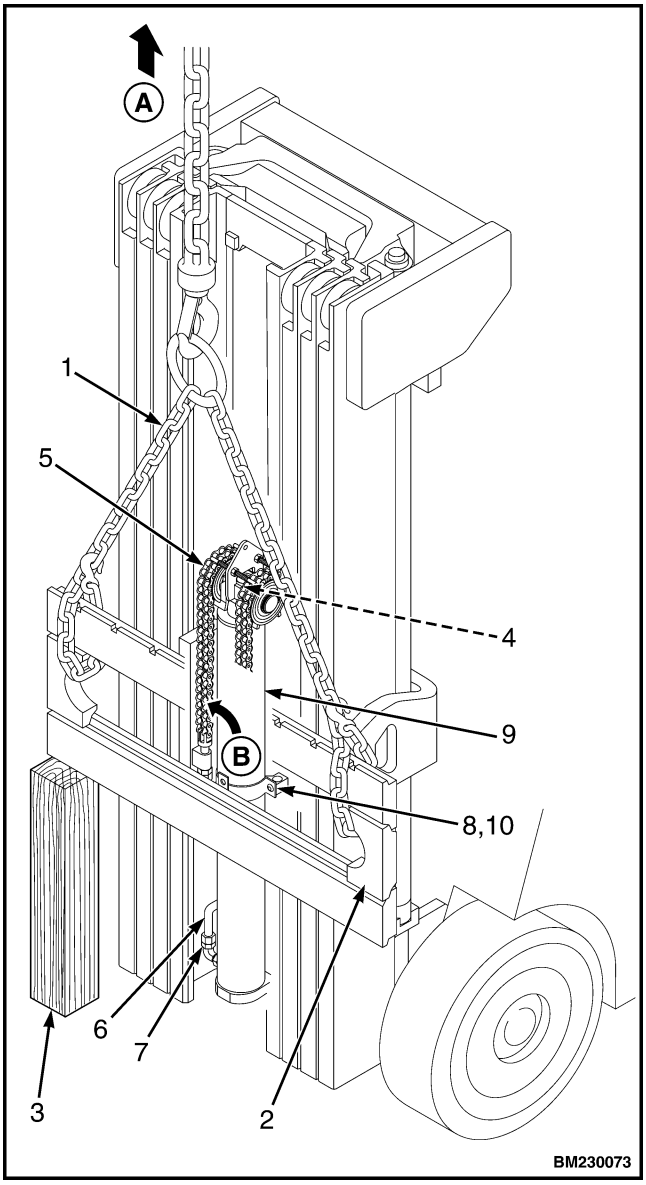
Perform Step 10 through Step 18 if mast has been removed from lift truck.

1. Completely lower carriage. Remove forks or other attachment, if equipped. Make sure free-lift cylinder is completely retracted.

WARNING

The carriage must be supported by a block while removing the cylinder to avoid possible injury.

2. Using lifting device, raise carriage to center of free-lift cylinder. Place wood block between lower carriage bar and floor. See Figure 49.



A. LIFTING DEVICE DIRECTION
B. CYLINDER REMOVAL DIRECTION

1. LIFTING DEVICE
2. CARRIAGE
3. BLOCK
4. SNAP RING
5. CROSSHEAD
6. TUBE
7. FITTING
8. CYLINDER MOUNT STRAP
9. FREE-LIFT CYLINDER
10. ALLEN SCREW

Figure 49. Free-Lift Cylinder Removal (Mast on Truck)

WARNING

Be careful when installing/removing snap rings. Use snap ring pliers. Always wear protective clothing and eye protection.

3. Remove snap ring securing crosshead to cylinder rod. See Figure 49.

4. Pull crosshead off cylinder rod. Secure crosshead to top bar of carriage.

NOTE: Position a suitable drip pan under hydraulic connection before disconnecting.

5. Disconnect hydraulic supply tube from fitting at bottom of free-lift cylinder. See Figure 49.

6. Attach lifting device to free-lift cylinder.

7. Remove Allen screws and cylinder mounting strap from free-lift cylinder. See Figure 49.

8. Remove roll pin from bottom of cylinder and mast.

9. Remove free-lift cylinder from mast. See Figure 49.

NOTE: Perform Step 10 through Step 18 if mast has been removed from lift truck.

10. Lay mast face up, with blocks under lower mounts to level mast. See Figure 50.

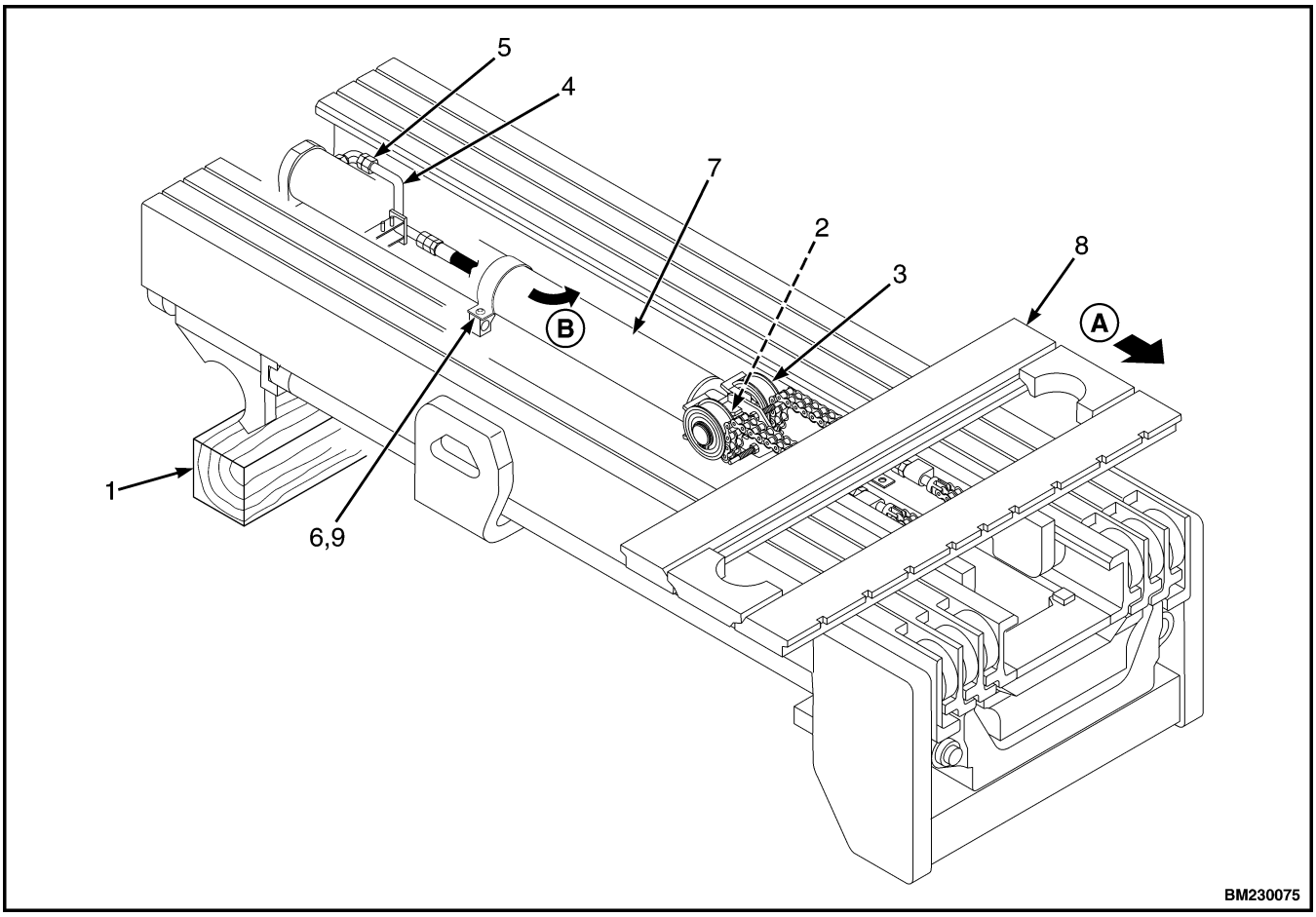


Figure 50. Free-Lift Cylinder Removal (Mast on Floor)

Legend for Figure 50.

A. CARRIAGE ROLL DIRECTION

B. CYLINDER REMOVE DIRECTION

1. BLOCK
2. SNAP RING
3. CROSSHEAD
4. TUBE
5. CYLINDER FITTING
6. CYLINDER MOUNTING STRAP
7. FREE-LIFT CYLINDER
8. CARRIAGE
9. ALLEN SCREW

11. Roll carriage upward to slacken free-lift chains and hoses.

WARNING

Be careful when installing/removing snap rings. Use snap ring pliers. Always wear protective clothing and eye protection.

12. Remove snap ring securing crosshead to cylinder rod. See Figure 50.

13. Pull crosshead, with chains and hoses, from cylinder rod.

14. Roll carriage above free-lift cylinder. See Figure 50.

15. Disconnect tube from cylinder fitting. See Figure 50. Cap cylinder fitting and tube.

16. Remove Allen screws and cylinder mounting strap from free-lift cylinder. See Figure 50.

17. Remove roll pin from bottom of cylinder and mast.

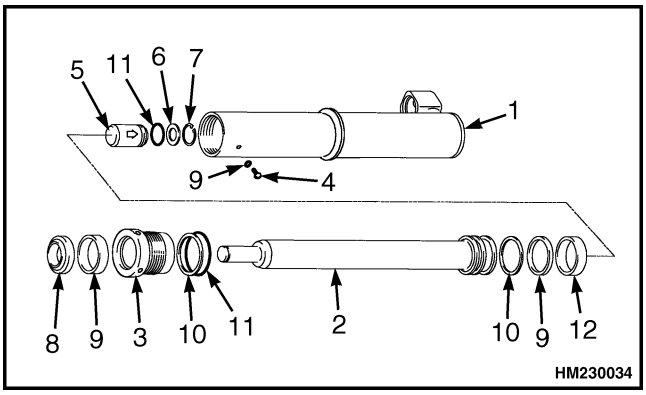
18. Remove cylinder from mast. See Figure 50.

Disassemble

Two-Stage and Three-Stage FFL Masts

1. Loosen gland with spanner wrench.

2. Remove gland from rod and shell. See Figure 51.



1. SHELL
2. ROD
3. GLAND
4. SCREW
5. CHECK VALVE
6. WASHER
7. SNAP RING
8. ROD WIPER
9. SEAL
10. BACKUP RING
11. O-RING
12. WEAR RING

Figure 51. Free-Lift Cylinder - Two-Stage and Three-Stage FFL Mast

3. Remove rod and piston assembly from shell. Drain any remaining hydraulic oil into drain pan.

NOTE: To prevent damage to sealing surfaces, use brass tools when removing seals and O-rings.

4. Remove and discard rod wiper, seal, O-ring, and backup ring from gland. See Figure 51.

WARNING

Be careful when removing or installing snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers, and wear eye and face protections during removal or installation.

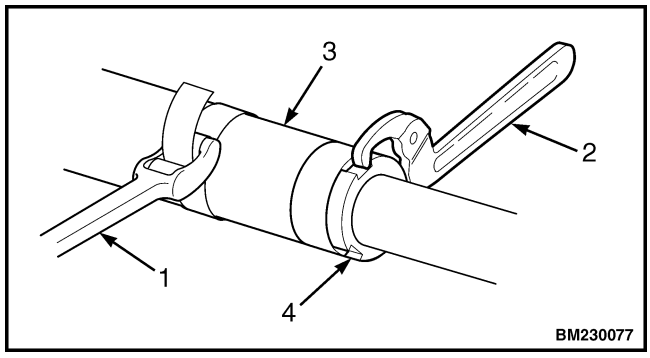
5. Remove snap ring, washer, and check valve from piston base. Remove and discard O-ring from check valve. See Figure 51.

6. Remove and discard wear ring, seal, and backup ring from piston end of rod. See Figure 51.

7. Remove screw and seal from shell. Discard seal. See Figure 51.

Four Stage FFL Mast

1. Using strap wrench to hold cylinder shell, remove gland from rod using claw-type spanner wrench. See Figure 52.



1. STRAP WRENCH
2. CLAW-TYPE SPANNER WRENCH
3. CYLINDER SHELL
4. GLAND

Figure 52. Gland Remove/Install

NOTE: Note orientation of seals prior to disassembly to aid in assembly.

2. Remove and discard wiper, rod seal, O-ring, and backup ring from gland. See Figure 53.

3. Remove rod and piston assembly from shell. See Figure 53. Drain any remaining hydraulic oil into drain pan.

4. Remove piston from rod. See Figure 53.

5. Remove and discard nylon ring, piston seal, wire ring, and wear ring from piston. See Figure 53.

6. Remove circlip, washer, and check valve from bottom of piston. See Figure 53.

7. Remove and discard O-ring from check valve. See Figure 53.

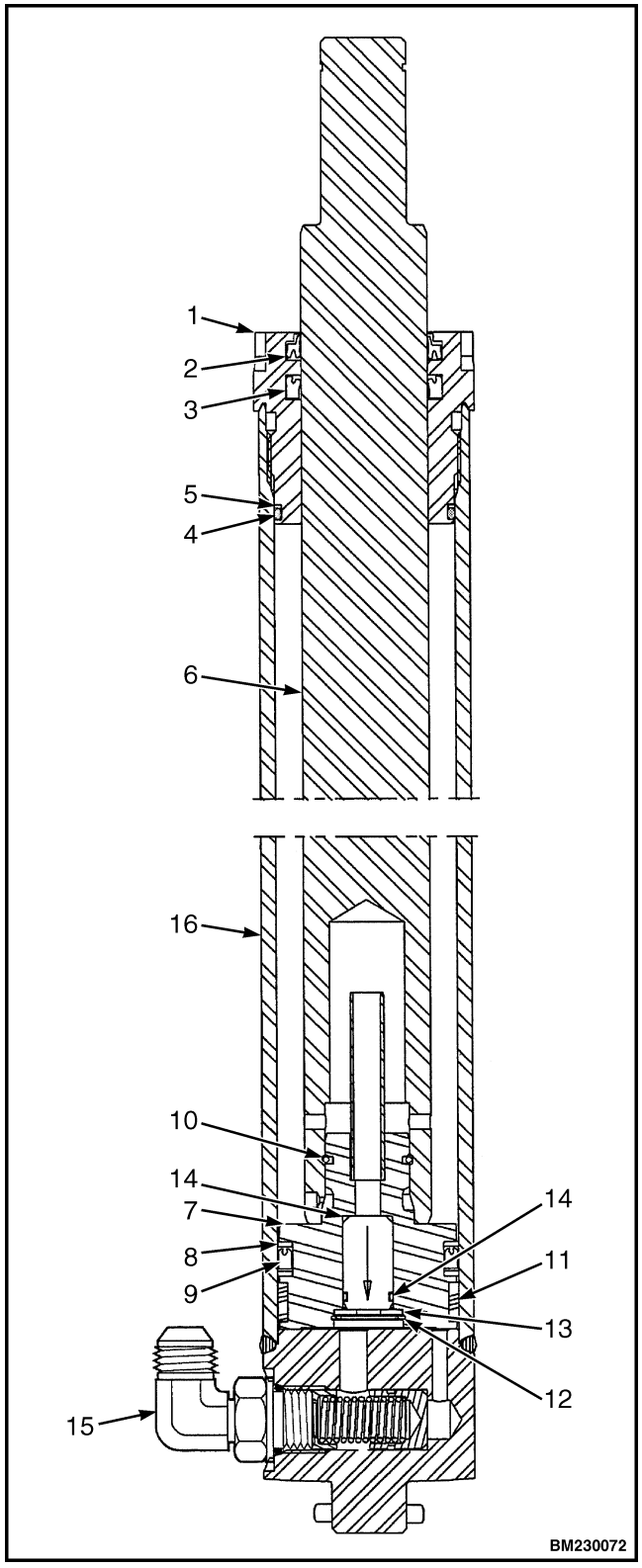


Figure 53. Free-Lift Cylinder Assembly

Legend for Figure 53.

1. GLAND
2. WIPER
3. ROD SEAL
4. BACKUP RING
5. O-RING
6. ROD
7. PISTON
8. NYLON RING
9. PISTON SEAL
10. WIRE RING
11. WEAR RING
12. CIRCLIP
13. WASHER
14. CHECK VALVE
15. FITTING
16. SHELL

Clean

WARNING

Cleaning solvents can be flammable and toxic and can cause skin irritation. When using cleaning solvents, always follow the solvent manufacturer's recommended safety procedures.

WARNING

Compressed air can move particles so they cause injury to the user or to other personnel. Make sure the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eyes.

CAUTION

DO NOT allow cleaning solvent to come in contact with rubber components, as it will damage those components.

Clean all metal parts in solvent and dry with compressed air.

Inspect

Inspect gland for damage to threads and seal surfaces. If damaged, replace gland.

Inspect piston for damage to seal surfaces. If damaged, replace rod and piston assembly.

Inspect rod for damage to rod surface and ensure that rod is not bent. If damaged, replace rod.

Inspect inner surface of cylinder tube for damage. If damaged, replace cylinder assembly.

Assemble

Two-Stage and Three-Stage FFL Masts

1. Lubricate all internal parts of the free-lift cylinder with clean hydraulic oil. Use new O-rings, seals, and wear rings.

NOTE: To prevent damage to sealing surfaces, use brass tools when installing seals and O-rings.

2. Install new O-ring onto check valve. See Figure 51.

WARNING

Be careful when removing or installing snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers, and wear eye and face protection during removal or installation.

3. Install check valve, washer and snap ring into piston base. Make sure arrow on check valve is pointing toward piston base. See Figure 51.

4. Install new backup ring, seal, and wear ring onto piston. See Figure 51.

5. Install new seal, rod wiper, backup ring, and O-ring onto gland. See Figure 51.

6. Install rod and piston assembly into shell. See Figure 51.

NOTE: To prevent possible damage to the rod and piston assembly, use care when installing gland.

7. Install gland onto rod in shell. Tighten gland to 475 to 540 N•m (350 to 400 lbf ft). See Figure 51.

8. Add 150 cc (5 oz) of hydraulic oil into cylinder through screw hole. This oil provides a hydraulic cushion when cylinder reaches the top of its stroke. Install seal and screw. See Figure 51.

Four-Stage FFL Mast

1. Lubricate all internal parts of the free-lift cylinder with clean hydraulic oil. Use new O-rings, seals, and wear rings.

NOTE: To prevent damage to sealing surfaces, use brass tools when installing seals and O-rings.

2. Install new O-ring onto check valve. See Figure 53.
3. Install check valve, washer, and circlip into bottom of piston. See Figure 53.
4. Install new wear ring, wire ring, piston seal, and nylon ring onto piston as noted during disassembly. See Figure 53.
5. Install piston onto rod. See Figure 53.
6. Install rod and piston assembly into shell. See Figure 53.
7. Pour 120 ml (4 oz) hydraulic oil into cylinder shell.
8. Install new backup ring, O-ring, rod seal, and wiper onto gland. See Figure 53.
9. Using strap wrench and claw-type spanner wrench, install gland onto rod and shell. See Figure 52. Tighten gland to 129 to 169 N•m (95 to 125 lbf ft).

Install

Two-Stage and Three-Stage FFL Masts

1. Install crosshead, pin, washer, and capscrew on top of free-lift cylinder. See Figure 48. Tighten capscrew to 270 N•m (199 lbf ft).
2. Install chain sheave with bearings, two spacers, and crosshead pin into crosshead. See Figure 48.
3. Using a lifting device install free-lift cylinder onto mast.
4. Install chain into chain sheave. See Figure 48.
5. Connect chain and pin to chain anchor. See Figure 47.
6. Install chain guard and four capscrews onto top of free-lift cylinder. See Figure 47.

NOTE: Nuts for two-stage FFL to be toward back of lift truck, nuts for three-stage FFL to be toward front of lift truck.

7. Install bracket, two washers, two capscrews, and two nuts onto inner mast bottom crossmember. Tighten nuts to 53 N•m (39 lbf ft). See Figure 47.

NOTE: Nuts to be toward front of lift truck.

8. Install cylinder guard bracket, two capscrews, two washers, and two nuts onto inner mast middle crossmember. Tighten nuts to 53 N•m (39 lbf ft). See Figure 47.

CAUTION

Disposal of lubricants and fluids must meet local environmental regulations.

9. Uncap hydraulic line and cylinder ports. Connect hydraulic line at free-lift cylinder. Dispose of drain pan contents.

Four-Stage FFL Mast

NOTE: Perform Step 1 through Step 8 if mast is on lift truck.

NOTE: Perform Step 9 through Step 17 if mast has been removed from lift truck.

1. Using lifting device, install free-lift cylinder onto mast. See Figure 54.

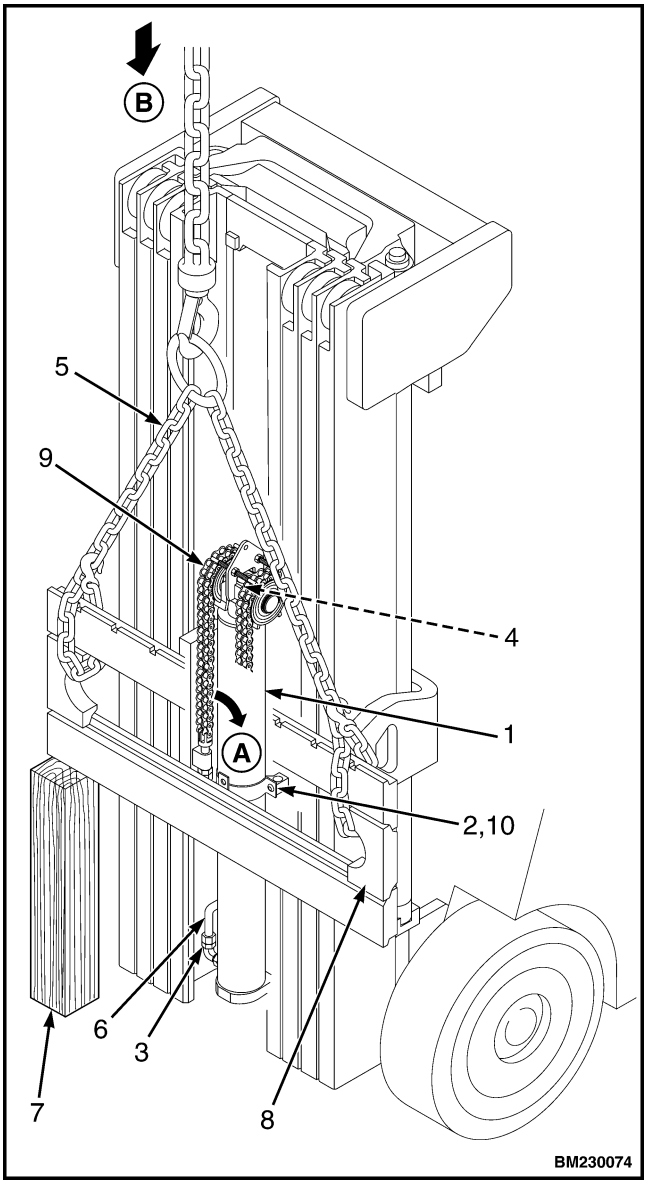


Figure 54. Free-Lift Cylinder - Install (Mast on Truck)

Legend for Figure 54.

A. CYLINDER INSTALL DIRECTION
B. LIFT DIRECTION

1. FREE-LIFT CYLINDER
2. CYLINDER MOUNTING STRAP
3. FITTING
4. SNAP RING
5. LIFTING DEVICE
6. TUBE
7. BLOCK
8. CARRIAGE
9. CROSSHEAD
10. ALLEN SCREW

2. Install roll pin into mast and bottom of cylinder.

3. Install cylinder mounting strap and Allen screws onto free-lift cylinder. See Figure 54.

CAUTION

Disposal of lubricants and fluids must meet local environmental regulations.

4. Connect hydraulic supply tube to fitting at bottom of free-lift cylinder. See Figure 54. Dispose of drain pan contents.

5. Install crosshead onto top of free-lift cylinder.

WARNING

Be careful when installing/removing snap rings. Use snap ring pliers. Always wear protective clothing and eye protection.

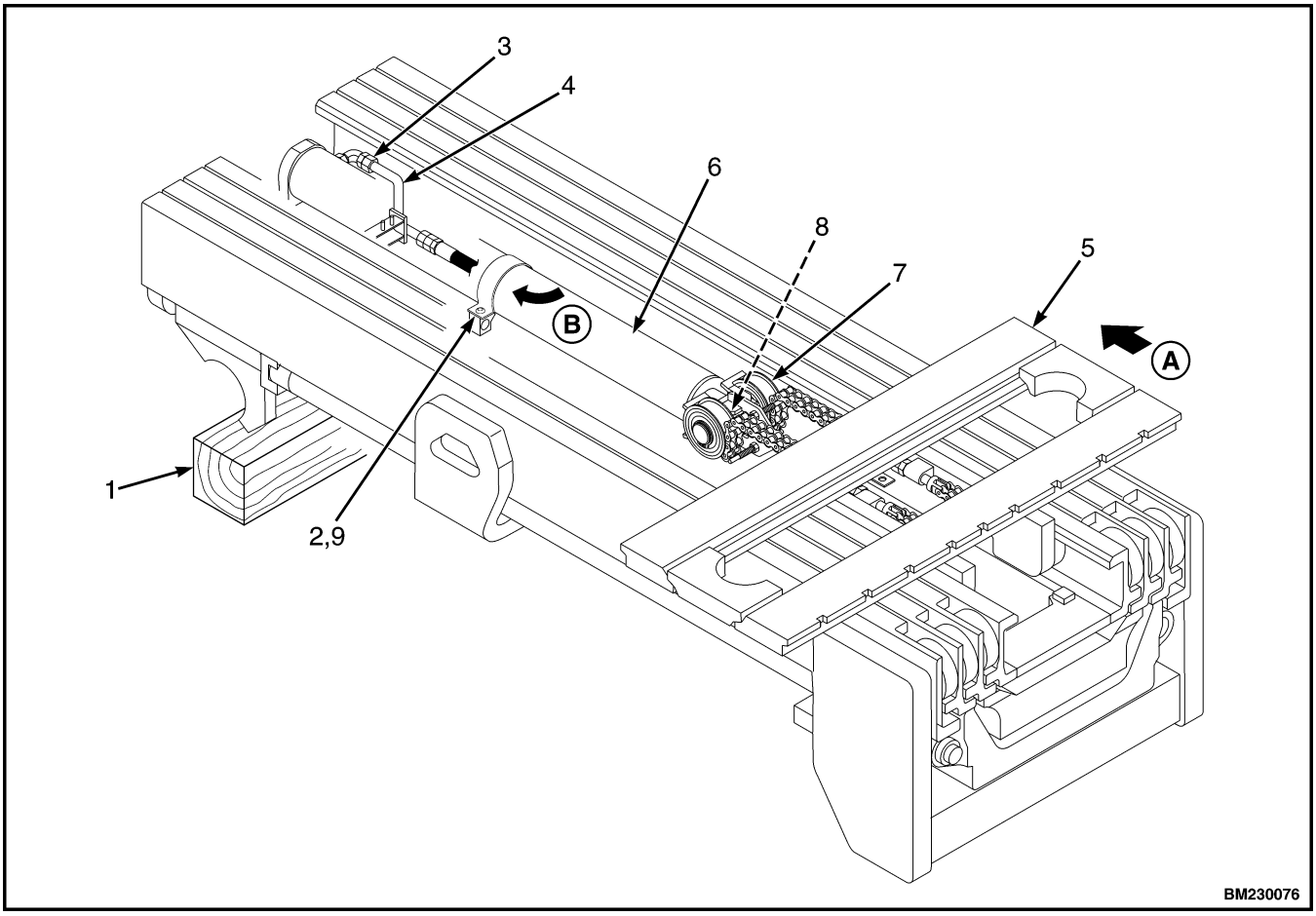
6. Install snap ring securing crosshead to free-lift cylinder rod. See Figure 54.

7. Using lifting device, raise carriage and remove wood block between lower carriage bar and floor. See Figure 54.

8. Lower carriage. Install forks or other attachments, if equipped.

NOTE: Perform Step 9 through Step 17 if mast has been removed from lift truck.

9. Using lifting device, install free-lift cylinder onto mast. See Figure 55.



A. CARRIAGE ROLL DIRECTION

B. CYLINDER INSTALL DIRECTION

1. BLOCK
2. CYLINDER MOUNTING STRAP
3. CYLINDER FITTING
4. TUBE
5. CARRIAGE
6. FREE-LIFT CYLINDER
7. CROSSHEAD
8. SNAP RING
9. ALLEN SCREW

Figure 55. Free-Lift Cylinder - Install (Mast on Floor)

10. Install roll pin into mast and bottom of free-lift cylinder.

11. Install cylinder mounting strap and Allen screws onto free-lift cylinder. See Figure 55.

CAUTION

Disposal of lubricants and fluids must meet local environmental regulations.

12. Uncap and connect tube to cylinder fitting. See Figure 55. Dispose of drain pan contents.

13. Roll carriage into position above free-lift cylinder as shown in Figure 55.

14. Install crosshead, with chains and hoses, onto cylinder rod.

15. Install snap ring securing crosshead to cylinder rod. See Figure 55.

16. Roll carriage downward to tighten free-lift chains and hoses.

17. Using lifting device raise mast upright and install onto lift truck.

All Masts

1. Install carriage as described in **Service Manual**

   Mast Repair (S/N A270, A271, A272) 4000SRM1386 for the lift truck models listed below

   - J1.6-2.0XNT (K160)
   - J1.6-2.0XN (A935)
   - E30-40HSD$_2$ (B219)
   - E30-40HSD$_3$ (C219)

   Mast Repair (S/N C661, C662, C663, C665) 4000SRM1405 for the lift truck models listed below

   - J1.5-2.0XNT (J30-40XNT) (K160)
   - J1.6-2.0XN (J30-40XN) (A935)
   - E30-40HSD$_2$ (B219)
   - E30-40HSD$_3$ (C219)

Free-Lift Cylinder Repair for 2.0-3.5T Trucks

This section outlines the free-lift cylinder repair procedures for lift truck models E2.2-3.5XN (E40-70XN) (A268) and J2.2-3.5XN (J45-70XN) (A276) .

FREE-LIFT CYLINDER

Remove

Two and Three-Stage FFL Mast

WARNING

Before working on or near the mast, see Safety Procedures When Working Near Mast.

1. Remove the carriage as described in the carriage removal procedures in the section **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338.

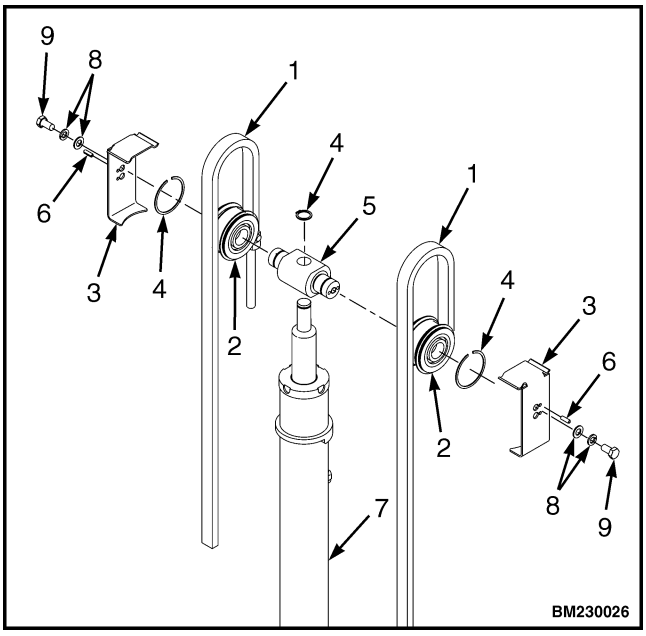
   Lower the mast completely.

WARNING

Hydraulic oil is hot after system operation and can cause burns. DO NOT disconnect any hydraulic hoses until the oil in the system is cool.

2. Put drain pan under the area of the hydraulic fittings. Disconnect hydraulic lines at free-lift cylinder and drain oil from cylinder. Cap hydraulic lines and cylinder ports.

3. Remove capscrew, two washers, pin, and chain guard from crosshead. See Figure 56. Repeat for opposite side.



1. LIFT CHAIN
2. CHAIN SHEAVE
3. CHAIN GUARD
4. SNAP RING
5. CROSSHEAD
6. PIN
7. FREE-LIFT CYLINDER
8. WASHER
9. CAPSCREW

Figure 56. Crosshead Assembly, Two and Three-Stage FFL Mast

4. Remove lift chains from chain sheaves. See Figure 56.

NOTE: Note placement of components during removal to aid in installation.

5. Remove brackets, capscrews, spacers, washers, and nuts holding free-lift cylinder to mast.

6. Using a lifting device, as necessary, remove free-lift cylinder from mast.

WARNING

Be careful when removing or installing snap rings. These snap rings can come loose during removal or installation with enough force to cause and injury. Always use the correct snap ring pliers, and wear eye and face protection during removal and installation.

7. Remove snap ring and chain sheaves from crosshead. See Figure 56.

8. Remove two pins from each side of crosshead.

9. Remove snap ring and crosshead from the cylinder rod. See Figure 56. Disassemble crosshead as necessary.

Four-Stage FFL For Lift Truck E2.2-3.5XN (E45-70XN) (A268)

WARNING

Before working on or near the mast, see Safety Procedures When Working Near Mast.

1. Remove the carriage as described in the carriage removal procedures in the section **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338.

   Lower the mast completely.

WARNING

Hydraulic oil is hot after system operation and can cause burns. DO NOT disconnect any hydraulic hoses until the oil in the system is cool.

2. Put drain pan under the area of the hydraulic fittings. Disconnect the hydraulic lines at the cylinder and drain oil from cylinder. Cap hydraulic lines and cylinder ports.

3. Remove two capscrews, two washers, two pins, and chain guard from crosshead. See Figure 57.

4. Remove chains from chain sheaves. See Figure 57.

5. Remove two nuts, two washers, and strap from mount. See Figure 57.

6. Remove four nuts, four washers, bracket, four spacers, and four capscrews from mast. See Figure 57.

7. Using lifting device, remove free-lift cylinder from mast.

WARNING

Be careful when removing or installing snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap rings pliers and war eye and face protections during removal or installation.

8. Remove four snap rings, four hose guides, and two chain sheaves from crosshead. See Figure 57.

9. Remove capscrew, two washers, and crosshead from free-lift cylinder. See Figure 57.

10. Remove alignment pin from free-lift cylinder. See Figure 57.

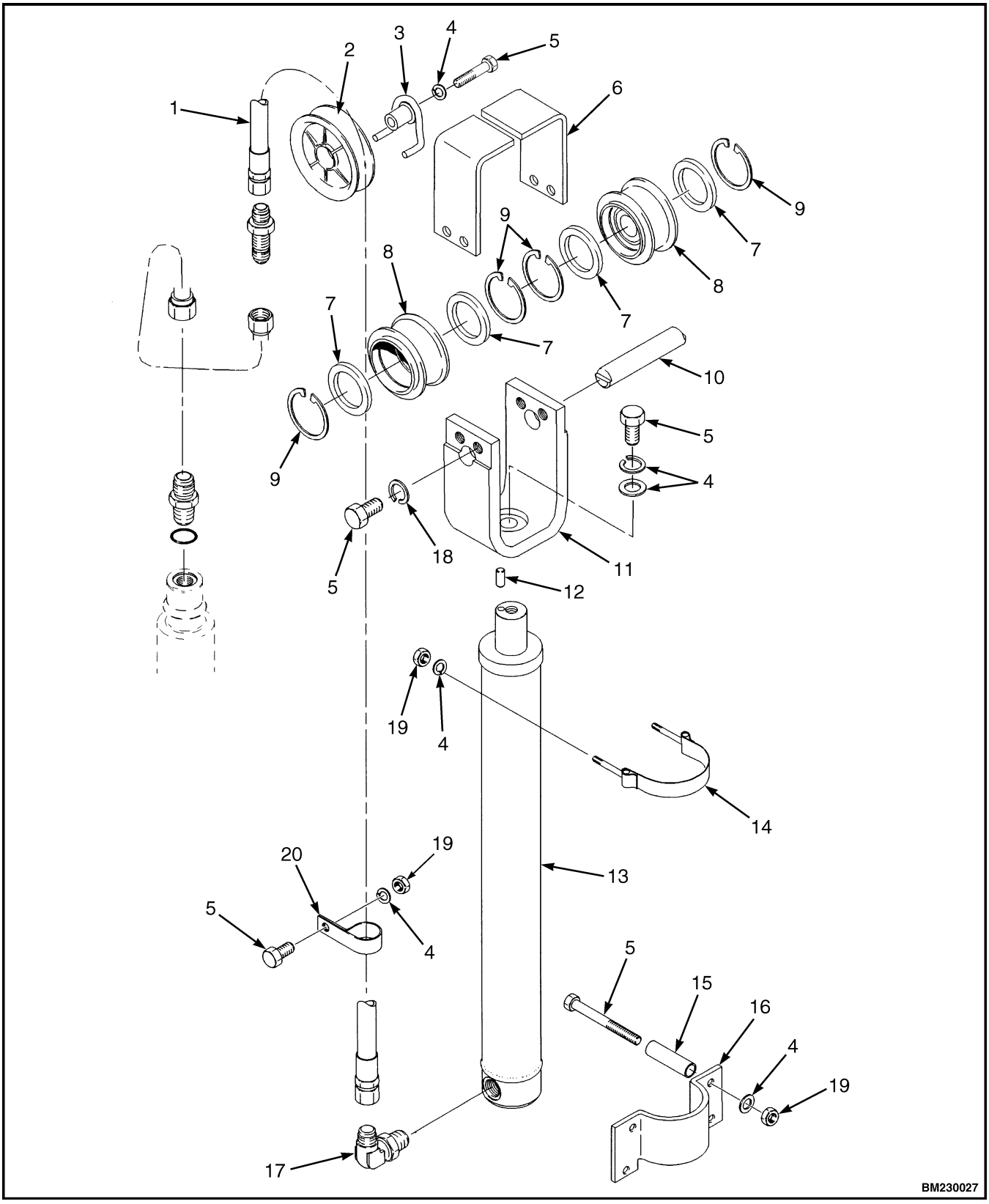


Figure 57. Free-Lift Cylinder and Crosshead - Four-Stage FFL Mast for Lift Truck E2.2-3.5XN (E45-70XN) (A268)

Legend for Figure 57.

1. HOSE
2. HOSE SHEAVE
3. STUB SHAFT WELDMENT
4. WASHER
5. CAPSCREW
6. CHAIN GUARD
7. HOSE GUIDE
8. CHAIN SHEAVE
9. SNAP RING
10. PIN
11. CROSSHEAD
12. ALIGNMENT PIN
13. FREE-LIFT CYLINDER
14. STRAP
15. SPACER
16. BRACKET
17. LOWERING CONTROL VALVE FITTING
18. NYLON WASHER
19. NUT
20. CLAMP

Disassemble

Two and Three-Stage FFL Mast

NOTE: Perform only those steps below required to repair the lift cylinder.

1. Loosen gland with spanner wrench.

2. Remove gland from rod and shell. See Figure 58.

3. Remove rod and piston assembly from shell. Drain any remaining hydraulic oil into drain pan.

NOTE: To prevent damage to sealing surfaces, use brass tools when removing seals and O-rings.

4. Remove and discard rod wiper, rod seal, backup ring, and O-ring from gland. See Figure 58.

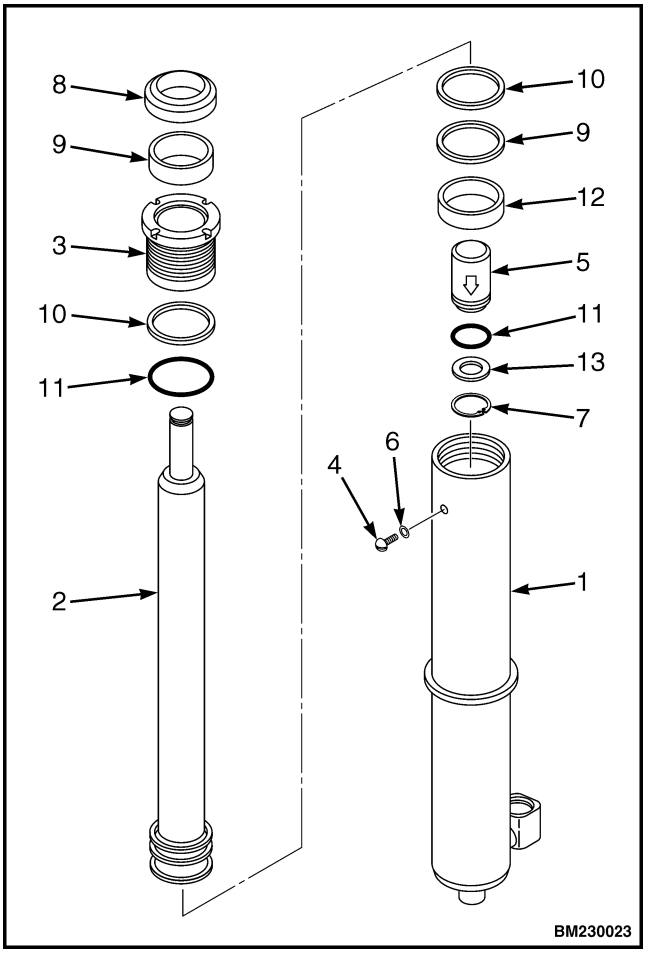
5. Remove and discard wear ring, rod seal, and backup ring from piston. See Figure 58.

WARNING

Be careful when removing or installing snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers, and wear eye and face protection during removal and installation.

6. Remove snap ring, washer, and check valve from piston base. Remove and discard O-ring from check valve. See Figure 58.

7. Remove capscrew and seal from shell. Discard seal. See Figure 58.



1. SHELL
2. ROD
3. GLAND
4. CAPSCREW
5. CHECK VALVE
6. SEAL
7. SNAP RING
8. ROD WIPER
9. ROD SEAL
10. BACKUP RING
11. O-RING
12. WEAR RING
13. WASHER

Figure 58. Free-Lift Cylinder - Two and Three-Stage FFL Mast

Four-Stage FFL Mast for Lift Truck E2.2-3.5XN (E45-70XN) (A268)

NOTE: Perform only those steps below required to repair the lift cylinder.

1. Loosen gland with spanner wrench.
2. Remove gland from rod and shell. See Figure 59.
3. Remove rod and piston assembly from shell. Drain any remaining hydraulic oil into drain pan.
4. Remove and discard rod wiper, rod seal, backup ring, and O-ring from gland. See Figure 59.
5. Remove and discard backup ring, seal, and wear ring from piston. See Figure 59.

WARNING

Be careful when removing or installing snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers and wear eye and face protection during removal or installation.

6. Remove snap ring, washer, and check valve from piston base. Remove and discard O-ring from check valve. See Figure 59.

Clean

WARNING

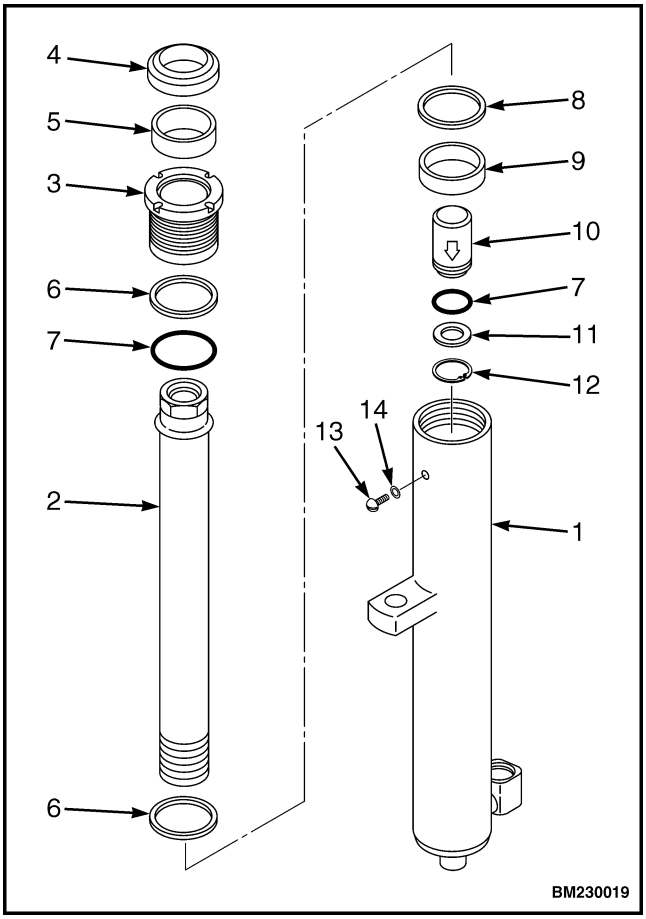
Cleaning solvents can be flammable and toxic and can cause skin irritation. When using cleaning solvents, always follow the solvent manufacturer's recommended safety procedures.

Compressed air can move particles so they can cause injury to the user or to other personnel. Make sure the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eyes.

CAUTION

DO NOT allow cleaning solvent to come in contact with rubber components, as it will damage those components.

Clean all metal parts in solvent and dry with compressed air.



1. SHELL
2. ROD
3. GLAND
4. ROD WIPER
5. ROD SEAL
6. BACKUP RING
7. O-RING
8. SEAL
9. WEAR RING
10. CHECK VALVE
11. WASHER
12. SNAP RING
13. CAPSCREW
14. WASHER-SEAL

Figure 59. Free Lift Cylinder - Four-Stage FFL Mast for Lift Truck E2.2-3.5XN (E45-70XN) (A268)

Inspect

Inspect gland for damage to threads and seal surfaces. If damaged, replace gland.

Inspect piston for any damage to seal surfaces. If damaged, replace rod and piston assembly.

Inspect rod for damage to rod surface and ensure that rod is not bent. If damaged, replace rod and piston assembly.

Inspect inner surface of cylinder shell for damage. If damaged, replace free-lift cylinder assembly.

Assemble

Two and Three-Stage FFL Mast

1. Lubricate all internal parts of the lift cylinder with clean hydraulic oil. Use new O-rings, seals, backup rings, and wear rings.

NOTE: To prevent damage to sealing surfaces, use brass tools when installing seals and O-rings.

2. Install O-ring onto check valve. See Figure 58.

WARNING

Be careful when removing or installing snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap rings pliers and war eye and face protections during removal or installation.

3. Install check valve, washer, and snap ring into piston base. Make sure arrow on check valve is toward piston base. See Figure 58.

CAUTION

A difficult and important step in assembling lift cylinders is the correct installation of the seals. Most lift cylinder maintenance is caused by seal leaks. DO NOT damage any parts during assembly.

4. Install backup ring, rod seal, and wear ring onto piston. See Figure 58.

5. Install backup ring, O-ring, rod seal, and rod wiper onto gland. See Figure 58.

6. Install rod and piston assembly into shell. See Figure 58.

NOTE: To prevent possible damage to rod and piston assembly, use care while installing gland.

7. Install gland onto rod in shell. Tighten gland to 475 to 540 N•m (350 to 400 lbf ft).

8. Pour 150 cc (5 oz) of hydraulic oil into the cylinder through the capscrew hole. This oil provides a hydraulic cushion when cylinder reaches the top of its stroke. Install seal and capscrew. Tighten capscrew to 5.5 to 6.5 N•m (49 to 58 lbf in).

Four-Stage FFL Mast for Lift Truck E2.2-3.5XN (E45-70XN) (A268)

1. Lubricate all internal parts of the lift cylinder with clean hydraulic oil. Use new O-rings, seals, backup rings, and wear rings.

2. Install O-ring onto check valve. See Figure 59.

WARNING

Be careful when removing or installing snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers and wear eye and face protection during removal or installation.

3. Install snap ring, washer, and check valve into piston base. Make sure arrow on check valve is toward piston base. See Figure 59.

CAUTION

A difficult and important step in assembling lift cylinders is the correct installation of seals. Most lift cylinder maintenance is cause by seal leaks. DO NOT damage any parts during assembly.

NOTE: To prevent damage to sealing surfaces, use brass tools when installing seals and O-rings.

4. Install backup ring, seal, and wear ring onto piston. See Figure 59.

5. Install backup ring, O-ring, rod seal, and wiper ring onto gland. See Figure 59.

6. Install rod and piston assembly into shell.

NOTE: To prevent possible damage to rod and piston assembly, use care while installing gland.

7. Install gland onto rod in shell. Tighten gland to 475 to 540 N•m (350 to 400 lbf ft).

Install

Two and Three-Stage FFL Mast

WARNING

Be careful when removing or installing snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers, and wear eye and face protection during removal or installation.

1. Assemble crosshead, if disassembled. Install crosshead and snap ring onto cylinder rod. See Figure 56.
2. Install chain sheaves and snap rings onto crosshead. See Figure 56.
3. Using a lifting device install free-lift cylinder into mast.
4. Install spacers, brackets, washers, capscrews, and nuts onto crossmembers to hold free-lift cylinder on mast as noted during removal. Tighten nuts to 53 N•m (39 lbf ft).
5. Install two pins into each side of crosshead.
6. Install lift chains to chain sheaves. See Figure 56.
7. Install chain guard, pin, two washers, and capscrew into crosshead. Pin to be installed on right-hand side of crosshead. See Figure 56.

CAUTION

Disposal of lubricants and fluids must meet local environmental regulations.

8. Uncap hydraulic line and cylinder port. Connect hydraulic line to free-lift cylinder. Dispose of drain pan contents.
9. Install carriage as described in the carriage installation procedures in the section **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338.
10. Adjust cylinders as specified in **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338.

Four-Stage FFL Mast for Lift Truck E2.2-3.5XN (E45-70XN) (A268)

1. Install alignment pin into free-lift cylinder. See Figure 57.
2. Install crosshead, two washers, and capscrew onto free-lift cylinder. See Figure 57.

WARNING

Be careful when removing or installing snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers, and wear eye and face protection during removal or installation.

3. Install two chain sheaves, four hose guides, and four snap rings into crosshead. See Figure 57.
4. Using a lifting device install free-lift cylinder onto mast.
5. Install four spacers, bracket, four washers, four capscrews, and four nuts around cylinder onto mast. Tighten nuts to 53 N•m (39 lbf ft). See Figure 57.
6. Install strap, two washers, and two nuts onto mount. See Figure 57.
7. Install chains into chain sheaves. See Figure 57.
8. Install chain guard, two pins, two washers, and two capscrews onto crosshead. Tighten capscrews to 38 N•m (28 lbf ft). See Figure 57.

CAUTION

Disposal of lubricants and fluids must meet local environmental regulations.

9. Uncap hydraulic line and cylinder ports. Connect hydraulic line to free-lift cylinder. Dispose of drain pan contents.

10. Install carriage as described in the carriage installation procedures in the section **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338.

11. Adjust cylinders as specified in **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338.

Free-Lift Cylinder Repair for 4.0-5.5T Trucks

This section outlines the free lift cylinder repair procedures for lift truck models E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099) and J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970).

FREE-LIFT CYLINDER

Remove

Two and Three-Stage FFL Mast

WARNING

Before working on or near the mast, see Safety Procedures When Working Near Mast.

1. Remove the carriage as described in the carriage removal procedures. Lower the mast completely. See section **Mast Repair (S/N A626-27, A751-52, B590-91, and B749-54)** 4000SRM1540.

See the section **Mast Repairs (S/N A551, A555, A559, A751, A752, B586, B587, B588, B590, B591, B749, B750, B751, B752, and B754)** 4000SRM1576 for lift truck model

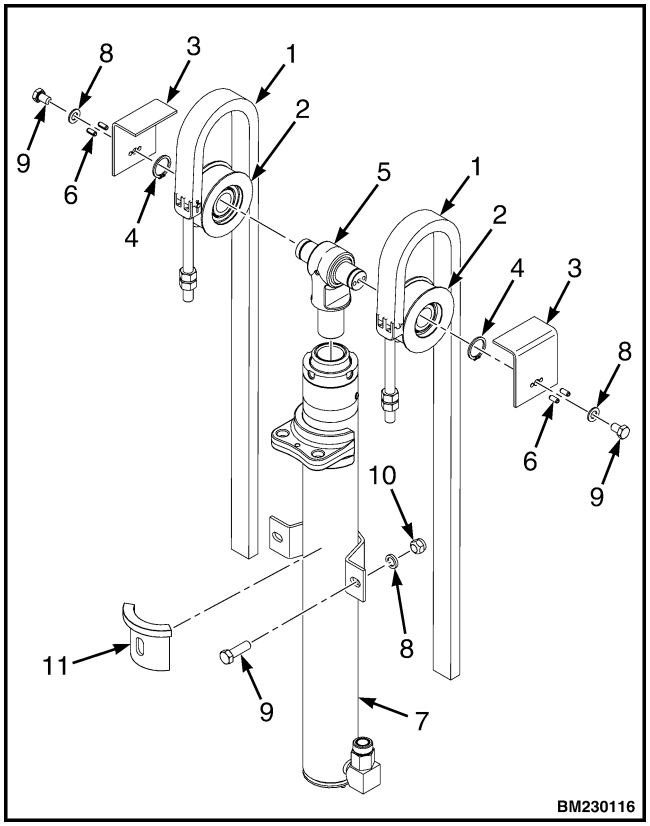
- E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

WARNING

Hydraulic oil is hot after system operation and can cause burns. DO NOT disconnect any hydraulic hoses until the oil in the system is cool.

2. Put drain pan under the area of the hydraulic fittings. Disconnect hydraulic lines at free-lift cylinder and drain oil from cylinder. Cap hydraulic lines and cylinder ports.

3. Remove capscrew, two washers, two pins, and chain guard from crosshead. See Figure 60. Repeat for opposite side.



1. LIFT CHAIN
2. CHAIN SHEAVE
3. CHAIN GUARD
4. SNAP RING
5. CROSSHEAD
6. PIN
7. FREE-LIFT CYLINDER
8. WASHER
9. CAPSCREW
10. NUT
11. SPACER

Figure 60. Crosshead Assembly, Two and Three-Stage FFL Mast

4. Remove lift chains from chain sheaves. See Figure 60.

NOTE: Note placement of components during removal to aid in installation.

5. Remove capscrews, spacers, washers, and nuts holding free-lift cylinder to mast.

6. Using a lifting device, as necessary, remove free-lift cylinder from mast.

WARNING

Be careful when removing or installing snap rings. These snap rings can come loose during removal or installation with enough force to cause and injury. Always use the correct snap ring pliers, and wear eye and face protection during removal and installation.

7. Remove snap ring and chain sheaves from crosshead. See Figure 60.

8. Remove crosshead from cylinder rod. See Figure 60. Disassemble crosshead as necessary.

Disassemble

Two and Three-Stage FFL Mast

NOTE: Perform only those steps below required to repair the lift cylinder.

1. Loosen gland with spanner wrench.

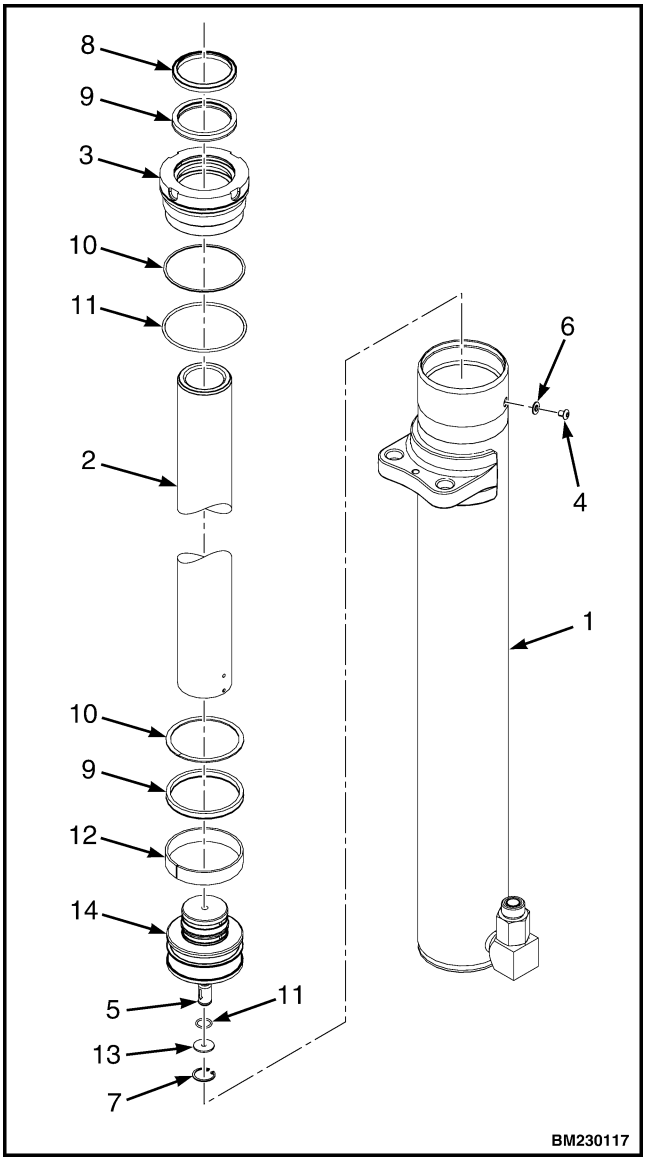
2. Remove gland from rod and shell. See Figure 61.

3. Remove rod and piston assembly from shell. Drain any remaining hydraulic oil into drain pan.

NOTE: To prevent damage to sealing surfaces, use brass tools when removing seals and O-rings.

4. Remove and discard rod wiper, rod seal, backup ring, and O-ring from gland. See Figure 61.

5. Remove and discard wear ring, rod seal, and backup ring from piston. See Figure 61.



1. SHELL
2. ROD
3. GLAND
4. CAPSCREW
5. CHECK VALVE
6. SEAL
7. SNAP RING
8. ROD WIPER
9. ROD SEAL
10. BACKUP RING
11. O-RING
12. WEAR RING
13. WASHER
14. PISTON

Figure 61. Free-Lift Cylinder - Two and Three-Stage FFL Mast

WARNING

Be careful when removing or installing snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers, and wear eye and face protection during removal and installation.

6. Remove snap ring, washer, and check valve from piston base. Remove and discard O-ring from check valve. See Figure 61.

7. Remove capscrew and seal from shell. Discard seal. See Figure 61.

Clean

WARNING

Cleaning solvents can be flammable and toxic and can cause skin irritation. When using cleaning solvents, always follow the solvent manufacturer's recommended safety procedures.

Compressed air can move particles so they can cause injury to the user or to other personnel. Make sure the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eyes.

CAUTION

DO NOT allow cleaning solvent to come in contact with rubber components, as it will damage those components.

Clean all metal parts in solvent and dry with compressed air.

Inspect

Inspect gland for damage to threads and seal surfaces. If damaged, replace gland.

Inspect piston for any damage to seal surfaces. If damaged, replace rod and piston assembly.

Inspect rod for damage to rod surface and ensure that rod is not bent. If damaged, replace rod and piston assembly.

Inspect inner surface of cylinder shell for damage. If damaged, replace free-lift cylinder assembly.

Assemble

Two and Three-Stage FFL Mast

1. Lubricate all internal parts of the lift cylinder with clean hydraulic oil. Use new O-rings, seals, backup rings, and wear rings.

NOTE: To prevent damage to sealing surfaces, use brass tools when installing seals and O-rings.

2. Install O-ring onto check valve. See Figure 61.

WARNING

Be careful when removing or installing snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap rings pliers and war eye and face protections during removal or installation.

3. Install check valve, washer, and snap ring into piston base. Make sure arrow on check valve is toward piston base. See Figure 61.

CAUTION

A difficult and important step in assembling lift cylinders is the correct installation of the seals. Most lift cylinder maintenance is caused by seal leaks. DO NOT damage any parts during assembly.

4. Install backup ring, rod seal, and wear ring onto piston. See Figure 61.

5. Install backup ring, O-ring, rod seal, and rod wiper onto gland. See Figure 61.

6. Install rod and piston assembly into shell. See Figure 61.

NOTE: To prevent possible damage to rod and piston assembly, use care while installing gland.

7. Install gland onto rod in shell. Tighten gland to 400 to 475 N•m (295 to 350 lbf ft).

8. Pour 150 cc (5 oz) of hydraulic oil into the cylinder through the capscrew hole. This oil provides a hydraulic cushion when cylinder reaches the top of its stroke. Install seal and capscrew. Tighten capscrew to 6.0 to 8.0 N•m (53 to 70 lbf in).

Install

Two and Three-Stage FFL Mast

WARNING

Be careful when removing or installing snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers, and wear eye and face protection during removal or installation.

1. Assemble crosshead, if disassembled. Install crosshead onto cylinder rod. See Figure 60.
2. Install chain sheaves and snap rings onto crosshead. See Figure 60.
3. Using a lifting device install free-lift cylinder into mast.
4. Install spacers, washers, capscrews, and nuts onto crossmembers to hold free-lift cylinder on mast as noted during removal. Tighten nuts to 175 N•m (129 lbf ft).
5. Install lift chains to chain sheaves. See Figure 60.
6. Install chain guard, two pins, two washers, and capscrew into crosshead. See Figure 60.

CAUTION

Disposal of lubricants and fluids must meet local environmental regulations.

7. Uncap hydraulic line and cylinder port. Connect hydraulic line to free-lift cylinder. Dispose of drain pan contents.
8. Install carriage as described in the carriage installation procedures.

   See the section **Mast Repair (S/N A626-27, A751-52, B590-91, and B749-54)** 4000SRM1540 for lift truck model

   - J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

   See the section **Mast Repairs (S/N A551, A555, A559, A751, A752, B586, B587, B588, B590, B591, B749, B750, B751, B752, and B754)** 4000SRM1576 for lift truck model

   - E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)
9. Adjust cylinders as specified.

   See the section **Mast Repair (S/N A626-27, A751-52, B590-91, and B749-54)** 4000SRM1540 for lift truck model

   - J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

   See the section **Mast Repairs (S/N A551, A555, A559, A751, A752, B586, B587, B588, B590, B591, B749, B750, B751, B752, and B754)** 4000SRM1576 for lift truck model

   - E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

Sideshift Cylinder Repair for 1.5-3.5T Trucks Prior to December 2016

This section outlines the sideshift cylinder repair procedures for lift truck models E2.2-3.5XN (E45-70XN) (A268), J2.2-3.5XN (J450-70XN) (A276), J1.5-2.0XNT (J30-40XNT) (K160), J1.6-2.0XN (J30-40XN) (A935), E30-40HSD$_3$ (C219), and E30-40HSD$_2$ (B219) .

REMOVE

WARNING

Before working on or near the mast, see Safety Procedures When Working Near Mast.

NOTE: Step 2 and Step 3 in this section cover all lift trucks except J30-40XNT (K160), E30-40HSD$_3$ (C219), and E30-40HSD$_2$ (B219) lift trucks equipped with a four stage FFL mast. For these lift truck models, go to Step 2 in the Disassemble section to remove and disassemble sideshift cylinder.

1. Remove sideshift carriage as described in carriage removal procedure in one of the following sections.

   Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564) 4000SRM1338 for lift truck models

   - E2.2-3.5XN (E45-70XN) (A268)
   - J2.2-3.5XN (J45-70XN) (A276)

   Mast Repair (S/N C661, C662, C663, C665) 4000SRM1405 for lift truck models

   - J1.5-2.0XNT (J30-40XNT) (K160)
   - J1.6-2.0XN (J30-40XN) (A935)
   - E30-40HSD$_2$ (B219)
   - E30-40HSD$_3$ (C219)

   Mast Repair (S/N A270, A271, A272) 4000SRM1386 for lift truck models

   - J1.5-2.0XNT (J30-40XNT) (K160)
   - J1.6-2.0XN (J30-40XN) (A935)
   - E30-40HSD$_3$ (C219)

2. Remove two hairpins, two clevis pins, and sideshift cylinder from sideshift carriage.

   See Figure 62 for lift truck models

   - E2.2-3.5XN (E45-70XN) (A268)
   - J2.2-3.5XN (J45-70XN) (A276)

   See Figure 63 for lift truck models

   - J1.5-2.0XNT (J30-40XNT) (K160)
   - J1.6-2.0XN (J30-40XN) (A935)
   - E30-40HSD$_2$ (B219)
   - E30-40HSD$_3$ (C219)

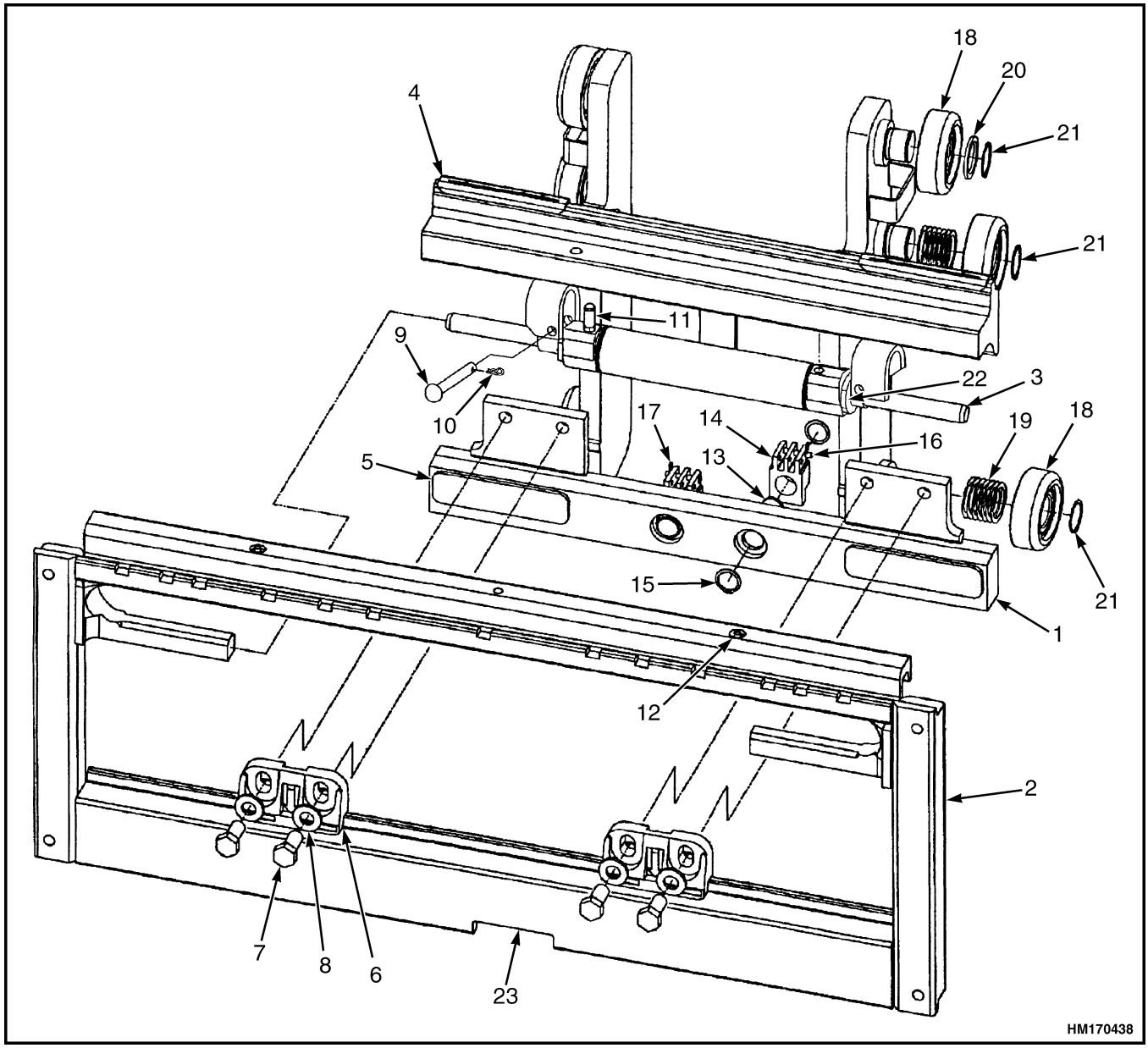
3. Remove pin from top of sideshift cylinder.

   See Figure 62 for lift truck models

   - E2.2-3.5XN (E45-70XN) (A268)
   - J2.2-3.5XN (J45-70XN) (A276)

   See Figure 63 for lift truck models

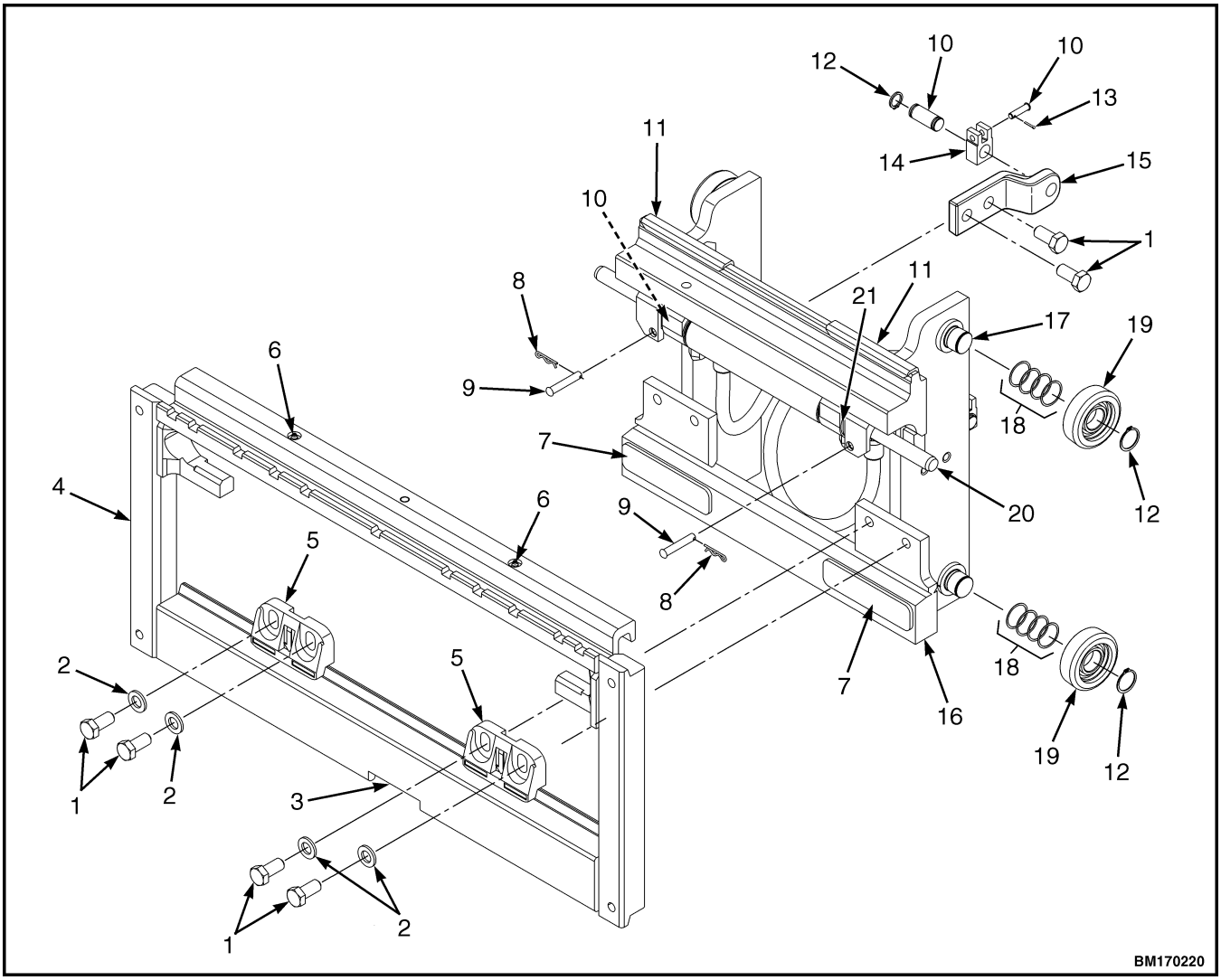
   - J1.5-2.0XNT (J30-40XNT) (K160)
   - J1.6-2.0XN (J30-40XN) (A935)
   - E30-40HSD$_2$ (B219)
   - E30-40HSD$_3$ (C219)



NOTE: TWO- AND THREE-STAGE FFL IS SHOWN. INTEGRAL SIDESHIFT CARRIAGE ASSEMBLY FOR FOUR-STAGE FFL AND TWO-STAGE LFL IS SIMILAR.

1. INNER FRAME
2. OUTER FRAME
3. SIDESHIFT CYLINDER
4. UPPER BEARING
5. LOWER BEARING
6. LOWER HOOK
7. CAPSCREW
8. WASHER
9. CLEVIS PIN
10. HAIRPIN
11. PIN
12. LUBE FITTING
13. PIN
14. CHAIN ANCHOR
15. SNAP RING
16. PIN
17. COTTER PIN
18. LOAD ROLLER
19. SHIMS
20. SPACER
21. SNAP RING
22. SPACER
23. FORK REMOVAL NOTCH

Figure 62. Integral Sideshift Carriage and Cylinder, Lift Truck Models E2.2-3.5XN (E45-70XN) (A268) and J2.2-3.5XN (J45-70XN) (A276)



NOTE: TWO-STAGE LFL CARRIAGE SHOWN. INTEGRAL SIDESHIFT CARRIAGE ASSEMBLY FOR THREE-STAGE FFL IS SIMILAR. FOR LIFT TRUCK MODELS J30-40XNT (K160), E30-40HSD$_2$ (B219), E30-40HSD$_3$ (C219) EQUIPPED WITH A FOUR STAGE FFL MAST SEE FIGURE 65.

1. CAPSCREW
2. WASHER
3. FORK REMOVAL NOTCH
4. OUTER FRAME
5. LOWER HOOK
6. LUBE FITTING
7. LOWER BEARING
8. HAIRPIN
9. CLEVIS PIN
10. PIN
11. UPPER BEARING
12. SNAP RING
13. COTTER PIN
14. CHAIN ANCHOR
15. CHAIN ANCHOR MOUNTING BRACKET
16. INNER FRAME
17. STUBSHAFT
18. SHIMS
19. LOAD ROLLER
20. SIDESHIFT CYLINDER
21. SPACER

Figure 63. Integral Sideshift Carriage and Cylinder, Lift Truck Models J1.5-2.0XNT (J30-40XNT) (K160), J1.6-2.0XN (J30-40XN) (A935), E30-40HSD$_2$ (B219), and E30-40HSD$_3$ (C219)

DISASSEMBLE

NOTE: Disassemble the sideshift cylinder only as necessary for repairs. Most repairs to the sideshift cylinder will be for replacement of O-rings, wipers, seals, and retainers to stop leaks. If other parts of the sideshift cylinder needs to be repaired, replace with new cylinder. See **Parts Manual**.

NOTE: The procedures in Step 1 cover all lift trucks except for J30-40XNT (K160), E30-40HSD$_2$ (B219), E30-40HSD$_3$ (C219) lift trucks equipped with a four stage FFL mast. For these lift truck models, go to Step 2 for the disassemble procedures.

NOTE: Drain oil from cylinder before making any repairs.

1. Disassemble the sideshift cylinder as follows:

a. Clamp one end of the cylinder shell in a vise between the hydraulic fitting and the retainer on the same end.

b. Unscrew the retainer from the cylinder. Slide the retainer off the cylinder rod. See Figure 64.

c. Clamp the other end of the cylinder shell in a vise between the hydraulic fitting and the retainer on the same end.

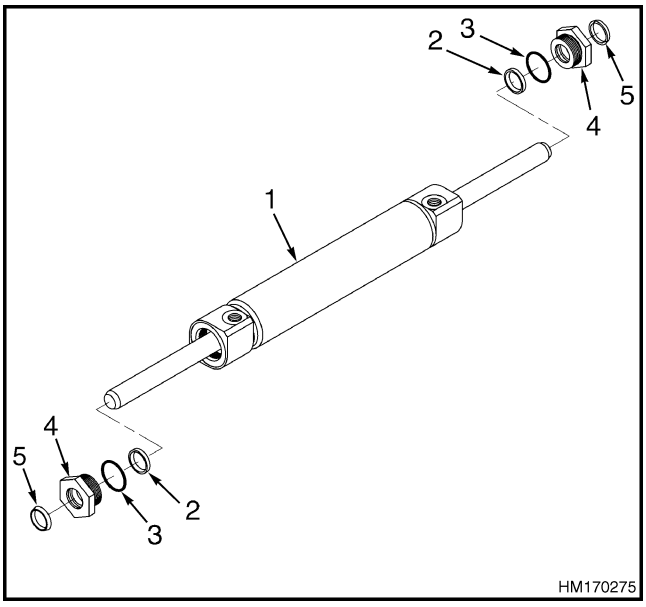
d. Unscrew the retainer from the cylinder. See Figure 64.

e. Remove and discard the seals and O-ring from each retainer with a brass O-ring tool. **DO NOT** scratch the grooves.

2. For J30-40XNT (K160) and E30-40HSD$_2$ (B219) lift trucks equipped with a four stage FFL mast, disassemble the sideshift cylinder as follows:

NOTE: When removing gland from cylinder block, do not scratch cylinder rod on cylinder block threads.

a. Place suitable container under cylinder block. Loosen gland from cylinder block thread and let oil drain into container.



1. CYLINDER SHELL AND ROD
2. SEAL
3. O-RING
4. RETAINER
5. WIPER

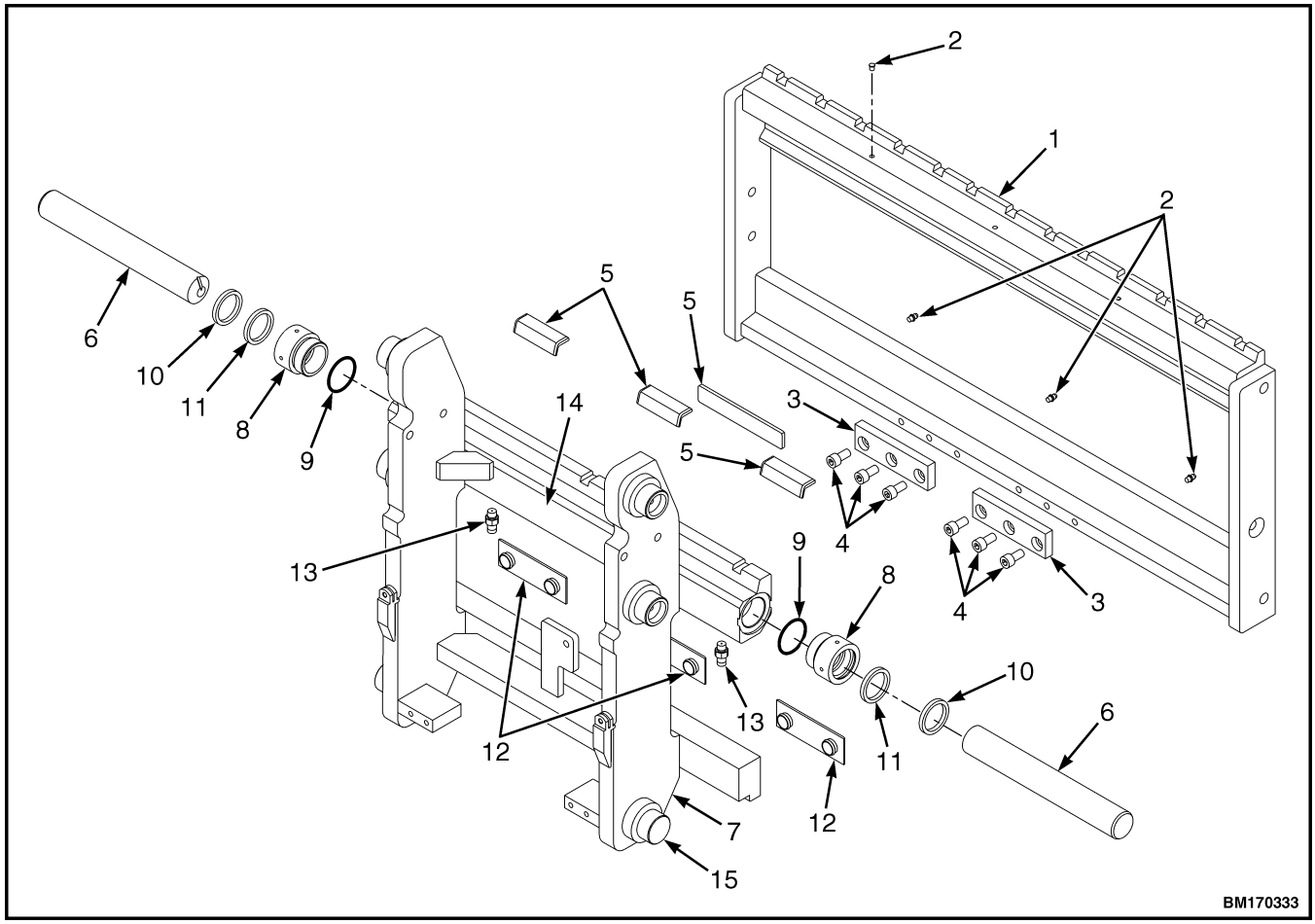
Figure 64. Integral Sideshift Cylinder

b. After oil has drained, remove gland from cylinder block. See Figure 65.

c. Push gland all the way down cylinder rod and remove gland from cylinder rod.

d. Remove O-ring, wiper, and seal from gland. Discard these parts after removal. See Figure 65.

e. Perform above steps for other side of sideshift cylinder.



1. OUTER FRAME
2. LUBE FITTING
3. LOWER RETAINER
4. CAPSCREW
5. UPPER BEARING
6. CYLINDER ROD
7. INNER FRAME
8. GLAND
9. O-RING
10. WIPER
11. SEAL
12. LOWER BEARING
13. HYDRAULIC FITTING
14. CYLINDER BLOCK
15. LOAD ROLLER STUBSHAFT

Figure 65. Integral Sideshift Carriage and Cylinder, Lift Truck Models Lift Trucks Equipped With A Four Stage FFL MastJ30-40XNT (K160), E30-40HSD$_2$ (B219), and E30-40HSD$_3$ (C219)

CLEAN AND INSPECT

WARNING

Cleaning solvents can be flammable and toxic and can cause skin irritation. When using cleaning solvents, always follow the solvent manufacturers recommended safety procedures.

WARNING

Compressed air can move particles so they can cause injury to the user or to other personnel. Make sure the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eye.

CAUTION

DO NOT allow cleaning solvent to come in contact with rubber components, as it will damage those components.

1. Clean the retainers, glands, and cylinder rods with cleaning solvent and dry with compressed air.

   See Figure 64 for lift truck models

   - E2.2-3.5XN (E45-70XN) (A268)
   - J2.2-3.5XN (J45-70XN) (A276)

   See Figure 65 for lift truck models

   - J1.5-2.0XNT (J30-40XNT) (K160)
   - J1.6-2.0XN (J30-40XN) (A935)
   - E30-40HSD$_2$ (B219)
   - E30-40HSD$_3$ (C219)

2. Inspect the cylinder rod for damage to rod surface and ensure that rod is not bent or scored. If damaged, replace sideshift cylinder assembly. See **Parts Manual**.

ASSEMBLE AND INSTALL

NOTE: Perform Step 1 and Step 2 for all lift trucks except J30-40XNT (K160), E30-40HSD$_2$ (B219), E30-40HSD $_3$ (C219). lift trucks equipped with a four stage FFL mast. For these lift truck models, go to Step 3 for the assemble and install procedures.

1. Assemble the sideshift cylinder as follows (see Figure 64):

NOTE: If new retainers that are already assembled with seals and O-rings are being installed, proceed to Step b.

   a. Lubricate new O-rings and seals with clean hydraulic oil. Install the seals and O-rings into the retainer grooves. Form the seals and O-rings into a "kidney" shape to ease placement into the groove. Note the direction of the seals. **Pressure seals are installed with the lip toward the pressure side of the cylinder.**

   b. Apply a film of hydraulic oil to the inside of the retainers.

   c. Clamp one end of the cylinder shell in a vise between the hydraulic fitting and the end.

   d. Screw the retainer into the cylinder. Tighten the retainer to 325 ±30 N•m (240 ±25 lbf ft).

   e. Clamp the other end of the cylinder shell in a vise between the hydraulic fitting and the end.

   f. Slide the retainer onto the cylinder rod. Screw the retainer into the cylinder. Tighten the retainer to 325 ±30 N•m (240 ±25 lbf ft).

NOTE: The pin, located on the top left side of the cylinder, looking from the front of the carriage, is for alignment purposes and to prevent the cylinder from rolling to the front or to the back.

See Figure 62 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268)
- J2.2-3.5XN (J45-70XN) (A276)

See Figure 63 for lift truck models

- J1.5-2.0XNT (J30-40XNT) (K160)
- J1.6-2.0XN (J30-40XN) (A935)
- E30-40HSD$_2$ (B219)
- E30-40HSD$_3$ (C219)

2. Install the sideshift cylinder onto the carriage with the pin in the up position. Install two clevis pins and two hairpins to secure sideshift cylinder to carriage.

3. For J30-40XNT (K160), E30-40HSD$_3$ (C219), and E30-40HSD$_2$ (B219) lift trucks equipped with a four stage FFL mast, assemble and install the sideshift cylinder as follows:

a. Lubricate new O-rings with clean hydraulic oil. Install O-rings on threaded side of gland.

NOTE: Form the seals and wipers into a "kidney" shape to ease placement into the groove. Note the direction of the seals and wipers. **Pressure seals are installed with the lip toward the pressure side of the cylinder.**

b. Lubricate new seals and wipers with clean hydraulic oil. Install seals into second slot from non-threaded side of gland. Install wipers into first slot from non-threaded side of gland.

CAUTION

To prevent damage to cylinder rod, DO NOT install assembled gland over tapered end of cylinder rod.

c. Apply two drops of Loctite™ 277 on cylinder block thread. See Figure 65. Slide assembled gland over rounded end of cylinder rod and Install gland into cylinder block and tighten by hand until fully seated in cylinder block.

d. Check gap between gland and cylinder block. Gap must not exceed 0.1 mm (.004 in.). If gap is not correct, inspect gland and replace if worn or damaged. See **Parts Manual**.

e. Tighten gland to 217 N•m (160 lbf ft).

WARNING

Before working on or near the mast, see Safety Procedures When Working Near Mast.

4. Install the sideshift carriage as described in carriage install procedure in one of the following sections:

Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564) 4000SRM1338 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268)
- J2.2-3.5XN (J45-70XN) (A276)

Mast Repair (S/N C661, C662, C663, C665) 4000SRM1405 for lift truck models

- J1.5-2.0XNT (J30-40XNT) (K160)
- J1.6-2.0XN (J30-40XN) (A935)
- E30-40HSD$_2$ (B219)
- E30-40HSD$_3$ (C219)

Mast Repair (S/N A270, A271, A272) 4000SRM1386 for lift truck models

- J1.5-2.0XNT (J30-40XNT) (K160)
- J1.6-2.0XN (J30-40XN) (A935)
- E30-40HSD$_3$ (C219)

Sideshift Cylinder Repair for 1.5-3.5T Trucks After December 2016

This section outlines the sideshift cylinder repair procedures *only* for lift truck models E2.2-3.5XN (E45-70XN) (**A268**), J30-40XNT (**K160**), J30-40XN (**A935**), and E30-40HSD$_3$ (**C219**) manufactured after December 2016.

REMOVE

WARNING

Before working on or near the mast, see Safety Procedures When Working Near Mast.

NOTE: Step 2 and Step 3 in this section cover all lift trucks except J30-40XNT (K160), and E30-40HSD$_3$ (C219) lift trucks equipped with a four stage FFL mast. For these lift truck models, go to Step 2 in the Disassemble section below to remove and disassemble the sideshift cylinder.

1. Remove outer frame from carriage as described in carriage removal procedure in one of the following sections.

Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564) 4000SRM1338 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268)

Mast Repair (S/N C661, C662, C663, C665) 4000SRM1405 for lift truck models

- J30-40XNT (K160)
- J30-40XN (A935)
- E30-40HSD$_3$ (C219)

Mast Repair (S/N A270, A271, A272) 4000SRM1386 for lift truck models

- J30-40XNT (K160)

- J30-40XN (A935)
- E30-40HSD$_3$ (C219)

2. Locate the cylinder rod and gland assembly for each side.

See Figure 66 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268)

See Figure 67 for lift truck models

- J30-40XNT (K160)
- J30-40XN (A935)
- E30-40HSD$_3$ (C219)

3. Turn one of the glands counter-clockwise to loosen. Remove rod and gland assembly from inner frame by unthreading from cylinder bore. Repeat for cylinder on opposite side of carriage.

See Figure 66 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268)

See Figure 67 for lift truck models

- J30-40XNT (K160)
- J30-40XN (A935)
- E30-40HSD$_3$ (C219)

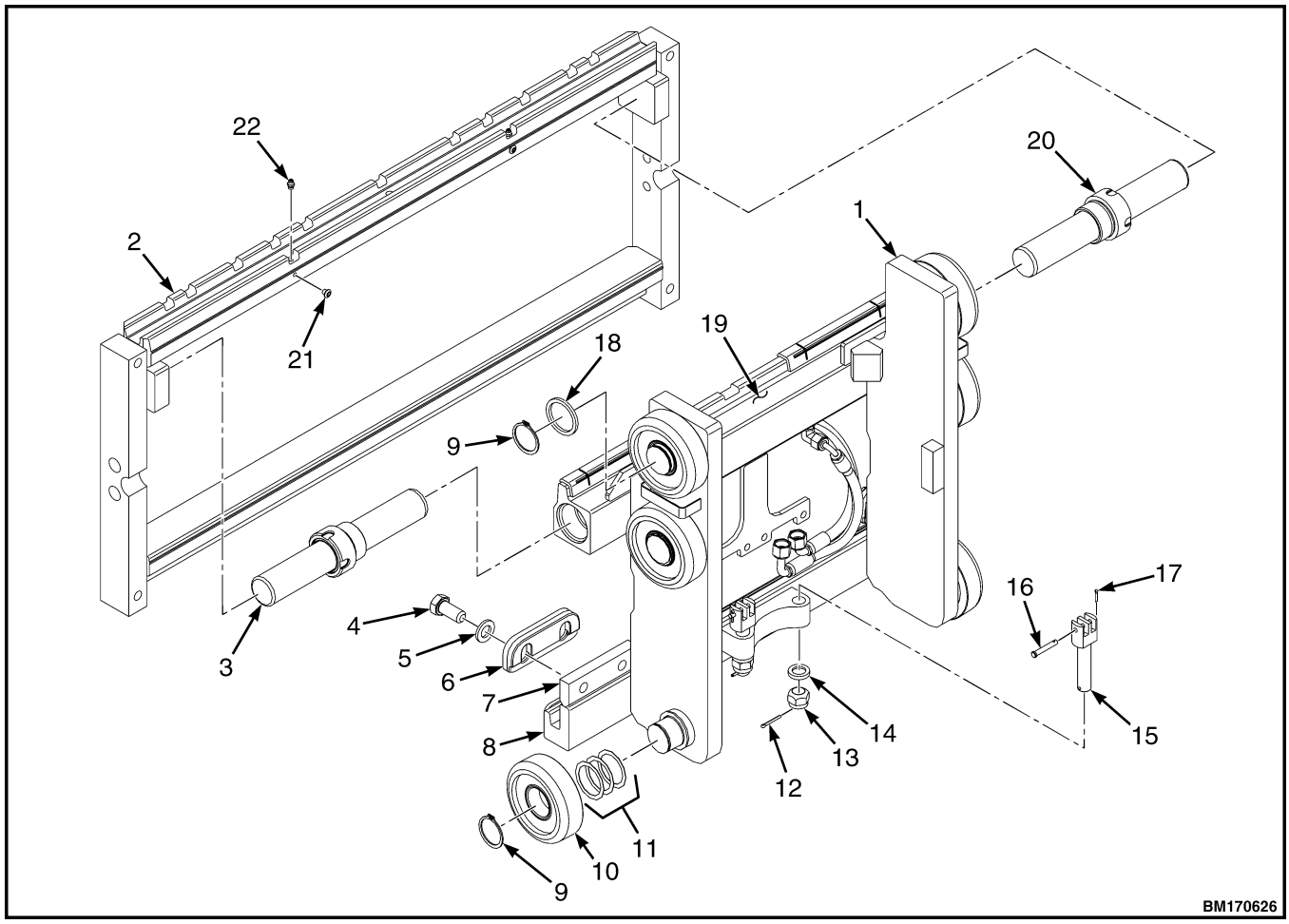
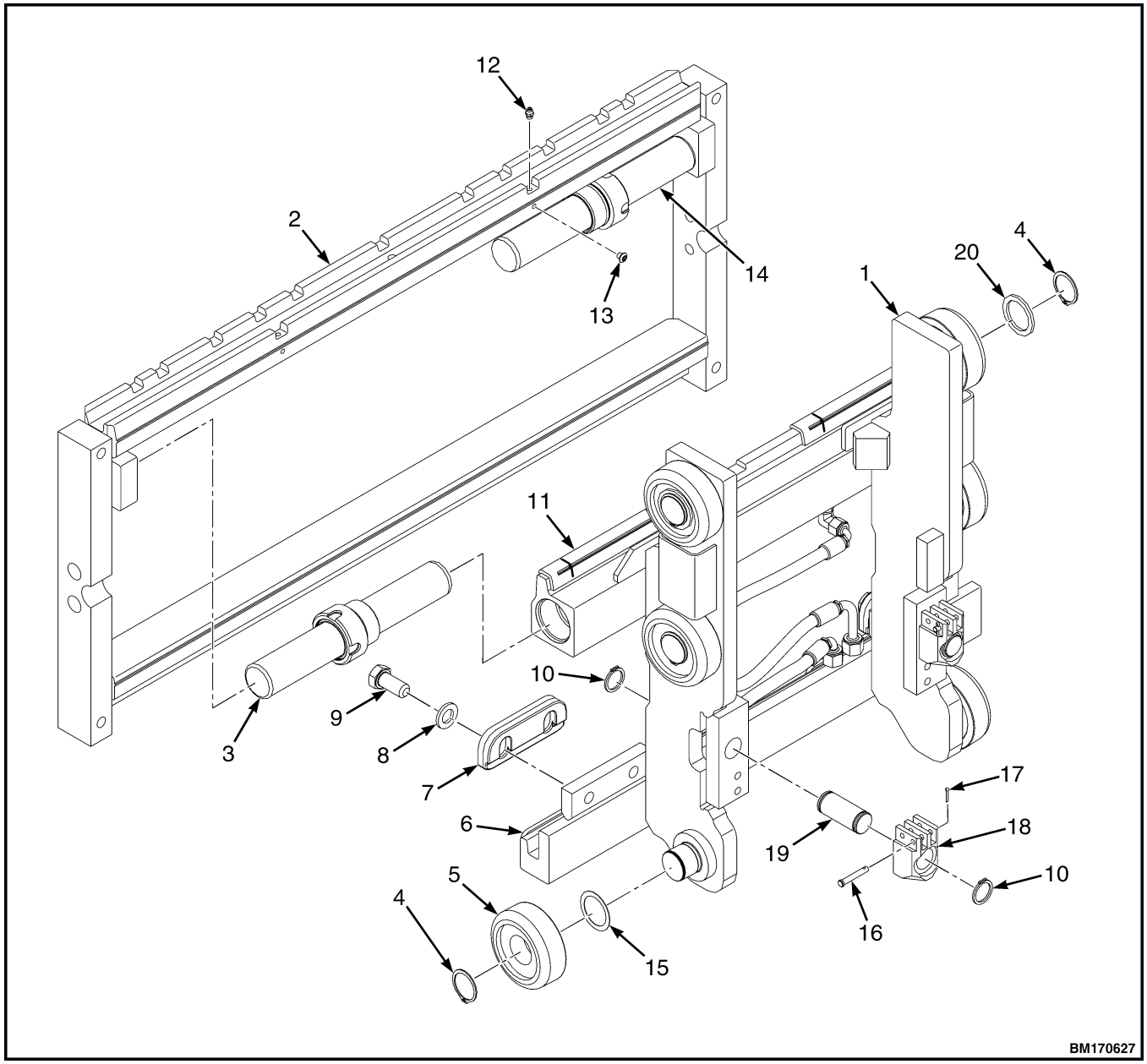


Figure 66. Integral Sideshift Carriage and Cylinder, Lift Truck Models E2.2-3.5XN (E45-70XN) (A268)

Legend for Figure 66.

NOTE: TWO- AND THREE-STAGE FFL IS SHOWN. INTEGRAL SIDESHIFT CARRIAGE ASSEMBLY FOR FOUR-STAGE FFL AND TWO-STAGE LFL IS SIMILAR.

1. INNER FRAME
2. OUTER FRAME
3. LH CYLINDER
4. CAPSCREW
5. WASHER
6. HOOK
7. PLATE
8. LOWER BEARING
9. SNAP RING
10. LOAD ROLLER
11. SHIMS
12. COTTER PIN
13. NUT
14. RING
15. CHAIN ANCHOR
16. PIN
17. COTTER PIN
18. SPACER
19. UPPER BEARING
20. RH CYLINDER
21. CAPSCREW
22. GREASE FITTING



NOTE: TWO-STAGE LFL CARRIAGE SHOWN. INTEGRAL SIDESHIFT CARRIAGE ASSEMBLY FOR THREE-STAGE FFL IS SIMILAR. FOR LIFT TRUCK MODELS J30-40XNT (K160) AND E30-40HSD$_3$ (C219) EQUIPPED WITH A FOUR STAGE FFL MAST SEE FIGURE 69.

1. INNER FRAME
2. OUTER FRAME
3. LH CYLINDER
4. SNAP RING
5. LOAD ROLLER
6. LOWER BEARING
7. HOOK
8. WASHER
9. CAPSCREW
10. RING
11. UPPER BEARING
12. GREASE FITTING
13. CAPSCREW
14. RH CYLINDER
15. SHIM
16. PIN
17. COTTER PIN
18. CHAIN ANCHOR
19. PIN
20. SPACER

Figure 67. Integral Sideshift Carriage and Cylinder, Lift Truck Models J30-40XNT (K160), J30-40XN (A935) and E30-40HSD$_3$ (C219)

DISASSEMBLE

WARNING

Hydraulic oil is hot after system operation and can cause burns. DO NOT disconnect any hydraulic hoses until oil in the system is cool.

NOTE: The procedures in Step 1 cover all lift trucks except for J30-40XNT (K160) and E30-40HSD$_3$ (C219) lift trucks equipped with a four stage FFL mast. For these lift truck models, go to Step 2 for the disassemble procedures.

NOTE: Disassemble the sideshift cylinder only as necessary for repairs. Most repairs to the sideshift cylinder will be for replacement of O-rings, wipers, seals, and retainers to stop leaks. If other parts of the sideshift cylinder needs to be repaired, replace with new cylinder. See **Parts Manual**.

NOTE: Drain oil from cylinder before making any repairs.

1. Disassemble the sideshift cylinder as follows:

a. Clamp one end of the cylinder rod in a vise.

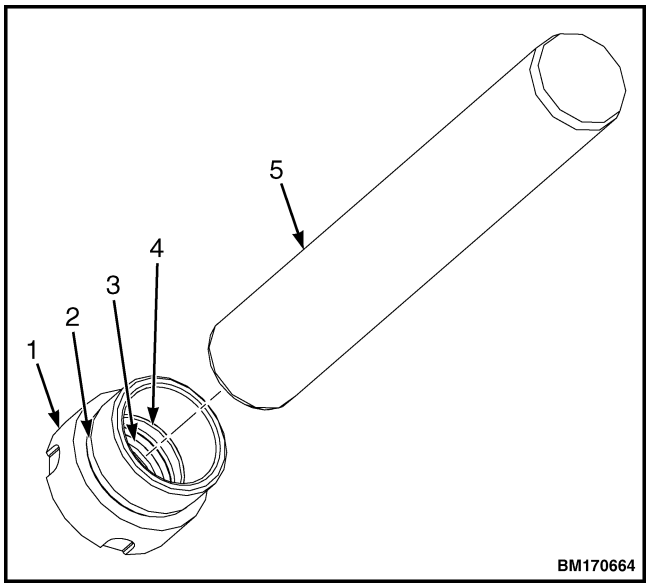
b. Slide gland off of cylinder rod. See Figure 68.

c. Remove and discard the seal, wiper, and O-ring with a brass O-ring tool. **DO NOT** scratch cylinder grooves.

2. For J30-40XNT (K160) and E30-40HSD$_3$ (C219) lift trucks equipped with a four stage FFL mast, disassemble the sideshift cylinder as follows:

NOTE: When removing gland from cylinder block, do not scratch cylinder rod on cylinder block threads.

a. Place suitable container under cylinder block. Loosen gland from cylinder block thread and let oil drain into container.



1. GLAND
2. O-RING
3. ROD WIPER
4. ROD SEAL
5. CYLINDER ROD

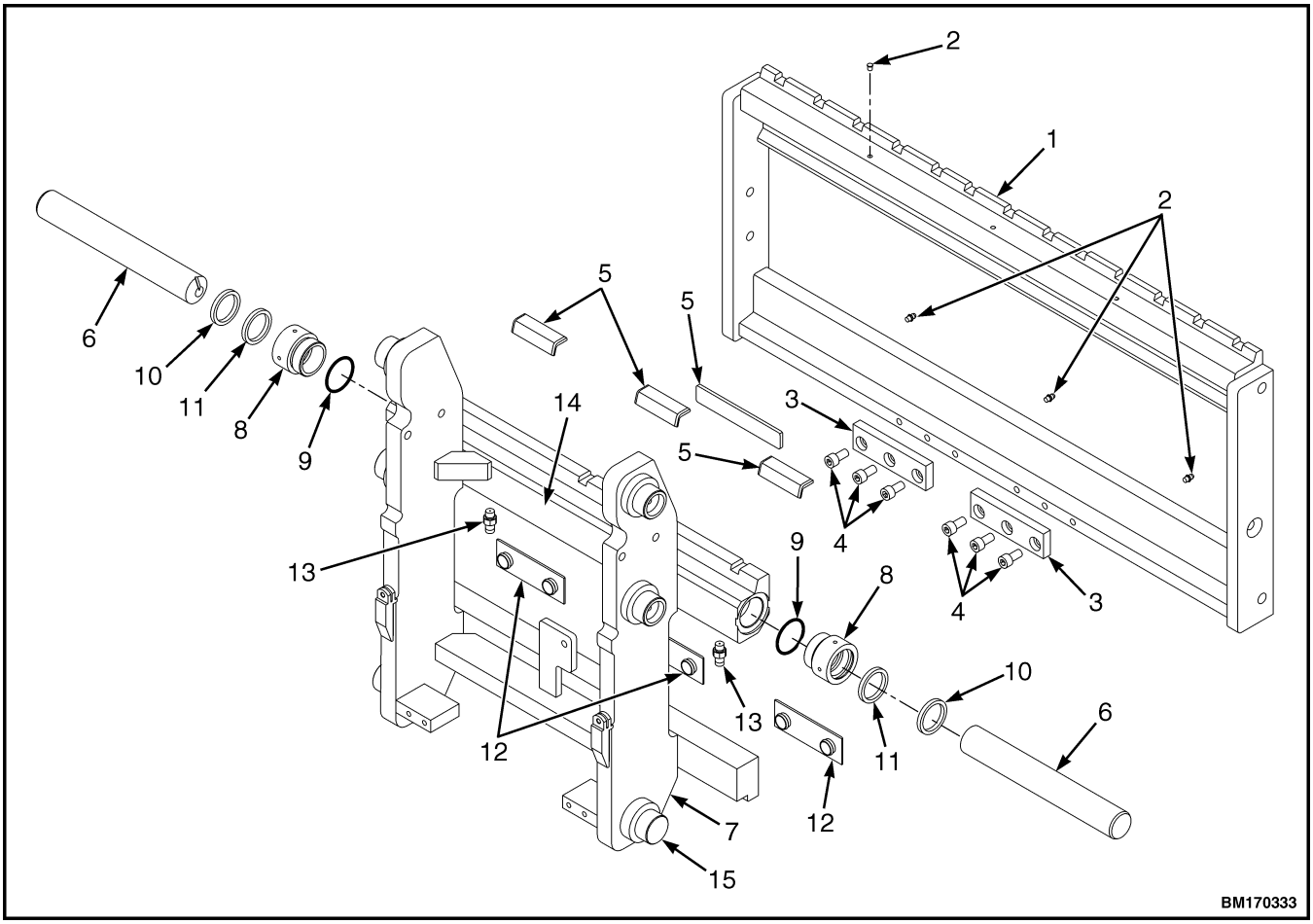
Figure 68. Integral Sideshift Cylinder, Disassemble

b. After oil has drained, remove gland from cylinder block. See Figure 69.

c. Push gland all the way down cylinder rod and remove gland from cylinder rod.

d. Remove O-ring, wiper, and seal from gland. Discard these parts after removal. See Figure 69.

e. Perform above steps for other side of sideshift cylinder.



1. OUTER FRAME
2. LUBE FITTING
3. LOWER RETAINER
4. CAPSCREW
5. UPPER BEARING
6. CYLINDER ROD
7. INNER FRAME
8. GLAND
9. O-RING
10. WIPER
11. SEAL
12. LOWER BEARING
13. HYDRAULIC FITTING
14. CYLINDER BLOCK
15. LOAD ROLLER STUBSHAFT

Figure 69. Integral Sideshift Carriage and Cylinder, Lift Trucks Equipped With A Four Stage FFL Mast J30-40XNT (K160) and E30-40HSD$_3$ (C219)

CLEAN AND INSPECT

WARNING

Cleaning solvents can be flammable and toxic and can cause skin irritation. When using cleaning solvents, always follow the solvent manufacturers recommended safety procedures.

WARNING

Compressed air can move particles so they can cause injury to the user or to other personnel. Make sure the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eye.

CAUTION

DO NOT allow cleaning solvent to come in contact with rubber components, as it will damage those components.

1. Clean the gland and cylinder rod with cleaning solvents and dry with compressed air.

   See Figure 68 for lift truck models

   - E2.2-3.5XN (E45-70XN) (A268)

   See Figure 69 for lift truck models

   - J30-40XNT (K160)
   - J30-40XN (A935)
   - E30-40HSD$_3$ (C219)

2. Inspect the cylinder rod for damage to rod surface and ensure that rod is not bent or scored. If damaged, replace sideshift cylinder rod. See **Parts Manual**.

ASSEMBLE AND INSTALL

NOTE: Perform Step 1 through Step 5 for all lift trucks except J30-40XNT (K160) and E30-40HSD $_3$ (C219) lift trucks equipped with a four stage FFL mast. For these lift truck models, go to Step 6 for the assemble and install procedures.

1. Assemble sideshift cylinder as follows (see Figure 68):

NOTE: If new glands, that are already assembled with seals and O-rings, are being installed, proceed to Step d.

a. Lubricate new O-ring, seals, and wipers with clean hydraulic oil.

b. Install seal, wiper, and O-ring into the gland grooves.

c. Form seals and O-rings into a "kidney" shape (see Figure 70) to ease placement into the grooves. Note the direction of the seals. **Pressure seals are installed with the lip toward the pressure side of the cylinder.**

d. Apply a thin film of hydraulic oil to the inside of the cylinder bore on the inner frame.

e. Clamp one end of the cylinder rod in a vise.

f. Apply Loctite® 243 to gland threads and slide gland with seal, wiper, and O-ring installed onto cylinder rod.

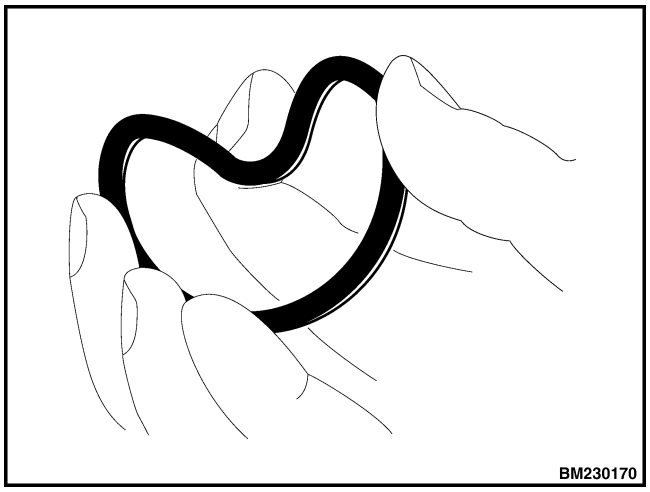


Figure 70. Forming Seals Into Kidney Shape Prior To Installation

CAUTION

Never install the gland and then drive rod into the assembly. To do so, can damage the seals. ALWAYS have rod assembled into the gland first, then begin tightening it, leaving no more than 75 mm (2.9 in.) of the cylinder rod exposed from the face of the gland, to allow for installation of outer frame.

2. Make sure inside of cylinder bore is free of all sediment and other particles.

3. Thread gland and rod assembly into cylinder bore on inner frame.

   See Figure 66 for lift truck models

   - E2.2-3.5XN (E45-70XN) (A268)

   See Figure 67 for lift truck models

   - J30-40XNT (K160)
   - J30-40XN (A935)
   - E30-40HSD$_3$ (C219)

CAUTION

Tighten glands using Only one of the tools described in Table 2. Using another tool to tighten glands can lead to fracturing of glands and damage to cylinder.

CAUTION

Do not grind gland tightening tool for clearance, as grinding will significantly weaken the tool and negatively impact its performance.

NOTE: If the integral side-shift carriage has a width narrower than 1067 mm (42 in.), it will have to be removed from the lift truck before using the gland tightening tool to tighten glands. The exception to this is lift trucks equipped with a four stage full free-lift mast. See one of the following manuals listed below for procedures to remove the integral side-shift carriage from lift truck.

Mast Repair (S/N C661, C662, C663, C665) 4000SRM1405 for lift truck models

- J30-40XNT (J160)
- J30-40XN (A935)
- E30-40HSD$_3$

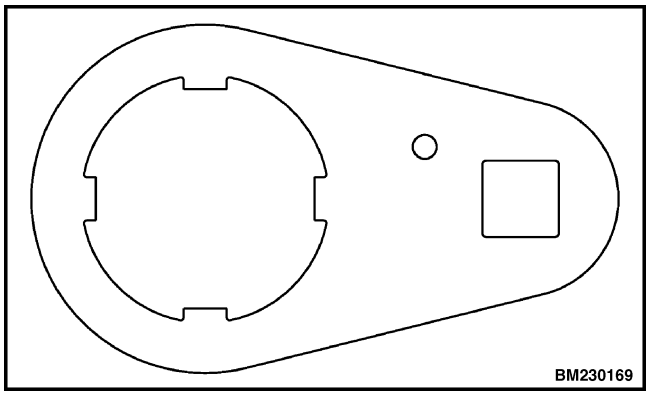
Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564) 4000SRM1338 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268)

4. Tighten gland to 450 N•m (332 lbf ft) using one of the tools shown in Table 2.

Table 2. Gland Tightening Tool

Gland Manufacture Date	Class II	Class III
Before July 10th, 2017	P/N 4197738	P/N 4197737
After July 10th, 2017	P/N 4197737	P/N 4197737



NOTE: Gland tightening tool P/N 4197738 shown. Gland tightening tool P/N 4197737 is similar.

5. Install outer frame of carriage back onto the inner frame.

   See Figure 66 for lift truck models

   - E2.2-3.5XN (E45-70XN) (A268)

   See Figure 67 for lift truck models

   - J30-40XNT (K160)
   - J30-40XN (A935)
   - E30-40HSD$_3$ (C219)

6. For J30-40XNT (K160) and E30-40HSD$_3$ lift trucks equipped with a four stage FFL mast, assemble and install the sideshift cylinder as follows:

a. Lubricate new O-rings with clean hydraulic oil. Install O-rings on threaded side of gland.

NOTE: Form the seals and wipers into a "kidney" shape (see Figure 70) to ease placement into the groove. Note the direction of the seals and wipers. **Pressure seals are installed with the lip toward the pressure side of the cylinder.**

b. Lubricate new seals and wipers with clean hydraulic oil. Install seals into second slot from non-threaded side of gland. Install wipers into first slot from non-threaded side of gland.

CAUTION

To prevent damage to cylinder rod, DO NOT install assembled gland over tapered end of cylinder rod.

c. Apply two drops of Loctite™ 277 on cylinder block thread. See Figure 69. Slide assembled gland over rounded end of cylinder rod and Install gland into cylinder block and tighten by hand until fully seated in cylinder block.

d. Check gap between gland and cylinder block. Gap must not exceed 0.1 mm (.004 in.). If gap is not correct, inspect gland and replace if worn or damaged. See **Parts Manual**.

CAUTION

Tighten glands using Only one of the tools described in Table 2. Using another tool to tighten glands can lead to fracturing of glands and damage to cylinder.

e. Tighten gland to 450 N•m (332 lbf ft) using one of the tools shown inTable 2.

WARNING

Before working on or near the mast, see Safety Procedures When Working Near Mast.

7. Install the sideshift carriage as described in carriage install procedure in one of the following sections:

Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564) 4000SRM1338 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268)

Mast Repair (S/N C661, C662, C663, C665) 4000SRM1405 for lift truck models

- J30-40XNT (K160)
- J30-40XN (A935)
- E30-40HSD$_3$ (C219)

Mast Repair (S/N A270, A271, A272) 4000SRM1386 for lift truck models

- J30-40XNT (K160)
- J30-40XN (A935)
- E30-40HSD$_3$ (C219)

INTEGRAL SIDE-SHIFT CYLINDER GLAND LEAK CHECKS

If a leak on one of the glands is suspected, clean the integral side-shift cylinder assembly of grease and dirt, then actuate cylinder at least five full strokes, lock to lock. If a leak is still suspected, perform the following to correct any leaks

1. Tighten the suspected gland using correct gland tightening tool to the correct torque as described in Assemble and Install section above.

2. If a leak is still suspected, loosen gland and inspect the O-ring, backup ring and seat. Replace O-ring and backup ring if damage is found. See **Parts Manual**.

3. If a leak is still occurring after performing Step 1 and Step 2, replace the entire rod and gland assembly with new parts. See **Parts Manual**.

Sideshift Cylinder Repair for 4.0-5.5T Trucks

This section outlines the sideshift cylinder repair procedures for lift truck models E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099) and J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) .

REMOVE

WARNING

Before working on or near the mast, see Safety Procedures When Working Near Mast.

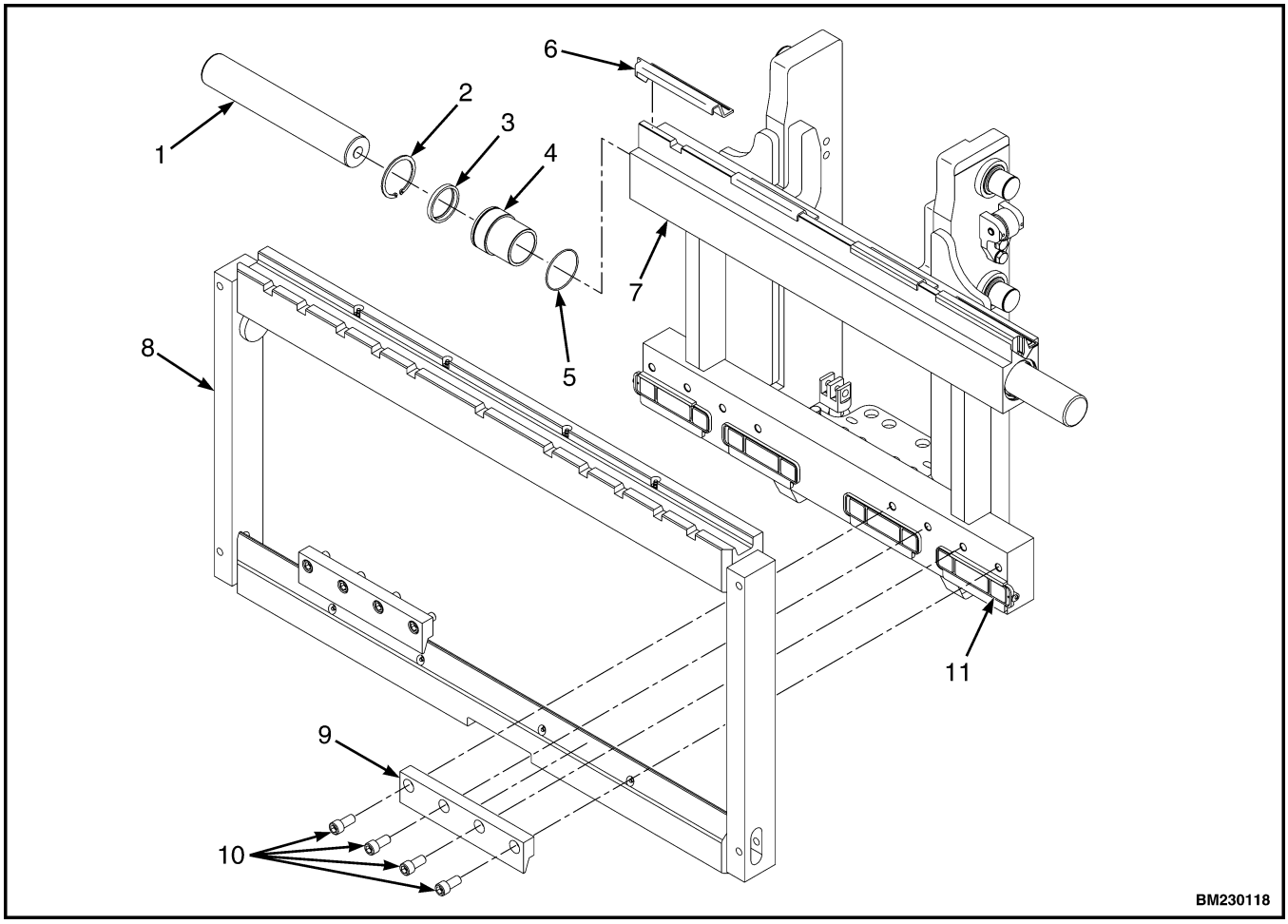
1. Remove sideshift carriage as described in carriage removal procedure in **Mast Repair (S/N A626-27, A751-52, B590-91, and B749-54)** 4000SRM1540.

   Mast Repairs (S/N A551, A555, A559, A751, A752, B586, B587, B588, B590, B591, B749, B750, B751, B752, and B754) 4000SRM1576 for lift truck model

   - E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

2. Remove four capscrews from right lower retainer and four capscrews from left lower retainer. See Figure 71.

3. Lift outer frame up and away from cylinder block. See Figure 71.



1. CYLINDER ROD
2. SNAP RING
3. WIPER
4. GLAND
5. O-RING
6. UPPER BEARING
7. CYLINDER BLOCK
8. OUTER FRAME
9. LOWER RETAINER
10. CAPSCREW
11. LOWER BEARING

Figure 71. Integral Sideshift Carriage and Cylinder, Lift Truck models J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) and E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

DISASSEMBLE

NOTE: Disassemble the sideshift cylinder only as necessary for repairs. Most repairs to sideshift cylinder will be for replacement of O-rings, wipers, snap ring, and retainers to stop leaks. If other parts of the sideshift cylinder need to be repaired, replace with new cylinder. See **Parts Manual**.

NOTE: When removing gland from cylinder block, DO NOT scratch cylinder rod on cylinder block threads.

1. Place suitable container under cylinder block. Loosen gland from cylinder block thread and let oil drain into container.
2. Remover gland from cylinder block. See Figure 71.
3. Push gland all the way down cylinder rod and remove gland from cylinder rod.
4. Remove O-ring, wiper, and snap ring from gland. Discard parts after removal. See Figure 71.

5. Perform Step 1 through Step 4 for other side of sideshift cylinder.

CLEAN AND INSPECT

WARNING

Cleaning solvents can be flammable and toxic and can cause skin irritation. When using cleaning solvents, always follow solvent manufacturers recommended safety procedures.

WARNING

Compressed air can move particles so they can cause injury to user or to other personnel. Make sure the path of the compressed air is away from all personnel. Wear protective goggles or face shield to prevent injury to the eyes.

CAUTION

DO NOT allow cleaning solvent to come in contact with rubber components, as it will damage components.

1. Clean retainers, glands and cylinder rods with cleaning solvent and dry with compressed air.

2. Inspect cylinder rod for damage to rod surface and ensure that rod is not bent or scored. If damaged, replace sideshift cylinder assembly. See **Parts Manual**.

ASSEMBLE AND INSTALL

1. Lubricate new O-rings with clean hydraulic oil. Install O-rings onto gland.

2. Apply a film of hydraulic oil to the inside of gland.

3. Slide wiper onto cylinder rod.

CAUTION

To prevent damage to cylinder rod, DO NOT install assembled gland over tapered end of cylinder rod.

4. Apply two drops of Loctite 277 on cylinder block thread. See Figure 71. Slide assembled gland over rounded end of cylinder rod.

5. Install gland and cylinder rod into cylinder block.

6. Tighten gland to 340 to 410 N•m (250 to 300 lbf ft).

7. Install snap ring into cylinder block.

8. Install sideshift cylinder onto carriage.

WARNING

Before working on or near the mast, see Safety Procedures When Working Near Mast.

9. Install the sideshift carriage as described in carriage install procedure in **Mast Repair (S/N A626-27, A751-52, B590-91, and B749-54)** 4000SRM1540.

   See the section **Mast Repairs (S/N A551, A555, A559, A751, A752, B586, B587, B588, B590, B591, B749, B750, B751, B752, and B754)** 4000SRM1576 for lift truck model

   - E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

Fork Positioner Cylinder Repair Prior to December 2016

REMOVE

WARNING

Before working on or near the mast, see Safety Procedures When Working Near Mast.

NOTE: Fork positioner is not used on lift truck models J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) and E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099) .

1. Remove fork positioner from integral sideshift carriage. See one of the following manuals for procedures.

Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564) 4000SRM1338 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268)
- J2.2-3.5XN (J45-70XN) (A276)

Mast Repair (S/N C661, C662, C663, C665) 4000SRM1405 for lift truck models

- J1.5-2.0XNT (J30-40XNT) (K160)
- J1.6-2.0XN (J30-40XN) (A935)
- E30-40HSD$_2$ (B219)
- E30-40HSD$_3$ (C219)

DISASSEMBLE

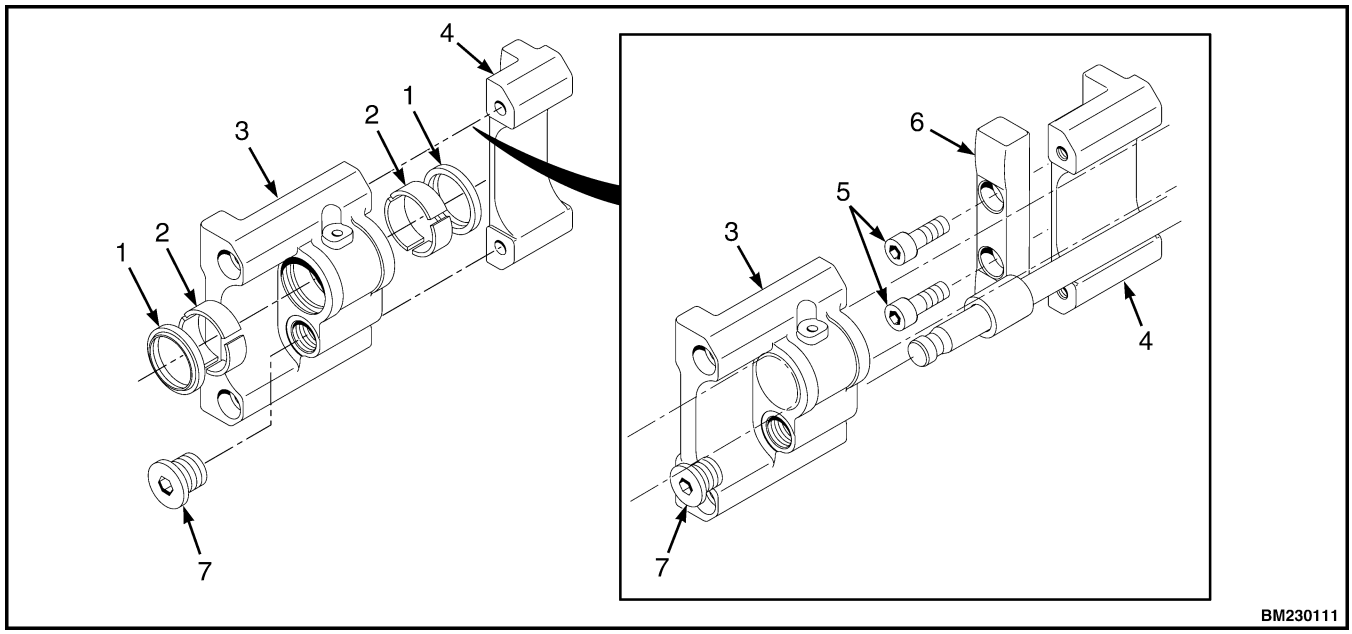
CAUTION

Carefully disassemble fork positioner so piston rods and sliding surfaces are not damaged.

NOTE: Disassemble fork positioner cylinders only as necessary for repairs. On the fork positioner covered in this manual, there are only three items that can be replaced: the bronze bearings in the outer fork carriers, the relief tube assemblies, and hose guides. If any other component parts need to be replaced, the whole fork positioner assembly will need to be replaced. See **Parts Manual** for replacement kits and part numbers.

NOTE: Depending on the size and configuration of the forks installed on lift truck, there may be a spacer bar between the inner and outer fork carriers. See Figure 72.

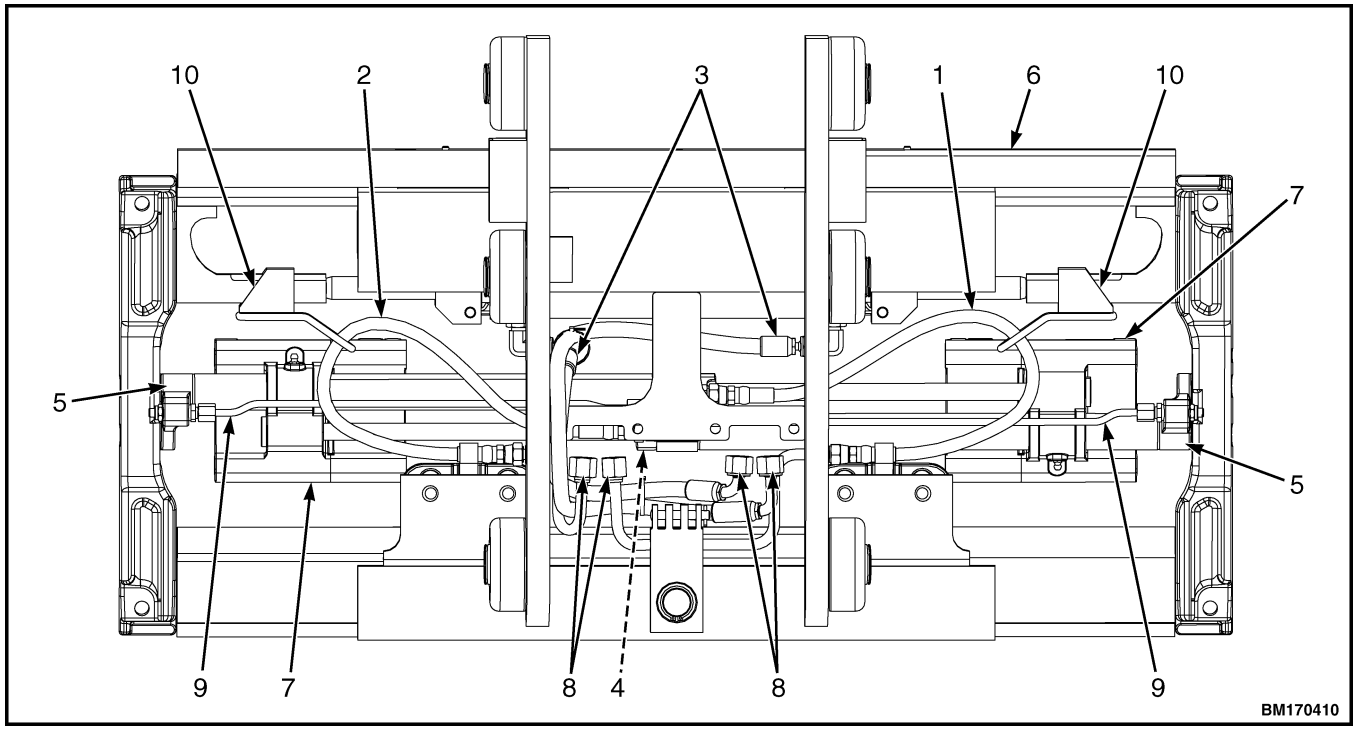
1. Remove cylinder rod anchor plug. See Figure 72.
2. Move fork carriers towards manifold and fully retract fork positioner cylinder rods.
3. Disconnect hydraulic hoses from manifold. See Figure 73.
4. Disconnect relief tube assembly. See Figure 73.



1. WIPER SHELL
2. BRONZE BEARINGS
3. OUTER FORK CARRIER
4. INNER FORK CARRIER
5. CAPSCREW*
6. SPACER BAR*
7. CYLINDER ROD ANCHOR PLUG

*Parts used on 977 mm (38.5 in.) and 1067 mm (42 in.) class II carriages.

Figure 72. Fork Positioner, Disassemble



NOTE: BACK (DRIVER'S) VIEW SHOWN. THREE STAGE FFL INTEGRAL SIDESHIFT CARRIAGE SHOWN.

1. FORK POSITIONER HYDRAULIC HOSE (OPEN)
2. FORK POSITIONER HYDRAULIC HOSE (CLOSE)
3. INTEGRAL SIDESHIFT CARRIAGE HYDRAULIC HOSES
4. MANIFOLD
5. FORK POSITIONER CYLINDER
6. OUTER FRAME
7. FORK CARRIER
8. TUBE ASSEMBLY
9. RELIEF TUBE ASSEMBLY
10. HOSE GUIDE

Figure 73. Hydraulic Connections, Fork Positioner Cylinder

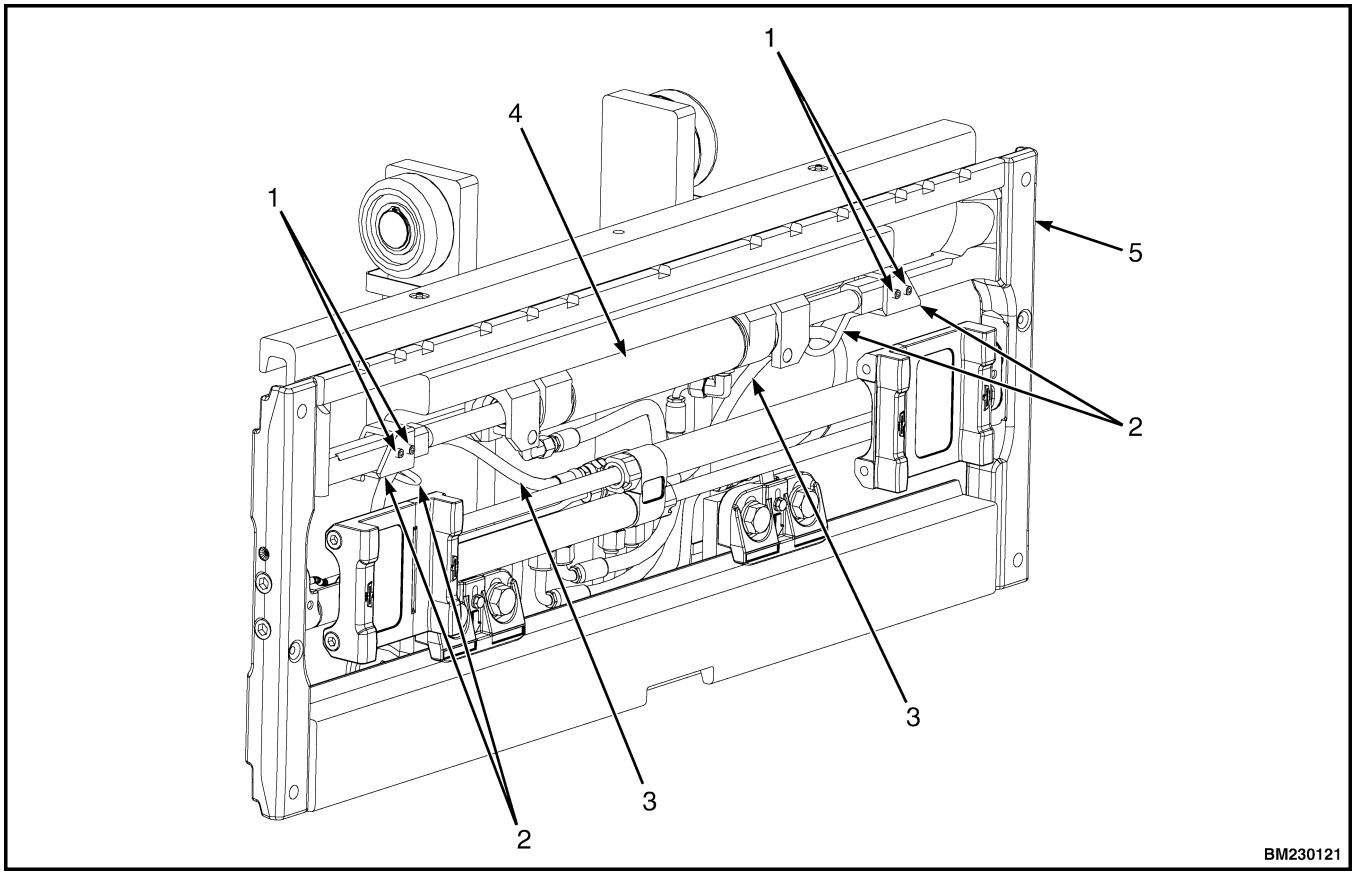
5. Remove cylinder rod retainer and remove fork positioner cylinder from manifold.

6. Remove fork carriers from cylinder shell.

7. Remove wiper shell and bronze bearings from outer fork carrier. See Figure 72.

8. Remove integral sideshift cylinder from carriage. See Sideshift Cylinder Repair sections for procedures.

9. Remove setscrews from hose guides and remove hose guides from outer frame. See Figure 74.



NOTE: FORK POSITIONER AND INTEGRAL SIDESHIFT CARRIAGE FOR LIFT TRUCKS E2.2-3.5XN (E45-70XN) (A268) SHOWN. FORK POSITIONER AND INTEGRAL SIDESHIFT CARRIAGE FOR OTHER LIFT TRUCKS COVERED IN THIS MANUAL ARE SIMILAR.

1. SETSCREW
2. HOSE GUIDE
3. HYDRAULIC HOSE
4. INTEGRAL SIDESHIFT CYLINDER
5. OUTER FRAME

Figure 74. Fork Positioner Hose Guide

CLEAN

WARNING

Cleaning solvents can be flammable and toxic and can cause skin irritation. When using cleaning solvents, always follow the solvent manufacturer's recommended safety procedures.

WARNING

Compressed air can move particles so they cause injury to the user or to other personnel. Make sure the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eyes.

CAUTION

DO NOT allow cleaning solvent to come in contact with rubber components, as it will damage those components.

1. Clean all metal parts in solvent and dry with compressed air.

INSPECT

NOTE: The bronze bearings in outer fork carriers, the relief tube assemblies, and hose guides are the only components that can be replaced. If other components are worn or damaged, the whole fork positioner assembly must be replaced. See the **Parts Manual** for replacement parts.

1. Inspect rod, piston, and retainer for any damage to seal surfaces. Replace fork positioner if damaged.
2. Inspect rod for damage to rod surface and ensure rod is not bent. Replace fork positioner if damaged or bent.
3. Inspect fork carrier bearings for wear. Replace bronze bearings as necessary. See Figure 72.
4. Inspect relief tube assembly for wear or damage. Replace relief tube assembly if necessary. See Figure 73.
5. Inspect hose guides for wear or damage. Replace hose guides if necessary. See Figure 74.

ASSEMBLE

1. Install hose guides onto outer frame. Tighten setscrews to 17 N•m (150 lbf in). See Figure 74.
2. Install integral sideshift cylinder to carriage. See Sideshift Cylinder Repair sections for procedures.

NOTE: Lubricate all internal parts of the cylinder with clean hydraulic oil during assembly.

3. Lubricate new fork carrier bronze bearings with clean hydraulic oil. Install new bronze bearings into outer fork carrier and install wiper shell. See Figure 72.
4. Connect relief tube assemblies. See one of the following **Service Manuals** for procedures.

   Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564) 4000SRM1338 for lift truck models
   - E2.2-3.5XN (E45-70XN) (A268)
   - J2.2-3.5XN (J45-70XN) (A276)

   Mast Repair (S/N C661, C662, C663, C665) 4000SRM1405 for lift truck models
   - J1.5-2.0XNT (J30-40XNT) (K160)
   - J1.6-2.0XN (J30-40XN) (A935)
   - E30-40HSD$_2$ (B219)
   - E30-40HSD$_3$ (C219)
5. Install fork carriers onto cylinder shell.
6. Install fork positioner cylinder assembly to manifold. See Figure 72.
7. Install rod retainer. Tighten rod retainer to 165 N•m (120 lbf ft).
8. Connect hydraulic hoses to manifold. See Figure 73.
9. Install cylinder rod anchor plug. Tighten cylinder rod anchor plug to 65 N•m (50 lbf ft). See Figure 72.

INSTALL

WARNING

Before working on or near the mast, see Safety Procedures When Working Near Mast.

1. Install fork positioner assembly and cylinders to the integral sideshift carriage. See one of the following service manuals for procedures.

   Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564) 4000SRM1338 for lift truck models
   - E2.2-3.5XN (E45-70XN) (A268)
   - J2.2-3.5XN (J45-70XN) (A276)

   Mast Repair (S/N C661, C662, C663, C665) 4000SRM1405 for lift truck models
   - J1.5-2.0XNT (J30-40XNT) (K160)
   - J1.6-2.0XN (J30-40XN) (A935)
   - E30-40HSD$_2$ (B219)
   - E30-40HSD$_3$ (C219)

Fork Positioner Cylinder Adjustment

To adjust the flow restrictors for equal fork movement, perform the following:

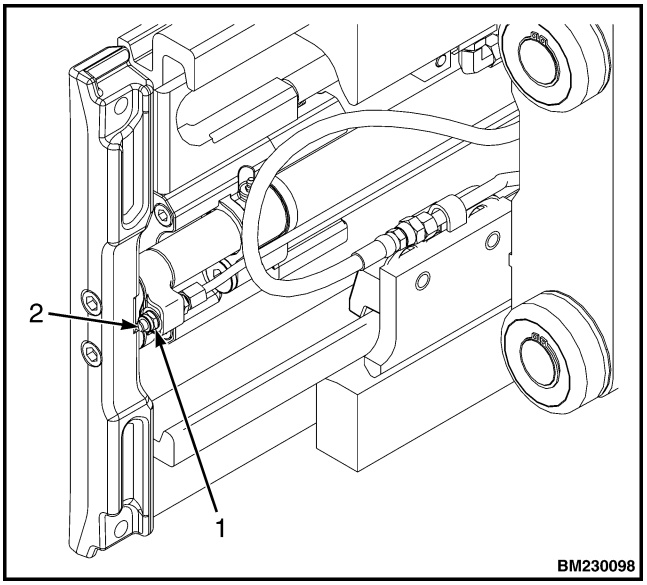
NOTE: Procedures below apply to flow restrictors on both fork positioner cylinders.

1. Loosen jam nut on flow restrictor and screw flow restrictor in until it bottoms. Turn flow restrictor counterclockwise approximately three turns. See Figure 75.
2. Open forks all the way, then close the forks. Watch for unequal fork movement.

3. To increase speed of forks opening, turn flow restrictor counterclockwise in ½ turn increments. To decrease speed of forks closing, turn flow restrictor clockwise in ½ turn increments. See Figure 75.

4. Open and close the forks again. If fork movement is not equal, repeat Step 2 and Step 3.

5. If fork movement is equal, tighten jam nut on flow restrictor. See Figure 75.



NOTE: BACK (DRIVER'S) VIEW SHOWN. LEFT FLOW RESTRICTOR SHOWN.

1. JAM NUT
2. FLOW RESTRICTOR

Figure 75. Fork Positioner Cylinder Adjustment

Fork Positioner Cylinder Repair After December 2016

This section outlines the fork positioner cylinder repair procedures for *only* lift truck models E2.2-3.5XN (E45-70XN) (**A268**), J30-40XNT (**K160**), J30-40XN (**A935**), and E30-40HSD$_3$ (**C219**) after December 2016.

REMOVE

WARNING

Before working on or near the mast, see Safety Procedures When Working Near Mast.

1. Remove fork positioner from integral sideshift carriage. See one of the following manuals for procedures.

   Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564) 4000SRM1338 for lift truck models

   - E2.2-3.5XN (E45-70XN) (A268)

   Mast Repair (S/N C661, C662, C663, C665) 4000SRM1405 for lift truck models

   - J30-40XNT (K160)
   - J30-40XN (A935)
   - E30-40HSD$_3$ (C219)

DISASSEMBLE

CAUTION

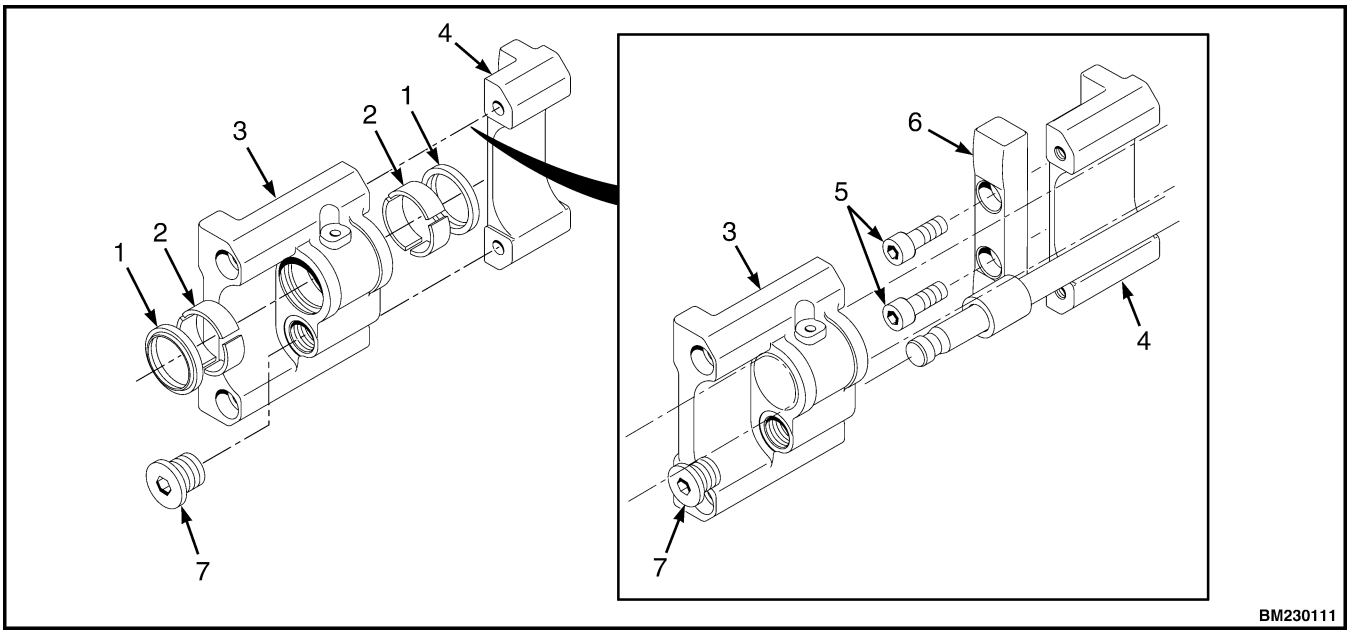
Carefully disassemble fork positioner so piston rods and sliding surfaces are not damaged.

NOTE: Disassemble fork positioner cylinders only as necessary for repairs. On the fork positioner covered in this manual, there are only three items that can be replaced: If any other component parts need to be replaced, the whole fork positioner assembly will need to be replaced. See **Parts Manual** for replacement kits and part numbers.

- The bronze bearings in the outer fork carriers
- The relief tube assemblies
- The hose guides

NOTE: Depending on the size and configuration of the forks installed on lift truck, there may be a spacer bar between the inner and outer fork carriers. See Figure 76.

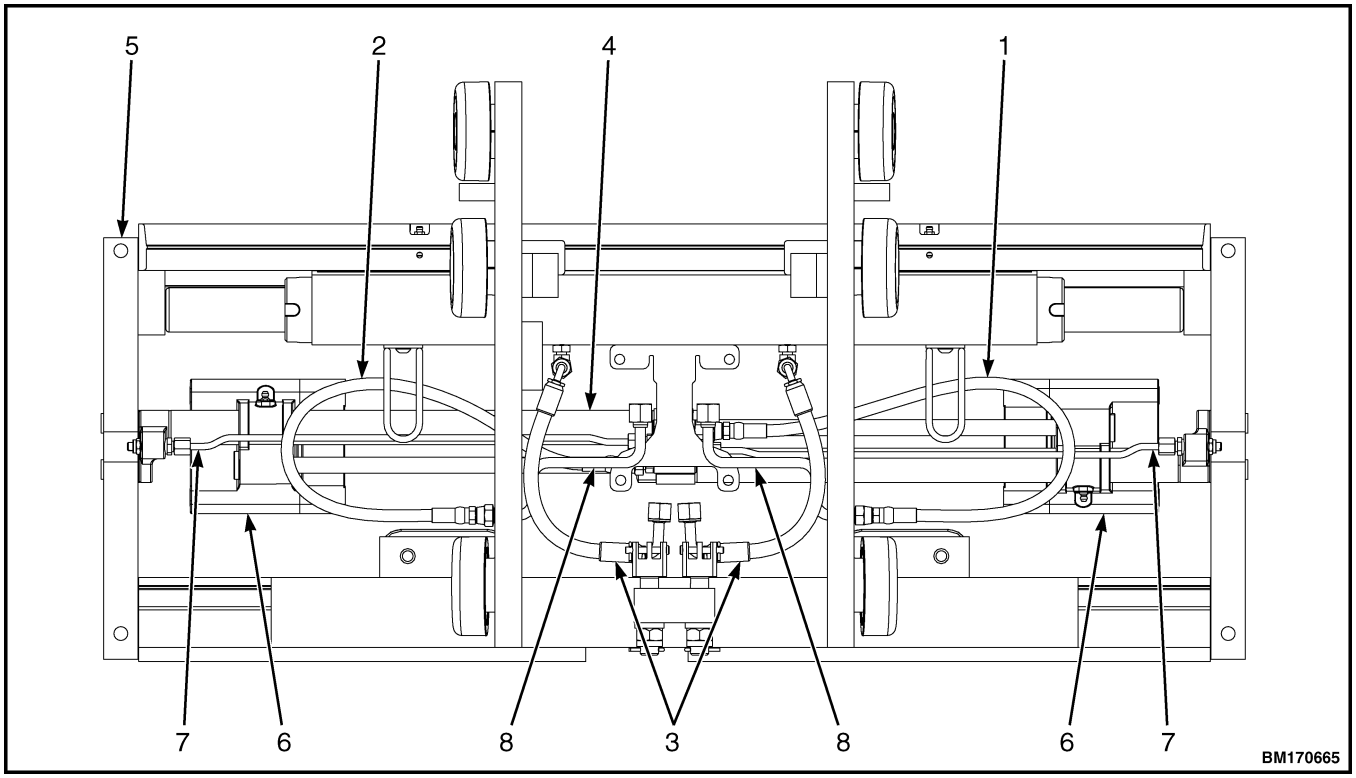
1. Remove cylinder rod anchor plug. See Figure 76.
2. Move fork carriers towards center of cylinder and fully retract fork positioner cylinder rods.
3. Disconnect hydraulic hoses from fork positioner. See Figure 77.
4. Disconnect relief tube assembly. See Figure 77.
5. Remove cylinder rod retainer and remove fork positioner cylinder.
6. Remove fork carriers from cylinder shell.
7. Remove wiper shell and bronze bearings from outer fork carrier. See Figure 78.
8. Remove integral sideshift cylinder from carriage. See Sideshift Cylinder Repair sections for procedures.
9. Remove capscrews from hose guides and remove hose guides from outer frame. See Figure 78.



1. WIPER SHELL
2. BRONZE BEARINGS
3. OUTER FORK CARRIER
4. INNER FORK CARRIER
5. CAPSCREW*
6. SPACER BAR*
7. CYLINDER ROD ANCHOR PLUG

*Parts used on 977 mm (38.5 in.) and 1067 mm (42 in.) class II carriages.

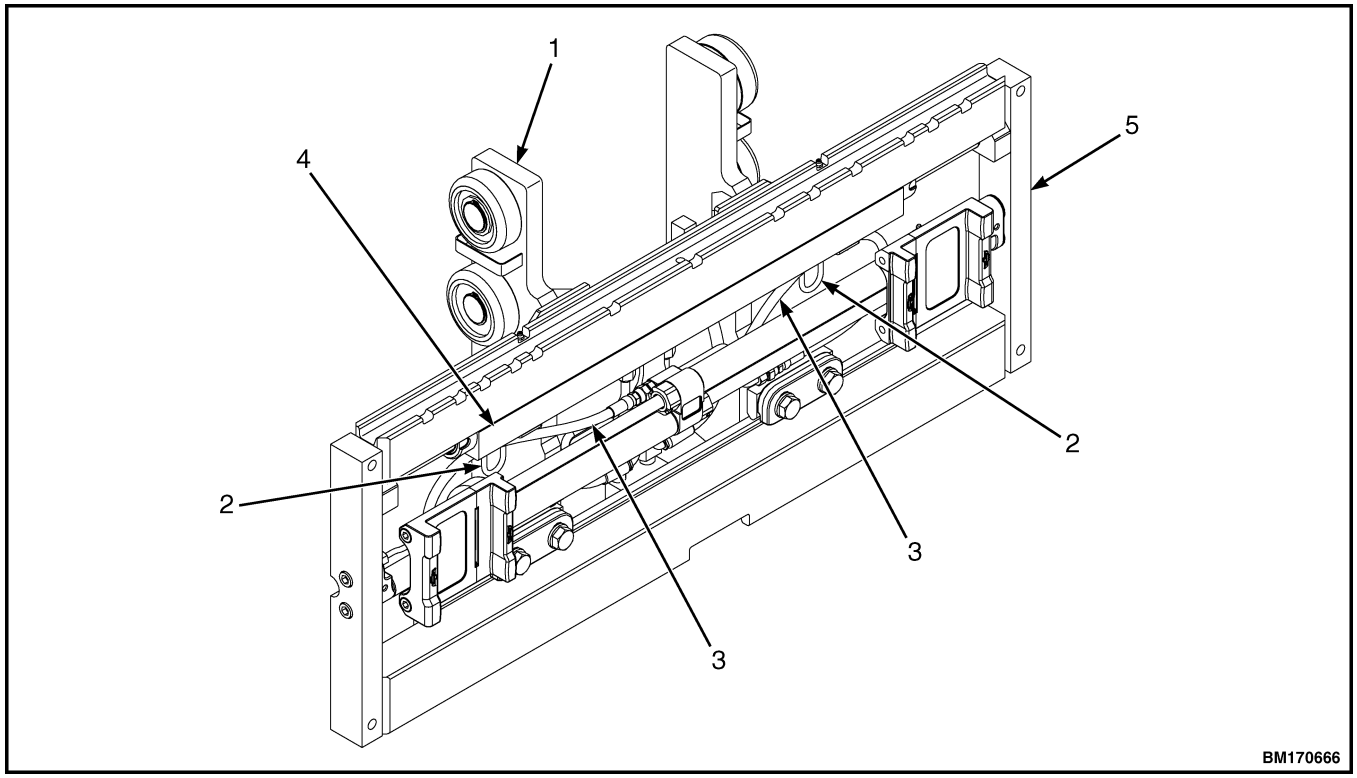
Figure 76. Fork Positioner, Disassemble



NOTE: BACK (DRIVER'S) VIEW SHOWN. THREE STAGE FFL INTEGRAL SIDESHIFT CARRIAGE SHOWN. OTHER ISS CARRIAGES ARE SIMILAR.

1. FORK POSITIONER HYDRAULIC HOSE (OPEN)
2. FORK POSITIONER HYDRAULIC HOSE (CLOSE)
3. INTEGRAL SIDESHIFT CARRIAGE HYDRAULIC HOSES
4. FORK POSITIONER CYLINDER
5. ISS CARRIAGE OUTER FRAME
6. FORK CARRIER
7. RELIEF TUBE ASSEMBLY
8. TUBE ASSEMBLY

Figure 77. Hydraulic Connections, Fork Positioner Cylinder



NOTE: FORK POSITIONER AND INTEGRAL SIDESHIFT CARRIAGE FOR LIFT TRUCKS E2.2-3.5XN (E45-70XN) (A268) SHOWN. FORK POSITIONER AND INTEGRAL SIDESHIFT CARRIAGE FOR OTHER LIFT TRUCKS COVERED IN THIS MANUAL ARE SIMILAR.

1. ISS CARRIAGE INNER FRAME
2. HOSE GUIDE
3. HYDRAULIC HOSE
4. INTEGRAL SIDESHIFT CYLINDER
5. ISS CARRIAGE OUTER FRAME

Figure 78. Fork Positioner Hose Guide

CLEAN

WARNING

Cleaning solvents can be flammable and toxic and can cause skin irritation. When using cleaning solvents, always follow the solvent manufacturer's recommended safety procedures.

WARNING

Compressed air can move particles so they cause injury to the user or to other personnel. Make sure the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eyes.

CAUTION

DO NOT allow cleaning solvent to come in contact with rubber components, as it will damage those components.

1. Clean all metal parts in solvent and dry with compressed air.

INSPECT

NOTE: The bronze bearings in outer fork carriers, the relief tube assemblies, and hose guides are the only components that can be replaced. If other components are worn or damaged, the whole fork positioner assembly must be replaced. See the **Parts Manual** for replacement parts.

1. Inspect rod, piston, and retainer for any damage to seal surfaces. Replace fork positioner if damaged.

2. Inspect rod for damage to rod surface and ensure rod is not bent. Replace fork positioner if damaged or bent.

3. Inspect fork carrier bearings for wear. Replace bronze bearings as necessary. See Figure 76.

4. Inspect relief tube assembly for wear or damage. Replace relief tube assembly if necessary. See Figure 77.

5. Inspect hose guides for wear or damage. Replace hose guides if necessary. See Figure 78.

ASSEMBLE

1. Install hose guides onto outer frame. Tighten setscrews to 17 N•m (150 lbf in). See Figure 78.

2. Install integral sideshift cylinder to carriage. See Sideshift Cylinder Repair sections for procedures.

NOTE: Lubricate all internal parts of the cylinder with clean hydraulic oil during assembly.

3. Lubricate new fork carrier bronze bearings with clean hydraulic oil. Install new bronze bearings into outer fork carrier and install wiper shell. See Figure 76.

4. Connect relief tube assemblies. See one of the following **Service Manuals** for procedures.

   Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564) 4000SRM1338 for lift truck models

   - E2.2-3.5XN (E45-70XN) (A268)

   Mast Repair (S/N C661, C662, C663, C665) 4000SRM1405 for lift truck models

   - J30-40XNT (K160)
   - J30-40XN (A935)
   - E30-40HSD$_3$ (C219)

5. Install fork carriers onto cylinder shell.

6. Install fork positioner cylinder assembly to outer frame. See Figure 76.

7. Install rod retainer. Tighten rod retainer to 165 N•m (120 lbf ft).

8. Connect hydraulic hoses to manifold. See Figure 77.

9. Install cylinder rod anchor plug. Tighten cylinder rod anchor plug to 65 N•m (50 lbf ft). See Figure 76.

INSTALL

WARNING

Before working on or near the mast, see Safety Procedures When Working Near Mast.

1. Install fork positioner assembly and cylinders to the integral sideshift carriage. See one of the following service manuals for procedures.

   Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564) 4000SRM1338 for lift truck models

   - E2.2-3.5XN (E45-70XN) (A268)

   Mast Repair (S/N C661, C662, C663, C665) 4000SRM1405 for lift truck models

   - J30-40XNT (K160)
   - J30-40XN (A935)
   - E30-40HSD$_3$ (C219)

Fork Positioner Cylinder Adjustment

To adjust the flow restrictors for equal fork movement, perform the following:

NOTE: Procedures below apply to flow restrictors on both fork positioner cylinders.

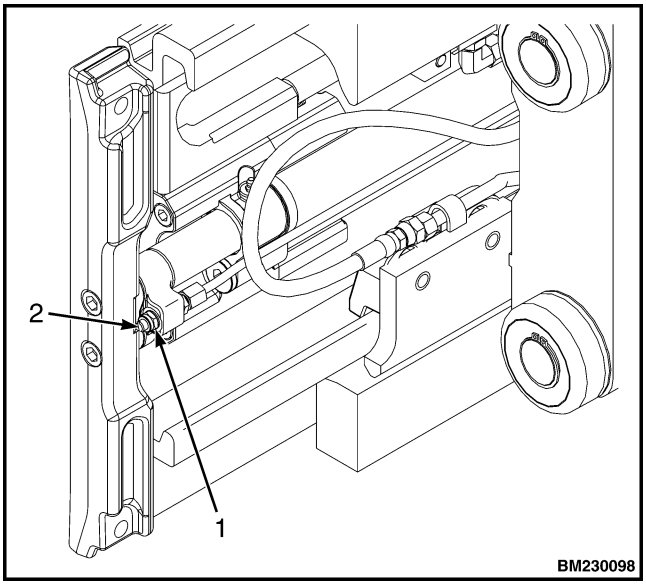
1. Loosen jam nut on flow restrictor and screw flow restrictor in until it bottoms. Turn flow restrictor counterclockwise approximately three turns. See Figure 79.

2. Open forks all the way, then close the forks. Watch for unequal fork movement.

3. To increase speed of forks opening, turn flow restrictor counterclockwise in 1/2 turn increments. To decrease speed of forks closing, turn flow restrictor clockwise in 1/2 turn increments. See Figure 79.

4. Open and close the forks again. If fork movement is not equal, repeat Step 2 and Step 3.

5. If fork movement is equal, tighten jam nut on flow restrictor. See Figure 79.



NOTE: BACK (DRIVER'S) VIEW SHOWN. LEFT FLOW RESTRICTOR SHOWN.

1. JAM NUT
2. FLOW RESTRICTOR

Figure 79. Fork Positioner Cylinder Adjustment

Lift Cylinder Leak Check

WARNING

During the test procedures for the hydraulic system, use chains to fasten the load to the carriage to prevent it from falling. Keep all people away from the lift truck during the tests.

DO NOT try to find hydraulic leaks by putting your hand on hydraulic components under pressure. Hydraulic oil can be injected into the body by the pressure.

NOTE: The following checks are to be performed with a capacity load on forks and with hydraulic oil at normal operating temperature.

1. Operate hydraulic system. Put capacity load on forks. Use safety chain to hold load to carriage. Raise and lower load several times. Lower load and tilt mast forward and backward several times. Check for leaks.

2. Put mast in vertical position and raise carriage and load 2.5 m (8 ft). If carriage slowly lowers when control valve is in **NEUTRAL** position, there are leaks in hydraulic system. The maximum speed the carriage is allowed to lower is 100 mm (4 in.) per 10 minutes when hydraulic oil is at normal operating temperature.

3. Check lift cylinders for internal leaks. Remove load from forks. Install valve in supply line between main control valve and mast. Put capacity load on forks again. Raise carriage 2.5 m (8 ft). Close valve. If carriage or mast lower slowly, seals in lift cylinders have leaks.

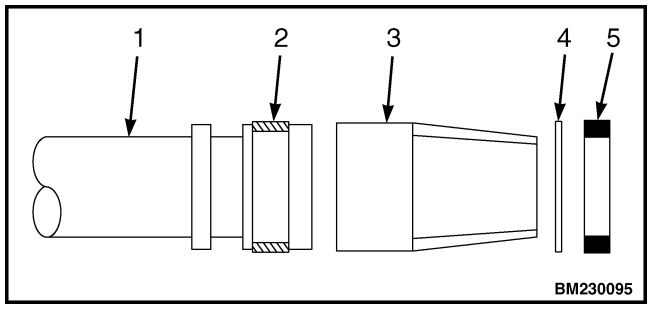
4. If carriage does not move, open valve and check movement again. If carriage lowers when valve is open, check for leaks in hydraulic lines and fittings. If no leaks are found, main control valve can be worn or damaged. Remove load from forks.

Seal Kit Installation

EXTERNAL INSTALLATION (SEAL AND BACK-UP RING)

NOTE: It is recommended that seal is heated in hydraulic oil prior to installation to make it more flexible and pliable.

1. Lubricate seal, back-up ring, external installation sleeve and piston rod groove with hydraulic fluid.
2. Install wear ring onto piston rod assembly. See Figure 80.
3. Slide external installation sleeve over piston rod assembly and wear ring. See Figure 80.
4. Install back-up ring into piston rod groove. See Figure 80.
5. Slide seal over external installation sleeve and into piston rod groove. See Figure 80.
6. Remove external installation sleeve.

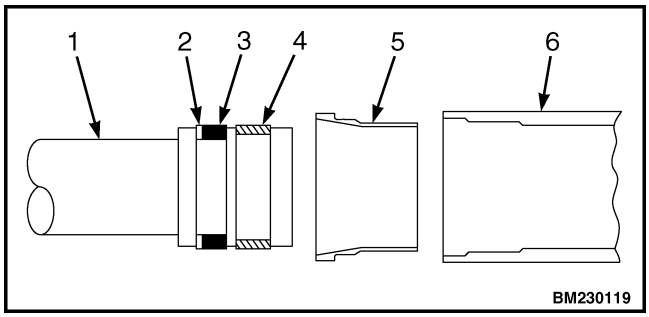


1. PISTON ROD ASSEMBLY
2. WEAR RING
3. EXTERNAL INSTALLATION SLEEVE
4. BACK-UP RING
5. SEAL

Figure 80. Cylinder External Seal Installation

INTERNAL INSTALLATION (PISTON ROD ASSEMBLY)

1. Insert internal installation sleeve into end of cylinder tube. See Figure 81.
2. Install piston rod assembly into cylinder tube. See Figure 81.
3. Remove internal installation sleeve from cylinder tube and piston rod assembly. See Figure 81.



1. PISTON ROD ASSEMBLY
2. BACK-UP RING
3. SEAL
4. INTERNAL INSTALLATION SLEEVE
5. CYLINDER TUBE
6. WEAR RING

Figure 81. Cylinder Internal Installation

Torque Specifications for Lift Truck Model J1.5XNT (K160)

TILT CYLINDERS

Piston Rod Lock-Nut
163-190 N•m (120-140 lbf ft)

Gland
163-190 N•m (120-140 lbf ft)

Tilt Cylinder Mounting Capscrew
90 N•m (66 lbf ft)

Tilt Cylinder Rod End Capscrew
38 N•m (28 lbf ft)

MAIN AND FREE-LIFT CYLINDERS

Gland, Main Lift Cylinder
340 to 410 N•m (250 to 300 lbf ft)

Piston, Main Lift Cylinder Two-Stage FFL
170 to 200 N•m (125 to 148 lbf ft)

Main Lift Cylinder Capscrew - Two-Stage FFL
6.0 to 8.0 N•m (53 to 71 lbf in)

Main Lift Cylinder Mount Nut
40 N•m (30 lbf ft)

Gland, Free-Lift Cylinder
475 to 540 N•m (350 to 400 lbf ft)

Crosshead Mount Capscrew
270 N•m (199 lbf ft)

Bracket Mount Capscrew
53 N•m (39 lbf ft)

Cylinder Guard Bracket Nuts
53 N•m (39 lbf ft)

Cylinder Clamp - Two-Stage FFL Mast
19 N•m (14 lbf ft)

Cylinder Restraint Capscrew
52 N•m (38 lbf ft)

Chain Sheave Cover Plate Bottom Capscrew
38 N•m (28 lbf ft)

Chain Sheave Cover Plate Top Capscrew
72 N•m (53 lbf ft)

Cylinder Clamp Nut, Left-Hand Main Lift Cylinder - Three-Stage FFL
25 N•m (18 lbf ft)

Cylinder Restraint Bracket Nut, Left-Hand Main Lift Cylinder - Three-Stage FFL
52 N•m (38 lbf ft)

Free-Lift Sheave Mounting Bracket Nut, Left-Hand Main Lift Cylinder - Three-Stage FFL
25 N•m (18 lbf ft)

Hose Sheave Cover Plate Bottom Capscrew, Left-Hand Main Lift Cylinder - Three-Stage FFL
38 N•m (28 lbf ft)

Hose Sheave Cover Plate Top Capscrew, Left-Hand Main Lift Cylinder - Three-Stage FFL
38 N•m (28 lbf ft)

Tube Mounting Plate Nut, Left-Hand Main Lift Cylinder - Three-Stage FFL
25 N•m (18 lbf ft)

Cylinder Port Clamp Nut, Right-Hand Main Lift Cylinder - Three-Stage FFL
25 N•m (18 lbf ft)

Cylinder Restraint Capscrew, Right-Hand Main Lift Cylinder - Three-Stage FFL
52 N•m (38 lbf ft)

Chain Sheave Cover Plate Bottom Capscrew, Right-Hand Main Lift Cylinder - Three-Stage FFL
38 N•m (28 lbf ft)

Chain Sheave Cover Plate Top Capscrew, Right-Hand Main Lift Cylinder - Three-Stage FFL
72 N•m (53 lbf ft)

SIDESHIFT CYLINDER

Sideshift Cylinder Retainer
325 ±30 N•m (240 ±22 lbf ft)

Torque Specifications for Lift Truck Models J1.6-2.0XNT (J30-40XNT) (K160), J1.6-2.0XN (J30-40XN) (A935), E30-40HSD$_2$ (B219), and E30-40HSD$_3$ (C219)

TILT CYLINDERS

Piston Rod Lock-Nut
163-190 N•m (120-140 lbf ft)

Gland
163-190 N•m (120-140 lbf ft)

Tilt Cylinder Mounting Capscrew
90 N•m (66 lbf ft)

Tilt Cylinder Rod End Capscrew
38 N•m (28 lbf ft)

MAIN AND FREE-LIFT CYLINDERS

Gland, Main Lift Cylinder - Two-Stage and Three-Stage FFL
340 to 410 N•m (250 to 300 lbf ft)

Gland, Main Lift Cylinder - Four-Stage FFL
68 N•m (50 lbf ft)

Piston, Main Lift Cylinder - Two-Stage FFL
170 to 200 N•m (125 to 148 lbf ft)

Piston, Main Lift Cylinder - Four-Stage FFL
68 N•m (50 lbf ft)

Main Lift Cylinder Capscrew - Two-Stage FFL
6.0 to 8.0 N•m (53 to 71 lbf in)

Main Lift Cylinder Mount Nut - Two-Stage and Three-Stage FFL
40 N•m (30 lbf ft)

Right-Hand Main Lift Cylinder Rod End - Four-Stage FFL
68 N•m (50 lbf ft)

Gland, Free-Lift Cylinder - Two-Stage and Three-Stage FFL
475 to 540 N•m (350 to 400 lbf ft)

Gland, Free-Lift Cylinder - Four-Stage FFL
129 to 169 N•m (95 to 125 lbf ft)

Crosshead Mount Capscrew - Two-Stage and Three-Stage FFL
270 N•m (199 lbf ft)

Bracket Mount Capscrew - Two-Stage and Three-Stage FFL
53 N•m (39 lbf ft)

Cylinder Guard Bracket Nuts - Two-Stage and Three-Stage FFL
53 N•m (39 lbf ft)

SIDESHIFT CYLINDER

Sideshift Cylinder Retainer (Before December, 2016)
325 ±30 N•m (240 ±22 lbf ft)

Sideshift Cylinder Gland (After December, 2016)
450 N•m (332 lbf ft)

Gland - Four Stage FFL Mast Only
217 N•m (160 lbf ft)

FORK POSITIONER CYLINDER

Cylinder Rod Retainer
165 N•m (120 lbf ft)

Fork Positioner Cylinder Mounting Capscrews
65 N•m (50 lbf ft)

Cylinder Rod Anchor Plug
65 N•m (50 lbf ft)

Fork Carrier Capscrews
35 N•m (25 lbf ft)

Torque Specifications for Lift Truck Models E2.2-3.5XN (E45-70XN) (A268) and J2.2-3.5XN (J45-70XN) (A276)

TILT CYLINDERS

Piston Rod Nut

E2.2-2.5XN (E45-55XN) (A268), and J2.2-2.5XN (J45-50XN) (A276)
170 to 220 N•m (125 to 163 lbf ft)

E2.2-3.5XN (E45-70XN) (A268) and J3.0-3.5XN (J60-70XN) (A276)
320 to 400 N•m (240 to 295 lbf ft)

Gland

E2.2-2.5XN (E45-55XN) (A268), and J2.2-2.5XN (J45-50XN) (A276)
170 to 237 N•m (125 to 175 lbf ft)

E3.0-3.5XN (E60-70) (A268), and J3.0-3.5XN (J60-70XN (A276)
400 to 500 N•m (295 to 370 lbf ft)

Tilt Cylinder Mounting Capscrew

For lift truck models E2.2-3.5XN (E45-70XN) (A268), and J2.2-3.5XN (J45-70XN) (A276)
38 N•m (28 lbf ft)

Tilt Cylinder Rod End Capscrew

For lift truck models E2.2-3.5XN (E45-70XN) (A268) and J2.2-3.5XN (J45-70XN) (A276)
90 N•m (66 lbf ft)

MAIN AND FREE-LIFT CYLINDER

Main Lift Cylinder Piston
170 to 200 N•m (125 to 148 lbf ft)

Gland, Main Lift Cylinders
340 to 410 N•m (250 to 300 lbf ft)

Main Lift Cylinder Capscrew
6.0 to 8.0 N•m (53 to 71 lbf in)

Main Lift Cylinder Mount Nut
40 N•m (30 lbf ft)

Main Lift Cylinder Keeper Nut - Four-Stage Mast
33 N•m (24 lbf ft)

Gland, Free-Lift Cylinder - Two and Three-Stage Mast
475 to 540 N•m (350 to 400 lbf ft)

Free-Lift Cylinder Bracket Capscrews
53 N•m (39 lbf ft)

Gland, Free-Lift Cylinder - Four-Stage Mast
340 to 410 N•m (250 to 300 lbf ft)

Gland, Two-Stage Limited Free-Lift Cylinder
340 to 410 N•m (250 to 300 lbf ft)

Full Free-Lift Cylinder Capscrew
5.5 to 6.5 N•m (49 to 58 lbf in)

Free-Lift Crosshead Capscrew - Four-Stage Mast
38 N•m (28 lbf ft)

SIDESHIFT CYLINDER

Sideshift Cylinder Retainer (Before December, 2016)
325 ±30 N•m (240 ±22 lbf ft)

Sideshift Cylinder Gland (Lift Truck Models E2.2-3.5XN (E45-70XN) (A268) After December, 2016)
450 N•m (332 lbf ft)

FORK POSITIONER CYLINDER

Cylinder Rod Retainer
165 N•m (120 lbf ft)

Fork Positioner Cylinder Mounting Capscrews
65 N•m (50 lbf ft)

Cylinder Rod Anchor Plug
65 N•m (50 lbf ft)

Fork Carrier Capscrews
35 N•m (25 lbf ft)

Torque Specifications for Lift Truck Model J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

TILT CYLINDERS

Piston Rod Nut
400 to 440 N•m (295 to 325 lbf ft)

Gland
400 to 500 N•m (295 to 370 lbf ft)

Tilt Cylinder Mounting Capscrew
66 to 73 N•m (49 to 54 lbf ft)

Tilt Cylinder Rod End Capscrew
90 N•m (66 lbf ft)

MAIN AND FREE-LIFT CYLINDER

Main Lift Cylinder Piston
170 to 200 N•m (125 to 148 lbf ft)

Gland, Main Lift Cylinders
340 to 410 N•m (250 to 300 lbf ft)

Main Lift Cylinder Capscrew
6.0 to 8.0 N•m (53 to 71 lbf in)

Main Lift Cylinder Mount Nut
33 N•m (24 lbf ft)

Gland, Free-Lift Cylinder - Two and Three-Stage Mast
400 to 475 N•m (295 to 350 lbf ft)

Free-Lift Cylinder Bracket Capscrews
175 N•m (129 lbf ft)

Gland, Two-Stage Limited Free-Lift Cylinder
340 to 410 N•m (250 to 300 lbf ft)

Full Free-Lift Cylinder Capscrew
6.0 to 8.0 N•m (53 to 70 lbf in)

SIDESHIFT CYLINDER

Sideshift Cylinder Retainer
325 ±30 N•m (240 ±22 lbf ft)

Torque Specifications for Lift Truck Model E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

TILT CYLINDER

Piston Rod Nut
400 to 440 N•m (295 to 325 lbf ft)

Gland
400 to 500 N•m (295 to 370 lbf ft)

Tilt Cylinder Mounting Capscrew
68 N•m (50 lbf ft)

Tilt Cylinder Rod End Capscrew
90 N•m (66 lbf ft)

MAIN AND FREE LIFT CYLINDER

Main Lift Cylinder Piston
170 to 200 N•m (125 to 148 lbf ft)

Gland, Main Lift Cylinders
340 to 410 N•m (250 to 300 lbf ft)

Main Lift Cylinder Capscrew
6.0 to 8.0 N•m (53 to 71 lbf in)

Main Lift Cylinder Mount Nut
33 N•m (24 lbf ft)

Gland, Free-Lift Cylinder - Two and Three-Stage Mast
400 to 475 N•m (295 to 350 lbf ft)

Free-Lift Cylinder Bracket Capscrews
175 N•m (129 lbf ft)

Gland, Two-Stage Limited Free-Lift Cylinder
340 to 410 N•m (250 to 300 lbf ft)

Full Free-Lift Cylinder Capscrew
6.0 to 8.0 N•m (50 to 70 lbf in)

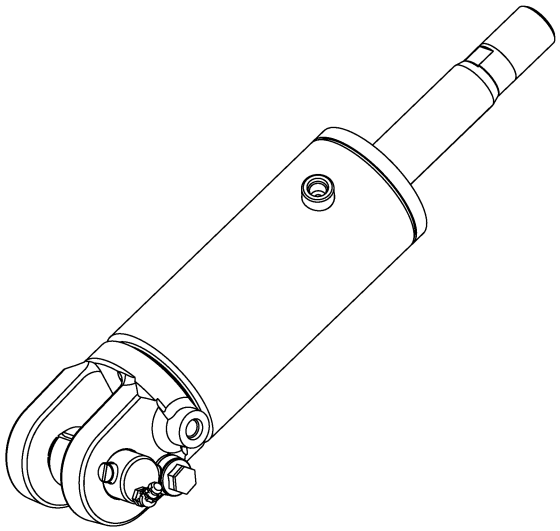
SIDESHIFT CYLINDER

Sideshift Cylinder Retainer
325 ±30 N•m (240 ±22 lbf ft)

NOTES

CYLINDER REPAIR (MAST S/N F507, F508, F562, F563)

E2.2-3.5XN
(E45-70XN) [A268];J2.2-3.5XN
(J45-70XN) [A276];S2.0-3.5FT
(S40-70FT) [F187, G187, H187];H2.0-3.5FT
(H40-70FT) [L177, N177, P177]



HYSTER

PART NO. 4099650

2100 SRM 1668

SAFETY PRECAUTIONS
MAINTENANCE AND REPAIR

- The Service Manuals are updated on a regular basis, but may not reflect recent design changes to the product. Updated technical service information may be available from your local authorized Hyster® dealer. Service Manuals provide general guidelines for maintenance and service and are intended for use by trained and experienced technicians. Failure to properly maintain equipment or to follow instructions contained in the Service Manual could result in damage to the products, personal injury, property damage or death.
- When lifting parts or assemblies, make sure all slings, chains, or cables are correctly fastened, and that the load being lifted is balanced. Make sure the crane, cables, and chains have the capacity to support the weight of the load.
- Do not lift heavy parts by hand, use a lifting mechanism.
- Wear safety glasses.
- DISCONNECT THE BATTERY CONNECTOR before doing any maintenance or repair on electric lift trucks. Disconnect the battery ground cable on internal combustion lift trucks.
- Always use correct blocks to prevent the unit from rolling or falling. See HOW TO PUT THE LIFT TRUCK ON BLOCKS in the **Operating Manual** or the **Periodic Maintenance** section.
- Keep the unit clean and the working area clean and orderly.
- Use the correct tools for the job.
- Keep the tools clean and in good condition.
- Always use **HYSTER APPROVED** parts when making repairs. Replacement parts must meet or exceed the specifications of the original equipment manufacturer.
- Make sure all nuts, bolts, snap rings, and other fastening devices are removed before using force to remove parts.
- Always fasten a DO NOT OPERATE tag to the controls of the unit when making repairs, or if the unit needs repairs.
- Be sure to follow the **WARNING** and **CAUTION** notes in the instructions.
- Gasoline, Liquid Petroleum Gas (LPG), Compressed Natural Gas (CNG), and Diesel fuel are flammable. Be sure to follow the necessary safety precautions when handling these fuels and when working on these fuel systems.
- Batteries generate flammable gas when they are being charged. Keep fire and sparks away from the area. Make sure the area is well ventilated.

NOTE: The following symbols and words indicate safety information in this manual:

WARNING

Indicates a hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION

Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury and property damage.

On the lift truck, the WARNING symbol and word are on orange background. The CAUTION symbol and word are on yellow background.

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This section is for the following models:

E2.2-3.5XN (E45-70XN) [A268];
J2.2-3.5XN (J45-70XN) [A276];
S2.0-3.5FT (S40-70FT) [F187, G187, H187];
H2.0-3.5FT (H40-70FT) [L177, N177, P177]

General

WARNING

Before working on or near the mast, see Safety Procedures When Working Near Mast in this manual.

CAUTION

Before working on any components of the hydraulic system, see the Hydraulic Cleanliness Procedures manual listed below, for procedures to prevent dirt and debris from entering the hydraulic system and cause damage.

This section contains the description and repair procedures for several different types of cylinders used on lift trucks equipped with a mast containing one of the following serial numbers:

- **F507** - Two-Stage, Limited Free-Lift (LFL) mast
- **F508** - Three-Stage, Full Free-Lift (FFL) mast
- **F562** - Two-Stage, Limited Free-Lift (FFL) mast
- **F563** - Three-Stage, Full Free-Lift (FFL) mast

The mast serial number is located on the right side of the outer mast. Other information about the mast can also be found in this area. See Figure 1.

The number and design of the parts can be different, but the operation of the cylinders is the same.

Additional information concerning the cylinders may be included in other sections when the information is closely related to other systems. Sections may include:

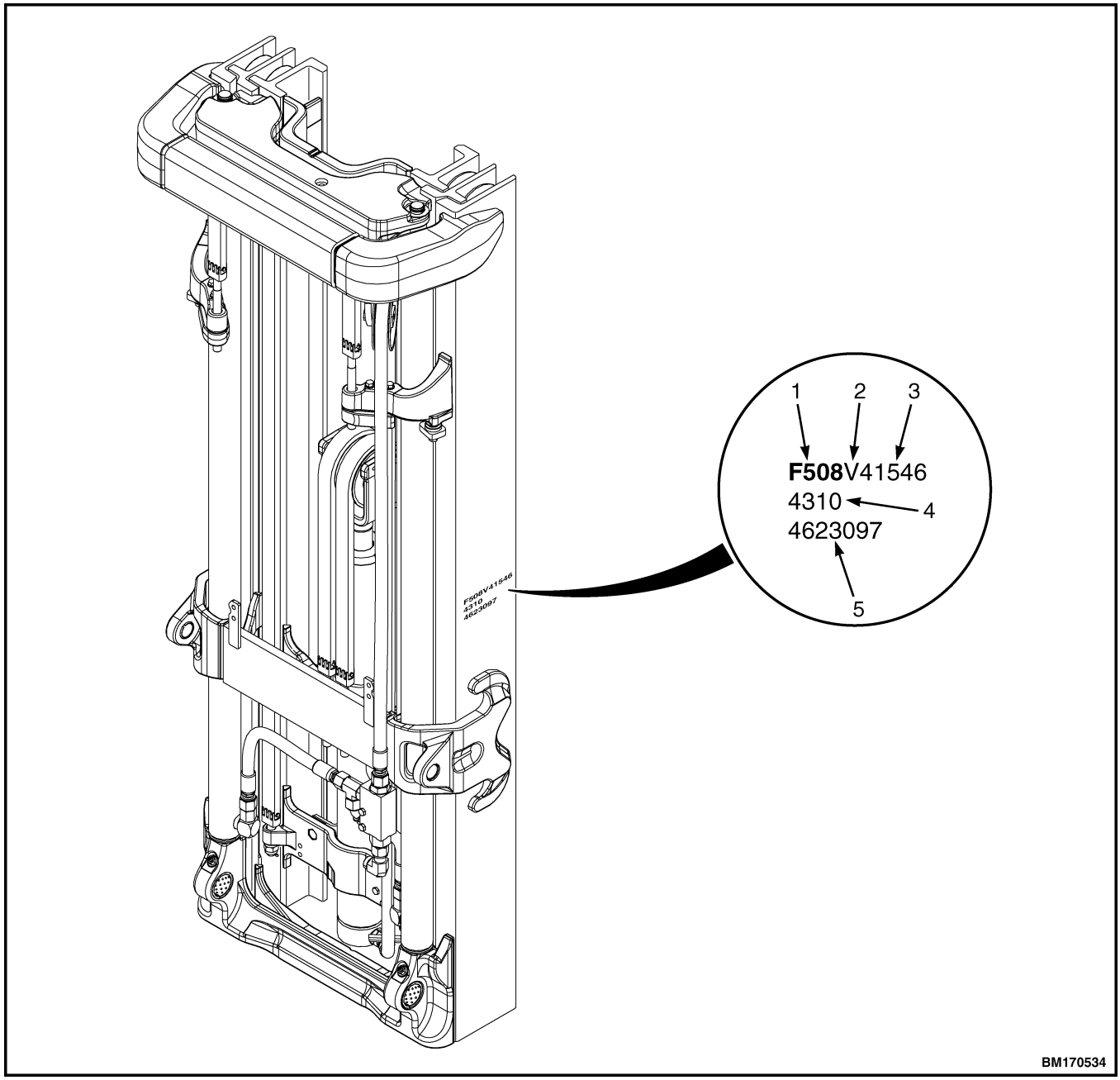
- **Mast Repair (S/N F507, F508, F562, F563)** 4000SRM1669
- **Hydraulic Cleanliness Procedures** 1900SRM1620
- **Main Control Valves** 2000SRM1334 for lift truck models

  E2.2-3.5XN (E45-70XN) (A268) and J2.2-3.5XN (J45-70XN) (A276)
- **Main Control Valve** 2000SRM1137 for lift truck models

  S2.0-3.5FT (S40-70FT) (F187) and H2.0-3.5FT (H40-70FT) (L177)
- **Main Control Valve** 2000SRM1684 for lift truck models

  S2.0-3.5FT (S40-70FT) (G187) and H2.0-3.5FT (H40-70FT) (N177)
- **Main Control Valve** 2000SRM1745 for lift truck models

  S2.0-3.5FT (S40-70FT) (H187) and H2.0-3.5FT (H40-70FT) (P177)



NOTE: THE MAST AND TEXT SHOWN IN ABOVE ILLUSTRATION ARE FOR ILLUSTRATIVE PURPOSES ONLY. YOUR MAST AND TEXT MAY BE DIFFERENT, BUT THE TEXT IS FOUND IN THE SAME LOCATION.

1. MAST SERIAL NUMBER
2. MANUFACTURING PLANT
3. PRODUCTION SEQUENCE
4. MAST LIFT HEIGHT (IN MILLIMETERS)
5. MAST ASSEMBLY PART NUMBER

Figure 1. Mast Serial Number Location

Safety Procedures When Working Near Mast

The following procedures **MUST** be used when inspecting or working near the mast. Additional precautions and procedures can be required when repairing or removing the mast. See the correct Service Manual section for the specific mast being repaired.

WARNING

The following procedures MUST be used when inspecting or working near the mast. Additional precautions and procedures can be required when repairing or removing the mast. See the correct Service Manual section for the specific mast being repaired.

- Never put any part of the body into or under the mast or carriage unless all parts are completely lowered or a safety chain is installed. Also make sure that the power is off and the key is removed. Put a **DO NOT OPERATE** tag in the operator's compartment. Disconnect the battery on electric lift trucks and put a tag or lock on the battery connector.
- Be careful of the forks. When the mast is raised, the forks can be at a height to cause an injury.
- **DO NOT** climb on the mast or lift truck at any time. Use a ladder or personnel lift to work on the mast.
- **DO NOT** use blocks to support the mast weldments or to restrain their movement.
- Mast repairs require disassembly and removal of parts and can require removal of the mast or carriage. Follow the repair procedures in the correct Service Manual for the mast.

WHEN WORKING NEAR THE MAST ALWAYS:

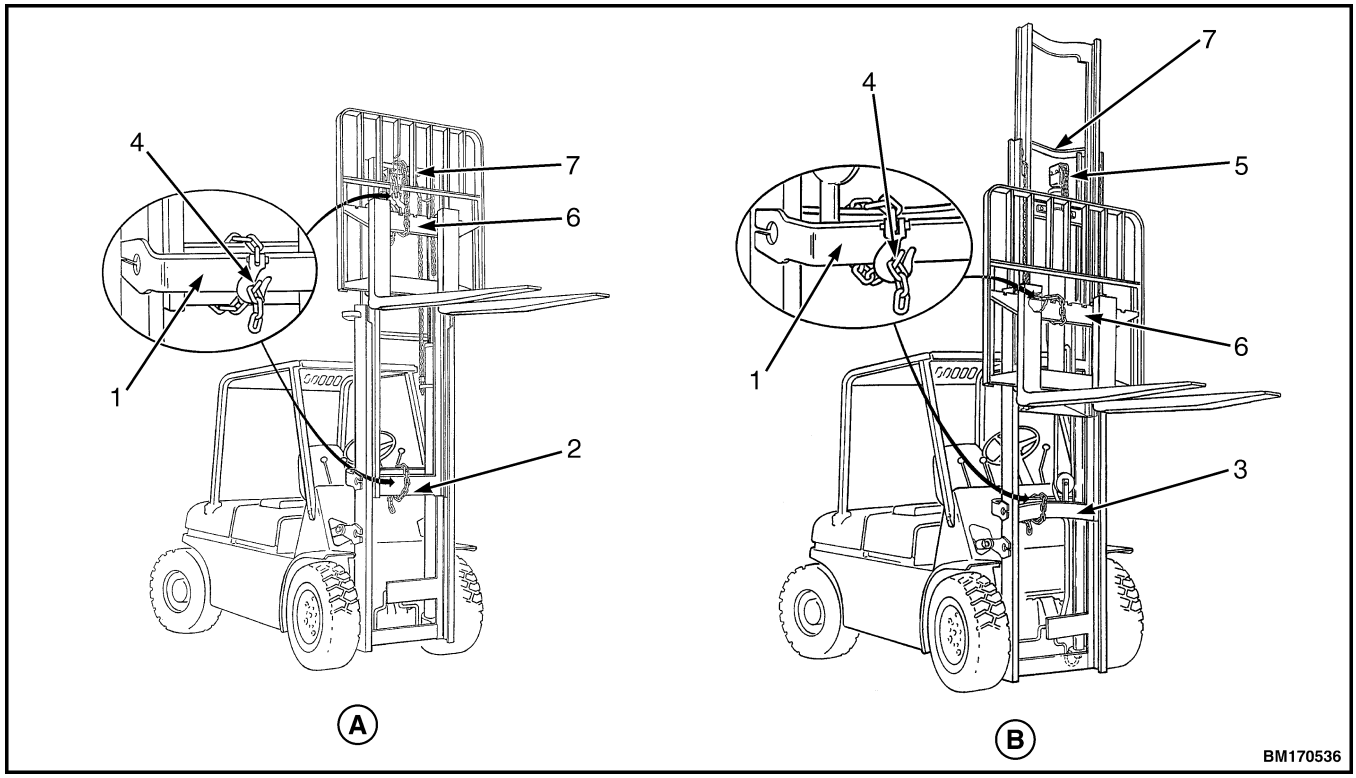
- Lower the mast and carriage completely. Push the lift/lower control lever forward and make sure there is no movement in the mast. Make sure that all parts of the mast that move are fully lowered.

OR

- If parts of the mast must be in a raised position, install a safety chain to restrain the moving parts of the mast. Connect moving parts to a part that does not move. Follow these procedures:

1. Put mast in vertical position.
2. Raise mast to align bottom crossmember of weldment that moves in the outer weldment with a crossmember on the outer weldment. On the two-stage and free-lift mast, the moving part is the inner weldment. On the three-stage mast, it is the intermediate weldment. See Figure 2.
3. Use a 3/8 inch minimum safety chain with a hook to fasten the crossmembers together so the movable member cannot lower. Put the hook on the back side of the mast. Make sure the hook is completely engaged with a link in the chain. Make sure the safety chain does not touch lift chains or chain sheaves, tubes, hoses, fittings, or other parts on the mast.
4. Lower mast until there is tension in the safety chain and the free-lift cylinder (three-stage) is completely retracted. If running, stop the engine. Apply parking brake. Install a **DO NOT REMOVE** tag on the safety chain(s).
5. Install another safety chain (3/8 inch minimum) between the top or bottom crossmember of the carriage and a crossmember on the outer weldment. See Figure 2.

NOTE: Apply parking brake. After lowering or restraining the mast, shut off power and remove key. Put a **DO NOT OPERATE** tag in the operator's compartment. Disconnect battery on electric lift trucks and put a tag or lock on battery connector.



A. TWO-STAGE LFL MAST

1. OUTER WELDMENT
2. INNER WELDMENT
3. INTERMEDIATE WELDMENT
4. HOOK

B. THREE-STAGE FFL MAST

5. FREE-LIFT CYLINDER
6. CROSSMEMBER
7. CROSSMEMBER

Figure 2. Two-Stage LFL and Three-Stage FFL Masts

Main Lift Cylinder Repair

REMOVE

WARNING

Before working on or near the mast, see Safety Procedures When Working Near Mast

NOTE: The following procedures are for the removal of the main lift cylinders with the mast installed on the lift truck.

1. Remove the carriage as described in the carriage removal procedures located in the **Mast** service manual listed in the General section of this manual.
2. Raise the mast until it is almost fully extended. Chain the mast as instructed in the section Safety Procedures When Working Near Mast.

WARNING

Be careful when removing or install snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers and wear eye and face protection during removal or installation.

3. Remove snap ring and shims (washers) at the top of the main lift cylinders. See Figure 3.

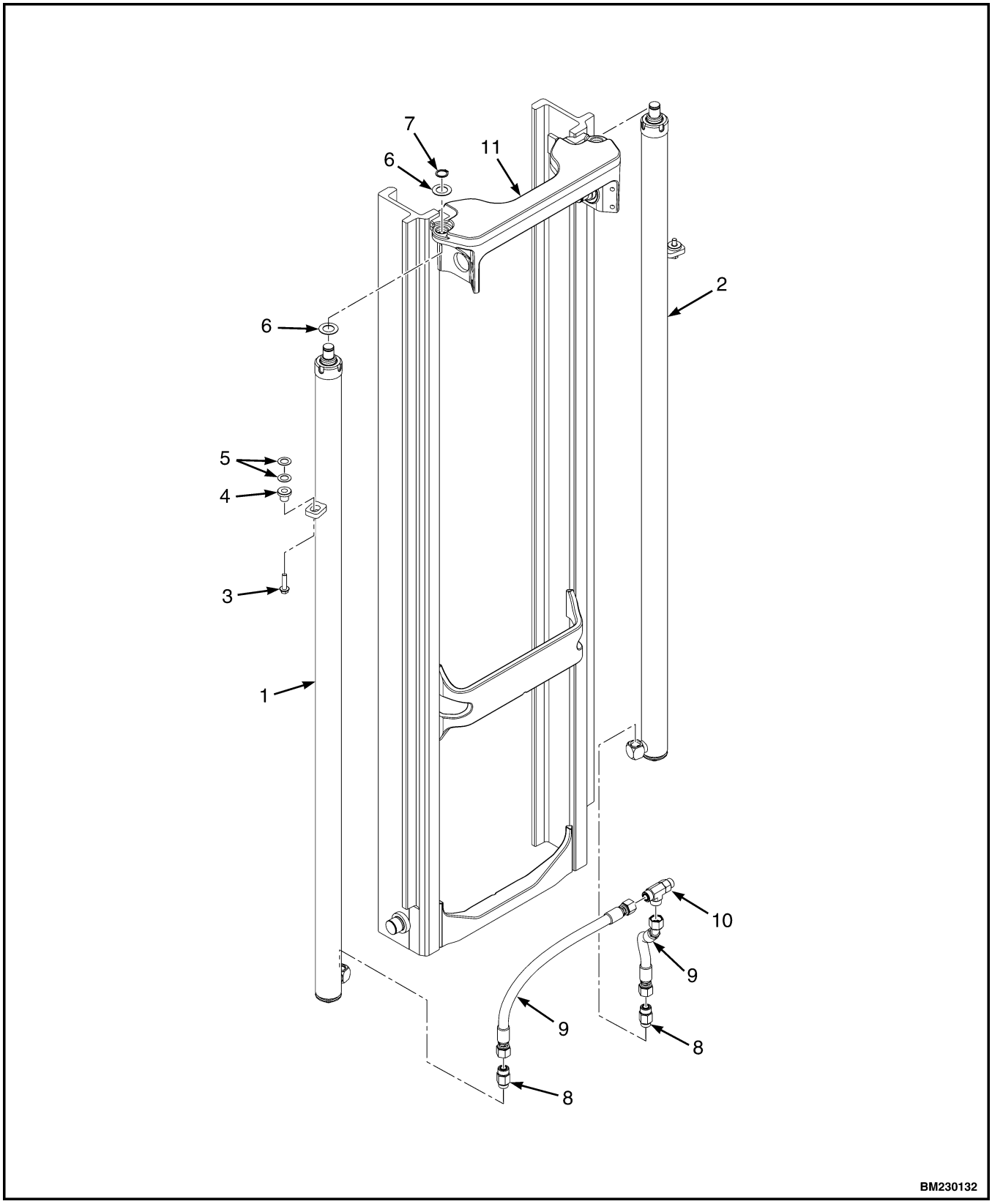


Figure 3. Main Lift Cylinder, Remove

Legend for Figure 3.

1. LEFT MAIN LIFT CYLINDER
2. RIGHT MAIN LIFT CYLINDER
3. CAPSCREW
4. ISOLATOR
5. WASHER
6. SHIM (WASHER)
7. SNAP RING
8. VELOCITY FUSE
9. HOSE ASSEMBLY
10. HYDRAULIC FITTING
11. INNER MAST

WARNING

Hydraulic oil is hot after system operation and can cause burns. DO NOT disconnect any hydraulic hoses until the oil in the hydraulic system is cool.

4. Put a drain pan under the area of the hydraulic fittings. Disconnect and cap the hydraulic lines at the cylinder. Retract the rod into the lift cylinder. See Figure 3.

5. Remove the capscrew, washer, and isolator at the mounting plate. Disconnect main lift chain at the mount. See Figure 3.

6. Using a lifting device, remove main lift cylinder from mast.

DISASSEMBLE

CAUTION

Carefully disassemble the main lift cylinders so the piston rods and sliding surfaces are not damaged.

1. Loosen gland with spanner wrench.

2. Remove gland from cylinder shell. See Figure 4.

3. Remove rod and piston assembly from cylinder shell. Drain hydraulic oil into container.

NOTE: To prevent damage to sealing surfaces, use brass tools when removing seals and O-rings.

4. Remove O-rings, rod seals, backup rings, wiper rings, and wear rings. Discard O-rings, rod seals, and wear rings. See Figure 4.

WARNING

Be careful when removing or install snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers and wear eye and face protection during removal or installation.

5. Remove snap ring, washer, and check valve from base of piston. See Figure 4.

6. Remove and discard O-ring from check valve. See Figure 4.

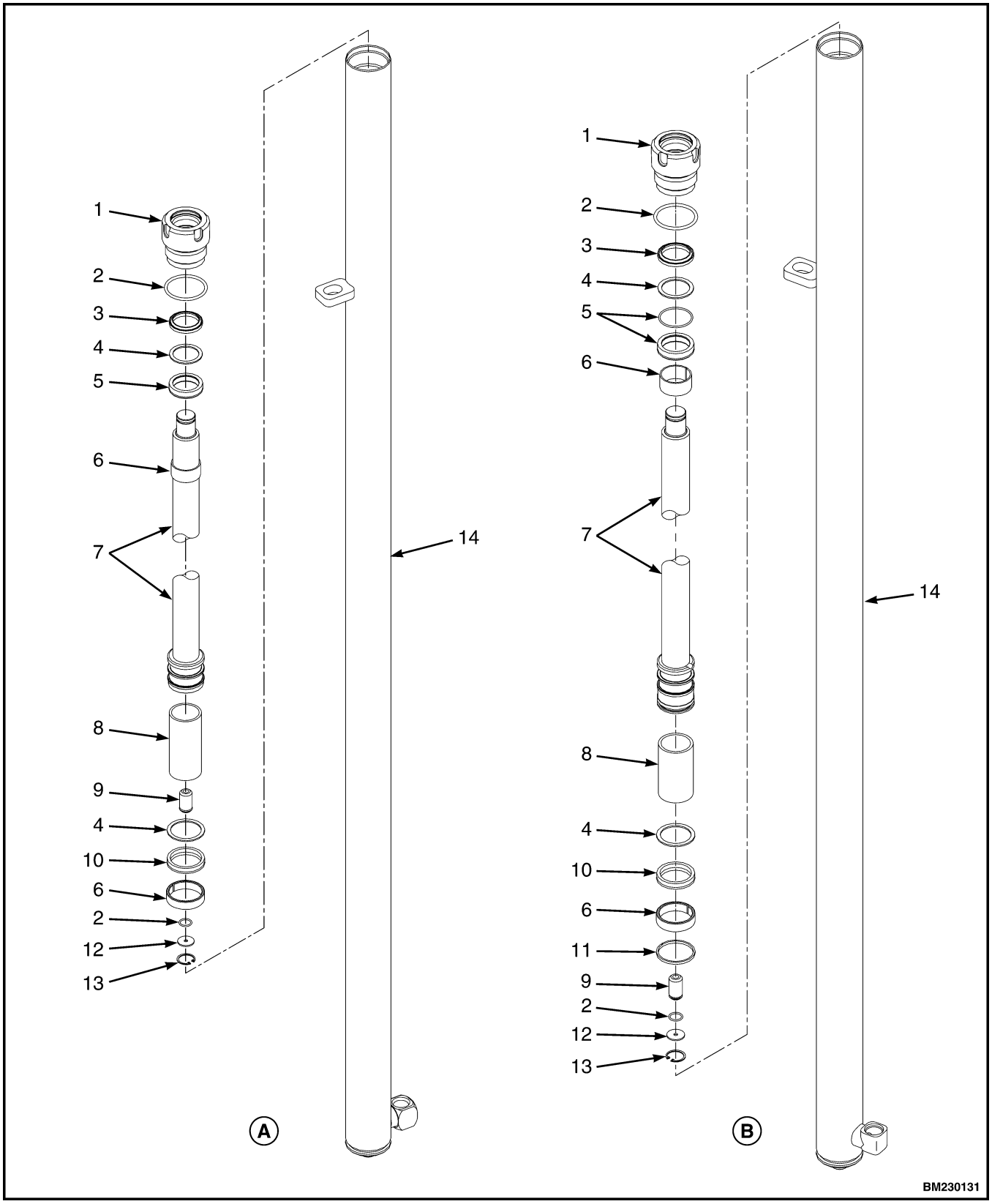
NOTE: Perform Step 7 for two-stage LFL mast.

7. Remove wear ring, piston seal, backup ring, and spacer from base of piston. Discard wear ring and piston seal. See Figure 4.

NOTE: Perform Step 8 for three-stage FFL mast.

8. Remove piston ring, wear ring, piston seal, backup ring, and spacer from base of piston. Discard wear ring and piston seal. See Figure 4.

9. Repeat Step 1 through Step 8 for opposite main lift cylinder.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A. TWO-STAGE LFL MAIN LIFT CYLINDER

1. GLAND
2. O-RING
3. WIPER RING
4. BACKUP RING
5. ROD SEAL
6. WEAR RING
7. ROD

B. THREE-STAGE FFL MAIN LIFT CYLINDER

8. SPACER
9. CHECK VALVE
10. PISTON SEAL
11. PISTON RING
12. WASHER
13. SNAP RING
14. SHELL

Figure 4. Main Lift Cylinder, Disassemble

CLEAN

WARNING

Cleaning solvents can be flammable and toxic and can cause skin irritation. When using cleaning solvents, always follow the solvent manufacturer's recommended safety procedures.

WARNING

Compressed air can move particles so they cause injury to the user or to other personnel. Make sure the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eyes.

CAUTION

DO NOT allow cleaning solvent to come in contact with rubber components. It will damage those components.

Clean all metal parts in solvent and dry with compressed air.

INSPECT

NOTE: See the **Parts Manual** for all replacement parts.

- Inspect the gland for damage to the threads and the seal surfaces. If damaged, replace gland.
- Inspect the piston for any damage to the seal surfaces. If damaged, replace piston.
- Inspect the rod for damage to the rod surface and ensure that the rod is not bent. If damaged, replace rod.
- Inspect the inner surface of the cylinder tube for damage. If damaged, replace cylinder assembly.

ASSEMBLE

NOTE: To prevent damage to sealing surfaces, use brass tools when installing seals and O-rings.

1. Lubricate all internal parts of main lift cylinder with clean hydraulic oil. Use new O-rings, seals and wear rings. See Figure 4.

2. Install O-ring on check valve.

WARNING

Be careful when removing or installing snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers and wear eye and face protection during removal or installation.

3. Install check valve, washer, and snap ring in base of piston. See Figure 4.

NOTE: For two-stage LFL mast, go to Step 4. For three-stage FFL mast, go to Step 5.

4. Install spacer, backup ring, piston seal, and wear ring on rod and piston. See Figure 4.

5. Install spacer, backup ring, piston seal, wear ring, and piston ring on rod and piston. See Figure 4.

6. Push piston and rod assembly into cylinder shell.

7. Install new wear ring, rod seals, backup rings, wiper ring, and O-ring on gland.

8. Install gland into cylinder shell and tighten gland to 340 to 410 N•m (250 to 300 lbf ft).

9. Repeat Step 1 through Step 8 for the opposite main lift cylinder.

INSTALL

1. Using a lifting device, install main lift cylinders in the mounts at the bottom of the outer mast.

2. Install isolator, washer, and capscrew at the mounting plate. Tighten capscrew to 38 N•m (28 lbf ft). See Figure 3.

3. Use a lifting device to lower the inner mast weldment (two-stage LFL mast) or the intermediate mast weldment (three-stage FFL mast) onto the main lift cylinders.

4. Install shims (washers) and snap rings at the top of main lift cylinders. See Figure 3.

5. Uncap hydraulic lines and cylinder ports. Connect hydraulic lines to cylinder ports.

CAUTION

Disposal of lubricants and fluids must meet local environmental regulations.

6. Dispose of drain pan contents.

7. Connect main lift chains and adjust as described in the **Mast** service manual listed in the General section of this manual.

MAIN LIFT CYLINDER LEAK CHECK

WARNING

During the test procedures for the hydraulic system, use chains to fasten the load to the carriage to prevent it from falling. Keep all people away from the lift truck during the tests.

WARNING

Do NOT try to find hydraulic leaks by putting your hand on hydraulic components under pressure. Hydraulic oil can be injected into the body by the pressure.

1. Operate hydraulic system. Put capacity load on forks. Use safety chain to hold load to carriage. Raise and lower load several times. Lower load and tilt mast forward and backward several times. Check for leaks.

2. Raise carriage and load 1 m (3 ft). If carriage slowly lowers when control valve is in **NEUTRAL** position, there are leaks in hydraulic system. The maximum speed the carriage is allowed to lower is 50 mm (2 in.) per 10 minutes when hydraulic oil is 30°C (86°F). If oil temperature is 70°C (158°F), the maximum speed the carriage can lower is 150 mm (6 in.) per 10 minutes.

3. Check lift cylinders for internal leaks. Remove load from forks. Install valve in supply line between main control valve and mast. Put capacity load on forks again. Raise carriage 1 m (3 ft). Close valve. If carriage or mast lower slowly, seals in lift cylinders have leaks.

4. If carriage does not move, open valve and check movement again. If carriage lowers when valve is open, check for leaks in hydraulic lines and fittings. If no leaks are found, main control valve can be worn or damaged. Remove load from forks.

Free-Lift Cylinder

REMOVE

WARNING

Before working on the mast, see the section Safety Procedures When Working Near Mast.

1. Remove the carriage as described in the carriage removal procedures in the **Mast** service manual listed in the General section of this manual.

2. Lower the mast completely.

WARNING

Hydraulic oil is hot after system operation and can cause burns. DO NOT disconnect any hydraulic hoses until the oil in the system is cool.

3. Put a drain pan under the area of the hydraulic fittings. Disconnect and cap hydraulic line at the free-lift cylinder. See Figure 5.

NOTE: Be sure to tag header hoses prior to disconnecting them to aid in re-connecting.

4. Disconnect and remove header hoses from crosshead plate. See Figure 5.

5. Remove capscrews, washers, and crosshead plate from crosshead. See Figure 5.

6. Remove lift chains from chain sheaves.

7. Remove capscrews, washers, nuts, and clamps from free-lift cylinder and mast. See Figure 5.

8. Using a lifting device, remove free-lift cylinder from mast.

9. Remove roll pin, pin, and chain sheaves from crosshead. See Figure 5.

10. Remove crosshead from free-lift cylinder rod. See Figure 5.

11. If necessary, remove spacers and ball bearings from chain sheave. See Figure 5.

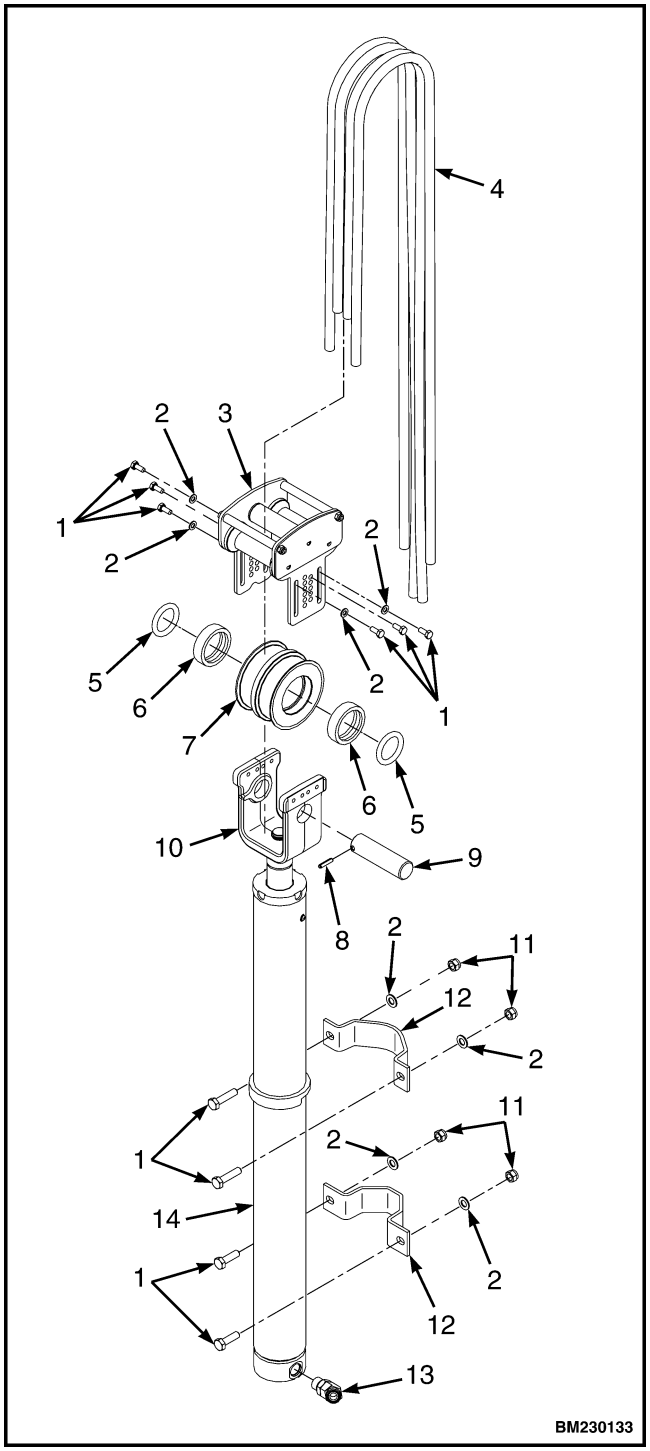


Figure 5. Free-Lift Cylinder, Remove

Legend for Figure 5.

1. CAPSCREW
2. WASHER
3. CROSSHEAD PLATE
4. HEADER HOSE
5. SPACER
6. BALL BEARING
7. CHAIN SHEAVE
8. ROLL PIN
9. PIN
10. CROSSHEAD
11. NUT
12. CLAMP
13. HYDRAULIC FITTING
14. FREE-LIFT CYLINDER

DISASSEMBLE

NOTE: To prevent damage to sealing surfaces, use brass tools when removing and installing seals and O-rings.

NOTE: Perform only those steps below required to repair the free-lift cylinder.

1. Loosen gland with spanner wrench.

2. Remove gland from shell. See Figure 6.

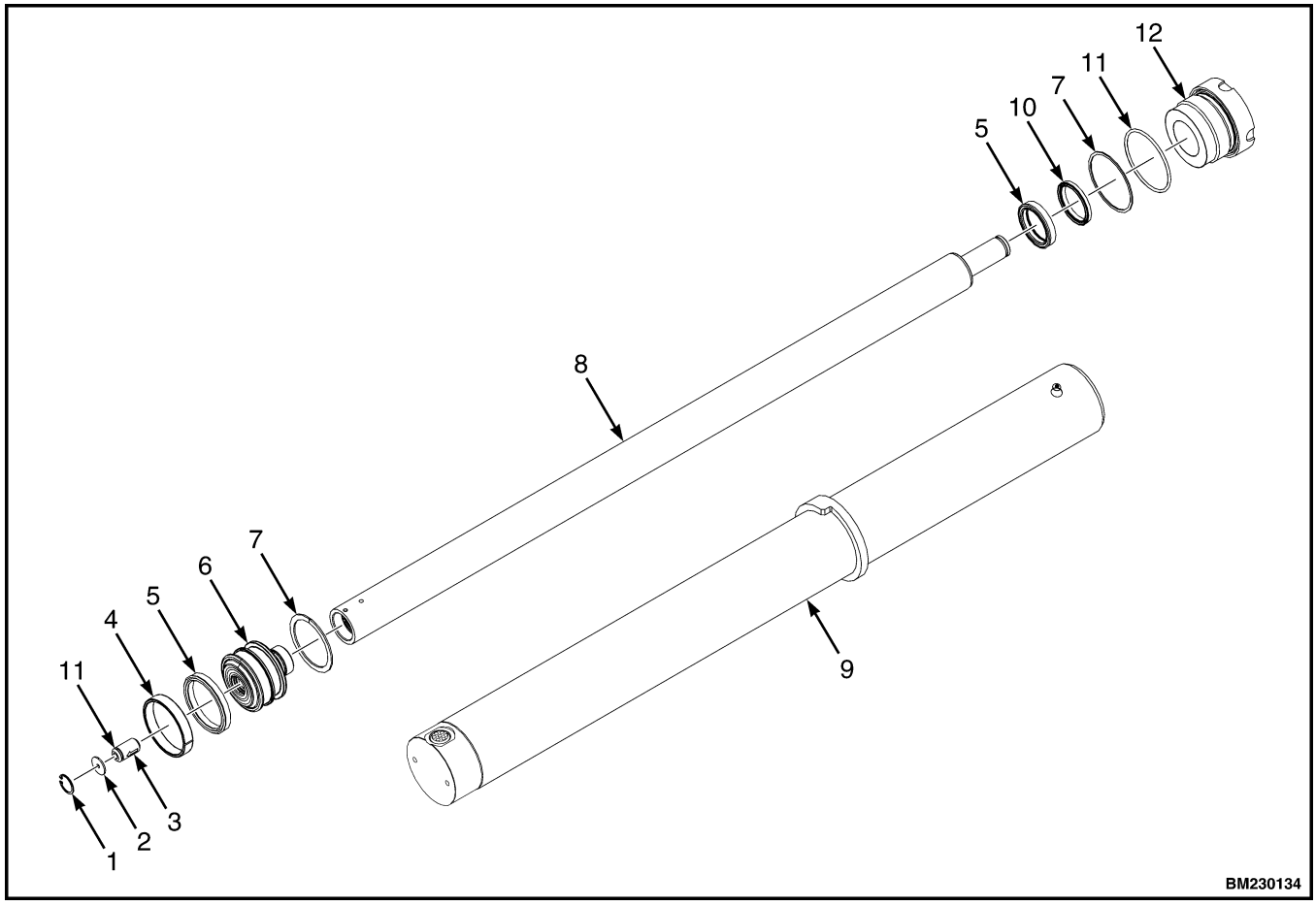
3. Remove rod and piston assembly from shell. Drain hydraulic oil into a container.

4. Remove and discard rod seal, rod wiper, backup ring, and O-ring from gland. See Figure 6.

WARNING

Be careful when removing or installing snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers and wear eye and face protection during removal or installation.

5. Remove snap ring, washer, check valve, wear ring, rod seal, and backup ring from piston. Discard snap ring, wear ring, rod seal, and backup ring. Remove and discard O-ring from check valve. See Figure 6.



1. SNAP RING
2. WASHER
3. CHECK VALVE
4. WEAR RING
5. ROD SEAL
6. PISTON
7. BACKUP RING
8. FREE-LIFT CYLINDER
9. SHELL
10. ROD WIPER
11. O-RING
12. GLAND

Figure 6. Free-Lift Cylinder, Disassemble

CLEAN

WARNING

Cleaning solvents can be flammable and toxic and cause skin irritation. When using cleaning solvents, always follow the solvent manufacturer's recommended safety procedures.

WARNING

Compressed air can move particles so they cause injury to the user or to other personnel. Make sure the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eyes.

CAUTION

DO NOT allow cleaning solvent to come in contact with rubber components. It will damage those components.

Clean all metal parts in solvent and dry with compressed air.

INSPECT

NOTE: See the **Parts Manual** for all replacement parts.

- Inspect the gland for damage to the threads and the seal surfaces. If damaged, replace gland.
- Inspect the piston for any damage to the seal surfaces. If damaged, replace piston.
- Inspect the rod for damage to the rod surface and ensure the rod is not bent. If damaged, replace rod.
- Inspect the inner surface of the cylinder tube for damages. If damaged, replace free-lift cylinder assembly.

ASSEMBLE

NOTE: To prevent damage to sealing surfaces, use brass tools when removing and installing seals and O-rings.

1. Lubricate all internal parts of the free-lift cylinder with clean hydraulic oil. Use new O-rings, seals, and wear rings. See Figure 6.
2. Install new O-ring on check valve. Install check valve in the base of the piston. Be sure arrow on check valve is pointing towards base of piston. Install washer and snap ring in the base of the pinon. See Figure 6.

CAUTION

A difficult and important step in assembling the free-lift cylinder is the correct installation of seals. Most free-lift cylinder repairs are caused by seal leaks. DO NOT damage any parts during assembly.

3. Install new backup ring, rod seal, and wear ring on the piston assembly. See Figure 6.
4. Carefully push the piston and rod assembly into the shell. See Figure 6.
5. Install rod wiper into the gland. Install new O-ring, backup ring, and rod seal on the outside of gland. See Figure 6.

CAUTION

Additives may damage the hydraulic system. Before using additives, contact your local Hyster dealer.

NOTE: Hydraulic oil is poured into the free-lift cylinder to act as a cushion during load lifting to prevent damage to the cylinder.

6. Before installing the gland, pour 150 cc (5 oz) of hydraulic oil into the free-lift cylinder shell.
7. Install the gland on the piston rod and tighten to 475 to 540 N•m (350 to 400 lbf ft).

INSTALL

1. If chain sheave was disassembled, install ball bearings and spacers. See Figure 5.
2. Install chain sheave into crosshead.
3. Install pin through chain sheave, then install roll pin. See Figure 5.

NOTE: When installing the free-lift cylinder to the inner mast crossmembers, the nuts are installed on the clamp side of the free-lift cylinder. See Figure 5.

4. Using a lifting device, install free-lift cylinder, two clamps, four washers, capscrews, and nuts onto inner mast. Tighten capscrews 53 N•m (39 lbf ft). See Figure 5.

5. Install lift chains to chain sheaves and chain anchors.

6. Install crosshead plate washers and capscrews to crosshead. Tighten capscrews to 18 N•m (159 lbf in). See Figure 5.

7. Install header hoses to free-lift cylinder. See the **Mast** service manual listed in the General section of this manual. for procedures.

CAUTION

Disposal of lubricants and fluids must meet local environmental regulations.

8. Uncap hydraulic line and cylinder port. Connect hydraulic line to free-lift cylinder. Dispose of drain pan contents.

9. Install carriage. See the **Mast** service manual listed in the General section of this manual. for procedures.

Tilt Cylinder Repair

REMOVE

WARNING

Before removing the tilt cylinder(s), tilt the mast forward. Use a chain to hold the mast to the frame to prevent the mast from moving forward.

WARNING

DO NOT push the anchor pins out of the rod end with your fingers and cause serious injury to hand and fingers. DO NOT permit the tilt cylinder to drop and cause damage to lift truck and/or tilt cylinders.

NOTE: Only lift truck models J2.2-3.5XN (J45-70XN) (A276) may be equipped with optional boots on the tilt cylinders.

1. At the mast end, remove capscrew and retainer from anchor pin. Using a drift pin or similar tool, push anchor pin out of rod end.

   See Figure 7 for lift truck models J2.2-3.5XN (J45-70XN) (A276) equipped with tilt cylinders with optional boots.

   See Figure 8 for lift trucks equipped with tilt cylinders without boots.

2. Stroke tilt cylinders to the full back tilt position.

3. Disconnect hydraulic line at tilt cylinder. Install cap on hydraulic line and in cylinder port.

4. Remove nut, capscrew, and washer from rod end on mast end of truck.

WARNING

DO NOT push the anchor pins out of the rod end with your fingers and cause serious injury to hand and fingers. DO NOT permit the tilt cylinder to drop and cause damage to lift truck and/or tilt cylinders.

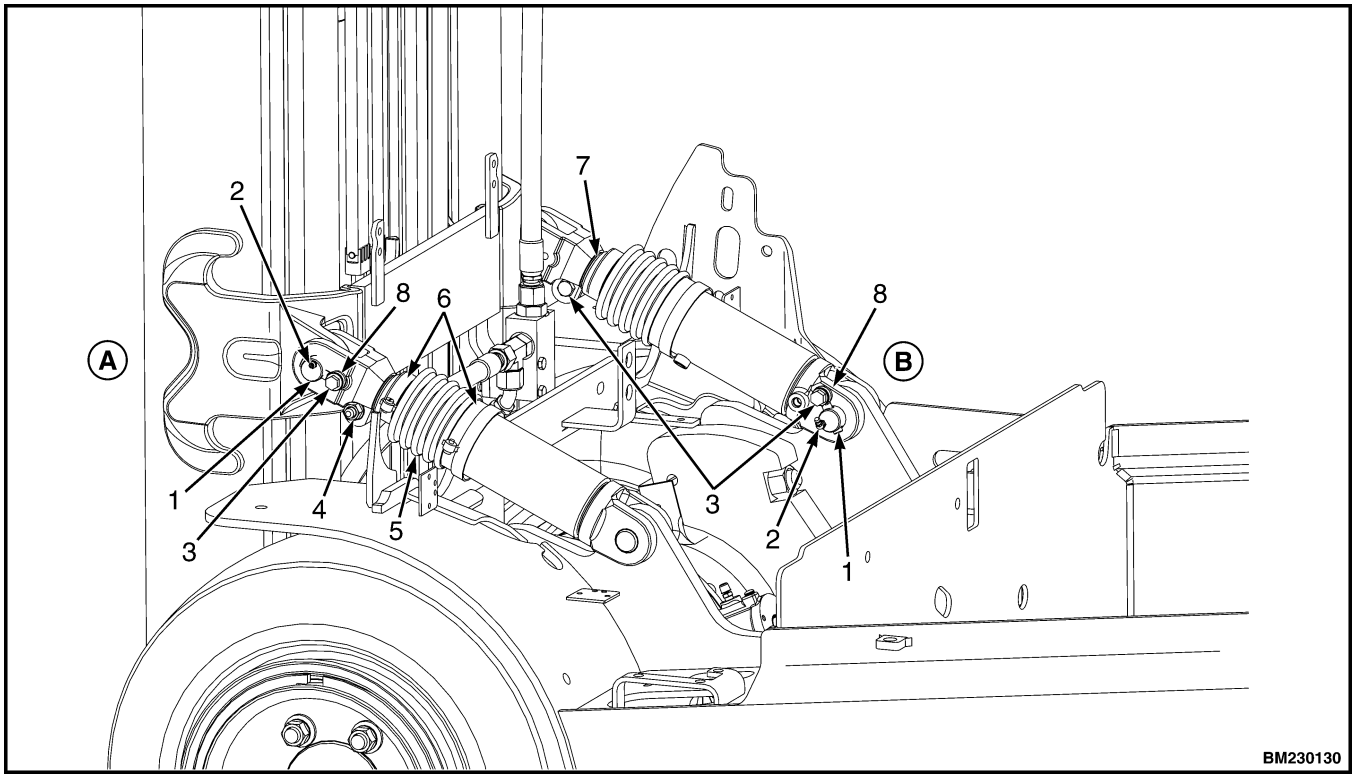
5. Use a lifting device to hold tilt cylinder. At the truck end, remove capscrew and retainer from anchor pin. Using a drift pin, or similar tool, push anchor pin out of lift truck frame.

   See Figure 7 for lift truck models J2.2-3.5XN (J45-70XN) (A276) equipped with tilt cylinders with optional boots.

   See Figure 8 for lift trucks equipped with tilt cylinders without boots.

6. Using lifting device, remove tilt cylinder from lift truck.

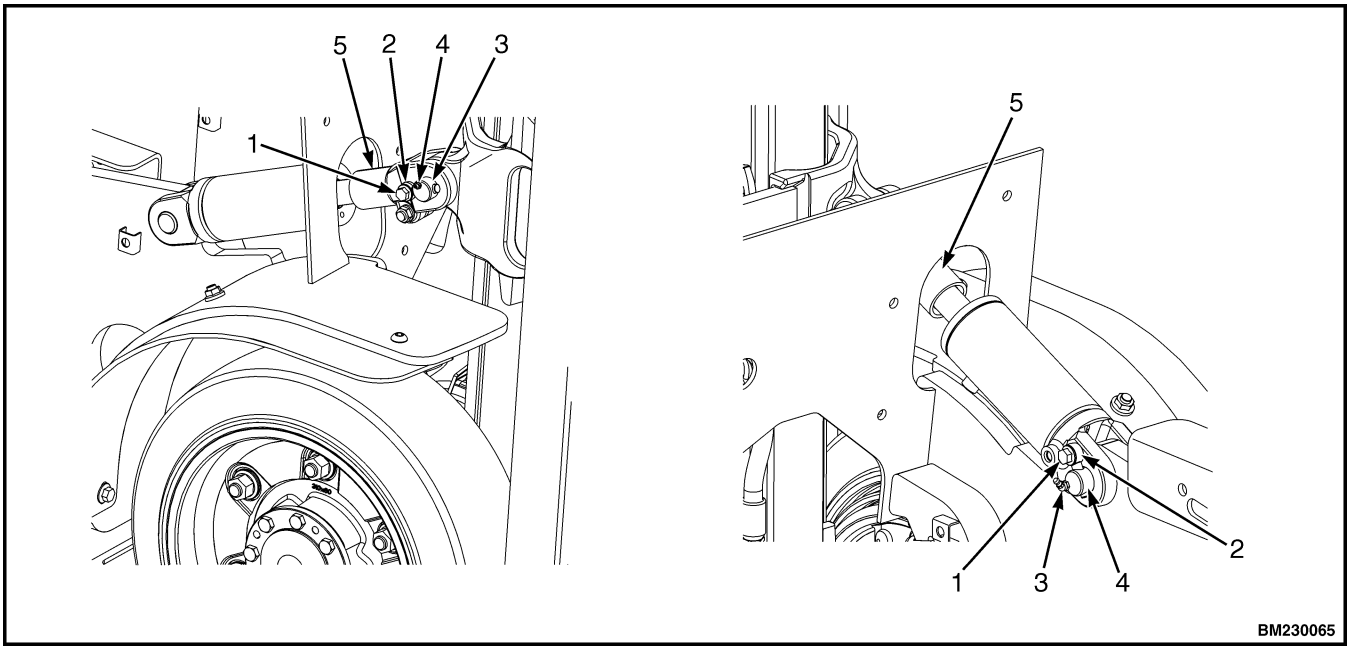
7. If necessary, repeat Step 1 through Step 6 for other tilt cylinder.



A. MAST END
B. TRUCK END

1. ANCHOR PIN
2. GREASE FITTING
3. CAPSCREW
4. NUT
5. BOOT
6. CLAMP
7. SPACER
8. RETAINER

Figure 7. Remove, Tilt Cylinder With Boot, Lift Truck Models J2.2-3.5XN (J45-70XN) (A276)



NOTE: HYDRAULIC HOSES NOT SHOWN FOR CLARITY.

1. CAPSCREW
2. RETAINER
3. LUBRICATION FITTING
4. ANCHOR PIN
5. TILT SPACER

Figure 8. Remove, Tilt Cylinder Without Boot

DISASSEMBLE

NOTE: The following steps have detailed disassembly instructions. Perform only those steps required to repair the tilt cylinder.

NOTE: Note position of rod end and the number of turns used to remove it from rod.

1. Place tilt cylinder in a soft-jaw vise.

a. Tilt Cylinder equipped with optional boot: Remove rod end and, if equipped, shims. Remove two clamps and boot from tilt cylinder. Remove tilt spacer from rod. See Figure 7.

b. Tilt cylinder not equipped with optional boot: Remove rod end and, if equipped, tilt spacer from rod end. See Figure 8.

2. Using a pin-type spanner wrench, remove gland from rod and shell.

3. Remove rod and piston assembly from shell. See Figure 9.

NOTE: To prevent damage to sealing surfaces, use brass tools when removing seals and O-rings.

4. Remove and discard O-ring, backup ring, seal, and rod wiper from gland. See Figure 9.

NOTE: Perform Step 5 only if piston or rod has been damaged.

5. Place rod in a soft-jaw vise and remove nut and piston from rod. See Figure 9.

NOTE: Perform the following step for lift truck models

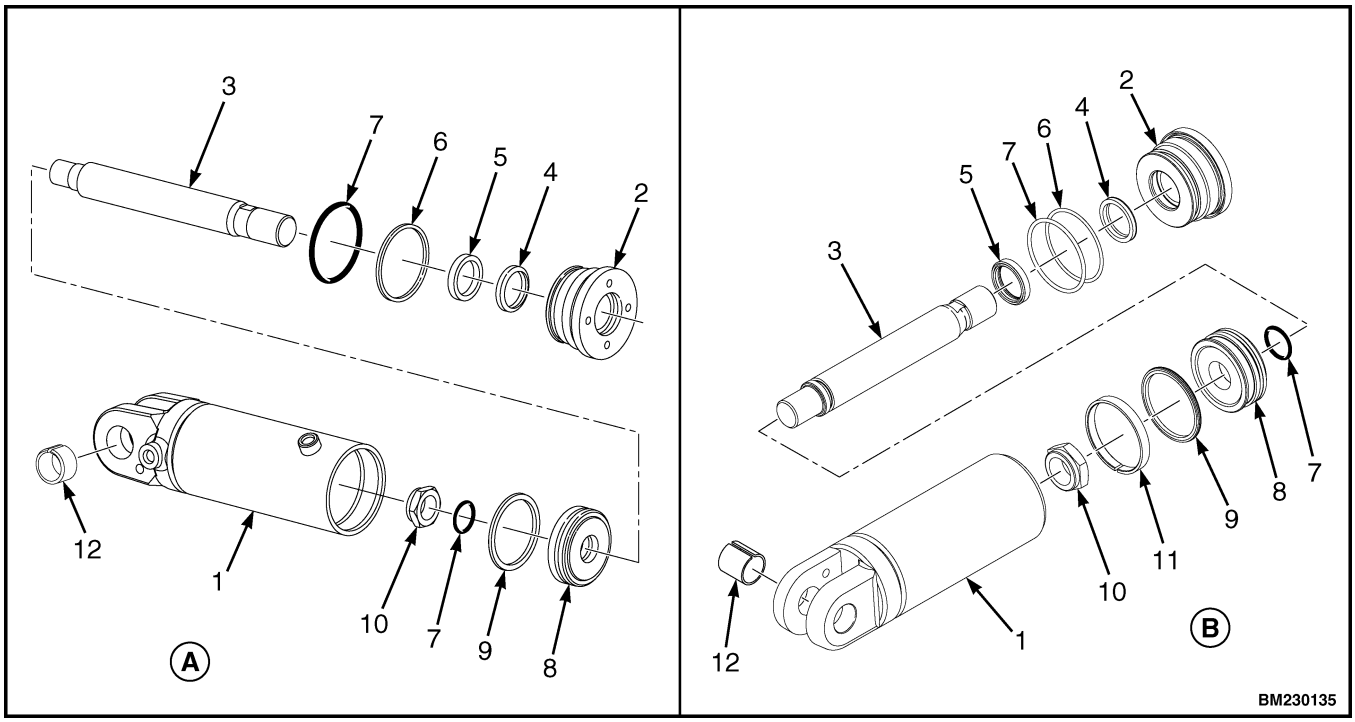
E2.2-3.0XN (E45-55XN) (A268)
J2.2-2.5XN (J45-50XN) (A276)
S2.0-2.5FT (S40-55FT) (F187, G187, H187)
H2.0-2.5FT (H40-50FT) (L177, N177, P177)

6. Remove and discard O-ring and piston seal from piston. See Figure 9.

NOTE: Perform the following step for lift truck models

E3.2-3.5XN (E60-70XN) (A268)
J3.0-3.5XN (J60-70XN) (A276)
S3.0-3.5FT (S60-70FT) (F187, G187, H187)
H3.0-3.5FT (H60-70FT) (L177, N177, P177)

7. Remove and discard O-ring, piston seal, and wear ring from piston. See Figure 9.



A. TILT CYLINDER FOR LIFT TRUCK MODELS E2.2-3.0XN (E45-55XN) (A268), J2.2-2.5XN (J45-50XN) (A276), S2.0-2.5FT (S40-55FT) (F187, G187, H187), AND H2.0-2.5FT (H40-50FT) (L177, N177, P177)
B. TILT CYLINDER FOR LIFT TRUCK MODELS E3.2-3.5XN (E60-70XN) (A268), J3.0-3.5XN (J60-70XN) (A276), S3.0-3.5FT (S60-70FT) (F187, G187, H187), AND H3.0-3.5FT (H60-70FT) (L177, N177, P177)

1. SHELL
2. GLAND
3. ROD
4. ROD WIPER
5. SEAL
6. BACKUP RING
7. O-RING
8. PISTON
9. PISTON SEAL
10. NUT
11. WEAR RING
12. BUSHING

Figure 9. Disassemble Tilt Cylinder

CLEAN

WARNING

Cleaning solvents can be flammable and toxic and can cause skin irritation. When using cleaning solvents, always follow the solvent manufacturer's recommended safety procedures.

WARNING

Compressed air can move particles so they cause injury to the user or to other personnel. Make sure the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eyes.

CAUTION

DO NOT allow cleaning solvent to come in contact with rubber components. It will damage those components.

Clean all metal parts in solvent and dry with compressed air.

INSPECT

NOTE: See the **Parts Manual** for all replacement parts.

- Inspect gland for damage to the threads and the sealing surface. Replace gland if damaged.
- Inspect piston for damage to the seal surfaces. Replace piston if damaged.
- Inspect rod for damage to the rod surface and ensure rod is not bent. Replace rod if damaged.
- Inspect inner surface of cylinder tube for damage. If tube is found to be damaged, replace the cylinder.
- Inspect bushings for damage. If damaged, replace bushings.

ASSEMBLE

NOTE: To prevent damage to sealing surfaces, use brass tools when installing seals and O-rings.

NOTE: Lubricate new seals, O-rings, and rings with clean hydraulic oil before installation.

NOTE: Perform the following step for lift truck models

E2.2-3.0XN (E45-55XN) (A268)
J2.2-2.5XN (J45-50XN) (A276)
S2.0-2.5FT (S40-55FT) (F187, G187, H187)
H2.0-2.5FT (H40-50FT) (L177, N177, P177)

1. Install new piston seal and O-ring on piston. See Figure 9.

NOTE: Perform the following step for lift truck models

E2.2-3.0XN (E45-55XN) (A268)
J2.2-2.5XN (J45-50XN) (A276)
S2.0-2.5FT (S40-55FT) (F187, G187, H187)
H2.0-2.5FT (H40-50FT) (L177, N177, P177)

2. Install new wear ring, piston seal and O-ring on piston. See Figure 9.

NOTE: Perform Step 3 only if piston was removed from rod.

3. Place rod in a soft-jaw vise and lube the threads of the nut with clean hydraulic oil. Install piston and nut on rod. Tighten nut to 170 to 220 N•m (125 to 162 lbf ft).

4. Install new rod wiper, seal, backup ring, and O-ring on gland. See Figure 9.

5. Install rod and piston assembly into shell. Using a pin-type spanner wrench, install gland onto rod in shell.

6. Tighten gland to
170 to 237 N•m (125 to 175 lbf ft) for lift truck models
   - E2.2-3.0XN (E45-55XN) (A268)
   - J2.2-2.5XN (J45-50XN) (A276)
   - S2.0-2.5FT (S40-55FT) (F187, G187, H187)
   - H2.0-2.5FT (H40-50FT) (L177, N177, P177)

   Tighten gland to
   400 to 500 N•m (295 to 370 lbf ft) for lift truck models
   - E3.0-3.5XN (E60-70XN) (A268)
   - J3.0-3.5XN (J60-70XN) (A276)
   - S3.0-3.5FT (S60-70FT) (F187, G187, H187)
   - H3.0-3.5FT (H60-70FT) (L177, N177, P177)

7. Place cylinder in a soft-jaw vise.

a. **Tilt cylinder not equipped with boot:** Install tilt spacer, if equipped, and rod end on rod as noted during removal. See Figure 8.

   Lubricate threads on capscrew with lubricant (Hyster P/N 186061) . Install capscrew in rod end so that capscrew head is on the inboard side of rod end. Install washer and nut on capscrew. Washer and nut must be on outboard side of rod end. Tighten nut to 90 N•m (66 lbf ft). See Figure 10.

b. **Tilt Cylinder equipped with optional boot:** Install tilt spacer tight against rod end. Install tilt cylinder boot with air holes on the bottom. Install tilt cylinder boot to tilt cylinder and tilt spacer using two clamps. See Figure 7.

   Lubricate threads on capscrew with lubricant (Hyster P/N 186061) . Install capscrew in rod end so that capscrew head is on the inboard side of rod end. Install washer and nut on capscrew. Washer and nut must be on outboard side of rod end. Tighten nut to 90 N•m (66 lbf ft). See Figure 10.

8. Repeat Step 1 through Step 7 for the opposite tilt cylinder.

INSTALL

1. Using a lifting device, place cylinder in mounting position on lift truck frame.

NOTE: Lubricate threads on capscrew that secures rod end to piston with lubricant, (Hyster P/N 186061) .

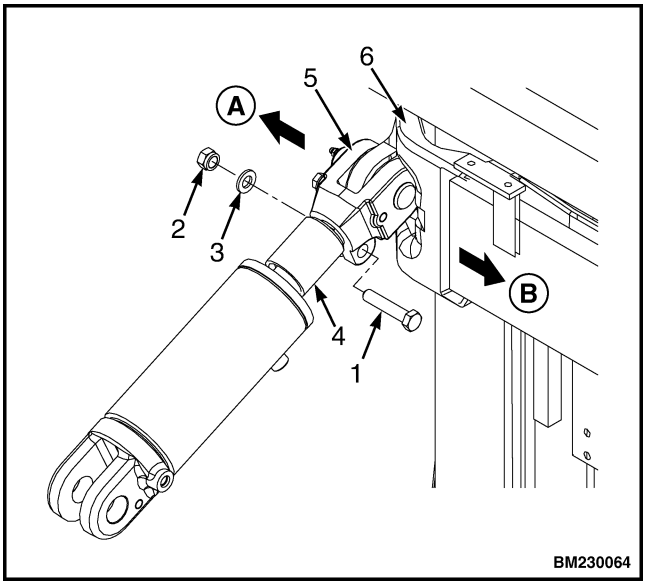
2. Install anchor pin, retainer, and capscrew.

3. Install rod end to mast with washer, capscrew, and nut. Tighten capscrew to 38 N•m (28 lbf ft).

   See Figure 7 for lift truck models J2.2-3.5XN (J45-70XN) (A276) equipped with tilt cylinders with optional boots

   See Figure 8

4. Connect hydraulic lines to tilt cylinder. Slowly stroke tilt cylinders until rod holes line up with mast tilt anchor holes.



NOTE: LEFT TILT CYLINDER WITHOUT BOOT SHOWN. TILT CYLINDERS WITH OPTIONAL BOOT INSTALLED IN SAME WAY.

A. OUTBOARD SIDE OF ROD END
B. INBOARD SIDE OF ROD END

1. CAPSCREW
2. NUT
3. WASHER
4. TILT SPACER
5. ROD END
6. MAST END MOUNT

Figure 10. Install Rod End

5. Install anchor pin and retainer on tilt anchor.

   See Figure 7 for lift truck models J2.2-3.5XN (J45-70XN) (A276) equipped with tilt cylinders with optional boots

   See Figure 8 for lift trucks equipped with tilt cylinders without boots

6. Repeat Step 1 through Step 5 for opposite tilt cylinder.

7. Remove chain holding mast to lift truck frame.

WARNING

DO NOT put hands between the cylinder rod end and the mast. Serious injury can occur.

8. Operate tilt cylinders and check for correct operation and leakage.

a. **Tilt cylinders equipped with optional boot:** Check that there is no slippage at boot collars when mast tilts forward and backward.

b. **All tilt cylinders:** Adjust the tilt cylinders. See section Tilt Cylinder Adjustment for procedures.

TILT CYLINDER ADJUSTMENT

WARNING

When the tilt cylinders have tilt limit spacers, make sure they are installed during the assembly procedures. Without tilt limit spacers, the mast can tilt too much and cause an accident or serious injury.

Check the tilt cylinder stroke by slowly tilting the mast forward and backward several times. Both tilt cylinders must stop their stroke at the same time. Adjust the rod ends as shown in Figure 11. There must be no twist in the mast weldments.

1. Adjust the stroke of the tilt cylinders **WITHOUT** tilt limit spacers as follows:

a. Adjust the rod ends to 20 mm (0.80 in.).

b. Slowly tilt the mast backwards until one cylinder rod stops. On the opposite cylinder rod, loosen the capscrews on the rod end.

c. Measure the distance from the end of the cylinder to the back end of the rod end.

d. Use a wrench and turn the cylinder rod **IN** until the dimension starts to decrease, then stop.

e. Repeat Step b through Step d until both cylinder rods stop at the same position within 0.5 mm (0.02 in.).

f. Tilt the mast fully backwards and measure the tilt angle. See the Nameplate for tilt angles. If necessary, adjust both rod ends equally for the correct angle.

g. After adjustments are complete, tighten nuts on rod end to 90 N•m (66 lbf ft).

2. Adjust the stroke of the tilt cylinders **WITH** tilt limit spacers as follows:

a. Adjust the rod ends to 20 mm (0.80 in.).

b. Slowly tilt the mast forward until one cylinder rod stops. On the opposite cylinder rod, loosen the capscrews on the rod end.

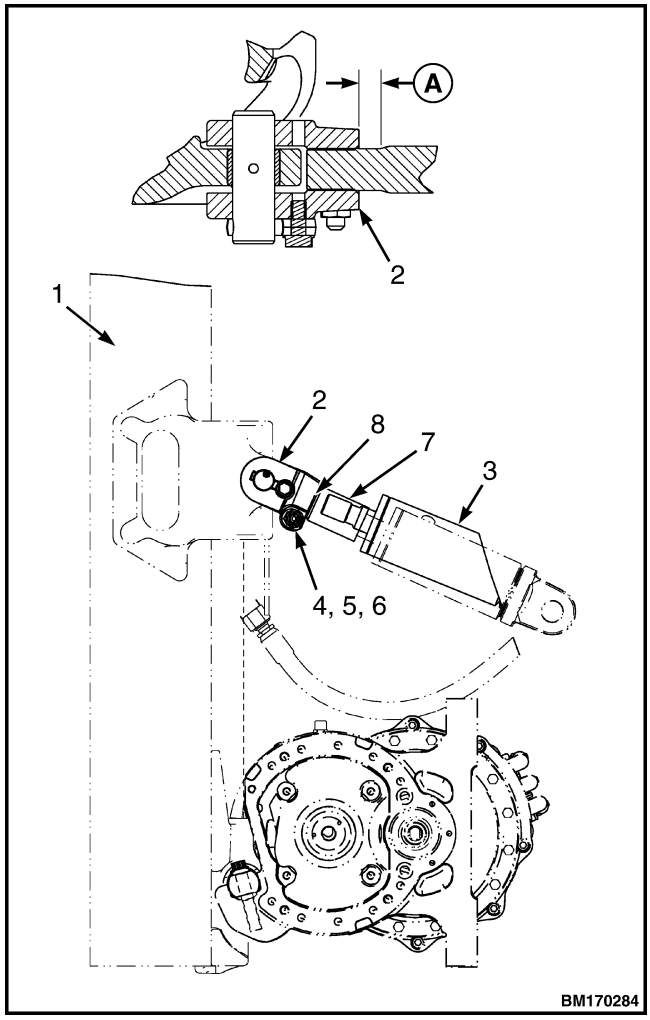
c. Use a wrench and turn the cylinder rod **IN** as necessary.

d. Repeat Step b and Step c until both cylinder rods stop at the same position within 0.5 mm (0.02 in.).

e. Slowly tilt the mast backward until one rod end just contacts the spacer. Add shims to fill the gap at the opposite rod end until both rod ends contact the spacers within 0.5 mm (0.02 in.).

f. Tilt the mast fully forward and measure the tilt angle. See the Nameplate for tilt angles. If necessary, add an equal number of shims to both rods for the correct angle.

g. After adjustments are complete, tighten nuts on rod end to 90 N•m (66 lbf ft).



NOTE: TILT CYLINDER WITHOUT BOOT SHOWN. TILT CYLINDER WITH BOOT IS SIMILAR.

A. DIMENSION A = 20 mm (0.80 in.)

1. MAST
2. ROD END
3. TILT CYLINDER
4. WASHER
5. CAPSCREW
6. NUT
7. TILT LIMIT SPACER
8. SHIMS

Figure 11. Tilt Cylinder Adjustment

TILT CYLINDER LEAK CHECK

WARNING

Never allow anyone under a raised carriage. DO NOT put any part of your body in or through the lift mechanism unless all parts of the mast are completely lowered and the key switch or keyless switch is turned OFF.

WARNING

DO NOT try to find hydraulic leaks by putting your hand on hydraulic components under pressure. Hydraulic oil can be injected into the body by the pressure.

1. Put a capacity load on the forks. Use a safety chain to hold the load to the carriage. See Safety Procedures When Working Near Mast. Raise the load approximately 2.5 m (8 ft). Put the mast in a vertical position.

2. Measure the distance that one of the rods for the tilt cylinders extends from the shell. Check the distance the rod move in five or ten minutes. Multiply the rate in Table 1 by the time of the test and compare the numbers.

3. If the tilt rate is greater than the specifications shown in Table 1, lower the mast and remove the load from the forks. Install a gate valve between the port at the front of the tilt cylinder and the hydraulic line. The gate valve must be able to completely shut off the flow of hydraulic oil.

4. Put the load on the forks again. Close the gate valve.

5. Tilt the mast forward just past the vertical position.

6. If the mast continues to tilt slowly forward, the seals on the piston are leaking and need to be replaced. See the **Parts Manual** for replacement parts.

7. If the mast does not move, open the gate valve and check the movement again. If the mast moves forward when the gate valve is open, check for leaks in the hydraulic lines and fittings.

8. If no leaks are found, the main control valve can be worn or damaged. See one of the **Main Control Valve** service manuals listed in the General section of this manual to repair the main control valve.

9. Remove the load from the forks when the checks are complete.

Table 1. Movement Rates (Maximum) for Tilt Cylinders

Lift Truck Models E2.2-3.5XN (E45-70XN) (A268)				
Hydraulic Oil Temperature		**Maximum Tilt Creep**		
		Mast Angle	**Cylinder Stroke**	
°C	**°F**	**Deg/Min**	**mm/Min**	**in./Min**
20	68	0.10	0.88	0.035
30	86	0.15	1.32	0.05
40	104	0.29	2.56	0.10
50	122	0.47	4.14	0.16
60	140	0.68	5.99	0.24
Lift Truck Models J2.2-3.5XN (J45-70XN) (A276)				
Hydraulic Oil Temperature		**Maximum Tilt Creep**		
		Mast Angle	**Cylinder Stroke**	
°C	**°F**	**Deg/Min**	**mm/Min**	**in./Min**
20	68	0.10	0.88	0.035
30	86	0.15	1.32	0.05
40	104	0.29	2.56	0.10
50	122	0.47	4.14	0.16
60	140	0.68	5.99	0.24
Lift Truck Models S2.0-3.5FT (S40-70FT) (F187, G187, H187)				
Hydraulic Oil Temperature		**Maximum Tilt Creep**		
		Mast Angle	**Cylinder Stroke**	
°C	**°F**	**Deg/Min**	**mm/Min**	**in./Min**
20	68	0.10	0.88	0.035
30	86	0.15	1.32	0.05
40	104	0.29	2.56	0.10
50	122	0.47	4.14	0.16
60	140	0.68	5.99	0.24
Lift Truck Models H2.0-3.5FT (H40-70FT) (L177, N177, P177)				
Hydraulic Oil Temperature		**Maximum Tilt Creep**		
		Mast Angle	**Cylinder Stroke**	
°C	**°F**	**Deg/Min**	**mm/Min**	**in./Min**
20	68	0.10	0.93	0.037

Table 1. Movement Rates (Maximum) for Tilt Cylinders (Continued)

Lift Truck Models H2.0-3.5FT (H40-70FT) (L177, N177, P177)				
30	86	0.15	1.40	0.06
40	104	0.29	2.70	0.11
50	122	0.47	4.37	0.17
60	140	0.68	6.32	0.25

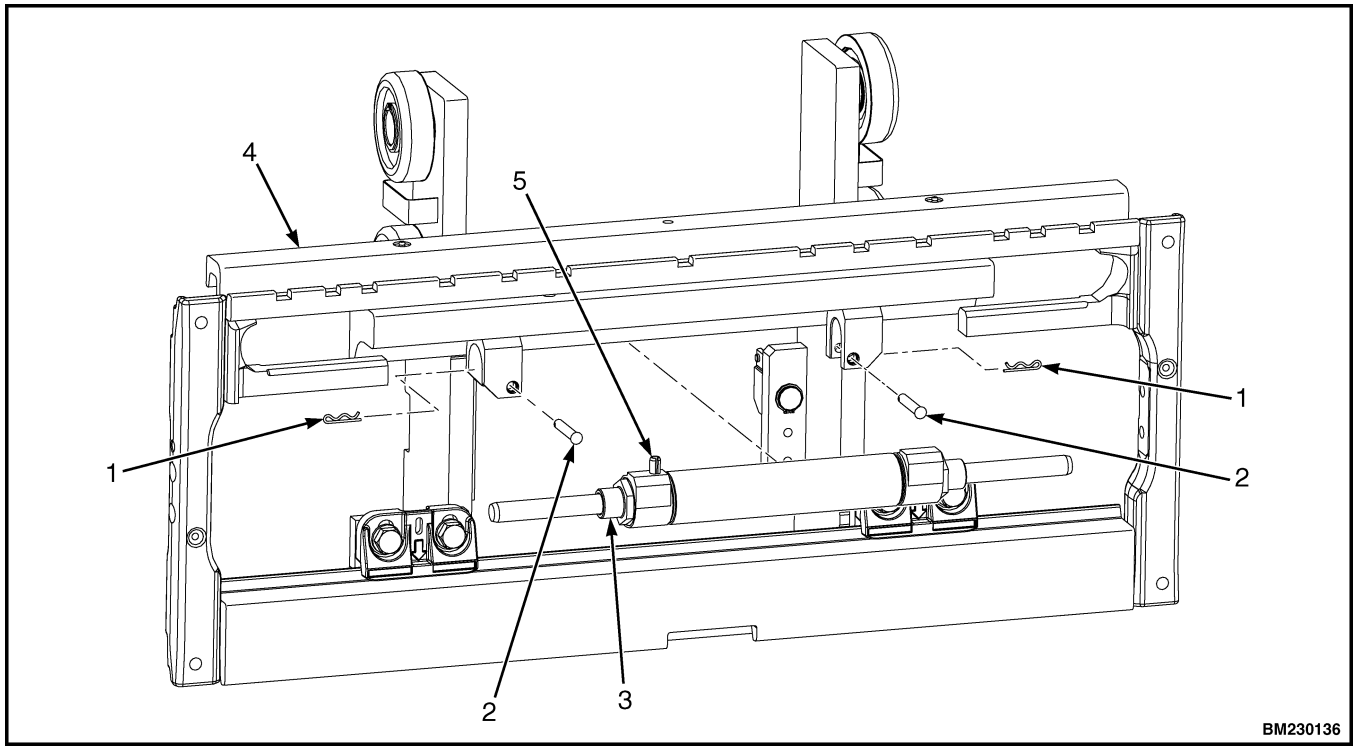
Integral Sideshift Cylinder Repair Prior to December 2016

REMOVE

WARNING

Before working on or near the mast, see Safety Procedures When Working Near Mast.

1. Remove integral sideshift carriage from mast as described in the **Mast** service manual listed in the General section of this manual.
2. Remove two cotter pins, two clevis pins, and sideshift cylinder from sideshift carriage. See Figure 12.
3. Remove pin from top of sideshift cylinder. See Figure 12.



1. COTTER PIN
2. CLEVIS PIN
3. INTEGRAL SIDESHIFT CYLINDER
4. INTEGRAL SIDESHIFT ASSEMBLY
5. PIN

Figure 12. Integral Sideshift Cylinder, Remove

DISASSEMBLE

WARNING

Hydraulic oil is hot after system operation and can cause burns. DO NOT disconnect any hydraulic hoses until oil in the system is cool.

NOTE: Disassemble the integral sideshift cylinder only as necessary for repairs. Most repairs to the sideshift cylinder will be for replacement of O-rings, wipers, seals, and retainers to stop leaks. If other parts of the sideshift cylinder need to be repaired, replace with a new cylinder. See **Parts Manual.**

1. Disassemble the integral sideshift cylinder as follows:

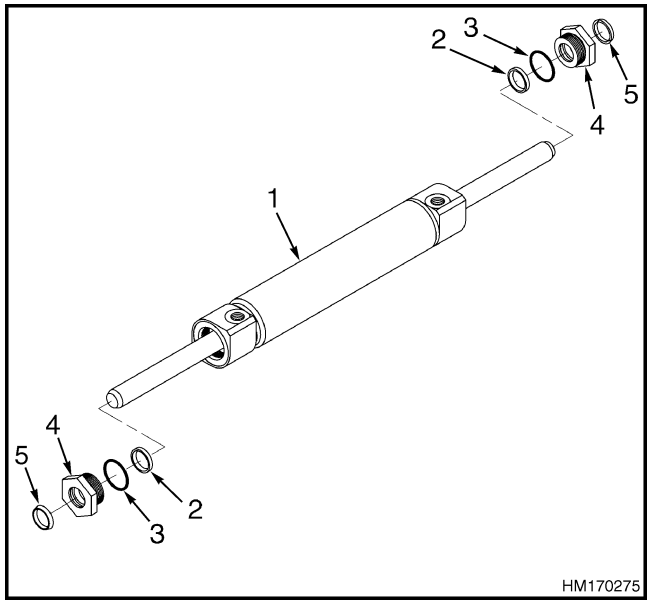
a. Clamp one end of the cylinder shell in a vise between the hydraulic fitting and the retainer on the same end.

b. Unscrew retainer from cylinder. Slide retainer off cylinder rod. See Figure 13.

c. Clamp other end of cylinder shell in a vise between the hydraulic fitting and the retainer on the same end.

d. Unscrew retainer from cylinder. See Figure 13.

e. Remove and discard the seals and O-rings from each retainer with a brass O-ring tool. **DO NOT** scratch cylinder grooves.



1. CYLINDER SHELL AND ROD
2. SEAL
3. O-RING
4. RETAINER
5. WIPER

Figure 13. Integral Sideshift Cylinder, Disassemble

CLEAN

WARNING

Cleaning solvents can be flammable and toxic and can cause skin irritation. When using cleaning solvents, always follow the solvent manufacturer's recommended safety procedures.

WARNING

Compressed air can move particles so they can cause injury to the user or other personnel. Make sure the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eyes.

CAUTION

DO NOT allow cleaning solvents to come in contact with rubber components. It will damage those components.

Clean the retainers, glands, and cylinder rods with cleaning solvents and dry with compressed air.

INSPECT

Inspect the cylinder rod for damage to rod surface and to ensure rod is not bent or scored. If damaged, replace sideshift cylinder assembly. See **Parts Manual.**

ASSEMBLE

1. Assemble the integral sideshift cylinder as follows:

NOTE: If new retainers, that are already assembled with seals and O-rings, are being installed proceed to Step b.

   a. Lubricate new O-rings and seals with clean hydraulic oil. Install seals and O-rings into the retainer grooves. Form the seals and O-rings into a "kidney" shape to ease placement into the groove. Note the direction of the seals. **Pressure seals are installed with the lip toward the pressure side of the cylinder.**

   b. Apply a thin film of hydraulic oil to the inside of the retainers.

   c. Clamp one end of the cylinder shell in a vise between the hydraulic fitting and the same end.

   d. Slide retainer onto cylinder rod. Screw retainer into cylinder shell. Tighten retainer to 295 to 355 N•m (215 to 265 lbf ft).

   e. Clamp other end of cylinder shell in a vise between the hydraulic fitting and the same end.

   f. Slide retainer onto cylinder rod. Screw retainer into cylinder shell. Tighten retainer to 295 to 355 N•m (215 to 265 lbf ft).

INSTALL

NOTE: The pin, located on top left of sideshift cylinder, looking from front of carriage, is for alignment purposes and to prevent cylinder from rolling to the front or to back. See Figure 12.

1. Install pin to top of sideshift cylinder (5, Figure 12).

2. Install sideshift cylinder onto the carriage with the pin in the UP position. Install two clevis pins and two cotter pins to secure sideshift cylinder to carriage.

3. Install integral sideshift carriage to mast. See the **Mast** service manual listed in the General section of this manual. for procedures.

Integral Sideshift Cylinder Repair After December 2016

GENERAL

This section outlines the integral sideshift cylinder repair procedures *only* for lift truck models E2.2-3.5XN (E45-70XN) (**A268**), S2.0-3.5FT (S40-70FT) (**H187**) and H40-70FT (**P177**) after December 2016.

REMOVE

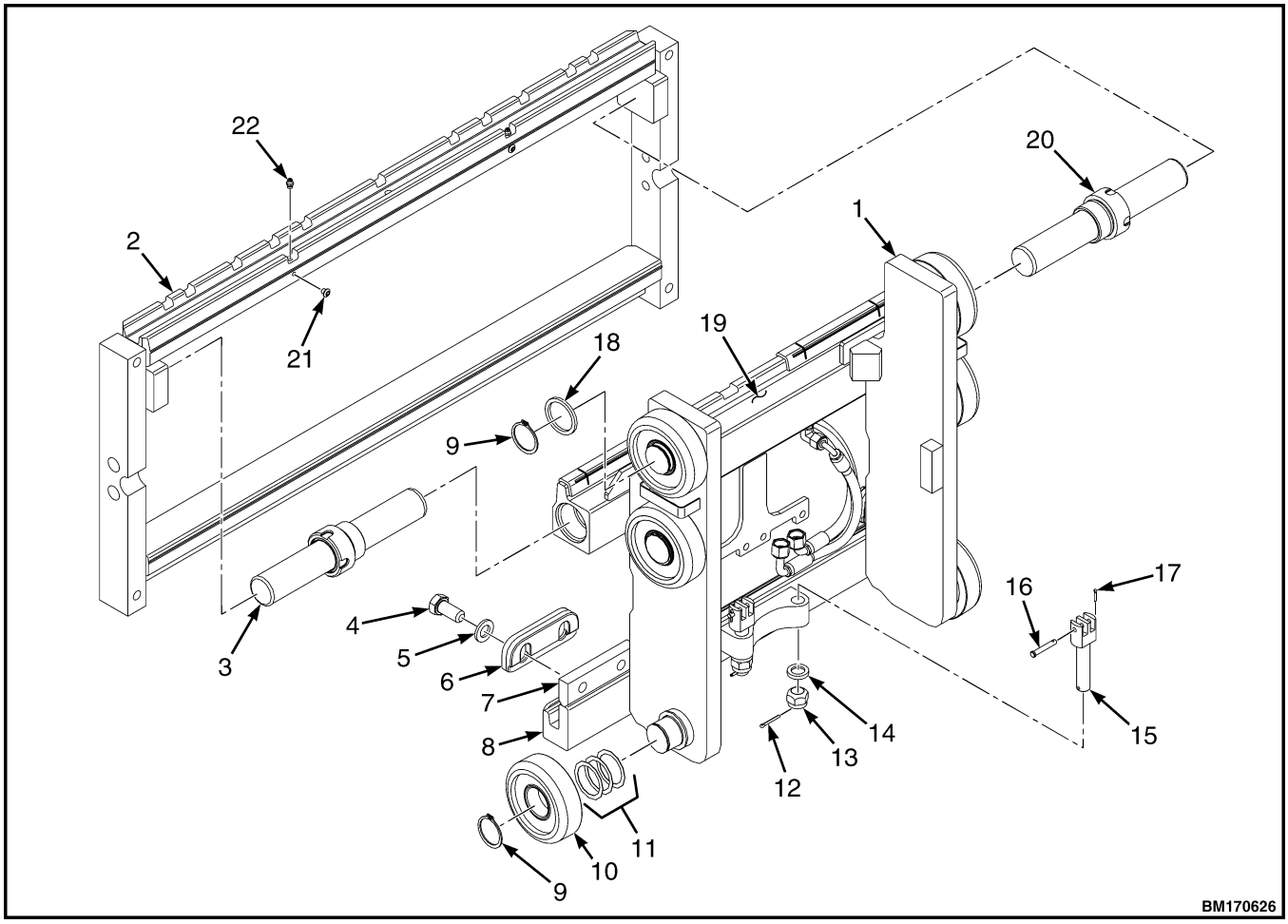
WARNING

Before working on or near the mast, see Safety Procedures When Working Near Mast.

1. Remove outer frame from carriage as described in carriage removal procedure in the **Mast** service manual listed in the General section of this manual.

2. Locate the cylinder rod and gland assembly for each side. See Figure 14.

3. Turn one of the glands counter-clockwise to loosen. Remove rod and gland assembly from inner frame by unthreading from cylinder bore. Repeat for cylinder on opposite side of carriage. See Figure 14.



NOTE: TWO AND THREE-STAGE FFL IS SHOWN. INTEGRAL SIDESHIFT CARRIAGE ASSEMBLY FOR FOUR-STAGE FFL AND TWO-STAGE LFL IS SIMILAR.

1. INNER FRAME
2. OUTER FRAME
3. LH CYLINDER
4. CAPSCREW
5. WASHER
6. HOOK
7. PLATE
8. LOWER BEARING
9. SNAP RING
10. LOAD ROLLER
11. SHIMS
12. COTTER PIN
13. NUT
14. RING
15. CHAIN ANCHOR
16. PIN
17. COTTER PIN
18. SPACER
19. UPPER BEARING
20. RH CYLINDER
21. CAPSCREW
22. GREASE FITTING

Figure 14. Integral Sideshift Carriage and Cylinder

DISASSEMBLE

WARNING

Hydraulic oil is hot after system operation and can cause burns. DO NOT disconnect any hydraulic hoses until oil in the system is cool.

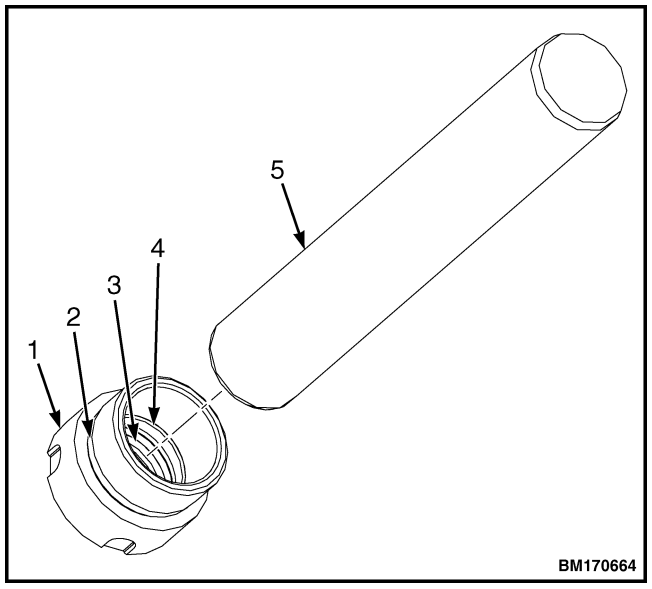
NOTE: Disassemble the integral sideshift cylinder only as necessary for repairs. Most repairs to the sideshift cylinder will be for replacement of O-rings, wipers, seals, and retainers to stop leaks. If other parts of the sideshift cylinder need to be repaired, replace with a new cylinder. See **Parts Manual.**

1. Disassemble the integral sideshift cylinder as follows:

   a. Clamp one end of the cylinder rod in a vise.

   b. Slide gland off of cylinder rod. See Figure 15.

   c. Remove and discard the seal, wiper, and O-ring with a brass O-ring tool. **DO NOT** scratch cylinder grooves.



1. GLAND
2. O-RING
3. ROD WIPER
4. ROD SEAL
5. CYLINDER ROD

Figure 15. Integral Sideshift Cylinder, Disassemble

CLEAN

WARNING

Cleaning solvents can be flammable and toxic and can cause skin irritation. When using cleaning solvents, always follow the solvent manufacturer's recommended safety procedures.

WARNING

Compressed air can move particles so they can cause injury to the user or other personnel. Make sure the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eyes.

CAUTION

DO NOT allow cleaning solvents to come in contact with rubber components. It will damage those components.

Clean the gland and cylinder rod with cleaning solvents and dry with compressed air. See Figure 15.

INSPECT

Inspect the cylinder rod for damage to rod surface and ensure that rod is not bent or scored. If damaged, replace sideshift cylinder rod. See **Parts Manual.**

ASSEMBLE

1. Assemble the integral sideshift cylinder as follows:

NOTE: If new retainers, that are already assembled with seals and O-rings, are being installed proceed to Step d.

   a. Lubricate new O-ring, seals, and wipers with clean hydraulic oil.

   b. Install seal, wiper, and O-ring into the gland grooves.

   c. Form seals and O-rings into a "kidney" shape (see Figure 16) to ease placement into the grooves. Note the direction of the seals. **Pressure seals are installed with the lip toward the pressure side of the cylinder.**

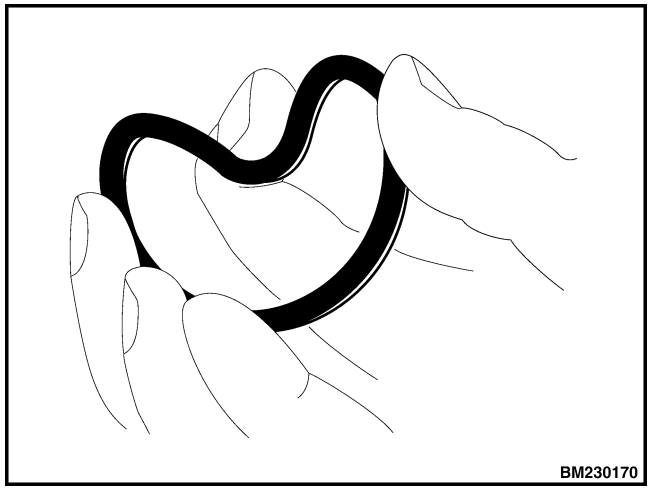


Figure 16. Forming Seals Into Kidney Shape Prior To Installation

d. Apply a thin film of hydraulic oil to the inside of the cylinder bore on the inner frame.

e. Clamp one end of the cylinder rod in a vise.

f. Apply Loctite® 243 to gland threads and slide gland with seal, wiper, and O-ring installed, onto cylinder rod.

INSTALL

CAUTION

Never install the gland and then drive rod into the assembly. To do so, can damage the seals. ALWAYS have rod assembled into the gland first, then begin tightening it, leaving no more than 75 mm (2.9 in.) of the cylinder rod exposed from the face of the gland, to allow for installation of outer frame.

1. Make sure inside of cylinder bore is free of all sediment and other particles.

2. Thread gland and rod assembly into cylinder bore on inner frame. See Figure 14.

CAUTION

Tighten glands using Only one of the tools shown in Table 2. Using another tool to tighten glands can lead to fracturing of glands and damage to cylinder.

CAUTION

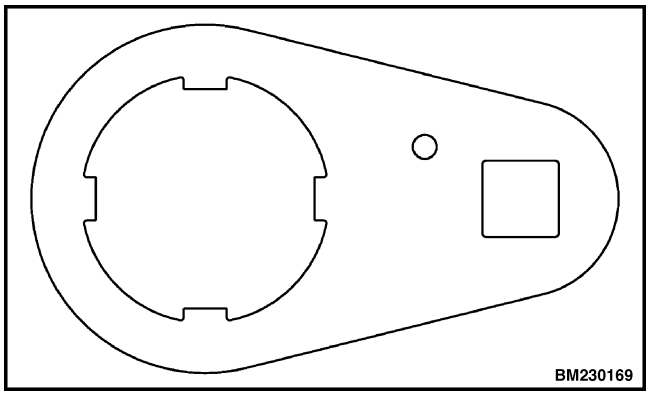
Do not grind gland tightening tool for clearance, as grinding will significantly weaken the tool and negatively impact its performance.

NOTE: If the integral side-shift carriage has a width narrower than 1067 mm (42 in.), it will have to be removed from the lift truck before using the gland tightening tool to tighten glands. The exception to this is lift trucks equipped with a four stage full free-lift mast. See the **Mast** service manual listed in the General section of this manual. for procedures to remove integral side-shift carriage from lift truck.

3. Tighten gland to 450 N•m (332 lbf ft) using one of the gland tightening tools shown in Table 2.

Table 2. Gland Tightening Tool

Gland Manufacture Date	Class II	Class III
Before July 10th, 2017	P/N 4197738	P/N 4197737
After July 10th, 2017	P/N 4197737	P/N 4197737



NOTE: Gland tightening tool P/N 4197738 shown. Gland tightening tool P/N 4197737 is similar.

4. Install outer frame of carriage back onto the inner frame. See the **Mast** service manual listed in the General section of this manual for installation procedures.

5. Install carriage back on to the mast. See the **Mast** service manual listed in the General section of this manual. for procedures.

INTEGRAL SIDE-SHIFT CYLINDER GLAND LEAK CHECKS

If a leak on one of the glands is suspected, clean the integral side-shift cylinder assembly of grease and dirt, then actuate cylinder at least five full strokes, lock to lock. If a leak is still suspected, perform the following to correct any leaks

1. Tighten the suspected gland using correct gland tightening tool to the correct torque as described in Install section above.

2. If a leak is still suspected, loosen gland and inspect the O-ring, backup ring and seat. Replace O-ring and backup ring if damage is found. See **Parts Manual**.

3. If a leak is still occurring after performing Step 1 and Step 3, replace the entire rod and gland assembly with new parts. See **Parts Manual**.

Fork Positioner Cylinder Repair Prior to December 2016

REMOVE

WARNING

Before working on or near the mast, see section Safety Procedures When Working Near Mast.

Remove the fork positioner and cylinders from the integral sideshift carriage. See the **Mast** service manual listed in the General section of this manual. for procedures.

DISASSEMBLE

CAUTION

Carefully disassemble fork positioner so piston rods and sliding surfaces are not damaged.

NOTE: Disassemble fork positioner cylinders only as necessary for repairs. On the fork positioner covered in this manual, there are only three items that can be replaced:

- The bronze bearings in the outer fork carriers
- The relief tube assemblies
- The hose guides

If any other component parts need to be replaced, the whole fork positioner assembly will need to be replaced. See **Parts Manual** for replacement kits and part numbers.

NOTE: Depending on the size and configuration of the forks installed on lift truck, there may be a spacer bar between the inner and outer fork carriers. See Figure 17.

1. Remove cylinder rod anchor plug. See Figure 17.
2. Move fork carriers towards center of cylinder and fully retract fork positioner cylinder rods.
3. Disconnect hydraulic hoses from fork positioner. See Figure 18.

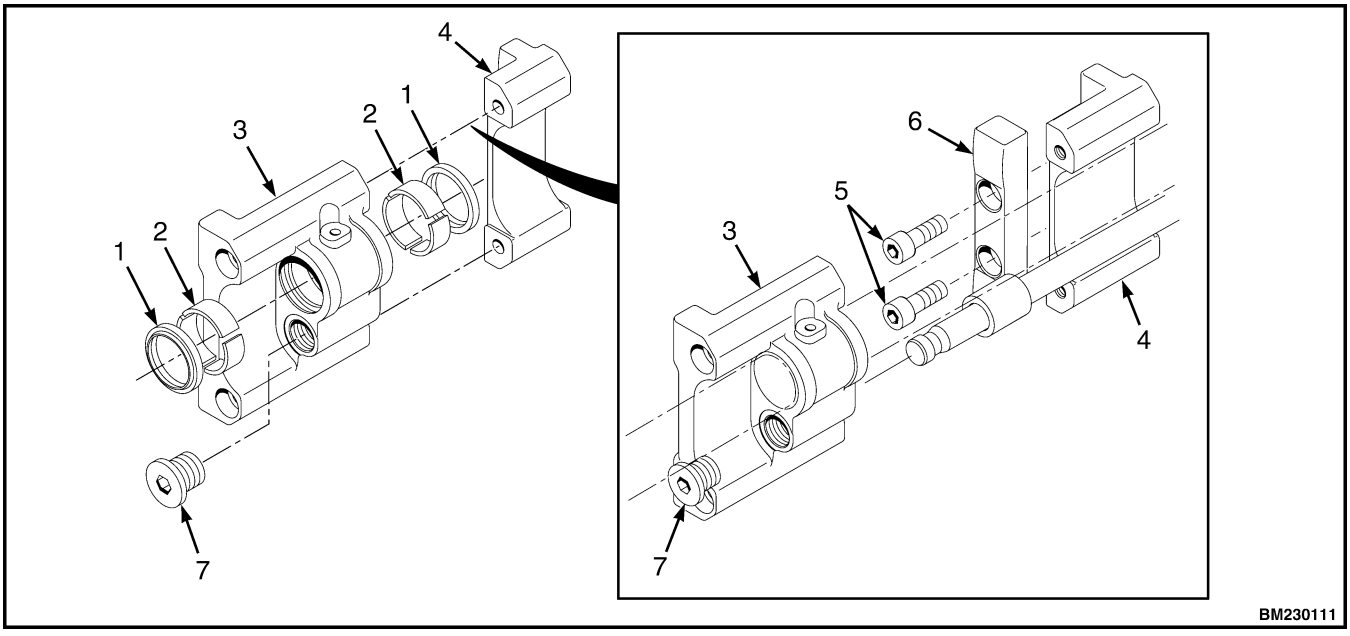


Figure 17. Fork Positioner, Disassemble

Legend for Figure 17.

1. WIPER SHELL
2. BRONZE BEARINGS
3. OUTER FORK CARRIER
4. INNER FORK CARRIER
5. CAPSCREW*
6. SPACER BAR*
7. CYLINDER ROD ANCHOR PLUG

*Parts used on 977 mm (38.5 in.) and 1067 mm (42 in.) class II carriages.

4. Disconnect relief tube assembly. See Figure 18.

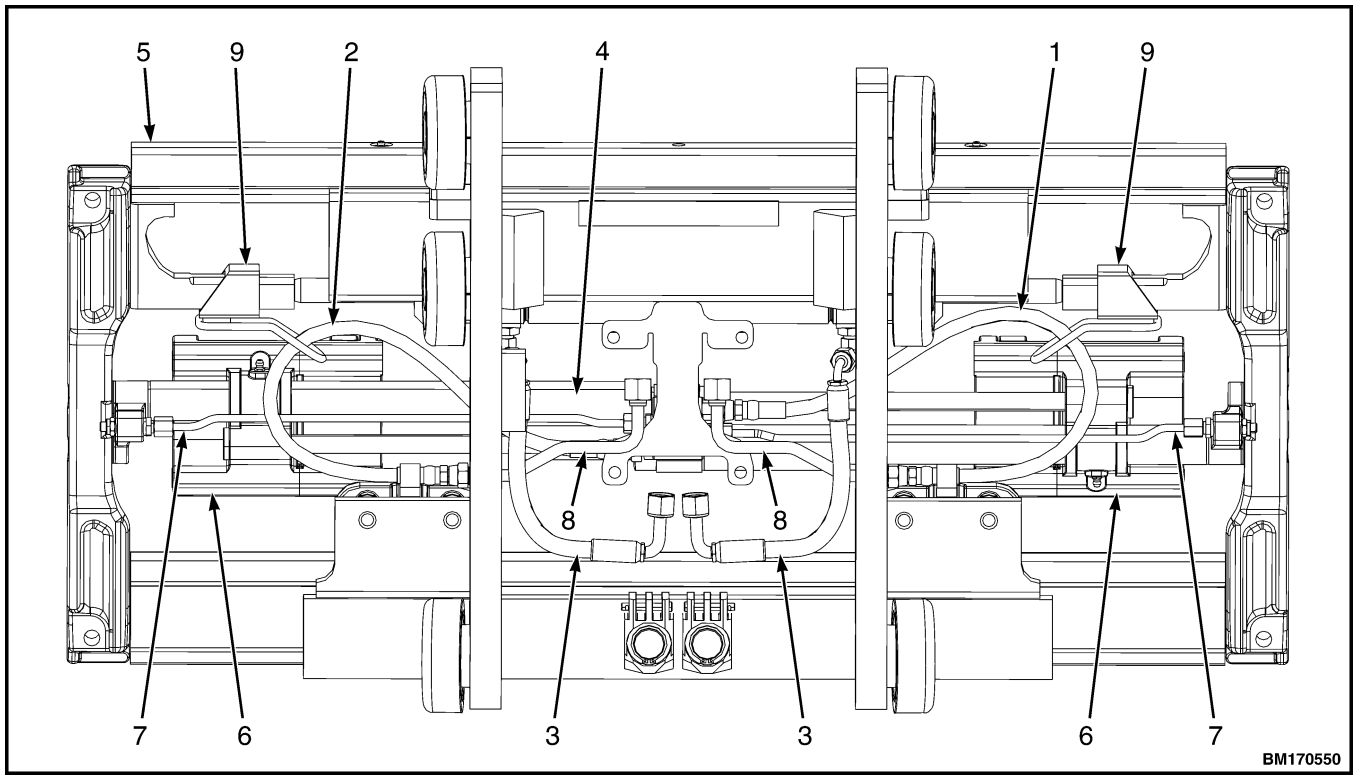
5. Remove cylinder rod retainer and remove fork positioner cylinder.

6. Remove fork carriers from cylinder shell.

7. Remove wiper shell and bronze bearings from outer fork carrier. See Figure 17.

8. Remove integral sideshift cylinder from carriage. See Integral Sideshift Cylinder Repair Prior to December 2016 for procedures.

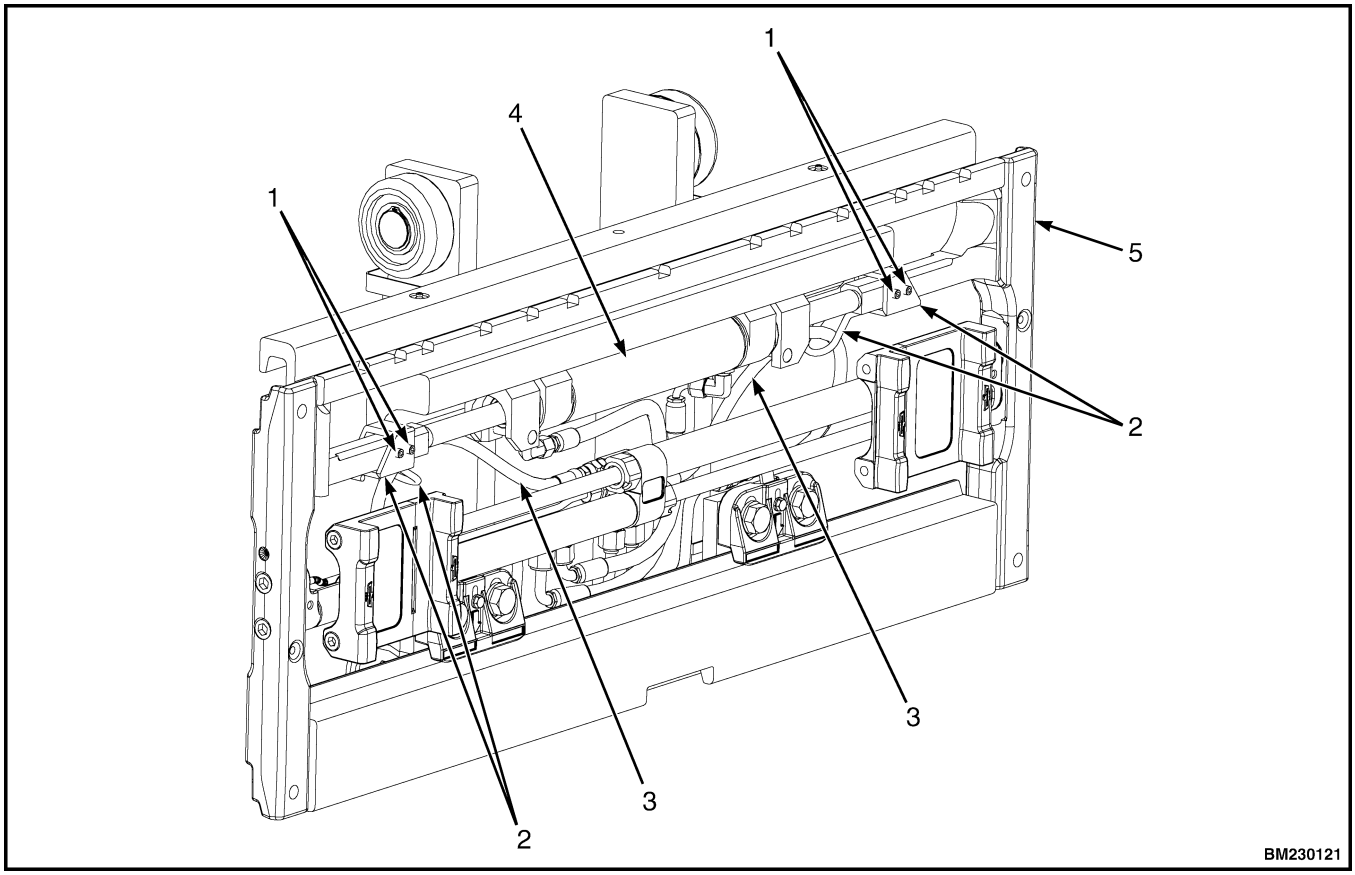
9. Remove setscrews from hose guides and remove hose guides from outer frame. See Figure 19.



NOTE: BACK (DRIVER'S) VIEW SHOWN. THREE STAGE FFL INTEGRAL SIDESHIFT SHOWN.

1. FORK POSITIONER HYDRAULIC HOSE (OPEN)
2. FORK POSITIONER HYDRAULIC HOSE (CLOSE)
3. INTEGRAL SIDESHIFT CARRIAGE HYDRAULIC HOSES
4. FORK POSITIONER CYLINDER
5. OUTER FRAME
6. FORK CARRIER
7. RELIEF TUBE ASSEMBLY
8. TUBE ASSEMBLY
9. HOSE GUIDE

Figure 18. Hydraulic Connections, Fork Positioner Cylinder



NOTE: FORK POSITIONER AND INTEGRAL SIDESHIFT CARRIAGE FOR LIFT TRUCKS E2.2-3.5XN (E45-70XN) (A268) SHOWN. FORK POSITIONER AND INTEGRAL SIDESHIFT CARRIAGE FOR OTHER LIFT TRUCKS COVERED IN THIS MANUAL ARE SIMILAR.

1. SETSCREW
2. HOSE GUIDE
3. HYDRAULIC HOSE
4. INTEGRAL SIDESHIFT CYLINDER
5. OUTER FRAME

Figure 19. Fork Positioner Hose Guide

CLEAN

WARNING

Cleaning solvents can be flammable and toxic and can cause skin irritation. When using cleaning solvents, always follow the solvent manufacturer's recommended safety procedures.

WARNING

Compressed air can move particles so they cause injury to the user or to other personnel. Make sure the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eyes.

CAUTION

DO NOT allow cleaning solvent to come in contact with rubber components. It will damage those components.

Clean all metal parts in solvent and dry with compressed air.

INSPECT

NOTE: The bronze bearings in outer fork carriers, the relief tube assemblies, and hose guides are the only components that can be replaced. If other components are worn or damaged, the whole fork positioner assembly must be replaced. See the **Parts Manual** for replacement parts.

- Inspect rod, piston, and retainer for any damage to seal surfaces. Replace fork positioner if damaged.
- Inspect rod for damage to rod surface and ensure rod is not bent. Replace fork positioner if damaged or bent.
- Inspect fork carrier bronze bearings for wear. Replace bronze bearings as necessary. See Figure 17.
- Inspect relief tube assembly for wear or damage. Replace relief tube assembly if necessary. See Figure 18.
- Inspect hose guides for wear or damage. Replace hose guides if necessary. See Figure 19.

ASSEMBLE

1. Install hose guides onto outer frame. Tighten setscrews to 17 N•m (150 lbf in). See Figure 19.

2. Install integral sideshift to carriage. See Integral Sideshift Cylinder Repair Prior to December 2016 for procedures.

NOTE: Lubricate all internal parts of the cylinder with clean hydraulic oil during assembly.

3. Lubricate new fork carrier bronze bearings with clean hydraulic oil. Install new bronze bearings into outer fork carrier and install wiper shell. See Figure 17.

4. Connect relief tube assemblies. See the **Mast** service manual listed in the General section of this manual for procedures.

5. Install fork carriers onto cylinder shell.

6. Install fork positioner cylinder assembly to outer frame. See Figure 18.

7. Install rod retainer. Tighten rod retainer to 165 N•m (120 lbf ft).

8. Connect hydraulic hoses to manifold. See Figure 18.

9. Install cylinder rod anchor plug. Tighten cylinder rod anchor plug to 65 N•m (50 lbf ft). See Figure 17.

INSTALL

WARNING

Before working on or near the mast, see section Safety Procedures When Working Near Mast.

Install fork positioner assembly and cylinders to the integral sideshift carriage. See the **Mast** service manual listed in the General section of this manual for procedures.

FORK POSITIONER CYLINDER ADJUSTMENT

To adjust the flow restrictors for equal fork movement, perform the following:

NOTE: The procedures below apply to flow restrictors on both fork positioner cylinders.

1. Loosen jam nut on flow restrictor and screw flow restrictor in until it bottoms. Turn flow restrictor counterclockwise approximately three turns. See Figure 20.

2. Open forks all the way, then close the forks. Watch for unequal fork movement.

3. To increase speed of forks opening, turn flow restrictor counterclockwise in ½ turn increments. To decrease speed of forks closing, turn flow restrictor clockwise in ½ turn increments. See Figure 20.

4. Open and close the forks again. If movement is not equal, repeat Step 2 and Step 3.

5. If fork movement is equal, tighten jam nut on flow restrictor. See Figure 20.

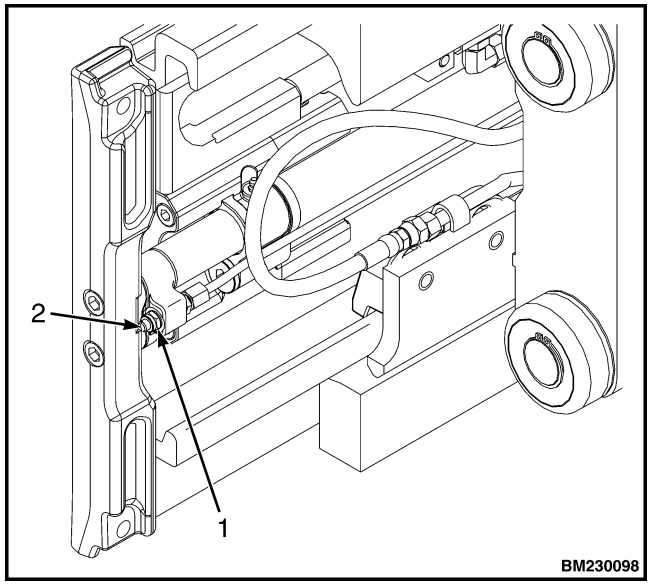


Figure 20. Fork Positioner Cylinder Adjustment

Legend for Figure 20.

NOTE: BACK (DRIVER'S) VIEW SHOWN. LEFT FLOW RESTRICTOR SHOWN.

1. JAM NUT
2. FLOW RESTRICTOR

Fork Positioner Cylinder Repair After December 2016

GENERAL

This section outlines the fork positioner cylinder repair procedures *only* for lift truck models E2.2-3.5XN (E45-70XN) (**A268**), S2.0-3.5FT (S40-70FT) (**H187**) and H40-70FT (**P177**) after December 2016.

REMOVE

WARNING

Before working on or near the mast, see section Safety Procedures When Working Near Mast.

Remove fork positioner from integral sideshift carriage. See the **Mast** service manual listed in the General section of this manual. for procedures.

DISASSEMBLE

CAUTION

Carefully disassemble fork positioner so piston rods and sliding surfaces are not damaged.

NOTE: Disassemble fork positioner cylinders only as necessary for repairs. On the fork positioner covered in this manual, there are only three items that can be replaced:

- The bronze bearings in the outer fork carriers
- The relief tube assemblies
- The hose guides

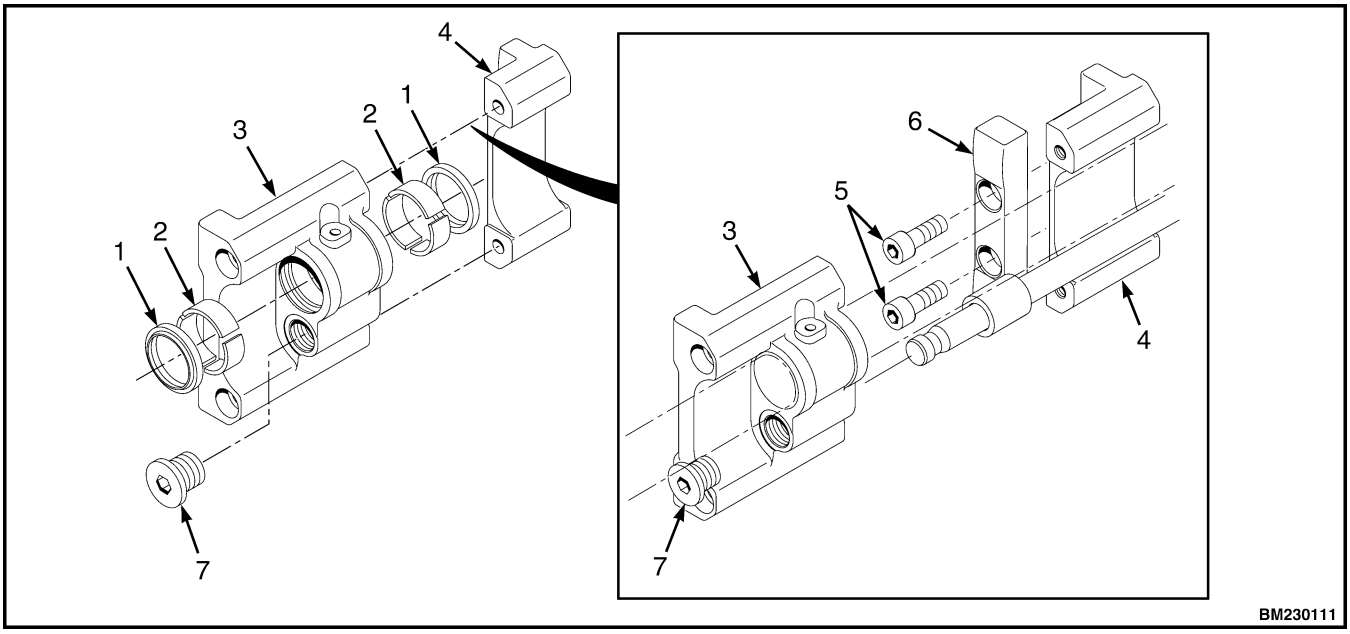
If any other component parts need to be replaced, the entire fork positioner assembly will need to be replaced. See **Parts Manual** for replacement kits and part numbers.

NOTE: Depending on the size and configuration of the forks installed on lift truck, there may be a spacer bar between the inner and outer fork carriers. See Figure 21.

1. Remove cylinder rod anchor plug. See Figure 21.

2. Move fork carriers towards center of cylinder and fully retract fork positioner cylinder rods.

3. Disconnect hydraulic hoses from fork positioner. See Figure 22.



1. WIPER SHELL
2. BRONZE BEARINGS
3. OUTER FORK CARRIER
4. INNER FORK CARRIER
5. CAPSCREW*
6. SPACER BAR*
7. CYLINDER ROD ANCHOR PLUG

*Parts used on 977 mm (38.5 in.) and 1067 mm (42 in.) class II carriages.

Figure 21. Fork Positioner, Disassemble

4. Disconnect relief tube assembly. See Figure 22.

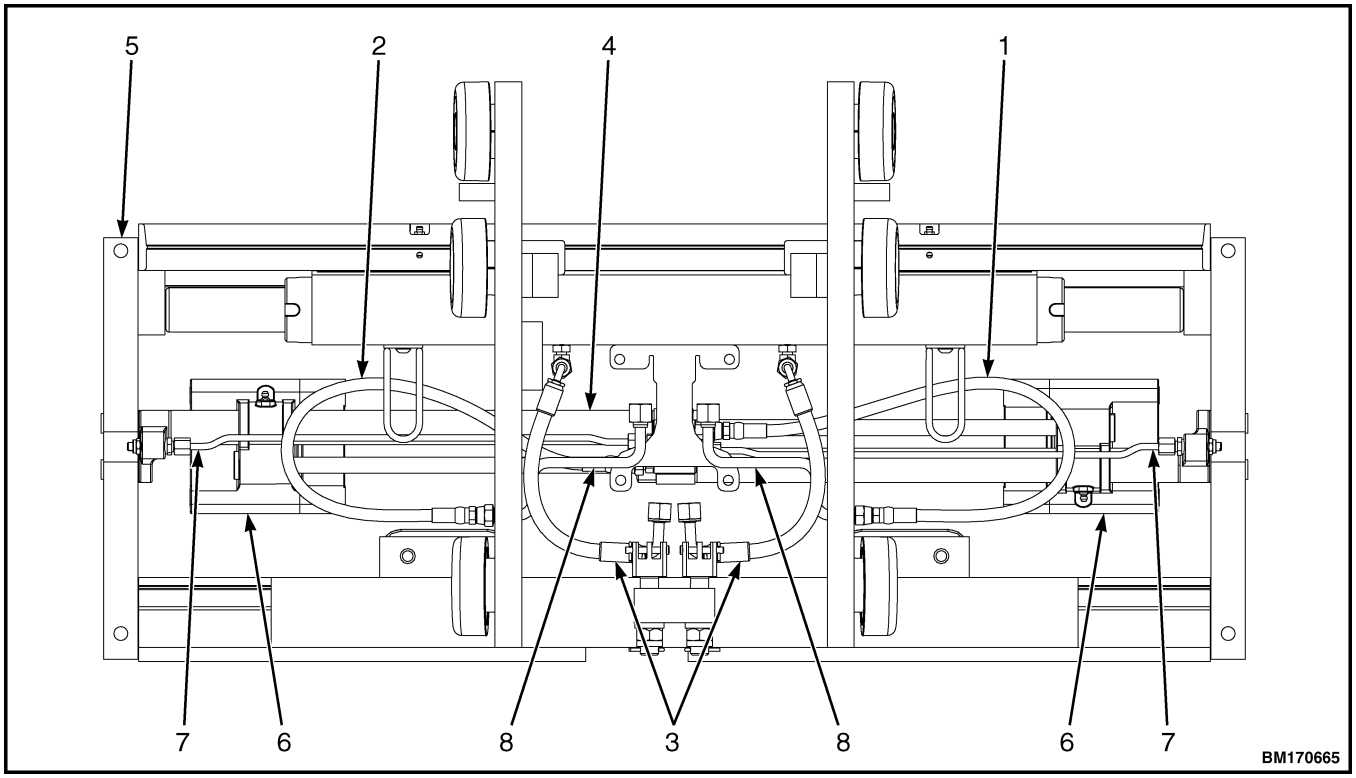
5. Remove cylinder rod retainer and remove fork positioner cylinder.

6. Remove fork carriers from cylinder shell.

7. Remove wiper shell and bronze bearings from outer fork carrier. See Figure 21.

8. Remove integral sideshift cylinder from carriage. See Integral Sideshift Cylinder Repair After December 2016 for procedures.

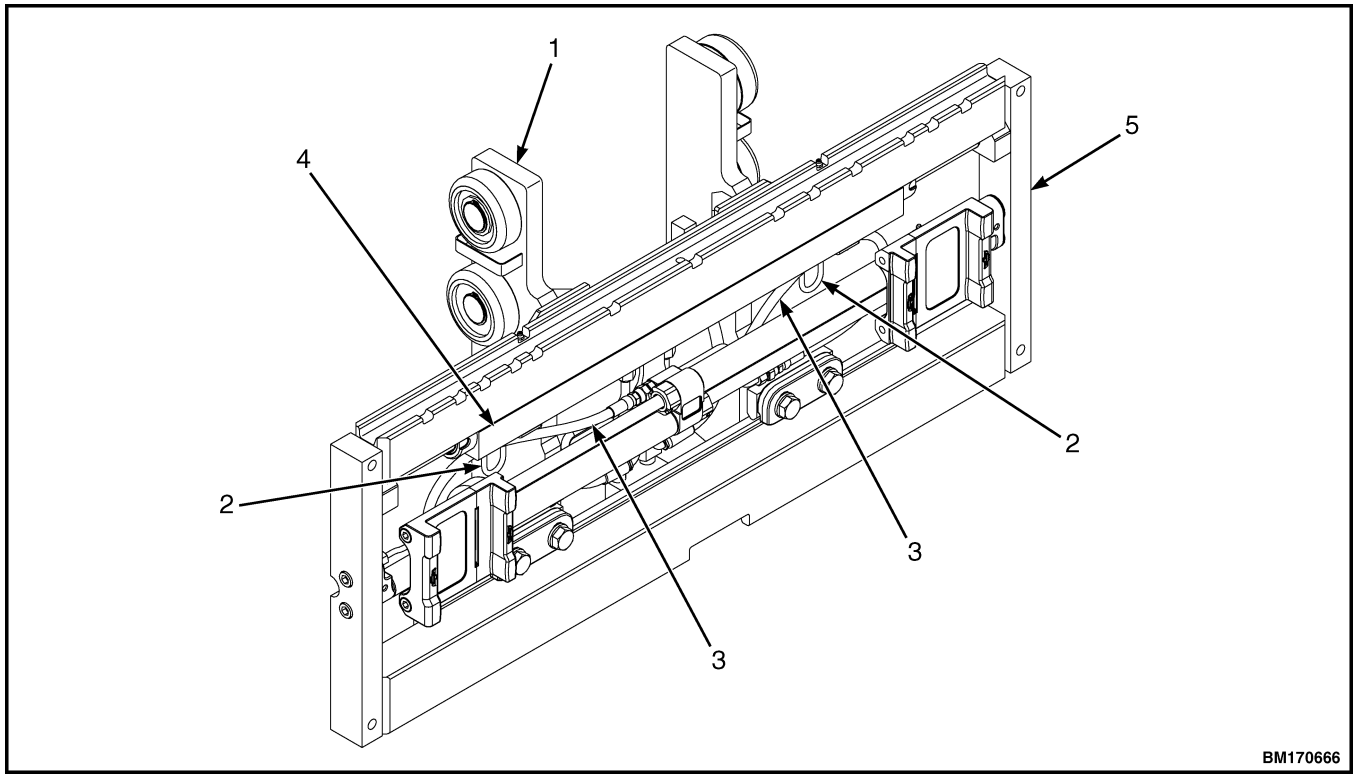
9. Remove capscrews from hose guides and remove hose guides from outer frame. See Figure 23.



NOTE: BACK (DRIVER'S) VIEW SHOWN. THREE STAGE FFL INTEGRAL SIDESHIFT CARRIAGE SHOWN. OTHER ISS CARRIAGES ARE SIMILAR.

1. FORK POSITIONER HYDRAULIC HOSE (OPEN)
2. FORK POSITIONER HYDRAULIC HOSE (CLOSE)
3. INTEGRAL SIDESHIFT CARRIAGE HYDRAULIC HOSES
4. FORK POSITIONER CYLINDER
5. ISS CARRIAGE OUTER FRAME
6. FORK CARRIER
7. RELIEF TUBE ASSEMBLY
8. TUBE ASSEMBLY

Figure 22. Hydraulic Connections, Fork Positioner Cylinder



NOTE: FORK POSITIONER AND INTEGRAL SIDESHIFT CARRIAGE FOR LIFT TRUCKS E2.2-3.5XN (E45-70XN) (A268) SHOWN. FORK POSITIONER AND INTEGRAL SIDESHIFT CARRIAGE FOR OTHER LIFT TRUCKS COVERED IN THIS MANUAL ARE SIMILAR.

1. ISS CARRIAGE INNER FRAME
2. HOSE GUIDE
3. HYDRAULIC HOSE
4. INTEGRAL SIDESHIFT CYLINDER
5. ISS CARRIAGE OUTER FRAME

Figure 23. Fork Positioner Hose Guide

CLEAN

WARNING

Cleaning solvents can be flammable and toxic and can cause skin irritation. When using cleaning solvents, always follow the solvent manufacturer's recommended safety procedures.

WARNING

Compressed air can move particles so they cause injury to the user or to other personnel. Make sure the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eyes.

CAUTION

DO NOT allow cleaning solvent to come in contact with rubber components. It will damage those components.

Clean all metal parts in solvent and dry with compressed air.

INSPECT

NOTE: The bronze bearings in outer fork carriers, the relief tube assemblies, and hose guides are the only components that can be replaced. If other components are worn or damaged, the entire fork positioner assembly must be replaced. See the **Parts Manual** for replacement parts.

- Inspect rod, piston, and retainer for any damage to seal surfaces. Replace fork positioner if damaged.
- Inspect rod for damage to rod surface and ensure rod is not bent. Replace fork positioner if damaged or bent.
- Inspect fork carrier bronze bearings for wear. Replace bronze bearings as necessary. See Figure 21.
- Inspect relief tube assembly for wear or damage. Replace relief tube assembly if necessary. See Figure 22.
- Inspect hose guides for wear or damage. Replace hose guides if necessary. See Figure 23.

ASSEMBLE

1. Install hose guides onto outer frame. Tighten screws to 17 N•m (150 lbf in). See Figure 23.

2. Install integral sideshift to carriage. See Integral Sideshift Cylinder Repair After December 2016 for procedures.

NOTE: Lubricate all internal parts of the cylinder with clean hydraulic oil during assembly.

3. Lubricate new fork carrier bronze bearings with clean hydraulic oil. Install new bronze bearings into outer fork carrier and install wiper shell. See Figure 21.

4. Connect relief tube assemblies. See in the **Mast** service manual listed in the General section of this manual for procedures.

5. Install fork carriers onto cylinder shell.

6. Install fork positioner cylinder assembly to outer frame. See Figure 22.

7. Install rod retainer. Tighten rod retainer to 165 N•m (120 lbf ft).

8. Connect hydraulic hoses. See Figure 22.

9. Install cylinder rod anchor plug. Tighten cylinder rod anchor plug to 65 N•m (50 lbf ft). See Figure 21.

INSTALL

WARNING

Before working on or near the mast, see section Safety Procedures When Working Near Mast.

Install fork positioner assembly and cylinders to the integral sideshift carriage. See the **Mast** service manual listed in the General section of this manual. for procedures.

FORK POSITIONER CYLINDER ADJUSTMENT

To adjust the flow restrictors for equal fork movement, perform the following:

NOTE: The procedures below apply to flow restrictors on both fork positioner cylinders.

1. Loosen jam nut on flow restrictor and screw flow restrictor in until it bottoms. Turn flow restrictor counterclockwise approximately three turns. See Figure 24.

2. Open forks all the way, then close the forks. Watch for unequal fork movement.

3. To increase speed of forks opening, turn flow restrictor counterclockwise in ½ turn increments. To decrease speed of forks closing, turn flow restrictor clockwise in ½ turn increments. See Figure 24.

4. Open and close the forks again. If movement is not equal, repeat Step 2 and Step 3.

5. If fork movement is equal, tighten jam nut on flow restrictor. See Figure 24.

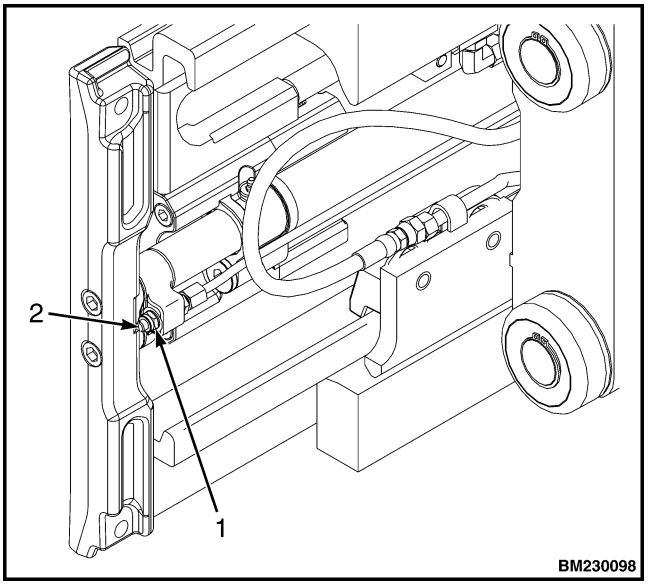


Figure 24. Fork Positioner Cylinder Adjustment

Legend for Figure 24.

NOTE: BACK (DRIVER'S) VIEW SHOWN. LEFT FLOW RESTRICTOR SHOWN.

1. JAM NUT
2. FLOW RESTRICTOR

Seal Kit Installation

EXTERNAL INSTALLATION (SEAL AND BACKUP RING)

NOTE: It is recommended that seal is heated in hydraulic oil prior to installation to make it more flexible and pliable.

1. Lubricate seal, backup ring, external installation sleeve, and piston rod groove with hydraulic oil.

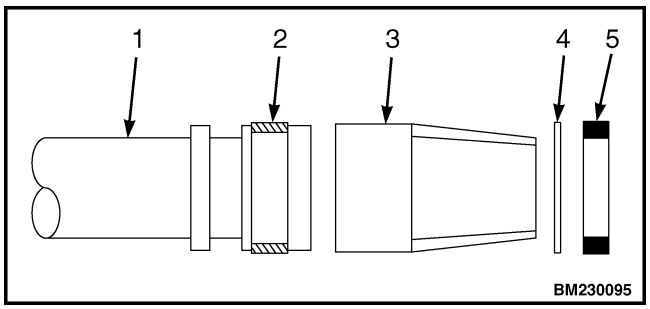
2. Install wear ring onto piston rod assembly. See Figure 25.

3. Slide external installation sleeve over piston rod assembly and wear ring.

4. Install backup ring into piston rod groove. See Figure 25.

5. Slide seal over external installation sleeve and into piston rod groove.

6. Remove external installation sleeve. See Figure 25.



1. PISTON ROD ASSEMBLY
2. WEAR RING
3. EXTERNAL INSTALLATION SLEEVE
4. BACKUP RING
5. SEAL

Figure 25. Cylinder External Seal Installation

INTERNAL INSTALLATION (PISTON ROD ASSEMBLY)

1. Insert internal installation sleeve into end of cylinder tube. See Figure 26.

2. Install piston rod assembly into cylinder tube.

3. Remove internal installation sleeve from cylinder tube and piston rod assembly. See Figure 26.

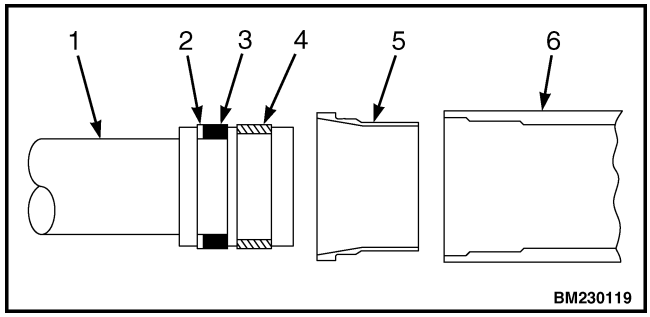


Figure 26. Cylinder Internal Installation

Legend for Figure 26.

1. PISTON ROD ASSEMBLY
2. BACKUP RING
3. SEAL
4. INTERNAL INSTALLATION SLEEVE
5. CYLINDER TUBE
6. WEAR RING

Torque Specifications

MAIN LIFT CYLINDERS

Gland, Main Lift Cylinders
340 to 410 N•m (250 to 300 lbf ft)

Main Lift Cylinder Mounting Capscrew To Mounting Plate
38 N•m (28 lbf ft)

FREE-LIFT CYLINDER

Gland, Free-Lift Cylinder
475 to 540 N•m (350 to 400 lbf ft)

Capscrews for Free-Lift Clamps
53 N•m (39 lbf ft)

Crosshead Plate Capscrews
18 N•m (159 lbf in)

TILT CYLINDERS

Piston Rod Nut
170 to 220 N•m (125 to 162 lbf ft)

Gland Lift truck models
170 to 237 N•m (125 to 175 lbf ft)

- E2.2-3.0XN (E45-55XN) (A268)
- J2.2-2.5XN (J45-50XN) (A276)
- S2.0-2.5FT (S40-55FT) (F187, G187, H187)
- H2.0-2.5FT (H40-50FT) (L177, N177, P177)

Gland Lift truck models
400 to 500 N•m (295 to 370 lbf ft)

- E3.0-3.5XN (E60-70XN) (A268)
- J3.0-3.5XN (J60-70XN) (A276)
- S3.0-3.5FT (S60-70FT) (F187, G187, H187)
- H3.0-3.5FT (H60-70FT) (L177, N177, P177)

Tilt Cylinder Rod End Nut
90 N•m (66 lbf ft)

Tilt Cylinder Mounting Capscrew
38 N•m (28 lbf ft)

INTEGRAL SIDESHIFT CYLINDER

Retainer onto Cylinder (Before December 2016)
295 to 355 N•m (215 to 265 lbf ft)

Gland onto Cylinder (After December 2016)
450 N•m (332 lbf ft)

FORK POSITIONER CYLINDER

Hose Guide Setscrew
17 N•m (150 lbf in)

Rod Retainer
165 N•m (120 lbf ft)

Cylinder Rod Anchor Plug
65 N•m (50 lbf ft)

NOTES

WIRE HARNESS REPAIR

E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) [A099];N35-40ZRS2, N30ZDRS2 [B265];S6.0-7.0FT (S135-155FT) [D024, E024, F024, G024]; A1.3-1.5XNT (A25-30XNT) [D203];N35ZDR2, N45ZR2 [D264]; S30-35FT, S40FTS [E010, F010];N35-40ZR2, N30ZDR2 [E470]; H1.6-1.8FT, H2.0FTS (H30-35FT, H40FTS) [F001, G001]; S2.0-3.5FT (S40-70FT, S55FTS) [F187, G187, H187]; S4.0-5.5FT, S5.5FTS (S80-120FT; S80-100FTBCS; S120FTS; S120FTPRS) [G004, H004, J004]; H6.0-7.0FT (H135-155FT) [H006, J006, K006, L006]; H2.0-3.5FT (H40-70FT) [L177, N177, P177]; H4.0FT5/FT6; H4.5FTS5, H4.5FT6; H5.0-5.5FT (H80-120FT) [N005, P005, R005, S005, U005]; E2.2-3.5XN (E45-70XN) [A268]; J2.2-3.5XN (J45-70XN) [A276];J1.5-2.0XNT (J30-40XNT) [K160];J1.6-2.0XN (J30-40XN) [A935]; H8.0FT, H8.0FT9, H9.0FT (H170FT, H175FT36, H190FT) [A299, B299, C299]; E30HSD$_2$, E35HSD$_2$, E40HSD$_2$ [B219];E30HSD$_3$, E35HSD$_3$, E40HSD$_3$ [C219]; S50CT [A267];S50CT, S50CT2 [B267];H2.0-2.5CT (H50CT) [A274, B274]; E1.6-2.0XN (E30-40XN) [A269];J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) [A970];H2.0-3.0XT (H40-60XT) [A380];J8.0XNL6, J8.0XNL9, J9.0XNL (J170-190XNL) [A250]; H3.0XT [A409]

HYSTER

PART NO. 1580517

2200 SRM 1128

SAFETY PRECAUTIONS
MAINTENANCE AND REPAIR

- The Service Manuals are updated on a regular basis, but may not reflect recent design changes to the product. Updated technical service information may be available from your local authorized Hyster® dealer. Service Manuals provide general guidelines for maintenance and service and are intended for use by trained and experienced technicians. Failure to properly maintain equipment or to follow instructions contained in the Service Manual could result in damage to the products, personal injury, property damage or death.
- When lifting parts or assemblies, make sure all slings, chains, or cables are correctly fastened, and that the load being lifted is balanced. Make sure the crane, cables, and chains have the capacity to support the weight of the load.
- Do not lift heavy parts by hand, use a lifting mechanism.
- Wear safety glasses.
- DISCONNECT THE BATTERY CONNECTOR before doing any maintenance or repair on electric lift trucks. Disconnect the battery ground cable on internal combustion lift trucks.
- Always use correct blocks to prevent the unit from rolling or falling. See HOW TO PUT THE LIFT TRUCK ON BLOCKS in the **Operating Manual** or the **Periodic Maintenance** section.
- Keep the unit clean and the working area clean and orderly.
- Use the correct tools for the job.
- Keep the tools clean and in good condition.
- Always use **HYSTER APPROVED** parts when making repairs. Replacement parts must meet or exceed the specifications of the original equipment manufacturer.
- Make sure all nuts, bolts, snap rings, and other fastening devices are removed before using force to remove parts.
- Always fasten a DO NOT OPERATE tag to the controls of the unit when making repairs, or if the unit needs repairs.
- Be sure to follow the **WARNING** and **CAUTION** notes in the instructions.
- Gasoline, Liquid Petroleum Gas (LPG), Compressed Natural Gas (CNG), and Diesel fuel are flammable. Be sure to follow the necessary safety precautions when handling these fuels and when working on these fuel systems.
- Batteries generate flammable gas when they are being charged. Keep fire and sparks away from the area. Make sure the area is well ventilated.

NOTE: The following symbols and words indicate safety information in this manual:

WARNING

Indicates a hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION

Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury and property damage.

On the lift truck, the WARNING symbol and word are on orange background. The CAUTION symbol and word are on yellow background.

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(N35-40ZRS2, N30ZDRS2) [B265];
S6.0-7.0FT (S135-155FT) [D024, E024, F024, G024];
A1.3-1.5XNT (A25-30XNT) [D203];
(N35ZDR2, N45ZR2) [D264];
(S30-35FT, S40FTS) [E010, F010];
(N35-40ZR2, N30ZDR2) [E470];
H1.6-1.8FT, H2.0FTS (H30-35FT, H40FTS) [F001, G001];
S2.0-3.5FT (S40-70FT, S55FTS) [F187, G187, H187];
S4.0-5.5FT, S5.5FTS (S80-120FT; S80-100FTBCS; S120FTS; S120FTPRS) [G004, H004, J004];
H6.0-7.0FT (H135-155FT) [H006, J006, K006, L006];
H2.0-3.5FT (H40-70FT) [L177, N177, P177];
H4.0FT5/FT6; H4.5FTS5, H4.5FT6; H5.0-5.5FT (H80-120FT) [N005, P005, R005, S005, U005];
E2.2-3.5XN (E45-70XN) [A268];
J2.2-3.5XN (J45-70XN) [A276];
J1.5-2.0XNT (J30-40XNT) [K160];
J1.6-2.0XN (J30-40XN) [A935];
H8.0FT, H8.0FT9, H9.0FT (H170FT, H175FT36, H190FT) [A299, B299, C299];
($E30HSD_2$, $E35HSD_2$, $E40HSD_2$) [B219];
($E30HSD_3$, $E35HSD_3$, $E40HSD_3$) [C219];
(S50CT) [A267];
(S50CT, S50CT2) [B267];
H2.0-2.5CT (H50CT) [A274, B274];
E1.6-2.0XN (E30-40XN) [A269];
J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) [A970];
H2.0-3.0XT (H40-60XT) [A380];
J8.0XNL6, J8.0XNL9, J9.0XNL (J170-190XNL) [A250];
H3.0XT [A409]

"THE QUALITY KEEPERS"

HYSTER APPROVED PARTS

General

This section covers the repair of the wire harness connectors, pins, sockets, and splicing of wires.

Deutsch Crimping Tool

HOW TO STRIP A WIRE FOR USE WITH DEUTSCH CRIMPING TOOL

1. Choose Metri-Pack Connectorsthe correct AWG for the contact being used. See Table 15.

2. See Table 15 for recommended strip length for contact size. Measure strip length from end of wire as shown in Figure 1.

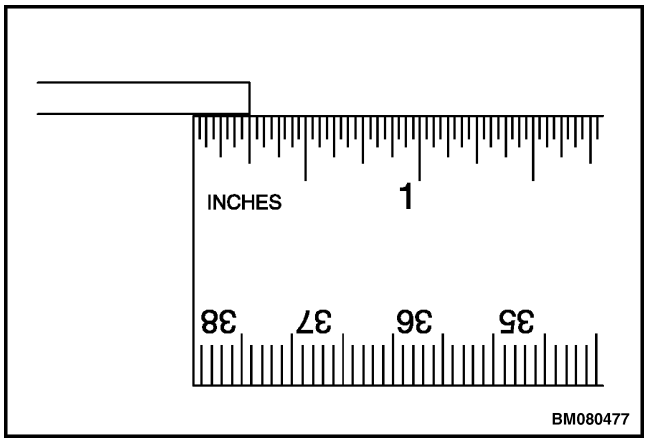


Figure 1. Strip Length Measurement

3. Strip the wire to the recommended strip length. A small piece of insulation should come off the wire after stripping. See Figure 2.

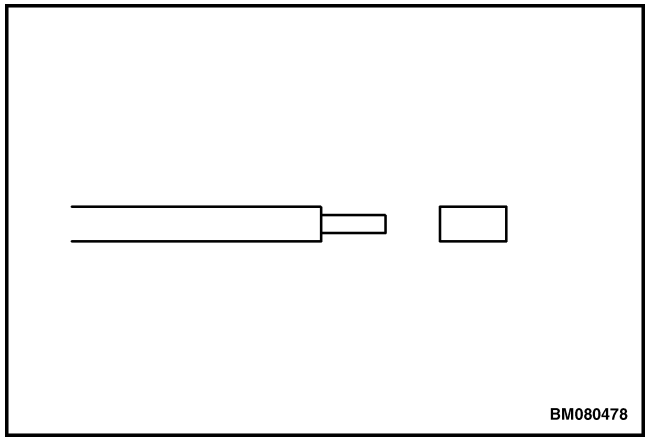


Figure 2. Stripped Wire

4. Check for any broken strands or for a nick in the wire. If either exists, the wires are damaged and should be cut and stripped again.

5. Measure the exposed strands to verify strip length is correct. See Figure 3.

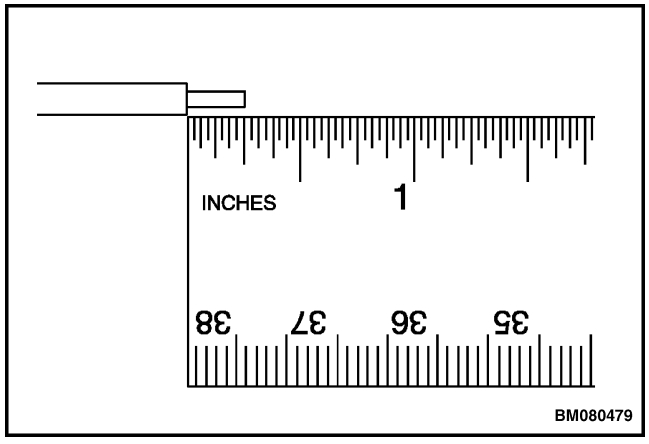


Figure 3. Strip Length Measurement Verification

Table 1. Wire Strip Length Specifications

Contact Part Number	Type	Wire Gauge Range	Recommended Strip Length
1463136	Pin	20 AWG (0.5 mm^2)	3.96 to 5.54 mm (0.156 to 0.218 in.)
1463137	Socket	20 AWG (0.5 mm^2)	3.96 to 5.54 mm (0.156 to 0.218 in.)
1660396	Pin	20 AWG (0.5 mm^2)	4.0 to 5.5 mm (0.157 to 0.217 in.)
1330433	Pin	16 to 20 AWG (1.0 to 0.5 mm^2)	6.35 to 7.92 mm (0.250 to 0.312 in.)
1330434	Socket	16 to 20 AWG (1.0 to 0.5 mm^2)	6.35 to 7.92 mm (0.250 to 0.312 in.)
1659638	Pin	16 to 20 AWG (1.0 to 0.5 mm^2)	6.4 to 7.9 mm (0.252 to 0.311 in.)
1579860	Socket	16 to 20 AWG (1.0 to 0.5 mm^2)	6.4 to 7.9 mm (0.252 to 0.311 in.)
1330435	Pin	14 AWG (2.0 mm^2)	6.35 to 7.92 mm (0.250 to 0.312 in.)
1330436	Socket	14 AWG (2.0 mm^2)	6.35 to 7.92 mm (0.250 to 0.312 in.)
1653804	Socket	14 AWG (2.0 mm^2)	6.4 to 7.9 mm (0.252 to 0.311 in.)
0866401	Pin	12 to 14 AWG (3.0 to 2.0 mm^2)	5.64 to 7.21 mm (0.222 to 0.284 in.)
1554359	Socket	12 to 14 AWG (3.0 to 2.0 mm^2)	5.64 to 7.21 mm (0.222 to 0.284 in.)

HOW TO CRIMP WITH THE DEUTSCH CRIMPING TOOL

1. Strip the insulation from the wire. See How to Strip a Wire for Use With Deutsch Crimping Tool.

2. Raise the selector knob and rotate until arrow is aligned with wire gauge to be crimped. See Figure 4.

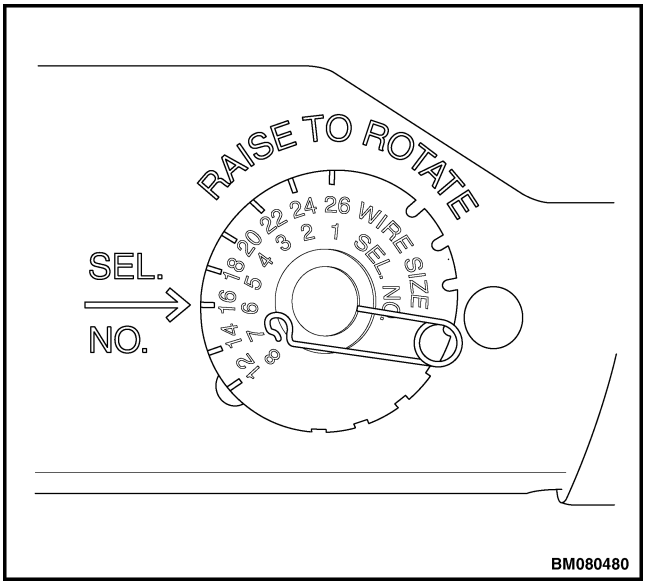
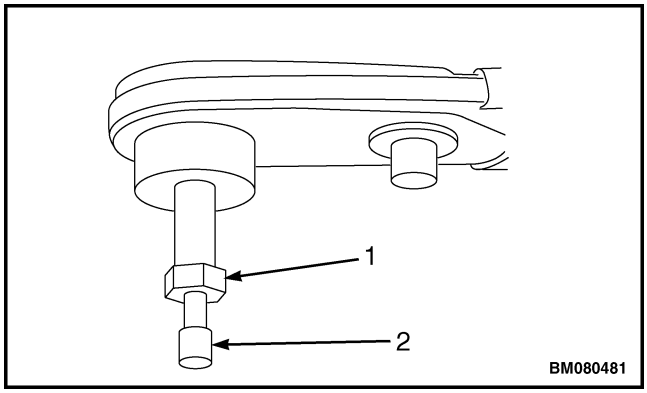


Figure 4. Selector Knob

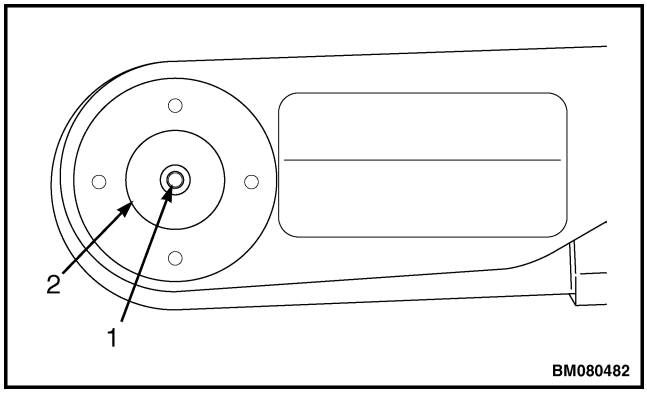
3. Loosen lock nut and turn adjusting screw until it stops. See Figure 5.



1. LOCK NUT
2. ADJUSTING SCREW

Figure 5. Adjusting Screw and Lock Nut

4. Insert the contact into the crimping tool; for pin contacts, insert short end into crimping tool; for socket contacts, insert long end into crimping tool. See Figure 6.



1. INSERTION POINT
2. INDENTOR COVER

Figure 6. Insertion Point

5. Turn the adjusting screw clockwise until the contact is flush or slightly above flush with the indentor cover (cover around insertion point). See Figure 6. Tighten the lock nut.

6. Insert the wire into the contact. There should be no loose strands. All strands should be contained in the contact barrel. The contact must be centered between indicators. See Figure 7.

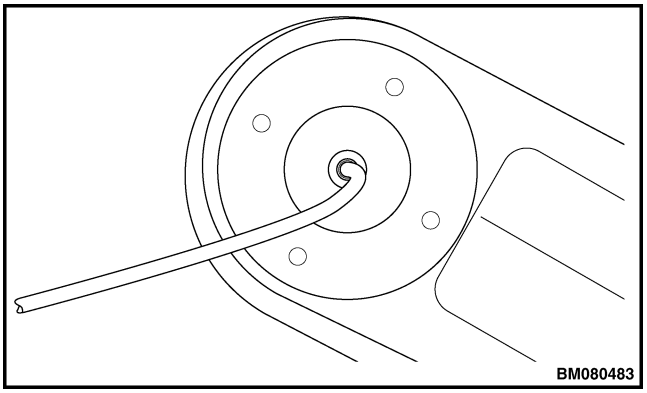


Figure 7. Wire Insertion

7. Close handles until handles stop.

8. Release handles and remove crimped contact.

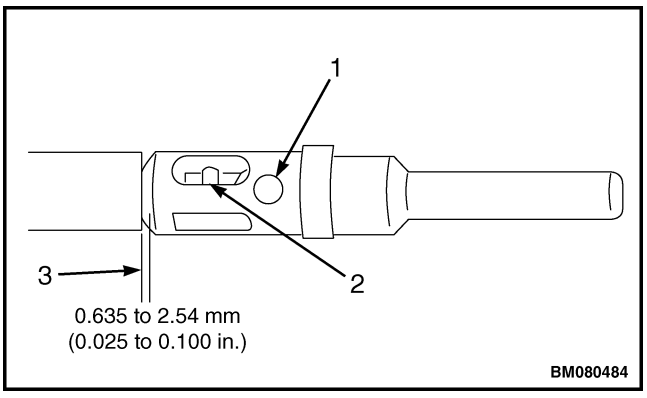
9. Visually check the crimped contact for the following:

a. The conductor is inserted to the proper depth and is visible through the inspection hole. See Figure 8.

b. There is about 0.635 to 2.54 mm (0.025 to 0.100 in.) of conductor between the contact and the insulator.

c. There are no damaged wire strands.

d. There are no frayed wires or wires not entering the contact barrel.



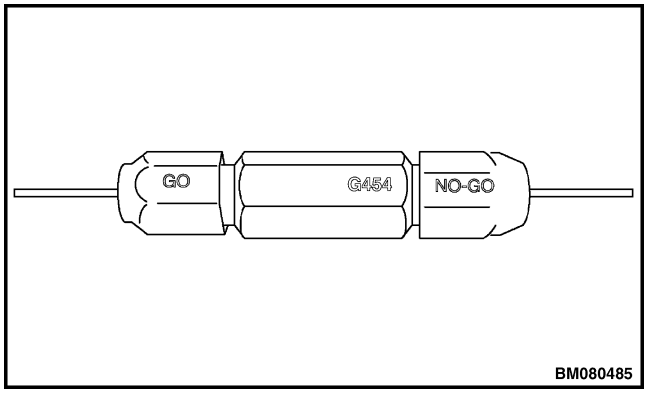
1. INSPECTION HOLE
2. CRIMP
3. INSULATION GAP, 0.635 TO 2.54 mm (0.025 TO 0.100 in.)

Figure 8. Proper Crimp

10. If any of the conditions in Step 9 are not met, discard the contact, re-cut and strip the wire, and start the crimping process over.

CALIBRATION TEST FOR THE DEUTSCH CRIMPING TOOL

The G454 testing tool is needed for the following procedures. The G454 testing tool is for use with the Deutsch hand crimping tool only. See Figure 9.

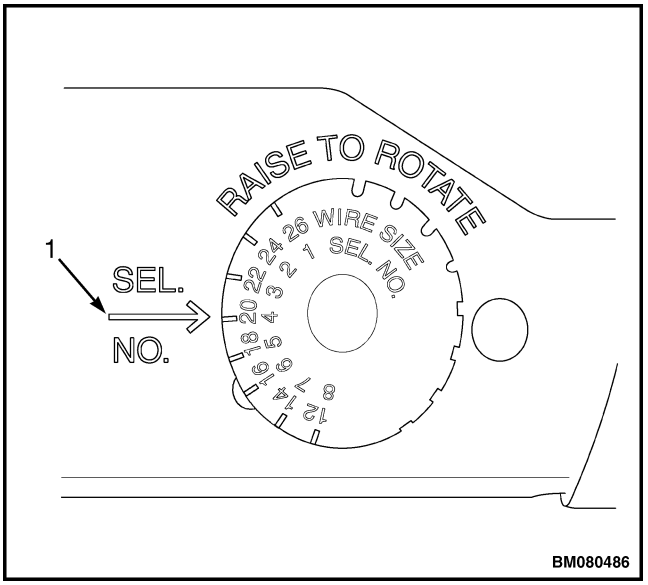


1. GO END (GREEN)
2. NO-GO END (RED)

Figure 9. G454 Testing Tool

NOTE: Testing for all wire sizes should be #20 wire size, selector number 4. This ensures proper calibration for all settings and further testing is not needed for the other selections.

1. Set the Deutsch hand crimp tool to #20 wire size, selector number 4. See Figure 10.



1. SELECTOR SET AT #20 WIRE SIZE, SELECTOR NUMBER 4

Figure 10. Selector Test Setting

2. Squeeze the handles of the crimp tool completely together. See Figure 11.

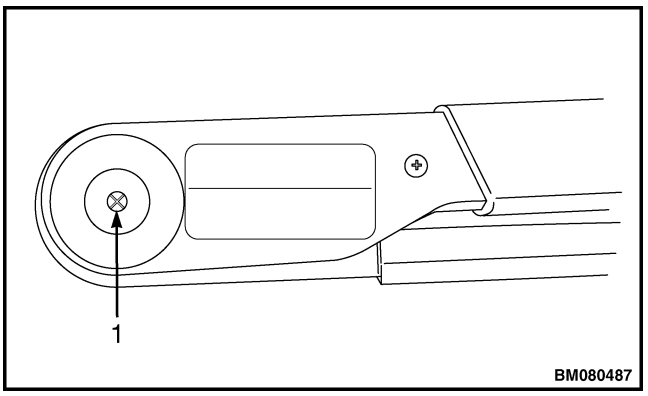
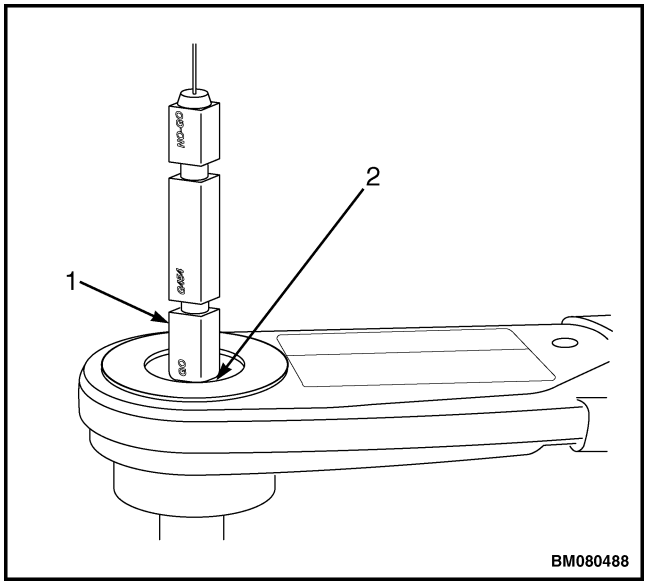


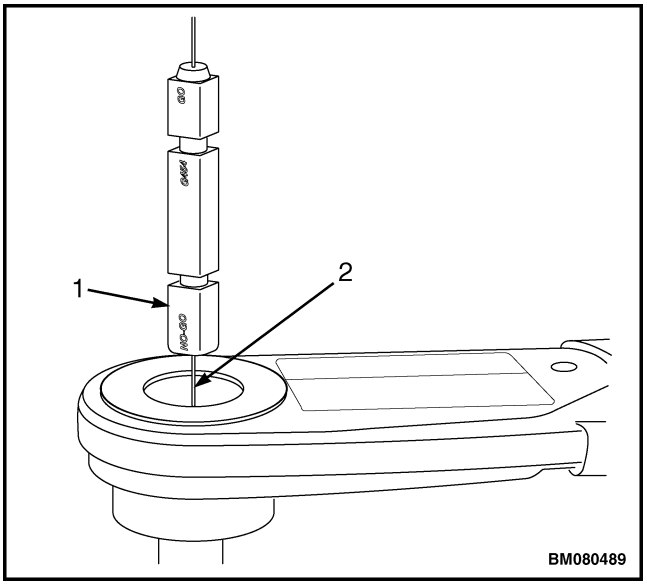
Figure 11. Insertion Point

3. Insert the Go end (green) of the G454 testing tool into the insertion point of the crimp tool while the handles are completely closed. The Go end (green) should insert easily. If it does not insert, the calibration is incorrect and the crimp tool must be replaced. See Figure 12.



1. GO END (GREEN)
2. GO END COMPLETELY INSERTED

Figure 12. Go End Test



1. NO-GO END (RED)
2. NO-GO END SHOULD NOT INSERT ANY FURTHER

Figure 13. No-Go End Test

4. Insert the No-Go end (red) of the G454 testing tool into the insertion point of the crimp tool while the handles are still completely closed. The No-Go end (red) should not insert. If it does insert, the calibration is incorrect and the crimp tool must be replaced. See Figure 13.

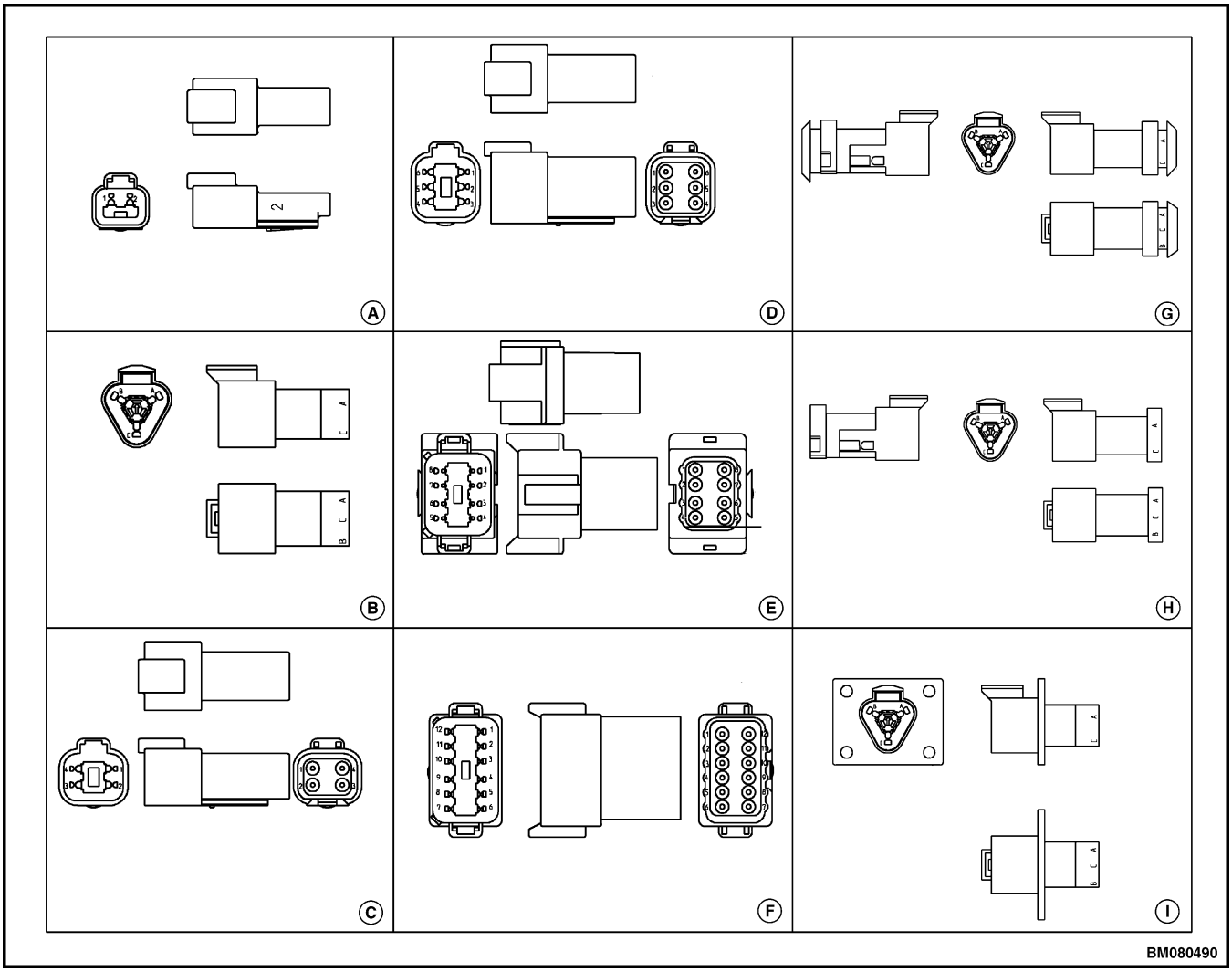
Deutsch Connectors

DT, DTM, AND DTP SERIES CONNECTORS

All Deutsch DT, DTM, and DTP series pin- and socket-type connectors are repaired in the same manner.

For examples of the DT connectors, see Figure 14 for the different connector receptacles, Figure 15 for the different connector receptacle secondary locks, Figure 16 for the different connector plugs, and Figure 17 for the different connector plug secondary locks.

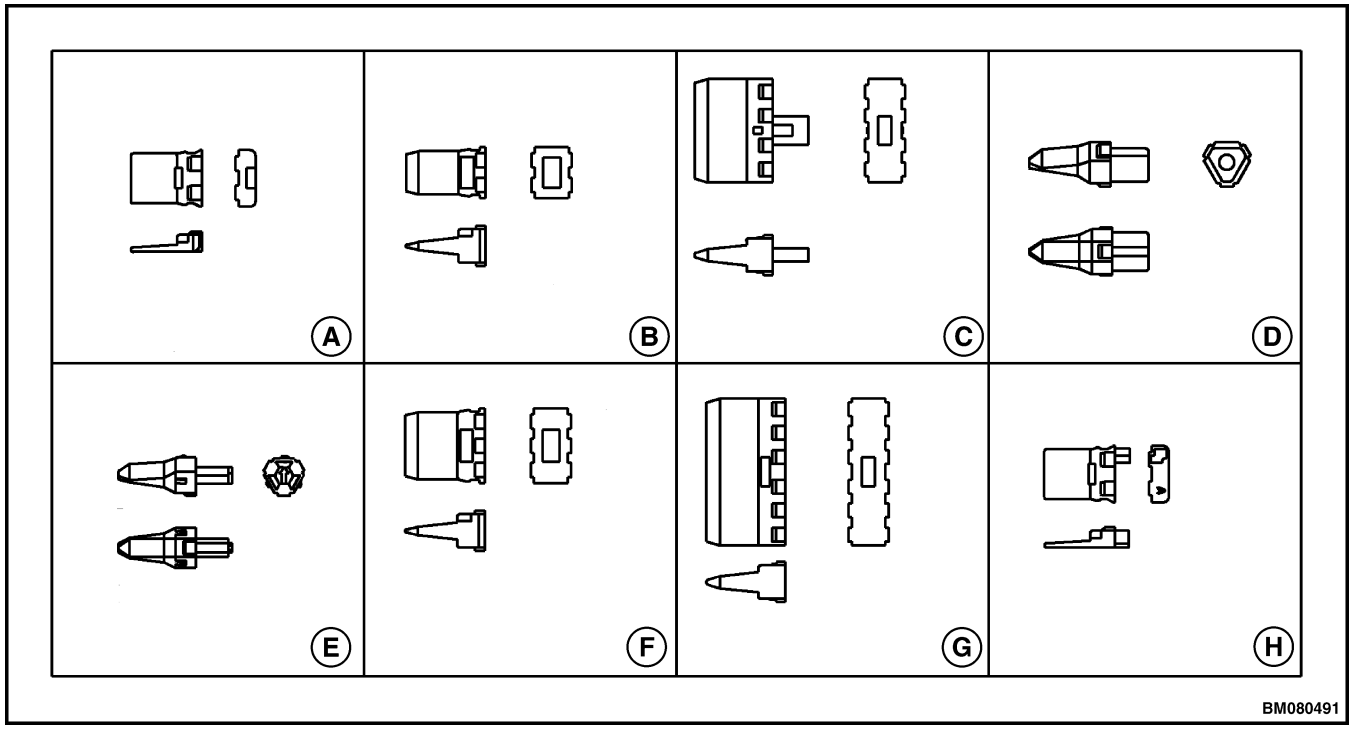
For examples of the DTM and DTP connectors, see Figure 18 for the different connector receptacles, Figure 19 for the different connector receptacle secondary locks, Figure 20 for the different connector plugs, and Figure 21 for the different connector plug secondary locks.



NOTE: ALL CONNECTOR RECEPTACLES ARE SHOWN WITH THE SECONDARY LOCK INSTALLED.

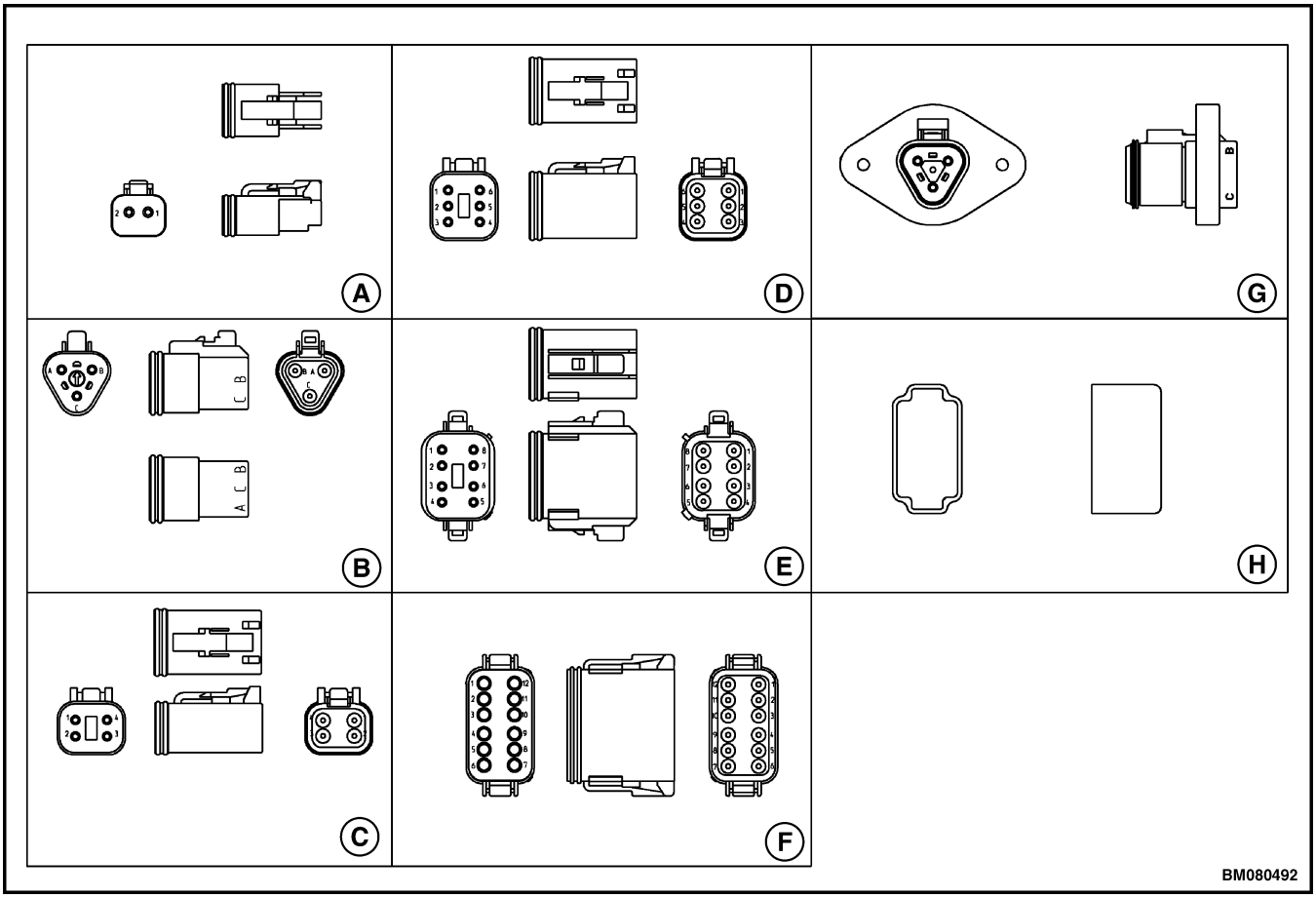
A. CONNECTOR TYPE AA
B. CONNECTOR TYPE AB
C. CONNECTOR TYPE AC
D. CONNECTOR TYPE AD
E. CONNECTOR TYPE AE
F. CONNECTOR TYPE AF
G. CONNECTOR TYPE AB-A (SIMILAR TO TYPE AB)
H. CONNECTOR TYPE AB-B (SIMILAR TO TYPE AB)
I. CONNECTOR TYPE AB-C (SIMILAR TO TYPE AB)

Figure 14. DT Connector Receptacles



A. SECONDARY LOCK TYPE BA
B. SECONDARY LOCK TYPE BB
C. SECONDARY LOCK TYPE BC
D. SECONDARY LOCK TYPE BD
E. SECONDARY LOCK TYPE BE
F. SECONDARY LOCK TYPE BF
G. SECONDARY LOCK TYPE BG
H. SECONDARY LOCK TYPE BH

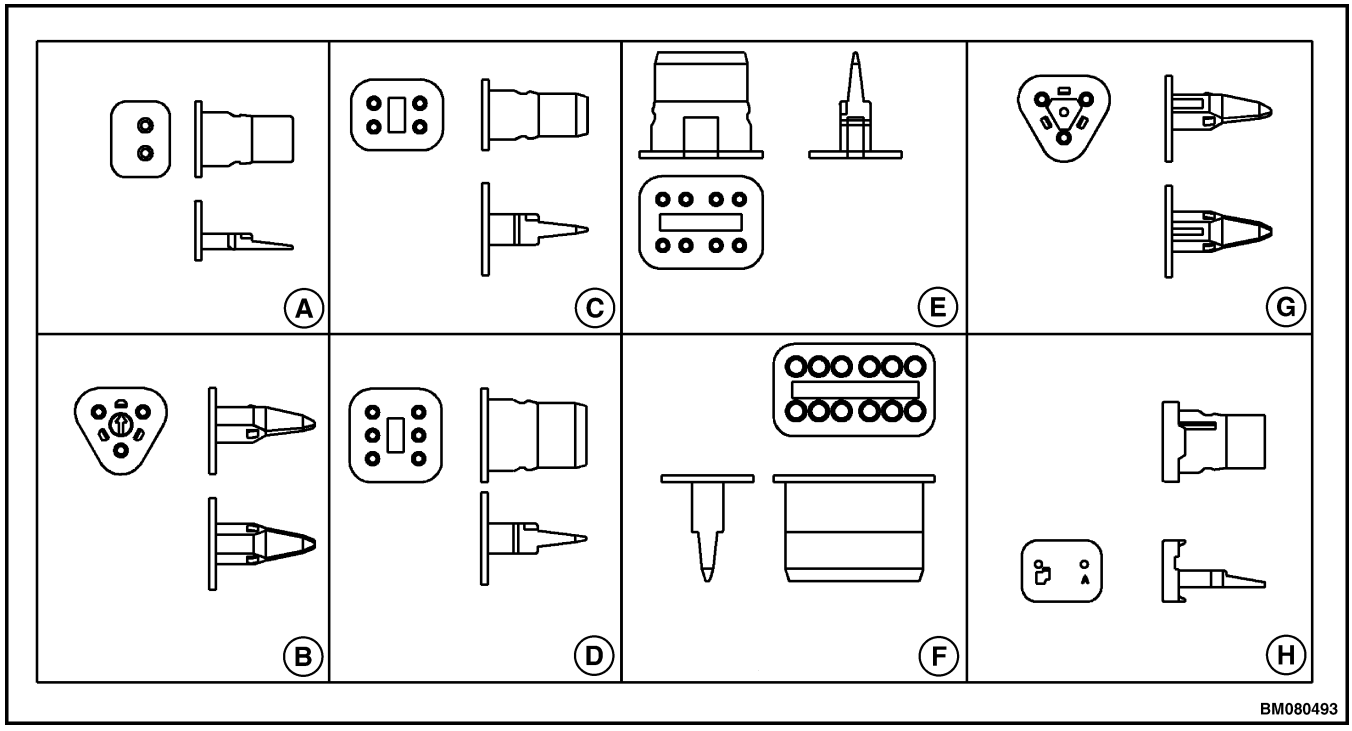
Figure 15. DT Connector Receptacle Secondary Locks



NOTE: ALL CONNECTOR PLUGS ARE SHOWN WITH THE SECONDARY LOCK INSTALLED.

A. CONNECTOR TYPE CA
B. CONNECTOR TYPE CB
C. CONNECTOR TYPE CC
D. CONNECTOR TYPE CD
E. CONNECTOR TYPE CE
F. CONNECTOR TYPE CF
G. CONNECTOR TYPE CH (SIMILAR TO TYPE CB)
H. CONNECTOR TYPE CG

Figure 16. DT Connector Plugs



A. SECONDARY LOCK TYPE DA
B. SECONDARY LOCK TYPE DB
C. SECONDARY LOCK TYPE DC
D. SECONDARY LOCK TYPE DD
E. SECONDARY LOCK TYPE DE
F. SECONDARY LOCK TYPE DF
G. SECONDARY LOCK TYPE DG
H. SECONDARY LOCK TYPE DH

Figure 17. DT Connector Plug Secondary Locks

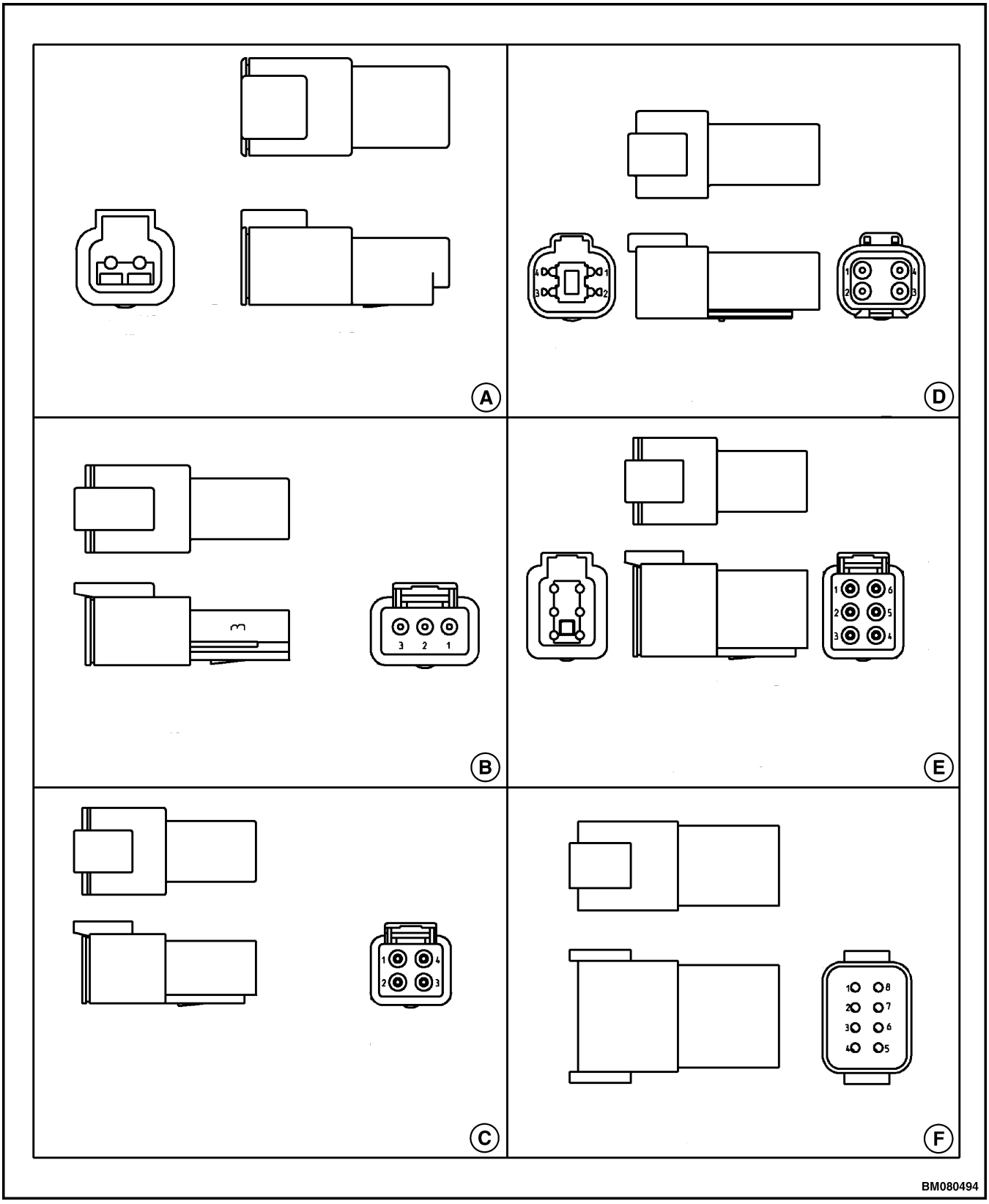
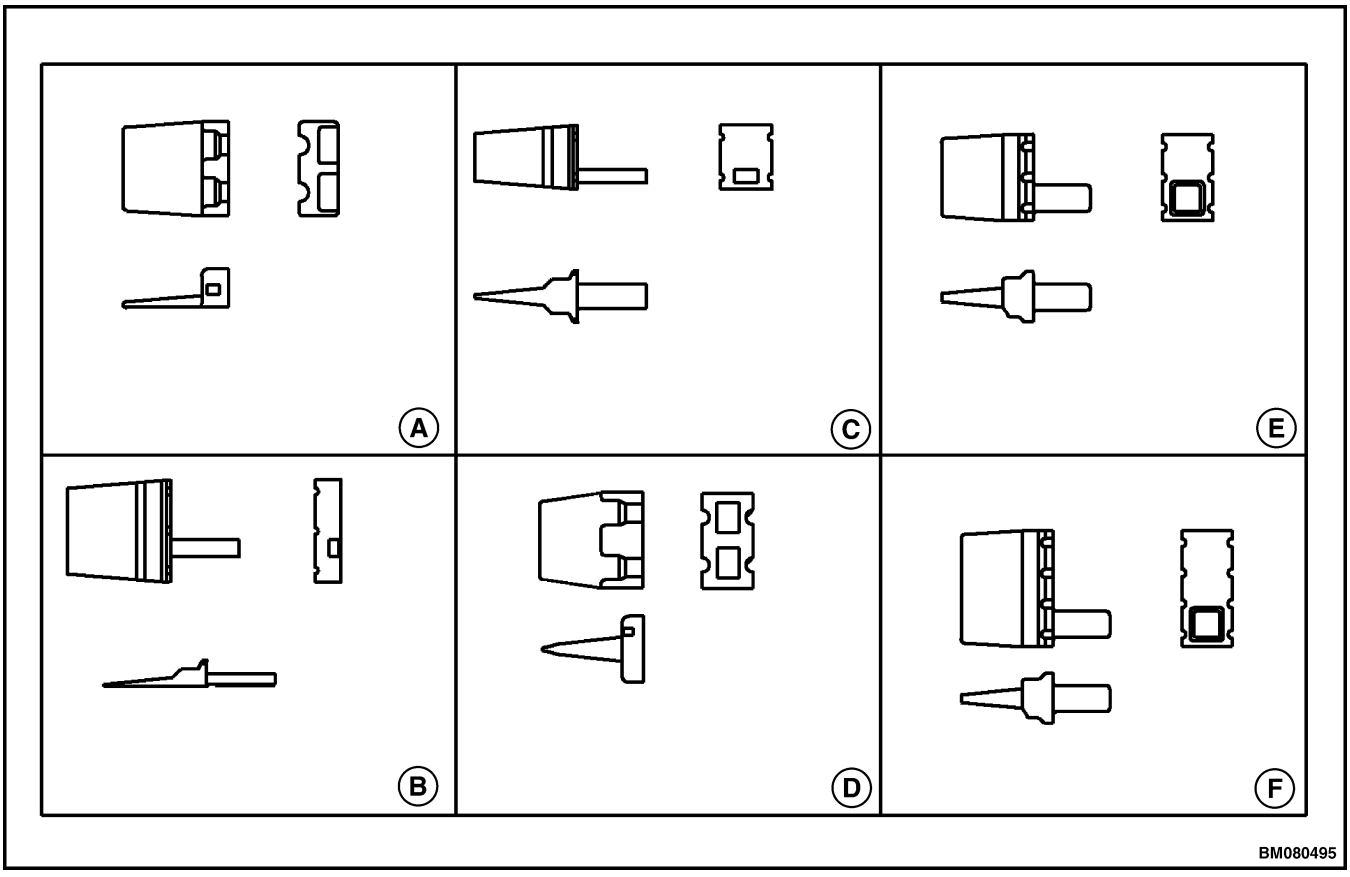


Figure 18. DTM and DTP Connector Receptacles

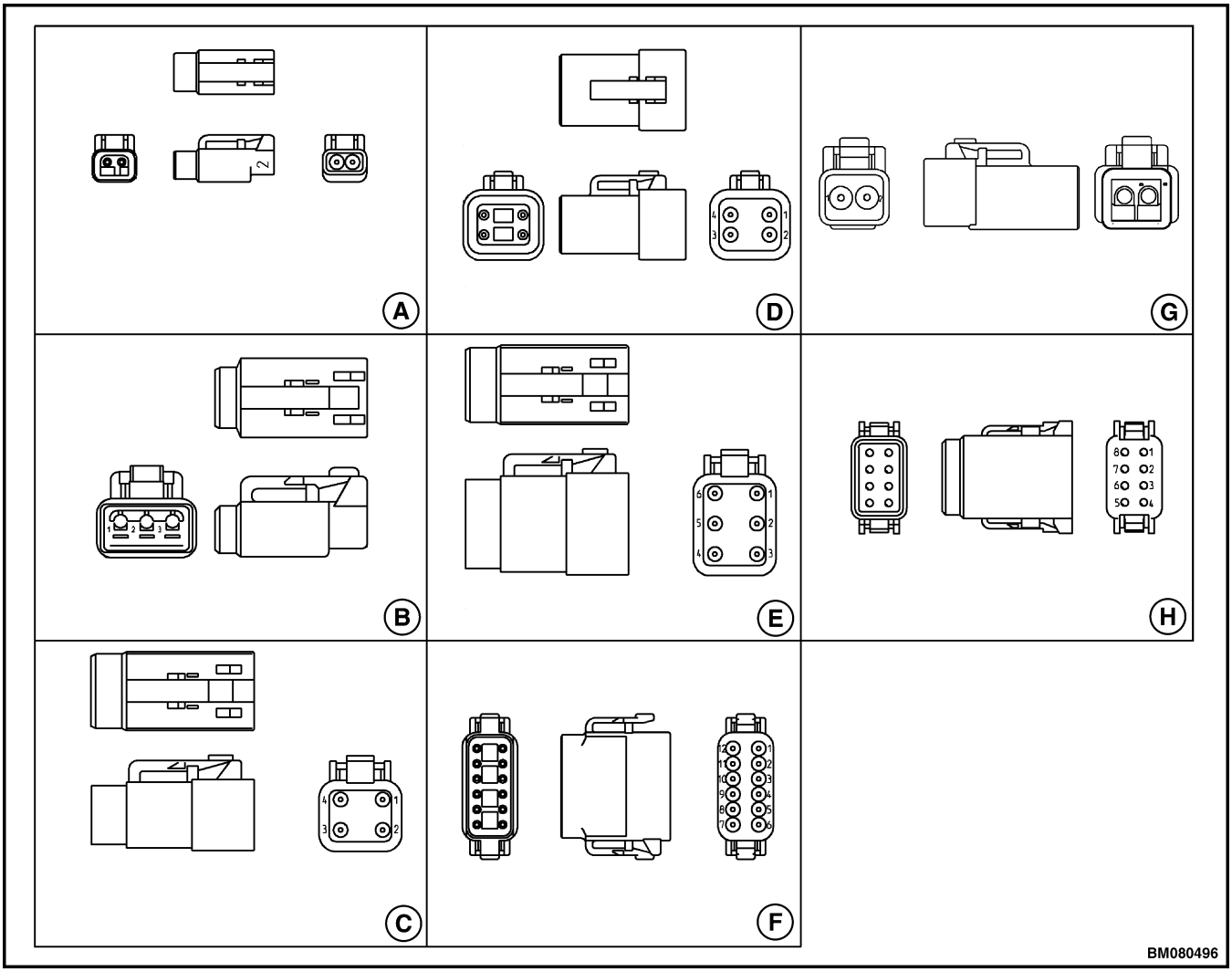
Legend for Figure 18.

A. DTP CONNECTOR TYPE EA
B. DTM CONNECTOR TYPE EB
C. DTM CONNECTOR TYPE EC
D. DTP CONNECTOR TYPE ED
E. DTM CONNECTOR TYPE EE
F. DTM CONNECTOR TYPE EF



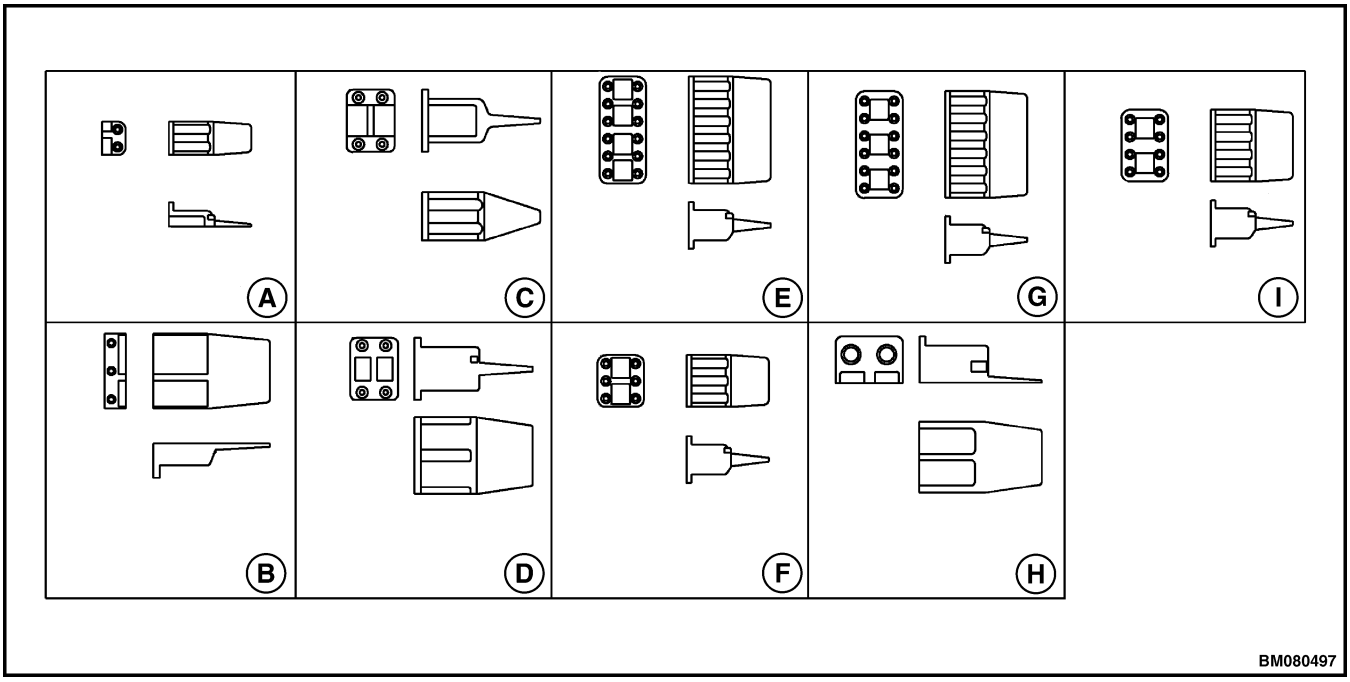
A. DTP SECONDARY LOCK TYPE FA
B. DTM SECONDARY LOCK TYPE FB
C. DTM SECONDARY LOCK TYPE FC
D. DTP SECONDARY LOCK TYPE FD
E. DTM SECONDARY LOCK TYPE FE
F. DTM SECONDARY LOCK TYPE FF

Figure 19. DTM and DTP Connector Receptacle Secondary Locks



A. DTM CONNECTOR TYPE GA
B. DTM CONNECTOR TYPE GB
C. DTM CONNECTOR TYPE GC
D. DTP CONNECTOR TYPE GD
E. DTM CONNECTOR TYPE GF
F. DTM CONNECTOR TYPE GE
G. DTP CONNECTOR TYPE GG
H. DTM CONNECTOR TYPE GH

Figure 20. DTM and DTP Connector Plugs

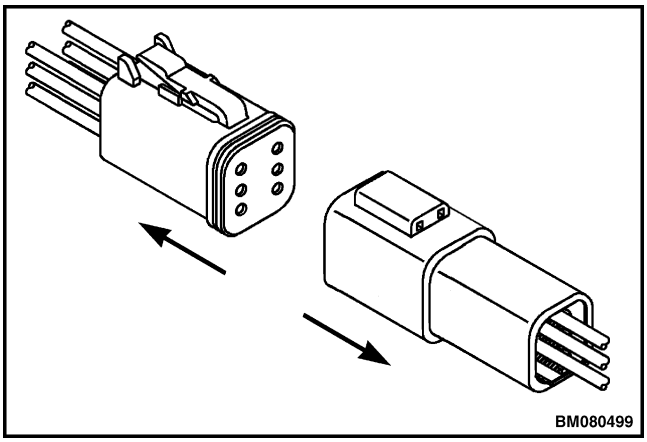


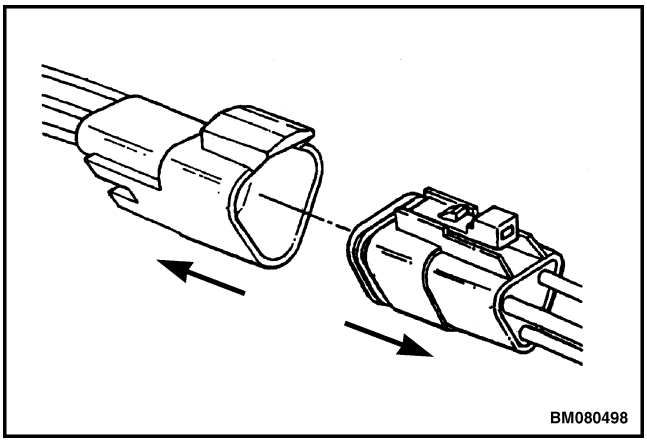
A. DTM SECONDARY LOCK TYPE HA
B. DTM SECONDARY LOCK TYPE HB
C. DTM SECONDARY LOCK TYPE HC
D. DTP SECONDARY LOCK TYPE HD
E. DTM SECONDARY LOCK TYPE HE
F. DTM SECONDARY LOCK TYPE HF
G. DTM SECONDARY LOCK TYPE HG
H. DTP SECONDARY LOCK TYPE HH
I. DTM SECONDARY LOCK TYPE HJ

Figure 21. DTM and DTP Connector Plug Secondary Locks

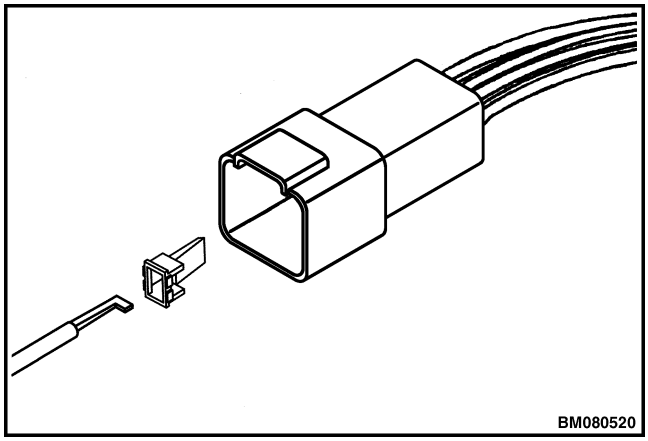
Connector Receptacle Replacement

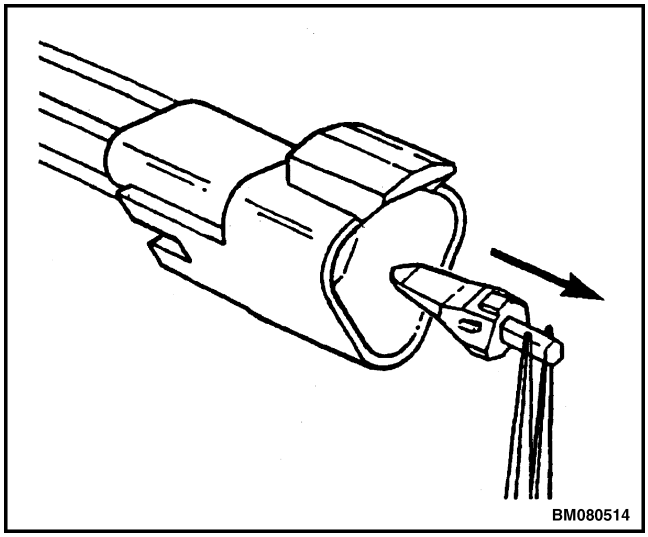
STEP 1.
Release the external locking clip(s) and separate the connector plug from the connector receptacle.



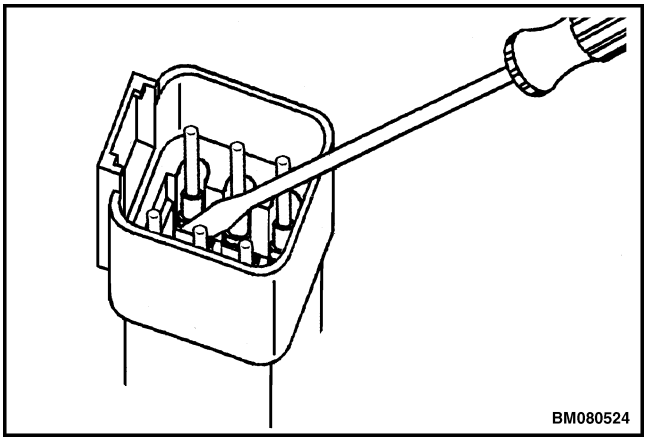


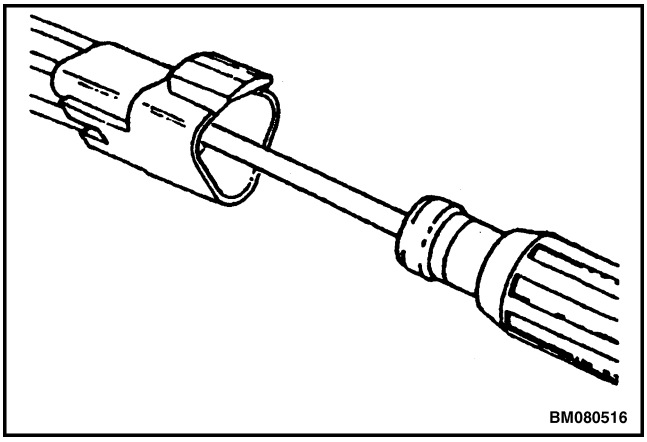
STEP 2.
Using a small hook end tool (Hyster Part No. 866404), or needle nose pliers, remove the secondary lock from the connector receptacle.



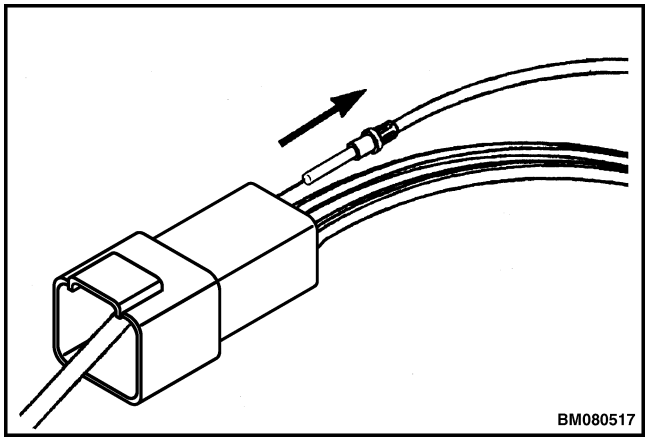


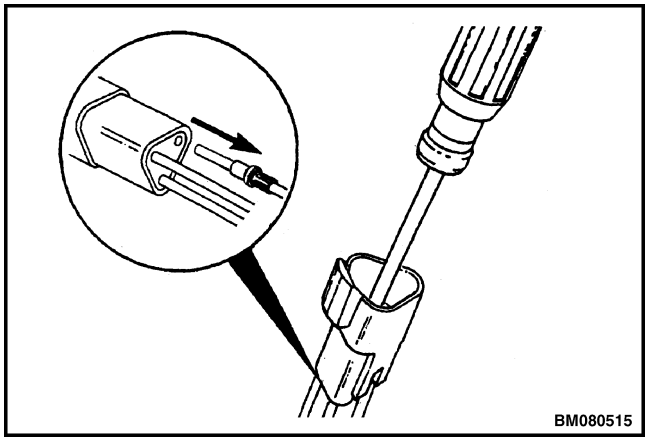
STEP 3.
Using a small, flat-blade screwdriver (Hyster P/N 866404), release the locking finger by moving it away from the pin.



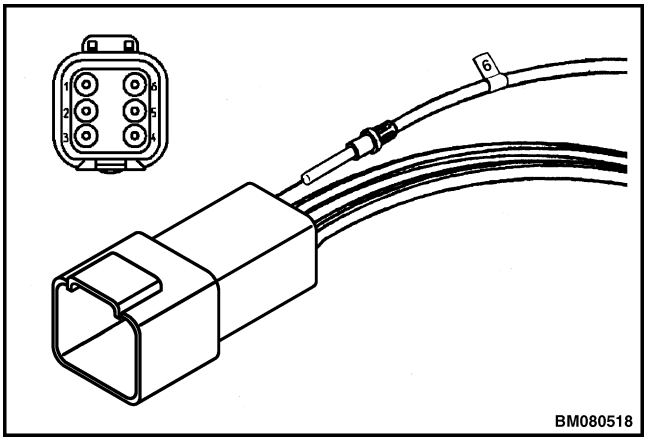


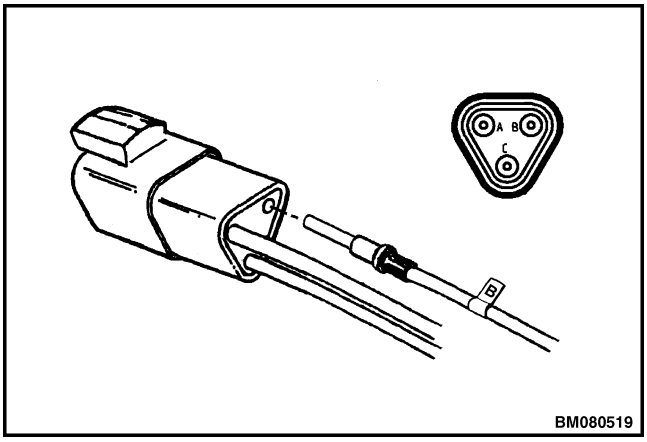
STEP 4.
Gently pull the wire backward while, at the same time, releasing the locking finger with the small, flat-blade screwdriver (Hyster P/N 866404).





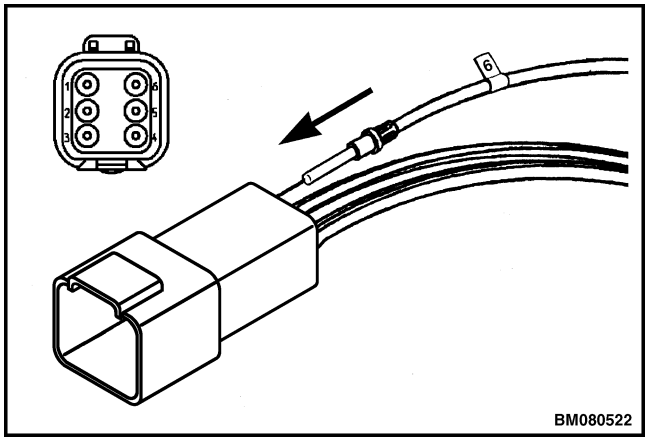
STEP 5.
Tag the wire and mark it with the corresponding number or letter on the back of the connector from which the wire was removed.

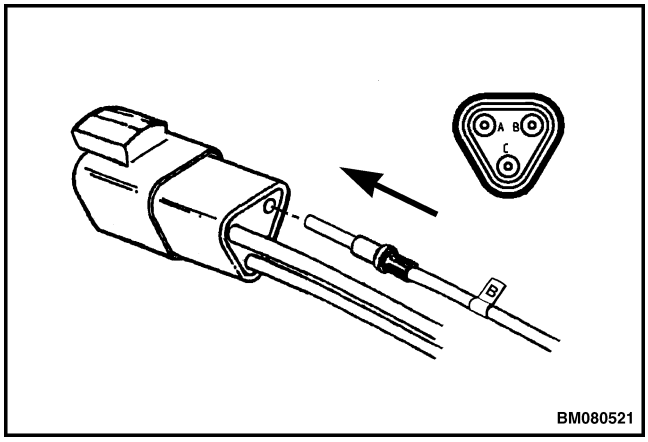




STEP 6.
Repeat Step 3 through Step 5 for the removal of the remaining wires.

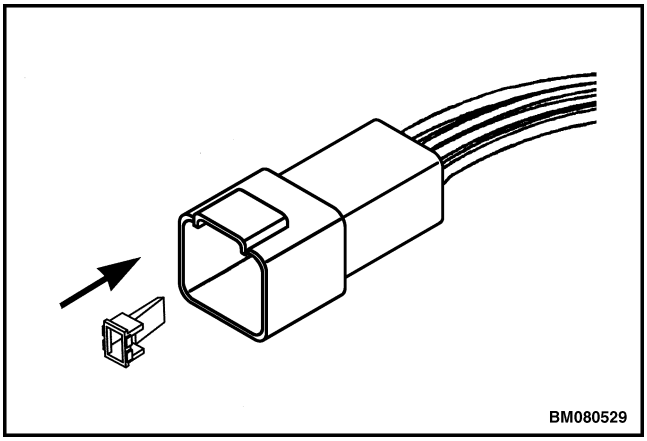
STEP 7.
Insert the wires into the new connector receptacle according to the number or letter on the tag and connector receptacle. Push the wires straight into the back of the receptacle until a click is felt. Slightly tug each wire to verify the wire is properly locked in place. Remove tags.

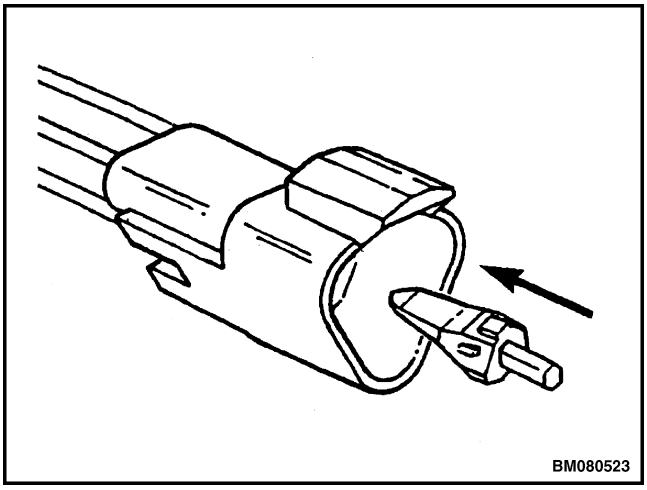




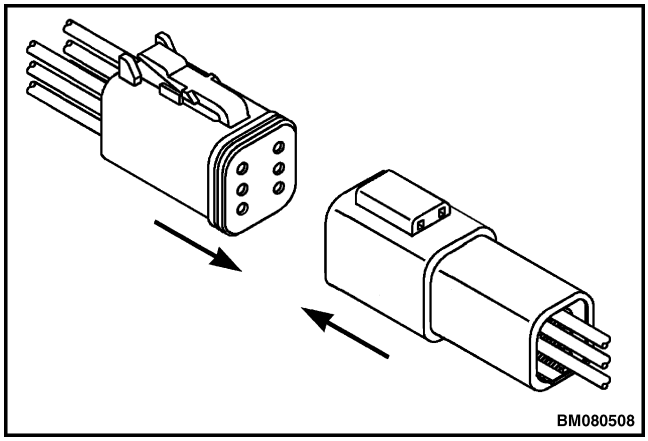
NOTE: Verify that the seal is in place on the connector plug before installing the secondary lock.

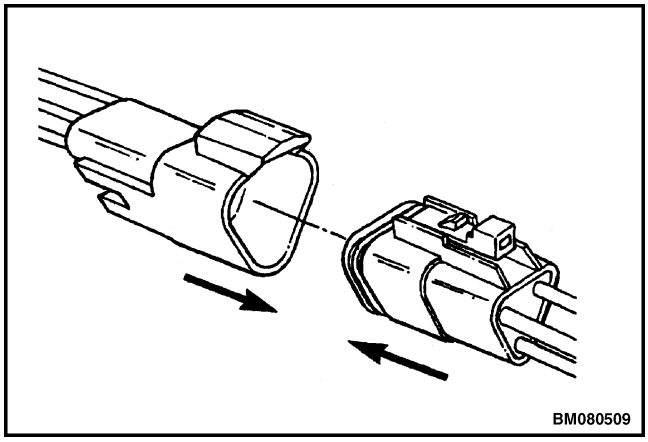
STEP 8.
Install the secondary lock. Push the lock straight in until the lock snaps into place.





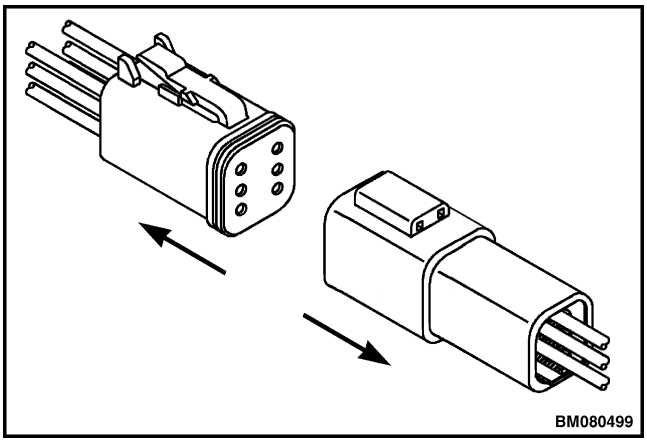
STEP 9.
Push the connector plug into the connector receptacle until the external locking mechanism(s) snap(s) into place.

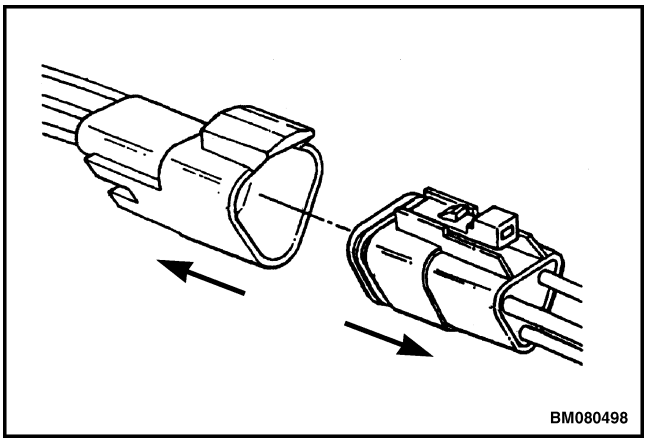




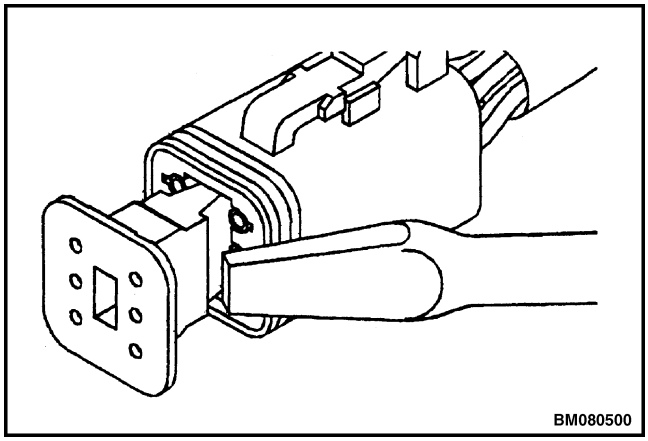
Connector Plug Replacement

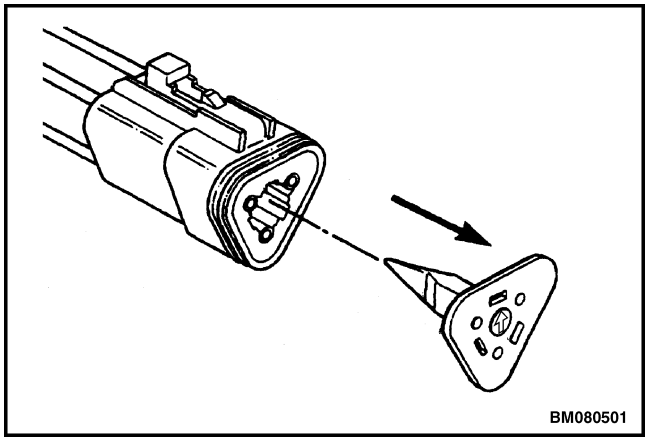
STEP 1.
Release the external locking clip(s) and separate the connector plug from the connector receptacle.



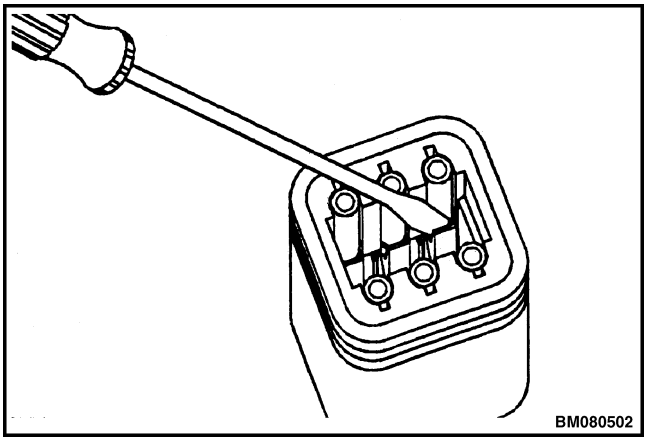


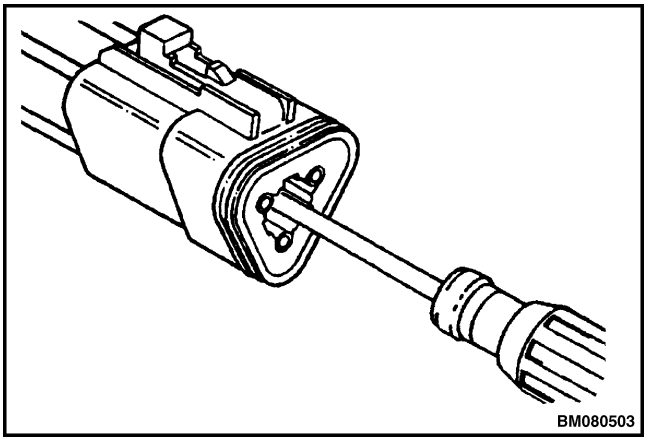
STEP 2.
Using a small, flat-blade screwdriver (Hyster P/N 866404), remove the secondary lock from the connector plug.



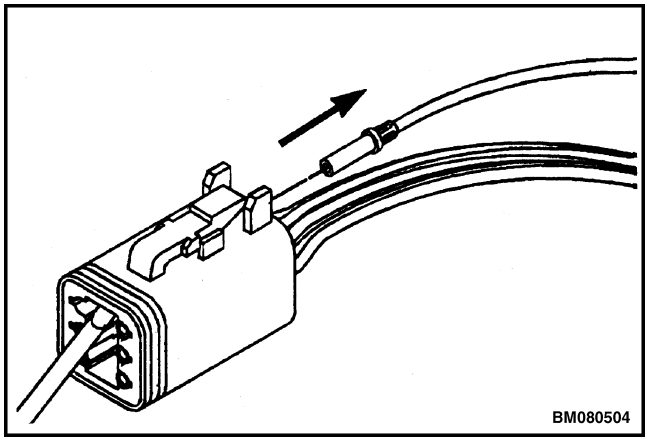


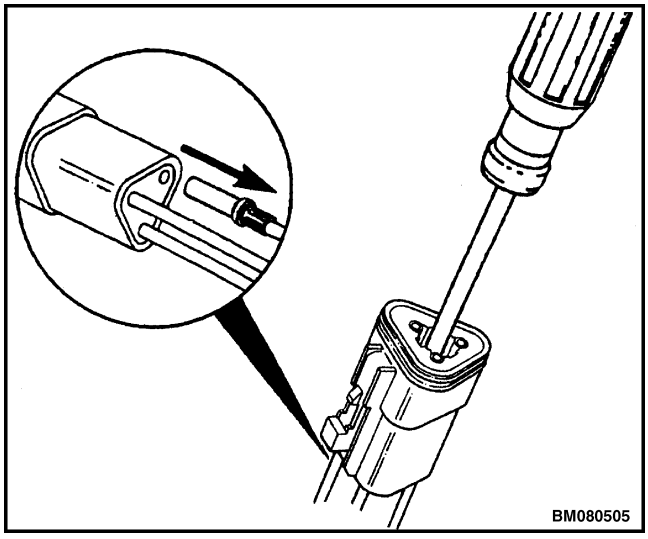
STEP 3.
Using a small, flat-blade screwdriver (Hyster P/N 866404), release the locking finger by moving it away from the socket.



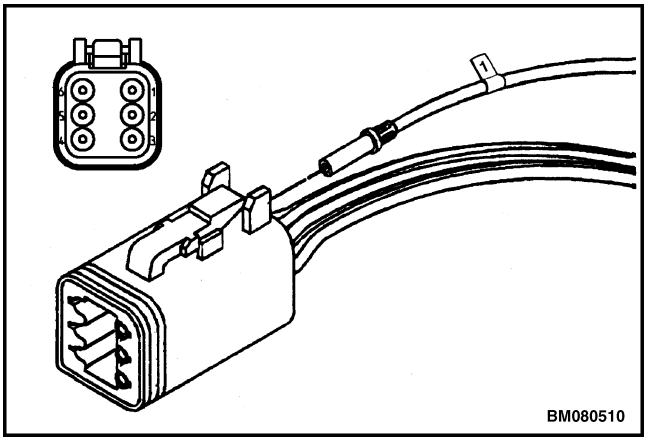


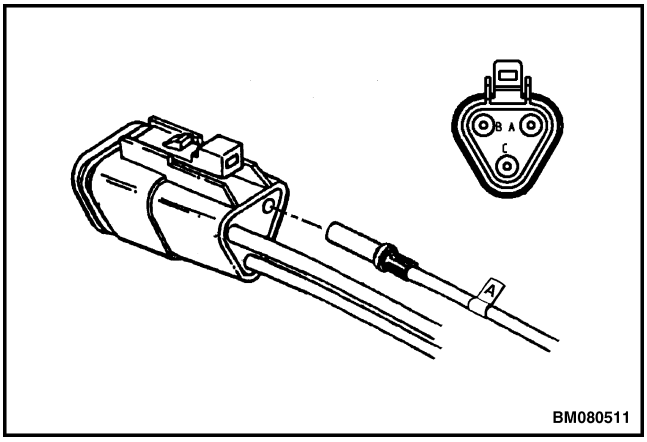
STEP 4.
Gently pull the wire backward while, at the same time, releasing the locking finger with the small, flat-blade screwdriver (Hyster P/N 866404).





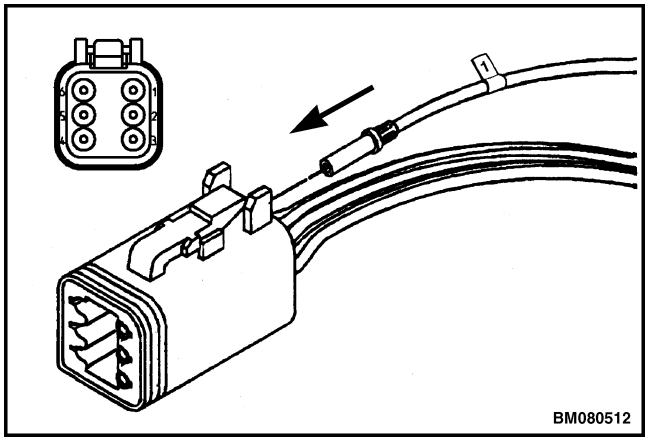
STEP 5.
Tag the wire and mark it with the corresponding number or letter on the back of the connector from which the wire was removed.

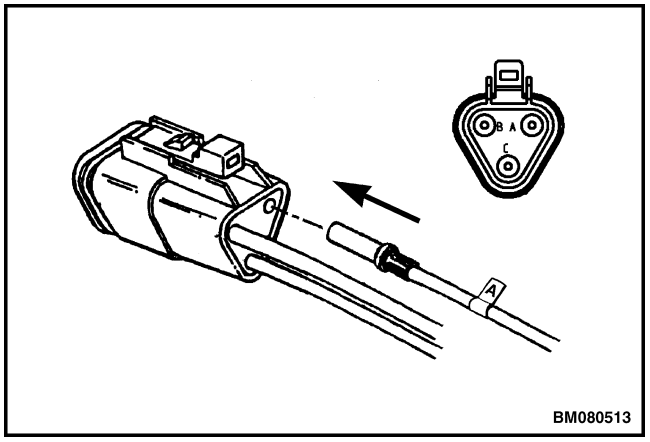




STEP 6.
Repeat Step 3 through Step 5 for the removal of the remaining wires.

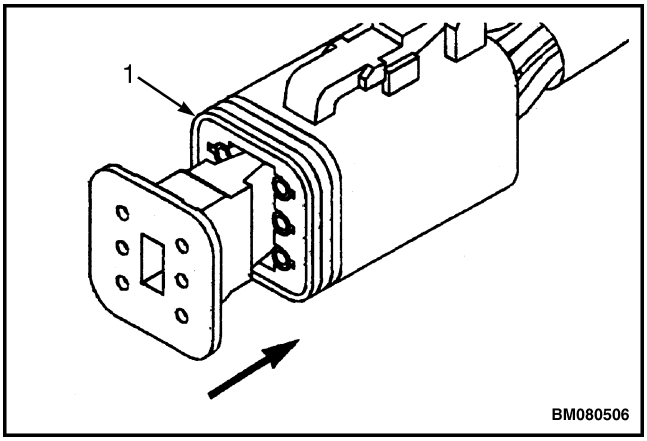
STEP 7.
Insert the wires into the back of the new connector plug according to the number or letter on the tag and connector plug. Push the wires straight into the back of the plug until a click is felt. Slightly tug each wire to verify the wire is properly locked in place. Remove tags.



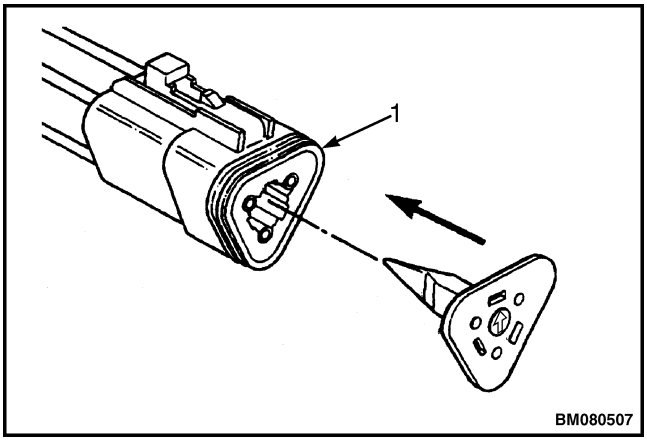


NOTE: Verify that the seal is in place on the connector plug before installing the secondary lock.

STEP 8.
Install the secondary lock. Push the lock straight in until the lock snaps into place. On 3-way secondary locks, the arrow on the lock must be oriented toward the exterior locking mechanism.

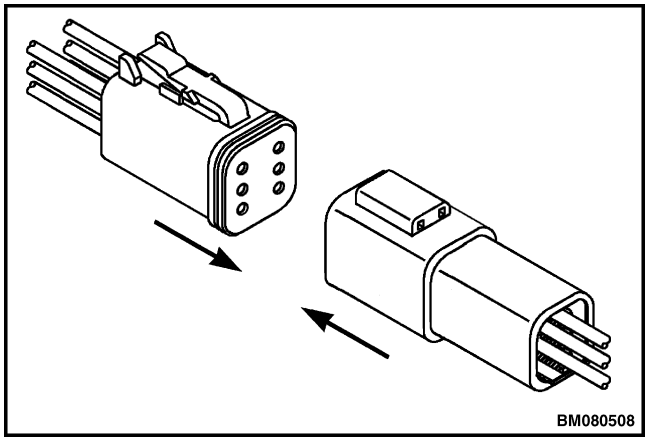


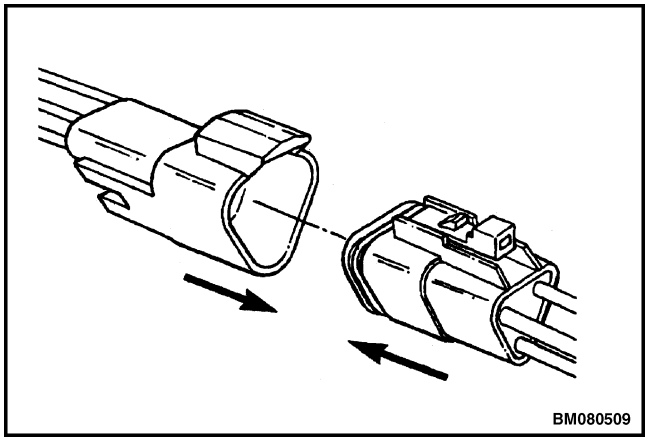
1. SEAL



1. SEAL

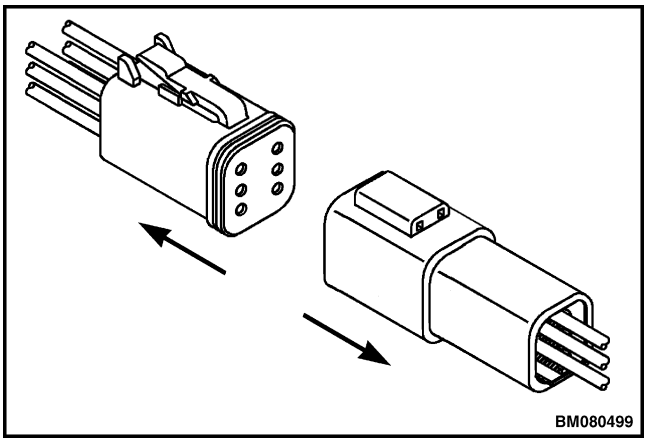
STEP 9.
Push the connector plug into the connector receptacle until the external locking mechanism(s) snap(s) into place.

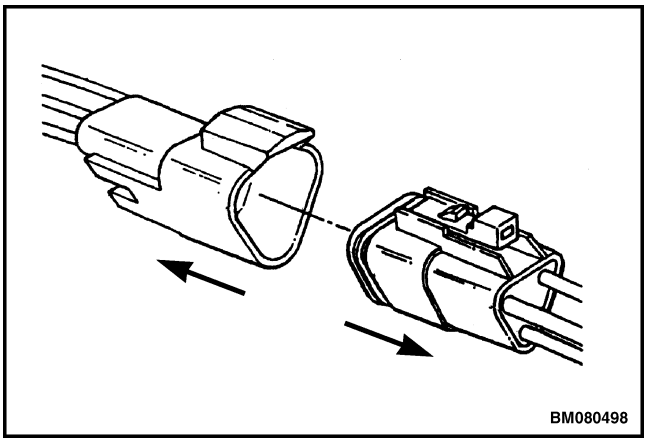




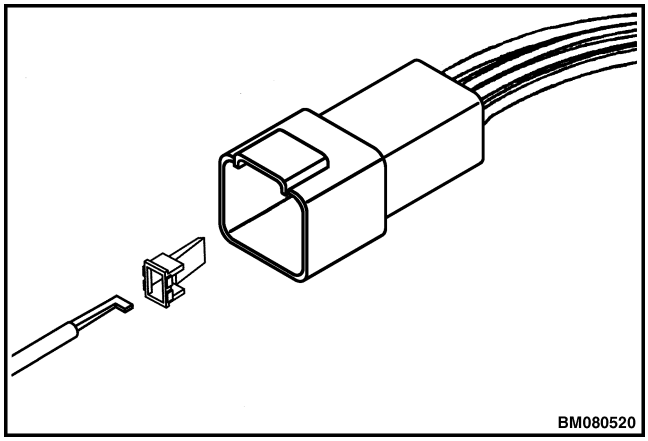
Connector Receptacle Pin Replacement

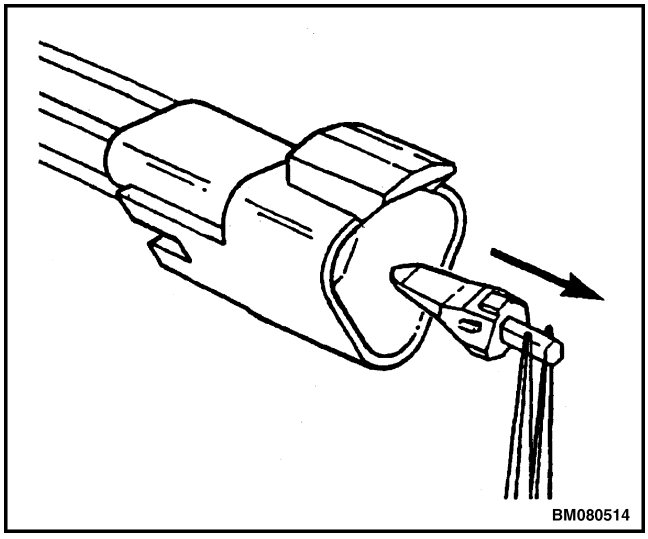
STEP 1.
Release the external locking clip(s) and separate the connector plug from the connector receptacle.



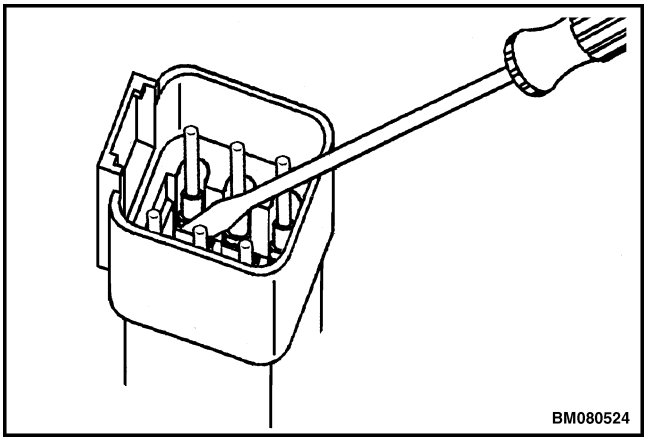


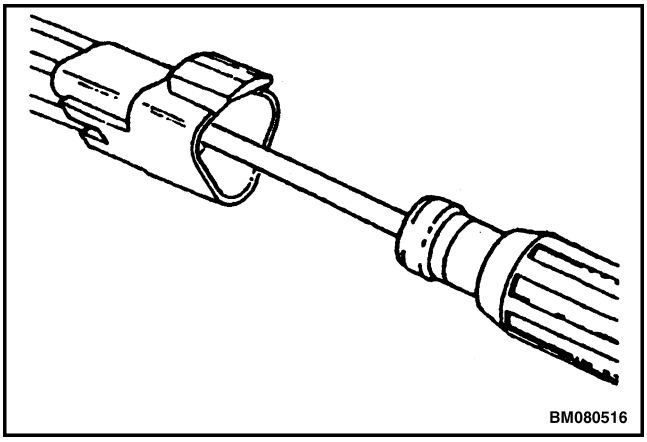
STEP 2.
Using a small hook end tool (Hyster P/N 866404), or needle nose pliers, remove the secondary lock from the connector receptacle.



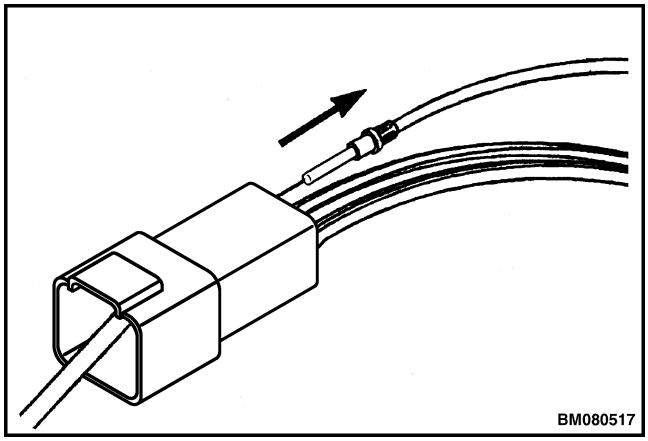


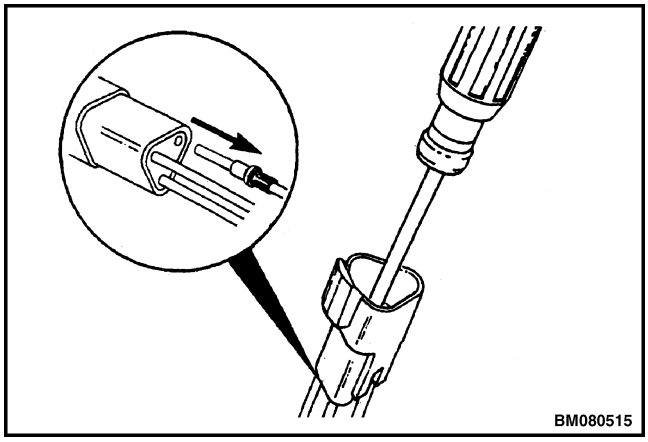
STEP 3.
Using a small, flat-blade screwdriver (Hyster P/N 866404), release the locking finger by moving it away from the pin.



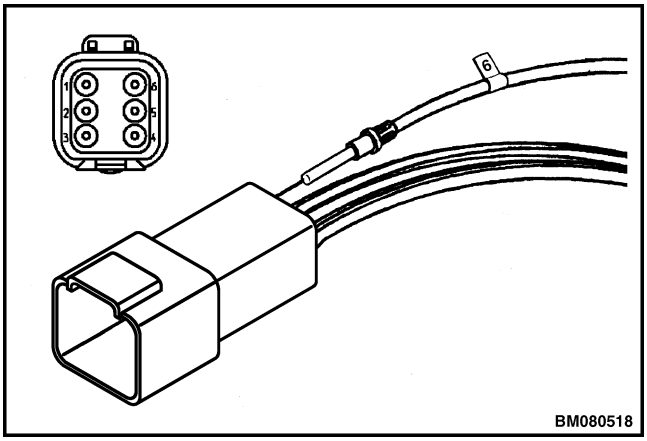


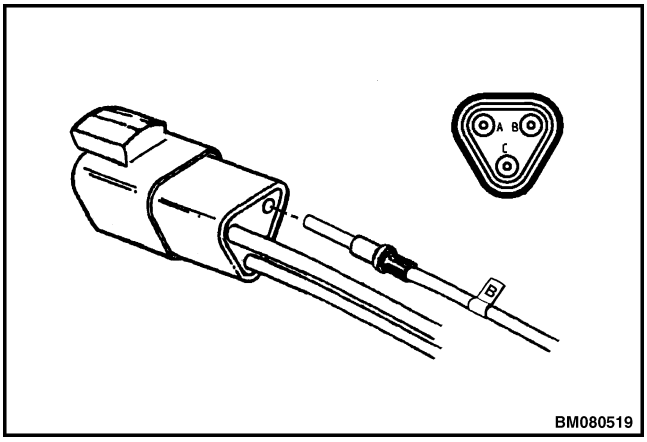
STEP 4.
Gently pull the wire backward while, at the same time, releasing the locking finger with the small, flat-blade screwdriver (Hyster P/N 866404).



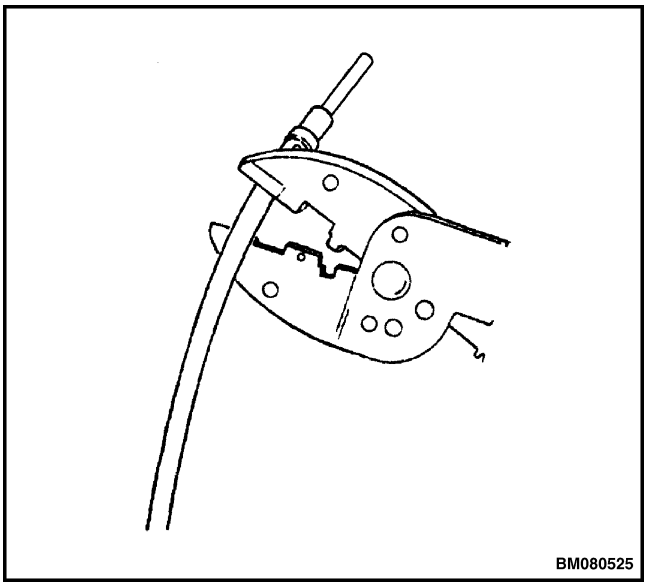


STEP 5.
If more than one pin is being replaced, tag the wire and mark it with the corresponding number or letter on the back of the connector from which the wire was removed.

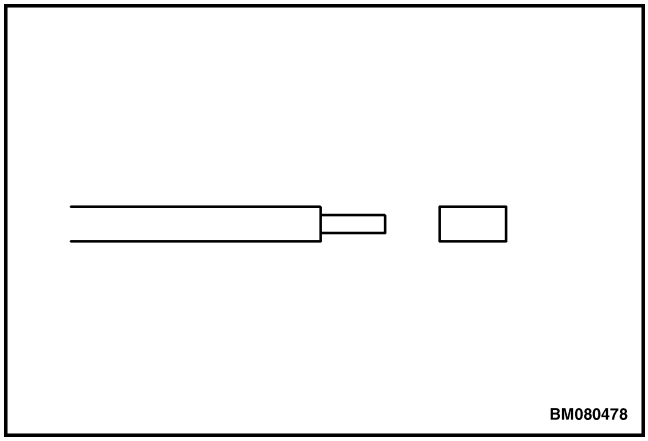




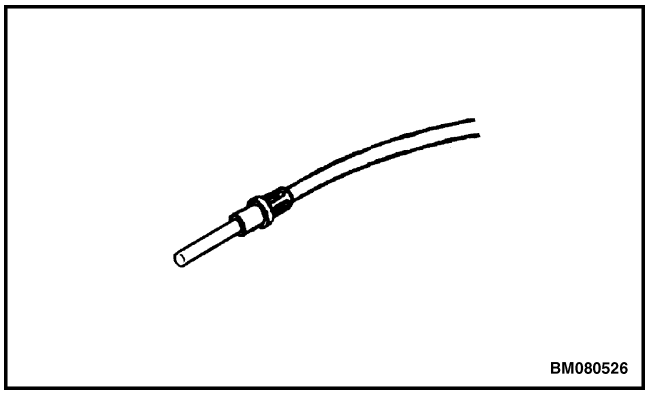
STEP 6.
Using wire cutters, cut the wire behind the old pin and discard old pin.



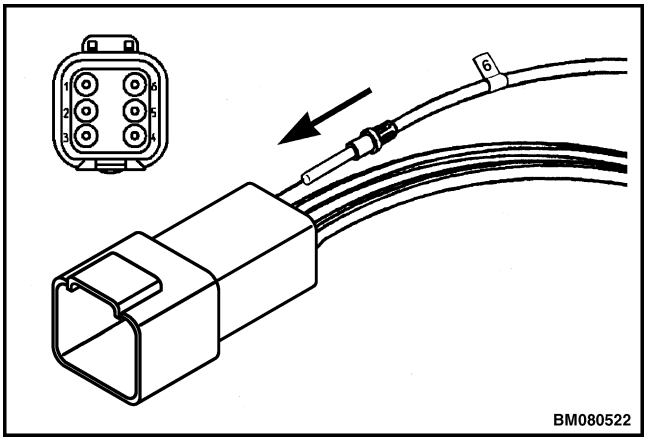
STEP 7.
Using wire strippers (Hyster P/N 866411), strip the wire to the recommended length shown in Table 15.

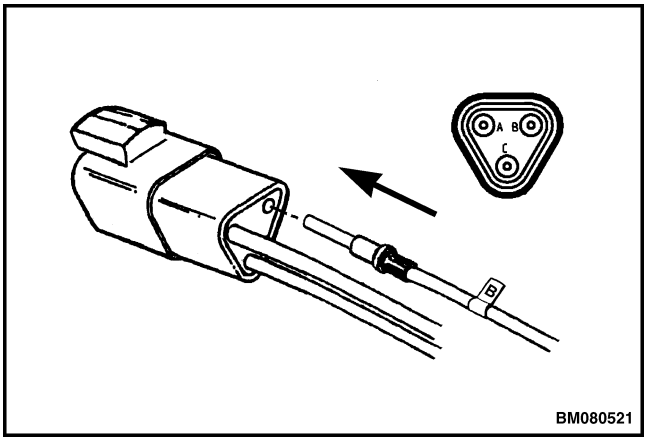


STEP 8.
Using the Deutsch Crimping Tool (Hyster P/N 867888), crimp the new pin on the wire as shown in How to Crimp With the Deutsch Crimping Tool.



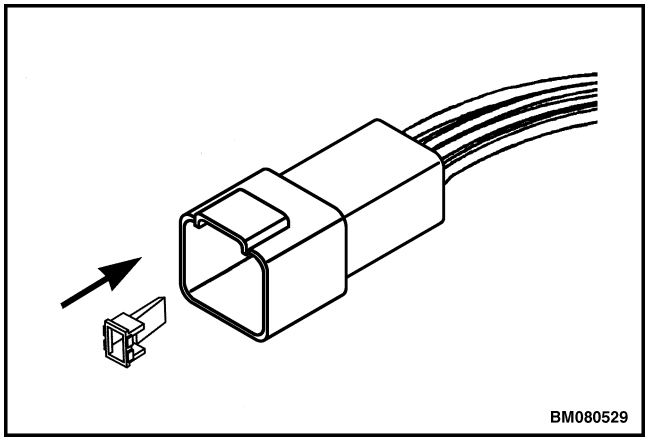
STEP 9.
Insert the wire into the connector receptacle according to the number or letter on the tag and connector receptacle. Push the wire straight into the back of the receptacle until a click is felt. Slightly tug the wire to verify the wire is properly locked in place. Remove tag.

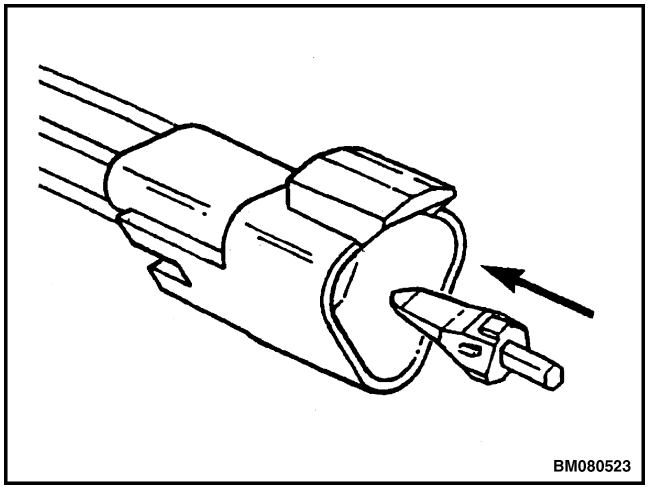




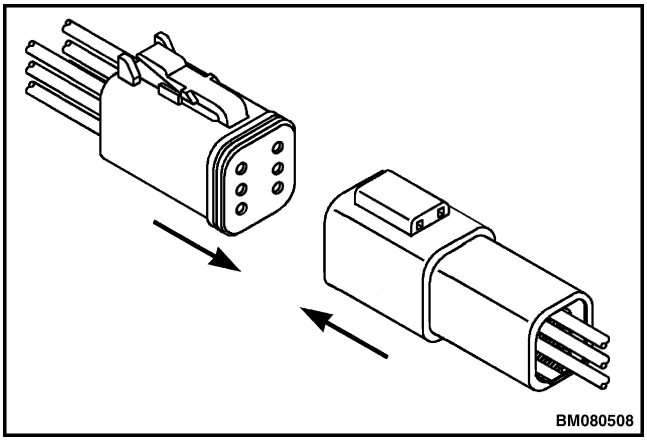
NOTE: Verify that the seal is in place on the connector plug before installing the secondary lock.

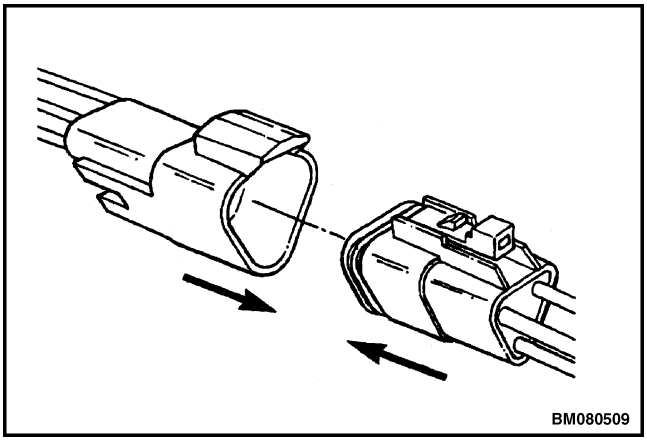
STEP 10.
Install the secondary lock. Push the lock straight in until the lock snaps into place.





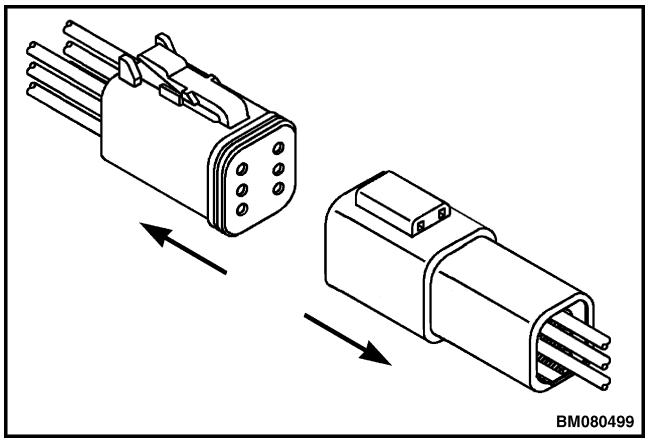
STEP 11.
Push the connector plug into the connector receptacle until the external locking mechanism(s) snap(s) into place.

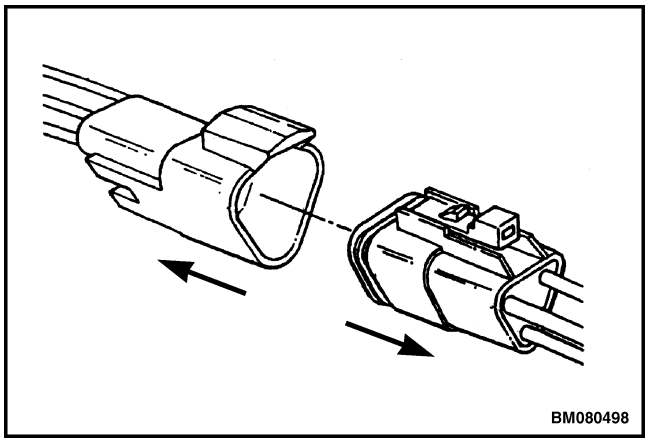




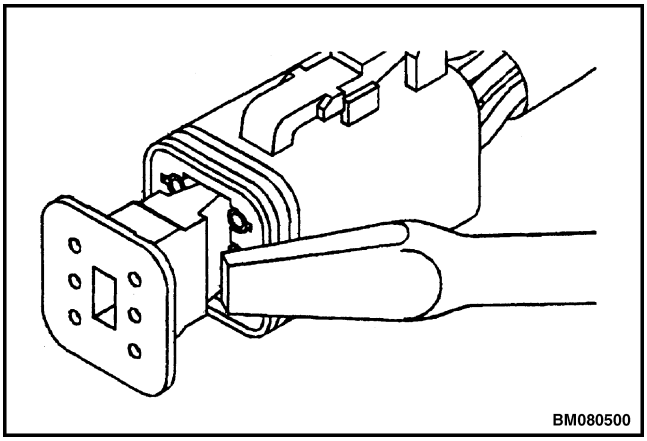
Connector Plug Socket Replacement

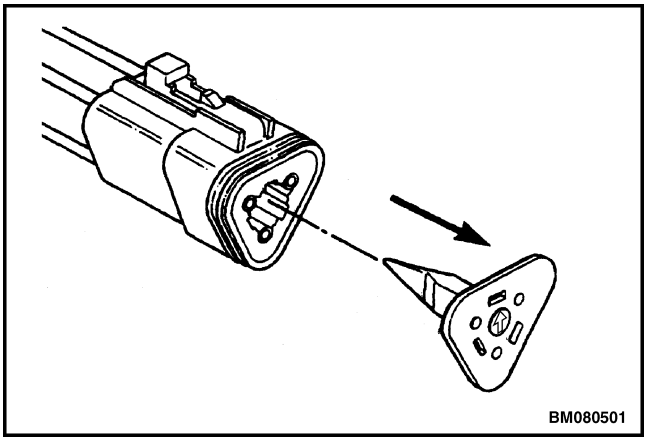
STEP 1.
Release the external locking clip(s) and separate the connector plug from the connector receptacle.



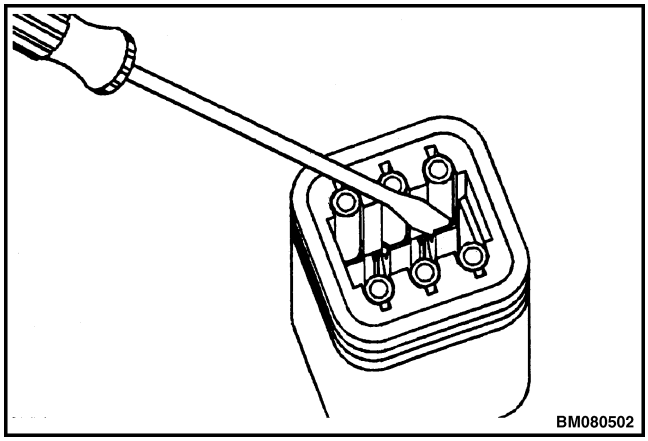


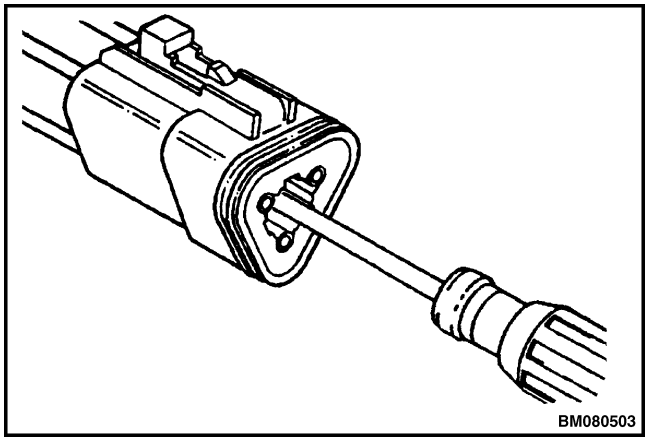
STEP 2.
Using a small, flat-blade screwdriver (Hyster P/N 866404), remove the secondary lock from the connector plug.



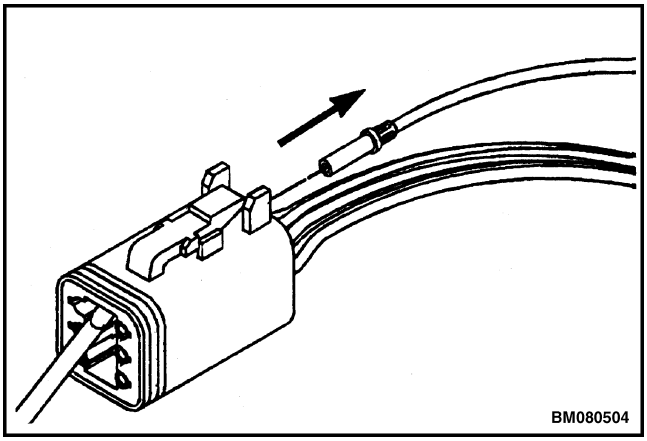


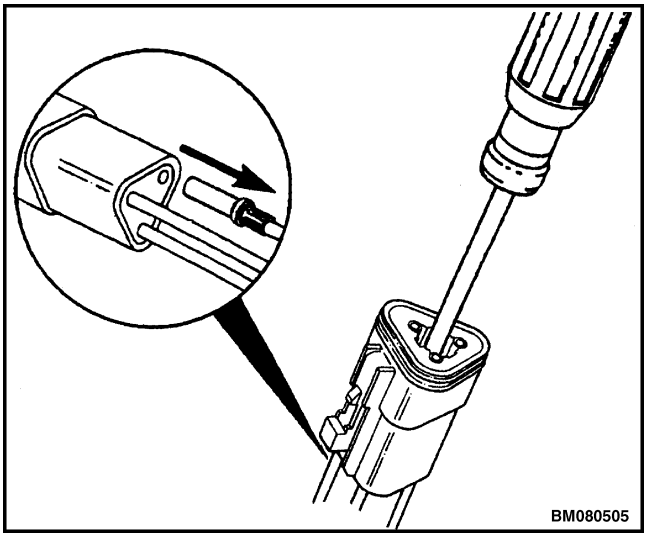
STEP 3.
Using a small, flat-blade screwdriver (Hyster P/N 866404), release the locking finger by moving it away from the socket.



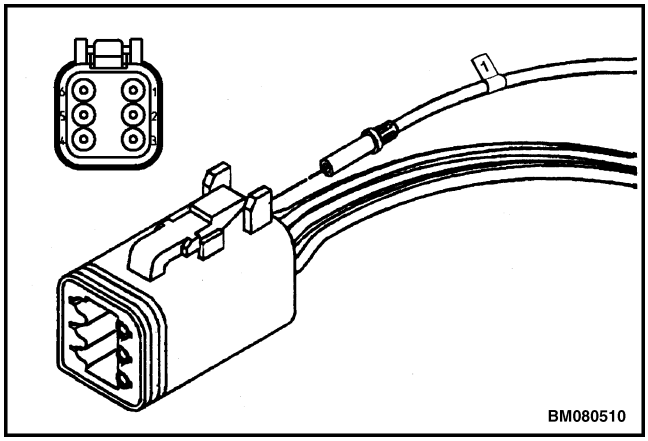


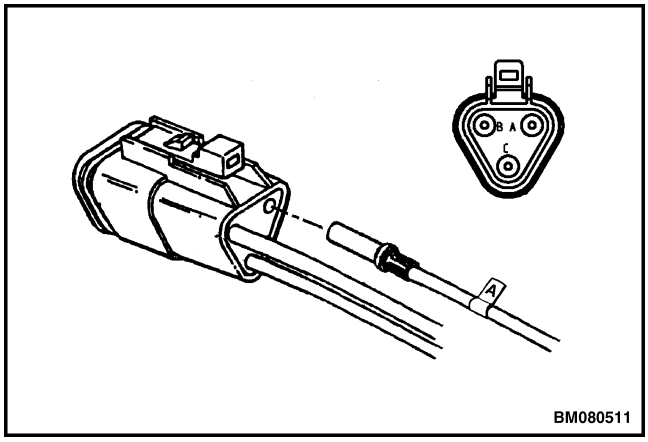
STEP 4.
Gently pull the wire backward while, at the same time, releasing the locking finger with the small, flat-blade screwdriver (Hyster P/N 866404).



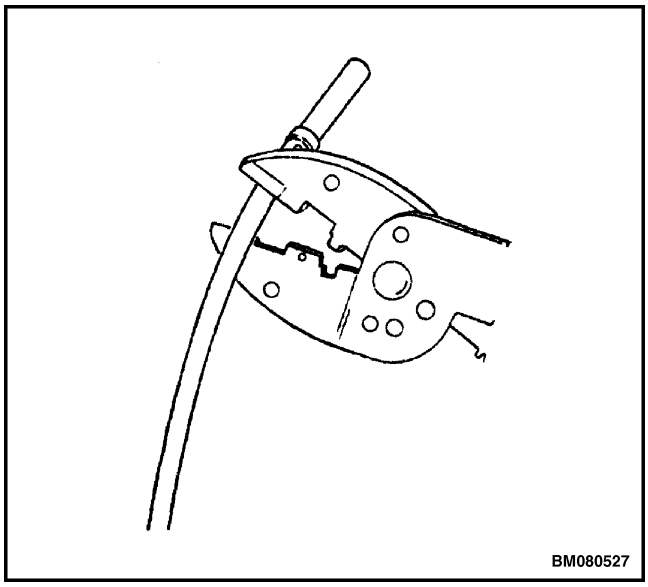


STEP 5.
If more than one socket is being removed, tag the wire and mark it with the corresponding number or letter on the back of the connector from which the wire was removed.

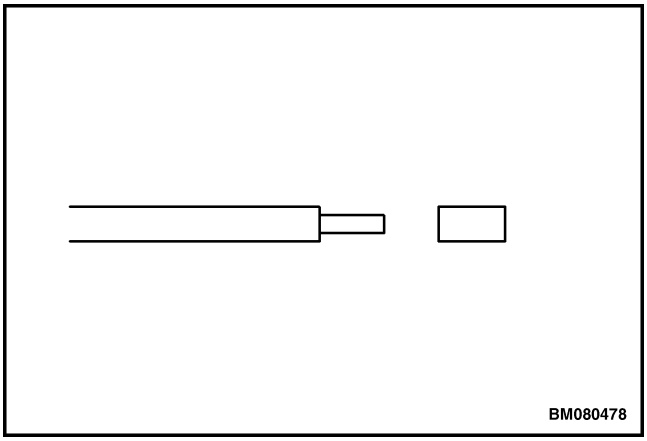




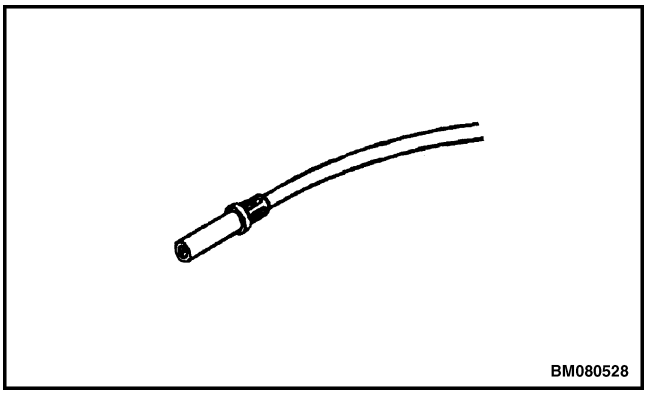
STEP 6.
Using wire cutters, cut the wire behind the old socket and discard old socket.



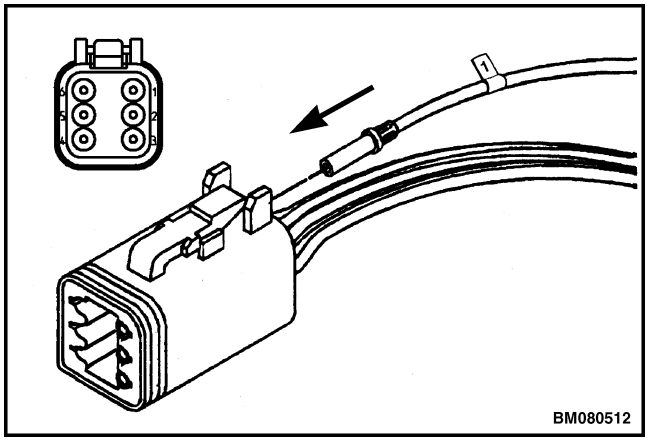
STEP 7.
Using wire strippers Hyster P/N 866411 , strip the wire to the recommended length shown in Table 15.

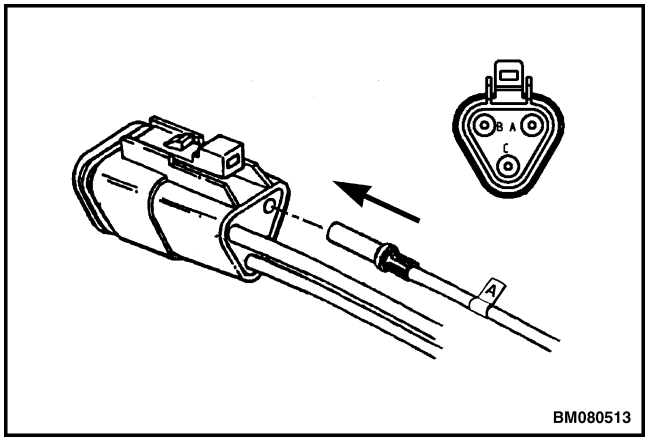


STEP 8.
Using the Deutsch Crimping Tool (Hyster P/N 867888), crimp the new socket on the wire as shown in How to Crimp With the Deutsch Crimping Tool.



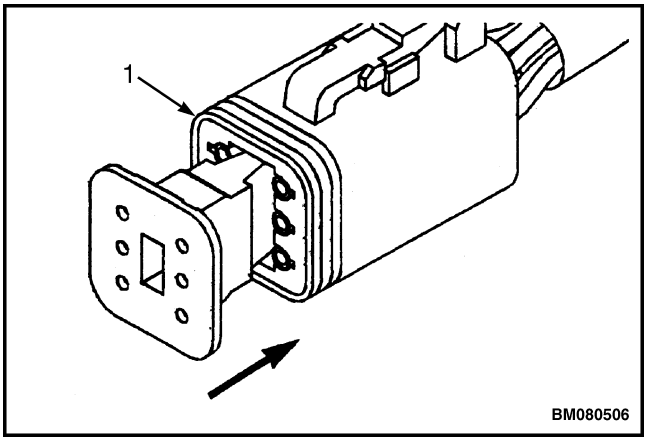
STEP 9.
Insert the wire into the back of the new connector plug according to the number or letter on the tag and connector plug. Push the wire straight into the back of the plug until a click is felt. Slightly tug the wire to verify the wire is properly locked in place. Remove tag.



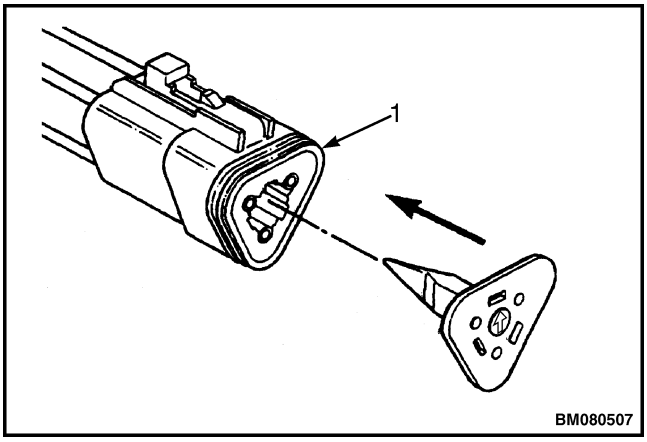


NOTE: Verify that the seal is in place on the connector plug before installing the secondary lock.

STEP 10.
Install the secondary lock. Push the lock straight in until the lock snaps into place. On 3-way secondary locks, the arrow on the lock must be oriented toward the exterior locking mechanism.

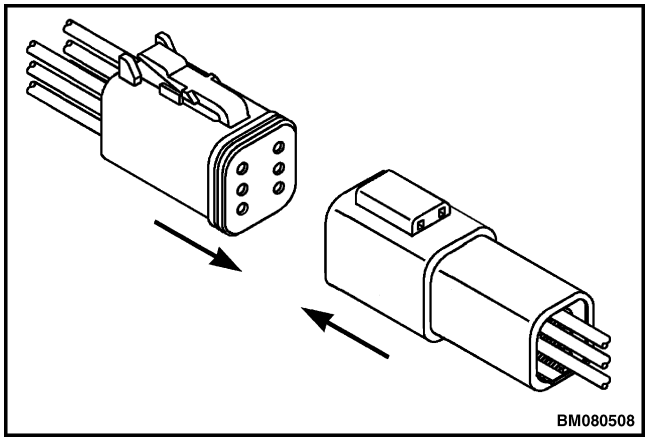


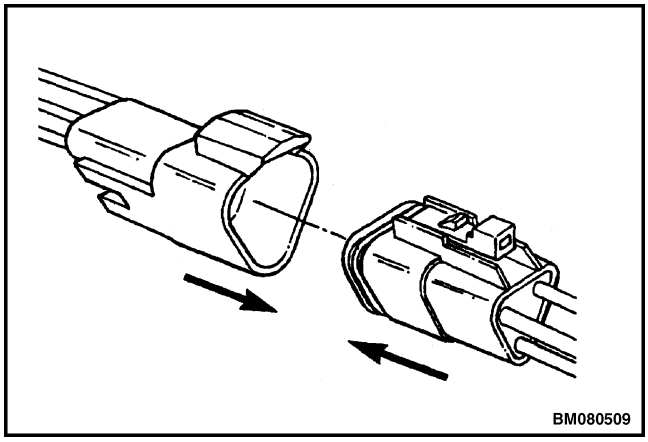
1. SEAL



1. SEAL

STEP 11.
Push the connector plug into the connector receptacle until the external locking mechanism(s) snap(s) into place.

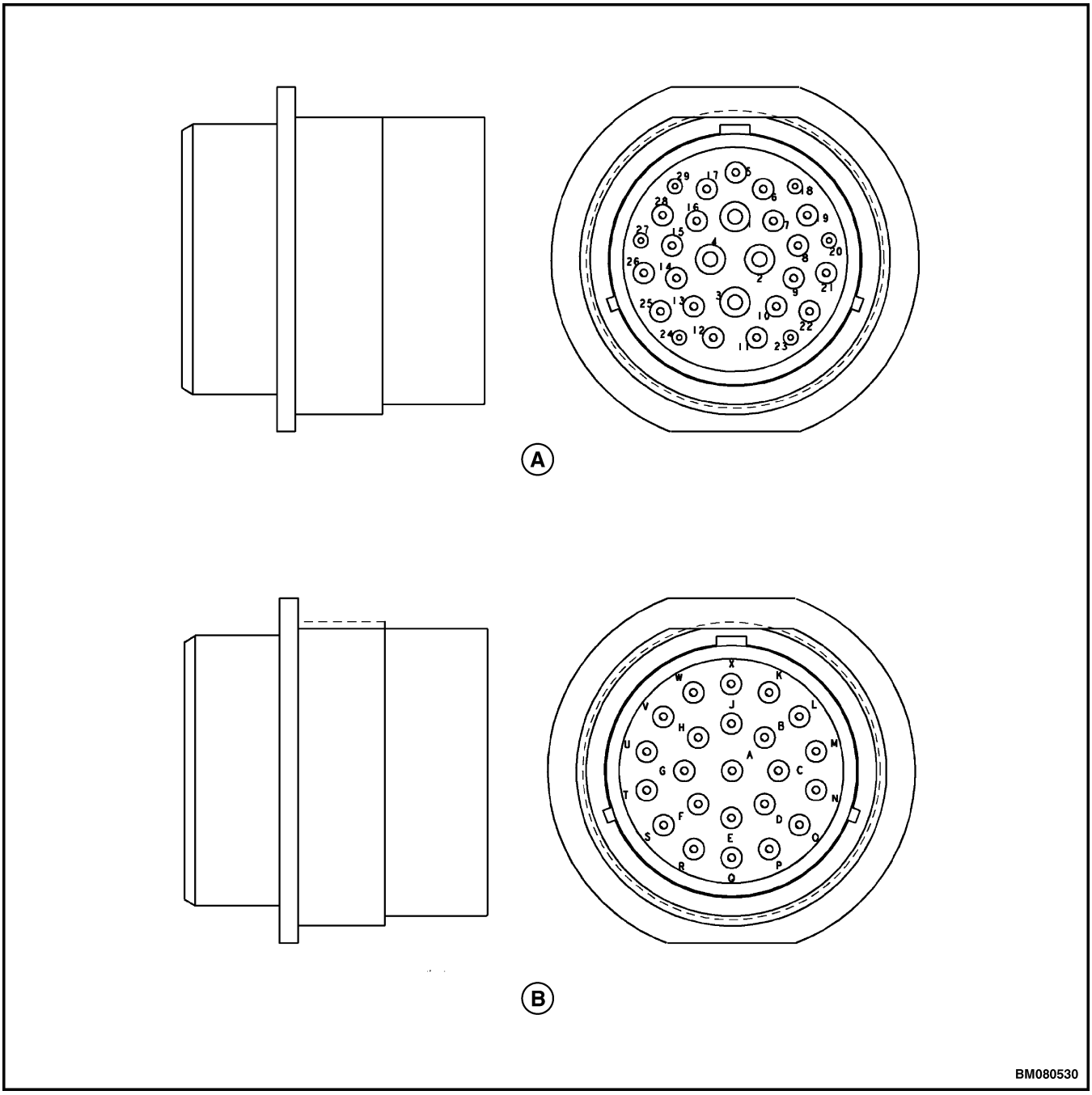




HD SERIES CONNECTORS

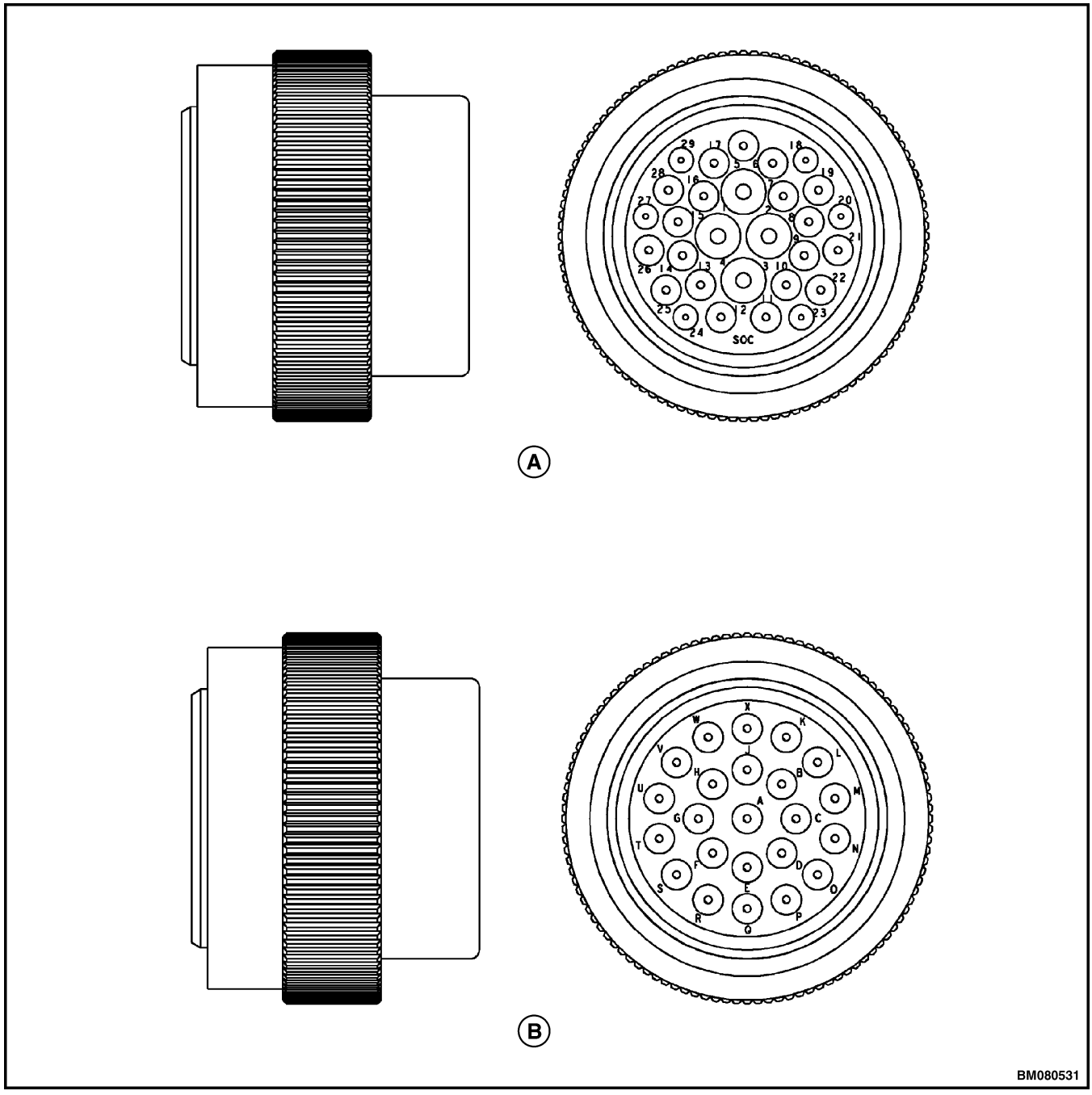
All Deutsch HD series pin-type connectors are repaired in the same manner.

For examples of the HD connectors, see Figure 22 for the different connector receptacles and Figure 23 for the different connector plugs.



A. TYPE A B. TYPE B

Figure 22. HD Connector Receptacles

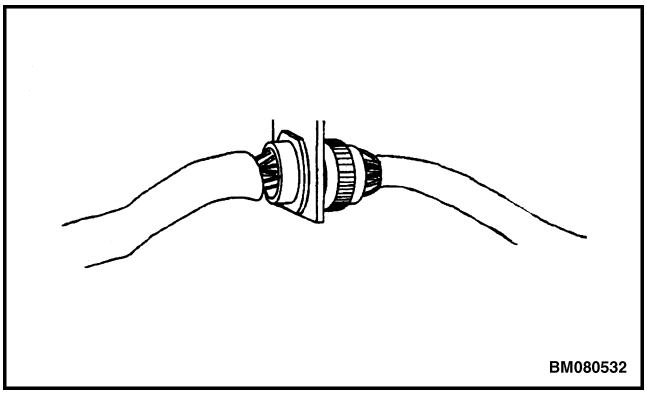


A. TYPE 1 B. TYPE 2

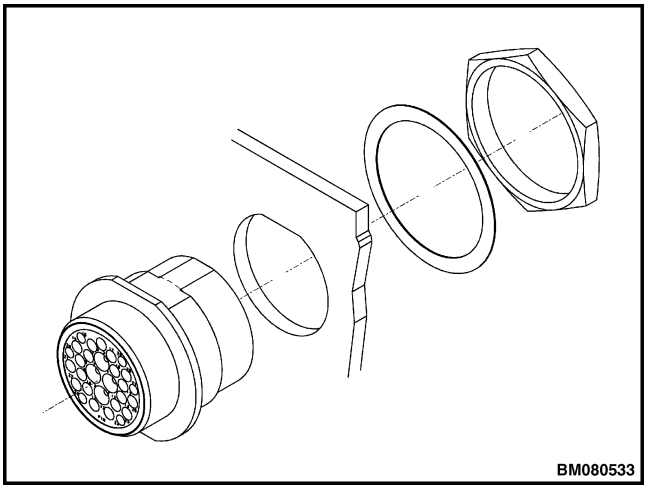
Figure 23. HD Connector Plugs

Connector Receptacle Replacement

STEP 1.
Separate the connector plug from the connector receptacle.

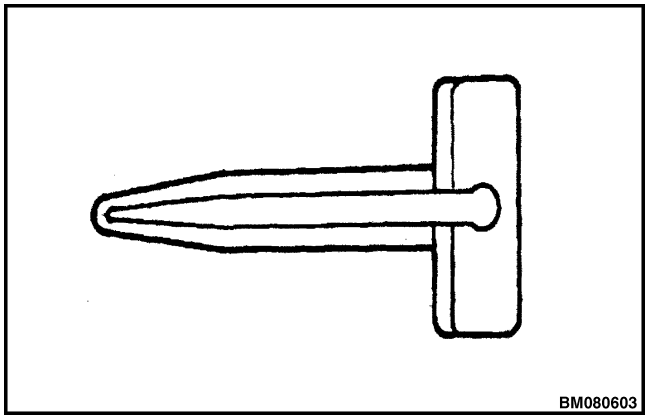


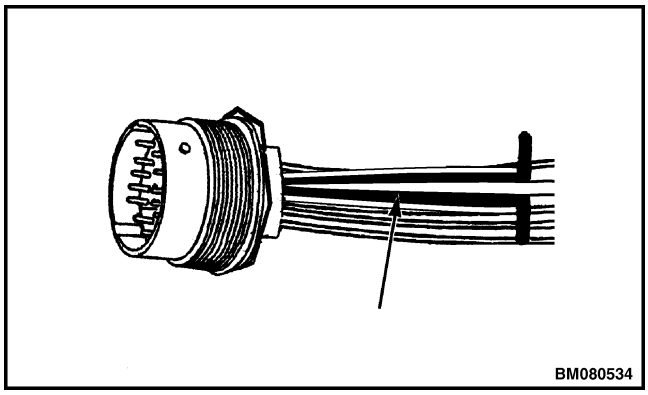
STEP 2.
Remove the lock nut and washer retaining the receptacle to the mounting structure. Remove receptacle from mounting structure.



NOTE: Be sure to use correct extraction tool; see Special Tools section of this manual.

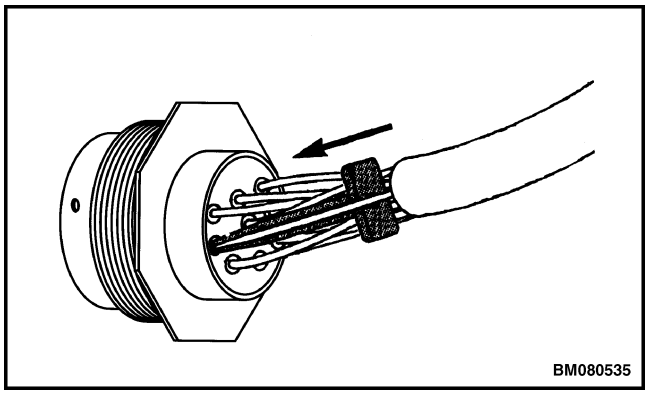
STEP 3.
Insert a Deutsch extraction tool over the wire being removed.





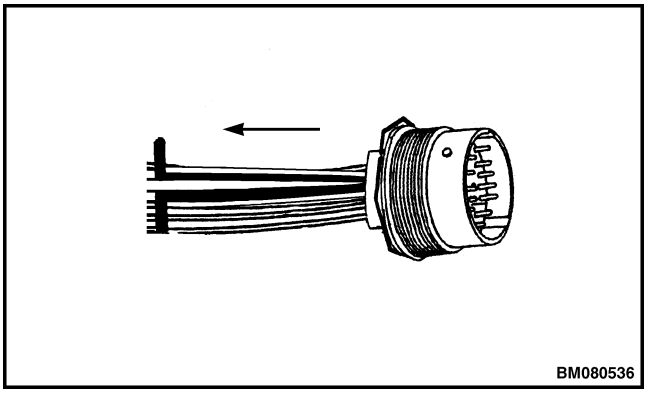
NOTE: Do not twist the tool or insert the tool at an angle.

STEP 4.
Push the tool into the connector about 25 mm (1 in.) until it bottoms on the contact flange.

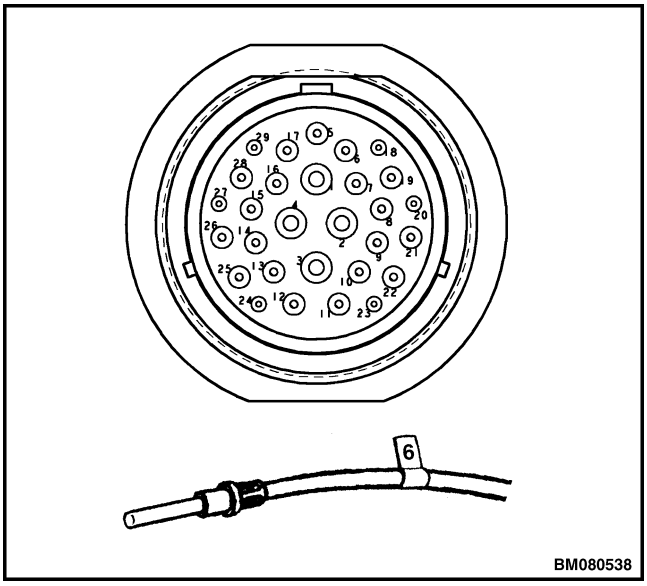


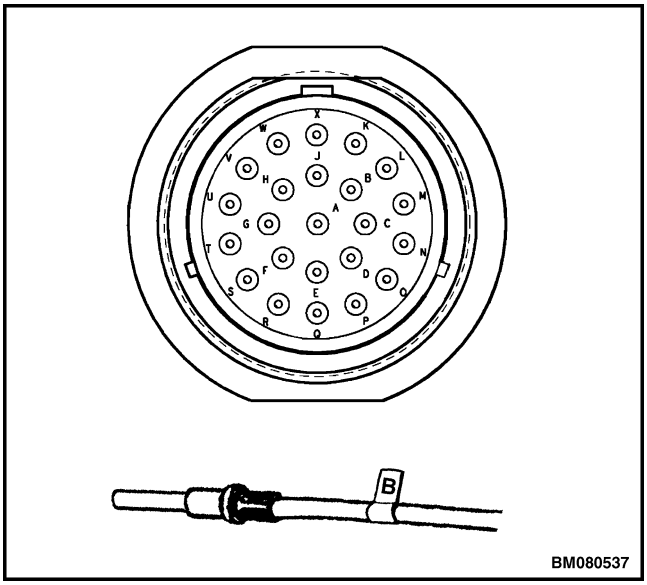
NOTE: If pin is difficult to remove, remove the extraction tool, turn the extraction tool 90 degrees, and reinsert the tool into the connector.

STEP 5.
Hold the tool on the contact flange and pull the wire and the connection pin out of the connector.



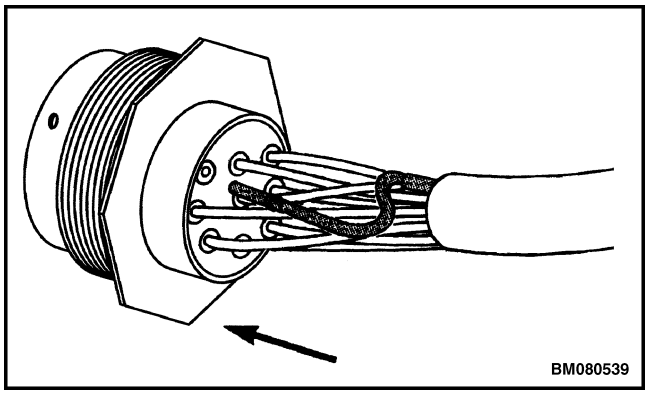
STEP 6.
Tag the wire and mark it with the corresponding number or letter on the back of the connector from which the wire was removed.



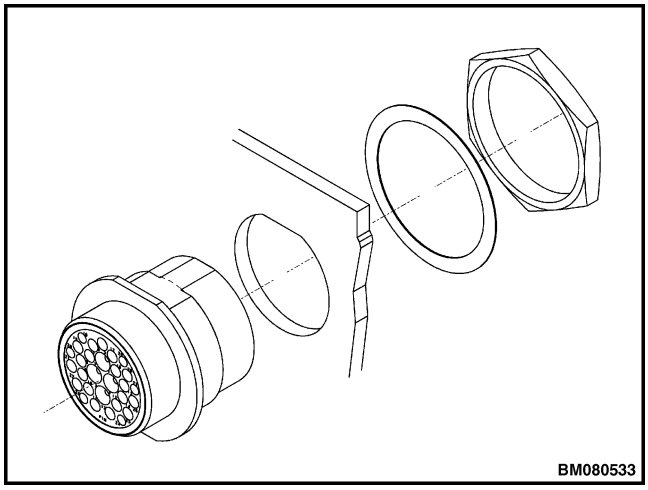


STEP 7.
Repeat Step 3 through Step 6 for the removal of the remaining wires.

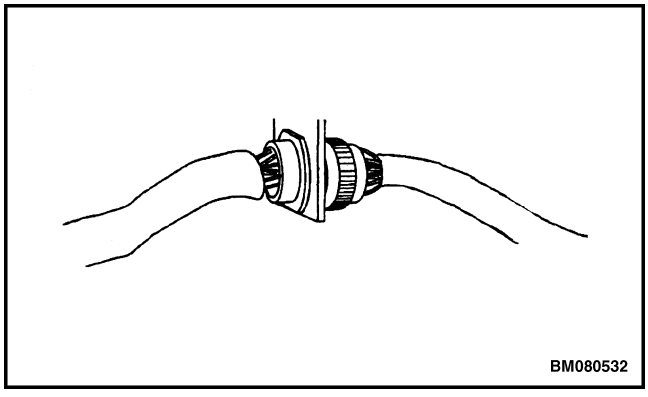
STEP 8.
Insert the wires into the back of the new connector receptacle according to the number or letter on the tag and connector receptacle. Push the wire straight into the back of the receptacle until a click is felt. Slightly tug each wire to verify the wire is properly locked in place. Remove tags.



STEP 9.
Install receptacle into mounting structure. Install the lock nut and washer to retain the receptacle to the mounting structure.

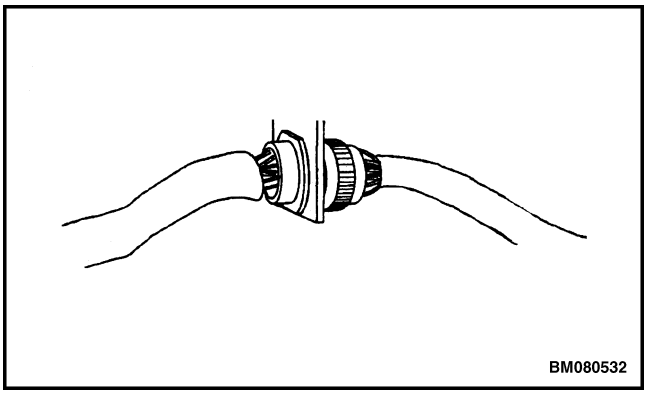


STEP 10.
Connect the connector plug to the connector receptacle.



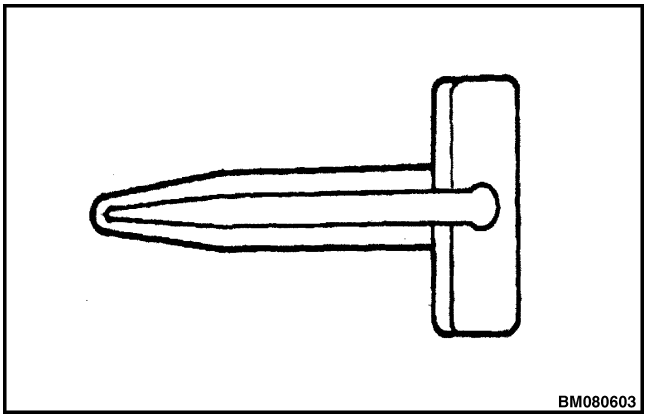
Connector Plug Replacement

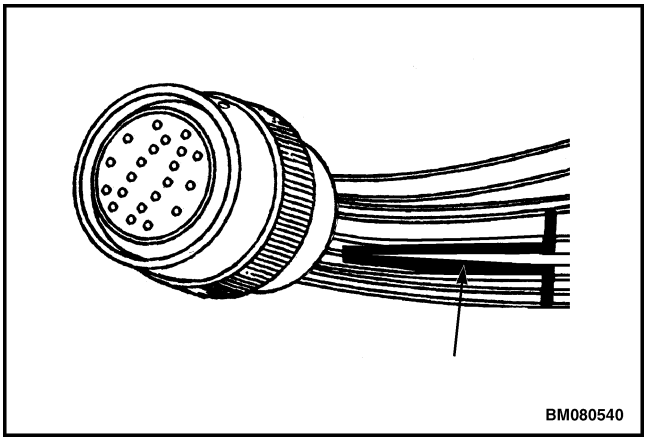
STEP 1.
Separate the connector plug from the connector receptacle.



NOTE: Be sure to use correct extraction tool; see Special Tools section of this manual.

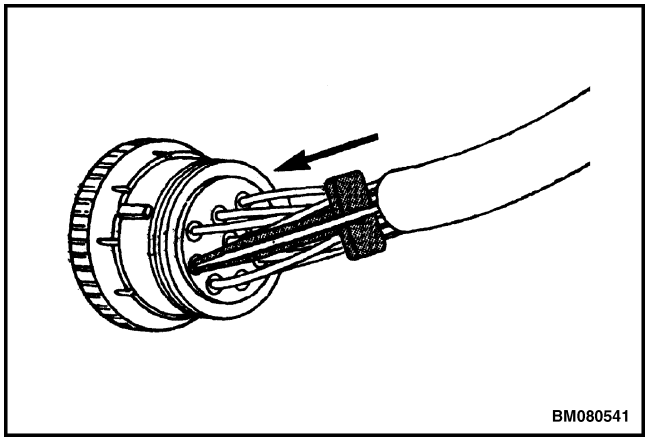
STEP 2.
Insert a Deutsch extraction tool over the wire being removed.





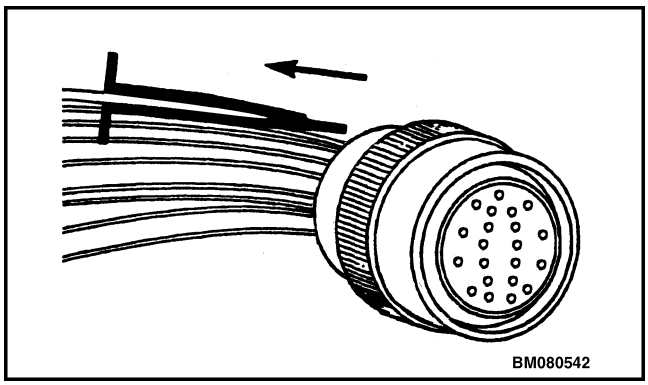
NOTE: Do not twist the tool or insert the tool at an angle.

STEP 3.
Push the tool into the connector about 25 mm (1 in.) until it bottoms on the contact flange.

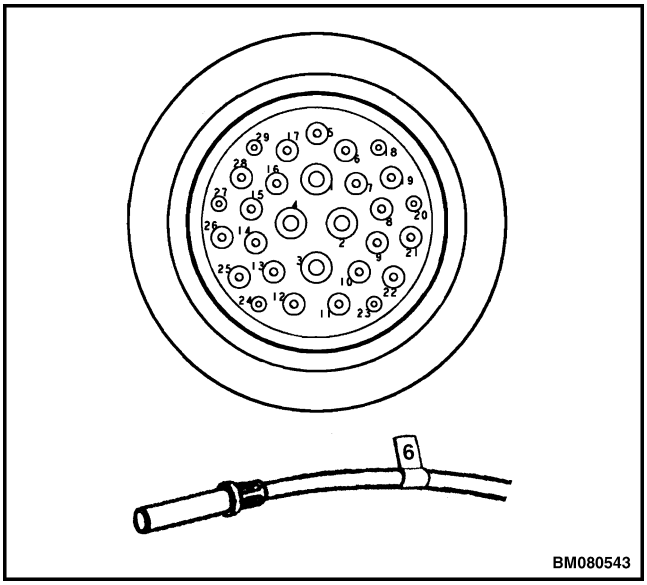


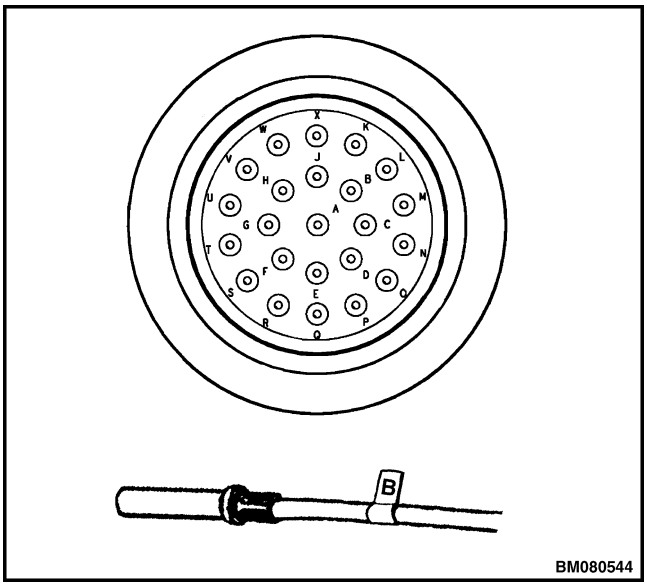
NOTE: If pin is difficult to remove, remove the extraction tool, turn the extraction tool 90 degrees, and reinsert the tool into the connector.

STEP 4.
Hold the tool on the contact flange and pull the wire and the connection socket out of the connector.



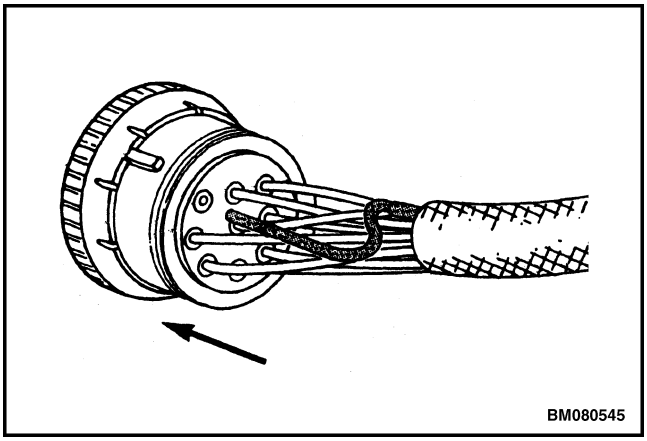
STEP 5.
Tag the wire and mark it with the corresponding number or letter on the back of the connector from which the wire was removed.



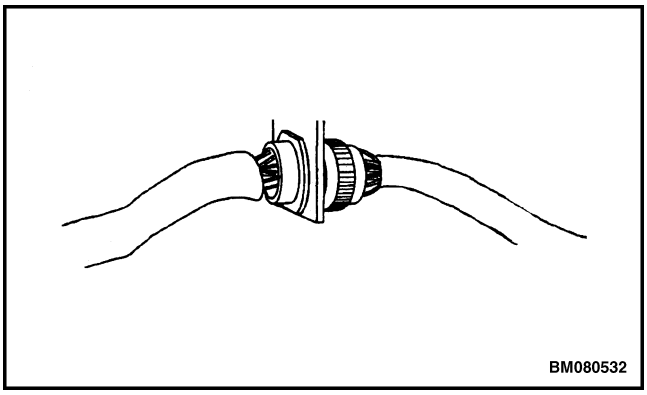


STEP 6.
Repeat Step 2 through Step 5 for the removal of the remaining wires.

STEP 7.
Insert the wires into the back of the new connector plug according to the number or letter on the tag and connector plug. Push the wire straight into the back of the plug until a click is felt. Slightly tug each wire to verify the wire is properly locked in place. Remove tags.

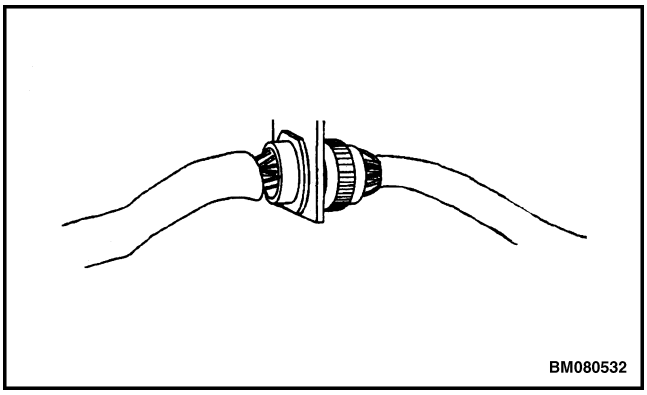


STEP 8.
Connect the connector plug to the connector receptacle.

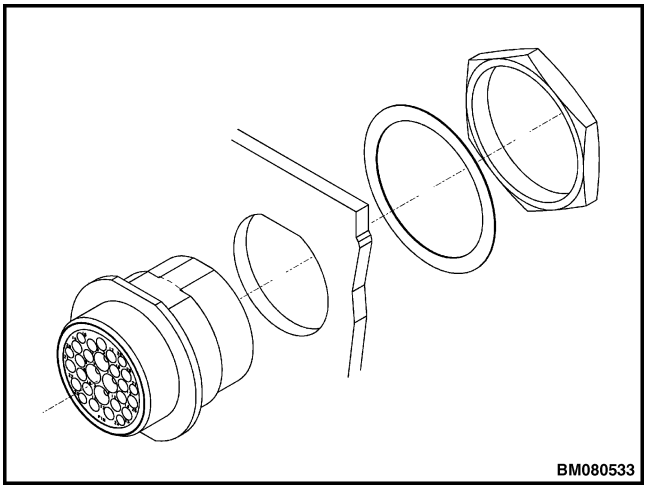


Connector Receptacle Pin Replacement

STEP 1.
Separate the connector plug from the connector receptacle.

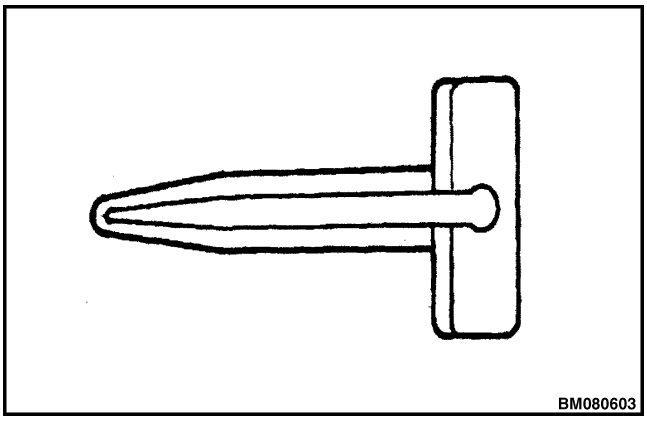


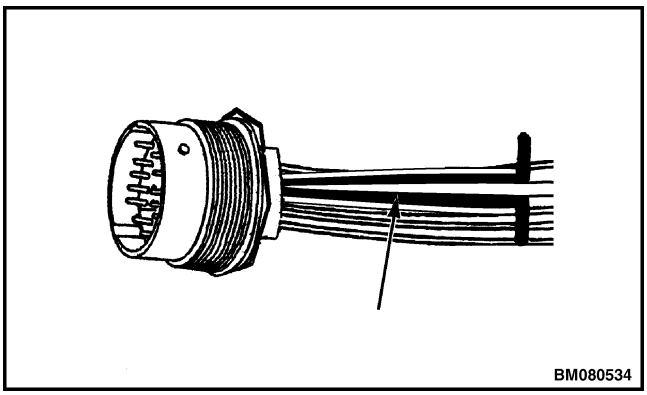
STEP 2.
Remove the lock nut and washer retaining the receptacle to the mounting structure. Remove receptacle from mounting structure.



NOTE: Be sure to use correct extraction tool; see Special Tools section of this manual.

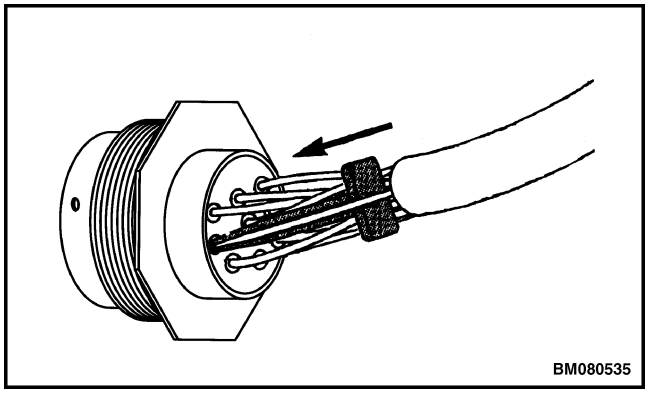
STEP 3.
Insert a Deutsch extraction tool over the wire being removed.



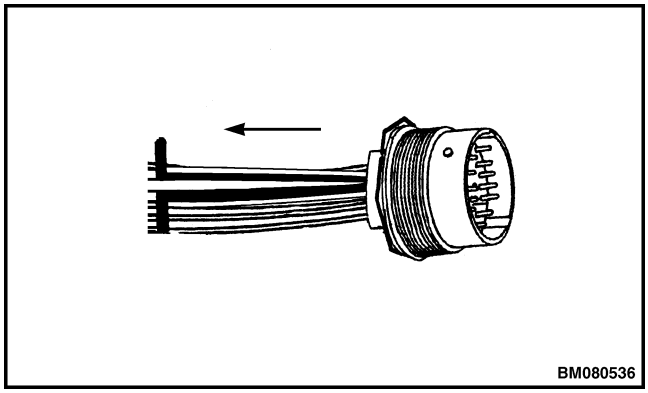


NOTE: Do not twist the tool or insert the tool at an angle.

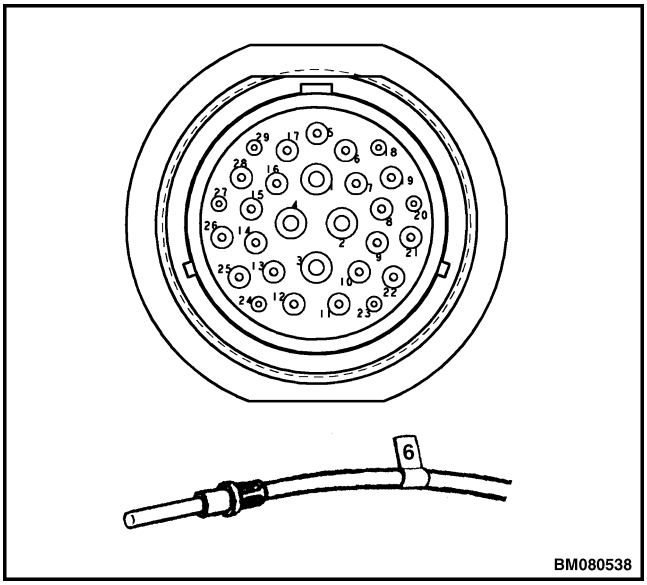
STEP 4.
Push the tool into the connector about 25 mm (1 in.) until it bottoms on the contact flange.

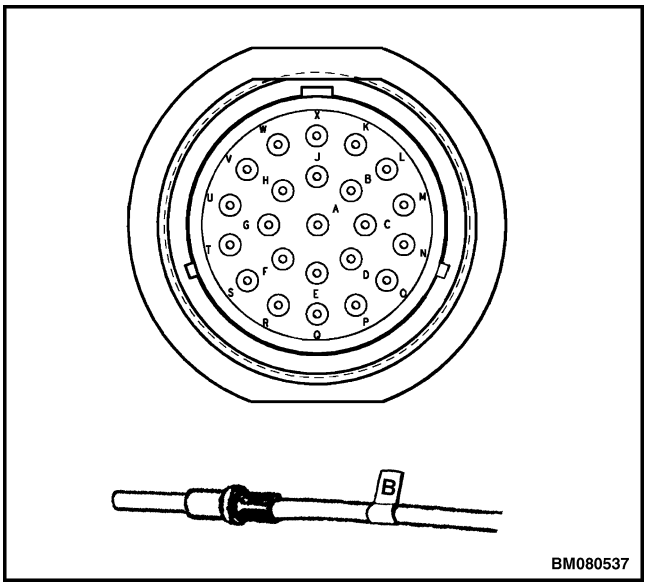


STEP 5.
Hold the tool on the contact flange and pull the wire and the connection pin out of the connector.

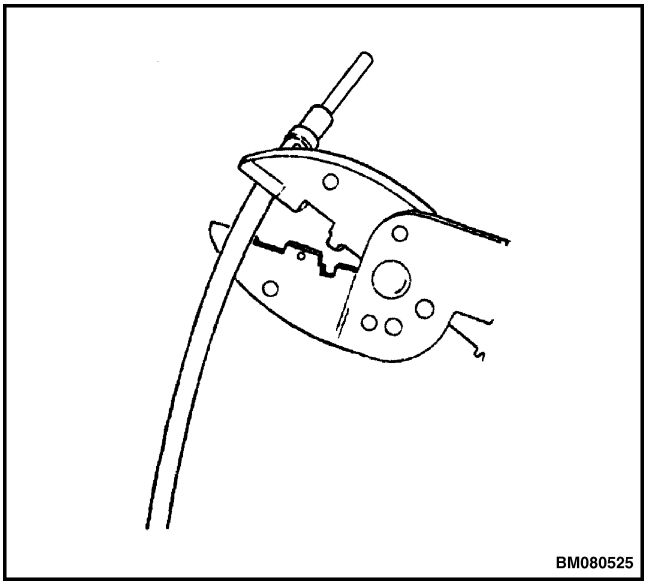


STEP 6.
If more than one wire is being removed, tag the wire and mark it with the corresponding number or letter on the back of the connector from which the wire was removed.

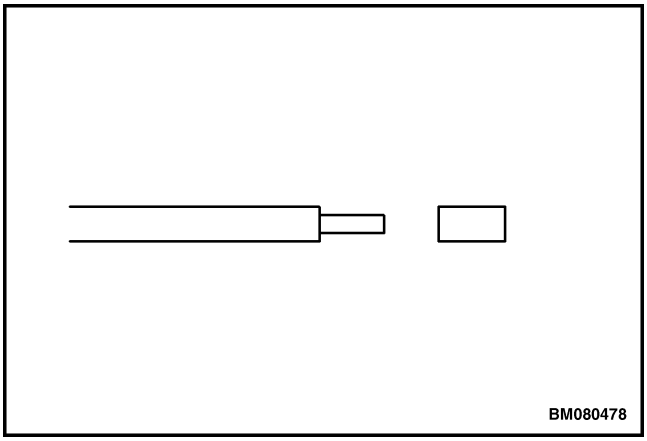




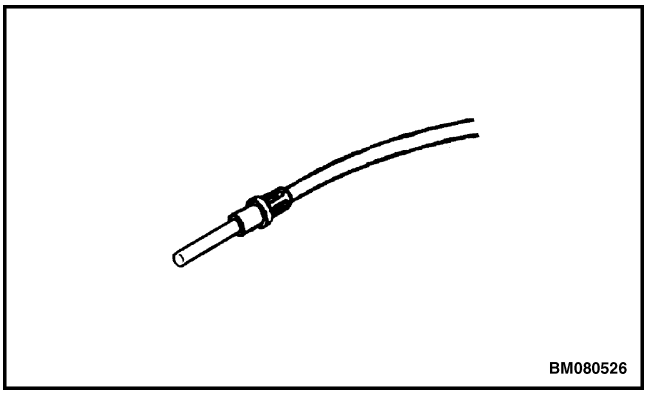
STEP 7.
Using wire cutters, cut the wire behind the old pin and discard old pin.



STEP 8.
Using wire strippers, Hyster P/N 866411 , strip the wire to the recommended length shown in Table 15.

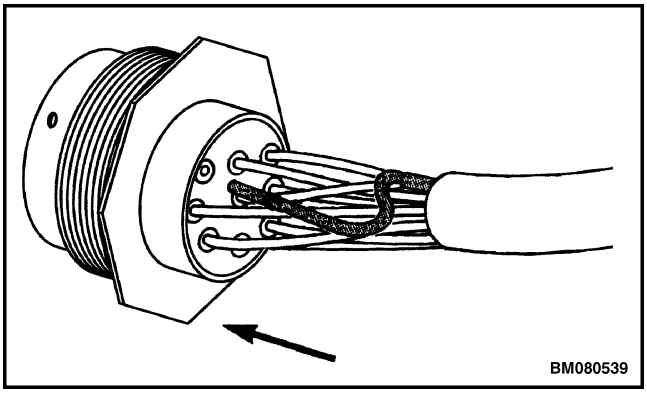


STEP 9.
Using the Deutsch Crimping Tool (Hyster P/N 867888), crimp the new pin on the wire as shown in How to Crimp With the Deutsch Crimping Tool.

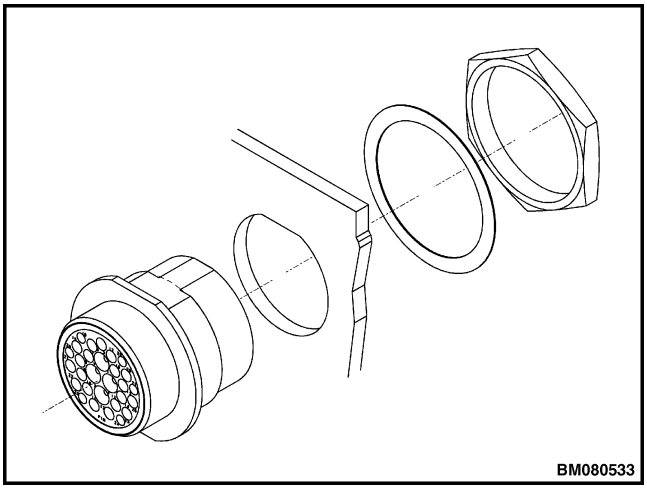


NOTE: The rear seal/grommet must be seated properly before inserting wires.

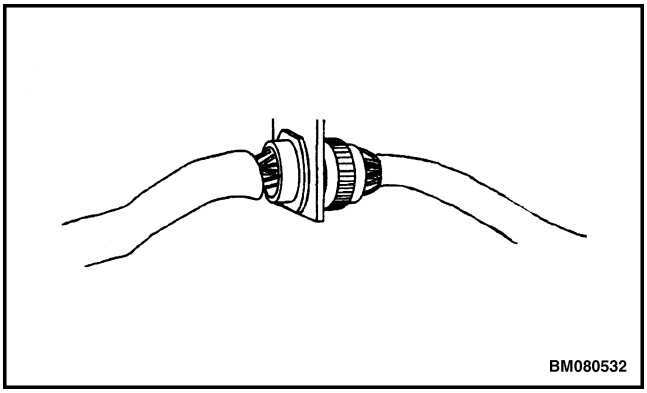
STEP 10.
Insert the wires into the back of the new connector receptacle according to the number or letter on the tag and connector receptacle. Push the wire straight into the back of the receptacle until a click is felt. Slightly tug each wire to verify the wire is properly locked in place. Remove tags.



STEP 11.
Install receptacle into mounting structure. Install the lock nut and washer to retain the receptacle to the mounting structure.

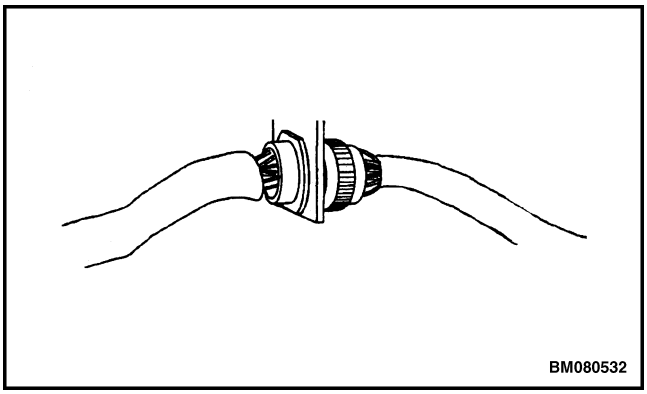


STEP 12.
Connect the connector plug to the connector receptacle.



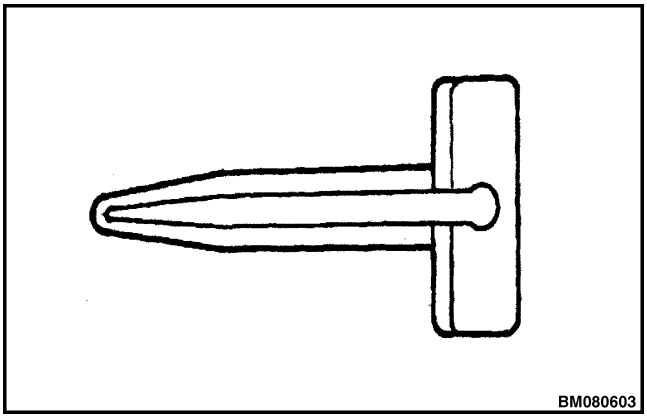
Connector Plug Socket Replacement

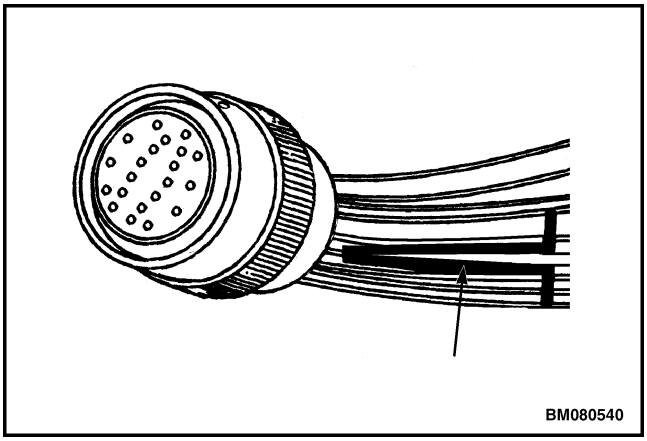
STEP 1.
Separate the connector plug from the connector receptacle.



NOTE: Be sure to use correct extraction tool; see Special Tools section of this manual.

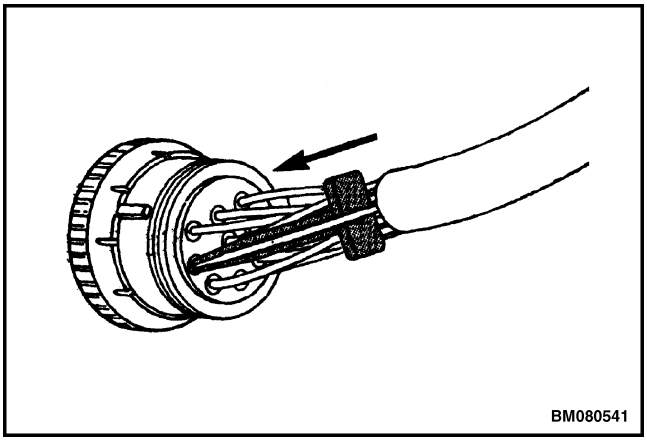
STEP 2.
Insert a Deutsch extraction tool over the wire being removed.



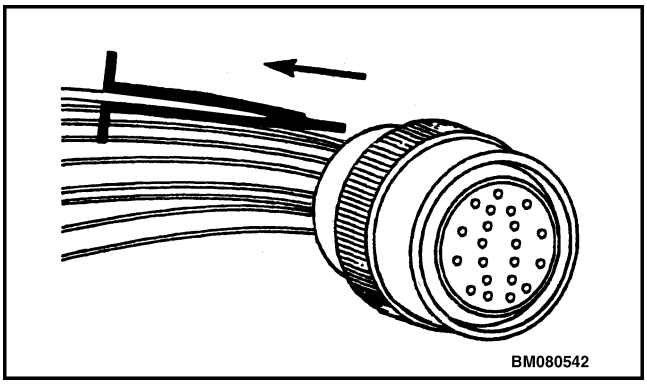


NOTE: Do not twist the tool or insert the tool at an angle.

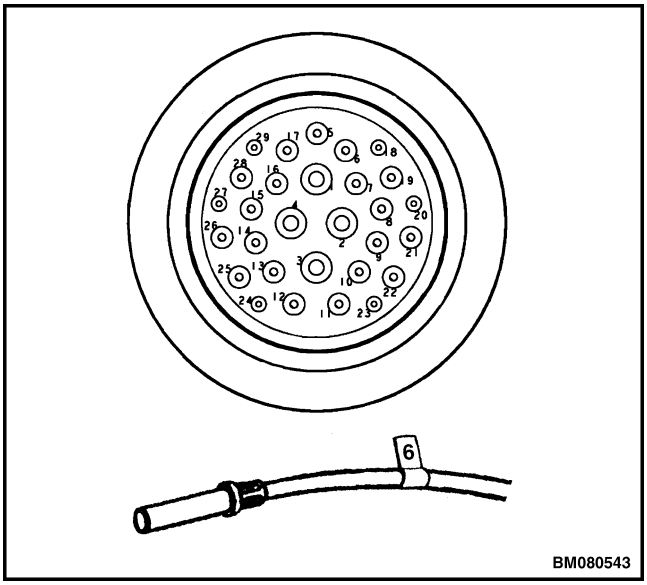
STEP 3.
Push the tool into the connector about 25 mm (1 in.) until it bottoms on the contact flange.

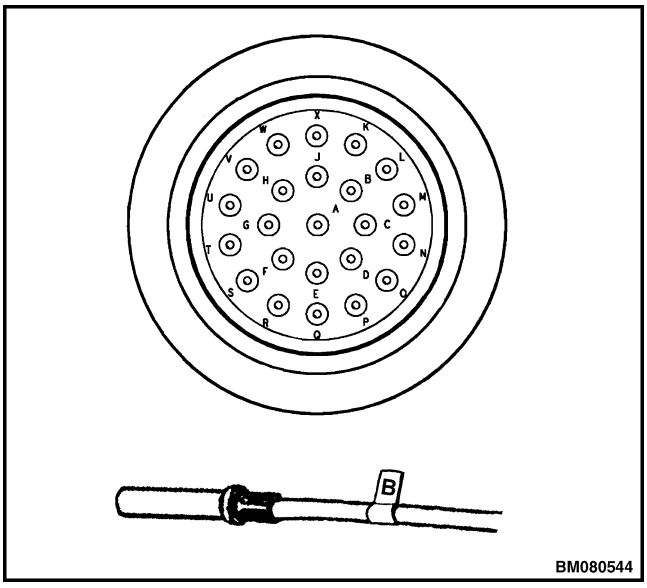


STEP 4.
Hold the tool on the contact flange and pull the wire and the connection socket out of the connector.

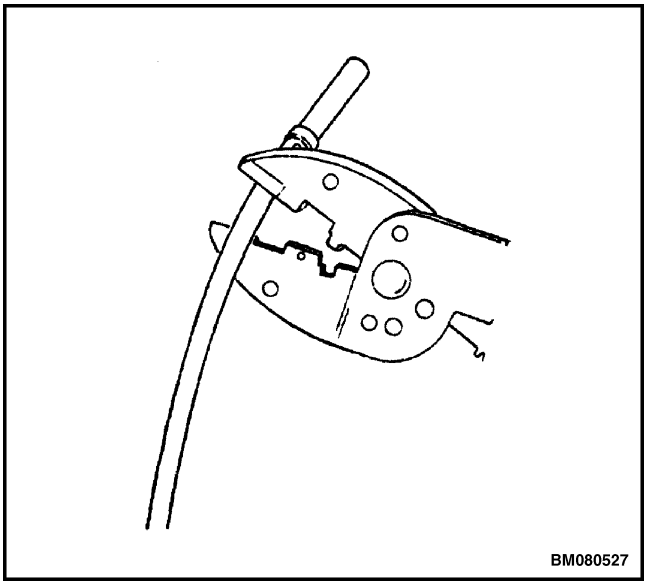


STEP 5.
If more than one wire is being removed, tag the wire and mark it with the corresponding number or letter on the back of the connector from which the wire was removed.

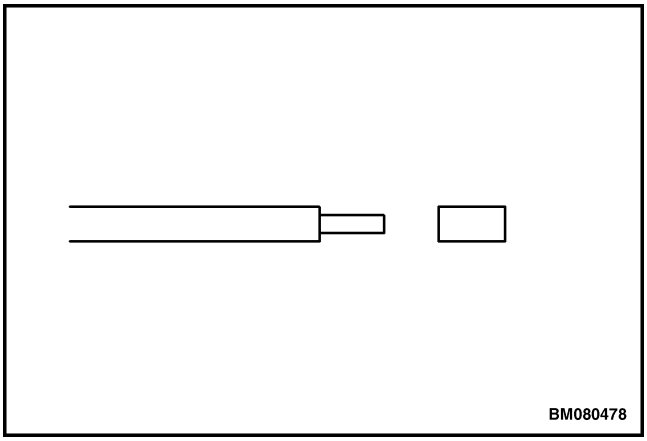




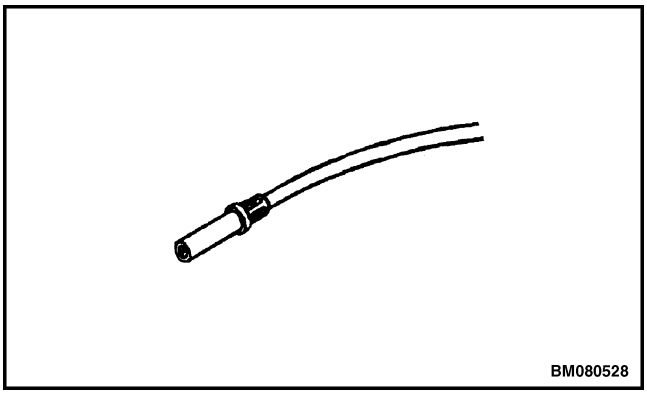
STEP 6.
Using wire cutters, cut the wire behind the old socket and discard old socket.



STEP 7.
Using wire strippers, Hyster P/N 866411 , strip the wire to the recommended length shown in Table 15.

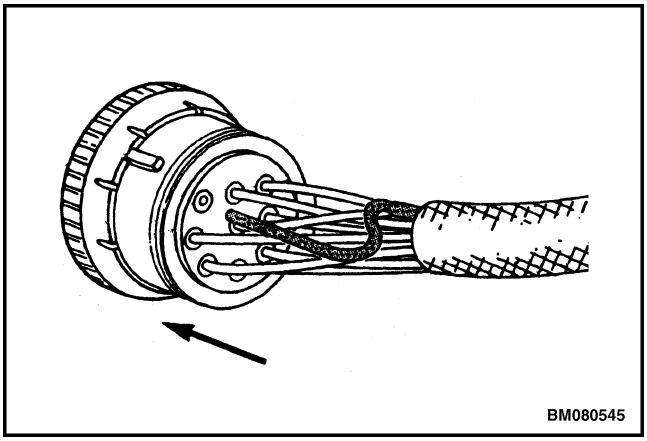


STEP 8.
Using the Deutsch Crimping Tool (Hyster P/N 867888), crimp the new socket on the wire as shown in How to Crimp With the Deutsch Crimping Tool.

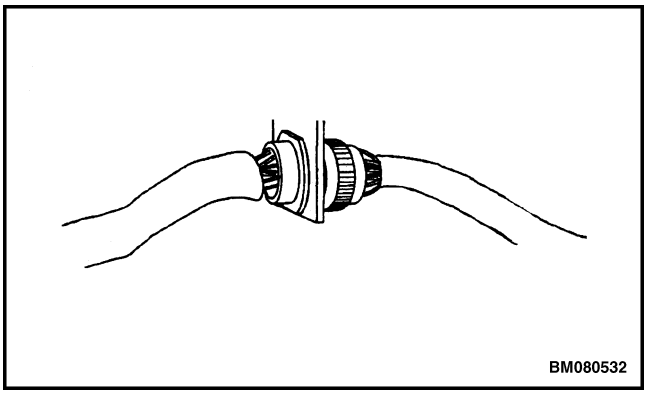


NOTE: The rear seal/grommet must be seated properly before inserting wires.

STEP 9.
Insert the wires into the back of the new connector plug according to the number or letter on the tag and connector plug. Push the wire straight into the back of the plug until a click is felt. Slightly tug wire to verify the wire is properly locked in place. Remove tags.

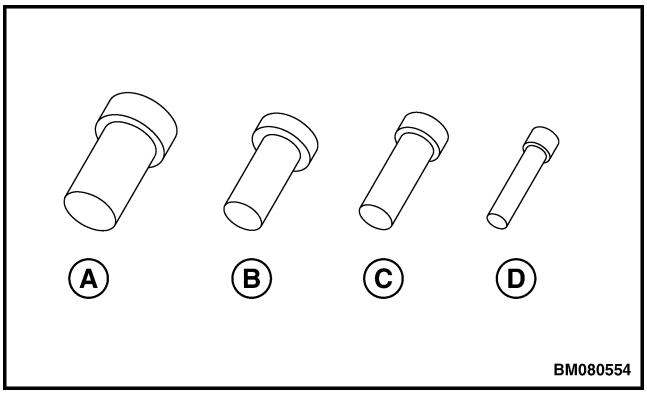


STEP 10.
Connect the connector plug to the connector receptacle.



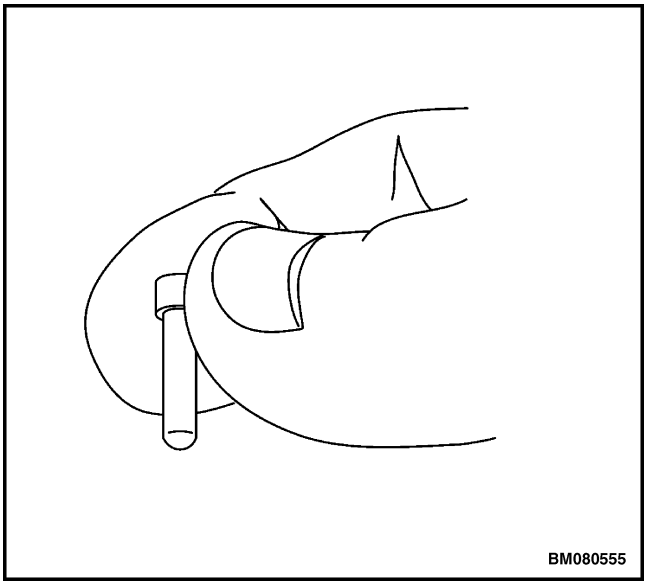
SEALING PLUGS

STEP 1.
All empty contact cavities must be filled with a sealing plug.

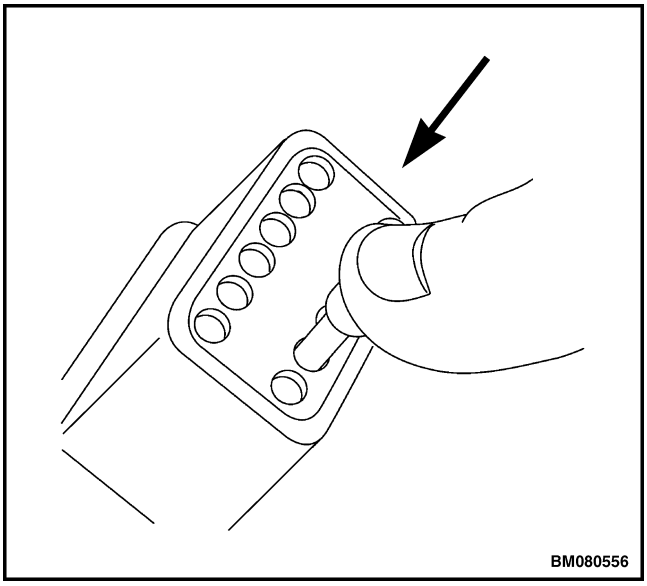


A. 6 AWG (DARK RED)
B. 8 AWG (CLEAR WHITE)
C. 12 TO 18 AWG (WHITE)
D. 20 AWG (RED)

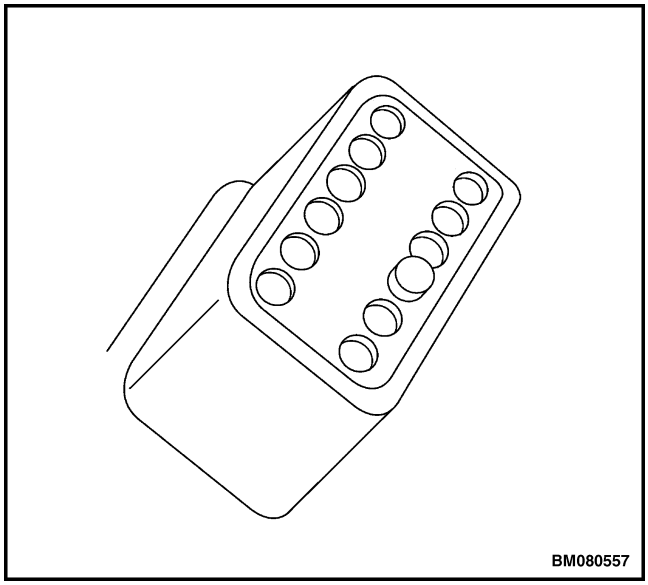
STEP 2.
Hold the sealing plug with the large diameter end away from the connector.



STEP 3.
Insert the sealing plug into the connector contact cavity. Gently apply downward pressure to force the sealing plug into the cavity.



STEP 4.
Apply pressure until sealing plug is forced to stop by the connector rear grommet. Visually inspect the sealing plug to ensure it is flush with the cavity opening.



Metri-Pack Connectors

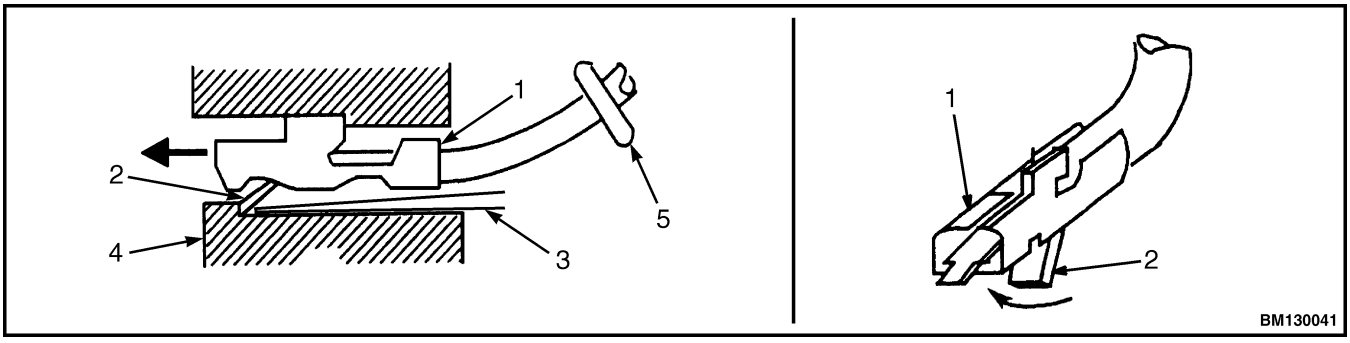
Some connectors use terminals called Metri-Pack Series 150. These may be used at the coolant sensor and TBI units on ICE lift trucks.

They are also called push-to-seat terminals because to install a terminal on a wire, the wire is first inserted through the seal and connector. The terminal is then crimped on the wire and the terminal pulled back into the connector to seat it in place.

NOTE: DO NOT cut contacts from reel, use loose contacts only.

REMOVE AND INSTALL

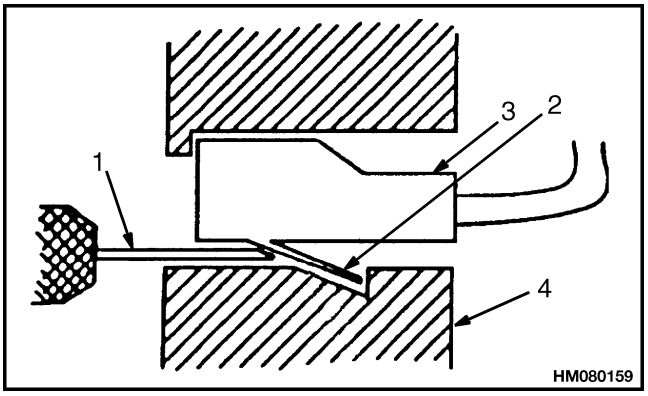
1. Slide the seal back on the wire.
2. Hold the wire and use it to push the terminal to its forward position in the connector body. Hold the terminal in this position. See Figure 24.



1. FEMALE TERMINAL
2. LOCKING TAB
3. TOOL KIT
4. CONNECTOR BODY
5. SEAL

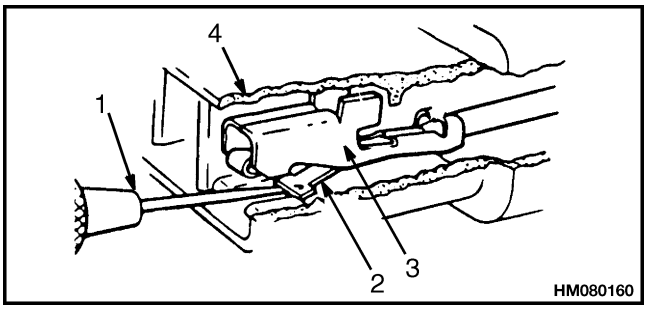
Figure 24. Metri-Pack Terminal Removal

3. Find the lock tab for the terminal in the connector channel. Push a removal tool (pick) (HYSTER P/N 866420) of the correct size into the connector channel. See Figure 25 and Figure 26.



1. TOOL (PICK)
2. LOCK TAB
3. TERMINAL
4. CONNECTOR BODY

Figure 25. Metri-Pack Push-to-Seat Connector



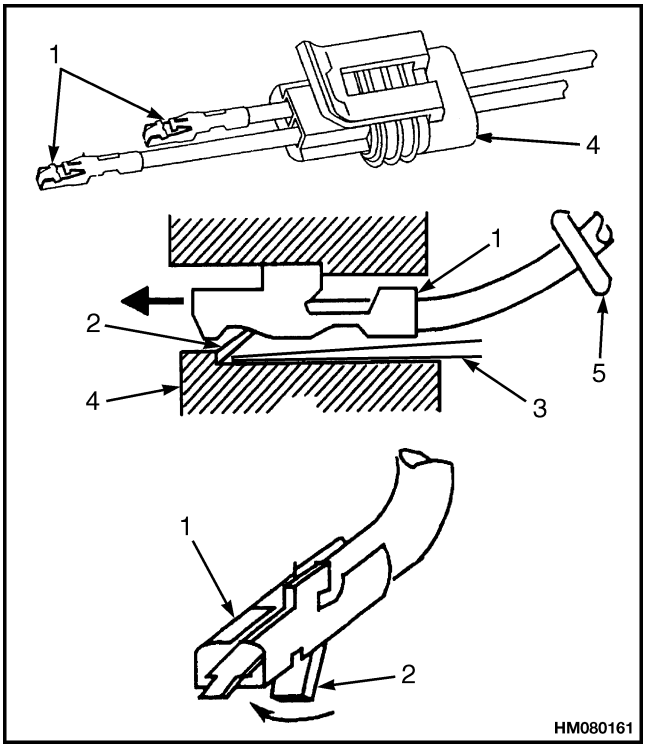
1. TOOL (PICK)
2. LOCK TAB
3. TERMINAL
4. CONNECTOR BODY

Figure 26. Metri-Pack Pull-to-Seat Connector

4. Use the removal tool (HYSTER P/N 866420) to move the lock tab to release the terminal from its seat.

Push-to-Seat - Gently pull the wire to remove the terminal from the back of the connector.

Pull-to-Seat - Gently push the wire to remove the terminal through the front of the connector. See Figure 27.



1. TERMINAL
2. LOCK TAB
3. TOOL KIT
4. CONNECTOR BODY
5. SEAL

Figure 27. Metri-Pack Pull-to-Seat Terminal Removal

CAUTION

Work carefully and do not use enough force to damage the terminal or the connector.

5. Inspect the terminal and connector for damage. See Figure 28.

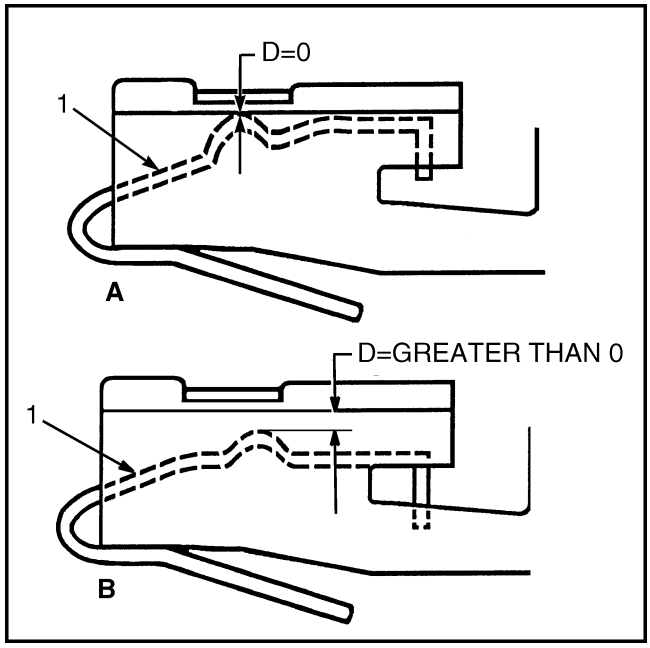


Figure 28. Metri-Pack Terminal Inspection

Legend for Figure 28.

NOTE: THE GREATER DISTANCE D, A FAULT CAN OCCUR IN THE CONNECTION.

1. CONTACT TAB

NOTE: If reusing the terminal, reshape the locking tab.

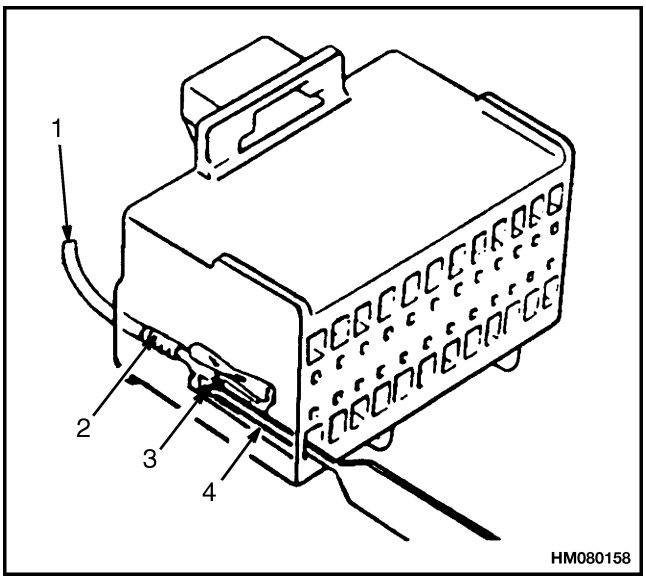
6. If the terminal will be used again, make sure the lock tab is correctly bent so that the terminal will be locked in the connector again.

7. Push the terminal into the connector channel. Make sure that the lock tab correctly locks the terminal in position.

8. Push the seals into their position and install any secondary locks.

Micro-Pack Connectors

The Micro-Pack connector is shown in Figure 29. This connector is normally used to connect the wire harness to the ECM. The repair procedures for the Micro-Pack connectors are the same as the Metri-Pack connectors. Refer to the section Metri-Pack Connectors for the repair procedures.



1. CABLE
2. TERMINAL
3. LOCKING TAB
4. TOOL KIT (HYSTER P/N 866422

Figure 29. Micro-Pack Connector

Weather-Pack Connectors

A Weather-Pack connector can be identified by a rubber seal at the rear of the connector. This connector, which is used in the engine compartment, protects against moisture and dirt which could create oxidation and deposits on the terminals. This protection is important because of the very low voltage and current levels found in the electronic system.

Repair of a Weather-Pack terminal is shown in Weather-Pack Terminal Repair. Use the tool kit to remove the pin and sleeve terminals. See Special Tools.

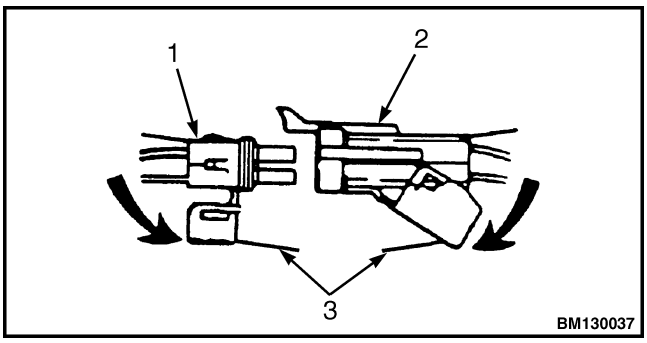
If removal is attempted with an ordinary pick, there is a good chance that the terminal will be bent or deformed. Unlike standard blade-type terminals, these terminals cannot be straightened once they are bent.

Make certain that the connectors are properly seated and all of the sealing rings are in place when connecting leads. The hinge-type flap provides a backup or secondary locking feature for the connector. They are used to improve the connector reliability by retaining the terminals if the small terminal lock tabs are not positioned properly.

Weather-Pack connections cannot be replaced with standard connections. Instructions are provided with Weather-Pack connector and terminal packages.

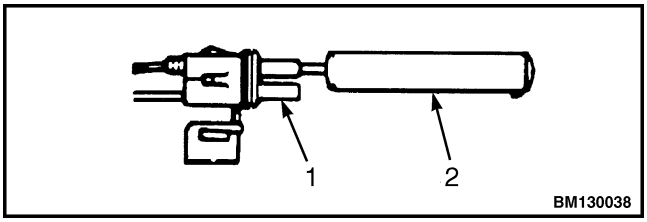
WEATHER-PACK TERMINAL REPAIR

STEP 1.
Open secondary lock hinge on connector.



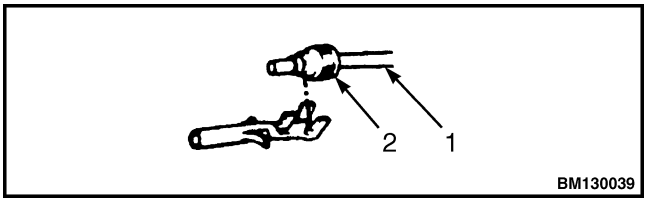
1. FEMALE CONNECTOR
2. MALE CONNECTOR
3. SECONDARY LOCK HINGE

STEP 2.
Remove terminal, using tool HYSTER P/N 866421 .



1. TERMINAL
2. TOOL

STEP 3.
Cut wire immediately behind cable seal.



1. WIRE
2. SEAL

STEP 4.
Replace terminal.

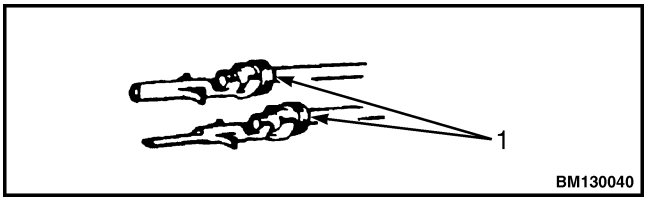
STEP 1.
Slip new seal onto wire.

STEP 2.
Strip 5 mm (0.2 in.) of insulation from wire.

STEP 3.
Crimp terminal over wire and seal.

STEP 5.
Push terminal and connector onto wire and engage locking tabs.

STEP 6.
Close secondary lock hinge.



1. SEAL

AMPSEAL Crimping Tools

AMP HAND CRIMPING TOOL WITH CERTI-CRIMP

Description

The tool, Hyster P/N 1698557 , features two upper inserts, two anvils, an insulation crimp adjustment lever, a contact support, a locator, an ejector, and a CERTI-CRIMP ratchet. The contact is inserted into the **FRONT** of the tool. The wire is inserted into the **BACK** of the tool. See Figure 30.

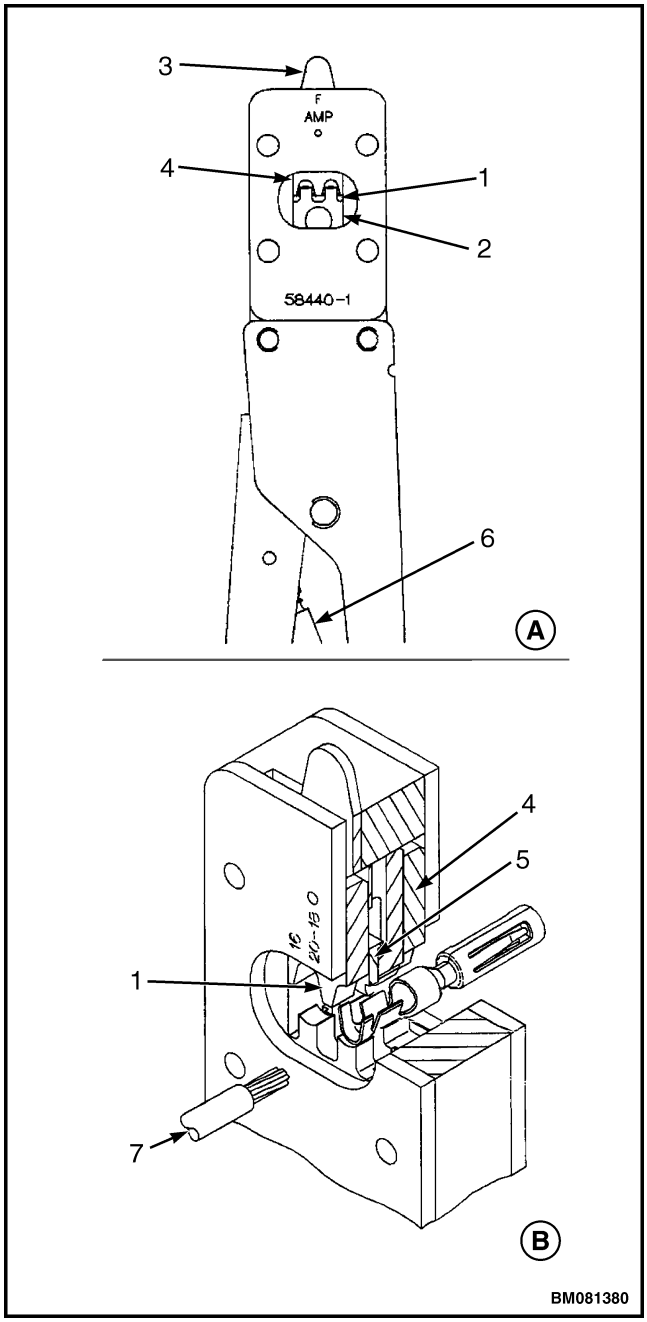


Figure 30. AMP Hand Crimping Tool

Legend for Figure 30.

A. FRONT OF TOOL
B. BACK OF TOOL

1. UPPER INSERT
2. ANVIL
3. INSULATION CRIMP ADJUSTMENT LEVER
4. CONTACT SUPPORT
5. LOCATOR
6. CERTI-CRIMP RATCHET
7. STRIPPED WIRE

The insulation adjust lever regulates the crimp height. See Insulation Crimp Adjustment.

The contact support prevents the contact from bending during crimping.

The locator functions two ways:

- position the contact between the upper insert and the anvil before crimping
- limits the insertion distance of the stripped wire into the contact.

The ejector pulls the locator down, and ejects the crimped contact when the tool handles are fully opened.

CAUTION

The crimping jaws bottom before the CERTI-CRIMP ratchet releases. This is a design feature that ensures maximum electrical and tensile performance of the crimp DO NOT readjust the ratchet.

The CERTI-CRIMP ratchet assures full crimping of the contact. Once engaged, the ratchet will not release until the handles have been fully closed.

Stripping Wire for Use with AMP Hand Crimping Tool

1. Choose the correct AWG for the contact being used.
2. See Table 2 for recommended strip length.

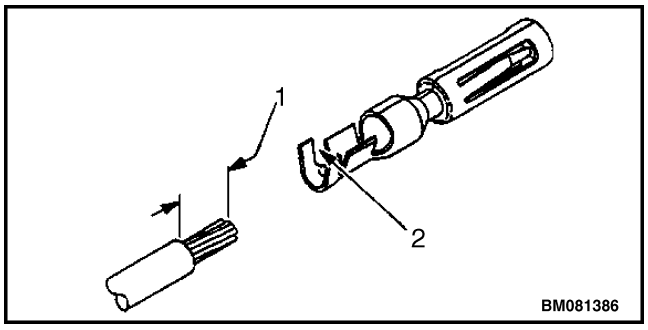
Table 2. Wire Size (AWG)

Wire Size (AWG)	Insulation Diameter Range	Tool Wire Size Marking	Contact	Wire Strip Length
16	1.7 to 2.7 mm (0.067 to 0.106 in.)	16	Hyster P/N 2035276	5.5 mm (0.215 in.)
20 - 18		20 - 18		4.7 mm (0.185 in.)

CAUTION

DO NOT cut or nick the wire strands.

3. Strip wire to recommended strip length. A small piece of insulation should come off the wire after stripping. See Figure 31.



NOTE: SEE TABLE 2 FOR WIRE STRIP LENGTH.

1. STRIPPED WIRE
2. LOCATOR SLOT

Figure 31. Strip Length

Insulation Crimp Adjustment

The insulation barrel crimp height is regulated by the insulation adjustment lever. To determine the proper setting, test crimp a contact using the setting which approximates the insulation size: 1) small, 2) medium, or 3) large. If the crimped insulation barrel is too tight or too loose, change the setting accordingly. The crimp should hold the insulation firmly without cutting into it.

Maintenance and Inspection for AMP Hand Crimping Tool

AMP Hand Crimping Tool

1. Perform maintenance and inspections as specified by AMP.

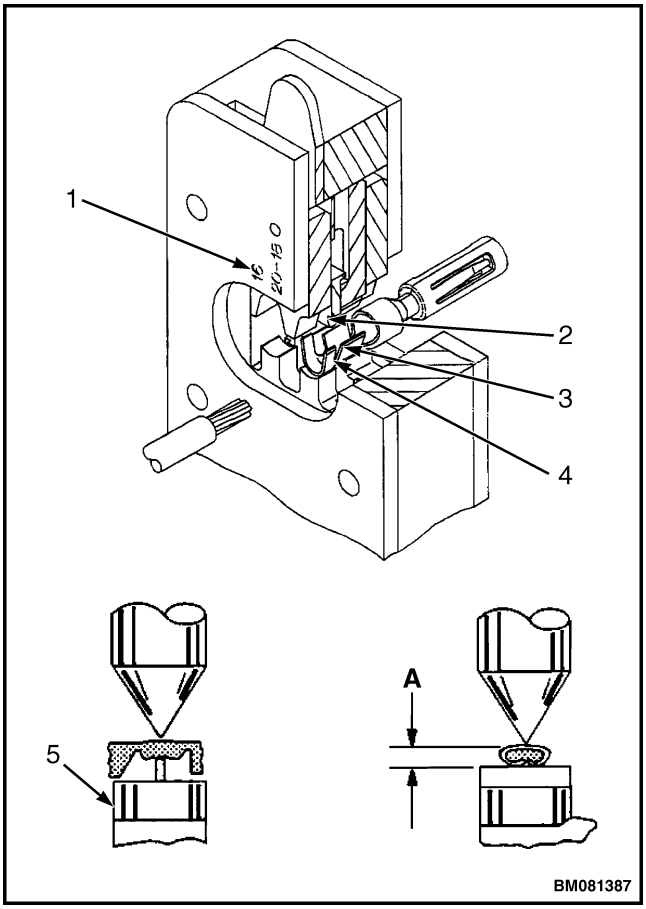
Crimp Height Inspection

1. This inspection requires the use of a micrometer with a modified anvil as shown in Figure 32.

2. Refer to Table 3 and select contact and wire (maximum size) for each crimp section listed.

3. Crimp a contact on to the wire according to How to use AMP Hand Crimping Tool procedure.

4. Using a modified micrometer, measure wire barrel crimp height as shown in Figure 32. If the crimp height conforms to measurement in Table 3 the tool is correct. If not, replace tool.



A. CRIMP HEIGHT - SEE TABLE 3

1. TOOL CRIMP SECTION MARKING
2. WIRE SLOT IN LOCATOR
3. WIRE BARREL
4. LOCATOR SLOT IN CONTACT
5. MODIFIED ANVIL ON MICROMETER

Figure 32. AMP Crimp Tool Inspection

Table 3. Crimp Height

Contact Part No	Wire Size (AWG)	Tool Crimp Section Marking	Crimp Height
Hyster P/N 2035276	20	20-18	1.22 ±0.05 mm (0.048 ±0.002 in.)
	18	20-18	1.22 ±0.05 mm (0.048 ±0.002 in.)
	16	16	1.40 ±0.05 mm (0.055 ±0.002 in.)

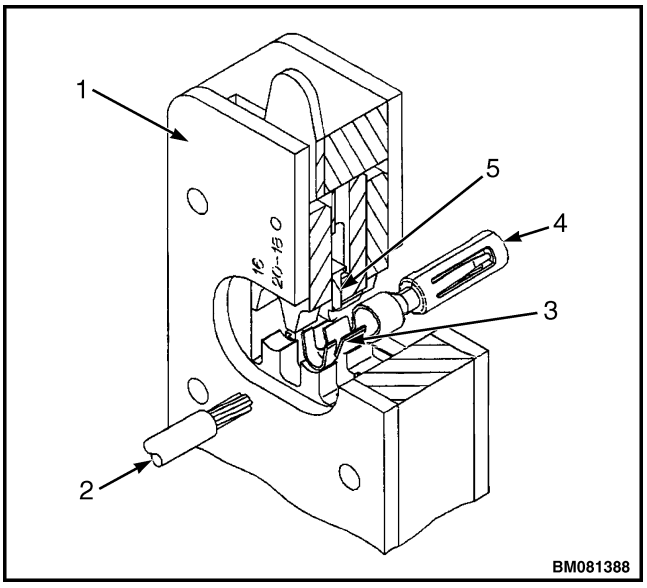
HOW TO USE AMP HAND CRIMPING TOOL

1. Strip insulation from wire. See Stripping Wire for Use with AMP Hand Crimping Tool.

2. Hold tool so **BACK** side (wire side) faces you.

3. Release tool ratchet by squeezing tool handles then allowing them to open.

4. Holding contact by its mating portion and looking straight into crimp section, insert contact from the **FRONT** of tool into **BACK** of crimp section. Position contact as shown in Figure 33.



1. BACK OF TOOL
2. STRIPPED WIRE
3. WIRE BARREL
4. CONTACT
5. LOCATOR

Figure 33. Crimp Contact to Wire

NOTE: Make sure wire barrel is not deformed during crimping procedure.

5. Holding contact in this position, squeeze tool handles together.

6. Insert properly stripped wire through locator and into wire barrel of contact.

7. Crimp contact onto wire while holding wire in place by squeezing tool handles together until ratchet releases.

8. Allow tool handles to open **fully** and remove crimped contact from tool.

AMP PRO-CRIMPER II TOOL

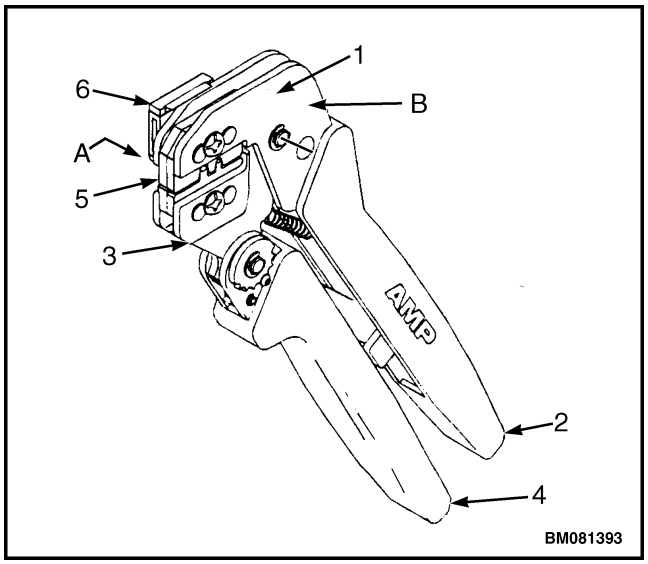
Description

This tool has a tool frame with stationary jaw and handle, a moving jaw and handle, and an adjustable ratchet to ensure full contact crimping. The tool frame contains a die assembly with two crimping sections.

The die assembly contains a wire anvil, an insulation anvil, a wire crimper and an insulation crimper. See Figure 34.

The locator assembly, on the outside of the frame, contains a locator, a spring retainer, and a contact support.

The dies are secured to the frame with retaining pins and retaining screws. A nut on the upper retaining screw holds the locator assembly in place.



A. TOOL FRONT
B. TOOL BACK

1. STATIONARY JAW
2. STATIONARY HANDLE
3. MOVING JAW
4. MOVING HANDLE
5. DIE ASSEMBLY
6. LOCATOR ASSEMBLY

Figure 34. AMP PRO-CRIMPER II Tool

Remove and Install Die Set and Locator Assembly

NOTE: Perform Step 1 through Step 3 for removal of die set and locator assembly. Follow Step 4 through Step 12 for installation of die set and locator assembly.

1. Close tool handles until ratchet releases.

2. Remove nut, locator assembly, upper and lower die retaining screws, and upper and lower die retaining pins. See Figure 35.

3. Slide wire anvil, insulation anvil, wire crimper, and insulation crimper out of tool frame. See Figure 35.

4. Install wire anvil and insulation anvil into moving jaw of tool frame, with chamfered sides and marked surfaces facing outward. See Figure 35.

5. Insert lower die retaining pins. See Figure 35.

6. Insert lower die retaining screw through moving jaw and both anvils. Tighten screw enough to hold the anvils in place, but DO NOT tighten completely. See Figure 35.

7. Insert wire crimper and insulation crimper into stationary jaw, with chamfered sides and marked surfaces facing outward. See Figure 35.

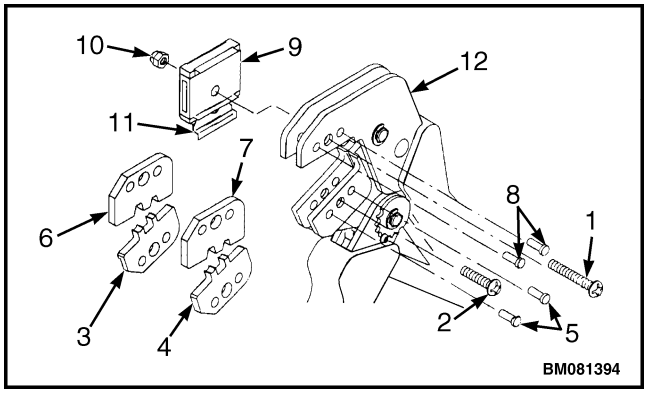
8. Insert upper die retaining pins. See Figure 35.

9. Insert upper die retaining screw through stationary jaw and both crimpers. See Figure 35. Tighten screw enough to hold crimpers in place, but DO NOT tighten completely.

10. Carefully close tool handles. Make sure anvils and crimpers align properly. Completely close tool handles until ratchet is engaged enough to hold anvils and crimpers in position. Tighten upper and lower die retaining screws.

11. Install locator assembly over the end of upper die retaining screw and position against the side of the tool jaw. See Figure 35.

12. Install nut onto the end of upper die retaining screw and tighten enough to hold locator assembly in place while allowing the locator to slide up and down. See Figure 35.



1. UPPER DIE RETAINING SCREW
2. LOWER DIE RETAINING SCREW
3. WIRE ANVIL
4. INSULATION ANVIL
5. LOWER DIE RETAINING PIN
6. WIRE CRIMPER
7. INSULATION CRIMPER
8. UPPER DIE RETAINING PIN
9. LOCATOR ASSEMBLY
10. NUT
11. LOCATOR
12. TOOL FRAME

Figure 35. Die Set and Locator Assembly

Stripping Wire for Use With AMP PRO-CRIMPER II Tool

1. Choose the correct AWG for the contact being used.

2. See Table 4 for recommended strip length.

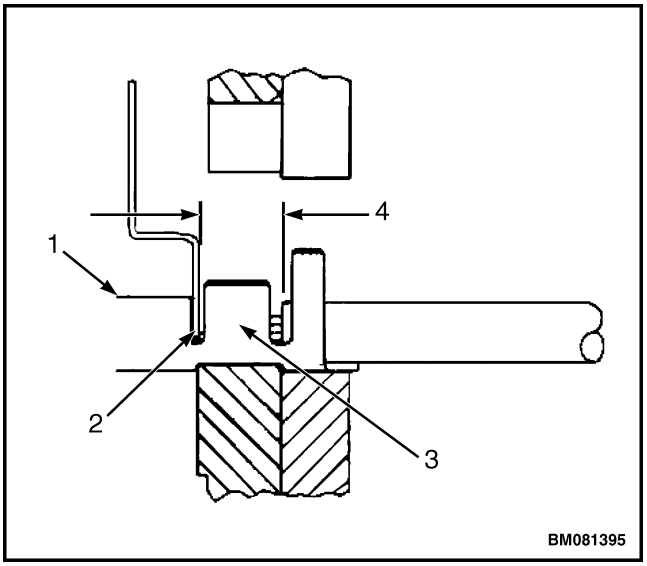
Table 4. Strip Length for PRO-CRIMPER II Tool

Wire Size (AWG)	Wire Insulation Diameter	Strip Length
16	1.7 to 2.7 mm (0.07 to 0.11 in.)	5.1 ±0.4 mm (0.20 ±0.02 in.)
18-20		

CAUTION

DO NOT cut or nick the wire strands.

3. Strip wire to recommended strip length. See Figure 36.



1. CONTACT
2. LOCATOR (IN WIRE STOP SLOT)
3. WIRE (INSERTED TO STOP)
4. STRIP LENGTH

Figure 36. Contact and Wire Strip

Contact Support Adjustment

1. Make a sample crimp. Determine if contact is straight, bent upward or downward.

2. If adjustment is required, loosen adjustment screw, DO NOT remove screw. See Figure 37.

3. Insert contact and wire into tool as shown in Figure 36. Close tool handles until the ratchet reaches the sixth clip or the contact support touches the contact.

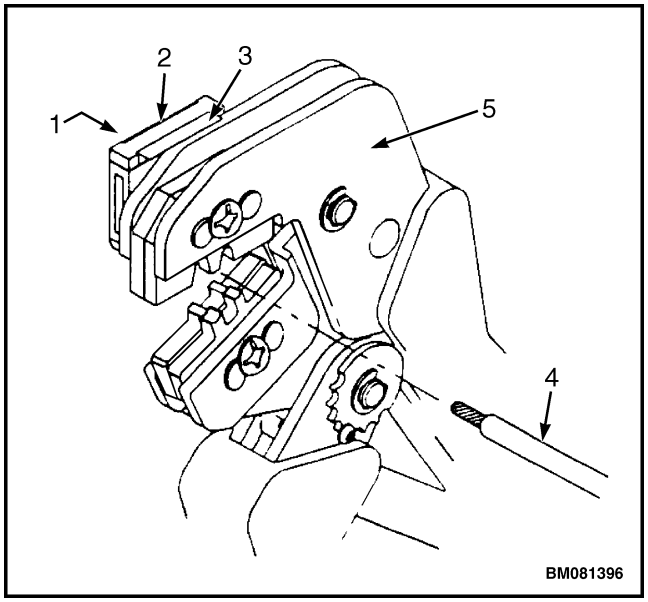
4. Loosen the nut, slightly, that holds the locator assembly onto the tool frame. See Figure 37.

5. Move the contact support to eliminate bending the contact.

6. Tighten the nut and squeeze handles until ratchet releases.

7. Remove and inspect the contact.

8. Make another sample crimp. If the contact is straight, tighten the adjustment screw. If the contact is bent, repeat Step 2 through Step 8.



1. ADJUSTMENT SCREW
2. CONTACT SUPPORT
3. LOCATOR
4. WIRE
5. BACK OF TOOL

Figure 37. Contact Support Adjustment

Crimp Height Adjustment

1. Remove lockscrew from ratchet adjustment wheel. See Figure 38.

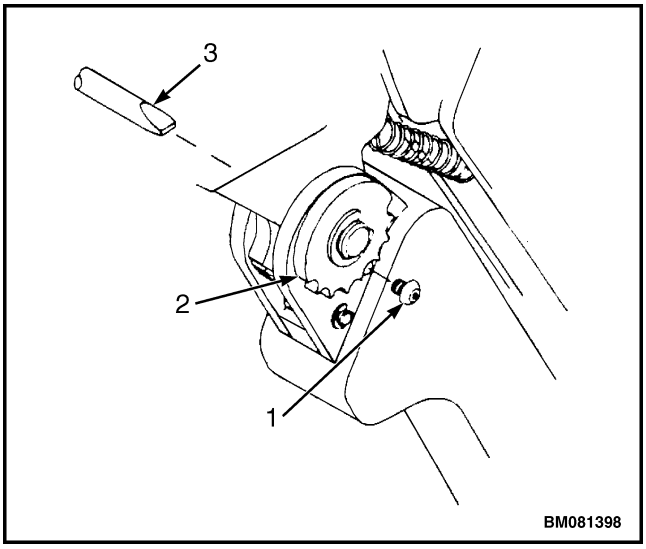
2. Using screwdriver, adjust ratchet wheel as indicated in Step 3 or Step 4.

3. To tighten crimp, rotate ratchet adjustment wheel **COUNTERCLOCKWISE**. See Figure 38.

4. To loosen crimp, rotate ratchet adjustment wheel **CLOCKWISE**. See Figure 38.

5. Replace lockscrew onto ratchet adjustment wheel. See Figure 38.

6. Make a sample crimp and measure the crimp height.



1. LOCKSCREW
2. RATCHET ADJUSTMENT WHEEL
3. SCREWDRIVER

Figure 38. Ratchet Adjustment Wheel

Maintenance and Inspection Procedures

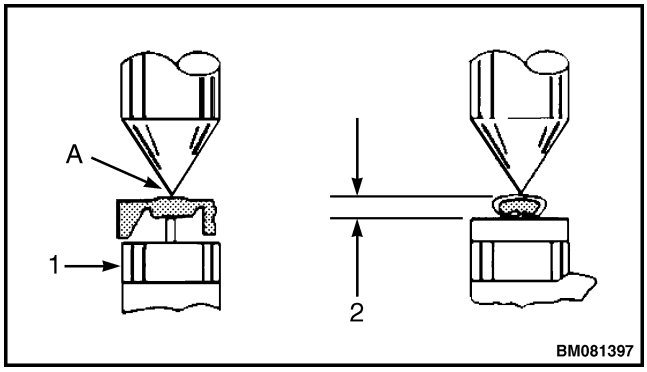
PRO-CRIMPER II Tool

1. Make sure the tool and dies are clean by wiping them with a clean, soft cloth. If debris is present, clear away with a soft brush. Keep handles closed when not in use to prevent objects from becoming stuck in crimping dies. Store in clean, dry area.

2. Inspect the crimping dies on a regular basis to ensure they are not worn or damaged. If crimp sections are flattened, chipped, worn or broken replace tool.

Crimp Height Inspection

1. This inspection requires the use of a micrometer with a modified anvil as shown in Figure 39.



A. POSITION POINT ON CENTER OF WIRE BARREL OPPOSITE SEAM.

1. MODIFIED ANVIL ON MICROMETER
2. CRIMP HEIGHT, SEE TABLE 5

Figure 39. Crimp Height

2. Refer to Table 5 to select wire for each crimp section listed.

Table 5. Crimp Measurement

Wire Size (AWG)	Crimp Height
18	1.22 ±0.05 mm (0.048 ±0.002 in.)
16	1.41 ±0.05 mm (0.056 ±0.002 in.)

3. Crimp a contact onto the selected wire according to How to Use AMP PRO-CRIMPER II Tool procedure.

4. Using a modified micrometer, measure wire barrel height as shown in Figure 39. If the crimp height matches measurement shown in Table 5 the tool is correct. If not, follow Crimp Height Adjustment procedure.

HOW TO USE AMP PRO-CRIMPER II TOOL

1. Strip insulation from wire. See Stripping Wire for Use With AMP PRO-CRIMPER II Tool procedure.

2. Hold PRO-CRIMPER II tool so **BACK** side (wire side) is facing you.

3. Squeeze tool handles together, then allow to fully open.

4. Holding contact by mating end, insulation barrel first, insert contact through front of tool and into appropriate crimp section.

5. Mating end of contact should be on locator side of tool; the open "U" of wire barrel and insulation barrel should face the top of the tool. The contact to be placed to that movable locator drips into slot in the contact. Butt the front end of the wire barrel against locator.

NOTE: Make sure neither wire barrel nor insulation barrel are damaged.

6. Hold contact in position and squeeze tool handles until ratchet engages enough to hold contact.

7. Insert stripped wire into contact insulation and wire barrels until butted against wire stop.

8. Squeeze tool handles, while holding wire in position, until ratchet releases.

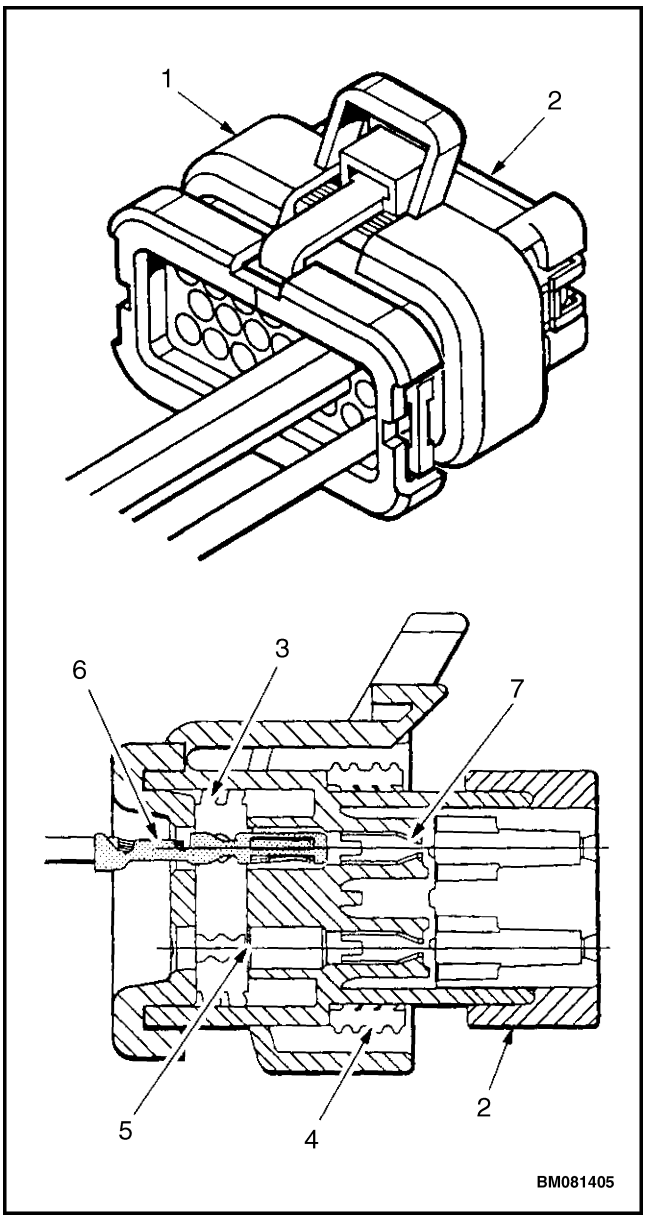
9. Allow tool handles to open and remove crimped contact from tool.

10. Check crimp height as described in Crimp Height Inspection.

AMPSEAL Connector Assemblies

DESCRIPTION FOR PLUG CONNECTOR ASSEMBLY

The plug assembly consists of a housing, a wedge lock, a wire seal, and a mating seal. See Figure 40.



1. HOUSING
2. WEDGE LOCK
3. WIRE SEAL
4. MATING SEAL
5. DIAPHRAGM
6. CONTACT
7. RETENTION FINGERS

Figure 40. AMPSEAL Plug Connector

For current ratings of special use connectors, AMPSEAL, refer to Table 6.

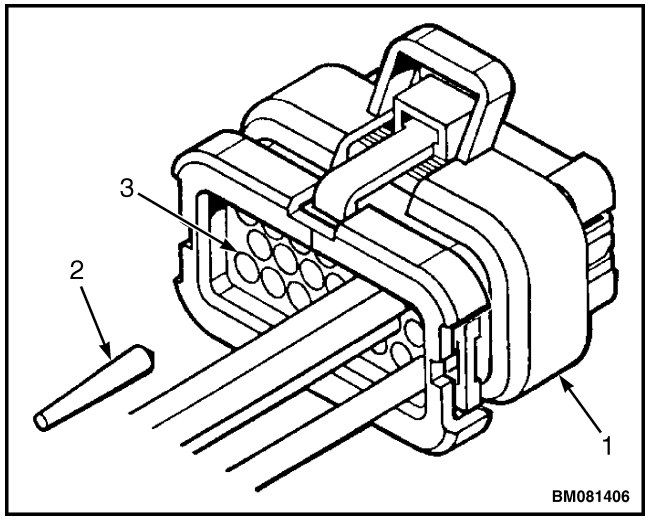
Table 6. Current Rating

Single Circuit Plating	Wire Size (AWG)	Current Rating (Max.)
Tin	16, 18, and 20	8A
Gold	16	14.5A
	18	13A
	20	11.5A

Seal Plug

All circuits are sealed by a diaphragm in the rubber wire seal. When assembling the connector, the diaphragm is pierced as the contact passes through it. Unused circuit cavities will remain sealed unless perforated by accidental insertion and removal of contact in the wrong cavity. The seal plug is designed to keep out contaminants if the diaphragm is pierced.

1. Insert the seal plug, large end first, into the circuit cavity as far as it will go. No insertion tool is usually required for this procedure. See Figure 41.



1. PLUG CONNECTOR
2. SEAL PLUG
3. CIRCUIT CAVITY

Figure 41. Seal Plug

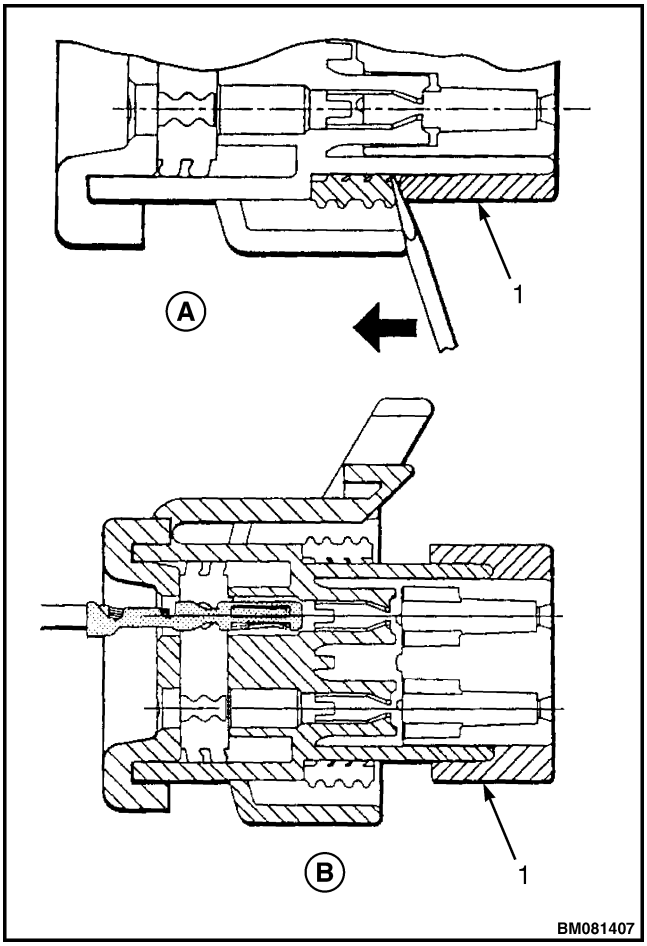
Contact Crimping

Information on contact crimping can be found in AMPSEAL Crimping Tools.

Contact Removal

NOTE: The wedge lock should never be removed from the housing for insertion or removal of the contacts.

STEP 1.
Insert a screwdriver blade between the mating seal and one of the red wedge lock tabs. Pry open the wedge lock to the OPEN position.

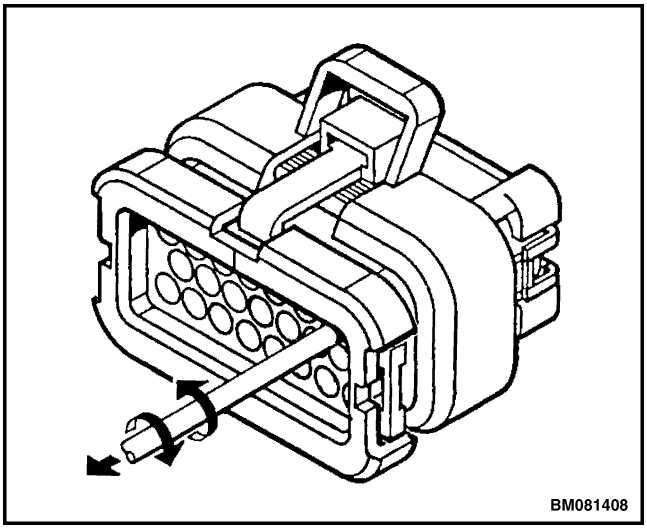


NOTE: SCREWDRIVER TO BE MOVED IN DIRECTION OF ARROW.

A. CLOSED POSITION
B. OPEN POSITION

1. WEDGE LOCK TAB

STEP 2.
While rotating the wire back and forth over a half turn (1/4 turn each direction), gently pull the wire until the contact is removed.



STEP 3.
Tag the wire and mark it with the corresponding number or letter on the back of the connector from which the wire was removed.

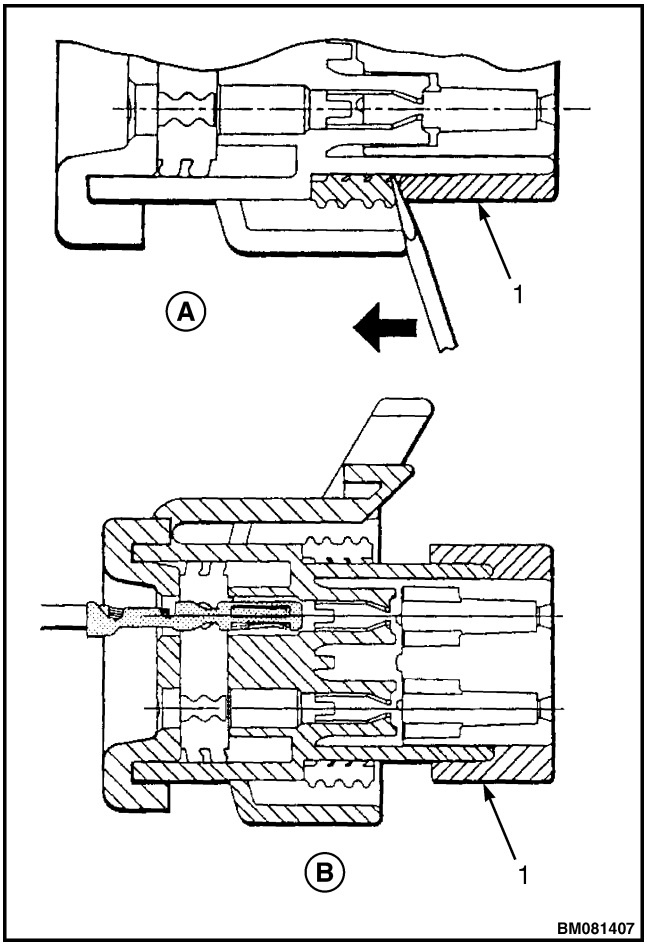
STEP 4.
Repeat Step 2 and Step 3 to remove remaining wires.

Contact Insertion

NOTE: The wedge lock should never be removed from the housing for insertion or removal of the contacts.

NOTE: Check to be sure the wedge lock is in the OPEN position. Perform Step 1 if wedge lock is closed.

STEP 1.
Insert a screwdriver blade between the mating seal and one of the red wedge lock tabs. Pry open the wedge lock to the OPEN position.

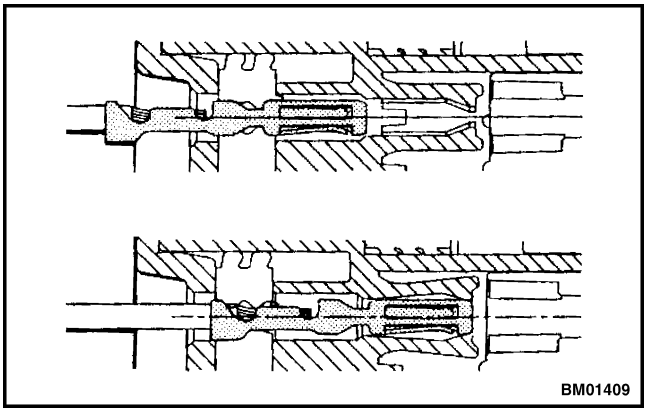


NOTE: SCREWDRIVER TO BE MOVED IN DIRECTION OF ARROW.

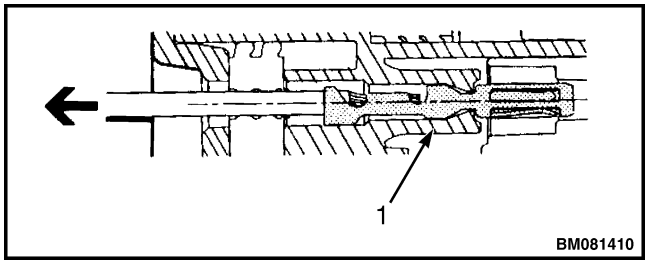
A. CLOSED POSITION
B. OPEN POSITION

1. WEDGE LOCK TAB

STEP 2.
Insert contact by pushing it straight into the appropriate circuit cavity as far as it will go.



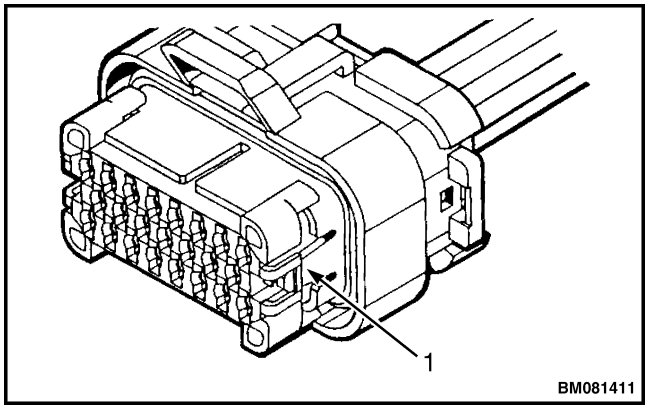
STEP 3.
Pull back on the contact wire with a force of 4 to 9 N (1 to 2 lbf) to be sure the retention fingers are holding the contact.



NOTE: PULL WIRE IN DIRECTION OF ARROW.

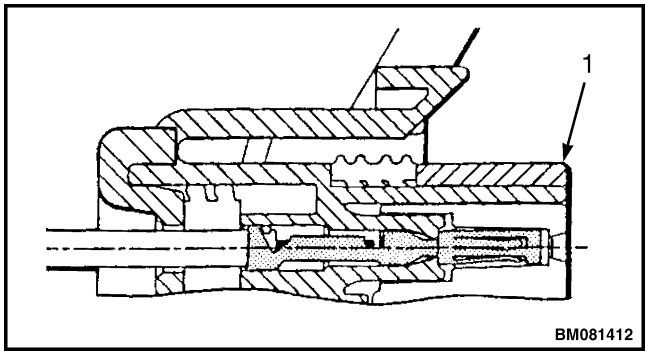
1. RETENTION FINGERS

STEP 4.
After all required contacts have been inserted, the wedge lock must be closed to its LOCKED position. Release the locking latches by squeezing them inward.



1. LOCKING LATCHES

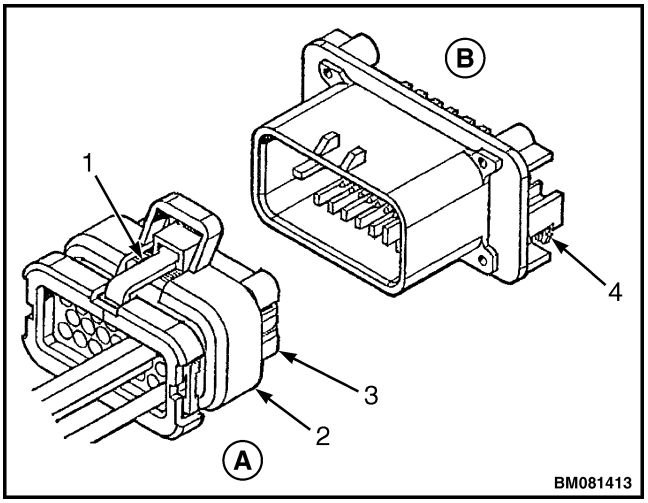
STEP 5.
Slide the wedge lock into the housing until it is flush with the housing.



1. WEDGE LOCK

DESCRIPTION FOR PLUG CONNECTOR AND HEADER ASSEMBLY

The plug assembly will accept multiple socket contacts. See Figure 42. The head assembly is designed to be fastened to the enclosure by four self-tapping screws. The screw length will depend on panel thickness.



Legend for Figure 42.

NOTE: PLUG AND HEADER ASSEMBLY COLORS ARE MECHANICALLY KEYED TO MATE ONLY WITH IDENTICAL COLORS.

A. PLUG ASSEMBLY
B. HEADER ASSEMBLY

1. MATING SEAL
2. HOUSING
3. WEDGE LOCK
4. RETENTION LEG

Panel mounting cutout requirements shown in Figure 43. Maximum panel thickness to be 2 mm (0.08 in.) for proper clearance.

Figure 42. AMPSEAL Plug and Header Assembly

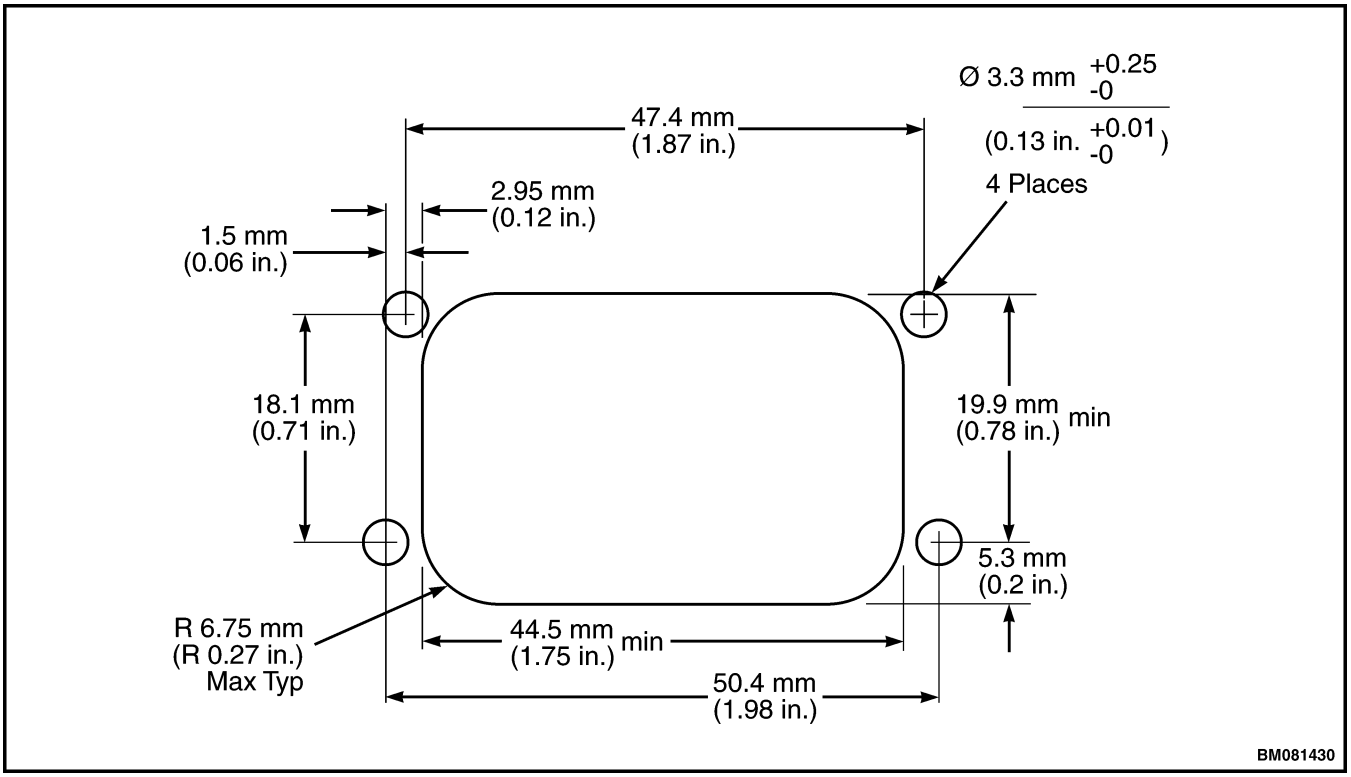
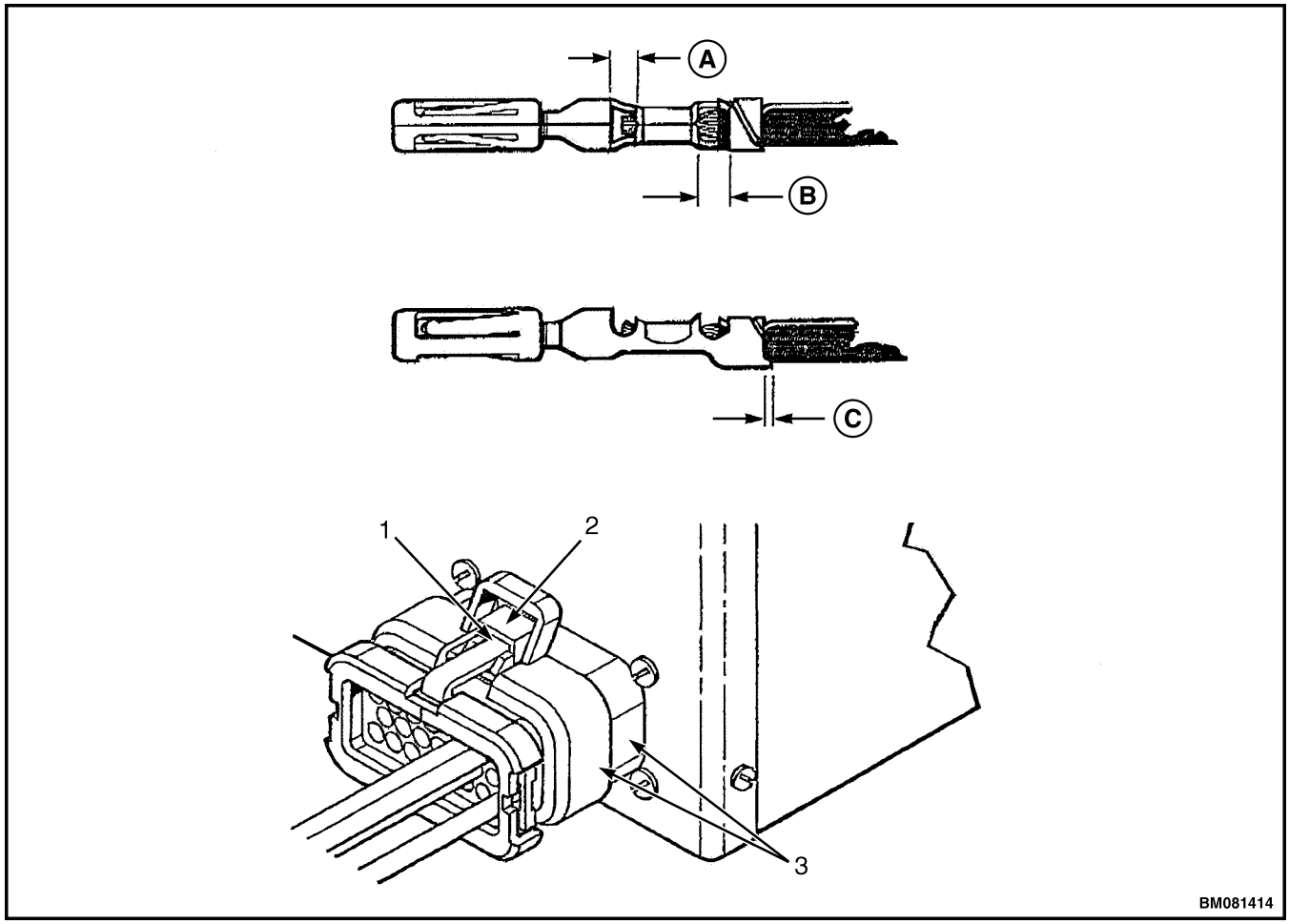


Figure 43. AMPSEAL Plug and Header Assembly Panel Mounting

Use screwdriver slot to lift latch for unmating. To mate, the plug and head must be identical in color. Securely fasten the locking latch when mating plug and header. See Figure 44.



A. WIRE STRANDS MUST BE VISIBLE IN THIS AREA
B. WIRE STRANDS AND INSULATION MUST BOTH BE VISIBLE IN THIS AREA
C. CUTOFF TAB MUST BE VISIBLE

1. SCREWDRIVER SLOT
2. LOCKING LATCH
3. PLUG AND HEADER

Figure 44. Contact, Plug, and Header

The wedge lock has slotted openings in the mating, forward, end. The slots are for circuit test tabs approximately 3.3 × 0.6 mm (0.13 × 0.02 in.), which prevent damage to the receptacle. Circuit testing in the field to be done by a flat probe, DO NOT use a sharp point.

Voltage Reading

CAUTION

DO NOT pierce wire insulation to take voltage readings.

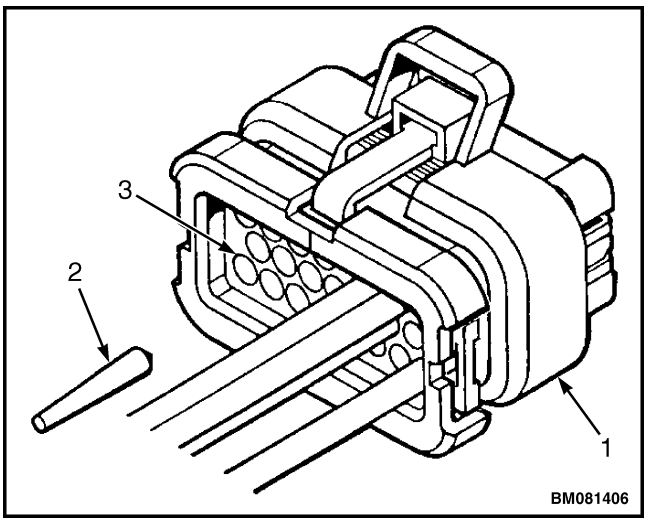
When using AMPSEAL plug assembly DO NOT pierce wire insulation with a sharp point. Pin holes in the insulation allow moisture to invade the sealed connector system nullifying effectiveness and resulting in possible system failure.

Seal Plug

All circuits are sealed by a diaphragm in the rubber wire seal. This diaphragm is pierced when the contact is pressed through it. Unused circuit cavities will remain sealed unless perforated by accidental insertion and removal of contact in the wrong cavity. The seal plug is designed to keep out

contaminants if the diaphragm is accidentally pierced.

1. Insert the seal plug, large end first, into the circuit cavity as far as it will go. No insertion tool is required for this procedure. See Figure 45.



1. PLUG CONNECTOR
2. SEAL PLUG
3. CIRCUIT CAVITY

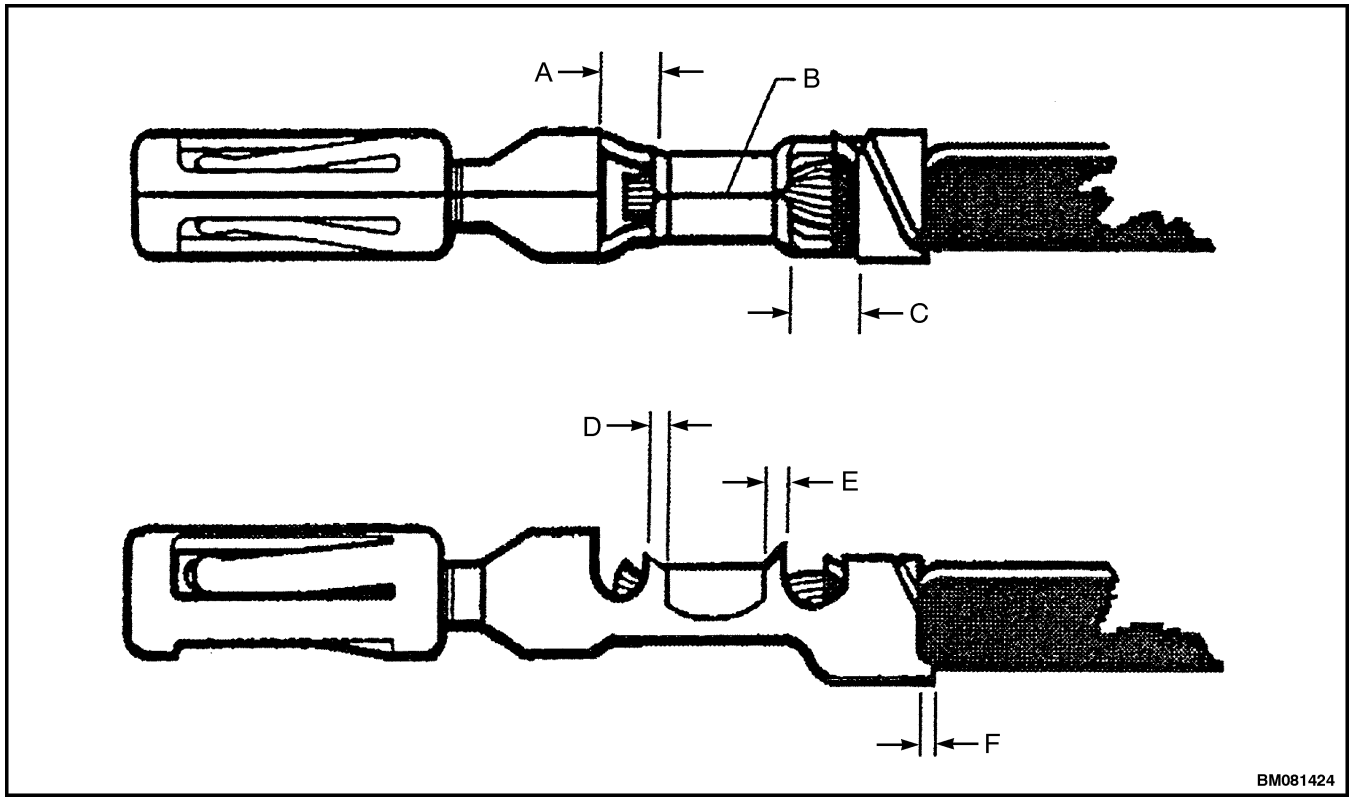
Figure 45. Seal Plug

Contact Crimping

1. Information on contact crimping can be found in AMPSEAL Crimping Tools.

NOTE: DO NOT cut contacts from "reel", use loose contacts only.

2. Crimped contacts to meet conditions shown in Figure 46 and Table 7.



A. WIRE STRAND ENDS MUST BE VISIBLE IN THIS AREA
B. WIRE BARREL SHALL BE CLOSED AT SEAM WITH NO STRANDS PROTRUDING OR SHOWING
C. WIRE STRANDS AND INSULATION SHALL BOTH BE VISIBLE
D. FRONT BELLMOUTH SHALL BE 0.25 mm (0.01 in.)MAX; 0.13 mm (0.005 in.)MIN
E. REAR BELLMOUTH SHALL BE 0.13 TO 0.75 mm (0.005 TO 0.03 in.)
F. CUTOFF TAB SHALL BE 0.25 mm (0.01 in.)MAX

Figure 46. Crimp Conditions

Table 7. Crimp Conditions

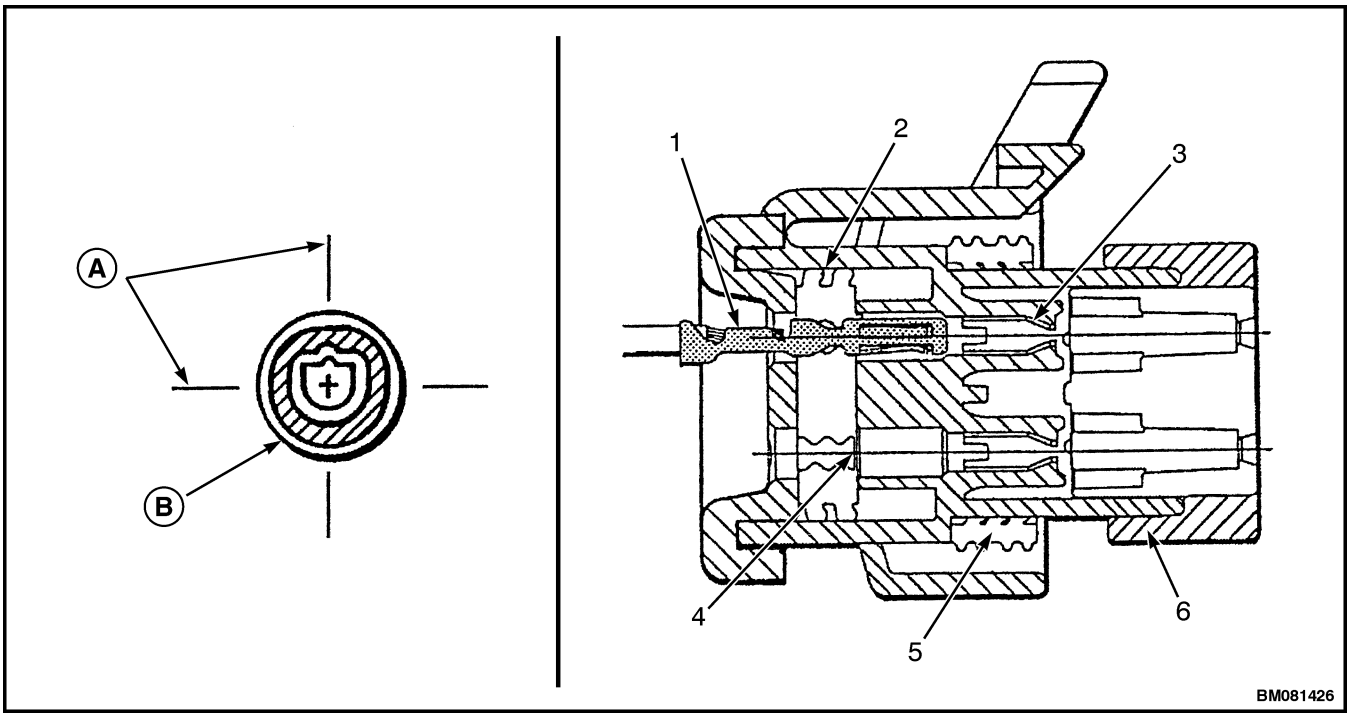
Wire			Wire Barrel		Insulation Barrel	
Size (AWG)	**Insulation Diameter Range**	**Strip Length**	**Crimp Height**	**Crimp Width (Nom)**	**Crimp Height Max**	**Crimp Width ±0.1**
20	1.7 to 2.7	5.1	1.17 ±0.08	2.03	3.2	3.1
18			1.27 ±0.05			
16			1.40 ±0.05			

CAUTION

Cable far end to be sealed or isolated from the environment. DO NOT damage insulation.

NOTE: Wire stripping tools may leave indentations on the surface of the wire insulation. If these indentations are present at the wire seal, leakage can occur. Insulation surface within 26 mm (1.02 in.) of contact tip must be smooth and free of indentations. Ensure wire insulation is not damaged during crimping procedure. The insulation bars to be wrapped around the wire insulation, leaving not sharp points to damage rubber wire seal.

3. The crimped contact to be a 2 mm (.08 in.) diameter cylinder. See Figure 47.



A. CENTERLINE
B. DIA 2 mm (0.08 in.)

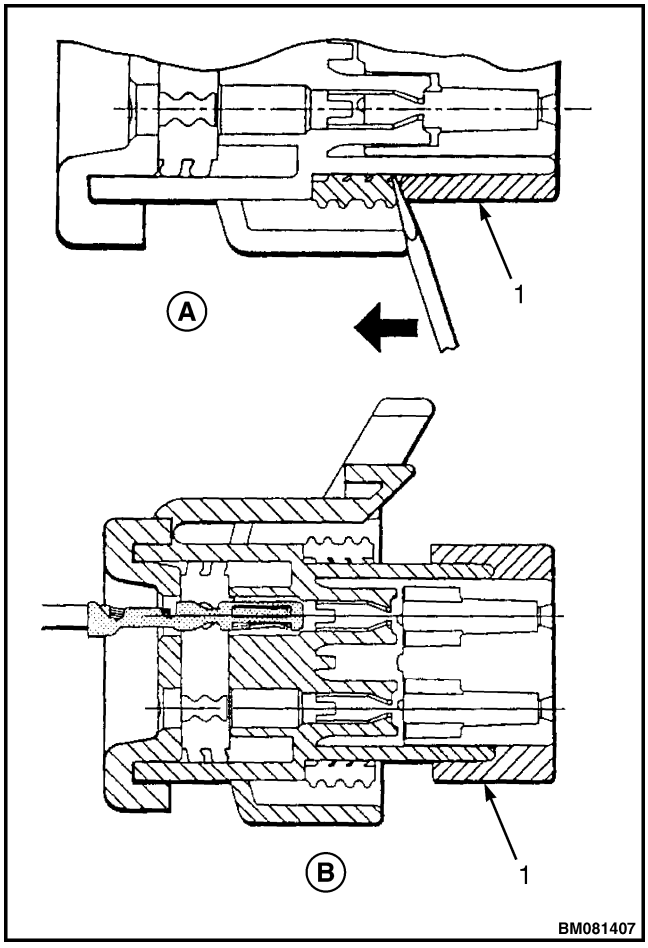
1. CONTACT (PARTIALLY INSERTED)
2. WIRE SEAL
3. RETENTION FINGERS
4. DIAPHRAGM
5. MATING SEAL
6. WEDGE LOCK (OPEN POSITION)

Figure 47. Contact Concentricity

Contact Removal

NOTE: The wedge lock should never be removed from the housing for insertion or removal of the contacts.

STEP 1.
Insert a screwdriver blade between the mating seal and one of the red wedge lock tabs. Pry open the wedge lock to the OPEN position.

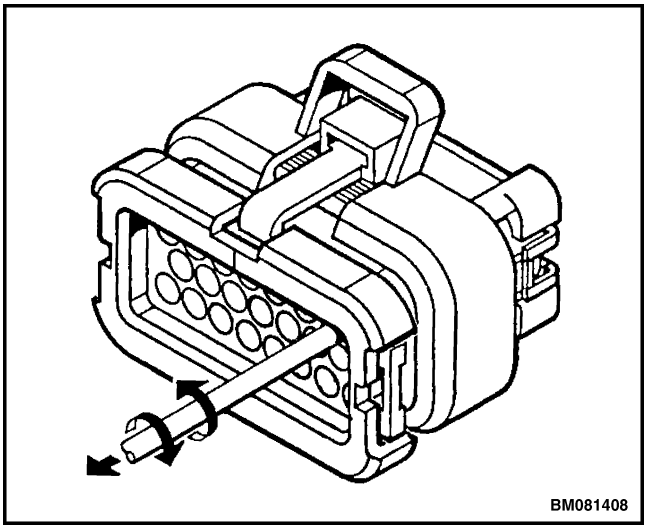


NOTE: SCREWDRIVER TO BE MOVED IN DIRECTION OF ARROW.

A. CLOSED POSITION
B. OPEN POSITION

1. WEDGE LOCK TAB

STEP 2.
While rotating the wire back and forth over a half turn (1/4 turn each direction), gently pull the wire until the contact is removed.



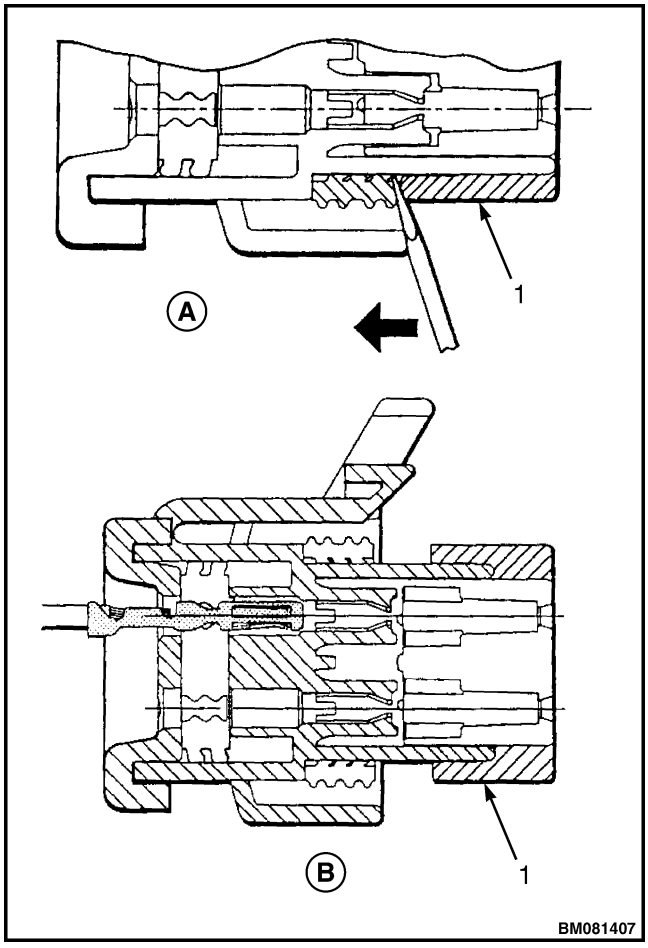
STEP 3.
Repeat Step 2 to remove remaining wires.

Contact Insertion

NOTE: The wedge lock should never be removed from the housing for insertion or removal of the contacts.

NOTE: Check to be sure the wedge lock is in the OPEN position. Perform Step 1 if wedge lock is closed.

STEP 1.
Insert a screw driver blade between the mating seal and one of the red wedge lock tabs. Pry open the wedge lock to the OPEN position.

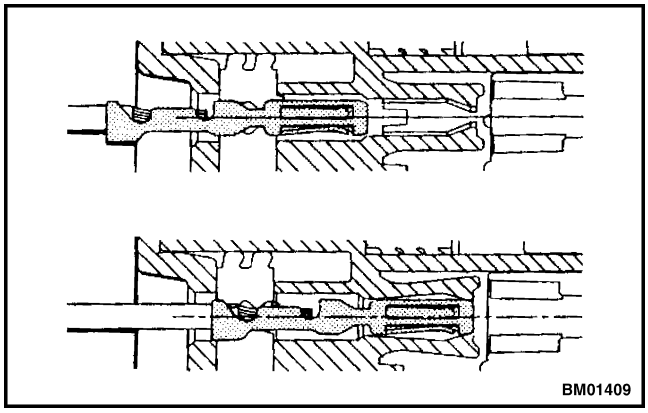


NOTE: SCREWDRIVER TO BE MOVED IN DIRECTION OF ARROW.

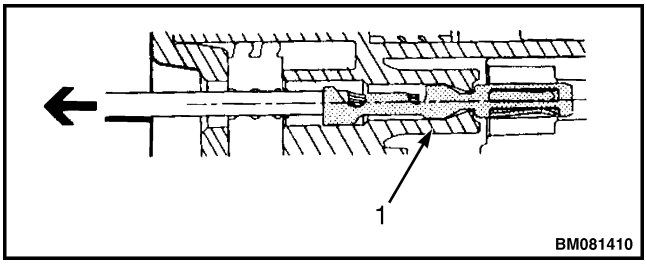
A. CLOSED POSITION
B. OPEN POSITION

1. WEDGE LOCK TAB

STEP 2.
Insert contact straight into circuit cavity as far as it will go.

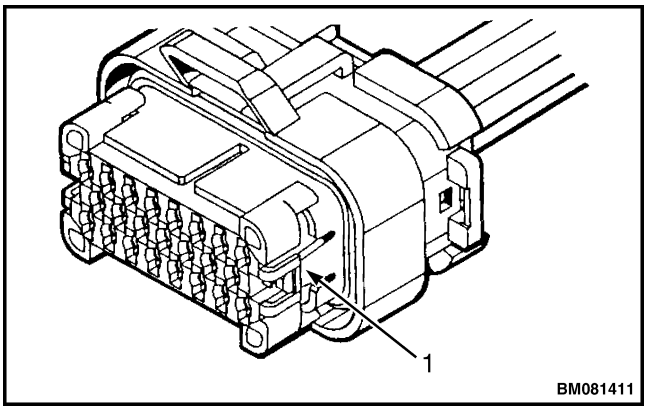


STEP 3.
Pull back on contact wire with 4 to 9 N•m (1 to 2 lbf) to be sure the retention fingers are holding the contact.



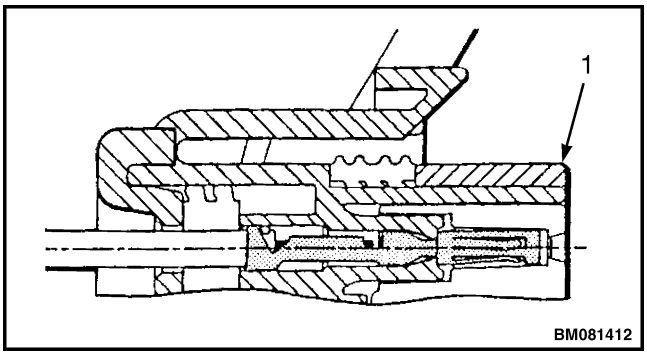
1. RETENTION FINGERS

STEP 4.
After all required contacts have been inserted, the wedge lock must be closed to the LOCKED position. Release the locking latches by squeezing them inward.



1. LOCKING LATCHES

STEP 5.
Slide the wedge lock into the housing until it is flush with the housing.



1. WEDGE LOCK

AMP Superseal 1.5 Crimping Tools

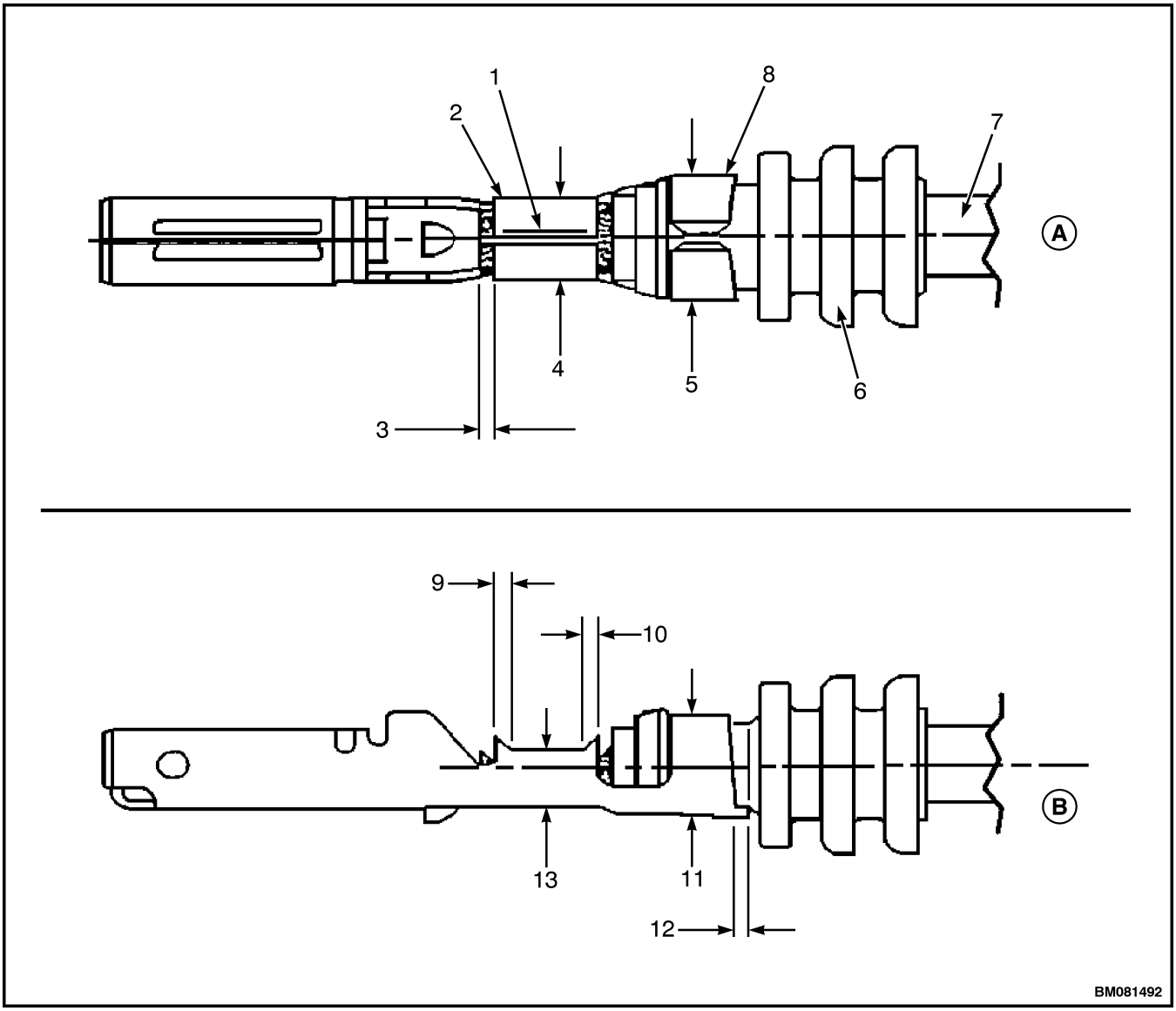
MINI MIC RECEPTACLE AND TAB CONTACTS

Description

Contacts are for 16-22 AWG wire, with single wire seals. Each wire is inserted into a discrete wire seal before crimping into contact. Insulation barrel is crimped so wire seal is gripped to avoid any movement of seal. Contacts are suitable for single wires only.

Crimping Conditions and Measurements

1. Cut-off tab length = 0.3 mm (0.01 in.) max. See Figure 48.
2. Front bellmouth = 0.10 mm (0.004 in.) × 45° max. See Figure 48.
3. Rear bellmouth = 0.25 mm (0.009 in.) × 45° max. See Figure 48.
4. Bend up = 5° max. See Figure 50.
5. Bend down = 5° max. See Figure 50.
6. Bend right = 5° max. See Figure 49.
7. Bend left = 5° max. See Figure 49.
8. Rolling = 5° max. See Figure 49.
9. Cable end protrusion = 0.2 to 0.7 mm (0.008 to 0.03 in.). See Figure 48.
10. Insulation stripping length = 3.0 to 3.5 mm (0.12 to 0.14 in.).
11. Wire barrel seam must be neatly closed. See Figure 48.



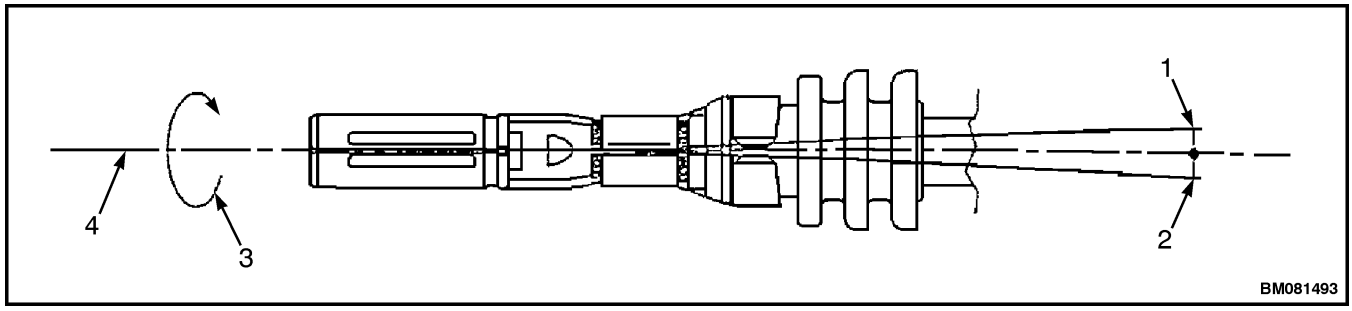
A. TOP VIEW

1. WIRE BARREL SEAM
2. WIRE BARREL
3. CABLE END PROTRUSION LENGTH
4. WIRE BARREL CRIMP WIDTH
5. INSULATION BARREL CRIMP WIDTH
6. RUBBER SEAL
7. CABLE

B. SIDE VIEW

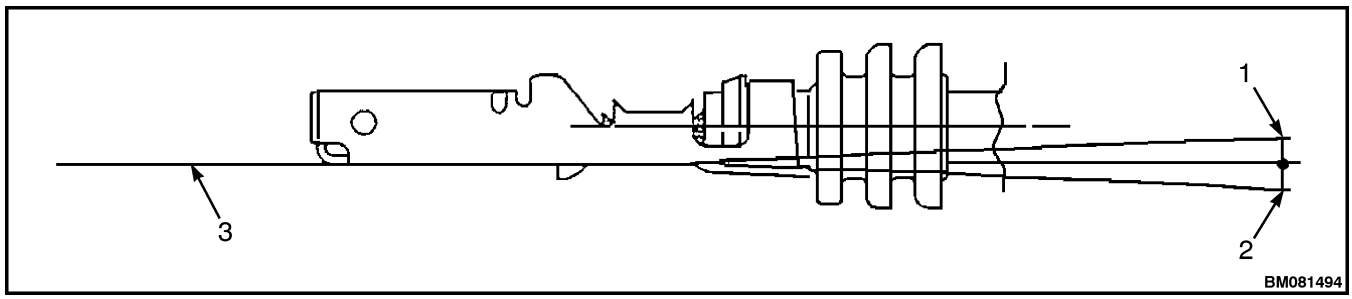
8. INSULATION BARREL
9. FRONT BELLMOUTH
10. REAR BELLMOUTH
11. INSULATION BARREL CRIMP HEIGHT
12. CUT-OFF TAB LENGTH
13. WIRE BARREL CRIMP HEIGHT

Figure 48. Crimping Conditions



1. BEND RIGHT
2. BEND LEFT
3. ROLLING
4. DATUM LINE

Figure 49. Crimping Conditions Bend Right/Left



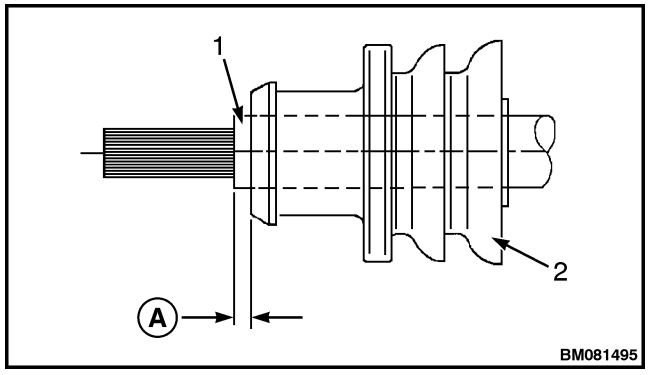
1. BEND UP
2. BEND DOWN
3. DATUM LINE

Figure 50. Crimping Conditions Bend Up/Down

Insertion of Rubber Seal on Cable

NOTE: Rubber seals are lubricated, lubrication must not be removed.

The end of cable insulation to be positioned from edge of rubber seal when rubber seal is installed on cable. See Figure 51.



A. 0.5 mm (0.02 in.)MAX

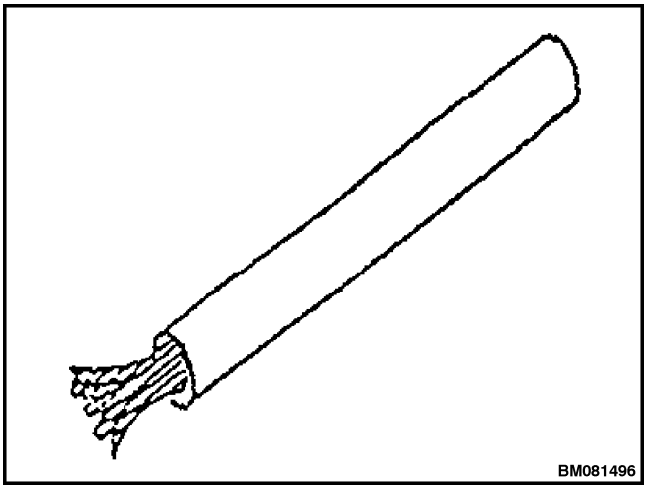
1. WIRE INSULATION 2. RUBBER SEAL

Figure 51. Rubber Seal Installed on Cable

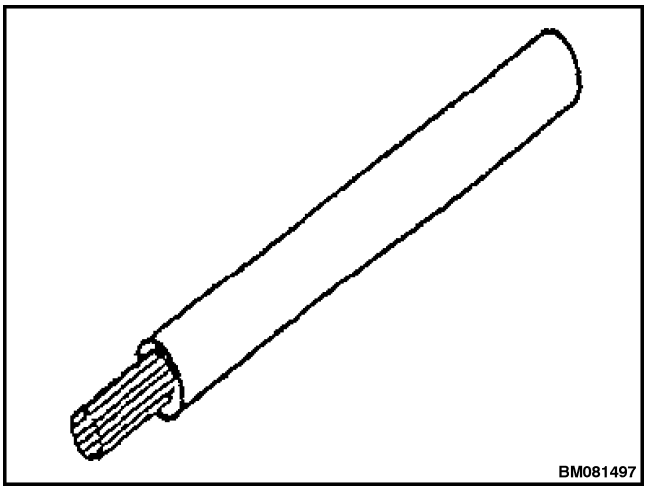
Correction or Replacement of Parts

STEP 1.
When defects or improper applications are found on parts to be installed, rework or replace with new parts.

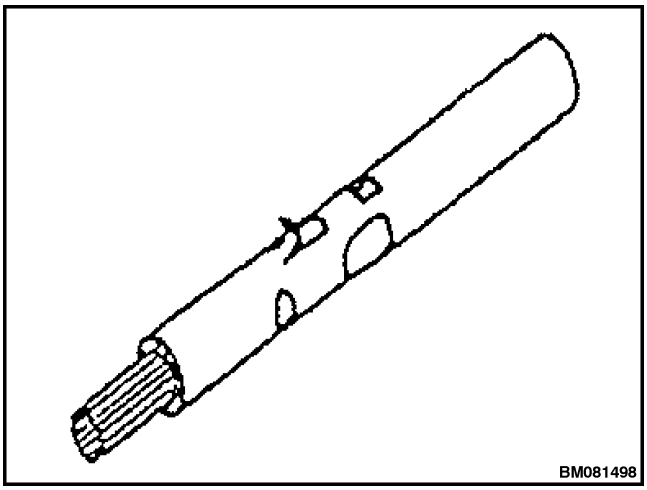
STEP 2.
Cut end of wire shall appear neat without any bend or stranded conductor.



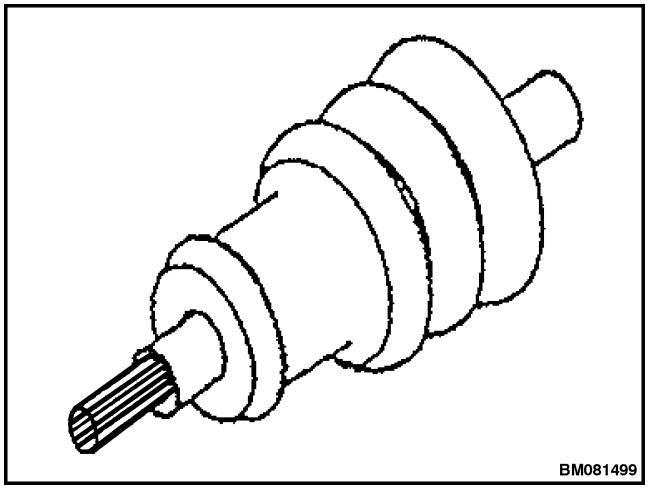
STEP 3.
Conductor shall be free from nick, cut or scrape.



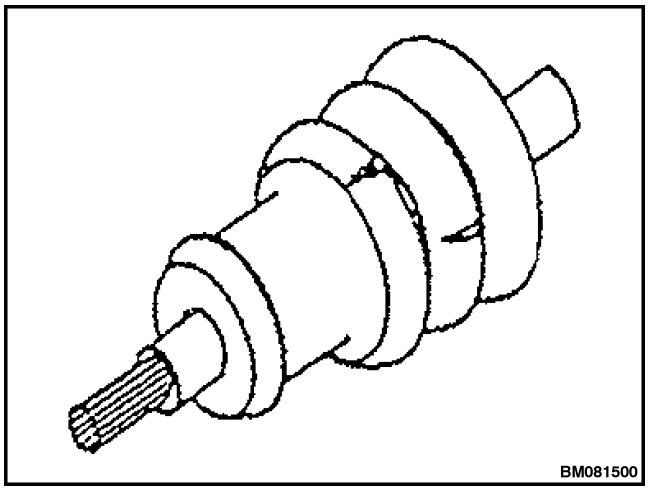
STEP 4.
Wire insulation must have smooth surface in a round form without damage, groove, or recessed surface.



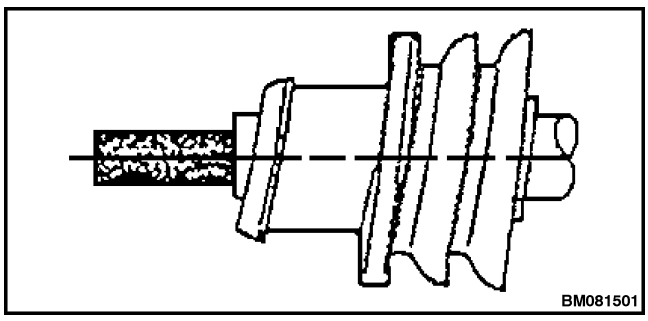
STEP 5.
wire end shall be straight without bend or untidiness after insertion of rubber seal.



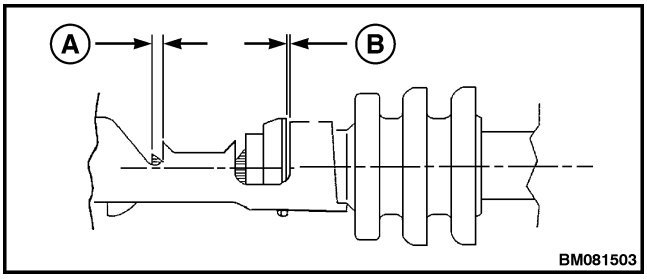
STEP 6.
Flanges of rubber seal to be free of cuts or damage.



STEP 7.
Insertion of rubber seal to be done straight and even. If flanges are tilted, plug must be corrected so flanges are perpendicular to contact center line.

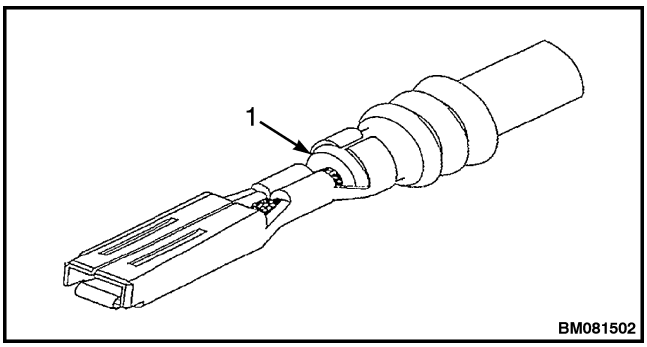


STEP 8.
After crimping, cable insulation inside rubber seal to be in good condition and within requirements as specified in Crimping Conditions and Measurements in this section.



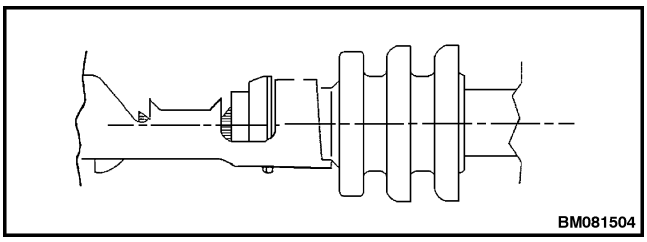
A. 0.2 TO 0.7 mm (0.008 TO 0.03 in.)
B. 0.2 mm (0.008 in.)

STEP 9.
Rubber seal must protrude from insulation crimp without damage. Check by visual inspection in the transition area (between wire and insulation barrel) as shown.

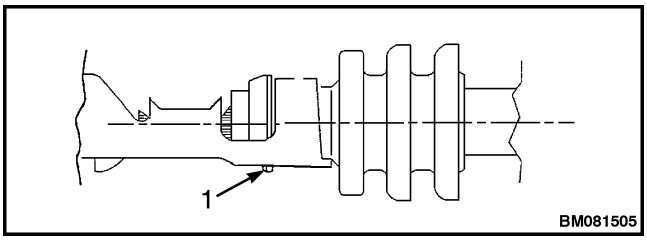


1. RUBBER SEAL

STEP 10.
No parts of insulation or rubber are allowed in the wire crimp, after crimping.

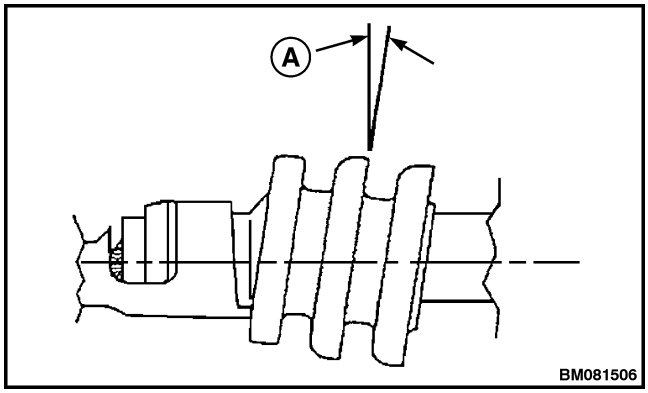


STEP 11.
Part of rubber seal must stick out of transition hole.



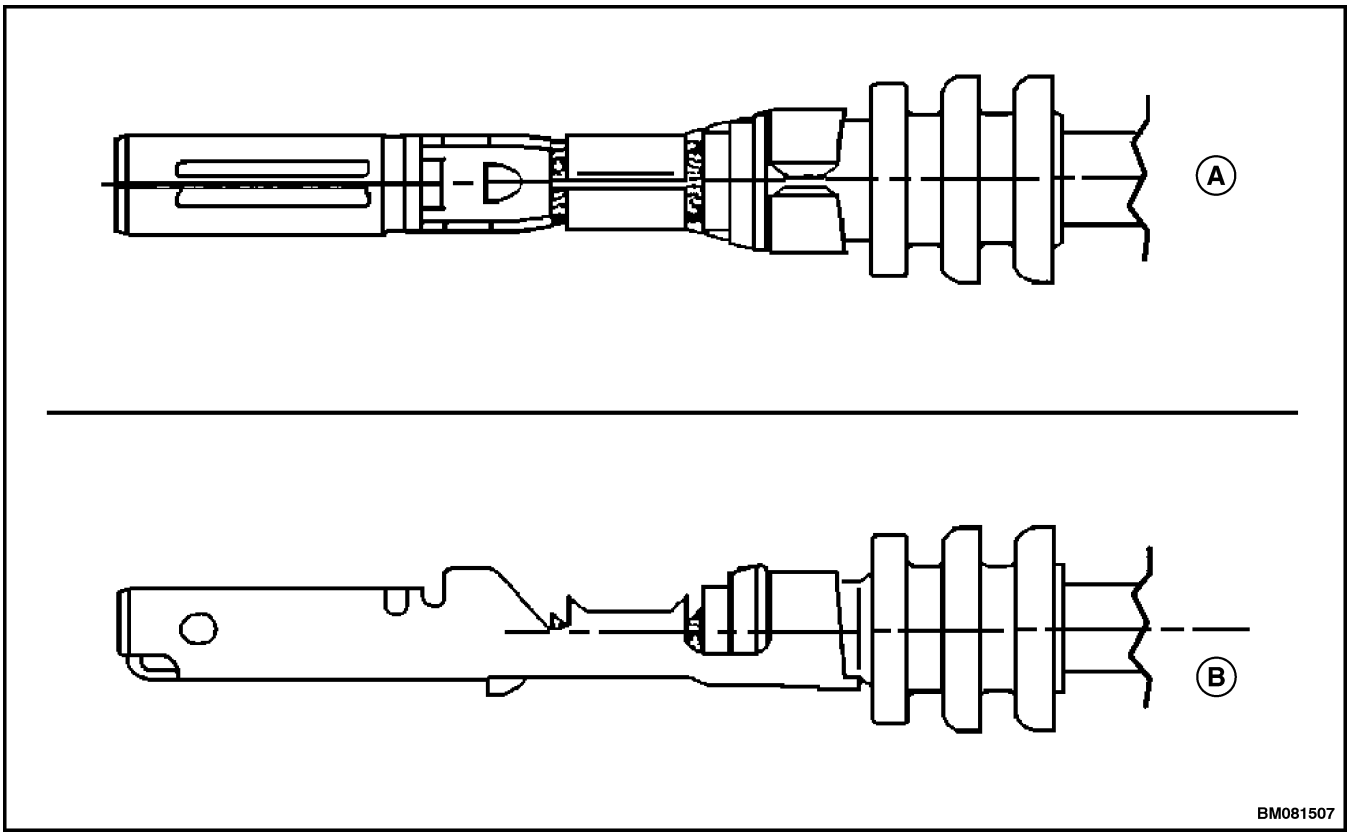
1. RUBBER SEAL

STEP 12.
Tilt shape of rubber seal is unacceptable.



A. 8° MAX

STEP 13.
Crimped contacts should appear as shown.



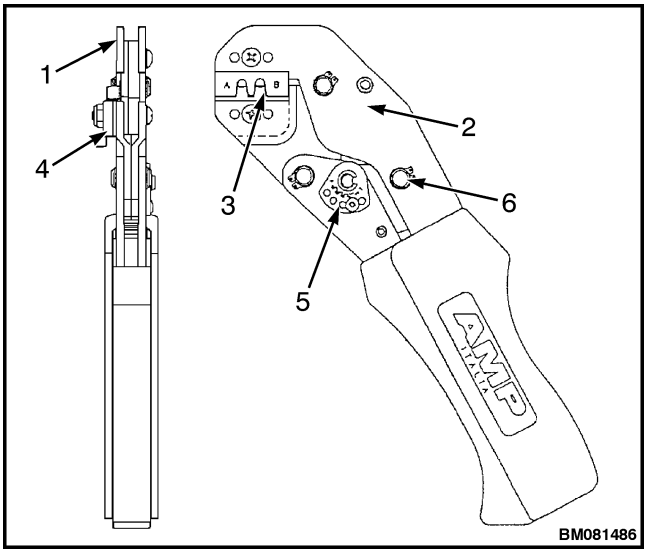
A. TOP VIEW

B. SIDE VIEW

AMP HAND APPLICATION TOOL

Description

This tool is designed for use with AMP Superseal 1.5 series contacts. The tool has two crimp sections, contact locator, wire stop, and ratchet. See Figure 52.



1. FRONT OF TOOL (LOCATOR SIDE)
2. BACK OF TOOL (WIRE SIDE)
3. DIE SET
4. MOVABLE LOCATOR
5. RATCHET ADJUSTMENT WHEEL
6. PIVOT PIN

Figure 52. AMP Hand Application Tool for AMP Superseal 1.5 Contacts

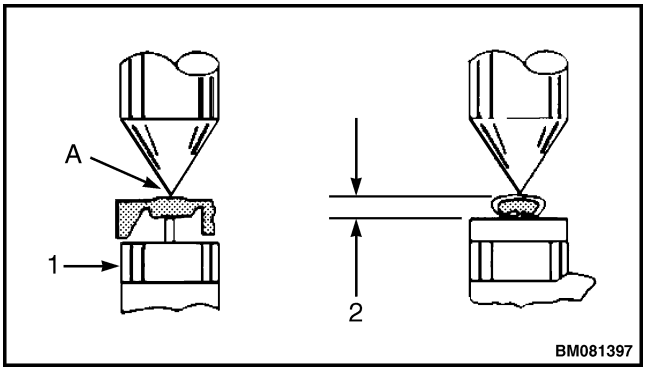
Maintenance and Inspection

1. Ensure tool and dies are clean by wiping with a clean, soft cloth. Remove any debris with clean, soft brush. DO NOT use objects that could damage tool. When not in use, keep handles closed to prevent debris from lodging in dies. Store in clean, dry area.

2. Crimping dies to be inspected on a regular basis for wear or damage. Inspect crimp sections for flattened, chipped, worn, or broken areas. Replace tool if damaged.

Crimp Height Inspection

1. This inspection requires the use of a micrometer with a modified anvil. See Figure 53.



A. POSITION POINT ON CENTER OF WIRE BARREL OPPOSITE SEAM.

1. MODIFIED ANVIL
2. CRIMP HEIGHT (SEE TABLE 8)

Figure 53. Crimp Height

2. Use Table 8 to select wire for crimp height inspection.

Table 8. Wire Strip Lengths

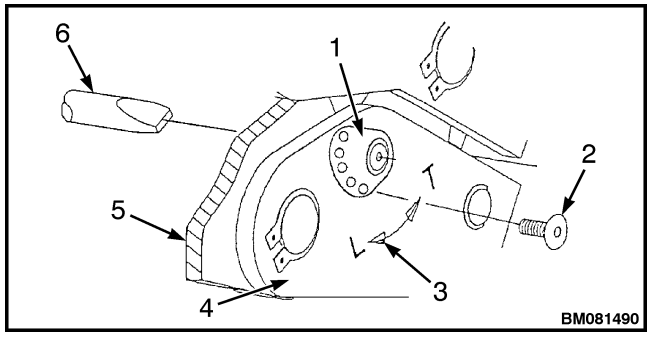
Wire Size (AWG)	Strip Length	Crimp Height ±0.05 mm (0.002 in.)
20	3.0 to 3.5 mm (0.12 to 0.13 in.)	1.12 mm (0.044 in.)
18	3.0 to 3.5 mm (0.12 to 0.13 in.)	1.30 mm (0.051 in.)
16	3.0 to 3.5 mm (0.12 to 0.13 in.)	1.45 mm (0.057 in.)

3. Crimp a contact onto the selected wire according to How to use AMP Hand Application Tool procedure.

4. Using crimp height comparator, measure wire barrel crimp height as shown in Figure 53. If crimp height matches that shown in Table 8, the tool is considered dimensionally correct. If not, follow Crimp Height Adjustment procedure.

Crimp Height Adjustment

1. Remove lockscrew from ratchet adjustment wheel. See Figure 54.



1. RATCHET ADJUSTMENT WHEEL
2. LOCKSCREW
3. LOOSEN-TIGHTEN
4. BACK OF TOOL
5. FRONT OF TOOL
6. SCREWDRIVER

Figure 54. Ratchet Wheel Adjustment

2. Using a screwdriver, adjust ratchet wheel from front of tool. See Figure 54.

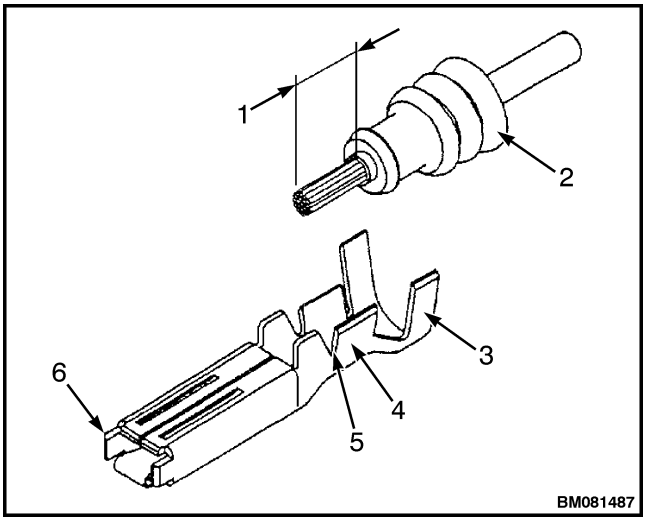
3. To tighten crimp, rotate ratchet adjustment wheel **COUNTERCLOCKWISE**. See Figure 54.

4. To loosen crimp, rotate ratchet adjustment wheel **CLOCKWISE**. See Figure 54.

5. Make a sample crimp and measure crimp height. If crimp height is acceptable, replace and tighten lockscrew. If crimp height is unacceptable, follow Step 3 or Step 4 until acceptable crimp height is achieved.

HOW TO USE AMP HAND APPLICATION TOOL

1. Strip insulation from wire. See Figure 55 and Table 9.



1. WIRE STRIP LENGTH
2. WIRE SEAL
3. INSULATION BARREL
4. WIRE BARREL
5. WIRE STOP SLOT
6. MATING END

Figure 55. Wire and Receptacle

Table 9. Wire Strip Lengths

Wire Size (AWG)	Insulation Diameter	Strip Length
20-16	1.7 to 2.4 mm (0.07 to 0.09 in.)	3.0 to 3.5 mm (0.12 to 0.13 in.)
22-20	1.7 to 2.4 mm (0.07 to 0.09 in.)	3.0 to 3.5 mm (0.12 to 0.13 in.)

2. Hold tool so **BACK** (wire side) faces you.

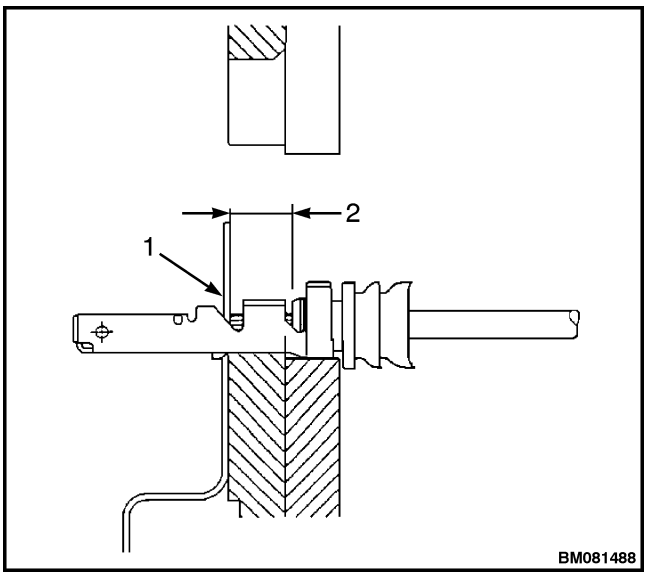
3. Release tool handles by squeezing them together then allowing them to open fully.

NOTE: Insert contact with open side of insulation and wire barrel toward movable crimping jaw.

4. Holding contact by insulation barrel, insert it through back of tool into appropriate crimp section, receptacle/tab end first.

NOTE: Ensure both sides of insulation barrel are started evenly into the crimper jaws. DO NOT attempt to crimp improperly positioned contacts.

5. Align contact wire stop slot with the wire stop in the crimping jaws. Contact insulation and wire barrels must be position in crimp section as shown in Figure 56.



1. WIRE INSERTED TO STOP
2. STRIP LENGTH (SEE TABLE 9)

Figure 56. Wire Stop Slot

6. Squeeze handles together until ratchet engages sufficiently to hold contact in position. DO NOT deform insulation or wire barrel.

7. Insert stripped wire into contact insulation and wire barrels until butted against wire stop. See Figure 56.

8. Holding wire in position, squeeze tool handles together until ratchet releases. Allow tool handles to open and remove crimped contact.

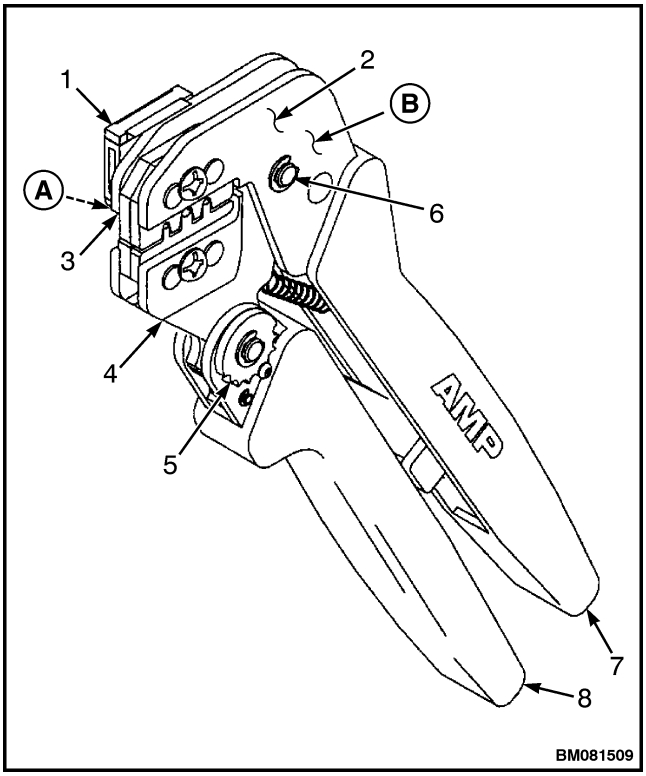
AMP PRO-CRIMPER II TOOL

Description

This tool has a tool frame with stationary jaw and handle, a moving jaw and handle, and an adjustable ratchet to endure full contact crimping. The tool frame contains a die assembly with three crimping sections.

The die assembly contains a wire anvil, an insulation anvil, a wire crimper and an insulation crimper. See Figure 57.

Die retaining pins and retaining screws are used to position and secure the dies in the tool frame. A nut is used on upper retaining screw to hold locator assembly in place. See Figure 57.



A. FRONT OF TOOL (LOCATOR SIDE)
B. BACK OF TOOL (WIRE SIDE)

1. LOCATOR ASSEMBLY
2. STATIONARY JAW
3. DIE ASSEMBLY
4. MOVING JAW
5. RATCHET ADJUSTMENT WHEEL
6. PIVOT PIN
7. STATIONARY HANDLE
8. MOVING HANDLE

Figure 57. AMP PRO-CRIMPER II Tool and Die

Remove and Install Die Set and Locator Assembly

1. Close tool handles until ratchet releases, remove the nut, locator assembly, upper retaining screw, lower retaining screw and four die retaining pins from tool frame. See Figure 58.

2. Slide wire anvil, insulation anvil, wire crimper, and insulation crimper out of tool frame. See Figure 58.

3. Install wire anvil and insulation anvil, with chamfered sides and marked surfaces facing outward, into moving jaw. See Figure 58.

4. Insert two die retaining pins. See Figure 58.

5. Insert lower retaining screw through moving jaw, insulation anvil, and wire anvil. Tighten lower retaining screw just enough to hold anvils in position. DO NOT tighten lower retaining screw completely. See Figure 58.

6. Install wire crimper and insulation crimper, with chamfered sides and marked surfaces facing outward, into stationary jaw. See Figure 58.

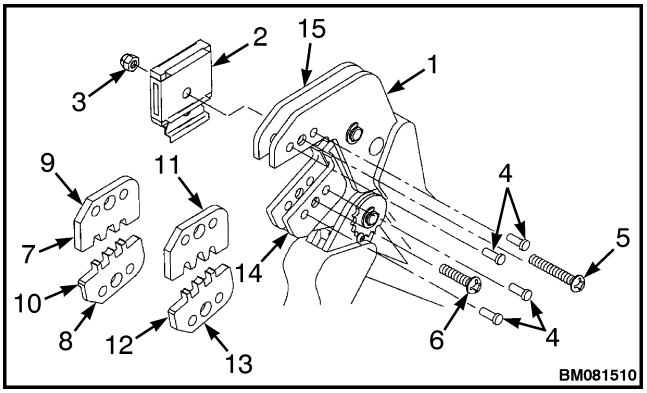
7. Insert two die retaining pins. See Figure 58.

8. Install upper die retaining screw through stationary jaw, insulation crimper, and wire crimper. Tighten upper retaining screw just enough to hold crimpers in position. DO NOT tighten upper retaining screw completely. See Figure 58.

9. Carefully close tool handles making sure anvils and crimpers align properly. Continue closing tool handles until ratchet in tool frame engages enough to hold anvils and crimpers in position. Tighten upper and lower retaining screws.

10. Install locator assembly over the end of upper retaining screw and position against tool frame. See Figure 58.

11. Install nut onto end of upper retaining screw and tighten enough to hold locator assembly in position while allowing locator to slide up and down. See Figure 58.



1. TOOL FRAME
2. LOCATOR ASSEMBLY
3. NUT
4. DIE RETAINING PIN
5. UPPER RETAINING SCREW
6. LOWER RETAINING SCREW
7. WIRE CRIMPER
8. WIRE ANVIL
9. CHAMFER
10. OFFSET
11. INSULATION CRIMPER
12. INSULATION ANVIL
13. CHAMFER
14. MOVING JAW
15. STATIONARY JAW

Figure 58. Die Set and Locator Assembly

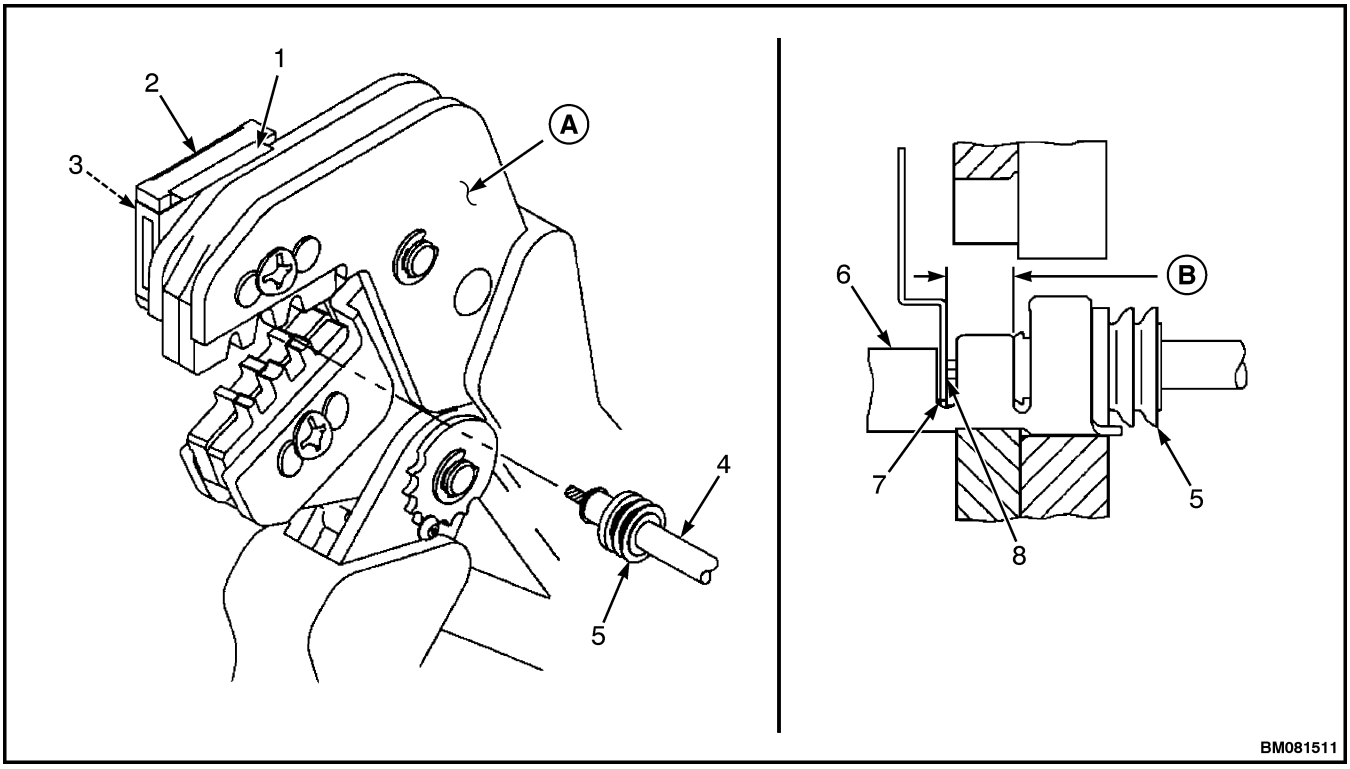
Adjustments

Contact Support

NOTE: Contact support is preset prior to shipment but minor adjustment may be necessary.

1. Make a sample crimp and determine if the contact is straight, bending upward, or bending downward.

2. If adjustment is required, loosen the adjustment screw holding contact support onto locator assembly. See Figure 59.



A. BACK OF TOOL

1. LOCATOR
2. CONTACT SUPPORT
3. ADJUSTMENT SCREW
4. WIRE

B. STRIP LENGTH

5. WIRE SEAL
6. CONTACT
7. LOCATOR IN WIRE STOP SLOT
8. WIRE INSERTED TO STOP

Figure 59. Contact Support and Wire Strip

NOTE: The ratchet has detents that create audible clicks as the tool handles are closed.

3. Position contact with wire in the proper nest and close the tool handles until the ratchet reaches the sixth click, or until the contact support touches the contact.

4. Slightly loosen the nut holding the locator assembly onto the tool frame.

5. Move the contact support as needed to eliminate the bending of the contact.

6. Tighten the nut and close the handles until the ratchet releases.

7. Remove and inspect the contact.

8. Make another sample crimp. If the contact is straight, tighten the adjustment screw. If the contact is still being bent during crimping, repeat adjustment procedure.

Crimp Height

1. Remove lockscrew from ratchet adjustment wheel. See Figure 60.

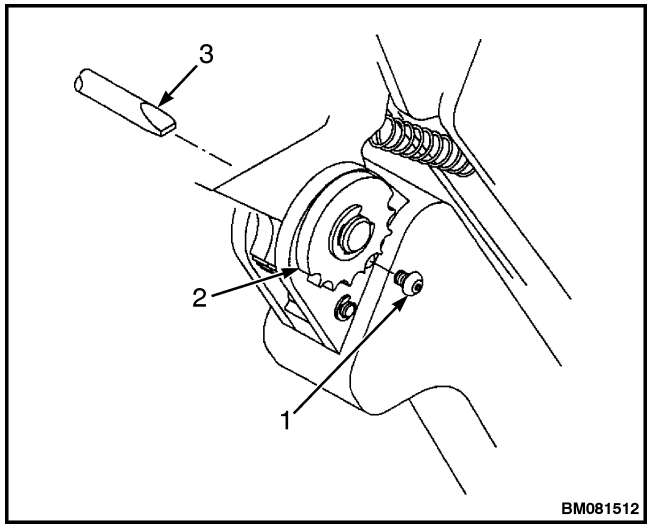
2. Using a screwdriver, adjust the ratchet wheel from locator side of tool. See Figure 60. Observe ratchet adjustment wheel.

3. If a tighter crimp is required, rotate ratchet adjustment wheel **COUNTERCLOCKWISE** to a higher-numbered setting.

4. If a looser crimp is required, rotate ratchet adjustment wheel **CLOCKWISE** to a lower-numbered setting.

5. Replace lockscrew. See Figure 60.

6. Make a sample crimp and measure the crimp height as specified in Crimp Height Inspection section. If the dimension is acceptable, secure lockscrew. If the dimension is unacceptable, continue to adjust the ratchet and measure a sample crimp.



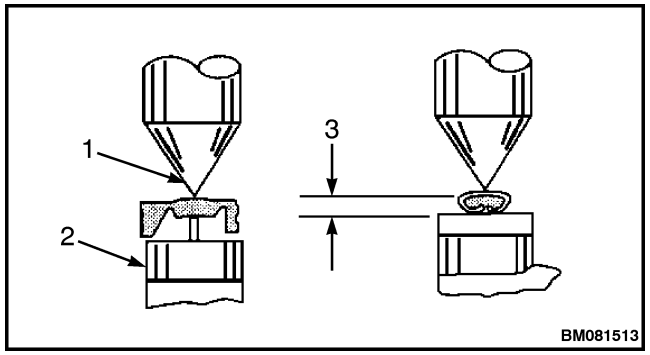
1. LOCKSCREW
2. RATCHET ADJUSTMENT WHEEL
3. SCREWDRIVER

Figure 60. Ratchet Adjustment Wheel

Inspections and Maintenance

Crimp Height Inspection

1. This inspection requires the use of a micrometer with a modifier anvil as shown in Figure 61



1. POSITION POINT ON CENTER OF WIRE BARREL OPPOSITE SEAM
2. MODIFIED ANVIL
3. CRIMP HEIGHT (SEE TABLE 10)

Figure 61. Crimp Height

2. See Table 10 and select a wire (maximum size) for each crimping chamber listed.

Table 10. Crimp Height - Dimension "3" in Figure 61

Wire Size AWG	Crimping Chamber (Wire Size Marking)	Crimp Height ± 0.05 mm (0.002 in.)
20	20	1.12 mm (0.044 in.)
18	18	1.30 mm (0.051 in.)
16	16	1.45 mm (0.057 in.)

3. See How to Use AMP Pro-Crimper II Tool section and crimp contact accordingly.

4. Using crimp height comparator, measure the wire barrel crimp height as shown in Figure 61. If crimp height conforms to dimensions shown in Table 10 the tool is considered dimensionally correct. If not, the tool must be adjusted; see Crimp Height section.

Visual Inspection

The crimping dies should be inspected on a regular basis to ensure they have not become worn or damaged. Inspect the crimping chamfers for flattened, chipped, worn or broken areas. If damage or abnormal wear is present, replace tool.

Maintenance

1. Wipe tool and dies with clean, soft cloth. Remove any debris with a clean, soft brush. DO NOT use objects that could damage the tool. When not in use, keep handles closed to prevent debris from becoming lodged in the crimping dies, and store in a clean, dry area.

HOW TO USE PRO-CRIMPER II TOOL

NOTE: This tool is provided with a crimp adjustment feature. Initially the crimp height should be verified as stipulated in Crimp Height Inspection and Crimp Height Adjustment sections to verify height before using the tool to crimp desired contacts and wire sizes.

1. Using Table 9 select wire of specified size and insulation diameter. Assemble wire seal onto wire as specified in Mini Mic Receptacle and Tab Contact section.

2. Strip wire to the length indicated in Table 9 taking care not to nick or cut wire strands. Select contact and identify appropriate crimping chamber according to the wire size markings on the tool.

3. Hold tool so that the back (wire side) is facing you. Squeeze tool handles together and allow them to open fully.

4. Holding contact by mating end, insert the contact, insulation barrel first, through the front of the tool and into the appropriate crimping chamber.

5. Position the contact tho that the mating end of contact is on locator side of tool and the open "U" of the wire and insulation barrels face the top of the tool. Fit the contact into the nest so the movable locator drops into the slot in the contact. See Figure 59. Butt front end of wire barrel against movable locator.

NOTE: Make sure both sides of insulation barrel are started evenly into the crimping chamber. DO NOT attempt to crimp and improperly positioned contact.

6. Hold contact in position and squeeze the tool handles together until ratchet engages enough to hold contact in position. DO NOT deform insulation barrel or wire barrel.

7. Insert stripped wire, with wire seal, into insulation and wire barrels until it is butted against wire stop. See Figure 59.

NOTE: The crimped contact may stick in the crimping area, but the contact can be easily removed by pushing downward on the top of the locator. See Figure 59.

8. Holding wire in position, squeeze tool handles together until ratchet releases. Allow tool handles to open and remove crimped contact.

9. Check contact crimp height as described in Crimp Height Inspection section. If necessary, adjust the crimp height as specified in Crimp Height section.

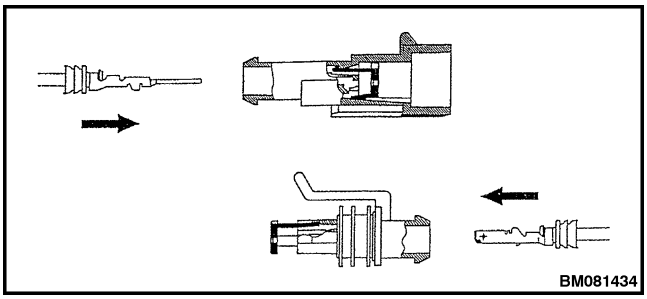
AMP Superseal 1.5 Connector Assemblies

DESCRIPTION

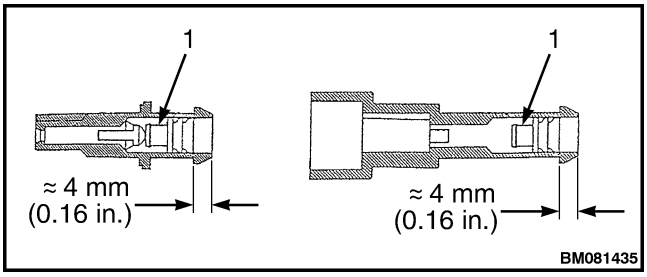
The AMP Superseal 1.5 connectors are designed to meet the performance requirements in the automotive field. The following information is intended as a general guide for the best use of the connectors for wire harnesses and their maintenance.

Harness Assembly

STEP 1.
Contacts can only be inserted into housing cavities in one position. The correct placing is shown. After insertion of a contact, pull back lightly on the wire to check that the contact is securely locked in position.



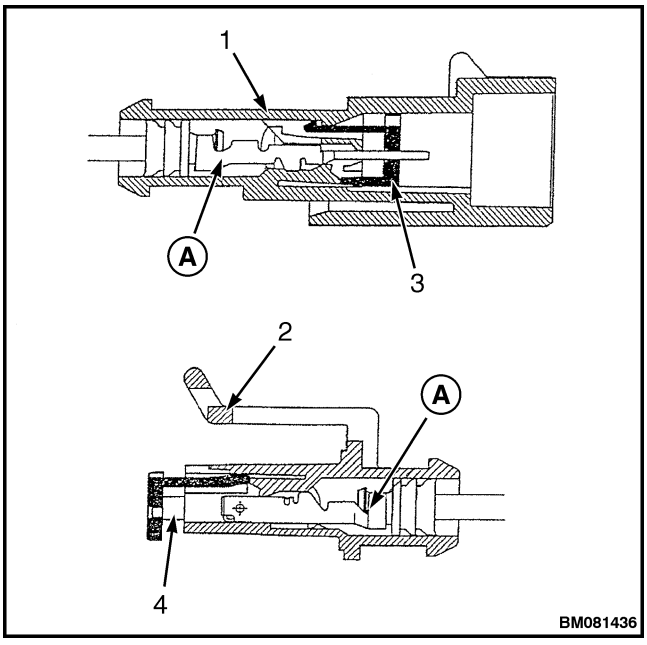
STEP 2.
Cavity plug, Hyster P/N 2069381 , must be used when a cavity is not loaded with a contact. This prevents the ingress of water. Insert cavity plug deeply into the cavity by means of a pin as shown. If necessary, the cavity plug can be removed by a pin point.



1. CAVITY PLUG

Positioning of Anti-Backout Device

STEP 1.
These connectors are supplied with an anti-backout device for both receptacle and tab housings. After loading all of the crimped contacts, these devices must be pushed into CLOSED position. If one contact is not properly seated in the cavity, the plastic locking lance remains deflected and the anti-backout device cannot be closed. This serves as a warning for the user. If the anti-backout device is not closed, the mating with a counterpart cannot be completed.

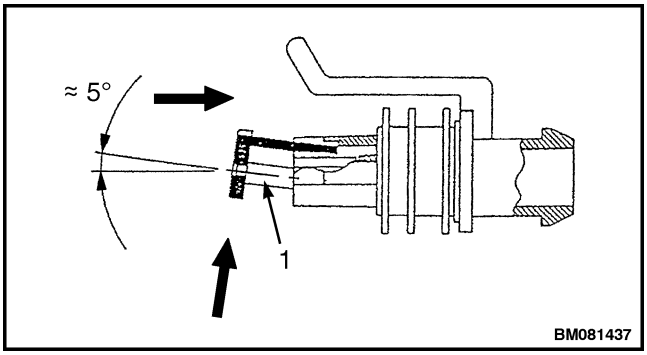


A. CONTACT NOT PROPERLY SEATED

1. TAB HOUSING
2. PLUG HOUSING
3. ANTI-BACK OUT DEVICE
4. ANTI-BACK OUT DEVICE

NOTE: Perform Step 2 for manually operated, position 2 to 6 plugs.

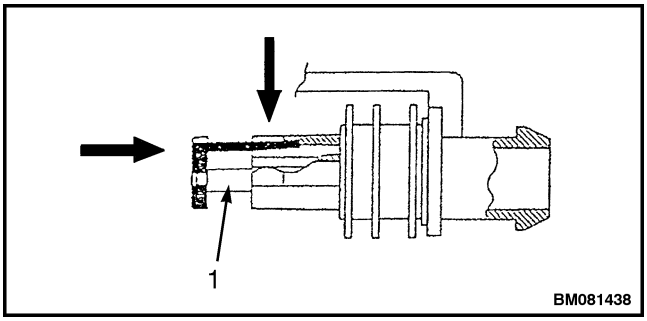
STEP 2.
Rotate the anti-back out device to deflect the central lances inward then push until the side arms lock.



1. ANTI-BACK OUT DEVICE

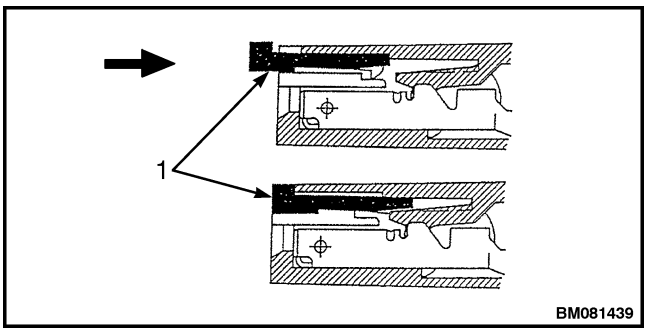
NOTE: Perform Step 3 for position 2 to 6 plugs inserted by a harness maker machine.

STEP 3.
Push the two lances for position 2 housing, the central lance for positions 3 and 5 housing, and the two central lances for positions 4 and 6 housing inward. Then push until the side arms lock.



1. ANTI-BACK OUT DEVICE

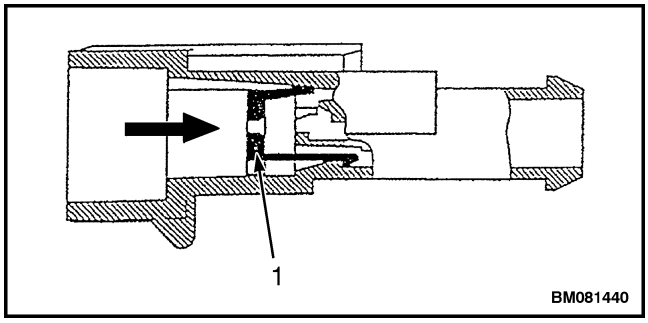
STEP 4.
For position 1, manually or machine operated, push the anti-backout device until its upper end is the same level as the housing mating face.



1. ANTI-BACK OUT DEVICE

NOTE: Different jigs are needed for position 1 and 2 housings and position 3 to 6 housings.

STEP 5.
To close the anti-backout device for tab housings, either manually or by machine, push the device in with a jig until it meets the stop.



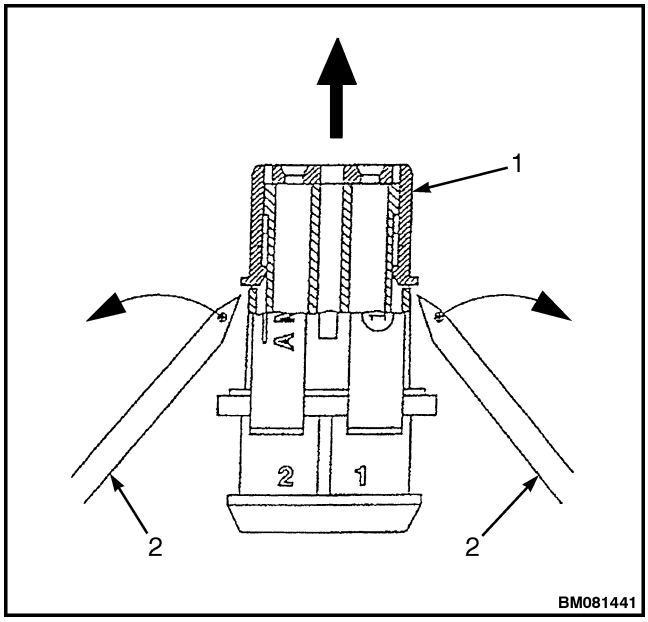
1. ANTI-BACK OUT DEVICE

Removal of Contacts

Since the locking lance of contacts can be reached from the mating side of the housings, it is necessary to remove the anti-backout device first.

NOTE: Perform Step 1 and Step 2 for removal of receptacle contact.

STEP 1.
Deflect the side arms of the anti-back out device and pull it away.

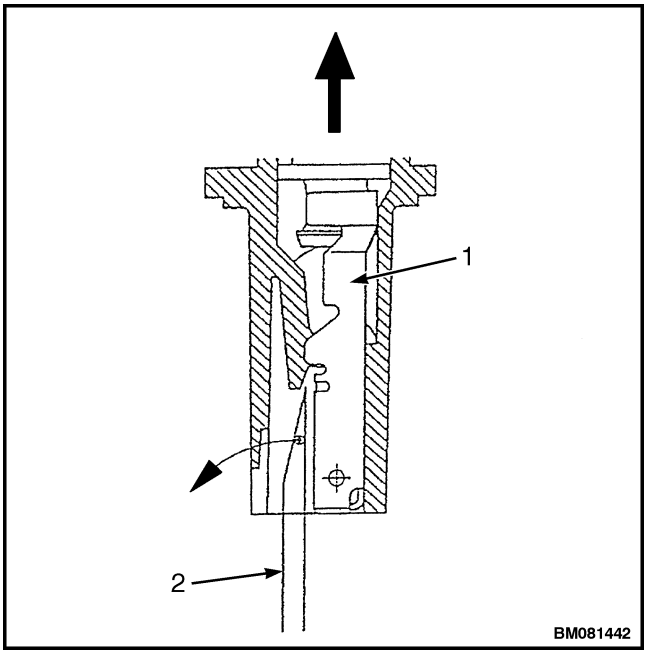


1. ANTI-BACK OUT DEVICE
2. EXTRACTION TOOL

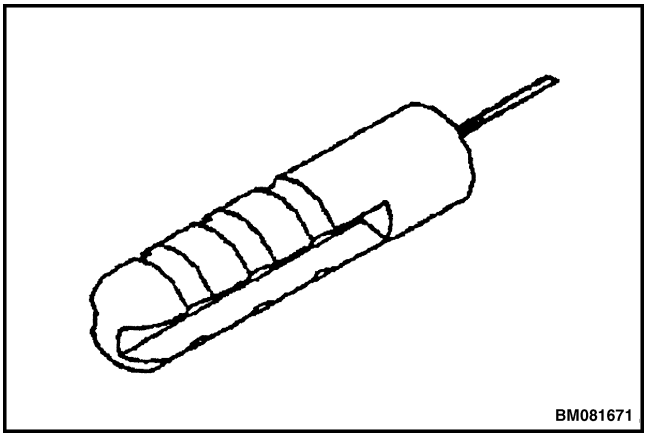
CAUTION

Be careful not to insert the extraction tool in the contacting area of the receptacle.

STEP 2.
Insert the contact extraction tool Hyster P/N 1698561 between contact and lance nose, then rotate slightly as shown. Pull the wire.

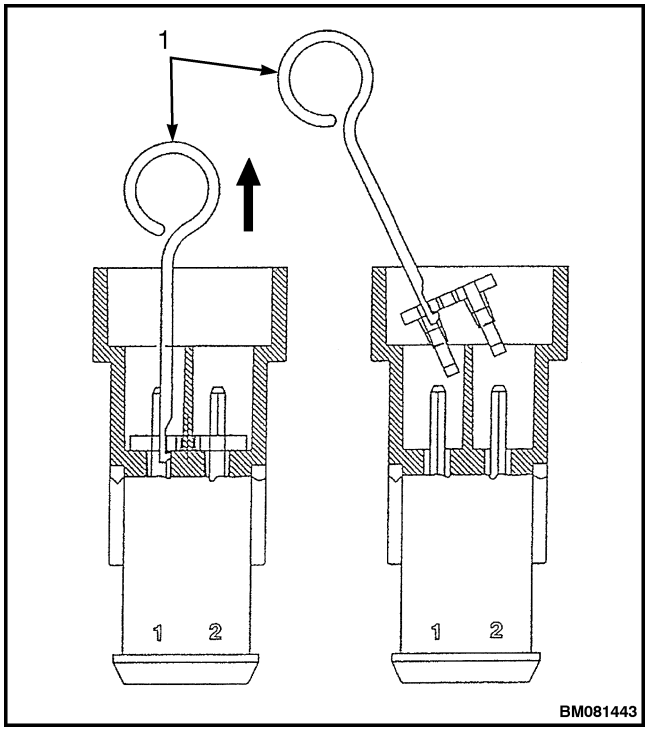


1. CONTACT
2. CONTACT EXTRACTION TOOL



NOTE: Perform Step 3 and Step 4 for removal of tab contact.

STEP 3.
Insert the extraction tool Hyster P/N 1698560 in one of the central holes of the anti-backout device and pull it away.



NOTE: Pull extraction tool in direction of arrow.

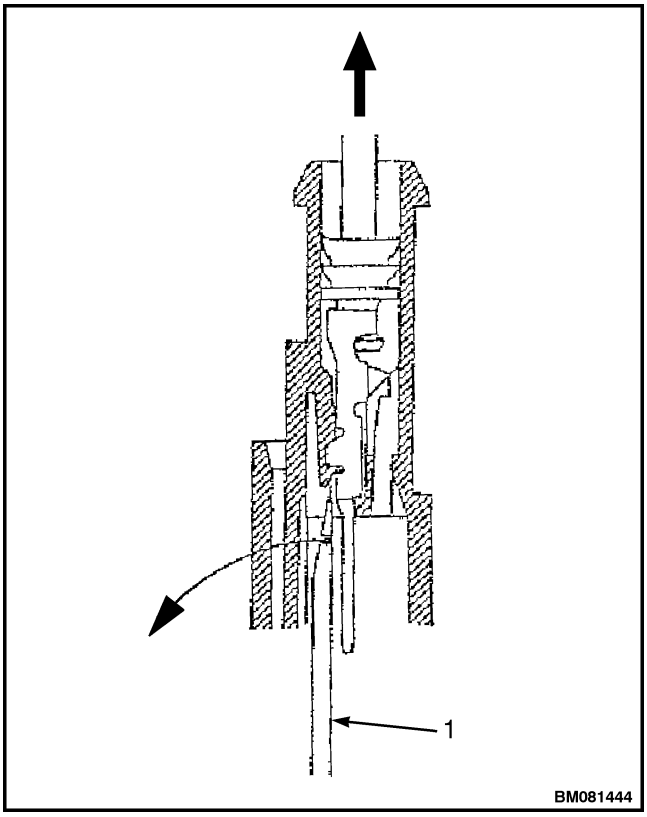
1. EXTRACTION TOOL

CAUTION

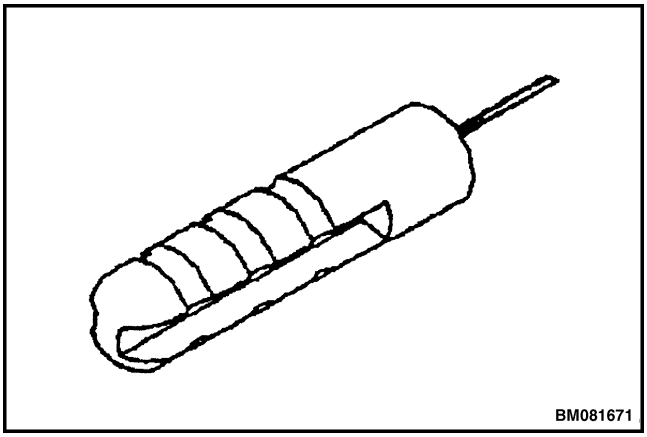
When rotating the extraction tool, be careful not to deform the tab.

STEP 4.

Insert the contact extraction tool Hyster P/N 1698561 between contact and lance note, then rotate slightly as shown. Pull the wire up as shown.



1. CONTACT EXTRACTION TOOL



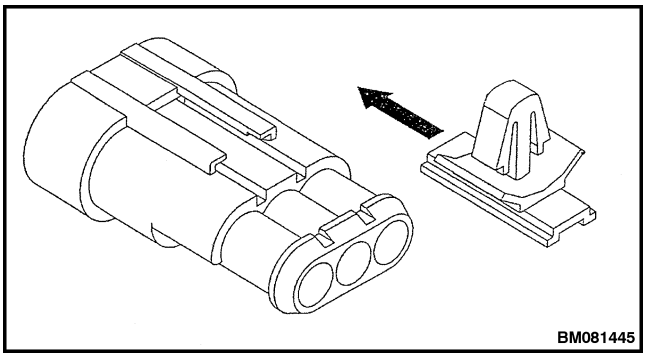
REPAIR AND MAINTENANCE

During repair and maintenance operation for wiring, replacement of contacts may be required. Following is the recommended procedure.

1. Cut the wire of the defective contact.
2. Strip the wire insulation to appropriate length.
3. Slide a new wire seal onto the wire.
4. Crimp the new contact on the wire using a hand crimping tool.

PANEL MOUNT OPTION

The tab housings come with two "L" shaped guides for the insertion of a special elastic clip, allowing panel mounting of the connector. The clip can be different shape according to the requirements. See example in Figure 62.



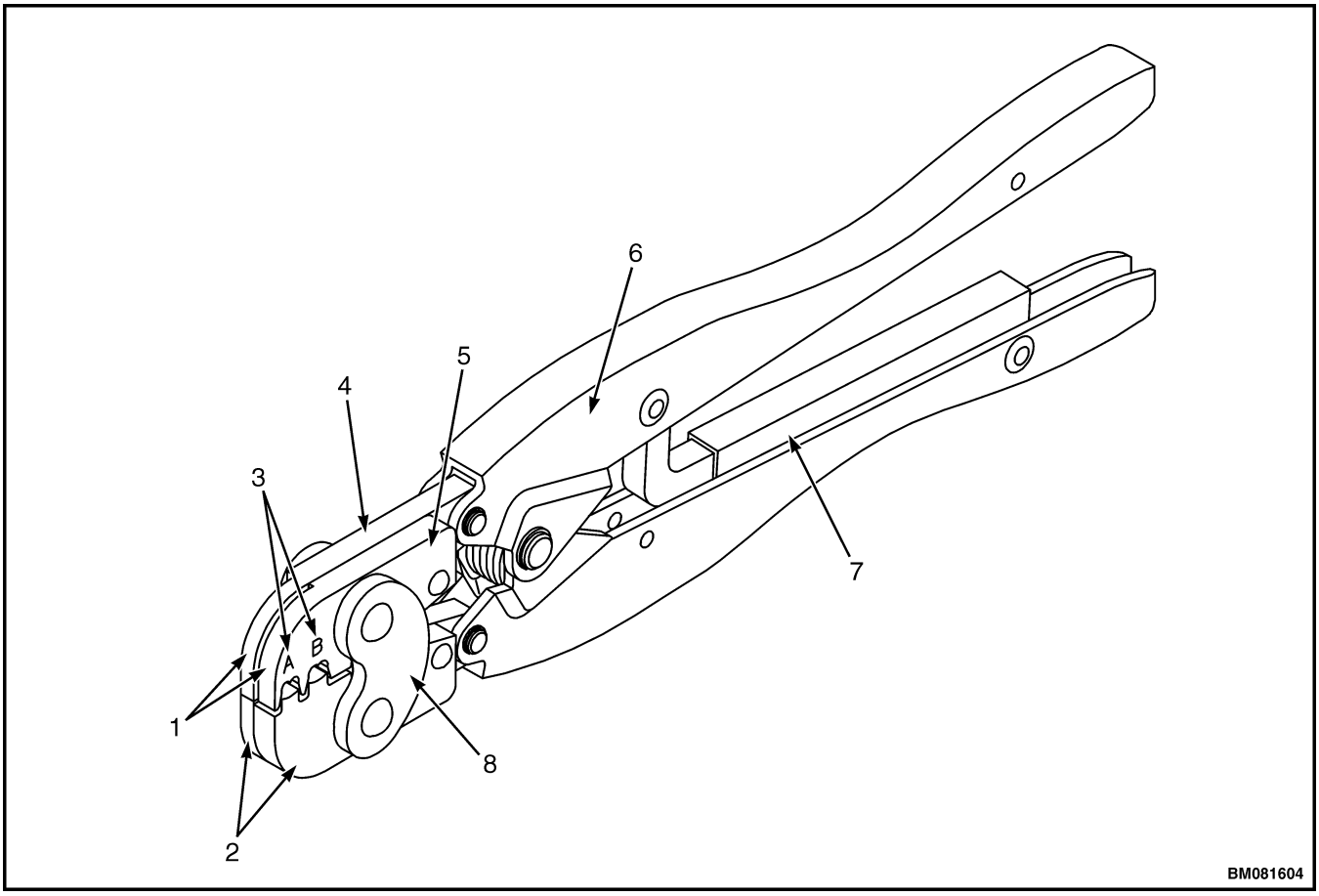
NOTE: SLIDE CLIP IN DIRECTION OF ARROW.

Figure 62. Panel Mount Clip Example

AMP Fastin-Faston Hand Tools

DESCRIPTION - AMP DOUBLE ACTION HAND TOOL

Hand-crimping tools that accommodate full wire size range are designed for repair applications. This tool is designed for use with AMP micro and mini relay receptacles. The tool has two crimping jaws, each consisting of an anvil and a crimper. When jaws are closed they form two crimping chambers, marked on **BACK** of tool as "A" and "B". Crimping jaws "bottom" before ratchet releases. This is a design feature to assure maximum electrical and tensile performance of crimp; DO NOT readjust ratchet. See Figure 63.



1. CRIMPER
2. ANVIL
3. CRIMPING CHAMBER MARKINGS
4. WIRE CRIMPING JAW
5. INSULATION CRIMPING JAWS
6. BACK OF TOOL
7. CERTI-CRIMP RATCHET
8. LINK

Figure 63. AMP Double Action Hand Tool

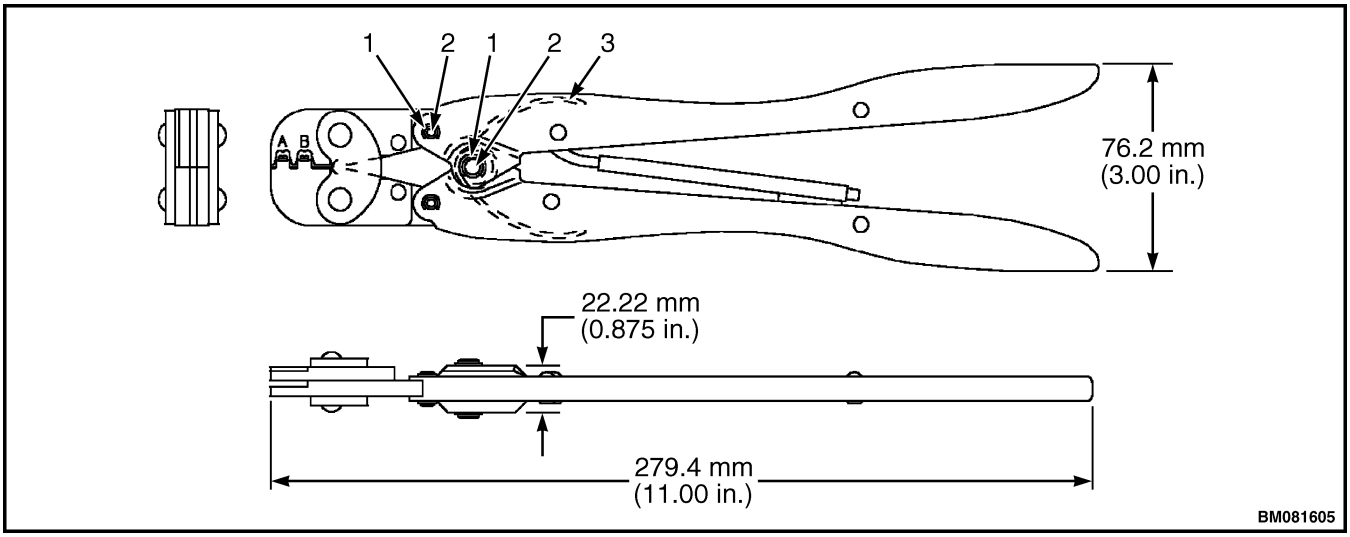
MAINTENANCE AND INSPECTION PROCEDURES

Daily Maintenance

1. Immerse tool, with handles partially closed, in reliable commercial de-greasing compound to remove accumulated debris. If de-greasing compound is not available, wipe tool with soft lint-free cloth. DO NOT use objects that could damage tool.

2. Ensure retaining pins are in place and secured with retaining rings. See Figure 64.

3. When not in use, keep handles closed to prevent debris from lodging in jaws. Store in clean dry area.



1. RETAINING RING
2. RETAINING PIN
3. HANDLE SPRING

Figure 64. Tool Inspection

Periodic Tool Inspection

Lubrication

1. Coat all pins, pivot points, and bearing surfaces with **thin** layer of SAE 20 motor oil per schedule below:

1 Tool used daily: lubricate weekly

2 Tool used weekly: lubricate monthly

2. Wipe excess oil from tool paying close attention to crimp area. Oil transferred from crimping area onto terminations can affect electrical characteristics of application.

Visual Inspection

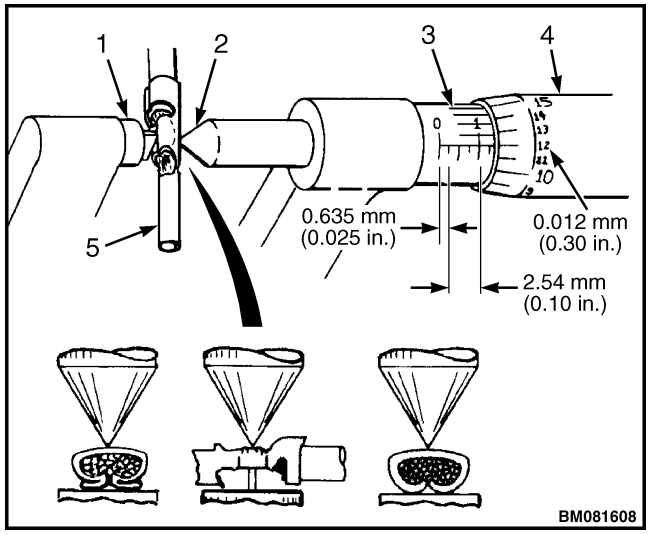
NOTE: Manufacturer's replacement and repair procedures included in documentation received with tool.

1. Close handles until ratchet releases and handles open freely. If handles DO NOT open quickly and fully, the spring is defective and must be replaced. See Figure 64. If spring is defective, follow manufacturers' replacement and repair procedures.

2. Inspect tool for worn, cracked, or broken jaws. If jaws are damaged follow manufacturers' replacement and repair procedures.

Crimp Height Inspection

1. This inspections requires the use of a modified micrometer with modified anvil and spindle. Modified micrometer to be used when crimp height is specified. See Figure 65.



NOTE: SAMPLE READING SHOWN IN ILLUSTRATION EQUALS 3.489 mm (0.1374 in.).

1. ANVIL
2. SPINDLE
3. STATIONARY HANDLE
4. MOVABLE HANDLE
5. TYPICAL CONTACT

Figure 65. Modified Micrometer

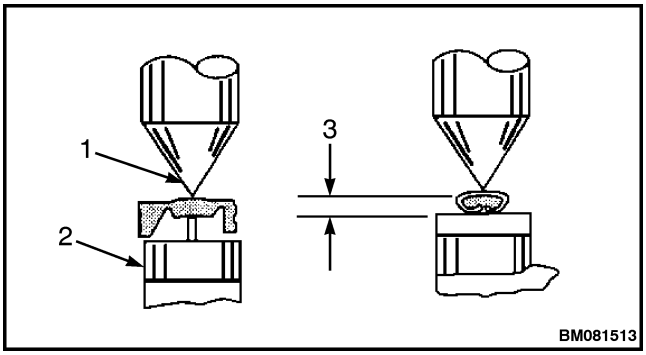
2. Use Table 11 to select **maximum** size wire for each crimping chamber.

Table 11. Wire Size and Crimp Height

Crimp Chamber	Wire Size (AWG)	Crimp Height
A	18-20	1.27 ±0.076 mm (0.05 ±0.003 in.)
B	14-16	1.65 ±0.076 mm (0.065 ±0.003 in.)

3. Crimp receptacle onto selected wire according to How to Use AMP Double Action Hand Tool procedure.

4. Using modified micrometer, measure wire barrel crimp height as shown in Figure 66. If crimp height matches measurement in Table 11, the tool is considered dimensionally correct. If not, follow manufacturers' replacement and repair procedure.



1. POSITION POINT ON CENTER OF WIRE BARREL OPPOSITE SEAM
2. MODIFIED ANVIL
3. CRIMP HEIGHT (SEE TABLE 11)

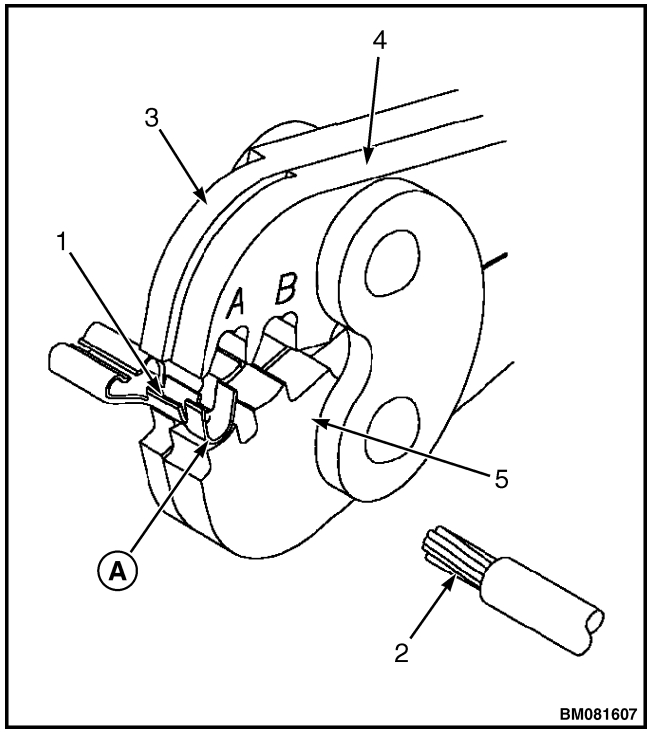
Figure 66. Crimp Height

Certi-Crimp Ratchet Inspection

The ratchet on this tool should be checked to ensure it does not release prematurely, allowing jaws to open before they have fully bottomed. Use a 0.025 mm (0.001 in.) shim suitable for checking clearance between bottoming surfaces of crimping jaws.

1. Select receptacle and **maximum** size wire for tool.

2. Position receptacle and wire between jaws as shown in Figure 67.



A. RECEPTACLE BARREL ALIGNMENT

1. RECEPTACLE CRIMPING BARREL
2. STRIPPED WIRE
3. WIRE CRIMPING JAW
4. INSULATION CRIMPING JAW
5. BACK SIDE OF TOOL

Figure 67. Crimp Alignment

3. While holding wire in position, squeeze tool handles together until ratchet releases. Hold handles in closed position.

4. Check clearance between bottoming surfaces of crimping jaws. If clearance is 0.025 mm (0.001 in.) or less, the ratchet is satisfactory. If clearance exceeds 0.025 mm (0.001 in.) follow manufacturers' replacement and repair procedure.

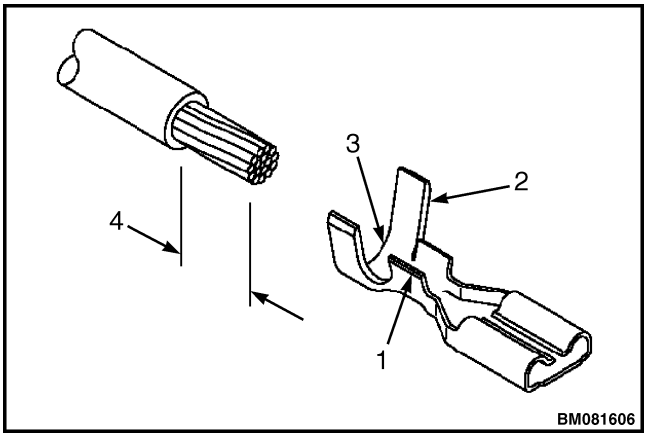
HOW TO USE AMP DOUBLE ACTION HAND TOOL

NOTE: Wire size and insulation diameter must be within specified range for receptacle. See Table 12.

1. Strip insulation from wire. See Table 12 and Figure 68.

Table 12. Wire Strip Length

Crimp Chamber	Wire Size (AWG)	Strip Length	Insulation Diameter
B	20-16	4.2 to 5.2 mm (0.16 to 0.20 in.)	2.2 to 3.1 mm (0.09 to 0.12 in.)
	18-14	5.1 to 6.1 mm (0.20 to 0.24 in.)	



1. WIRE BARREL
2. INSULATION BARREL
3. LOCATOR SLOT
4. WIRE STRIP LENGTH (SEE TABLE 12)

Figure 68. Wire and Receptacle

2. Hold tool so **BACK** side is facing you.

3. Release tool handles by squeezing them together until ratchet releases.

4. Insert receptacle barrel into crimping area as shown in Figure 67.

5. Squeeze tool handles together just enough to hold receptacle in place.

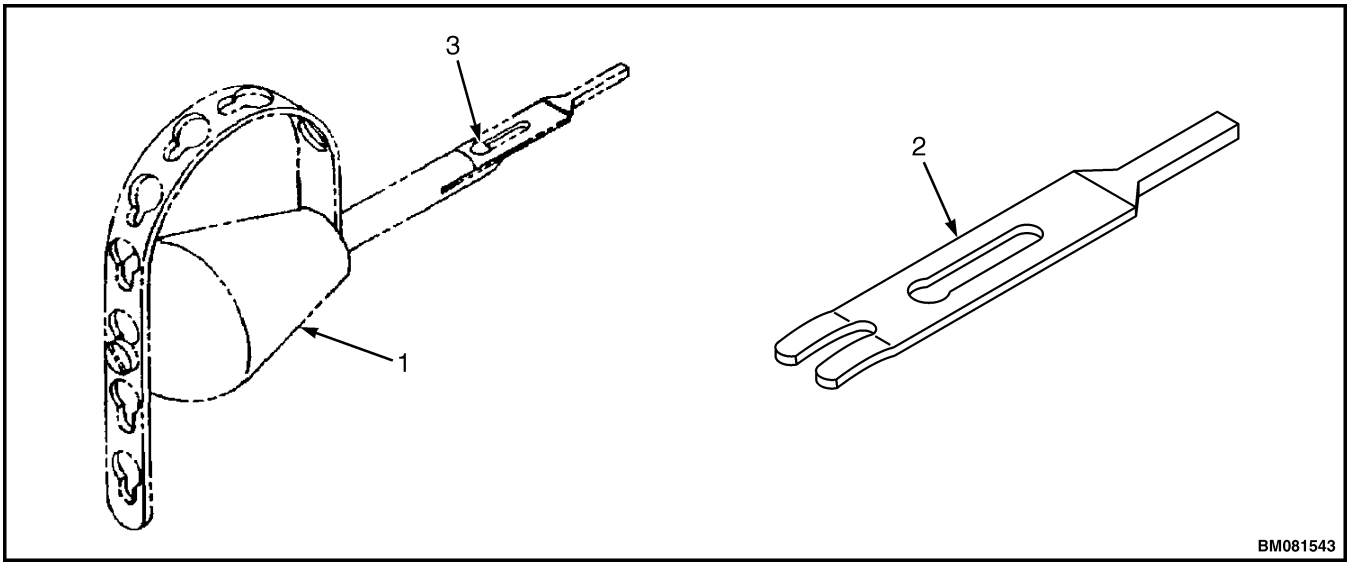
NOTE: Make sure insulation DOES NOT enter wire barrel.

6. Insert stripped wire into receptacle crimping barrel from **BACK** of tool.

7. While holding wire position, squeeze tool handles together until ratchet releases. Open tool handles and remove crimped receptacle.

DESCRIPTION - AMP EXTRACTION TOOL

Extraction tools are designed to release locking lance inside connector housing without damaging housing or connectors. The extraction tip is used with the universal handle as shown in Figure 69. Extraction tip, installed, is aligned with mating face of connector housing to depress locking lance of receptacle holding it in housing.

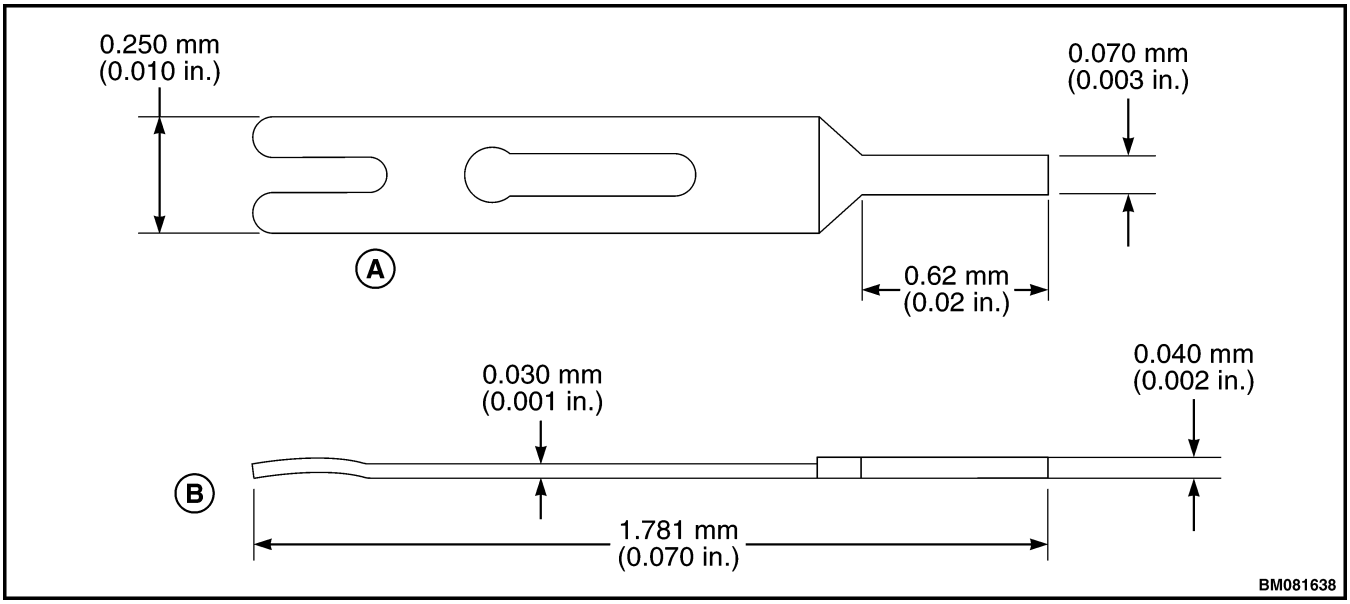


1. UNIVERSAL HANDLE 2. EXTRACTION TIP 3. DRIVE SCREW

Figure 69. AMP Extraction Tool With Tip

MAINTENANCE AND INSPECTION

For proper operation, tool to conform to measurements indicated in Figure 70. Inspections to be performed at regular intervals, refer to manufacturers data for specifics.



A. TOP VIEW B. SIDE VIEW

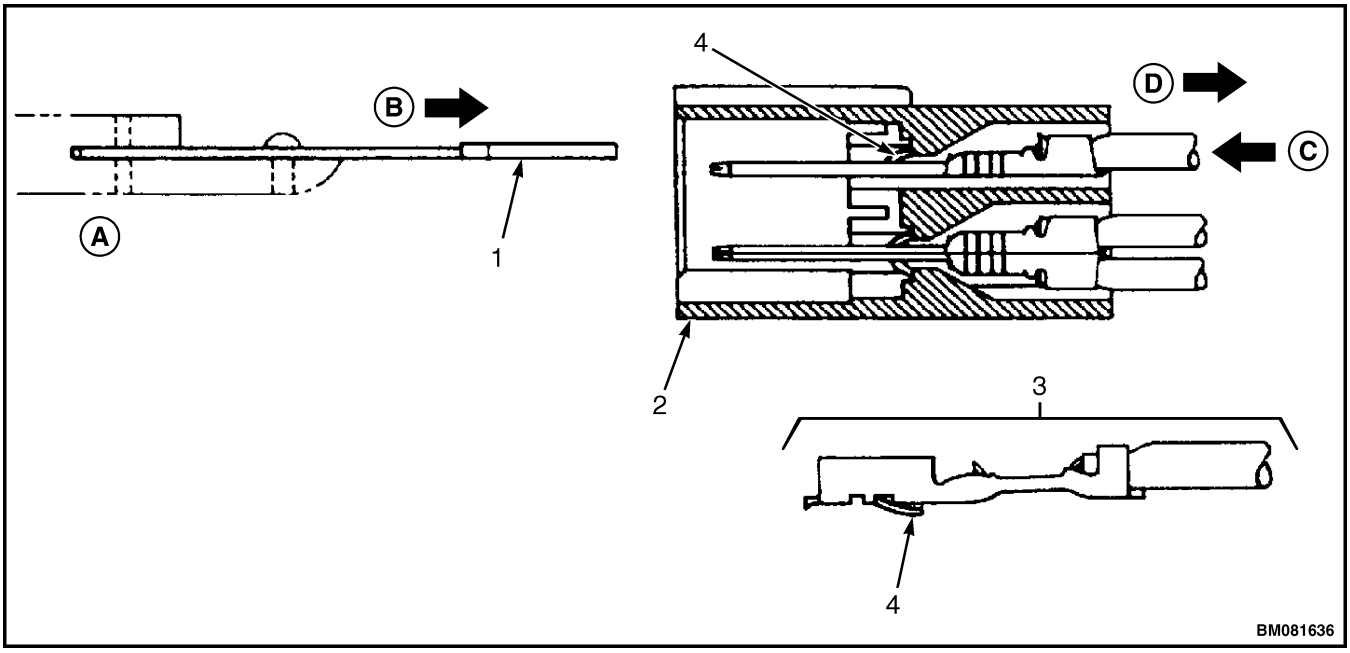
Figure 70. Tool Tip Inspection

Clean extraction tool with clean, soft, lint-free cloth and store in clean, dry place.

HOW TO USE AMP EXTRACTION TOOL

It is necessary to depress locking lance of receptacle from its cavity inside connector housing. Procedure below describes steps of extraction.

1. Orient extraction tool tip with mating face of connector. See view A of Figure 71.
2. Insert tip of extraction tool, aligned in center of housing cavity where locking lance is located. See view B of Figure 71.
3. Push wire from **BACK** of housing TOWARD tool and depress locking lance. See view C of Figure 71.
4. Pull **BACK** on wire and remove receptacle from housing. See view D of Figure 71.
5. Remove extraction tool from housing.



A. EXTRACTION TOOL ORIENTATION
B. TOOL TIP ALIGNMENT
C. WIRE DEPRESSIONS
D. RECEPTACLE REMOVAL

1. EXTRACTION TOOL
2. HOUSING
3. RECEPTACLE
4. LOCKING LANCE

Figure 71. Contact Extraction

AMP Fastin-Faston Receptacles and Housings

DESCRIPTION

This manual section covers FASTIN-FASTON receptacle installation. These connectors are the multiple circuit connectors use primarily as wire harness connectors.

CAUTION

DO NOT nick, scrape, or cut the wire conductor during the striping operation.

1. Install receptacles as specified in How to Use AMP Double Action Hand Tool. See Figure 72 for tool image.

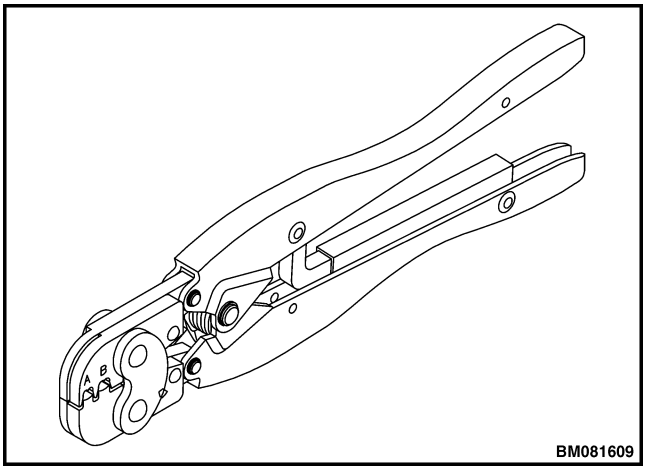
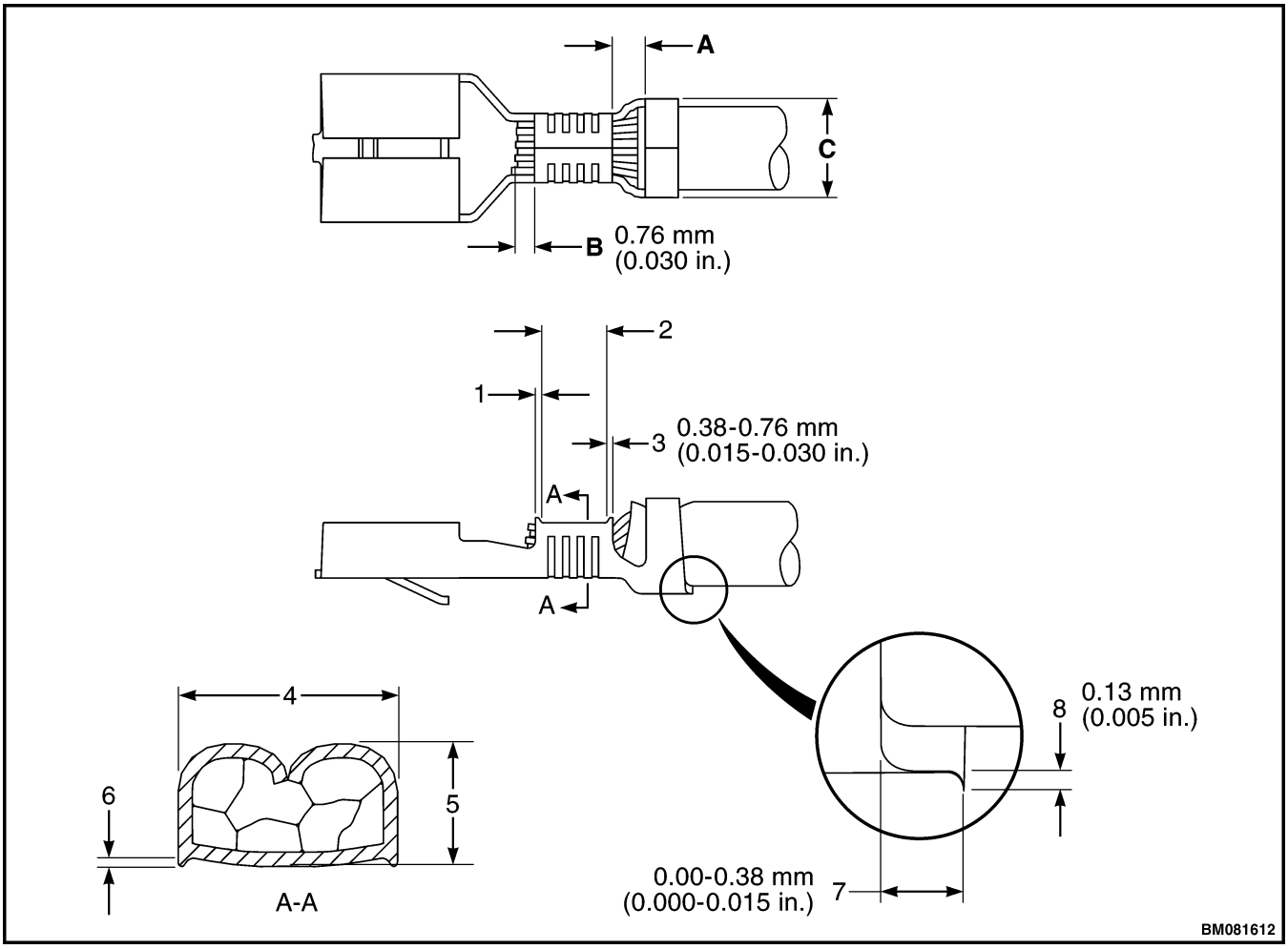


Figure 72. AMP Double Action Hand Tool

2. Receptacle contact should appear as shown in Figure 73.



A. WIRE CONDUCTORS AND INSULATION BOTH VISIBLE IN THIS AREA
B. CONDUCTOR VISIBLE
C. INSULATION BARREL CRIMP WIDTH

1. FRONT BELLMOUTH
2. CRIMP LENGTH
3. REAR BELLMOUTH
4. WIRE BARREL CRIMP WIDTH
5. WIRE BARREL CRIMP HEIGHT
6. WIRE BARREL FLASH
7. CUTOFF TAB
8. MAX BURR

Figure 73. Typical Crimped Receptacle

a. The most critical and compressed area is the crimp applied to the wire portion of the contact to ensure optimum electrical and mechanical performance of crimped receptacle. See Figure 74 and Table 13.

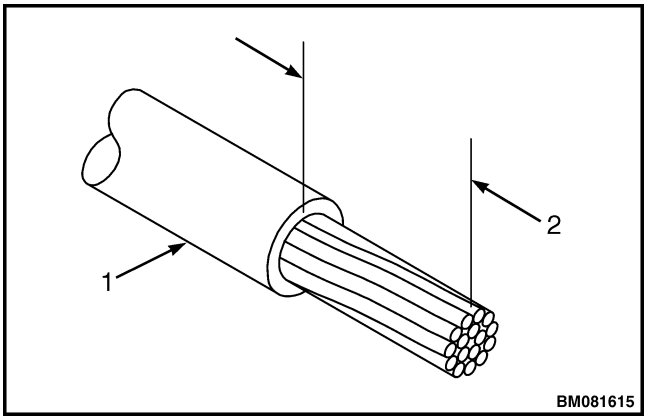


Figure 74. Wire Strip Length

Legend for Figure 74.

1. WIRE INSULATION
2. STRIP LENGTH (SEE TABLE 13)

Table 13. Wire Strip Length and Crimp Measurements

Wire Size (AWG)	Insulation Diameter	Strip Length	Wire Barrel		Insulation Barrel
			Crimp Width	Crimp Height	Crimp Width
20	1.52 to 2.54 mm (0.06 to 0.10 in.)	5.82 to 6.48 mm (0.229 to 0.255 in.)	2.24 to 2.34 mm (0.088 to 0.092 in.)	1.07 to 1.32 mm (0.042 to 0.052 in.)	2.49 to 2.59 mm (0.98 to 0.102 in.)
	2.16 to 3.18 mm (0.085 to 0.125 in.)				3.5 to 3.61 mm (0.138 to 0.142 in.)

Table 13. Wire Strip Length and Crimp Measurements (Continued)

Wire Size (AWG)	Insulation Diameter	Strip Length	Wire Barrel		Insulation Barrel
			Crimp Width	Crimp Height	Crimp Width
18	3.05 to 4.32 mm (0.120 to 0.170 in.)	6.23 to 6.48 mm (0.245 to 0.255 in.)	2.74 to 2.84 mm (0.108 to 0.112 in.)	1.5 to 1.6 mm (0.059 to 0.063 in.)	4.01 to 4.11 mm (0.158 to 0.162 in.)
	3.05 to 4.06 mm (0.120 to 0.160 in.)	5.41 to 5.66 mm (0.213 to 0.223 in.)			
	3.5 to 3.68 mm (0.120 to 0.145 in.)				
	2.54 to 4.42 mm (0.100 to 0.170 in.)			1.37 to 1.42 mm (0.054 to 0.058 in.)	4.52 to 4.62 mm (0.178 to 0.182 in.)
				1.47 to 1.57 mm (0.054 to 0.062 in.)	4.01 to 4.11 mm (0.158 to 0.162 in.)
	2.16 to 3.18 mm (0.085 to 0.125 in.)	6.22 to 6.48 mm (0.245 to 0.255 in.)	2.24 to 2.34 mm (0.088 to 0.092 in.)	1.35 to 1.45 mm (0.053 to 0.057 in.)	3.5 to 3.61 mm (0.138 to 0.142 in.)
		5.82 to 6.07 mm (0.229 to 0.239 in.)		1.17 to 1.27 mm (0.046 to 0.050 in.)	
	1.52 to 2.54 mm (0.060 to 0.100 in.)	6.22 to 6.48 mm (0.245 to 0.255 in.)		1.35 to 1.45 mm (0.053 to 0.057 in.)	2.49 to 2.59 mm (0.098 to 0.102 in.)
		5.82 to 6.07 mm (0.229 to 0.239 in.)		1.17 to 1.27 mm (0.046 to 0.050 in.)	
	2.2 to 4.44 mm (0.090 to 0.175 in.)	5.1 to 6.1 mm (0.200 to 0.240 in.)	2.74 to 2.84 mm (0.108 to 0.112 in.)	1.42 to 1.52 mm (0.056 to 0.060 in.)	4.52 to 4.62 mm (0.178 to 0.182 in.)

Table 13. Wire Strip Length and Crimp Measurements (Continued)

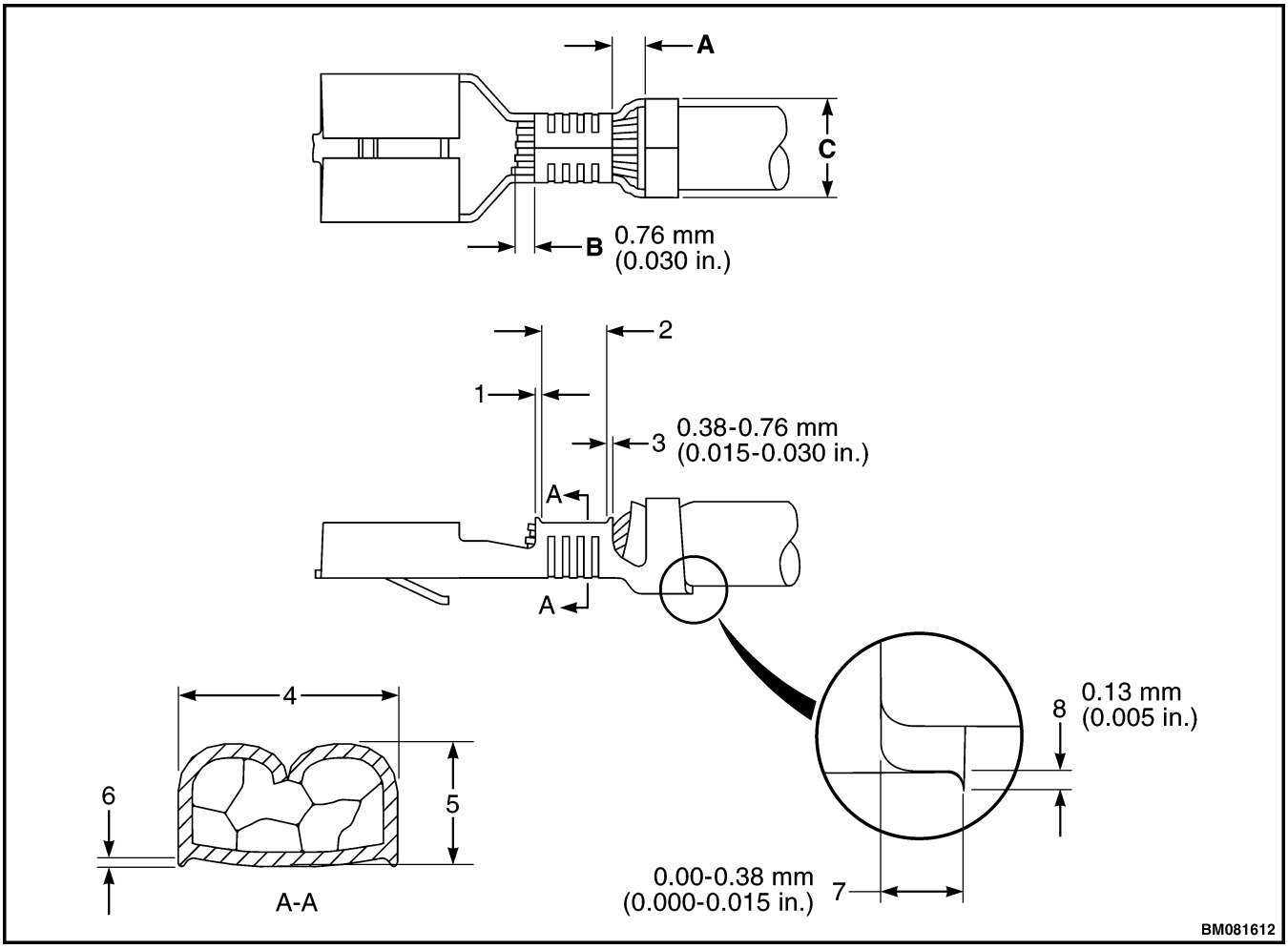
Wire Size (AWG)	Insulation Diameter	Strip Length	Wire Barrel		Insulation Barrel
			Crimp Width	Crimp Height	Crimp Width
16	4.06 to 5.33 mm (0.160 to 0.210 in.)	5.82 to 6.07 mm (0.229 to 0.239 in.)	3.0 to 3.11 mm (0.118 to 0.122 in.)	1.5 to 1.83 mm (0.059 to 0.072 in.)	6.3 to 6.4 mm (0.248 to 0.252 in.)
	3.81 to 4.83 mm (0.150 to 0.190 in.)			1.73 to 1.83 mm (0.068 to 0.072 in.)	5.28 to 5.38 mm (0.208 to 0.212 in.)
	3.3 mm (0.130 in.)MAX (2 Wires)			1.85 to 2.18 mm (0.073 to 0.086 in.)	6.3 to 6.4 mm (0.248 to 0.252 in.)
	3.05 to 4.32 mm (0.120 to 0.170 in.)	6.22 to 6.48 mm (0.245 to 0.255 in.)	2.74 to 2.84 mm (0.108 to 0.112 in.)	1.65 to 1.75 mm (0.065 to 0.069 in.)	4.01 to 4.11 mm (0.158 to 0.162 in.)
	3.05 to 4.06 mm (0.120 to 0.160 in.)	5.41 to 5.66 mm (0.213 to 0.223 in.)			
	3.05 to 3.68 mm (0.120 to 0.145 in.)				
	2.54 to 4.32 mm (0.100 to 0.170 in.)			1.32 to 1.42 mm (0.052 to 0.056 in.)	4.52 to 4.62 mm (0.178 to 0.182 in.)
				1.6 to 1.7 mm (0.063 to 0.067 in.)	4.01 to 4.11 mm (0.158 to 0.162 in.)
	2.2 to 4.44 mm (0.090 to 0.175 in.)	5.1 to 6.1 mm (0.200 to 0.240 in.)		1.57 to 1.68 mm (0.062 to 0.066 in.)	4.52 to 4.62 mm (0.178 to 0.182 in.)

Table 13. Wire Strip Length and Crimp Measurements (Continued)

Wire Size (AWG)	Insulation Diameter	Strip Length	Wire Barrel		Insulation Barrel
			Crimp Width	Crimp Height	Crimp Width
14	4.06 to 5.33 mm (0.106 to 0.210 in.)	6.22 to 6.45 mm (0.245 to 0.255 in.)	3.0 to 3.1 mm (0.118 to 0.122 in.)	1.7 to 2.03 mm (0.067 to 0.080 in.)	6.3 to 6.4 mm (0.248 to 0.252 in.)
	3.81 to 4.83 mm (0.150 to 0.190 in.)			1.93 to 2.03 mm (0.076 to 0.080 in.)	5.28 to 5.38 mm (0.208 to 0.212 in.)
	3.05 to 4.32 mm (0.120 to 0.170 in.)	7.01 to 7.26 mm (0.276 to 0.286 in.)	2.74 to 2.84 mm (0.108 to 0.112 in.)	1.88 to 1.98 mm (0.074 to 0.078 in.)	4.01 to 4.11 mm (0.158 to 0.162 in.)
		6.60 to 6.86 mm (0.260 to 0.270 in.)	3.25 to 3.35 mm (0.128 to 0.132 in.)	1.78 to 1.88 mm (0.070 to 0.074 in.)	4.52 to 4.62 mm (0.178 to 0.182 in.)
	3.05 to 4.06 mm (0.120 to 0.160 in.)	5.82 to 6.07 mm (0.229 to 0.239 in.)	2.74 to 2.84 mm (0.108 to 0.112 in.)	1.88 to 1.98 mm (0.074 to 0.078 in.)	4.01 to 4.62 mm (0.158 to 0.182 in.)
	3.05 to 3.68 mm (0.120 to 0.145 in.)				4.01 to 4.11 mm (0.158 to 0.162 in.)
	2.54 to 4.32 mm (0.100 to 0.170 in.)			1.55 to 1.65 mm (0.061 to 0.065 in.)	4.52 to 4.62 mm (0.178 to 0.182 in.)
				1.83 to 1.93 mm (0.072 to 0.076 in.)	4.01 to 4.11 mm (0.158 to 0.162 in.)
	2.2 to 4.44 mm (0.090 to 0.175 in.)	5.1 to 6.1 mm (0.201 to 0.240 in.)		1.8 to 1.9 mm (0.071 to 0.075 in.)	4.52 to 4.62 mm (0.178 to 0.182 in.)

b. Crimp length must be within dimensions indicated in Table 13.

c. Front and rear bellmouths to match images and dimensions shown in Figure 75.



A. WIRE CONDUCTORS AND INSULATION BOTH VISIBLE IN THIS AREA
B. CONDUCTOR VISIBLE
C. INSULATION BARREL CRIMP WIDTH

1. FRONT BELLMOUTH
2. CRIMP LENGTH (SEE TABLE 13)
3. REAR BELLMOUTH
4. WIRE BARREL CRIMP WIDTH (SEE TABLE 13)
5. WIRE BARREL CRIMP HEIGHT (SEE TABLE 13)
6. WIRE BARREL FLASH
7. CUTOFF TAB
8. MAX BURR

Figure 75. Typical Crimp - Fastin-Faston Receptacle

d. The cutoff tab to be cut as shown in Figure 75.

e. Max burr on cutoff tab shall not exceed dimensions indicated in enlarged view of Figure 75.

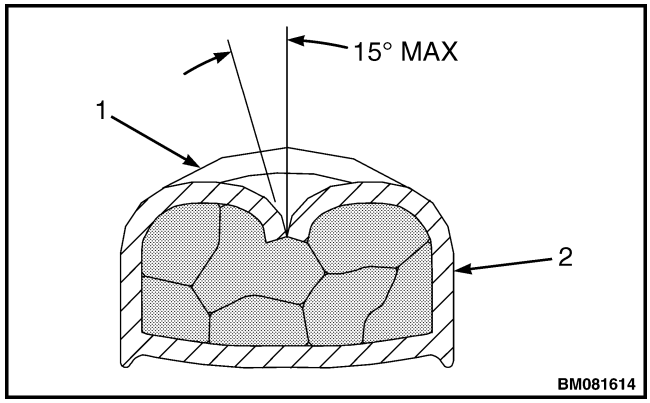
f. Acceptable dimensions for wire barrel flash shown in section A-A, Figure 75.

g. After crimping, wire conductor and insulation to be visible in areas shown in Figure 75.

h. Conductor may extend beyond wire barrel to maximum dimension shown in Figure 75.

i. Wire barrel seam to be closed, no loose wire strands visible.

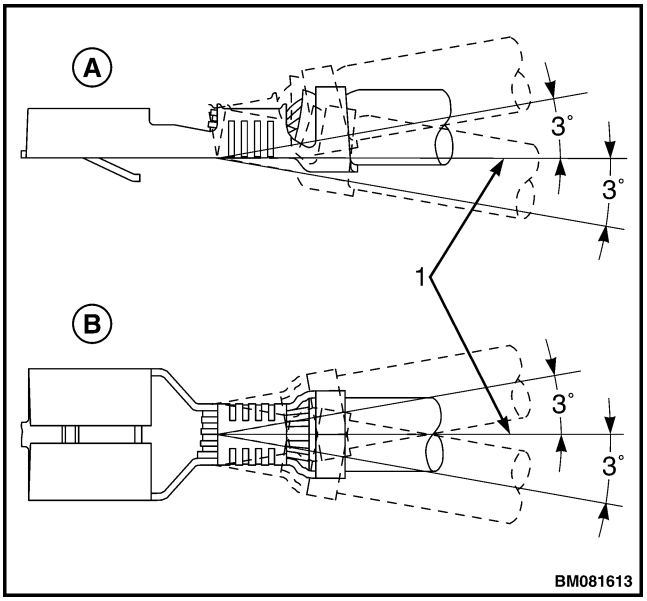
j. There shall be no twist, roll, deformation, or other damage to mating portion of crimped receptacle that will prevent proper mating. See Figure 76.



1. FRONT OF RECEPTACLE
2. WIRE BARREL

Figure 76. Mating Portion

k. Force applied during crimping can cause bending between the crimped wire barrel and mating portion of receptacle. Bending is acceptable within limits shown in Figure 77.



NOTE: ANGLES DRAWN FOR CLARIFICATION ONLY, NOT TO SCALE. ANGLES ARE **MAXIMUM** DISTANCE FROM DATUM LINE.

A. UP AND DOWN B. SIDE TO SIDE

1. DATUM LINE

Figure 77. Receptacle Bending Limits

3. Crimped receptacle should hold wire firmly and have a pull-test tensile value as specified in Table 14.

Table 14. Crimp Pull-Out Test

Wire Size (AWG)	Minimum Force	
	Newtons	Pounds
20	57.8	13
18	89.0	20
16	133.4	30
14	222.4	50

4. Damaged crimped receptacles or housings must be removed, discarded, and replaced with new components. See Figure 78 and Figure 79 for tools used during removal.

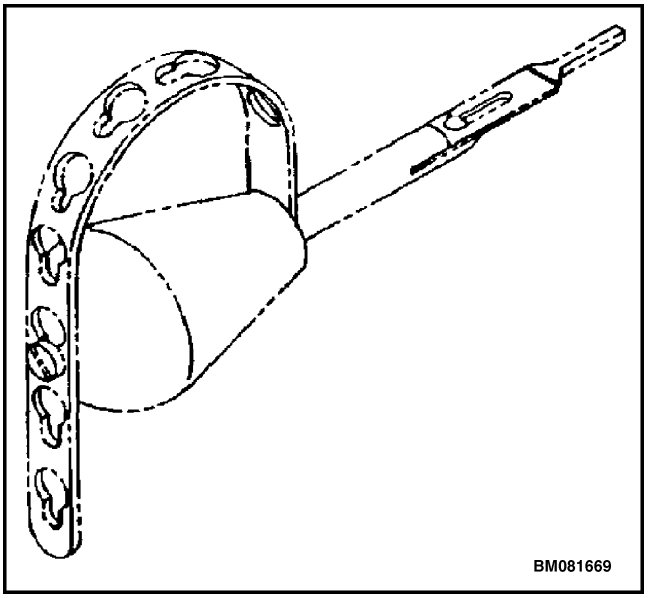


Figure 78. AMP Extraction Tool Universal Handle

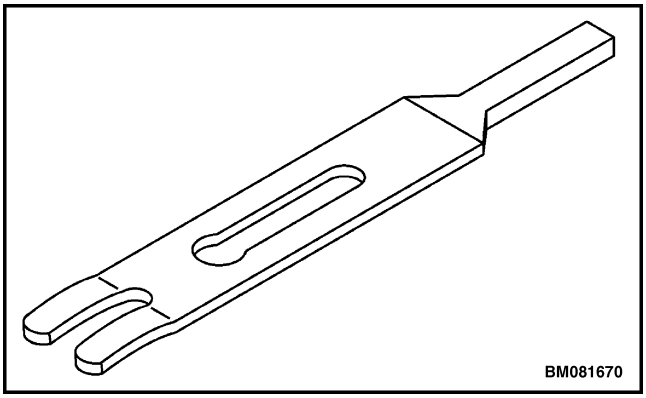


Figure 79. AMP Extraction Tool Tip

5. For procedure to remove receptacles for connector housings, see How to Use AMP Extraction Tool section.

Wire Repair

WIRE SPLICING REQUIREMENTS

Refer to the following for determining which procedure to use for wire repairs.

1. 8 Gauge or heavier wire - no splicing, replace full length of wire or replace harness.
2. Wires not meeting requirements of Step 3 through Step 5 - no splicing, replace full length of wire or replace harness.
3. 10 to 20 Gauge wire in area allowing use of a heat gun - repair using Del-City crimp-solder-shrink splice.
4. 12 to 14 Gauge wire in area allowing 12.7 mm (0.5 in.) diameter × 63.5 mm (2.5 in.) long splice - use Deutsch jiffy splice.
5. 14 to 20 Gauge wire in area allowing 9.78 mm (0.385 in.) diameter × 62.74 mm (2.47 in.) long splice - use Deutsch jiffy splice.

Table 15. Wire Strip Length Specifications

Contact Part Number	Type	Wire Gauge Range	Recommended Strip Length
1463136	Pin	20 AWG (0.5 mm^2)	3.96 to 5.54 mm (0.156 to 0.218 in.)
1463137	Socket	20 AWG (0.5 mm^2)	3.96 to 5.54 mm (0.156 to 0.218 in.)
1660396	Pin	20 AWG (0.5 mm^2)	4.0 to 5.5 mm (0.157 to 0.217 in.)
1330433	Pin	16 to 20 AWG (1.0 to 0.5 mm^2)	6.35 to 7.92 mm (0.250 to 0.312 in.)
1330434	Socket	16 to 20 AWG (1.0 to 0.5 mm^2)	6.35 to 7.92 mm (0.250 to 0.312 in.)

Table 15. Wire Strip Length Specifications (Continued)

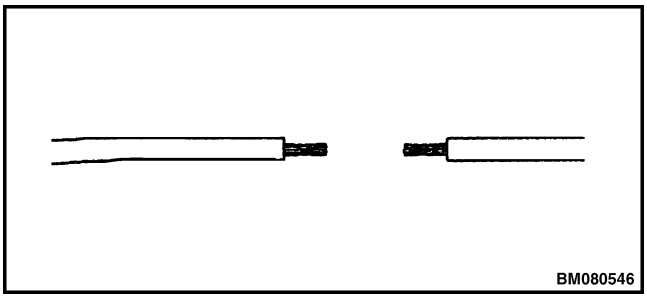
Contact Part Number	Type	Wire Gauge Range	Recommended Strip Length
1659638	Pin	16 to 20 AWG (1.0 to 0.5 mm^2)	6.4 to 7.9 mm (0.252 to 0.311 in.)
1579860	Socket	16 to 20 AWG (1.0 to 0.5 mm^2)	6.4 to 7.9 mm (0.252 to 0.311 in.)
1330435	Pin	14 AWG (2.0 mm^2)	6.35 to 7.92 mm (0.250 to 0.312 in.)
1330436	Socket	14 AWG (2.0 mm^2)	6.35 to 7.92 mm (0.250 to 0.312 in.)
1653804	Socket	14 AWG (2.0 mm^2)	6.4 to 7.9 mm (0.252 to 0.311 in.)
0866401	Pin	12 to 14 AWG (3.0 to 2.0 mm^2)	5.64 to 7.21 mm (0.222 to 0.284 in.)
1554359	Socket	12 to 14 AWG (3.0 to 2.0 mm^2)	5.64 to 7.21 mm (0.222 to 0.284 in.)

DEUTSCH JIFFY SPLICE

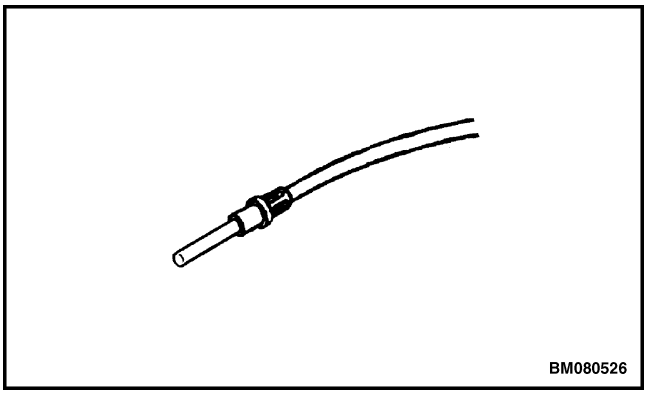
This splicing procedure adds 19.05 mm (0.75 in.) to the length of the wire and may be used when slight lengthening of the wire is desired.

Assemble

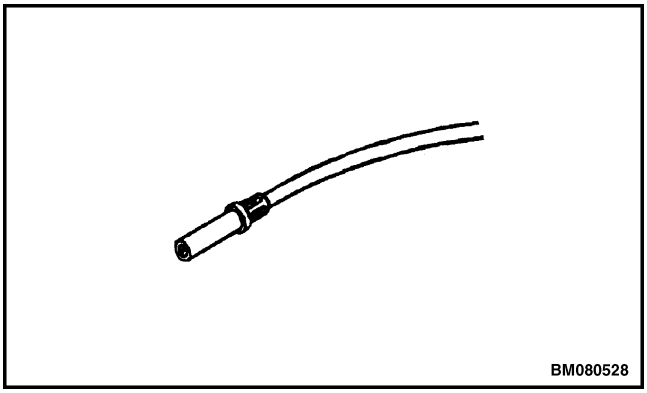
STEP 1.
Strip both wire ends to the specifications in Table 15.



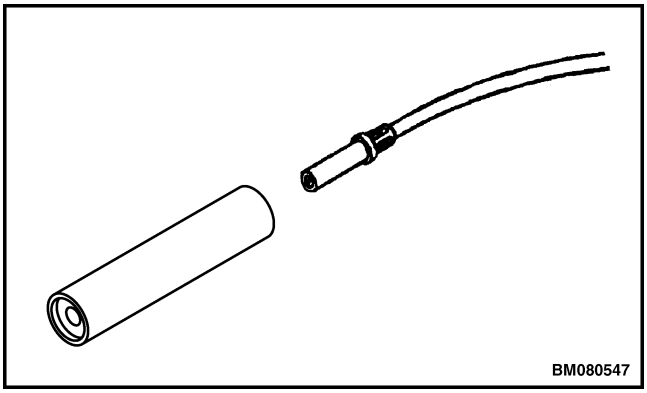
STEP 2.
On one wire, crimp the appropriate pin onto the wire using the Deutsch Crimping Tool (Hyster P/N 867888). See How to Crimp With the Deutsch Crimping Tool.



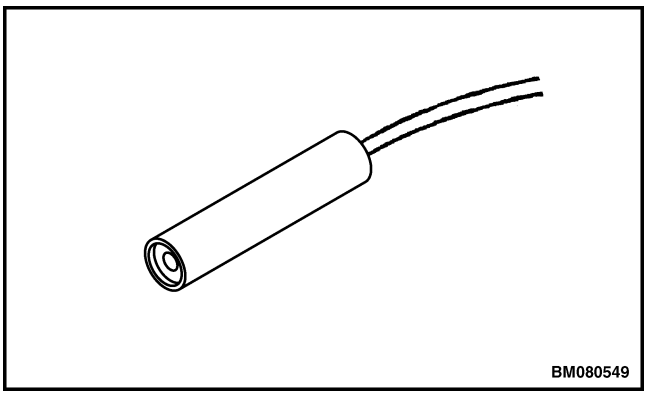
STEP 3.
On second wire, crimp the appropriate socket onto the wire using the Deutsch Crimping Tool (Hyster P/N 867888). See How to Crimp With the Deutsch Crimping Tool.



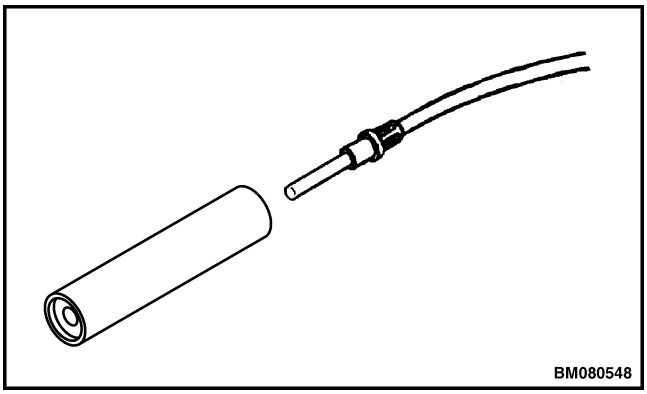
STEP 4.
Insert the wire with the socket contact into one end of the jiffy splice.



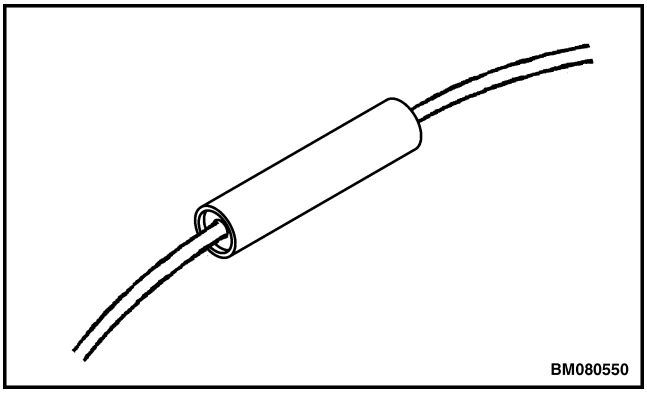
STEP 5.
Push the contact into the jiffy splice until a positive stop is felt. An audible snap will occur when correctly installed. Slightly tug the wire to verify the wire is properly locked in place.



STEP 6.
Insert the wire with the pin contact into opposite end of the jiffy splice.

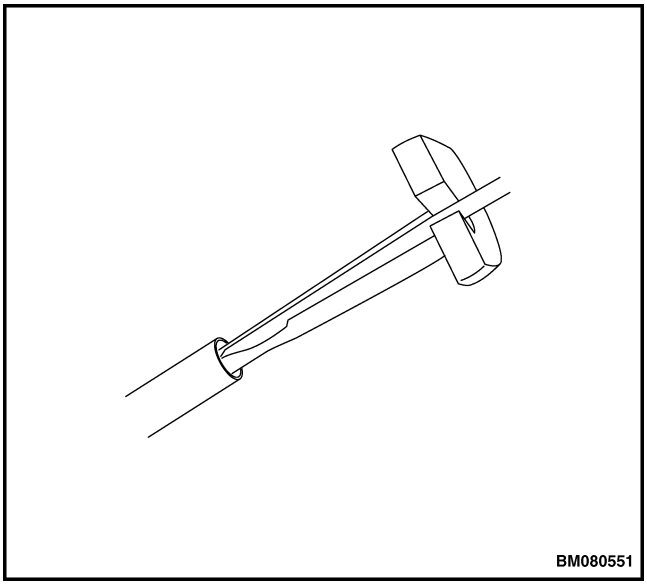


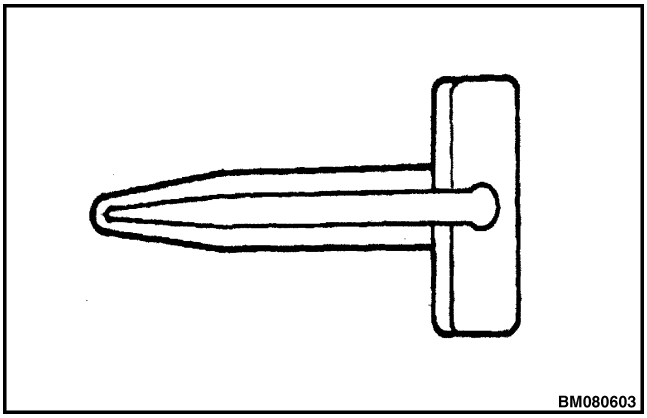
STEP 7.
Push the contact into the jiffy splice until a positive stop is felt. An audible snap will occur when correctly installed. Slightly tug the wire to verify the wire is properly locked in place.



Disassemble

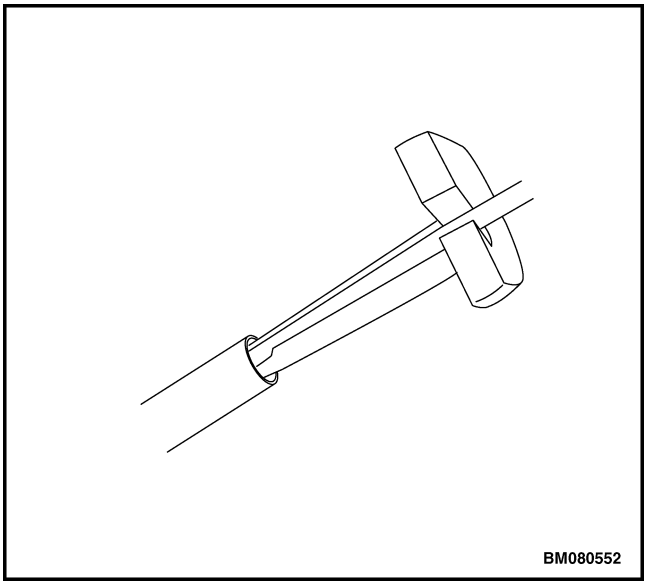
STEP 1.
Insert appropriate Deutsch extraction tool over the wire being removed.





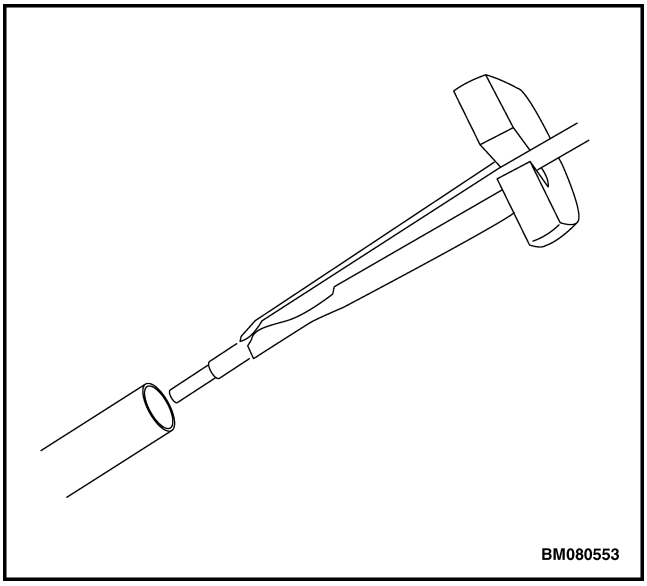
NOTE: Do not twist the tool or insert the tool at an angle.

STEP 2.
Push the tool into the splice connector about 25 mm (1 in.), until it bottoms on the contact flange.



NOTE: If pin is difficult to remove, remove the extraction tool, turn the extraction tool 90 degrees and reinsert the tool into the connector.

STEP 3.
Hold the tool on the contact flange and pull the wire and the connection socket or pin out of the connector.



STEP 4.
Repeat Step 1 through Step 3 on opposite end.

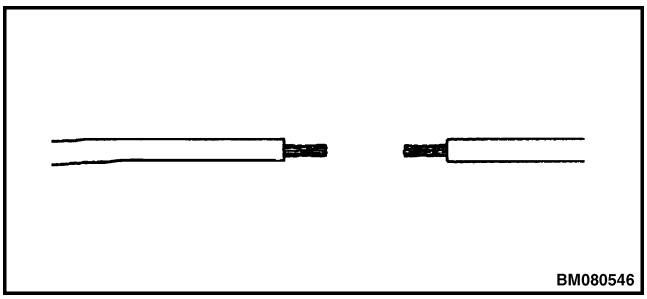
DEL-CITY CRIMP-SOLDER-SHRINK SPLICE

Refer to Table 16 for the correct splice part number for the wire gauge being repaired.

Table 16. Wire Splice Size

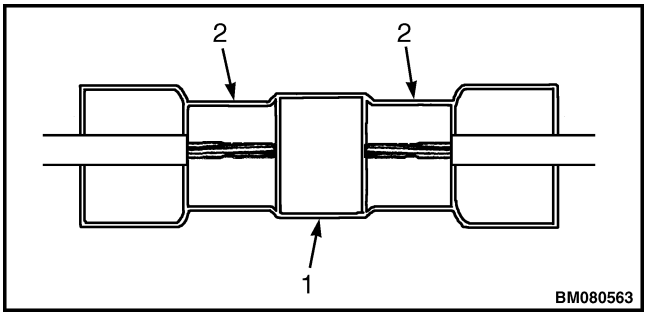
Part Number	Wire Gauge Range
866417	10 to 12 AWG (5.0 to 3.0 mm^2)
866418	14 to 16 AWG (2.0 to 1.0 mm^2)
866419	18 to 20 AWG (0.8 to 0.5 mm^2)

STEP 1.
Strip approximately 9.525 mm (0.375 in.) from both wire ends.



CAUTION
Do not crimp solder sleeve in the center of the connector. This will make the connector unserviceable.

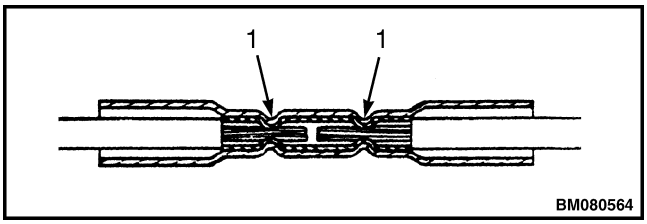
STEP 2.
Insert one wire into the connector. Make sure wire is properly seated and crimp the connector using an insulated connector crimping tool nest that matches the color or gauge of the connector.



1. SOLDER SLEEVE 2. CRIMP POINT

CAUTION
Do not crimp solder sleeve in the center of the connector. This will make the connector unserviceable.

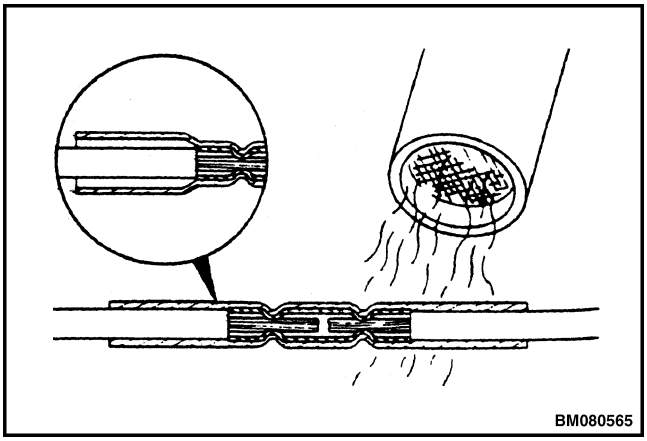
STEP 3.
Insert the second wire into the opposite end of the connector. Make sure wire is properly seated and crimp the connector using an insulated connector crimping tool nest that matches the color or gauge of the connector.

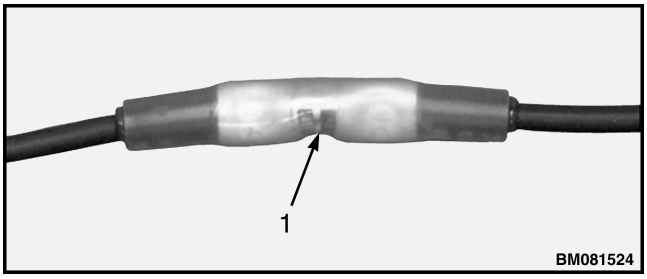


1. CRIMP POINT

STEP 4.
Using a heat gun, apply heat evenly, to approximately 135°C (275°F), around the length of the tubing (including the crimp area) from the center out to the ends until the tubing fully recovers and adhesive flows.

Continue distributing the heat over the solder sleeve until solder flows into the terminal barrel. Remove from the heat and let cool for ultimate connection performance.





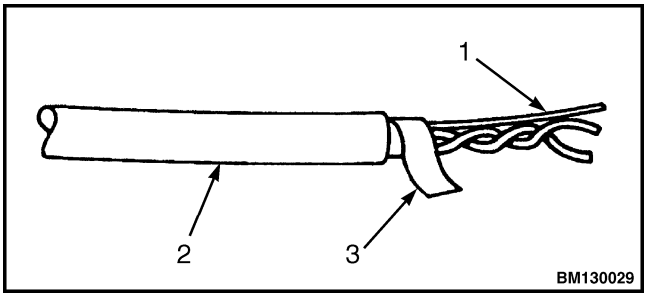
1. EXPOSED NOTCHES AFTER SOLDER BAND MELTS

Twisted/Shielded Cable and Leads Repair

TWISTED/SHIELDED CABLE REPAIR

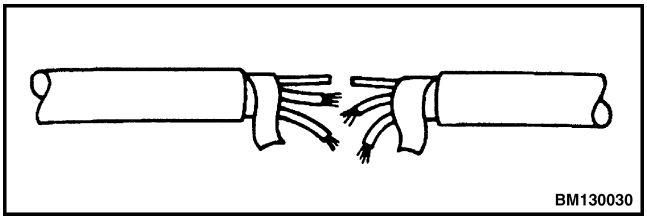
STEP 1.
Remove outer jacket.

STEP 2.
Unwrap aluminum mylar tape. Do not remove mylar tape.

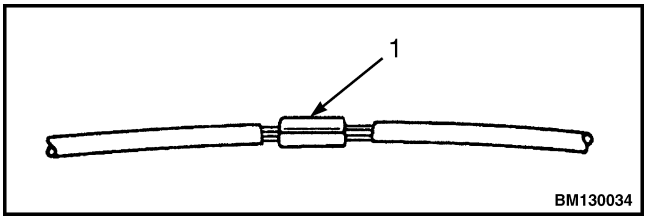


1. DRAIN WIRE
2. OUTER JACKET
3. MYLAR

STEP 3.
Untwist conductors and strip insulation as necessary.



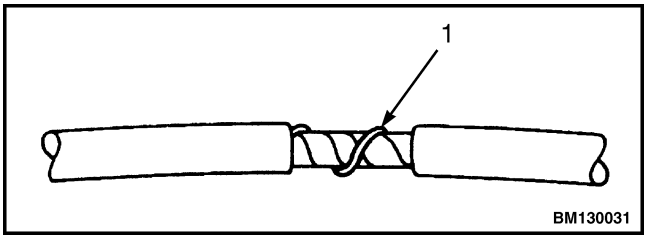
STEP 4.
Splice wires using splice clips and rosin core solder. Wrap each splice to insulate.



1. SPLICE AND SOLDER

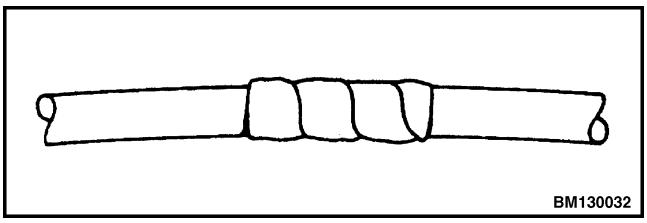
STEP 5.
Splice the drain (uninsulated) wire using splice clip and rosin core solder.

STEP 6.
Wrap with mylar and drain (uninsulated) wire.



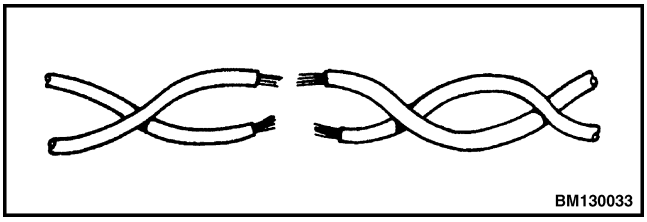
1. DRAIN WIRE

STEP 7.
Apply electrical tape over whole bundle to secure.

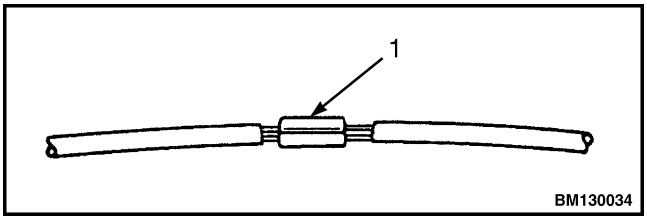


TWISTED LEADS REPAIR

STEP 1.
Locate damaged wire and remove insulation as required.



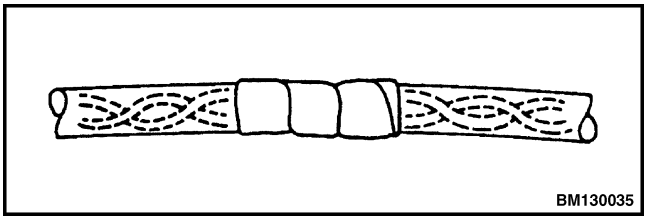
STEP 2.
Splice the two wires using splice clips and rosin core solder.



1. SPLICE AND SOLDER

STEP 3.
Cover splice with electrical tape to insulate from other wires.

STEP 4.
Twist and tape with electrical tape.



Special Tools

Illustration	Tool Description
Not Illustrated	**Deutsch Connector Kit**Hyster P/N 866410
Not Illustrated	**Deutsch Connector/ Crimp/ Stripper Kit**Hyster P/N 867892
	Wire Stripper Hyster P/N 866411 Used for stripping wires.

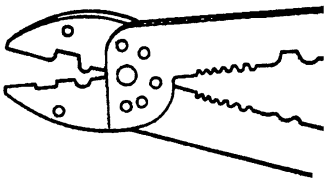
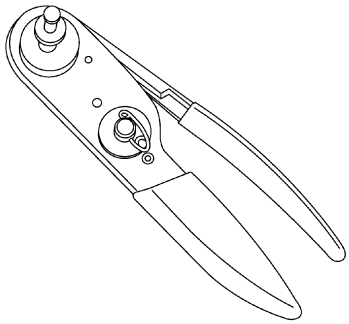
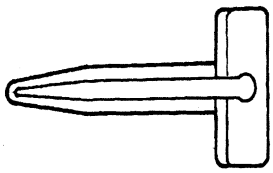
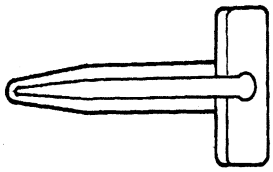
Illustration	Tool Description
BM081082	**Wire Stop for Wire Stripper**Hyster P/N 866412
 BM080560	**Wire Crimping Pliers** Used for crimping connectors. (Except Deutsch and AMP Connectors)
 BM080562	**Deutsch Hand Crimping Tool**Hyster P/N 867888 Used for crimping pins and sockets for Deutsch connectors.
BM081470	**Deutsch Wedge Removal Tool**Hyster P/N 866404 Used to remove secondary lock for Deutsch connectors.
 BM080558	**Yellow Extracting Tool**Hyster P/N 866402 Used to repair Deutsch HD 12 to 14 AWG connectors.
 BM080558	**Orange Extracting Tool (E-Seal)**Hyster P/N 866413 Extra thin wall tool. Used to repair Deutsch HD 12 to 14 AWG connectors.

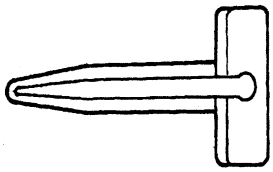
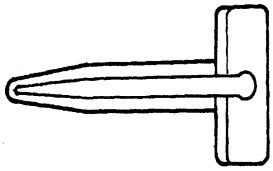
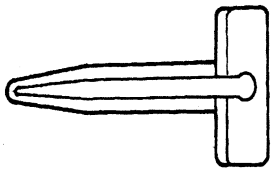
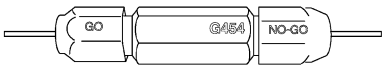
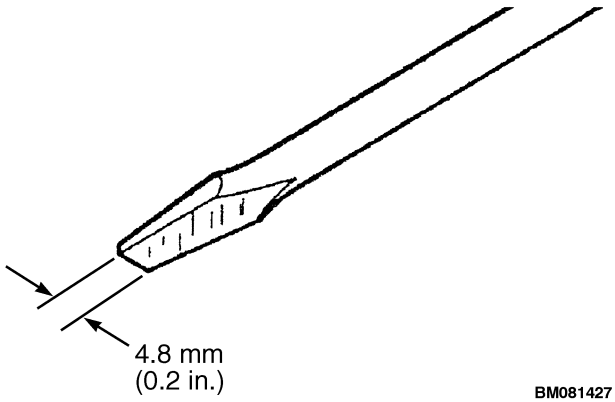
Illustration	Tool Description
 BM080558	**Light Blue Extracting Tool**Hyster P/N 866400 Used to repair Deutsch HD 16 to 18 AWG connectors.
 BM080558	**Dark Blue Extracting Tool (E-Seal)**Hyster P/N 866414 Extra thin wall tool. Used to repair Deutsch HD 16 to 18 AWG connectors.
 BM080558	**Red Extracting Tool**Hyster P/N 866415 Used to repair Deutsch HD 20 to 24 AWG connectors.
 BM080561	**Deutsch G454 Testing Tool**Hyster P/N 866416 Used to check calibration of Deutsch Hand Crimping Tool
 BM081427	**Flat Blade Screwdriver** Used to open wedge lock for AMP plug connectors

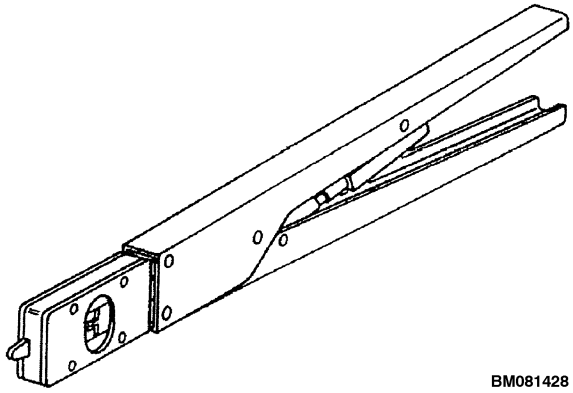
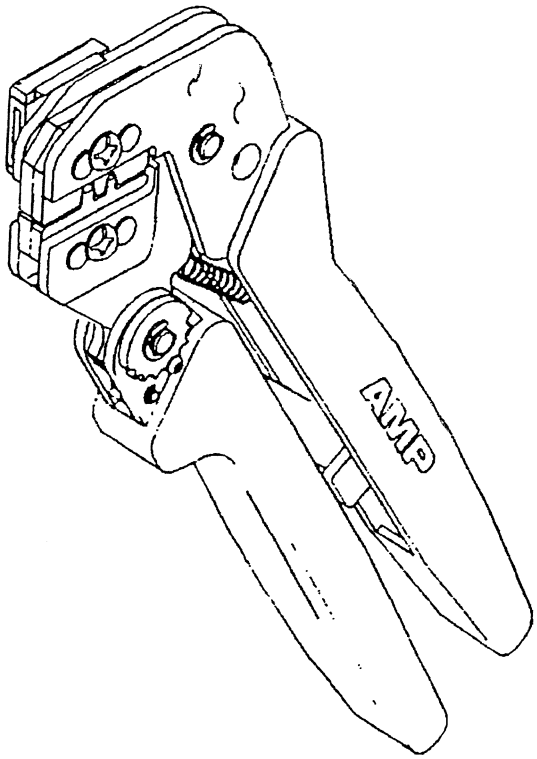
Illustration	Tool Description
 BM081428	**AMP Hand Crimping Tool**Hyster P/N 1698557 (AMP P/N 58440-1) Use for crimping AMPSEAL contacts
 BM081429	**AMP Pro-Crimper II**Hyster P/N 1698558 with Die Set 1698559 Use for crimping AMPSEAL contacts

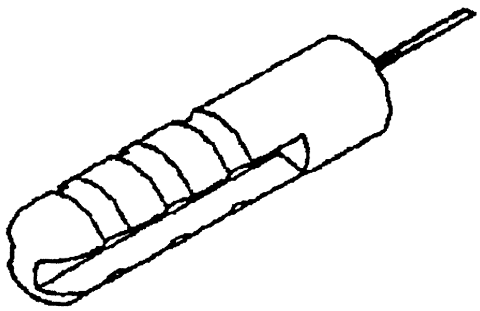
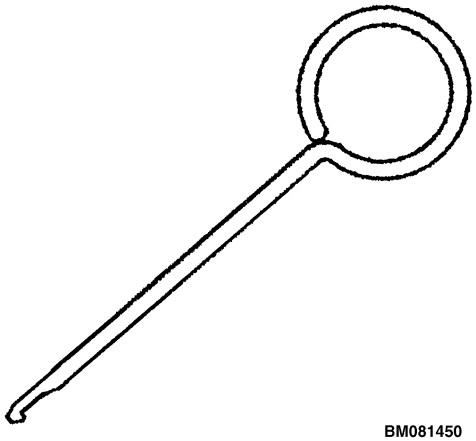
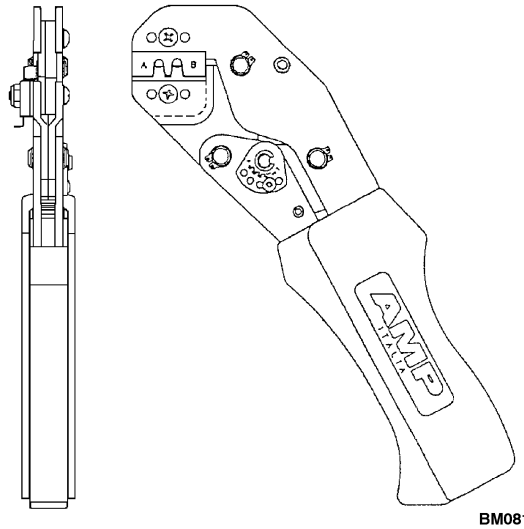
Illustration	Tool Description
 BM081449	**AMP Extracting Tool**Hyster P/N 1698561 AMP Receptacle and Tab Contact Extraction Tool for AMPSeal connectors
 BM081450	**AMP Extracting Tool**Hyster P/N 1698560 AMP Tab Contact Extraction Tool for AMPSeal connectors
 BM081491	**AMP Hand Application Tool**Hyster P/N 1698562 with Die Set Hyster P/N 1698563 Use for crimping AMP Superseal 1.5 Series Contacts

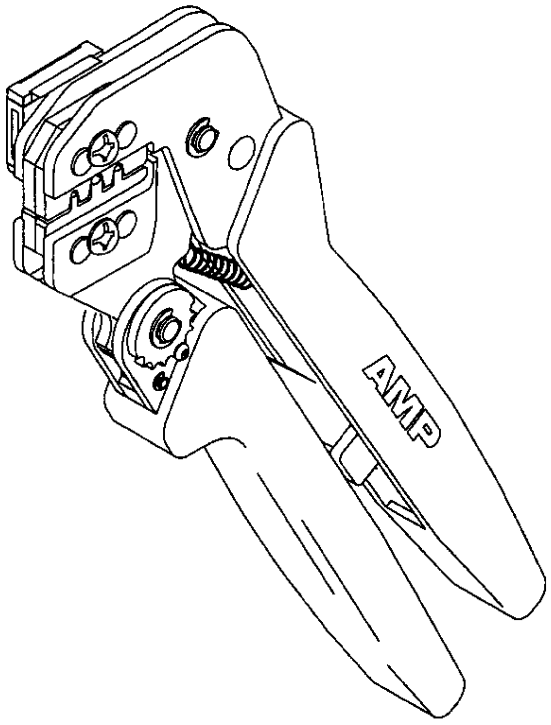
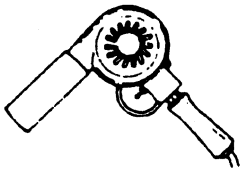
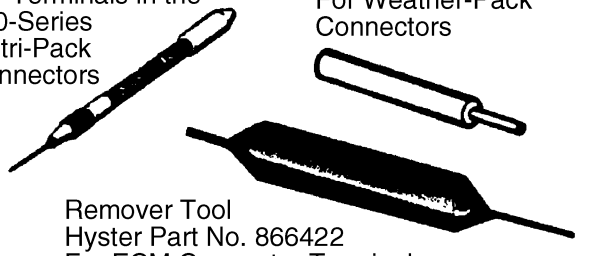
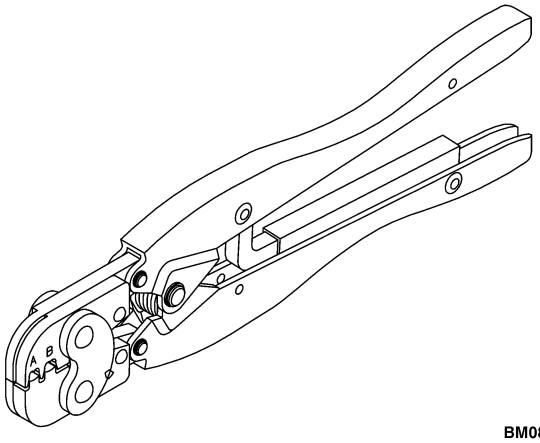
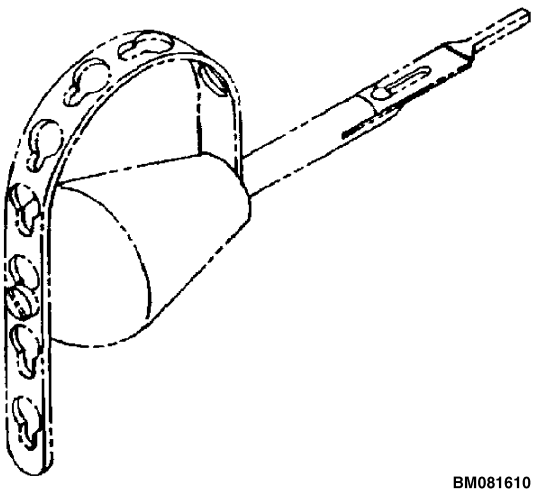
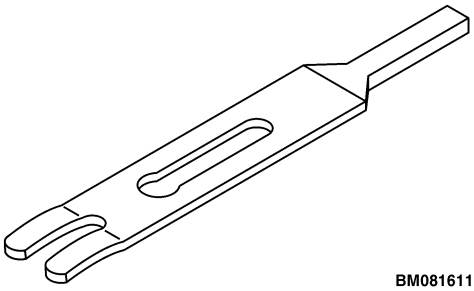
Illustration	Tool Description
 BM081420	**AMP Pro-Crimper II**Hyster P/N 1698565 with Die Set Hyster P/N 1698566 Used for crimping AMP Superseal 1.5 Series Contacts
 BM080559	**Heat Gun** Used to repair connector wires.
 HM081517	**Tool Kit for Terminal Repair** Terminals cannot be removed from their connectors or repaired without special tools. This kit has the special removal and installation tools and crimping tools required to make repairs in Micro-Pack, Metri-Pack, and Weather-Pack connectors. This repair kit does not have the terminals or the connectors.

Illustration	Tool Description
 BM081668	**AMP Double Action Hand Tool**Hyster P/N 1701710 Use for crimping Fastin-Faston receptacle connectors.
 BM081610	**AMP Universal Handle Assembly with Strap**Hyster P/N 1701712 Use with Extraction Tool Tip for Fastin-Faston receptacle connector extraction from connector housings.
 BM081611	**AMP Extraction Tool Tip**Hyster P/N 1701711 Use with Universal Handle Assembly for Fastin-Faston receptacle connector extractions.

USER INTERFACE SUPERVISOR

E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) [A099];
A1.3-1.5XNT (A25-30XNT) [D203];
J1.5-2.0XNT (J30-40XNT) [K160];
E2.2-3.5XN (E45-70XN) [A268];
E1.6-2.0XN (E30-40XN) [A269];
J2.2-3.5XN (J45-70XN) [A276];
J1.6-2.0XN (J30-40XN) [A935];
J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) [A970];
J8.0XNL6, J8.0XNL9, J9.0XNL (J170-190XNL) [A250]

HYSTER

PART NO. 1688878 **2200 SRM 1335**

SAFETY PRECAUTIONS
MAINTENANCE AND REPAIR

- The Service Manuals are updated on a regular basis, but may not reflect recent design changes to the product. Updated technical service information may be available from your local authorized Hyster® dealer. Service Manuals provide general guidelines for maintenance and service and are intended for use by trained and experienced technicians. Failure to properly maintain equipment or to follow instructions contained in the Service Manual could result in damage to the products, personal injury, property damage or death.
- When lifting parts or assemblies, make sure all slings, chains, or cables are correctly fastened, and that the load being lifted is balanced. Make sure the crane, cables, and chains have the capacity to support the weight of the load.
- Do not lift heavy parts by hand, use a lifting mechanism.
- Wear safety glasses.
- DISCONNECT THE BATTERY CONNECTOR before doing any maintenance or repair on electric lift trucks. Disconnect the battery ground cable on internal combustion lift trucks.
- Always use correct blocks to prevent the unit from rolling or falling. See HOW TO PUT THE LIFT TRUCK ON BLOCKS in the **Operating Manual** or the **Periodic Maintenance** section.
- Keep the unit clean and the working area clean and orderly.
- Use the correct tools for the job.
- Keep the tools clean and in good condition.
- Always use **HYSTER APPROVED** parts when making repairs. Replacement parts must meet or exceed the specifications of the original equipment manufacturer.
- Make sure all nuts, bolts, snap rings, and other fastening devices are removed before using force to remove parts.
- Always fasten a DO NOT OPERATE tag to the controls of the unit when making repairs, or if the unit needs repairs.
- Be sure to follow the **WARNING** and **CAUTION** notes in the instructions.
- Gasoline, Liquid Petroleum Gas (LPG), Compressed Natural Gas (CNG), and Diesel fuel are flammable. Be sure to follow the necessary safety precautions when handling these fuels and when working on these fuel systems.
- Batteries generate flammable gas when they are being charged. Keep fire and sparks away from the area. Make sure the area is well ventilated.

NOTE: The following symbols and words indicate safety information in this manual:

WARNING

Indicates a hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION

Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury and property damage.

On the lift truck, the WARNING symbol and word are on orange background. The CAUTION symbol and word are on yellow background.

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This section is for the following models:

E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) [A099];
A1.3-1.5XNT (A25-30XNT) [D203];
J1.5-2.0XNT (J30-40XNT) [K160];
E2.2-3.5XN (E45-70XN) [A268];
E1.6-2.0XN (E30-40XN) [A269];
J2.2-3.5XN (J45-70XN) [A276];
J1.6-2.0XN (J30-40XN) [A935];
J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) [A970];
J8.0XNL6, J8.0XNL9, J9.0XNL (J170-190XNL) [A250]

"THE QUALITY KEEPERS"

HYSTER APPROVED PARTS

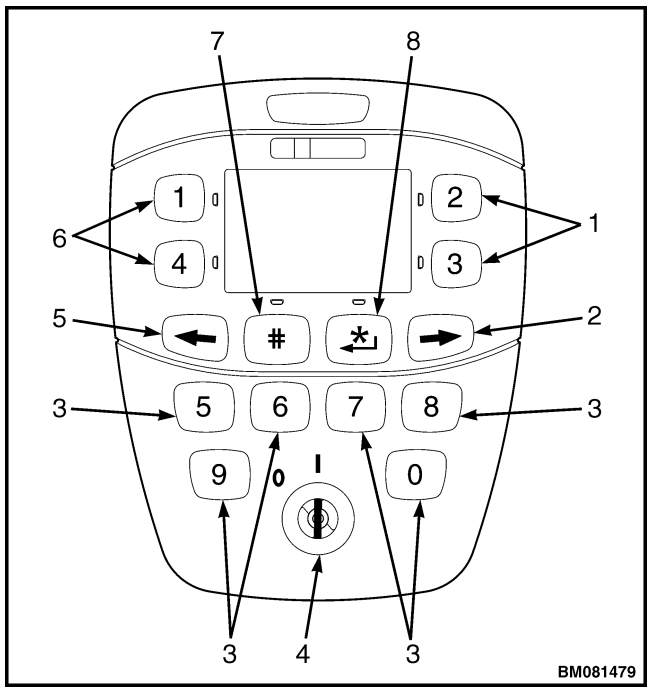
General

DESCRIPTION

The information provided in this **Service Manual** describes the functions of the display panel that are available to the Supervisor. With a proper service technician password, a Service Technician can access menu items that are not visible at Operator or Supervisor password-level access.

DISPLAY PANEL MENU ACCESS

Turning the keyless start switch or key switch to the **ON** position activates the Display Panel. Figure 1 shows the layout of the Display Panel including the location of the keyless start switch or key switch.



1. 2 AND 3 KEYS
2. SCROLL FORWARD KEY (RIGHT ARROW)
3. 5, 6, 7, 8, 9, AND 0 KEYS
4. KEYLESS START SWITCH OR KEY SWITCH
5. SCROLL BACK KEY (LEFT ARROW)
6. 1 AND 4 KEYS
7. POUND KEY (# KEY)
8. ENTER KEY (* STAR KEY)

Figure 1. Lift Truck Display Panel

The operator password screen appears at startup as shown in Figure 2, if Operator Passwords are enabled.

Use the number keys on the Display Panel to enter your five-digit Supervisor password. For more information, see the Password Screen topic.

If a non-service technician password has already been entered at the initial password screen, you can navigate to the Password Screen by pressing the **Enter Key** (*****) to go to the Main Menu, then press either the **Scroll Back Key** (◂—) or the **Scroll Forward Key** (—▸) to access the Password Screen. Refer to the Menu Navigation topic for orientation on the Main Menu title screens (the main level menus).

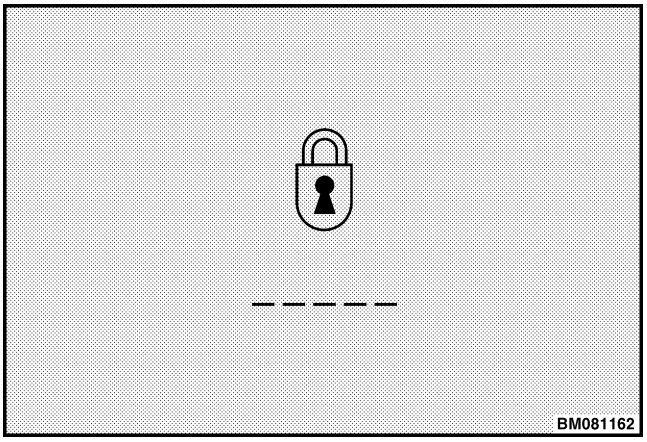


Figure 2. Password Screen

Menu Flowchart

SUPERVISOR MENU FLOWCHART

NOTE: Depending upon how the lift truck is equipped, some of the functions described in this section may not be included in the on-board menu structure for a particular lift truck.

NOTE: The icons displayed on the Operating Screen vary from any one time to another, depending on the current operation of the lift truck and other factors. The Battery Discharge Indicator, system time, and direction indicator are always displayed.

All available menus are grouped by function under the main menu screens, which are also called top-level title menus. When you select a main menu screen, the system then presents submenus, also known as second-level menus, that you can cycle through using the **UP** ↑ or **DOWN** ↓ keys until you find the one you want on the Display Panel. Two main menu screens, the Operating Screen and the Password Screen, have no associated submenus, but the other main menus lead to submenus.

The following flowchart is for the Supervisor use only. See Figure 3 and Table 1.

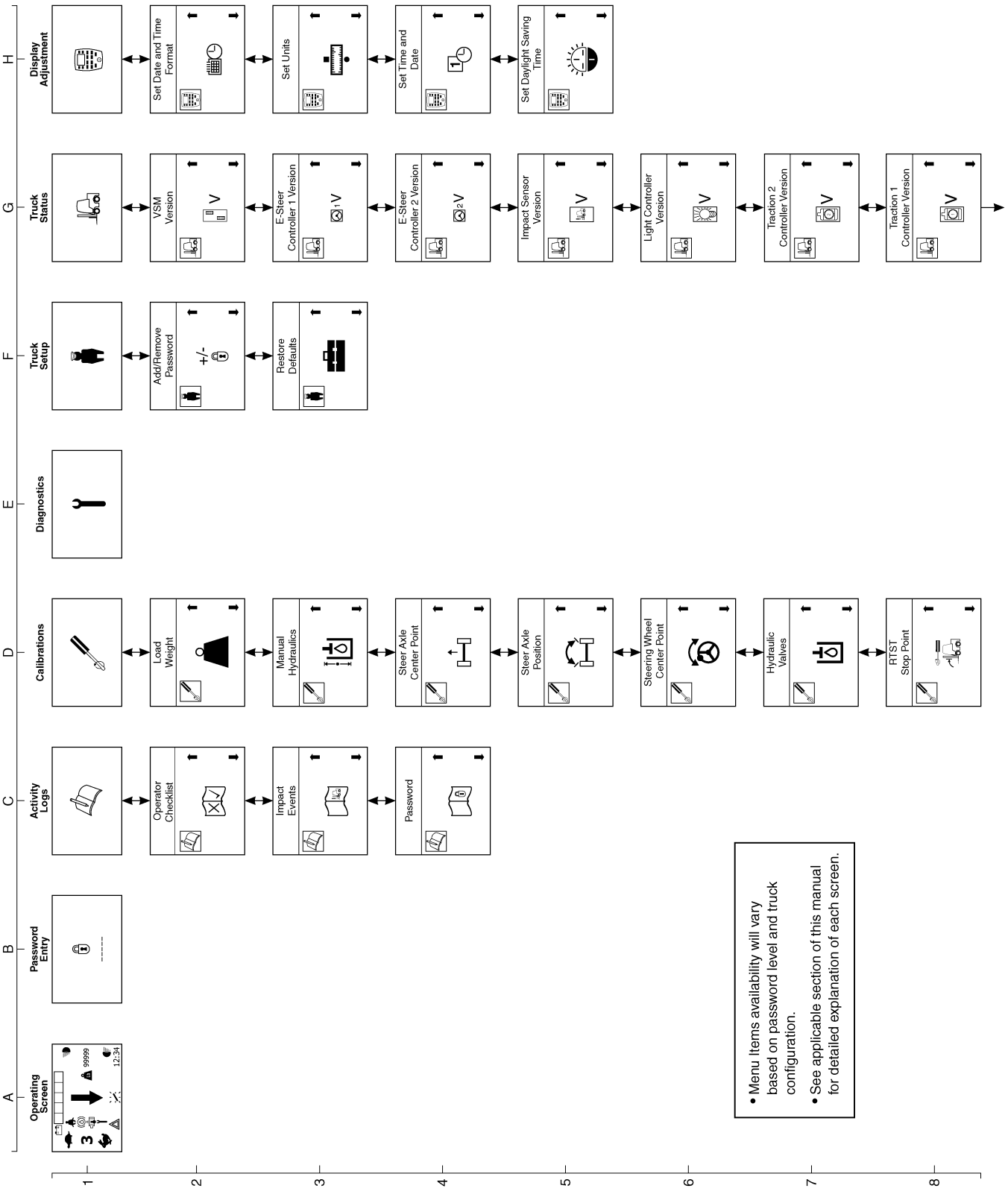


Figure 3. Supervisor Flowchart (Sheet 1 of 4)

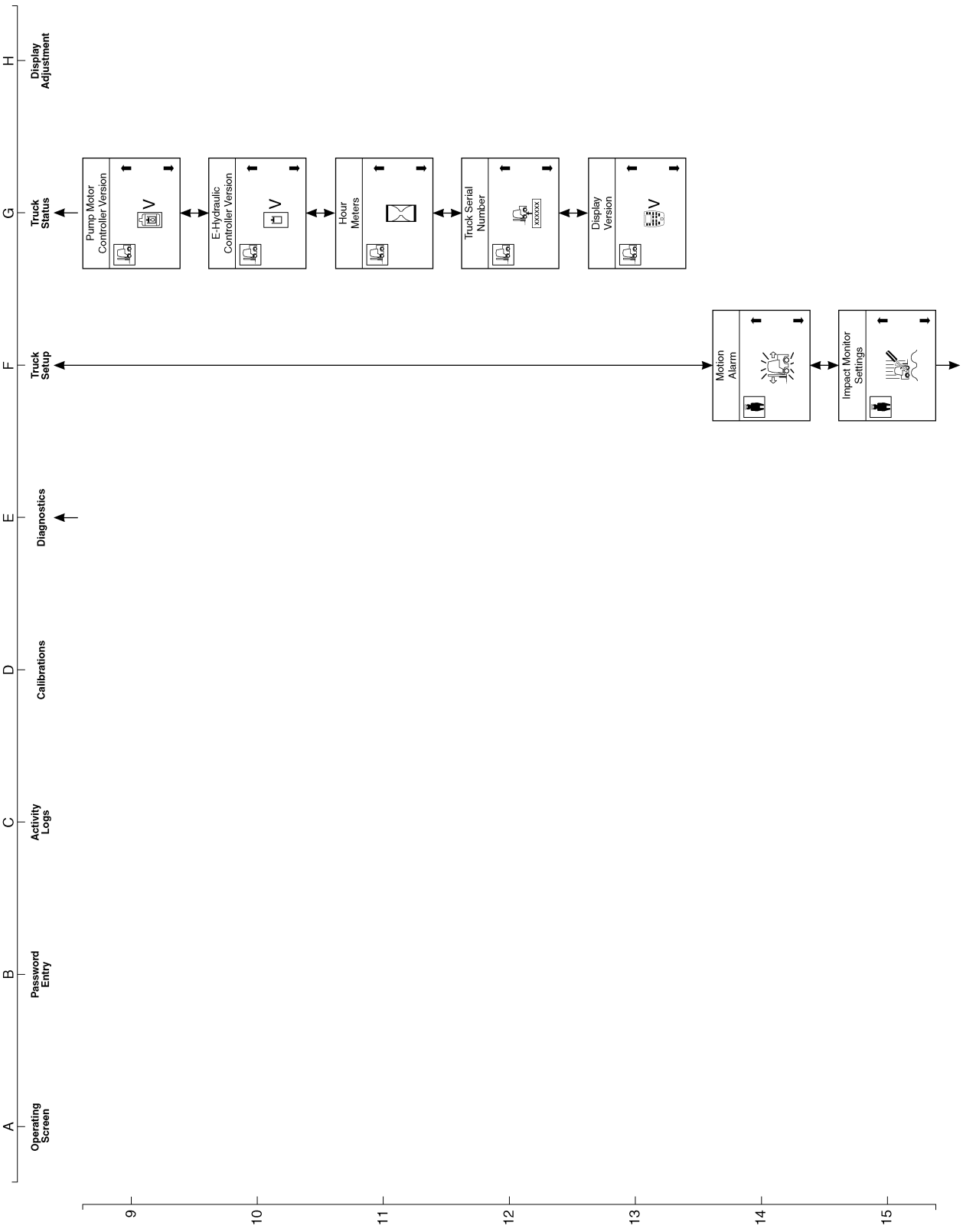


Figure 3. Supervisor Flowchart (Sheet 2 of 4)

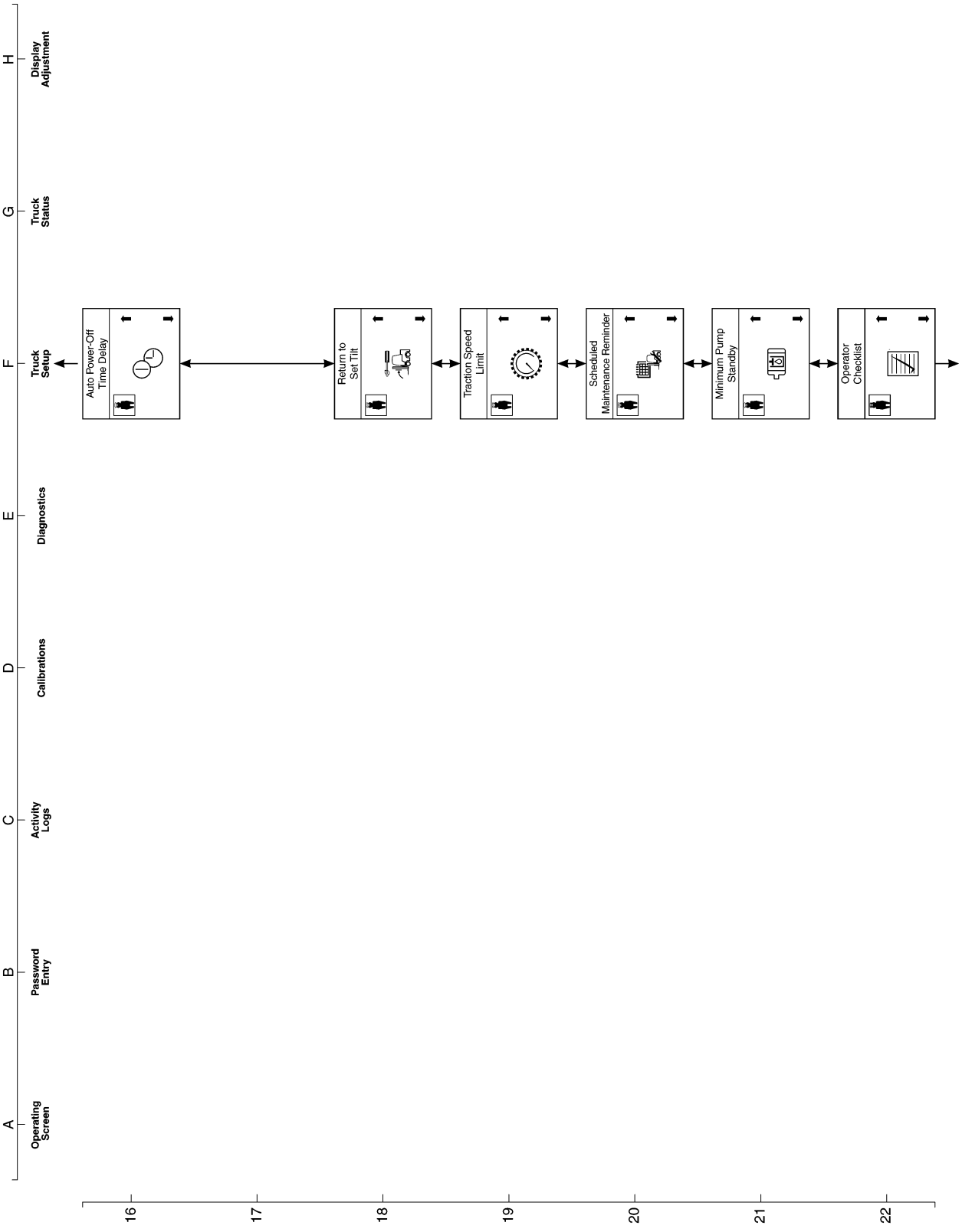


Figure 3. Supervisor Flowchart (Sheet 3 of 4)

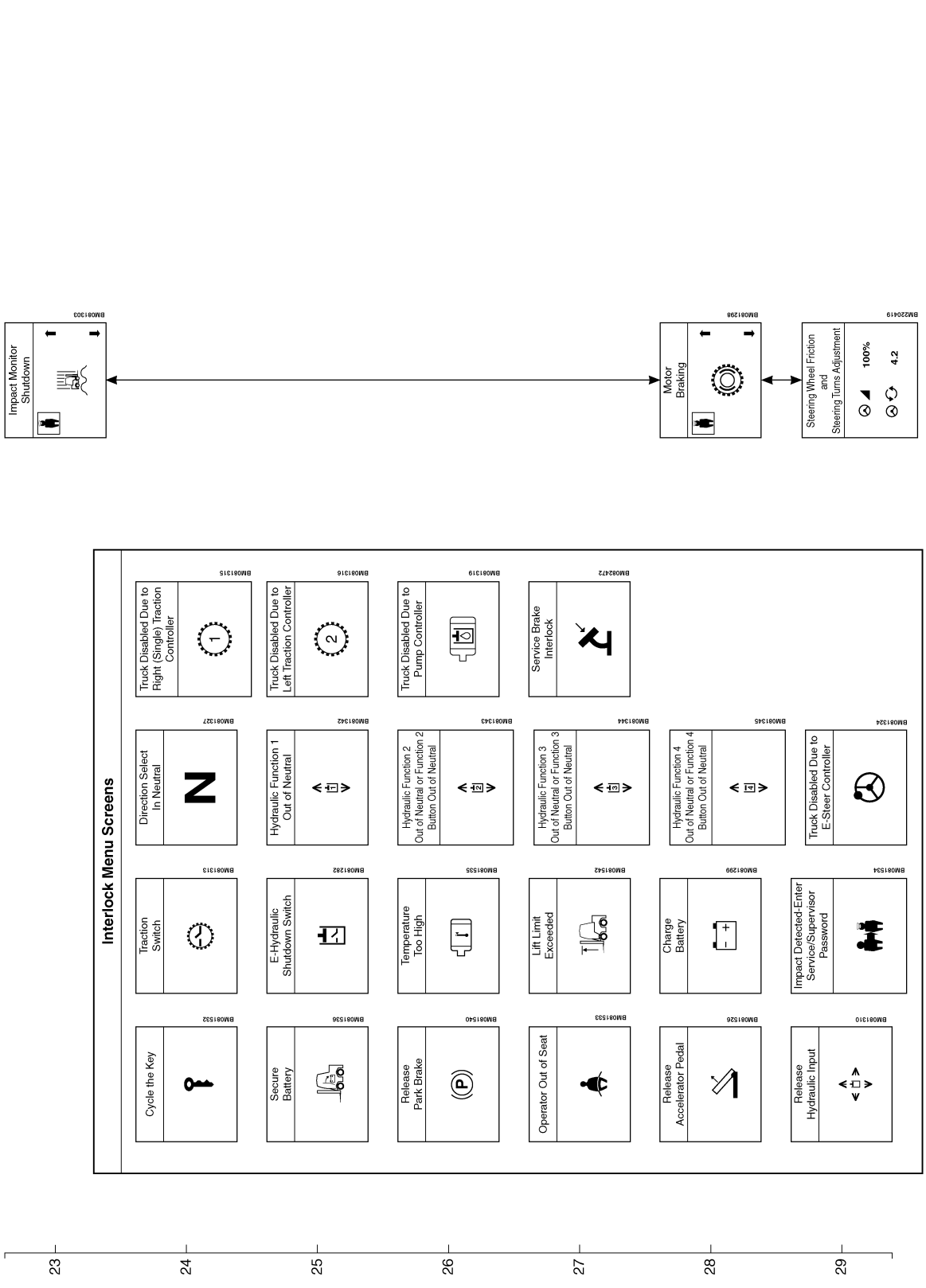


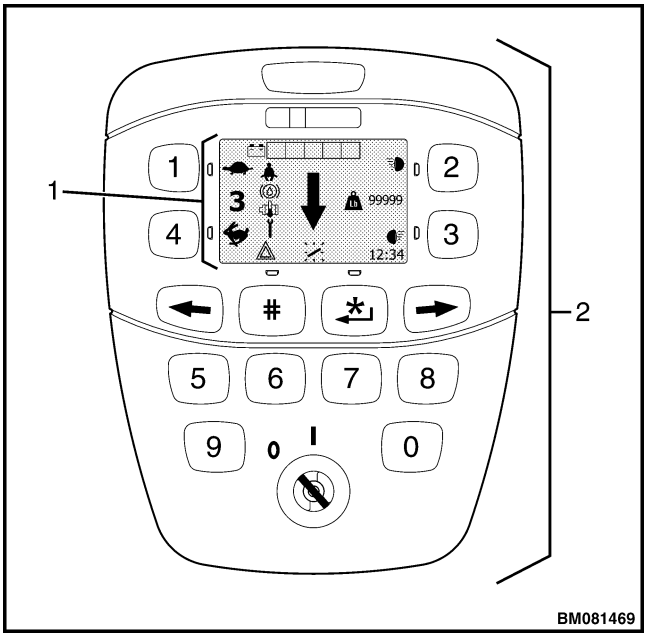
Figure 3. Supervisor Flowchart (Sheet 4 of 4)

Table 1. Supervisor Menu Flowchart

	A	B	C	D	E	F	G	H
1	**Operating Screen**	**Password Entry**	**Activity Log**	**Calibration**	**Diagnostics**	**Truck Setup**	**Truck Status**	**Display Adjustment**
2			Operator Checklist	Load Weight		Add/Remove Password	VSM Version	Set Date and Time Format
3			Impact Events	Manual Hydraulics		Restore Default	E-Steer Controller 1 Version	Set Units
4			Password	Steering Axle Center Point			E-Steer Controller 2 Version	Set Time and Date
5	**SHEET 1**			Steering Axle Position			Impact Sensor Version	Set Daylight Saving Time
6				Steering Wheel Center Point			Light Controller Version	
7				Valve Threshold			Traction Motor Controller 2 Version	
8				Return to Set Tilt Stop			Traction Motor Controller 1 Version	
9							Pump Motor Controller Version	
10							E-Hydraulic Controller Version	
11	**SHEET 2**						Hour Meters	
12							Truck Serial Number	
13							Display Version	
14						Motion Alarm		
15						Impact Monitor Settings		
16						Auto Power-Off Time Delay		
17								
18						Return to Set Tilt		
19	**SHEET 3**					Traction Speed Limit		
20						Scheduled Maintenance Required		
21						Minimum Pump Standby		
22						Operator Checklist		
23		Interlock Menu Screen				Impact Monitor Shutdown		
24		Cycle the Key	Traction Switch	Direction Select in Neutral	Truck Disabled Due to Right (Single) Traction Controller			
25		Secure Battery	Hydraulic Switch	Hydraulic Function 1 Out of Neutral	Truck Disabled Due to Left Traction Controller			
26	**SHEET 4**	Release Park Brake	Temperature Too High	Hydraulic Function 2 Out of Neutral of Function 2 Button Out of Neutral	Truck Disabled Due to Pump Controller			
27		Operator out of Seat	Lift Limit Exceeded	Hydraulic Function 3 Out of Neutral of Function 3 Button Out of Neutral	Service Brake Interlock			
28		Release Accelerator	Charge Battery	Hydraulic Function 4 Out of Neutral of Function 4 Button Out of Neutral		Motor Braking		
29		Release Hydraulic Input	Impact Detected-Enter Service/ Supervisor Password	Truck Disabled Due to E-Steer Controller		Steering Wheel Friction and Steering Turns Adjustment		

Menu Navigation

This topic explains how to use the keys on the Display Panel, shown in Figure 4, to navigate from one menu to another and change settings.



1. LCD SCREEN
2. DISPLAY PANEL

Figure 4. Display Panel With Operating Screen Displayed

Keys used for menu navigation include:

- The **1**, **2**, **3**, **4**, and **#** keys.
- The **Enter Key** (*) which is also called the star key because of its * label.
- The **Scroll Back Key** (◂—) and the **Scroll Forward Key** (—▸). These keys are explained in detail in the General section of this document.

The Password Screen, discussed in the Adding/ Removing/Changing Passwords topic in the Password Screen section, is the first screen displayed when the key switch or keyless switch is turned to the On position unless Operator Passwords are deactivated (in this case, the Activity Log Title Screen appears). After entering your password successfully, the system displays the Operating Screen on the orange 1.5 x 2.5 inch LCD screen of the Display Panel as shown in Figure 4.

When a title screen or a menu screen is displayed on the LCD screen, the screen is still referred to as the "screen" in a generic way, but the actual Operating Screen is shown in Figure 4. See the Operating Screen section for details.

When the Operating Screen is displayed, pressing the **Scroll Forward Key** (—▸) causes the system to display the Password Screen. If you press the **Scroll Forward Key** a second time, the system displays the Activity Log Title Screen, shown in Figure 5, on the LCD screen.

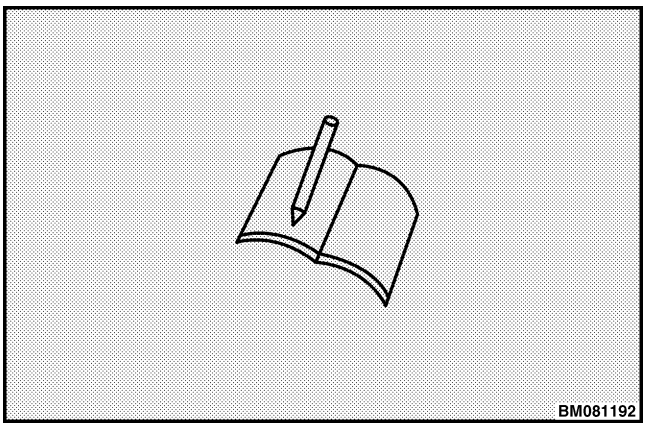
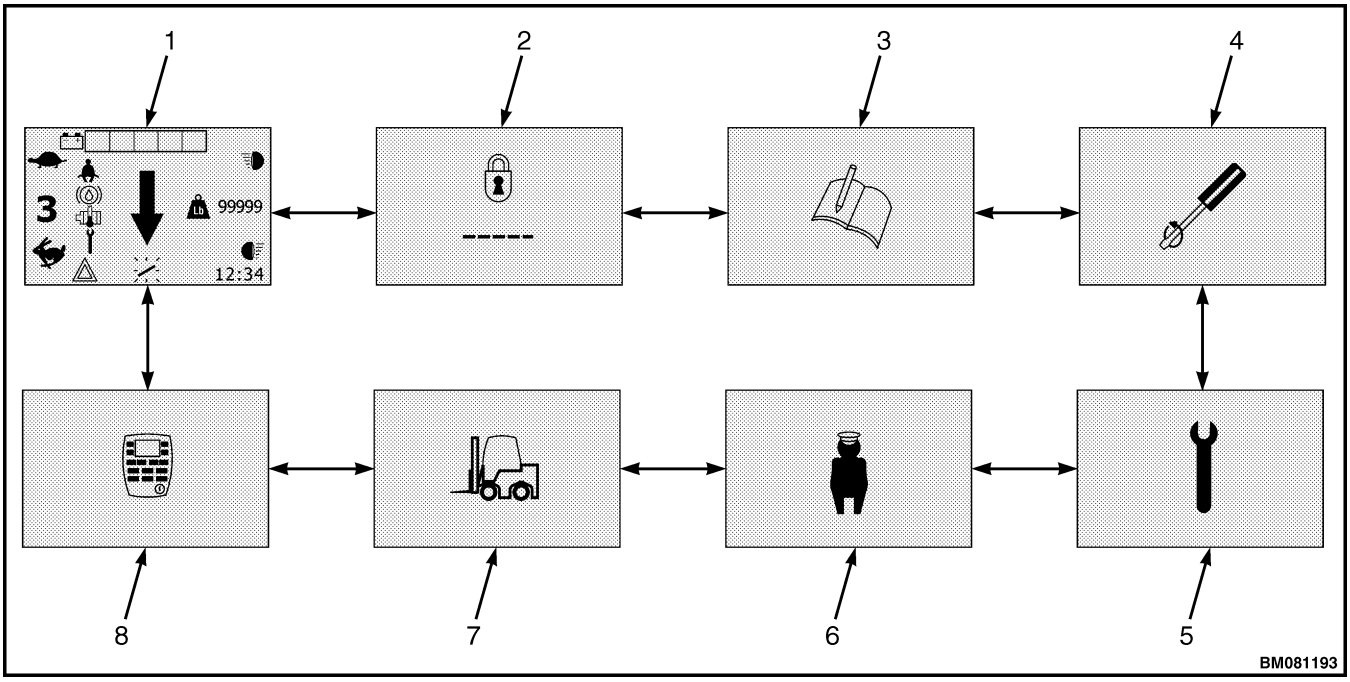


Figure 5. Activity Log Title Screen

Main Menu Structure

The main menus (top-level menus) appear on the screen in the order shown in Figure 6.

Use the **Scroll Back Key** or the **Scroll Forward Key** to move from one title screen to another. Press the **Enter Key** to enter one of these main menus.



1. OPERATING SCREEN
2. PASSWORD SCREEN
3. ACTIVITY LOG TITLE SCREEN
4. CALIBRATION TITLE SCREEN
5. DIAGNOSTICS TITLE SCREEN
6. TRUCK SETUP TITLE SCREEN
7. STATUS TITLE SCREEN
8. DISPLAY TITLE SCREEN

Figure 6. Main Menu Structure

Screens and Title Screens

The main menu has eight menus, or screens, which are shown in Figure 6. By pressing the **Scroll Forward Key** to advance through all of them.

If you press the **Scroll Forward Key** after reaching the Display Title Screen, the system returns (loops back) to the Operating Screen. Press the **Scroll Forward Key** to scroll through the screens again. Alternatively, use the **Scroll Back Key** to scroll through the screens in the reverse direction.

The Password Screen and Operating Screen do not have submenus below them. The other title screens are all main menus which have submenus under them. Submenus can also be called second-level menus. Figure 5 is an example of a main menu screen.

Supervisors have access to the Activity Log, Calibration, Display, Truck Setup, and Status Title Screens. Service Technicians have access to all title screens; Operators use only the Password Screen, Operating Screen, and Calibration Title Screen.

Submenus

Submenus are the “branches” of a main menu. The Activity Log Menu has only three submenus, while the Truck Setup Menu has 13 submenus. Each submenu is represented by a title screen. When the title screen of the submenu you want is displayed on the screen, press the **Enter Key** to enter that submenu. For example, if you enter the Operator Checklist Log submenu, shown in Figure 7, the system displays the menu shown in Figure 8.

When viewing a submenu title screen, you can return to the main menu at any time by pressing the **Scroll Back Key** or the **Scroll Forward Key**.

Menu navigation is possible through the use of soft keys, which are explained in the Soft Keys topic. For example, if you scroll to the Activity Log Title Screen and have it displayed on the screen as shown in Figure 5, press the **Enter Key** (*) to enter the Activity Log menu. The system will display the first submenu in the Activity Log menu, which is shown in Figure 7. Press the **Enter Key** again and the system will display the Operator Checklist Log, shown in Figure 8. The Activity Log Icon in the

upper left corner of this submenu indicates you are in the Activity Log main menu.

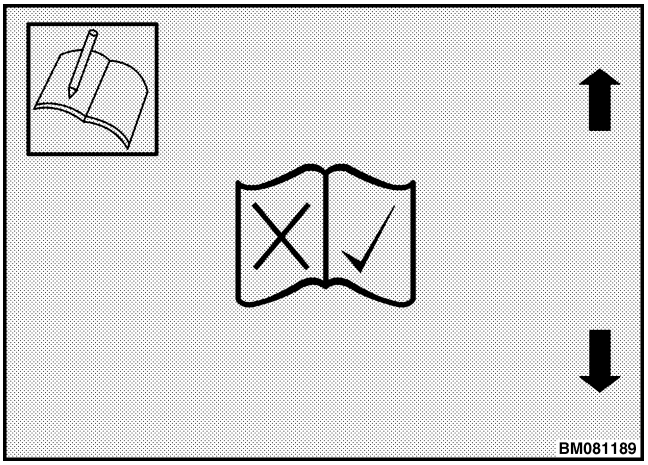


Figure 7. Operator Checklist Log Title Screen

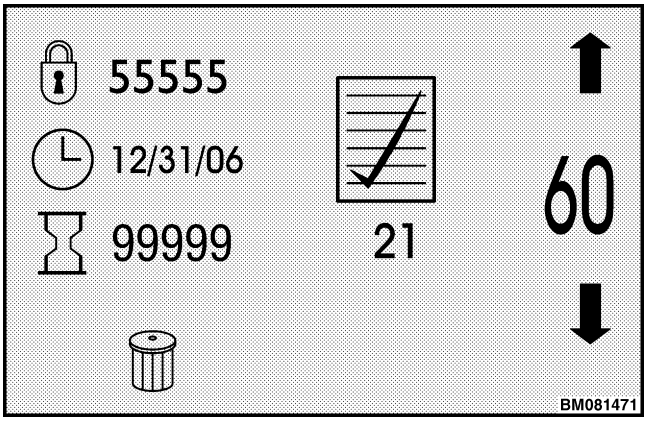


Figure 8. Operator Checklist Log Menu

Returning to the Main Menu

To return to the main menu from a submenu, press the **Scroll Forward Key** (—▸). This returns you to the title screen of the submenu (second-level menu) you are using. If you press the **Scroll Forward Key** a second time, the system returns you to the main menu. You can return to the main menu, or back out of a submenu, by pressing the **Scroll Back Key**.

Press the **Enter Key** to save any changes you make in submenu before exiting from the submenu. If you return to the main menu before saving a change, the system does not store the change.

Icons and Settings

An icon is a simple graphic that represents an object, such as a clock, or a setting such as battery voltage. Each submenu has at least one icon on it, and each icon represents: 1) a setting that can be changed, or 2) a status value that can be viewed, such as a truck's serial number, or 3) an action that can be taken, such as clearing the fault log. Only a logged in user who has the proper privileges can change a setting, view a status value, or take an action.

A setting is a value that controls the operation of a lift truck in some way. For example, there are four values for the performance mode setting, 1, 2, 3, and 4. Some settings have only two values, such as Enabled and Disabled, while other settings may present a series of values you can select from by using the soft keys. In some cases, you need to enter a numerical value that is within an acceptable range for a setting. In this case, you key in the value using the number keys. This is discussed in the Entering Numbers topic at the end of this section.

On submenus that have two or more icons, the icons correspond to related settings. To change settings you need to use the buttons called soft keys, which are explained in the next topic.

Soft Keys

Certain keys on the Display Panel called "soft keys" make it possible to navigate from one menu to another, change settings, delete a log entry, or take other actions. A soft key is a key that has been programmed to serve more than one function, and the function it serves depends on which menu is active. For example, when the Operating Screen is displayed, the **#** key lets you turn the Hazard Flashers On or Off, but when you are in the Activity Log Checklist menu, the **#** key can be used to delete a log entry.

The soft keys include the **1** and **4** keys on the left, the **2** and **3** keys on the right, and the **#** and ***** keys below the Operating Screen. There are no icon indicators for the soft keys.

The ***** soft key serves as an **Enter Key** in all menus except when using the Operator Checklist (see the Operator Checklist topic in the Truck Setup Menu section). In a lot of menus, the **2** and **3** soft keys are programmed for navigating up or down in the menu to the setting value you want to change. Also, in most but not all menus, the **2** and **3** soft keys are programmed for moving up or down though the

available values or options for the currently selected setting. When this is the case, the up and down arrows are displayed on the right side of the screen.

The following example shows how to use the soft keys.

How to Change the Battery Voltage Setting

1 Starting from the main menu, use the **Scroll Back Key** (◂—) or **Scroll Forward Key** (—▸) to navigate to the Truck Setup Title Screen and press the **Enter Key** (*).

2 Use the **2** or **3** arrow soft keys to step through the menus to the Battery Setup submenu (the title screen of this submenu has a battery icon on it) and press the **Enter Key**.

3 Press the **2** or **3** arrow soft key to "move to" the value located to the right of the top icon an the system will place a "selection box" around the value. This number indicates the current battery voltage, such as 36.

4 With the selection box around the battery voltage value, press the **Enter Key**.

5 Use the **2** and **3** arrow soft keys to move up or down though the available values (36, 48, 72, and 80) until 48 is displayed, then press the **Enter Key**.

The system stores the 48 Volt value and begins using it as the new battery voltage setting.

NOTE: While changing a setting, all other sub-items (setting items) disappear.

Entering Numbers

The preceding example shows how the system allows a user to select one value out of a series of values. In some menus, you will use the number keys (0 through 9) to enter a value directly. These are:

- The **1**, **2**, **3**, and **4** soft keys. These keys can be used as number keys only in the menus that accept numerical input. These keys are programmed for use as soft keys in most menus.
- The **5**, **6**, **7**, **8**, **9**, and **0** keys. These keys can be used to enter numbers in menus that allow numerical input. These keys are not soft keys in any menu.

Passwords are a special case of entering numbers. The user is required to enter a five digit “password” number, such as 15324, on the Password Screen. This number must consist only of the numbers 1, 2, 3, 4, 5, 6, 7, 8, and 9 and is entered using the **1**, **2**, **3**, **4**, **5**, **6**, **7**, **8**, and **9** keys. Pressing any other numeric key has no effect.

Icon Glossary

INTRODUCTION

An icon is a symbol that conveys a unique meaning without words, such as an arrow. The Operating Screen on this lift truck presents information to an operator solely through the use of symbols which are mostly icons, along with some numbers and a few text characters. Icons make it possible to simultaneously display up to 12 kinds of information graphically in a small space. In addition, the use of icons reduces the difficulty of communicating with operators who speak different languages.

The meaning of some icons is apparent when the icon appears by itself, such as the seat belt icon. Other icons need to have numeric information displayed alongside them to present information, such as when **24** appears beside the clock icon to indicate the times are being displayed using the 24-hour clock system. Sometimes two icons are displayed side by side to convey information, such as when the icon that means "enabled" is shown beside the rear lights icon. Also, two icons can be displayed at the same time, one over the other, which is discussed in the Overlay Icons topic.

The icons and their meanings are presented in these categories:

- Soft Key Icons
- Overlay Icons
- Icons on System Off Screen and Alert Screens
- Main Menu Screens
- Submenu Icons Grouped by Menu

SOFT KEY ICONS

Some of the icons on the Operating Screen are called soft key icons because they associate an operation or function with a nearby key (**1**, **2**, **3**, **4**, **#**, or *****) on the Display Panel. The result of pressing one of these keys depends on which menu is currently active, because the icons nearest these keys change from one menu to another. The soft keys are programmed to function in relation to the current menu context. Table 2 shows the soft key icons that appear on the Display Panel along with a short description of each one's purpose.

Table 2. Soft Key Icons

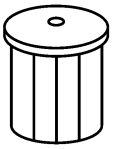
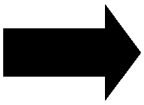
Icon	Description
	Hare Performance Mode "increase" Icon. Press the **1** soft key (or the **#** soft key in some cases) to increase performance.
	Tortoise Performance Mode “decrease” Icon. Press the **3** soft key to decrease performance.
	Trash Can Icon. Used to delete all entries in a log. Press the **4** soft key (or the **#** soft key in some cases) to empty a log.
	Up Arrow soft key. Press **2** to scroll up in most screens. Also used to view next log entry in log screen.
	Down Arrow soft key. Press **3** to scroll down in most screens. Also used to view next log entry in log screen.
	View Next Device Log Icon. Press the **#** key for previous.
	View Previous Device Log Icon. Press the ***** key for next.

Table 2. Soft Key Icons (Continued)

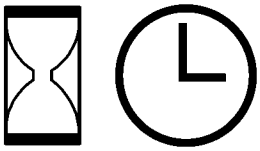
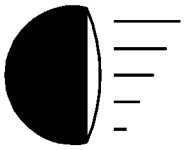
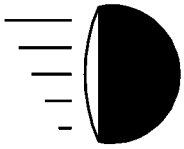
Icon	Description
	This icon points to the ***** key (the soft **Enter Key**) and is used to accept a value, command a calibration action, or restore defaults, depending on the context when the ***** key is pressed.
	Enable Current Item Icon. When the ***** key is pressed, the current item displayed will appear during the Operator Checklist sequence.
	Deactivate Soft Key Icon. Indicates function is deactivated. Press the ***** key to deactivate.
	“Enable” Traction and Hydraulics for Forklift Icon. Press the **2** key to enable.
	“Disable” Traction and Hydraulics for Forklift Icon. Press the **4** key to disable.
	Hazard Flashers Icon. Press the **#** key to toggle the hazard flashers on and off.
	Select system time for Fault Log event. Press the **1** key to select system time (this soft key toggles between system times and hour meters).
	Front Truck Lights Icon. Only available with CAN light controller. Press the **4** key to turn truck lights on.

Table 2. Soft Key Icons (Continued)

Icon	Description
	Rear Truck Lights Icon. Only available with CAN light controller. Press the **2** key to turn truck lights off.

OVERLAY ICONS

Icons that look like they are placed over another icon are called overlay icons. This type of icon always appears in conjunction with another icon, not by itself. Table 3 shows the overlay icons and describes how they are used.

Table 3. Overlay Icons

Icon	Description
	Null Symbol Icon. When this icon overlays another icon it indicates that a setting value is invalid or out-of-range.
	X Icon. This icon indicates that a feature has been deactivated (disabled).

ICONS ON SYSTEM OFF SCREEN AND ALERT SCREENS

The System Off Screen and the various Alert Screens appear only briefly. These screens also show interlocks such as Operator Not in Seat. Refer to System Off/Alert Screens for more information on these screens. The icons used in alert screens identify either status or warning conditions. Table 4 shows the icons that can appear on these screens.

Table 4. Alert Screen Icons

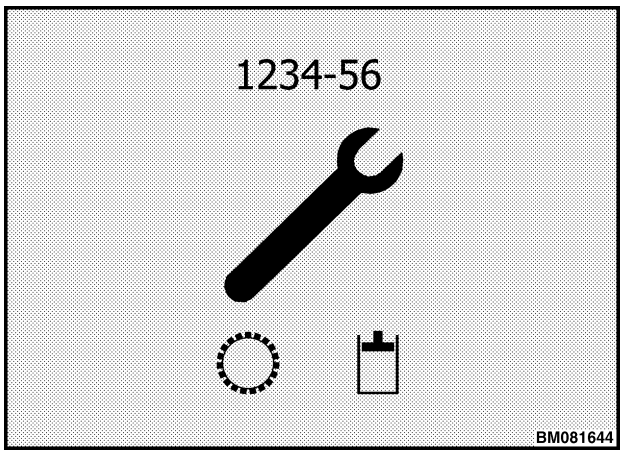
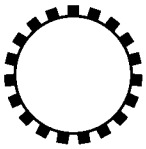
Icon	Description
Alert	
	
Example of a Fault Screen	
	Traction Icon
	Forklift Truck Icon
	Service Required Icon
	Hydraulics Icon

Table 4. Alert Screen Icons (Continued)

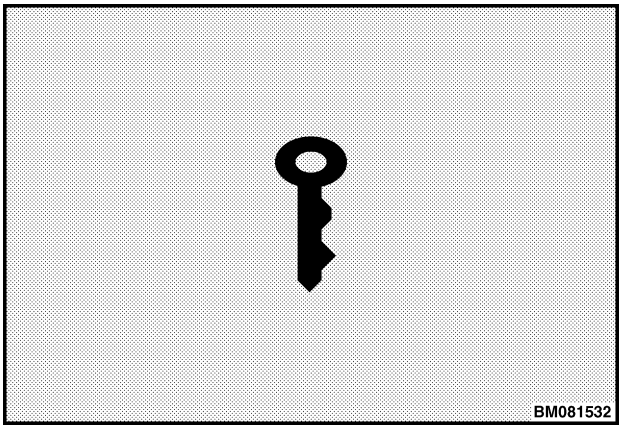
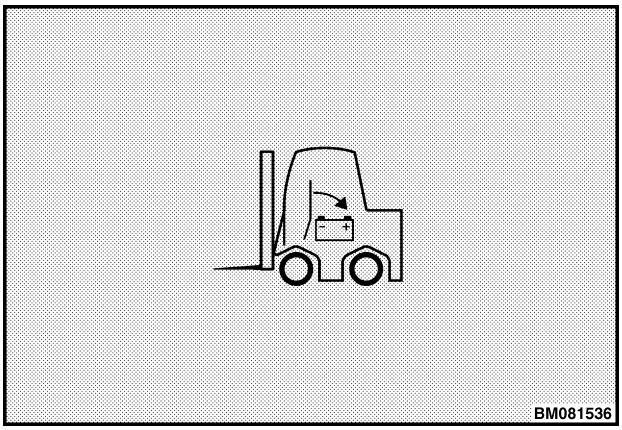
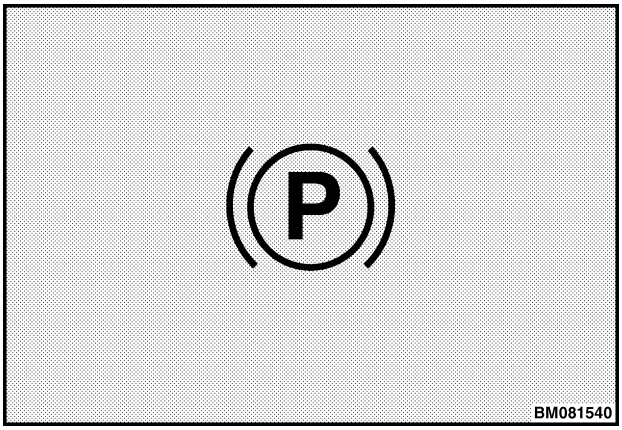
Icon	Description
Alert	
Alert Screens	
	Cycle the Key
	Secure Battery
	Release Park Brake

Table 4. Alert Screen Icons (Continued)

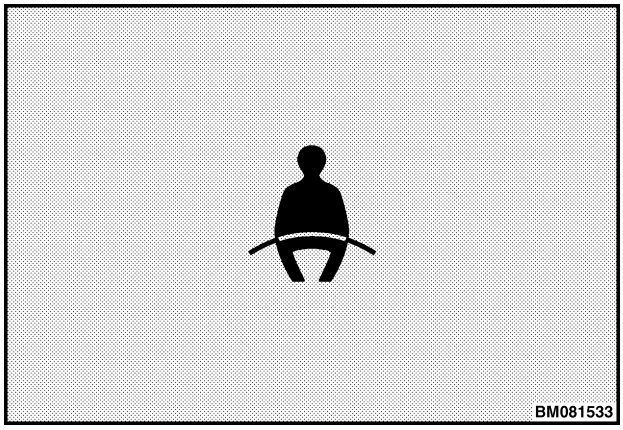
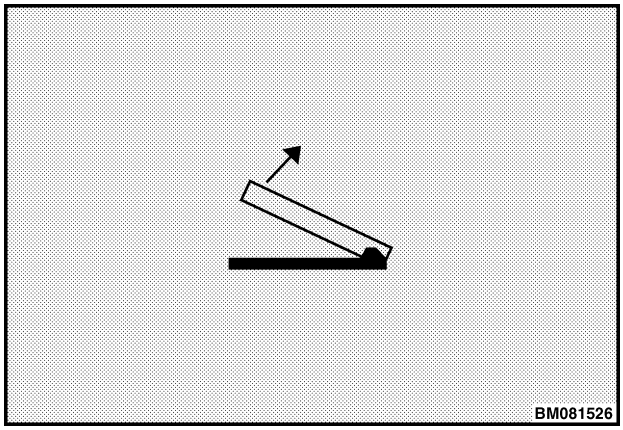
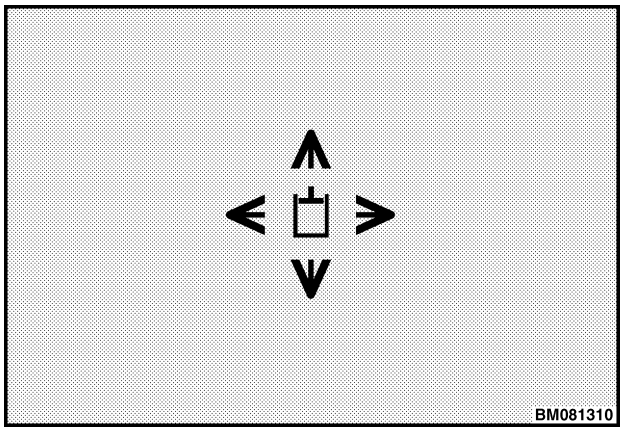
Icon	Description
Alert	
	Operator Out of Seat
	Release Pedal
	Release Hydraulic Input

Table 4. Alert Screen Icons (Continued)

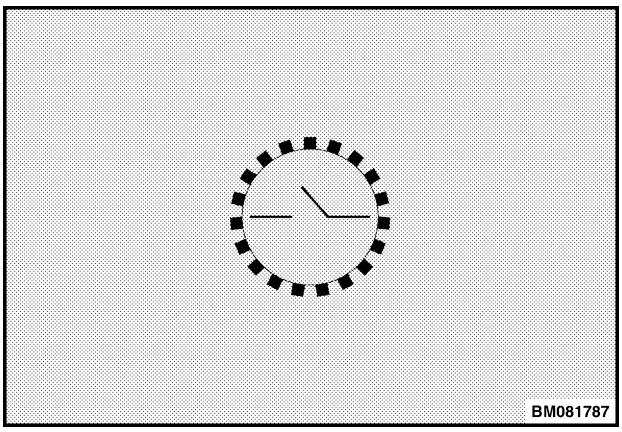
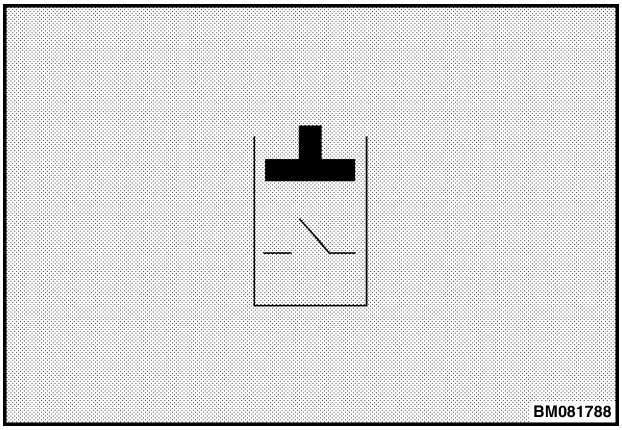
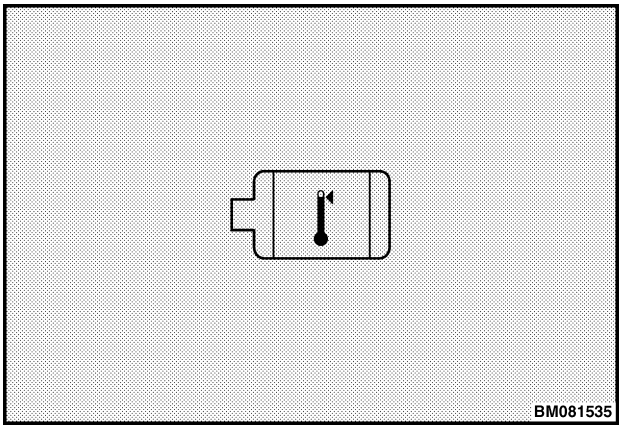
Icon	Description
Alert	
	Traction Switch
	Hydraulic Switch
	Temperature Too High

Table 4. Alert Screen Icons (Continued)

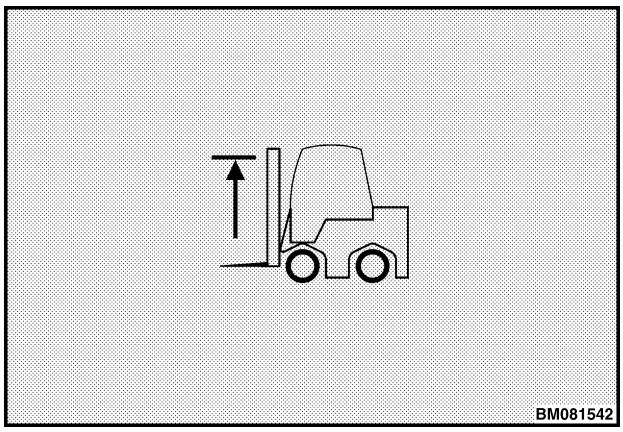
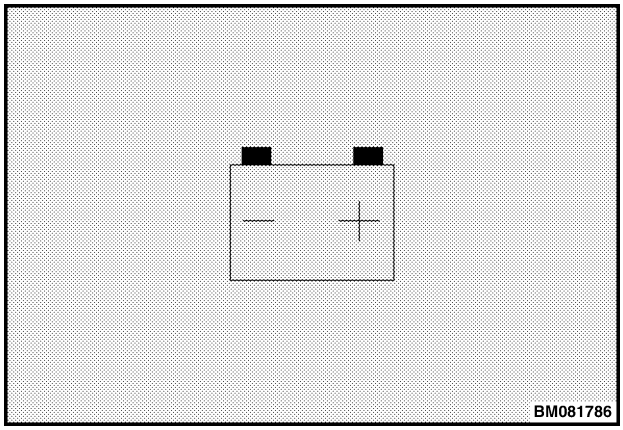
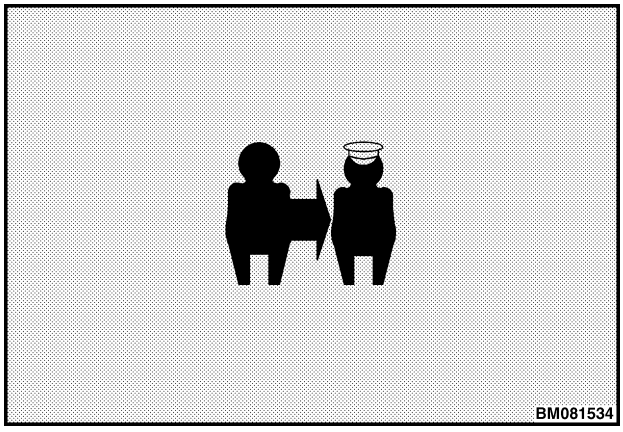
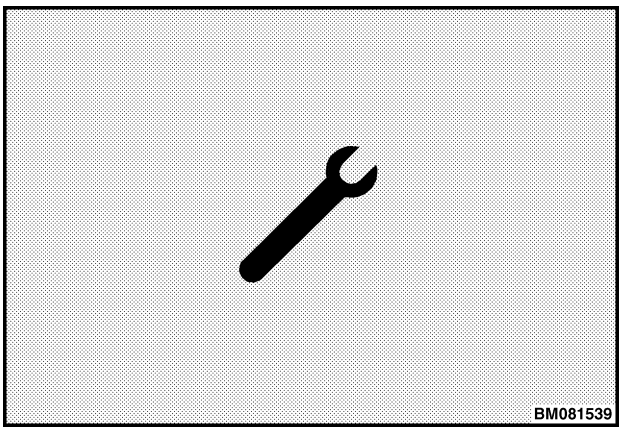
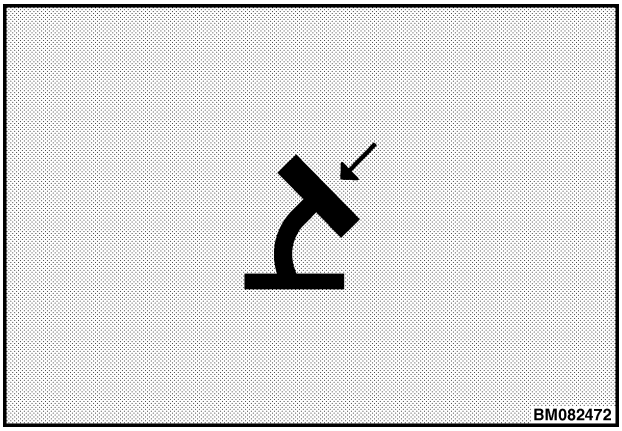
Icon	Description
Alert	
	Lift Limit
	Charge Battery
	Truck Locked — Impact Detected — See Supervisor to Unlock

Table 4. Alert Screen Icons (Continued)

Icon	Description
Alert	
	Fault Detected
	Service Brake Interlock

MAIN MENU TITLE SCREENS

All available menus are grouped by function under the main menu screens, which are also called top-level title menus. When you select a main menu screen, the system then presents submenus, also known as second-level menus, that you can cycle through until you find the one you want by pressing the **Scroll Back Key** (◂—) or **Scroll Forward Key** (—▸) on the Display Panel. Two main menu screens, the Operating Screen and the Password screen, have no associated submenus, but the other main menus lead to submenus.

When you are at the main menu level, pressing the **Scroll Back Key** takes you to the previous main menu screen. Pressing the **Scroll Forward Key** takes you to the next main menu screen. If you are in a submenu, pressing the **Scroll Back Key** or **Scroll Forward Key** returns you to the main menu screens. Table 5 presents the main menu screens.

Table 5. Main Menu Title Screens

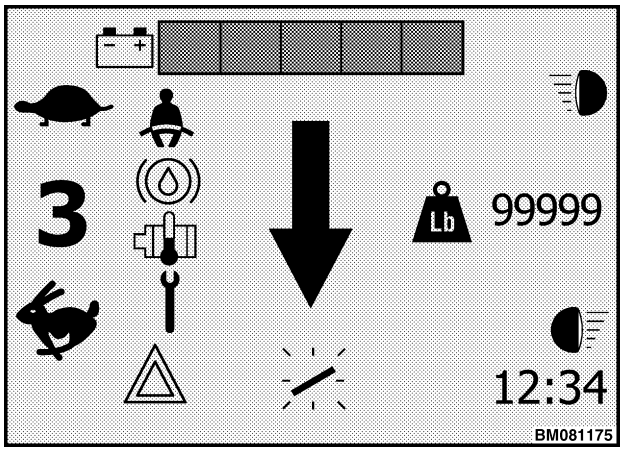
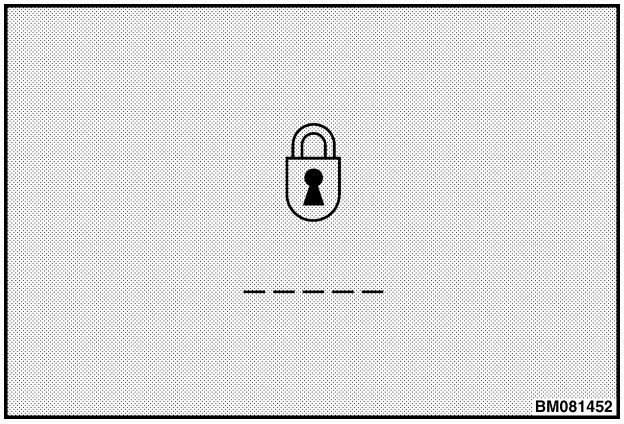
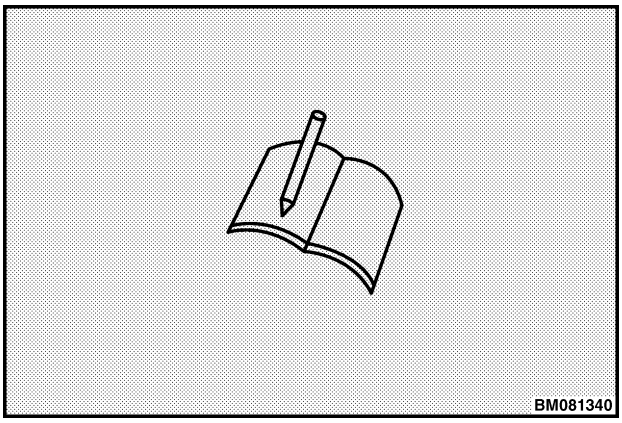
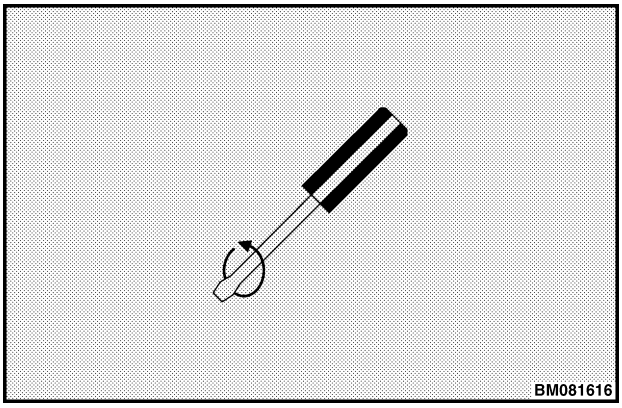
Operating Screen

NOTE: Icons for Front and Rear Lights are shown. These are optional features.
Password Screen


Table 5. Main Menu Title Screens (Continued)

Activity Log Title Screen



Calibration Title Screen



Display Title Screen

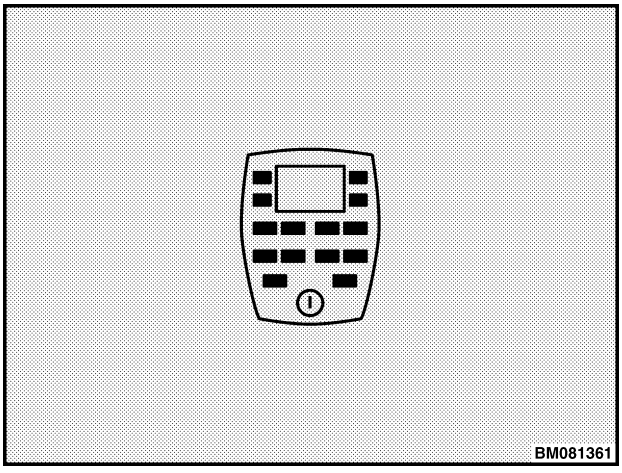
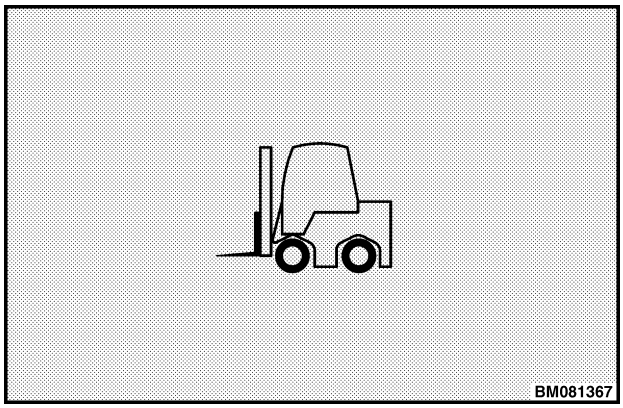
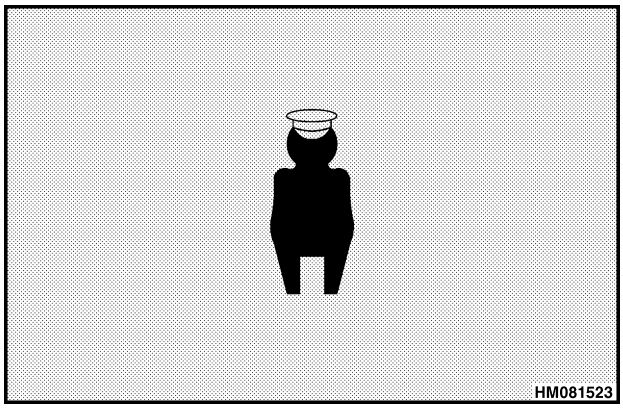


Table 5. Main Menu Title Screens (Continued)

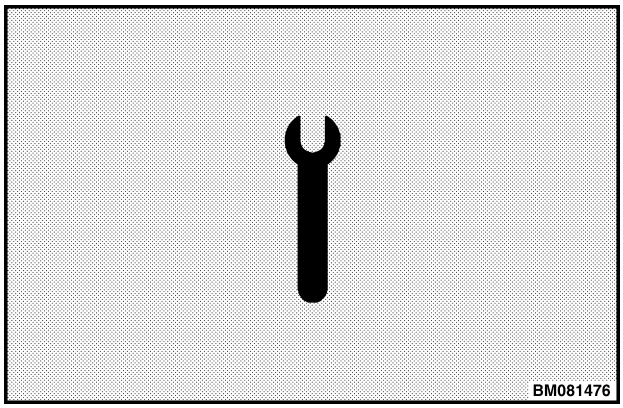
Status Title Screen



Truck Setup Title Screen



Diagnostics Title Screen



SUBMENU ICONS GROUPED BY MENU

This topic presents the icons used in submenus in groups, with one table for each title screen of the main menu.

Operating Screen Icons

Table 6 shows the icons that appear on the Operating Screen. Normally the icons convey status or operating information such as battery charge level, steer angle, front and rear work light soft keys, and system time. Sometimes icons are displayed to provide critical information, such as warnings. Refer to the Operating Screen topic for more information.

NOTE: The icons displayed on the Operating Screen vary from any one time to another, depending on the current operation of the lift truck and other factors. The Battery Discharge Indicator, system time, and direction indicator are always displayed.

Table 6. Operating Screen Icons

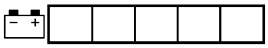
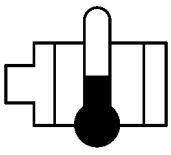
Icon	Description
	Hare Performance Mode Icon. Press the **1** or **#** soft key to increase performance. (The soft key to use depends on the currently displayed menu.)
	Tortoise Performance Mode Icon. Press the **3** soft key to decrease performance.
	Battery Discharge Indicator (BDI) Icon
	Seat Belt Warning Icon
	Brake Fluid Low Warning Icon
	Motor Temperature High Warning Icon

Table 6. Operating Screen Icons (Continued)

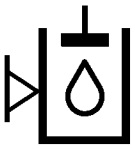
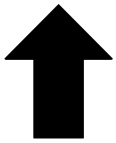
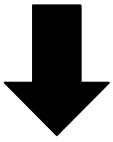
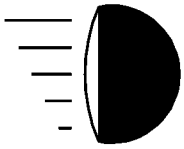
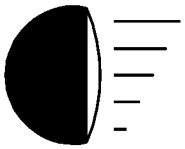
Icon	Description
	Hydraulic Fluid Level Low Warning Icon. (Displayed only on trucks that have the Hydraulic Filter Monitoring option.)
	Hydraulic Filter Warning (restriction) Icon. (Displayed only on trucks that have the Hydraulic Filter Monitoring option.)
	Service Due Soon Warning Icon
	Hazard Flashers Icon. See Table 2 for more information.
	Forward Direction Indicator Icon
	Neutral Indicator Icon
	Reverse Direction Indicator Icon
	Park Brake On Icon
	Steer Angle Indicator Icon

Table 6. Operating Screen Icons (Continued)

Icon	Description
	Rear Work Light Icon. This is an optional feature.
	Front Work Light Icon. This is an optional feature.
	Load Weight In Pounds (lb) Icon
	Load Weight In Kilograms (kg) Icon
99999	Load Weight Readout (example)
12:34	System Time Readout (example)

Password Screen Icons

The Password Screen has only one icon, which is shown in Table 7. If the truck is equipped with Operator Passwords enabled, the Password Screen is the first screen to appear when you turn on the key switch or turn the keyless switch to the **ON** position. See the Passwords Screen topic for more information.

Table 7. Password Screen Icons

Icon	Description
	Password Lock Icon

Table 7. Password Screen Icons (Continued)

Icon	Description
A field with five blanks appears below the Password Lock Icon. See Figure 2.	

Activity Log Submenu Icons

Table 8 presents the icons that appear on the Activity Log Submenus. These icons provide status information or numeric information. Refer to Activity Log Menu for more information.

Table 8. Activity Log Submenus and Icons

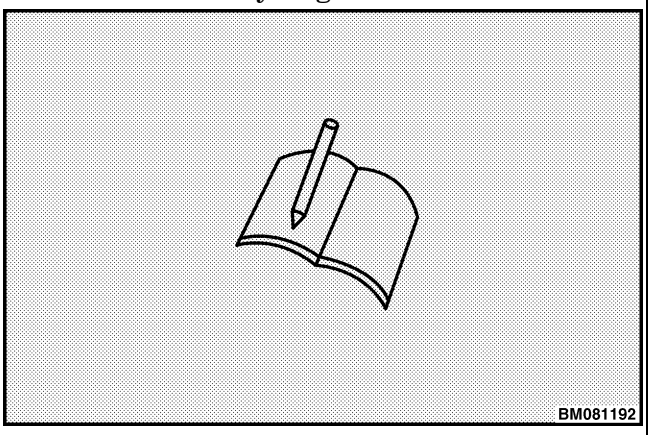
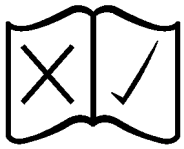
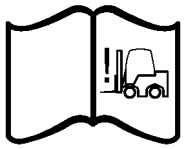
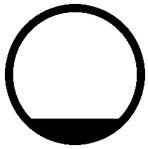
Icon	Description
Activity Log Submenus 	
	**Operator Checklist Log Submenu**
	Password Log Submenu
	**Impact Events Log Submenu**
	Empty Log Icon

Table 8. Activity Log Submenus and Icons (Continued)

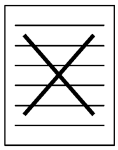
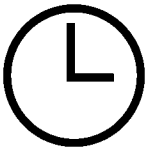
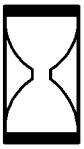
Icon	Description
	Checklist Failed Icon
	Checklist Passed Icon
	Password Lock Icon
*****	Hidden or "no password" Field Log Entry Icon
	Clock Icon for occurrence date
	Hourglass Icon for system time
	Operator Password Type Icon
	Supervisor Password Type Icon
	Service Password Type Icon

Table 8. Activity Log Submenus and Icons (Continued)

Icon	Description
	Soft Impact Type Icon
	Hard Impact Type Icon

Calibration Submenu Icons

Table 9 presents the icons that appear on the Calibration Submenus. See Calibration Menu for more information.

Table 9. Calibration Submenus and Icons

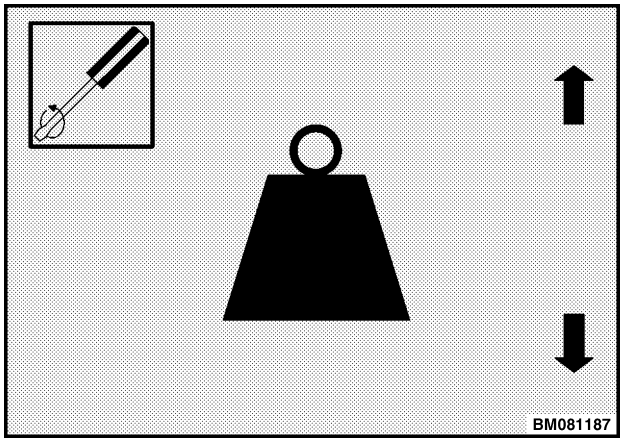
Icon	Description
Load Weight Display Submenu 	
	"Position Empty Forks To Load Weight Height" Prompt Icon
	"Enter Known Load Weight" Prompt Icon

Table 9. Calibration Submenus and Icons (Continued)

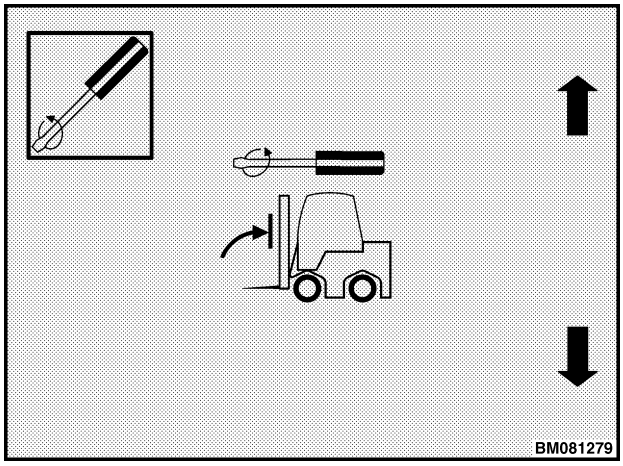
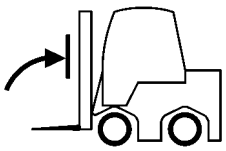
Icon	Description
	"Position Load Weight To Height" Prompt Icon
	"Known Load Weight Value (lb)" Prompt Icon
	"Known Load Weight Value (kg)" Prompt Icon
	This icon points to the * key (the Enter soft key) and is used for load weight calibration in this submenu.
Return to Set Tilt Stop Point Submenu 	
	Return to Set Tilt (RTST) Set Point Prompt Icon
	This icon points to the * key and is used for RTST calibration in this submenu.

Table 9. Calibration Submenus and Icons (Continued)

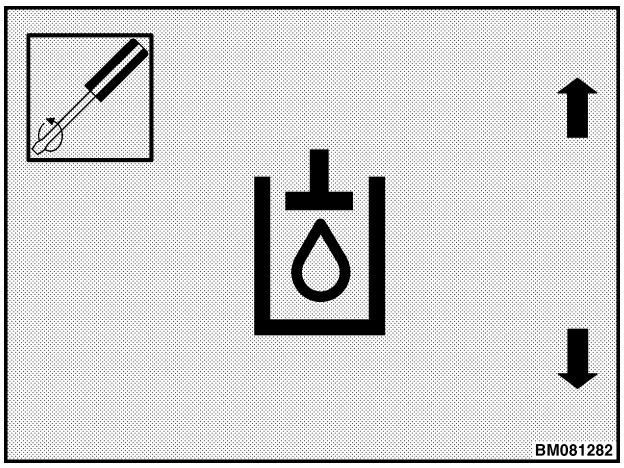
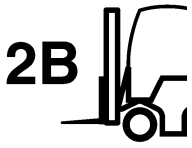
Icon	Description
Valve Threshold Submenu 	
	Valve Threshold Function 1 "A" Direction Prompt Icon
	Valve Threshold Function 1 "B" Direction Prompt Icon
	Valve Threshold Function 2 "A" Direction Prompt Icon
	Valve Threshold Function 2 "B" Direction Prompt Icon
	Valve Threshold Function 3 "A" Direction Prompt Icon
	Valve Threshold Function 3 "B" Direction Prompt Icon

Table 9. Calibration Submenus and Icons (Continued)

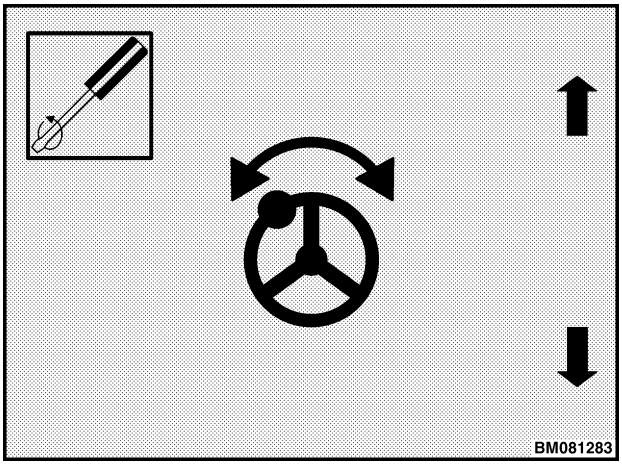
Icon	Description
	Valve Threshold Function 4 "A" Direction Prompt Icon
	Valve Threshold Function 4 "B" Direction Prompt Icon
	This icon points to the * key and is used for valve calibration in this submenu.
Steering Wheel Knob Center Point Submenu 	
	Center Steering Wheel Prompt Icon
	This icon points to the * key and is used for steering wheel center point calibration in this submenu.

Table 9. Calibration Submenus and Icons (Continued)

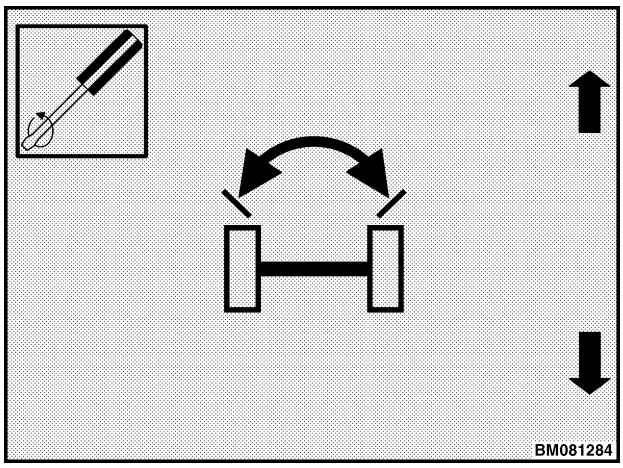
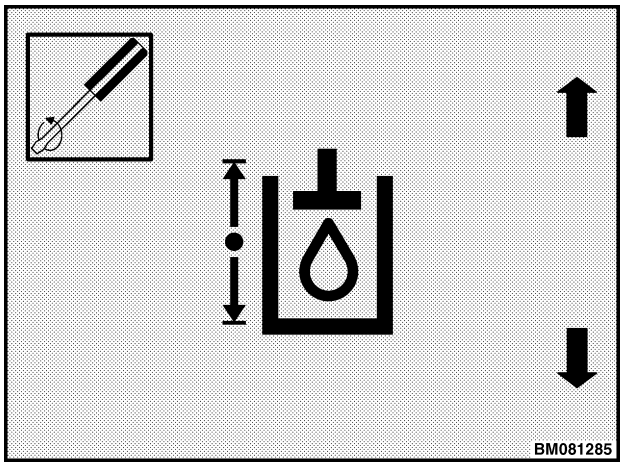
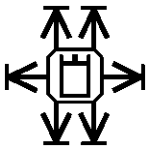
Icon	Description
Steer Axle Position Submenu 	
	Steering Wheel Full Left Prompt Icon
	Steering Wheel Full Right Prompt Icon
	This icon points to the * key and is used for steer axle position in this submenu.
Manual Hydraulics Submenu 	

Table 9. Calibration Submenus and Icons (Continued)

Icon	Description
	Manual Hydraulic End Point Calibration Prompt Icon
	This icon points to the * key and is used for manual hydraulic end point calibration in this submenu.

Display Submenu Icons

Table 10 presents the icons that appear on the Display Submenus. Refer to Display Menu for more information.

Table 10. Display Submenus and Icons

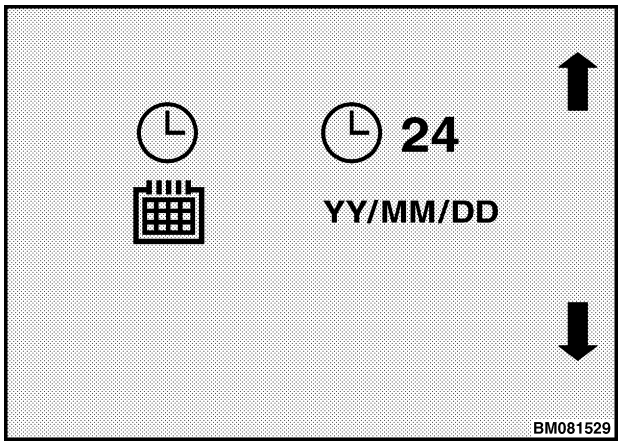
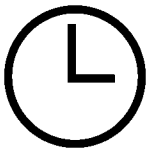
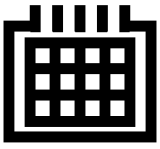
Icon	Description
Set Date and Time Format Submenu 	
	Clock Icon for setting time
	Calendar Icon for setting date

Table 10. Display Submenus and Icons (Continued)

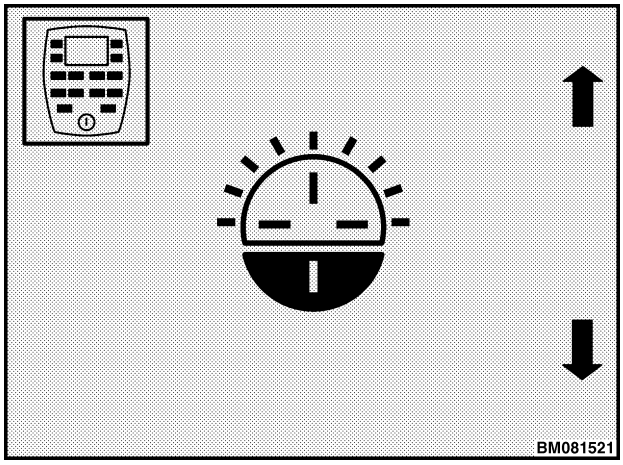
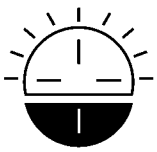
Icon	Description
	24-Hour Clock Icon
	12-Hour Clock Icon
DD/MM/YY	DD/MM/YY (Europe) Date Format Icon
MM/DD/YY	MM/DD/YY (USA) Date Format Icon
YY/MM/DD	YY/MM/DD (ISO 8601) Date Format Icon
Set Daylight Savings Submenu 	
	Daylight Savings Adjustment Enable Icon

Table 10. Display Submenus and Icons (Continued)

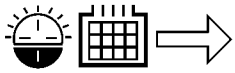
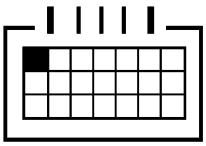
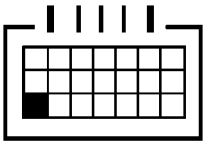
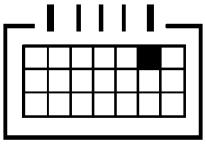
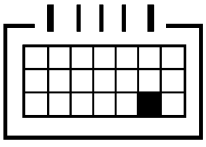
Icon	Description
	Daylight Savings Start Month Indicator Icon
	Daylight Savings Start Day Indicator Icon
	Daylight Savings End Month Indicator Icon
	Daylight Savings End Day Indicator Icon
	First Sunday Icon
	Last Sunday Icon
	First Friday Icon
	Last Friday Icon
NOTE: Not all icons for setting daylight savings time are shown. The four icons above serve as examples of the 14 variations.	

Table 10. Display Submenus and Icons (Continued)

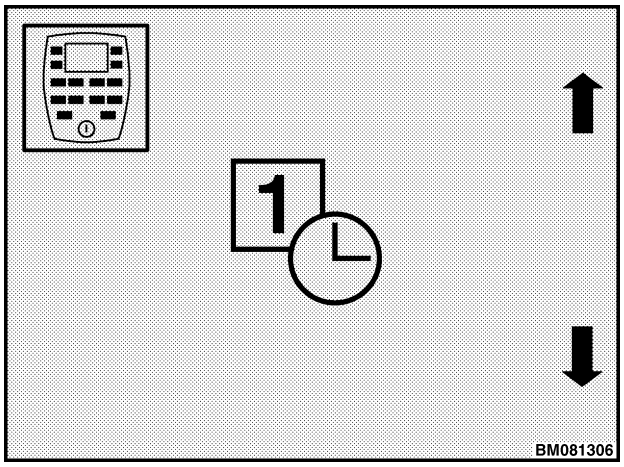
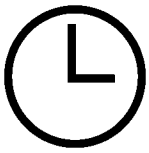
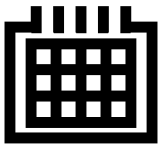
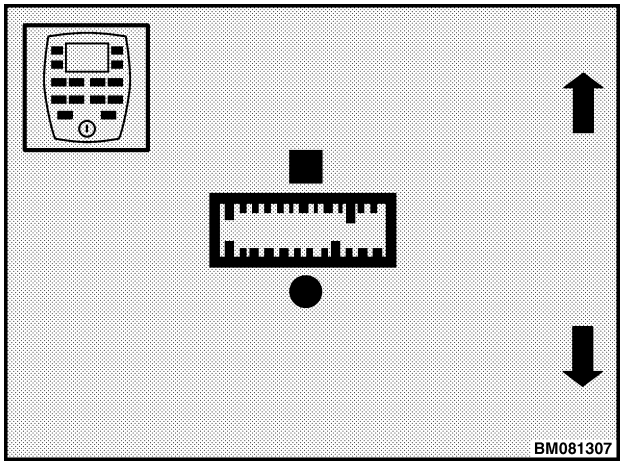
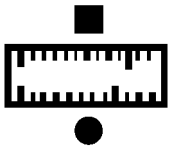
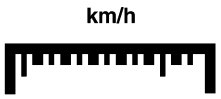
Icon	Description
Set Time and Date Submenu	
	
	Clock Icon for setting time
	Calendar Icon for setting date
Set Units Submenu	
	
	Set Units Icon

Table 10. Display Submenus and Icons (Continued)

Icon	Description
	Imperial Units Indicator Icon
	Metric Units Indicator Icon

Status Submenu Icons

Table 11 presents the icons that appear on the Status Submenus. See Status Menu for more information.

Table 11. Status Submenus and Icons

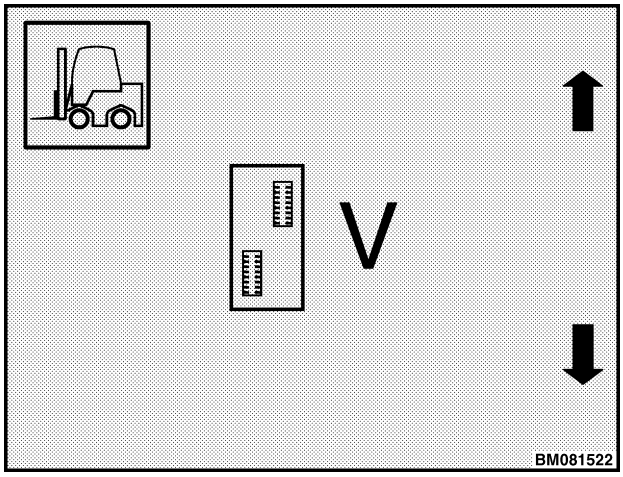
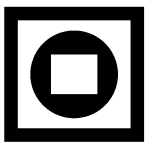
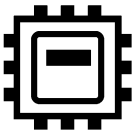
Icon	Description
Vehicle System Manager (VSM) Version Submenu	
	
	Hardware Version Indicator Icon
	Software Version Indicator Icon
Display Version Menu	

Table 11. Status Submenus and Icons (Continued)

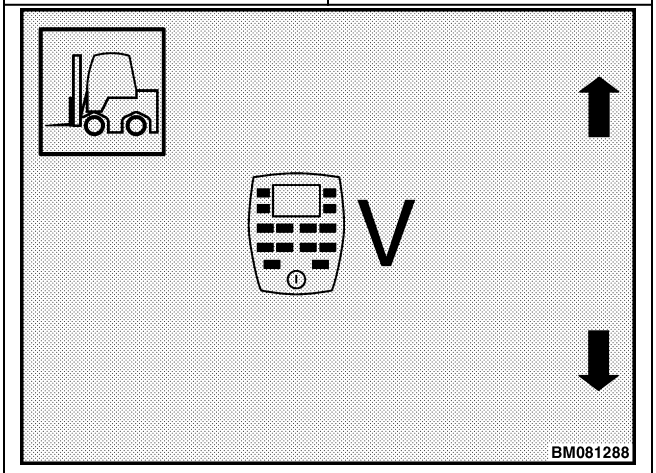
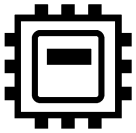
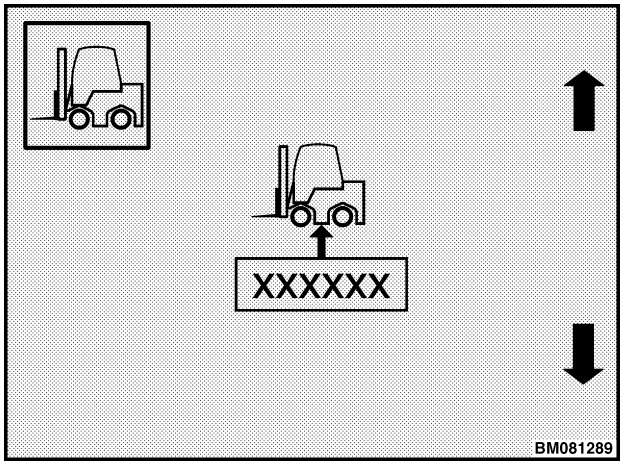
Icon	Description
	
	Hardware Version Indicator Icon
	Software Version Indicator Icon
Truck Serial Number Submenu	
	
#	Truck Serial Number Symbol Icon

Table 11. Status Submenus and Icons (Continued)

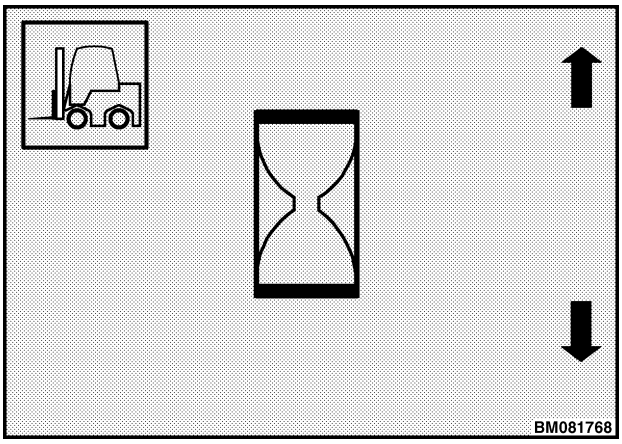
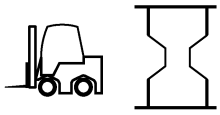
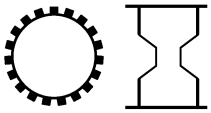
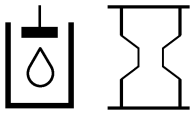
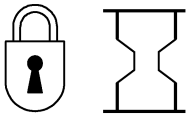
Icon	Description
Hour Meters Submenu	
	
	Truck Hour Meter Icon
	Traction Hour Meter Icon
	Pump Hour Meter Icon
	Secure Hour Meter Indicator Icon

Table 11. Status Submenus and Icons (Continued)

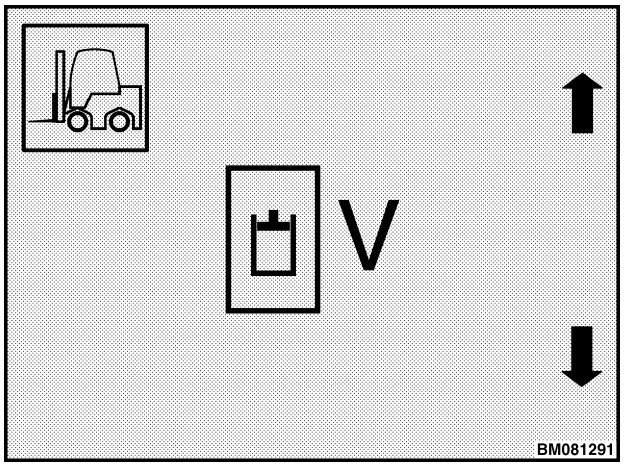
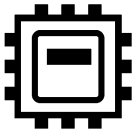
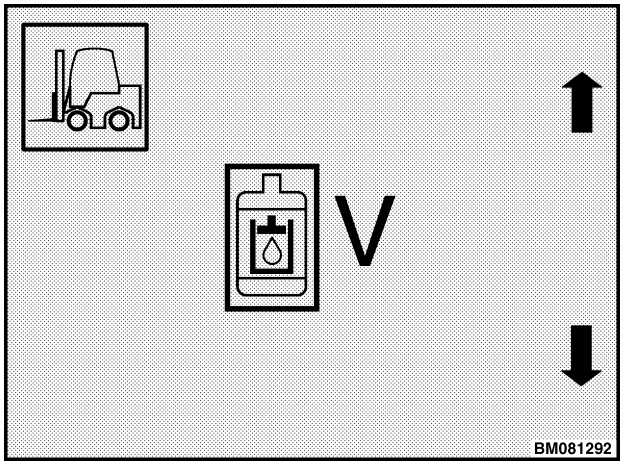
Icon	Description
E-Hydraulic Controller Version Submenu	
	
	Hardware Version Indicator Icon
	Software Version Indicator Icon
Pump Motor Controller Version Submenu	
	
	Hardware Version Indicator Icon

Table 11. Status Submenus and Icons (Continued)

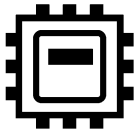
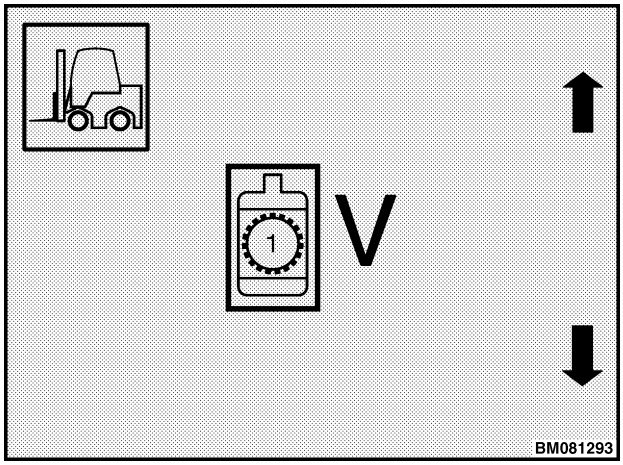
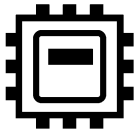
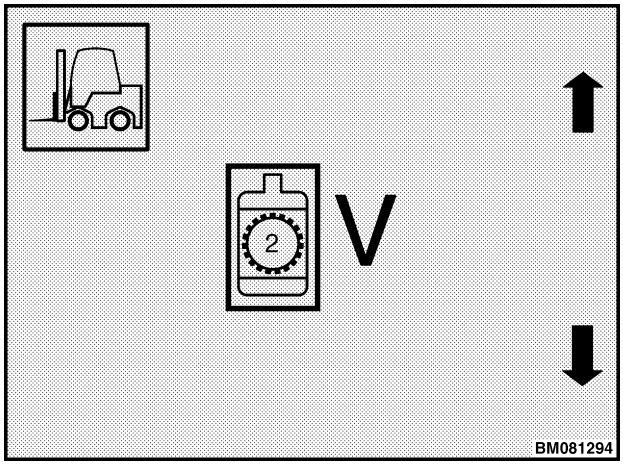
Icon	Description
	Software Version Indicator Icon
Traction Controller 1 Version Submenu	
	
	Hardware Version Indicator Icon
	Software Version Indicator Icon
Traction Controller 2 Version Submenu	
	

Table 11. Status Submenus and Icons (Continued)

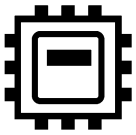
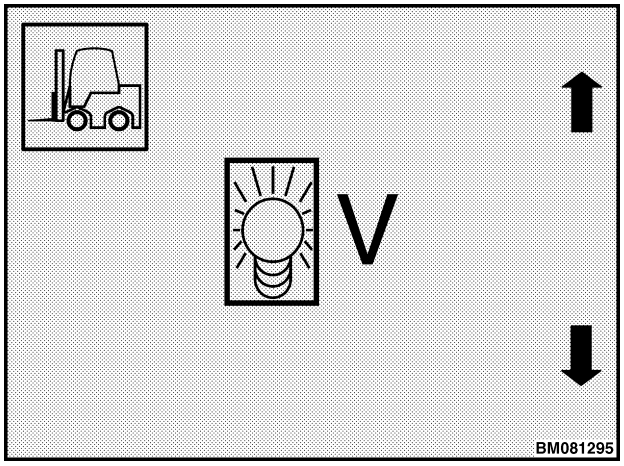
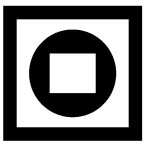
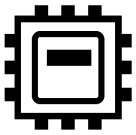
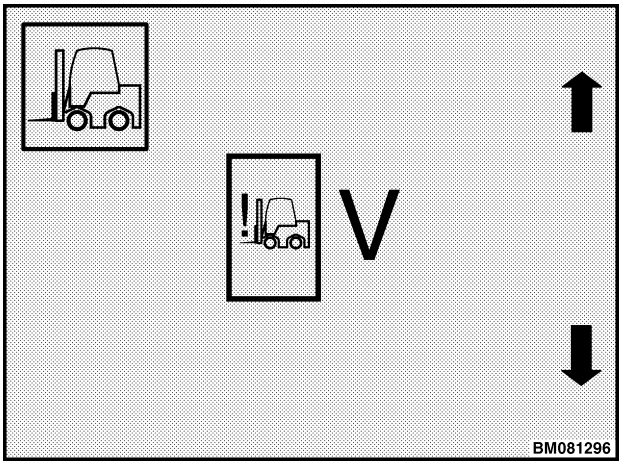
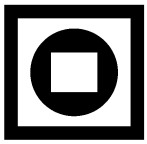
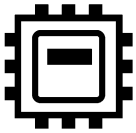
Icon	Description
	Hardware Version Indicator Icon
	Software Version Indicator Icon
Light Controller Version Submenu	
	
	Hardware Version Indicator Icon
	Software Version Indicator Icon

Table 11. Status Submenus and Icons (Continued)

Icon	Description
Impact Sensor Version Submenu	
	
	Hardware Version Indicator Icon
	Software Version Indicator Icon

Truck Setup Submenu Icons

Table 12 presents the icons that appear on the Truck Setup Submenus. See Truck Setup Menu for more information.

Table 12. Truck Setup Submenu Icons

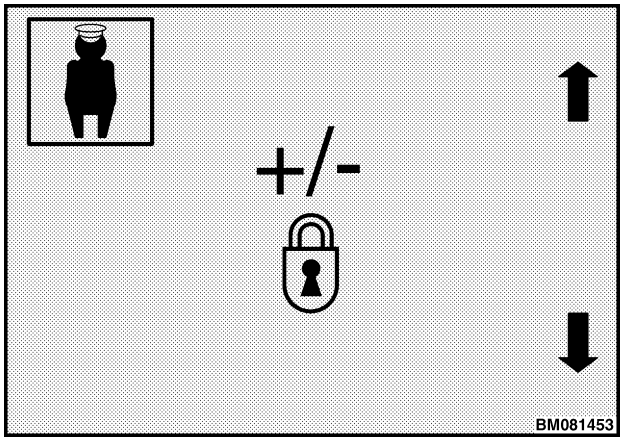
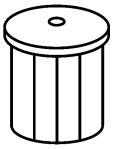
Icon	Description
Add/Remove Password Submenu	
	
	Password Icon
	Null Symbol Icon
	Supervisor Password Type Icon
	Trash Can Icon
	Hare (increase performance) Icon

Table 12. Truck Setup Submenu Icons (Continued)

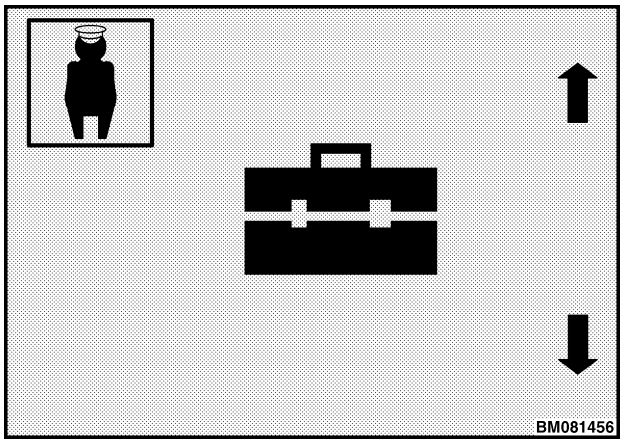
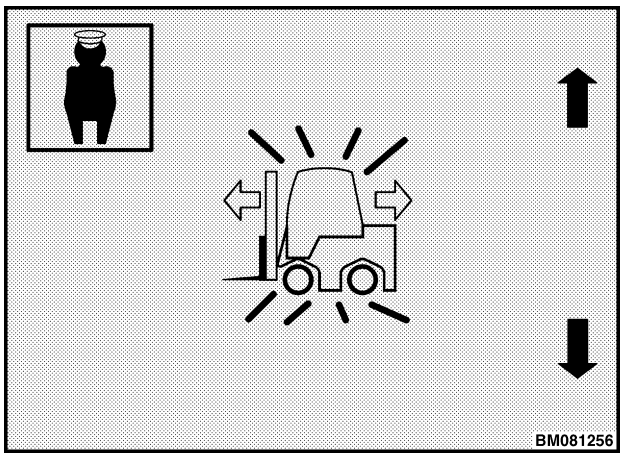
Icon	Description
Restore Defaults Submenu	
	
	Restore Defaults Icon
	This icon points to the * key and is used for restoring defaults in this submenu.
Motion Alarm Submenu	
	
	Motion Alarm Indicator Icon

Table 12. Truck Setup Submenu Icons (Continued)

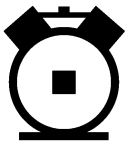
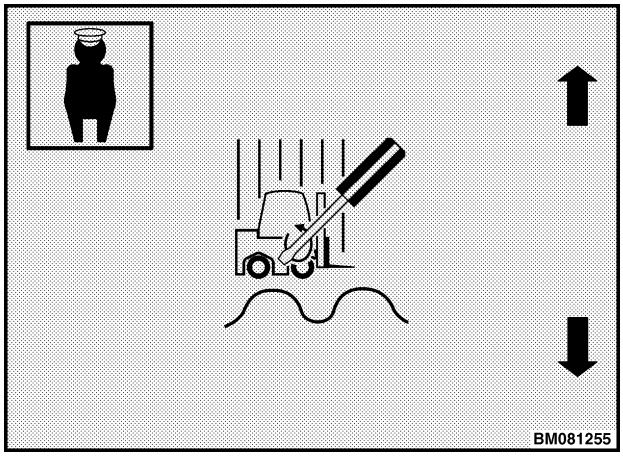
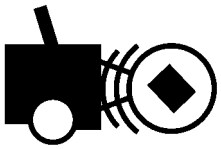
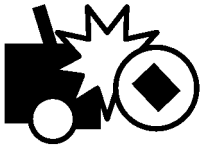
Icon	Description
	Motion Alarm Indicator Disabled Icon. The X over the icon means the motion alarm is deactivated (turned off).
	Motion Alarm Clock Icon
Impact Monitor Settings Submenu	
	
	Soft Impact Force Icon
	Soft Impact Time Icon
	Hard Impact Force Icon
	Hard Impact Time Icon

Table 12. Truck Setup Submenu Icons (Continued)

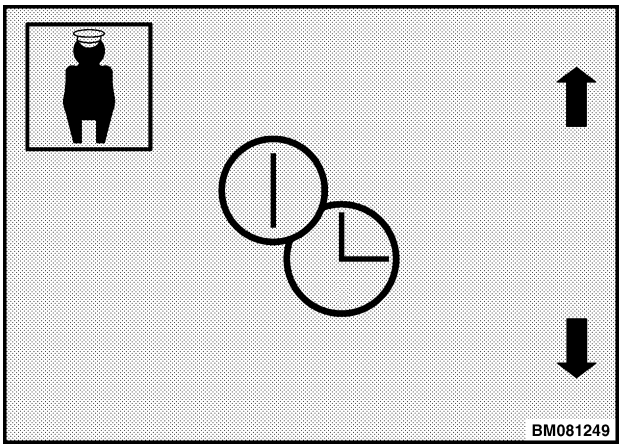
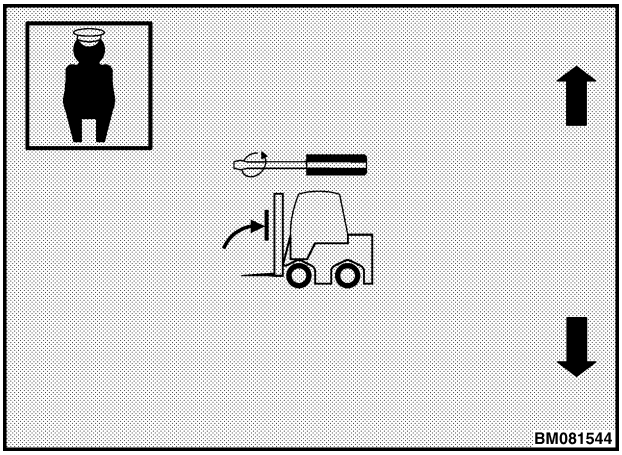
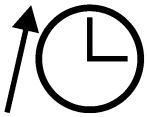
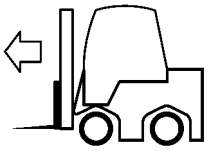
Icon	Description
Auto Power-Off Time Delay Submenu	
	
	Auto Power-off Time Delay Indicator Icon
Return to Set Tilt (RTST) Submenu	
	
	Return To Set Tilt Delay Icon
	Return To Set Tilt Truck Icon

Table 12. Truck Setup Submenu Icons (Continued)

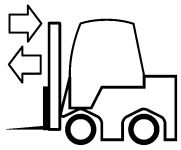
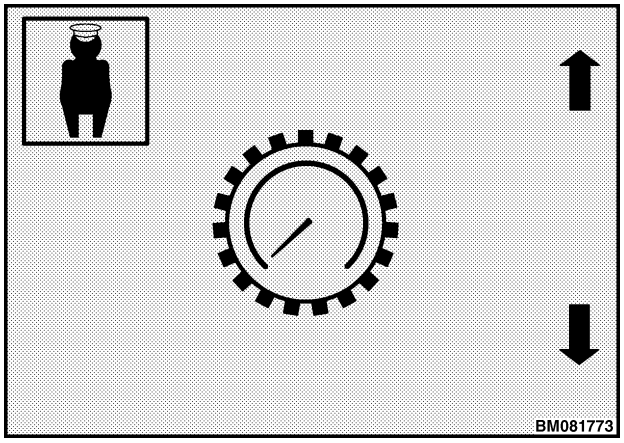
Icon	Description
	Tilt Both Ways Icon
∞	Infinity Symbol Icon
Traction Speed Limit Submenu	
	
	Forward MPH Icon
	Reverse MPH Icon
	Forward km/h Icon
	Reverse km/h Icon

Table 12. Truck Setup Submenu Icons (Continued)

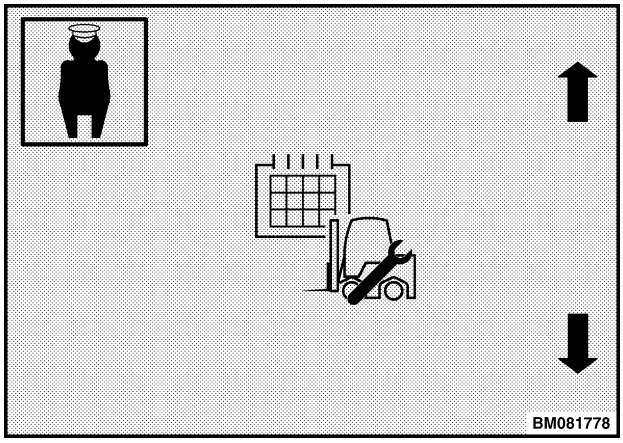
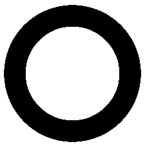
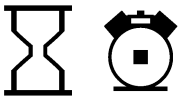
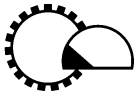
Icon	Description
Scheduled Maintenance Reminder Submenu	
	
	Scheduled Maintenance Reminder, enabled (ON)
	Scheduled Maintenance Reminder, disabled (OFF)
	Interval Month Setting Icon
	Interval Hourmeter Setting Icon
	Derated Traction Speed Icon

Table 12. Truck Setup Submenu Icons (Continued)

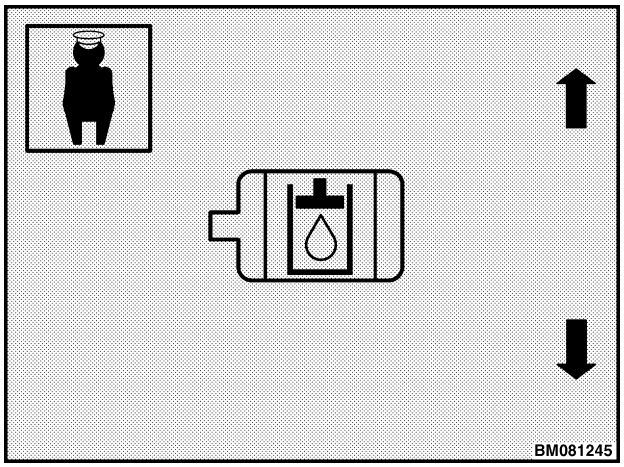
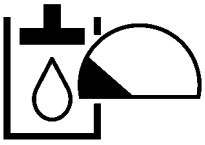
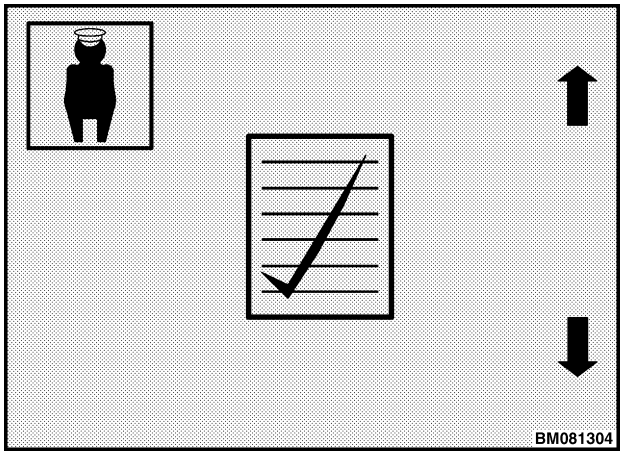
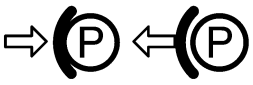
Icon	Description
Minimum Pump Standby Submenu	
	
	Minimum Standby Pump Flow Rate Icon
Operator Checklist Submenu	
	
Note: The icons displayed when using this submenu correspond to the submenu icons for the various functions. Up to 30 checklist items can be enabled for the Operator Checklist.	
	Check Park Brake Icon

Table 12. Truck Setup Submenu Icons (Continued)

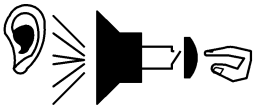
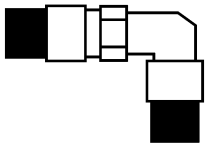
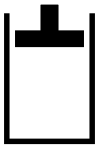
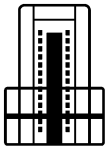
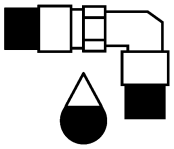
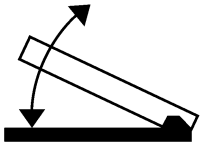
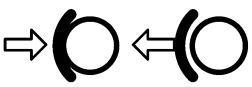
Icon	Description
	Check Fuses Icon
	Check Horn Icon
	Check Hoses Icon
	Check Hydraulics Icon
	Check Mast Icon
	Check for Leaks Icon
	Check Operator Restraint Icon
	Check Pedal Movement Icon
	Check Service Brake Icon

Table 12. Truck Setup Submenu Icons (Continued)

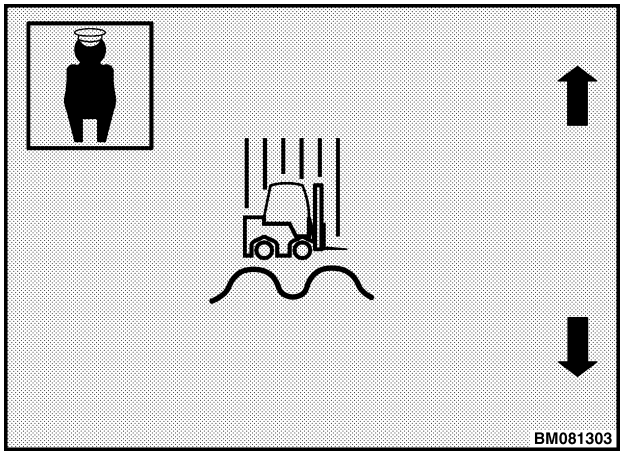
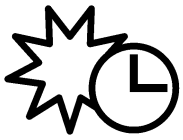
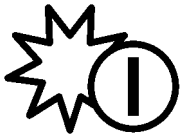
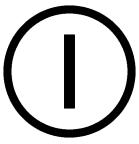
Icon	Description
	Press the * key (**Enter Key**) below this icon to indicate proper operation of the current checklist item.
	Press the * key below this icon to indicate improper operation of the current checklist item (to indicate a problem with it).
Impact Monitor Shutdown Submenu 	
	Impact Shutdown Delay Icon
	Impact Shutdown Type Icon
	Impact Detection Icon
	ON Icon

Table 12. Truck Setup Submenu Icons (Continued)

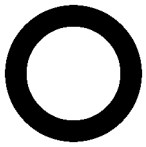
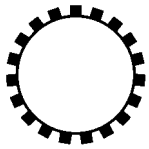
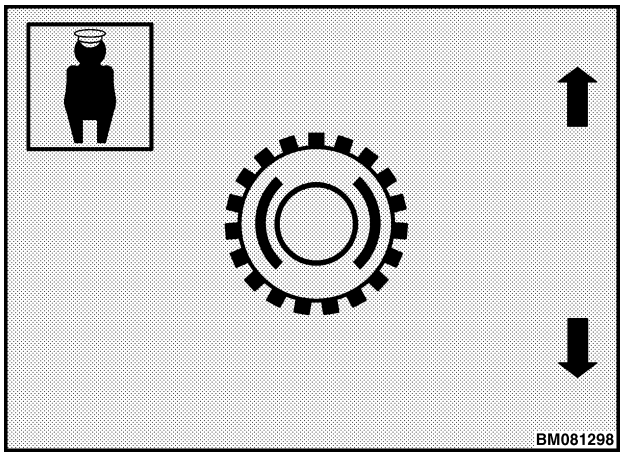
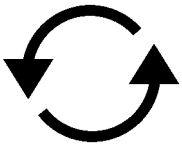
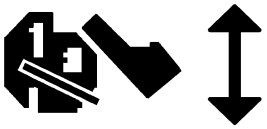
Icon	Description
	OFF Icon
	Disable Traction Icon
	Disable All Icon
Motor Braking Submenu 	
	Regenerative Braking Indicator Icon
	Automatic Deceleration Rate Indicator Icon
	Deceleration Type Indicator Icon

Table 12. Truck Setup Submenu Icons (Continued)

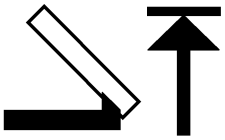
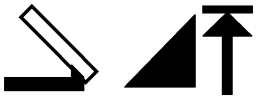
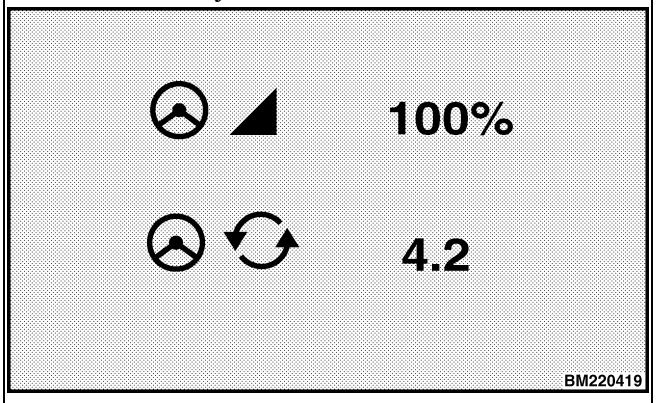
Icon	Description
	Pedal Up Setting Icon. This setting lets the lift truck coast until the pedal is fully released.
	Proportional Setting Icon. With this setting, the lift truck decelerates in proportion to how far the pedal is released in relation to the current traction speed.
	Supervisor Icon
Steering Wheel Friction and Steering Turns Adjustment Submenu 	
	Steering Wheel Friction Icon
	Steering Wheel Number of Turns Icon
	Supervisor Icon

Table 12. Truck Setup Submenu Icons (Continued)

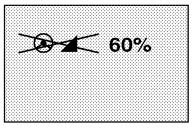
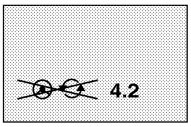
Icon	Description
	Steering Wheel Icon
	E-Steer Setting Out of Range Icon

Table 12. Truck Setup Submenu Icons (Continued)

Icon	Description
	Steering Turns Out of Range Icon

Operating Screen

INTRODUCTION

The Operating Screen, shown in Figure 9, is located on the Display Panel along with the numeric keys and control keys. At key-on, the Password Screen is the first screen displayed unless Operator Passwords are disabled. After a valid password is entered, the Operating Screen appears by default. The Operating Screen uses small graphic images, called icons, to provide continuous feedback to the lift truck operator. This feedback includes performance settings, status and warning messages, and essential truck operating information. The Operating Screen is active at all times during normal lift truck operation.

NOTE: Icons for the front and rear work lights are shown. These are optional features.

The icons, indicators, and numbers on the Operating Screen are explained in the topics that follow.

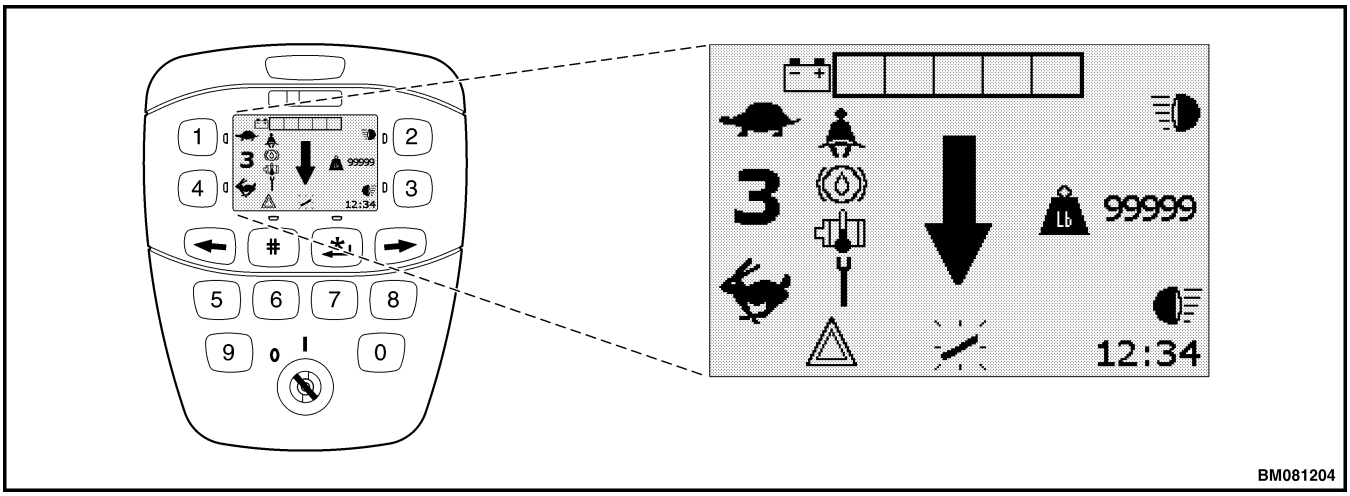
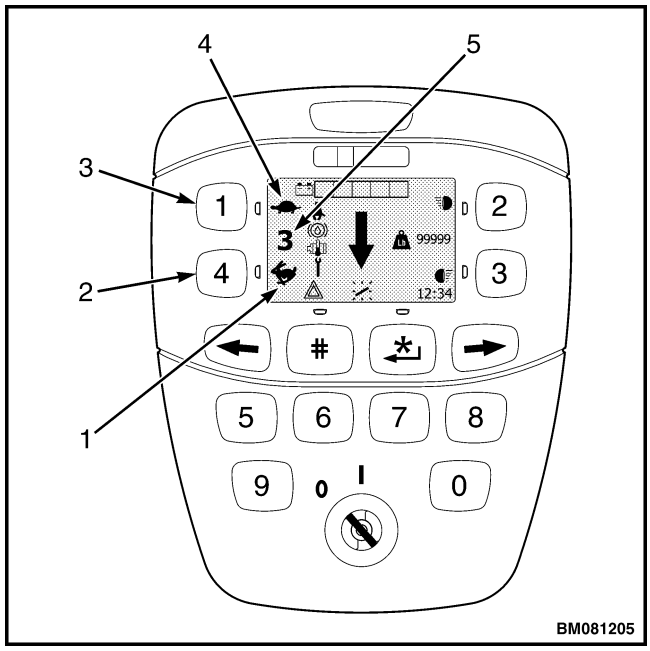


Figure 9. Operating Screen

PERFORMANCE MODE CONTROLS

The Performance Mode controls are shown in Figure 10.



1. PERFORMANCE MODE INDICATOR - INCREASE
2. PERFORMANCE MODE SOFT KEY - INCREASE
3. PERFORMANCE MODE SOFT KEY - DECREASE
4. PERFORMANCE MODE INDICATOR - DECREASE
5. CURRENT PERFORMANCE MODE

Figure 10. Performance Mode Controls

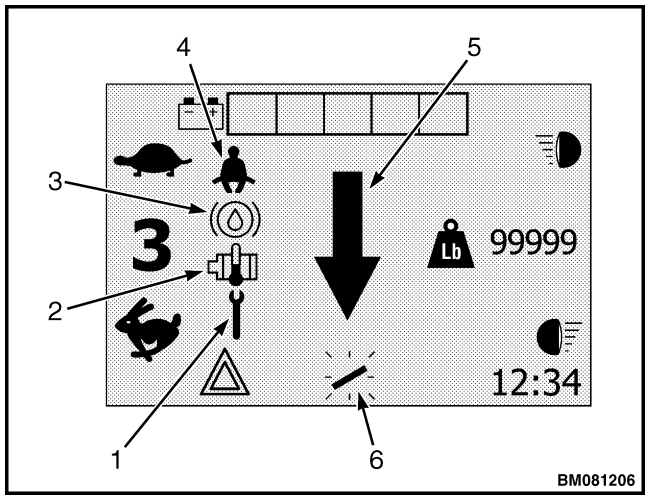
The current performance mode is shown on the Operating Screen. There are four available performance modes, numbered 1, 2, 3, and 4. Performance mode 4 provides the maximum performance. If passwords are enabled, the last active performance mode on the truck is displayed on the screen when the truck is powered On, unless the current operator has been assigned a lower available performance mode. The maximum performance mode allowed for each operator is set by the Supervisor or Service Technician during the Add/Remove Password section of Truck Setup. See the Password Screen topic for more information. Depending on the maximum performance mode allowed, it may be possible for the operator to use the Performance Mode soft keys on the Display Panel to change the current performance mode.

- MODE 4 - This is the highest performance mode. Other modes are a lower percentage of Mode 4.
- MODE 3 - Top speed is the same as Mode 4. Acceleration is 80 percent of Mode 4.
- MODE 2 - Top speed is 80 percent of Mode 4. Acceleration is 70 percent of Mode 4.
- MODE 1 - Top speed is 60 percent of Mode 4. Acceleration is 60 percent of Mode 4.

Pressing the "Hare" soft key, **4**, increases the current mode and pressing the "Tortoise" soft key, **1**, decreases the current mode, assuming performance mode change is available to the current operator. The performance mode can be changed only when both the hydraulic and direction controls are in Neutral and the truck is stopped. If a performance mode change is attempted at a time when either of these conditions is not met, the newly selected mode will flash and the change will not occur until the necessary conditions are met.

STATUS AND WARNING ICONS

When the truck is powered **ON**, the system continuously monitors a number of parameters and displays up to six icons to provide status information and warnings to the operator, as shown in Figure 11. Also see the Table 6 topic.



1. SERVICE DUE
2. MOTOR TEMPERATURE HIGH
3. BRAKE FLUID LOW WARNING
4. SEAT BELT WARNING
5. DIRECTION / PARK BRAKE INDICATORS
6. STEER ANGLE

Figure 11. Status and Warning Icons

NOTE: Icons for front and rear lights are shown. These are optional features.

Depending on conditions, the following icons can appear in this area (see the Table 6 topic):

- Wrench Icon
- Temperature High Icon
- Brake Fluid Low Icon
- Hydraulic Fluid Level Icon
- Hydraulic Filter Icon
- Fasten Seat Belt Icon

When the wrench icon is continuously **ON**, it means that scheduled maintenance is due. When it is flashing, it indicates that an active fault has been detected by the system. The wrench icon appears in the bottom location of the status/warning icon area when it is displayed. It has the lowest priority of the three icons, wrench, hydraulic filter, or hydraulic fluid level, that can be displayed in this location.

The hydraulic filter icon shows in the same location, in place of the wrench icon, if a hydraulic filter restriction is detected. It has the second highest priority of the three icons that can be displayed in this location.

The hydraulic fluid level icon shows in the same location, in place of the wrench icon or the hydraulic filter icon, if a low level is detected in the hydraulic fluid reservoir. It has the highest priority of the three icons that can be displayed in this location.

The motor temperature high icon is displayed if a high motor temperature is detected, meaning that the motor temperature of one of the motors or motor controllers has gone above the defined threshold temperature.

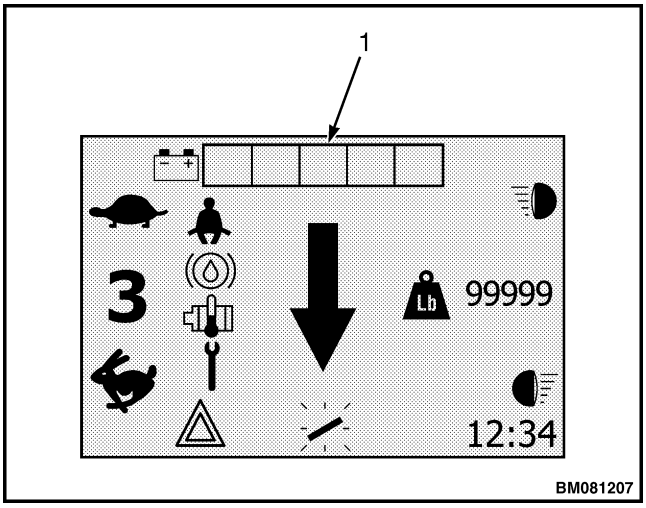
The brake fluid low icon is displayed if a low level is detected in the brake fluid reservoir.

The fasten seat belt icon is displayed for the first ten seconds after the truck is powered **ON**, or for ten seconds after the seat is reoccupied after the operator leaves the seat for ten seconds or more. This warning is based on seat occupancy, not the seat belt connection itself. If the operator selects a screen other than the Operating Screen before the ten seconds are up, the fasten seat belt icon will no longer be displayed.

BATTERY DISCHARGE INDICATOR

NOTE: Because the Battery Discharge Indicator (BDI) algorithm determines the Battery State Of Charge (BSOC) based on information gathered during operation it may take several seconds for the BDI to show the correct BSOC for the battery.

The BDI is located in the top center of the Operating Screen, as shown in Figure 12. The BDI is displayed as a five-segment horizontal bar and it has a battery icon on its left side.



1. BATTERY DISCHARGE INDICATOR

Figure 12. Battery Discharge Indicator

The system continuously monitors the truck's current BSOC, and this is indicated on the BDI by the number of filled bar segments. Table 13 shows the battery's state of charge in percentages, compared to the number of filled segments.

Table 13. BSOC in Relation to BDI

BSOC Charge Remaining (%)	Number of Filled Segments
76% or more	Five (5)
50% to 75%	Four (4)
35% to 50%	Three (3)
25% to 35%	Two (2)
21% to 25%	One (1) segment, plus flashing plus low battery alarm
0 to 20%	Zero (0) segments, plus flashing plus a second low battery alarm

The BDI is always visible when the Operating Screen is active. All five of the BDI segments are filled (illuminated) when the BSOC is at 75% or higher. As the BSOC goes down, the segments on

the right change to just outlines until the BSOC reaches 25%, which is indicated when only the leftmost segment, next to the battery icon, is filled.

If the battery charge drops below 25%, the "low battery alarm" sounds and the BDI begins flashing. The "low battery alarm" also sounds if the lift truck is turned **ON** when the BSOC is below 25%. If the BSOC drops to 20%, the leftmost segment changes to an outline and a second "low battery alarm" sounds. The lift truck will be subjected to operating and performance limitations if the BSOC drops below 20%.

DIRECTION AND PARKING BRAKE INDICATORS

These indicators are displayed in the center of the Operating Screen, as shown in Figure 11.

- An up-arrow indicates the truck will move forward if the accelerator is pressed.
- A down-arrow indicates the truck will move backward (reverse) if the accelerator is pressed.
- A solid "N" indicates the truck will not move if the accelerator is pressed, though it can still roll if the service brake is released.
- The parking brake icon is a "P" with a circle around it to represent a wheel and arcs around the circle to represent brakes. When this icon is displayed, it indicates the truck parking brake is applied and the truck will not move if the accelerator is pressed.

HAZARD FLASHERS AND LIGHTING CONTROLS

If the lift truck is equipped with CAN controlled hazard flashers and lighting controls, the icons that indicate the status of the lift truck's lights and hazard flashers are displayed on the Operating Screen. The soft keys the operator can use to control these lights are located near the Operating Screen.

- The Front Work Light Icon, on the lower right of the screen, is always visible. The operator can turn the front lights **ON** and **OFF** by pressing the **2** soft key.
- The Rear Work Light Icon, on the upper right of the screen, is always visible. The operator can turn the rear lights **ON** and **OFF** by pressing the **3** soft key.
- The Hazard Flashers Icon, a triangle on the lower left of the screen, is always visible if the lift truck is equipped with hazard flashers. The operator can press the **#** soft key to toggle the truck's hazard flashers **ON** and turn them back **OFF** by pressing the **#** soft key a second time.

STEER ANGLE INDICATOR

The Steer Angle indicator is displayed in the lower center of the Operating Screen, as shown in Figure 11. The purpose of this indicator is to show the operator the current steer angle (the direction of the tires that steer the truck). This informs the operator which way the truck will move if the accelerator pedal is pressed, given the current steer angle. The Steer Angle indicator shows the steering angle to the nearest 22.5° from full left, to full right.

SYSTEM TIME

The System Time for the lift truck, shown as 12:34 in Figure 11, appears in the lower right corner of the Operating Screen. System time can be reset by a Supervisor or Service Technician using the procedures described in Display Menu. If the Clock Hour Format is set to a 12-hour clock, the time numbers will be followed by an "A" (AM) or a "P" (PM) as appropriate. Otherwise, the system time uses a 24-hour clock.

LOAD WEIGHT INDICATOR

The Load Weight indicator for the lift truck, shown as 99999 beside the Load Weight Icon in Figure 11, appears at the midpoint of the right side of the Operating Screen. If the lift truck supports the Load Weight feature, the Operating Screen will display the load weight during any mast hydraulic command and for five seconds afterwards.

The Load Weight Icon indicates whether lb (pound) or kg (kilogram) units are being used. Use the procedures described in the Set Units Menu topic in the Display Menu section to set the load units for this lift truck. Use the procedures in the Load Weight Display topic in the Calibration Menu section to calibrate the load weight for this lift truck.

System Off/Alert Screens

INTRODUCTION

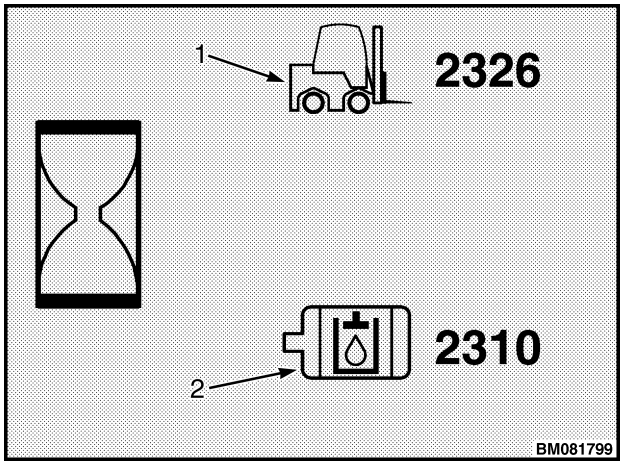
Several screens appear only briefly on the Operating Screen. These include the System Off Screen and Alert Screens. The purpose of the System Off Screen is to supply brief status information as the system is powered off. Alert Screens appear momentarily to attract attention. The topics that follow provide more information about these types of screens.

SYSTEM OFF SCREEN

When the lift truck power is first turned **OFF**, the System Off Screen is displayed for five seconds. The system will also display this screen for five seconds if the **Scroll Forward Key** (—▸) is pressed while the truck is powered **OFF**. Figure 13 shows the System Off Screen.

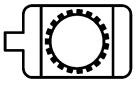
The System Off Screen displays the Truck Hour Meter in the upper right corner of the Operating Screen and the Hydraulic Pump Motor Hour Meter in the lower right. If equipped, the System Off screen can show any two of the following four hour meters.

- The Truck Hour Meter shows the total time the operator has been in the seat with the key or keyless switch in the **ON** position.
- The Pump Hour Meter shows the total time the hydraulic pump has been running.
- The Traction Hour Meter shows the total time on traction motor while the truck has been moving.
- The Secure Hour Meter shows the total time the operator has been in the seat with the key or keyless switch in the **ON** position and cannot be reset.
- The time shown on the meters is displayed in hours, but the system stores the values to the nearest 0.1 hour.



1. TRUCK HOUR METER
2. HYDRAULIC PUMP MOTOR HOUR METER

Figure 13. System Off Screen

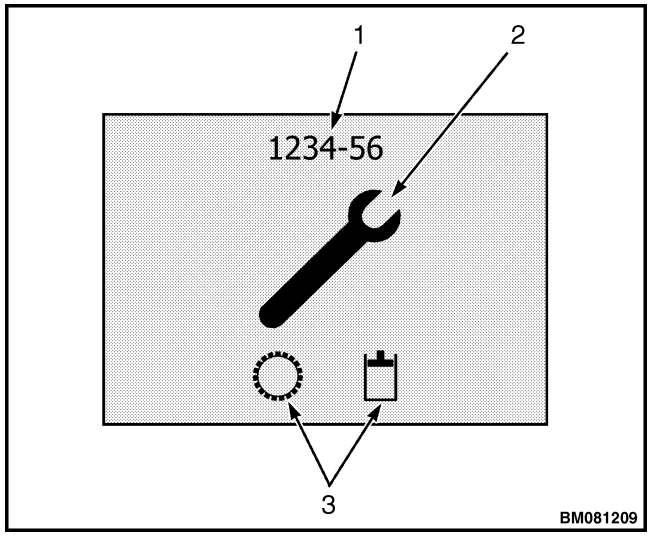
Icon	Description
	Truck Hour Meter Icon
	Traction Hour Meter Icon
	Hydrualic Pump Motor Hour Meter Icon
	Secure Hour Meter Indicator Icon

These meters can be examined more closely or reset by a Service Technician using the procedures described in the Status Menu section.

ALERT SCREENS

There are two types of alert screens, Fault Screens (failure indication screens) and Interlock Notification Screens. Both types of alert screens are temporary in nature because the system immediately restores the original screen after a key press or other action removes the problem.

When the system detects an active failure, the display changes to a Fault Screen which flashes a fault code, the wrench icon, and other icons to indicate the problem, similar to the example shown in Figure 14. As it is displayed, the alert screen flashes to draw the user's attention. Pressing either the **Scroll Back Key** (◂—) or **Scroll Forward Key** (—▸) after the alert screen appears causes the system to return to the last screen displayed.



1. EXAMPLE FAULT CODE
2. WRENCH ICON
3. ICONS OF DISABLED/PERFORMANCE LIMITED FUNCTIONS

Figure 14. Example Fault Screen

The Interlock Notification Screen appears whenever the operator tries to apply an input that is not available because one or more interlock conditions have not been met. For example, if the operator is not seated and tries to apply the accelerator pedal, the system will switch from the Operating Screen to an alert screen showing the seat belt icon, as shown in Figure 15.

In this example, if the operator releases the accelerator pedal, the system will change the screen back to the Operating Screen. Alternatively, the operator can press either the **Scroll Back Key** or the **Scroll Forward Key** to go to a top-level menu but the accelerator pedal input will still be unavailable because the interlock condition has not been met.

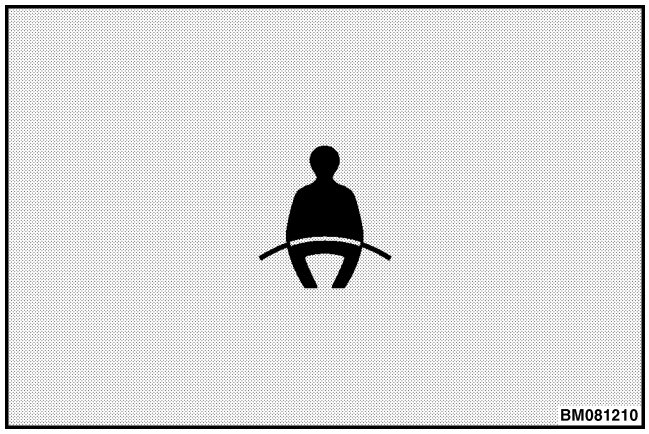


Figure 15. Example Interlock Alert Screen

Password Screen

INTRODUCTION

The Password Screen is a main menu (top-level menu) that is visible at Service Technician, Supervisor, and Operator password access levels. When the key switch or keyless switch is turned on, the Password Screen is the first screen displayed (unless Operator Passwords are deactivated). To access this menu at another time, cycle through the main title screens by pressing the **Scroll Back Key** (◂—) or **Scroll Forward Key** (—▸) until the Password Screen is displayed, as shown in Figure 16. Next, press the **Enter Key** (*****) to enter the Password Screen.

The Password Screen also appears when an operator first starts to use a lift truck, and it also appears when a defined time limit is exceeded under certain conditions.

There are no submenus below the Password Screen, but there are submenus under two other top-level menus that involve passwords:

- The Add/Remove Password submenu under the Truck Setup menu
- The Password Log submenu under the Activity Log menu

Explanations of the Password Screen and the Add/Remove Password submenu (accessed through the Truck Setup menu) follow.

PASSWORD SCREEN

NOTE: Operator passwords are used only on trucks equipped with a software enable option.

As already stated, the Password Screen is the first screen to appear when the key switch or keyless switch is turned on (unless Operator Passwords are deactivated). The Password Screen is visible at all password access levels.

Figure 16 shows the initial Password Screen that is displayed after power **ON**. A line of five blanks below the Password Icon serves as the password entry field.

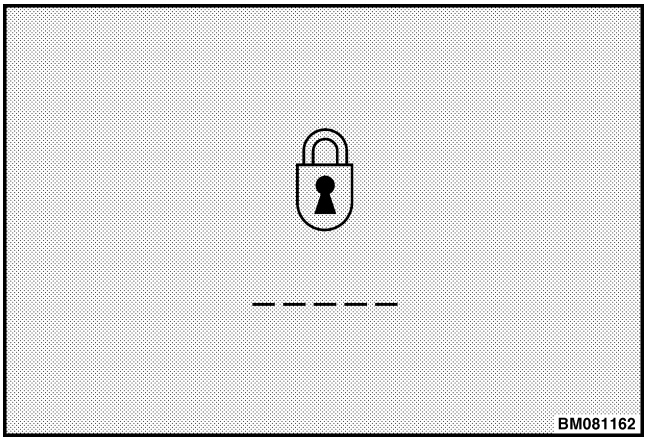


Figure 16. Initial Password Screen

NOTE: A valid password must be a five digit number composed of only the numbers 0, 1, 2, 3, 4, 5, 6, 7, 8, and 9 such as 37524 or 22954. If invalid keys (i.e., #, or *) are pressed they will be ignored. If more than five valid numbers are pressed for the password, only the last five are accepted.

Service Technician Password Setup

Service Technician-level password access is required to add, delete, or edit Service Level Passwords and to do the first installation of a Supervisor-level password. Anyone with Service Technician-level access can add, delete, or edit Operator or Supervisor passwords.

NOTE: A Service Technician-level password is required to input an initial Supervisor password for the lift truck. Once an initial Supervisor password is installed, that Supervisor-level password access can be used to add, delete, or edit additional Supervisor passwords as well as Operator passwords.

Perform the following steps to set up a password:

1. Using keys 0-9, enter a valid password.
2. Press the **Enter Key** to input the password to the system. Once you press the **Enter Key**, the system uses the five most recently entered valid numbers to compare with the currently stored password list.
3. If the password entered does not match any currently stored password, an invalid password screen is displayed for up to five seconds or until the user starts to enter another password, as shown in Figure 17.

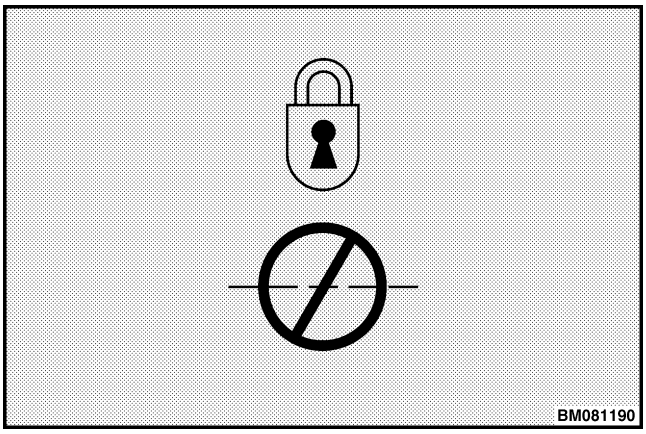


Figure 17. Invalid Password Screen

4. Once the system accepts the entered password, the operator is granted access to the menus associated with that password (i.e., menus displayed at Operator-level, Supervisor-level, or Service Technician-level access).

NOTE: In certain circumstances a default operator password of 11111 will be in the currently stored password list.

NOTE: If there are no Service Technician-level passwords in the currently stored password list, the factory default Service Technician-level password, 55555, can be used to gain access to the system.

Use the factory default Service Technician-level password, 55555, when installing the lift truck at the customer location to set up customer passwords. When initial installation is complete, choose a new Service Technician-level password. However, once a new Service Technician-level password has been assigned, 55555 is no longer a usable password and it cannot be assigned as a password through the screen menu or by using the PC Service Tool. (If all Service Technician-level passwords are deleted, the

system again accepts the 55555 default password.) If there is only one Service Technician password and it is lost, the password can be reset using the PC Service Tool.

ADDING/REMOVING/CHANGING PASSWORDS

The Add/Remove Password submenu is accessible through the Truck Setup Menu and it is visible at Service Technician and Supervisor password access levels. This menu allows a Service Technician or a Supervisor to add, remove, or change passwords whose level is equal to or lower than their own password level. This means a Service Technician can modify the passwords assigned to Operators, Supervisors, and other Service Technicians, while a Supervisor can modify passwords assigned to Operators or other Supervisors. Up to 250 passwords can be assigned for use. Table 14 shows the process for adding a new password.

Table 14. Add Password

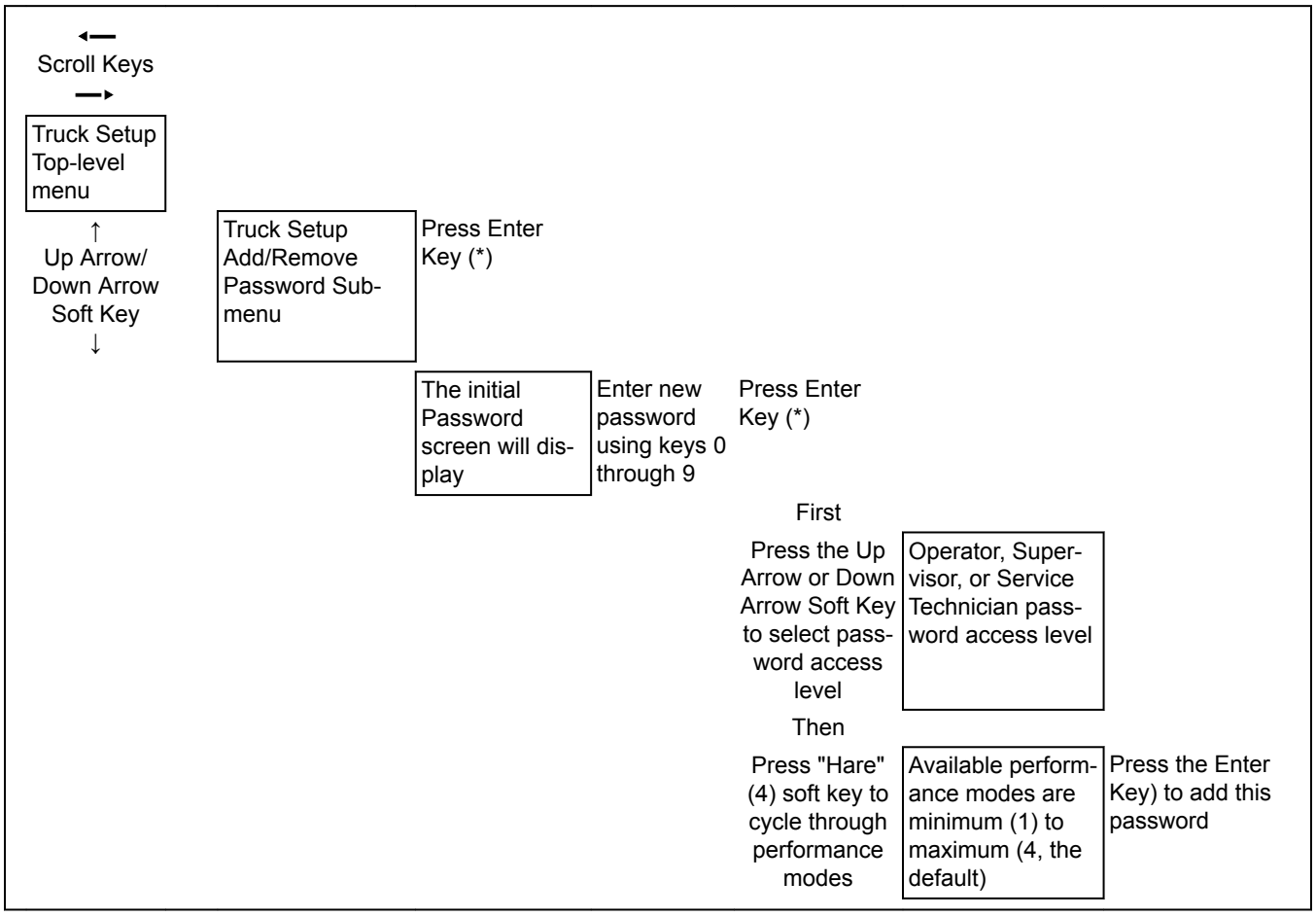
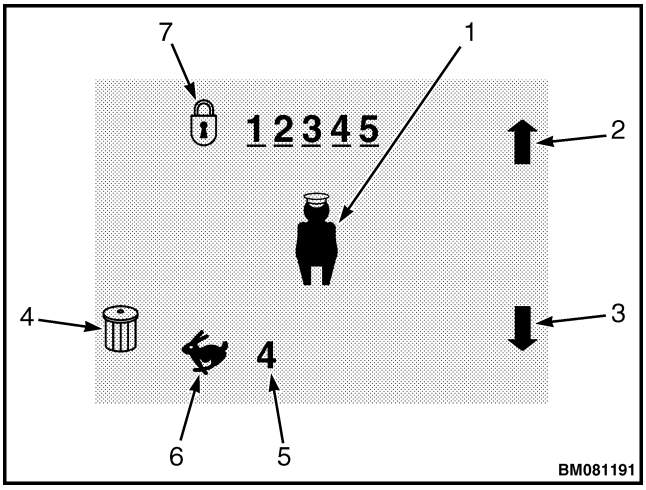


Figure 18 shows the Change/Remove password screen. The Up Arrow/Down Arrow soft keys (i.e., **2** and **3**) cycle between the privilege level(s) associated with this password. You can use the Hare soft key (**#**) to cycle through the available performance modes for this password. Press the Trash Can soft key (**4**) to remove this password from the current passwords.

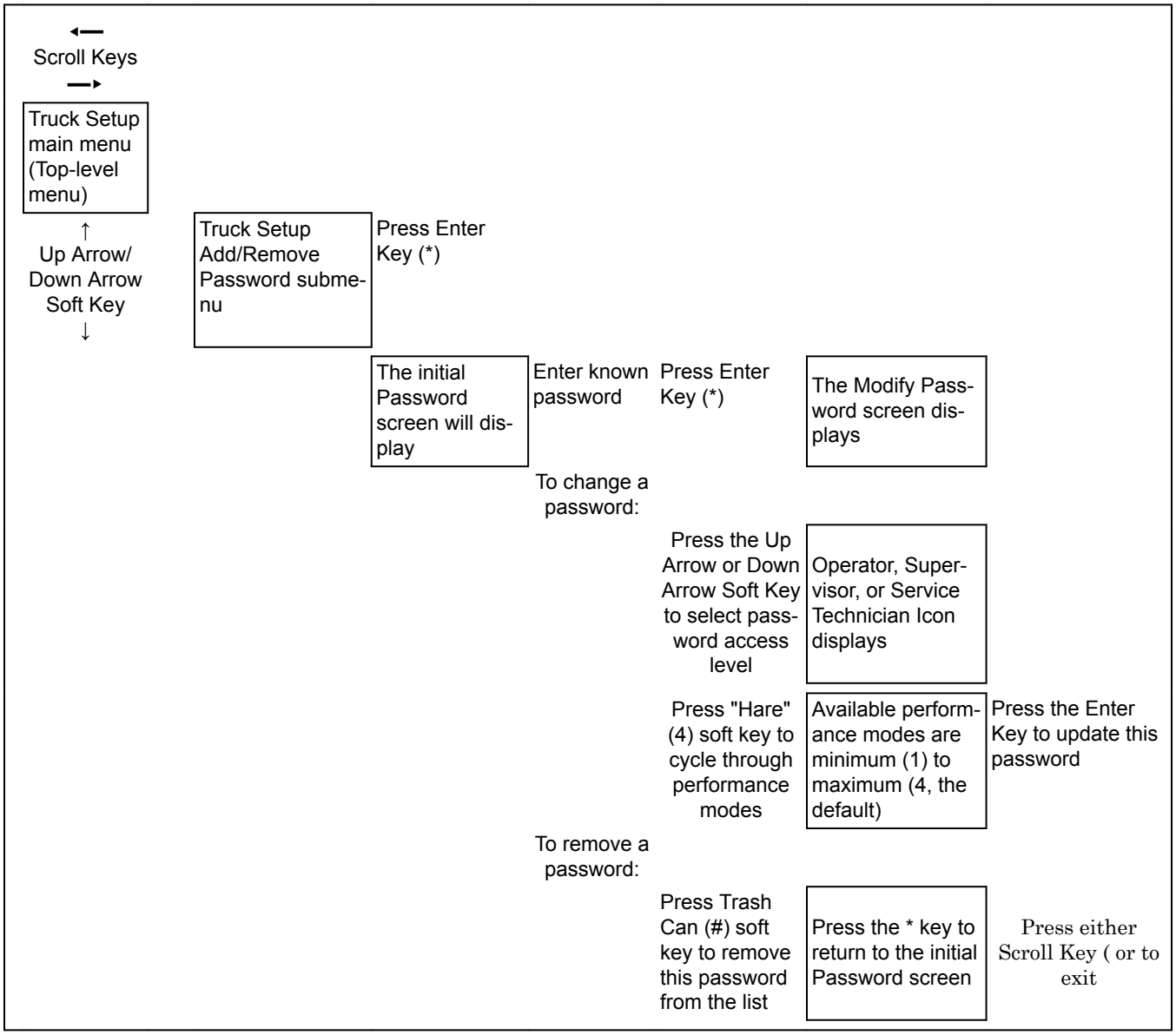
In order to remove an individual password or modify the privileges associated with it, you need to know the password number. In addition, you must have a privilege level equal to or greater than the privilege level of the password being modified. This means a Service Technician can modify all passwords, but a Supervisor can only modify the passwords of Operators and other Supervisors. Table 15 shows the process for changing or removing an existing password for the lift truck.



1. ICON FOR TYPE OF PASSWORD ENTERED (OPERATOR/SUPERVISOR/SERVICE TECHNICIAN)
2. UP ARROW SOFT KEY ICON
3. DOWN ARROW SOFT KEY ICON
4. "TRASH CAN" SOFT KEY ICON
5. CURRENT PERFORMANCE MODE
6. "HARE" SOFT KEY ICON
7. CURRENT PASSWORD ICON AND FIELD

Figure 18. Change/Remove Password Screen

Table 15. Change or Remove Password



PASSWORD LOG

The Password Log submenu is accessible through the Activity Log Title menu. See the next section, Activity Log Menu, for more information. This menu allows a Service Technician or a Supervisor to view the last 250 valid passwords entered into the system and the password access level (i.e., Operator, Supervisor, or Service Technician) associated with each password.

Activity Log Menu

INTRODUCTION

The Activity Log Menu is a main menu (top-level menu) that is visible at Service Technician and Supervisor password access levels. To access this menu, cycle through the main menu title screens by pressing the **Scroll Back Key** (◂—) or **Scroll Forward Key** (—▸) until the Activity Log Title Screen is displayed, as shown in Figure 19.

Press the **Enter Key** (*****) to enter the Activity Log Menu. Three submenus are available under this menu as shown in Figure 20.

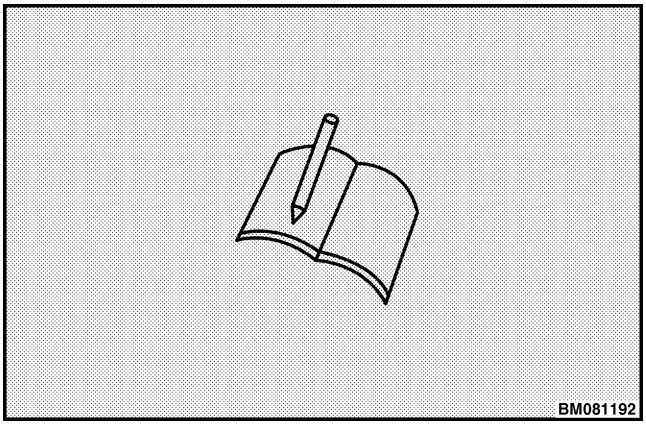
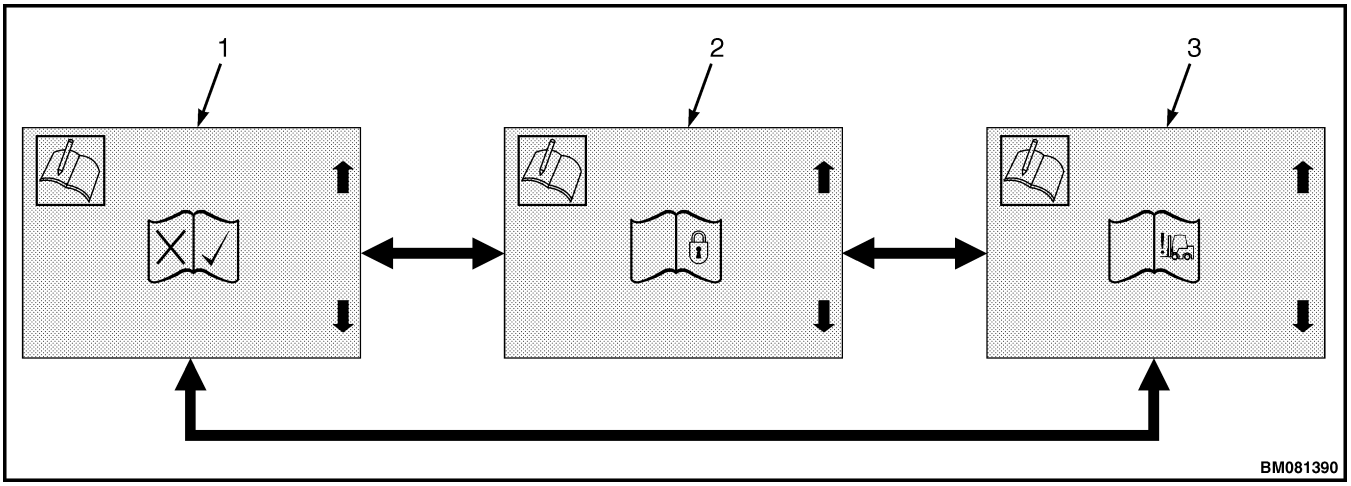


Figure 19. Activity Log Title Screen



1. OPERATOR CHECKLIST LOG
2. PASSWORD LOG
3. IMPACT EVENTS LOG

Figure 20. Activity Log Submenus

The first of the three submenus provided under the Activity Log menu, the Operator Checklist Log, appears on the Operating Screen. See Figure 21. You can enter the Operator Checklist Log submenu by pressing the **Enter Key**. To access the Password Log menu or the Impact Events Log menu, press the **Scroll Back Key** or **Scroll Forward Key** and then press the **Enter Key**.

The following sections describe the Activity Log submenus.

OPERATOR CHECKLIST LOG

This submenu is visible at Service Technician and Supervisor password access levels. This second-level menu allows a Service Technician or a Supervisor to view the 60 most recent checklist events, where an event is defined as:

- Each failed checklist item, or
- A completely successful pass through the full checklist.

Figure 21 shows the title screen for this menu.

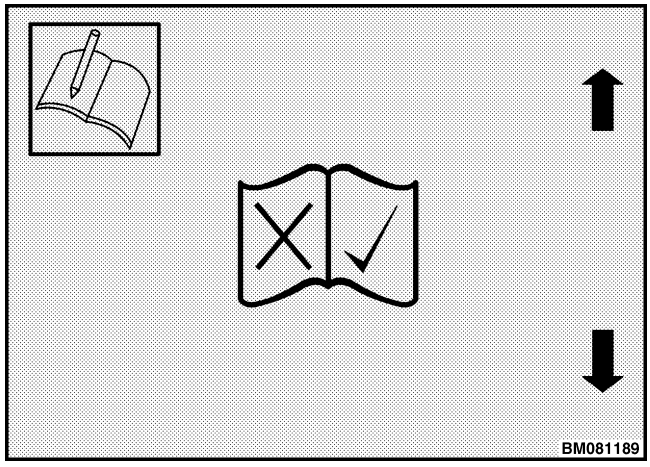
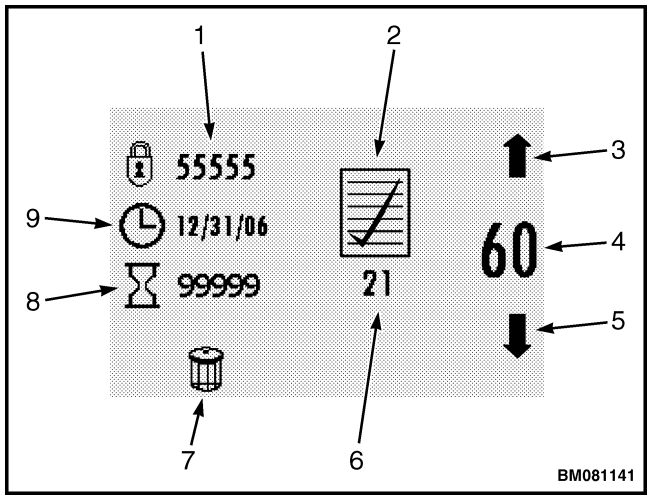


Figure 21. Operator Checklist Log Menu

Pressing the **Scroll Back Key** or **Scroll Forward Key** while anywhere in this submenu returns the Activity Log main menu title screen to the Operating Screen.

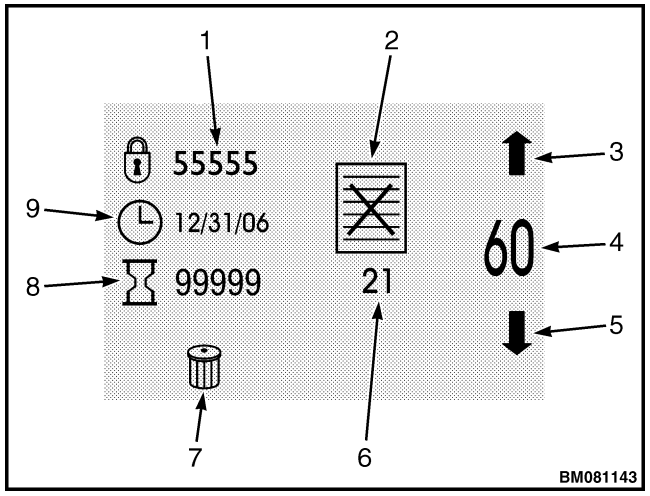
Figure 22 shows an example Operator Checklist Log screen and indicates the available controls.



1. PASSWORD VALUE AT LOG OCCURRENCE
2. TYPE OF ENTRY (PASS/FAIL)
3. UP ARROW SOFT KEY ICON
4. CURRENT LOG ENTRY (OR "EMPTY" SYMBOL)
5. DOWN ARROW SOFT KEY ICON
6. CHECKLIST ITEM THAT PASSED
7. TRASH CAN SOFT KEY (USED TO EMPTY LOG)
8. TRACTION HOURS AT LOG OCCURRENCE
9. SYSTEM DATE AT LOG OCCURRENCE

Figure 22. Operator Checklist Log Screen

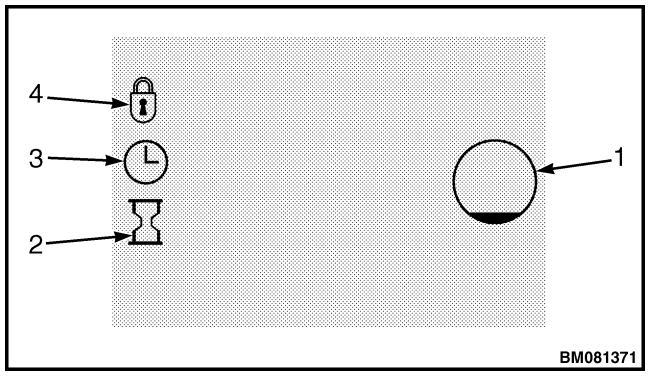
Figure 23 shows a failed Checklist Log Entry.



1. PASSWORD VALUE AT LOG OCCURRENCE
2. TYPE OF ENTRY (PASS/FAIL)
3. UP ARROW SOFT KEY ICON
4. CURRENT LOG ENTRY (OR "EMPTY" SYMBOL)
5. DOWN ARROW SOFT KEY ICON
6. CHECKLIST ITEM THAT FAILED
7. TRASH CAN SOFT KEY (USED TO EMPTY LOG)
8. TRACTION HOURS AT LOG OCCURRENCE
9. SYSTEM DATE AT LOG OCCURRENCE

Figure 23. Failed Checklist Log Entry

If there are no log entries or the final log entry has been scrolled past, an empty log screen is displayed, as shown in Figure 24.

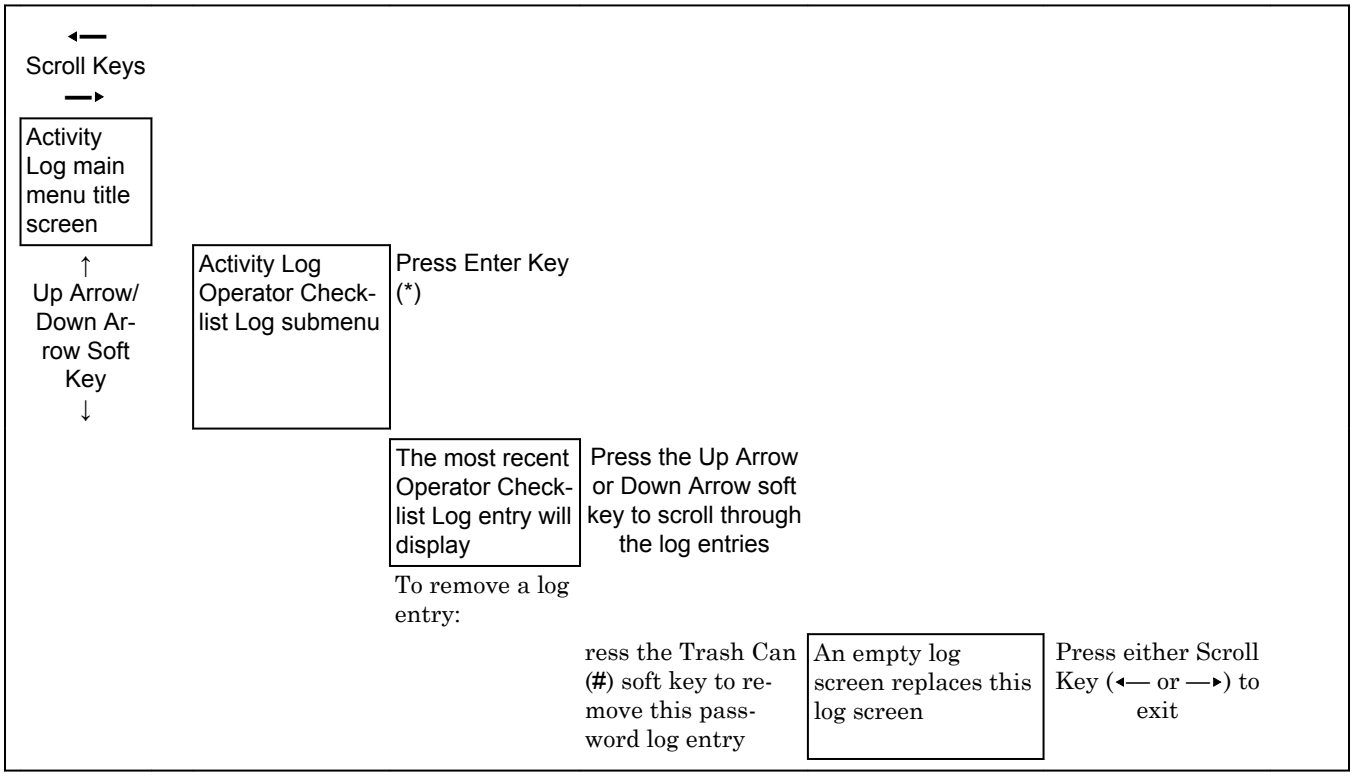


1. EMPTY SYMBOL
2. SYSTEM TIME ICON
3. SYSTEM DATE ICON
4. PASSWORD ICON

Figure 24. Empty Log Screen

The process for viewing and removing the operator checklist logs from the system is shown in Table 16.

Table 16. Access Operator Checklist Log Screens



When a person with Supervisor password-level access views the log, any recorded events under Service Technician-level access will show ***** instead of the actual password number. Also, if there was no password logged in at the time of an event, the password will show as *****.

PASSWORD LOG

The Password Log Submenu is visible at Service Technician and Supervisor password access levels. A Service Technician or a Supervisor can use it to view the last 250 valid passwords entered into the system and the password access level (i.e., Operator, Supervisor, or Service Technician) associated with each password.

Figure 25 shows the title screen for this menu.

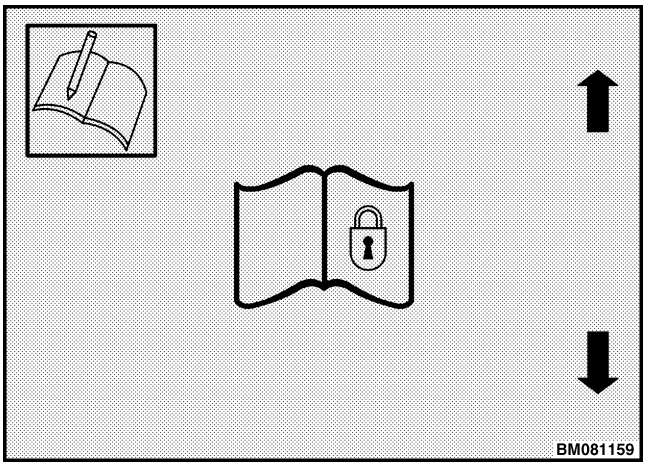
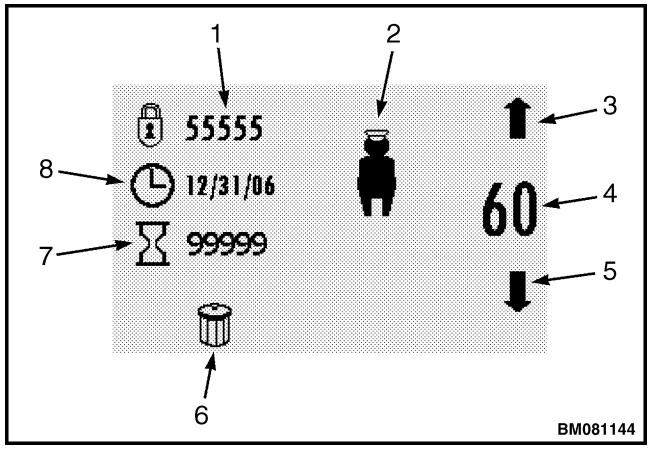


Figure 25. Password Log Menu

Pressing the **Scroll Back Key** or **Scroll Forward Key** while anywhere in this submenu will return the Activity Log main menu title screen to the Operating Screen.

Figure 26 shows an example Password Log screen and indicates the available controls.

The process for viewing and removing password logs from the system is shown in Table 17.



Legend for Figure 26.

1. PASSWORD VALUE AT LOG OCCURRENCE
2. OPERATOR/SUPERVISOR/SERVICE TECHNICIAN ICON
3. UP ARROW SOFT KEY ICON
4. CURRENT LOG ENTRY (OR "EMPTY" SYMBOL)
5. DOWN ARROW SOFT KEY ICON
6. "TRASH CAN" SOFT KEY ICON
7. TRACTION HOURS AT LOG OCCURRENCE
8. SYSTEM DATE AT LOG OCCURRENCE

Figure 26. Password Log Screen

Table 17. Access Password Log Screens

←— Scroll Keys —→					
Activity Log main menu title screen					
↑ Up Arrow/ Down Arrow Soft Key ↓	Activity Log Password Log submenu	Press Enter Key (*)			
		The most recent Password Log entry will display	Press the Up Arrow or Down Arrow soft key to scroll through the log entries		
		To remove all log entries:	Press Trash Can (#) Key to remove all password log entries	This log screen is replaced by the Empty log screen	Press either Scroll Key (←— or —→) to exit

A person viewing the password log cannot see the passwords of other operators or Supervisors who have access privileges higher than their own. This means that a Supervisor viewing the Password Log cannot see a Service Technician's password. When viewing the log entry of a person with a higher access level, the password is displayed as *****.

After removing a log entry, an "Empty" symbol replaces the former log entry number until the next entry has been scrolled into view. If there are no remaining log entries, an "Empty" log screen is displayed, as shown in Figure 24.

IMPACT EVENTS LOG

This submenu is visible at Service Technician and Supervisor password access levels. This menu allows a Service Technician or a Supervisor to view the 20 most recent impact events, where an event is defined as:

- Soft impact (0.2 to 2.5 g in tenths of g force), or
- Hard impact (0.5 to 3.0 g in tenths of g force) as defined during the Truck Setup process

Figure 27 shows the title screen for this menu.

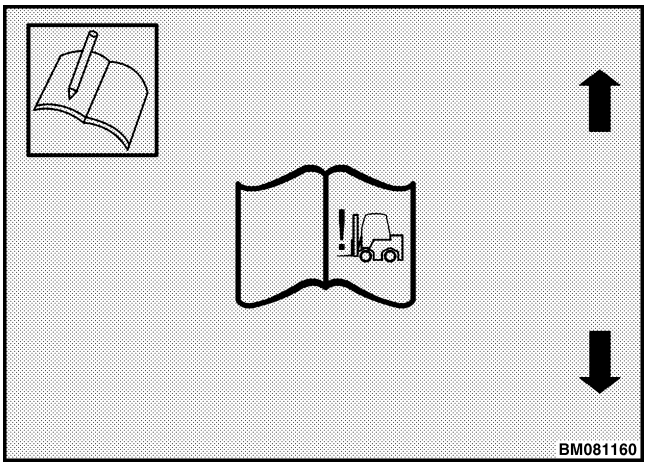
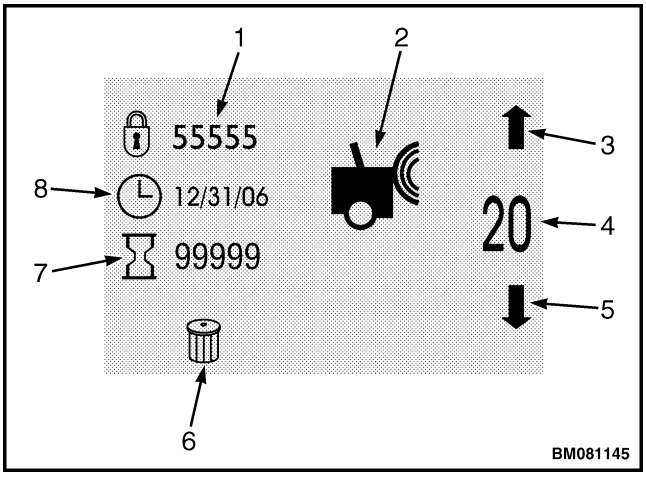


Figure 27. Impact Events Log Menu

Pressing the **Scroll Back Key** or **Scroll Forward Key** while anywhere in this submenu returns the Activity Log main menu title screen to the Operating Screen.

Figure 28 shows an example Impact Events Log screen and indicates the available controls.



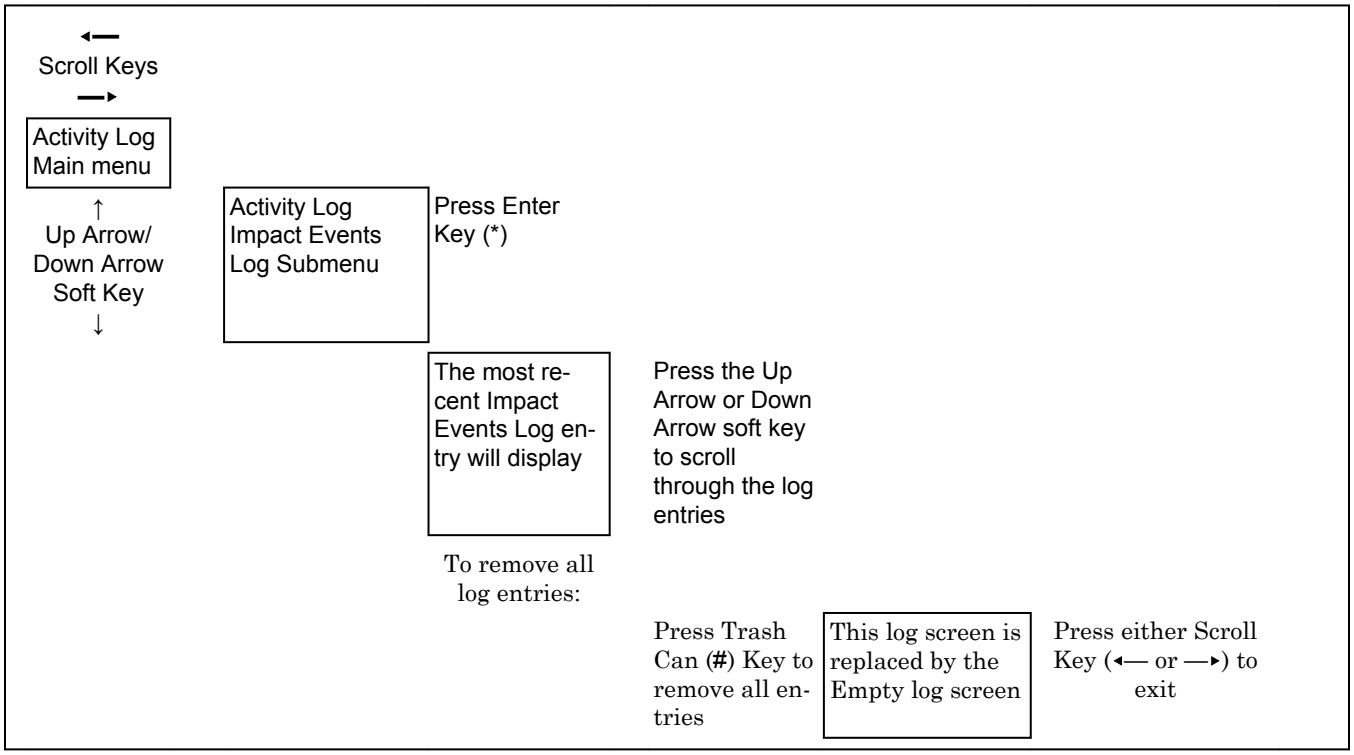
1. PASSWORD VALUE AT LOG OCCURRENCE
2. TYPE OF IMPACT (SOFT/HARD) ICON
3. UP ARROW SOFT KEY ICON
4. CURRENT LOG ENTRY (OR "EMPTY" SYMBOL)
5. DOWN ARROW SOFT KEY ICON
6. "TRASH CAN" SOFT KEY ICON
7. TRACTION HOURS AT LOG OCCURRENCE
8. SYSTEM DATE AT LOG OCCURRENCE

Figure 28. Impact Events Log Screen

If there are no log entries or the final log entry has been scrolled past, the system displays an "Empty" log screen, as Figure 24 shows.

The process for viewing and removing the system's operator checklist logs is shown in Table 18.

Table 18. Access Impact Events Log Screens



When a person with Supervisor password-level access views the log, any recorded events under Service Technician-level access are shown as ***** instead of the actual password number. Also, if there was no password logged in at the time of an event, the password appears as *****.

Calibration Menu

INTRODUCTION

The Calibration Menu is a main menu (top-level menu) that is visible at Service Technician, Supervisor, and Operator password access levels. The Table 9 topic shows the icons displayed on calibration screens. To access this menu, cycle through the main menu title screens by pressing the **Scroll Back Key** (**?**—) or **Scroll Forward Key** (—**?**) until the Calibration Title Screen is displayed, as shown in Figure 29.

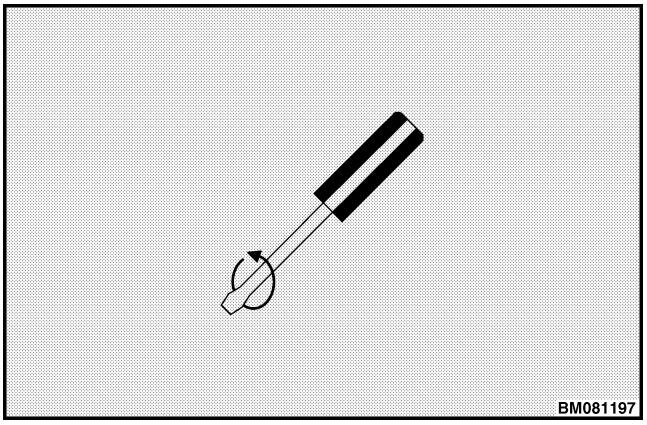


Figure 29. Calibration Title Screen

Press the **Enter Key** (*****) to enter the Calibration Menu and the system will display the first submenu in the Calibration Menu, the Load Weight Display submenu, which is shown in Figure 30. Press the

Enter Key again if you want to enter this submenu. If you want a different submenu, use the **Scroll Back Key** or **Scroll Forward Key** to move to another submenu and press the **Enter Key**.

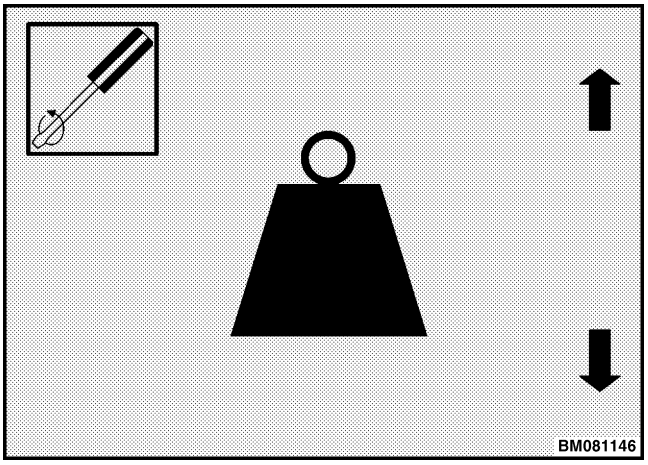


Figure 30. Load Weight Display Submenu

The Calibration Menu presents these submenus:

- Load Weight Display
- Return to Set Tilt Stop Point
- E-Hydraulic Valves
- Steering Wheel Center Point
- Steer Axle Position
- Steer Axle Center Point
- Manual Hydraulics

The following sections describe the Calibration submenus.

LOAD WEIGHT CALIBRATION

NOTE: This measurement is not for trade.

This menu item, shown in Figure 30, allows a Service Technician, Supervisor, or Operator to calibrate Load Weight. To calibrate Load Weight, select this submenu from the Calibration Menu and follow the prompts on the display.

NOTE: When the user is logged in under an operator level password or default password, only the tare weight default zero point calibration is available.

To calibrate the Load Weight Display:

1 Starting from the Calibration Menu, scroll to the Load Weight Display screen and press the **Enter Key**.

2 When prompted, position the empty forks at the load weight height, which is site dependent.

3 Press the **Enter Key**.

4 When prompted, use the numeric keys to enter the known load weight in lb or kg units, as indicated in the load weight icon. Use a load weight that is between 1,000 lbs (450 kg) and 16,000 lbs (7,260 kg).

NOTE: Do not exceed the truck's rated capacity.

5 Press the **Enter Key**.

6 When prompted, position the load by adjusting the tilt and height of the mast and forks to the load weight height.

7 Press the **Enter Key**. The system stores the new setting and returns to the Calibration Menu.

RETURN TO SET TILT STOP POINT CALIBRATION

NOTE: This calibration must be done by a supervisor or service technician and is only available on trucks that have the Return to Set Tilt feature.

Figure 31 shows the screen display during a Return to Set Tilt Stop Point calibration. To calibrate Return to Set Tilt Stop Point:

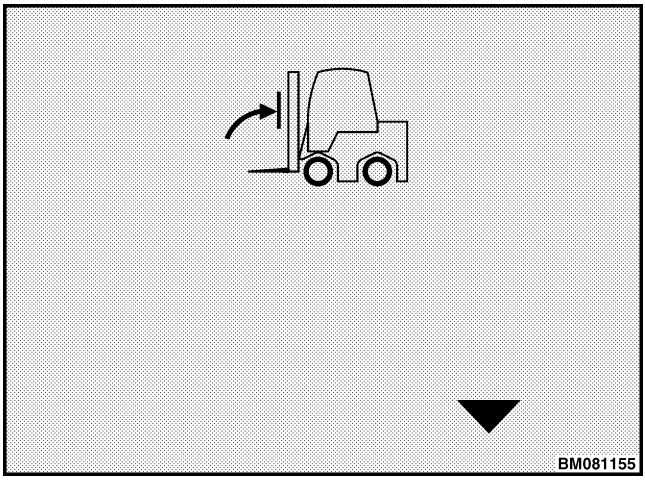


Figure 31. Return to Set Tilt Stop Point Sequence

1 Starting from the Calibration Menu, scroll to the Return to Set Tilt Stop Point screen and press the **Enter Key**.

2 When prompted, position the mast at the desired tilt angle.

3 Press the **Enter Key**. The system records the new setting and returns to the Calibration Menu.

E-HYDRAULIC AND MANUAL VALVE THRESHOLD CALIBRATION

NOTE: This calibration must be done by a supervisor or service technician.

Figure 32 shows how the E-Hydraulic Valve calibration sequence starts with the 1A function, followed by the 1B function, and so on. The screen display changes from one function to the next as the user calibrates these control valves. To calibrate the E-Hydraulic and manual valves:

1 Turn key or keyless switch to **ON** position.

2 Perform an air bleed operation by exercising all functions until they operate smoothly.

3 Starting from the Calibration Menu, scroll to the E-Hydraulic Valves screen and press the **Enter Key**.

See **Main Control Valves** 2000SRM1334, Calibration Procedure for lift truck models

- E2.2-3.5XN (E45-70XN) (A268)
- J2.2-3.5XN (J45-70XN) (A276)
- J1.5-2.0XNT (J30-40XNT) (K160)
- J1.6-2.0XN (J30-40XN) (A935)
- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)
- E4.0-5.5XN (E80-120XN) (A099)

See **Main Control Valves** 2000SRM1439, Calibration Menu for lift truck models

- E1.6-2.0XN (E30-40XN) (A269)

See **Main Control Valves** 2000SRM1520, Calibration Menu for lift truck models

- A1.3-1.5XNT (A25-30XNT) (D203)

See **Diagnostic Troubleshooting Manual** 9000SRM1377 for lift truck models

- J8.0XN, J8.0XN9, J9.0XN (A250)

4 With no load on the forks, raise them, if they are not already raised.

5 When prompted, move the lever toward the mast, the A direction, until the forks begin to creep. Creep means moving the forks as slowly as possible. Press the **Enter Key** and the system records the valve reading.

6 When prompted, move the lever toward the rear of the truck, the B direction, until the forks begin to creep and press the **Enter Key**. The system records the valve reading. Steps 5 and 6 provide the hydraulic input for function 1.

NOTE: If a valve reading is not within the acceptable range, an abort message appears. Press any key to continue.

7 Continue the process for functions 2, 3, and 4 as prompted by the system. The system records the valve readings for each function, and when this calibration process is completed, returns to the Calibration Menu.

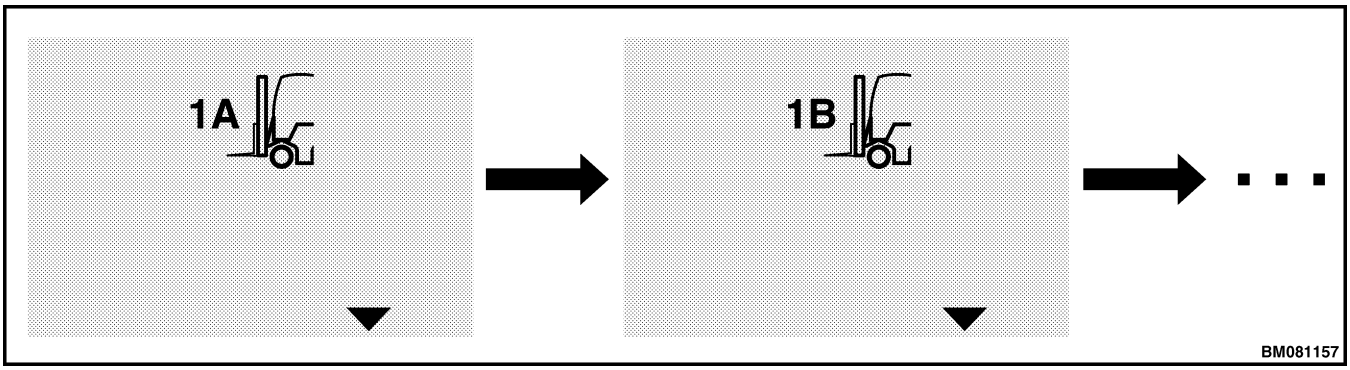


Figure 32. E-Hydraulic Valves

STEERING WHEEL CENTER POINT CALIBRATION

The steering wheel center point is the position to which the system adjusts the steering wheel while the lift truck is being driven straight ahead.

NOTE: This calibration must be done by a supervisor or service technician and is only available on trucks equipped with the Synchronized Steering function.

Figure 33 shows the screen display during a Steering Wheel Center Point calibration.

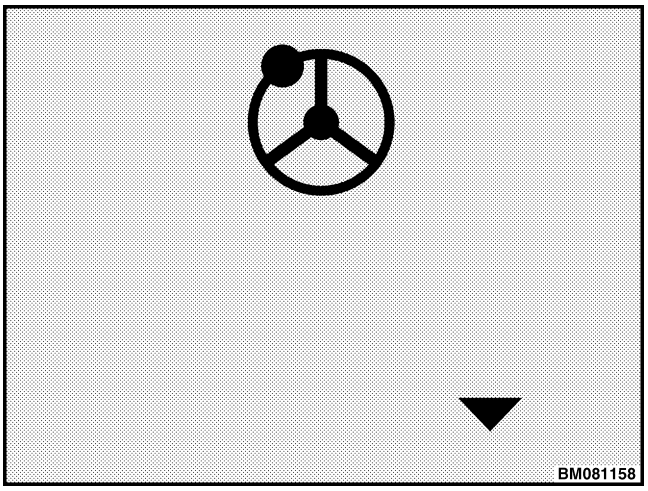


Figure 33. Steering Wheel Center Point

To calibrate the Steering Wheel Center Point:

1. Starting from the Calibration Menu, scroll to the Steering Wheel Center Point screen and press the **Enter Key**.
2. When prompted, position the steering wheel in the position that will drive the lift truck straight ahead.
3. Press the **Enter Key**. The system records the steering wheel position as the new center point and returns to the Calibration Menu.

STEER AXLE POSITION CALIBRATION

NOTE: This calibration must be done by a supervisor or service technician and is only available on trucks equipped with the Synchronized Steering function or dual traction motors.

Figure 34 shows the screens that appear while calibrating the Steer Axle Position. To calibrate the Steer Axle Position:

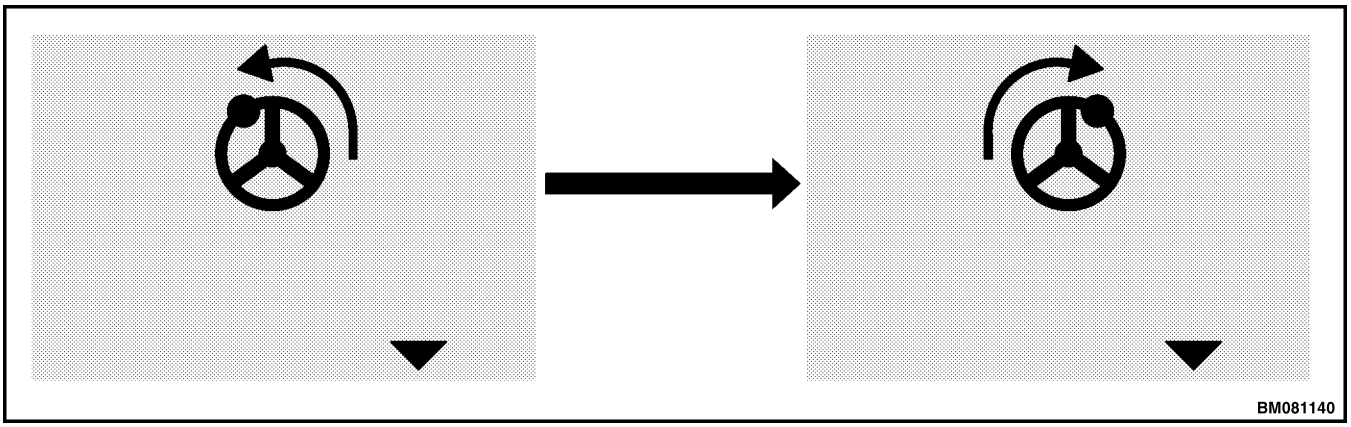


Figure 34. Calibrating Steer Axle Position

1. Starting from the Calibration Menu, scroll to the Steer Axle Position screen and press the **Enter Key**.
2. When prompted, turn the steering wheel counterclockwise until the axle hits the stop.
3. Press the **Enter Key**.
4. When prompted, turn the steering wheel clockwise until the axle hits the stop.

5 Press the **Enter Key**. If the settings are acceptable, the system records the steer positions and returns to the Calibration Menu. If the settings are outside of the acceptable range, an X appears over the calibration icon. Press the **Enter Key** and the system will prompt the user to repeat steps 2 – 5.

STEER AXLE CENTER POINT CALIBRATION

NOTE: This calibration must be done by a supervisor or service technician and is only available on trucks equipped with E-Steering.

Figure 35 shows the screen menu the system displays during this calibration.

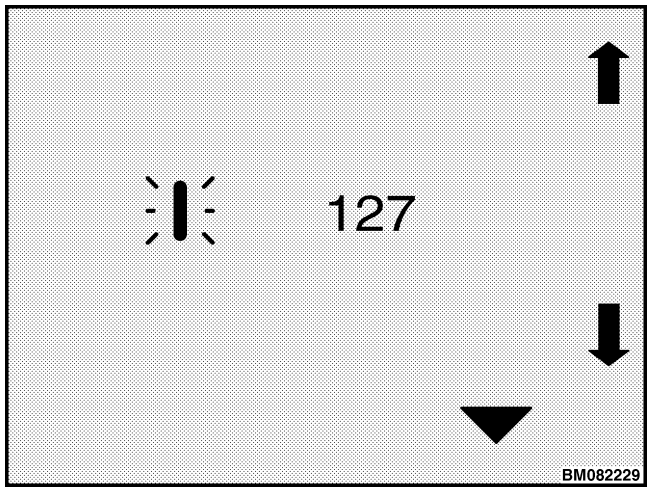


Figure 35. Steer Axle Center Point Offset Calibration

Operator adjusts the offset value and then drives the truck while holding the steering wheel at the straight ahead position to determine if correct.

1. Starting from the Calibration Menu, scroll to the Steer Axle Center Point Offset screen and press the **Enter Key**.

2. Use the 2 up arrow soft key increase the offset by 1.

3. Use the 3 down arrow soft key to decrease the offset by 1.

4. Once the truck drives in a straight when the steer wheel is in the calibrated center point position press the **Enter Key**. If the settings are acceptable, the system records the center point and returns to the Calibration Menu. If the settings are outside of the acceptable range, an X appears over the Calibration Icon. Press the **Enter Key** and the system will prompt the user to repeat steps 2 - 5.

MANUAL HYDRAULICS CALIBRATION

NOTE: This calibration must be done by a supervisor or service technician and is only available on trucks equipped with manual hydraulics.

Figure 36 shows the screen menu the system displays during this calibration. To calibrate the Manual Hydraulic end point:

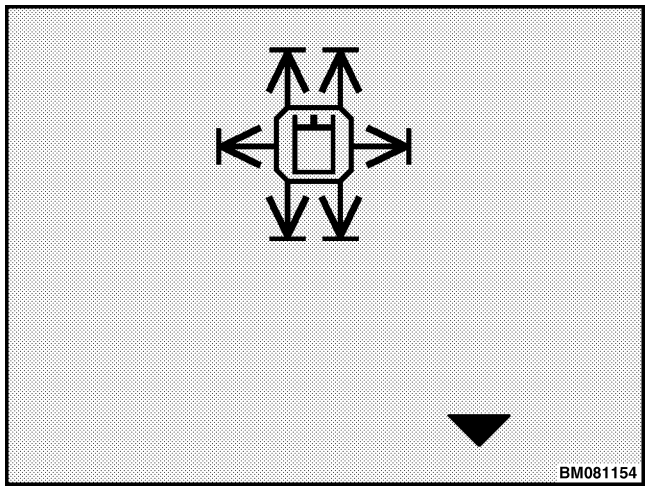


Figure 36. Manual Hydraulic End Point Calibration

1 With no load on the forks, raise them, if they are not already raised.

2 Starting from the Calibration Menu, scroll to the Manual Hydraulic End Point Calibration screen and press the **Enter Key**.

3 When prompted, move all hydraulic levers to both of their extreme locations; that is, move each lever as far as it will go in both directions.

4 Press the **Enter Key**. The system records the extreme locations and returns to the Calibration Menu.

Display Menu

INTRODUCTION

The Display Menu is a main menu (top-level menu) that is visible at Supervisor and Service Technician password access levels. To access this menu, cycle through the main level menu screens by pressing the **Scroll Back Key** (◂—) or **Scroll Forward Key** (—▸) until the Display Title Screen is displayed, as shown in Figure 37.

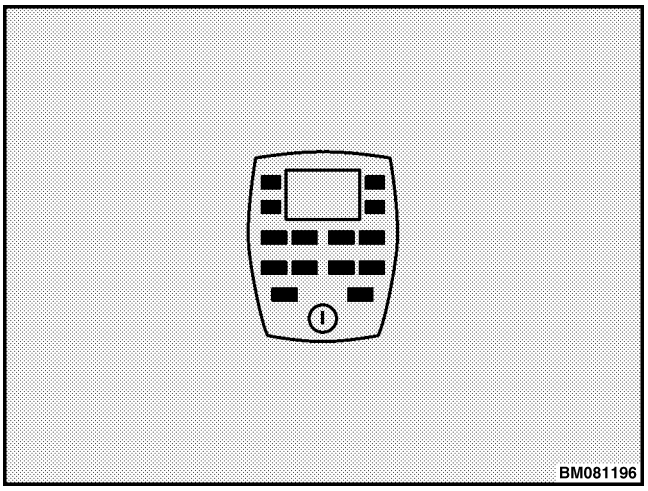


Figure 37. Display Title Screen

Press the **Enter Key** (*) to enter the Display Menu and the system will display the Set Date and Time Format screen as shown in Figure 38. Press the **Enter Key** again to enter this submenu. For a different submenu, use the **Scroll Back Key** or **Scroll Forward Key** to move to the desired submenu and press the **Enter Key**.

To return to the Display Menu, press the **Scroll Back Key** or **Scroll Forward Key**. Press the **Scroll Back Key** or **Scroll Forward Key** a second time to return to the main menu.

The Display Menu offers these submenus (see the Table 10 topic):

- Set Date and Time Format Menu
- Set Daylight Saving Time Menu
- Set Time and Date Menu
- Set Units Menu

The sections that follow describe these submenus.

SET DATE AND TIME FORMAT MENU

A Supervisor or a Service Technician can use this menu to define the system date and time format. Figure 38 shows the title screen for this menu.

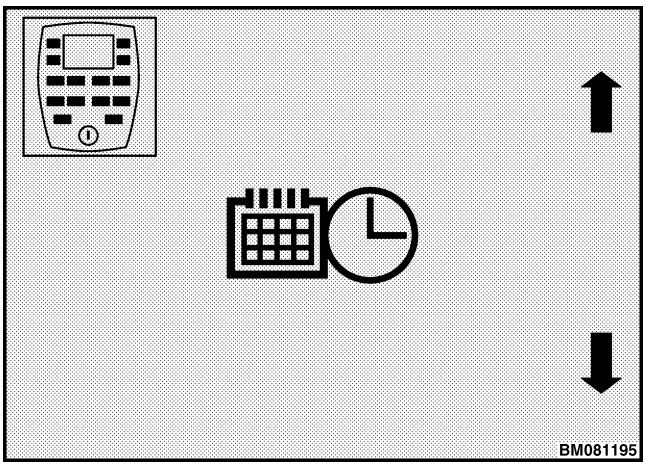
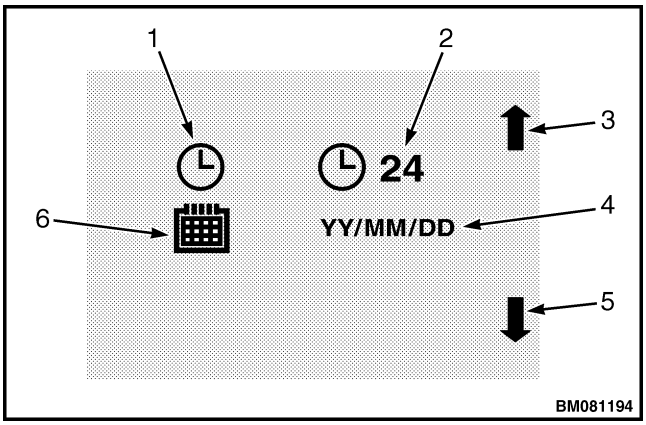


Figure 38. Set Date and Time Format Menu

To enter this submenu, press the **Enter Key**. Figure 39 shows the Set Date and Time Format screen that will appear.



1. CLOCK ICON
2. CLOCK HOUR FORMAT
3. UP ARROW SOFT KEY ICON
4. CURRENT DATE FORMAT
5. DOWN ARROW SOFT KEY ICON
6. CALENDAR ICON

Figure 39. Set Date and Time Format Screen

The Clock Hour Format can be set to either a 12-hour clock or a 24-hour clock. To set the Clock Hour

Format, press the **2** Up Arrow soft key. The system will place a box around the current Clock Hour Format. Press the **Enter Key** and then use the **2** Up Arrow soft key or **3** Down Arrow soft key to select either the 12-hour or the 24-hour clock format. When you have the desired format displayed, press the **Enter Key** and the system will begin using the selected clock hour format for all menus in the system.

To set the Current Date Format, use the **3** Down Arrow soft key to change the focus to the Current Date Format Icon.

There are three options for the Current Date Format:

- USA, MM/DD/YY
- Europe, DD/MM/YY
- ISO 8601, YY/MM/DD

Use the **2** or **3** soft key to cycle through the Current Date Format options. When you have the desired format displayed, press the **Enter Key** and the system will begin using that date format as the current date format setting for all menus in the system.

Table 19 shows the process for selecting and changing the date and time formats for the system.

Table 19. Accessing the Set Date and Time Format Screen

Use the Scroll Keys (◂— or —▸) Display the main menu						
Use the Up Arrow ↑ or Down Arrow ↓ Key	Display the Set Date and Time Format Menu submenu	Press Enter Key (*)				
	The Set Date and Time Format screen will display	Use the 2 Up Arrow soft key to select the Set Time Format Icon and display the 12-hour or 24-hour clock icon	*Next*	Use the 3 Down Arrow soft key to select the Set date Format Icon and display the three date formats	Press Enter Key to update the time and date format for all menus in the system	
					Press either Scroll Key (◂— or —▸) to exit	

SET DAYLIGHT SAVING TIME MENU

A Supervisor or a Service Technician can use this submenu to enable or disable the use of daylight saving time on trucks and set it up to make automatic time changes. When this feature is enabled (set to On), the system time clock increases by one hour at 2:00 am on the selected Start Date and decreases by one hour at the same time on the selected End Date. Figure 40 shows the title screen for this menu.

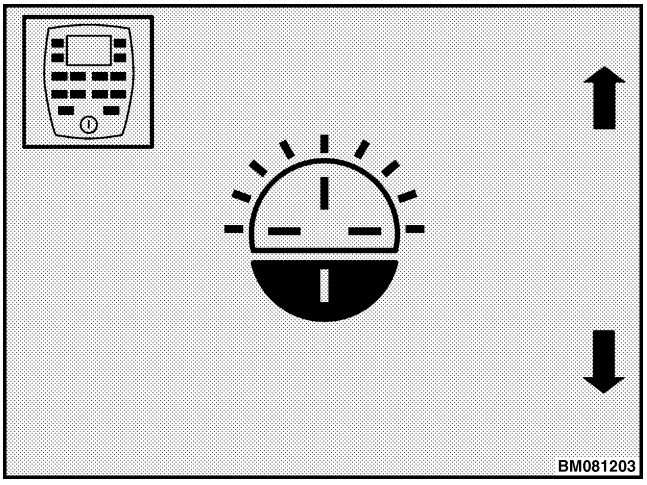
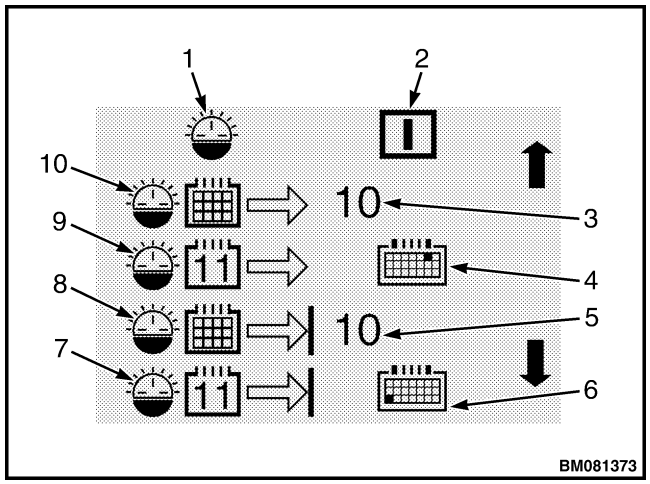


Figure 40. Set Daylight Saving Time Menu

To enable daylight saving time, press the **Enter Key** at the menu shown in Figure 40.

The system will display the screen shown in Figure 41.



1. DAYLIGHT SAVINGS ENABLE
2. ENABLE INDICATOR (THE ON SETTING IS UP)
3. DAYLIGHT SAVINGS START MONTH SETTING
4. START DAY INDICATOR
5. DAYLIGHT SAVINGS END DAY SETTING
6. END DAY INDICATOR
7. DAYLIGHT SAVINGS END DAY INDICATOR
8. DAYLIGHT SAVINGS END MONTH INDICATOR
9. DAYLIGHT SAVINGS START DAY INDICATOR
10. DAYLIGHT SAVINGS START MONTH INDICATOR

Figure 41. Set Daylight Saving Time Screen

Procedure for Setting Up Automatic Daylight Savings Time

NOTE: To exit from the Daylight Savings menu at any time without making any changes, press the **Scroll Back Key** or **Scroll Forward Key**. The system returns to the Display menu.

1. Navigate to the Daylight Savings submenu.

2. Press the **2** Up Arrow soft key to set daylight saving time to On and press the **Enter Key** (*).

3. Set the month daylight saving time will begin.

a. Press the **3** Down Arrow soft key to activate the Start Month indicator and press the **Enter Key**.

b. Use the **2** or **3** soft key to cycle through the numbers, 1-12, of the months to the desired start month and press the **Enter Key**.

4. Set the day daylight saving time will begin.

a. Press the **3** Down Arrow soft key to activate the Start Date indicator and press the **Enter Key**.

b. Use the **2** or **3** soft key to cycle through the dates by numbers, by first days of the week, and by last days of the week to the desired start day. This can be a date, such as the 13th of the month, or a day of the week, such as Sunday. When you get to the desired date, press the **Enter Key**.

5. Set the month daylight saving time will end.

a. Press the **3** Down Arrow soft key to activate the End Month Indicator and press the **Enter Key**.

b. Use the **2** or **3** soft key to cycle through the numbers, 1-12, of the months to the desired end month and press the **Enter Key**.

6. Set the day daylight saving time will end.

a. Press the **3** Down Arrow soft key to activate the End Day indicator and press the **Enter Key**.

b. Use the **2** or **3** soft key to cycle through the numbers, first days of the week, and last days of the week to the desired end day and press the **Enter Key**.

7. Exit from the Daylight Savings submenu and return to the Display menu by pressing the **Scroll Back Key** or **Scroll Forward Key**.

Table 20. Set Daylight Saving Time Menu

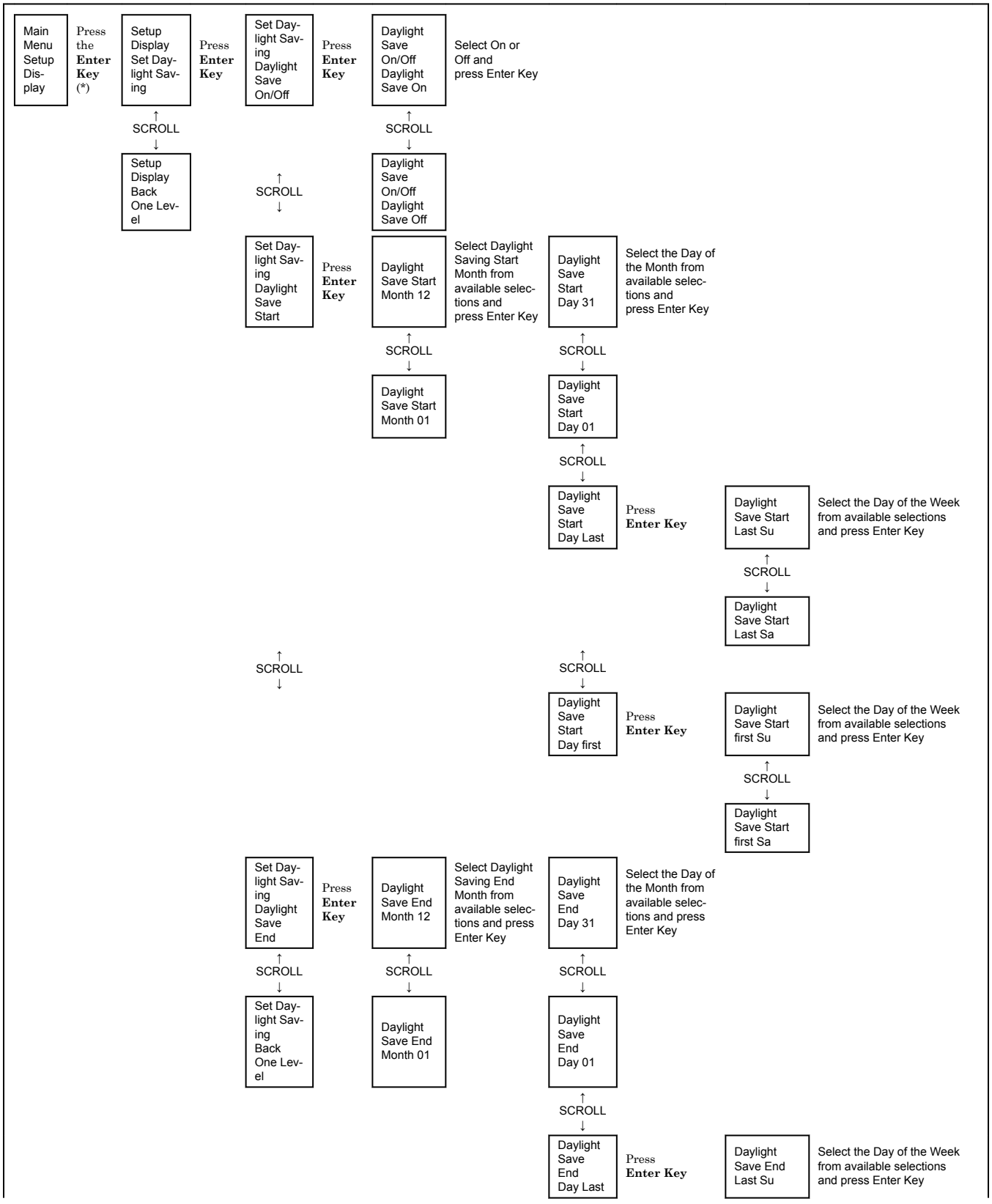
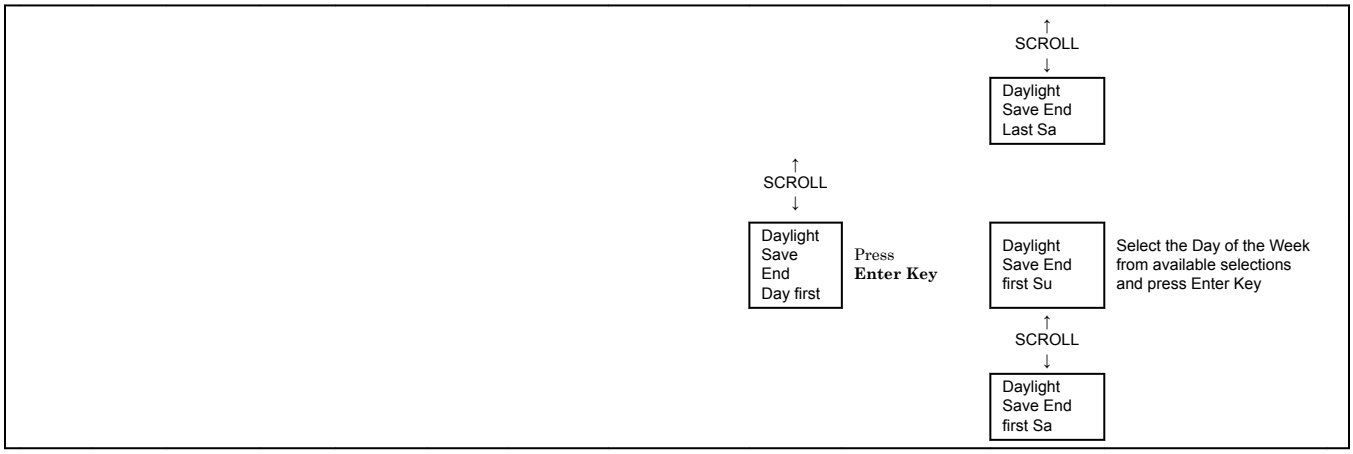


Table 20. Set Daylight Saving Time Menu (Continued)



SET TIME AND DATE MENU

A Supervisor or a Service Technician can use this menu to set the system time and date format on the on-board clock. Figure 42 shows the title screen for this menu.

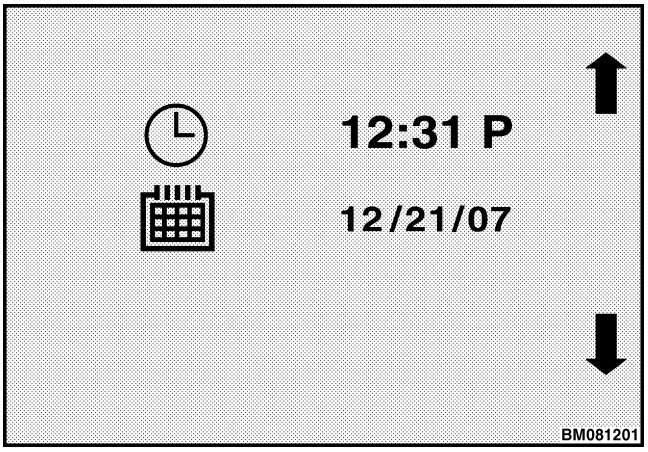


Figure 42. Set Date and Time Menu

Procedure for Setting Time and Date

NOTE: To exit from a menu at any time without making any changes, press the **Scroll Back Key** or **Scroll Forward Key**.

1. At the Display Menu, scroll to the Set Time and Date Format submenu, unless already there, and press the **Enter Key** (*) to enter this submenu.

1. Press the **2** or **3** soft key to select the time icon, then press the **Enter Key**.

   The system will display a flashing line under the hour portion of the time. To change the hour:

   a. Use the number keys to enter the correct hour and press the **Enter Key**. If the hour does not need to be changed, just press the **Enter Key**.

      If the number you entered is a valid hour setting, the system accepts it and moves the flashing line to the next segment, the minutes portion of the time.

   b. Use the number keys to enter the minutes and press the **Enter Key**. If the minutes are correct, simply press the **Enter Key**.

      If the number you entered is a valid minutes setting, the system accepts it and moves the flashing line to the A (for AM) or P (for PM) designator.

   c. To change the AM/PM setting, use the **2** or **3** soft key, then press the **Enter Key**. If the current AM or PM setting is correct, simply press the **Enter Key**.

      The system puts the new time settings into effect immediately.

2. To set the system date, use the **2** or **3** soft key to select the date icon and press the **Enter Key**.

The system will display a flashing line under the left segment of the date. If the Current Date Format is DD/MM/YY, for example, then the left segment displayed is the day of the month. (Current Date Format can be changed in the Set Date and Time Format submenu.)

a. Use the number keys to enter the correct value and press the **Enter Key**. If the current value for the left segment of the date is correct, simply press the **Enter Key**.

b. Repeat step a. for the middle and right segments of the date.

The system will put the new system date into effect immediately.

SET UNITS MENU

A Supervisor or a Service Technician can use this menu to set the type of units the system will use to either Imperial or Metric. Figure 43 shows the Set Units submenu.

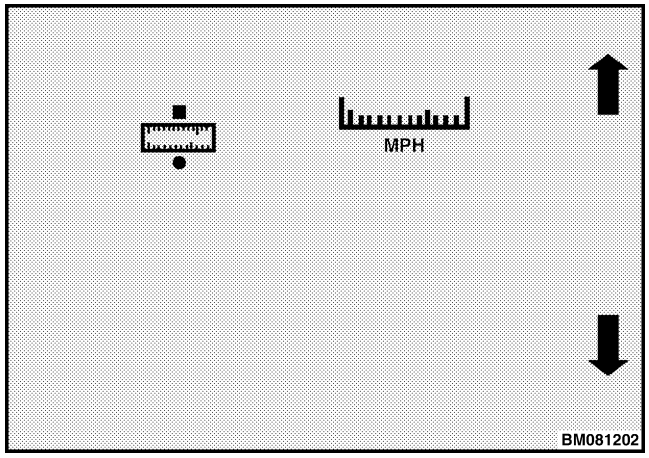


Figure 43. Set Units Menu

To set the type of units the system will use, either Imperial or Metric, enter the Set Units Menu. Use the **2** Up Arrow or **3** Down Arrow soft key to select Imperial or Metric. When the corresponding icon for the type of units desired is displayed on the screen, press the **Enter Key** and the system will begin using the units selected immediately.

Status Menu

INTRODUCTION

The Status Menu is a main menu (top-level menu) that is visible at Supervisor and Service Technician password access levels. To access this menu, cycle through the main menu title screens by pressing the **Scroll Back Key** (◂—) or **Scroll Forward Key** (—▸) until the Status Title Screen is displayed, as shown in Figure 44.

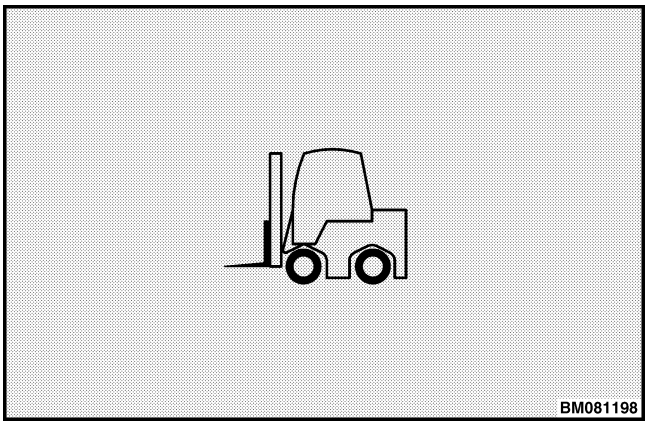


Figure 44. Status Title Screen

Press the **Enter Key** (*) to enter the Status Menu and the system will display the Vehicle System Manager (VSM) Version submenu as shown in Figure 45. Press the **Enter Key** again to enter this submenu. For a different submenu, use the **Scroll Back Key** or **Scroll Forward Key** to move to the desired submenu and press the **Enter Key**.

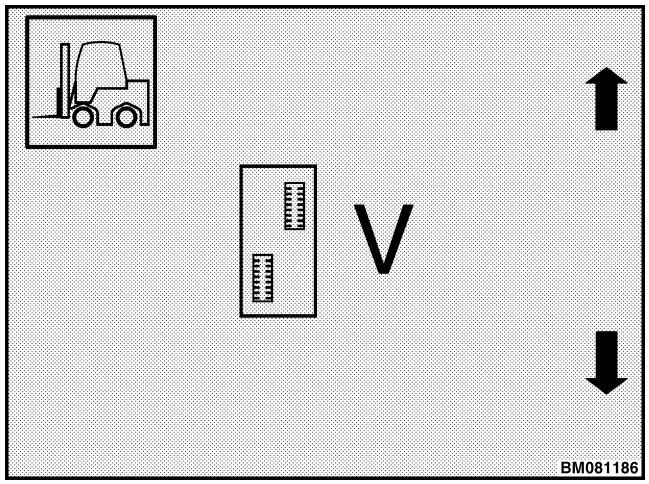


Figure 45. Status Menu

The Status Menu provides these submenus:

- VSM Versions
- Display Versions
- Truck Serial Number
- Hour Meters
- E-Hydraulic Controller Versions
- Pump Motor Controller Versions
- Traction Motor Controller 1 Versions
- Traction Motor Controller 2 Versions
- Light Controller Versions
- Impact Sensor Versions

The topics that follow describe the Status submenus.

NOTE: These menu selections are only available to logged in Supervisors and Service Technicians.

VSM VERSIONS

NOTE: The manufacturer's hardware and software versions may not match the hardware and software versions shown on the device's exterior label.

This submenu makes it possible to view the manufacturer's internal hardware and software versions of the VSM Controller. Figure 46 shows how the version information is displayed on the screen. The top line lists the manufacturer's hardware version; the second line lists the manufacturer's software version.

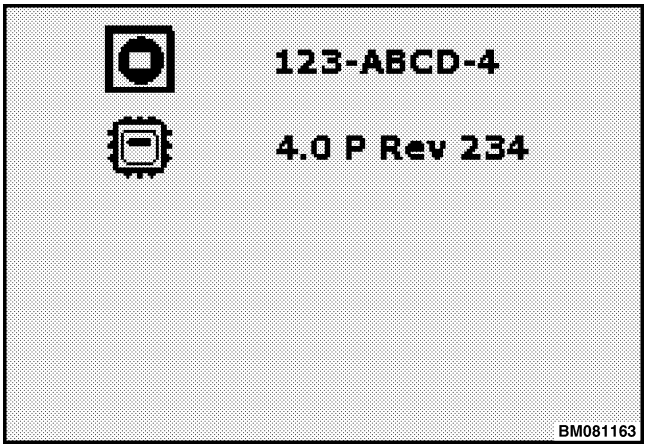


Figure 46. Versions Screen

DISPLAY VERSIONS

NOTE: The manufacturer's hardware and software versions may not match the hardware and software versions shown on the device's exterior label.

Use this submenu to view the manufacturer's internal hardware and software versions of the Display. The screen for Display Versions is identical to the screen used for VSM Versions. Figure 46 shows how the information is presented on the screen. The top line lists the manufacturer's hardware version; the second line lists the manufacturer's software version.

TRUCK SERIAL NUMBER

Use this submenu to view the serial number assigned to the truck. The truck serial number always has 11 characters, plus a 3 digit version number. The serial number can include letters with the numbers. Figure 47 shows how the serial number is displayed on the screen.

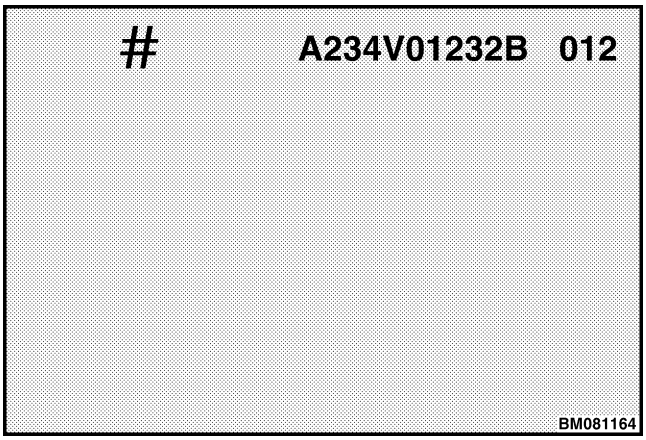


Figure 47. Truck Serial Number

HOUR METERS

Use this submenu to view hour meter readings. These include a truck hour meter, traction hour meter, pump hour meter (displayed only if the Master Controller is controlling the hydraulic pump), and a secure hour meter. Secure hour meters cannot be reset. Figure 48 shows an example of the way hour meters and readings are presented on the screen.

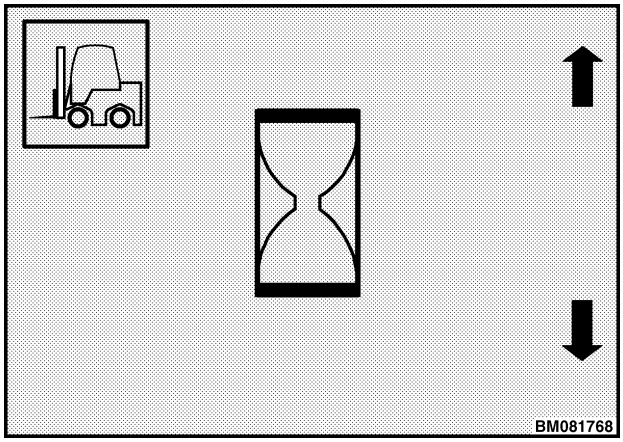


Figure 48. Hour Meters Screen

E-HYDRAULIC CONTROLLER VERSIONS

NOTE: The manufacturer's hardware and software versions may not match the hardware and software versions shown on the device's exterior label.

Use this submenu to view the manufacturer's internal hardware and software versions of the E-Hydraulic Input Controller.

NOTE: This item is visible only on trucks equipped with E-Hydraulics.

The manufacturer's hardware and manufacturer's software version information is presented on the screen as shown in Figure 46.

PUMP MOTOR CONTROLLER VERSIONS

NOTE: The manufacturer's hardware and software versions may not match the hardware and software versions shown on the device's exterior label.

Use this submenu to view the manufacturer's internal hardware and software versions of the Pump Motor Controller. The manufacturer's hardware and manufacturer's software version information is presented on the screen as shown in Figure 46.

TRACTION MOTOR CONTROLLER 1 VERSIONS

NOTE: The manufacturer's hardware and software versions may not match the hardware and software versions shown on the device's exterior label.

Use this submenu to view the manufacturer's internal hardware and software versions of Traction Motor Controller 1.

NOTE: If the truck is equipped with two traction motors, this submenu displays the versions for the right side traction motor only.

The manufacturer's hardware and manufacturer's software version information is presented on the screen as shown in Figure 46.

TRACTION MOTOR CONTROLLER 2 VERSIONS

NOTE: The manufacturer's hardware and software versions may not match the hardware and software versions shown on the device's exterior label.

Use this submenu to view the manufacturer's internal hardware and software versions of Traction Motor Controller 2. Traction Motor Controller 2 controls the left side traction motor.

NOTE: The Status Menu displays this item only if the CDF configuration indicates dual traction motors are present.

The manufacturer's hardware and manufacturer's software version information is presented on the screen as shown in Figure 46.

LIGHT CONTROLLER VERSIONS

NOTE: The manufacturer's hardware and software versions may not match the hardware and software versions shown on the device's exterior label.

Use this submenu to view the manufacturer's internal hardware and software versions of the Light Controller. The manufacturer's hardware and manufacturer's software version information is presented on the screen as shown in Figure 46.

IMPACT SENSOR VERSIONS

NOTE: Hardware and software versions may not match the hardware and software versions shown on the device's exterior label.

Use this submenu to view the manufacturer's internal hardware and software versions of the Impact Sensor.

NOTE: If the truck is not equipped with an Impact Sensor, this submenu is not displayed.

The manufacturer's hardware and manufacturer's software version information is presented on the screen as shown in Figure 46.

Truck Setup Menu

INTRODUCTION

NOTE: This menu is available only when the truck is not moving and the E-Hydraulics controller is in the neutral position.

To access this menu, cycle through the main menu title screens by pressing the **Scroll Back Key** (◂—) or **Scroll Forward Key** (—▸) until the Truck Setup Title Screen is displayed, as shown in Figure 49.

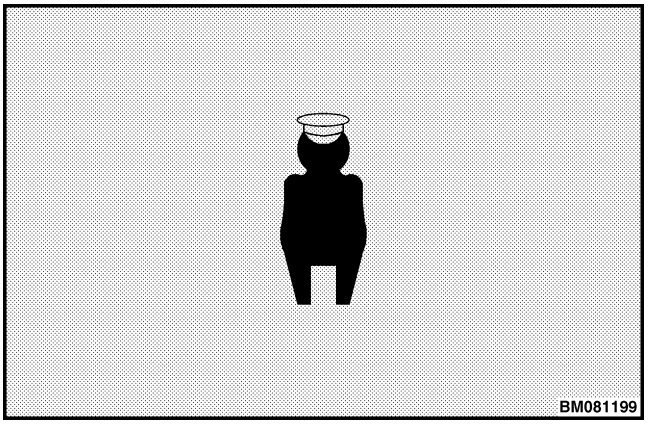


Figure 49. Truck Setup Title Screen

Press the **Enter Key** (*****) to enter the Truck Setup Menu. The system will display the Add/Remove Password submenu shown in Figure 50. Press the **Enter Key** again to enter this submenu. For a different submenu, use the **Scroll Back Key** or **Scroll Forward Key** to move to the desired submenu and press the **Enter Key**.

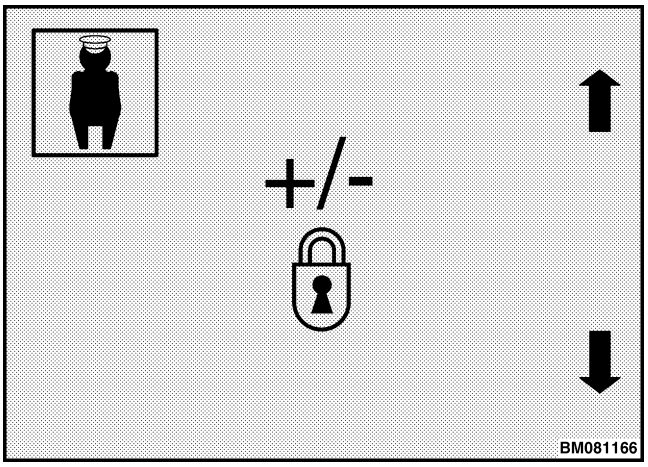


Figure 50. Add/Remove Password Submenu

The Truck Setup Menu presents these submenus to Supervisors:

- Add/Remove Password
- Restore Default Settings
- Motion Alarm
- Impact Monitor Settings
- Auto Power-Off Time Delay
- Return to Set Tilt
- Traction Speed Limit
- Scheduled Maintenance Reminder
- Minimum Pump Standby Flow Rate
- Operator Checklist
- Impact Monitor Shutdown
- Motor Braking

The following sections describe the Truck Setup submenus.

ADD/REMOVE PASSWORD

NOTE: This menu selection is available to logged in Supervisors and Service Technicians.

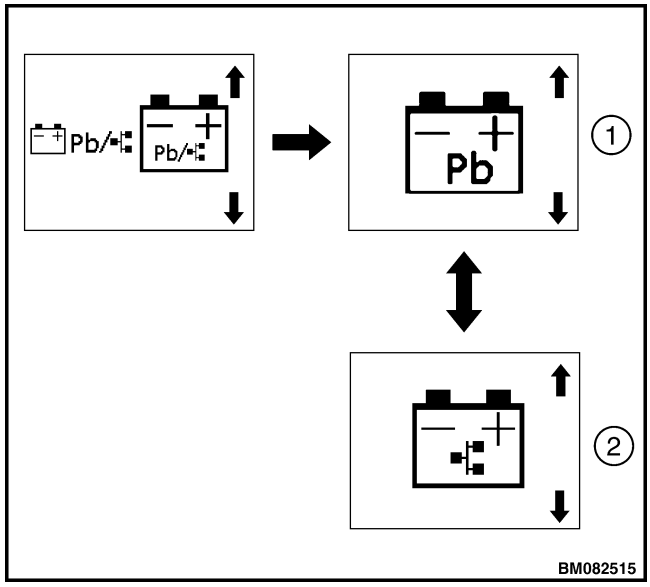
This submenu, shown in Figure 50, allows Supervisors and Service Technicians to add or remove passwords. See the Password Screen topic in the Password Screen section for more information.

BATTERY SETTINGS

NOTE: This submenu is available to logged in Service Technicians and Supervisors. It is visible only on trucks equipped with the Lithium-Ion Ready option.

This menu provides settings for battery type installed on the truck.

There are two possible battery settings, lead-acid and lithium-ion battery. See Figure 51.



1. LEAD-ACID BATTERY SETTING
2. LITHIUM-ION BATTERY SETTING

Figure 51. Battery Settings

It is important that the setting match the battery type installed to allow for accurate function of the battery discharge indicator and Shutdown Warning System.

RESTORE DEFAULT SETTINGS

NOTE: This submenu is available on all trucks to logged in Supervisors and Service Technicians.

This menu allows a Supervisor or a Service Technician to change all adjustable truck settings back to their factory default settings. Calibrations are NOT reset when this function is used. Figure 52 shows the Restore Defaults screen.

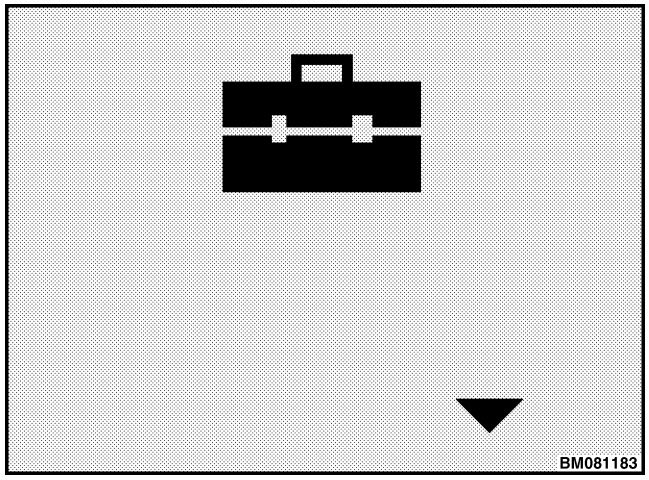


Figure 52. Restore Defaults Screen

While in this menu, press the **Enter Key** to restore all truck settings, except hour meters and system time, to their factory default settings. The system then returns to the Truck Setup Menu.

MOTION ALARM

NOTE: This submenu is available to logged in Supervisors and Service Technicians on all trucks.

Use this menu to enable or disable the Motion Alarm feature. Figure 53 shows the Motion Alarm Setup Screen with the alarm option set to On.

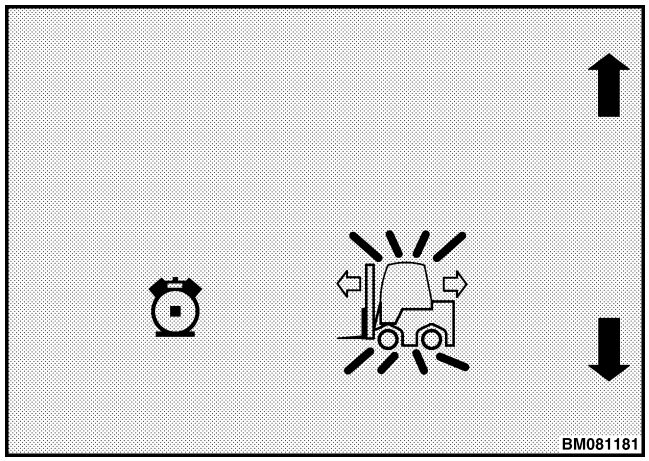


Figure 53. Motion Alarm Setup Screen

Use the **2** and **3** soft keys to toggle the setting between On and Off. An X over the fork lift truck icon indicates the Motion Alarm feature is set to Off. If this feature is Off and you want to enable it, press the **2** or **3** soft key to have the system display the

icon without an X over it, then press the **Enter Key** to store the setting.

IMPACT MONITOR SETTINGS

NOTE: This submenu is available to logged in Service Technicians and Supervisors. It is visible only on trucks equipped with the Impact Monitoring feature.

This menu provides a way to adjust the settings the impact monitor uses when it detects impacts. Figure 54 shows the Impact Monitor Settings Screen.

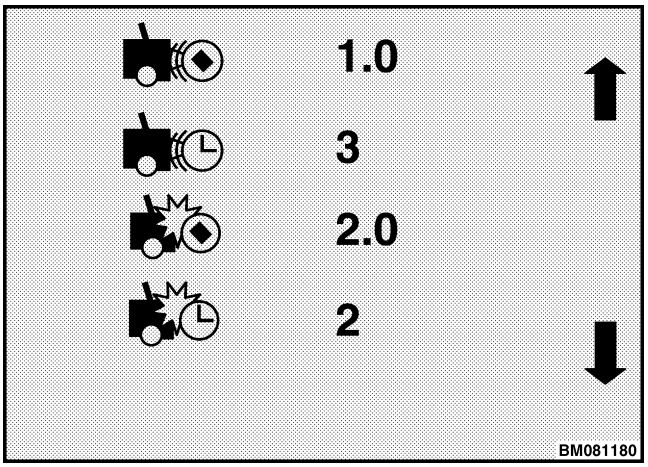


Figure 54. Impact Monitor Settings Screen

Impact Detection

The impact monitor can detect both hard and soft impacts.

An example of a hard impact is a truck colliding with a steel column in a warehouse which causes the truck to stop suddenly. In this case the impact force is very strong but it occurs during a short time period.

An example of a soft impact is a truck rolling over and crushing a wooden pallet. In this case the impact force is much less than experienced with a hard impact but it lasts for a significantly longer time period.

Setting Adjustments

Use the **2** and **3** soft keys to move up or down through the current values for the four settings for Impact Force and Impact Times. When there is a box around the setting you want to change, press the **Enter Key**, then use the **2** or **3** soft key to step through the valid values for that setting.

The Soft Impact Force, the setting at the top of the screen, can be set to a value in the range 0.2 to 2.5 g., in tenths of gravitational force.

The Soft Impact Time, the second setting down from the top, can be adjusted to require the impact monitor to see an impact force greater than the Soft Impact Force for 1 to 12 samples before a soft impact event will be reported.

The Hard Impact Force, the third setting down, can be set to a value in the range 0.5 to 3.0 g., in tenths of gravitational force.

The Hard Impact Time, the forth setting down from the top, can be adjusted to require the impact monitor to see an impact force greater than the Hard Impact Force for 1 or 2 samples before a hard impact event will be reported.

The Hard Impact Force, the third setting down, can be set to a value in the range 0.5 to 3.0 g., in tenths of gravitational force.

Initial Adjustment of Soft and Hard Impact Settings

NOTE: When adjusting the impact sensor settings, be sure to:

Adjust the truck to the lowest Soft Impact Force setting, the Soft Impact Time set to 6, and the highest Hard Impact Force Setting. Drive the truck at the fastest operational speed for the environment. Apply the brakes to bring the truck to an abrupt stop. Determine if an impact event has occurred.

Increase either the Soft Impact Force setting until the vehicle can be abruptly stopped with the service brake without reporting an impact event. Read and record the value, from the dash display, that was triggered a Soft Impact when abruptly stopping the truck. Change the Soft Impact Force threshold to the next highest setting.

To adjust the hard threshold, take the soft threshold value and add 0.3 g. Set the Hard Impact Time to 2.

Monitor truck during all normal operations. If impacts are recorded during normal operations, go to (**Readjustment of Soft and Hard Impact Settings**).

Readjustment of Soft and Hard Impact Settings.

If the majority of impacts recorded during the initial adjustment period are soft impacts, change the settings as follows:

- Increase the Soft Impact Time by 1 for large scale adjustments.
- Increase the Soft Impact Force by 0.1g for smaller adjustments.
- Increase the Hard Impact Force to the current Soft Impact + 0.3g.

If the majority of impacts recorded during the initial adjustment period are hard impacts, change the settings as follows:

- Increase the Hard Impact Time by 1 sample for large adjustments.
- Increase the Hard Impact Force by 0.1g for smaller adjustments.

After making the necessary adjustments, have the operator again operate the lift truck under normal conditions to ensure that the adjustments are correct.

AUTO POWER-OFF TIME DELAY

NOTE: This submenu is available to logged in Supervisors and Service Technicians.

This menu can be used to adjust the setting for the amount of time before the truck enters the Power Off mode. Figure 55 shows an Auto Power-Off Delay Setup Screen that has a 20m delay setting value, which is a 20 minute delay.

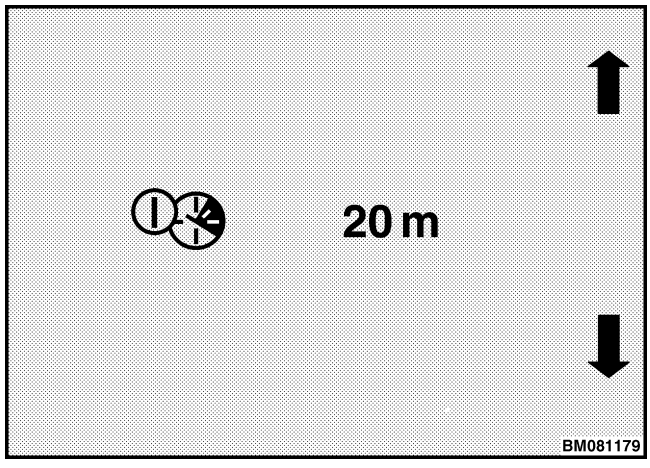


Figure 55. Auto Power-Off Time Delay Setup Screen

To change the Auto Power-Off Time Delay setting, select the current value. When a box is around it, press the **Enter Key**, then use the number keys to enter a value from 0 to 30 minutes and press the **Enter Key** to save the new setting.

RETURN TO SET TILT

NOTE: This submenu is available to logged in Supervisors and Service Technicians. It is visible only on trucks equipped with the Return to Set Tilt (RTST) feature.

This menu provides a way to adjust the RTST delay time and to program this feature to work only in the forward direction or in both directions. Figure 56 shows the RTST Setup Screen with the delay direction set to Forward.

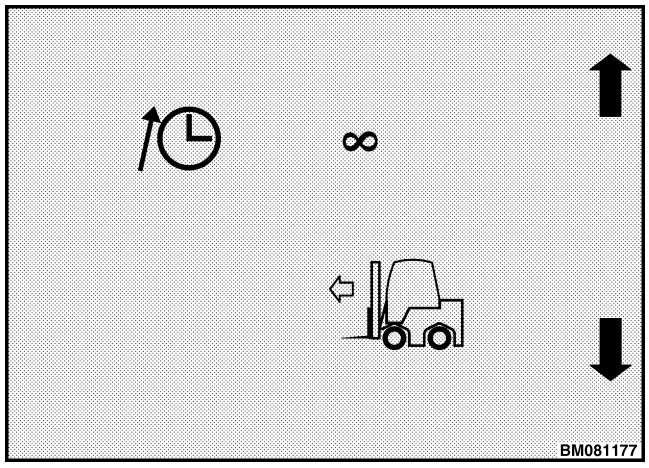


Figure 56. RTST Setup Screen

The icon at the top left of the screen is for the delay time. When a box is around the current value, press the **Enter Key**. Then use the **2** or **3** soft key to step through the available values for the delay time, 0, 0.1, 0.2, 0.4, 0.6, 0.8, 1.0, 2.0, 3.0 seconds or Continuous and press the **Enter Key** to save the new value. When the delay time is set to 0, this feature is deactivated. When set to Continuous, the delay time is infinite (limitless).

The lift truck icon in Figure 56 indicates the mast assembly is programmed to return to the set tilt angle only when it is moving forward, which is the Forward option. To set up the mast assembly so that it returns to the set tilt whether it is moving forward or backward, use the **2** or **3** soft key to set the direction.

TRACTION SPEED LIMIT

NOTE: This submenu is available to logged in Supervisors and Service Technicians.

The example shown in Figure 57 shows the MPH Icon and a current Traction Speed Limit setting of 12.0.. The type of speed units, MPH or km/h, is set in a submenu of the Display main menu.

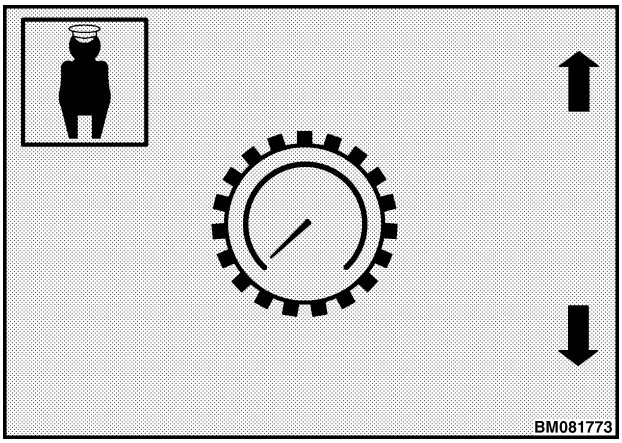


Figure 57. Traction Speed Limit Example

To change the traction speed limit setting, use the number keys to enter the new value desired, then press the **Enter Key** to save it. Acceptable values for the traction speed limit range from 1 to 99 MPH when Imperial units are in use or from 1 to99 km/h when metric units are in use.

SCHEDULED MAINTENANCE REMINDER

NOTE: This submenu is available to logged in Service Technicians and Supervisors.

This menu item is only visible on trucks equipped with the Scheduled Maintenance Reminder feature. The examples shown in Figure 58, Figure 59, and Figure 60 show the icons for the scheduled maintenance reminder screen.

Using this menu item the user shall be able to adjust the scheduled maintenance reminder settings. The items available to the user are:

- Maintenance Reminders **ON/OFF**.
- Maintenance Interval in Months.
- Maintenance Interval in Truck Hours.
- Derated Traction Speed Percentage after the scheduled time has expired.

The maintenance intervals are countdown timers that are set by the users. Once the user has set the interval it begins counting down. Each time the user enters the menu the current count until the interval will expire will be displayed.

Setting the Maintenance Reminders Status to **OFF** deactivates the feature. Setting an Interval to 0 deactivates that Interval.

With the Maintenance Reminder Status set to **ON** and Setting one or both of the reminder intervals to nonzero numbers activates the maintenance reminders feature.

Once a previously active interval counts down to zero, the maintenance reminder becomes active. To deactivate the maintenance reminder the user must either set the status to **OFF** or enter a new service interval.

The scheduled maintenance month interval is based on the system date. The value ranges from 0 to 99 in increments of 1 month.

The scheduled maintenance hour interval is based on the trucks hour meter. The value ranges from 0 to 9999 in increments of 1 hour.

The derated traction speed percentage setting is a percentage of the current maximum speed limit. A setting of 100% has no reduction in top speed while 0% disables the traction system. This value can be from 0% to 100% in increments of 1%.

When scheduled maintenance reminder interval has expired, a reminder is activated. If a reminder is active the system will display the maintenance reminder alert screen for 5 seconds at key **ON**.

If the maintenance reminder is not reset or deactivated within 20 hours after the maintenance interval has expired, lift truck operation will be slowed to the derated traction speed setting on the next key cycle.

The truck will operate with a reduced traction speed until the maintenance reminder interval is set or the feature is turned **OFF**.

The service technician must reset the scheduled time for the next maintenance time interval to allow normal operation again.

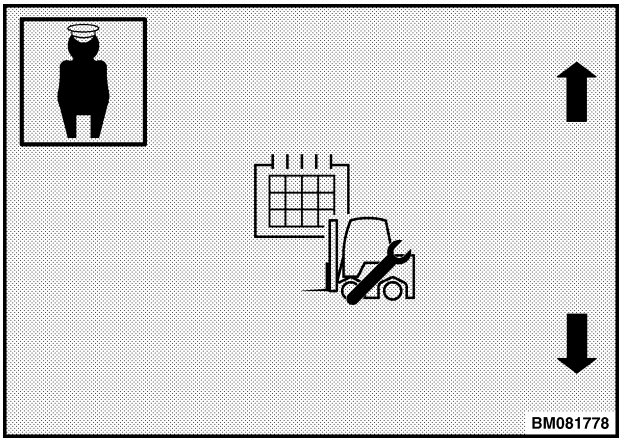


Figure 58. Scheduled Maintenance Reminder

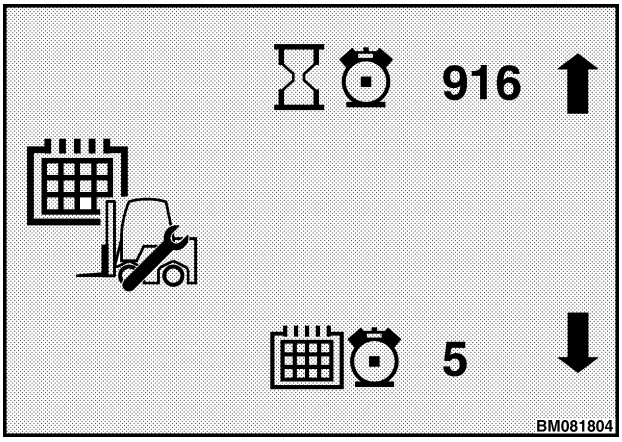


Figure 59. System Off Screen

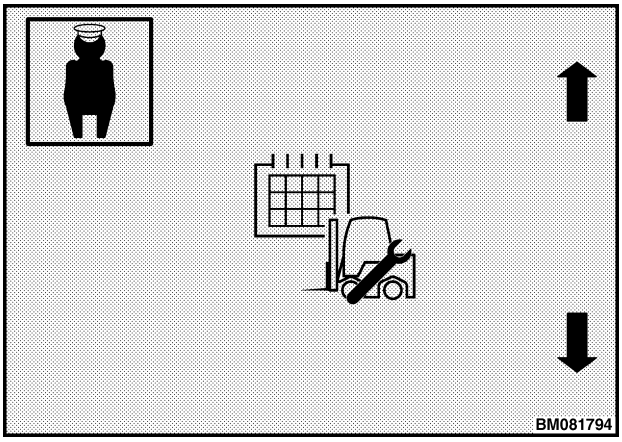


Figure 60. Maintenance Reminder Alert Screen

MINIMUM PUMP STANDBY FLOW RATE

NOTE: This submenu is available to logged in Supervisors and Service Technicians.

This menu can be used to adjust the minimum standby pump flow rate. Values stored in the truck's CDF determine the range of allowable values for this setting. This means a setting of 1% the value is the lowest available setting for the minimum standby pump flow rate and it is equal to the lowest defined value in the CDF. A 100% value is the highest available setting for the minimum standby pump flow rate. The example presented in Figure 61 shows the icon for minimum pump standby flow rate and a current value of **56**, which means the value is 56% of the maximum allowed.

NOTE: A setting of 0% turns the standby flow off which may result in decreased steering performance.

To change the setting for the minimum standby pump flow rate, use the number keys to enter the new rate desired, then press the **Enter Key** to save the new setting. The value of this setting can range from 0% to 100% in steps of 1%.

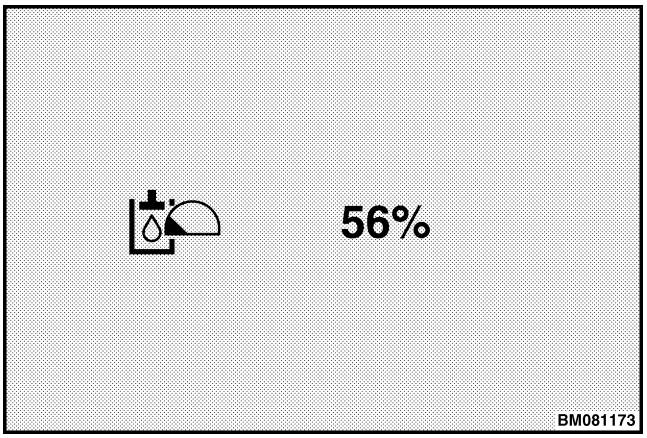


Figure 61. Minimum Pump Standby Flow Rate Screen

OPERATOR CHECKLIST

NOTE: This submenu is available to logged in Supervisors and Service Technicians.

A Supervisor or a Service Technician can use this menu to program the checklist items that will be displayed to users.

The lift truck system can be set up to display all, some, or none of the 30 items in the Operator Checklist when the key switch or keyless switch is turned on. Each checklist item is represented by a separate icon. During setup, the 30 icons are displayed, one at a time, in the middle of the screen. If an X appears over the icon when it is displayed,

the checklist item represented by the icon is inactive (deactivated) and the checklist item will not appear during the Operator Checklist sequence. If there is no X over the icon, the checklist item is active (enabled).

Figure 62 shows the Activate/Deactivate Checklist Item Screen with an icon that represents a checklist item.

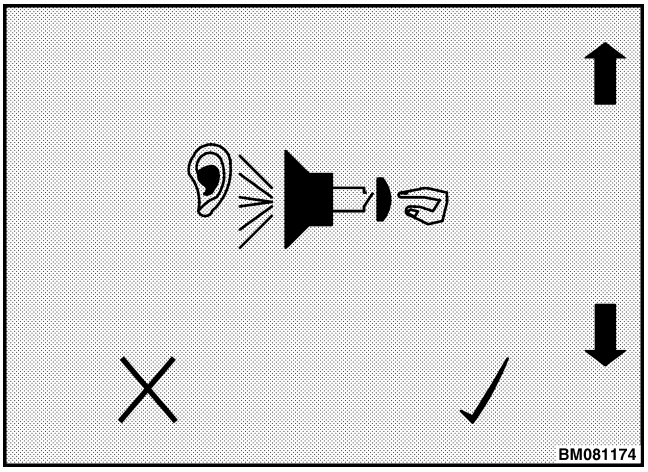


Figure 62. Activate/Deactivate Checklist Item Screen

The icon in Figure 62 does not have an X over it, so the checklist item this icon represents is enabled (activated). The X Icon in the lower left area of the screen, right above the **#** soft key indicates the currently displayed checklist item will be deactivated if the **#** key is pressed. If the checklist item was deactivated, pressing the **Enter Key** (*) above the Check Mark Icon in the lower right area of the screen would enable it.

Any checklist item can be activated or deactivated by a Supervisor or Service Technician as follows: Use the **2** and **3** soft keys (the up and down arrow keys) to move through the icons to the one that represents the checklist item you want to enable or disable. If the currently displayed icon has an X over it, press the **Enter Key**. The system will enable the checklist function the icon represents and redraw the icon with no X over it and the checklist function will now be programmed to appear during the Operator Checklist sequence. If the currently displayed icon does not have an X over it, press the **#** soft key to disable the checklist function the icon represents. The system will redraw the icon with an X over it and this checklist function will be skipped (it will not appear) during the Operator Checklist sequence.

NOTE: If all items on the checklist are deactivated, the Operator Checklist feature is deactivated and the system does not present the Operator Checklist to the operator.

IMPACT MONITOR SHUTDOWN

NOTE: This submenu is available to logged in Supervisors and Service Technicians.

This menu makes it possible to adjust the way the system reacts after an impact is detected. These settings are laid out on the screen as shown in Figure 63.

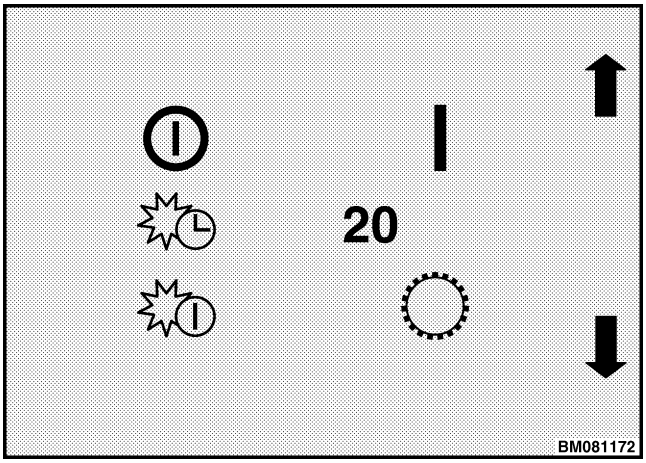


Figure 63. Setup Screen for Impact Settings

The top left icon is the Impact Detection Icon. To set impact detection to On or Off, use the **2** and **3** soft keys to select the current value for this setting. When there is a box around the On or Off Icon, use the **2** or **3** soft key to display the desired setting and press the **Enter Key** to save it.

The second icon down from the top is the Impact Monitor Shutdown Delay Icon. To set the Shutdown Delay, use the **2** and **3** soft keys to select the current value for this setting. When there is a box around the value, press the **Enter Key**, then use the number keys on the Display Panel to enter a value from 0 to 30 seconds and press the **Enter Key** to save the new setting.

The third icon down from the top is the Impact Monitor Shutdown Type Icon. To set the Disable Type to All or Traction, use the **2** and **3** soft keys to select the current value for this setting. When there is a box around the All Icon or the Traction Icon, use

the **2** or **3** soft key to display the desired setting and press the **Enter Key** to save it.

MOTOR BRAKING

NOTE: This submenu is available to logged in Service Technicians and Supervisors.

There are three motor braking settings, Regenerative Braking Rate, Auto Deceleration Rate, and Auto Deceleration Type. See Figure 64.

Regenerative Braking setting controls how much motor braking is applied when the direction is changed from Forward to Reverse or Reverse to Forward. This type of deceleration is proportional to the accelerator pedal position. The further the accelerator is depressed the greater the deceleration.

Auto Deceleration setting controls how much motor braking is applied when transitioning from higher accelerator pedal position to a lower acceleration pedal position. There are two types of Auto Deceleration, Pedal Up and Proportional. A fully released pedal produces maximum deceleration for both Pedal Up or Proportional deceleration.

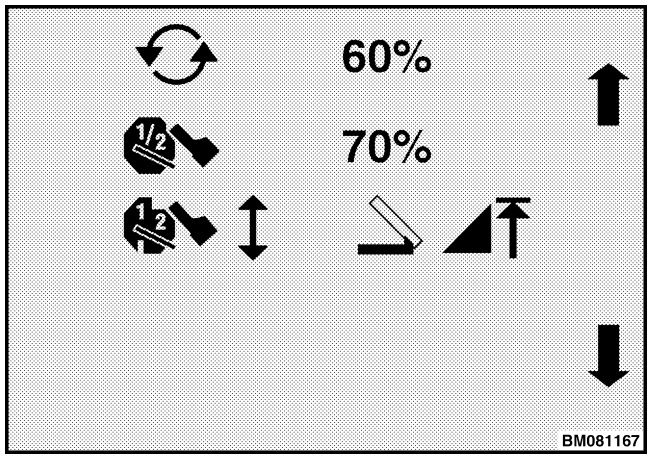


Figure 64. Motor Braking Setup

Changing the Motor Braking Settings

To change the Set Regenerative Braking Rate or Set Auto Deceleration Rate setting, use the **2** and **3** soft keys to select the current value of the setting you want to adjust. When there is a box around the value you want to change, press the **Enter Key**. Next, use the number keys to enter the desired value, then press the **Enter Key** to save the new setting.

The Regenerative Braking Rate setting is the value at the top of the screen. This value can be from 0 to 100% in increments of 1%. A 100% setting provides maximum regenerative braking while a 0% setting in effect deactivates regenerative braking.

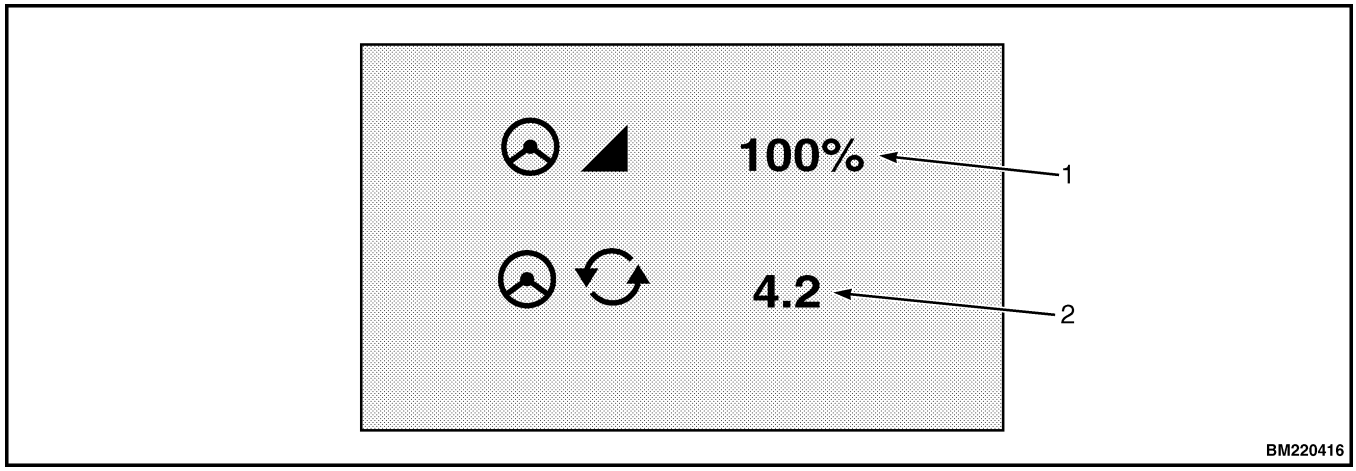
The Auto Deceleration Rate setting is the second setting down from the top. The setting value can be in the 0 to 100% in increments of 1%. A 100% setting provides maximum auto deceleration while a 0% setting in effect deactivates it. Auto Deceleration rate is always a percentage of the current Regenerative Braking Rate. Thus, if Regeneration brake = 0% then Auto Deceleration = 0%.

The Auto Deceleration Type is the third setting down from the top. To change the type, use the **2** and **3** soft keys to select the current type and press the **Enter Key**. Next, use the **2** or **3** soft key to choose either Pedal Up or Proportional deceleration and press the **Enter Key** to save the new setting. Pedal Up deceleration allows the truck to coast until the pedal is fully released. Proportional deceleration causes the truck to decelerate in proportion to how far the pedal is released in relation to the current traction speed. A fully released pedal produces maximum deceleration for both Pedal Up or Proportional deceleration.

STEERING WHEEL FRICTION AND STEERING TURNS ADJUSTMENT

NOTE: This submenu is available to logged in Service Technicians and Supervisors.

On trucks equipped with electronic steering or "E-Steer", the screen shown in Figure 65 allows the operator to adjust the friction on the steering wheel and the number of steering wheel turns from stop to stop.



1. STEERING WHEEL FRICTION SETTING IN %
2. STEERING WHEEL NUMBER OF TURNS LOCK TO LOCK

Figure 65. Steering Wheel Friction and Steering Turns

How to Adjust Settings

Steering Friction Setting

1. Open the "Steering Wheel Friction and Steering Turns Adjustment" screen. See Figure 66.

2. Navigate cursor to the steering friction setting and press enter. See Figure 66.

NOTE: Setting must be within 0 to 100%. If out of range, setting will not be saved.

3. Enter adjustment using the keypad. See Figure 67.

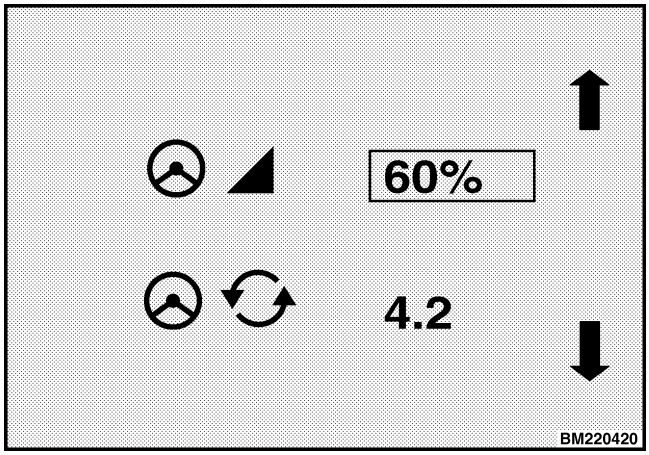


Figure 66. Steering Wheel Friction Adjustment Screen

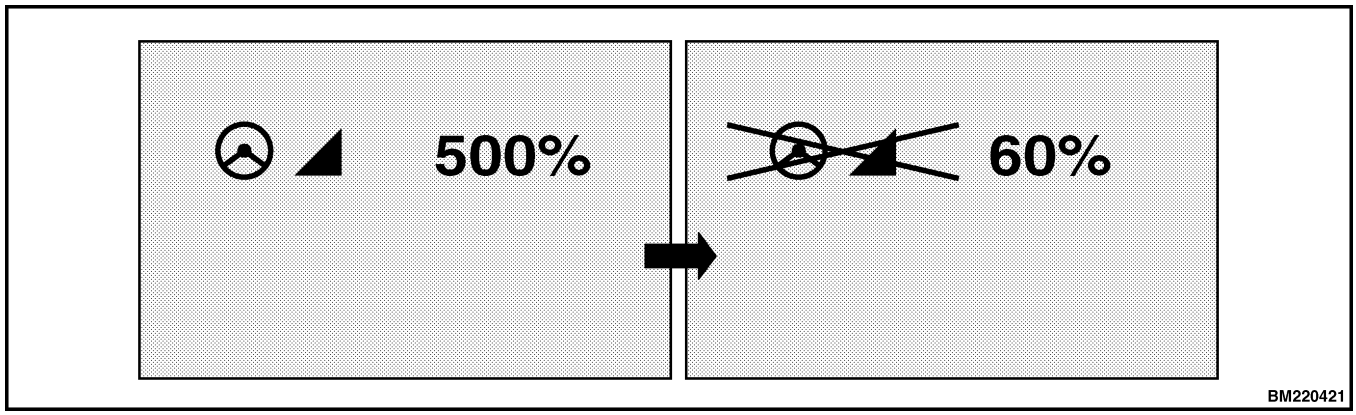


Figure 67. Steering Friction Adjustment and Out of Range Screens

4. If valid setting is entered, setting will be saved and shown on the screen. See Figure 68.

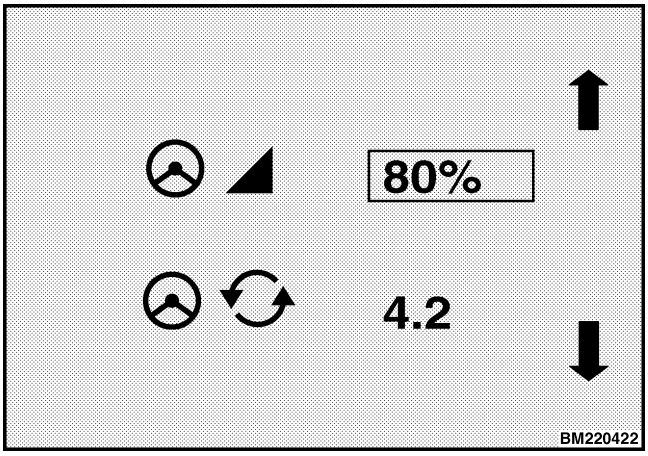


Figure 68. Steering Friction Screen, Valid Entry

Steering Wheel Number of Turns

1. Open the "Steering Wheel Friction and Steering Turns Adjustment" screen. See Figure 69.

2. Navigate cursor to the steering wheel number of turns settings and press enter. See Figure 69.

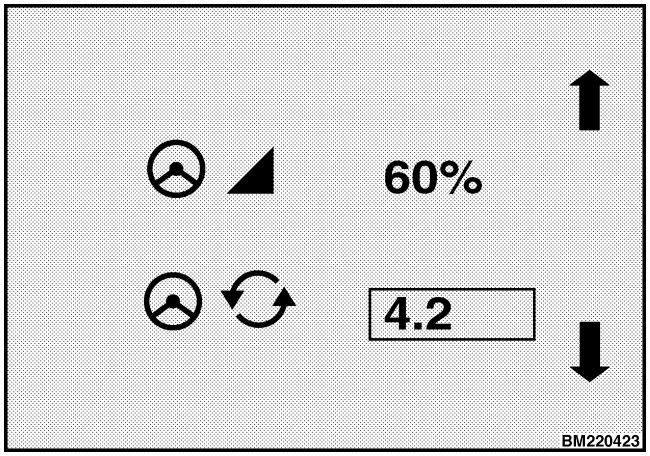


Figure 69. Steering Wheel Turns Adjustment Screen

NOTE: Setting must be within 4.0 and 6.0 turns. If out of range, setting will not be saved.

3. Enter adjustment using the keypad. See Figure 70.

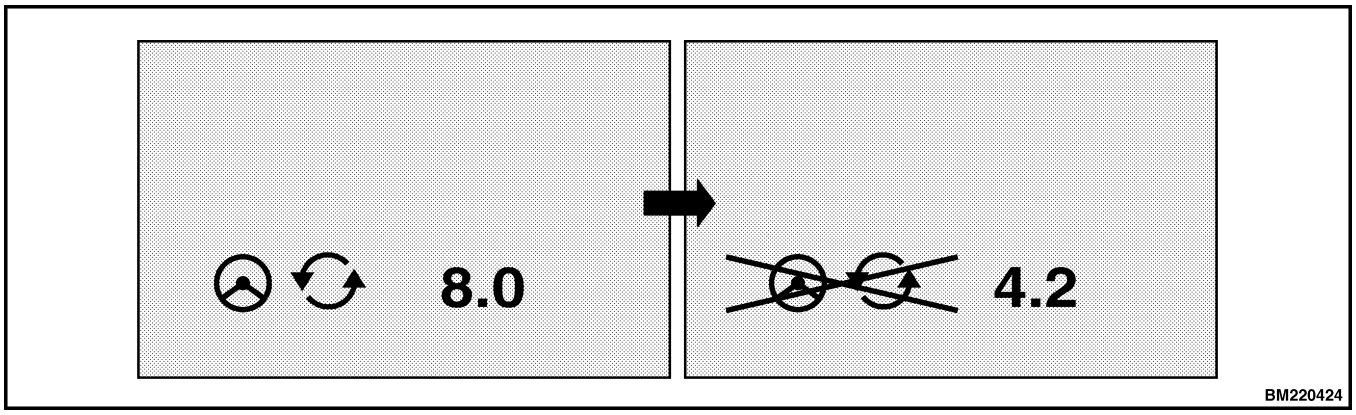


Figure 70. Steering Wheel Number of Turns Adjustment and Out of Range Screens

4. If valid setting is entered, setting will be saved and shown on the screen. See Figure 71.

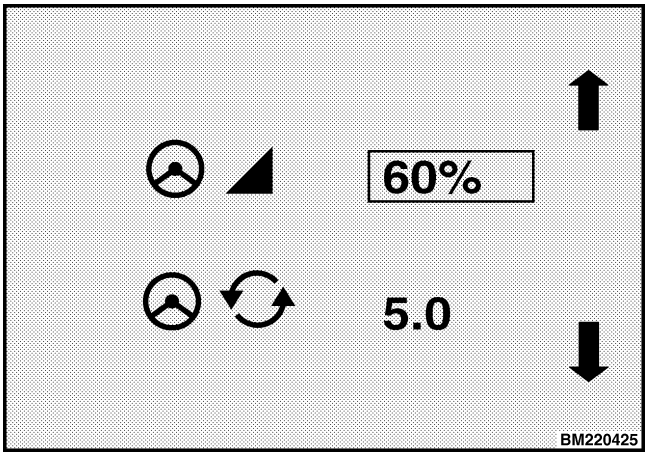


Figure 71. Steering Wheel Number of Turns, Valid Entry

USER INTERFACE SERVICE TECHNICIAN

E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) [A099];
A1.3-1.5XNT (A25-30XNT) [D203];
J1.5-2.0XNT (J30-40XNT) [K160];
E2.2-3.5XN (E45-70XN) [A268];
E1.6-2.0XN (E30-40XN) [A269];
J2.2-3.5XN (J45-70XN) [A276];
J1.6-2.0XN (J30-40XN) [A935];
J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) [A970];
J8.0XNL6, J8.0XNL9, J9.0XNL (J170-190XNL) [A250]

HYSTER

PART NO. 1688879 **2200 SRM 1336**

SAFETY PRECAUTIONS
MAINTENANCE AND REPAIR

- The Service Manuals are updated on a regular basis, but may not reflect recent design changes to the product. Updated technical service information may be available from your local authorized Hyster® dealer. Service Manuals provide general guidelines for maintenance and service and are intended for use by trained and experienced technicians. Failure to properly maintain equipment or to follow instructions contained in the Service Manual could result in damage to the products, personal injury, property damage or death.
- When lifting parts or assemblies, make sure all slings, chains, or cables are correctly fastened, and that the load being lifted is balanced. Make sure the crane, cables, and chains have the capacity to support the weight of the load.
- Do not lift heavy parts by hand, use a lifting mechanism.
- Wear safety glasses.
- DISCONNECT THE BATTERY CONNECTOR before doing any maintenance or repair on electric lift trucks. Disconnect the battery ground cable on internal combustion lift trucks.
- Always use correct blocks to prevent the unit from rolling or falling. See HOW TO PUT THE LIFT TRUCK ON BLOCKS in the **Operating Manual** or the **Periodic Maintenance** section.
- Keep the unit clean and the working area clean and orderly.
- Use the correct tools for the job.
- Keep the tools clean and in good condition.
- Always use **HYSTER APPROVED** parts when making repairs. Replacement parts must meet or exceed the specifications of the original equipment manufacturer.
- Make sure all nuts, bolts, snap rings, and other fastening devices are removed before using force to remove parts.
- Always fasten a DO NOT OPERATE tag to the controls of the unit when making repairs, or if the unit needs repairs.
- Be sure to follow the **WARNING** and **CAUTION** notes in the instructions.
- Gasoline, Liquid Petroleum Gas (LPG), Compressed Natural Gas (CNG), and Diesel fuel are flammable. Be sure to follow the necessary safety precautions when handling these fuels and when working on these fuel systems.
- Batteries generate flammable gas when they are being charged. Keep fire and sparks away from the area. Make sure the area is well ventilated.

NOTE: The following symbols and words indicate safety information in this manual:

WARNING

Indicates a hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION

Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury and property damage.

On the lift truck, the WARNING symbol and word are on orange background. The CAUTION symbol and word are on yellow background.

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This section is for the following models:

E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) [A099];
A1.3-1.5XNT (A25-30XNT) [D203];
J1.5-2.0XNT (J30-40XNT) [K160];
E2.2-3.5XN (E45-70XN) [A268];
E1.6-2.0XN (E30-40XN) [A269];
J2.2-3.5XN (J45-70XN) [A276];
J1.6-2.0XN (J30-40XN) [A935];
J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) [A970];
J8.0XNL6, J8.0XNL9, J9.0XNL (J170-190XNL) [A250]

"THE QUALITY KEEPERS"

HYSTER APPROVED PARTS

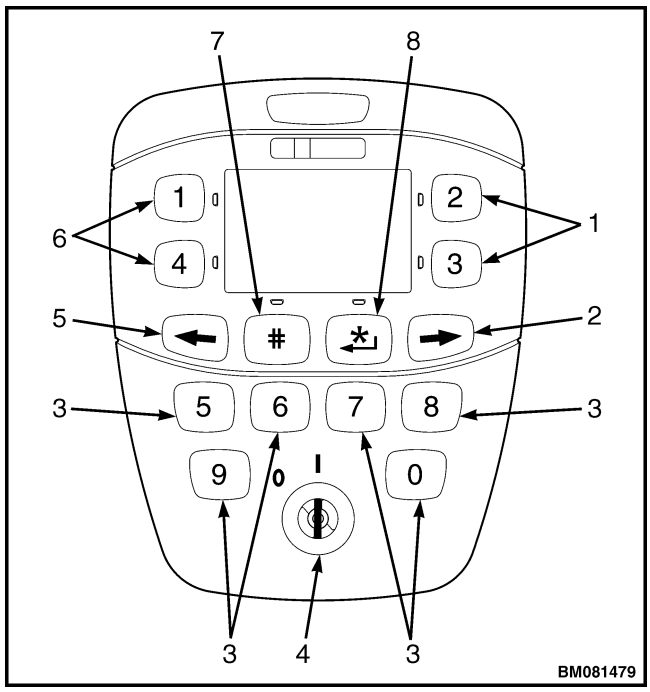
General

DESCRIPTION

The information provided in this **Service Manual** describes the functions of the display panel that are available to the Service Technician. With a proper service technician password, a Service Technician can access menu items that are not visible at Operator or Supervisor password-level access.

DISPLAY PANEL MENU ACCESS

Turning the keyless start switch or key switch to the **ON** position activates the Display Panel. Figure 1 shows the layout of the Display Panel including the location of the key switch or keyless start switch.



1. 2 AND 3 KEYS
2. SCROLL FORWARD KEY (RIGHT ARROW)
3. 5, 6, 7, 8, 9, AND 0 KEYS
4. KEYLESS START SWITCH OR KEY SWITCH
5. SCROLL BACK KEY (LEFT ARROW)
6. 1 AND 4 KEYS
7. POUND KEY (# KEY)
8. ENTER KEY (* STAR KEY)

Figure 1. Lift Truck Display Panel

The operator password screen appears at startup as shown in Figure 2, if Operator Passwords are enabled.

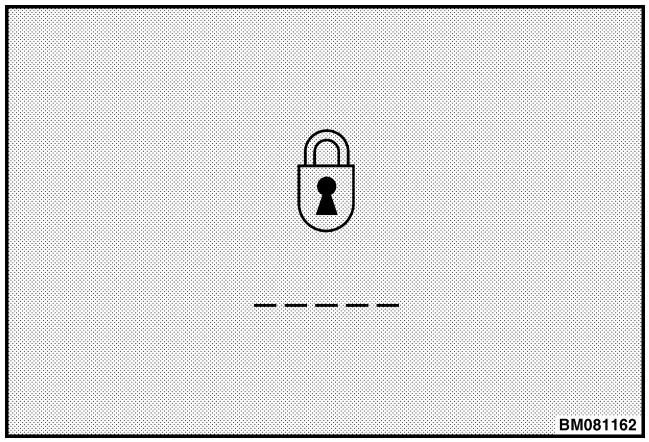


Figure 2. Password Screen

Use the number keys on the Display Panel to enter your five-digit Service Technician Password.

If a non-service technician password has already been entered at the initial password screen, you can navigate to the Password Screen by pressing the **Enter Key** (*****) to go to the Main Menu, then press either the **Scroll Back Key** (◂—) or the **Scroll Forward Key** (—▸) to access the Password Screen. Refer to the Figure 6, Main Menu Structure topic for orientation on the Main Menu title screens (the main level menus).

Menu Flowchart

TECHNICIAN MENU FLOWCHART

NOTE: Depending upon how the lift truck is equipped, some of the functions described in this section may not be included in the on-board menu structure for a particular lift truck.

NOTE: The icons displayed on the Operating Screen vary from any one time to another, depending on the current operation of the lift truck and other factors. The Battery Discharge Indicator, system time, and direction indicator are always displayed.

All available menus are grouped by function under the main menu screens, which are also called top-level title menus. When you select a main menu screen, the system then presents submenus, also known as second-level menus, that you can cycle through using the **UP** ↑ or **DOWN** ↓ keys until you find the one you want on the Display Panel. Two main menu screens, the Operating Screen and the Password Screen, have no associated submenus, but the other main menus lead to submenus.

The following flowchart is for the Technician use only. See Figure 3 and Table 1.

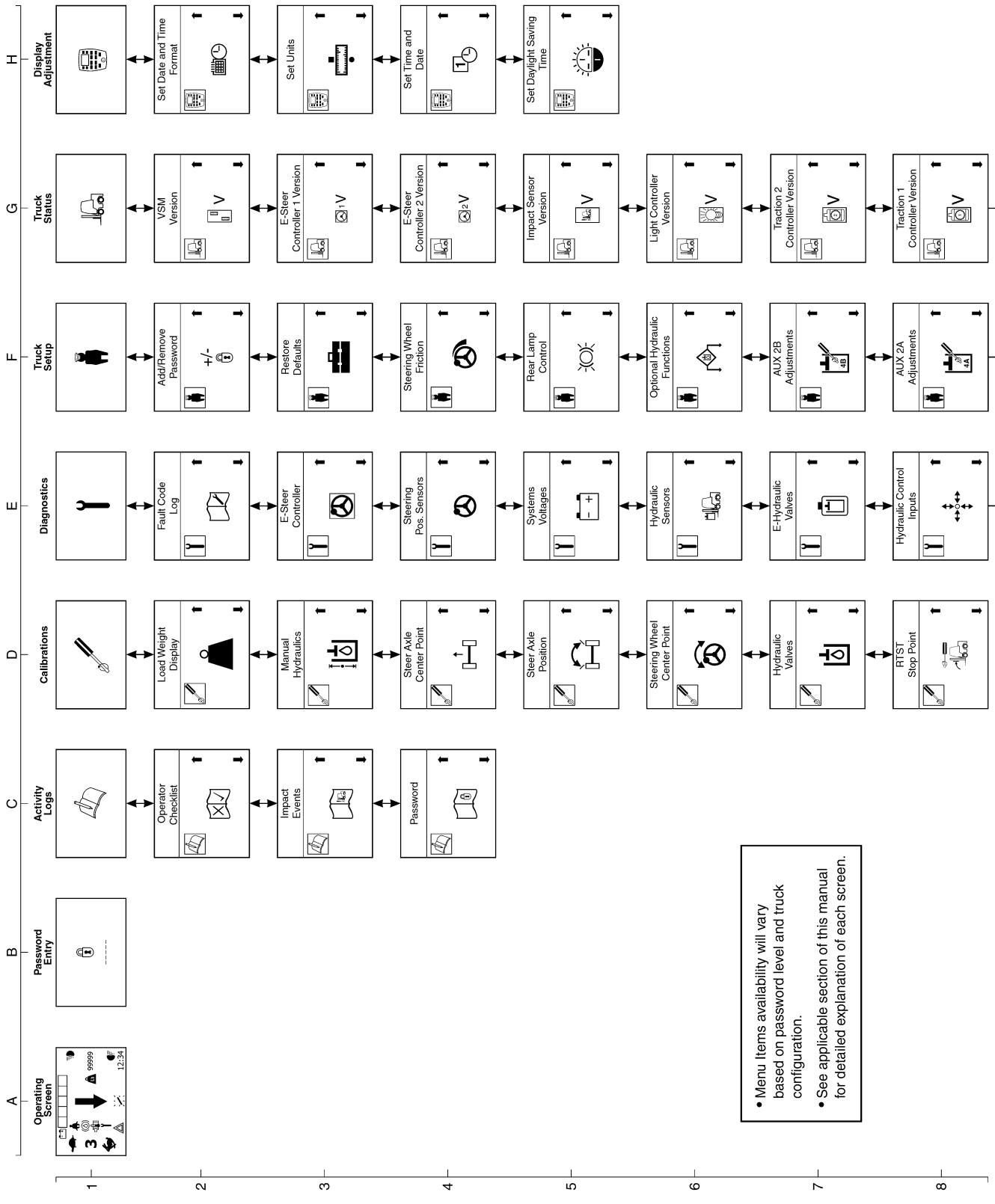


Figure 3. Technician Flowchart (Sheet 1 of 4)

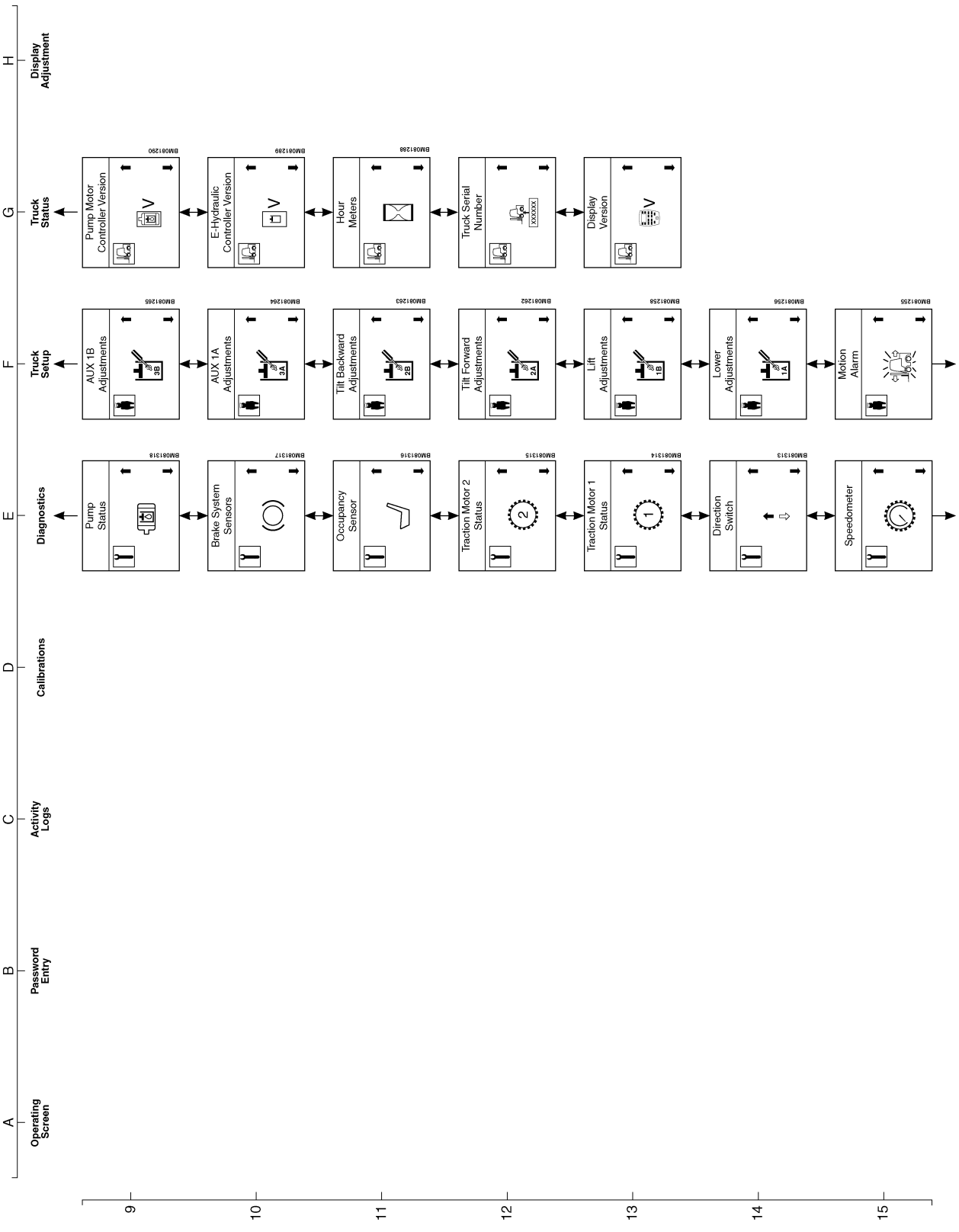


Figure 3. Technician Flowchart (Sheet 2 of 4)

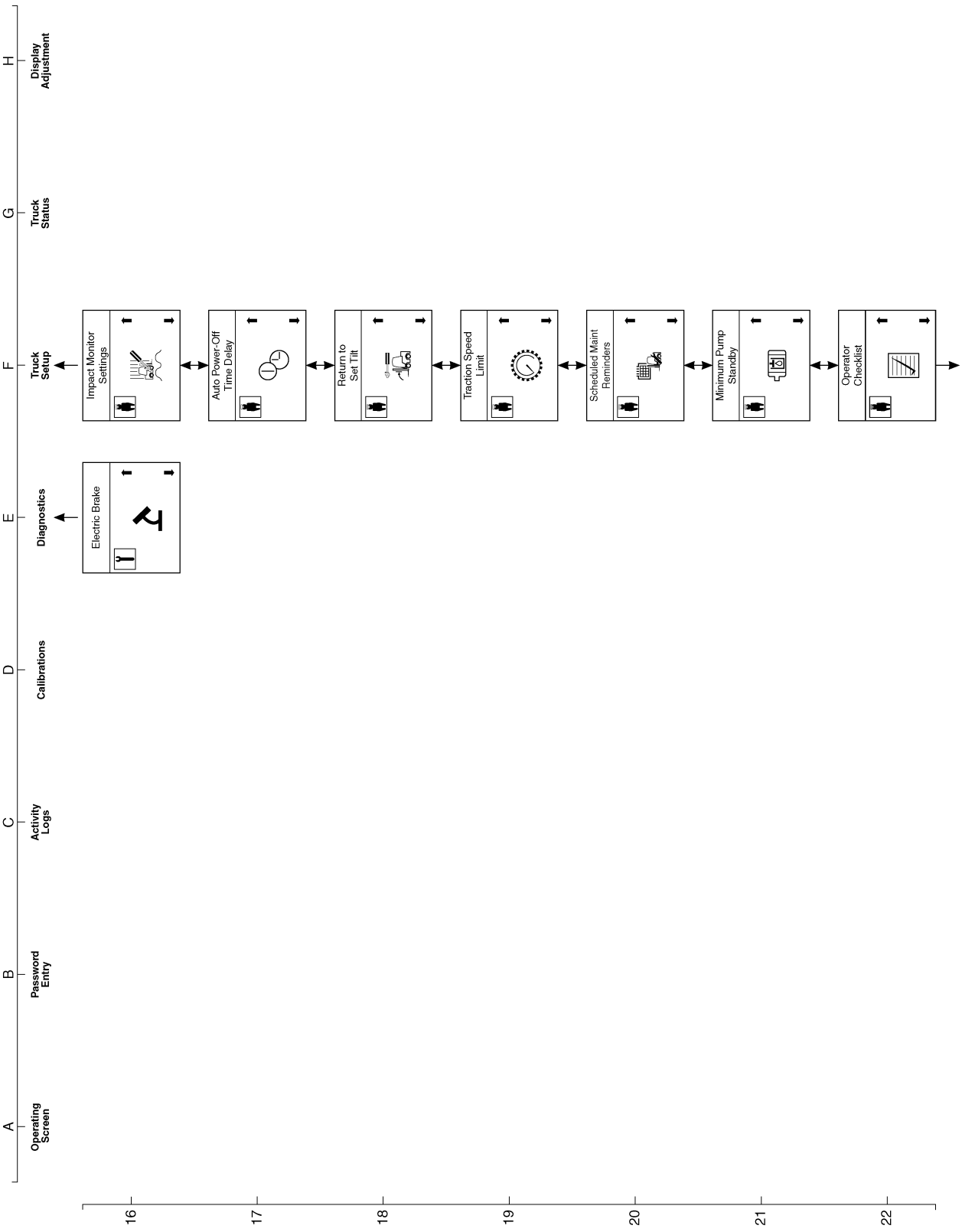


Figure 3. Technician Flowchart (Sheet 3 of 4)

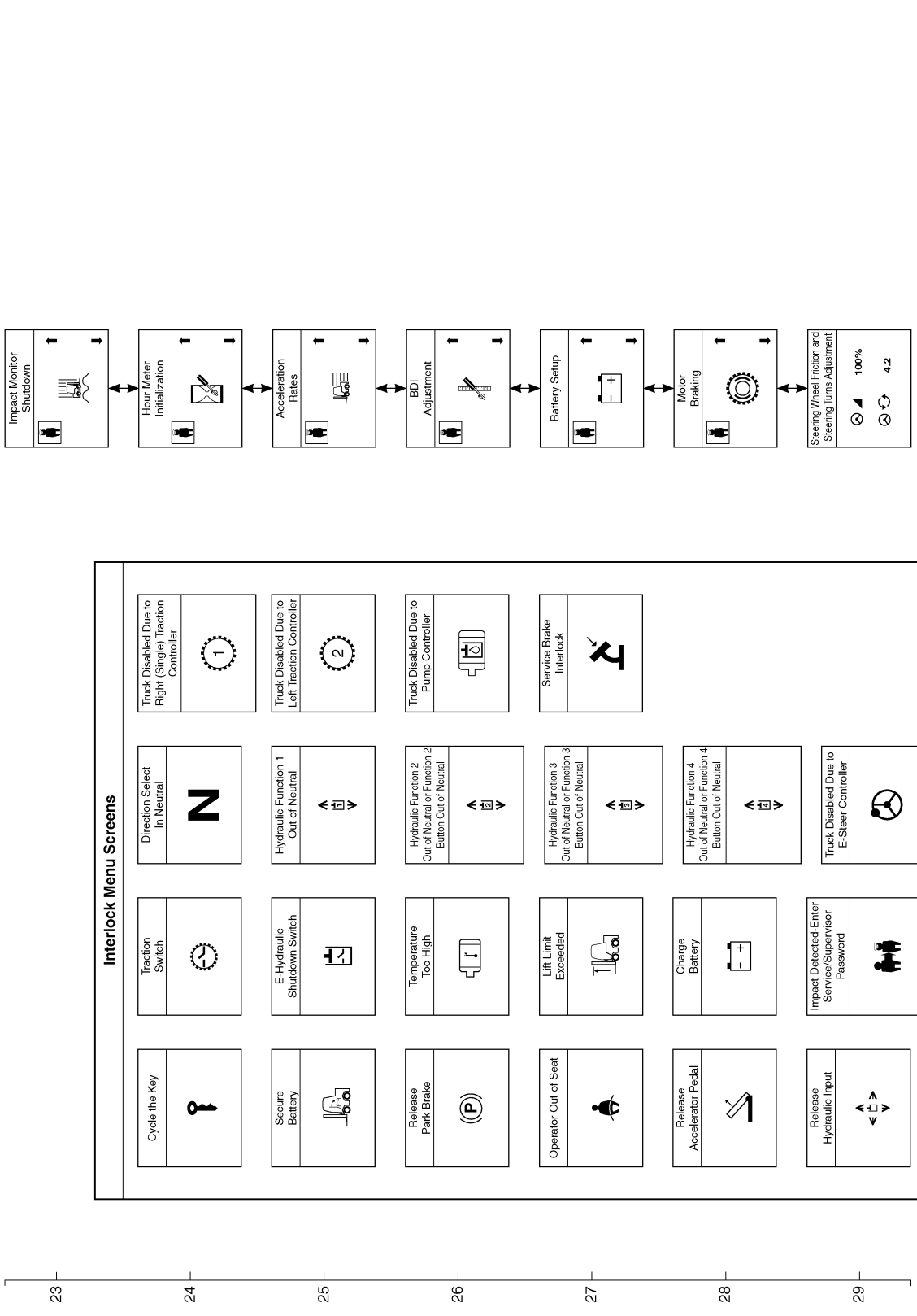


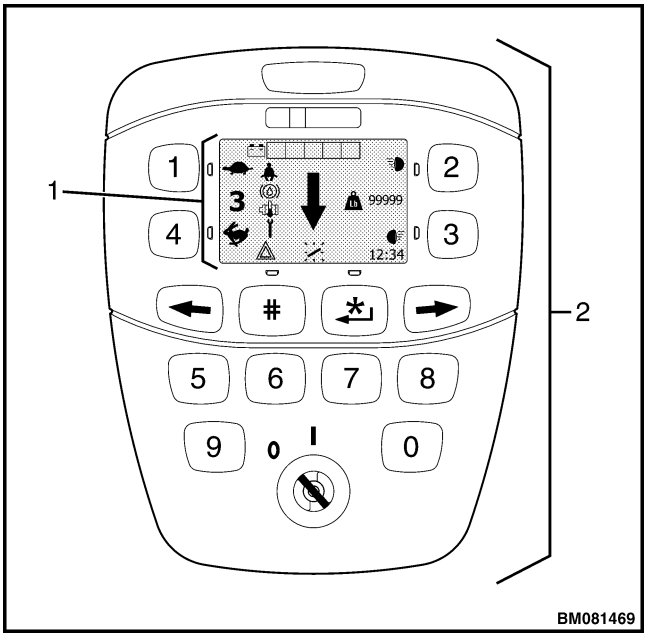
Figure 3. Technician Flowchart (Sheet 4 of 4)

Table 1. Technician Menu Flowchart

	A	B	C	D	E	F	G	H
1	**Operating Screen**	**Password Entry**	**Activity Log**	**Calibration**	**Diagnostics**	**Truck Setup**	**Truck Status**	**Display Adjustment**
2			Operator Checklist	Load Weight Display	Fault Code Log	Add/Remove Password	VSM Version	Set Date and Time Format
3			Impact Events	Manual Hydraulics	E-Steer Controller	Restore Default	E-Steer Controller 1 Version	Set Units
4			Password	Steering Axle Center Point	Steering Pos. Sensors	Steering Wheel Friction	E-Steer Controller 2 Version	Set Time and Date
5	**SHEET 1**			Steering Axle Position	System Voltages	Rear Lamp Control	Impact Sensor Version	Set Daylight Saving Time
6				Steering Wheel Center Point	Hydraulic Sensors	Optional Hydraulic Functions	Light Controller Version	
7				Hydraulic Valves	E-Hydraulic Valves	AUX 2B Adjustments	Traction 2 Controller Version	
8				RTST Stop Point	Hydraulic Control Inputs	AUX 2A Adjustments	Traction 1 Controller Version	
9					Pump Status	AUX 1B Adjustments	Pump Motor Controller Version	
10					Brake System Sensors	Aux 1A Adjustments	E-Hydraulic Controller Version	
11	**SHEET 2**				Occupancy Sensor	Tilt Backward Adjustments	Hour Meters	
12					Traction Motor 2 Status	Tilt Forward Adjustments	Truck Serial Number	
13					Traction Motor 1 Status	Lift Adjustments	Display Version	
14					Direction Switch	Lower Adjustments		
15					Speedometer	Motion Alarm		
16					Electric Brake	Impact Monitor Settings		
17						Auto Power-Off Time Delay		
18						Return to Set Tilt		
19	**SHEET 3**					Traction Speed Limit		
20						Scheduled Maintenance Required		
21						Minimum Pump Standby		
22						Operator Checklist		
23		Interlock Screen				Impact Monitor Shutdown		
24		Cycle the Key	Traction Switch	Direction Select in Neutral	Truck Disabled Due to Right (Single) Traction Controller	Hour Meter Initialization		
25		Secure Battery	Hydraulic Switch	Hydraulic Function 1 Out of Neutral	Truck Disabled Due to Left Traction Controller	Acceleration Rates		
26	**SHEET 4**	Release Park Brake	Temperature Too High	Hydraulic Function 2 Out of Neutral or Function 2 Button Out of Neutral	Truck Disabled Due to Pump Controller	BDI Adjustment		
27		Operator out of Seat	Lift Limit Exceeded	Hydraulic Function 3 Out of Neutral or Function 3 Button Out of Neutral	Service Brake Interlock	Battery Setup		
28		Release Accelerator	Charge Battery	Hydraulic Function 4 Out of Neutral or Function 4 Button Out of Neutral		Motor Braking		
29		Release Hydraulic Input	Impact Detected-Enter Service/ Supervisor Password	Truck Disabled Due to E-Steer Controller		Steering Wheel Friction and Steering Turns Adjustment		

Menu Navigation

This topic explains how to use the keys on the Display Panel, shown in Figure 4, to navigate from one menu to another and change settings.



1. LCD SCREEN
2. DISPLAY PANEL

Figure 4. Display Panel with Operating Screen Displayed

Keys used for menu navigation include:

- The **1**, **2**, **3**, **4**, and **#** keys.
- The **Enter Key** (*) which is also called the star key because of its * label.
- The **Scroll Back Key** (◂—) and the **Scroll Forward Key** (—▸). These keys are explained in detail in the General section of this document.

The Password Screen, discussed in the Adding/ Removing/Changing Passwords topic in the Password Screen section, is the first screen displayed when the key switch or keyless switch is turned to the On position unless Operator Passwords are deactivated (in this case, the Activity Log Title Screen appears). After entering your password successfully, the system displays the Operating Screen on the orange 1.5 x 2.5 inch LCD screen of the Display Panel as shown in Figure 4.

When a title screen or a menu screen is displayed on the LCD screen, the screen is still referred to as the "screen" in a generic way, but the actual Operating Screen is shown in Figure 4. See the Operating Screen section for details.

When the Operating Screen is displayed, pressing the **Scroll Forward Key** (—▸) causes the system to display the Password Screen. If you press the **Scroll Forward Key** a second time, the system displays the Activity Log Title Screen, shown in Figure 5, on the LCD screen.

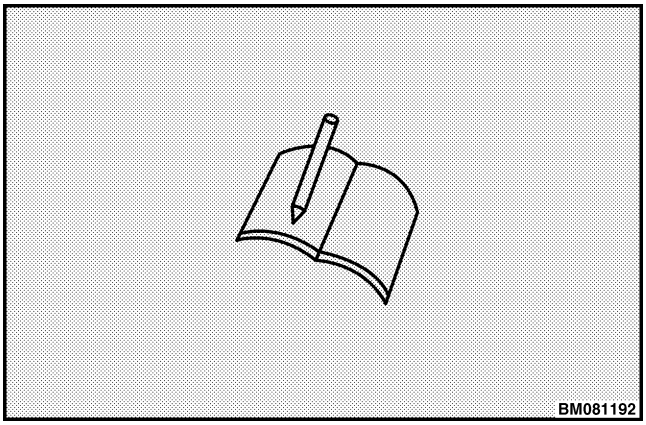
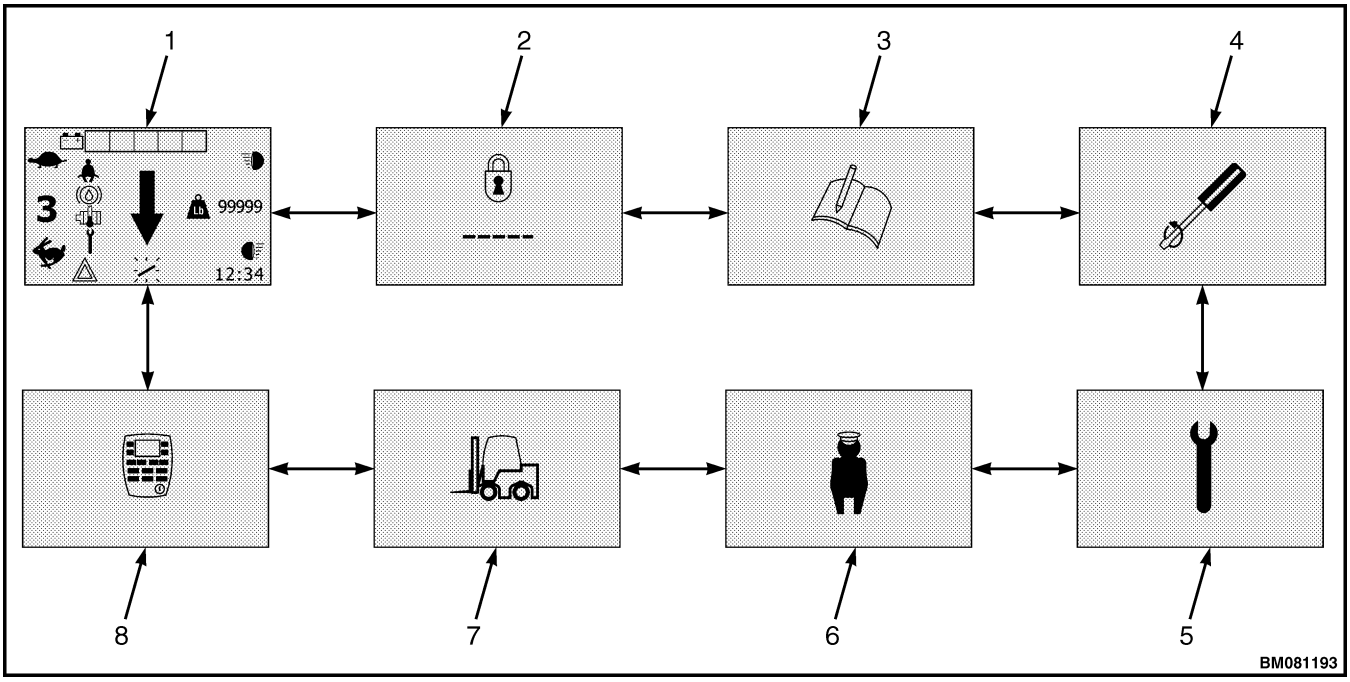


Figure 5. Activity Log Title Screen

Main Menu Structure

The main menus (top-level menus) appear on the screen in the order shown in Figure 6.



1. OPERATING SCREEN
2. PASSWORD SCREEN
3. ACTIVITY LOG TITLE SCREEN
4. CALIBRATION TITLE SCREEN
5. DIAGNOSTICS TITLE SCREEN
6. TRUCK SETUP TITLE SCREEN
7. STATUS TITLE SCREEN
8. DISPLAY TITLE SCREEN

Figure 6. Main Menu Structure

Use the **Scroll Back Key** or the **Scroll Forward Key** to move from one title screen to another. Press the **Enter Key** to enter one of these main menus.

Screens and Title Screens

The main menu has eight menus, or screens, which are shown in Figure 6. Press the **Scroll Forward Key** to advance through all of them.

If you press the **Scroll Forward Key** after reaching the Display Title Screen, the system returns (loops back) to the Operating Screen. Press the **Scroll Forward Key** again to scroll through the screens again. Alternatively, use the **Scroll Back Key** to scroll through the screens in the reverse direction.

The Password Screen and Operating Screen do not have submenus below them. The other title screens are all main menus which have submenus under them. Submenus can also be called second-level menus. Figure 5 is an example of a main menu screen.

Service Technicians have access to all title screens while Supervisors have access to the Activity Log, Calibration, Display, Status, and Truck Setup Title Screens. Operators can use only the Password Screen, Operating Screen, and Calibration Title Screen.

Submenus

Submenus are the “branches” of a main menu. The Activity Log Menu has only three submenus, while the Truck Setup Menu has 27 submenus. Each submenu is represented by a title screen. When the title screen of the submenu you want is displayed on the screen, press the **Enter Key** to enter that submenu. For example, if you enter the Operator Checklist Log submenu, shown in Figure 7, the system displays the menu shown in Figure 8.

When viewing a submenu title screen, you can return to the main menu at any time by pressing the **Scroll Back Key** or the **Scroll Forward Key**.

Menu navigation is possible through the use of soft keys, which are explained in the Soft Keys topic. For example, if you scroll to the Activity Log Title Screen and have it displayed on the screen as shown in Figure 5, press the **Enter Key** (*) to enter the Activity Log menu. The system will display the first

submenu in the Activity Log menu, which is shown in Figure 7. Press the **Enter Key** again and the system will display the Operator Checklist Log, shown in Figure 8. The Activity Log Icon in the upper left corner of this submenu indicates you are in the Activity Log main menu.

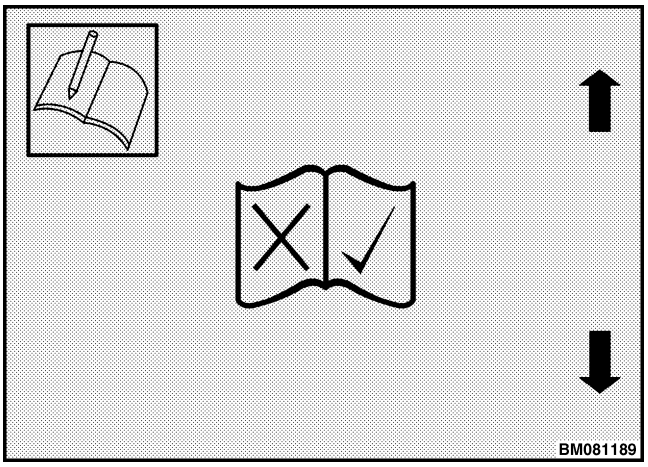


Figure 7. Operator Checklist Log Title Screen

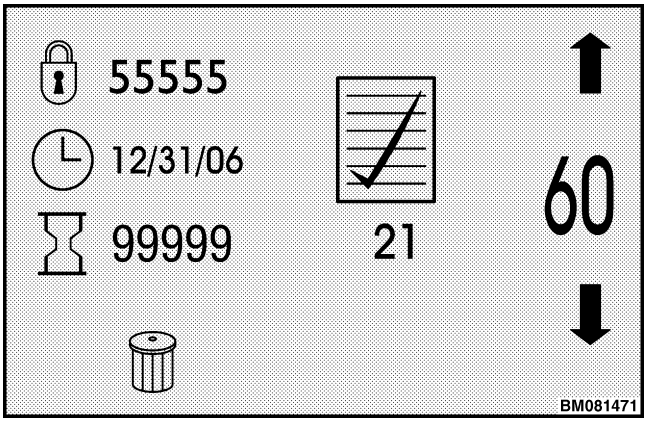


Figure 8. Operator Checklist Log Menu

Returning to the Main Menu

To return to the main menu from a submenu, press the **Scroll Forward Key** (—▸). This returns you to the title screen of the submenu (second-level menu) you are using. If you press the **Scroll Forward Key** a second time, the system returns you to the main menu. You can also return to the main menu, or back out of a submenu, by pressing the **Scroll Back Key**.

Press the **Enter Key** to save any changes you make in a submenu before exiting from the submenu. If you return to the main menu before saving a change, the system does not store the change.

Icons and Settings

An icon is a simple graphic that represents an object, such as a clock, or a setting such as battery voltage. Each submenu has at least one icon on it, and each icon represents: 1) a setting that can be changed, or 2) a status value that can be viewed, such as a truck's serial number, or 3) an action that can be taken, such as clearing the fault log. Only a logged in user who has the proper privileges can change a setting, view a status value, or take an action.

A setting is a value that controls the operation of a lift truck in some way. For example, there are four values for the performance mode setting, 1, 2, 3, and 4. Some settings have only two values, such as Enabled and Disabled, while other settings may present a series of values you can select from by using the soft keys. In some cases, you need to enter a numerical value that is within an acceptable range for a setting. In this case, you key in the value using the number keys. This is discussed in the Entering Numbers topic at the end of this section.

On submenus that have two or more icons, the icons correspond to related settings. To change settings you need to use the buttons called soft keys, which are explained in the next topic.

Soft Keys

Certain keys on the Display Panel called "soft keys" make it possible to navigate from one menu to another, change settings, delete a log entry, or take other actions. A soft key is a key that has been programmed to serve more than one function, and the function it serves depends on which menu is active. For example, when the Operating Screen is displayed, the **#** key lets you turn the Hazard Flashers On or Off, but when you are in the Activity Log Checklist menu, the **#** key can be used to delete a log entry.

The soft keys include the **1** and **4** keys on the left, the **2** and **3** keys on the right, and the **#** and ***** keys below the Operating Screen. There are no icon indicators for the soft keys.

The ***** soft key serves as an **Enter Key** in all menus except when using the Operator Checklist (see the Operator Checklist topic in the Truck Setup Menu section). In a lot of menus, the **2** and **3** soft keys are programmed for navigating up or down in the menu

to the setting value you want to change. Also, in most but not all menus, the **2** and **3** soft keys are programmed for moving up or down though the available values or options for the currently selected setting. When this is the case, the up and down arrows are displayed on the right side of the screen.

The following example shows how to use the soft keys.

How to Change the Battery Voltage Setting

1 Starting from the main menu, use the **Scroll Back Key** (◂—) or **Scroll Forward Key** (—▸) to navigate to the Truck Setup Title Screen and press the **Enter Key** (*).

2 Use the **2** or **3** arrow soft keys to step through the menus to the Battery Setup submenu (the title screen of this submenu has a battery icon on it) and press the **Enter Key**.

3 Press the **2** or **3** arrow soft key to "move to" the value located to the right of the top icon and the system will place a "selection box" around the value. This number indicates the current battery voltage, such as 36.

4 With the selection box around the battery voltage value, press the **Enter Key**.

5 Use the **2** and **3** arrow soft keys to move up or down though the available values (36, 48, 72, and 80) until 48 is displayed, then press the **Enter Key**.

The system stores the 48 Volt value and begins using it as the new battery voltage setting.

NOTE: While changing a setting, all other sub-items (setting items) disappear.

Entering Numbers

The preceding example shows how the system allows a user to select one value out of a series of values. In some menus, you will use the number keys (0 through 9) to enter a value directly. These are:

- The **1**, **2**, **3**, and **4** soft keys. These keys can be used as number keys only in the menus that accept numerical input. These keys are programmed for use as soft keys in most menus.
- The **5**, **6**, **7**, **8**, **9**, and **0** keys. These keys can be used to enter numbers in menus that allow numerical input. These keys are not soft keys in any menu.

Passwords are a special case of entering numbers. The user is required to enter a five digit “password” number, such as 15324, on the Password Screen. This number must consist only of the numbers 1, 2, 3, 4, 5, 6, 7, 8, and 9 and is entered using the **1**, **2**, **3**, **4**, **5**, **6**, **7**, **8**, and **9** keys. Pressing any other numeric key has no effect.

Icon Glossary

INTRODUCTION

An icon is a symbol that conveys a unique meaning without words, such as an arrow. The Operating Screen on this lift truck presents information to an operator solely through the use of symbols which are mostly icons, along with some numbers and a few text characters. Icons make it possible to simultaneously display up to 12 kinds of information graphically in a small space. In addition, the use of icons reduces the difficulty of communicating with operators who speak different languages.

The meaning of some icons is apparent when the icon appears by itself, such as the seat belt icon. Other icons need to have numeric information displayed alongside them to present information, such as when **24** appears beside the clock icon to indicate the times are being displayed using the 24-hour clock system. Sometimes two icons are displayed side by side to convey information, such as when the icon that means "enabled" is shown beside the rear lights icon. Also, two icons can be displayed at the same time, one over the other, which is discussed in the Overlay Icons topic.

The icons and their meanings are presented in these categories:

- Soft Key Icons
- Overlay Icons
- Icons on System Off Screen and Alert Screens
- Main Menu Screens
- Submenu Icons Grouped by Menu

SOFT KEY ICONS

Some of the icons on the Operating Screen are called soft key icons because they associate an operation or function with a nearby key (**1**, **2**, **3**, **4**, **#**, or *****) on the Display Panel. The result of pressing one of these keys depends on which menu is currently active, because the icons nearest these keys change from one menu to another. The soft keys are programmed to function in relation to the current menu context. Table 2 shows the soft key icons that appear on the Display Panel along with a short description of each one's purpose.

Table 2. Soft Key Icons

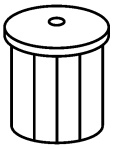
Icon	Description
	Hare Performance Mode "increase" Icon. Press the **1** soft key (or the **#** soft key in some cases) to increase performance.
	Tortoise Performance Mode “decrease” Icon. Press the **3** soft key to decrease performance.
	Trash Can Icon. Used to delete all entries in a log. Press the **4** soft key (or the **#** soft key in some cases) to empty a log.
	Up Arrow soft key. Press **2** to scroll up in most screens. Also used to view next log entry in log screen.
	Down Arrow soft key. Press **3** to scroll down in most screens. Also used to view next log entry in log screen.
	View Next Device Log Icon. Press the **#** key for previous.
	View Previous Device Log Icon. Press the ***** key for next.

Table 2. Soft Key Icons (Continued)

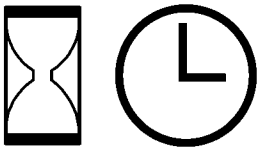
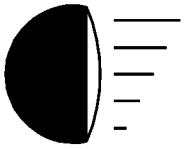
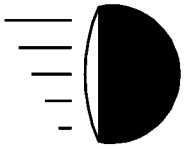
Icon	Description
	This icon points to the ***** key (the soft **Enter Key**) and is used to accept a value, command a calibration action, or restore defaults, depending on the context when the ***** key is pressed.
	Enable Current Item Icon. When the ***** key is pressed, the current item displayed will appear during the Operator Checklist sequence.
	Deactivate Soft Key Icon. Indicates function is deactivated. Press the ***** key to deactivate.
	“Enable” Traction and Hydraulics for Forklift Icon. Press the **2** key to enable.
	“Disable” Traction and Hydraulics for Forklift Icon. Press the **4** key to disable.
	Hazard Flashers Icon. Press the **#** key to toggle the hazard flashers on and off.
	Select system time for Fault Log event. Press the **1** key to select system time (this soft key toggles between system times and hour meters).

Table 2. Soft Key Icons (Continued)

Icon	Description
	Front Truck Lights Icon. Only available with CAN light controller. Press the **4** key to turn truck lights on.
	Rear Truck Lights Icon. Only available with CAN light controller. Press the **2** key to turn truck lights off.

OVERLAY ICONS

Icons that look like they are placed over another icon are called overlay icons. This type of icon always appears in conjunction with another icon, not by itself. Table 3 shows the overlay icons and describes how they are used.

Table 3. Overlay Icons

Icon	Description
	Null Symbol Icon. When this icon overlays another icon it indicates that a setting value is invalid or out-of-range.
	X Icon. This icon indicates that a feature has been deactivated (disabled).

SYSTEM OFF SCREEN AND ALERT SCREENS

The System Off Screen and the various Alert Screens show interlocks, such as operator not in seat. These screens appear only briefly. Refer to System Off/Alert Screens for more information on these screens. The icons used in alert screens identify either status or warning conditions as shown in the examples in Table 4.

Table 4. Alert Screen Icons

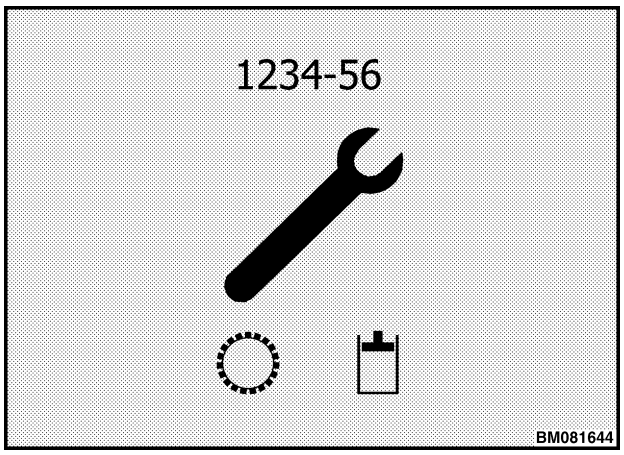
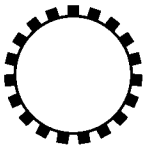
Icon	Description
Alert	
	
Example of a Fault Screen	
	Traction Icon
	Forklift Truck Icon
	Service Required Icon
	Hydraulics Icon
Alert Screens	

Table 4. Alert Screen Icons (Continued)

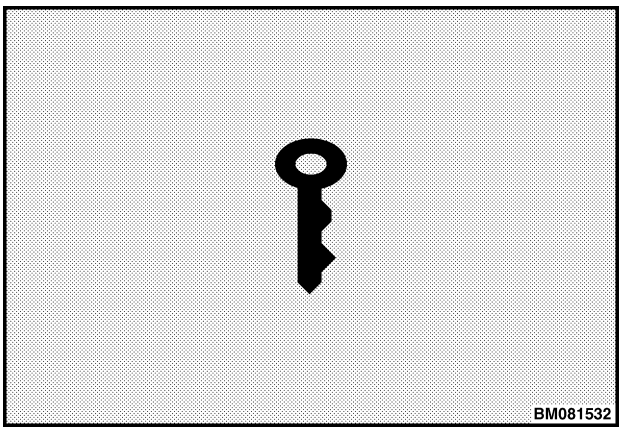
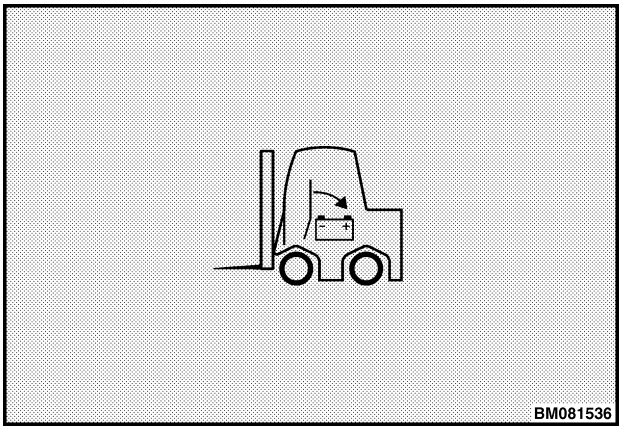
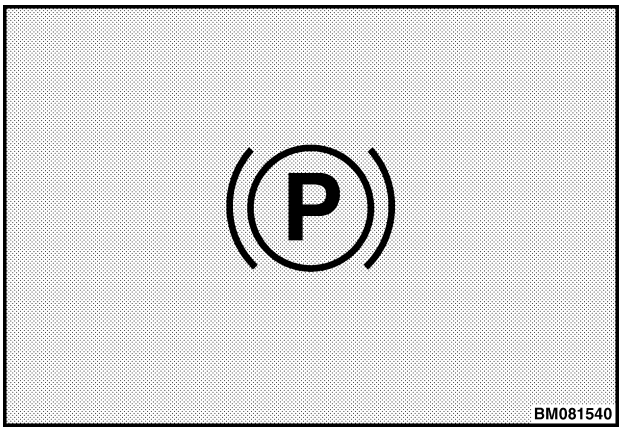
Icon	Description
Alert	
 BM081532	Cycle the Key
 BM081536	Secure Battery
 BM081540	Release Park Brake

Table 4. Alert Screen Icons (Continued)

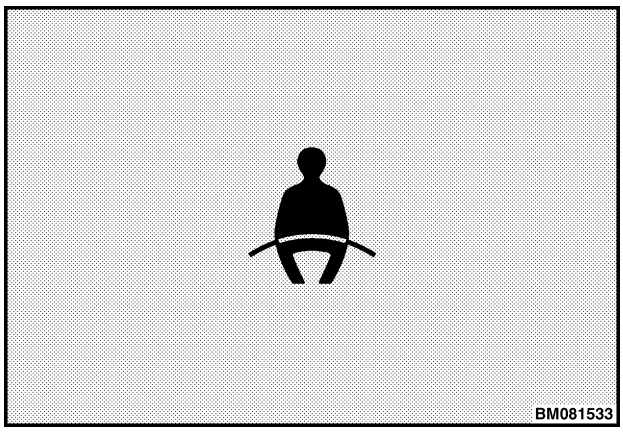
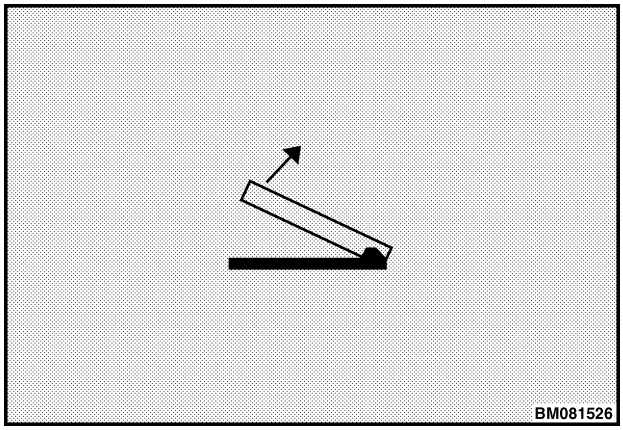
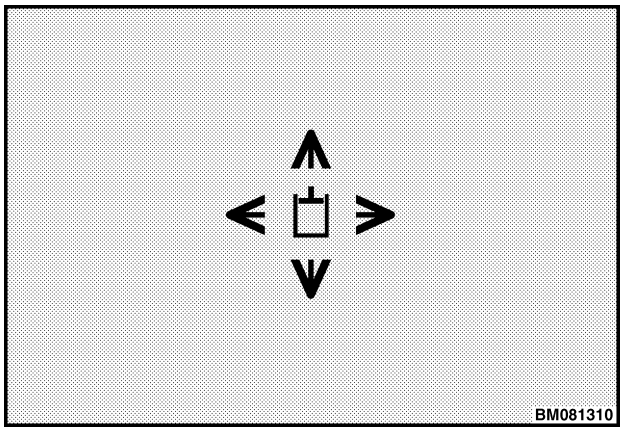
Icon	Description
Alert	
 BM081533	Operator Out of Seat
 BM081526	Release Pedal
 BM081310	Release Hydraulic Input

Table 4. Alert Screen Icons (Continued)

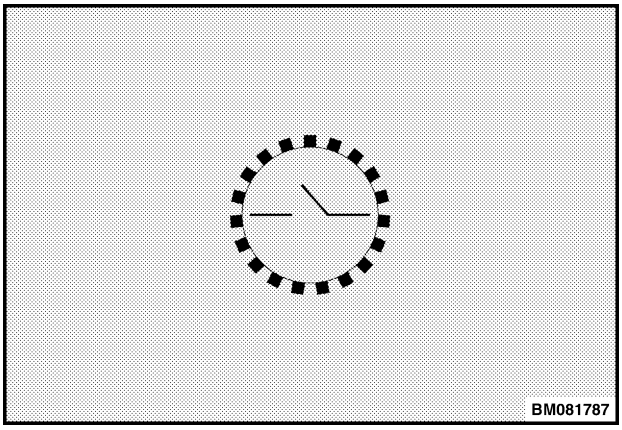
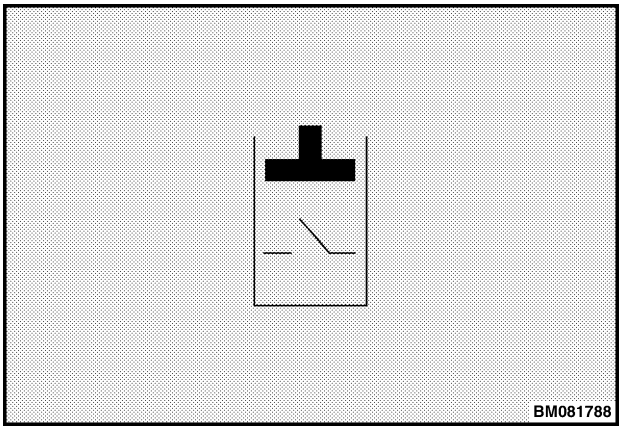
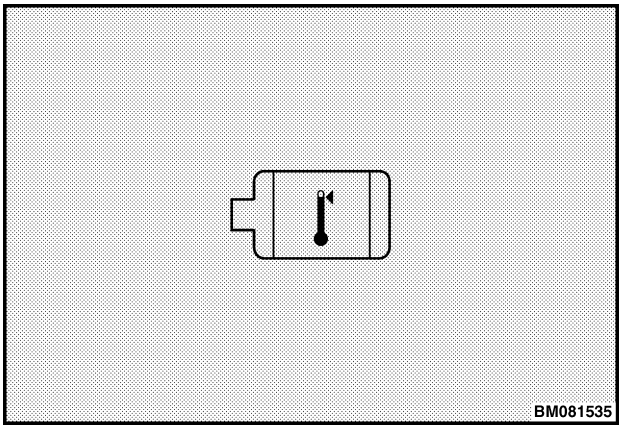
Icon	Description
Alert	
	Traction Switch
	Hydraulic Switch
	Temperature Too High

Table 4. Alert Screen Icons (Continued)

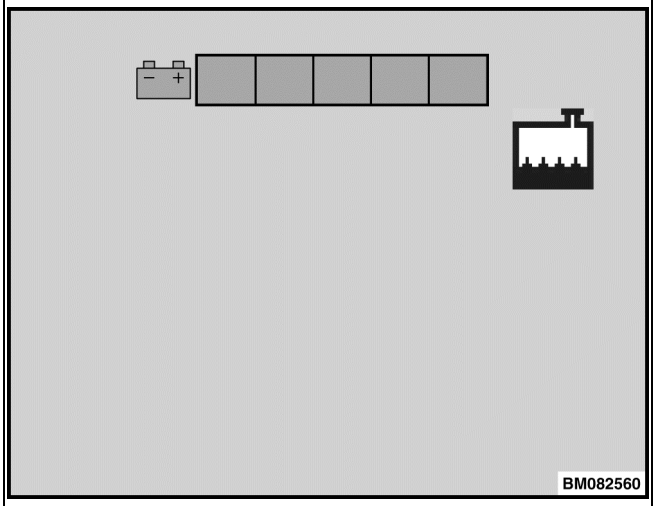
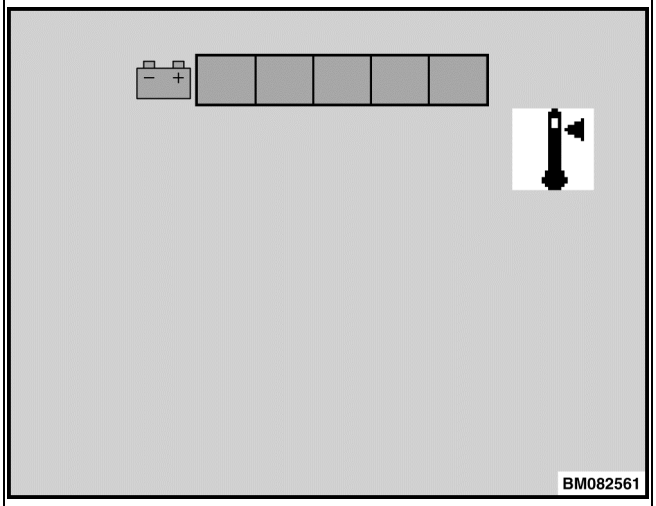
Icon	Description
Alert	
	Low Coolant Warning
	High Temperature Warning

Table 4. Alert Screen Icons (Continued)

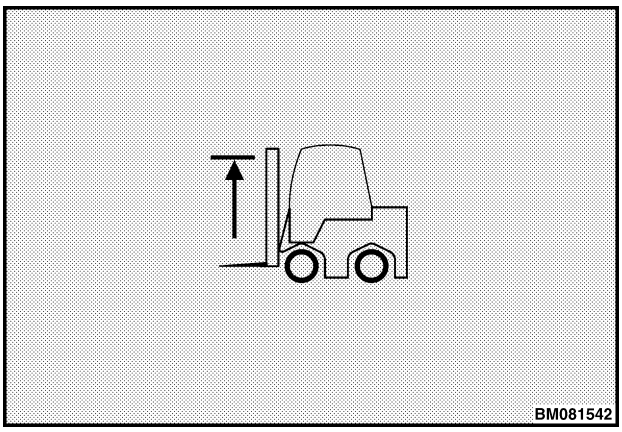
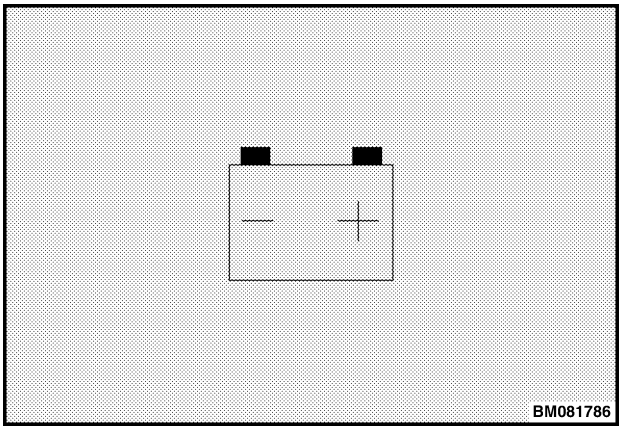
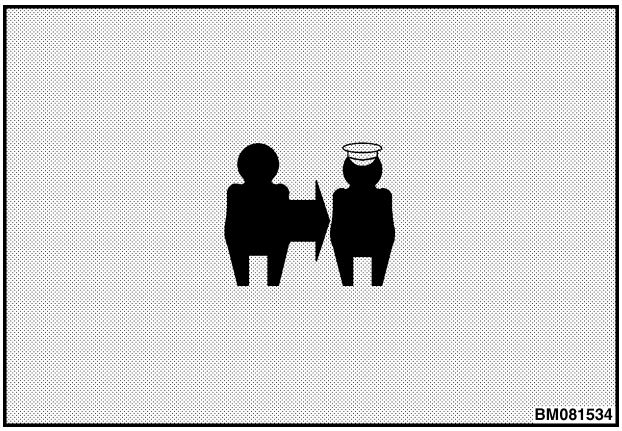
Icon	Description
Alert	
 BM081542	Lift Limit
 BM081786	Charge Battery
 BM081534	Truck Locked — Impact Detected — See Supervisor to Unlock

Table 4. Alert Screen Icons (Continued)

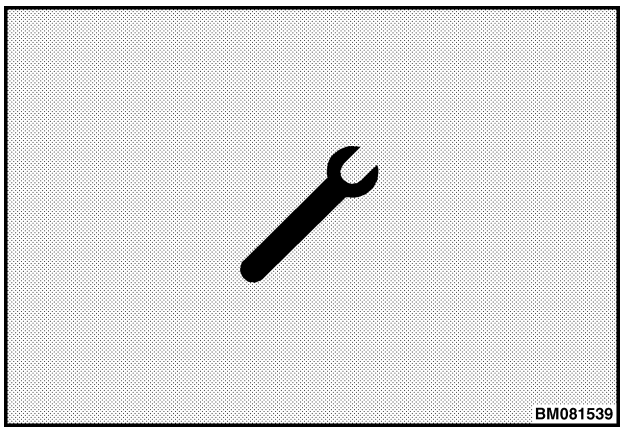
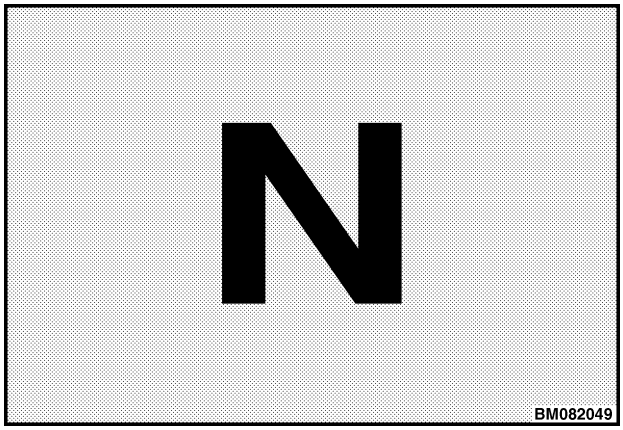
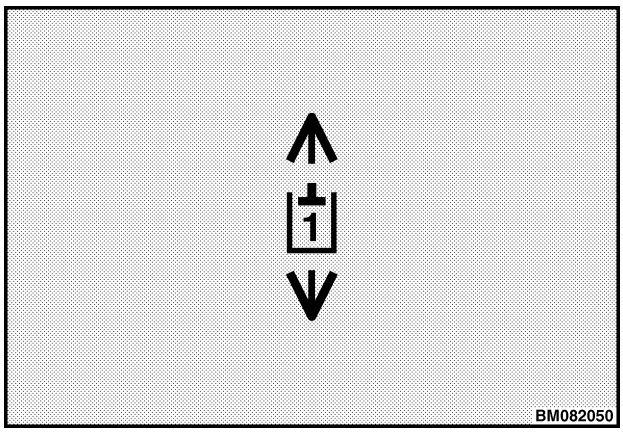
Icon	Description
Alert	
 BM081539	Fault Detected
 BM082049	Direction Select in Neutral
 BM082050	Hydraulic Function 1 Out of Neutral

Table 4. Alert Screen Icons (Continued)

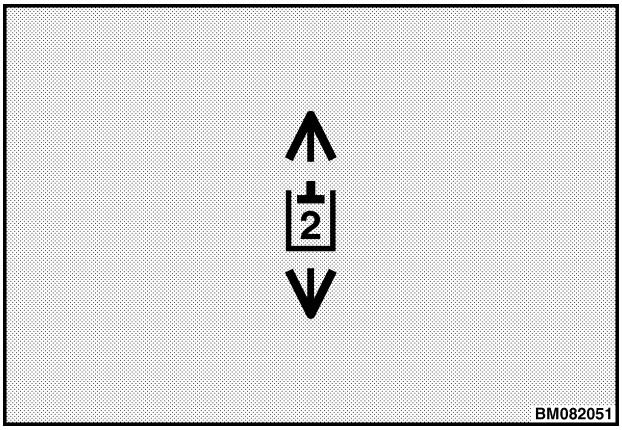
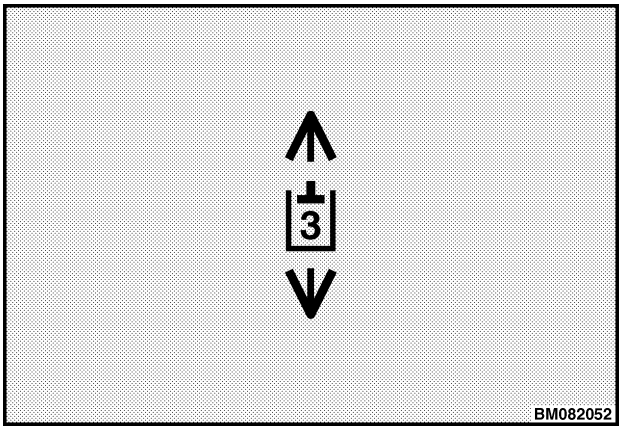
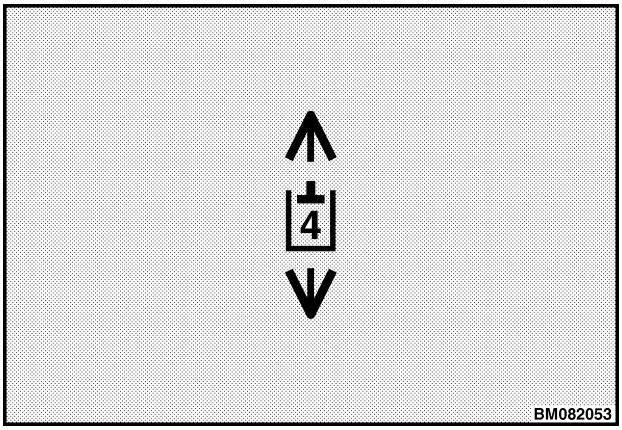
Icon	Description
Alert	
	Hydraulic Function 2 Out of Neutral or Function 2 Button Out of Neutral
	Hydraulic Function 3 Out of Neutral or Function 3 Button Out of Neutral
	Hydraulic Function 4 Out of Neutral or Function 4 Button Out of Neutral

Table 4. Alert Screen Icons (Continued)

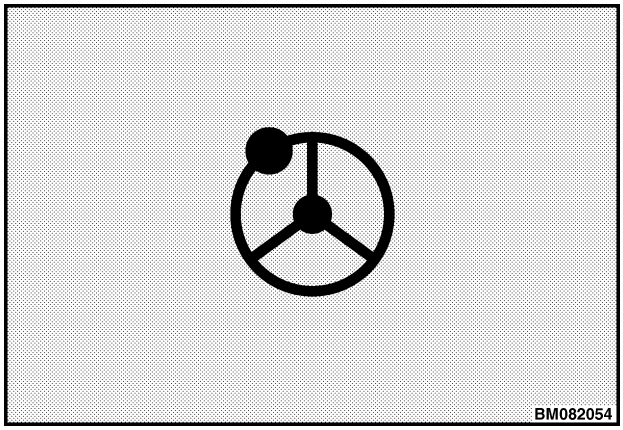
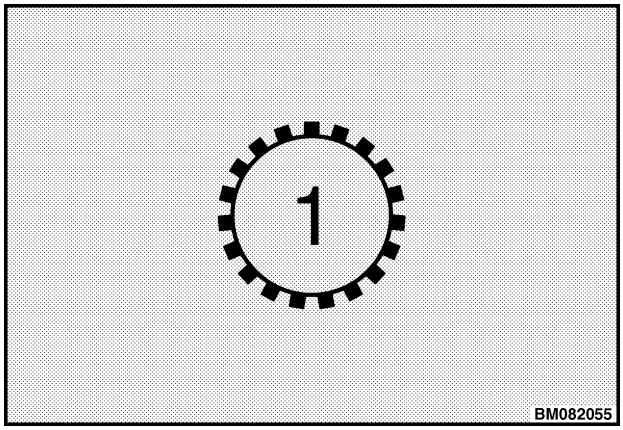
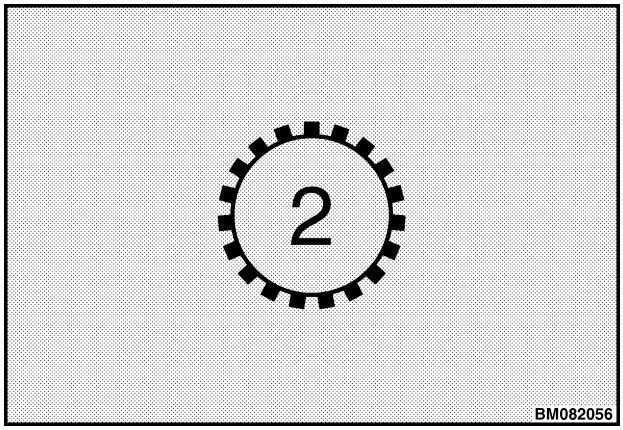
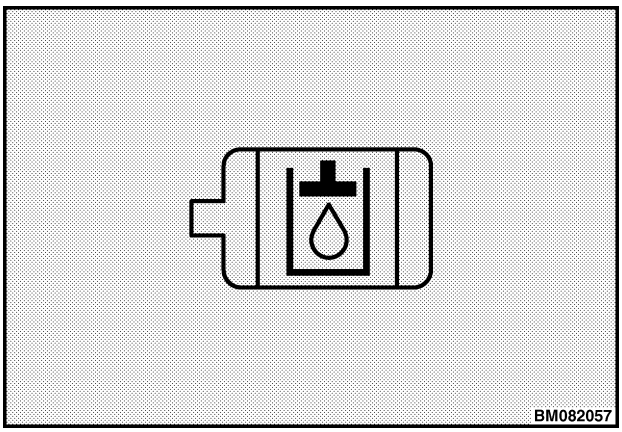
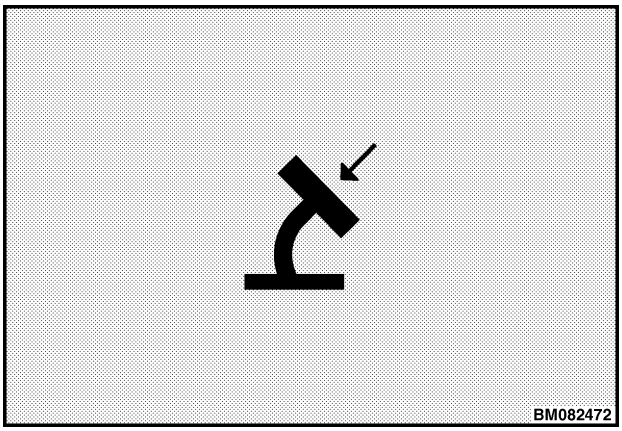
Icon	Description
Alert	
	Truck Disabled Due to E-Steer Controller
	Truck Disabled Due to Right (Single) Traction Controller
	Truck Disabled Due to Left Traction Controller

Table 4. Alert Screen Icons (Continued)

Icon	Description
Alert	
	Truck Disabled Due to Pump Controller
	Service Brake Interlock

MAIN MENU TITLE SCREENS

All available menus are grouped by function under the main menu screens, which are also called top-level title menus. When you select a main menu screen, the system then presents submenus, also known as second-level menus, that you can cycle through until you find the one you want by pressing the **Scroll Back Key** (◂—) or **Scroll Forward Key** (—▸) on the Display Panel. Two main menu screens, the Operating Screen and the Password screen, have no associated submenus, but the other main menus lead to submenus.

When you are at the main menu level, pressing the **Scroll Back Key** takes you to the previous main menu screen. Pressing the **Scroll Forward Key** takes you to the next main menu screen. If you are in a submenu, pressing the **Scroll Back Key** or **Scroll Forward Key** returns you to the main menu screens. Table 5 presents the main menu screens.

Table 5. Main Menu Title Screens

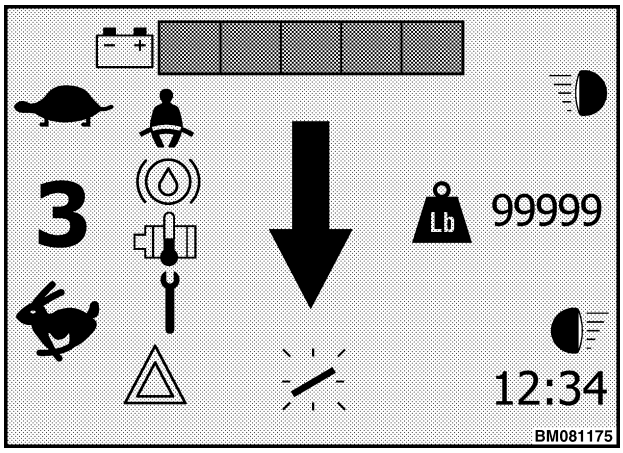
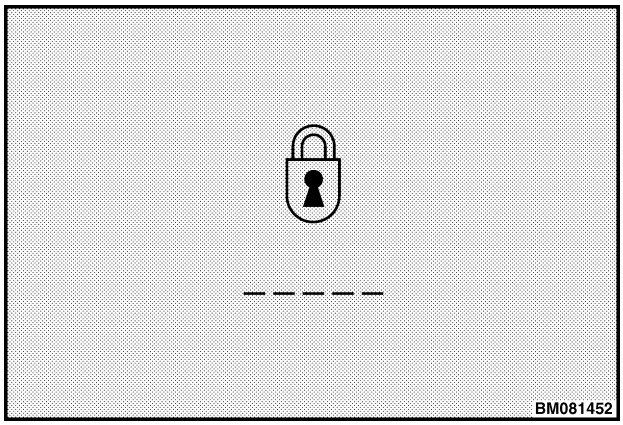
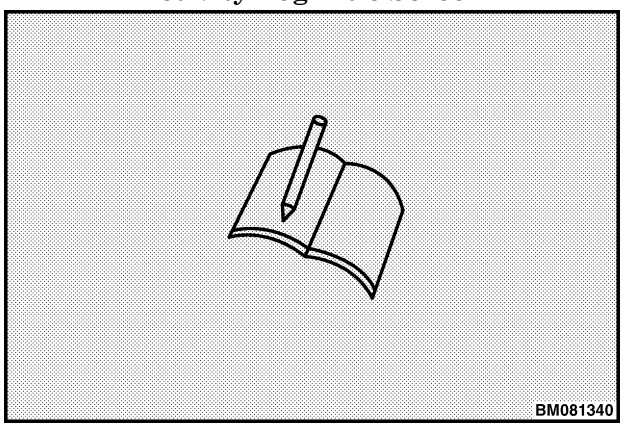
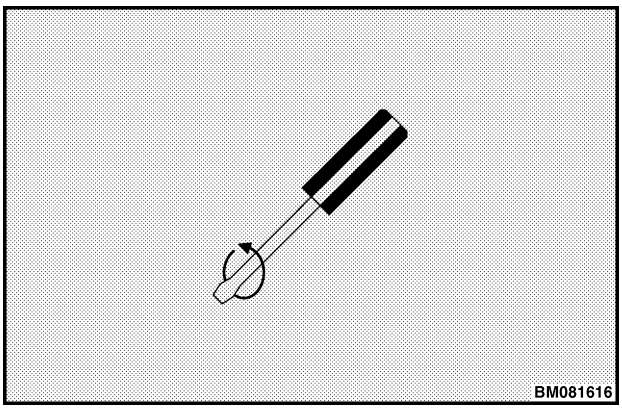
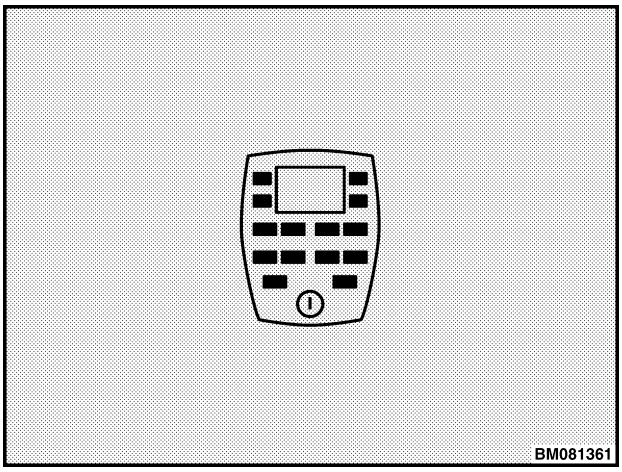
Operating Screen

NOTE: Icons for Front and Rear Lights are shown. These are optional features.
Password Screen

Activity Log Title Screen


Table 5. Main Menu Title Screens (Continued)

Calibration Title Screen



Display Title Screen



Status Title Screen

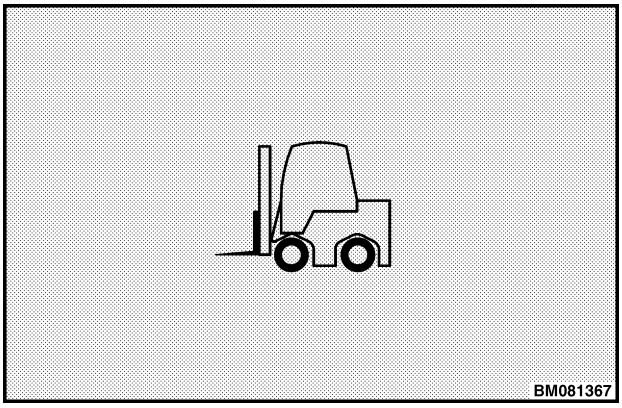
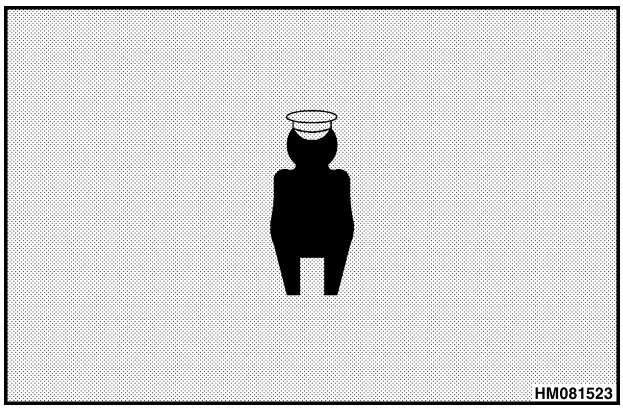
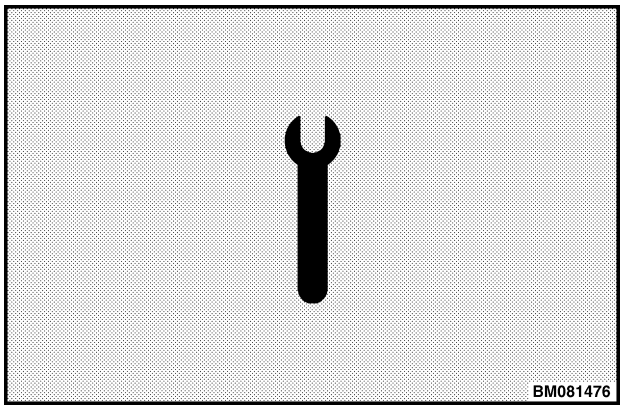


Table 5. Main Menu Title Screens (Continued)

Truck Setup Title Screen



Diagnostics Title Screen



SUBMENU ICONS GROUPED BY MENU

This topic presents the icons used in submenus in groups, with one table for each title screen of the main menu.

Operating Screen Icons

Table 6 shows the icons that appear on the Operating Screen. Normally the icons convey status or operating information such as battery charge level, steer angle, front and rear work light soft keys, and system time. Sometimes icons are displayed to provide critical information, such as warnings. Refer to the Operating Screen topic for more information.

NOTE: The icons displayed on the Operating Screen vary from any one time to another, depending on the current operation of the lift truck and other factors. The Battery Discharge Indicator, system time, and direction indicator are always displayed.

Table 6. Operating Screen Icons

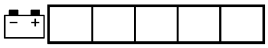
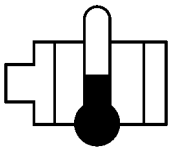
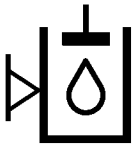
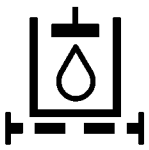
Icon	Description
	Hare Performance Mode Icon. Press the **4** key to increase performance. (The soft key to use depends on the currently displayed menu.)
	Tortoise Performance Mode Icon. Press the **1** key to decrease performance.
	Battery Discharge Indicator (BDI) Icon
	Seat Belt Warning Icon
	Brake Fluid Low Warning Icon
	Temperature High Warning Icon
	Hydraulic Fluid Level Low Warning Icon. (Displayed only on trucks that have the Hydraulic Fluid Level Monitoring option.)
	Hydraulic Filter Warning (restriction) Icon. (Displayed only on trucks that have the Hydraulic Filter Monitoring option.)

Table 6. Operating Screen Icons (Continued)

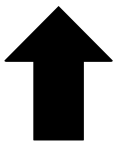
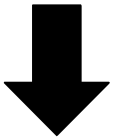
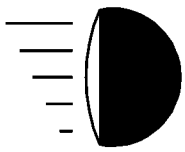
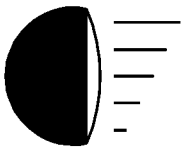
Icon	Description
	Service Due Soon Warning Icon or Fault
	Hazard Flashers Icon. See Table 2 for more information.
	Forward Direction Indicator Icon
	Neutral Indicator Icon
	Reverse Direction Indicator Icon
	Park Brake On Icon
	Steer Angle Indicator Icon
	Rear Work Light Icon. This is an optional feature.
	Front Work Light Icon. This is an optional feature.

Table 6. Operating Screen Icons (Continued)

Icon	Description
	Load Weight In Pounds (lb) Icon
	Load Weight In Kilograms (kg) Icon
99999	Load Weight Readout (example)
12:34	System Time Readout (example)

Password Screen Icons

The Password Screen has only one icon, which is shown in Table 7. If the truck is equipped with Operator Passwords enabled, the Password Screen is the first screen to appear when you turn on the key switch or turn the keyless switch to the **ON** position. See the Password Screen topic for more information.

Table 7. Password Screen Icons

Icon	Description
	Password Lock Icon
A field with five blanks appears below the Password Lock Icon. See Figure 2.	

Activity Log Submenu Icons

Table 8 presents the icons that appear on the Activity Log Submenus. These icons provide status information or numeric information. Refer to Activity Log Menu for more information.

Table 8. Activity Log Submenus and Icons

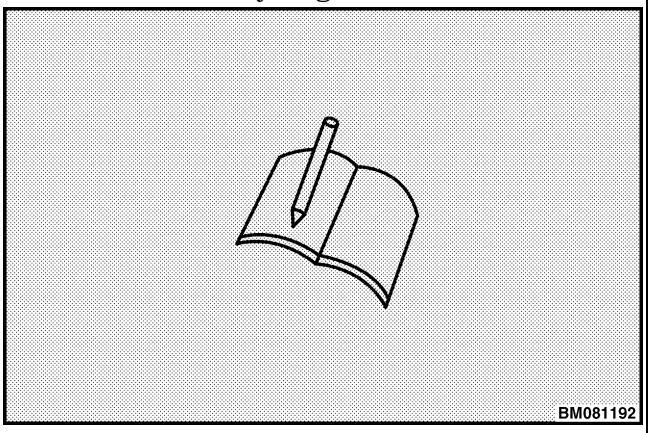
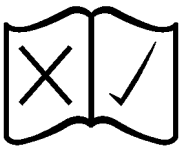
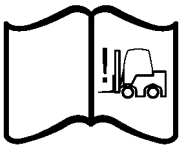
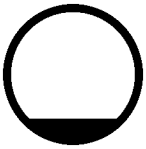
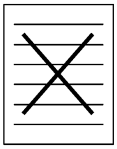
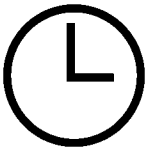
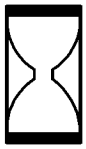
Icon	Description
Activity Log Submenus 	
	**Operator Checklist Log Submenu**
	Password Log Submenu
	**Impact Events Log Submenu**
	Empty Log Icon
	Checklist Failed Icon
	Checklist Passed Icon

Table 8. Activity Log Submenus and Icons (Continued)

Icon	Description
	Password Lock Icon
*****	Hidden or "no password" Field Log Entry Icon
	Clock Icon for occurrence date
	Hourglass Icon for system time
	Operator Password Type Icon
	Supervisor Password Type Icon
	Service Password Type Icon
	Soft Impact Type Icon
	Hard Impact Type Icon

Calibration Submenu Icons

Table 9 presents the icons that appear on the Calibration Submenus. See Calibration Menu for more information.

Table 9. Calibration Submenus and Icons

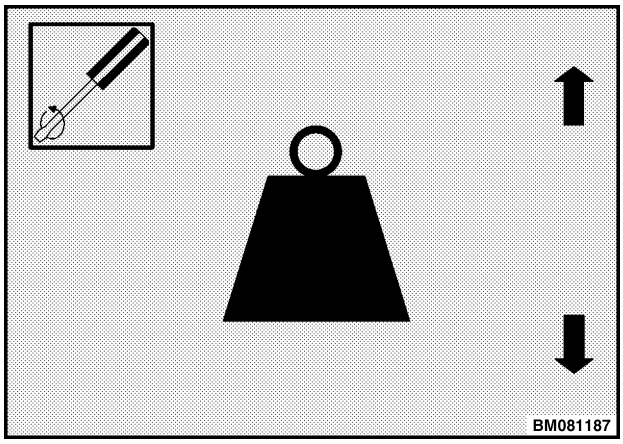
Icon	Description
Load Weight Display Submenu 	
	"Position Empty Forks To Load Weight Height" Prompt Icon
	"Enter Known Load Weight" Prompt Icon
	"Position Load Weight To Height" Prompt Icon
	"Known Load Weight Value (lb)" Prompt Icon
	"Known Load Weight Value (kg)" Prompt Icon

Table 9. Calibration Submenus and Icons (Continued)

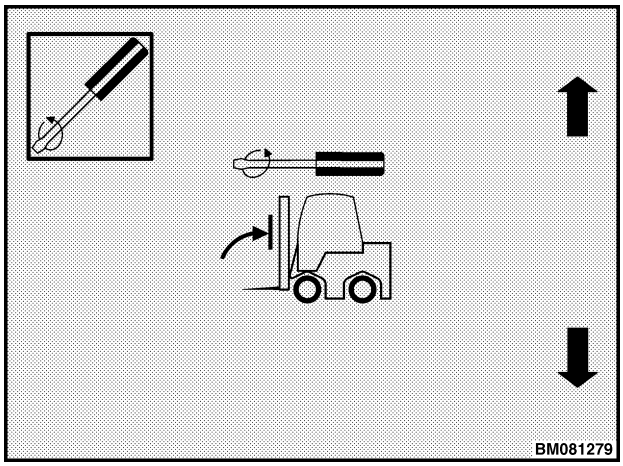
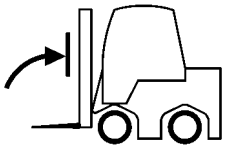
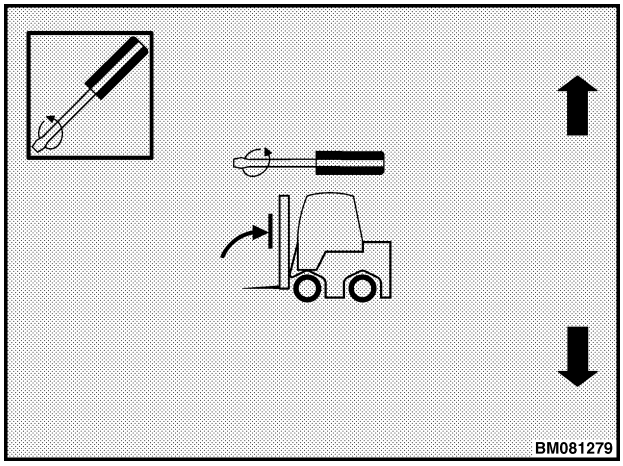
Icon	Description
	This icon points to the * key (the Enter soft key) and is used for load weight calibration in this submenu.
Return to Set Tilt Stop Point Submenu	
	
	Return to Set Tilt (RTST) Set Point Prompt Icon
	This icon points to the * key and is used for RTST calibration in this submenu.
Return to Set Height Stop Point Submenu	
	

Table 9. Calibration Submenus and Icons (Continued)

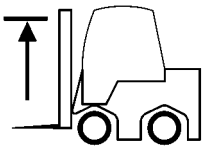
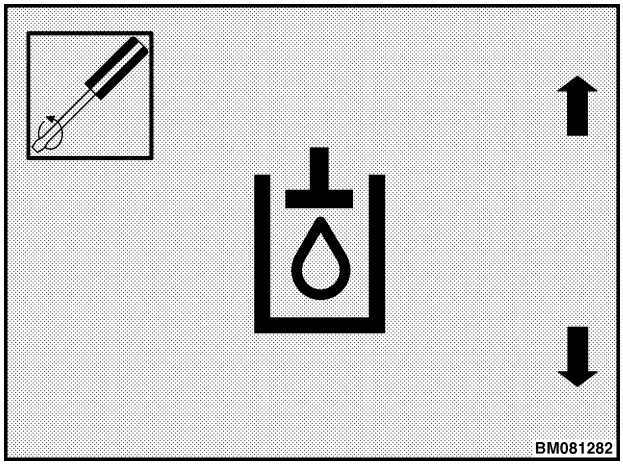
Icon	Description
	Return to Set Height (RTSH) Set Point Prompt Icon
	This icon points to the * key and is used for RTSH calibration in this submenu.
Valve Threshold Submenu	
	
	Valve Threshold Function 1 "A" Direction Prompt Icon
	Valve Threshold Function 1 "B" Direction Prompt Icon
	Valve Threshold Function 2 "A" Direction Prompt Icon
	Valve Threshold Function 2 "B" Direction Prompt Icon

Table 9. Calibration Submenus and Icons (Continued)

Icon	Description
	Valve Threshold Function 3 "A" Direction Prompt Icon
	Valve Threshold Function 3 "B" Direction Prompt Icon
	Valve Threshold Function 4 "A" Direction Prompt Icon
	Valve Threshold Function 4 "B" Direction Prompt Icon
	Valve Threshold Function 5 "A" Direction Prompt Icon
	Valve Threshold Function 5 "B" Direction Prompt Icon
	This icon points to the * key and is used for valve calibration in this submenu.

Table 9. Calibration Submenus and Icons (Continued)

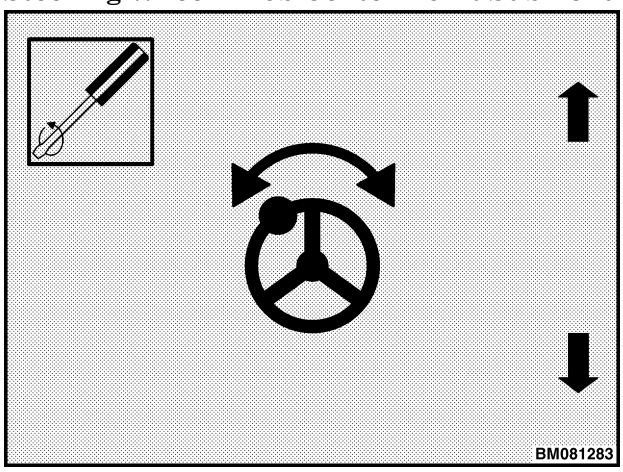
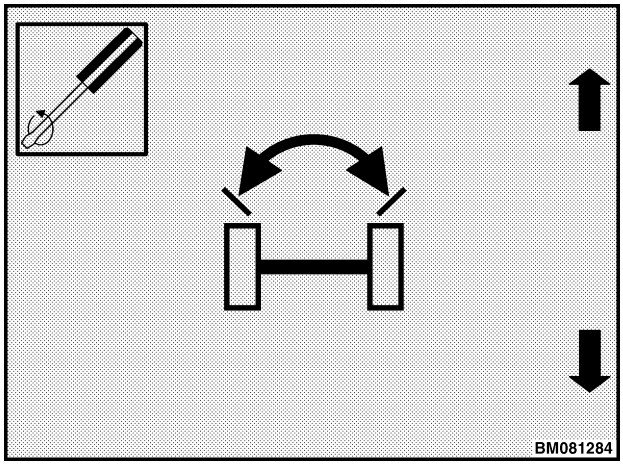
Icon	Description
Steering Wheel Knob Center Point Submenu 	
	Center Steering Wheel Prompt Icon
	This icon points to the * key and is used for steering wheel center point calibration in this submenu.
Steer Axle Position Submenu 	
	Steering Wheel Full Left Prompt Icon

Table 9. Calibration Submenus and Icons (Continued)

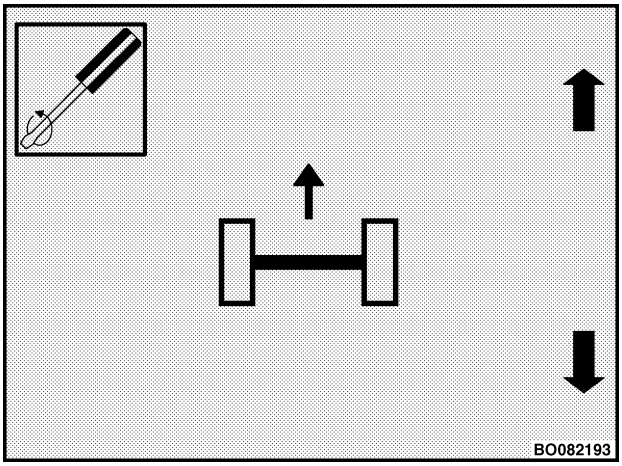
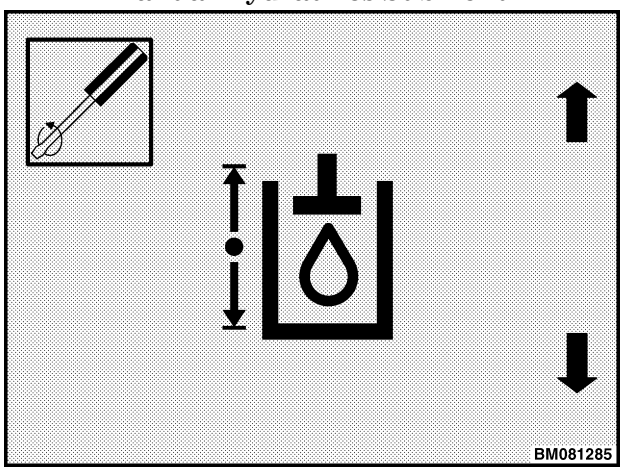
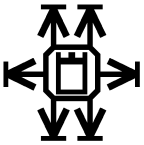
Icon	Description
	Steering Wheel Full Right Prompt Icon
	This icon points to the * key and is used for steer axle position calibration in this submenu.
Steer Axle Center Point 	
	Steer Axle Center Point Icon
	This icon points to the * key and is used for steer axle center point callibration in this submenu.

Table 9. Calibration Submenus and Icons (Continued)

Icon	Description
Manual Hydraulics Submenu 	
	Main Manual Hydraulic End Point Calibration Prompt Icon
	This icon points to the * key and is used for manual hydraulic end point calibration in this submenu.

Display Submenu Icons

Table 10 presents the icons that appear on the Display Submenus. Refer to Display Menu for more information.

Table 10. Display Submenus and Icons

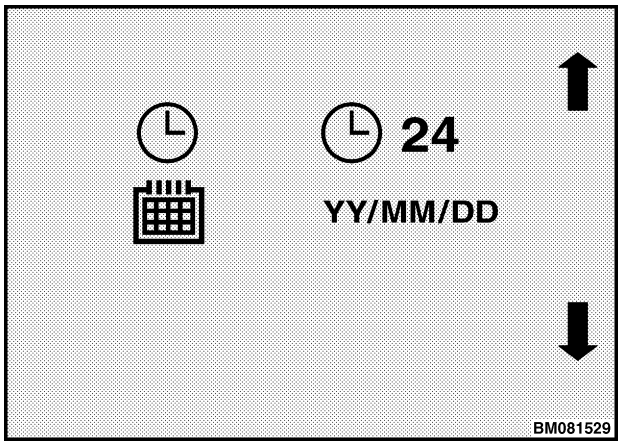
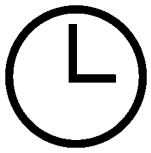
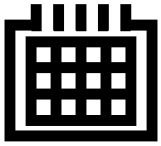
Icon	Description
Set Date and Time Format Submenu 	
	Clock Icon for setting time
	Calendar Icon for setting date
	24-Hour Clock Icon
	12-Hour Clock Icon
DD/MM/YY	DD/MM/YY (Europe) Date Format Icon
MM/DD/YY	MM/DD/YY (USA) Date Format Icon

Table 10. Display Submenus and Icons (Continued)

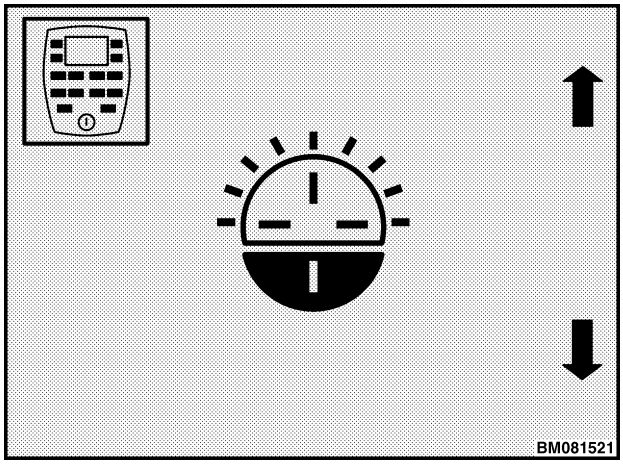
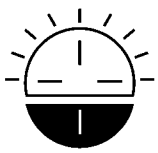
Icon	Description
YY/MM/DD	YY/MM/DD (ISO 8601) Date Format Icon
Set Daylight Savings Submenu 	
	Daylight Savings Adjustment Enable Icon
	Daylight Savings Start Month Indicator Icon
	Daylight Savings Start Day Indicator Icon
	Daylight Savings End Month Indicator Icon
	Daylight Savings End Day Indicator Icon

Table 10. Display Submenus and Icons (Continued)

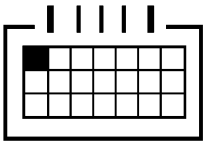
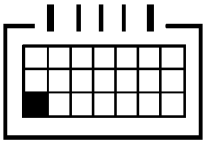
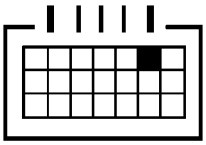
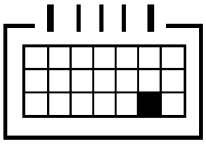
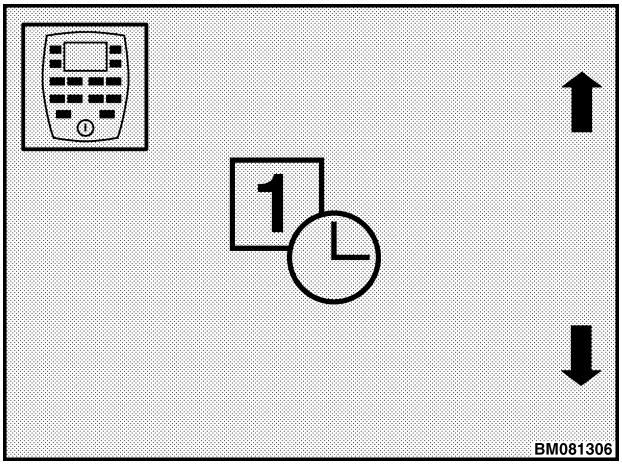
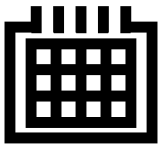
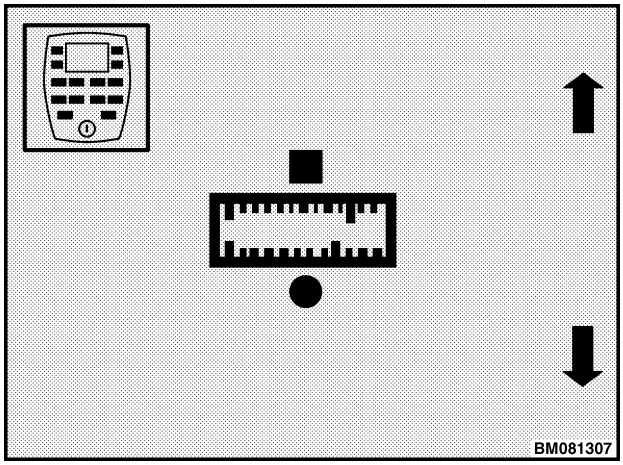
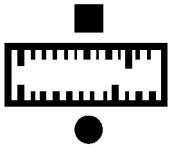
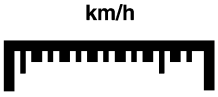
Icon	Description
	First Sunday Icon
	Last Sunday Icon
	First Friday Icon
	Last Friday Icon
NOTE: Not all icons for setting daylight savings time are shown. The four icons above serve as examples of the 14 variations.	
Set Time and Date Submenu 	
	Clock Icon for setting time

Table 10. Display Submenus and Icons (Continued)

Icon	Description
	Calendar Icon for setting date
Set Units Submenu 	
	Set Units Icon
	Imperial Units Indicator Icon
	Metric Units Indicator Icon

Status Submenu Icons

Table 11 presents the icons that appear on the Status Submenus. See Status Menu for more information.

Table 11. Status Submenus and Icons

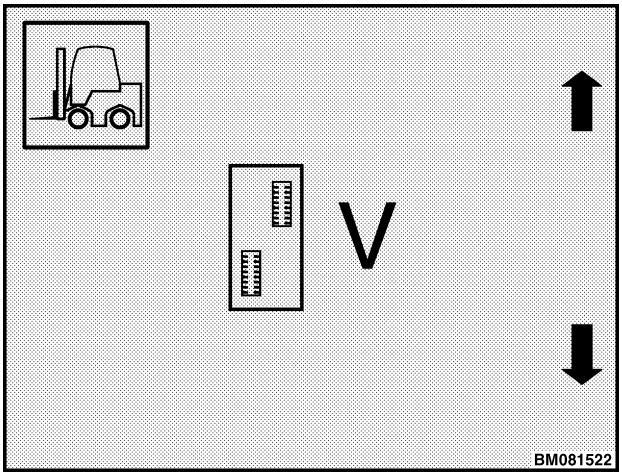
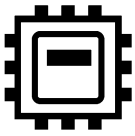
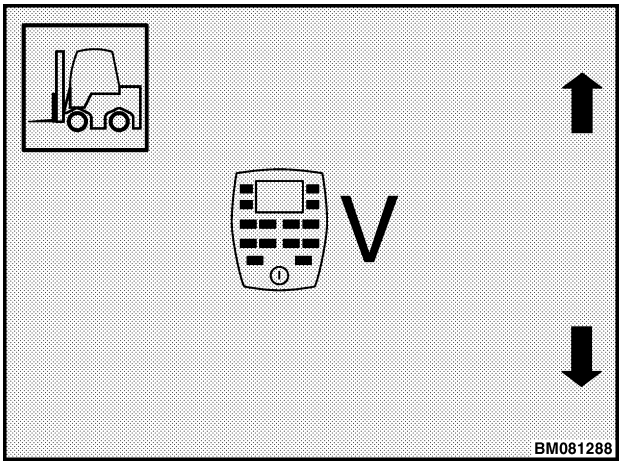
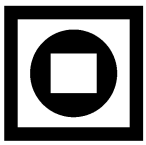
Icon	Description
Vehicle System Manager (VSM) Version Submenu	
	
	Hardware Version Indicator Icon
	Software Version Indicator Icon
Display Version menu	
	
	Hardware Version Indicator Icon

Table 11. Status Submenus and Icons (Continued)

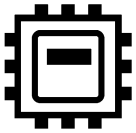
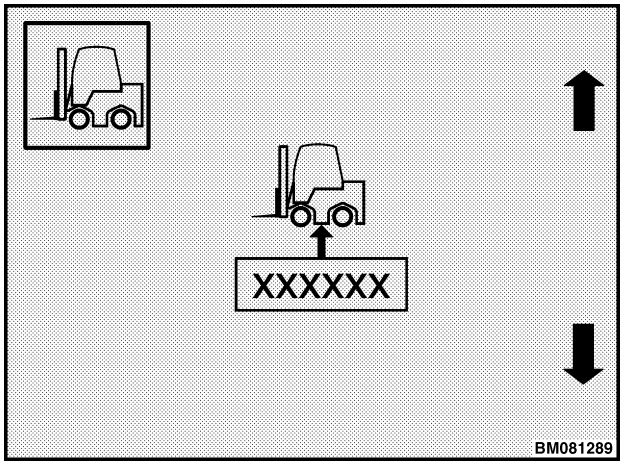
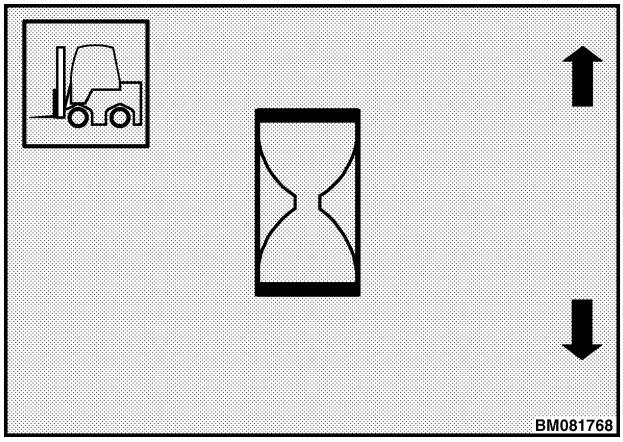
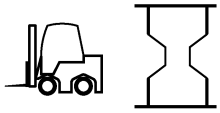
Icon	Description
	Software Version Indicator Icon
Truck Serial Number Submenu	
	
	Truck Serial Number Symbol Icon
Hour Meters Submenu	
	
	Truck Hour Meter Icon

Table 11. Status Submenus and Icons (Continued)

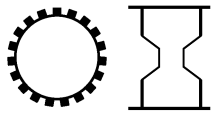
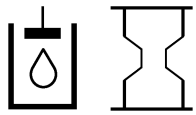
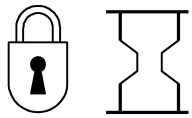
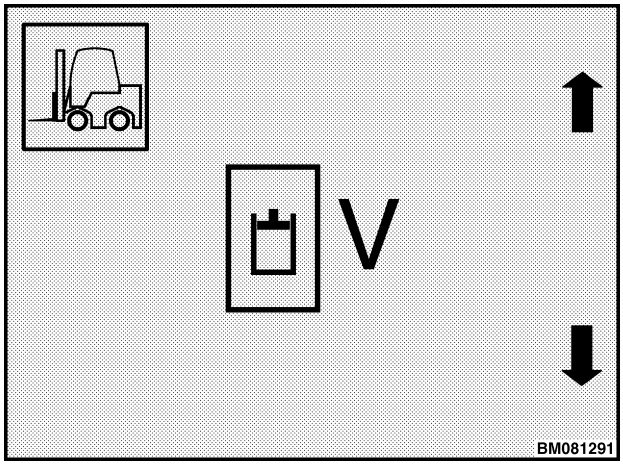
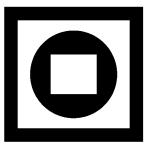
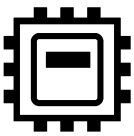
Icon	Description
	Traction Hour Meter Icon
	Pump Hour Meter Icon
	Secure Hour Meter Indicator Icon
E-Hydraulic Controller Version Submenu 	
	Hardware Version Indicator Icon
	Software Version Indicator Icon

Table 11. Status Submenus and Icons (Continued)

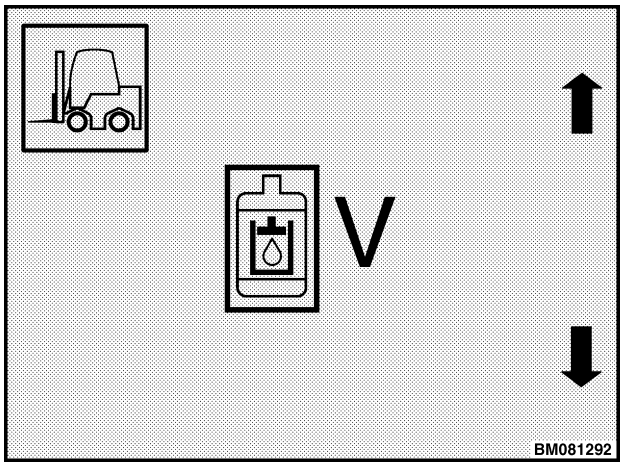
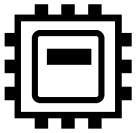
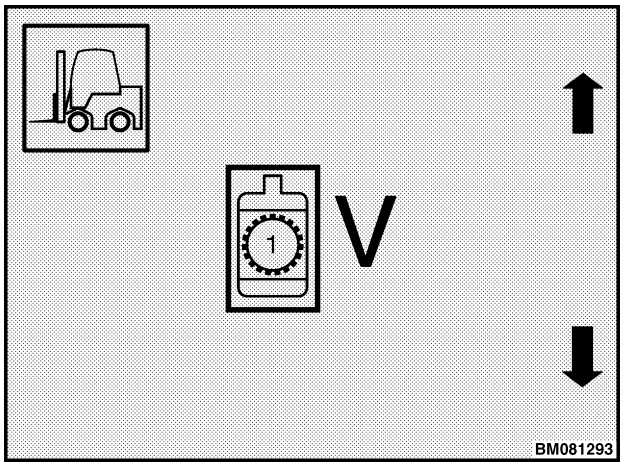
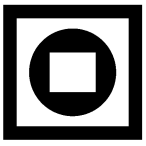
Icon	Description
Pump Motor Controller Version Submenu 	
	Hardware Version Indicator Icon
	Software Version Indicator Icon
Traction Controller 1 Version Submenu 	
	Hardware Version Indicator Icon

Table 11. Status Submenus and Icons (Continued)

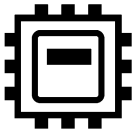
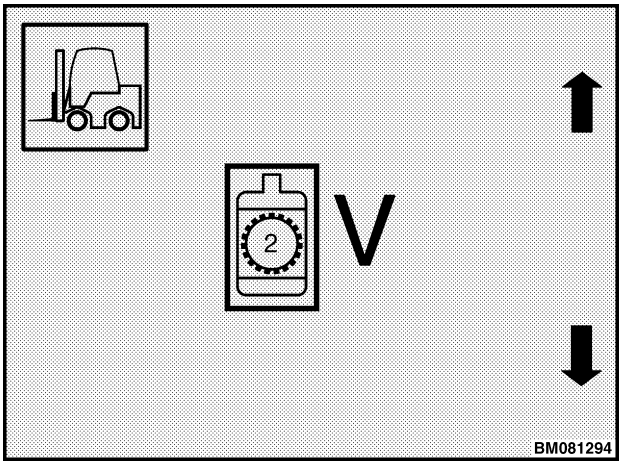
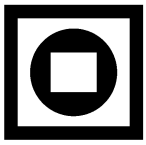
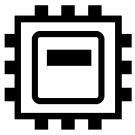
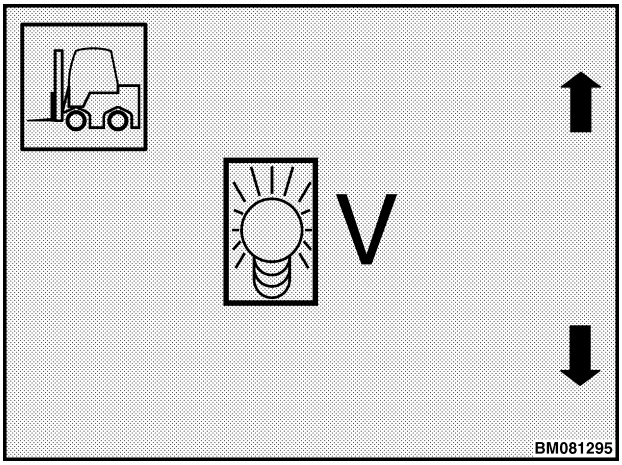
Icon	Description
	Software Version Indicator Icon
Traction Controller 2 Version Submenu	
	
	Hardware Version Indicator Icon
	Software Version Indicator Icon
Light Controller Version Submenu	
	

Table 11. Status Submenus and Icons (Continued)

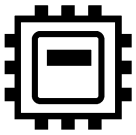
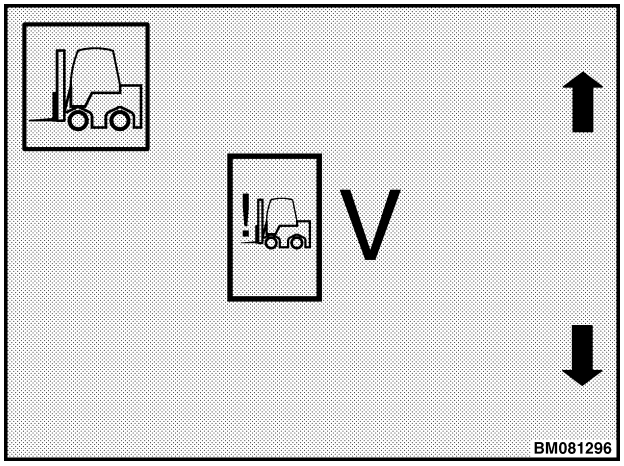
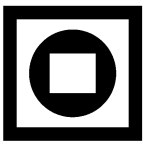
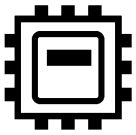
Icon	Description
	Hardware Version Indicator Icon
	Software Version Indicator Icon
Impact Sensor Version Submenu	
	
	Hardware Version Indicator Icon
	Software Version Indicator Icon

Table 11. Status Submenus and Icons (Continued)

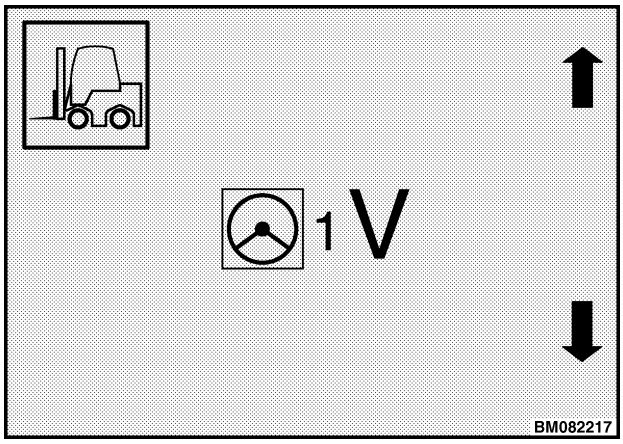
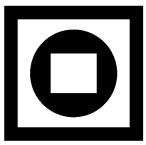
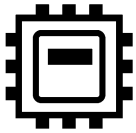
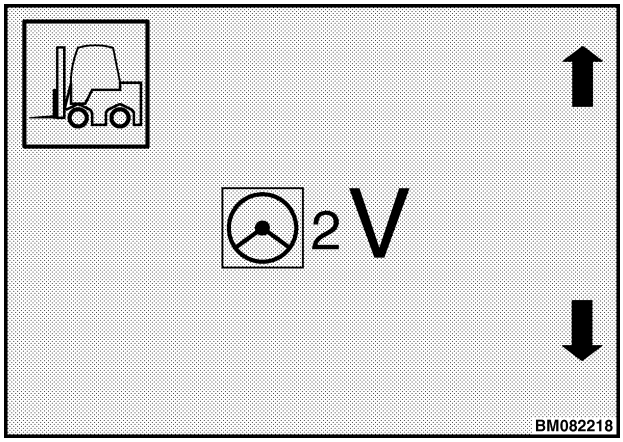
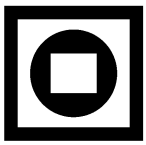
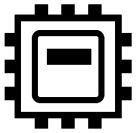
Icon	Description
E-Steer Controller 1 Version Submenu	
	
	Hardware Version Indicator Icon
	Software Version Indicator Icon
E-Steer Controller 2 Version Submenu	
	
	Hardware Version Indicator Icon

Table 11. Status Submenus and Icons (Continued)

Icon	Description
	Software Version Indicator Icon

Truck Setup Submenu Icons

Table 12 presents the icons that appear on the Truck Setup Submenus. See Truck Setup Menu for more information

Table 12. Truck Setup Submenu Icons

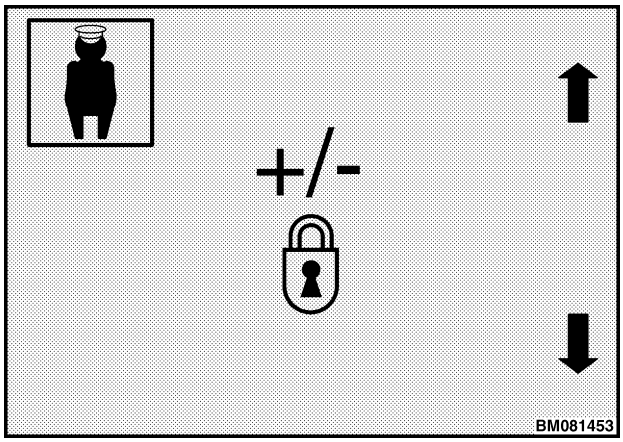
Icon	Description
Add/Remove Password Submenu	
	
	Password Icon
	Null Symbol Icon
	Operator Password Type Icon

Table 12. Truck Setup Submenu Icons (Continued)

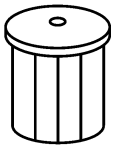
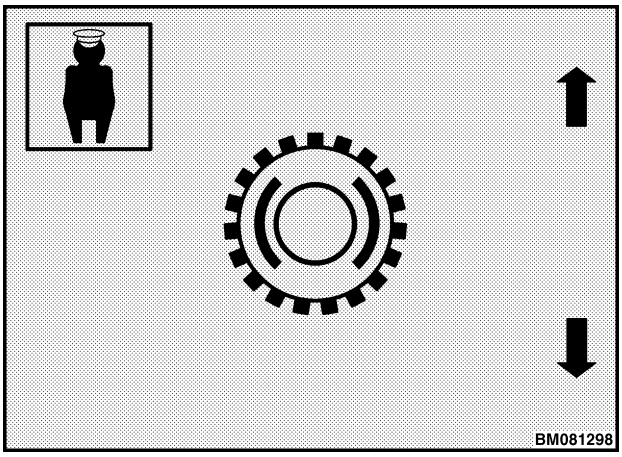
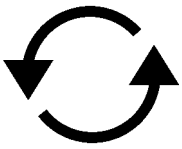
Icon	Description
	Supervisor Password Type Icon
	Service Password Type Icon
	Trash Can Icon
	Hare (increase performance) Icon
Motor Braking Submenu 	
	Regenerative Braking Indicator Icon
	Automatic Deceleration Rate Indicator Icon

Table 12. Truck Setup Submenu Icons (Continued)

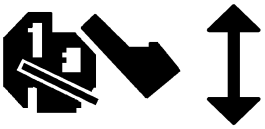
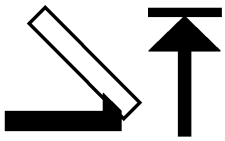
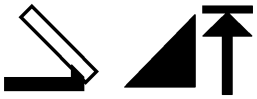
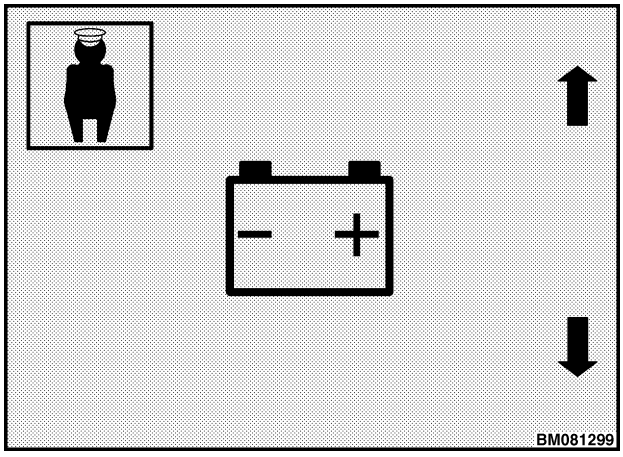
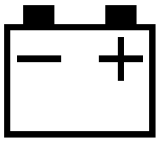
Icon	Description
	Deceleration Type Indicator Icon
	Pedal Up Setting Icon. This setting lets the lift truck coast until the pedal is fully released.
	Proportional Setting Icon. With this setting, the lift truck decelerates in proportion to how far the pedal is released in relation to the current traction speed.
	Supervisor Icon
Battery Setup Submenu 	
	Operating Voltage Icon
	Battery Capacity Icon

Table 12. Truck Setup Submenu Icons (Continued)

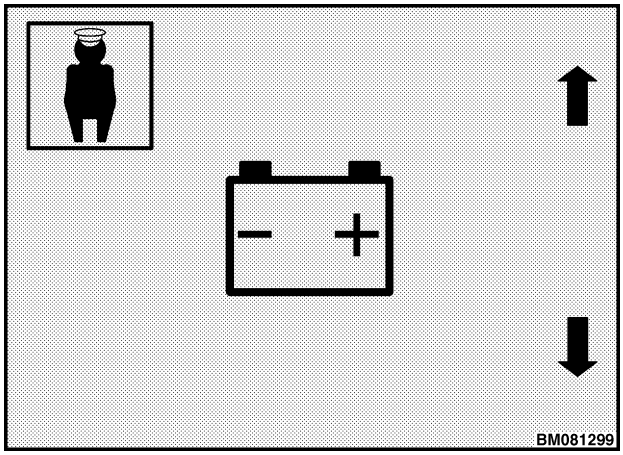
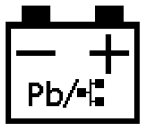
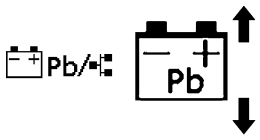
Icon	Description
	Full Cell Voltage Icon
	Empty Cell Voltage Icon
Battery Select Submenu 	
	Battery Select
	Motor Braking
	Lead Battery
	Li-Ion Battery

Table 12. Truck Setup Submenu Icons (Continued)

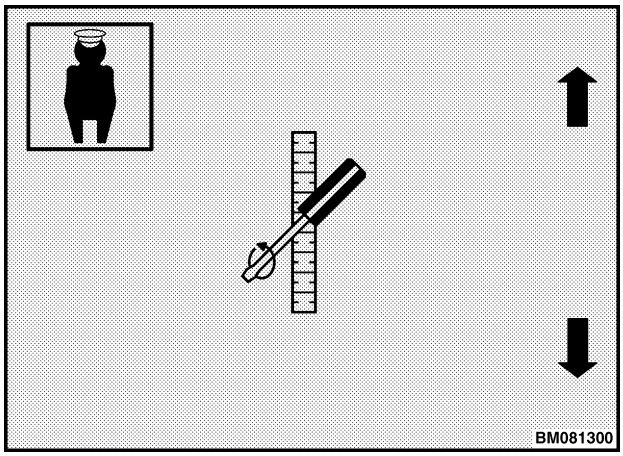
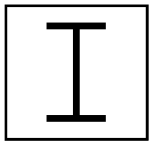
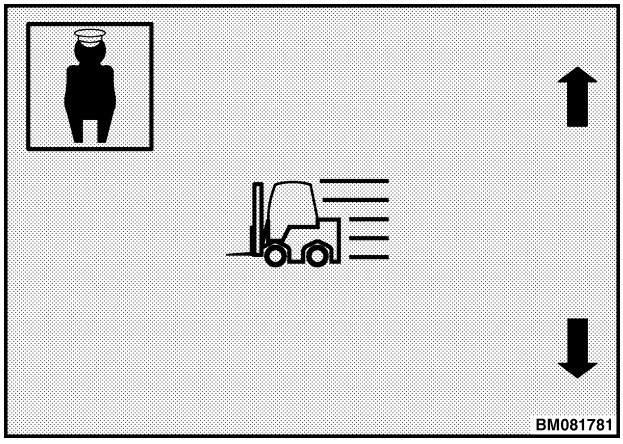
Icon	Description
BDI Adjustment Submenu 	
	Parasitic Current Icon
Acceleration Rates Submenu Visible to Service Technicians only. 	
	Low Speed Acceleration Rate Setting Icon
	High Speed Acceleration Rate Setting Icon

Table 12. Truck Setup Submenu Icons (Continued)

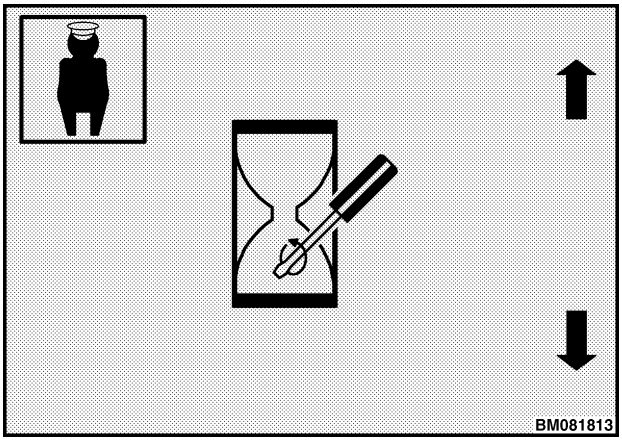
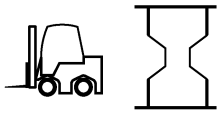
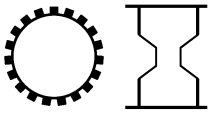
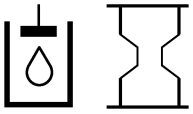
Icon	Description
	Performance Type Indicator Icon
	Standard Performance Rate Icon
	Extended Shift Performance Rate Icon
Hour Meter Initialization Submenu Visible to Service Technicians only. 	
	Truck Hour Meter Icon
	Traction Hour Meter Icon
	Pump Hour Meter Icon

Table 12. Truck Setup Submenu Icons (Continued)

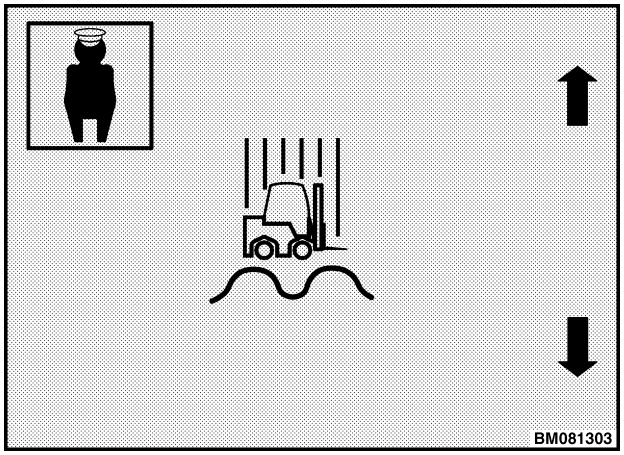
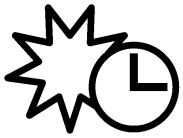
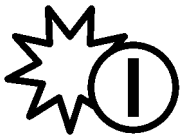
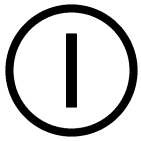
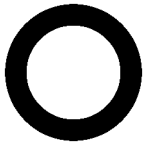
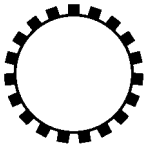
Icon	Description
Impact Monitor Shutdown Submenu 	
	Impact Shutdown Delay Icon
	Impact Shutdown Type Icon
	Impact Detection Icon
	ON Icon
	OFF Icon
	Disable Traction Icon

Table 12. Truck Setup Submenu Icons (Continued)

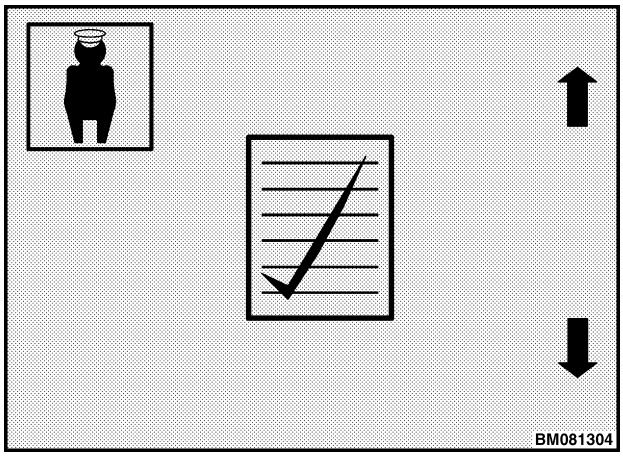
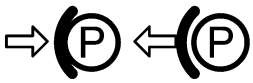
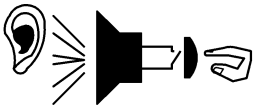
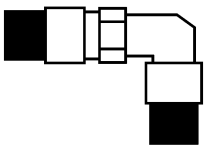
Icon	Description
	Disable All Icon
Operator Checklist Submenu 	
NOTE: The icons displayed when using this submenu correspond to the submenu icons for the various functions. Up to 30 checklist items can be enabled for the Operator Checklist.	
	Check Park Brake Icon
	Check Fuses Icon
	Check Horn Icon
	Check Hoses Icon

Table 12. Truck Setup Submenu Icons (Continued)

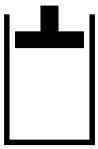
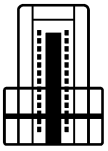
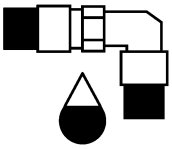
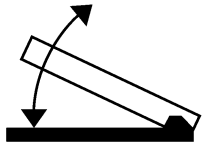
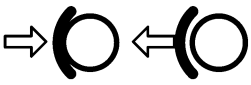
Icon	Description
	Check Hydraulics Icon
	Check Mast Icon
	Check for Leaks Icon
	Check Operator Restraint Icon
	Check Pedal Movement Icon
	Check Service Brake Icon
	Press the ***** key (**Enter Key**) below this icon to indicate proper operation of the current checklist item.
	Press the **#** key below this icon to indicate improper operation of the current checklist item (to indicate a problem with it).

Table 12. Truck Setup Submenu Icons (Continued)

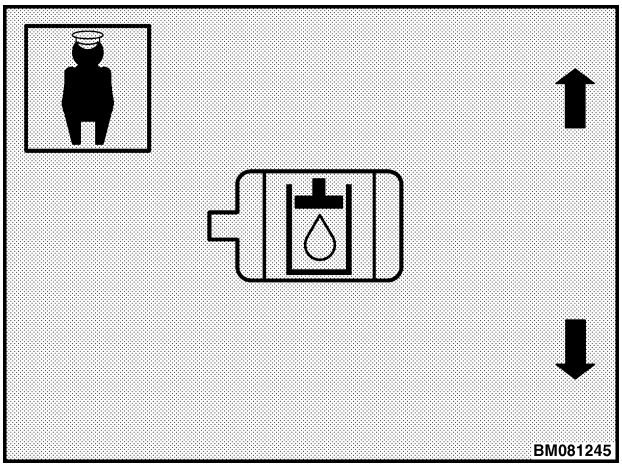
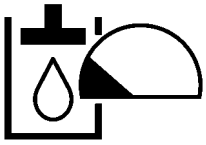
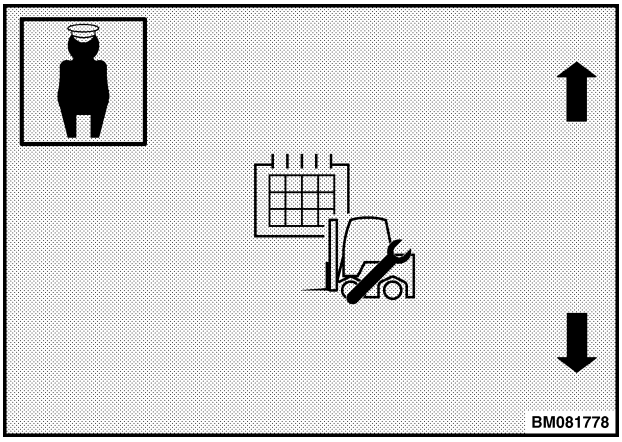
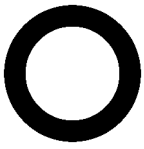
Icon	Description
Minimum Pump Standby Submenu	
	
	Minimum Standby Pump Flow Rate Icon
Scheduled Maintenance Reminder Submenu	
	
	Scheduled Maintenance Reminder, enabled (ON)
	Scheduled Maintenance Reminder, disabled (OFF)

Table 12. Truck Setup Submenu Icons (Continued)

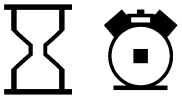
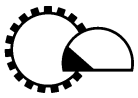
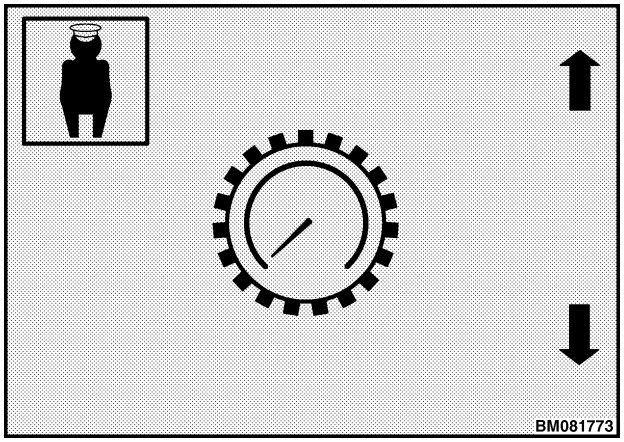
Icon	Description
	Interval Month Setting Icon
	Interval Hourmeter Setting Icon
	Derated Traction Speed Icon
Traction Speed Limit Submenu	
	
	Forward MPH Icon
	Reverse MPH Icon
	Forward km/h Icon
	Reverse km/h Icon

Table 12. Truck Setup Submenu Icons (Continued)

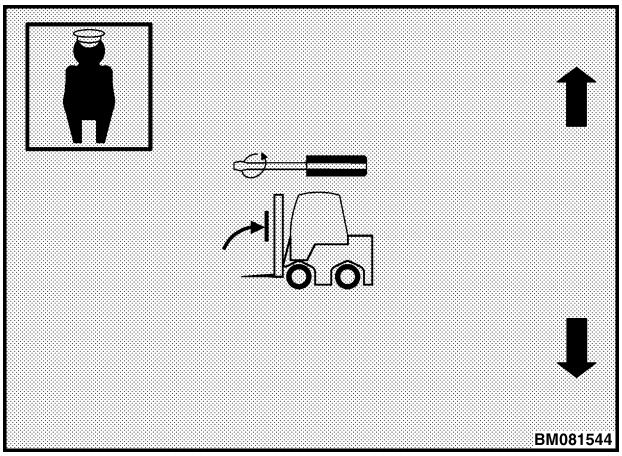
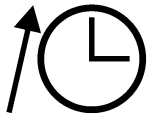
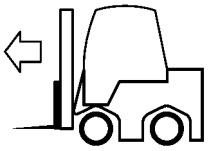
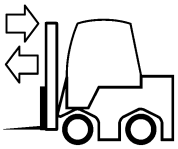
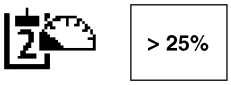
Icon	Description
Return to Set Tilt (RTST) Submenu	
	
	Return To Set Tilt Delay Icon
	Tilt Forward Only Icon
	Tilt Both Ways Icon
∞	Infinity Symbol Icon
	Enhanced Tilt Icon
	Enhanced Tilt Indicator Icon

Table 12. Truck Setup Submenu Icons (Continued)

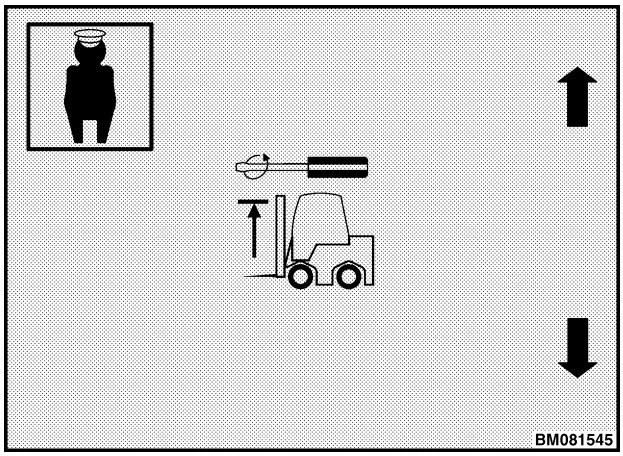
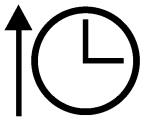
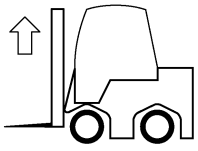
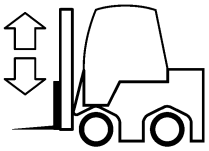
Icon	Description
Return to Set Height (RTSH) Submenu	
	
	Auto Power-Off Time Delay Indicator Icon
	Lift to Height Only Icon
	Lift/Lower Icon
∞	Infinity Symbol Icon

Table 12. Truck Setup Submenu Icons (Continued)

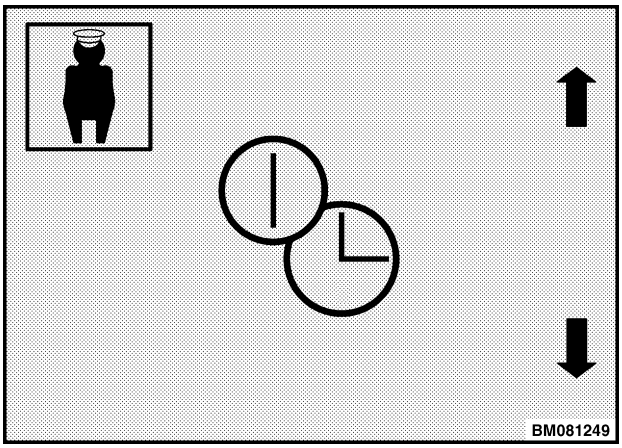
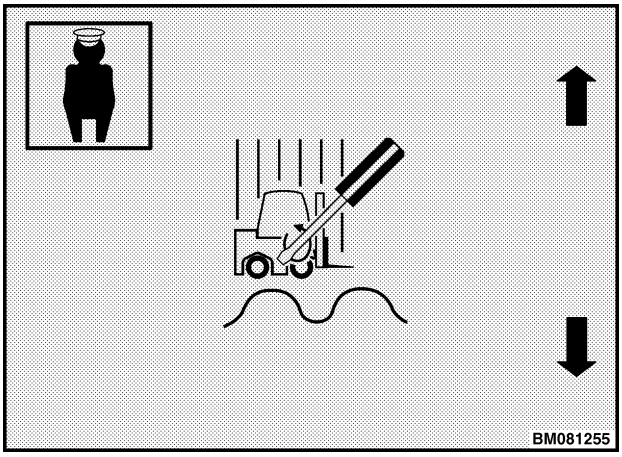
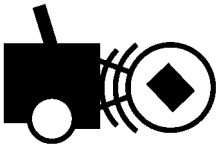
Icon	Description
Auto Power-Off Time Delay Submenu	
	
	Auto Power-Off Time Delay Indicator Icon
Impact Monitor Settings Submenu	
	
	Soft Impact Force Icon
	Soft Impact Time Icon

Table 12. Truck Setup Submenu Icons (Continued)

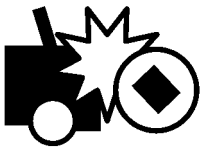
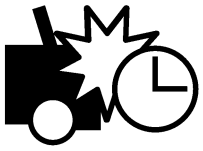
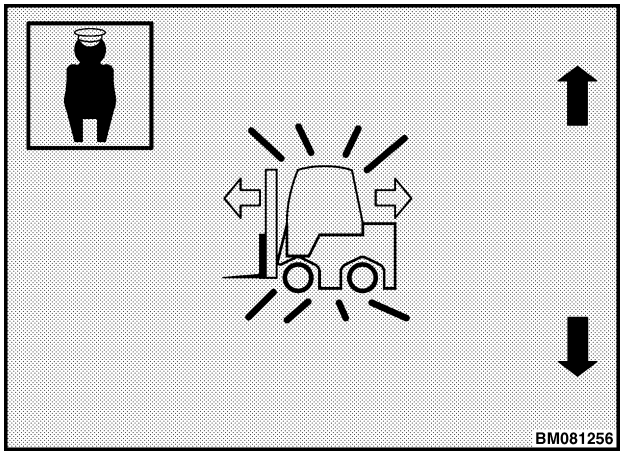
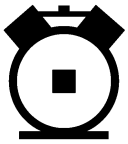
Icon	Description
	Hard Impact Force Icon
	Hard Impact Time Icon
Motion Alarm Submenu	
	
	Motion Alarm Indicator Icon
	Motion Alarm Indicator Disabled Icon. The X over the icon means the motion alarm is deactivated (turned off).
	Motion Alarm Icon

Table 12. Truck Setup Submenu Icons (Continued)

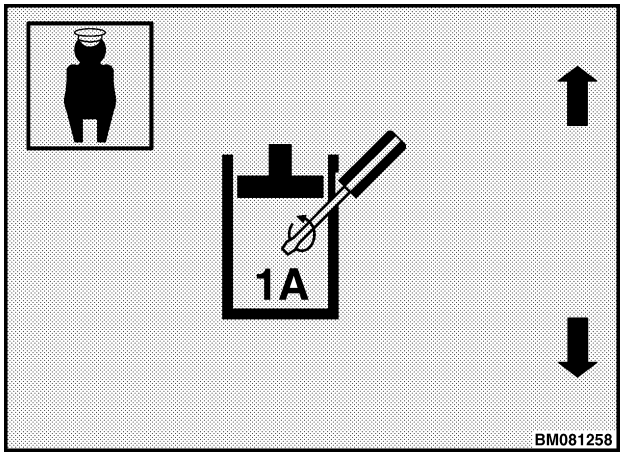
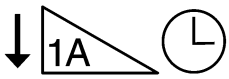
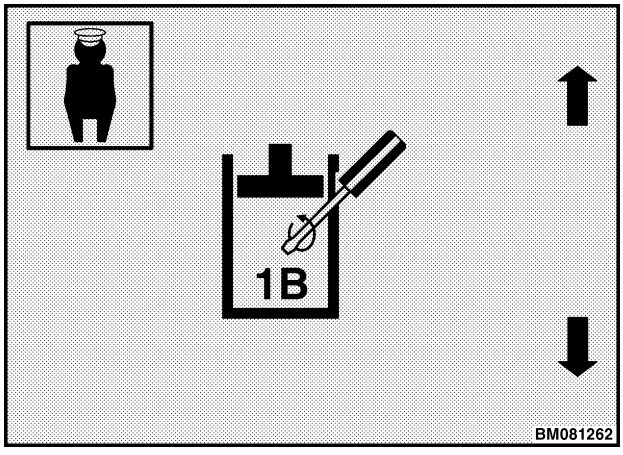
Icon	Description
Lower Adjustments Submenu Visible to service technicians only. 	
	Ramp Up Time Indicator Icon. Ramp rate can be from 0 to 2 seconds in 0.1 second increments.
	Ramp Down Time Indicator Icon. Ramp rate can be from 0 to 2 seconds in 0.1 second increments.
	Lower Max Speed Indicator Icon
Lift Adjustments Submenu Visible to service technicians only. 	

Table 12. Truck Setup Submenu Icons (Continued)

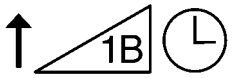
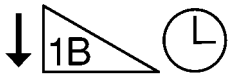
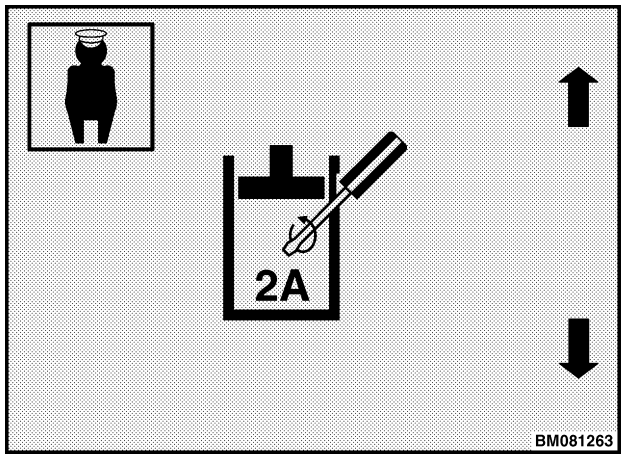
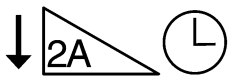
Icon	Description
	Ramp Up Time Indicator Icon. Ramp rate can be from 0 to 2 seconds in 0.1 second increments.
	Ramp Down Time Indicator Icon. Ramp rate can be from 0 to 2 seconds in 0.1 second increments.
	Lift Max Speed Indicator Icon
Tilt Forward Adjustments Submenu Visible to service technicians only. 	
	Ramp Up Time Indicator Icon. Ramp rate can be from 0 to 2 seconds in 0.1 second increments.
	Ramp Down Time Indicator Icon. Ramp rate can be from 0 to 2 seconds in 0.1 second increments.
	Tilt Forward Max Speed Indicator Icon

Table 12. Truck Setup Submenu Icons (Continued)

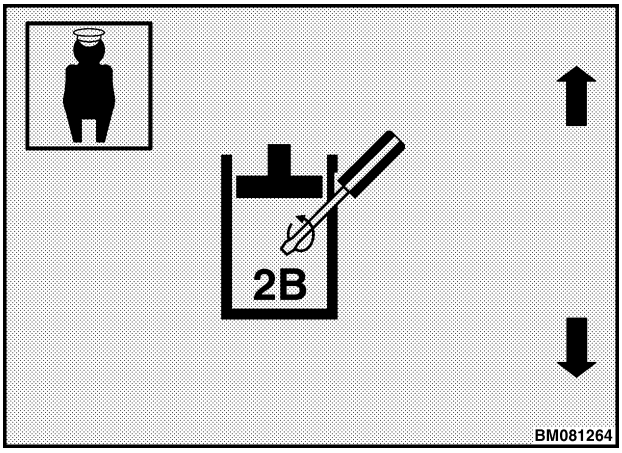
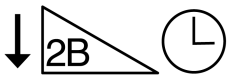
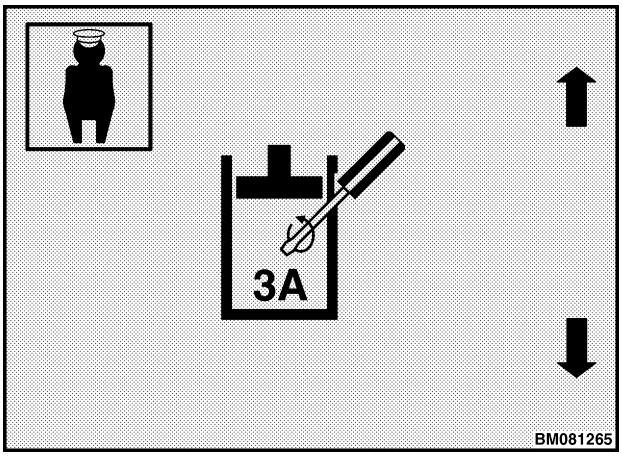
Icon	Description
Tilt Back Adjustments Submenu Visible to service technicians only. 	
	Ramp Up Time Indicator Icon. Ramp rate can be from 0 to 2 seconds in 0.1 second increments.
	Ramp Down Time Indicator Icon. Ramp rate can be from 0 to 2 seconds in 0.1 second increments.
	Tilt Back Max Speed Indicator Icon
Aux 1A Adjustments Submenu Visible to service technicians only. 	

Table 12. Truck Setup Submenu Icons (Continued)

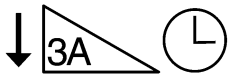
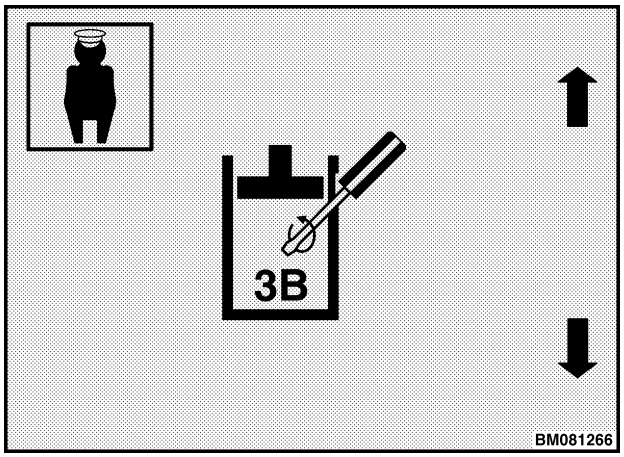
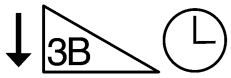
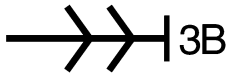
Icon	Description
	Ramp Up Time Indicator Icon. Ramp rate can be from 0 to 2 seconds in 0.1 second increments.
	Ramp Down Time Indicator Icon. Ramp rate can be from 0 to 2 seconds in 0.1 second increments.
	Aux 1A Max Speed Indicator Icon
Aux 1B Adjustments Submenu Visible to service technicians only. 	
	Ramp Up Time Indicator Icon. Ramp rate can be from 0 to 2 seconds in 0.1 second increments.
	Ramp Down Time Indicator Icon. Ramp rate can be from 0 to 2 seconds in 0.1 second increments.
	Aux 1B Max Speed Indicator Icon

Table 12. Truck Setup Submenu Icons (Continued)

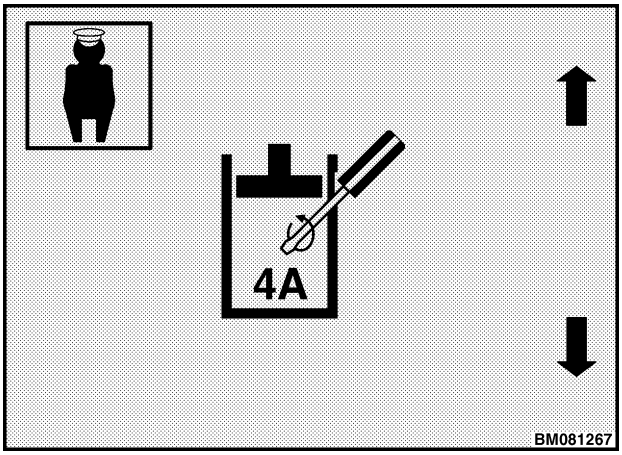
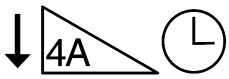
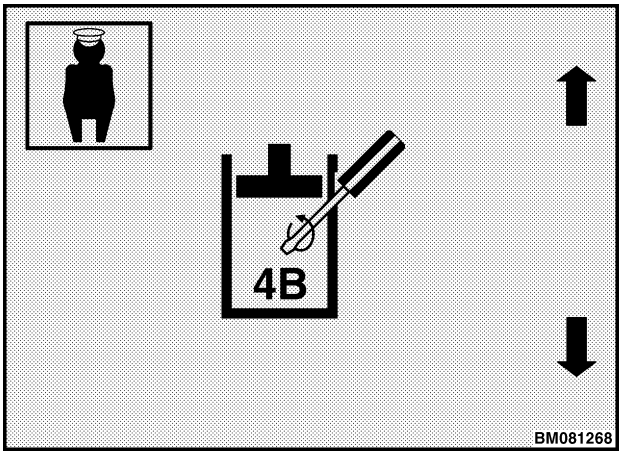
Icon	Description
Aux 2A Adjustments Submenu Visible to service technicians only. 	
	Ramp Up Time Indicator Icon. Ramp rate can be from 0 to 2 seconds in 0.1 second increments.
	Ramp Down Time Indicator Icon. Ramp rate can be from 0 to 2 seconds in 0.1 second increments.
	Aux 2A Max Speed Indicator Icon
Aux 2B Adjustments Submenu Visible to service technicians only. 	

Table 12. Truck Setup Submenu Icons (Continued)

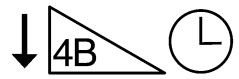
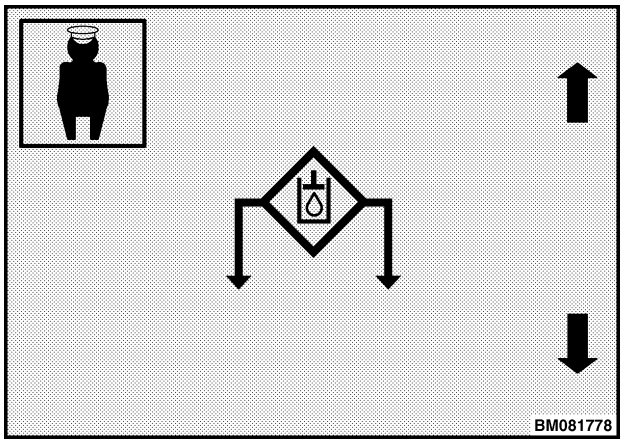
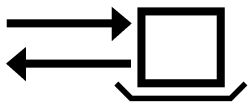
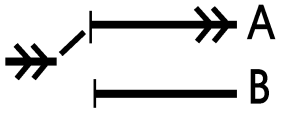
Icon	Description
	Ramp Up Time Indicator Icon. Ramp rate can be from 0 to 2 seconds in 0.1 second increments.
	Ramp Down Time Indicator Icon. Ramp rate can be from 0 to 2 seconds in 0.1 second increments.
	Aux 2B Max Speed Indicator Icon
Optional Hydraulics Functions Submenu 	
	Slip Sheet Control Icon
	Dual Function Control Icon
Rear Lights Submenu Visible to Service Technicians only. The Service Technician can use this menu to turn **ON** or turn **OFF** brake, tail, and	

Table 12. Truck Setup Submenu Icons (Continued)

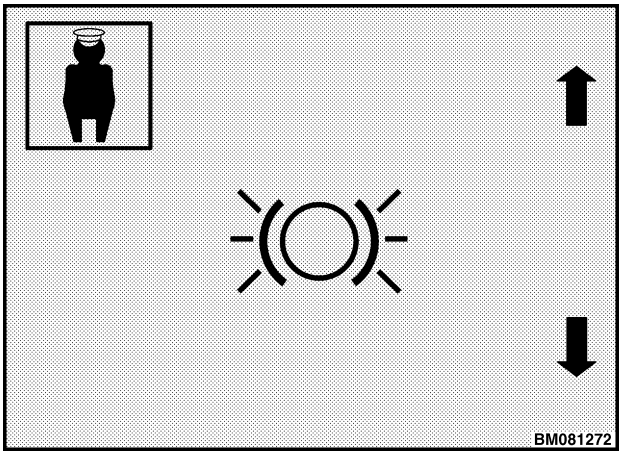
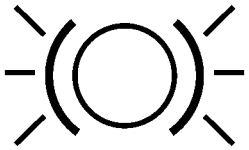
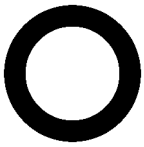
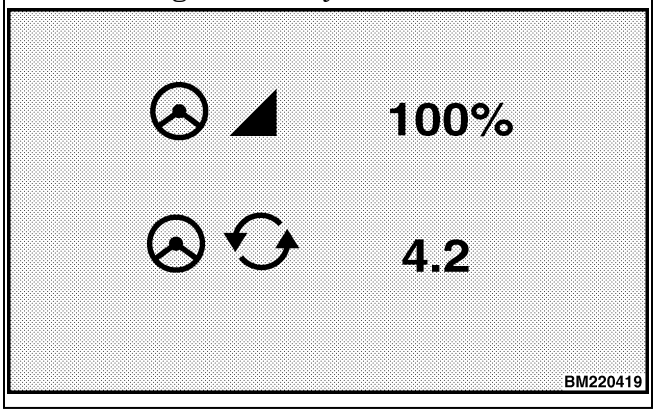
Icon	Description
backup lamps. 	
	Brake Lamp Indicator Icon
	Brake Lamp Status Icon, enabled (ON)
	Brake Lamp Status Icon, disabled (OFF)
Steering Wheel Friction (E-Steer) and Steering Turns Adjustment Submenu 	

Table 12. Truck Setup Submenu Icons (Continued)

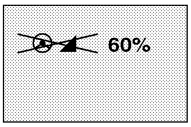
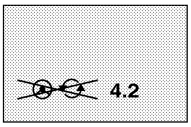
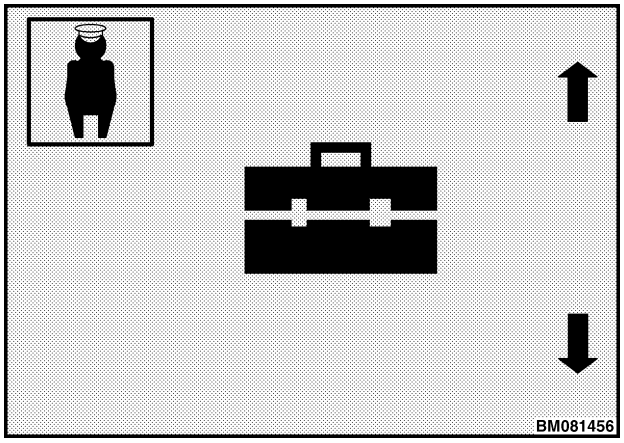
Icon	Description
	Steering Wheel Friction Icon
	Steering Wheel Number of Turns Icon
	Supervisor Icon
	Steering Wheel Icon
	E-Steer Setting Out of Range Icon
	Steering Turns Out of Range Icon
Restore Defaults Submenu 	

Table 12. Truck Setup Submenu Icons (Continued)

Icon	Description
	Restore Defaults Icon
	This icon points to the * key and is used for restoring defaults in this submenu.

Diagnostics Submenu Icons

Table 13 presents the icons that appear on the Diagnostics Submenus. See Diagnostics Menu for more information.

Table 13. Diagnostic Submenu Icons

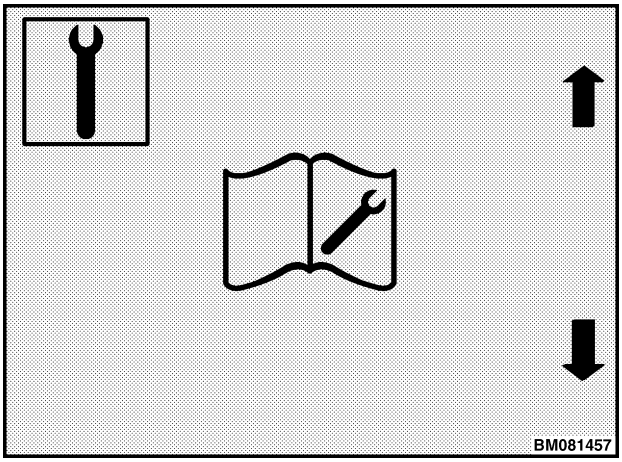
Icon	Description
Fault Code Log Submenu 	
	Up Arrow soft key
	Down Arrow soft key

Table 13. Diagnostic Submenu Icons (Continued)

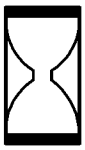
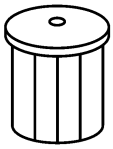
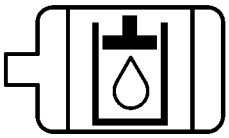
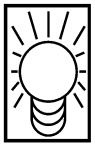
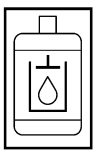
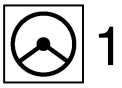
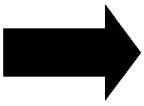
Icon	Description
	Hour Meter Icon
	Trash Can Icon
	Traction 1 Icon
	Traction 2 Icon
	Hour Meter / Time Stamp of first occurrence
	Hour Meter / Time Stamp of last occurrence
	Hydraulic Pump Icon
	Light Controller Icon
	E-Hydraulic Valves Icon

Table 13. Diagnostic Submenu Icons (Continued)

Icon	Description
	Impact Icon
	E-Steer Controller 1 Icon
	E-Steer Controller 2 Icon
	Display Icon
	View Next Device Fault Log Icon
	View Previous Device Fault Log Icon

Speedometer Submenu

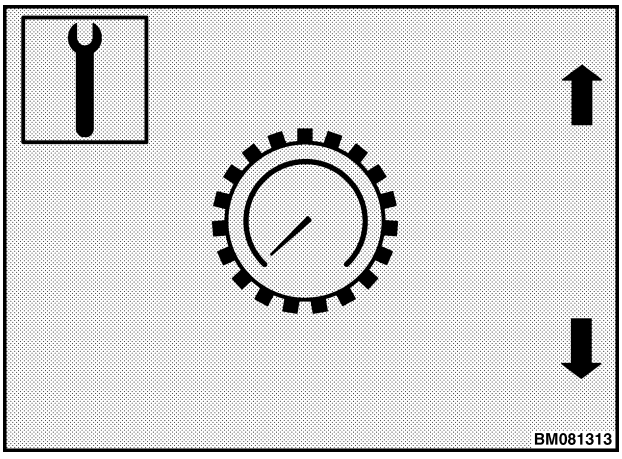


Table 13. Diagnostic Submenu Icons (Continued)

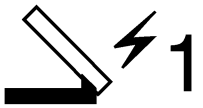
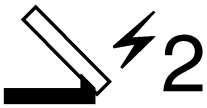
Icon	Description
	MPH Icon. Indicates reading is in miles per hour.
	km/h Icon. Indicates reading is in kilometers per hour.
	Accelerator Pedal Position (APP) Icon
	APP Sensor Voltage 1 Indicator Icon
	APP Sensor Voltage 2 Indicator Icon
	Forklift Truck Enabled Icon
	Forklift Truck Disabled Icon indicates that traction and hydraulics are disabled.

Table 13. Diagnostic Submenu Icons (Continued)

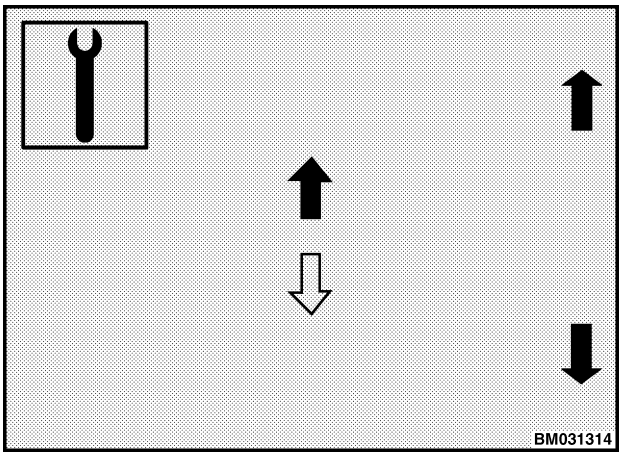
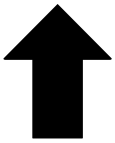
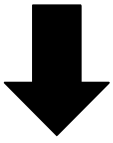
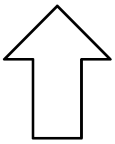
Icon	Description
Direction Select Submenu 	
	Forklift Truck Enabled Icon
	Forklift Truck Disabled Icon indicates that traction and hydraulics are disabled.
	Direction Indicator Icon. Filled up arrow means forward direction is selected.
	Direction Indicator Icon. Filled N indicates truck is in neutral.
	Direction Indicator Icon. Filled down arrow means reverse direction is selected.
	Direction Indicator Icon. Unfilled up arrow means forward direction is not selected.

Table 13. Diagnostic Submenu Icons (Continued)

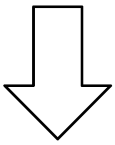
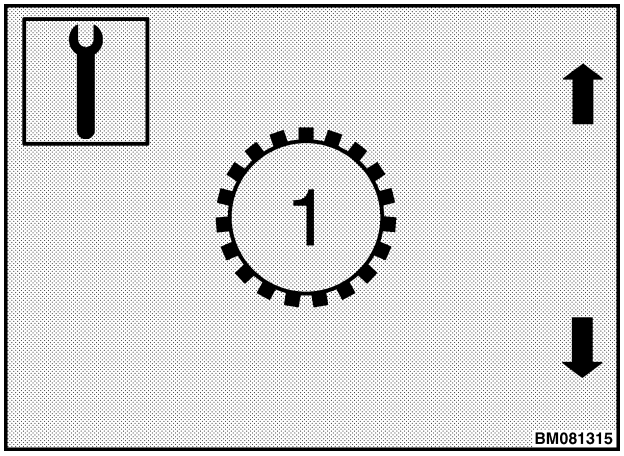
Icon	Description
	Direction Indicator Icon. Unfilled N indicates truck is not in neutral.
	Direction Indicator Icon. Unfilled down arrow means reverse direction is not selected.
	Park Brake On Icon.
Traction Motor 1 Status Submenu 	
°C	Temperature in degrees Celsius
°F	Temperature in degrees Fahrenheit
	Forklift Truck Enabled Icon
	Forklift Truck Disabled Icon

Table 13. Diagnostic Submenu Icons (Continued)

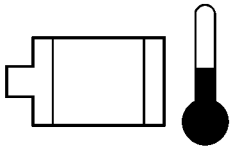
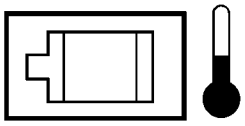
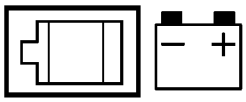
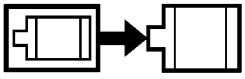
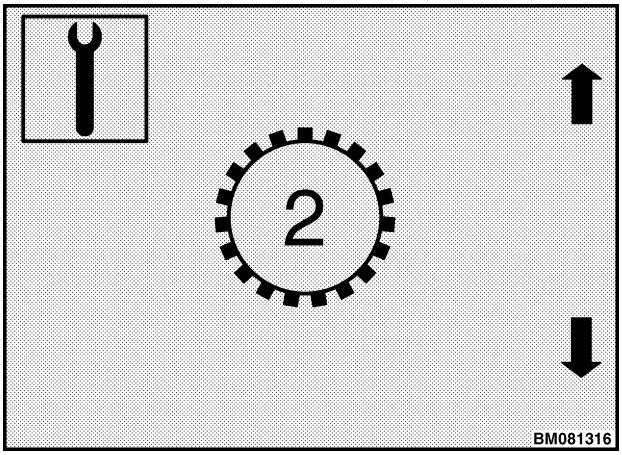
Icon	Description
	RPM Indicator Icon
	Motor Temperature Indicator Icon
	Motor Controller Temperature Indicator Icon
	Motor Controller Voltage Indicator Icon
	Motor RMS Current Indicator Icon. RMS = Root Mean Squared
Traction Motor 2 Status Submenu 	
The icons on the Traction Motor 2 Status submenu are the same as on the Traction Motor 1 Status submenu.	

Table 13. Diagnostic Submenu Icons (Continued)

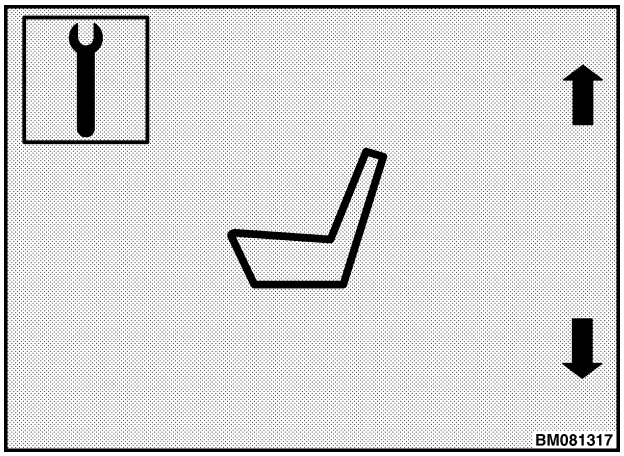
Icon	Description
Occupancy Sensor Submenu 	
	Forklift Truck Enabled Icon
	Forklift Truck Disabled Icon
	Occupancy Sensed, Seat Icon. The current voltage reading from the seat occupancy sensor is displayed to the right of this icon.
	This icon is in the lower right corner of the screen. If seat belt monitoring is in effect and no occupancy is detected, the seat belt icon has an X overlay icon over it.

Table 13. Diagnostic Submenu Icons (Continued)

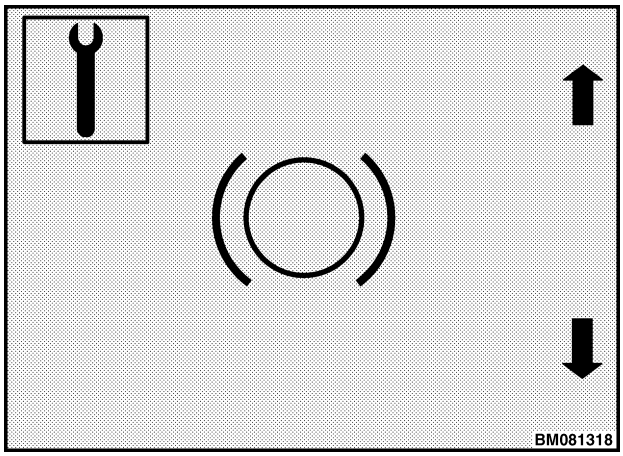
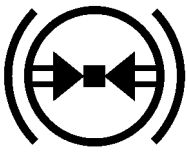
Icon	Description
Brake System Sensors Submenu 	
	Forklift Truck Enabled Icon
	Forklift Truck Disabled Icon
	Park Brake Indicator Icon
	Brake Fluid Sensor Icon. Measures brake fluid voltage.
	Brake Pressure Icon. Brake pressure sensor reports current brake voltage which is displayed in Volts.

Table 13. Diagnostic Submenu Icons (Continued)

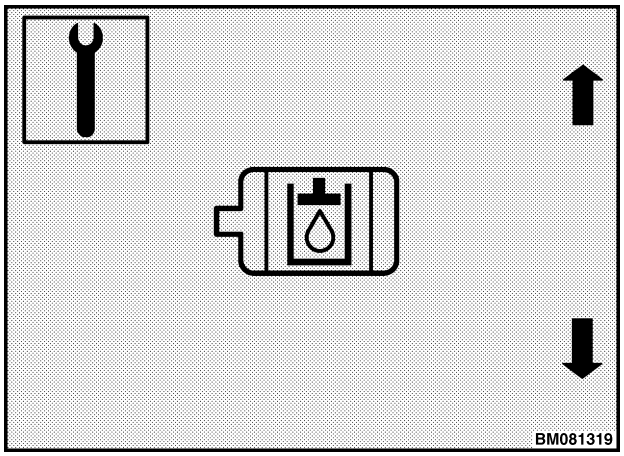
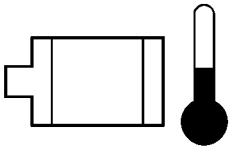
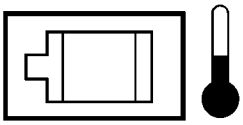
Icon	Description
Pump Status Submenu 	
°C	Temperature in degrees Celsius
°F	Temperature in degrees Fahrenheit
	Forklift Truck Enabled Icon
	Forklift Truck Disabled Icon
	RPM Indicator Icon
	Motor Temperature Indicator Icon
	Motor Controller Temperature Indicator Icon

Table 13. Diagnostic Submenu Icons (Continued)

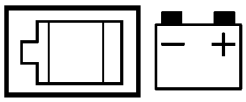
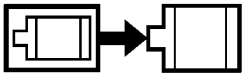
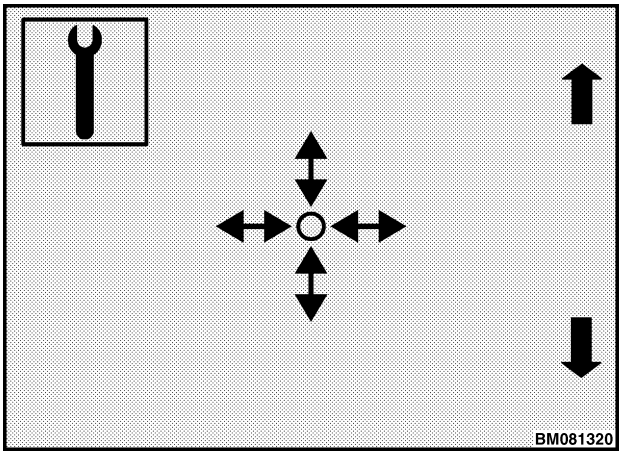
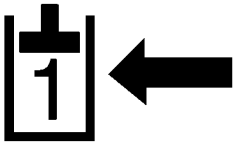
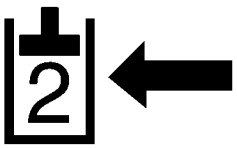
Icon	Description
	Motor Controller Voltage Indicator Icon
	Motor RMS Current Indicator Icon. (RMS = Root Mean Square)
Hydraulic Control Inputs Submenu 	
	Forklift Truck Enabled Icon
	Forklift Truck Disabled Icon
	Hydraulic Function 1 Input Indicator Icon
	Hydraulic Function 2 Input Indicator Icon

Table 13. Diagnostic Submenu Icons (Continued)

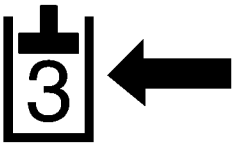
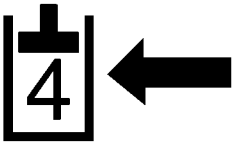
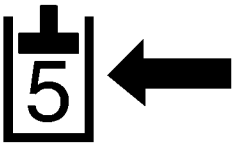
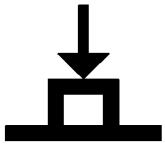
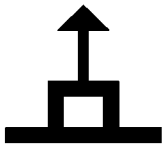
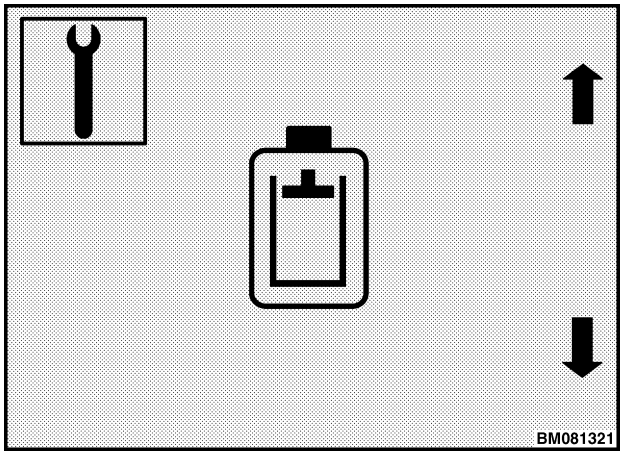
Icon	Description
	Hydraulic Function 3 Input Indicator Icon
	Hydraulic Function 4 Input Indicator Icon
	Hydraulic Function 5 Input Indicator Icon
	Button Pressed Icon for Functions 1-5. This icon shows the status of the function. (This icon is not displayed on trucks not equipped with Hydraulic functions.)
	Button Released Icon for Functions 1-5. This icon shows the status of the function. (This icon is not displayed on trucks not equipped with Hydraulic functions.)
E-Hydraulic Valves Submenu 	

Table 13. Diagnostic Submenu Icons (Continued)

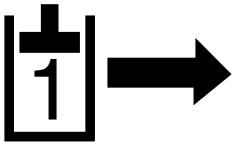
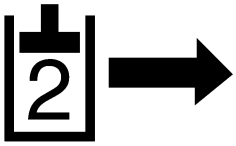
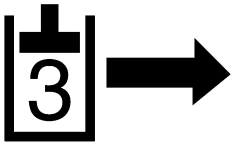
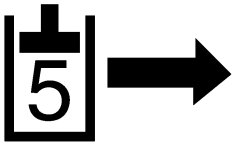
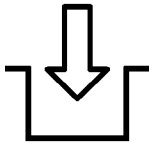
Icon	Description
	Forklift Truck Icon
	Forklift Truck Disabled Icon
	Hydraulic Function Icon
	Hydraulic Function 1 Output Indicator Icon
	Hydraulic Function 2 Output Indicator Icon
	Hydraulic Function 3 Output Indicator Icon
	Hydraulic Function 4 Output Indicator Icon
	Hydraulic Function 5 Output Indicator Icon
	Engaged Icon for Functions 1-5. This icon means the auxiliary solenoid is being driven.

Table 13. Diagnostic Submenu Icons (Continued)

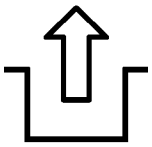
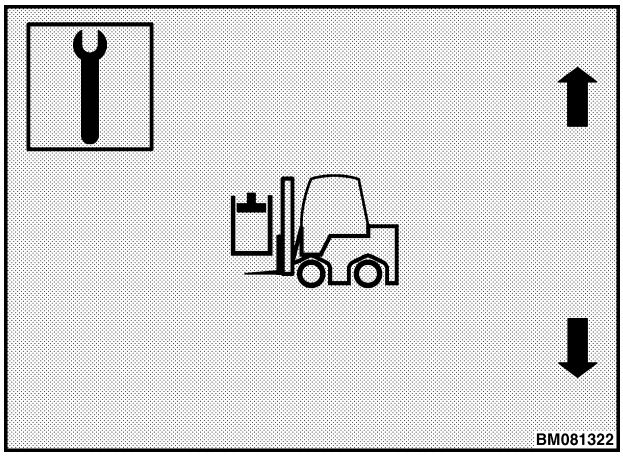
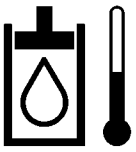
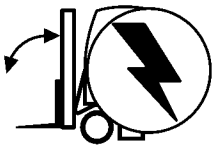
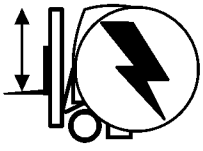
Icon	Description
	Disengaged Icon for Functions 1-5. This icon means the auxiliary solenoid is not being driven.
Hydraulic Sensors Submenu 	
	Forklift Truck Enabled Icon
	Forklift Truck Disabled Icon
	Hydraulic Temperature Indicator Icon
	Tilt Sensor Indicator Icon
	Height Sensor Indicator Icon

Table 13. Diagnostic Submenu Icons (Continued)

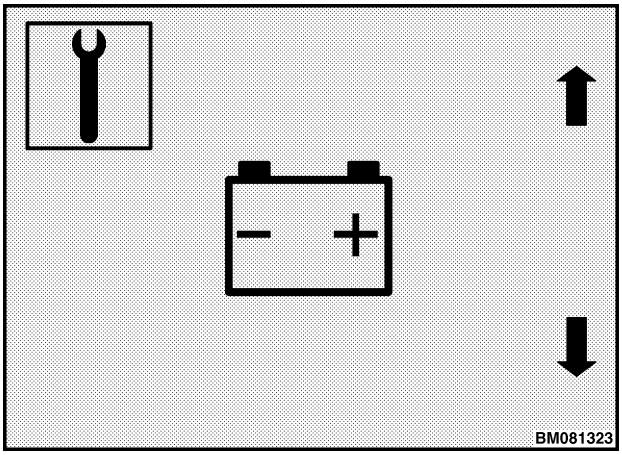
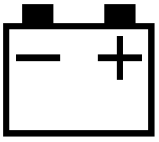
Icon	Description
	Load Weight Sensor Indicator Icon
System Voltages Submenu 	
	Forklift Truck Enabled Icon
	Forklift Truck Disabled Icon
	Battery Voltage Indicator Icon
	5 V Supply Voltage Indicator Icon
	12 V Supply Voltage Indicator Icon

Table 13. Diagnostic Submenu Icons (Continued)

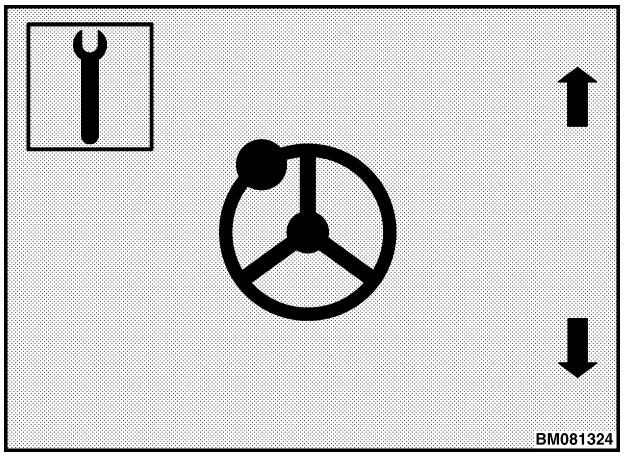
Icon	Description
Steering Position Sensors Submenu 	
	Forklift Truck Enabled Icon
	Forklift Truck Disabled Icon
	Steering Wheel Position Sensor Icon
	Axle Position Sensor Icon. Visible only on trucks equipped with the dual traction controllers or the Steer Synchronization feature.

Table 13. Diagnostic Submenu Icons (Continued)

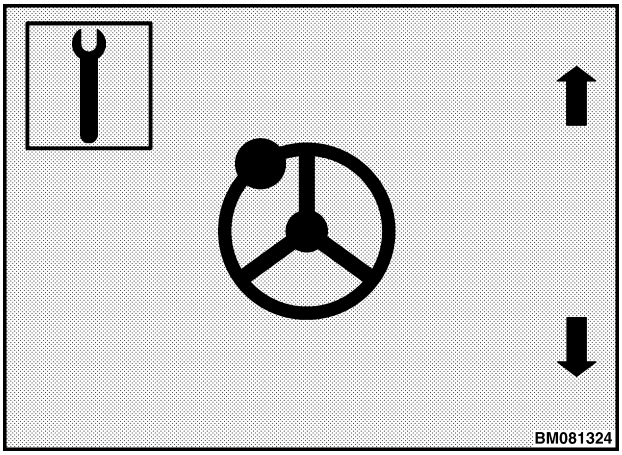
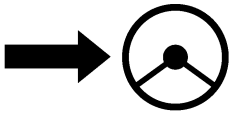
Icon	Description
Steering Position Sensors E-Steer Submenu 	
	Forklift Truck Enabled Icon
	Forklift Truck Disabled Icon
	Current for Torque Friction Device Icon
	Steer Wheel Position Sensor Voltage per E-Steer Controller 1 Icon
	Steer Wheel Position Sensor Voltage per E-Steer Controller 2 Icon
	E-Steer Controller 1 Axle Position Sensor Voltage Icon

Table 13. Diagnostic Submenu Icons (Continued)

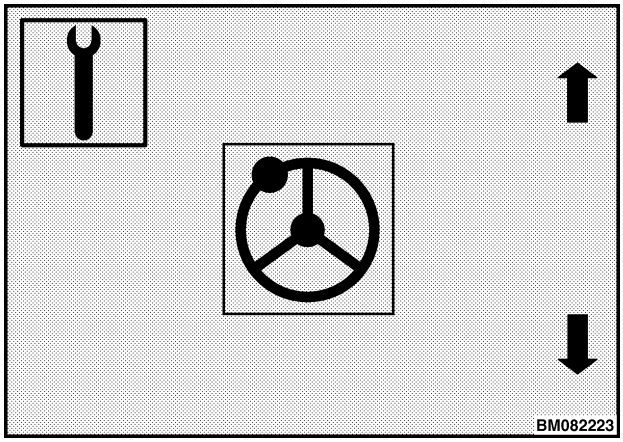
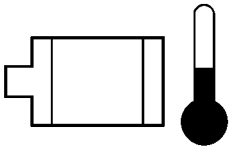
Icon	Description
	E-Steer Controller 2 Axle Position Sensor Voltage Icon
E-Steer Controller Status Submenu 	
°C	Temperature in degrees Celsius
°F	Temperature in degrees Fahrenheit
	Forklift Truck Enabled Icon
	Forklift Truck Disabled Icon
	RPM Indicator Icon
	Motor Temperature Indicator Icon

Table 13. Diagnostic Submenu Icons (Continued)

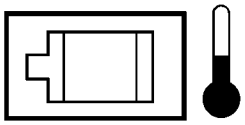
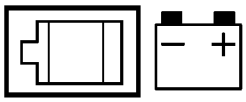
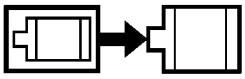
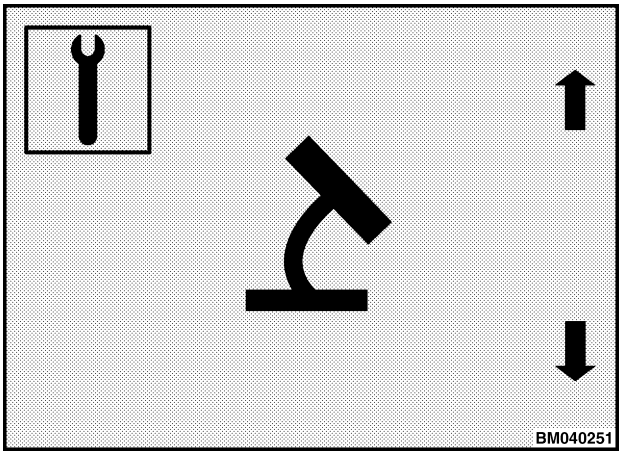
Icon	Description
	Motor Controller Temperature Indicator Icon
	Motor Controller Voltage Indicator Icon
	Motor RMS Current Indicator Icon. (RMS = Root Mean Square)
Electric Brake Diagnostic Submenu 	

Table 13. Diagnostic Submenu Icons (Continued)

Icon	Description
	Brake Pedal Percentage Icon
	Brake Pedal Signal 1 Output Icon
	Brake Pedal Signal 2 Output Icon

Operating Screen

INTRODUCTION

The Operating Screen, shown in Figure 9, is located on the Display Panel along with the numeric keys and control keys. At key-on, the Password Screen is the first screen displayed unless Operator Passwords are disabled. After a valid password is entered, the Operating Screen appears by default.

The Operating Screen uses small graphic images, called icons, to provide continuous feedback to the lift truck operator. This feedback includes performance settings, status and warning messages, and essential truck operating information. The Operating Screen is active at all times during normal lift truck operation.

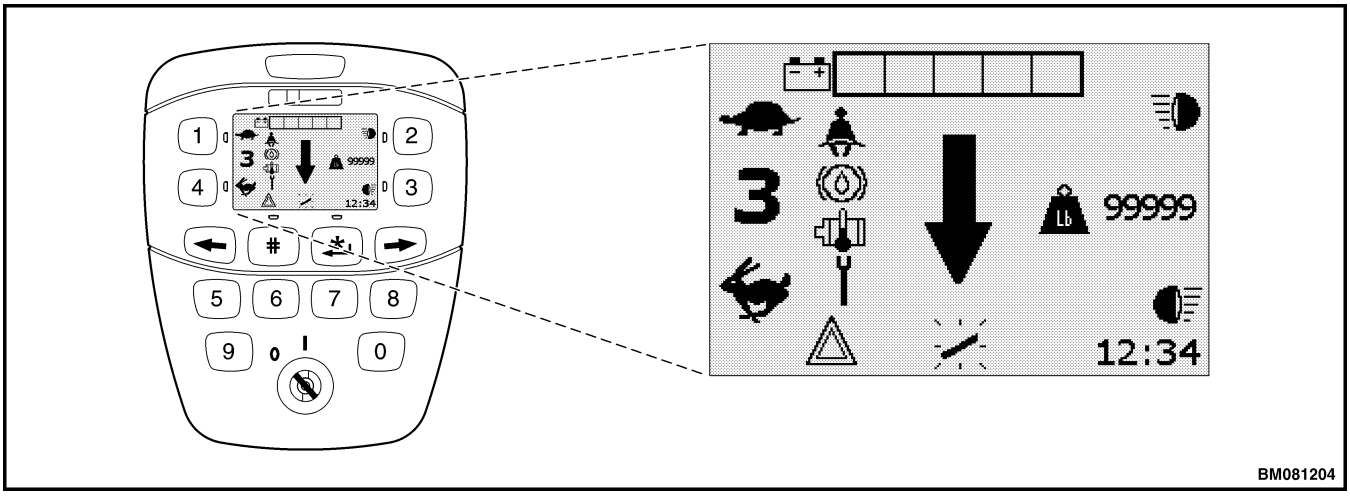


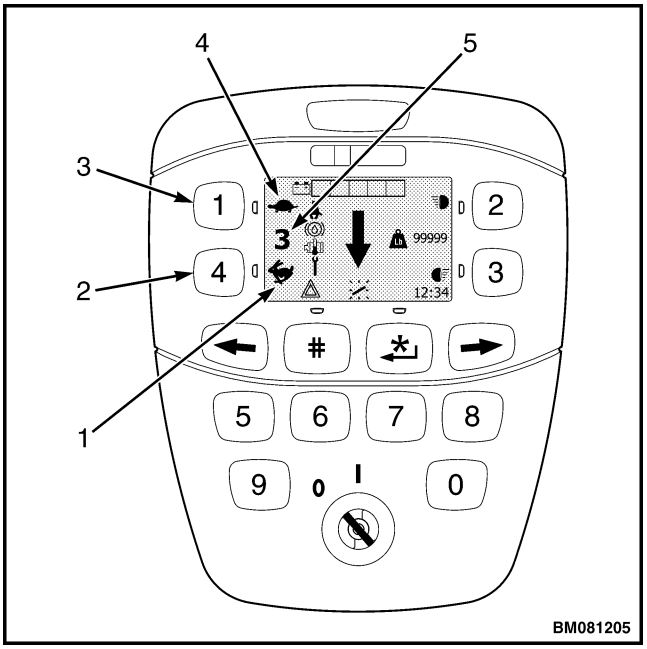
Figure 9. Operating Screen

NOTE: Icons for the front and rear work lights are shown. These are optional features.

The icons, indicators, and numbers on the Operating Screen are explained in the topics that follow.

PERFORMANCE MODE CONTROLS

The Performance Mode controls are shown in Figure 10.



1. PERFORMANCE MODE INDICATOR - INCREASE
2. PERFORMANCE MODE SOFT KEY - INCREASE
3. PERFORMANCE MODE SOFT KEY - DECREASE
4. PERFORMANCE MODE INDICATOR - DECREASE
5. CURRENT PERFORMANCE MODE

Figure 10. Performance Mode Controls

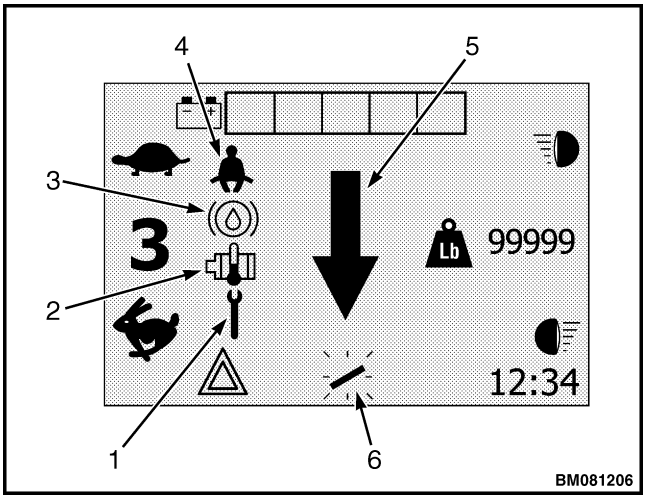
The current performance mode is shown on the Operating Screen. There are four available performance modes, numbered 1, 2, 3, and 4. Performance mode 4 provides the maximum performance. If passwords are enabled, the last active performance mode on the truck is displayed on the screen when the truck is powered On, unless the current operator has been assigned a lower available performance mode. The maximum performance mode allowed for each operator is set by the Supervisor or Service Technician during the Add/Remove Password section of Truck Setup. See the Password Screen topic for more information. Depending on the maximum performance mode allowed, it may be possible for the operator to use the Performance Mode soft keys on the Display Panel to change the current performance mode.

- MODE 4 - This is the highest performance mode. Other modes are a lower percentage of Mode 4.
- MODE 3 - Top speed is the same as Mode 4. Acceleration is 80 percent of Mode 4.
- MODE 2 - Top speed is 80 percent of Mode 4. Acceleration is 70 percent of Mode 4.
- MODE 1 - Top speed is 60 percent of Mode 4. Acceleration is 60 percent of Mode 4.

Pressing the "Hare" soft key, **4**, increases the current mode and pressing the "Tortoise" soft key, **1**, decreases the current mode, assuming performance mode change is available to the current operator. The performance mode can be changed only when both the hydraulic and direction controls are in Neutral and the truck is stopped. If a performance mode change is attempted at a time when either of these conditions is not met, the newly selected mode will flash and the change will not occur until the necessary conditions are met.

STATUS AND WARNING ICONS

When the truck is powered **ON**, the system continuously monitors a number of parameters and displays up to six icons to provide status information and warnings to the operator, as shown in Figure 11. Also see the Operating Screen Icons topic.



1. SERVICE DUE
2. MOTOR TEMPERATURE HIGH
3. BRAKE FLUID LOW WARNING
4. SEAT BELT WARNING
5. DIRECTION / PARK BRAKE INDICATORS
6. STEER ANGLE

Figure 11. Status and Warning Icons

NOTE: Icons for front and rear lights are shown. These are optional features.

Depending on conditions, the following icons can appear in this area (see the Operating Screen Icons topic):

- Wrench Icon
- Temperature High Icon
- Brake Fluid Low Icon
- Hydraulic Fluid Level Icon
- Hydraulic Filter Icon
- Fasten Seat Belt Icon

When the wrench icon is continuously **ON**, it means that scheduled maintenance is due. When it is flashing, it indicates that an active fault has been detected by the system. The wrench icon appears in the bottom location of the status/warning icon area when it is displayed. It has the lowest priority of the three icons, wrench, hydraulic filter, or hydraulic fluid level, that can be displayed in this location.

The hydraulic filter icon shows in the same location, in place of the wrench icon, if a hydraulic filter restriction is detected. It has the second highest priority of the three icons that can be displayed in this location.

The hydraulic fluid level icon shows in the same location, in place of the wrench icon or the hydraulic filter icon, if a low level is detected in the hydraulic fluid reservoir. It has the highest priority of the three icons that can be displayed in this location.

The motor temperature high icon is displayed if a high motor temperature is detected, meaning that the temperature of one of the motors or motor controllers has gone above the defined threshold temperature.

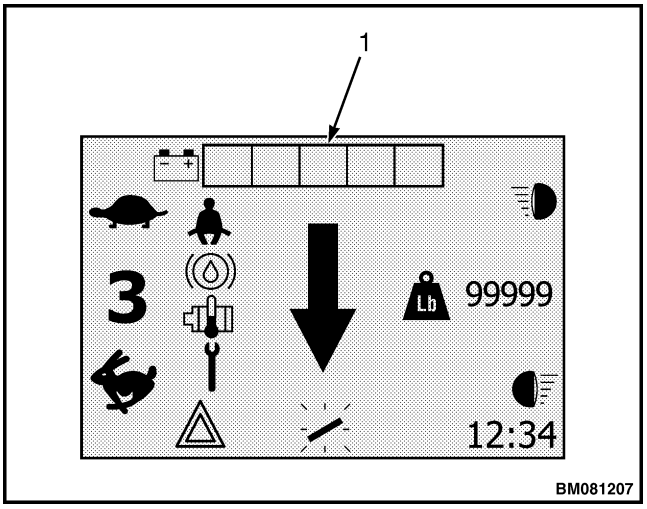
The brake fluid low icon is displayed if a low level is detected in the brake fluid reservoir.

The fasten seat belt icon is displayed for the first ten seconds after the truck is powered **ON**, or for ten seconds after the seat is reoccupied after the operator leaves the seat for ten seconds or more. This warning is based on seat occupancy, not the seat belt connection itself. If the operator selects a screen other than the Operating Screen before the ten seconds are up, the fasten seat belt icon will no longer be displayed.

BATTERY DISCHARGE INDICATOR

NOTE: Because the Battery Discharge Indicator (BDI) algorithm determines the Battery State Of Charge (BSOC) based on information gathered during operation it may take several seconds for the BDI to show the correct BSOC for the battery.

The BDI is located in the top center of the Operating Screen, as shown in Figure 12. The BDI is displayed as a five-segment horizontal bar and it has a battery icon on its left side.



1. BATTERY DISCHARGE INDICATOR

Figure 12. Battery Discharge Indicator

The system continuously monitors the truck's current BSOC, and this is indicated on the BDI by the number of filled bar segments. Table 14 shows the battery's state of charge in percentages, compared to the number of filled segments.

Table 14. BSOC in Relation to BDI

BSOC Charge Remaining (%)	Number of Filled Segments
76% or more	Five (5)
50% to 75%	Four (4)
35% to 50%	Three (3)
25% to 35%	Two (2)
21% to 25%	One (1) segment, plus flashing plus low battery alarm
0 to 20%	Zero (0) segments, plus flashing plus a second low battery alarm

The BDI is always visible when the Operating Screen is active. All five of the BDI segments are filled (illuminated) when the BSOC is at 75% or higher. As the BSOC goes down, the segments on the right change to just outlines until the BSOC reaches 25%, which is indicated when only the leftmost segment, next to the battery icon, is filled.

If the battery charge drops below 25%, the "low battery alarm" sounds and the BDI begins flashing. The "low battery alarm" also sounds if the lift truck is turned **ON** when the BSOC is below 25%. If the BSOC drops to 20%, the leftmost segment changes to an outline and a second "low battery alarm" sounds. The lift truck will be subjected to operating and performance limitations if the BSOC drops below 20%.

DIRECTION AND PARKING BRAKE INDICATORS

These indicators are displayed in the center of the Operating Screen, as shown in Figure 11.

- An up-arrow indicates the truck will move forward if the accelerator is pressed.
- A down-arrow indicates the truck will move backward (reverse) if the accelerator is pressed.
- A solid "N" indicates the truck will not move if the accelerator is pressed, though it can still roll if the service brake is released.
- The parking brake icon is a "P" with a circle around it to represent a wheel and arcs around the circle that represent brakes. When this icon is displayed, it indicates the truck parking brake is applied and the truck will not move if the accelerator is pressed.

HAZARD FLASHERS AND LIGHTING CONTROLS

If the lift truck is equipped with CAN controlled hazard flashers and lighting controls, the icons that indicate the status of the lift truck's hazard flashers and lights are displayed on the Operating Screen. The soft keys the operator can use to control these lights are located near the Operating Screen.

- The Front Work Light Icon, on the lower right of the screen, is always visible. The operator can turn the front lights **ON** and **OFF** by pressing the **2** soft key.
- The Rear Work Light Icon, on the upper right of the screen, is always visible. The operator can turn the rear lights **ON** and **OFF** by pressing the **3** soft key.
- The Hazard Flashers Icon, a triangle on the lower left of the screen, is always visible if the lift truck is equipped with hazard flashers. The operator can press the **#** soft key to toggle the truck's hazard flashers **ON** and **OFF**.

STEER ANGLE INDICATOR

The Steer Angle indicator is displayed in the lower center of the Operating Screen, as shown in Figure 11. The purpose of this indicator is to show the operator the current steer angle (the direction of the tires that steer the truck). This informs the operator which way the truck will move if the accelerator pedal is pressed, given the current steer angle. The Steer Angle indicator shows the steering angle to the nearest 22.5° from full left, to full right.

SYSTEM TIME

The System Time for the lift truck, shown as 12:34 in Figure 11, appears in the lower right corner of the Operating Screen. System time can be reset by a Supervisor or Service Technician using the procedures described in Display Menu. If the Clock Hour Format is set to a 12-hour clock, the time numbers will be followed by an "A" (AM) or a "P" (PM) as appropriate. Otherwise, the system time uses a 24-hour clock.

LOAD WEIGHT INDICATOR

The Load Weight indicator for the lift truck, shown as 99999 beside the Load Weight Icon in Figure 11, appears at the midpoint of the right side of the Operating Screen. If the lift truck supports the Load Weight feature, the Operating Screen will display the load weight during any mast hydraulic command and for five seconds afterwards.

The Load Weight Icon indicates whether lb (pound) or kg (kilogram) units are being used. Use the procedures described in the Set Units Menu topic in the Display Menu section to set the load units for this lift truck. Use the procedures in the Load Weight Display topic in the Calibration Menu section to calibrate the load weight for this lift truck.

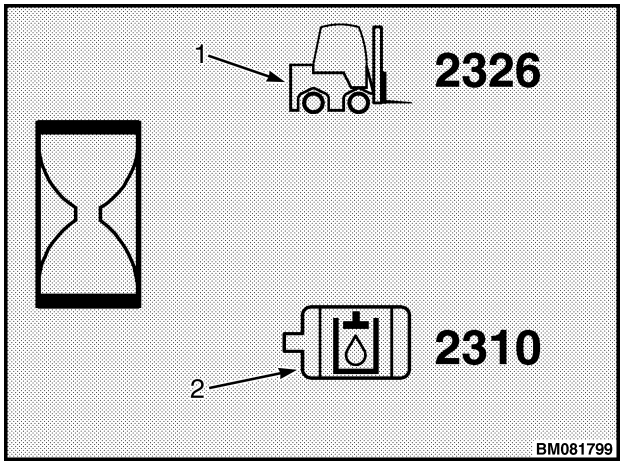
System Off/Alert Screens

INTRODUCTION

Several screens appear only briefly on the Operating Screen. These include the System Off Screen and Alert Screens. The purpose of the System Off Screen is to supply brief status information as the system is powered off. Alert Screens appear momentarily to attract attention. The topics that follow provide more information about these types of screens.

SYSTEM OFF SCREEN

When the lift truck power is first turned **OFF**, the System Off Screen is displayed for five seconds. The system will also display this screen for five seconds if the **Scroll Forward Key** (—▸) is pressed while the truck is powered off. Figure 13 shows the System Off Screen.

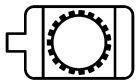


1. TRUCK HOUR METER
2. HYDRAULIC PUMP MOTOR HOUR METER

Figure 13. System Off Screen

The System Off Screen displays the Truck Hour Meter in the upper right corner of the Operating Screen and the Hydraulic Pump Hour Meter in the lower right. If equipped, the System Off screen can show any two of the following four hour meters.

- The Truck Hour Meter shows the total time the operator has been in the seat with the key or keyless switch in the **ON** position.
- The Pump Hour Meter shows the total time the hydraulic pump has been running.
- The Traction Hour Meter shows the total time on traction motor while the truck has been moving.
- The Secure Hour Meter shows the total time the operator has been in the seat with the key or keyless switch in the **ON** position and cannot be reset.
- The time shown on the meters is displayed in hours, but the system stores the values to the nearest 0.1 hour.

	Truck Hour Meter Icon
	Traction Hour Meter Icon
	Hydraulic Pump Motor Hour Meter Icon
	Secure Hour Meter Indicator Icon

These meters can be examined more closely or reset by a Service Technician using the procedures described in the Status Menu section.

ALERT SCREENS

There are two types of alert screens, Fault Screens (failure indication screens) and Interlock Notification Screens. Both types of alert screens are temporary in nature because the system immediately restores the original screen after a key press or other action removes the problem.

When the system detects an active failure, the display changes to a Fault Screen which flashes a fault code, the Wrench Icon, and other icons to indicate the problem, similar to the example shown in Figure 14. As it is displayed, the alert screen flashes to draw the user's attention. Pressing either the **Scroll Back Key** (◂—) or **Scroll Forward Key** (—▸) after the alert screen appears causes the system to return to the last screen displayed.

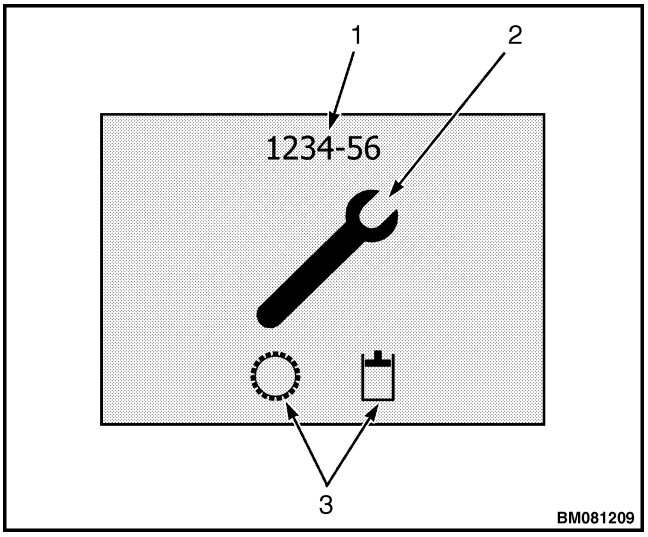


Figure 14. Example Fault Screen

Legend for Figure 14.

1. EXAMPLE FAULT CODE
2. WRENCH ICON
3. ICONS OF DISABLED/PERFORMANCE LIMITED FUNCTIONS

The Interlock Notification Screen appears whenever the operator tries to apply an input that is not available because one or more interlock conditions have not been met. For example, if the operator is not seated and tries to apply the accelerator pedal, the system will switch from the Operating Screen to an alert screen showing the Seatbelt Icon, as shown in Figure 15.

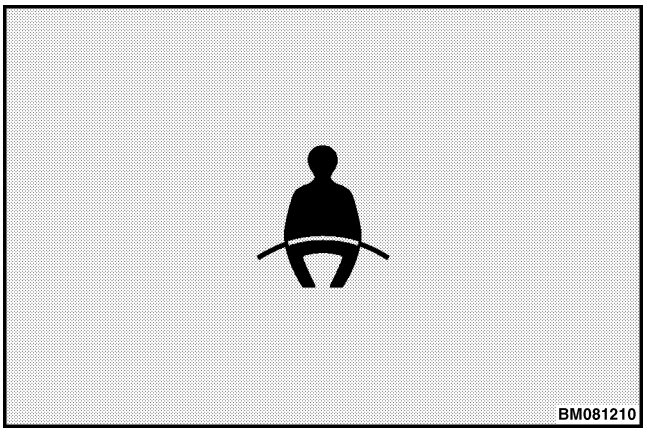


Figure 15. Example Interlock Alert Screen

In this example, if the operator releases the accelerator pedal, the system will change the screen back to the Operating Screen. Alternatively, the operator can press either the **Scroll Back Key** or the **Scroll Forward Key** to go to a top-level menu but the accelerator pedal input will still be unavailable because the interlock condition has not been met.

Password Screen

INTRODUCTION

The Password Screen is a main menu (top-level menu) that is visible at Service Technician, Supervisor, and Operator password access levels. When the key switch or keyless switch is turned on, the Password Screen is the first screen displayed (unless Operator Passwords are deactivated). To access this menu at another time, cycle through the main title screens by pressing the **Scroll Back Key** (◂—) or **Scroll Forward Key** (—▸) until the Password Screen is displayed, as shown in Figure 16. Next, press the **Enter Key** (*****) to enter the Password Screen.

The Password Screen also appears when an operator first starts to use a lift truck, and it also appears when a defined time limit is exceeded under certain conditions.

There are no submenus below the Password Screen, but there are submenus under two other top-level menus that involve passwords:

- The Add/Remove Password submenu under the Truck Setup menu
- The Password Log submenu under the Activity Log menu

Explanations of the Password Screen and the Add/Remove Password submenu (accessed through the Truck Setup menu) follow.

PASSWORD SCREEN

NOTE: Operator passwords are used only on trucks equipped with software enable option.

As already stated, the Password Screen is the first screen to appear when the key switch or keyless switch is turned on (unless Operator Passwords are

deactivated). The Password Screen is visible at all password access levels.

Figure 16 shows the initial Password Screen that is displayed after power **ON**. A line of five blanks below the Password Icon serves as the password entry field.

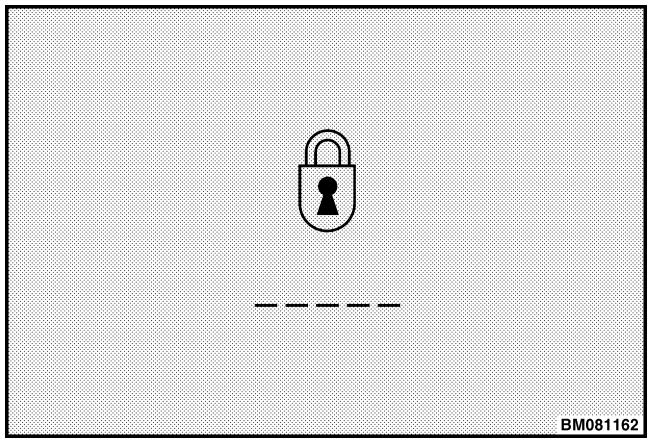


Figure 16. Initial Password Screen

NOTE: A valid password must be a five digit number composed of only the numbers 0, 1, 2, 3, 4, 5, 6, 7, 8, and 9 such as 37524 or 22954. If invalid keys (i.e., #, or *) are pressed they will be ignored. If more than five valid numbers are pressed for the password, only the last five are accepted.

Service Technician Password Setup

Service Technician-level password access is required to add, delete, or edit Service Level Passwords and to do the first installation of a Supervisor-level password. Anyone with Service Technician-level access can add, delete, or edit Operator or Supervisor passwords.

NOTE: A Service Technician-level password is required to input an initial Supervisor password for the lift truck. Once an initial Supervisor password is installed, that Supervisor-level password access can be used to add, delete, or edit additional Supervisor passwords as well as Operator passwords.

Perform the following steps to set up a password:

1. Using keys 0-9, enter a valid password.
2. Press the **Enter Key** to input the password to the system. Once you press the **Enter Key**, the system uses the five most recently entered valid numbers to compare with the currently stored password list.
3. If the password entered does not match any currently stored password, an invalid password screen is displayed for up to five seconds or until the user starts to enter another password, as shown in Figure 17.

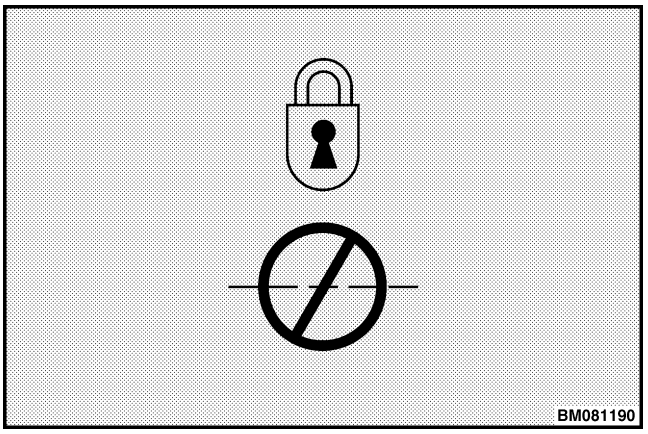


Figure 17. Invalid Password Screen

4. Once the system accepts the entered password, the operator is granted access to the menus associated with that password (i.e., menus displayed at Operator-level, Supervisor-level, or Service Technician-level access).

NOTE: In certain circumstances a default operator password of 11111 will be in the currently stored password list.

NOTE: If there are no Service Technician-level passwords in the currently stored password list, the factory default Service Technician-level password, 55555, can be used to gain access to the system.

Use the factory default Service Technician-level password, 55555, when installing the lift truck at the customer location to set up customer passwords. When initial installation is complete, choose a new Service Technician-level password. However, once a new Service Technician-level password has been assigned, 55555 is no longer a usable password and it cannot be assigned as a password through the screen menu or by using the PC Service Tool. (If all Service Technician-level passwords are deleted, the system again accepts the 55555 default password.) If there is only one Service Technician password and

it is lost, the password can be reset using the PC Service Tool.

ADDING/REMOVING/CHANGING PASSWORDS

The Add/Remove Password submenu is accessible through the Truck Setup Menu and it is visible at Service Technician and Supervisor password access levels. This menu allows a Service Technician or a Supervisor to add, remove, or change passwords whose level is equal to or lower than their own password level. This means a Service Technician can modify the passwords assigned to Operators, Supervisors, and other Service Technicians, while a Supervisor can modify passwords assigned to Operators or other Supervisors. Up to 250 passwords can be assigned for use. Table 15 shows the process for adding a new password.

Table 15. Add Password

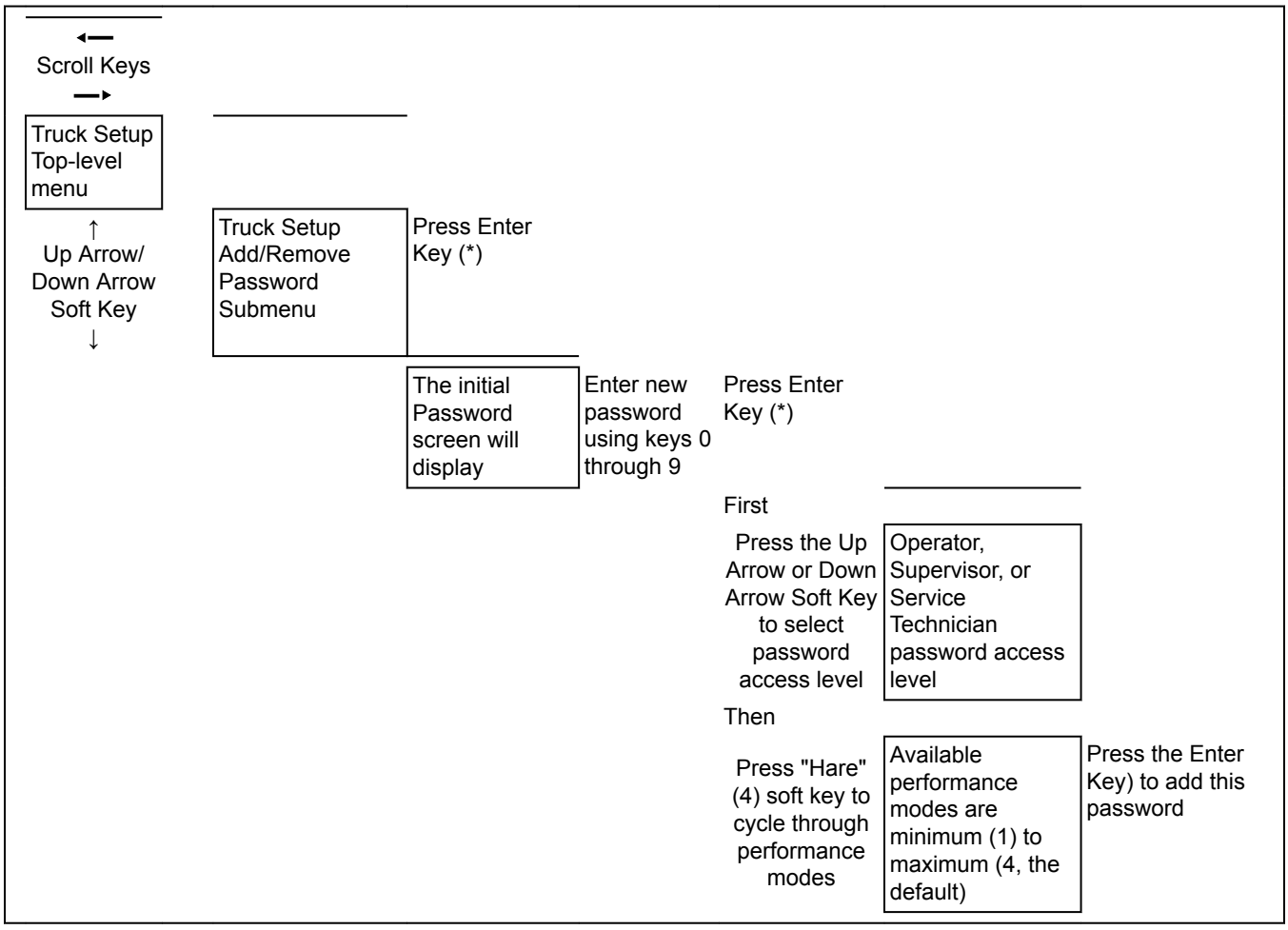


Figure 18 shows the Change/Remove password screen. The Up Arrow/Down Arrow soft keys (i.e., **2** and **3**) cycle between the privilege level(s) associated with this password. You can use the Hare soft key (**#**) to cycle through the available performance modes for this password. Press the Trash Can soft key (**4**) to remove this password from the current passwords.

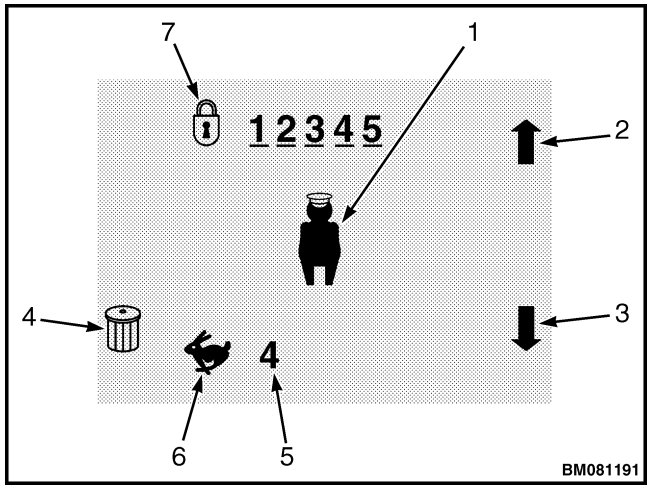


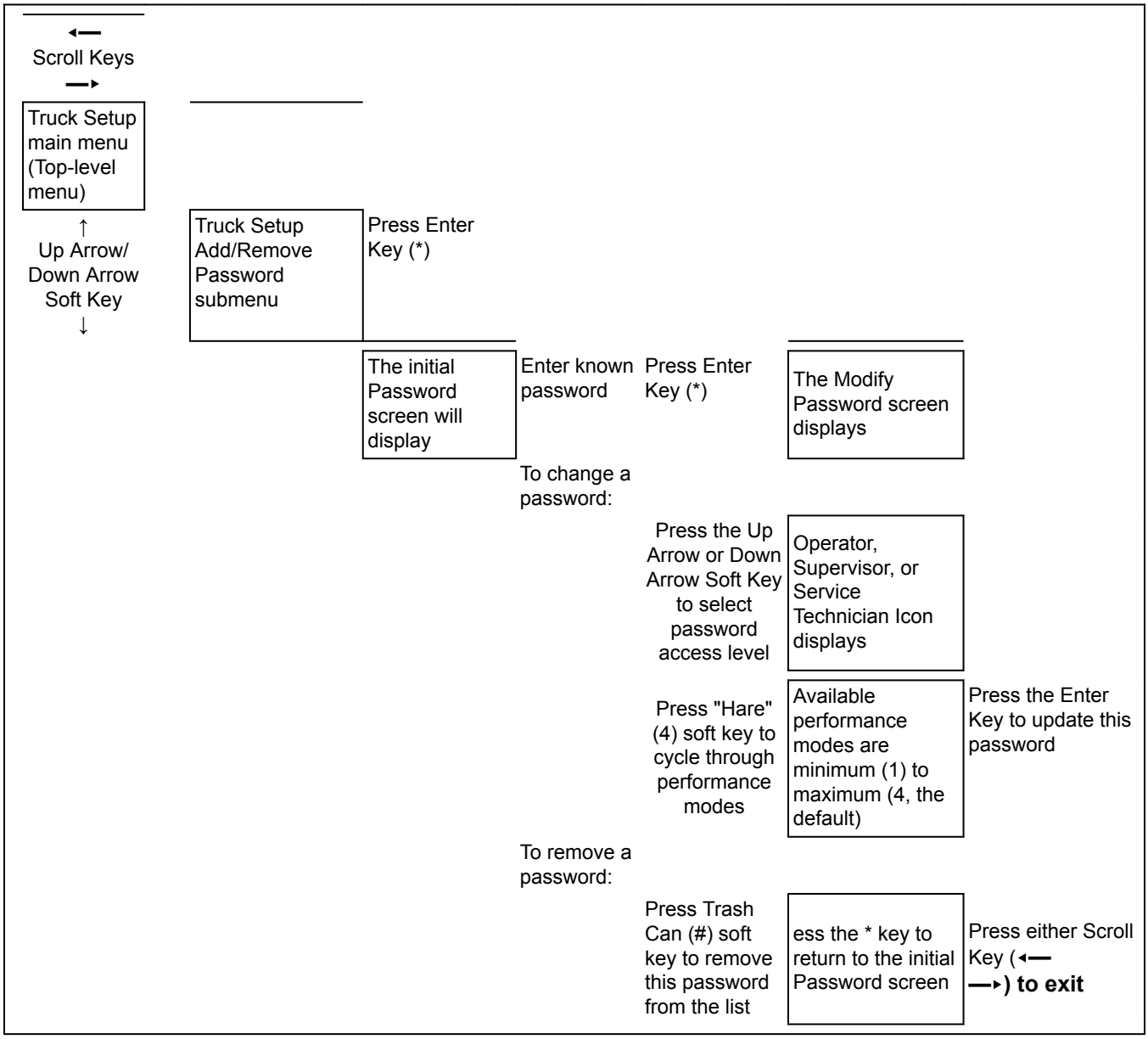
Figure 18. Change/Remove Password Screen

Legend for Figure 18.

1. ICON FOR TYPE OF PASSWORD ENTERED (OPERATOR/SUPERVISOR/SERVICE TECHNICIAN)
2. UP ARROW SOFT KEY ICON
3. DOWN ARROW SOFT KEY ICON
4. "TRASH CAN" SOFT KEY ICON
5. CURRENT PERFORMANCE MODE
6. "HARE" SOFT KEY ICON
7. CURRENT PASSWORD ICON AND FIELD

In order to remove an individual password or modify the privileges associated with it, you need to know the password number. In addition, you must have a privilege level equal to or greater than the privilege level of the password being modified. This means a Service Technician can modify all passwords, but a Supervisor can only modify the passwords of Operators and other Supervisors. Table 16 shows the process for changing or removing an existing password for the lift truck.

Table 16. Change or Remove Password



PASSWORD LOG

The Password Log submenu is accessible through the Activity Log Title menu. See the next section, Activity Log Menu, for more information. This menu allows a Service Technician or a Supervisor to view the last 250 valid passwords entered into the system and the password access level (i.e., Operator, Supervisor, or Service Technician) associated with each password.

Activity Log Menu

INTRODUCTION

The Activity Log Menu is a main menu (top-level menu) that is visible at Service Technician and Supervisor password access levels. To access this menu, cycle through the main menu title screens by pressing the **Scroll Back Key** (◂—) or **Scroll Forward Key** (—▸) until the Activity Log Title Screen is displayed, as shown in Figure 19.

Press the **Enter Key** (*****) to enter the Activity Log Menu. Three submenus are available under this menu as shown in Figure 20.

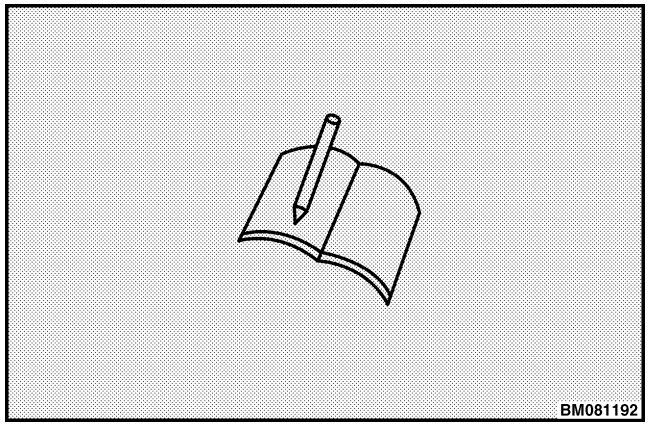
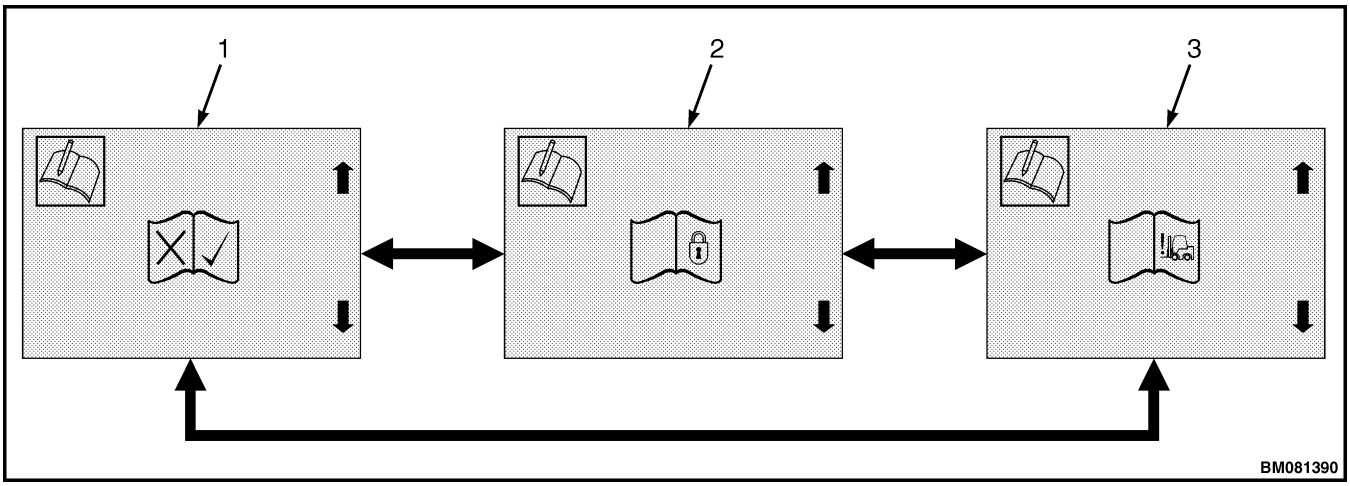


Figure 19. Activity Log Title Screen



1. OPERATOR CHECKLIST LOG
2. PASSWORD LOG
3. IMPACT EVENTS LOG

Figure 20. Activity Log Submenus

The first of the three submenus provided under the Activity Log menu, the Operator Checklist Log, appears on the Operating Screen. See Figure 21. You can enter the Operator Checklist Log submenu by pressing the **Enter Key**. To access the Password Log menu or the Impact Events Log menu, press the **Scroll Back Key** or **Scroll Forward Key** and then press the **Enter Key**.

The following sections describe the Activity Log submenus.

OPERATOR CHECKLIST LOG

This submenu is visible at Service Technician and Supervisor password access levels. This second-level menu allows a Service Technician or a Supervisor to view the 60 most recent checklist events, where an event is defined as:

- Each failed checklist item, or
- A completely successful pass through the full checklist.

Figure 21 shows the title screen for this menu.

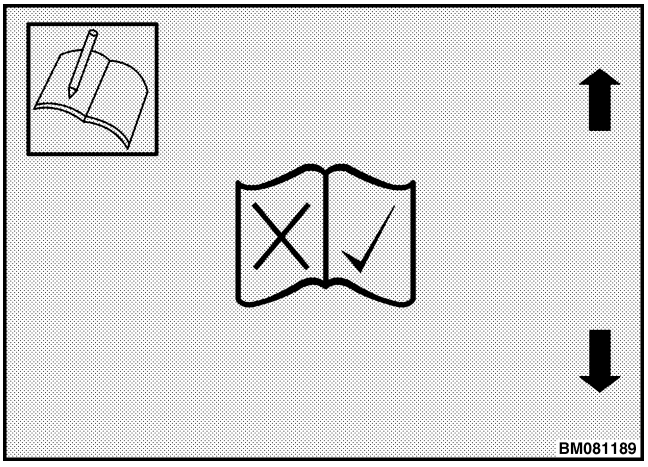
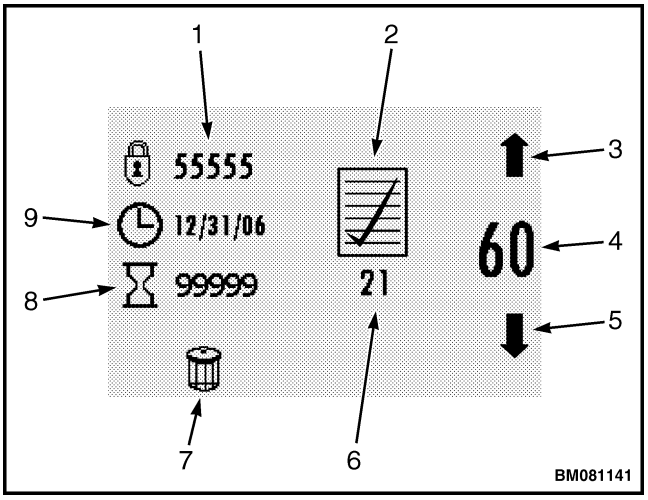


Figure 21. Operator Checklist Log Menu

Pressing the **Scroll Back Key** or **Scroll Forward Key** while anywhere in this submenu returns the Activity Log main menu title screen to the Operating Screen.

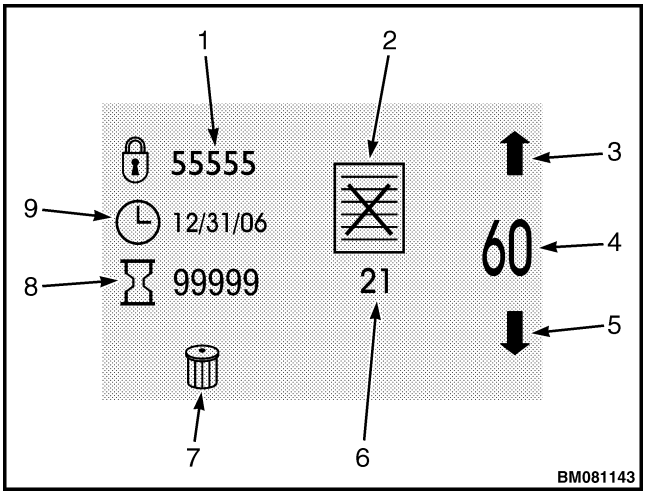
Figure 22 shows an example Operator Checklist Log screen and indicates the available controls.



1. PASSWORD VALUE AT LOG OCCURRENCE
2. TYPE OF ENTRY (PASS/FAIL)
3. UP ARROW SOFT KEY ICON
4. CURRENT LOG ENTRY (OR "EMPTY" SYMBOL)
5. DOWN ARROW SOFT KEY ICON
6. CHECKLIST ITEM THAT PASSED
7. TRASH CAN SOFT KEY (USED TO EMPTY LOG)
8. TRACTION HOURS AT LOG OCCURRENCE
9. SYSTEM DATE AT LOG OCCURRENCE

Figure 22. Operator Checklist Log Screen

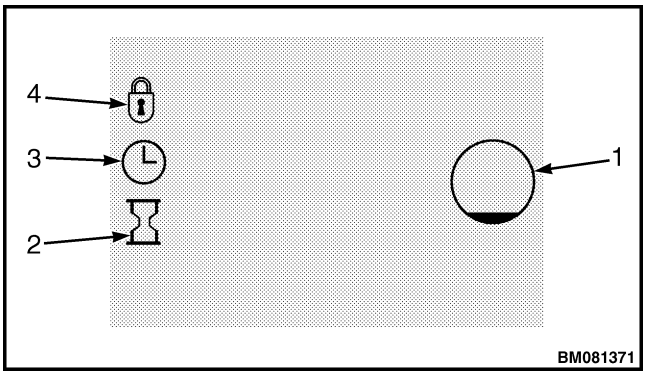
Figure 23 shows a failed Checklist Log Entry.



1. PASSWORD VALUE AT LOG OCCURRENCE
2. TYPE OF ENTRY (PASS/FAIL)
3. UP ARROW SOFT KEY ICON
4. CURRENT LOG ENTRY (OR "EMPTY" SYMBOL)
5. DOWN ARROW SOFT KEY ICON
6. CHECKLIST ITEM THAT FAILED
7. TRASH CAN SOFT KEY (USED TO EMPTY LOG)
8. TRACTION HOURS AT LOG OCCURRENCE
9. SYSTEM DATE AT LOG OCCURRENCE

Figure 23. Failed Checklist Log Entry

If there are no log entries or the final log entry has been scrolled past, an empty log screen is displayed, as shown in Figure 24.

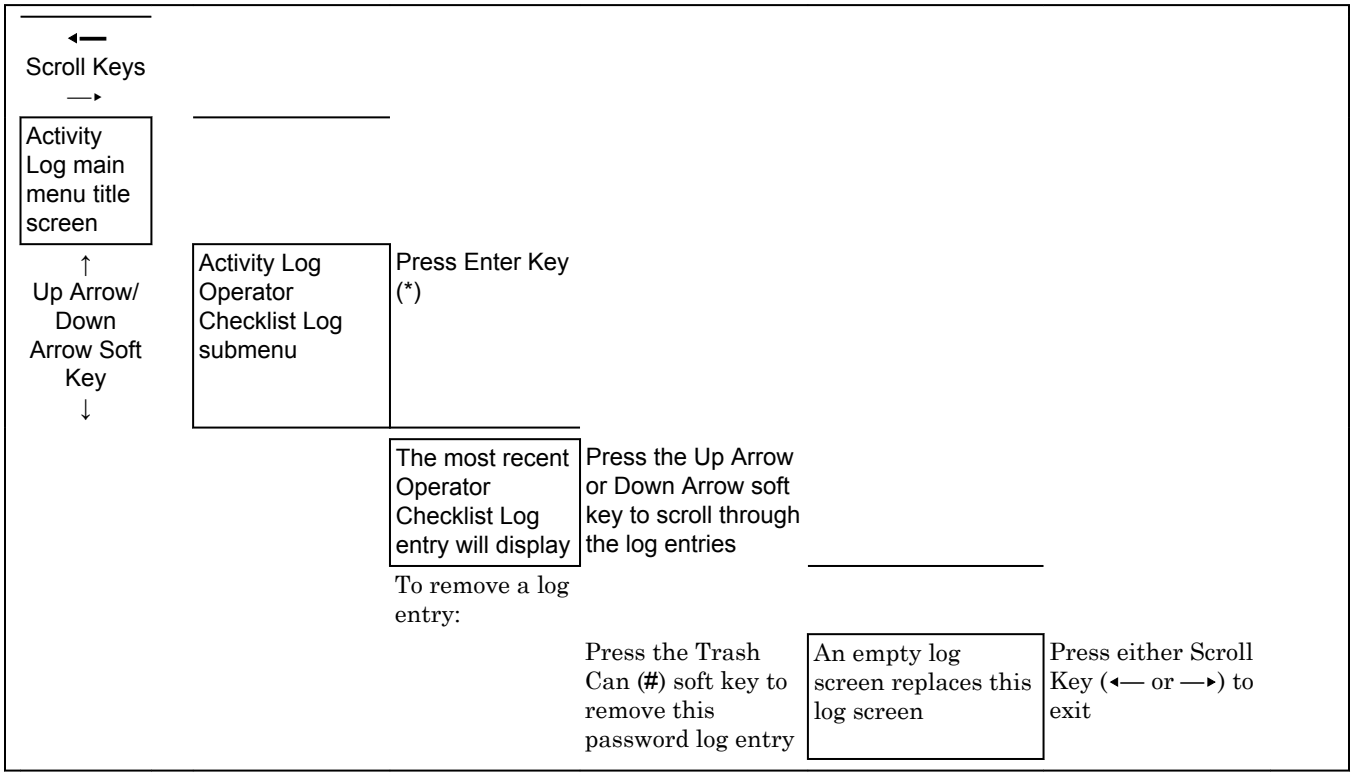


1. EMPTY SYMBOL
2. SYSTEM TIME ICON
3. SYSTEM DATE ICON
4. PASSWORD ICON

Figure 24. Empty Log Screen

The process for viewing and removing the operator checklist logs from the system is shown in Table 17.

Table 17. Access Operator Checklist Log Screens



When a person with Supervisor password-level access views the log, any recorded events under Service Technician-level access will show ***** instead of the actual password number. Also, if there was no password logged in at the time of an event, the password will show as *****.

PASSWORD LOG

The Password Log Submenu is visible at Service Technician and Supervisor password access levels. A Service Technician or a Supervisor can use it to view the last 250 valid passwords entered into the system and the password access level (i.e., Operator, Supervisor, or Service Technician) associated with each password.

Figure 25 shows the title screen for this menu.

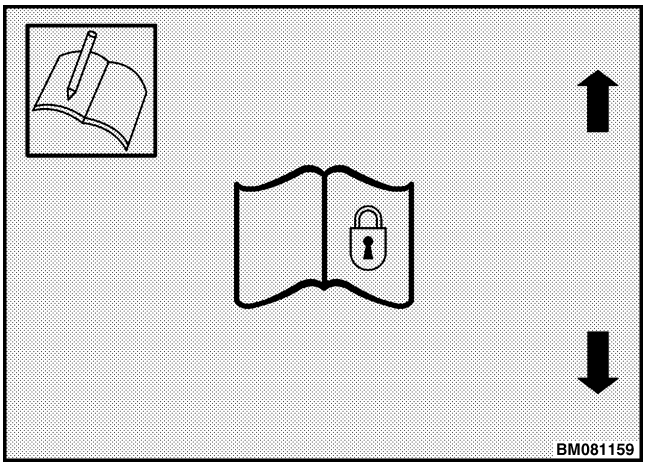
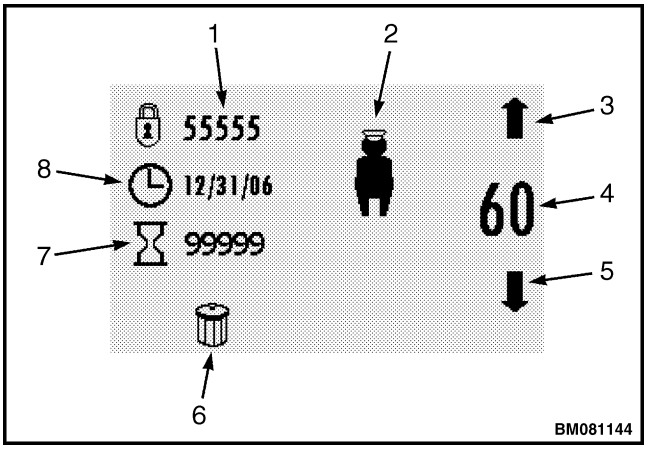


Figure 25. Password Log Menu

Pressing the **Scroll Back Key** or **Scroll Forward Key** while anywhere in this submenu will return the Activity Log main menu title screen to the Operating Screen.

Figure 26 shows an example Password Log screen and indicates the available controls.

The process for viewing and removing password logs from the system is shown in Table 18.

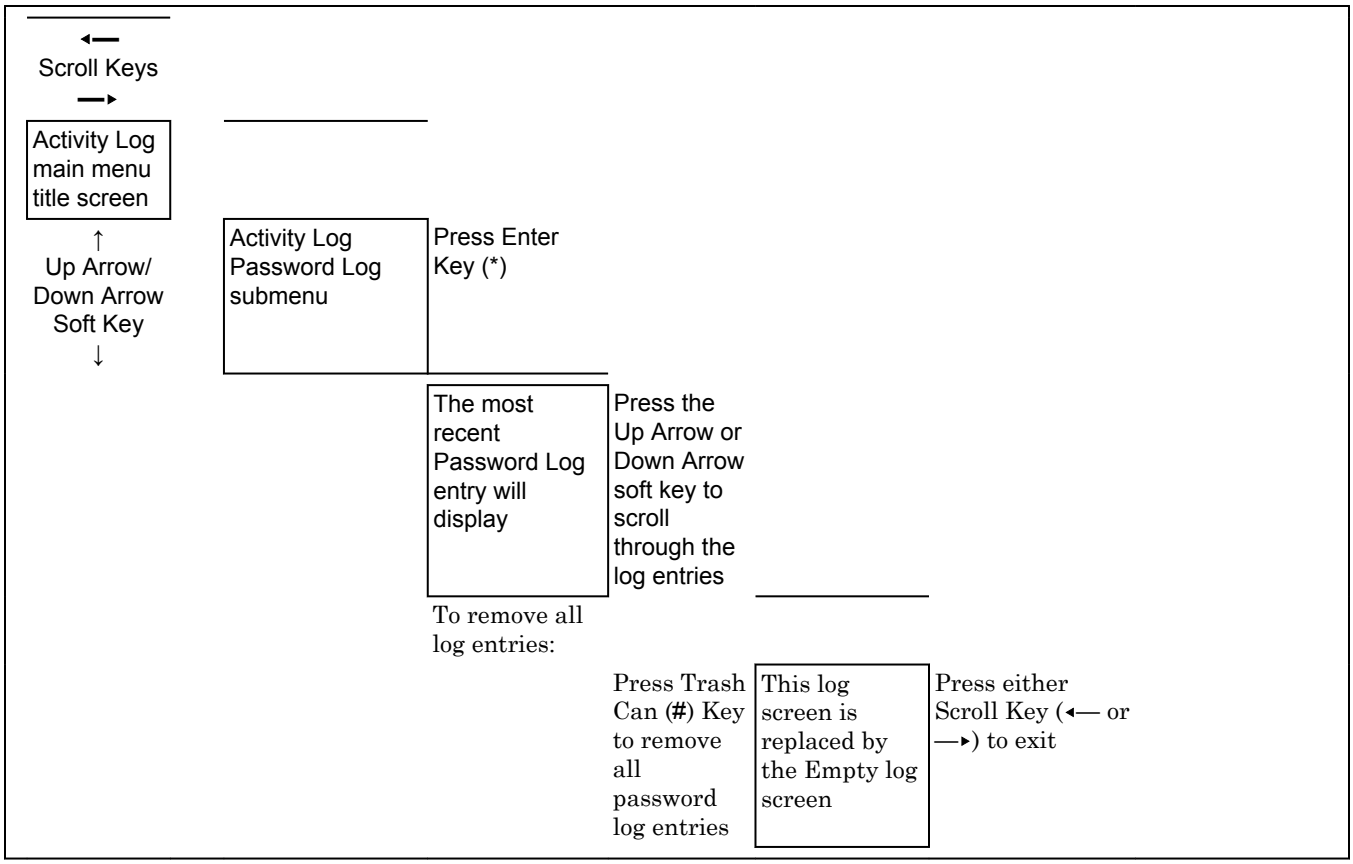


Legend for Figure 26.

1. PASSWORD VALUE AT LOG OCCURRENCE
2. OPERATOR/SUPERVISOR/SERVICE TECHNICIAN ICON
3. UP ARROW SOFT KEY ICON
4. CURRENT LOG ENTRY (OR "EMPTY" SYMBOL)
5. DOWN ARROW SOFT KEY ICON
6. "TRASH CAN" SOFT KEY ICON
7. TRACTION HOURS AT LOG OCCURRENCE
8. SYSTEM DATE AT LOG OCCURRENCE

Figure 26. Password Log Screen

Table 18. Access Password Log Screens



A person viewing the password log cannot see the passwords of other operators or Supervisors who have access privileges higher than their own. This means that a Supervisor viewing the Password Log cannot see a Service Technician's password. When viewing the log entry of a person with a higher access level, the password is displayed as *****.

After removing a log entry, an "Empty" symbol replaces the former log entry number until the next entry has been scrolled into view. If there are no remaining log entries, an "Empty" log screen is displayed, as shown in Figure 24.

IMPACT EVENTS LOG

This submenu is visible at Service Technician and Supervisor password access levels. This menu allows a Service Technician or a Supervisor to view the 20 most recent impact events, where an event is defined as:

- Soft impact (0.2 to 2.5 g in tenths of g force), or
- Hard impact (0.5 to 3.0 g in tenths of g force) as defined during the Truck Setup process

Figure 27 shows the title screen for this menu.

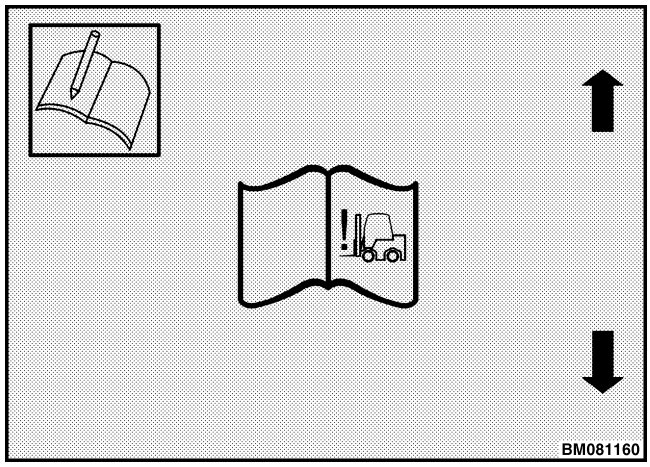
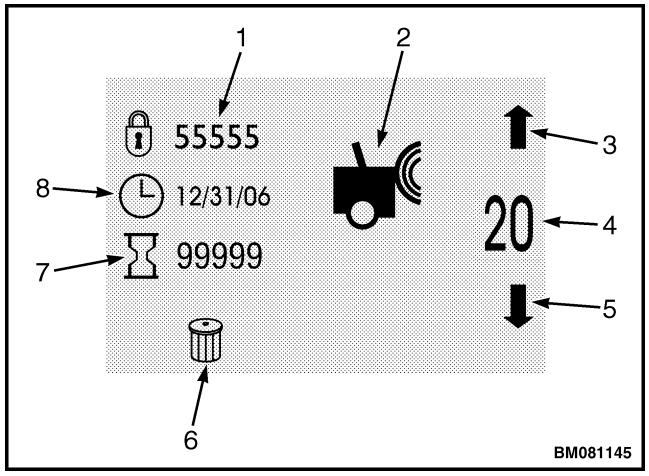


Figure 27. Impact Events Log Menu

Pressing the **Scroll Back Key** or **Scroll Forward Key** while anywhere in this submenu returns the Activity Log main menu title screen to the Operating Screen.

Figure 28 shows an example Impact Events Log screen and indicates the available controls.



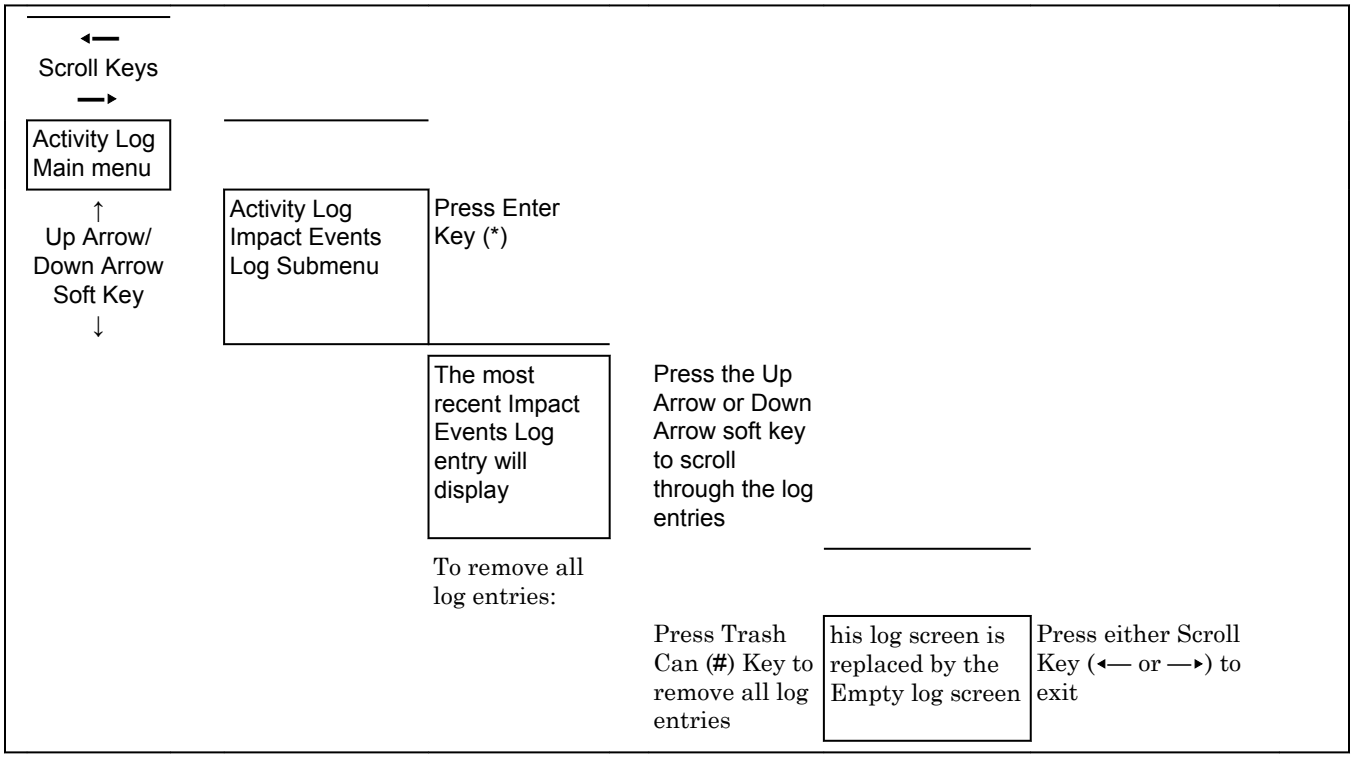
1. PASSWORD VALUE AT LOG OCCURRENCE
2. TYPE OF IMPACT (SOFT/HARD) ICON
3. UP ARROW SOFT KEY ICON
4. CURRENT LOG ENTRY (OR "EMPTY" SYMBOL)
5. DOWN ARROW SOFT KEY ICON
6. "TRASH CAN" SOFT KEY ICON
7. TRACTION HOURS AT LOG OCCURRENCE
8. SYSTEM DATE AT LOG OCCURRENCE

Figure 28. Impact Events Log Screen

If there are no log entries or the final log entry has been scrolled past, the system displays an "Empty" log screen, as Figure 24 shows.

The process for viewing and removing the Impact Events Log is shown in Table 19.

Table 19. Access Impact Events Log Screens



When a person with Supervisor password-level access views the log, any recorded events under Service Technician-level access are shown as ***** instead of the actual password number. Also, if there was no password logged in at the time of an event, the password appears as *****.

Calibration Menu

INTRODUCTION

The Calibration Menu is a main menu (top-level menu) that is visible at Service Technician, Supervisor, and Operator password access levels. The Calibration Submenus and Icons topic shows the icons displayed on calibration screens. To access this menu, cycle through the main menu title screens by pressing the **Scroll Back Key** (**?**—) or **Scroll Forward Key** (—**?**) until the Calibration Title Screen is displayed, as shown in Figure 29.

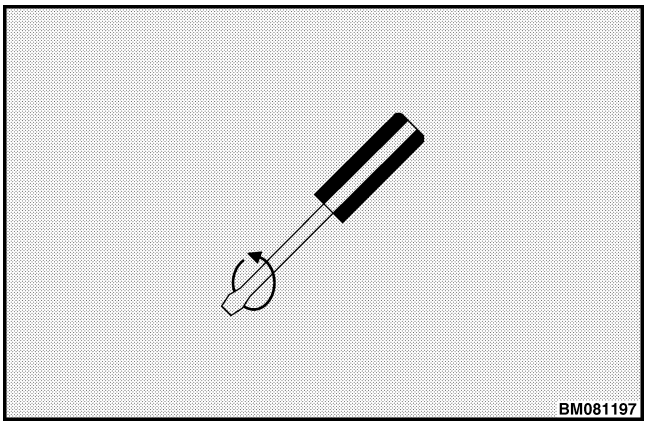


Figure 29. Calibration Title Screen

Press the **Enter Key** (*****) to enter the Calibration Menu and the system will display the first submenu in the Calibration Menu, the Load Weight Display submenu, which is shown in Figure 30. Press the

Enter Key again if you want to enter this submenu. If you want a different submenu, use the **Scroll Back Key** or **Scroll Forward Key** to move to another submenu and press the **Enter Key**.

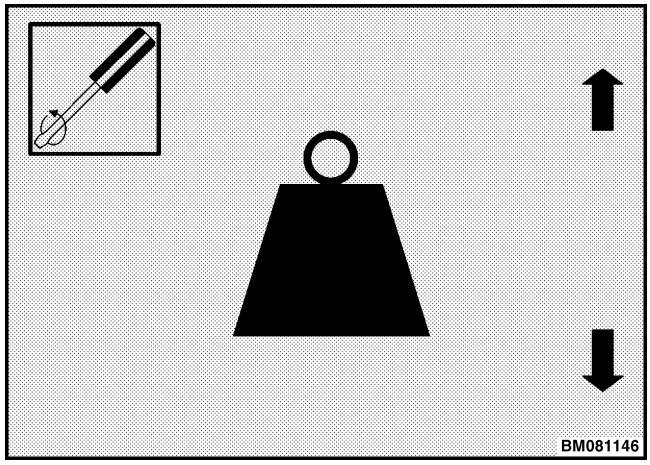


Figure 30. Load Weight Display Submenu

The Calibration Menu presents these submenus:

- Load Weight Display
- Return to Set Tilt Stop Point
- E-Hydraulic Valves
- Steering Wheel Center Point
- Steer Axle Position
- Steer Axle Center Point
- Manual Hydraulics

The following sections describe the Calibration submenus.

LOAD WEIGHT CALIBRATION

NOTE: This measurement is not for trade.

This menu item, shown in Figure 30, allows a Service Technician, Supervisor, or Operator to calibrate Load Weight. To calibrate Load Weight, select this submenu from the Calibration Menu and follow the prompts on the display.

NOTE: When the user is logged in under an operator level password or default password, only the tare weight default zero point calibration is available.

To calibrate the Load Weight Display:

1 Starting from the Calibration Menu, scroll to the Load Weight Display screen and press the **Enter Key**.

2 When prompted, position the empty forks at the load weight height, which is site dependent.

3 Press the **Enter Key**.

4 When prompted, use the numeric keys to enter the known load weight in lb or kg units, as indicated in the Load Weight Icon. Use a load weight that is between 1,000 lbs (450 kg) and 16,000 lbs (7,260 kg).

NOTE: Do not exceed the truck's rated capacity.

5 Press the **Enter Key**.

6 When prompted, position the load by adjusting the tilt and height of the mast and forks to the load weight height.

7 Press the **Enter Key**. The system stores the new setting and returns to the Calibration Menu.

RETURN TO SET TILT STOP POINT CALIBRATION

NOTE: This calibration must be done by a service technician or supervisor and is only available on trucks that have the Return to Set Tilt feature.

Figure 31 shows the screen display during a Return to Set Tilt Stop Point calibration.

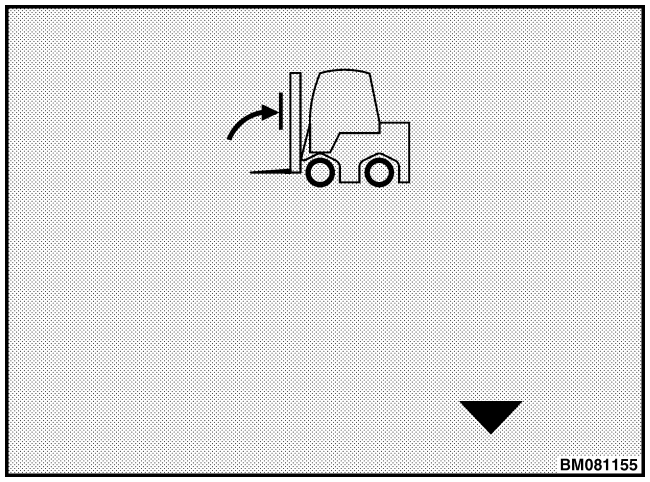


Figure 31. Return to Set Tilt Stop Point Sequence

To calibrate the Return to Set Tilt Stop Point:

1 Starting from the Calibration Menu, scroll to the Return to Set Tilt Stop Point screen and press the **Enter Key**.

2 When prompted, position the mast at the desired tilt angle.

3 Press the **Enter Key**. The system records the new setting and returns to the Calibration Menu.

E-HYDRAULIC AND MANUAL VALVE THRESHOLD CALIBRATION

NOTE: This calibration must be done by a service technician or supervisor.

Figure 32 shows how the E-Hydraulic Valve calibration sequence starts with the 1A function, followed by the 1B function, and so on. The screen display changes from one function to the next as the user calibrates these control valves.

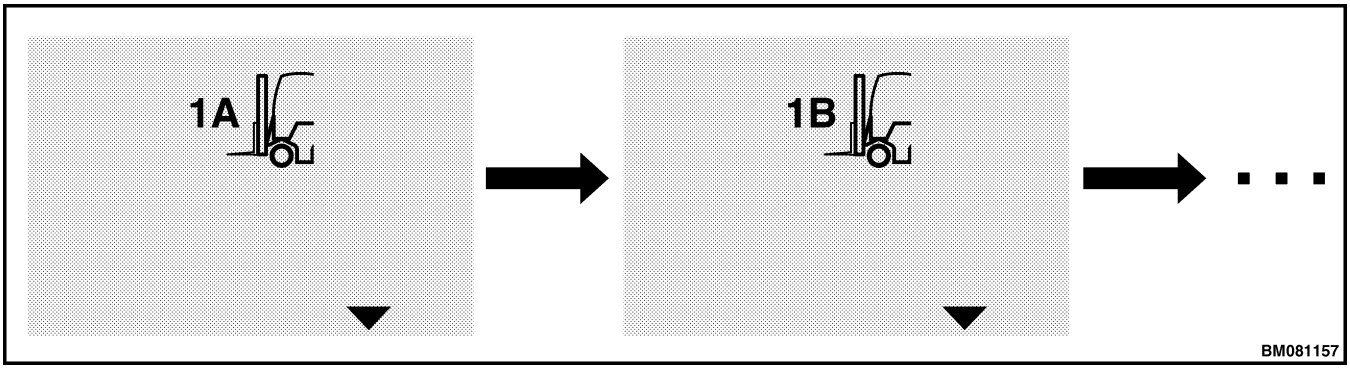


Figure 32. E-Hydraulic Valves

To calibrate the E-Hydraulic and manual valves:

1 Turn key or keyless switch to the **ON** position.

2 Perform an air bleed operation by exercising all functions until they operate smoothly.

3 Starting from the Calibration Menu, scroll to the E-Hydraulic Valves screen and press the **Enter Key**.

See **Main Control Valves** 2000SRM1334, Calibration Procedure for lift truck models

- E2.2-3.5XN (E45-70XN) (A268)
- J2.2-3.5XN (J45-70XN) (A276)
- J1.5-2.0XNT (J30-40XNT) (K160)
- J1.6-2.0XN (J30-40XN) (A935)
- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)
- E4.0-5.5XN (E80-120XN) (A099)

See **Main Control Valves** 2000SRM1439, Calibration Menu for lift truck models

- E1.6-2.0XN (E30-40XN) (A269)

See **Main Control Valves** 2000SRM1520, Calibration Menu for lift truck models

- A1.3-1.5XNT (A25-30XNT) (D203)

See **Diagnostic Troubleshooting Manual** 9000SRM1377 for lift truck models

- J8.0XN, J8.0XN9, J9.0XN (A250)

4 With no load on the forks, raise them, if they are not already raised.

5 When prompted, move the lever toward the mast, the A direction, until the forks begin to creep. Creep means moving the forks as slowly as possible. Press the **Enter Key** and the system records the valve reading.

When prompted, move the lever toward the rear of the truck, the B direction, until the forks begin to creep and press the **Enter Key**. The system records the valve reading. Steps 5 and 6 provide the hydraulic input for function 1.

NOTE: If a valve reading is not within the acceptable range, an abort message appears. Press any key to continue.

6 Continue the process for functions 2, 3, and 4 as prompted by the system. The system records the valve readings for each function, and when this calibration process is completed, returns to the Calibration Menu.

STEERING WHEEL CENTER POINT CALIBRATION

The steering wheel knob center point is the position to which the system adjusts the steering wheel while the lift truck is being driven straight ahead.

NOTE: This calibration must be done by a service technician or supervisor and is only available on trucks equipped with the Synchronized Steering function.

Figure 33 shows the screen display during a Steering Wheel Knob Center Point calibration.

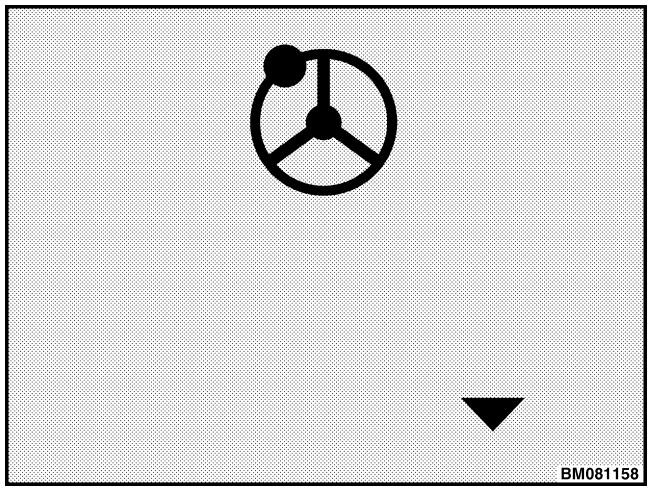


Figure 33. Steering Wheel Center Point

To calibrate the Steering Wheel Center Point:

1 Starting from the Calibration Menu, scroll to the Steering Wheel Center Point screen and press the **Enter Key**.

2 When prompted, position the steering wheel in the position that will drive the lift truck straight ahead.

3 Press the **Enter Key**. The system records the steering wheel position as the new center point and returns to the Calibration Menu.

STEER AXLE POSITION CALIBRATION

NOTE: This calibration must be done by a service technician or supervisor and is only available on trucks equipped with the Synchronized Steering function or dual traction motors.

Figure 34 shows the screens that appear while calibrating the Steer Axle Position.

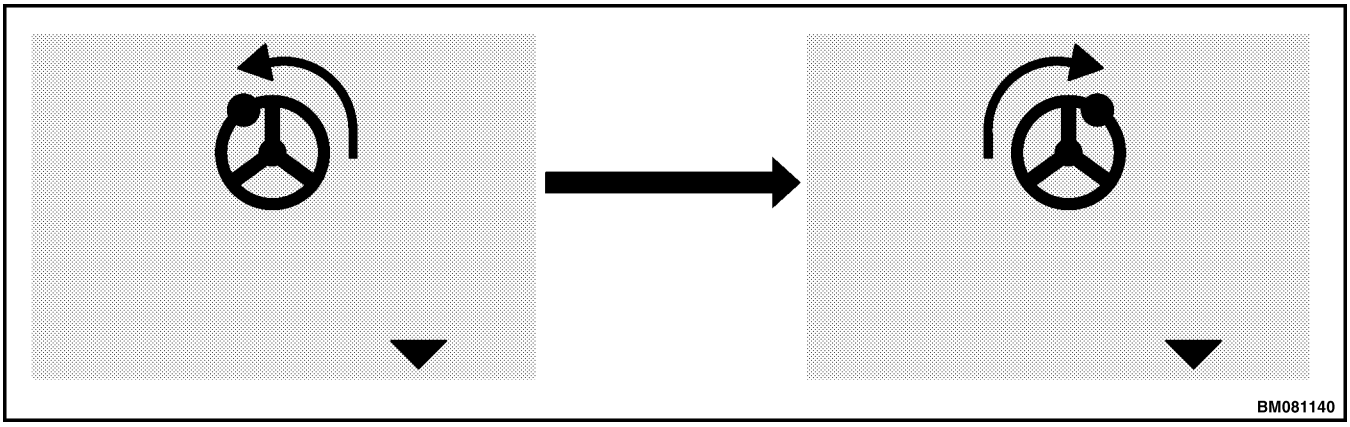


Figure 34. Calibrating Steer Axle Position

To calibrate the Steer Axle Position:

1 Starting from the Calibration Menu, scroll to the Steer Axle Position screen and press the **Enter Key**.

2 When prompted, turn the steering wheel counterclockwise until the axle hits the stop.

3 Press the **Enter Key**.

4 When prompted, turn the steering wheel clockwise until the axle hits the stop.

5 Press the **Enter Key**. If the settings are acceptable, the system records the steer positions and returns to the Calibration Menu. If the settings are outside of the acceptable range, an X appears over the Calibration Icon. Press the **Enter Key** and the system will prompt the user to repeat steps 2 – 5.

STEER AXLE CENTER POINT CALIBRATION

NOTE: This calibration must be done by a service technician or supervisor and is only available on trucks equipped with E-Steering.

Figure 35 shows the screen menu the system displays during this calibration.

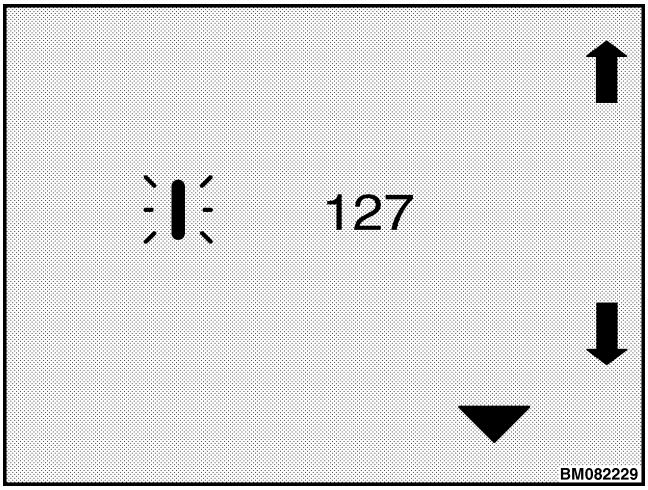


Figure 35. Steer Axle Center Point Offset Calibration

Operator adjusts the offset value and then drives the truck while holding the steering wheel at the straight ahead position to determine if correct.

1 Starting from the Calibration Menu, scroll to the Steer Axle Center Point Offset screen and press the **Enter Key**.
2 Use the 2 up arrow soft key to increase the offset by 1
3 Use the 3 down arrow soft key to decrease the offset by 1
4 Once the truck drives in a straight when the steer wheel is in the calibrated center point position press the **Enter Key**. If the settings are acceptable, the system records the center point and returns to the Calibration Menu. If the settings are outside of the acceptable range, an X appears over the Calibration Icon. Press the **Enter Key** and the system will prompt the user to repeat steps 2 – 5.

MANUAL HYDRAULICS CALIBRATION

NOTE: This calibration must be done by a service technician or supervisor and is only available on trucks equipped with manual hydraulics.

Figure 36 shows the screen menu the system displays during this calibration.

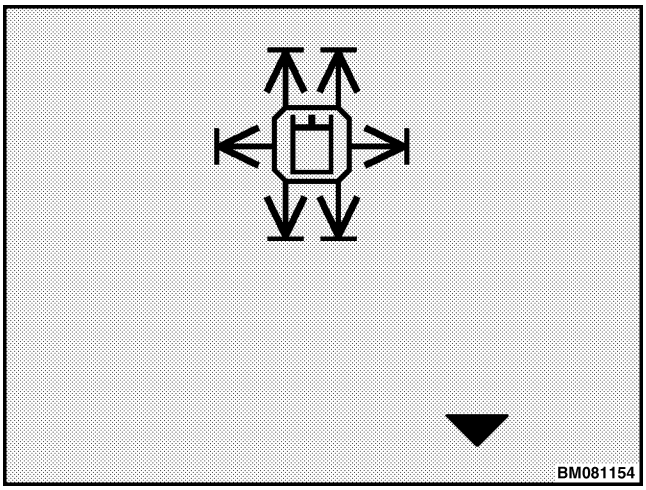


Figure 36. Manual Hydraulic End Point Calibration

To calibrate the Manual Hydraulic end point:

1 With no load on the forks, raise them, if they are not already raised.
2 Starting from the Calibration Menu, scroll to the Manual Hydraulic End Point Calibration screen and press the **Enter Key**.
3 When prompted, move all hydraulic levers to both of their extreme locations; that is, move each lever as far as it will go in both directions.
4 Press the **Enter Key**. The system records the extreme locations and returns to the Calibration Menu.

Display Menu

INTRODUCTION

The Display Menu is a main menu (top-level menu) that is visible at Service Technician and Supervisor password access levels. To access this menu, cycle through the main menu title screens by pressing the **Scroll Back Key** (◂—) or **Scroll Forward Key** (—▸) until the Display Title Screen is displayed, as shown in Figure 37.

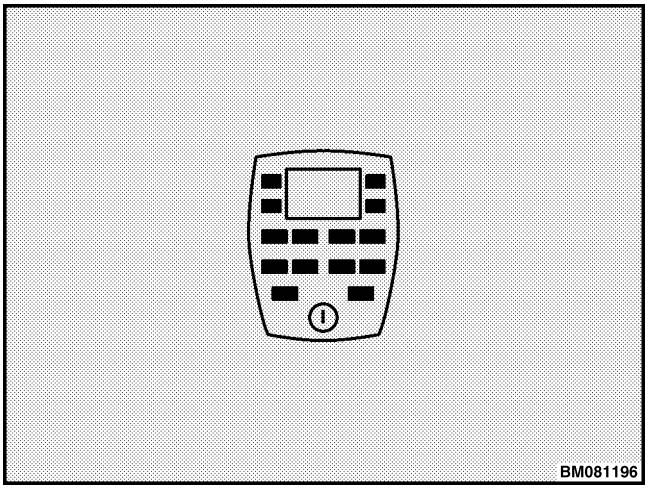


Figure 37. Display Title Screen

Press the **Enter Key** (*) to enter the Display Menu and the system will display the Set Date and Time Format screen as shown in Figure 38. Press the **Enter Key** again to enter this submenu. For a different submenu, use the **Scroll Back Key** or **Scroll Forward Key** to move to the desired submenu and press the **Enter Key**.

To return to the Display Menu, press the **Scroll Back Key** or **Scroll Forward Key**. Press the **Scroll Back Key** or **Scroll Forward Key** a second time to return to the main menu.

The Display Menu offers these submenus (see the Display Submenus and Icons topic):

- Set Date and Time Format Menu
- Set Daylight Saving Time Menu
- Set Time and Date Menu
- Set Units Menu

The sections that follow describe these submenus.

SET DATE AND TIME FORMAT MENU

A Supervisor or a Service Technician can use this menu to define the system date and time format. Figure 38 shows the title screen for this menu.

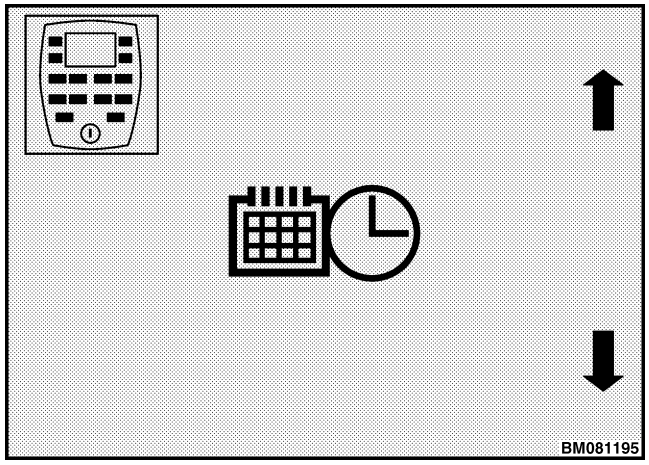


Figure 38. Set Date and Time Format Menu

To enter this submenu, press the **Enter Key**. Figure 39 shows the Set Date and Time Format screen that will appear.

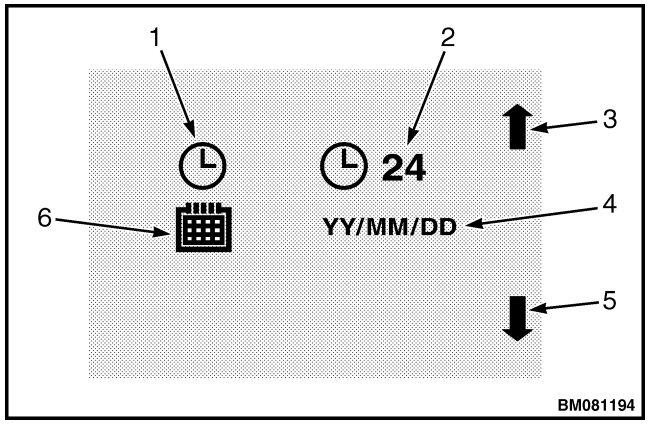


Figure 39. Set Date and Time Format Screen

Legend for Figure 39.

1. CLOCK ICON
2. CLOCK HOUR FORMAT
3. UP ARROW SOFT KEY ICON
4. CURRENT DATE FORMAT
5. DOWN ARROW SOFT KEY ICON
6. CALENDAR ICON

The Clock Hour Format can be set to either a 12-hour clock or a 24-hour clock. To set the Clock Hour Format, press the **2** Up Arrow soft key. The system will place a box around the current Clock Hour Format. Press the **Enter Key** and then use the **2** Up Arrow soft key or **3** Down Arrow soft key to select either the 12-hour or the 24-hour clock format. When you have the desired format

displayed, press the **Enter Key** and the system will begin using the selected clock hour format for all menus in the system.

To set the Current Date Format, use the **3** Down Arrow soft key to change the focus to the Current Date Format Icon.

There are three options for the Current Date Format:

- USA, MM/DD/YY
- Europe, DD/MM/YY
- ISO 8601, YY/MM/DD

Use the **2** or **3** soft key to cycle through the Current Date Format options. When you have the desired format displayed, press the **Enter Key** and the system will begin using that date format as the current date format setting for all menus in the system.

Table 20 shows the process for selecting and changing the date and time formats for the system.

Table 20. Accessing the Set Date and Time Format Screen

Use the Scroll Keys (◂— or —▸)						
Display the main menu						
Use the Up Arrow ↑ or Down Arrow↓ Key	Display the Set Date and Time Format Menu submenu	Press Enter Key (*)				
	The Set Date and Time Format screen will display	Use the 2 Up Arrow soft key to select the Set Time Format Icon and display the 12-hour or 24-hour clock icon	*Next*	Use the 3 Down Arrow soft key to select the Set Date Format Icon and display the three date formats	Press Enter Key to update the time and date format for all menus in the system	
					Press either Scroll Key (◂— or —▸) to exit	

SET DAYLIGHT SAVING TIME MENU

A Service Technician or a Supervisor can use this submenu to enable or disable the use of daylight saving time on trucks and set it up to make automatic time changes. When this feature is enabled (set to On), the system time clock increases by one hour at 2:00 am on the selected Start Date and decreases by one hour at the same time on the selected End Date. Figure 40 shows the title screen for this menu.

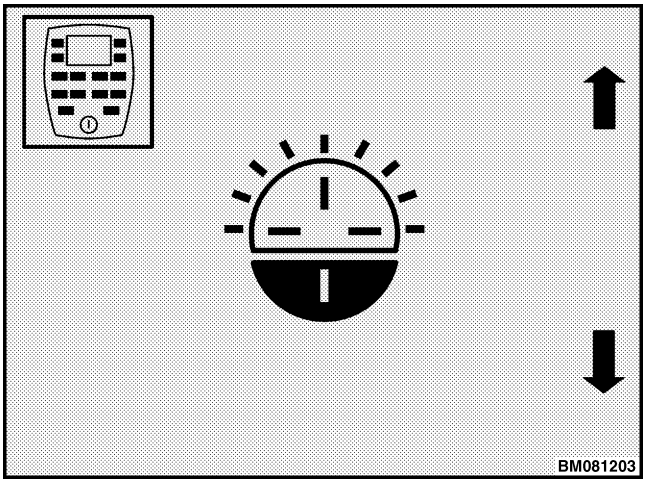
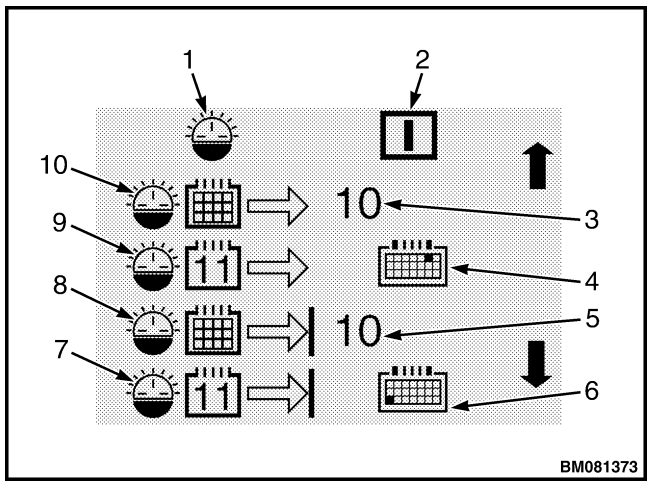


Figure 40. Set Daylight Saving Time Menu

To enable daylight saving time, press the **Enter Key** at the menu shown in Figure 40.

The system will display the screen shown in Figure 41.



1. DAYLIGHT SAVINGS ENABLE
2. ENABLE INDICATOR (THE ON SETTING IS UP)
3. DAYLIGHT SAVINGS START MONTH SETTING
4. START DAY INDICATOR
5. DAYLIGHT SAVINGS END DAY SETTING
6. END DAY INDICATOR
7. DAYLIGHT SAVINGS END DAY INDICATOR
8. DAYLIGHT SAVINGS END MONTH INDICATOR
9. DAYLIGHT SAVINGS START DAY INDICATOR
10. DAYLIGHT SAVINGS START MONTH INDICATOR

Figure 41. Set Daylight Saving Time Screen

Procedure for Setting Up Automatic Daylight Savings Time

NOTE: To exit from the Daylight Savings submenu at any time without making any changes, press the **Scroll Back Key** or **Scroll Forward Key**. The system returns to the Display menu.

1. Navigate to the Daylight Savings submenu.

2. Press the **2** Up Arrow soft key to set daylight saving time to On and press the **Enter Key** (*).

3. Set the month daylight saving time will begin.

a. Press the **3** Down Arrow soft key to activate the Start Month indicator and press the **Enter Key**.

b. Use the **2** or **3** soft key to cycle through the numbers, 1-12, of the months to the desired start month and press the **Enter Key**.

4. Set the day daylight saving time will begin.

a. Press the **3** Down Arrow soft key to activate the Start Date indicator and press the **Enter Key**.

b. Use the **2** or **3** soft key to cycle through the dates by numbers, by first days of the week, and by last days of the week to the desired start day. This can be a date, such as the 13th of the month, or a day of the week, such as Sunday. When you get to the desired date, press the **Enter Key**.

5. Set the month daylight saving time will end.

a. Press the **3** Down Arrow soft key to activate the End Month Indicator and press the **Enter Key**.

b. Use the **2** or **3** soft key to cycle through the numbers, 1-12, of the months to the desired end month and press the **Enter Key**.

6. Set the day daylight saving time will end.

a. Press the **3** Down Arrow soft key to activate the End Day indicator and press the **Enter Key**.

b. Use the **2** or **3** soft key to cycle through the numbers, first days of the week, and last days of the week to the desired end day and press the **Enter Key**.

7. Exit from the Daylight Savings submenu and return to the Display menu by pressing the **Scroll Back Key** or **Scroll Forward Key**.

Table 21. Set Daylight Saving Time Menu

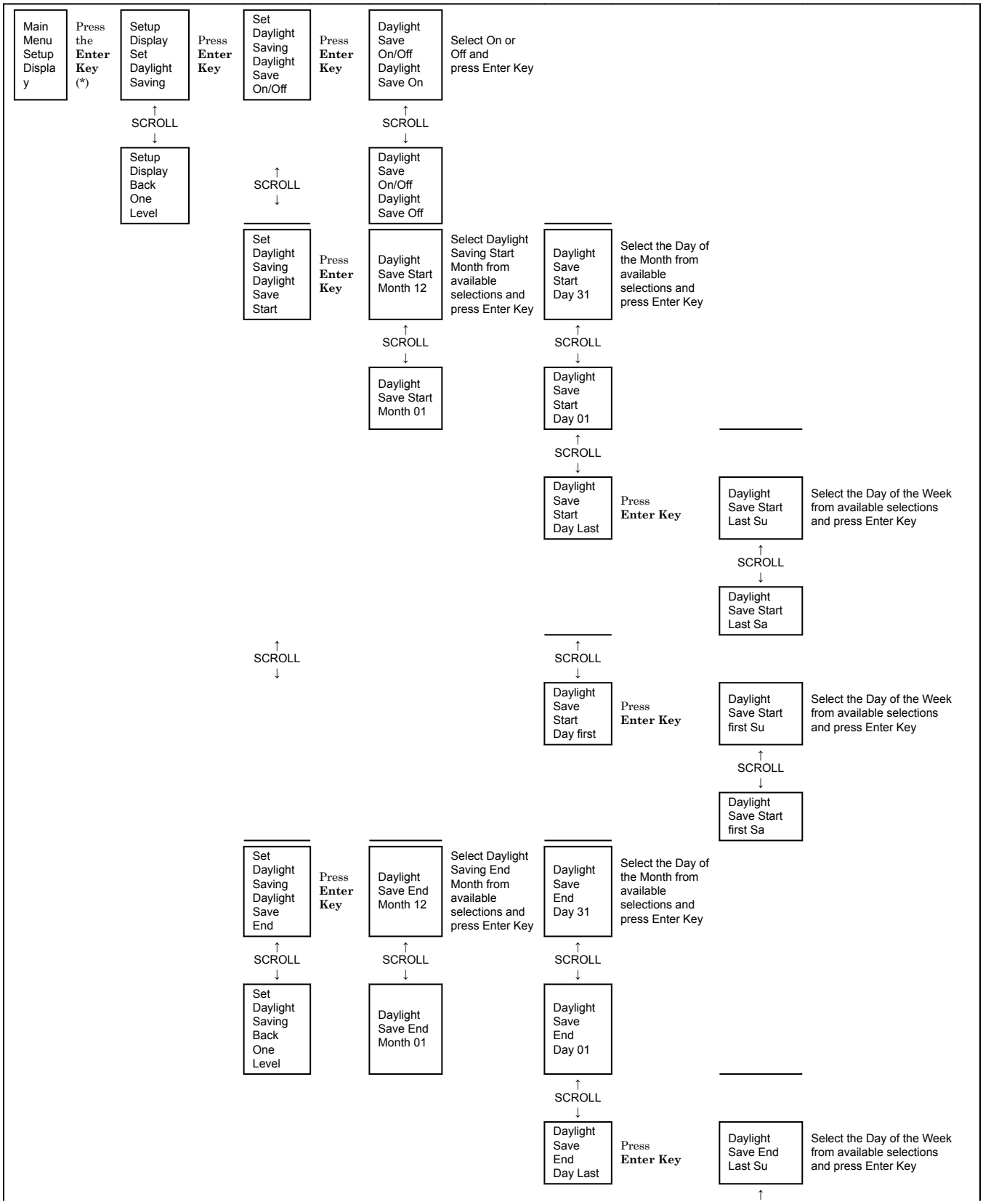
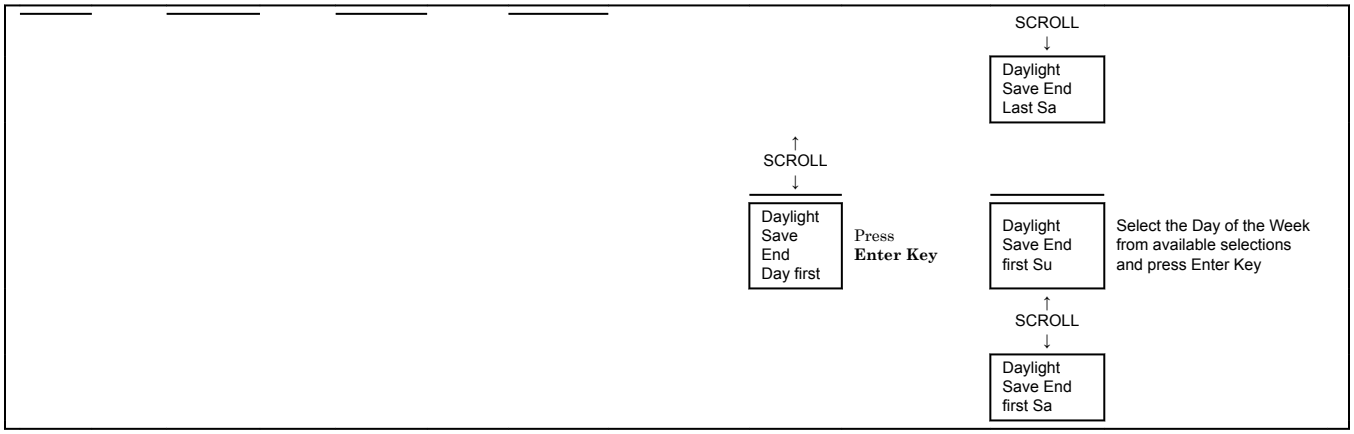


Table 21. Set Daylight Saving Time Menu (Continued)



SET TIME AND DATE MENU

A Service Technician or a Supervisor can use this menu to set the time and date on the on-board clock. Figure 42 shows the title screen for this menu.

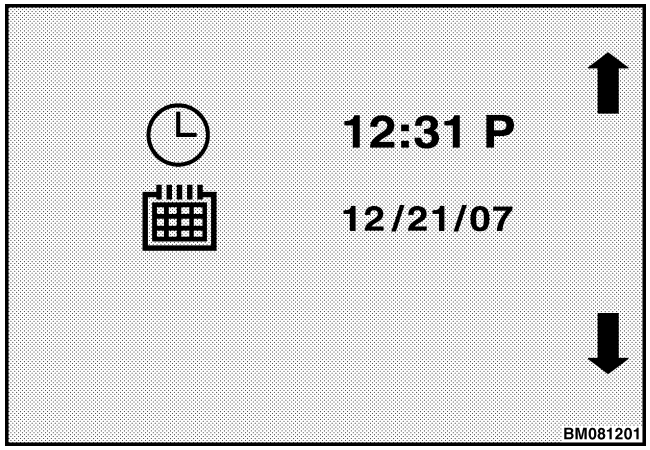


Figure 42. Set Date and Time Menu

Procedure for Setting Time and Date

NOTE: To exit from a menu at any time without making any changes, press the **Scroll Back Key** or **Scroll Forward Key**.

1. At the Display Menu, scroll to the Set Time and Date Format submenu, unless already there, and press the **Enter Key** (*) to enter this submenu.

2. Press the **2** or **3** soft key to select the Time Icon, then press the **Enter Key**.

   The system will display a flashing line under the hour portion of the time. To change the hour:

   a. Use the number keys to enter the correct hour and press the **Enter Key**. If the hour does not need to be changed, just press the **Enter Key**.

      If the number you entered is a valid hour setting, the system accepts it and moves the flashing line to the next segment, the minutes portion of the time.

   b. Use the number keys to enter the minutes and press the **Enter Key**. If the minutes are correct, simply press the **Enter Key**.

      If the number you entered is a valid minutes setting, the system accepts it and moves the flashing line to the A (for AM) or P (for PM) designator.

   c. To change the AM/PM setting, use the **2** or **3** soft key, then press the **Enter Key**. If the current AM or PM setting is correct, simply press the **Enter Key**.

      The system puts the new time settings into effect immediately.

3. To set the system date, use the **2** or **3** soft key to select the Date Icon and press the **Enter Key**.

   The system will display a flashing line under the left segment of the date. If the Current Date Format is DD/MM/YY, for example, then the left segment displayed is the day of the month. (Current Date Format can be changed in the Set Date and Time Format submenu.)

a. Use the number keys to enter the correct value and press the **Enter Key**. If the current value for the left segment of the date is correct, simply press the **Enter Key**.

b. Repeat step a. for the middle and right segments of the date.

The system will put the new system date into effect immediately.

SET UNITS MENU

A Service Technician or a Supervisor can use this menu to set the type of units the system will use to either Imperial or Metric. Figure 43 shows the Set Units submenu.

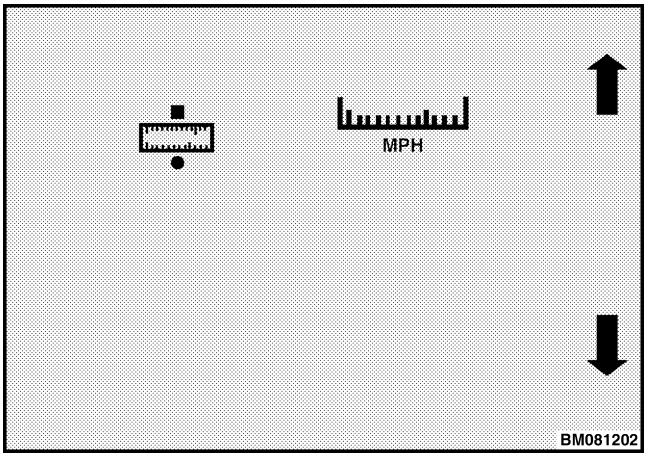


Figure 43. Set Units Menu

To set the type of units the system will use, either Imperial or Metric, enter the Set Units Menu. Use the **2** Up Arrow or **3** Down Arrow soft key to select Imperial or Metric. When the corresponding icon for the type of units desired is displayed on the screen, press the **Enter Key** and the system will begin using the units selected immediately.

Status Menu

INTRODUCTION

The Status Menu is a main menu (top-level menu) that is visible at Service Technician and Supervisor password access levels. To access this menu, cycle through the main menu title screens by pressing the **Scroll Back Key** (◂—) or **Scroll Forward Key** (—▸) until the Status Title Screen is displayed, as shown in Figure 44.

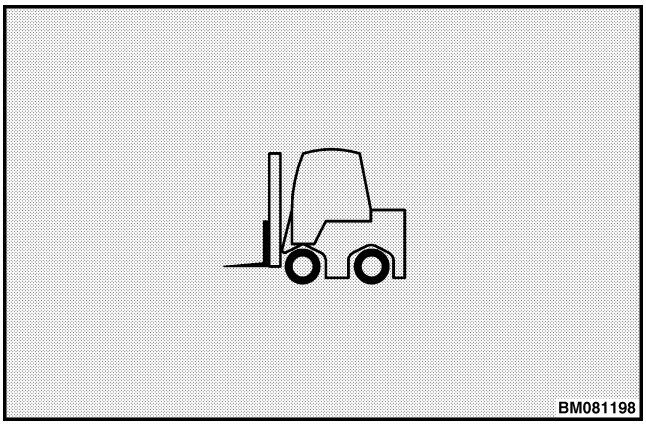


Figure 44. Status Title Screen

Press the **Enter Key** (*) to enter the Status Menu and the system will display the Vehicle System Manager (VSM) Version submenu as shown in Figure 45. Press the **Enter Key** again to enter this submenu. For a different submenu, use the **Scroll Back Key** or **Scroll Forward Key** to move to the desired submenu and press the **Enter Key**.

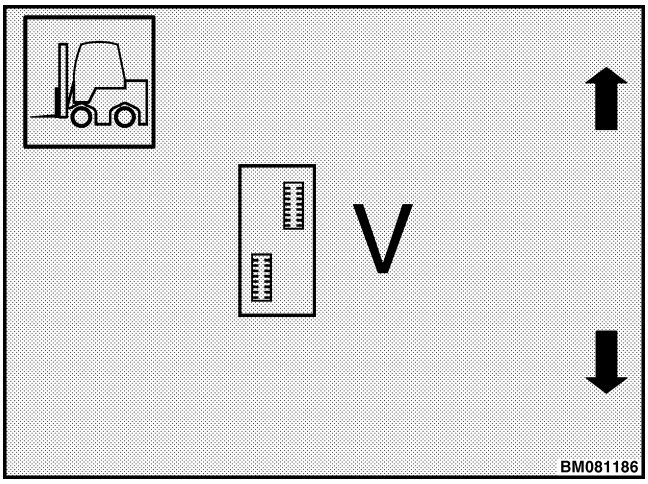


Figure 45. Status Menu

The Status Menu provides these submenus:

- VSM Versions
- Display Versions
- Truck Serial Number
- Hour Meters
- E-Hydraulic Controller Versions
- Pump Motor Controller Versions
- Traction Motor Controller 1 Versions
- Traction Motor Controller 2 Versions
- Light Controller Versions
- Impact Sensor Versions

The topics that follow describe the Status submenus.

NOTE: These menu selections are only available to logged in Service Technicians and Supervisors.

VSM VERSIONS

NOTE: The manufacturer's hardware and software versions may not match the hardware and software versions shown on the device's exterior label.

This submenu makes it possible to view the manufacturer's internal hardware and software versions of the VSM Controller. Figure 46 shows how the version information is displayed on the screen. The top line lists the manufacturer's hardware version; the second line lists the manufacturer's software version.

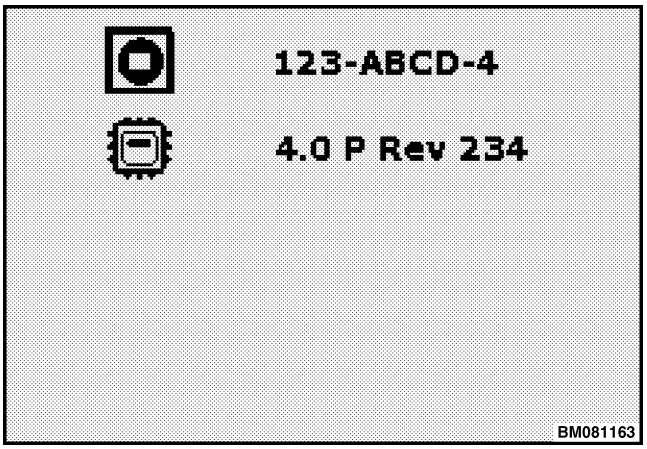


Figure 46. Versions Screen

DISPLAY VERSIONS

NOTE: The manufacturer's hardware and software versions may not match the hardware and software versions shown on the device's exterior label.

Use this submenu to view the hardware and software versions of the Display. The screen for Display Versions is identical to the screen used for VSM Versions. Figure 46 shows how the information is presented on the screen. The top line lists the hardware version; the second line lists the software version.

TRUCK SERIAL NUMBER

Use this submenu to view the serial number assigned to the truck. The truck serial number always has 11 characters, plus a 3 digit version number. The serial number can include letters with the numbers. Figure 47 shows how the serial number is displayed on the screen.

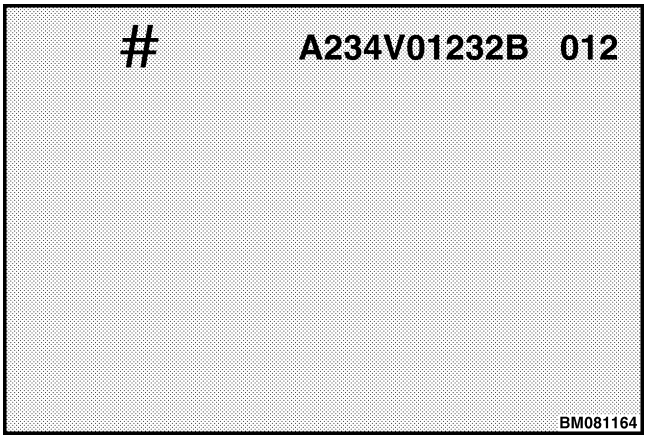


Figure 47. Truck Serial Number

HOUR METERS

Use this submenu to view hour meter readings. These include a truck hour meter, traction hour meter, pump hour meter (displayed only if the Master Controller is controlling the hydraulic pump), and a secure hour meter. Secure hour meters cannot be reset. Figure 48 shows an example of the way hour meters and readings are presented on the screen.

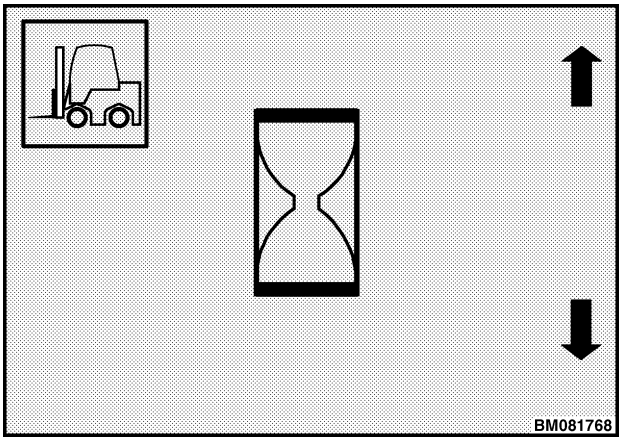


Figure 48. Hour Meters Screen

E-HYDRAULIC CONTROLLER VERSIONS

NOTE: The manufacturer's hardware and software versions may not match the hardware and software versions shown on the device's exterior label.

Use this submenu to view the manufacturer's internal hardware and software versions of the E-Hydraulic Input Controller.

NOTE: This item is visible only on trucks equipped with E-Hydraulics.

The manufacturer's hardware and manufacturer's software version information is presented on the screen as shown in Figure 46.

PUMP MOTOR CONTROLLER VERSIONS

NOTE: The manufacturer's hardware and software versions may not match the hardware and software versions shown on the device's exterior label.

Use this submenu to view the manufacturer's internal hardware and software versions of the Pump Motor Controller. The manufacturer's hardware and manufacturer's software version information is presented on the screen as shown in Figure 46.

TRACTION MOTOR CONTROLLER 1 VERSIONS

NOTE: The manufacturer's hardware and software versions may not match the hardware and software versions shown on the device's exterior label.

Use this submenu to view the manufacturer's internal hardware and software versions of Traction Motor Controller 1.

NOTE: If the truck is equipped with two traction motors, this submenu displays the versions for the right side traction motor only.

The manufacturer's hardware and manufacturer's software version information is presented on the screen as shown in Figure 46.

TRACTION MOTOR CONTROLLER 2 VERSIONS

NOTE: The manufacturer's hardware and software versions may not match the hardware and software versions shown on the device's exterior label.

Use this submenu to view the manufacturer's internal hardware and software versions of Traction Motor Controller 2. Traction Motor Controller 2 controls the left side traction motor.

NOTE: The Status Menu displays this item only if the CDF configuration indicates dual traction motors are present.

The manufacturer's hardware and manufacturer's software version information is presented on the screen as shown in Figure 46.

LIGHT CONTROLLER VERSIONS

NOTE: The manufacturer's hardware and software versions may not match the hardware and software versions shown on the device's exterior label.

Use this submenu to view the manufacturer's internal hardware and software versions of the Light Controller. The manufacturer's hardware and manufacturer's software version information is presented on the screen as shown in Figure 46.

IMPACT SENSOR VERSIONS

NOTE: The manufacturer's hardware and software versions may not match the hardware and software versions shown on the device's exterior label.

Use this submenu to view the manufacturer's internal hardware and software versions of the Impact Sensor.

NOTE: If the truck is not equipped with an Impact Sensor, this submenu is not displayed.

The manufacturer's hardware and manufacturer's software version information is presented on the screen as shown in Figure 46.

E-STEER CONTROLLER 1 VERSIONS

NOTE: The manufacturer's hardware and software versions may not match the hardware and software versions shown on the device's exterior label.

Use this submenu to vew the manufacturer's internal hardware and software versions of the E-Steer Controller 1 Sensor.

NOTE: If the truck is not equipped with E-Steering, this submenu is not displayed.

The manufacturer's hardware and manufacturer's software version information is presented on the screen as shown in Figure 46.

E-STEER CONTROLLER 2 VERSIONS

NOTE: The manufacturer's hardware and software versions may not match the hardware and software versions shown on the device's exterior label.

Use this submenu to vew the manufacturer's internal hardware and software versions of the E-Steer Controller 2 Sensor.

NOTE: If the truck is not equipped with E-Steering, this submenu is not displayed.

The manufacturer's hardware and manufacturer's software version information is presented on the screen as shown in Figure 46.

Truck Setup Menu

INTRODUCTION

The Truck Setup Menu is a main menu (top-level menu) that is visible at Service Technician and Supervisor password access levels.

NOTE: This menu is available only when the truck is not moving and the E-Hydraulics controller is in the neutral position.

To access this menu, cycle through the main menu title screens by pressing the **Scroll Back Key** (◂—) or **Scroll Forward Key** (—▸) until the Truck Setup Title Screen is displayed, as shown in Figure 49.

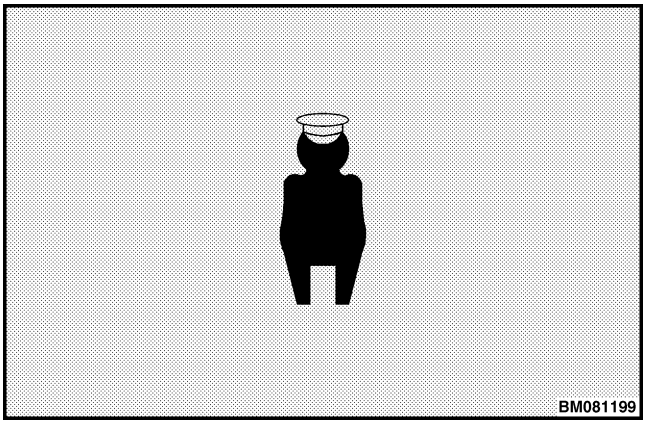


Figure 49. Truck Setup Title Screen

Press the **Enter Key** (*****) to enter the Truck Setup Menu. The system will display the Add/Remove Password submenu shown in Figure 50. Press the

Enter Key again to enter this submenu. For a different submenu, use the **Scroll Back Key** or **Scroll Forward Key** to move to the desired submenu and press the **Enter Key**.

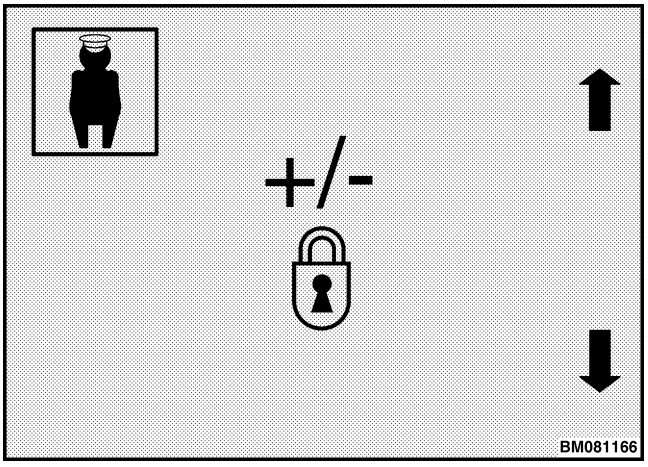


Figure 50. Add/Remove Password Submenu

The Truck Setup Menu presents these submenus:

- Add/Remove Password
- Motor Braking
- Battery Setup
- BDI Adjustment Settings
- Acceleration Rates
- Hour Meter Initialization
- Impact Monitor Shutdown
- Operator Checklist
- Minimum Pump Standby Flow Rate
- Scheduled Maintenance Reminder
- Traction Speed Limit
- Return to Set Tilt
- Auto Power-Off Time Delay
- Impact Monitor Settings
- Motion Alarm
- Lift Hydraulic Function Maximum Speed and Ramp Times
- Lower Hydraulic Function Maximum Speed and Ramp Times
- Tilt Forward Hydraulic Function Maximum Speed and Ramp Times
- Tilt Backward Hydraulic Function Maximum Speed and Ramp Times
- Auxiliary 1A Hydraulic Function Maximum Speed and Ramp Times
- Auxiliary 1B Hydraulic Function Maximum Speed and Ramp Times
- Auxiliary 2A Hydraulic Function Maximum Speed and Ramp Times
- Auxiliary 2B Hydraulic Function Maximum Speed and Ramp Times
- Optional Hydraulic Functions
- Rear Lights Control
- Restore Default Settings

The following sections describe the Truck Setup submenus.

ADD/REMOVE PASSWORD

NOTE: This submenu is available to logged in Service Technicians and Supervisors.

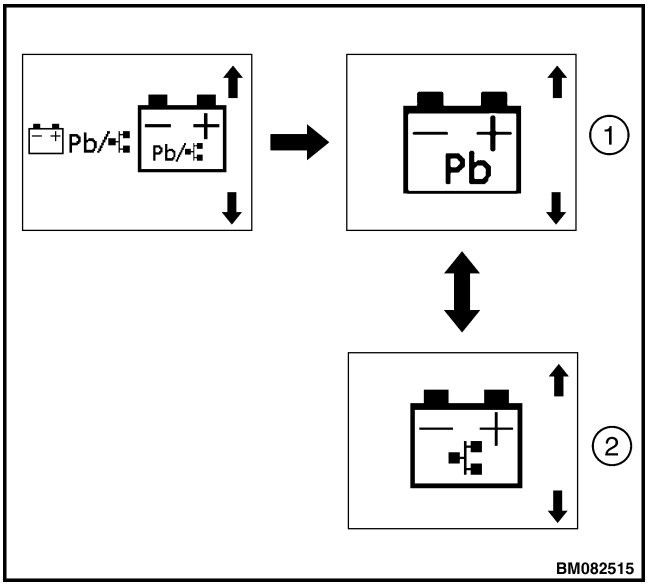
This submenu, shown in Figure 50, allows Service Technicians and Supervisors to add or remove passwords. See the Adding/Removing/Changing Passwords topic in the Password Screen section for more information.

BATTERY SETTINGS

NOTE: This submenu is available to logged in Service Technicians and Supervisors. It is visible only on trucks equipped with the Lithium-Ion Ready option.

This menu provides settings for battery type installed on the truck.

There are two possible battery settings, lead-acid and lithium-ion battery. See Figure 51.



1. LEAD-ACID BATTERY SETTING
2. LITHIUM-ION BATTERY SETTING

Figure 51. Battery Settings

It is important that the setting match the battery type installed to allow for accurate function of the battery discharge indicator and Shutdown Warning System.

MOTOR BRAKING

NOTE: This submenu is available to logged in Service Technicians and Supervisors.

There are three motor braking settings, Regenerative Braking Rate, Auto Deceleration Rate, and Auto Deceleration Type. See Figure 52.

Regenerative Braking setting controls how much motor braking is applied when the direction is changed from Forward to Reverse or Reverse to Forward. This type of deceleration is proportional to the accelerator pedal position. The further the accelerator is depressed the greater the deceleration.

Auto Deceleration setting controls how much motor braking is applied when transitioning from higher accelerator pedal position to a lower acceleration pedal position. There are two types of Auto Deceleration, Pedal Up and Proportional. A fully released pedal produces maximum deceleration for both Pedal Up or Proportional deceleration.

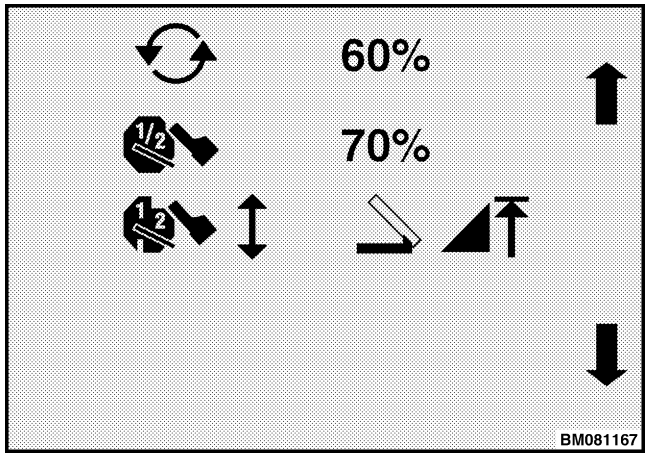


Figure 52. Motor Braking Setup

Changing the Motor Braking Settings

To change the Set Regenerative Braking Rate or Set Auto Deceleration Rate setting, use the **2** and **3** soft keys to select the current value of the setting you want to adjust. When there is a box around the value you want to change, press the **Enter Key**. Next, use the number keys to enter the desired value, then press the **Enter Key** to save the new setting.

The Regenerative Braking Rate setting is the value at the top of the screen. This value can be from 0 to 100% in increments of 1%. A 100% setting provides maximum regenerative braking while a 0% setting in effect deactivates regenerative braking.

The Auto Deceleration Rate setting is the second setting down from the top. The setting value can be in the 0 to 100% in increments of 1%. A 100% setting provides maximum auto deceleration while a 0% setting in effect deactivates it. Auto Deceleration rate is always a percentage of the current Regenerative Braking Rate. Thus, if Regeneration brake = 0% then Auto Deceleration = 0%.

The Auto Deceleration Type is the third setting down from the top. To change the type, use the **2** and **3** soft keys to select the current type and press the **Enter Key**. Next, use the **2** or **3** soft key to choose either Pedal Up or Proportional deceleration and press the **Enter Key** to save the new setting. Pedal Up deceleration allows the truck to coast until the pedal is fully released. Proportional deceleration causes the truck to decelerate in proportion to how far the pedal is released in relation to the current traction speed.

BATTERY SETUP

NOTE: This submenu is available to logged in Service Technicians only.

There are four battery settings, Battery Voltage, Battery Amp Hour settings, Cell Voltage levels, and Empty Cell Voltage. Use this menu to change the truck system's voltage and ampere settings or to adjust the battery's cell voltage levels.

Figure 53 shows how the Battery Setup information is displayed on the screen.

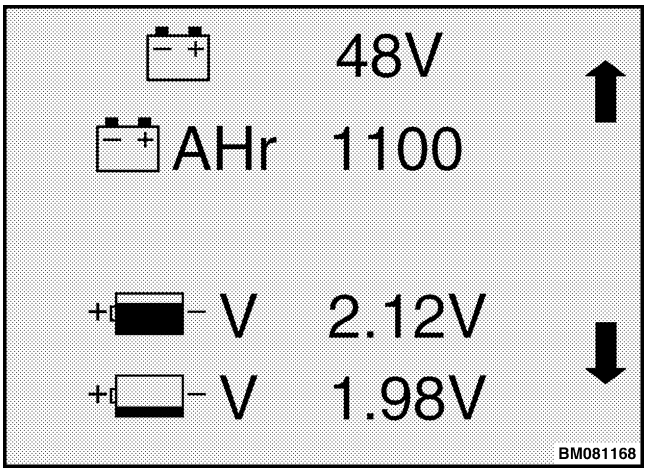


Figure 53. Battery Setup

Press the **2** and **3** soft keys to select the setting value you want to change. When there is a box around the value, press the **Enter Key**.

The available values for the Battery Voltage Setting are 24, 36, 48, 72, and 80 V. To change the **Battery Voltage** use the soft keys to move the selection box to the **Battery Voltage** symbol and press the **Enter Key**. Enter 24, 36, 48, 72 or 80 with the number keys and press the **Enter Key** to save it.

The available values for the **Battery Amp Hour Capacity** range from 200 to 3000 Amp Hour (AHr) in 10 Amperes per Hour increments. To change the **Battery Amp Hour Capacity** use the soft keys to move the selection box to the **Battery AHr** symbol and press the **Enter Key**. Enter three or four digits as required. The last digit will be rounded to the nearest 10. Press the **Enter Key** to save it.

The available values for the **Full Cell Voltage** (Charged) range from 1.00 to 3.00 V in 0.01 Volt increments. To change use the soft keys to move the selection box to the **Full Cell Voltage** symbol and press the **Enter Key**. Enter three digits within the allowable range and press the **Enter Key** to save the change.

The available values for the **Empty Cell Voltage** (Discharged) range from 1.00 to 3.00 V in 0.01 Volt increments. To change the capacity use the soft keys to move the selection box to the **Empty Cell Voltage** symbol and press the **Enter Key**. Enter three digits within the allowable range and press the **Enter Key** to save the change.

NOTE: If adjustments are required determine the correct settings as follows:

Determine Amp Hour Capacity from the battery data plate. If multiple capacity batteries are available for the truck use an average of the high and low capacities.

Determine "Full Cell Voltage" and "Empty Cell Voltage".

Due to parasitic loads, cable and contactor resistances, and variations in the battery temperature the open circuit voltages when measured with a volt meter will not exactly match the voltages shown on the display. The following instructions assume the Battery Setup settings are set to the factory defaults. See Table 22. If the Battery Setup settings are not at the factory defaults reset them before proceeding.

There are four problems that may require a cell voltage setting change.

- The display does not read 5 bars with a fresh charged battery. See Step 1 below.
- The display stays at 5 bars as the battery discharges. See Step 2 below.
- The display reads 0 bars at too high a battery specific gravity or voltage. See Step 3 below.
- The display reads 0 bars at too low a battery specific gravity or voltage. See Step 4 below.

Table 22. Battery Setup Factory Defaults

Model	Battery Full	Battery Empty
E2.2-3.5XN (E45-70XN) (A268)	2.12 Volts	1.98 Volts
J2.2-3.5XN (J45-70XN) (A276)	2.10 Volts	2.00 Volts
E1.6-2.0XN (E30-40XN) (A269)	2.12 Volts	1.98 Volts
J1.5-2.0XNT (J30-40XNT) (K160)	2.12 Volts	1.96 Volts
J1.6-2.0XN (J30-40XN) (A935)	2.12 Volts	1.96 Volts
A1.3-1.5XNT (A25-30XNT) (D203)	2.12 Volts	1.96 Volts
J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)	2.15 Volts	1.96 Volts
E4.0-5.5XN (E80-120XN) (A099)	2.12 Volts	2.00 Volts

1. If the display does not read 5 bars with a fresh charged battery the full cell voltage needs to be lowered. For the BDI to read correctly the truck must be operated for 10 minutes doing light driving. If the display still does not read 5 bars after light driving lower the full cell voltage 0.01V (a change of 0.01V will make a significant change) Use the left arrow key to return to the Operating Screen and drive the truck momentarily and check to see if the BDI is now at 5 bars. If not lower the full cell voltage another 0.01V, return to the Operating Screen, drive momentarily and check as above. Repeat as necessary.

2. If the display stays at 5 bars as the battery discharges the full cell voltage need to be increased. Run truck until battery is at 75% of the usable charge as measured per the battery manufacturer's instructions (discharged 20% if 80% is usable). If BDI indicator is still at 5 bars increase the full cell voltage. As above a step of 0.01cell voltage will make a significant change. Use the left arrow key to return to the Operating Screen and check to see if there are now 4 bars showing. Repeat as necessary.

NOTE: The battery must be charged to at leased 50% of its capacity to reset lift lockout

3. If the display reads 0 bars at too high a battery specific gravity or voltage operate the truck checking the battery per the battery manufactures recommendations until the battery is discharged to the manufacturer's recommendation. Decrease the empty cell voltage in steps of 0.01 volts. Use the left arrow key to return to the Operating Screen and check to see if there are now 1 or more bars showing. Repeat if necessary.

4. If the display reads 1 or more bars and the battery is discharged when measured as per the battery manufacturer's recommendation. Increase the empty cell voltage in steps of 0.01 volts. Use the left arrow key to return to the Operating Screen and check to see 0 bars are displayed. Repeat if necessary.

BDI ADJUSTMENT SETTING

NOTE: This submenu is available to logged in Service Technicians only.

Figure 54 shows how the Battery Discharge Indicator (BDI) adjustment setting is displayed on the screen. The Parasitic Current Icon and the present value are located in the middle of the screen.

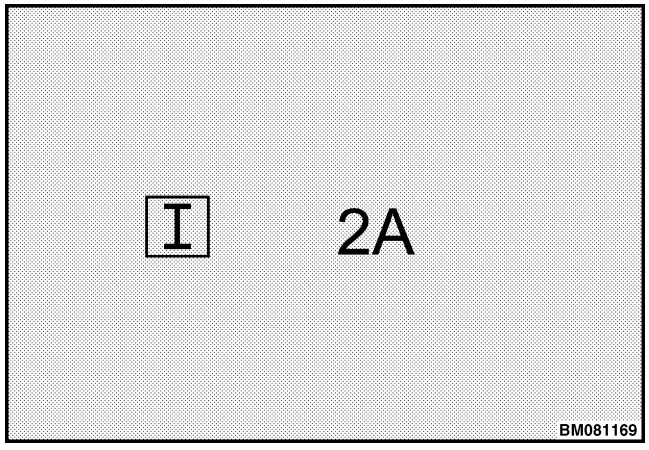


Figure 54. BDI Adjustment Setting

The BDI Adjustment Setting menu provides a way to adjust the Parasitic Current so it is well suited to current truck conditions. If extra hardware or equipment that draws significant power, such as heater vests, have been installed on the truck since it went into service, a BDI adjustment should be made to compensate for the additional power draw.

The factory setting accounts for the DC-DC converter and other normal loads. Increase this setting as required if additional items have been added to the truck. When items are added that have an intermittent duty cycle average the current based on the duty cycle.

To adjust the Parasitic Current, use the number keys to enter the new value and press the **Enter Key** to save it.

Acceptable values for Parasitic Current range from 0 to 200 Amp, in 1 Ampere increments.

ACCELERATION RATES

NOTE: This submenu is available to logged in Service Technicians only.

Use this menu to set Acceleration Rate 1 or Acceleration Rate 2 or to select either Standard or Extended Shift mode.

Figure 55 shows how the Acceleration rates and type are presented on the screen.

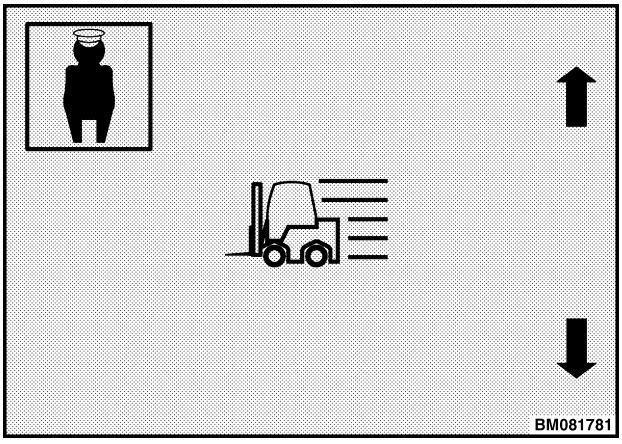


Figure 55. Acceleration Setup

The icon at the top left of the screen is for Acceleration Rate 1 and the icon below it is for Acceleration Rate 2.

- Acceleration Rate 1 is used to limit the acceleration of the traction system at low speeds. A setting of 100% is the maximum available acceleration, below this the vehicle acceleration will be reduced.
- Rate 2 is used to limit the acceleration of the traction system at high speeds. At higher motor speeds the maximum acceleration of the vehicle is limited by the traction motor(s), thus the default setting is the maximum available acceleration.
- Standard Performance Mode has a greater acceleration and higher speeds on grades as compared to Extended Shift Mode but at the cost of increased power consumption and shorter battery shift lift.

To change an acceleration rate setting, use the **2** and **3** soft keys to select the value for Acceleration Rate 1 or Acceleration Rate 2. When there is a box around the current value, press the **Enter Key**. Next, use the number keys to enter the new value desired. Acceptable values range from 5 to 100%. A 100% setting produces maximum acceleration at slow speeds. After entering the new value, press the **Enter Key** to save it.

The third icon down from the top is for Acceleration Type. An X over the setting icon in Figure 55 means the truck is currently set to operate in Standard shift mode, not Extended Shift mode. To change the acceleration type, use the **2** and **3** soft keys to move to the current value for the acceleration type. Press the **Enter Key** to select it, then use the **2** or **3** soft key to select either Standard or Extended Shift mode and press the **Enter Key** to save your selection.

HOUR METER INITIALIZATION

NOTE: The key must be cycled in order for the Hour Meter Initialization to take affect.

NOTE: This submenu is available to logged in Service Technicians only.

Use this menu to view and change the Traction Hour, Pump Hour, and Truck Hour settings. Figure 56 shows how the settings are displayed on the screen.

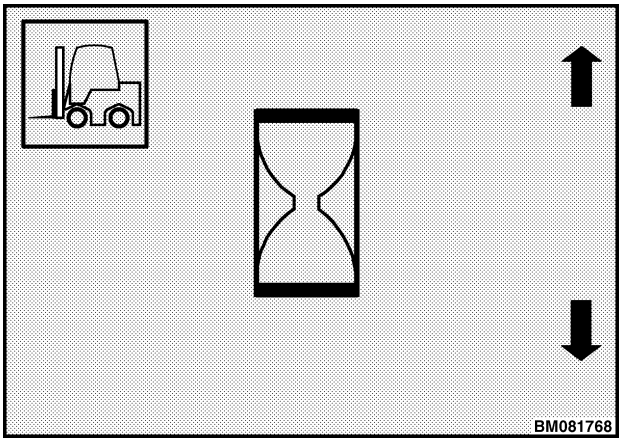


Figure 56. Hour Meter Setup

The top icon is for Truck Hour, the second icon down is for Traction Hour, and the third icon down is for Pump Hour. To adjust the Truck Hour, Traction Hour, or Pump Hour setting, use the **2** and **3** soft keys to select the current value of the setting you want to change. When there is a box around the value for the traction hour meter, pump hour meter, or truck hour meter, press the **Enter Key**, then use the number keys to enter a new value up to 99999 and press the **Enter Key** to save it.

IMPACT MONITOR SHUTDOWN

NOTE: This submenu is available to logged in Service Technicians and Supervisors.

Use this menu to turn impact detection on or off, set the length of time before the truck shuts down after an impact event, and to set whether the entire truck or only the traction motor shuts down after an impact event. See Figure 57.

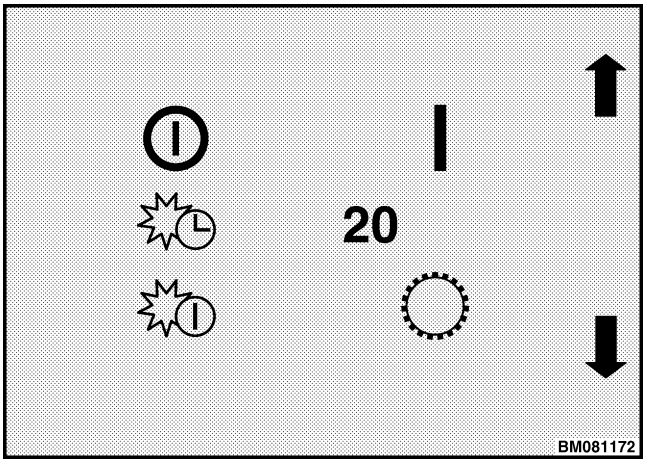
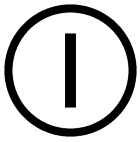
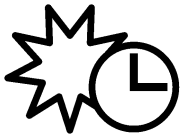
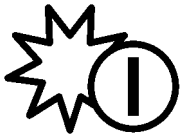
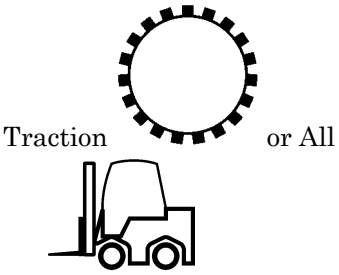


Figure 57. Setup Screen for Impact Settings

Use the **2** and **3** soft keys to highlight the setting to change. Press the **Enter Key**, then use the **2** or **3** soft key to set the value for the highlighted setting.

Icon	Setting	Values	Description
	Impact Detection	**ON** or **OFF**	When **ON**, the truck will shut down when an impact event is recorded.
	Impact Monitor Shutdown Delay	0 to 30 seconds	The length of time after an impact event is recorded before the truck shuts down. If set to a non-zero value, an audible alarm will shound and the Impact Detection icon will display during shutdown time. If set to zero, no audible alarm will sound and the truck will shut down immediately.
	Impact Monitor Shutdown Type	 Traction or All	When set to Traction, only the traction motor will shut down. When set to All, all truck functions will shut down.

OPERATOR CHECKLIST

NOTE: This submenu is available to logged in Service Technicians and Supervisors.

A Service Technician or Supervisor can use this menu to program the checklist items that will be displayed to users.

The lift truck system can be set up to display all, some, or none of the 30 items in the Operator Checklist when the key switch or keyless switch is turned on. Each checklist item is represented by a separate icon. During setup, the 30 icons are displayed, one at a time, in the middle of the screen. If an X appears over the icon when it is displayed, the checklist item represented by the icon is inactive (deactivated) and the checklist item will not appear during the Operator Checklist sequence. If there is no X over the icon, the checklist item is active (enabled).

Figure 58 shows the Activate/Deactivate Checklist Item Screen with an icon that represents a checklist item.

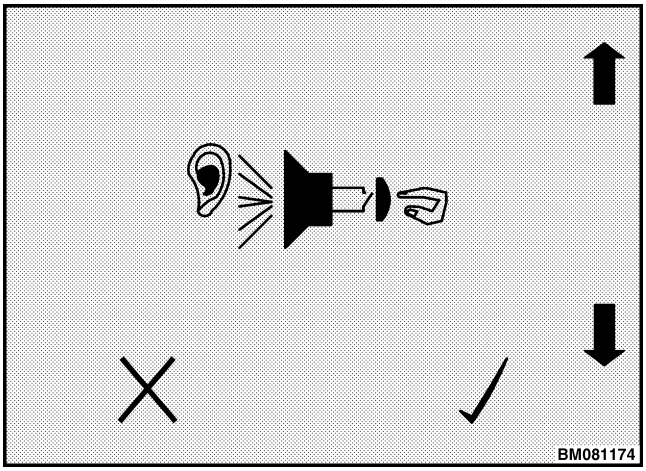


Figure 58. Activate/Deactivate Checklist Item Screen

The icon in Figure 58 does not have an X over it, so the checklist item this icon represents is enabled (activated). The X Icon in the lower left area of the screen, right above the **#** soft key indicates the currently displayed checklist item will be deactivated if the **#** key is pressed. If the checklist item was deactivated, pressing the **Enter Key** (*) above the Check Mark Icon in the lower right area of the screen would enable it.

Any checklist item can be activated or deactivated by a Service Technician or Supervisor as follows: Use the **2** and **3** soft keys (the up and down arrow keys) to move through the icons to the one that represents the checklist item you want to enable or disable. If the currently displayed icon has an X over it, press the **Enter Key**. The system will enable the checklist function the icon represents and redraw the icon with no X over it and the checklist function will now be programmed to appear during the Operator Checklist sequence. If the currently displayed icon does not have an X over it, press the **#** soft key to disable the checklist function the icon represents. The system will redraw the icon with an X over it and this checklist function will be skipped (it will not appear) during the Operator Checklist sequence.

NOTE: If all items on the checklist are deactivated, the Operator Checklist feature is deactivated and the system does not present the Operator Checklist to the operator.

MINIMUM PUMP STANDBY FLOW RATE

NOTE: This submenu is available to logged in Service Technicians and Supervisors.

This menu can be used to adjust the minimum standby pump flow rate. Values stored in the truck's CDF determine the range of allowable values for this setting. This means a setting of 1% the value is the lowest available setting for the minimum standby pump flow rate and it is equal to the lowest defined value in the CDF. A 100% value is the highest available setting for the minimum standby pump flow rate. The example presented in Figure 59 shows the icon for minimum pump standby flow rate and a current value of **56**, which means the value is 56% of the maximum allowed.

NOTE: A setting of 0% turns the standby flow off which may result in decreased steering performance.

To change the setting for the minimum standby pump flow rate, use the number keys to enter the new rate desired, then press the **Enter Key** to save the new setting. The value of this setting can range from 0% to 100% in steps of 1%.

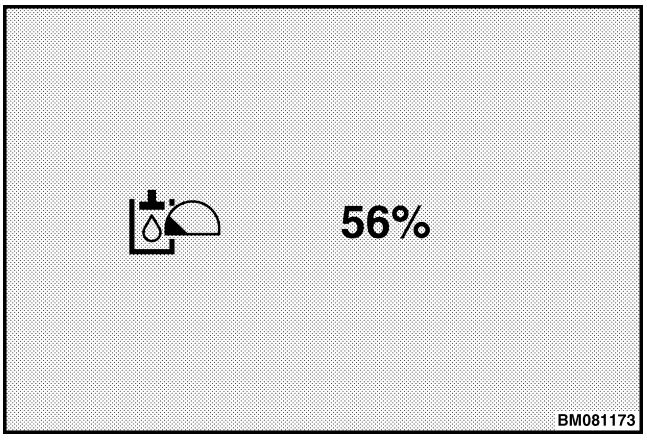


Figure 59. Minimum Pump Standby Flow Rate Screen

SCHEDULED MAINTENANCE REMINDER

NOTE: This submenu is available to logged in Service Technicians and Supervisors.

This menu item is only visible on trucks equipped with the Scheduled Maintenance Reminder feature. The examples shown in Figure 60, Figure 61, and Figure 62 show the icons for the scheduled maintenance reminder screen.

Using this menu item the user shall be able to adjust the scheduled maintenance reminder settings. The items available to the user are:

- Maintenance Reminders **ON/OFF**.
- Maintenance Interval in Months.
- Maintenance Interval in Truck Hours.
- Derated Traction Speed Percentage after the scheduled time has expired.

The maintenance intervals are countdown timers that are set by the users. Once the user has set the interval it begins counting down. Each time the user enters the menu the current count until the interval will expire will be displayed.

Setting the Maintenance Reminders Status to **OFF** deactivates the feature. Setting an Interval to 0 deactivates that Interval.

With the Maintenance Reminder Status set to **ON** and Setting one or both of the reminder intervals to

nonzero numbers activates the maintenance reminders feature.

Once a previously active interval counts down to zero, the maintenance reminder becomes active. To deactivate the maintenance reminder the user must either set the status to **OFF** or enter a new service interval.

The scheduled maintenance month interval is based on the system date. The value ranges from 0 to 99 in increments of 1 month.

The scheduled maintenance hour interval is based on the trucks hour meter. The value ranges from 0 to 9999 in increments of 1 hour.

The derated traction speed percentage setting is a percentage of the current maximum speed limit. A setting of 100% has no reduction in top speed while 0% disables the traction system. This value can be from 0% to 100% in increments of 1%.

When scheduled maintenance reminder interval has expired, a reminder is activated. If a reminder is active the system will display the maintenance reminder alert screen for 5 seconds at key **ON**.

If the maintenance reminder is not reset or deactivated within 20 hours after the maintenance interval has expired, lift truck operation will be slowed to the derated traction speed setting on the next key cycle.

The truck will operate with a reduced traction speed until the maintenance reminder interval is set or the feature is turned **OFF**.

The service technician must reset the scheduled time for the next maintenance time interval to allow normal operation again.

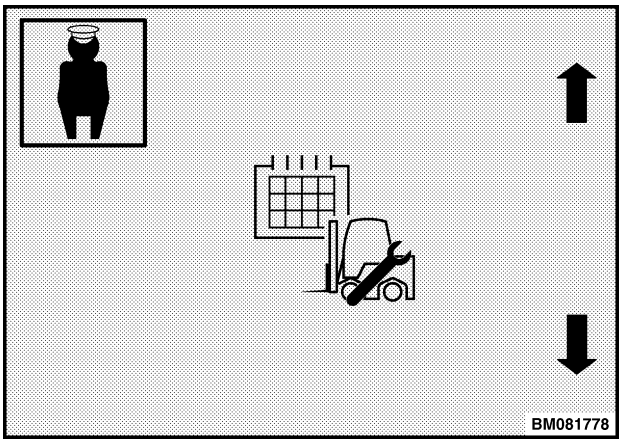


Figure 60. Scheduled Maintenance Reminder

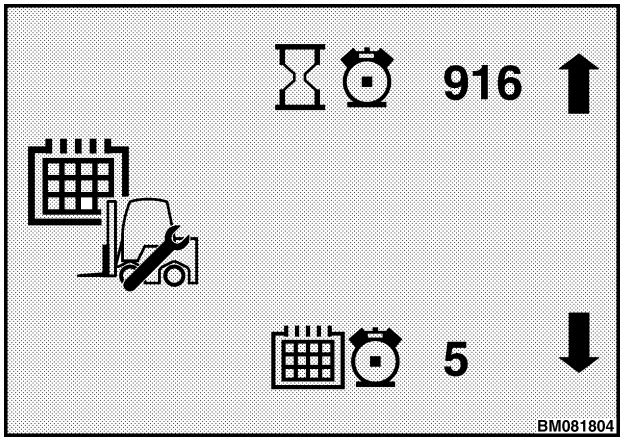


Figure 61. System Off Screen

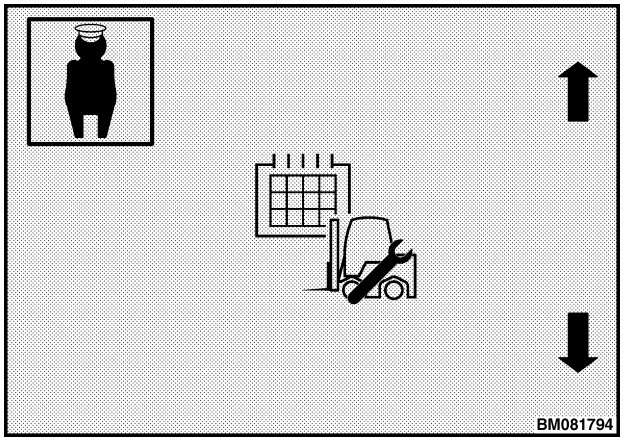


Figure 62. Maintenance Reminder Alert Screen

TRACTION SPEED LIMIT

NOTE: This submenu is available to logged in Service Technicians and Supervisors.

The example shown in Figure 63 shows the MPH Icon and a current Traction Speed Limit setting of 12. The type of speed units, MPH or km/h is set in a submenu of the Display main menu.

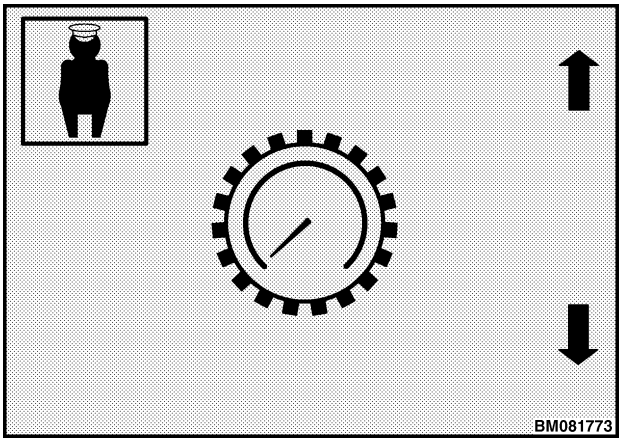


Figure 63. Traction Speed Limit Example

To change the traction speed limit setting, use the number keys to enter the new value desired, then press the **Enter Key** to save it. Acceptable values for the traction speed limit range from 1 to 99 km/h when metric units are in use, and 1 to 99 MPH when Imperial units are in use.

NOTE: The maximum traction speed will always be limited by the maximum traction motor speed as set by the CDF, regardless of the traction speed limit setting.

RETURN TO SET TILT

NOTE: This submenu is available to logged in Service Technicians and Supervisors. It is visible only on trucks equipped with the RTST feature.

This menu provides a way to adjust the Return to Set Tilt (RTST) delay time and to program this feature to work only in the forward direction or in both directions. Figure 64 shows the RTST Setup Screen with the delay direction set to Forward.

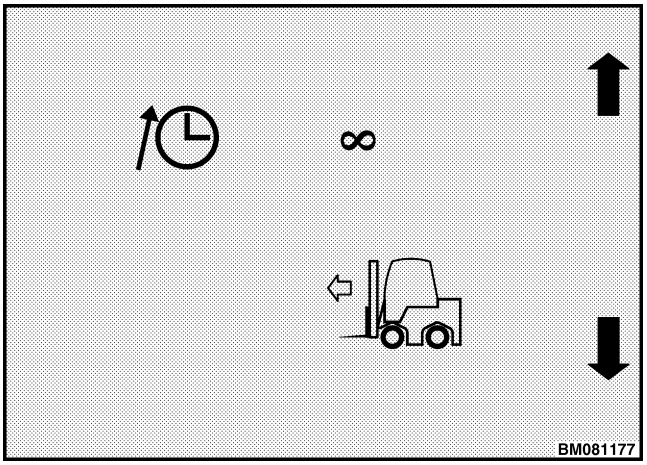


Figure 64. RTST Setup Screen

The icon at the top left of the screen is for the delay time. When a box is around the current value, press the **Enter Key**. Then use the **2** or **3** soft key to step through the available values for the delay time, 0, 0.1, 0.2, 0.4, 0.6, 0.8, 1.0, 2.0, 3.0 seconds or Continuous and press the **Enter Key** to save the new value. When the delay time is set to 0, this feature is deactivated. When set to Continuous, the delay time is infinite (limitless).

The lift truck icon in Figure 64 indicates the mast assembly is programmed to return to the set tilt angle only when it is moving forward, which is the Forward option. To set up the mast assembly so that it returns to the set tilt whether it is moving forward or backward, use the **2** or **3** soft key to set the RTSH direction to Both.

AUTO POWER-OFF TIME DELAY

NOTE: This submenu is available to logged in Service Technicians and Supervisors.

This menu can be used to shut the lift truck OFF if the operator has left the seat for a set number of minutes.

This menu can be used to adjust the setting for the amount of time before the truck enters the Power Off mode. Figure 65 shows an Auto Power-Off Delay Setup Screen that has a 20m delay setting value, which is a 20 minute delay.

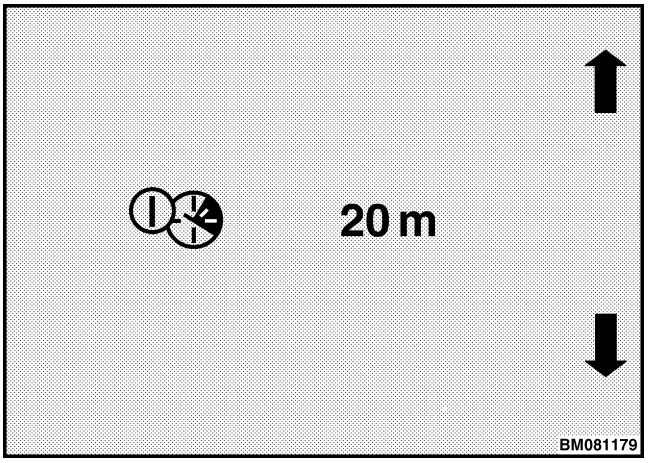


Figure 65. Auto Power-Off Time Delay Setup Screen

To change the Auto Power-Off Time Delay setting, select the current value. When a box is around it, press the **Enter Key**, then use the number keys to enter a value from 0 to 30 minutes and press the **Enter Key** to save the new setting.

IMPACT MONITOR SETTINGS

NOTE: This submenu is available to logged in Service Technicians and Supervisors. It is visible only on trucks equipped with the Impact Monitoring feature.

This menu provides a way to adjust the settings the impact monitor uses when it detects impacts. Figure 66 shows the Impact Monitor Settings Screen.

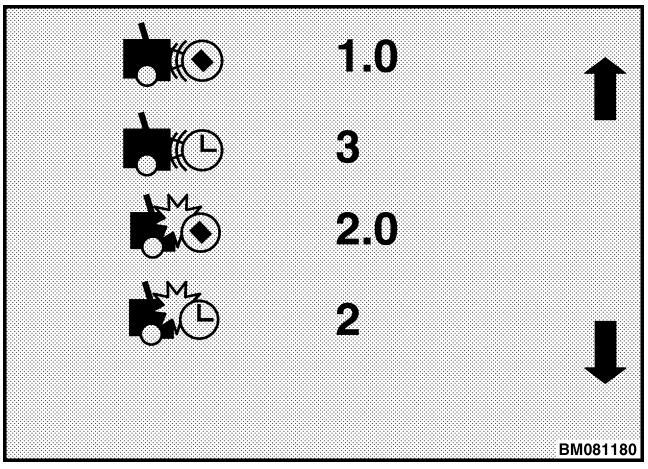


Figure 66. Impact Monitor Settings Screen

Impact Detection

The impact monitor can detect both hard and soft impacts.

An example of a hard impact is a truck colliding with a steel column in a warehouse which causes the truck to stop suddenly. In this case the impact force is very strong but it occurs during a short time period.

An example of a soft impact is a truck rolling over and crushing a wooden pallet. In this case the impact force is much less than experienced with a hard impact but it lasts for a significantly longer time period.

Setting Adjustments

Use the **2** and **3** soft keys to move up or down through the current values for the four settings for Impact Force and Impact Times. When there is a box around the setting you want to change, press the **Enter Key**, then use the **2** or **3** soft key to step through the valid values for that setting.

The Soft Impact Force, the setting at the top of the screen, can be set to a value in the range 0.2 to 2.5 g., in tenths of gravitational force.

The Soft Impact Time, the second setting down from the top, can be adjusted to require the impact monitor to see an impact force greater than the Soft Impact Force for 1 to 12 samples before a soft impact event will be reported.

The Hard Impact Force, the third setting down, can be set to a value in the range 0.5 to 3.0 g., in tenths of gravitational force.

The Hard Impact Time, the fourth setting down from the top, can be adjusted to require the impact monitor to see an impact force greater than the Hard Impact Force for 1 or 2 samples before a hard impact event will be reported.

Initial Adjustment of Soft and Hard Impact Settings

NOTE: When adjusting the impact sensor settings, be sure to:

Adjust the truck to the lowest Soft Impact Force setting, the Soft Impact Time set to 6, and the highest Hard Impact Force Setting. Drive the truck at the fastest operational speed for the environment. Apply the brakes to bring the truck to an abrupt stop. Determine if an impact event has occurred.

Increase either the Soft Impact Force setting until the vehicle can be abruptly stopped with the service brake without reporting an impact event. Read and record the value, from the dash display, that was triggered a Soft Impact when abruptly stopping the truck. Change the Soft Impact Force threshold to the next highest setting.

To adjust the hard threshold, take the soft threshold value and add 0.3 g. Set the Hard Impact Time to 2.

Monitor truck during all normal operations. If impacts are recorded during normal operations, go to (**Readjustment of Soft and Hard Impact Settings**).

Readjustment of Soft and Hard Impact Settings.

If the majority of impacts recorded during the initial adjustment period are soft impacts, change the settings as follows:

- Increase the Soft Impact Time by 1 for large scale adjustments.
- Increase the Soft Impact Force by 0.1g for smaller adjustments.
- Increase the Hard Impact Force to the current Soft Impact + 0.3g.

If the majority of impacts recorded during the initial adjustment period are hard impacts, change the settings as follows:

- Increase the Hard Impact Time by 1 sample for large adjustments.
- Increase the Hard Impact Force by 0.1g for smaller adjustments.

After making the necessary adjustments, have the operator again operate the lift truck under normal conditions to ensure that the adjustments are correct.

MOTION ALARM

NOTE: This submenu is available to logged in Service Technicians and Supervisors and visible on all trucks.

Use this menu to enable or disable the Motion Alarm feature. Figure 67 shows the Motion Alarm Setup Screen with the alarm option set to On.

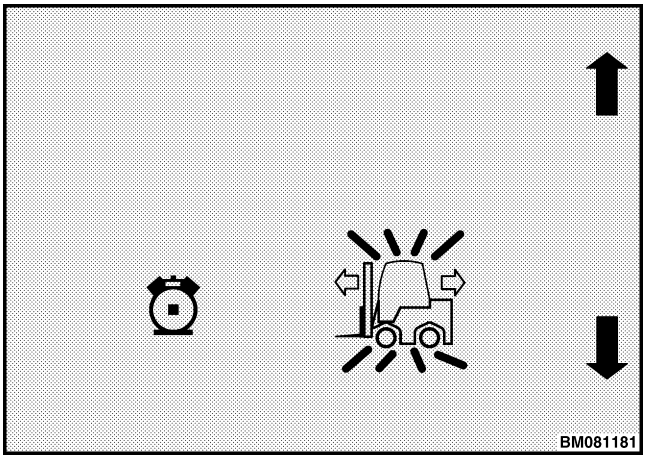


Figure 67. Motion Alarm Setup Screen

Use the **2** and **3** soft keys to toggle the setting between On and Off. An X over the fork lift truck icon indicates the Motion Alarm feature is set to Off. If this feature is Off and you want to enable it, press the **2** or **3** soft key to have the system display the icon without an X over it, then press the **Enter Key** to store the setting.

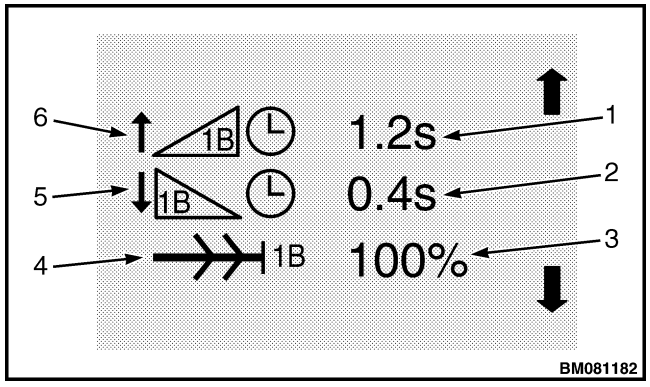
LIFT HYDRAULIC FUNCTION MAXIMUM SPEED AND RAMP TIMES

Flow rate adjustment of the lift function is available on all trucks.

Ramp up and ramp down rate adjustments of the hoist function are available only on trucks equipped with E-Hydraulics.

Use this menu to enable or disable the valve whether the truck has E-Hydraulics or manual hydraulics. Valid maximum flow rate settings can be from 0% to 100%. A value of 0% deactivates the hydraulic function and associated diagnostics.

Figure 68 shows the Lift/Lower Max Speed Setup Screen.



1. LIFT RAMP UP TIME SETTING
2. LIFT RAMP DOWN TIME SETTING
3. LIFT MAXIMUM SPEED CURRENT SETTING
4. LIFT MAXIMUM SPEED INDICATOR
5. LIFT RAMP DOWN TIME INDICATOR
6. LIFT RAMP UP TIME INDICATOR

Figure 68. Lift/Lower Max Speed Setup Screen

To change the ramp up time setting, use the **2** and **3** soft keys to select the value beside the top left icon, the hoist function's ramp up time. When there is a box around this value, press the **Enter Key**, then use the **2** or **3** soft key to step through the valid settings for ramp up time, which can be from 0 to 2 seconds in 0.1 second increments. When you have the desired value displayed, press the **Enter Key**.

To change the ramp down time setting, follow the same procedure except in this case, select the value beside the second icon down.

To adjust the maximum hydraulic flow supplied for the lift function (1B), select the value beside the lower left icon and press the **Enter Key**. Then use the number keys to enter the desired value for the maximum hydraulic flow, which can be 0% to 100%. A value of 0% deactivates this function.

LOWER HYDRAULIC FUNCTION MAXIMUM SPEED AND RAMP TIMES

To change the ramp up or down time setting or to adjust the maximum flow supplied for the Lower function (the hydraulic function 1A settings), follow the procedure given in Lift Hydraulic Function Maximum Speed and Ramp Times.

Set the maximum hydraulic flow to a value from 0% to 100%. A value of 0% deactivates this function.

Set the ramp time settings for the hoist function to a value of 0 to 2 seconds in 0.1 second increments.

The setup screen for this submenu is similar to Figure 68.

TILT FORWARD HYDRAULIC FUNCTION MAXIMUM SPEED AND RAMP TIMES

To change the ramp up or down time setting or to adjust the maximum flow supplied for the tilt forward (the hydraulic function 2A settings), follow the procedure given in Lift Hydraulic Function Maximum Speed and Ramp Times.

Set the maximum hydraulic flow supplied for the tilt forward function to a value from 0% to 100%. A value of 0% deactivates this function.

Set the ramp time settings to a value of 0 to 2 seconds.

The setup screen for this submenu is similar to Figure 68.

TILT BACKWARD HYDRAULIC FUNCTION MAXIMUM SPEED AND RAMP TIMES

To change the ramp up or down time setting or to adjust the maximum flow supplied for the tilt backward (the hydraulic function 2B settings), follow the procedure given in Lift Hydraulic Function Maximum Speed and Ramp Times.

Set the maximum hydraulic flow supplied for the tilt backward function to a value from 0% to 100%. A value of 0% deactivates this function.

Set the ramp time settings to a value of 0 to 2 seconds.

The setup screen for this submenu is similar to Figure 68.

AUXILIARY 1A HYDRAULIC FUNCTION MAXIMUM SPEED AND RAMP TIMES

To change the ramp up or down time setting or to adjust the maximum flow supplied for hydraulic function 3A, follow the procedure given in Lift Hydraulic Function Maximum Speed and Ramp Times.

Set the maximum hydraulic flow to a value from 0% to 100%. A value of 0% deactivates this function.

Set the ramp time settings to a value of 0 to 2 seconds.

The setup screen for this submenu is similar to Figure 68.

AUXILIARY 1B HYDRAULIC FUNCTION MAXIMUM SPEED AND RAMP TIMES

To change the ramp up or down time setting or to adjust the maximum flow supplied for hydraulic function 3B, follow the procedure given in Lift Hydraulic Function Maximum Speed and Ramp Times.

Set the maximum hydraulic flow to a value from 0% to 100%. A value of 0% deactivates this function.

Set the ramp time settings to a value of 0 to 2 seconds.

The setup screen for this submenu is similar to Figure 68.

AUXILIARY 2A HYDRAULIC FUNCTION MAXIMUM SPEED AND RAMP TIMES

To change the ramp up or down time setting or to adjust the maximum flow supplied for hydraulic function 4A, follow the procedure given in Lift Hydraulic Function Maximum Speed and Ramp Times.

Set the maximum hydraulic lift to a value from 0% to 100%. A value of 0% deactivates this function.

Set the ramp time settings to a value of 0 to 2 seconds.

The setup screen for this submenu is similar to Figure 68.

AUXILIARY 2B HYDRAULIC FUNCTION MAXIMUM SPEED AND RAMP TIMES

To change the ramp up or down time setting or to adjust the maximum flow supplied for hydraulic function 4B, follow the procedure given in Lift Hydraulic Function Maximum Speed and Ramp Times.

Set the maximum hydraulic lift to a value from 0% to 100%. A value of 0% deactivates this function.

Set the ramp time settings for the hoist to a value of 0 to 2 seconds.

The setup screen for this submenu is similar to Figure 68.

OPTIONAL HYDRAULIC FUNCTIONS

NOTE: This submenu is displayed only to logged in Service Technicians or Supervisors.

This menu allows a Service Technician or Supervisor to enable or disable dual hydraulic function control. This feature allows control of two hydraulic functions from a single valve. Figure 69 shows the Hydraulic Accessories Setup Screen.

Slip Sheet: When the optional slip sheet function is enabled the truck will enter a freewheeling state when the truck is below a set travel speed, the pedals are released, and the associated hydraulic function is engaged (standard interlocks still apply). If equipped with an automatic park brake the brake shall be released.

Auxiliary Hydraulics: This feature enables/disables control of a diverter solenoid allowing control of 2 hydraulic functions from a single valve. In some applications, customers may wish to add an additional function to the hydraulic system without changing the valve assembly. In such a case, it is desirable to redirect flow from the Aux 1, Aux 2 or Aux 3 valves to a different function using an external direction select valve. This solenoid valve diverts the A and B flow to a different function while the main valve controls flow and direction.

Press the **2** or **3** soft key to set control of this function to Enabled or Disabled.

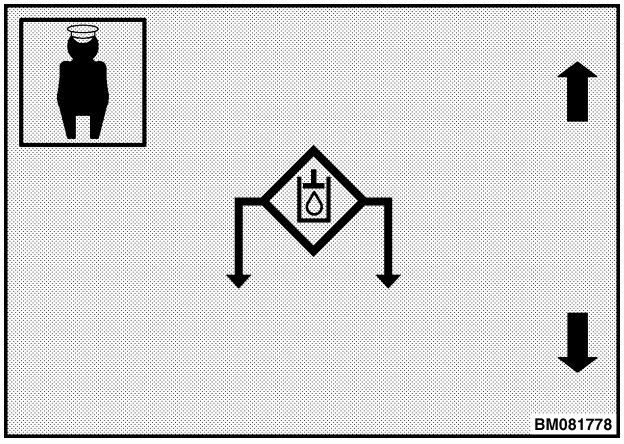


Figure 69. Hydraulic Accessories Setup Screen

REAR LIGHTS CONTROL

NOTE: This submenu is available to logged in Service Technicians only.

This menu permits a Service Technician to enable or disable the outputs that control brake, tail, and backup lamps. Figure 70 shows the Rear Lights Control Setup Screen.

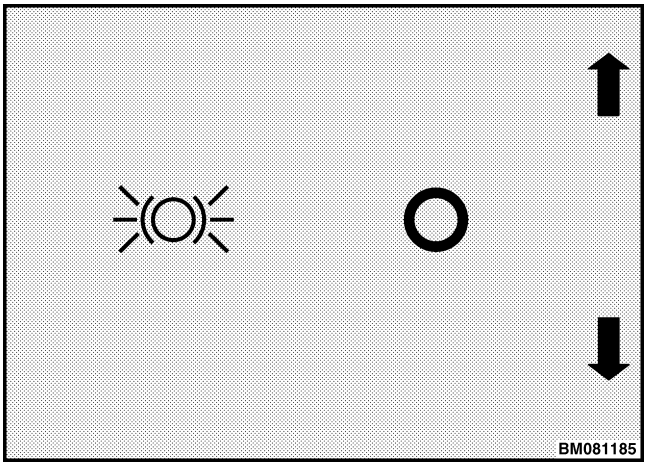


Figure 70. Rear Lights Control Setup Screen

Press the **2** or **3** soft key to set the outputs that control the rear lights to Enabled or Disabled.

RESTORE DEFAULT SETTINGS

NOTE: This submenu is available on all trucks to logged in Service Technicians and Supervisors.

This menu allows a Service Technician or Supervisor to change all adjustable truck settings back to their factory default settings. Calibrations are NOT reset when this function is used. Figure 71 shows the Restore Defaults Screen.

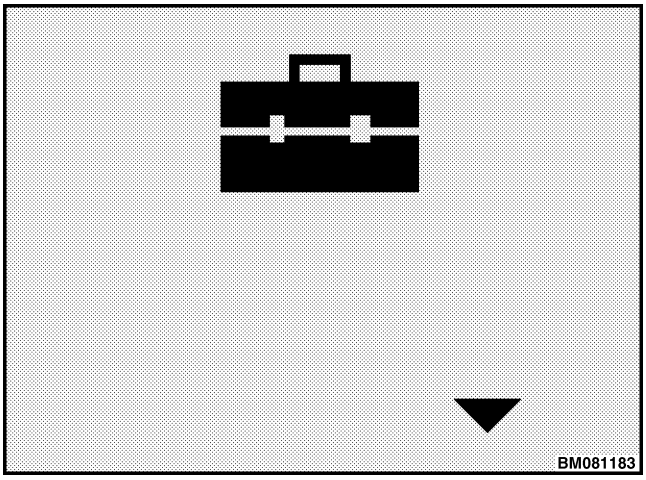


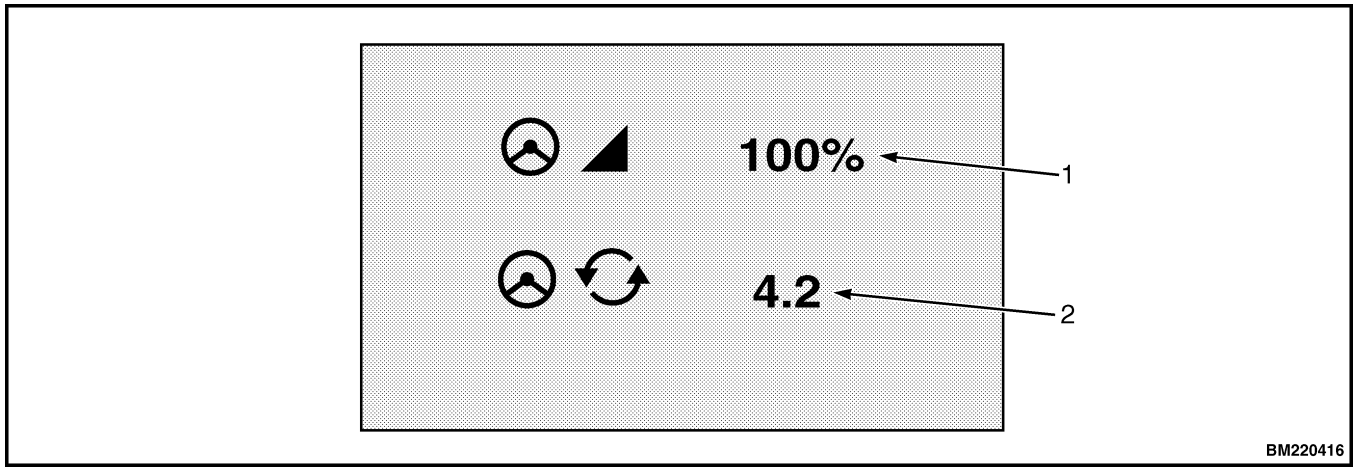
Figure 71. Restore Defaults Screen

While in this menu, press the **Enter Key** to restore all truck settings, except hour meters and system time, to their factory default settings. The system then returns to the Truck Setup Menu.

STEERING WHEEL FRICTION AND STEERING TURNS ADJUSTMENT

NOTE: This submenu is available to logged in Service Technicians and Supervisors.

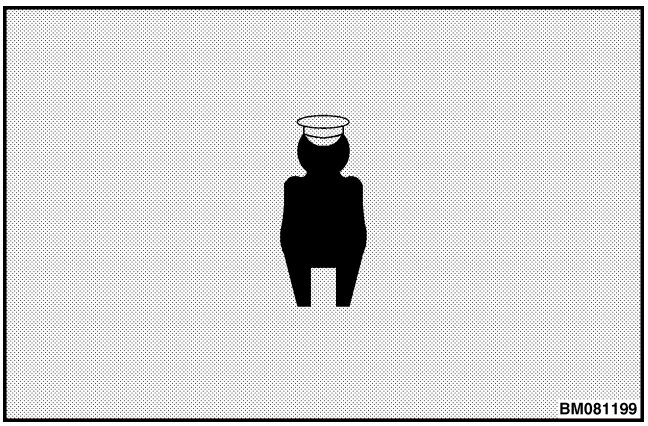
On trucks equipped with electronic steering or "E-Steer", this screen allows the operator to adjust the friction on the steering wheel and the number of steering wheel turns from stop to stop.

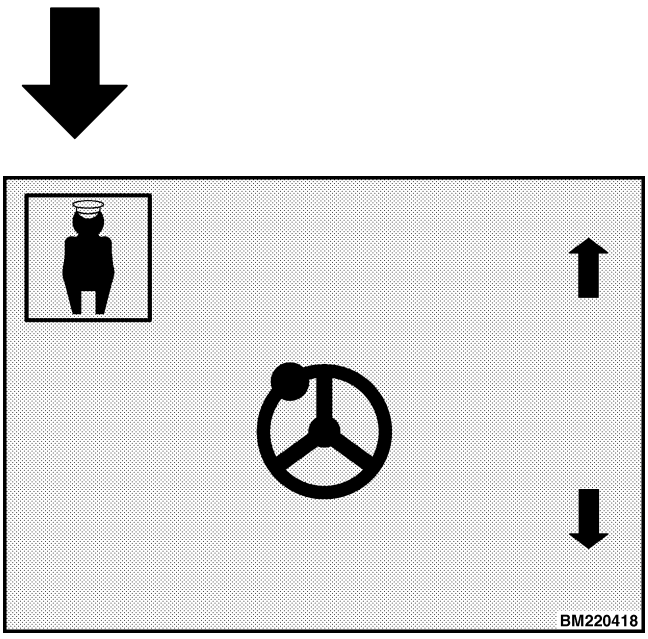


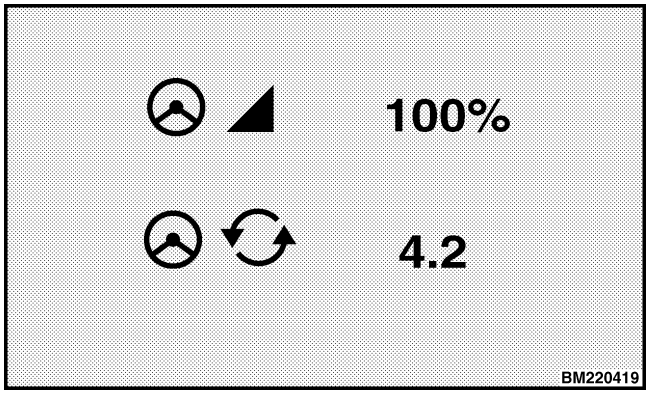
1. STEERING WHEEL FRICTION SETTING IN %
2. STEERING WHEEL NUMBER OF TURNS LOCK TO LOCK

Figure 72. Steering Wheel Friction and Steering Turns

Navigation







How to Adjust Settings

Steering Friction

1. Open the "Steering Wheel Friction and Steering Turns Adjustment" screen. See Figure 73.

2. Navigate cursor to the steering friction setting and press enter. See Figure 73.

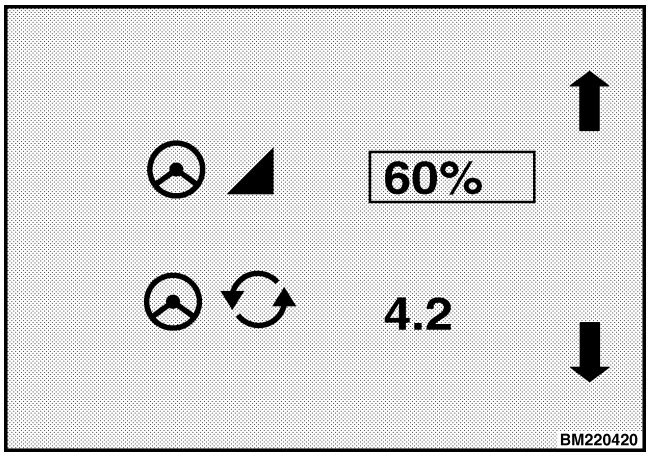


Figure 73. Steering Wheel Friction Adjustment Screen

NOTE: Setting must be within 0 to 100%. If out of range, setting will not be saved.

3. Enter adjustment using the keypad. See Figure 74.

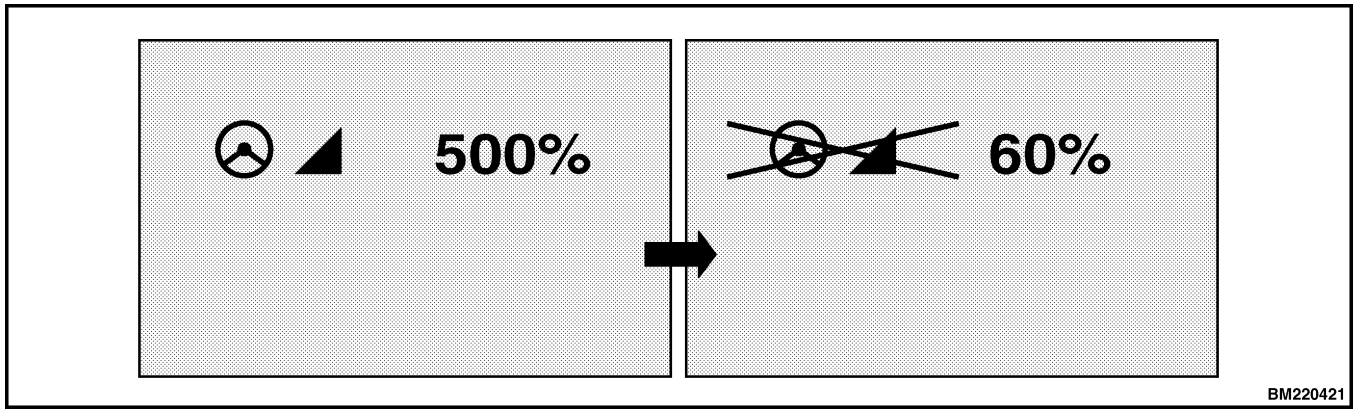


Figure 74. Steering Friction Adjustment and Out of Range Screens

4. If valid setting is entered, setting will be saved and shown on the screen. See Figure 75.

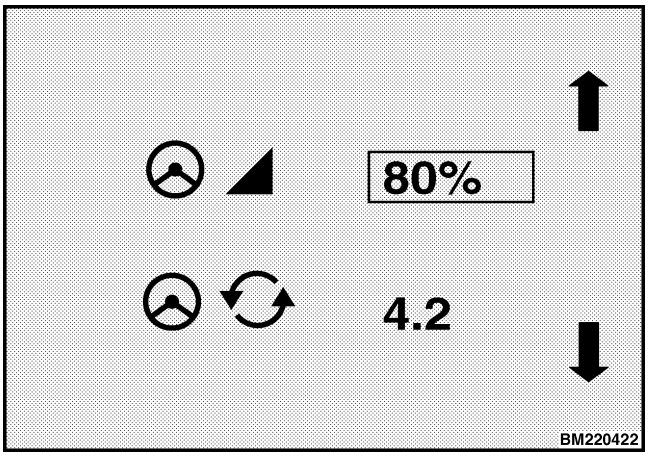


Figure 75. Steering Friction Screen, Valid Entry

Steering Wheel Number of Turns

1. Open the "Steering Wheel Friction and Steering Turns Adjustment" screen. See Figure 76.

2. Navigate cursor to the steering wheel number of turns settings and press enter. See Figure 76.

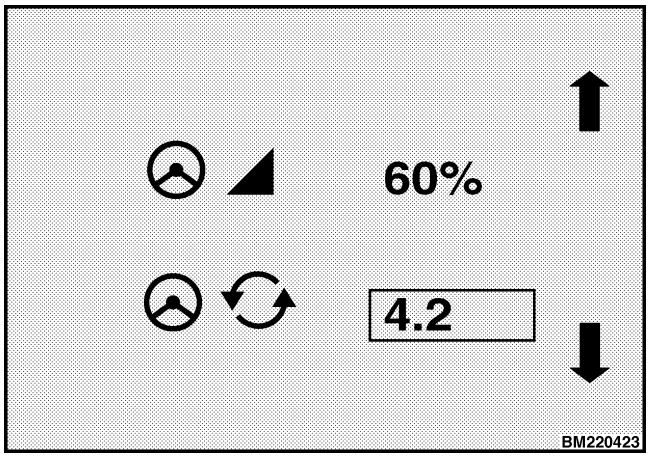


Figure 76. Steering Wheel Turns Adjustment Screen

NOTE: Settings must be within 4.0 and 6.0 turns. If out of range, settings will not be saved.

3. Enter adjustment using the keypad. See Figure 77.

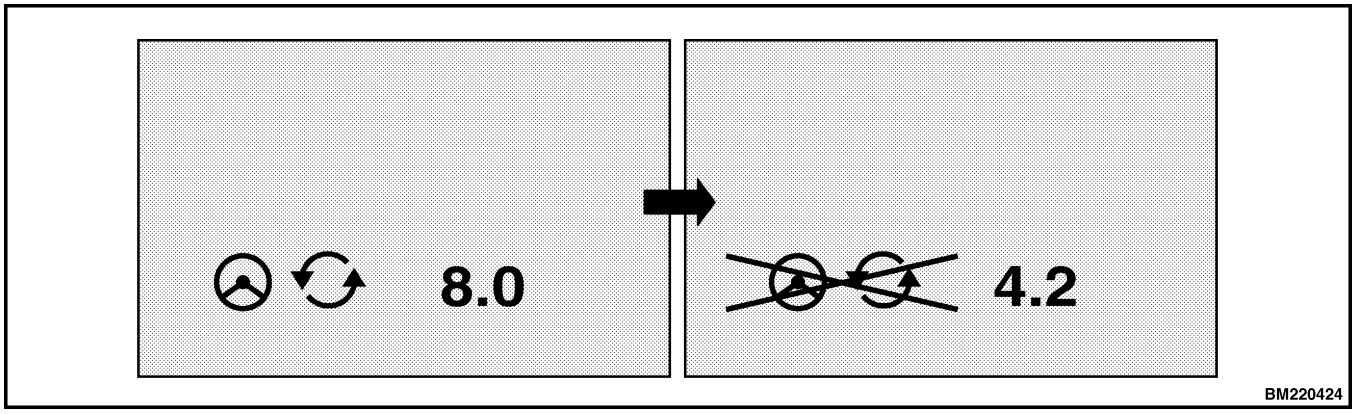


Figure 77. Steering Wheel Number of Turns Adjustment and Out of Range Screens

4. If valid setting is entered, setting will be saved and shown on the screen. See Figure 78.

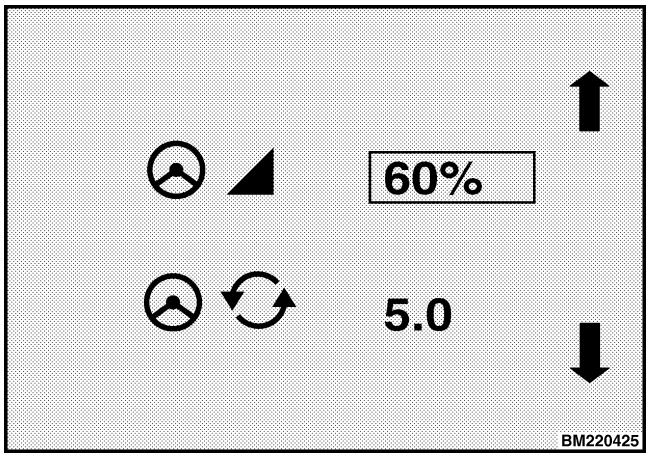


Figure 78. Steering Wheel Number of Turns, Valid Entry

Diagnostics Menu

INTRODUCTION

The Diagnostics Menu is a main menu (top-level menu) that is visible only at the Service Technician password access level. To enter this menu, cycle through the main menu title screens by pressing the **Scroll Back Key** (◂—) or **Scroll Forward Key** (—▸) until the Diagnostics Title Screen is displayed, as shown in Figure 79.

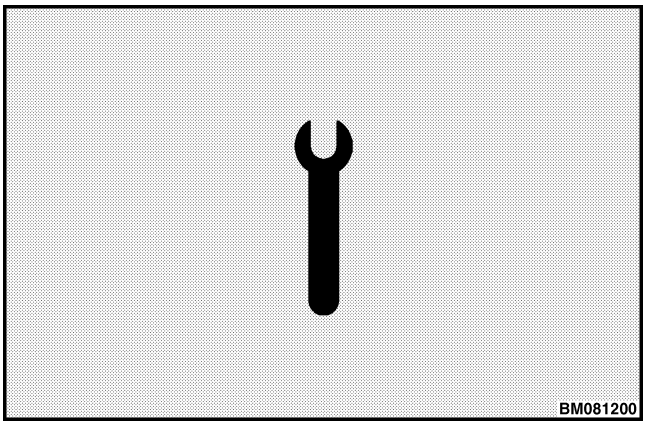


Figure 79. Diagnostics Title Screen

Press the **Enter Key** (*) to enter the Diagnostics Menu. The system will then display the first submenu in this menu, the Fault Code Log submenu, which is shown in Figure 80. Press the **Enter Key** again to enter this submenu. For a different submenu, use the **Scroll Back Key** or **Scroll Forward Key** to move to the desired submenu and press the **Enter Key**.

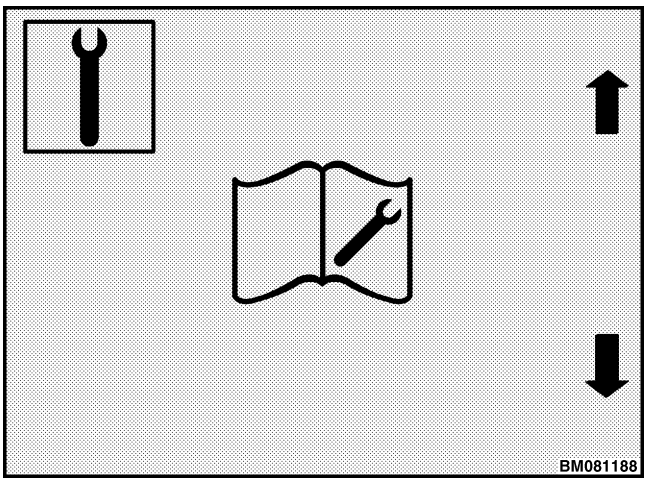


Figure 80. Fault Code Log Submenu

The Diagnostics Menu offers these submenus (see the Diagnostic Submenu Icons topic in the Icon Glossary):

- Fault Code Log
- Speedometer
- Direction Switch
- Traction Motor 1 Status
- Traction Motor 2 Status
- Occupancy Sensor
- Brake System Sensors
- Pump Status
- Hydraulic Control Inputs
- E-Hydraulic Valves
- Hydraulic Sensors
- System Voltages
- Steering Position Sensors

The following topics describe the Diagnostics submenus.

FAULT CODE LOG

Use this submenu to view the 20 most recent fault codes for any of these devices: Master Controller, Traction Controller 1 or 2, Pump Controller, Light Controller, E-Hydraulics, Impact, or Display.

NOTE: Pressing the **Scroll Back Key** or **Scroll Forward Key** returns the user to the Diagnostics Menu list.

Figure 81 shows how the devices appear on the display. The Master Controller's fault log displays first.

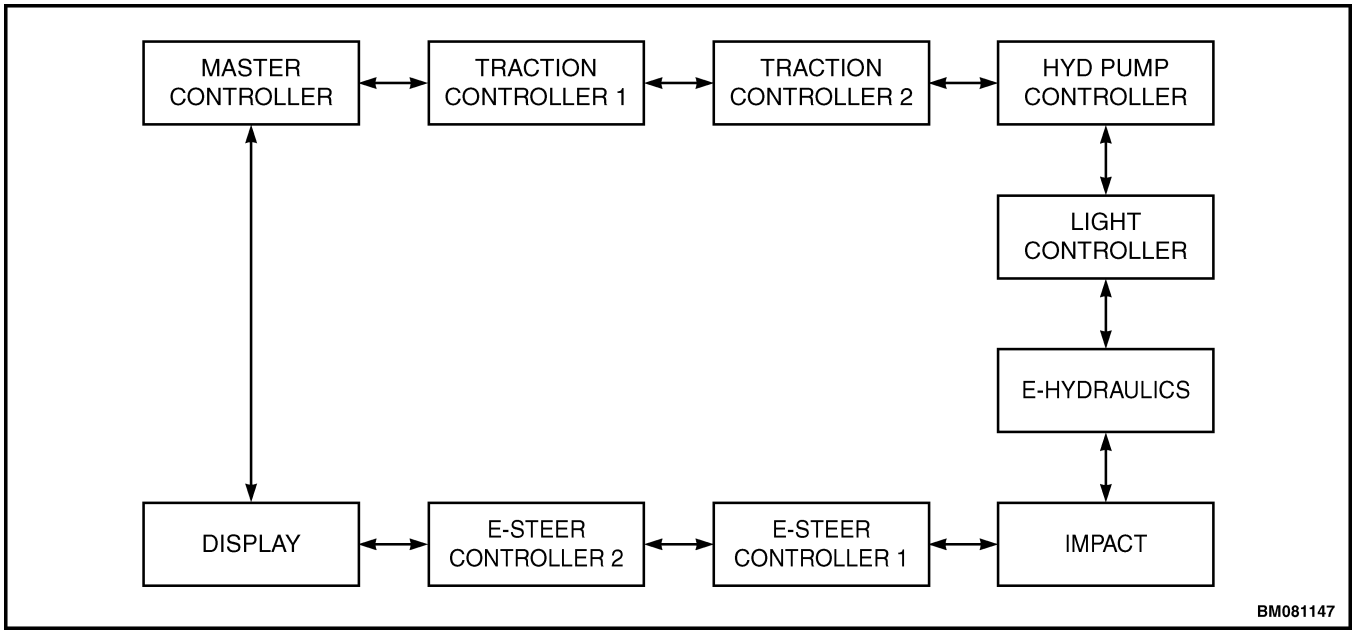


Figure 81. Fault Log Menu Order

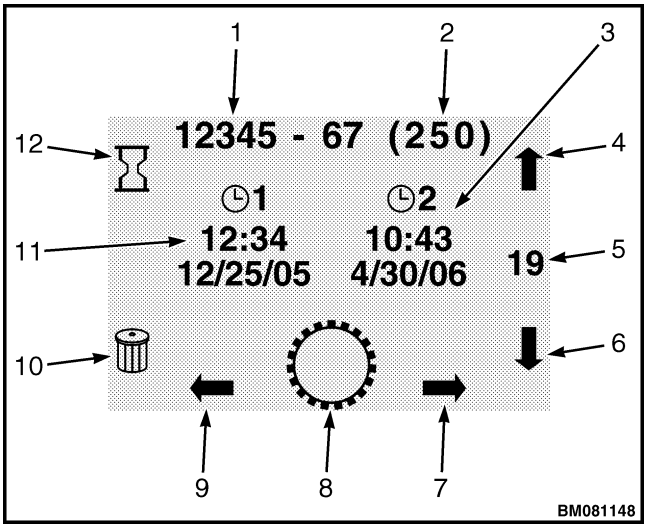
Press the **2** Up Arrow soft key to view a previous log or press the **3** Down Arrow soft key to view the next log.

To clear the fault log for the device being viewed, press the **4** soft key near the Trash Can Icon.

Fault Log Details

Each log entry presents the fault code, the number of occurrences, the truck hour at the time of the first occurrence, the system time at the first occurrence, and the system time at the last occurrence.

The system shows either the system time of the occurrences or the hour meter reading of the occurrences as shown in Figure 82. Press the **1** soft key next to the hour glass or clock Icon in the upper left corner of the display to switch between display of system times or hour meter readings.

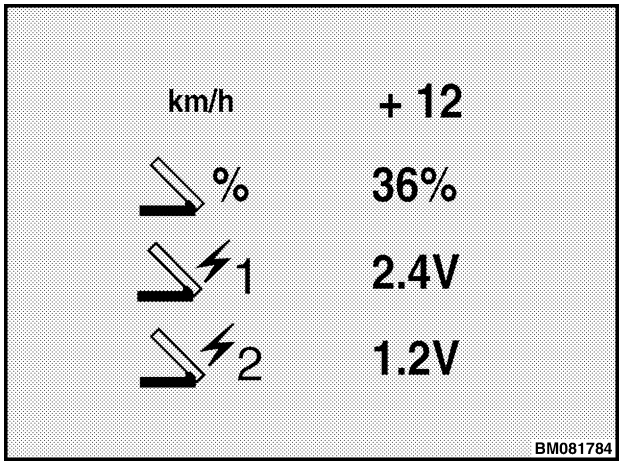


1. FAULT CODE
2. OCCURRENCE COUNT
3. HOUR METER/TITLE STAMP OF LAST OCCURRENCE
4. SOFT KEY - VIEW PREVIOUS LOG FAULT ENTRY
5. FAULT LOG ENTRY NUMBER
6. SOFT KEY - VIEW NEXT LOG FAULT ENTRY
7. SOFT KEY - VIEW FAULT LOG OF NEXT ENTRY
8. DEVICE INDICATOR
9. SOFT KEY - VIEW FAULT LOG OF PREVIOUS ENTRY
10. TRASH CAN SOFT KEY - CLEARS FAULT LOG
11. HOUR METER/TIME STAMP OF FIRST OCCURRENCE
12. SOFT KEY - CHANGES BETWEEN SYSTEM TIMES AND HOUR METERS

Figure 82. Fault Log Example

SPEEDOMETER

Use this submenu to view the current wheel based travel speed, which is shown in MPH or km/h. A positive value indicates a forward travel speed; a negative value indicates a reverse travel speed.



The type of speed units, MPH or km/h is set in a submenu of the Display main menu.

The accelerator pedal percentage indicator displays the current calculated accelerator pedal percent, where less than 2% is considered a fully released accelerator pedal and 100% is considered fully applied accelerator pedal.

Accelerator pedal voltage 1 is used to calculate the position of the accelerator pedal.

Accelerator pedal voltage 2 is used for diagnostic purposes.

DIRECTION SWITCH

Use this submenu to view the current status of the direction switch. A solid (filled) up arrow indicates the currently selected direction is forward as shown in Figure 83.

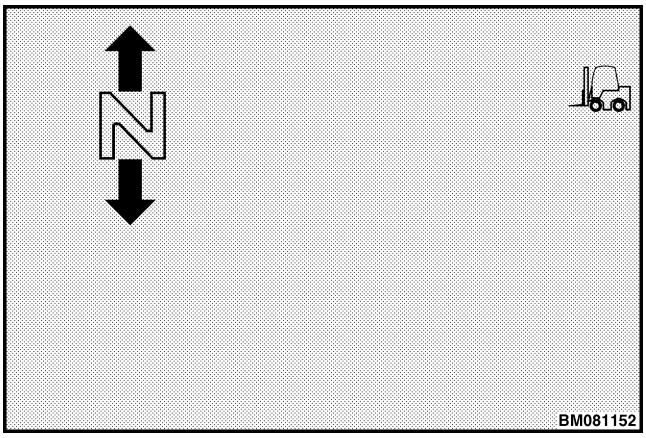


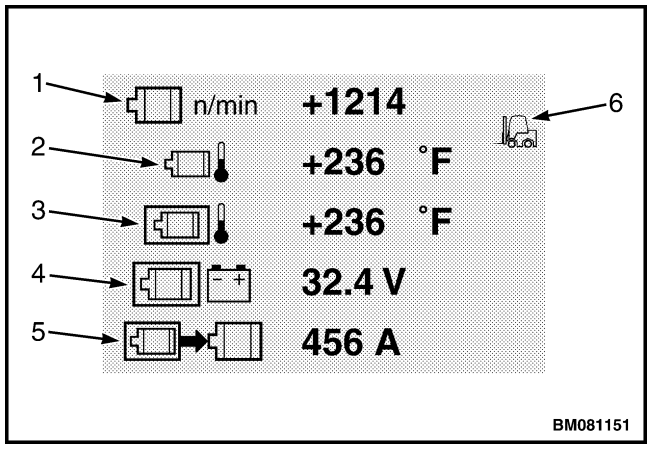
Figure 83. Direction Switch Example

If both directions are indicated on the display, it means the user has pressed both the forward and reverse switches on a Monotrol pedal.

When a Null Icon (circle with diagonal line across it) appears over the Forklift Truck Icon in the top right corner of the screen, it means traction and hydraulics are deactivated.

TRACTION MOTOR 1 STATUS

Figure 84 shows the Traction Motor 1 Status screen.



1. MOTOR RPM
2. MOTOR TEMPERATURE
3. CONTROLLER TEMPERATURE
4. MOTOR CONTROLLER VOLTAGE
5. MOTOR RMS CURRENT
6. FORKLIFT TRUCK ICON

Figure 84. Motor Status Example

The value to the right of the icon at the top of the screen is the traction pump motor's current RPM.

The second value down from the top is the temperature of the pump motor. Temperatures are shown in degrees Fahrenheit or Celsius, depending on the units assigned in the Set Units item on the Maintenance Menu.

The third value down is the temperature of the controller.

The fourth value down is the motor controller voltage (or the battery voltage read by the controller).

The fifth value down is the RMS (Root Mean Squared) AC current from the motor to the controller in Amperes.

When there is a Null Icon over the Forklift Truck Icon in the top right corner of the screen, it indicates traction and hydraulics are deactivated.

TRACTION MOTOR 2 STATUS

This screen is the identical to the Traction Motor 1 Status screen. It is displayed only if the truck has dual traction motors.

OCCUPANCY SENSOR

Figure 85 shows the Occupancy Sensor screen.

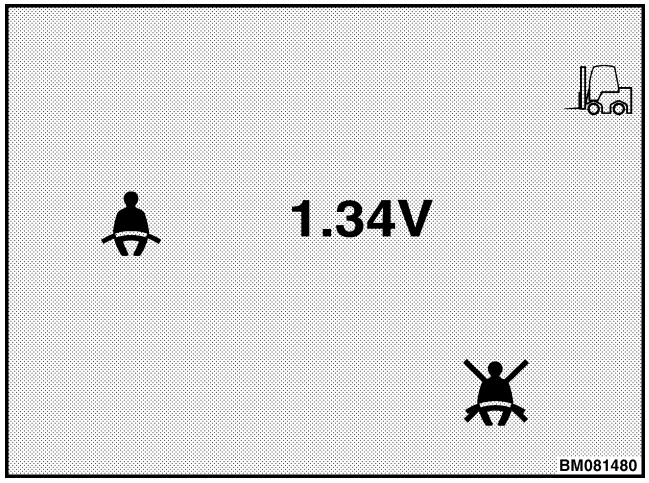


Figure 85. Occupancy Sensor Screen

The value to the right of the Seat Indicator Icon is the current voltage of the occupancy sensor.

If seat belt monitoring is engaged, the seat belt status is also shown by the icon in the lower right corner of the screen. If the occupancy sensor detects the presence of an operator, the Seat Belt Icon is shown; if the seat is not occupied, an X is displayed over the Seat Belt Icon.

When there is a Null Icon over the Forklift Truck Icon in the top right corner of the screen, it indicates traction and hydraulics are deactivated.

BRAKE SYSTEM SENSORS

Figure 86 illustrates the Brake System Sensors screen, which presents the current voltages of the park brake, the brake fluid sensor, and the brake pressure system.

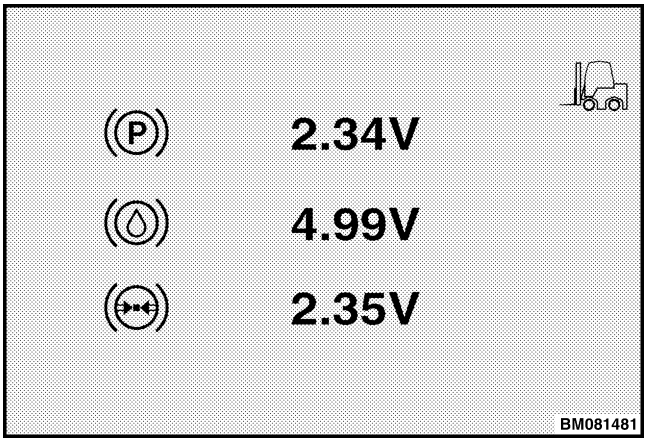


Figure 86. Brake Diagnostics Screen

The value to the right of the Park Brake Icon is the current voltage reading from the park brake's position sensor.

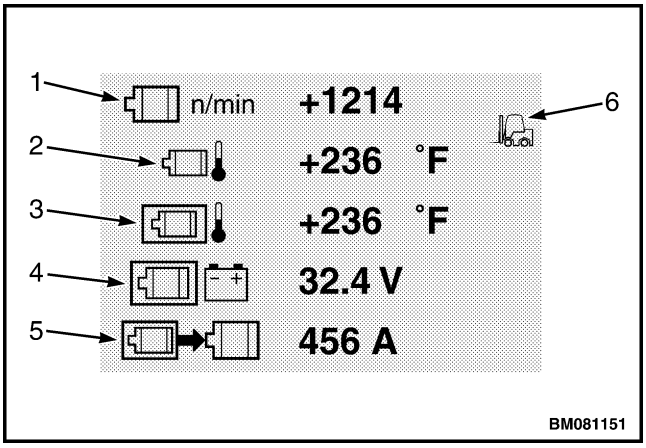
The second value down is the current voltage reading from the brake fluid sensor.

The third value down is the current voltage reading from the brake pressure sensor.

When there is a Null Icon over the Forklift Truck Icon in the top right corner of the screen, it indicates traction and hydraulics are deactivated.

PUMP STATUS

Figure 87 shows the Pump Status screen, which shows the pump motor's RPM, the temperature of the motor and temperature of the controller, the battery voltage read by the controller, and the AC current reading.



1. MOTOR RPM
2. MOTOR TEMPERATURE
3. CONTROLLER TEMPERATURE
4. MOTOR CONTROLLER VOLTAGE
5. MOTOR RMS CURRENT
6. FORKLIFT TRUCK ICON

Figure 87. Pump Motor Status Screen

The value to the right of the icon at the top of the screen is the traction pump motor's current RPM.

The second value down from the top is the current temperature of the pump motor. Temperatures are shown in degrees Fahrenheit or Celsius, depending on the units assigned in the Set Units item on the Maintenance Menu.

The third value down is the current temperature of the controller.

The fourth value down is the motor controller voltage.

The fifth value down is the RMS (Root Mean Squared) AC current from the motor to the controller in Amperes.

When there is a Null Icon over the Forklift Truck Icon in the top right corner of the screen, it indicates traction and hydraulics are deactivated.

HYDRAULIC CONTROL INPUTS

This screen, shown in Figure 88, displays input position information from the hydraulic function controls, including lever positions for lift/lower, forward/backward, Auxiliary 1 input, Auxiliary 2 input, and any digital switches as indicated by the controllers. Auxiliary inputs are displayed only on trucks equipped with hydraulic function controls 3-4.

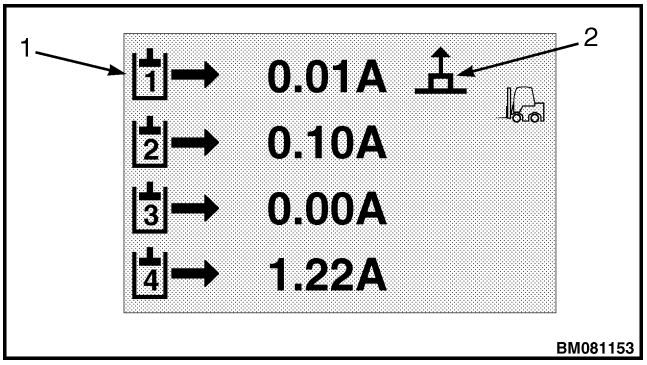
Figure 88. Hydraulic Control Inputs Diagnostics

Use the **1** and **4** soft keys to select the hydraulic function control you want to view. Digital switch input, or Button Status, is shown as pressed or released for each displayed lever input. If the Hydraulics controller reports the switch is not available, the switch state is displayed in the released position. Controller motions to the rear of the truck (B direction) are shown as negative values.

When there is a Null Icon over the Forklift Truck Icon in the top right corner of the screen, it indicates traction and hydraulics are deactivated.

E-HYDRAULIC VALVES

This screen is a submenu that displays the electrical current output information from the hydraulic controls known as Hydraulic Functions 1-4. It provides current feedback from each of the equipped E-Hydraulic valves (also called Electro-Hydraulic valves). Data shown includes amperes (A) and the present state of the Auxiliary Function Solenoid; that is, whether it is Engaged or Not Engaged. This menu displays only on trucks equipped with E-Hydraulics, which provides hydraulic functions 1-4. See Figure 88.



1. HYDRAULIC FUNCTION 1
2. AUXILIARY FUNCTION SOLENOID

Figure 89. E-Hydraulic Valves Menu

The value on the right hand side of the Hydraulic Function 1 Icon at the top of the screen shows the Hydraulic Function 1 amperes of the valve assembly for lift/lower.

The second value down from the top of the screen shows the Hydraulic Function 2 amperes for the valve assembly for tilt forward/back.

The third, fourth, and fifth values down are for the Auxiliary 1 and 2 inputs. Since these inputs are optional, they are displayed only if the truck is equipped with them. The third value down shows the Hydraulic Function 3 (Auxiliary 1 input) amperes and the fourth value down shows the Hydraulic Function 4 (Auxiliary 2 input) amperes.

When the ampere value is a positive number, it is a value in the A direction (the A direction means motion toward the front or the right of the truck). If the value is a negative number, the value shown is in the B direction (motion toward the rear or the left of the truck).

If the forklift truck is equipped with this function, the state of the auxiliary function solenoid is displayed. This icon at the top of the screen indicates whether the valve assembly is released or pressed. If the auxiliary function solenoid is being driven, the engaged icon is displayed and the icon has an up arrow. If this solenoid is not being driven, the disengaged icon is shown and the icon has a down arrow.

The Forklift Truck Icon in the top right corner of the screen shows whether truck operations are enabled or disabled. If a Null Icon overlays the Forklift Truck Icon, traction and hydraulics are deactivated.

To enable traction and hydraulics, press the **2** soft key.

HYDRAULIC SENSORS

Figure 90 displays the current temperature of the hydraulic tank and the current voltages of the mast tilt sensor, the mast height sensor, and the hydraulic pressure sensor that detects load weight.

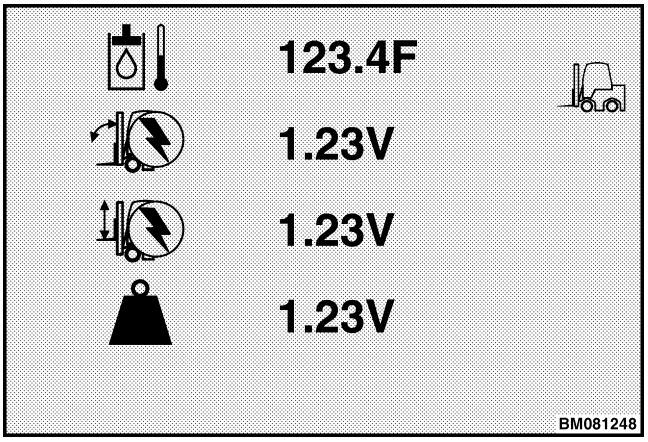


Figure 90. Mast Diagnostics Screen

The current temperature of the hydraulic tank is the value at the top of the screen.

The second value down from the top of the screen is the current voltage of the mast tilt sensor.

The third value down is the current voltage of the mast height sensor.

The fourth value down is the hydraulic pressure sensor that detects load weight.

When the Forklift Truck Icon in the top right corner of the screen has a Null Icon over it, it indicates traction and hydraulics are deactivated.

SYSTEM VOLTAGES

Figure 91 shows the System Voltage Diagnostics screen.

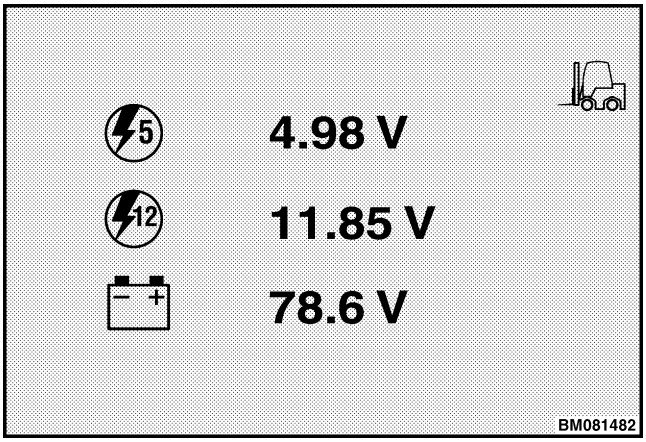


Figure 91. Voltage Diagnostics Screen

The value to the right of the top icon is the current system operating voltage of the 5 V supply.

The value to the right of the second icon down from the top of the screen is the current system operating voltage of the 12 V supply.

The value to the right of the third icon down is the battery voltage.

STEERING POSITION SENSORS

Figure 92 shows the Steering Sensor screen.

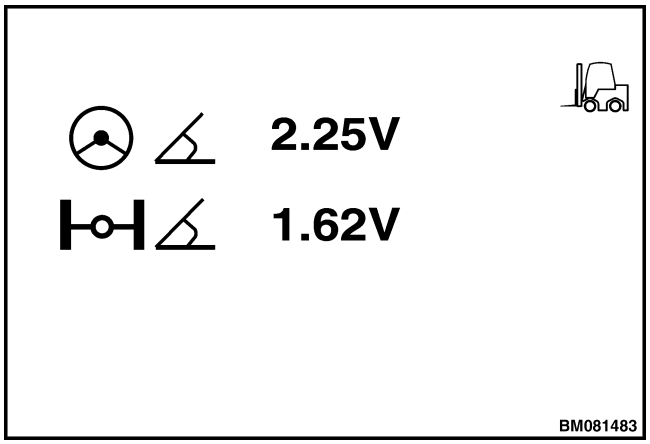


Figure 92. Steering Sensor Screen

This submenu displays the current voltage output from the steering wheel and axle position sensors. The status of the axle position displays only on trucks equipped with either dual traction motors of the Steer Synchronization feature.

E-STEERING POSITION SENSORS

Figure 93 shows the E-Steering Sensor screen, which shows the torque friction device current indicator, e-steer controller 1 steering wheel position indicator, e-steer controller 2 steering wheel position indicator, e-steer controller 1 axle position indicator, and e-steer controller 2 axle position indicator.

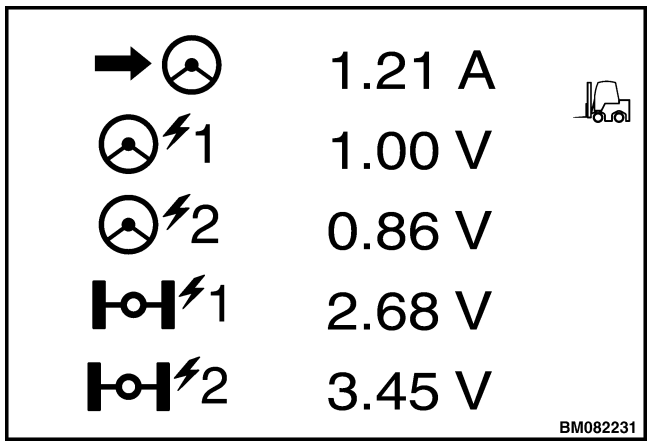


Figure 93. E-Steering Sensor Screen

The value to the right of the icon at the top of the screen is the current through torque friction device.

The second value down from the top is the steering wheel position sensor voltage as reported by e-steer controller 1.

The third value down from the top is the steering wheel position sensor voltage as reported by e-steer controller 2.

The fourth value down from the top is the steer axle position sensor voltage as reported by e-steer controller 1. This is visible only when the truck is equipped with dual traction controllers or Steer Synchronization feature.

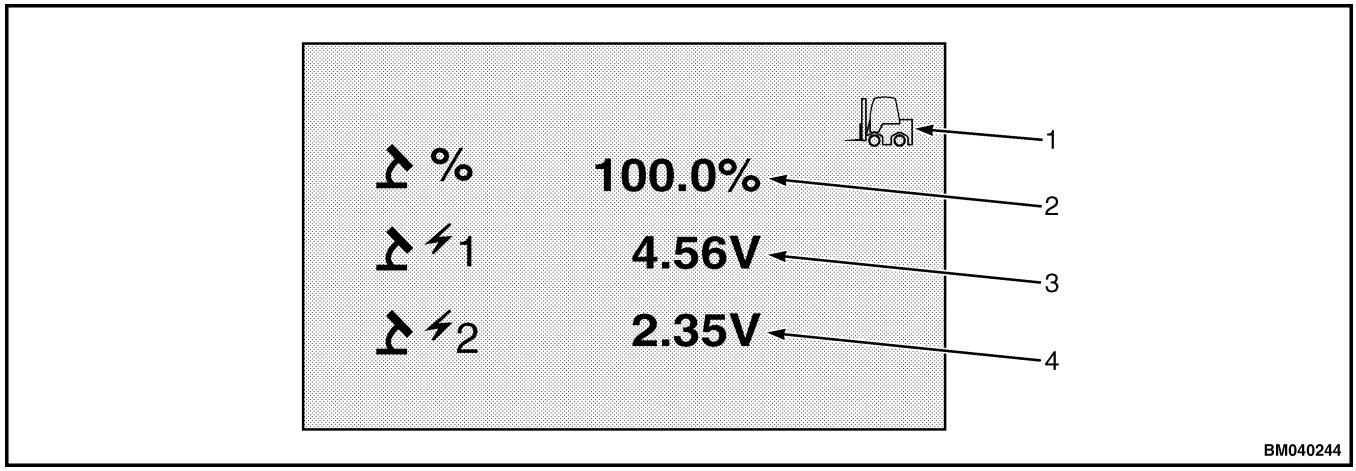
The fifth value down from the top is the steer axle position sensor voltage as reported by e-steer controller 2. This is visible only when the truck is equipped with dual traction controllers or Steer Synchronization feature.

When there is a Null Icon over the Forklift Truck Icon in the top right corner of the screen, it indicates traction and hydrualics are deactivated.

ELECTRIC BRAKE

NOTE: This submenu is available to logged in Service Technicians.

On trucks equipped with electric brake, this screen displays the brake percentage and signal outputs.

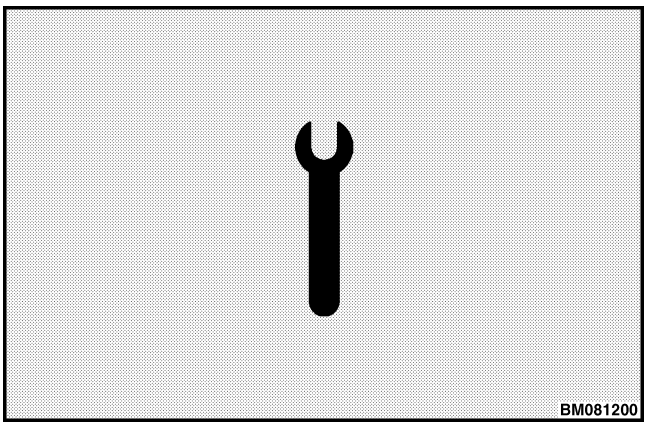


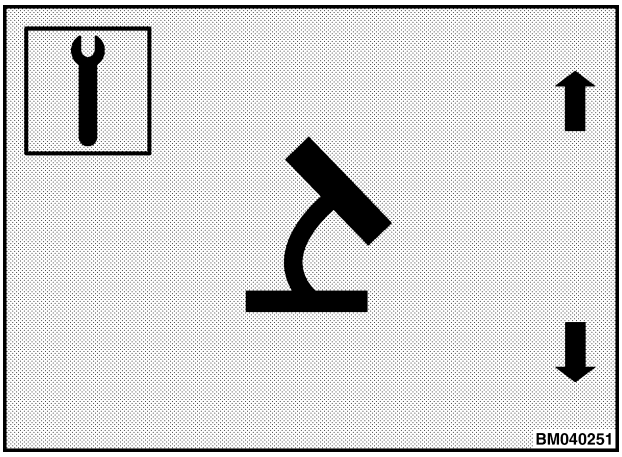
1. TRACTION ENABLE/DISABLE
2. BRAKE PEDAL PERCENTAGE
3. BRAKE PEDAL SIGNAL 1 OUTPUT
4. BRAKE PEDAL SIGNAL 2 OUTPUT

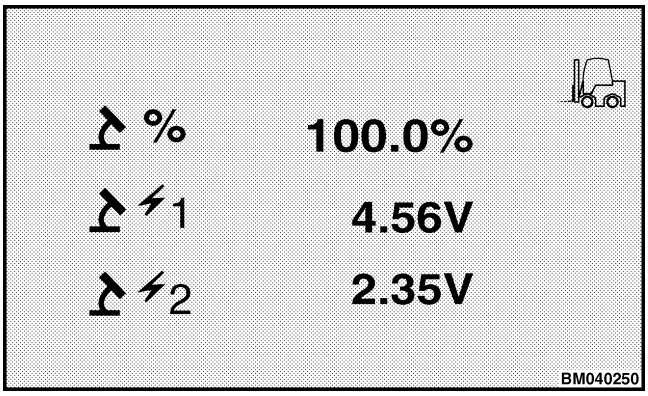
Figure 94. Signal Ouput and Brake Percentage

Number	Symbol	Meaning
1		Traction enable/disable Icons Forklifts without overlay - Enables Traction and Hydraulics Forklifts with overlay - Disables Traction and Hydraulics
2		Brake pedal percentage Icon
3		Brake pedal signal 1 output Icon
4		Brake pedal signal 2 output Icon

Navigation



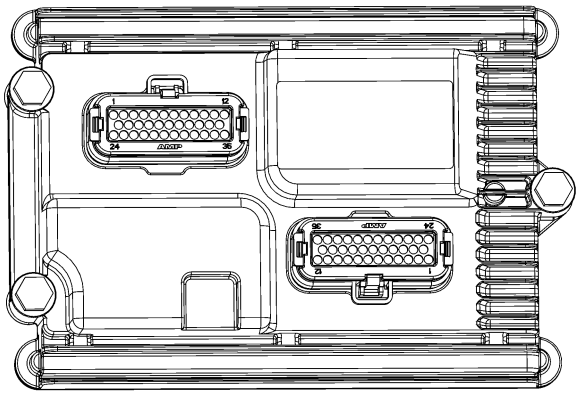




NOTES

ELECTRICAL SYSTEM

E4.0-5.5XN, E5.0XNS
(E80-120XN, E100XNS) [A099];
E2.2-3.5XN (E45-70XN) [A268];
E1.6-2.0XN (E30-40XN) [A269];
J2.2-3.5XN (J45-70XN) [A276];
J4.0-5.0XN, J5.0-5.5XN6
(J80-120XN, J100XNL) [A970]



HYSTER

PART NO. 1688880

2200 SRM 1369

SAFETY PRECAUTIONS
MAINTENANCE AND REPAIR

- The Service Manuals are updated on a regular basis, but may not reflect recent design changes to the product. Updated technical service information may be available from your local authorized Hyster® dealer. Service Manuals provide general guidelines for maintenance and service and are intended for use by trained and experienced technicians. Failure to properly maintain equipment or to follow instructions contained in the Service Manual could result in damage to the products, personal injury, property damage or death.
- When lifting parts or assemblies, make sure all slings, chains, or cables are correctly fastened, and that the load being lifted is balanced. Make sure the crane, cables, and chains have the capacity to support the weight of the load.
- Do not lift heavy parts by hand, use a lifting mechanism.
- Wear safety glasses.
- DISCONNECT THE BATTERY CONNECTOR before doing any maintenance or repair on electric lift trucks. Disconnect the battery ground cable on internal combustion lift trucks.
- Always use correct blocks to prevent the unit from rolling or falling. See HOW TO PUT THE LIFT TRUCK ON BLOCKS in the **Operating Manual** or the **Periodic Maintenance** section.
- Keep the unit clean and the working area clean and orderly.
- Use the correct tools for the job.
- Keep the tools clean and in good condition.
- Always use **HYSTER APPROVED** parts when making repairs. Replacement parts must meet or exceed the specifications of the original equipment manufacturer.
- Make sure all nuts, bolts, snap rings, and other fastening devices are removed before using force to remove parts.
- Always fasten a DO NOT OPERATE tag to the controls of the unit when making repairs, or if the unit needs repairs.
- Be sure to follow the **WARNING** and **CAUTION** notes in the instructions.
- Gasoline, Liquid Petroleum Gas (LPG), Compressed Natural Gas (CNG), and Diesel fuel are flammable. Be sure to follow the necessary safety precautions when handling these fuels and when working on these fuel systems.
- Batteries generate flammable gas when they are being charged. Keep fire and sparks away from the area. Make sure the area is well ventilated.

NOTE: The following symbols and words indicate safety information in this manual:

WARNING

Indicates a hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION

Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury and property damage.

On the lift truck, the WARNING symbol and word are on orange background. The CAUTION symbol and word are on yellow background.

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This section is for the following models:

E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) [A099];
E2.2-3.5XN (E45-70XN) [A268];
E1.6-2.0XN (E30-40XN) [A269];
J2.2-3.5XN (J45-70XN) [A276];
J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) [A970]

General

The removal and replacement procedures for the following electrical components are covered in this service manual:

- Display panel
- Electronic and manual hydraulic control components
- Motor controllers
- Sensors and switches
- Lights
- Fuses, alarm and horn
- Battery
- Vehicle System Manger (VSM)

For adjustment procedure for switches located on linkage for manual control valve,

-
-

See **Main Control Valves** 2000SRM1334 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268)
- J2.2-3.5XN (J45-70XN) (A276)
- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)
- E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

See **Main Control Valves** 2000SRM1439 for lift truck models

- E1.6-2.0XN (E30-40XN) (A269)

If lift truck is equipped with an E-Hydraulic control valve, see section below for replacement procedures for Electro-Hydraulic Valve Driver Module:

-
-

See **Main Control Valves** 2000SRM1334 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268)
- J2.2-3.5XN (J45-70XN) (A276)
- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)
- E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

See **Main Control Valves** 2000SRM1439 for lift truck models

- E1.6-2.0XN (E30-40XN) (A269)

For information on servicing and maintaining AC hydraulic pump motor for all lift truck models covered in this manual and for traction motor on lift truck models E2.2-3.5XN (E45-70XN) (A268) , see **AC Motor Repair** 0620SRM1385.

For information on battery for all lift truck models covered in this manual see **Industrial Battery** 2240SRM0001.

For information on servicing and maintaining transaxle motors:

-
-

See **Transaxle** 1300SRM1370 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276)

See **Transaxle** 1300SRM1539 for lift truck models

- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

See **Drive Axle, Speed Reducer, and Differential** 1300SRM1366 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268)
- E1.6-2.0XN (E30-40XN) (A269)
- E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

If any of wire harnesses need to be repaired, see **Wire Harness Repair** 2200SRM1128 for repair procedures.

Some components used are made of plastic. When using screws to replace and install plastic components, screws should be rotated counterclockwise until screw thread turns over the last thread in the plastic part. The screw can then be turned clockwise to make a connection. This prevents "cutting" new threads and damaging existing thread in plastic components.

If any welding must be done, obtain proper authorization from a Resident Service Engineer. If authorization is given, be sure to follow procedures in **WARNING** and **CAUTIONS** below.

WARNING

Forklift frames and components may be painted with a catalyzed paint such as polyurethane or a two-part primer. Welding, burning, or other heat sufficient to cause thermal decomposition of the paint may release isocyanates. These chemicals are allergic sensitizers to the skin and respiratory tract and overexposure may occur without odor warning. Should work be performed, utilize good industrial hygiene practices including removal of all paint (prime and finish coats) to the metal around the area to be welded, local ventilation, and/or supplied-air respiratory protection.

CAUTION

When an arc welder is used, always disconnect the battery connector on the lift truck. This action will prevent damage to the motor controllers.

Connect the ground clamp for the arc welder as close as possible to the weld area. This action will prevent damage to a bearing from the large current from the welder.

Before performing arc welding repairs, disconnect motor controller and VSM connections to prevent damage to motor controllers and VSM. See sections Motor Controllers Replacement and Vehicle Systems Manager for procedures.

DISCHARGING THE CAPACITORS

WARNING

DO NOT make repairs or adjustments unless you have been properly trained and authorized to do so. Improper repairs and adjustments can create dangerous operating conditions. DO NOT operate a lift truck that needs repairs. Report the need for repairs to your supervisor immediately. If repair is necessary, attach a DO NOT OPERATE tag on the steering wheel and disconnect the battery.

Disconnect the battery and allow the capacitors to discharge before opening any compartment covers or inspecting or repairing the electrical system. DO NOT place tool on top of the battery. If a tool causes a short circuit, the high current flow from the battery can cause personal injury and property damage.

Some checks and adjustments are performed with the battery connected. DO NOT connect the battery until the procedure instructs you to do so. Never wear any metallic items on your fingers, arms, or neck. Metal items can accidentally make an electrical connection and cause injury.

Before performing any tests or adjustment, block the lift truck to prevent unexpected movement.

The capacitor in the transistor controller(s) can hold an electrical charge for about 10 seconds after the battery is disconnected. To prevent an electrical shock and personal injury, discharge the capacitor(s) before inspecting or repairing any component in the drive unit compartment. Make certain that the battery has been disconnected.

DO NOT short across the motor controller terminals with a screwdriver or jumper wire.

Make certain the Emergency-Disconnect switch has not been activated. This will isolate the controllers and prevent the capacitors from discharging properly. The proper way to disconnect the battery is by separating the battery connectors.

1. Ensure capacitors are discharged by performing Step 2 through Step 6 below.
2. Turn key or keyless switch to **OFF** position.
3. Disconnect battery by separating connectors.
4. Block drive wheels to prevent lift truck from moving.
5. Make sure Emergency-Disconnect switch **HAS NOT** been activated. If Emergency-Disconnect switch is activated, rotate switch to the right until it pops up.
6. Press horn button. Wait 30 seconds to be sure capacitors are fully discharged.

If a torque value is not specified, go to **Metric and Inch (SAE) Fasteners** 8000SRM0231 for torque values.

Display Panel and Key or Keyless Switch Replacement

DISPLAY PANEL, REPLACE

Remove

WARNING

Before replacing the display panel, fully lower all parts of the mast and tilt it forward until the tips of the forks touch the ground. This action will prevent the mast from lowering suddenly if the control lever is accidently moved.

WARNING

Disconnect the battery before doing any work on the electrical system. Serious injury to personnel and/or damage to lift truck components can occur if battery is not disconnected.

Discharge capacitors as directed in Discharging the Capacitors in General section of this manual.

CAUTION

A short circuit and damage can occur if wires are not installed correctly. Make sure wire connectors do not touch the other meter terminals or wire connectors, metal brackets, or the bracket mounting nuts. Make sure the wires are not pulled tight and are not touching other parts to damage the insulation.

NOTE: The display panel cannot be repaired and must be replaced as a unit, if it has a malfunction. See **Parts Manual** for replacement part number. The key or keyless switch can be replaced without replacing the whole display panel.

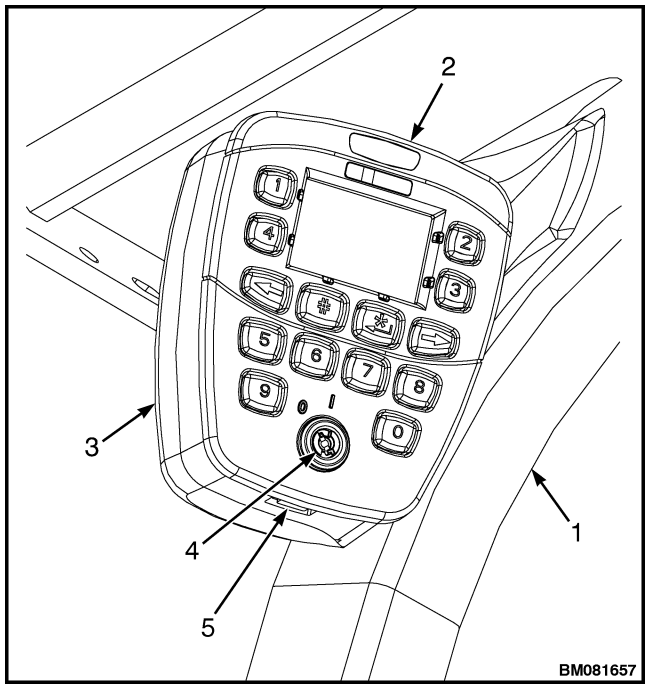
The high mount display panel is mounted inside of a display panel cover. The display panel cover is mounted to a bracket on upper right corner of overhead guard. See Figure 1.

The optional low mount display panel is mounted inside of a display panel cover. The display panel cover is mounted on a bracket which is mounted in the middle of the right front leg of the overhead guard. See Figure 2.

1. Read and follow **WARNING** and **CAUTION** above.
2. Insert a flat head screwdriver in slot on the bottom of display panel.

   See Figure 1 for high mount display panel.

   See Figure 2 for low mount display panel.
3. Pull screwdriver down to loosen display panel from slot. When display panel is loose from slot, pull display panel out of display panel cover. See Figure 3 .



NOTE: STANDARD KEY SWITCH SHOWN.

1. OVERHEAD GUARD
2. DISPLAY PANEL
3. DISPLAY PANEL COVER
4. KEY OR KEYLESS SWITCH
5. SLOT

Figure 1. High Mount Display Panel Arrangement

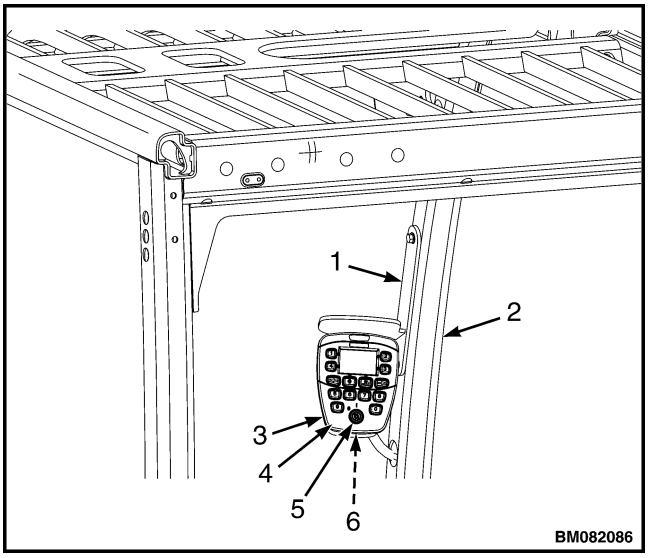
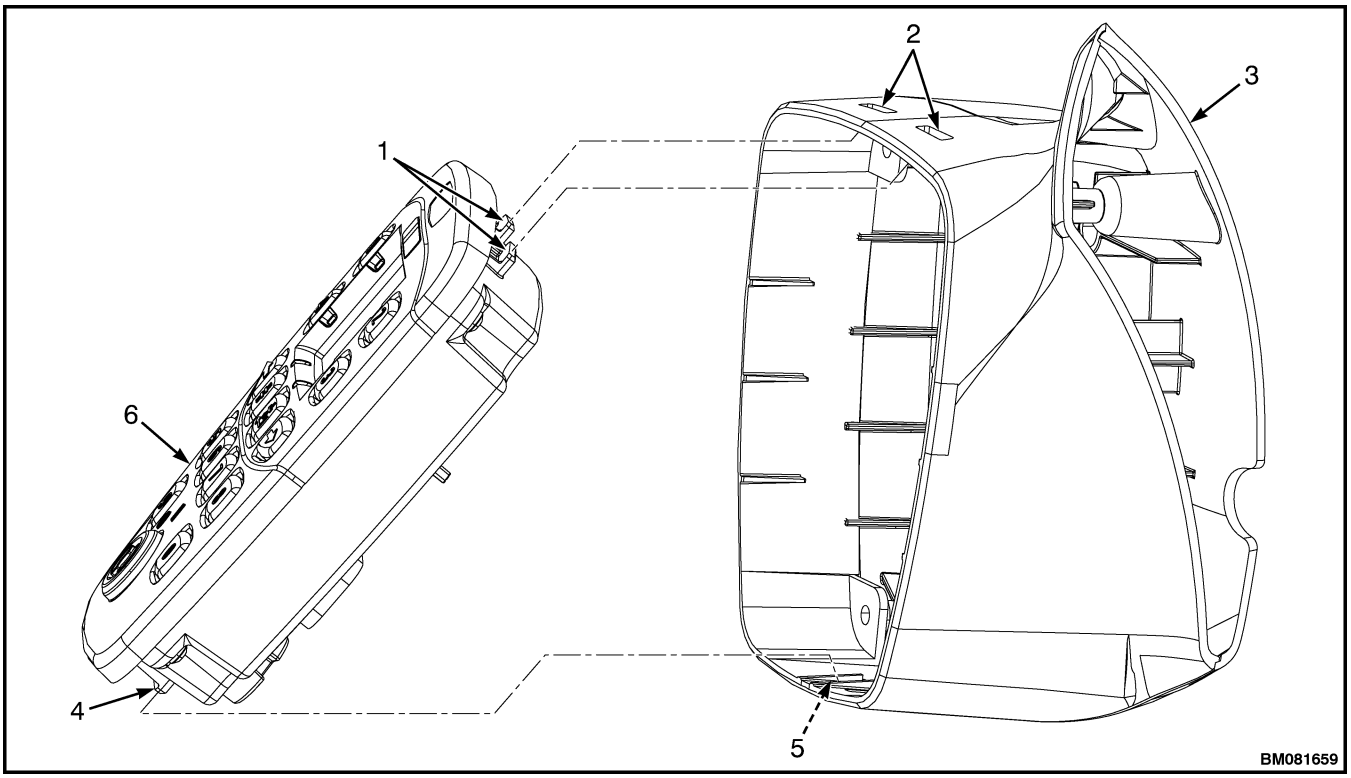


Figure 2. Low Mount Display Panel Arrangement

Legend for Figure 2.

1. MOUNTING BRACKET
2. OVERHEAD GUARD
3. DISPLAY PANEL COVER
4. DISPLAY PANEL
5. KEY OR KEYLESS SWITCH
6. SLOT

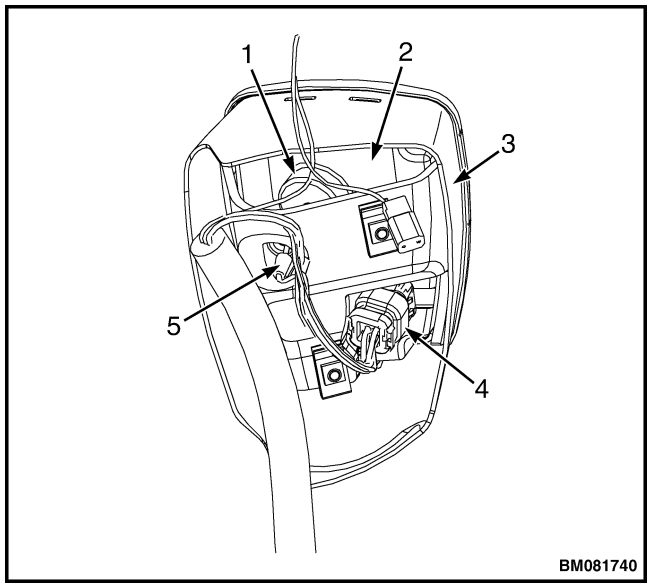


NOTE: HIGH MOUNT DISPLAY PANEL SHOWN. LOW MOUNT IS SIMILAR.

1. TOP NOTCHES
2. TOP SLOTS
3. DISPLAY PANEL COVER
4. BOTTOM NOTCH
5. BOTTOM SLOT
6. DISPLAY PANEL

Figure 3. Display Panel Removal

4. When display panel is pulled from display panel cover, the warning buzzer will disconnect from the rear of display panel. See Figure 4.



NOTE: REAR OF DISPLAY PANEL AND DISPLAY PANEL COVER SHOWN. SOME ELECTRICAL COMPONENTS AND CONNECTIONS OMITTED FOR CLARITY.

1. WARNING BUZZER
2. DISPLAY PANEL
3. DISPLAY PANEL COVER
4. DISPLAY WIRE HARNESS
5. WARNING BUZZER ELECTRICAL CONNECTION

Figure 4. Warning Buzzer

5. Disconnect display wire harness from pin connector on the back of display panel. Remove display panel from lift truck. See Figure 5.

6. Remove key or keyless switch from display panel by pinching in on the pinch points and pulling key or keyless switch from display panel. See Figure 6.

Install

WARNING

The ignition switch is a reed switch which uses an applied magnetic field. If a strong magnet is placed near the ignition switch, it may not function properly (such as not shutting off power). To ensure ignition switch functions properly, do not place a magnet near the ignition switch.

NOTE: If switch being installed uses a key, insert key into switch first. This will help install switch into display panel. If switch is keyless, use knob to help install switch into display panel.

NOTE: For lift truck models J2.2-3.5XN (J45-70XN) (A276) and J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) , equipped with Outdoor Protection/ Wash-down Package, apply dielectric grease to the key switch terminals.

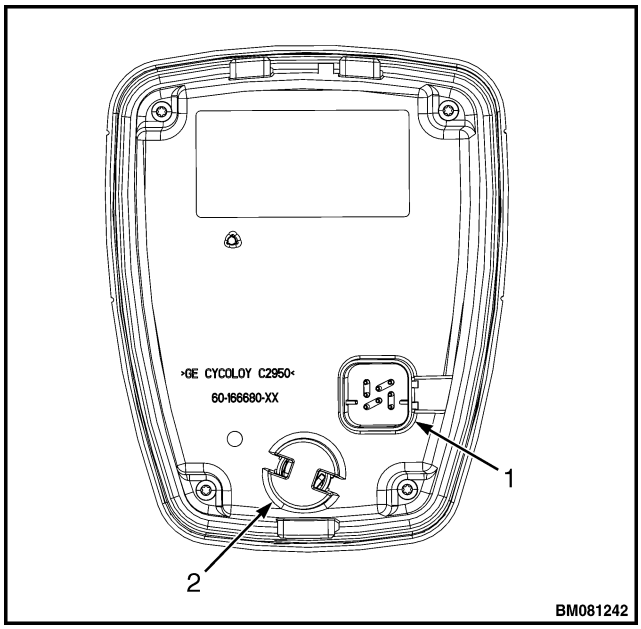
1. Take new key or keyless switch and install into display panel. Match notches on the switch with holes on the switch cover. See Figure 6 and Figure 7. Switch will snap into place.

NOTE: Perform Step 2 for lift truck models J2.2-3.5XN (J45-70XN) (A276) and J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) , equipped with Outdoor Protection/Wash-down Package.

2. Apply dielectric grease to display wire harness connector.

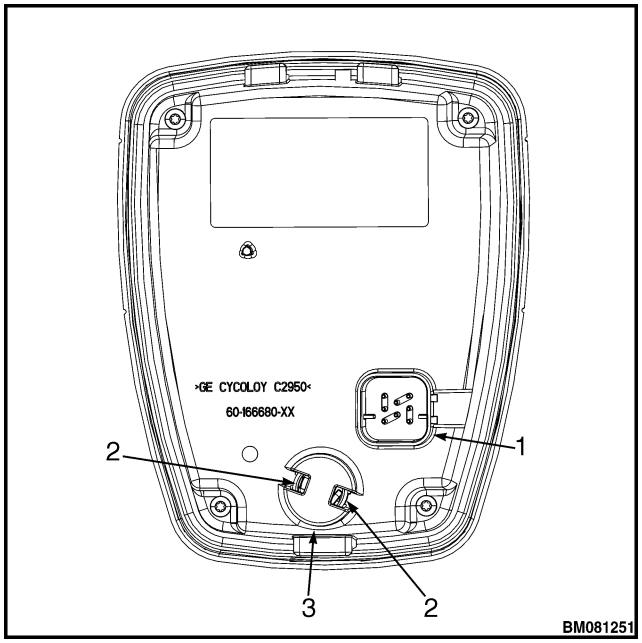
3. Connect display wire harness to pin connector on the back of display panel. See Figure 5.

4. Connect warning buzzer to the back of display panel. See Figure 4.



1. PIN CONNECTOR
2. KEY SWITCH

Figure 5. Disconnecting Display Panel



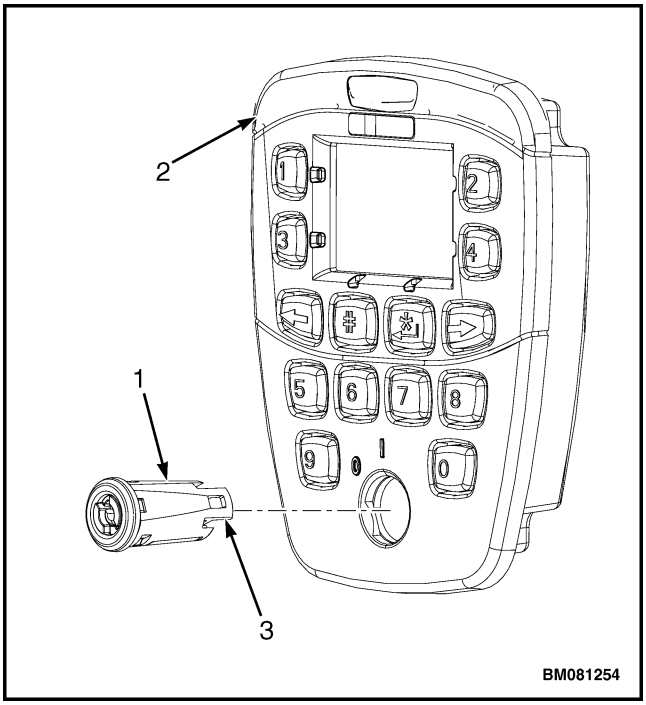
NOTE: BACK SIDE OF DISPLAY PANEL SHOWN.

1. PIN CONNECTOR
2. PINCH POINTS
3. KEY OR KEYLESS SWITCH COVER

Figure 6. Key or Keyless Switch Removal

5. Insert notches on top of display panel into slots on top of display panel cover. See Figure 3 .

6. Push in bottom of display panel until notch on the bottom slides into slot on the bottom and display panel locks into place inside cover. See Figure 3 .



NOTE: KEY SWITCH SHOWN.

1. KEY SWITCH
2. DISPLAY PANEL
3. NOTCH

Figure 7. Key or Keyless Switch Installation

Electronic and Manual Hydraulic Controls

GENERAL

WARNING

Before replacing any part of the electronic or manual hydraulic control assembly, fully lower all parts of the mast and tilt it forward until the tips of the forks touch the ground. This action will prevent the mast from lowering suddenly if the control lever is accidently moved.

WARNING

Discharge capacitors as directed in Discharging the Capacitors in General section of this manual.

Disconnect the battery before doing any work on the electrical system. Serious injury to personnel and/or damage to lift truck components can occur if battery is not disconnected.

WARNING

Never wear any metallic items on your fingers, arms, or neck. Metal items can accidently make an electrical connection and cause an injury.

CAUTION

A short circuit and damage can occur if wires are not installed correctly. Make sure wire connectors do not touch the other metal terminals or wire connectors, metal brackets, or the bracket mounting nuts. Make sure the wires are not pulled tight and are not touching other parts to damage the insulation.

The lift trucks covered in this service manual come standard with manual hydraulic control levers, but have the option of using electronic-hydraulic (E-Hydraulic) mini-lever controls. In each hydraulic control arrangement, there are several electronic component parts that can be replaced if they are no longer working properly. These components are:

- **Direction Control Switch** - The direction control switch is an optional feature and is used to select the direction of travel when lift truck is equipped with a standard accelerator pedal.
- **Emergency Disconnect Switch** - The emergency disconnect switch is used to disconnect all electrical power to lift truck. The switch is operated by pushing the button down until it clicks. To reset (re-connect) emergency disconnect switch and energize electrical circuits, turn switch clockwise until button pops up.
- **Horn Button** - These buttons are used to sound the horn. On lift trucks equipped with E-Hydraulic mini-levers, there is an optional horn button on the armrest.

  To replace horn switch on steering wheel or optional rear horn button on rear right overhead guard leg or on hood, see Sensors and Switches section in this manual.
- **Clamp Button** - The lift trucks covered in this service manual may be equipped with a clamp function. On lift trucks equipped with manual hydraulic control levers, if lift truck is equipped with three levers, the button for clamp function is located on top of the third lever. If lift truck has four levers, the clamp button is on top of the fourth lever.

  For lift trucks equipped with E-Hydraulic mini-levers, if lift truck is equipped with three mini-levers, the momentary switch for clamp function is located behind third lever on the palm rest. If lift truck has four levers, the momentary switch is located behind fourth lever on the palm rest.
- **Return To Set Tilt (RTST)** - The Return To Set Tilt (RTST) is an optional feature on all lift truck models covered in this manual that are equipped with E-Hydraulic mini-levers. The RTST feature can also be on lift truck models E45-70XN (A268) manufactured after November 2014 and equipped with manual hydraulic control levers.

  The RTST option automatically stops the tilt function at a set point. To override the RTST option, press the override button, located directly behind the tilt mini-lever, for lift trucks equipped with E-Hydraulic mini-levers, or press the override button located on the top of the tilt lever, for lift trucks equipped with manual hydraulic control levers, and push the mini-lever or manual tilt lever forward or pull it backward.

When removing and replacing sensors or switches, be sure to tag connectors to aid in correct installation.

MANUAL HYDRAULIC CONTROLS

Upper Front Cover

NOTE: To replace direction control switch, emergency disconnect switch, and the RTST and clamp buttons (if equipped), the upper front cover must be removed first from manual hydraulic control lever assembly as described below.

1. Read and follow **WARNING** and **CAUTION** section in General section above.

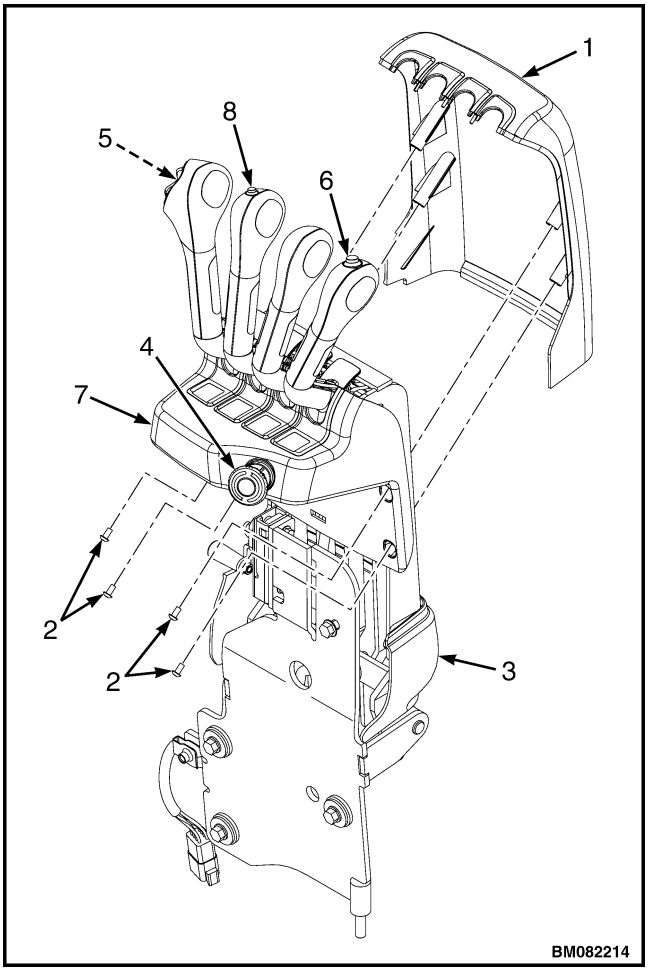
2. Remove four capscrews and front cover from hydraulic lever assembly.

   See Figure 8 for lift truck models

   - E2.2-3.5XN (E45-70XN) (A268)
   - J2.2-3.5XN (J45-70XN) (A276)
   - J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)
   - E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

   See Figure 9 for lift truck models

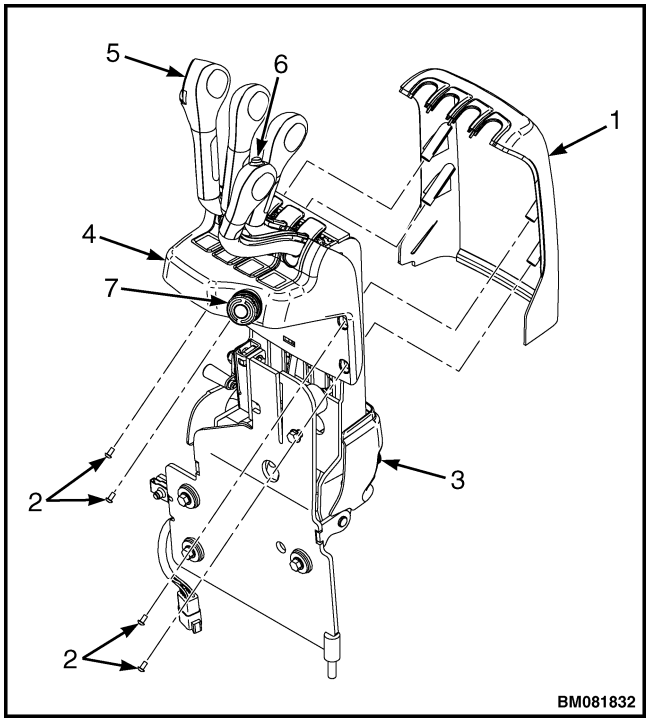
   - E1.6-2.0XN (E30-40XN) (A269)



NOTE: OPTIONAL DIRECTION CONTROL SWITCH AND CLAMP BUTTON SHOWN. FOUR LEVERS SHOWN. IF LIFT TRUCK IS EQUIPPED WITH THREE LEVERS, CLAMP BUTTON IS ON THE TOP OF THIRD LEVER.
NOTE: OPTIONAL RTST BUTTON FOR LIFT TRUCK MODELS E45-70XN (A268) MANUFACTURED AFTER NOVEMBER 2014 SHOWN

1. UPPER FRONT COVER
2. CAPSCREWS
3. LOWER COVER
4. UPPER REAR COVER
5. DIRECTION CONTROL SWITCH
6. CLAMP BUTTON
7. EMERGENCY DISCONNECT SWITCH
8. RETURN TO SET TILT BUTTON

Figure 8. Manual Hydraulic Control Lever Assemble for Lift Truck Models , and E2.2-3.5XN (E45-70XN) (A268), J2.2-3.5XN (J45-70XN) (A276), J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)



NOTE: OPTIONAL DIRECTION CONTROL SWITCH AND CLAMP BUTTON SHOWN. FOUR LEVERS SHOWN. IF LIFT TRUCK IS EQUIPPED WITH THREE LEVERS, CLAMP BUTTON IS ON THE TOP OF THIRD LEVER.

1. UPPER FRONT COVER
2. CAPSCREWS
3. LOWER COVER
4. UPPER REAR COVER
5. DIRECTION CONTROL SWITCH
6. CLAMP BUTTON
7. EMERGENCY DISCONNECT SWITCH

Figure 9. Manual Hydraulic Control Lever Assembly for Lift Truck Model E1.6-2.0XN (E30-40XN) (A269)

3. Using four capscrews, install front cover on hydraulic lever assembly.

See Figure 8 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268)
- J2.2-3.5XN (J45-70XN) (A276)
- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)
- E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

See Figure 9 for lift truck models

- E1.6-2.0XN (E30-40XN) (A269)

Direction Control Switch

Remove

1. Read and follow **WARNING** and **CAUTION** section in General section above.

2. Remove upper front cover. See section Upper Front Cover for procedures. Disconnect manual control valve wire harness from direction control switch. See Figure 10.

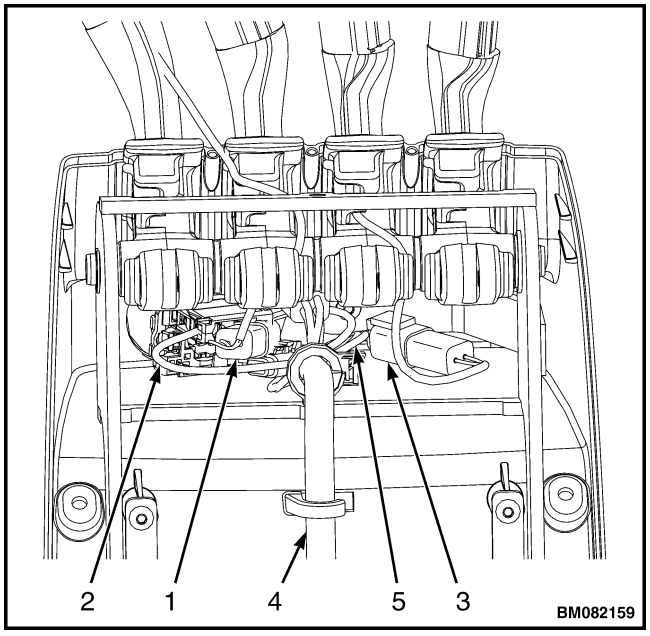
3. Remove two outer capscrews and lift/lower with direction control switch handle from manual lift/lower lever.

   See Figure 11 for lift truck models

   - E2.2-3.5XN (E45-70XN) (A268)
   - J2.2-3.5XN (J45-70XN) (A276)
   - J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)
   - E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

   See Figure 12 for lift truck models

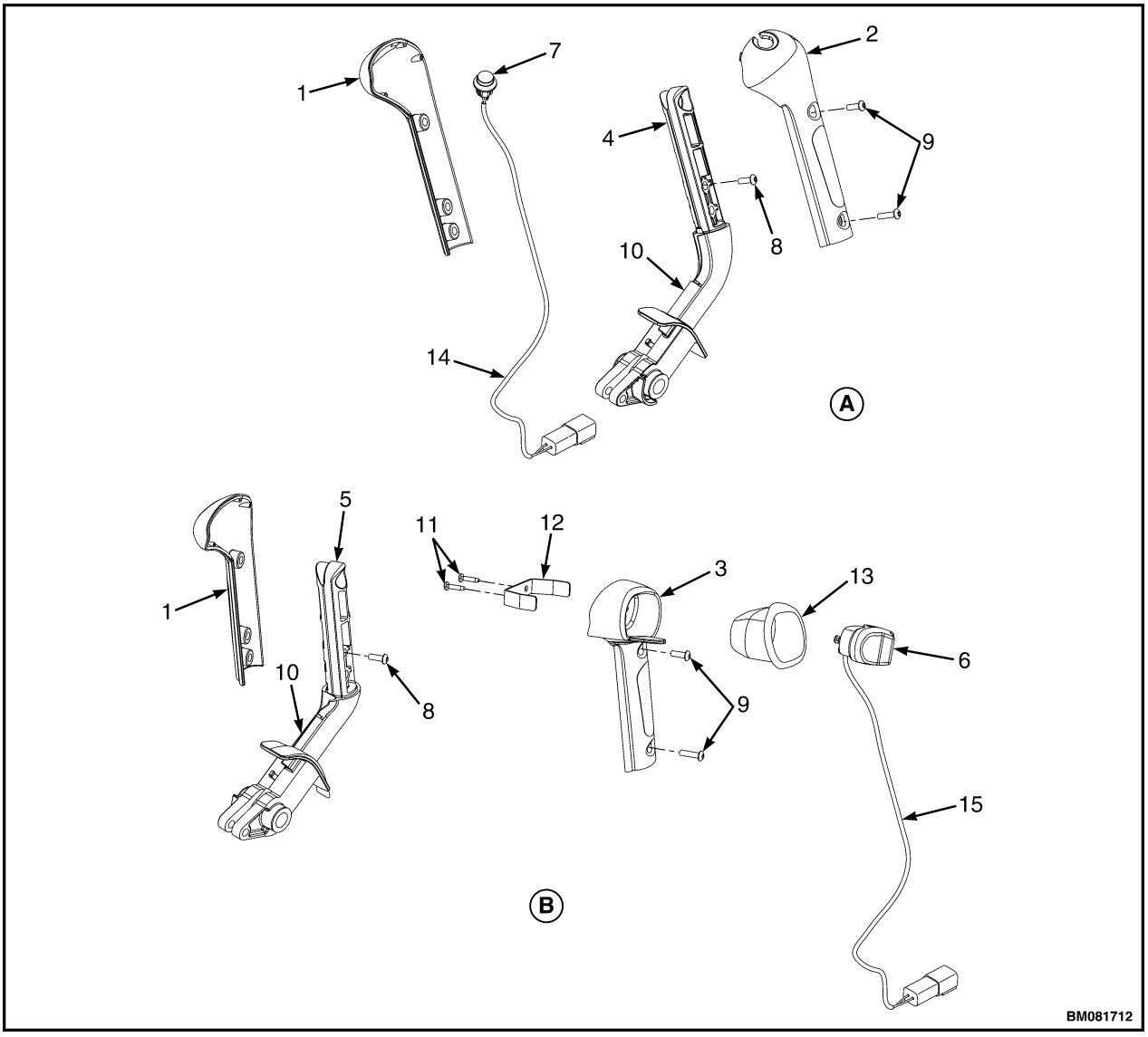
   - E1.6-2.0XN (E30-40XN) (A269)



NOTE: RETURN TO SET TILT BUTTON USED ONLY ON LIFT TRUCK MODELS E45-70XN (A268) MANUFACTURED AFTER NOVEMBER 2014.

1. CLAMP BUTTON CONNECTOR
2. EMERGENCY DISCONNECT SWITCH CONNECTOR
3. RETURN TO SET TILT BUTTON CONNECTOR
4. DIRECTION CONTROL SWITCH CONNECTOR
5. MANUAL CONTROL VALVE WIRE HARNESS

Figure 10. Manual Control Levers Assembly Electrical Components



A. AUX HANDLE WITH DUAL FUNCTION AND TILT HANDLE WITH RTST

B. LIFT/LOWER WITH DIRECTION CONTROL SWITCH

1. PALM SIDE GRIP HANDLE
2. CLAMP/RTST SWITCH HANDLE
3. LIFT/LOWER WITH DIRECTION CONTROL SWITCH HANDLE
4. MANUAL AUX 2 LEVER/TILT LEVER WITH RTST
5. MANUAL LIFT LEVER
6. DIRECTION CONTROL SWITCH
7. CLAMPING/RTST PUSH-BUTTON
8. INNER CAPSCREW
9. OUTER CAPSCREW
10. CABLE TRACK
11. SCREW
12. DIRECTION CONTROL SWITCH RETAINER
13. DIRECTION CONTROL SWITCH CUP
14. PUSH-BUTTON CABLE
15. DIRECTION CONTROL SWITCH CABLE

Figure 11. Manual Hydraulic Control Handles for Lift Truck Models E2.2-3.5XN (E45-70XN) (A268) J2.2-3.5XN (J45-70XN) (A276), J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970), and E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

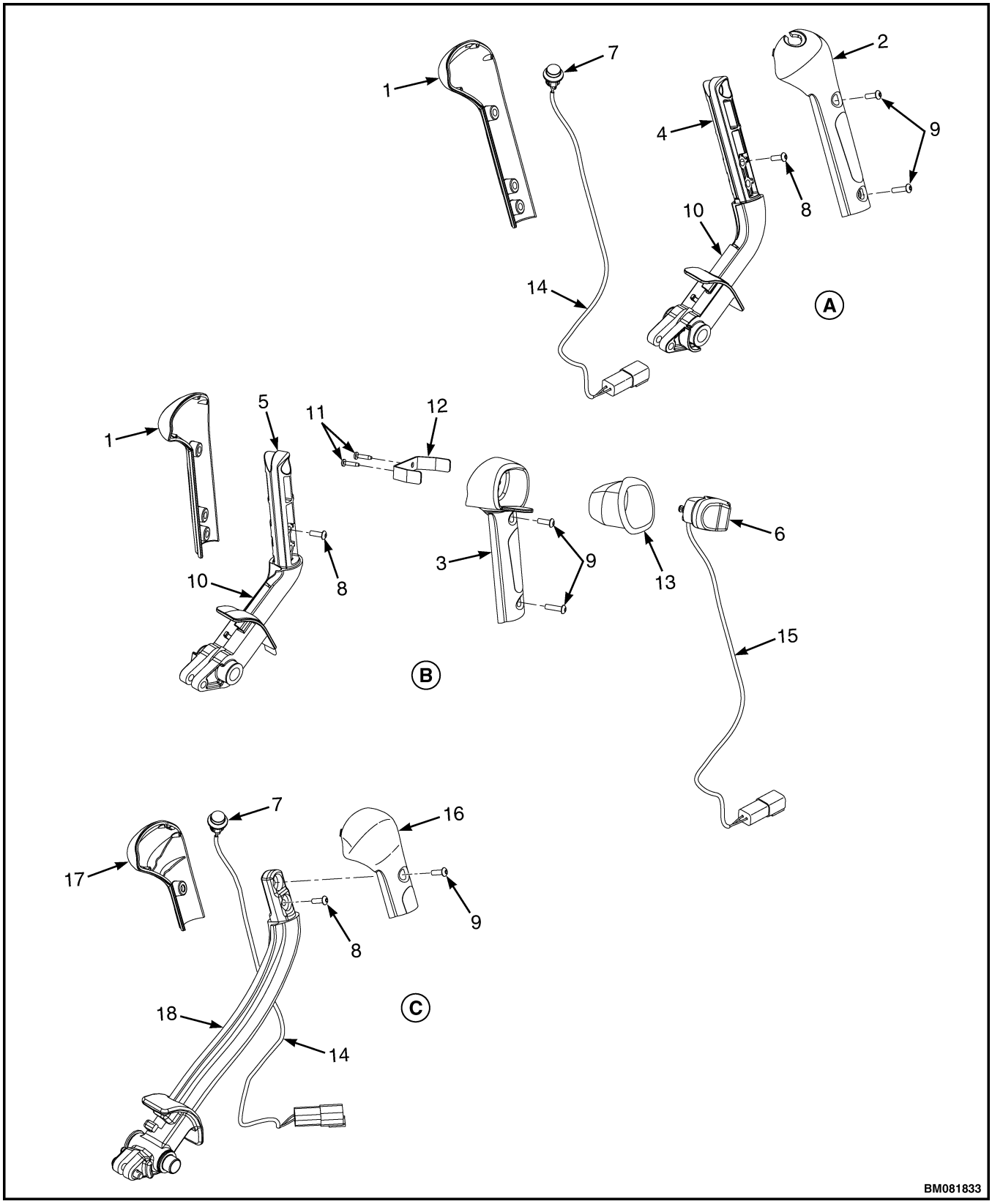


Figure 12. Manual Hydraulic Control Lever Assembly for Lift Truck Models E1.6-2.0XN (E30-40XN) (A269)

Legend for Figure 12.

A. AUX HANDLE WITH DUAL FUNCTION
B. LIFT/LOWER WITH DIRECTION CONTROL SWITCH
C. DTR HANDLE WITH DUAL FUNCTION

1. PALM SIDE GRIP HANDLE
2. CLAMP SWITCH HANDLE
3. LIFT/LOWER WITH DIRECTION CONTROL SWITCH HANDLE
4. MANUAL AUX 2 LEVER
5. MANUAL LIFT LEVER
6. DIRECTION CONTROL SWITCH
7. CLAMPING PUSH-BUTTON
8. INNER CAPSCREW
9. OUTER CAPSCREW
10. CABLE TRACK
11. SCREW
12. DIRECTION CONTROL SWITCH RETAINER
13. DIRECTION CONTROL SWITCH CUP
14. PUSH-BUTTON CABLE
15. DIRECTION CONTROL SWITCH CABLE
16. DRIVE-THRU RACK (DTR) CLAMPING HANDLE
17. DRIVE-THRU RACK (DTR) PALMSIDE HANDLE
18. LEVER ASSEMBLY

4. Remove one inner capscrew and palm side grip handle from manual lift lever.

See Figure 11 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268)
- J2.2-3.5XN (J45-70XN) (A276)
- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)
- E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

See Figure 12 for lift truck models

- E1.6-2.0XN (E30-40XN) (A269)

5. Remove direction control switch cable from cable track.

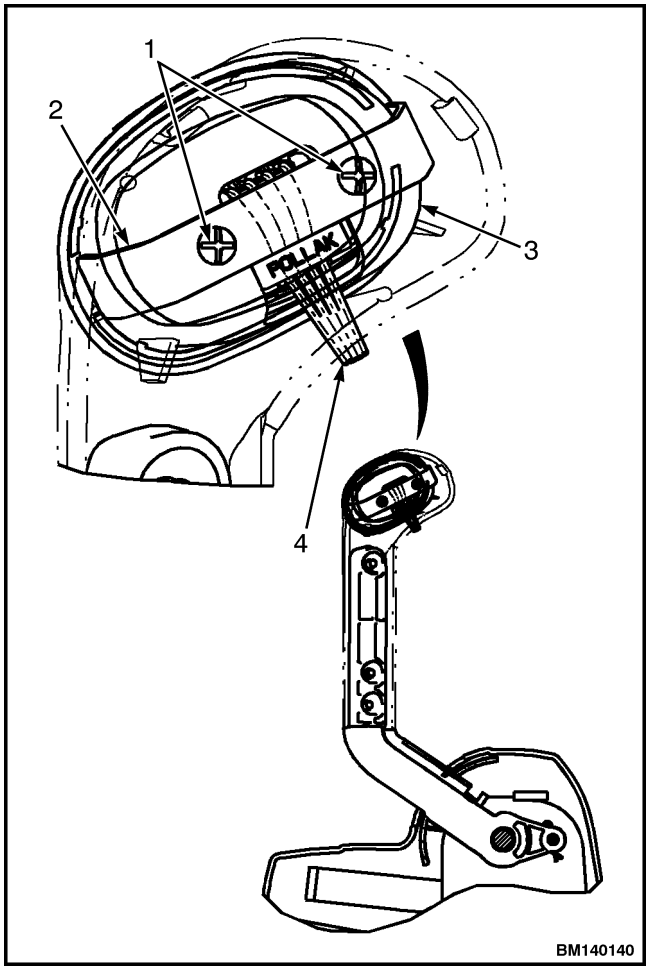
See Figure 11 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268)
- J2.2-3.5XN (J45-70XN) (A276)
- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)
- E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

See Figure 12 for lift truck models

- E1.6-2.0XN (E30-40XN) (A269)

6. Remove two screws, direction control switch retainer, direction control switch cup, and direction control switch from lift/lower lever with direction control switch handle. See Figure 13.



1. SCREW
2. DIRECTION CONTROL SWITCH RETAINER
3. DIRECTION CONTROL SWITCH CUP
4. DIRECTION CONTROL SWITCH CABLE

Figure 13. Direction Control Switch

Install

1. Install direction control switch into direction control switch cup. See Figure 13.

2. Install direction control switch cup and direction control switch into lift/lower direction control switch handle. See Figure 13.

3. Install direction control switch retainer onto back side of direction control switch cup, inside lift/lower with direction control switch handle. See Figure 13.

4. Install two screws through retainer and direction control switch cup into direction control switch. See Figure 13.

5. Route direction control switch cable through cable track on manual lift/lower lever.

   See Figure 11 for lift truck models

   - E2.2-3.5XN (E45-70XN) (A268)
   - J2.2-3.5XN (J45-70XN) (A276)
   - J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)
   - E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

   See Figure 12 for lift truck models

   - E1.6-2.0XN (E30-40XN) (A269)

6. Install palm side handle and one capscrew on manual lift/lower lever.

   See Figure 11 for lift truck models

   - E2.2-3.5XN (E45-70XN) (A268)
   - J2.2-3.5XN (J45-70XN) (A276)
   - J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)
   - E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

   See Figure 12 for lift truck models

   - E1.6-2.0XN (E30-40XN) (A269)

7. Install lift/lower with direction control switch handle and two outer capscrews on manual lift/lower lever. Tighten outer capscrews 1.35 to 1.65 N•m (11.9 to 14.6 lbf in).

   See Figure 11 for lift truck models

   - E2.2-3.5XN (E45-70XN) (A268)
   - J2.2-3.5XN (J45-70XN) (A276)
   - J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)
   - E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

   See Figure 12 for lift truck models

   - E1.6-2.0XN (E30-40XN) (A269)

8. Install upper front cover. See section Upper Front Cover for procedures.

Clamp Button

Remove

1. Read and follow **WARNING** and **CAUTION** section in General section above.

2. Remove upper front cover. See section Upper Front Cover for procedures. Disconnect manual control valve wire harness from clamp button. See Figure 10.

3. Remove two outer capscrews and clamp switch handle from manual aux 2 lever.

   See Figure 11 for lift truck models

   - E2.2-3.5XN (E45-70XN) (A268)
   - J2.2-3.5XN (J45-70XN) (A276)
   - J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)
   - E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

4. Remove one inner capscrew and palm side grip handle from manual aux 2 lever.

   See Figure 11 for lift truck models

   - E2.2-3.5XN (E45-70XN) (A268)
   - J2.2-3.5XN (J45-70XN) (A276)
   - J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)
   - E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

NOTE: Perform Step 5 and Step 6 for lift truck models E1.6-2.0XN (E30-40XN) (A269) .

5. Remove one outer capscrew and Drive-Thru Rack (DTR) clamping handle from lever assembly. See Figure 12.

6. Remove one inner capscrew and DTR Palmside handle from lever assembly. See Figure 12.

7. Remove push-button cable from cable track.

   See Figure 11 for lift truck models

   - E2.2-3.5XN (E45-70XN) (A268)
   - J2.2-3.5XN (J45-70XN) (A276)
   - J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)
   - E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

   See Figure 12 for lift truck models

   - E1.6-2.0XN (E30-40XN) (A269)

Install

1. Route push-button cable through cable track on manual aux 2 lever.

   See Figure 11 for lift truck models

   - E2.2-3.5XN (E45-70XN) (A268)
   - J2.2-3.5XN (J45-70XN) (A276)
   - J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)
   - E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

   See Figure 12 for lift truck models

   - E1.6-2.0XN (E30-40XN) (A269)

2. Install palm side handle and one inner capscrew on manual aux 2 lever.

   See Figure 11 for lift truck models

   - E2.2-3.5XN (E45-70XN) (A268)
   - J2.2-3.5XN (J45-70XN) (A276)
   - J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)
   - E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

   See Figure 12 for lift truck models

   - E1.6-2.0XN (E30-40XN) (A269)

NOTE: Ensure clamping push-button is in correct position on clamp switch handle by aligning notches and flats during assembly.

3. Install clamp switch handle and two outer capscrews on manual aux 2 lever. Tighten outer capscrews 1.35 to 1.65 N•m (11.9 to 14.6 lbf in).

   See Figure 11 for lift truck models

   - E2.2-3.5XN (E45-70XN) (A268)
   - J2.2-3.5XN (J45-70XN) (A276)
   - J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)
   - E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

   See Figure 12 for lift truck models

   - E1.6-2.0XN (E30-40XN) (A269)

NOTE: Perform Step 4 and Step 5 for lift truck models E1.6-2.0XN (E30-40XN) (A269) .

4. Install DTR palmside handle and one inner capscrew on lever assembly. See Figure 12.

5. Install DTR clamping handle and one outer capscrew on lever assembly. See Figure 12.

6. Install upper front cover. See section Upper Front Cover for procedures.

Return To Set Tilt (RTST) Button

Remove

NOTE: The Return To Set Tilt button is an optional feature on lift truck models E45-70XN (A268) manufactured after November 2014

1. Read the following **WARNING** and **CAUTION** section in General section above.

2. Remove upper front cover. See section Upper Front Cover for procedures. Disconnect manual control valve wire harness from RTST button. See Figure 10.

3. Remove two outer capscrews and RTST switch handle from manual tilt lever. See Figure 11.

4. Remove one inner capscrew and palm side grip handle from tilt lever. See Figure 11.

5. Remove push-button cable from cable track. See Figure 11.

Install

1. Route push-button cable through cable track on tilt lever. See Figure 11.

2. Install palm side handle and one inner capscrew on tilt handle.

NOTE: Ensure RTST push-button is in correct position on RTST switch handle by aligning notches and flats during assembly.

3. Install RTST switch handle and two outer capscrews on tilt lever. Tighten outer capscrews to 1.35 to 1.65 N•m (11.9 to 14.6 lbf in). See Figure 11.

4. Install upper front cover. See section Upper Front Cover for procedures.

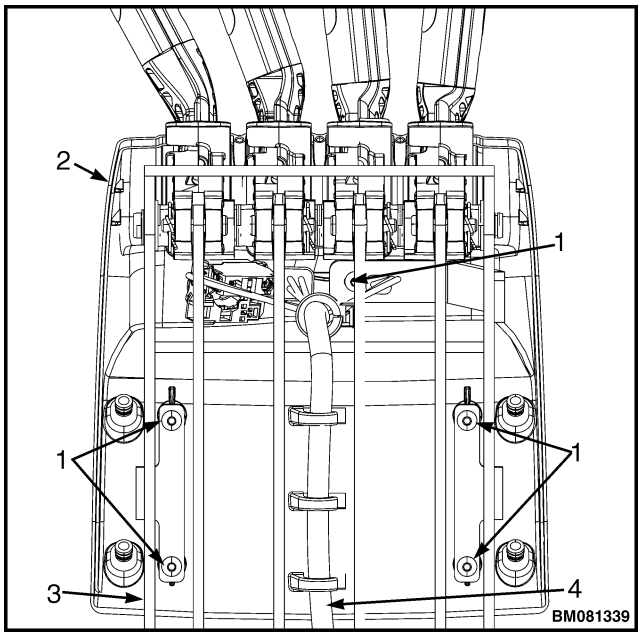
Emergency Disconnect Switch

Remove

1. Read and follow **WARNING** and **CAUTION** section in General section above.

2. Remove upper front cover. See section Upper Front Cover above for procedures.

3. Remove five socket head capscrews from upper rear cover. See Figure 14. Pull cover rearward to generate enough space to disconnect emergency disconnect switch wires. See Figure 10.



1. SOCKET HEAD SCREWS
2. UPPER REAR COVER
3. LEVER LINKAGE
4. MANUAL HYDRAULICS WIRE HARNESS

Figure 14. Upper Rear Cover Removal

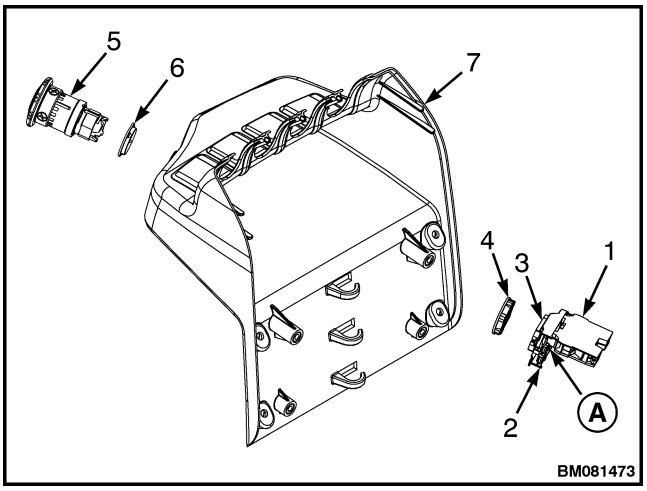
4. Disconnect clamp function, RTST function, and direction control switch if lift truck is equipped with these features. See Figure 10.

5. Insert screwdriver or other flat tipped tool into slot on side of switch. Pull tool up to remove emergency disconnect switch, switch adapter, and lock from upper rear cover. See Figure 15.

6. Remove nut from upper rear cover. Remove emergency disconnect button and bushing from hole in upper rear cover. See Figure 15.

Install

1. Insert emergency disconnect button and bushing into hole in upper rear cover. See Figure 15. Place nut on button and turn it clockwise to secure emergency disconnect button and bushing in hole. Tighten nut to 2.2 ±0.2 N•m (19.5 ±1.8 lbf in).



NOTE: THE EMERGENCY DISCONNECT SWITCH SHOWN IN FIGURE 15 IS ALSO USED ON LIFT TRUCKS EQUIPPED WITH E-HYDRAULIC CONTROLS.

A. INSERT SCREWDRIVER HERE

1. EMERGENCY DISCONNECT SWITCH
2. SWITCH ADAPTER
3. LOCK
4. NUT
5. EMERGENCY DISCONNECT BUTTON
6. BUSHING
7. UPPER REAR COVER HOLE

Figure 15. Emergency Disconnect Switch Replacement

NOTE: For lift truck models J2.2-3.5XN (J45-70XN) (A276) , equipped with Outdoor Protection/Wash-down Package, apply dielectric grease to emergency disconnect switch terminals.

2. Connect wires to emergency disconnect switch. Tighten screws to 0.8 to 1.2 N•m (8.55 to 10.7 lbf in).

3. Install switch adapter and lock onto emergency disconnect button assembly. Install switches, by pushing switches onto switch adapter until switch clicks into place. Connect main wire harness to emergency disconnect switch. See Figure 10.

4. Connect clamp function, RTST function, and direction control switch if lift truck is equipped with these functions. See Figure 10.

5. Install and tighten five socket head capscrews to secure upper rear cover to manual lever assembly. See Figure 15.

6. Install upper front cover. See section Upper Front Cover for procedures.

E-HYDRAULIC CONTROLS - TEST

Mini-Levers

Perform all of the following test procedures to be sure mini-levers operate properly.

See **User Interface Service Technician** 2200SRM1336 instructions to view Lever output Value. With Service Password, view Diagnostics – Hydraulic Data Display – Hydraulic Input.

Full Stroke Test

Check for full stroke of mini-lever. Use DSC or install the Service Tool to monitor functions.

1. Stroke each lever to full stroke, forward and backward, and allow lever to snap back to center.

2. Turn key switch to **ON** position.

3. Display electro-hydraulic diagnostics menu on dash display panel. Operate each lever to full stroke forward and read input.
   - Is lever output = -92%?
   - **YES:** Go to Step 4.
   - **NO:** Mini-lever not working properly. See procedures for each generation of MLM for repair or replacement. Upon completion, rerun test.

4. Operate each lever to full stroke backward and read input.
   - Is lever output = +92%?
   - **YES:** Mini-lever is supplying full stroke.
   - **NO:** Mini-lever not working properly. See procedures for each generation of MLM for repair or replacement. Upon completion, rerun test.

5. If mini-lever continues to not function properly, contact your local **HYSTER** dealer or see **Hyster Hypass Online** .

Function Returns to Neutral Test

Check to confirm function returns to neutral (0%). Use DSC or install Service Tool to monitor functions.

1. Stroke each lever to full stroke, forward and backward, and allow lever to snap back to center.

2. Turn key switch to **ON** position.

3. Display electro-hydraulic diagnostics menu on dash display panel.
   - Is each lever output = 0%?
   - **YES:** Go to Step 4.
   - **NO:** Mini-lever is not working properly. See procedures for each generation of MLM for repair or replacement. Upon completion, rerun test.

4. Operate each lever to full stroke forward and slowly release (1-2 seconds from full stroke). Read output when fully released.
   - Is each lever output = 0%?
   - **YES:** Go to Step 5.
   - **NO:** Mini-lever is not working properly. See procedures for each generation of MLM for repair or replacement. Upon completion, rerun test.

5. Operate each lever to full stroke back and slowly release (1-2 seconds from full stroke). Read output when fully released.
   - Is each lever output = 0%?
   - **YES:** Mini-lever function is returning to neutral.
   - **NO:** Mini-lever is not working properly. See procedures for each generation of MLM for repair or replacement. Upon completion, rerun test.

6. If mini-lever continues to not function, contact your local **HYSTER** dealer or see **Hyster Hypass Online** .

Push Button Switch

1. Check that push button switch operates properly by operating applicable function.

2. If system does not function, see procedures for each generation of MLM for repair or replacement. Upon completion, rerun test.

3. If push button switch continues to not function properly, contact your local **HYSTER** dealer or see **Hyster Hypass Online** .

E-HYDRAULIC CONTROLS

The lift trucks covered in this service manual may be equipped with optional E-Hydraulic control mini-levers (see Figure 16). Each mini-lever can be replaced separately if one malfunctions. Like manual control levers, E-Hydraulic control mini-levers can be equipped with one or two optional functions: a clamp function (either the third or fourth mini-lever) and a Return To Set Tilt (RTST) function (second mini-lever). There is a momentary switch behind the mini-levers that engage and disengage clamp and RTST functions. If either the clamping or RTST function quits working, mini-lever and momentary switch may need to be replaced. See sections
Mini-levers, Remove and Install and
Momentary Switches and Function Selection Button
for replacement procedures.

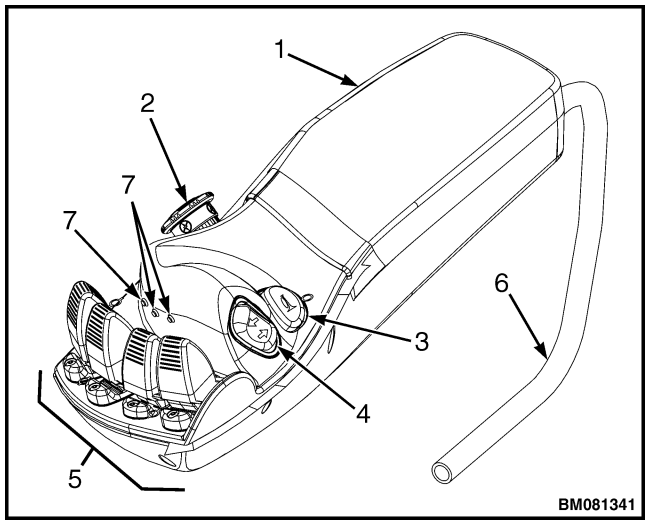
Mini-levers, Remove and Install

CAUTION

The following procedure should only be performed by Hyster trained certified technicians. The removal and replacement of the mini-levers should be done in a clean environment whenever possible and on an electrically grounded surface. DO NOT touch any printed circuit board (PCB) surface to prevent damage from electrostatic voltage.

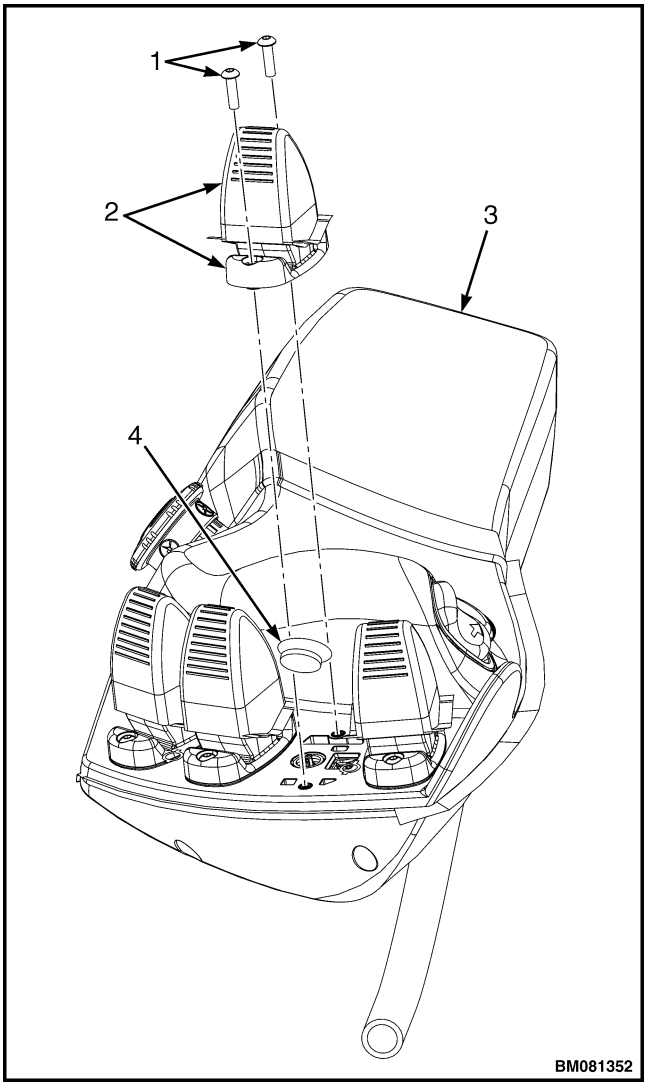
1. Read and follow **WARNING** and **CAUTION** section in General section above.

2. Remove two capscrews that secure mini-lever to armrest. Remove mini-lever from armrest. See Figure 17.



1. ARMREST
2. EMERGENCY DISCONNECT SWITCH
3. HORN BUTTON
4. DIRECTION CONTROL SWITCH
5. MINI-LEVERS
6. WIRE HARNESS
7. MOMENTARY SWITCHES

Figure 16. E-Hydraulic Controls Arrangement



1. CAPSCREWS
2. MINI-LEVER
3. ARMREST
4. MOMENTARY SWITCH

Figure 17. Mini-Lever Removal

NOTE: Before installing new mini-lever, check **Parts Manual** for correct part number to be sure correct mini-lever is being installed.

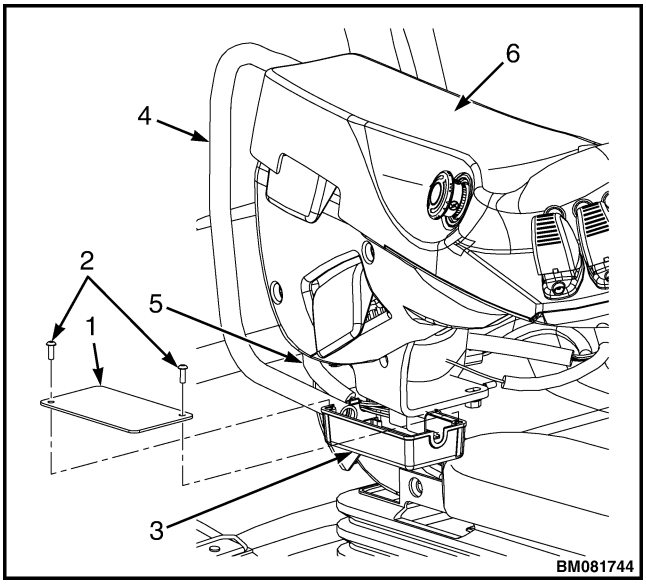
3. Install new mini-lever onto armrest using two capscrews.

Armrest Assembly

Remove

1. Read and follow **WARNING** and **CAUTION** in General section above.

2. Remove two capscrews from seat box cover and remove cover from seat box. Disconnect main E-Hydraulic control wire harness from E-Hydraulic armrest harness. See Figure 18.



NOTE: COMPONENTS PARTS AND ELECTRICAL CONNECTIONS OMITTED OR MOVED FOR CLARITY.

1. SEAT BOX COVER
2. CAPSCREWS
3. SEAT BOX
4. E-HYDRAULIC ARMREST HARNESS
5. OPERATOR PRESENCE SYSTEM HARNESS
6. ARMREST

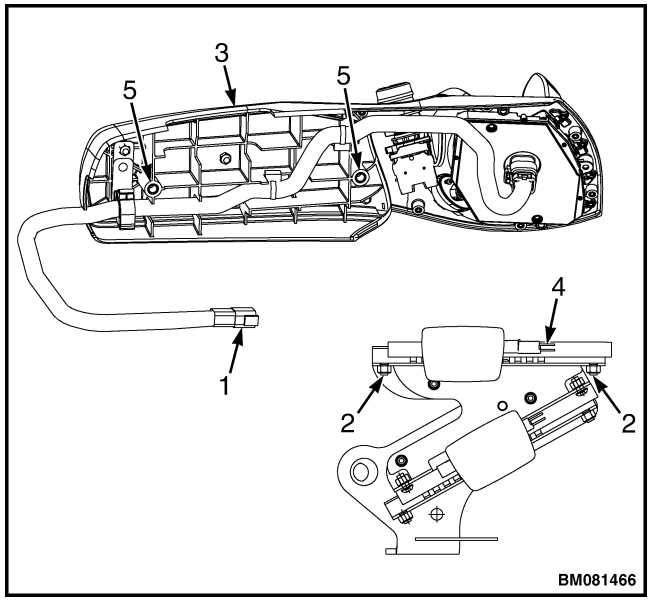
Figure 18. Seat Box Cover Removal

3. Pull up on handle (see Figure 20) and slide armrest all the way forward and remove flange capscrew from under armrest mounting bracket that attaches armrest to mounting bracket. Pull up on handle and slide armrest all the way back and remove other flange capscrew. See Figure 19.

4. Remove armrest from armrest mounting bracket.

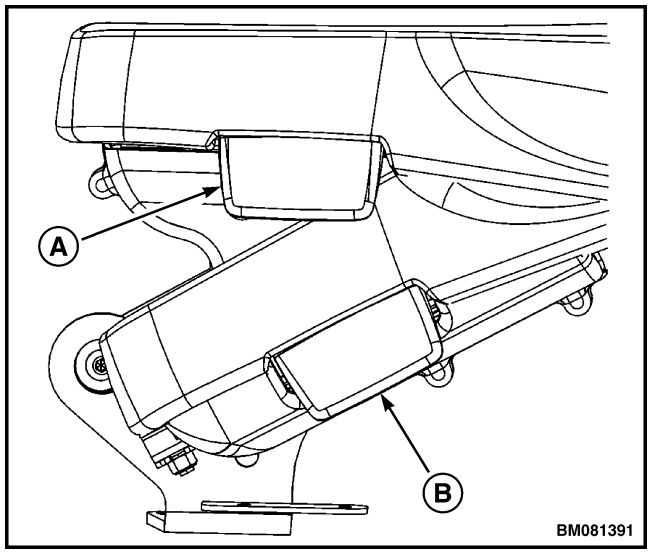
5. Remove six socket head screws that fasten bottom and top armrest covers together. See Figure 21.

6. Remove five socket head capscrews from bottom armrest cover and armrest. Remove bottom armrest cover.



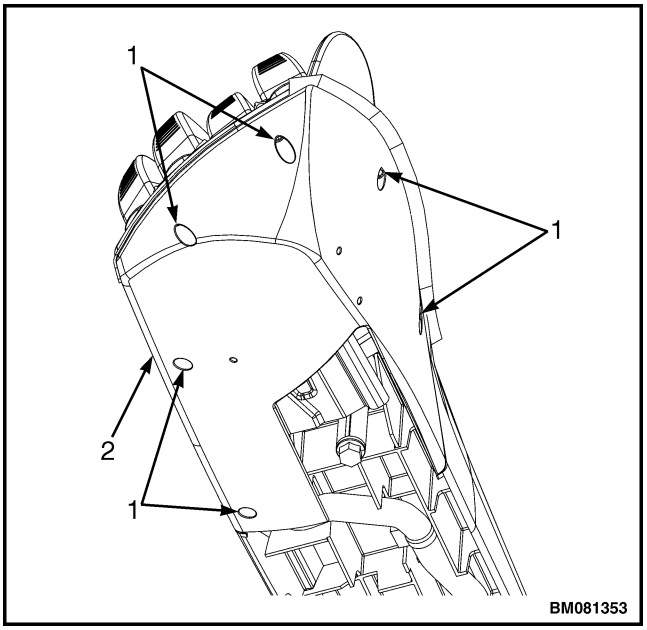
1. E-HYDRAULIC CONTROL WIRE HARNESS
2. FLANGE CAPSCREWS
3. ARMREST
4. ARMREST MOUNTING BRACKET
5. HOLES FOR FLANGE CAPSCREWS

Figure 19. E-Hydraulic Armrest and Mounting Bracket



A. HANDLE MOVES ARMREST FORWARD OR BACKWARD
B. HANDLE MOVES ARMREST UP OR DOWN

Figure 20. Armrest Adjustment Handles



1. SOCKET HEAD SCREWS
2. BOTTOM ARMREST COVER

Figure 21. Bottom Armrest Cover Removal

NOTE: The momentary switches and function selection button are optional features. If lift truck is not equipped with these features, there will be a plug covering electrical connector on PCB cassette.

7. Disconnect momentary switches/function selection button connector from PCB cassette. See Figure 22.

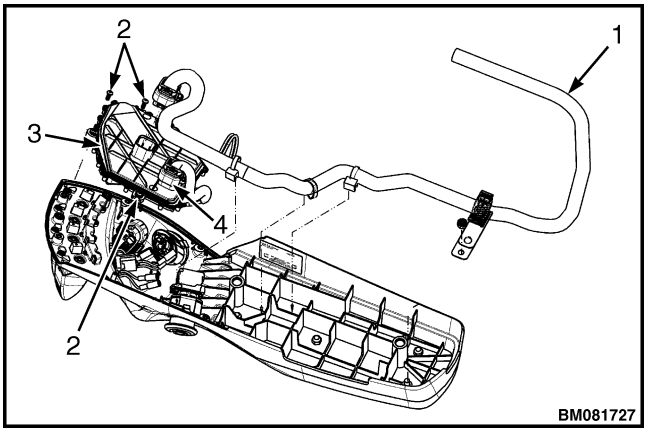
8. Remove three socket screws from PCB cassette and remove PCB cassette from armrest. See Figure 22.

Install

1. Install PCB cassette to armrest with three socket head screws. See Figure 22.

2. If lift truck is equipped, connect momentary switches/function selection button connector to PCB cassette. See Figure 22.

3. Install bottom armrest cover to armrest with five socket head screws. See Figure 21.



1. TO E-HYDRAULIC CONTROL WIRE HARNESS
2. SOCKET HEAD SCREWS
3. PCB CASSETTE
4. MOMENTARY SWITCHES/FUNCTION SELECTION BUTTON CONNECTOR

Figure 22. PCB Cassette Removal

4. Install new armrest onto mounting bracket with flange capscrews. Tighten flange capscrews to 13 to 15 N•m (115 to 132 lbf in).

5. Install six socket head screws that fasten bottom and top armrest covers together. See Figure 21.

6. Connect E-hydraulic wire harness to armrest. See Figure 19. Install seat box cover to seat box with two capscrews. See Figure 18. Tighten capscrews to 1.2 N•m (10.6 lbf in).

7. Connect the battery.

Horn Button

Remove

1. Read and follow **WARNING** and **CAUTION** section in General section above.

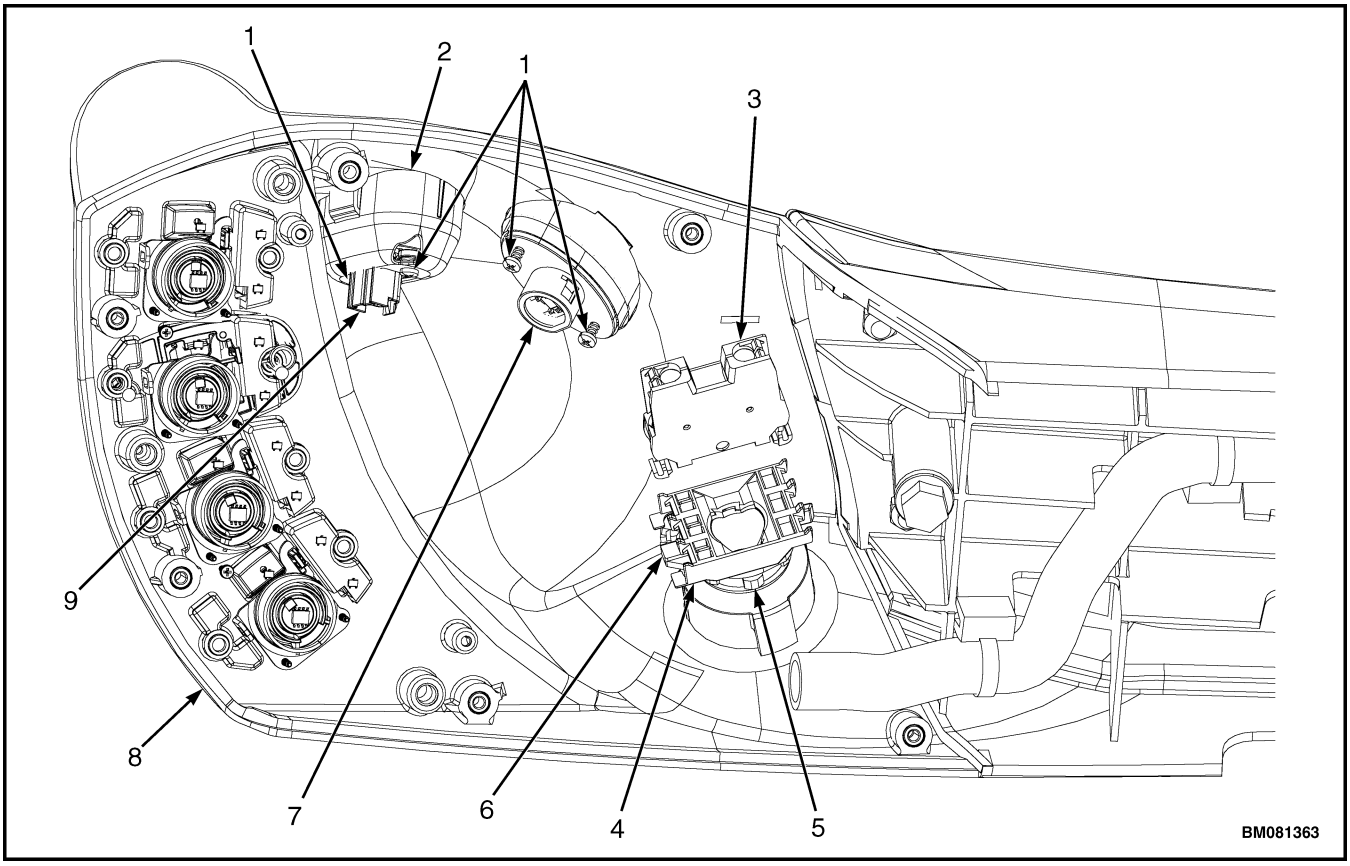
2. Remove armrest from armrest mounting bracket. Remove bottom armrest and PCB cassette. See section Armrest Assembly for removal procedures.

3. Remove two Phillips head screws that attach horn button to armrest. See Figure 23. Remove horn button from armrest.

Install

1. Insert new horn switch into armrest and secure switch to armrest with two Phillips head screws. See Figure 23.

2. Install armrest and PCB cassette to armrest and install armrest to armrest mounting bracket. See section Armrest Assembly for installation procedures.



NOTE: MOMENTARY SWITCHES AND FUNCTION SELECTION BUTTON CONNECTIONS NOT SHOWN FOR CLARITY. SEE FIGURE 27 FOR MOMENTARY SWITCHES AND FUNCTION SELECTION BUTTON CONNECTIONS.

1. PHILLIPS HEAD SCREWS
2. DIRECTION CONTROL SWITCH ADAPTER
3. EMERGENCY DISCONNECT SWITCH
4. EMERGENCY DISCONNECT SWITCH ADAPTER
5. NUT
6. LOCK
7. HORN SWITCH
8. ARMREST
9. DIRECTION CONTROL SWITCH CONNECTOR

Figure 23. Switch Arrangement and Connections, E-Hydraulic Mini-Levers

Direction Control Switch

Remove

1. Read and follow **WARNING** and **CAUTION** section in General section above.

2. Remove armrest from armrest mounting bracket. Remove bottom armrest cover. See section Armrest Assembly for removal procedures.

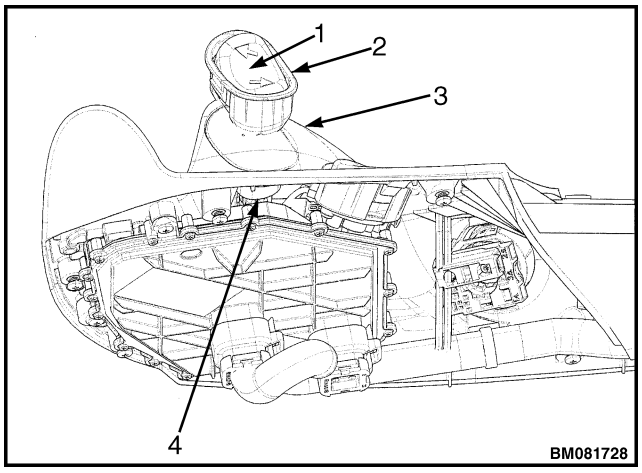
3. Remove direction control switch assembly from armrest by compressing clips on either side of bezel and carefully pulling assembly out. Disconnect E-Hydraulic control wiring harness from direction control switch. See Figure 24.

4. Remove direction control switch from bezel. See Figure 24.

Install

1. Insert new direction control switch into bezel. See Figure 24.

2. Connect E-Hydraulic control valve wiring harness to direction control switch. Install direction control switch assembly into armrest by compressing clips on either side of bezel and pushing assembly into armrest until clips latch. See Figure 24.



1. DIRECTION CONTROL SWITCH
2. BEZEL
3. ARMREST
4. E-HYDRAULIC CONTROL VALVE WIRING HARNESS

Figure 24. Direction Control Switch Replacement

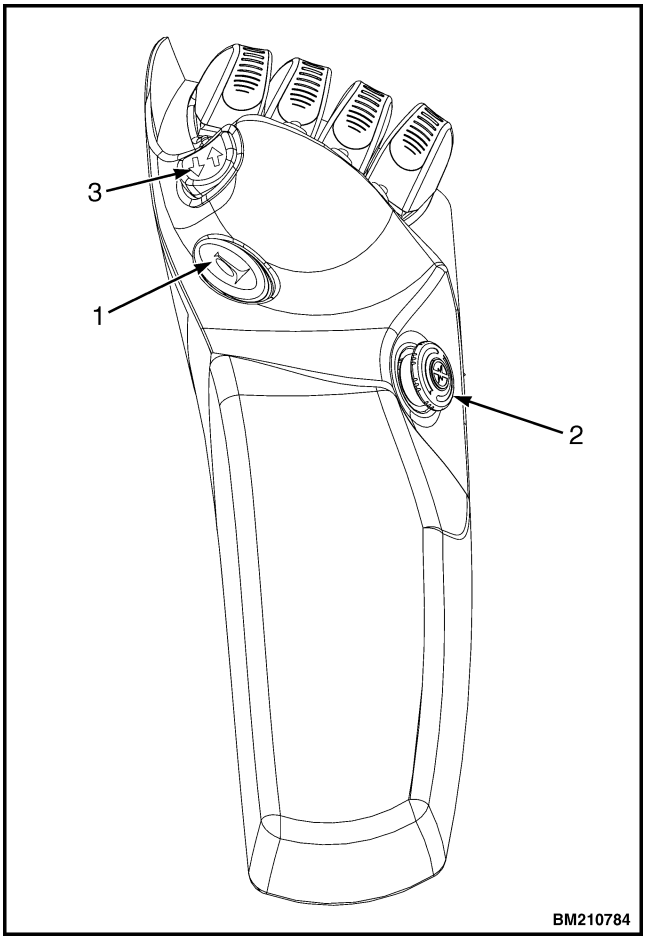
3. Install armrest cover to armrest, and install armrest to armrest mounting bracket. See section Armrest Assembly for installation procedures.

Emergency Disconnect Switch

Both E-Hydraulic controls and manual hydraulic controls use the same emergency disconnect switch. See Figure 25.

Remove

1. Read and follow **WARNING** and **CAUTION** section in General section above.



1. HORN BUTTON
2. EMERGENCY DISCONNECT SWITCH
3. DIRECTION CONTROL SWITCH

Figure 25. Emergency Disconnect Switch Location, E-Hydraulic Controls

2. Remove armrest from armrest mounting bracket. Remove bottom armrest and PCB cassette. See section Armrest Assembly for removal procedures.

3. Disconnect wires from emergency disconnect switch.

4. Insert screwdriver or other flat tipped tool into slot on side of switch (see Figure 15). Pull tool up to remove emergency disconnect switch, switch adapter, and lock from underneath armrest.

5. Remove nut from underneath armrest. Remove emergency disconnect button and bushing from top part of armrest. See Figure 23.

Install

1. Insert emergency disconnect button and bushing into hole in top part of armrest.

2. Place nut on button and turn it clockwise to secure emergency disconnect button and bushing to armrest. Tighten nut to 2.2 ±0.2 N•m (19.5 ±1.8 lbf in). See Figure 23.

3. Install switch adapter and lock onto emergency disconnect button assembly. Install switches, by pushing switches onto switch adapter until switches clicks into place.

4. Connect wires to emergency disconnect switch. Tighten screws to 0.8 to 1.2 N•m (8.55 to 10.7 lbf in).

5. Install armrest and PCB cassette to armrest and install armrest to armrest mounting bracket. See section Armrest Assembly for installation procedures.

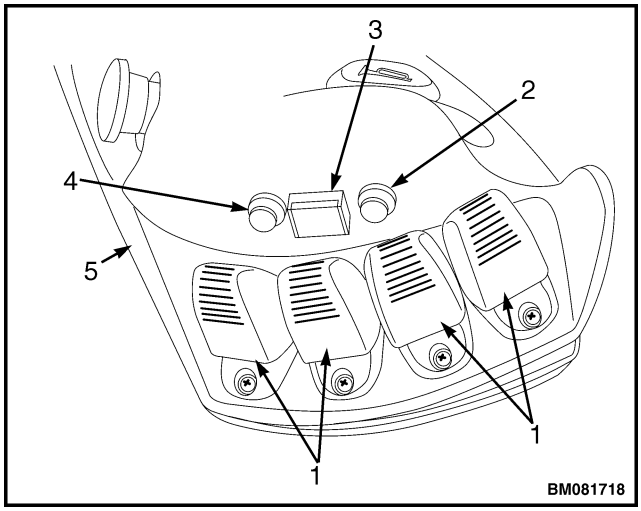
Momentary Switches and Function Selection Button

On lift trucks equipped with E-Hydraulic controls, there may be two optional momentary switches (green buttons) and a function selection button (yellow button) located behind the second, third, or fourth mini-lever. See Figure 26. The momentary switch located behind the second mini-lever is used to override the Return To Set Tilt (RTST) function. By pressing this switch, the RTST parameters are overridden and the mast is allowed to tilt unrestricted.

If the lift truck is equipped with three mini-levers and a four function control valve, there will be a function selection button behind the third mini-lever. Pressing this button allows the third mini-lever to switch between the third and fourth functions. If the lift truck is equipped with four mini-levers and a five function control valve, the function selection button will be located behind the fourth mini-lever. Pressing the button allows the fourth mini-lever to switch between the fourth and fifth functions.

If the lift truck is equipped with a clamp attachment, the last mini-lever on the right controls the clamp function. Behind this lever will be a momentary switch. To engage the clamp, move the mini-lever backward. To disengage the clamp, push the momentary switch behind the mini-lever and move mini-lever forward.

The different configurations of switches and buttons discussed in this section may not be found on your lift truck.



NOTE: ALL POSSIBLE MOMENTARY SWITCHES AND FUNCTION SELECTION BUTTON CONFIGURATIONS SHOWN. NOT ALL LIFT TRUCK MAY HAVE ALL SWITCHES AND BUTTONS SHOWN.

1. MINI-LEVERS
2. MOMENTARY SWITCH (RTST)
3. FUNCTION SELECTION BUTTON
4. MOMENTARY SWITCH (CLAMP)
5. ARMREST HOUSING

Figure 26. Momentary Switches and Function Selection Button Location

Remove

1. Read and follow **WARNING** and **CAUTION** section in General section above.

2. Remove armrest from armrest mounting bracket. Remove bottom armrest and PCB cassette. See procedures in Armrest Assembly section above.

NOTE: Tag wires prior to disconnecting them to aid in reconnecting.

3. Pull momentary switches or function selection button connectors apart to disconnect them from wire harness. See Figure 27.

4. If momentary switch is being replaced, remove lock nut from back of green, round, push button. Remove push button switch from armrest. See Figure 27.

NOTE: Note the position of the yellow, rectangular, function button before removal to aid in installation. See Figure 26.

5. If function selection button is being replaced:

   a. Remove knurl nut. See Figure 27.

   b. Rotate red screw to left stop. Remove blue connector by sliding it from black cylinder. See Figure 27.

   c. Remove function button from armrest.

Install

1. If installing a new function selection button:

   a. Insert black cylinder portion of function selection button through armrest housing.

   b. Slide blue connector onto cylinder. See Figure 27.

   c. Rotate red screw to right stop.

   d. Adjust position of yellow, rectangular function selection button. See Figure 26. Install and tighten knurl nut to secure function selection button to armrest.

   e. Apply Nye 760G grease (supplied in kit) to function selection button switch connector. Push function selection button connector to wire harness. See Figure 27.

2. If installing a momentary switch:

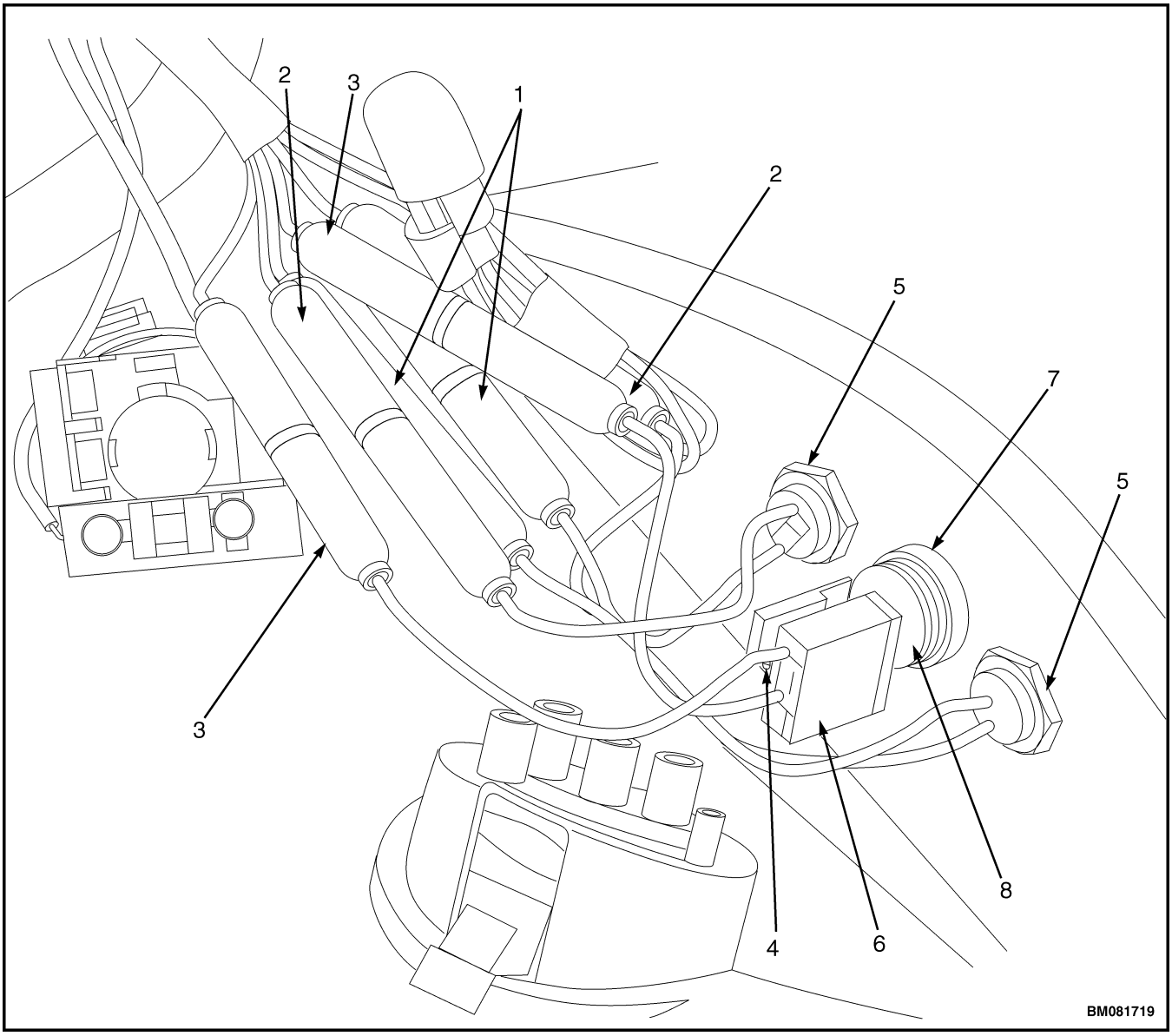
   a. Install new green, round momentary switch assembly through armrest housing.

   b. Install and tighten lock nut to secure momentary switch to armrest. See Figure 27.

   c. Push momentary switch connector to wire harness. See Figure 27.

3. Install armrest and PCB cassette to armrest and install armrest to armrest mounting bracket. See section Armrest Assembly for installation procedures.

4. Connect E-hydraulic wire harness to armrest. See Figure 19.



1. CLAMP BUTTON CONNECTION
2. RTST CONNECTION
3. FUNCTION SELECTION BUTTON CONNECTION
4. RED SCREW
5. LOCK NUT
6. BLUE CONNECTOR
7. KNURL NUT
8. BLACK CYLINDER

Figure 27. Momentary Switches and Function Selection Button Replacement

Sensors and Switches

GENERAL

WARNING

Before replacing any sensor or switch, fully lower all parts of the mast and tilt it forward until the tips of the forks touch the ground. This action will prevent the mast from lowering suddenly if the control lever is accidently moved.

Never have any metal on your fingers, arms, or neck. These metal items can accidentally create an electrical connection and cause an injury.

WARNING

Discharge capacitors as directed in Discharging the Capacitors in General section of this manual.

Disconnect the battery before doing any work on the electrical system. Serious injury to personnel and/or damage to lift truck components can occur if battery is not disconnected.

CAUTION

A short circuit and damage can occur if wires are not installed correctly. Make sure wire connectors DO NOT touch the other metal terminals or wire connectors, metal brackets, or the bracket mounting nuts. Make sure the wires are not pulled tight and are not touching other parts to damage the insulation.

All sensors and switches used on these trucks are non-repairable parts. Replace with new sensors or switches whenever a sensor or switch malfunctions and is not operating correctly. See **Parts Manual** for replacement part numbers. Before installing new sensors or switches, use a clean cloth and make sure area around sensor or switch is clean and free of oils and contaminates.

Lift truck models J2.2-3.5XN (J45-70XN) (A276) and J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) , equipped with Outdoor Protection/ Wash-down Package will have sealed wiring harnesses as well as light switches and windshield wiper switches that are fully sealed.

When removing and replacing sensors or switches, be sure to tag connectors to aid in correct reconnecting.

SYNCHRONOUS STEERING VALVE

On lift trucks equipped with E-Hydraulics and Synchronous Steering, refer to **Steering System** 1600SRM1363 prior to removing Synchronous Steering Valve Kit.

STEERING AXLE SENSOR

The steering axle sensor is located on right side of steering axle.

The steering axle sensor is an optional feature on lift truck model E2.2-3.5XN (E45-70XN) (A268) .

See Figure 28 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268)

See Figure 29 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276)
- J4.0-5.0XN (J80-100XN) (A970) manufactured before November 2014

See Figure 30 for lift truck models

- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) manufactured after November 2014

See Figure 31 for lift truck model

- E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

Remove

1. Read and follow **WARNING** and **CAUTION** section in General section above.

2. Put lift truck on jacks or blocks and remove right steer tire and wheel.

   See **Periodic Maintenance** 8000SRM1364 for lift truck models

   - E2.2-3.5XN (E45-70XN) (A268)

   See **Periodic Maintenance** 8000SRM1372 for lift truck models

   - J2.2-3.5XN (J45-70XN) (A276)

See **Periodic Maintenance** 8000SRM1541 for lift truck models

- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

See **Periodic Maintenance** 8000SRM1577 for lift truck model

- E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

3. Disconnect steering wire harness from steering axle sensor.

See Figure 28 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268)

See Figure 29 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276)
- J4.0-5.0XN (J80-100XN) (A970) manufactured before November 2014

See Figure 30 for lift truck models

- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) manufactured after November 2014

See Figure 31 for lift truck model

- E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

4. Remove flange capscrew and protective cover from steering axle.

5. Remove two socket head screws and sensor from steering axle.

See Figure 28 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268)

See Figure 29 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276)
- J4.0-5.0XN (J80-100XN) (A970) manufactured before November 2014

See Figure 30 for lift truck models

- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) manufactured after November 2014

See Figure 31 for lift truck model

- E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

Install

1. Using two socket head screws, install new sensor onto steering axle.

See Figure 28 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268)

See Figure 29 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276)
- J4.0-5.0XN (J80-100XN) (A970) manufactured before November 2014

See Figure 30 for lift truck models

- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) manufactured after November 2014

See Figure 31 for lift truck model

- E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

2. Connect steering wire harness to steering axle sensor. Install protective cover to steering axle with flange capscrew.

3. Install wheel and tire to steering axle and remove lift truck from blocks.

See **Periodic Maintenance** 8000SRM1364 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268)

See **Periodic Maintenance** 8000SRM1372 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276)

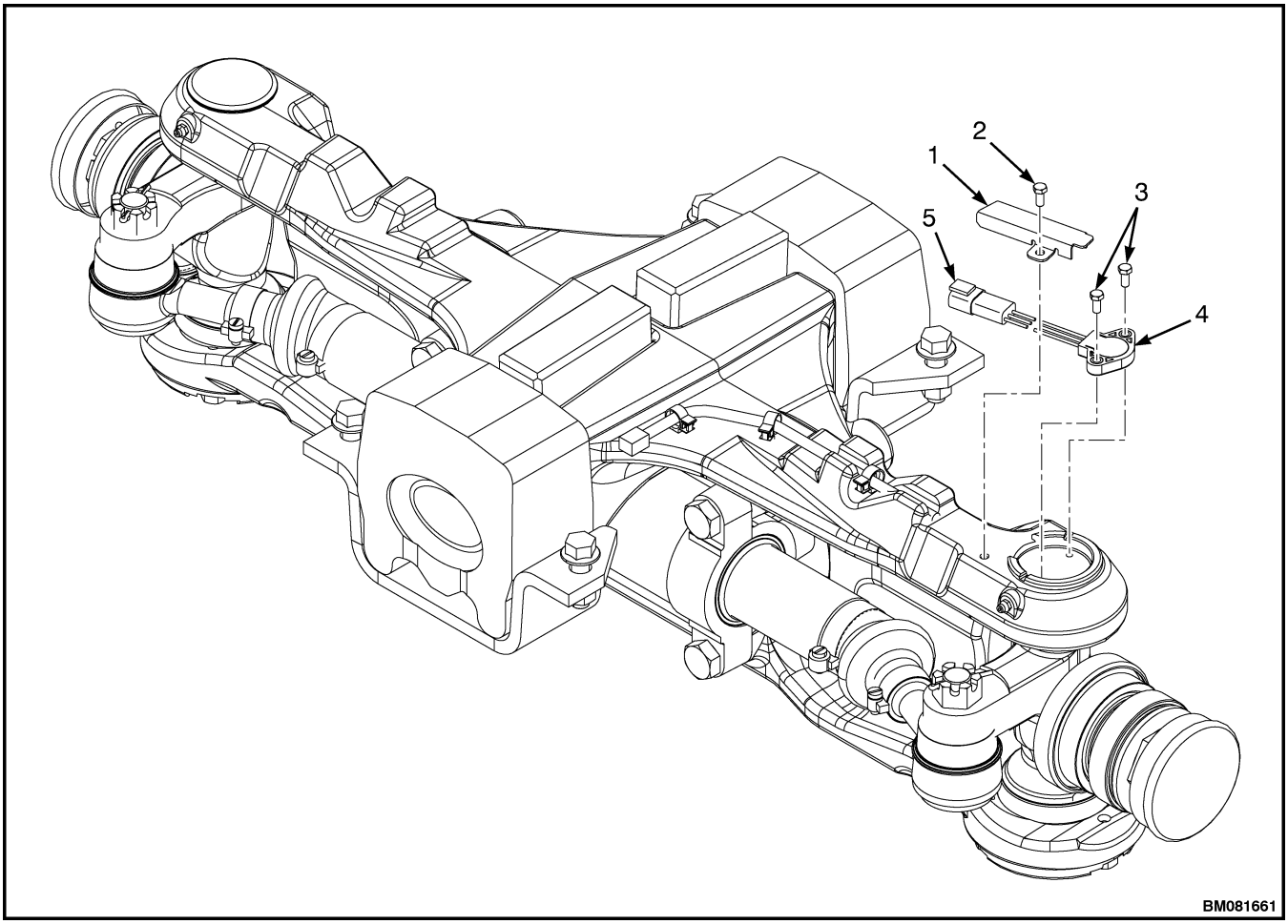
See **Periodic Maintenance** 8000SRM1541 for lift truck models

- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

See **Periodic Maintenance** 8000SRM1577 for lift truck model

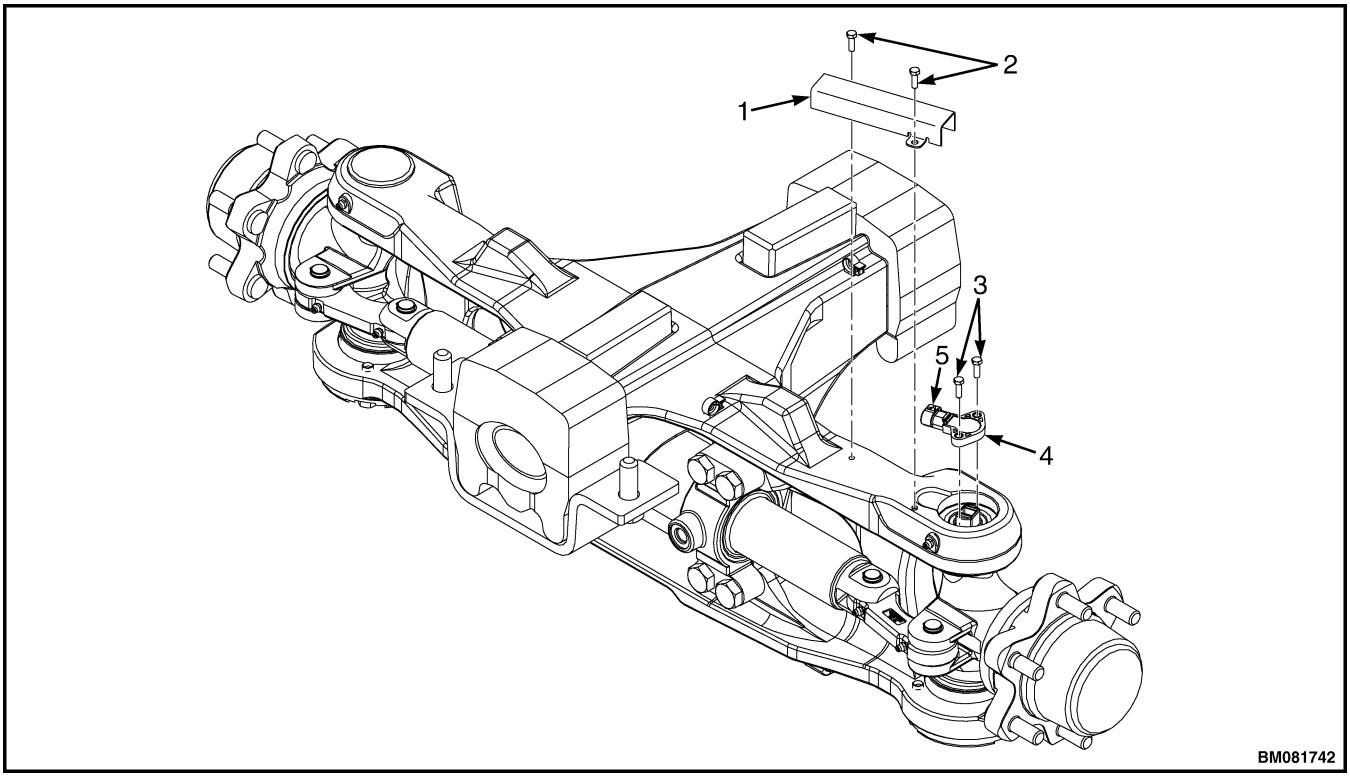
- E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

4. Connect the battery.



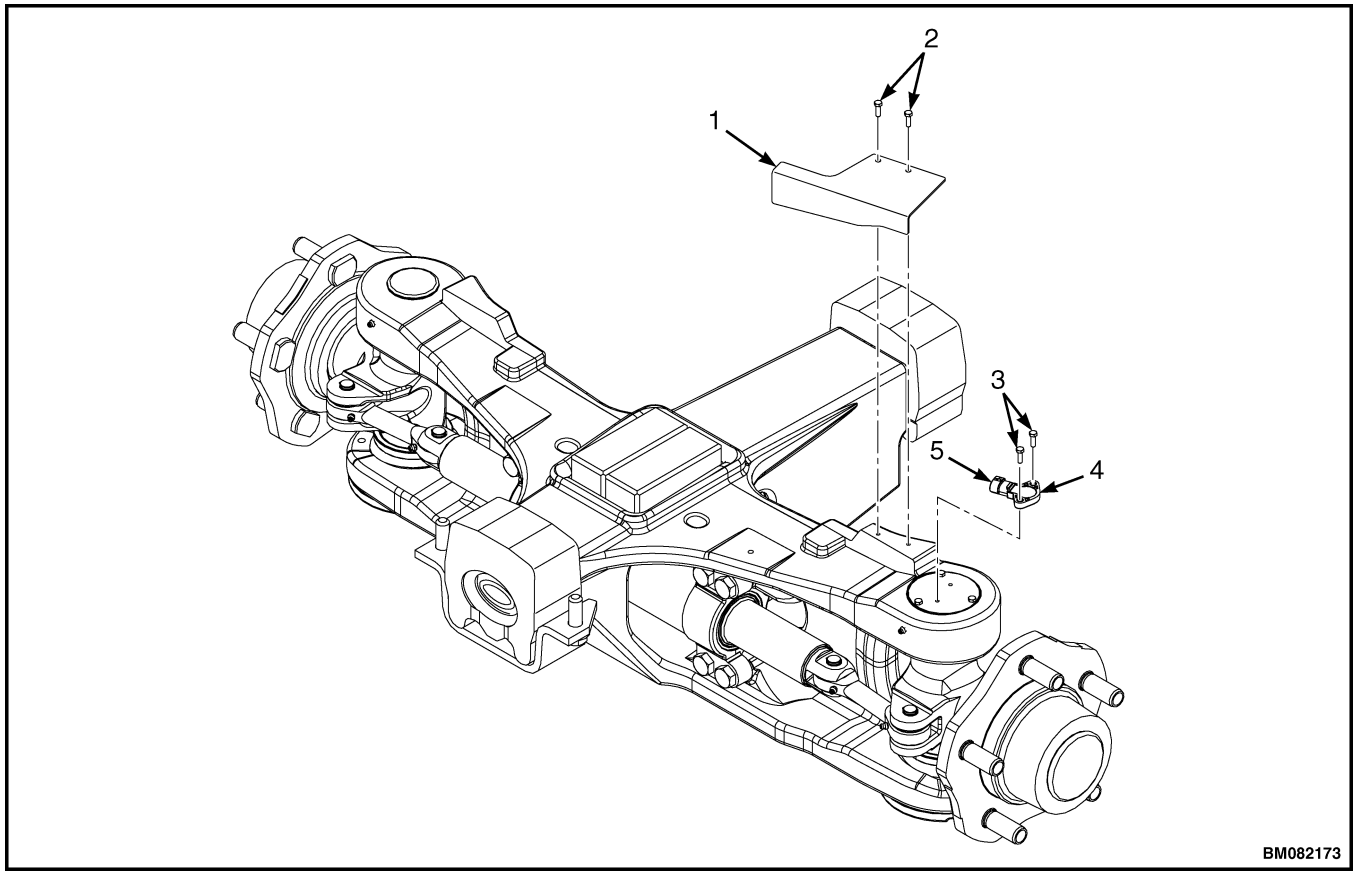
1. PROTECTIVE COVER
2. FLANGE CAPSCREW
3. SOCKET HEAD SCREWS
4. STEERING AXLE SENSOR
5. STEERING WIRE HARNESS CONNECTOR

Figure 28. Steering Axle Sensor Replacement, Lift Truck Models E2.2-3.5XN (E45-70XN) (A268)



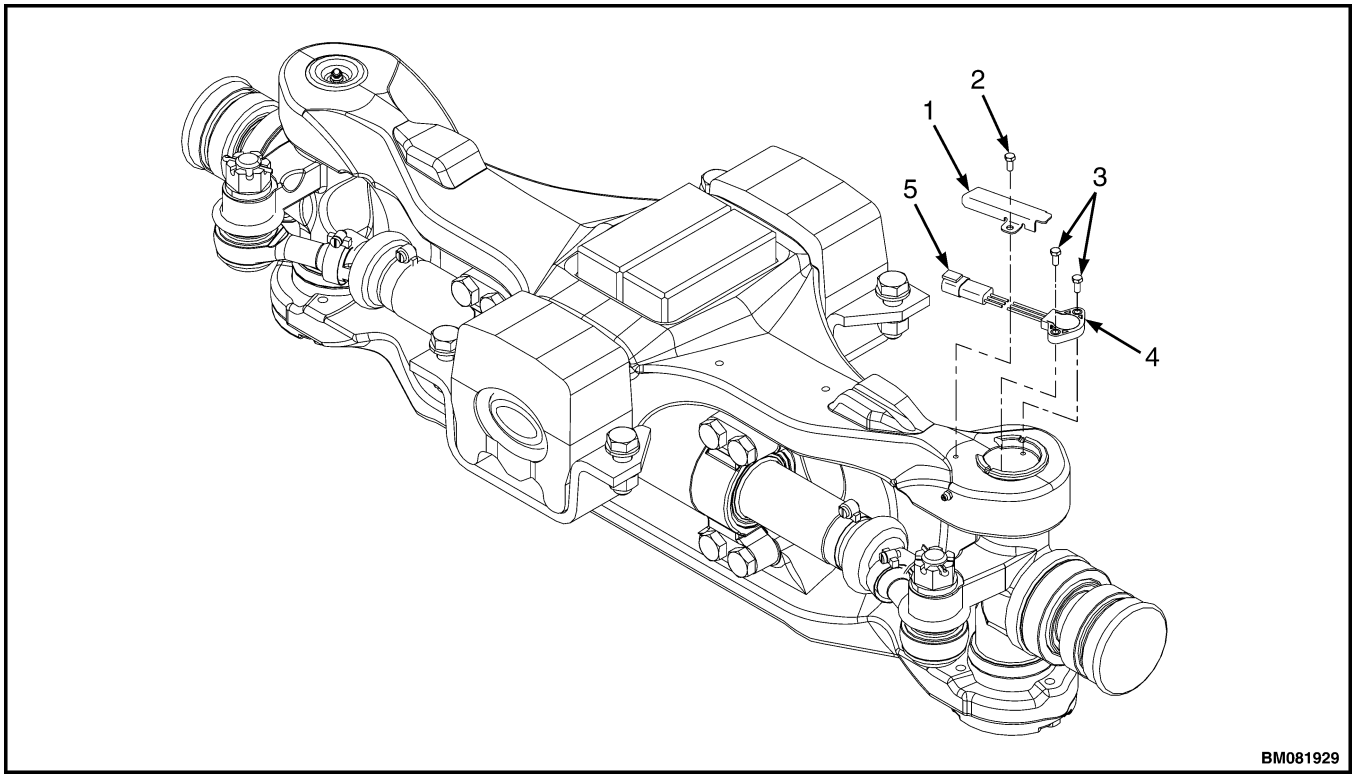
1. PROTECTIVE COVER
2. FLANGE CAPSCREW
3. SOCKET HEAD SCREWS
4. STEERING AXLE SENSOR
5. STEERING AXLE SENSOR CONNECTOR

Figure 29. Steering Axle Sensor Replacement, Lift Truck Models Manufactured Before November 2014 and J4.0-5.0XN (J80-100XN) (A970) J2.2-3.5XN (J45-70XN) (A276)



1. PROTECTIVE COVER
2. FLANGE CAPSCREW
3. SOCKET HEAD SCREWS
4. STEERING AXLE SENSOR
5. STEERING AXLE SENSOR CONNECTOR

Figure 30. Steering Axle Sensor Replacement, Lift Truck Models Manufactured After November 2014J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)



1. PROTECTIVE COVER
2. FLANGE CAPSCREW
3. SOCKET HEAD SCREWS
4. STEERING AXLE SENSOR
5. STEERING AXLE SENSOR CONNECTOR

Figure 31. Steering Axle Sensor Replacement, Lift Truck Model E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

HYDRAULIC MOTOR SPEED SENSOR

Lift Truck Models E2.2-3.5XN (E45-70XN) (A268)

Remove

1. Read and follow **WARNING** and **CAUTION** section in General section above.
2. For lift trucks manufactured before June 2012:
   a. Remove floor mat. Remove rear floor plate.
   b. Remove capscrews and washers from front floor plate and lift front floor plate up enough to disconnect accelerator pedal or MONOTROL® pedal. Remove front floor plate with accelerator or MONOTROL® pedal still attached. See Figure 32.
3. For lift trucks manufactures after June 2012:
   a. Remove floor mat. Remove rear floor plate.
   b. Lift front floor plate up enough to disconnect accelerator pedal or MONOTROL® pedal. Remove front floor plate with accelerator or MONOTROL® pedal still attached. See Figure 33.
4. Disconnect main wire harness from hydraulic motor speed sensor.
5. If lift truck is equipped with an 80 volt hydraulic pump motor, there is a shroud that covers hydraulic motor speed sensor that must be removed first. To remove shroud, perform the following:
   a. Remove three hex nut and hex bolts from mounting bracket. Remove mounting bracket from shroud. See Figure 34.
   b. Remove two Allen head screws from each side of shroud. Remove shroud from hydraulic pump motor. See Figure 34.
6. Remove socket head screw, hydraulic motor speed sensor, and hydraulic motor speed sensor connector from hydraulic motor. See Figure 35.

Install

1. Install new hydraulic motor speed sensor and hydraulic motor speed sensor connector into hydraulic motor. See Figure 35.
2. Attach hydraulic motor speed sensor to hydraulic motor with socket head screw.
3. Connect main wire harness to hydraulic motor speed sensor.
4. If lift truck is equipped with an 80 volt hydraulic pump motor, install shroud over the hydraulic motor speed sensor. To install shroud, perform the following:
   a. Install shroud to hydraulic pump motor using two Allen head screws. See Figure 34.
   b. Install mounting bracket to bottom of shroud using three hex bolts and hex nuts. See Figure 34. Tighten hex nuts and bolts to 60 to 70 N•m (44 to 52 lbf ft).
5. Connect accelerator pedal or MONOTROL® pedal, (see Figure 32).

   Install front floor plate using capscrews and washers for lift truck models E2.2-3.5XN (E45-70XN) (A268) manufactured before June 2012.

   No hardware is required to install front floor plate for lift truck models E2.2-3.5XN (E45-70XN) (A268) manufactured after June 2012.
6. Install rear floor plate. Install floor mat and connect the battery.

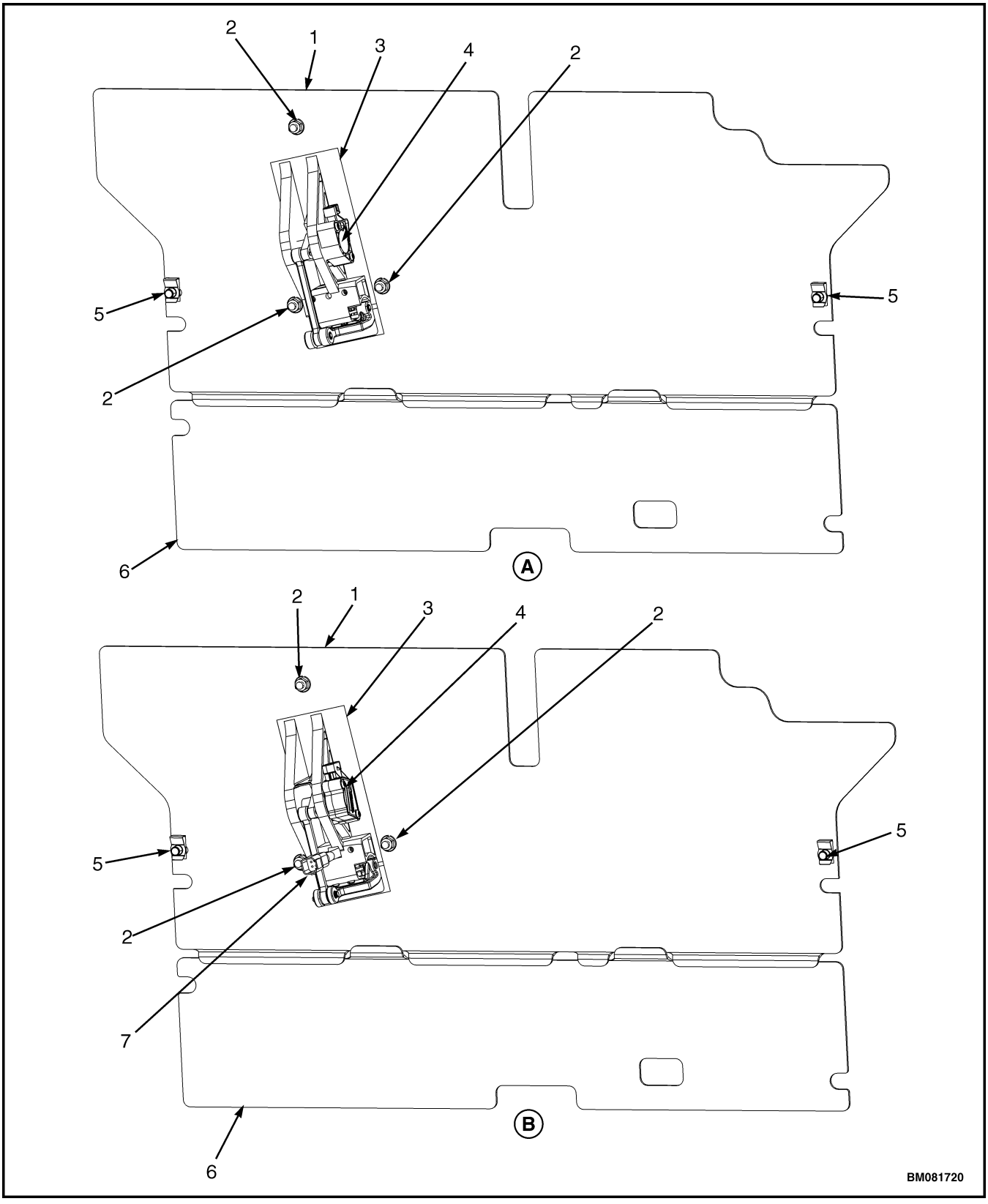


Figure 32. Removing Floor Plate and Accelerator or Pedal, Manufactured Before June 2012MONOTROL®

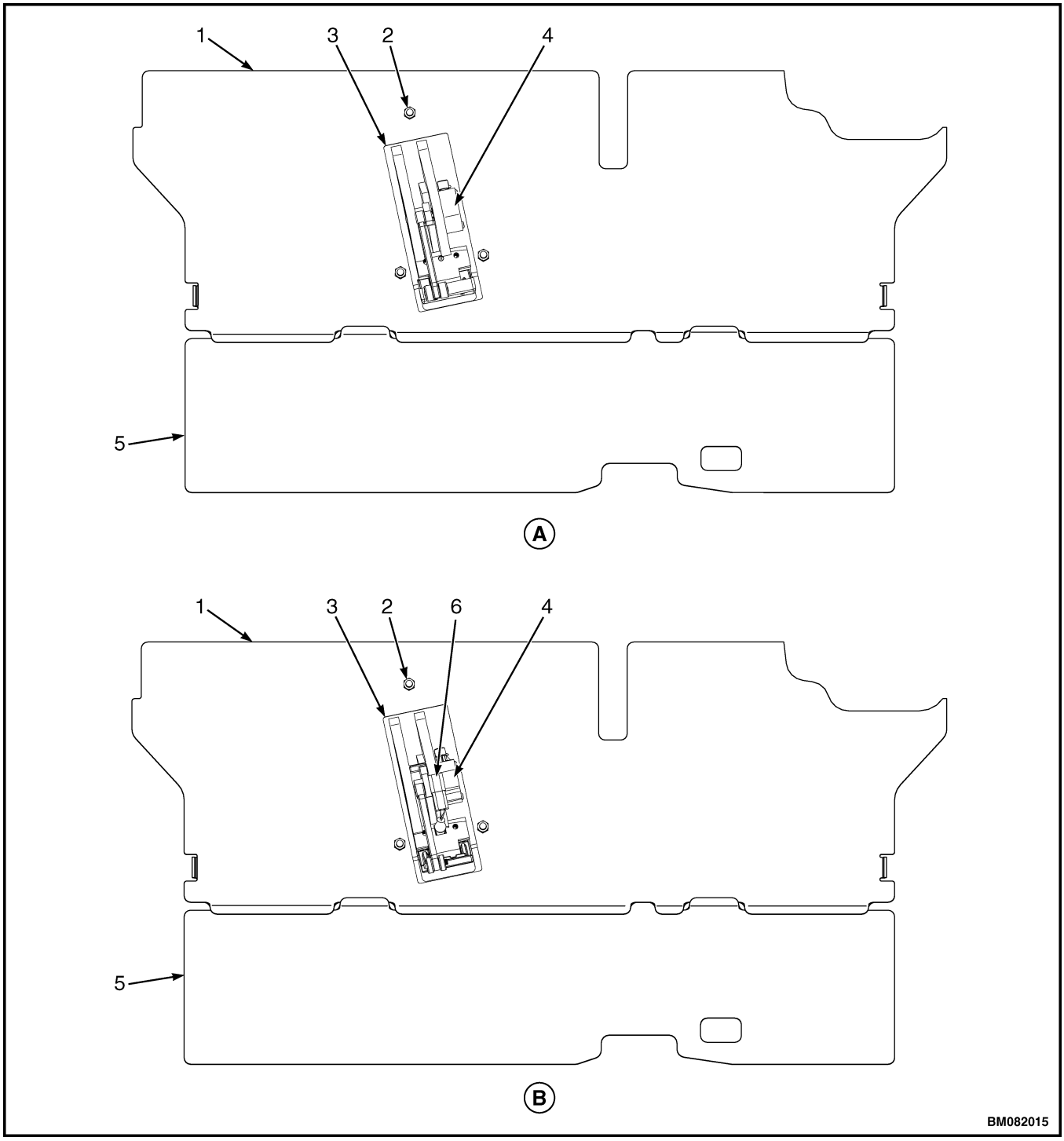
Legend for Figure 32.

A. STANDARD ACCELERATOR PEDAL

1. FRONT FLOOR PLATE
2. CAPSCREW AND NUT (PEDAL BASE)
3. PEDAL BASE
4. ACCELERATOR PEDAL POSITION SENSOR

B. MONOTROL® PEDAL

5. CAPSCREW, WASHER, NUT (FRONT FLOOR PLATE)
6. REAR FLOOR PLATE
7. MONOTROL® PEDAL CONNECTOR



A. STANDARD ACCELERATOR PEDAL

B. MONOTROL® PEDAL

1. FRONT FLOOR PLATE
2. CAPSCREW AND NUT (PEDAL BASE)
3. PEDAL BASE
4. ACCELERATOR PEDAL POSITION SENSOR
5. REAR FLOOR PLATE
6. MONOTROL® PEDAL CONNECTOR

Figure 33. Removing Floor Plate and Accelerator or Pedal, Manufactured After June 2012MONOTROL®

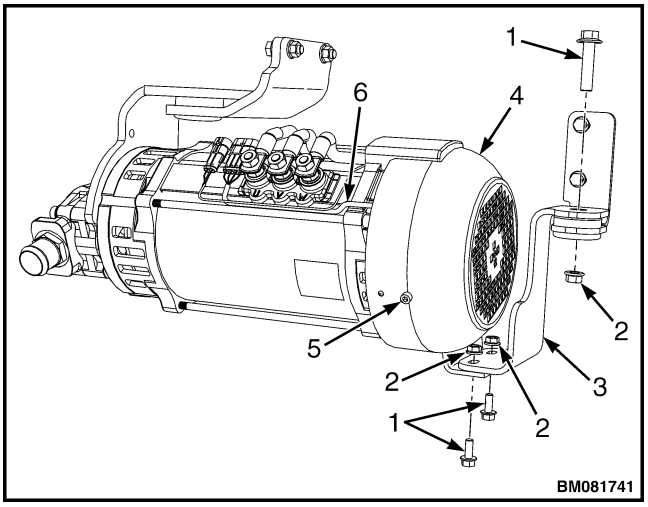
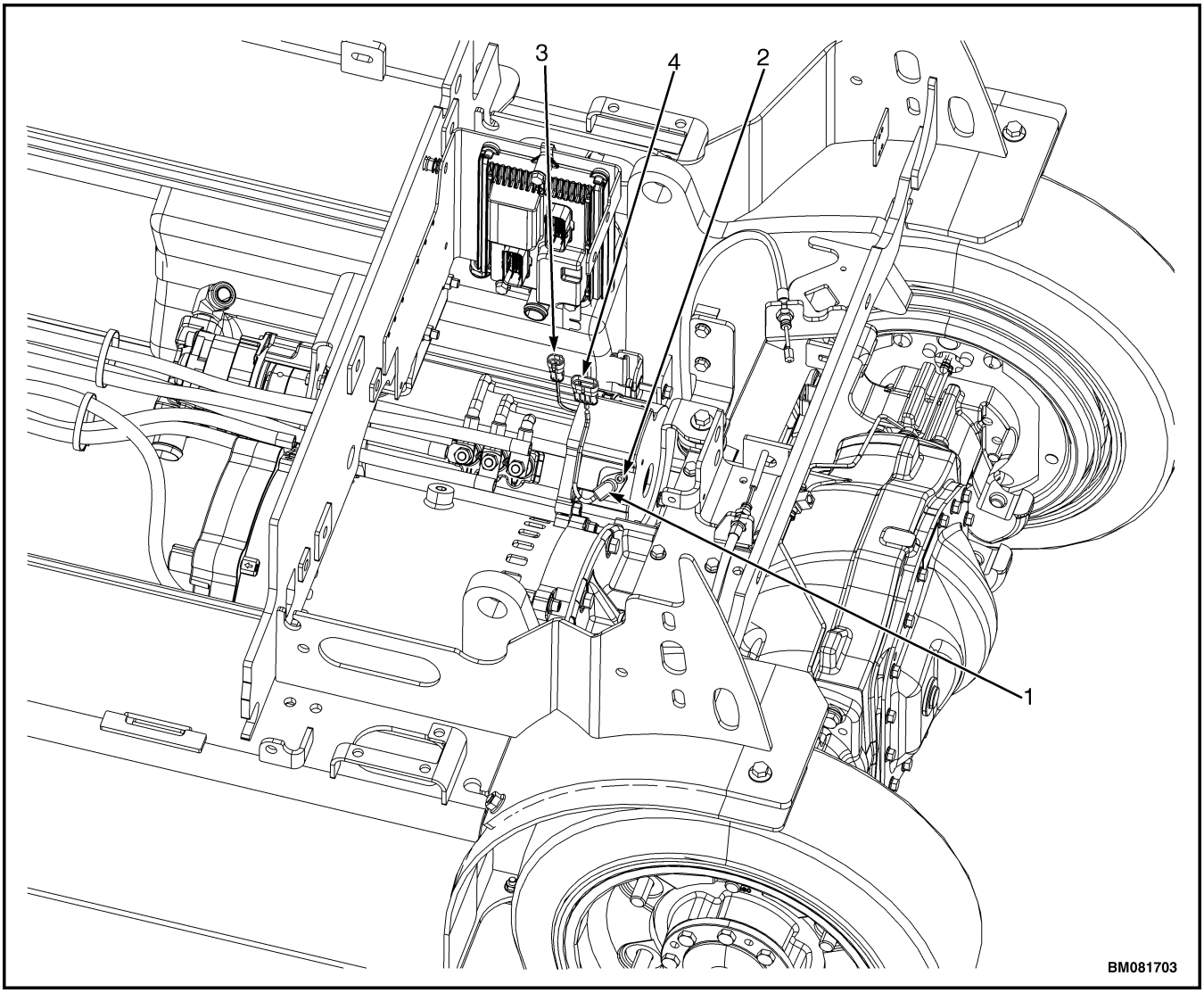


Figure 34. Shroud Removal

Legend for Figure 34.

1. HEX BOLT
2. HEX NUT
3. MOUNTING BRACKET
4. SHROUD
5. ALLEN HEAD SCREW
6. HYDRAULIC MOTOR SPEED SENSOR WIRE



1. HYDRAULIC MOTOR SPEED SENSOR
2. SOCKET HEAD SCREW
3. HYDRAULIC MOTOR TEMPERATURE SENSOR CONNECTOR
4. HYDRAULIC MOTOR SPEED SENSOR CONNECTOR

Figure 35. Hydraulic Motor Speed Sensor, Lift Truck Models E2.2-3.5XN (E45-70XN) (A268)

Lift Truck Models J2.2-3.5XN (J45-70XN) (A276) and J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

Remove

1. Read and follow **WARNING** and **CAUTION** section in General section above.

2. Remove tow pin and counterweight cover from counterweight. See Figure 36 or Figure 37.

3. Disconnect hydraulic motor speed sensor wire harness.

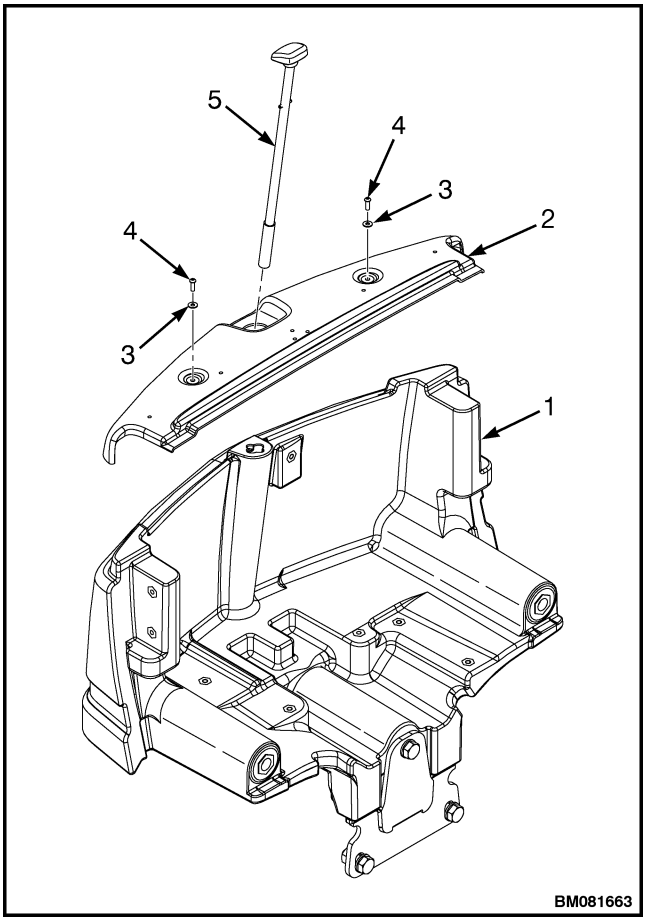
See Figure 38 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276)
- J4.0-5.0XN (J80-100XN) (A970) manufactured before November 2014

See Figure 40 for lift truck models

- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) manufactured after November 2014

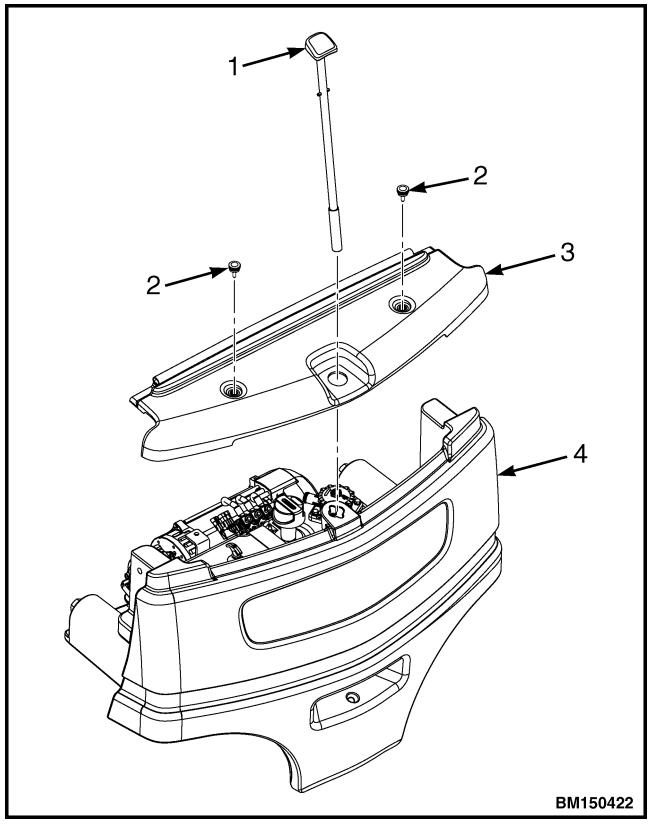
4. Remove socket head screw and hydraulic motor speed sensor from hydraulic motor. See Figure 38 or Figure 39.



NOTE: COUNTERWEIGHT FOR LIFT TRUCK MODELS J2.2-3.5XN (J45-70XN) (A276) SHOWN. COUNTERWEIGHT FOR LIFT TRUCK MODELS J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) IS SIMILAR.

1. COUNTERWEIGHT
2. COUNTERWEIGHT COVER
3. WASHER
4. CAPSCREW
5. TOW PIN

Figure 36. Tow Pin and Counterweight Cover Removal, Lift Truck Models Manufactured Prior to November, 2015 and J2.2-3.5XN (J45-70XN) (A276) J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)



1. TOW PIN
2. KNOB SCREW
3. COUNTERWEIGHT COVER
4. COUNTERWEIGHT

Figure 37. Tow Pin and Counterweight Cover Remove, Lift Truck Model Manufactured After November, 2015J2.2-3.5XN (J45-70XN) (A276)

Install

1. Install new hydraulic motor speed sensor and connector into hydraulic motor.

See Figure 38 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276)
- J4.0-5.0XN (J80-100XN) (A970) manufactured before November 2014

See Figure 40 for lift truck models

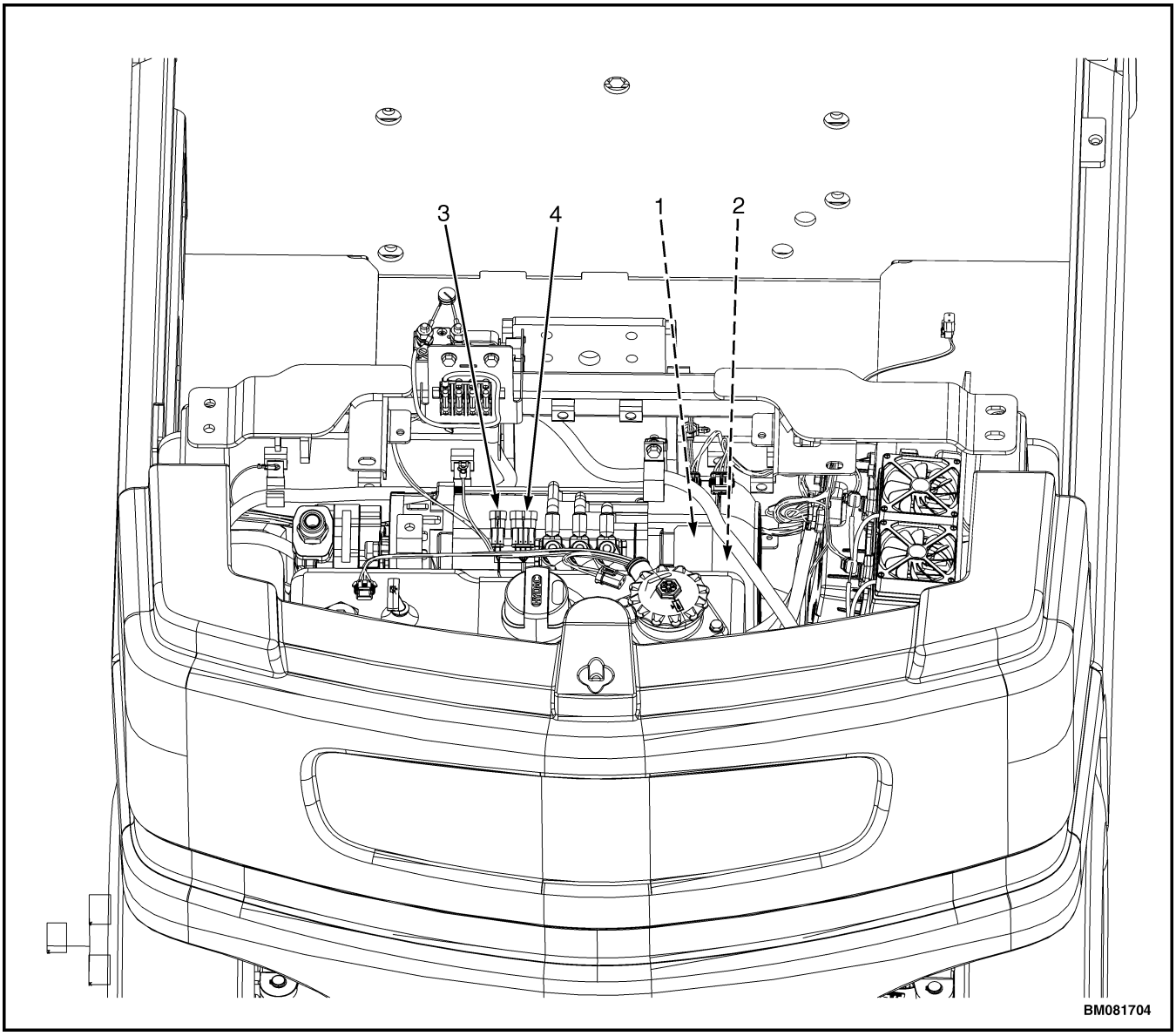
- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) manufactured after November 2014

2. Attach hydraulic motor speed sensor to hydraulic motor with socket head screw.

3. Connect main wire harness to hydraulic motor speed sensor.

4. Install counterweight cover and tow pin. See Figure 36 or Figure 37.

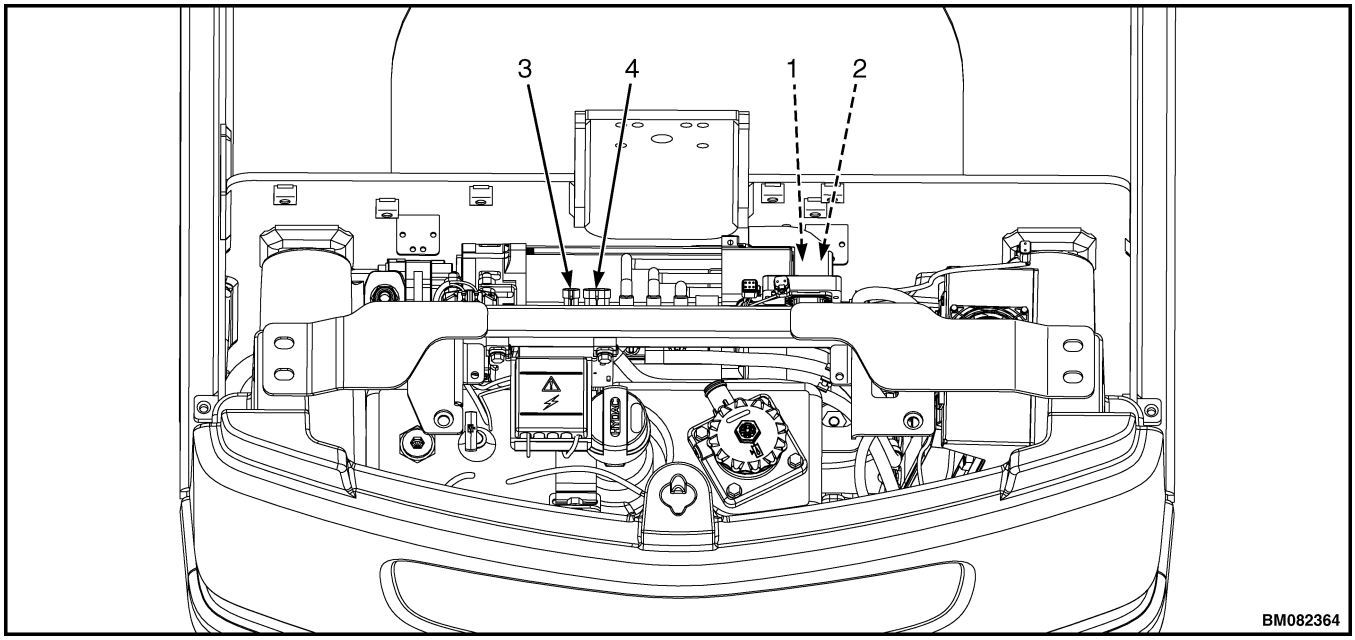
5. Connect the battery.



NOTE: J2.2-3.5XN (J45-70XN) (A276) SHOWN. J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) IS SIMILAR.

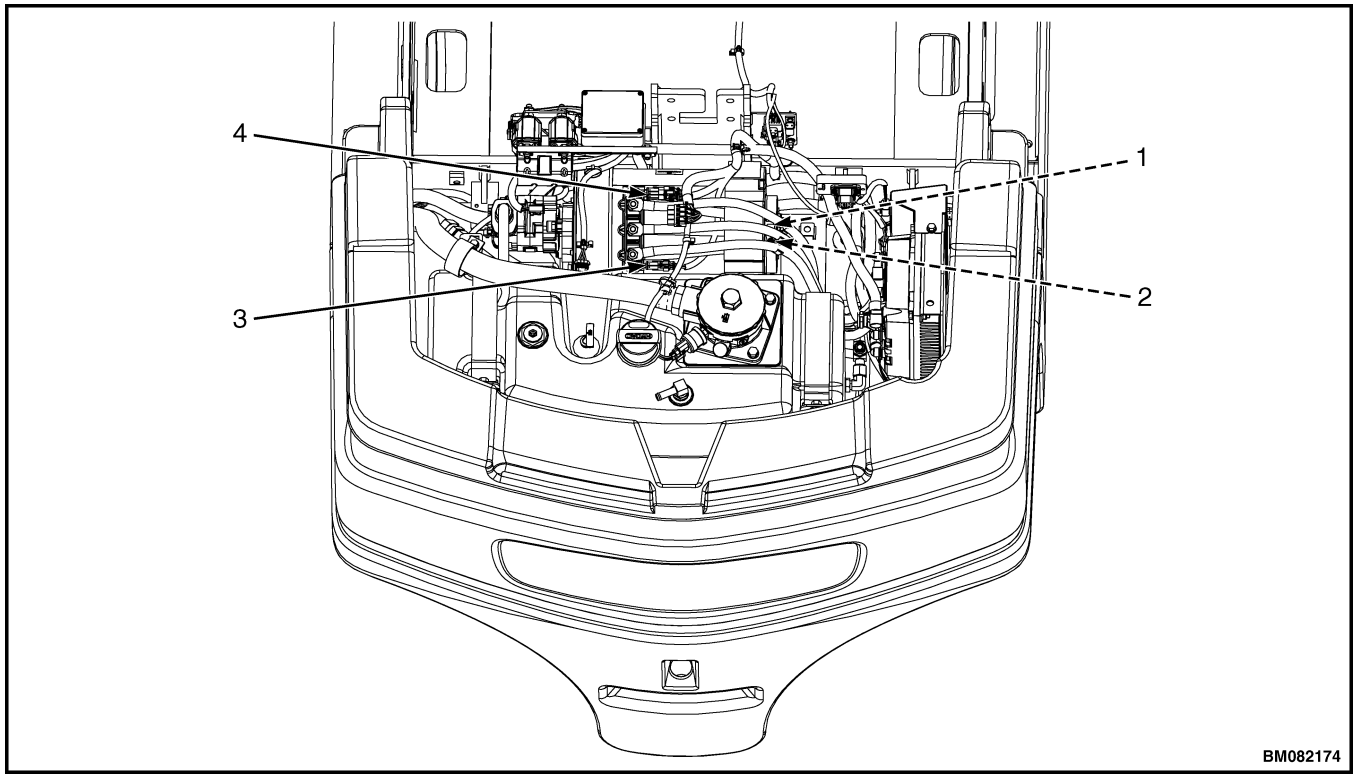
1. HYDRAULIC MOTOR SPEED SENSOR
2. SOCKET HEAD SCREW
3. HYDRAULIC MOTOR TEMPERATURE SENSOR CONNECTOR
4. HYDRAULIC MOTOR SPEED SENSOR CONNECTOR

Figure 38. Hydraulic Motor Speed Sensor, Lift Truck Models Manufactured Before November 2014 and Manufactured Prior to November 2015.J4.0-5.0XN (J80-100XN) (A970) J2.2-3.5XN (J45-70XN) (A276)



1. HYDRAULIC MOTOR SPEED SENSOR
2. SOCKET HEAD SCREW
3. HYDRAULIC MOTOR TEMPERATURE SENSOR CONNECTOR
4. HYDRAULIC MOTOR SPEED SENSOR CONNECTOR

Figure 39. Hydraulic Motor Speed Sensor, Lift Truck Model Manufactured After November, 2015J2.2-3.5XN (J45-70XN) (A276)



1. HYDRAULIC MOTOR SPEED SENSOR
2. SOCKET HEAD SCREW
3. HYDRAULIC MOTOR TEMPERATURE SENSOR CONNECTOR
4. HYDRAULIC MOTOR SPEED SENSOR CONNECTOR

Figure 40. Hydraulic Motor Speed Sensor, Lift Truck Models Manufactured After November 2014J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

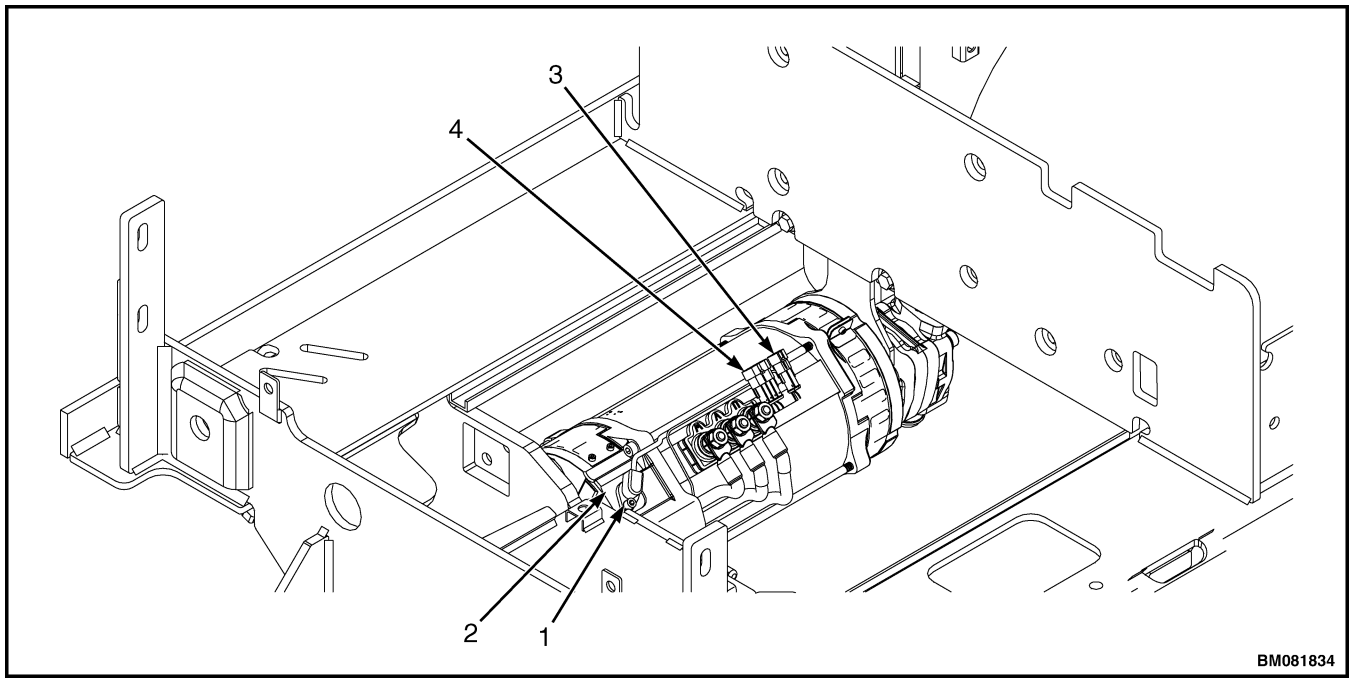
Lift Truck Models E1.6-2.0XN (E30-40XN) (A269)

Remove

1. Read and follow **WARNING** and **CAUTION** section in General section above.
2. Disconnect and remove battery. See **Periodic Maintenance** 8000SRM1442 for procedures.
3. Remove battery tray with rollers. See **Frame** 0100SRM1342 for procedures.
4. Disconnect hydraulic motor speed sensor wire harness. See Figure 41.
5. Remove socket head screw and hydraulic motor speed sensor from hydraulic motor. See Figure 41.

Install

1. Install new hydraulic motor speed sensor and socket head screw. See Figure 41.
2. Connect hydraulic motor speed sensor wire harness. See Figure 41.
3. Install battery tray with rollers. See **Frame** 0100SRM1342 for procedures.
4. Install and connect battery. See **Periodic Maintenance** 8000SRM1442 for procedures.



1. HYDRAULIC MOTOR SPEED SENSOR
2. SOCKET HEAD SCREW
3. HYDRAULIC MOTOR TEMPERATURE SENSOR CONNECTOR
4. HYDRAULIC MOTOR SPEED SENSOR CONNECTOR

Figure 41. Hydraulic Motor Speed Sensor for Lift Truck Model E1.6-2.0XN (E30-40XN) (A269)

Lift Truck Model E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

Remove

1. Read and follow **WARNING** and **CAUTION** section in General section above.
2. Remove floor mat. Remove rear floor plate.

   Lift front floor plate up enough to disconnect accelerator pedal or Monotrol® pedal. See Figure 42. Remove front floor plate with accelerator or Monotrol® pedal still attached.
3. Disconnect main wire harness from hydraulic motor speed sensor. See Figure 43.
4. Remove socket head screw, hydraulic motor speed sensor, and hydraulic motor speed sensor connector from hydraulic motor. See Figure 43.

Install

1. Install new hydraulic motor speed sensor and hydraulic motor speed sensor connector into hydraulic motor. See Figure 43.
2. Attach hydraulic motor speed sensor to hydraulic motor with socket head screw.
3. Connect main wire harness to hydraulic motor speed sensor.
4. Connect accelerator pedal or Monotrol® pedal (see Figure 42), and install front plate. Install rear floor plate. Install floor mat and connect the battery.

HYDRAULIC MOTOR TEMPERATURE SENSOR

The hydraulic motor temperature sensor is heat welded and sealed onto winding coils in stator housing in hydraulic motor. It is a non-replaceable part and cannot be replaced separately from hydraulic motor.

See Figure 35 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268)

See Figure 38 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276)
- J4.0-5.0XN (J80-100XN) (A970) manufactured before November 2014

See Figure 40 for lift truck models

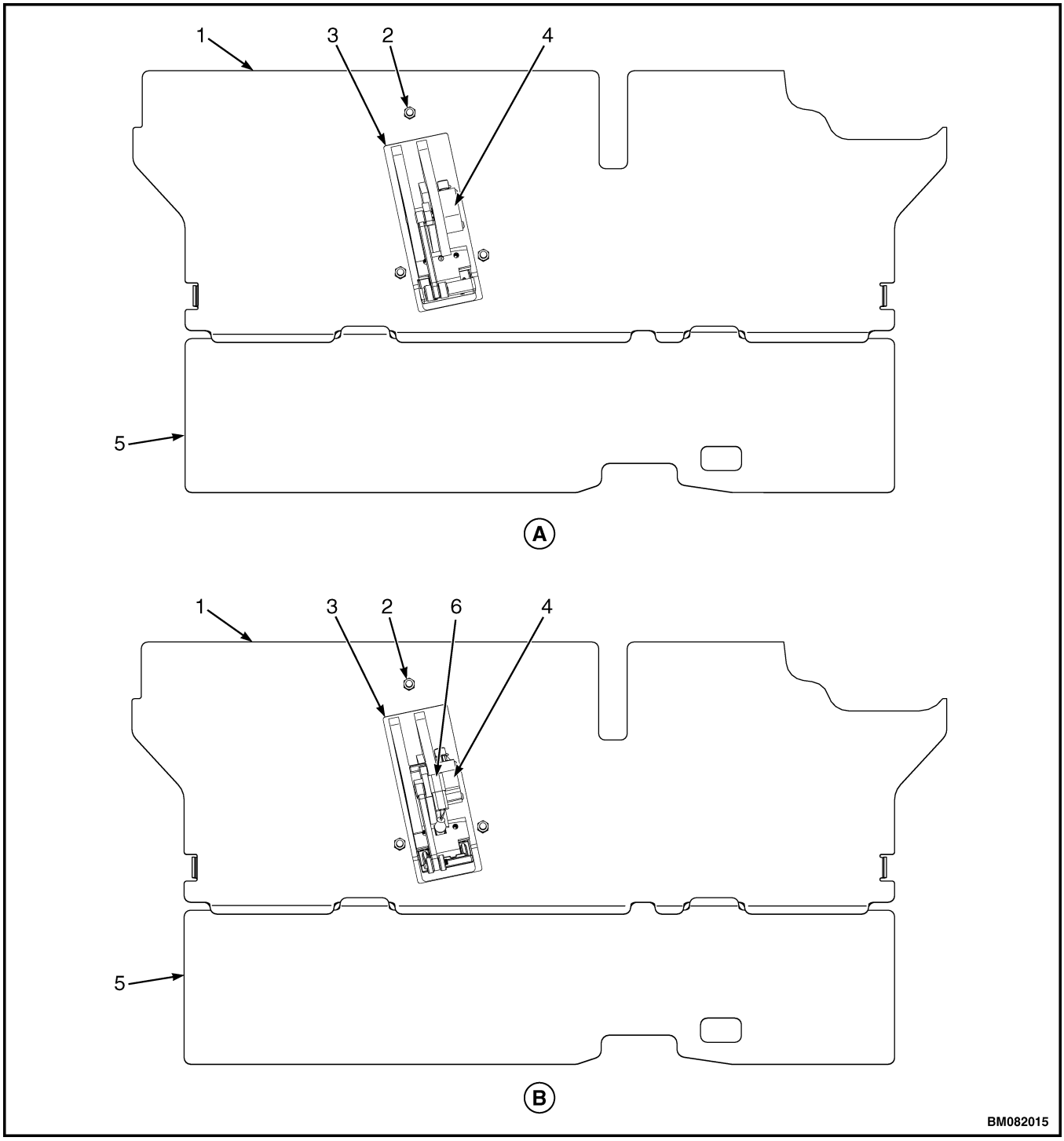
- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) manufactured after November 2014

See Figure 41 for lift truck models

- E1.6-2.0XN (E30-40XN) (A269)

See Figure 43 for lift truck models

- E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

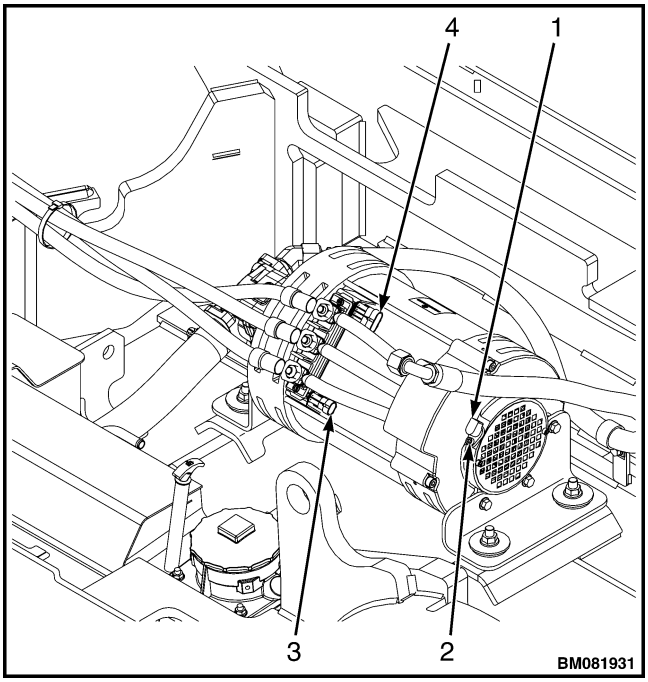


A. STANDARD ACCELERATOR PEDAL

B. MONOTROL® PEDAL

1. FRONT FLOOR PLATE
2. CAPSCREW AND NUT (PEDAL BASE)
3. PEDAL BASE
4. ACCELERATOR PEDAL POSITION SENSOR
5. REAR FLOOR PLATE
6. MONOTROL® PEDAL CONNECTOR

Figure 42. Removing Floor Plate and Accelerator or PedalMonotrol®



1. HYDRAULIC MOTOR SPEED SENSOR
2. SOCKET HEAD SCREW
3. HYDRAULIC MOTOR TEMPERATURE SENSOR CONNECTOR
4. HYDRAULIC MOTOR SPEED SENSOR CONNECTOR

Figure 43. Hydraulic Motor Speed Sensor, Lift Truck Models E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

HYDRAULIC TANK LEVEL SENSOR

Lift Truck Models J2.2-3.5XN (J45-70XN) (A276) and J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

Remove

1. Read and follow **WARNING** and **CAUTION** section in General section above.

2. Remove tow pin and counterweight cover from counterweight. See Figure 36.

3. Disconnect main wire harness from hydraulic tank level sensor.

See Figure 44 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276) manufactured prior to November 2015
- J4.0-5.0XN (J80-100XN) (A970) manufactured before November 2014

See Figure 45 for lift truck model

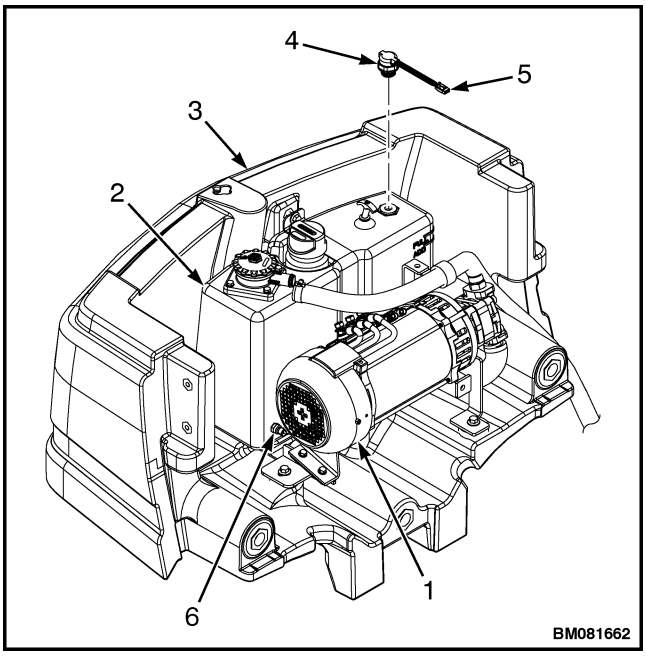
- J2.2-3.5XN (J45-70XN) (A276) manufactured after November 2015

See Figure 46 for lift truck models

- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) manufactured after November 2014

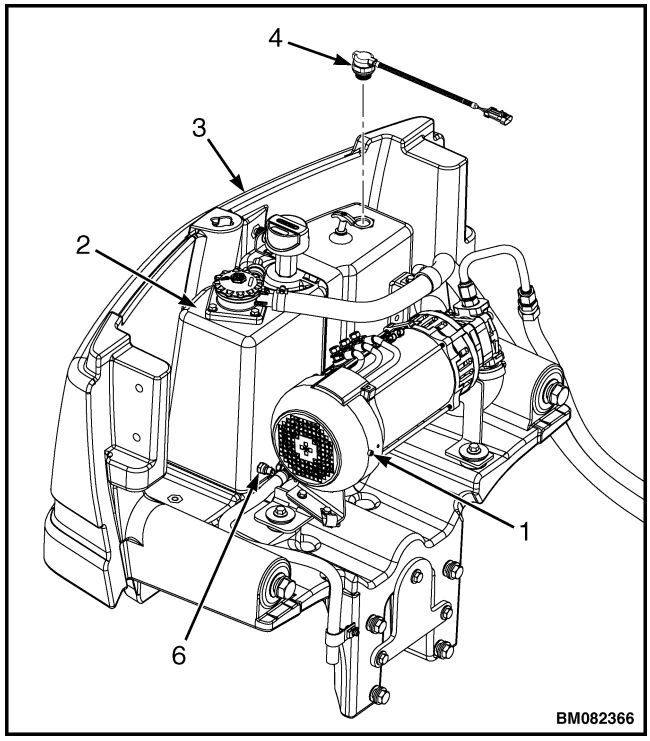
NOTE: DO NOT twist wires on hydraulic tank level sensor during removal.

4. Turn hydraulic tank level sensor counterclockwise to unscrew and remove hydraulic tank level sensor from hydraulic tank.



1. HYDRAULIC PUMP MOTOR
2. HYDRAULIC TANK
3. COUNTERWEIGHT
4. HYDRAULIC TANK LEVEL SENSOR
5. SENSOR CONNECTOR
6. HYDRAULIC OIL TEMPERATURE SENSOR

Figure 44. Hydraulic Tank Level and Hydraulic Oil Temperature Sensors, Lift Truck Models Manufactured Before November 2014 and Manufactured Prior to November 2015J4.0-5.0XN (J80-100XN) (A970) J2.2-3.5XN (J45-70XN) (A276)



1. HYDRAULIC PUMP MOTOR
2. HYDRAULIC TANK
3. COUNTERWEIGHT
4. HYDRAULIC TANK LEVEL SENSOR
5. SENSOR CONNECTOR
6. HYDRAULIC OIL TEMPERATURE SENSOR

Figure 45. Hydraulic Tank Level and Hydraulic Oil Temperature Sensors, Lift Truck Model Manufactured After November 2015J2.2-3.5XN (J45-70XN) (A276)

Install

NOTE: DO NOT twist wires on hydraulic tank level sensor during installation.

1. Install new hydraulic tank level sensor by turning it clockwise to screw it into hydraulic tank. Tighten hydraulic tank level sensor to 4 to 7 N•m (35 to 62 lbf in).

2. Connect main wire harness to hydraulic tank level sensor.

See Figure 44 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276) manufactured prior to November 2015
- J4.0-5.0XN (J80-100XN) (A970) manufactured before November 2014

See Figure 45 for lift truck model

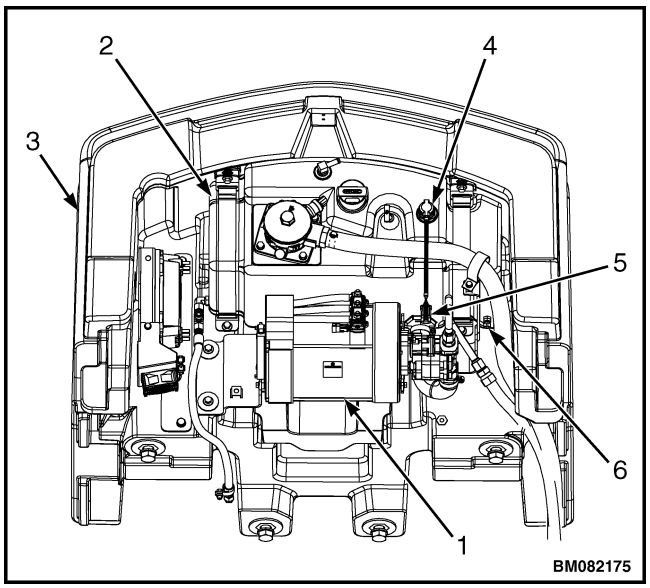
- J2.2-3.5XN (J45-70XN) (A276) manufactured after November 2015

See Figure 46 for lift truck models

- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) manufactured after November 2014

3. Install counterweight cover and tow pin onto counterweight. See Figure 36 or Figure 37.

4. Connect the battery.



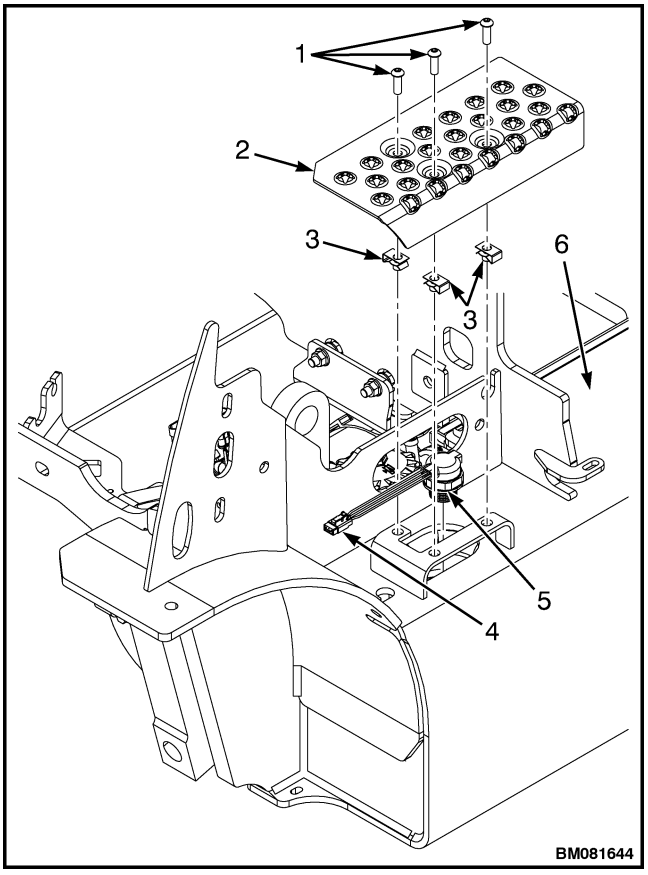
1. HYDRAULIC PUMP MOTOR
2. HYDRAULIC TANK
3. COUNTERWEIGHT
4. HYDRAULIC TANK LEVEL SENSOR
5. SENSOR CONNECTOR
6. HYDRAULIC OIL TEMPERATURE SENSOR

Figure 46. Hydraulic Tank Level and Hydraulic Oil Temperature Sensors, Lift Truck Models Manufactured After November 2014J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

Lift Truck Models E2.2-3.5XN (E45-70XN) (A268) and E1.6-2.0XN (E30-40XN) (A269)

Remove

1. Read and follow **WARNING** and **CAUTION** section in General section above.
2. Remove three socket head capscrews and foldover nuts and remove step plate from frame channel. See Figure 47
3. Disconnect main wire harness from hydraulic tank level sensor.



1. SOCKET HEAD CAPSCREW
2. LEFT STEP PLATE
3. FOLDOVER NUT
4. SENSOR CONNECTOR
5. HYDRAULIC TANK LEVEL SENSOR
6. LEFT FRAME CHANNEL

Figure 47. Hydraulic Tank Level Sensor, Lift Truck Models and E2.2-3.5XN (E45-70XN) (A268) E1.6-2.0XN (E30-40XN) (A269)

NOTE: DO NOT twist wires on hydraulic tank level sensor during removal.

4. Remove hydraulic tank level sensor by turning sensor counterclockwise. See Figure 47.

Install

NOTE: DO NOT twist wires on hydraulic tank level sensor during installation

1. Install new hydraulic tank level sensor by turning it clockwise to screw it into hydraulic tank. Tighten hydraulic tank level sensor 4 to 7 N•m (35 to 62 lbf in).
2. Connect main wire harness to hydraulic tank level sensor. See Figure 47.
3. Install step plate to frame channel using three socket head capscrews and foldover nuts. See Figure 47.
4. Connect the battery.

Lift Truck Models E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

Remove

1. Read and follow **WARNING** and **CAUTION** section in General section above.
2. Lift hood to **UP** position and remove the battery. See the **Operating Manual** or **Periodic Maintenance** 8000SRM1577 for procedures.
3. Disconnect main wire harness from hydraulic tank level sensor.

NOTE: DO NOT twist wires on hydraulic tank level sensor during removal.

4. Remove connector from mounting bracket by pulling mounting clip up. See Figure 48.
5. Remove hydraulic tank level sensor from hydraulic tank by turning sensor counterclockwise. See Figure 48.

Install

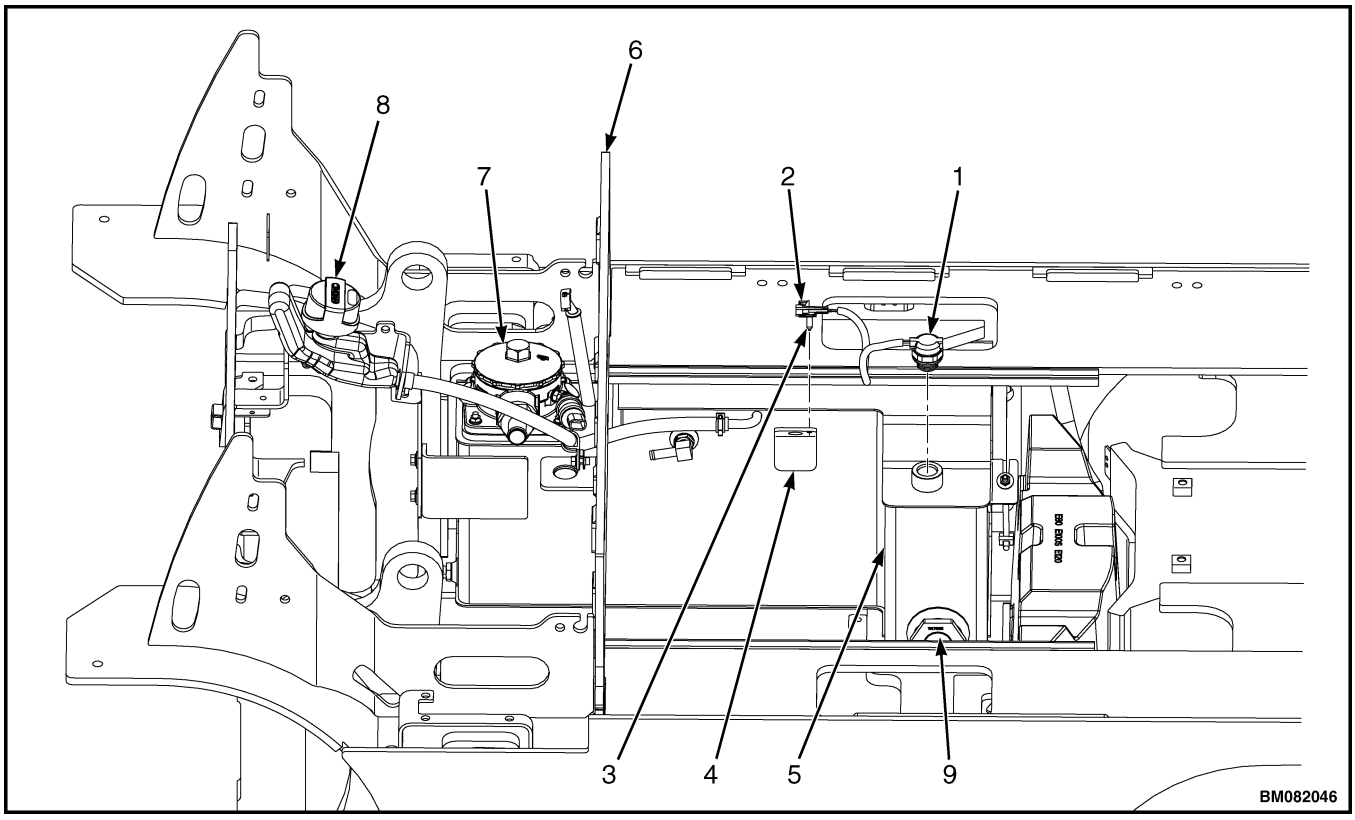
NOTE: DO NOT twist wires on hydraulic tank level sensor during removal.

1. Install new hydraulic tank level sensor by turning it clockwise to screw it into hydraulic tank. See Figure 48. Tighten hydraulic tank level sensor 4 to 7 N•m (35 to 62 lbf in).

2. Install connector to mounting bracket by pushing mounting clip into hole in mounting bracket.

3. Connect main wire harness to hydraulic tank level sensor. See Figure 48.

4. Install battery into lift truck. Connect battery and close hood. See the **Operating Manual** or **Periodic Maintenance** 8000SRM1577 for procedures.



1. HYDRAULIC TANK LEVEL SENSOR
2. HYDRAULIC TANK LEVEL SENSOR CONNECTOR
3. MOUNTING CLIP
4. MOUNTING BRACKET
5. HYDRAULIC TANK
6. FRONT BULKHEAD
7. HYDRAULIC OIL FILTER
8. HYDRAULIC TANK BREATHER
9. SUCTION STRAINER

Figure 48. Hydraulic Tank Level Sensor, Lift Truck Models E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

HYDRAULIC FILTER SENSOR

Lift Truck Models J2.2-3.5XN (J45-70XN) (A276) and J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

Remove

1. Read and follow **WARNING** and **CAUTION** section in General section above.
2. Remove tow pin and counterweight cover from counterweight. See Figure 36 or Figure 37.
3. Disconnect main wire harness from hydraulic filter sensor.
4. Remove hydraulic filter sensor from hydraulic filter by loosening nut on hydraulic filter sensor.

   See Figure 49 for lift truck models

   - J2.2-3.5XN (J45-70XN) (A276)
   - J4.0-5.0XN (J80-100XN) (A970) manufactured before November 2014

   See Figure 50 for lift truck models

   - J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) manufactured after November 2014

Install

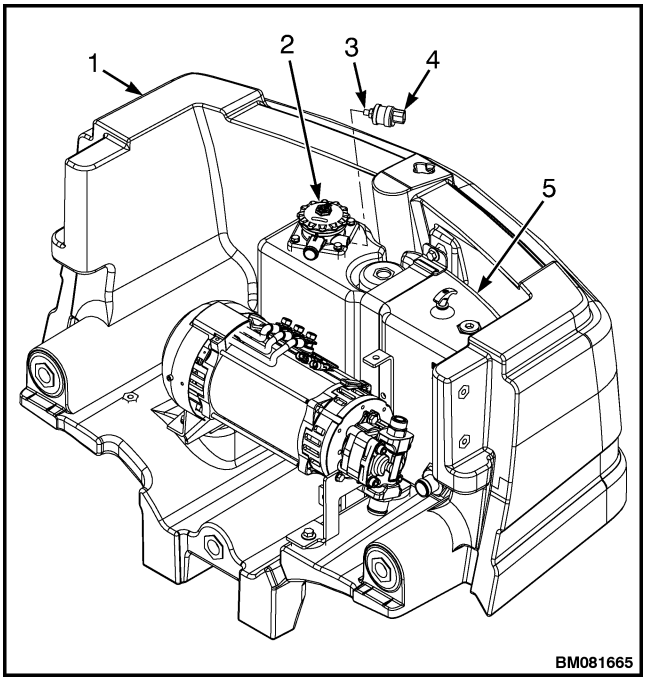
1. Install new hydraulic filter sensor into hydraulic filter by tightening nut on hydraulic filter sensor to 4 to 7 N • m (3 to 5 lbf in).

   See Figure 49 for lift truck models

   - J2.2-3.5XN (J45-70XN) (A276)
   - J4.0-5.0XN (J80-100XN) (A970) manufactured before November 2014

   See Figure 50 for lift truck models

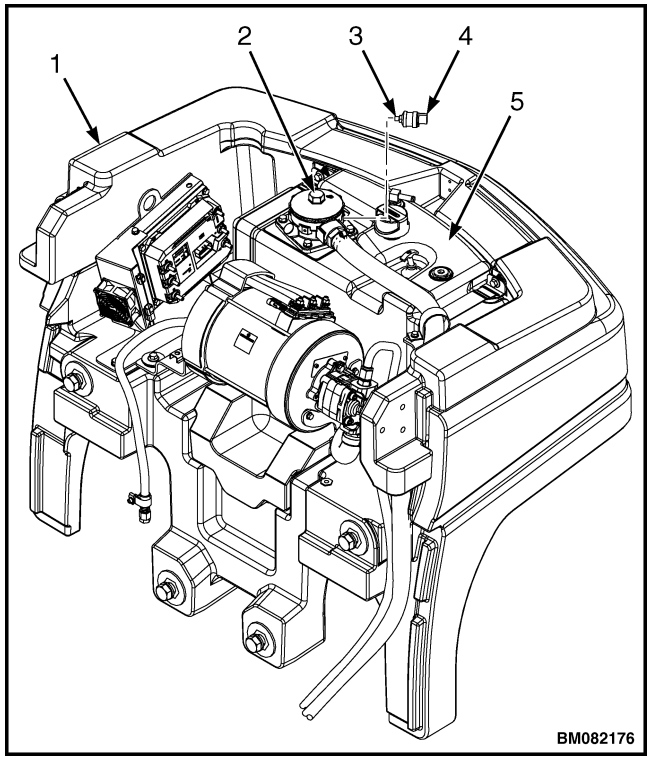
   - J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) manufactured after November 2014
2. Connect main wire harness to hydraulic filter sensor.
3. Install tow pin and counterweight cover to counterweight. See Figure 36 or Figure 37.
4. Connect the battery.



NOTE: SOME HYDRAULIC SYSTEM COMPONENTS OMITTED FOR CLARITY.
NOTE: LIFT TRUCK MODEL J2.2-3.5XN (J45-70XN) (A276) MANUFACTURED PRIOR TO NOVEMBER 2015 SHOWN. LIFT TRUCK MODEL J2.2-3.5XN (J45-70XN) (A276) MANUFACTURED AFTER NOVEMBER 2015 SIMILAR.

1. COUNTERWEIGHT
2. HYDRAULIC FILTER
3. NUT
4. HYDRAULIC FILTER SENSOR
5. HYDRAULIC TANK

Figure 49. Hydraulic Filter Sensor, Lift Truck Models Manufactured Before November 2014 and J4.0-5.0XN (J80-100XN) (A970) J2.2-3.5XN (J45-70XN) (A276)



NOTE: SOME HYDRAULIC SYSTEM COMPONENTS OMITTED FOR CLARITY.

1. COUNTERWEIGHT
2. HYDRAULIC FILTER
3. NUT
4. HYDRAULIC FILTER SENSOR
5. HYDRAULIC TANK

Figure 50. Hydraulic Filter Sensor, Lift Truck Models Manufactured After November 2014 J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

Lift Truck Models E2.2-3.5XN (E45-70XN) (A268), E1.6-2.0XN (E30-40XN) (A269) and E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

Remove

1. Read and follow **WARNING** and **CAUTION** in General section above.

NOTE: Perform Step 2 and Step 3 for lift truck models E1.6-2.0XN (E30-40XN) (A269) and E2.2-3.5XN (E45-70XN) (A268) manufactured before June 2012

2. Remove floor mat. Remove rear floor plate.

3. Remove capscrews and washers from front floor plate and lift front floor plate up enough to disconnect accelerator pedal or MONOTROL® pedal. See Figure 32. Remove front floor plate with the accelerator or MONOTROL® pedal still attached.

NOTE: Perform Step 4 and Step 5 for lift truck models E2.2-3.5XN (E45-70XN) (A268) manufactured after June 2012, and lift truck models E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099) .

4. Remove the floor mat and floor plate.

5. Lift front floor plate up enough to disconnect the accelerator pedal or MONOTROL® pedal. See Figure 33. Remove front floor plate with the accelerator or MONOTROL® pedal still attached.

6. Disconnect main wire harness from hydraulic filter sensor.

7. Remove hydraulic filter sensor from hydraulic filter adapter and hydraulic filter by loosening nut on hydraulic filter sensor.

See Figure 51 for lift truck models

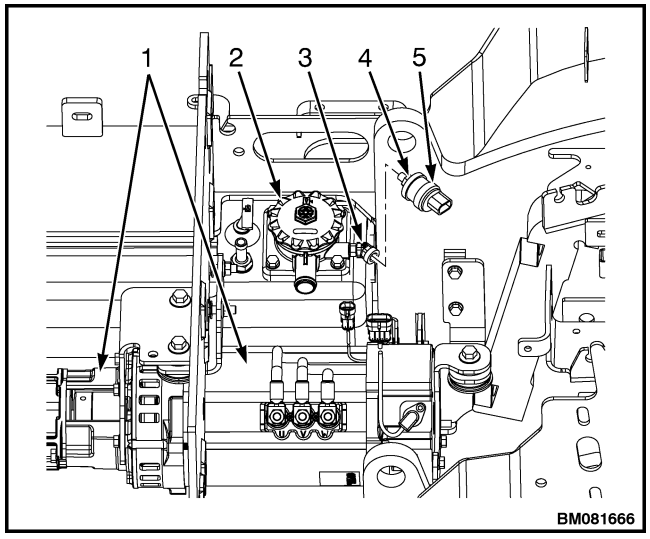
- E2.2-3.5XN (E45-70XN) (A268)

See Figure 52 for lift truck models

- E1.6-2.0XN (E30-40XN) (A269)

See Figure 53 for lift truck model

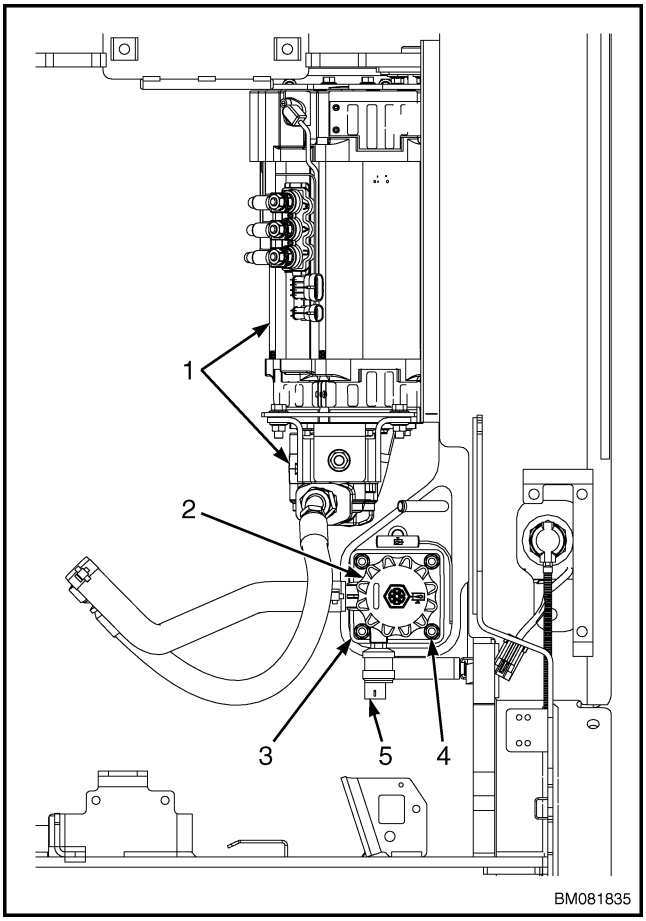
- E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)



NOTE: SOME HYDRAULIC SYSTEM COMPONENTS OMITTED FOR CLARITY.

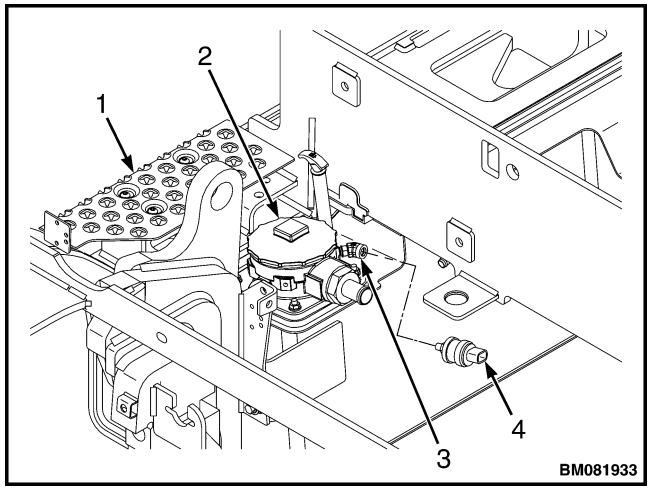
1. HYDRAULIC PUMP AND MOTOR
2. HYDRAULIC FILTER
3. HYDRAULIC FILTER ADAPTER
4. NUT
5. HYDRAULIC FILTER SENSOR

Figure 51. Hydraulic Filter Sensor, Lift Truck Models E2.2-3.5XN (E45-70XN) (A268)



1. HYDRAULIC PUMP AND MOTOR
2. HYDRAULIC FILTER
3. HYDRAULIC FILTER ADAPTER
4. NUT
5. HYDRAULIC FILTER SENSOR

Figure 52. Hydraulic Filter Sensor for Lift Truck Model E1.6-2.0XN (E30-40XN) (A269)



1. RIGHT STEP PLATE
2. HYDRAULIC FILTER
3. HYDRAULIC FILTER ADAPTER
4. HYDRAULIC FILTER SENSOR

Figure 53. Hydraulic Filter Sensor for Lift Truck Model E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

Install

1. Install new hydraulic filter sensor into hydraulic filter adapter by tightening nut on hydraulic filter sensor to 25 N • m (18 lbf ft).

See Figure 51 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268)

See Figure 52 for lift truck models

- E1.6-2.0XN (E30-40XN) (A269)

See Figure 53 for lift truck model

- E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

2. Connect main wire harness to hydraulic filter sensor.

3. Connect accelerator pedal or MONOTROL® pedal. See Figure 32.

NOTE: Perform Step 4 for lift truck models E1.6-2.0XN (E30-40XN) (A269) and E2.2-3.5XN (E45-70XN) (A268) manufactured before June 2012.

4. Install front floor plate using capscrews and washers.

NOTE: Perform Step 5 for lift truck models E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099) and E2.2-3.5XN (E45-70XN) (A268) manufactured after June 2012.

5. No hardware is required to install the front floor plate.

6. Install rear floor plate. Install floor mat and connect the battery.

HYDRAULIC OIL TEMPERATURE SENSOR

NOTE: Lift truck models E1.6-2.0XN (E30-40XN) (A269) and E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099) are not equipped with a Hydraulic Oil Temperature Sensor.

Lift Truck Models J2.2-3.5XN (J45-70XN) (A276) and J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

Remove

1. Read and follow **WARNING** and **CAUTION** section in General section above.

2. Remove tow pin and counterweight cover from counterweight. See Figure 36 or Figure 37.

3. Disconnect main wire harness from hydraulic oil temperature sensor.

4. Unscrew and remove hydraulic oil temperature sensor from hydraulic tank.

See Figure 44 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276)
- J4.0-5.0XN (J80-100XN) (A970) manufactured before November 2014

See Figure 39 for lift truck model

- J2.2-3.5XN (J45-70XN) (A276) manufactured after November 2015

See Figure 46 for lift truck models

- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) manufactured after November 2014

Install

1. Install new hydraulic oil temperature sensor to hydraulic tank. Tighten hydraulic oil temperature sensor to 20 N•m (177 lbf in).
2. Connect main wire harness to hydraulic oil temperature sensor.
3. Install tow pin and counterweight cover to counterweight. See Figure 36 or Figure 37.
4. Connect the battery.

Lift Truck Models E2.2-3.5XN (E45-70XN) (A268)

Remove

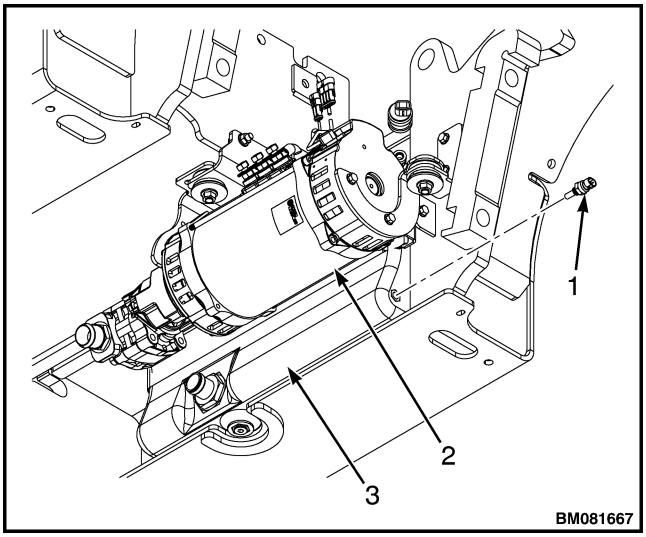
1. Read and follow **WARNING** and **CAUTION** section in General section above.

NOTE: Perform Step 2 to Step 4 for lift trucks manufactured before June 2012.

2. Remove floor mat. Remove rear floor plate.
3. Remove capscrews and washers from front floor plate and lift front floor plate up enough to disconnect accelerator pedal or MONOTROL® pedal. See Figure 32.
4. Remove front floor plate with accelerator or MONOTROL® pedal still attached.

NOTE: Perform Step 5 to Step 7 for lift trucks manufactured after June 2012.

5. Remove floor mat. Remove rear floor plate.
6. Lift front floor plate up enough to disconnect accelerator pedal or MONOTROL® pedal. See Figure 33
7. Remove front floor plate with accelerator or MONOTROL® pedal still attached.
8. Disconnect main wire harness from hydraulic oil temperature sensor.
9. Loosen nut on hydraulic oil temperature sensor and remove sensor from hydraulic tank. See Figure 54.



NOTE: SOME HYDRAULIC SYSTEM COMPONENTS OMITTED FOR CLARITY

1. HYDRAULIC OIL TEMPERATURE SENSOR
2. HYDRAULIC MOTOR
3. HYDRAULIC TANK

Figure 54. Hydraulic Oil Temperature Sensor, Lift Truck Models E2.2-3.5XN (E45-70XN) (A268)

Install

1. Install new hydraulic oil temperature sensor to hydraulic tank. Tighten hydraulic oil temperature sensor to 20 N•m (177 lbf in).
2. Connect main wire harness to hydraulic oil temperature sensor.
3. Connect accelerator pedal or MONOTROL® pedal.

   See Figure 32 for lift trucks manufactured before June 2012.

   See Figure 33 for lift trucks manufactured after June 2012.

NOTE: Perform Step 4 for lift truck models E2.2-3.5XN (E45-70XN) (A268) manufactured before June 2012.

4. Install front floor plate using capscrews and washers.

NOTE: Perform Step 5 and Step 6 for lift truck models E2.2-3.5XN (E45-70XN) (A268) manufactured after June 2012.

5. No hardware is required to install front floor plate.

6. Install rear floor plate.

7. Install floor mat and connect the battery.

TRACTION SPEED SENSOR

Lift Truck Models J2.2-3.5XN (J45-70XN) (A276) and J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

Remove

NOTE: There are two speed sensors. The procedures below describe how to replace one sensor. The procedures are the same for both sensors.

1. Read and follow **WARNING** and **CAUTION** section in General section above.

2. Put lift truck on blocks and remove tire and wheel. See **Operating Manual** or section

   Periodic Maintenance 8000SRM1372 for lift truck models

   - J2.2-3.5XN (J45-70XN) (A276)

   Periodic Maintenance 8000SRM1541 for lift truck models

   - J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

3. Disconnect main wire harness from speed sensor.

4. Remove socket head screw securing speed sensor to traction motor. Remove speed sensor and sensor connector from traction motor.

   See Figure 55 for lift truck models

   - J2.2-3.5XN (J45-70XN) (A276)

   See Figure 56 for lift truck models

   - J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

Install

1. Install new speed sensor and sensor connector onto traction motor. Secure speed sensor to traction motor with socket head screws.

   See Figure 55 for lift truck models

   - J2.2-3.5XN (J45-70XN) (A276)

   See Figure 56 for lift truck models

   - J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

2. Connect main wire harness to speed sensor.

3. Install tire and wheel. Remove lift truck from blocks. See **Operating Manual** or section

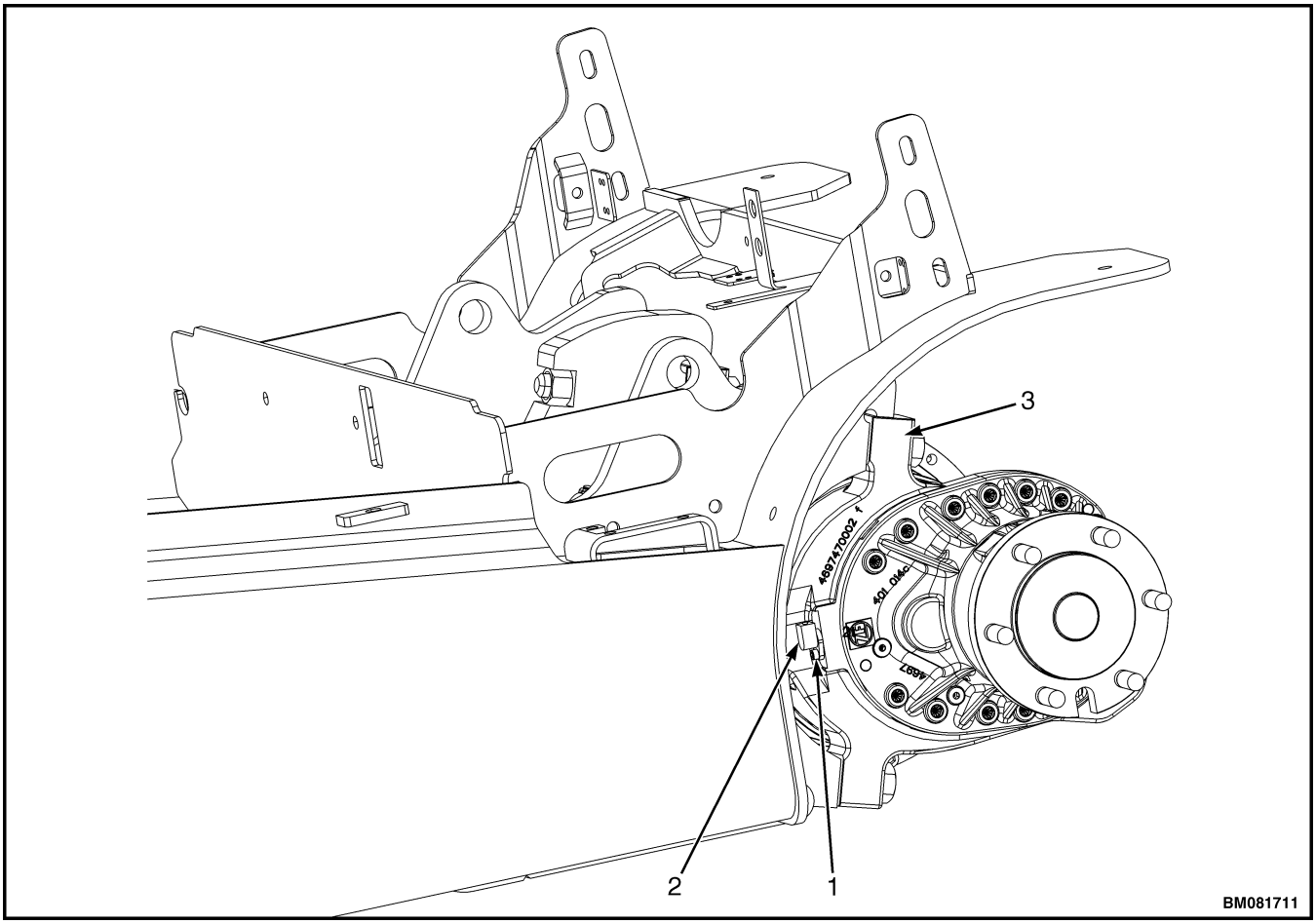
   Periodic Maintenance 8000SRM1372 for lift truck models

   - J2.2-3.5XN (J45-70XN) (A276)

   Periodic Maintenance 8000SRM1541 for lift truck models

   - J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

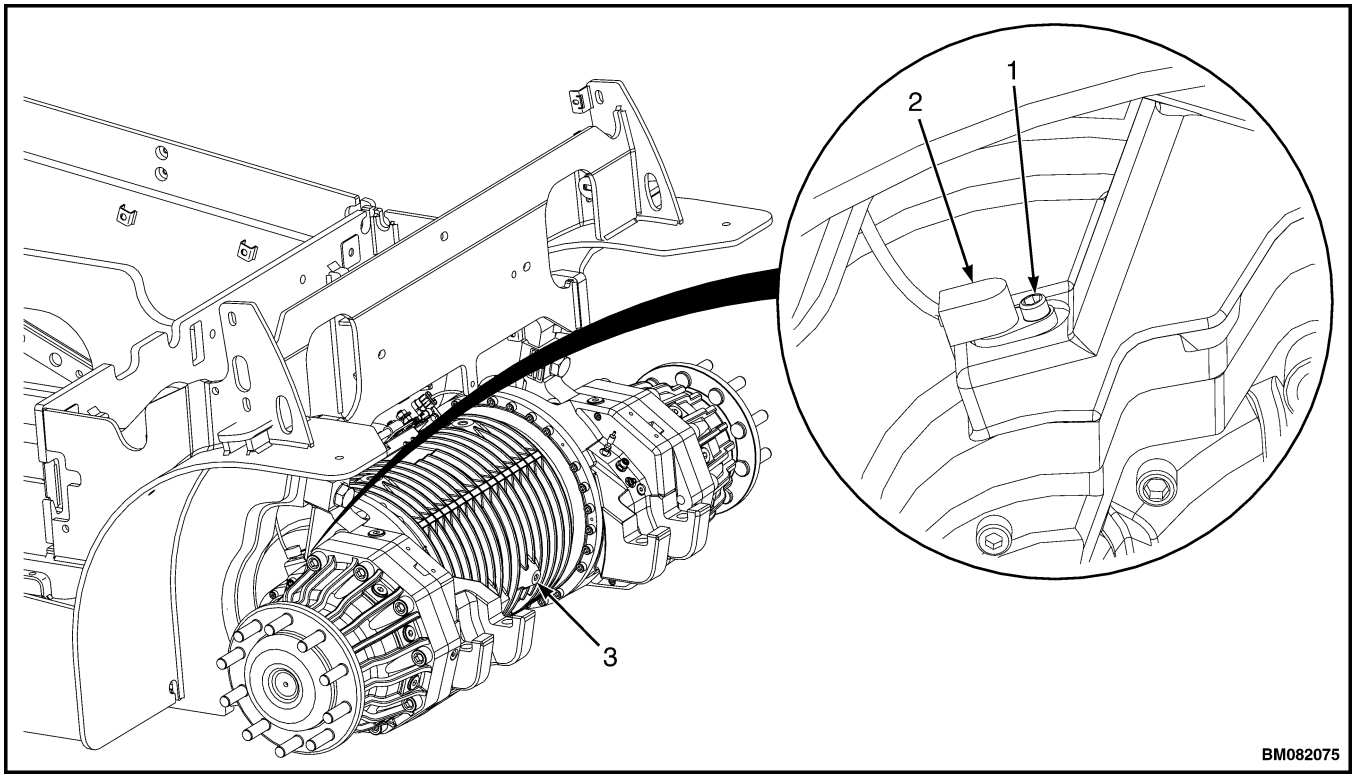
4. Connect the battery.



NOTE: SOME COMPONENT PARTS OMITTED FOR CLARITY. RIGHT SIDE SPEED SENSOR SHOWN. LEFT SIDE IS THE SAME.

1. SOCKET HEAD SCREW
2. TRACTION SPEED SENSOR
3. TRANSAXLE ASSEMBLY

Figure 55. Speed Sensor Removal, Lift Truck Models J2.2-3.5XN (J45-70XN) (A276)



NOTE: SOME COMPONENT PARTS OMITTED FOR CLARITY. RIGHT SIDE SPEED SENSOR SHOWN. LEFT SIDE IS THE SAME.

1. SOCKET HEAD SCREW
2. TRACTION SPEED SENSOR
3. TRANSAXLE ASSEMBLY

Figure 56. Speed Sensor Removal, Lift Truck Models J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

Lift Truck Models E2.2-3.5XN (E45-70XN) (A268) and E1.6-2.0XN (E30-40XN) (A269)

Remove

1. Read and follow **WARNING** and **CAUTION** section in General section above.
2. Put lift truck on blocks. See **Operating Manual** or section

   Periodic Maintenance 8000SRM1364 for lift truck models

   - E2.2-3.5XN (E45-70XN) (A268)

   Periodic Maintenance 8000SRM1442 for lift truck models

   - E1.6-2.0XN (E30-40XN) (A269)
3. Remove drip shield for access to speed sensor.
4. Disconnect main wire harness from speed sensor connector.

   See Figure 57 for lift truck models

   - E2.2-3.5XN (E45-70XN) (A268)

   See Figure 58 for lift truck models

   - E1.6-2.0XN (E30-40XN) (A269)
5. Remove socket head screw securing speed sensor to traction motor. Remove speed sensor connector from sensor wiring connector mounting bracket.

Install

1. Install new speed sensor to traction motor.

   See Figure 57 for lift truck models

   - E2.2-3.5XN (E45-70XN) (A268)

   See Figure 58 for lift truck models

   - E1.6-2.0XN (E30-40XN) (A269)
2. Connect main wire harness to speed sensor.
3. Install drip shield.
4. Remove lift truck from blocks.
5. Connect the battery.

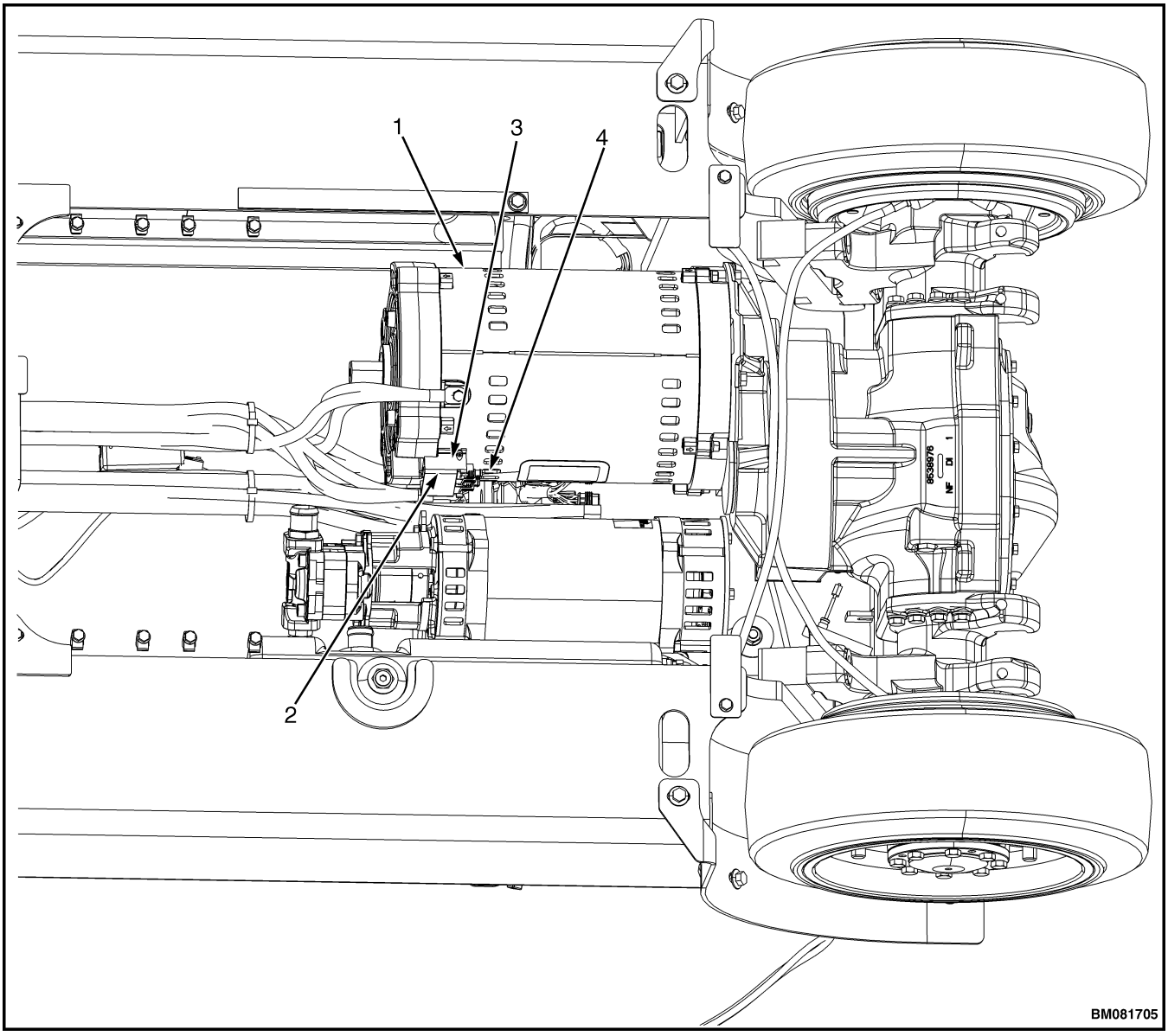
Lift Truck Model E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

Remove

1. Read and follow **WARNING** and **CAUTION** section in General section above.
2. Raise hood and seat assembly and remove batteries and floor plates. See **Frame** 0100SRM1342 for procedures.
3. Disconnect wire harness from speed sensor connector. See Figure 59.
4. Remove socket head screw securing speed sensor to sensor mounting bracket on traction motor. See Figure 59.
5. Remove sensor mounting bracket. See Figure 59.
6. Remove socket head screw securing speed sensor to traction motor. See Figure 59.
7. Remove speed sensor and speed sensor connector from traction motor. See Figure 59.

Install

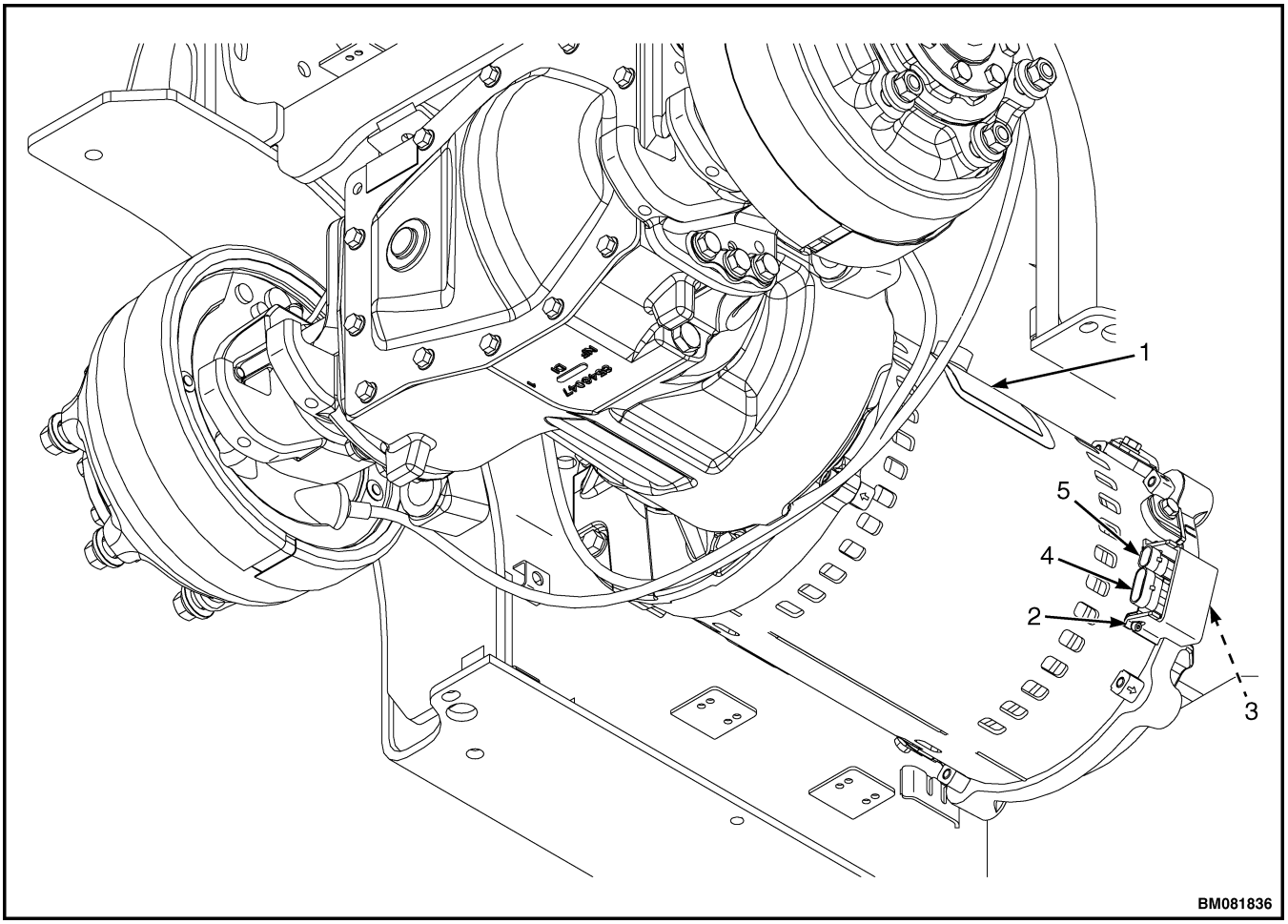
1. Install new speed sensor and speed sensor connector. See Figure 59.
2. Install socket head capscrew securing speed sensor to traction motor. See Figure 59.
3. Install sensor mounting bracket and two socket head capscrews. See Figure 59.
4. Connect wire harness to speed sensor connector. See Figure 59.
5. Install floor plates and batteries. See **Frame** 0100SRM1342 for procedures.
6. Lower hood and seat assembly.



NOTE: BOTTOM VIEW SHOWN.

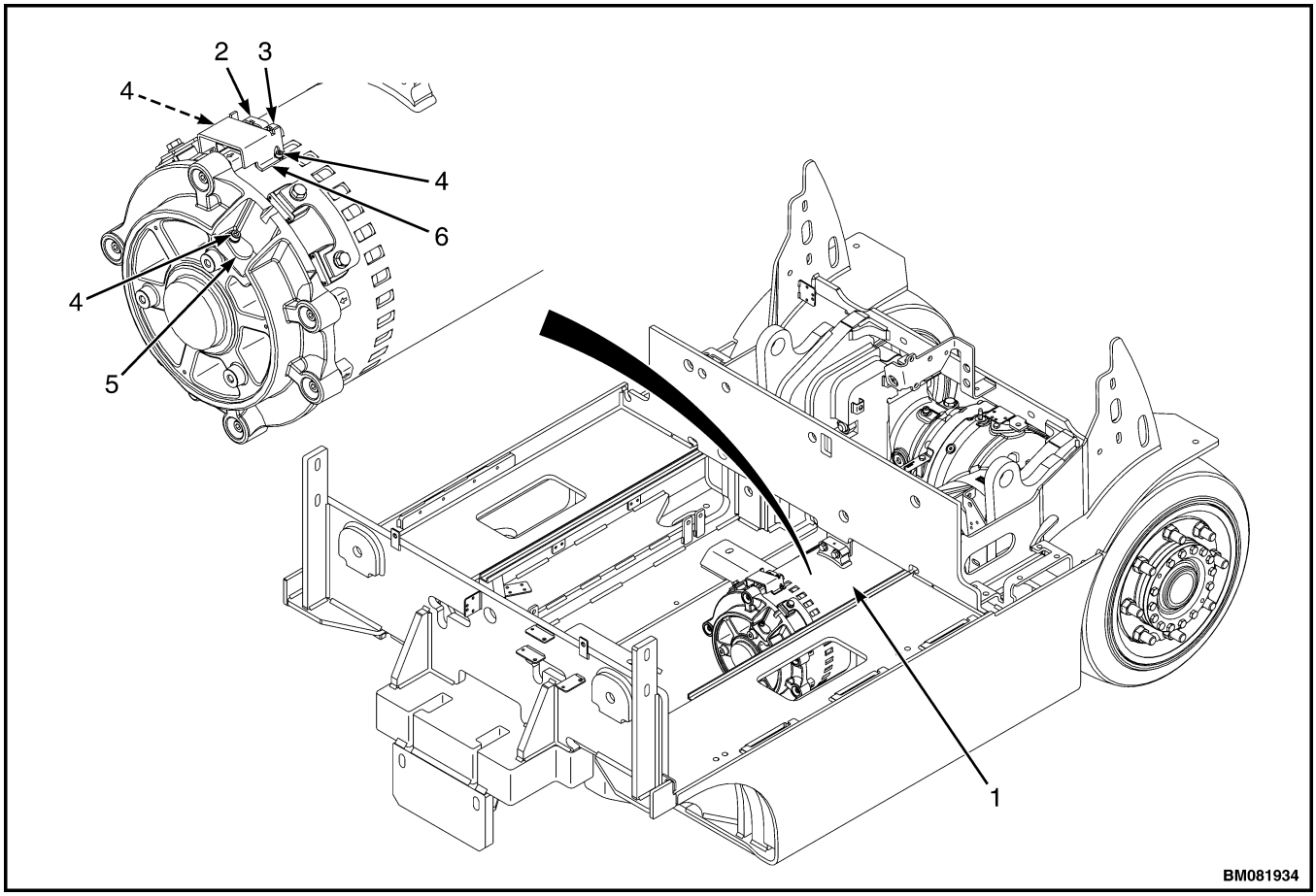
1. TRACTION MOTOR
2. SENSOR MOUNTING BRACKET
3. SPEED SENSOR
4. SPEED SENSOR CONNECTOR

Figure 57. Speed Sensor Removal Lift Truck Models E2.2-3.5XN (E45-70XN) (A268)



1. TRACTION MOTOR
2. SENSOR WIRING BRACKET
3. SPEED SENSOR
4. SPEED SENSOR CONNECTOR
5. TRACTION MOTOR TEMPERATURE SENSOR CONNECTOR

Figure 58. Speed Sensor Removal Lift Truck Model E1.6-2.0XN (E30-40XN) (A269)



1. TRACTION MOTOR
2. SPEED SENSOR CONNECTOR
3. TRACTION MOTOR TEMPERATURE SENSOR CONNECTOR
4. SOCKET HEAD CAPSCREW
5. SPEED SENSOR
6. SENSOR MOUNTING BRACKET

Figure 59. Speed Sensor Removal Lift Truck Models E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

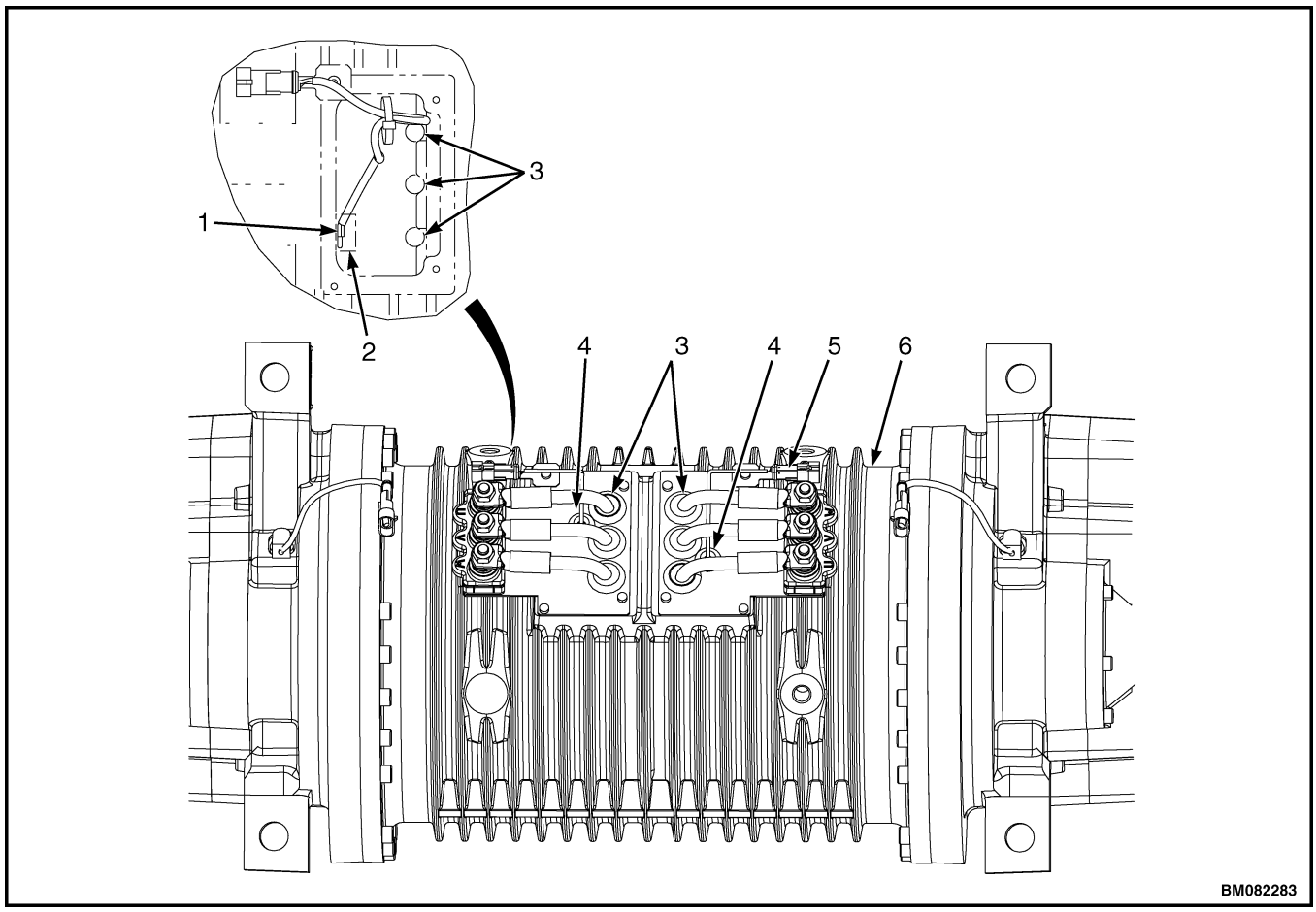
TRACTION MOTOR TEMPERATURE SENSOR E2.2-3.5XN (E45-70XN) (A268) AND J2.2-3.5XN (J45-70XN) (A276)

The traction motor temperature sensor is heat welded and sealed onto winding coils in stator housing in traction motor. It is a non-replaceable part and cannot be replaced separately from traction motor.

TRACTION MOTOR TEMPERATURE SENSOR J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

Remove

1. Locate and note which side of axle has failed.
2. Disconnect temperature sensor plug from main wire harness. See Figure 60.
3. Remove axle from lift truck
4. Remove motor terminal cover from failed sensor side.
5. Cut off and remove existing sensor. Remove cable from grommet in motor terminal cover. See Figure 60.
6. Clean adhesive from motor terminal cover.



1. THERMAL SENSOR
2. ADHESIVE
3. POWER LEAD
4. GROMMET
5. TEMPERATURE SENSOR CONNECTOR
6. TRACTION MOTOR

Figure 60. Traction Motor Temperature Sensor

Install

1. Route new sensor cable through grommet in motor terminal cover before installing new temperature sensor. See Figure 60.
2. Apply a good quantity of adhesive to cleaned area.
3. Insert temperature sensor into adhesive. See Figure 60.
4. Allow 3-4 hours for adhesive to cure.
5. Install motor terminal cover.
6. Install axle into lift truck.
7. Connect temperature sensor plug to main wire harness. See Figure 60.

TILT POSITION SENSOR E2.2-3.5XN (E45-70XN) (A268), J2.2-3.5XN (J45-70XN) (A276), AND J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

WARNING

Before replacing any components installed on the mast, fully lower all parts of the mast and tilt it forward until the tips of the forks touch the ground. This action will prevent the mast from lowering suddenly if the control lever is accidently moved.

The tilt position sensor is located on left side of mast. It is mounted on a bracket on left tilt cylinder rod end. See Figure 61. The tilt position sensor is an optional feature on lift trucks covered in this service manual.

Remove

1. Read and follow **WARNING** and **CAUTION** section in General section above.
2. Disconnect main wire harness from tilt position sensor. Remove two grommets and wire harness from tilt position sensor bracket.
3. Remove two torx capscrews from tilt position sensor.

   See Figure 61 for lift truck models

   - E2.2-3.5XN (E45-70XN) (A268)
   - J2.2-3.5XN (J45-70XN) (A276)
   - J4.0-5.0XN (J80-100XN) (A970) manufactured before November 2014

   See Figure 62 for lift truck models

   - J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) manufactured after November 2014
4. Remove tilt position sensor from tilt position sensor bracket.

Install

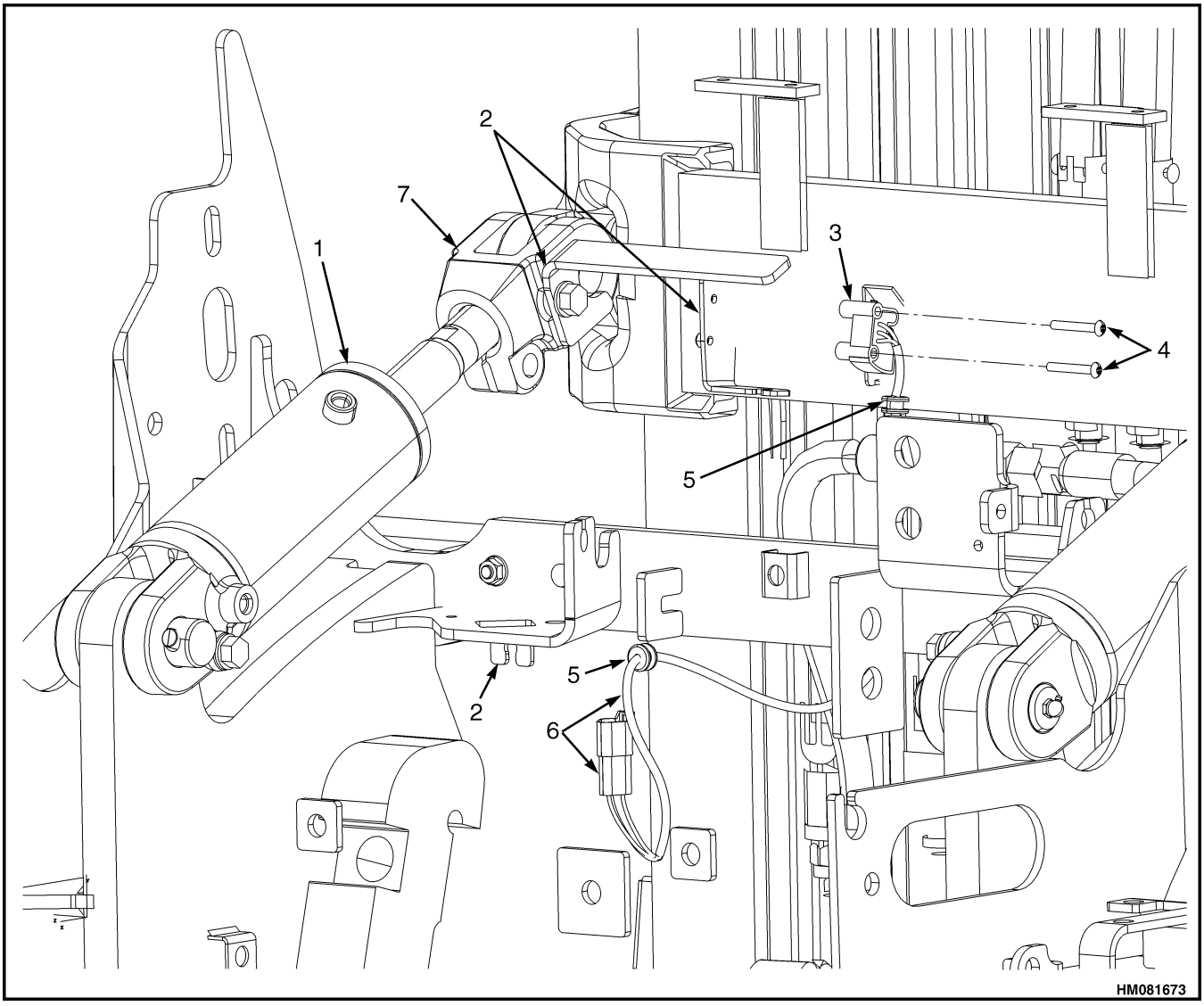
1. Install new tilt position sensor on tilt position sensor bracket using two torx head capscrews. See Figure 61.
2. Install grommets and wire harness to tilt position sensor bracket.
3. Connect main wire harness to tilt position sensor connector.

   See Figure 61 for lift truck models

   - E2.2-3.5XN (E45-70XN) (A268)
   - J2.2-3.5XN (J45-70XN) (A276)
   - J4.0-5.0XN (J80-100XN) (A970) manufactured before November 2014

   See Figure 62 for lift truck models

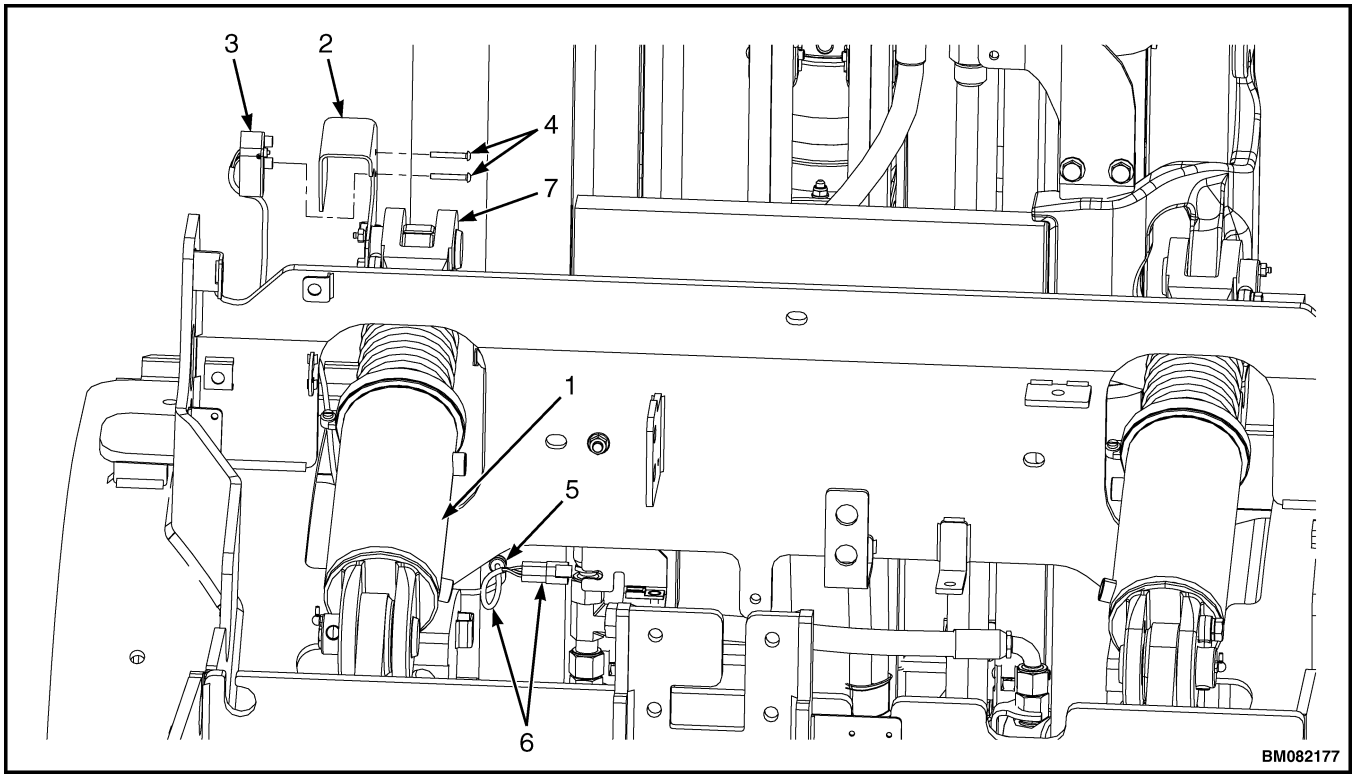
   - J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) manufactured after November 2014
4. Connect the battery.



NOTE: COMPONENTS OF COWL AND MAST OMITTED FOR CLARITY. LEFT SIDE SHOWN.

1. TILT CYLINDER
2. TILT POSITION SENSOR MOUNTING BRACKET
3. TILT POSITION SENSOR
4. TORX CAPSCREWS
5. GROMMET
6. TILT POSITION SENSOR WIRE AND CONNECTOR
7. TILT CYLINDER ROD END

Figure 61. Tilt Position Sensor Removal for Lift Truck Models Manufactured Before November 2014 and and J4.0-5.0XN (J80-100XN) (A970) E2.2-3.5XN (E45-70XN) (A268) J2.2-3.5XN (J45-70XN) (A276)



NOTE: COMPONENTS OF COWL AND MAST OMITTED FOR CLARITY. LEFT SIDE SHOWN.

1. TILT CYLINDER
2. TILT POSITION SENSOR MOUNTING BRACKET
3. TILT POSITION SENSOR
4. TORX CAPSCREWS
5. GROMMET
6. TILT POSITION SENSOR WIRE AND CONNECTOR
7. TILT CYLINDER ROD END

Figure 62. Tilt Position Sensor Removal, Lift Truck Models Manufactured After November 2014J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

TILT POSITION SENSOR E1.6-2.0XN (E30-40XN) (A269)

WARNING

Before replacing any components installed on the mast, fully lower all parts of the mast and tilt it forward until the tips of the forks touch the ground. This action will prevent the mast from lowering suddenly if the control lever is accidently moved.

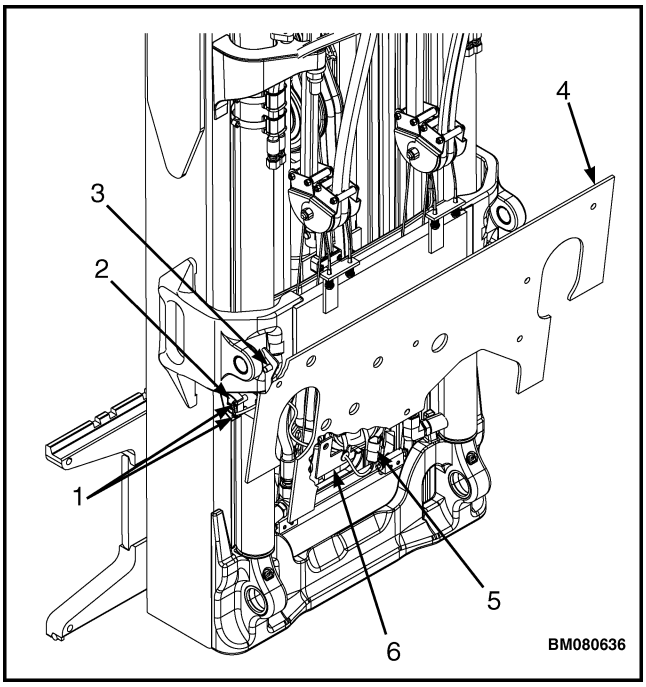
The tilt position sensor is located on left side of mast. It is mounted on a bracket on left tilt cylinder rod end. See Figure 63. The tilt position sensor is an optional feature on lift trucks covered in this service manual. Perform the following procedures if lift truck is equipped with tilt position sensor.

Remove

1. Read and follow **WARNING** and **CAUTION** section in General section above.
2. Disconnect mast harness from cowl harness.
3. Remove two torx capscrews, nuts, and tilt sensor from sensor bracket on mast. See Figure 63.
4. Remove mast harness from sensor and mast brackets.

Install

1. Install new tilt position sensor on sensor bracket using two torx head capscrews and two nuts. See Figure 63.
2. Install mast harness to harness bracket.
3. Connect mast harness to cowl harness. See Figure 63.
4. Tilt mast completely forward and backward to ensure tilt sensor is installed and connected correctly.



1. TORX CAPSCREWS
2. RETURN TO SET TILT (TILT ANGLE) SENSOR
3. SENSOR BRACKET
4. COWL
5. MAST HARNESS (TO COWL HARNESS)
6. HARNESS BRACKET

Figure 63. Tilt Position Sensor for Lift Truck Model E1.6-2.0XN (E30-40XN) (A269)

TILT POSITION SENSOR E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

WARNING

Before replacing any components installed on the mast, fully lower all parts of the mast and tilt it forward until the tips of the forks touch the ground. This action will prevent the mast from lowering suddenly if the control lever is accidently moved.

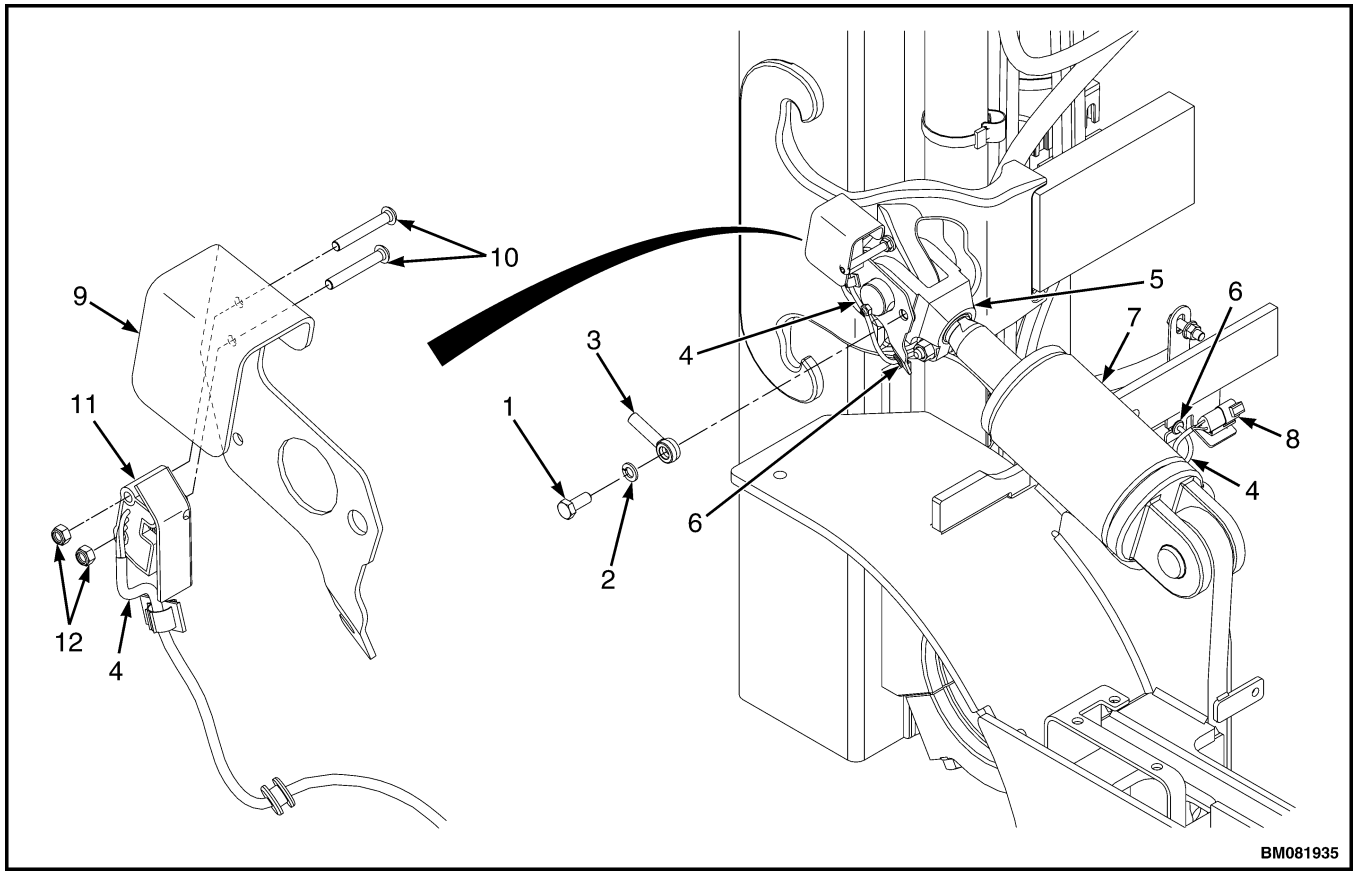
The tilt position sensor is located on left side of mast. It is mounted on a bracket on left tilt cylinder rod end. See Figure 64. The tilt position sensor is an optional feature on lift trucks covered in this service manual.

Remove

1. Read and follow **WARNING** and **CAUTION** section in General section above.
2. Disconnect main wire harness from tilt position sensor wire connector. Remove tilt sensor wire, grommets and other tilt sensor wire retainers from chassis and set aside. See Figure 64.
3. Remove anchor capscrews from anchor, sensor bracket and tilt cylinder rod end. See Figure 64.
4. Remove anchor. See Figure 64.
5. Remove sensor bracket from tilt cylinder rod end. See Figure 64.
6. Remove two nuts and two torx head capscrews from tilt position sensor. See Figure 64.
7. Remove tilt position sensor from sensor bracket. See Figure 64.
8. Remove tilt position sensor and tilt position sensor wire. See Figure 64.

Install

1. Install tilt position sensor in sensor bracket using two nuts and two torx head capscrews. See Figure 64.
2. Install sensor bracket onto tilt cylinder rod end. See Figure 64.
3. Install anchor, washer, and anchor capscrew. Tighten anchor capscrew to 68 N•m (50 lbf ft). See Figure 64.
4. Install tilt position wire, grommets and other sensor wire retainers into chassis as shown in Figure 64.
5. Connect main wire harness to tilt position sensor wire connector. See Figure 64.
6. Connect the battery.



1. ANCHOR CAPSCREW
2. WASHER
3. ANCHOR
4. TILT POSITION SENSOR WIRE
5. TILT CYLINDER ROD END
6. GROMMET
7. TILT CYLINDER
8. TILT POSITION SENSOR WIRE CONNECTOR
9. SENSOR BRACKET
10. TORX CAPSCREW
11. TILT POSITION SENSOR
12. NUT

Figure 64. Tilt Position Sensor Removal for E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

LOW LEVEL BRAKE FLUID SWITCH FOR LIFT TRUCK MODELS E2.2-3.5XN (E45-70XN) (A268), E1.6-2.0XN (E30-40XN) (A269), J2.2-3.5XN (J45-70XN) (A276), AND J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

NOTE: The low level brake fluid switch is a component of the master brake cylinder reservoir and is located on bottom of reservoir.

Remove

1. Read and follow **WARNING** and **CAUTION** section in General section above.

NOTE: Perform Step 2 to Step 4 for lift truck models E2.2-3.5XN (E45-70XN) (A268) manufactured before June 2012 and E1.6-2.0XN (E30-40XN) (A269) , J2.2-3.5XN (J45-70XN) (A276) , and J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) .

2. Remove floor mat and rear floor plate.

3. Remove capscrews and washers from front floor plate and lift front floor plate up enough to disconnect accelerator pedal or MONOTROL® pedal. See Figure 32.

4. Remove front floor plate with accelerator or MONOTROL® pedal still attached.

NOTE: Perform Step 5 to Step 7 for lift truck models E2.2-3.5XN (E45-70XN) (A268) manufactured after June 2012.

5. Remove floor mat and rear floor plate.

6. Lift front floor plate up enough to disconnect accelerator pedal or MONOTROL® pedal. See Figure 33.

7. Remove front floor plate with accelerator or MONOTROL® pedal still attached.

8. Disconnect main wire harness from low brake fluid level switch connector.

   See Figure 65 for lift truck models

   - E2.2-3.5XN (E45-70XN) (A268)
   - E1.6-2.0XN (E30-40XN) (A269)
   - J2.2-3.5XN (J45-70XN) (A276)
   - J4.0-5.0XN (J80-100XN) (A970) manufactured before November 2014

   See Figure 66 for lift truck models

   - J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) manufactured after November 2014

9. Press retaining clip on low level brake fluid switch and pop low level brake fluid switch out. Remove switch from brake fluid reservoir. See Figure 67.

Install

1. Install new low level brake fluid switch into brake fluid reservoir. Switch will snap into position. See Figure 67.

2. Connect main wire harness to low brake fluid level switch connector.

   See Figure 65 for lift truck models

   - E2.2-3.5XN (E45-70XN) (A268)
   - E1.6-2.0XN (E30-40XN) (A269)
   - J2.2-3.5XN (J45-70XN) (A276)
   - J4.0-5.0XN (J80-100XN) (A970) manufactured before November 2014

   See Figure 66 for lift truck models

   - J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) manufactured after November 2014

3. Connect accelerator pedal or MONOTROL® pedal. See Figure 32.

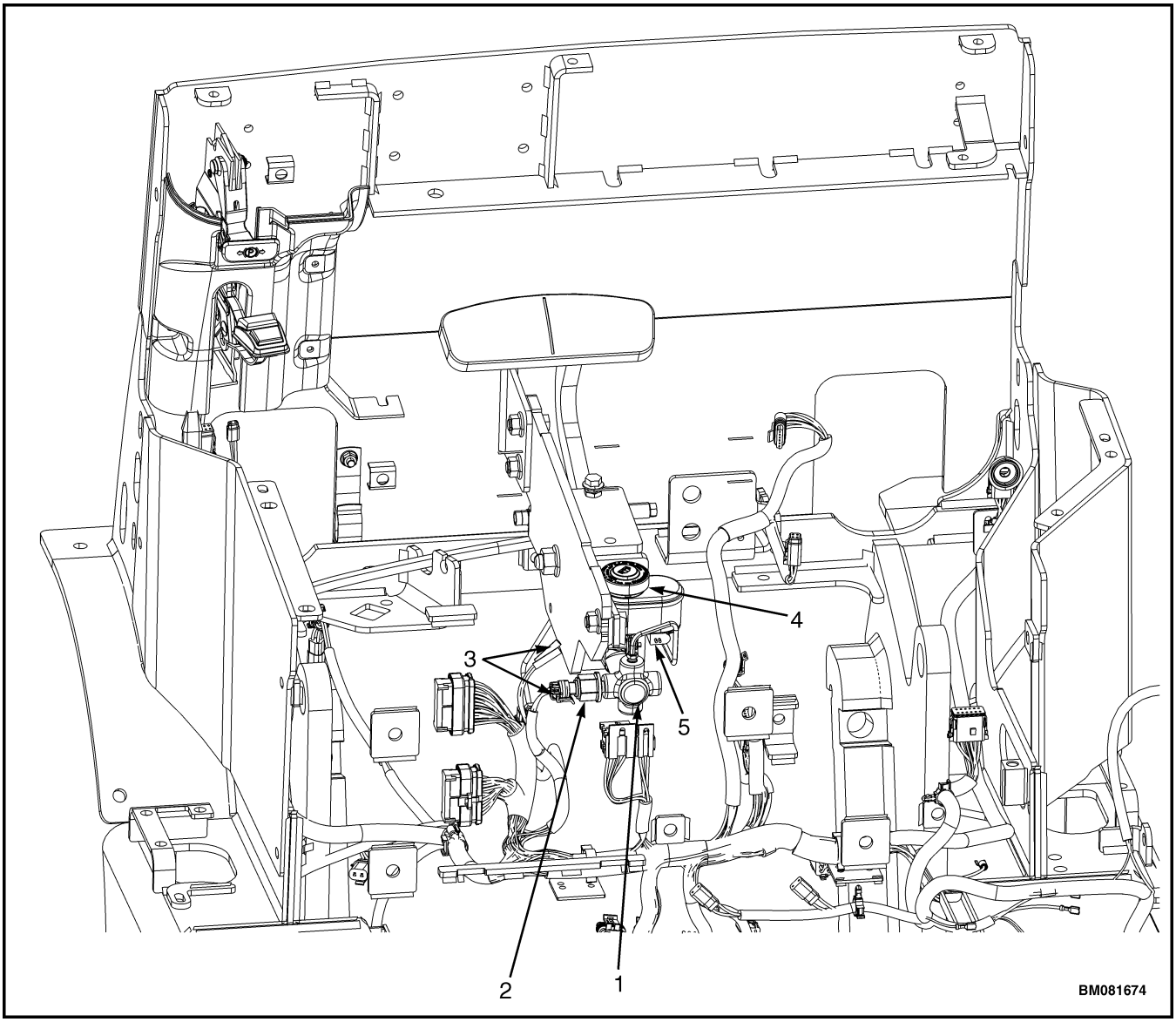
NOTE: Perform Step 4 for lift truck models E1.6-2.0XN (E30-40XN) (A269) , J2.2-3.5XN (J45-70XN) (A276) , J4.0-5.0XN (J80-100XN) (A970) , and E2.2-3.5XN (E45-70XN) (A268) manufactured before June 2012.

4. Install front floor plate using capscrews and washers

NOTE: Perform Step 5 for lift truck model E2.2-3.5XN (E45-70XN) (A268) manufactured after June 2012.

5. No hardware is required to install the front floor plate.

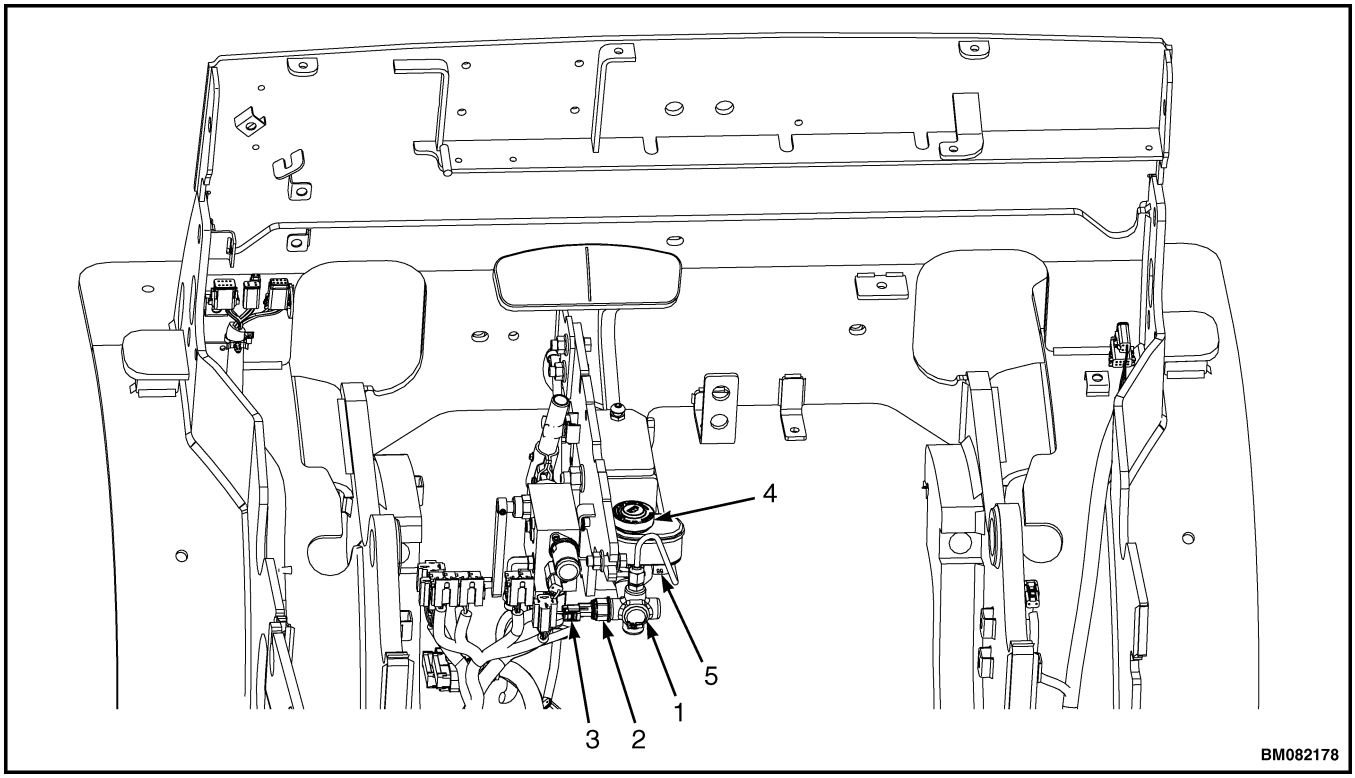
6. Install rear floor plate. Install floor mat and connect the battery.



NOTE: SOME COMPONENTS OMITTED FOR CLARITY

1. BRAKE MASTER CYLINDER
2. BRAKE PRESSURE SENSOR
3. COWL HARNESS CONNECTOR
4. BRAKE FLUID RESERVOIR
5. LOW LEVEL BRAKE FLUID SWITCH CONNECTOR

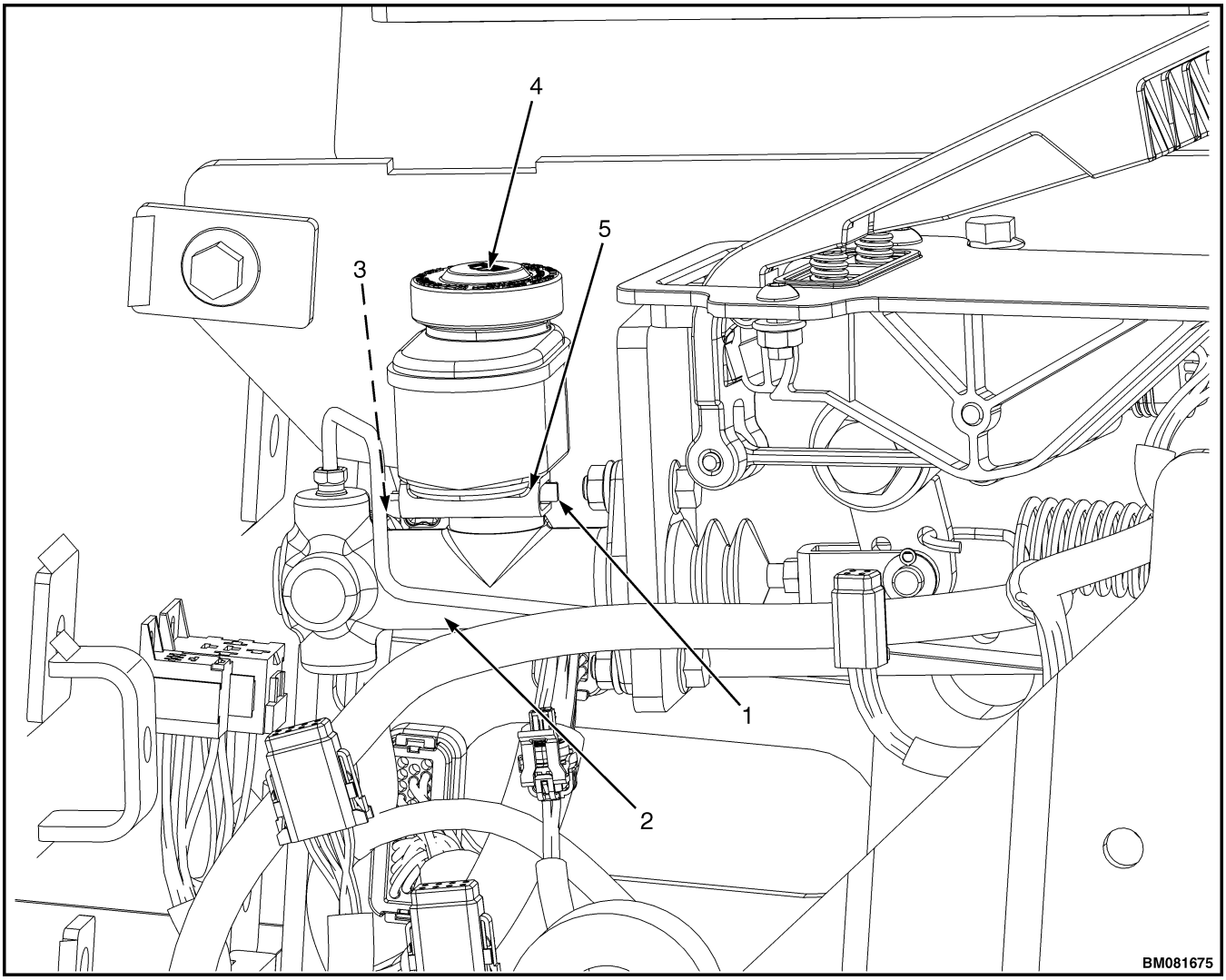
Figure 65. Brake System Switches and Sensors Lift Truck Models Manufactured Before November 2014 and , , and J4.0-5.0XN (J80-100XN) (A970) E2.2-3.5XN (E45-70XN) (A268) E1.6-2.0XN (E30-40XN) (A269) J2.2-3.5XN (J45-70XN) (A276)



NOTE: SOME COMPONENTS OMITTED FOR CLARITY

1. BRAKE MASTER CYLINDER
2. BRAKE PRESSURE SENSOR
3. COWL HARNESS CONNECTOR
4. BRAKE FLUID RESERVOIR
5. LOW LEVEL BRAKE FLUID SWITCH CONNECTOR

Figure 66. Brake System Switches and Sensors Lift Truck Models Manufactured After November 2014J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)



1. RETAINING CLIP
2. BRAKE MASTER CYLINDER
3. BRAKE PRESSURE SENSOR
4. BRAKE FLUID RESERVOIR
5. LOW LEVEL BRAKE FLUID SWITCH

Figure 67. Low Level Brake Fluid Switch Replacement

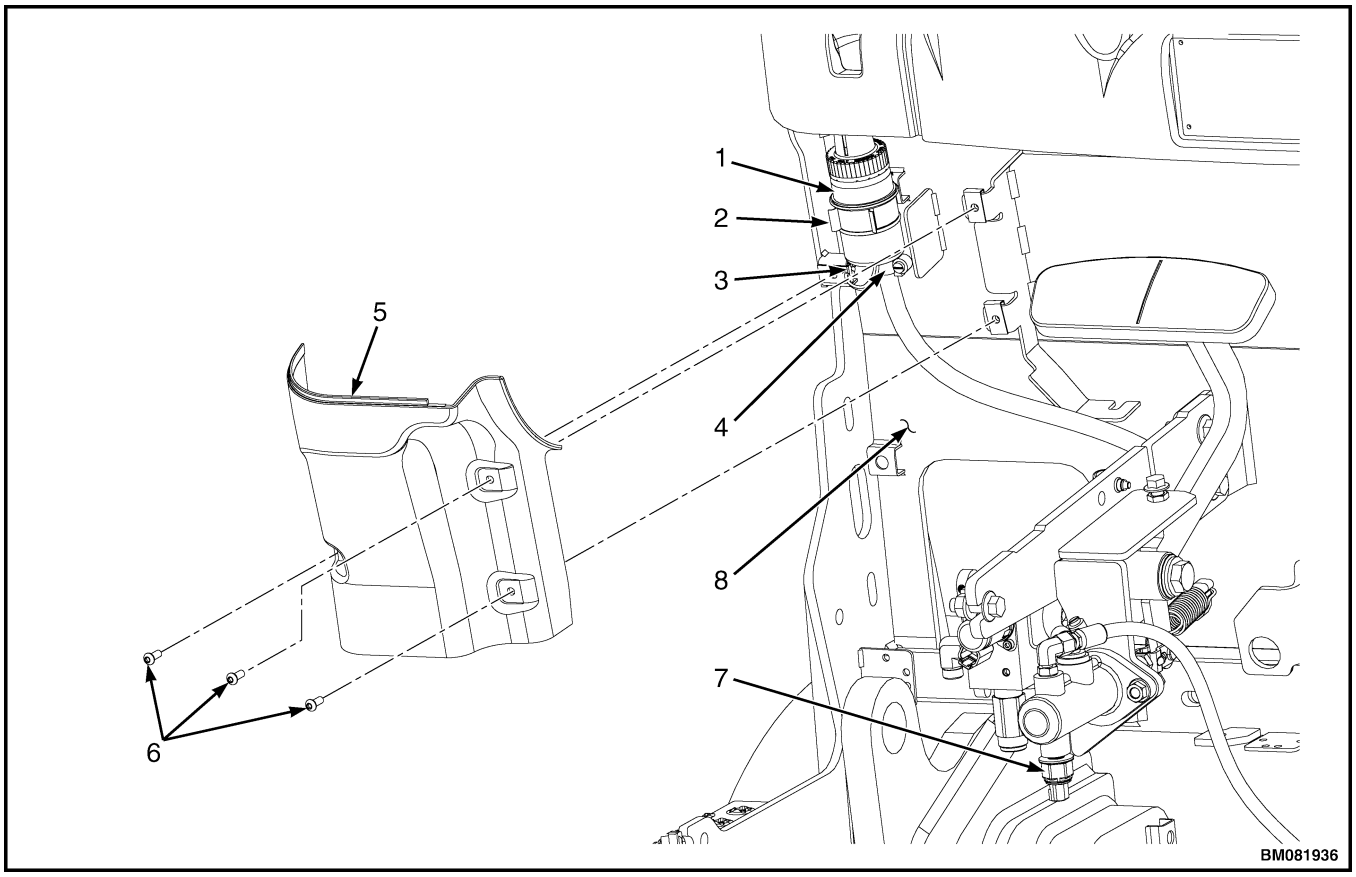
LOW LEVEL BRAKE FLUID SWITCH FOR LIFT TRUCK MODEL E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

NOTE: The low level brake fluid switch is a non-serviceable component of brake fluid reservoir. If low level brake fluid switch needs to be replaced, the brake fluid reservoir will need to be replaced as well.

NOTE: Drain fluid from master cylinder prior to performing this repair procedure. See **Drive Axle Repair** 1300SRM1575.

Remove

1. Read and follow **WARNING** and **CAUTION** section in General section above.
2. Remove three button head capscrews from brake fluid reservoir cover. See Figure 68.
3. Remove brake fluid reservoir cover. See Figure 68.
4. Disconnect main wire harness from low brake fluid reservoir electrical connector. See Figure 68.
5. Loosen clamp on brake fluid reservoir and press retaining clip holding brake fluid reservoir to cowl to remove brake fluid reservoir from lift truck. See Figure 68.



NOTE: SOME COMPONENTS OMITTED FOR CLARITY.

1. BRAKE FLUID RESERVOIR
2. RETAINING CLIP
3. LOW LEVEL BRAKE FLUID SWITCH CONNECTOR
4. CLAMP
5. BRAKE FLUID RESERVOIR COVER
6. BUTTON HEAD CAPSCREWS
7. BRAKE PRESSURE SENSOR
8. COWL

Figure 68. Brake System Switches and Sensors E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

Install

1. Install new brake fluid reservoir onto hose and tighten clamp. See Figure 68.
2. Add correct amount of fluid to reach operating level. See **Operating Manual** or **Periodic Maintenance** 8000SRM1577 for proper fluid type and amount.
3. Press brake fluid reservoir into retaining clip.
4. Connect main wire harness to low level brake fluid reservoir electrical connector. See Figure 68.
5. Bleed brake system as described in **Drive Axle Repair** 1300SRM1575.
6. Install brake fluid reservoir cover. See Figure 64.
7. Install three button head capscrews into brake fluid reservoir cover. See Figure 68.

SERVICE BRAKE PRESSURE SENSOR FOR LIFT TRUCK MODELS E2.2-3.5XN (E45-70XN) (A268), E1.6-2.0XN (E30-40XN) (A269), J2.2-3.5XN (J45-70XN) (A276), AND J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

Remove

1. Read and follow **WARNING** and **CAUTION** section in General section above.

NOTE: Perform Step 2 to Step 4 for lift truck models E1.6-2.0XN (E30-40XN) (A269) , J2.2-3.5XN (J45-70XN) (A276) , J4.0-5.0XN (J80-100XN) (A970) , and E2.2-3.5XN (E45-70XN) (A268) manufactured before June 2012:

2. Remove floor mat. Remove rear floor plate.
3. Remove capscrews and washers from front floor plate and lift front floor plate up enough to disconnect accelerator pedal or MONOTROL® pedal. See Figure 32.
4. Remove front floor plate with accelerator or MONOTROL® pedal still attached.

NOTE: Perform Step 5 to Step 7 for lift truck models E2.2-3.5XN (E45-70XN) (A268) manufactured after June 2012.

5. Remove floor mat. Remove rear floor plate.
6. Lift front floor plate up enough to disconnect accelerator pedal or MONOTROL® pedal. See Figure 33.
7. Remove front floor plate with accelerator or MONOTROL® pedal still attached.
8. Disconnect main wire harness from brake pressure sensor and remove it from master cylinder. See Figure 65.

Install

1. Install a new brake pressure sensor on master cylinder. Tighten brake pressure sensor to 23 to 28 N•m (204 to 248 lbf in).
2. Connect main wire harness to new brake pressure sensor. See Figure 65.
3. Connect accelerator pedal or MONOTROL® pedal, (see Figure 32).

NOTE: Perform Step 4 for lift truck models E1.6-2.0XN (E30-40XN) (A269) , J2.2-3.5XN (J45-70XN) (A276) , J4.0-5.0XN (J80-100XN) (A970) , and E2.2-3.5XN (E45-70XN) (A268) manufactured before June 2012.

4. Install the front floor plate using capscrews and washers.

NOTE: Perform Step 5 and Step 6 for lift truck model E2.2-3.5XN (E45-70XN) (A268) manufactured after June 2012.

5. No hardware is required to install front floor plate.
6. Install rear floor plate. Install floor mat and connect the battery.
7. Bleed brake system as described in the section **Brake System** 1800SRM1359 for lift truck models
   - E2.2-3.5XN (E45-70XN) (A268)
   - J2.2-3.5XN (J45-70XN) (A276)

Brake System 1800SRM1438 for lift truck models

- E1.6-2.0XN (E30-40XN) (A269)

Transaxle 1300SRM1539 for lift truck models

- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

SERVICE BRAKE PRESSURE SENSOR FOR LIFT TRUCK MODEL E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

Remove

1. Read and follow **WARNING** and **CAUTION** section in General section above.
2. Remove floor mat. Remove rear floor plate. Lift front floor plate up enough to disconnect the accelerator pedal or MONOTROL® pedal. See Figure 33. Remove front floor plate with accelerator or MONOTROL® pedal still attached.
3. Install container beneath service brake pressure sensor to catch any fluid. Container should have a capacity of at least 0.35 liter (0.37 qt).
4. Disconnect main wire harness from brake pressure sensor and remove it from master cylinder. See Figure 68.
5. Remove container.

Install

1. Install a new brake pressure sensor on master cylinder. Tighten brake pressure sensor to 23 to 28 N•m (204 to 248 lbf in).
2. Connect main wire harness to new brake pressure sensor. See Figure 68.
3. Connect accelerator pedal or MONOTROL® pedal, (see Figure 42).

   Install the front floor plate. Install rear floor plate. Install floor mat and connect the battery.
4. Add brake fluid. See **Operating Manual** or **Periodic Maintenance** 8000SRM1577 for proper fluid type and amount.
5. Bleed brake system as described in **Drive Axle Repair** 1300SRM1575.

ACCELERATOR PEDAL POSITION SENSOR

Remove

NOTE: The accelerator pedal position sensor cannot be replaced separately from accelerator pedal. If accelerator pedal position sensor malfunctions, accelerator pedal assembly must be replaced.

NOTE: In the steps and illustrations below, the standard accelerator pedal is used. The procedures to replace a MONOTROL® pedal are the same.

1. Read and follow **WARNING** and **CAUTION** section in General section above.

NOTE: Perform Step 2 to Step 4 for lift truck models E1.6-2.0XN (E30-40XN) (A269) , J2.2-3.5XN (J45-70XN) (A276) , J4.0-5.0XN (J80-100XN) (A970) and E2.2-3.5XN (E45-70XN) (A268) manufactured before June 2012:

2. Remove floor mat. Remove rear floor plate.
3. Remove capscrews and washers from front floor plate and lift front floor plate up enough to disconnect accelerator pedal or MONOTROL® pedal. See Figure 32.
4. Remove front floor plate with accelerator or MONOTROL® pedal still attached.

NOTE: Perform Step 5 to Step 7 for lift truck models E2.2-3.5XN (E45-70XN) (A268) manufactured after June 2012.

5. Remove floor mat. Remove rear floor plate.
6. Lift front floor plate up enough to disconnect accelerator pedal or MONOTROL® pedal. See Figure 33.
7. Remove front floor plate with accelerator or MONOTROL® pedal still attached.
8. Remove three capscrews and nuts that attach the accelerator pedal and pedal base to accelerator pedal mounting plate. See Figure 32. Remove accelerator pedal mounting plate.

Install

1. Install new accelerator pedal, pedal base and accelerator pedal mounting plate to front floor plate with capscrews and nuts. See Figure 32.

NOTE: Perform Step 2 for lift truck models E1.6-2.0XN (E30-40XN) (A269) , J2.2-3.5XN (J45-70XN) (A276) , J4.0-5.0XN (J80-100XN) (A970) , and E2.2-3.5XN (E45-70XN) (A268) manufactured before June 2012.

2. Install front floor plate using capscrews and washers

NOTE: Perform Step 3 for lift truck model E2.2-3.5XN (E45-70XN) (A268) manufactured after June 2012.

3. No hardware is required to install the front floor plate.

4. Install rear floor plate. Install floor mat and connect the battery.

SEAT BELT SEQUENCE MODULE

NOTE: This module is used with Optional Operator Presence System

NOTE: Before performing the procedures below, read and follow the **WARNING** and **CAUTION** in the General section above.

Lift Truck Models J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

Remove

NOTE: Tag connectors to aid in installation.

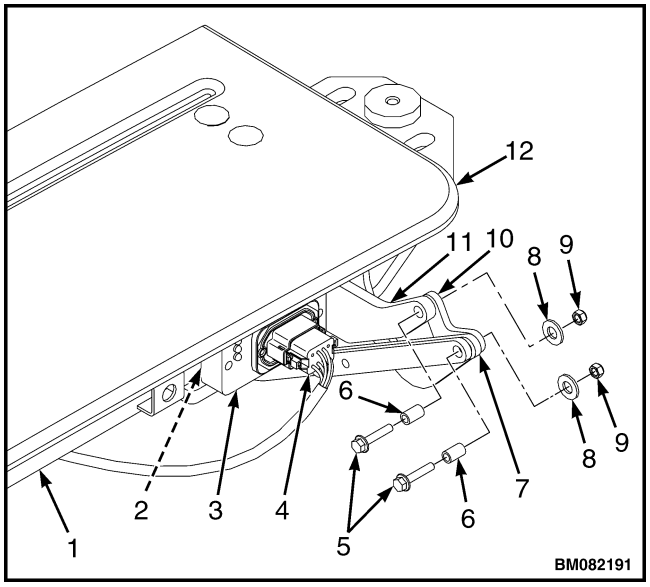
1. Remove three captive screws and counterweight cover from counterweight.

2. Remove four nuts, capscrews, spacers, and washers from hinge, link, and crossmember plate. Remove rear cover. See Figure 69.

3. Disconnect wire harness connector from seat belt sequence module.

4. Remove seat belt sequence module from hood crossmember.

5. Clean foam tape residue from battery connector bracket.



1. HOOD CROSSMEMBER
2. FOAM TAPE
3. SEAT BELT SEQUENCE MODULE
4. CONNECTOR
5. CAPSCREW
6. SPACER
7. LINK
8. WASHER
9. NUT
10. HINGE
11. CROSSMEMBER PLATE
12. REAR COVER

Figure 69. Seat Belt Sequence Module, Lift Truck Models J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

Install

1. Install foam tape on back of seat belt sequence module.

2. Install seat belt sequence module on hood crossmember. See Figure 69.

3. Connect wire harness connector to seat belt sequence module.

4. Install rear cover. Install four washers, spacers, capscrews, and nuts on crossmember plate, link, and hinge.

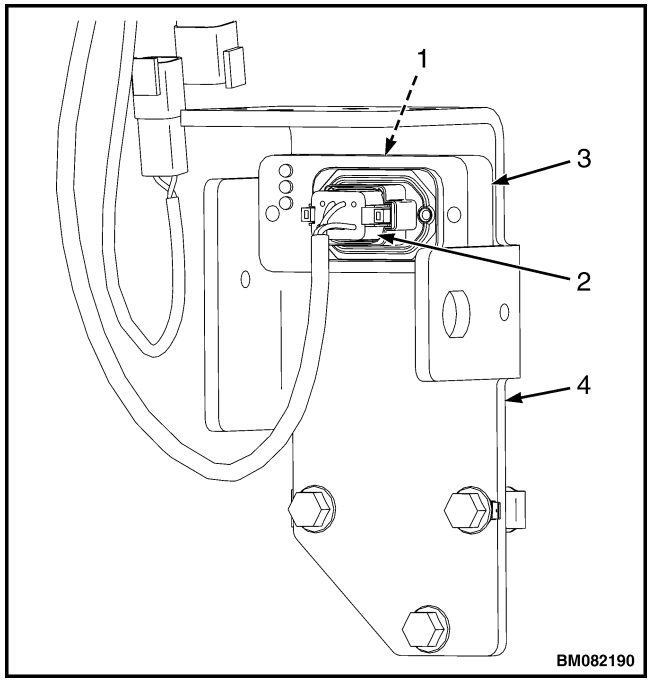
5. Install counterweight cover and three captive screws on counterweight.

Lift Truck Models J2.2-3.5XN (J45-70XN) (A276)

Remove

NOTE: Tag connectors to aid in installation.

1. Remove two e-clips, captive screws, nylon washers, and counterweight cover from counterweight.
2. Disconnect wire harness connector from seat belt sequence module. See Figure 70.
3. Remove seat belt sequence module from battery connector.
4. Clean foam tape residue from battery connector bracket.



1. FOAM TAPE
2. CONNECTOR
3. SEAT BELT SEQUENCE MODULE
4. BATTERY BRACKET

Figure 70. Seat Belt Sequence Module, Lift Truck Models J2.2-3.5XN (J45-70XN) (A276)

Install

1. Install foam tape on back of seat belt sequence module.
2. Install seat belt sequence module on battery connector bracket. See Figure 70.
3. Connect wire harness connector to seat belt sequence module.
4. Install counterweight cover, two nylon washers, captive screws, and e-clips on counterweight.

Lift Truck Models E2.2-3.5XN (E45-70XN) (A268)

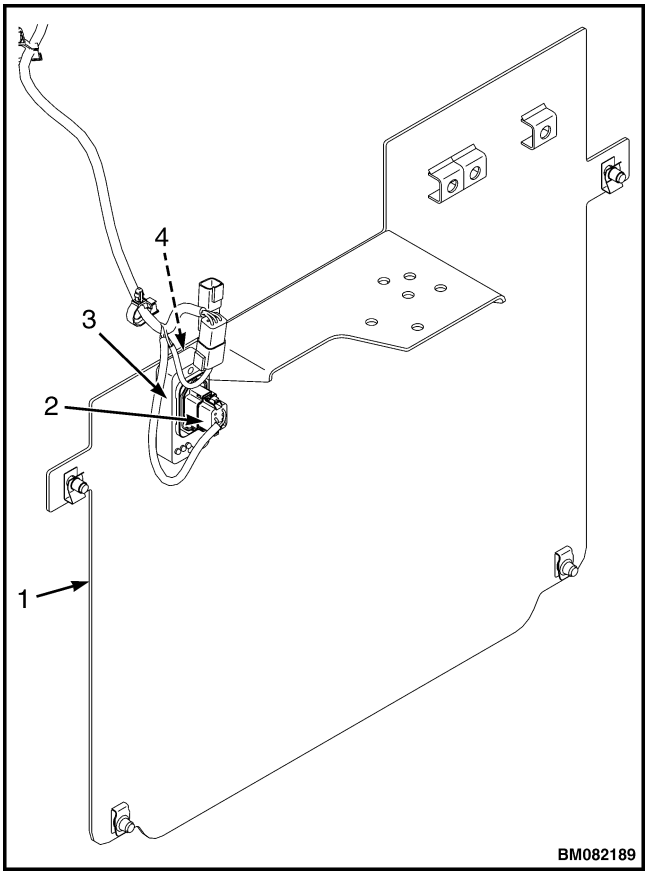
Remove

NOTE: Tag connectors to aid in installation.

1. Remove two captive screws and counterweight cover from counterweight.
2. Disconnect wire harness connector from seat belt sequence module. See Figure 71.
3. Remove seat belt sequence module from controller cover.
4. Clean foam tape residue from controller cover.

Install

1. Install foam tape on back of seat belt sequence module.
2. Install seat belt sequence module on controller cover. See Figure 71.
3. Connect wire harness connector to seat belt sequence module.
4. Install counterweight cover and two captive screws on counterweight.



1. CONTROLLER COVER
2. CONNECTOR
3. SEAT BELT SEQUENCE MODULE
4. FOAM TAPE

Figure 71. Seat Belt Sequence Module, Lift Truck Models E2.2-3.5XN (E45-70XN) (A268)

Lift Truck Models E1.6-2.0XN (E30-40XN) (A269) and E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

Remove

NOTE: Tag connectors to aid in installation.

1. Remove two captive screws, tow pin, and counterweight cover from counterweight.

2. Disconnect wire harness connector from seat belt sequence module. See Figure 72.

3. Remove seat belt sequence module from rear bulkhead.

4. Clean foam tape residue from rear bulkhead.

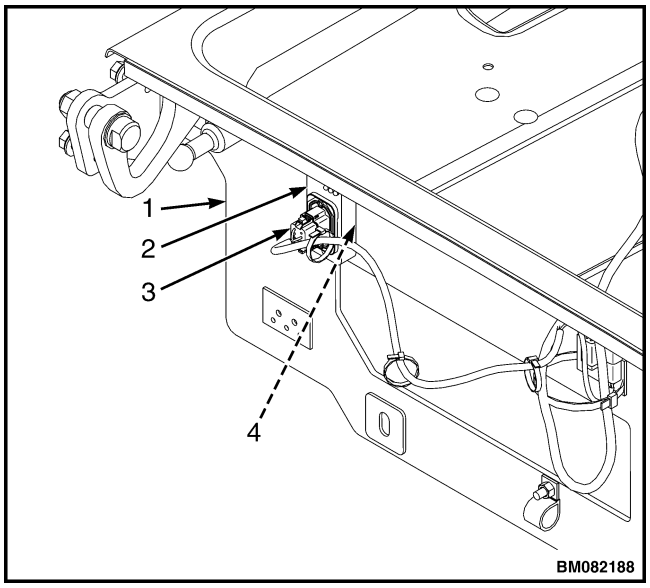
Install

1. Install foam tape on back of seat belt sequence module.

2. Install seat belt sequence module on rear bulkhead. See Figure 72.

3. Connect wire harness connector to seat belt sequence module.

4. Install counterweight cover, tow pin, and two captive screws on counterweight.



1. REAR BULKHEAD
2. SEAT BELT SEQUENCE MODULE
3. CONNECTOR
4. FOAM TAPE

Figure 72. Seat Belt Sequence Module, Lift Truck Models E1.6-2.0XN (E30-40XN) (A269) and E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

SEAT SENSOR (OPERATOR PRESENCE SYSTEM)

Non-Suspension Seat

Remove

1. Read and follow **WARNING** and **CAUTION** section in General section above.

2. Tilt steering column all the way up.

NOTE: Before removing seat from hood, tag or mark holes that mount the seat to hood. This will aid in correctly installing seat to hood.

See Figure 73 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268)

See Figure 74 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276)
- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

See Figure 75 for lift truck model

- E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

3. Disconnect chassis harness from seat harness. Remove four capscrews and washers holding seat to hood. Remove seat from hood. Remove spacer bars.

   See Figure 73 for lift truck models

   - E2.2-3.5XN (E45-70XN) (A268)

   See Figure 74 for lift truck models

   - J2.2-3.5XN (J45-70XN) (A276)
   - J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

   See Figure 75 for lift truck model

   - E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

4. Disconnect seat harness from seat sensor. See Figure 76.

5. Remove two capscrews, washers, and seat sensor from seat.

Install

1. Using two capscrews and washers, install sensor to seat. See Figure 76.

2. Connect seat harness to seat sensor.

   See Figure 73 for lift truck models

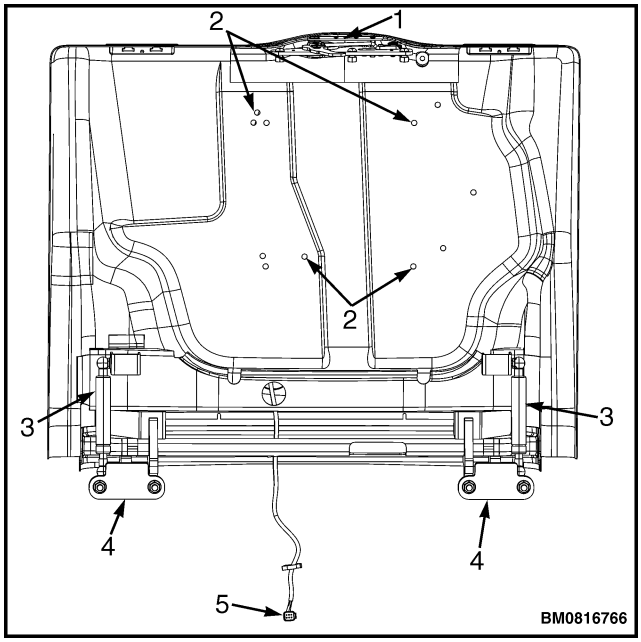
   - E2.2-3.5XN (E45-70XN) (A268)

   See Figure 74 for lift truck models

   - J2.2-3.5XN (J45-70XN) (A276)
   - J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

   See Figure 75 for lift truck model

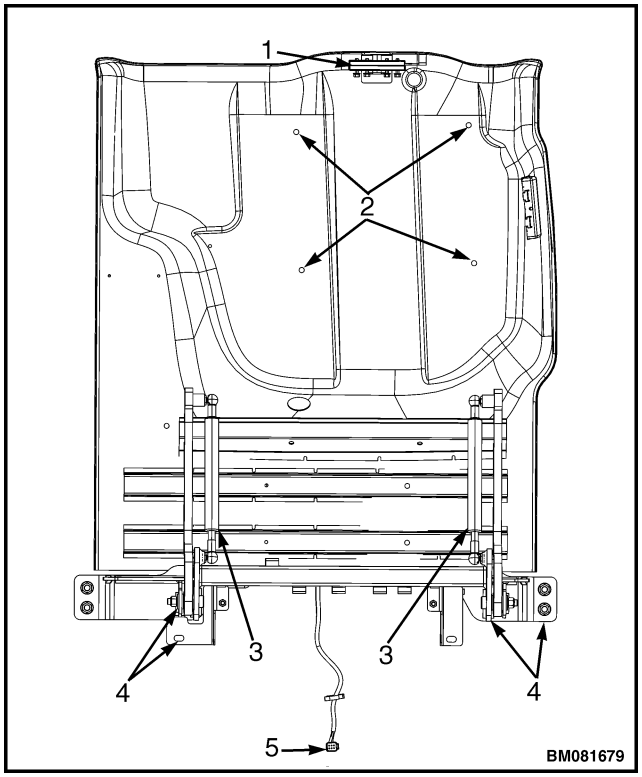
   - E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)



NOTE: BOTTOM VIEW OF HOOD SHOWN.

1. HOOD LATCH ASSEMBLY
2. MOUNTING HOLES, NON-SUSPENSION SEAT
3. GAS SPRING
4. HOOD HINGE ASSEMBLY
5. SEAT HARNESS

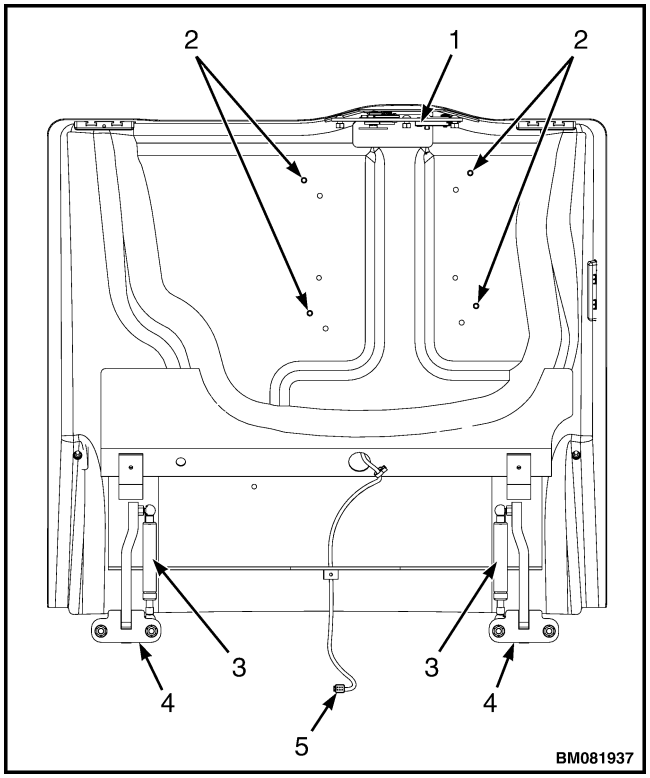
Figure 73. Seat Removal, Non-Suspension Seat, Lift Truck Models E2.2-3.5XN (E45-70XN) (A268)



NOTE: BOTTOM VIEW OF HOOD SHOWN.

1. HOOD LATCH ASSEMBLY
2. MOUNTING HOLES, NON-SUSPENSION SEAT
3. GAS SPRING
4. HOOD HINGE ASSEMBLY
5. SEAT HARNESS

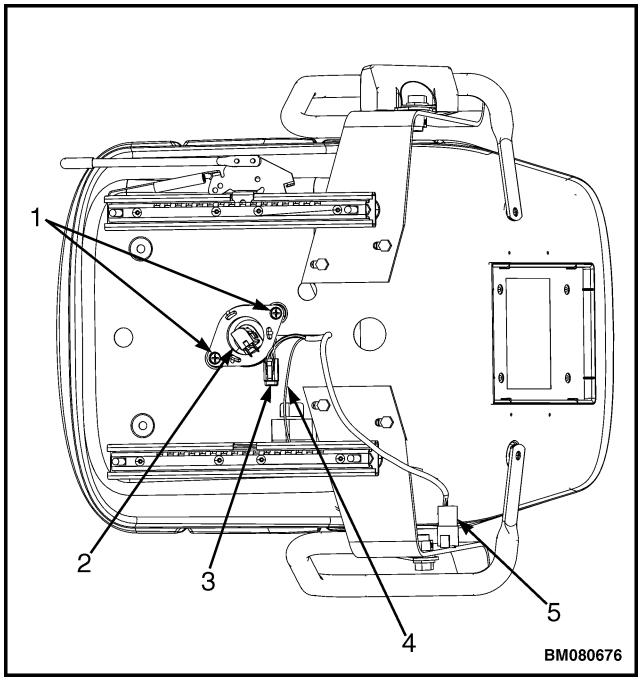
Figure 74. Seat Removal, Non-Suspension Seat, Lift Truck Models and J2.2-3.5XN (J45-70XN) (A276) J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)



NOTE: BOTTOM VIEW OF HOOD SHOWN.

1. HOOD LATCH ASSEMBLY
2. MOUNTING HOLES, NON-SUSPENSION SEAT
3. GAS SPRING
4. HOOD HINGE ASSEMBLY
5. SEAT HARNESS

Figure 75. Seat Removal, Non-Suspension Seat, Lift Truck Model E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)



1. CAPSCREWS
2. SEAT SENSOR
3. SEAT SENSOR ELECTRICAL CONNECTOR
4. SEAT GROUND WIRE
5. SEAT HARNESS

Figure 76. Seat Sensor, Non- and Semi-Suspension Seat

3. Install seat onto hood using four capscrews, spacer bars, and washers in correct holes, as marked during removal. Tighten capscrews to 18 N•m (156 lbf in).

See Figure 73 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268)

See Figure 74 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276)
- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

See Figure 75 for lift truck model

- E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

4. Connect chassis harness to seat harness.

5. Connect battery and close hood.

Full Suspension and Swivel Seats

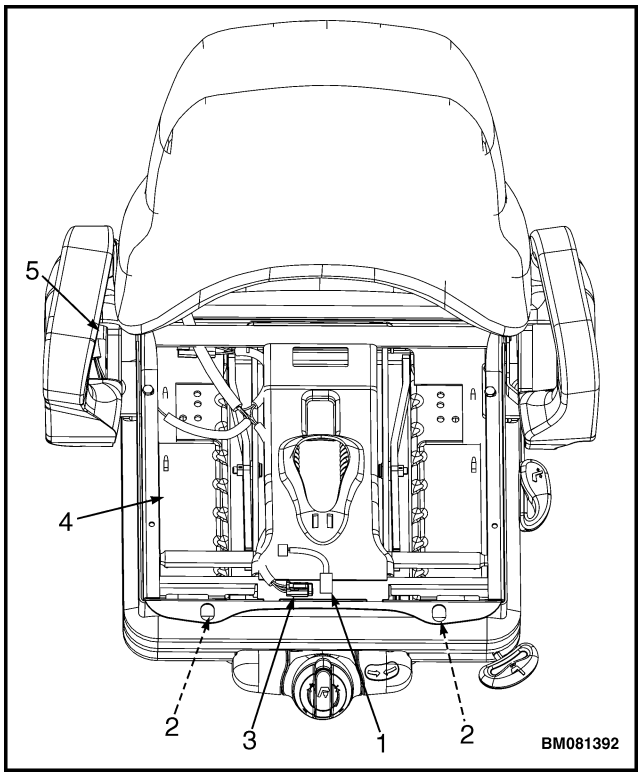
Remove

1. Read and follow **WARNING** and **CAUTION** section in General section above.

2. Pull out two pins that secure bottom seat cushion to seat base.

3. Lift bottom seat cushion up and disconnect seat harness from seat sensor.

4. Use a small, flat-bladed screwdriver and remove seat sensor from seat base. See Figure 77.



1. SEAT SENSOR
2. CUSHION PINS
3. SEAT HARNESS
4. SEAT BASE
5. TO CHASSIS HARNESS

Figure 77. Seat Sensor, Full Suspension Seat

Install

1. Install new seat sensor into seat base.
2. Connect seat harness to seat sensor. See Figure 77.
3. Place bottom seat cushion onto seat base and attach cushion to base with pins.
4. Connect the battery.

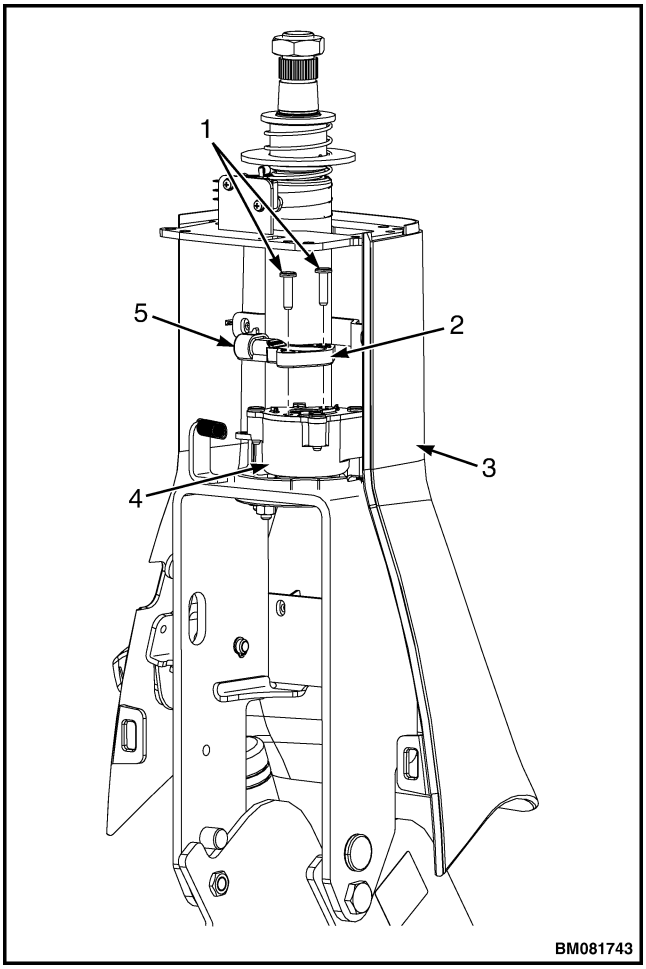
STEERING DIRECTION SENSOR

Remove

1. Read and follow **WARNING** and **CAUTION** section in General section above.
2. Remove upper steering column cover by pressing from both sides and pulling cover up and out. See Figure 84.
3. Disconnect steering wire harness from steering direction sensor electrical connector. See Figure 78.
4. Remove two capscrews from steering direction sensor and remove steering direction sensor from sensor mounting plate. See Figure 78.

Install

1. Install new steering direction sensor onto sensor mounting plate. Secure steering direction sensor to sensor mounting plate with two capscrews. See Figure 78.
2. Connect steering wire harness to steering direction sensor.
3. Install steering column upper cover by pressing from both sides and pushing against steering column lower cover until steering column upper cover snaps into place. See Figure 84.
4. Connect battery. Adjust steering column for operator comfort.



1. CAPSCREWS
2. STEERING DIRECTION SENSOR
3. LOWER STEERING COLUMN COVER
4. SENSOR MOUNTING PLATE
5. STEERING DIRECTION SENSOR ELECTRICAL CONNECTOR

Figure 78. Steering Direction Sensor

LOAD WEIGHT SENSOR

NOTE: The lift trucks covered in this manual may be equipped with an optional load weight sensor. See **Operating Manual** for a more detailed description on how load weight sensor works.

Remove

1. Read and follow **WARNING** and **CAUTION** section in General section above.

NOTE: Perform Step 2 to Step 4 for lift truck models E1.6-2.0XN (E30-40XN) (A269) , J2.2-3.5XN (J45-70XN) (A276) , J4.0-5.0XN (J80-100XN) (A970) , and E2.2-3.5XN (E45-70XN) (A268) manufactured before June 2012.

2. Remove floor mat. Remove rear floor plate.

3. Remove capscrews and washers from front floor plate and lift front floor plate up enough to disconnect accelerator pedal or MONOTROL® pedal. See Figure 32.

4. Remove front floor plate with accelerator or MONOTROL® pedal still attached.

NOTE: Perform Step 5 to Step 7 for lift truck models E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099) and E2.2-3.5XN (E45-70XN) (A268) manufactured after June 2012.

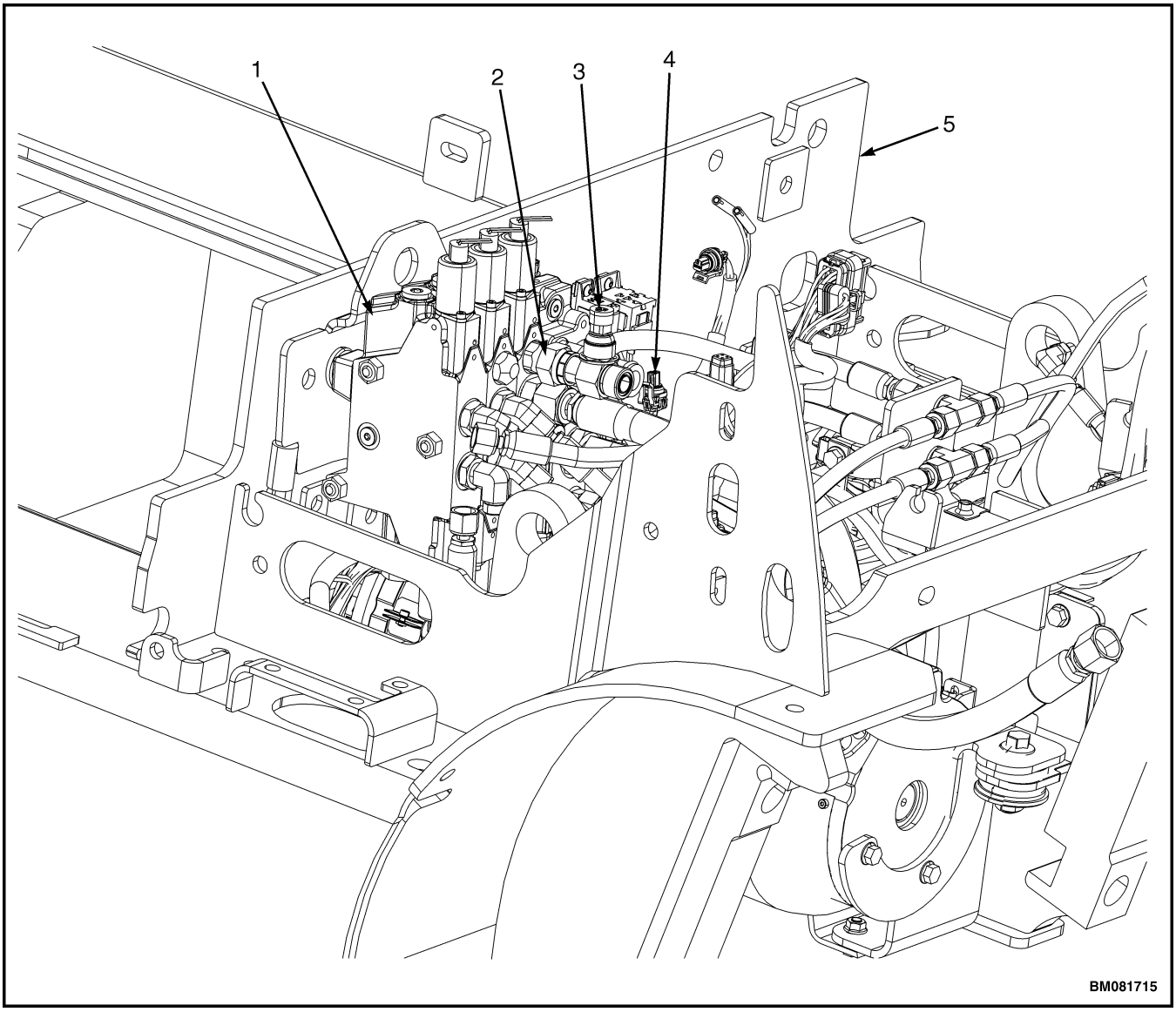
5. Remove floor mat. Remove rear floor plate.

6. Lift front floor plate up enough to disconnect accelerator pedal or MONOTROL® pedal. See Figure 33.

7. Remove front floor plate with accelerator or MONOTROL® pedal still attached.

8. Disconnect harness connector from load weight sensor.

9. Remove load weight sensor from T-Fitting on hydraulic control valve. See Figure 79.



NOTE: E-HYDRAULIC CONTROL VALVE SHOWN. RIGHT SIDE SHOWN. LOAD WEIGHT SENSOR IS IN SAME POSITION ON MANUAL HYDRAULIC CONTROL VALVE.

1. HYDRAULIC CONTROL VALVE
2. T-FITTING
3. LOAD WEIGHT SENSOR
4. HARNESS CONNECTOR
5. FRONT BULKHEAD

Figure 79. Load Weight Sensor

Install

1. Insert new load weight sensor into T-Fitting. Tighten sensor by hand, and then torque sensor to 25 N•m (221 lbf in).

2. Connect harness connector to load weight sensor. See Figure 79.

3. Connect accelerator pedal or MONOTROL® pedal. See Figure 32.

NOTE: Perform Step 4 for lift truck models E1.6-2.0XN (E30-40XN) (A269) , J2.2-3.5XN (J45-70XN) (A276) , J4.0-5.0XN (J80-100XN) (A970) , and E2.2-3.5XN (E45-70XN) (A268) manufactured before June 2012.

4. Install front floor plate using capscrews and washers.

NOTE: Perform Step 5 and Step 6 for lift truck model E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099) and E2.2-3.5XN (E45-70XN) (A268) manufactured after June 2012.

5. No hardware is required to install front floor plate.

6. Install rear floor plate. Install floor mat and connect the battery.

7. Re-calibrate load weight sensor. See section **User Interface Service Technician** 2200SRM1336 for calibration procedures.

BATTERY GATE SWITCH

NOTE: The lift truck models covered in this manual may be equipped with a battery restraint system that may include rollers, a fork lift tray or battery tray, a side battery lift out gate, or drop-in battery door, or a hinged battery gate for horizontal removal of the battery. There is a switch for the side battery gate, located on right side of lift truck. This switch can be replaced if it malfunctions.

NOTE: Read and follow **WARNING** and **CAUTION** section in General section above.

Lift Truck Models E2.2-3.5XN (E45-70XN) (A268), E1.6-2.0XN (E30-40XN) (A269), and E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

Remove

1. Lift up hood and remove battery for access to battery gate switch. See **Operating Manual** or service manual **Frame** 0100SRM1342 for procedures.

2. Remove battery plate that is closest to battery gate on right side of lift truck frame. See Figure 80.

3. Disconnect main wire harness from battery gate switch connector and wire harness. See Figure 80. Remove two capscrews and battery gate switch from bracket.

Install

1. Install new battery gate switch and two capscrews on bracket. See Figure 80. Connect main wire harness to battery gate connector and wire harness.

2. Install battery plate into battery compartment.

3. Install battery and close hood. See **Operating Manual** or service manual **Frame** 0100SRM1342 for procedures.

4. Connect the battery.

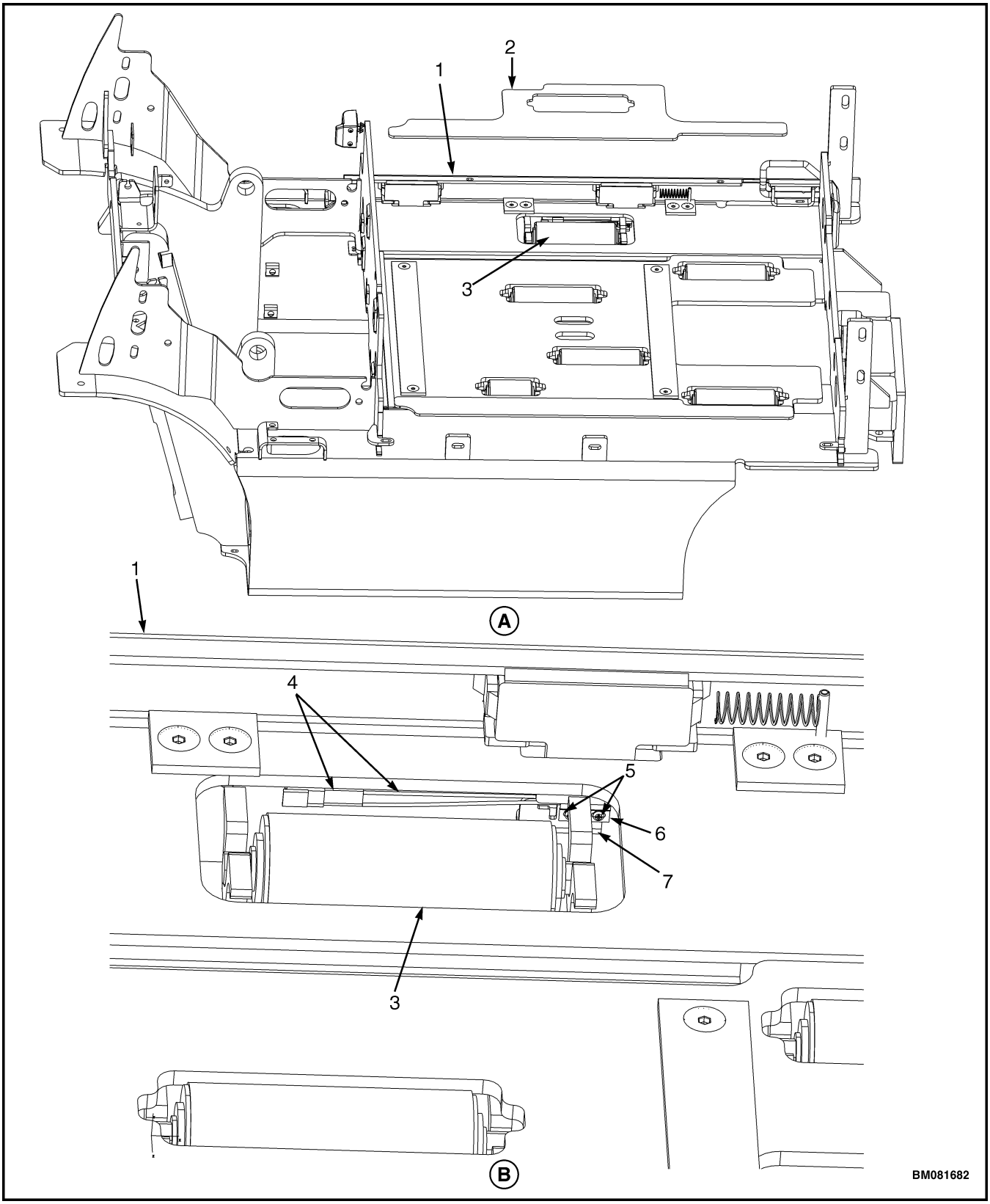


Figure 80. Battery Gate Switch Replacement

Legend for Figure 80.

NOTE: LIFT TRUCK MODEL E2.2-3.5XN (E45-70XN) (A268) SHOWN, LIFT TRUCK MODEL E1.6-2.0XN (E30-40XN) (A269) AND E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099) SIMILAR.

A. REMOVE BATTERY PLATE

1. BATTERY GATE
2. BATTERY PLATE
3. BATTERY ROLLER
4. BATTERY GATE SWITCH CONNECTOR AND WIRE HARNESS

B. REPLACE BATTERY GATE SWITCH

5. CAPSCREWS
6. BATTERY GATE SWITCH
7. BRACKET

Lift Truck Models J2.2-3.5XN (J45-70XN) (A276)

Remove

1. Lift up hood and remove right side panel. See **Operating Manual** or service manual **Frame** 0100SRM1342 for procedures.
2. If lift truck is equipped with hinged door, open door until it latches in open position. See **Operator Manual** or service manual **Frame** 0100SRM1342 for procedures.
3. Disconnect main wire harness from battery gate switch. See Figure 81 or Figure 82.
4. Remove two capscrews and two washers from battery gate switch. Remove battery gate switch from bracket. See Figure 81 or Figure 82.

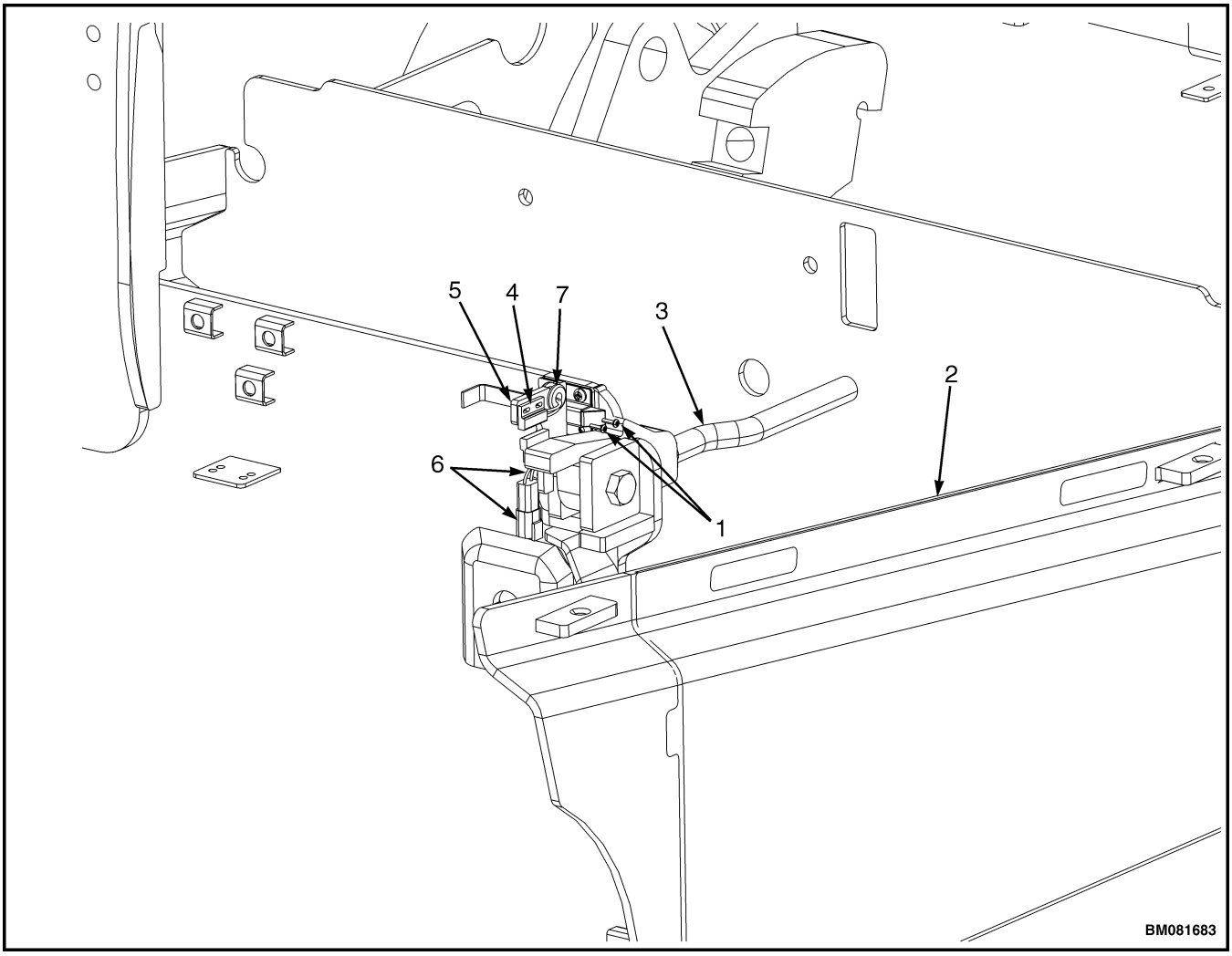
Install

1. Install new battery gate switch to bracket with two washers and two capscrews. See Figure 81 or Figure 82.
2. Connect main wire harness to battery gate switch connector.
3. Install right side panel. See **Operating Manual** or service manual **Frame** 0100SRM1342 for procedures.
4. If lift truck is equipped with hinged door, close door. See **Operating Manual** or service manual **Frame** 0100SRM1342 for procedures.
5. Connect the battery and close the hood.

Lift Truck Models J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

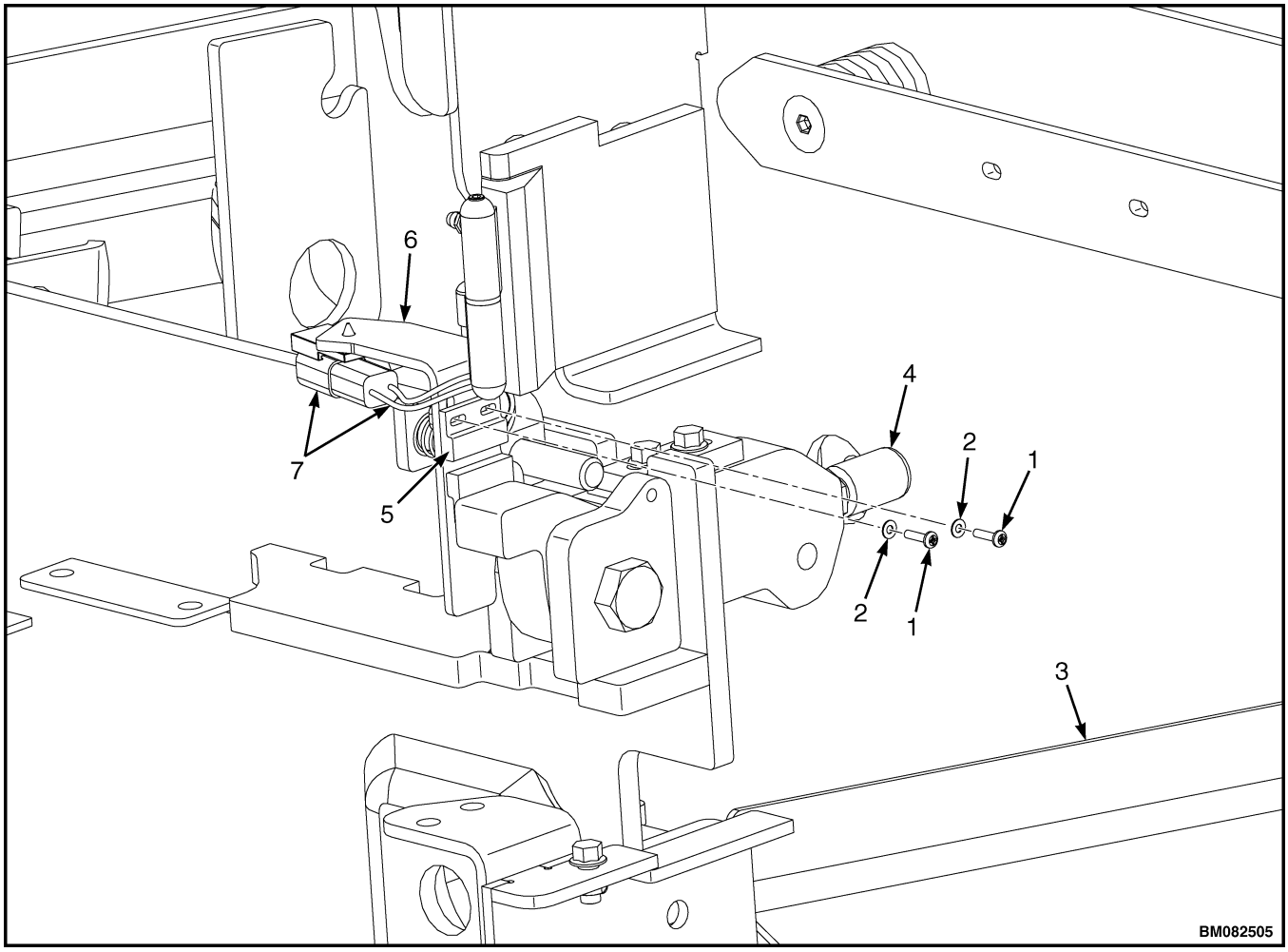
Remove

1. Lift up hood and remove right side panel. See **Operating Manual** or service manual **Frame** 0100SRM1342 for procedures.
2. If lift truck is equipped with hinged door, open door until it latches in open position. See **Operator Manual** for procedures.
3. Disconnect main wire harness from battery gate switch. See Figure 83.
4. Remove two capscrews and two grommets from battery gate switch. Remove battery gate switch from bracket. See Figure 83.
5. Install right side panel. See **Operating Manual** or service manual **Frame** 0100SRM1342 for procedures.
6. If lift truck is equipped with hinged door, close door. See **Operating Manual**.
7. Connect the battery and close the hood.



1. CAPSCREWS
2. LIFTOUT BATTERY GATE
3. BATTERY RETENTION ROD
4. BATTERY GATE SWITCH
5. BRACKET
6. BATTERY GATE SWITCH CONNECTOR AND WIRE HARNESS
7. GROMMET

Figure 81. Liftout Battery Gate Switch Replace, Lift Truck Models J2.2-3.5XN (J45-70XN) (A276)

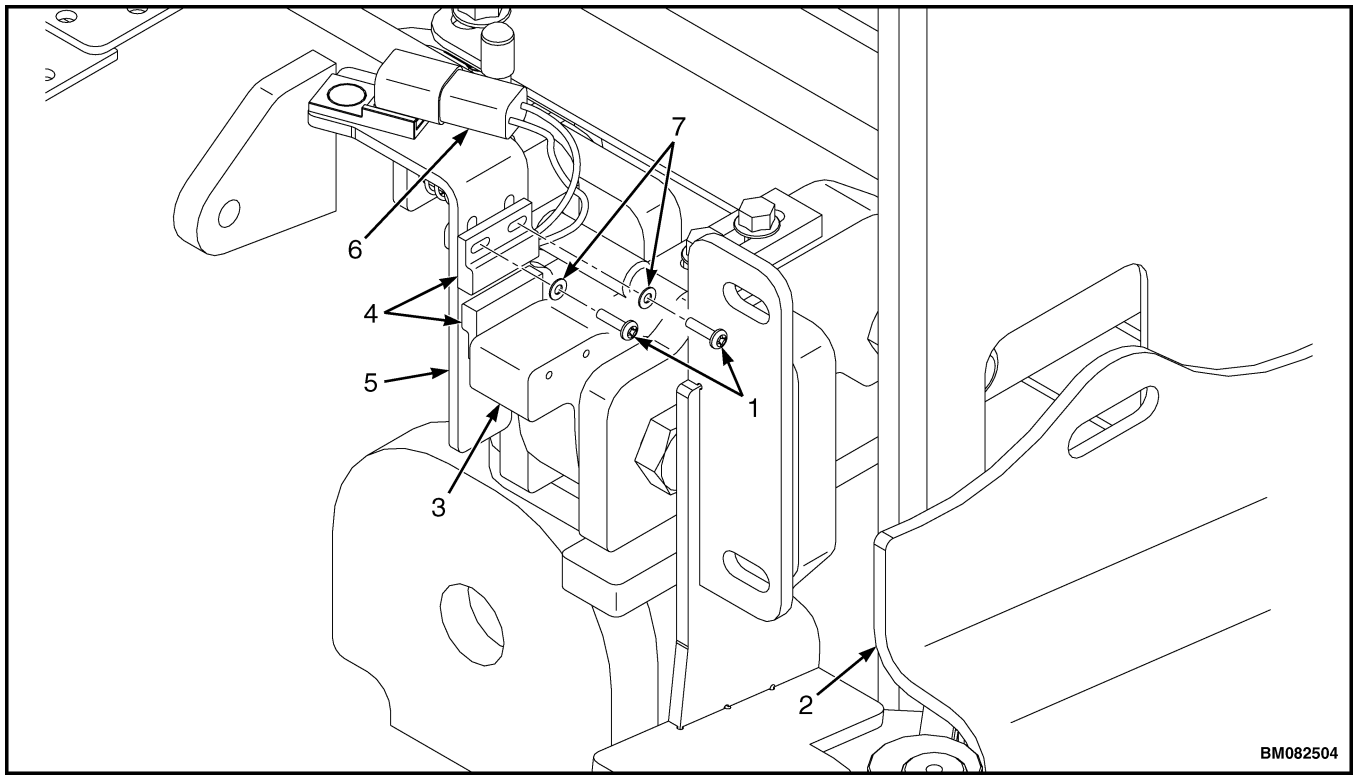


1. CAPSCREWS
2. WASHER
3. HINGED BATTERY GATE
4. BATTERY RETENTION ROD
5. BATTERY GATE SWITCH
6. BRACKET
7. BATTERY GATE SWITCH CONNECTOR AND WIRE HARNESS

Figure 82. Hinged Battery Gate Switch Replace, Lift Truck Models J2.2-3.5XN (J45-70XN) (A276)

Install

1. Install new battery gate switch to bracket with two grommets and two capscrews. See Figure 83.
2. Connect main wire harness to battery gate switch connector. See Figure 83.
3. Install right side panel. See **Operating Manual** or service manual **Frame** 0100SRM1342 for procedures.
4. If lift truck is equipped with hinged door, close door. See **Operating Manual**.
5. Connect the battery and close the hood.



NOTE: LIFT TRUCKS EQUIPPED WITH DROP-IN BATTERY DOOR SHOWN. BATTERY GATE SWITCH ON LIFT TRUCKS EQUIPPED WITH HINGED BATTERY DOOR IS SIMILAR.
NOTE: ONLY LIFT TRUCK MODELS J80-120XN, J100XNL (A970) CAN BE EQUIPPED WITH DROP-IN BATTERY DOOR.

1. CAPSCREWS
2. DROP-IN BATTERY DOOR
3. BATTERY RETENTION ROD
4. BATTERY GATE SWITCH
5. BRACKET
6. BATTERY GATE SWITCH CONNECTOR AND WIRE HARNESS
7. GROMMET

Figure 83. Battery Gate Switch Replace, Lift Truck Models J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

HORN SWITCH

NOTE: The procedures below are for replacing horn switch and horn switch mechanism located on steering column. If your lift truck is equipped with E-Hydraulic mini-levers, there is an option for a horn button on the armrest. See section Electronic and Manual Hydraulic Controls for procedures to replace horn sensor on the E-Hydraulic armrest.

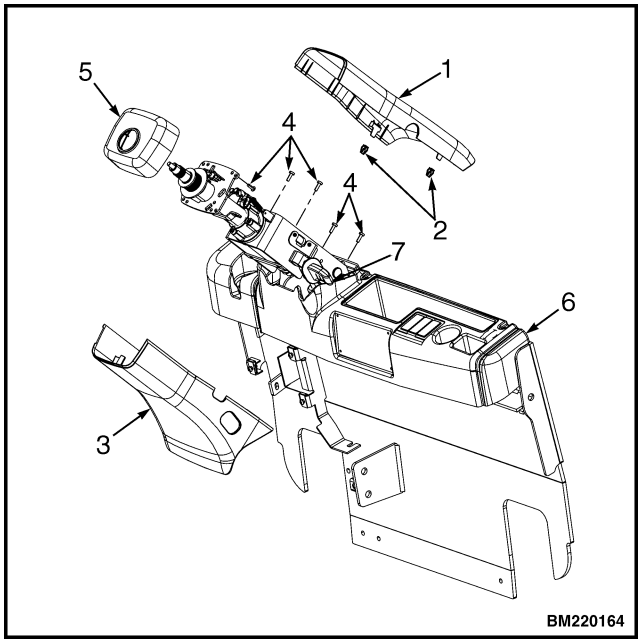
Fixed Steering Column

Remove

1. Read and follow **WARNING** and **CAUTION** section in General section above.

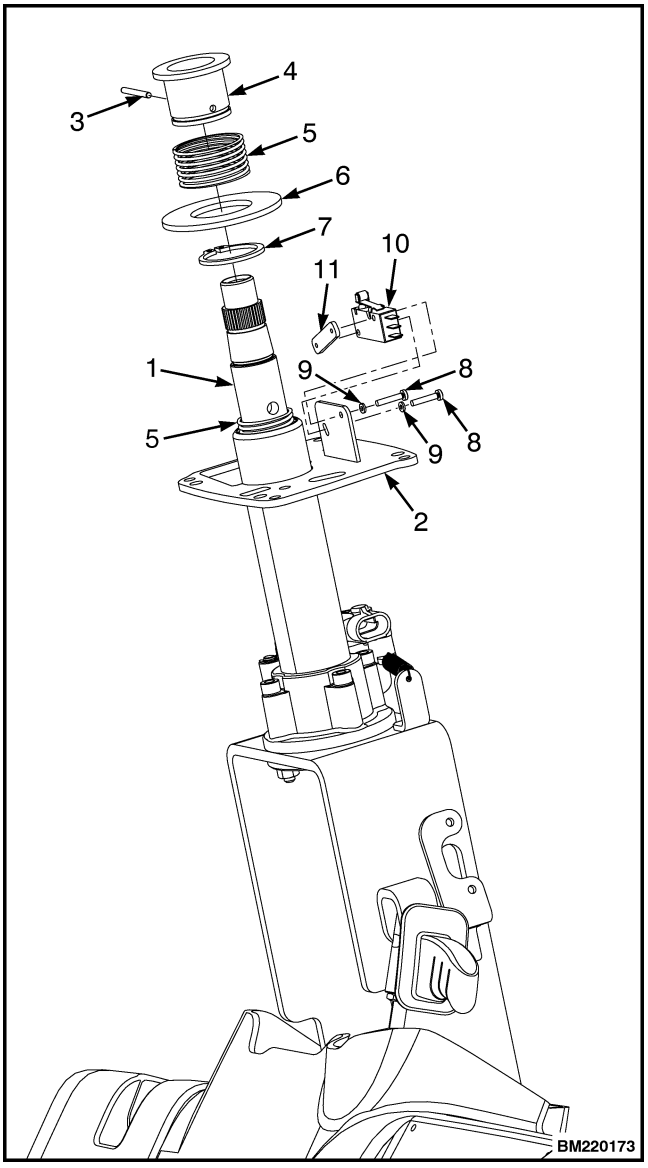
2. Remove upper steering column cover by pressing from both sides and pulling cover up and out. See Figure 84.

3. Disconnect steering wire harness from horn switch. Remove capscrews, washers, and tapped plate from horn switch. Remove horn switch from horn switch plate. See Figure 85.



1. STEERING COLUMN UPPER COVER
2. CLIP
3. STEERING COLUMN LOWER COVER
4. CAPSCREW
5. STEERING COLUMN TOP COVER
6. DASH PANEL
7. TILT POSITION LEVER

Figure 84. Steering Column Covers



NOTE: FIXED STEERING COLUMN SHOWN. HORN SWITCH ON OPTIONAL TELESCOPIC STEERING COLUMN IS THE SAME.

1. FIXED STEERING COLUMN
2. HORN SWITCH PLATE
3. PIN
4. RETAINING RING
5. SPRING
6. SWITCH CONTACT WASHER
7. SNAP RING
8. CAPSCREW
9. WASHER
10. HORN SWITCH
11. TAPPED PLATE

Figure 85. Horn Switch

Install

1. Install new horn switch, tapped plate, washers, and capscrews to horn switch plate. See Figure 85.

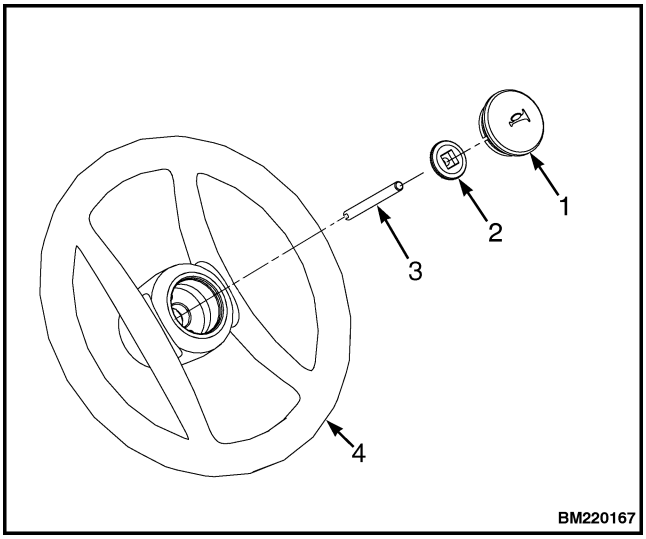
NOTE: Perform Step 2 for lift truck models J2.2-3.5XN (J45-70XN) (A276) , equipped with Outdoor Protection/ Wash-down Package.

2. Apply dielectric grease to horn switch terminal.
3. Connect steering wire harness to horn switch.
4. Install steering column upper cover by pressing from both sides and pushing against steering column lower cover until steering column upper cover snaps into place. See Figure 84.
5. Connect the battery.

Telescopic Steering Column

Remove

1. Read and follow **WARNING** and **CAUTION** section in General section above.
2. Remove horn button, nut, and rod from steering wheel. See Figure 86.



1. HORN BUTTON
2. NUT
3. ROD
4. STEERING WHEEL

Figure 86. Horn Button Assembly and Electrical Connections

3. Remove hex nut and steering wheel from steering column. If necessary, use a puller tool to remove steering wheel. See Figure 87.

4. Remove upper steering column cover by pressing from both sides and pulling cover up and out. See Figure 84.

5. Remove four mounting capscrews and steering column top cover from steering column plate. See Figure 87.

6. Disconnect steering wire harness from horn switch. Remove capscrews, washers, and tapped plate from horn switch. Remove horn switch from horn switch plate. See Figure 85.

Install

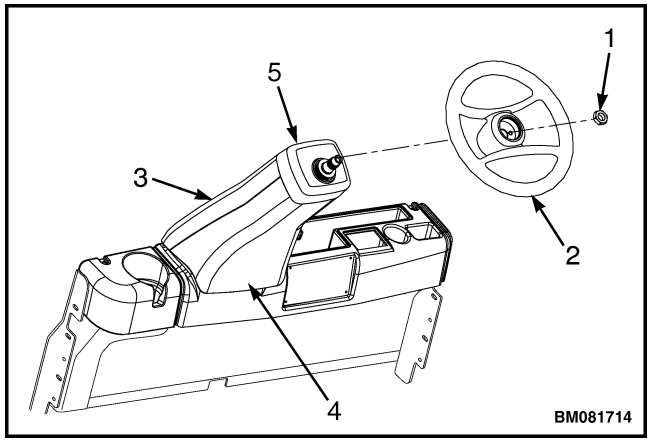
1. Install new horn switch, tapped plate, washers, and capscrews to horn switch plate. See Figure 85.

NOTE: Perform Step 2 for lift truck models J2.2-3.5XN (J45-70XN) (A276) , equipped with Outdoor Protection/ Wash-down Package.

2. Apply dielectric grease to horn switch terminal.

3. Connect steering wire harness to horn switch.

4. Install steering column top cover and four mounting capscrews on steering column plate. See Figure 87.



1. HEX NUT
2. STEERING WHEEL
3. STEERING COLUMN UPPER COVER
4. STEERING COLUMN LOWER COVER
5. STEERING COLUMN TOP COVER

Figure 87. Steering Wheel

5. Install steering column upper cover by pressing from both sides and pushing against steering column lower cover until steering column upper cover snaps into place. See Figure 84.

6. Install steering wheel and hex nut on steering column. Tighten nut 40 to 54 N•m (30 to 40 lbf ft). See Figure 87.

7. Install rod, nut, and horn button in steering wheel. See Figure 86.

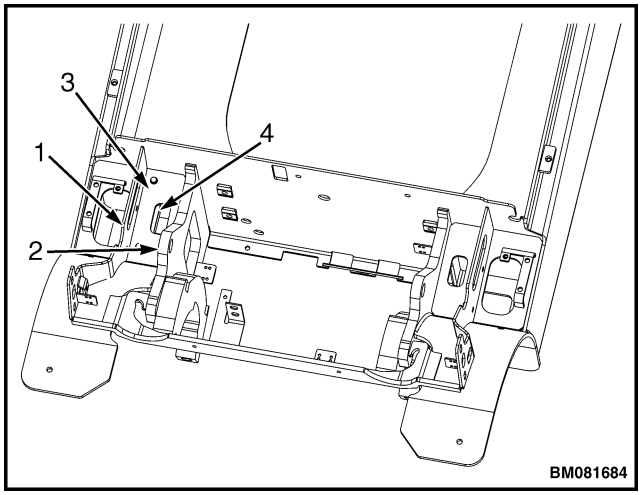
8. Connect the battery.

IMPACT SENSOR

Lift Truck Models J2.2-3.5XN (J45-70XN) (A276) and J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

Remove

NOTE: The impact sensor is located on right side of lift truck between right tilt anchor plate and right front overhead guard mounting plate. See Figure 88.



1. RIGHT FRONT OVERHEAD GUARD MOUNTING PLATE
2. RIGHT TILT ANCHOR PLATE
3. PLATE
4. IMPACT SENSOR

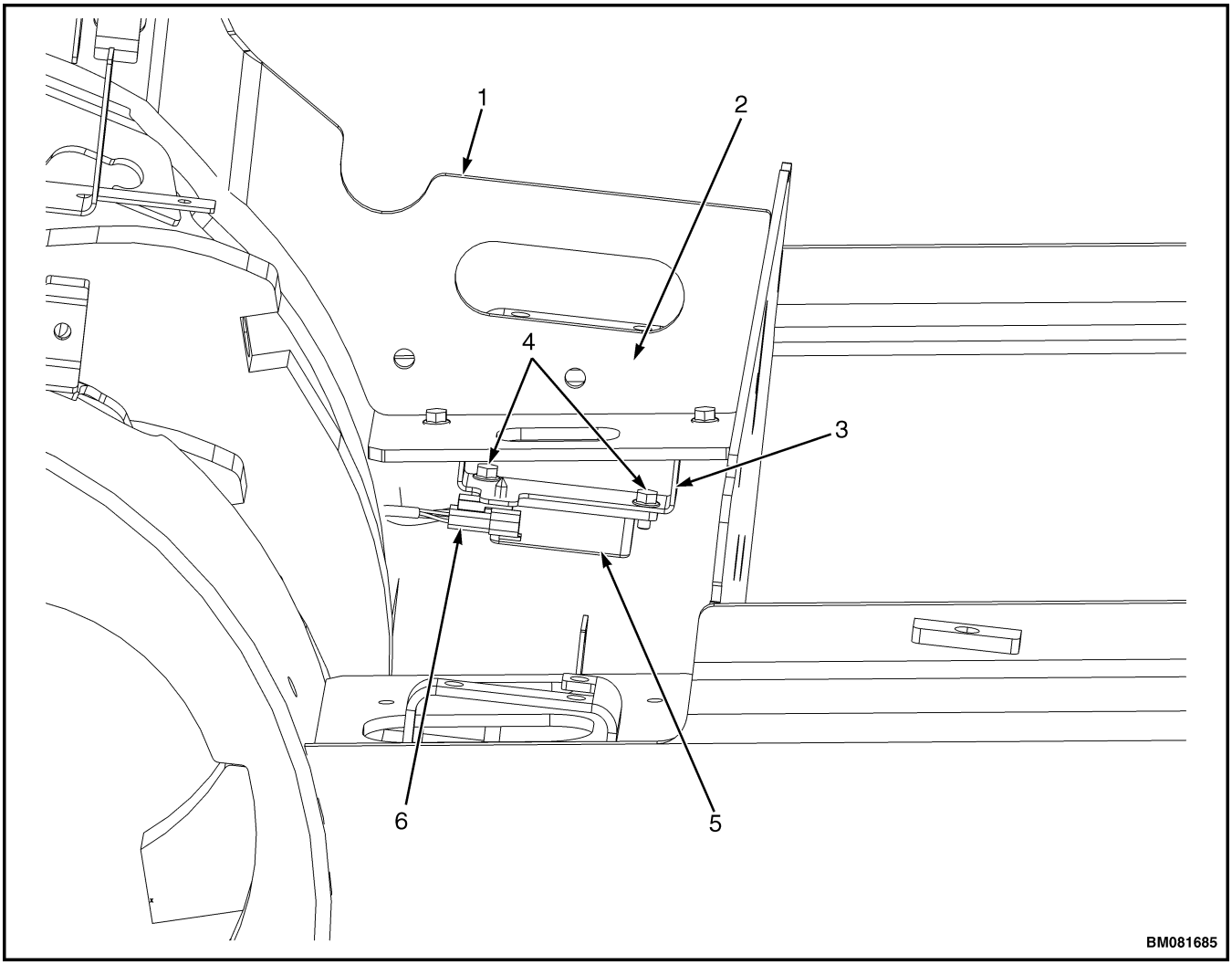
Figure 88. Impact Sensor Location, Lift Truck Models and J2.2-3.5XN (J45-70XN) (A276) J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

NOTE: Read and follow **WARNING** and **CAUTION** section in General section above.

1. Remove floor mat. Remove rear floor plate.
2. Remove capscrews and washers from front floor plate and lift front floor plate up enough to disconnect accelerator pedal or MONOTROL® pedal. See Figure 32. Remove front floor plate with accelerator or MONOTROL® pedal still attached.
3. Going through the opening in right tilt anchor plate (see Figure 88), disconnect main wire harness from impact sensor.

NOTE: Note placement and orientation of impact sensor prior to removal to aid in installation.

4. Remove two impact sensor mounting capscrews and impact sensor from impact sensor mounting bracket. See Figure 89.



NOTE: RIGHT ANCHOR TILT PLATE AND OTHER FRAME COMPONENTS OMITTED FOR CLARITY.

1. RIGHT FRONT OVERHEAD GUARD MOUNTING PLATE
2. PLATE
3. IMPACT SENSOR MOUNTING BRACKET
4. IMPACT SENSOR MOUNTING CAPSCREW
5. IMPACT SENSOR
6. IMPACT SENSOR CONNECTOR

Figure 89. Impact Sensor Replace, Lift Truck Models and J2.2-3.5XN (J45-70XN) (A276) J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

Install

1. Install new impact sensor and two impact sensor mounting capscrews on impact sensor mounting bracket as noted during removal. See Figure 89.
2. Connect main wiring harness to impact sensor as tagged during removal.
3. Connect accelerator pedal or MONOTROL® pedal, and install front floor plate using capscrews and washers.
4. Install rear floor plate and floor mat. See Figure 32.
5. Connect the battery.

Lift Truck Models E2.2-3.5XN (E45-70XN) (A268) and E1.6-2.0XN (E30-40XN) (A269)

NOTE: The impact sensor is located on right side of lift truck on a mounting plate that is mounted to the inside of the right frame channel.

Remove

1. Read and follow **WARNING** and **CAUTION** section in General section above.

NOTE: Perform Step 2 to Step 4 for lift trucks models E1.6-2.0XN (E30-40XN) (A269) and E2.2-3.5XN (E45-70XN) (A268) manufactured before June 2012.

2. Remove floor mat. Remove rear floor plate.
3. Remove capscrews and washers from front floor plate and lift front floor plate up enough to disconnect accelerator pedal or MONOTROL® pedal. See Figure 32.
4. Remove front floor plate with accelerator or MONOTROL® pedal still attached.

NOTE: Perform Step 5 to Step 7 for lift truck models E2.2-3.5XN (E45-70XN) (A268) manufactured after June 2012:

5. Remove floor mat. Remove rear floor plate.
6. Lift front floor plate up enough to disconnect accelerator pedal or MONOTROL® pedal. See Figure 33.
7. Remove front floor plate with accelerator or MONOTROL® pedal still attached.
8. Disconnect main wire harness from impact sensor. See Figure 90.

NOTE: Note placement and orientation of impact sensor prior to removal to aid in installation.

9. Remove three mounting plate capscrews and mounting plate with impact sensor from lift truck.
10. Remove two impact sensor capscrews and impact sensor from mounting plate. See Figure 90.

Install

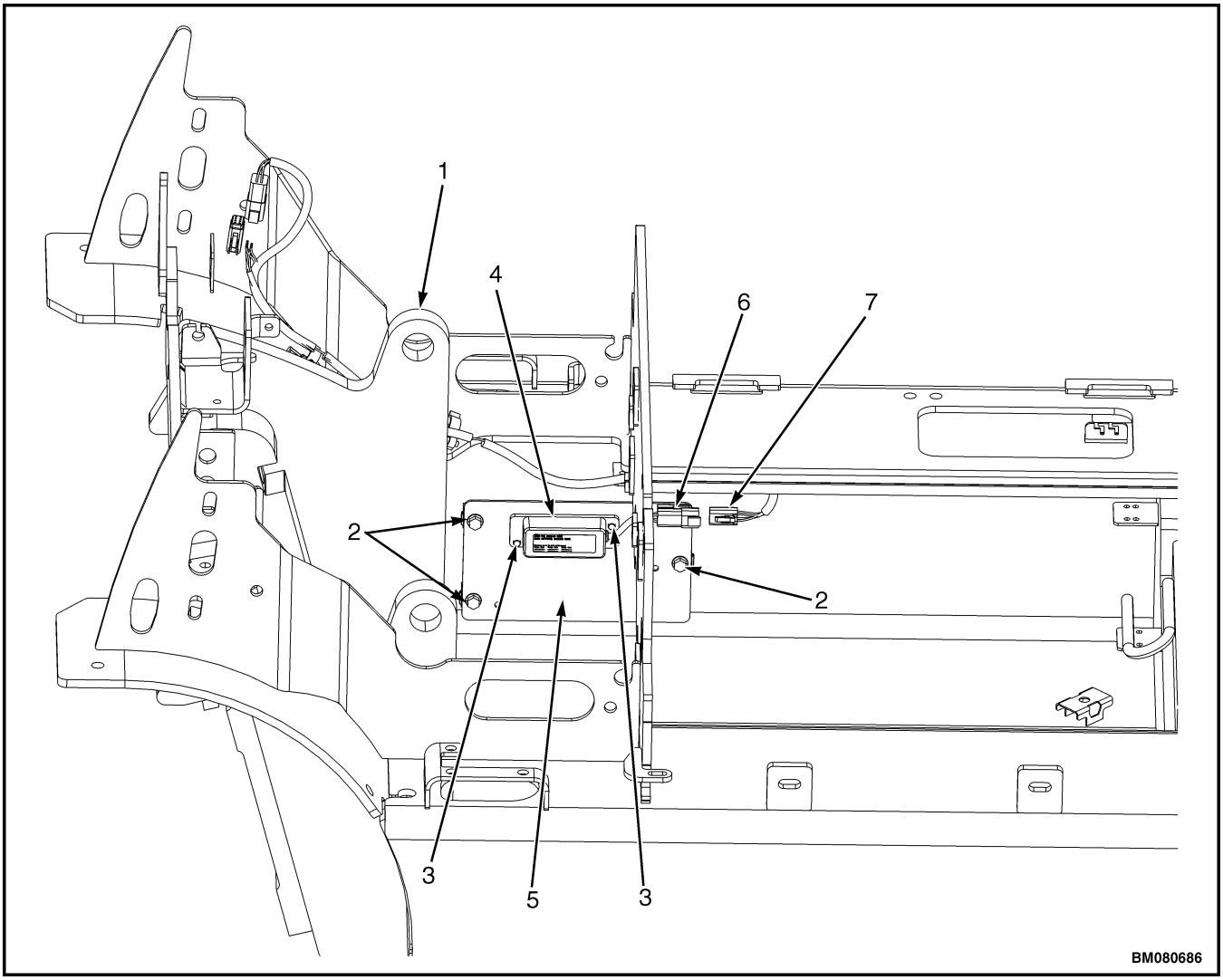
1. Install new impact sensor and two impact sensor capscrew on mounting plate. See Figure 90.
2. Install mounting plate, with new impact sensor attached, and three mounting plate capscrews on right frame channel.
3. Connect main wiring harness to impact sensor as tagged during removal.
4. Connect accelerator pedal or MONOTROL® pedal. See Figure 32.

NOTE: Perform Step 5 for lift truck models E1.6-2.0XN (E30-40XN) (A269) and E2.2-3.5XN (E45-70XN) (A268) manufactured before June 2012.

5. Install front floor plate using capscrews and washers.

NOTE: Perform Step 6 and Step 7 for lift truck model E2.2-3.5XN (E45-70XN) (A268) manufactured after June 2012.

6. No hardware is required to install front floor plate.
7. Install rear floor plate. Install floor mat.
8. Connect the battery.



NOTE: LIFT TRUCK MODEL E2.2-3.5XN (E45-70XN) (A268) SHOWN, LIFT TRUCK MODEL E1.6-2.0XN (E30-40XN) (A269) SIMILAR.

1. TILT ANCHOR PLATE
2. MOUNTING PLATE CAPSCREWS
3. IMPACT SENSOR CAPSCREWS
4. IMPACT SENSOR
5. MOUNTING PLATE
6. IMPACT SENSOR CONNECTOR
7. MAIN WIRING HARNESS CONNECTOR

Figure 90. Impact Sensor Replace, Lift Truck Models E2.2-3.5XN (E45-70XN) (A268)

Lift Truck Model E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

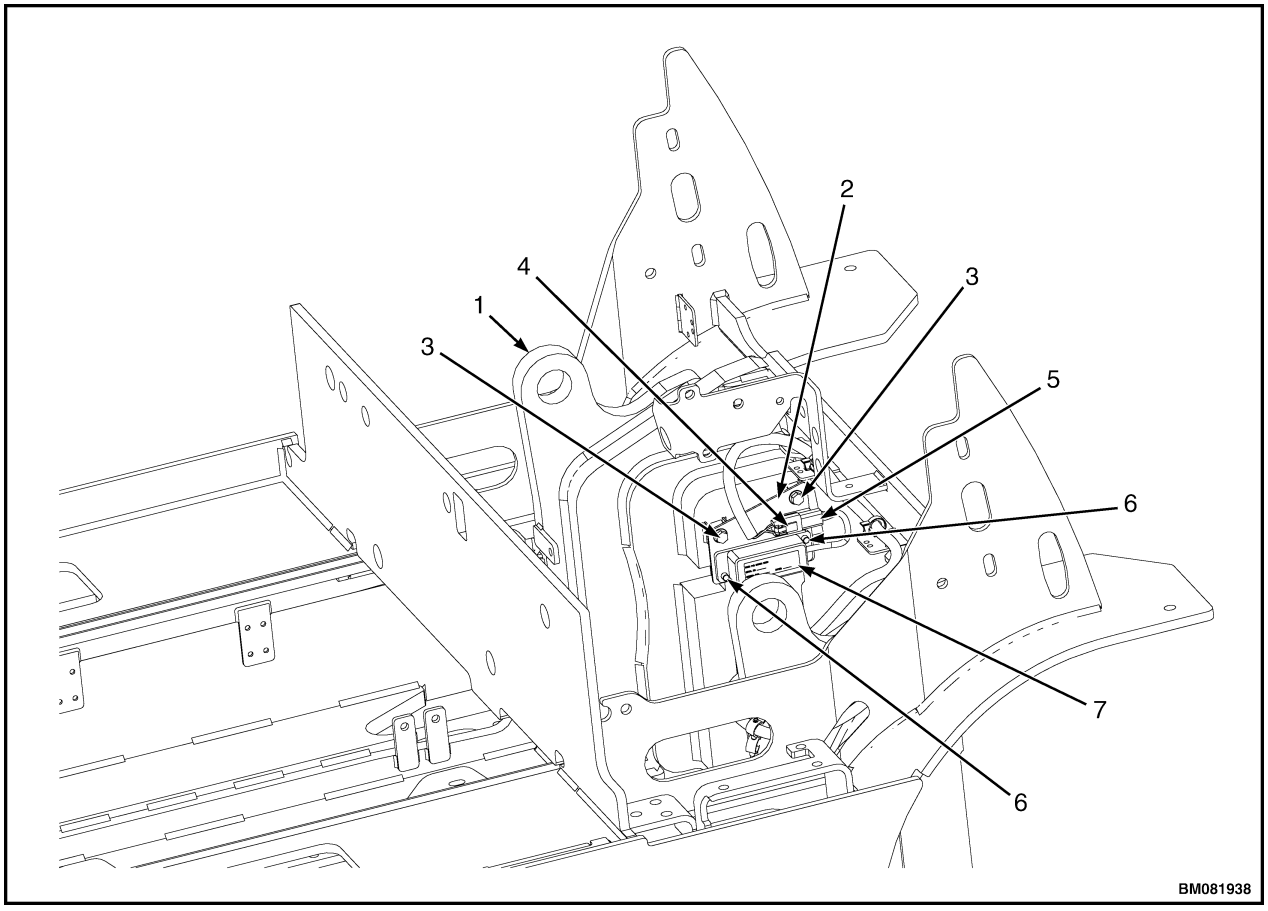
Remove

NOTE: The impact sensor is located on the left side of lift truck between the left tilt anchor plate and left front overhead guard mounting plate. See Figure 91.

1. Read and follow **WARNING** and **CAUTION** section in General section above.
2. Remove floor mat. Remove rear floor plate.
3. Lift front floor plate up enough to disconnect accelerator pedal or MONOTROL® pedal. See Figure 33.
4. Remove front floor plate with accelerator or MONOTROL® pedal still attached.
5. Disconnect main wire harness from impact sensor. See Figure 91.

NOTE: Note placement and orientation of impact sensor prior to removal to aid in installation.

6. Remove two impact sensor capscrews and remove impact sensor from mounting plate. See Figure 91.



1. LEFT TILT ANCHOR PLATE
2. MOUNTING PLATE
3. MOUNTING PLATE CAPSCREW
4. MAIN WIRING HARNESS CONNECTOR
5. IMPACT SENSOR CONNECTOR
6. IMPACT SENSOR CAPSCREW
7. IMPACT SENSOR

Figure 91. Impact Sensor Location, Lift Truck Model E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

Install

1. Install new impact sensor to mounting plate with two impact sensor capscrews. See Figure 91.
2. Connect main wiring harness to impact sensor as tagged during removal.
3. Connect accelerator pedal or MONOTROL® pedal, and install front floor plate.
4. Install rear floor plate.
5. Install floor mat. See Figure 42.
6. Connect the battery.

REAR AND HOOD HORN BUTTON SWITCHES

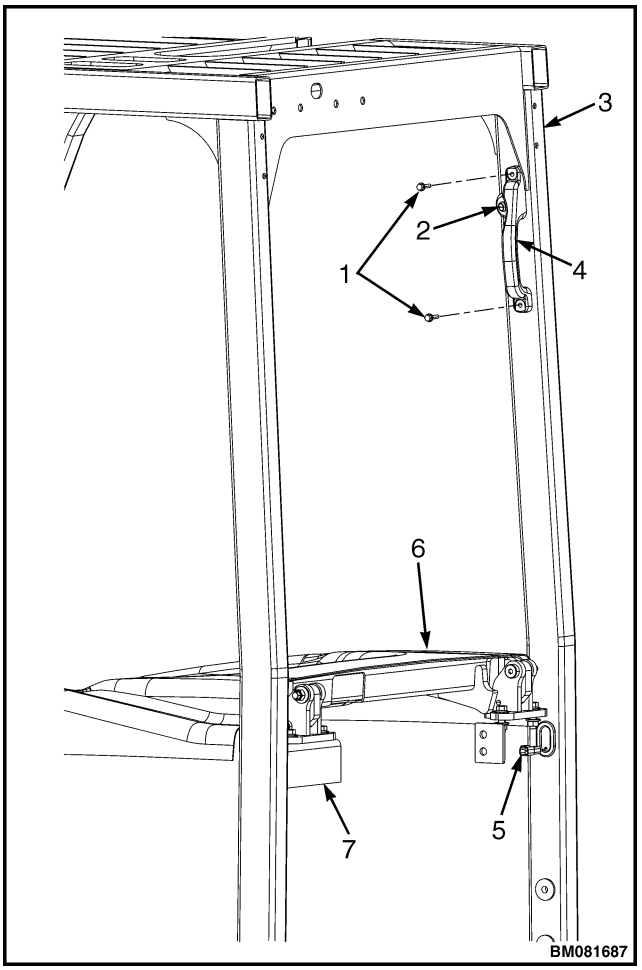
NOTE: The procedures below are for replacing the optional horn switch located in the rear handle on rear right overhead guard leg or in the handle located on right side of hood. Lift truck models E3.2-3.5XN (E65-70XN) (A268) and J4.0-5.0XN (J80-100XN) (A970) are the only trucks that may be equipped with a horn button on hood.

If your lift tucks is equipped with E-Hydraulic mini-levers, there is an optional horn button on armrest. See section Electronic and Manual Hydraulic Controls for procedures to replace horn sensor on E-Hydraulic armrest.

Rear Horn Button Switch

Remove

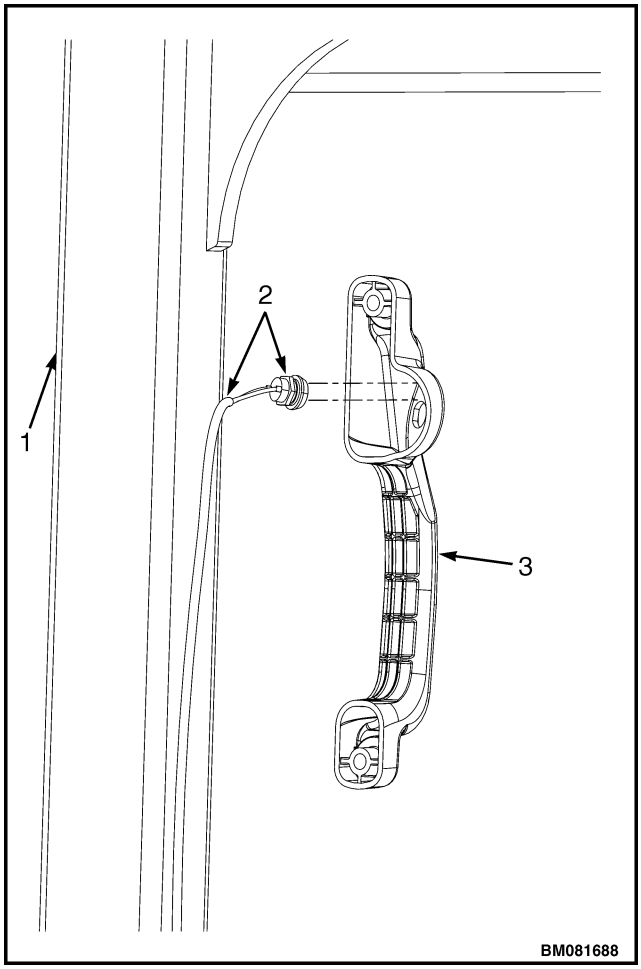
1. Read and follow **WARNING** and **CAUTION** section in General section above.
2. Raise hood, and reach underneath right hood mounting bracket to disconnect main wiring harness from rear horn button switch. See Figure 92.
3. Remove two capscrews that attach rear handle to right rear overhead guard leg. See Figure 92. Remove handle from right rear overhead guard leg.
4. Remove rear horn button switch and horn harness from the back of rear handle. See Figure 93.



NOTE: RIGHT HOOD MOUNTING BRACKET OMITTED FOR CLARITY.

1. CAPSCREWS
2. REAR HORN BUTTON
3. RIGHT REAR OVERHEAD GUARD LEG
4. REAR HANDLE
5. REAR HORN SWITCH CONNECTOR
6. HOOD
7. LEFT HOOD MOUNTING BRACKET

Figure 92. Rear Horn Button Switch Arrangement



1. RIGHT REAR OVERHEAD GUARD LEG
2. REAR HORN BUTTON SWITCH AND HORN HARNESS
3. REAR HANDLE

Figure 93. Rear Horn Button Switch Replace

Install

1. Install new rear horn button switch and horn harness into rear handle.
2. Thread horn harness and connector end through right overhead guard leg so that connector end comes out the hole and into right hood mounting bracket. See Figure 92.
3. Using two capscrews, attach rear handle and new horn button switch to right rear overhead guard leg. See Figure 93.
4. Connect main wire harness to rear horn switch connector. Close and secure hood.
5. Connect the battery.

Hood Horn Button Switch

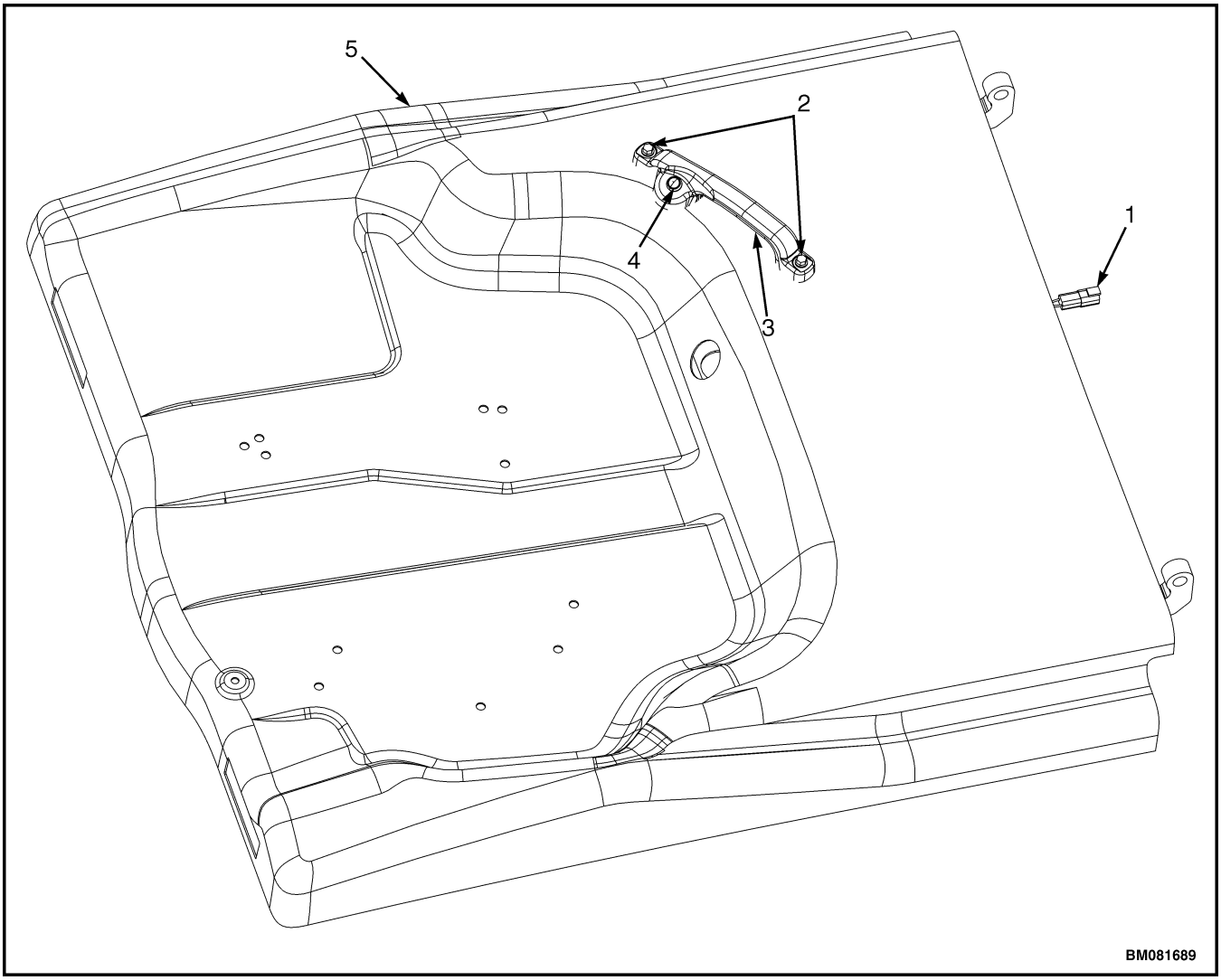
NOTE: The hood horn button switch is an option found only on lift truck models E3.2-3.5XN (E65-70XN) (A268) and E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099) .

Remove

1. Read and follow **WARNING** and **CAUTION** in General section above.
2. Raise hood and disconnect main wire harness from hood horn switch connector. See Figure 94.
3. Close hood and remove two capscrews from rear handle. See Figure 94. Remove rear handle from hood.
4. Remove hood horn button switch and horn harness from rear handle. See Figure 93.

Install

1. Install new hood horn button switch and horn harness into rear handle. See Figure 93.
2. Thread hood horn switch connector and horn harness through the hole in hood and using two capscrews, install rear handle to hood. See Figure 94.
3. Raise hood and connect hood horn switch connector to main wiring harness.
4. Close hood after connecting the hood horn switch to main wiring harness.
5. Connect the battery.



1. HOOD HORN SWITCH CONNECTOR
2. CAPSCREWS
3. REAR HANDLE
4. HOOD HORN BUTTON SWITCH
5. HOOD

Figure 94. Hood Horn Button Switch Arrangement

Motor Controllers Replacement

GENERAL

WARNING

Before replacing any of the motor controllers, fully lower all parts of the mast and tilt it forward until the tips of the forks touch the ground. This action will prevent the mast from lowering suddenly if the control lever is accidently moved.

WARNING

Discharge capacitors as directed in Discharging the Capacitors in General section at the beginning of this manual.

Disconnect the battery before doing any work on the electrical system. Serious injury to personnel and/or damage to lift truck components can occur if battery is not disconnected.

CAUTION

A short circuit and damage can occur if wires are not installed correctly. Make sure wire connectors do not touch the other metal terminals or wire connectors, metal brackets, or the bracket mounting nuts. Make sure the wires are not pulled tight and are not touching other parts to damage the insulation.

CAUTION

DO NOT remove the small screws that fasten the cover of the motor controller.

Make sure there is no dirt between the plate of the motor controller and the mount surface of the lift truck frame.

The hydraulic pump and motor controller and traction motor controller, control and monitor the electrical function for their respective components.

See Figure 95 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268) manufactured before September, 2012.

See Figure 96 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268) manufactured after September, 2012.

See Figure 97 for lift truck models

- E45-70XN (A268) manufactured after November 2014.

See Figure 98 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276) , manufactured before February, 2009

See Figure 99 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276) , manufactured after February, 2009

See Figure 100 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276) , manufactured after November 2014

See Figure 101 for lift truck model

- J2.2-3.5XN (J45-70XN) (A276) , manufactured after November 2015

See Figure 102 for lift truck models

- J4.0-5.0XN (J80-100XN) (A970) manufactured before November 2014

See Figure 103 for lift truck models

- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) manufactured after November 2014

See Figure 104 for lift truck models

- E1.6-2.0XN (E30-40XN) (A269) manufactured before November 2014

See Figure 105 for lift truck models

- E30-40XN (A269) manufactured after November 2014

See Figure 106 for lift truck model

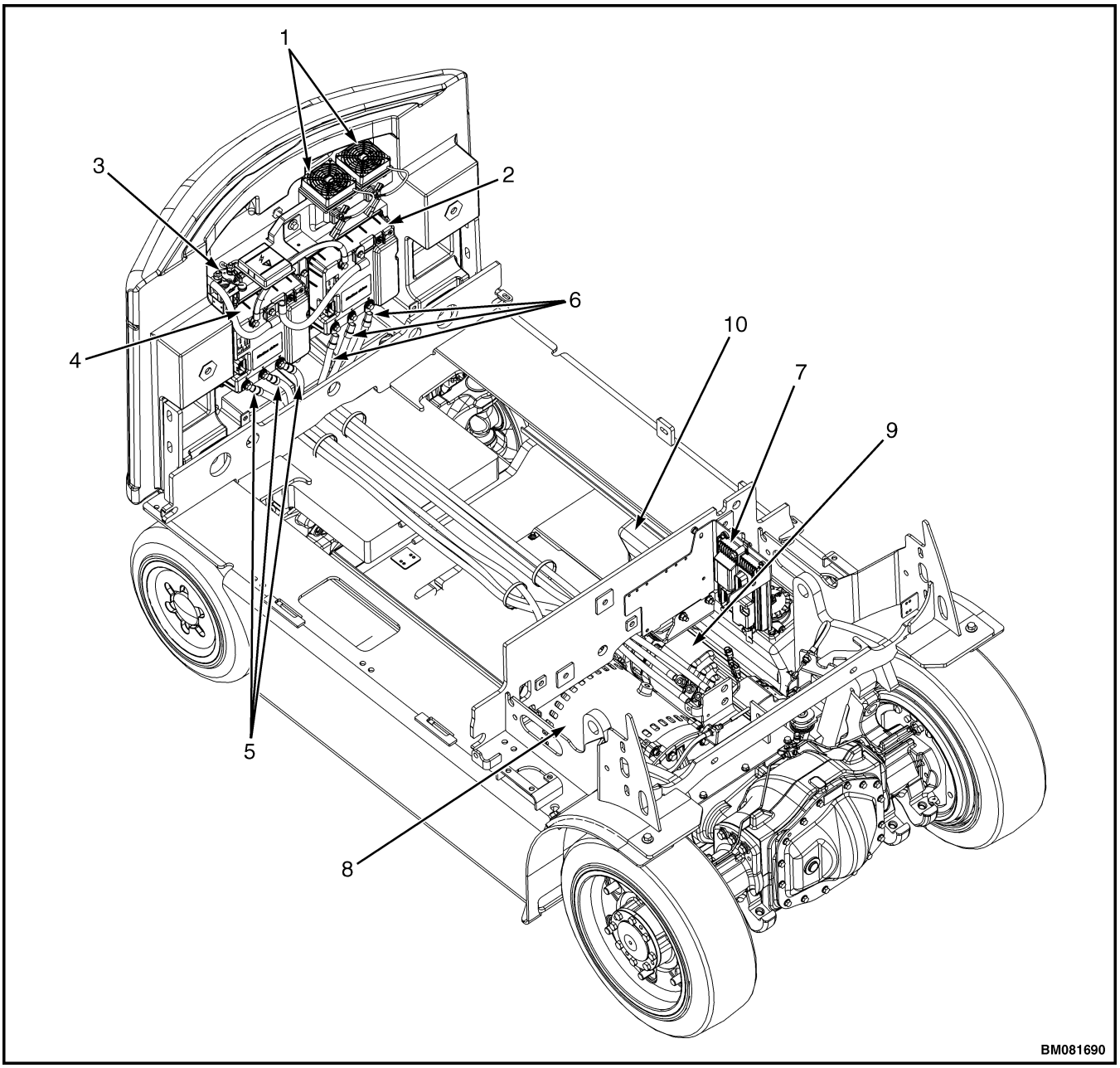
- E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099) manufactured before November 2014

See Figure 107 for lift truck model

- E80-120XN, E100XNS (A099) manufactured after November 2014

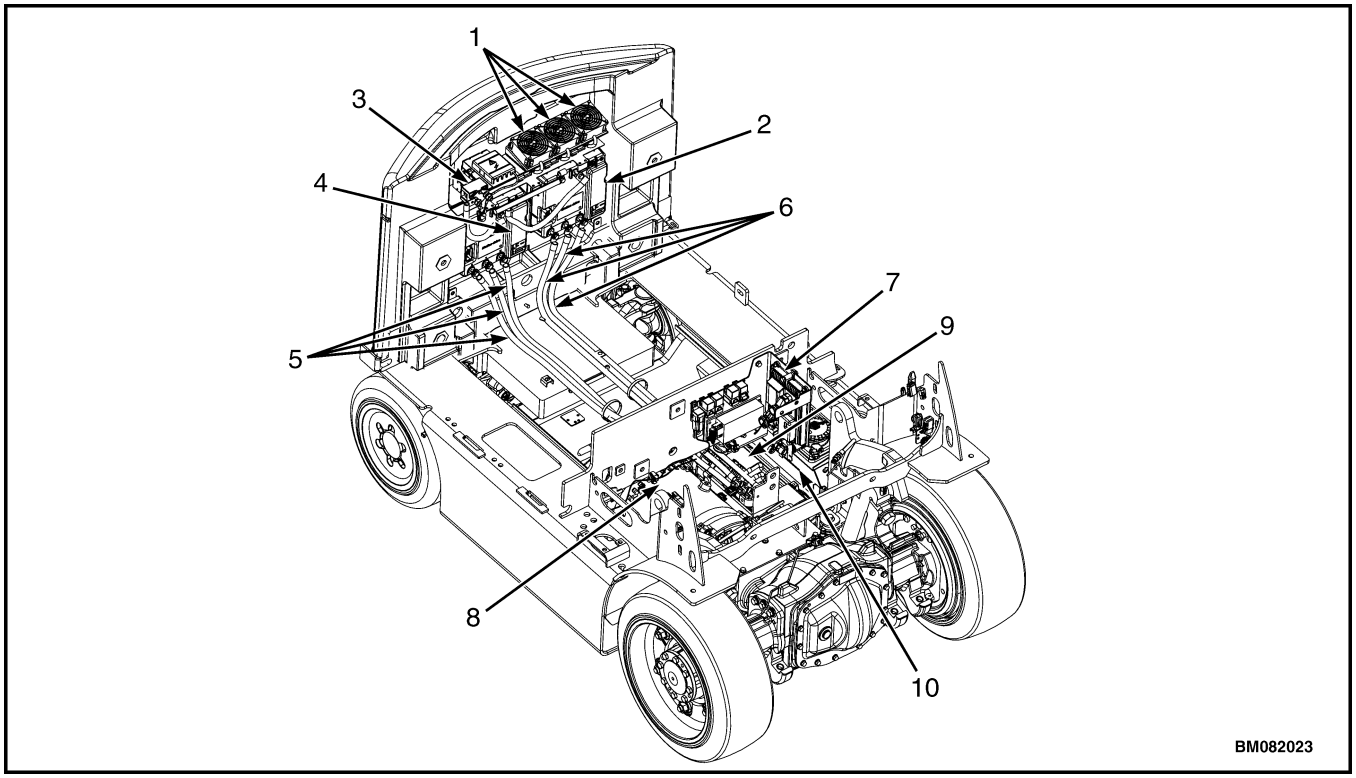
Before replacing any motor controllers, follow capacitor discharge procedure outlined in Discharging the Capacitors in the General section of this manual. Attach a tag to truck battery connector stating **DO NOT CONNECT BATTERY**. Remove the key or turn the keyless switch **OFF**.

Make an identification for correct connection of the power cables on the power terminals of the motor controller and all electrical connections that are disconnected prior to removing the controller. This will aid in reconnecting during installation.



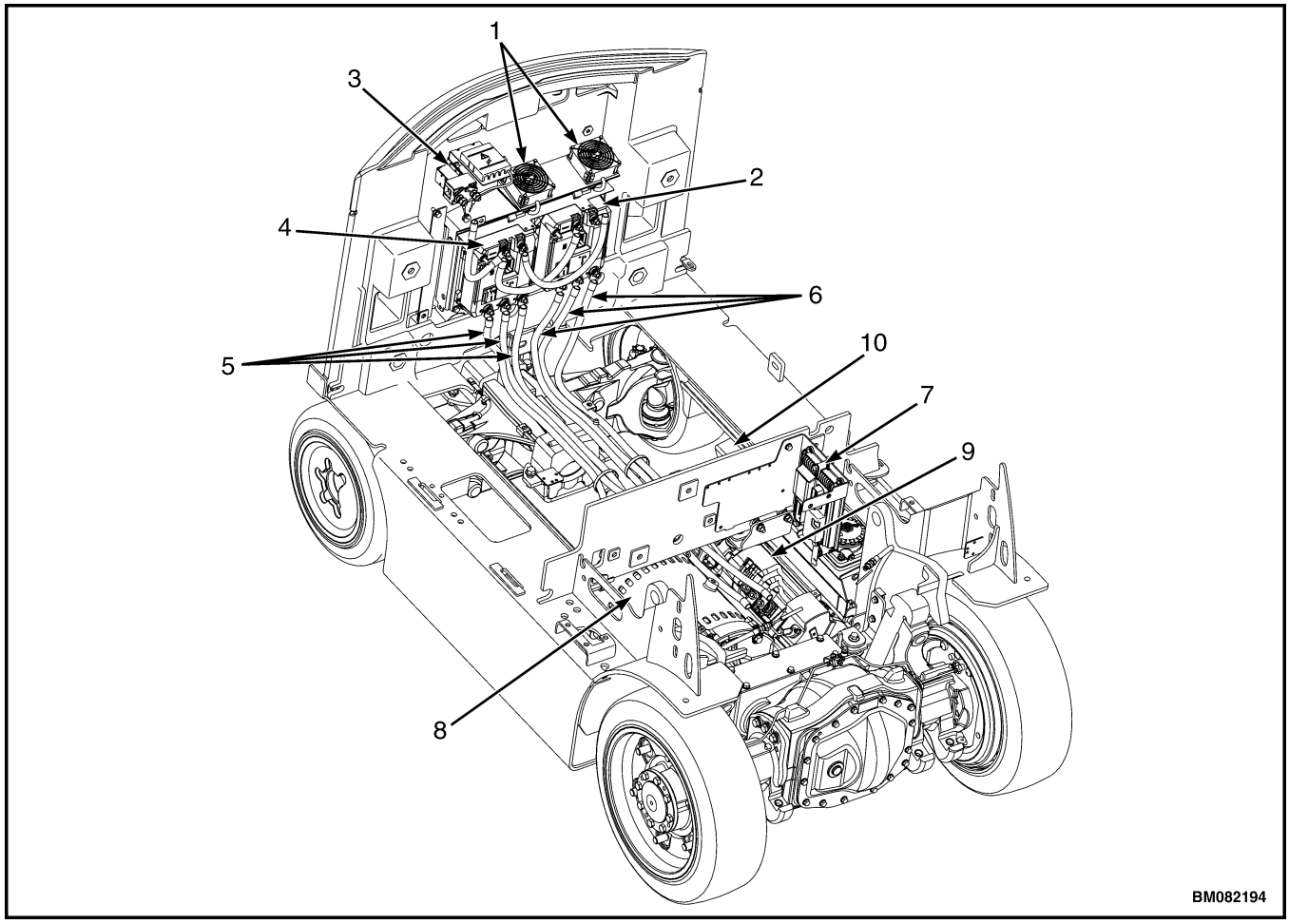
1. FANS
2. HYDRAULIC PUMP AND MOTOR CONTROLLER
3. LINE CONTACTOR
4. TRACTION MOTOR CONTROLLER
5. TRACTION MOTOR POWER CABLES
6. HYDRAULIC PUMP AND MOTOR POWER CABLES
7. VEHICLE SYSTEM MANAGER
8. TRACTION MOTOR
9. HYDRAULIC PUMP AND MOTOR
10. HYDRAULIC TANK

Figure 95. Motor Controllers and Electrical Components Arrangement, Lift Truck Models , Manufactured Before September 2012E2.2-3.5XN (E45-70XN) (A268)



1. FANS
2. HYDRAULIC PUMP AND MOTOR CONTROLLER
3. LINE CONTACTOR
4. TRACTION MOTOR CONTROLLER
5. TRACTION MOTOR POWER CABLES
6. HYDRAULIC PUMP AND MOTOR POWER CABLES
7. VEHICLE SYSTEM MANAGER
8. TRACTION MOTOR
9. HYDRAULIC PUMP AND MOTOR
10. HYDRAULIC TANK

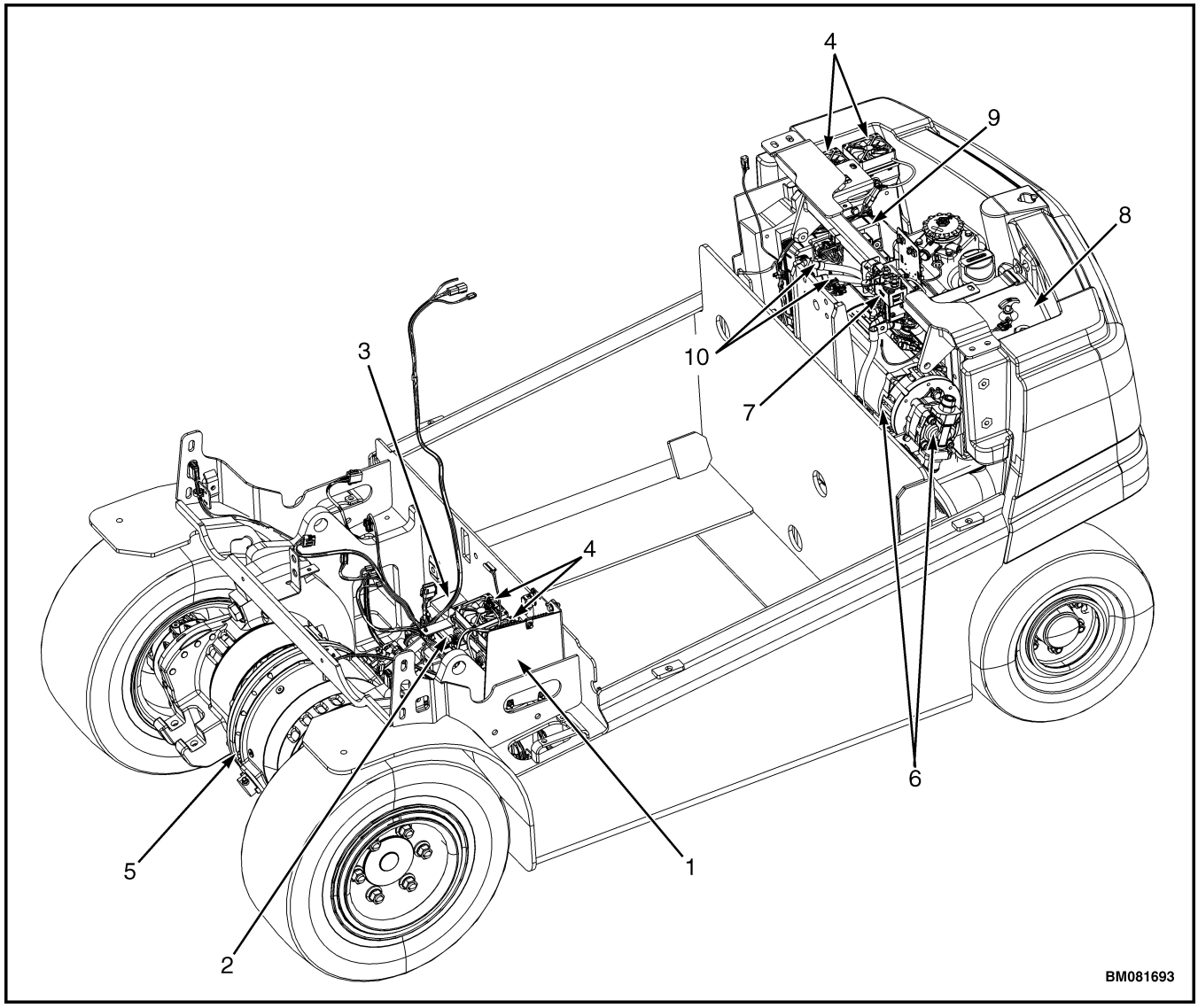
Figure 96. Motor Controllers and Electrical Components Arrangement, Lift Truck Models , Manufactured After September 2012E2.2-3.5XN (E45-70XN) (A268)



NOTE: BULKHEAD REMOVED FOR CLARITY.

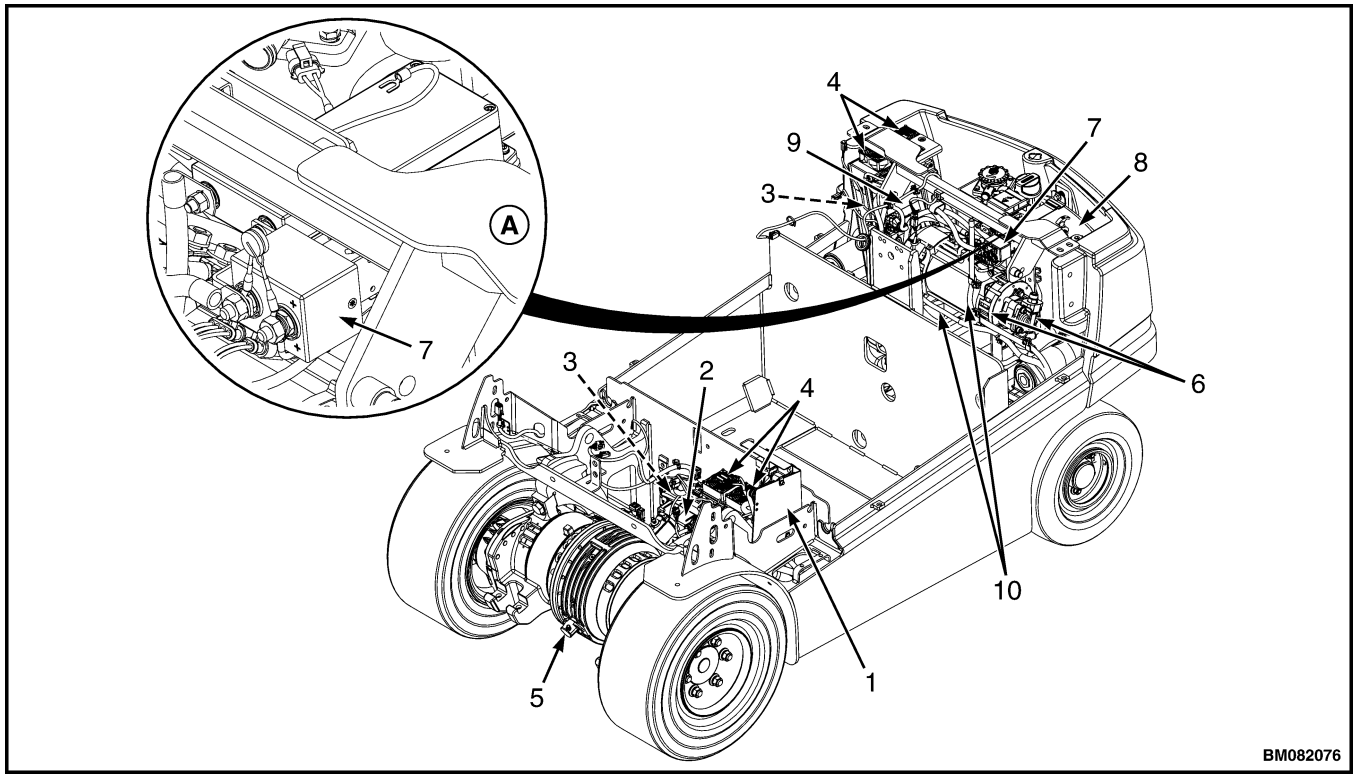
1. FANS
2. HYDRAULIC PUMP AND MOTOR CONTROLLER
3. LINE CONTACTOR
4. TRACTION MOTOR CONTROLLER
5. TRACTION MOTOR POWER CABLES
6. HYDRAULIC PUMP AND MOTOR POWER CABLES
7. VEHICLE SYSTEM MANAGER
8. TRACTION MOTOR
9. HYDRAULIC PUMP AND MOTOR
10. HYDRAULIC TANK

Figure 97. Motor Controllers and Electrical Components Arrangement, Lift Truck Models , Manufactured After November 2014E45-70XN (A268)



1. VEHICLE SYSTEM MANAGER MOUNTING PLATE
2. TRACTION MOTOR CONTROLLERS
3. HEATSINK
4. FANS
5. DRIVE AXLE ASSEMBLY
6. HYDRAULIC PUMP AND MOTOR
7. LINE CONTACTOR
8. HYDRAULIC TANK
9. HYDRAULIC PUMP AND MOTOR CONTROLLER
10. POWER CABLES

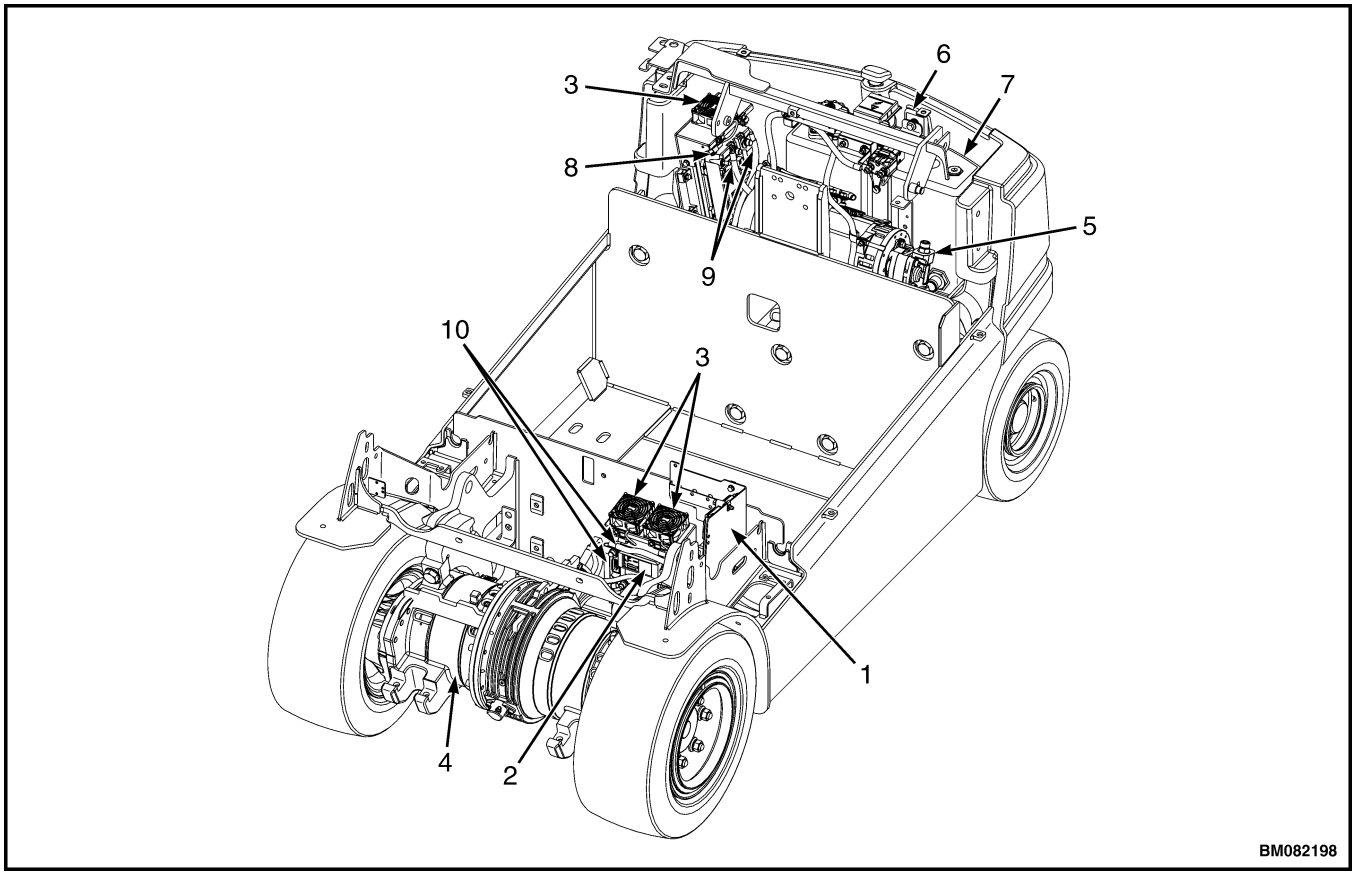
Figure 98. Motor Controllers and Electrical Components Arrangement, Lift Truck Models , Manufactured Before February 2009J2.2-3.5XN (J45-70XN) (A276)



A. ELECTRICAL COMPONENTS FOR LIFT TRUCK MODELS J2.2-3.5XN (J45-70XN) (A276) , EQUIPPED WITH OUTDOOR PROTECTION/WASH-DOWN PACKAGE, MANUFACTURED AFTER OCTOBER, 2013

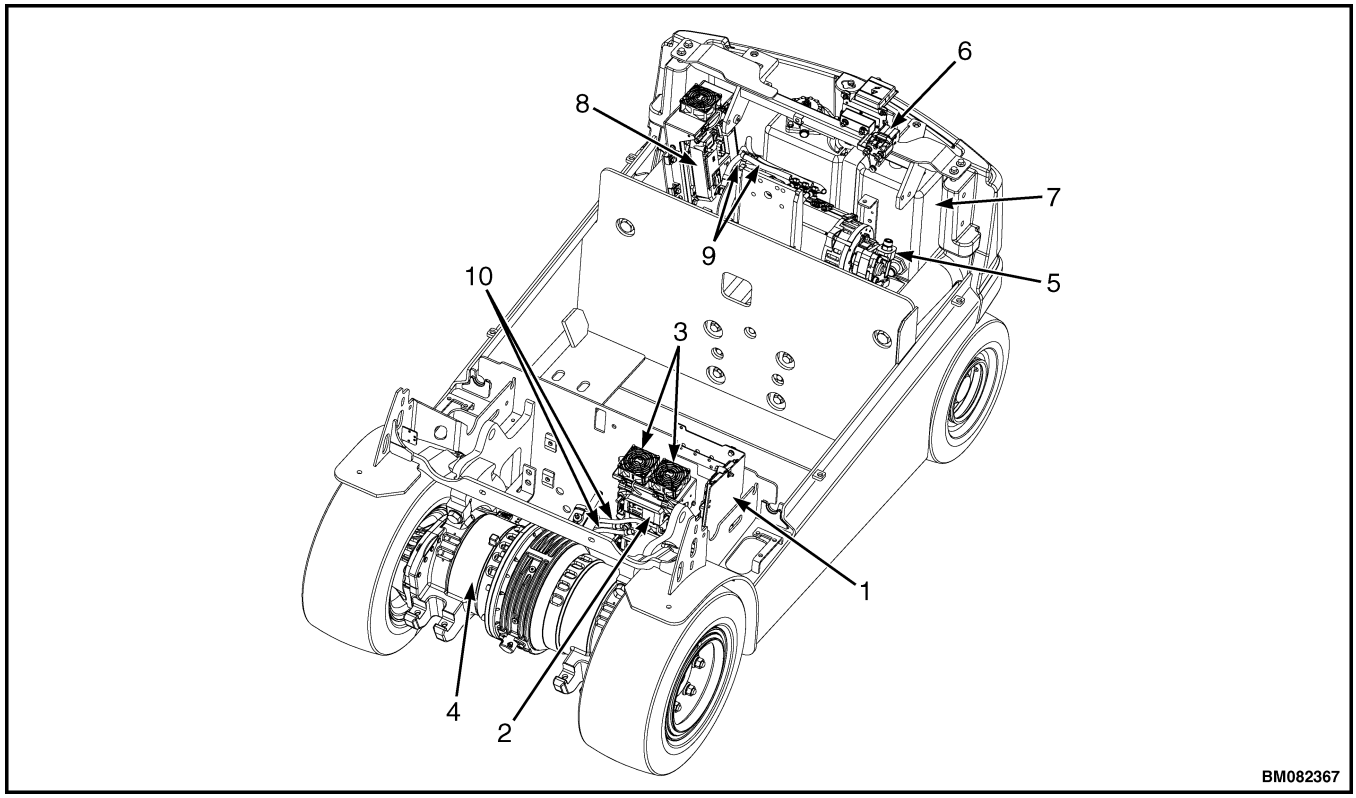
1. VEHICLE SYSTEM MANAGER MOUNTING PLATE
2. TRACTION MOTOR CONTROLLERS
3. HEATSINK
4. FANS
5. DRIVE AXLE ASSEMBLY
6. HYDRAULIC PUMP AND MOTOR
7. LINE CONTACTOR
8. HYDRAULIC TANK
9. HYDRAULIC PUMP AND MOTOR CONTROLLER
10. POWER CABLES

Figure 99. Motor Controllers and Electrical Components Arrangement, Lift Truck Models , Manufactured After February 2009J2.2-3.5XN (J45-70XN) (A276)



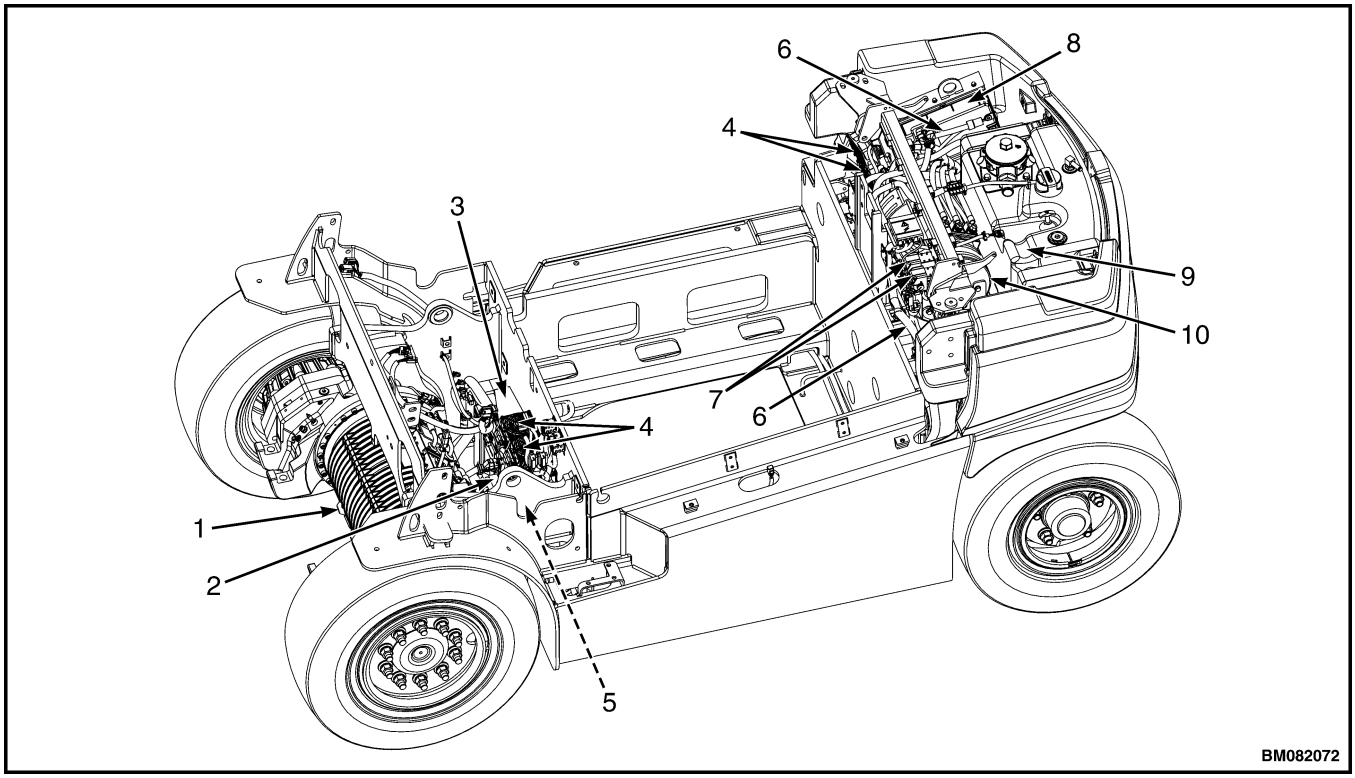
1. VEHICLE SYSTEM MANAGER MOUNTING PLATE
2. TRACTION MOTOR CONTROLLERS
3. FANS
4. DRIVE AXLE ASSEMBLY
5. HYDRAULIC PUMP AND MOTOR
6. LINE CONTACTOR
7. HYDRAULIC TANK
8. HYDRAULIC PUMP AND MOTOR CONTROLLER
9. HYDRAULIC PUMP AND MOTOR POWER CABLES
10. TRACTION MOTOR POWER CABLES

Figure 100. Motor Controllers and Electrical Components Arrangement, Lift Truck Models , Manufactured After November 2014J2.2-3.5XN (J45-70XN) (A276)



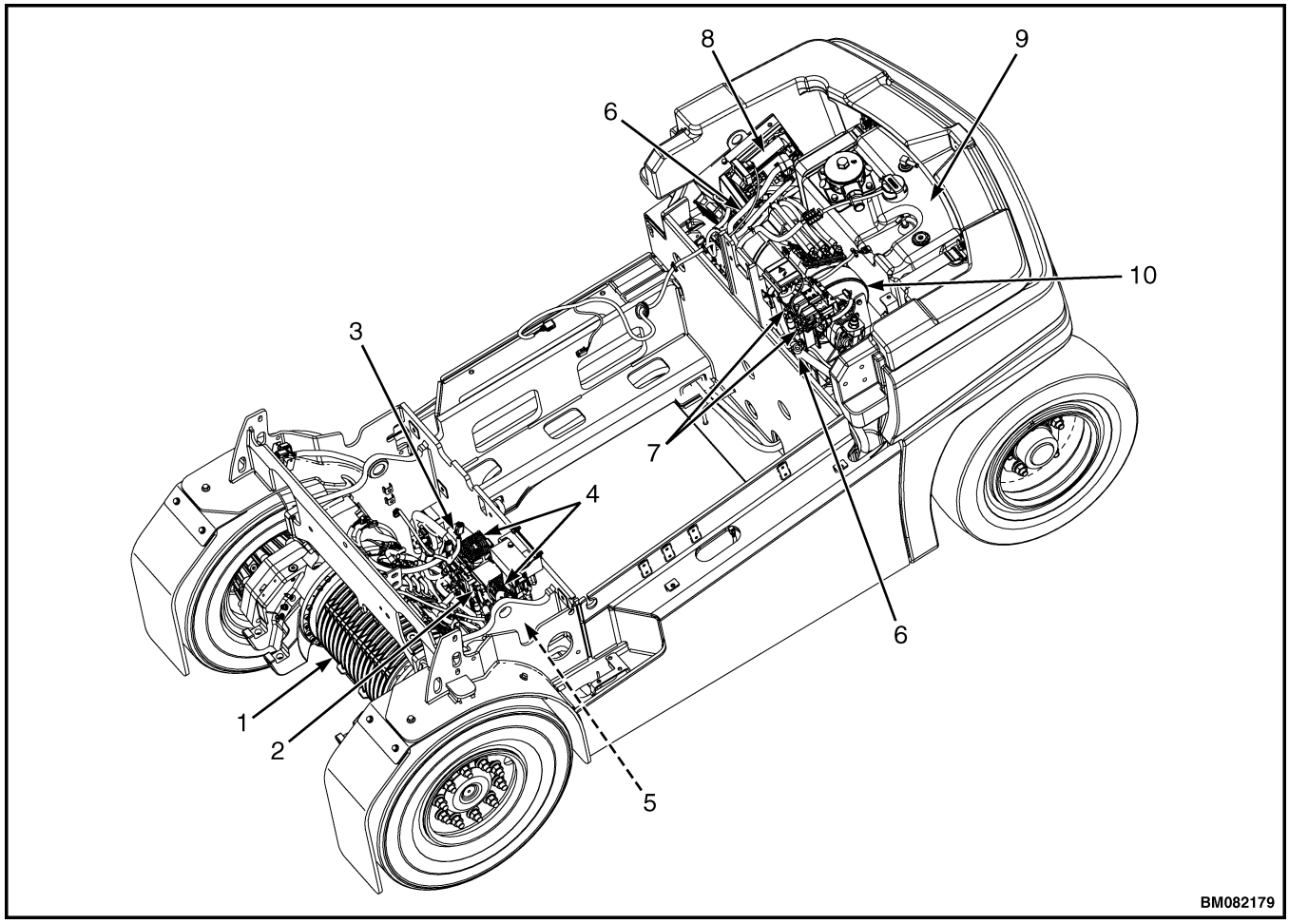
1. VEHICLE SYSTEM MANAGER MOUNTING PLATE
2. TRACTION MOTOR CONTROLLERS
3. FANS
4. DRIVE AXLE ASSEMBLY
5. HYDRAULIC PUMP AND MOTOR
6. LINE CONTACTOR
7. HYDRAULIC TANK
8. HYDRAULIC PUMP AND MOTOR CONTROLLER
9. HYDRAULIC PUMP AND MOTOR POWER CABLES
10. TRACTION MOTOR POWER CABLES

Figure 101. Motor Controllers and Electrical Components Arrangement, Lift Truck Models , Manufactured After November 2015J2.2-3.5XN (J45-70XN) (A276)



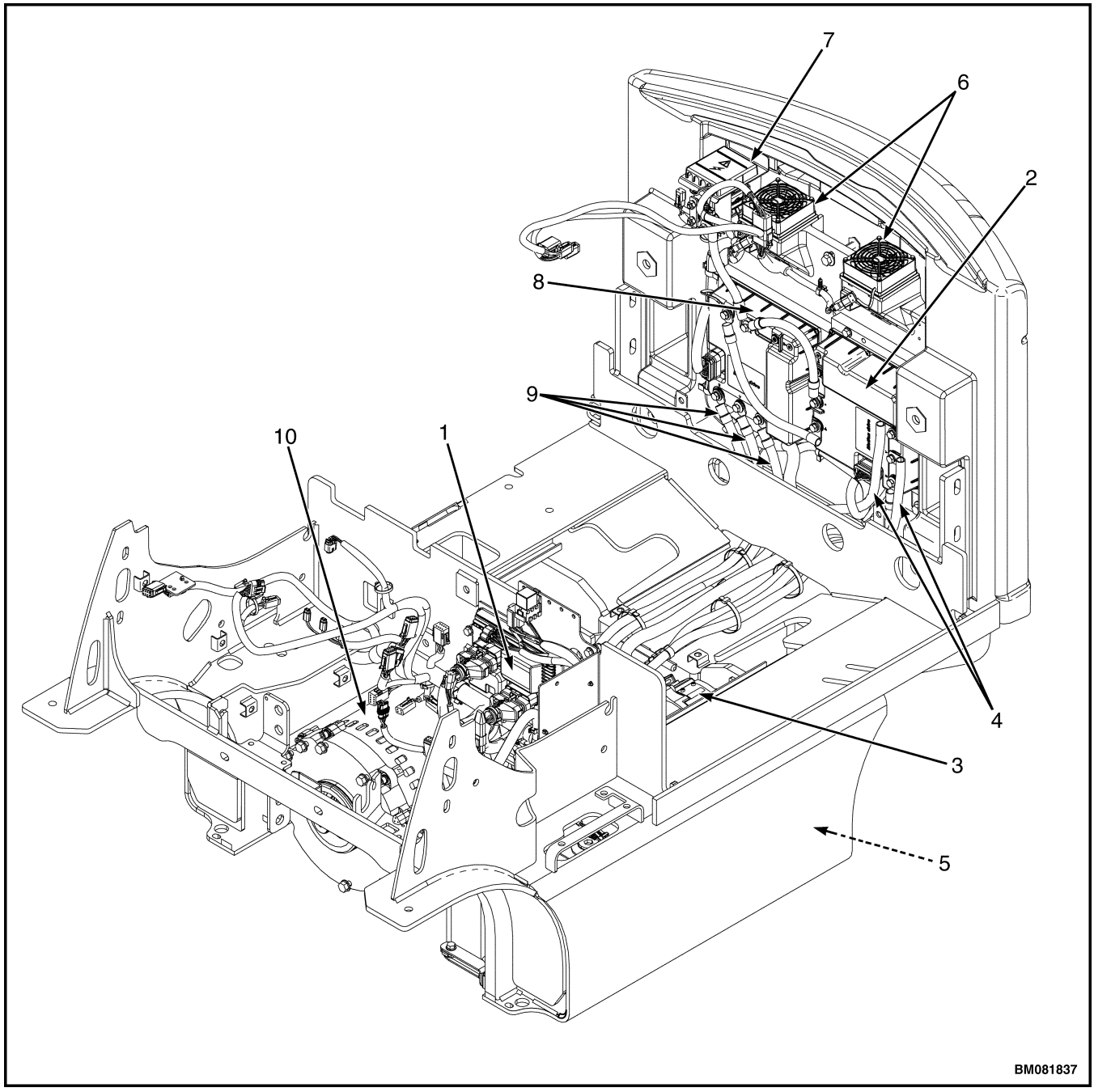
1. DRIVE AXLE ASSEMBLY
2. TRACTION MOTOR CONTROLLER
3. HEAT SINK
4. FANS
5. VEHICLE SYSTEM MANAGER MOUNTING PLATE
6. POWER CABLES
7. LINE CONTACTOR
8. HYDRAULIC PUMP AND MOTOR CONTROLLER
9. HYDRAULIC TANK
10. HYDRAULIC PUMP AND MOTOR

Figure 102. Motor Controllers and Electrical Components Arrangement, Lift Truck Models, Manufactured Before November 2014J4.0-5.0XN (J80-100XN) (A970)



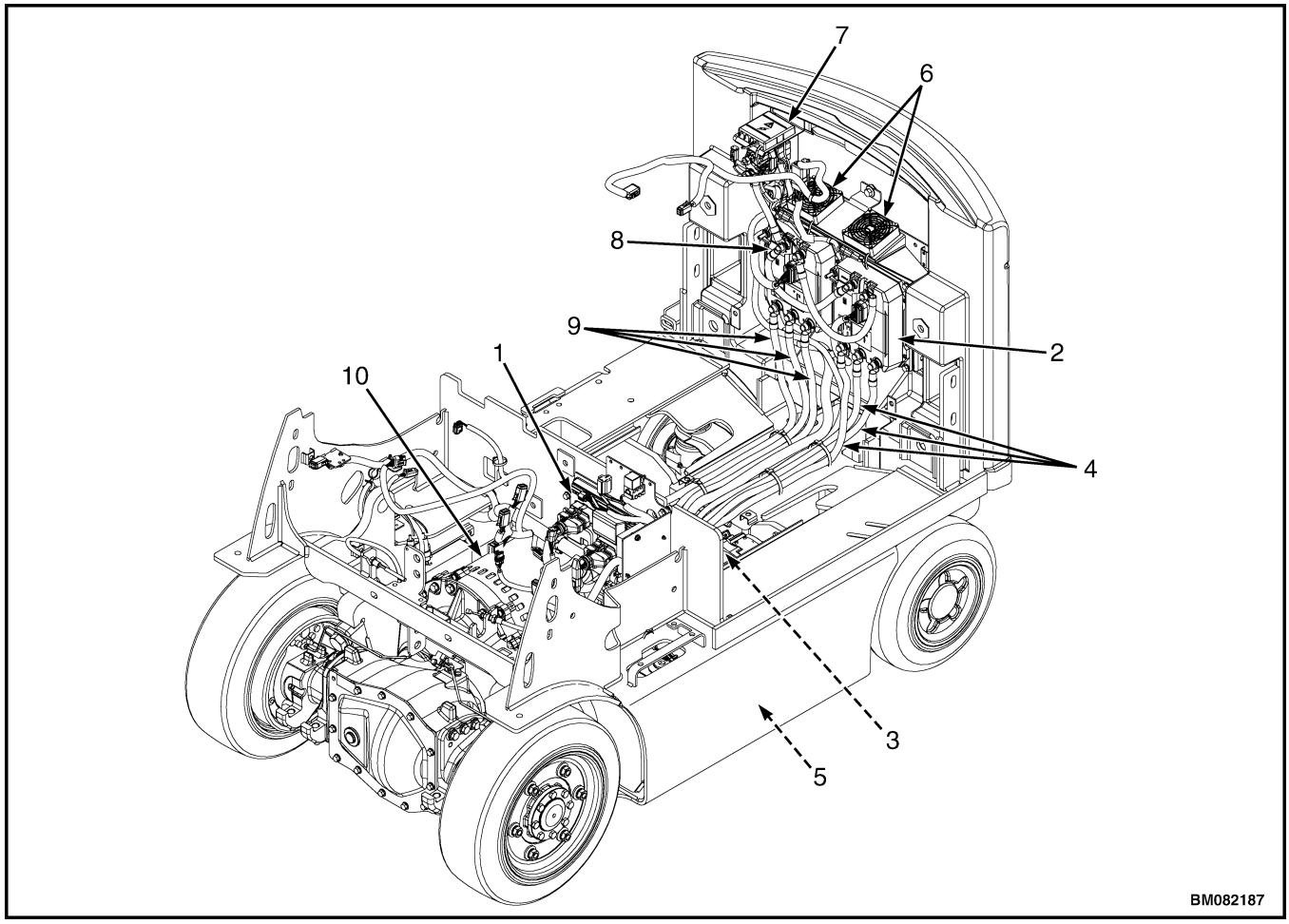
1. DRIVE AXLE ASSEMBLY
2. TRACTION MOTOR CONTROLLER
3. HEAT SINK
4. FANS
5. VEHICLE SYSTEM MANAGER MOUNTING PLATE
6. POWER CABLES
7. LINE CONTACTOR
8. HYDRAULIC PUMP AND MOTOR CONTROLLER
9. HYDRAULIC TANK
10. HYDRAULIC PUMP AND MOTOR

Figure 103. Motor Controllers and Electrical Components Arrangement, Lift Truck Models, Manufactured After November 2014J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)



1. VEHICLE SYSTEM MANAGER
2. HYDRAULIC PUMP AND MOTOR CONTROLLER
3. HYDRAULIC PUMP AND MOTOR
4. HYDRAULIC PUMP AND MOTOR POWER CABLES
5. HYDRAULIC TANK
6. FANS
7. LINE CONTACTOR
8. TRACTION MOTOR CONTROLLER
9. TRACTION MOTOR POWER CABLES
10. TRACTION MOTOR

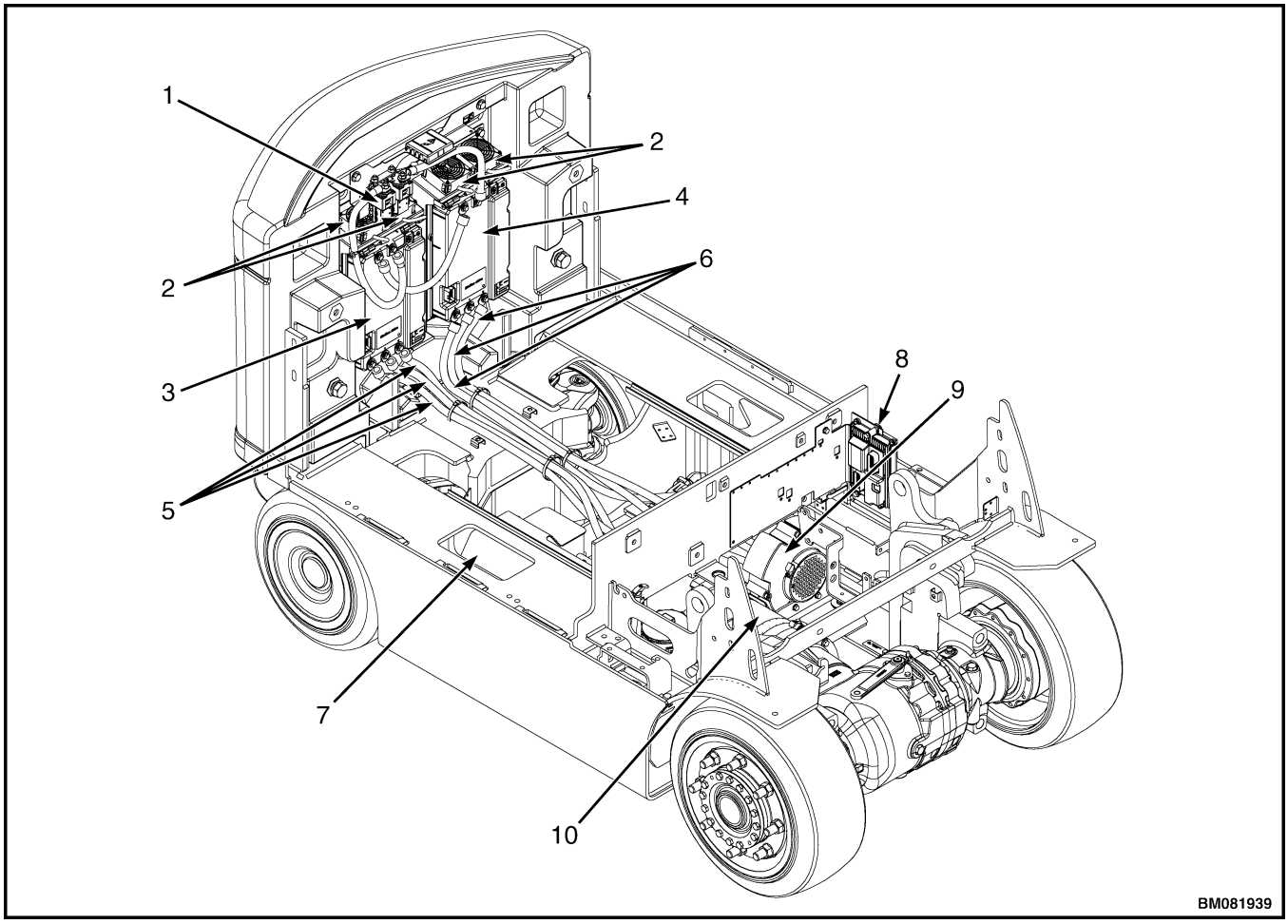
Figure 104. Motor Controllers and Electrical Components Arrangement for Lift Truck Models Manufactured Before November 2014E1.6-2.0XN (E30-40XN) (A269)



NOTE: BULKHEAD REMOVED FOR CLARITY.

1. VEHICLE SYSTEM MANAGER
2. HYDRAULIC PUMP AND MOTOR CONTROLLER
3. HYDRAULIC PUMP AND MOTOR
4. HYDRAULIC PUMP AND MOTOR POWER CABLES
5. HYDRAULIC TANK
6. FANS
7. LINE CONTACTOR
8. TRACTION MOTOR CONTROLLER
9. TRACTION MOTOR POWER CABLES
10. TRACTION MOTOR

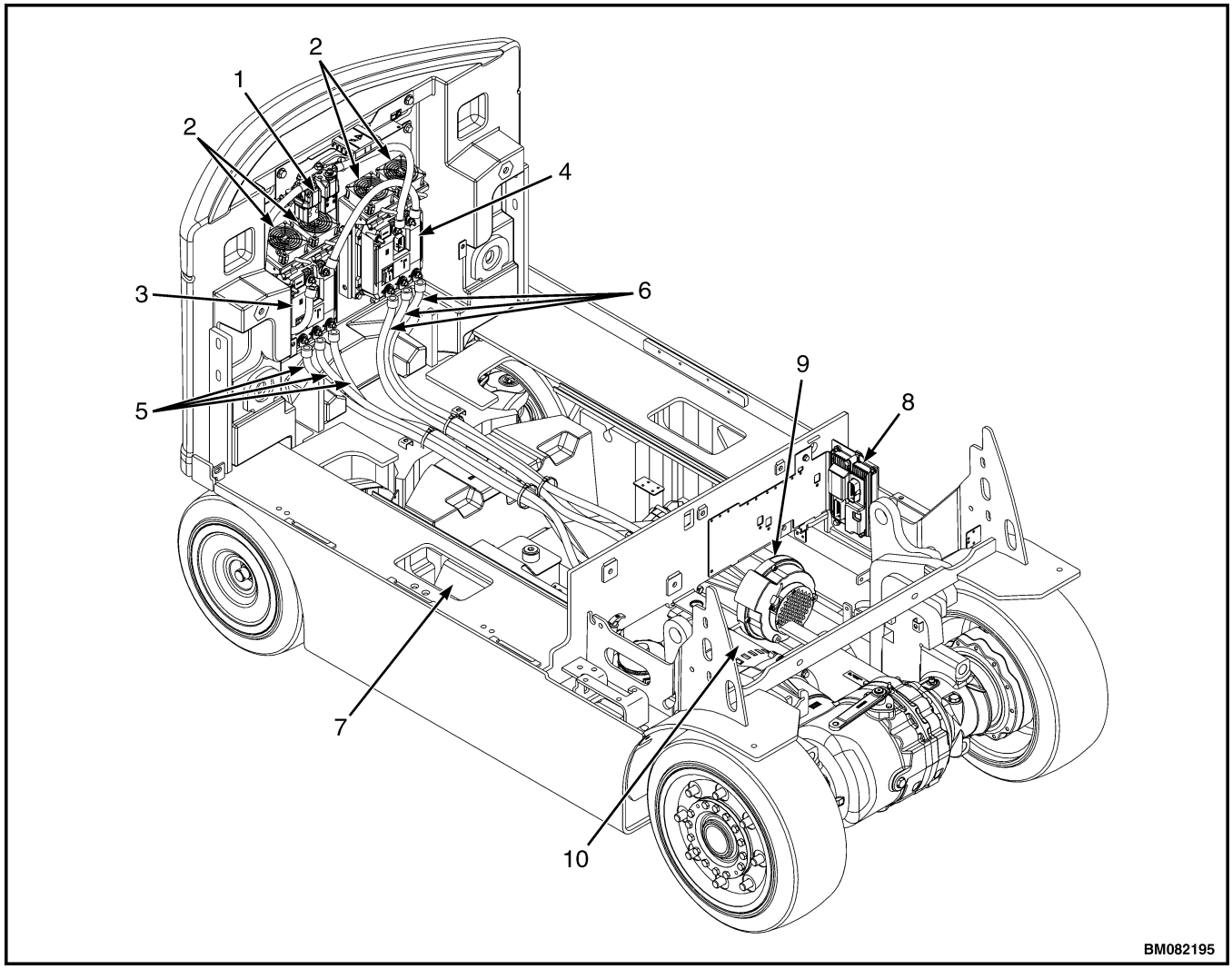
Figure 105. Motor Controllers and Electrical Components Arrangement for Lift Truck Models Manufactured After November 2014E30-40XN (A269)



NOTE: BULKHEAD REMOVED FOR CLARITY.

1. LINE CONTACTOR
2. FANS
3. TRACTION MOTOR CONTROLLER
4. HYDRAULIC PUMP AND MOTOR CONTROLLER
5. TRACTION MOTOR POWER CABLES
6. HYDRAULIC PUMP AND MOTOR POWER CABLES
7. HYDRAULIC TANK
8. VEHICLE SYSTEM MANAGER
9. HYDRAULIC PUMP AND MOTOR
10. TRACTION MOTOR

Figure 106. Motor Controllers and Electrical Components Arrangement, Lift Truck Model Manufactured Before November 2014E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)



NOTE: BULKHEAD REMOVED FOR CLARITY.

1. LINE CONTACTOR
2. FANS
3. TRACTION MOTOR CONTROLLER
4. HYDRAULIC PUMP AND MOTOR CONTROLLER
5. TRACTION MOTOR POWER CABLES
6. HYDRAULIC PUMP AND MOTOR POWER CABLES
7. HYDRAULIC TANK
8. VEHICLE SYSTEM MANAGER
9. HYDRAULIC PUMP AND MOTOR
10. TRACTION MOTOR

Figure 107. Motor Controllers and Electrical Components Arrangement, Lift Truck Model Manufactured After November 2014E80-120XN, E100XNS (A099)

LIFT TRUCK MODELS E2.2-3.5XN (E45-70XN) (A268) AND E1.6-2.0XN (E30-40XN) (A269)

Traction Motor and Hydraulic Pump and Motor Controllers

Remove

1. Read and follow the **WARNING** and **CAUTION** section in the General section above.

2. Remove the battery for access to the motor controllers. See the **Operating Manual** or service manual

   Periodic Maintenance 8000SRM1364 for lift truck models

   - E2.2-3.5XN (E45-70XN) (A268)

   Periodic Maintenance 8000SRM1442 for lift truck models

   - E1.6-2.0XN (E30-40XN) (A269)

3. Remove the plate that is in front of the motor controllers.

NOTE: Make sure all power cables and electrical connections are clearly marked before disconnecting them to help in reconnecting.

4. Disconnect the power cables and all electrical connections from the motor controllers.

   See Figure 108 for lift truck models

   - E2.2-3.5XN (E45-70XN) (A268) manufactured before September, 2012.

   See Figure 109 for lift truck models

   - E2.2-3.5XN (E45-70XN) (A268) manufactured after September, 2012.

   See Figure 110 for lift truck models

   - E45-70XN (A268) manufactured after November 2014.

   See Figure 111 for lift truck models

   - E1.6-2.0XN (E30-40XN) (A269) manufactured before November 2014

   See Figure 112 for lift truck models

   - E30-40XN (A269) manufactured after November 2014.

NOTE: Perform Step 5 for lift truck models E2.2-3.5XN (E45-70XN) (A268) , manufactured before September, 2012, and lift truck models E1.6-2.0XN (E30-40XN) (A269) manufactured before November 2014.

5. Remove eight flange capscrews from motor controllers. Remove motor controllers from heatsink.

   See Figure 108 for lift truck models

   - E2.2-3.5XN (E45-70XN) (A268) manufactured before September, 2012

   See Figure 111 for lift truck models

   - E1.6-2.0XN (E30-40XN) (A269) manufactured before November 2014

NOTE: Perform Step 6 for lift truck models E2.2-3.5XN (E45-70XN) (A268) , manufactured after September, 2012 and lift truck models E45-70XN (A268) and E30-40XN (A269) manufactured after November 2014.

6. Remove eight flange capscrews from motor controllers and heatsink. Remove motor controllers and heatsink from mounting bracket.

   See Figure 109 for lift truck models

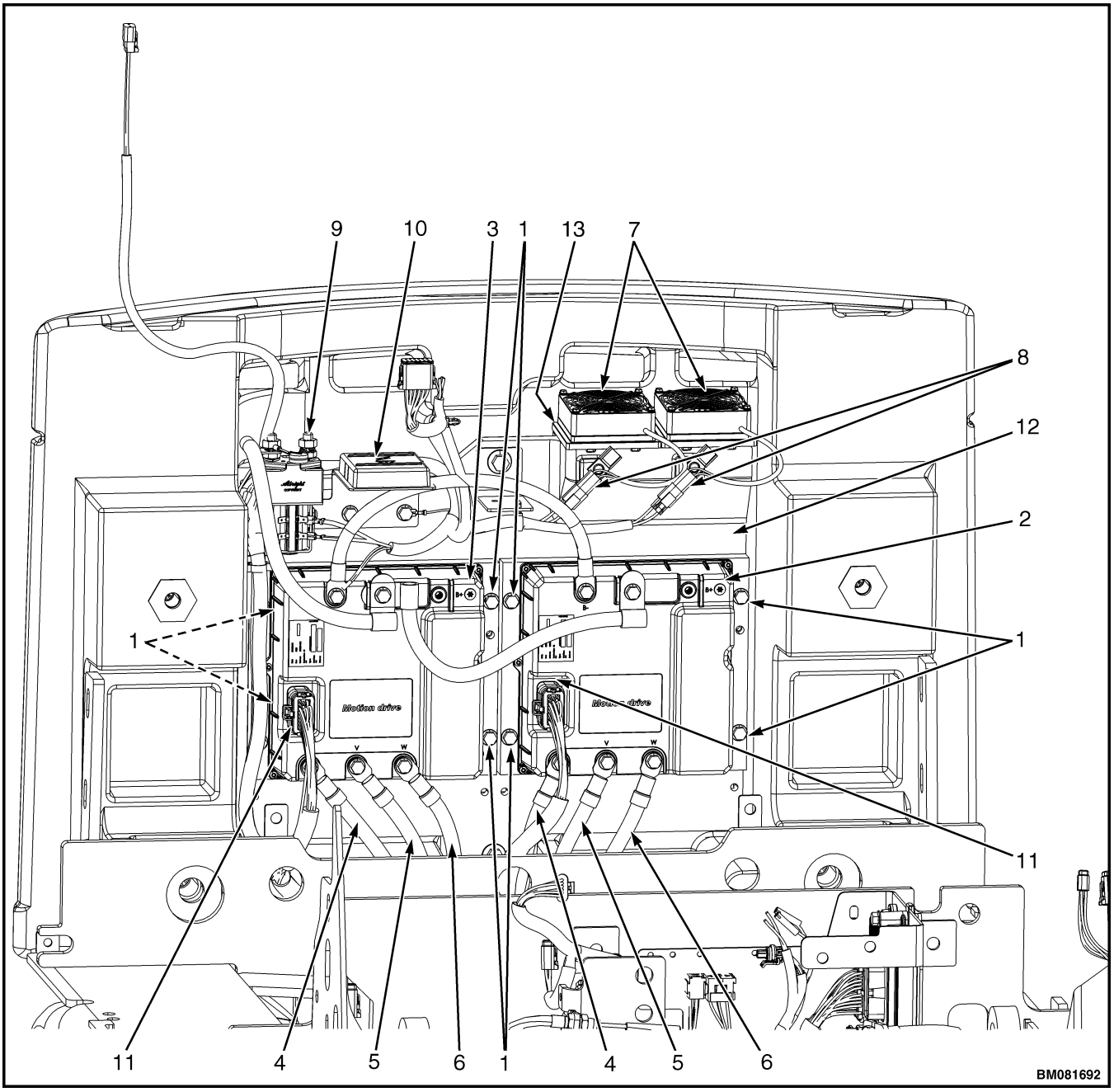
   - E2.2-3.5XN (E45-70XN) (A268) manufactured after September, 2012

   See Figure 110 for lift truck models

   - E45-70XN (A268) manufactured after November 2014

   See Figure 112 for lift truck models

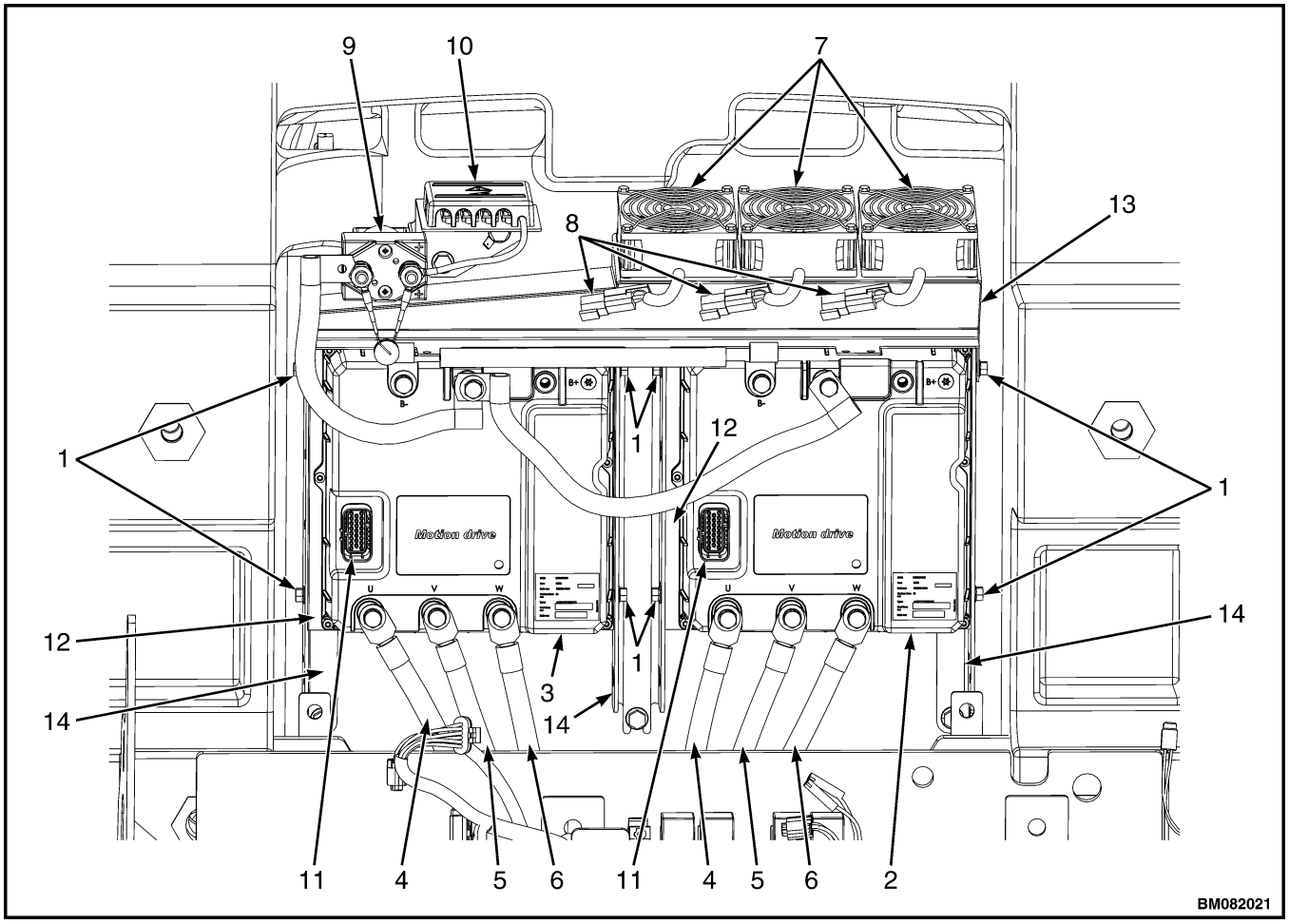
   - E30-40XN (A269) manufactured after November 2014



NOTE: STANDARD PERFORMANCE MOTOR CONTROLLER PANELS SHOWN. ENHANCED PERFORMANCE MOTOR CONTROLLER PANELS ARE SIMILAR.

1. FLANGE CAPSCREW
2. HYDRAULIC PUMP DRIVE MOTOR CONTROLLER
3. TRACTION MOTOR CONTROLLER
4. POWER CABLE **U**
5. POWER CABLE **V**
6. POWER CABLE **W**
7. FANS
8. FAN CONNECTORS
9. CONTACTOR
10. FUSE COVER
11. CONTROLLER ELECTRICAL CONNECTORS
12. AIR DUCT
13. FAN TO AIR DUCT

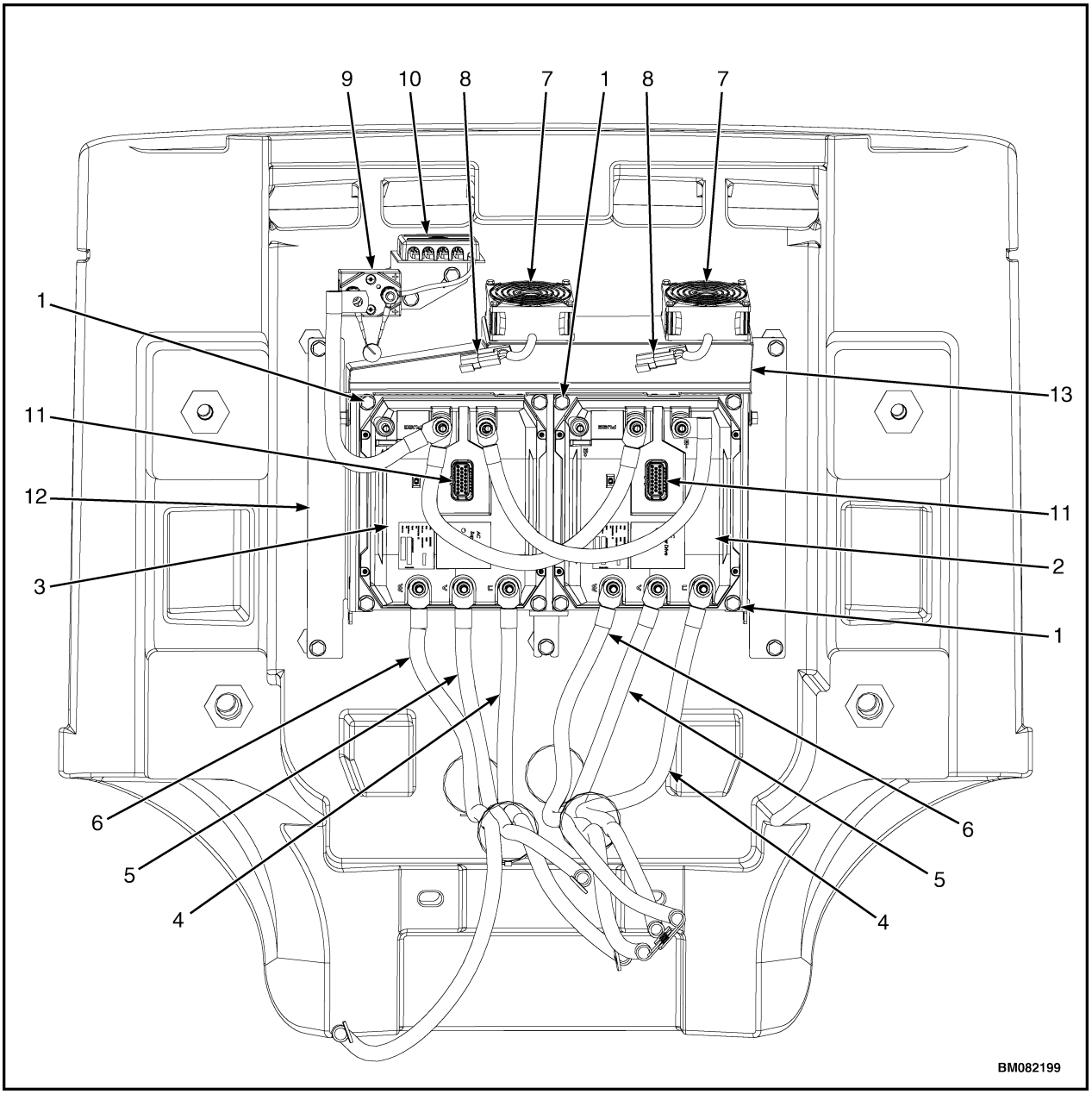
Figure 108. Motor Controllers Replace for Lift Truck Models , Manufactured Before September, 2012E2.2-3.5XN (E45-70XN) (A268)



NOTE: STANDARD PERFORMANCE MOTOR CONTROLLER PANELS SHOWN. ENHANCED PERFORMANCE MOTOR CONTROLLER PANELS ARE SIMILAR.

1. FLANGE CAPSCREW
2. HYDRAULIC PUMP DRIVE MOTOR CONTROLLER
3. TRACTION MOTOR CONTROLLER
4. POWER CABLE **U**
5. POWER CABLE **V**
6. POWER CABLE **W**
7. FANS
8. FAN CONNECTORS
9. CONTACTOR
10. FUSE COVER
11. CONTROLLER ELECTRICAL CONNECTORS
12. HEATSINK
13. FAN AIR DUCT
14. MOTOR CONTROLLERS MOUNTING BRACKET

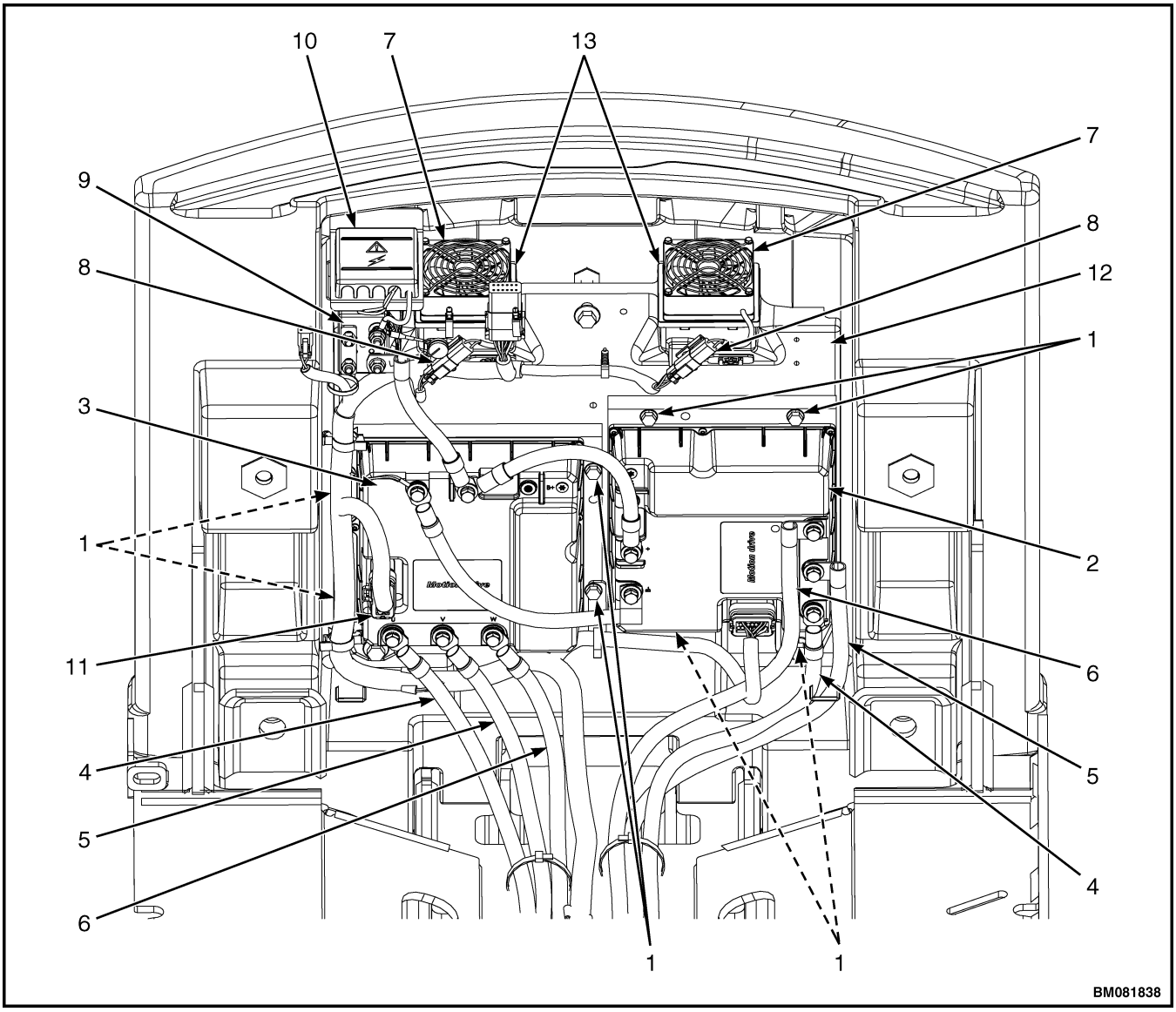
Figure 109. Motor Controllers Replace for Lift Truck Models , Manufactured After September, 2012E2.2-3.5XN (E45-70XN) (A268)



NOTE: STANDARD PERFORMANCE MOTOR CONTROLLER PANELS SHOWN. ENHANCED PERFORMANCE MOTOR CONTROLLER PANELS ARE SIMILAR.

1. FLANGE CAPSCREW
2. HYDRAULIC PUMP DRIVE MOTOR CONTROLLER
3. TRACTION MOTOR CONTROLLER
4. POWER CABLE **U**
5. POWER CABLE **V**
6. POWER CABLE **W**
7. FANS
8. FAN CONNECTORS
9. CONTACTOR
10. FUSE COVER
11. CONTROLLER ELECTRICAL CONNECTORS
12. MOTOR CONTROLLERS MOUNTING BRACKET
13. FAN AIR DUCT

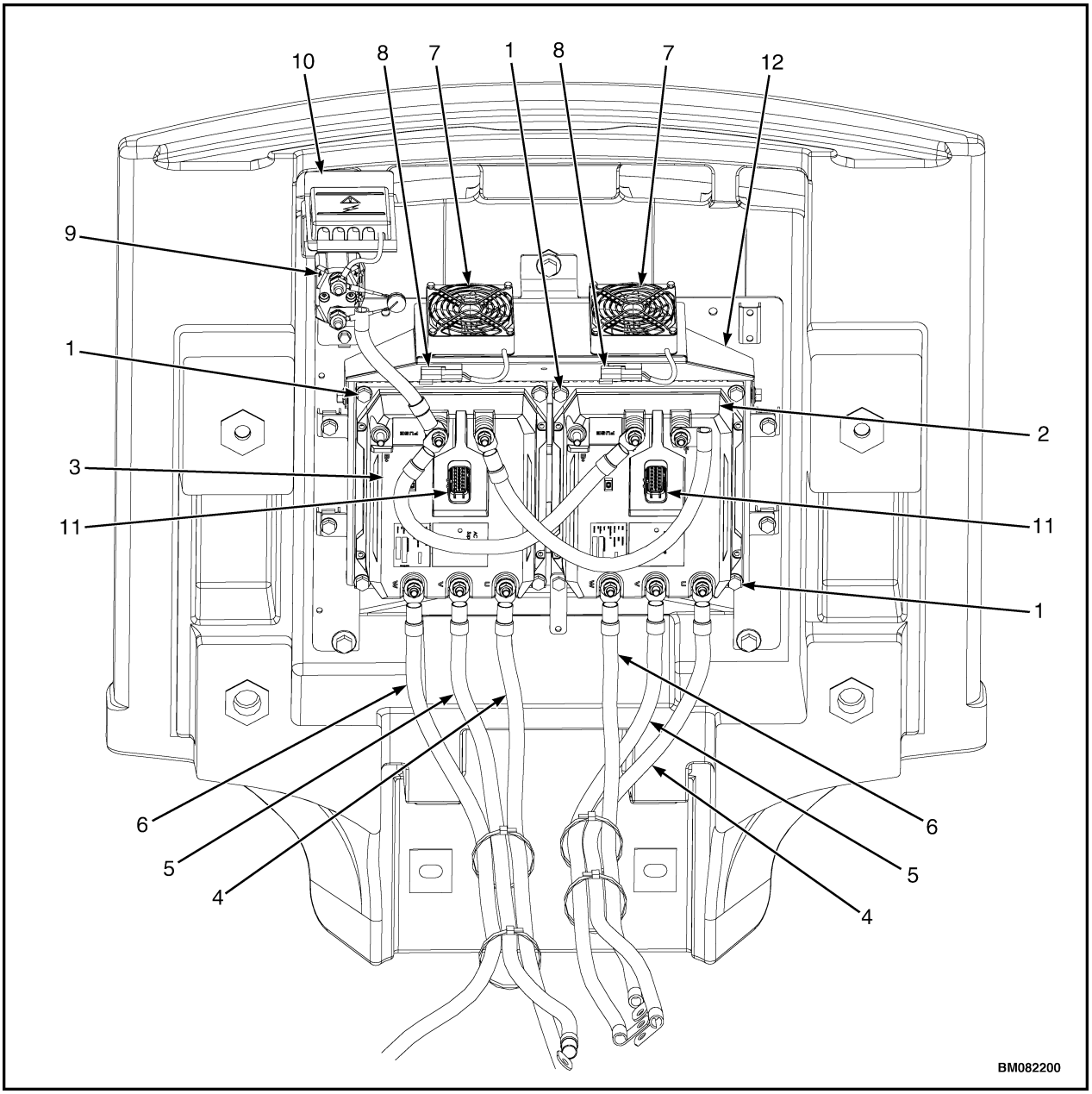
Figure 110. Motor Controllers Replace for Lift Truck Models , Manufactured After November 2014E45-70XN (A268)



NOTE: STANDARD PERFORMANCE MOTOR CONTROLLER PANELS SHOWN. ENHANCED PERFORMANCE MOTOR CONTROLLER PANELS ARE SIMILAR.

1. FLANGE CAPSCREW
2. HYDRAULIC PUMP AND MOTOR CONTROLLER
3. TRACTION MOTOR CONTROLLER
4. POWER CABLE **U**
5. POWER CABLE **V**
6. POWER CABLE **W**
7. FANS
8. FAN CONNECTORS
9. CONTACTOR
10. FUSE COVER
11. CONTROLLER ELECTRICAL CONNECTORS
12. HEATSINK
13. FAN SPACER

Figure 111. Motor Controllers Replace for Lift Truck Models Manufactured Before November 2014E1.6-2.0XN (E30-40XN) (A269)



NOTE: STANDARD PERFORMANCE MOTOR CONTROLLER PANELS SHOWN. ENHANCED PERFORMANCE MOTOR CONTROLLER PANELS ARE SIMILAR.

1. FLANGE CAPSCREW
2. HYDRAULIC PUMP AND MOTOR CONTROLLER
3. TRACTION MOTOR CONTROLLER
4. POWER CABLE **U**
5. POWER CABLE **V**
6. POWER CABLE **W**
7. FANS
8. FAN CONNECTORS
9. CONTACTOR
10. FUSE COVER
11. CONTROLLER ELECTRICAL CONNECTORS
12. FAN AIR DUCT

Figure 112. Motor Controllers Replace for Lift Truck Models Manufactured After November 2014E30-40XN (A269)

Install

NOTE: The information in Step 1 and Step 2 applies to lift truck models E2.2-3.5XN (E45-70XN) (A268) , manufactured before September, 2012, and lift truck models E1.6-2.0XN (E30-40XN) (A269) manufactured before November 2014.

1. Before installing new motor controllers to heatsink, clean motor controllers and heatsink mating surfaces to ensure they are clean and free of any debris or paint. Apply 1.5 mm (0.06 in.) coat of silicon grease (Hyster Part No. 1636646) to baseplate of motor controllers and heatsink mating surface. The silicon grease should cover at least 90% of controller baseplate.

2. Install new motor controllers to heatsink using eight flange capscrews. Tighten flange capscrews to 13.5 to 17.5 N•m (119. to 155 lbf in).

   See Figure 108 for lift truck models

   - E2.2-3.5XN (E45-70XN) (A268) manufactured before September, 2012

   See Figure 111 for lift truck models

   - E1.6-2.0XN (E30-40XN) (A269) manufactured before November 2014

NOTE: The information in Step 3 applies to lift truck models E2.2-3.5XN (E45-70XN) (A268) , manufactured after September, 2012 and lift truck models E45-70XN (A268) and E30-40XN (A269) manufactured after November 2014.

3. Install new motor controllers and heatsink to motor controllers mounting bracket using eight flange capscrews. Tighten flange capscrews to 5.5 to 8.5 N•m (49 to 75 lbf in).

   See Figure 109 for lift truck models

   - E2.2-3.5XN (E45-70XN) (A268) manufactured after September, 2012

   See Figure 110 for lift truck models

   - E45-70XN (A268) manufactured after November 2014

   See Figure 112 for lift truck models

   - E30-40XN (A269) manufactured after November 2014

4. Connect the fans and other electrical connections as noted during removal. Connect power cables at the power terminals of the motor controllers as identified during removal. Tighten power cables to 18 to 21 N•m (159 to 186 lbf in).

5. Install the plate in front of the motor controllers using four capscrews.

6. Install the battery in lift truck. See the **Operating Manual** or service manual

   Periodic Maintenance 8000SRM1364 for lift truck models

   - E2.2-3.5XN (E45-70XN) (A268)

   Periodic Maintenance 8000SRM1442 for lift truck models

   - E1.6-2.0XN (E30-40XN) (A269)

7. Connect the battery.

LIFT TRUCK MODELS J2.2-3.5XN (J45-70XN) (A276) AND J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

Hydraulic Pump and Motor Controller

Remove

1. Read and follow the **WARNING** and **CAUTION** section in the General section above.

2. Remove the battery for access to the hydraulic pump and motor controller. See the **Operating Manual** or service manual below for battery removal procedures.

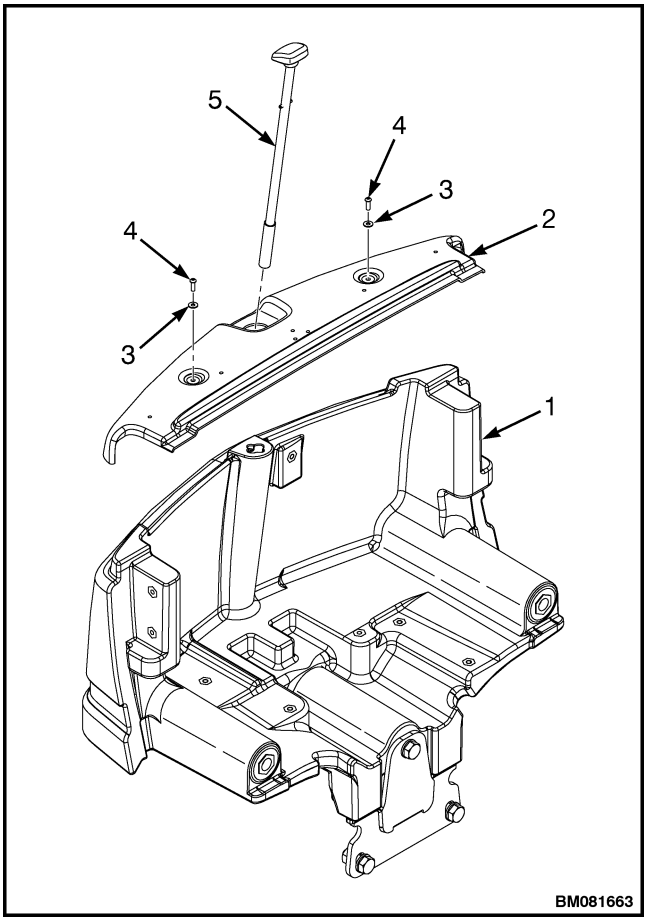
   Periodic Maintenance 8000SRM1372 for lift truck models

   - J2.2-3.5XN (J45-70XN) (A276)

   Periodic Maintenance 8000SRM1541 for lift truck models

   - J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

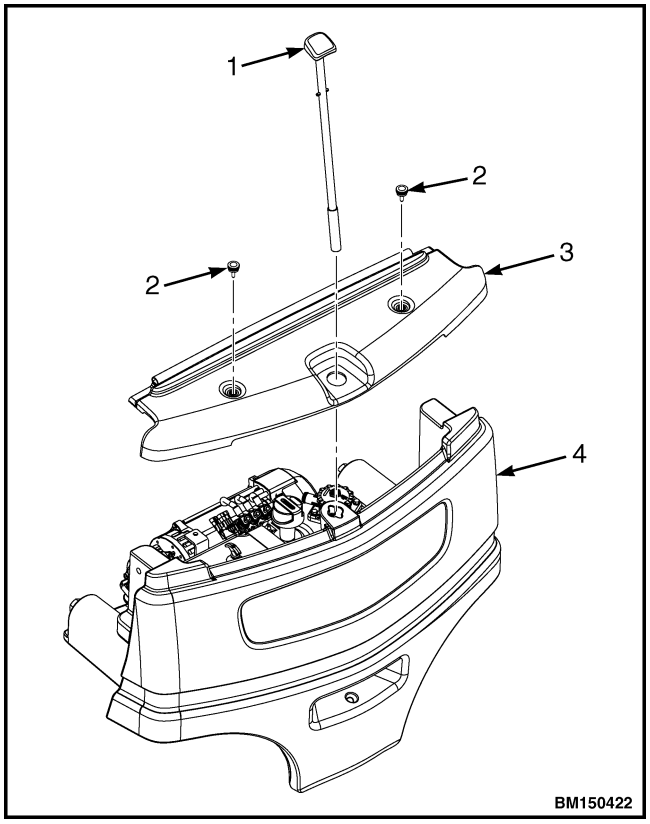
3. Remove the counterweight cover and tow pin for access to the hydraulic pump and motor controller. See Figure 113 or Figure 114.



NOTE: COUNTERWEIGHT FOR LIFT TRUCK MODELS J2.2-3.5XN (J45-70XN) (A276) SHOWN. COUNTERWEIGHT FOR LIFT TRUCK MODELS J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) IS SIMILAR.

1. COUNTERWEIGHT
2. COUNTERWEIGHT COVER
3. WASHER
4. CAPSCREWS
5. TOW PIN

Figure 113. Counterweight Cover Removal



1. TOW PIN
2. KNOB SCREWS
3. COUNTERWEIGHT COVER
4. COUNTERWEIGHT

Figure 114. Counterweight Cover Removal for Lift Truck Model Manufactured After November, 2015J2.2-3.5XN (J45-70XN) (A276)

NOTE: Make sure all power cables and electrical connections are clearly marked before disconnecting them to help aid in reconnecting.

4. Disconnect the power cables and all electrical connections from hydraulic pump and motor controller.

   See Figure 115 for lift truck models

   - J2.2-3.5XN (J45-70XN) (A276) , manufactured before February, 2009

   See Figure 116 for lift truck models

   - J2.2-3.5XN (J45-70XN) (A276) , manufactured after February, 2009

   See Figure 117 for lift truck models

   - J2.2-3.5XN (J45-70XN) (A276) manufactured after November 2014

   See Figure 118 for lift truck models

   - J4.0-5.0XN (J80-100XN) (A970) manufactured before November 2014

   See Figure 119 for lift truck models

   - J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) manufactured after November 2014

5. For lift truck models manufactured before November 2014, remove four flange capscrews from motor controller. Remove motor controller from heatsink and lift truck frame.

   For lift truck models manufactured after November 2014, remove four flange capscrews from motor controller and heatsink. Remove motor controller and heatsink from lift truck frame.

Install

NOTE: Step 1 and Step 2 apply to lift trucks manufactured before November 2014.

1. Before installing new motor controller to heatsink, clean motor controller and heatsink mating surface to ensure it is clean and free of any debris or paint. Apply 1.5 mm (0.06 in.) coat of silicon grease (Hyster Part No. 1636646) to baseplate of motor controller and heatsink mating surface. The silicon grease should cover at least 90% of controller baseplate.

2. Install new hydraulic pump and motor controller onto heatsink with four flange capscrews. Tighten flange capscrews to 13.5 to 17.5 N•m (119 to 155 lbf in).

   See Figure 115 for lift truck models

   - J2.2-3.5XN (J45-70XN) (A276) , manufactured before February, 2009

   See Figure 116 for lift truck models

   - J2.2-3.5XN (J45-70XN) (A276) , manufactured after February, 2009

   See Figure 118 for lift truck models

   - J4.0-5.0XN (J80-100XN) (A970) manufactured before November 2014

NOTE: Step 3 applies to lift trucks manufactured after November 2014

3. Install new motor controller and heatsink to motor controller mounting bracket using four flange capscrews. Tighten flange capscrews to 5.8 to 8.5 N•m (49 to 75 lbf in).

   See Figure 117 for lift truck models

   - J2.2-3.5XN (J45-70XN) (A276) , manufactured after November 2014

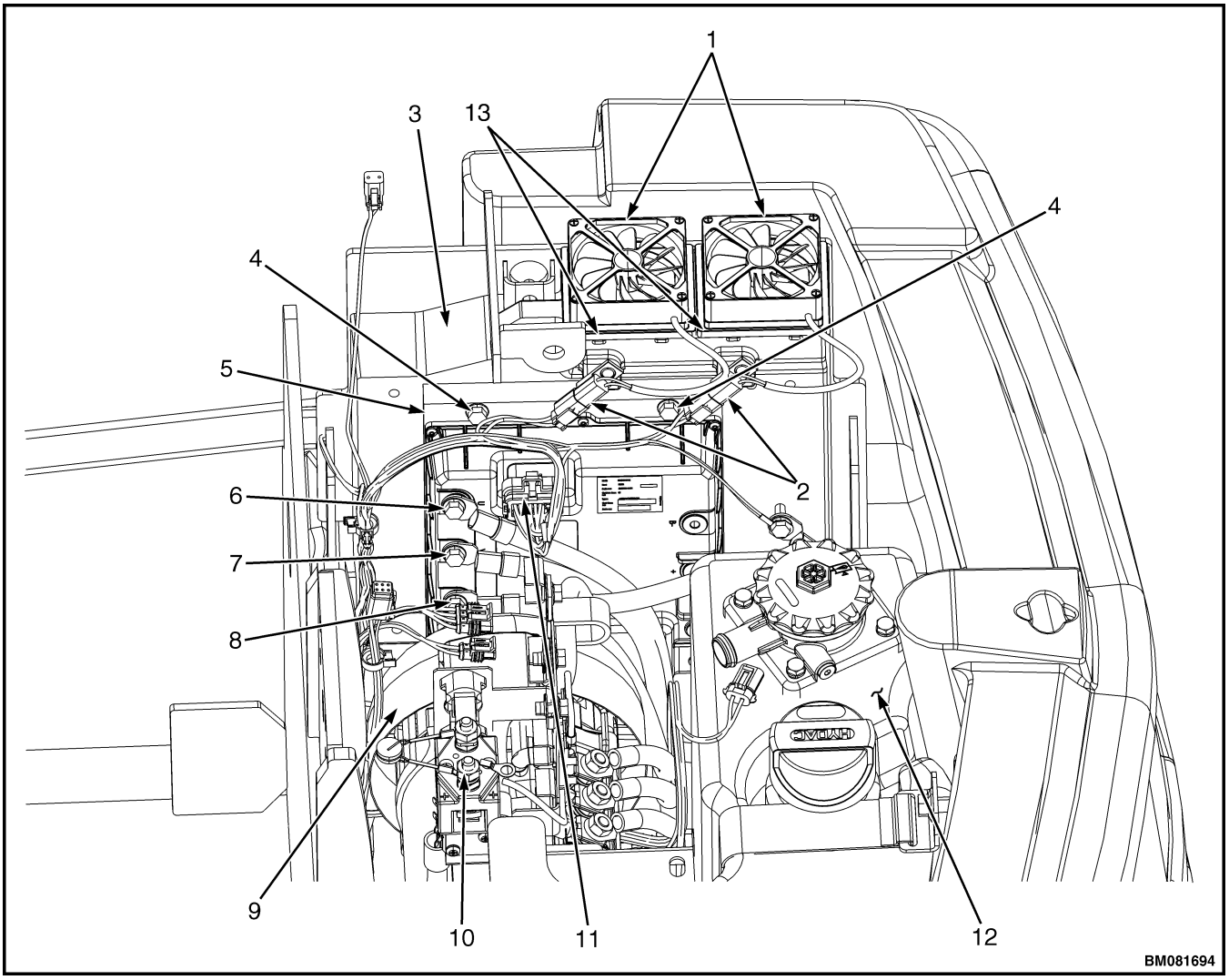
   See Figure 119 for lift truck models

   - J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) manufactured after November 2014

NOTE: Apply dielectric grease to the controller wiring harness connector for lift truck models J2.2-3.5XN (J45-70XN) (A276) , equipped with Outdoor Protection/ Wash-down Package. See Figure 116.

4. Connect the fans and other electrical connections as noted during removal. Connect power cables at the power terminals of the hydraulic pump and motor controller as identified during removal. Tighten power cables to 18 to 21 N•m (159 to 186 lbf in).

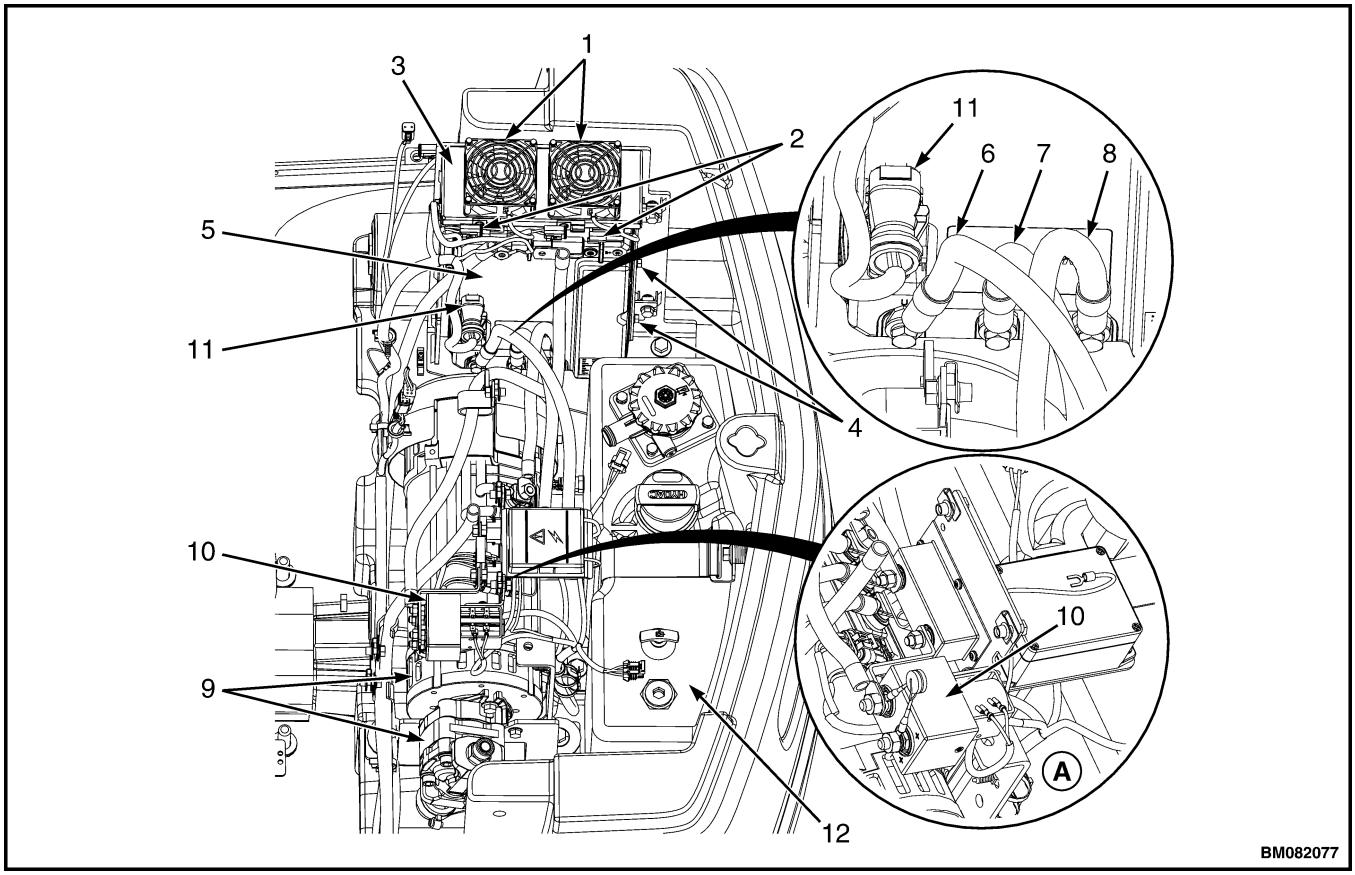
5. For lift truck models J2.2-3.5XN (J45-70XN) (A276) , equipped with Outdoor Protection/ Wash-down Package, spray power cable terminals on controller with rust inhibitor-ignition sealer.



NOTE: STANDARD PERFORMANCE HYDRAULIC PUMP AND MOTOR CONTROLLER PANEL SHOWN. ENHANCED PERFORMANCE HYDRAULIC PUMP AND MOTOR CONTROLLER PANEL IS SIMILAR.

1. FANS
2. FAN CONNECTORS
3. AIR DUCT
4. FLANGE CAPSCREW
5. HYDRAULIC PUMP AND MOTOR CONTROLLER
6. POWER CABLE **U**
7. POWER CABLE **V**
8. POWER CABLE **W**
9. HYDRAULIC PUMP AND MOTOR
10. CONTACTOR
11. CONTROLLER ELECTRICAL CONNECTORS
12. HYDRAULIC TANK
13. FAN SPACER

Figure 115. Hydraulic Pump and Motor Controller Replace, Lift Truck Models , Manufactured Before February, 2009J2.2-3.5XN (J45-70XN) (A276)



NOTE: STANDARD PERFORMANCE HYDRAULIC PUMP AND MOTOR CONTROLLER PANEL SHOWN. ENHANCED PERFORMANCE HYDRAULIC PUMP AND MOTOR CONTROLLER PANEL IS SIMILAR.

A. ELECTRICAL COMPONENTS FOR LIFT TRUCK MODELS J2.2-3.5XN (J45-70XN) (A276) , EQUIPPED WITH OUTDOOR PROTECTION/WASH-DOWN PACKAGE, MANUFACTURED AFTER OCTOBER, 2013

1. FANS
2. FAN CONNECTORS
3. AIR DUCT
4. FLANGE CAPSCREW
5. HYDRAULIC PUMP AND MOTOR CONTROLLER
6. POWER CABLE **U**
7. POWER CABLE **V**
8. POWER CABLE **W**
9. HYDRAULIC PUMP AND MOTOR
10. LINE CONTACTOR
11. CONTROLLER ELECTRICAL CONNECTORS
12. HYDRAULIC TANK

Figure 116. Hydraulic Pump and Motor Controller Replace, Lift Truck Models , Manufactured After February, 2009J2.2-3.5XN (J45-70XN) (A276)

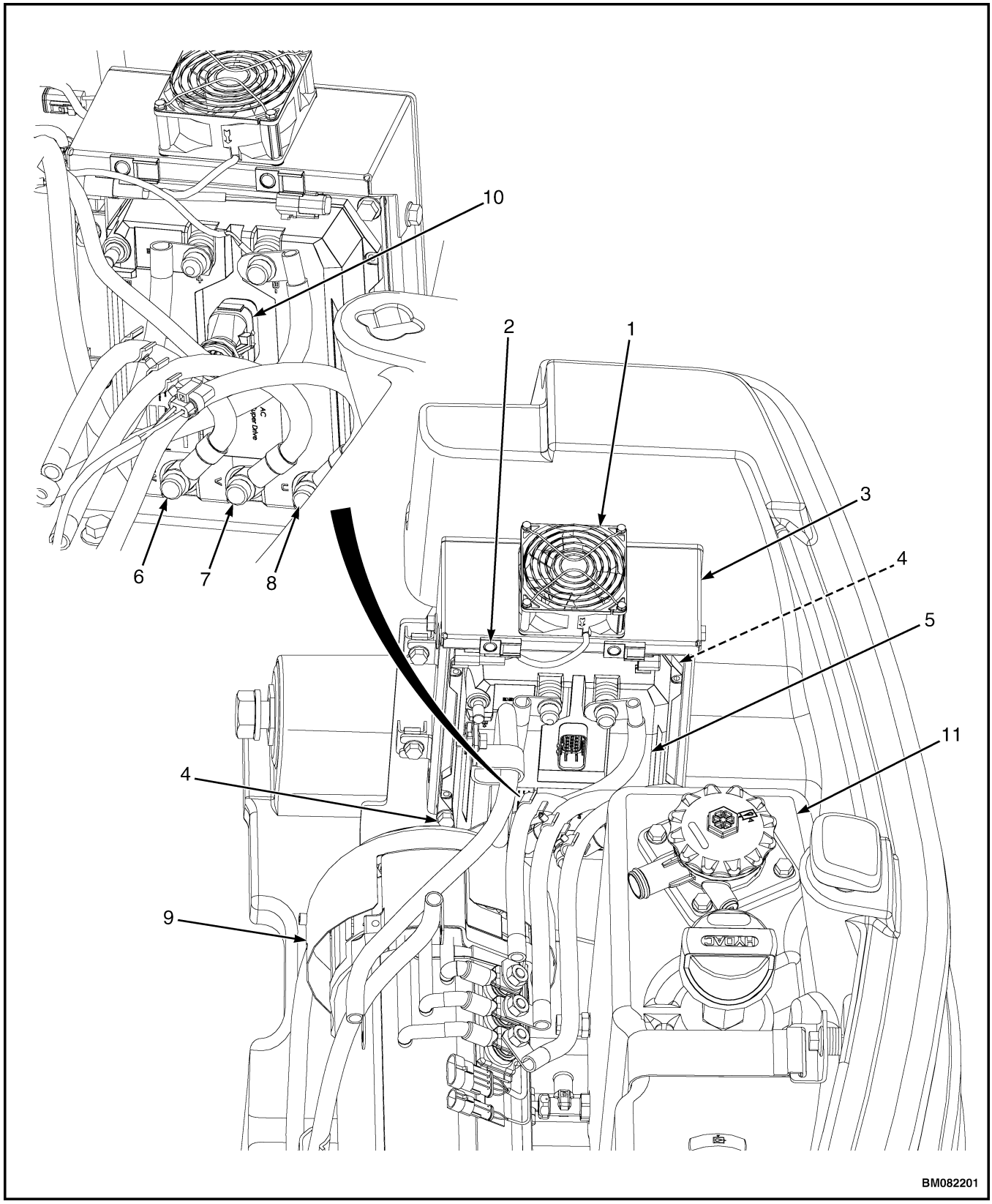
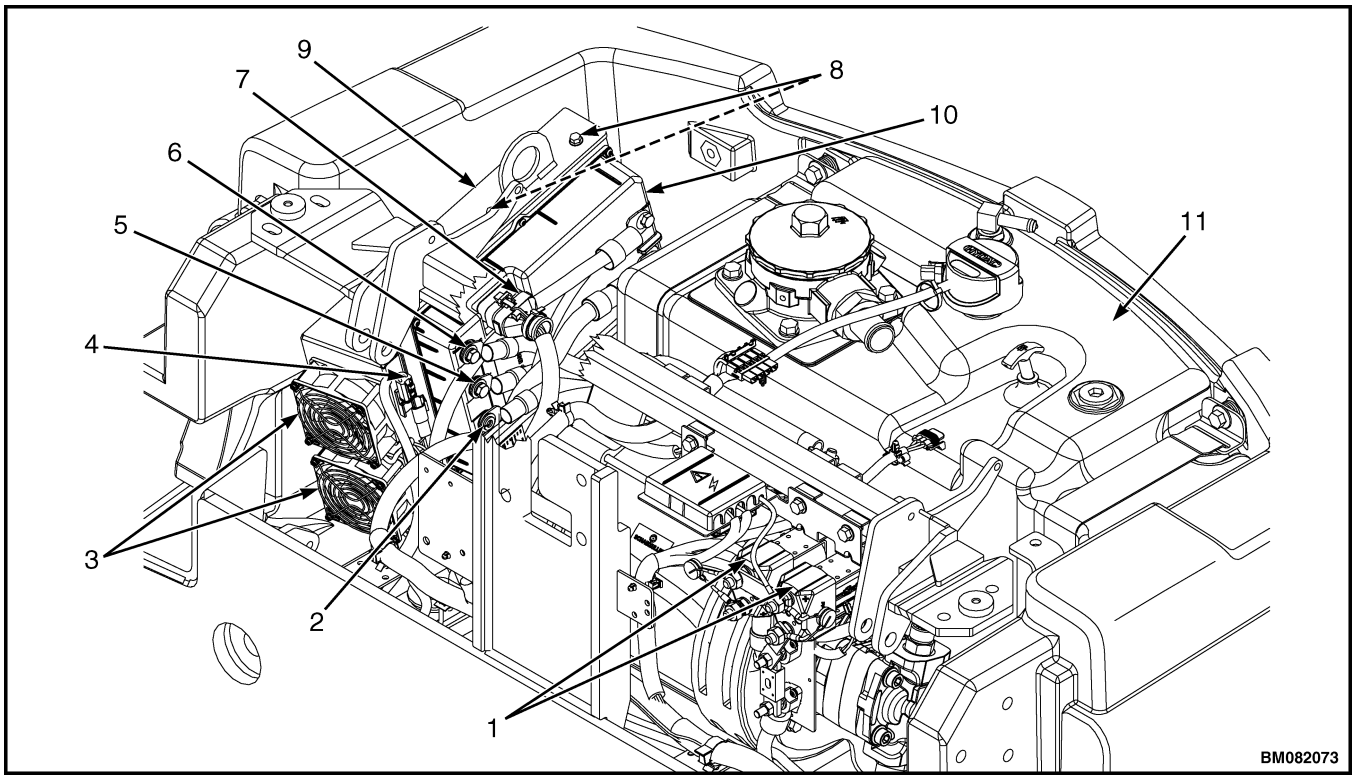


Figure 117. Hydraulic Pump and Motor Controller Replace, Lift Truck Models Manufactured After November 2014J2.2-3.5XN (J45-70XN) (A276)

Legend for Figure 117.

NOTE: STANDARD PERFORMANCE HYDRAULIC PUMP AND MOTOR CONTROLLER PANEL SHOWN. ENHANCED PERFORMANCE HYDRAULIC PUMP AND MOTOR CONTROLLER PANEL IS SIMILAR.

1. FANS
2. FAN CONNECTORS
3. AIR DUCT
4. FLANGE CAPSCREW
5. HYDRAULIC PUMP AND MOTOR CONTROLLER
6. POWER CABLE **W**
7. POWER CABLE **V**
8. POWER CABLE **U**
9. HYDRAULIC PUMP AND MOTOR
10. CONTROLLER ELECTRICAL CONNECTORS
11. HYDRAULIC TANK



NOTE: STANDARD PERFORMANCE HYDRAULIC PUMP AND MOTOR CONTROLLER PANEL SHOWN. ENHANCED PERFORMANCE HYDRAULIC PUMP AND MOTOR CONTROLLER PANEL IS SIMILAR.

1. CONTACTORS
2. POWER CABLE **W**
3. FANS
4. FAN CONNECTOR
5. POWER CABLE **V**
6. POWER CABLE**U**
7. CONTROLLER ELECTRICAL CONNECTORS
8. FLANGE CAPSCREW
9. AIR DUCT
10. HYDRAULIC PUMP AND MOTOR CONTROLLER
11. HYDRAULIC TANK

Figure 118. Hydraulic Pump and Motor Controller Replace, Lift Truck Models Manufactured Before November 2014J4.0-5.0XN (J80-100XN) (A970)

6. Install the battery into the lift truck. See the **Operating Manual** or service manual section below for battery installation procedures.

Periodic Maintenance 8000SRM1372 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276)

Periodic Maintenance 8000SRM1541 for lift truck models

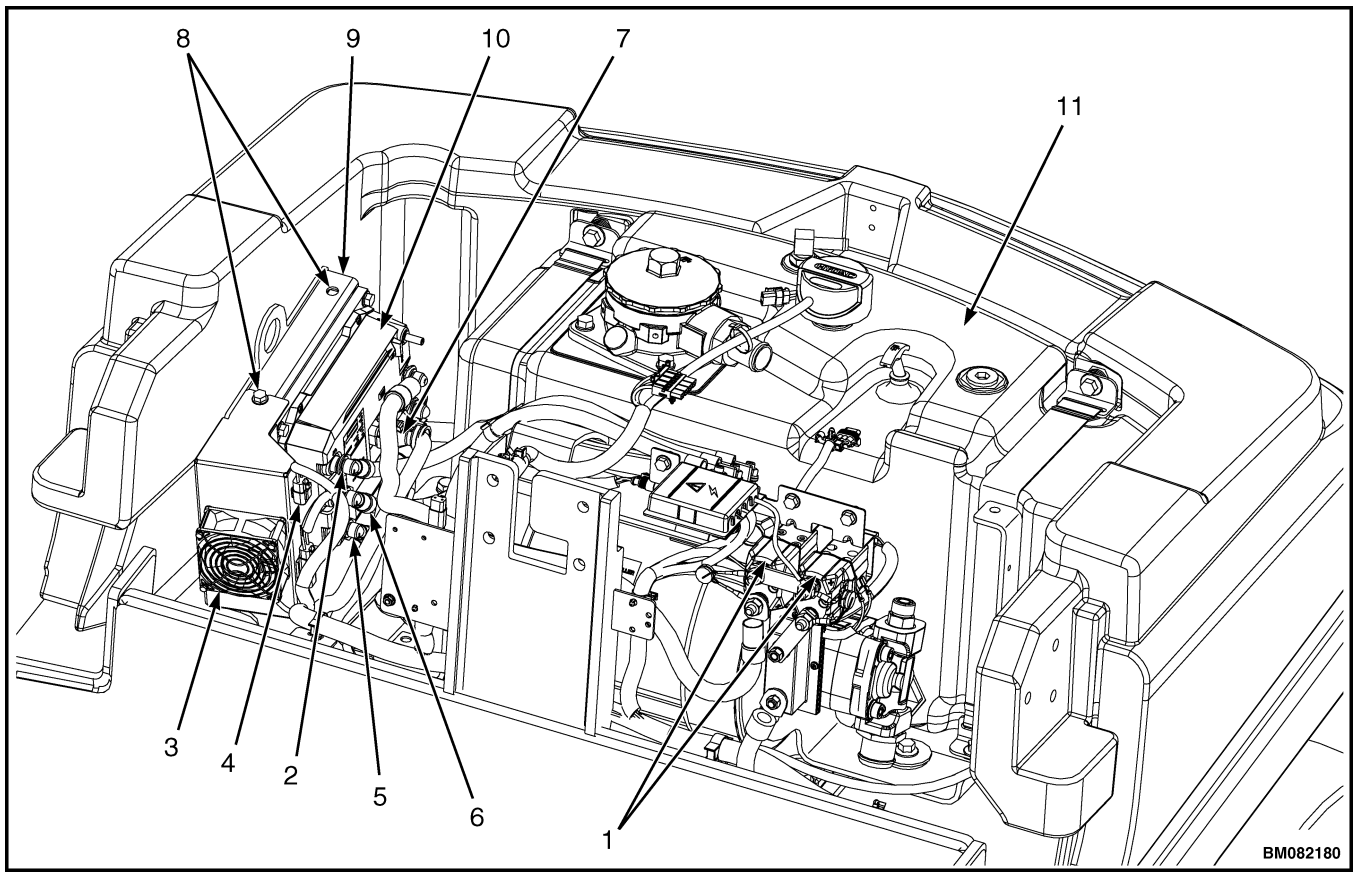
- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

7. Install the tow pin and counterweight cover using two capscrews. See Figure 113 or Figure 114.

8. Connect the battery.

9. For lift truck models J2.2-3.5XN (J45-70XN) (A276) , equipped with Outdoor Protection/ Wash-down package, spray battery connectors terminals with rust inhibitor-ignition sealer, after tightening terminals.

10. After install complete, perform ground test. See **Frame** 0100SRM1342, Ground Test section.



NOTE: STANDARD PERFORMANCE HYDRAULIC PUMP AND MOTOR CONTROLLER PANEL SHOWN. ENHANCED PERFORMANCE HYDRAULIC PUMP AND MOTOR CONTROLLER PANEL IS SIMILAR.

1. CONTACTORS
2. POWER CABLE **W**
3. FANS
4. FAN CONNECTOR
5. POWER CABLE **V**
6. POWER CABLE**U**
7. CONTROLLER ELECTRICAL CONNECTORS
8. FLANGE CAPSCREW
9. AIR DUCT
10. HYDRAULIC PUMP AND MOTOR CONTROLLER
11. HYDRAULIC TANK

Figure 119. Hydraulic Pump and Motor Controller Replace, Lift Truck Models Manufactured After November 2014J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

Traction Motor Controllers

Remove

1. Read and follow the **WARNING** and **CAUTION** section in the General section above.

2. Remove two bolts and belly pan from underside of lift truck.

3. Disconnect motor controller connector from main wiring harness.

4. Remove the floor mat. Remove rear floor plate. Remove capscrews and washers from front floor plate and lift front floor plate up enough to disconnect the accelerator pedal or MONOTROL® pedal. See Figure 120. Remove front floor plate with the accelerator or MONOTROL® pedal still attached.

5. Remove the brake pedal assembly for access to the traction motor controllers.

   See **Transaxle** 1300SRM1370 for lift truck models

   - J2.2-3.5XN (J45-70XN) (A276)

   See **Transaxle** 1300SRM1539 for lift truck models

   - J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

NOTE: Make sure all power cables and electrical connections are clearly marked before disconnecting them to help aid in reconnecting.

6. Disconnect the power cables and all electrical connections from traction motor controllers.

   See Figure 121 for lift truck models

   - J2.2-3.5XN (J45-70XN) (A276) , manufactured before February, 2009

   See Figure 122 for lift trucks models

   - J2.2-3.5XN (J45-70XN) (A276) , manufactured after February, 2009

   See Figure 123 for lift trucks models

   - J2.2-3.5XN (J45-70XN) (A276) , manufactured after November 2014

   See Figure 124 for lift truck models

   - J4.0-5.0XN (J80-100XN) (A970) manufactured before November 2014

   See Figure 125 for lift truck models

   - J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) manufactured after November 2014

7. For lift truck models J2.2-3.5XN (J45-70XN) (A276) manufactured before November 2014 and lift truck models J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) , remove eight flange capscrews securing the traction motor controllers to the air duct and remove traction motor controllers.

8. For lift truck models J2.2-3.5XN (J45-70XN) (A276) manufactured after November 2014, remove eight socket head capscrews and traction motor controller from mounting bracket.

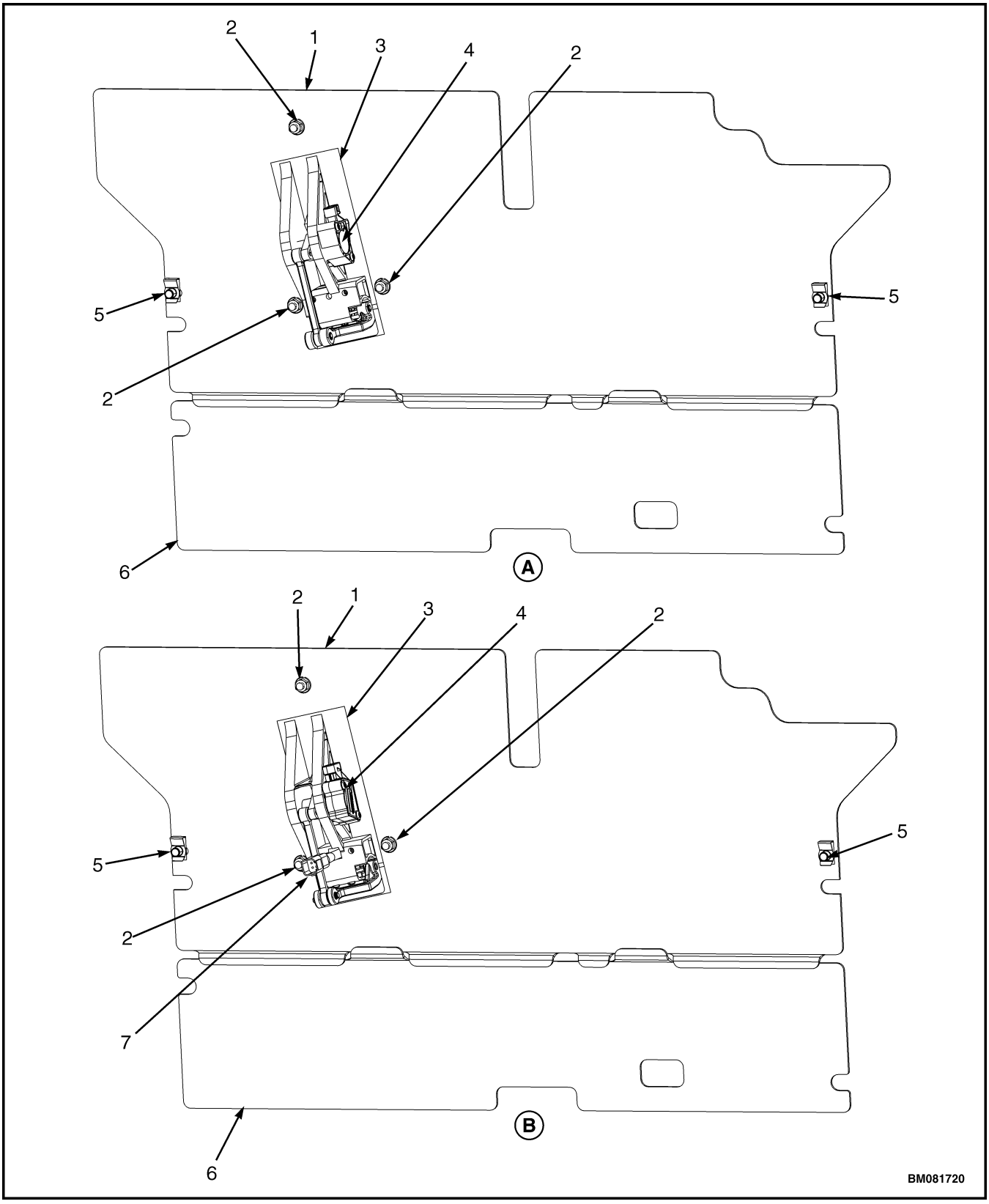


Figure 120. Removing Floor Plate and Accelerator or PedalMONOTROL®

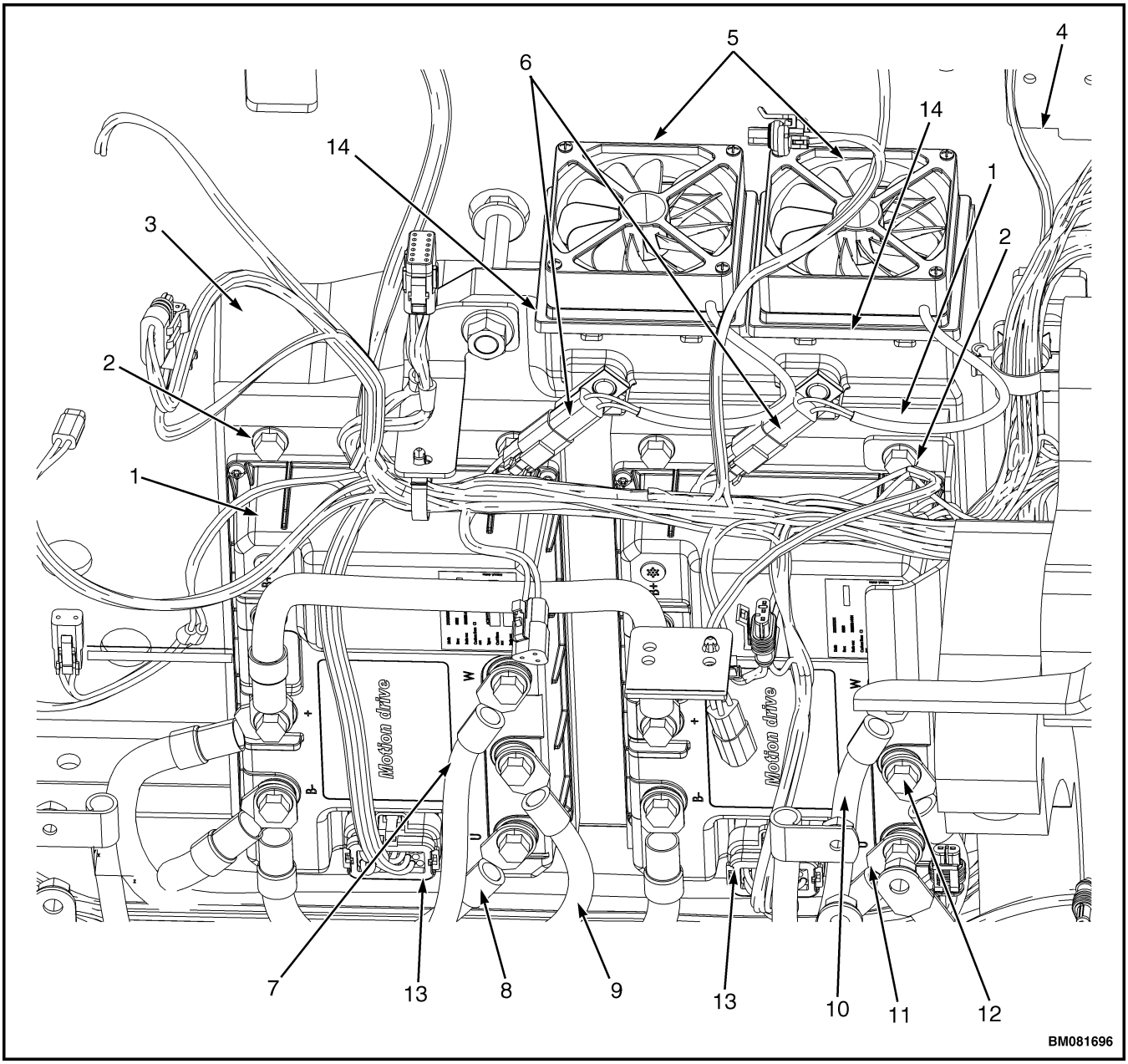
Legend for Figure 120.

A. STANDARD ACCELERATOR PEDAL

1. FRONT FLOOR PLATE
2. CAPSCREW AND NUT (PEDAL BASE)
3. PEDAL BASE
4. ACCELERATOR PEDAL POSITION SENSOR

B. MONOTROL® PEDAL

5. CAPSCREW, WASHER, NUT (FRONT FLOOR PLATE)
6. REAR FLOOR PLATE
7. MONOTROL® PEDAL CONNECTOR



1. TRACTION MOTOR CONTROLLER
2. FLANGE CAPSCREW
3. AIR DUCT
4. FRONT BULKHEAD
5. FAN
6. FAN CONNECTORS
7. RIGHT POWER CABLE **W**
8. RIGHT POWER CABLE **U**
9. RIGHT POWER CABLE **V**
10. LEFT POWER CABLE **W**
11. LEFT POWER CABLE **U**
12. LEFT POWER CABLE **V**
13. TRACTION MOTOR CONTROLLER CONNECTORS TO MAIN WIRE HARNESS
14. FAN SPACER

Figure 121. Traction Motor Controllers, Replace, Lift Truck Models , Manufactured Before February, 2009J2.2-3.5XN (J45-70XN) (A276)

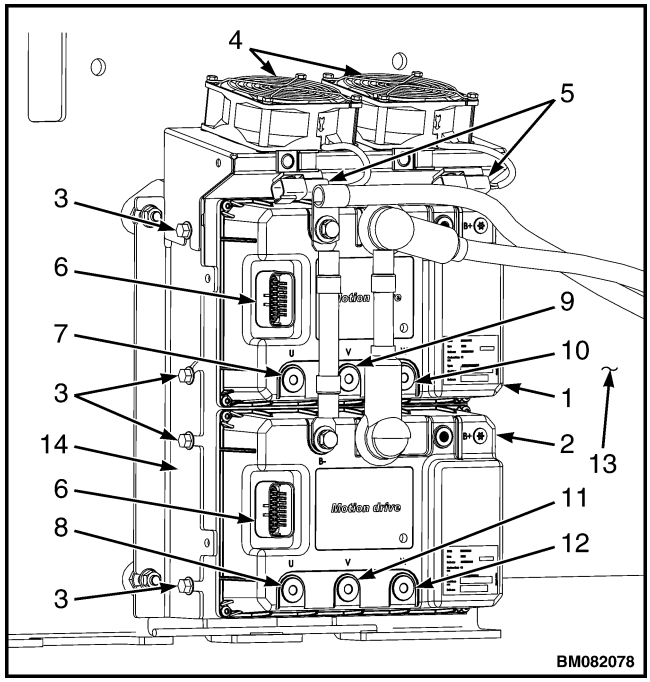
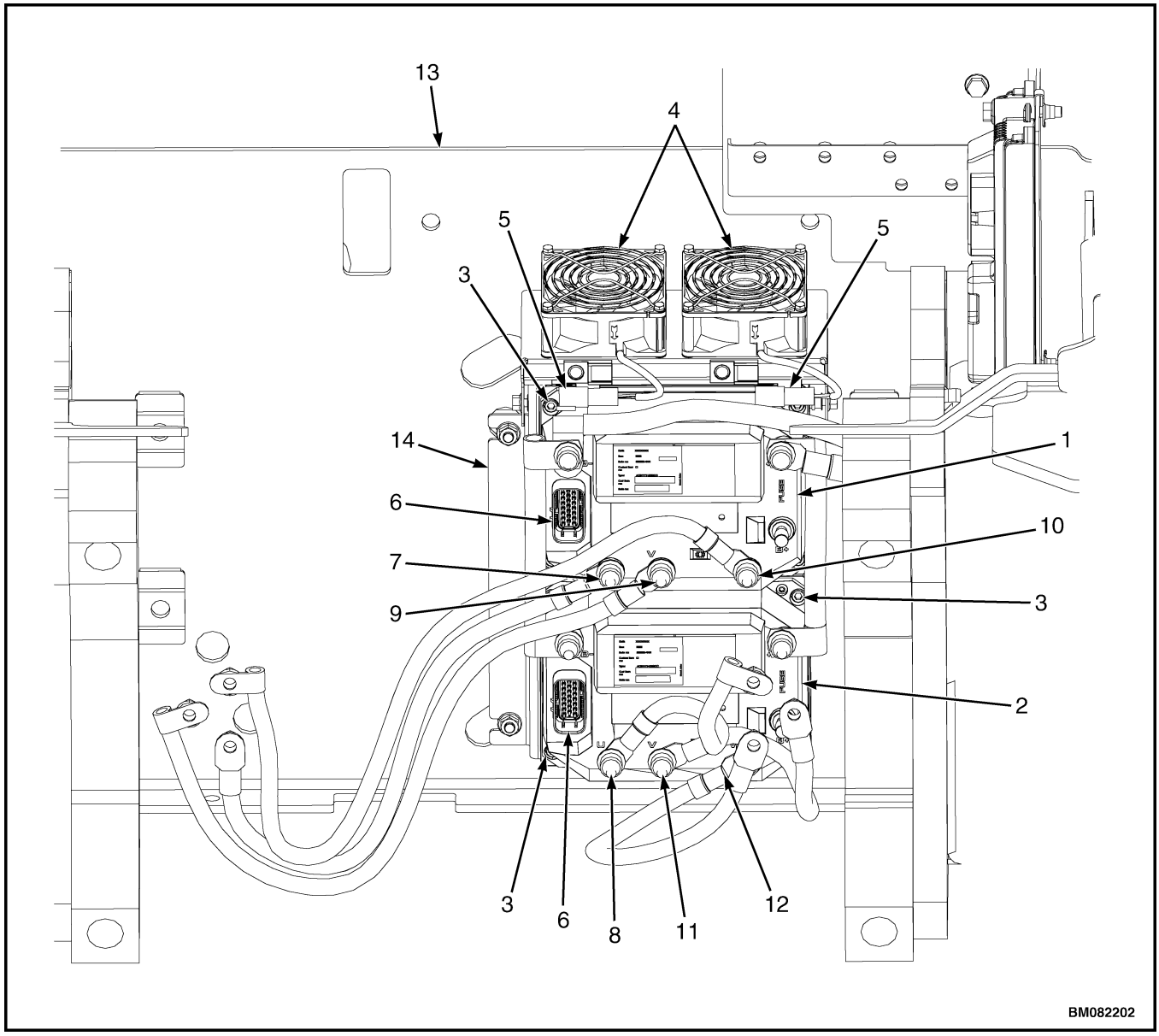


Figure 122. Traction Motor Controllers, Replace, Lift Truck Models , Manufactured After February, 2009J2.2-3.5XN (J45-70XN) (A276)

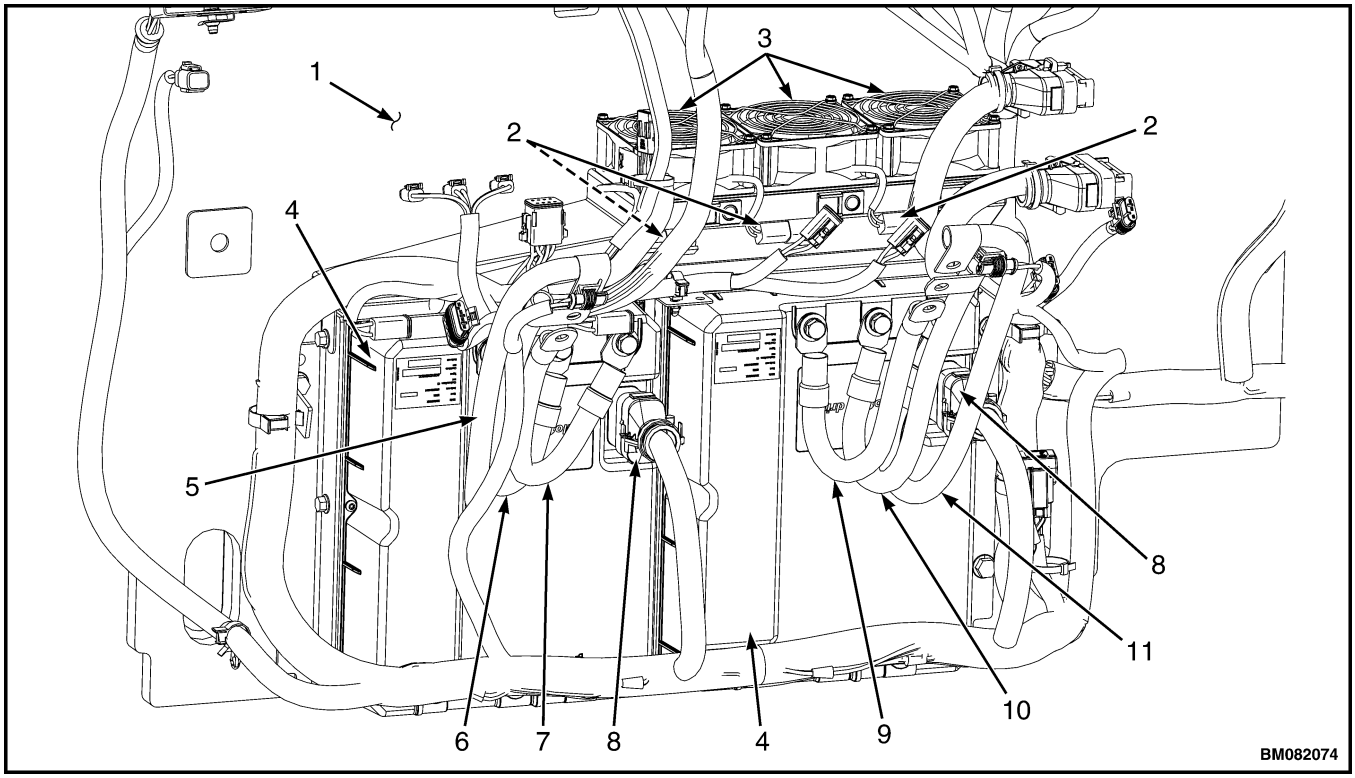
Legend for Figure 122.

1. RIGHT TRACTION MOTOR CONTROLLER
2. LEFT TRACTION MOTOR CONTROLLER
3. FLANGE CAPSCREW
4. FANS
5. FAN CONNECTIONS
6. TRACTION MOTOR CONTROLLER CONNECTORS TO MAIN WIRE HARNESS
7. RIGHT POWER CABLE **U** TERMINAL
8. LEFT POWER CABLE **U** TERMINAL
9. RIGHT POWER CABLE **V** TERMINAL
10. RIGHT POWER CABLE **W** TERMINAL
11. LEFT POWER CABLE **V** TERMINAL
12. LEFT POWER CABLE **W** TERMINAL
13. FRONT BULKHEAD



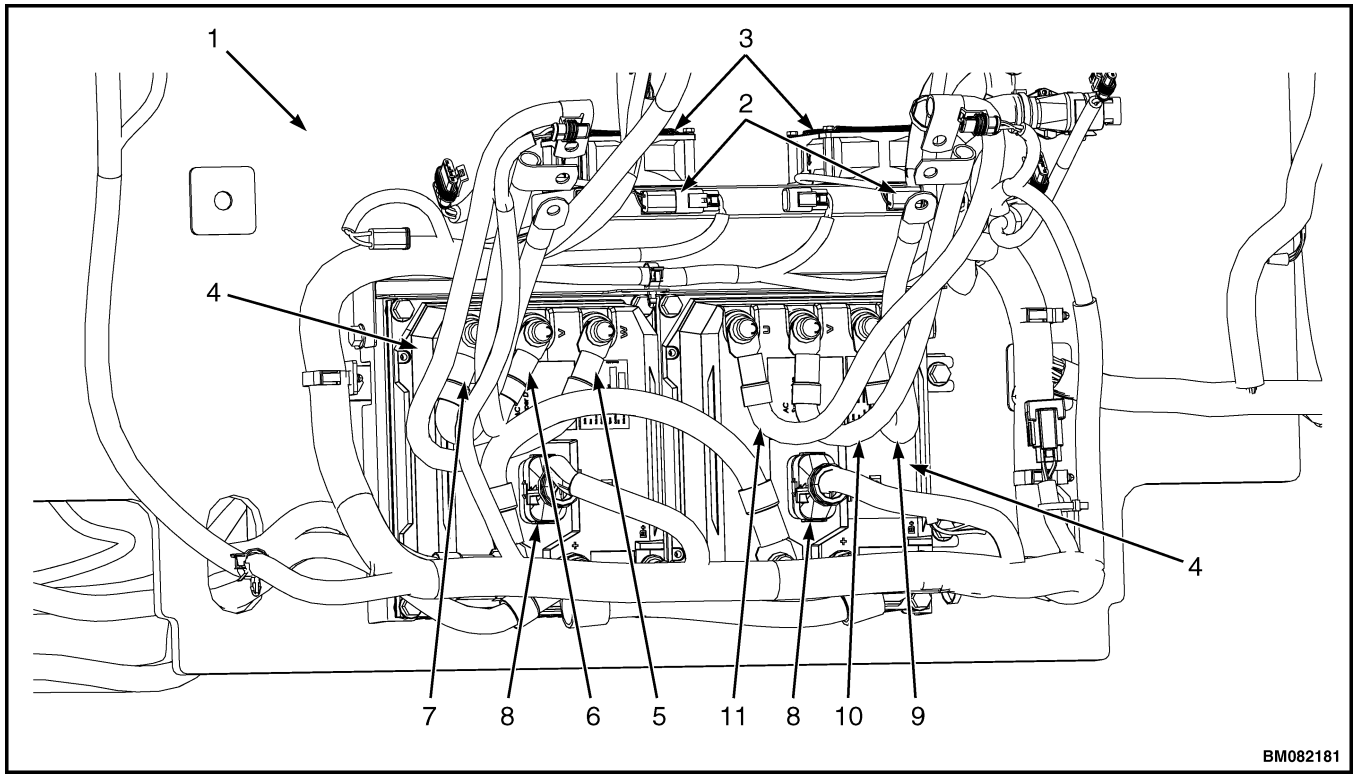
1. RIGHT TRACTION MOTOR CONTROLLER
2. LEFT TRACTION MOTOR CONTROLLER
3. SOCKET HEAD CAPSCREW
4. FANS
5. FAN CONNECTIONS
6. TRACTION MOTOR CONTROLLER CONNECTORS TO MAIN WIRE HARNESS
7. RIGHT POWER CABLE **U** TERMINAL
8. LEFT POWER CABLE **U** TERMINAL
9. RIGHT POWER CABLE **V** TERMINAL
10. RIGHT POWER CABLE **W** TERMINAL
11. LEFT POWER CABLE **V** TERMINAL
12. LEFT POWER CABLE **W** TERMINAL
13. FRONT BULKHEAD
14. MOUNTING BRACKET

Figure 123. Traction Motor Controllers, Replace, Lift Truck Models , Manufactured After November 2014J2.2-3.5XN (J45-70XN) (A276)



1. FRONT BULKHEAD
2. FAN CONNECTORS
3. FAN
4. TRACTION MOTOR CONTROLLER
5. RIGHT POWER CABLE **W**
6. RIGHT POWER CABLE **V**
7. RIGHT POWER CABLE **U**
8. TRACTION MOTOR CONTROLLER CONNECTORS TO MAIN WIRE HARNESS
9. LEFT POWER CABLE **W**
10. LEFT POWER CABLE **V**
11. LEFT POWER CABLE **U**

Figure 124. Traction Motor Controller, Replace, Manufactured Before November 2014J4.0-5.0XN (J80-100XN) (A970)



1. FRONT BULKHEAD
2. FAN CONNECTORS
3. FAN
4. TRACTION MOTOR CONTROLLER
5. RIGHT POWER CABLE **W**
6. RIGHT POWER CABLE **V**
7. RIGHT POWER CABLE **U**
8. TRACTION MOTOR CONTROLLER CONNECTORS TO MAIN WIRE HARNESS
9. LEFT POWER CABLE **W**
10. LEFT POWER CABLE **V**
11. LEFT POWER CABLE **U**

Figure 125. Traction Motor Controller, Replace, Manufactured After November 2014J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

Install

1. Before installing new motor controllers to heatsink, clean motor controllers and heatsink mating surface to ensure they are clean and free of any debris or paint.

2. For lift truck models J2.2-3.5XN (J45-70XN) (A276) manufactured before November 2014 and lift truck models J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) , install new traction motor controllers into air duct using eight flange capscrews.

For lift truck models J2.2-3.5XN (J45-70XN) (A276) manufactured after November 2014, install new traction motor controllers onto mounting bracket using eight socket head capscrews.

NOTE: Apply dielectric grease to the controller wiring harness connector for lift truck models J2.2-3.5XN (J45-70XN) (A276) , equipped with Outdoor Protection/ Wash-down Package.

3. Connect the fans and other electrical connections as noted during removal. Connect power cables at the power terminals of the traction motor controllers as identified during removal. Tighten power cables to 18 to 21 N•m (159 to 186 lbf in).

4. For lift truck models J2.2-3.5XN (J45-70XN) (A276) , equipped with Outdoor Protection/ Wash-down Package, spray power cable terminals on controller with rust inhibitor-ignition sealer.

5. Install the brake pedal assembly. For installation procedure

   See **Transaxle** 1300SRM1370 for lift truck models

   - J2.2-3.5XN (J45-70XN) (A276)

   See **Transaxle** 1300SRM1539 for lift truck models

   - J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

6. Connect the accelerator pedal or MONOTROL® pedal, (see Figure 120) and install the front floor plate using capscrews and washers. Install rear floor plate.

7. Connect motor controller connector to main wiring harness.

8. Install belly pan and two bolts onto underside of lift truck.

9. Connect the battery.

10. For lift truck models J2.2-3.5XN (J45-70XN) (A276) , equipped with Outdoor Protection/ Wash-down Package, spray battery connector terminals with rust inhibitor-ignition sealer, after tightening terminals.

11. After install complete, perform ground test. See **Frame** 0100SRM1342, Ground Test section.

LIFT TRUCK MODEL E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

Traction Motor and Hydraulic Pump and Motor Controllers

Remove

1. Read and follow the **WARNING** and **CAUTION** section in the General section above.

2. Remove the battery for access to the motor controllers. See the **Operating Manual** or service manual **Periodic Maintenance** 8000SRM1577.

NOTE: Make sure all power cables and electrical connections are clearly marked before disconnecting them to help in reconnecting.

3. Disconnect the power cables and all electrical connections from the motor controllers. See Figure 126.

   See Figure 126 for lift truck models

   - E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099) manufactured before November 2014

   See Figure 127 for lift truck models

   - E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099) manufactured after November 2014

NOTE: Step 4 through Step 6 apply to lift truck models manufactured before November 2014.

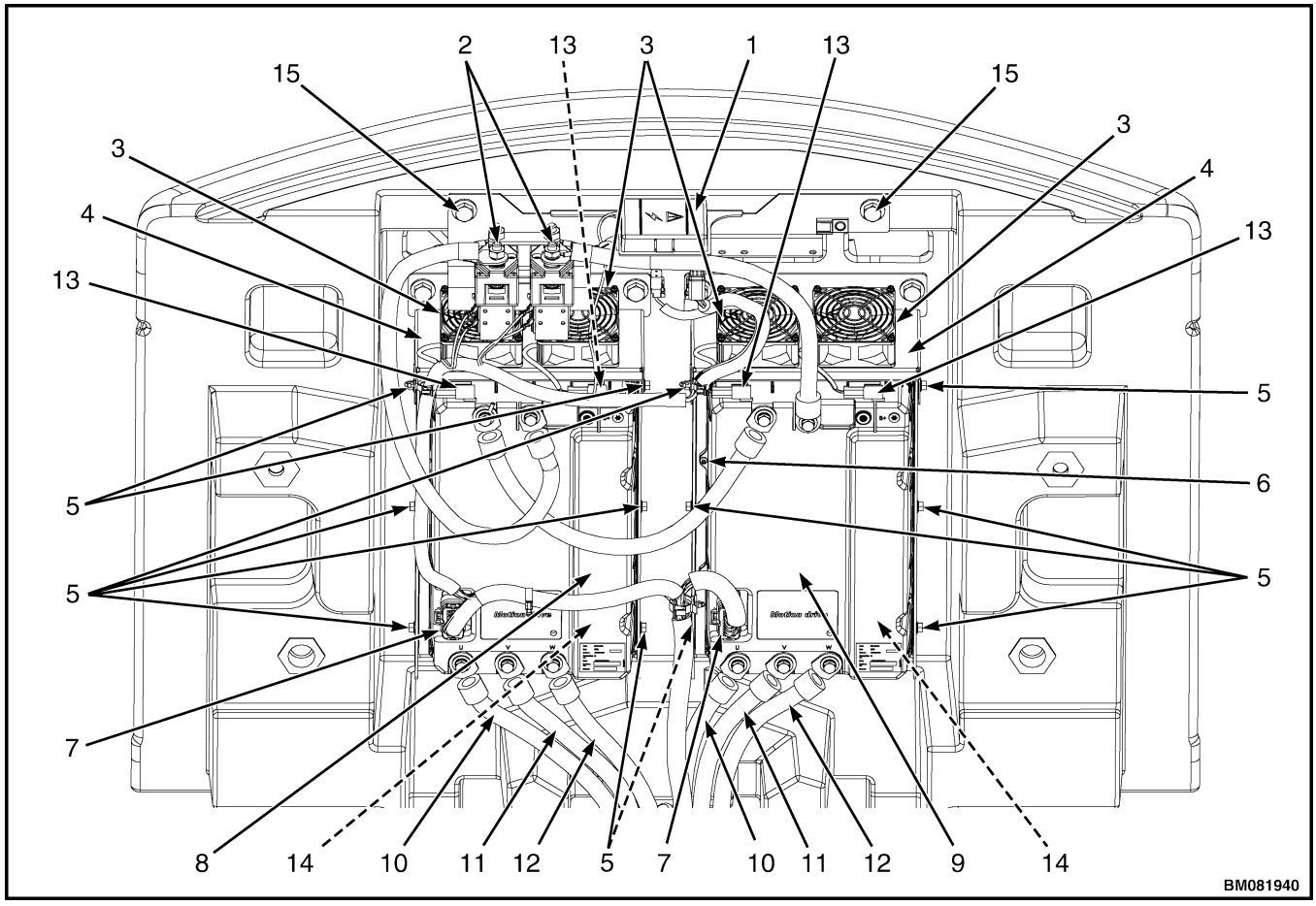
4. Remove 12 flange capscrews from motor controllers. See Figure 126.

5. Remove motor controllers and heatsink from air duct as an assembly. See Figure 126.

6. Remove 16 screws securing motor controllers to heatsink. See Figure 126.

NOTE: Step 7 applies to lift trucks manufactured after November 2014.

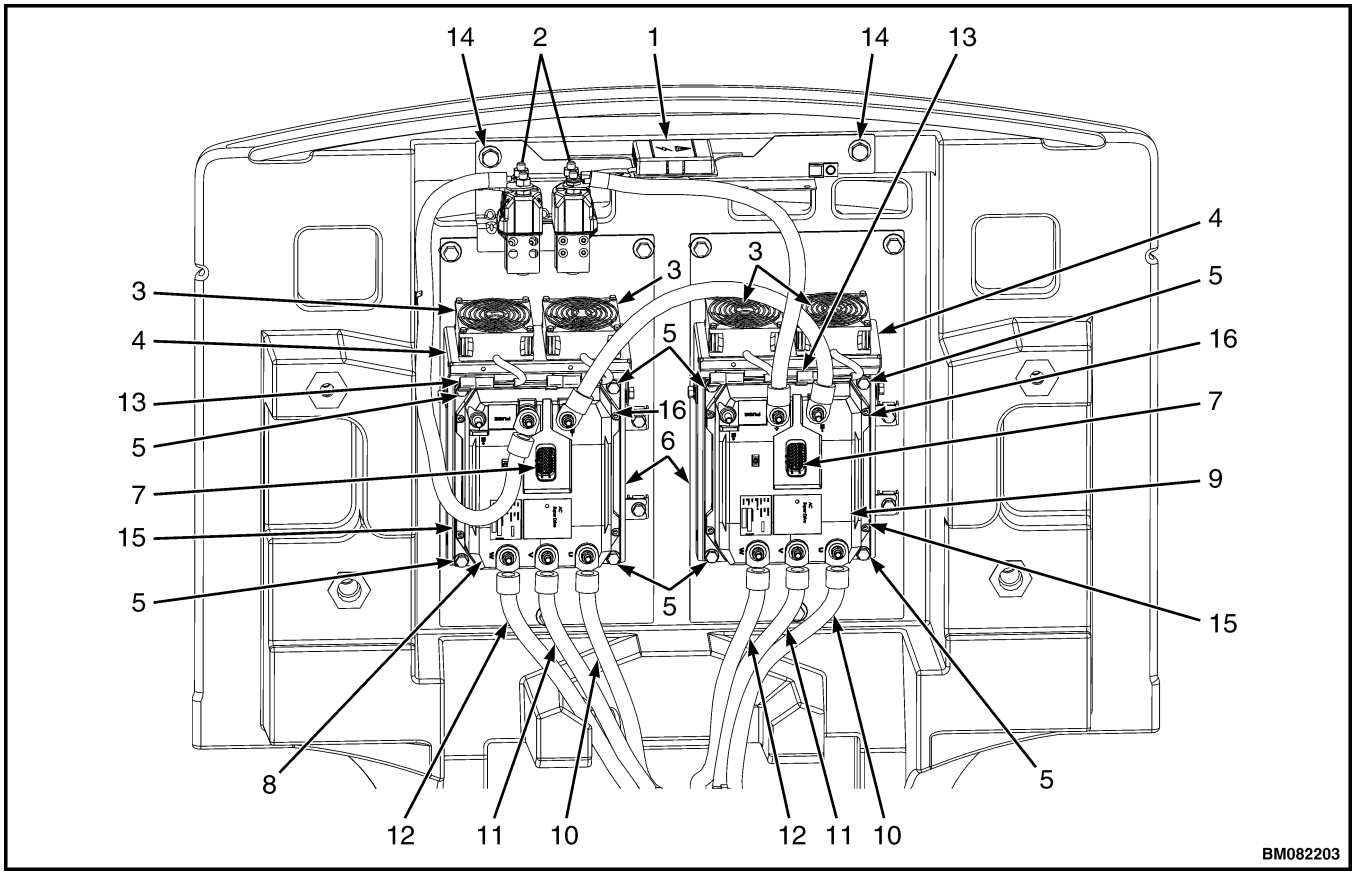
7. Remove eight flange capscrews from motor controllers. Remove motor controllers from mounting bracket. See Figure 127.



NOTE: STANDARD PERFORMANCE MOTOR CONTROLLER PANELS SHOWN. ENHANCED PERFORMANCE MOTOR CONTROLLER PANELS ARE SIMILAR.

1. FUSE COVER
2. CONTACTOR
3. FAN
4. AIR DUCT
5. FLANGE CAPSCREW
6. SCREW
7. CONTROLLER ELECTRICAL CONNECTORS
8. TRACTION MOTOR CONTROLLER
9. HYDRAULIC PUMP AND MOTOR CONTROLLER
10. POWER CABLE **U**
11. POWER CABLE **V**
12. POWER CABLE **W**
13. FAN CONNECTORS
14. HEATSINK
15. LINE CONTACTOR MOUNTING BRACKET CAPSCREW

Figure 126. Motor Controllers Replace for Lift Truck Model Manufactured Before November 2014E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)



NOTE: STANDARD PERFORMANCE MOTOR CONTROLLER PANELS SHOWN. ENHANCED PERFORMANCE MOTOR CONTROLLER PANELS ARE SIMILAR.

1. FUSE COVER
2. CONTACTOR
3. FAN
4. AIR DUCT
5. FLANGE CAPSCREW
6. MOUNTING BRACKET
7. CONTROLLER ELECTRICAL CONNECTORS
8. TRACTION MOTOR CONTROLLER
9. HYDRAULIC PUMP AND MOTOR CONTROLLER
10. POWER CABLE **U**
11. POWER CABLE **V**
12. POWER CABLE **W**
13. FAN CONNECTORS
14. LINE CONTACTOR MOUNTING BRACKET CAPSCREW
15. SOCKET HEAD CAPSCREWS

Figure 127. Motor Controllers Replace for Lift Truck Model Manufactured After November 2014E80-120XN, E100XNS (A099)

Install

NOTE: Step 1 through Step 4 apply to lift trucks manufactured before November 2014.

1. Before installing new motor controllers to heatsink, clean motor controllers and heatsink mating surfaces to ensure they are clean and free of any debris or paint. Apply 1.5 mm (0.06 in.) coat of silicon grease (Hyster Part No. 1636646) to baseplate of motor controllers and heatsink mating surface. The silicon grease should cover at least 90% of controller baseplate.

2. Install 16 screws into motor controller and heatsink. See Figure 126.

3. Install motor controller and heat sink in air duct.

4. Install 12 flange capscrews and tighten to 9 to 11 N•m (80 to 97 lbf in).

NOTE: Step 5 applies to lift trucks manufactured after November 2014.

5. Install motor controllers to mounting brackets using eight flange capscrews and tighten to 9 to 11 N•m (80 to 97 lbf in). See Figure 127.

6. Connect the fans and other electrical connections as noted during removal. Connect power cables at the power terminals of the motor controllers as identified during removal. Tighten power cables to 18 to 21 N•m (159 to 186 lbf in).

7. Install the battery in lift truck. See the **Operating Manual** or service manual **Periodic Maintenance** 8000SRM1577.

8. Connect the battery.

LINE CONTACTOR

NOTE: The procedures to replace the line contactor are the same for all lift truck models covered in this repair manual. The line contactor is located on the right side of the counterweight, just above the traction motor controller for lift truck models E2.2-3.5XN (E45-70XN) (A268), E1.6-2.0XN (E30-40XN) (A269), and E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099) .

See Figure 95 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268) manufactured before September, 2012.

See Figure 96 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268) manufactured after September, 2012.

See Figure 97 for lift truck models

- E45-70XN (A268) manufactured after November 2014.

See Figure 104 for lift truck models

- E1.6-2.0XN (E30-40XN) (A269) manufactured before November 2014.

See Figure 105 for lift truck models

- E30-40XN (A269) manufactured after November 2014.

See Figure 106 for lift truck model

- E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099) manufactured before November 2014.

See Figure 107 for lift truck model

- E80-120XN, E100XNS (A099) manufactured after November 2014.

The line contactor is located just above the hydraulic pump and motor for lift truck models J2.2-3.5XN (J45-70XN) (A276) and J4.0-5.0XN (J80-100XN) (A970) .

For lift truck model J2.2-3.5XN (J45-70XN) (A276) , equipped with Outdoor Protection/Wash-down Package, the line contactor is enclosed and power fuse is shrouded.

See Figure 98 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276) manufactured before February, 2009

See Figure 99 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276) manufactured after February, 2009

See Figure 100 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276) manufactured after November 2015

See Figure 101 for lift truck model

- J2.2-3.5XN (J45-70XN) (A276) manufactured after November 2014

See Figure 102 for lift truck models

- J4.0-5.0XN (J80-100XN) (A970) manufactured before November 2014

See Figure 103 for lift truck models

- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) manufactured after November 2014

Remove

1. Read and follow the **WARNING** and **CAUTION** section in the General section above.

2. Remove the counterweight cover for access to the line contactor.

   See Figure 128 for lift truck models

   - E2.2-3.5XN (E45-70XN) (A268)
   - E1.6-2.0XN (E30-40XN) (A269)
   - E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

   See Figure 113 or Figure 114 for lift truck models

   - J2.2-3.5XN (J45-70XN) (A276)
   - J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

NOTE: Tag or mark line contactor wire connections before disconnecting them to aid in reconnecting during installation.

3. Disconnect all wires from line contactor.

   See Figure 129 for lift truck models

   - E2.2-3.5XN (E45-70XN) (A268) manufactured before September, 2012
   - E1.6-2.0XN (E30-40XN) (A269) manufactured before November 2014

   See Figure 130 for lift truck models

   - E30-40XN (A269) manufactured after November 2014

   See Figure 131 for lift truck models

   - E2.2-3.5XN (E45-70XN) (A268) manufactured after September, 2012

   See Figure 132 for lift truck models

   - E45-70XN (A268) manufactured after November 2014

   See Figure 133 for lift truck models

   - J2.2-3.5XN (J45-70XN) (A276) manufactured before November 2014

   See Figure 134 for lift truck models

   - J2.2-3.5XN (J45-70XN) (A276) manufactured after November 2014

   See Figure 135 for lift truck models

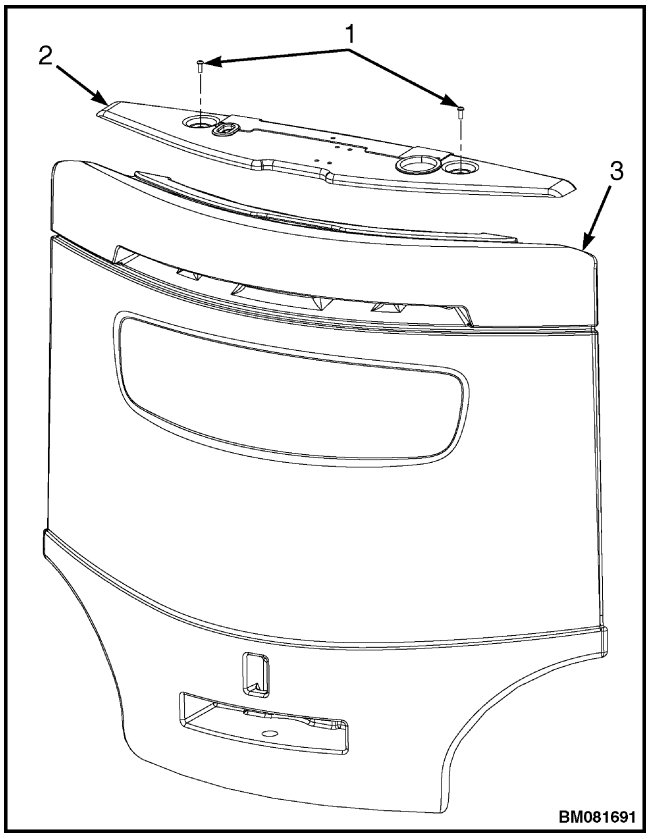
   - J2.2-3.5XN (J45-70XN) (A276) , equipped with Outdoor Protection/Wash-down Package, manufactured after October, 2013

   See Figure 136 for lift truck models

   - J4.0-5.0XN (J80-100XN) (A970) manufactured before November 2014

   See Figure 137 for lift truck models

   - J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) manufactured after November 2014



1. CAPSCREWS
2. COUNTERWEIGHT COVER
3. COUNTERWEIGHT

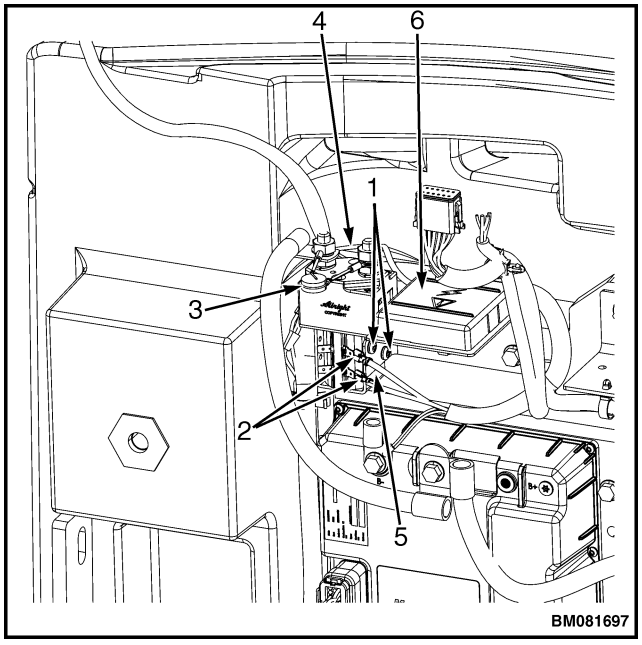
Figure 128. Counterweight Cover Removal, Lift Truck Models and E2.2-3.5XN (E45-70XN) (A268), E1.6-2.0XN (E30-40XN) (A269), E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

See Figure 138 for lift truck model

- E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099) manufactured before November 2014

See Figure 139 for lift truck model

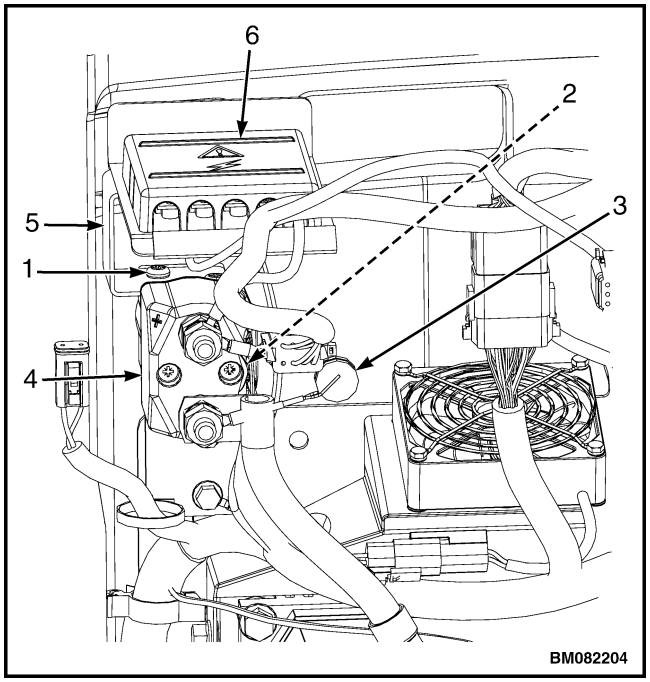
- E80-120XN, E100XNS (A099) manufactured after November 2014



NOTE: SEVERAL ELECTRICAL COMPONENTS AND CONNECTIONS OMITTED FOR CLARITY.

1. CAPSCREW
2. MAIN WIRE HARNESS CONNECTIONS
3. PTC THERMISTOR ASSEMBLY
4. LINE CONTACTOR
5. MOUNTING BRACKET
6. FUSE COVER

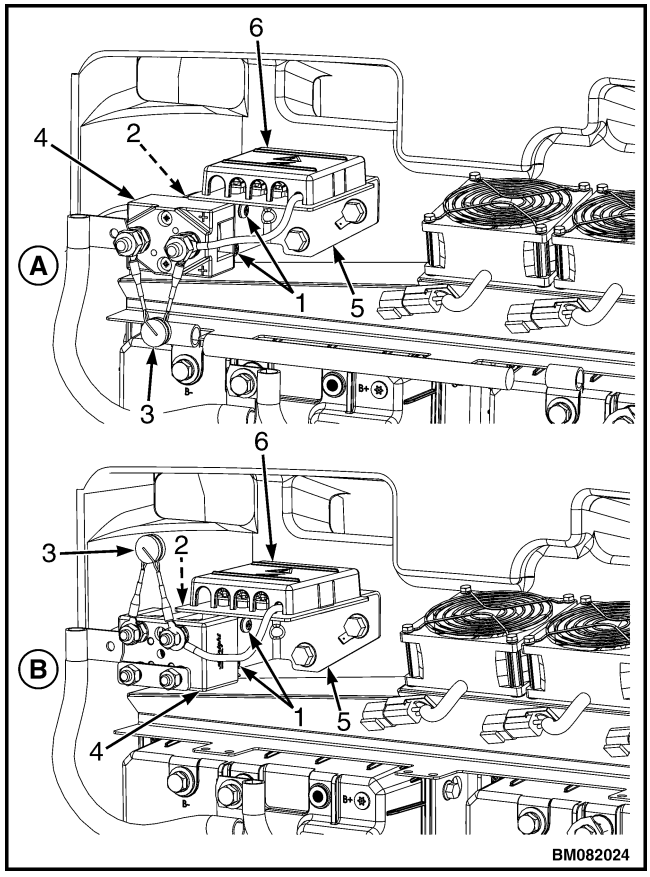
Figure 129. Line Contactor Replacement, Lift Truck Models and E2.2-3.5XN (E45-70XN) (A268) Manufactured Before September, 2012 E1.6-2.0XN (E30-40XN) (A269) Manufactured Before November 2014



NOTE: SEVERAL ELECTRICAL COMPONENTS AND CONNECTIONS OMITTED FOR CLARITY.

1. CAPSCREW
2. MAIN WIRE HARNESS CONNECTIONS
3. PTC THERMISTOR ASSEMBLY
4. LINE CONTACTOR
5. MOUNTING BRACKET
6. FUSE COVER

Figure 130. Line Contactor Replacement, Lift Truck Models Manufactured After November 2014E30-40XN (A269)

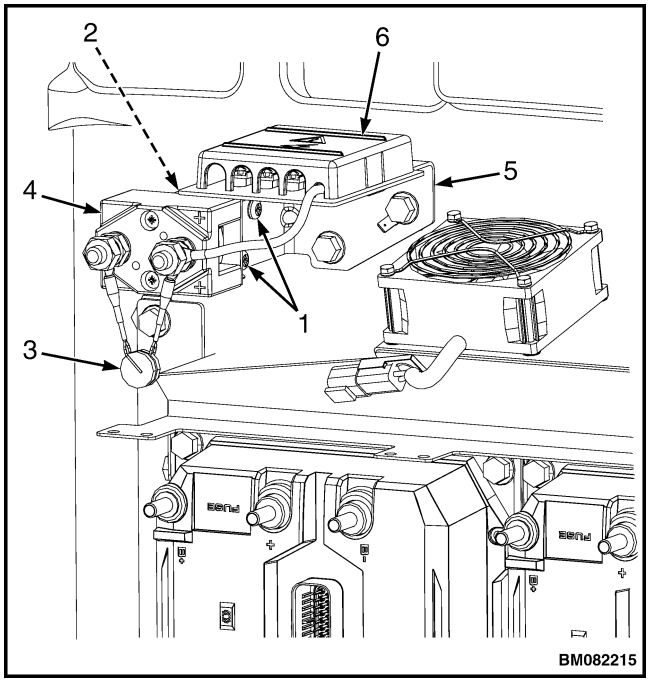


NOTE: SEVERAL ELECTRICAL COMPONENTS AND CONNECTIONS OMITTED FOR CLARITY.

A. LINE CONTACTOR USED ON LIFT TRUCK MODELS E2.2-3.5XN (E45-70XN) (A268)
B. TWO POLE LINE CONTACTOR OPTION USED ON LIFT TRUCK MODELS E2.2-3.5XN (A268)

1. CAPSCREW
2. MAIN WIRE HARNESS CONNECTIONS
3. PTC THERMISTOR ASSEMBLY
4. LINE CONTACTOR
5. MOUNTING BRACKET
6. FUSE COVER

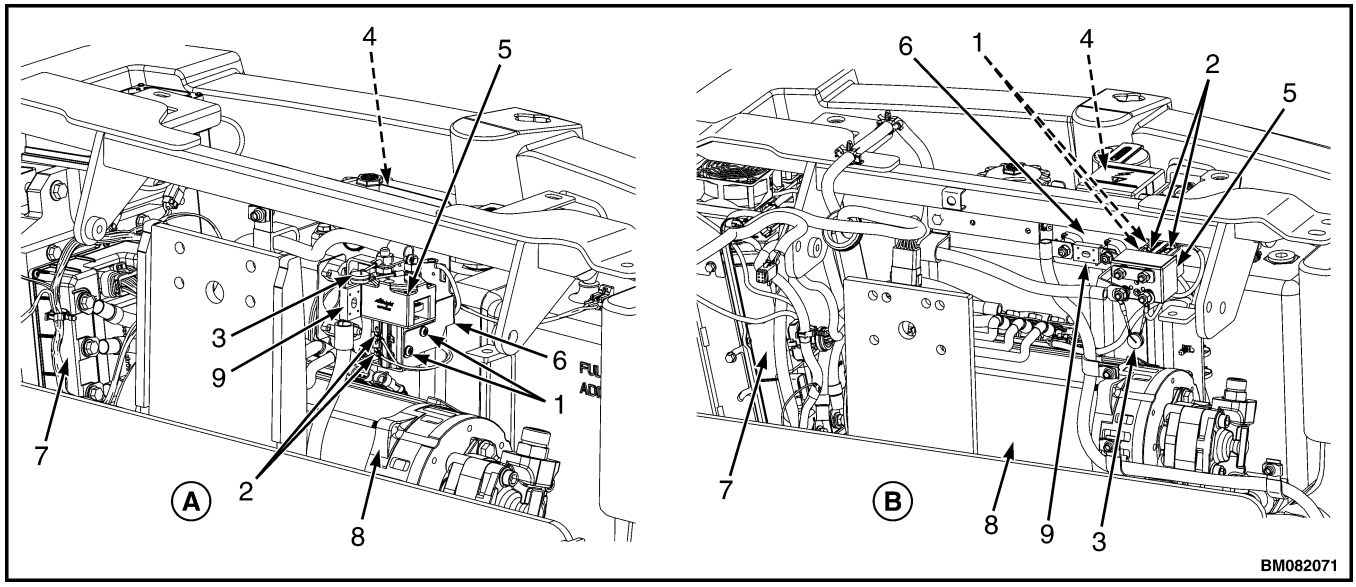
Figure 131. Line Contactor Replacement, Lift Truck Models Manufactured After September, 2012E2.2-3.5XN (E45-70XN) (A268)



NOTE: SEVERAL ELECTRICAL COMPONENTS AND CONNECTIONS OMITTED FOR CLARITY.

1. CAPSCREW
2. MAIN WIRE HARNESS CONNECTIONS
3. PTC THERMISTOR ASSEMBLY
4. LINE CONTACTOR
5. MOUNTING BRACKET
6. FUSE COVER

Figure 132. Line Contactor Replacement, Lift Truck Models Manufactured After November 2014E45-70XN (A268)



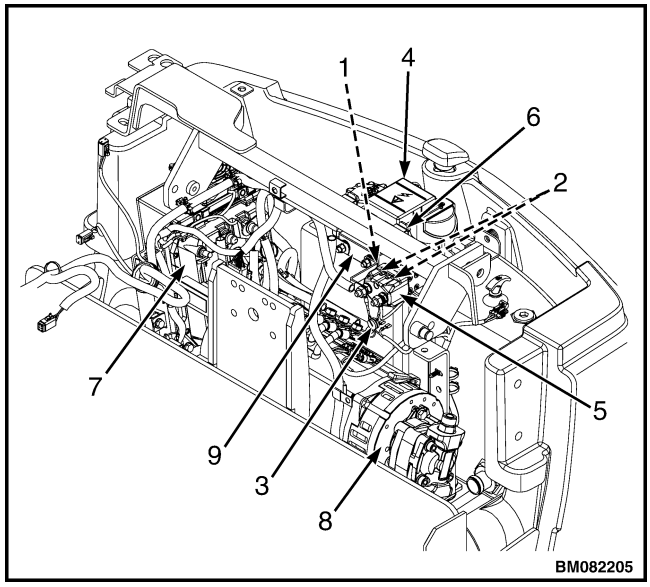
NOTE: SOME ELECTRICAL COMPONENTS AND CONNECTIONS OMITTED FOR CLARITY.

A. LIFT TRUCK MODELS J2.2-3.5XN (J45-70XN) (A276) , MANUFACTURED BEFORE FEBRUARY, 2009

B. LIFT TRUCK MODELS J2.2-3.5XN (J45-70XN) (A276) , MANUFACTURED AFTER FEBRUARY, 2009

1. CAPSCREWS
2. MAIN WIRE HARNESS CONNECTIONS
3. PTC THERMISTOR ASSEMBLY
4. FUSES
5. LINE CONTACTOR
6. MOUNTING BRACKET
7. HYDRAULIC PUMP AND MOTOR CONTROLLER
8. HYDRAULIC PUMP AND MOTOR
9. LINE CONTACTOR FUSE

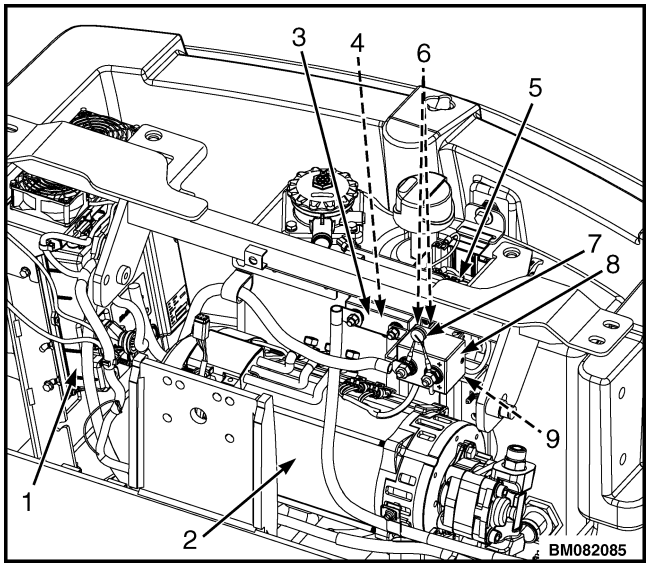
Figure 133. Line Contactor Replacement, Lift Truck Models Manufactured Before November 2014J2.2-3.5XN (J45-70XN) (A276)



NOTE: SOME ELECTRICAL COMPONENTS AND CONNECTIONS OMITTED FOR CLARITY.

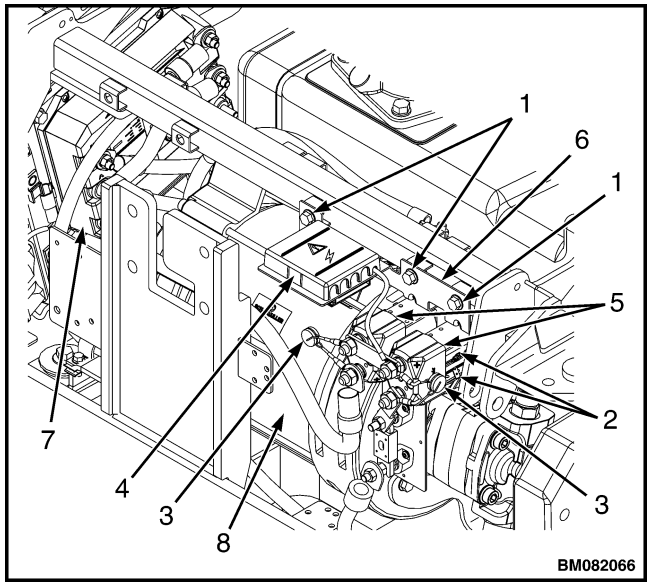
1. CAPSCREWS
2. MAIN WIRE HARNESS CONNECTIONS
3. PTC THERMISTOR ASSEMBLY
4. FUSES
5. LINE CONTACTOR
6. MOUNTING BRACKET
7. HYDRAULIC PUMP AND MOTOR CONTROLLER
8. HYDRAULIC PUMP AND MOTOR
9. LINE CONTACTOR FUSE

Figure 134. Line Contactor Replacement, Lift Truck Models Manufactured After November 2014J2.2-3.5XN (J45-70XN) (A276)



1. HYDRAULIC PUMP AND MOTOR CONTROLLER
2. HYDRAULIC PUMP AND MOTOR
3. LINE CONTACTOR POWER FUSE SHROUD
4. LINE CONTACTOR POWER FUSE
5. FUSES
6. CAPSCREWS
7. PTC THERMISTOR ASSEMBLY
8. LINE CONTACTOR
9. MAIN WIRE HARNESS CONNECTIONS

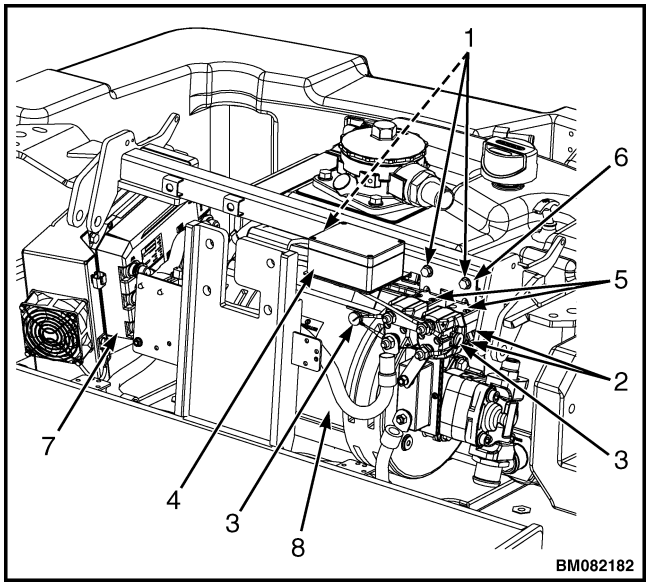
Figure 135. Line Contactor Replacement for Lift Truck Models , Equipped With Outdoor Protection/ Wash-down PackageJ2.2-3.5XN (J45-70XN) (A276)



NOTE: SOME ELECTRICAL COMPONENTS AND CONNECTIONS OMITTED FOR CLARITY.

1. CAPSCREWS
2. MAIN WIRE HARNESS CONNECTIONS
3. PTC THERMISTOR ASSEMBLY
4. FUSES
5. LINE CONTACTOR
6. MOUNTING BRACKET
7. HYDRAULIC PUMP AND MOTOR CONTROLLER
8. HYDRAULIC PUMP AND MOTOR

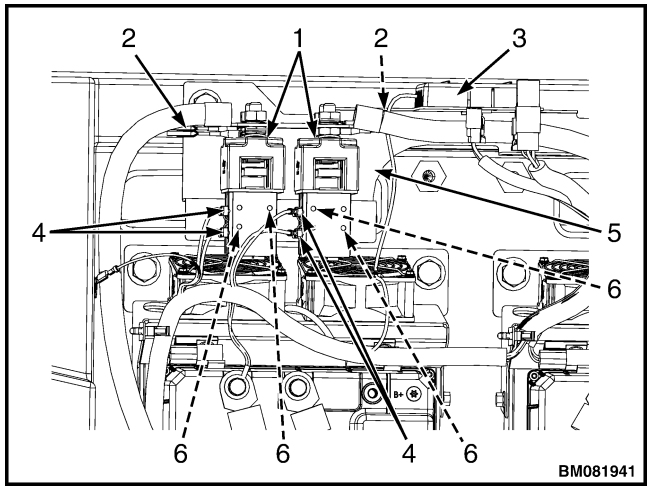
Figure 136. Line Contactor Replacement, Lift Truck Models Manufactured Before November 2014J4.0-5.0XN (J80-100XN) (A970)



NOTE: SOME ELECTRICAL COMPONENTS AND CONNECTIONS OMITTED FOR CLARITY.

1. CAPSCREWS
2. MAIN WIRE HARNESS CONNECTIONS
3. PTC THERMISTOR ASSEMBLY
4. FUSES
5. LINE CONTACTOR
6. MOUNTING BRACKET
7. HYDRAULIC PUMP AND MOTOR CONTROLLER
8. HYDRAULIC PUMP AND MOTOR

Figure 137. Line Contactor Replacement, Lift Truck Models Manufactured After November 2014J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)



1. LINE CONTACTOR
2. PTC THERMISTOR
3. FUSE COVER
4. MAIN WIRE HARNESS CONNECTION
5. MOUNTING BRACKET
6. CAPSCREW

Figure 138. Line Contactor Replacement, Lift Truck Model Manufactured Before November 2014E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

4. Remove two capscrews and remove line contactor from mounting bracket.

NOTE: Perform Step 5 and Step 6 for lift truck model E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099) .

5. Remove two line contactor mounting bracket capscrews.

See Figure 126 for lift truck model

- E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099) manufactured before November 2014

See Figure 127 for lift truck model

- E80-120XN, E100XNS (A099) manufactured after November 2014

6. Remove four line contactor capscrews from back of mounting bracket and remove line contactors from mounting bracket.

See Figure 138 for lift truck model

- E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099) manufactured before November 2014

See Figure 139 for lift truck model

- E80-120XN, E100XNS (A099) manufactured after November 2014

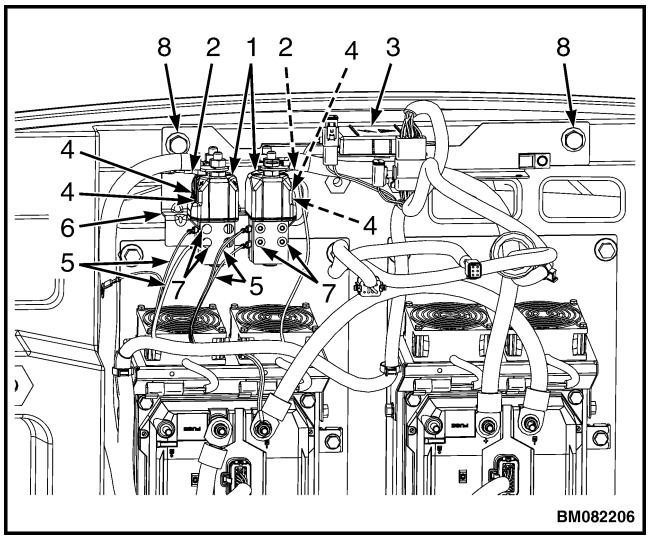
Install

1. Before installing new line contactor, check to ensure the PTC thermistor assembly is on contactor posts.

NOTE: Perform Step 2 and Step 3 for lift truck model E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099) .

2. Install new line contactors to mounting bracket using four capscrews. Tighten capscrews to 14 to 15 N•m (123.9 to 132.8 lbf in). See Figure 138.

3. Install mounting bracket in lift truck using two line contactor bracket capscrews and tighten to 66 to 83 N•m (49 to 61 lbf ft).



1. LINE CONTACTOR
2. PTC THERMISTOR
3. FUSE COVER
4. MAIN WIRE HARNESS CONNECTION
5. MAIN WIRE HARNESS
6. LINE CONTACTOR MOUNTING BRACKET
7. LINE CONTACTOR CAPSCREW
8. MOUNTING BRACKET CAPSCREWS

Figure 139. Line Contactor Replacement, Lift Truck Model Manufactured After November 2014E80-120XN, E100XNS (A099)

4. Install new line contactor to mounting bracket using two capscrews.

See Figure 129 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268) manufactured before September, 2012
- E1.6-2.0XN (E30-40XN) (A269) manufactured before November 2014

See Figure 130 for lift truck models

- E30-40XN (A269) manufactured after November 2014

See Figure 131 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268) manufactured after September, 2012

See Figure 132 for lift truck models

- E45-70XN (A268) manufactured after November 2014

See Figure 133 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276) manufactured before November 2014

See Figure 134 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276) manufactured after November 2014

See Figure 135 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276) , equipped with Outdoor Protection/Wash-down Package

See Figure 136 for lift truck models

- J4.0-5.0XN (J80-100XN) (A970) manufactured before November 2014

See Figure 137 for lift truck models

- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) manufactured after November 2014

See Figure 138 for lift truck model

- E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099) manufactured before November 2014

See Figure 139 for lift truck model

- E80-120XN, E100XNS (A099) manufactured after November 2014

5. Connect all wires to line contactor in same positions as noted during removal.

6. Tighten main contactor terminals as indicated below:

- Lift truck models E30-40XN (A269) - 8 to 10 N•m (70.8 to 88.5 lbf in)
- Lift truck models E2.2-3.5XN (E45-70XN) (A268) - 14 to 15 N•m (123.9 to 132.8 lbf in)
- Lift truck models J2.2-3.5XN (J45-70XN) (A276) -

  stud size M8 - 8 to 10 N•m (70.8 to 88.5 lbf in)

  stud size M10 - 14 to 15 N•m (123.9 to 132.8 lbf in)
- Lift truck models J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) - 14 to 15 N•m (123.9 to 132.8 lbf in)
- Lift truck models E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099) - 14 to 15 N•m (123.9 to 132.8 lbf in)

7. Install the counterweight cover using two capscrews.

See Figure 128 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268)
- E1.6-2.0XN (E30-40XN) (A269)
- E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

See Figure 113 or Figure 114 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276)
- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

8. For lift truck models J2.2-3.5XN (J45-70XN) (A276) , equipped with Outdoor Protection/ Wash-down Package, spray rust inhibitor-ignition sealer on line contactor fuse power cable terminals, after tightening nuts retaining line contactor fuse. See Figure 133.

9. Connect the battery.

10. For lift truck models J2.2-3.5XN (J45-70XN) (A276) , equipped with Outdoor Protection/ Wash-down Package, spray battery connector terminals with rust inhibitor-ignition sealer, after tightening terminals.

FANS FOR LIFT TRUCK MODELS MANUFACTURED BEFORE NOVEMBER 2014E2.2-3.5XN (E45-70XN) (A268), E1.6-2.0XN (E30-40XN) (A269), J2.2-3.5XN (J450-70XN) (A276), AND J4.0-5.0XN (J80-100XN) (A970)

NOTE: For all lift truck models except E2.2-3.5XN (E45-70XN) (A268) manufactured after September, 2012, the same style of fan assembly is used and the procedures to install a new fan assembly are the same.

For lift truck models E2.2-3.5XN (E45-70XN) (A268) manufactured before September, 2012, and lift truck models E1.6-2.0XN (E30-40XN) (A269) the fan assembly is located on two fan spacers mounted to the heatsink on the counterweight, just above the hydraulic pump and motor controller.

See Figure 95 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268) manufactured before September, 2012

See Figure 104 for lift truck models

- E1.6-2.0XN (E30-40XN) (A269)

For lift truck models J2.2-3.5XN (J45-70XN) (A276) and J4.0-5.0XN (J80-100XN) (A970) there are two sets of fans. One set is located on the right side of the counterweight mounted on two fan spacers, mounted to the heatsink, just above the hydraulic pump and motor controller. The other fan set is located under the floor plate and mounted to two fan spacers on the heatsink above the traction motor controller.

See Figure 98 for lift truck model

- J2.2-3.5XN (J45-70XN) (A276) , manufactured before February, 2009

See Figure 99 for lift truck model

- J2.2-3.5XN (J45-70XN) (A276) , manufactured after February, 2009

See Figure 100 for lift truck model

- J2.2-3.5XN (J45-70XN) (A276) , manufactured after November, 2014

See Figure 101 for lift truck model

- J2.2-3.5XN (J45-70XN) (A276) , manufactured after November, 2015

See Figure 102 for lift truck model

- J4.0-5.0XN (J80-100XN) (A970)

For lift truck models E2.2-3.5XN (E45-70XN) (A268) manufactured after September, 2012 three fan assemblies are mounted to an air duct, which is mounted to the motor controllers mounting bracket just above the traction motor controller and hydraulic pump and motor controller. See Figure 141.

Remove

1. Read and follow the **WARNING** and **CAUTION** in the General section above.

2. Remove the counterweight cover for lift truck models E2.2-3.5XN (E45-70XN) (A268) , E1.6-2.0XN (E30-40XN) (A269) , J2.2-3.5XN (J45-70XN) (A276) , and J4.0-5.0XN (J80-100XN) (A970) if the fans for the hydraulic pump and motor controller will be replaced.

   See Figure 128 for lift truck models

   - E2.2-3.5XN (E45-70XN) (A268)
   - E1.6-2.0XN (E30-40XN) (A269)

   See Figure 113 or Figure 114 for lift truck models

   - J2.2-3.5XN (J45-70XN) (A276)
   - J4.0-5.0XN (J80-100XN) (A970)

3. On lift truck models J2.2-3.5XN (J45-70XN) (A276) and J4.0-5.0XN (J80-100XN) (A970) , if the fans for the traction motor are being replaced, remove the floor mat. Remove rear floor plate. Remove capscrew, washer, and nut from front floor plate. Remove front floor plate with accelerator or MONOTROL® pedal still attached. See Figure 120.

4. Disconnect main wire harness from fan assembly.

   See Figure 108 for lift truck models

   - E2.2-3.5XN (E45-70XN) (A268) manufactured before September, 2012

   See Figure 109 for lift truck models

   - E2.2-3.5XN (E45-70XN) (A268) manufactured after September, 2012

   See Figure 111 for lift truck models

   - E1.6-2.0XN (E30-40XN) (A269)

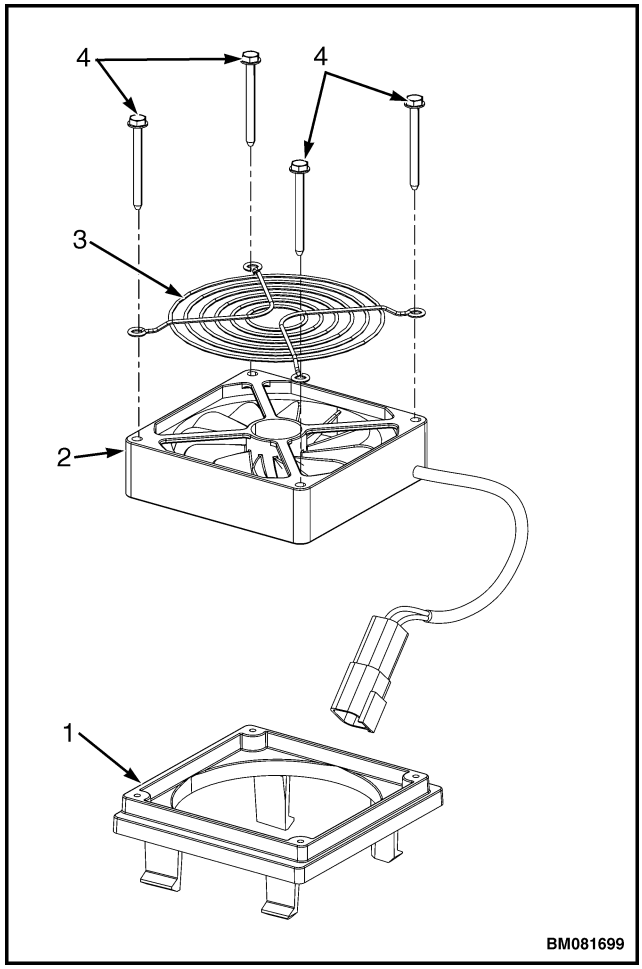
See Figure 115, and Figure 121 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276)
- J4.0-5.0XN (J80-100XN) (A970)

NOTE: DO NOT discard finger guard removed in Step 5 and Step 6. It will be used with new fan assembly.

5. For all lift truck models, except E2.2-3.5XN (E45-70XN) (A268) manufactured after September, 2012, remove four screws that attach fan assembly to fan spacer. Remove finger guard and fan assembly from fan spacer. See Figure 140.

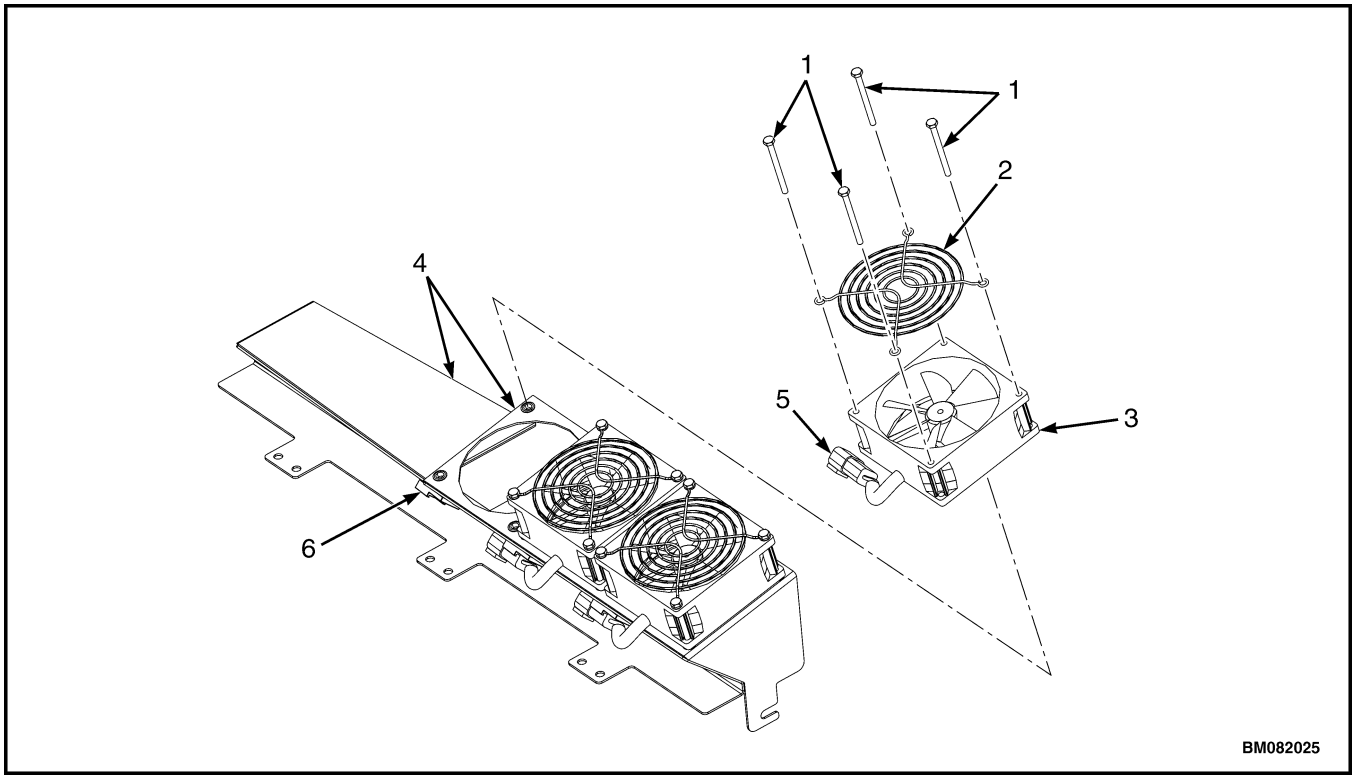
6. For lift truck models E2.2-3.5XN (E45-70XN) (A268) manufactured after September, 2012, remove four capscrews that attach fan assembly to air duct. Remove finger guard and connector from clip. Remove fan assembly from air duct. See Figure 141.



NOTE: FAN FOR E1.6-2.0XN (E30-40XN) (A269) SHOWN. OTHER FANS SIMILAR.

1. FAN SPACER
2. FAN ASSEMBLY
3. FINGER GUARD
4. SCREWS

Figure 140. Fan Assembly Replacement, All Lift Truck Models Except Manufactured After September, 2012E2.2-3.5XN (E45-70XN) (A268)



1. SCREWS
2. FINGER GUARD
3. FAN ASSEMBLY
4. AIR DUCT
5. CONNECTOR
6. CONNECTOR CLIP

Figure 141. Fan Assembly Replacement, Lift Truck Models Manufactured After September, 2012E2.2-3.5XN (E45-70XN) (A268)

Install

NOTE: For all lift truck models, except E2.2-3.5XN (E45-70XN) (A268) manufactured after September, 2012, when installing new fan assembly, fan connector wire must be on right bottom of fan assembly when viewed from the motor controller side.

For lift truck models E2.2-3.5XN (E45-70XN) (A268) manufactured after September, 2012, when installing new fan assembly, fan connector wire must be on center bottom of fan assembly when viewed from the motor controller side.

See Figure 108 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268) manufactured before September, 2012

See Figure 109 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268) manufactured after September, 2012

See Figure 111 for lift truck models

- E1.6-2.0XN (E30-40XN) (A269)

See Figure 115 and Figure 121 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276) , manufactured before February, 2009

See Figure 116 and Figure 122 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276) , manufactured after February, 2009

See Figure 118 and Figure 124 for lift truck models

- J4.0-5.0XN (J80-100XN) (A970)

1. For all lift truck models, except E2.2-3.5XN (E45-70XN) (A268) manufactured after September, 2012, install new fan assembly and finger guard to fan spacer with four screws. See Figure 140.

2. For lift truck models E2.2-3.5XN (E45-70XN) (A268) manufactured after September, 2012, install new fan assembly and finger guard to air duct with four capscrews.

3. Connect main wire harness to fan assembly.

4. Install the counterweight cover, if the fans for the hydraulic pump and motor controller were replaced.

   See Figure 128 for lift truck models

   - E2.2-3.5XN (E45-70XN) (A268)
   - E1.6-2.0XN (E30-40XN) (A269)

   See Figure 113 or Figure 114 for lift truck models

   - J2.2-3.5XN (J45-70XN) (A276)
   - J4.0-5.0XN (J80-100XN) (A970)

5. For lift truck models J2.2-3.5XN (J45-70XN) (A276) and J4.0-5.0XN (J80-100XN) (A970) , if the fans for the traction motor were replaced, connect the accelerator pedal or MONOTROL® pedal, (see Figure 120) and install the front floor plate using capscrews, washers, and nuts. Install rear floor plate. Install floor mat.

6. Connect the battery.

FANS FOR LIFT TRUCK MODEL MANUFACTURED BEFORE NOVEMBER 2014E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

NOTE: The same style of fan assembly is used on all lift truck models covered in this service manual. The procedures to install a new fan assembly are the same for all trucks.

The fan assembly is mounted to the air duct on the counterweight, just above the traction motor and hydraulic pump and motor controllers for lift truck model E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099) . See Figure 126.

Remove

1. Read and follow the **WARNING** and **CAUTION** in the General section above.

2. Remove the counterweight cover. See Figure 128.

3. Disconnect main wire harness from fan assembly. See Figure 126.

NOTE: DO NOT discard finger guard. It will be used with new fan assembly.

4. Remove four screws that attach fan assembly to air duct. Remove finger guard and fan assembly from air duct. See Figure 140.

5. Repeat Step 4 for three other fan assemblies.

Install

NOTE: When installing new fan assembly, fan connector wire must be on left bottom of fan assembly when viewed from the motor controller side. See Figure 126.

1. Install new fan assembly and finger guard to air duct with four screws. See Figure 140.

2. Repeat Step 1 for three other fan assemblies.

3. Connect main wire harness to fan assembly. See Figure 126.

4. Install the counterweight cover. See Figure 128.

5. Connect the battery.

FANS FOR LIFT TRUCK MODELS MANUFACTURED AFTER NOVEMBER 2014E45-70XN (A268), E30-40XN (A269), E80-120XN, E100XNS (A099), J2.2-3.5XN (J450-70XN) (A276) AND J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

On lift truck models E45-70XN (A268) , E30-40XN (A269) , and E80-120XN, E100XNS (A099) , the fan assembly is mounted to the air duct on the counterweight, just above the traction motor and hydraulic pump and motor controllers.

See Figure 142 for lift truck models

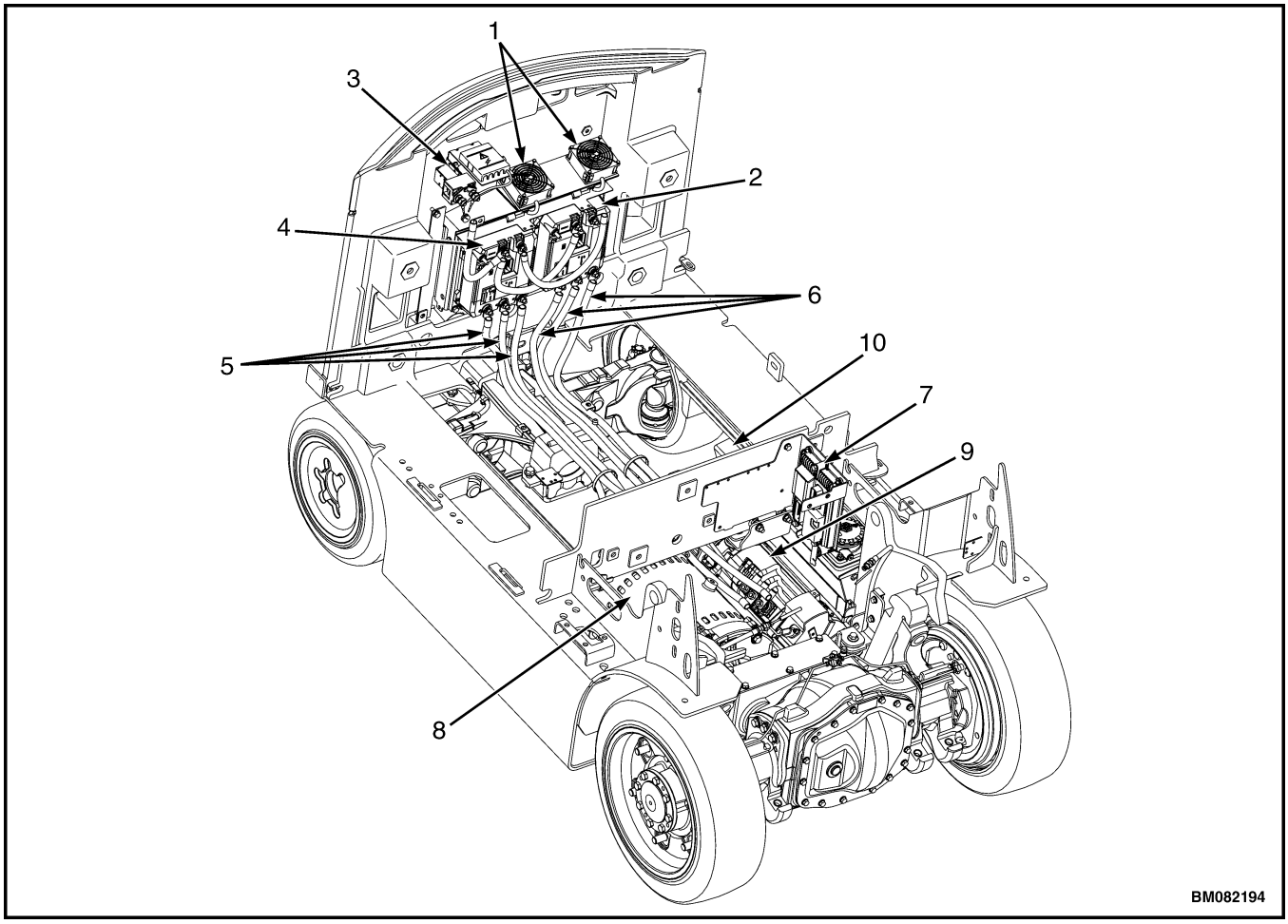
- E45-70XN (A268)

See Figure 143 for lift truck models

- E30-40XN (A269)

See Figure 144 for lift truck models

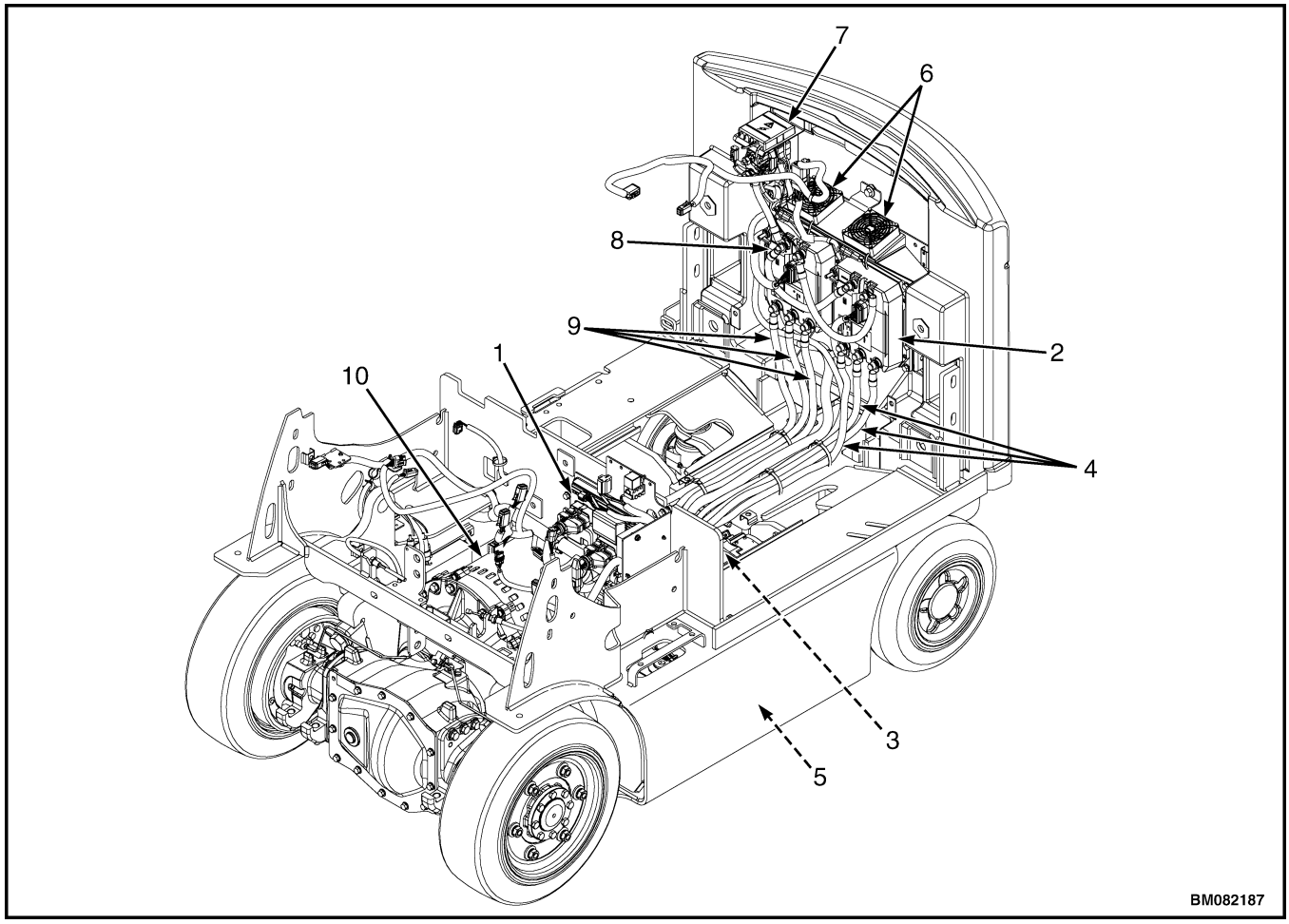
- E80-120XN, E100XNS (A099)



NOTE: BULKHEAD REMOVED FOR CLARITY.

1. FANS
2. HYDRAULIC PUMP AND MOTOR CONTROLLER
3. LINE CONTACTOR
4. TRACTION MOTOR CONTROLLER
5. TRACTION MOTOR POWER CABLES
6. HYDRAULIC PUMP AND MOTOR POWER CABLES
7. VEHICLE SYSTEM MANAGER
8. TRACTION MOTOR
9. HYDRAULIC PUMP AND MOTOR
10. HYDRAULIC TANK

Figure 142. Motor Controllers and Electrical Components Arrangement, Lift Truck Models E45-70XN (A268)



NOTE: BULKHEAD REMOVED FOR CLARITY.

1. VEHICLE SYSTEM MANAGER
2. HYDRAULIC PUMP AND MOTOR CONTROLLER
3. HYDRAULIC PUMP AND MOTOR
4. HYDRAULIC PUMP AND MOTOR POWER CABLES
5. HYDRAULIC TANK
6. FANS
7. LINE CONTACTOR
8. TRACTION MOTOR CONTROLLER
9. TRACTION MOTOR POWER CABLES
10. TRACTION MOTOR

Figure 143. Motor Controllers and Electrical Components Arrangement for Lift Truck Models E30-40XN (A269)

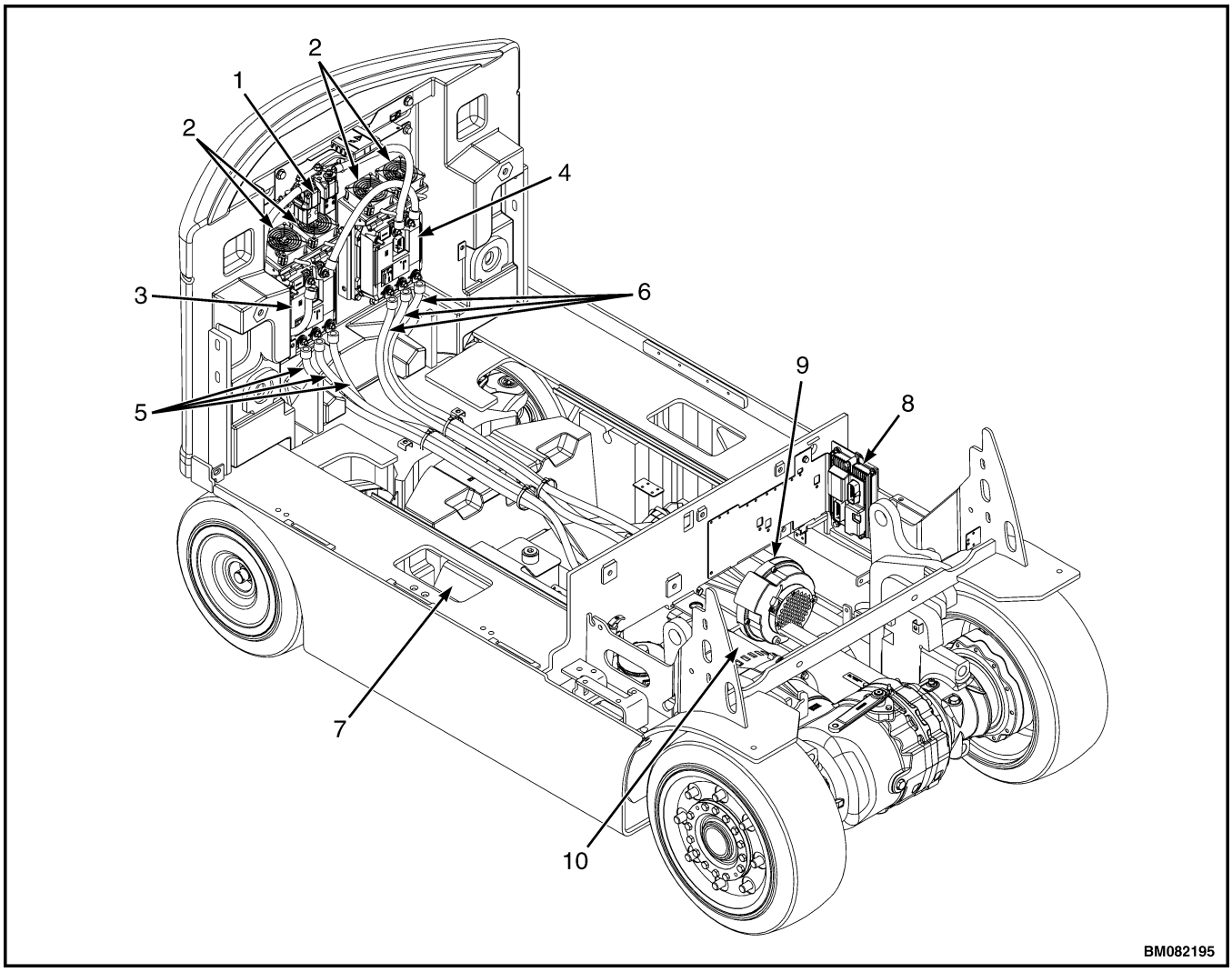
For lift truck models J2.2-3.5XN (J450-70XN) (A276) , and J4.0-5.0XN (J80-100XN) (A970) , there are two sets of fan assemblies. One set is mounted to the air duct on the counterweight, just above the hydraulic pump and motor controller.

See Figure 145 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276)

See Figure 146 for lift truck models

- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)



NOTE: BULKHEAD REMOVED FOR CLARITY.

1. LINE CONTACTOR
2. FANS
3. TRACTION MOTOR CONTROLLER
4. HYDRAULIC PUMP AND MOTOR CONTROLLER
5. TRACTION MOTOR POWER CABLES
6. HYDRAULIC PUMP AND MOTOR POWER CABLES
7. HYDRAULIC TANK
8. VEHICLE SYSTEM MANAGER
9. HYDRAULIC PUMP AND MOTOR
10. TRACTION MOTOR

Figure 144. Motor Controllers and Electrical Components Arrangement, Lift Truck Model E80-120XN, E100XNS (A099)

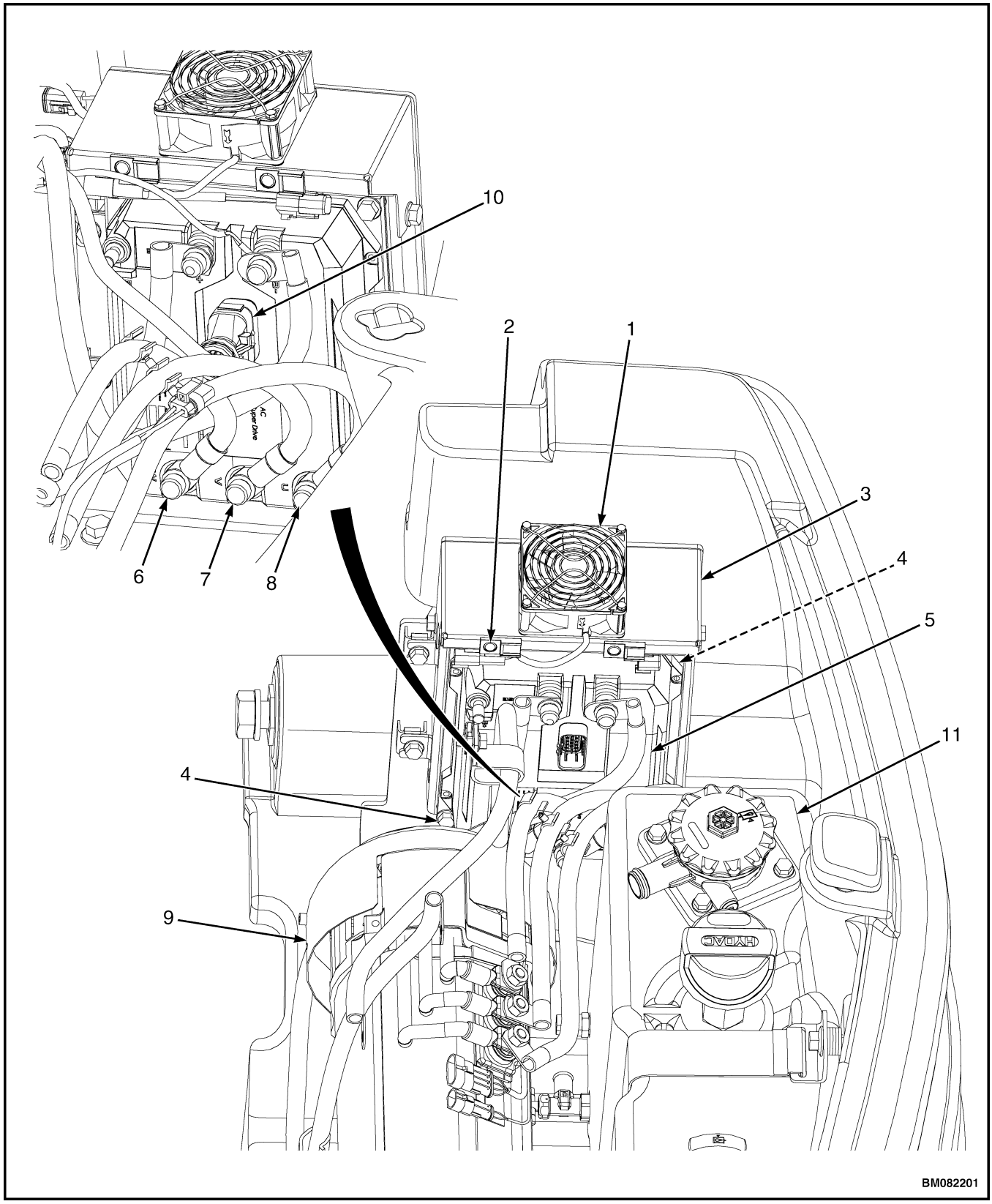
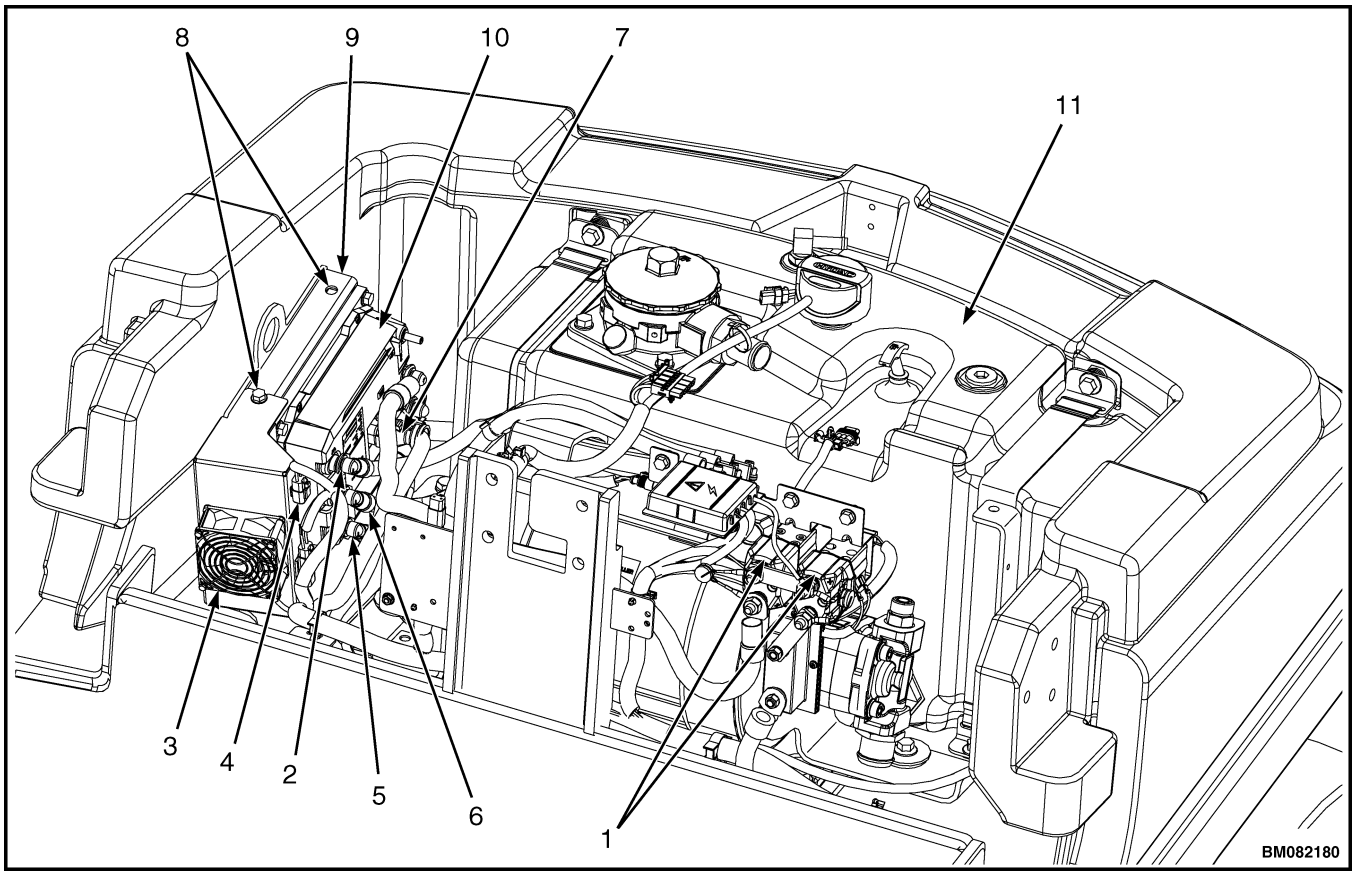


Figure 145. Hydraulic Pump and Motor Controller and Electrical Components Arrangement, Lift Truck Models J2.2-3.5XN (J45-70XN) (A276)

Legend for Figure 145.

NOTE: STANDARD PERFORMANCE HYDRAULIC PUMP AND MOTOR CONTROLLER PANEL SHOWN. ENHANCED PERFORMANCE HYDRAULIC PUMP AND MOTOR CONTROLLER PANEL IS SIMILAR.

1. FANS
2. FAN CONNECTORS
3. AIR DUCT
4. FLANGE CAPSCREW
5. HYDRAULIC PUMP AND MOTOR CONTROLLER
6. POWER CABLE **W**
7. POWER CABLE **V**
8. POWER CABLE **U**
9. HYDRAULIC PUMP AND MOTOR
10. CONTROLLER ELECTRICAL CONNECTORS
11. HYDRAULIC TANK



NOTE: STANDARD PERFORMANCE HYDRAULIC PUMP AND MOTOR CONTROLLER PANEL SHOWN. ENHANCED PERFORMANCE HYDRAULIC PUMP AND MOTOR CONTROLLER PANEL IS SIMILAR.

1. CONTACTORS
2. POWER CABLE **W**
3. FANS
4. FAN CONNECTOR
5. POWER CABLE **V**
6. POWER CABLE**U**
7. CONTROLLER ELECTRICAL CONNECTORS
8. FLANGE CAPSCREW
9. AIR DUCT
10. HYDRAULIC PUMP AND MOTOR CONTROLLER
11. HYDRAULIC TANK

Figure 146. Hydraulic Pump and Motor Controller and Electrical Components Arrangement, Lift Truck Models J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

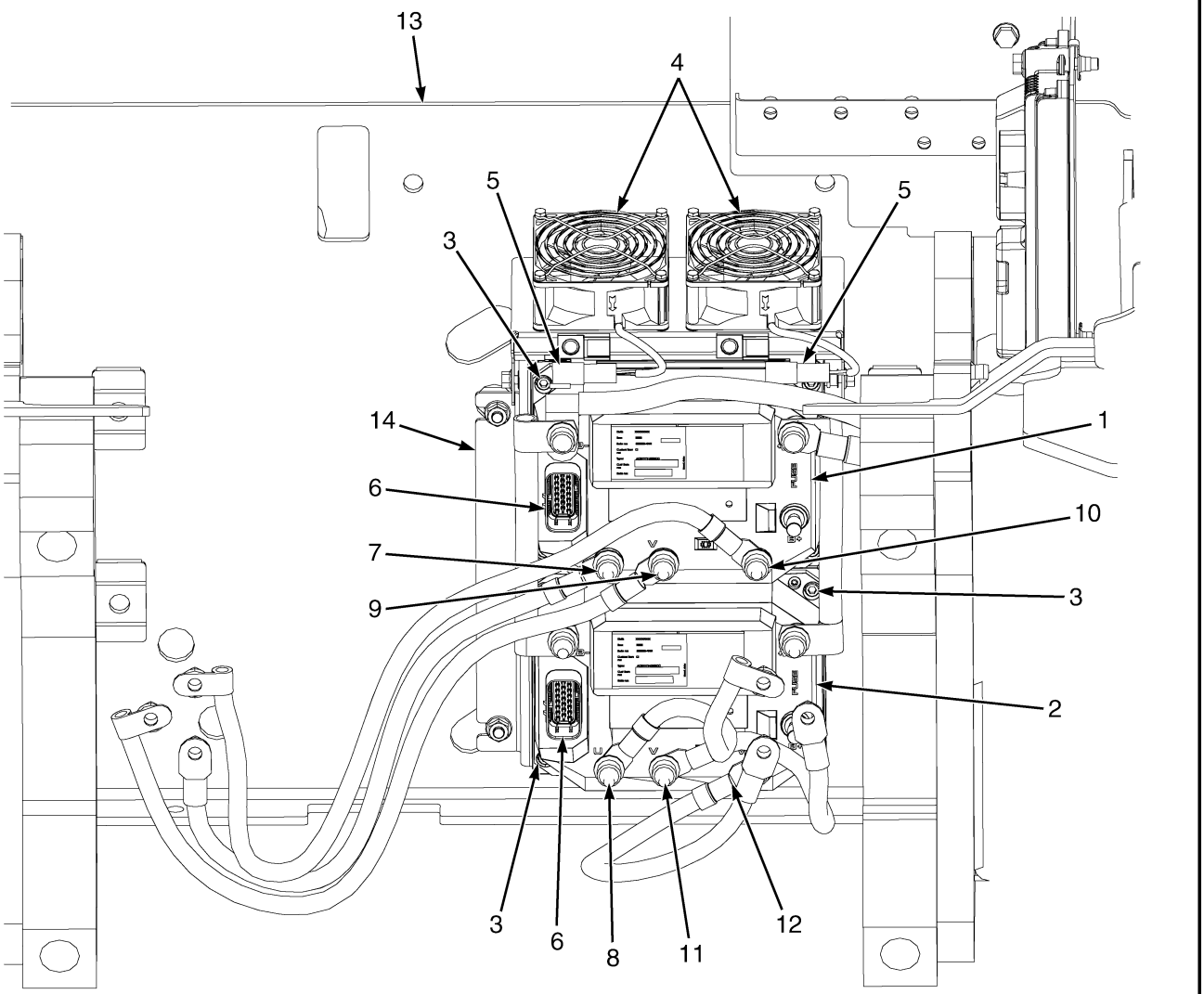
The other set is mounted to the air duct on the front bulkhead for the traction motor controller.

See Figure 147 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276)

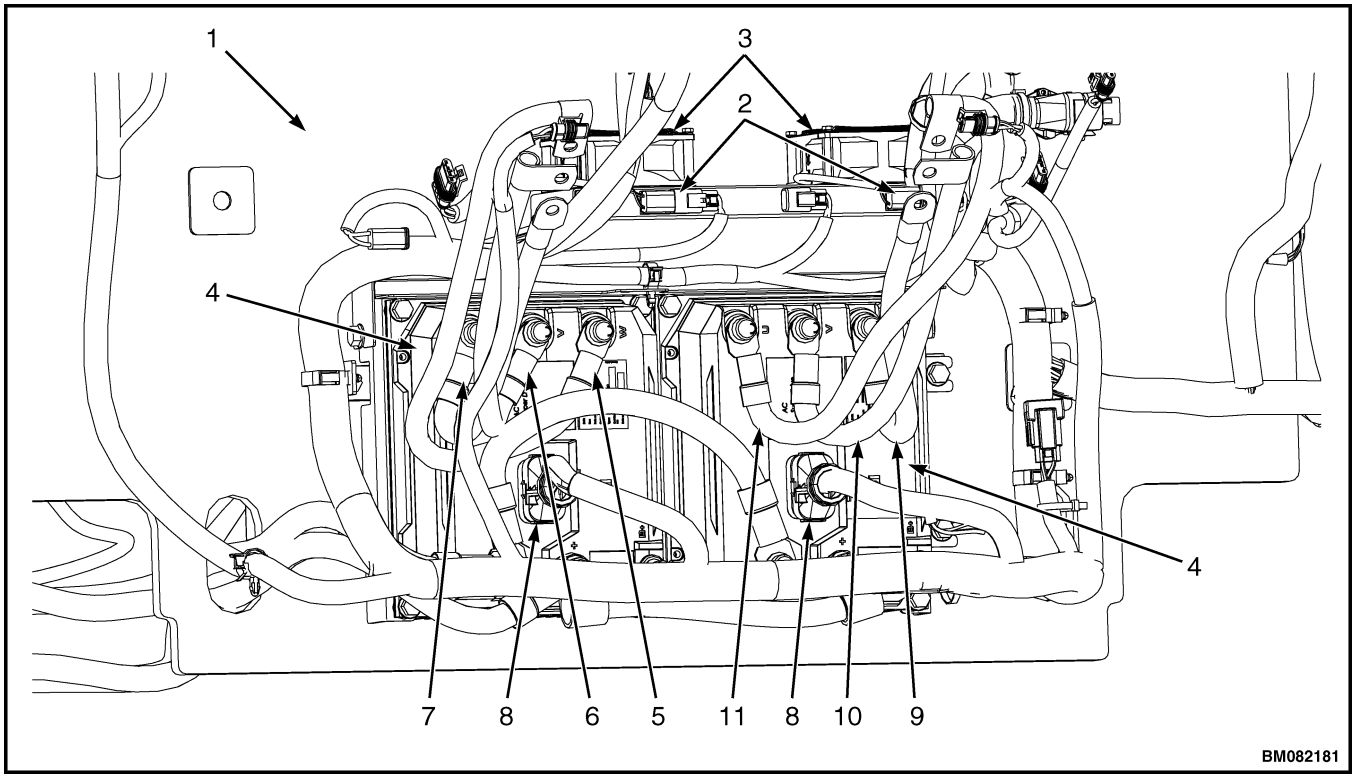
See Figure 148 for lift truck models

- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)



1. RIGHT TRACTION MOTOR CONTROLLER
2. LEFT TRACTION MOTOR CONTROLLER
3. SOCKET HEAD CAPSCREW
4. FANS
5. FAN CONNECTIONS
6. TRACTION MOTOR CONTROLLER CONNECTORS TO MAIN WIRE HARNESS
7. RIGHT POWER CABLE **U** TERMINAL
8. LEFT POWER CABLE **U** TERMINAL
9. RIGHT POWER CABLE **V** TERMINAL
10. RIGHT POWER CABLE **W** TERMINAL
11. LEFT POWER CABLE **V** TERMINAL
12. LEFT POWER CABLE **W** TERMINAL
13. FRONT BULKHEAD
14. MOUNTING BRACKET

Figure 147. Traction Motor Controllers and Electrical Components Arrangement, Lift Truck Models J2.2-3.5XN (J45-70XN) (A276)



1. FRONT BULKHEAD
2. FAN CONNECTORS
3. FAN
4. TRACTION MOTOR CONTROLLER
5. RIGHT POWER CABLE **W**
6. RIGHT POWER CABLE **V**
7. RIGHT POWER CABLE **U**
8. TRACTION MOTOR CONTROLLER CONNECTORS TO MAIN WIRE HARNESS
9. LEFT POWER CABLE **W**
10. LEFT POWER CABLE **V**
11. LEFT POWER CABLE **U**

Figure 148. Traction Motor Controller and Electrical Components Arrangement, Lift Truck Models J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

For all lift truck models covered in this section, the same style of fan assembly is used and the procedures to remove and install a new fan assembly are the same.

Remove

1. Read and follow the **WARNING** and **CAUTION** in the General section above.

2. Remove counterweight cover for access to both traction motor and hydraulic pump and motor controller fans for lift truck modelsE45-70XN (A268) , E30-40XN (A269) , E80-120XN, E100XNS (A099) and for access to hydraulic pump and motor fans for lift truck models J2.2-3.5XN (J450-70XN) (A276) , and J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) .

   See Figure 113 or Figure 114 for lift truck models

   - J2.2-3.5XN (J450-70XN) (A276)
   - J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

   See Figure 128 for lift truck models

   - E45-70XN (A268)
   - E30-40XN (A269)
   - E80-120XN, E100XNS (A099)

NOTE: Perform Step 3 through Step 5 for access to fan on traction motor controller for lift truck models J2.2-3.5XN (J450-70XN) (A276) and J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) .

3. Remove two bolts and belly pan from underside of lift truck.

4. Remove floor mat and rear floor plate. Remove capscrews and washers from front floor plate and lift front floor plate up enough to disconnect the accelerator or MONOTROL® pedal. Remove front floor plate with the accelerator or MONOTROL® pedal still attached. See Figure 149.

5. Remove brake pedal assembly for access to traction motor controller and fan.

   See **Transaxle** 1300SRM1370 for lift truck models

   - J2.2-3.5XN (J450-70XN) (A276)

   See **Transaxle** 1300SRM1539 for lift truck models

   - J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

6. Disconnect main wire harness from fan electrical connector.

NOTE: DO NOT discard finger guard. It will be used with new fan assembly.

7. Remove four screws that attach fan assembly to air duct. Remove finger guard and fan assembly from air duct. See Figure 150.

8. Repeat Step 7 for other fan assemblies.

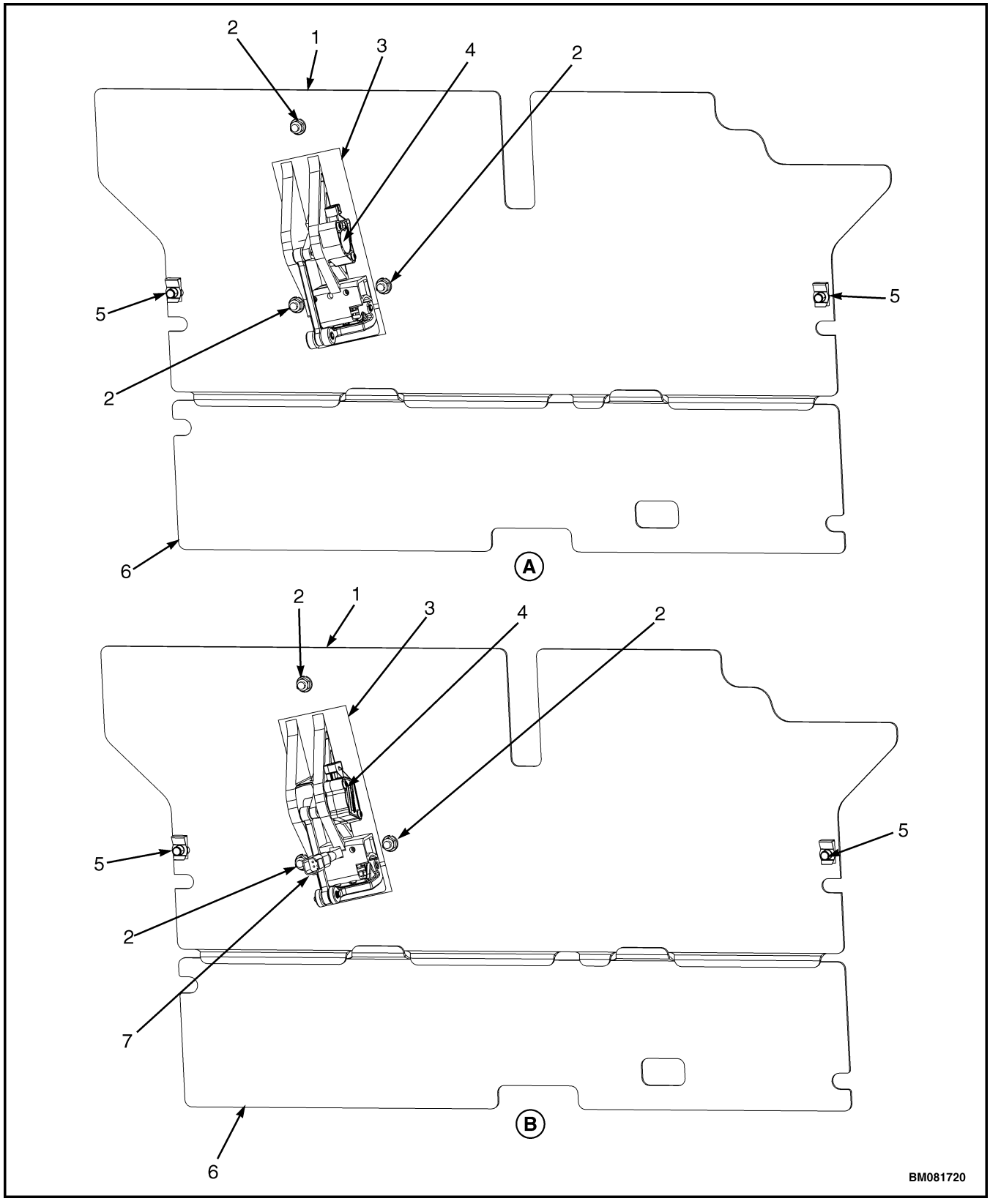


Figure 149. Removing Floor Plate and Accelerator or PedalMONOTROL®

Legend for Figure 149.

A. STANDARD ACCELERATOR PEDAL

B. MONOTROL® PEDAL

1. FRONT FLOOR PLATE
2. CAPSCREW AND NUT (PEDAL BASE)
3. PEDAL BASE
4. ACCELERATOR PEDAL POSITION SENSOR
5. CAPSCREW, WASHER, NUT (FRONT FLOOR PLATE)
6. REAR FLOOR PLATE
7. MONOTROL® PEDAL CONNECTOR

Install

NOTE: When installing new fan assembly, fan connector wire must be on the left bottom of fan assembly when viewed from the motor controller side. See Figure 150.

1. Install new fan assembly and finger guard to air duct with four screws.

2. Repeat Step 1 for other fan assemblies.

3. Connect wire harness to fan electrical connector. See Figure 150.

4. Install counterweight cover.

NOTE: Perform Step 5 through Step 7 if fan on traction motor controller for lift truck models J2.2-3.5XN (J450-70XN) (A276) and J4.0-5.0XN (J80-100XN) (A970) was replaced.

5. Install brake pedal assembly. See one of the following manuals for procedures.

See **Transaxle** 1300SRM1370 for lift truck models

- J2.2-3.5XN (J450-70XN) (A276)

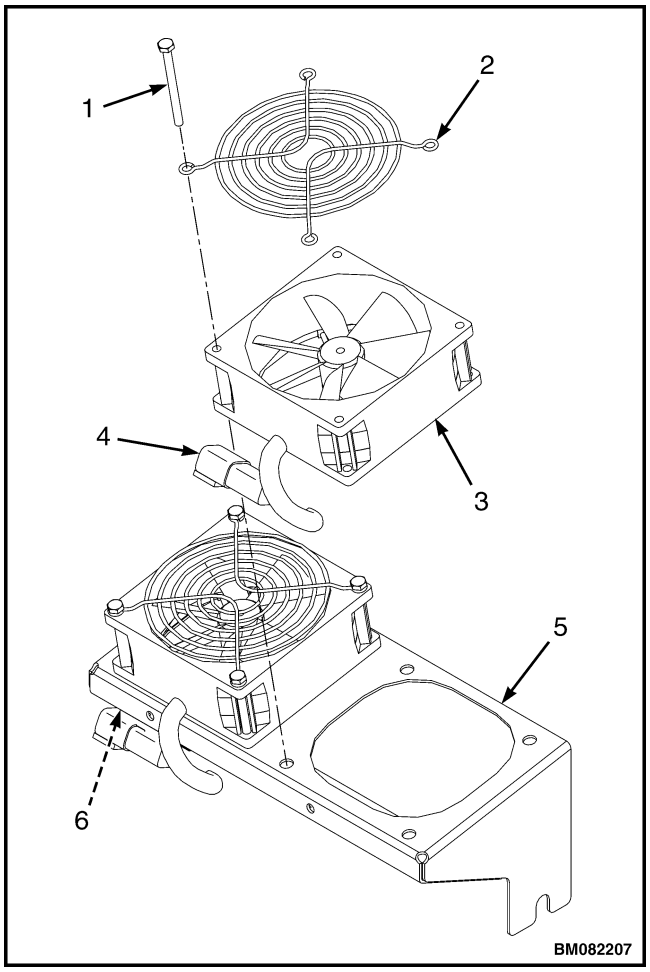
See **Transaxle** 1300SRM1539 for lift truck models

- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

6. Connect the accelerator or MONOTROL® pedal (see Figure 149) and install front floor plate using capscrews and washers. Install rear floor plate.

7. Install belly pan and two bolts onto underside of lift truck.

8. Connect the battery.



1. SCREWS
2. FINGER GUARD
3. FAN ASSEMBLY
4. FAN ELECTRICAL CONNECTOR
5. AIR DUCT
6. CONNECTOR CLIP

Figure 150. Fan Assembly

Vehicle System Manager

GENERAL

WARNING

Before replacing the Vehicle System Manager (VSM), fully lower all parts of the mast and tilt it forward until the tips of the forks touch the ground. This action will prevent the mast from lowering suddenly if the control lever is accidently moved.

Never have any metal on your fingers, arms, or neck. These metal items can accidentally create an electrical connection and cause an injury.

WARNING

Discharge capacitors as directed in Discharging the Capacitors in the General section at the beginning of this manual.

Disconnect the battery before doing any work on the electrical system. Serious injury to personnel and/or damage to lift truck components can occur if battery is not disconnected.

CAUTION

A short circuit and damage can occur if wires are not installed correctly. Make sure wire connectors DO NOT touch the other metal terminals or wire connectors, metal brackets, or the bracket mounting nuts. Make sure the wires are not pulled tight and are not touching other parts to damage the insulation.

CAUTION

Make sure there is no dirt between the plate of the VSM and the mount surface of the lift truck frame.

The Vehicle System Manager (VSM) is a microprocessor-powered controller which controls or monitors directly or indirectly, every electrical device on the lift truck.

For lift truck models E2.2-3.5XN (E45-70XN) (A268), J2.2-3.5XN (J45-70XN) (A276), J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) and E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099) the VSM is located on a mounting bracket under the floor mat and floor plate and to the left of the front bulkhead. See Figure 151.

See Figure 151 for the following lift truck models manufactured before November 2014

- E2.2-3.5XN (E45-70XN) (A268)
- J2.2-3.5XN (J45-70XN) (A276)
- J4.0-5.0XN (J80-100XN) (A970)
- E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

See Figure 152 for the following lift truck models manufactured after November 2014

- E45-70XN (A268)
- J2.2-3.5XN (J45-70XN) (A276)
- E80-120XN, E100XNS (A099)

See Figure 153 for the following lift truck models manufactured after November 2014

- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

For lift truck models E1.6-2.0XN (E30-40XN) (A269) the VSM is mounted to a bracket that is attached to the center of the front bulkhead. See Figure 154.

REMOVE

NOTE: The VSM is not a serviceable part. If it malfunctions, replace with a new VSM. See **Parts Manual** for replacement part number.

1. Read and follow **WARNING** and **CAUTION** section above in General section.
2. Remove floor mat.
3. Remove rear floor plate.
4. Remove capscrews and washers from front floor plate and lift front floor plate up enough to disconnect accelerator pedal or MONOTROL® pedal. See Figure 120.
5. Remove front floor plate with accelerator or MONOTROL® pedal still attached.

NOTE: Be sure to tag all connectors to aid correct installation.

6. Disconnect two main harness electrical connectors from VSM.

7. Remove bolts securing VSM to VSM mounting bracket on front bulkhead. Remove VSM from lift truck.

   See Figure 151 for lift truck models manufactured before November 2014

   - E2.2-3.5XN (E45-70XN) (A268)
   - J2.2-3.5XN (J45-70XN) (A276)
   - J4.0-5.0XN (J80-100XN) (A970)
   - E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

   See Figure 152 for the following lift truck models manufactured after November 2014

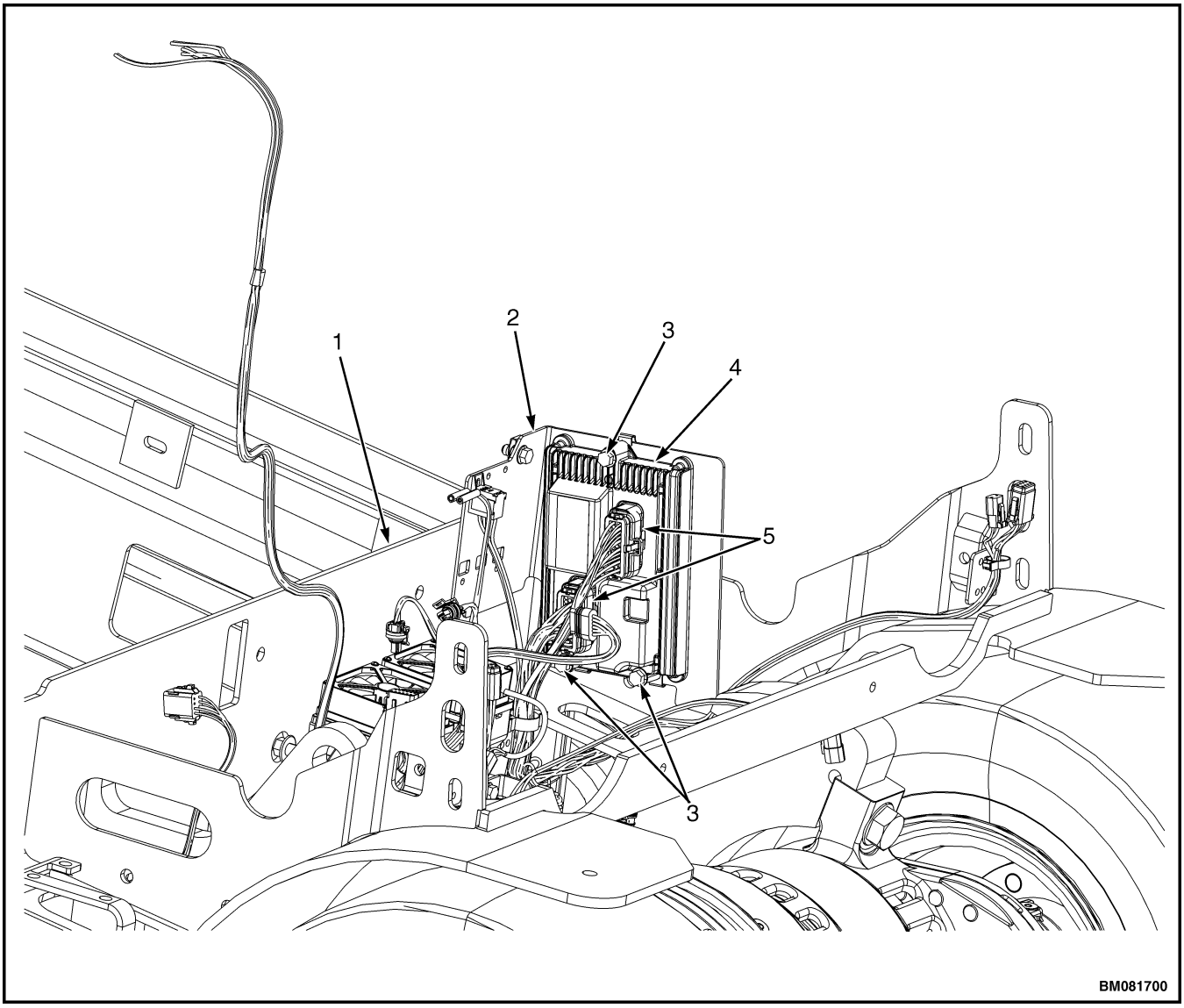
   - E45-70XN (A268)
   - J2.2-3.5XN (J45-70XN) (A276)
   - E80-120XN, E100XNS (A099)

   See Figure 153 for the following lift truck models manufactured after November 2014

   - J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

   See Figure 154 for lift truck models

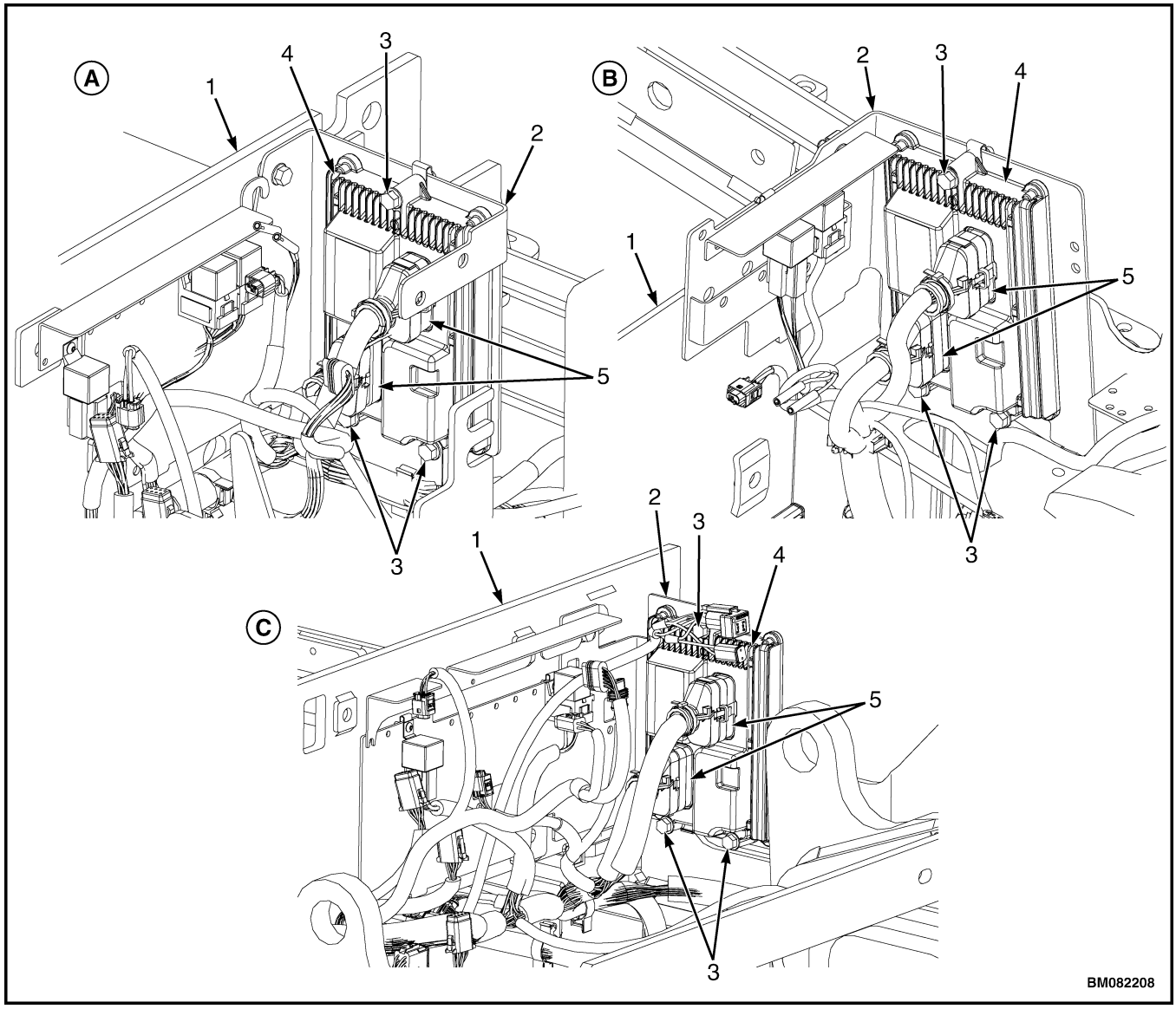
   - E1.6-2.0XN (E30-40XN) (A269)



NOTE: VEHICLE SYSTEM MANAGER FOR LIFT TRUCK MODELS J2.2-3.5XN (J45-70XN) (A276) WITH E-HYDRAULIC CONTROLS SHOWN.

1. FRONT BULKHEAD
2. VSM MOUNTING BRACKET
3. BOLTS
4. VEHICLE SYSTEM MANAGER
5. MAIN HARNESS ELECTRICAL CONNECTORS

Figure 151. Vehicle System Manager Removal, Lift Truck Models Manufactured Before November 2014E2.2-3.5XN (E45-70XN) (A268), J2.2-3.5XN (J45-70XN) (A276), J4.0-5.0XN (J80-100XN) (A970) and E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)



NOTE: VEHICLE SYSTEM MANAGER FOR LIFT TRUCK MODELS EQUIPPED WITH E-HYDRAULIC CONTROLS SHOWN.

A. VSM ARRANGEMENT, LIFT TRUCK MODELS E45-70XN (A268)
B. VSM ARRANGEMENT, LIFT TRUCK MODELS J2.2-3.5XN (J45-70XN) (A276)
C. VSM ARRANGEMENT, LIFT TRUCK MODELS AND E80-120XN, E100XNS (A099)

1. FRONT BULKHEAD
2. VSM MOUNTING BRACKET
3. BOLTS
4. VEHICLE SYSTEM MANAGER
5. MAIN HARNESS ELECTRICAL CONNECTORS

Figure 152. Vehicle System Manager Removal, Lift Truck Models Manufactured After November 2014E45-70XN (A268), J2.2-3.5XN (J45-70XN) (A276), and E80-120XN, E100XNS (A099)

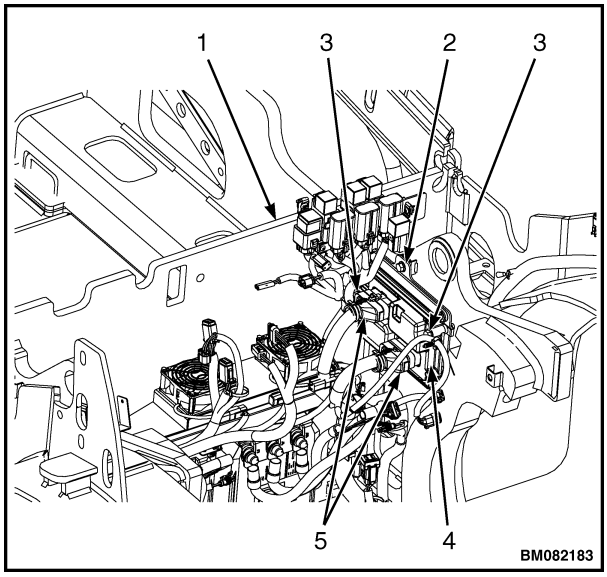
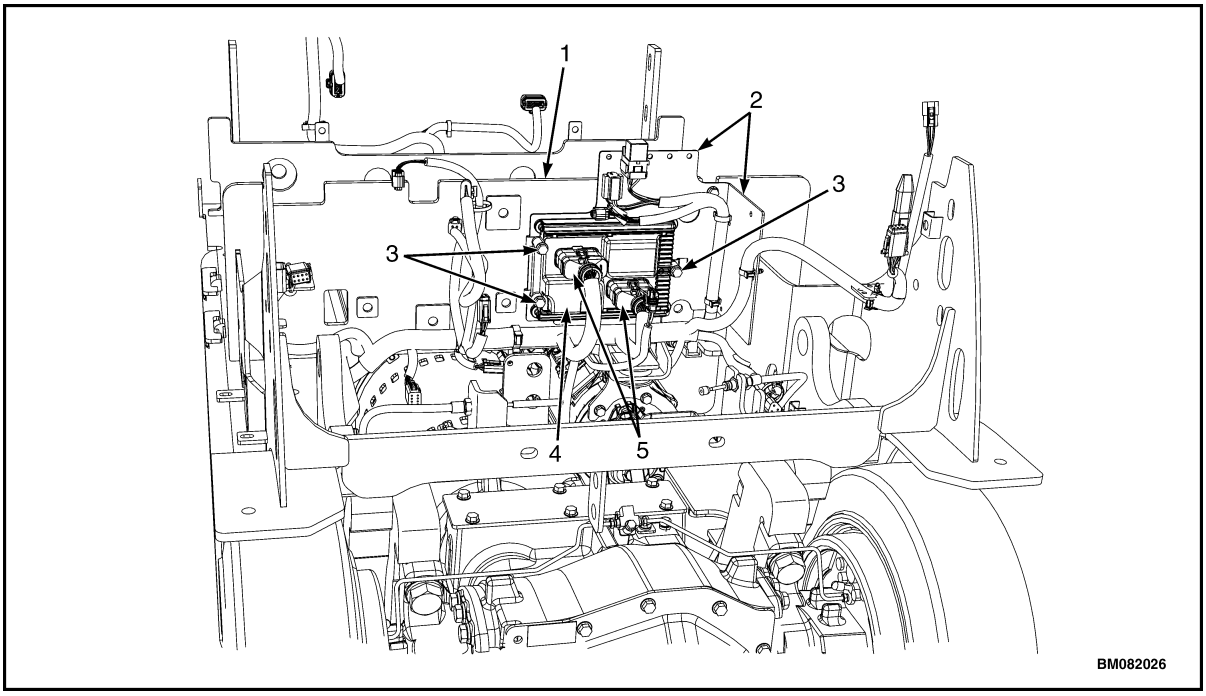


Figure 153. Vehicle System Manager Removal, Lift Truck Models Manufactured After November 2014J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

Legend for Figure 153.

1. FRONT BULKHEAD
2. VSM MOUNTING BRACKET
3. BOLTS
4. VEHICLE SYSTEM MANAGER
5. MAIN HARNESS ELECTRICAL CONNECTORS



1. FRONT BULKHEAD
2. VSM MOUNTING BRACKET
3. BOLTS
4. VEHICLE SYSTEM MANAGER
5. MAIN HARNESS ELECTRICAL CONNECTORS

Figure 154. Vehicle Systems Manager Removal, Lift Truck Models E1.6-2.0XN (E30-40XN) (A269)

INSTALL

1. Install new VSM onto mounting bracket. Tighten bolts to 19 N•m (168 lbf in).

NOTE: On lift truck models J2.2-3.5XN (J45-70XN) (A276) , equipped with Outdoor Protection/ Wash-down Package, apply dielectric grease to VSM electrical connectors before performing Step 2.

2. Connect all electrical connections, as noted, to VSM.

   See Figure 151 for lift truck models manufactured before November 2014

   - E2.2-3.5XN (E45-70XN) (A268)
   - J2.2-3.5XN (J45-70XN) (A276)
   - J4.0-5.0XN (J80-100XN) (A970)
   - E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

   See Figure 152 for the following lift truck models manufactured after November 2014

   - E45-70XN (A268)
   - J2.2-3.5XN (J45-70XN) (A276)
   - E80-120XN, E100XNS (A099)

   See Figure 153 for the following lift truck models manufactured after November 2014

   - J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

   See Figure 154 for lift truck models

   - E1.6-2.0XN (E30-40XN) (A269)

3. Connect accelerator pedal or MONOTROL® pedal, and install front floor plate using capscrews and washers.

4. Install rear floor plate.

5. Install floor mat and connect the battery. See Figure 120.

PROGRAMMING A NEW VSM AND/OR DISPLAY PANEL

NOTE: See section **Diagnostic Troubleshooting Manual** 9000SRM1377 for information on how delete and reset fault codes to the VSM, how to use the PC Service Tool software, and for the procedures to troubleshoot the VSM, display panel, and other electrical components used on these trucks.

NOTE: When installing a new VSM or Display use PC Service Tool to upload Application Code and the correct Configuration Data File.

Two file types are required to operate the VSM; Application Code File and Configuration Data File (CDF). New VSMs will have the Application Code loaded but you will need to upload a truck specific CDF.

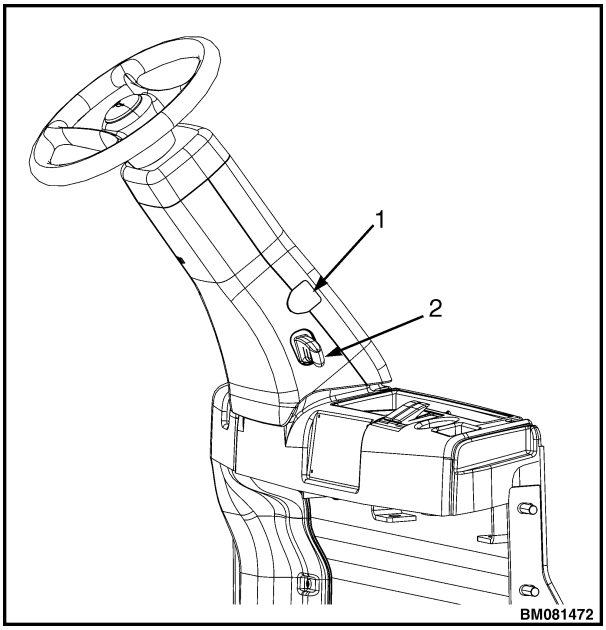
- **Application Code File** - These are operating files for the VSM and Display.
- **Configuration Data File (CDF)** - This file contains a unique set of data values that represent how a truck is equipped, how systems are controlled, and what options are enabled. The CDF is also linked and unique to the truck serial number. An example of a lift truck serial number is K160V12345A001. The first 11 characters (K160V12345A) represent the truck's serial number and the last 3 digits (001) represent the CDF revision loaded on the truck. The serial number of a lift truck is stored in the display panel. See **User Interface Service Technician** 2200SRM1336 for the procedures to find the serial number. The CDF can be found online at **Hypass Online®** using the serial number.

  The CDF revision will change every time a new version is ordered and transferred to **Hypass Online®**. The CDF cannot be modified by a service technician. However, a replacement file (with alternate options [SEF]) can be loaded into a truck VSM by a service technician.

A non-blank VSM or display panel is one that has been used previously. A non-blank VSM or display panel is not usable outside of the system it was originally connected to. In other words, a VSM or display panel cannot be removed from one lift truck and installed onto another lift truck. If a VSM or display panel must be replaced, a new part (blank) must be used. See the **Parts Manual** for part numbers for replacement parts.

PC SERVICE TOOL SOFTWARE

To perform diagnostic service, the PC Service Tool software can be used. To connect the PC Service Tool, remove the dust cover that covers the PC service tool diagnostic connector on the right side of the steering column and connect the interface cable (Hyster Part No. 1534010) to the PC service tool diagnostic connector. See Figure 155. All transfers will create a transfer log on the PC's hard drive and can be accessed by service personnel. The file transfer log will include all serial number transfers and other configuration information related to a specific truck. For minimum PC requirements to run the software, refer to the PC Service Tool Installation and Use Guide, Systems Requirements section.



1. DUST COVER
2. TILT MEMORY LEVER

Figure 155. Connecting PC Service Tool

Fuses and Relays

Fuses

WARNING

Disconnect the battery and separate the connector before opening the compartment cover or inspecting/repairing the electrical system. If a tool causes a short circuit, the high-current flow from the battery can cause an injury or parts damage.

WARNING

Use only fuses of the same type and rating as specified in Figure 156, Figure 157, and Figure 158. Replacing fuses of a different type or with higher or lower amperage ratings than specified may cause injury or parts damage.

WARNING

Discharge capacitors as directed in Discharging the Capacitors in the General section at the beginning of this manual.

The fuse panel for lift trucks covered in this service manual are located in the counterweight. For lift truck models E2.2-3.5XN (E45-70XN) (A268) and E1.6-2.0XN (E30-40XN) (A269) , fuses are located on back wall and right side of counterweight, just above traction motor controller. See Figure 156.

For lift truck models J2.2-3.5XN (J45-70XN) (A276) and J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) , fuses are mounted on same bracket as line contactor. The fuses and line contactor assembly bracket is mounted to a crossmember in the center of counterweight.

See Figure 157 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276)

See Figure 158 for lift truck models

- J4.0-5.0XN (J80-100XN) (A970) manufactured before November 2014

See Figure 159 for lift truck models

- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) manufactured after November 2014

The fuse panel for lift truck model E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099) is located

under counterweight cover above and centered between motor controllers. See Figure 158.

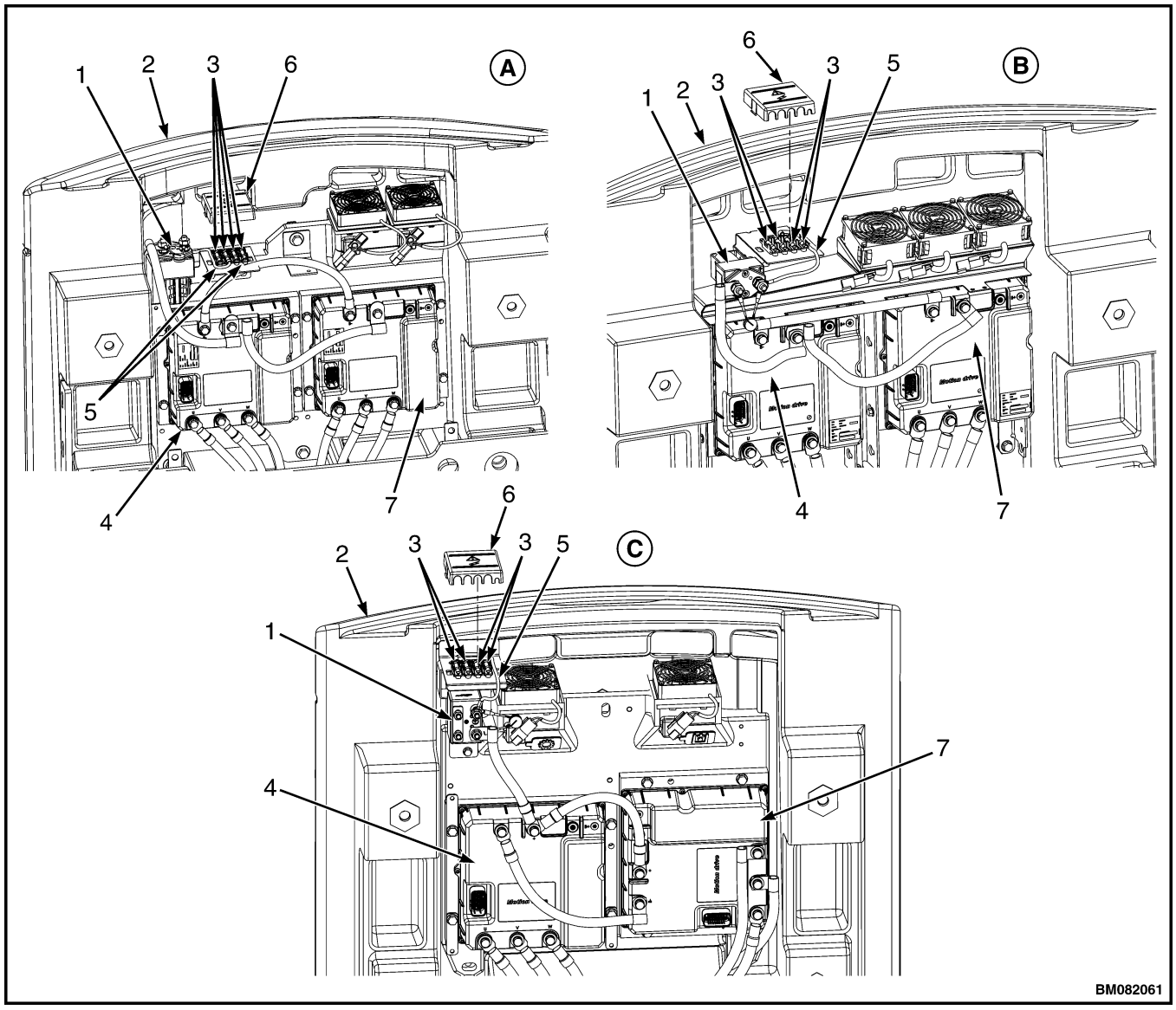


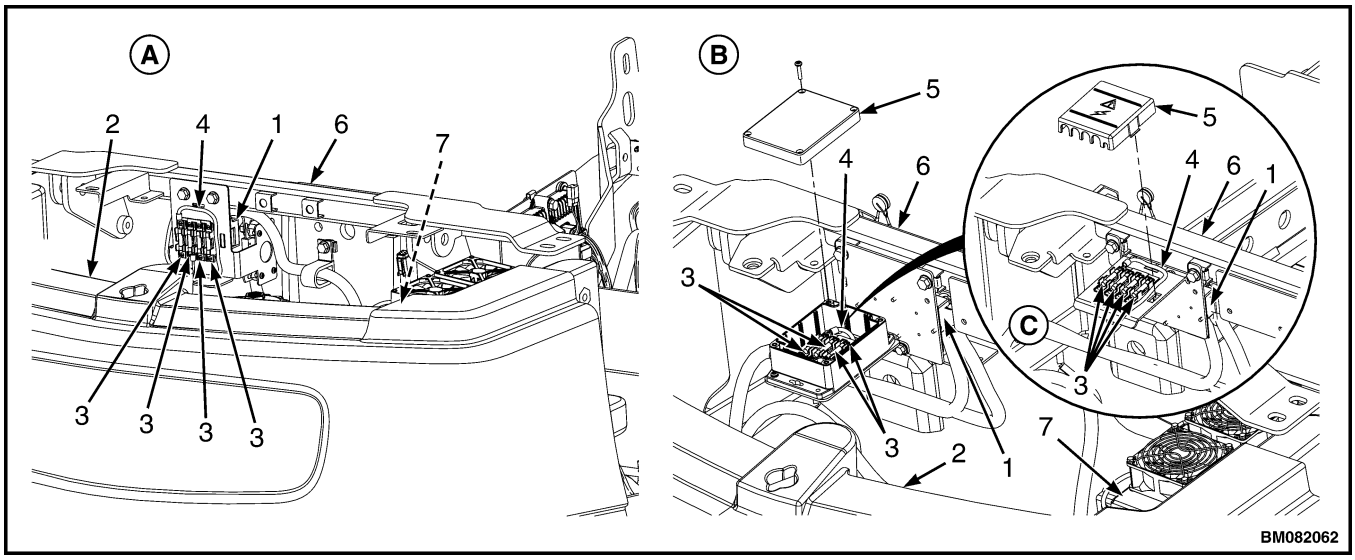
Figure 156. Fuse Location for Lift Truck Models and E2.2-3.5XN (E45-70XN) (A268) E1.6-2.0XN (E30-40XN) (A269)

Legend for Figure 156.

NOTE: STANDARD PERFORMANCE CONTROLLER SHOWN. ENHANCED PERFORMANCE IS SIMILAR.

A. FUSE LOCATION FOR LIFT TRUCK MODELS E2.2-3.5XN (E45-70XN) (A268) MANUFACTURED BEFORE SEPTEMBER, 2011
B. FUSE LOCATION FOR LIFT TRUCK MODELS E2.2-3.5XN (E45-70XN) (A268) MANUFACTURED AFTER SEPTEMBER, 2011
C. FUSE LOCATION FOR LIFT TRUCK MODEL E1.6-2.0XN (E30-40XN) (A269) MANUFACTURED BEFORE NOVEMBER 2014 SHOWN. FUSE LOCATION FOR LIFT TRUCK MODEL E30-40XN (A269) MANUFACTURED AFTER NOVEMBER 2014 IS THE SAME.

1. LINE CONTACTOR
2. COUNTERWEIGHT
3. FUSES (5 AMPS AND 15 AMPS)
4. TRACTION MOTOR CONTROLLER
5. FUSE WIRES
6. FUSE COVER
7. HYDRAULIC PUMP AND MOTOR CONTROLLER

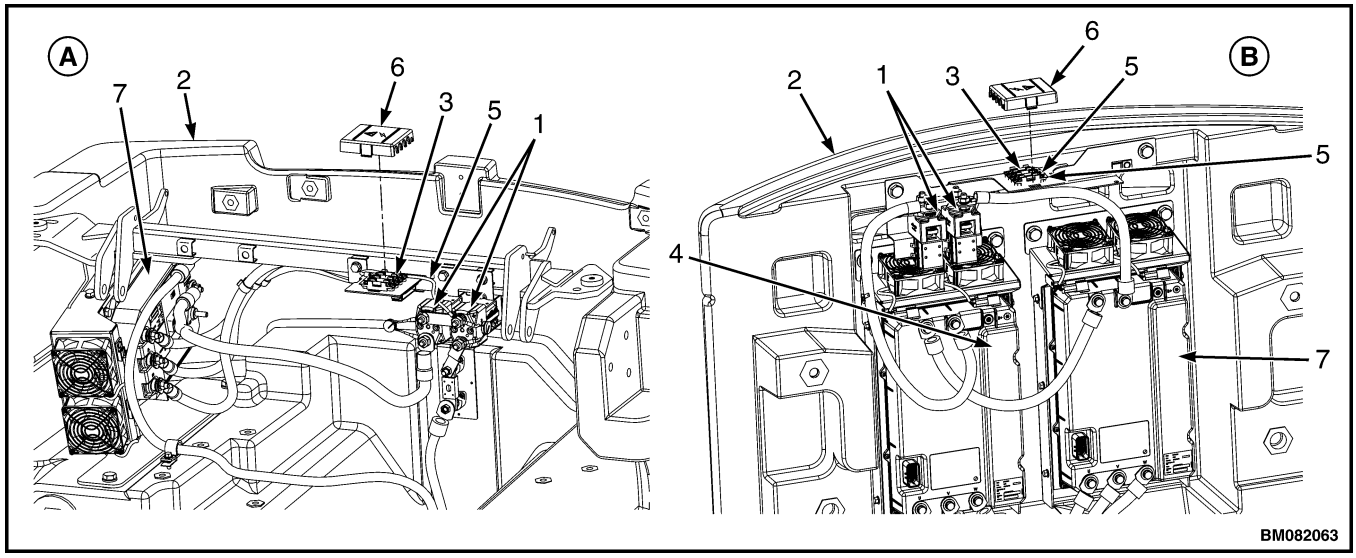


NOTE: STANDARD PERFORMANCE CONTROLLER SHOWN. ENHANCED PERFORMANCE IS SIMILAR.

A. FUSE LOCATION ON LIFT TRUCK MODELS MANUFACTURED BEFORE SEPTEMBER, 2009 (STANDARD APPLICATION)
B. FUSE LOCATION ON LIFT TRUCK MODELS MANUFACTURED AFTER NOVEMBER, 2013 (OUTDOOR APPLICATION)
C. FUSE LOCATION ON LIFT TRUCK MODELS MANUFACTURED AFTER SEPTEMBER, 2009 (STANDARD APPLICATION)

1. LINE CONTACTOR
2. COUNTERWEIGHT
3. FUSES (5 AMPS AND 15 AMPS)
4. FUSE WIRES
5. FUSE COVER
6. CROSSMEMBER
7. HYDRAULIC PUMP AND MOTOR CONTROLLER

Figure 157. Fuse Locations for Lift Truck Models J2.2-3.5XN (J45-70XN) (A276)

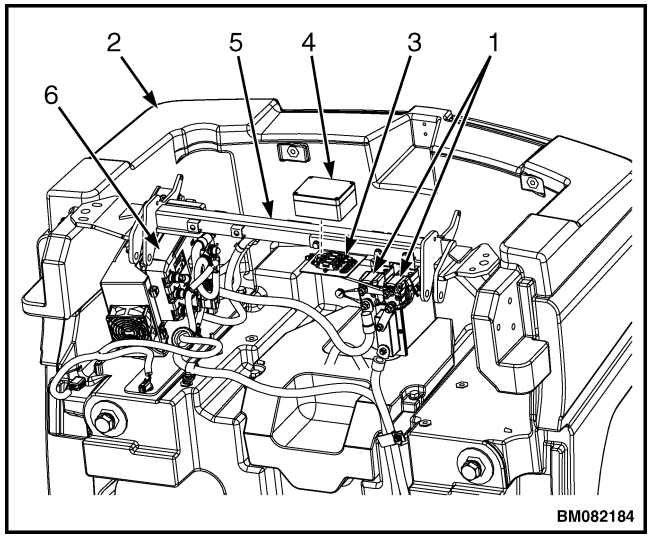


NOTE: STANDARD PERFORMANCE CONTROLLER SHOWN. ENHANCED PERFORMANCE IS SIMILAR.

A. FUSE LOCATION ON LIFT TRUCK MODELS E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)
B. FUSE LOCATION ON LIFT TRUCK MODELS J4.0-5.0XN (J80-100XN) (A970)

1. LINE CONTACTOR
2. COUNTERWEIGHT
3. FUSES (5 AMPS AND 15 AMPS)
4. FUSE WIRES
5. FUSE COVER
6. CROSSMEMBER
7. HYDRAULIC PUMP AND MOTOR CONTROLLER

Figure 158. Fuse Locations for Lift Truck Models Manufactured Before November 2014 and J4.0-5.0XN (J80-100XN) (A970) E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)



NOTE: STANDARD PERFORMANCE CONTROLLER SHOWN. ENHANCED PERFORMANCE IS SIMILAR.

1. LINE CONTACTOR
2. COUNTERWEIGHT
3. FUSES (5 AMPS AND 15 AMPS)
4. FUSE COVER
5. CROSSMEMBER
6. HYDRAULIC PUMP AND MOTOR CONTROLLER

Figure 159. Fuse Locations for Lift Truck Models Manufactured After November 2014J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

Remove the counterweight cover for access to the fuses.

See Figure 160 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268)
- E1.6-2.0XN (E30-40XN) (A269)
- E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

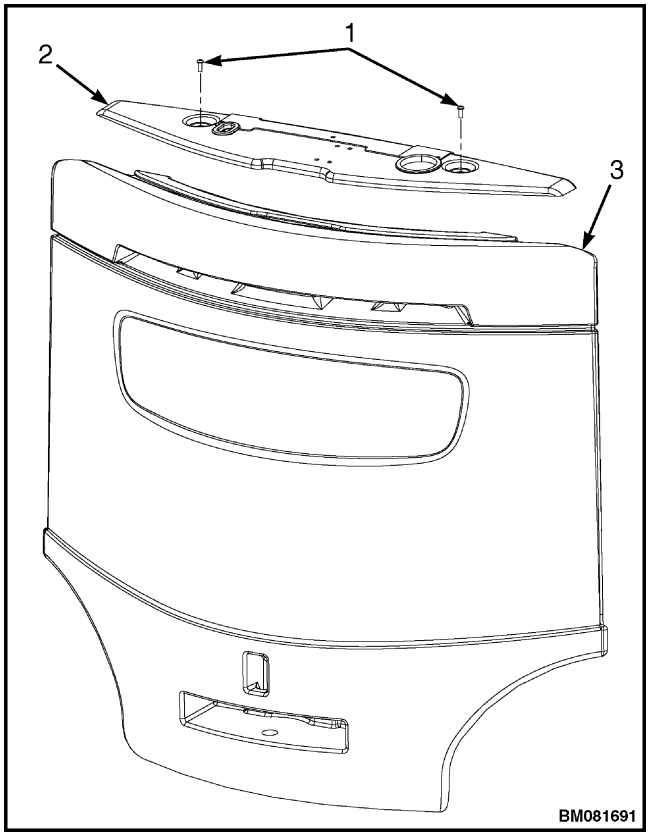
See Figure 161or Figure 162 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276)
- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

Fuses must be checked with a multimeter. Discharge capacitors as specified in Discharging the Capacitors in General section at the beginning of this service manual.

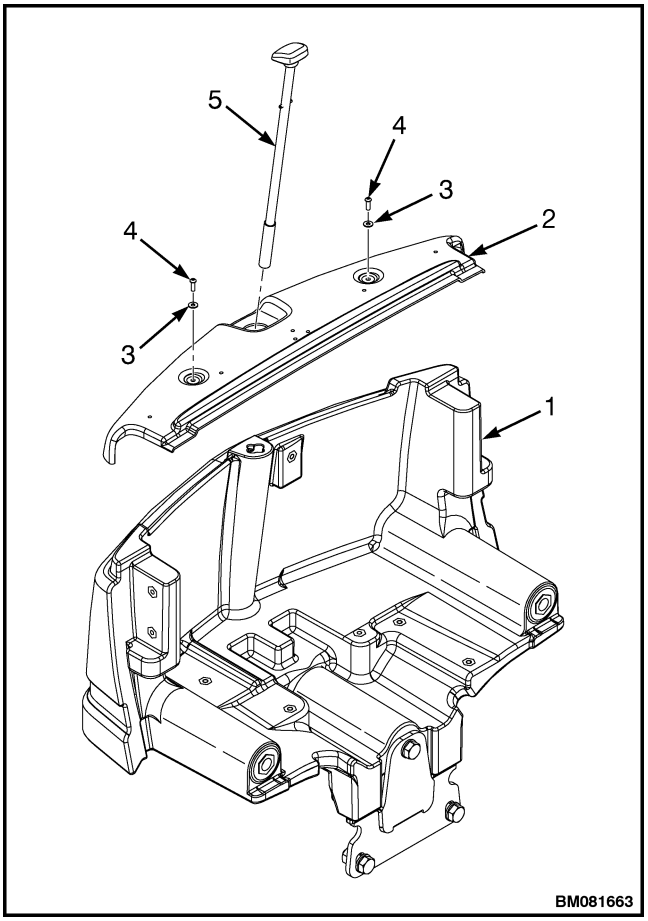
Before replacing any failed fuses, check to see what caused the fuse to open before connecting the battery. Make certain to replace any failed fuse with one of the same type and amperage.

For lift truck models J2.2-3.5XN (J45-70XN) (A276) , equipped with Outdoor Protection/Wash-down Package, spray fuse connection with rust inhibitor-ignition sealer.



1. CAPSCREWS
2. COUNTERWEIGHT COVER
3. COUNTERWEIGHT

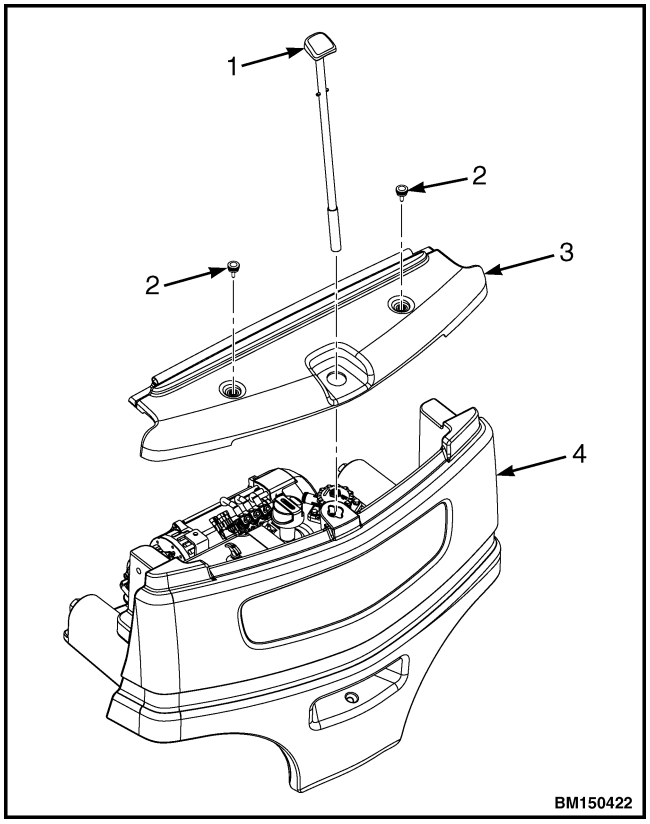
Figure 160. Counterweight Cover Removal, Lift Truck Models and E2.2-3.5XN (E45-70XN) (A268), E1.6-2.0XN (E30-40XN) (A269), E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)



NOTE: COUNTERWEIGHT FOR LIFT TRUCK MODELS J2.2-3.5XN (J45-70XN) (A276) SHOWN. COUNTERWEIGHT FOR LIFT TRUCK MODELS J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) IS SIMILAR.

1. COUNTERWEIGHT
2. COUNTERWEIGHT COVER
3. WASHER
4. CAPSCREWS
5. TOW PIN

Figure 161. Counterweight Cover Removal, Lift Truck Models and J2.2-3.5XN (J45-70XN) (A276) J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)



1. TOW PIN
2. KNOB SCREWS
3. COUNTERWEIGHT COVER
4. COUNTERWEIGHT

Figure 162. Counterweight Cover Removal, Lift Truck Models Manufactured After November, 2015J2.2-3.5XN (J45-70XN) (A276)

Relays

WARNING

Disconnect the battery and separate the connector before opening the compartment cover or inspecting/repairing the electrical system. If a tool causes a short circuit, the high-current flow from the battery can cause an injury or parts damage.

WARNING

Discharge capacitors as directed in Discharging the Capacitors in the General section at the beginning of this manual.

NOTE: When replacing relays, use only Hyster approved relays.

On lift truck models E2.2-3.5XN (E45-70XN) (A268) and E1.6-2.0XN (E30-40XN) (A269) , relays and receptacles are mounted in the center of front bulkhead.

On lift truck models J2.2-3.5XN (J45-70XN) (A276), J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970), and E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099) , relays and receptacles are mounted on left side of front bulkhead, near Vehicle Systems Manager (VSM).

For lift truck models J2.2-3.5XN (J45-70XN) (A276) , equipped with Outdoor Protection/Wash-down Package, control circuit relays are sealed relays with sealed connectors or fitted with individual weatherproof covers.

See Figure 163 for the following lift truck models manufactured before November 2014

- E2.2-3.5XN (E45-70XN) (A268)
- J2.2-3.5XN (J45-70XN) (A276)
- J4.0-5.0XN (J80-100XN) (A970)
- E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

See Figure 164 for the following lift truck models manufactured before November 2014

- E1.6-2.0XN (E30-40XN) (A269)

See Figure 165 for the following lift truck models manufactured after November 2014

- E45-70XN (A268)
- J2.2-3.5XN (J45-70XN) (A276)

See Figure 166 for the following lift truck models manufactured after November 2014

- E80-120XN, E100XNS (A099)

See Figure 167 for the following lift truck models manufactured after November 2014

- E30-40XN (A269)

See Figure 168 for the following lift truck models manufactured after November 2014

- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

1. Remove floor mat and floor plate for access to relays.

2. Remove relay from receptacle.

   See Figure 163 for the following lift truck models manufactured before November 2014

   - E2.2-3.5XN (E45-70XN) (A268)
   - J2.2-3.5XN (J45-70XN) (A276)
   - J4.0-5.0XN (J80-100XN) (A970)
   - E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

   See Figure 164 for the following lift truck models manufactured before November 2014

   - E1.6-2.0XN (E30-40XN) (A269)

   See Figure 165 for the following lift truck models manufactured after November 2014

   - E45-70XN (A268)
   - J2.2-3.5XN (J45-70XN) (A276)

   See Figure 166 for the following lift truck models manufactured after November 2014

   - E80-120XN, E100XNS (A099)

   See Figure 167 for the following lift truck models manufactured after November 2014

   - E30-40XN (A269)

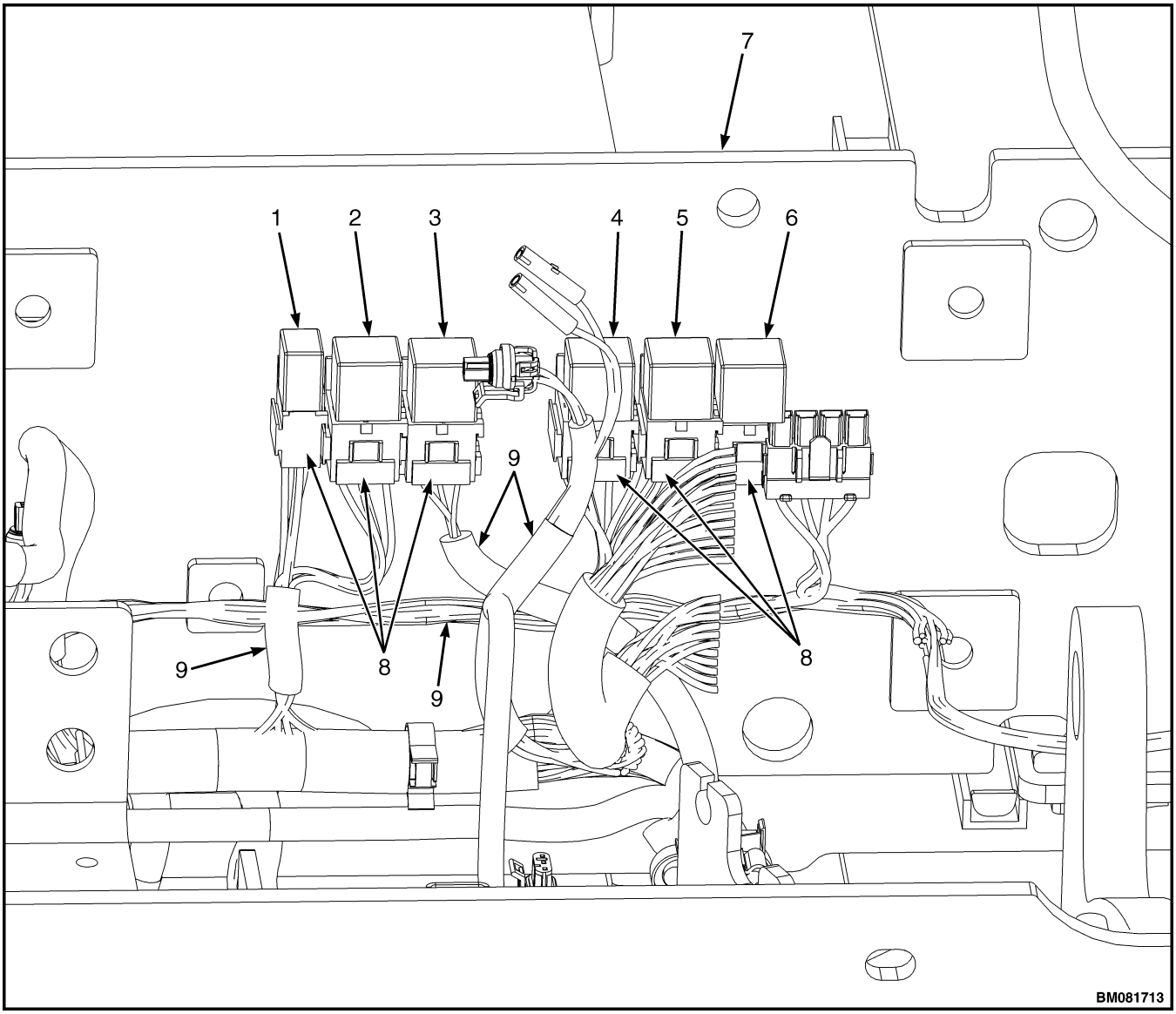
   See Figure 168 for the following lift truck models manufactured after November 2014

   - J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

3. For lift truck models J2.2-3.5XN (J45-70XN) (A276) , equipped with Outdoor Protection/ Wash-down Package, apply dielectric grease to flasher relay terminal connections.

4. Replace with new relay by aligning the relay with mounting holes in receptacle.

5. Install floor plate and floor mat.



NOTE: RELAYS FOR LIFT TRUCK MODELS E2.2-3.5XN (E45-70XN) (A268) SHOWN. RELAYS FOR TRUCKS EQUIPPED WITH OPTIONAL E-HYDRAULICS, OPTIONAL SYNCHRONOUS STEERING, AND OTHER OPTIONS SHOWN.

1. KEYSWITCH RELAY (12 VOLTS)
2. E-HYDRAULIC RELAY (24 VOLTS)
3. SYNCHRONOUS STEER VALVE RELAY (24 VOLTS)
4. BRAKE LIGHT RELAY (24 VOLTS)
5. REVERSE RELAY (24 VOLTS)
6. TURN SIGNAL RELAY (24 VOLTS)
7. FRONT BULKHEAD
8. RECEPTACLE
9. WIRE HARNESS

Figure 163. Relay Replacement for Lift Truck Models Manufactured Before November 2014E2.2-3.5XN (E45-70XN) (A268), J2.2-3.5XN (J45-70XN) (A276), J4.0-5.0XN (J80-100XN) (A970), and E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

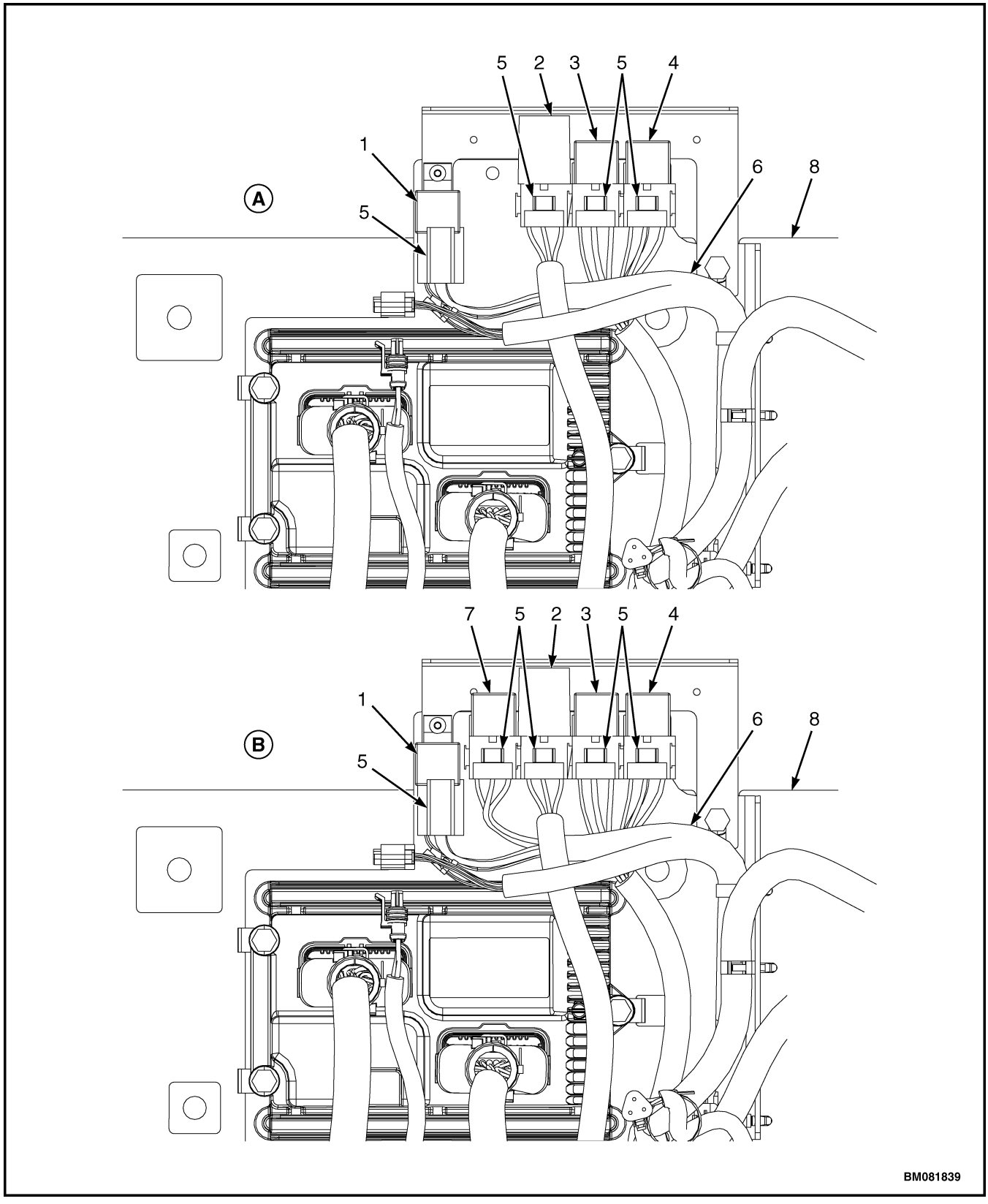


Figure 164. Relay Replacement for Lift Truck Model Manufactured Before November 2014E1.6-2.0XN (E30-40XN) (A269)

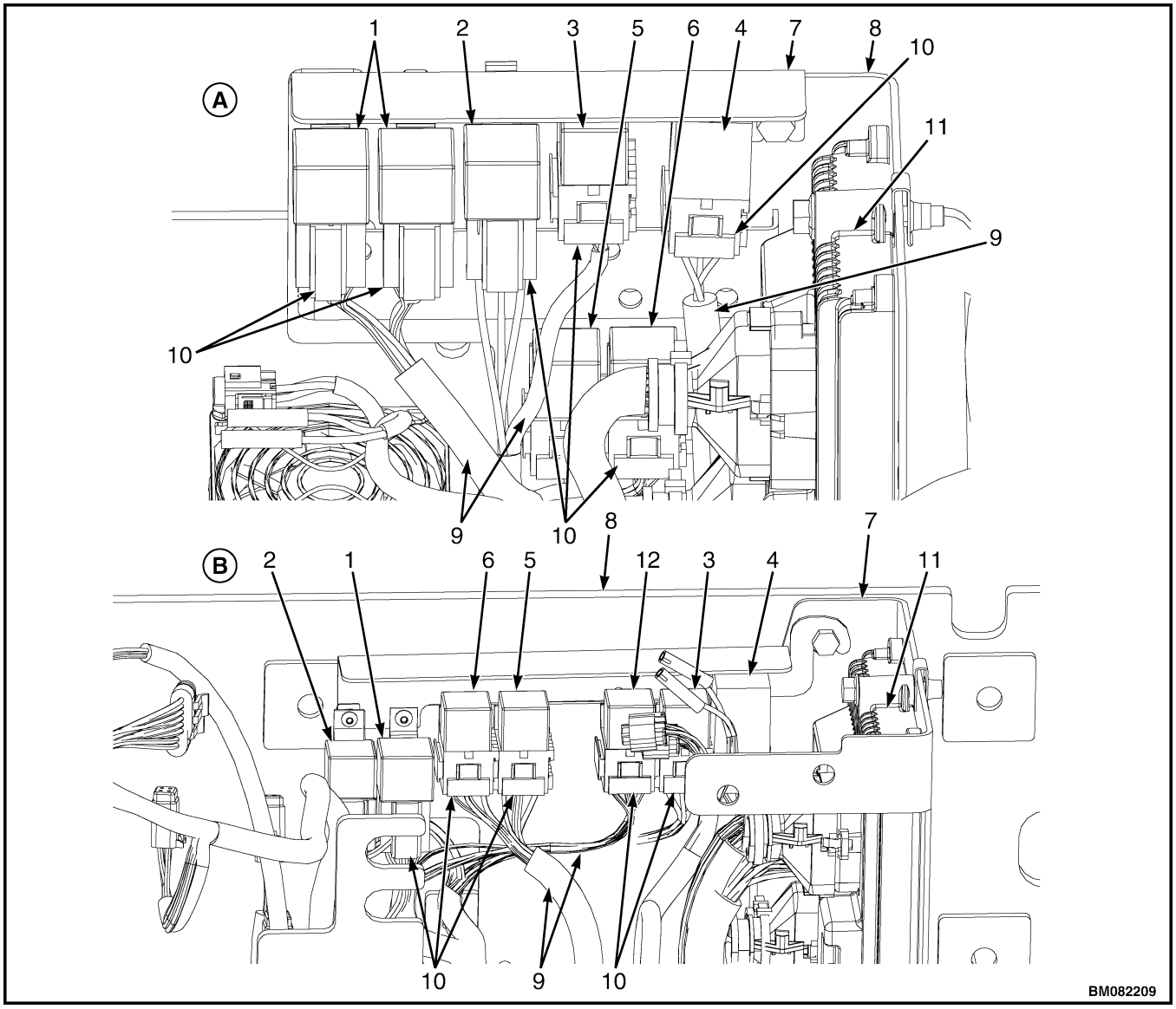
Legend for Figure 164.

A. MANUAL HYDRAULICS

1. KEY SWITCH RELAY
2. FLASHER (TURN SIGNAL OPTION) RELAY
3. BRAKE LIGHT RELAY
4. REVERSE RELAY

B. E-HYDRAULICS

5. RECEPTACLE
6. WIRE HARNESS
7. E-HYDRAULIC ENABLE RELAY
8. FRONT BULKHEAD

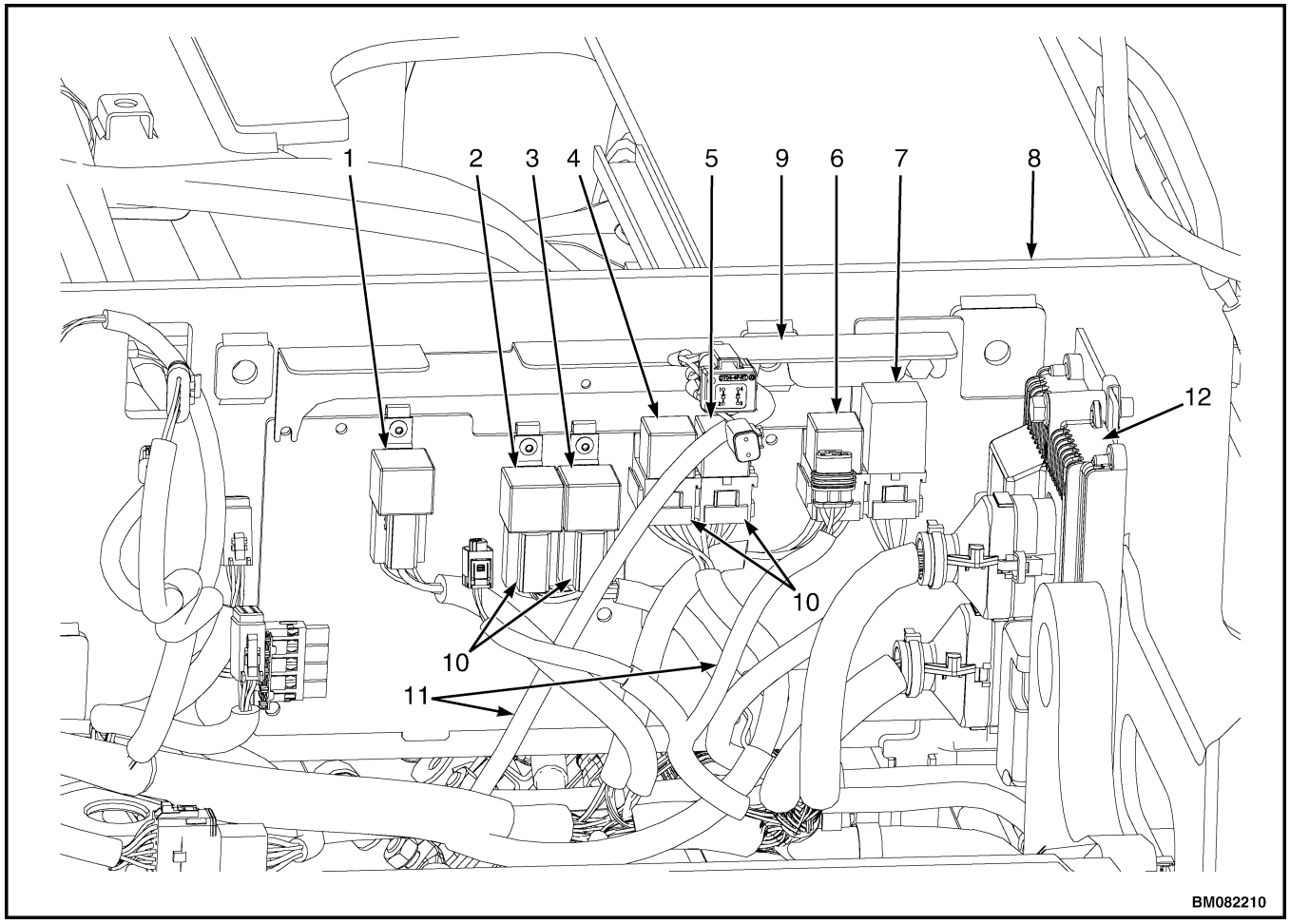


A. RELAY ARRANGEMENT, LIFT TRUCK MODELS J2.2-3.5XN (J45-70XN) (A276)

B. RELAY ARRANGEMENT, LIFT TRUCK MODELS E45-70XN (A268)

1. PUMP FAN (12VOLTS)
2. KEY SWITCH (12 VOLTS)
3. E-HYDRAULIC RELAY (24 VOLTS)
4. TURN SIGNAL (24 VOLTS)
5. REVERSE RELAY (24 VOLTS)
6. BRAKE LIGHT (24 VOLTS)
7. MOUNTING BRACKET
8. FRONT BULKHEAD
9. WIRE HARNESS
10. RECEPTACLE
11. VEHICLE SYSTEMS MANAGER
12. SYNCHRONOUS STEERING (24 VOLTS)

Figure 165. Relay Replacement for Lift Truck Models Manufactured After November 2014E45-70XN (A268) and J2.2-3.5XN (J45-70XN) (A276)



1. KEY SWITCH (12VOLTS)
2. TRACTION MOTOR FAN (12 VOLTS)
3. HYDRAULIC PUMP AND MOTOR FAN RELAY (12 VOLTS)
4. REVERSE RELAY (24 VOLTS)
5. BRAKE LIGHT (24 VOLTS)
6. E-HYDRAULIC RELAY (24 VOLTS)
7. TURN SIGNAL FLASHER (24 VOLTS)
8. FRONT BULKHEAD
9. MOUNTING BRACKET
10. RECEPTACLE
11. WIRE HARNESS
12. VEHICLE SYSTEMS MANAGER

Figure 166. Relay Replacement for Lift Truck Models Manufactured After November 2014E80-120XN, E100XNS (A099)

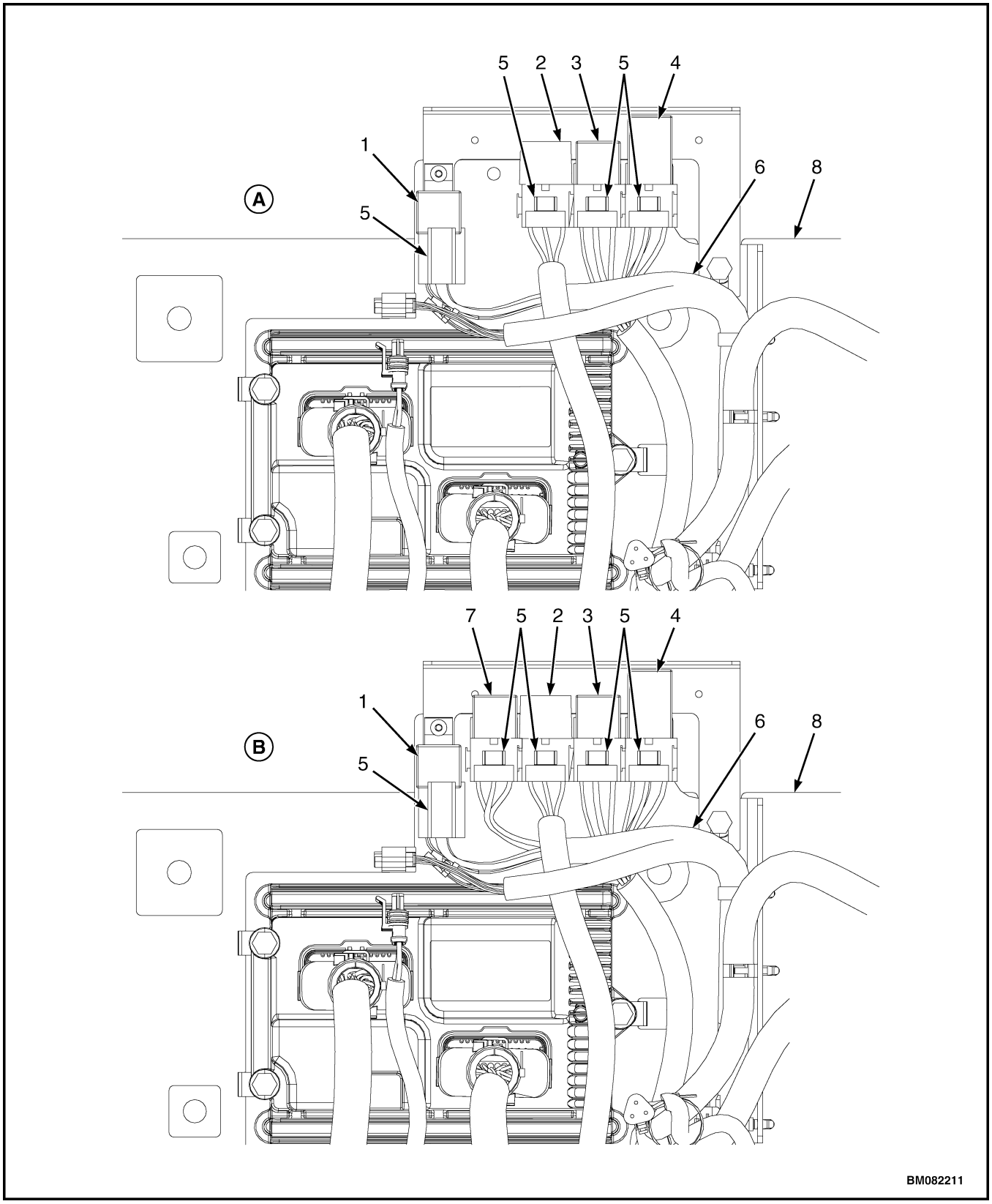
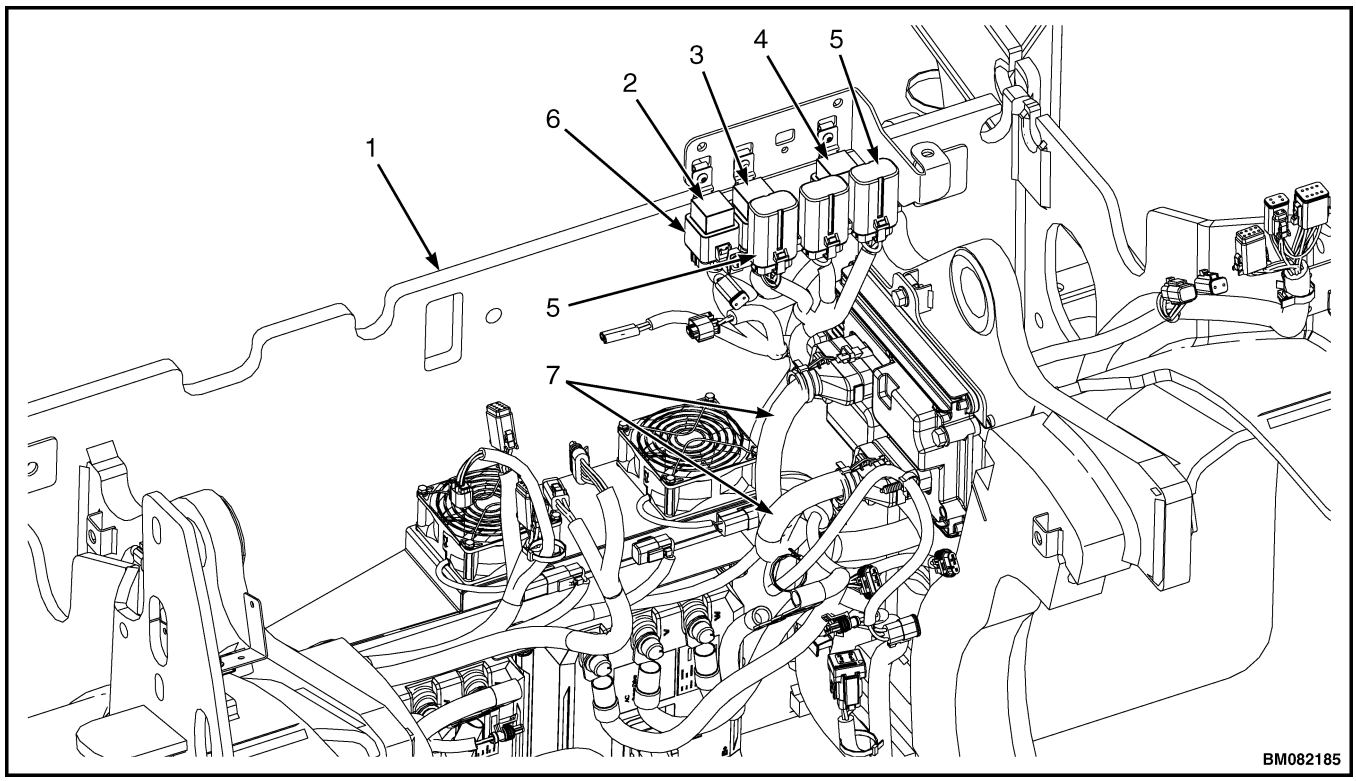


Figure 167. Relay Replacement for Lift Truck Model Manufactured After November 2014E30-40XN (A269)

Legend for Figure 167.

A. MANUAL HYDRAULICS
B. E-HYDRAULICS

1. KEY SWITCH RELAY
2. FLASHER (TURN SIGNAL OPTION) RELAY
3. BRAKE LIGHT RELAY
4. REVERSE RELAY
5. RECEPTACLE
6. WIRE HARNESS
7. E-HYDRAULIC ENABLE RELAY
8. FRONT BULKHEAD



1. FRONT BULKHEAD
2. E-HYDRAULIC RELAY (24 VOLTS)
3. REVERSE RELAY (24 VOLTS)
4. BRAKE LIGHT RELAY (24 VOLTS)
5. FAN RELAY (24 VOLTS)
6. RECEPTACLE
7. WIRE HARNESS

Figure 168. Relay Replacement for Lift Truck Models Manufactured After November 2014J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

Backup Alarm

WARNING

DO NOT operate a truck if the backup alarm does not function properly. Injury to personnel may occur.

A backup alarm is used to indicate backwards travel. When backing up, the operator may be preoccupied with the position of the mast or carriage or have a restricted range of visibility. The backup alarm sounds when the lift truck is moved backwards to alert nearby traffic to pay close attention when near the lift truck. The alarm is located inside of the counterweight.

See Figure 169 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268)
- J2.2-3.5XN (J45-70XN) (A276)
- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

See Figure 170 for lift truck models

- E1.6-2.0XN (E30-40XN) (A269)

See Figure 171 for lift truck model

- E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

If backup alarm is not functioning properly, remove counterweight cover for access.

See Figure 160 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268)
- E1.6-2.0XN (E30-40XN) (A269)
- E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

See Figure 161 or Figure 162 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276)
- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

Test voltage to backup alarm by sitting in seat and moving Direction Control Switch (DCS) to reverse position. When proper voltage (12 to 48 volts) is reaching the assembly yet no sound is produced, the assembly must be replaced. Disconnect alarm connector from lighting wiring harness. Remove two capscrews attaching alarm to mounting plate. Position new backup alarm as removed and secure using two capscrews. Tighten capscrews to 3.5 to 4 N•m (31 to 35 lbf in). Connect alarm connector as removed and test for proper operation. Install counterweight cover and return to service.

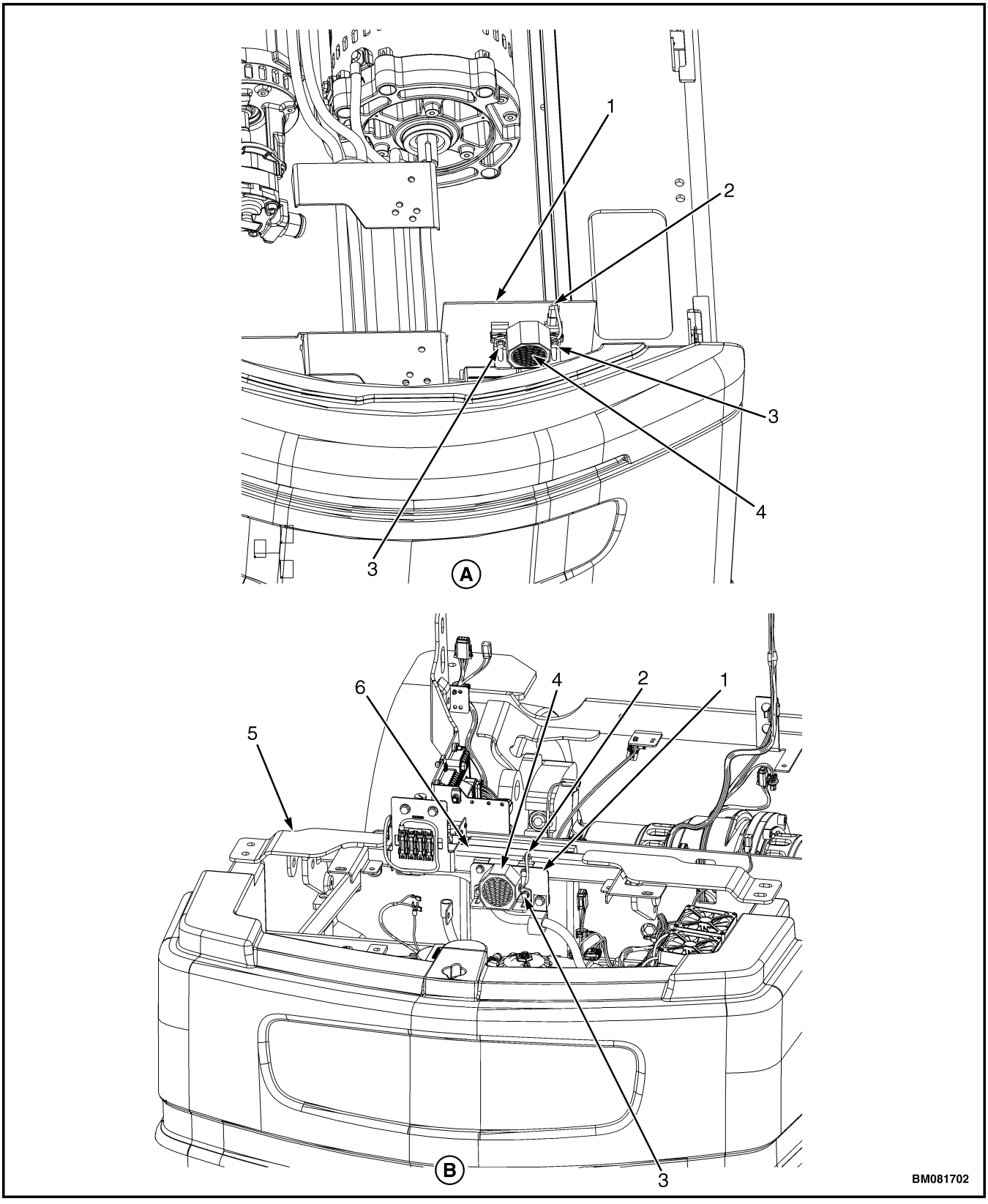


Figure 169. Backup Alarm for Lift Truck Models , , and E2.2-3.5XN (E45-70XN) (A268) J2.2-3.5XN (J45-70XN) (A276) J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

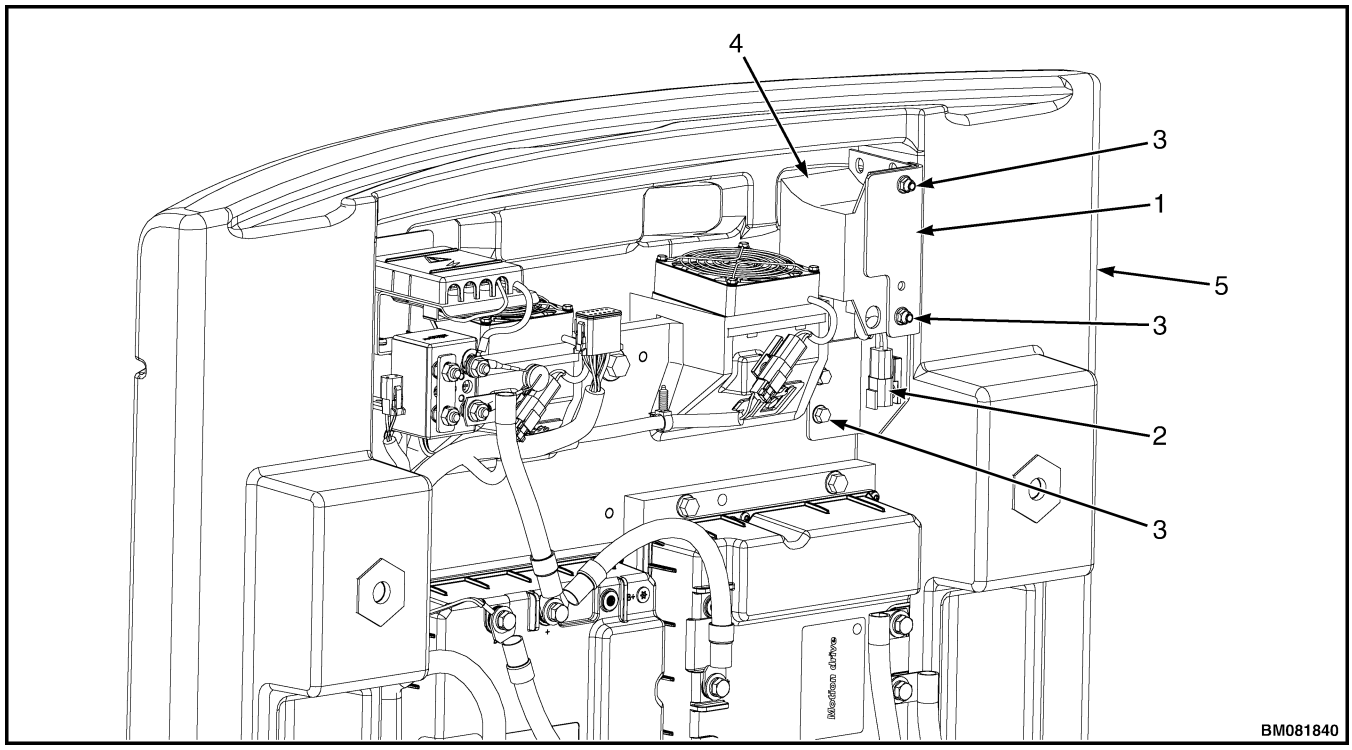
Legend for Figure 169.

NOTE: SEVERAL COMPONENTS OMITTED FOR CLARITY.

A. BACKUP ALARM LOCATION FOR LIFT TRUCK MODELS E2.2-3.5XN (E45-70XN) (A268)

B. BACKUP ALARM LOCATION FOR LIFT TRUCK MODELS J2.2-3.5XN (J45-70XN) (A276) AND J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

1. MOUNTING PLATE
2. ALARM CONNECTOR
3. CAPSCREW
4. BACKUP ALARM
5. COUNTERWEIGHT
6. CROSSMEMBER



1. MOUNTING PLATE
2. ALARM CONNECTOR
3. CAPSCREW
4. BACKUP ALARM
5. COUNTERWEIGHT

Figure 170. Backup Alarm for Lift Truck Model E1.6-2.0XN (E30-40XN) (A269)

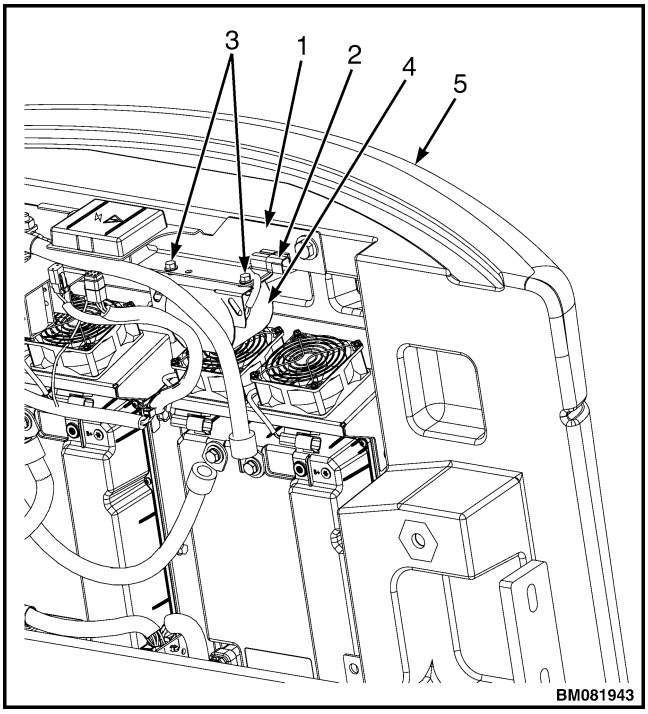


Figure 171. Backup Alarm for Lift Truck Model E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

Legend for Figure 171.

1. MOUNTING PLATE
2. ALARM CONNECTOR
3. CAPSCREW
4. BACKUP ALARM
5. COUNTERWEIGHT

Battery Connection

The battery cables supply power from the battery terminals through the battery cable connectors and then to the connections of the motor controllers and main contactor in the truck.

INSPECT

Inspect battery cables for cuts or damage to insulation. Inspect for abrasions of insulation or burned insulation or connector ends. Inspect battery connectors for worn or damaged cable ends or cracked housings. Overheated cables or heat affected terminal lug ends are signs of cable damage, loose connections, or improper battery charging or maintenance. Replace any damaged cables and repair or replace damaged battery connectors.

REPLACING CABLES

WARNING

Making repairs with the battery connected can cause a short circuit. Disconnect the battery by separating the connectors before inspecting or repairing the electrical system.

Be careful using tools near the battery terminals. Contact between terminals can cause a short circuit. High current flow during a short circuit can result in injury or parts damage.

1. Move lift truck to a safe, level area and completely lower mast. Turn key switch to **OFF** position and attach a **DO NOT OPERATE** tag to control handle. Block drive wheel to prevent unexpected movement.

2. Pull connector (battery side) from fixed connector (truck side) to separate battery cable connectors. See Figure 172.

3. If power cables or connector (battery side) are damaged, replace cables:

   a. Remove battery from lift truck. See **Operating Manual** or **Periodic Maintenance** for procedures to remove battery from lift truck.

   b. Disconnect cables from battery terminals.

   c. Install new cables.

   d. Reinstall battery to lift truck. See **Operating Manual** or **Periodic Maintenance** for procedures to install battery in lift truck.

   e. Connect battery connectors.

4. If power cables or connector (truck side) are damaged, replace cables:

   a. For lift trucks manufactured before June 2012:

      Remove floor mat. Remove rear floor plate. Remove capscrews and washers from front floor plate and lift front floor plate up enough to disconnect accelerator pedal or MONOTROL® pedal. See Figure 120. Remove front floor plate with accelerator or MONOTROL® pedal still attached for access to main contactor.

      For lift trucks manufactured after June 2012:

      Remove floor mat. Remove rear floor plate. Lift front floor plate up enough to disconnect accelerator pedal or MONOTROL® pedal. See Figure 33. Remove front floor plate with accelerator or MONOTROL® pedal still attached for access to main contactor.

   b. Discharge capacitors. See Discharging the Capacitors in General section of this manual for procedures.

NOTE: Make note of position of cables for proper reinstallation.

   c. Remove nuts securing cables to terminals of main contactor. Remove cables from terminals.

   d. Remove two clamps securing cables to frame inside electrical compartment. One cable is on top of hydraulic filter and the other is under hydraulic motor.

   e. Remove hardware securing connector (truck side) to mounting bracket.

   f. Remove power cables from lift truck.

   g. Route new cables into electrical compartment.

   h. Secure connector to mounting bracket using capscrews and attaching hardware.

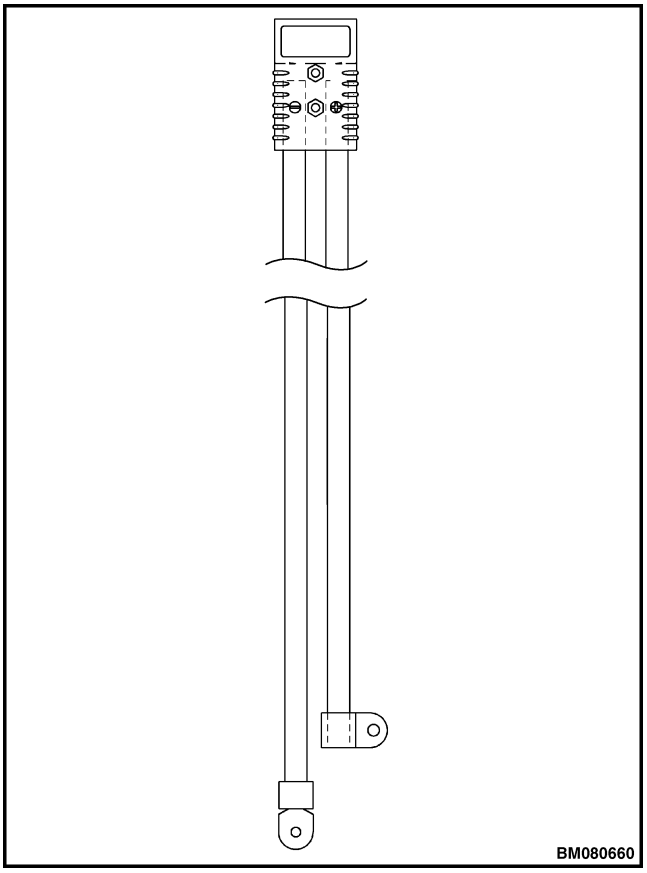


Figure 172. Battery Connector and Cables

i. Position power cables onto terminals as removed. Secure cables to terminals of main contactor and hoist controller using attaching hardware. Tighten hardware to 18 to 21 N•m (159 to 186 lbf in).

j. Install two clamps securing power cables to frame inside electrical compartment as removed.

k. Connect accelerator pedal or MONOTROL® pedal, (see Figure 120) and install front floor plate using capscrews and washers. Install rear floor plate. Install floor mat and connect the battery.

Cab Heater

For repair procedures on the cab heater refer to section **Operator's Cab** 0100SRM1446.

Lights

GENERAL

WARNING

Before replacing any of the lights, fully lower all parts of the mast and tilt it forward until the tips of the forks touch the ground. This action will prevent the mast from lowering suddenly if the control lever is accidently moved.

Never have any metal on your fingers, arms, or neck. These metal items can accidentally create an electrical connection and cause an injury.

WARNING

Discharge capacitors as directed in Discharging the Capacitors in General section of this manual.

Disconnect the battery before doing any work on the electrical system. Serious injury to personnel and/or damage to lift truck components can occur if battery is not disconnected.

CAUTION

A short circuit and damage can occur if wires are not installed correctly. Make sure wire connectors do not touch the other metal terminals or wire connectors, metal brackets, or the bracket mounting nuts. Make sure the wires are not pulled tight and are not touching other parts to damage the insulation.

Lift truck models E45-70XN (A268), J45-70XN (A276), J80-120XN, J100XNL (A970), E80-120XN, E100XNS (A099), and E30-40XN (A269) manufactured after November 2014 may be equipped with an option that automatically turns the front lights on whenever the key or keyless switch is turned on and go off when the key or keyless switch is turned off.

In addition, these lift truck models may also be equipped with a rear drive light that is activated whenever the lift truck travels in the reverse direction or reverse is selected with either the MONOTROL pedal or direction control switch.

There are no switches on the dash panel if lift truck is equipped with these light options. See the **Operating Manual** for procedures to check the operation of these light options.

There are several different options for lights used on lift trucks covered in this service manual. Your lift truck may not be equipped with all lights discussed in this section.

See Figure 173 for lift truck models

- E2.2-3.5XN (E45-70XN) (A268)
- J2.2-3.5XN (J45-70XN) (A276)
- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)
- E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

See Figure 174 for lift truck models

- E1.6-2.0XN (E30-40XN) (A269)

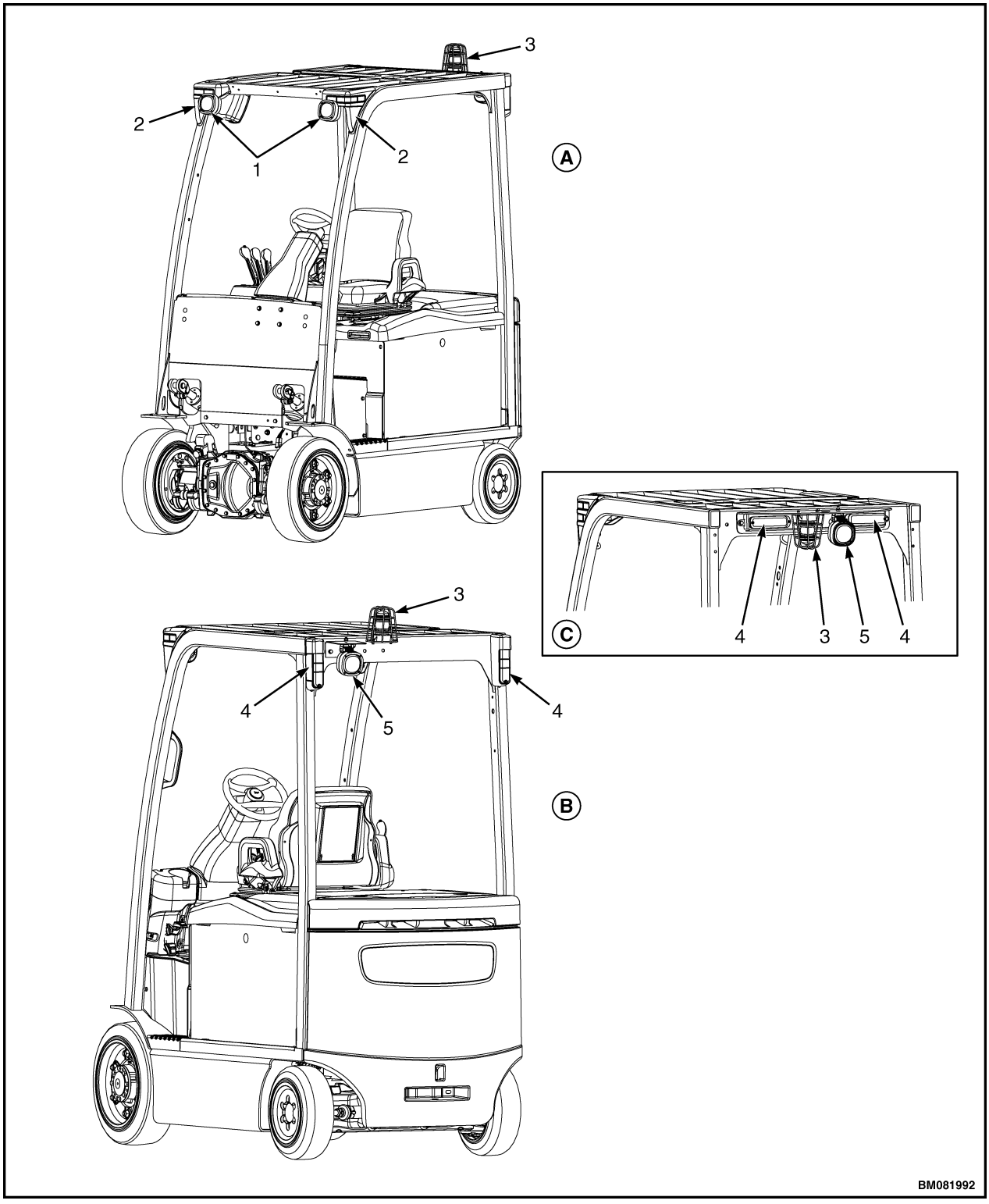


Figure 173. Lights Arrangement for Lift Truck Models and E2.2-3.5XN (E45-70XN) (A268), J2.2-3.5XN (J45-70XN) (A276), J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

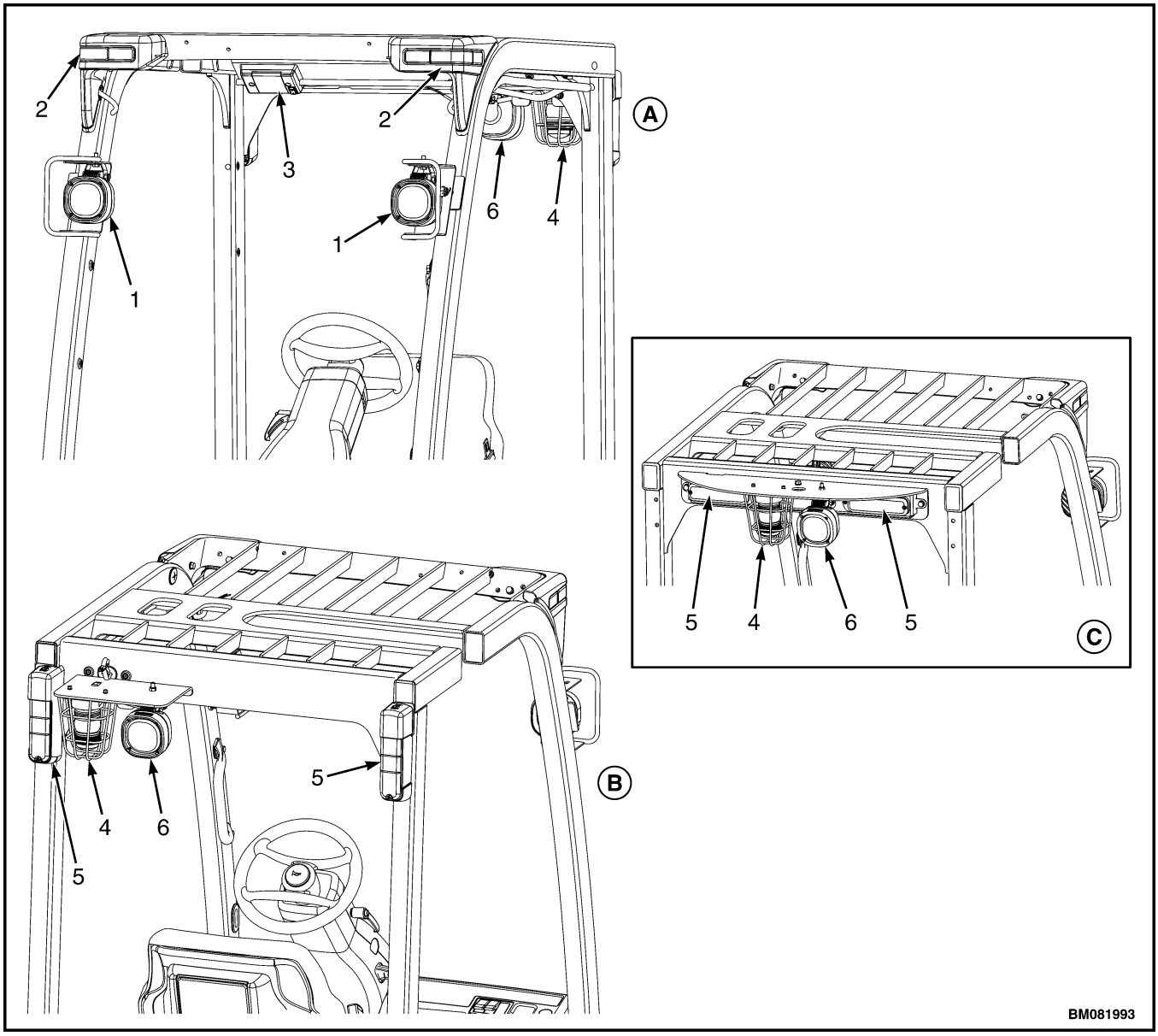
Legend for Figure 173.

NOTE: LIFT TRUCK MODELS E2.2-3.5XN (E45-70XN) (A268) SHOWN. LIGHTS ARRANGEMENT FOR LIFT TRUCK MODELS J2.2-3.5XN (J45-70XN) (A276) , J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) , AND E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099) IS THE SAME.

NOTE: FRONT AND REAR HALOGEN WORK LIGHTS SHOWN. FOR FRONT AND REAR LED LIGHTS, SEE LED LIGHTS.

A. FRONT VIEW
B. REAR VIEW BEFORE JUNE 2012
C. REAR VIEW AFTER JUNE 2012

1. FRONT WORK LIGHTS
2. FRONT MARKER/TURN SIGNAL LIGHTS
3. STROBE LIGHT
4. LED TAIL, BACKUP, AND BRAKE LIGHTS
5. REAR WORK LIGHTS



NOTE: FRONT AND REAR HALOGEN WORK LIGHTS SHOWN. FOR FRONT AND REAR LED LIGHTS, SEE LED LIGHTS.

A. FRONT VIEW
B. REAR VIEW BEFORE JUNE 2012
C. REAR VIEW AFTER JUNE 2012

1. FRONT WORK LIGHT
2. FRONT MARKER/TURN SIGNAL LIGHT
3. DOME LIGHT
4. STROBE LIGHT
5. TAIL, BACKUP, AND BRAKE LIGHT
6. REAR WORK LIGHT

Figure 174. Lights Arrangement for Lift Truck Model E1.6-2.0XN (E30-40XN) (A269)

WORK LIGHTS (FRONT AND REAR)

Halogen Bulb Lights

Remove

1. Read and follow **WARNING** and **CAUTION** section in General section above.
2. Disconnect negative battery cable from terminal.

CAUTION

DO NOT touch the Halogen bulb surface or inside reflectors with your bare hands. Oils from skin can lead to breakage or shorten the life of the lamp. Use clean gloves or lint free cloth for installation and removal.

Clean any dirt or oil, from the lamp surface with alcohol and a lint free cloth or tissue. Any foreign particles or materials on the bulb surface can cause hot spots on the bulb and result in lamp failure.

3. To replace bulb, remove lens assembly by removing four capscrews. See Figure 175. Replace bulb and reinstall lens assembly.
4. To replace work light assembly, disconnect overhead guard harness from light and remove capscrew, washer, and nut attaching work light to overhead guard for front work lights, or to mounting bracket for rear work lights.

Install

1. Install work light on overhead guard using capscrew, washer, and nut. See Figure 175. Tighten nut to 20 N•m (177 lbf in). Connect overhead guard harness to work light.
2. Connect negative battery cable to terminal.

LED Lights

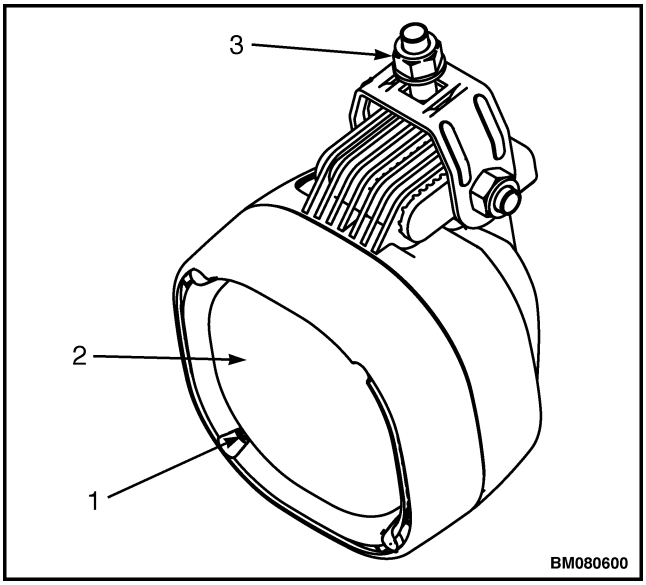
NOTE: LED work lights are an optional feature on lift trucks covered in this service manual. If LED work light malfunctions, the whole LED work light assembly must be replaced.

Remove

1. Read and follow **WARNING** and **CAUTION** section in General section above.
2. Disconnect negative battery cable from terminal.
3. Disconnect overhead guard harness from work light.
4. Remove locknut, washer, and capscrew and remove LED work light from overhead guard. See Figure 176.

Install

1. Install new LED work light assembly by using capscrew, washer, and locknut. For lift truck models manufactured before April, 2017, tighten locknut to 20 N•m (177 lbf in). For lift truck models manufactured after April, 2017, tighten locknut to 5 to 6 N•m (44 to 53 lbf in). See Figure 176.
2. Connect overhead guard harness to work light.
3. Connect negative battery cable to terminal.



NOTE: REAR WORK LIGHT SHOWN, FRONT WORK LIGHT IS SIMILAR.

1. CAPSCREWS (LENS ASSEMBLY)
2. LENS ASSEMBLY
3. NUT (ATTACHES LIGHT TO OVERHEAD GUARD)

Figure 175. Halogen Bulb Work Lights

STROBE LIGHT

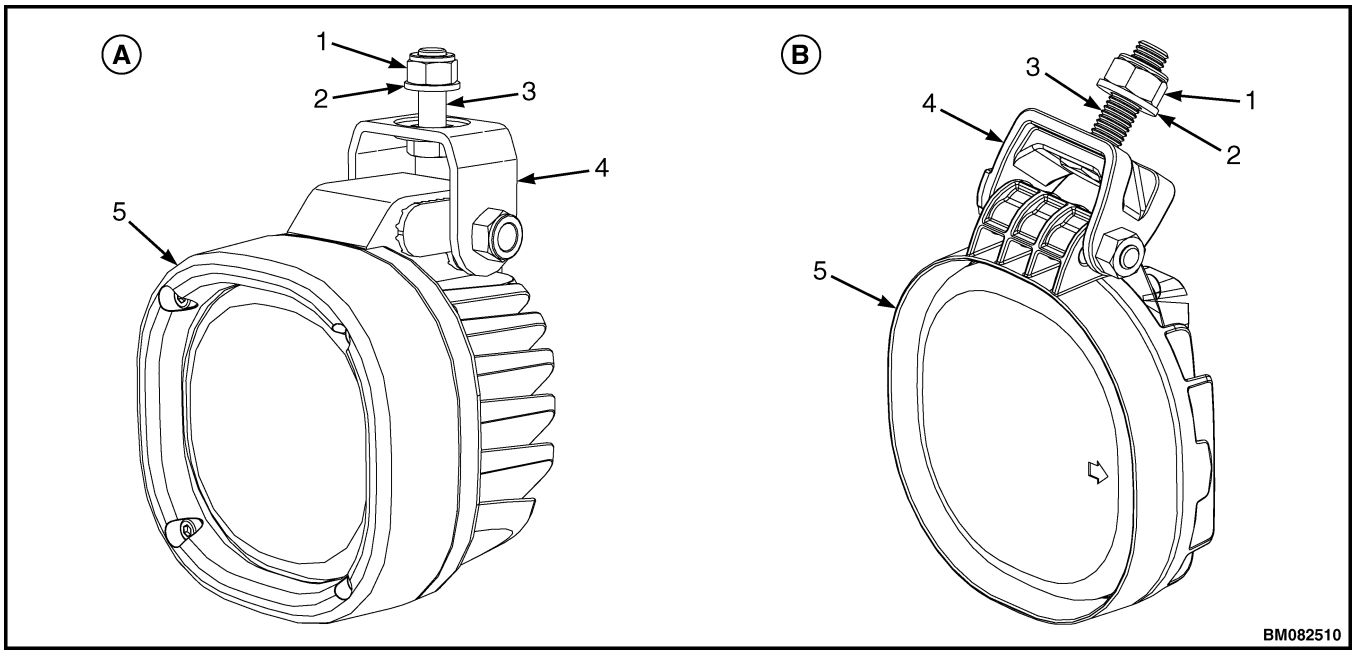
NOTE: The strobe light may either be mounted above the top of overhead guard (high-mounted) or below the top of overhead guard (low-mounted). The removal and installation procedures are the same for both options.

Remove

1. Read and follow **WARNING** and **CAUTION** section in General section above.
2. Disconnect negative battery cable from terminal.
3. Disconnect overhead guard harness from strobe light electrical connector.
4. Remove capscrews, washers, lockwasher, and nuts securing strobe light and light guard to strobe light mounting bracket. See Figure 177. Remove strobe light and guard from lift truck.

NOTE: If strobe light on your lift truck is equipped with a replaceable halogen bulb, go to Step 5. If strobe light is equipped with LED lights, the whole light assembly must be replaced. Go to Step 2 in the Install section.

5. If strobe light bulb needs to be replaced, remove strobe light lens from base and remove bulb.



A. LED WORK LIGHT FOR LIFT TRUCK MODELS MANUFACTURED BEFORE APRIL, 2017

1. LOCKNUT
2. WASHER
3. CAPSCREW

B. LED WORK LIGHT FOR LIFT TRUCK MODELS MANUFACTURED AFTER APRIL, 2017

4. MOUNTING BRACKET
5. LED LIGHT ASSEMBLY

Figure 176. LED Work Lights

Install

1. If bulb is being replaced, install new bulb into strobe light base. Install strobe light lens onto base.

2. Place strobe light assembly and strobe light guard onto mounting bracket. Secure assembly to mounting bracket with capscrews, washers, lockwasher, and nuts. See Figure 177.

3. Connect overhead guard harness to strobe light electrical connector.

4. Connect negative battery cable to terminal.

LED TAIL, BACKUP, AND BRAKE LIGHTS

NOTE: These light assemblies are non-repairable and must be replaced as an assembly. See **Parts Manual** for replacement LED lights.

Remove

1. Read and follow **WARNING** and **CAUTION** section in General section above.

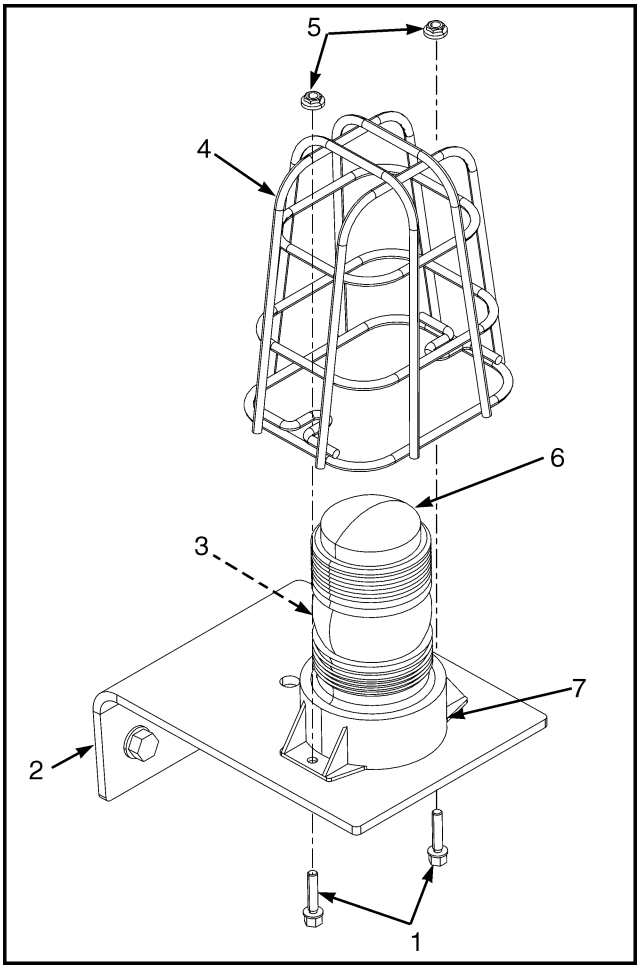
2. Remove key, or turn keyless switch OFF, if truck is equipped with this switch.

3. Disconnect negative battery cable from terminal.

4. Remove torx head screw securing LED light assembly to LED light housing. See Figure 178.

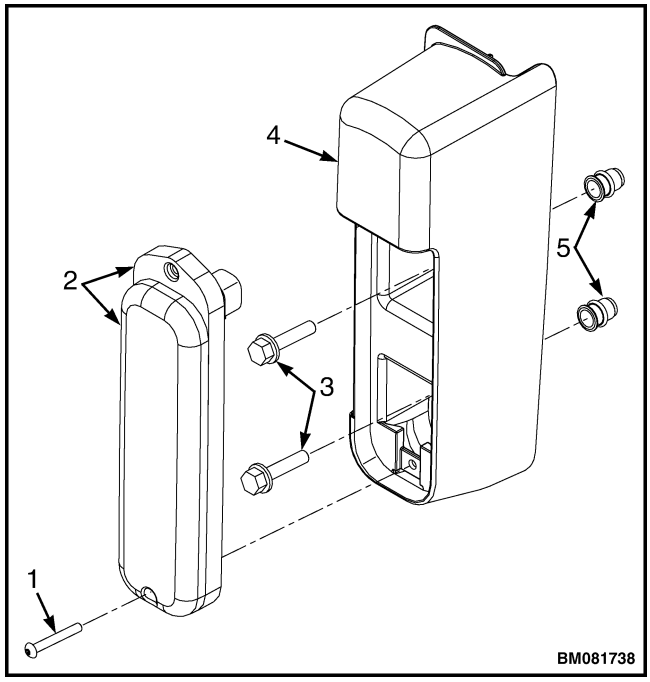
5. Disconnect chassis light harness from LED light assembly.

6. If LED light housing must be removed from overhead guard leg, remove two capscrews and LED light housing from overhead guard leg. The inserts should remain attached to housing. See Figure 178.



1. CAPSCREW
2. MOUNTING BRACKET
3. STROBE LIGHT BULB
4. STROBE LIGHT GUARD
5. NUT
6. STROBE LIGHT LENS
7. LIGHT BASE

Figure 177. Strobe Light Assembly



1. TORX HEAD SCREW
2. LED LIGHT ASSEMBLY
3. CAPSCREW
4. LED LIGHT HOUSING
5. INSERT

Figure 178. LED Tail, Backup, and Brake Lights Replacement

Install

1. If LED light housing was removed, install housing on overhead guard leg with two capscrews and inserts.

2. Connect chassis light harness to LED light assembly.

3. Insert torx head screw and install LED light assembly to LED light housing. See Figure 178.

4. Connect negative battery cable to terminal.

FRONT MARKER/TURN SIGNAL LIGHTS

Remove

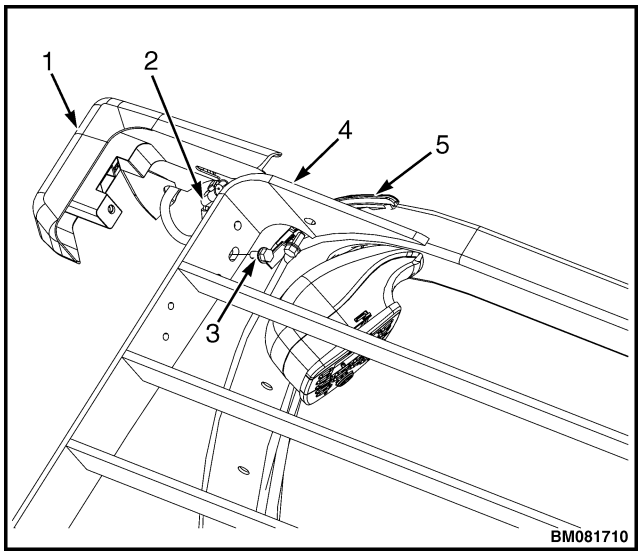
1. Read and follow **WARNING** and **CAUTION** in General section above.

2. Disconnect negative battery cable from terminal.

3. Disconnect light wire harness from front marker/turn signal light connector.

4. Remove two bolts located at top of the front marker/turn signal light assembly and inside corner of overhead guard. See Figure 179.

5. Remove front marker/turn signal light assembly from overhead guard and trim. See Figure 179.



NOTE: RIGHT FRONT MARKER/TURN SIGNAL LIGHT ASSEMBLY SHOWN. PROCEDURES TO REMOVE AND REPLACE LEFT FRONT MARKER/TURN SIGNAL LIGHT ASSEMBLY ARE THE SAME.

1. FRONT MARKER/TURN SIGNAL LIGHT ASSEMBLY
2. CONNECTOR
3. BOLT
4. OVERHEAD GUARD
5. TRIM

Figure 179. Front Marker/Turn Signal Light Assembly Removal

Install

1. Install new front marker/turn signal light assembly to overhead guard and trim using two bolts. See Figure 179.

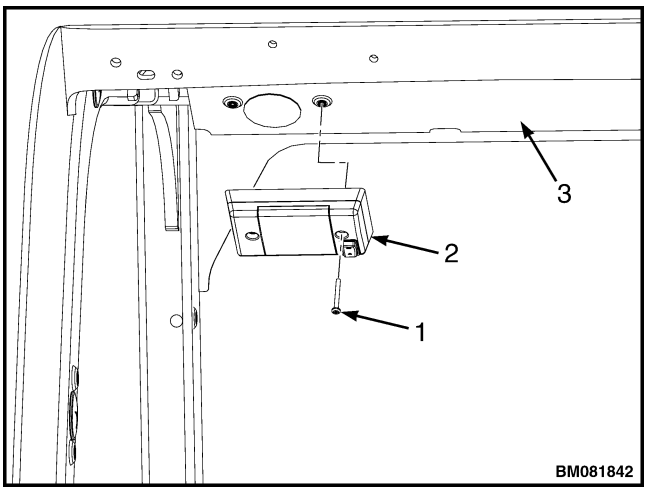
2. Connect light wire harness to front marker/turn signal light connector.

3. Connect negative battery cable to terminal.

DOME LIGHT

Remove

1. Read and follow **WARNING** and **CAUTION** in General section above.
2. Disconnect negative battery terminal.
3. Disconnect light wire harness from dome light connector.
4. Remove two screws and dome light from overhead guard. See Figure 180.



1. SCREWS
2. DOME LIGHT
3. OVERHEAD GUARD

Figure 180. Dome Light

Install

1. Install new dome light and two screws on overhead guard. See Figure 180.
2. Connect light wire harness to dome light connector.
3. Connect negative battery terminal.

CONVERTER

The LED tail, backup, and brake Lights operate at 12 volts with a DC/DC converter. On lift truck models E2.2-3.5XN (E45-70XN) (A268), E1.6-2.0XN (E30-40XN) (A269), and E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099) manufactured before November 2014, the standard converter is mounted to the front bulkhead, behind the hydraulic pump and motor. Lift truck models manufactured before November 2014 E2.2-3.5XN (E45-70XN) (A268) and E1.6-2.0XN (E30-40XN) (A269) may also be equipped with an optional converter that is mounted on the right wall of the frame.

On lift truck models E30-40XN (A269) manufactured after November 2014, the standard converter is mounted on a mounting bracket attached to the front bulkhead and to the left of the Vehicle Systems Manager (VSM). These lift trucks may be equipped with an optional converter that is mounted on a mounting bracket on the right wall of the frame.

On lift truck models E45-70XN (A268) manufactured after November 2014, the converter is mounted on a mounting bracket on the right wall of the frame.

On lift truck models J2.2-3.5XN (J45-70XN) (A276) and J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) , the converter is mounted on the rear bulkhead, in front of the hydraulic tank.

See Figure 181 for the following lift truck models manufactured before November 2014

- E2.2-3.5XN (E45-70XN) (A268)
- E1.6-2.0XN (E30-40XN) (A269)

See Figure 182 for the following lift truck models manufactured after November 2014

- E45-70XN (A268)
- E30-40XN (A269)

See Figure 183 for lift truck models

- J2.2-3.5XN (J45-70XN) (A276)
- J4.0-5.0XN (J80-100XN) (A970) manufactured before November 2014

See Figure 184 for the following lift truck models manufactured after November 2014

- J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

See Figure 185 for the following lift truck models manufactured before November 2014

- E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

See Figure 186 for the following lift truck models manufactured after November 2014

- E80-120XN, E100XNS (A099)

Remove

1. Read and follow the **WARNING** and **CAUTION** section in the General section above.

2. Disconnect negative battery cable from terminal.

3. For lift truck models E2.2-3.5XN (E45-70XN) (A268) and E1.6-2.0XN (E30-40XN) (A269) , remove the floor mat. Remove rear floor plate. Remove capscrews and washers from front floor plate and lift front floor plate up enough to disconnect the accelerator pedal or MONOTROL® pedal. Remove front floor plate with the accelerator or MONOTROL® pedal still attached for access to the converter. See Figure 120.

4. For lift truck models J2.2-3.5XN (J45-70XN) (A276) and J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) , remove the tow pin and counterweight cover for access to the converter. See Figure 113.

5. Disconnect main wire harness from electrical connector.

6. For lift truck models E2.2-3.5XN (E45-70XN) (A268) and E1.6-2.0XN (E30-40XN) (A269) , remove four capscrews from converter and remove converter from front bulkhead. If lift truck is equipped with an optional converter, remove two capscrews from converter and remove converter from mounting plate.

   Figure 181 for the following lift truck models manufactured before November 2014

   - E2.2-3.5XN (E45-70XN) (A268) and E1.6-2.0XN (E30-40XN) (A269)

   See Figure 182 for the following lift truck models manufactured after November 2014

   - E2.2-3.5XN (E45-70XN) (A268) and E1.6-2.0XN (E30-40XN) (A269)

7. For lift truck models J2.2-3.5XN (J45-70XN) (A276) and J4.0-5.0XN (J80-100XN) (A970) , remove four capscrews from converter and remove converter from rear bulkhead.

   See Figure 183 for lift truck models

   - J2.2-3.5XN (J45-70XN) (A276)
   - J4.0-5.0XN (J80-100XN) (A970) manufactured before November 2014

   See Figure 184 for the following lift truck models manufactured after November 2014

   - J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) manufactured after November 2014

8. For lift truck model E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099) remove two capscrews from converter and remove converter from front bulkhead.

   See Figure 185 for the following lift trucks manufactured before November 2014

   - E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)

   See Figure 186 for following lift trucks manufactured after November 2014

   - E80-120XN, E100XNS (A099)

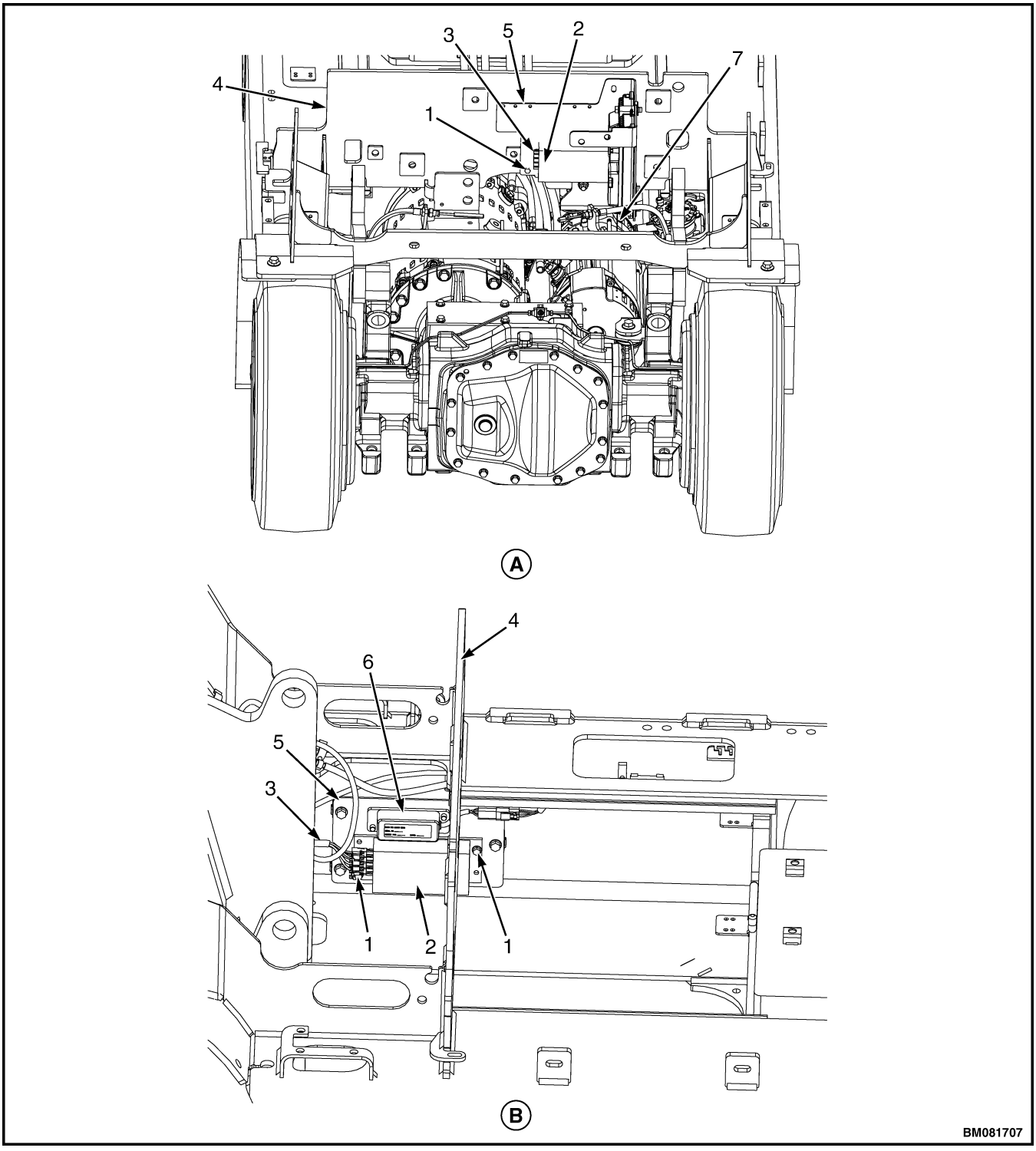


Figure 181. Converter, Lift Truck Models and Manufactured Before November 2014E2.2-3.5XN (E45-70XN) (A268) E1.6-2.0XN (E30-40XN) (A269)

Legend for Figure 181.

A. STANDARD CONVERTER LOCATION

B. OPTIONAL CONVERTER LOCATION

1. CAPSCREW
2. CONVERTER
3. ELECTRICAL CONNECTION
4. FRONT BULKHEAD
5. MOUNTING PLATE
6. IMPACT SENSOR
7. HYDRAULIC PUMP AND MOTOR

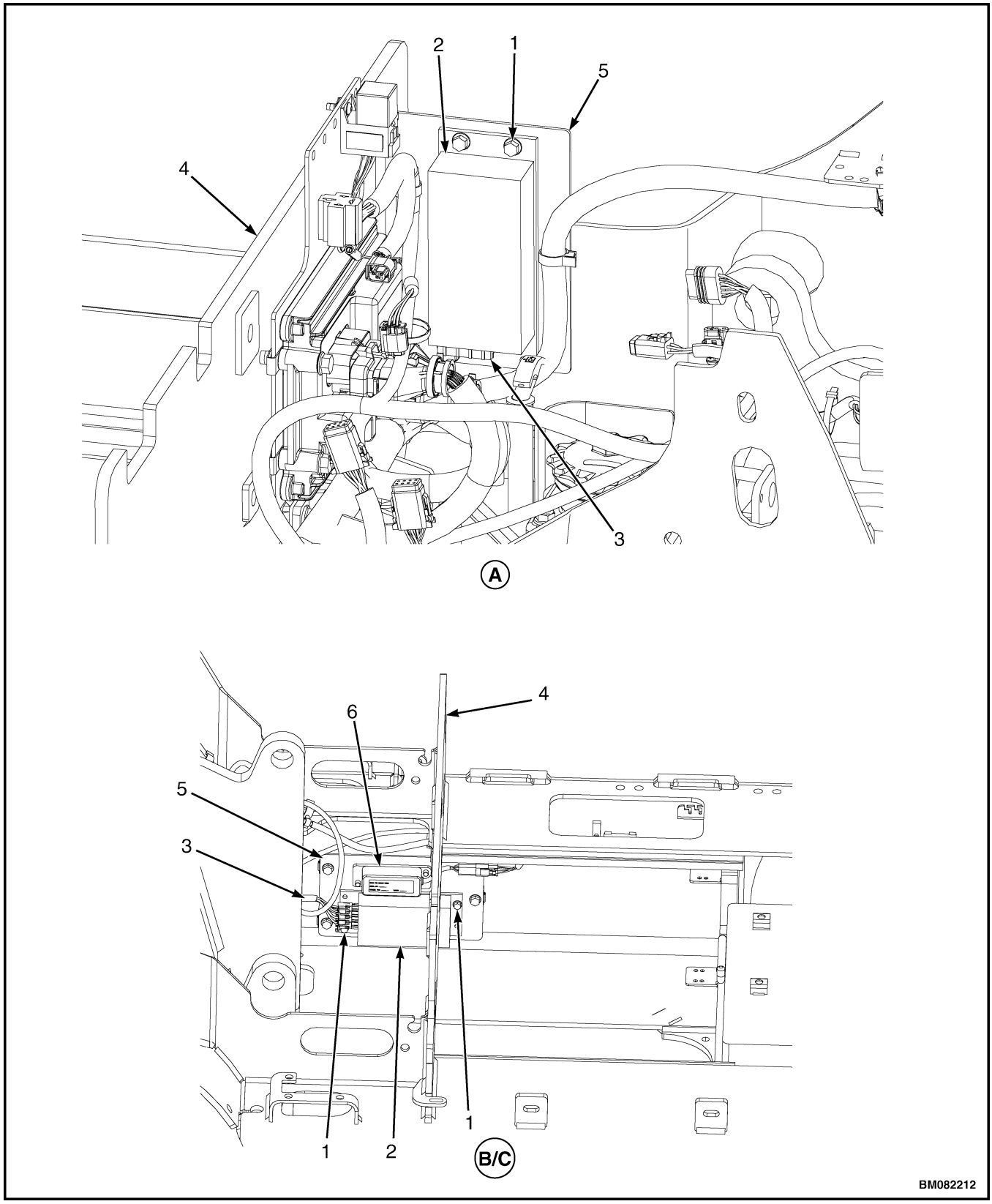
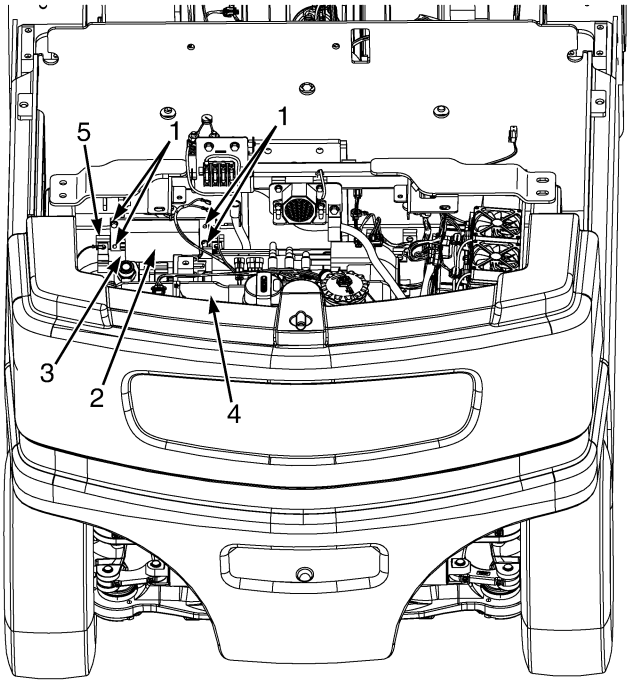


Figure 182. Converter, Lift Truck Models Manufactured After November 2014E45-70XN (A268) and E30-40XN) (A269)

Legend for Figure 182.

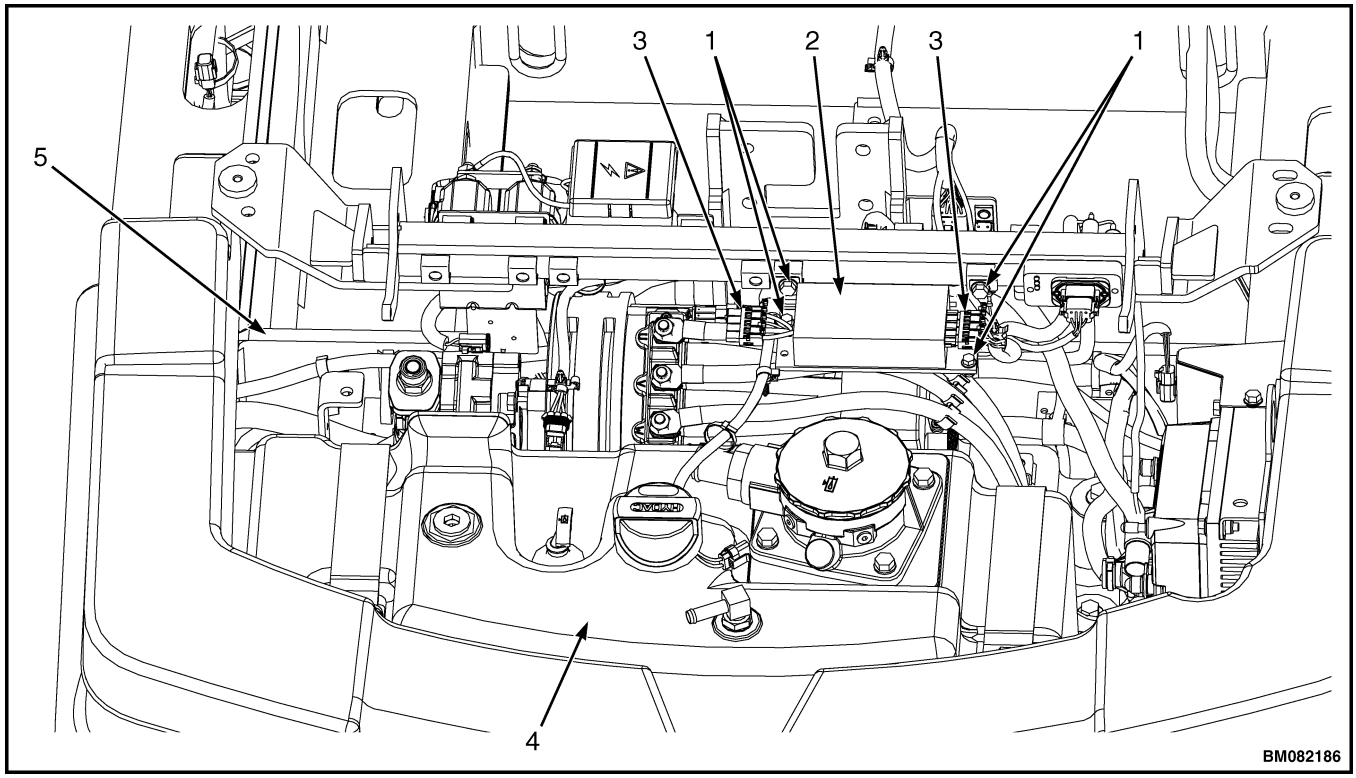
A. STANDARD CONVERTER LOCATION, LIFT TRUCK MODELS E30-40XN) (A269)
B. OPTIONAL CONVERTER LOCATION, LIFT TRUCK MODELS E30-40XN) (A269)
C. STANDARD CONVERTER LOCATION, LIFT TRUCK MODELS E45-70XN (A268)

1. CAPSCREW
2. CONVERTER
3. ELECTRICAL CONNECTION
4. FRONT BULKHEAD
5. MOUNTING PLATE
6. IMPACT SENSOR



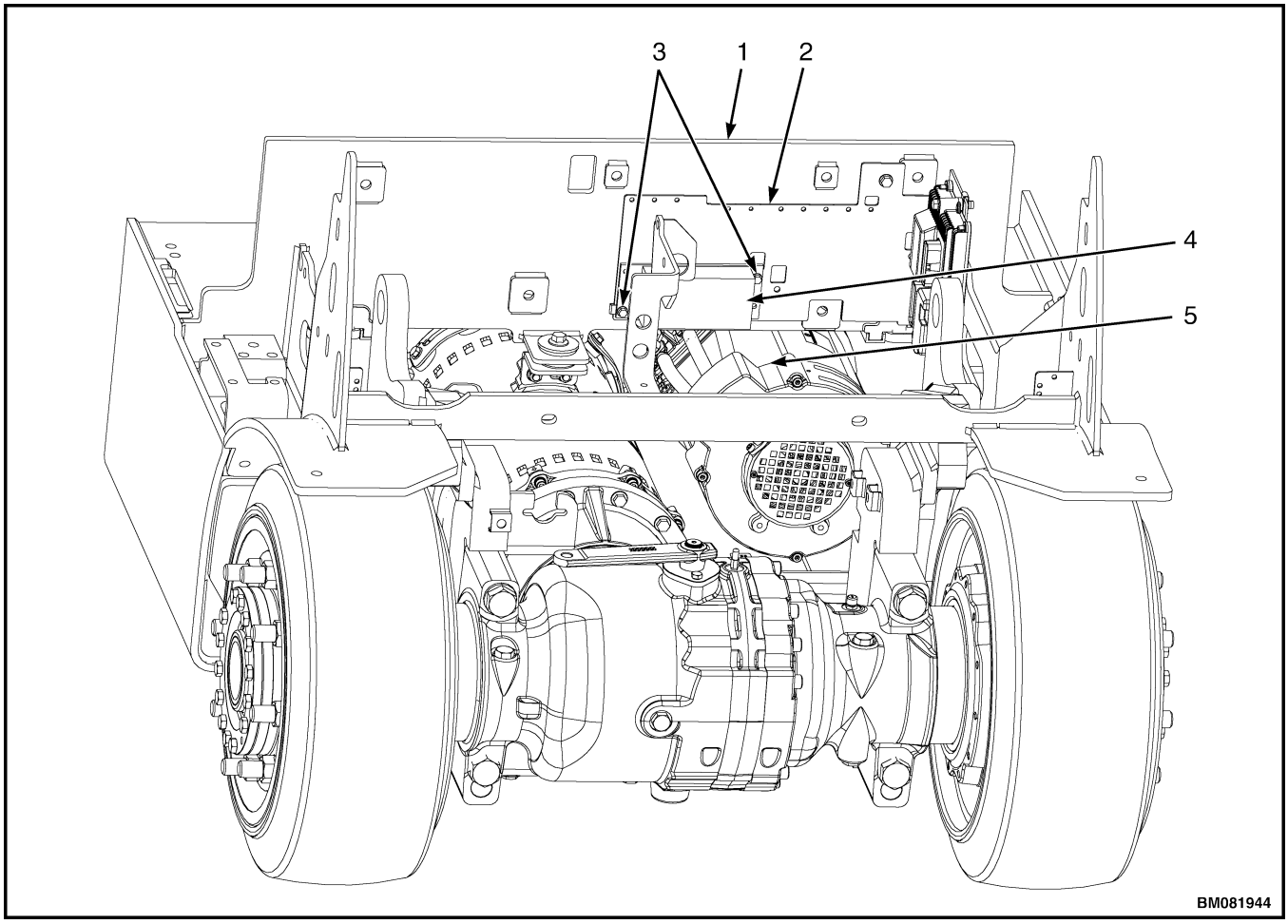
1. CAPSCREW
2. CONVERTER
3. ELECTRICAL CONNECTION
4. HYDRAULIC TANK
5. REAR BULKHEAD

Figure 183. Converter, Lift Truck Models Manufactured before November 2014 and J4.0-5.0XN (J80-100XN) (A970) J2.2-3.5XN (J45-70XN) (A276)



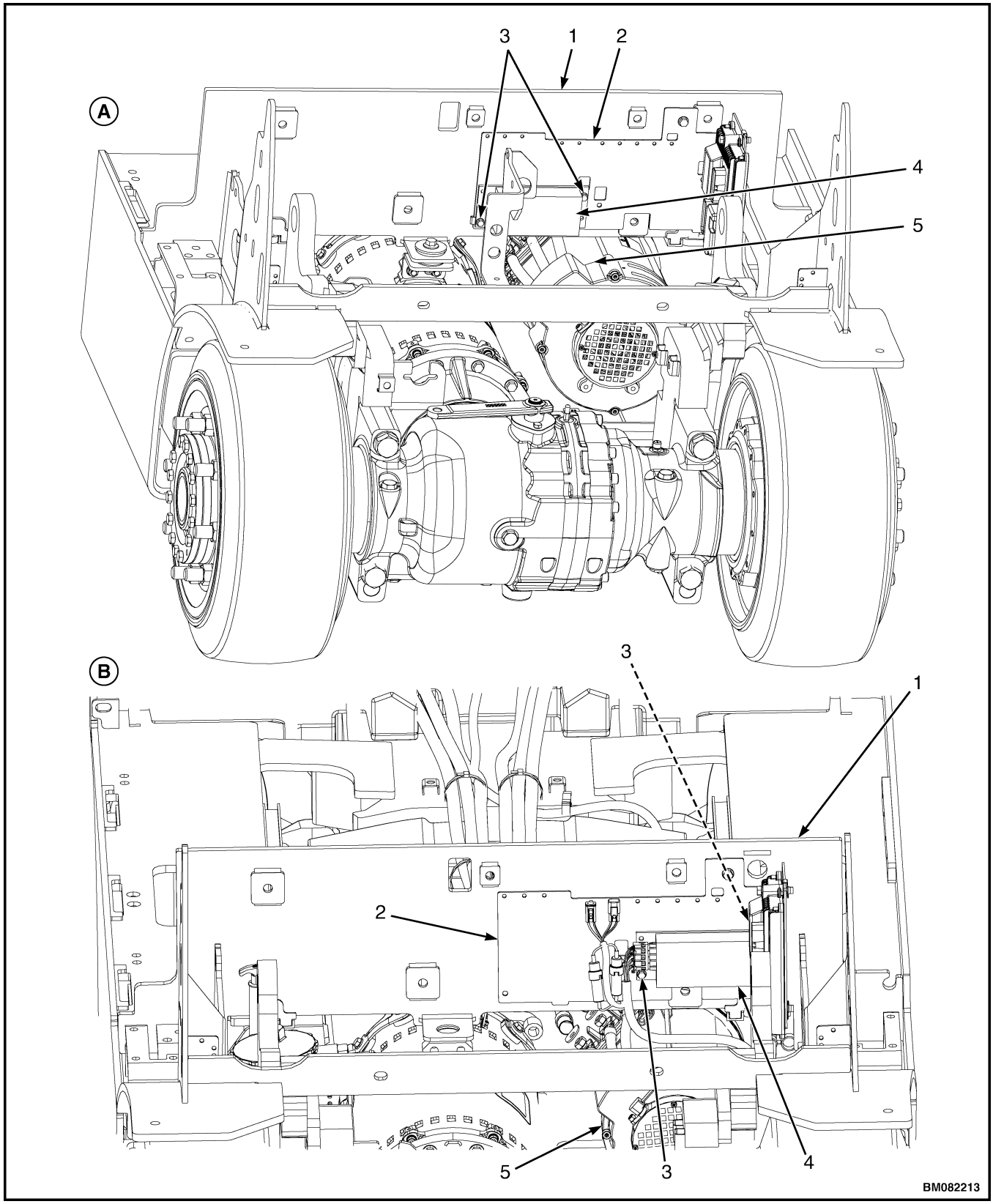
1. CAPSCREW
2. CONVERTER
3. ELECTRICAL CONNECTION
4. HYDRAULIC TANK
5. REAR BULKHEAD

Figure 184. Converter, Lift Truck Models Manufactured After November 2014 J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)



1. FRONT BULKHEAD
2. MOUNTING PLATE
3. CAPSCREW
4. CONVERTER
5. HYDRAULIC PUMP AND MOTOR

Figure 185. Converter, Lift Truck Model Manufactured Before November 2014E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099)


A
3
1
2
4
5
B
3
1
2
5
3
4
BM082213

A. STANDARD CONVERTER LOCATION
B. OPTIONAL CONVERTER LOCATION

1. FRONT BULKHEAD
2. MOUNTING PLATE
3. CAPSCREW
4. CONVERTER
5. HYDRAULIC PUMP AND MOTOR

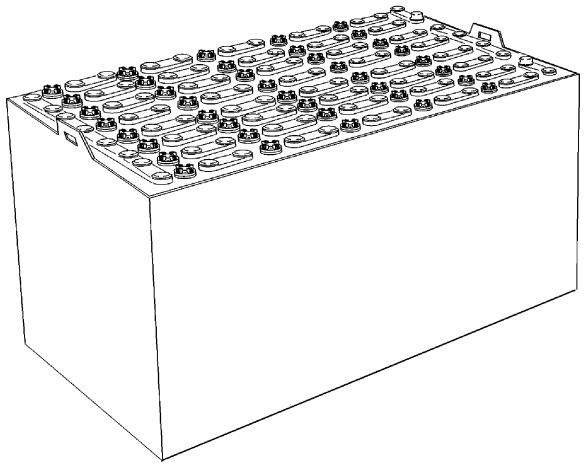
Figure 186. Converter, Lift Truck Model Manufactured After November 2014E80-120XN, E100XNS (A099)

Install

1. For lift truck model E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099) install new standard converter on front bulkhead using two capscrews.
2. For lift truck models E2.2-3.5XN (E45-70XN) (A268) and E1.6-2.0XN (E30-40XN) (A269) , install new, standard converter on the front bulkhead using four capscrews. If lift truck is equipped with optional converter, install new, optional converter to mounting plate using two capscrews. .
3. For lift truck models J2.2-3.5XN (J45-70XN) (A276) and J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970) , install new converter on the rear bulkhead using four capscrews.
4. Apply 3 mm (0.12 in.) of lubricating grease, (Hyster P/N 1463849) to each terminal opening on electrical connector plug on main wire harness.
5. Connect converter to main wiring harness.
6. Connect negative battery cable to terminal.
7. For lift truck models J2.2-3.5XN (J45-70XN) (A276), J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970), E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) (A099) , install the tow pin and counterweight cover. See Figure 113.
8. For lift truck models E2.2-3.5XN (E45-70XN) (A268) and E1.6-2.0XN (E30-40XN) (A269) , connect the accelerator pedal or MONOTROL® pedal, and install the front floor plate using capscrews and washers. Install rear floor plate. Install floor mat and connect the battery. See Figure 120.

NOTES

INDUSTRIAL BATTERY



HYSTER

PART NO. 899648

2240 SRM 0001

SAFETY PRECAUTIONS
MAINTENANCE AND REPAIR

- When lifting parts or assemblies, make sure all slings, chains, or cables are correctly fastened, and that the load being lifted is balanced. Make sure the crane, cables, and chains have the capacity to support the weight of the load.
- Do not lift heavy parts by hand, use a lifting mechanism.
- Wear safety glasses.
- DISCONNECT THE BATTERY CONNECTOR before doing any maintenance or repair on electric lift trucks. Disconnect the battery ground cable on internal combustion lift trucks.
- Always use correct blocks to prevent the unit from rolling or falling. See HOW TO PUT THE LIFT TRUCK ON BLOCKS in the **Operating Manual** or the **Periodic Maintenance** section.
- Keep the unit clean and the working area clean and orderly.
- Use the correct tools for the job.
- Keep the tools clean and in good condition.
- Always use **HYSTER** ® **APPROVED** parts when making repairs. Replacement parts must meet or exceed the specifications of the original equipment manufacturer.
- Make sure all nuts, bolts, snap rings, and other fastening devices are removed before using force to remove parts.
- Always fasten a DO NOT OPERATE tag to the controls of the unit when making repairs, or if the unit needs repairs.
- Be sure to follow the **WARNING** and **CAUTION** notes in the instructions.
- Gasoline, Liquid Petroleum Gas (LPG), Compressed Natural Gas (CNG), and Diesel fuel are flammable. Be sure to follow the necessary safety precautions when handling these fuels and when working on these fuel systems.
- Batteries generate flammable gas when they are being charged. Keep fire and sparks away from the area. Make sure the area is well ventilated.

NOTE: The following symbols and words indicate safety information in this manual:

WARNING

Indicates a hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION

Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury and property damage.

On the lift truck, the WARNING symbol and word are on orange background. The CAUTION symbol and word are on yellow background.

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This section is for the following models:

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"THE QUALITY KEEPERS"

HYSTER APPROVED PARTS

General

This section describes how to select and do the maintenance for large batteries used in electric lift trucks. This information is for service personnel that must do the maintenance on large lead-acid batteries. Battery repair requires special training and equipment. Do not try to repair a battery unless you have the correct tools, equipment, and experience. Most battery repairs are done by a special repair service. Some batteries have a nameplate attached to the face of the battery cover. This nameplate communicates specific information about the battery including the name of the battery manufacturer, battery type, serial number, nominal voltage, capacity in amperes at the five-hour rate, and service mass (with ballast if used to compensate for lack of battery mass).

Battery Type

LEAD-ACID BATTERIES

A lead-acid battery converts chemical energy into electrical energy. See Figure 1. Chemical changes within the battery give the electrical energy. When the chemical reaction has occurred so the battery will not give its rated voltage and current, the battery is discharged. A reverse chemical action must occur so the battery can be used again. The batteries described in this section can be charged again by an electric voltage and current from an outside source so there is a reverse chemical action. The lead-acid chemicals store the electric energy until the electric energy is needed to operate an electric device.

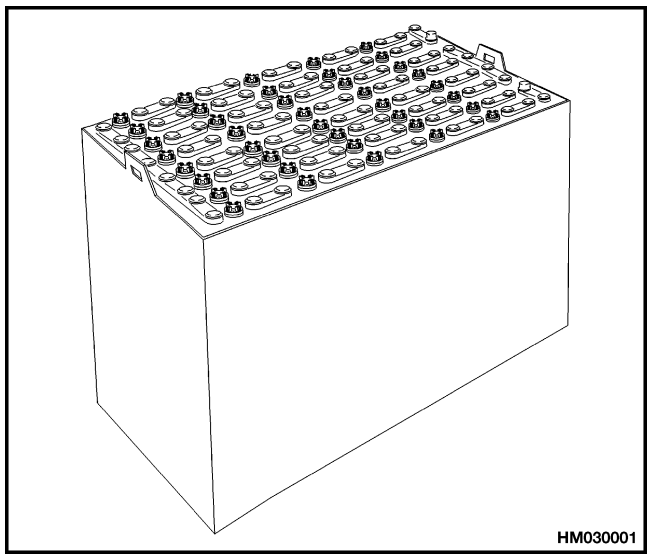


Figure 1. Lead-Acid Industrial Battery

A lead-acid battery is made from several lead-acid batteries called cells. Each cell has positive and negative plates with dielectric spacers between each plate. All of the plates are within a solution of electrolyte. See Figure 2.

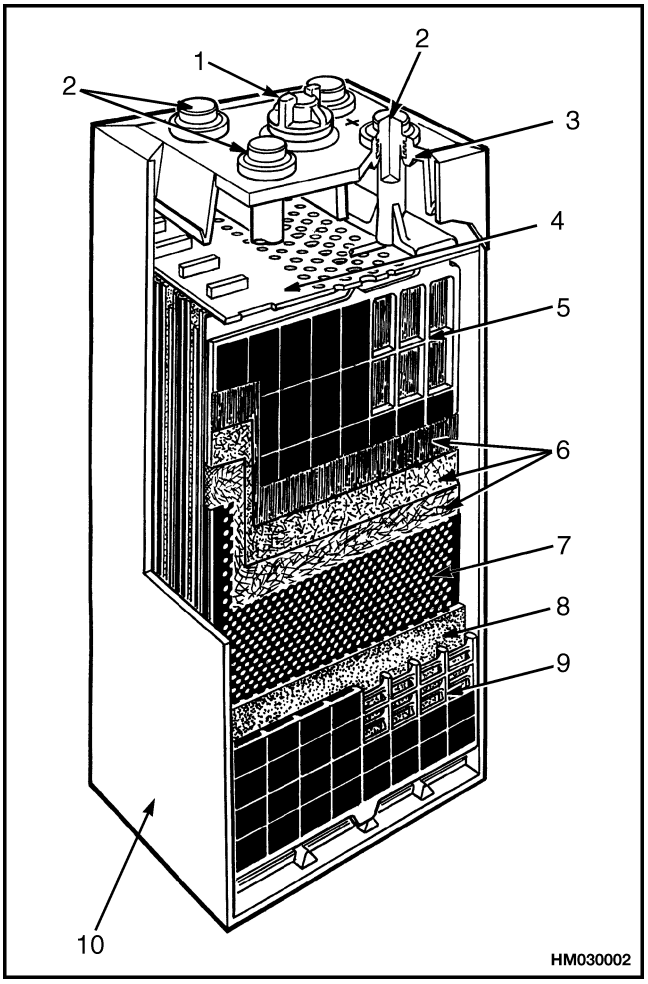


Figure 2. Battery Cell

Legend for Figure 2.

1. VENT AND FILL CAP
2. POST
3. POST SEAL
4. PLATE PROTECTOR (SHIELD)
5. POSITIVE PLATE
6. EXPANSION MATS
7. RETAINER
8. SEPARATOR
9. NEGATIVE PLATE
10. BATTERY JAR

LITHIUM-ION BATTERIES

A lithium-ion battery converts chemical energy into electrical energy. Chemical changes within the battery give the electrical energy. When the chemical reaction has occurred so the battery will not give its rated voltage and current, the battery is discharged. A reverse chemical action must occur so the battery can be used again. The batteries described in this section can be charged again by an electric voltage and current from an outside source so there is a reverse chemical action. The battery stores the electric energy until the electric energy is needed to operate an electric device. A lithium-ion battery is made from several cells. Each cell has positive and negative electrodes. The positive electrode is a cathode while the negative is considered an anode. A cathode is the electrode or terminal in which current leaves the cell or battery while the anode is the electrode or terminal in which current enters the cell or battery. Lithium-ion batteries are maintenance-free and do not require equalization charges or specific gravity corrections.

Specific Gravity

The strength of the electrolyte is measured in points of specific gravity. For example, a solution of sulfuric acid has a specific gravity of 1.835. Water has a specific gravity of 1.000. Electrolyte is 27 percent acid and 73 percent water and has a specific gravity of 1.275.

Chemical Reaction in a Cell

WARNING

NEVER pour water into concentrated acid. Combining these liquids creates the rapid production of heat which can cause the water to boil and the acid to erupt and splash out of the container. ALWAYS pour concentrated acid into water when making a dilute solution of acid.

In a fully-charged cell, the electrolyte has a specific gravity of 1.270 to 1.130. NEVER discharge a battery below a specific gravity of 1.130. The battery

can have permanent damage if discharged below 1.130.

The cell generates a voltage (potential difference) when two different types of metal are in the electrolyte. The two metals in a lead-acid cell are lead peroxide (PbO_3) for positive plates, and sponge lead (Pb) for negative plates. See Figure 3. A potential difference of approximately 2 volts per cell is generated. The potential difference does not vary according to the size of the cell.

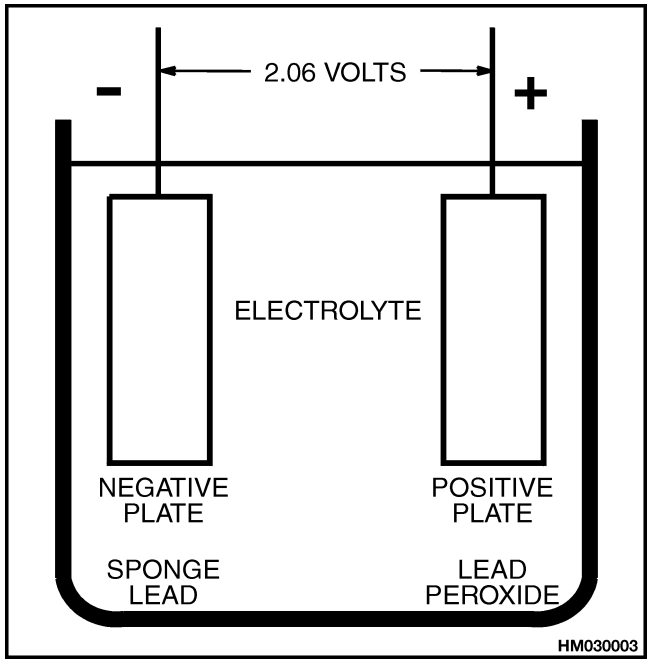


Figure 3. Fully Charged Cell

During the discharge of the cell, lead peroxide and sponge lead mix with sulfuric acid to make lead sulfate ($PbSO_4$) on both plates. See Figure 4. This action decreases the voltage in the cell. When the sulfuric acid is removed from the electrolyte, the specific gravity of the electrolyte decreases. See Figure 5. The potential difference of a discharged cell is approximately 1.75 volts.

When a direct current is applied to a discharged cell, the lead sulfate is changed into lead and sulfuric acid. The lead goes to the positive plate and stays as lead and to the negative plate and stays as lead peroxide. See Figure 6. The concentration of sulfuric acid in the electrolyte increases. The specific gravity of the electrolyte increases as the concentration of sulfuric acid increases. In a fully charged cell, the positive plate again contains the lead peroxide and the negative plate contains the sponge lead.

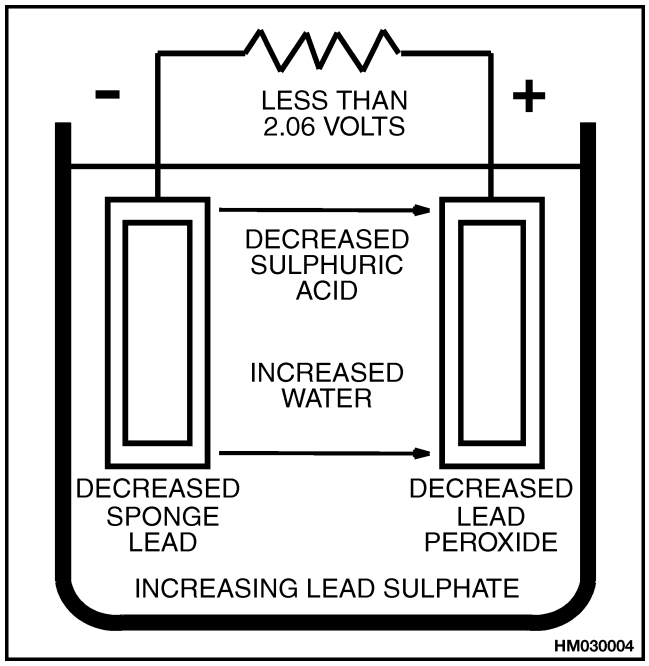


Figure 4. Discharging Cell

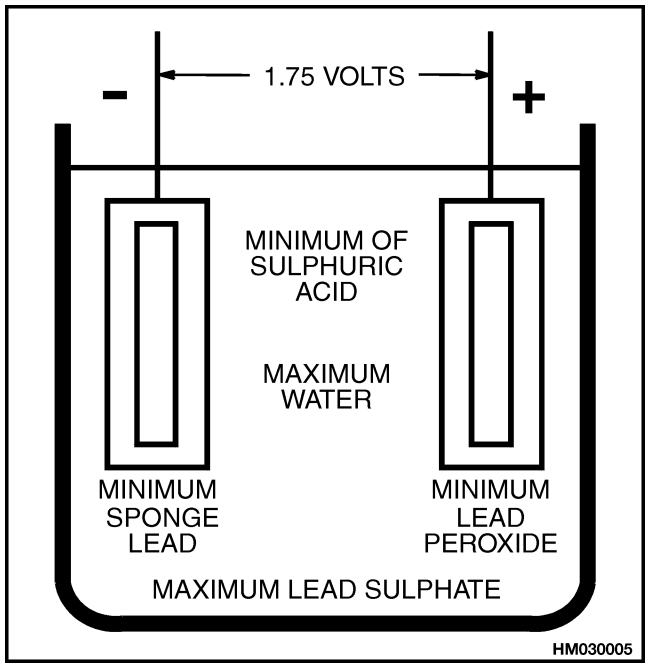


Figure 5. Discharged Cell

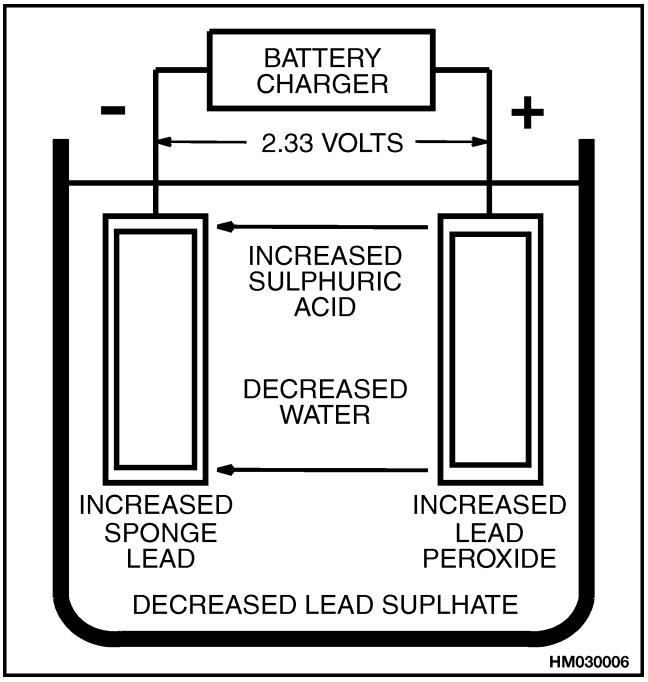


Figure 6. Charging Cell

Electrical Terms

Voltage: Is an electromotive force (EMF) (also called "potential difference") caused by the difference in electric charge between two points. See Figure 7.

Ampere: Is a measurement of electric current.

Watt: Is a measure of electric power. The number of watts is equal to the number of volts multiplied by the number of amperes. A kilowatt-hour is 1000 watts of electric power used in 1 hour.

Ohms: Is the measurement of electrical resistance.

Polarity: In a battery, the electric current is shown to flow from the positive terminal to the negative terminal.

Maintenance-Free Battery: The electrolyte level in the battery does not need to be checked during the life of the battery. Maintenance-free batteries use a calcium alloy of lead instead of an antimony alloy, which reduces the amount of electrolysis. In a maintenance-free battery, the amount of free-standing electrolyte above the plates is much higher, ensuring enough electrolytes to keep the plates covered during extended periods of use. Therefore, there is no need to add water to a maintenance-free battery during the course of its life.

Flooded Cell: This is a lead acid battery that has free flowing electrolyte fluid in each cell of the battery. The electrolyte is a mixture of sulfuric acid and water.

Direct Current (DC): When the voltage between the two terminals is always the same polarity, the current flow and voltage are called Direct Current.

Alternating Current (AC): When the polarity of voltage between two terminals is changing between positive and negative at a quick and constant rate, the voltage is called Alternating Current.

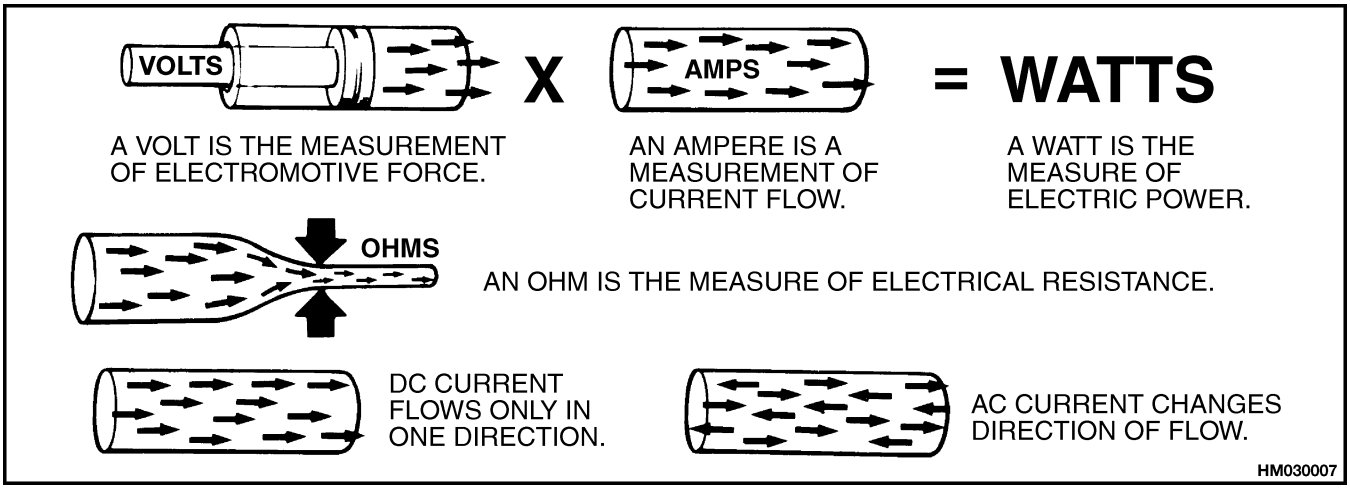


Figure 7. Electrical Terms

Battery Selection

NOTE: The capacity of the battery can be found on the lift truck's Nameplate. See the **Frame** section or **Operating Manual** for your lift truck for the location of the Nameplate.

The battery needed to operate a period of 8 hours depends on many conditions. Operations that require the lift truck to go up ramps or require the use of additional attachments increase the use of power from the battery. Some work conditions require that more than one battery must be used during a work period. The number of 8-hour work periods per day is normally equal to the number of batteries needed. For example, for three work periods, you need three batteries. The capacity of the battery you need is found as follows:

- The size of the lift truck and the attachments.
- The type of work. Heavy-duty operation or normal operation for one 8-hour work period.

Lift trucks are available in various voltage ranges. See Figure 8. The small "walkie" lift trucks are normally 12 or 24 volts. The larger sit-down rider lift trucks are normally 24, 36, 48, 72, or 80 volts. The number of cells in a lead-acid battery gives the battery voltage. See Figure 9. A fully charged cell has a potential difference of approximately 2 volts. See Figure 8. This potential difference does not change with size of the cell.

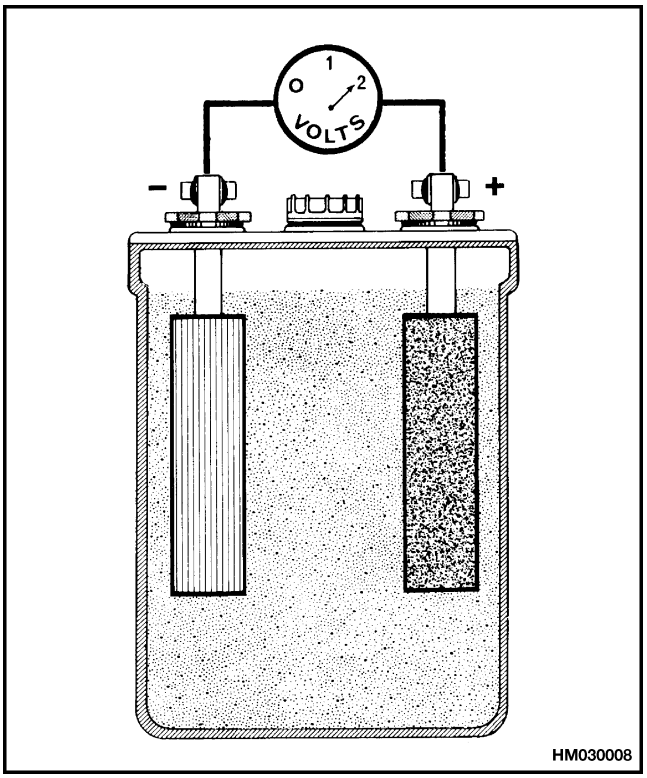


Figure 8. Cell Voltage

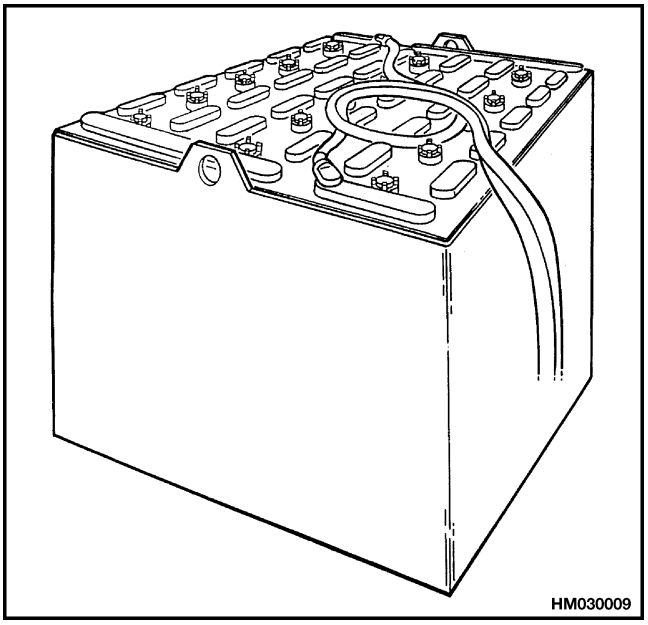


Figure 9. Multicell Battery for Electric Lift Truck

Battery Voltage

NOTE: The voltage of the battery can be found on the lift truck's Nameplate. See the **Frame** section or **Operating Manual** for your lift truck for the location of the Nameplate.

The battery voltage you need is found as follows:

- Will your lift truck operate on more than one voltage?
- If you have more than one lift truck in operation, do the battery voltages need to be the same?

To reach the necessary battery voltage, the cells are connected in series. For example:

24 volts = 12-cell battery

36 volts = 18-cell battery

48 volts = 24-cell battery

72 volts = 36-cell battery

80 volts = 40-cell battery

Battery as a Counterweight

On electric lift trucks that use the battery as part of the counterweight, the battery is part of the capacity of the lift truck to lift loads. The minimum weight of the battery is shown on the nameplate. If the battery is not the minimum weight, the capacity of the lift truck is reduced. If the battery used in the lift truck is less than the size of the battery compartment, blocks and spacers must be installed to hold the battery in position.

See the **Frame** or **Periodic Maintenance** service manual or **Operating Manual** for your lift truck model for the correct measurements for installing battery spacers.

Battery Ratings

The ratings of batteries are measured in ampere-hours and kilowatt-hours at a constant rate of discharge. A rating of 6 hours is the standard. Ampere-hours is the measurement of battery capacity. To calculate ampere-hours, multiply amperes by hours. See Table 1. For example, 5 amperes times 5 hours is 25 ampere-hours. You cannot change the potential difference of a cell. You

can increase the ampere-hour rating by increasing the number of plates in a cell, or by installation of larger plates. The constant rate of discharging can be compared to a measurement of the battery capacity and ampere-hours. For example, a battery with a rating of 600 ampere-hours during a work period of 6 hours will generate 100 amperes per hour for 6 hours. The same battery cannot generate 300 amperes for 2 hours. The heat generated within the battery will damage the battery.

Table 1. Battery Capacity Terms

Amperes × Hours = Ampere-Hours
600 Ampere Hours = 100 Amperes for 6 Hours
Volts × Amperes × Hours/1000 = Kilowatt-Hours (KWH)

KILOWATT-HOURS

A kilowatt is 1000 watts. A watt is a measure of electric power. The capacity in kilowatt-hours is the total power generated by the battery. Watt-hours are measured by multiplying the voltage by ampere-hours. To measure the kilowatt-hours, divide the watt-hours by 1000.

$$\frac{\text{volts} \times \text{amperes} \times \text{hours}}{1000} = \text{kilowatt-hours or kWh}$$

To calculate the kilowatt-hours for a battery that has a rating of 600 ampere-hours and a 48-volt system, use this formula:

$$\frac{48 \text{ volts} \times 600 \text{ amperes} \times \text{hours}}{1000} = 28.8 \text{ kWh}$$

The watt-hours can be converted to kilowatt-hours to indicate the battery needed for the operation. Always select the correct type of battery. Remember, a battery that has a rating of 300 ampere-hours will not do the same job as a battery that has a rating of 600 ampere-hours. Do not permit the specific gravity to go below the limits shown in the manual.

Battery Maintenance

Battery maintenance must include the following items:

- A good battery charger
- A clean battery
- Keep the electrolyte at the correct level (see Figure 13)
- Keep a record of the battery
- An Equalization Charge once a month

SAFETY PROCEDURES

1. Wear a rubber apron, gloves, boots, and goggles or a face shield when doing maintenance on batteries.

2. Batteries generate hydrogen gas when they are being charged. Keep open fire away from batteries. Do not check the electrolyte level with a match or a lighter. Do not smoke and do not create sparks.

3. Lift batteries correctly with a crane or equipment designed for the job. Always use a spreader bar designed and adjusted for the battery. Move batteries with a lift truck or a conveyor or rollers designed for that purpose. If the battery does not have a cover, a rubber mat or insulating material must be put over the top of the battery to prevent a short circuit with other equipment. Make sure the lifting equipment has enough capacity for the job. Do not use chain or wire rope slings.

4. Never put metal materials or tools on a battery.

5. Disconnect battery from lift truck before doing maintenance or repairs.

6. When maintenance on the battery or the battery charger is required, disconnect both the AC and DC power. If the battery connectors must be replaced, make sure the positive and negative terminals and cables are kept separate and insulated from each other. Even a momentary short circuit can cause an explosion and damage the battery.

7. Keep water readily available to flush spilled electrolyte. Electrolyte in the eyes must be flushed with water immediately, and then quickly get medical attention. Special showers and eye wash systems are required in areas where battery maintenance is done.

8. If electrolyte is spilled on a work surface or the floor, flush area with water, use a solution of soda (sodium bicarbonate) to make the acid neutral.

9. Only trained persons are permitted to do maintenance on batteries and battery chargers. Make sure the regulations by government safety agencies, government insurers, private insurers, and private organizations are followed when doing maintenance on batteries.

MAINTENANCE RECORDS

NOTE: Follow the same sequence when you record the cell number. Always begin the record with a positive cell. Follow a sequence so the last cell is always the cell for the negative cable.

Record the beginning ampere reading of the charger each time the battery is charged. Any difference in the daily ampere reading can indicate a problem with the battery or the charger.

NEW BATTERY

CAUTION

Always use a spreader bar and slings that lift vertically on the lifting eyes of the battery. DO NOT use a chain or sling without a spreader bar or you will damage the battery case.

Use the correct blocks or spacers to hold the battery in position in the lift truck. Make sure the battery compartment is clean and dry. All vent caps must be in position when the battery is in service. If the vent caps are not installed, the electrolyte will leak, causing corrosion on the battery case and in the battery compartment.

Inspect a new battery for damage. Make sure the electrolyte in each of the cells is at the correct level. Charge the battery for 6 hours or until the specific gravity is correct. Make sure the battery is correctly installed in the lift truck. Use a spreader bar with slings designed for the battery to lift and move the battery. See Figure 10.

Always complete the Battery Inspection Report and the Daily Battery Report. See Figure 11 and Figure 12.

CLEANING BATTERY

WARNING

Compressed air can move particles so that they cause injury to the user or to other personnel. Make sure that the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eyes.

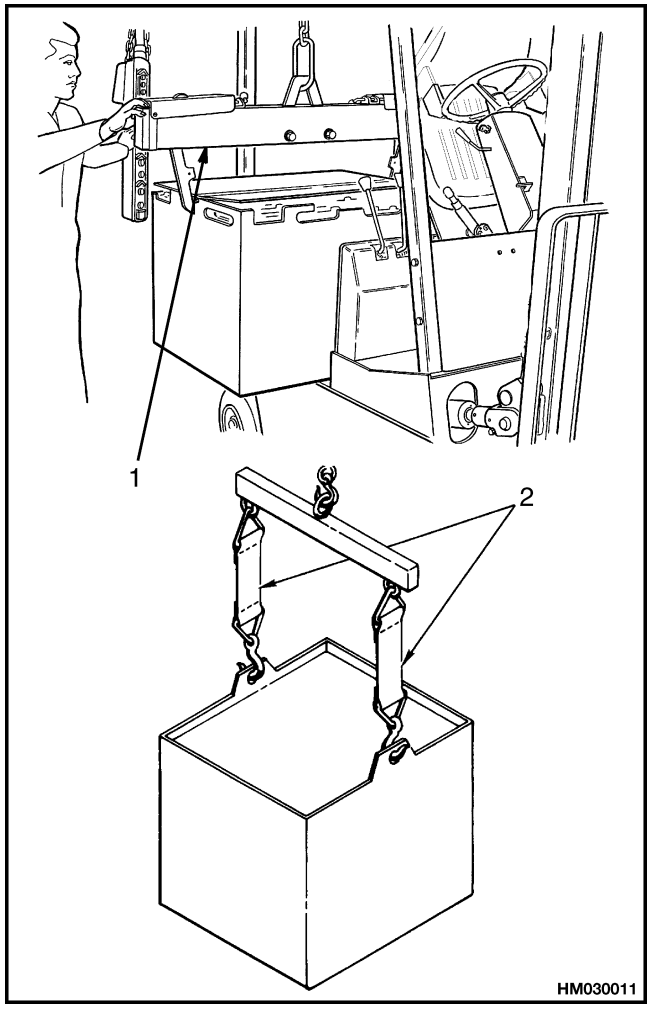
Keep the battery compartment clean and dry. Use a clean cloth to wash the battery with water. Dry with compressed air.

CAUTION

Do not clean the battery with steam or hot water. Do not use a high-pressure hose.

Remove any electrolyte from the battery compartment to prevent corrosion. If there is electrolyte on the top of the battery, apply a solution of bicarbonate of soda. Mix a solution containing 0.5 kg of soda for every 4 liters of water. Apply the solution, then flush the solution from the battery with clean water. Wash the battery and battery compartment as needed, but within a 6-month period as the maximum time.

NOTE: If the top of the battery is wet from electrolyte, check that the electrolyte level is not too high or the battery charger is not operating correctly.



Legend for Figure 10.

1. INSULATED SPREADER BAR
2. INSULATED STRAPS

Figure 10. Change the Battery

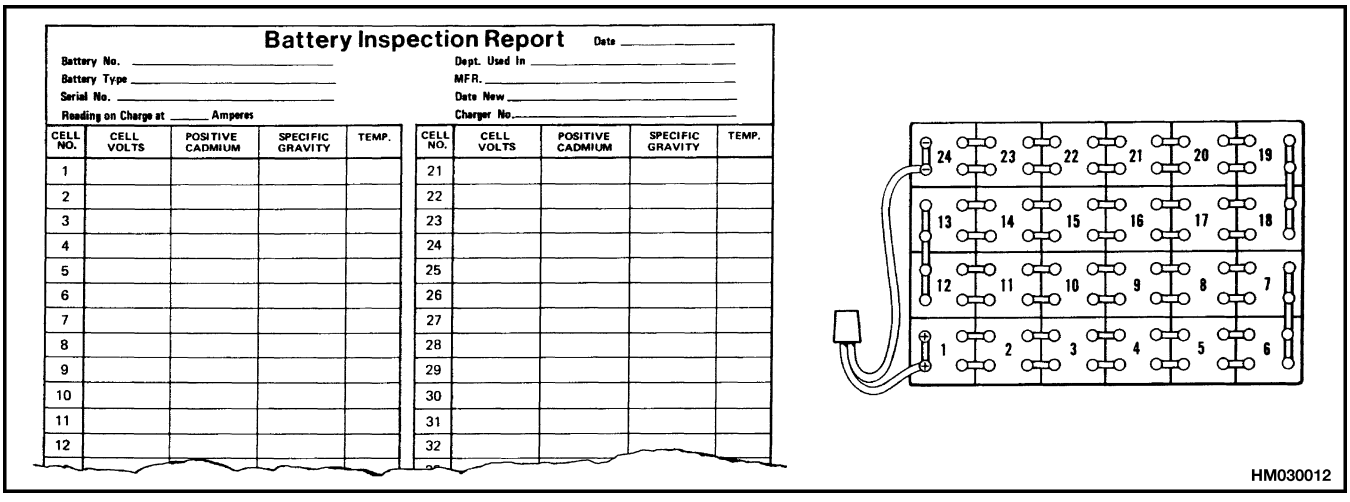


Figure 11. Battery Inspection Report

Daily Battery Record

Battery No. _____ Month _____ Year _____
Battery Type _____ MFR. _____
Serial No. _____ Date New _____
Total Cycles For Month _____ Total Cycles To Date _____

DATE	TRUCK NO.	SPECIFIC GRAVITY IN	SPECIFIC GRAVITY OUT	TEMP. PILOT CELL	TIME ON CHARGE	TIME OFF CHARGE	INITIAL AMPS	WATER ADDED	OPERATOR

HM030013

Figure 12. Daily Battery Report

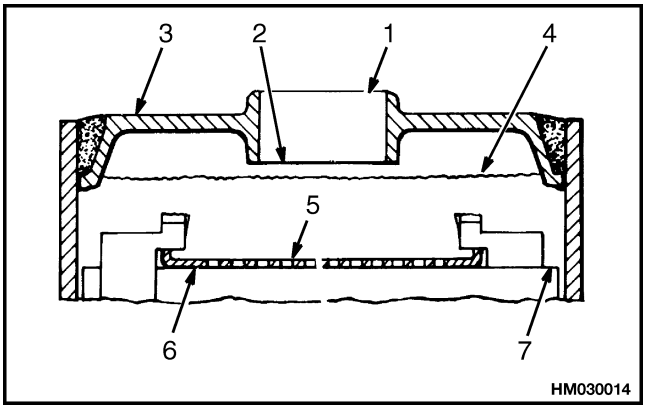
ADDING WATER TO BATTERY

NOTE: Some batteries have sealed cells. These batteries do not need water added to the electrolyte.

Some water is lost from the electrolyte of each cell during the charge and discharge cycle when the battery is in service. Check the electrolyte level daily. Some service persons check some of the cells each day so all cells are checked each week. If the level of the electrolyte goes below the level of the top of the separators for the plates, the cell can be damaged.

KEEPING THE ELECTROLYTE LEVEL WITHIN THE CORRECT LIMITS IS THE MOST IMPORTANT ITEM OF BATTERY MAINTENANCE.

See the instructions from the manufacturer of your battery for the operating level of the electrolyte. Always use distilled water. If you add distilled water, wait 5 minutes before measuring the specific gravity with a hydrometer. DO NOT add water to a cell before or during the charging cycle; water must be added after the charging cycle. If water is added before the charging cycle, the electrolyte level may rise, which will cause electrolyte to be forced out of the vent plugs. The electrolyte can flow out of the cell through the fill hole. The correct electrolyte level is shown in Figure 13.



1. FILL TUBE
2. BOTTOM OF FILL TUBE
3. CELL COVER
4. MAXIMUM LEVEL OF ELECTROLYTE
5. MINIMUM LEVEL OF ELECTROLYTE
6. PLATE PROTECTOR
7. TOP OF SEPARATORS

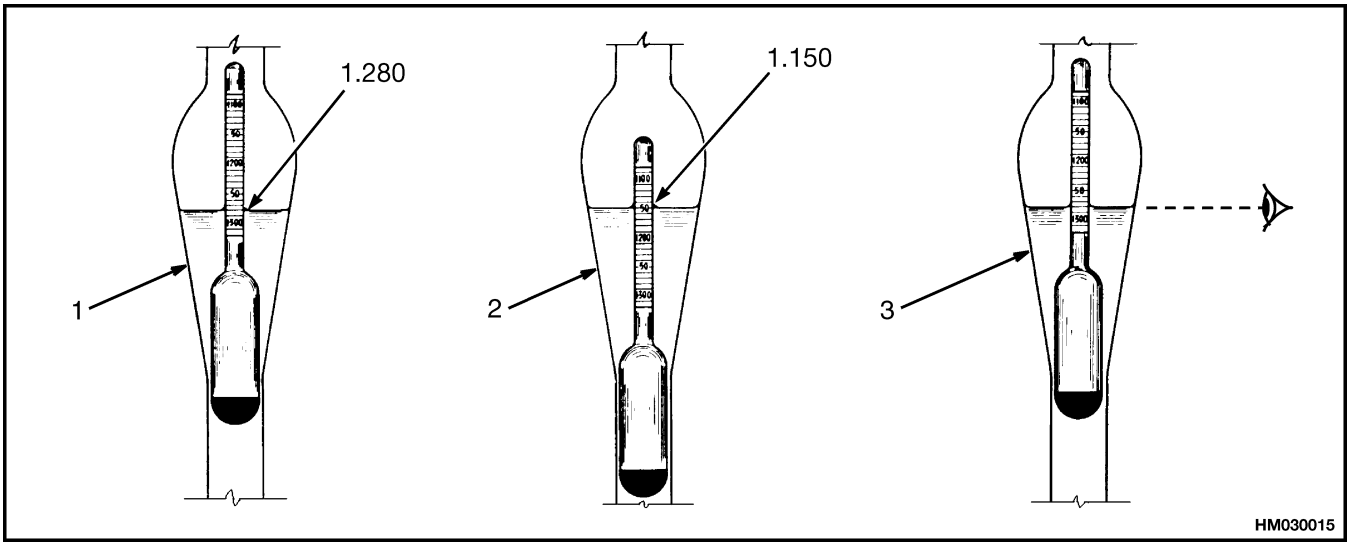
Figure 13. Electrolyte Level

HYDROMETER

NOTE: Some batteries have sealed cells. The specific gravity of the electrolyte cannot be checked on these batteries.

Use a hydrometer to measure the specific gravity of the battery. Make sure there is enough electrolyte in the battery cells. See Adding Water to Battery in this section. A high level or low level of the electrolyte can change the specific gravity measurement. When the electrolyte level is low, the percent of sulfuric acid in the electrolyte increases. When the electrolyte level decreases by 3 mm (1/8 in.), the specific gravity measurement can increase by 3 to 5 points.

When you use the hydrometer, make sure there is enough liquid in the barrel to let the float move freely. The float must not touch the side, top, or bottom of the barrel. See Figure 14 for the correct method of reading the hydrometer.



1. HIGH FLOAT MEANS HIGH SPECIFIC GRAVITY.
2. LOW FLOAT MEANS LOW SPECIFIC GRAVITY.
3. CORRECT METHOD OF READING HYDROMETER: EYE LEVEL EVEN WITH SURFACE OF ELECTROLYTE.

Figure 14. Reading Hydrometer

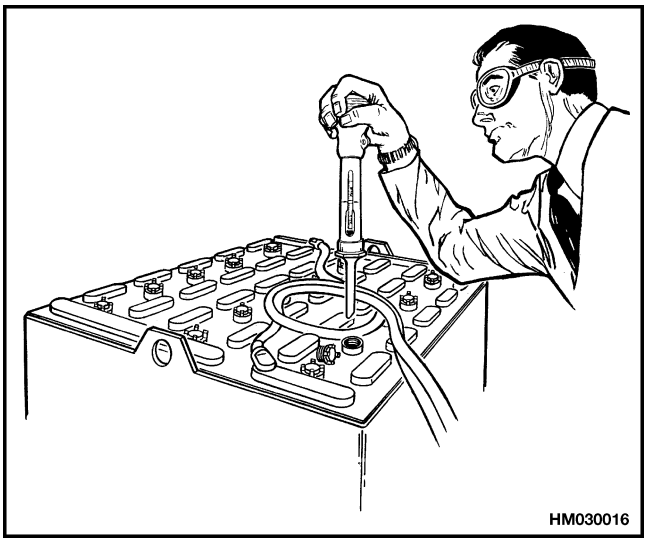
BATTERY TEMPERATURE

The temperature of the electrolyte will change the reading of the specific gravity. When the temperature increases approximately 6°C (10°F), the specific gravity will decrease by 0.003 point. See Figure 15 for making specific gravity corrections. If the hydrometer you are using does not have a temperature correction, you will have to use a thermometer. Special battery thermometers are available that will indicate the correction factor directly and add or subtract the correct number of points. See Figure 16.

NEVER charge a battery at a rate that will raise the electrolyte temperature above 49°C (120°F). NEVER let a battery stay discharged for long periods. A temperature above this amount will damage the battery. The cells in the center of the battery are normally at the highest temperature. If the battery temperature is too hot, make sure the ventilation of the battery is increased and make sure the charge or discharge rate is not too high. A recommendation for a battery in service is 8 hours of use (discharge), followed by 8 hours of charging, followed by 8 hours of cooling.

To charge the battery, a direct current must pass through the cells in the opposite direction to the discharging current. The ampere-hours must be equal to the discharging ampere-hours plus the energy lost as heat. This additional amount of charge will vary according to the battery and the temperature, but the average additional charge is 12 percent. When the battery is nearly charged, the final charging must be at a low rate. A charging rate that is too high will cause heating in the battery and a high loss of water from the electrolyte. The

charging of the battery must be done correctly, or the service life of the battery will be decreased.



Specific Gravity Reading	Electrolyte Temp.	Correction Points	Correct Value
1.210	31°C (88°F)	+0.003	1.213
1.210	27°C (81°F)	+0.001	1.211
1.210	25°C (77°F)	0.000	1.210
1.210	18°C (64°F)	−0.004	1.206
+0.001 or −0.001 for each 2 degrees C from the 25-degree base value.			

Figure 15. Specific Gravity Check

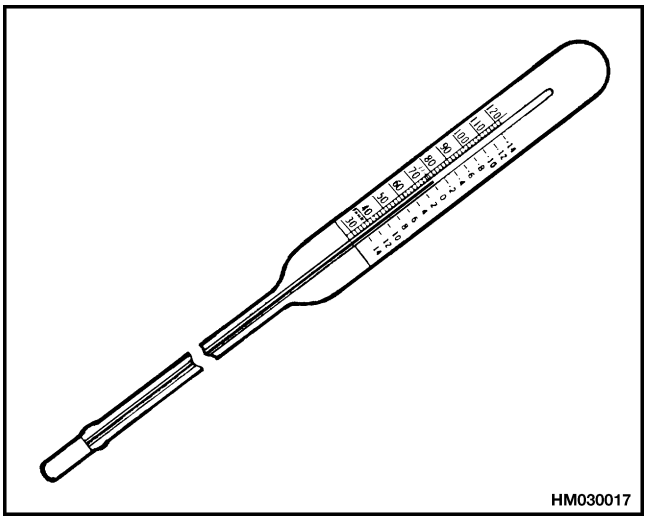


Figure 16. Battery Thermometer

CHARGING BATTERY

NOTE: There can be one of two types of batteries. One type has removable cell caps. The other type has sealed cells. The sealed batteries require a different charger. The electrolyte level or specific gravity cannot be checked, and water cannot be added to the electrolyte of these sealed batteries.

WARNING

The acid in the electrolyte can cause injury. If electrolyte is spilled, use water to flush the area. Make the acid neutral with a solution of sodium bicarbonate.

Batteries generate explosive fumes when they are being charged. Keep fire, sparks, and burning material away from the battery charger area. Prevent sparks from the battery connectors.

Charge batteries only in the special area for charging batteries. When charging the batteries, keep the vent caps clean. The battery charger area must have ventilation so that explosive fumes are removed. Open the hood over the battery or remove the cover if the battery has a cover.

Disconnect the battery when doing cleaning and maintenance.

If the lift truck has been operated with a low battery, check the contactors for welded contacts before a charged battery is connected. The circuit will not reset and lift truck operation cannot be controlled if the contacts are welded. To check the contacts, see the Contactor inspection procedure for your lift truck.

CAUTION

Use only battery chargers approved by the battery manufacturer or dealer.

CAUTION

NEVER connect the battery charger plug to the plug of the lift truck. You can damage the traction control circuit. Make sure the charger voltage is the correct voltage for the battery.

Correct use of the hydrometer (see Figure 14) and proper operation of the battery charger is important. Also see Figure 15. Follow the instructions of the charger manufacturer. NEVER let the battery discharge below the minimum value

given by the battery manufacturer. A fully charged battery will have a specific gravity of 1.265 to 1.310 at 25°C (77°F). See Figure 15. NEVER charge a battery at a rate that will raise the electrolyte temperature above 49°C (120°F). Never let a battery stay discharged for long periods.

Types of Battery Charges

1. NORMAL CHARGE. This charge is usually given to a battery that is discharged from normal operation. This is often an 8-hour charge. Many customers charge the battery at regular intervals that depend on use. This procedure will keep the battery correctly charged if the battery is not discharged below the limit. Always use a hydrometer to check the battery if the battery is charged at regular intervals. Frequent charging of a battery that has a 2/3 or more charge can decrease the life of the battery.

2. EQUALIZING CHARGE. This charge is at a low rate and balances the charge in all the cells. The equalizing charge is usually given approximately once a month. It is a charge at a slow rate for 3 to 6 hours in addition to the regular charging cycle. Do not give an equalizing charge more than once a week. The most accurate specific gravity measurements for a charged battery will be after an equalizing charge. If the specific gravity difference is more than 0.020 between cells of the battery after an equalizing charge, there can be a damaged cell. Consult your battery dealer.

NOTE: Many customers have battery chargers that can follow a program to automatically charge a battery according to recommendations of the battery manufacturer. Use the recommendations of the battery manufacturer for charging the battery.

When performing a monthly equalization charge it is recommended to check individual cell voltages.

1 Complete an equalization charge.

2 Measure and compare the voltage for each cell.

3 Record any cells differing more than 0.5 volts from other cells.

4 Calculation the expected specific gravity (average cell voltage -0.845 = specific gravity). For example 2.09 volts - 0.845 = 1.24.

5 Verify calculated specific gravity by performing a specific gravity measurement of each cell with a hydrometer.

The discharge limits and the limits for the specific gravity before the battery must be charged again are shown in Figure 17. NEVER discharge a battery below the limits shown in Figure 18. Discharging a battery beyond the design limits will decrease the service life of the battery.

NOTE: Sometimes the capacity of a battery is not enough to complete a work period. Check for the following conditions:

- The battery is too small for the job.
- The battery is not fully charged.
- The battery charger is not operating correctly.
- The battery is near the end of its service life.

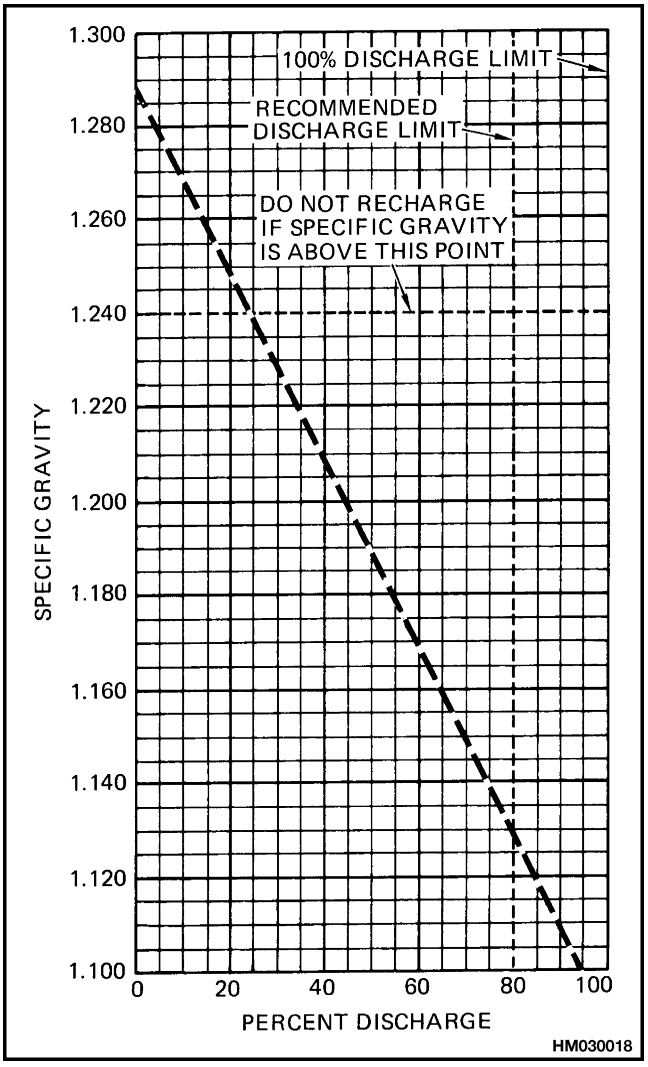


Figure 17. Specific Gravity Versus Percent Discharge

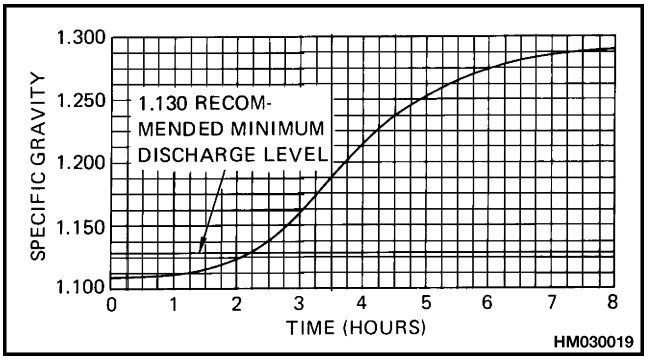


Figure 18. Specific Gravity Compared to Charging Time

Methods of Charging

There are three methods of charging a battery.

1. GRADUAL CHARGE. This method uses a solid-state automatic battery charger. The charging rate begins at 20 to 25 amps/100 amp-hours and decreases to less than 5 amps/100 amp-hours when the battery is 80 percent charged. The charging current decreases when the voltage across the cell increases during the charging cycle shown in Figure 19. The increase in the voltage from the charger is approximately the same as the increase in the specific gravity in the cells.

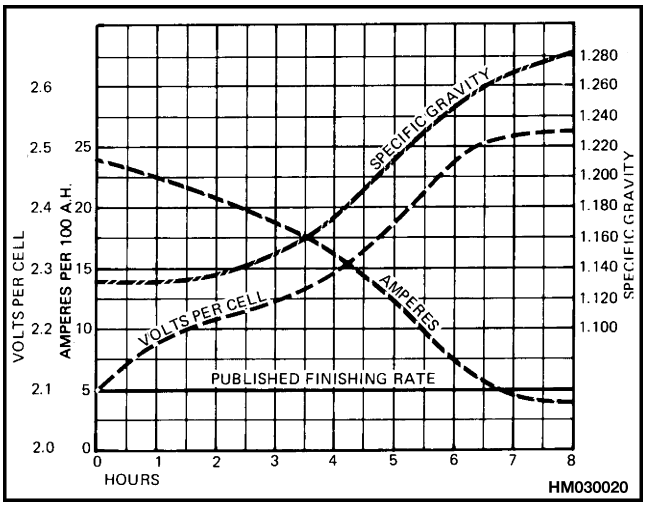


Figure 19. Specific Gravity Compared to Charging Time

2. MODIFIED CONSTANT VOLTAGE. This method uses a generator to generate a constant voltage that is controlled by a resistor. When the charging current decreases, the voltage across the resistor increases. The increasing voltage across the resistor causes an increasing voltage at the battery terminals. The charging is similar to the gradual charge. The resistor must be correctly set, or the charging rate will be wrong. The typical graphs for a modified constant voltage charger are shown in Figure 20.

3. TWO-RATE CHARGE. This method also uses a high charging rate at the beginning followed by a lower rate. Two resistors control the charging rate. One resistor controls the charging rate at the beginning of the cycle and a second resistor reduces the charging rate when the voltage in the cells reaches 2.37 volts. A relay automatically controls the second resistor. The two-rate charging cycle is shown in Figure 21.

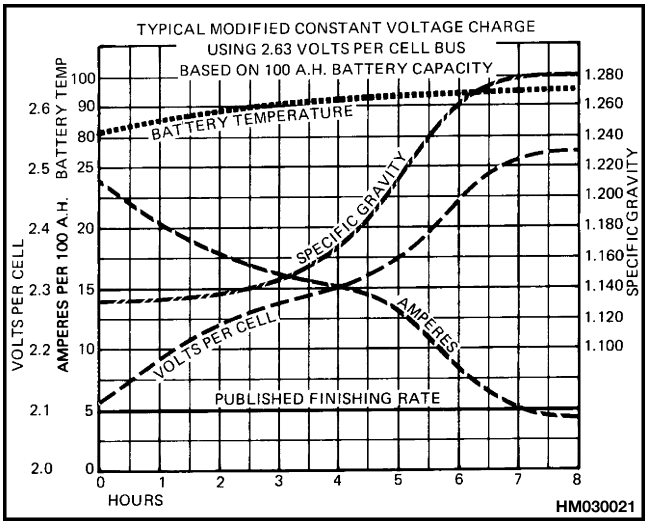


Figure 20. Modified Constant Voltage Charger

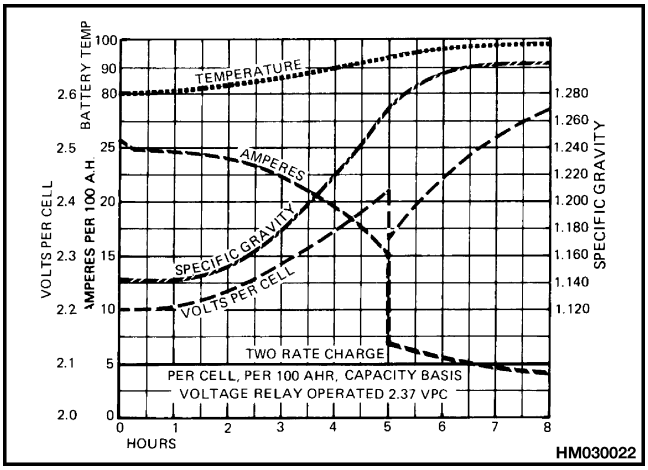


Figure 21. Two-Rate Charging Cycle

NOTE: Many users have battery chargers that can follow a program to automatically charge a battery according to recommendations of the battery manufacturer. Use the recommendations of the battery manufacturer for charging the battery.

Troubleshooting Charger

Battery chargers normally operate automatically without constant attention. It is necessary to make a periodic check that the charger is operating correctly. Check for the following conditions:

1. Battery temperature is too high. The temperature in a battery will not normally rise more than 14°C (25°F) during an 8-hour charging period. Higher temperatures indicate the charging rate needs adjustment.

2. Continuous operation of the charger. Check the automatic controls on the charger. Check the charging rate. A low charging rate can be the problem.

3. Continuous operation of a charger at a high rate. Normally, the charging rate begins at a high rate and decreases as the battery becomes charged. If the rate does not decrease, the controls need repair or adjustment.

Knowing When Battery Is Fully Charged

WARNING

Always connect the positive cable to the positive terminal and connect the negative cable to the negative terminal. Any other connection will cause injury and damage.

Always charge the battery at the end of the work period (shift). Never let the specific gravity decrease to a level less than the limits shown in the manual.

Always de-energize the charger before you connect or disconnect the charger from the battery.

NEVER connect the battery charger plug to the plug of the lift truck. You can damage the traction control circuit. Make sure the charger voltage is the correct voltage for the battery.

1. During charging, the voltage increases slowly. When the battery is fully charged, the voltage level is constant.

2. Remove a vent cap and look in the opening. If you see bubbles in the electrolyte, the battery is either fully charged or in the final stage of charging.

3. The specific gravity reading is constant and within the limits of a charged battery. If the temperature increases after the battery is charged, the specific gravity will decrease a small amount.

4. Constant meter indications on the charger will indicate the end of the charging cycle.

WHERE TO CHARGE BATTERIES

To increase the service life and reduce maintenance, a special area is needed for charging the batteries. The following information is necessary for the design of this area:

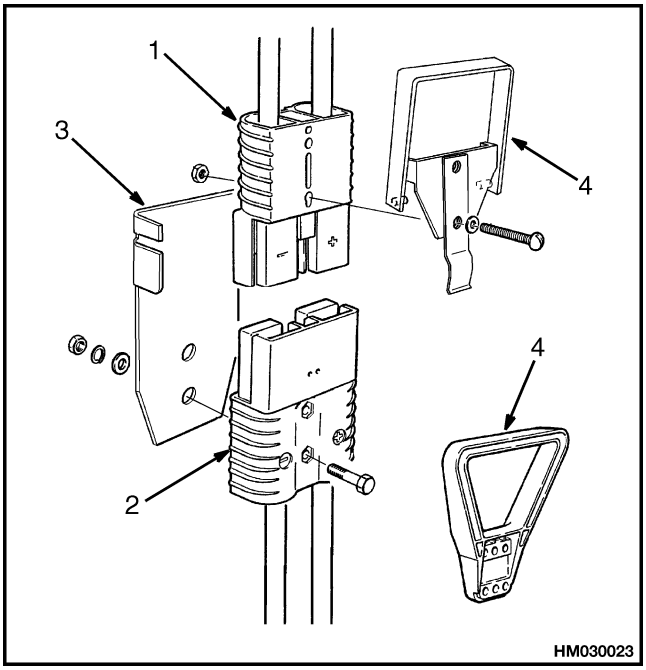
- Location of power supply
- Ventilation; hydrogen gas comes from the batteries during charging
- Drains for cleaning the batteries
- Type and size of the batteries
- Type of lift trucks
- Distances the lift trucks must travel for service
- Safety regulations and instructions

Equipment Needed

- A lifting device to remove the battery from the lift truck
- Racks to hold the batteries during charging and storage (these racks must be made of wood or must not be metal; metal racks that are covered with an insulating material can be used)
- A battery charger that will charge your batteries
- Tools for maintenance
- An area with a drain for cleaning batteries and battery compartments
- Distilled water
- Air and water supplies for cleaning
- Maintenance records (see Figure 11 and Figure 12)
- A workbench
- Spare parts and repair equipment
- Protective clothing and safety equipment for handling batteries
- Water source for washing eyes and preventing acid burns
- Install a NO SMOKING sign in the service area
- Keep the charger in a clean, dry area with good ventilation

BATTERY CONNECTORS

A special heavy-duty connector is used to connect the battery to the electrical system of the lift truck. See Figure 22 and Figure 23. When a connector has a handle and is within the operator's reach, the connector is also a safety device that can be used to quickly disconnect the battery in an emergency. Most connectors have a handle to connect the two halves of the connector. The connector can be quickly disconnected by pulling the handle upward. This action separates the two halves of the connector. The connector and its attached handle must be kept in good repair so that it will function correctly. The battery connector must be disconnected when maintenance is done on the lift truck that does not require electric power. The SBE, SBX, and FEM or DIN 12- volt battery connectors are shown in Figure 23.

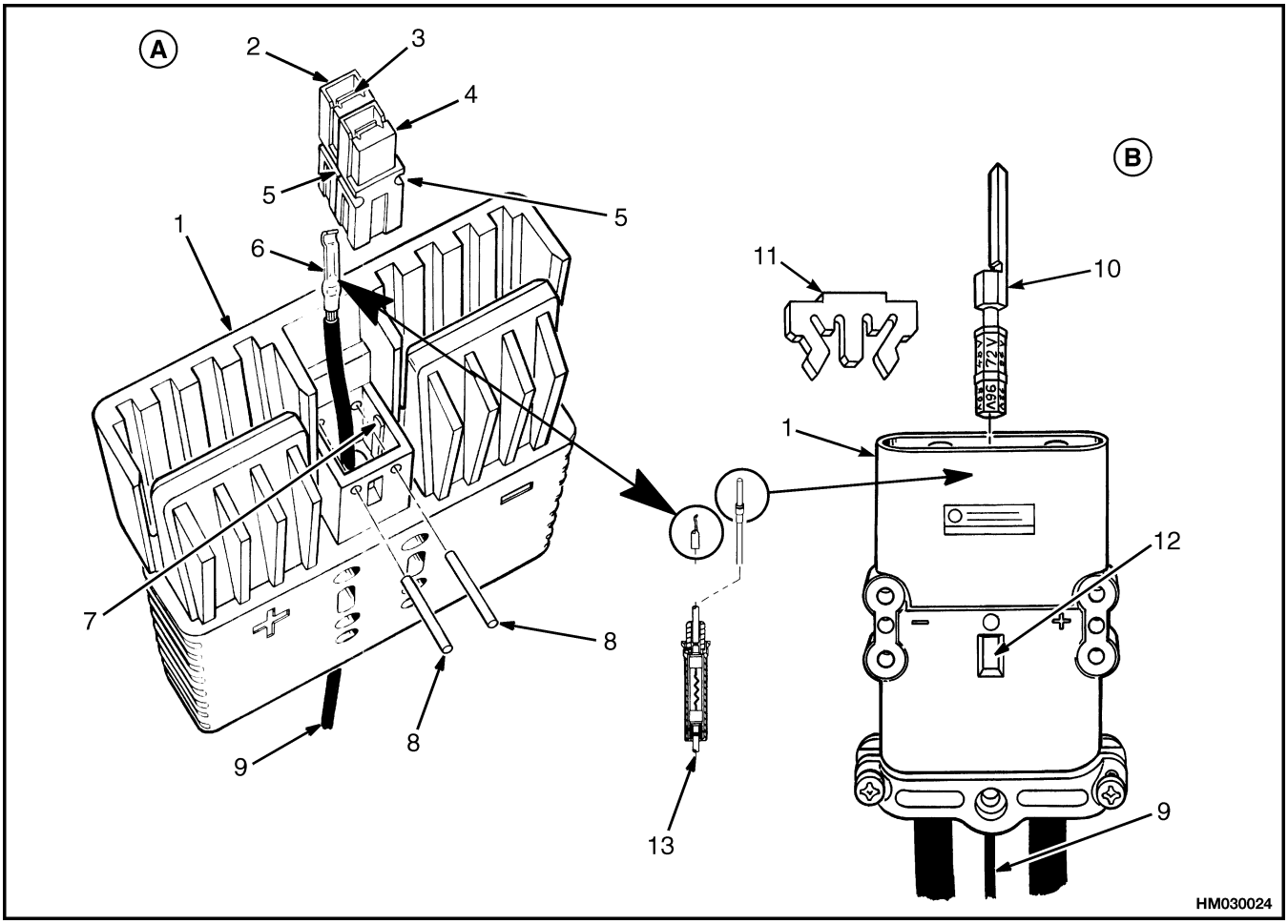


1. SB CONNECTOR FOR BATTERY CABLES
2. SB CONNECTOR FOR POWER CABLES TO LIFT TRUCK
3. BRACKET
4. CONNECT AND DISCONNECT HANDLES

Figure 22. SB Battery Connector

BATTERY CARE

1. Keep batteries clean. Remove any spilled electrolyte.
2. DO NOT overcharge the battery. This action will damage the battery.
3. DO NOT discharge the battery to less than the recommendation. A deep discharge will shorten the battery life.
4. Charge batteries in an area with good ventilation to remove explosive gases and acid fumes.
5. Keep the electrolyte at the correct level. Check the electrolyte level before and after charging the battery. Use distilled water. Do not add acid.
6. Prevent batteries from freezing.
7. Keep batteries charged. A discharged battery in storage will shorten the battery life.
8. Use a battery charger that is correct for the battery. A battery charger that is set for an ampere-hour rate that is too high will cause a high internal heat and damage the battery. A low ampere-hour rate setting on a battery charger can require a longer charging time but will not damage the battery.
9. When batteries are moved, make sure a short circuit does not occur. See the Safety Procedures in Battery Maintenance of this section.



NOTE: INDICATOR INSERT (2). GREEN - FOR BATTERY WITH CELL CAPS. GRAY - FOR BATTERY WITH SEALED CELLS.

NOTE: CONNECTOR BODY COLOR [ANDERSON SBE CONNECTOR ONLY (1)]. GRAY - 36-VOLT BATTERY. BLUE - 48-VOLT BATTERY. GREEN - 72-VOLT BATTERY. BLACK - 80-VOLT BATTERY.

A. ANDERSON SBE OR SBX CONNECTOR

B. FEM OR DIN CONNECTOR

1. HALF OF CONNECTOR SET
2. RED HOUSING FOR +12 VOLT "BATTERY TAP"
3. LOCK SPRING (TIP OF CONTACT MUST LOCK OVER TOP OF LOCK SPRING)
4. BLACK CONNECTOR HOUSING (ASSEMBLED ON RED HOUSING WITH SLOTS FOR LOCK PINS ALIGNED AS SHOWN - NO WIRE OR CONTACT IN HOUSING)
5. SLOT FOR LOCK PIN
6. CONTACT FOR CONNECTOR OF +12 VOLT BATTERY TAP
7. KEY [RED (2) AND BLACK (4) CONNECTORS ALIGN ON KEY]
8. LOCK PINS FOR +12 VOLT CONNECTOR (MUST INSTALL FROM FRONT OF CONNECTOR THROUGH RED AND BLACK CONNECTORS)
9. +12 VOLT WIRE TO TRUCK (TRUCK HALF) OR TO BATTERY (BATTERY HALF)
10. INDICATOR INSERT FOR BATTERY VOLTAGE AND BATTERY TYPE [ROTATE FOR CORRECT VOLTAGE IN WINDOW (12); COLOR SHOWS BATTERY TYPE]
11. LOCK FOR ALL CABLE TERMINALS AND INDICATOR
12. WINDOW SHOWING BATTERY VOLTAGE
13. IN-LINE FUSE ASSEMBLY AND CONTACT FOR +12 VOLT CONNECTOR (TRUCK HALF OF BATTERY CONNECTOR ONLY) (SBE/SBX CONTACT SHOWN)

Figure 23. Detail of Battery Connectors With +12 Volt Tap

Troubleshooting

Table 2. BATTERY TROUBLESHOOTING GUIDE

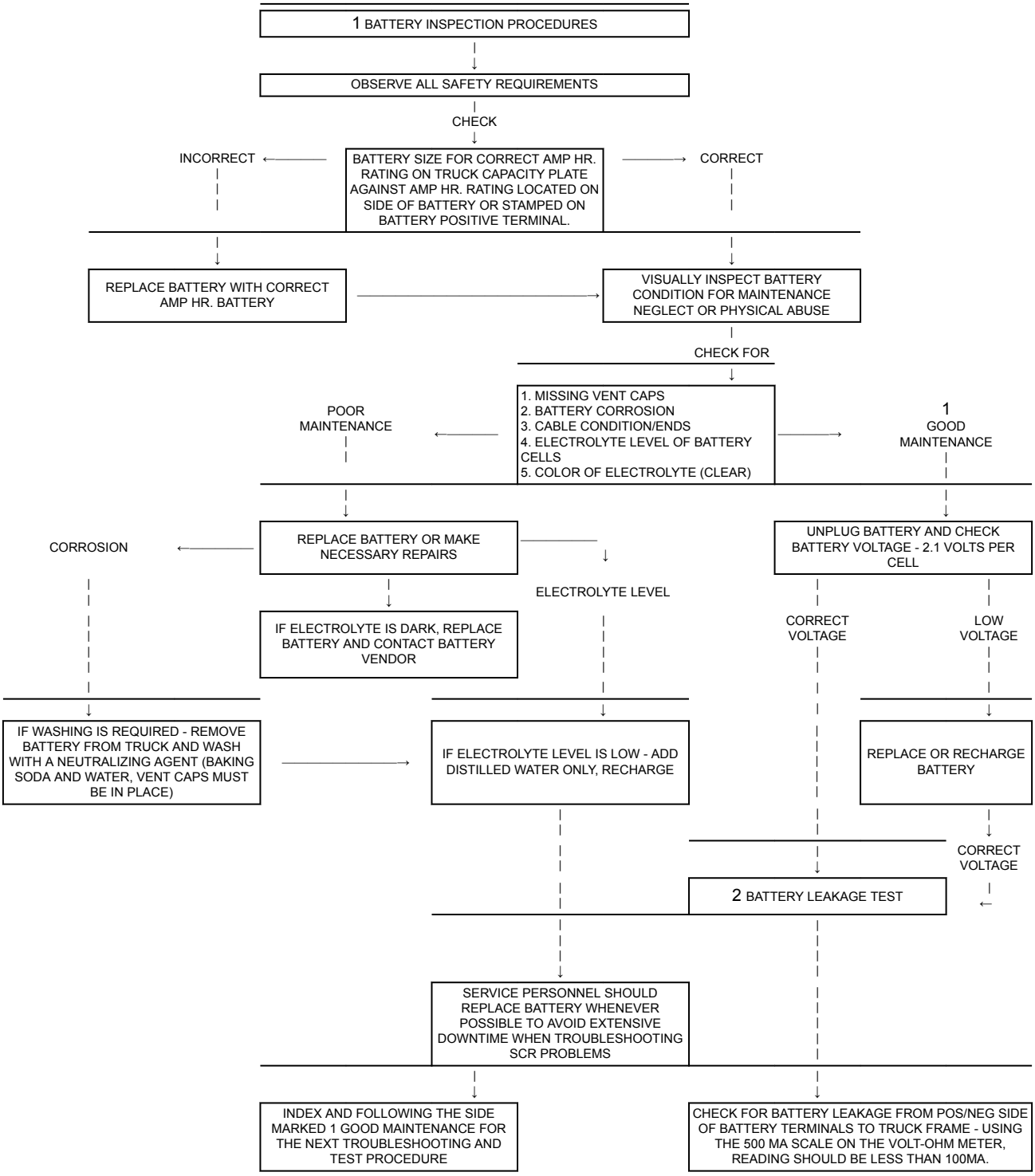


Table 2. BATTERY TROUBLESHOOTING GUIDE (Continued)

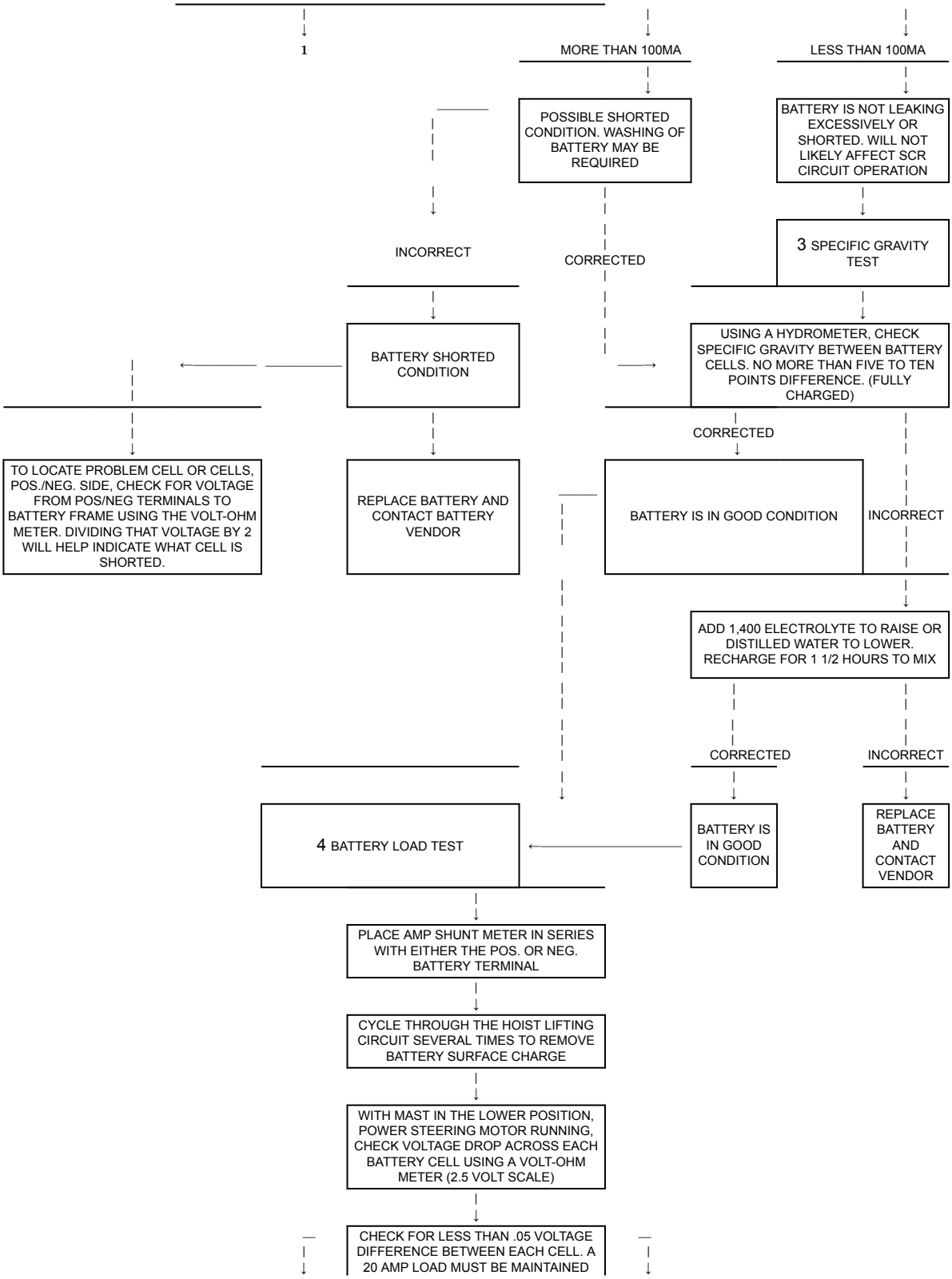
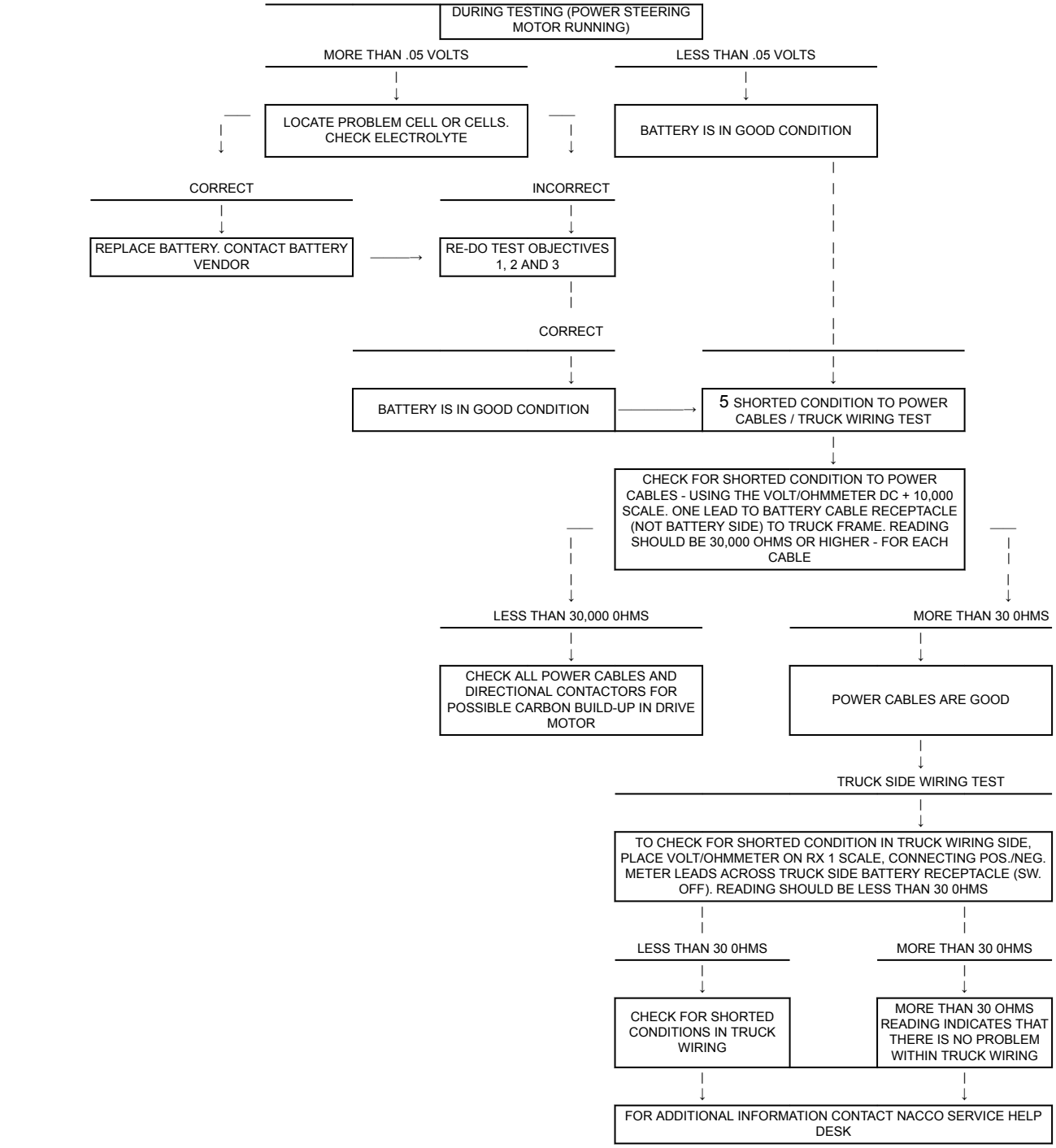


Table 2. BATTERY TROUBLESHOOTING GUIDE (Continued)



Note: Occasionally, a battery failure will occur due to thermally induced stress. Since this type of defect does not occur until the battery has operated under a full loaded condition, for several minutes or hours, it may be required to monitor the discharge cycle.

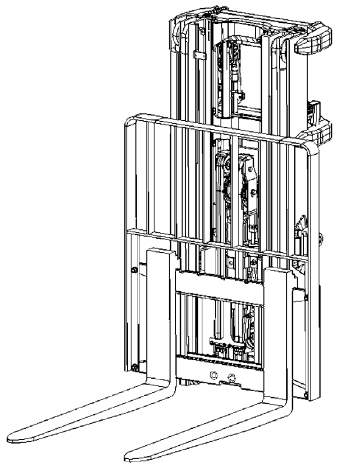
NOTES

MAST REPAIR

(S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)

2-, 3-, AND 4-STAGE MASTS

E2.2-3.5XN (E45-70XN) [A268];
J2.2-3.5XN (J45-70XN) [A276]



HYSTER

PART NO. 1688881

4000 SRM 1338

SAFETY PRECAUTIONS
MAINTENANCE AND REPAIR

- The Service Manuals are updated on a regular basis, but may not reflect recent design changes to the product. Updated technical service information may be available from your local authorized Hyster® dealer. Service Manuals provide general guidelines for maintenance and service and are intended for use by trained and experienced technicians. Failure to properly maintain equipment or to follow instructions contained in the Service Manual could result in damage to the products, personal injury, property damage or death.
- When lifting parts or assemblies, make sure all slings, chains, or cables are correctly fastened, and that the load being lifted is balanced. Make sure the crane, cables, and chains have the capacity to support the weight of the load.
- Do not lift heavy parts by hand, use a lifting mechanism.
- Wear safety glasses.
- DISCONNECT THE BATTERY CONNECTOR before doing any maintenance or repair on electric lift trucks. Disconnect the battery ground cable on internal combustion lift trucks.
- Always use correct blocks to prevent the unit from rolling or falling. See HOW TO PUT THE LIFT TRUCK ON BLOCKS in the **Operating Manual** or the **Periodic Maintenance** section.
- Keep the unit clean and the working area clean and orderly.
- Use the correct tools for the job.
- Keep the tools clean and in good condition.
- Always use **HYSTER APPROVED** parts when making repairs. Replacement parts must meet or exceed the specifications of the original equipment manufacturer.
- Make sure all nuts, bolts, snap rings, and other fastening devices are removed before using force to remove parts.
- Always fasten a DO NOT OPERATE tag to the controls of the unit when making repairs, or if the unit needs repairs.
- Be sure to follow the **WARNING** and **CAUTION** notes in the instructions.
- Gasoline, Liquid Petroleum Gas (LPG), Compressed Natural Gas (CNG), and Diesel fuel are flammable. Be sure to follow the necessary safety precautions when handling these fuels and when working on these fuel systems.
- Batteries generate flammable gas when they are being charged. Keep fire and sparks away from the area. Make sure the area is well ventilated.

NOTE: The following symbols and words indicate safety information in this manual:

WARNING

Indicates a hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION

Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury and property damage.

On the lift truck, the WARNING symbol and word are on orange background. The CAUTION symbol and word are on yellow background.

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This section is for the following models:

E2.2-3.5XN (E45-70XN) [A268];
J2.2-3.5XN (J45-70XN) [A276]

General

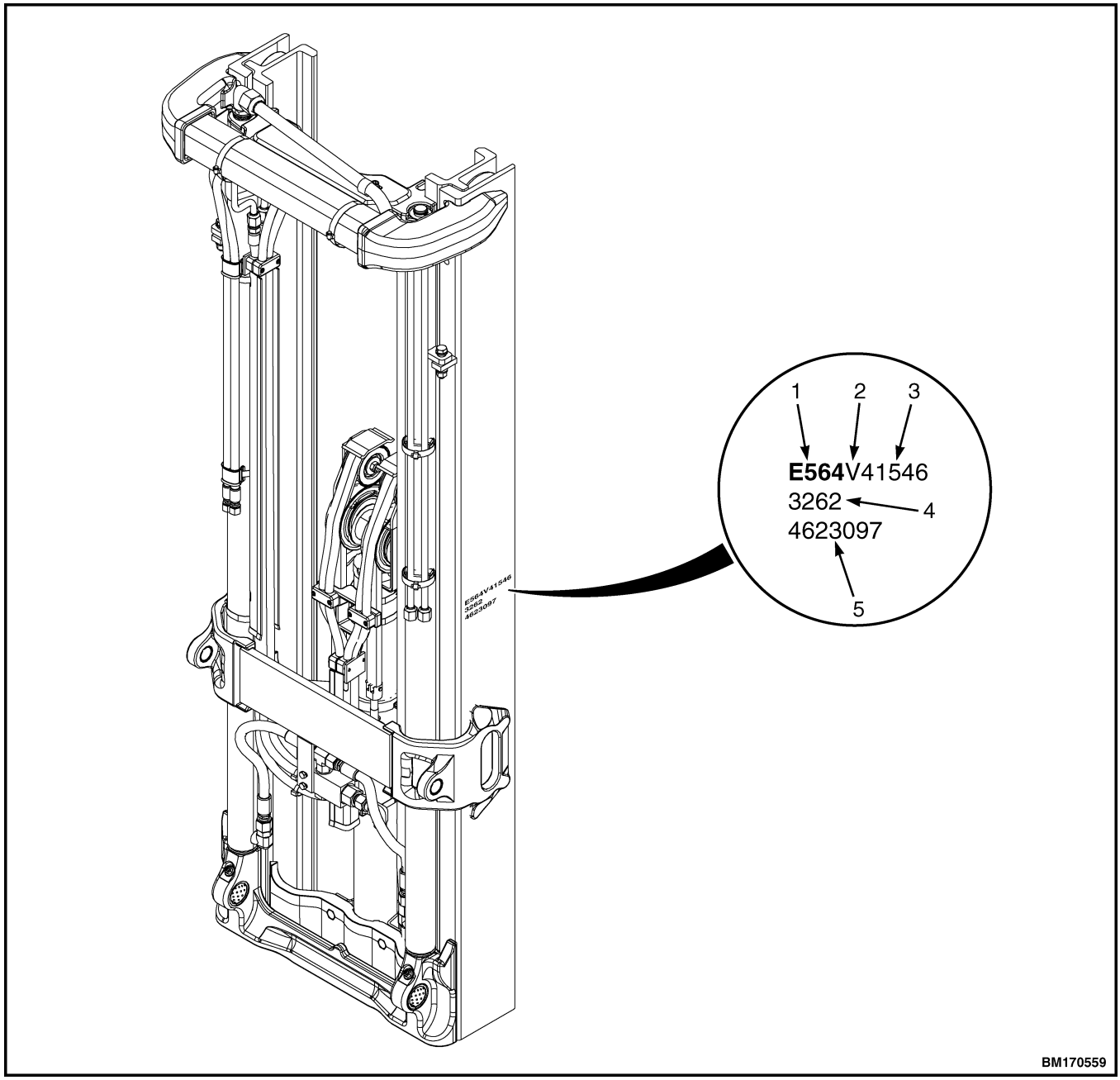
WARNING

Before working on or near the mast, see the section
Safety Procedures When Working Near Mast in this SRM .

NOTE: Hoses have a service life that is determined by application and time. Install a new hose if the hose is leaking, worn through, or damaged. A hose has been damaged if the hose cover is cracked, exposing the braiding, or if the hose has been kinked or crushed, or if the hose is no longer flexible. Install a new hose if the hose has been tensioned beyond the adjustment range. If necessary, make a comparison to a new hose that is the correct replacement for the hose you are inspecting.

This section has the repair procedures for the Two-Stage, Limited Free-Lift (LFL) mast and Two, Three, and Four-Stage, Full Free-Lift (FFL) masts and carriages. The mast serial number is located on the right side of the outer mast. Other information about the mast can also be found in this area. See Figure 1.

Procedures for adjusting the carriage, lift chains, mast, and tilt cylinders are located at the end of this manual.



NOTE: MAST AND SERIAL NUMBER SHOWN ARE NOT COVERED IN THIS MANUAL. ART USED FOR ILLUSTRATIVE PURPOSES. INFORMATION SHOWN IS FOUND IN SAME POSITION ON ALL MASTS COVERED IN THIS MANUAL.

1. MAST SERIAL NUMBER
2. MANUFACTURING PLANT
3. PRODUCTION SEQUENCE
4. MAST LIFT HEIGHT (IN MILLIMETERS)
5. MAST ASSEMBLY PART NUMBER

Figure 1. Mast Serial Number Location

Safety Procedures When Working Near Mast

The following procedures MUST be used when inspecting or working near the mast. Additional precautions and procedures can be required when repairing or removing the mast.

WARNING

Mast parts are heavy and can shift. Distances between parts are small. Serious injury or death can result if part of the body is hit by parts of the mast or the carriage.

- **Never put any part of the body into or under the mast or carriage unless all parts are completely lowered or a safety chain is installed. Also make sure that the power is OFF and the key is removed. Put a DO NOT OPERATE tag in the operator's compartment. Disconnect the battery and put a tag or lock on the battery connector.**
- **Be careful of the forks. When the mast is raised, the forks can be at a height to cause an injury.**
- **DO NOT climb on the mast or lift truck at any time. Use a ladder or personnel lift to work on the mast.**
- **Mast repairs require disassembly and removal of parts and can require removal of the mast or carriage. Follow the repair procedures in this section.**

WHEN WORKING NEAR THE MAST ALWAYS:

- **Lower the mast and carriage completely: Turn the key switch to the ON position and push the lift/lower control lever forward until there is no movement in the mast. Make sure that all parts of the mast that move are fully lowered.**

  OR

- **If parts of the mast must be in a raised position, install a safety chain to restrain the moving parts of the mast. Connect moving parts to a part that does not move. Follow these procedures:**

1. Put mast in vertical position.
2. Raise mast to align bottom crossmember of mast upright that moves in outer mast with crossmember on outer mast. On the two-stage mast, the moving part is the inner mast. On the three-stage mast, it is the intermediate mast. On the four-stage mast, it is the first intermediate mast. See Figure 2 .
3. Use a 3/8-inch minimum safety chain with a hook to fasten the crossmembers together so the movable member cannot lower. Put hook on back side of mast. Make sure hook is completely engaged with a link in the chain. Make sure safety chain does not touch lift chains or chain sheaves, tubes, hoses, fittings, or other parts on the mast.
4. Lower mast until there is tension in safety chain and free-lift cylinder (full free-lift models) is completely retracted.

NOTE: Apply the parking brake. After lowering or restraining the mast, shut off the power, and remove key. Put a **DO NOT OPERATE** tag in the operator's compartment. Disconnect battery and put a tag or lock on battery connector.

5. Install another safety chain (9.5 mm (3/8 in.) minimum) between the top or bottom bar of the carriage and a crossmember on the outer mast as a secondary safety device. Install a **DO NOT REMOVE** tag on the safety chain(s).

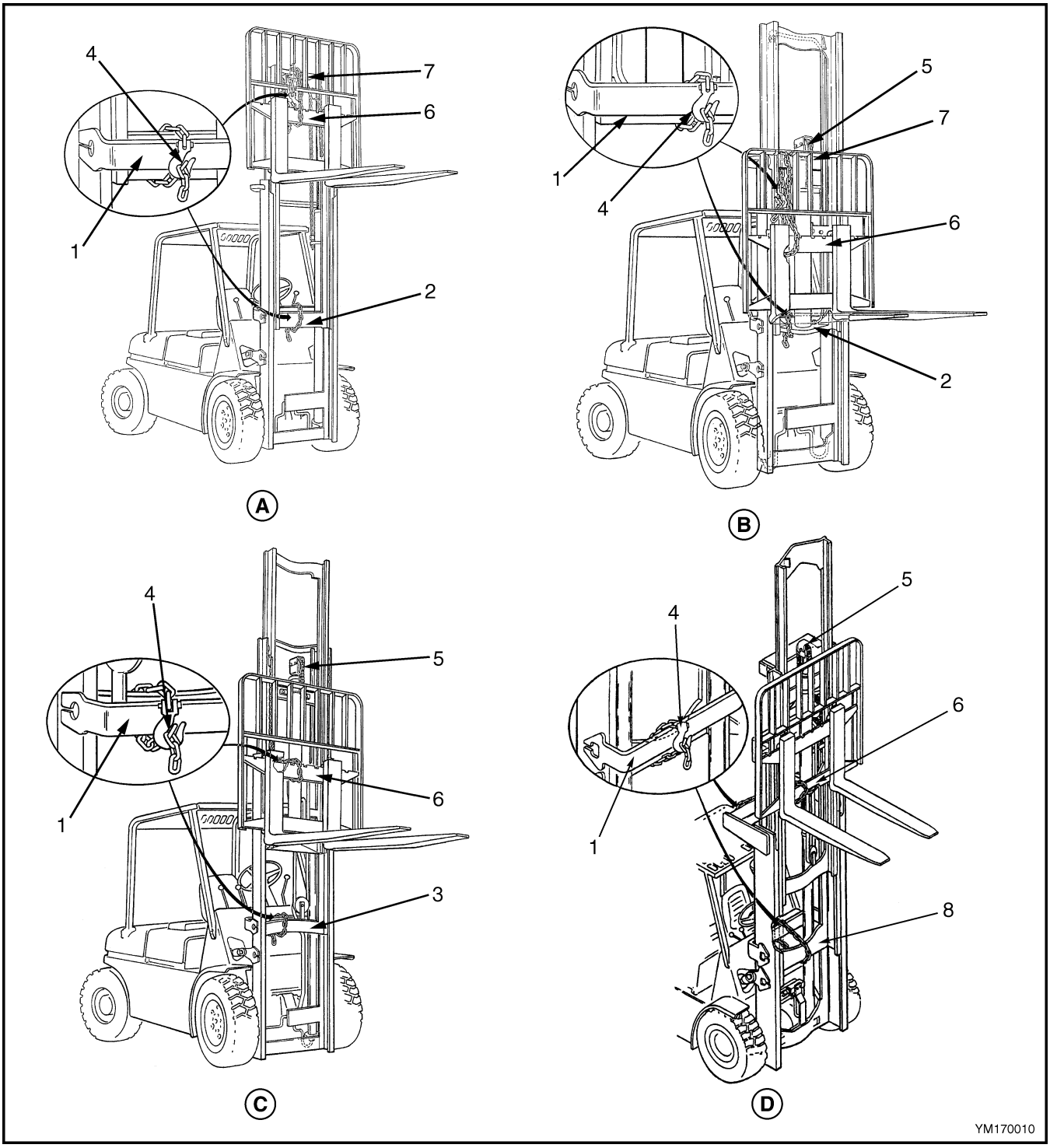


Figure 2. Safety Chaining the Mast

Legend for Figure 2.

A. TWO-STAGE LFL MAST
B. TWO-STAGE FFL MAST
C. THREE-STAGE FFL MAST
D. FOUR-STAGE FFL MAST

1. OUTER MAST
2. INNER MAST
3. INTERMEDIATE MAST
4. HOOK
5. FREE-LIFT CYLINDER
6. CARRIAGE BAR
7. CROSSMEMBER
8. FIRST INTERMEDIATE MAST

Fork Replacement

CAUTION

Remove fork latch pins if adding a fork positioner attachment. Damage to forks and other carriage components can occur if fork latch pins are not removed prior to using attachment.

Forks are held on the carriage by hooks. Forks used on a standard carriage or an integral sideshift carriage are held in position by pins that fit through the top fork hooks and into slots in the top carriage bar. If pin does not remain engaged in carriage slot, replace with new pin. Always check that pins for the forks keep forks in position on carriage. Replace damaged fork pin parts. Forks are removed from carriage by aligning forks with fork removal notch. Fork removal notch is in the bottom bar of carriage. See Figure 3.

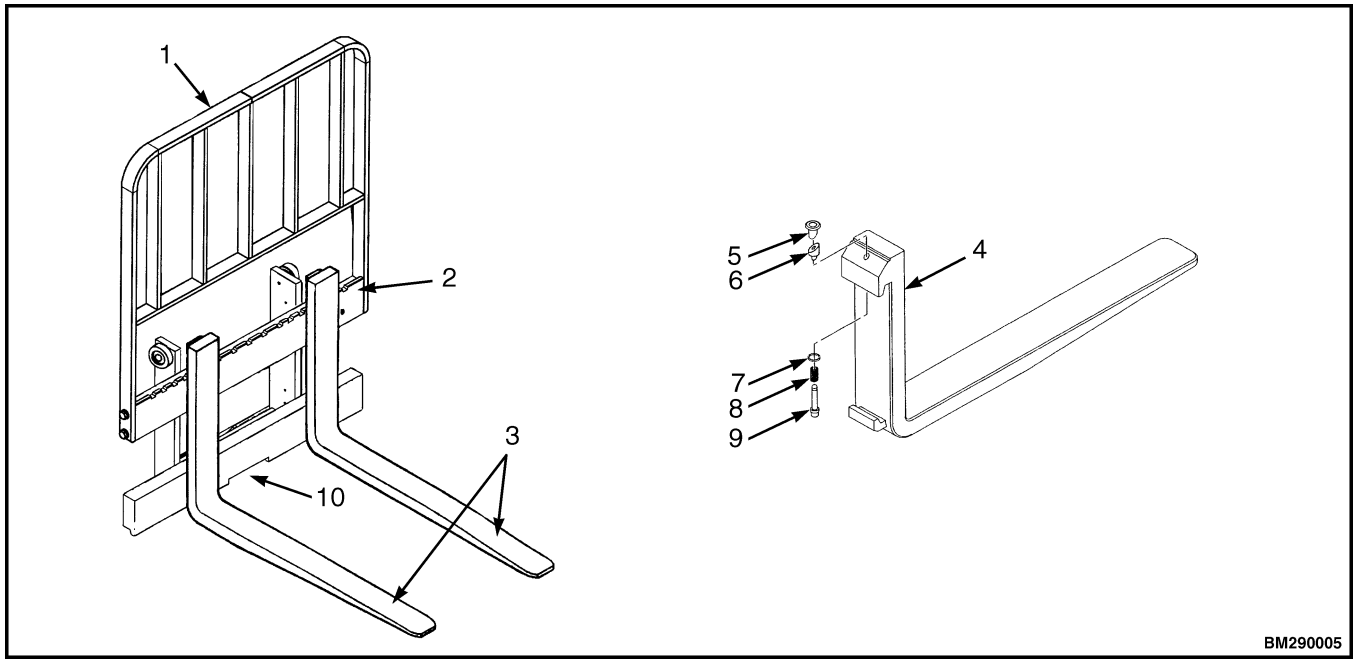
REMOVE

If lift truck is equipped with a fork positioner, see Carriages Repair for procedures to remove the forks.

WARNING

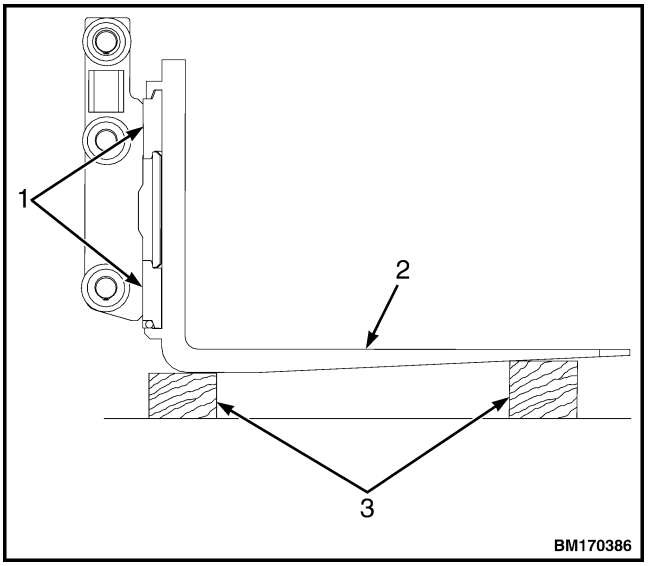
DO NOT try to remove a fork without a lifting device. Each hook fork for these lift trucks can weigh 45 to 115 kg (99 to 254 lb).

A fork can be removed from the carriage for replacement of the fork or other maintenance. Slide fork to the fork removal notch in bottom bar of the carriage. See Figure 3. Lower fork onto blocks so bottom hook of fork moves through fork removal notch. See Figure 4. Lower carriage further so top hook of fork is disengaged from top carriage bar. Move carriage away from fork or use a lifting device to move the fork away from carriage.



1. LOAD BACKREST
2. CARRIAGE
3. FORKS
4. FORK
5. KNOB
6. WEDGE
7. WASHER
8. SPRING
9. PIN
10. FORK REMOVAL NOTCH

Figure 3. Carriage and Forks



1. CARRIAGE BARS
2. HOOK FORK
3. BLOCKS

Figure 4. Hook Fork Removal

INSTALL

If lift truck is equipped with a fork positioner, see Carriages Repair for procedures to install the forks.

Move the fork and carriage so the top hook on the fork can engage the upper carriage bar. See Figure 4. Raise the carriage to move the lower hook through the fork removal notch. Slide the fork on the carriage so both upper and lower hooks engage the carriage bars. Engage the latch pin with a notch in the upper carriage bar.

CHECKS

WARNING

DO NOT try to correct fork tip alignment by bending the forks or adding shims. Replace bent forks.

Never repair damaged forks by heating or welding. Forks are made of tempered steel using special procedures. Always replace damaged forks as a complete set.

1. Inspect the forks for cracks and wear. Check the alignment of the fork tips as shown in Table 1. Check that the bottom of the fork is not worn (item A, Figure 6).

2. Replace any damaged or broken parts that are used to keep forks locked in position.

3. Inspect fork wear. Ensure heel wear is not more than 10% of original thickness. If fork wear is more than 10%, fork must be replaced or rerated. Perform fork wear inspection using a BOL256N1 caliper ruler Hyster P/N 4092984 , as follows. See Figure 6.

   a. Determine the normal thickness of the "N" of the fork using the scale or ruler portion of the caliper ruler. Measurement has to be done on the fork shank using the caliper ruler.

   b. Position the caliper at the end of the heel internal radius (item A, Figure 6) with the opening corresponding to the measure thickness of the fork shank in above (e.g. N 1.75 use N 1.75 opening). This is typically the section of the fork where wear is the greatest. Note that the opening distance has been reduced by 10% from the nominal thickness.

   c. If the fork enters the opening, it is mandatory to replace it. DANGER OF BREAKING. Furthermore, a 10% reduction in fork blade thickness results in 20% reduction in operating capacity.

Table 1. Fork Tip Alignment

Fork Tip Alignment Specifications			
Standard Fork Lengths		Maximum Fork Tip Difference[1]	
mm	(in.)	mm	(in.)
914	(36)	27	(1.08)
1000	(39)	30	(1.17)
1016	(40)	30	(1.2)
1067	(42)	32	(1.26)
1100	(43)	33	(1.29)
1200	(47)	36	(1.42)
1207	(47.5)	36	(1.42)
1219	(48)	37	(1.46)
1372	(54)	41	(1.61)
1400	(55)	42	(1.65)
1500	(59)	45	(1.77)
1524	(60)	46	(1.81)
1829	(72)	55	(2.16)
[1]Difference of alignment between fork tips must be no more than 3% of the total fork length.			

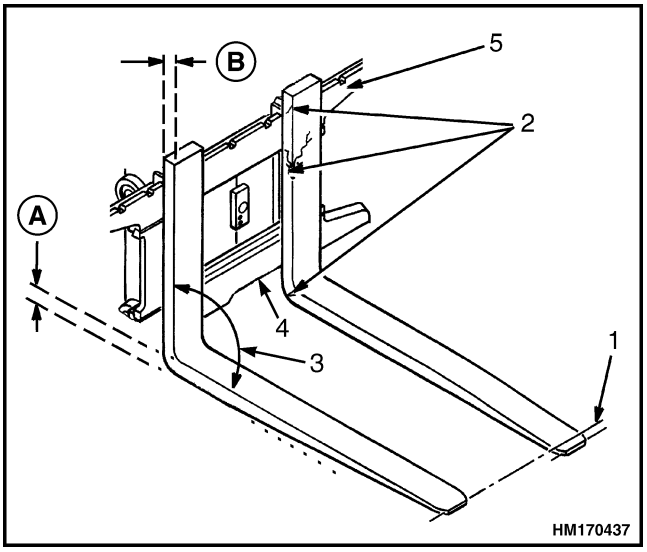


Figure 5. Fork Check

Legend for Figure 5.

A. HEEL OF FORK (MUST BE 90% OF DIMENSION B)
B. ORIGINAL FORK THICKNESS (DIMENSION B)

1. TIP ALIGNMENT (MUST BE WITHIN 3% OF FORK LENGTH)
2. CRACKS
3. MAXIMUM ANGLE 93°
4. FORK REMOVAL NOTCH
5. CARRIAGE

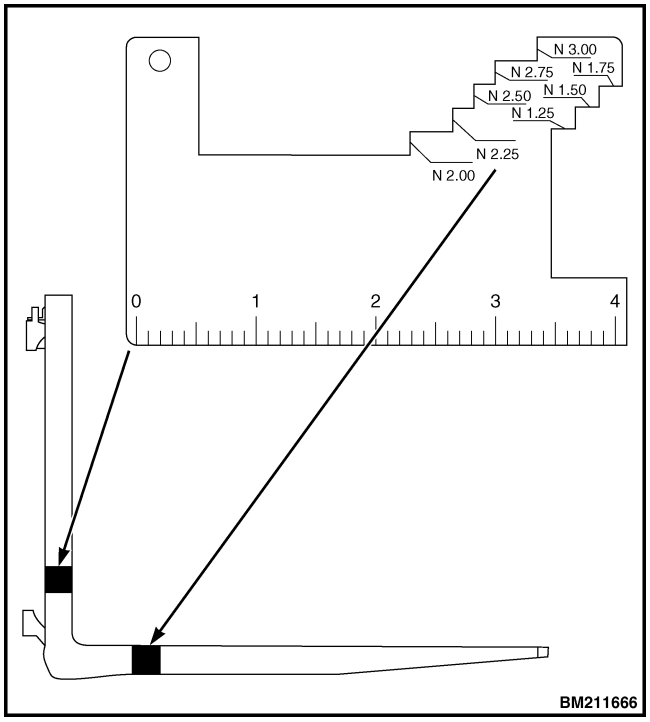


Figure 6. Fork Wear Check

Carriages Repair

STANDARD CARRIAGE

Remove

1. Remove the forks. See Fork Replacement.

2. Remove four capscrews, nuts, washers and load backrest from carriage. See Figure 7.

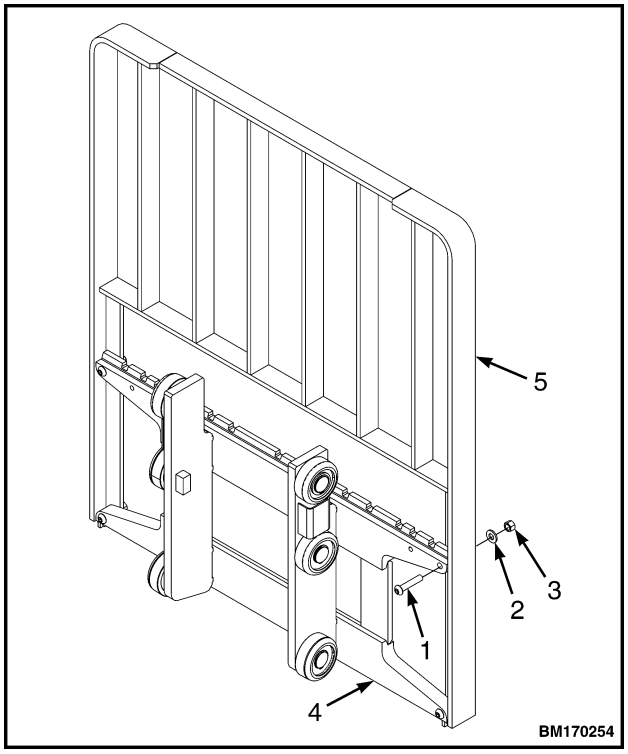


Figure 7. Load Backrest Removal

Legend for Figure 7.

NOTE: THREE-STAGE FFL CARRIAGE SHOWN. LOAD BACK REST MOUNTED THE SAME WAY ON TWO-STAGE FFL AND TWO-STAGE LFL CARRIAGES. MOUNTING OF LOAD BACK REST IS SIMILAR ON FOUR-STAGE FFL MAST.

1. CAPSCREW
2. WASHER
3. NUT
4. CARRIAGE
5. LOAD BACKREST

3. Connect a lifting device to the carriage. Lift the carriage so that the lift chains become loose.

WARNING

When disconnecting the lift chains, keep control of the ends. Use wire to temporarily connect the ends of the lift chains to the mast. This procedure will prevent the lift chains from falling and causing an injury or damage.

4. Remove the pin from each chain anchor at the carriage. See Figure 8. Disconnect the lift chains from the carriage. Use wire to connect the ends of the lift chains to a part of the mast. Make sure the chains can move freely when the inner mast is raised.

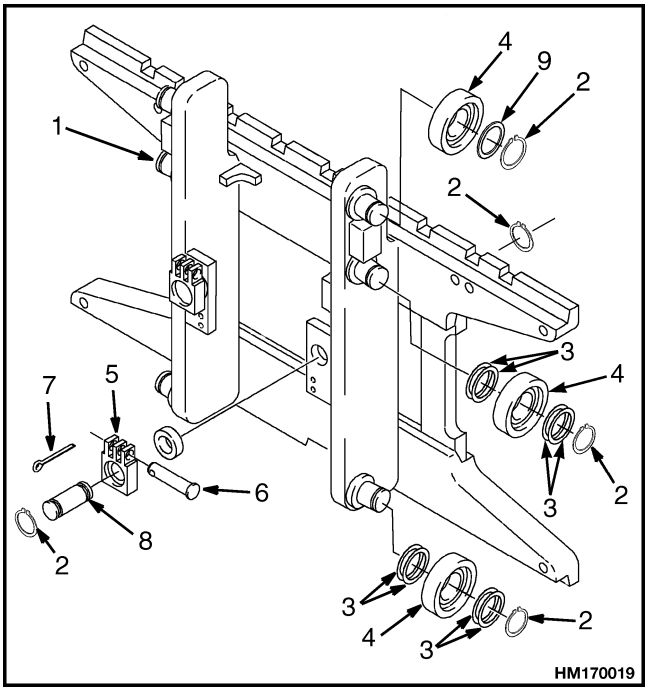


Figure 8. Standard Carriage

Legend for Figure 8.

NOTE: TWO-STAGE LFL CARRIAGE SHOWN. TWO, THREE, AND FOUR STAGE FFL CARRIAGES ARE SIMILAR.

1. CARRIAGE
2. SNAP RING
3. SHIM
4. LOAD ROLLER
5. CHAIN ANCHOR
6. CHAIN PIN
7. COTTER PIN
8. ANCHOR PIN
9. SPACER

WARNING

To help prevent possible injury, make sure the carriage is stable and will not fall over when the inner mast is raised above the load rollers of the carriage.

5. Use the lift cylinders to raise the inner or intermediate mast. If the hydraulic system cannot be used, disconnect the lift cylinders from the inner or intermediate mast. See the section **Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564)** 2100SRM1382. Connect a crane [the capacity of the crane must be at least 681 kg (1501 lb)] to the top of the inner mast. Carefully raise the inner mast until it is above the load rollers of the carriage. Install safety chains to secure the mast in its extended position and disconnect the crane. See Safety Procedures When Working Near Mast.

6. Move lift truck away from the carriage. Completely lower the inner mast so it cannot move.

Clean and Inspect

NOTE: Shims are installed on the bottom and middle rollers only.

1. If any of the load rollers must be replaced (see Figure 8), make a note of the location and number of the shims. Install the shims, load rollers, and snap rings. See Carriage Adjustments for correct adjustment of the load rollers.

WARNING

Compressed air can move particles so that they cause injury to the user or to other personnel. Make sure that the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eyes.

WARNING

Cleaning solvents can be flammable and toxic, and can cause skin irritation. When using cleaning solvents, always follow the recommendations of the manufacturer.

CAUTION

DO NOT use cleaning solvent, compressed air, or steam to clean lift chain sheaves or load rollers. The bearings in the lift chain sheaves and load rollers are sealed and lubricated. Cleaning solvent, compressed air, and steam can damage the load roller bearings.

2. Clean any oil, grease, dirt, and other debris from the carriage frame. Use a cleaning solvent and compressed air to dry.

WARNING

Improper welding procedures can damage the structure of the mast or cause incorrect function of the mast. Consult your Hyster lift truck dealer for more information before welding on the mast.

3. If the carriage bars have any protruding welds or damaged notches, repair by grinding, filing, or welding.

4. Clean and inspect the chain anchors and chain anchor pins. See Figure 8. Check chain anchors and anchor pins for wear and serviceability. Discard worn or unserviceable chain anchors and chain anchor pins. Discard cotter pins.

Install

1. Use the hydraulic system of the lift truck or a crane to raise the inner mast. If the hydraulic system cannot be used, disconnect the lift cylinders from the inner or intermediate mast. See the section **Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564)** 2100SRM1382. Connect a crane [the capacity of the crane must be at least 681 kg (1501 lb)] to the top of the inner mast. Carefully raise the inner mast until it is above the load rollers of the carriage. Install safety chains to secure the mast in its extended position and disconnect the crane. See Safety Procedures When Working Near Mast.

2. Move the lift truck toward the carriage until the inner mast is aligned with the carriage rollers. If the inner mast has been raised and secured using a crane and safety chains, connect the crane, raise the inner mast, and remove the safety chains. Carefully lower the inner mast until it engages all of the load rollers. Disconnect the crane, if attached, and reconnect the lift cylinders. See **Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564)** 2100SRM1382.

3. Check the clearance of the load rollers. See Carriage Adjustments in this manual.

NOTE: Use new cotter pins each time the chain pins are removed.

4. Connect the lift chains to the chain anchors at the carriage. Install the cotter pins in the chain pins. Adjust the lift chains as described in Lift Chains Adjustment in this manual.

5. Install load backrest onto carriage using capscrews, washers, and nuts (see Figure 7). Tighten capscrews to 195 N•m (144 lbf ft).

6. Install forks. See Fork Replacement.

INTEGRAL SIDESHIFT CARRIAGE, LIFT TRUCKS MANUFACTURED PRIOR TO DECEMBER, 2016

Remove

1. Lower carriage completely. Remove forks. See Fork Replacement for removal procedures.

2. Remove four capscrews, washers, nuts and load backrest from carriage. See Figure 7.

WARNING

Before disconnecting the hydraulic hoses, relieve the pressure in the hydraulic system. Serious injury can occur if pressure is not relieved from hydraulic system prior to disconnecting hydraulic hoses.

3. Relieve hydraulic pressure to the sideshift cylinder by moving sideshift lever in both directions several times.

WARNING

Always wear the proper protective equipment including eye protection and petroleum-resistant gloves when handling hydraulic oil. Thoroughly wash oil from exposed areas of skin as soon as possible.

The hydraulic oil is hot at normal operating temperatures. Be careful when draining the oil.

Never check for leaks by putting hands on hydraulic lines or components under pressure. Hydraulic oil under pressure can be injected into the skin.

CAUTION

Protect the hydraulic system from dirt and contaminants when servicing the hydraulic system.

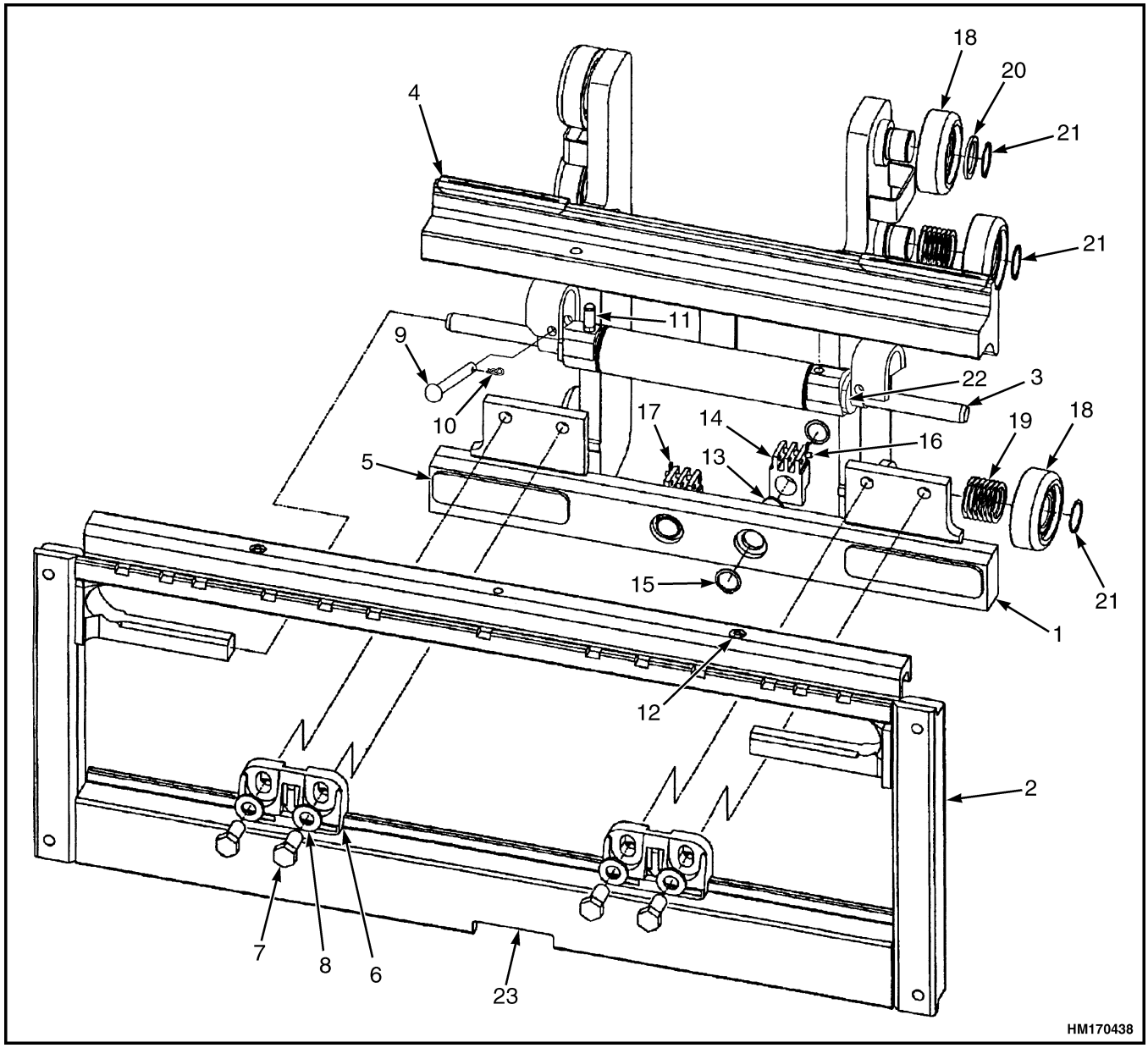
NOTE: Tag hydraulic lines and fittings prior to disconnecting to aid in connecting during installation.

4. Disconnect hydraulic lines from sideshift cylinder. Put caps and plugs on open lines and cylinder ports.

5. Remove lower mounting hooks by removing four capscrews and washers securing the hooks.

   See Figure 9 for early lift truck models

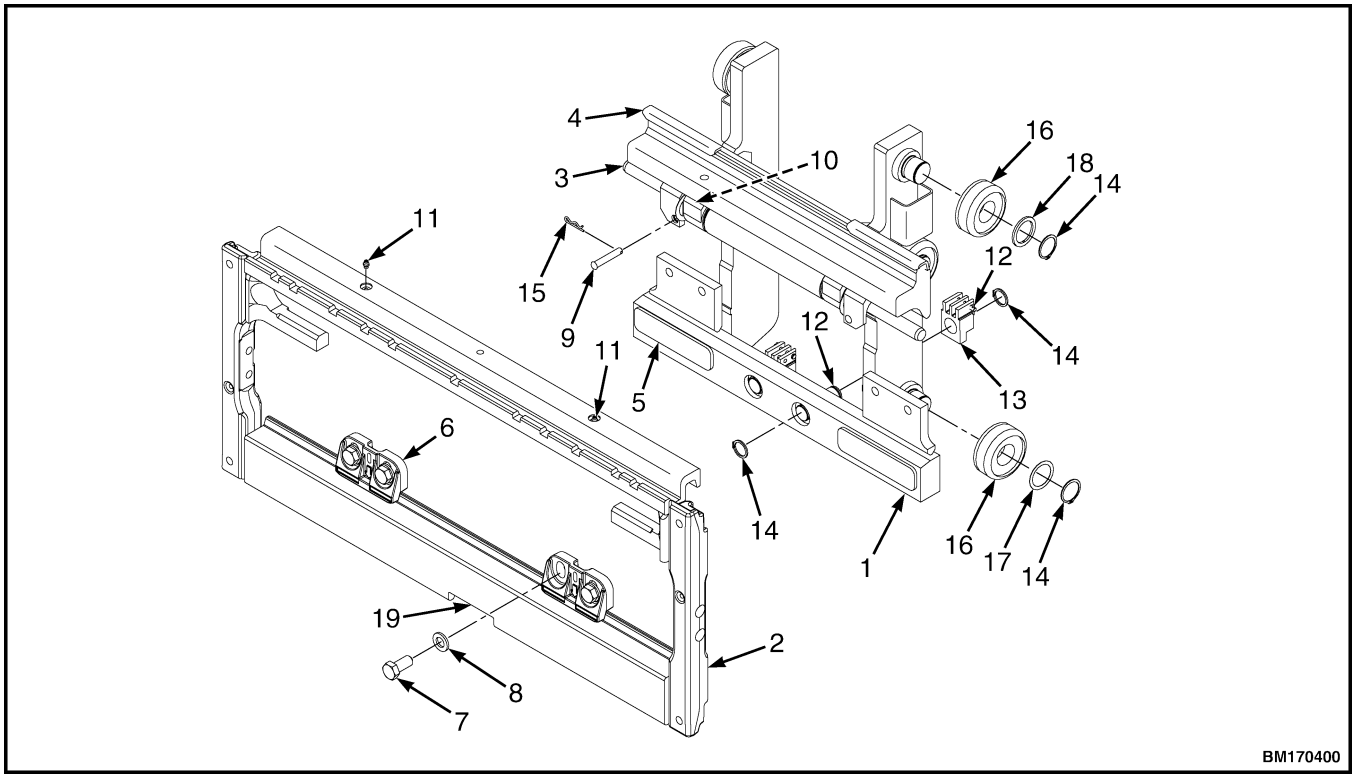
   See Figure 10 for later lift truck models



NOTE: TWO- AND THREE-STAGE FFL IS SHOWN. INTEGRAL SIDESHIFT CARRIAGE ASSEMBLY FOR FOUR-STAGE FFL AND TWO-STAGE LFL IS SIMILAR.

1. INNER FRAME
2. OUTER FRAME
3. SIDESHIFT CYLINDER
4. UPPER BEARING
5. LOWER BEARING
6. LOWER HOOK
7. CAPSCREW
8. WASHER
9. CLEVIS PIN
10. HAIRPIN
11. PIN
12. LUBE FITTING
13. PIN
14. CHAIN ANCHOR
15. SNAP RING
16. PIN
17. COTTER PIN
18. LOAD ROLLER
19. SHIMS
20. SPACER
21. SNAP RING
22. SPACER
23. FORK REMOVAL NOTCH

Figure 9. Integral Sideshift Carriage, Early Lift Truck Models



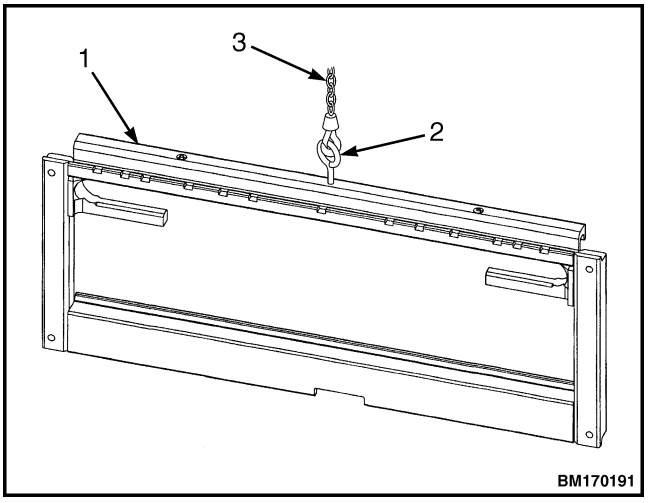
NOTE: TWO- AND THREE-STAGE FFL IS SHOWN. INTEGRAL SIDESHIFT CARRIAGE ASSEMBLY FOR FOUR-STAGE FFL AND TWO-STAGE LFL IS SIMILAR.

1. INNER FRAME
2. OUTER FRAME
3. SIDESHIFT CYLINDER
4. UPPER BEARING
5. LOWER BEARING
6. LOWER HOOK
7. CAPSCREW
8. WASHER
9. CLEVIS PIN
10. PIN
11. LUBE FITTING
12. PIN
13. CHAIN ANCHOR
14. SNAP RING
15. COTTER PIN
16. LOAD ROLLER
17. SHIMS
18. SPACER
19. FORK REMOVAL NOTCH

Figure 10. Integral Sideshift Carriage, Later Lift Truck Models

6. Remove sideshift cylinder from carriage. See **Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564)** 2100SRM1382. for procedures.

7. Use a crane with a capacity of at least 40 kg (90 lb) to lift outer frame away from the inner frame (see Figure 11). Lay the outer frame flat on a pallet or workbench.



1. OUTER FRAME
2. LIFTING HOOK
3. LIFTING DEVICE

Figure 11. Remove Outer Frame

Clean and Inspect

1. Inspect the lower mounting hooks for wear. Replace the hooks if they are worn beyond the wear limit. The wear limit clearance range is 0.76 mm (0.03 in.) minimum and 1.52 mm (0.06 in.) maximum. See **A** in Figure 12.

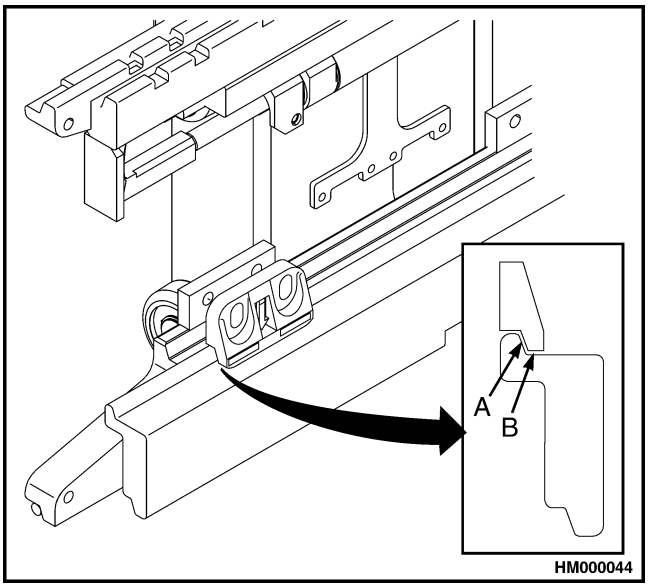


Figure 12. Lower Mounting Hooks Wear Limit and Clearance Adjustment

Legend for Figure 12.

A. WEAR LIMIT - 0.76 mm (0.03 in.) MINIMUM AND 1.52 mm (0.06 in.) MAXIMUM.
B. CLEARANCE ADJUSTMENT - 0.76 mm (0.03 in.) MINIMUM AND 1.52 mm (0.06 in.) MAXIMUM.

2. Clean and inspect inner and outer carriage bars for damage and smoothness. Ensure the bars are parallel and the ends are flush.

3. Clean the bearing areas. Inspect the sideshift bearings for wear as follows:

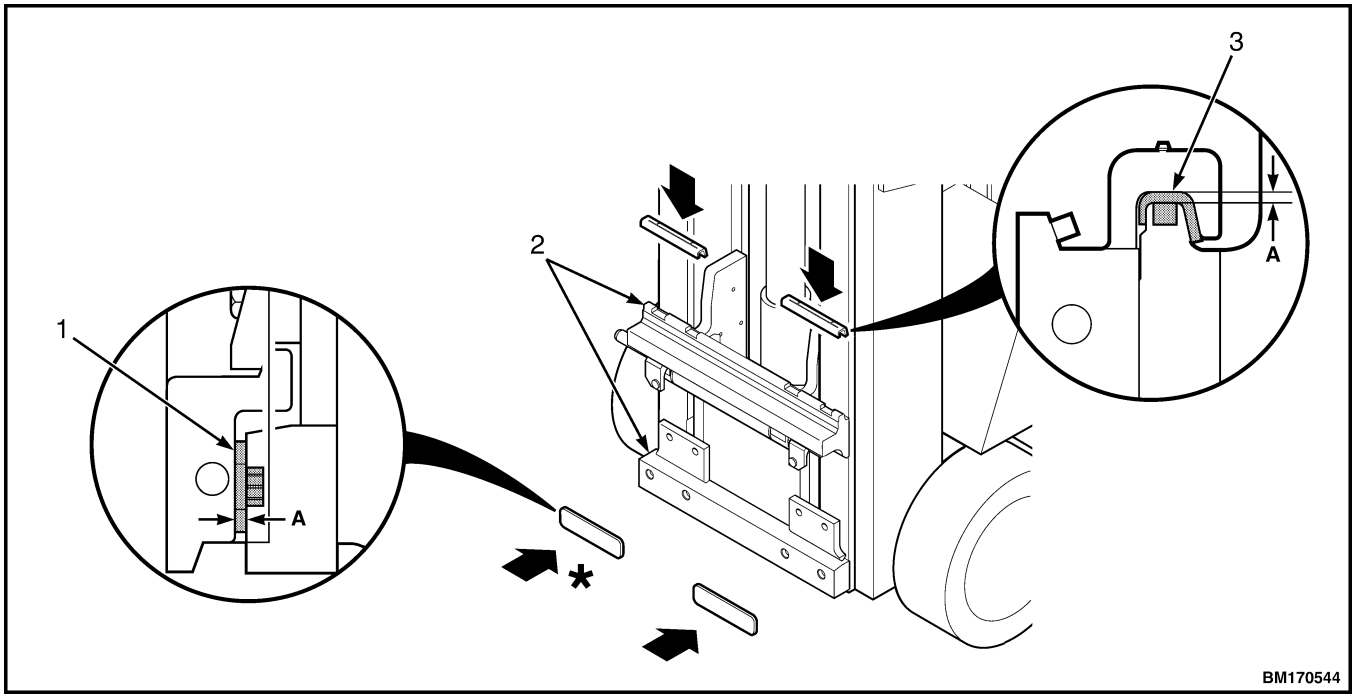
a. Remove the upper bearings from the inner frame. If either upper bearing is worn to less than 2.5 mm (0.1 in.) thickness, replace both upper bearings by driving the upper bearings from the inner frame. See Figure 13.

b. Remove the lower bearings from inner frame. If either lower bearing is worn to less than 2.5 mm (0.1 in.) thickness, replace both lower bearings by prying the lower bearings from inner frame. See Figure 13.

4. Inspect the sideshift cylinder. See **Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564)** 2100SRM1382. for procedures.

Repair

1. If any of the load rollers must be replaced (see Figure 9 and Figure 10), make a note of the location and number of the shims. Install the shims, load rollers, and snap rings. See Carriage Adjustments for correct adjustment.



A. MINIMUM THICKNESS 2.5 mm (0.1 in.)

1. LOWER BEARINGS
2. CARRIAGE BARS
3. UPPER BEARINGS

*Bold Arrows Indicate Which Side To Apply Grease.

Figure 13. Upper and Lower Bearings

WARNING

Improper welding procedures can damage the structure of the mast or cause incorrect function of the mast. Consult your Hyster lift truck dealer for more information before welding on the mast.

2. If the carriage bars have any protruding welds or damaged notches, repair by grinding, filing, or welding.

Install

NOTE: Use a wood block or a plastic hammer to fully seat upper bearings onto upper carriage bar. Proper lower hook clearance requires upper bearings be fully seated.

1. Apply a 1 mm (0.040 in.) layer of multipurpose grease to upper and lower bearing surfaces. Install the upper and lower bearings onto inner frame:

a. To install new upper bearing, align the pins on the bottom side of bearing to notches on top carriage bar and slide into place on top carriage. See Figure 13 .

b. To install new lower bearing, align the circular pins on backside of lower bearing to holes on lower carriage bar and tap bearing into place on lower carriage bar using a rubber or brass hammer. See Figure 13.

2. Install sideshift cylinder onto the carriage. See **Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564)** 2100SRM1382 for procedures.

3. Use a crane with a capacity of at least 40 kg (90 lb) to install outer frame on inner frame.

4. Install lower mounting hooks and four capscrews. Tighten capscrews to 165 ±15 N•m (120 ±12 lbf ft). For proper sideshift operation, make sure there is 0.76 to 1.52 mm (0.03 to 0.06 in.) clearance between bottom of hooks and outer frame. See **B** in Figure 12.

5. Connect hydraulic lines, as noted during removal, to sideshift cylinder.

6. Install backrest and capscrews on sideshift carriage. Tighten capscrews to 195 N•m (144 lbf ft).

7. Install forks. See Fork Replacement, in this service manual, for procedures.

INTEGRAL SIDESHIFT CARRIAGE, LIFT TRUCKS MANUFACTURED AFTER DECEMBER, 2016

NOTE: This section applies to lift truck models E2.2-3.5XN (E45-70XN) (A268) equipped with an integral sideshift carriage and manufactured after December, 2016.

Remove

1. Lower carriage completely. Remove forks. See Fork Replacement for removal procedures.

2. Remove four capscrews, nuts, washers, and load backrest from carriage. See Figure 7.

WARNING

Before disconnecting the hydraulic hoses, relieve the pressure in the hydraulic system. Serious injury can occur if pressure is not relieved from hydraulic system prior to disconnecting hydraulic hoses.

3. Relieve hydraulic pressure to the sideshift cylinder by moving sideshift lever in both directions several times.

WARNING

Always wear the proper protective equipment including eye protection and petroleum-resistant gloves when handling hydraulic oil. Thoroughly wash oil from exposed areas of skin as soon as possible.

The hydraulic oil is hot at normal operating temperatures. Be careful when draining the oil.

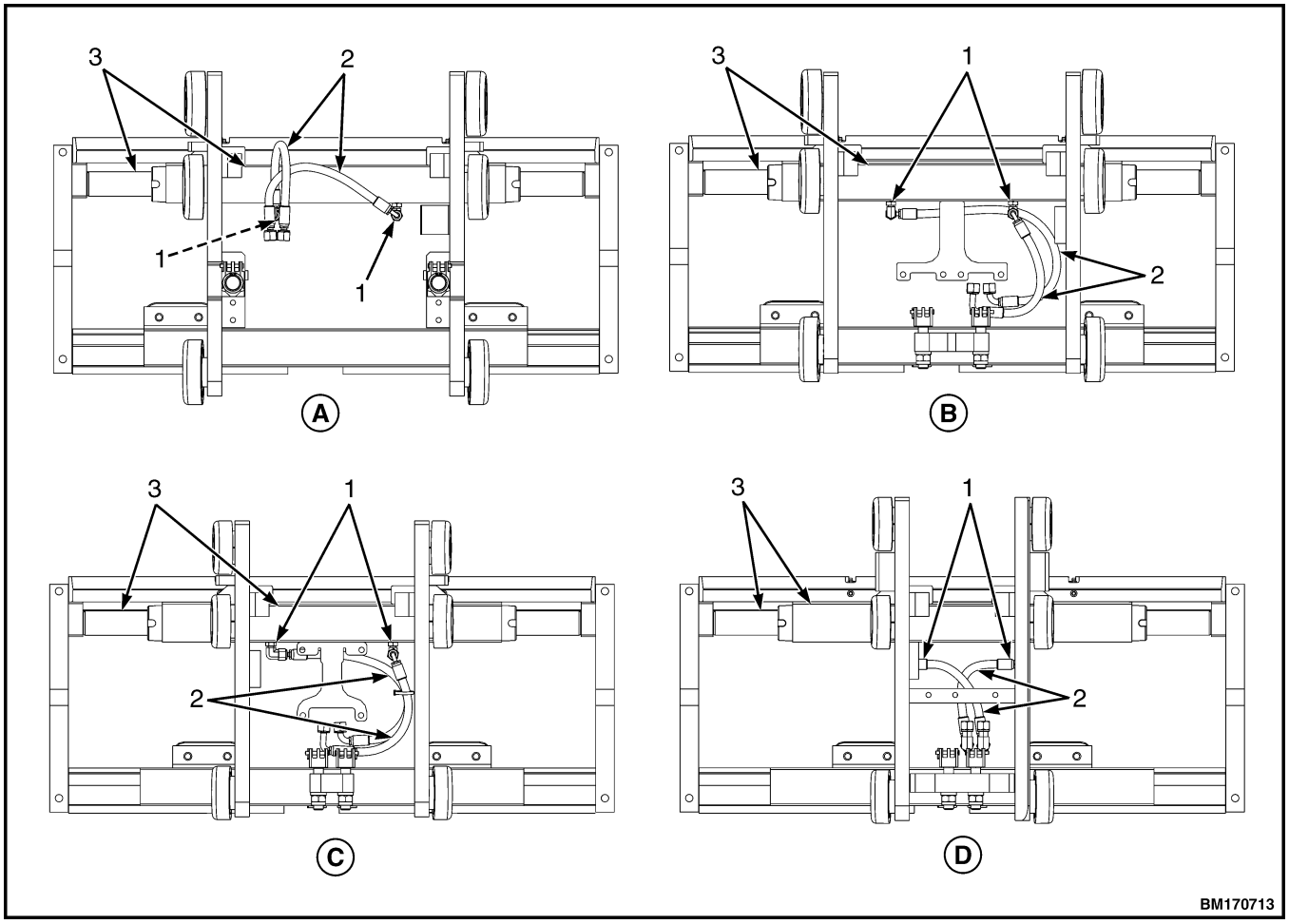
Never check for leaks by putting hands on hydraulic lines or components under pressure. Hydraulic oil under pressure can be injected into the skin.

CAUTION

Protect the hydraulic system from dirt and contaminants when servicing the hydraulic system.

NOTE: Tag hydraulic lines and fittings prior to disconnecting to aid in connecting during installation.

4. Disconnect hydraulic lines from sideshift cylinder. Put caps and plugs on open lines and cylinder ports. See Figure 14.



NOTE: CLASS II CARRIAGES FOR TWO-STAGE LFL AND TWO-, THREE-STAGE FFL MAST SHOWN. CLASS III CARRIAGES ARE SIMILAR.

A. TWO-STAGE LFL INTEGRAL SIDESHIFT CARRIAGE
B. TWO-STAGE FFL INTEGRAL SIDESHIFT CARRIAGE
C. THREE-STAGE FFL INTEGRAL SIDESHIFT CARRIAGE
D. FOUR-STAGE FFL INTEGRAL SIDESHIFT CARRIAGE

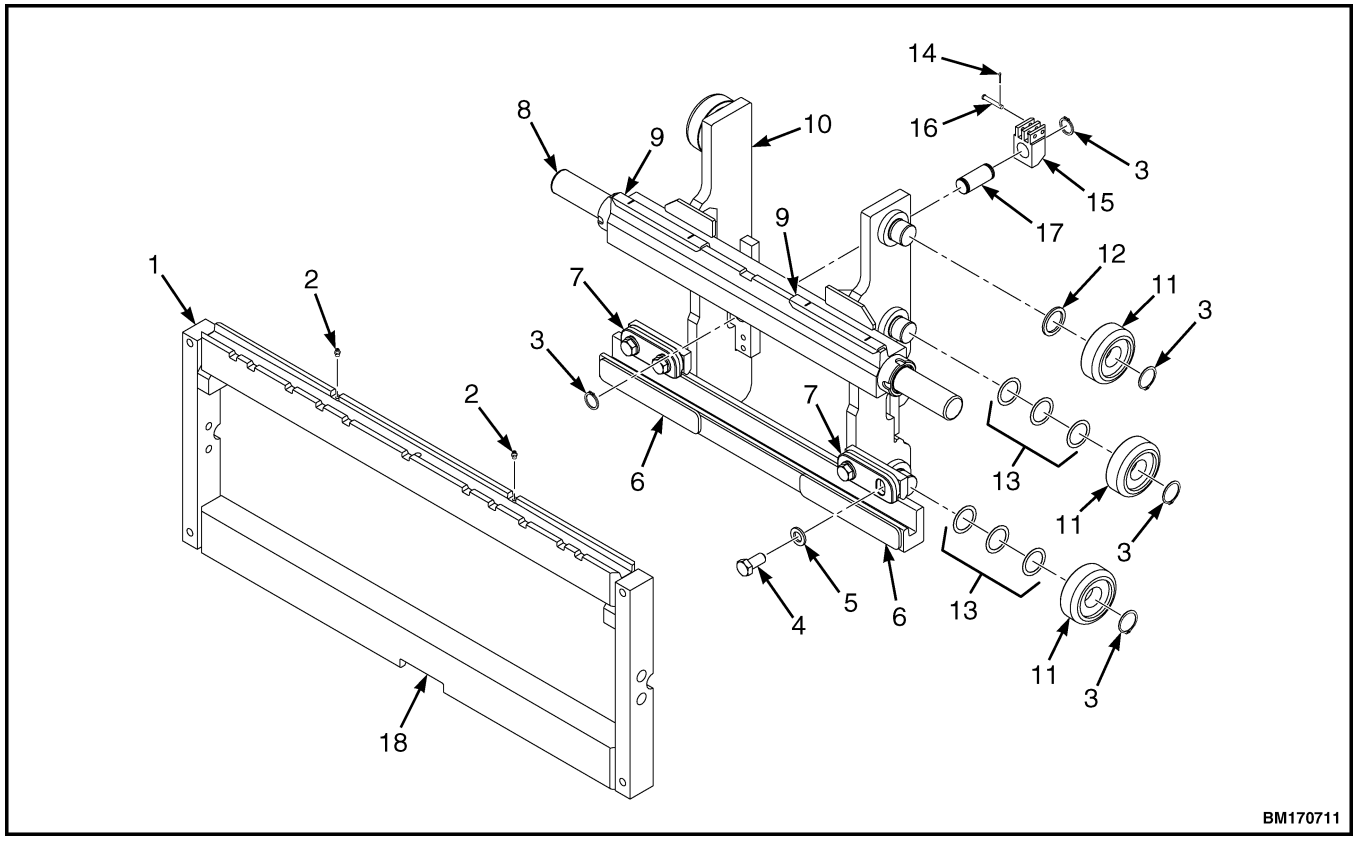
1. HYDRAULIC FITTINGS
2. INTEGRAL SIDESHIFT HYDRAULIC HOSES
3. INTEGRAL SIDESHIFT CYLINDER

Figure 14. Integral Sideshift Carriage Hydraulic Hose Connections

5. Remove lower mounting hooks by removing four capscrews and washers securing the hooks.

See Figure 15 for lift trucks equipped with a two-stage LFL mast.

See Figure 16 for lift trucks equipped with a two-, three-, or four-stage FFL mast.



NOTE: TWO-STAGE LFL, CLASS II INTEGRAL SIDESHIFT CARRIAGE SHOWN. TWO-STAGE LFL, CLASS III INTEGRAL SIDESHIFT CARRIAGE IS SIMILAR.

1. OUTER FRAME
2. LUBE FITTING
3. SNAP RING
4. CAPSCREW
5. WASHER
6. LOWER BEARING
7. LOWER HOOK
8. INTEGRAL SIDESHIFT CYLINDER
9. UPPER BEARING
10. INNER FRAME
11. LOAD ROLLER
12. SPACER
13. SHIMS
14. COTTER PIN
15. CHAIN ANCHOR
16. ANCHOR PIN
17. CHAIN PIN
18. FORK REMOVAL NOTCH

Figure 15. Integral Sideshift Carriage, Two-Stage LFL Mast

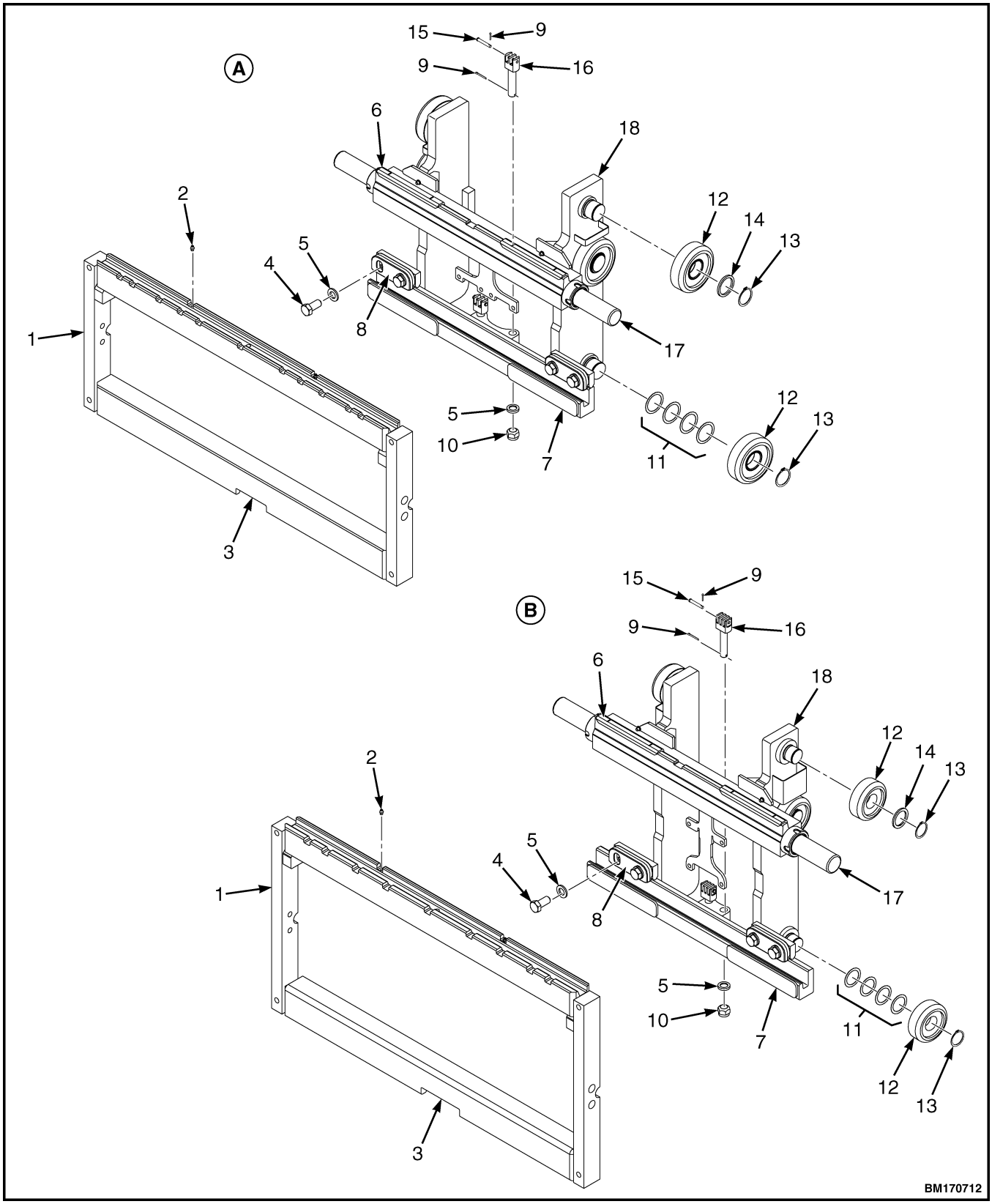


Figure 16. Integral Sideshift Carriage, Two-,Three, and Four-Stage FFL Masts

Legend for Figure 16.

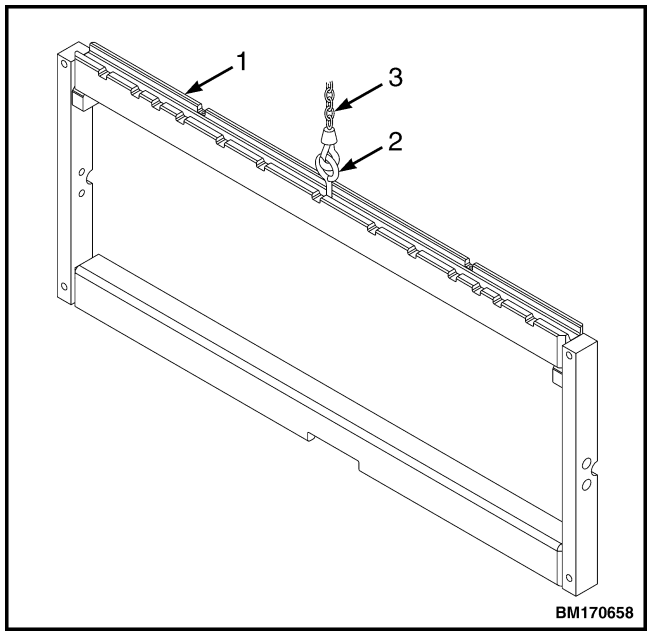
NOTE: THE MIDDLE AND BOTTOM LOAD ROLLERS CONTAIN THE SAME COMPONENTS.

A. TWO-STAGE FFL, CLASS II INTEGRAL SIDESHIFT CARRIAGE SHOWN. TWO-STAGE FFL, CLASS III INTEGRAL SIDESHIFT CARRIAGE IS SIMILAR.
B. THREE-STAGE FFL, CLASS III INTEGRAL SIDESHIFT CARRIAGE SHOWN. THREE-STAGE FFL, CLASS II AND FOUR-STAGE FFL INTEGRAL SIDESHIFT CARRIAGES ARE SIMILAR.

1. OUTER FRAME
2. LUBE FITTING
3. FORK REMOVAL NOTCH
4. CAPSCREW
5. WASHER
6. UPPER BEARING
7. LOWER BEARING
8. LOWER HOOK
9. COTTER PIN
10. NUT
11. SHIMS
12. LOAD ROLLER
13. SNAP RING
14. SPACER
15. CHAIN ANCHOR PIN
16. CHAIN ANCHOR
17. INTEGRAL SIDESHIFT CYLINDER
18. INNER FRAME

6. Remove sideshift cylinder from carriage. See **Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564)** 2100SRM1382 for procedures.

7. Use a crane with a capacity of at least 40 kg (90 lb) to lift outer frame away from the inner frame (see Figure 17). Lay outer frame flat on a pallet or workbench.



1. OUTER FRAME
2. LIFTING HOOK
3. LIFTING DEVICE

Figure 17. Remove Outer Frame

Disassemble

1. Remove the upper and lower bearings from the inner frame.

See Figure 15 for lift trucks equipped with a two-stage LFL mast

See Figure 16 for lift trucks equipped with a two-, three-, and four-stage FFL mast

2. If damaged, remove lube fittings from outer frame.

3. Disassemble sideshift cylinder. See **Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564)** 2100SRM1382 for procedures.

Clean and Inspect

WARNING

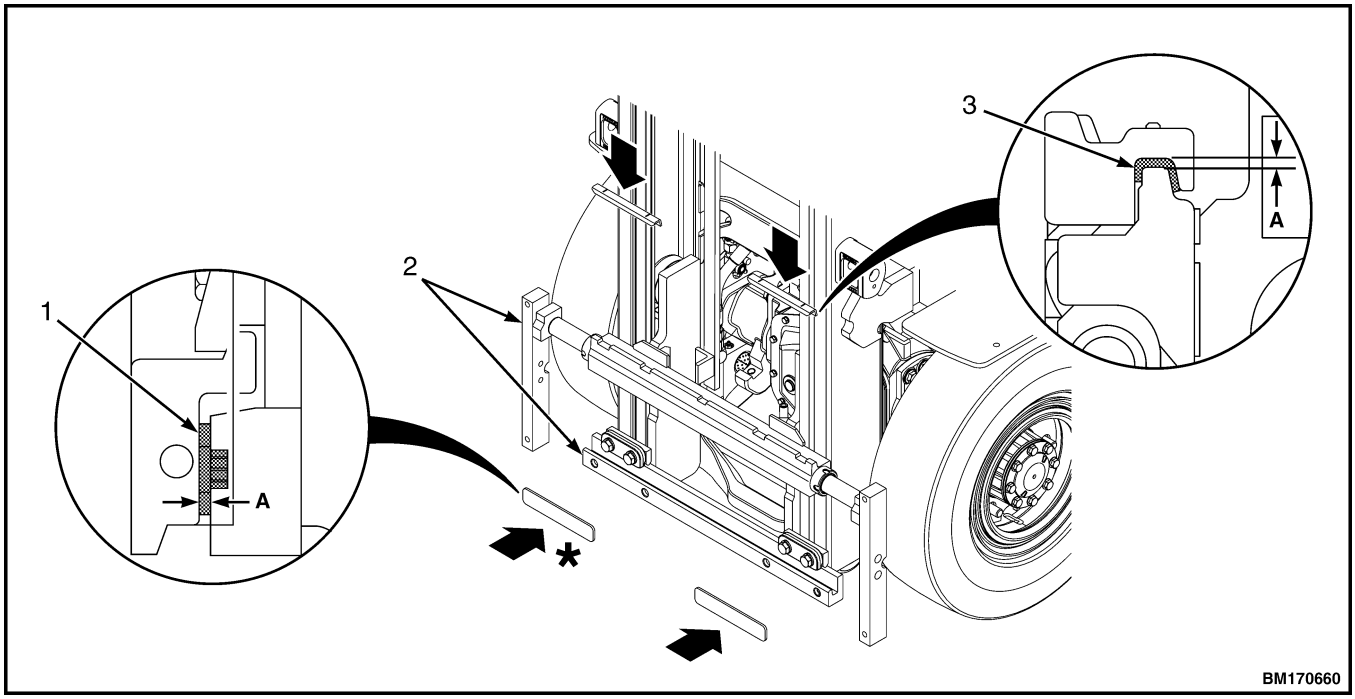
Improper welding procedures can damage the structure of the mast or cause incorrect function of the mast. Consult your Hyster lift truck dealer for more information before welding on the mast.

1. Clean and inspect the carriage bars for damage and smoothness. Ensure the carriage bars are parallel and the ends are flush. If carriage bars have any protruding welds or damaged notches, repair by grinding, filing, or welding.

2. Clean the bearing areas. Inspect the sideshift bearings for wear as follows:

a. If either upper bearing is worn to less than 2.5 mm (0.1 in.) thickness, replace both upper bearings by driving the upper bearings from the inner frame. See Assemble section for procedures to replace upper bearings and Figure 18.

b. If either lower bearing is worn to less than 2.5 mm (0.1 in.) thickness, replace both lower bearings by prying the lower bearings from the inner frame. See Assemble section for procedures to replace lower bearings and Figure 18.



A. MINIMUM THICKNESS, 2.5 mm (0.1 in.)

1. LOWER BEARINGS
2. CARRIAGE BARS
3. UPPER BEARINGS

*Bold arrows indicate which side to apply grease.

Figure 18. Upper and Lower Bearings

3. Inspect sideshift cylinder. See **Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564)** 2100SRM1382 for procedures.

4. Inspect load rollers for wear and damage. If load rollers must be replaced, make a note of the location and number of the shims to ensure correct installation.

See Figure 15 for lift trucks equipped with a two-stage LFL mast

See Figure 16 for lift trucks equipped with a two-, three-, and four-stage FFL mast

Assemble

1. Assemble sideshift cylinder. See **Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564)** 2100SRM1382 for procedures.

2. If lube fittings were removed, install new lube fittings into outer frame.

See Figure 15 for lift trucks equipped with a two-stage LFL mast

See Figure 16 for lift trucks equipped with a two-, three-, and four-stage FFL mast

NOTE: Use a wood block or a plastic hammer to fully seat the upper bearings onto the inner frame. Proper lower hook clearance requires the upper bearings be fully seated.

3. Apply a 1 mm (0.040 in.) layer of multipurpose grease to upper and lower bearing surfaces. Install the upper and lower bearings onto inner frame:

   a. To install new upper bearing, align the pins on the bottom side of bearing to notches on top carriage bar and slide into place on top carriage. See Figure 18.

   b. To install new lower bearing, align the circular pins on backside of lower bearing to holes on lower carriage bar and tap bearing into place on lower carriage bar using a rubber or brass hammer. See Figure 18.

Install

1. Use a crane, with a capacity of 40 kg (90 lb), and install outer frame onto inner frame. See Figure 17

2. Install lower mounting hook using four capscrews and washers. Tighten capscrews to 150 to 180 N•m (108 to 132 lbf ft).

3. Connect hydraulic lines, as noted during removal, to sideshift cylinder. See Figure 14.

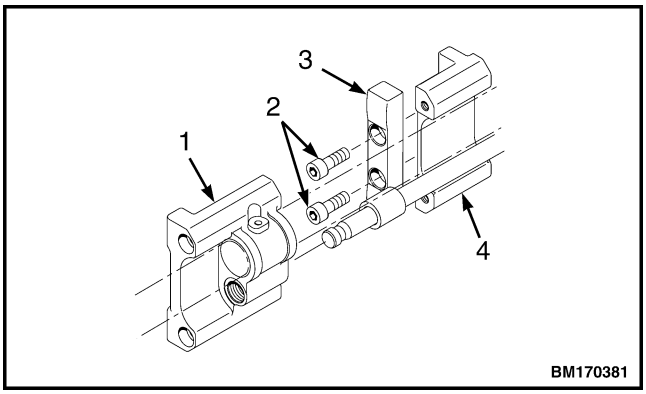
4. Install load backrest onto integral sideshift carriage. Tighten capscrews to 195 N•m (144 lbf ft). See Figure 7.

5. Install forks. See Fork Replacement section for procedures.

FORK POSITIONER, LIFT TRUCKS MANUFACTURED PRIOR TO DECEMBER, 2016

NOTE: The fork positioner can be removed from the integral sideshift carriage with the integral sideshift carriage on or off the mast. In the steps below, the fork positioner is removed with the integral sideshift carriage on the mast. If integral sideshift carriage must be removed from mast first, go to
Integral Sideshift Carriage, Lift Trucks Manufactured Prior To December, 2016.

NOTE: Depending on the size and configuration of the forks installed on the lift truck, there may be a spacer bar between the inner and outer fork carriers. See Figure 19.



1. OUTER FORK CARRIER
2. CAPSCREW
3. SPACER BAR*
4. INNER FORK CARRIER

*Spacer bar used on 977 mm (38.5 in.) and 1067 mm (42 in.) class II carriages.

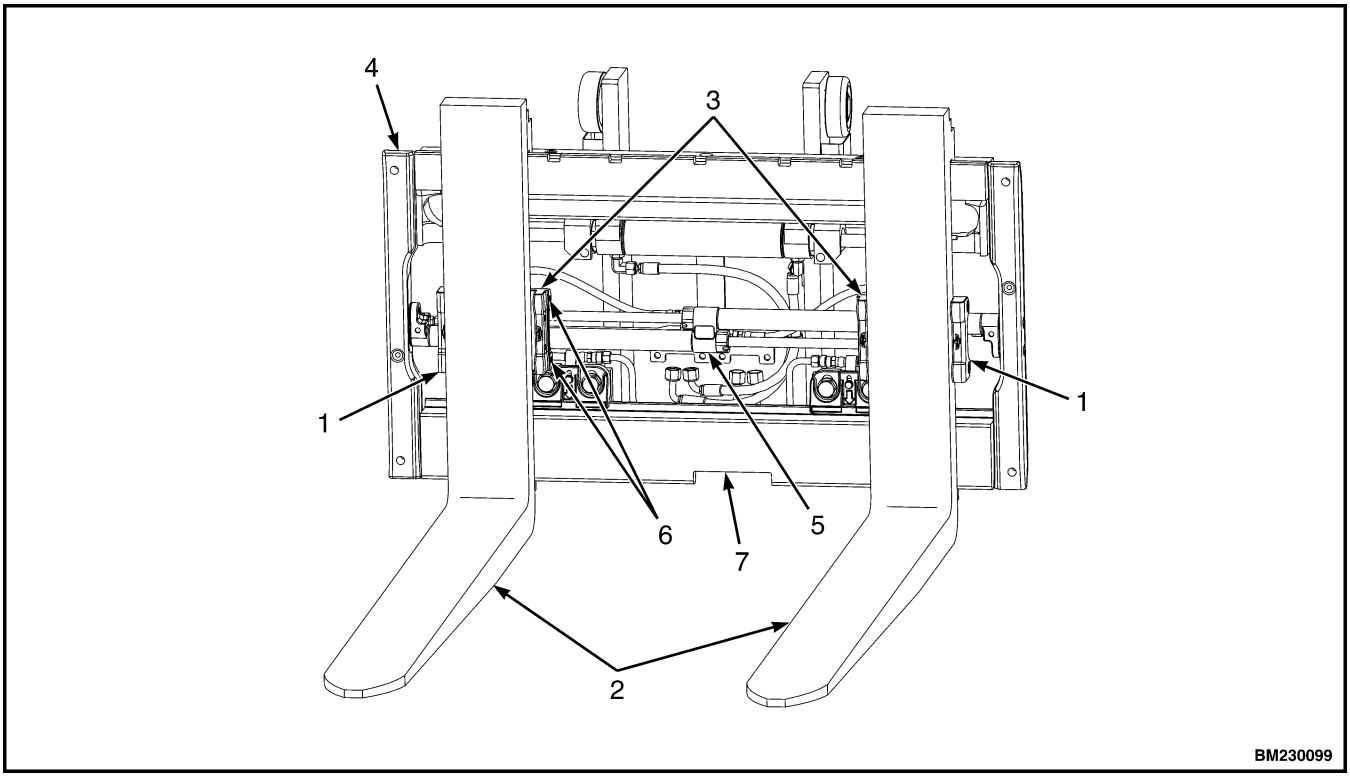
Figure 19. Fork Carrier Spacer Bar

Remove

CAUTION

Remove fork latch pins if adding a fork positioner attachment. Damage to forks and other carriage components can occur if fork latch pins are not removed prior to using attachment.

1. Lower the carriage and remove four capscrews from inner fork carriers. Slide inner fork carriers down cylinder shell to remove forks. See Figure 20.



1. OUTER FORK CARRIER
2. FORKS
3. INNER FORK CARRIER
4. OUTER FRAME
5. FORK POSITIONER
6. CAPSCREWS
7. FORK REMOVAL NOTCH

Figure 20. Fork Removal

WARNING

DO NOT try to remove a fork without a lifting device. Each hook fork for these lift trucks can weigh 45 to 115 kg (99 to 254 lb)

2. Slide fork to fork removal notch in bottom bar of carriage. See Figure 20. Lower fork onto blocks so the bottom hook of the fork moves through the fork removal notch. Lower the carriage further so the top hook of the fork is disengaged from the top carriage bar. Move carriage away from fork or use a lifting device to move fork away from the carriage.

3. Remove four capscrews and load backrest from carriage. See Figure 7.

WARNING

Before disconnecting the hydraulic hoses, relieve the pressure in the hydraulic system. Serious injury can occur if pressure is not relieved from hydraulic system prior to disconnecting hydraulic hoses.

WARNING

Always wear the proper protective equipment including eye protection and petroleum-resistant gloves when handling hydraulic oil. Thoroughly wash oil from exposed areas of skin as soon as possible.

The hydraulic oil is hot at normal operating temperatures. Be careful when draining the oil.

Never check for leaks by putting hands on hydraulic lines or components under pressure. Hydraulic oil under pressure can be injected into the skin.

CAUTION

Protect the hydraulic system from dirt and contaminants when servicing the hydraulic system.

CAUTION

DO NOT bend tube assemblies during removal.

NOTE: Note placement of fork positioner cylinders and tag all hydraulic hoses, lines, and fittings prior to removal to aid in installation.

4. Disconnect and cap tube assemblies (8, Figure 21) from header hoses.

5. Remove lower hooks and bracket weldments. See Figure 22 and Figure 24.

6. Install lifting eye in hole (see Figure 22) on integral sideshift carriage and use lifting device to lift outer frame up to disconnect relief tube assembly and hydraulic hoses (open and close) from fork positioner. See Figure 22.

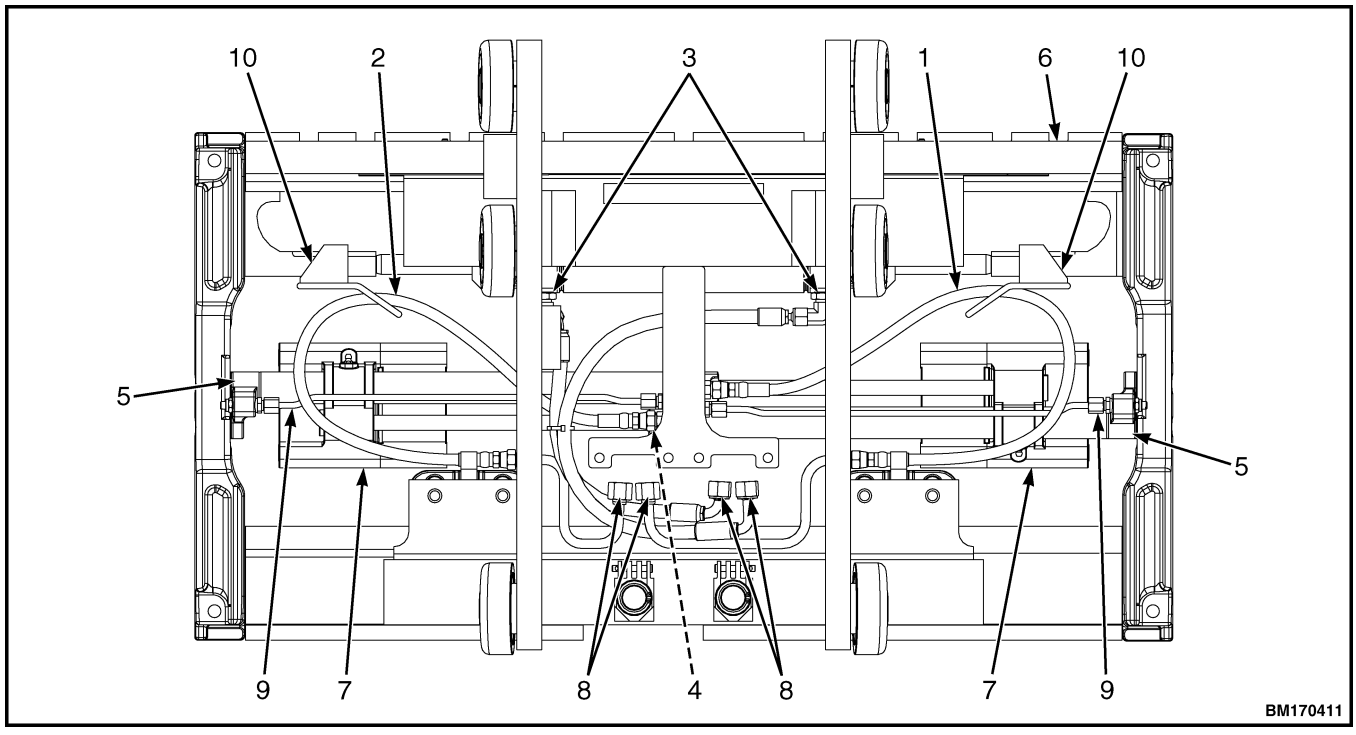
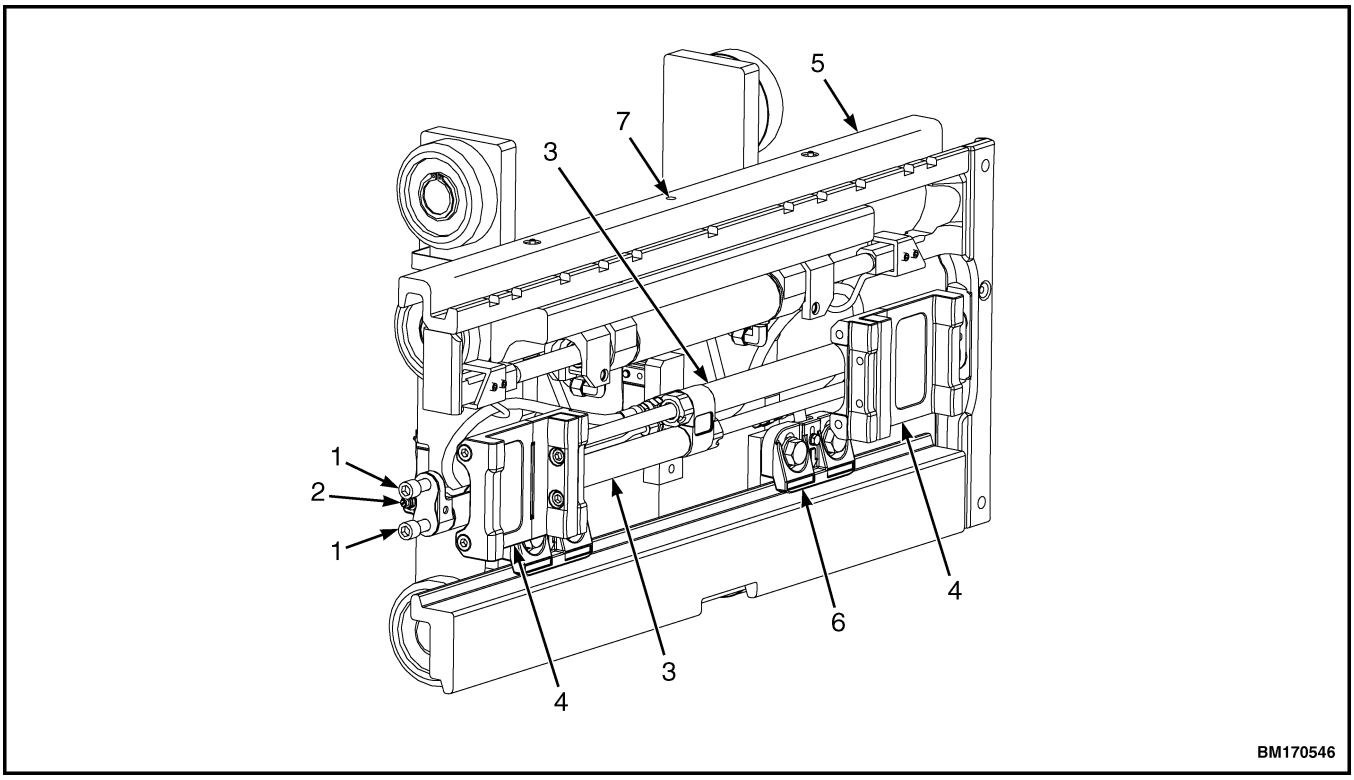


Figure 21. Hydraulic Connections, Fork Positioner Cylinder

Legend for Figure 21.

NOTE: BACK (DRIVER'S) VIEW SHOWN. THREE STAGE FFL INTEGRAL SIDESHIFT CARRIAGE SHOWN.

1. FORK POSITIONER HYDRAULIC HOSE (OPEN)
2. FORK POSITIONER HYDRAULIC HOSE (CLOSE)
3. INTEGRAL SIDESHIFT CARRIAGE HYDRAULIC HOSES
4. MANIFOLD
5. FORK POSITIONER CYLINDER
6. OUTER FRAME
7. FORK CARRIER
8. TUBE ASSEMBLY
9. RELIEF TUBE ASSEMBLY
10. HOSE GUIDE



NOTE: RIGHT OUTER FRAME BAR REMOVED FOR CLARITY. THREE STAGE FFL INTEGRAL SIDESHIFT CARRIAGE SHOWN. SOME COMPONENTS OMITTED FOR CLARITY.

NOTE: FRONT VIEW SHOWN.

1. CAPSCREW AND LOCK WASHER
2. SHIM
3. FORK POSITIONER CYLINDER
4. FORK CARRIER
5. INTEGRAL SIDESHIFT CARRIAGE ASSEMBLY
6. LOWER HOOK
7. TAPPED HOLE FOR LIFT EYE

Figure 22. Fork Positioner Cylinder Removal

NOTE: Make note of shims used to aid in reassembly.

7. Remove capscrews, lock washers, and shims from integral sideshift carriage. See Figure 22. Remove fork positioner from outer frame.

Clean and Inspect

See the section **Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564)** 2100SRM1382 for cleaning and inspection procedures.

Disassemble and Assemble

To disassemble and assemble the fork positioner cylinders, see the section **Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564)** 2100SRM1382 for procedures.

Install

1. Place fork positioner cylinders onto outer frame. Hand tighten capscrew and lockwasher on one side. See Figure 22. Add shims as follows:

NOTE: Maximum number of shims per side is five. The maximum difference in number of shims per side is two.

   a. Measure gap at opposite side and determine the number of shims required.

NOTE: The maximum gap allowed before tightening capscrews is 0.50 mm (.020 in.).

   b. Install equal amount of shims on both sides of the fork positioner assembly.

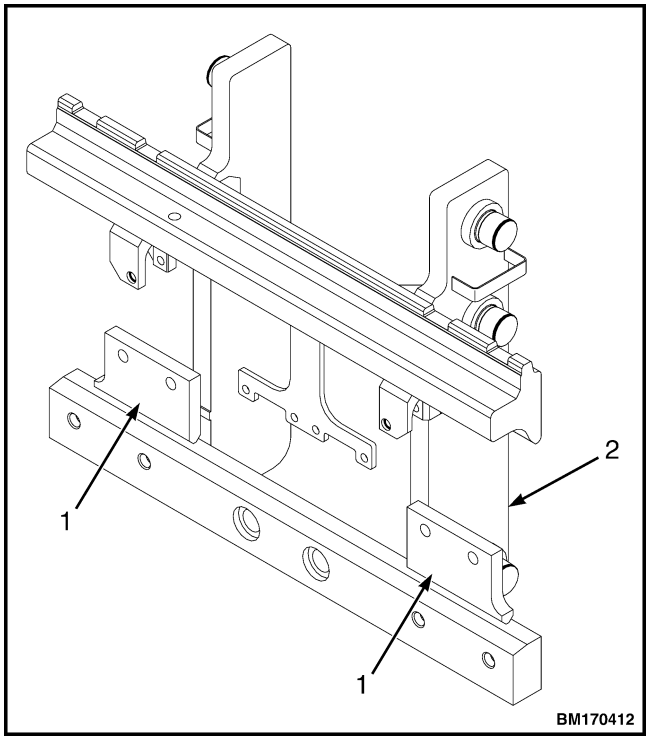
2. Finish installing fork positioner assembly to outer frame by tightening both capscrews and lockwashers to 65 N•m (50 lbf ft). See Figure 22.

3. Connect fork positioner hydraulic hoses to fork positioner manifold. Tighten to 21 N•m (186 lbf in). See Figure 21.

4. Thread fork positioner hydraulic hoses through hose guides.

5. Assemble outer frame with fork positioner to inner frame. Using a lifting device, position outer frame at approximately the same height of the inner frame and approximately 150 mm (6 in.) away. From the rear of the outer frame, connect fork positioner hydraulic tubes to header hoses and hand tighten. See Figure 21.

6. Assemble outer frame onto inner frame. Position fork positioner hydraulic tubes so they are in line with inner frame retainer plates. See Figure 23.

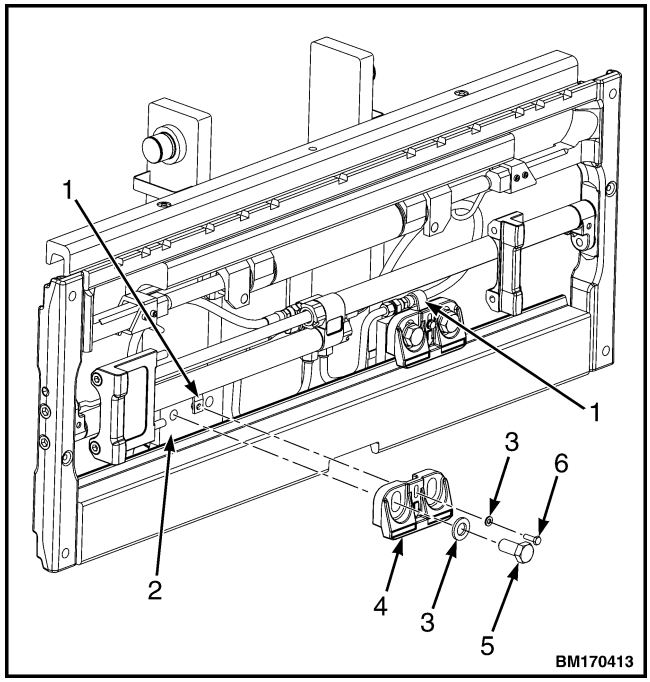


1. RETAINER PLATE
2. INNER FRAME

Figure 23. Inner Frame Retainer Plates

7. Assemble bracket weldment to lower hook and hand tighten. Assemble lower hook on retainer plate and tighten capscrews to 165 N•m (122 lbf ft). See Figure 24.

8. Position bracket weldment over fork positioner hydraulic hoses (see Figure 21) and adjust so that bracket weldment makes contract with fork positioner hoses and tighten capscrew to 8 N•m (71 lbf in). See Figure 24.



1. BRACKET WELDMENT
2. RETAINER PLATE
3. WASHER
4. LOWER HOOK
5. CAPSCREW (LOWER HOOK)
6. CAPSCREW (BRACKET WELDMENT)

Figure 24. Bracket Weldment and Lower Hook Assembly

9. Tighten fork positioner hydraulic tubes to header hoses to 42 N•m (31 lbf ft).

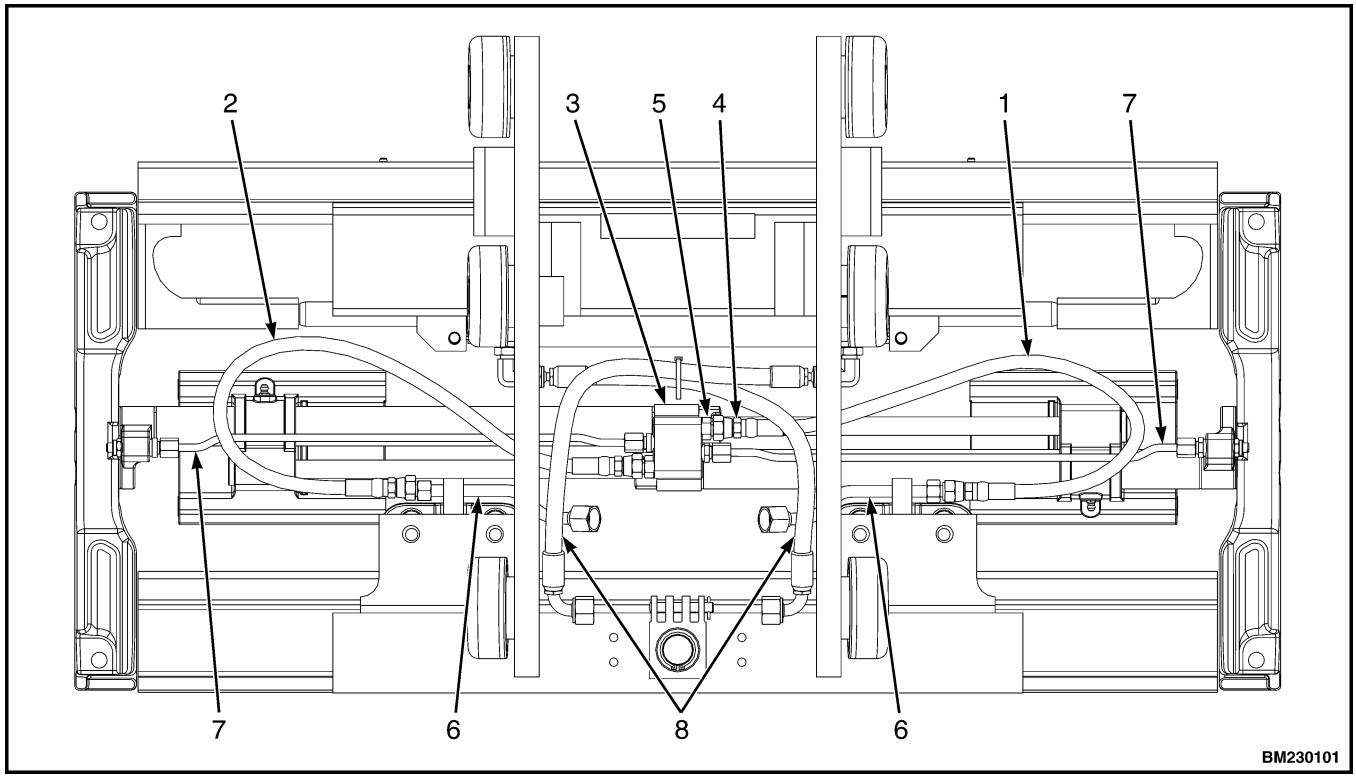
Fork Positioner Hydraulic Hose Adjustment

1. To adjust the fork positioner hydraulic hoses, hold the large hex nut and rotate the small hex nut towards the load face of the carriage (towards the forks). See Figure 25.

2. The fork positioner hoses are correctly adjusted when the fork positioner hydraulic hoses stay entirely within the integral sideshift carriage and do not contact the mast channels under all conditions.

3. Move fork positioner and check to ensure fork carriers clear fork positioner relief tubes through complete fork carrier cycle. See Figure 21.

10. Install backrest and capscrews on sideshift carriage. Tighten capscrews to 195 N•m (144 lbf ft). See Figure 7.



NOTE: BACK (DRIVER'S) VIEW SHOWN. THREE STAGE FFL INTEGRAL SIDESHIFT CARRIAGE SHOWN. HOSE BRACKET AND GUIDES OMITTED FOR CLARITY.

1. FORK POSITIONER HYDRAULIC HOSE (OPEN)
2. FORK POSITIONER HYDRAULIC HOSE (CLOSE)
3. MANIFOLD
4. SMALL HEX NUT
5. LARGE HEX NUT
6. TUBE ASSEMBLY
7. RELIEF TUBE ASSEMBLY
8. INTEGRAL SIDESHIFT HYDRAULIC HOSES

Figure 25. Fork Positioner Hydraulic Hose Adjustment

WARNING

DO NOT try to install a fork without a lifting device. Each hook fork for these lift trucks can weigh 45 to 115 kg (99 to 254 lb)

CAUTION

Remove fork latch pins if adding a fork positioner attachment. Damage to forks and other carriage components can occur if fork latch pins are not removed prior to using attachment.

11. Install forks to outer fork carriers. Secure inner fork carriers to outer fork carriers using four capscrews. Tighten capscrews to 35 N•m (25 lbf ft). See Figure 20.

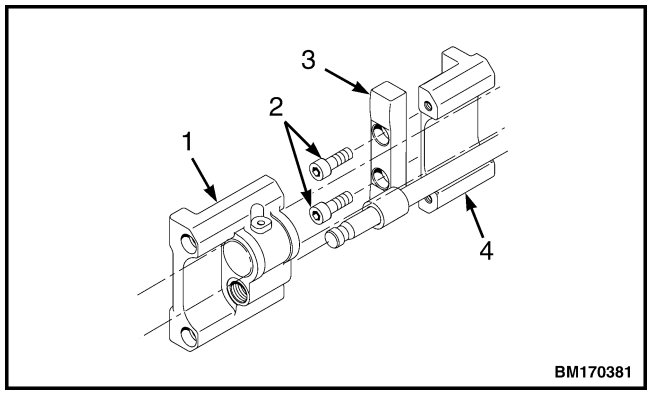
12. To adjust the fork positioner cylinders, See **Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564)** 2100SRM1382 for procedures.

FORK POSITIONER CARRIAGE, LIFT TRUCKS MANUFACTURED AFTER DECEMBER, 2016

NOTE: This section applies to lift truck models E2.2-3.5XN (E45-70XN) (A268) equipped with a fork positioner on an integral sideshift carriage and manufactured after December, 2016.

NOTE: The fork positioner can be removed from the integral sideshift carriage with the integral sideshift carriage on or off the mast. In the steps below, the fork positioner is removed with the integral sideshift carriage on the mast. If integral sideshift carriage must be removed from mast first, go to
Integral Sideshift Carriage, Lift Trucks Manufactured After December, 2016.

NOTE: Depending on the size and configuration of the forks installed on the lift truck, there may be a spacer bar between the inner and outer fork carriers. See Figure 26.



1. OUTER FORK CARRIER
2. CAPSCREW
3. SPACER BAR*
4. INNER FORK CARRIER

*Spacer bar used on 977 mm (38.5 in.) class II carriages.

Figure 26. Fork Carrier Spacer Bar

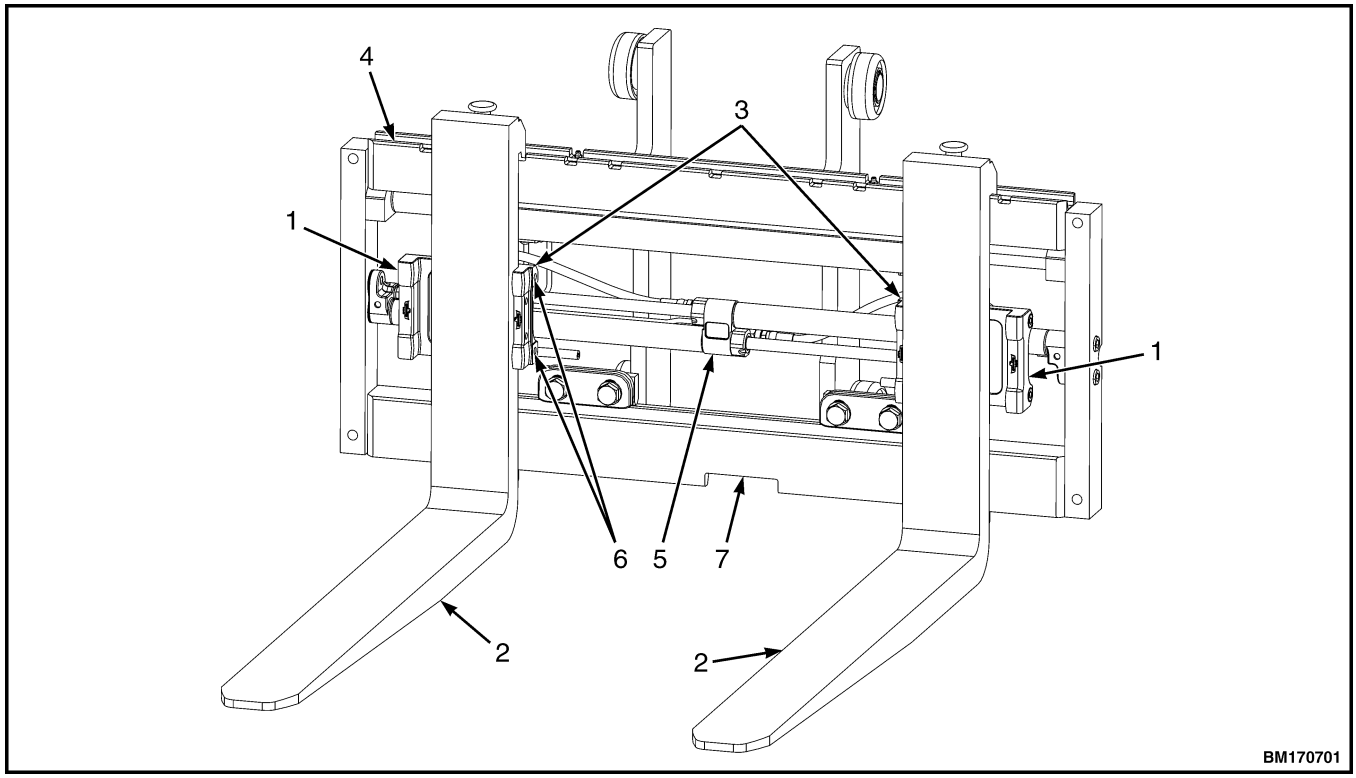
Remove

1. Lower carriage and remove four capscrews from inner fork carriers. Slide inner fork carriers down cylinder shell to remove forks. See Figure 27.

WARNING

DO NOT try to remove a fork without a lifting device. Each hook fork for these lift trucks can weigh 45 to 115 kg (99 to 254 lb).

2. Slide fork to fork removal notch in bottom bar of carriage. See Figure 27. Lower fork onto blocks so bottom hook of fork moves through fork removal notch. Lower carriage further so top hook of fork is disengaged from top carriage bar. Move carriage away from fork or use a lifting device to move fork away from carriage.



1. OUTER FORK CARRIER
2. FORKS
3. INNER FORK CARRIER
4. OUTER FRAME
5. FORK POSITIONER
6. CAPSCREWS
7. FORK REMOVAL NOTCH

Figure 27. Fork Removal

3. Remove four capscrews, washers, nuts, and load backrest from carriage. See Figure 7.

WARNING

Before disconnecting the hydraulic hoses, relieve the pressure in the hydraulic system. Serious injury can occur if pressure is not relieved from hydraulic system prior to disconnecting hydraulic hoses.

WARNING

Always wear the proper protective equipment including eye protection and petroleum-resistant gloves when handling hydraulic oil. Thoroughly wash oil from exposed areas of skin as soon as possible.

WARNING

The hydraulic oil is hot at normal operating temperatures. Be careful when draining the oil.

Never check for leaks by putting hands on hydraulic lines or components under pressure. Hydraulic oil under pressure can be injected into the skin.

CAUTION

Protect the hydraulic system from dirt and contaminants when servicing the hydraulic system.

CAUTION

DO NOT bend tube assemblies during removal.

NOTE: Tag all hydraulic hoses, lines, and fittings prior to removal to aid in installation.

4. Disconnect and cap tube assemblies (10, Figure 28) from header hoses.

5. Remove capscrews and washers and remove lower hooks from retainer plates on inner frame. See Figure 28.

6. Install lifting eye in hole (7, Figure 29) on outer frame of integral sideshift carriage. Use a lifting device, with a capacity of 54 kg (120 lb), to lift outer frame with fork positioner attached.

7. Disconnect relief tube assembly and hydraulic hoses (open and close) from fork positioner. See Figure 28.

NOTE: Make note of shims used to aid in reassembly.

8. Remove capscrews, lockwashers, and shims from integral sideshift carriage. See Figure 28.

9. Remove fork positioner from outer frame.

   For procedures to repair the fork positioner cylinder, see **Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564)** 2100SRM1382

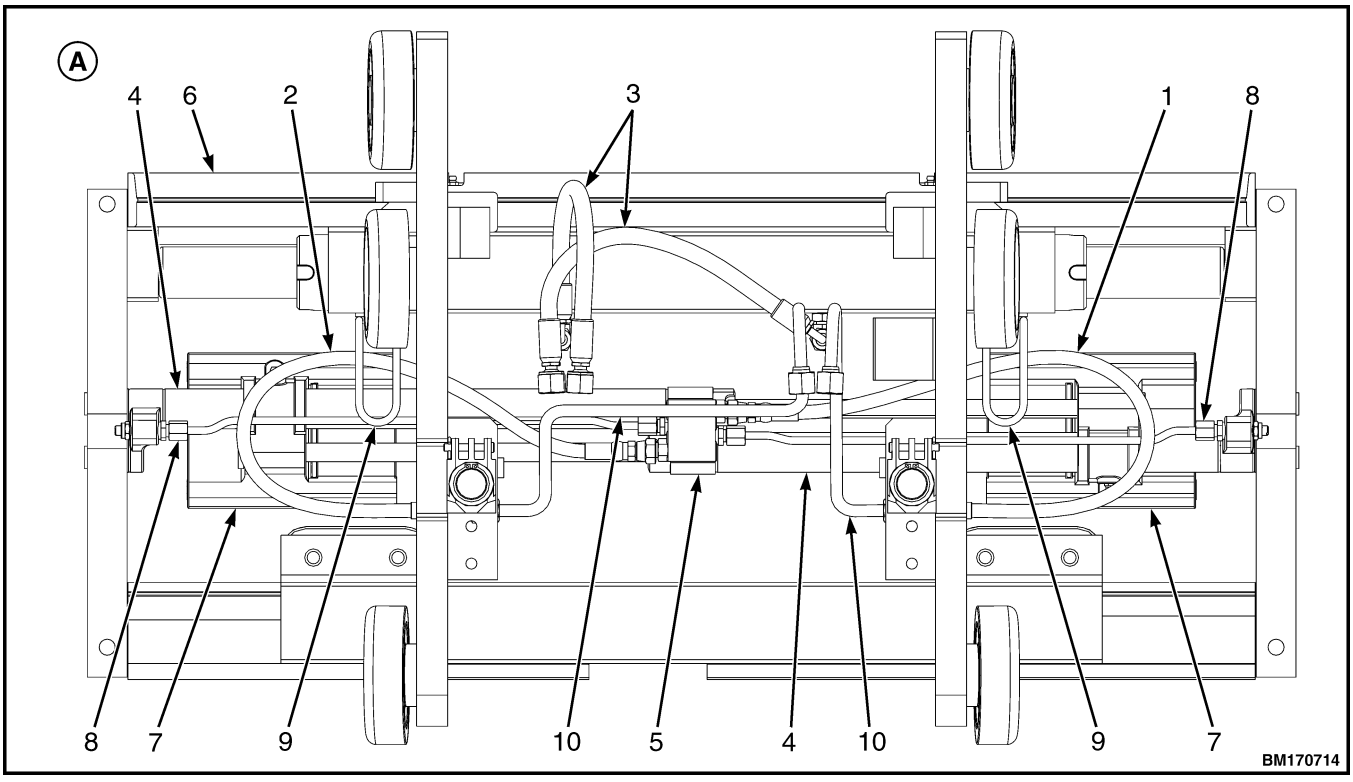
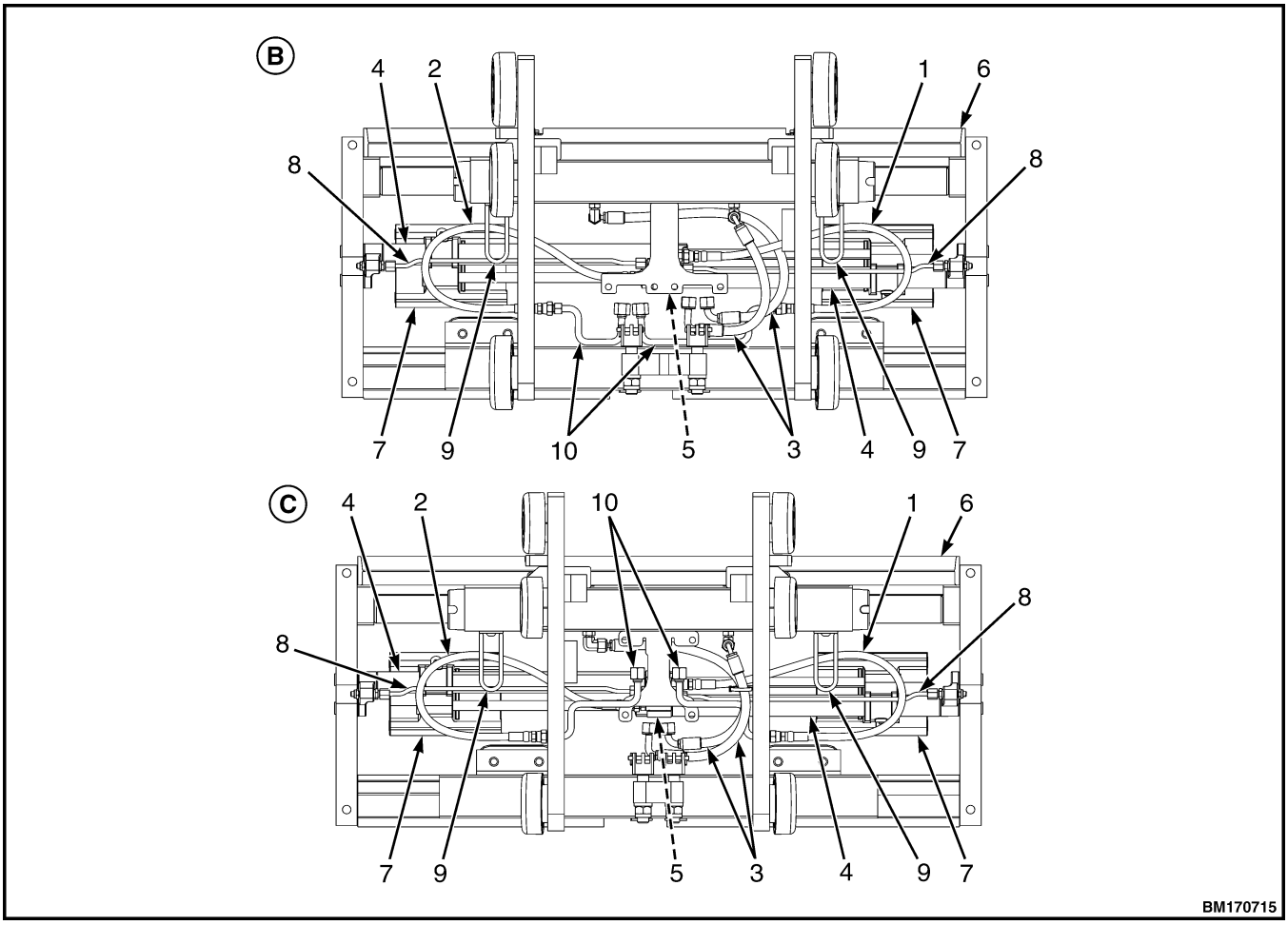


Figure 28. Fork Positioner Hydraulic Hose Connections (Sheet 1 of 2)

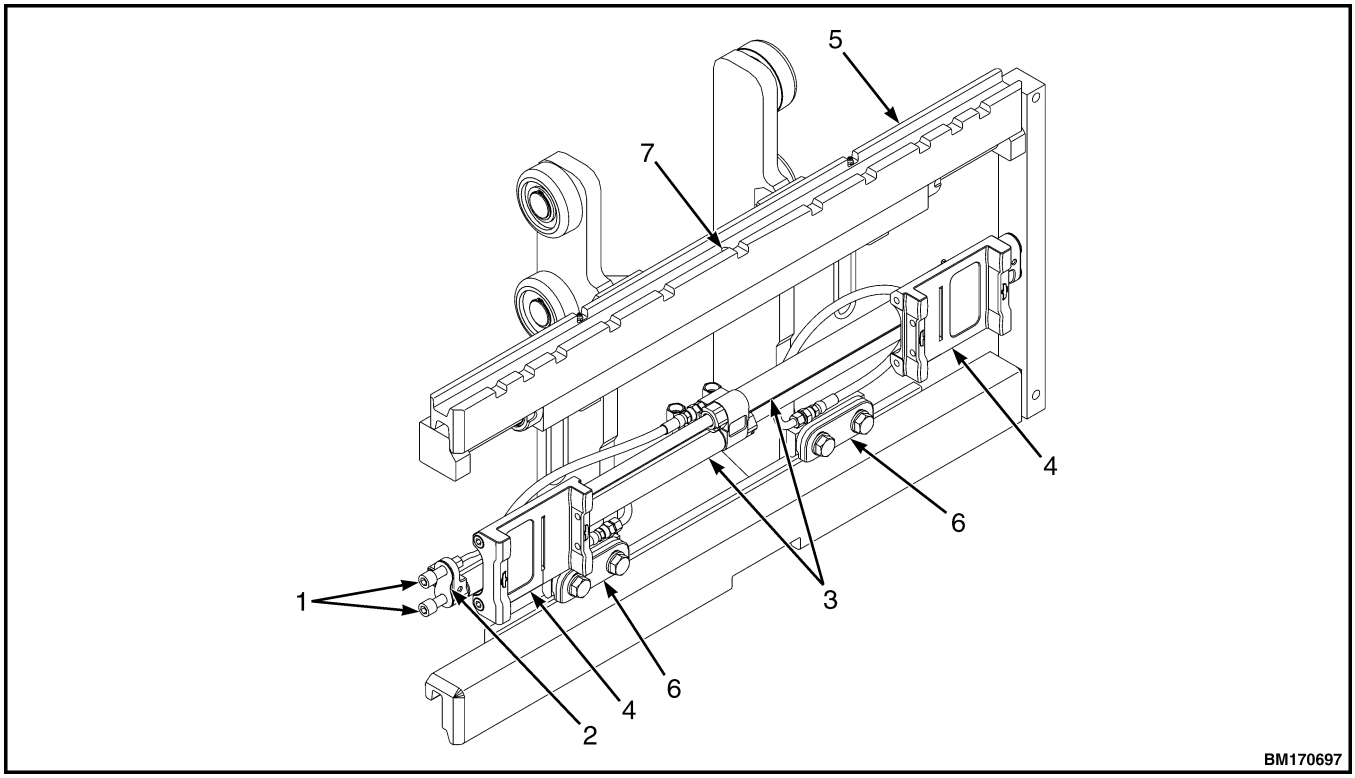


NOTE: BACK (DRIVER'S) VIEW SHOWN.

A. TWO-STAGE LFL ISS CARRIAGE AND FORK POSITIONER
B. TWO-STAGE FFL ISS CARRIAGE AND FORK POSITIONER
C. THREE-STAGE FFL ISS CARRIAGE AND FORK POSITIONER

1. FORK POSITIONER HYDRAULIC HOSE (OPEN)
2. FORK POSITIONER HYDRAULIC HOSE (CLOSE)
3. INTEGRAL SIDESHIFT CARRIAGE HYDRAULIC HOSES
4. FORK POSITIONER CYLINDER
5. MANIFOLD
6. OUTER FRAME
7. FORK CARRIER
8. RELIEF TUBE ASSEMBLY
9. HOSE GUIDE
10. TUBE ASSEMBLY

Figure 28. Fork Positioner Hydraulic Hose Connections (Sheet 2 of 2)



NOTE: FRONT VIEW SHOWN.

1. CAPSCREW AND LOCKWASHER
2. SHIMS
3. FORK POSITIONER CYLINDER
4. FORK CARRIER
5. INTEGRAL SIDESHIFT CARRIAGE ASSEMBLY
6. LOWER HOOK
7. TAPPED HOLE FOR LIFT EYE

Figure 29. Fork Positioner Cylinder Removal

Clean and Inspect

See **Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564)** 2100SRM1382 for cleaning and inspection procedures on the fork positioner cylinder.

Disassemble and Assemble

See **Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564)** 2100SRM1382 to disassemble and assemble the fork positioner cylinders.

Install

1. Place fork positioner cylinders onto outer frame. Install lockwasher and capscrew on one side and hand tighten capscrew. See Figure 29. Add shims as follows:

NOTE: The maximum number of shims per side is five. The maximum difference in number of shims per side is two. The maximum gap allowed before tightening capscrews is 0.50 mm (.020 in.).

- **a.** Measure gap at opposite side and determine the number of shims required.
- **b.** Install shims on both sides of the fork positioner assembly.

2. Install second lockwasher and capscrew. Tighten both capscrews to 65 N•m (50 lbf ft). See Figure 29.

3. Connect fork positioner hydraulic hoses to fork positioner manifold. Tighten hoses to 21 N•m (186 lbf in). See Figure 28.

4. Thread fork positioner hydraulic hoses through hose guides. See Figure 28.

5. Install lifting eye and use a lifting device, with a capacity of 62 kg (136 lb), to install outer frame, with fork positioner attached, onto inner frame.

6. Using a lifting device, position outer frame at the same height of inner frame and 150 mm (6 in.) away.

7. From rear of outer frame, connect fork positioner hydraulic tubes to header hoses and hand tighten. See Figure 28.

8. Position fork positioner hydraulic tubes so they are in line with retainer plates on inner frame. See Figure 30.

9. Using a washer and capscrew, install lower hook to retainer plates and tighten capscrews to 165 N•m (122 lbf ft). See Figure 30.

10. Tighten fork positioner hydraulic tubes to header hoses to 42 N•m (31 lbf ft). See Figure 28.

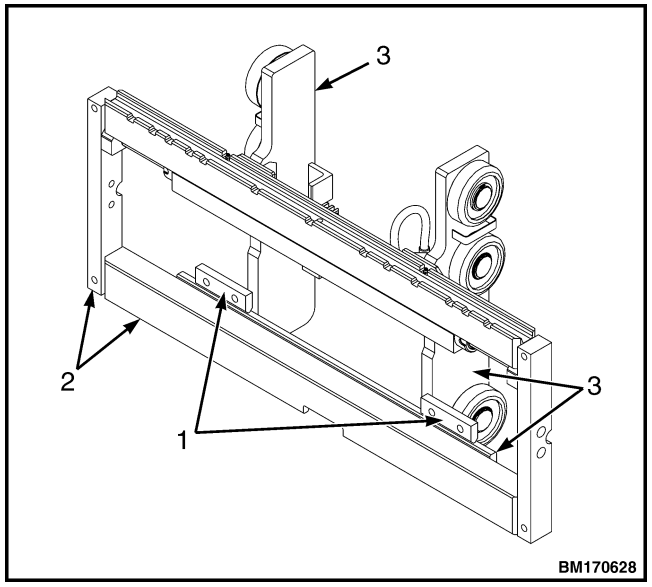


Figure 30. Retainer Plates and Inner and Outer Frame

Legend for Figure 30.

1. RETAINER PLATES
2. OUTER FRAME (FORK BAR)
3. INNER FRAME

Fork Positioner Hydraulic Hose Adjustment

1. To adjust the fork positioner hydraulic hoses, hold the large hex nut and rotate the small hex nut towards the load face of the carriage (towards the forks). See Figure 31.

2. Fork positioner hoses are correctly adjusted when fork positioner hydraulic hoses stay entirely within the integral sideshift carriage and do not contact mast channels under all conditions. See Figure 31.

3. Move fork positioner and check to ensure fork carriers clear fork positioner relief tubes through complete fork carrier cycle. See Figure 28.

4. Install load backrest to sideshift carriage. Tighten capscrews to 195 N•m (144 lbf ft). See Figure 7.

WARNING

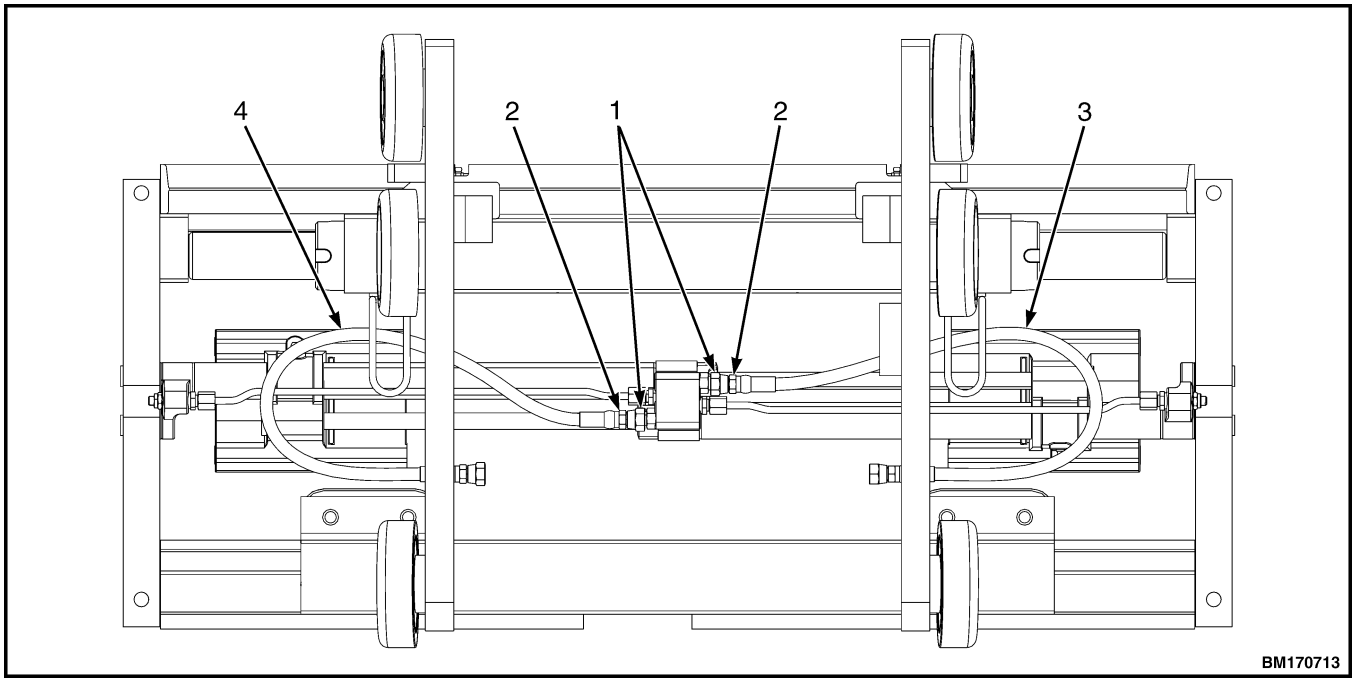
DO NOT try to install a fork without a lifting device. Each hook fork for these lift trucks can weigh 45 to 115 kg (99 to 254 lb)

CAUTION

Remove fork latch pins if adding a fork positioner attachment. Damage to forks and other carriage components can occur if fork latch pins are not removed prior to using attachment.

5. Install forks to outer fork carriers. Secure inner fork carriers to outer fork carriers using four capscrews. Tighten capscrews to 35 N•m (25 lbf ft). See Figure 27.

6. Adjust fork positioner cylinders. See **Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564)** 2100SRM1382 for procedures.



1. LARGE HEX NUT
2. SMALL HEX NUT
3. FORK POSITIONER HYDRAULIC HOSE (OPEN)
4. FORK POSITIONER HYDRAULIC HOSE (CLOSE)

Figure 31. Fork Positioner Hydraulic Hoses Adjustment

Two-Stage Mast With Limited Free-Lift Repair

REMOVE

WARNING

The mast is heavy. The mast can weigh approximately 907 kg (2000 lb). Make sure all lifting devices (hoists, cables, chains, slings, etc.) are suitable and of adequate capacity to lift the mast.

WARNING

Mast weldments can slide when the mast is moved. A weldment that slides can cause serious injury.

CAUTION

Make sure all the mast weldments are fastened together. Make sure the safety chains will not damage the sheaves, tubing, or other parts of the mast.

NOTE: If the mast needs to be disassembled, remove the forks and carriage. See sections Fork Replacement and Carriages Repair in this service manual for procedures. If only the main lift cylinders need to be removed for repair, the mast does not need to be removed from the lift truck. See section **Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564)** 2100SRM1382 for procedures to remove the main lift cylinders.

NOTE: The length of the lift chains must be checked before the mast is removed. See Lift Chains Adjustment.

1. Fully lower all of the mast weldments. Tilt the mast fully forward. Connect a crane with a capacity of at least 907 kg (2000 lb) to the top of the mast using chains to support the mast in an upright position when the tilt cylinders are disconnected. See the section Safety Procedures When Working Near Mast in this manual.

WARNING

Always wear the proper protective equipment including eye protection and petroleum-resistant gloves when handling hydraulic oil. Thoroughly wash oil from exposed areas of skin as soon as possible.

Completely lower forks to relieve hydraulic pressure before disassembling any part of the lift pump or disconnecting any hoses.

The hydraulic oil is hot at normal operating temperatures. Be careful when draining the oil.

CAUTION

Protect the hydraulic system from dirt and contaminants when servicing the hydraulic system.

2. Position a drip pan under the area of the hydraulic fittings. Disconnect the hydraulic line at the external lowering control valve on the outer mast. See Figure 38.

WARNING

Use a driver, NOT your fingers, to push the anchor pins from the clevises on the tilt cylinders. The cylinder or mast can move and cause serious injury.

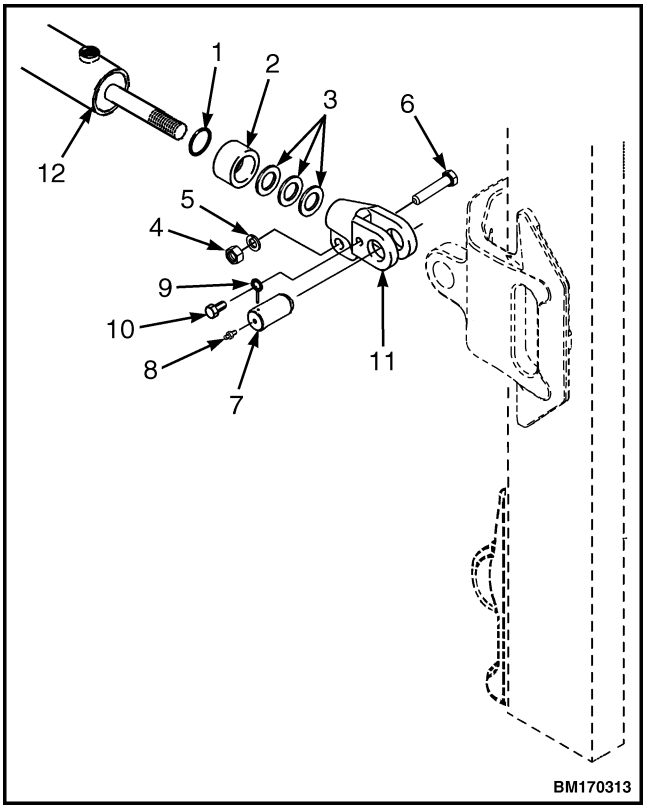
3. On lift trucks NOT equipped with optional boot on tilt cylinders, remove the capscrews, washers, anchor pins, and pivot pins at the tilt cylinder mounts on the outer mast. See Figure 32.

4. On lift truck models J2.2-3.5XN (J45-70XN) (A276) equipped with tilt cylinders with optional boots, remove capscrews, washers, nuts, anchor pins, and pivot pins at the tilt cylinder mounts on outer mast. See Figure 33.

5. Using a brass drift pin, remove tilt rod bushings from outer mast. Discard tilt rod bushings. See Figure 34.

NOTE: Allow the mast to tilt forward enough to gain access to the mast mount capscrews.

6. Disconnect the lower mast mounts from the lift truck by removing the capscrews that hold the mast pivot pins to the mounts on the drive axle. See Figure 35



1. O-RING
2. SPACER
3. SHIMS
4. NUT
5. WASHER
6. CAPSCREW
7. PIVOT PIN
8. GREASE FITTING
9. ANCHOR PIN
10. CAPSCREW
11. ROD END
12. TILT CYLINDER

Figure 32. Mast Mounting, Tilt Cylinder Without Boot

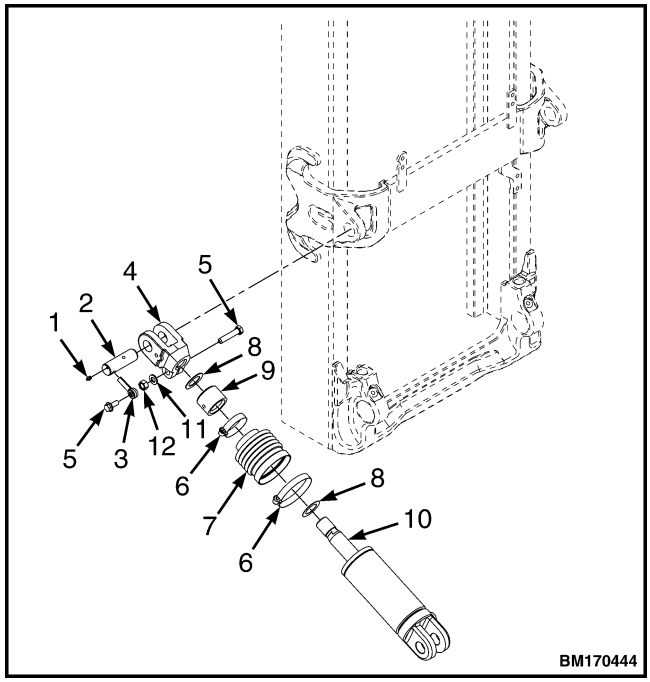
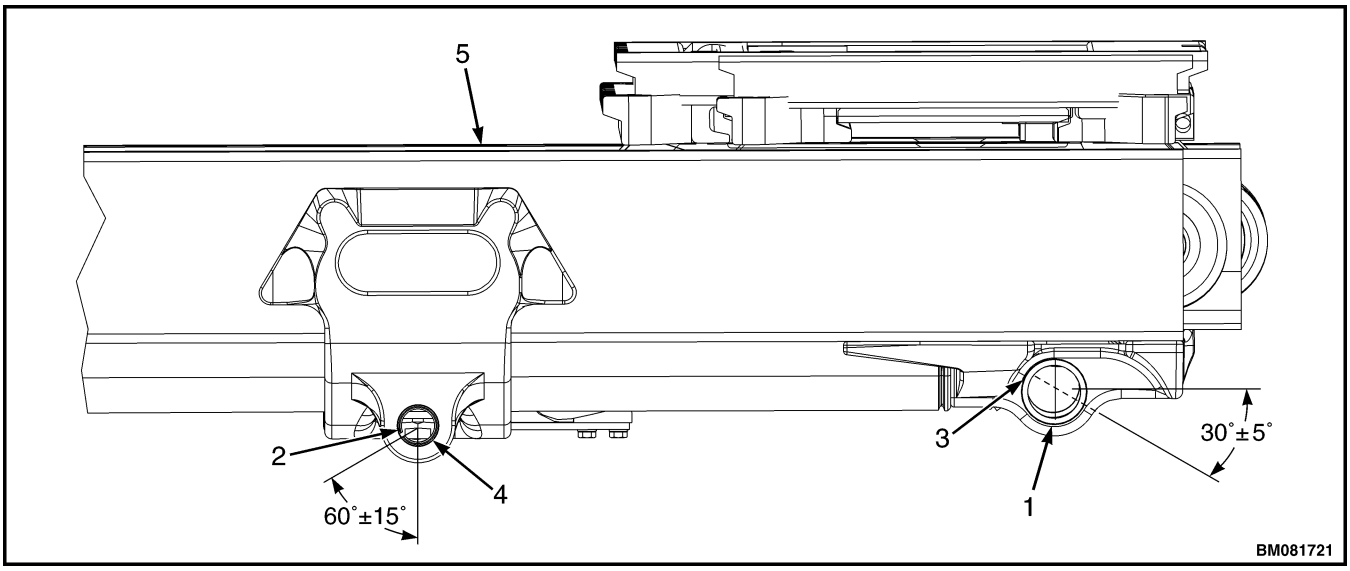


Figure 33. Mast Mounting, Tilt Cylinder With Optional Boot

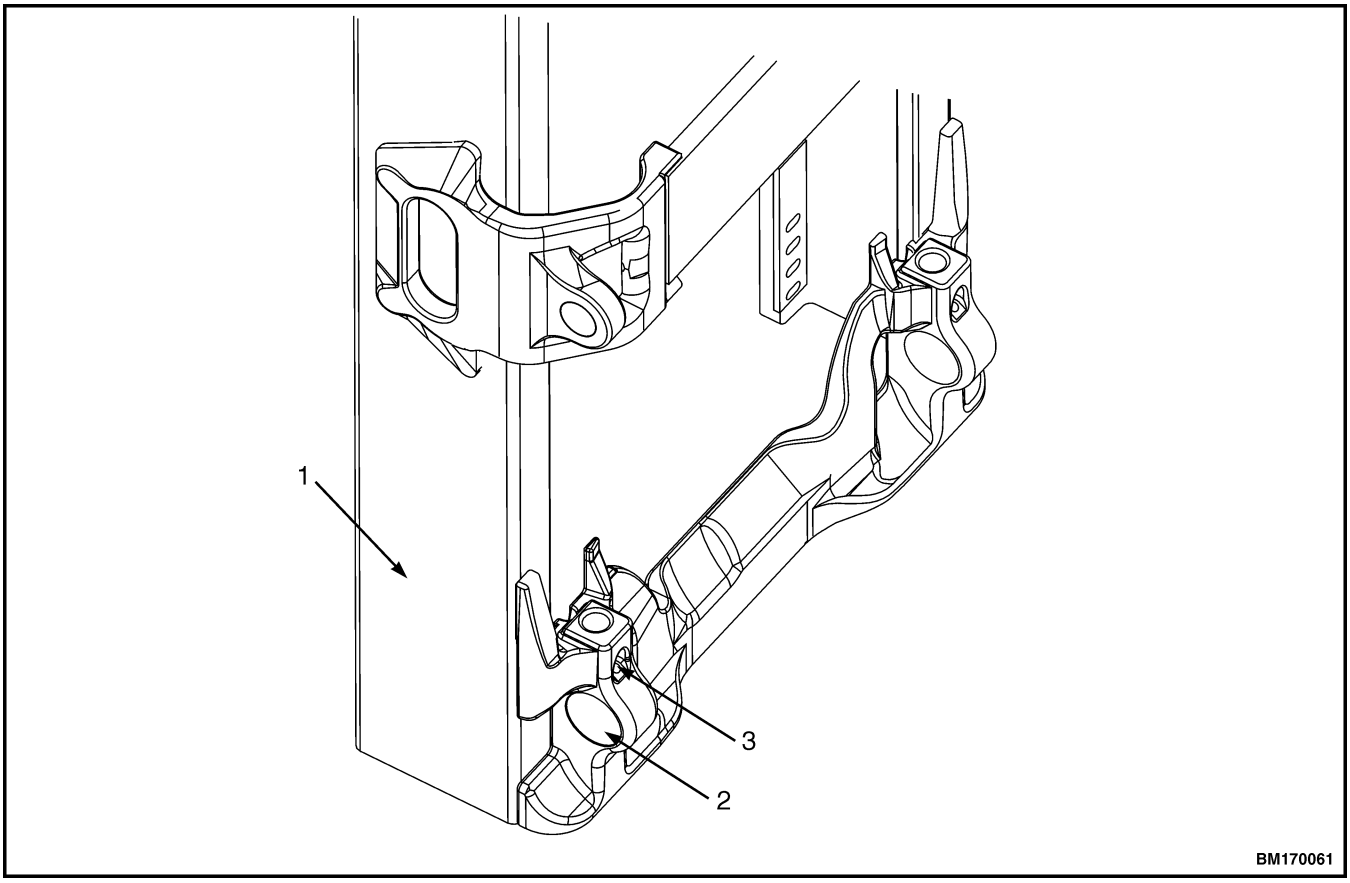
Legend for Figure 33.

1. GREASE FITTING
2. PIVOT PIN
3. ANCHOR PIN
4. ROD END
5. CAPSCREW
6. CLAMP
7. BOOT
8. SHIM
9. SPACER
10. TILT CYLINDER
11. WASHER
12. NUT



1. MAST MOUNTING BUSHING
2. BUSHING SPLIT
3. BUSHING HOLE
4. TILT ROD BUSHING
5. OUTER MAST

Figure 34. Tilt Rod and Mast Mounting Bushings



1. OUTER MAST
2. BUSHING
3. GREASE FITTING

Figure 35. Mast Mounts, Outer Mast

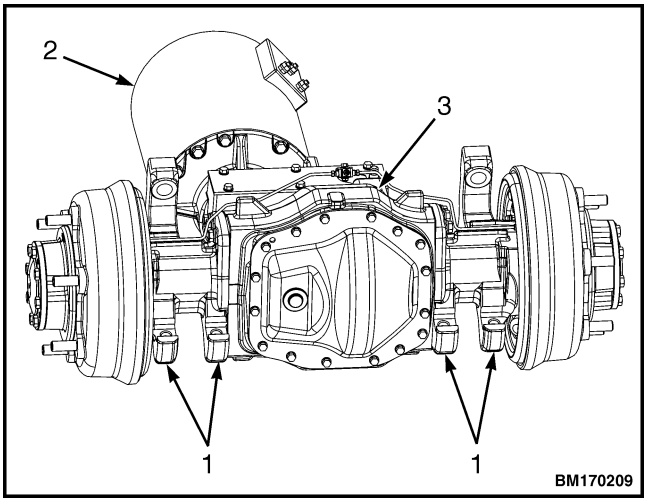


Figure 36. Mast Mounts, Drive Axle

Legend for Figure 36.

NOTE: DRIVE AXLE AND TRACTION MOTOR ARRANGEMENT FOR LIFT TRUCK MODELS E2.2-3.5XN (E45-70XN) (A268) SHOWN. MAST MOUNTS FOR LIFT TRUCK MODELS J2.2-3.5XN (J45-70XN) (A276) ARE THE SAME.

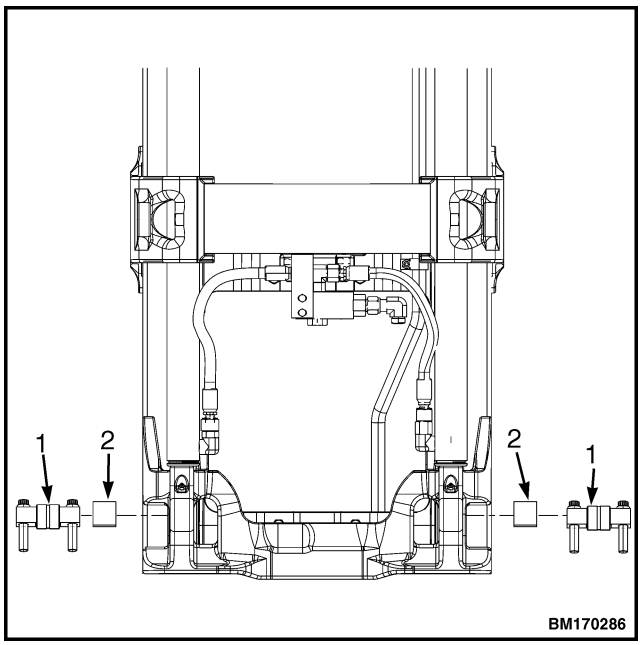
1. HANGER MOUNTS
2. TRACTION MOTOR
3. DRIVE AXLE

WARNING

The mast is heavy. The mast can weigh approximately 907 kg (2000 lb). Make sure all lifting devices (hoists, cables, chains, slings, etc.) are suitable and of adequate capacity to lift the mast.

7. Use the crane to lift the mast assembly from the lift truck. Position the mast across wooden beams on the floor with the carriage side up.

8. Check the mast and mounting flanges for wear or damage by removing the mast pivot pins from the outer mast. Check that the pins fit snug in the outer mast. If pins can be moved up and down a minimum of 4 mm (0.20 in.), replace bushings in outer mast and/or mast pivot pins as required. See Figure 37. Use a brass drift pin to remove mast mounting bushings from outer mast. Discard mast mounting bushings. See Figure 34.



1. MAST PIVOT PINS
2. BUSHING

Figure 37. Mast Pivot Pin

DISASSEMBLE

WARNING

Always wear the proper protective equipment including eye protection and petroleum-resistant gloves when handling hydraulic oil. Thoroughly wash oil from exposed areas of skin as soon as possible.

Completely lower forks to relieve hydraulic pressure before disassembling any part of the lift pump or disconnecting any hydraulic hoses.

The hydraulic oil is hot at normal operating temperatures. Be careful when draining the oil.

CAUTION

Protect the hydraulic system from dirt and contaminants when servicing the hydraulic system.

NOTE: If the main lift cylinders alone need to be removed and repaired, see **Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564)** 2100SRM1382 for procedures. When the mast has header hoses, see Header Hose Installation and Adjustment in this service manual.

1. Clean the area around the hydraulic fittings for the lift cylinders. Disconnect the fittings at the lift cylinders and put caps on the open lines. See Figure 38.

2. Remove the chains and header hoses.

3. Disconnect hydraulic lines and fittings between lowering control valve housing and main lift cylinders. Remove capscrews and nuts and remove lowering control valve housing and valve from bracket on outer mast. See Figure 38.

WARNING

Be careful when removing or installing snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers, and wear eye and face protection during removal or installation.

4. Remove the nut, capscrew, spacer, and washer at the mount near the top of each main lift cylinder. Remove the snap rings and washers from the top of each main lift cylinder. Disconnect the main lift chains at the mounts. See Figure 38.

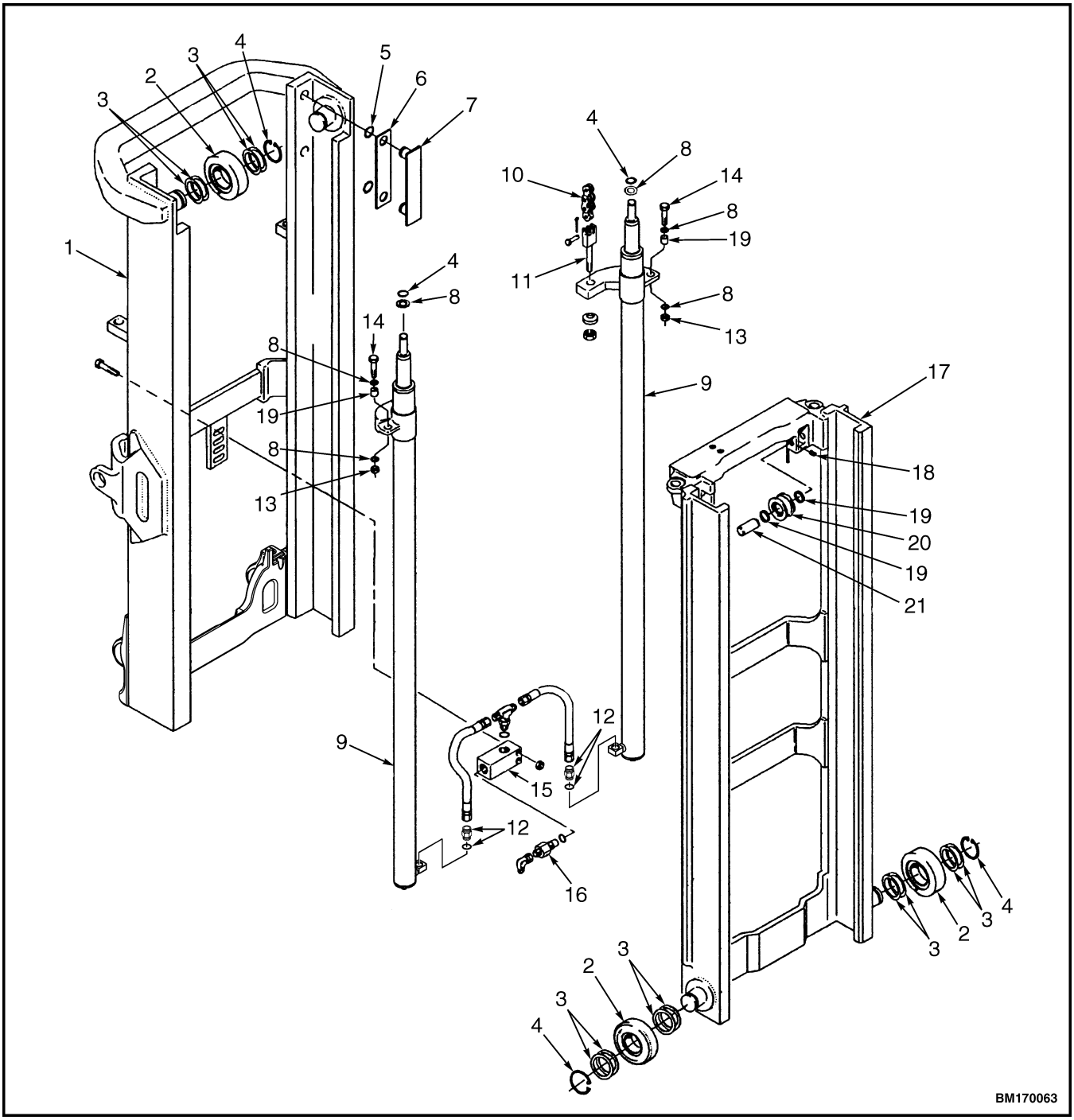


Figure 38. Two-Stage, Limited Free-Lift (LFL) Mast

Legend for Figure 38.

1. OUTER MAST
2. LOAD ROLLER
3. SHIM
4. SNAP RING
5. O-RING
6. SHIM(S)
7. STRIP BEARING
8. WASHER
9. MAIN LIFT CYLINDER
10. MAIN LIFT CHAIN
11. CHAIN ANCHOR
12. VELOCITY FUSE
13. NUT
14. CAPSCREW
15. HOUSING
16. LOWERING CONTROL VALVE
17. INNER MAST
18. PIN (2)
19. SPACER
20. CHAIN SHEAVE
21. PIN

WARNING

The mast weldments can slide when the mast is moved. A weldment that slides can cause injury.

5. Slide the inner mast from the outer mast approximately 30 cm (12 in.) to disengage the main lift cylinders from the inner mast. Remove the main lift cylinders from the outer mast. See Figure 38.

6. Slide the inner mast from the bottom of the outer mast approximately 30 cm (12 in.). Remove the strip bearings and load rollers from the top of the outer mast. Remove the load rollers from the bottom of the inner mast. Make a note of each shim arrangement and load roller location. The shim arrangements will be approximately the same during assembly. See Figure 38.

WARNING

The mast is heavy. The mast can weigh approximately 907 kg (2000 lb). Make sure all lifting devices (hoists, cables, chains, slings, etc.) are suitable and of adequate capacity to lift the mast.

NOTE: When replacing the outer mast, copy the part number and date code information from the old channel and stamp that information on the new channel with a letter **R** at the end to indicate that it has been replaced.

7. Slide the inner mast halfway out of the top of the outer mast. Connect a crane with a capacity of at least 907 kg (2000 lb) to the center of the inner mast. See Figure 39. Slide the inner mast out of the outer mast until the mast stub shafts of the inner mast are in the notches of the outer channels. Remove the inner mast from the outer mast.

8. Remove the chain sheaves and disassemble them as necessary for repair and cleaning.

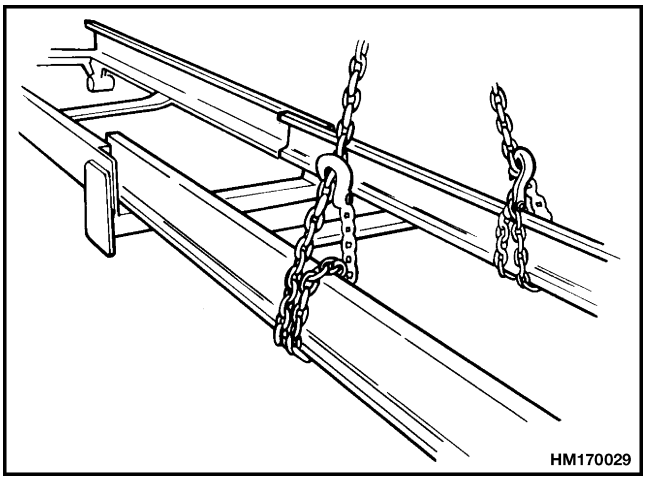


Figure 39. Inner Mast

CLEAN AND INSPECT

CAUTION

DO NOT use steam or high-pressure water to clean the load rollers or the lift chains. Steam and high-pressure water can remove the lubrication from the bearings in the load rollers. Water in the bearings of the sheaves and the link pins of chains can also shorten the service life of these parts.

1. Inspect chain sheaves and load rollers for wear or damage. DO NOT use steam to clean lift chain sheaves or load rollers. The bearings in the sheaves and load rollers are sealed and lubricated.

WARNING

Cleaning solvents may be flammable and toxic and can cause severe skin irritation. When using commercial cleaning solvents, always comply with solvent manufacturer's recommended safety precautions.

WARNING

Compressed air can move particles so that they cause injury to the user or to other personnel. Make sure that the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eyes.

2. Clean the lift chains by soaking in solvent for 30 minutes to remove all dirt and grease. Hang lift chains up and remove solvent using compressed air.

WARNING

Never replace only the worn section of a chain. Replace the complete chain. Never replace only one chain of a chain pair. Replace both chains. Damage to the lift truck and serious injury can occur if lift chains are not replaced correctly.

NOTE: The chains must be inspected in the area of chain that passes over the chain sheave during the first portion of a lift. These links will show maximum wear.

3. Inspect the lift chains for wear and damage. A lift chain becomes longer when it is worn. If a chain is 3% longer than a new lift chain, the lift chain must be replaced.

4. If a chain scale is available (Hyster Part No. 599737) , check lift chains as shown in Figure 40. If a chain scale is not available measure 20 links of chain. Measure from the center of a pin to the center of another pin 20 pitches away. Compare the length with the chart in Figure 40. Replace chain if the length of 20 links of the worn section is more than the maximum wear limit.

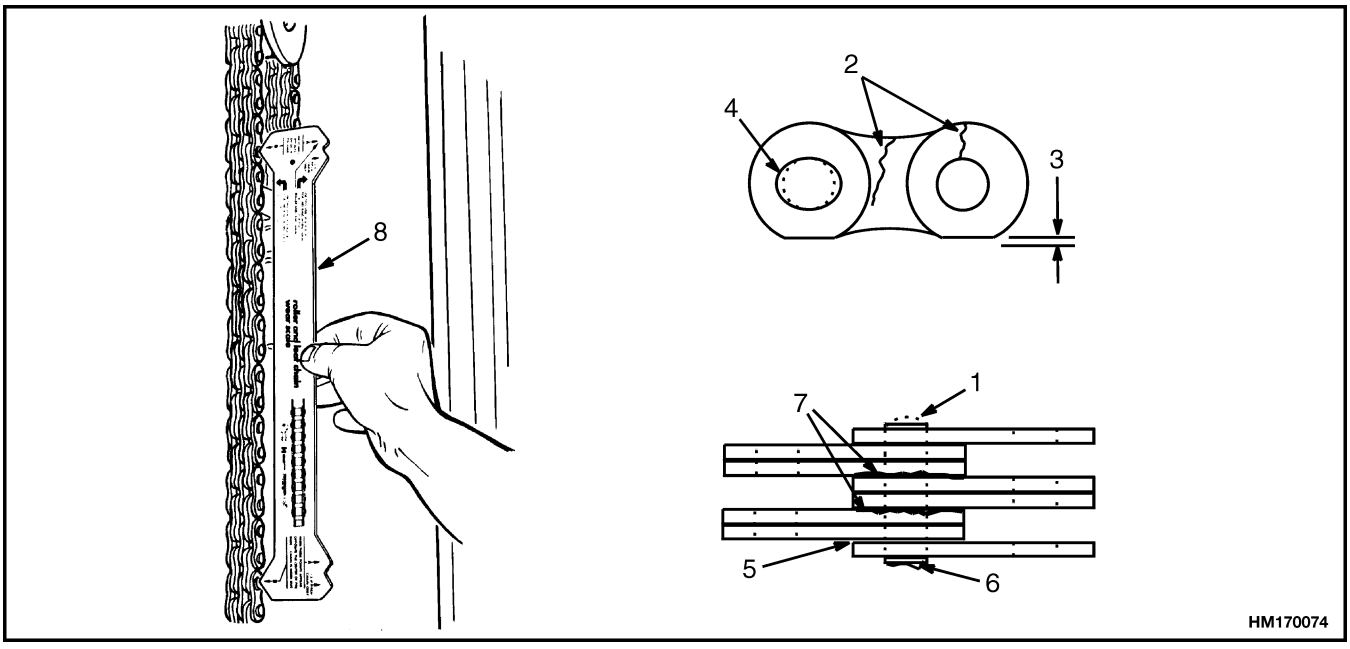
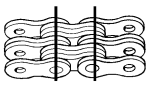


Figure 40. Lift Chains Check

Legend for Figure 40.

NOTE: THE INSTRUCTIONS FOR MEASURING CHAIN WEAR ARE SHOWN ON THE CHAIN WEAR SCALE.

Pitch 	Total length of 20 links (pitch) of new chain	Wear Limit The maximum length of 20 links
12.7 mm (0.5 in.)	254.0 mm (10.0 in.)	261.6 mm (10.3 in.)
15.9 mm (0.6 in.)	317.5 mm (12.5 in.)	327.0 mm (12.9 in.)
19.1 mm (0.8 in.)	381.0 mm (15.0 in.)	392.4 mm (15.4 in.)
25.4 mm (1.0 in.)	508.0 mm (20.0 in.)	523.3 mm (20.6 in.)

1. WORN PIN
2. CRACKS
3. EDGE WEAR
4. HOLE WEAR
5. LOOSE LEAVES
6. DAMAGED PIN
7. RUST
8. CHAIN WEAR SCALE

5. Lubricate lift chains by soaking them in SAE 30 engine oil for 30 minutes. Hang chains over a drip pan for one hour to remove excess oil.

NOTE: Chain anchor pins **MUST** be replaced anytime chains are replaced.

6. Inspect the chain anchors and pins. Replace any parts that are worn or damaged. See Figure 38.

WARNING

Cleaning solvents may be flammable and toxic and can cause severe skin irritation. When using commercial cleaning solvents, always comply with solvent manufacturer's recommended safety precautions.

WARNING

Steam can cause serious burns. Wear protective clothing, gloves, and eye protection. Never expose your skin to steam.

7. Clean the mast weldments with steam or solvent.

WARNING

Improper welding procedures can damage the structure of the mast or cause incorrect function of the mast which can result in serious injury to personnel. Consult your Hyster lift truck dealer for more information before welding on the mast.

8. Inspect the sliding surfaces for wear or damage. Inspect the load roller contact surfaces for wear or damage. Inspect all welds for cracks.

ASSEMBLE

WARNING

The mast is heavy. The mast can weigh approximately 907 kg (2000 lb). Make sure all lifting devices (hoists, cables, chains, slings, etc.) are suitable and of adequate capacity to lift the mast.

NOTE: The shims for the load rollers keep the mast weldments parallel and provide correct clearance. During assembly, the shim arrangement will be approximately the same as before disassembly. Check the clearance and adjust the shims for wear or for changes caused by repairs. The strip bearings are also adjusted by using shims. See Mast Adjustments in this service manual for the adjustment procedures.

NOTE: When the mast has header hoses, see the procedures for Header Hose Installation and Adjustment.

1. Connect a crane with a capacity of at least 907 kg (2000 lb) to the center of the inner mast. Fit the stub shafts through the notches in the outer mast. Slide the inner mast into the outer mast so the stub shafts are seen at the top and bottom of the weldments. See Figure 38.

2. Install the strip bearings and the shims on the outer mast. See Figure 41. Apply chassis lube to the bearing surface. Check the clearance of the strip bearings as described in Mast Adjustments in this service manual.

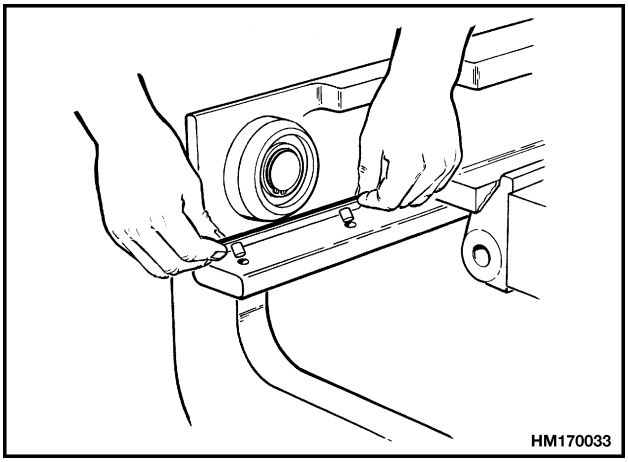


Figure 41. Strip Bearings

3. Install the load rollers and shims on both weldments. Check the clearance of the load rollers as described in Mast Adjustments and Carriage Adjustments. in this service manual.

4. Push the inner mast to engage the rods of the lift cylinders. Install the washer and snap ring.

5. Install the spacers, capscrew, nuts, and washers at the mounts for the lift cylinders. Tighten the bolts to 40 N•m (30 lbf ft). See Figure 38.

6. Install the housing for the lowering control valve on bracket on outer mast. Tighten the nuts for the lowering control valve housing to 18 N•m (13 lbf ft). Install the lowering control valve in the housing. Connect the hydraulic lines and fittings between the housing and the main lift cylinders. See Figure 38.

7. Install the chain sheaves at the inner mast. Be sure to install both pins that hold the shaft for the chain sheave in position. Connect the lift chains to the chain anchors at the main lift cylinder mounts. Attach wires between the ends of the lift chains and the crossmember to control the lift chains during mast installation.

INSTALL

1. Install new bushings into mast mounts at bottom of outer mast. Be sure the hole and bushing split are installed at the correct angle as shown in Figure 34. Bushing must be flush with outer mast surface.

2. Apply an even coat of grease to the pivot pins and install them into mounts at bottom of outer mast. See Figure 37.

3. Connect crane to top of mast using chains. Make sure all mast uprights are fastened together. Make sure chains will not damage sheaves, tubing, or other parts of mast. Make sure crane has a capacity of at least 1600 kg (3500 lb).

4. Use crane to position mast assembly onto its lower mounts. Position mast so pivot pins seat into hanger mounts on drive axle. Install capscrews that hold mast pivot pins to drive axle hangers. Tighten capscrews to 270 N•m (199 lbf ft). Refer to Figure 36.

5. Install new tilt rod bushings into outer mast. Be sure to install bushings with split at correct angle as shown in Figure 34.

WARNING

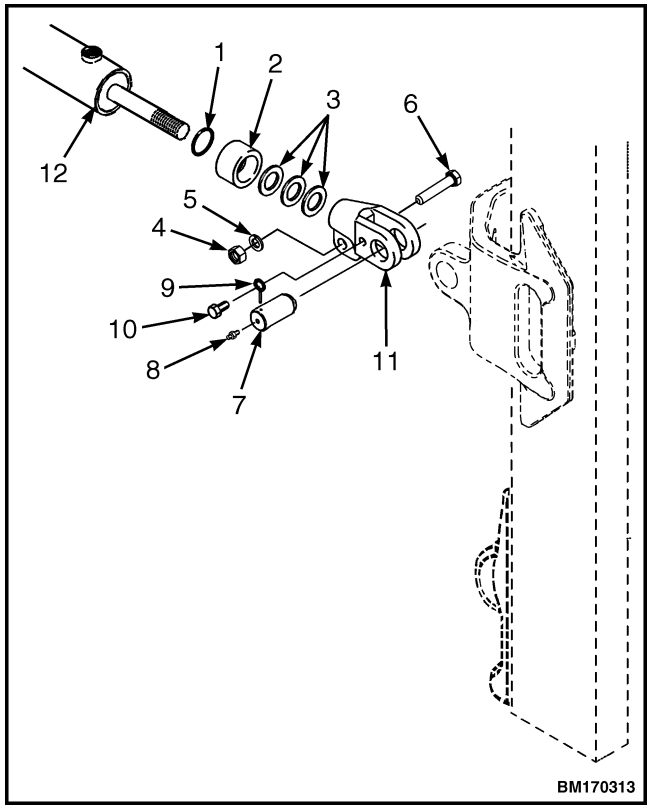
Use a pry bar, NOT your fingers, to align the tilt cylinder clevises with the outer mast. The cylinder or mast can shift and cause serious injury.

NOTE: Use multipurpose grease #2 with 2 to 4% molybdenum disulfide for normal operations.

6. Apply grease to pivot pins and connect tilt cylinders to mast using pivot pins. Install anchor pins and capscrews to rod ends. Apply anti-seize compound to capscrew threads and tighten 38 N•m (28 lbf ft).

   See Figure 42 for lift trucks equipped with tilt cylinder without optional boot

   See Figure 43 for lift trucks equipped with tilt cylinder with optional boot



1. O-RING
2. SPACER
3. SHIMS
4. NUT
5. WASHER
6. CAPSCREW
7. PIVOT PIN
8. GREASE FITTING
9. ANCHOR PIN
10. CAPSCREW
11. ROD END
12. TILT CYLINDER

Figure 42. Mast Mounting, Tilt Cylinder Without Boot

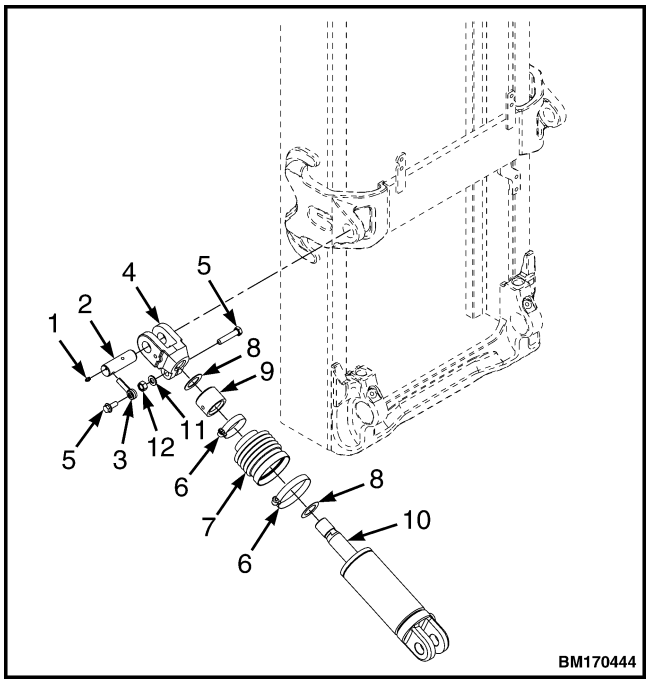
7. Connect hydraulic line to lowering control valve.

8. Install carriage as described in the section Carriages Repair.

WARNING

Never check for leaks by putting hands on hydraulic lines or components under pressure. Hydraulic oil under pressure can be injected into the skin.

9. Check tilt cylinder adjustment as described in **Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564)** 2100SRM1382. Operate mast and check for leaks and correct operation. Check lift chains as described in Lift Chains Adjustment in this manual.



1. GREASE FITTING
2. PIVOT PIN
3. ANCHOR PIN
4. ROD END
5. CAPSCREW
6. CLAMP
7. BOOT
8. SHIM
9. SPACER
10. TILT CYLINDER
11. WASHER
12. NUT

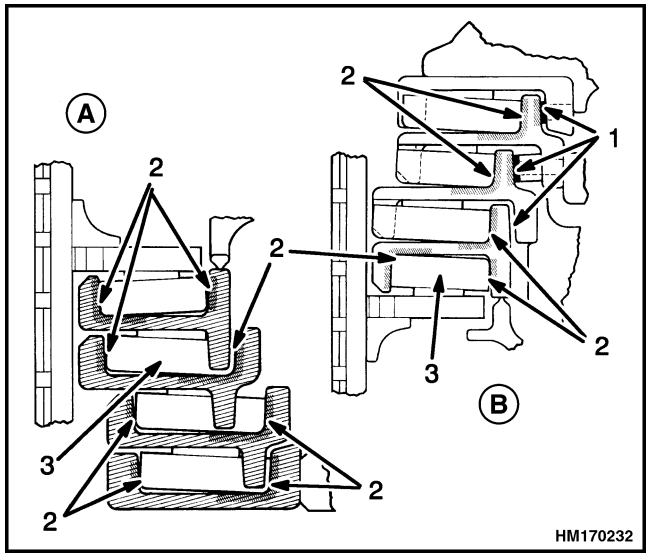
Figure 43. Mast Mounting, Tilt Cylinder With Optional Boot

NOTE: Before checking for mast side kicking, the mast must be fully assembled to include the carriage, forks, load backrest and any attachments.

10. Raise the mast, without a load to its full height and check for side kicking. Mast side kicking is when the mast moves either to the right or left as it is being raised to its full height. If the mast is side kicking, see the Mast Adjustments section in this manual for procedures to correct mast side kicking.

NOTE: The load rollers and sheaves have sealed bearings and do not need additional lubrication.

11. Lubricate sliding surfaces and load roller surfaces along full length of channels as shown in Figure 44. Apply lubricant only to surfaces indicated.



A. LOWER LOAD ROLLERS
B. UPPER LOAD ROLLERS

1. LUBRICATE STRIP BEARINGS SURFACES
2. LUBRICATE LOAD ROLLER SURFACES
3. LOAD ROLLER

Figure 44. Lubricate Mast

HEADER HOSE INSTALLATION AND ADJUSTMENT

Installation

WARNING

Always wear the proper protective equipment including eye protection and petroleum-resistant gloves when handling hydraulic oil. Thoroughly wash oil from exposed areas of skin as soon as possible.

Never check for leaks by putting hands on hydraulic lines or components under pressure. Hydraulic oil under pressure can be injected into the skin.

WARNING

Before working on or near the mast, see Safety Procedures When Working Near Mast in this section.

Before installing the header hoses, make sure you know the lift height of the mast. The tension on the header hoses is adjusted according to lift height. The lift height is on the Nameplate of the lift truck and on the right side of the outer mast.

Some lift trucks are equipped with auxiliary hydraulic functions that are fastened to the carriage. Examples of attachments that use these auxiliary functions are sideshift carriages, roll clamps, and fork positioners. These auxiliary functions require header hoses for their operation.

NOTE: This procedure is for the four-function option. The three-function option will have hoses **A** and **B** only.

NOTE: The carriage height must be correct before the header hoses can be adjusted. See Lift Chains Adjustment for the carriage adjustment procedure.

1. Mark each hose with a single letter: **A**, **B**, **C**, and **D**. See Figure 45.

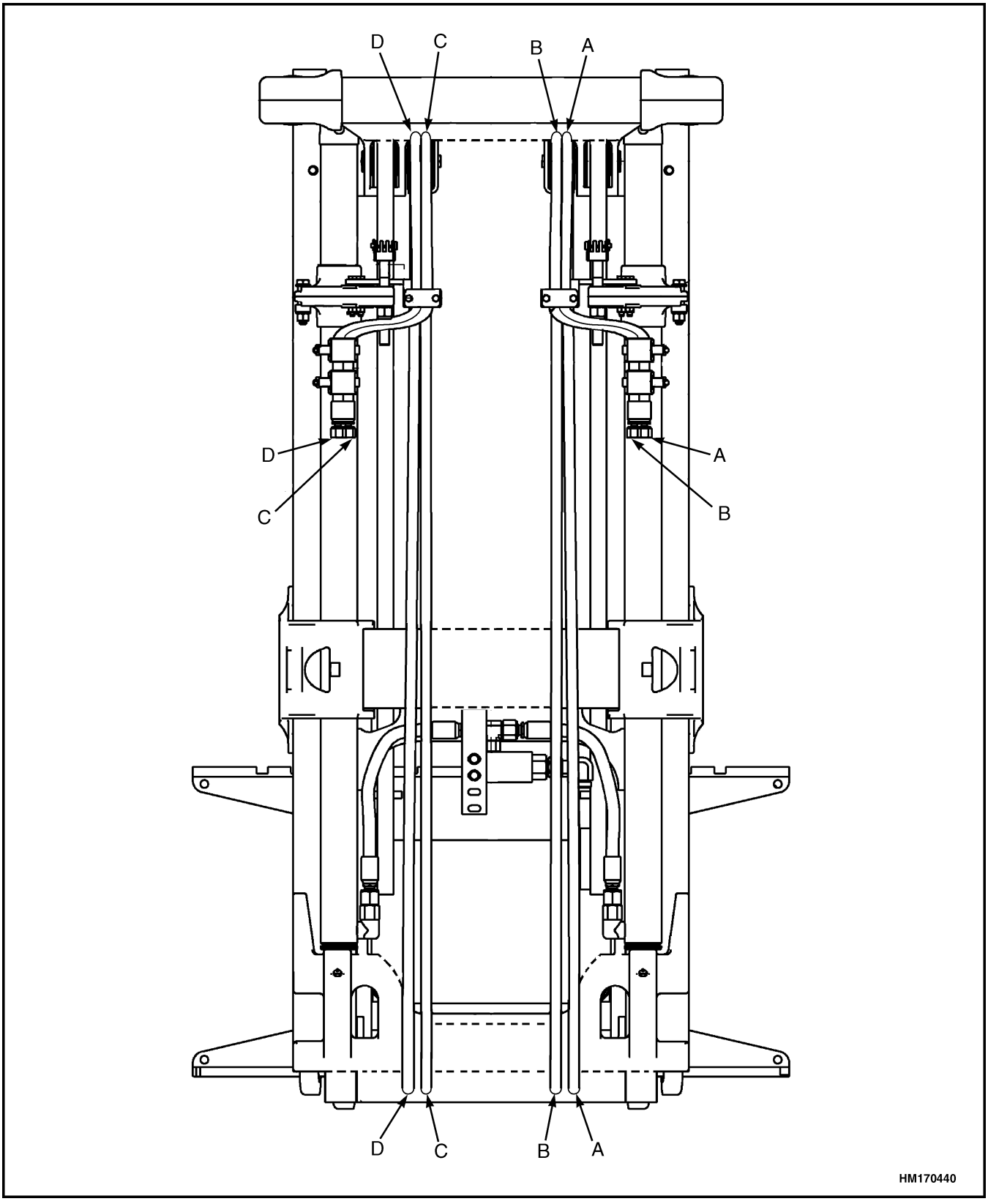


Figure 45. Header Hose Alignment for Two-Stage Limited Free-Lift Mast

Legend for Figure 45.

A. HOSE
B. HOSE
C. HOSE
D. HOSE

2. Dimension **E** is determined by the height of the outer mast channel from the ground and the length of the outer mast channel. See dimensions **Y** and **Z** in Figure 46. To determine **E**,

See

Table 2 for lift truck models

- E3.0-3.5XN (E60-70XN) (A268)
- J3.0-3.5XN (J60-70XN) (A276)

See Table 3 for lift truck models

- E3.0-3.5XN (E60-70XN) (A268)
- J3.0-3.5XN (J60-70XN) (A276)

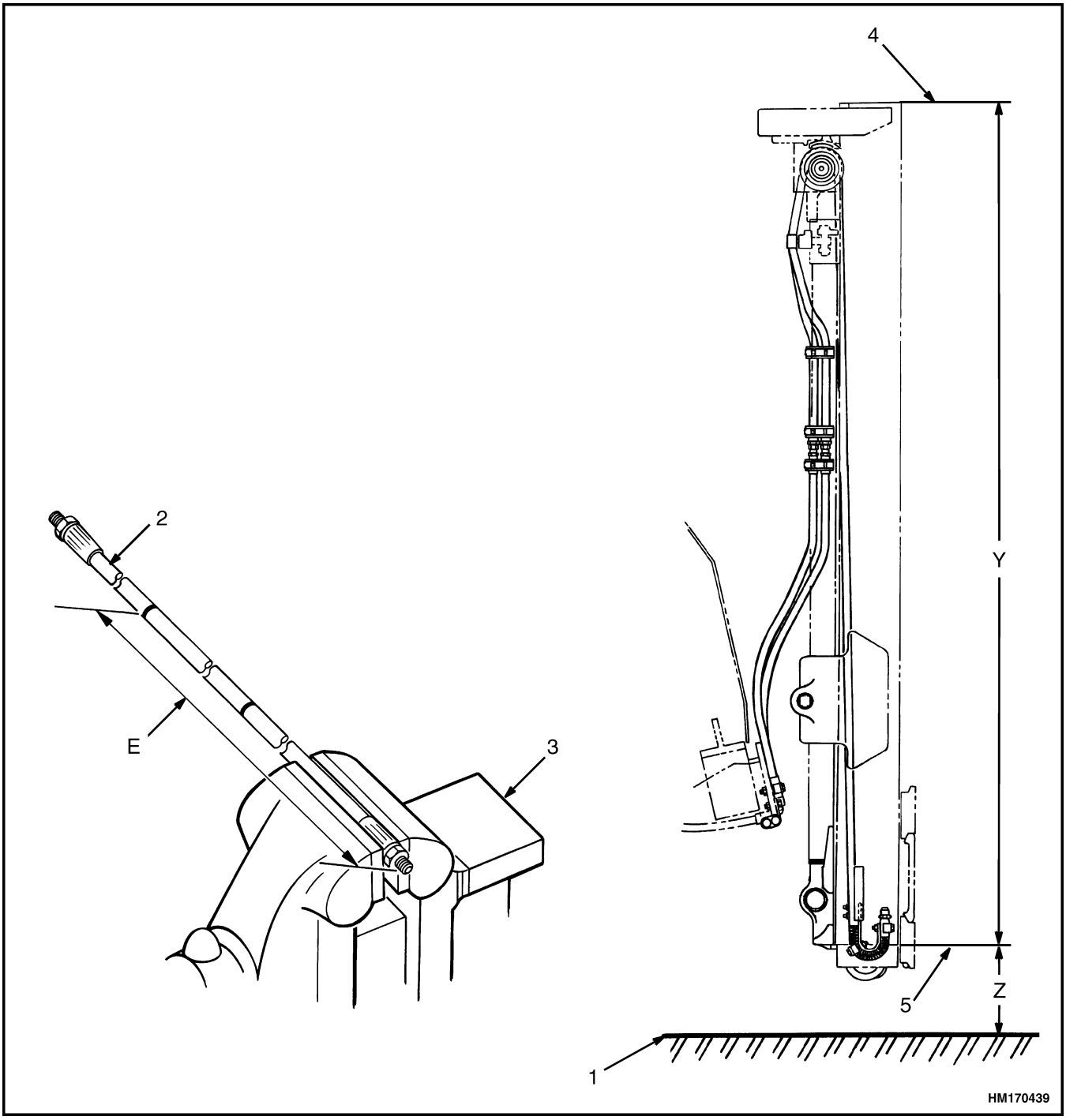
3. Clamp the end of the hose (the smaller fitting) that attaches to the carriage in a vise (**DO NOT** clamp on the threads), and pull on the other end until the hose is straight. **DO NOT** apply enough force to stretch the hose. See Figure 46.

NOTE: This mark will be used to pretension the header hoses during installation.

4. Place a mark on all the hoses at dimension **E** (all measurements are made from the carriage end of the hose [the smaller fitting]).

5. Attach the hoses to the carriage brackets with the clamps. See Figure 47.

6. Place the hoses at the location of the hose sheave. The sheave(s) and stub shafts must be assembled, and the hose(s) must be routed onto the sheave(s) before the hose(s) are attached to the mast. Refer to Figure 47. Tighten the hose clamp hardware (12) to 8 N•m (71 lbf in) and the sheave assembly capscrews (13) to 66 N•m (49 lbf ft).



1. GROUND LEVEL
2. HOSE
3. VISE
4. TOP OUTER CHANNEL
5. BOTTOM OUTER CHANNEL

Figure 46. Header Hose Measurement for Two-Stage Limited Free-Lift Mast

Table 2. Standard Two-Stage LFL Hose Dimensions, Lift Truck Models E2.2-2.5XN (E45-55XN) (A268) and J2.2-2.5XN (J45-50XN) (A276)

Lift Height		Channel Length (Reference)	Dimension "E" Pneumatic Tire Trucks		Dimension "E" Cushion Tire Trucks	
mm	in.	mm	mm	in.	mm	in.
3152	124.1	1990	2325	91.5	2320	91.3
3352	132.0	2090	2425	95.4	2420	95.2
3452	135.9	2140	2470	97.2	2470	97.2
Lift height is measured from top of forks. Lift heights shown are standard. If your lift height is not shown, go to **Hyster Hypass Online** to find the correct header hose measurement for your lift height.						

Table 3. Standard Two-Stage LFL Hose Dimensions, Lift Truck Models E3.0-3.5XN (E60-70XN) (A268) and J3.0-3.5XN (J60-70XN) (A276)

Lift Height		Channel Length (Reference)	Dimension "E" Pneumatic Tire Trucks		Dimension "E" Cushion Tire Trucks	
mm	in.	mm	mm	in.	mm	in.
2959	116.5	1990	2325	91.5	2320	91.3
3159	124.4	2090	2425	95.4	2420	95.2
3259	128.3	2140	2470	97.2	2470	97.2
Lift height is measured from top of forks. Lift heights shown are standard. If your lift height is not shown, go to **Hyster Hypass Online** to find the correct header hose measurement for your lift height.						

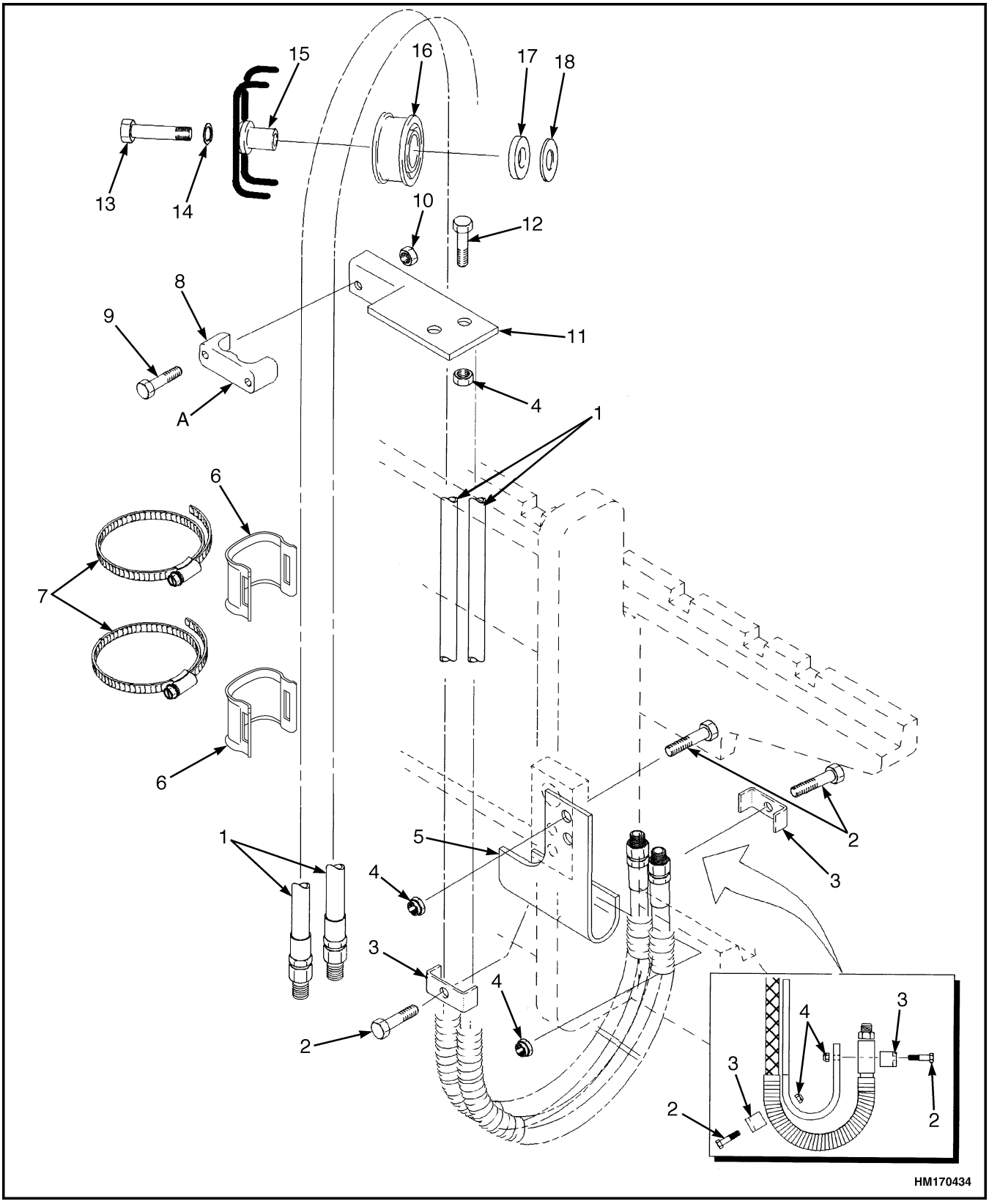


Figure 47. Header Hoses for Two-Stage Limited Free-Lift Mast

Legend for Figure 47.

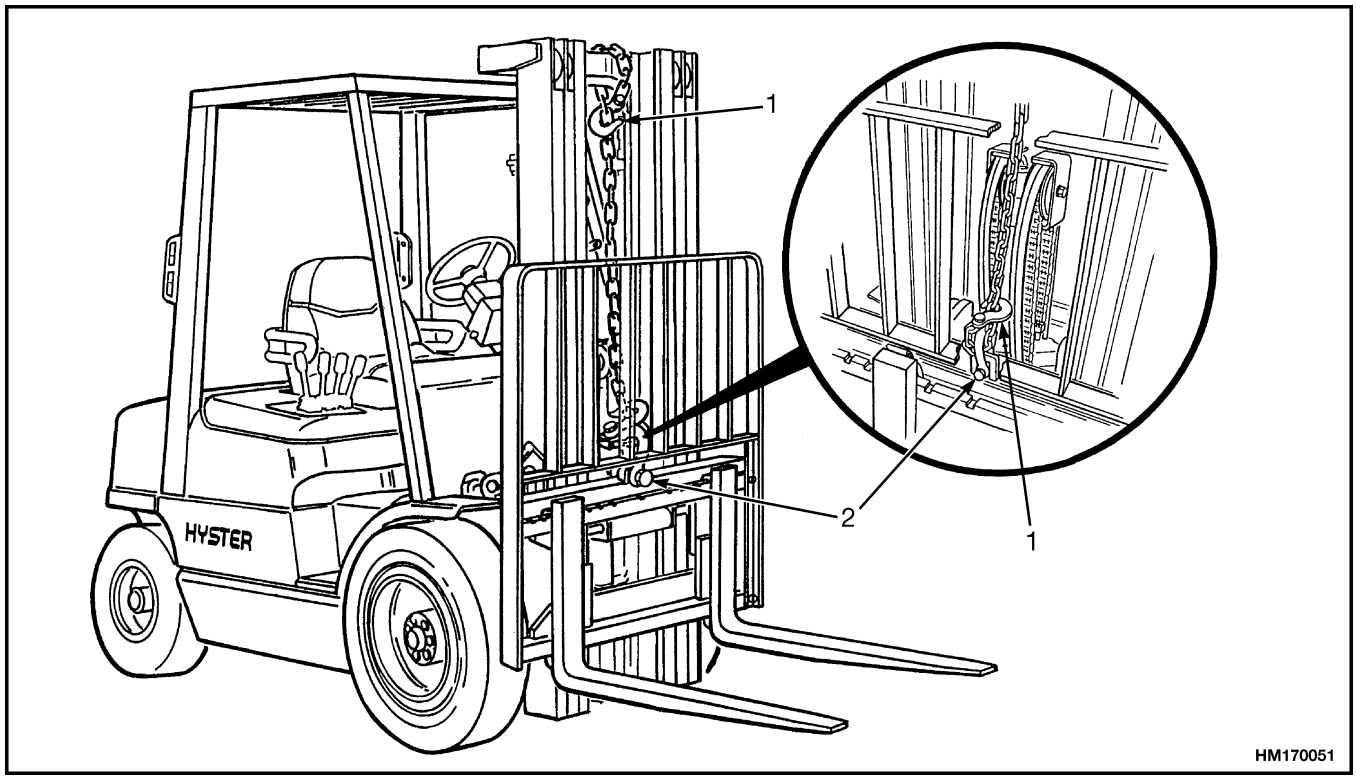
A. ALIGN MARK E AT BOTTOM OF THIS CLAMP

1. HOSE
2. CAPSCREW
3. CLAMP
4. NUT
5. BRACKET
6. CLAMP
7. CLAMP
8. CLAMP
9. CAPSCREW
10. NUT
11. BRACKET
12. CAPSCREW
13. CAPSCREW
14. LOCKWASHER
15. STUB SHAFT
16. SHEAVE
17. SPACER
18. WASHER

7. Put the clamps (item #8 in Figure 47) over the hoses and attach the clamps to the upper brackets. **DO NOT** tighten the hardware.

NOTE: To make the alignment of dimension **E** easier, use a crane with a capacity of at least 907.2 kg (2000 lb) to raise the carriage high enough to install a safety chain. See Figure 48.

8. Align mark **E** at the bottom of the clamps. Tighten the hardware to 8 N•m (71 lbf in). Refer to Figure 47.



1. HOOK
2. SHACKLE

Figure 48. Chaining the Carriage (LFL)

9. Connect the header hoses to the cowl hoses.

10. Use the rubber clamps and hose clamps to attach the hoses to the main lift cylinders. **DO NOT** allow the hoses to stretch or fold while tilting the mast fully forward and backward.

Adjustment

When properly adjusted, the hoses will not be so tight that they compress when they pass over the sheaves, nor will they be so loose that they touch the load backrest or any crossmember that is next to a sheave.

1. Cap off hoses when attachments have been removed.

2. Check that hoses and cables are routed properly.

3. Slowly raise the main lift cylinders to take up slack in the lift chains.

4. Tighten strap clamps at the bracket weldment.

5. Cycle the mast a few times to ensure proper tracking of hoses.

6. Secure hose assemblies to main lift cylinders with hose clamp and screw clamp.

7. If the tension of the hoses is incorrect, loosen the clamps and pull the hoses down (if too loose) or push the hoses up (if too tight) so they can move 15.0 mm (0.6 in.) side to side. Retighten the hardware to 8 N•m (71 lbf in).

8. With no load on the forks, check the header hose adjustment by operating the mast through the full lift cycle two times. When properly adjusted, the hoses will not be so tight that they compress when they pass over the sheaves nor will they be so loose that they touch the load backrest or any crossmember that is next to a sheave. If necessary, repeat until the hoses are properly adjusted.

Two-Stage Mast With Full Free-Lift Repair

REMOVE

WARNING

The mast is heavy. The mast can weigh approximately 907 kg (2000 lb). Make sure all lifting devices (hoists, cables, chains, slings, etc.) are suitable and of adequate capacity to lift the mast.

WARNING

Mast weldments can slide when the mast is moved. A weldment that slides can cause serious injury.

CAUTION

Make sure all the mast weldments are fastened together. Make sure the safety chains will not damage the sheaves, tubing, or other parts of the mast.

NOTE: If the mast needs to be disassembled, remove the forks and carriage. see the sections Fork Replacement and Carriages Repair in this service manual for procedures. If only the main lift cylinders need to be removed for repair, the mast does not need to be removed from the lift truck. See the section **Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564)** 2100SRM1382 for procedures to remove the main lift cylinders.

NOTE: The length of the lift chains must be checked before the mast is removed. See Lift Chains Adjustment.

1. Fully lower all of the mast weldments. Tilt the mast fully forward. Connect a crane with a capacity of at least 907 kg (2000 lb) to the top of the mast using chains to support the mast in an upright position when the tilt cylinders are disconnected. See the section Safety Procedures When Working Near Mast in this manual.

WARNING

Always wear the proper protective equipment including eye protection and petroleum-resistant gloves when handling hydraulic oil. Thoroughly wash oil from exposed areas of skin as soon as possible.

Completely lower forks to relieve hydraulic pressure before disassembling any part of the lift pump or disconnecting any hoses.

The hydraulic oil is hot at normal operating temperatures. Be careful when draining the oil.

CAUTION

Protect the hydraulic system from dirt and contaminants when servicing the hydraulic system.

2. Position a drip pan under the area of the hydraulic fittings. Disconnect the hydraulic line at the external lowering control valve on the outer mast.

WARNING

Use a driver, NOT your fingers, to push the anchor pins from the clevises on the tilt cylinders. The cylinder or mast can move and cause serious injury.

3. On lift trucks NOT equipped with optional boot on tilt cylinders, remove the capscrews, washers, anchor pins, and pivot pins at the tilt cylinder mounts on the outer mast. See Figure 49.

4. On lift truck models J2.2-3.5XN (J45-70XN) (A276) equipped with tilt cylinders with optional boots, remove capscrews, washers, nuts, anchor pins, and pivot pins at the tilt cylinder mounts on outer mast. See Figure 50.

5. Using a brass drift pin, remove tilt rod bushings from outer mast. Discard tilt rod bushings. See Figure 51.

NOTE: Allow the mast to tilt forward enough to gain access to the mast mount capscrews.

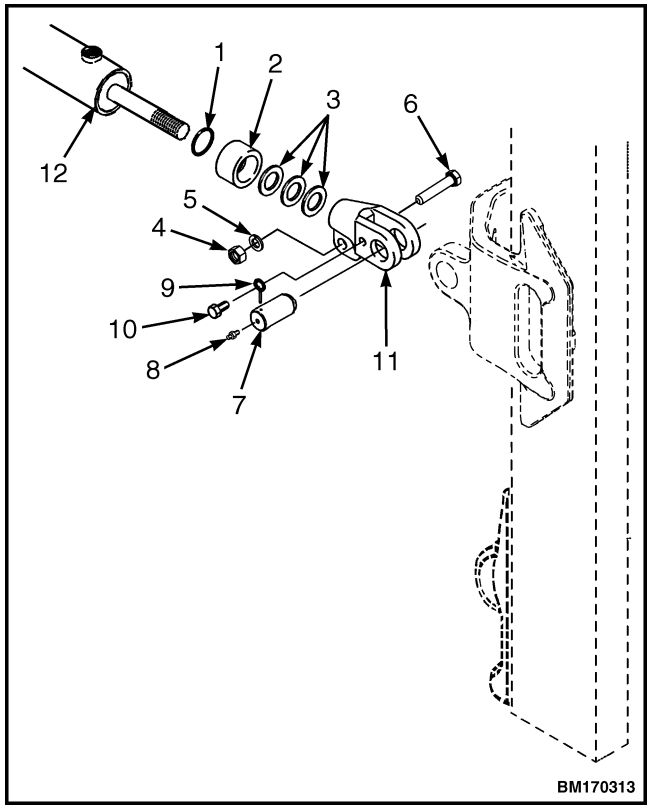
6. Disconnect the lower mast mounts from the lift truck by removing the capscrews that hold the mast pivot pins to the mounts on the drive axle. See Figure 52 and Figure 53.

WARNING

The mast is heavy. The mast can weigh approximately 907 kg (2000 lb). Make sure all lifting devices (hoists, cables, chains, slings, etc.) are suitable and of adequate capacity to lift the mast.

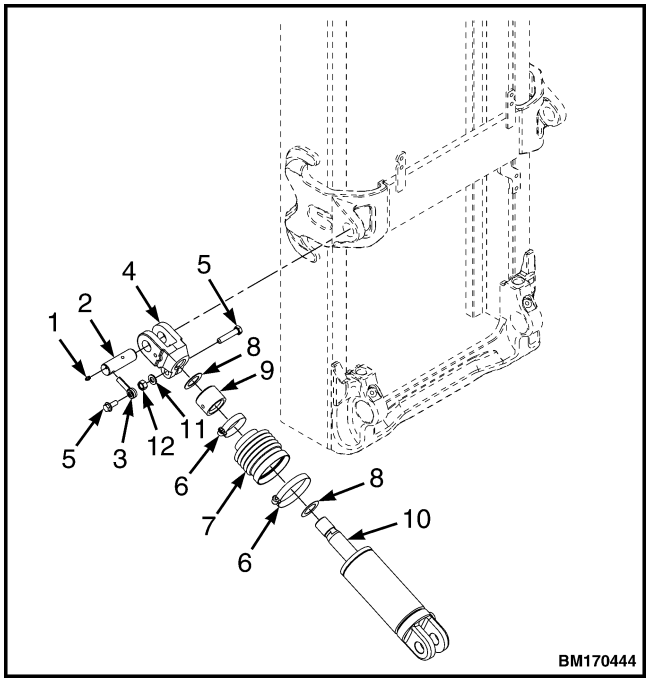
7. Use the crane to lift the mast assembly from the lift truck. Position the mast across wooden beams on the floor with the carriage side up.

8. Check the mast and mounting flanges for wear or damage by removing the mast pivot pins from the outer mast. Check that the pins fit snug in the outer mast. If pins can be moved up and down a minimum of 4 mm (0.20 in.), replace bushings in outer mast and/or mast pivot pins as required. See Figure 51 and Figure 54. Use a brass drift pin to remove mast mounting bushings from outer mast. Discard mast mounting bushings.



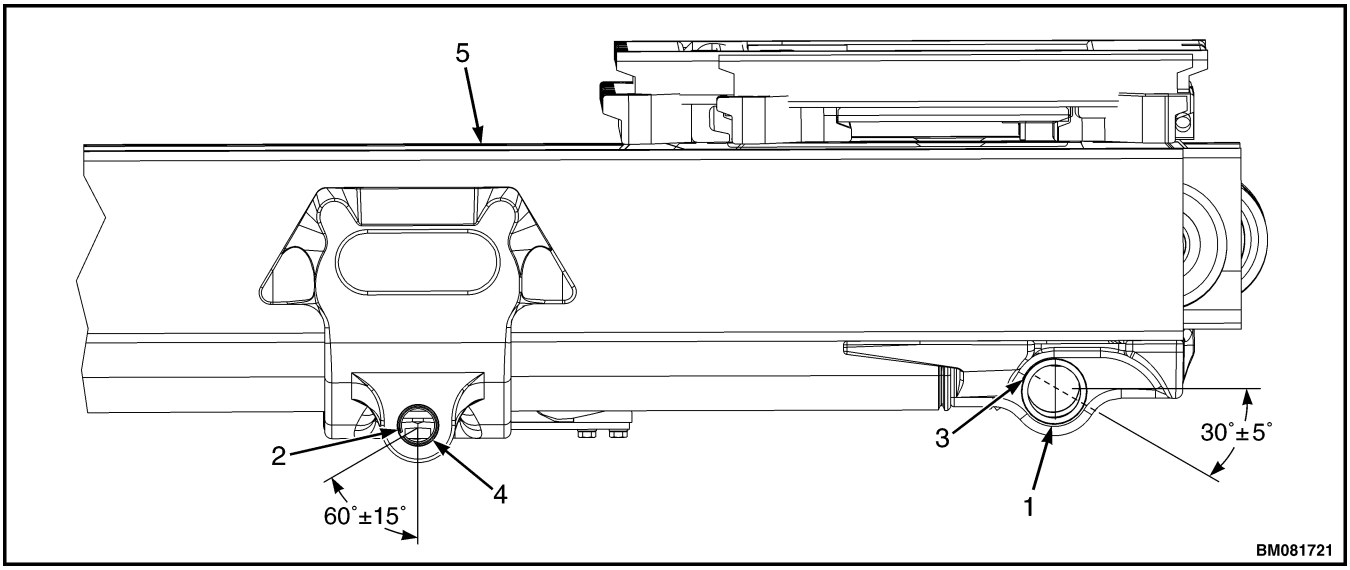
1. O-RING
2. SPACER
3. SHIMS
4. NUT
5. WASHER
6. CAPSCREW
7. PIVOT PIN
8. GREASE FITTING
9. ANCHOR PIN
10. CAPSCREW
11. ROD END
12. TILT CYLINDER

Figure 49. Mast Mounting, Tilt Cylinders Equipped Without Optional Boot



1. GREASE FITTING
2. PIVOT PIN
3. ANCHOR PIN
4. ROD END
5. CAPSCREW
6. CLAMP
7. BOOT
8. SHIM
9. SPACER
10. TILT CYLINDER
11. WASHER
12. NUT

Figure 50. Mast Mounting, Tilt Cylinder With Optional Boot



1. MAST MOUNTING BUSHING
2. BUSHING SPLIT
3. BUSHING HOLE
4. TILT ROD BUSHING
5. OUTER MAST

Figure 51. Tilt Rod and Mast Mounting Bushings

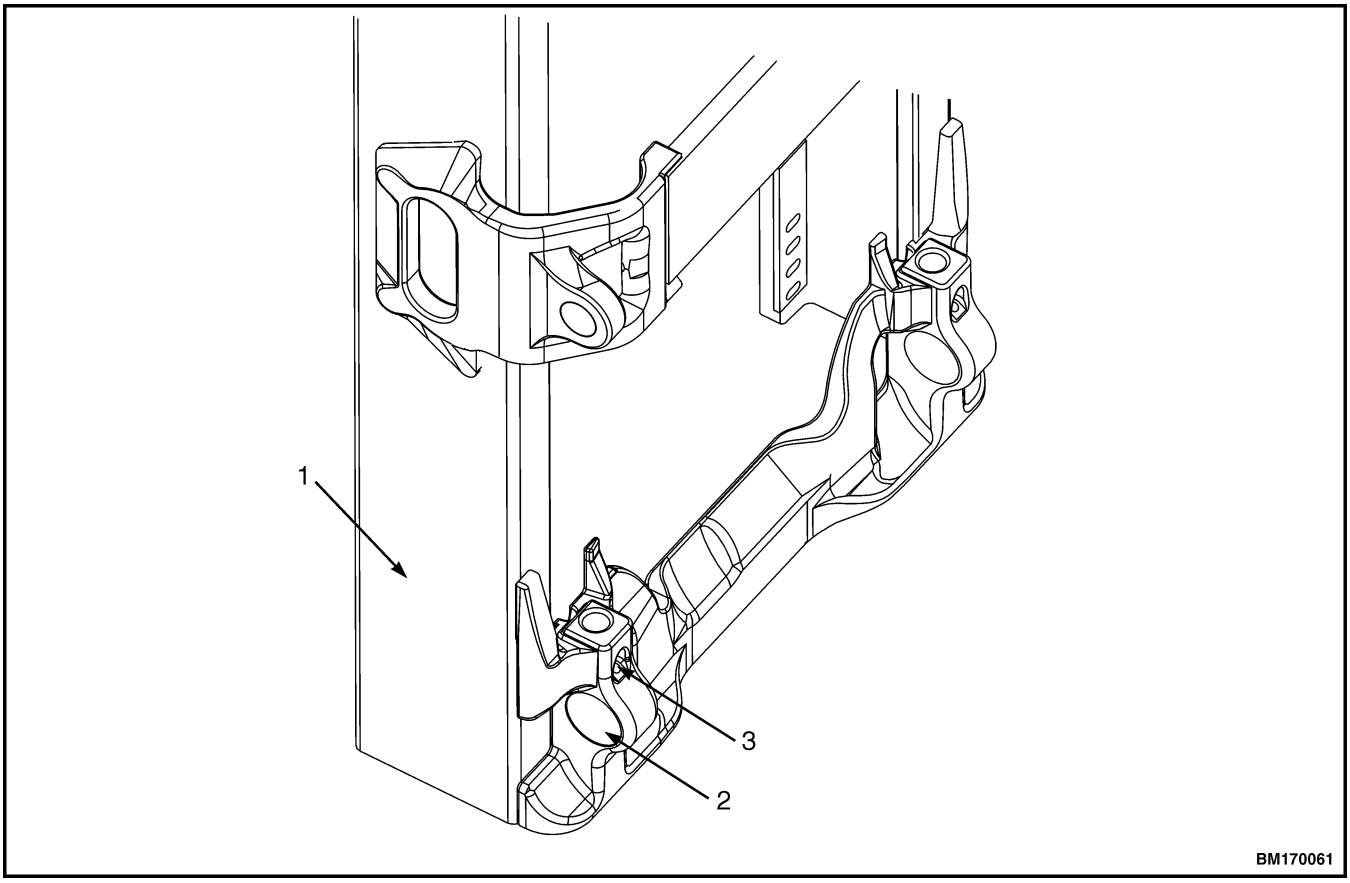
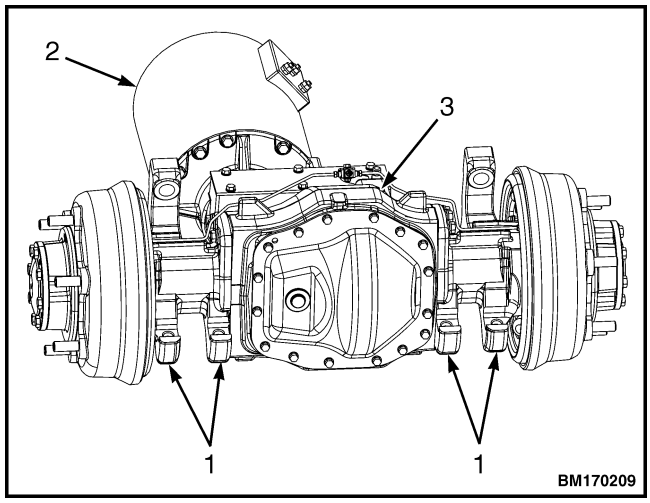


Figure 52. Mast Mounts, Outer Mast

Legend for Figure 52.

1. OUTER MAST
2. BUSHING
3. GREASE FITTING



NOTE: DRIVE AXLE FOR LIFT TRUCK MODELS E2.2-3.5XN (E45-70XN) (A268) SHOWN. HANGER MOUNTS THE SAME FOR J2.2-3.5XN (J45-70XN) (A276) LIFT TRUCK MODELS.

1. HANGER MOUNTS
2. TRACTION MOTOR
3. DRIVE AXLE

Figure 53. Mast Mounts, Drive Axle

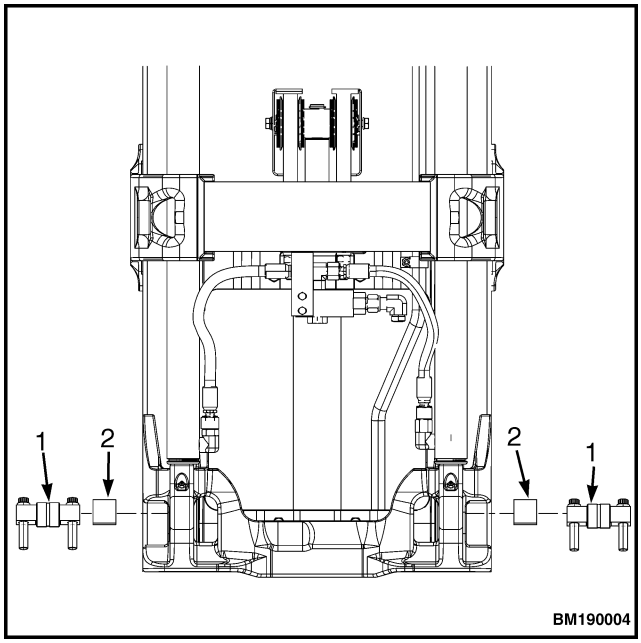


Figure 54. Mast Pivot Pin

Legend for Figure 54.

1. MAST PIVOT PINS
2. BUSHING

DISASSEMBLE

WARNING

Always wear the proper protective equipment including eye protection and petroleum-resistant gloves when handling hydraulic oil. Thoroughly wash oil from exposed areas of skin as soon as possible.

Completely lower forks to relieve hydraulic pressure before disassembling any part of the lift pump or disconnecting any hydraulic hoses.

The hydraulic oil is hot at normal operating temperatures. Be careful when draining the oil.

CAUTION

Protect the hydraulic system from dirt and contaminants when servicing the hydraulic system.

NOTE: If the main lift cylinders alone need to be removed and repaired, see service manual **Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564)** 2100SRM1382 for procedures. When the mast has header hoses, see the section Header Hose Installation and Adjustment in this service manual.

1. Clean the area around the hydraulic fittings for the main lift cylinders. Disconnect the fittings at the main lift cylinders and put caps on the open lines. See Figure 55.

2. Remove the chains and header hoses. Remove the brackets and disconnect the hydraulic line for the free-lift cylinder. Remove the free-lift cylinder. Disconnect the free-lift chains at the crossmember. See Figure 55.

WARNING

Be careful when removing or installing snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers, and wear eye and face protection during removal or installation.

3. Remove the nut, bolt, and spacer at the mount near the top of each main lift cylinder. Remove the snap rings and washers from the top of each main lift cylinder. Disconnect the main lift chains at the mounts. See Figure 55.

4. Disconnect the FFL supply tube and remove the hydraulic fitting from the top of the left- or right-hand main lift cylinder.

WARNING

The mast weldments can slide when the mast is moved. A weldment that slides can cause injury.

5. Slide the inner mast from the outer mast approximately 30 cm (12 in.) to disengage the main lift cylinders from the inner mast. Remove the main lift cylinders from the outer mast. See Figure 55.

6. Slide the inner mast from the bottom of the outer mast approximately 30 cm (12 in.). Remove the strip bearings and load rollers from the top of the outer mast. Remove the load rollers from the bottom of the inner mast. Make a note of each shim arrangement and load roller location. The shim arrangements will be approximately the same during assembly.

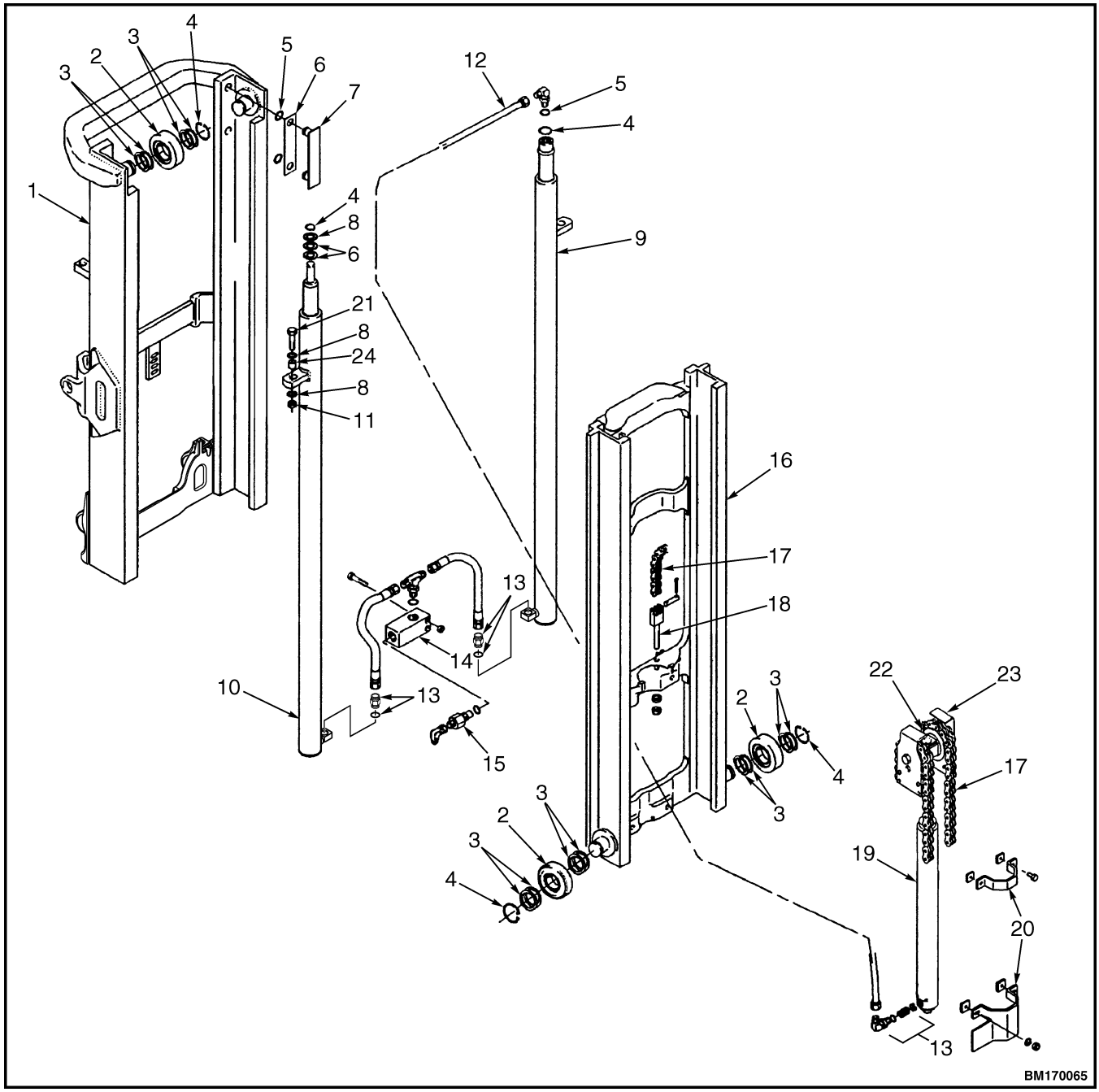


Figure 55. Two-Stage, Full Free-Lift (FFL) Mast

Legend for Figure 55.

1. OUTER MAST
2. LOAD ROLLER
3. SHIM
4. SNAP RING
5. O-RING
6. SHIM(S)
7. STRIP BEARING
8. WASHER
9. MAIN LIFT CYLINDER (L)
10. MAIN LIFT CYLINDER ®)
11. NUT
12. TUBE
13. VELOCITY FUSE
14. HOUSING
15. LOWERING CONTROL VALVE
16. INNER MAST
17. FREE-LIFT CHAIN
18. CHAIN ANCHOR
19. FREE-LIFT CYLINDER
20. CYLINDER BRACKET
21. CAPSCREW
22. CROSSHEAD
23. CHAIN GUARD
24. SPACER

WARNING

The mast is heavy. The mast can weigh approximately 907 kg (2000 lb). Make sure all lifting devices (hoists, cables, chains, slings, etc.) are suitable and of adequate capacity to lift the mast.

NOTE: When replacing the outer mast, copy the part number and date code information from the old channel and stamp that information on the new channel with a letter **R** at the end to indicate that it has been replaced.

7. Slide the inner mast halfway out of the top of the outer mast. Connect a crane [the capacity of the crane must be at least 907 kg (2000 lb)] to the center of the inner mast. See Figure 56. Slide the inner mast out of the outer mast until the mast stub shafts of the inner mast are in the notches of the outer channels. Remove the inner mast from the outer mast.

8. Remove the chain sheaves and disassemble them as necessary for repair and cleaning.

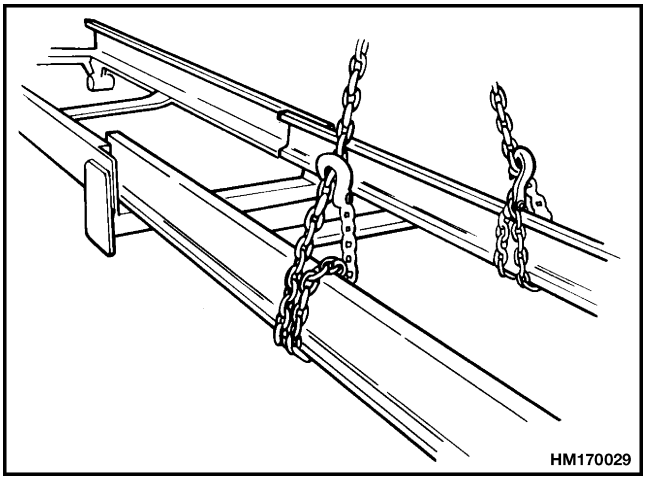


Figure 56. Inner Mast

CLEAN AND INSPECT

CAUTION

DO NOT use steam or high-pressure water to clean the load rollers or the lift chains. Steam and high-pressure water can remove the lubrication from the bearings in the load rollers. Water in the bearings of the sheaves and the link pins of chains can also shorten the service life of these parts.

1. Inspect chain sheaves and load rollers for wear or damage. **DO NOT** use steam to clean lift chain sheaves or load rollers. The bearings in the sheaves and load rollers are sealed and lubricated.

WARNING

Cleaning solvents may be flammable and toxic and can cause severe skin irritation. When using commercial cleaning solvents, always comply with solvent manufacturer's recommended safety precautions.

WARNING

Compressed air can move particles so that they cause injury to the user or to other personnel. Make sure that the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eyes.

2. Clean the lift chains by soaking in solvent for 30 minutes to remove all dirt and grease. Hang lift chains up and remove solvent using compressed air.

WARNING

Never replace only the worn section of a chain. Replace the complete chain. Never replace only one chain of a chain pair. Replace both chains. Damage to the lift truck and serious injury can occur if lift chains are not replaced correctly.

NOTE: The chains must be inspected in the area of chain that passes over the chain sheave during the first portion of a lift. These links will show maximum wear.

3. Inspect the lift chains for wear and damage. A lift chain becomes longer when it is worn. If a chain is 3% longer than a new lift chain, the lift chain must be replaced.

4. If a chain scale is available (Hyster Part No. 599737) , check lift chains as shown in Figure 57. If a chain scale is not available measure 20 links of chain. Measure from the center of a pin to the center of another pin 20 pitches away. Compare the length with the chart in Figure 57. Replace chain if the length of 20 links of the worn section is more than the maximum wear limit.

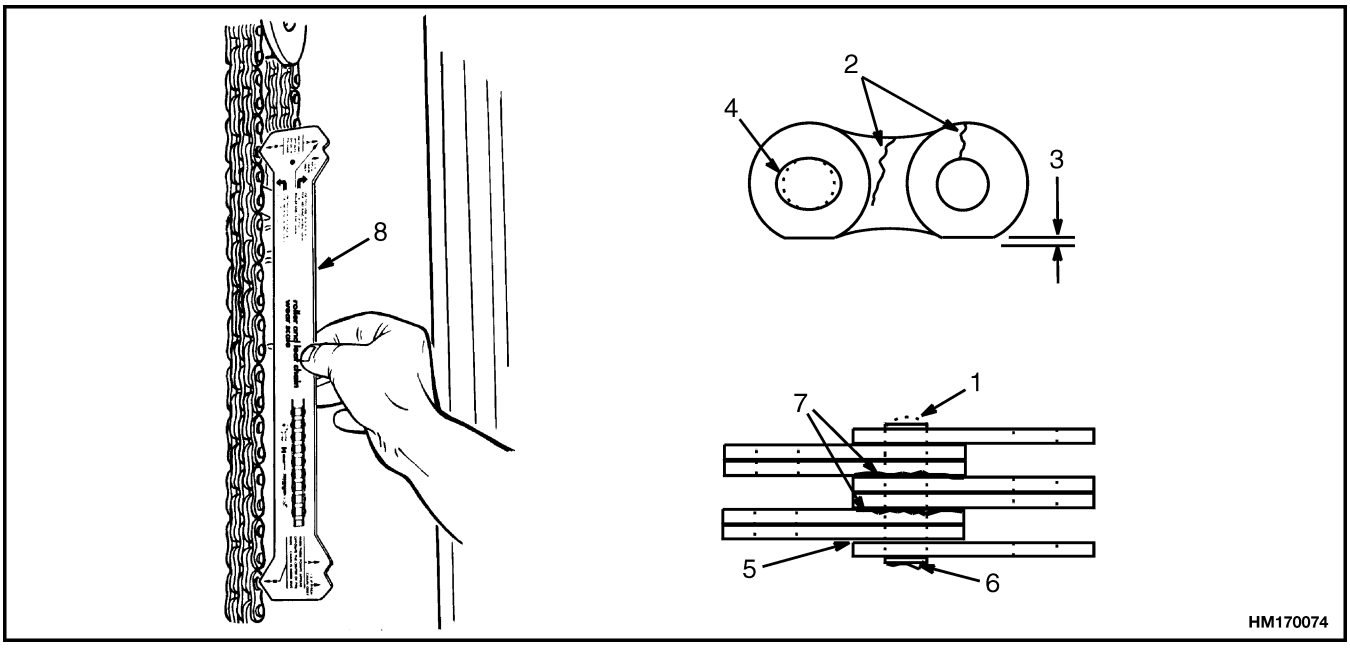
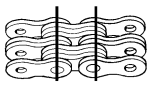


Figure 57. Lift Chains Check

Legend for Figure 57.

NOTE: THE INSTRUCTIONS FOR MEASURING CHAIN WEAR ARE SHOWN ON THE CHAIN WEAR SCALE.

Pitch 	Total length of 20 links (pitch) of new chain	Wear Limit The maximum length of 20 links
12.7 mm (0.5 in.)	254.0 mm (10.0 in.)	261.6 mm (10.3 in.)
15.9 mm (0.6 in.)	317.5 mm (12.5 in.)	327.0 mm (12.9 in.)
19.1 mm (0.8 in.)	381.0 mm (15.0 in.)	392.4 mm (15.4 in.)
25.4 mm (1.0 in.)	508.0 mm (20.0 in.)	523.3 mm (20.6 in.)

1. WORN PIN
2. CRACKS
3. EDGE WEAR
4. HOLE WEAR
5. LOOSE LEAVES
6. DAMAGED PIN
7. RUST
8. CHAIN WEAR SCALE

5. Lubricate lift chains by soaking them in SAE 30 engine oil for 30 minutes. Hang chains over a drip pan for one hour to remove excess oil.

NOTE: Chain anchor pins **MUST** be replaced anytime chains are replaced.

6. Inspect the chain anchors and pins. Replace any parts that are worn or damaged.

WARNING

Cleaning solvents may be flammable and toxic and can cause severe skin irritation. When using commercial cleaning solvents, always comply with solvent manufacturer's recommended safety precautions.

WARNING

Steam can cause serious burns. Wear protective clothing, gloves, and eye protection. Never expose your skin to steam.

7. Clean the mast weldments with steam or solvent.

WARNING

Improper welding procedures can damage the structure of the mast or cause incorrect function of the mast which can result in serious injury to personnel. Consult your Hyster lift truck dealers for more information before welding on the mast.

8. Inspect the sliding surfaces for wear or damage. Inspect the load roller contact surfaces for wear or damage. Inspect all welds for cracks.

ASSEMBLE

WARNING

The mast is heavy. The mast can weigh approximately 907 kg (2000 lb). Make sure all lifting devices (hoists, cables, chains, slings, etc.) are suitable and of adequate capacity to lift the mast.

NOTE: The shims for the load rollers keep the mast weldments parallel and provide correct clearance. During assembly, the shim arrangement will be approximately the same as before disassembly. Check the clearance and adjust the shims for wear or for changes caused by repairs. The strip bearings are also adjusted by using shims. See Mast Adjustments in this service manual for the adjustment procedures.

NOTE: When the mast has header hoses, see Header Hose Installation and Adjustment for procedures.

1. Connect a crane with a capacity of at least 907 kg (2000 lb) to the center of the inner mast. Fit the stub shafts through the notches in the outer mast. Slide the inner mast into the outer mast so the stub shafts are seen at the top and bottom of the weldments. See Figure 55.

2. Install the strip bearings and the shims on the outer mast. See Figure 58. Apply chassis lube to the bearing surface. Check the clearance of the strip bearings as described in Mast Adjustments in this service manual.

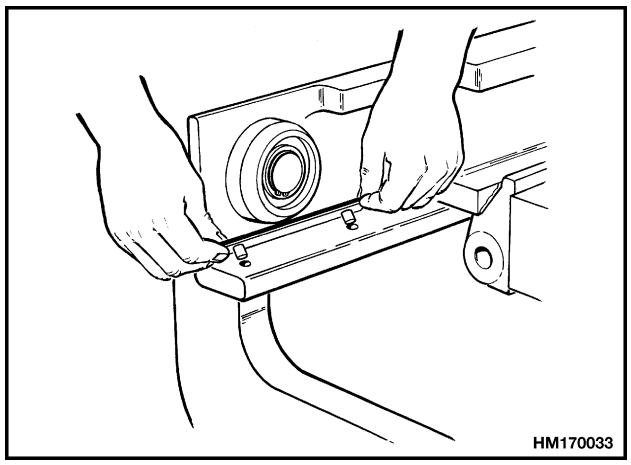


Figure 58. Strip Bearings

3. Install the load rollers and shims on both weldments. Check the clearance of the load rollers as described in Carriage Adjustments.

NOTE: The clearance check and adjustment in Step 4 is only an initial setup. The final check and adjustment is done after the mast is installed on the lift truck.

4. To install the main lift cylinders, perform the following procedures (see Figure 55):

   a. Install the washers at the top of the right-hand cylinder. Push the inner mast to engage the rods of the lift cylinders.

   b. Check the clearance at the top of the lift cylinder mounts. Add or remove washers at the right-hand cylinder until it is even with the left-hand cylinder.

   c. Install the snap ring at the top of the right-hand lift cylinder. Install the hydraulic fitting on the left-hand cylinder.

5. On lift truck models equipped with tilt cylinders without boot, install the spacers, nuts, and bolts at the mounts for the lift cylinders. Tighten the bolts to 40 N•m (30 lbf ft). See Figure 59.

6. On lift truck models equipped with tilt cylinders with boot, install capscrews and isolators at the mounts for the lift cylinders. Tighten capscrews to 38 N•m (28 lbf ft). See Figure 60.

7. Install the housing for the lowering control valve on the outer mast. Tighten the nuts for the lowering control valve to 18 N•m (13 lbf ft). Install the lowering control valve in the housing. Connect the hydraulic lines and fittings between the housing and the main lift cylinders.

8. Connect the lift chains to the chain anchors at the main lift cylinder mounts. Attach wires between the ends of the lift chains and the crossmember to control the lift chains during mast installation.

9. Install the free-lift cylinder in the mounts on the inner mast. Install the brackets for the cylinder and tighten the bolts to 53 N•m (39 lbf ft).

10. Install the tubing or hoses that connect the free-lift cylinder to the main lift cylinder.

11. Connect the free-lift chains to the chain anchors at the crossmember. Attach a wire between the end of the lift chain and the bottom of the mast to control the lift chain during installation.

INSTALL

1. Install new bushings into mast mounts at bottom of outer mast. Be sure the hole and bushing split are installed at the correct angle as shown in Figure 51. Bushing must be flush with outer mast surface.

2. Lubricate the lower mast mounting surface to prepare for installation. Apply an even coat of grease to the pivot pins and install them into mounts at bottom of outer mast.

WARNING

The mast is heavy. The mast can weigh approximately 907 kg (2000 lb). Make sure all lifting devices (hoists, cables, chains, slings, etc.) are suitable and of adequate capacity to lift the mast.

3. Connect crane to top of mast using chains. Make sure all mast uprights are fastened together. Make sure chains will not damage sheaves, tubing, or other parts of mast. Make sure crane has a capacity of at least 907 kg (2000 lb).

4. Use crane to position mast assembly onto its lower mounts. Position mast so pivot pins seat into hanger mounts on drive axle. Install capscrews that hold mast pivot pins to drive axle hangers. Tighten capscrews to 270 N•m (199 lbf ft). Refer to Figure 53 and Figure 54.

5. Install new tilt rod bushings into outer mast. Be sure to install bushings with split at correct angle as shown in Figure 51.

WARNING

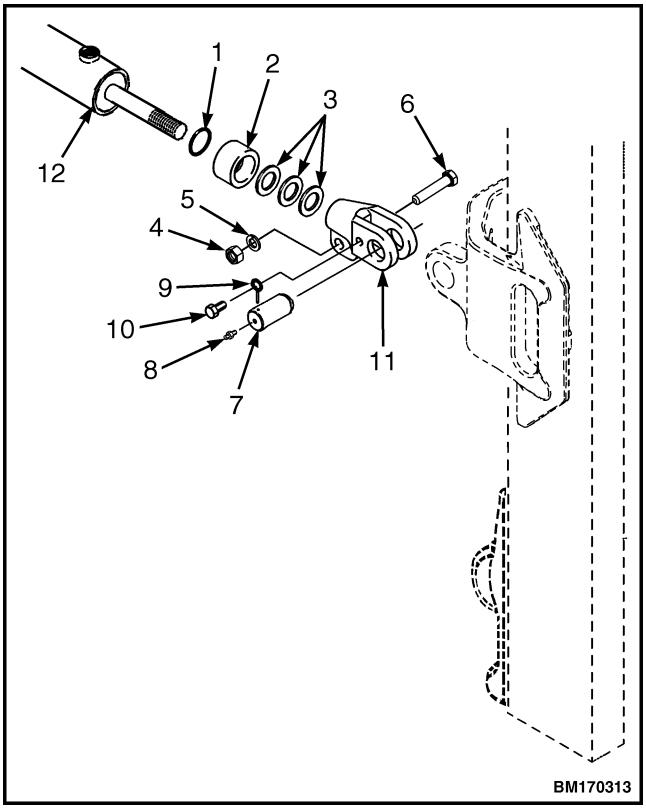
Use a pry bar, NOT your fingers, to align the tilt cylinder clevises with the outer mast. The cylinder or mast can shift and cause serious injury.

NOTE: Use multipurpose grease #2 with 2 to 4% molybdenum disulfide for normal operations.

6. Apply grease to pivot pins and connect tilt cylinders to mast using pivot pins. Install anchor pins and capscrews to rod ends. Apply anti-seize compound to capscrew threads and tighten 38 N•m (28 lbf ft).

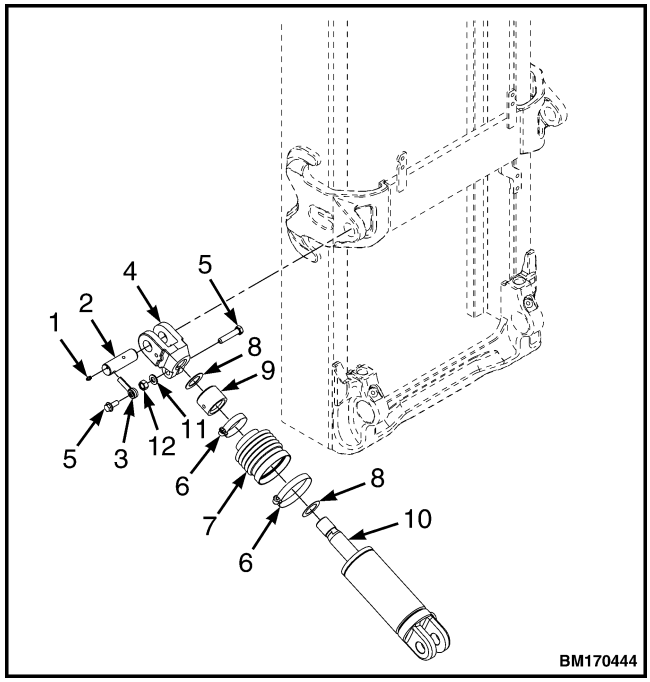
   See Figure 59 for lift trucks equipped with tilt cylinders without boots

   See Figure 60 for lift trucks equipped with tilt cylinders with boots



1. O-RING
2. SPACER
3. SHIMS
4. NUT
5. WASHER
6. CAPSCREW
7. PIVOT PIN
8. GREASE FITTING
9. ANCHOR PIN
10. CAPSCREW
11. ROD END
12. TILT CYLINDER

Figure 59. Mast Mounting, Tilt Cylinder Without Optional Boot



1. GREASE FITTING
2. PIVOT PIN
3. ANCHOR PIN
4. ROD END
5. CAPSCREW
6. CLAMP
7. BOOT
8. SHIM
9. SPACER
10. TILT CYLINDER
11. WASHER
12. NUT

Figure 60. Mast Mounting, Tilt Cylinder With Optional Boot

7. Connect hydraulic line to lowering control valve.

8. Install carriage as described in the section Carriages Repair.

WARNING

Never check for leaks by putting hands on hydraulic lines or components under pressure. Hydraulic oil under pressure can be injected into the skin.

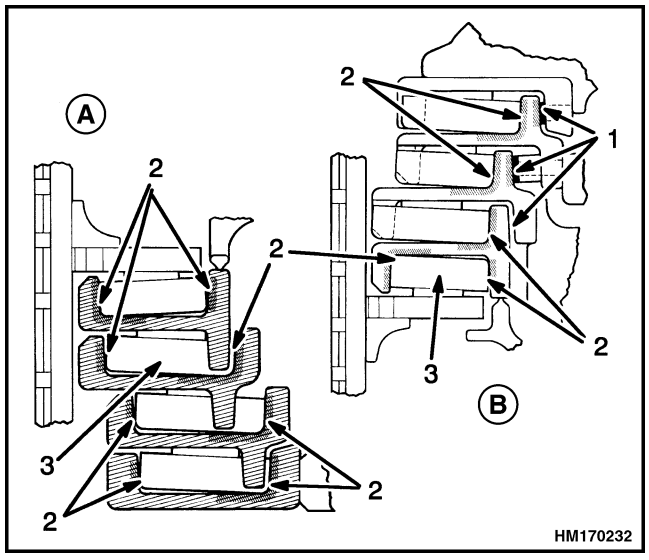
9. Check tilt cylinder adjustment as described in **Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564)** 2100SRM1382. Operate mast and check for leaks and correct operation. Check lift chains as described in Lift Chains Adjustment.

NOTE: Before checking for mast side kicking, the mast must be fully assembled to include the carriage, forks, load backrest and any attachments.

10. Raise the mast, without a load to its full height and check for side kicking. Mast side kicking is when the mast moves either to the right or left as it is being raised to its full height. If the mast is side kicking, see the Mast Adjustments section for procedures to correct mast side kicking.

NOTE: The load rollers and sheaves have sealed bearings and do not need additional lubrication.

11. Lubricate sliding surfaces and load roller surfaces along full length of channels as shown in Figure 61. Apply lubricant only to surfaces indicated.



A. LOWER LOAD ROLLERS
B. UPPER LOAD ROLLERS

1. LUBRICATE STRIP BEARINGS SURFACES
2. LUBRICATE LOAD ROLLER SURFACES
3. LOAD ROLLER

Figure 61. Lubricate Mast

HEADER HOSE INSTALLATION AND ADJUSTMENT

Installation

WARNING

Always wear the proper protective equipment including eye protection and petroleum-resistant gloves when handling hydraulic oil. Thoroughly wash oil from exposed areas of skin as soon as possible.

Never check for leaks by putting hands on hydraulic lines or components under pressure. Hydraulic oil under pressure can be injected into the skin.

WARNING

Before working on or near the mast, see Safety Procedures When Working Near Mast in this section.

Before installing the header hoses, make sure you know the lift height of the mast. The tension on the header hoses is adjusted according to lift height. The lift height is on the Nameplate of the lift truck and on the right side of the outer mast.

Some lift trucks are equipped with auxiliary hydraulic functions that are fastened to the carriage. Examples of attachments that use these auxiliary functions are sideshift carriages, roll clamps, and fork positioners. These auxiliary functions require header hoses for their operation.

NOTE: This procedure is for the four-function option. The three-function option will have hoses **A** and **B** only.

NOTE: The carriage height must be correct before the header hoses can be adjusted. See Lift Chains Adjustment for the carriage adjustment procedure.

1. Mark each hose with a single letter: **A**, **B**, **C**, and **D**.

2. Dimensions **E** and **G** are determined by the height of the outer mast channel from the ground and the length of the outer mast channel. See dimensions **Y** and **Z** in Figure 62. To find **E** and **G** see

   Table 4 for lift truck models

   - E2.2-2.5XN (E45-55XN) (A268)

   Table 5 for lift truck models

   - E3.0-3.5XN (E60-70XN) (A268)

   Table 6 for lift truck models

   - J2.2-2.5XN (J45-50XN) (A276)

   Table 7 for lift truck models

   - J3.0-3.5XN (J60-70XN) (A276)

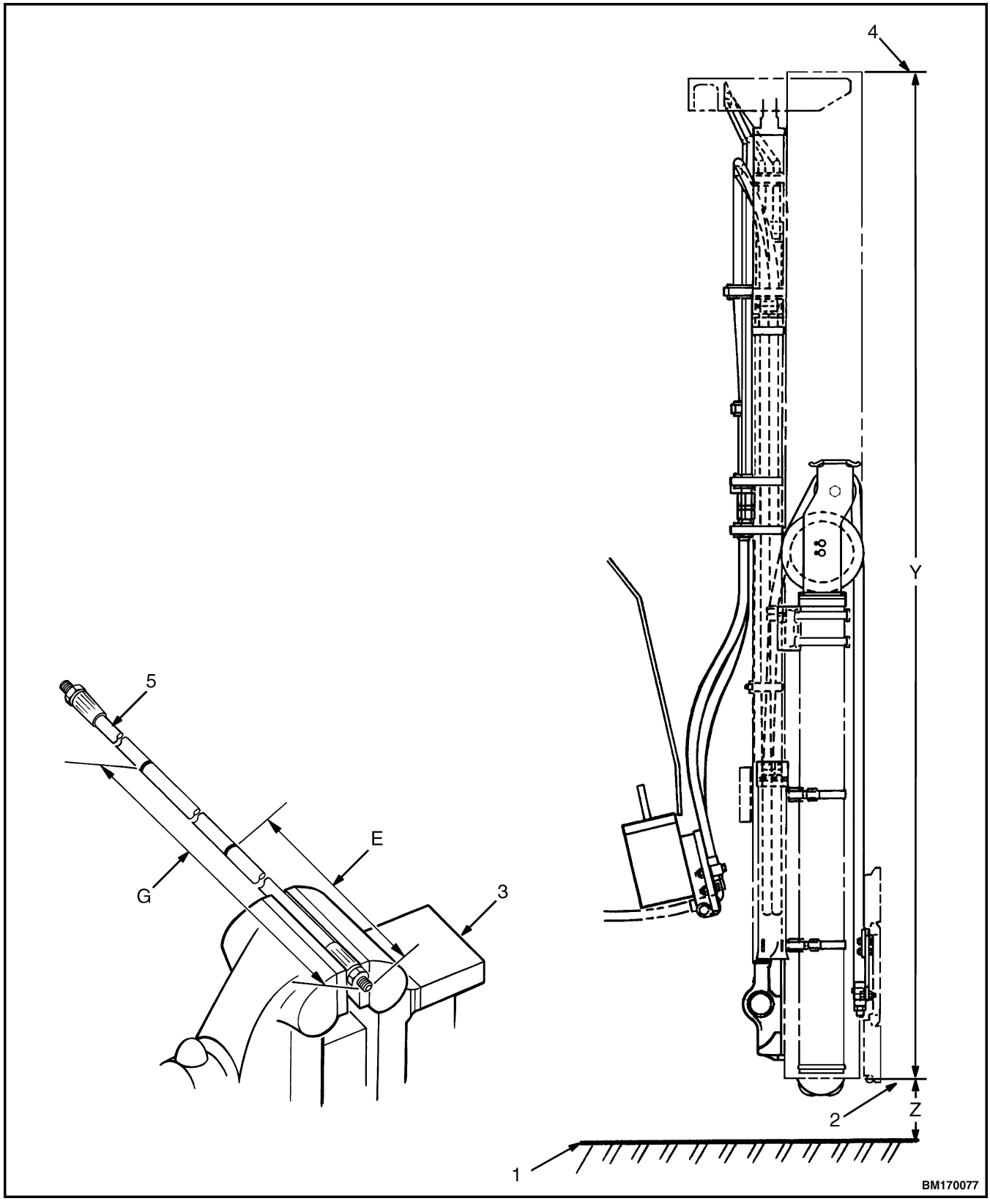


Figure 62. Header Hose Measurement for Two-Stage Full Free-Lift Mast

Legend for Figure 62.

1. GROUND LEVEL
2. BOTTOM OUTER CHANNEL
3. VISE
4. TOP OUTER CHANNEL
5. HOSE

Table 4. Standard Two-Stage FFL Hose Dimensions, Lift Truck Models E2.2-2.5XN (E45-55XN) (A268)

Lift Height		Channel Length (Reference)	Dimension "E"		Dimension "G" Third Function		Dimension "G" Fourth Function	
mm	in.	mm	mm	in.	mm	in.	mm	in.
3262	128.4	2040	1397	54.9	3234	127.3	3106	122.2
3462	136.5	2140	1447	56.9	3433	135.1	3304	130.1
3562	140.2	2190	1471	57.9	3533	139.1	3404	134.0
Lift height is measured from bottom of forks. Lift heights shown are standard. If your lift height is not shown, go to **Hyster Hypass Online** to find the correct header hose measurement for your lift height.								

Table 5. Standard Two-Stage FFL Hose Dimensions, Lift Truck Models E3.0-3.5XN (E60-70XN) (A268)

Lift Height		Channel Length (Reference)	Dimension "E"		Dimension "G" Third Function		Dimension "G" Fourth Function	
mm	in.	mm	mm	in.	mm	in.	mm	in.
3060	120.5	2040	1363	53.6	3183	125.3	3054	120.2
3260	128.3	2140	1412	55.6	3380	133.1	3251	127.9
3360	132.3	2190	1437	56.6	3479	136.9	3350	131.8
Lift height is measured from bottom of forks. Lift heights shown are standard. If your lift height is not shown, go to **Hyster Hypass Online** to find the correct header hose measurement for your lift height.								

Table 6. Standard Two-Stage FFL Hose Dimensions, Lift Truck Models J2.2-2.5XN (J45-50XN) (A276)

Lift Height		Channel Length (Reference)	Dimension "E"		Dimension "G" Third Function		Dimension "G" Fourth Function	
mm	in.	mm	mm	in.	mm	in.	mm	in.
3262	128.4	2040	1428	56.2	3248	127.8	3119	122.7
3462	136.5	2140	1477	58.1	3445	135.6	3316	130.5
3562	140.2	2190	1502	59.1	3544	139.5	3415	134.4
Lift height is measured from bottom of forks. Lift heights shown are standard. If your lift height is not shown, go to **Hyster Hypass Online** to find the correct header hose measurement for your lift height.								

Table 7. Standard Two-Stage FFL Hose Dimensions, Lift Truck Models J3.0-3.5XN (J60-70XN) (A276)

Lift Height		Channel Length (Reference)	Dimension "E"		Dimension "G" Third Function		Dimension "G" Fourth Function	
mm	in.	mm	mm	in.	mm	in.	mm	in.
3060	120.5	2040	1438	56.6	3276	128.9	3147	123.8
3260	128.3	2140	1487	58.5	3473	136.7	3344	131.6
3360	132.3	2190	1512	59.5	3573	140.6	3444	135.5
Lift height is measured from bottom of forks. Lift heights shown are standard. If your lift height is not shown, go to **Hyster Hypass Online** to find the correct header hose measurement for your lift height.								

3. Clamp the end of the hose (the smaller fitting) that attaches to the carriage in a vise (**DO NOT** clamp on the threads), and pull on the other end until the hose is straight. **DO NOT** apply enough force to stretch the hose. See Figure 62.

NOTE: These marks will be used to pretension the header hoses during installation.

4. Place a mark on all the hoses at dimension **E** and **G** (all measurements are made from the carriage end of the hose [the smaller fitting]).

5. Attach the hoses to the carriage bracket with clamps. Tighten hardware to 18 N•m (159 lbf in).

6. Put the header hoses over the free-lift chains. See Figure 63 and Figure 64.

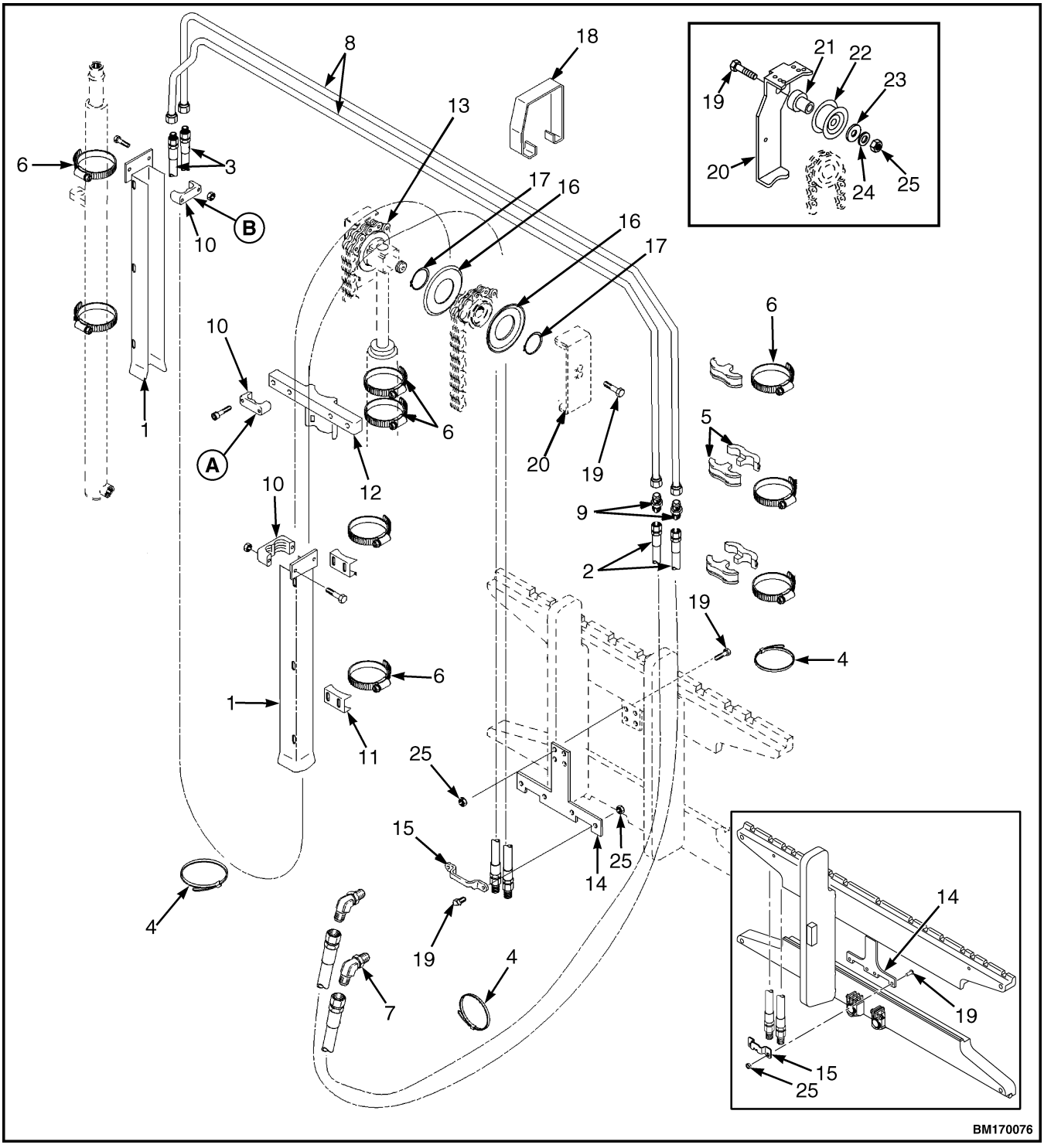


Figure 63. Header Hoses for Two-Stage Full Free-Lift Mast

Legend for Figure 63.

NOTE: THREE-FUNCTION MAST SHOWN.

A. ALIGN MARK E AT BOTTOM OF THIS CLAMP.

B. ALIGN MARK G AT TOP OF THIS CLAMP.

1. CHANNEL
2. COWL HOSES
3. HEADER HOSES
4. STRAP CLAMP
5. CLAMP
6. CLAMP
7. FITTING
8. TUBE
9. FITTING
10. CLAMP
11. BRACKET
12. FREE-LIFT BRACKET
13. FREE-LIFT CHAIN
14. CARRIAGE BRACKET
15. LOWER CLAMP
16. HOSE GUIDE
17. SNAP RING
18. CLIP
19. CAPSCREW
20. HOSE GUARD
21. STUB SHAFT
22. FITTING
23. SPACER
24. WASHER
25. NUT

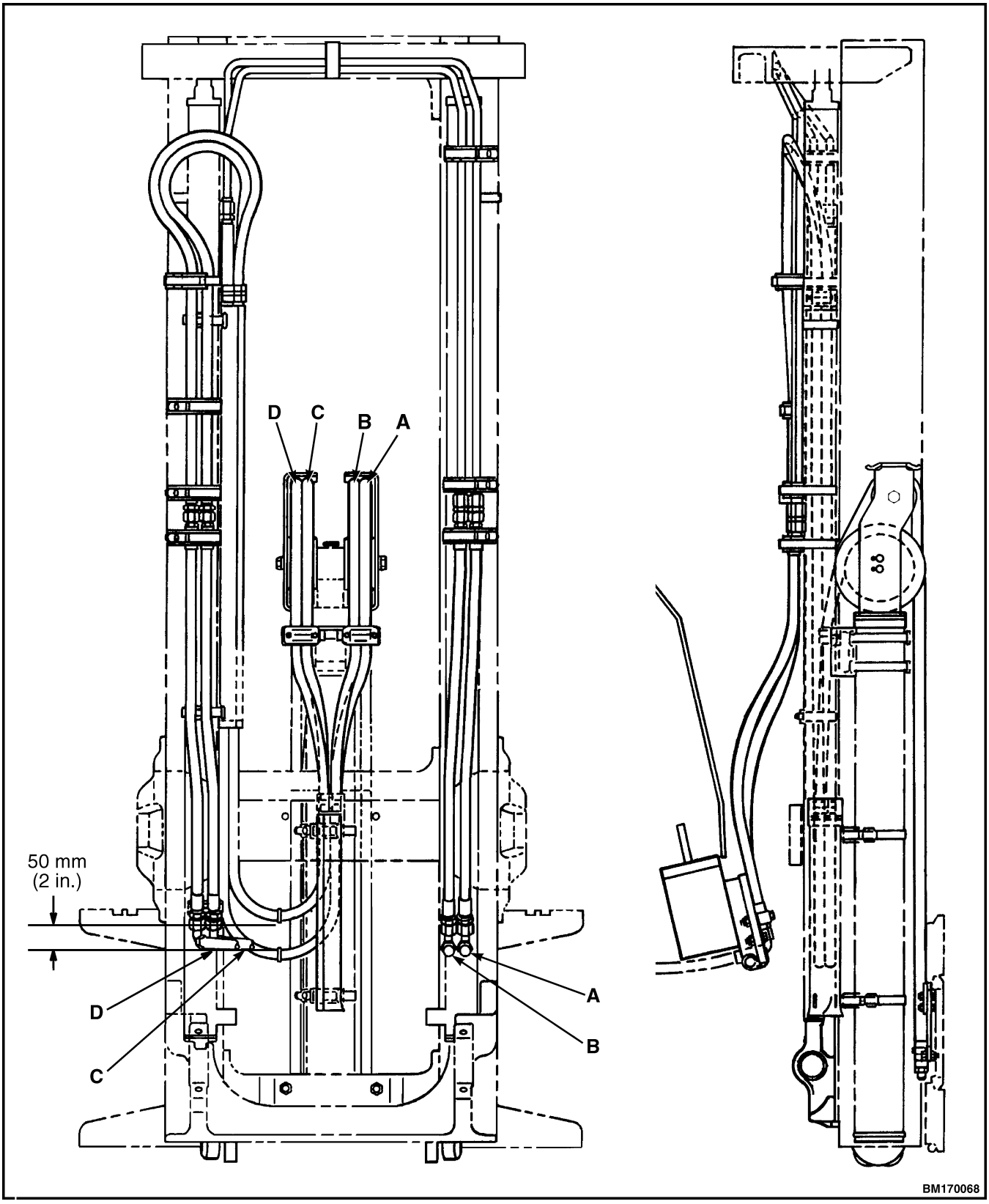


Figure 64. Header Hose Alignment for Two-Stage Full Free-Lift Mast

Legend for Figure 64.

NOTE: PLACE STRAP CLAMP AT BOTTOM OF THIRD AND, IF EQUIPPED, FOURTH FUNCTION HOSE LOOP AFTER MAIN LIFT CYLINDER IS FULLY STROKED. HOSES MUST BE 50 mm (2.0 in.) APART FOR CORRECT OPERATION.

A. HEADER HOSE
B. HEADER HOSE
C. HEADER HOSE
D. HEADER HOSE

7. Put the clamps over the header hoses and attach the clamps to the free-lift bracket. **DO NOT** tighten the hardware.

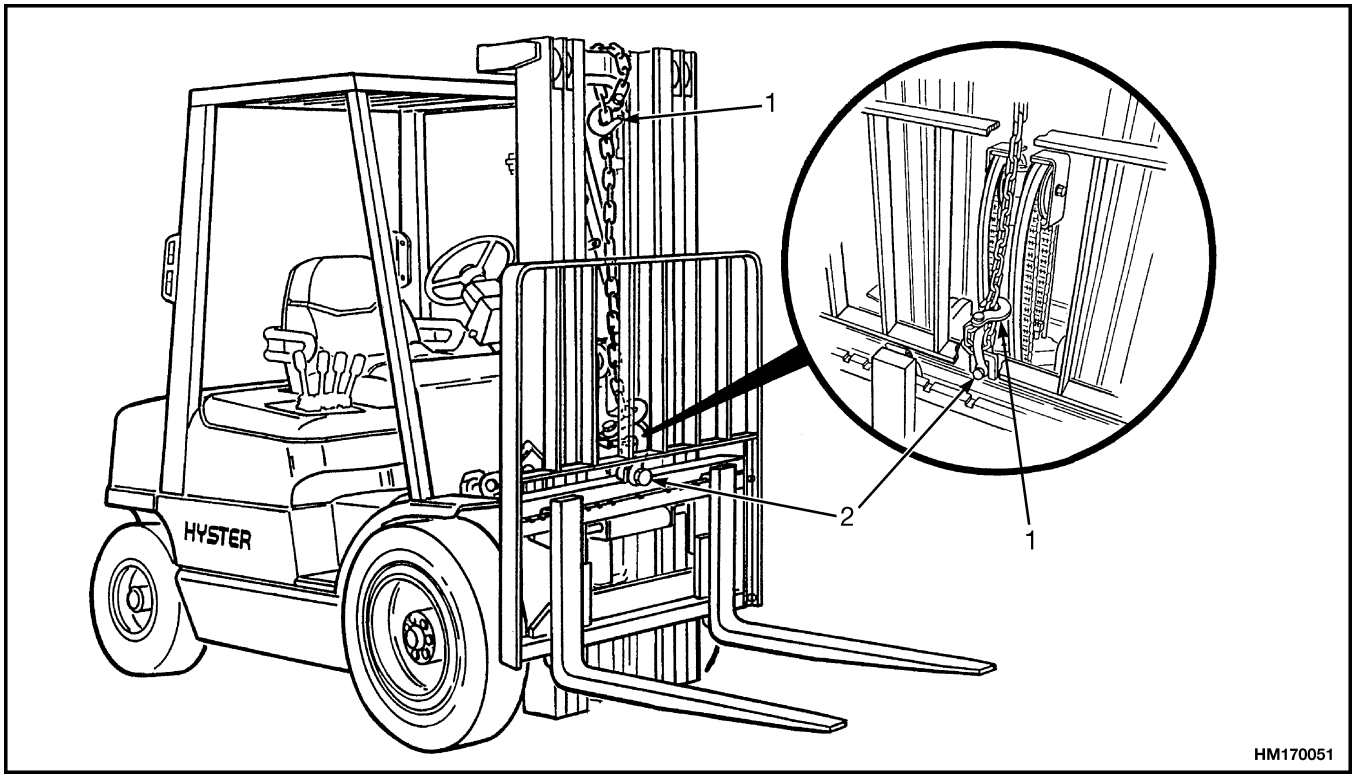
NOTE: To make the alignment of dimension **E** easier, use a crane with a capacity at least 907.2 kg (2000 lb) to raise the carriage high enough to install a safety chain. See Figure 65.

8. Align mark **E** at the bottom of the clamp. Tighten the hardware to 8 N•m (71 lbf in).

9. Apply a spray lubricant on the hoses in the area that will contact the channels. Make sure the hoses are properly aligned in the channels. Put the clamps over the hoses and attach the clamps to the channels. Tighten the hardware to 8 N•m (71 lbf in).

10. Connect the header hoses C and D) to the cowl hoses. Connect the header hoses (A and B) to the tubes. See Figure 63 and Figure 64.

11. Use the rubber clamps and strap clamps to attach the hoses to the main lift cylinders. **DO NOT** allow the cowl hoses to stretch or fold while tilting the mast fully forward and backward.



1. HOOK
2. SHACKLE

Figure 65. Chaining the Carriage (FFL)

Adjustment

When properly adjusted, the hoses will not be so tight that they compress when they pass over the sheaves, nor will they be so loose that they touch the load backrest or any crossmember that is next to a sheave.

1. Cap off hoses when attachments have been removed.
2. Check that hoses and cables are routed properly.
3. Slowly raise the free-lift and main cylinders to take up slack in the lift chains.
4. Tighten strap clamps at the bracket weldment.
5. Cycle the mast a few times to ensure proper tracking of hoses.
6. Secure hose assemblies to main lift cylinders with hose clamp and screw clamp.

NOTE: If the hose tension between the carriage and the clamp at the free-lift bracket is correct, go to Step 7.

If the hose tension between the carriage and the clamp at the free-lift bracket is incorrect, loosen the clamps and pull (if the hoses are loose) or push (if the hoses are tight) on the hoses so they move 15.0 mm (0.6 in.) side to side. Tighten the hardware to 8 N•m (71 lbf in).

NOTE: If the hose tension between the clamp at the upper bracket and the clamp at the free-lift bracket is correct, go to Step 8.

7. If the tension of the hoses is incorrect, loosen the clamps and pull the hoses down (if too loose) or push the hoses up (if too tight) so they can move 15.0 mm (0.6 in.) side to side. Retighten the hardware to 8 N•m (71 lbf in).
8. With no load on the forks, check the header hose adjustment by operating the mast through the full lift cycle two times. When properly adjusted, the hoses will not be so tight that they compress when they pass over the sheaves nor will they be so loose that they touch the load backrest or any crossmember that is next to a sheave. If necessary, repeat until the hoses are properly adjusted.

Three-Stage Mast With Full Free-Lift Repair

REMOVE

WARNING

The mast is heavy. The mast can weigh approximately 907 kg (2000 lb). Make sure all lifting devices (hoists, cables, chains, slings, etc.) are suitable and of adequate capacity to lift the mast.

WARNING

Mast weldments can slide when the mast is moved. A weldment that slides can cause serious injury.

CAUTION

Make sure all the mast weldments are fastened together. Make sure the safety chains will not damage the sheaves, tubing, or other parts of the mast.

NOTE: If the mast needs to be disassembled, remove the forks and carriage. see the sections Fork Replacement and Carriages Repair in this service manual for procedures. If only the main lift cylinders need to be removed for repair, the mast does not need to be removed from the lift truck. See the section **Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564)** 2100SRM1382 for procedures to remove the main lift cylinders.

NOTE: The length of the lift chains must be checked before the mast is removed. See Lift Chains Adjustment.

1. Fully lower all of the mast weldments. Tilt the mast fully forward. Connect a crane with a capacity of at least 907 kg (2000 lb) to the top of the mast using chains to support the mast in an upright position when the tilt cylinders are disconnected. See the section Safety Procedures When Working Near Mast in this manual.

WARNING

Always wear the proper protective equipment including eye protection and petroleum-resistant gloves when handling hydraulic oil. Thoroughly wash oil from exposed areas of skin as soon as possible.

Completely lower forks to relieve hydraulic pressure before disassembling any part of the lift pump or disconnecting any hoses.

The hydraulic oil is hot at normal operating temperatures. Be careful when draining the oil.

CAUTION

Protect the hydraulic system from dirt and contaminants when servicing the hydraulic system.

2. Position a drip pan under the area of the hydraulic fittings. Disconnect the hydraulic line at the external lowering control valve on the outer mast. See Figure 72.

WARNING

Use a driver, NOT your fingers, to push the anchor pins from the clevises on the tilt cylinders. The cylinder or mast can move and cause serious injury.

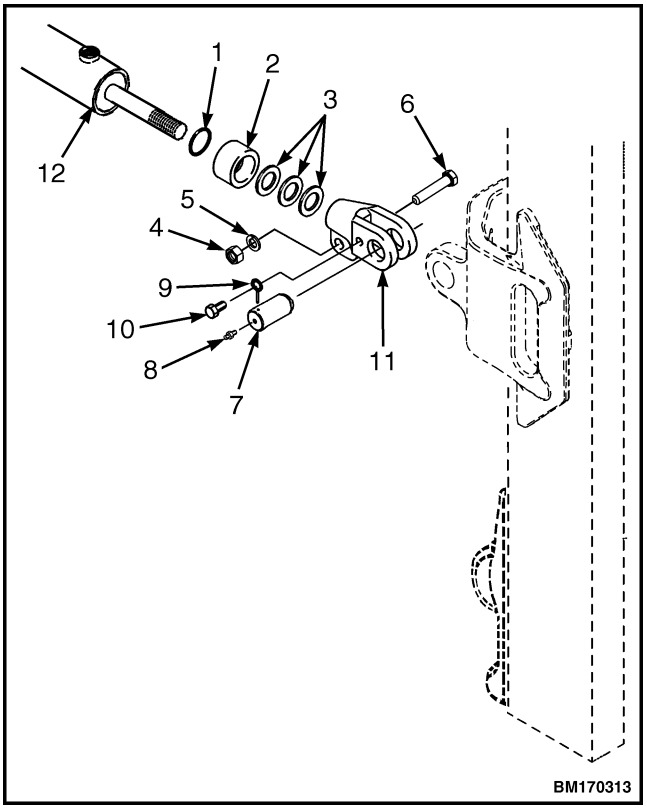
3. On lift trucks NOT equipped with optional boot on tilt cylinders, remove the capscrews, washers, anchor pins, and pivot pins at the tilt cylinder mounts on the outer mast. See Figure 66.

4. On lift truck models J2.2-3.5XN (J45-70XN) (A276) equipped with tilt cylinders with optional boots, remove capscrews, washers, nuts, anchor pins, and pivot pins at tilt cylinder mounts on outer mast. See Figure 67.

5. Using a brass drift pin, remove tilt rod bushings from outer mast. Discard tilt rod bushings. See Figure 68.

NOTE: Allow the mast to tilt forward enough to gain access to the mast mount capscrews.

6. Disconnect the lower mast mounts from the lift truck by removing the capscrews that hold the mast pivot pins to the mounts on the drive axle. See Figure 69.



1. O-RING
2. SPACER
3. SHIMS
4. NUT
5. WASHER
6. CAPSCREW
7. PIVOT PIN
8. GREASE FITTING
9. ANCHOR PIN
10. CAPSCREW
11. ROD END
12. TILT CYLINDER

Figure 66. Mast Mounting, Tilt Cylinder Without Optional Boot

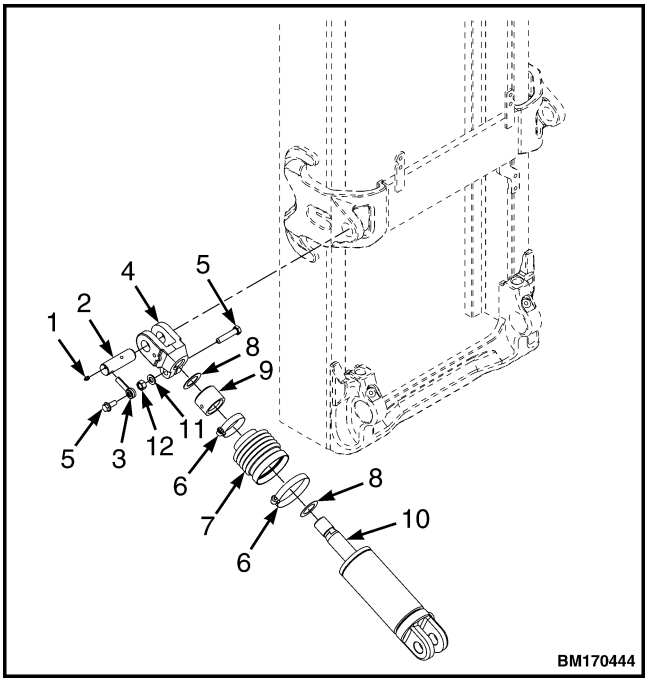
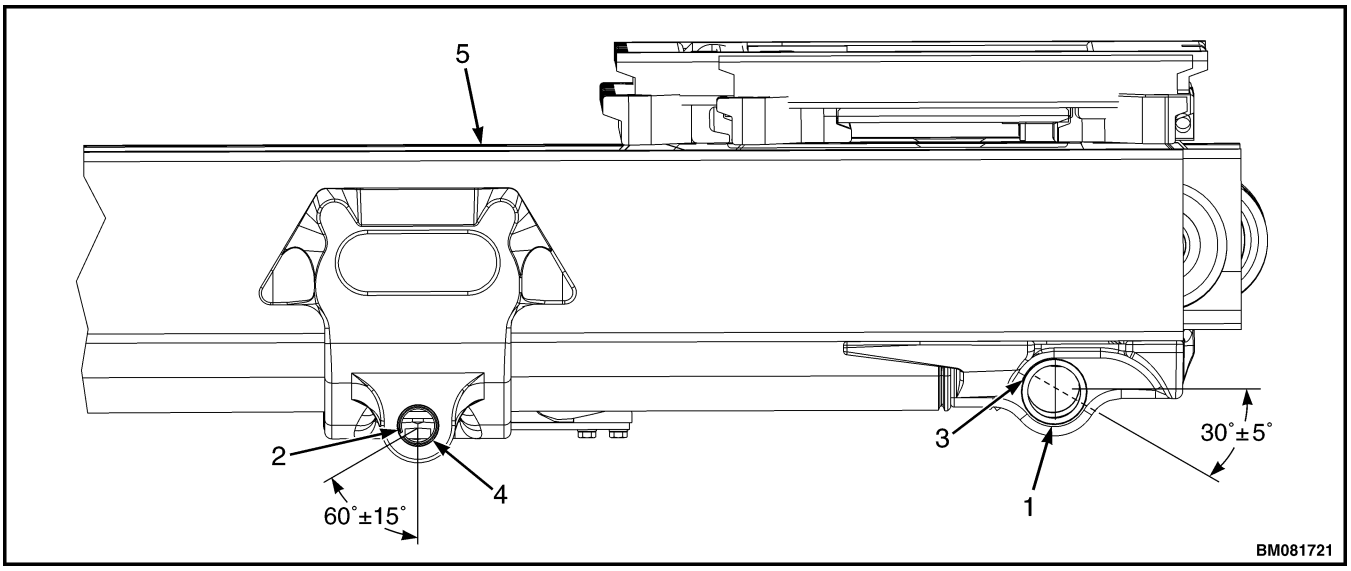


Figure 67. Mast Mounting, Tilt Cylinder With Optional Boot

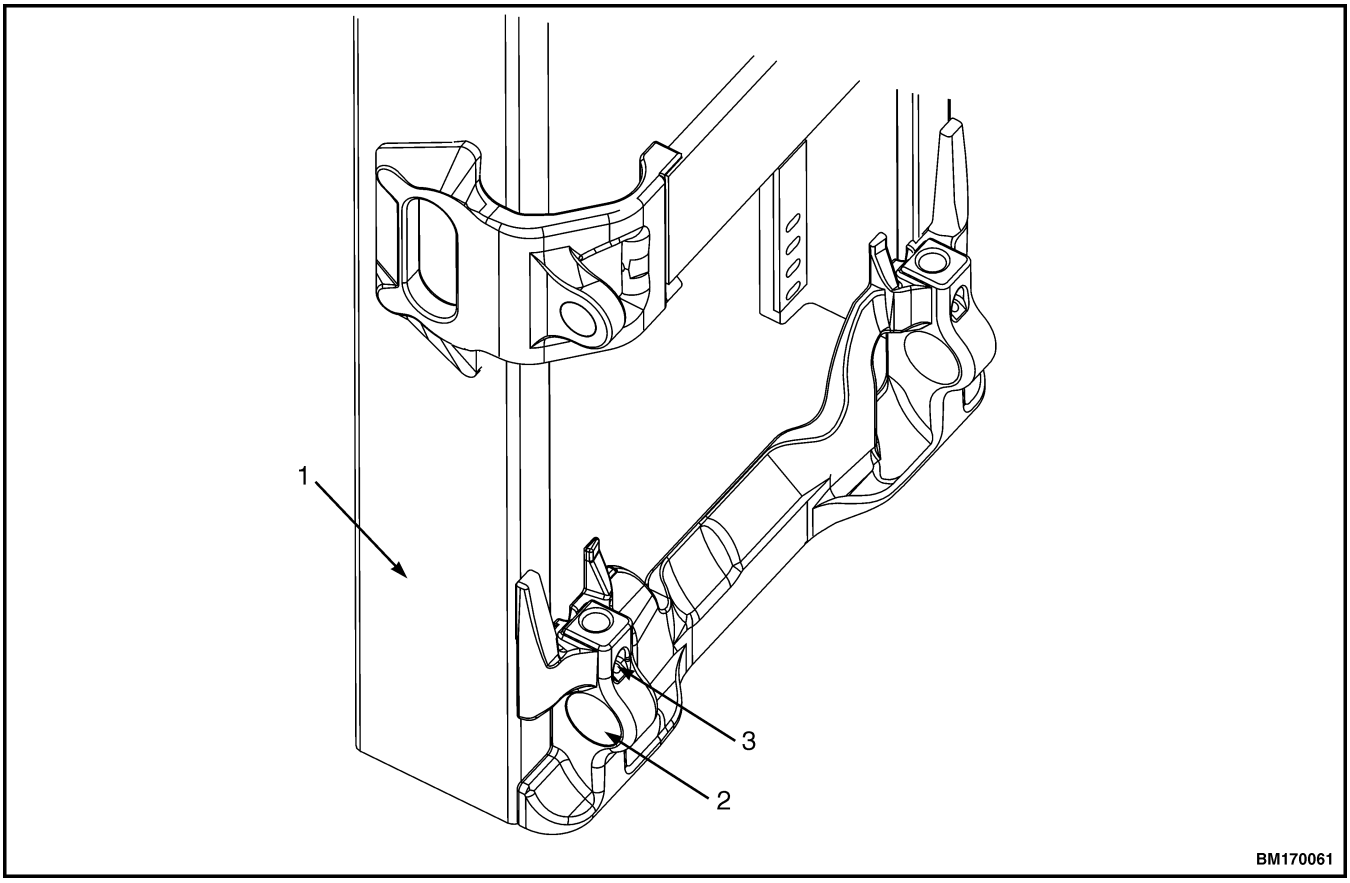
Legend for Figure 67.

1. GREASE FITTING
2. PIVOT PIN
3. ANCHOR PIN
4. ROD END
5. CAPSCREW
6. CLAMP
7. BOOT
8. SHIM
9. SPACER
10. TILT CYLINDER
11. WASHER
12. NUT



1. MAST MOUNTING BUSHING
2. BUSHING SPLIT
3. BUSHING HOLE
4. TILT ROD BUSHING
5. OUTER MAST

Figure 68. Tilt Rod and Mast Mounting Bushings



1. OUTER MAST
2. BUSHING
3. GREASE FITTING

Figure 69. Mast Mounts, Outer Mast

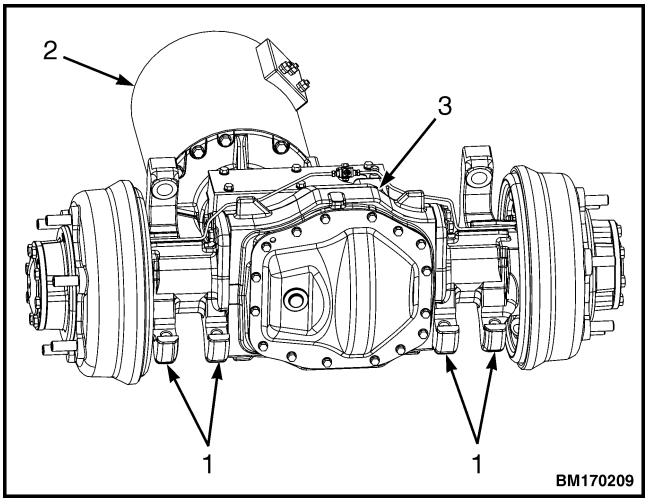


Figure 70. Mast Mounts, Drive Axle

Legend for Figure 70.

NOTE: DRIVE AXLE FOR LIFT TRUCK MODELS E2.2-3.5XN (E45-70XN) (A268) SHOWN. HANGER MOUNTS THE SAME FOR J2.2-3.5XN (J45-70XN) (A276) LIFT TRUCK MODELS.

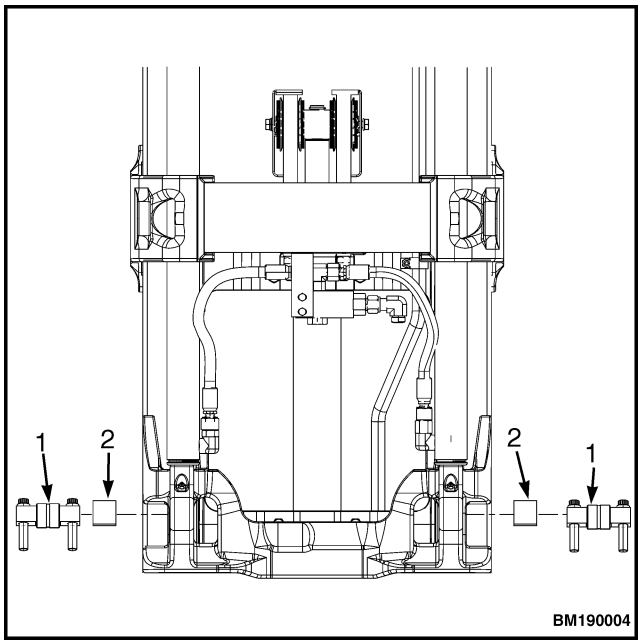
1. HANGER MOUNTS
2. TRACTION MOTOR
3. DRIVE AXLE

WARNING

The mast is heavy. The mast can weigh approximately 907 kg (2000 lb). Make sure all lifting devices (hoists, cables, chains, slings, etc.) are suitable and of adequate capacity to lift the mast.

7. Use the crane to lift the mast assembly from the lift truck. Position the mast across wooden beams on the floor with the carriage side up.

8. Check the mast and mounting flanges for wear or damage by removing the mast pivot pins from the outer mast. Check that the pins fit snug in the outer mast. If pins can be moved up and down a minimum of 4 mm (0.20 in.), replace bushings in outer mast and/or mast pivot pins as required. See Figure 71. Use a brass drift pin to remove mast mounting bushings from outer mast. Discard mast mounting bushings. See Figure 68.



1. MAST PIVOT PINS
2. BUSHING

Figure 71. Mast Pivot Pin

DISASSEMBLE

WARNING

Always wear the proper protective equipment including eye protection and petroleum-resistant gloves when handling hydraulic oil. Thoroughly wash oil from exposed areas of skin as soon as possible.

WARNING

Hydraulic oil is hot after system operation and can cause burns. DO NOT disconnect any hydraulic hoses until the oil in the system has cooled.

Completely lower forks to relieve hydraulic pressure before disconnecting any hydraulic hoses.

CAUTION

Protect the hydraulic system from dirt and contaminants when disconnecting hydraulic hoses from the mast. If hydraulic system becomes contaminated, damage to the hydraulic system can occur.

1. Disconnect the free-lift chain at the crosshead. See Figure 72

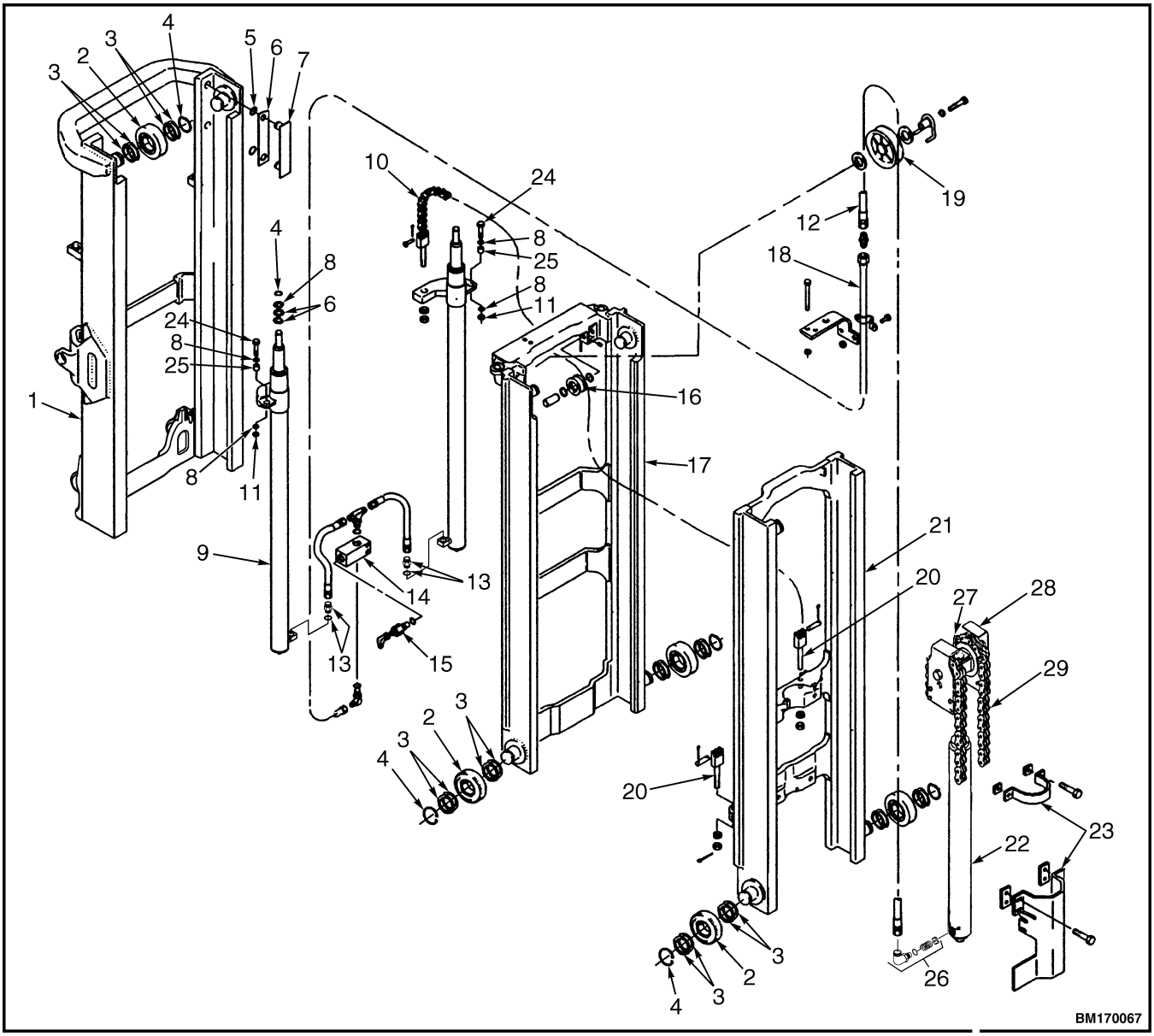


Figure 72. Three Stage, Full Free-Lift (FFL) Mast

Legend for Figure 72.

1. OUTER MAST
2. LOAD ROLLER
3. SHIM
4. SNAP RING
5. O-RING
6. SHIM(S)
7. STRIP BEARING
8. WASHER
9. MAIN LIFT CYLINDER
10. LIFT CHAIN
11. NUT
12. HOSE
13. VELOCITY FUSE
14. HOUSING
15. LOWERING CONTROL VALVE
16. CHAIN SHEAVE
17. INTERMEDIATE MAST
18. HOSE
19. HOSE SHEAVE
20. CHAIN ANCHOR
21. INNER MAST
22. FREE-LIFT CYLINDER
23. BRACKET
24. CAPSCREW
25. SPACER
26. FLOW CONTROL ASSEMBLY
27. CROSSHEAD
28. CHAIN GUARD
29. FREE-LIFT CHAIN

2. Disconnect and remove the hydraulic line from free-lift cylinder. Remove the brackets clamping the free-lift cylinder. Remove the free-lift cylinder. See Figure 72.

3. Disconnect the main lift chains from the chain anchors near the top of the main lift cylinders. Disconnect the other end of the main lift chains at the bottom of the inner mast. Push the inner mast toward the bottom of the mast assembly until the bottom load rollers can be seen.

WARNING

The weldments can slide when the mast is moved. A weldment that slides can cause injury. Use a crane to turn the mast slowly and carefully.

4. Remove the strip bearings at the top of the intermediate mast. Remove the load rollers at the bottom of the inner mast. Remove the load rollers at the top of the intermediate mast. Make a note of each shim arrangement and load roller location. The shim arrangements will be approximately the same during assembly. See Figure 72.

WARNING

The mast is heavy. The mast can weigh approximately 907 kg (2000 lb). Make sure all lifting devices (hoists, cables, chains, slings, etc.) are suitable and of adequate capacity to lift the mast.

5. Slide the inner mast halfway out of the top of the intermediate mast. Connect a crane with a capacity of at least 907 kg (2000 lb) to the center of the inner mast. See Figure 73. Slide the inner mast out of the intermediate mast until the stub shafts are in the notches of the intermediate mast. Remove the inner mast from the intermediate mast.

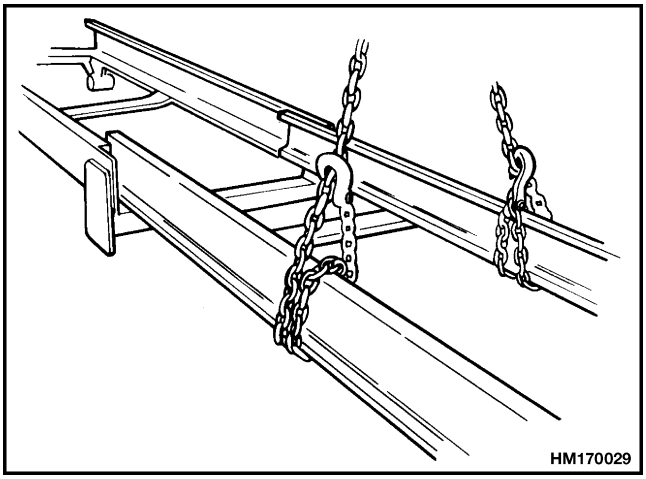


Figure 73. Mast Disassembly

WARNING

Be careful when removing or installing snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers, and wear eye and face protection during removal or installation.

6. Remove the nut, capscrew, spacer, and washer at the mount near the top of each main lift cylinder. Remove the snap rings and washers from the top of each main lift cylinder. Disconnect the main lift chains at the mounts. See Figure 72.

7. Push the intermediate mast to disengage the main lift cylinders. Remove the main lift cylinders.

8. Slide the intermediate mast from the bottom of the outer mast approximately 30 cm (12 in.). Remove the strip bearings at the top of the outer mast. Remove the snap rings and load rollers from both weldments. Make a note of each shim arrangement and load roller location. The shim arrangements will be approximately the same during assembly. See Figure 72.

WARNING

The mast is heavy. The mast can weigh approximately 907 kg (2000 lb). Make sure all lifting devices (hoists, cables, chains, slings, etc.) are suitable and of adequate capacity to lift the mast.

9. Slide the intermediate mast halfway out of the top of the outer mast. Connect a crane with a capacity of at least 907 kg (2000 lb) to the center of the intermediate mast. See Figure 73. Slide the intermediate mast out of the outer mast until the stub shafts are in the notches of the outer mast. Remove the intermediate mast from the outer mast.

10. Disassemble the chain sheaves as necessary for repair and cleaning. Remove the hydraulic lines and fittings from the weldments as necessary.

CLEAN AND INSPECT

CAUTION

DO NOT use steam or high-pressure water to clean the load rollers or the lift chains. Steam and high-pressure water can remove the lubrication from the bearings in the load rollers. Water in the bearings of the sheaves and the link pins of chains can also shorten the service life of these parts.

1. Inspect chain sheaves and load rollers for wear or damage. **DO NOT** use steam to clean lift chain sheaves or load rollers. The bearings in the sheaves and load rollers are sealed and lubricated.

WARNING

Cleaning solvents may be flammable and toxic and can cause severe skin irritation. When using commercial cleaning solvents, always comply with solvent manufacturer's recommended safety precautions.

WARNING

Compressed air can move particles so that they cause injury to the user or to other personnel. Make sure that the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eyes.

2. Clean the lift chains by soaking in solvent for 30 minutes to remove all dirt and grease. Hang lift chains up and remove solvent using compressed air.

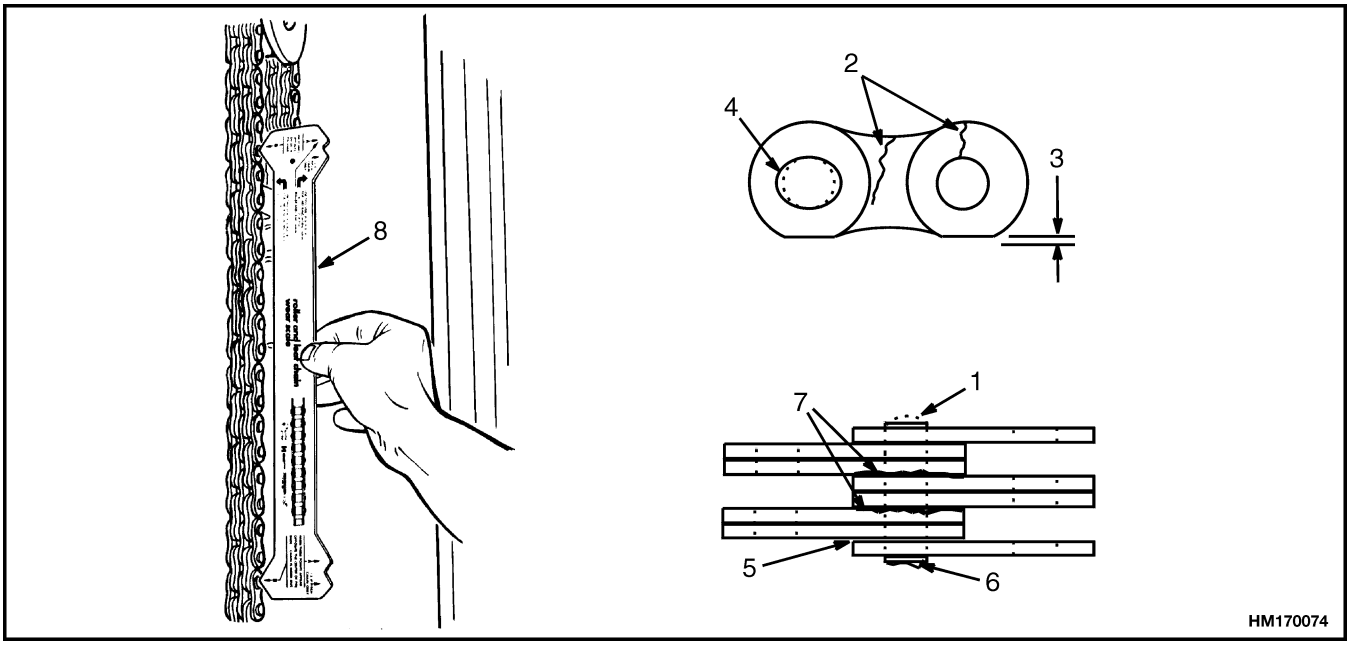
WARNING

Never replace only the worn section of a chain. Replace the complete chain. Never replace only one chain of a chain pair. Replace both chains. Damage to the lift truck and serious injury can occur if lift chains are not replaced correctly.

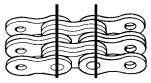
NOTE: The chains must be inspected in the area of chain that passes over the chain sheave during the first portion of a lift. These links will show maximum wear.

3. Inspect the lift chains for wear and damage. A lift chain becomes longer when it is worn. If a chain is 3% longer than a new lift chain, the lift chain must be replaced.

4. If a chain scale is available (Hyster Part No. 599737) , check lift chains as shown in Figure 74. If a chain scale is not available measure 20 links of chain. Measure from the center of a pin to the center of another pin 20 pitches away. Compare the length with the chart in Figure 74. Replace chain if the length of 20 links of the worn section is more than the maximum wear limit.



NOTE: THE INSTRUCTIONS FOR MEASURING CHAIN WEAR ARE SHOWN ON THE CHAIN WEAR SCALE.

Pitch 	Total length of 20 links (pitch) of new chain	Wear Limit The maximum length of 20 links
12.7 mm (0.5 in.)	254.0 mm (10.0 in.)	261.6 mm (10.3 in.)
15.9 mm (0.6 in.)	317.5 mm (12.5 in.)	327.0 mm (12.9 in.)
19.1 mm (0.8 in.)	381.0 mm (15.0 in.)	392.4 mm (15.4 in.)
25.4 mm (1.0 in.)	508.0 mm (20.0 in.)	523.3 mm (20.6 in.)

1. WORN PIN
2. CRACKS
3. EDGE WEAR
4. HOLE WEAR
5. LOOSE LEAVES
6. DAMAGED PIN
7. RUST
8. CHAIN WEAR SCALE

Figure 74. Lift Chains Check

5. Lubricate lift chains by soaking them in SAE 30 engine oil for 30 minutes. Hang chains over a drip pan for one hour to remove excess oil.

NOTE: Chain anchor pins **MUST** be replaced anytime chains are replaced.

6. Inspect the chain anchors and pins. Replace any parts that are worn or damaged. See Figure 72.

WARNING

Cleaning solvents may be flammable and toxic and can cause severe skin irritation. When using commercial cleaning solvents, always comply with solvent manufacturer's recommended safety precautions.

WARNING

Steam can cause serious burns. Wear protective clothing, gloves, and eye protection. Never expose your skin to steam.

7. Clean the mast weldments with steam or solvent.

WARNING

Improper welding procedures can damage the structure of the mast or cause incorrect function of the mast which can result in serious injury to personnel. Consult your Hyster lift truck dealer for more information before welding on the mast.

8. Inspect the sliding surfaces for wear or damage. Inspect the load roller contact surfaces for wear or damage. Inspect all welds for cracks.

ASSEMBLE

NOTE: The shims for the load rollers keep the weldments parallel and provide correct clearance. During assembly, the shim arrangement will be approximately the same as before disassembly. Check the clearance and adjust the shims for wear or for changes caused by repairs. The strip bearings are also adjusted by using shims. See Mast Adjustments in this manual for the adjustment procedures.

1. Put the outer mast on the floor with the carriage side up. Connect a crane with a capacity of at least 907 kg (2000 lb) to the center of the intermediate mast. Fit the lower stub shafts of the intermediate mast into the notches in the top of the outer mast. Slide the intermediate mast into the outer mast so the stub shafts are seen at the top and bottom of both weldments.

NOTE: The load rollers must be in place before strip bearing can be shimmed.

2. Install the strip bearings and the shims on the channels of the outer mast. See Figure 75. Apply chassis lube to the bearing surfaces. Check the clearance of the strip bearings as described in Mast Adjustments in this manual.

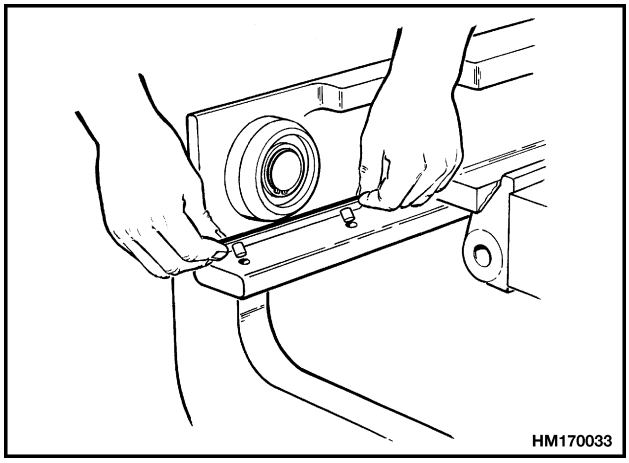


Figure 75. Strip Bearings

3. Install the load rollers and the shims on the outer mast and at the bottom of the intermediate mast. Before doing Step 4, adjust the intermediate mast and check the clearance of the load rollers as described in Mast Adjustments in this manual.

NOTE: The clearance check and adjustment in Step 4 is only an initial setup. The final check and adjustment is done after the mast is installed on the lift truck.

4. Install the main lift cylinders. Push the intermediate mast to engage the lift cylinders. Check the clearance at the top of the lift cylinder mounts. Add or remove washers at the top of the cylinder rods until they are even. Install the snap ring and washer at the top of the lift cylinders. See Figure 72.

5. Install the housing for the lowering control valve on the outer mast. Tighten the nuts for the lowering control valve to 18 N•m (13 lbf ft). Install the lowering control valve in the housing. Connect the hydraulic lines and fittings between the housing and the main lift cylinders.

6. Install the chain sheaves at the intermediate mast. Be sure to install both pins that hold the shaft for the chain sheave in position.

7. Install the spacers, capscrews, nuts, and washers at the mounts for the main lift cylinders. Tighten the bolts to 40 N•m (30 lbf ft). See Figure 72.

8. Connect a crane with a capacity of at least 907 kg (2000 lb) to the center of the inner mast. Slide the inner mast into the intermediate mast so the stub shafts are seen at the top and bottom of both.

NOTE: Use multipurpose grease #2 with 2 to 4% Molybdenum Disulfide for normal operations.

NOTE: The load rollers must be in place before bearing strips can be shimmed.

9. Install the strip bearings and the shims on the channels of the intermediate mast. Apply grease to the bearing surfaces. Install the load rollers and the shims on the intermediate and inner masts. Before doing the next step, adjust the inner mast as described in Mast Adjustments in this manual.

10. Connect the main lift chains to the chain anchors at the main lift cylinder mounts. Put the lift chains over the chain sheaves and connect them to the anchors at the bottom of the inner mast. See Figure 72.

11. Install the free-lift cylinder in the mounts on the inner mast. Install the brackets for the cylinder and tighten the nuts to 53 N•m (39 lbf ft). The nuts are installed on the bracket side of the free-lift cylinder.

12. Install the chain sheave for the free-lift cylinder. Tighten the capscrew for the chain sheave to 66 N•m (49 lbf ft). Install the hydraulic hose and tubing for the free-lift cylinder.

13. Connect the free-lift chains to the chain anchors at the crossmember. Attach a wire between the end of the lift chain and the bottom of the mast to control the lift chain during mast installation.

INSTALL

1. Install new bushings into mast mounts at bottom of outer mast. Be sure the hole and bushing split are installed at the correct angle as shown in Figure 68. Bushing must be flush with outer mast surface.

2. Apply an even coat of grease to the pivot pins and install them into mounts at bottom of outer mast. See Figure 71.

WARNING

The mast is heavy. The mast can weigh approximately 907 kg (2000 lb). Make sure all lifting devices (hoists, cables, chains, slings, etc.) are suitable and of adequate capacity to lift the mast.

3. Connect crane to top of mast using chains. Make sure all mast uprights are fastened together. Make sure chains will not damage sheaves, tubing, or other parts of mast. Make sure crane has a capacity of at least 907 kg (2000 lb).

4. Use crane to position mast assembly onto its lower mounts. Position mast so pivot pins seat into hanger mounts on drive axle. Install capscrews that hold mast pivot pins to drive axle hangers. Tighten capscrews to 270 N•m (199 lbf ft). Refer to Figure 70 and Figure 71.

5. Install new tilt rod bushings into outer mast. Be sure to install bushings with split at correct angle as shown in Figure 68.

WARNING

Use a pry bar, NOT your fingers, to align the tilt cylinder clevises with the outer mast. The cylinder or mast can shift and cause serious injury.

NOTE: Use multipurpose grease #2 with 2 to 4% molybdenum disulfide for normal operations.

6. Apply grease to pivot pins and connect tilt cylinders to mast using pivot pins. Install anchor pins and capscrews to rod ends. Apply anti-seize compound to capscrew threads and tighten 38 N•m (28 lbf ft).

   See Figure 76 for lift trucks equipped with tilt cylinders without boot

   See Figure 77 for lift trucks equipped with tilt cylinders with boot

7. Connect hydraulic line to lowering control valve. See Figure 72.

8. Install carriage as described in the section Carriages Repair in this service manual.

WARNING

Never check for leaks by putting hands on hydraulic lines or components under pressure. Hydraulic oil under pressure can be injected into the skin.

9. Check tilt cylinder adjustment as described in **Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564)** 2100SRM1382. Operate mast and check for leaks and correct operation. Check lift chains as described in Lift Chains Adjustment.

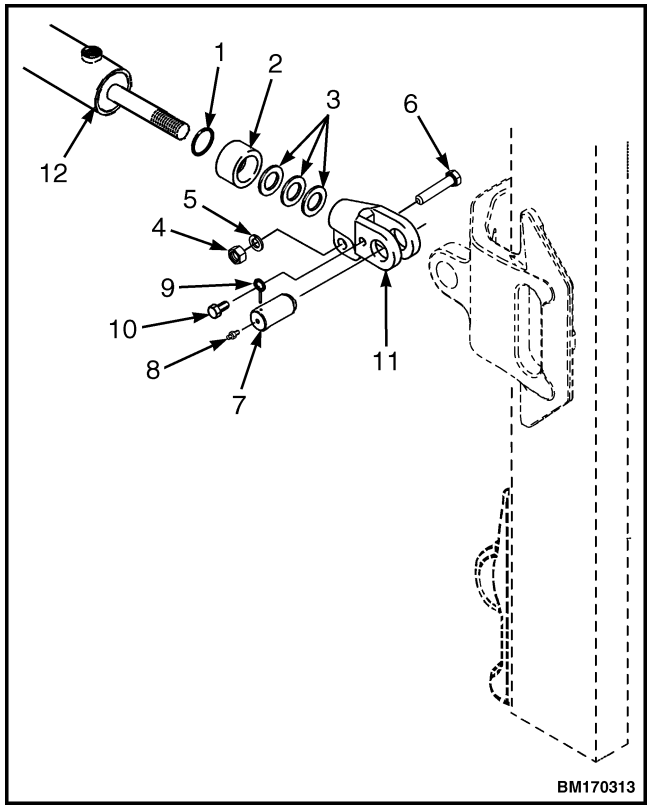
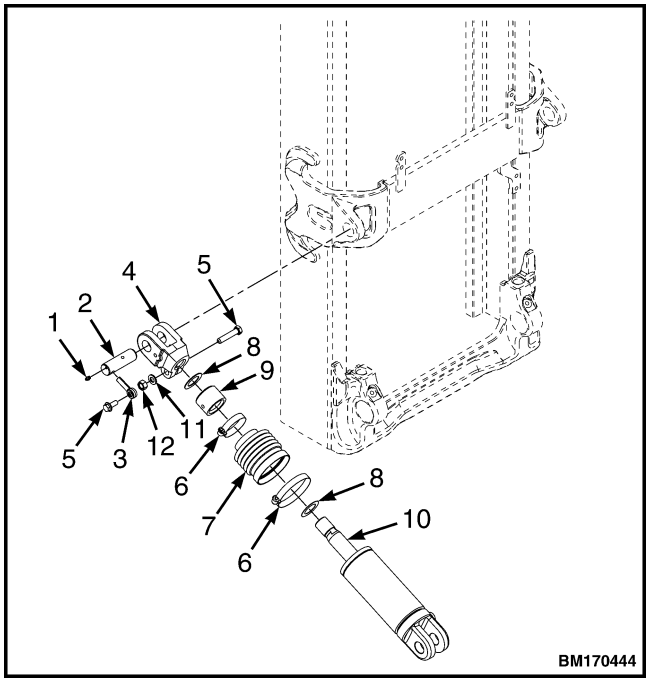


Figure 76. Mast Mounting, Tilt Cylinders Without Optional Boot

Legend for Figure 76.

1. O-RING
2. SPACER
3. SHIMS
4. NUT
5. WASHER
6. CAPSCREW
7. PIVOT PIN
8. GREASE FITTING
9. ANCHOR PIN
10. CAPSCREW
11. ROD END
12. TILT CYLINDER



1. GREASE FITTING
2. PIVOT PIN
3. ANCHOR PIN
4. ROD END
5. CAPSCREW
6. CLAMP
7. BOOT
8. SHIM
9. SPACER
10. TILT CYLINDER
11. WASHER
12. NUT

Figure 77. Mast Mounting, Tilt Cylinder With Optional Boot

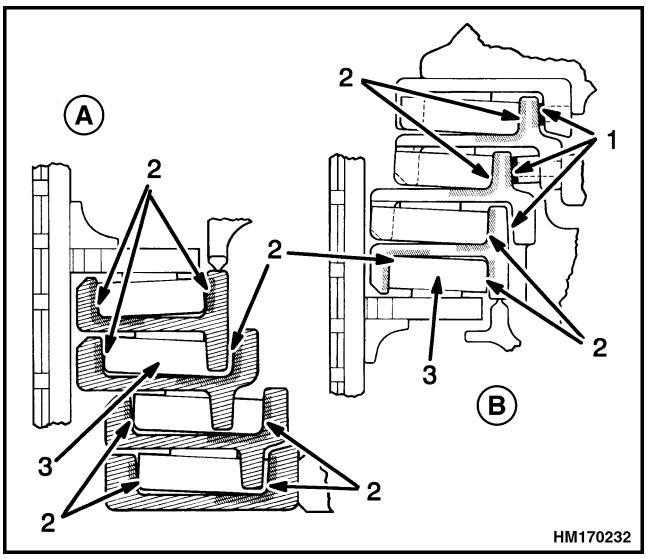
NOTE: Before checking for mast side kicking and adjusting the chain anchors on the main lift cylinders, the mast must be fully assembled to include the carriage, forks, load backrest and any attachments if the lift truck is equipped with one.

10. Adjust chain anchors on the main lift cylinders until the tops of the inner and outer mast are at the same level within ±1.5 mm (0.06 in.). See Figure 72.

11. Raise the mast, without a load to its full height and check for side kicking. Mast side kicking is when the mast moves either to the right or left as it is being raised to its full height. If the mast is side kicking, see the Mast Adjustments section in this manual for procedures to correct mast side kicking.

NOTE: The load rollers and sheaves have sealed bearings and do not need additional lubrication.

12. Lubricate sliding surfaces and load roller surfaces along full length of channels as shown in Figure 78. Apply lubricant only to surfaces indicated.



A. LOWER LOAD ROLLERS
B. UPPER LOAD ROLLERS

1. LUBRICATE STRIP BEARINGS SURFACES
2. LUBRICATE LOAD ROLLER SURFACES
3. LOAD ROLLER

Figure 78. Lubricate Mast

HEADER HOSE INSTALLATION AND ADJUSTMENT

Installation

WARNING

Always wear the proper protective equipment including eye protection and petroleum-resistant gloves when handling hydraulic oil. Thoroughly wash oil from exposed areas of skin as soon as possible.

Never check for leaks by putting hands on hydraulic lines or components under pressure. Hydraulic oil under pressure can be injected into the skin.

WARNING

Before working on or near the mast, see Safety Procedures When Working Near Mast in this section.

Before installing the header hoses, make sure you know the lift height of the mast. The tension on the header hoses is adjusted according to lift height. The lift height is on the Nameplate of the lift truck and on the right side of the outer mast.

Some lift trucks are equipped with auxiliary hydraulic functions that are fastened to the carriage. Examples of attachments that use these auxiliary functions are sideshift carriages, roll clamps, and fork positioners. These auxiliary functions require header hoses for their operation.

NOTE: This procedure is for the four-function option. The three-function option will have hoses **A** and **B** only.

NOTE: The carriage height must be correct before the header hoses can be adjusted. See Lift Chains Adjustment for the carriage adjustment procedure.

1. Mark each hose with a single letter: **A**, **B**, **C**, and **D**. See Figure 79.

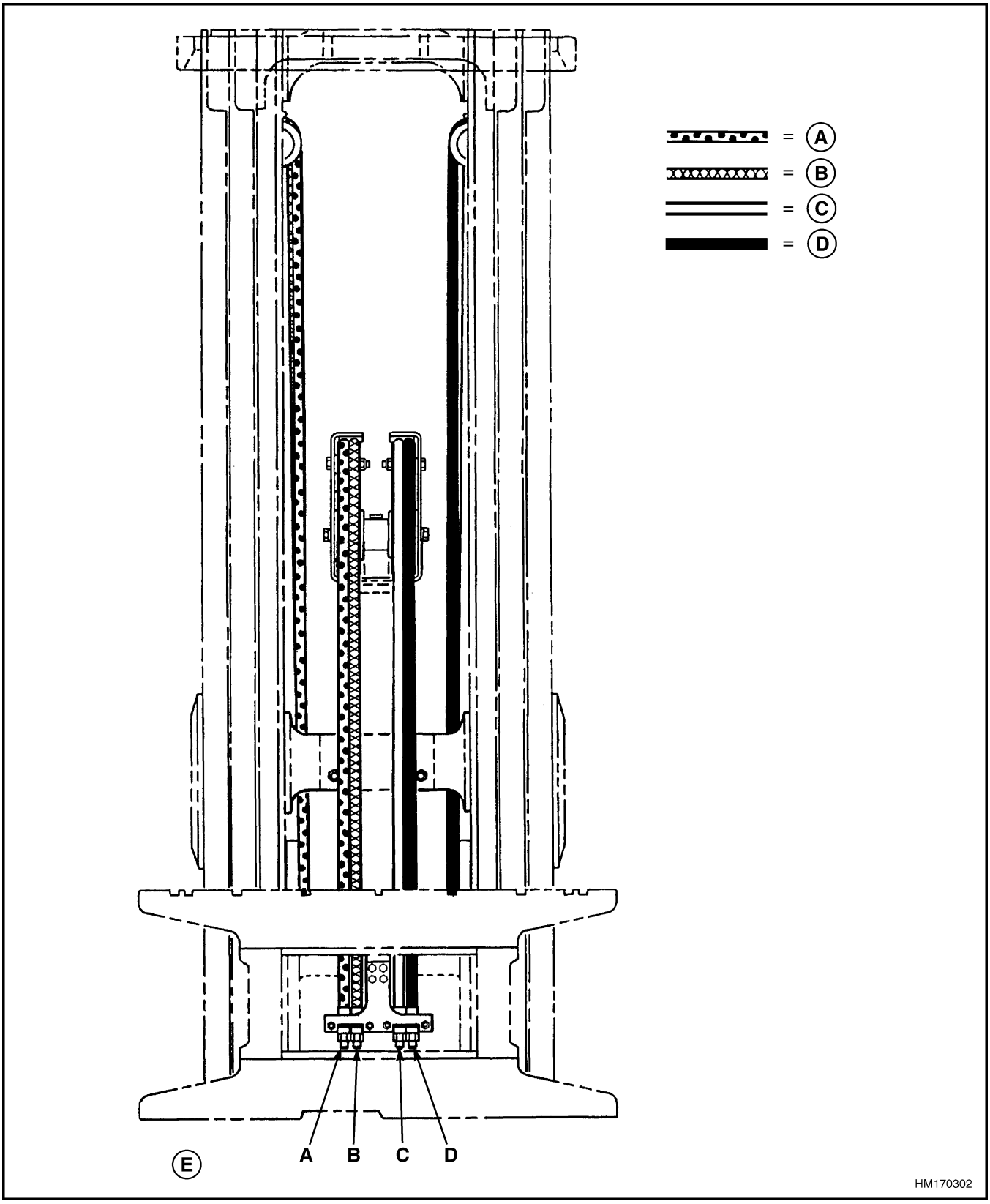


Figure 79. Header Hose Alignment for Three-Stage Full Free-Lift Mast (Sheet 1 of 3)

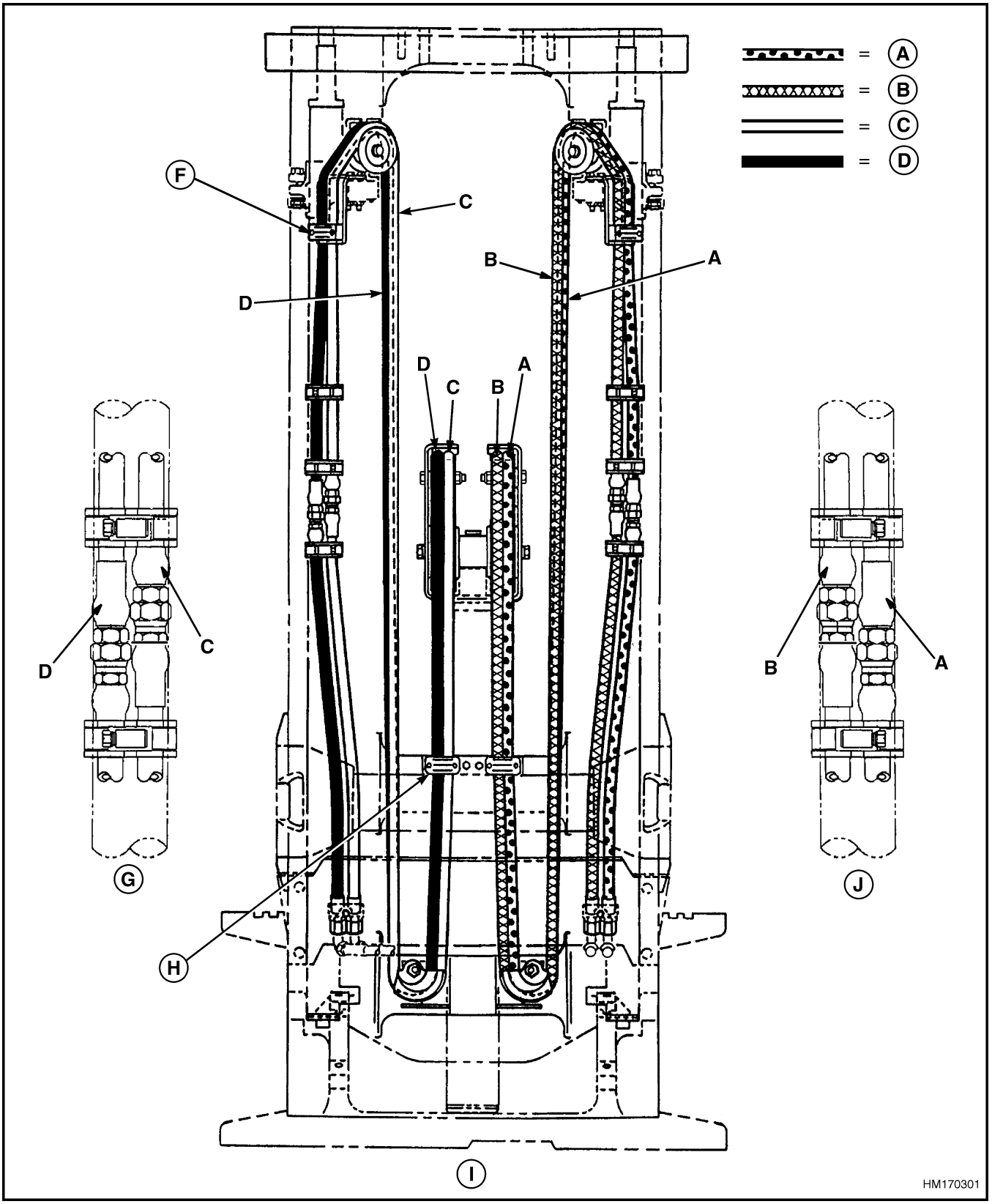
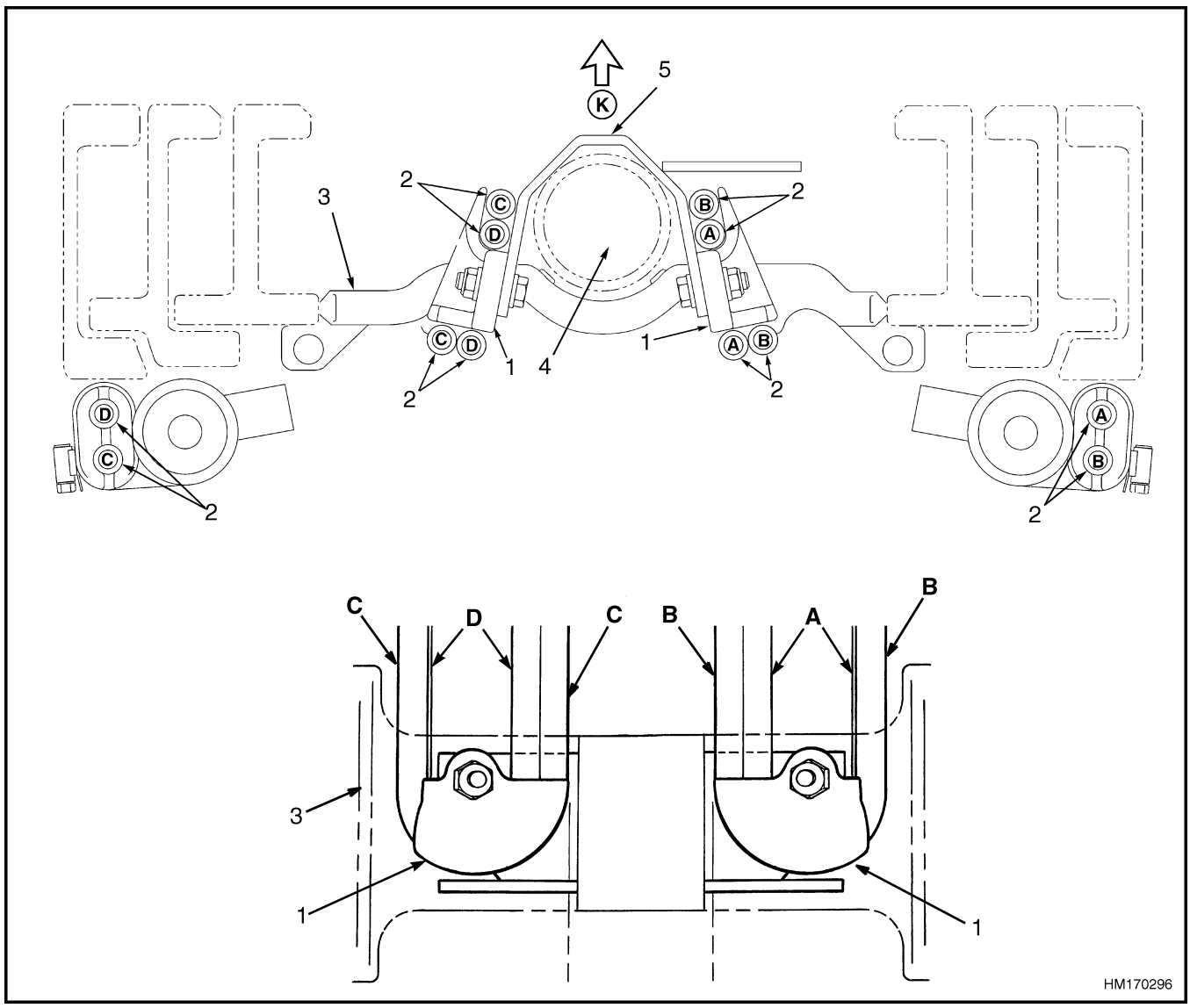


Figure 79. Header Hose Alignment for Three-Stage Full Free-Lift Mast (Sheet 2 of 3)



A. HOSE A
B. HOSE B
C. HOSE C
D. HOSE D
E. FRONT VIEW
F. ALIGN G ON HOSES A AND D AT BOTTOM OF THIS CLAMP. ALIGN G ON HOSES B AND C AT BOTTOM OF THIS CLAMP.
G. LEFT-HAND CYLINDER
H. ALIGN MARK E AT BOTTOM OF THIS CLAMP.
I. REAR VIEW
J. RIGHT-HAND CYLINDER
K. FORKS

1. HOSE GUIDE
2. HOSE
3. BOTTOM CROSSMEMBER, INNER CHANNEL
4. FREE-LIFT CYLINDER
5. CYLINDER GUARD

Figure 79. Header Hose Alignment for Three-Stage Full Free-Lift Mast (Sheet 3 of 3)

2. Dimensions **E** and **G** are determined by the height of the outer mast channel from the ground and the length of the outer mast channel. See dimensions **Y** and **Z** in Figure 80. To find **E** and **G**

See Table 8 for lift truck models

- E2.2-2.5XN (E45-55XN) (A268)

See Table 9 for lift truck models

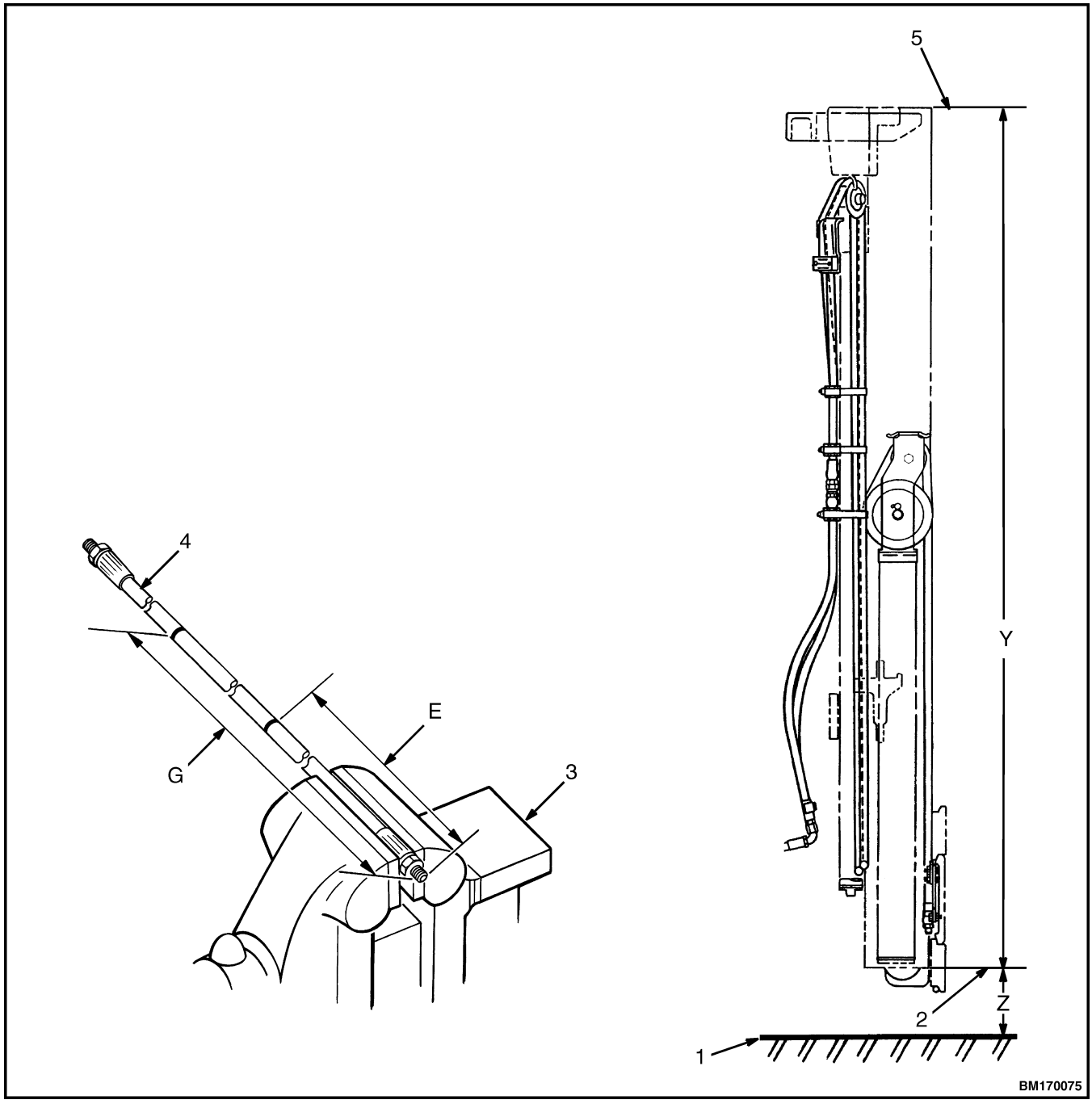
- E3.0-3.5XN (E60-70XN) (A268)

See Table 10 for lift truck models

- J2.2-2.5XN (J45-50XN) (A276)

See Table 11 for lift truck models

- J3.0-3.5XN (J60-70XN) (A276)



1. GROUND LEVEL
2. BOTTOM OUTER CHANNEL
3. VISE
4. HOSE
5. TOP OUTER CHANNEL

Figure 80. Header Hose Measurement for Three-Stage Full Free-Lift Mast

Table 8. Standard Three-Stage FFL Hose Dimensions, Lift Truck Models E2.2-2.5XN (E45-55XN) (A268)

Lift Height		Channel Length (Reference)	Dimension "E"		Dimension "G" Third Function		Dimension "G" Fourth Function	
mm	in.	mm	mm	in.	mm	in.	mm	in.
4760	187.4	1990	1726	67.9	4050	159.4	4063	159.9
4910	193.3	2040	1775	69.8	4148	163.3	4161	163.8
5060	199.2	2140	1874	73.7	4345	171.1	4358	171.5
5510	216.9	2290	2021	79.5	4639	182.6	4652	183.1
5960	234.6	2490	2218	87.3	5021	197.6	5014	197.4
Lift height is measured from top of forks. Lift heights shown are standard. If your lift height is not shown, go to **Hyster Hypass Online** to find the correct header hose measurement for your lift height.								

Table 9. Standard Three-Stage FFL Hose Dimensions, Lift Truck Models E3.0-3.5XN (E60-70XN) (A268)

Lift Height		Channel Length (Reference)	Dimension "E"		Dimension "G" Third Function		Dimension "G" Fourth Function	
mm	in.	mm	mm	in.	mm	in.	mm	in.
4418	173.9	1990	1726	67.9	4050	159.4	4063	159.9
4568	179.8	2040	1775	69.8	4148	163.3	4161	163.8
4718	185.7	2140	1874	73.7	4345	171.1	4358	171.5
5168	203.5	2290	2021	79.5	4639	182.6	4652	183.1
5618	221.2	2490	2218	87.3	5021	197.6	5014	197.4
Lift height is measured from top of forks. Lift heights shown are standard. If your lift height is not shown, go to **Hyster Hypass Online** to find the correct header hose measurement for your lift height.								

Table 10. Standard Three-Stage FFL Hose Dimensions, Lift Truck Models J2.2-2.5XN (J45-50XN) (A276)

Lift Height		Channel Length (Reference)	Dimension "E"		Dimension "G" Third Function		Dimension "G" Fourth Function	
mm	in.	mm	mm	in.	mm	in.	mm	in.
4760	187.4	1990	1766	69.5	4080	160.6	4094	161.1
4910	193.3	2040	1816	71.4	4178	164.4	4192	165.0
5060	199.2	2140	1914	75.3	4178	164.4	4192	165.0
5510	216.9	2290	2062	81.1	4472	176.1	4486	176.6
5960	234.6	2490	2259	88.9	4864	191.4	4878	192.0
Lift height is measured from top of forks. Lift heights shown are standard. If your lift height is not shown, go to **Hyster Hypass Online** to find the correct header hose measurement for your lift height.								

Table 11. Standard Three-Stage FFL Hose Dimensions, Lift Truck Models J3.0-3.5XN (J60-70XN) (A276)

Lift Height		Channel Length (Reference)	Dimension "E"		Dimension "G" Third Function		Dimension "G" Fourth Function	
mm	in.	mm	mm	in.	mm	in.	mm	in.
4418	173.9	1990	1775	69.8	4208	165.6	4217	166.0
4568	179.8	2040	1824	71.8	4405	173.4	4414	175.7
4718	185.7	2140	1923	75.7	4405	173.4	4414	175.7
5168	203.5	2290	2070	81.4	4699	184.9	4708	185.3
5618	221.2	2490	2267	89.2	5092	200.4	5101	200.8
Lift height is measured from top of forks. Lift heights shown are standard. If your lift height is not shown, go to **Hyster Hypass Online** to find the correct header hose measurement for your lift height.								

3. Clamp the end of the hose (the smaller fitting) that attaches to the carriage in a vise (**DO NOT** clamp on the threads), and pull on the other end until the hose is straight. **DO NOT** apply enough force to stretch the hose.

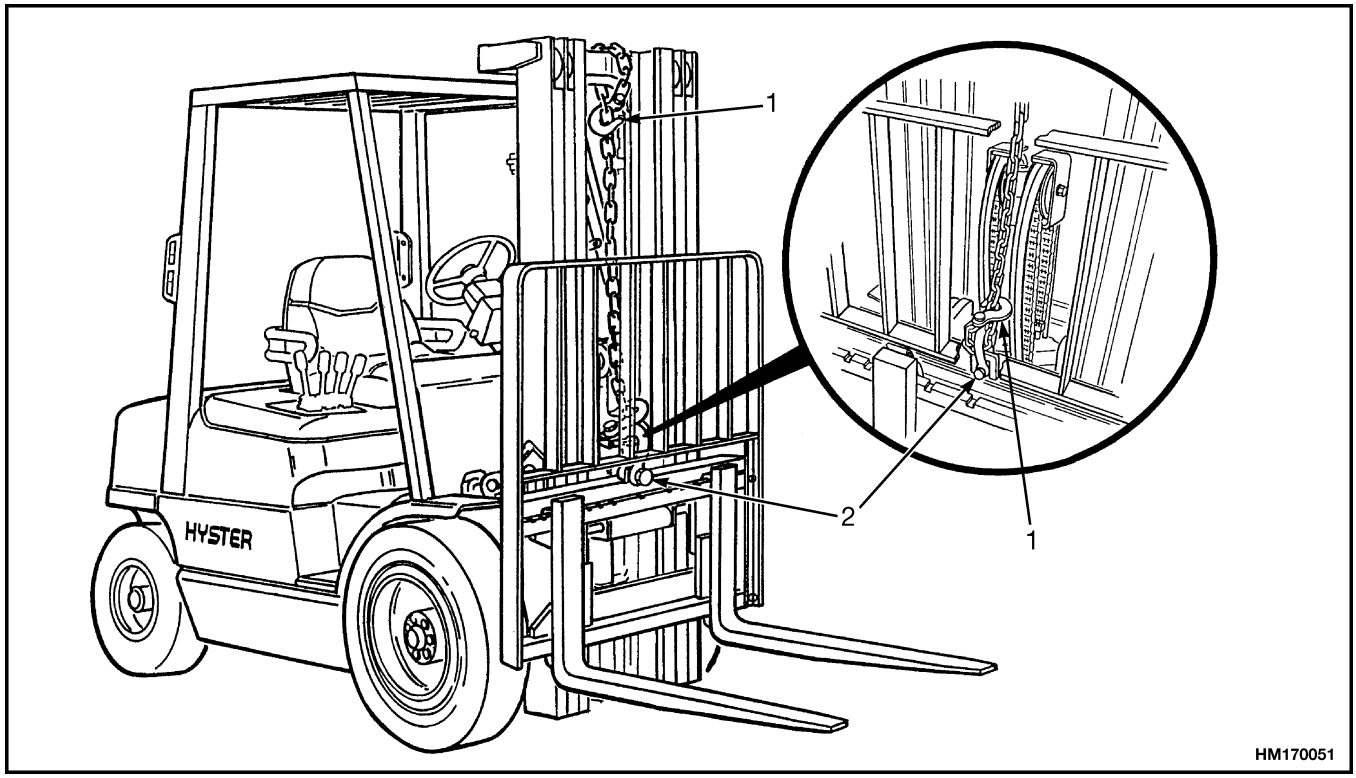
NOTE: These marks will be used to pretension the header hose during installation.

4. Place a mark on all the hoses at dimensions **E** and **G** (all measurements are made from the carriage end of the hose [the smaller fitting]). See Figure 80.

5. Attach the hoses to the carriage bracket with clamps. Apply spray lubricant to the surface of the hose guide that contacts the hoses. Tighten clamp hardware to 18 N•m (159 lbf in).

6. Place the hoses over the top of the free-lift chains and under the hose guides. Attach the hose guides to the lower crossmember and tighten the mounting hardware to 33 N•m (24 lbf ft). Make sure the bracket is between the crossmember and the hose guide. Put the clamps over the hoses and attach the clamps to the free-lift bracket. **DO NOT** tighten the hardware. See Figure 79.

NOTE: To make the alignment of dimension **E** easier, use a crane with a capacity of at least 907.2 kg (2000 lb) to raise the carriage high enough to attach a safety chain. See Figure 81.



1. HOOK
2. SHACKLE

Figure 81. Chaining the Carriage (FFL)

7. Align the mark for dimension **E** at the bottom of the clamp to create the proper hose tension. Tighten the hardware to 8 N•m (71 lbf in). Install the hose guards. Tighten the capscrews that mount the guards to 18 N•m (13 lbf ft).

8. Position the hoses at the hose sheave. The hose sheave and stub shaft must be installed on the hose before they are attached to the mast. Tighten the hardware to 66 N•m (49 lbf ft).

9. Put the clamps over the hoses and attach the clamps to the upper brackets. **DO NOT** tighten the hardware.

NOTE: To make the alignment of dimension **G** easier, use a crane to raise the inner channel high enough to install a safety chain.

10. Align mark **G** on hoses **A** and **D** at the bottom edge of clamp to create the proper tension. Align mark **G** on hoses **B** and **C** at the top edge of clamp to create the proper tension. Tighten the hardware to 8 N•m (71 lbf in). See .

11. Install the clamps. See Figure 82.

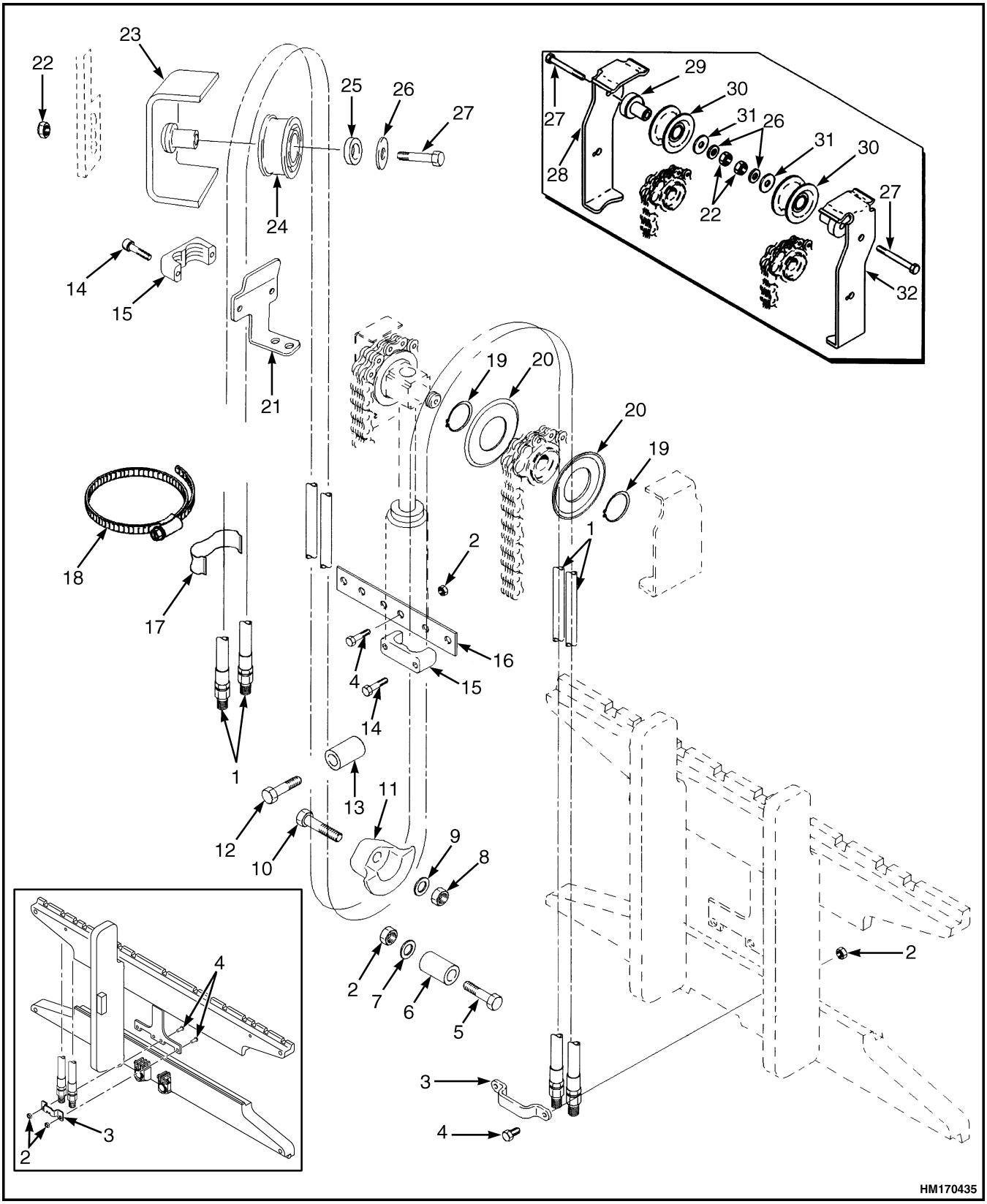


Figure 82. Header Hoses for Three-Stage Full Free-Lift (FFL) Mast

Legend for Figure 82.

1. HOSE
2. NUT
3. CLAMP
4. CAPSCREW
5. CAPSCREW
6. RESTRAINT
7. WASHER
8. NUT
9. WASHER
10. CAPSCREW
11. SHEAVE
12. CAPSCREW
13. TUBE
14. CAPSCREW
15. CLAMP
16. PLATE
17. CLAMP
18. CLAMP
19. SNAP RING
20. HOSE GUIDE
21. BRACKET
22. NUT
23. STUB SHAFT
24. HOSE GUIDE AND SHEAVE
25. SPACER
26. WASHER
27. CAPSCREW
28. BRACKET (RH)
29. STUB SHAFT
30. SHEAVE
31. WASHER
32. BRACKET (LH)

12. Connect the header hoses to the cowl hoses.

13. Use the rubber clamps and strap clamps to attach the hoses to the main lift cylinders. Make sure the hoses do not stretch or fold while tilting the mast fully forward and backward.

Adjustment

When properly adjusted, the hoses will not be so tight that they compress when they pass over the sheaves, nor will they be so loose that they touch the load backrest or any crossmember that is next to a sheave.

1. Cap off hoses when attachments have been removed.

2. Check that hoses and cables are routed properly.

3. Slowly raise the free-lift and main cylinders to take up slack in the lift chains.

4. Tighten strap clamps at the bracket weldment.

5. Cycle the mast a few times to ensure proper tracking of hoses.

6. Secure hose assemblies to main lift cylinders with hose clamp and screw clamp.

NOTE: If the hose tension between the carriage and the clamp at the free-lift bracket is correct, go to Step 7.

If the hose tension between the carriage and the clamp at the free-lift bracket is incorrect, loosen the clamps and pull (if the hoses are loose) or push (if the hoses are tight) on the hoses so they move 15.0 mm (0.6 in.) side to side. Tighten the hardware to 8 N•m (71 lbf in).

NOTE: If the hose tension between the clamp at the upper bracket and the clamp at the free-lift bracket is correct, go to Step 8.

7. If the tension of the hoses is incorrect, loosen the clamps and pull the hoses down (if too loose) or push the hoses up (if too tight) so they can move 15.0 mm (0.6 in.) side to side. Retighten the hardware to 8 N•m (71 lbf in).

8. With no load on the forks, check the header hose adjustment by operating the mast through the full lift cycle two times. When properly adjusted, the hoses will not be so tight that they compress when they pass over the sheaves nor will they be so loose that they touch the load backrest or any crossmember that is next to a sheave. If necessary, repeat until the hoses are properly adjusted.

Four-Stage Mast With Full Free-Lift Repair

NOTE: This information in this section applies only to lift truck models E2.2-3.5XN (E45-70XN) (A268) .

REMOVE

WARNING

The mast is heavy. The mast can weigh approximately 907 kg (2000 lb). Make sure all lifting devices (hoists, cables, chains, slings, etc.) are suitable and of adequate capacity to lift the mast. Serious injury can occur if the mast falls.

WARNING

Mast weldments can slide when the mast is moved. A weldment that slides can cause serious injury.

CAUTION

Make sure all the mast weldments are fastened together. Make sure the safety chains will not damage the sheaves, tubing, or other parts of the mast.

NOTE: If the mast needs to be disassembled, remove the forks and carriage. See the sections Fork Replacement and Carriages Repair for procedures. If only the main lift cylinders need to be repaired, the mast does not need to be removed from the lift truck. See the section **Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564)** 2100SRM1382 for procedures. For header hose installation and adjustment procedures, see the section
Header Hose Installation and Adjustment.

NOTE: The length of the lift chains must be checked before the mast is removed. See the section Lift Chains Adjustment in this manual.

1. Fully lower all mast weldments. Tilt the mast fully forward. Connect a crane with a capacity of at least 907 kg (2000 lb) to all top crossmembers of the mast weldments using chains to support the mast in an upright position when the tilt cylinders are disconnected.

WARNING

Hydraulic oil is hot after system operation and can cause burns. DO NOT disconnect any hydraulic hoses until the oil in the system has cooled.

Completely lower forks to relieve hydraulic pressure before disconnecting any hoses.

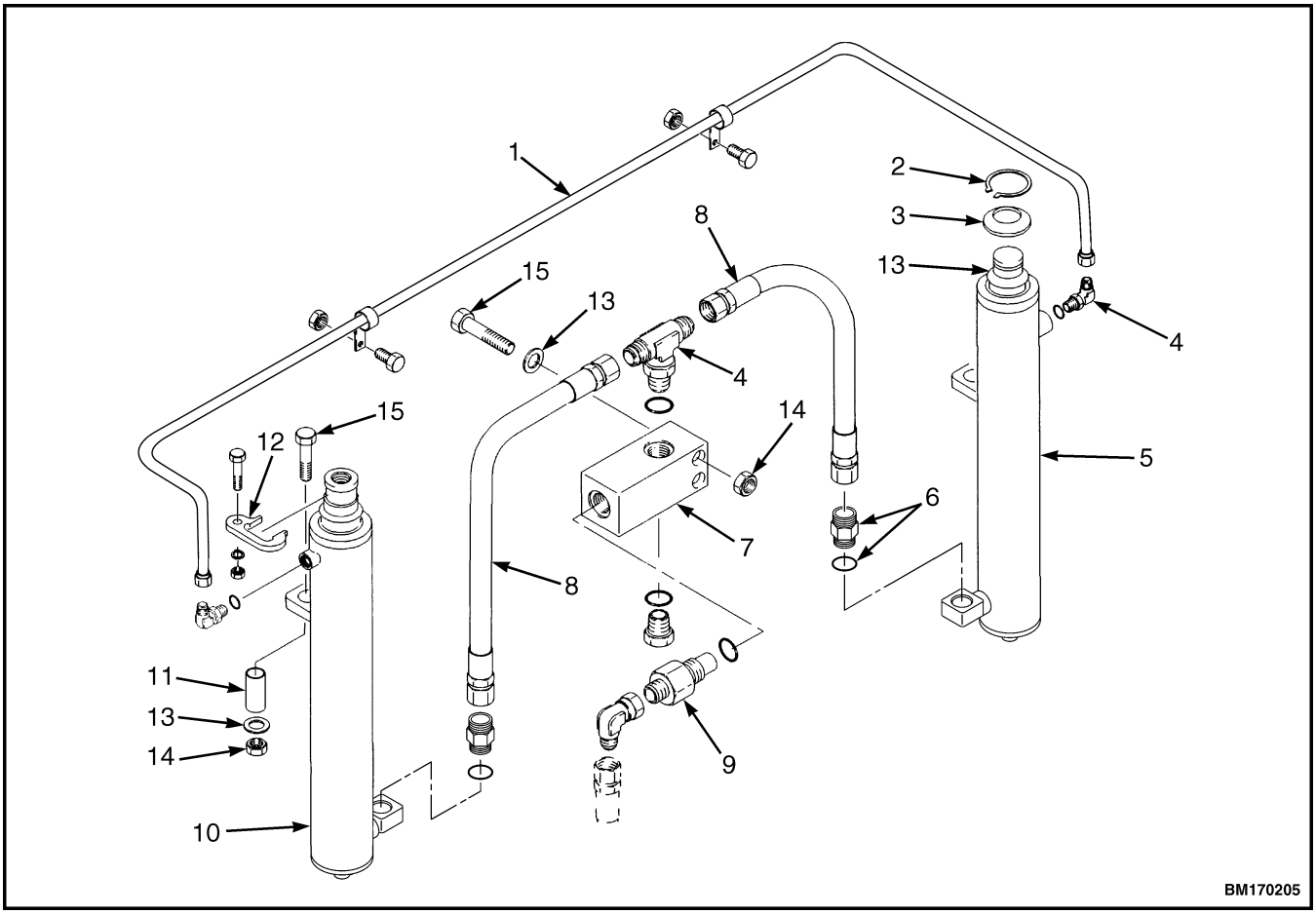
CAUTION

Protect the hydraulic system from dirt and contaminants when disconnecting hydraulic hoses from the mast. If hydraulic system becomes contaminated, damage to hydraulic system can occur.

CAUTION

Disposal of lubricants and fluids must meet local environmental regulations.

2. Position a drip pan under the area of the hydraulic fittings. Disconnect the hydraulic line at the lowering control valve on the outer mast. See Figure 83.



1. BALANCE LINE
2. SNAP RING
3. SHIM
4. FITTING AND O-RING
5. MAIN LIFT CYLINDER (LH)
6. VELOCITY FUSE
7. LOWERING CONTROL VALVE HOUSING
8. HOSE
9. LOWERING CONTROL VALVE
10. MAIN LIFT CYLINDER (RH)
11. SPACER
12. RETAINER
13. WASHER
14. NUT
15. CAPSCREW

Figure 83. Main Lift Cylinders and Lowering Control Valve

WARNING

Use a driver, NOT your fingers, to push the anchor pins from the clevises on the tilt cylinders. The cylinder or mast can move and cause serious injury.

3. Remove the capscrews, washers, nuts, anchor pins, and pivot pins at the tilt cylinder mounts on the outer mast. See Figure 84.

4. Using a brass drift pin, remove tilt rod bushings from outer mast. Discard tilt rod bushings. See Figure 85.

NOTE: Tilt the mast forward enough to allow for access to mast mount capscrews. See Figure 86.

5. Disconnect the lower mast mounts from the lift truck by removing the capscrews that hold the mast pivot pins to the mounts on the drive axle. See Figure 87.

6. Use the lifting device to lift the mast assembly from the lift truck. Position the outer mast across wooden beams on the floor with the carriage side up.

7. Check the mast and mounting flanges for wear or damage by removing the mast pivot pins from the outer mast. Check that the pins fit snug in the outer mast. If pins can be moved up and down a minimum of 4 mm (0.20 in.), replace bushings in outer mast and/or mast pivot pins as required. See Figure 88. Use a brass drift pin to remove mast mounting bushings from outer mast. See Figure 85.

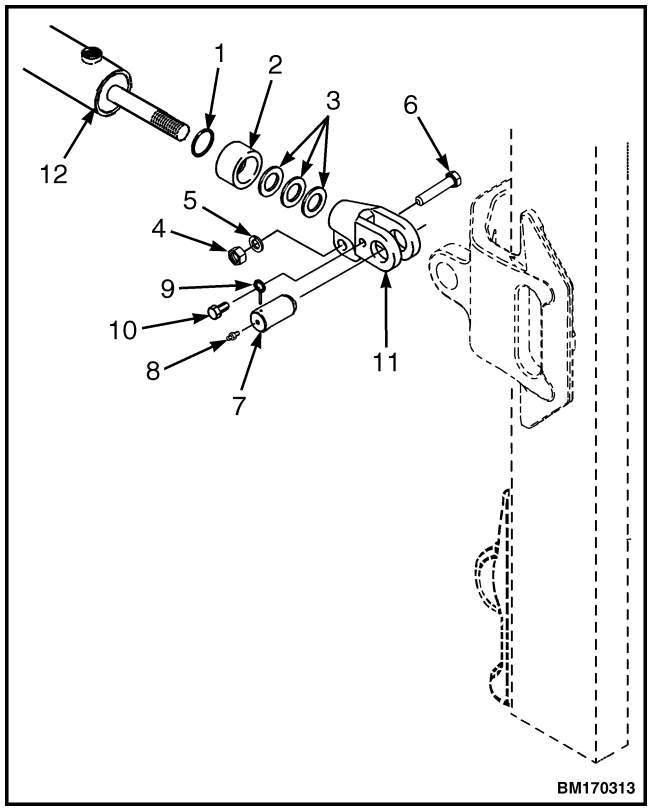
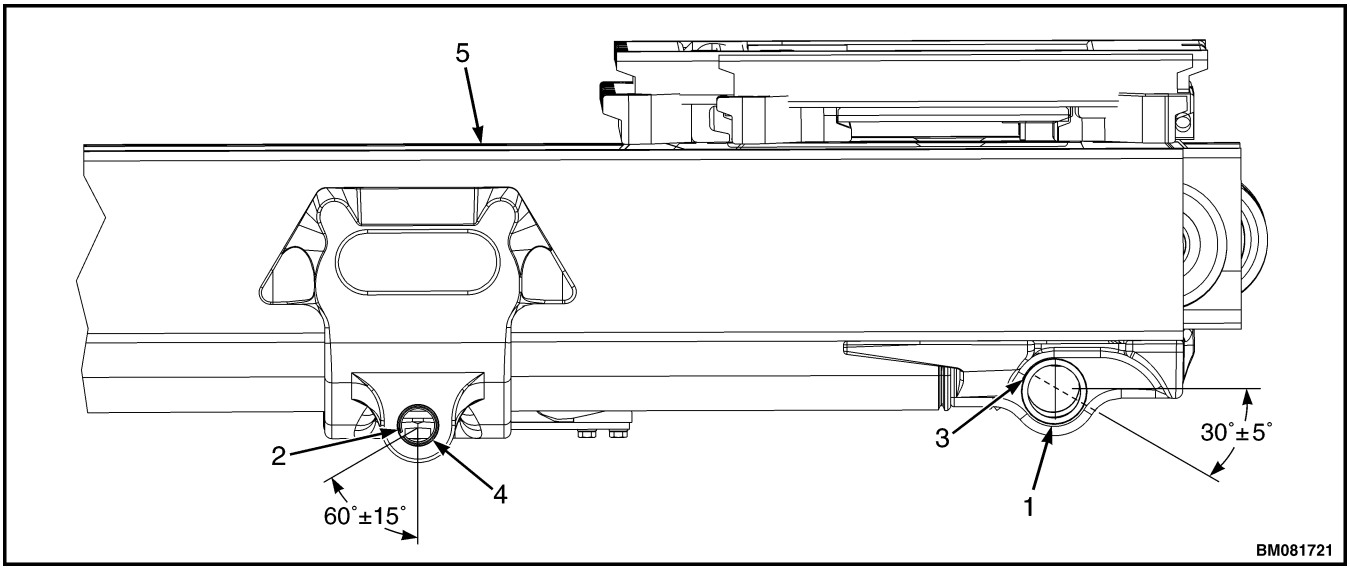


Figure 84. Mast Mounting

Legend for Figure 84.

1. O-RING
2. SPACER
3. SHIMS
4. NUT
5. WASHER
6. CAPSCREW
7. PIVOT PIN
8. GREASE FITTING
9. ANCHOR PIN
10. CAPSCREW
11. ROD END
12. TILT CYLINDER



1. MAST MOUNTING BUSHING
2. BUSHING SPLIT
3. BUSHING HOLE
4. TILT ROD BUSHING
5. OUTER MAST

Figure 85. Tilt Rod and Mast Mounting Bushings

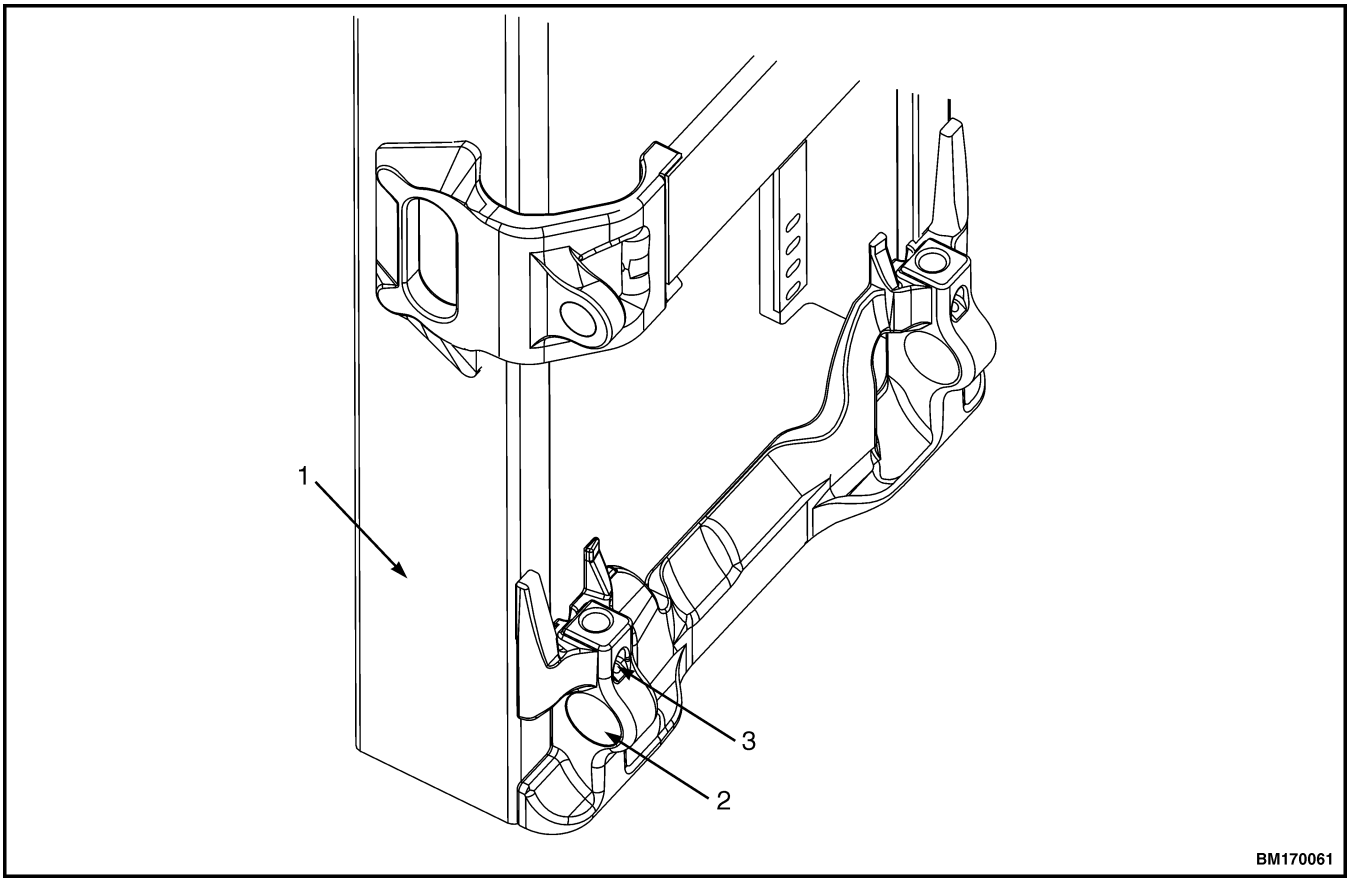
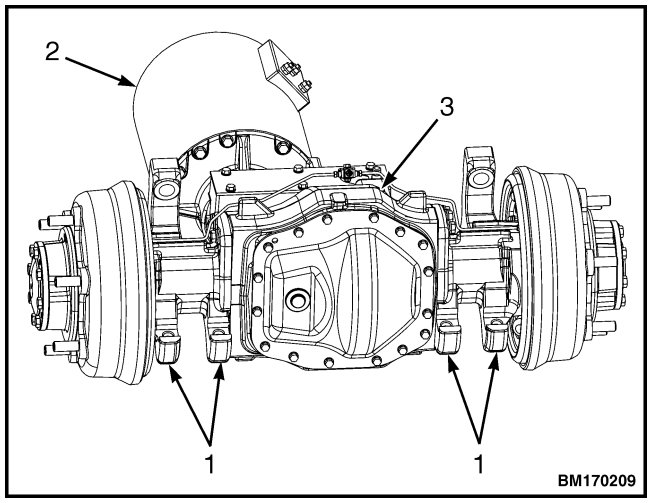


Figure 86. Mast Mounts, Drive Axle

Legend for Figure 86.

1. OUTER MAST
2. BUSHING
3. GREASE FITTING



NOTE: DRIVE AXLE FOR LIFT TRUCK MODELS E2.2-3.5XN (E45-70XN) (A268) SHOWN. HANGER MOUNTS THE SAME FOR J2.2-3.5XN (J45-70XN) (A276) LIFT TRUCK MODELS.

1. HANGER MOUNTS
2. TRACTION MOTOR
3. DRIVE AXLE

Figure 87. Drive Axle Mast Hanger Mounts

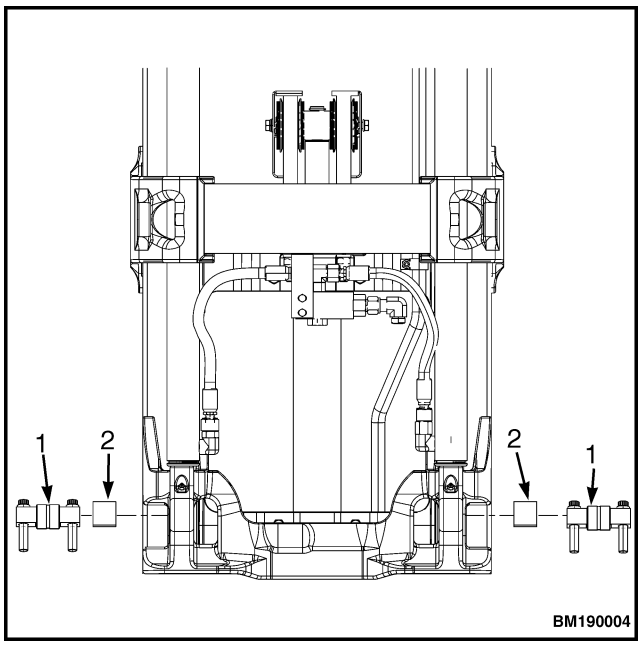


Figure 88. Mast Pivot Pin

Legend for Figure 88.

1. MAST PIVOT PINS
2. BUSHING

DISASSEMBLE

WARNING

Hydraulic oil is hot after system operation and can cause burns. DO NOT disconnect any hydraulic hoses until the oil in the system has cooled.

Completely lower forks to relieve hydraulic pressure before disconnecting any hydraulic hoses.

CAUTION

Protect the hydraulic system from dirt and contaminants when disconnecting hydraulic hoses from the mast. If hydraulic system becomes contaminated, damage to the hydraulic system can occur.

NOTE: If only the main lift cylinders need to be removed for repair, the mast does not need to be removed from the lift truck. See the section **Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564)** 2100SRM1382 for procedures to remove the main lift cylinders. When the mast has header hoses, see the section Header Hose Installation and Adjustment in this manual.

1. Disconnect and remove hydraulic lines for free-lift cylinder. Remove brackets for free-lift cylinder. Remove free-lift cylinder. Disconnect free-lift chains at crossmember See Figure 89.

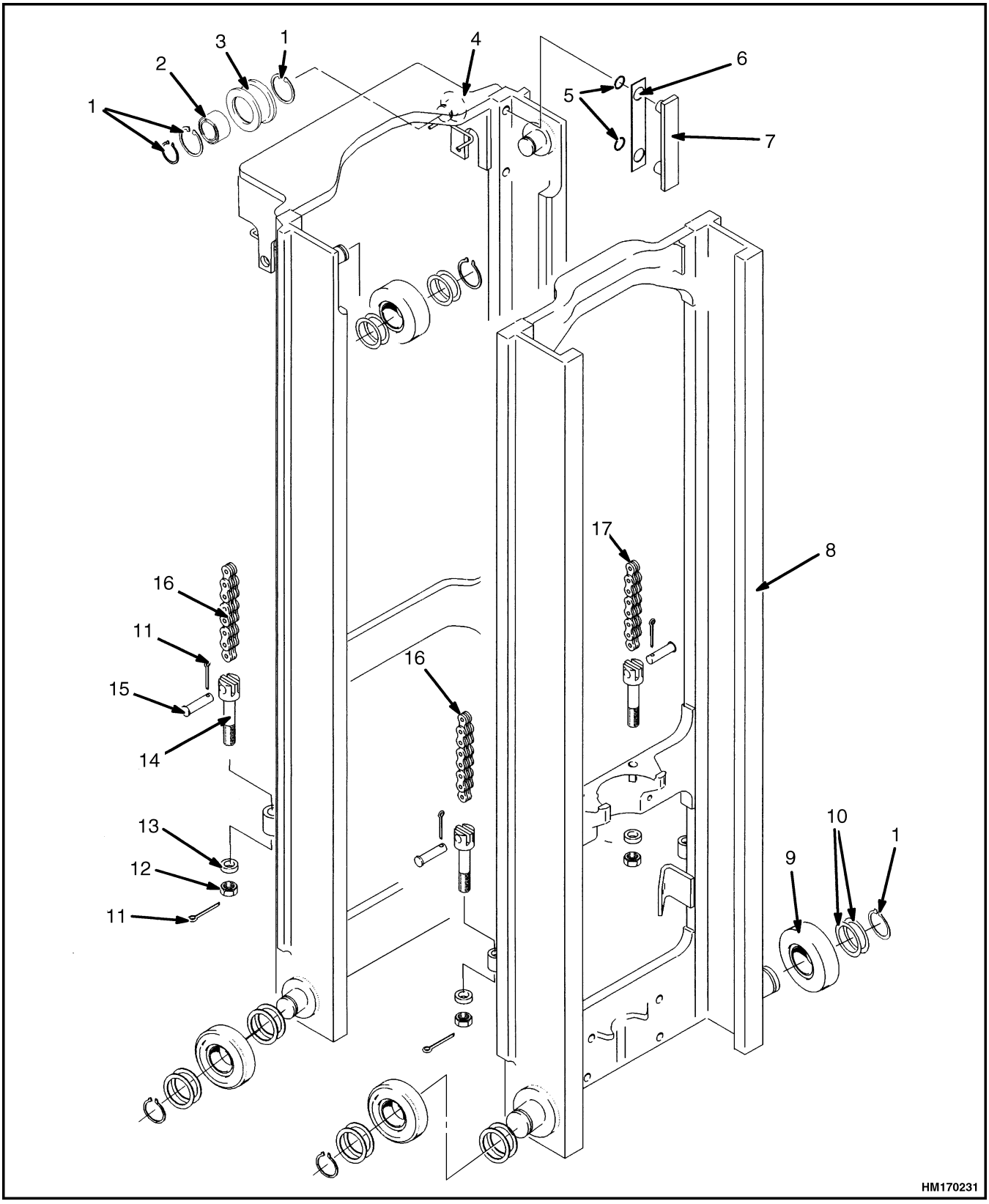


Figure 89. Second Intermediate and Inner Mast

Legend for Figure 89.

1. SNAP RING
2. BEARING
3. CHAIN SHEAVE
4. SECOND INTERMEDIATE MAST
5. O-RING
6. SHIM(S)
7. STRIP BEARING
8. INNER MAST
9. LOAD ROLLER
10. SHIMS
11. COTTER PIN
12. NUT
13. WASHER
14. CHAIN ANCHOR
15. ANCHOR PIN
16. LIFT CHAIN
17. FREE-LIFT CHAIN

2. Disconnect lift chains at bottom of inner mast and top of first intermediate mast. Remove lift chains. Push inner mast toward bottom of mast assembly until bottom load rollers are seen. See Figure 89 and Figure 90.

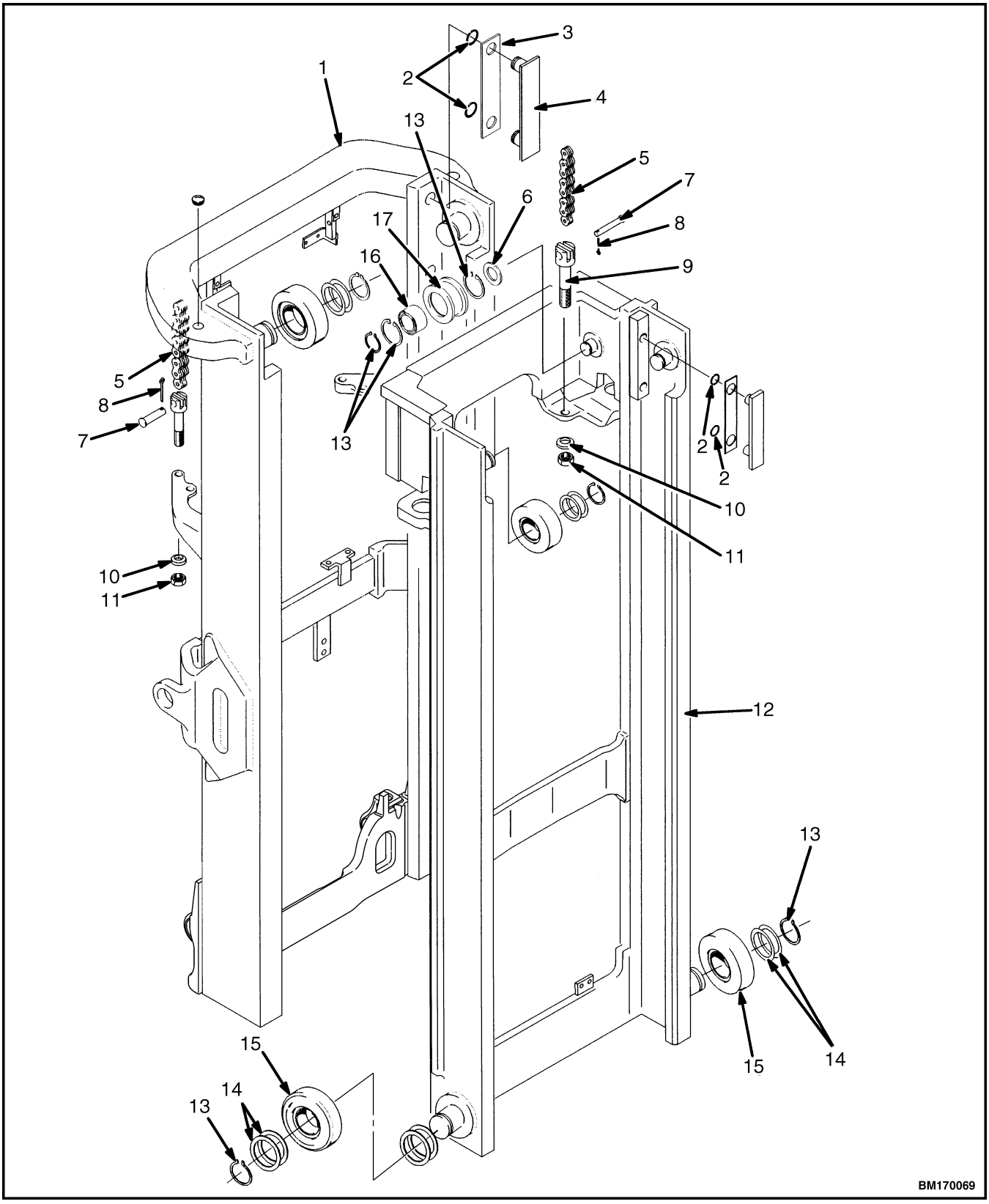


Figure 90. Outer and First Intermediate Masts

Legend for Figure 90.

1. OUTER MAST
2. O-RING
3. SHIM(S)
4. STRIP BEARING
5. LIFT CHAIN
6. SPACER
7. ANCHOR PIN
8. COTTER PIN
9. CHAIN ANCHOR
10. WASHER
11. NUT
12. FIRST INTERMEDIATE MAST
13. SNAP RING
14. SHIMS
15. LOAD ROLLER
16. BEARING
17. CHAIN SHEAVE
18. LOWERING CONTROL VALVE BRACKET

3. Remove strip bearings at top of second intermediate mast. Remove load rollers at bottom of inner mast. See Figure 89. Remove load rollers at top of second intermediate mast. Make a note of each shim arrangement and load roller location. The shim arrangements will be approximately the same during assembly.

WARNING

The mast is heavy. The mast can weigh approximately 907 kg (2000 lb). Make sure all lifting devices (hoists, cables, chains, slings, etc.) are suitable and of adequate capacity to lift the mast.

4. Slide inner mast halfway out of top of second intermediate mast. Connect crane to center of inner mast. See Figure 91. Slide inner mast out until stubshafts are in notches of second intermediate mast. Remove inner mast from second intermediate mast.

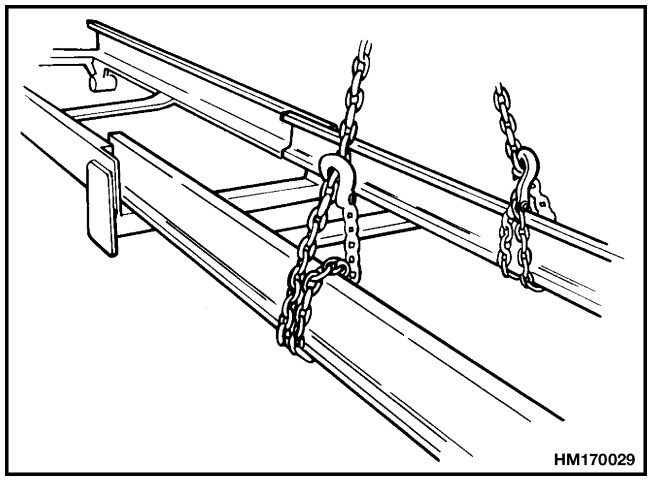


Figure 91. Mast Disassembly

5. Disconnect lift chains at bottom of second intermediate mast and top of outer mast. Remove lift chains. Push second intermediate mast toward bottom of mast assembly until bottom load rollers are seen. See Figure 89 and Figure 90.

6. Remove strip bearings and spacers at top of first intermediate mast. Remove load rollers at bottom of second intermediate mast. Remove load rollers at top of first intermediate mast. Make a note of each shim arrangement and load roller location. The shim arrangements will be approximately the same during assembly. See Figure 89 and Figure 90.

WARNING

The mast is heavy. The mast can weigh approximately 907 kg (2000 lb). Make sure all lifting devices (hoists, cables, chains, slings, etc.) are suitable and of adequate capacity to lift the mast.

WARNING

The weldments can slide when the mast is moved. A weldment that slides can cause injury. Use a crane to turn the mast slowly and carefully.

7. Slide second intermediate mast halfway out of top of first intermediate mast. Connect crane to center of second intermediate mast. See Figure 91. Slide second intermediate mast out until stub shafts are in notches of first intermediate mast. Remove second intermediate mast.

8. Disconnect hydraulic lines at top and bottom of lift cylinders. Disconnect balance line at top of right-hand lift cylinder. See Figure 83.

WARNING

Be careful when removing or installing snap rings on the main lift cylinders. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers and wear eye and face protection when removing and installing snap rings onto main lift cylinders.

9. Remove snap rings, shims, and washers at top of main lift cylinders. See Figure 83. Remove nut, capscrew, washer, and spacer at mount near top of each main lift cylinder.

10. Push first intermediate mast to disengage lift cylinders. Remove main lift cylinders. Keep shims from top of right-hand lift cylinder with cylinder.

WARNING

The weldments can slide when the mast is moved. A weldment that slides can cause injury. Use a crane to turn the mast slowly and carefully.

11. Slide first intermediate mast from bottom of outer mast approximately 30 cm (12 in.). Remove strip bearings at top of outer mast. Remove snap rings and load rollers from both mast uprights. Make a note of each shim arrangement and load roller location. The shim arrangements will be approximately the same during assembly.

WARNING

The mast is heavy. The mast can weigh approximately 907 kg (2000 lb). Make sure all lifting devices (hoists, cables, chains, slings, etc.) are suitable and of adequate capacity to lift the mast.

WARNING

The weldments can slide when the mast is moved. A weldment that slides can cause injury. Use a crane to turn the mast slowly and carefully.

12. Slide intermediate mast halfway out of top of outer mast. Connect crane to center of first intermediate mast. See Figure 91. Slide first intermediate mast out of outer mast until stub shafts are in notches of outer mast. Remove first intermediate mast from outer mast.

13. Disassemble chain sheaves as necessary for repair and cleaning. Remove hydraulic lines and fittings from mast uprights as necessary.

CLEAN AND INSPECT

CAUTION

DO NOT use steam or high-pressure water to clean the load rollers or the lift chains. Steam and high-pressure water can remove the lubrication from the bearings in the load rollers. Water in the bearings of the sheaves and the link pins of chains can also shorten the service life of these parts.

1. Inspect chain sheaves and load rollers for wear or damage. **DO NOT** use steam to clean lift chain sheaves or load rollers. The bearings in the sheaves and load rollers are sealed and lubricated.

WARNING

Cleaning solvents may be flammable and toxic and can cause severe skin irritation. When using commercial cleaning solvents, always comply with solvent manufacturer's recommended safety precautions.

WARNING

Compressed air can move particles so that they cause injury to the user or to other personnel. Make sure that the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eyes.

2. Clean the lift chains by soaking in solvent for 30 minutes to remove all dirt and grease. Hang lift chains up and remove solvent using compressed air.

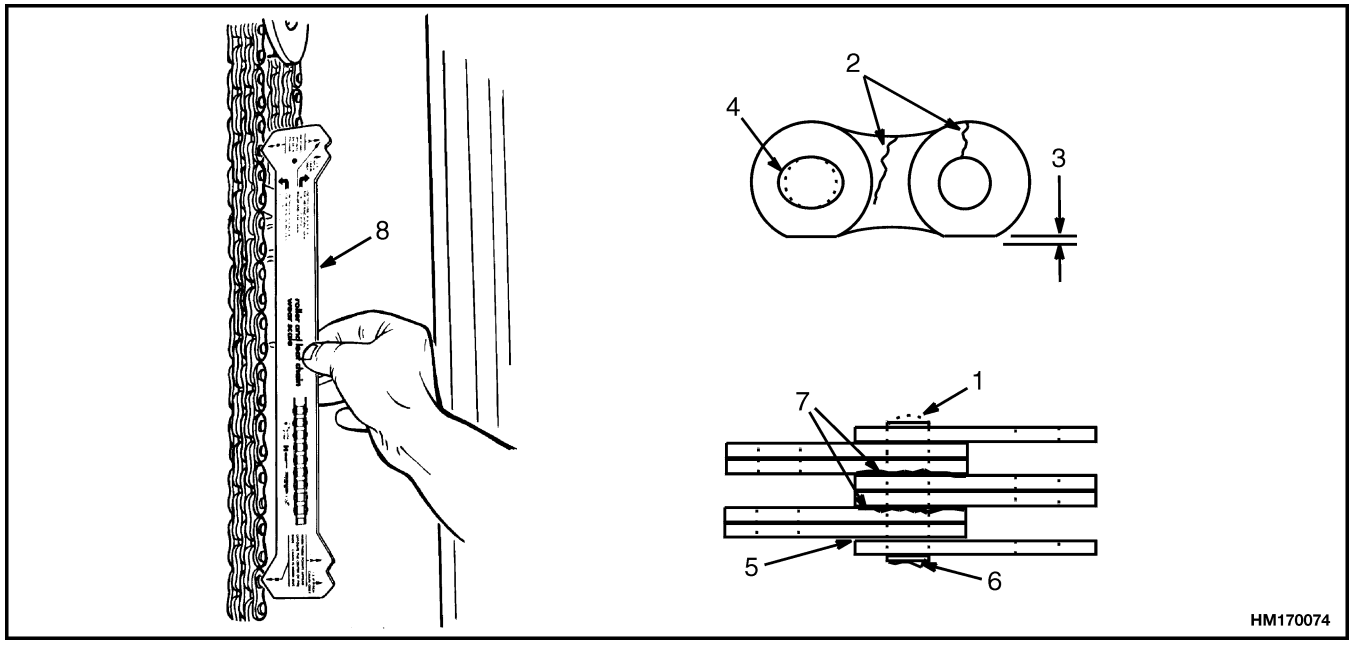
WARNING

Never replace only the worn section of a chain. Replace the complete chain. Never replace only one chain of a chain pair. Replace both chains. Damage to the lift truck and serious injury can occur if lift chains are not replace correctly.

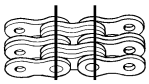
NOTE: The chains must be inspected in the area of chain that passes over the chain sheave during the first portion of a lift. These links will show maximum wear.

3. Inspect the lift chains for wear and damage. A lift chain becomes longer when it is worn. If a chain is 3% longer than a new lift chain, the lift chain must be replaced.

4. If a chain scale is available (Hyster Part No. 599737) , check lift chains as shown in Figure 92. If a chain scale is not available measure 20 links of chain. Measure from the center of a pin to the center of another pin 20 pitches away. Compare the length with the chart in Figure 92. Replace chain if the length of 20 links of the worn section is more than the maximum wear limit.



NOTE: THE INSTRUCTIONS FOR MEASURING CHAIN WEAR ARE SHOWN ON THE CHAIN WEAR SCALE.

Pitch 	Total length of 20 links (pitch) of new chain	Wear Limit The maximum length of 20 links
12.7 mm (0.5 in.)	254.0 mm (10.0 in.)	261.6 mm (10.3 in.)
15.9 mm (0.6 in.)	317.5 mm (12.5 in.)	327.0 mm (12.9 in.)
19.1 mm (0.8 in.)	381.0 mm (15.0 in.)	392.4 mm (15.4 in.)
25.4 mm (1.0 in.)	508.0 mm (20.0 in.)	523.3 mm (20.6 in.)

1. WORN PIN
2. CRACKS
3. EDGE WEAR
4. HOLE WEAR
5. LOOSE LEAVES
6. DAMAGED PIN
7. RUST
8. CHAIN WEAR SCALE

Figure 92. Lift Chains Check

5. Lubricate lift chains by soaking them in SAE 30 engine oil for 30 minutes. Hang chains over a drip pan for one hour to remove excess oil.

6. Inspect the chain anchors and pins. Replace any parts that are worn or damaged.

NOTE: Chain anchor pins **MUST** be replaced anytime chains are replaced.

WARNING

Cleaning solvents may be flammable and toxic and can cause severe skin irritation. When using commercial cleaning solvents, always comply with solvent manufacturer's recommended safety precautions.

WARNING

Steam can cause serious burns. Wear protective clothing, gloves, and eye protection. Never expose your skin to steam.

7. Clean the mast weldments with steam or solvent.

WARNING

Improper welding procedures can damage the structure of the mast or cause incorrect function of the mast which can result in serious injury to personnel. Consult your Hyster lift truck dealer for more information before welding on the mast.

8. Inspect the sliding surfaces for wear or damage. Inspect the load roller contact surfaces for wear or damage. Inspect all welds for cracks.

ASSEMBLE

WARNING

The mast is heavy. The mast can weigh approximately 907 kg (2000 lb). Make sure all lifting devices (hoists, cables, chains, slings, etc.) are suitable and of adequate capacity to lift the mast.

WARNING

The weldments can slide when the mast is moved. A weldment that slides can cause injury. Use a crane to turn the mast slowly and carefully.

NOTE: The shims for the load rollers keep the mast uprights parallel and provide correct clearance. During assembly, the shim arrangement will be approximately the same as before disassembly. Check clearance and adjust shims for wear or for changes caused by repairs. The strip bearings are also adjusted by using shims. See the section Mast Adjustments for the adjustment procedures.

NOTE: When the mast has header hoses installed, see the procedures in the section Header Hose Installation and Adjustment.

1. Put outer mast on floor with mast pivots toward floor. See Figure 86 Connect crane to center of first intermediate mast. Fit lower stubshafts of first intermediate mast into notches in top of outer mast. Slide first intermediate mast into outer mast so stubshafts are seen at top and bottom of both mast uprights.

2. Install strip bearings and shims on channels of outer mast. See Figure 93. Apply grease to bearing surfaces.

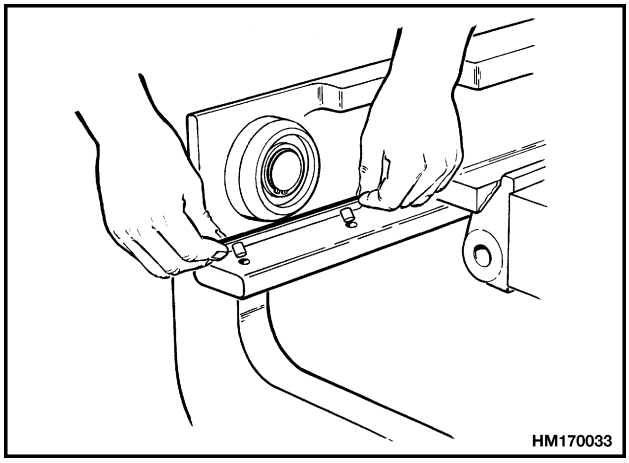


Figure 93. Strip Bearings

3. Install load rollers and shims on outer mast and at bottom of first intermediate mast. Before doing Step 4, adjust first intermediate mast as described in Mast Adjustments in this service manual. Install chain sheaves, shims, and snap rings on first intermediate weldment.

WARNING

Be careful when removing or installing snap rings on the main lift cylinders. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers and wear eye and face protection when removing and installing snap rings onto main lift cylinders.

4. Install main lift cylinders in mounts at bottom of outer mast. See Figure 83. Push intermediate mast to engage lift cylinders. Check clearance at top of lift cylinder mounts. Add or remove shims at top of left cylinder rod until both cylinders are even. Install retainer at top of right cylinder. Install snap ring and washer at top of lift cylinders. Install nuts, capscrews, washers, and spacers at lift cylinder mounts on outer mast. Tighten nuts to 40 N•m (30 lbf ft).

5. Install housing for lowering control valve on outer mast. Tighten nuts for lowering control valve to 18 N•m (13 lbf ft). Install lowering control valve in housing. Connect hydraulic lines and fittings between lowering control valve and main lift cylinders. See Figure 83.

6. Install chain sheaves and snap rings on second intermediate mast. See Figure 89.

WARNING

The mast is heavy. The mast can weigh approximately 907 kg (2000 lb). Make sure all lifting devices (hoists, cables, chains, slings, etc.) are suitable and of adequate capacity to lift the mast.

WARNING

The weldments can slide when the mast is moved. A weldment that slides can cause injury. Use a crane to turn the mast slowly and carefully.

7. Connect crane to center of second intermediate mast (see Figure 91). Slide mast into first intermediate mast so stub shafts are seen at top and bottom of both mast uprights.

8. Install strip bearings and shims on channels of first intermediate mast. See Figure 93. Apply grease to bearing surfaces. Install load rollers and shims on first and second intermediate mast. Before doing Step 9, adjust second intermediate mast as described in Mast Adjustments.

9. Connect lift chains to chain anchors at outer mast. Put lift chains over chain sheaves on first intermediate mast and connect them to anchors at bottom of second intermediate mast.

10. Connect crane to center of inner mast. See Figure 91. Slide mast into second intermediate mast so stub shafts are seen at top and bottom of both uprights.

11. Install strip bearings and shims on channels of second intermediate mast. Apply grease to bearing surfaces. Install load rollers and shims on second intermediate and inner mast. Before doing Step 12, adjust inner mast as described in Mast Adjustments.

12. Connect lift chains to chain anchors at top of first intermediate mast. Put lift chains over chain sheaves on second intermediate mast and connect them to anchors at bottom of inner weldment. See Figure 90.

13. Install free-lift cylinder in mounts on inner mast. Install brackets for cylinder and tighten nuts and capscrew to 40 N•m (30 lbf ft). See Figure 94.

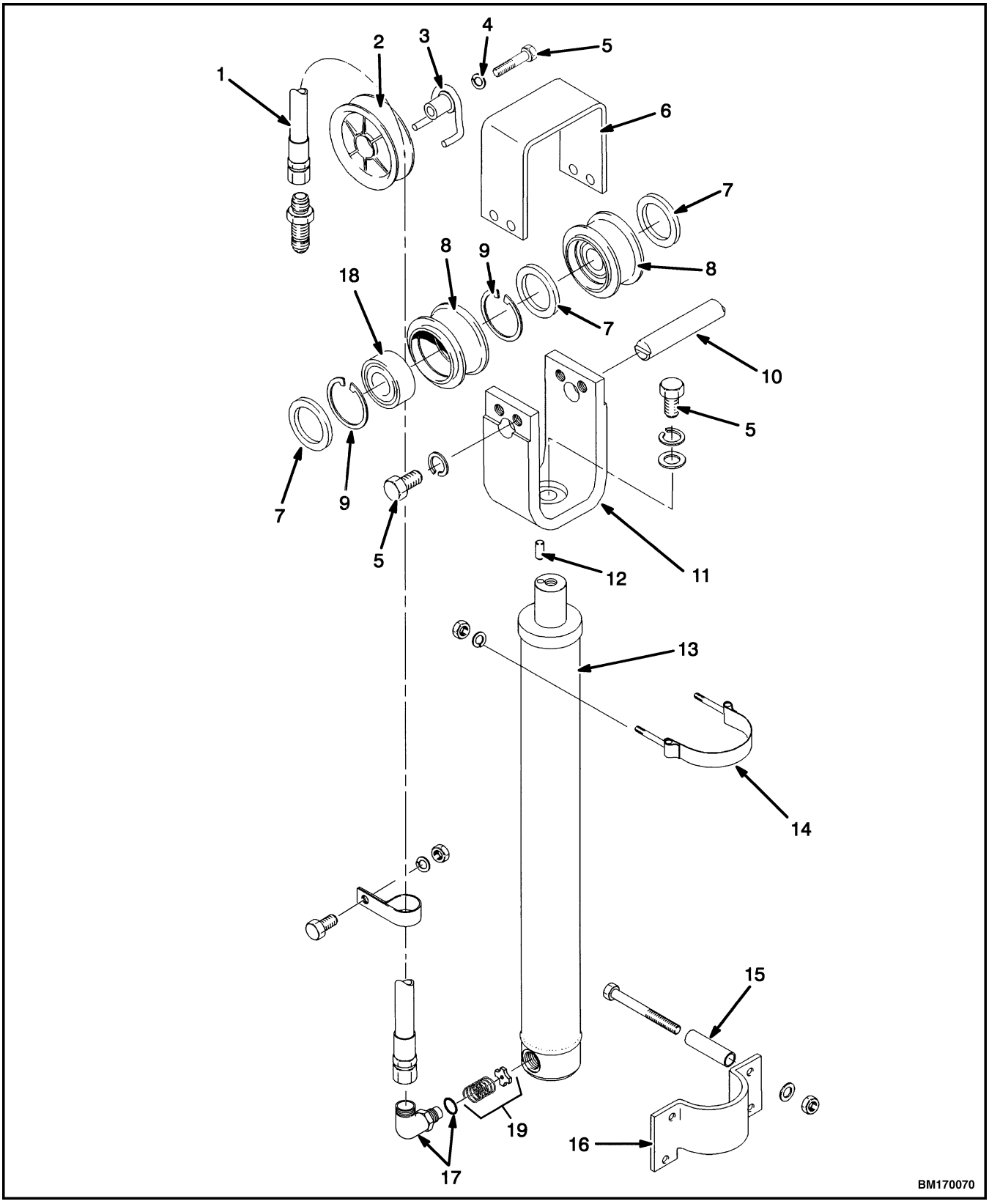


Figure 94. Free-Lift Cylinder Assembly

Legend for Figure 94.

1. HOSE
2. SHEAVE
3. STUB SHAFT
4. LOCKWASHER
5. CAPSCREW
6. CHAIN GUARD
7. SPACER
8. CHAIN SHEAVE
9. RETAINING RING
10. PIN
11. BRACKET
12. PIN
13. FREE-LIFT CYLINDER
14. CLAMP
15. STANDOFF
16. CLAMP
17. FITTING
18. BEARING
19. FLOW CONTROL ASSEMBLY

14. Install hose sheave for free-lift cylinder. See Figure 94. Install hydraulic hose and tubing that connect free-lift cylinder to right-hand lift cylinder. Install balance line between two main lift cylinders. See Figure 83.

15. Connect free-lift chains to chain anchors at inner crossmember. Attach wire between other end of lift chain and bottom of mast to control free-lift chain during installation of mast.

INSTALL

1. Install new bushings into mast mounts at bottom of outer mast. Be sure the hole and bushing split are installed at the correct angle as shown in Figure 85. Bushing must be flush with outer mast surface.

2. Apply an even coat of grease to the mast pivot pins and install them into the mounts at the bottom of the outer mast. See Figure 86.

WARNING

The mast is heavy. The mast can weigh approximately 907 kg (2000 lb). Make sure all lifting devices (hoists, cables, chains, slings, etc.) are suitable and of adequate capacity to lift the mast. Serious injury can occur if the mast falls.

3. Connect a lifting device to the top of the mast using chains. Make sure all mast uprights are fastened together. Make sure chains will not damaged chain sheaves, tubing, or other parts of the mast.

4. Use the lifting device and position mast so that the pivot pins seat into hanger mounts on the drive axle. See Figure 87. Install capscrews that hold mast pivot pins to drive axle hangers and tighten capscrews to 270 N•m (199 lbf ft). See Figure 88.

5. Install new tilt rod bushings into outer mast. Be sure to install bushings with split at correct angle as shown in Figure 85.

WARNING

Use a pry bar, NOT your fingers, to align the tilt cylinder clevises with the outer mast. The cylinder or mast can shift and cause serious injury.

NOTE: Use multipurpose grease #2 with 2 to 4% molybdenum disulfide for normal operations.

6. Apply grease to pivot pins and connect tilt cylinders to mast using pivot pins. Install anchor pins and capscrews to rod ends. Apply anti-seize compound to capscrew threads and tighten 38 N•m (28 lbf ft). See Figure 84.

7. Connect hydraulic line to lowering control valve.

8. Install the carriage as described in Carriages Repair and install the forks as shown in the section Fork Replacement in this service manual.

9. Check the tilt cylinder adjustment. See the service manual **Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564)** 2100SRM1382 for the procedures. Operate the mast and check for leaks and to ensure mast is operating correctly. Check lift chains as described in the section Lift Chains Adjustment.

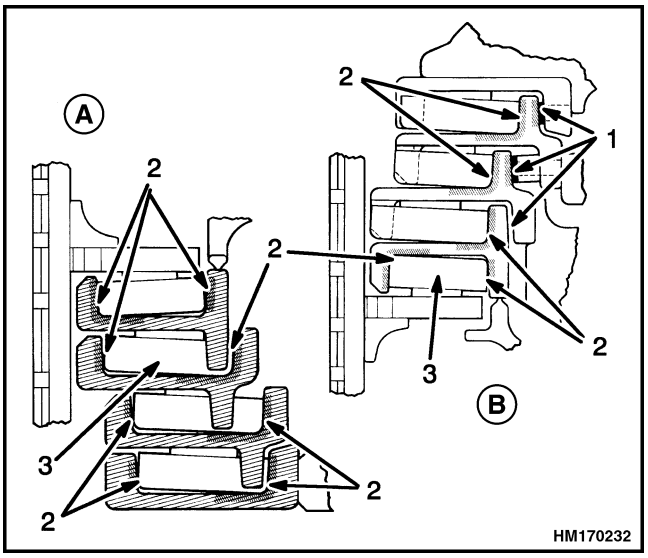
NOTE: Before checking for mast side kicking and adjusting the chain anchors on the main lift cylinders, the mast must be fully assembled to include the carriage, forks, load backrest and any attachments if the lift truck is equipped with one.

10. Adjust chain anchors on the outer mast until the tops of the second intermediate and outer mast are at the same level within ±1.5 mm (0.06 in.). See Figure 90. Adjust chain anchors on the first intermediate mast until the tops of the inner and outer mast are at the same level within ±1.5 mm (0.06 in.).

NOTE: Before checking for mast side kicking, the mast must be fully assembled to include the carriage, forks, load backrest and any attachments.

11. Raise the mast, without a load to its full height and check for side kicking. Mast side kicking is where the mast, without a load, moves either to the right or left as it is being raised to its full height. If the mast is side kicking, see the Mast Adjustments section for procedures to correct mast side kicking.

12. Lubricate the sliding surfaces and load roller surfaces along the full length of the channels as shown in Figure 95. Apply lubricant only to surfaces indicated in Figure 95.



A. LOWER LOAD ROLLERS
B. UPPER LOAD ROLLERS

1. LUBRICATE STRIP BEARING SURFACES
2. LUBRICATE LOAD ROLLER SURFACES
3. LOAD ROLLER

Figure 95. Mast Lubrication

HEADER HOSE INSTALLATION AND ADJUSTMENT

Installation

WARNING

Always wear the proper protective equipment including eye protection and petroleum-resistant gloves when handling hydraulic oil. Thoroughly wash oil from exposed areas of skin as soon as possible.

Never check for leaks by putting hands on hydraulic lines or components under pressure. Hydraulic oil under pressure can be injected into the skin.

WARNING

Before working on or near the mast, see the section
Safety Procedures When Working Near Mast in this service manual.

Before installing the header hoses, make sure you know the lift height of the mast. The tension on the header hoses is adjusted according to lift height. The lift height is on the Nameplate of the lift truck and on the right side of the outer mast.

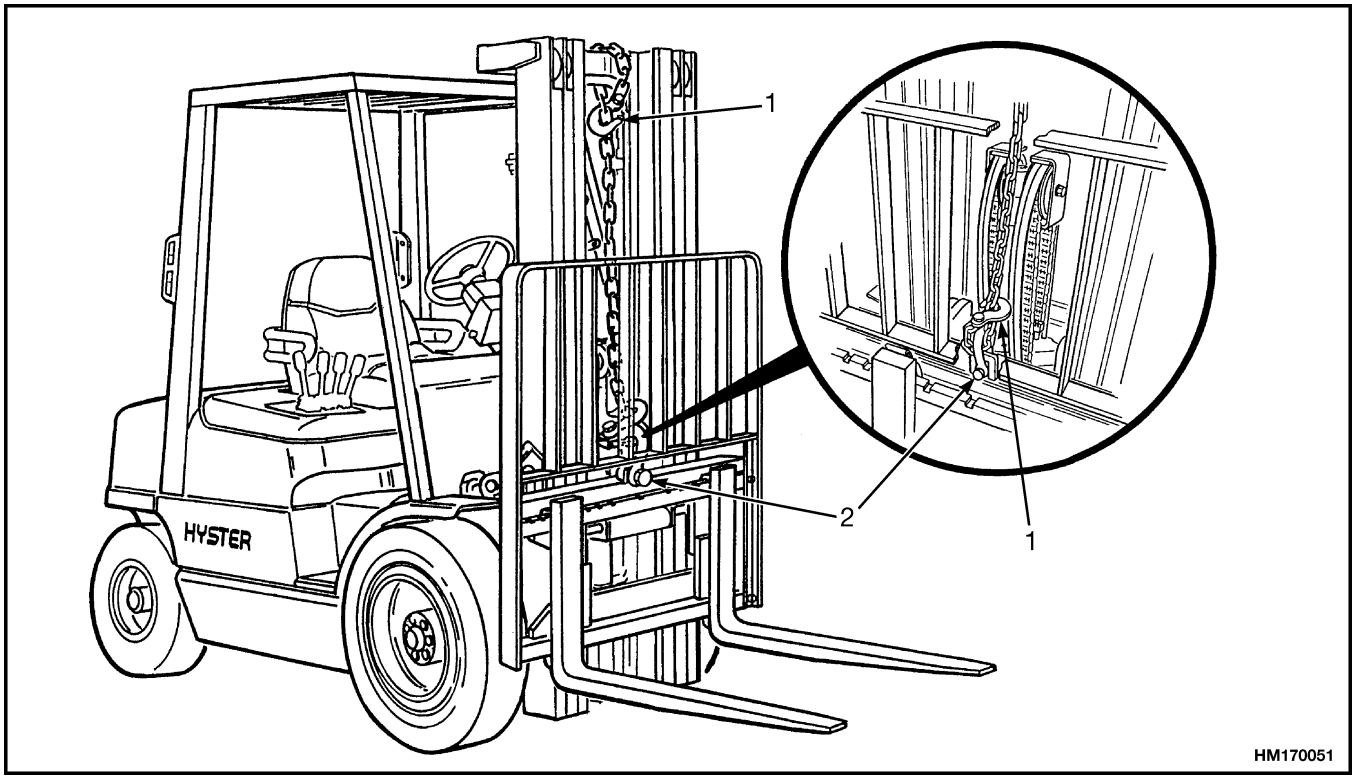
Some lift trucks are equipped with auxiliary hydraulic functions that are fastened to the carriage. Examples of attachments that use these auxiliary functions are sideshift carriages, roll clamps, and fork positioners. These auxiliary functions require header hoses for their operation.

NOTE: This procedure is for the four-function option. The three-function option will have hoses **A** and **B** only.

NOTE: The carriage height must be correct before the header hoses can be adjusted. See the section Lift Chains Adjustment for the carriage adjustment procedures.

NOTE: If the header hoses were removed, use this procedure to install the header hoses. See Table 12. If the mast components have not been assembled, assemble the mast as described in the Assemble section this manual.

1. Raise carriage so free-lift chains are not tight. See Figure 97, Figure 98, and Figure 99. Raise inner channel so main lift chains are not tight. Install chains to prevent inner channel and carriage from moving. The chains must not be in the path of the header hose. See Figure 96.
2. Install all hose sheaves loosely. **DO NOT** tighten capscrews and nuts until header hoses are installed.



1. HOOK
2. SHACKLE

Figure 96. Chaining The Carriage (FFL)

Table 12. Standard Four-Stage FFL Hose Dimensions

Lift Height		Channel Length (Reference)	Dimension "E"		Dimension "G" All Functions		Dimension "H" All Functions	
mm	**in.**	**mm**	**mm**	**in.**	**mm**	**in.**	**mm**	**in.**
6058	238.5	2040	1773	69.8	5998	236.1	4125	162.4
6364	250.6	2141	1873	73.7	6394	251.7	4521	178.0
6670	262.6	2243	1973	77.7	6791	267.4	4918	193.6
Lift height is measured from top of forks. Lift heights shown are standard. If your lift height is not shown, go to **Hyster Hypass Online** to find the correct header hose measurement for your lift height.								

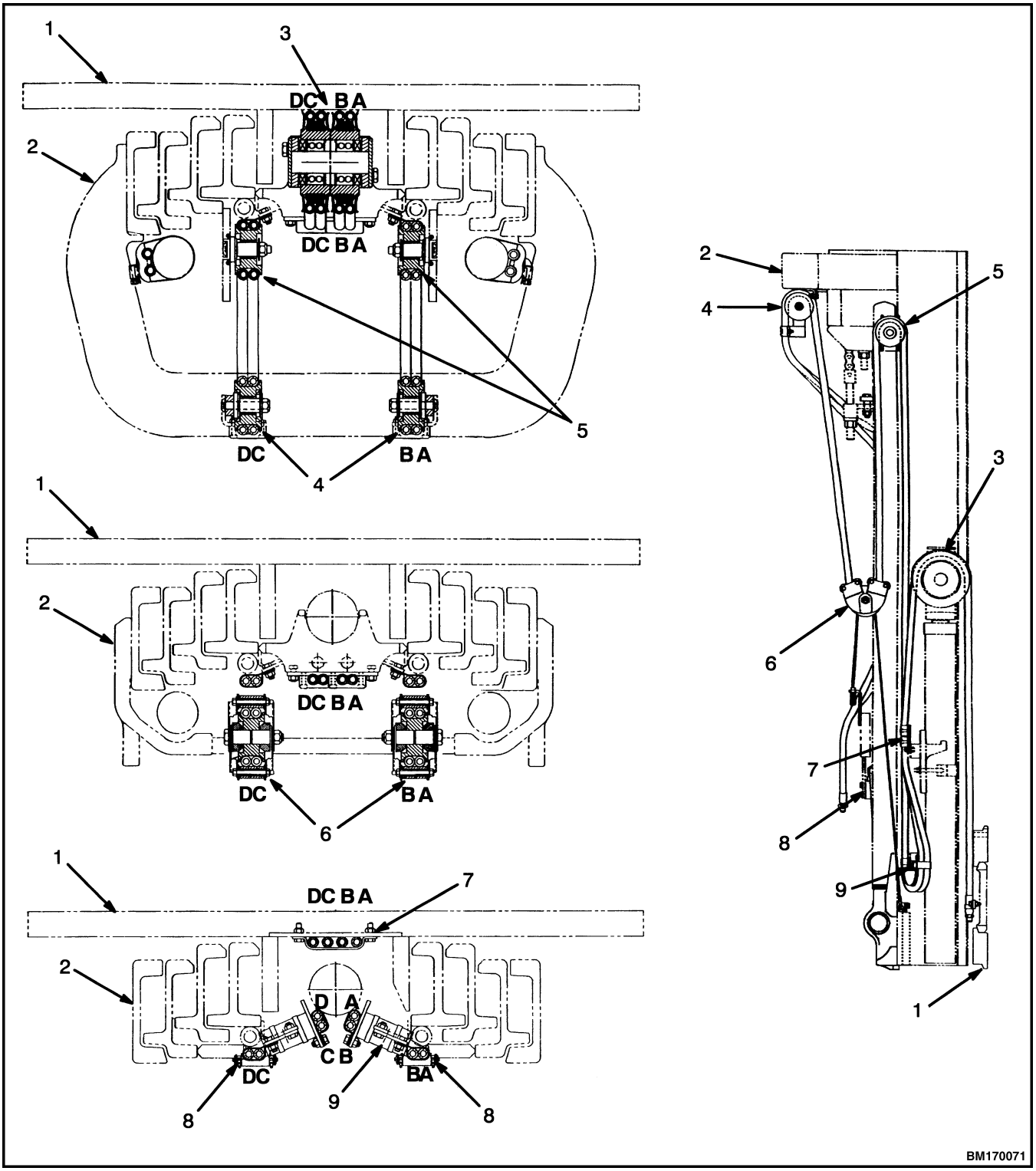


Figure 97. Hose Sheaves and Routing, Four-Stage Mast

Legend for Figure 97.

1. CARRIAGE
2. MAST ASSEMBLY
3. CHAIN AND HOSE SHEAVES AT FREE-LIFT CYLINDER
4. REAR HOSE SHEAVES
5. FRONT HOSE SHEAVES
6. MIDDLE HOSE SHEAVES
7. MIDDLE HOSE CLAMP
8. CABLE MOUNT BLOCKS
9. BOTTOM HOSE CLAMP ASSEMBLIES

A B C D = Hoses

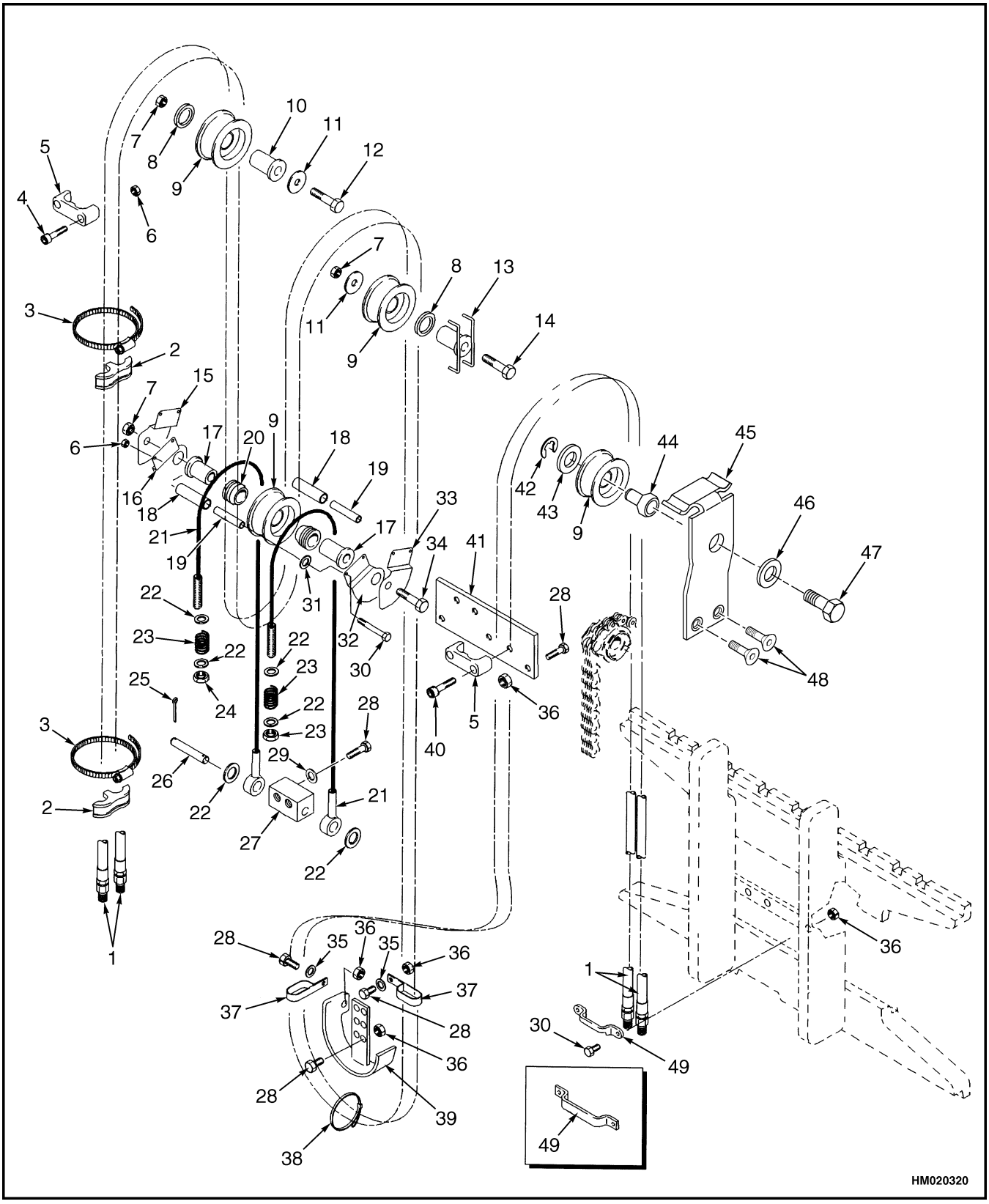


Figure 98. Header Hoses, Four-Stage Mast

Legend for Figure 98.

1. HOSE
2. CLAMP
3. CLAMP
4. CAPSCREW
5. CLAMP
6. NUT
7. LOCK NUT
8. SPACER
9. SHEAVE
10. STUB SHAFT
11. WASHER
12. CAPSCREW
13. STUB SHAFT
14. CAPSCREW
15. HOSE GUARD
16. HOSE GUARD
17. STUB SHAFT
18. ROLLER
19. SPACER
20. IDLER
21. CABLE
22. WASHER
23. SPRING
24. NUT
25. COTTER PIN
26. PIN
27. BLOCK
28. CAPSCREW
29. LOCKWASHER
30. CAPSCREW
31. WASHER
32. HOSE GUARD (RH INNER)
33. HOSE GUARD (RH OUTER)
34. CAPSCREW
35. WASHER
36. NUT
37. CLAMP
38. STRAP CLAMP
39. BRACKET
40. CAPSCREW
41. PLATE
42. SNAP RING
43. WASHER
44. STUB SHAFT
45. GUARD
46. WASHER
47. CAPSCREW
48. CAPSCREW
49. CLAMP

3. Make sure replacement header hose is correct part number for your mast assembly. Make sure header hoses are straight on a flat surface. Mark header hose at points **E**, **G**, and **H** (mm) as shown in Table 12. Measure from end of hose with small fitting.

4. Loosely assemble hose sheaves as shown in Figure 98:

   a. Put coating of multipurpose grease on stub shafts before assembly.

   b. The nuts for the sheave capscrew (axle) must be on the inside of each assembly.

   c. **DO NOT** tighten any nuts or capscrews. They must be loose to allow installation of hoses on hose sheave.

5. Install plate at middle hose clamp and tighten capscrews to 8 N•m (71 lbf in).

6. Install bottom hose clamps as shown in Figure 97. Put some grease on bottom of brackets so hoses can slip to equalize the pressure. Ensure that the inside hose goes through the rear of the bracket and tracks to the inside. The outside hose goes through the front of the bracket and becomes the outside. Tighten capscrews and nuts of bracket to 18 N•m (13 lbf ft). **DO NOT** tighten capscrews and nuts for strap clamps at this time.

7. If the crosshead of the free-lift cylinder does not have hose guides, remove chain guard brackets, chains, and chain sheaves. Install hose guides (flare toward outside) and snap rings to chain sheaves. Install free-lift sheaves, chains, and chain guard brackets as shown in Figure 97 and Figure 99.

8. Install hoses over free-lift cylinder with marks **E** aligned with top edge of clamp of middle hose clamp assemblies. Tighten capscrews and nuts of clamps to 8 N•m (71 lbf in). Refer to Figure 97 and Figure 98.

9. Pass hoses under lower hose clamps and install strap clamps on hoses. Align marks **G** to bottoms of lower hose clamps at the top of the outer mast. Tighten capscrews and nuts of strap clamps to 18 N•m (159 lbf in).

10. Align marks **H** to bottom of lower hose clamps. Tighten capscrews and nuts of strap clamps to 8 N•m (71 lbf in).

11. Install hoses on hose sheaves (see Figure 97) with loops long enough to install on floating hose sheaves. Tighten axle capscrews and nuts of sheaves to 53 N•m (39 lbf ft).

12. Partially assemble floating sheaves as shown in Figure 97 and Figure 98. Install loops of hoses under sheaves. Then install roller guide assemblies over hoses and between hose guards. See Figure 97 and Figure 99. Tighten roller guide capscrews and nuts to 8 N•m (71 lbf in).

13. Fasten looped ends of cables of floating sheaves to cable mount blocks. Use pins, washers, and cotter pins to fasten cable loops. See Figure 98. If necessary, install mount blocks on bottom crossmember of intermediate channel using capscrews and washers. Tighten capscrews to 18 N•m (13 lbf ft).

14. Make sure cables are in grooves of idler wheels and under formed feature of hose guards of floating sheaves. Install ends of cables in brackets so there is spring tension on cables. Make sure axle capscrews and nuts of sheaves are tightened to 53 N•m (39 lbf ft).

15. Slowly operate hydraulic system so lift chains are tight. Remove chains that fasten carriage and channel weldment. Slowly raise carriage using hydraulic system. Make sure hoses move through all sheaves correctly.

16. Slowly operate mast through a few cycles to make sure hoses track correctly. Tighten strap clamps at bottom hose clamps to 18 N•m (13 lbf ft). Fasten hose assemblies to main cylinders using hose clamps and screw clamps as shown in Figure 97 and Figure 98.

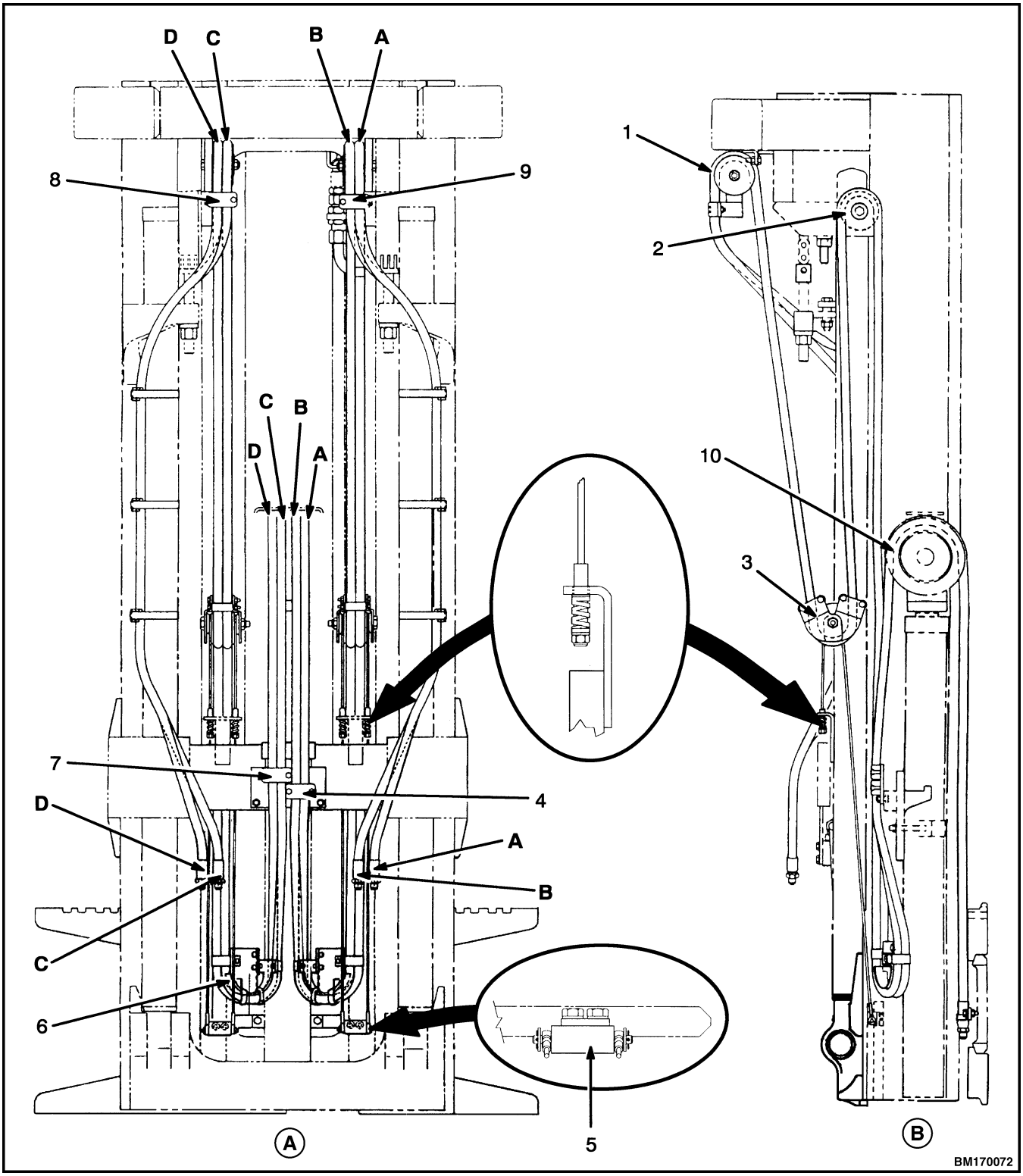


Figure 99. Header Hose Arrangement, Four-Stage Mast

Legend for Figure 99.

A. BACK VIEW

1. HOSE SHEAVE NO. 1
2. HOSE SHEAVE NO. 2
3. FLOATING SHEAVE ASSEMBLY
4. A-B CLAMP
5. CABLE MOUNT

B. SIDE VIEW

6. GUIDE BRACKET
7. C-D CLAMP
8. C-D CLAMP
9. A-B CLAMP
10. FREE-LIFT CROSSHEAD

Adjustment

When properly adjusted, the hoses will not be so tight that they compress when they pass over the sheaves, nor will they be so loose that they touch the load backrest or any crossmember that is next to a sheave.

1. Cap off hoses when attachments have been removed.

2. Check that hoses and cables are routed properly.

3. Slowly raise the free-lift and main cylinders to take up slack in the lift chains.

4. Tighten strap clamps at the bracket weldment.

5. Cycle the mast a few times to ensure proper tracking of hoses.

6. Secure hose assemblies to main lift cylinders with hose clamp and screw clamp.

NOTE: If the hose tension between the carriage and the clamp at the free-lift bracket is correct, go to Step 7.

If the hose tension between the carriage and the clamp at the free-lift bracket is incorrect, loosen the clamps and pull (if the hoses are loose) or push (if the hoses are tight) on the hoses so they move 15.0 mm (0.6 in.) side to side. Tighten the hardware to 8 N•m (71 lbf in).

NOTE: If the hose tension between the clamp at the upper bracket and the clamp at the free-lift bracket is correct, go to Step 8.

7. If the tension of the hoses is incorrect, loosen the clamps and pull the hoses down (if too loose) or push the hoses up (if too tight) so they can move 15.0 mm (0.6 in.) side to side. Retighten the hardware to 8 N•m (71 lbf in).

8. With no load on the forks, check the header hose adjustment by operating the mast through the full lift cycle two times. When properly adjusted, the hoses will not be so tight that they compress when they pass over the sheaves nor will they be so loose that they touch the load backrest or any crossmember that is next to a sheave. If necessary, repeat until the hoses are properly adjusted.

9. Adjust the floating sheave cable tensions to ensure that they are approximately the same. Check that the sheaves are aligned properly with the header hoses.

QUICK DISCONNECT ATTACHMENTS

Disconnect

NOTE: Some lift trucks are equipped with auxiliary tube extensions to be used with optional equipment. The auxiliary tube extensions use quick disconnect fittings to couple together optional equipment.

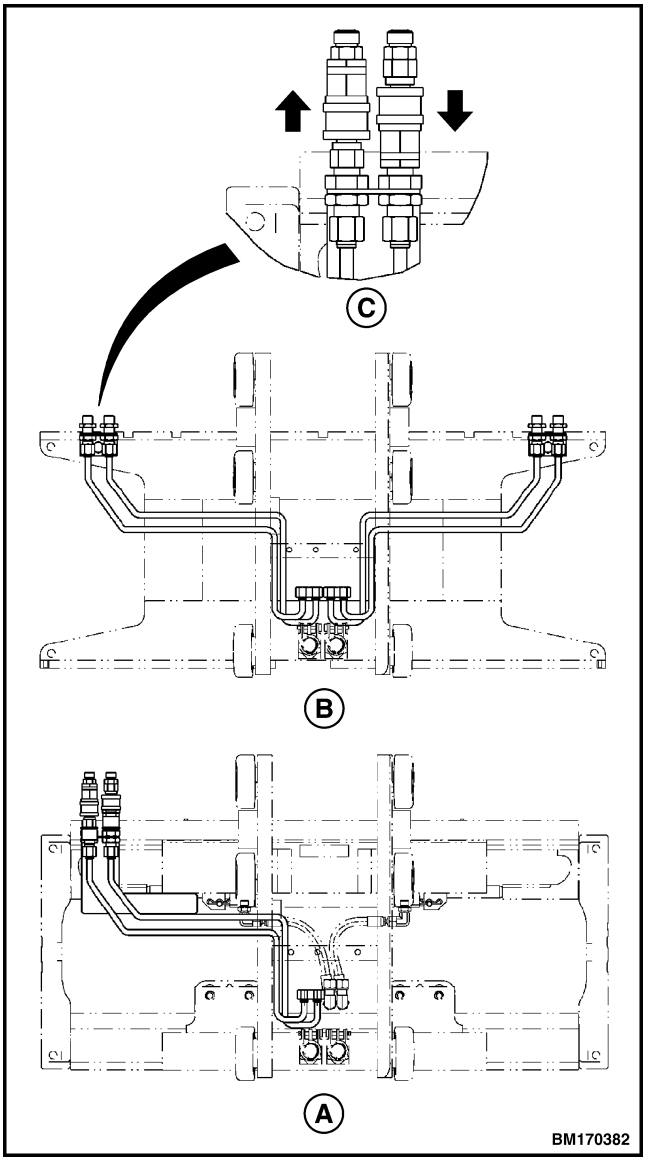
NOTE: Tag hoses before removal to aid in re-connection.

1. Pull spring loaded quick disconnect socket head sleeve back to disconnect fittings. See Figure 100.
2. Remove optional equipment hose.

Reconnect

NOTE: Reconnect quick disconnect fittings as indicated by tags.

1. Pull spring loaded quick disconnect socket head sleeve back and press optional equipment fitting into socket head; release quick disconnect socket head sleeve. See Figure 100.
2. Test connection by pulling quick disconnect and optional equipment fitting away from each other.
3. Repeat Step 1 and Step 2 until connection is made.



A. DUAL EXTENSION TUBES WITHOUT QUICK DISCONNECTS
B. SINGLE EXTENSION TUBES WITH QUICK DISCONNECTS.
C. QUICK DISCONNECT SLEEVE DIRECTION.

Figure 100. Quick Disconnect and Auxiliary Tubes, Four-Stage Mast

Lift Chains Adjustment

WARNING

When working on or near the mast, see the section Safety Procedures When Working Near Mast.

During test procedures for the hydraulic system, fasten the load to the carriage with chains to prevent it from falling. Keep all personnel away from the lift truck during the tests.

Never allow anyone under a raised carriage. DO NOT put any part of your body in or through the lift mechanism unless all parts of the mast are completely lowered and the engine is STOPPED.

Never check for leaks by putting hands on hydraulic lines or components under pressure. Hydraulic oil under pressure can be injected into the skin.

When the lift chains are correctly adjusted:

- The tension will be the same on each chain of the chain set. Check tension by pushing on both chains at the same time.
- The chain length will be correct.
- The chains must travel freely through the complete cycle.

NOTE: When the lift chain adjustments are complete, make sure the threads on the nuts of the chain anchors are completely engaged. Inspect the torque of the prevailing torque nut (locknut) used to adjust the chain anchor with every lift chain adjustment. After carriage and or mast section(s) are adjusted for proper ground clearance, prevent the carriage and or mast section(s) from fully lowering (see
Safety Procedures When Working Near Mast). With slack chain(s), check locknut torque. If 2.5 N•m (22.1 lbf in) for ½-20, 4.5 N•m (39.8 lbf in) for ⅝-18 nuts, 6.0 N•m (53.1 lbf in) for ¾-16 of torque cannot be reached; replace locknut. The chain anchors, after adjustment, must be able to move on their mountings.

NOTE: When directed to a step from step 1, perform that step only.

1. When adjusting the lift chains on forklift trucks equipped with either pin or hook-type forks installed, go to Step 2. If the forklift truck is normally equipped with a hook-type carriage and has an attachment without forks, go to Step 3. If the forklift truck is normally equipped with a pin-type carriage and has an attachment without forks, go to Step 4.

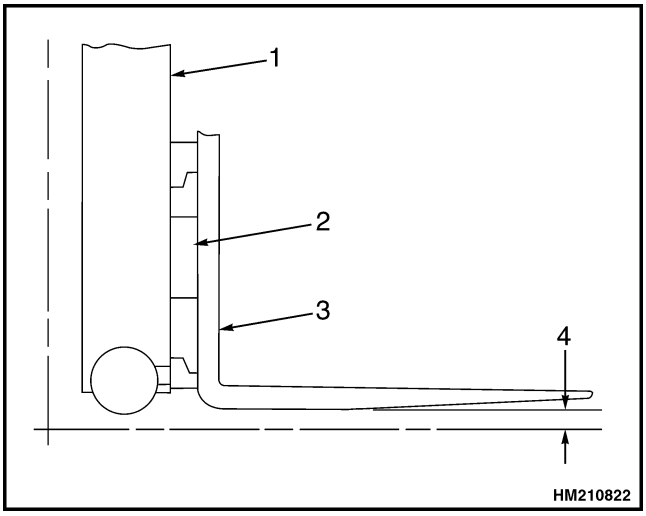
NOTE: Prior to performing adjustment procedures, make sure the forklift truck is parked on a level surface and the mast is in the vertical position.

2. Adjust the chain anchors that support the carriage, until the bottom of the fork heel is 12 +3.0/−6.0 mm (0.47 +0.12/−0.24 in.) above the floor level. See Figure 101.

3. Adjust the chain anchors that support the carriage, until the bottom of the lower carriage bar is above the floor level as shown in Table 13 and Figure 102.

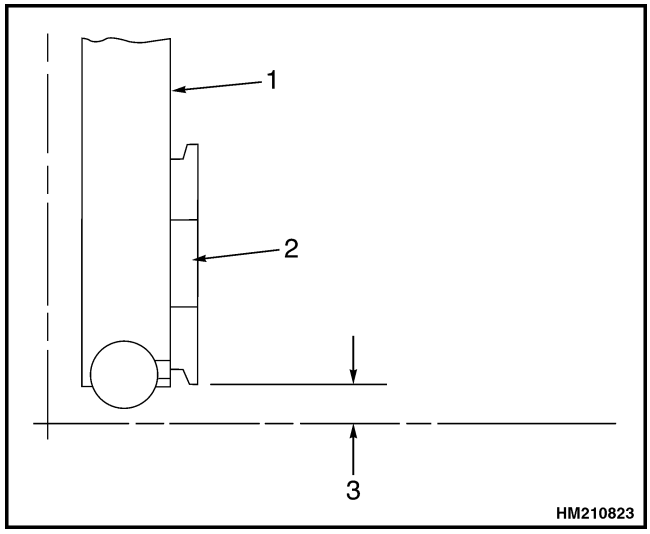
Table 13. Chain Adjustment With Attachment Installed

Class II and III	82.5 ±3.0 mm (3.25 ±0.12 in.)
Class IV	133.5 ±3.0 mm (5.26 ±0.12 in.)



1. MAST
2. CARRIAGE
3. FORK
4. HEEL OF FORK IS 12 +3.0/−6.0 mm (0.47 +0.12/−0.24 in.) ABOVE FLOOR LEVEL

Figure 101. Lift Chain Adjustment, Forks



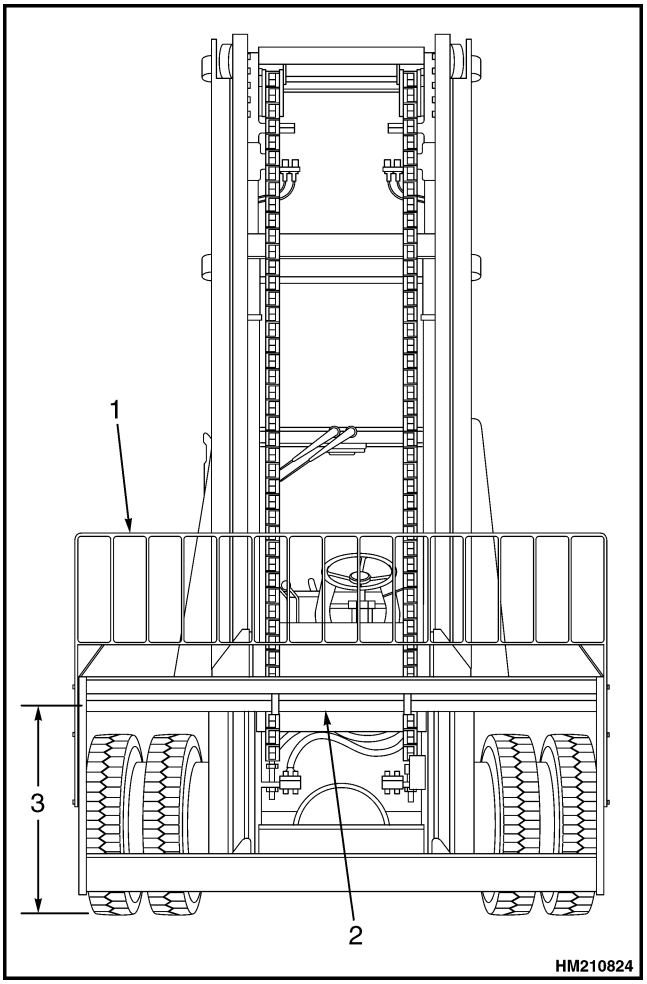
1. MAST
2. CARRIAGE
3. DISTANCE FROM FLOOR TO LOWER CARRIAGE BAR

Figure 102. Lift Chain Adjustment With Attachment Installed

4. See Figure 103. Adjust the chain anchors, which support the carriage, until the center line of the fork pin is above the floor level as shown in Table 14.

Table 14. Pin-Type Carriage Chain Adjustment

4-5.5T Class III	545.0 ±3.0 mm (21.5 ±0.12 in.)
4-5.5T Class IV	708.0 ±3.0 mm (27.87 ±0.12 in.)
6-7T Class IV	907.0 ±3.0 mm (35.71 ±0.12 in.)



1. LOAD BACK REST
2. FORK PIN
3. DISTANCE FROM FORK PIN TO FLOOR

Figure 103. Lift Chain Adjustment, Pin-Type Carriage

Carriage Adjustments

1. Install the load rollers on the carriage. Install the shims for the load rollers onto the stubshaft in the same sequence as when disassembled.

2. Use a lifting device to raise carriage. Find the point of tightest fit between the carriage load rollers and inner mast channels.

3. Remove carriage from mast. Adjust shim arrangement for each roller for clearance between roller and inner channel. Repeat Step 1 and Step 2 until there is zero clearance at the point of tightest fit.

4. Keep shim arrangement on each side of carriage approximately equal. The carriage must be centered within the inner mast within +1.50 mm (0.06 in.).

CAUTION

Too much grease will cause the rollers to slide and wear flat areas on the rollers and introduce contamination into and on mast channels.

5. After adjustment, lubricate channels with a thin layer of grease. Adjust hydraulic hoses and make sure connections are correct, if the carriage is equipped with hydraulic attachments.

Mast Adjustments

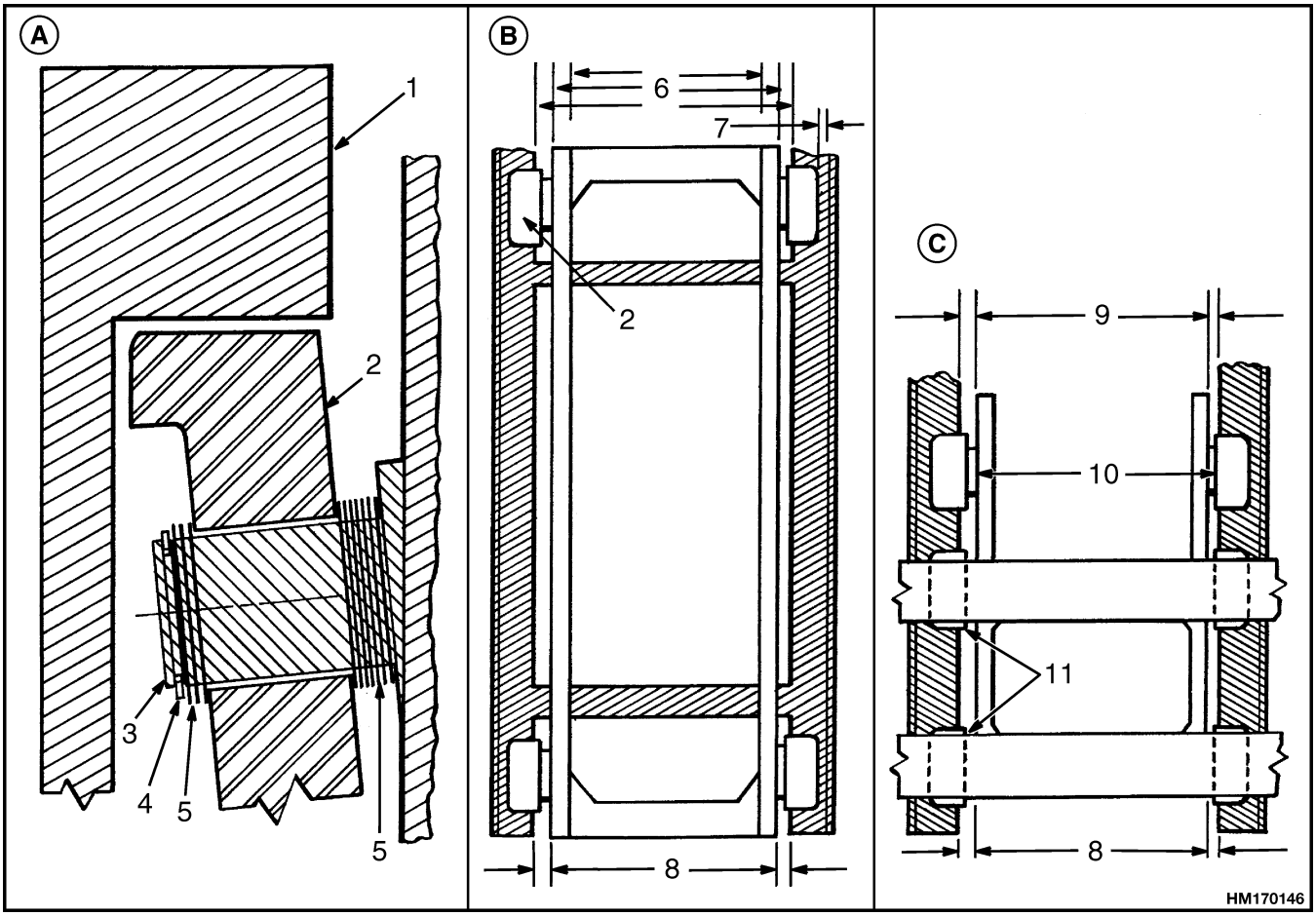
LOAD ROLLER, ADJUST

NOTE: Shims are installed on both sides of the load rollers. **DO NOT** add to or remove shims from the stub shafts. To change the position of the roller on the stub shaft, move the shims from one side of the load roller to the other.

During assembly, the shim arrangement will be approximately the same as before disassembly.

Check the clearance and adjust shims after repairs have been completed.

1. The load rollers control the alignment of the mast uprights. See Figure 104. The alignment conditions are given on a list below with the most important condition first.



NOTE: USE SHIMS TO KEEP CARRIAGE AND MAST UPRIGHTS PARALLEL, TO GIVE APPROXIMATELY EQUAL SPACE BETWEEN BOTH SIDES OF CARRIAGE AND UPRIGHTS, AND TO GIVE ZERO CLEARANCE AT POINT OF TIGHTEST FIT.

A. TOP VIEW
B. MAST FRONT VIEW
C. CARRIAGE FRONT VIEW

1. CHANNEL
2. LOAD ROLLER
3. STUB SHAFT
4. SNAP RING
5. SHIMS
6. PARALLEL TO CHANNEL ±1.5 mm (0.060 in.)
7. ZERO CLEARANCE AT POINT OF TIGHTEST FIT
8. EQUAL SPACE ±1.5 mm (0.060 in.)
9. PARALLEL TO CHANNEL ±1.5 mm (0.060 in.)
10. PUT SPACER ON OUTSIDE OF TOP LOAD ROLLER, UNDER SNAP RING
11. SHIM FOR ZERO CLEARANCE AT POINT OF TIGHTEST FIT

Figure 104. Mast Adjustments

a. The mast uprights must be parallel to each other.

b. Use shims to adjust load rollers so there is zero clearance between load roller and channel at point of tightest fit.

c. The number of shims under a load roller must be approximately the same as the stub shaft in the opposite side of the upright. This ensures the uprights will be approximately in the center.

2. Perform the following steps to adjust the mast load rollers:

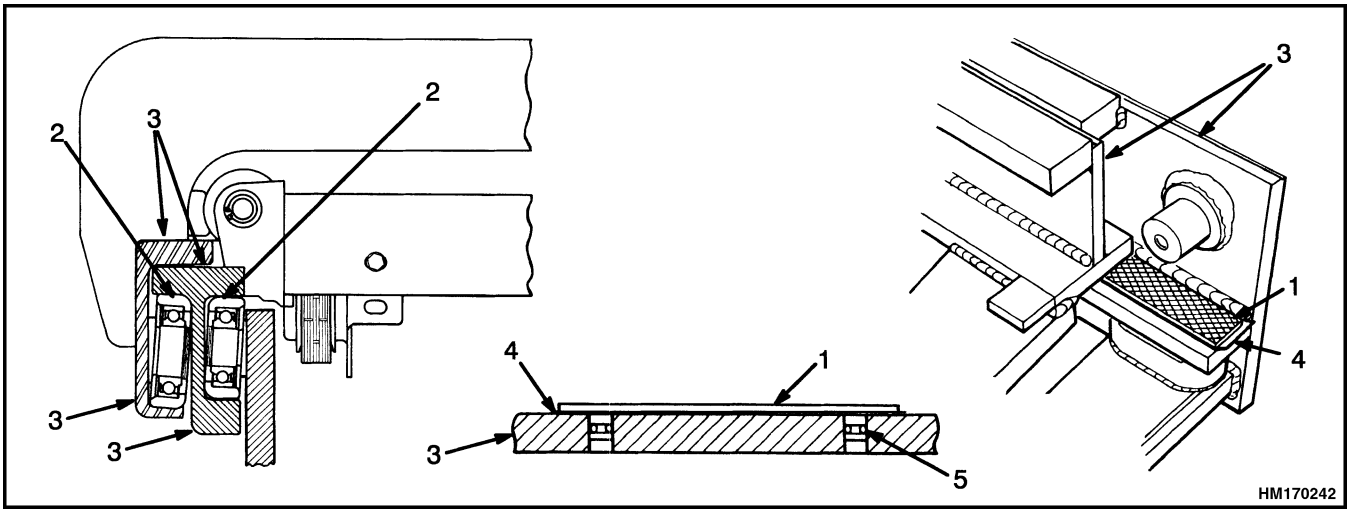
a. Use a crowbar to move mast uprights from side to side to measure movement. Measure movement in a minimum of three different positions of each mast upright.

b. Separate mast uprights and change shim arrangements as required. Assemble uprights. Slide upright all the way to the top and bottom to find the tightest fit.

c. Repeat Step a and Step b until there is zero clearance at the point of the tightest fit.

d. Measure distance between channels of mast uprights on top and bottom. Change shims to keep distance equal between top and bottom so mast uprights are parallel. Also make sure the mast uprights are parallel within 1.5 mm (0.060 in.).

3. Adjust strip bearings. See Figure 105. Insert shims under strip bearing. Adjust clearance until there is less than 0.8 mm (0.030 in.) at the tightest fit. See Figure 104.



1. STRIP BEARING
2. LOAD ROLLER
3. MAST UPRIGHT
4. SHIMS
5. O-RING

Figure 105. Strip Bearings Arrangement

MAST SIDE KICKING, ADJUST

Mast side kicking is where the mast, without a load, moves either to the right or left as it is being fully raised. When this happens, it is an indication that one of the main lift cylinders is raising at a faster rate then the other. Before checking for mast side kicking, the mast must be completely assembled to include the carriage, forks, load backrest, and any attachments if the lift truck is equipped with one.

To adjust the mast for side kicking, do the following:

1. Place the lift truck on a level surface and apply the parking brake.

2. Raise the mast and visually inspect it as it reaches its full height.

3. If the mast is moving to the left, shims will need to either be added or removed from the top of the right main lift cylinder. If mast moves to the right, shims will need to either be added or removed from the top of the left main lift cylinder. .

4. If shims will be added, use the smallest shim size that can be used on the mast that is being adjusted. See the **Parts Manual** for shim sizes and part numbers.

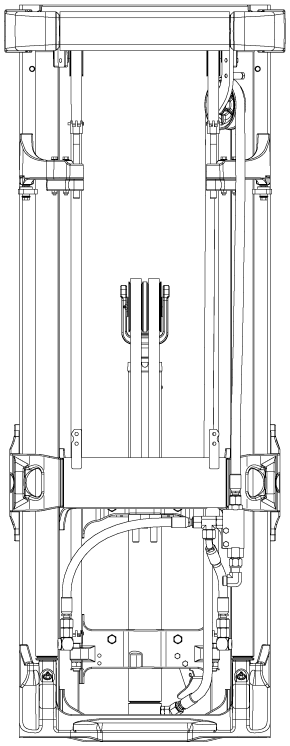
5. Raise the mast again and visually inspect it to ensure that it is no longer side kicking. If side kicking is still present, repeat Step 3 and Step 4.

MAST REPAIR

(S/N F507, F508, F562, F563)

TWO-STAGE LFL AND THREE-STAGE FFL MAST

E2.2-3.5XN (E45-70XN) [A268];
J2.2-3.5XN (J45-70XN) [A276];
S2.0-3.5FT (S40-70FT) [F187, G187, H187];
H2.0-3.5FT (H40-70FT) [L177, N177, P177]



HYSTER

PART NO. 4099655

4000 SRM 1669

SAFETY PRECAUTIONS
MAINTENANCE AND REPAIR

- The Service Manuals are updated on a regular basis, but may not reflect recent design changes to the product. Updated technical service information may be available from your local authorized Hyster® dealer. Service Manuals provide general guidelines for maintenance and service and are intended for use by trained and experienced technicians. Failure to properly maintain equipment or to follow instructions contained in the Service Manual could result in damage to the products, personal injury, property damage or death.
- When lifting parts or assemblies, make sure all slings, chains, or cables are correctly fastened, and that the load being lifted is balanced. Make sure the crane, cables, and chains have the capacity to support the weight of the load.
- Do not lift heavy parts by hand, use a lifting mechanism.
- Wear safety glasses.
- DISCONNECT THE BATTERY CONNECTOR before doing any maintenance or repair on electric lift trucks. Disconnect the battery ground cable on internal combustion lift trucks.
- Always use correct blocks to prevent the unit from rolling or falling. See HOW TO PUT THE LIFT TRUCK ON BLOCKS in the **Operating Manual** or the **Periodic Maintenance** section.
- Keep the unit clean and the working area clean and orderly.
- Use the correct tools for the job.
- Keep the tools clean and in good condition.
- Always use **HYSTER APPROVED** parts when making repairs. Replacement parts must meet or exceed the specifications of the original equipment manufacturer.
- Make sure all nuts, bolts, snap rings, and other fastening devices are removed before using force to remove parts.
- Always fasten a DO NOT OPERATE tag to the controls of the unit when making repairs, or if the unit needs repairs.
- Be sure to follow the **WARNING** and **CAUTION** notes in the instructions.
- Gasoline, Liquid Petroleum Gas (LPG), Compressed Natural Gas (CNG), and Diesel fuel are flammable. Be sure to follow the necessary safety precautions when handling these fuels and when working on these fuel systems.
- Batteries generate flammable gas when they are being charged. Keep fire and sparks away from the area. Make sure the area is well ventilated.

NOTE: The following symbols and words indicate safety information in this manual:

WARNING

Indicates a hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION

Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury and property damage.

On the lift truck, the WARNING symbol and word are on orange background. The CAUTION symbol and word are on yellow background.

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This section is for the following models:

E2.2-3.5XN (E45-70XN) [A268];
J2.2-3.5XN (J45-70XN) [A276];
S2.0-3.5FT (S40-70FT) [F187, G187, H187];
H2.0-3.5FT (H40-70FT) [L177, N177, P177]

"THE QUALITY KEEPERS"

HYSTER APPROVED PARTS

General

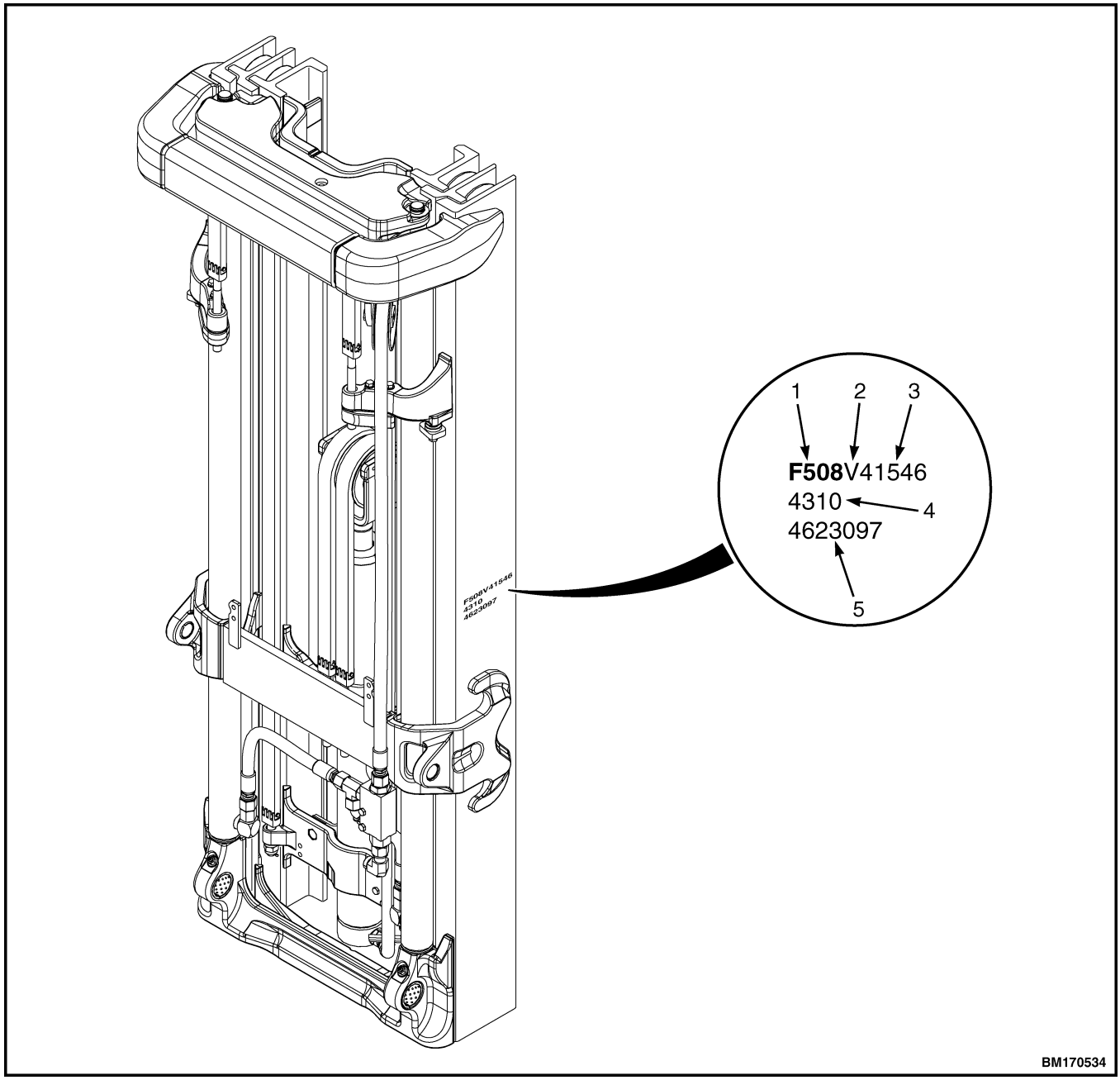
WARNING

Before working on or near the mast, see the section
Safety Procedures When Working Near Mast.

NOTE: Hoses have a service life that is determined by application and time. Install a new hose if the hose is leaking, worn through, or damaged. A hose has been damaged if the hose cover is cracked, exposing the braiding, or if the hose has been kinked or crushed, or if the hose is no longer flexible. Install a new hose if the hose has been tensioned beyond the adjustment range. If necessary, make a comparison to a new hose that is the correct replacement for the hose you are inspecting.

This section contains the repair procedures for the Two-Stage, Limited Free-Lift (LFL) mast with serial numbers **F507** and **F562** and the Three-Stage, Full Free-Lift (FFL) mast with serial numbers **F508** and **F563**. The mast serial number is located on the right side of the outer mast. Other information about the mast can also be found in this area. See Figure 1.

Procedures to repair the carriage, replace the forks, and adjust the lift chains, carriage, and mast are also covered in this manual.



1. MAST SERIAL NUMBER
2. MANUFACTURING PLANT
3. PRODUCTION SEQUENCE
4. MAST LIFT HEIGHT (IN MILIMETERS)
5. MAST ASSEMBLY PART NUMBER

Figure 1. Mast Serial Number Location

Safety Procedures When Working Near Mast

The following procedures **MUST** be used when inspecting or working near the mast. Additional precautions and procedures can be required when repairing or removing the mast. See the correct Service Manual section for the specific mast being repaired.

WARNING

The following procedures MUST be used when inspecting or working near the mast. Additional precautions and procedures can be required when repairing or removing the mast. See the correct Service Manual section for the specific mast being repaired.

- Never put any part of the body into or under the mast or carriage unless all parts are completely lowered or a safety chain is installed. Also make sure that the power is off and the key is removed. Put a **DO NOT OPERATE** tag in the operator's compartment. Disconnect the battery on electric lift trucks and put a tag or lock on the battery connector.
- Be careful of the forks. When the mast is raised, the forks can be at a height to cause an injury.
- **DO NOT** climb on the mast or lift truck at any time. Use a ladder or personnel lift to work on the mast.
- **DO NOT** use blocks to support the mast weldments or to restrain their movement.
- Mast repairs require disassembly and removal of parts and can require removal of the mast or carriage. Follow the repair procedures in the correct Service Manual for the mast.

WHEN WORKING NEAR THE MAST ALWAYS:

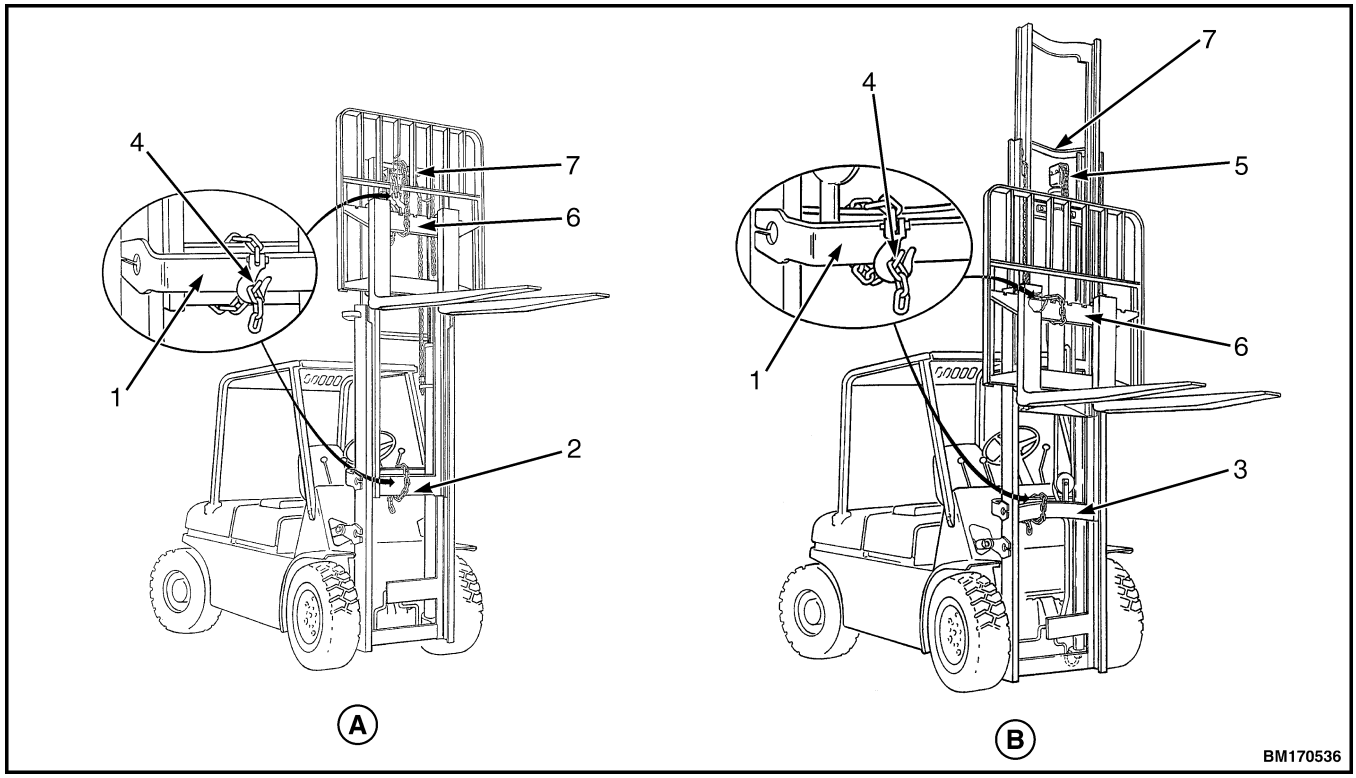
- Lower the mast and carriage completely. Push the lift/lower control lever forward and make sure there is no movement in the mast. Make sure that all parts of the mast that move are fully lowered.

OR

- If parts of the mast must be in a raised position, install a safety chain to restrain the moving parts of the mast. Connect moving parts to a part that does not move. Follow these procedures:

1. Put mast in vertical position.
2. Raise mast to align bottom crossmember of weldment that moves in the outer weldment with a crossmember on the outer weldment. On the two-stage and free-lift mast, the moving part is the inner weldment. On the three-stage mast, it is the intermediate weldment. See Figure 2.
3. Use a 3/8 inch minimum safety chain with a hook to fasten the crossmembers together so the movable member cannot lower. Put the hook on the back side of the mast. Make sure the hook is completely engaged with a link in the chain. Make sure the safety chain does not touch lift chains or chain sheaves, tubes, hoses, fittings, or other parts on the mast.
4. Lower mast until there is tension in the safety chain and the free-lift cylinder (three-stage) is completely retracted. If running, stop the engine. Apply parking brake. Install a **DO NOT REMOVE** tag on the safety chain(s).
5. Install another safety chain (3/8 inch minimum) between the top or bottom crossmember of the carriage and a crossmember on the outer weldment. See Figure 2.

NOTE: Apply parking brake. After lowering or restraining the mast, shut off power and remove key. Put a **DO NOT OPERATE** tag in the operator's compartment. Disconnect battery on electric lift trucks and put a tag or lock on battery connector.



A. TWO-STAGE LFL MAST

B. THREE-STAGE FFL MAST

1. OUTER WELDMENT
2. INNER WELDMENT
3. INTERMEDIATE WELDMENT
4. HOOK
5. FREE-LIFT CYLINDER
6. CROSSMEMBER
7. CROSSMEMBER

Figure 2. Two-Stage LFL and Three-Stage FFL Masts

Fork Replacement

STANDARD CARRIAGE AND INTEGRAL SIDESHIFT CARRIAGE

On lift trucks equipped with a standard carriage or an integral sideshift carriage, the forks are held on the carriage by hooks. Forks are held in position by pins that fit through the top fork hooks and into slots in top carriage bar.

If pin does not remain engaged in carriage slot, replace with new pin. Always check that pins for forks keep forks in position on carriage. Replace damaged fork pin parts.

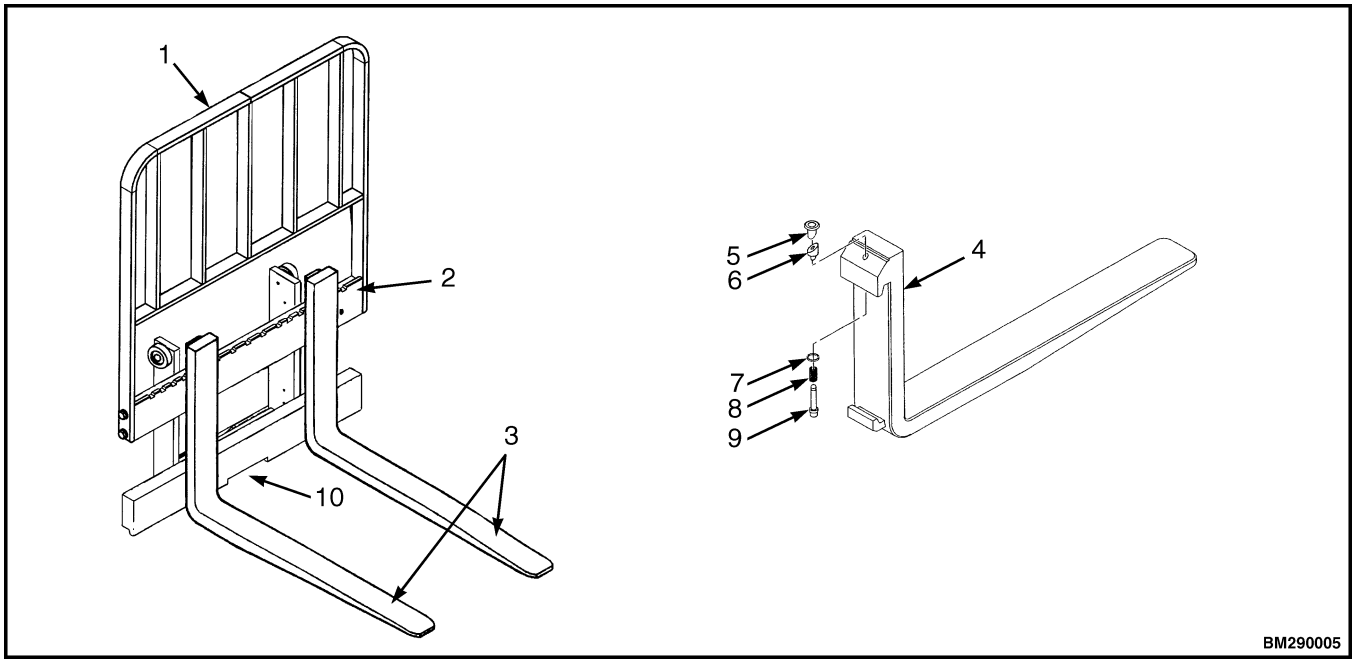
Remove

WARNING

DO NOT try to remove a fork without a lifting device. Each hook fork for these lift trucks can weigh 45 to 115 kg (99 to 254 lb).

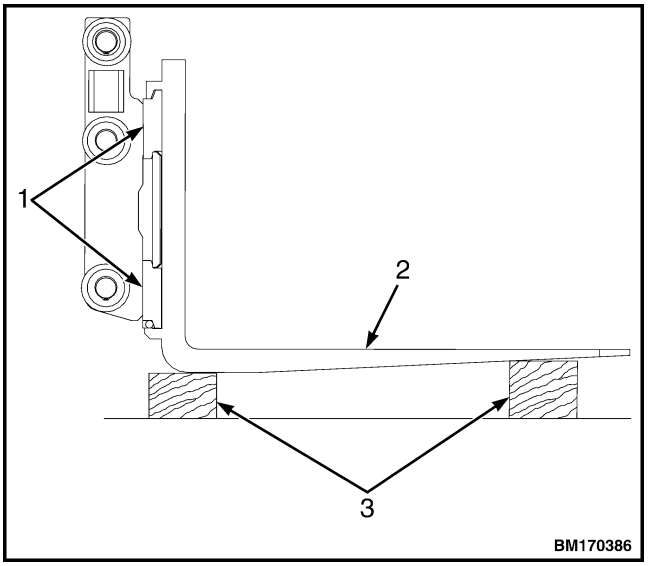
NOTE: Forks are to be replace in sets by trained personnel only. DO NOT replace forks individually.

1. Slide fork to fork removal notch on bottom bar of carriage. See Figure 3.
2. Lower fork onto blocks (see Figure 4), so bottom hook of fork moves through fork removal notch.
3. Lower carriage further so top hook of fork is disengaged from top carriage bar.
4. Move carriage away from fork or use a lifting device to move fork away from carriage.



1. LOAD BACKREST
2. CARRIAGE
3. FORKS
4. FORK
5. KNOB
6. WEDGE
7. WASHER
8. SPRING
9. PIN
10. FORK REMOVAL NOTCH

Figure 3. Carriage and Forks



1. CARRIAGE BARS
2. HOOK FORK
3. BLOCKS

Figure 4. Hook Fork, Remove

Install

WARNING

DO NOT try to install a fork without a lifting device. Each hook fork for these lift trucks can weigh 45 to 115 kg (99 to 254 lb).

NOTE: Forks are to be replace in sets by trained personnel only. DO NOT replace forks individually.

1. Move fork and carriage so top hook of fork can engage upper carriage bar.

2. Raise carriage to move bottom hook of fork through fork removal notch.

3. Slide fork on carriage so both upper and lower hooks engage carriage bars. See Figure 4.

4. Install latch pin in top hook and notch in upper carriage bar. See Figure 3.

Checks

WARNING

Never repair damaged forks by heating or welding. Forks are made of tempered steel using special procedures. Always replace damaged forks as a pair.

1. Inspect forks for cracks and wear. Check alignment of fork tips. The difference in height of fork tips must be less than three percent of length of forks. See Table 1 and Figure 5.

Some applications may require closer alignment. If forks do not meet specification, they both must be replaced.

2. Check for smooth and proper operation of fork lock pins. Repair or replace any damaged or broken fork lock pins or components and lubricate, as necessary.

3. Inspect fork wear. Ensure heel wear is not more than 10% of original thickness. If fork wear is more than 10% fork must be replaced or rerated. Perform fork wear inspection using a BOL256N1 caliper ruler Hyster P/N 4092984 as follows. See Figure 6.

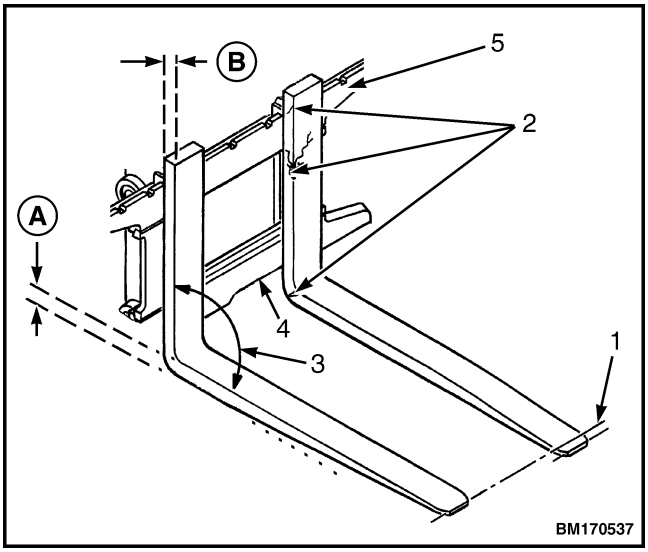
a. Determine normal thickness of the "N" of the fork using scale or ruler portion of caliper ruler. Measurement has to be done on fork shank using caliper ruler.

b. Position caliper at end of heel internal radius (item A, Figure 5) with opening corresponding to measured thickness of fork shank in Step a above. (e.g. for N 1.75 use N 1.75 opening). This is typically the section of fork where wear is greatest. Note that opening distance has been reduced by 10% from nominal thickness.

c. If fork enters opening, it is mandatory to replace it. DANGER OF BREAKING. Furthermore a 10% reduction in fork blade thickness results in 20% reduction in operating capacity.

Table 1. Fork Tip Alignment

Fork Tip Alignment Specifications			
Standard Fork Lengths		**Maximum Fork Tip Difference***	
mm	**(in.)**	**mm**	**(in.)**
914	(36)	27	(1.08)
1000	(39)	30	(1.17)
1016	(40)	30	(1.2)
1067	(42)	32	(1.26)
1100	(43)	33	(1.29)
1200	(47)	36	(1.42)
1207	(47.5)	36	(1.42)
1219	(48)	37	(1.44)
1372	(54)	41	(1.62)
1400	(55)	42	(1.65
1500	(59)	42	(1.77)
1524	(60)	46	(1.80)
1829	(72)	55	(2.16)
*Difference of alignment between fork tips must be no more than 3% of the total fork length.			



A. HEEL OF FORK (MUST BE 90% OF DIMENSION B)
B. ORIGINAL FORK THICKNESS (DIMENSION B)

1. TIP ALIGNMENT (MUST BE WITHIN 3% OF FORK LENGTH)
2. CRACKS
3. MAXIMUM ANGLE 93°
4. FORK REMOVAL NOTCH
5. CARRIAGE

Figure 5. Fork Checks

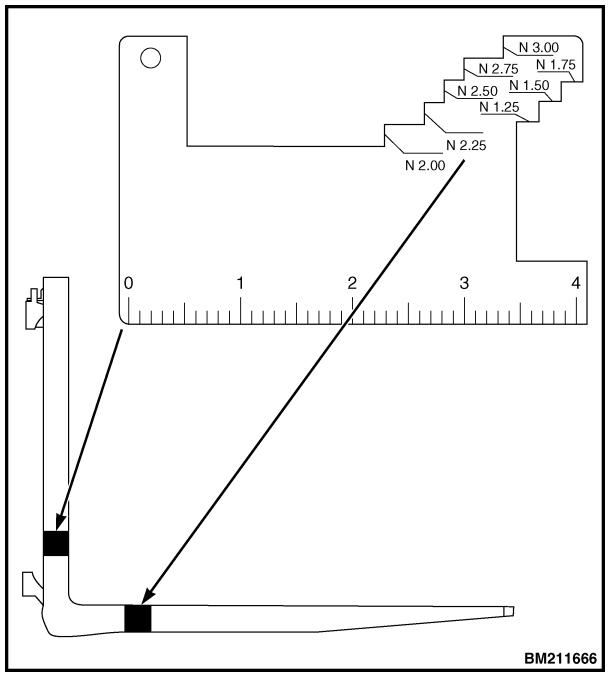
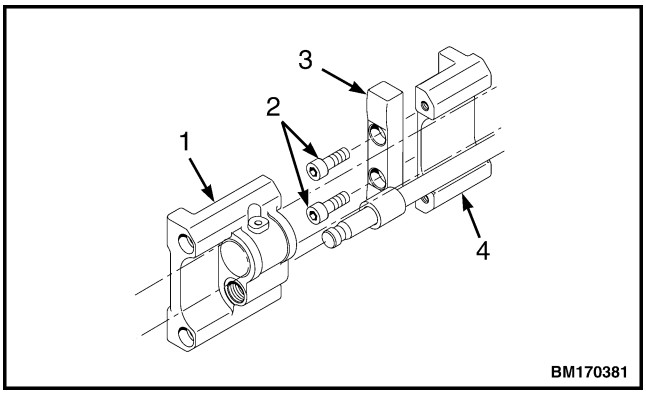


Figure 6. Fork Wear Check

FORK POSITIONER CARRIAGE

NOTE: The fork positioner can be removed from the integral sideshift carriage with integral sideshift carriage on or off the mast. In the steps below, the fork positioner is removed with integral sideshift carriage on the mast. If integral sideshift carriage must be removed from mast first, go to section Carriages Repair, Two-Stage LFL Mast or Carriages Repair, Three-Stage FFL Mast for removal procedures.

Forks used on an integral sideshift carriage equipped with a fork positioner attachment, are held in position with fork carriers (inner and outer) that slide along the fork positioner cylinder. Depending on the size and configuration of forks installed on lift truck, there may be a spacer bar between inner and outer fork carriers. See Figure 7. Forks are removed from carriage by aligning forks with fork removal notch. Fork removal notch is in the bottom bar of carriage. See Figure 8.



1. OUTER FORK CARRIER
2. CAPSCREW
3. SPACER BAR*
4. INNER FORK CARRIER

*Spacer Bar used on 977 mm (38.5 in.) and 1067 mm (42 in.) class II carriages.

Figure 7. Fork Carrier Components

Remove

WARNING

DO NOT try to remove a fork without a lifting device. Each hook fork for these lift trucks can weigh 45 to 115 kg (99 to 254 lb).

CAUTION

Remove fork latch pins if adding a fork positioner attachment. Damage to forks and other carriage components can occur if fork latch pins are not removed prior to using attachment.

NOTE: Forks are to be replace in sets by trained personnel only. DO NOT replace forks individually.

1. Lower carriage and remove four capscrews from inner fork carriers. Slide inner fork carriers down cylinder shell to remove forks.

   See Figure 8 for lift trucks manufactured prior to December, 2016

   Figure 9 for lift truck models E2.2-3.5XN (E45-70XN) (A268), S2.0-3.5FT (S40-70FT) (H187), and H40-70FT (P177) manufactured after December, 2016

2. Slide fork to fork removal notch in bottom bar of carriage.

   See Figure 8 for lift trucks manufactured prior to December, 2016

   See Figure 9 for lift truck models E2.2-3.5XN (E45-70XN) (A268), S2.0-3.5FT (S40-70FT) (H187), and H40-70FT (P177) manufactured after December, 2016

3. Lower forks onto blocks (see Figure 4) so bottom hook of fork moves through fork removal notch. Lower carriage further so top hook of fork is disengaged from top carriage bar.

4. Move carriage away from fork or use a lifting device to move fork away from carriage.

Install

WARNING

DO NOT try to install a fork without a lifting device. Each hook fork for these lift trucks can weigh 45 to 115 kg (99 to 254 lb).

CAUTION

Remove fork latch pins if adding a fork positioner attachment. Damage to forks and other carriage components can occur if fork latch pins are not removed prior to using attachment.

NOTE: Forks are to be replace in sets by trained personnel only. DO NOT replace forks individually.

1. Move fork and carriage so top hook of fork can engage upper carriage bar.

2. Raise carriage to move bottom hook of fork through fork removal notch.

   See Figure 8 for lift trucks manufactured prior to December, 2016

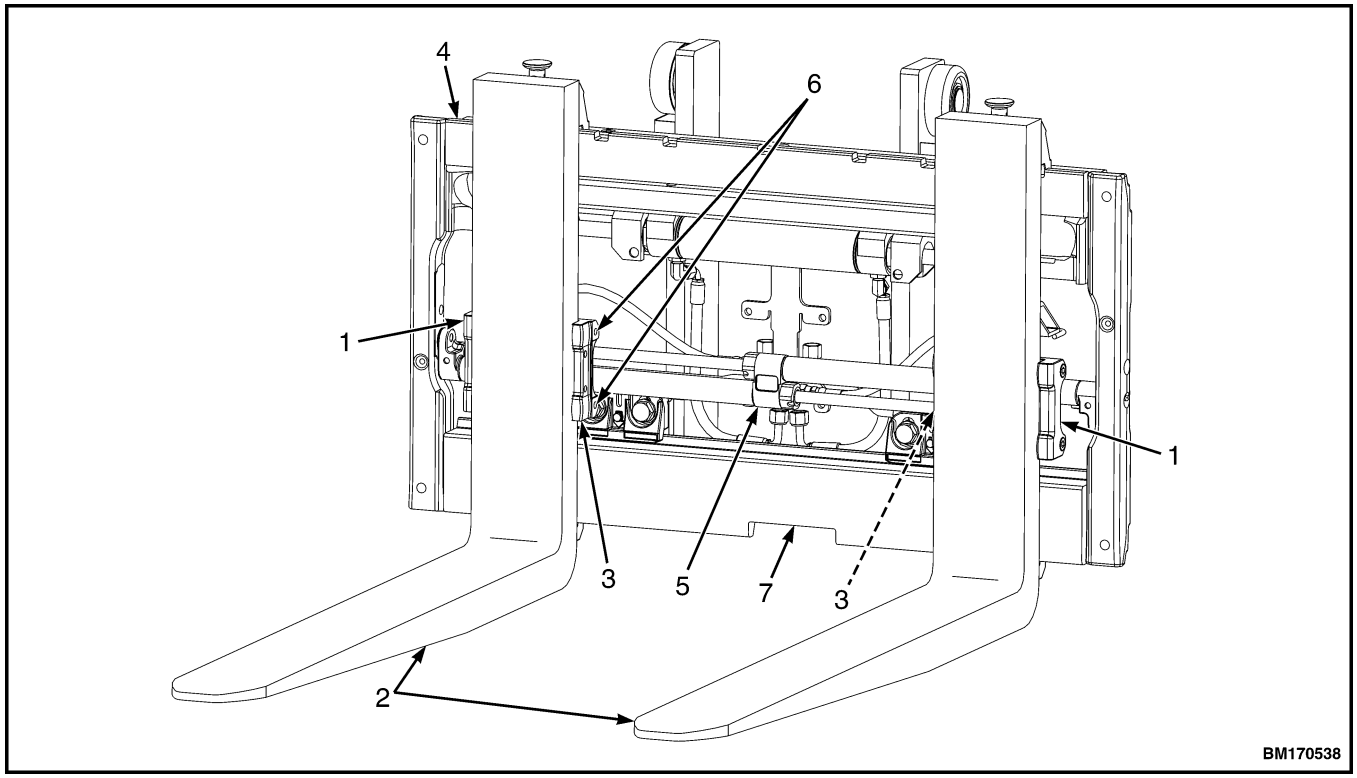
   See Figure 9 for lift truck models E2.2-3.5XN (E45-70XN) (A268), S2.0-3.5FT (S40-70FT) (H187), and H40-70FT (P177) manufactured after December, 2016

3. Slide fork on carriage so both upper and lower hooks engage carriage bars. See Figure 4.

4. Move fork into place on outer fork carrier. Secure inner fork carrier to outer fork carrier using four capscrews. Tighten capscrew to 35 N•m (25 lbf ft).

   See Figure 8 for lift trucks manufactured prior to December, 2016

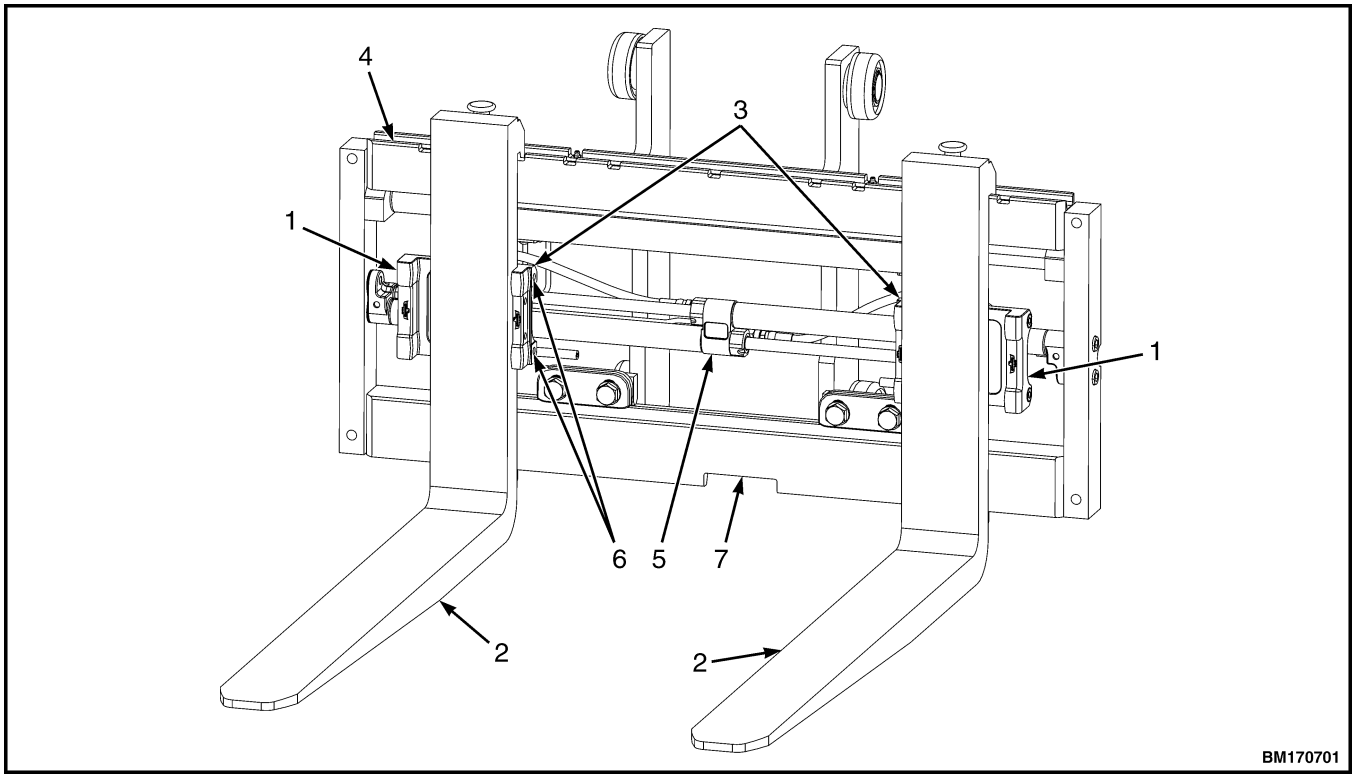
   See Figure 9 for lift truck models E2.2-3.5XN (E45-70XN) (A268), S2.0-3.5FT (S40-70FT) (H187), and H40-70FT (P177) manufactured after December, 2016



NOTE: FORK POSITIONER FOR LIFT TRUCK EQUIPPED WITH THREE-STAGE FFL MAST SHOWN. REMOVAL OF FORKS FROM FORK POSITIONER ON LIFT TRUCKS EQUIPPED WITH TWO-STAGE LFL MAST IS SIMILAR.

1. OUTER FORK CARRIER
2. FORKS
3. INNER FORK CARRIER
4. OUTER FRAME
5. FORK POSITIONER
6. CAPSCREWS
7. FORK REMOVAL NOTCH

Figure 8. Fork Positioner Fork Removal, Lift Trucks Manufactured Prior To December, 2016



1. OUTER FORK CARRIER
2. FORKS
3. INNER FORK CARRIER
4. OUTER FRAME
5. FORK POSITIONER
6. CAPSCREWS
7. FORK REMOVAL NOTCH

Figure 9. Fork Positioner Fork Removal, Lift Truck Models Manufactured After December, 2016E2.2-3.5XN (E45-70XN) (A268), S2.0-3.5FT (S40-70FT) (H187), and H40-70FT (P177)

Checks

WARNING

Never repair damaged forks by heating or welding. Forks are made of tempered steel using special procedures. Always replace damaged forks as a pair.

1. Inspect forks for cracks and wear. Check alignment of fork tips. The difference in height of fork tips must be less than three percent of the length of the forks. See Table 2 and Figure 10.

   Some applications may require closer alignment. If forks do not meet specification, they both must be replaced.

2. Check for smooth and proper operation of the fork lock pins. Repair or replace any damaged or broken fork lock pins or components and lubricate, as necessary.

3. Inspect fork wear. Ensure heel wear is not more than 10% of original thickness.

   If fork wear is more than 10% , fork must be replaced or rerated. Perform fork wear inspection using a BOL256N1 caliper ruler Hyster P/N 4092984 as follows. See Figure 11.

   a. Determine normal thickness of "N" of fork using scale or ruler portion of caliper ruler. Measurement has to be done on fork shank using caliper ruler.

   b. Position caliper at end of heal internal radius (item A,) with opening corresponding to measured thickness of fork shank in Step a above. (e.g. for N 1.75 use N 1.75 opening). This is typically the section of fork where wear is greatest. Note that the opening distance has been reduced by 10% from nominal thickness.

   c. If fork enters opening, it is mandatory to replace it. DANGER OF BREAKING. Furthermore, a 10% reduction in fork blade thickness results in 20% reduction in operating capacity.

Table 2. Fork Tip Alignment

Fork Tip Alignment Specifications			
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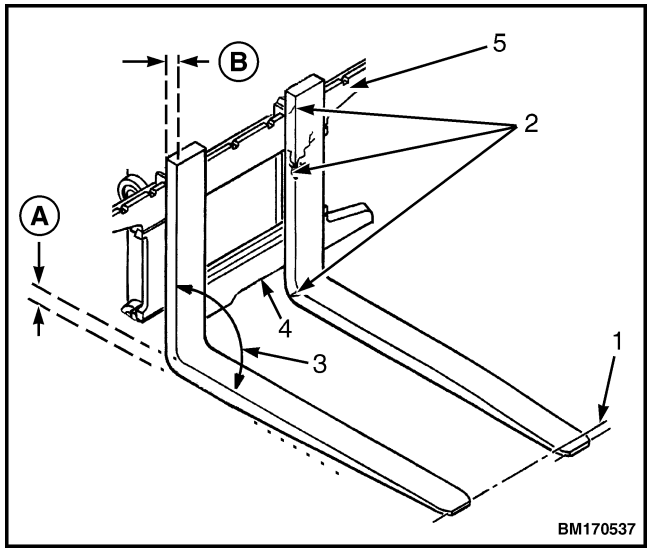
*Difference of alignment between fork tips must be no more than 3% of the total fork length.			



A. HEEL OF FORK (MUST BE 90% OF DIMENSION B
B. ORIGINAL FORK THICKNESS (DIMENSION B)

1. TIP ALIGNMENT (MUST BE WITHIN 3% OF FORK LENGTH)
2. CRACKS
3. MAXIMUM ANGLE 93°
4. FORK REMOVAL NOTCH
5. CARRIAGE

Figure 10. Fork Checks

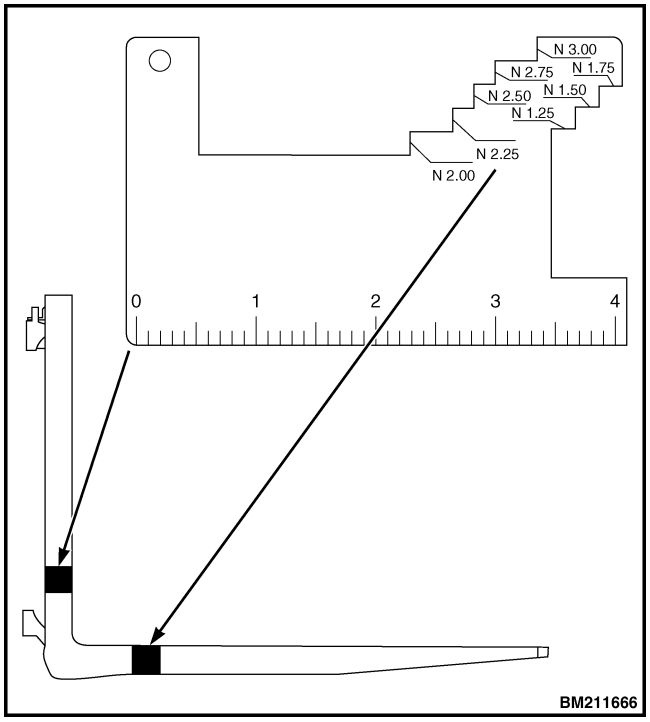


Figure 11. Fork Wear Check

Carriages Repair, Two-Stage LFL Mast

STANDARD CARRIAGE

Remove

1. Remove forks. See Fork Replacement for procedures.

2. Remove four capscrews, washers, nuts, and load backrest from carriage. See Figure 12.

3. Connect a lifting device to the carriage. Lift carriage so that lift chains become loose.

WARNING

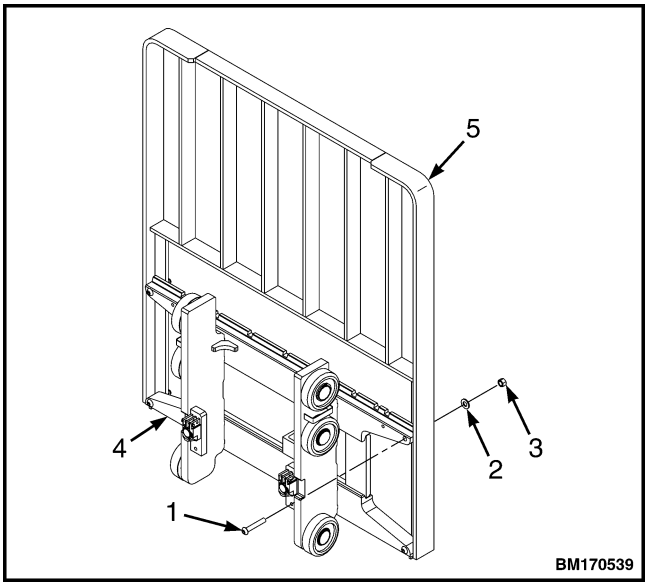
When disconnecting the lift chains, keep control of the ends. Use wire to temporarily connect the ends of the lift chains to the mast. This procedure will prevent the lift chains from falling and causing an injury or damage.

4. Remove chain pin from each chain anchor at the carriage. Disconnect lift chains from carriage. Use wire to connect the ends of lift chains to a part of the mast. Make sure chains can move freely when inner mast is raised. See Figure 13.

WARNING

To help prevent possible injury, make sure the carriage is stable and will not fall over when the inner mast is raised above the load rollers of the carriage.

5. Use lift cylinders to raise inner mast. If hydraulic system cannot be used, disconnect lift cylinders from inner mast. See the section **Cylinder Repair (Mast S/N F507, F508, F562, F563)** 2100SRM1668.



1. CAPSCREW
2. WASHER
3. NUT
4. CARRIAGE
5. LOAD BACKREST

Figure 12. Load Backrest, Remove

6. Connect a crane with a capacity of at least 681 kg (1501 lb), to top of inner mast. Carefully raise inner mast until it is above the load rollers of the carriage. Install safety chains to secure mast in its extended position and disconnect the crane. See Safety Procedures When Working Near Mast.

7. Move lift truck away from carriage. Completely lower inner mast so it cannot move.

Clean and Inspect

NOTE: Shims are installed on the bottom and middle load rollers only.

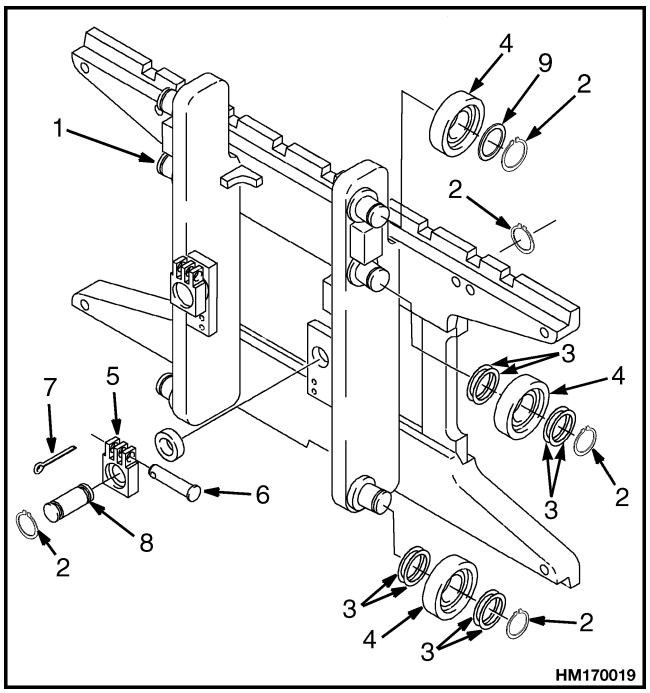
1. If load rollers must be replaced (see Figure 13), make a note of the location and number of shims. Install shims, load rollers, and snap rings. See Carriage Adjustments section for correct adjustment of the load rollers.

WARNING

Compressed air can move particles so that they cause injury to the user or to other personnel. Make sure that the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eyes.

WARNING

Cleaning solvents can be flammable and toxic, and can cause skin irritation. When using cleaning solvents, always follow the recommendations of the manufacturer.



1. CARRIAGE
2. SNAP RING
3. SHIM
4. LOAD ROLLER
5. CHAIN ANCHOR
6. CHAIN PIN
7. COTTER PIN
8. ANCHOR PIN
9. SPACER

Figure 13. Standard Carriage Components

CAUTION

DO NOT use cleaning solvent, compressed air, or steam to clean lift chain sheaves or load rollers. The bearings in the lift chain sheaves and load rollers are sealed and lubricated. Cleaning solvent, compressed air, and steam can damage the load roller bearings.

2. Clean any oil, grease, dirt, and other debris from carriage frame. Use a cleaning solvent and compressed air to dry.

WARNING

Improper welding procedures can damage the structure of the mast or cause incorrect function of the mast. Consult a Resident Service Engineering through the Contact Management System before welding on the mast.

3. If carriage bars have any protruding welds or damaged notches, repair by grinding, filing, or welding.

4. Clean and inspect the chain anchors and chain anchor pins. See Figure 13. Check chain anchors and anchor pins for wear and serviceability. Discard worn or unserviceable chain anchors and chain anchor pins. Discard used cotter pins.

Install

1. Move the lift truck towards the carriage until inner mast is aligned with carriage rollers. If inner mast has been raised and secured using a crane and safety chains, connect the crane, raise inner mast, and remove safety chains. Carefully lower inner mast until it engages all of the load rollers. Disconnect the crane, if attached, and reconnect lift cylinders. See **Cylinder Repair (Mast S/N F507, F508, F562, F563)** 2100SRM1668.

2. Check the clearance of the load rollers. See Carriage Adjustments section for procedures.

NOTE: Use new cotter pins each time chain pins are removed.

3. Connect lift chains to chain anchors at the carriage. Install cotter pins in chain pins. Adjust lift chains as described in Lift Chains Adjustment.

4. Install load backrest on carriage. Tighten capscrews to 195 N•m (144 lbf ft).

5. Install forks. See section Fork Replacement for procedures.

INTEGRAL SIDESHIFT CARRIAGE, LIFT TRUCKS MANUFACTURED PRIOR TO DECEMBER, 2016

Remove

1. Lower carriage completely. Remove forks. See Fork Replacement for removal procedures.

2. Remove four capscrews, washers, nuts, and load backrest from carriage. See Figure 12.

WARNING

Before disconnecting the hydraulic hoses, relieve the pressure in the hydraulic system. Serious injury can occur if pressure is not relieved from hydraulic system prior to disconnecting hydraulic hoses.

3. Relieve hydraulic pressure to the sideshift cylinder by moving sideshift lever in both directions several times.

WARNING

Always wear the proper protective equipment including eye protection and petroleum-resistant gloves when handling hydraulic oil. Thoroughly wash oil from exposed areas of skin as soon as possible.

The hydraulic oil is hot at normal operating temperatures. Be careful when draining the oil.

WARNING

Never check for leaks by putting hands on hydraulic lines or components under pressure. Hydraulic oil under pressure can be injected into the skin.

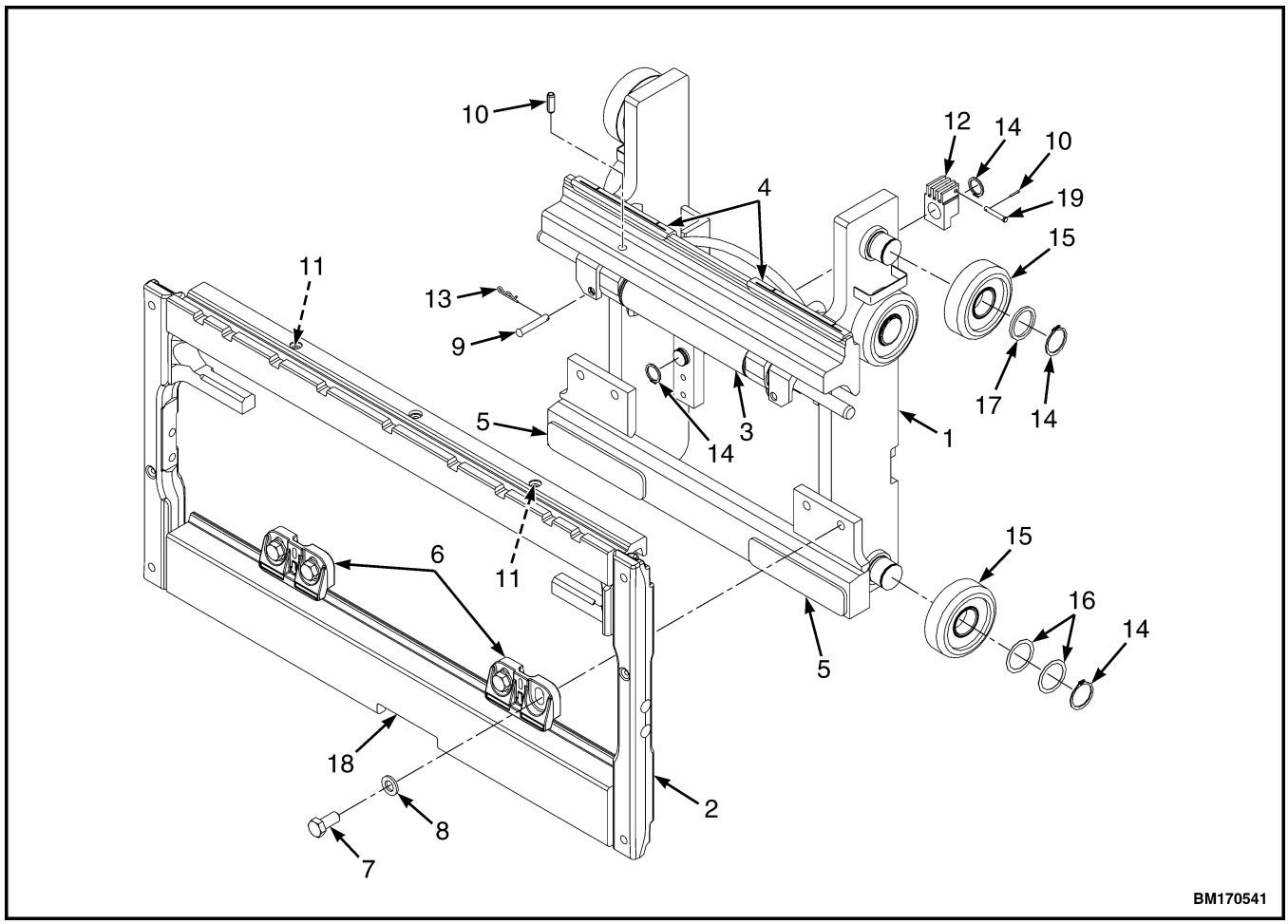
NOTE: Tag hydraulic lines and fittings prior to disconnecting to aid in connecting during installation.

4. Disconnect hydraulic lines from sideshift cylinder. Put caps and plugs on open lines and cylinder ports.

5. Remove lower mounting hooks by removing four capscrews and washers securing the hooks. See Figure 14.

6. Remove sideshift cylinder from carriage. See **Cylinder Repair (Mast S/N F507, F508, F562, F563)** 2100SRM1668.

7. Use a crane with a capacity of at least 48 kg (106 lb) to lift outer frame away from inner frame. Lay outer frame flat on a pallet or work bench. See Figure 15.



1. INNER FRAME
2. OUTER FRAME
3. SIDESHIFT CYLINDER
4. UPPER BEARING
5. LOWER BEARING
6. LOWER HOOK
7. CAPSCREW
8. WASHER
9. CLEVIS PIN
10. PIN
11. LUBE FITTING
12. CHAIN ANCHOR
13. COTTER PIN
14. SNAP RING
15. LOAD ROLLER
16. SHIMS
17. SPACER
18. FORK REMOVAL NOTCH
19. CHAIN ANCHOR PIN

Figure 14. Integral Sideshift Carriage Component Parts

Disassemble

1. Remove upper and lower bearings from inner frame. See Clean and Inspect section for procedures. See Figure 14.

2. If damaged, remove lube fittings from outer frame. See Figure 14.

3. Disassemble the intergral sideshift cylinder. See **Cylinder Repair (Mast S/N F507, F508, F562, F563)** 2100SRM1668 for procedures.

Clean and Inspect

1. Inspect lower mounting hooks for wear. Replace hooks if they are worn beyond the wear limit. The wear limit clearance range is 0.76 mm (0.03 in.) minimum and 1.52 mm (0.06 in.) maximum. See **A** in Figure 16.

CAUTION

Improper welding procedures can damage the structure of the mast or cause incorrect function of the mast. Consult your Hyster lift truck dealer for more information before welding on the mast.

2. Clean and inspect carriage bars for damage and smoothness. Ensure carriage bars are parallel and ends are flush. If carriage bars have any protruding welds or damaged notches, repair by grinding, filing, or welding.

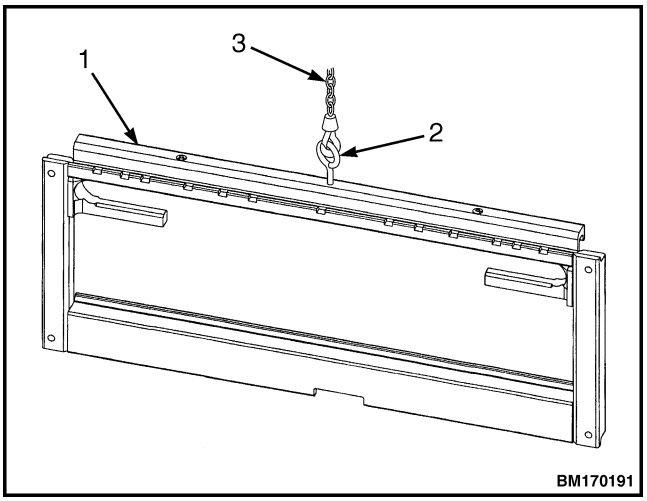
3. Clean bearing areas. Inspect sideshift bearings for wear as follows:

   a. If either upper bearing is worn to less than 2.5 mm (0.1 in.) thickness, replace both upper bearings by driving the upper bearings from the inner frame. See Figure 17.

   b. If either lower bearing is worn to less than 2.5 mm (0.1 in.) thickness, replace lower bearings by prying the lower bearings from the inner frame. See Figure 17.

4. Inspect the sideshift cylinder. See **Cylinder Repair (Mast S/N F507, F508, F562, F563)** 2100SRM1668 for procedures.

5. Inspect load rollers for wear or damage (see Figure 14). If load rollers must be replaced, make a note of the location and number of shims. Install shims, load rollers and snap rings. See section Carriage Adjustments for correct adjustment.



1. OUTER FRAME
2. LIFTING HOOK
3. LIFTING DEVICE

Figure 15. Remove Outer Frame

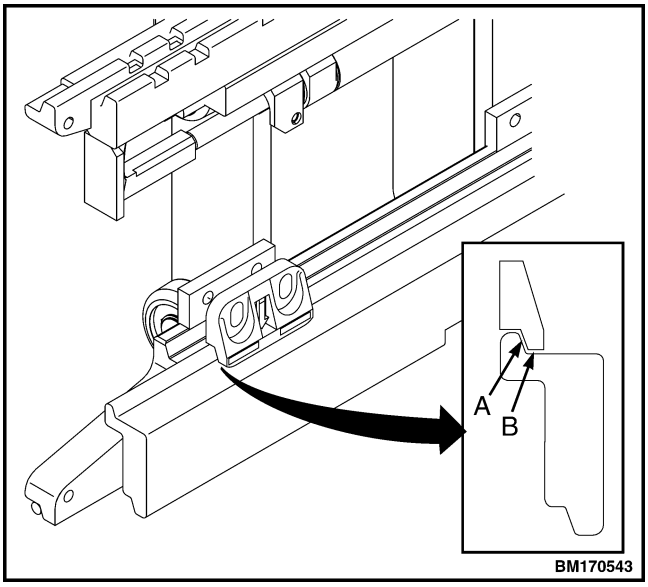
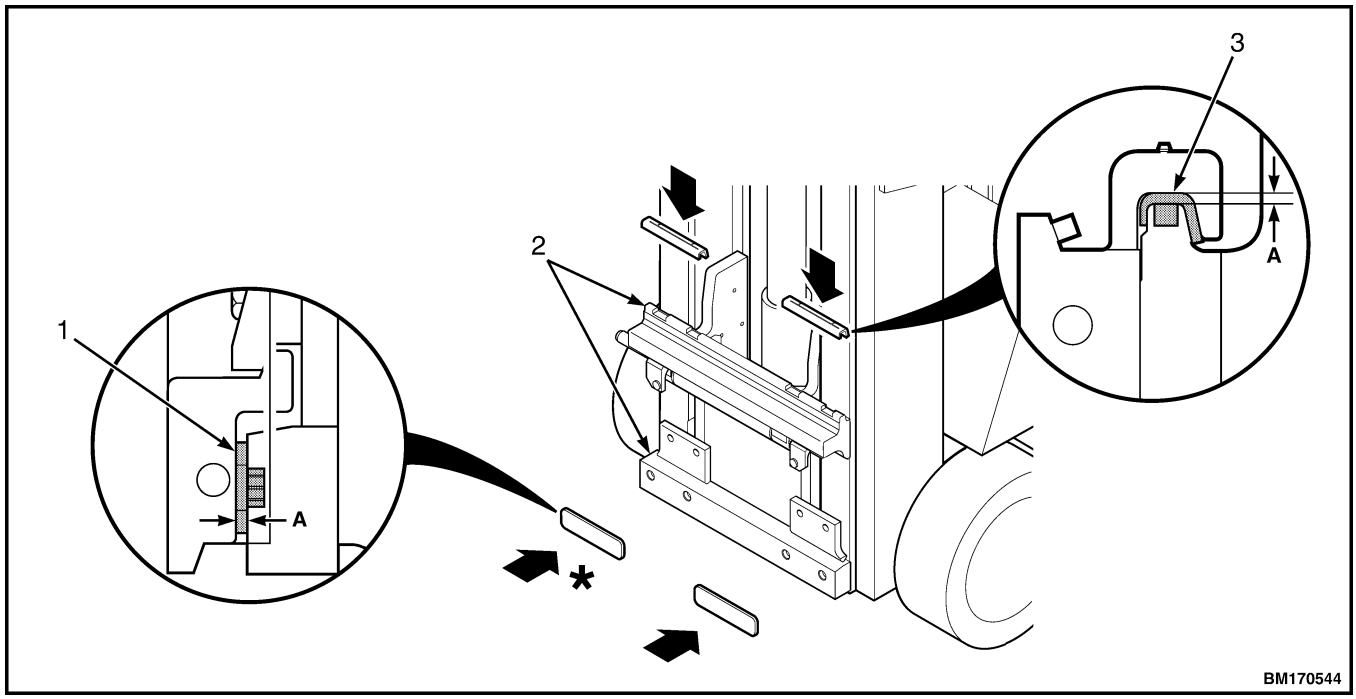


Figure 16. Lower Mounting Hooks Wear Limit and Clearance Adjustment

Legend for Figure 16.

A. WEAR LIMIT - 0.76 mm (0.03 in.) MINIMUM AND 1.52 mm (0.06 in.) MAXIMUM
B. CLEARANCE ADJUSTMENT - 0.76 mm (0.03 in.) MINIMUM AND 1.52 mm (0.06 in.) MAXIMUM



A. MINIMUM THICKNESS 2.5 mm (0.1 in.).

1. LOWER BEARINGS
2. CARRIAGE BARS
3. UPPER BEARINGS

*Bold arrows indicate which side to apply grease.

Figure 17. Upper and Lower Bearings

Assemble

1. Assemble integral sideshift cylinder. See **Cylinder Repair (Mast S/N F507, F508, F562, F563)** 2100SRM1668 for procedures.

2. If lube fittings were removed, install new lube fittings into outer frame. See Figure 14.

NOTE: Use a wood block or a plastic hammer to fully seat upper bearings onto inner frame. Proper lower hook clearance requires the upper bearings be fully seated.

3. Apply a 1 mm (0.040 in.) layer of multipurpose grease to upper and lower bearing surfaces. Install upper and lower bearings into the inner frame. Bearings snap into place. See Figure 17.

Install

1. Install integral sideshift cylinder onto carriage. See **Cylinder Repair (Mast S/N F507, F508, F562, F563)** 2100SRM1668 for procedures.

2. Use a crane with a capacity of at least 48 kg (106 lb) and install outer frame onto inner frame. See Figure 14.

3. Install lower mounting hooks using four capscrews. Tighten to 150 to 180 N•m (108 to 132 lbf ft). For proper sideshift operation, make sure there is 0.76 to 1.52 mm (0.03 to 0.06 in.) clearance between the bottom of the hooks and the outer frame. See **B** in Figure 16.

4. Connect hydraulic lines, as noted during removal, to sideshift cylinder.

5. Install load backrest to sideshift carriage. Tighten capscrews to 195 N•m (144 lbf ft). See Figure 12.

6. Install forks. See section Fork Replacement, in this manual, for procedures.

INTEGRAL SIDESHIFT CARRIAGE, LIFT TRUCKS MANUFACTURED AFTER DECEMBER, 2016

This section covers lift truck models E2.2-3.5XN (E45-70XN) (A268), S2.0-3.5FT (S40-70FT) (H187), and H40-70FT (P177) equipped with an integral sideshift carriage and manufactured after December, 2016.

Remove

1. Lower carriage completely. Remove forks. See Fork Replacement for removal procedures.

2. Remove four capscrews, nuts, washers, and load backrest from carriage. See Figure 12.

WARNING

Before disconnecting the hydraulic hoses, relieve the pressure in the hydraulic system. Serious injury can occur if pressure is not relieved from hydraulic system prior to disconnecting hydraulic hoses.

3. Relieve hydraulic pressure to the sideshift cylinder by moving sideshift lever in both directions several times.

WARNING

Always wear the proper protective equipment including eye protection and petroleum-resistant gloves when handling hydraulic oil. Thoroughly wash oil from exposed areas of skin as soon as possible.

The hydraulic oil is hot at normal operating temperatures. Be careful when draining the oil.

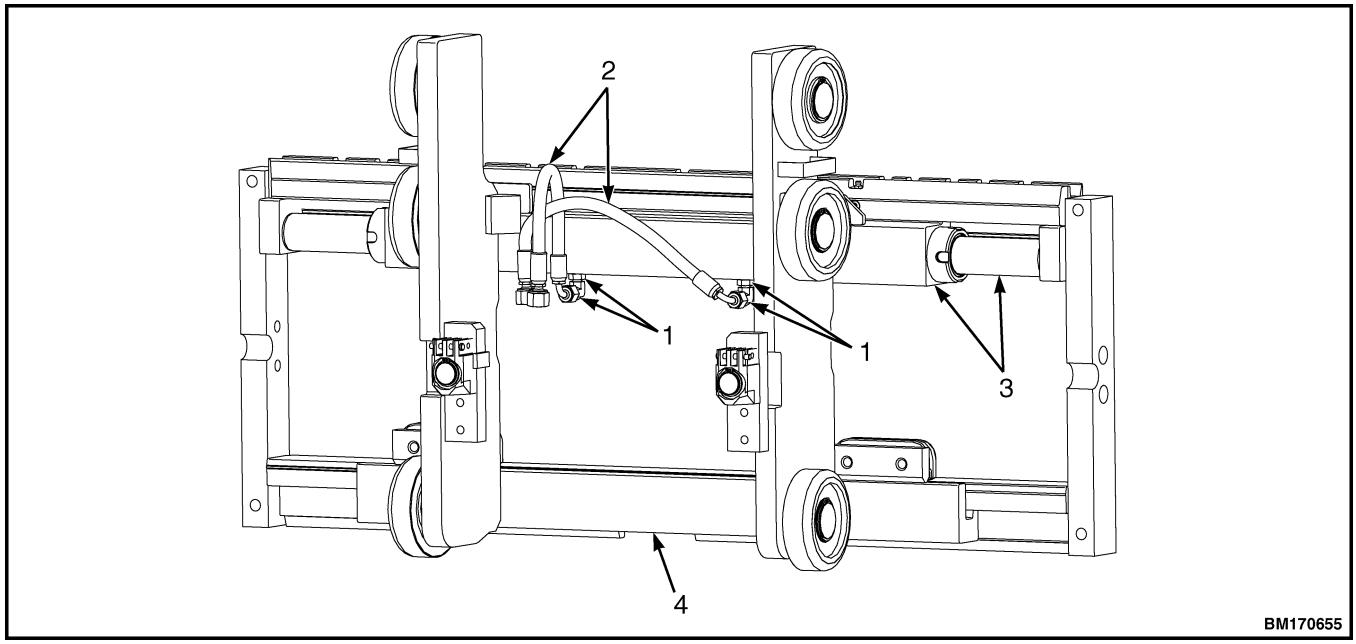
Never check for leaks by putting hands on hydraulic lines or components under pressure. Hydraulic oil under pressure can be injected into the skin.

CAUTION

Protect the hydraulic system from dirt and contaminants when servicing the hydraulic system.

NOTE: Tag hydraulic lines and fittings prior to disconnecting to aid in connecting during installation.

4. Disconnect hydraulic lines from sideshift cylinder. Put caps and plugs on open lines and cylinder ports. See Figure 18.



NOTE: CLASS II CARRIAGE SHOWN. CLASS III CARRIAGE IS SIMILAR.

1. HYDRAULIC HOSE FITTINGS
2. INTEGRAL SIDESHIFT HYDRAULIC HOSES
3. INTEGRAL SIDESHIFT CYLINDER
4. INTEGRAL SIDESHIFT CARRIAGE ASSEMBLY

Figure 18. Integral Sideshift Carriage Hydraulic Hose Connections

5. Remove lower mounting hooks by removing four capscrews and washers securing the hooks. See Figure 19.

6. Remove integral sideshift cylinder from carriage. See **Cylinder Repair (Mast S/N F507, F508, F562, F563)** 2100SRM1668 for procedures.

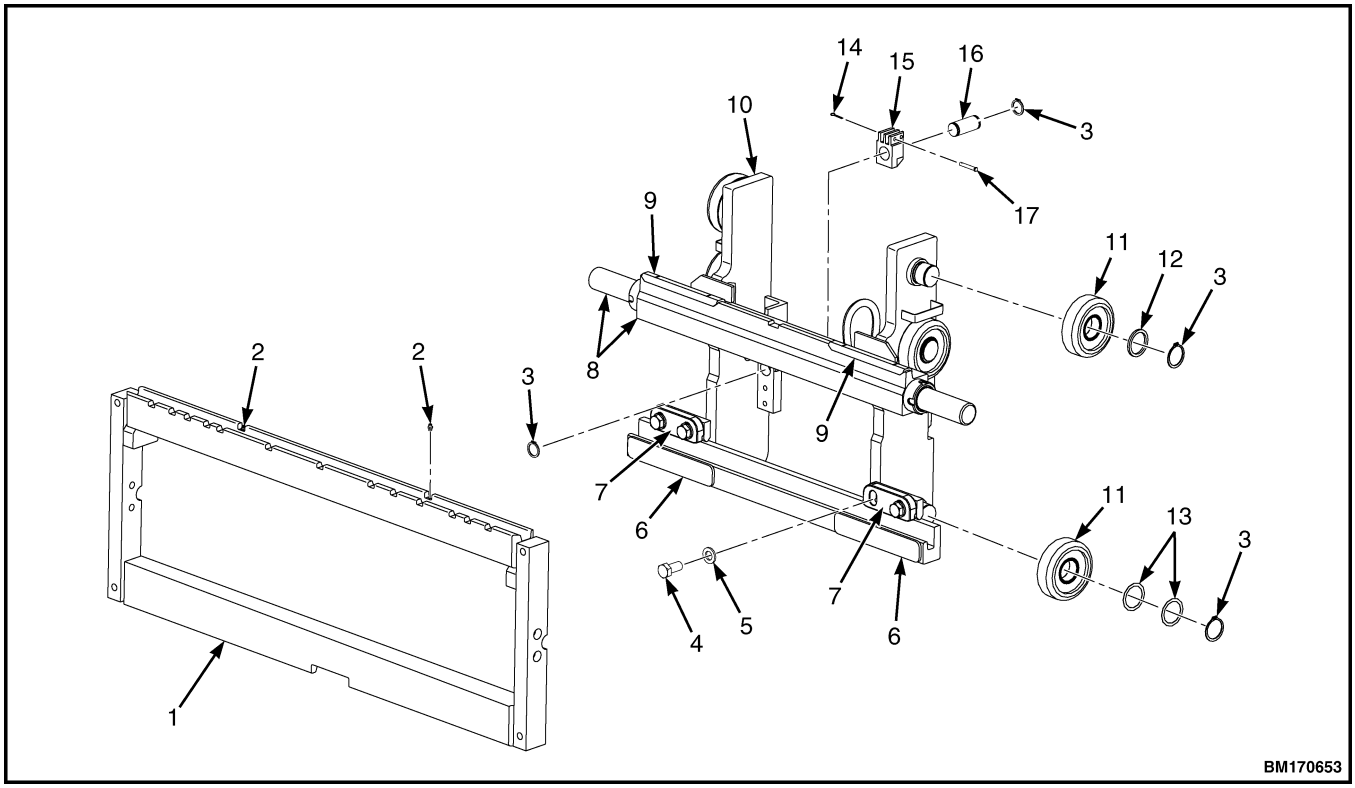
7. Use a crane with a capacity of at least 48 kg (106 lb) to lift outer frame away from the inner frame (see Figure 20). Lay outer frame flat on a pallet or workbench.

Disassemble

1. Remove the upper and lower bearings from the inner frame. See Clean and Inspect section for procedures.

2. If damaged, remove lube fittings from outer frame. See Figure 19.

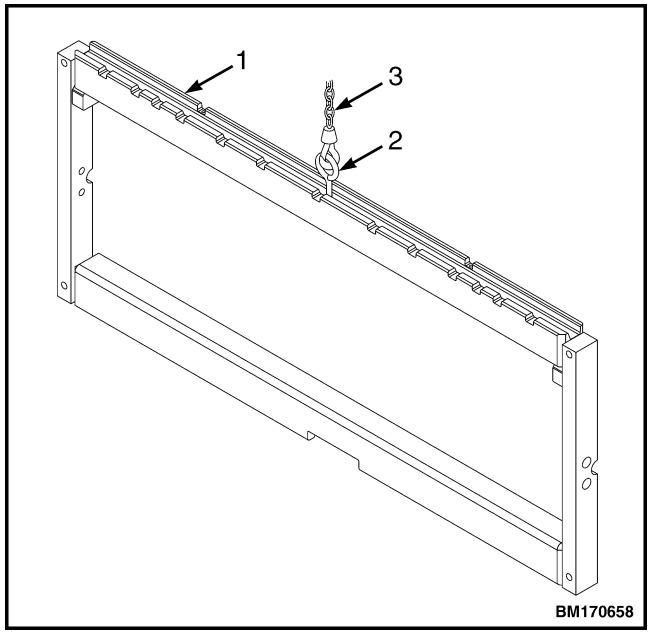
3. Disassemble sideshift cylinder. See **Cylinder Repair (Mast S/N F507, F508, F562, F563)** 2100SRM1668 for procedures.



NOTE: TWO-STAGE LFL, CLASS II INTEGRAL SIDESHIFT CARRIAGE SHOWN. TWO-STAGE LFL, CLASS III INTEGRAL SIDESHIFT CARRIAGE IS SIMILAR.

1. OUTER FRAME
2. LUBE FITTING
3. SNAP RING
4. CAPSCREW
5. WASHER
6. LOWER BEARING
7. LOWER HOOK
8. INTEGRAL SIDESHIFT CYLINDER
9. UPPER BEARING
10. INNER FRAME
11. LOAD ROLLER
12. SPACER
13. SHIMS
14. COTTER PIN
15. CHAIN ANCHOR
16. PIN
17. CHAIN ANCHOR PIN

Figure 19. Integral Sideshift Carriage, Two-Stage LFL Mast



1. OUTER FRAME
2. LIFTING HOOK
3. LIFTING DEVICE

Figure 20. Remove Outer Frame

Clean and Inspect

WARNING

Improper welding procedures can damage the structure of the mast or cause incorrect function of the mast. Consult your Hyster lift truck dealer for more information before welding on the mast.

1. Clean and inspect carriage bars for damage and smoothness. Ensure the carriage bars are parallel and the ends are flush. If carriage bars have any protruding welds or damaged notches, repair by grinding, filing, or welding.

2. Clean the bearing areas. Inspect the sideshift bearings for wear as follows:

   a. If either upper bearing is worn to less than 2.5 mm (0.1 in.) thickness, replace both upper bearings by driving the upper bearings from the inner frame. See Assemble section for procedures to replace upper bearings and Figure 21.

   b. If either lower bearing is worn to less than 2.5 mm (0.1 in.) thickness, replace both lower bearings by prying the lower bearings from the inner frame. See Assemble section for procedures to replace lower bearings and Figure 21.

3. Inspect sideshift cylinder. See **Cylinder Repair (Mast S/N F507, F508, F562, F563)** 2100SRM1668 for procedures.

4. Inspect load rollers for wear and damage (see Figure 19). If load rollers must be replaced, make a note of the location and number of the shims to ensure correct installation. See Carriage Adjustments.

Assemble

1. Assemble sideshift cylinder. See **Cylinder Repair (Mast S/N F507, F508, F562, F563)** 2100SRM1668 for procedures.

2. If lube fittings were removed, install new lube fittings into outer frame. See Figure 19.

NOTE: Use a wood block or a plastic hammer to fully seat the upper bearings onto the inner frame. Proper lower hook clearance requires the upper bearings be fully seated.

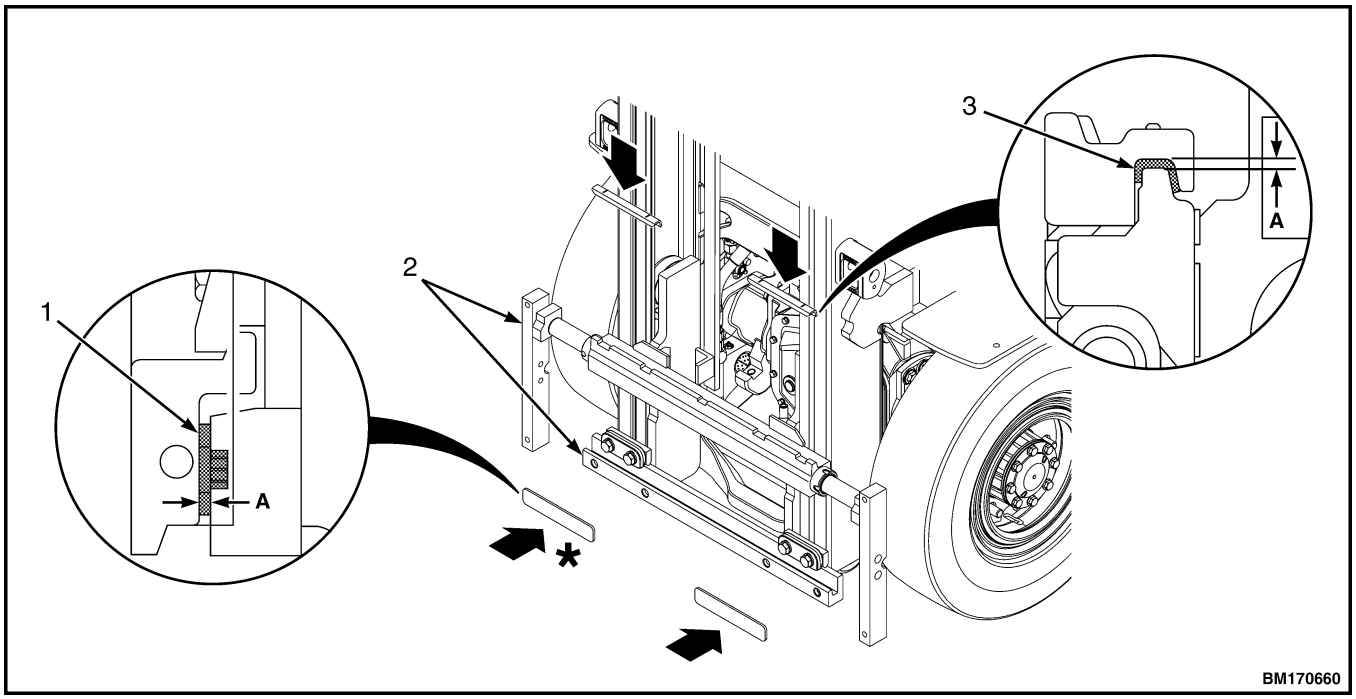
3. Apply a 1 mm (0.040 in.) layer of multipurpose grease to upper and lower bearing surfaces. Install the upper and lower bearings onto inner frame:

   a. To install new upper bearing, align the pins on the bottom side of bearing to notches on top carriage bar and slide into place on top carriage. See Figure 21.

   b. To install new lower bearing, align the circular pins on backside of lower bearing to holes on lower carriage bar and tap bearing into place on lower carriage bar using a rubber or brass hammer. See Figure 21.

Install

1. Install integral sideshift cylinder onto carriage. See **Cylinder Repair (Mast S/N F507, F508, F562, F563)** 2100SRM1668 for procedures.
2. Use a crane, with a capacity of 48 kg (106 lb), and install outer frame onto inner frame. See Figure 20.
3. Install lower mounting hook using four capscrews and washers. Tighten capscrews to 150 to 180 N•m (108 to 132 lbf ft).
4. Connect hydraulic lines, as noted during removal, to sideshift cylinder. See Figure 18.
5. Install load backrest onto integral sideshift carriage. Tighten capscrews to 195 N•m (144 lbf ft). See Figure 12.
6. Install forks. See Fork Replacement section for procedures.



A. MINIMUM THICKNESS, 2.5 mm (0.1 in.)

1. LOWER BEARINGS
2. CARRIAGE BARS
3. UPPER BEARINGS

*Bold arrows indicate which side to apply grease.

Figure 21. Upper and Lower Bearings

FORK POSITIONER CARRIAGE, LIFT TRUCKS MANUFACTURED PRIOR TO DECEMBER, 2016

Remove

NOTE: The fork positioner can be removed from the integral sideshift carriage with integral sideshift carriage on or off the mast. In the steps below, the fork positioner is removed with integral sideshift carriage on the mast. If integral sideshift carriage must be removed from mast first, go to Integral Sideshift Carriage, Lift Trucks Manufactured Prior To December, 2016 in this section.

1. Remove forks. See Fork Replacement section for procedures.

2. Remove four capscrews, washers, nuts, and load backrest from carriage. See Figure 12.

WARNING

Before disconnecting the hydraulic hoses, relieve the pressure in the hydraulic system. Serious injury can occur if pressure is not relieved from hydraulic system prior to disconnecting hydraulic hoses.

WARNING

Always wear the proper protective equipment including eye protection and petroleum-resistant gloves when handling hydraulic oil. Thoroughly wash oil from exposed areas of skin as soon as possible.

WARNING

The hydraulic oil is hot at normal operating temperatures. Be careful when draining the oil.

Never check for leaks by putting hands on hydraulic lines or components under pressure. Hydraulic oil under pressure can be injected into the skin.

CAUTION

Protect the hydraulic system from dirt and contaminants when servicing the hydraulic system.

CAUTION

DO NOT bend tube assemblies during removal.

NOTE: Tag all hydraulic hoses, lines, and fittings prior to removal to aid in installation.

3. Disconnect and cap tube assemblies (8, Figure 22) from header hoses.

4. Remove capscrews and washers and remove lower hooks and bracket weldments from carriage. See Figure 23 and Figure 25.

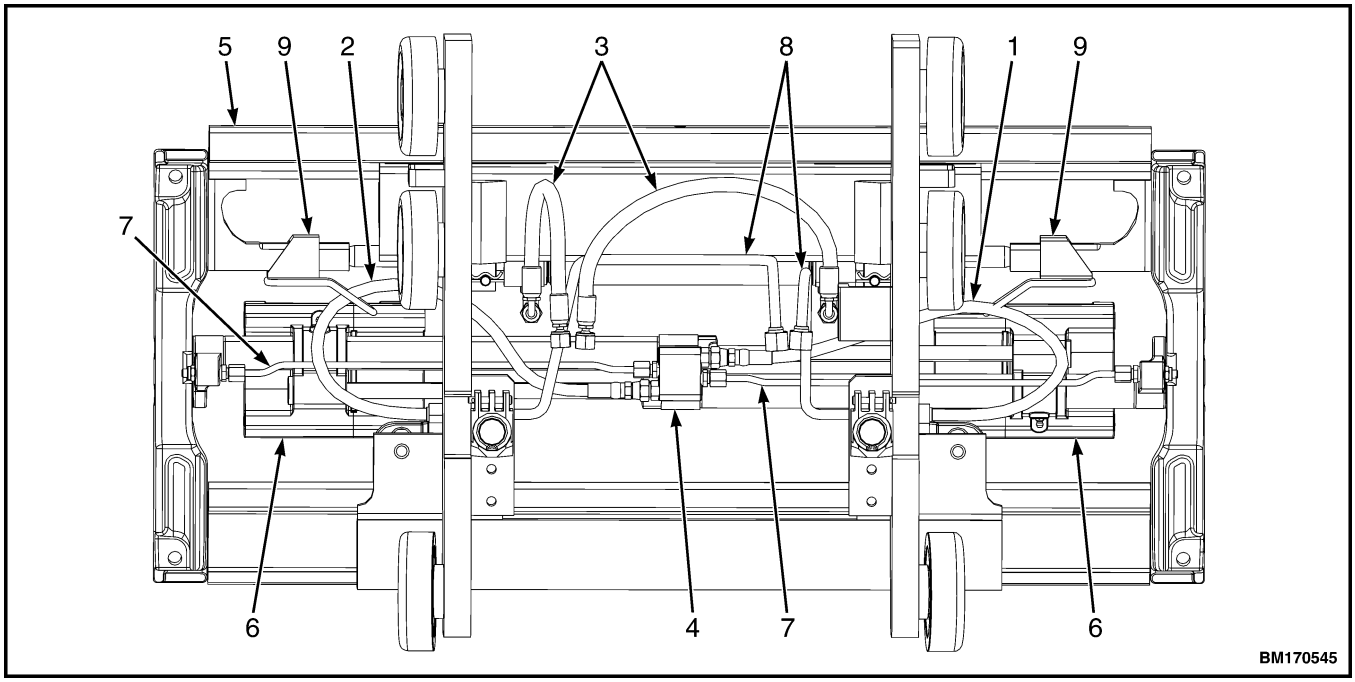
5. Install lifting eye in hole (see Figure 23) on integral sideshift carriage and use lifting device to lift outer frame up.

6. Disconnect relief tube assembly and hydraulic hoses (open and close) from fork positioner. See Figure 23.

NOTE: Make note of shims used to aid in reassembly.

7. Remove capscrews, lockwashers, and shims from integral sideshift carriage. See Figure 23.

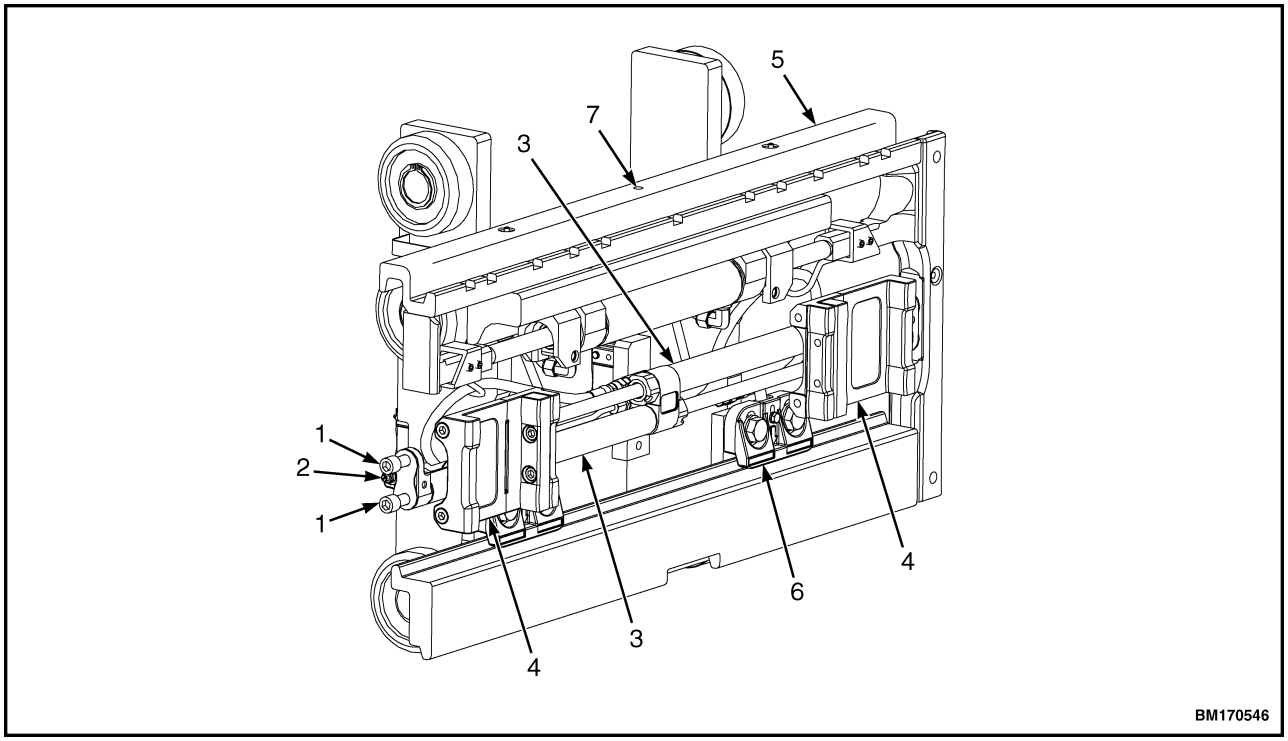
8. Remove fork positioner from outer frame.



NOTE: BACK (DRIVER'S) VIEW SHOWN.

1. FORK POSITIONER HYDRAULIC HOSE (OPEN)
2. FORK POSITIONER HYDRAULIC HOSE (CLOSED)
3. INTEGRAL SIDESHIFT CARRIAGE HYDRAULIC HOSES
4. FORK POSITIONER
5. OUTER FRAME
6. FORK CARRIER
7. RELIEF TUBE ASSEMBLY
8. TUBE ASSEMBLY
9. HOSE GUIDE

Figure 22. Hydraulic Connections, Fork Positioner Cylinder



NOTE: RIGHT OUTER FRAME BAR REMOVED FOR CLARITY.
NOTE: FRONT VIEW SHOWN.

1. CAPSCREW AND LOCKWASHER
2. SHIM
3. FORK POSITIONER CYLINDER
4. FORK CARRIER
5. INTEGRAL SIDESHIFT CARRIAGE ASSEMBLY
6. LOWER HOOK
7. TAPPED HOLE FOR LIFT EYE

Figure 23. Fork Positioner Cylinder Removal

For procedures to repair the fork positioner cylinder, see **Cylinder Repair (Mast S/N F507, F508, F562, F563)** 2100SRM1668.

Install

1. Place fork positioner cylinders onto outer frame. Install lockwasher and capscrew on one side and hand tighten capscrew. See Figure 23. Add shims as follows:

NOTE: The maximum number of shims per side is five. The maximum difference in number of shims per side is two. The maximum gap allowed before tightening capscrews is 0.50 mm (.020 in.).

a. Measure gap at opposite side and determine the number of shims required.

b. Install shims on both sides of the fork positioner assembly.

2. Install second lockwasher and capscrew. Tighten both capscrews to 65 N•m (50 lbf ft). See Figure 23.

3. Connect fork positioner hydraulic hoses to fork positioner manifold. Tighten hoses to 21 N•m (186 lbf in). See Figure 22.

4. Thread fork positioner hydraulic hoses through hose guides. See Figure 22.

5. Install outer frame, with fork positioner, on inner frame.

6. Using a lifting device, position outer frame at the same height of inner frame and 150 mm (6 in.) away.

7. From rear of outer frame, connect fork positioner hydraulic tubes to header hoses and hand tighten. See Figure 22.

8. Position fork positioner hydraulic tubes so they are in line with inner frame retainer plates. See Figure 24.

9. Using washer and capscrew, install bracket weldment to lower hook and hand tighten capscrew. Install lower hook on retainer plate with washer and capscrew and tighten capscrews to 165 N•m (122 lbf ft). See Figure 25.

10. Position bracket weldment over fork positioner hydraulic hoses (see Figure 22) and adjust so that bracket weldment makes contact with fork positioner hoses. Tighten capscrew to 8 N•m (71 lbf in). See Figure 25.

11. Tighten fork positioner hydraulic tubes to header hoses to 42 N•m (31 lbf ft).

WARNING

DO NOT try to install a fork without a lifting device. Each hook fork for these lift trucks can weigh 45 to 115 kg (99 to 254 lb).

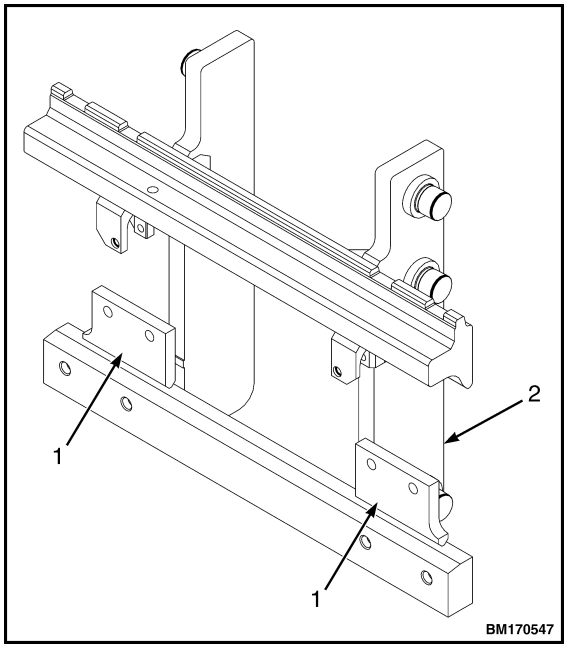
CAUTION

Remove fork latch pins (see Figure 3) if adding a fork positioner attachment. Damage to forks and other carriage components can occur if fork latch pins are not removed prior to using a fork positioner attachment.

NOTE: Before proceeding to Step 12 and Step 13, adjust the fork positioner hydraulic hoses. See Fork Positioner Hydraulic Hose Adjustment for procedures.

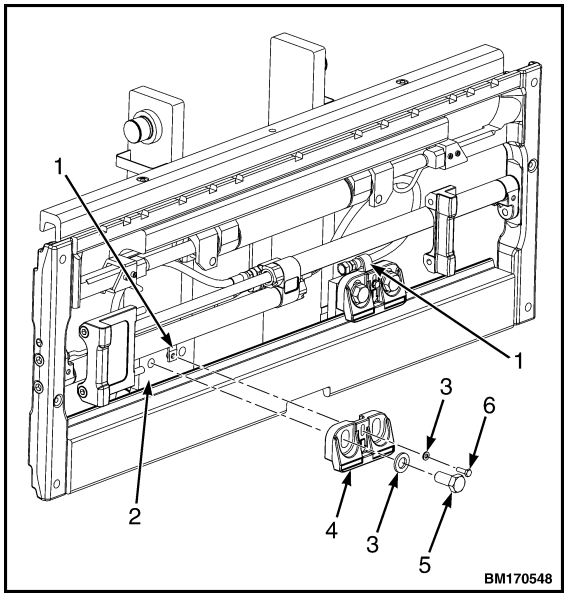
12. Install forks to outer fork carriers. Secure inner fork carriers to outer fork carriers using four capscrews. Tighten capscrews to 35 N•m (25 lbf ft). See Figure 8.

13. To adjust the fork positioner cylinders, see **Cylinder Repair (Mast S/N F507, F508, F562, F563)** 2100SRM1668 for procedures.



1. RETAINER PLATE
2. INNER FRAME

Figure 24. Inner Frame Retainer Plates



1. BRACKET WELDMENT
2. RETAINER PLATE
3. WASHER
4. LOWER HOOK
5. CAPSCREW (LOWER HOOK)
6. CAPSCREW (BRACKET WELDMENT)

Figure 25. Bracket Weldment and Lower Hook Assembly

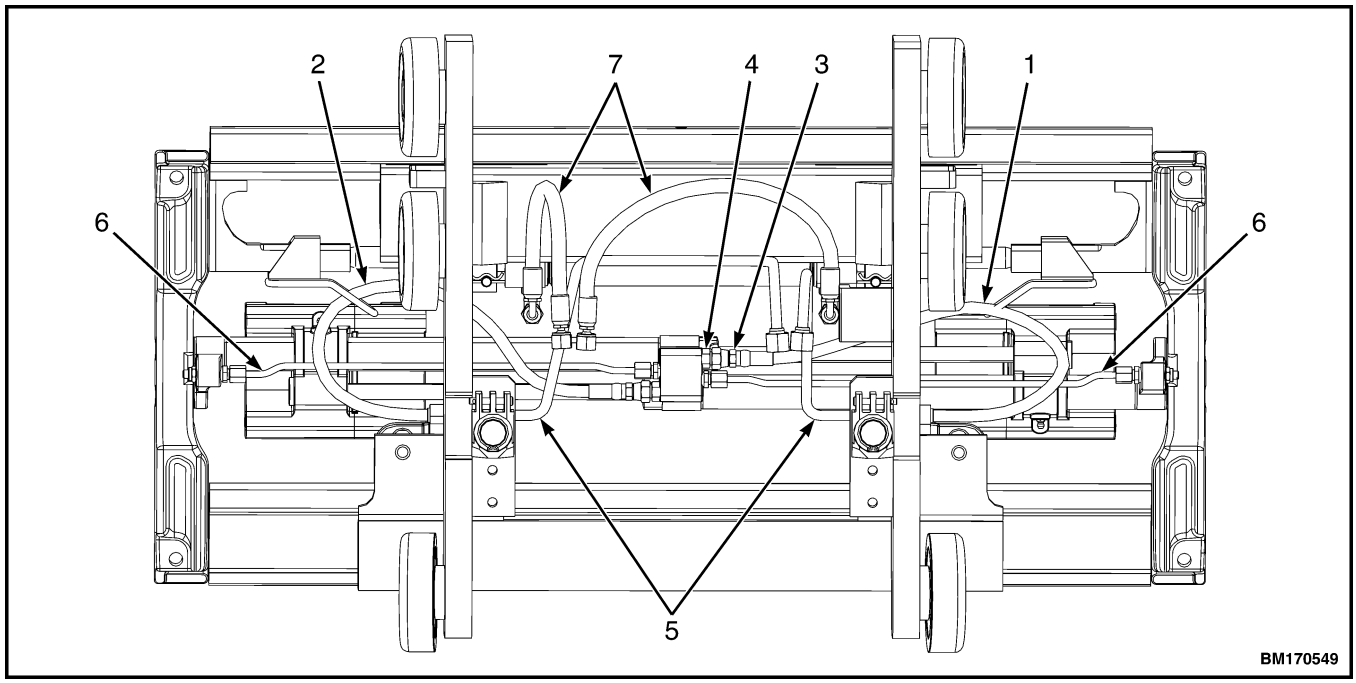
Fork Positioner Hydraulic Hose Adjustment

1. To adjust the fork positioner hydraulic hoses, hold the large hex nut and rotate the small hex nut towards the load face of the carriage (towards the forks). See Figure 26.

2. Fork positioner hoses are correctly adjusted when fork positioner hydraulic hoses stay entirely within the integral sideshift carriage and do not contact mast channels under all conditions.

3. Move fork positioner and check to ensure fork carriers clear fork positioner relief tubes through complete fork carrier cycle. See Figure 26.

4. Install load backrest to sideshift carriage. Tighten capscrews to 195 N•m (144 lbf ft). See Figure 12.



NOTE: BACK (DRIVER'S) VIEW SHOWN.

1. FORK POSITIONER HYDRAULIC HOSE (OPEN)
2. FORK POSITIONER HYDRAULIC HOSE (CLOSE)
3. SMALL HEX NUT
4. LARGE HEX NUT
5. TUBE ASSEMBLY
6. RELIEF TUBE ASSEMBLY
7. INTEGRAL SIDESHIFT HYDRAULIC HOSES

Figure 26. Fork Positioner Hydraulic Hose Adjustment

FORK POSITIONER CARRIAGE, LIFT TRUCKS MANUFACTURED AFTER DECEMBER, 2016

This section covers lift truck models E2.2-3.5XN (E45-70XN) (A268), S2.0-3.5FT (S40-70FT) (H187), and H40-70FT (P177) equipped with a fork positioner on an integral sideshift carriage and manufactured after December, 2016.

Remove

NOTE: The fork positioner can be removed from the integral sideshift carriage with integral sideshift carriage on or off the mast. In the steps below, the fork positioner is removed with integral sideshift carriage on the mast. If integral sideshift carriage must be removed from mast first, go to Integral Sideshift Carriage, Lift Trucks Manufactured After December, 2016 in this section for procedures.

1. Remove forks. See Fork Replacement section for procedures.

2. Remove four capscrews, washers, nuts and load backrest from carriage. See Figure 12.

WARNING

Before disconnecting the hydraulic hoses, relieve the pressure in the hydraulic system. Serious injury can occur if pressure is not relieved from hydraulic system prior to disconnecting hydraulic hoses.

WARNING

Always wear the proper protective equipment including eye protection and petroleum-resistant gloves when handling hydraulic oil. Thoroughly wash oil from exposed areas of skin as soon as possible.

WARNING

The hydraulic oil is hot at normal operating temperatures. Be careful when draining the oil.

Never check for leaks by putting hands on hydraulic lines or components under pressure. Hydraulic oil under pressure can be injected into the skin.

CAUTION

Protect the hydraulic system from dirt and contaminants when servicing the hydraulic system.

CAUTION

DO NOT bend tube assemblies during removal.

NOTE: Tag all hydraulic hoses, lines, and fittings prior to removal to aid in installation.

3. Disconnect and cap tube assemblies (8, Figure 27) from header hoses.

4. Remove capscrews and washers and remove lower hooks from retainer plates on inner frame. See Figure 28.

5. Install lifting eye in hole (7, Figure 28) on outer frame of integral sideshift carriage. Use a lifting device with a capacity of 62 kg (136 lb), to lift outer frame with fork positioner attached. See Figure 29 .

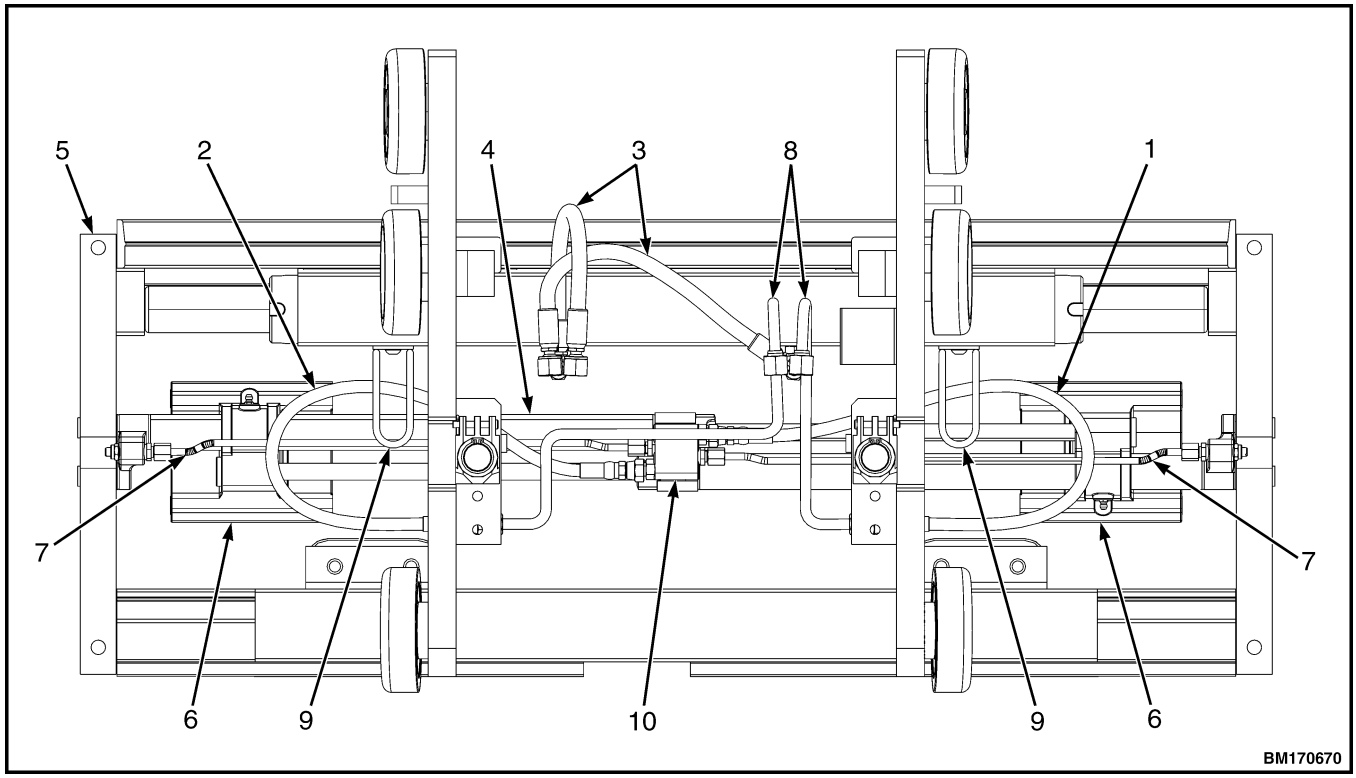
6. Disconnect relief tube assembly and hydraulic hoses (open and close) from fork positioner. See Figure 27.

NOTE: Make note of shims used to aid in reassembly.

7. Remove capscrews, lockwashers, and shims from integral sideshift carriage. See Figure 28.

8. Remove fork positioner from outer frame.

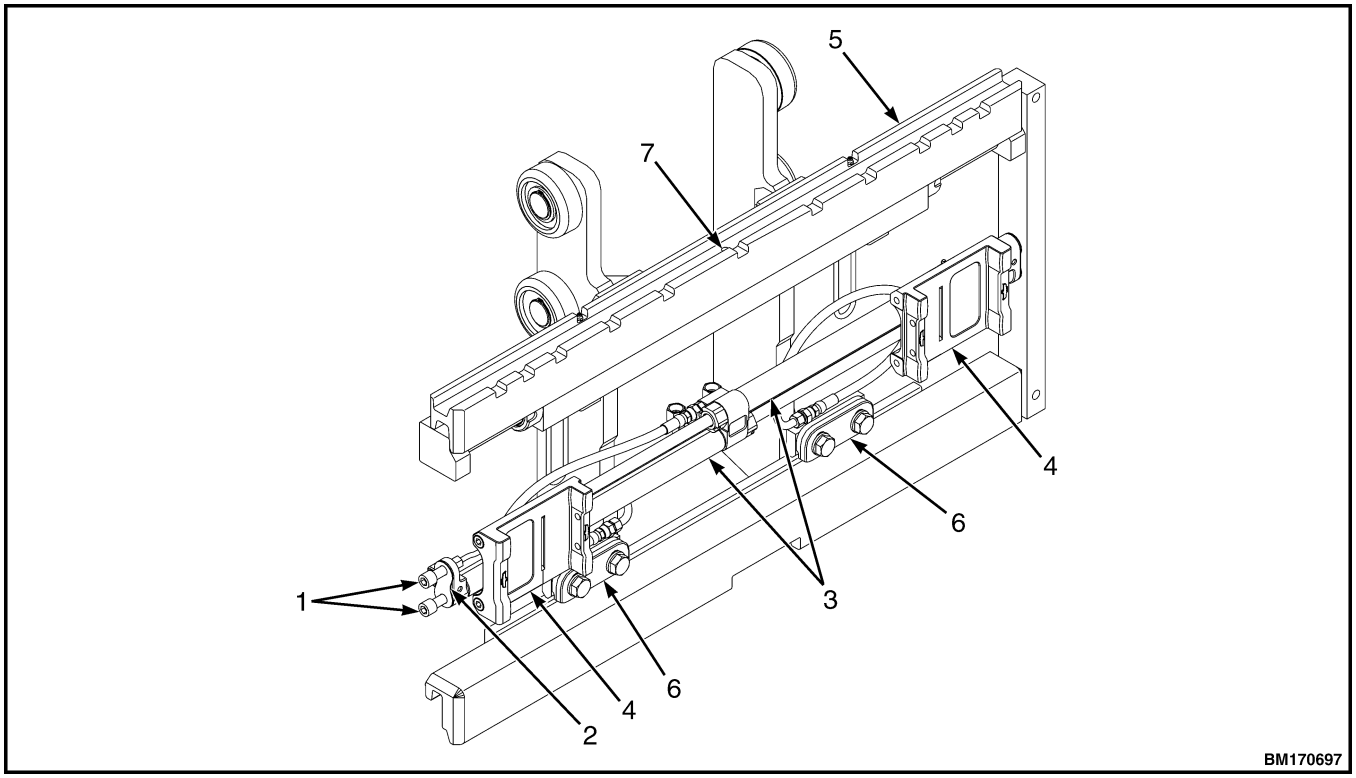
   For procedures to repair the fork positioner cylinder, see **Cylinder Repair (Mast S/N F507, F508, F562, F563)** 2100SRM1668



NOTE: BACK (DRIVER'S) VIEW SHOWN.

1. FORK POSITIONER HYDRAULIC HOSE (OPEN)
2. FORK POSITIONER HYDRAULIC HOSE (CLOSE)
3. INTEGRAL SIDESHIFT CARRIAGE HYDRAULIC HOSES
4. FORK POSITIONER CYLINDER
5. OUTER FRAME
6. FORK CARRIER
7. RELIEF TUBE ASSEMBLY
8. TUBE ASSEMBLY
9. HOSE GUIDE
10. MANIFOLD

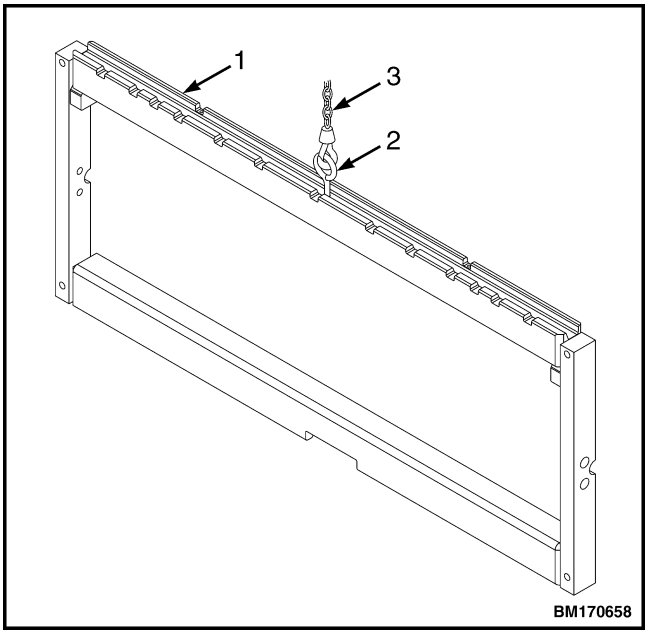
Figure 27. Hydraulic Connections, Fork Positioner Cylinder



NOTE: FRONT VIEW SHOWN.

1. CAPSCREW AND LOCKWASHER
2. SHIMS
3. FORK POSITIONER CYLINDER
4. FORK CARRIER
5. INTEGRAL SIDESHIFT CARRIAGE ASSEMBLY
6. LOWER HOOK
7. TAPPED HOLE FOR LIFT EYE

Figure 28. Fork Positioner Cylinder Removal



1. OUTER FRAME
2. LIFTING HOOK
3. LIFTING DEVICE

Figure 29. Remove Outer Frame

Disassemble and Assemble

See **Cylinder Repair (Mast S/N F507, F508, F562, F563)** 2100SRM1668 for disassemble and assemble procedures for fork positioner cylinder.

Clean and Inspect

See **Cylinder Repair (Mast S/N F507, F508, F562, F563)** 2100SRM1668 for cleaning and inspection procedures on the fork positioner cylinder.

Install

1. Place fork positioner cylinders onto outer frame. Install lockwasher and capscrew on one side and hand tighten capscrew. See Figure 28. Add shims as follows:

NOTE: The maximum number of shims per side is five. The maximum difference in number of shims per side is two. The maximum gap allowed before tightening capscrews is 0.50 mm (.020 in.).

   a. Measure gap at opposite side and determine the number of shims required.

   b. Install shims on both sides of the fork positioner assembly.

2. Install second lockwasher and capscrew. Tighten both capscrews to 65 N•m (50 lbf ft). See Figure 28.

3. Connect fork positioner hydraulic hoses to fork positioner manifold. Tighten hoses to 21 N•m (186 lbf in). See Figure 27.

4. Thread fork positioner hydraulic hoses through hose guides. See Figure 27.

5. Install lifting eye and use a lifting device, with a capacity of 62 kg (136 lb), to install outer frame, with fork positioner attached, onto inner frame. See Figure 29.

6. Using a lifting device, position outer frame at the same height of inner frame and 150 mm (6 in.) away.

7. From rear of outer frame, connect fork positioner hydraulic tubes to header hoses and hand tighten. See Figure 27.

8. Position fork positioner hydraulic tubes so they are in line with retainer plates on inner frame. See Figure 30.

9. Using a washer and capscrew, install lower hook to retainer plates and tighten capscrews to 165 N•m (122 lbf ft).

10. Tighten fork positioner hydraulic tubes to header hoses to 42 N•m (31 lbf ft).

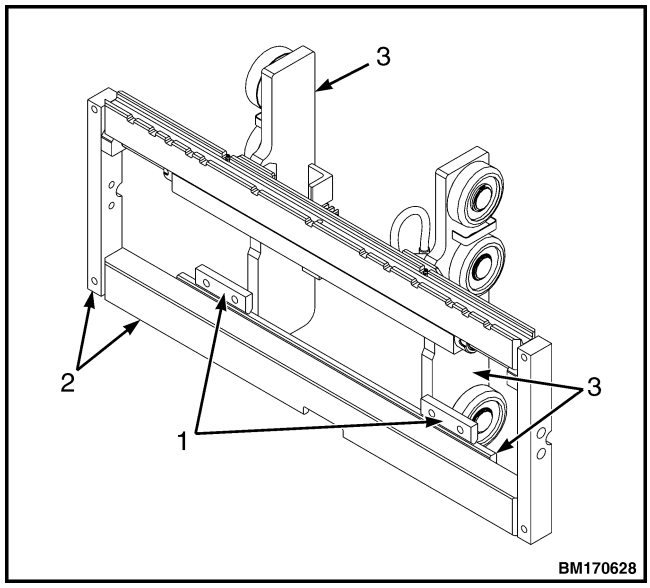
CAUTION

Remove fork latch pins (see Fork Replacement) if adding a fork positioner attachment. Damage to forks and other carriage components can occur if fork latch pins are not removed prior to using a fork positioner attachment.

NOTE: Before proceeding to Step 11 and Step 12, adjust the fork positioner hydraulic hoses. See Fork Positioner Hydraulic Hose Adjustment for procedures.

11. Install forks to outer fork carriers. See Fork Replacement section for procedures.

12. To adjust the fork positioner cylinders, see **Cylinder Repair (Mast S/N F507, F508, F562, F563)** 2100SRM1668 for procedures.



1. RETAINER PLATES
2. OUTER FRAME (FORK BAR)
3. INNER FRAME

Figure 30. Retainer Plates and Inner and Outer Frame

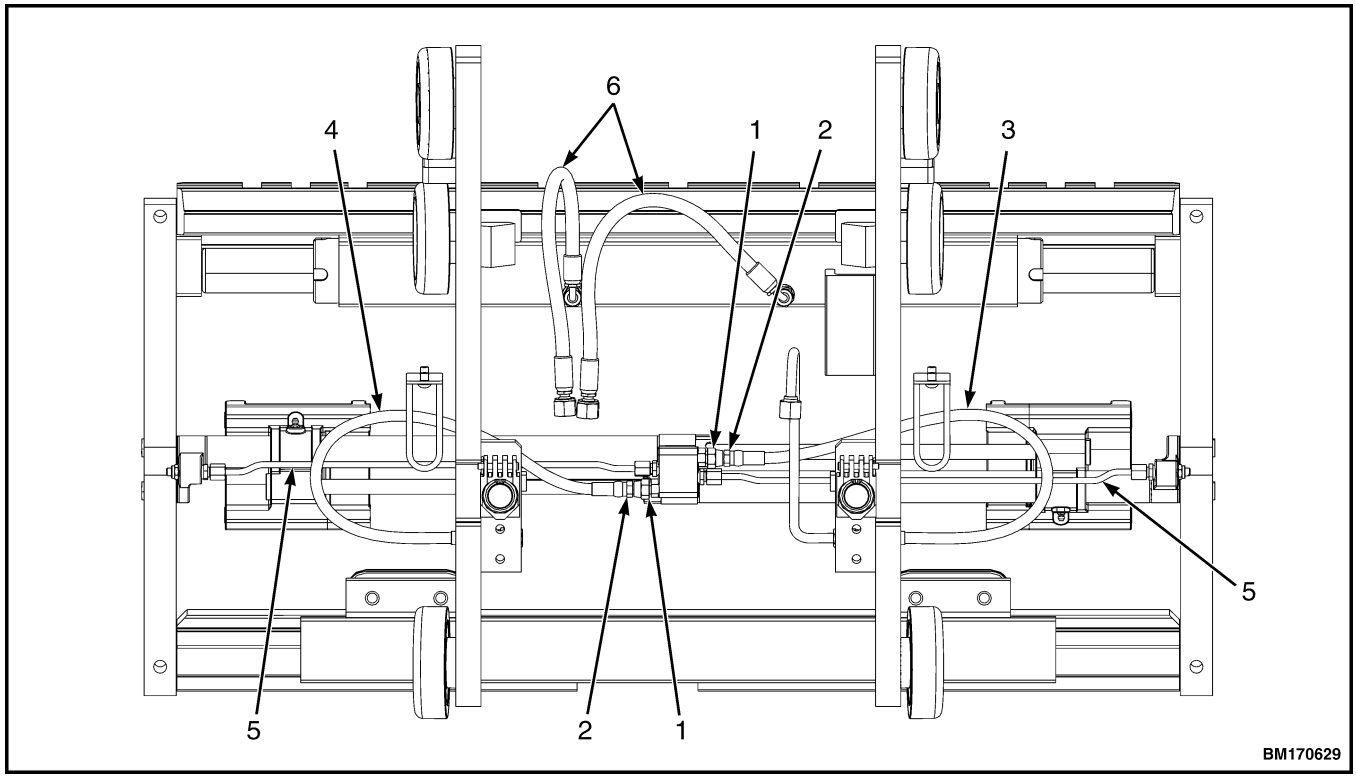
Fork Positioner Hydraulic Hose Adjustment

1. To adjust the fork positioner hydraulic hoses, hold the large hex nut and rotate the small hex nut towards the load face of the carriage (towards the forks). See Figure 31.

2. Fork positioner hoses are correctly adjusted when fork positioner hydraulic hoses stay entirely within the integral sideshift carriage and do not contact mast channels under all conditions.

3. Move fork positioner and check to ensure fork carriers clear fork positioner relief tubes through complete fork carrier cycle. See Figure 31.

4. Install load backrest to sideshift carriage. Tighten capscrews to 195 N•m (144 lbf ft). See Figure 12.



1. LARGE HEX NUT
2. SMALL HEX NUT
3. FORK POSITIONER HYDRAULIC HOSE (OPEN)
4. FORK POSITIONER HYDRAULIC HOSE (CLOSE)
5. RELIEF TUBE ASSEMBLY
6. INTEGRAL SIDESHIFT HYDRAULIC HOSES

Figure 31. Fork Positioner Hydraulic Hoses Adjustment

Two-Stage LFL Mast Repair

MAST WITH SERIAL NUMBER F507

Remove

WARNING

The mast is heavy. The mast can weigh approximately 907 kg (2000 lb). Make sure all lifting devices (hoists, cables, chains, slings, etc.) are suitable and of adequate capacity to lift the mast.

WARNING

Mast weldments can slide when the mast is moved. A weldment that slides can cause serious injury.

WARNING

Before working on or near the mast, see Safety Procedures When Working Near Mast in this manual.

CAUTION

Make sure all the mast weldments are fastened together. Make sure the safety chains will not damage the sheaves, tubing, or other parts of the mast.

NOTE: If mast needs to be disassembled, remove the forks and carriage. See sections Carriages Repair, Two-Stage LFL Mast and Fork Replacement in this manual for procedures. If only the main lift cylinders need to be removed for repair, the mast does not need to be removed from lift truck. See **Cylinder Repair (Mast S/N F507, F508, F562, F563)** 2100SRM1668 for procedures to remove the main lift cylinders.

NOTE: The length of the lift chains must be checked before mast is removed. See Lift Chains Adjustment.

1. Fully lower all mast weldments. Tilt mast fully forward.

2. Connect a crane with a capacity of at least 907 kg (2000 lb) to top of mast using chains to support mast in an upright position when tilt cylinders are disconnected. See section Safety Procedures When Working Near Mast in this manual.

WARNING

Always wear the proper protective equipment including eye protection and petroleum-resistant gloves when handling hydraulic oil. Thoroughly wash oil from exposed areas of skin as soon as possible.

Completely lower forks to relieve hydraulic pressure before disassembling any part of the lift pump or disconnecting any hoses.

The hydraulic oil is hot at normal operating temperatures. Be careful when draining the oil.

CAUTION

Protect the hydraulic system from dirt and contaminants when servicing the hydraulic system.

3. Position a drip pan under the area of hydraulic fittings. Disconnect hydraulic line at the external lowering control valve on outer mast. See Figure 37.

WARNING

Use a driver, NOT your fingers, to push the anchor pins from the clevises on the tilt cylinders.

The cylinder or mast can move and cause serious injury.

4. On lift trucks NOT equipped with optional boot on tilt cylinders, remove capscrews, washers, anchor pins, and pivot pins at the tilt cylinder mounts on the outer mast. See Figure 32.

5. On lift truck models J2.2-3.5XN (J45-70XN) (A276) equipped with tilt cylinders with optional boots, remove capscrews, washers, nuts, anchor pins, and pivot pins at the tilt cylinder mounts on outer mast. See Figure 33.

6. Using a brass drift pin, remove tilt rod bushings from outer mast. Discard tilt rod bushings. See Figure 34.

NOTE: Allow mast to tilt forward enough to gain access to the mast mount capscrews.

7. Disconnect lower mast mounts from lift truck by removing capscrews that hold mast pivot pins to the mounts on the drive axle. See Figure 35 and Figure 36.

WARNING

The mast is heavy. The mast can weigh approximately 907 kg (2000 lb). Make sure all lifting devices (hoists, cables, chains, slings, etc.) are suitable and of adequate capacity to lift the mast.

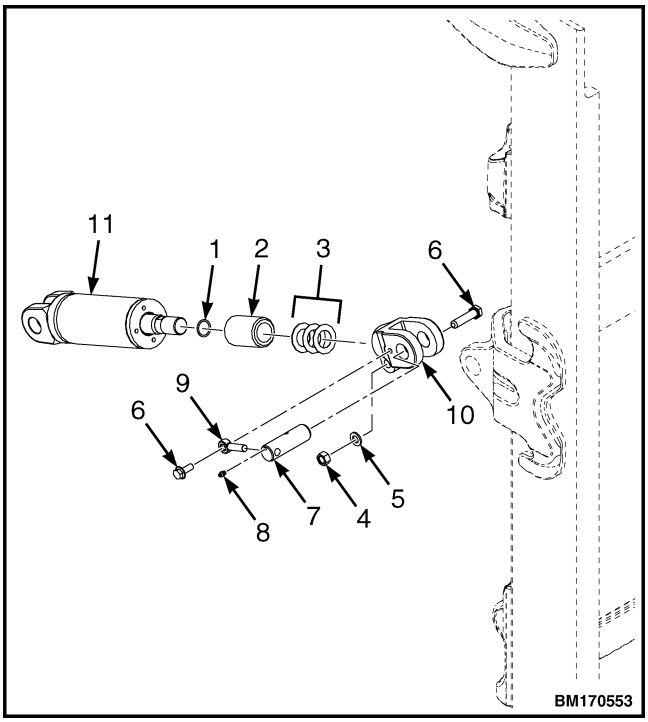
8. Use the crane to lift the mast assembly from lift truck. Position mast across wooden beams on the floor with the carriage side up.

NOTE: If mast mounting bushing needs to be replaced in Step 9, go to Step 11 for procedures.

9. Check the mast and mounting flanges for wear or damage by removing mast pivot pins from outer mast. See Figure 36.

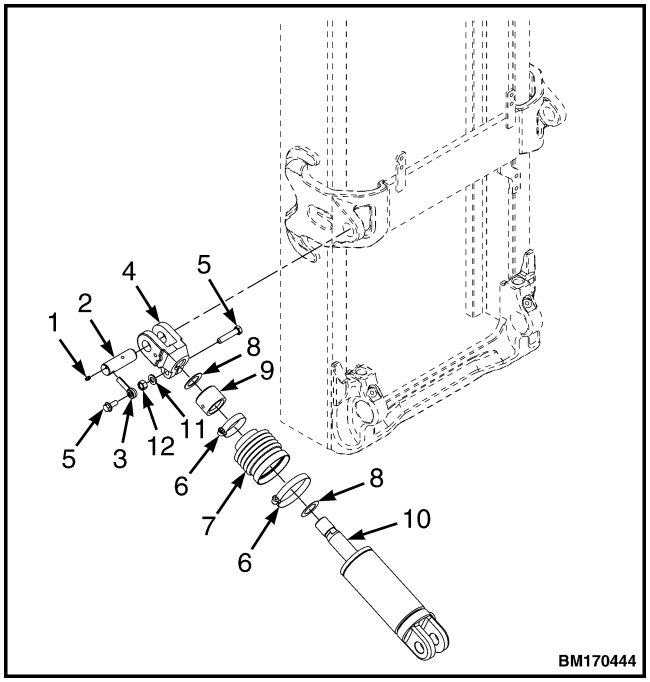
10. Check that pins fit snug in the outer mast. If pins can be moved up and down a minimum of 4 mm (0.20 in.), replace bushings in outer mast and/or mast pivot pins as required. See Figure 34.

11. Remove lube fitting, lube capscrew, and washer from mast mounts. See Figure 40. Use a brass drift pin to remove mast mounting bushings from outer mast. Discard mast mounting bushings. See Figure 34.



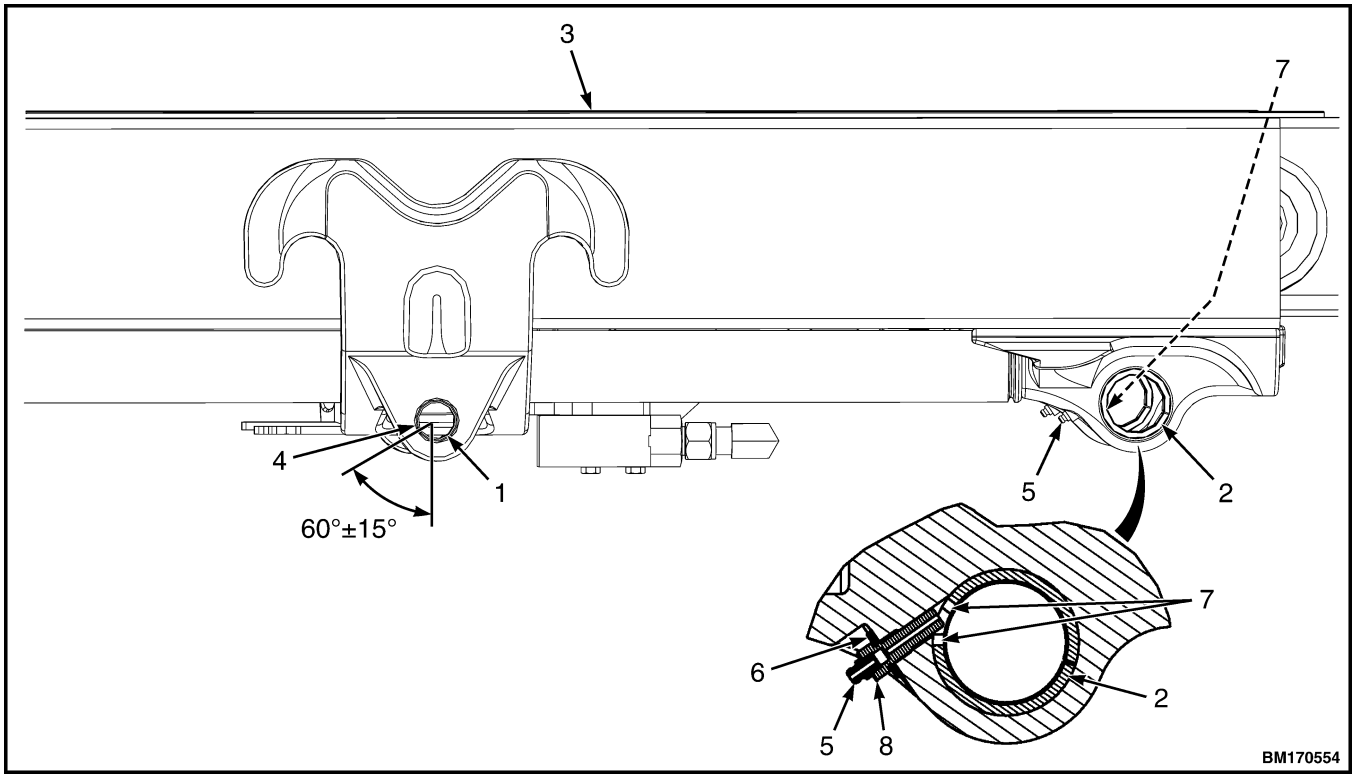
1. O-RING
2. SPACER
3. SHIMS
4. NUT
5. WASHER
6. CAPSCREW
7. PIVOT PIN
8. GREASE FITTING
9. ANCHOR PIN
10. CAPSCREW
11. ROD END

Figure 32. Mast Mounting, Tilt Cylinder Without Boot



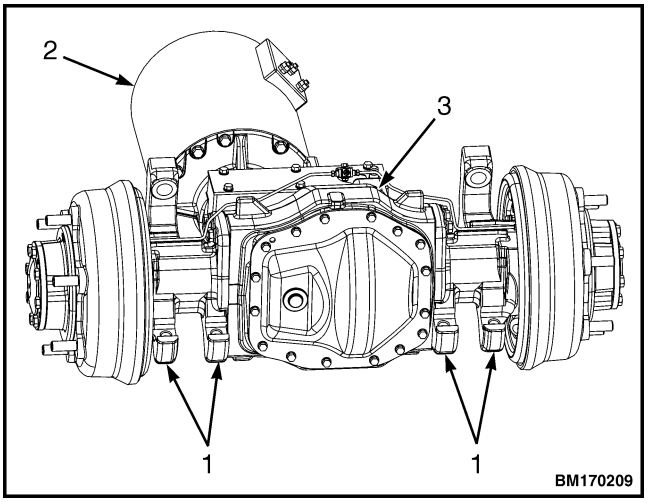
1. GREASE FITTING
2. PIVOT PIN
3. ANCHOR PIN
4. ROD END
5. CAPSCREW
6. CLAMP
7. BOOT
8. SHIM
9. SPACER
10. TILT CYLINDER
11. WASHER
12. NUT

Figure 33. Mast Mounting, Tilt Cylinder With Boot, Lift Truck Models J2.2-3.5XN (J45-70XN) (A276)



1. TILT ROD BUSHING
2. MAST MOUNTING BUSHING (BRONZE)
3. OUTER MAST
4. BUSHING SPLIT
5. LUBE FITTING
6. WASHER
7. BUSHING HOLE
8. LUBE CAPSCREW

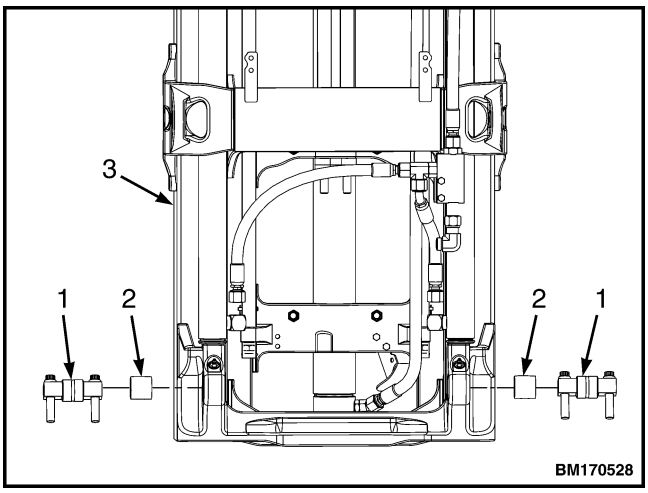
Figure 34. Tilt Rod and Mast Mounting Bushings



NOTE: DRIVE AXLE AND MAST MOUNTS FOR LIFT TRUCK MODELS E2.2-3.5XN (E45-70XN) (A268) SHOWN. DRIVE AXLE AND MAST MOUNTS FOR THE OTHER LIFT TRUCKS COVERED IN THIS MANUAL ARE SIMILAR.

1. HANGER MOUNTS
2. TRACTION MOTOR
3. DRIVE AXLE

Figure 35. Mast Mounts, Drive Axle



1. MAST PIVOT PIN
2. MAST MOUNTING BUSHING (BRONZE)
3. OUTER MAST

Figure 36. Mast Pivot Pins

Disassemble

WARNING

Always wear the proper protective equipment including eye protection and petroleum-resistant gloves when handling hydraulic oil. Thoroughly wash oil from exposed areas of skin as soon as possible.

WARNING

Completely lower forks to relieve hydraulic pressure before disconnecting any hydraulic hoses.

WARNING

Hydraulic oil is hot after system operation and can cause burns. DO NOT disconnect any hydraulic hoses until the oil in the system has cooled.

CAUTION

Protect the hydraulic system from dirt and contaminants when disconnecting hydraulic hoses from the mast. If hydraulic system becomes contaminated, damage to the hydraulic system can occur.

NOTE: If only the main lift cylinders need to be removed and repaired, see **Cylinder Repair (Mast S/N F507, F508, F562, F563)** 2100SRM1668 for procedures. When mast has header hoses, see section Header Hoses for procedures to install and adjust the header hoses.

1. Clean the area around hydraulic fittings for lift cylinders. Disconnect fittings at the lift cylinders and put caps on the open lines. See Figure 37.

2. Remove chains and header hoses.

3. Disconnect hydraulic lines and fittings between lowering control valve housing and main lift cylinders. Remove capscrews and nuts and remove lowering control valve housing and valve from bracket on outer mast. See Figure 37.

WARNING

Be careful when removing or installing snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers, and wear eye and face protection during removal or installation.

4. Remove the nut, capscrew, spacer, and washer at the mount near top of each main lift cylinder. Remove snap rings and washers from top of each main lift cylinder. Disconnect main lift chains at the mounts. See Figure 37.

WARNING

The mast weldments can slide when the mast is moved. A weldment that slides can cause injury.

5. Slide the inner mast from the outer mast approximately 30 cm (12 in.) to disengage the main lift cylinders from the inner mast. Remove the main lift cylinders from the outer mast.

6. Slide the inner mast from the bottom of the outer mast 30 cm (12 in.). See Figure 37.

7. Remove the strip bearings and load rollers from the top of the outer mast. See Figure 40.

8. Remove the load rollers from the bottom of the inner mast. Make a note of each shim arrangement and load roller location. The shim arrangements will be the same during assembly. See Figure 38.

WARNING

The mast is heavy. The mast can weigh approximately 907 kg (2000 lb). Make sure all lifting devices (hoists, cables, chains, slings, etc.) are suitable and of adequate capacity to lift the mast.

NOTE: When replacing the outer mast, copy the part number and date code information from the old channel and stamp that information on the new channel with a letter **R** at the end to indicate that it has been replaced.

9. Slide inner mast halfway out of the top of the outer mast. Connect a crane with a capacity of at least 907 kg (2000 lb) to the center of the inner mast. See Figure 39. Slide inner mast out of the outer mast until the mast stub shafts of the inner mast are in the notches of the outer channels. Remove the inner mast from the outer mast.

10. Remove chain sheaves and disassemble them as necessary for repair and cleaning. See Figure 38.

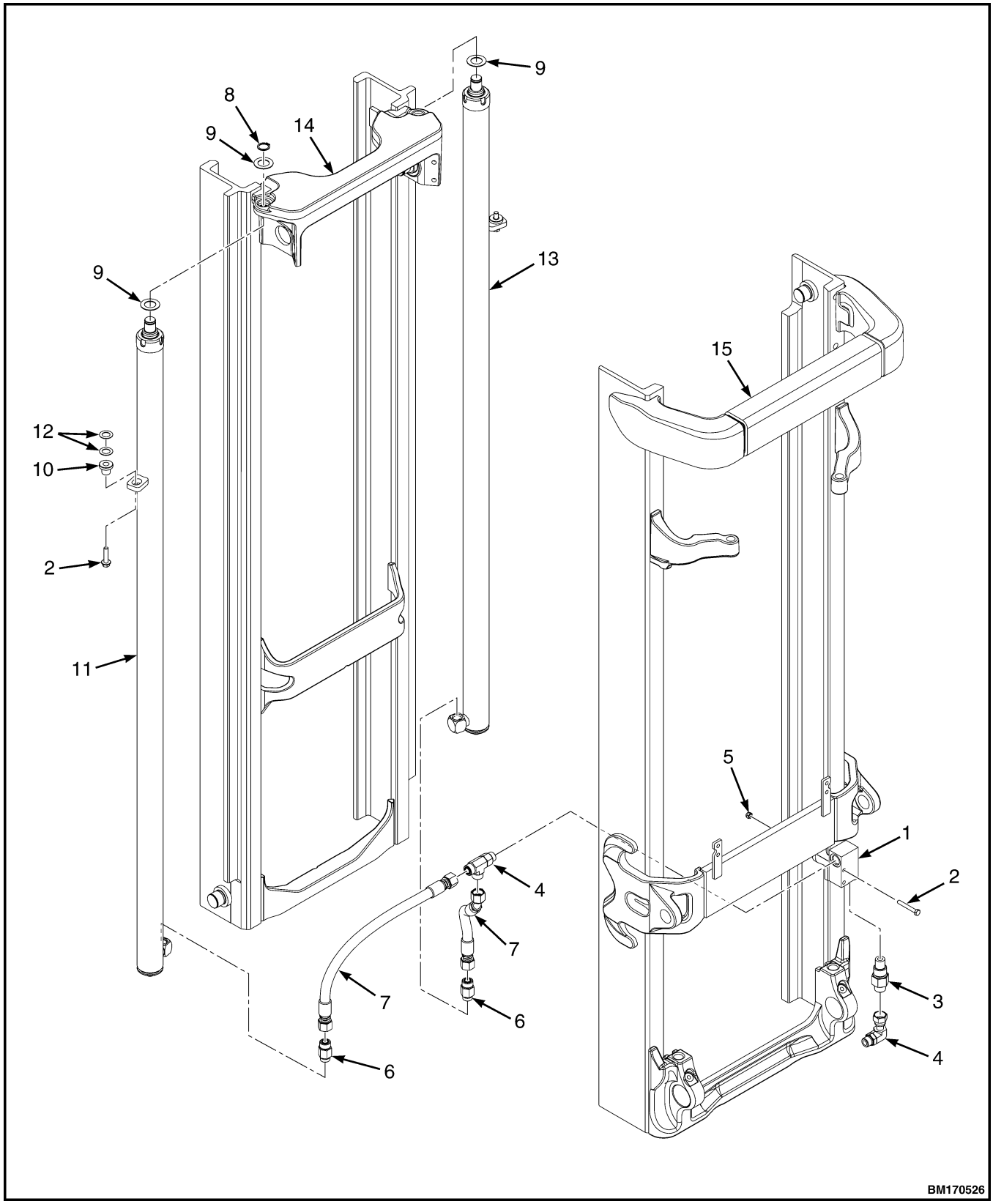


Figure 37. Main Lift Cylinders

Legend for Figure 37.

1. LOWERING CONTROL VALVE HOUSING
2. CAPSCREW
3. LOWERING CONTROL VALVE
4. FITTING
5. NUT
6. HYDRAULIC VELOCITY FUSE
7. HOSE ASSEMBLY
8. SNAP RING
9. WASHER
10. ISOLATOR
11. LEFT MAIN LIFT CYLINDER
12. WASHER
13. RIGHT MAIN LIFT CYLINDER
14. INNER MAST
15. OUTER MAST

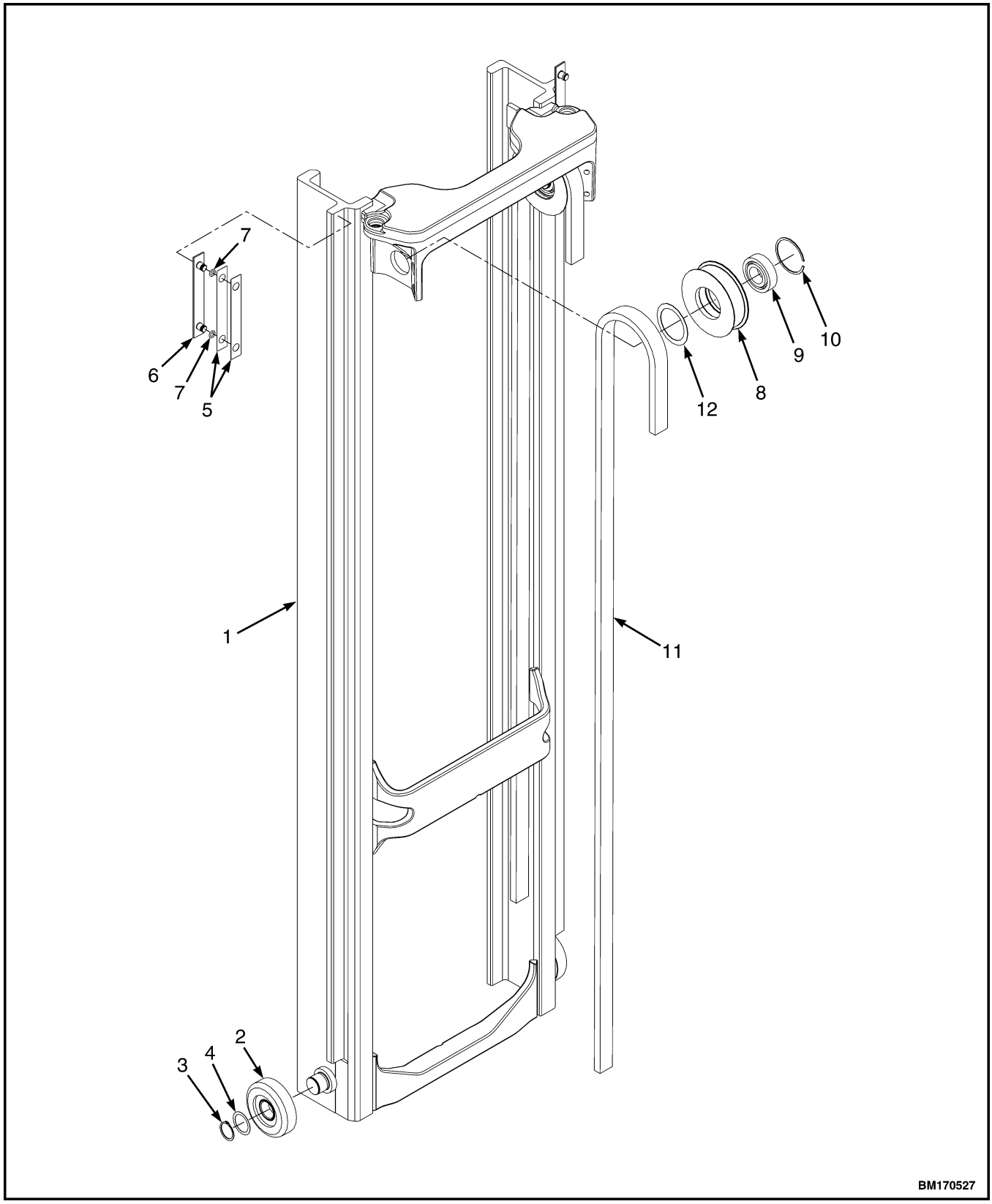


Figure 38. Inner Mast Components

Legend for Figure 38.

1. INNER MAST
2. LOAD ROLLER
3. SNAP RING
4. SHIM
5. BEARING STRIP
6. SHIM
7. O-RING
8. CHAIN SHEAVE
9. BEARING
10. SNAP RING
11. MAIN LIFT CHAIN
12. SPACER

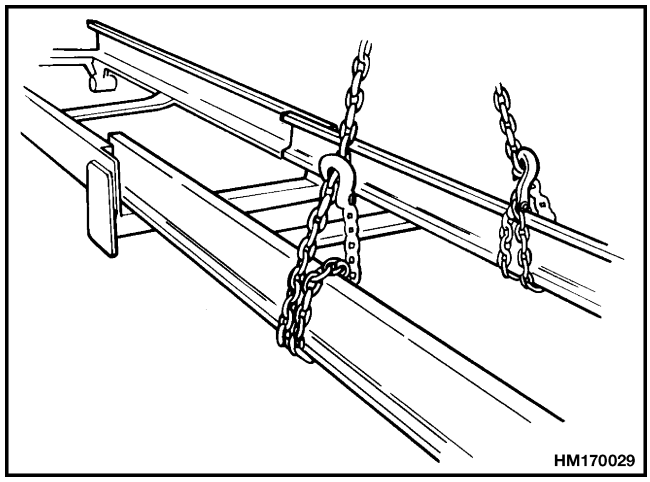


Figure 39. Connecting A Crane

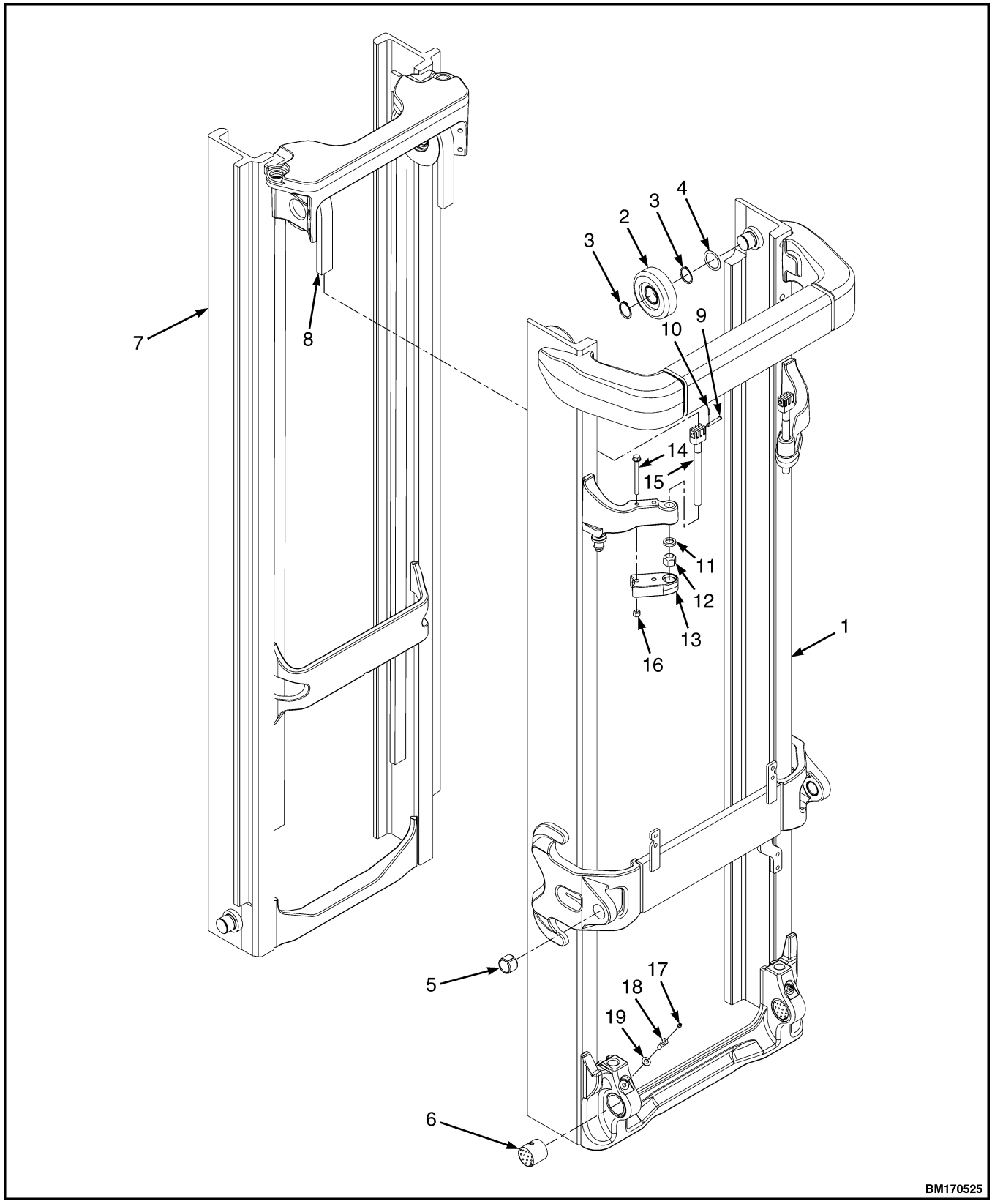


Figure 40. Outer Mast

Legend for Figure 40.

1. OUTER MAST
2. LOAD ROLLER
3. SNAP RING
4. SHIM
5. BUSHING
6. BUSHING (BRONZE)
7. INNER MAST
8. LIFT CHAIN
9. PIN
10. COTTER PIN
11. RING
12. NUT
13. CHAIN ANCHOR RESTRAINT
14. CAPSCREW
15. CHAIN ANCHOR
16. NUT
17. LUBE FITTING
18. LUBE CAPSCREW
19. WASHER

Clean and Inspect

CAUTION

DO NOT use steam or high-pressure water to clean the load rollers or the lift chains. Steam and high-pressure water can remove the lubrication from the bearings in the load rollers. Water in the bearings of the sheaves and the link pins of chains can also shorten the service life of these parts.

1. Inspect chain sheaves and load rollers (see Figure 38 and Figure 40) for wear or damage. DO NOT use steam to clean lift chain sheaves or load rollers. The bearings in the sheaves and load rollers are sealed and lubricated.

WARNING

Cleaning solvents may be flammable and toxic and can cause severe skin irritation. When using commercial cleaning solvents, always comply with solvent manufacturer's recommended safety precautions.

WARNING

Compressed air can move particles so that they cause injury to the user or to other personnel. Make sure that the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eyes.

2. Clean lift chains by soaking in solvent for 30 minutes to remove all dirt and grease. Hang lift chains up and remove solvent using compressed air.

WARNING

Never replace only the worn section of a chain. Replace the complete chain. Never replace only one chain of a chain pair. Replace both chains. Damage to the lift truck and serious injury can occur if lift chains are not replaced correctly.

NOTE: The chains must be inspected in the area of chain that passes over chain sheave during the first portion of a lift. These links will show maximum wear.

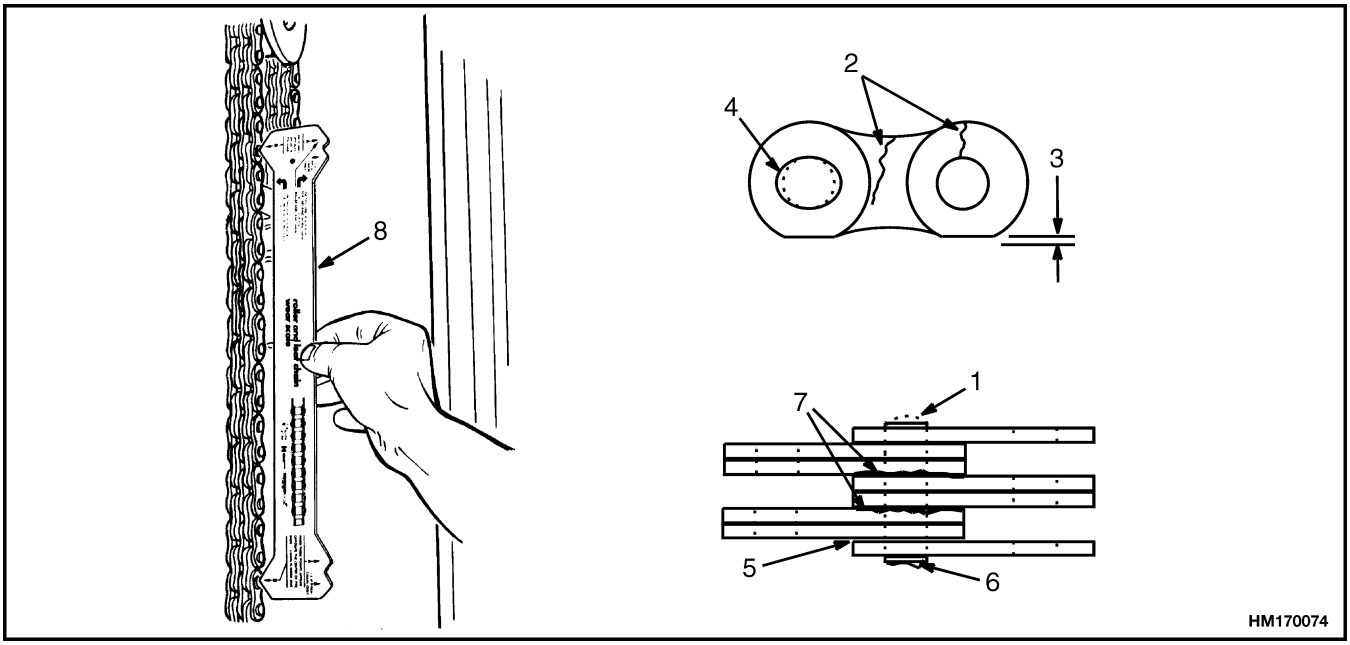
3. Inspect lift chains for wear and damage. A lift chain becomes longer when it is worn. If a chain is 3% longer than a new lift chain, the lift chain must be replaced.

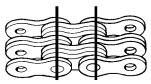
4. If a chain scale is available (Hyster Part No. 599737) , check lift chains as shown in Figure 41. If a chain scale is not available measure 20 links of chain. Measure from the center of a pin to the center of another pin 20 pitches away. Compare the length with the chart in Figure 41. Replace chain if the length of 20 links of the worn section is more than the maximum wear limit.

5. Lubricate lift chains by soaking them in SAE 30 engine oil for 30 minutes. Hang chains over a drip pan for one hour to remove excess oil.

NOTE: Chain anchor pins **Must** be replaced anytime chains are replaced.

6. Inspect chain anchors, chain anchor pins, and chain anchor restraints. Replace any parts that are worn or damaged. See Figure 40.



Pitch 	Total Length of 20 Links (Pitch) of New Chain	Wear Limit - The Maximum Length of 20 Links
12.7 mm (0.5 in.)	254.0 mm (10.0 in.)	261.6 mm (10.3 in.)
15.9 mm (0.6 in.)	317.5 mm (12.5 in.)	327.0 mm (12.9 in.)
19.1 mm (0.8 in.)	381.0 mm (15.0 in.)	392.4 mm (15.4 in.)
25.4 mm (1.0 in.)	508.0 mm (20. in.)	523.3 mm (20.6 in.)

NOTE: THE INSTRUCTION FOR MEASURING CHAIN WEAR ARE SHOWN ON THE CHAIN WEAR SCALE.

1. WORN PIN
2. CRACKS
3. EDGE WEAR
4. HOLE WEAR
5. LOOSE LEAVES
6. DAMAGED PIN
7. RUST
8. CHAIN WEAR SCALE

Figure 41. Lift Chain Check

WARNING

Cleaning solvents may be flammable and toxic and can cause severe skin irritation. When using commercial cleaning solvents, always comply with solvent manufacturer's recommended safety precautions.

WARNING

Steam can cause serious burns. Wear protective clothing, gloves, and eye protection. Never expose your skin to steam.

7. Clean mast weldments with steam or solvent.

WARNING

Improper welding procedures can damage the structure of the mast or cause incorrect function of the mast which can result in serious injury to personnel. Consult your lift truck dealer for more information before welding on the mast

8. Inspect sliding surfaces for wear or damage. Inspect the load roller contact surfaces for wear or damage. Inspect all welds for cracks.

Assemble

WARNING

The mast is heavy. The mast can weigh approximately 907 kg (2000 lb). Make sure all lifting devices (hoists, cables, chains, slings, etc.) are suitable and of adequate capacity to lift the mast.

NOTE: Shims for the load rollers keep the mast weldments parallel and provide correct clearance. During assembly, shims should be reinstalled in the same location they were in before disassembly. Check clearance and adjust shims for wear or for changes caused by repairs. The strip bearings are also adjusted by using shims and should also be reinstalled in the same location they were in before disassembly. See the section Mast Adjustments in this service manual for the adjustment procedures.

NOTE: When the mast has header hoses, see section Header Hoses for procedures to install and adjust the header hoses.

1. Connect a crane with a capacity of at least 907 kg (2000 lb) to the center of the inner mast. See Figure 39. Fit the stub shafts through the notches in the outer mast. Slide the inner mast into the outer mast so the stub shafts are seen at the top and bottom of the weldments. See Figure 38.

2. Install the strip bearings and shims on the outer mast. See Figure 42. Apply chassis lube to the bearing surface. Check the clearance of the strip bearings as described in Mast Adjustments section in this manual.

3. Install load rollers and shims on both weldments. Check the clearance of the load rollers as described in sections Mast Adjustments and Carriage Adjustments in this service manual.

4. Push the inner mast to engage the rods of the main lift cylinders. Install washer and snap ring. See Figure 37.

5. Install capscrews, isolators, and O-rings at the mounts for main lift cylinders. Tighten capscrews to 38 N•m (28 lbf ft). See Figure 37.

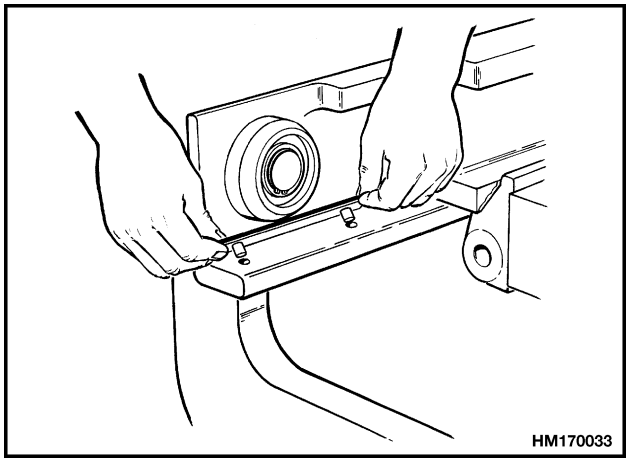


Figure 42. Strip Bearings

6. Install housing for lowering control valve on bracket on outer mast. Tighten the nuts for the lowering control valve housing to 18 N•m (13 lbf ft). Install the lowering control valve in the housing. Connect the hydraulic lines and fittings between the housing and the main lift cylinders. See Figure 37.

7. Install the chain sheaves at the inner mast. Be sure to install both pins that hold the shaft for the chain sheave in position. See Figure 40.

8. Connect the lift chains to the chain anchors at the main lift cylinder mounts. See Figure 37.

9. Attach wires between the ends of the lift chains and the crossmember to control the lift chains during mast installation.

Install

1. Install new bushings into mast mounts at bottom of outer mast. Be sure to align the hole in the bushing with the lube fitting hole in the bottom of the outer mast. See Figure 34. Bushing must be flush with outer mast surface.

2. Apply an even coat of grease to pivot pins and install them into mast mounts at bottom of outer mast. See Figure 36.

3. Install washer and lube capscrew in hole in bottom of outer mast. Tighten lube capscrew to 25 N•m (18 lbf ft). Install lube fitting onto lube capscrew. Tighten lube fitting to 6 N•m (53 lbf in). See Figure 34 or Figure 40.

WARNING

The mast is heavy. The mast can weigh approximately 907 kg (2000 lb). Make sure all lifting devices (hoists, cables, chains, slings, etc.) are suitable and of adequate capacity to lift the mast.

4. Connect crane to top of mast using chains. Make sure all mast uprights are fastened together. Make sure chains will not damage sheaves, tubing, or other parts of mast. Make sure crane has a capacity of at least 907 kg (2000 lb).

5. Use crane to position mast assembly onto its lower mounts. Position mast so pivot pins seat into hanger mounts on drive axle. Install capscrews that hold mast pivot pins to drive axle hangers. Tighten capscrews to 270 N•m (199 lbf ft). See Figure 35.

6. Install new bushings into the tilt anchors on the outer mast. Be sure tilt bushing split is installed at the correct angle as shown in Figure 34.

WARNING

Use a pry bar, NOT your fingers, to align the tilt cylinder clevises with the outer mast. The cylinder or mast can shift and cause serious injury.

NOTE: Use multipurpose grease #2 with 2 to 4% molybdenum disulfide for normal operations.

7. Apply an even coat of grease to pivot pins and connect tilt cylinders to mast using pivot pins. Install anchor pins and capscrews to rod ends. Apply anti-seize compound to capscrew threads and tighten 38 N•m (28 lbf ft).

   See Figure 43 for lift trucks equipped with tilt cylinders without optional boots.

   See Figure 44 for lift trucks equipped with tilt cylinders with optional boots.

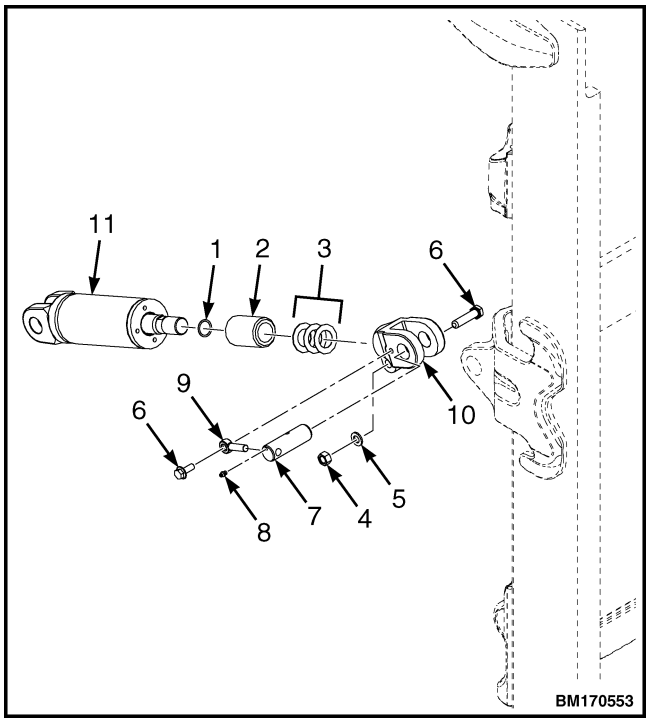
8. Connect hydraulic lines to lowering control valve.

9. Install carriage as described in section Carriages Repair, Two-Stage LFL Mast.

WARNING

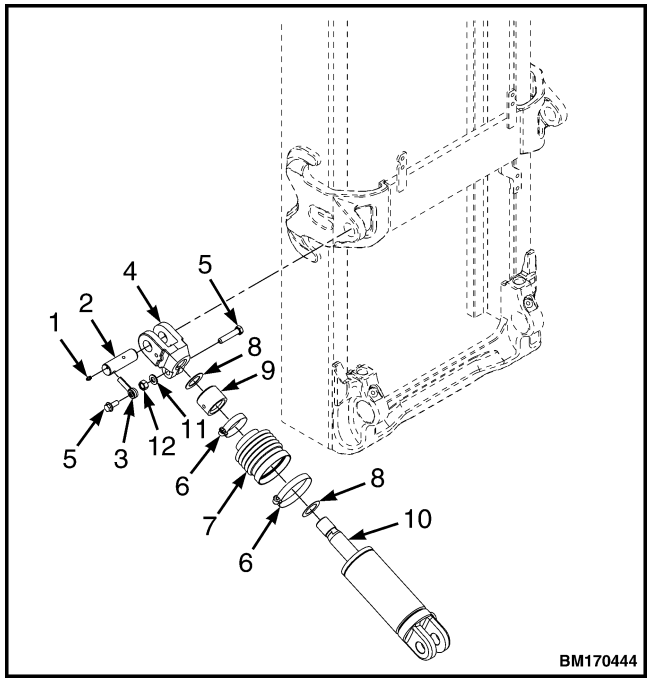
Never check for leaks by putting hands on hydraulic lines or components under pressure. Hydraulic oil under pressure can be injected into the skin.

10. Check tilt cylinder adjustments as described in **Cylinder Repair (Mast S/N F507, F508, F562, F563)** 2100SRM1668. Operate mast and check for leaks and correct operation. Check lift chains as described in Lift Chains Adjustment section in this manual.



1. O-RING
2. SPACER
3. SHIMS
4. NUT
5. WASHER
6. CAPSCREW
7. PIVOT PIN
8. GREASE FITTING
9. ANCHOR PIN
10. CAPSCREW
11. ROD END

Figure 43. Mast Mounting, Tilt Cylinder Without Boot



1. GREASE FITTING
2. PIVOT PIN
3. ANCHOR PIN
4. ROD END
5. CAPSCREW
6. CLAMP
7. BOOT
8. SHIM
9. SPACER
10. TILT CYLINDER
11. WASHER
12. NUT

Figure 44. Mast Mounting, Tilt Cylinder With Boot, Lift Truck Models J2.2-3.5XN (J45-70XN) (A276)

WARNING

Never check for leaks by putting hands on hydraulic lines or components under pressure. Hydraulic oil under pressure can be injected into the skin.

11. Check tilt cylinder adjustments as described in **Cylinder Repair (Mast S/N F507, F508, F562, F563)** 2100SRM1668.

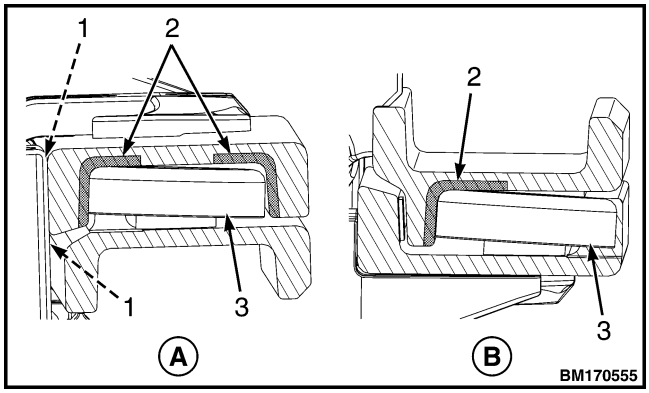
Operate mast and check for leaks and correct operation. Check lift chains as described in Lift Chains Adjustment section in this manual.

NOTE: Before checking for mast side kicking, the mast must be fully assembled to include the carriage, forks, load backrest and any attachments.

12. Raise mast, without a load to its full height and check for side kicking. Mast side kicking is when the mast moves either to the right or left as it is being raised to its full height. If mast is side kicking, see Mast Adjustments section in this manual for procedures to correct mast side kicking.

NOTE: Load rollers and sheaves have sealed bearings and do not need additional lubrication.

13. Lubricate sliding surfaces and load roller surfaces along full length of channels as shown in Figure 45. Apply lubricant only to surfaces indicated.



A. UPPER LOAD ROLLERS
B. LOWER LOAD ROLLERS

1. LUBRICATE STRIP BEARING SURFACES
2. LUBRICATE LOAD ROLLER SURFACES
3. LOAD ROLLER

Figure 45. Lubricate Mast

Header Hoses

Remove

Read and follow the
Safety Procedures When Working Near Mast as well as all **WARNINGS** and **CAUTIONS** before removing any header hoses.

NOTE: Access to some of the fittings can be difficult. If necessary, operate hydraulic system to move mast weldments or carriage. Make sure the hydraulic system does not have pressure as described in Step 1.

1. To replace any header hoses, fully lower carriage. Make sure hydraulic system does not have hydraulic pressure. Hold the control for each function in the forward position for approximately five seconds to release pressure. Make sure hydraulic pump does not operate. Move key or keyless switch, if equipped, to the **OFF** position.

2. Disconnect battery and put a tag or lock on battery connector.

3. Disconnect header hoses and install caps on ends to prevent dirt and debris from entering the hydraulic system.

Installation

WARNING

Always wear the proper protective equipment including eye protection and petroleum-resistant gloves when handling hydraulic oil. Thoroughly wash oil from exposed areas of skin as soon as possible.

WARNING

Never check for leaks by putting hands on hydraulic lines or components under pressure. Hydraulic oil under pressure can be injected into the skin.

WARNING

Before working on or near the mast, see Safety Procedures When Working Near Mast in this manual.

1. Some lift trucks are equipped with auxiliary hydraulic functions that are fastened to the carriage. Examples of attachments that use these auxiliary functions are sideshift carriages, roll clamps, and fork positioners. These auxiliary functions require header hoses for their operation.

NOTE: The procedures in this section are for the four function option. Lift trucks equipped with three-function option will only have hoses **A** and **B**. See Figure 46.

NOTE: The carriage height must be correct before the header hose tension can be measured. See Lift Chains Adjustment for carriage adjustment procedures.

Mark each hose with a single letter: **A, B, C,** and **D**.

All four hoses are the same length. Before installing new header hoses, add tension marks to each hose. See Figure 47.

2. Clamp one end of the hose in a vise. **DO NOT** clamp on the threads. Pull on the other end until hose is straight. **DO NOT** apply enough force to stretch the hose.

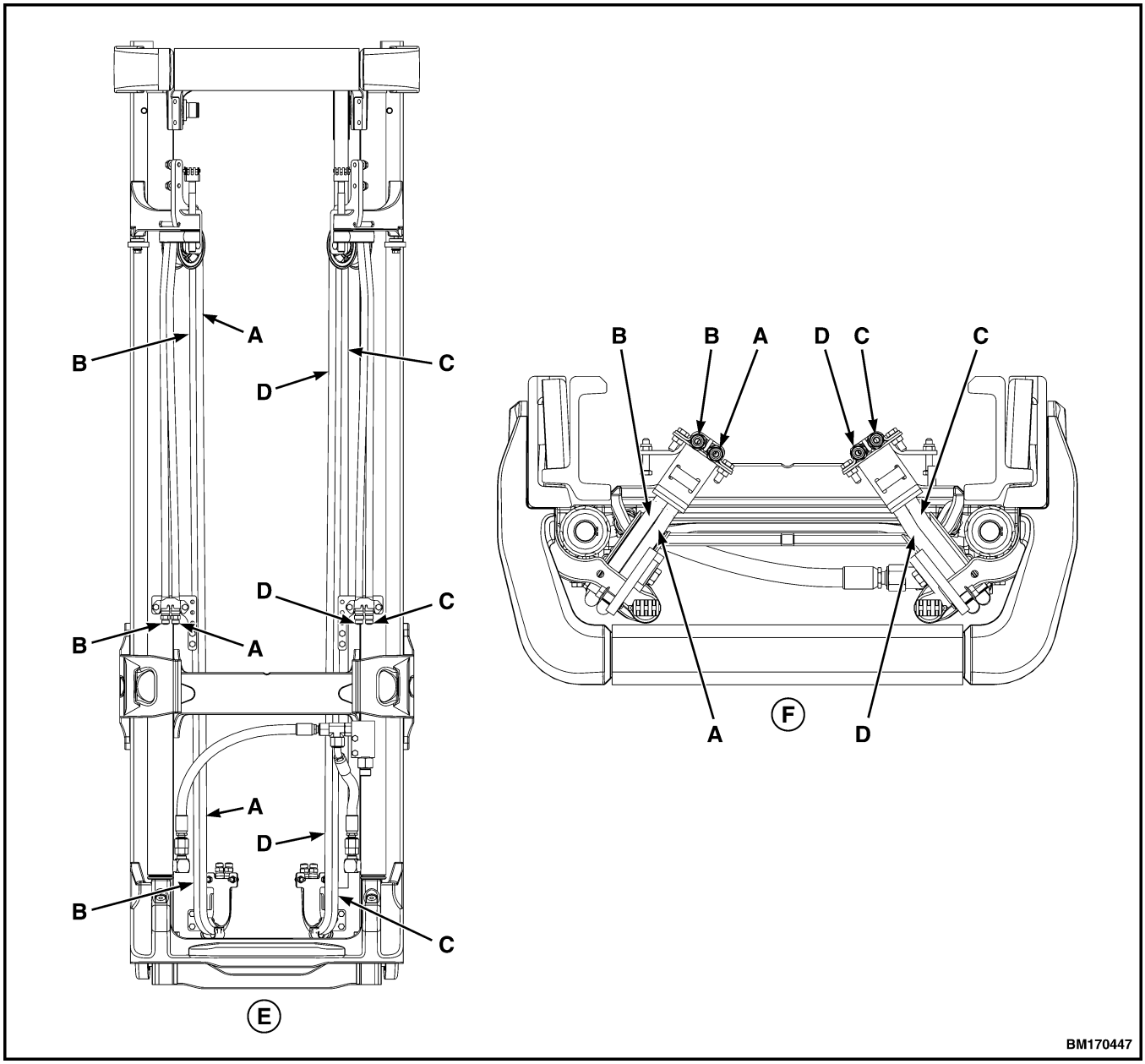
NOTE: Header hose tension specification is 2.0% ±1%. Install hose caps to marked end (truck end) of hoses.

3. Put reference marks on the header hoses. Starting at either end of each of the hoses, place a mark at 100 ±10 mm (4.0 ±0.40 in.). This is dimension **M1**. See Figure 47.

4. From dimension **M1**, place another mark at 500 ±2.0 mm (20.0 ±0.08 in.). This is dimension **M2**. See Figure 47.

5. Attach three-function hoses (**A** and **B**) and four-function hoses (**C** and **D**) to turnaround brackets on carriage. See Figure 47.

6. Route hoses over the turnaround brackets and secure the end of the hose to the turnaround bracket with hose clamps and worm screw clamps. Worm screw clamps go through the hose clamps and around the turnaround bracket to protect the header hoses. See Figure 47.



A. HEADER HOSE
B. HEADER HOSE
C. HEADER HOSE
D. HEADER HOSE
E. REAR VIEW
F. TOP VIEW

Figure 46. Header Hose Alignment for Two-Stage LFL Mast

7. Route hoses up over hose sheaves and secure hoses to hose sheaves with spacers.

8. Clamp marked end of hoses to brackets on mid-outer crossmember. See Figure 47.

9. With header hoses installed on mast and the carriage correctly adjusted (see Carriage Adjustments) and the forks off the ground, measure header hose tension on mast as follows:

   a. Measure the distance between marks **M1** and **M2**. See Figure 47.

   b. The header hose specification between marks **M1** and **M2** is 510 ±5 mm (2.0% ±1.0%).

   c. If tension mark measurement is 505 mm (20.0 in.) or lower, adjust plate attached to bracket on mid-outer crossmember, downward by one hole and re-measure tension mark. If tension mark is still 505 mm (20.0 in.) or lower, replace hose and re-set plate to the upper position.

   d. If tension mark is 515 mm (20.3 in.) or higher, adjust carriage to maximum height allowed. See Carriage Adjustments section for procedures.

Adjustment

NOTE: Tire size variations and adjusting of the lift chains may require adjustment of header hose tension. Lift chain adjustment for tire wear will reduce header hose tension.

1. To increase header hose tension, raise carriage at least 100 mm (4.0 in.).

2. Place a block under lower carriage bar and lower carriage onto block to relieve hose tension. Chain carriage to inner mast. See Safety Procedures When Working Near Mast in this manual.

3. Loosen hardware on bracket on mid-outer crossmember for the three and/or four function hoses needing adjustment. Lower bracket and tighten nut to 18 N•m (159 lbf in). See Figure 48.

4. Release chain, remove block, and lower the carriage.

5. With no load on the forks, check the header hose adjustment by operating the mast through the full lift cycle two times.

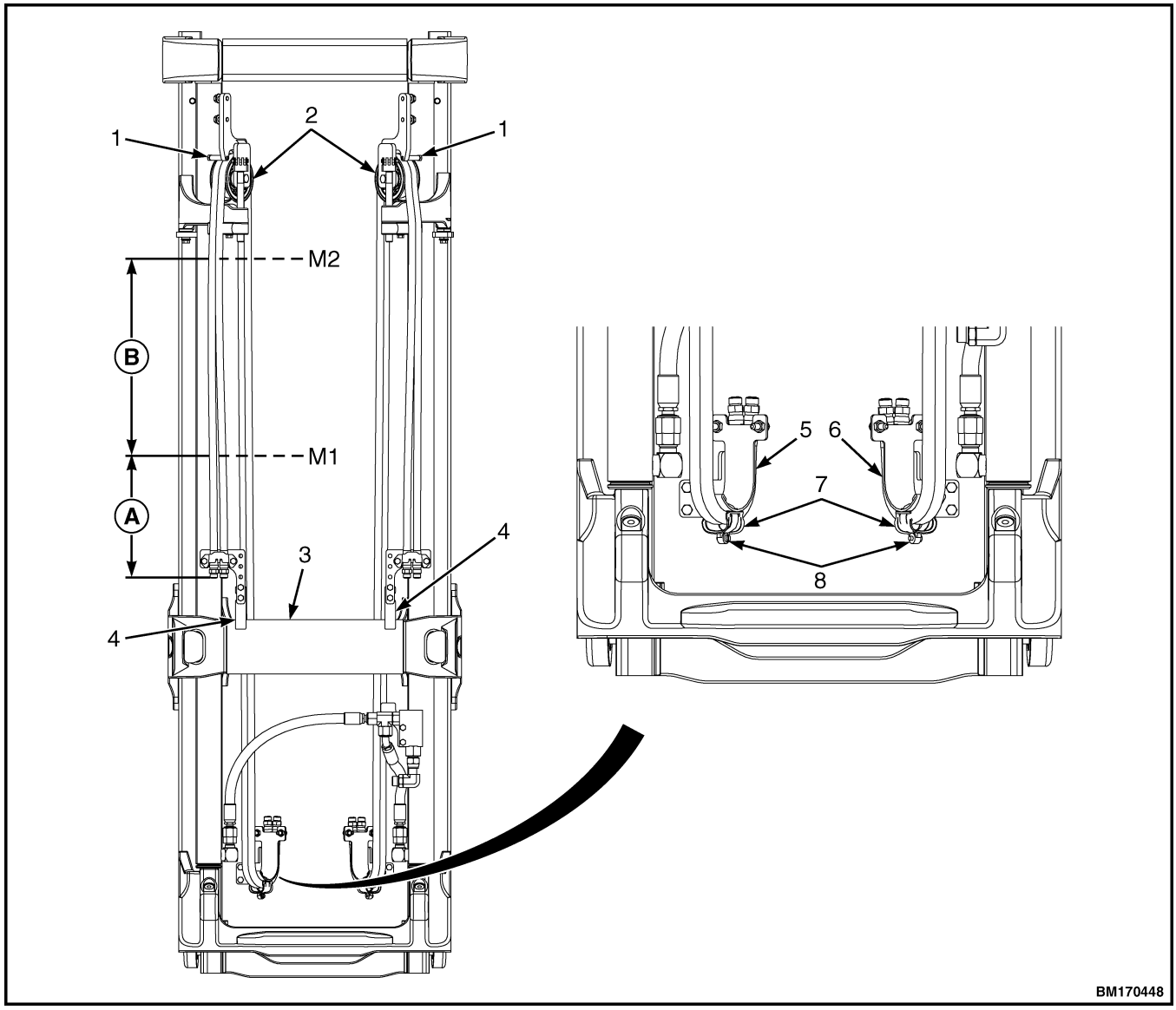
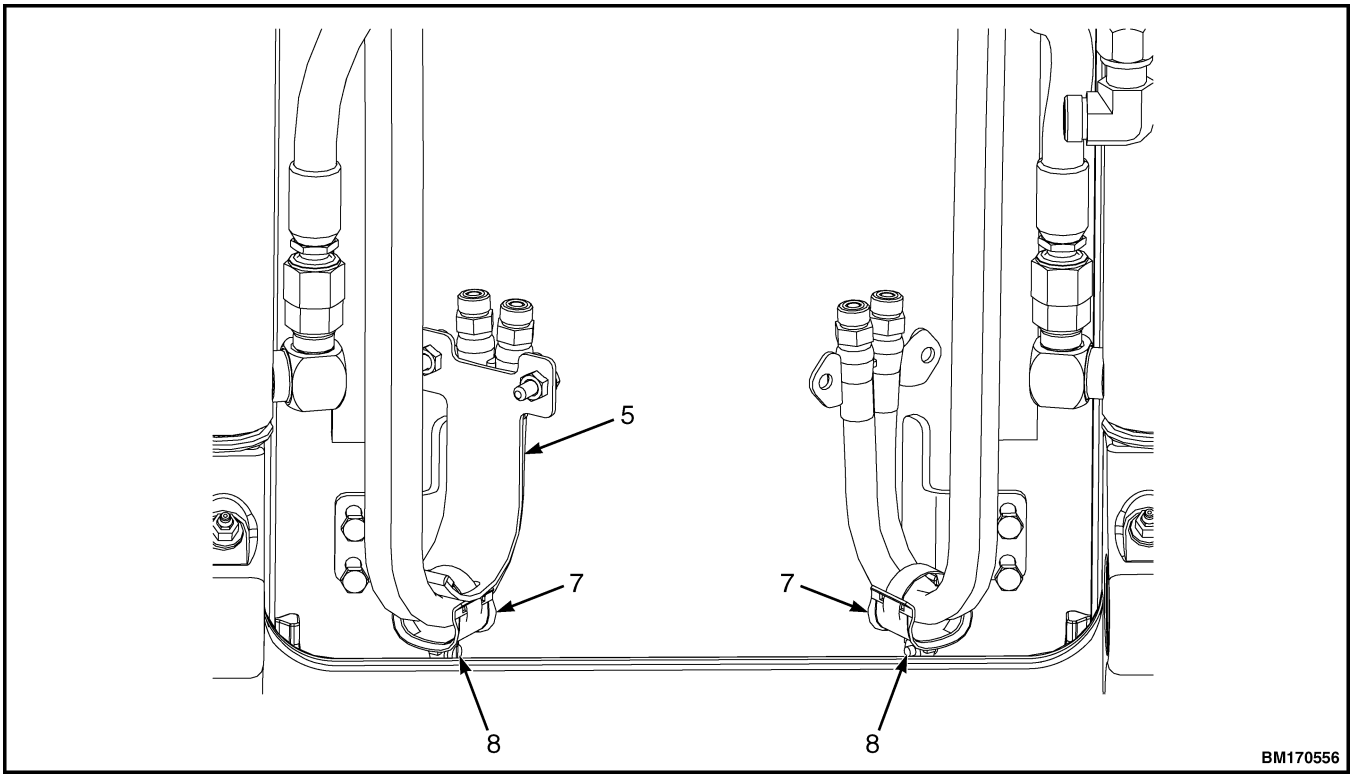


Figure 47. Header Hose Dimensions and Installation, Two-Stage LFL Mast (Sheet 1 of 2)



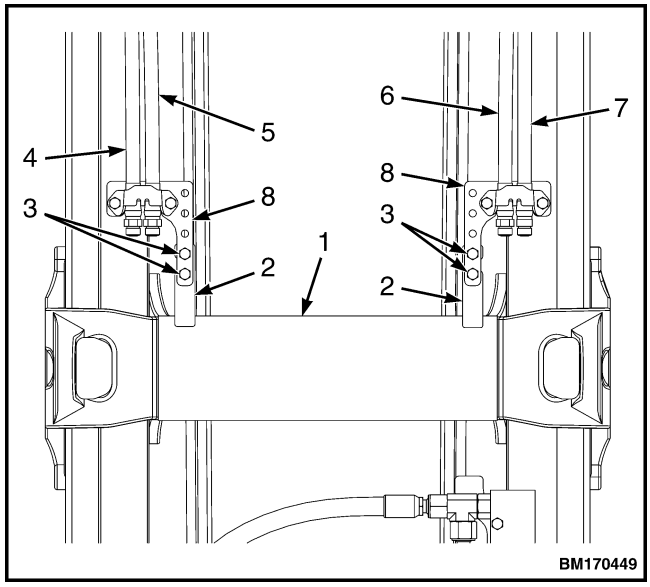
A. DIMENSION = 100 ±10 mm (4.0 ±0.40 in.)

B. DIMENSION = 500 ±2.0 mm (20.0 ±0.08 in.)

1. SPACER
2. HOSE SHEAVE
3. MID-OUTER CROSSMEMBER
4. BRACKET
5. TURNAROUND BRACKET (THREE-FUNCTION)
6. TURNAROUND BRACKET (FOUR-FUNCTION)
7. HOSE CLAMP
8. WORM SCREW CLAMP

Distance Installed	Hose Tension
505 mm (19.8 in.)	1%
510 mm (20.1 in.)	2%
515 mm (20.3 in.)	3%

Figure 47. Header Hose Dimensions and Installation, Two-Stage LFL Mast (Sheet 2 of 2)



1. MID-OUTER CROSSMEMBER
2. BRACKET
3. MOUNTING HARDWARE
4. HEADER HOSE **B**
5. HEADER HOSE **A**
6. HEADER HOSE **D**
7. HEADER HOSE **C**
8. PLATE

Figure 48. Header Hose Adjustment, Two-Stage LFL Mast

MAST WITH SERIAL NUMBER F562

Remove

WARNING

The mast is heavy. The mast can weigh approximately 907 kg (2000 lb). Make sure all lifting devices (hoists, cables, chains, slings, etc.) are suitable and of adequate capacity to lift the mast.

WARNING

Mast weldments can slide when the mast is moved. A weldment that slides can cause serious injury.

WARNING

Before working on or near the mast, see Safety Procedures When Working Near Mast in this manual.

CAUTION

Make sure all the mast weldments are fastened together. Make sure the safety chains will not damage the sheaves, tubing, or other parts of the mast.

NOTE: If mast needs to be disassembled, remove the forks and carriage. See sections Carriages Repair, Two-Stage LFL Mast and Fork Replacement in this manual for procedures. If only the main lift cylinders need to be removed for repair, the mast does not need to be removed from lift truck. See section **Cylinder Repair (Mast S/N F507, F508, F562, F563)** 2100SRM1668 for procedures to remove the main lift cylinders.

NOTE: The length of the lift chains must be checked before the mast is removed. See Lift Chains Adjustment.

1. Fully lower all mast weldments. Tilt mast fully forward.

2. Connect a crane with a capacity of at least 907 kg (2000 lb) to the top of the mast using chains to support the mast in an upright position when the tilt cylinders are disconnected. See section Safety Procedures When Working Near Mast in this manual.

WARNING

Always wear the proper protective equipment including eye protection and petroleum-resistant gloves when handling hydraulic oil. Thoroughly wash oil from exposed areas of skin as soon as possible.

Completely lower forks to relieve hydraulic pressure before disassembling any part of the lift pump or disconnecting any hoses.

The hydraulic oil is hot at normal operating temperatures. Be careful when draining the oil.

CAUTION

Protect the hydraulic system from dirt and contaminants when servicing the hydraulic system.

3. Position a drip pan under the area of the hydraulic fittings. Disconnect the hydraulic line at the external lowering control valve on the outer mast. See Figure 54.

WARNING

Use a driver, NOT your fingers, to push the anchor pins from the clevises on the tilt cylinders. The cylinder or mast can move and cause serious injury.

4. On lift trucks NOT equipped with optional boot on tilt cylinders, remove capscrews, washers, anchor pins, and pivot pins at the tilt cylinder mounts on the outer mast. See Figure 49.

5. On lift truck models J2.2-3.5XN (J45-70XN) (A276) equipped with tilt cylinders with optional boots, remove capscrews, washers, nuts, anchor pins, and pivot pins at the tilt cylinder mounts on outer mast. See Figure 50.

6. Using a brass drift pin, remove tilt rod bushings from outer mast. Discard tilt rod bushings. See Figure 51.

NOTE: Allow mast to tilt forward enough to gain access to the mast mount capscrews.

7. Disconnect lower mast mounts from lift truck by removing capscrews that hold the mast pivot pins to the mounts on the drive axle. See Figure 52 and Figure 53.

WARNING

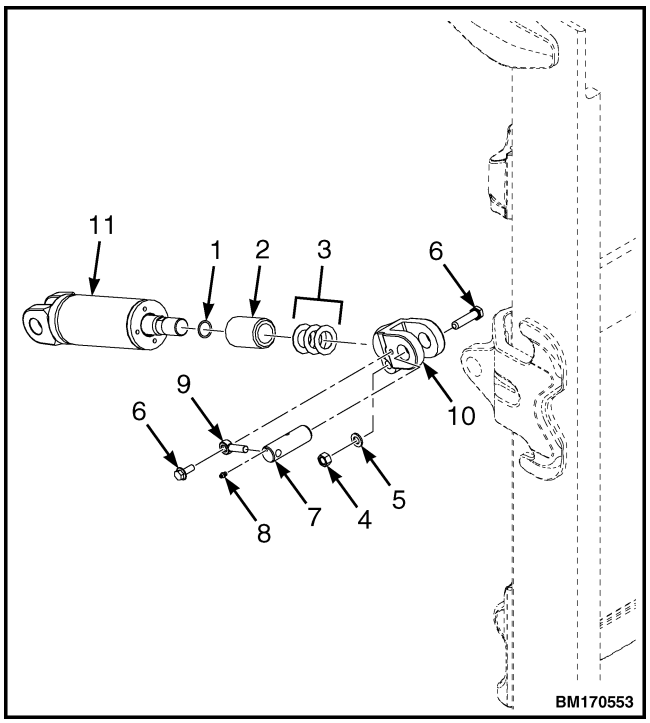
The mast is heavy. The mast can weigh approximately 907 kg (2000 lb). Make sure all lifting devices (hoists, cables, chains, slings, etc.) are suitable and of adequate capacity to lift the mast.

8. Use the crane to lift mast assembly from lift truck. Position the mast across wooden beams on floor with carriage side up.

NOTE: If mast mounting bushing needs to be replace in Step 9, go to Step 10 for procedures.

9. Check the mast and mounting flanges for wear or damage by removing mast pivot pins from outer mast. Check that pins fit snug in the outer mast. See Figure 53. If pins can be moved up and down a minimum of 4 mm (0.20 in.), replace bushings in outer mast and/or mast pivot pins as required. See Figure 51.

10. Remove lube fitting, lube capscrew, and washer from mast mounts. See Figure 57. Use a brass drift pin to remove mast mounting bushings from outer mast. Discard mast mounting bushings. See Figure 51.



1. O-RING
2. SPACER
3. SHIMS
4. NUT
5. WASHER
6. CAPSCREW
7. PIVOT PIN
8. GREASE FITTING
9. ANCHOR PIN
10. CAPSCREW
11. ROD END

Figure 49. Mast Mounting, Tilt Cylinder Without Boot

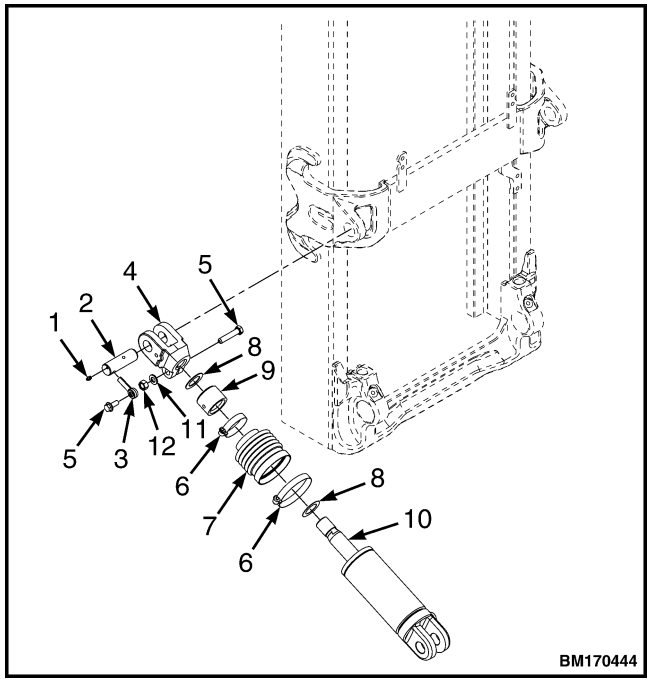
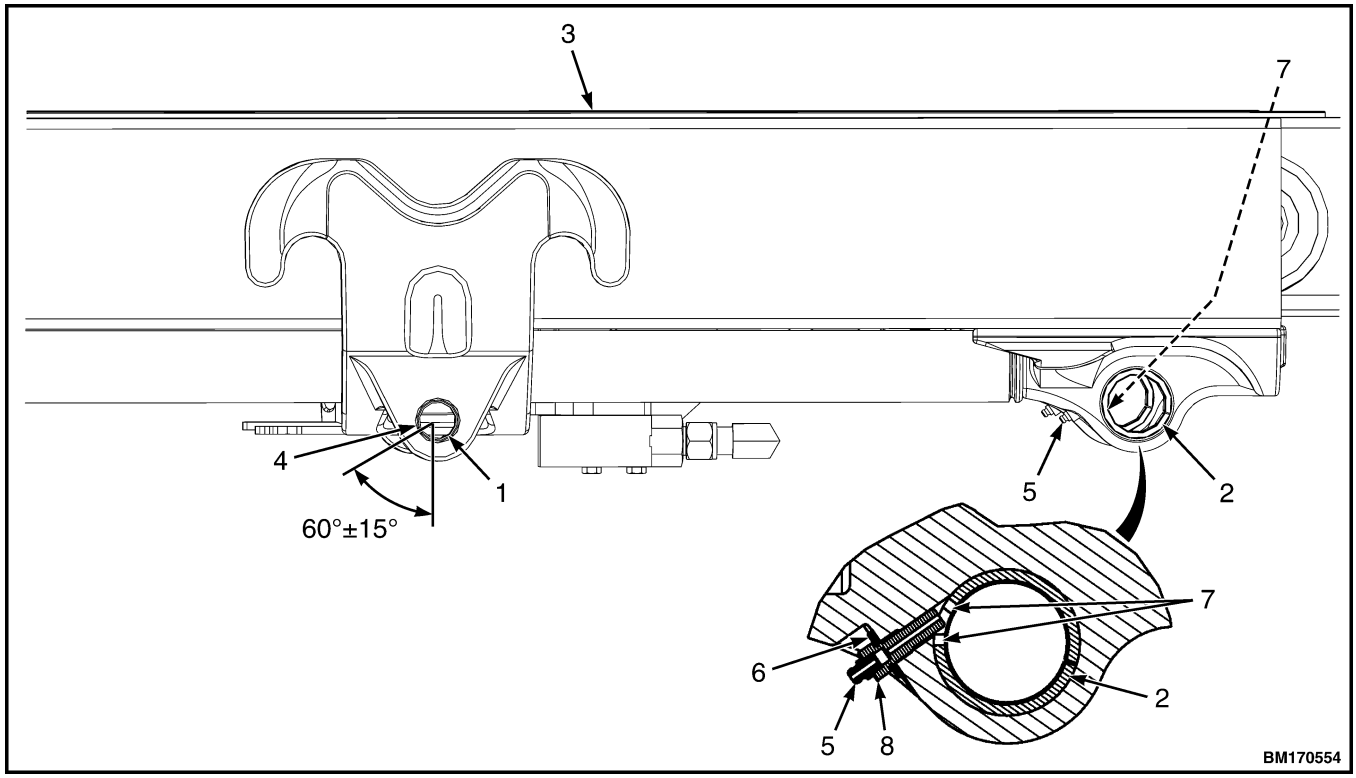


Figure 50. Mast Mounting, Tilt Cylinder With Boot, Lift Truck Models J2.2-3.5XN (J45-70XN) (A276)

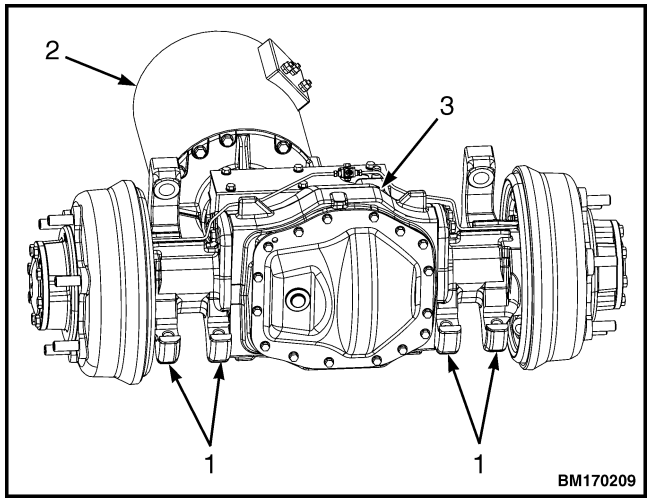
Legend for Figure 50.

1. GREASE FITTING
2. PIVOT PIN
3. ANCHOR PIN
4. ROD END
5. CAPSCREW
6. CLAMP
7. BOOT
8. SHIM
9. SPACER
10. TILT CYLINDER
11. WASHER
12. NUT



1. TILT ROD BUSHING
2. MAST MOUNTING BUSHING (BRONZE)
3. OUTER MAST
4. BUSHING SPLIT
5. LUBE FITTING
6. WASHER
7. BUSHING HOLE
8. LUBE CAPSCREW

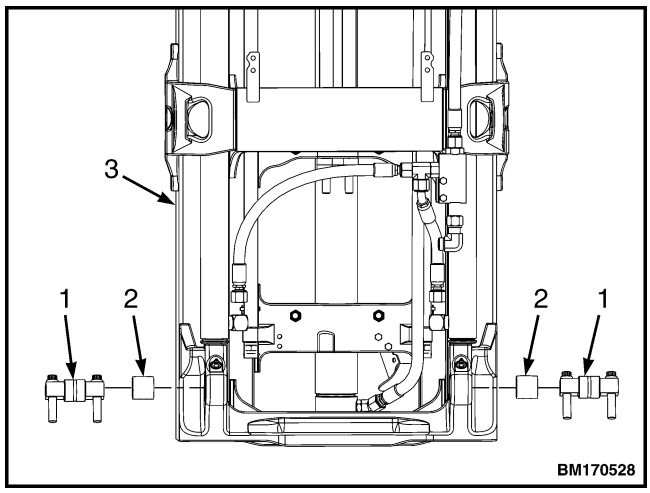
Figure 51. Tilt Rod and Mast Mounting Bushings



NOTE: DRIVE AXLE AND MAST MOUNTS FOR LIFT TRUCK MODELS E2.2-3.5XN (E45-70XN) (A268) SHOWN. DRIVE AXLE AND MAST MOUNTS FOR THE OTHER LIFT TRUCKS COVERED IN THIS MANUAL ARE SIMILAR.

1. HANGER MOUNTS
2. TRACTION MOTOR
3. DRIVE AXLE

Figure 52. Mast Mounts, Drive Axle



1. MAST PIVOT PIN
2. MAST MOUNTING BUSHING (BRONZE)
3. OUTER MAST

Figure 53. Mast Pivot Pins

Disassemble

WARNING

Always wear the proper protective equipment including eye protection and petroleum-resistant gloves when handling hydraulic oil. Thoroughly wash oil from exposed areas of skin as soon as possible.

WARNING

Completely lower forks to relieve hydraulic pressure before disconnecting any hydraulic hoses.

WARNING

Hydraulic oil is hot after system operation and can cause burns. DO NOT disconnect any hydraulic hoses until the oil in the system has cooled.

CAUTION

Protect the hydraulic system from dirt and contaminants when disconnecting hydraulic hoses from the mast. If hydraulic system becomes contaminated, damage to the hydraulic system can occur.

NOTE: If only the main lift cylinders need to be removed and repaired, see **Cylinder Repair (Mast S/N F507, F508, F562, F563)** 2100SRM1668 for procedures. When the mast has header hoses, see section Header Hose Installation and Adjustment for procedures to install and adjust the header hoses.

1. Clean area around hydraulic fittings for lift cylinders. Disconnect fittings at lift cylinders and put caps on the open lines. See Figure 54.

2. Remove chains and header hoses.

3. Disconnect hydraulic lines and fittings between lowering control valve housing and main lift cylinders. Remove capscrews and nuts and remove lowering control valve housing and valve from bracket on outer mast. See Figure 54.

WARNING

Be careful when removing or installing snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers, and wear eye and face protection during removal or installation.

4. Remove nut, capscrew, spacer, and washer at the mount near the top of each main lift cylinder. Remove snap rings and washers from top of each main lift cylinder. Disconnect main lift chains at the mounts. See Figure 54.

WARNING

The mast weldments can slide when the mast is moved. A weldment that slides can cause injury.

5. Slide inner mast from outer mast 30 cm (12 in.) to disengage the main lift cylinders from the inner mast. Remove the main lift cylinders from the outer mast.

6. Slide the inner mast from the bottom of the outer mast 30 cm (12 in.). See Figure 54.

7. Remove the strip bearings and load rollers from the top of the outer mast. See Figure 57.

8. Remove the load rollers from the bottom of the inner mast. Make a note of each shim arrangement and load roller location. The shim arrangements will be the same during assembly. See Figure 55.

WARNING

The mast is heavy. The mast can weigh approximately 907 kg (2000 lb). Make sure all lifting devices (hoists, cables, chains, slings, etc.) are suitable and of adequate capacity to lift the mast.

NOTE: When replacing the outer mast, copy the part number and date code information from the old channel and stamp that information on the new channel with a letter **R** at the end to indicate that it has been replaced.

9. Slide the inner mast halfway out of the top of the outer mast. Connect a crane with a capacity of at least 907 kg (2000 lb) to the center of the inner mast. See Figure 56. Slide the inner mast out of the outer mast until the mast stub shafts of the inner mast are in the notches of the outer channels. Remove the inner mast from the outer mast.

10. Remove chain sheaves and disassemble them as necessary for repair and cleaning. See Figure 55.

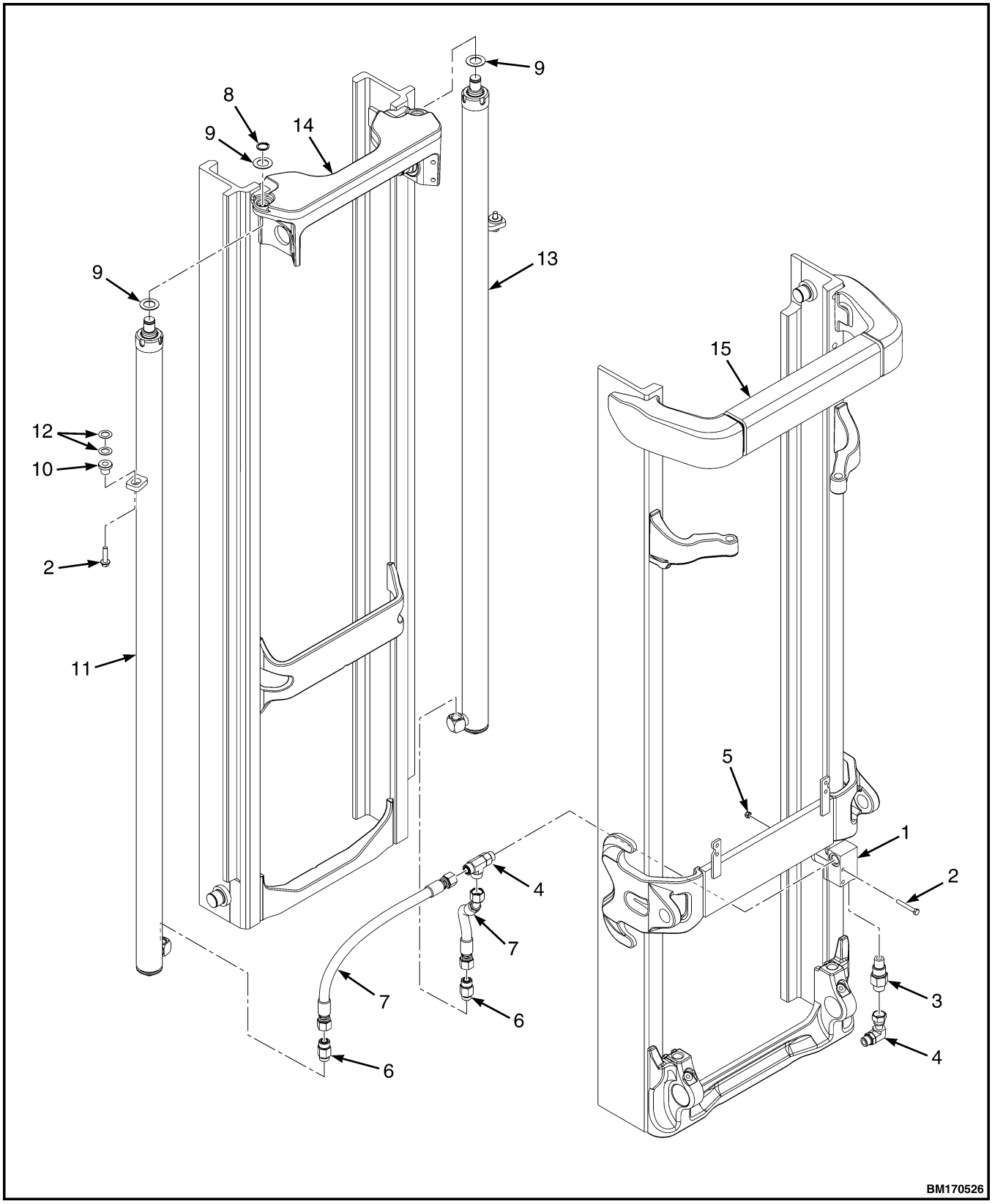


Figure 54. Main Lift Cylinders

Legend for Figure 54.

1. LOWERING CONTROL VALVE HOUSING
2. CAPSCREW
3. LOWERING CONTROL VALVE
4. FITTING
5. NUT
6. HYDRAULIC VELOCITY FUSE
7. HOSE ASSEMBLY
8. SNAP RING
9. WASHER
10. ISOLATOR
11. LEFT MAIN LIFT CYLINDER
12. WASHER
13. RIGHT MAIN LIFT CYLINDER
14. INNER MAST
15. OUTER MAST

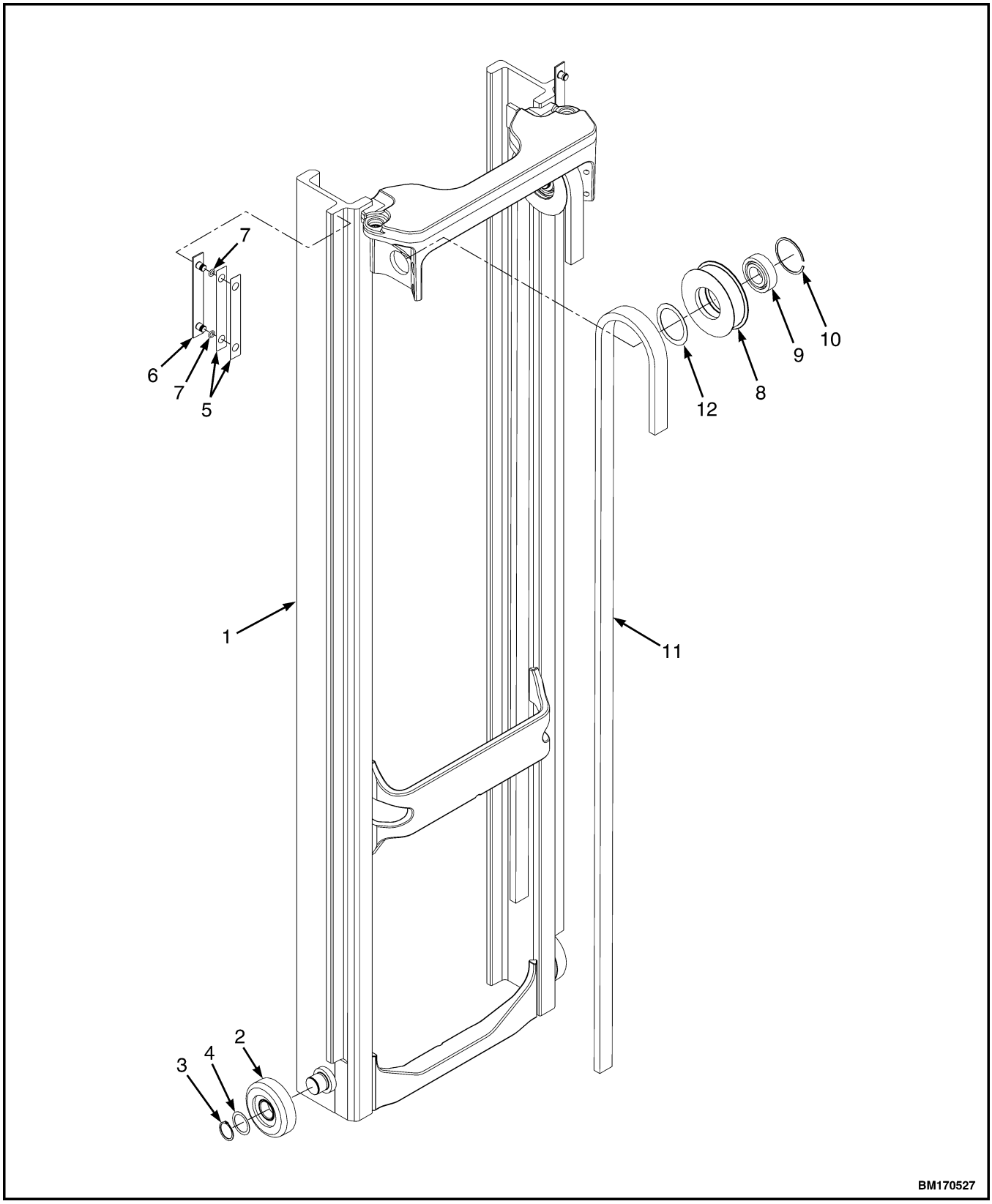


Figure 55. Inner Mast Components

Legend for Figure 55.

1. INNER MAST
2. LOAD ROLLER
3. SNAP RING
4. SHIM
5. BEARING STRIP
6. SHIM
7. O-RING
8. CHAIN SHEAVE
9. BEARING
10. SNAP RING
11. MAIN LIFT CHAIN
12. SPACER

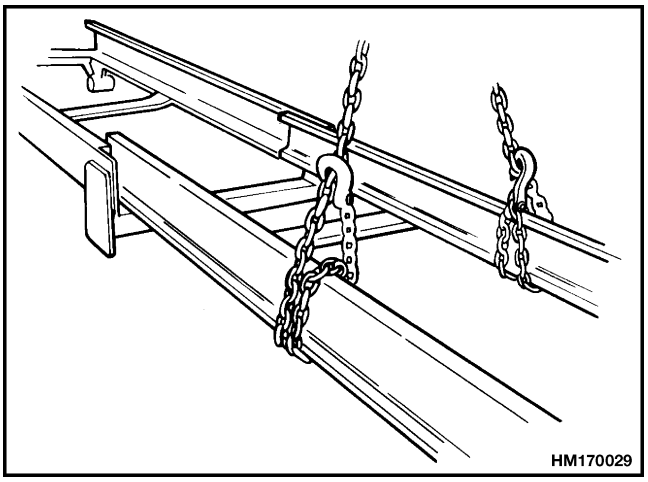


Figure 56. Connecting A Crane

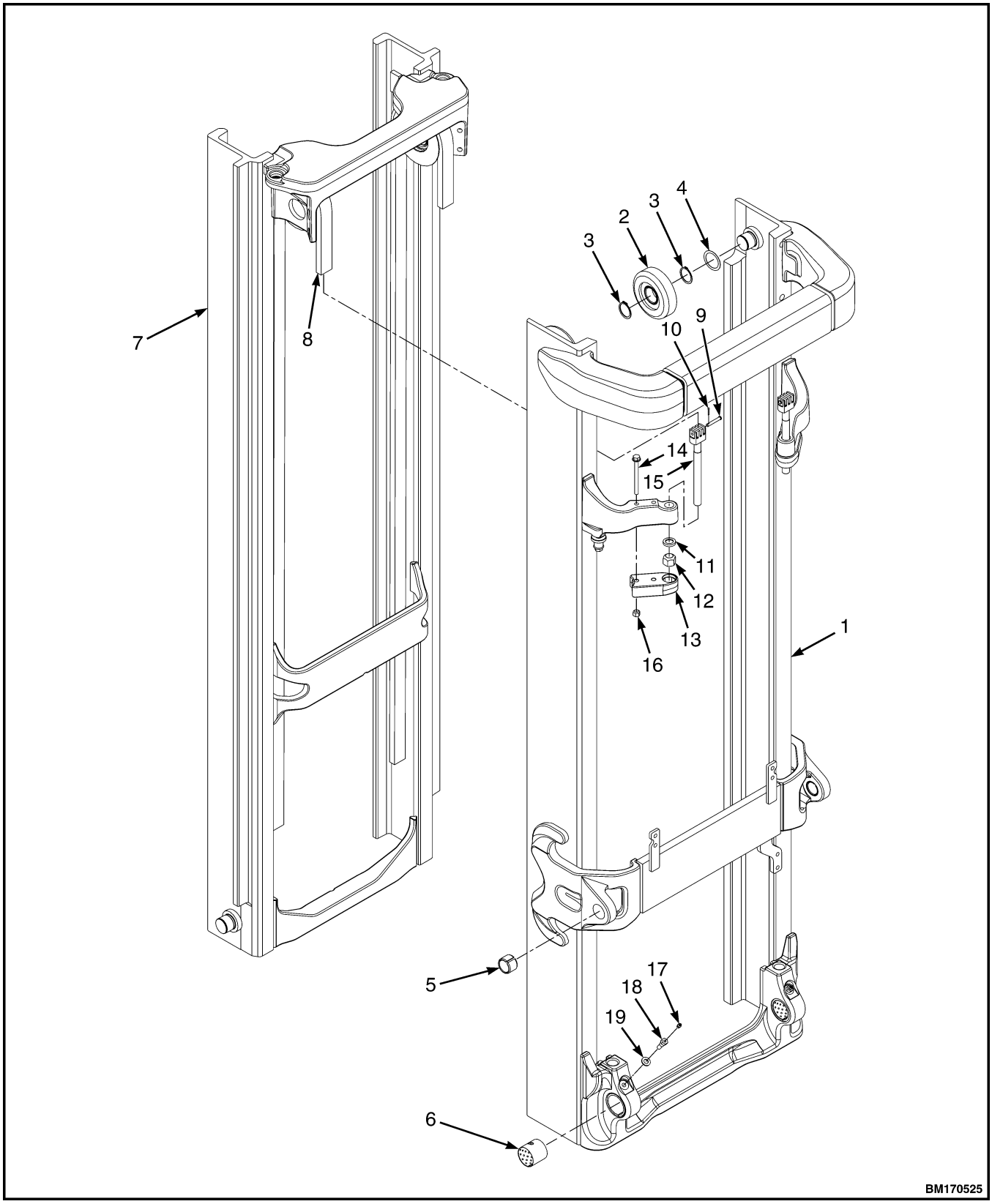


Figure 57. Outer Mast

Legend for Figure 57.

1. OUTER MAST
2. LOAD ROLLER
3. SNAP RING
4. SHIM
5. BUSHING
6. BUSHING (BRONZE)
7. INNER MAST
8. LIFT CHAIN
9. PIN
10. COTTER PIN
11. RING
12. NUT
13. CHAIN ANCHOR RESTRAINT
14. CAPSCREW
15. CHAIN ANCHOR
16. NUT
17. LUBE FITTING
18. LUBE CAPSCREW
19. WASHER

Clean and Inspect

CAUTION

DO NOT use steam or high-pressure water to clean the load rollers or the lift chains. Steam and high-pressure water can remove the lubrication from the bearings in the load rollers. Water in the bearings of the sheaves and the link pins of chains can also shorten the service life of these parts.

1. Inspect chain sheaves and load rollers (see Figure 55 and Figure 57) for wear or damage. DO NOT use steam to clean lift chain sheaves or load rollers. The bearings in the sheaves and load rollers are sealed and lubricated.

WARNING

Cleaning solvents may be flammable and toxic and can cause severe skin irritation. When using commercial cleaning solvents, always comply with solvent manufacturer's recommended safety precautions.

WARNING

Compressed air can move particles so that they cause injury to the user or to other personnel. Make sure that the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eyes.

2. Clean the lift chains by soaking in solvent for 30 minutes to remove all dirt and grease. Hang lift chains up and remove solvent using compressed air.

WARNING

Never replace only the worn section of a chain. Replace the complete chain. Never replace only one chain of a chain pair. Replace both chains. Damage to the lift truck and serious injury can occur if lift chains are not replaced correctly.

NOTE: The chains must be inspected in the area of chain that passes over the chain sheave during the first portion of a lift. These links will show maximum wear.

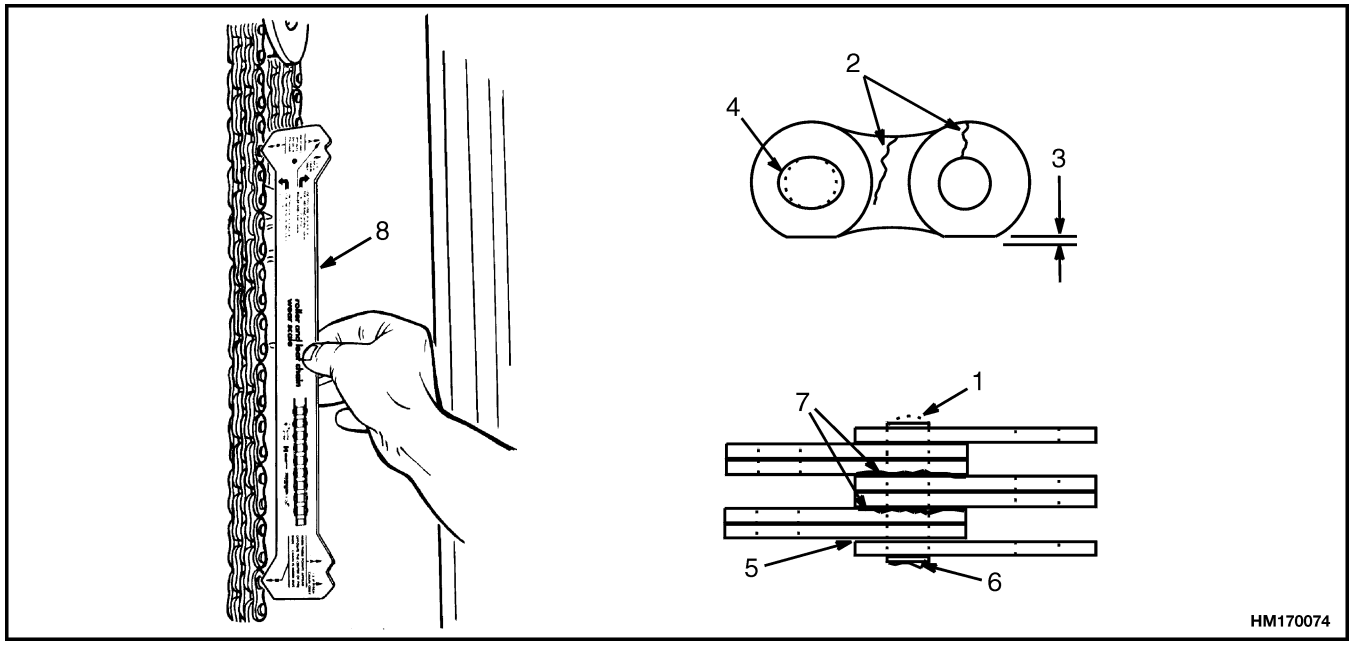
3. Inspect lift chains for wear and damage. A lift chain becomes longer when it is worn. If a chain is 3% longer than a new lift chain, the lift chain must be replaced.

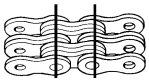
4. If a chain scale is available (Hyster Part No. 599737) , check lift chains as shown in Figure 58. If a chain scale is not available measure 20 links of chain. Measure from the center of a pin to the center of another pin 20 pitches away. Compare the length with the chart in Figure 58. Replace chain if the length of 20 links of the worn section is more than the maximum wear limit.

5. Lubricate lift chains by soaking them in SAE 30 engine oil for 30 minutes. Hang chains over a drip pan for one hour to remove excess oil.

NOTE: Chain anchor pins **Must** be replaced anytime chains are replaced.

6. Inspect chain anchors, chain anchor pins, and chain anchor restraints. Replace any parts that are worn or damaged. See Figure 57.



Pitch 	Total Length of 20 Links (Pitch) of New Chain	Wear Limit - The Maximum Length of 20 Links
12.7 mm (0.5 in.)	254.0 mm (10.0 in.)	261.6 mm (10.3 in.)
15.9 mm (0.6 in.)	317.5 mm (12.5 in.)	327.0 mm (12.9 in.)
19.1 mm (0.8 in.)	381.0 mm (15.0 in.)	392.4 mm (15.4 in.)
25.4 mm (1.0 in.)	508.0 mm (20. in.)	523.3 mm (20.6 in.)

NOTE: THE INSTRUCTION FOR MEASURING CHAIN WEAR ARE SHOWN ON THE CHAIN WEAR SCALE.

1. WORN PIN
2. CRACKS
3. EDGE WEAR
4. HOLE WEAR
5. LOOSE LEAVES
6. DAMAGED PIN
7. RUST
8. CHAIN WEAR SCALE

Figure 58. Lift Chain Check

WARNING

Cleaning solvents may be flammable and toxic and can cause severe skin irritation. When using commercial cleaning solvents, always comply with solvent manufacturer's recommended safety precautions.

WARNING

Steam can cause serious burns. Wear protective clothing, gloves, and eye protection. Never expose your skin to steam.

7. Clean mast weldments with steam or solvent.

WARNING

Improper welding procedures can damage the structure of the mast or cause incorrect function of the mast which can result in serious injury to personnel. Consult your lift truck dealer for more information before welding on the mast

8. Inspect the sliding surfaces for wear or damage. Inspect the load roller contact surfaces for wear or damage. Inspect all welds for cracks.

Assemble

WARNING

The mast is heavy. The mast can weigh approximately 907 kg (2000 lb). Make sure all lifting devices (hoists, cables, chains, slings, etc.) are suitable and of adequate capacity to lift the mast.

NOTE: The shims for the load rollers keep the mast weldments parallel and provide correct clearance. During assembly, shims should be reinstalled in the same location they were in before disassembly. Check the clearance and adjust the shims for wear or for changes caused by repairs. The strip bearings are also adjusted by using shims and should also be reinstalled in the same location they were in before disassembly. See the section Mast Adjustments in this service manual for the adjustment procedures.

NOTE: When the mast has header hoses, see section Header Hose Installation and Adjustment for procedures to install and adjust the header hoses.

1. Connect a crane with a capacity of at least 907 kg (2000 lb) to the center of the inner mast. See Figure 56. Fit the stub shafts through the notches in the outer mast. Slide the inner mast into the outer mast so the stub shafts are seen at the top and bottom of the weldments. See Figure 55.

2. Install the strip bearings and shims on the outer mast. See Figure 59. Apply chassis lube to the bearing surface. Check the clearance of the strip bearings as described in Mast Adjustments section in this manual.

3. Install the load rollers and shims on both weldments. Check the clearance of the load rollers as described in sections Mast Adjustments and Carriage Adjustments in this service manual.

4. Push the inner mast to engage the rods of the main lift cylinders. Install washer and snap ring. See Figure 54.

5. Install capscrews, isolators, and O-rings at the mounts for main lift cylinders. Tighten capscrews to 38 N•m (28 lbf ft). See Figure 54.

6. Install housing for the lowering control valve on bracket on outer mast. Tighten the nuts for the lowering control valve housing to 18 N•m (13 lbf ft). Install the lowering control valve in the housing. Connect the hydraulic lines and fittings between the housing and the main lift cylinders. See Figure 54.

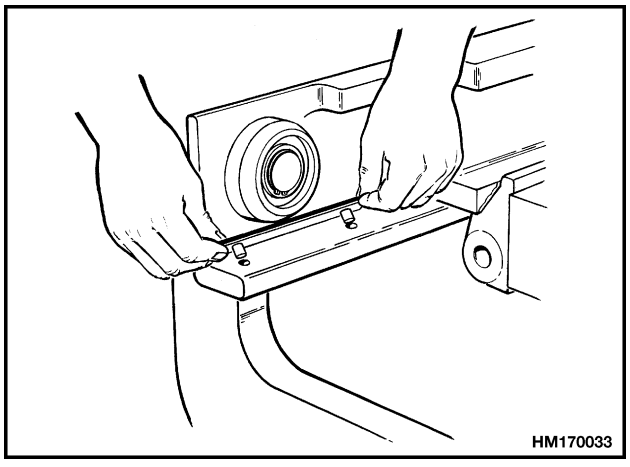


Figure 59. Strip Bearings

7. Install the chain sheaves at the inner mast. Be sure to install both pins that hold the shaft for the chain sheave in position. See Figure 57.

8. Connect the lift chains to the chain anchors at the main lift cylinder mounts. See Figure 54.

9. Attach wires between the ends of the lift chains and the crossmember to control the lift chains during mast installation.

Install

1. Install new bushings into mast mounts at bottom of outer mast. Be sure to align the hole in the bushing with the lube fitting hole in the bottom of the outer mast. Bushing must be flush with outer mast surface. See Figure 51.

2. Apply an even coat of grease to the pivot pins and install them into mast mounts at bottom of outer mast. See Figure 53.

3. Install washer and lube capscrew in hole in bottom of outer mast. Tighten lube capscrew to 25 N•m (18 lbf ft). Install lube fitting onto lube capscrew. Tighten lube fitting to 6 N•m (53 lbf in).

WARNING

The mast is heavy. The mast can weigh approximately 907 kg (2000 lb). Make sure all lifting devices (hoists, cables, chains, slings, etc.) are suitable and of adequate capacity to lift the mast.

4. Connect crane to top of mast using chains. Make sure all mast uprights are fastened together. Make sure chains will not damage sheaves, tubing, or other parts of mast. Make sure crane has a capacity of at least 907 kg (2000 lb).

5. Use crane to position mast assembly onto its lower mounts. Position mast so pivot pins seat into hanger mounts on drive axle. Install capscrews that hold mast pivot pins to drive axle hangers. Tighten capscrews to 270 N•m (199 lbf ft). See Figure 52.

6. Install new bushings into the tilt anchors on the outer mast. Be sure tilt bushing split is installed at the correct angle as shown in Figure 51.

WARNING

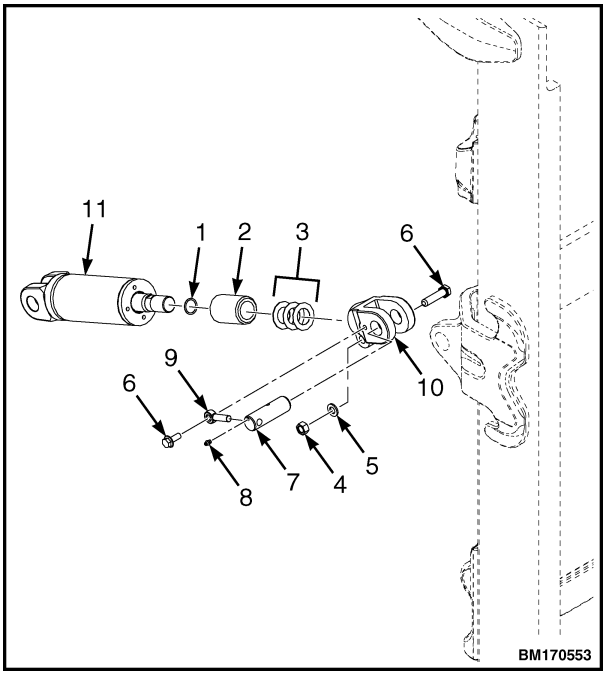
Use a pry bar, NOT your fingers, to align the tilt cylinder clevises with the outer mast. The cylinder or mast can shift and cause serious injury.

NOTE: Use multipurpose grease #2 with 2 to 4% molybdenum disulfide for normal operations.

7. Apply grease to pivot pins and connect tilt cylinders to mast using pivot pins. Install anchor pins and capscrews to rod ends. Apply anti-seize compound to capscrew threads and tighten 38 N•m (28 lbf ft).

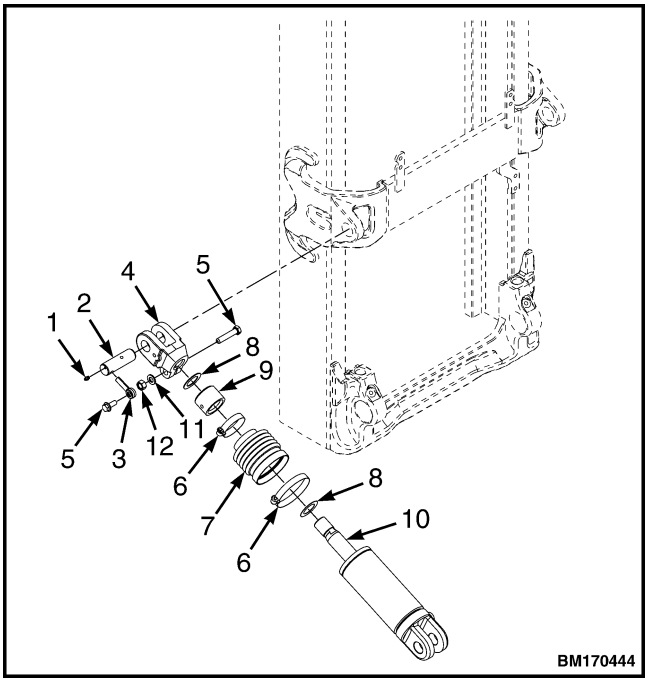
   See Figure 60 for lift trucks equipped with tilt cylinders without optional boots

   See Figure 61 for lift trucks equipped with tilt cylinders with optional boots



1. O-RING
2. SPACER
3. SHIMS
4. NUT
5. WASHER
6. CAPSCREW
7. PIVOT PIN
8. GREASE FITTING
9. ANCHOR PIN
10. CAPSCREW
11. ROD END

Figure 60. Mast Mounting, Tilt Cylinder Without Boot



1. GREASE FITTING
2. PIVOT PIN
3. ANCHOR PIN
4. ROD END
5. CAPSCREW
6. CLAMP
7. BOOT
8. SHIM
9. SPACER
10. TILT CYLINDER
11. WASHER
12. NUT

Figure 61. Mast Mounting, Tilt Cylinder With Boot, Lift Truck Models J2.2-3.5XN (J45-70XN) (A276)

8. Connect hydraulic lines to lowering control valve.

9. Install the carriage as described in the section Carriages Repair, Two-Stage LFL Mast.

WARNING

Never check for leaks by putting hands on hydraulic lines or components under pressure. Hydraulic oil under pressure can be injected into the skin.

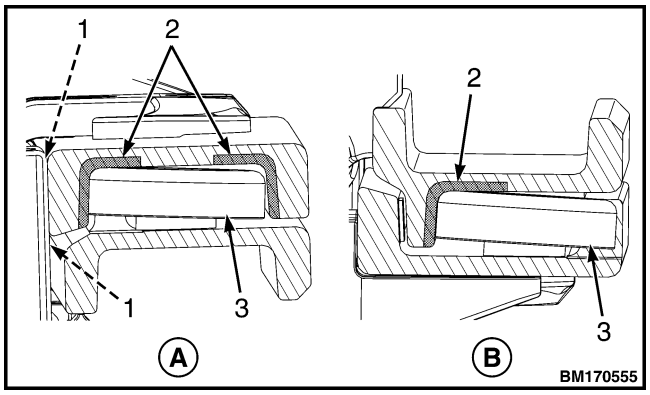
10. Check tilt cylinder adjustments as described in **Cylinder Repair (Mast S/N F507, F508, F562, F563)** 2100SRM1668. Operate mast and check for leaks and correct operation. Check lift chains as described in Lift Chains Adjustment section in this manual.

NOTE: Before checking for mast side kicking, the mast must be fully assembled to include the carriage, forks, load backrest and any attachments.

11. Raise the mast, without a load to its full height and check for side kicking. Mast side kicking is when the mast moves either to the right or left as it is being raised to its full height. If the mast is side kicking, see the Mast Adjustments section in this manual for procedures to correct mast side kicking.

NOTE: Load rollers and sheaves have sealed bearings and do not need additional lubrication.

12. Lubricate sliding surfaces and load roller surfaces along full length of channels as shown in Figure 62. Apply lubricant only to surfaces indicated.



A. UPPER LOAD ROLLERS
B. LOWER LOAD ROLLERS

1. LUBRICATE STRIP BEARING SURFACES
2. LUBRICATE LOAD ROLLER SURFACES
3. LOAD ROLLER

Figure 62. Lubricate Mast

Header Hose Installation and Adjustment

Remove

Read and follow the
Safety Procedures When Working Near Mast as well as all **WARNINGS** and **CAUTIONS** before removing any header hoses.

NOTE: Access to some of the fittings can be difficult. If necessary, operate the hydraulic system to move mast weldments or the carriage. Make sure the hydraulic system does not have pressure as described in Step 1.

1. To replace any header hoses, fully lower the carriage. Make sure the hydraulic system does not have hydraulic pressure. Hold the control for each function in the forward position for approximately five seconds to release the pressure. Make sure the hydraulic pump does not operate. Move the key or keyless switch, if equipped, to the **OFF** position.

2. Disconnect the battery and put a tag or lock on the battery connector.

3. Disconnect the header hoses and install caps on ends to prevent dirt and debris from entering the hydraulic system.

Installation

WARNING

Always wear the proper protective equipment including eye protection and petroleum-resistant gloves when handling hydraulic oil. Thoroughly wash oil from exposed areas of skin as soon as possible.

WARNING

Never check for leaks by putting hands on hydraulic lines or components under pressure. Hydraulic oil under pressure can be injected into the skin.

WARNING

Before working on or near the mast, see Safety Procedures When Working Near Mast in this manual.

1. Some lift trucks are equipped with auxiliary hydraulic functions that are fastened to the carriage. Examples of attachments that use these auxiliary functions are sideshift carriages, roll clamps, and fork positioners. These auxiliary functions require header hoses for their operation.

NOTE: The procedures in this section are for the four function option. Lift trucks equipped with three-function option will only have hoses **A** and **B**. See Figure 63.

NOTE: The carriage height must be correct before the header hose tension can be measured. See Lift Chains Adjustment for carriage adjustment procedures.

Mark each hose with a single letter: **A, B, C,** and **D**.

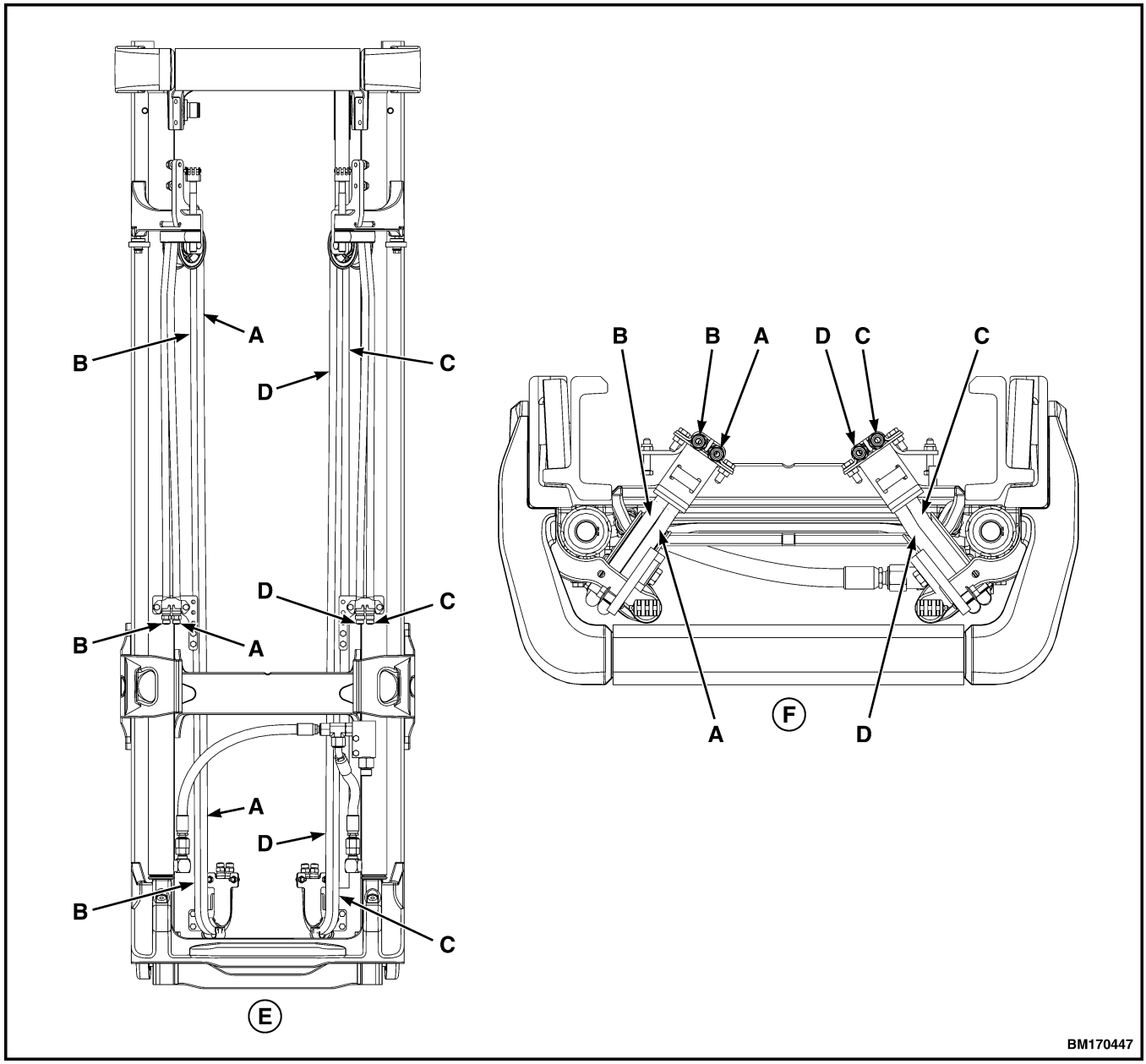
All four hoses are the same length. Before installing new header hoses, add tension marks to each hose. See Figure 64.

2. Clamp one end of the hose in a vise. **DO NOT** clamp on the threads. Pull on the other end until hose is straight. **DO NOT** apply enough force to stretch the hose.

NOTE: The header hose tension specification is 2.0% ±1%. Install hose caps to marked end (truck end) of hoses.

3. Put reference marks on the header hoses. Starting at either end of each of the hoses, place a mark at 100 ±10 mm (4.0 ±0.40 in.). This is dimension **M1**. See Figure 64.

4. From dimension **M1**, place another mark at 500 ±2.0 mm (20.0 ±0.08 in.). This is dimension **M2**. See Figure 64.



A. HEADER HOSE
B. HEADER HOSE
C. HEADER HOSE
D. HEADER HOSE
E. REAR VIEW
F. TOP VIEW

Figure 63. Header Hose Alignment for Two-Stage LFL Mast

5. Attach three-function hoses (**A** and **B**) and four-function hoses (**C** and **D**) to turnaround brackets on carriage. See Figure 47.

6. Route hoses over the turnaround brackets and secure the end of the hose to the turnaround bracket with hose clamps and worm screw clamps. Worm screw clamps go through the hose clamps and around the turnaround bracket to protect the header hoses. See Figure 64.

7. Route hoses up over hose sheaves and secure hoses to hose sheaves with spacers.

8. Clamp marked end of hoses to brackets on mid-outer crossmember. See Figure 64.

9. With header hoses installed on mast and the carriage correctly adjusted (see Carriage Adjustments) and the forks off the ground, measure header hose tension on mast as follows:

   a. Measure the distance between marks **M1** and **M2**. See Figure 64.

   b. The header hose specification between marks **M1** and **M2** is 510 ±5 mm (2.0% ±1.0%).

   c. If tension mark measurement is 505 mm (20.0 in.) or lower, adjust plate attached to bracket on mid-outer crossmember, downward by one hole and re-measure tension mark. If tension mark is still 505 mm (20.0 in.) or lower, replace hose and re-set plate to the upper position.

   d. If tension mark is 515 mm (20.3 in.) or higher, adjust carriage to maximum height allowed. See Carriage Adjustments section for procedures.

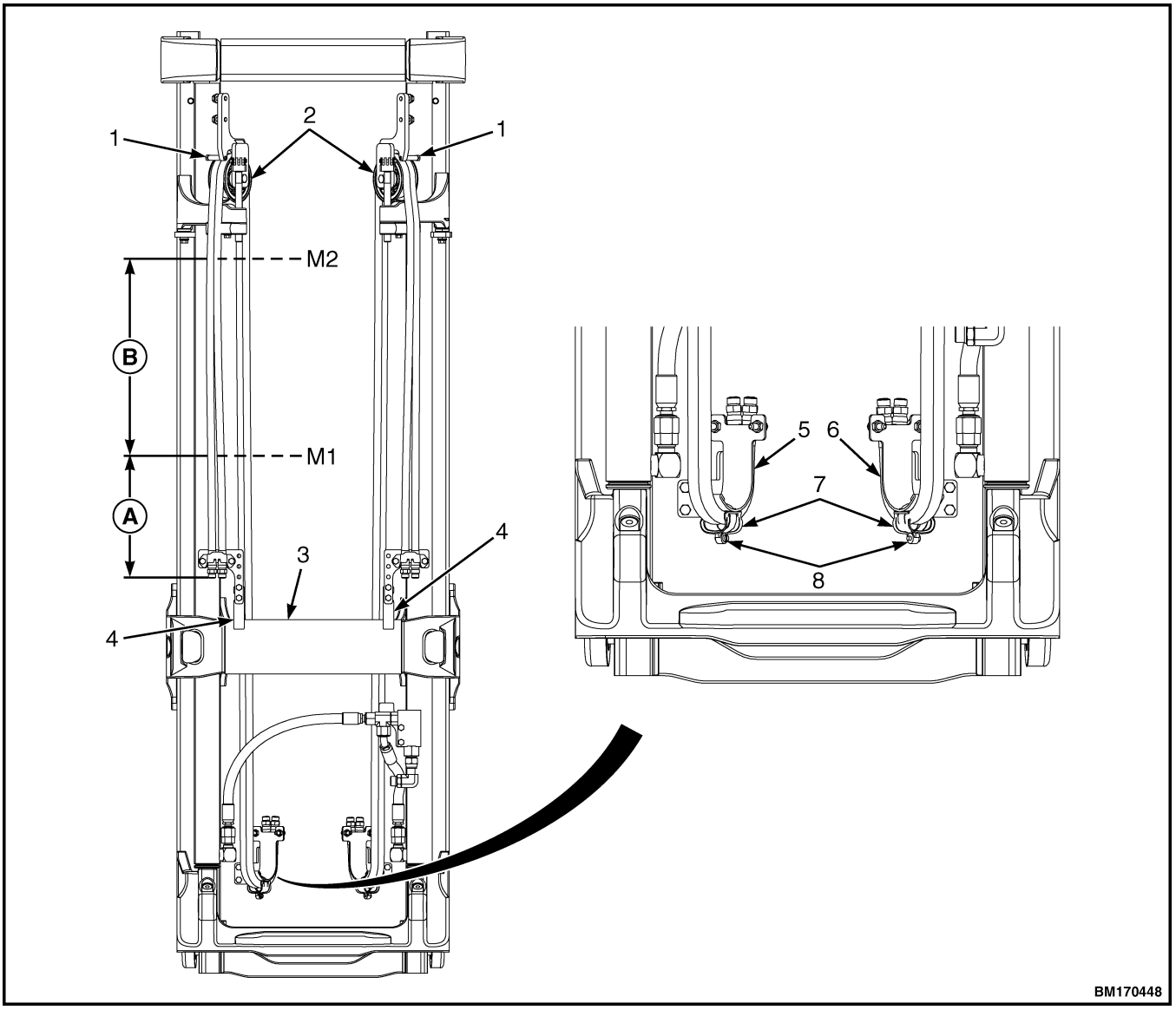
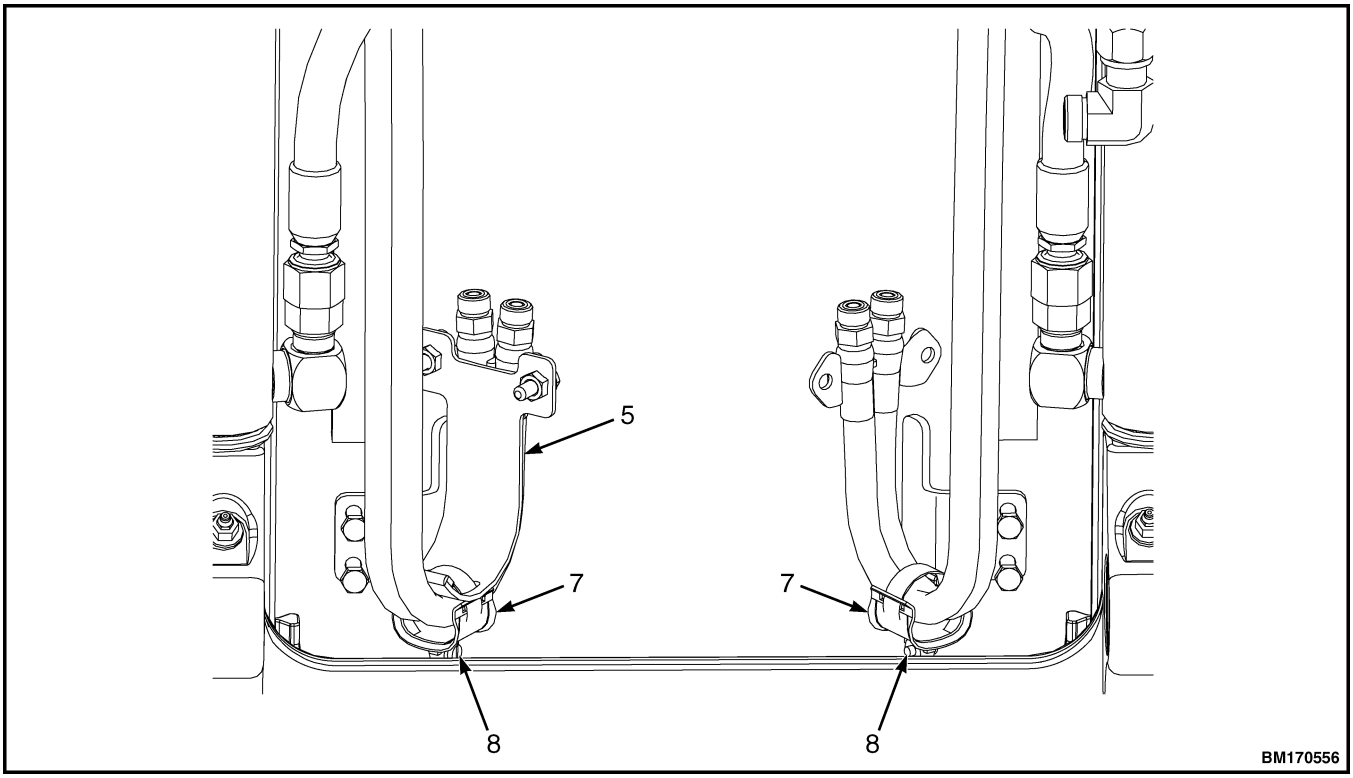


Figure 64. Header Hose Dimensions and Installation, Two-Stage LFL Mast (Sheet 1 of 2)



A. DIMENSION = 100 ±10 mm (4.0 ±0.40 in.)

B. DIMENSION = 500 ±2.0 mm (20.0 ±0.08 in.)

1. SPACER
2. HOSE SHEAVE
3. MID-OUTER CROSSMEMBER
4. BRACKET
5. TURNAROUND BRACKET (THREE-FUNCTION)
6. TURNAROUND BRACKET (FOUR-FUNCTION)
7. HOSE CLAMP
8. WORM SCREW CLAMP

Distance Installed	Hose Tension
505 mm (19.8 in.)	1%
510 mm (20.1 in.)	2%
515 mm (20.3 in.)	3%

Figure 64. Header Hose Dimensions and Installation, Two-Stage LFL Mast (Sheet 2 of 2)

Adjustment

NOTE: Tire size variations and adjusting of the lift chains may require adjustment of header hose tension. Lift chain adjustment for tire wear will reduce header hose tension.

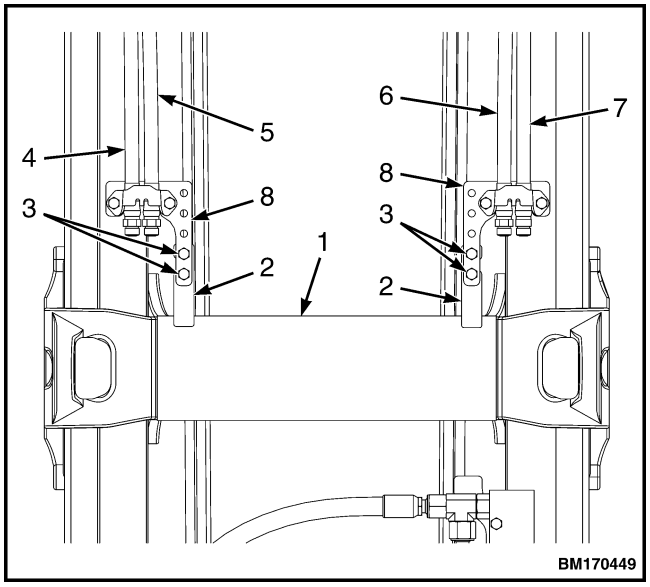
1. To increase header hose tension, raise carriage at least 100 mm (4.0 in.).

2. Place a block under lower carriage bar and lower carriage onto block to relieve hose tension. Chain carriage to inner mast. See Safety Procedures When Working Near Mast in this manual.

3. Loosen hardware on bracket on mid-outer crossmember for the three and/or four function hoses needing adjustment. Lower bracket and tighten nut to 18 N•m (159 lbf in). See Figure 65.

4. Release chain, remove block, and lower the carriage.

5. With no load on the forks, check the header hose adjustment by operating the mast through the full lift cycle two times. When properly adjusted, the hoses will not be so tight that they compress when they pass over the hose sheaves nor will they be so loose that they touch the load backrest or any crossmember that is next to a sheave. If necessary, repeat adjustment procedure until the hoses are properly adjusted.



1. MID-OUTER CROSSMEMBER
2. BRACKET
3. MOUNTING HARDWARE
4. HEADER HOSE **B**
5. HEADER HOSE **A**
6. HEADER HOSE **D**
7. HEADER HOSE **C**
8. PLATE

Figure 65. Header Hose Adjustment, Two-Stage LFL Mast

Carriages Repair, Three-Stage FFL Mast

STANDARD CARRIAGE

Remove

1. Remove forks. See Fork Replacement for procedures.

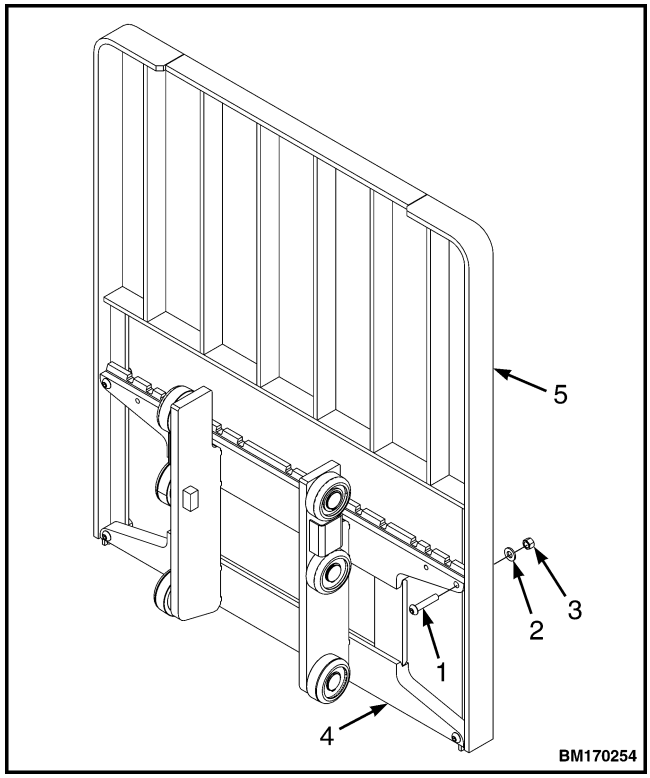
2. Remove four capscrews, washers, nuts, and load backrest from carriage. See Figure 66.

3. Connect a lifting device to the carriage. Lift carriage so that lift chains become loose.

WARNING

When disconnecting the lift chains, keep control of the ends. Use wire to temporarily connect the ends of the lift chains to the mast. This procedure will prevent the lift chains from falling and causing an injury or damage.

4. Remove chain pin from each chain anchor at the carriage. Disconnect lift chains from the carriage. Use wire to connect the ends of lift chains to a part of the mast. Make sure chains can move freely when inner mast is raised. See Figure 67.



1. CAPSCREW
2. WASHER
3. NUT
4. CARRIAGE
5. LOAD BACKREST

Figure 66. Load Backrest, Remove

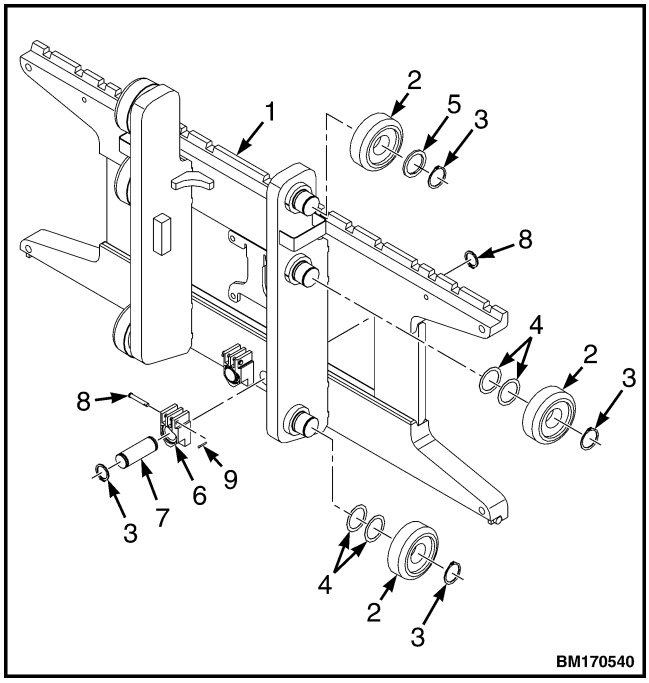
WARNING

To help prevent possible injury, make sure the carriage is stable and will not fall over when the inner mast is raised above the load rollers of the carriage.

5. Use lift cylinders to raise intermediate mast. If hydraulic system cannot be used, disconnect lift cylinders from intermediate mast. See the section **Cylinder Repair (Mast S/N F507, F508, F562, F563)** 2100SRM1668.

6. Connect a crane with a capacity of at least 681 kg (1501 lb), to top of the inner mast. Carefully raise inner mast until it is above the load rollers of the carriage. Install safety chains to secure mast in its extended position and disconnect the crane. See Safety Procedures When Working Near Mast.

7. Move lift truck away from the carriage. Completely lower inner mast so it cannot move.



1. CARRIAGE
2. SNAP RING
3. SHIM
4. LOAD ROLLER
5. CHAIN ANCHOR
6. CHAIN PIN
7. COTTER PIN
8. ANCHOR PIN
9. SPACER

Figure 67. Standard Carriage Components

Clean and Inspect

NOTE: Shims are installed on the bottom and middle load rollers only.

1. If load rollers must be replaced (see Figure 67), make a note of the location and number of shims. Install shims, load rollers, and snap rings. See Carriage Adjustments section for correct adjustment of load rollers.

WARNING

Compressed air can move particles so that they cause injury to the user or to other personnel. Make sure that the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eyes.

WARNING

Cleaning solvents can be flammable and toxic, and can cause skin irritation. When using cleaning solvents, always follow the recommendations of the manufacturer.

CAUTION

DO NOT use cleaning solvent, compressed air, or steam to clean lift chain sheaves or load rollers. The bearings in the lift chain sheaves and load rollers are sealed and lubricated. Cleaning solvent, compressed air, and steam can damage the load roller bearings.

2. Clean any oil, grease, dirt, and other debris from carriage frame. Use a cleaning solvent and compressed air to dry.

WARNING

Improper welding procedures can damage the structure of the mast or cause incorrect function of the mast. Consult a Resident Service Engineering through the Contact Management System before welding on the mast.

3. If carriage bars have any protruding welds or damaged notches, repair by grinding, filing, or welding.

4. Clean and inspect the chain anchors and chain anchor pins. See Figure 67. Check chain anchors and anchor pins for wear and serviceability. Discard worn or unserviceable chain anchors and chain anchor pins. Discard used cotter pins.

Install

1. Move lift truck towards the carriage until inner mast is aligned with carriage rollers. If inner mast has been raised and secured using a crane and safety chains, connect the crane, raise inner mast, and remove safety chains. Carefully lower inner mast until it engages all of the load rollers. Disconnect the crane, if attached, and reconnect lift cylinders. See **Cylinder Repair (Mast S/N F507, F508, F562, F563)** 2100SRM1668.

2. Check the clearance of the load rollers. See Carriage Adjustments section for procedures.

NOTE: Use new cotter pins each time the chain pins are removed.

3. Connect lift chains to chain anchors at the carriage. Install cotter pins in chain pins. Adjust lift chains as described in Lift Chains Adjustment.

4. Install load backrest on carriage. Tighten capscrews to 195 N•m (144 lbf ft).

5. Install forks. See section Fork Replacement for procedures.

INTEGRAL SIDESHIFT CARRIAGE, LIFT TRUCKS MANUFACTURED PRIOR TO DECEMBER, 2016

Remove

1. Lower carriage completely. Remove forks. See Fork Replacement for removal procedures.

2. Remove four capscrews, washers, nuts, and load backrest from carriage. See Figure 66.

WARNING

Before disconnecting the hydraulic hoses, relieve the pressure in the hydraulic system. Serious injury can occur if pressure is not relieved from hydraulic system prior to disconnecting hydraulic hoses.

3. Relieve hydraulic pressure to the sideshift cylinder by moving sideshift lever in both directions several times.

WARNING

Always wear the proper protective equipment including eye protection and petroleum-resistant gloves when handling hydraulic oil. Thoroughly wash oil from exposed areas of skin as soon as possible.

The hydraulic oil is hot at normal operating temperatures. Be careful when draining the oil.

WARNING

Never check for leaks by putting hands on hydraulic lines or components under pressure. Hydraulic oil under pressure can be injected into the skin.

NOTE: Tag hydraulic lines and fittings prior to disconnecting to aid in connecting during installation.

4. Disconnect hydraulic lines from sideshift cylinder. Put caps and plugs on open lines and cylinder ports.

5. Remove lower mounting hooks by removing four capscrews securing the hooks. See Figure 68.

6. Remove sideshift cylinder from carriage. See **Cylinder Repair (Mast S/N F507, F508, F562, F563)** 2100SRM1668.

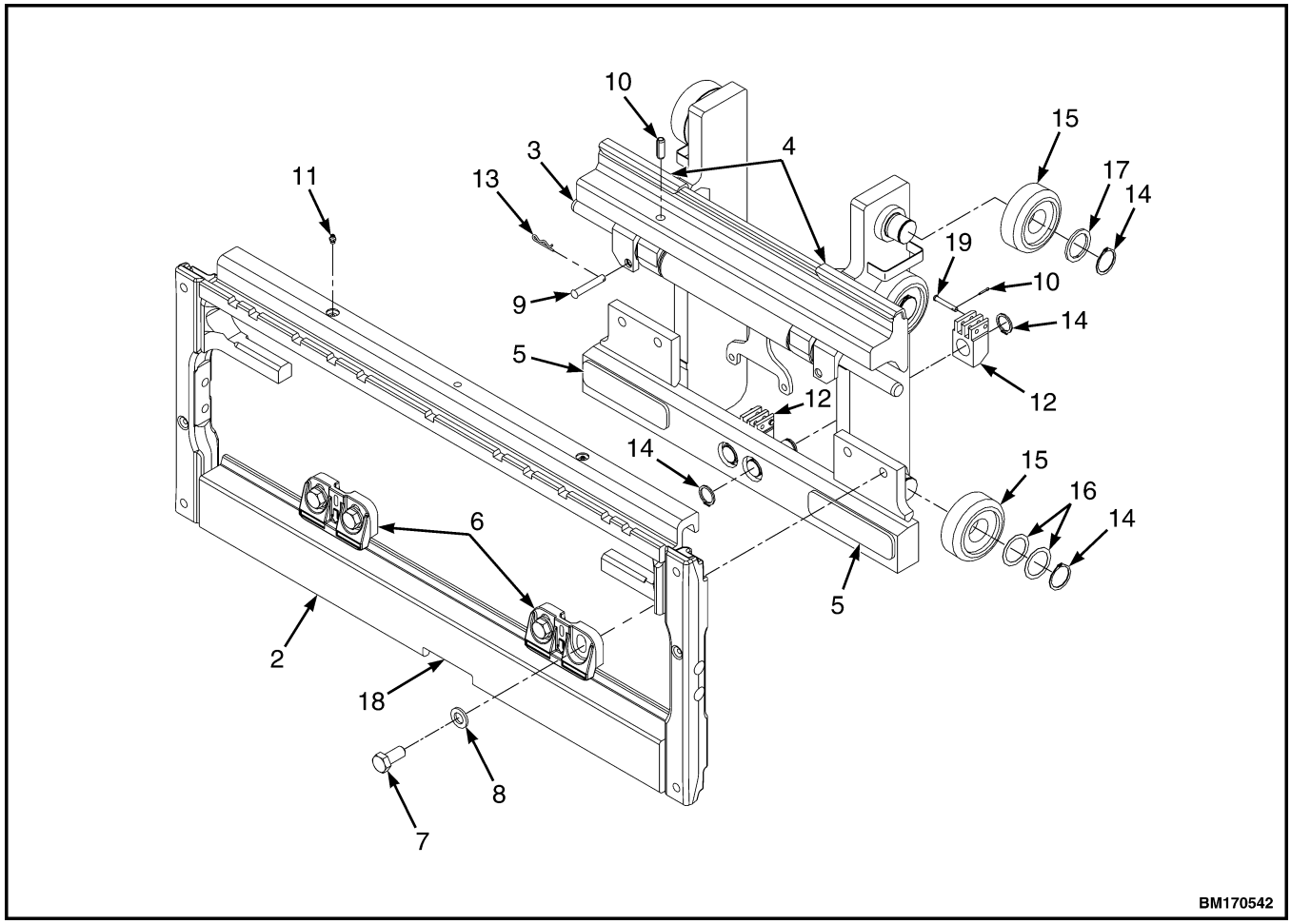
7. Use a crane with a capacity of at least 48 kg (106 lb) to lift outer frame away from inner frame. Lay outer frame flat on a pallet or work bench. See Figure 69.

Disassemble

1. Remove upper and lower bearings from inner frame. See Clean and Inspect for procedures. See Figure 68.

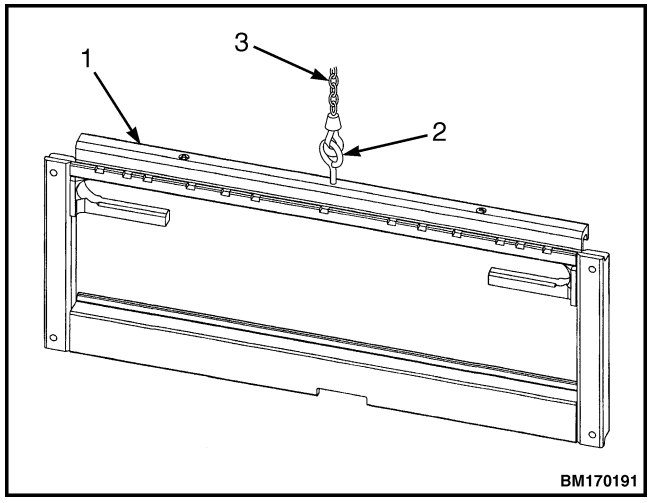
2. If damaged, remove lube fittings from outer frame. See Figure 68.

3. Disassemble the intergral sideshift cylinder. See **Cylinder Repair (Mast S/N F507, F508, F562, F563)** 2100SRM1668 for procedures.



1. INNER FRAME
2. OUTER FRAME
3. SIDESHIFT CYLINDER
4. UPPER BEARING
5. LOWER BEARING
6. LOWER HOOK
7. CAPSCREW
8. WASHER
9. CLEVIS PIN
10. PIN
11. LUBE FITTING
12. CHAIN ANCHOR
13. COTTER PIN
14. SNAP RING
15. LOAD ROLLER
16. SHIMS
17. SPACER
18. FORK REMOVAL NOTCH
19. CHAIN ANCHOR PIN

Figure 68. Integral Sideshift Carriage Component Parts



1. OUTER FRAME
2. LIFTING HOOK
3. LIFTING DEVICE

Figure 69. Remove Outer Frame

Clean and Inspect

1. Inspect lower mounting hooks for wear. Replace the hooks if they are worn beyond the wear limit. The wear limit clearance range is 0.76 mm (0.03 in.) minimum and 1.52 mm (0.06 in.) maximum. See **A** in Figure 70.

CAUTION

Improper welding procedures can damage the structure of the mast or cause incorrect function of the mast. Consult your Hyster lift truck dealer for more information before welding on the mast.

2. Clean and inspect carriage bars for damage and smoothness. Ensure carriage bars are parallel and ends are flush. If carriage bars have any protruding welds or damaged notches, repair by grinding, filing, or welding.

3. Clean bearing areas. Inspect sideshift bearings for wear as follows:

   a. If either upper bearing is worn to less than 2.5 mm (0.1 in.) thickness, replace both upper bearings by driving the upper bearings from the inner frame. See Figure 71.

   b. If either lower bearing is worn to less than 2.5 mm (0.1 in.) thickness, replace lower bearings by prying the lower bearings from the inner frame. See Figure 71.

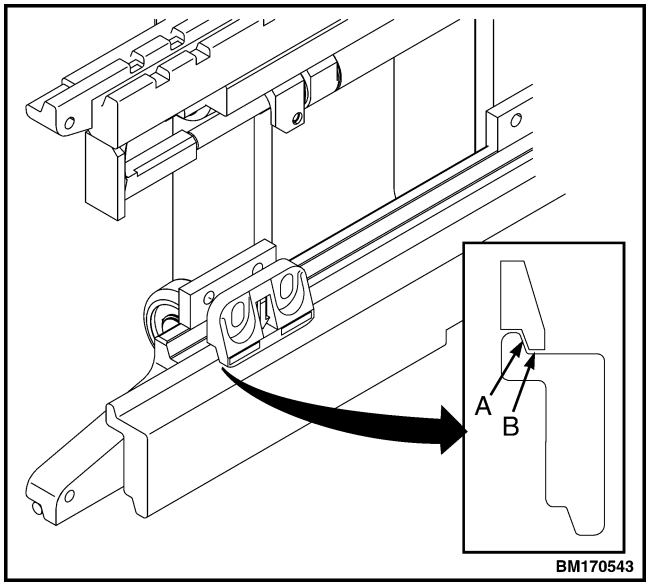
4. Inspect the sideshift cylinder. See **Cylinder Repair (Mast S/N F507, F508, F562, F563)** 2100SRM1668 for procedures.

5. Inspect load rollers for wear or damage (see Figure 68). If load rollers must be replaced, make a note of the location and number of shims. Install shims, load rollers and snap rings. See section Carriage Adjustments for correct adjustment.

Assemble

1. Assemble integral sideshift cylinder. See **Cylinder Repair (Mast S/N F507, F508, F562, F563)** 2100SRM1668 for procedures.

2. If lube fittings were removed, install new lube fittings into outer frame. See Figure 68.



A. WEAR LIMIT - 0.76 mm (0.03 in.) MINIMUM AND 1.52 mm (0.06 in.) MAXIMUM
B. CLEARANCE ADJUSTMENT - 0.76 mm (0.03 in.) MINIMUM AND 1.52 mm (0.06 in.) MAXIMUM

Figure 70. Lower Mounting Hooks Wear Limit and Clearance Adjustment

NOTE: Use a wood block or a plastic hammer to fully seat upper bearings onto inner frame. Proper lower hook clearance requires the upper bearings be fully seated.

3. Apply a 1 mm (0.040 in.) layer of multipurpose grease to upper and lower bearing surfaces. Install upper and lower bearings into the inner frame. Bearings snap into place. See Figure 71.

Install

1. Install integral sideshift cylinder onto carriage. See **Cylinder Repair (Mast S/N F507, F508, F562, F563)** 2100SRM1668 for procedures.

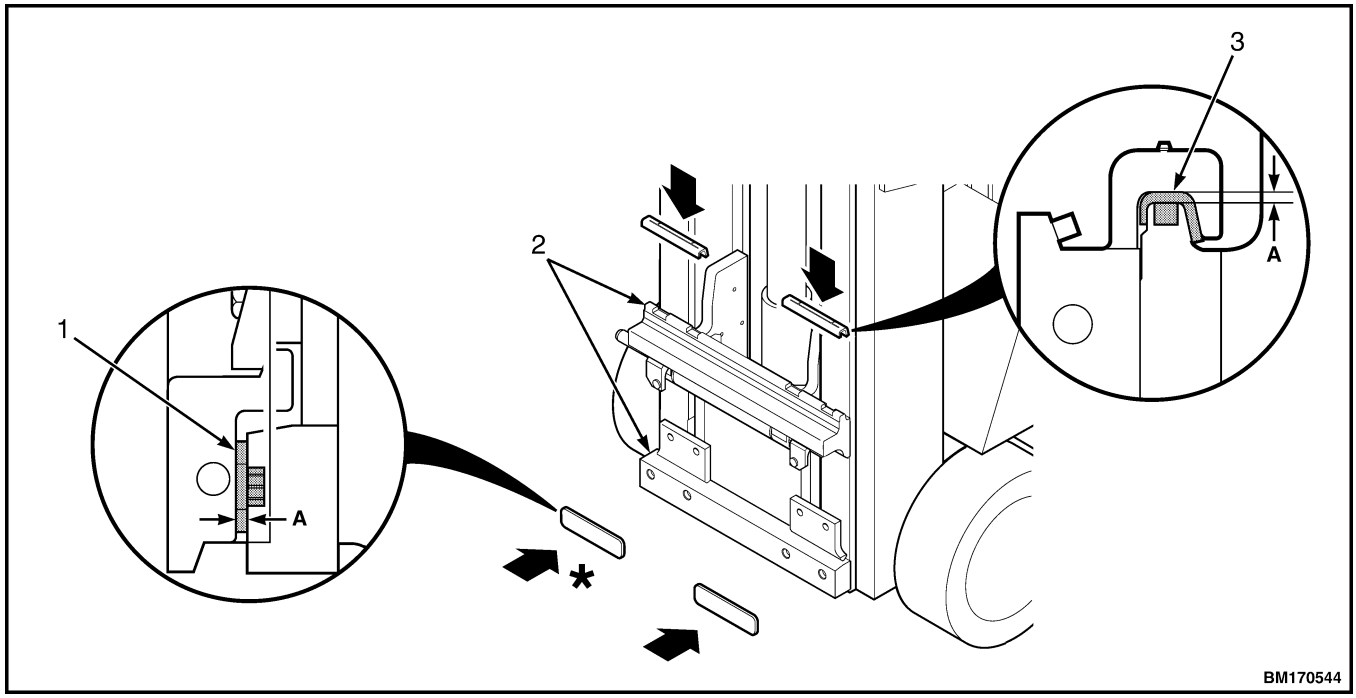
2. Use a crane with a capacity of at least 48 kg (106 lb) and install outer frame onto inner frame. See Figure 68.

3. Install the lower mounting hooks using four capscrews. Tighten to 150 to 180 N•m (108 to 132 lbf ft). For proper sideshift operation, make sure there is 0.76 to 1.52 mm (0.03 to 0.06 in.) clearance between the bottom of the hooks and the outer frame. See **B** in Figure 70.

4. Connect hydraulic lines, as noted during removal, to sideshift cylinder.

5. Install load backrest to sideshift carriage. Tighten capscrews to 195 N•m (144 lbf ft). See Figure 66.

6. Install forks. See section Fork Replacement, in this manual, for procedures.



A. MINIMUM THICKNESS 2.5 mm (0.1 in.).

1. LOWER BEARINGS
2. CARRIAGE BARS
3. UPPER BEARINGS

*Bold arrows indicate which side to apply grease.

Figure 71. Upper and Lower Bearings

INTEGRAL SIDESHIFT CARRIAGE, LIFT TRUCKS MANUFACTURED AFTER DECEMBER, 2016

This section applies to lift truck modelsE2.2-3.5XN (E45-70XN) (A268), S2.0-3.5FT (S40-70FT) (H187), and H40-70FT (P177) equipped with an integral sideshift carriage and manufactured after December, 2016.

Remove

1. Lower carriage completely. Remove forks. See Fork Replacement for removal procedures.

2. Remove four capscrews, washers, nuts, and load backrest from carriage. See Figure 66.

WARNING

Before disconnecting the hydraulic hoses, relieve the pressure in the hydraulic system. Serious injury can occur if pressure is not relieved from hydraulic system prior to disconnecting hydraulic hoses.

3. Relieve hydraulic pressure to the sideshift cylinder by moving sideshift lever in both directions several times.

WARNING

Always wear the proper protective equipment including eye protection and petroleum-resistant gloves when handling hydraulic oil. Thoroughly wash oil from exposed areas of skin as soon as possible. The hydraulic oil is hot at normal operating temperatures. Be careful when draining the oil.

WARNING

Never check for leaks by putting hands on hydraulic lines or components under pressure. Hydraulic oil under pressure can be injected into the skin.

NOTE: Tag hydraulic lines and fittings prior to disconnecting to aid in connecting during installation.

4. Disconnect hydraulic hoses from sideshift cylinder. Put caps and plugs on open lines and cylinder ports. See Figure 72.

5. Remove lower mounting hooks by removing four capscrews and washers securing the hooks. See Figure 73.

6. Remove integral sideshift cylinder from carriage. See **Cylinder Repair (Mast S/N F507, F508, F562, F563)** 2100SRM1668 for procedures.

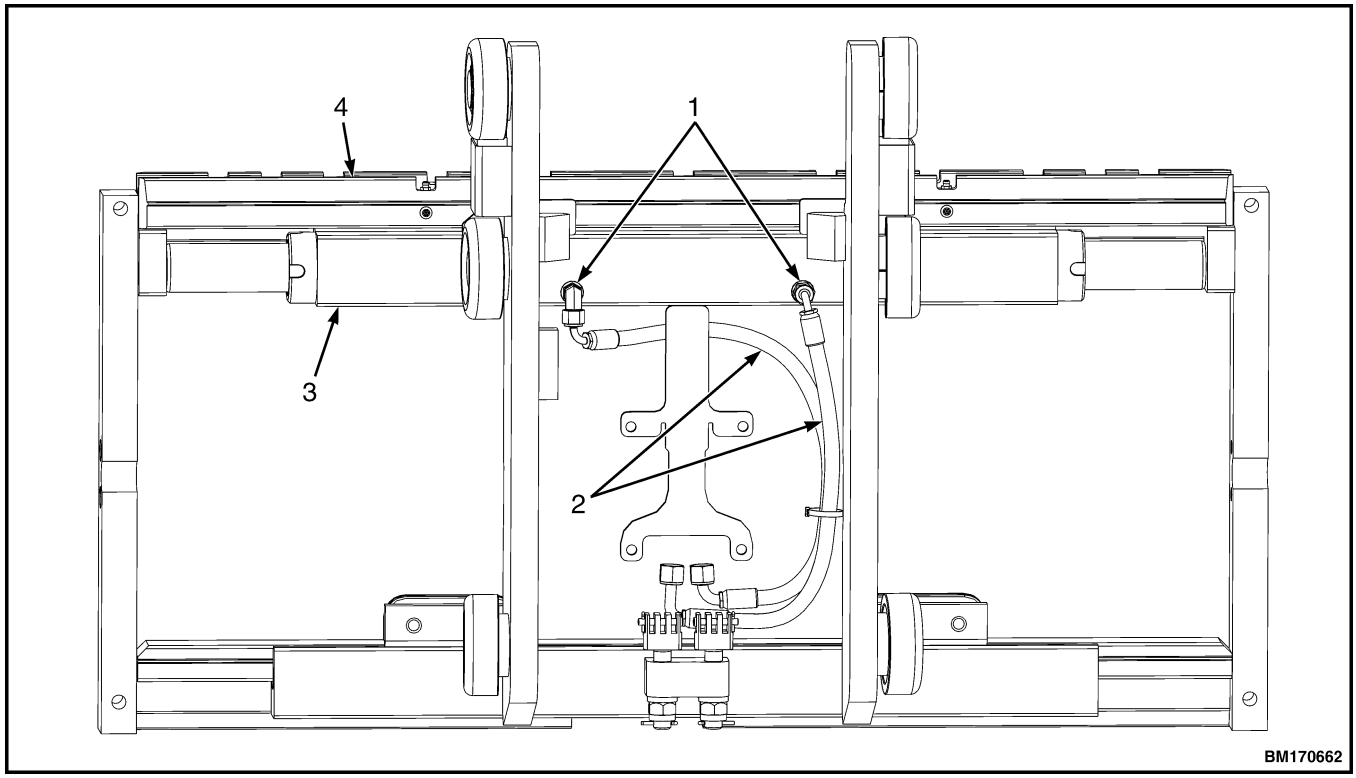
7. Use a crane with a capacity of at least 48 kg (106 lb) to lift outer frame away from inner frame. Lay outer frame flat on a pallet or work bench. See Figure 74.

Disassemble

1. Remove upper and lower bearings from inner frame. See Clean and Inspect section for procedures.

2. If damaged, remove lube fittings from outer frame. See Figure 73.

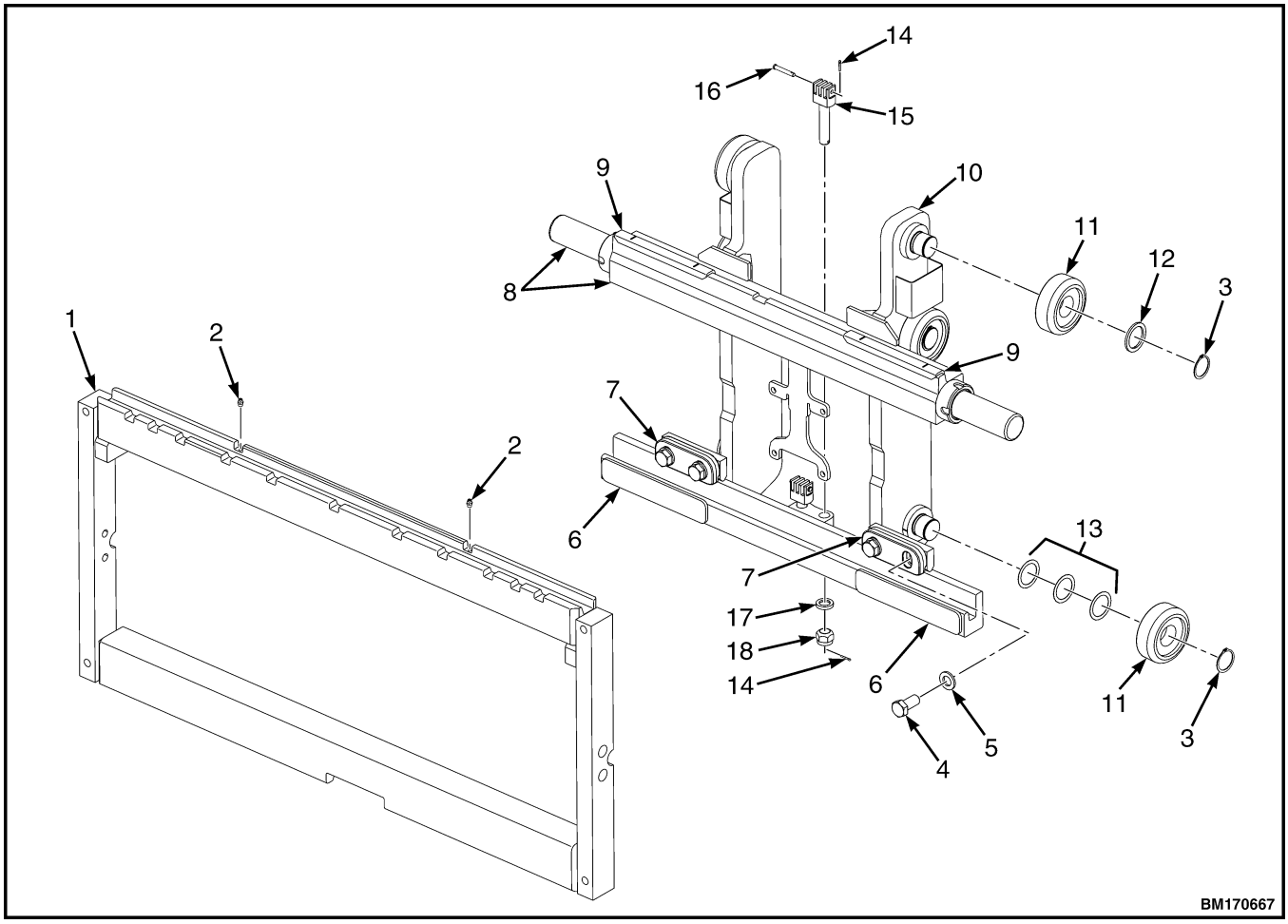
3. Dissemble the integral sideshift cylinder. See **Cylinder Repair (Mast S/N F507, F508, F562, F563)** 2100SRM1668 for procedures.



NOTE: PARTS OF CARRIAGE OMITTED FOR CLARITY.
NOTE: CLASS III INTEGRAL SIDESHIFT CARRIAGE SHOWN. CLASS II INTEGRAL SIDESHIFT CARRIAGE IS SIMILAR.

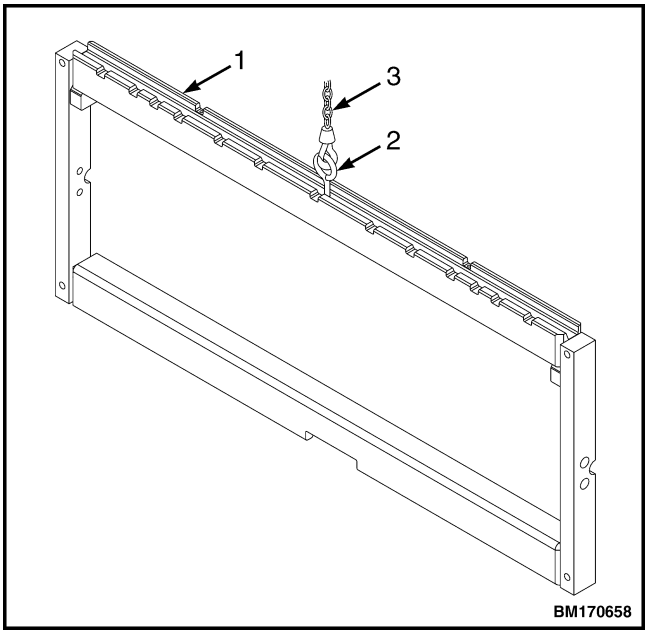
1. HOSE FITTINGS
2. HYDRAULIC HOSES
3. INTEGRAL SIDESHIFT CYLINDER
4. INTEGRAL SIDESHIFT CARRIAGE ASSEMBLY

Figure 72. Integral Sideshift Carriage Hydraulic Hoses



1. OUTER FRAME
2. LUBE FITTING
3. SNAP RING
4. CAPSCREW
5. WASHER
6. LOWER BEARING
7. LOWER MOUNTING HOOK
8. INTEGRAL SIDESHIFT CYLINDER
9. UPPER BEARINGS
10. INNER FRAME
11. LOAD ROLLERS
12. SPACER
13. SHIMS
14. COTTER PIN
15. CHAIN ANCHOR
16. CHAIN ANCHOR PIN
17. WASHER
18. NUT

Figure 73. Integral Sideshift Component Parts



NOTE: OUTER FRAME SHOWN MAY BE DIFFERENT FROM WHAT IS ON YOUR LIFT TRUCK. HOWEVER, REMOVING THE OUTER FRAME FROM THE INNER FRAME IS THE SAME.

1. OUTER FRAME
2. LIFTING HOOK
3. LIFTING DEVICE

Figure 74. Remove Outer Frame

Clean and Inspect

CAUTION

Improper welding procedures can damage the structure of the mast or cause incorrect function of the mast. Consult your Hyster lift truck dealer for more information before welding on the mast.

1. Clean and inspect carriage bars for damage and smoothness. Ensure carriage bars are parallel and ends are flush. If carriage bars have any protruding welds or damaged notches, repair by grinding, filing, or welding.

2. Clean bearing areas. Inspect sideshift bearings for wear as follows:

   a. If either upper bearing is worn to less than 2.5 mm (0.1 in.) thickness, replace both upper bearings by driving the upper bearings from the inner frame. See Figure 75. See Assemble section to install new upper bearings.

   b. If either lower bearing is worn to less than 2.5 mm (0.1 in.) thickness, replace lower bearings by prying the lower bearings from the inner frame. See Figure 75. See Assemble section to install new lower bearings.

3. Inspect sideshift cylinder. See **Cylinder Repair (Mast S/N F507, F508, F562, F563)** 2100SRM1668 for procedures.

4. Inspect load rollers for wear or damage (see Figure 73). If load rollers must be replaced, make a note of the location and number of shims. Install shims, load rollers and snap rings. See section Carriage Adjustments for correct adjustment.

5. Clean and inspect chain anchors and chain anchor pins. Check chain anchors and anchor pins for wear and serviceability. Discard worn or unserviceable chain anchors and chain anchor pins. Discard used cotter pins. See Figure 73.

Assemble

1. Assemble the integral sideshift cylinder. See **Cylinder Repair (Mast S/N F507, F508, F562, F563)** 2100SRM1668 for procedures.

2. If lube fittings were removed, install new lube fittings into outer frame. See Figure 73.

NOTE: Use a wood block or a plastic hammer to fully seat upper bearings onto inner frame. Proper lower hook clearance requires the upper bearings be fully seated.

3. Apply a 1 mm (0.040 in.) layer of multipurpose grease to upper and lower bearing surfaces. Install upper and lower bearings onto the inner frame.

   a. To install new upper bearing, align the pins on the bottom side of bearing to notches on top carriage bar and slide into place on top carriage. See Figure 75.

   b. To install new lower bearing, align the circular pins on backside of lower bearing to holes on lower carriage bar and tap bearing into place on lower carriage bar using a rubber or brass hammer. See Figure 75

Install

1. Install integral sideshift cylinder onto carriage. See **Cylinder Repair (Mast S/N F507, F508, F562, F563)** 2100SRM1668 for procedures.

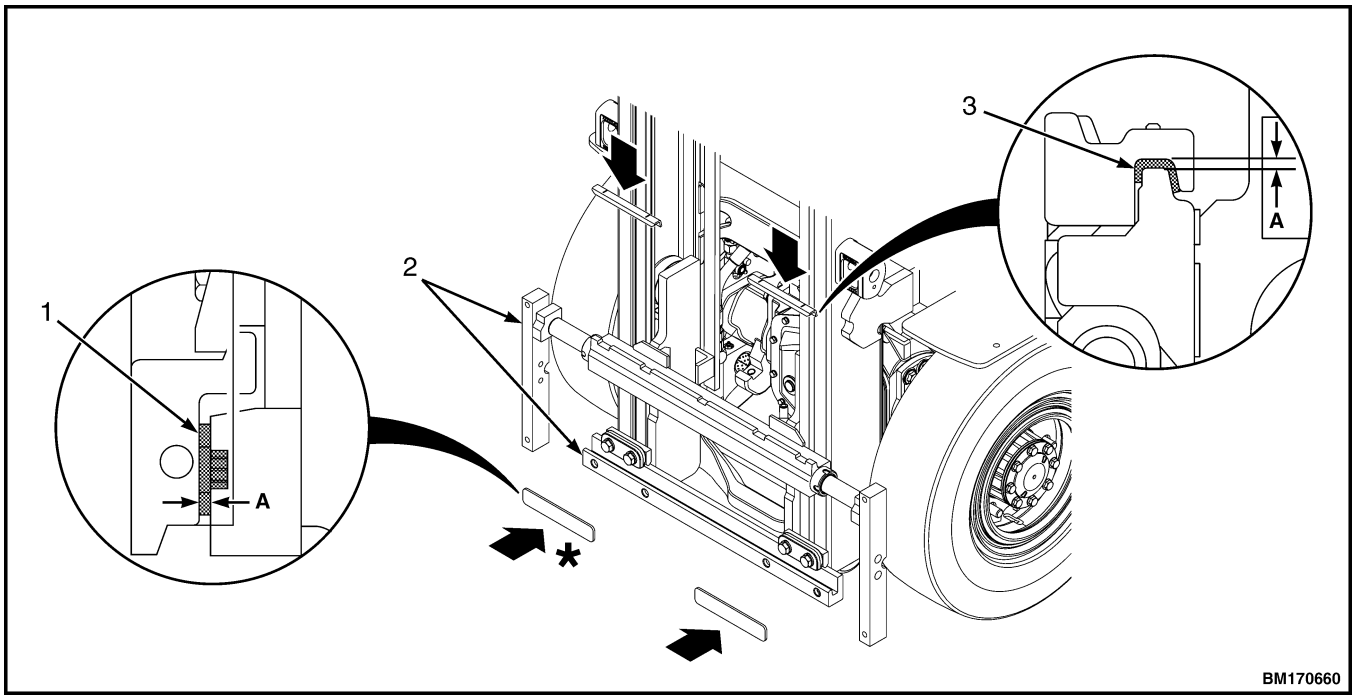
2. Use a crane with a capacity of at least 48 kg (106 lb) and install outer frame onto inner frame. See Figure 74.

3. Install lower mounting hooks using four capscrews. Tighten to 150 to 180 N•m (108 to 132 lbf ft).

4. Connect hydraulic hoses, as noted during removal, to sideshift cylinder. See Figure 72.

5. Install load backrest to sideshift carriage. Tighten capscrews to 195 N•m (144 lbf ft). See Figure 66.

6. Install forks. See Fork Replacement section for procedures.



A. MINIMUM THICKNESS 2.5 mm (0.1 in.)

1. LOWER BEARINGS
2. CARRIAGE BARS
3. UPPER BEARINGS

*Bold Arrows Indicate Which Side To Apply Grease.

Figure 75. Upper and Lower Bearings

FORK POSITIONER CARRIAGE, LIFT TRUCKS MANUFACTURED PRIOR TO DECEMBER, 2016

Remove

NOTE: The fork positioner can be removed from the integral sideshift carriage with the integral sideshift carriage on or off the mast. In the steps below, the fork positioner is removed with the integral sideshift carriage on the mast. If integral sideshift carriage must be removed from mast first, go to Integral Sideshift Carriage, Lift Trucks Manufactured Prior To December, 2016 in this section.

1. Remove forks. See Fork Replacement section for procedures.

2. Remove four capscrews, washers, nuts, and load backrest from carriage. See Figure 66.

WARNING

Before disconnecting the hydraulic hoses, relieve the pressure in the hydraulic system. Serious injury can occur if pressure is not relieved from hydraulic system prior to disconnecting hydraulic hoses.

WARNING

Always wear the proper protective equipment including eye protection and petroleum-resistant gloves when handling hydraulic oil. Thoroughly wash oil from exposed areas of skin as soon as possible.

WARNING

The hydraulic oil is hot at normal operating temperatures. Be careful when draining the oil.

Never check for leaks by putting hands on hydraulic lines or components under pressure. Hydraulic oil under pressure can be injected into the skin.

CAUTION

Protect the hydraulic system from dirt and contaminants when servicing the hydraulic system.

CAUTION

DO NOT bend tube assemblies during removal.

NOTE: Tag all hydraulic hoses, lines, and fittings prior to removal to aid in installation.

3. Disconnect and cap tube assemblies (8, Figure 76) from header hoses.

4. Remove capscrews and washers and remove lower hooks and bracket weldments from carriage. See Figure 77 and Figure 79.

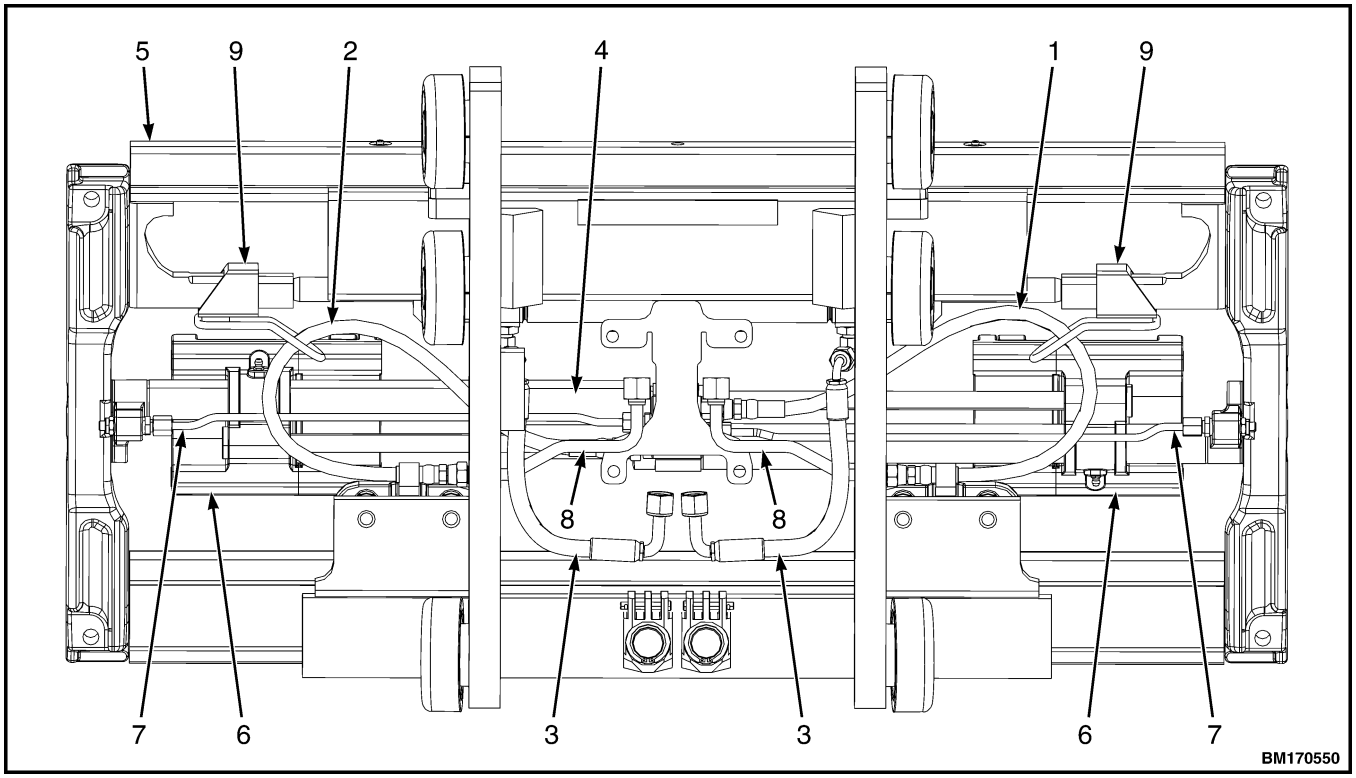
5. Install lifting eye in hole (see Figure 77) on integral sideshift carriage and use lifting device to lift outer frame up.

6. Disconnect relief tube assembly and hydraulic hoses (open and close) from fork positioner. See Figure 77.

NOTE: Make note of shims used to aid in reassembly.

7. Remove capscrews, lockwashers, and shims from integral sideshift carriage. See Figure 77.

8. Remove fork positioner from outer frame.



NOTE: BACK (DRIVER'S) VIEW SHOWN.

1. FORK POSITIONER HYDRAULIC HOSE (OPEN)
2. FORK POSITIONER HYDRAULIC HOSE (CLOSED)
3. INTEGRAL SIDESHIFT CARRIAGE HYDRAULIC HOSES
4. FORK POSITIONER
5. OUTER FRAME
6. FORK CARRIER
7. RELIEF TUBE ASSEMBLY
8. TUBE ASSEMBLY
9. HOSE GUIDE

Figure 76. Hydraulic Connections, Fork Positioner Cylinder

For procedures to repair the fork positioner cylinder, see **Cylinder Repair (Mast S/N F507, F508, F562, F563)** 2100SRM1668

Install

1. Place fork positioner cylinders onto outer frame. Install lockwasher and capscrew on one side and hand tighten capscrew. See Figure 77. Add shims as follows:

NOTE: The maximum number of shims per side is five. The maximum difference in the number of shims per side is two. The maximum gap allowed before tightening capscrews is 0.50 mm (.020 in.).

   a. Measure gap at opposite side and determine the number of shims required.

   b. Install shims on both sides of the fork positioner assembly.

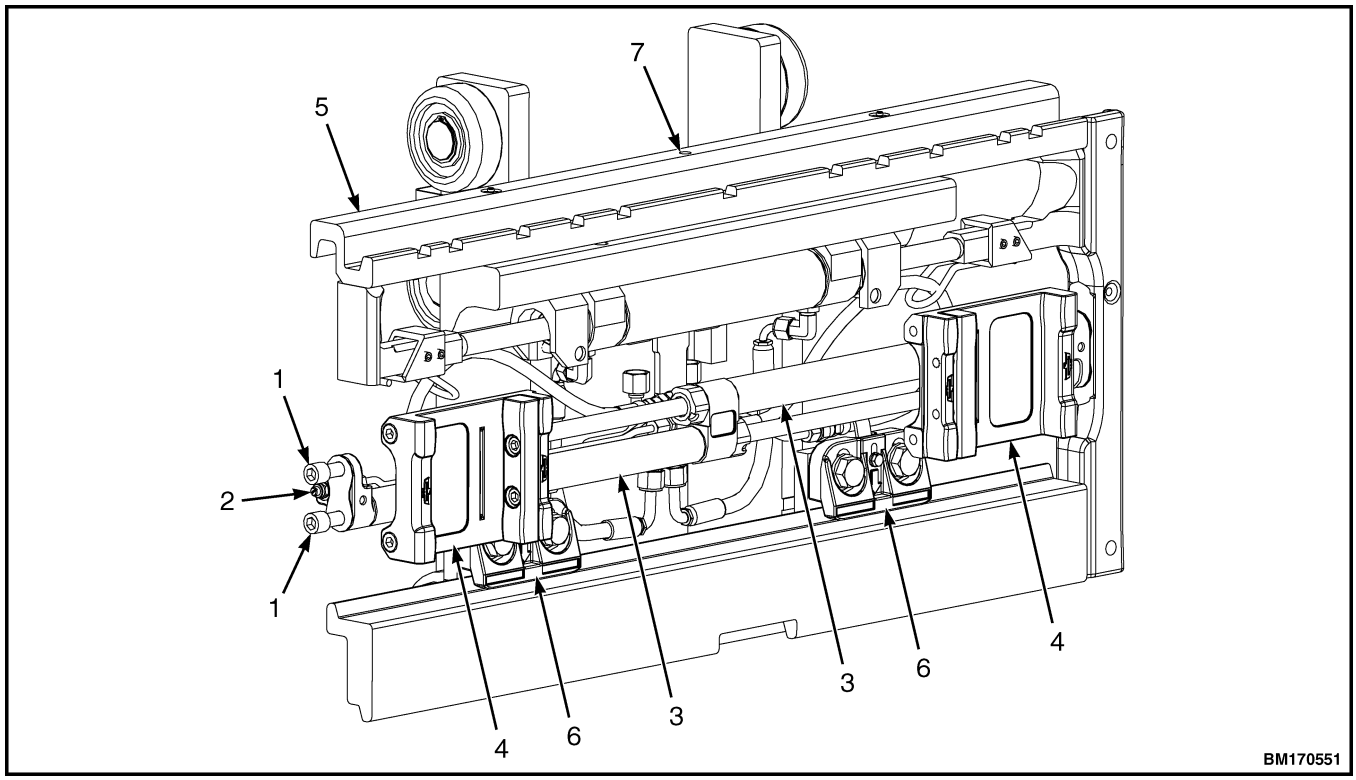
2. Install second lockwasher and capscrew. Tighten both capscrews to 65 N•m (50 lbf ft). See Figure 77.

3. Connect fork positioner hydraulic hoses to fork positioner manifold. Tighten hoses to 21 N•m (186 lbf in). See Figure 76.

4. Thread fork positioner hydraulic hoses through hose guides. See Figure 76.

5. Install outer frame, with fork positioner, to inner frame.

6. Using a lifting device, position outer frame at the same height of inner frame and 150 mm (6 in.) away.



NOTE: RIGHT OUTER FRAME BAR REMOVED FOR CLARITY.
NOTE: FRONT VIEW SHOWN.

1. CAPSCREW AND LOCKWASHER
2. SHIM
3. FORK POSITIONER CYLINDER
4. FORK CARRIER
5. INTEGRAL SIDESHIFT CARRIAGE ASSEMBLY
6. LOWER HOOK
7. TAPPED HOLE FOR LIFT EYE

Figure 77. Fork Positioner Cylinder Removal

7. From rear of outer frame, connect fork positioner hydraulic tubes to header hoses and hand tighten. See Figure 76.

8. Position fork positioner hydraulic tubes so they are in line with inner frame retainer plates. See Figure 78.

9. Using washer and capscrew, install bracket weldment to lower hook and hand tighten capscrew. Install lower hook on retainer plate with washer and capscrew and tighten capscrews to 165 N•m (122 lbf ft). See Figure 79.

10. Position bracket weldment over fork positioner hydraulic hoses (see Figure 76) and adjust so that bracket weldment makes contact with fork positioner hoses. Tighten capscrew to 8 N•m (71 lbf in). See Figure 79.

11. Tighten fork positioner hydraulic tubes to header hoses to 42 N•m (31 lbf ft).

WARNING

DO NOT try to install a fork without a lifting device. Each hook fork for these lift trucks can weigh 45 to 115 kg (99 to 254 lb).

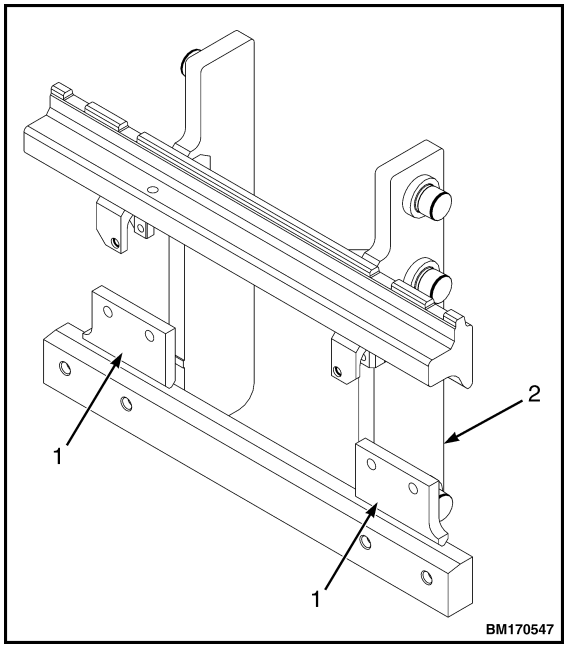
CAUTION

Remove fork latch pins (see Figure 3) if adding a fork positioner attachment. Damage to forks and other carriage components can occur if fork latch pins are not removed prior to using a fork positioner attachment.

NOTE: Before proceeding to Step 12 and Step 13, adjust the fork positioner hydraulic hoses. See Fork Positioner Hydraulic Hose Adjustment for procedures.

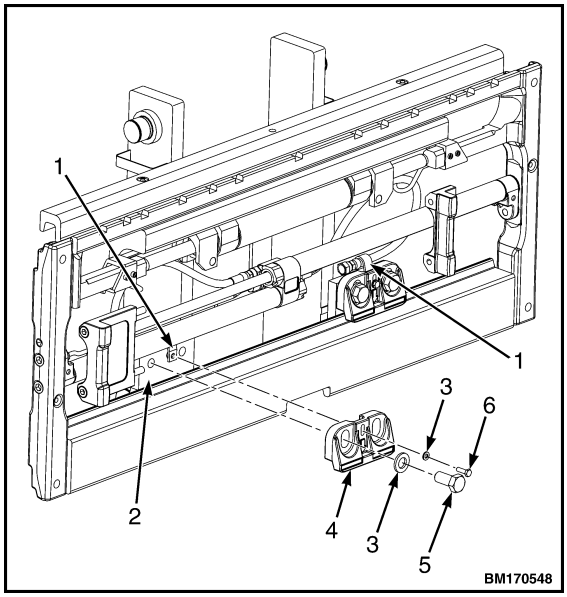
12. Install forks to outer fork carriers. Secure inner fork carriers to outer fork carriers using four capscrews. Tighten capscrews to 35 N•m (25 lbf ft). See Figure 8.

13. To adjust the fork positioner cylinders, see **Cylinder Repair (Mast S/N F507, F508, F562, F563)** 2100SRM1668 for procedures.



1. RETAINER PLATE
2. INNER FRAME

Figure 78. Inner Frame Retainer Plates



1. BRACKET WELDMENT
2. RETAINER PLATE
3. WASHER
4. LOWER HOOK
5. CAPSCREW (LOWER HOOK)
6. CAPSCREW (BRACKET WELDMENT)

Figure 79. Bracket Weldment and Lower Hook Assembly

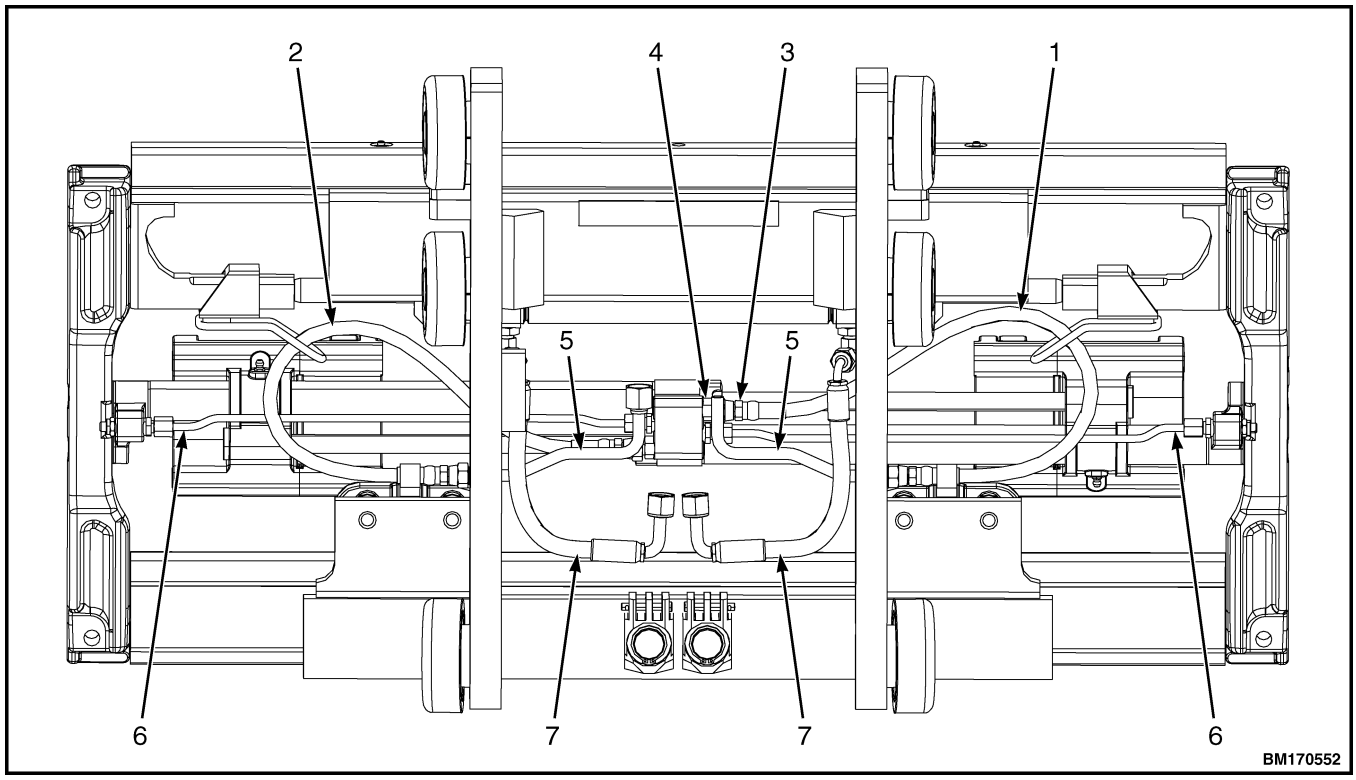
Fork Positioner Hydraulic Hose Adjustment

1. To adjust the fork positioner hydraulic hoses, hold the large hex nut and rotate the small hex nut towards the load face of the carriage (towards the forks). See Figure 80.

2. Fork positioner hoses are correctly adjusted when fork positioner hydraulic hoses stay entirely within the integral sideshift carriage and do not contact mast channels under all conditions.

3. Move fork positioner and check to ensure fork carriers clear fork positioner relief tubes through complete fork carrier cycle. See Figure 80.

4. Install load backrest to sideshift carriage. Tighten capscrews to 195 N•m (144 lbf ft). See Figure 66.



NOTE: BACK (DRIVER'S) VIEW SHOWN.

1. FORK POSITIONER HYDRAULIC HOSE (OPEN)
2. FORK POSITIONER HYDRAULIC HOSE (CLOSE)
3. MANIFOLD
4. SMALL HEX NUT
5. LARGE HEX NUT
6. TUBE ASSEMBLY
7. RELIEF TUBE ASSEMBLY
8. INTEGRAL SIDESHIFT HYDRAULIC HOSES

Figure 80. Fork Positioner Hydraulic Hose Adjustment

FORK POSITIONER CARRIAGE, LIFT TRUCKS MANUFACTURED AFTER DECEMBER, 2016

This section applies to lift truck modelsE2.2-3.5XN (E45-70XN) (A268), S2.0-3.5FT (S40-70FT) (H187), and H40-70FT (P177) equipped with a fork positioner on an integral sideshift carriage and manufactured after December, 2016.

Remove

NOTE: The fork positioner can be removed from the integral sideshift carriage with integral sideshift carriage on or off the mast. In the steps below, the fork positioner is removed with integral sideshift carriage on the mast. If integral sideshift carriage must be removed from mast first, go to Integral Sideshift Carriage, Lift Trucks Manufactured After December, 2016 in this section for procedures.

1. Remove forks. See Fork Replacement section for procedures.

2. Remove four capscrews, washers, nuts, and load backrest from carriage. See Figure 66.

WARNING

Before disconnecting the hydraulic hoses, relieve the pressure in the hydraulic system. Serious injury can occur if pressure is not relieved from hydraulic system prior to disconnecting hydraulic hoses.

WARNING

Always wear the proper protective equipment including eye protection and petroleum-resistant gloves when handling hydraulic oil. Thoroughly wash oil from exposed areas of skin as soon as possible.

WARNING

The hydraulic oil is hot at normal operating temperatures. Be careful when draining the oil.

Never check for leaks by putting hands on hydraulic lines or components under pressure. Hydraulic oil under pressure can be injected into the skin.

CAUTION

Protect the hydraulic system from dirt and contaminants when servicing the hydraulic system.

CAUTION

DO NOT bend tube assemblies during removal.

NOTE: Tag all hydraulic hoses, lines, and fittings prior to removal to aid in installation.

3. Disconnect and cap tube assemblies (8, Figure 81) from header hoses.

4. Remove capscrews and washers and remove lower hooks from retainer plates on inner frame. See Figure 82.

5. Install lifting eye in hole (7, Figure 82) on outer frame of integral sideshift carriage. Use a lifting device, with a capacity of 62 kg (136 lb), to lift outer frame with fork positioner attached. See Figure 74.

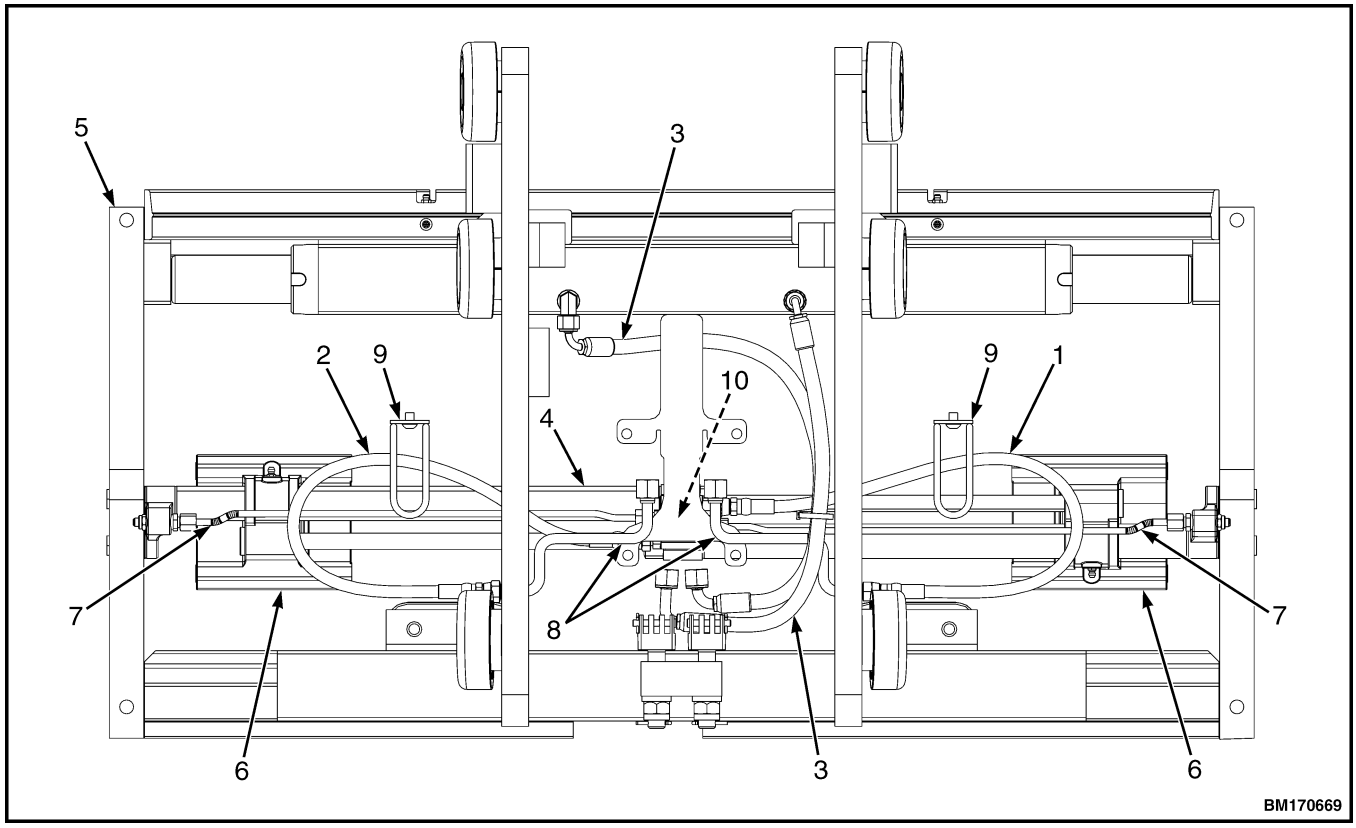
6. Disconnect relief tube assembly and hydraulic hoses (open and close) from fork positioner. See Figure 81.

NOTE: Make note of shims used to aid in reassembly.

7. Remove capscrews, lockwashers, and shims from integral sideshift carriage. See Figure 82.

8. Remove fork positioner from outer frame.

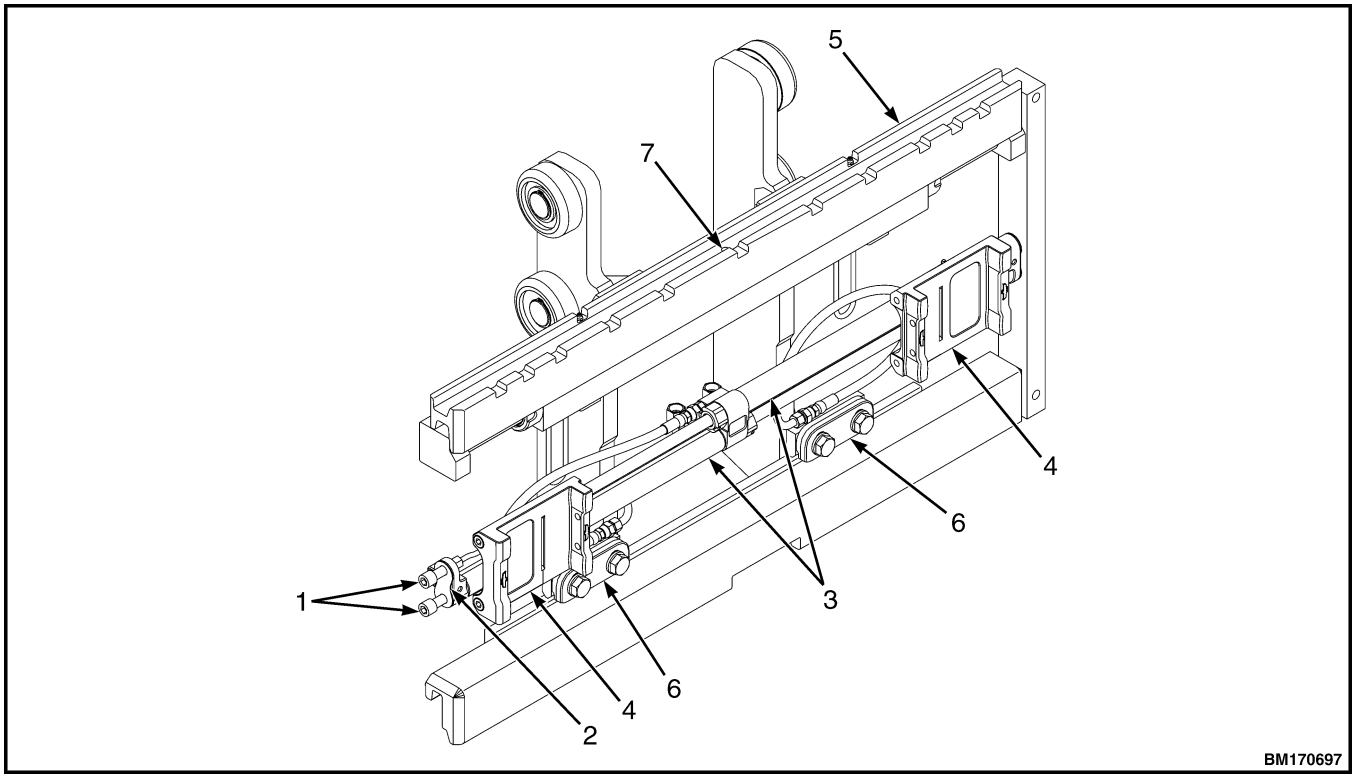
   For procedures to repair the fork positioner cylinder, see **Cylinder Repair (Mast S/N F507, F508, F562, F563)** 2100SRM1668.



NOTE: BACK (DRIVER'S) VIEW SHOWN.
NOTE: CLASS III INTEGRAL SIDESHIFT CARRIAGE WITH FORK POSITIONER SHOWN. CLASS II INTEGRAL SIDESHIFT CARRIAGE WITH FORK POSITIONER IS SIMILAR.

1. FORK POSITIONER HYDRAULIC HOSE (OPEN)
2. FORK POSITIONER HYDRAULIC HOSE (CLOSE)
3. INTEGRAL SIDESHIFT CARRIAGE HYDRAULIC HOSES
4. FORK POSITIONER CYLINDER
5. OUTER FRAME
6. FORK CARRIER
7. RELIEF TUBE ASSEMBLY
8. TUBE ASSEMBLY
9. HOSE GUIDE
10. MANIFOLD

Figure 81. Hydraulic Connections, Fork Positioner Cylinder



NOTE: FRONT VIEW SHOWN.

1. CAPSCREW AND LOCKWASHER
2. SHIMS
3. FORK POSITIONER CYLINDER
4. FORK CARRIER
5. INTEGRAL SIDESHIFT CARRIAGE ASSEMBLY
6. LOWER HOOK
7. TAPPED HOLE FOR LIFT EYE

Figure 82. Fork Positioner Cylinder Removal

Disassemble and Assemble

See **Cylinder Repair (Mast S/N F507, F508, F562, F563)** 2100SRM1668 for procedures to disassemble and assemble fork positioner cylinder.

Clean and Inspect

See **Cylinder Repair (Mast S/N F507, F508, F562, F563)** 2100SRM1668 for cleaning and inspection procedures of fork positioner cylinder.

Install

1. Place fork positioner cylinders onto outer frame. Install lockwasher and capscrew on one side and hand tighten capscrew. See Figure 82. Add shims as follows:

NOTE: The maximum number of shims per side is five. The maximum difference in number of shims per side is two. The maximum gap allowed before tightening capscrews is 0.50 mm (.020 in.).

   a. Measure gap at opposite side and determine the number of shims required.

   b. Install shims on both sides of the fork positioner assembly.

2. Install second lockwasher and capscrew. Tighten both capscrews to 65 N•m (50 lbf ft). See Figure 82.

3. Connect fork positioner hydraulic hoses to fork positioner manifold. Tighten hoses to 21 N•m (186 lbf in). See Figure 81.

4. Thread fork positioner hydraulic hoses through hose guides. See Figure 81.

5. Install lifting eye and use a lifting device, with a capacity of 92 kg (202 lb), to install outer frame, with fork positioner attached, onto inner frame.

6. Using a lifting device, position outer frame at the same height of inner frame and 150 mm (6 in.) away.

7. From rear of outer frame, connect fork positioner hydraulic tubes to header hoses and hand tighten. See Figure 81.

8. Position fork positioner hydraulic tubes so they are in line with retainer plates on inner frame. See Figure 83.

9. Using a washer and capscrew, install lower hook to retainer plates and tighten capscrews to 165 N•m (122 lbf ft). See Figure 82.

10. Tighten fork positioner hydraulic tubes to header hoses to 42 N•m (31 lbf ft).

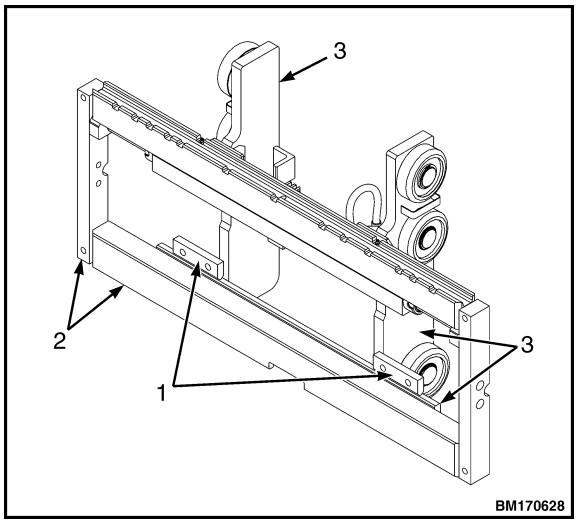
CAUTION

Remove fork latch pins (see Fork Replacement) if adding a fork positioner attachment. Damage to forks and other carriage components can occur if fork latch pins are not removed prior to using a fork positioner attachment.

NOTE: Before proceeding to Step 11 and Step 12, adjust the fork positioner hydraulic hoses. See Fork Positioner Hydraulic Hose Adjustment for procedures.

11. Install forks to outer fork carriers. See Fork Replacement section for procedures.

12. To adjust the fork positioner cylinders, see **Cylinder Repair (Mast S/N F507, F508, F562, F563)** 2100SRM1668 for procedures.



1. RETAINER PLATES
2. OUTER FRAME (FORK BAR)
3. INNER FRAME

Figure 83. Retainer Plates and Inner and Outer Frame

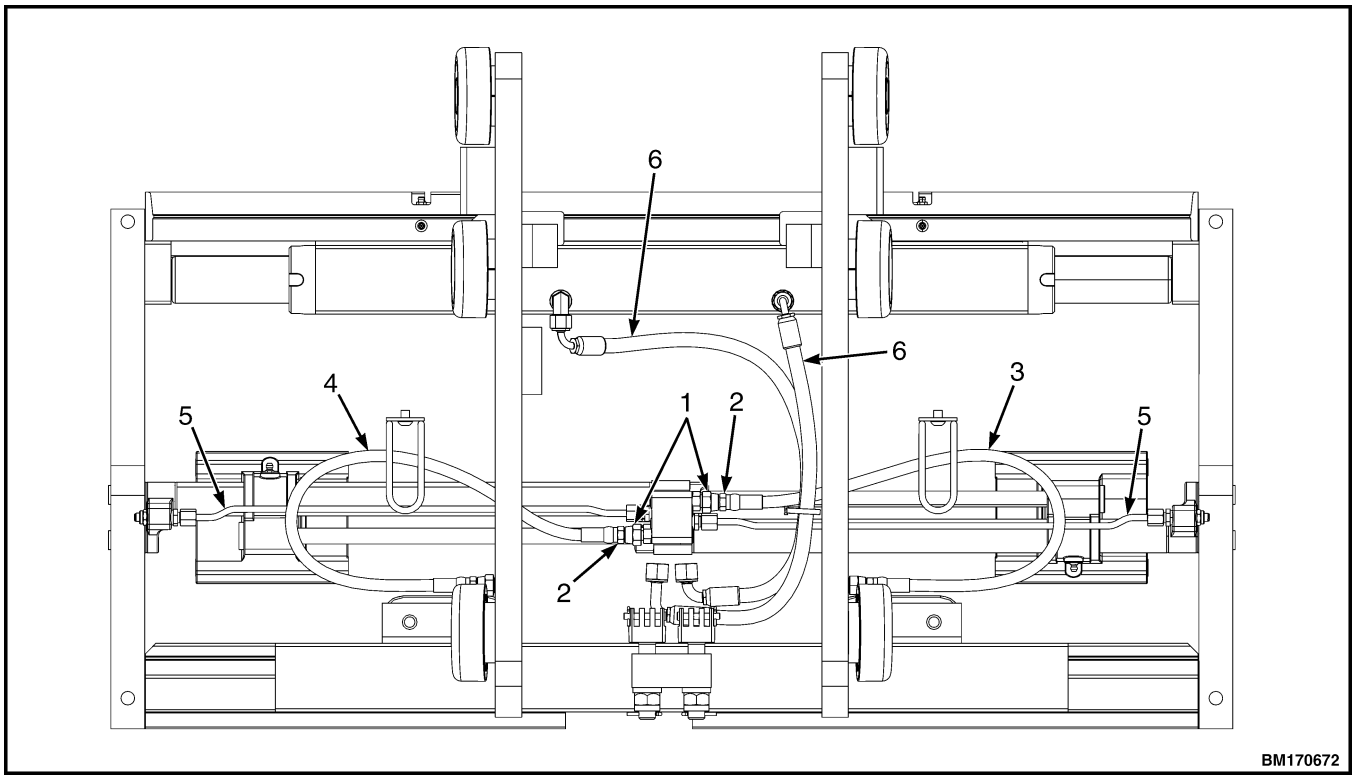
Fork Positioner Hydraulic Hose Adjustment

1. To adjust the fork positioner hydraulic hoses, hold the large hex nut and rotate the small hex nut towards the load face of the carriage (towards the forks). See Figure 84.

2. Fork positioner hoses are correctly adjusted when fork positioner hydraulic hoses stay entirely within the integral sideshift carriage and do not contact mast channels under all conditions.

3. Move fork positioner and check to ensure fork carriers clear fork positioner relief tubes through complete fork carrier cycle. See Figure 84.

4. Install load backrest to sideshift carriage. Tighten capscrews to 195 N•m (144 lbf ft). See Figure 66.



1. LARGE HEX NUT
2. SMALL HEX NUT
3. FORK POSITIONER HYDRAULIC HOSE (OPEN)
4. FORK POSITIONER HYDRAULIC HOSE (CLOSE)
5. RELIEF TUBE ASSEMBLY
6. INTEGRAL SIDESHIFT HYDRAULIC HOSES

Figure 84. Fork Positioner Hydraulic Hoses Adjustment

Three-Stage FFL Mast Repair

MAST WITH SERIAL NUMBER F508

Remove

WARNING

The mast is heavy. The mast can weigh approximately 907 kg (2000 lb). Make sure all lifting devices (hoists, cables, chains, slings, etc.) are suitable and of adequate capacity to lift the mast.

WARNING

Mast weldments can slide when the mast is moved. A weldment that slides can cause serious injury.

CAUTION

Make sure all the mast weldments are fastened together. Make sure the safety chains will not damage the sheaves, tubing, or other parts of the mast.

NOTE: If mast needs to be disassembled, remove the forks and carriage. see the sections Fork Replacement and Carriages Repair, Three-Stage FFL Mast in this service manual for procedures. If only the main lift cylinders need to be removed for repair, the mast does not need to be removed from the lift truck. See the section **Cylinder Repair (Mast S/N F507, F508, F562, F563)** 2100SRM1668 for procedures to remove the main lift cylinders.

NOTE: The length of the lift chains must be checked before the mast is removed. See Lift Chains Adjustment section in this manual for procedures.

1. Fully lower all of mast weldments. Tilt mast fully forward. Connect a crane with a capacity of at least 907 kg (2000 lb) to the top of the mast using chains to support the mast in an upright position when the tilt cylinders are disconnected. See the section Safety Procedures When Working Near Mast in this manual.

WARNING

Always wear the proper protective equipment including eye protection and petroleum-resistant gloves when handling hydraulic oil. Thoroughly wash oil from exposed areas of skin as soon as possible.

Completely lower forks to relieve hydraulic pressure before disassembling any part of the lift pump or disconnecting any hoses.

The hydraulic oil is hot at normal operating temperatures. Be careful when draining the oil.

CAUTION

Protect the hydraulic system from dirt and contaminants when servicing the hydraulic system.

2. Position a drip pan under area of hydraulic fittings. Disconnect hydraulic line at the external lowering control valve on the outer mast. See Figure 90.

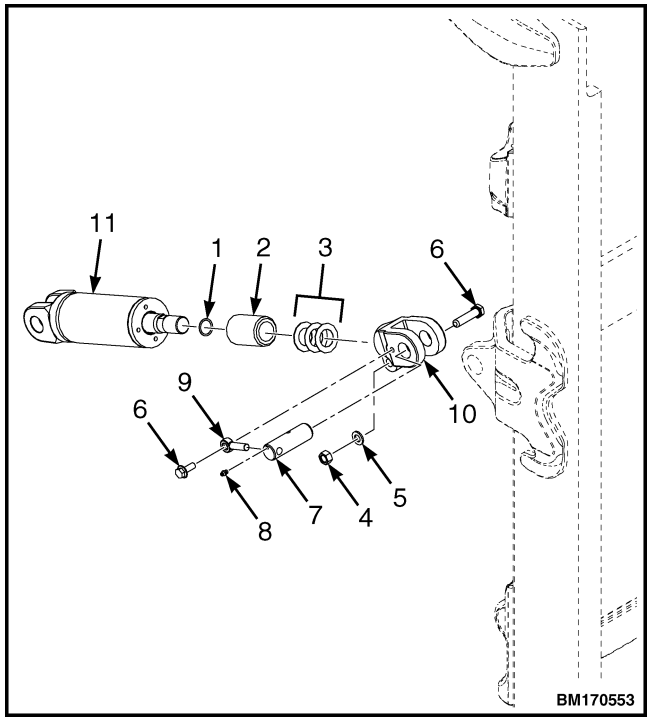
WARNING

Use a driver, NOT your fingers, to push the anchor pins from the clevises on the tilt cylinders. The cylinder or mast can move and cause serious injury.

3. On lift trucks NOT equipped with optional boot on tilt cylinders, remove the capscrews, washers, anchor pins, and pivot pins at the tilt cylinder mounts on the outer mast. See Figure 85.

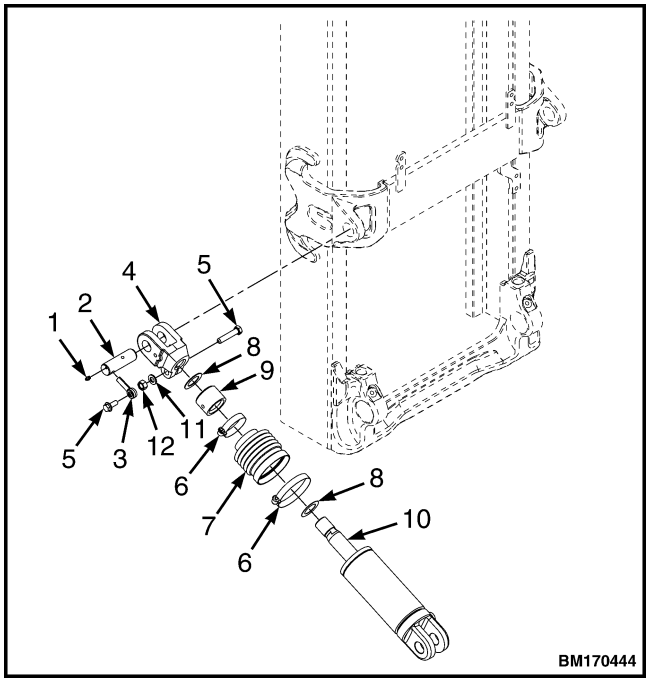
4. On lift truck models J2.2-3.5XN (J45-70XN) (A276) equipped with tilt cylinders with optional boots, remove capscrews, washers, nuts, anchor pins, and pivot pins at tilt cylinder mounts on outer mast. See Figure 86.

5. Using a brass drift pin, remove tilt rod bushings from outer mast. Discard tilt rod bushings. See Figure 87.



1. O-RING
2. SPACER
3. SHIMS
4. NUT
5. WASHER
6. CAPSCREW
7. PIVOT PIN
8. GREASE FITTING
9. ANCHOR PIN
10. CAPSCREW
11. ROD END

Figure 85. Mast Mounting, Tilt Cylinder Without Optional Boot



1. GREASE FITTING
2. PIVOT PIN
3. ANCHOR PIN
4. ROD END
5. CAPSCREW
6. CLAMP
7. BOOT
8. SHIM
9. SPACER
10. TILT CYLINDER
11. WASHER
12. NUT

Figure 86. Mast Mounting, Tilt Cylinder With Optional Boot, Lift Truck Models J2.2-3.5XN (J45-70XN) (A276)

NOTE: Allow the mast to tilt forward enough to gain access to the mast mount capscrews.

6. Disconnect lower mast mounts from the lift truck by removing the capscrews that hold the mast pivot pins to the mounts on the drive axle. See Figure 88 and Figure 89.

WARNING

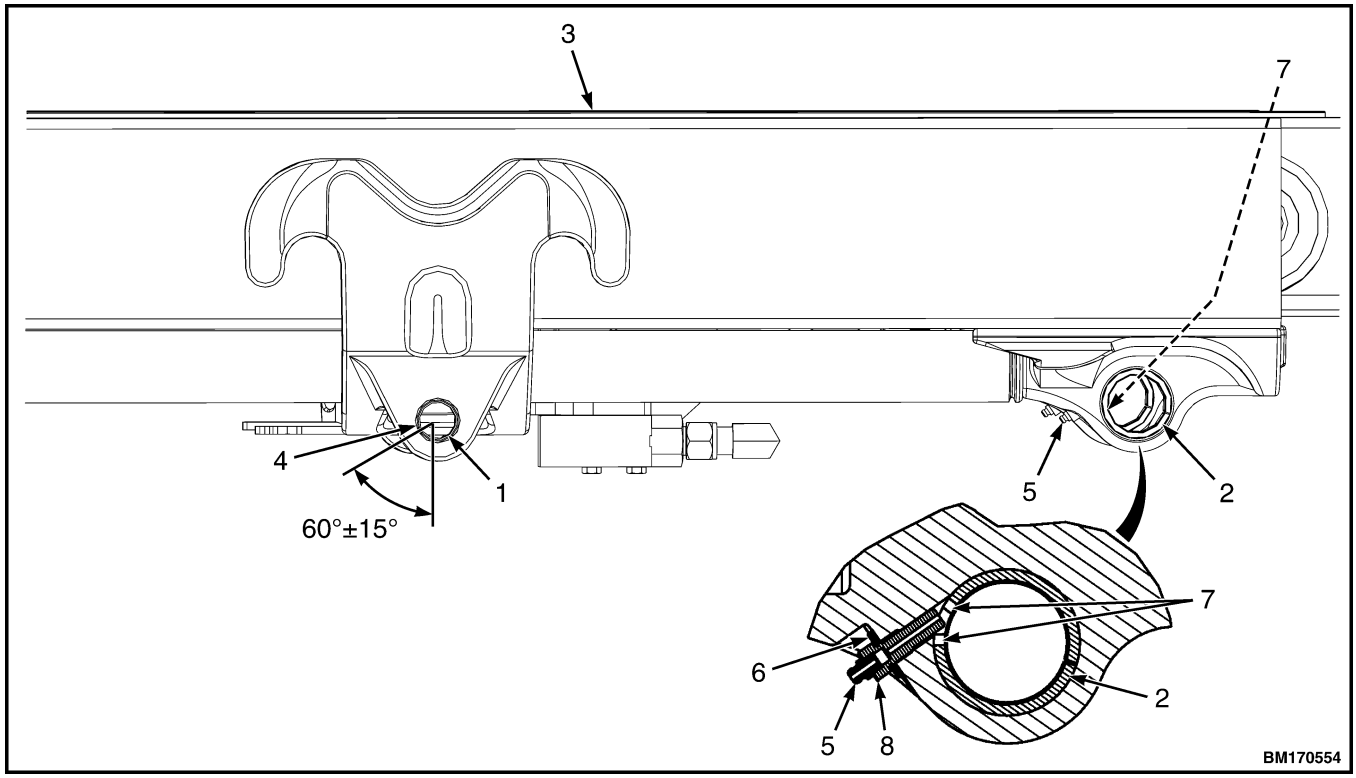
The mast is heavy. The mast can weigh approximately 907 kg (2000 lb). Make sure all lifting devices (hoists, cables, chains, slings, etc.) are suitable and of adequate capacity to lift the mast.

7. Use the crane to lift the mast assembly from the lift truck. Position the mast across wooden beams on the floor with the carriage side up.

NOTE: If mast mounting bushing needs to be replaced in Step 8, go to Step 9 for procedures.

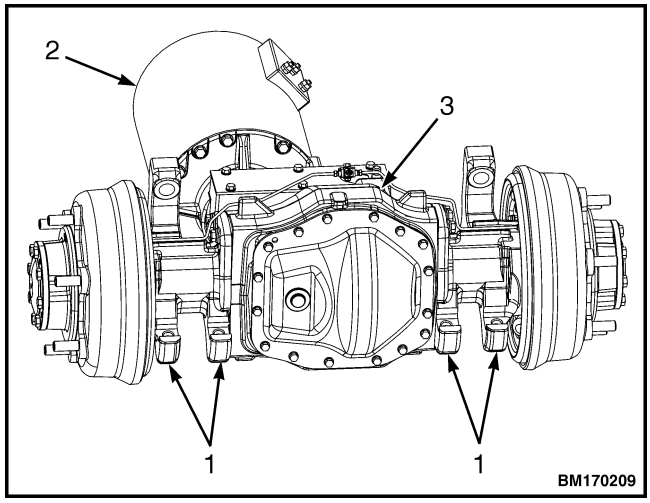
8. Check the mast and mounting flanges for wear or damage by removing the mast pivot pins from the outer mast. Check that the pins fit snug in the outer mast. If pins can be moved up and down a minimum of 4 mm (0.20 in.), replace bushings in outer mast and/or mast pivot pins as required. See Figure 89.

9. Remove lube fitting, lube capscrew, and washer from the mast mounts. See Figure 92. Use a brass drift pin to remove mast mounting bushings from outer mast. Discard mast mounting bushings. See Figure 87.



1. TILT ROD BUSHING
2. MAST MOUNTING BUSHING (BRONZE)
3. OUTER MAST
4. BUSHING SPLIT
5. LUBE FITTING
6. WASHER
7. BUSHING HOLE
8. LUBE CAPSCREW

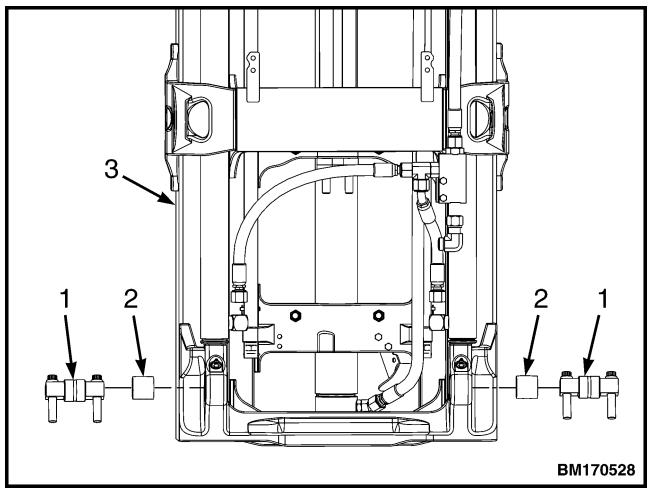
Figure 87. Tilt Rod and Mast Mounting Bushings



NOTE: DRIVE AXLE AND MAST MOUNTS FOR LIFT TRUCK MODELS E2.2-3.5XN (E45-70XN) (A268) SHOWN. DRIVE AXLE AND MAST MOUNTS FOR THE OTHER LIFT TRUCKS COVERED IN THIS MANUAL ARE SIMILAR.

1. HANGER MOUNTS
2. TRACTION MOTOR
3. DRIVE AXLE

Figure 88. Mast Mounts, Drive Axle



1. MAST PIVOT PINS
2. MAST MOUNTING BUSHING (BRONZE)
3. OUTER MAST

Figure 89. Mast Pivot Pins

Disassemble

WARNING

Always wear the proper protective equipment including eye protection and petroleum-resistant gloves when handling hydraulic oil. Thoroughly wash oil from exposed areas of skin as soon as possible.

WARNING

Hydraulic oil is hot after system operation and can cause burns. DO NOT disconnect any hydraulic hoses until the oil in the system has cooled.

Completely lower forks to relieve hydraulic pressure before disconnecting any hydraulic hoses.

CAUTION

Protect the hydraulic system from dirt and contaminants when disconnecting hydraulic hoses from the mast. If hydraulic system becomes contaminated, damage to the hydraulic system can occur.

1. Disconnect free-lift chain at the crosshead. See Figure 91.

2. Disconnect and remove the hydraulic line from free-lift cylinder. Remove the brackets clamping the free-lift cylinder. Remove the free-lift cylinder. See Figure 91.

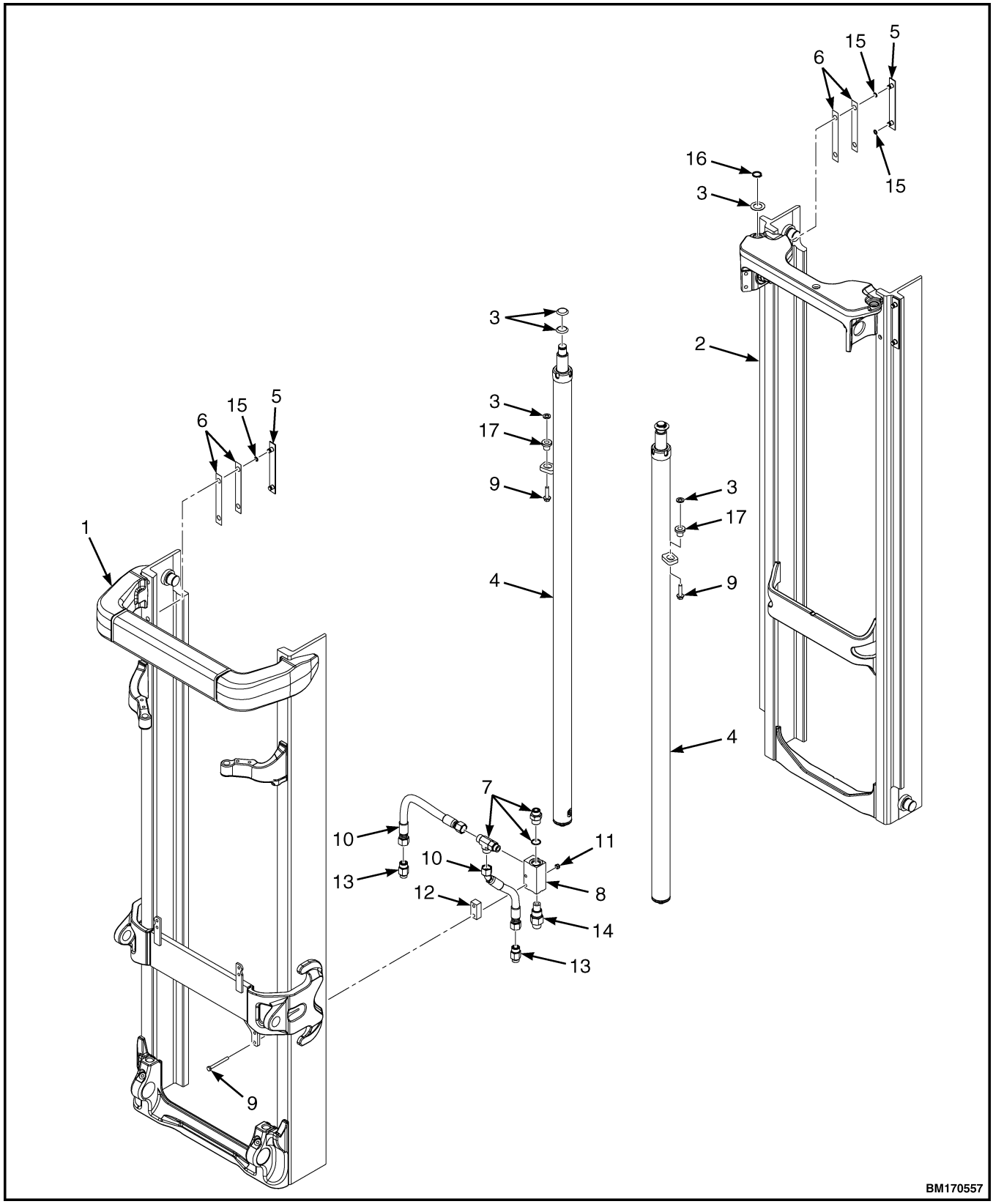


Figure 90. Main Lift Cylinder Attaching Parts

Legend for Figure 90.

1. OUTER MAST
2. INTERMEDIATE MAST
3. WASHER
4. MAIN LIFT CYLINDER
5. STRIP BEARING
6. SHIM
7. FITTING
8. LOWERING CONTROL HOUSING
9. CAPSCREW
10. HOSE ASSEMBLY
11. NUT
12. SPACER
13. HYDRAULIC VELOCITY FUSE
14. LOWERING CONTROL VALVE
15. O-RING
16. SNAP RING
17. ISOLATOR

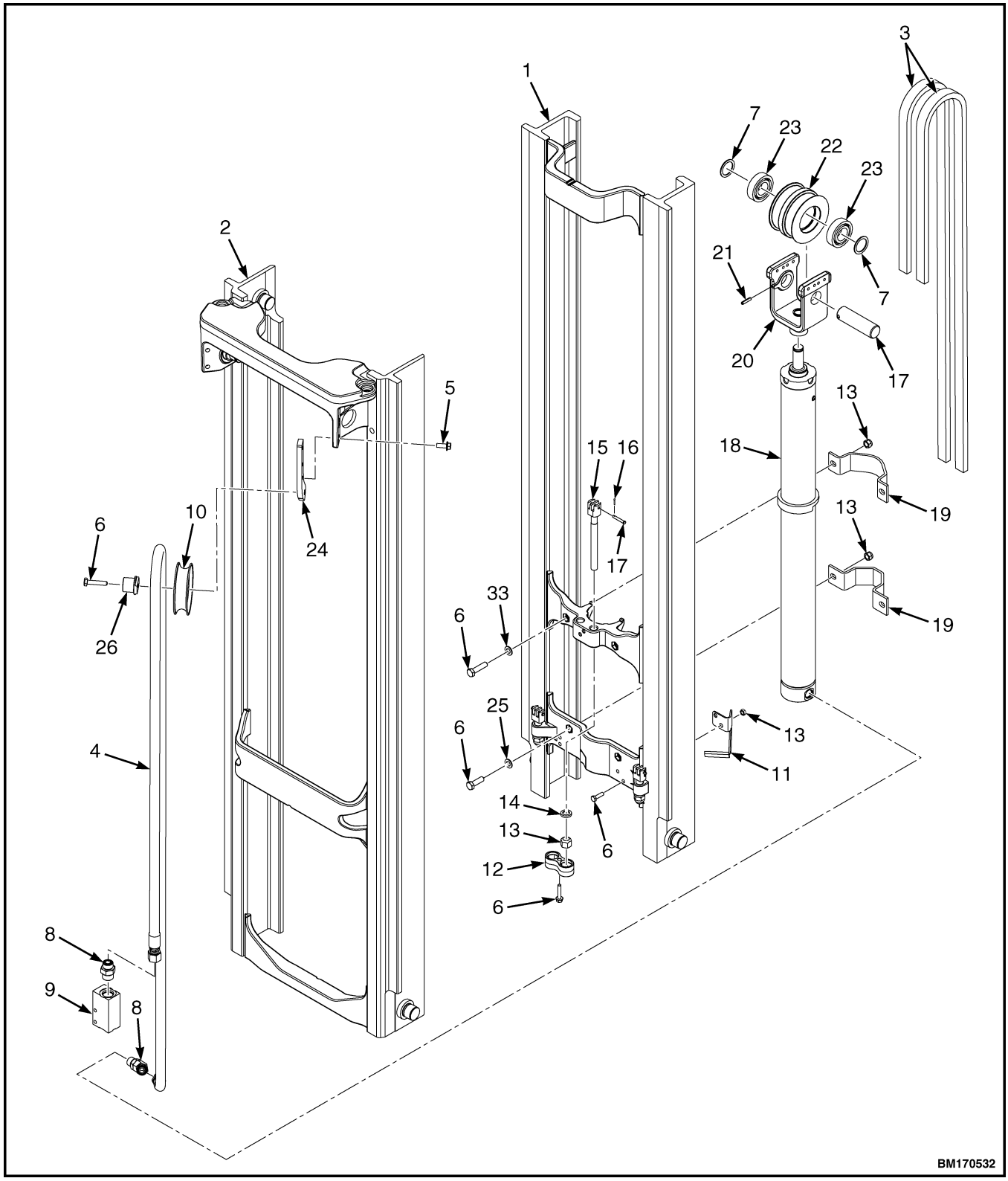


Figure 91. Free-Lift Cylinder Assembly and Component Parts

Legend for Figure 91.

1. INNER MAST
2. INTERMEDIATE MAST
3. CHAIN
4. HOSE ASSEMBLY
5. CAPSCREW
6. CAPSCREW
7. STUBSHAFT
8. FITTING
9. LOWERING CONTROL VALVE HOUSING
10. HOSE SHEAVE
11. BRACKET WELDMENT
12. CHAIN ANCHOR RESTRAINT
13. NUT
14. RING
15. CHAIN ANCHOR
16. COTTER PIN
17. PIN
18. FREE-LIFT CYLINDER
19. CLAMP
20. FREE-LIFT CROSSHEAD
21. ROLL PIN
22. CHAIN SHEAVE
23. BEARING
24. PLATE
25. WASHER

3. Disconnect main lift chains from the chain anchors near the top of the main lift cylinders. See Figure 92. Disconnect the other end of the main lift chains at the bottom of the inner mast. Push the inner mast toward the bottom of the mast assembly until the bottom load rollers can be seen. See Figure 93.

WARNING

The weldments can slide when the mast is moved. A weldment that slides can cause injury. Use a crane to turn the mast slowly and carefully.

4. Remove strip bearings at the top of the intermediate mast. Remove load rollers at the bottom of the inner mast. Remove load rollers at the top of the intermediate mast. Make a note of each shim arrangement and load roller location. The shim arrangements will be the same during assembly. See Figure 93 and Figure 94.

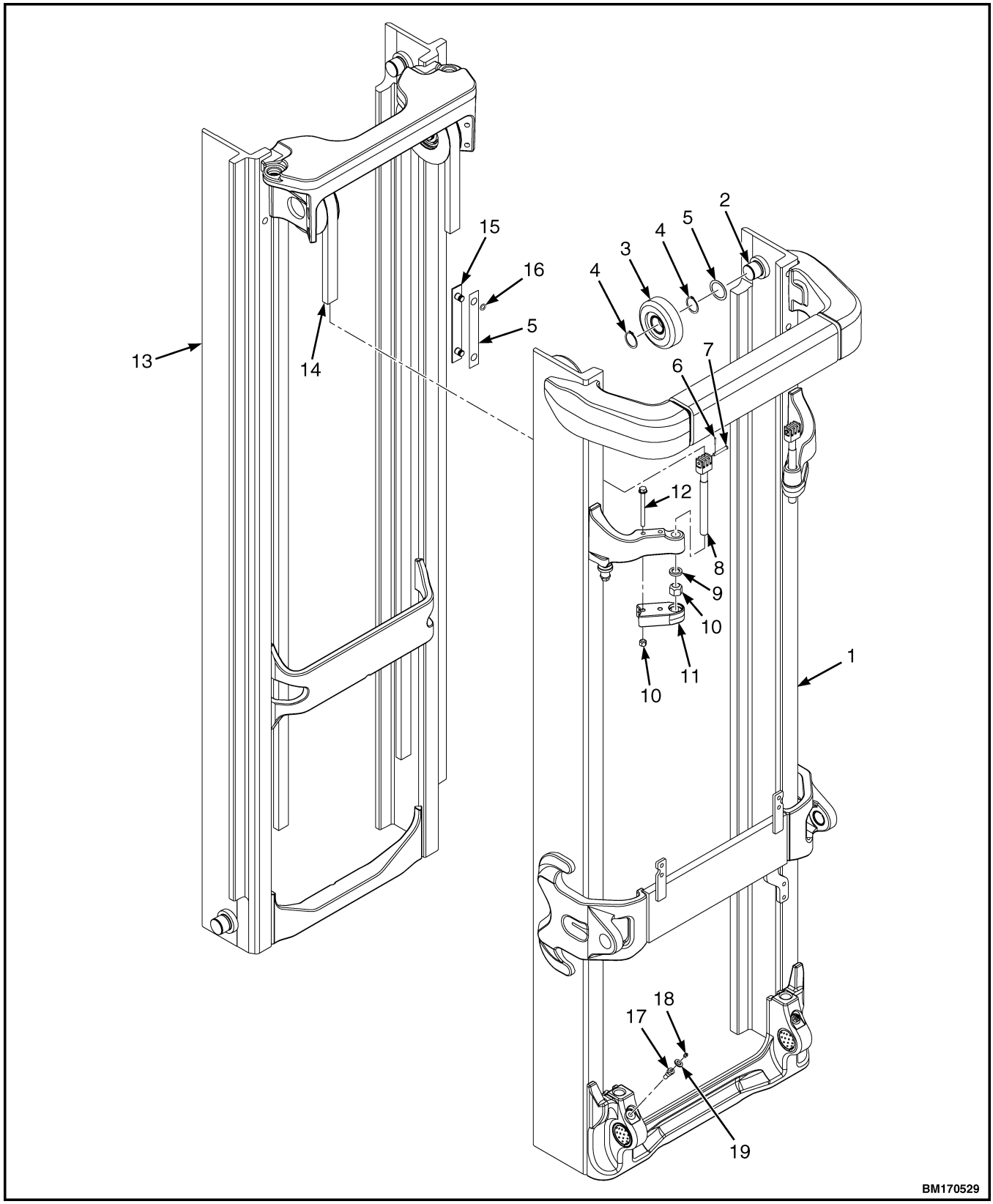


Figure 92. Outer Mast Assembly

Legend for Figure 92.

1. OUTER MAST
2. STUBSHAFT
3. LOAD ROLLER
4. SNAP RING
5. SHIM
6. COTTER PIN
7. PIN
8. CHAIN ANCHOR
9. RING
10. NUT
11. CHAIN ANCHOR RESTRAINT
12. CAPSCREW
13. INTERMEDIATE MAST
14. LIFT CHAIN
15. WEAR STRIP
16. O-RING
17. LUBE CAPSCREW
18. LUBE FITTING
19. WASHER

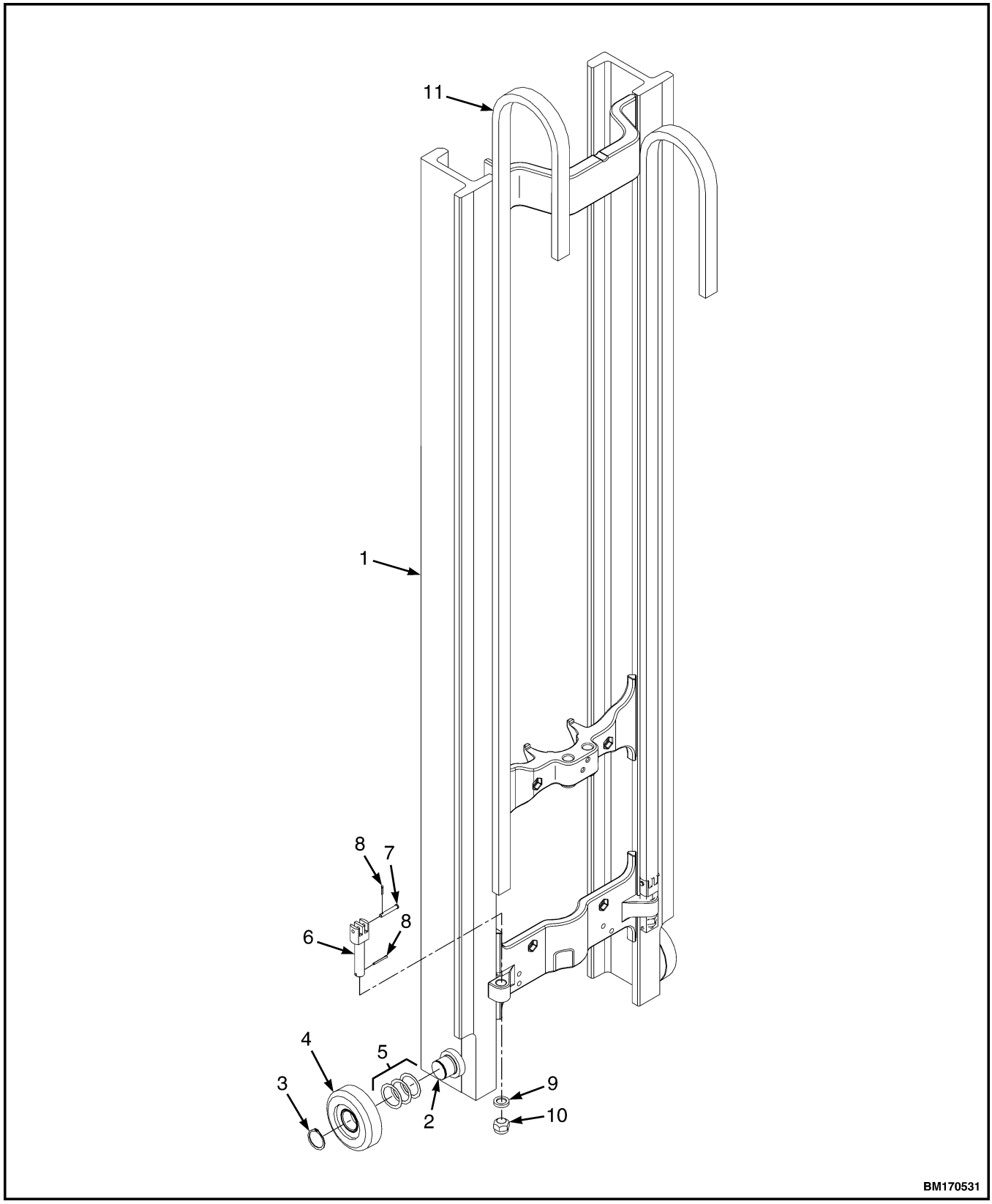
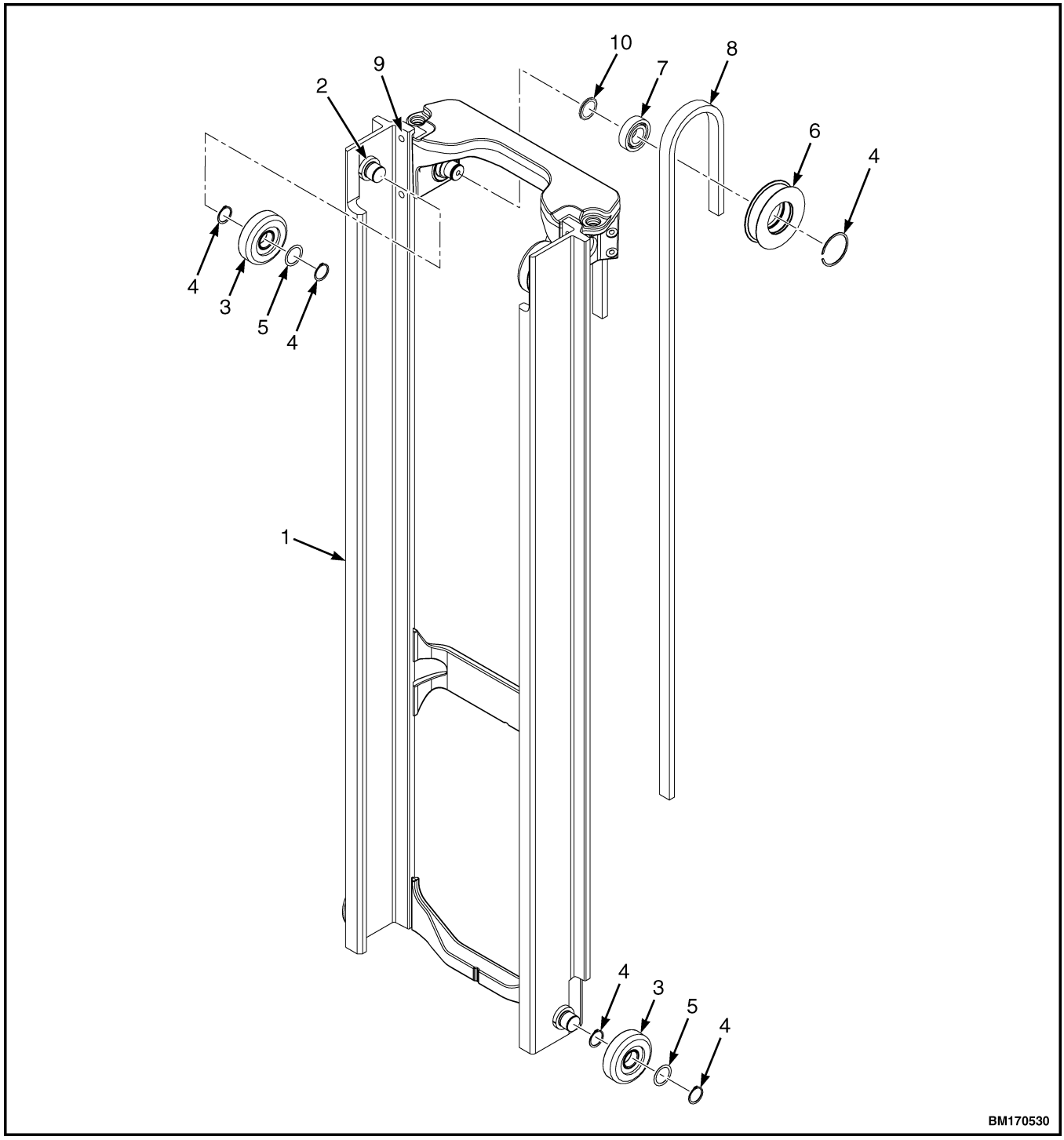


Figure 93. Inner Mast Assembly

Legend for Figure 93.

1. INNER MAST
2. STUBSHAFT
3. SNAP RING
4. LOAD ROLLER
5. SHIM
6. CHAIN ANCHOR
7. PIN
8. COTTER PIN
9. RING
10. NUT
11. LIFT CHAIN



1. INTERMEDIATE MAST
2. STUBSHAFT
3. LOAD ROLLER
4. SNAP RING
5. SHIM
6. CHAIN SHEAVE
7. BEARING
8. LIFT CHAIN
9. STRIP BEARING
10. SPACER

Figure 94. Intermediate Mast Assembly

WARNING

The mast is heavy. The mast can weigh approximately 907 kg (2000 lb). Make sure all lifting devices (hoists, cables, chains, slings, etc.) are suitable and of adequate capacity to lift the mast.

1. Slide inner mast halfway out of the top of the intermediate mast. Connect a crane with a capacity of at least 907 kg (2000 lb) to the center of the inner mast. See Figure 95. Slide the inner mast out of the intermediate mast until the stub shafts are in the notches of the intermediate mast. Remove the inner mast from the intermediate mast.

WARNING

Be careful when removing or installing snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers, and wear eye and face protection during removal or installation.

2. Remove capscrews and isolator near the top of each main lift cylinder. Remove snap rings and washer from top of each main lift cylinder. Disconnect main lift cylinder at the mounts. See Figure 90.

3. Push intermediate mast to disengage the main lift cylinders. Remove the main lift cylinders.

4. Slide intermediate mast from the bottom of the outer mast 30 cm (12 in.). Remove the strip bearings at the top of the outer mast. Remove the snap rings and load rollers from both weldments. Make a note of each shim arrangement and load roller location. The shim arrangements will be approximately the same during assembly. See Figure 92 and Figure 94.

WARNING

The mast is heavy. The mast can weigh approximately 907 kg (2000 lb). Make sure all lifting devices (hoists, cables, chains, slings, etc.) are suitable and of adequate capacity to lift the mast.

5. Slide intermediate mast halfway out of the top of the outer mast. Connect a crane with a capacity of at least 907 kg (2000 lb) to the center of the intermediate mast. See Figure 95. Slide the intermediate mast out of the outer mast until the stub shafts are in the notches of the outer mast. Remove the intermediate mast from the outer mast.

6. Disassemble chain sheaves as necessary for repair and cleaning. See Figure 91 and Figure 94. Remove hydraulic lines and fittings from mast weldments as necessary.

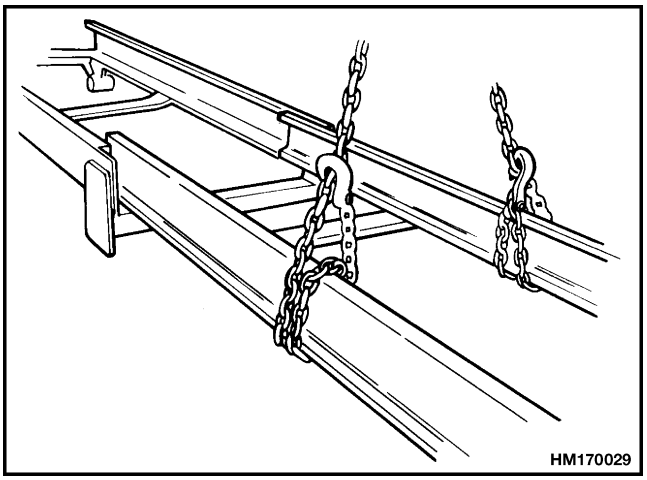


Figure 95. Connecting a Crane

Clean and Inspect

CAUTION

DO NOT use steam or high-pressure water to clean the load rollers or the lift chains. Steam and high-pressure water can remove the lubrication from the bearings in the load rollers. Water in the bearings of the sheaves and the link pins of chains can also shorten the service life of these parts.

1. Inspect chain sheaves and load rollers for wear or damage. See Figure 92, Figure 93, and Figure 94. DO NOT use steam to clean lift chain sheaves or load rollers. The bearings in the sheaves and load rollers are sealed and lubricated.

WARNING

Cleaning solvents may be flammable and toxic and can cause severe skin irritation. When using commercial cleaning solvents, always comply with solvent manufacturer's recommended safety precautions.

WARNING

Compressed air can move particles so that they cause injury to the user or to other personnel. Make sure that the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eyes.

2. Clean the lift chains by soaking in solvent for 30 minutes to remove all dirt and grease. Hang lift chains up and remove solvent using compressed air.

WARNING

Never replace only the worn section of a chain. Replace the complete chain. Never replace only one chain of a chain pair. Replace both chains. Damage to the lift truck and serious injury can occur if lift chains are not replaced correctly.

NOTE: The chains must be inspected in the area of chain that passes over the chain sheave during the first portion of a lift. These links will show maximum wear.

3. Inspect the lift chains for wear and damage. A lift chain becomes longer when it is worn. If a chain is 3% longer than a new lift chain, the lift chain must be replaced.

4. If a chain scale is available (Hyster Part No. 599737) , check lift chains as shown in Figure 96. If a chain scale is not available measure 20 links of chain. Measure from the center of a pin to the center of another pin 20 pitches away. Compare the length with the chart in Figure 96. Replace chain if the length of 20 links of the worn section is more than the maximum wear limit.

5. Lubricate lift chains by soaking them in SAE 30 engine oil for 30 minutes. Hang chains over a drip pan for one hour to remove excess oil.

NOTE: Chain anchor pins **Must** be replaced anytime chains are replaced.

6. Inspect chain anchors, chain anchor pins, and chain anchor restraints. Replace any parts that are worn or damaged.

WARNING

Cleaning solvents may be flammable and toxic and can cause severe skin irritation. When using commercial cleaning solvents, always comply with solvent manufacturer's recommended safety precautions.

WARNING

Steam can cause serious burns. Wear protective clothing, gloves, and eye protection. Never expose your skin to steam.

7. Clean mast weldments with steam or solvent.

WARNING

Improper welding procedures can damage the structure of the mast or cause incorrect function of the mast which can result in serious injury to personnel. Consult your lift truck dealer for more information before welding on the mast

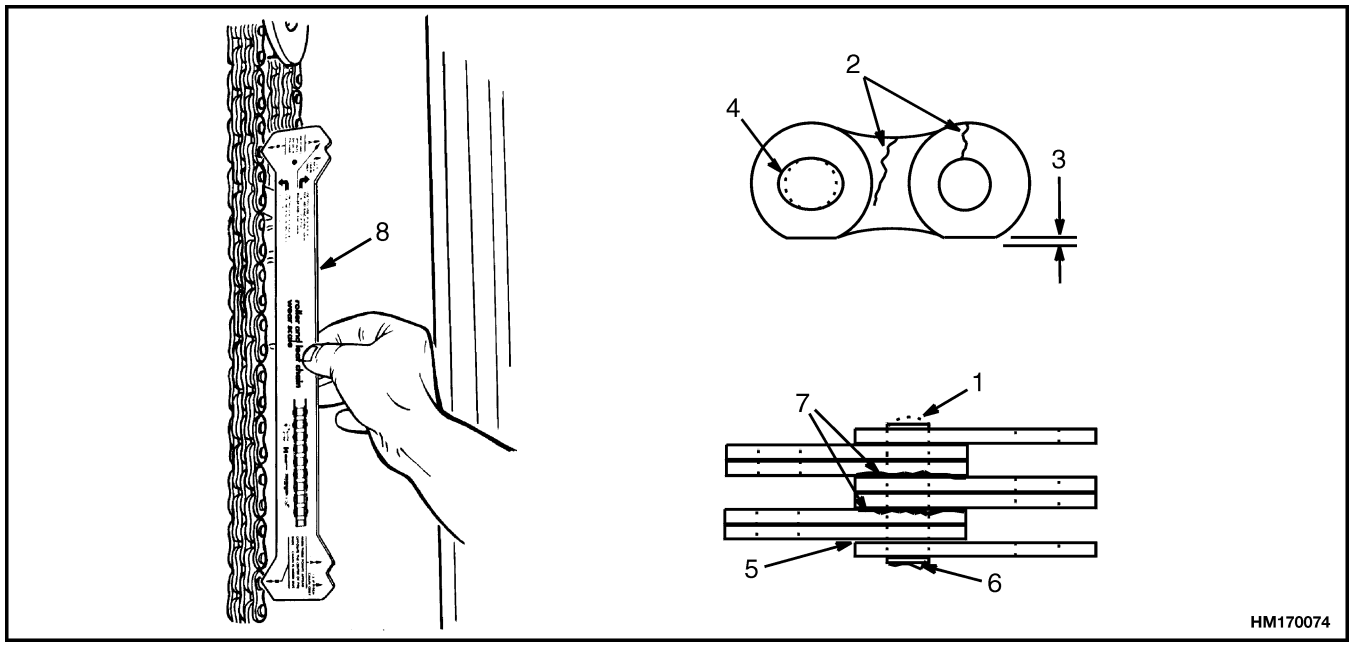
8. Inspect sliding surfaces for wear or damage. Inspect load roller contact surfaces for wear or damage. Inspect all welds for cracks.

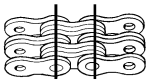
Assemble

NOTE: Shims for the load rollers keep the weldments parallel and provide correct clearance. During assembly, shims should be reinstalled in the same location they were in before disassembly. Check the clearance and adjust the shims for wear or for changes caused by repairs. The strip bearings are also adjusted by using shims. Shims for strip bears should also be reinstalled in the same location they were in before disassembly. See Mast Adjustments in this manual for the adjustment procedures.

1. Put the outer mast on the floor with the carriage side up. Connect a crane with a capacity of at least 907 kg (2000 lb) to the center of the intermediate mast. Fit the lower stub shafts of the intermediate mast into the notches in the top of the outer mast. Slide the intermediate mast into the outer mast so the stub shafts are seen at the top and bottom of both weldments.

NOTE: Load roller must be in place before strip bearings can be shimmed.



Pitch 	Total Length of 20 Links (Pitch) of New Chain	Wear Limit - The Maximum Length of 20 Links
12.7 mm (0.5 in.)	254.0 mm (10.0 in.)	261.6 mm (10.3 in.)
15.9 mm (0.6 in.)	317.5 mm (12.5 in.)	327.0 mm (12.9 in.)
19.1 mm (0.8 in.)	381.0 mm (15.0 in.)	392.4 mm (15.4 in.)
25.4 mm (1.0 in.)	508.0 mm (20. in.)	523.3 mm (20.6 in.)

NOTE: THE INSTRUCTION FOR MEASURING CHAIN WEAR ARE SHOWN ON THE CHAIN WEAR SCALE.

1. WORN PIN
2. CRACKS
3. EDGE WEAR
4. HOLE WEAR
5. LOOSE LEAVES
6. DAMAGED PIN
7. RUST
8. CHAIN WEAR SCALE

Figure 96. Lift Chain Check

2. Install strip bearings and shims on the channels of the outer mast. See Figure 97 Apply chassis lube to the bearing surfaces. Check the clearance of the strip bearings as described in Mast Adjustments in this manual.

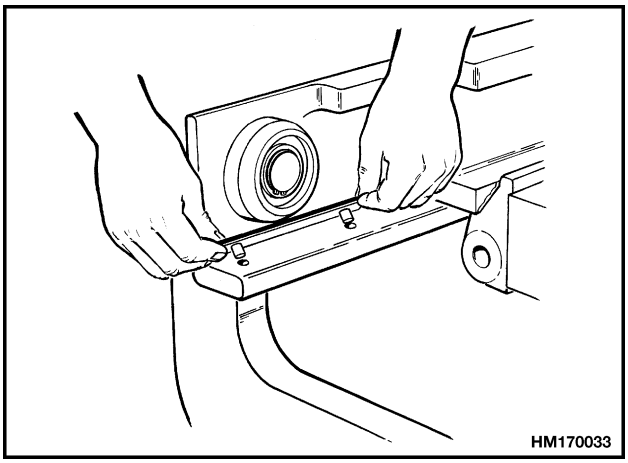


Figure 97. Strip Bearings

3. Install the load rollers and the shims on the outer mast and at the bottom of the intermediate mast. Before doing Step 4, adjust the intermediate mast and check the clearance of the load rollers as described in Mast Adjustments in this manual.

NOTE: The clearance check and adjustment in Step 4 is only an initial setup. The final check and adjustment is done after the mast is installed on the lift truck.

4. Install the main lift cylinders. Push the intermediate mast to engage the main lift cylinders. Check the clearance at the top of the main lift cylinder mounts. Add or remove washers at the top of the cylinder rods in the same location they were in before disassembly. Install the snap ring and washer at the top of the main lift cylinders. See Figure 90.

5. Install the housing for the lowering control valve on the outer mast. Tighten the nuts for the lowering control valve to 18 N•m (13 lbf ft). Install the lowering control valve in the housing. Connect the hydraulic lines and fittings between the housing and the main lift cylinders. See Figure 90.

6. Install chain sheaves at the intermediate mast. See Figure 94.

7. Install capscrews and isolators at the mount for main lift cylinders. Tighten capscrews to 38 N•m (28 lbf ft). See Figure 90.

8. Connect a crane with a capacity of at least 907 kg (2000 lb) to the center of the inner mast. See Figure 95. Slide the inner mast into the intermediate mast so the stub shafts are seen at the top and bottom of both.

NOTE: Use multipurpose grease #2 with 2 to 4% Molybdenum Disulfide for normal operations.

NOTE: The load rollers must be in place before strip bearings can be shimmed.

9. Install strip bearings and shims on the channels of the intermediate mast. See Figure 94 and Figure 97. Apply grease to the bearing surfaces. Install the load rollers and the shims on the intermediate and inner masts. Before doing the next step, adjust the inner mast as described in Mast Adjustments in this manual.

10. Connect the main lift chains to the chain anchors at the main lift cylinder mounts. Put the lift chains over the chain sheaves and connect them to the anchors at the bottom of the inner mast.

11. Install the free-lift cylinder in the mounts on the inner mast. Install the brackets for the cylinder and tighten the nuts to 53 N•m (39 lbf ft). The nuts are installed on the bracket side of the free-lift cylinder. See Figure 91.

12. Install the chain sheave for the free-lift cylinder. Tighten the capscrew for the chain sheave to 66 N•m (49 lbf ft). Install the hydraulic hose and tubing for the free-lift cylinder.

13. Connect free-lift chains to the chain anchors at the crossmember. Attach a wire between the end of the lift chain and the bottom of the mast to control the lift chain during mast installation. See Figure 91.

Install

1. Install new bushings into mast mounts at bottom of outer mast. Be sure to align the hole in the bushing with the lube fitting hole in the bottom of the outer mast. See Figure 87. Bushing must be flush with outer mast surface.

2. Apply an even coat of grease to pivot pins and install them into mounts at bottom of outer mast. See Figure 89.

3. Install washer and lube capscrew in hole in bottom of outer mast. Tighten lube capscrew to 25 N•m (18 lbf ft). Install lube fitting onto lube capscrew. Tighten lube fitting to 6 N•m (53 lbf in). See Figure 87 or Figure 92.

WARNING

The mast is heavy. The mast can weigh approximately 907 kg (2000 lb). Make sure all lifting devices (hoists, cables, chains, slings, etc.) are suitable and of adequate capacity to lift the mast.

4. Connect crane to top of mast using chains. Make sure all mast uprights are fastened together. Make sure chains will not damage sheaves, tubing, or other parts of mast. Make sure crane has a capacity of at least 907 kg (2000 lb).

5. Use crane to position mast assembly onto its lower mounts. Position mast so pivot pins seat into hanger mounts on drive axle. Install capscrews that hold mast pivot pins to drive axle hangers. Tighten capscrews to 270 N•m (199 lbf ft). See Figure 88.

6. Install new tilt rod bushings into the tilt anchors on the outer mast. Be sure tilt bushing split is installed at the correct angle as shown in Figure 87.

WARNING

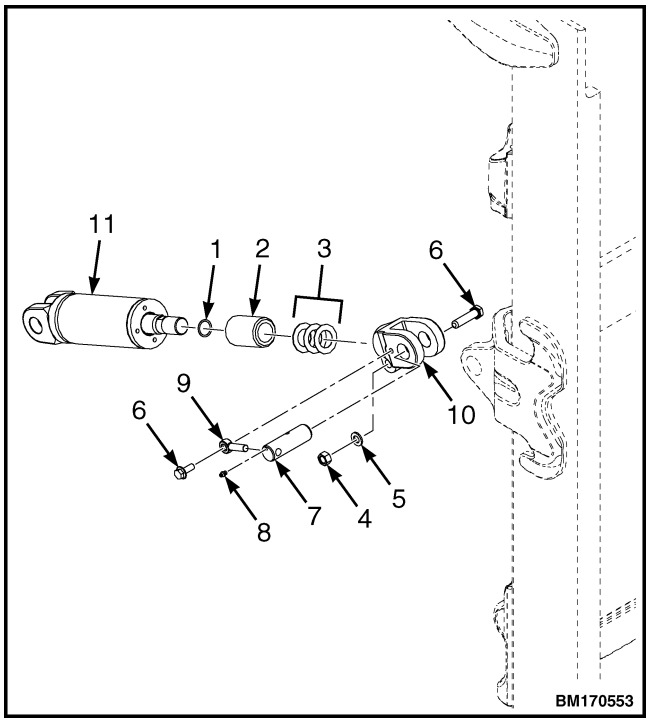
Use a pry bar, NOT your fingers, to align the tilt cylinder clevises with the outer mast. The cylinder or mast can shift and cause serious injury.

NOTE: Use multipurpose grease #2 with 2 to 4% molybdenum disulfide for normal operations.

7. Apply grease to pivot pins and connect tilt cylinders to mast using pivot pins. Install anchor pins and capscrews to rod ends. Apply anti-seize compound to capscrew threads and tighten 38 N•m (28 lbf ft).

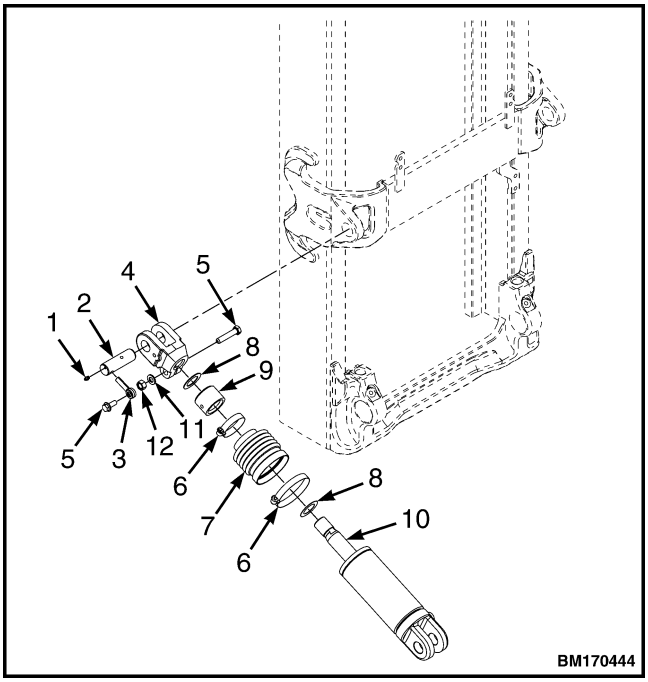
   See Figure 98 for lift trucks equipped with tilt cylinders without optional boot.

   See Figure 99 for lift trucks equipped with tilt cylinders with optional boot.



1. O-RING
2. SPACER
3. SHIMS
4. NUT
5. WASHER
6. CAPSCREW
7. PIVOT PIN
8. GREASE FITTING
9. ANCHOR PIN
10. CAPSCREW
11. ROD END

Figure 98. Mast Mounting, Tilt Cylinder Without Optional Boot



1. GREASE FITTING
2. PIVOT PIN
3. ANCHOR PIN
4. ROD END
5. CAPSCREW
6. CLAMP
7. BOOT
8. SHIM
9. SPACER
10. TILT CYLINDER
11. WASHER
12. NUT

Figure 99. Mast Mounting, Tilt Cylinder With Optional Boot, Lift Truck Models J2.2-3.5XN (J45-70XN) (A276)

8. Connect hydraulic line to lowering control valve. See Figure 90.

9. Install carriage as described in Carriages Repair, Three-Stage FFL Mast section in this manual.

WARNING

Never check for leaks by putting hands on hydraulic lines or components under pressure. Hydraulic oil under pressure can be injected into the skin.

10. Check tilt cylinder adjustment as described in **Cylinder Repair (Mast S/N F507, F508, F562, F563)** 2100SRM1668. Operate mast and check for leaks and correct operation. Check lift chains as described in Lift Chains Adjustment.

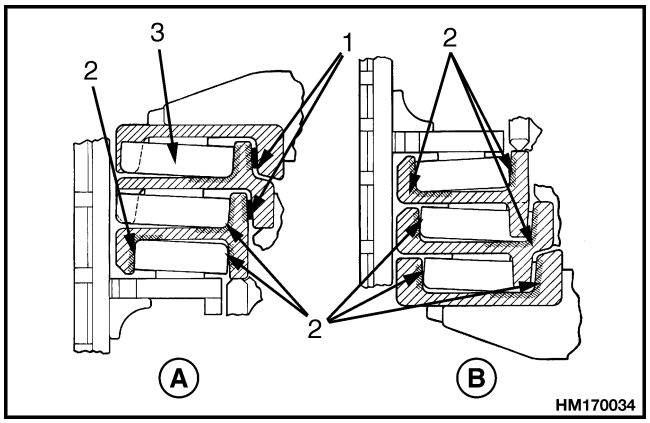
NOTE: Before checking for mast side kicking and adjusting the chain anchors on the main lift cylinders, the mast must be fully assembled to include the carriage, forks, load backrest and any attachments if the lift truck is equipped with one.

11. Adjust chain anchors on the main lift cylinders until the tops of the inner and outer mast are at the same level within ±1.5 mm (0.06 in.). See Figure 92.

12. Raise mast, without a load to its full height and check for side kicking. Mast side kicking is when the mast moves either to the right or left as it is being raised to its full height. If the mast is side kicking, see the Mast Adjustments section in this manual for procedures to correct mast side kicking.

NOTE: The load rollers and sheaves have sealed bearings and do not need additional lubrication.

13. Lubricate sliding surfaces and load roller surfaces along full length of channels as shown in Figure 100. Apply lubricant only to surfaces indicated.



A. UPPER LOAD ROLLERS
B. LOWER LOAD ROLLERS

1. LUBRICATE STRIP BEARINGS SURFACES
2. LUBRICATE LOAD ROLLER SURFACES
3. LOAD ROLLER

Figure 100. Lubricate Mast

Header Hose Installation and Adjustment

Remove

Read and follow the
Safety Procedures When Working Near Mast as well as all **WARNINGS** and **CAUTIONS** before removing and header hoses.

NOTE: Access to some of the fittings can be difficult. If necessary, operate the hydraulic system to move mast weldments or the carriage. Make sure the hydraulic system does not have pressure as described in Step 1.

1. To replace any header hoses, fully lower the carriage. Make sure the hydraulic system does not have hydraulic pressure. Hold the control for each function in the forward position for approximately five seconds to release the pressure. Make sure the hydraulic pump does not operate. Move the key or keyless switch, if equipped, to the **OFF** position.

2. Disconnect the battery and put a tag or lock on the battery connector.

3. Disconnect the header hoses and install caps on ends to prevent dirt and debris from entering the hydraulic system.

Installation

WARNING

Always wear the proper protective equipment including eye protection and petroleum-resistant gloves when handling hydraulic oil. Thoroughly wash oil from exposed areas of skin as soon as possible.

Never check for leaks by putting hands on hydraulic lines or components under pressure. Hydraulic oil under pressure can be injected into the skin.

WARNING

Before working on or near the mast, see Safety Procedures When Working Near Mast in this section.

Some lift trucks are equipped with auxiliary hydraulic functions that are fastened to the carriage. Examples of attachments that use these auxiliary functions are sideshift carriages, roll clamps, and fork positioners. These auxiliary functions require header hoses for their operation.

NOTE: This procedure is for the four function option. The three function option will have hoses **A** and **B** only. See Figure 101.

NOTE: The carriage height must be correct before the header hose tension can be measured. See Carriage Adjustments section in this manual for the carriage adjustment procedure.

1. Before installing new header hoses, add tension marks to each hose. See Figure 102 and Figure 103.

2. Clamp one end of the hose in a vise. **DO NOT** clamp on the threads. Pull on the other end until hose is straight. **DO NOT** apply enough force to stretch the hose.

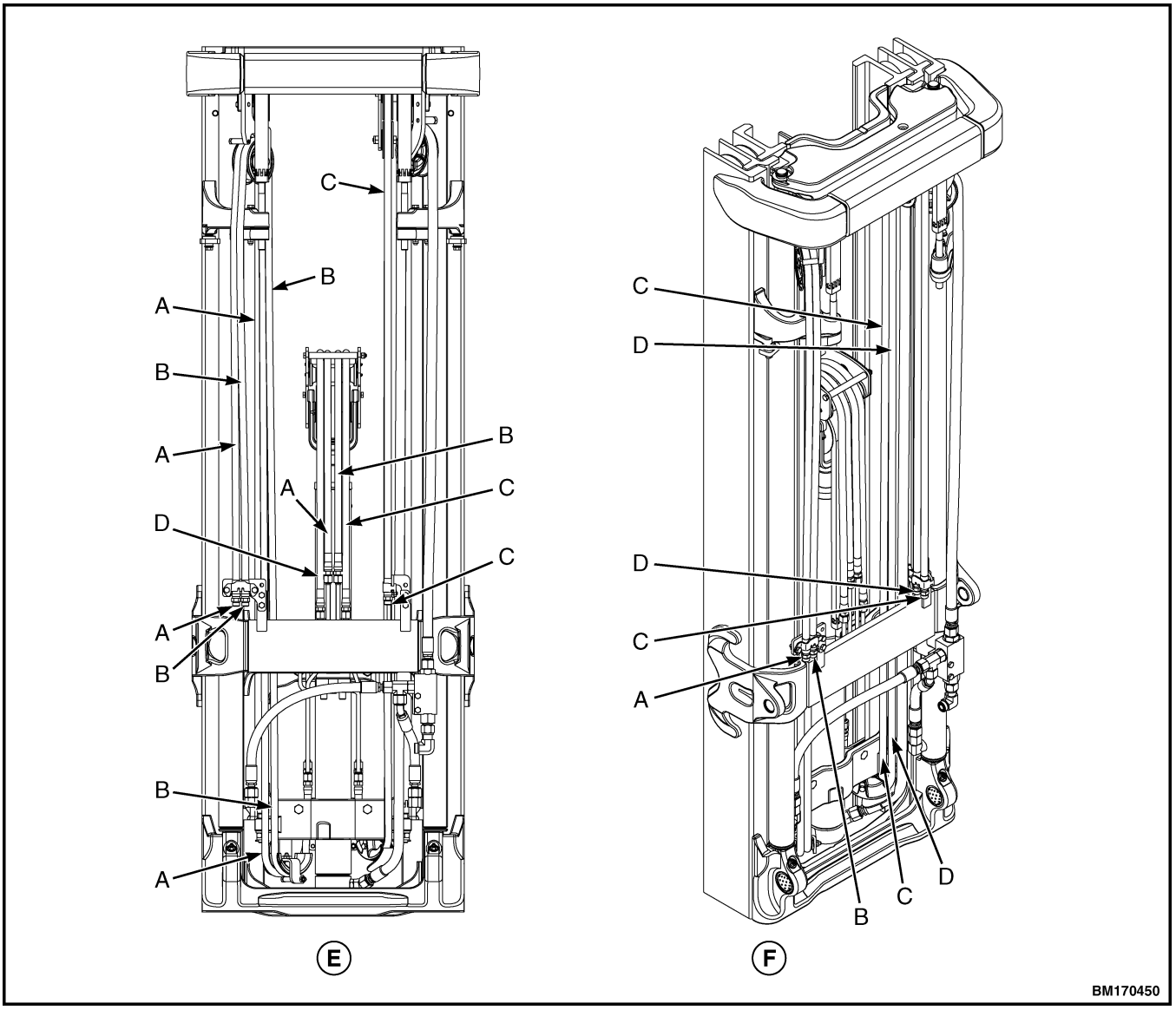
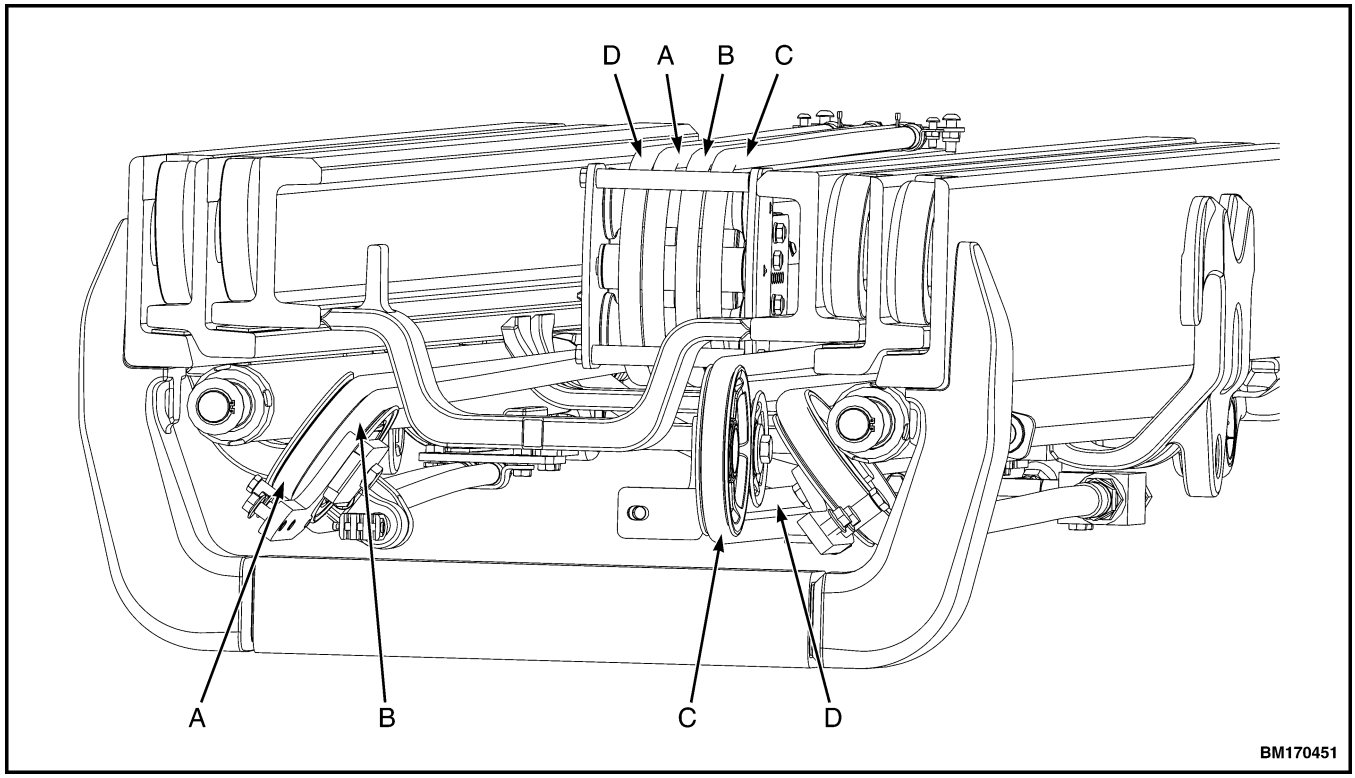


Figure 101. Header Hose Alignment for Three-Stage FFL Mast (Sheet 1 of 2)



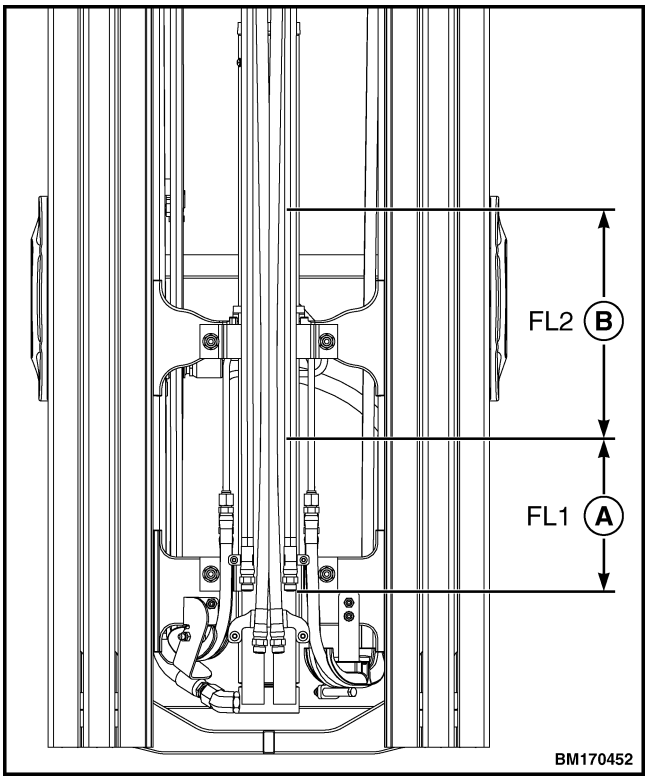
A. HEADER HOSE
B. HEADER HOSE
C. HEADER HOSE
D. HEADER HOSE
E. REAR VIEW (DRIVER'S VIEW)
F. LEFT SIDE VIEW

Figure 101. Header Hose Alignment for Three-Stage FFL Mast (Sheet 2 of 2)

NOTE: The header hose tension specification is 2.0% ±1.0%. Install hose caps to marked end (truck end) of hoses.

3. Put reference marks on each free-lift header hoses. Starting at either end of hose, place a mark at 400 ±10 mm (16.0 ±0.40 in.). This is dimension **FL1**. See Figure 102.

4. From dimension **FL1**, place another mark at 500 ±2.0 mm (20.0 ±0.08 in.). This is dimension **FL2**. See Figure 102.



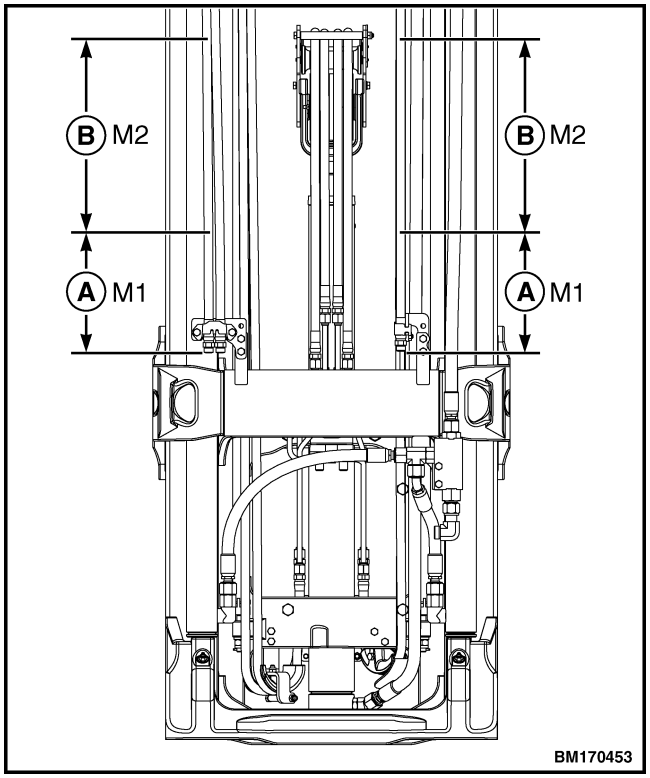
A. DIMENSION = 400 ±10 mm (16.0 ±0.40 in.)
B. DIMENSION = 500 ±2.0 mm (20.0 ±0.08 in.)

INSTALL LENGTH (FL2)	HOSE TENSION
505 mm (19.8 in.)	1%
510 mm (20.1 in.)	2%
515 mm (20.3 in.)	3%

Figure 102. Free-Lift Header Hose Reference Marks

5. Put reference marks on main lift header hoses. Starting at either end of the hose, place a mark at 100 ±10 mm (4.0 ±0.40 in.). This is dimension **M1**. See Figure 103.

6. From dimension **M1**, place another mark at 500 ±2.0 mm (20.0 ±0.08 in.). This is dimension **M2**. See Figure 103.



A. DIMENSION = 100 ±10 mm (4.0 ±0.40 in.)
B. DIMENSION = 500 ±2.0 mm (20.0 ±0.08 in.)

INSTALL LENGTH (M2)	HOSE TENSION
505 mm (19.8 in.)	1%
510 mm (20.1 in.)	2%
515 mm (20.3 in.)	3%

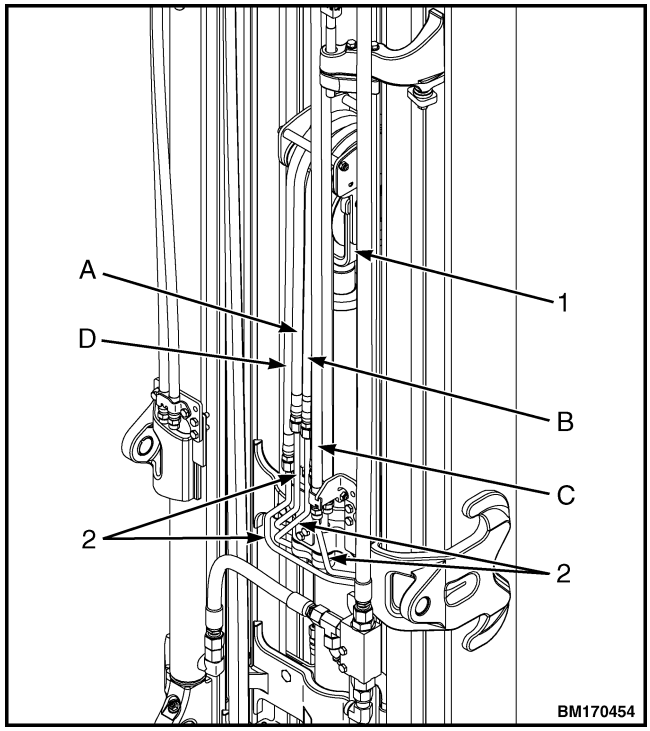
Figure 103. Main Lift Header Hose Reference Marks

7. Route free-lift hoses through the crosshead and attach them to the tube assemblies. See Figure 104.

8. For three function main lift hoses (hoses **A** and **B**), attach hoses to free-lift tube assemblies. Route hoses through turnaround bracket and secure hoses to turnaround bracket and turnaround with spacer. See Figure 105.

9. Route three function main lift hoses up over hose sheaves and secure hoses to hose sheaves with spacer. Attach marked end of hoses to bracket on mid-outer crossmember. See Figure 105.

10. Attach four function main lift hoses (hoses **C** and **D**), to free-lift tube assemblies and route hoses through turnaround bracket. See Figure 106.



A. FREE-LIFT HEADER HOSE **A**
B. FREE-LIFT HEADER HOSE **B**
C. FREE-LIFT HEADER HOSE **C**
D. FREE-LIFT HEADER HOSE**D**

1. CROSSHEAD
2. TUBE ASSEMBLY

Figure 104. Free-Lift Header Hose Installation

11. Route four function hoses up and over hose sheaves. Attached marked end of hoses to bracket (either upper or lower bracket) on mid-outer crossmember. See Figure 106.

NOTE: The header hose tension specification between marks is 510 ±5 mm (2.0 ±1.0%).

12. With header hoses installed on mast and the carriage correctly adjusted (see Carriage Adjustments), and the forks off the ground, measure the distance between marks **FL1** and **FL2** as follows:

    a. If tension mark measurement is less than 505 mm (20.0 in.), raise crosshead plate one hole and take measurement again to insure it is within specifications. See Figure 107.

    b. If tension mark measurement is more than 515 mm (20.3 in.), lower crosshead plate one hole and take measurement again to insure it is within specifications. See Figure 107.

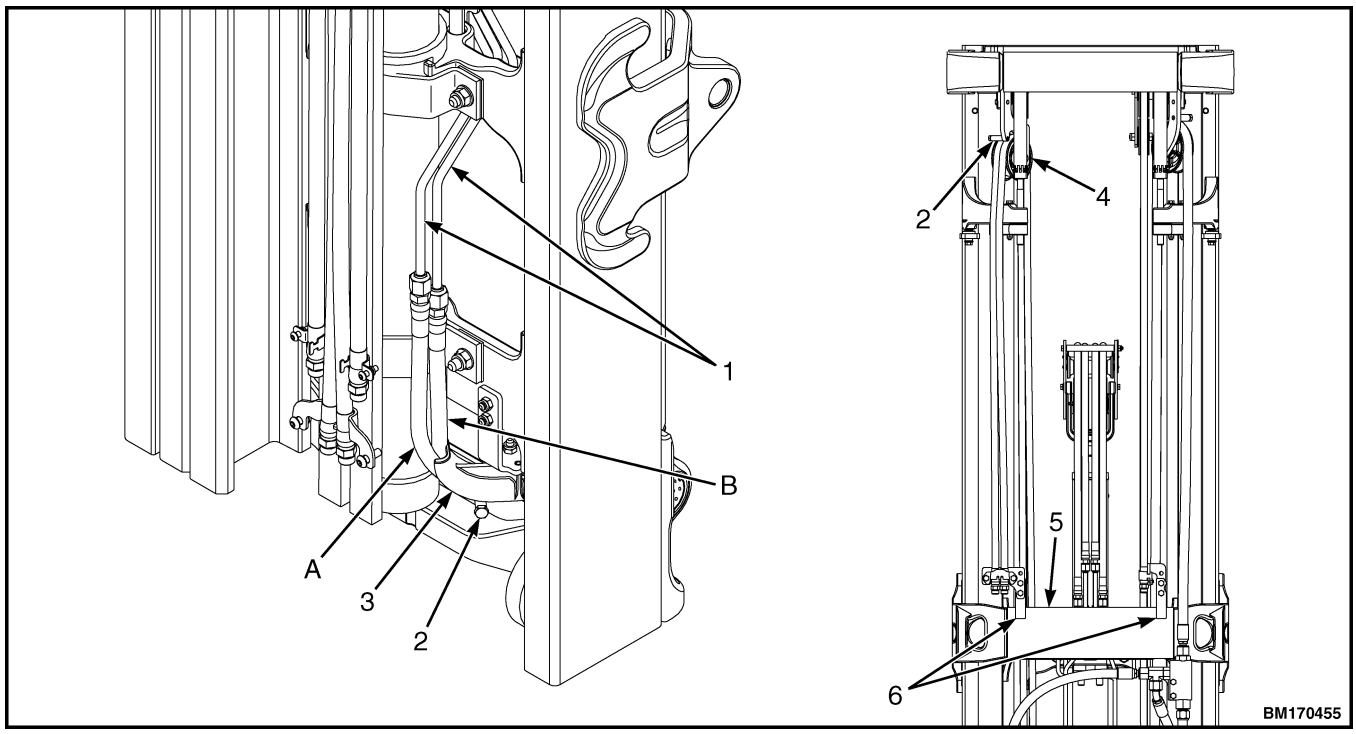
    c. If crosshead can not be moved, or if after moving crosshead plate two holes in either direction, header hose tension is still not correct, replace the hose and re-set crosshead plate to starting position and do Step a and Step b again with new hose.

NOTE: The header hose tension specification between marks is 510 ±5 mm (2.0 ±1.0%).

13. With header hoses installed on mast and the carriage correctly adjusted (see Carriage Adjustments), and the forks off the ground, measure the distance between marks **M1** and **M2** as follows:

    a. If tension mark measurement is less than 505 mm (20.0 in.), lower the upper bracket one hole and take measurement again to insure it is within specifications. If tension mark measurement is still less than 505 mm (20.0 in.), the hose has been permanently stretched. Replace hose and re-set upper bracket to original position and measure again with new hose. See Figure 108.

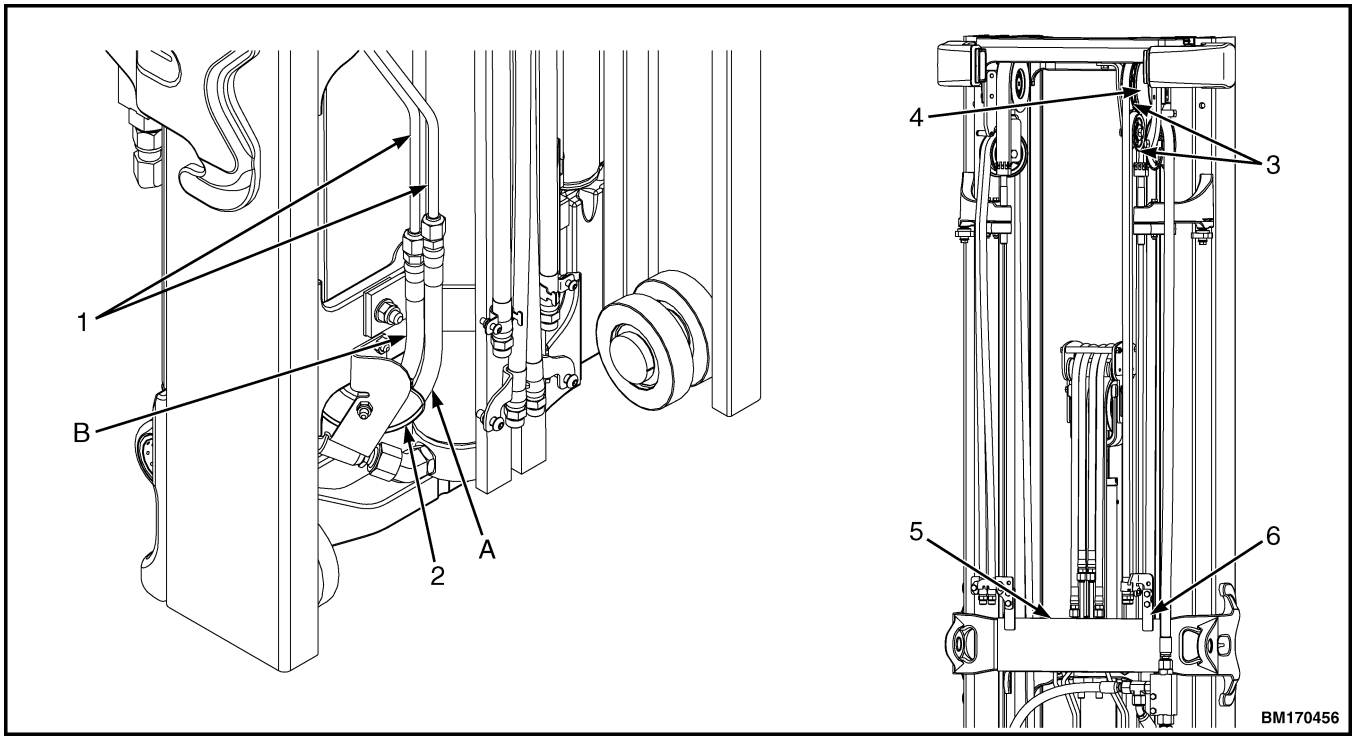
b. If tension mark measurement is more than 515 mm (20.3 in.), raise the upper bracket one hole and take the measurement again to insure it is within specifications. If the hose has been permanently over stretched, replace hose with a new hose. See Figure 108.



A. THREE-FUNCTION HEADER HOSE **A**
B. THREE-FUNCTION HEADER HOSE **B**

1. FREE-LIFT HOSE TUBE
2. SPACER
3. TURNAROUND BRACKET
4. HOSE SHEAVE
5. MID-OUTER CROSSMEMBER
6. BRACKET (LOWER)

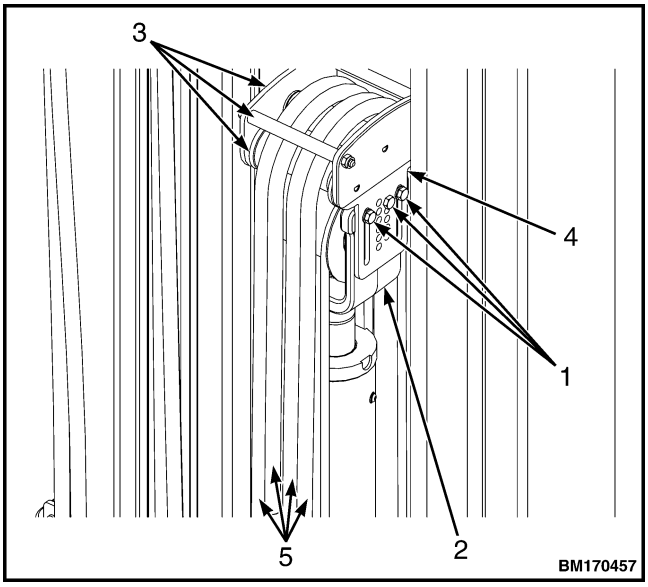
Figure 105. Three-Function Header Hose Installation



A. FOUR-FUNCTION HEADER HOSE **C**
B. FOUR-FUNCTION HEADER HOSE **D**

1. FREE-LIFT HOSE TUBE
2. TURNAROUND BRACKET
3. HOSE SHEAVE
4. CHAIN SHEAVE
5. MID-OUTER CROSSMEMBER
6. BRACKET (LOWER)

Figure 106. Four-Function Header Hose Installation



1. CAPSCREW
2. CROSSHEAD
3. HEADER HOSE ROLLER ASSEMBLY
4. CROSSHEAD PLATE
5. HEADER HOSES

Figure 107. Free-Lift Header Hose Adjustment

14. Raise and lower mast two to three times to check for proper routing of hoses. Hoses should smoothly go over the hose sheaves and not rub against crossmembers or the load backrest.

15. Tilt the mast two to three times and check that the hoses routed between truck cowl and mast move freely during both forward and backward tilt.

Adjustment

NOTE: Tire size variations and adjusting of the lift chains may require adjustment of free-lift and main lift header hose tension. Lift chain adjustment for tire wear will reduce header hose tension.

1. To adjust the free-lift header hoses, perform the following:

a. Raise carriage at least 100 mm (4.0 in.)

b. Place blocks under lower carriage bar and lower carriage onto blocks to relieve hose tension. Chain carriage to inner mast. See Safety Procedures When Working Near Mast in this manual.

c. Loosen six (three on each side) capscrews on crosshead plate. Remove middle capscrew. See Figure 107.

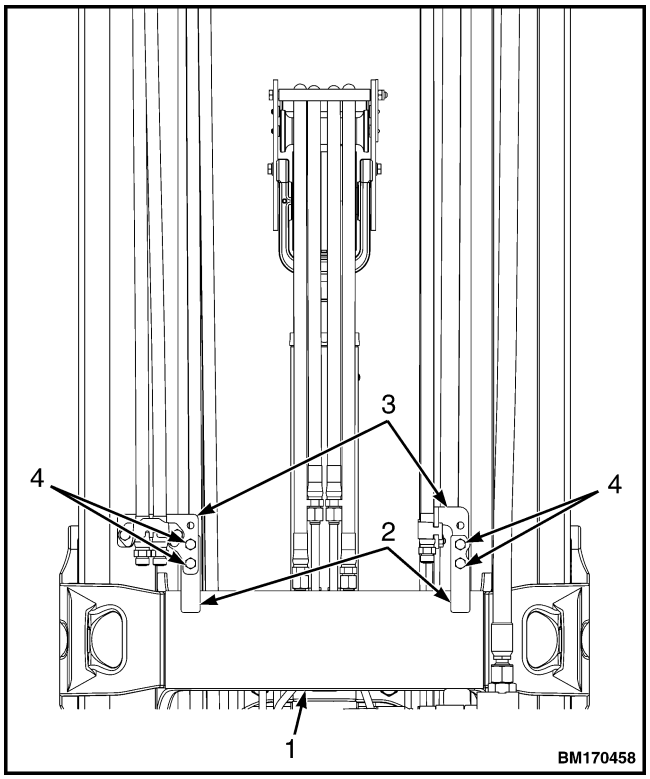
d. Move free-lift header hose roller assembly up to increase hose tension, and down to decrease hose tension. See Figure 107.

2. To adjust main lift header hoses, perform the following:

a. Raise inner mast and place a block under inner mast.

b. Chain inner mast weldment to outer or intermediate mast weldment. See Safety Procedures When Working Near Mast in this manual.

c. Lower inner mast onto block.



1. MID-OUTER CROSSMEMBER
2. LOWER BRACKET
3. UPPER BRACKET
4. CAPSCREW AND NUT

Figure 108. Main Lift Header Hose Adjustment

d. Loosen upper bracket above mid-outer crossmember and then lower upper bracket until correct hose tension is achieved. Tighten nut to 18 N•m (159 lbf in). See Figure 108.

MAST WITH SERIAL NUMBER F563

Remove

WARNING

The mast is heavy. The mast can weigh approximately 907 kg (2000 lb). Make sure all lifting devices (hoists, cables, chains, slings, etc.) are suitable and of adequate capacity to lift the mast.

WARNING

Mast weldments can slide when the mast is moved. A weldment that slides can cause serious injury.

CAUTION

Make sure all the mast weldments are fastened together. Make sure the safety chains will not damage the sheaves, tubing, or other parts of the mast.

NOTE: If mast needs to be disassembled, remove forks and carriage. See the sections Fork Replacement and Carriages Repair, Three-Stage FFL Mast in this service manual for procedures. If only the main lift cylinders need to be removed for repair, the mast does not need to be removed from the lift truck. See **Cylinder Repair (Mast S/N F507, F508, F562, F563)** 2100SRM1668 for procedures to remove the main lift cylinders.

NOTE: The length of the lift chains must be checked before the mast is removed. See Lift Chains Adjustment section in this manual for procedures.

1. Fully lower all mast weldments. Tilt mast fully forward. Connect a crane with a capacity of at least 907 kg (2000 lb) to top of the mast using chains to support the mast in an upright position when the tilt cylinders are disconnected. See the section Safety Procedures When Working Near Mast in this manual.

WARNING

Always wear the proper protective equipment including eye protection and petroleum-resistant gloves when handling hydraulic oil. Thoroughly wash oil from exposed areas of skin as soon as possible.

Completely lower forks to relieve hydraulic pressure before disassembling any part of the lift pump or disconnecting any hoses.

The hydraulic oil is hot at normal operating temperatures. Be careful when draining the oil.

CAUTION

Protect the hydraulic system from dirt and contaminants when servicing the hydraulic system.

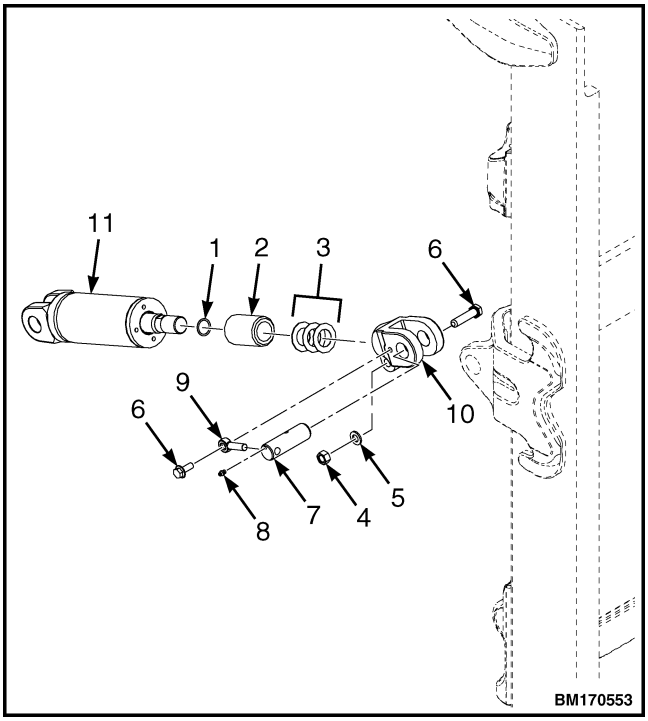
2. Position a drip pan under the area of the hydraulic fittings. Disconnect the hydraulic line at the external lowering control valve on the outer mast. See Figure 114.

WARNING

Use a driver, NOT your fingers, to push the anchor pins from the clevises on the tilt cylinders. The cylinder or mast can move and cause serious injury.

3. On lift trucks NOT equipped with optional boot on tilt cylinders, remove the capscrews, washers, anchor pins, and pivot pins at the tilt cylinder mounts on the outer mast. See Figure 109.

4. On lift truck models J2.2-3.5XN (J45-70XN) (A276) equipped with tilt cylinders with optional boots, remove capscrews, washers, nuts, anchor pins, and pivot pins at tilt cylinder mounts on outer mast. See Figure 110.



1. O-RING
2. SPACER
3. SHIMS
4. NUT
5. WASHER
6. CAPSCREW
7. PIVOT PIN
8. GREASE FITTING
9. ANCHOR PIN
10. CAPSCREW
11. ROD END

Figure 109. Mast Mounting, Tilt Cylinder Without Optional Boot

5. Using a brass drift pin, remove tilt rod bushings from outer mast. Discard tilt rod bushings. See Figure 111.

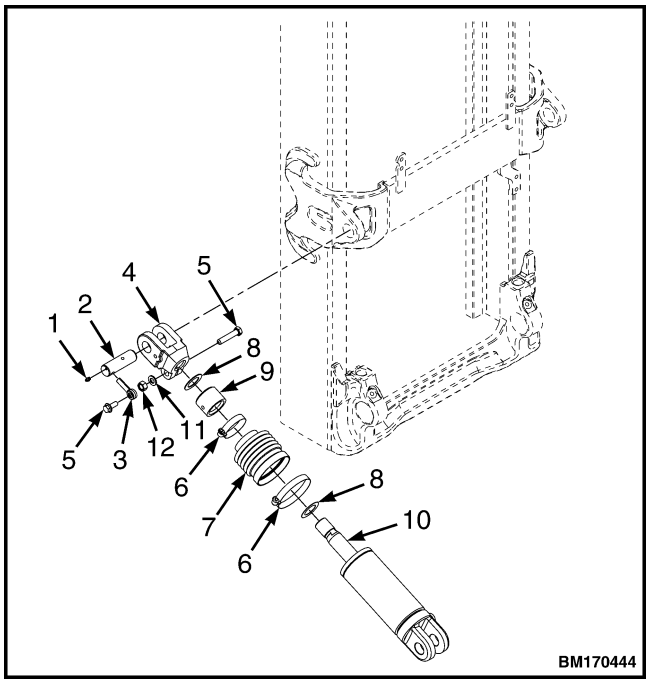
NOTE: Allow the mast to tilt forward enough to gain access to the mast mount capscrews.

6. Disconnect the lower mast mounts from the lift truck by removing the capscrews that hold the mast pivot pins to the mounts on the drive axle. See Figure 112 and Figure 113.

WARNING

The mast is heavy. The mast can weigh approximately 907 kg (2000 lb). Make sure all lifting devices (hoists, cables, chains, slings, etc.) are suitable and of adequate capacity to lift the mast.

7. Use the crane to lift the mast assembly from the lift truck. Position the mast across wooden beams on the floor with the carriage side up.



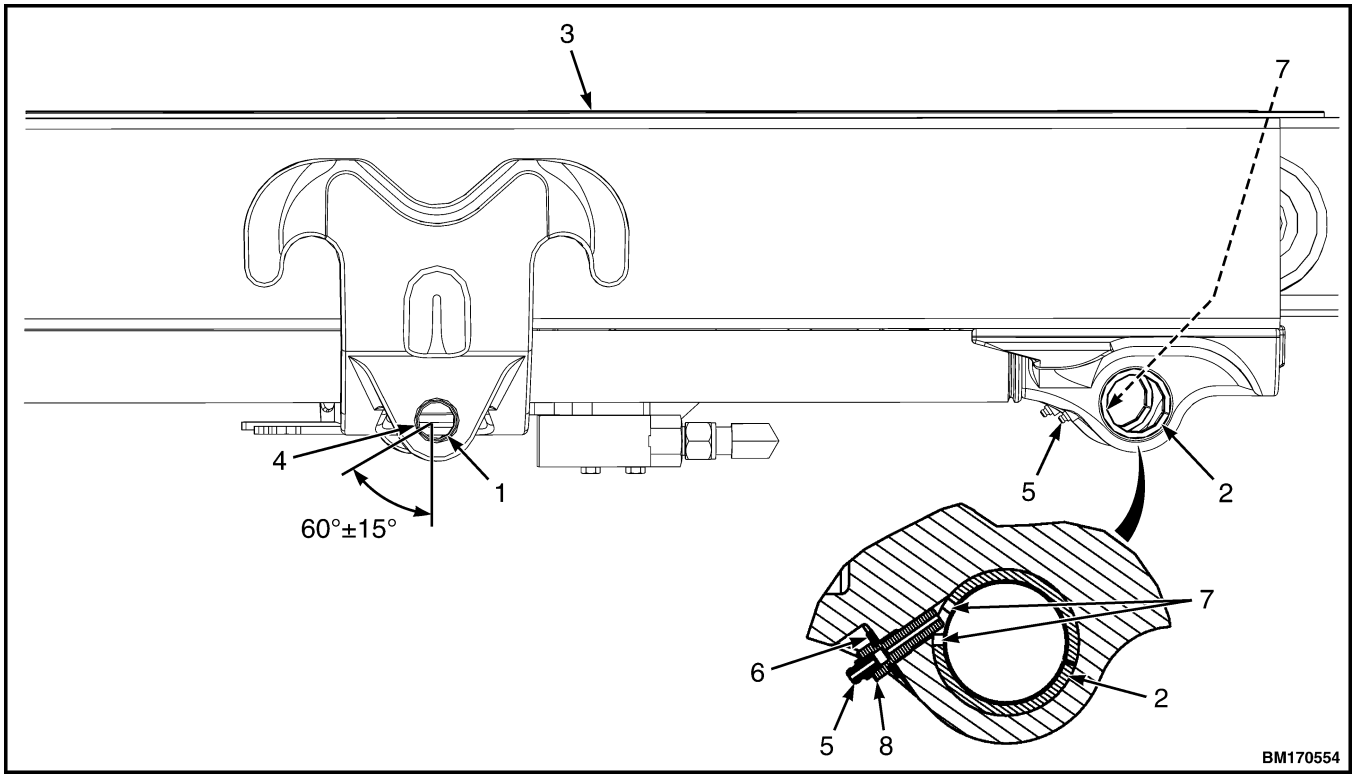
1. GREASE FITTING
2. PIVOT PIN
3. ANCHOR PIN
4. ROD END
5. CAPSCREW
6. CLAMP
7. BOOT
8. SHIM
9. SPACER
10. TILT CYLINDER
11. WASHER
12. NUT

Figure 110. Mast Mounting, Tilt Cylinder With Optional Boot, Lift Truck Models J2.2-3.5XN (J45-70XN) (A276)

NOTE: If mast mounting bushing need to be replaced in Step 8 go to Step 9 for procedures.

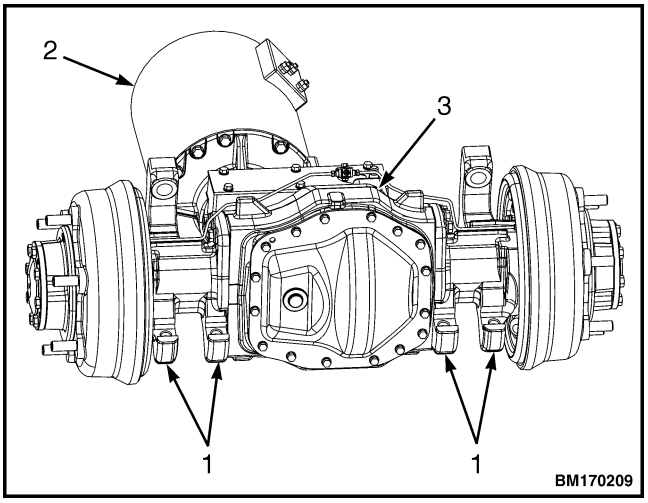
8. Check mast and mounting flanges for wear or damage by removing mast pivot pins from outer mast. Check that pins fit snug in outer mast. If pins can be moved up and down a minimum of 4 mm (0.20 in.), replace bushings in outer mast and/or mast pivot pins as required. See Figure 113.

9. Remove lube fitting, lube capscrew, and washer from the mast mounts. See Figure 116. Use a brass drift pin to remove mast mounting bushings from outer mast. Discard mast mounting bushings. See Figure 111.



1. TILT ROD BUSHING
2. MAST MOUNTING BUSHING (BRONZE)
3. OUTER MAST
4. BUSHING SPLIT
5. LUBE FITTING
6. WASHER
7. BUSHING HOLE
8. LUBE CAPSCREW

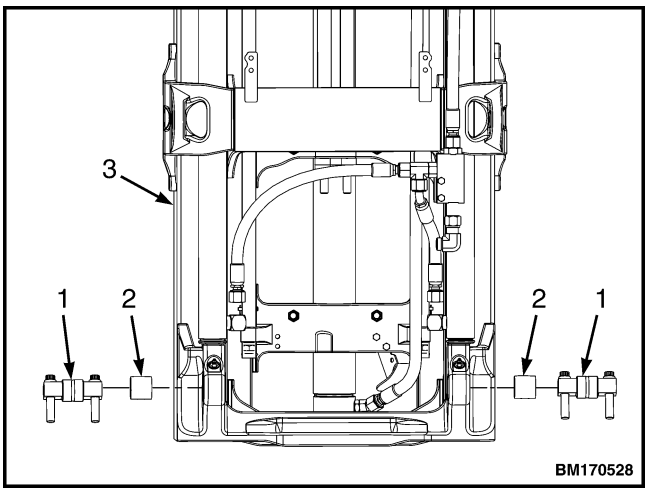
Figure 111. Tilt Rod and Mast Mounting Bushings



NOTE: DRIVE AXLE AND MAST MOUNTS FOR LIFT TRUCK MODELS E2.2-3.5XN (E45-70XN) (A268) SHOWN. DRIVE AXLE AND MAST MOUNTS FOR THE OTHER LIFT TRUCKS COVERED IN THIS MANUAL ARE SIMILAR.

1. HANGER MOUNTS
2. TRACTION MOTOR
3. DRIVE AXLE

Figure 112. Mast Mounts, Drive Axle



1. MAST PIVOT PINS
2. BUSHING
3. OUTER MAST

Figure 113. Mast Pivot Pins

Disassemble

WARNING

Always wear the proper protective equipment including eye protection and petroleum-resistant gloves when handling hydraulic oil. Thoroughly wash oil from exposed areas of skin as soon as possible.

WARNING

Hydraulic oil is hot after system operation and can cause burns. DO NOT disconnect any hydraulic hoses until the oil in the system has cooled.

Completely lower forks to relieve hydraulic pressure before disconnecting any hydraulic hoses.

CAUTION

Protect the hydraulic system from dirt and contaminants when disconnecting hydraulic hoses from the mast. If hydraulic system becomes contaminated, damage to the hydraulic system can occur.

1. Disconnect free-lift chain at crosshead. See Figure 115.

2. Disconnect and remove hydraulic line from free-lift cylinder. Remove the brackets clamping the free-lift cylinder. Remove the free-lift cylinder. See Figure 115.

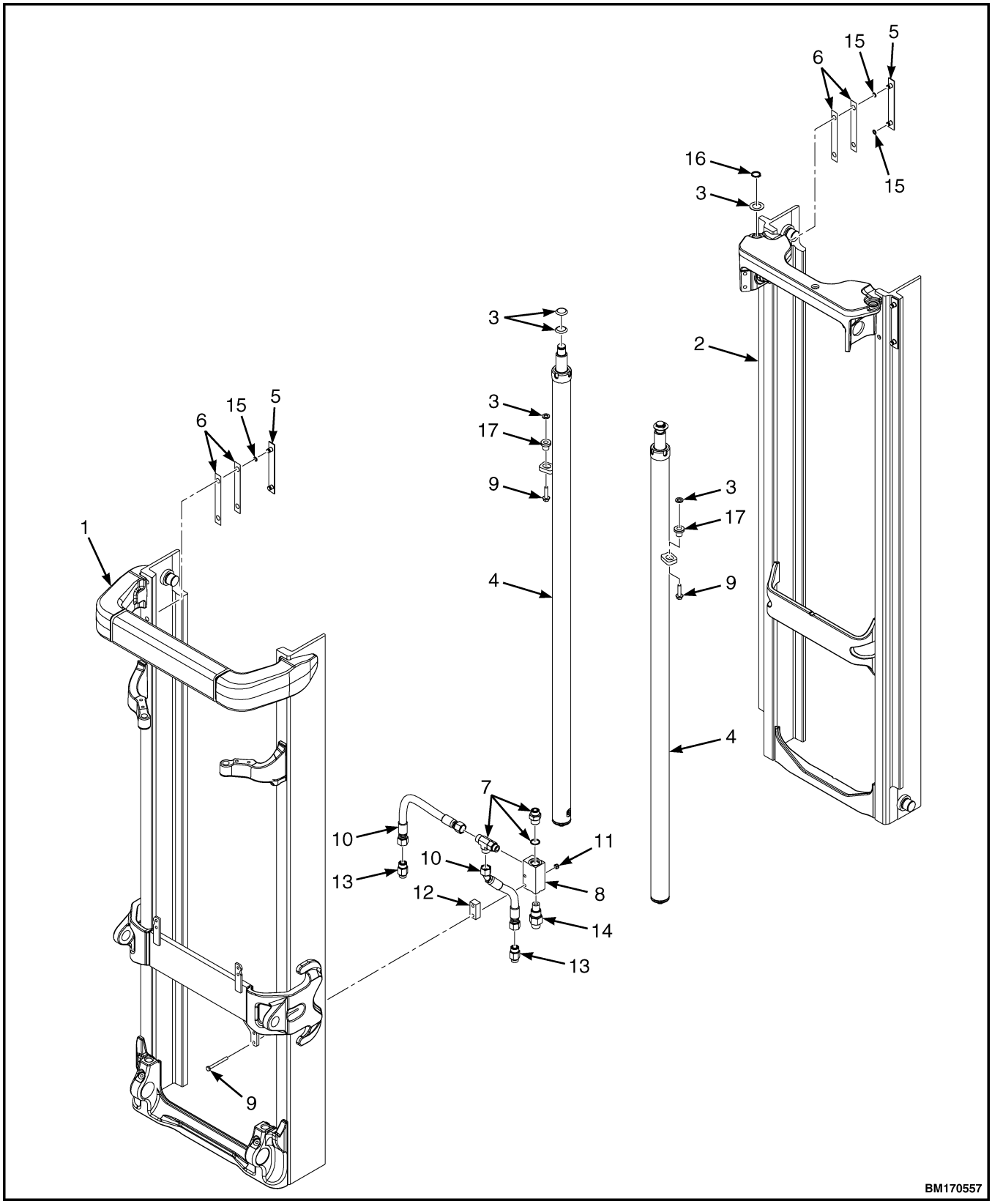


Figure 114. Main Lift Cylinder Attaching Parts

Legend for Figure 114.

1. OUTER MAST
2. INTERMEDIATE MAST
3. WASHER
4. MAIN LIFT CYLINDER
5. STRIP BEARING
6. SHIM
7. FITTING
8. LOWERING CONTROL HOUSING
9. CAPSCREW
10. HOSE ASSEMBLY
11. NUT
12. SPACER
13. HYDRAULIC VELOCITY FUSE
14. LOWERING CONTROL VALVE
15. O-RING
16. SNAP RING
17. ISOLATOR

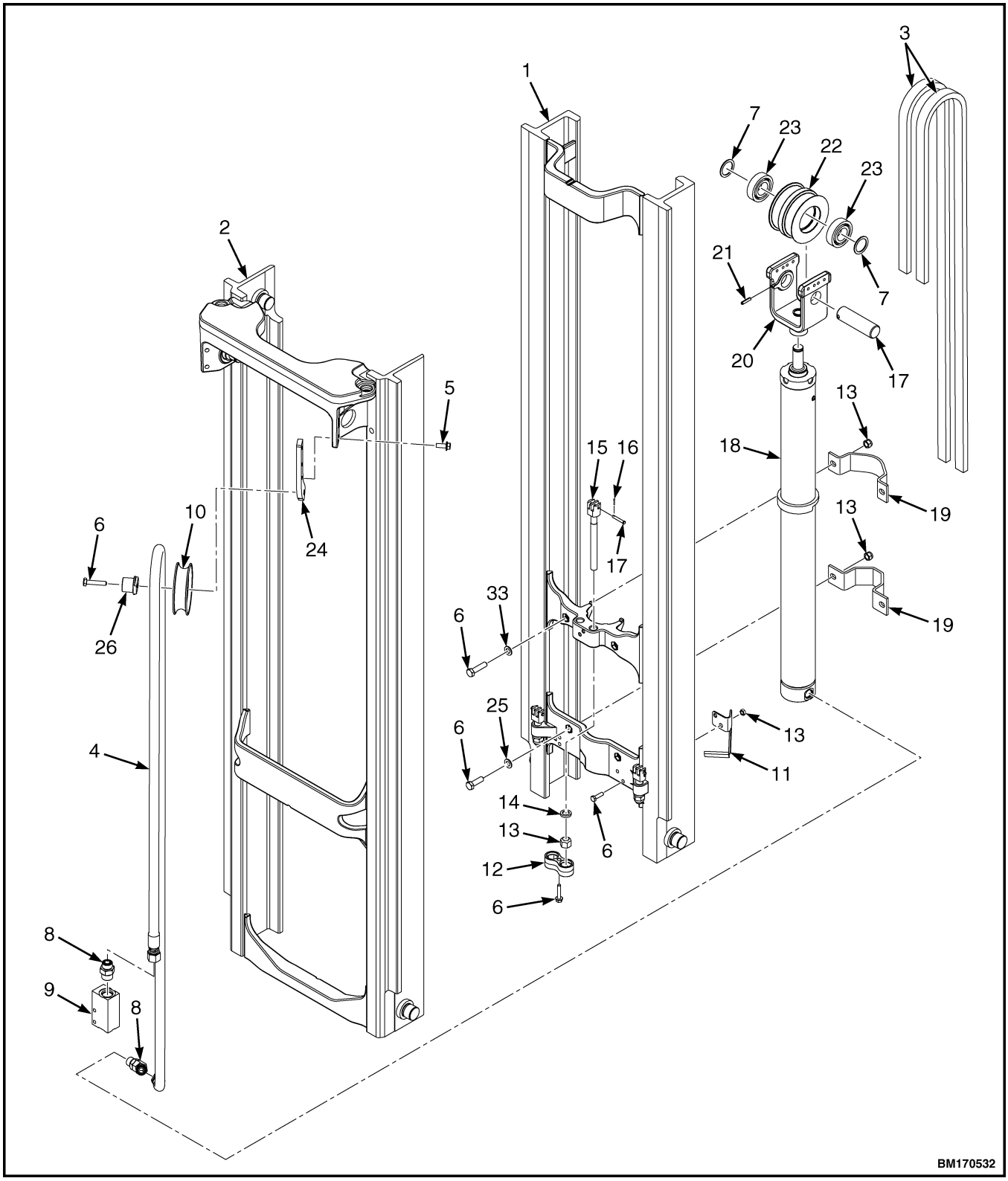


Figure 115. Free-Lift Cylinder Assembly and Component Parts

Legend for Figure 115.

1. INNER MAST
2. INTERMEDIATE MAST
3. CHAIN
4. HOSE ASSEMBLY
5. CAPSCREW
6. CAPSCREW
7. STUBSHAFT
8. FITTING
9. LOWERING CONTROL VALVE HOUSING
10. HOSE SHEAVE
11. BRACKET WELDMENT
12. CHAIN ANCHOR RESTRAINT
13. NUT
14. RING
15. CHAIN ANCHOR
16. COTTER PIN
17. PIN
18. FREE-LIFT CYLINDER
19. CLAMP
20. FREE-LIFT CROSSHEAD
21. ROLL PIN
22. CHAIN SHEAVE
23. BEARING
24. PLATE
25. WASHER

3. Disconnect the main lift chains from the chain anchors near the top of the main lift cylinders. See Figure 116. Disconnect the other end of the main lift chains at the bottom of the inner mast. Push the inner mast toward the bottom of the mast assembly until the bottom load rollers can be seen. See Figure 117.

WARNING

The weldments can slide when the mast is moved. A weldment that slides can cause injury. Use a crane to turn the mast slowly and carefully.

4. Remove the strip bearings at the top of the intermediate mast. Remove the load rollers at the bottom of the inner mast. Remove the load rollers at the top of the intermediate mast. Make a note of each shim arrangement and load roller location. The shim arrangements will be approximately the same during assembly. See Figure 117 and Figure 118.

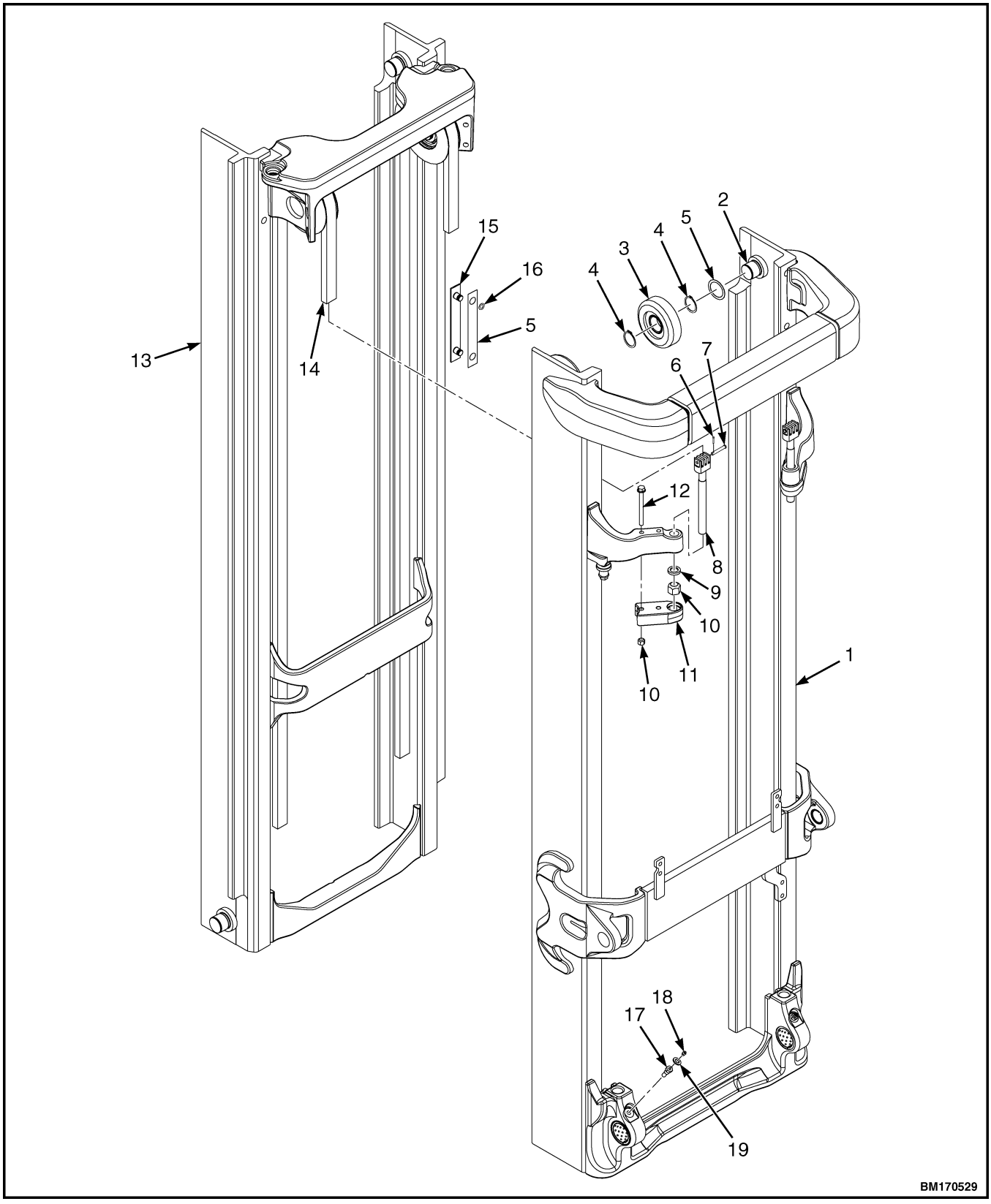


Figure 116. Outer Mast Assembly

Legend for Figure 116.

1. OUTER MAST
2. STUBSHAFT
3. LOAD ROLLER
4. SNAP RING
5. SHIM
6. COTTER PIN
7. PIN
8. CHAIN ANCHOR
9. RING
10. NUT
11. CHAIN ANCHOR RESTRAINT
12. CAPSCREW
13. INTERMEDIATE MAST
14. LIFT CHAIN
15. WEAR STRIP
16. O-RING
17. LUBE CAPSCREW
18. LUBE FITTING
19. WASHER

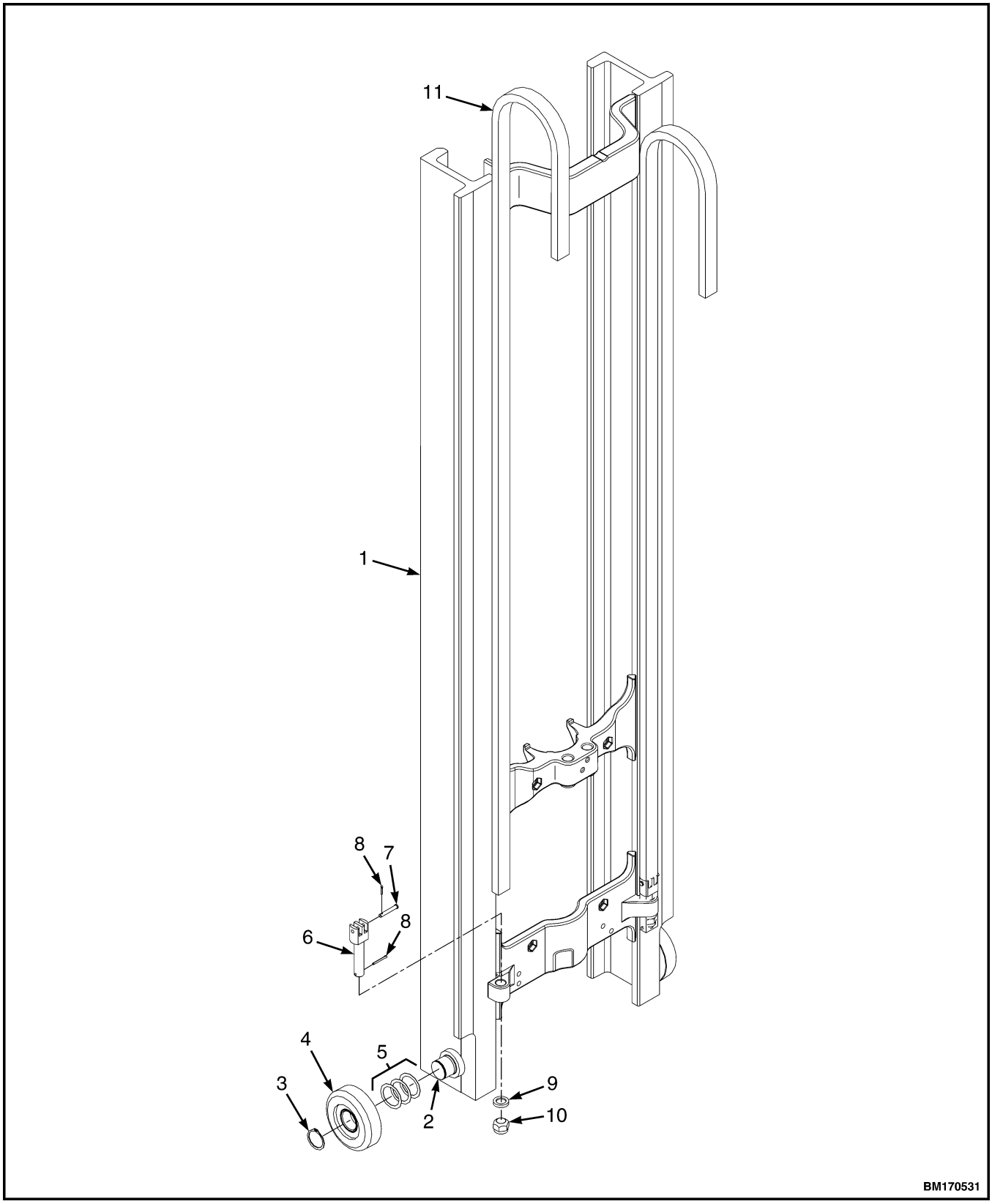
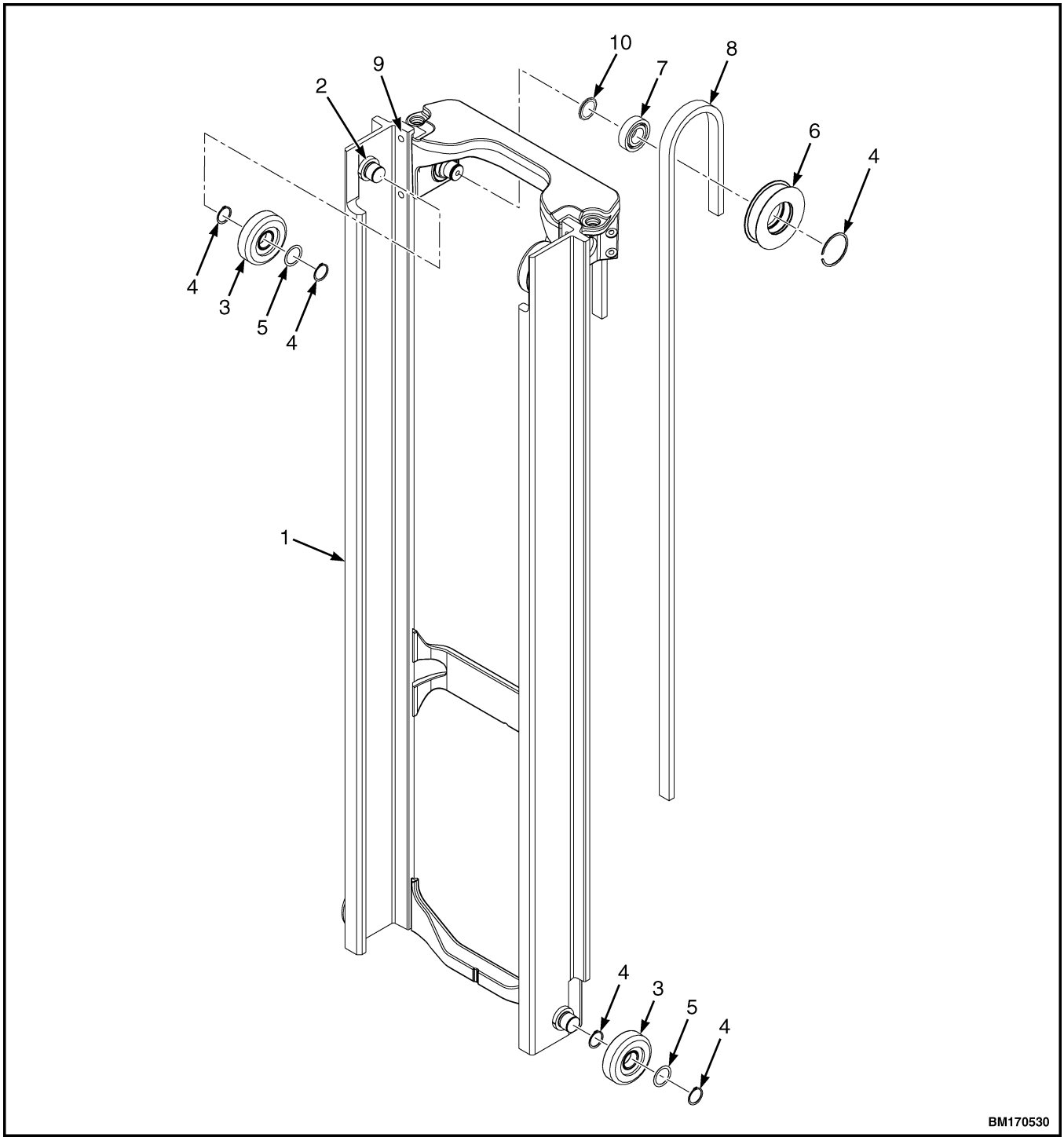


Figure 117. Inner Mast Assembly

Legend for Figure 117.

1. INNER MAST
2. STUBSHAFT
3. SNAP RING
4. LOAD ROLLER
5. SHIM
6. CHAIN ANCHOR
7. PIN
8. COTTER PIN
9. RING
10. NUT
11. LIFT CHAIN



1. INTERMEDIATE MAST
2. STUBSHAFT
3. LOAD ROLLER
4. SNAP RING
5. SHIM
6. CHAIN SHEAVE
7. BEARING
8. LIFT CHAIN
9. STRIP BEARING
10. SPACER

Figure 118. Intermediate Mast Assembly

WARNING

The mast is heavy. The mast can weigh approximately 907 kg (2000 lb). Make sure all lifting devices (hoists, cables, chains, slings, etc.) are suitable and of adequate capacity to lift the mast.

1. Slide inner mast halfway out of the top of the intermediate mast. Connect a crane with a capacity of at least 907 kg (2000 lb) to the center of the inner mast. See Figure 119. Slide inner mast out of intermediate mast until the stub shafts are in the notches of the intermediate mast. Remove the inner mast from the intermediate mast.

WARNING

Be careful when removing or installing snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers, and wear eye and face protection during removal or installation.

2. Remove capscrews and isolator near the top of each main lift cylinder. Remove snap rings and washer from top of each main lift cylinder. Disconnect main lift cylinder at the mounts. See Figure 114.

3. Push intermediate mast to disengage the main lift cylinders. Remove the main lift cylinders.

4. Slide intermediate mast from the bottom of the outer mast approximately 30 cm (12 in.). Remove the strip bearings at the top of the outer mast. Remove the snap rings and load rollers from both weldments. Make a note of each shim arrangement and load roller location. The shim arrangements will be approximately the same during assembly. See Figure 116 and Figure 118.

WARNING

The mast is heavy. The mast can weigh approximately 907 kg (2000 lb). Make sure all lifting devices (hoists, cables, chains, slings, etc.) are suitable and of adequate capacity to lift the mast.

5. Slide intermediate mast halfway out of the top of the outer mast. Connect a crane with a capacity of at least 907 kg (2000 lb) to the center of the intermediate mast. See Figure 119. Slide the intermediate mast out of the outer mast until the stub shafts are in the notches of the outer mast. Remove the intermediate mast from the outer mast.

6. Disassemble chain sheaves as necessary for repair and cleaning. See Figure 115 and Figure 118. Remove hydraulic lines and fittings from mast weldments as necessary.

Clean and Inspect

CAUTION

DO NOT use steam or high-pressure water to clean the load rollers or the lift chains. Steam and high-pressure water can remove the lubrication from the bearings in the load rollers. Water in the bearings of the sheaves and the link pins of chains can also shorten the service life of these parts.

1. Inspect chain sheaves and load rollers for wear or damage. See Figure 116, Figure 117, and Figure 118. DO NOT use steam to clean lift chain sheaves or load rollers. The bearings in the sheaves and load rollers are sealed and lubricated.

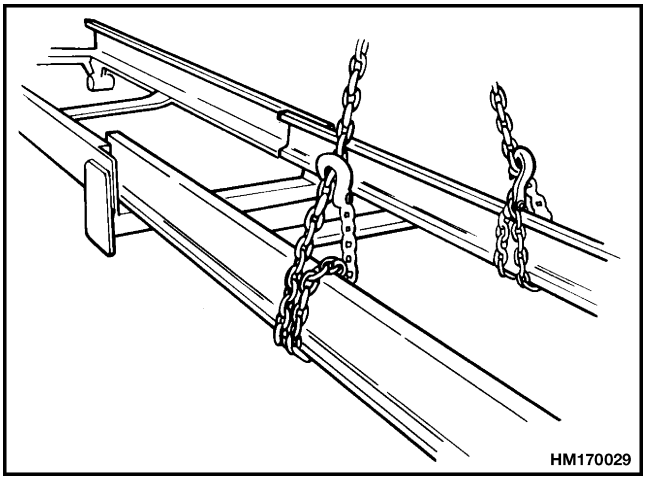


Figure 119. Connecting a Crane

WARNING

Cleaning solvents may be flammable and toxic and can cause severe skin irritation. When using commercial cleaning solvents, always comply with solvent manufacturer's recommended safety precautions.

WARNING

Compressed air can move particles so that they cause injury to the user or to other personnel. Make sure that the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eyes.

2. Clean the lift chains by soaking in solvent for 30 minutes to remove all dirt and grease. Hang lift chains up and remove solvent using compressed air.

WARNING

Never replace only the worn section of a chain. Replace the complete chain. Never replace only one chain of a chain pair. Replace both chains. Damage to the lift truck and serious injury can occur if lift chains are not replaced correctly.

NOTE: The chains must be inspected in the area of chain that passes over the chain sheave during the first portion of a lift. These links will show maximum wear.

3. Inspect the lift chains for wear and damage. A lift chain becomes longer when it is worn. If a chain is 3% longer than a new lift chain, the lift chain must be replaced.

4. If a chain scale is available (Hyster Part No. 599737) , check lift chains as shown in Figure 120. If a chain scale is not available measure 20 links of chain. Measure from the center of a pin to the center of another pin 20 pitches away. Compare the length with the chart in Figure 120. Replace chain if the length of 20 links of the worn section is more than the maximum wear limit.

5. Lubricate lift chains by soaking them in SAE 30 engine oil for 30 minutes. Hang chains over a drip pan for one hour to remove excess oil.

NOTE: Chain anchor pins **Must** be replaced anytime chains are replaced.

6. Inspect chain anchors, chain anchor pins, and chain anchor restraints. Replace any parts that are worn or damaged.

WARNING

Cleaning solvents may be flammable and toxic and can cause severe skin irritation. When using commercial cleaning solvents, always comply with solvent manufacturer's recommended safety precautions.

WARNING

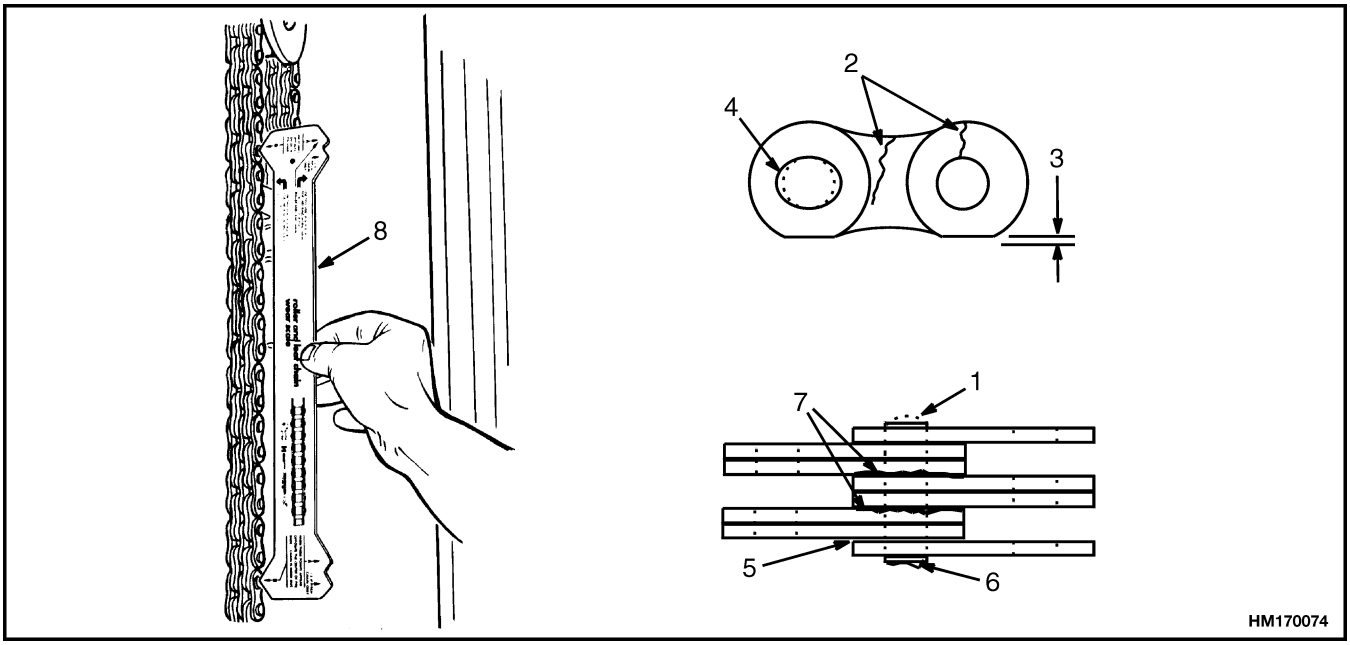
Steam can cause serious burns. Wear protective clothing, gloves, and eye protection. Never expose your skin to steam.

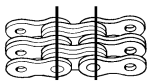
7. Clean mast weldments with steam or solvent.

WARNING

Improper welding procedures can damage the structure of the mast or cause incorrect function of the mast which can result in serious injury to personnel. Consult your lift truck dealer for more information before welding on the mast

8. Inspect the sliding surfaces for wear or damage. Inspect the load roller contact surfaces for wear or damage. Inspect all welds for cracks.



Pitch 	Total Length of 20 Links (Pitch) of New Chain	Wear Limit - The Maximum Length of 20 Links
12.7 mm (0.5 in.)	254.0 mm (10.0 in.)	261.6 mm (10.3 in.)
15.9 mm (0.6 in.)	317.5 mm (12.5 in.)	327.0 mm (12.9 in.)
19.1 mm (0.8 in.)	381.0 mm (15.0 in.)	392.4 mm (15.4 in.)
25.4 mm (1.0 in.)	508.0 mm (20. in.)	523.3 mm (20.6 in.)

NOTE: THE INSTRUCTION FOR MEASURING CHAIN WEAR ARE SHOWN ON THE CHAIN WEAR SCALE.

1. WORN PIN
2. CRACKS
3. EDGE WEAR
4. HOLE WEAR
5. LOOSE LEAVES
6. DAMAGED PIN
7. RUST
8. CHAIN WEAR SCALE

Figure 120. Lift Chain Check

Assemble

NOTE: The shims for the load rollers keep the weldments parallel and provide correct clearance. During assembly, shims should be reinstalled in the same location they were in before disassembly. Check the clearance and adjust the shims for wear or for changes caused by repairs. The strip bearings are also adjusted by using shims. Shims for strip bears should also be reinstalled in the same location they were in before disassembly. See Mast Adjustments in this manual for the adjustment procedures.

1. Put the outer mast on the floor with the carriage side up. Connect a crane with a capacity of at least 907 kg (2000 lb) to the center of the intermediate mast. Fit the lower stub shafts of the intermediate mast into the notches in the top of the outer mast. Slide intermediate mast into the outer mast so the stub shafts are seen at the top and bottom of both weldments.

NOTE: The load roller must be in place before strip bearings can be shimmed.

2. Install strip bearings and the shims on the channels of the outer mast. See Figure 121. Apply chassis lube to the bearing surfaces. Check the clearance of the strip bearings as described in Mast Adjustments in this manual.

3. Install load rollers and shims on the outer mast and at the bottom of the intermediate mast. Before doing Step 4, adjust the intermediate mast and check the clearance of the load rollers as described in Mast Adjustments in this manual.

NOTE: The clearance check and adjustment in Step 4 is only an initial setup. The final check and adjustment is done after the mast is installed on the lift truck.

4. Install the main lift cylinders. Push intermediate mast to engage the main lift cylinders. Check the clearance at the top of the main lift cylinder mounts. Add or remove washers at the top of the cylinder rods in the same location they were in before disassembly. Install the snap ring and washer at the top of the main lift cylinders. See Figure 114.

5. Install housing for the lowering control valve on the outer mast. Tighten the nuts for the lowering control valve to 18 N•m (13 lbf ft). Install the lowering control valve in the housing. Connect the hydraulic lines and fittings between the housing and the main lift cylinders. See Figure 114.

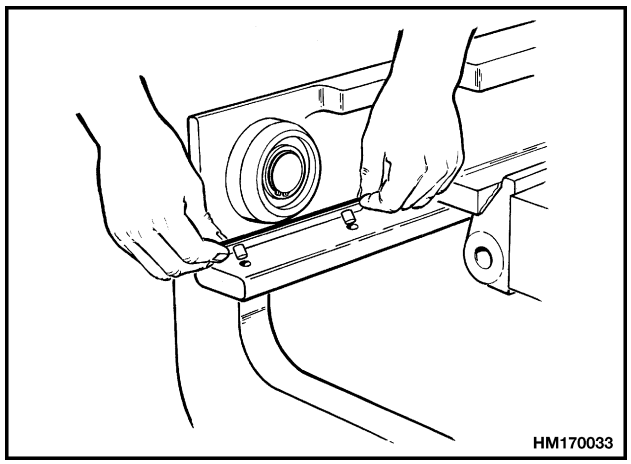


Figure 121. Strip Bearings

6. Install chain sheaves at the intermediate mast. See Figure 118.

7. Install capscrews and isolators at the mount for main lift cylinders. Tighten capscrews to 38 N•m (28 lbf ft). See Figure 118.

8. Connect a crane with a capacity of at least 907 kg (2000 lb) to the center of the inner mast. See Figure 119. Slide the inner mast into the intermediate mast so the stub shafts are seen at the top and bottom of both.

NOTE: Use multipurpose grease #2 with 2 to 4% Molybdenum Disulfide for normal operations.

NOTE: The load rollers must be in place before bearing strips can be shimmed.

9. Install the strip bearings and the shims on the channels of the intermediate mast. See Figure 118 and Figure 121. Apply grease to the bearing surfaces. Install the load rollers and the shims on the intermediate and inner masts. Before doing the next step, adjust the inner mast as described in Mast Adjustments in this manual.

10. Connect the main lift chains to the chain anchors at the main lift cylinder mounts. Put the lift chains over the chain sheaves and connect them to the anchors at the bottom of the inner mast.

11. Install the free-lift cylinder in the mounts on the inner mast. Install the brackets for the cylinder and tighten the nuts to 53 N•m (39 lbf ft). The nuts are installed on the bracket side of the free-lift cylinder. See Figure 115.

12. Install the chain sheave for the free-lift cylinder. Tighten the capscrew for the chain sheave to 66 N•m (49 lbf ft). Install the hydraulic hose and tubing for the free-lift cylinder.

13. Connect the free-lift chains to the chain anchors at the crossmember. Attach a wire between the end of the lift chain and the bottom of the mast to control the lift chain during mast installation. See Figure 115.

Install

1. Install new bushings into mast mounts at bottom of outer mast. Be sure to align the hole in the bushing with the lube fitting hole in the bottom of the outer mast. See Figure 111. Bushing must be flush with outer mast surface.

2. Apply an even coat of grease to pivot pins and install them into mounts at bottom of outer mast. See Figure 113.

3. Install washer and lube capscrew in hole in bottom of outer mast. Tighten lube capscrew to 25 N•m (18 lbf ft). Install lube fitting onto lube capscrew. Tighten lube fitting to 6 N•m (53 lbf in) See Figure 111 or Figure 116.

WARNING

The mast is heavy. The mast can weigh approximately 907 kg (2000 lb). Make sure all lifting devices (hoists, cables, chains, slings, etc.) are suitable and of adequate capacity to lift the mast.

4. Connect crane to top of mast using chains. Make sure all mast uprights are fastened together. Make sure chains will not damage sheaves, tubing, or other parts of mast. Make sure crane has a capacity of at least 907 kg (2000 lb).

5. Use crane to position mast assembly onto its lower mounts. Position mast so pivot pins seat into hanger mounts on drive axle. Install capscrews that hold mast pivot pins to drive axle hangers. Tighten capscrews to 270 N•m (199 lbf ft). See Figure 112.

6. Install new tilt rod bushings into the tilt anchors on the outer mast. Be sure tilt bushing split is installed at the correct angle as shown Figure 111.

WARNING

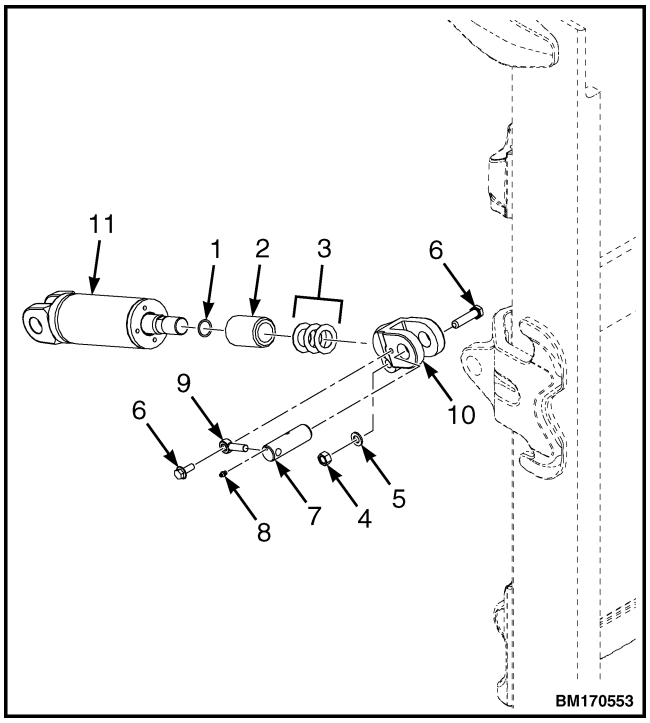
Use a pry bar, NOT your fingers, to align the tilt cylinder clevises with the outer mast. The cylinder or mast can shift and cause serious injury.

NOTE: Use multipurpose grease #2 with 2 to 4% molybdenum disulfide for normal operations.

7. Apply grease to pivot pins and connect tilt cylinders to mast using pivot pins. Install anchor pins and capscrews to rod ends. Apply anti-seize compound to capscrew threads and tighten 38 N•m (28 lbf ft).

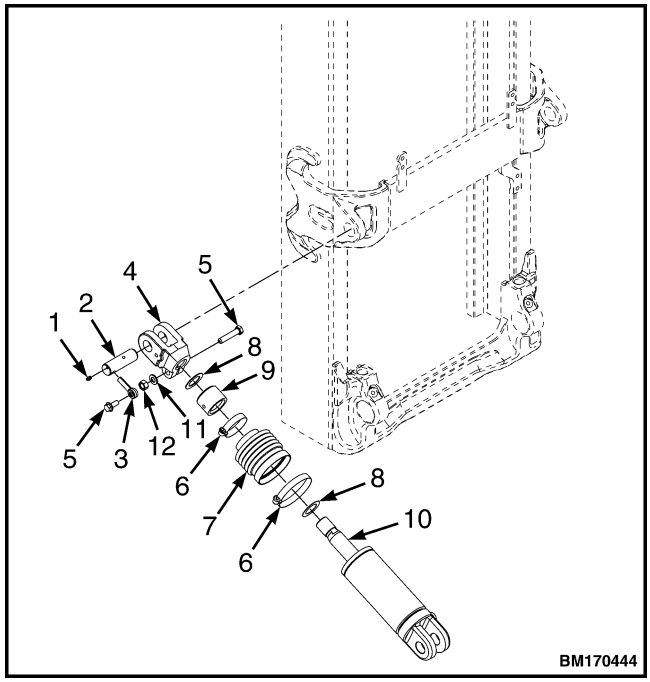
   See Figure 122 for lift trucks equipped with tilt cylinders without optional boot.

   See Figure 123 for lift trucks equipped with tilt cylinders with optional boot.



1. O-RING
2. SPACER
3. SHIMS
4. NUT
5. WASHER
6. CAPSCREW
7. PIVOT PIN
8. GREASE FITTING
9. ANCHOR PIN
10. CAPSCREW
11. ROD END

Figure 122. Mast Mounting, Tilt Cylinder Without Optional Boot



1. GREASE FITTING
2. PIVOT PIN
3. ANCHOR PIN
4. ROD END
5. CAPSCREW
6. CLAMP
7. BOOT
8. SHIM
9. SPACER
10. TILT CYLINDER
11. WASHER
12. NUT

Figure 123. Mast Mounting, Tilt Cylinder With Optional Boot, Lift Truck Models J2.2-3.5XN (J45-70XN) (A276)

8. Connect hydraulic line to lowering control valve. See Figure 114.

9. Install carriage as described in Carriages Repair, Three-Stage FFL Mast section in this manual.

WARNING

Never check for leaks by putting hands on hydraulic lines or components under pressure. Hydraulic oil under pressure can be injected into the skin.

10. Check tilt cylinder adjustment as described in **Cylinder Repair (Mast S/N F507, F508, F562, F563)** 2100SRM1668. Operate mast and check for leaks and correct operation. Check lift chains as described in Lift Chains Adjustment.

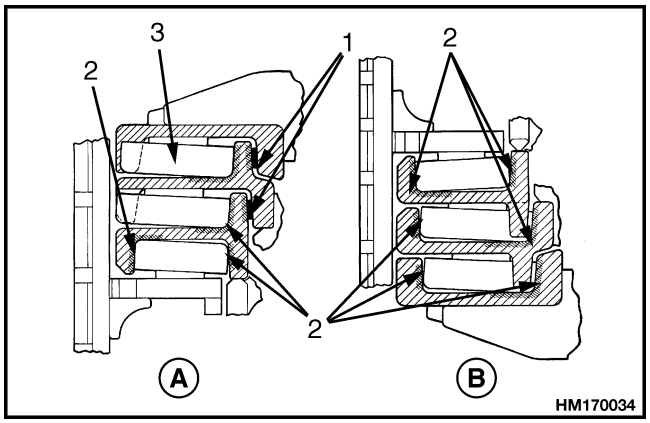
NOTE: Before checking for mast side kicking and adjusting the chain anchors on the main lift cylinders, the mast must be fully assembled to include the carriage, forks, load backrest and any attachments if the lift truck is equipped with one.

11. Adjust chain anchors on the main lift cylinders until the tops of the inner and outer mast are at the same level within ±1.5 mm (0.06 in.). See Figure 116.

12. Raise the mast, without a load to its full height and check for side kicking. Mast side kicking is when the mast moves either to the right or left as it is being raised to its full height. If the mast is side kicking, see the Mast Adjustments section in this manual for procedures to correct mast side kicking.

NOTE: The load rollers and sheaves have sealed bearings and do not need additional lubrication.

13. Lubricate sliding surfaces and load roller surfaces along full length of channels as shown in Figure 124. Apply lubricant only to surfaces indicated.



A. UPPER LOAD ROLLERS
B. LOWER LOAD ROLLERS

1. LUBRICATE STRIP BEARINGS SURFACES
2. LUBRICATE LOAD ROLLER SURFACES
3. LOAD ROLLER

Figure 124. Lubricate Mast

Header Hose Installation and Adjustment

Remove

Read and follow the
Safety Procedures When Working Near Mast as well as all **WARNINGS** and **CAUTIONS** before removing and header hoses.

NOTE: Access to some of the fittings can be difficult. If necessary, operate the hydraulic system to move mast weldments or the carriage. Make sure the hydraulic system does not have pressure as described in Step 1.

1. To replace any header hoses, fully lower the carriage. Make sure the hydraulic system does not have hydraulic pressure. Hold the control for each function in the forward position for approximately five seconds to release the pressure. Make sure the hydraulic pump does not operate. Move the key or keyless switch, if equipped, to the **OFF** position.

2. Disconnect battery and put a tag or lock on the battery connector.

3. Disconnect header hoses and install caps on ends to prevent dirt and debris from entering the hydraulic system.

Installation

WARNING

Always wear the proper protective equipment including eye protection and petroleum-resistant gloves when handling hydraulic oil. Thoroughly wash oil from exposed areas of skin as soon as possible.

Never check for leaks by putting hands on hydraulic lines or components under pressure. Hydraulic oil under pressure can be injected into the skin.

WARNING

Before working on or near the mast, see Safety Procedures When Working Near Mast in this section.

Some lift trucks are equipped with auxiliary hydraulic functions that are fastened to the carriage. Examples of attachments that use these auxiliary functions are sideshift carriages, roll clamps, and fork positioners. These auxiliary functions require header hoses for their operation.

NOTE: This procedure is for the four function option. The three function option will have hoses **A** and **B** only. See Figure 125

NOTE: The carriage height must be correct before the header hose tension can be measured. See Carriage Adjustments section in this manual for the carriage adjustment procedure.

1. Before installing new header hoses, add tension marks to each hose. See Figure 126 and Figure 127.

2. Clamp one end of the hose in a vise. **DO NOT** clamp on the threads. Pull on the other end until hose is straight. **DO NOT** apply enough force to stretch the hose.

NOTE: The header hose tension specification is 2.0% ±1.0%. Install hose caps to marked end (truck end) of hoses.

3. Put reference marks on each free-lift header hoses. Starting at either end of hose, place a mark at 400 ±10 mm (16.0 ±0.40 in.). This is dimension **FL1**. See Figure 126.

4. From dimension **FL1**, place another mark at 500 ±2.0 mm (20.0 ±0.08 in.). This is dimension **FL2**. See Figure 126.

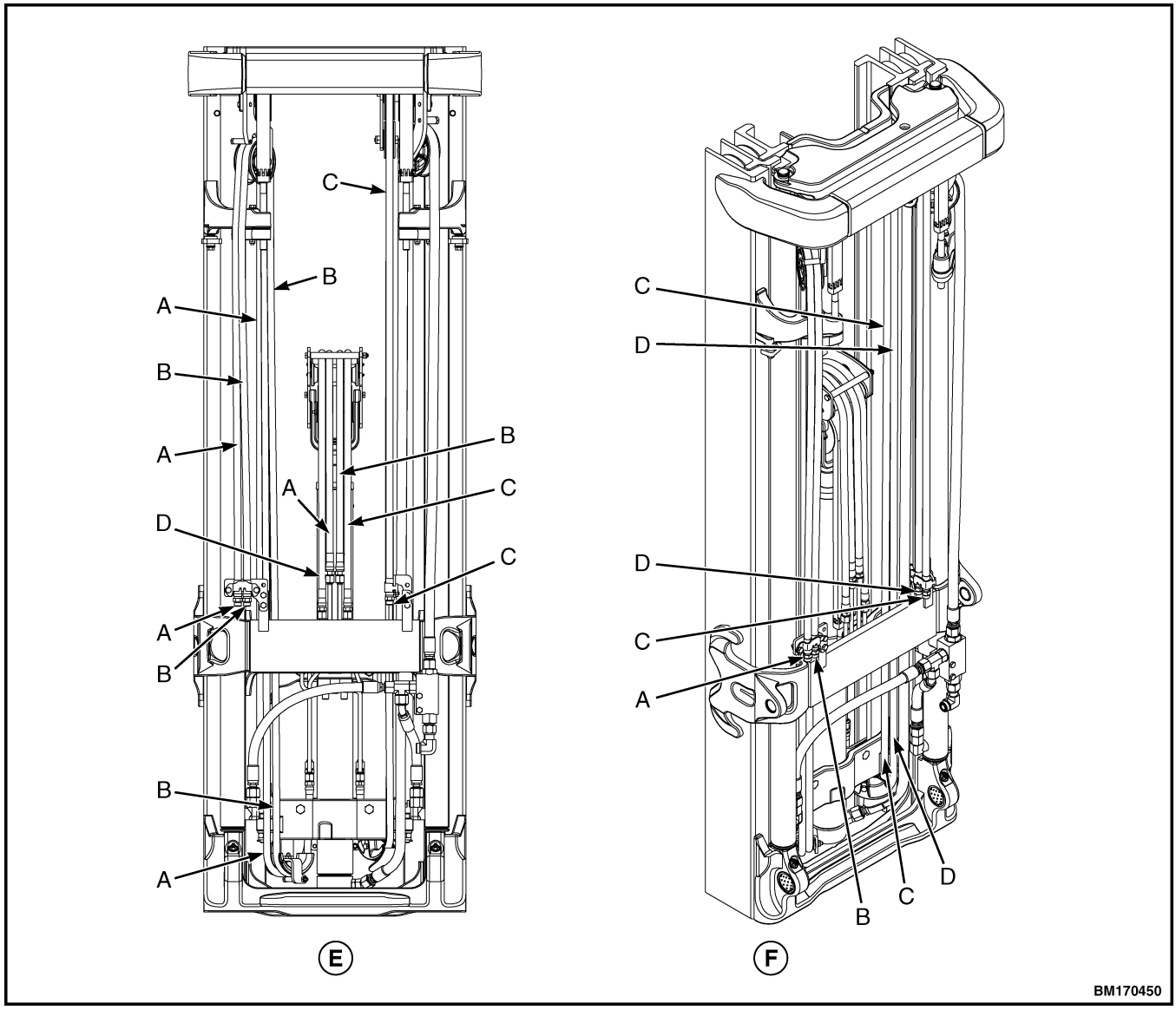
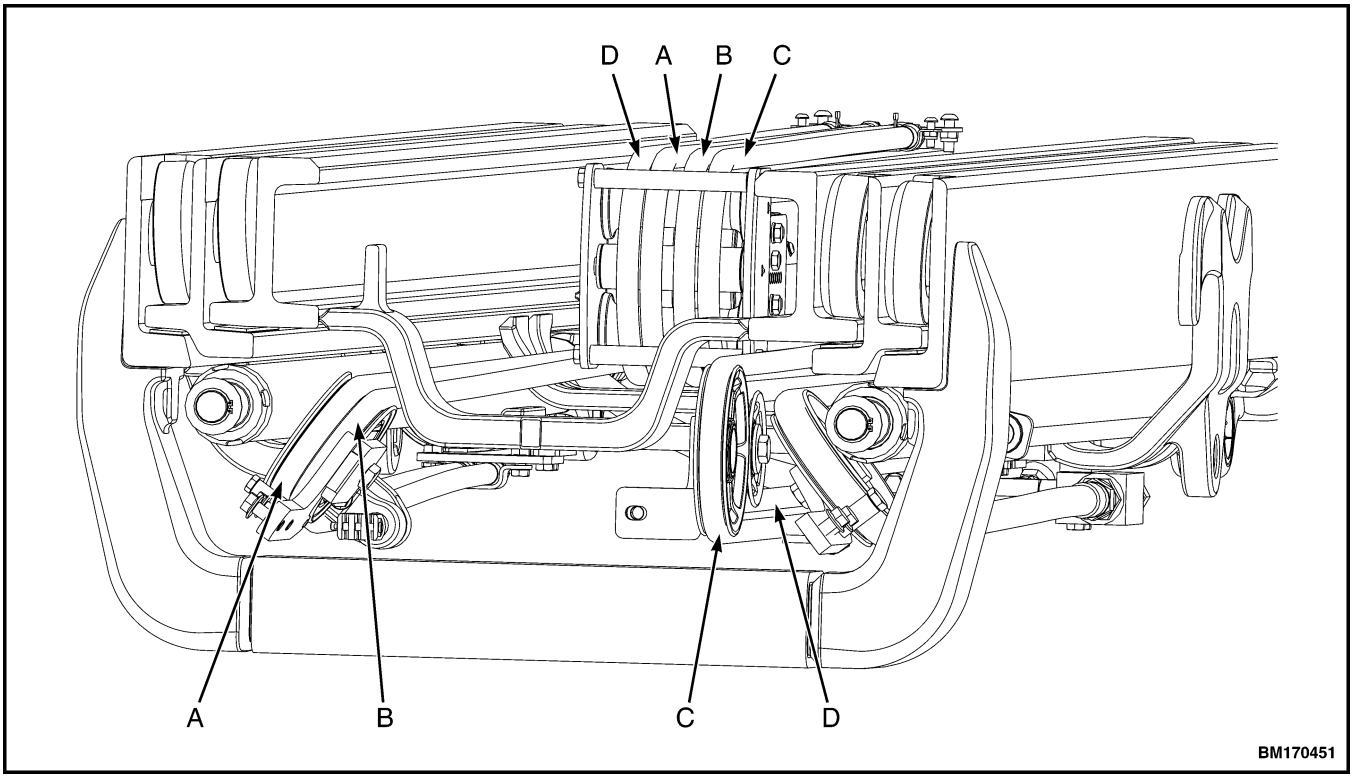
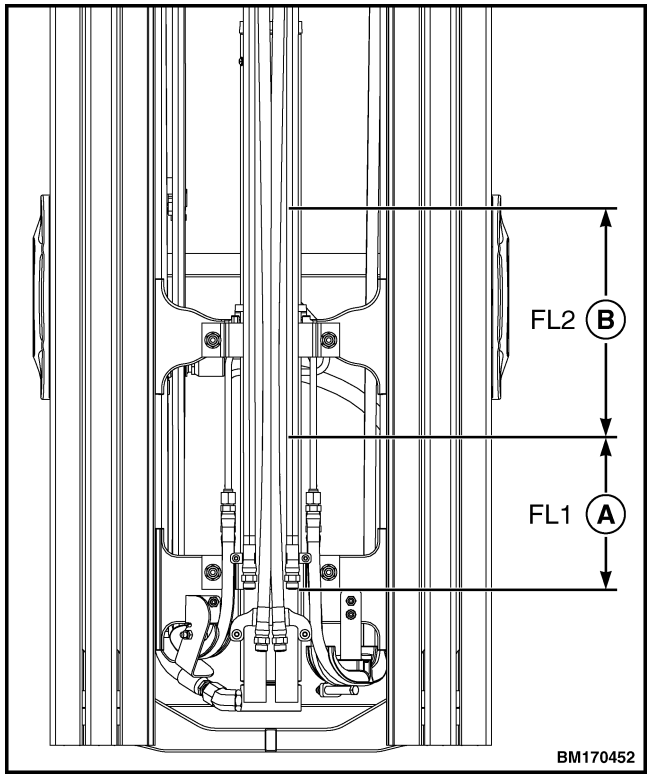


Figure 125. Header Hose Alignment for Three-Stage FFL Mast (Sheet 1 of 2)



A. HEADER HOSE
B. HEADER HOSE
C. HEADER HOSE
D. HEADER HOSE
E. REAR VIEW (DRIVER'S VIEW)
F. LEFT SIDE VIEW

Figure 125. Header Hose Alignment for Three-Stage FFL Mast (Sheet 2 of 2)



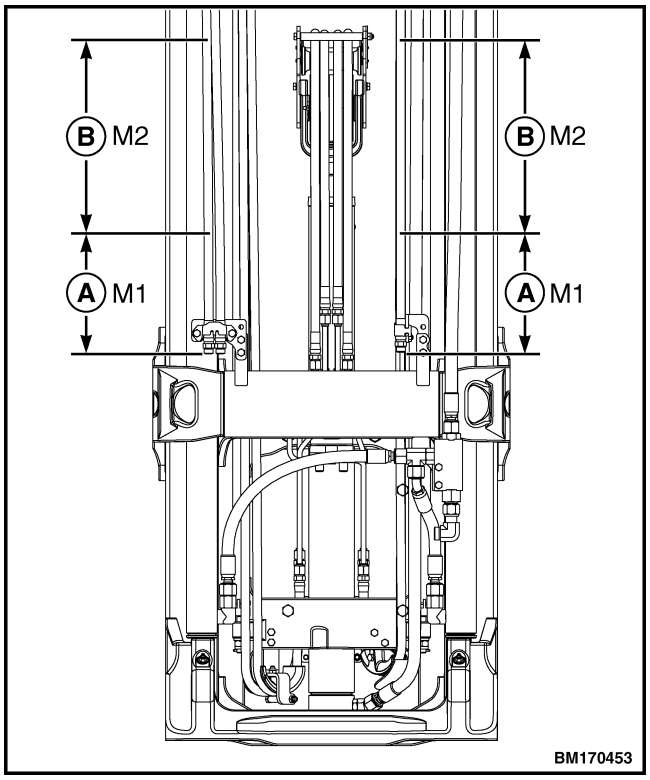
A. DIMENSION = 400 ±10 mm (16.0 ±0.40 in.)
B. DIMENSION = 500 ±2.0 mm (20.0 ±0.08 in.)

INSTALL LENGTH (FL2)	HOSE TENSION
505 mm (19.8 in.)	1%
510 mm (20.1 in.)	2%
515 mm (20.3 in.)	3%

Figure 126. Free-Lift Header Hose Reference Marks

5. Put reference marks on main lift header hoses. Starting at either end of the hose, place a mark at 100 ±10 mm (4.0 ±0.40 in.). This is dimension **M1**. See Figure 127.

6. From dimension **M1**, place another mark at 500 ±2.0 mm (20.0 ±0.08 in.). This is dimension **M2**. See Figure 127.



A. DIMENSION **M1** = 100 ±10 mm (4.0 ±0.40 in.)
B. DIMENSION **M2** = 500 ±2.0 mm (20.0 ±0.08 in.)

INSTALL LENGTH (M2)	HOSE TENSION
505 mm (19.8 in.)	1%
510 mm (20.1 in.)	2%
515 mm (20.3 in.)	3%

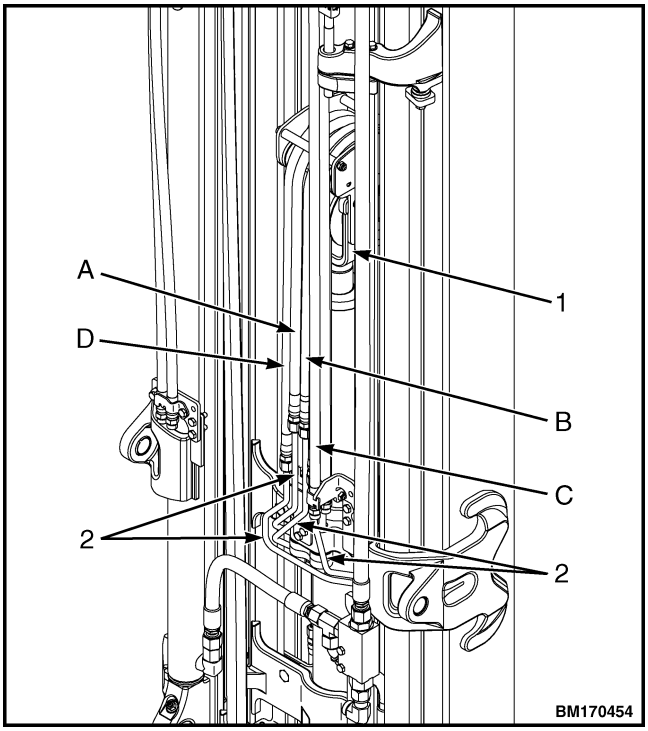
Figure 127. Main Lift Header Hose Reference Marks

7. Route free-lift hoses through the crosshead and attach them to tube assemblies. See Figure 128.

8. For three function main lift hoses (hoses **A** and **B**), attach hoses to free-lift tube assemblies. Route hoses through turnaround bracket and secure hoses to turnaround bracket and turnaround with spacer. See Figure 129.

9. Route three function main lift hoses up over hose sheaves and secure hoses to hose sheaves with spacer. Attach marked end of hoses to bracket on mid-outer crossmember. See Figure 129.

10. Attach four function main lift hoses (hoses **C** and **D**), to free-lift tube assemblies and route hoses through turnaround bracket. See Figure 130.



A. FREE-LIFT HEADER HOSE **A**
B. FREE-LIFT HEADER HOSE **B**
C. FREE-LIFT HEADER HOSE **C**
D. FREE-LIFT HEADER HOSE**D**

1. CROSSHEAD
2. TUBE ASSEMBLY

Figure 128. Free-Lift Header Hose Installation

11. Route four function hoses up and over hose sheaves. Attached marked end of hoses to bracket (either upper or lower bracket) on mid-outer crossmember. See Figure 130.

NOTE: The header hose tension specification between marks is 510 ±5 mm (2.0 ±1.0%).

12. With header hoses installed on mast and the carriage correctly adjusted (see Carriage Adjustments), and the forks off the ground, measure the distance between marks **FL1** and **FL2** as follows:

    a. If tension mark measurement is less than 505 mm (20.0 in.), raise crosshead plate one hole and take measurement again to insure it is within specifications. See Figure 132.

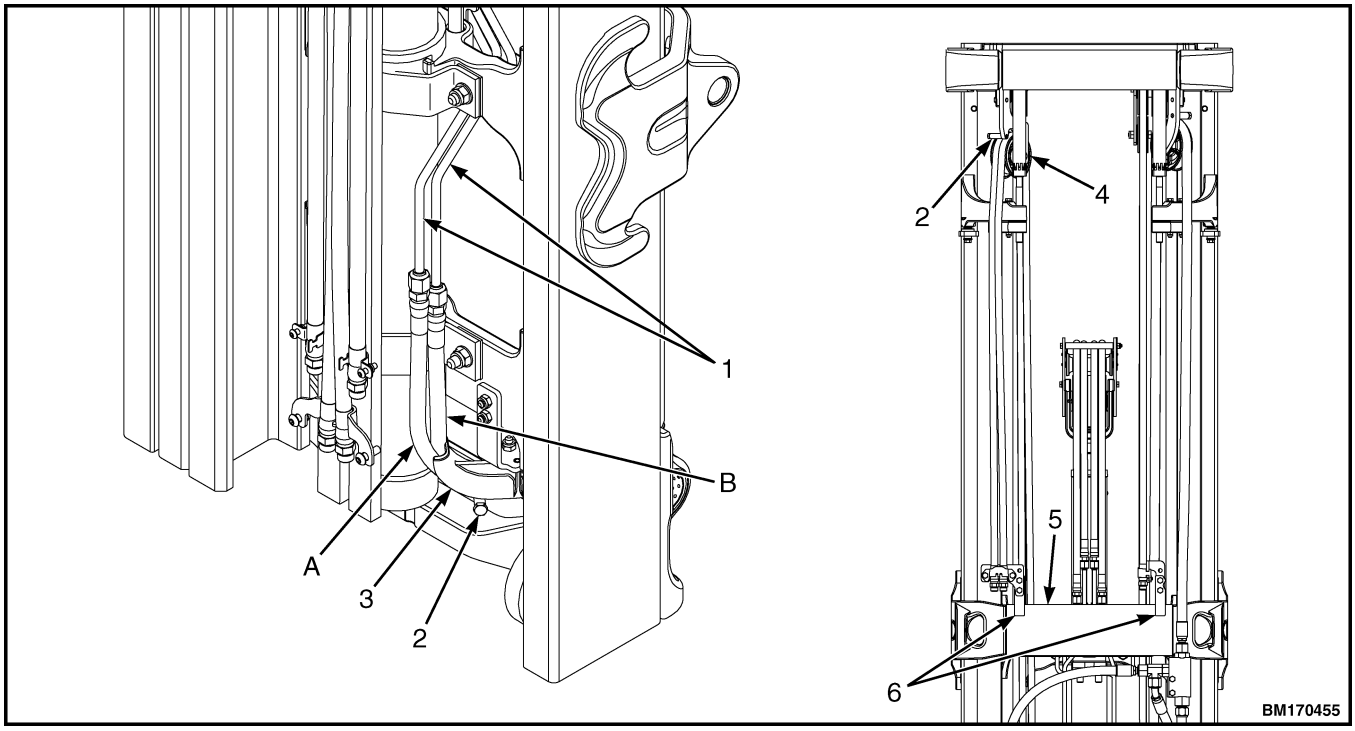
    b. If tension mark measurement is more than 515 mm (20.3 in.), lower crosshead plate one hole and take measurement again to insure it is within specifications. See Figure 132.

    c. If crosshead can not be moved, or if after moving crosshead plate two holes in either direction, header hose tension is still not correct, replace the hose and re-set crosshead plate to starting position and do Step a and Step b again with new hose.

NOTE: The header hose tension specification between marks is 510 ±5 mm (2.0 ±1.0%).

13. With header hoses installed on mast and the carriage correctly adjusted (see Carriage Adjustments), and the forks off the ground, measure the distance between marks **M1** and **M2** as follows:

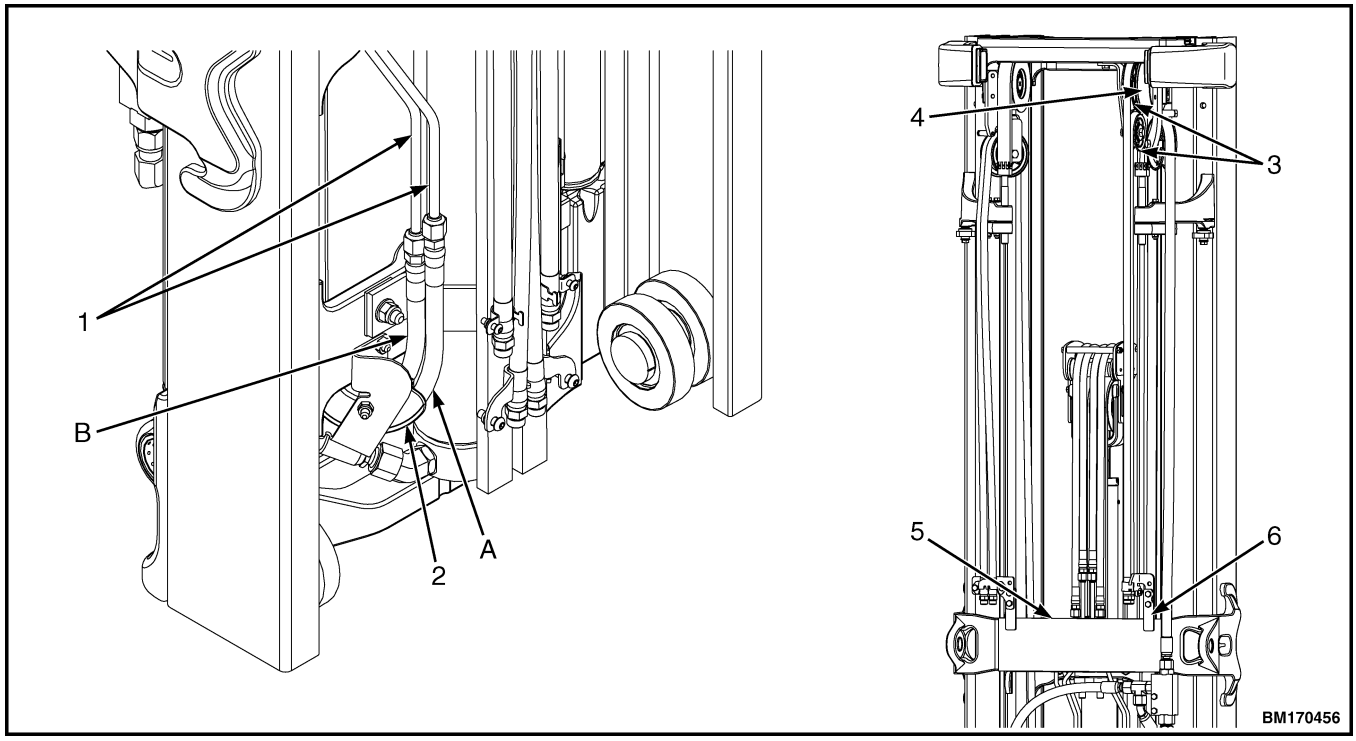
    a. If tension mark measurement is less than 505 mm (20.0 in.), lower the upper bracket one hole and take measurement again to insure it is within specifications. If tension mark measurement is still less than 505 mm (20.0 in.), the hose has been permanently stretched. Replace hose and re-set upper bracket to original position and measure again with new hose. See Figure 131.



A. THREE-FUNCTION HEADER HOSE **A**
B. THREE-FUNCTION HEADER HOSE **B**

1. FREE-LIFT HOSE TUBE
2. SPACER
3. TURNAROUND BRACKET
4. HOSE SHEAVE
5. MID-OUTER CROSSMEMBER
6. BRACKET (LOWER)

Figure 129. Three-Function Header Hose Installation



A. FOUR-FUNCTION HEADER HOSE **C**
B. FOUR-FUNCTION HEADER HOSE **D**

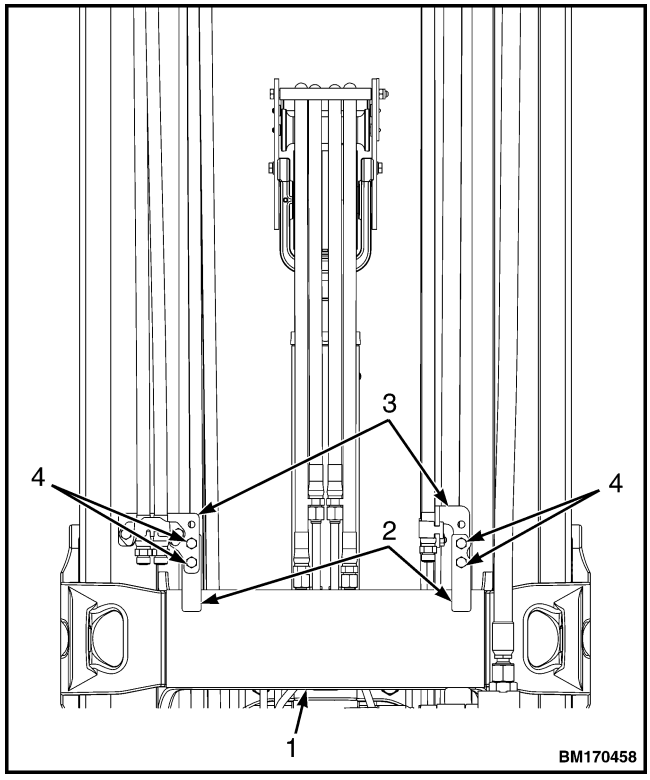
1. FREE-LIFT HOSE TUBE
2. TURNAROUND BRACKET
3. HOSE SHEAVE
4. CHAIN SHEAVE
5. MID-OUTER CROSSMEMBER
6. BRACKET (LOWER)

Figure 130. Four-Function Header Hose Installation

b. If tension mark measurement is more than 515 mm (20.3 in.), raise the upper bracket one hole and take the measurement again to insure it is within specifications. If the hose has been permanently over stretched, replace hose with a new hose. See Figure 131.

14. Raise and lower mast two to three times to check for proper routing of hoses. Hoses should smoothly go over the hose sheaves and not rub against crossmembers or the load backrest.

15. Tilt the mast two to three times and check that the hoses routed between truck cowl and mast move freely during both forward and backward tilt.



1. MID-OUTER CROSSMEMBER
2. LOWER BRACKET
3. UPPER BRACKET
4. CAPSCREW AND NUT

Figure 131. Main Lift Header Hose Adjustment

Adjustment

NOTE: Tire size variations and adjusting of the lift chains may require adjustment of free-lift and main lift header hose tension. Lift chain adjustment for tire wear will reduce header hose tension.

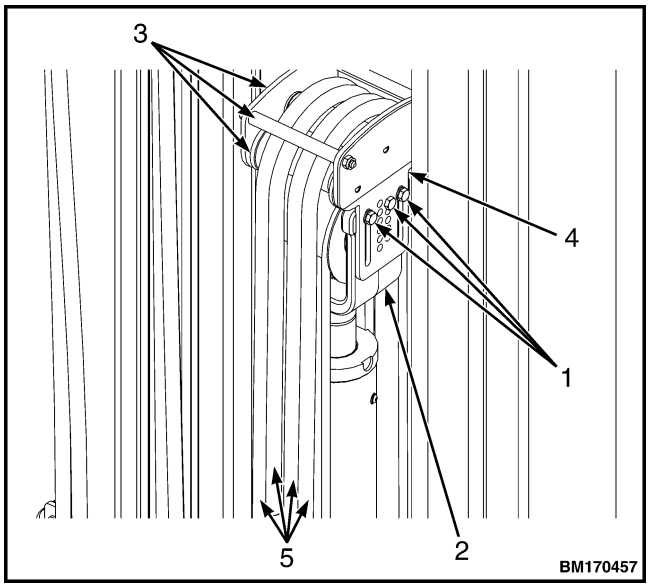
1. To adjust the free-lift header hoses, perform the following:

a. Raise carriage at least 100 mm (4.0 in.)

b. Place blocks under lower carriage bar and lower carriage onto blocks to relieve hose tension. Chain carriage to inner mast. See Safety Procedures When Working Near Mast in this manual.

c. Loosen six (three on each side) capscrews on crosshead plate. Remove middle capscrew. See Figure 132.

d. Move free-lift header hose roller assembly up to increase hose tension, and down to decrease hose tension. See Figure 132.



1. CAPSCREW
2. CROSSHEAD
3. HEADER HOSE ROLLER ASSEMBLY
4. CROSSHEAD PLATE
5. HEADER HOSES

Figure 132. Free-Lift Header Hose Adjustment

2. To adjust main lift header hoses, perform the following:

   a. Raise inner mast and place a block under inner mast.

   b. Chain inner mast weldment to outer or intermediate mast weldment. See Safety Procedures When Working Near Mast in this manual.

   c. Lower inner mast onto block.

   d. Loosen upper bracket above mid-outer crossmember and then lower upper bracket until correct hose tension is achieved. Tighten nut to 18 N•m (159 lbf in). See Figure 131.

Mast Adjustments

LOAD ROLLER, ADJUST

NOTE: Shims are installed on both sides of the load rollers. **DO NOT** add to or remove shims from the stub shafts. To change the position of the roller on the stub shaft, move the shims from one side of the load roller to the other.

During assembly, the shim arrangement will be approximately the same as before disassembly. Check the clearance and adjust shims after repairs have been completed.

1. The load rollers control the alignment of the mast uprights. See Figure 133. The alignment conditions are provided on a list below with the most important condition first.

   a. The mast uprights must be parallel to each other.

   b. Use shims to adjust load rollers so there is zero clearance between load roller and channel at point of tightest fit.

   c. The number of shims under a load roller must be approximately the same as the stub shaft in the opposite side of the upright. This ensures the uprights will be approximately in the center.

2. Perform the following steps to adjust the mast load rollers:

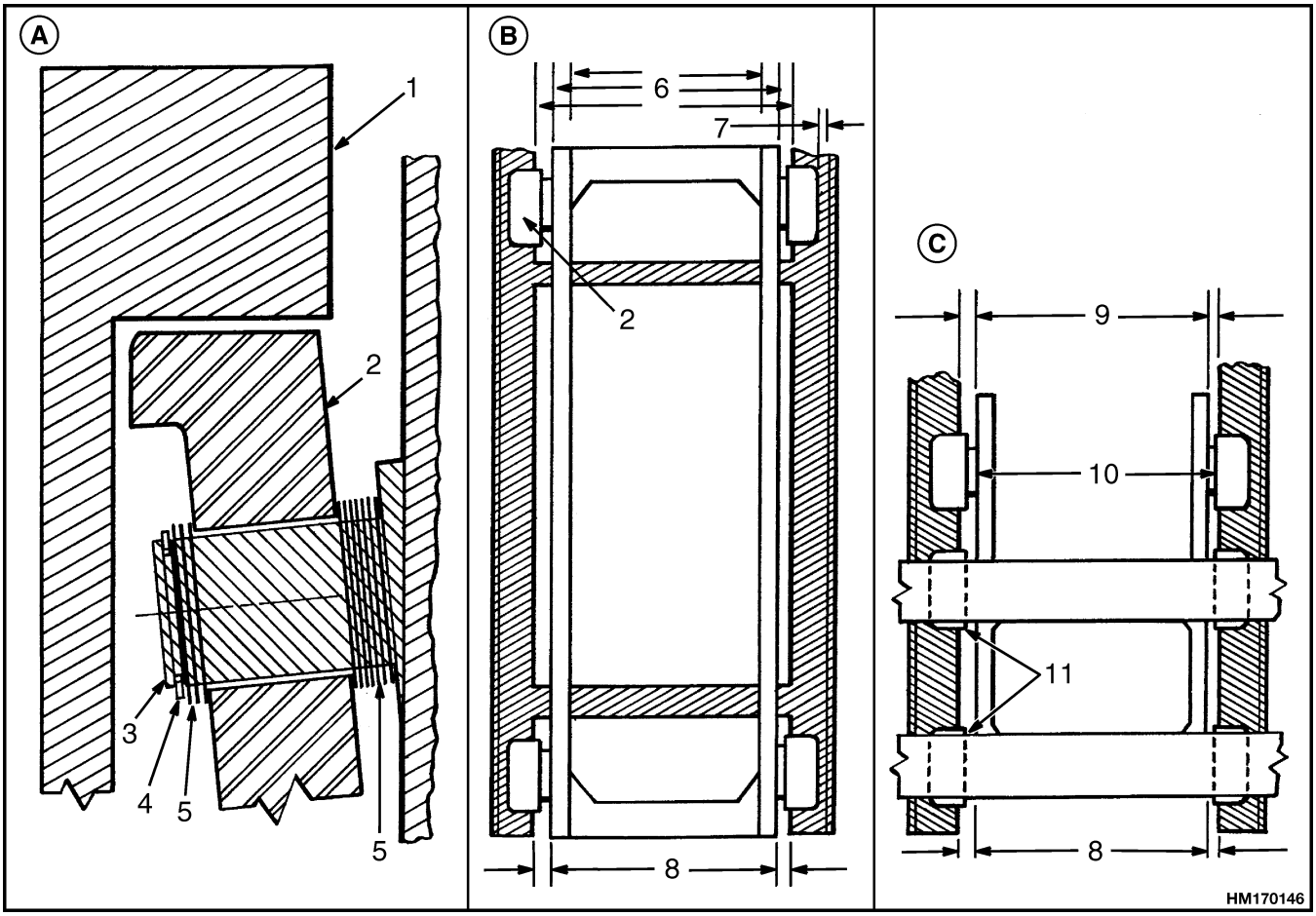
   a. Use a crowbar to move mast uprights from side to side to measure movement. Measure movement in a minimum of three different positions of each mast upright.

   b. Separate mast uprights and change shim arrangements as required. Assemble uprights. Slide upright all the way to the top and bottom to find the tightest fit.

   c. Repeat Step a and Step b until there is zero clearance at the point of the tightest fit.

   d. Measure distance between channels of mast uprights on top and bottom. Change shims to keep distance equal between top and bottom so mast uprights are parallel. Also make sure the mast uprights are parallel within 1.5 mm (0.060 in.).

3. Adjust strip bearings. See Figure 134. Insert shims under strip bearing. Adjust clearance until there is less than 0.8 mm (0.030 in.) at the tightest fit. See Figure 133.

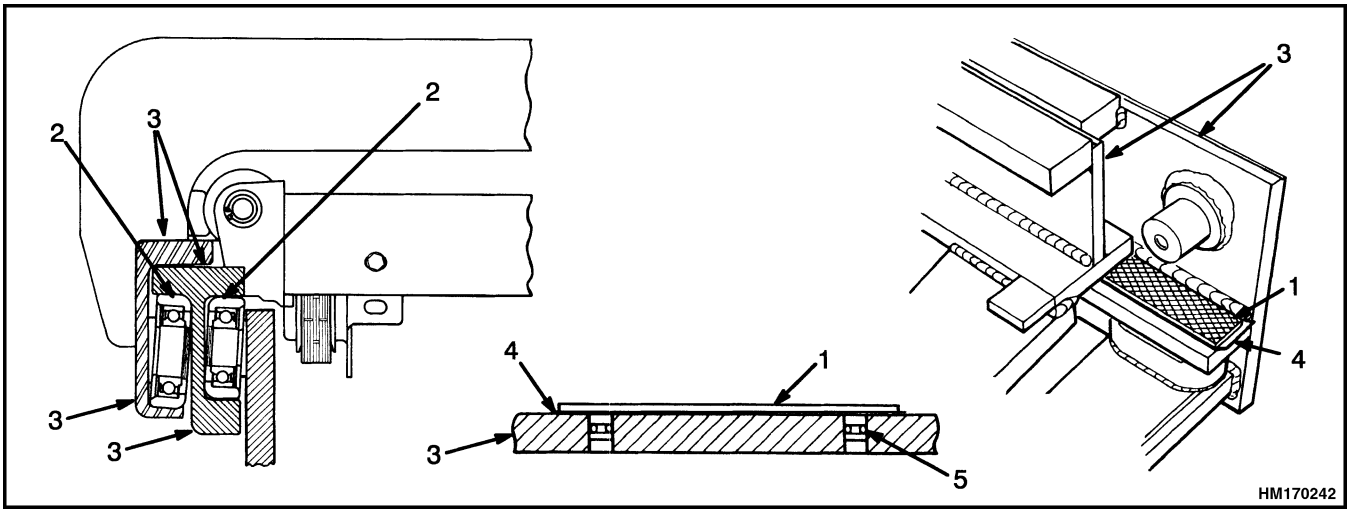


NOTE: USE SHIMS TO KEEP CARRIAGE AND MAST UPRIGHTS PARALLEL, TO GIVE APPROXIMATELY EQUAL SPACE BETWEEN BOTH SIDES OF CARRIAGE AND UPRIGHTS, AND TO GIVE ZERO CLEARANCE AT POINT OF TIGHTEST FIT.

A. TOP VIEW
B. MAST FRONT VIEW
C. CARRIAGE FRONT VIEW

1. CHANNEL
2. LOAD ROLLER
3. STUB SHAFT
4. SNAP RING
5. SHIMS
6. PARALLEL TO CHANNEL ±1.5 mm (0.060 in.)
7. ZERO CLEARANCE AT POINT OF TIGHTEST FIT
8. EQUAL SPACE ±1.5 mm (0.060 in.)
9. PARALLEL TO CHANNEL ±1.5 mm (0.060 in.)
10. PUT SPACER ON OUTSIDE OF TOP LOAD ROLLER, UNDER SNAP RING
11. SHIM FOR ZERO CLEARANCE AT POINT OF TIGHTEST FIT

Figure 133. Mast Adjustments



1. STRIP BEARING
2. LOAD ROLLER
3. MAST UPRIGHT
4. SHIMS
5. O-RING

Figure 134. Strip Bearings Arrangement

MAST SIDE KICKING, ADJUST

Mast side kicking is where the mast, without a load, moves either to the right or left as it is being fully raised. When this happens, it is an indication that one of the main lift cylinders is raising at a faster rate then the other. Before checking for mast side kicking, the mast must be completely assembled to include the carriage, forks, load backrest, and any attachments if the lift truck is equipped with one.

To adjust the mast for side kicking, do the following:

1. Place the lift truck on a level surface and apply the parking brake.

2. Raise the mast and visually inspect it as it reaches its full height.

3. If the mast is moving to the left, shims will need to either be added or removed from the top of the right main lift cylinder. If mast moves to the right, shims will need to either be added or removed from the top of the left main lift cylinder. See Two-Stage LFL Mast Repair or Three-Stage FFL Mast Repair.

4. If shims will be added, use the smallest shim size that can be used on the mast that is being adjusted. See the **Parts Manual** for shim sizes and part numbers.

5. Raise the mast again and visually inspect it to ensure that it is no longer side kicking. If side kicking is still present, repeat Step 3 and Step 4.

Carriage Adjustments

1. Install the load rollers on the carriage. Install the shims for the load rollers onto the stubshaft in the same sequence as when disassembled. There are no shims under the top load rollers.
   - See Figure 135 for lift trucks equipped with a two-stage LFL mast
   - See Figure 136 for lift trucks equipped with a three-stage FFL mast
2. Use a lifting device to raise carriage. Find the point of tightest fit between the carriage load rollers and inner mast channels.
3. Remove carriage from mast. Adjust shim arrangement for each roller for clearance between roller and inner channel. Repeat Step 1 and Step 2 until there is zero clearance at the point of tightest fit.
4. Keep shim arrangement on each side of carriage approximately equal. The carriage must be centered within the inner mast within +1.50 mm (0.06 in.).

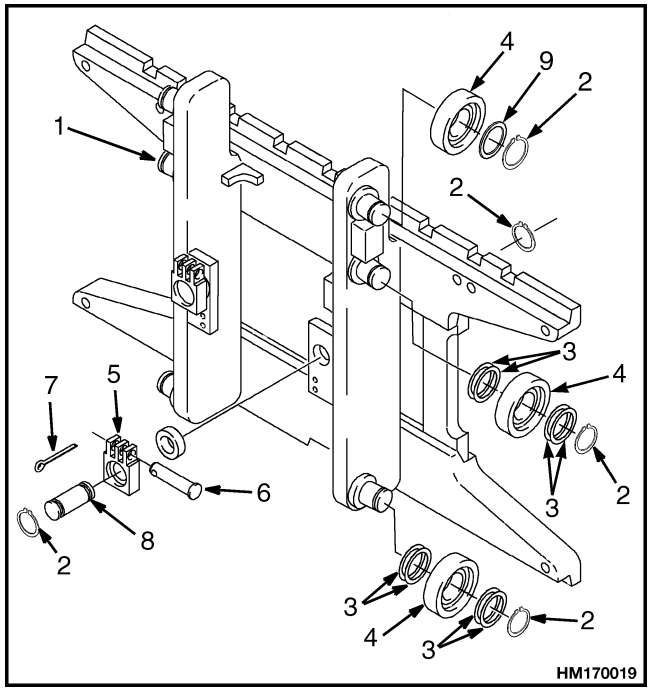
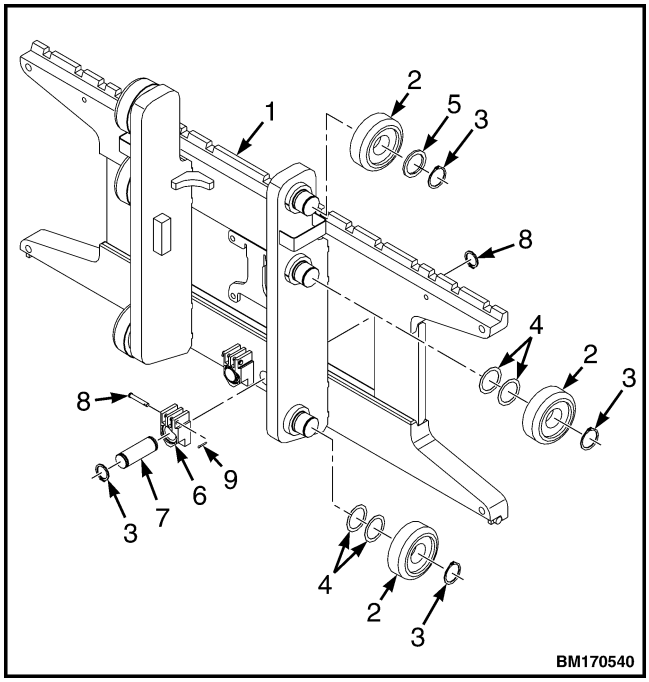


Figure 135. Carriage Adjustments, Two-Stage LFL Mast

Legend for Figure 135.

1. CARRIAGE
2. SNAP RINGS
3. SHIM
4. LOAD ROLLER
5. CHAIN ANCHOR
6. CHAIN PIN
7. COTTER PIN
8. ANCHOR PIN
9. SPACER



1. CARRIAGE
2. SNAP RINGS
3. SHIM
4. LOAD ROLLER
5. CHAIN ANCHOR
6. CHAIN PIN
7. COTTER PIN
8. ANCHOR PIN
9. SPACER

Figure 136. Carriage Adjustments, Three-Stage FFL Mast

5. Check lateral movement of carriage:

   a. Fully lower carriage to ground.

   b. Place hand or small pry bar between top of carriage side plate and the inner channel flange. See Figure 133.

   c. Move carriage back and forth and check movement.

   d. Carriage lateral movement must not be greater than 2.5 mm (0.10 in.).

   e. If carriage lateral movement is greater than 2.5 mm (0.10 in.), add or remove shims and repeat Step a through Step d until correct movement is achieved.

CAUTION

Too much grease will cause the rollers to slide and wear flat areas on the rollers and introduce contamination into and on mast channels.

6. After adjustment, lubricate channels with a thin layer of grease. Adjust hydraulic hoses and make sure connections are correct, if the carriage is equipped with hydraulic attachments.

Lift Chains Adjustment

WARNING

When working on or near the mast, see the section Safety Procedures When Working Near Mast.

During test procedures for the hydraulic system, fasten the load to the carriage with chains to prevent it from falling. Keep all personnel away from the lift truck during the tests.

Never allow anyone under a raised carriage. DO NOT put any part of your body in or through the lift mechanism unless all parts of the mast are completely lowered and the engine is STOPPED.

Never check for leaks by putting hands on hydraulic lines or components under pressure. Hydraulic oil under pressure can be injected into the skin.

When the lift chains are correctly adjusted:

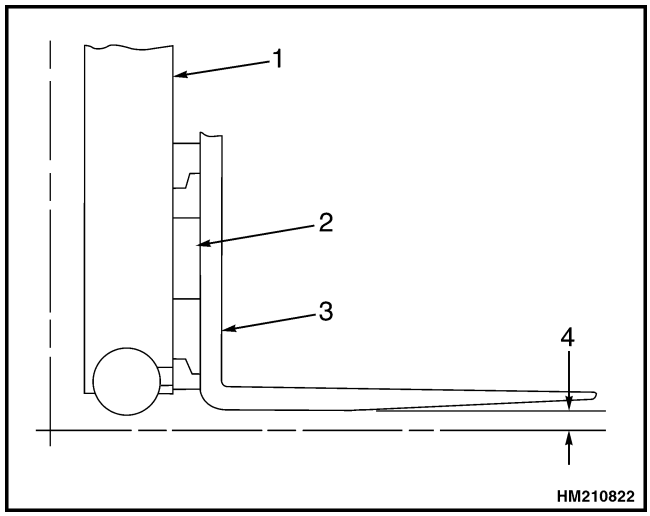
- The tension will be the same on each chain of the chain set. Check tension by pushing on both chains at the same time.
- The chain length will be correct.
- The chains must travel freely through the complete cycle.

NOTE: When the lift chain adjustments are complete, make sure the threads on the nuts of the chain anchors are completely engaged. Inspect the torque of the prevailing torque nut (locknut) used to adjust the chain anchor with every lift chain adjustment. After carriage and or mast section(s) are adjusted for proper ground clearance, prevent the carriage and or mast section(s) from fully lowering (see Safety Procedures When Working Near Mast). With slack chain(s), check locknut torque. If 2.5 N•m (22.1 lbf in) for ½-20, 4.5 N•m (39.8 lbf in) for 5/8-18 nuts, 6.0 N•m (53.1 lbf in) for 3/4-16 of torque cannot be reached; replace locknut. The chain anchors, after adjustment, must be able to move on their mountings.

NOTE: Prior to performing adjustment procedures, make sure the forklift truck is parked on a level surface and the mast is in the vertical position.

Lift Trucks Equipped with Forks

1. Adjust the chain anchors that support the carriage, until the bottom of the fork heel is 12 +3.0/−6.0 mm (0.47 +0.12/−0.24 in.) above the floor level. See Figure 137.



1. MAST
2. CARRIAGE
3. FORK
4. HEEL OF FORK IS 12 +3.0/−6.0 mm (0.47 +0.12/−0.24 in.) ABOVE FLOOR LEVEL

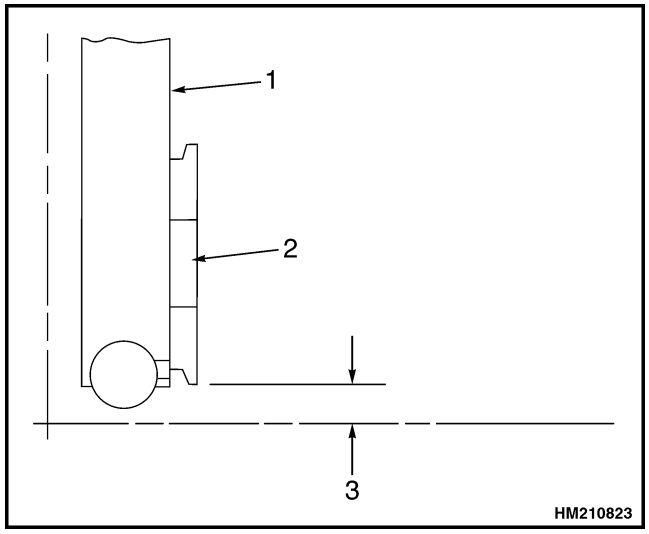
Figure 137. Lift Chain Adjustment, With Forks

Lift Trucks Equipped with Hook-Type Carriage and Attachment Without Forks

1. Adjust the chain anchors that support the carriage, until the bottom of the lower carriage bar is above the floor level as shown in Table 3 and Figure 138.

Table 3. Hook-Type Carriage Chain Adjustment

Class II and III	82.5 ±3.0 mm (3.25 ±0.12 in.)
Class IV	133.5 ±3.0 mm (5.26 ±0.12 in.)



1. MAST
2. CARRIAGE
3. DISTANCE FROM FLOOR TO LOWER CARRIAGE BAR

Figure 138. Lift Chain Adjustment, Hook-Type Carriage

Lift Trucks Equipped With Pin-Type Carriage and Attachment Without Forks

1. Adjust the chain anchors, which support the carriage, until the center line of the fork pin is above the floor level as shown in Table 4 and Figure 139.

Table 4. Pin-Type Carriage Chain Adjustment

4-5.5T Class III	545.0 ±3.0 mm (21.5 ±0.12 in.)
4-5.5T Class IV	708.0 ±3.0 mm (27.87 ±0.12 in.)
6-7T Class IV	907.0 ±3.0 mm (35.71 ±0.12 in.)

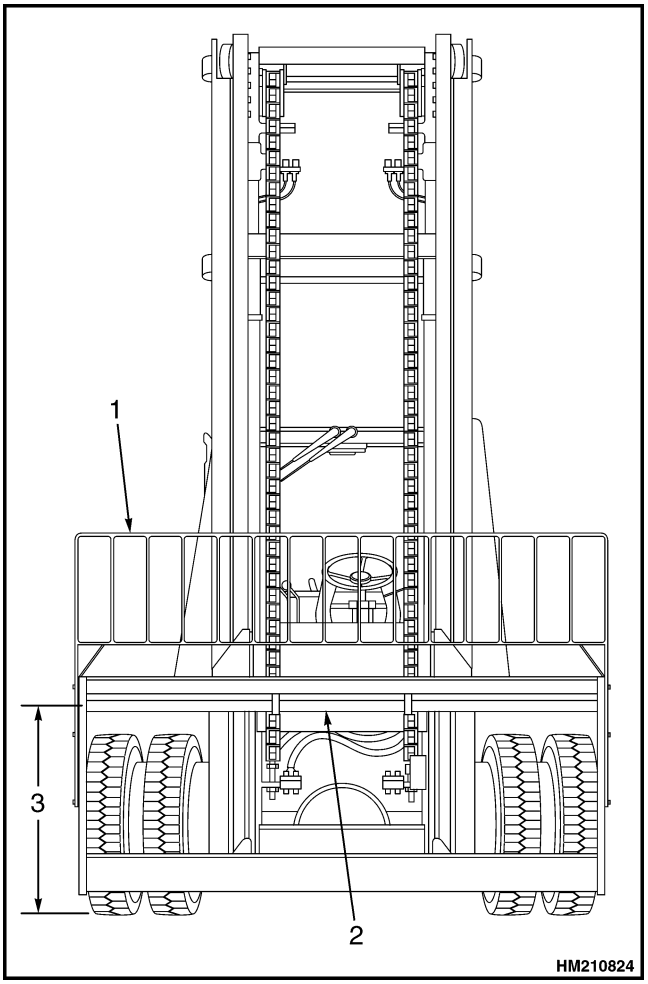


Figure 139. Lift Chain Adjustment, Pin-Type Carriage

Legend for Figure 139.

1. LOAD BACK REST
2. FORK PIN
3. DISTANCE FROM FORK PIN TO FLOOR

Hydraulic Quick Disconnect Hoses

Some lift trucks are equipped with auxiliary tube extensions to be used with optional equipment. The auxiliary tube extensions use quick disconnect fittings to attach together optional equipment.

DISCONNECTING ATTACHMENT HYDRAULIC QUICK DISCONNECT HOSES, LIFT TRUCK MODELS S2.0-3.5FT (S40-70FT (F187, G187, H187) AND H2.0-3.5FT (H40-70FT) (L177, N177, P177)

Lift Trucks Equipped With E-Hydraulic Controls

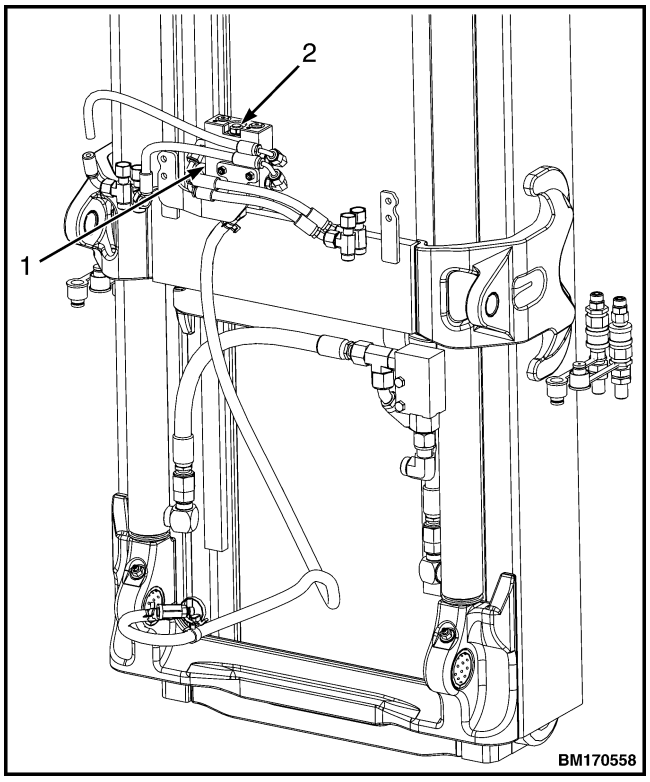
WARNING

Before disconnecting the hydraulic hoses, relieve the pressure in the hydraulic system. Serious injury can occur if pressure is not relieved from hydraulic system prior to disconnecting hydraulic hoses.

1. Turn key switch or keyless switch to **OFF** position.
2. Disconnect the battery.

NOTE: If the Quick Disconnect hose connectors cannot be disconnected, repeat Step 3 and Step 4.

3. Press the plunger button, located on the top of the pressure relief valve, and listen for the flow of hydraulic fluid through the valve when the button is pressed. See Figure 140.
4. Disconnect the Quick Disconnect hose connections. See Figure 141.



1. PRESSURE RELIEF VALVE
2. PLUNGER BUTTON

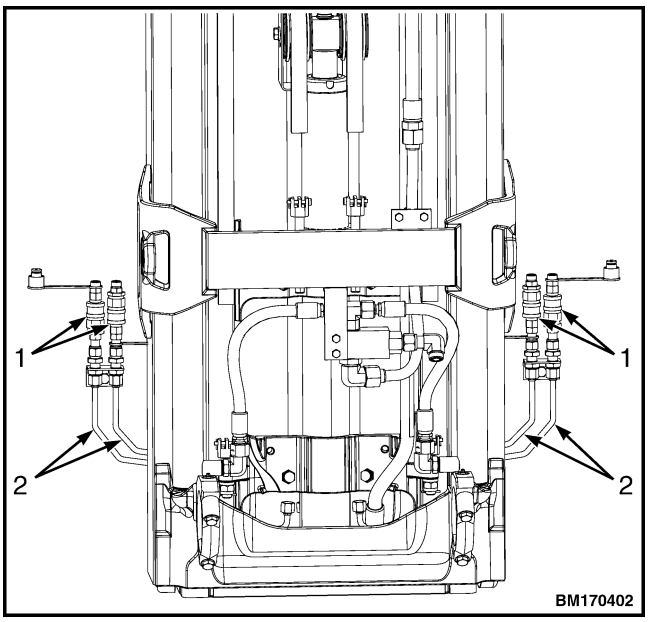
Figure 140. Pressure Relief Valve Plunger Button

Lift Trucks Equipped With Manual Hydraulic Controls

WARNING

Before disconnecting the hydraulic hoses, relieve the pressure in the hydraulic system. Serious injury can occur if pressure is not relieved from hydraulic system prior to disconnecting hydraulic hoses.

1. Turn key switch or keyless switch to **OFF** position.
2. Disconnect the battery.
3. Disconnect the Quick Disconnect hose connections. See Figure 141.



1. QUICK DISCONNECT FITTINGS
2. HYDRAULIC TUBES

Figure 141. Quick Disconnect Hydraulic Hoses

CONNECTING ATTACHMENT HYDRAULIC QUICK DISCONNECT HOSES, LIFT TRUCK MODELS S2.0-3.5FT (S40-70FT (F187, G187, H187) AND H2.0-3.5FT (H40-70FT) (L177, N177, P177)

Lift Trucks Equipped With E-Hydraulic Controls

1. Connect the Quick Disconnect hose connectors. See Figure 141.
2. Connect the battery.
3. Turn key switch or keyless switch to the **ON** position and start lift truck.
4. Move the mini lever forward and backward.

WARNING

Never check for leaks by putting hands on hydraulic lines or components under pressure. Hydraulic oil under pressure can be injected into the skin.

5. Check the hydraulic system for leaks.

Lift Trucks Equipped With Manual Hydraulic Controls

1. Connect the Quick Disconnect hose connectors. See Figure 141.
2. Connect the battery.
3. Turn key switch or keyless switch to the **ON** position.
4. Move the manual hydraulic lever forward and backward.

WARNING

Never check for leaks by putting hands on hydraulic lines or components under pressure. Hydraulic oil under pressure can be injected into the skin.

5. Check the hydraulic system for leaks.

DISCONNECTING ATTACHMENT HYDRAULIC QUICK DISCONNECT HOSES, LIFT TRUCK MODELS E2.2-3.5XN (E45-70XN) (A268) AND J2.2-3.5XN (J45-70XN) (A276)

NOTE: Some lift trucks are equipped with auxiliary tube extensions to be used with optional equipment. The auxiliary tube extensions use quick disconnect fittings to couple together optional equipment.

NOTE: Tag hoses before removal to aid in re-connection.

1. Pull spring loaded quick disconnect socket head sleeve back to disconnect fittings. See Figure 142.

2. Remove optional equipment hose.

CONNECTING ATTACHMENT HYDRAULIC QUICK DISCONNECT HOSES, LIFT TRUCK MODELS E2.2-3.5XN (E45-70XN) (A268) AND J2.2-3.5XN (J45-70XN) (A276)

NOTE: Reconnect quick disconnect fittings as indicated by tags.

1. Pull spring loaded quick disconnect socket head sleeve back and press optional equipment fitting into socket head; release quick disconnect socket head sleeve. See Figure 142.

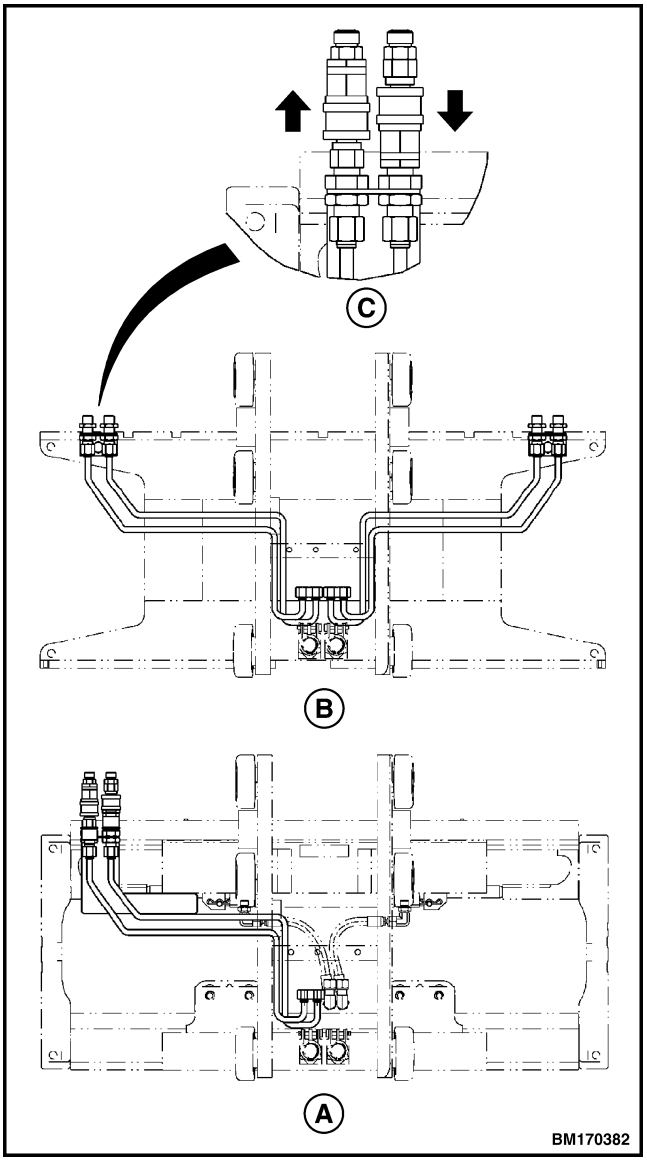
2. Test connection by pulling quick disconnect and optional equipment fitting away from each other.

3. Repeat Step 1 and Step 2 until connection is made.

WARNING

Never check for leaks by putting hands on hydraulic lines or components under pressure. Hydraulic oil under pressure can be injected into the skin.

4. Check the hydraulic system for leaks.

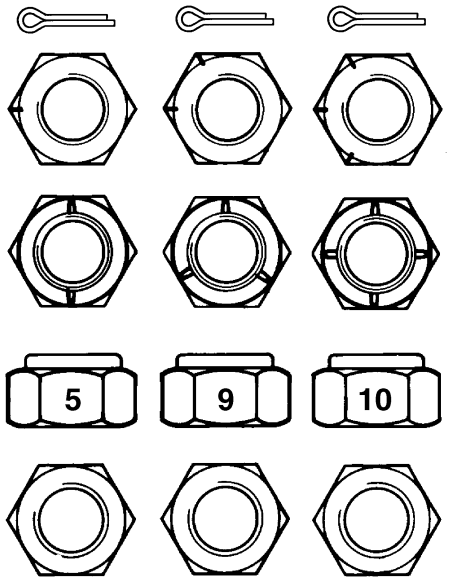


1. DUAL EXTENSION TUBES WITHOUT QUICK DISCONNECTS
2. SINGLE EXTENSION TUBE WITH QUICK DISCONNECTS
3. QUICK DISCONNECT SLEEVE DIRECTION

Figure 142. Quick Disconnect and Auxiliary Tubes

NOTES

METRIC AND INCH (SAE) FASTENERS



HM210064

HYSTER

PART NO. 910442

8000 SRM 0231

SAFETY PRECAUTIONS
MAINTENANCE AND REPAIR

- When lifting parts or assemblies, make sure all slings, chains, or cables are correctly fastened, and that the load being lifted is balanced. Make sure the crane, cables, and chains have the capacity to support the weight of the load.
- Do not lift heavy parts by hand, use a lifting mechanism.
- Wear safety glasses.
- DISCONNECT THE BATTERY CONNECTOR before doing any maintenance or repair on electric lift trucks. Disconnect the battery ground cable on internal combustion lift trucks.
- Always use correct blocks to prevent the unit from rolling or falling. See HOW TO PUT THE LIFT TRUCK ON BLOCKS in the **Operating Manual** or the **Periodic Maintenance** section.
- Keep the unit clean and the working area clean and orderly.
- Use the correct tools for the job.
- Keep the tools clean and in good condition.
- Always use **HYSTER** ® **APPROVED** parts when making repairs. Replacement parts must meet or exceed the specifications of the original equipment manufacturer.
- Make sure all nuts, bolts, snap rings, and other fastening devices are removed before using force to remove parts.
- Always fasten a DO NOT OPERATE tag to the controls of the unit when making repairs, or if the unit needs repairs.
- Be sure to follow the **WARNING** and **CAUTION** notes in the instructions.
- Gasoline, Liquid Petroleum Gas (LPG), Compressed Natural Gas (CNG), and Diesel fuel are flammable. Be sure to follow the necessary safety precautions when handling these fuels and when working on these fuel systems.
- Batteries generate flammable gas when they are being charged. Keep fire and sparks away from the area. Make sure the area is well ventilated.

NOTE: The following symbols and words indicate safety information in this manual:

WARNING

Indicates a hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION

Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury and property damage.

On the lift truck, the WARNING symbol and word are on orange background. The CAUTION symbol and word are on yellow background.

TABLE OF CONTENTS

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Threaded Fasteners 1
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Strength Identification 2
Cotter (Split) Pins 3
Fastener Torque Tables 8
Conversion Table 10

This section is for the following models:

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"THE QUALITY KEEPERS"

HYSTER APPROVED PARTS

General

THREADED FASTENERS

Threaded fasteners, like bolts, nuts, capscrews, and studs, are made to specifications that describe the mechanical strength and hardness of the fastener. A fastener used in a design application is selected according to its specifications. Hyster® Company buys parts from many countries. Parts that are purchased must be to Hyster® Company standards. There are several standards used by these countries in the manufacture of threaded fasteners. Many of these fasteners are similar, but cannot be used as a direct replacement. To make sure that you have the correct fastener, order fasteners and parts through the Hyster® Parts Depot.

Service persons must use replacement fasteners that have the same specifications. Fasteners made to each specification have identification marks for that specification. This specification is commonly called "Grade" for SAE standards and "property class" for metric standards. This section describes the identification of some common fasteners.

The metric system used by Hyster® Company is described as SI (Le Systeme d'Unites or the International System of units, also called SI in all languages). The SI System of measurement is described in ISO Standard 1000, 1973. A conversion table of common measurements is shown in Table 7.

NOMENCLATURE, THREADS

The thread design is specified by a series of numbers and letters for inch and metric fasteners.

See Figure 1. The diameter of the shank of the fastener is shown first in the series [M12 = 12 mm, M20 = 20 mm (1/2 = 1/2 in., 3/4 = 3/4 in.)].

The number of threads per inch is normally not shown for inch nomenclature and only the UNC (Unified National Coarse) or UNF (Unified National Fine) is shown. This number of threads per inch is not shown because a UNC or UNF fastener has a standard number of threads per inch for a specific diameter. Metric fasteners show the number of threads per millimeter.

The length of the shank is often indicated as part of the description of a fastener. This length is shown in inches for inch fasteners and in millimeters for metric fasteners.

A capscrew will have the following description:

Metric	Inch
M12 × 1.75 × 50	1/2 × 13 UNC × 1-1/2
A B C	A B C D
A = Thread Size	A = Shank Diameter
B = Pitch	B = Number of Threads Per Unit of Length
C = Length	C = type of Thread
	D = Shank Length

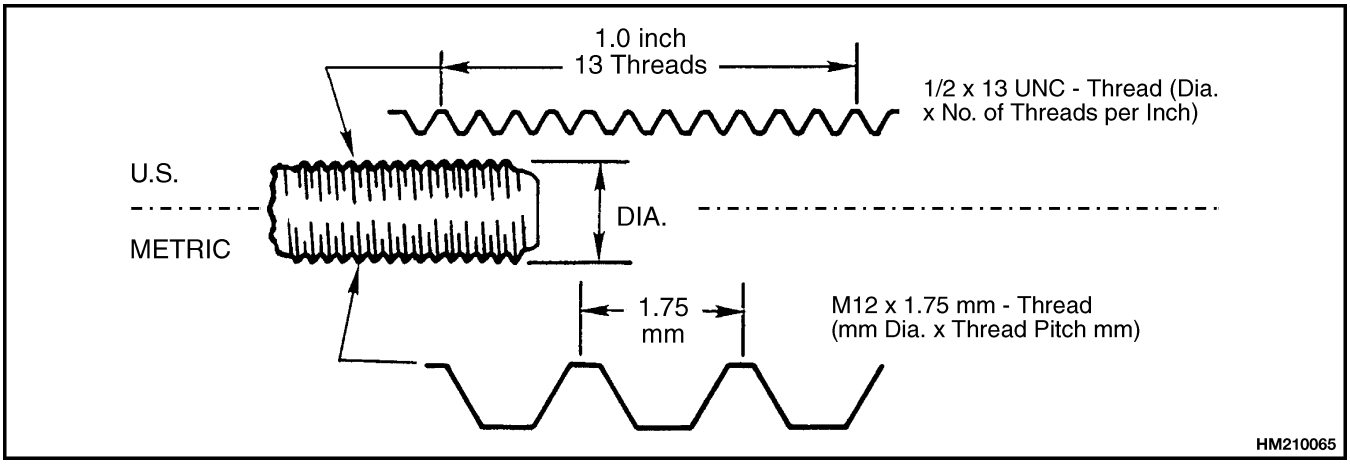


Figure 1. Thread Design

STRENGTH IDENTIFICATION

CAUTION

When fasteners must be replaced, the new fasteners must be of the same strength or greater than the original fasteners. The new fasteners must also be the correct size.

NOTE: Identification marks are according to bolt strength. The higher the number or the increase in the number of marks indicates increased bolt strength.

The most common property classes for metric fasteners are 8.8 and 10.9. The property class is marked with a number on the head of the capscrew or on a nut. Property classes less than 8.8 are often not marked. Grades for inch bolts go from 2 to 8. Grade 2 fasteners normally do not have any marks. The following tables show the marks that identify the grades and property classes for different fasteners.

COTTER (SPLIT) PINS

Cotter (split) pins are used in many applications on your forklift. They are typically used to retain parts such as pins and nuts. Cotter (split) pins are typically not used as load-bearing members. Service personnel must use new cotter (split) pins. Do not reuse a cotter (split) pin. Replacement cotter (split) pin must be of the correct size. See Table 8.

The legs of a cotter (split) pin are bent for the following reasons:

- To retain the cotter (split) pin in the part
- To provide clearance between the cotter pin legs and other parts or members. One or both cotter (split) pin legs must be bent to provide a minimum 90° angle between the legs. See Figure 2.

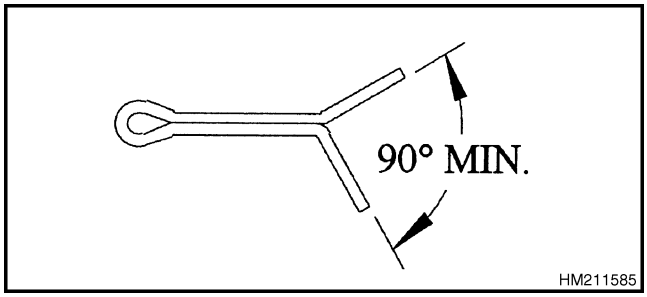
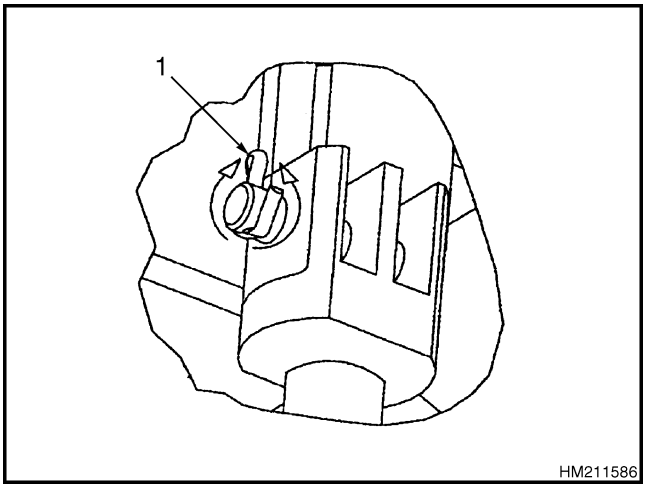


Figure 2. Minimum Angle Between Cotter Pin Legs

Unless otherwise specified, the legs of chain anchor cotter (split) pins are to be bent against the pin. See Figure 3.



1. COTTER PIN

Figure 3. Cotter (Split) Pins Used On Mast Chain Anchors

Table 1. Bolts and Screws

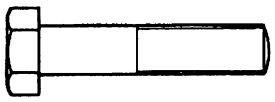
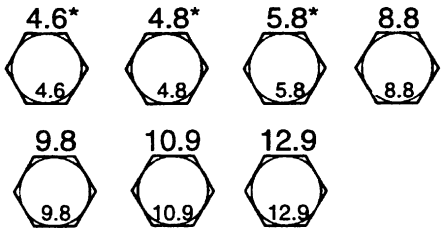
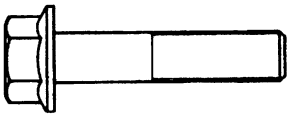
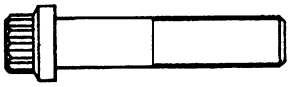
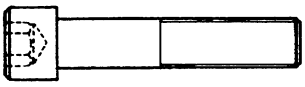
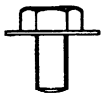
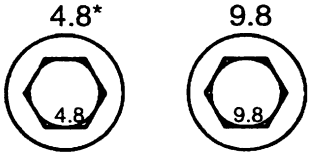
TYPE OF FASTENER	METRIC FASTENERS STRENGTH LEVELS: PROPERTY CLASS * MARKINGS NOT REQUIRED	INCH FASTENERS STRENGTH LEVELS: SAE GRADES * MARKINGS NOT REQUIRED
 HEX HEAD BOLTS AND CAPSCREWS	 MARKINGS FOR SIZE M5 AND LARGER	
 HEX HEAD FLANGE SCREWS	SAME AS ABOVE	
 12–POINT FLANGE SCREWS		
 HEX SOCKET HEAD CAPSCREWS		MARKINGS NOT REQUIRED
 SEMS		 HM210066

Table 2. Studs and Nuts

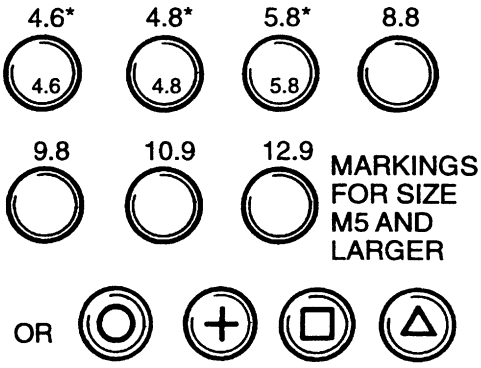
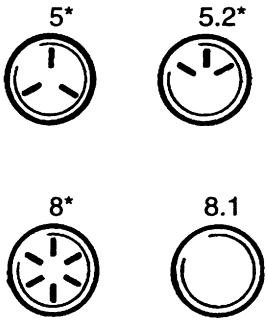
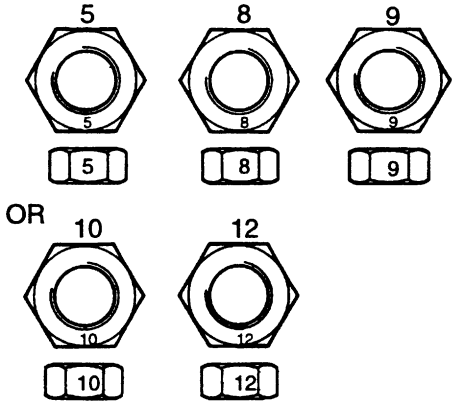
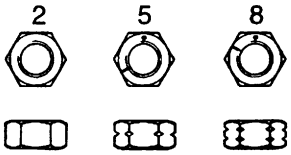
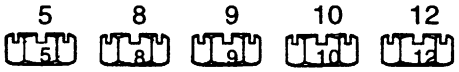
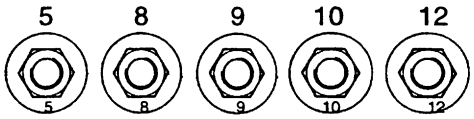
TYPE OF FASTENER	METRIC FASTENERS STRENGTH LEVELS: PROPERTY CLASS * MARKINGS NOT REQUIRED	INCH FASTENERS STRENGTH LEVELS: SAE GRADES * MARKINGS NOT REQUIRED
 STUDS		
 HEX NUTS		OR 
 HEX SLOTTED NUTS		MARKINGS NOT REQUIRED
 HEX FLANGE NUTS		MARKINGS NOT REQUIRED HM210067

Table 3. Torque Nuts

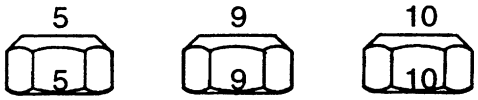
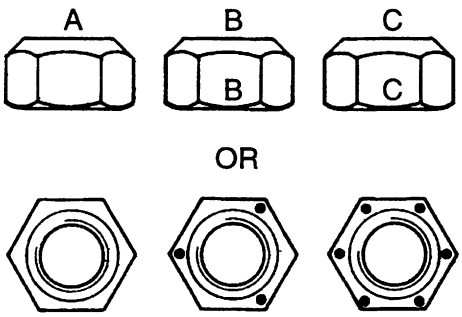
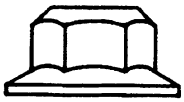
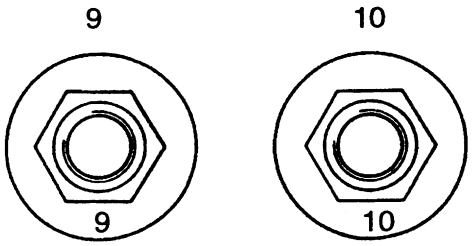
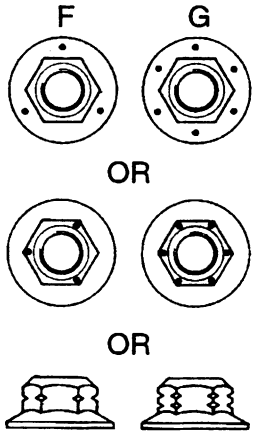
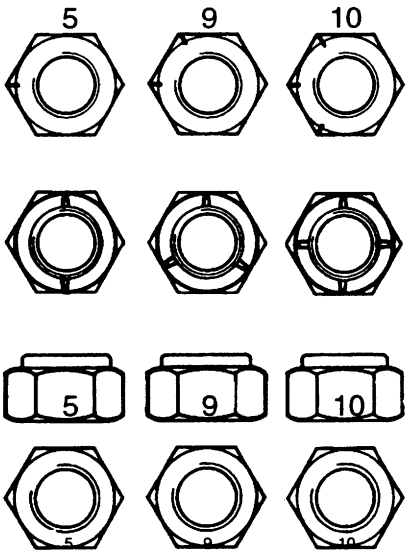
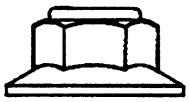
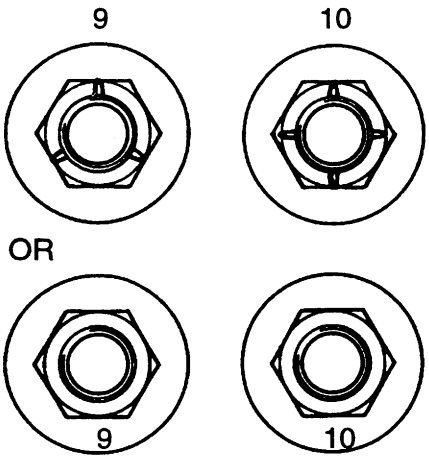
TYPE OF FASTENER	METRIC FASTENERS STRENGTH LEVELS: PROPERTY CLASS	INCH FASTENERS STRENGTH LEVELS: SAE GRADES
 ALL METAL PREVAILING TORQUE NUTS		
 ALL METAL PREVAILING TORQUE FLANGE NUTS		 HM210068

Table 4. Torque Nuts With Nylon Insert

TYPE OF FASTENER	METRIC FASTENERS STRENGTH LEVELS: PROPERTY CLASS	INCH FASTENERS STRENGTH LEVELS: SAE GRADES
 NYLON INSERT PREVAILING TORQUE NUTS		MARKINGS NOT REQUIRED
 NYLON INSERT PREVAILING TORQUE NUTS		MARKINGS NOT REQUIRED HM210069

FASTENER TORQUE TABLES

*Table 5. Torque Values for Metric Fasteners**

Size and Pitch	Property Class 5.8[1]		Grade 8.8[2]		Grade 10.9[3]	
	N•m	lbf ft	N•m	lbf ft	N•m	lbf ft
M3 × 0.5 M3.5 × 0.6 M4 × 0.7 M5 × 0.8 M6 × 1	0.62 0.97 1.44 2.91 4.94	0.5 0.7 1.1 2.1 3.6	0.99 1.55 2.30 4.65 7.90	0.7 1.1 2.1 3.6 6	1.34 2.11 3.13 6.33 10.8	1.0 1.6 2.3 4.7 8
M8 × 1.25 M8 × 1 M10 × 1.5 M10 × 1.25	12.0 12.8 23.8 25.1	9 9 18 19	19.2 20.5 38.0 40.1	14 15 28 30	26.1 27.9 52 55	19 21 38 41
M12 × 1.75 M12 × 1.25 M14 × 2 M14 × 1.5	41.4 45.3 66 72	31 33 49 53	66 72 105 115	49 53 77 85	90 98 145 155	66 72 105 115
M16 × 2 M16 × 1.5 M20 × 2.5 M20 × 1.5	105 110 200 225	77 81 150 165	165 175 320 355	122 130 235 260	225 240 435 485	165 175 320 360
M24 × 3 M24 × 2 M27 × 3 M27 × 2	345 375 505 550	255 275 370 405	555 605 810 875	410 445 600 645	755 820 1,100 1,190	560 605 810 880
M30 × 3.5 M30 × 3 M30 × 2 M33 × 3.5 M33 × 2	690 715 765 940 1,030	510 530 565 695 760	1,100 1,140 1,220 1,500 1,640	810 840 900 1,100 1,210	1,500 1,550 1,660 2,040 2,240	1,100 1,140 1,230 1,510 1,660
M36 × 4 M36 × 3 M39 × 4 M39 × 3	1,200 1,280 1,560 1,640	885 945 1,150 1,210	1,930 2,040 2,490 2,630	1,430 1,510 1,840 1,940	2,620 2,780 3,390 3,570	1,940 2,050 2,500 2,640
M42 × 4.5 M42 × 3 M45 × 4.5 M45 × 3 M48 × 5 M48 × 3	1,930 2,070 2,410 2,580 2,900 3,160	1,430 1,530 1,780 1,910 2,140 2,330	3,080 3,320 3,850 4,120 4,630 5,040	2,280 2,450 2,840 3,040 3,420 3,720	4,200 4,510 5,240 5,610 6,300 6,860	3,100 3,330 3,870 4,140 4,650 5,060

* Unless otherwise specified [1] Approximately equal to Grade 2 [2] Approximately equal to Grade 5 [3] Approximately equal to Grade 8

*Table 6. Torque Values for Inch Fasteners**

Size and Pitch		Grade 2[1]		Grade 5[2]		Grade 8[3]	
		lbf ft	N•m	lbf ft	N•m	lbf ft	N•m
1/4 1/4	20 UNC 28 UNF	4 5	6 6	6 7	9 10	9 10	12 14
5/16 5/16	18 UNC 24 UNF	8 9	11 13	13 14	18 20	18 20	25 28
3/8 3/8	16 UNC 24 UNF	15 17	20 23	23 26	31 36	33 37	44 50
7/16 7/16	14 UNC 20 UNF	24 27	33 36	37 41	50 56	52 58	71 79

* Unless otherwise specified [1] Approximately equal to metric Property Class 5.8 [2] Approximately equal to metric Property Class 8.8 [3] Approximately equal to metric Property Class 10.9

Table 6. Torque Values for Inch Fasteners (Continued)*

Size and Pitch		Grade 2[1]		Grade 5[2]		Grade 8[3]	
		lbf ft	N•m	lbf ft	N•m	lbf ft	N•m
1/2 1/2	13 UNC 20 UNF	37 41	50 56	57 85	77 115	80 90	110 120
9/16 9/16	12 UNC 18 UNF	53 59	72 80	82 91	110 125	115 130	155 175
5/8 5/8	11 UNC 18 UNF	73 83	99 110	115 130	155 175	160 180	215 245
3/4 3/4	10 UNC 16 UNF	130 145	175 195	200 225	270 300	280 315	380 425
7/8 7/8	9 UNC 14 UNF	125 140	170 185	320 355	435 480	455 500	615 680
1 1	8 UNC 14 UNF	185 210	255 285	485 540	655 735	680 765	925 1,040
1-1/8 1-1/8	7 UNC 12 UNF	265 300	360 405	595 670	805 905	965 1,080	1,310 1,470
1-1/4 1-1/4	7 UNC 12 UNF	375 415	510 565	840 930	1,140 1,260	1,360 1,500	1,850 2,050
1-3/8 1-3/8	6 UNC 12 UNF	490 560	665 760	1,100 1,250	1,490 1,700	1,780 2,040	2,420 2,760
1-1/2 1-1/2	6 UNC 12 UNF	650 735	885 995	1,460 1,650	1,980 2,230	2,370 2,670	3,210 3,620

* Unless otherwise specified [1] Approximately equal to metric Property Class 5.8 [2] Approximately equal to metric Property Class 8.8 [3] Approximately equal to metric Property Class 10.9

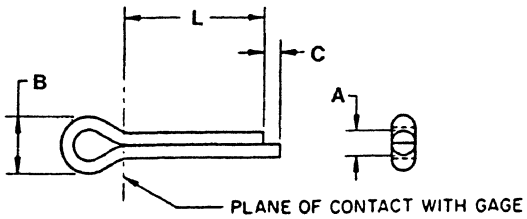
CONVERSION TABLE

Table 7. Conversion Table for Metric and English units

Multiply	By	To Get	Multiply	By	To Get
Area					
inches 2 (in. 2)	× 6.452	= centimeters 2 (cm 2)	centimeters 2 (cm 2)	× 0.155	= inches 2 (in. 2)
feet 2 (ft 2)	× 0.093	= meters 2 (m 2)	meters 2 (m 2)	× 10.764	= feet 2 (ft 2)
Linear					
inches (in.)	× 25.4	= millimeters (mm)	millimeter (mm)	× 0.039	= inches (in.)
feet (ft)	× 0.305	= meters (m)	meter (m)	× 3.281	= feet (ft)
yards (yd)	× 0.914	= meters (m)	meter (m)	× 1.094	= yards (yd)
miles (mi)	× 1.609	= kilometers (km)	kilometer (km)	× 0.621	= miles (mi)
Mass					
ounces (oz)	× 28.35	= grams (g)	grams (g)	× 0.035	= ounces (oz)
pounds (lb)	× 0.454	= kilograms (kg)	kilograms (kg)	× 2.205	= pounds (lb)
tons (2,000 lb)	× 907.18	= kilograms (kg)	kilograms (kg)	× 0.001	= tons (2,000 lb)
tons (2,000 lb)	× 0.907	= metric ton (t)	metric ton (t)	× 1.102	= tons (2,000 lb)
Power					
horsepower (hp)	× 0.746	= kilowatts (kW)	kilowatts (kW)	× 1.34	= horsepower (hp)
Pressure					
pounds/in. 2 (psi)	× 6.895	= kilopascal (kPa)	kilopascals (kPa)	× 0.145	= pounds/in. 2 (psi)
pounds/in. 2 (psi)	× 0.007	= megapascal (MPa)	megapascals (MPa)	× 145.04	= pounds/in. 2 (psi)
Temperature					
(°Fahrenheit−32)	× 0.56	= °Celsius (C)	(°Celsius × 1.8) +32		= °Fahrenheit
Torque					
pound inches (lbf in.)	× 0.113	= Newton meter (N•m)	Newton meter (N•m)	× 8.851	= pound inches (lb f in.)
pound feet (lbf ft)	× 1.356	= Newton meter (N•m)	Newton meter (N•m)	× 0.738	= pound feet (lb f ft)
Velocity					
miles/hour (mph)	× 1.609	= kilometer/hour (km/h)	kilometer/hr (km/h)	× 0.621	= miles/hour (mph)
Volume					
inches 3 (in. 3)	× 16.387	= centimeters 3 (cm 3)	centimeters 3 (cm 3)	× 0.061	= inches 3 (in. 3)
inches 3 (in. 3)	× 0.016	= liters (l)	liters (l)	× 61.024	= inches 3 (in. 3)
quarts, U.S. (qt)	× 0.946	= liters (l)	liters (l)	× 1.057	= quarts, U.S. (qt)
quarts, U.S. (qt)	× 0.83	= quarts, Imp. (qt)	quarts, Imp. (qt)	× 1.205	= quarts, U.S. (qt)
gallons, U.S. (gal)	× 3.785	= liters (l)	liters (l)	× 0.264	= gallons, U.S. (gal)
gallons, U.S. (gal)	× 0.83	= gallons, Imp. (gal)	gallons, Imp. (gal)	× 1.205	= gallons, U.S. (gal)
ounces (oz)	× 29.57	= milliliters (ml)	milliliters (ml)	× 0.034	= ounces (oz)

Table 8. Cotter Pin Dimensional Data

Nominal Size A	Shank Diameter A		Head Dia. B	Length of Extended Prong C		Recommended Hole Size	
	max	min	min	max	min	min	max
1.00 mm (0.031 in.)	0.90 mm (0.035 in.)	0.70 mm (0.028 in.)	1.50 mm (0.060 in.)	1.52 mm (0.060 in.)	0.25 mm (0.01 in.)	0.91 mm (0.036 in.)	1.37 mm (0.054 in.)
1.60 mm (0.047 in.)	1.20 mm (0.048 in.)	0.90 mm (0.035 in.)	1.50 mm (0.060 in.)	2.54 mm (0.10 in.)	0.51 mm (0.02 in.)	1.50 mm (0.059 in.)	1.78 mm (0.070 in.)
2.00 mm (0.062 in.)	1.50 mm (0.060 in.)	1.30 mm (0.051 in.)	2.40 mm (0.094 in.)	2.54 mm (0.10 in.)	0.76 mm (0.03 in.)	1.90 mm (0.075 in.)	2.18 mm (0.086 in.)
2.50 mm (0.094 in.)	2.30 mm (0.091 in.)	2.10 mm (0.083 in.)	4.00 mm (0.158 in.)	2.54 mm (0.10 in.)	1.00 mm (0.04 in.)	2.41 mm (0.095 in.)	2.95 mm (0.116 in.)
3.20 mm (0.125 in.)	3.00 mm (0.120 in.)	2.70 mm (0.106 in.)	5.10 mm (0.201 in.)	3.30 mm (0.13 in.)	1.52 mm (0.06 in.)	3.12 mm (0.123 in.)	3.76 mm (0.148 in.)
4.00 mm (0.156 in.)	3.80 mm (0.150 in.)	3.50 mm (0.138 in.)	6.50 mm (0.256 in.)	4.06 mm (0.16 in.)	1.78 mm (0.07 in.)	3.94 mm (0.155 in.)	4.55 mm (0.179 in.)
5.00 mm (0.188 in.)	4.60 mm (0.181 in.)	4.40 mm (0.172 in.)	8.00 mm (0.315 in.)	4.06 mm (0.16 in.)	2.03 mm (0.08 in.)	4.93 mm (0.194 in.)	5.33 mm (0.210 in.)
6.30 mm (0.250 in.)	5.90 mm (0.232 in.)	5.60 mm (0.220 in.)	10.3 mm (0.406 in.)	4.06 mm (0.16 in.)	2.03 mm (0.08 in.)	6.22 mm (0.245 in.)	6.96 mm (0.274 in.)
8.00 mm (0.312 in.)	7.50 mm (0.295 in.)	7.00 mm (0.275 in.)	13.1 mm (0.516 in.)	4.06 mm (0.16 in.)	2.03 mm (0.08 in.)	7.85 mm (0.309 in.)	8.28 mm (0.326 in.)
9.50 mm (0.375 in.)	9.50 mm (0.374 in.)	8.40 mm (0.329 in.)	16.6 mm (0.654 in.)	6.35 mm (0.25 in.)	4.06 mm (0.16 in.)	9.45 mm (0.372 in.)	9.73 mm (0.383 in.)
13.0 mm (0.500 in.)	12.4 mm (0.488 in.)	11.9 mm (0.467 in.)	21.7 mm (0.854 in.)	6.35 mm (0.25 in.)	3.05 mm (0.12 in.)	12.62 mm (0.497 in.)	13.21 mm (0.520 in.)
16.0 mm (0.625 in.)	15.4 mm (0.606 in.)	15.0 mm (0.590 in.)	27.0 mm (1.063 in.)	8.89 mm (0.35 in.)	3.05 mm (0.12 in.)	15.80 mm (0.622 in.)	16.28 mm (0.641 in.)

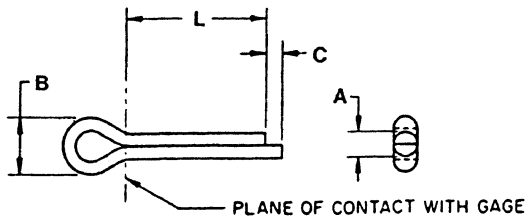


EXTENDED PRONG

HM211587

Table 9. Cotter Pin Dimensional Data

Nominal Length L	Length Range		Nominal Size - Part Numbers				
	max	min	1.00 mm (0.031 in.)	1.60 mm (0.047 in.)	2.00 mm (0.062 in.)	2.50 mm (0.094 in.)	3.20 mm (0.125 in.)
6.35 mm (0.250 in.)	7.10 mm (0.280 in.)	5.50 mm (0.217 in.)	0221870	0221875			
9.525 mm (0.375 in.)	10.5 mm (0.413 in.)	8.80 mm (0.345 in.)	0221871	0221876			
12.7 mm (0.500 in.)	13.5 mm (0.530 in.)	11.5 mm (0.453 in.)	0221872	0221877	0015200	0015211	0015221
19.05 mm (0.750 in.)	20.5 mm (0.807 in.)	18.3 mm (0.720 in.)	0221873	0221878	0015201	0015212	0015222
25.4 mm (1.000 in.)	26.9 mm (1.060 in.)	23.9 mm (0.940 in.)	0221874	0221879	0015202	0015213	0015223
31.75 mm (1.250 in.)	33.3 mm (1.310 in.)	29.2 mm (1.150 in.)			0015203	0015216	0015224
38.1 mm (1.500 in.)	40.9 mm (1.610 in.)	36.6 mm (1.440 in.)			0015204	0015217	0015225
44.45 mm (1.750 in.)	46.0 mm (1.810 in.)	42.9 mm (1.690 in.)			0015205	0015218	0015226
50.8 mm (2.000 in.)	52.3 mm (2.060 in.)	49.3 mm (1.940 in.)			0015206	0015219	0015227
57.15 mm (2.250 in.)	58.7 mm (2.310 in.)	55.1 mm (2.170 in.)				0015220	0056997
63.5 mm (2.500 in.)	65.0 mm (2.560 in.)	62.0 mm (2.440 in.)				0221894	0015229
69.85 mm (2.750 in.)	72.1 mm (2.840 in.)	68.3 mm (2.690 in.)					0015230
76.2 mm (3.000 in.)	81.3 mm (3.200 in.)	74.7 mm (2.940 in.)					0015279
88.9 mm (3.500 in.)	91.4 mm (3.600 in.)	87.4 mm (3.440 in.)					

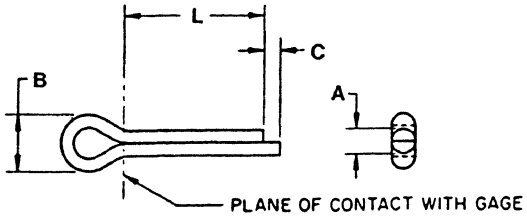


EXTENDED PRONG

HM211587

Table 9. Cotter Pin Dimensional Data (Continued)

Nominal Length L	Length Range		Nominal Size - Part Numbers				
	max	min	1.00 mm (0.031 in.)	1.60 mm (0.047 in.)	2.00 mm (0.062 in.)	2.50 mm (0.094 in.)	3.20 mm (0.125 in.)
101.6 mm (4.000 in.)	113.3 mm (4.460 in.)	98.8 mm (3.890 in.)					
127.0 mm (5.000 in.)	128.5 mm (5.060 in.)	123.7 mm (4.870 in.)					
152.4 mm (6.000 in.)	153.9 mm (3.060 in.)	5.460 mm (138.7 in.)					



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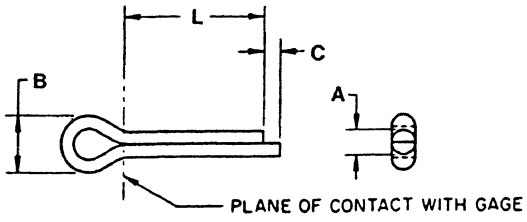
HM211587

Table 10. Cotter Pin Dimensional Data

Nominal Length L	Length Range		Nominal Size - Part Numbers				
	max	min	4.00 mm (0.156 in.)	5.00 mm (0.188 in.)	6.30 mm (0.250 in.)	8.00 mm (0.312 in.)	9.52 mm (0.375 in.)
6.35 mm (0.250 in.)	7.10 mm (0.280 in.)	5.50 mm (0.217 in.)					
9.525 mm (0.375 in.)	10.5 mm (0.413 in.)	8.80 mm (0.345 in.)					
12.7 mm (0.500 in.)	13.5 mm (0.530 in.)	11.5 mm (0.453 in.)					
19.05 mm (0.750 in.)	20.5 mm (0.807 in.)	18.3 mm (0.720 in.)	0015232	0015241			

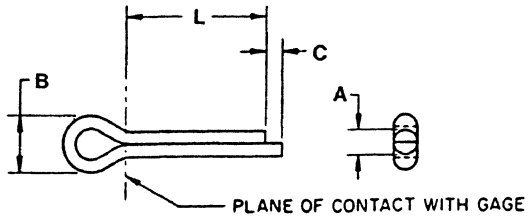


EXTENDED PRONG

HM211587

Table 10. Cotter Pin Dimensional Data (Continued)

Nominal Length L	Length Range		Nominal Size - Part Numbers				
	max	min	4.00 mm (0.156 in.)	5.00 mm (0.188 in.)	6.30 mm (0.250 in.)	8.00 mm (0.312 in.)	9.52 mm (0.375 in.)
25.4 mm (1.000 in.)	26.9 mm (1.060 in.)	23.9 mm (0.940 in.)	0015233	0015242	0015251	0015261	
31.75 mm (1.250 in.)	33.3 mm (1.310 in.)	29.2 mm (1.150 in.)	0015234	0015243	0015252	0015262	0221884
38.1 mm (1.500 in.)	40.9 mm (1.610 in.)	36.6 mm (1.440 in.)	0015235	0015244	0015253	0015263	0221885
44.45 mm (1.750 in.)	46.0 mm (1.810 in.)	42.9 mm (1.690 in.)	0015236	0015245	0015254	0015264	0221886
50.8 mm (2.000 in.)	52.3 mm (2.060 in.)	49.3 mm (1.940 in.)	0015237	0015246	0015255	0015265	0015271
57.15 mm (2.250 in.)	58.7 mm (2.310 in.)	55.1 mm (2.170 in.)	0015238	0015247	0015256	0221880	0221887
63.5 mm (2.500 in.)	65.0 mm (2.560 in.)	62.0 mm (2.440 in.)	0015240	0015248	0015257	0221881	0015273
69.85 mm (2.750 in.)	72.1 mm (2.840 in.)	68.3 mm (2.690 in.)	0015280	0015249	0015258	0221882	0015286
76.2 mm (3.000 in.)	81.3 mm (3.200 in.)	74.7 mm (2.940 in.)	0015283	0015250	0015259	0015267	0015272
88.9 mm (3.500 in.)	91.4 mm (3.600 in.)	87.4 mm (3.440 in.)		0015239	0015284	0015266	0015274
101.6 mm (4.000 in.)	113.3 mm (4.460 in.)	98.8 mm (3.890 in.)		0015301	0015260	0128754	0015275
127.0 mm (5.000 in.)	128.5 mm (5.060 in.)	123.7 mm (4.870 in.)				0221883	0015277
152.4 mm (6.000 in.)	153.9 mm (3.060 in.)	5.460 mm (138.7 in.)					0221888



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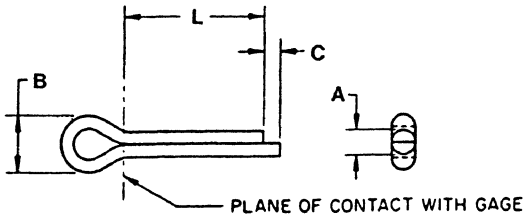
HM211587

Table 11. Cotter Pin Dimensional Data

Nominal Length L	Length Range		Nominal Size - Part Numbers	
	max	min	13.0 mm (0.500 in.)	16.00 mm (0.625 in.)
19.05 mm (0.750 in.)	20.5 mm (0.807 in.)	18.3 mm (0.720 in.)		
25.4 mm (1.00 in.)	26.9 mm (1.060 in.)	23.9 mm (0.940 in.)		
31.75 mm (1.250 in.)	33.3 mm (1.310 in.)	29.2 mm (1.150 in.)		
38.1 mm (1.500 in.)	40.9 mm (1.610 in.)	36.6 mm (1.440 in.)		
44.45 mm (1.750 in.)	46.0 mm (1.810 in.)	42.9 mm (1.690 in.)	0221889	
50.8 mm (2.000 in.)	52.3 mm (2.060 in.)	49.3 mm (1.940 in.)	0221890	
57.15 mm (2.250 in.)	58.7 mm (2.310 in.)	55.1 mm (2.170 in.)	0221891	
63.5 mm (2.500 in.)	65.0 mm (2.560 in.)	62.0 mm (2.440 in.)	0221892	
69.85 mm (2.750 in.)	72.1 mm (2.840 in.)	68.3 mm (2.690 in.)	0221893	0221895
76.2 mm (3.000 in.)	81.3 mm (3.200 in.)	74.7 mm (2.940 in.)	0015291	0221896
88.9 mm (3.500 in.)	91.4 mm (3.600 in.)	87.4 mm (3.440 in.)	0015292	0221897
101.6 mm (4.000 in.)	113.3 mm (4.460 in.)	98.8 mm (3.890 in.)	0015293	0221898
127.0 mm (5.000 in.)	128.5 mm (5.060 in.)	123.7 mm (4.870 in.)	0015295	0221899
152.4 mm (6.000 in.)	153.9 mm (3.060 in.)	138.7 mm (5.460 in.)	0015297	0221900



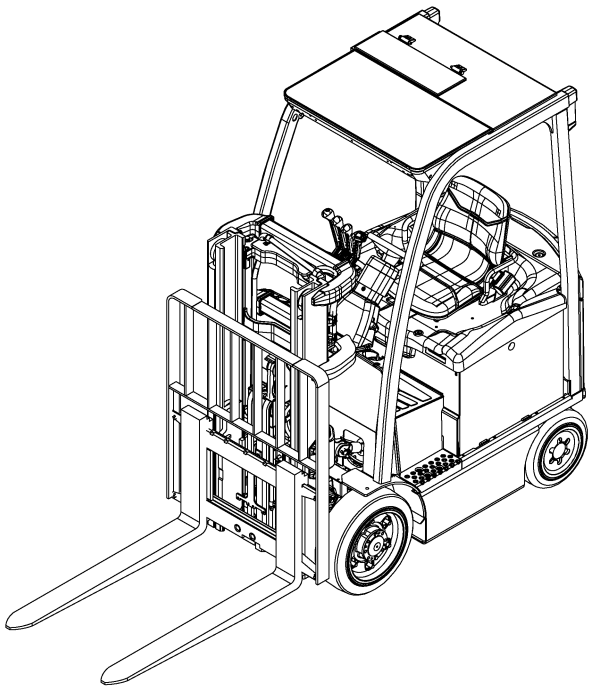
EXTENDED PRONG

HM211587

NOTES

PERIODIC MAINTENANCE

E45-70XN [A268]



HYSTER

PART NO. 1688882

8000 SRM 1364

SAFETY PRECAUTIONS
MAINTENANCE AND REPAIR

- The Service Manuals are updated on a regular basis, but may not reflect recent design changes to the product. Updated technical service information may be available from your local authorized Hyster® dealer. Service Manuals provide general guidelines for maintenance and service and are intended for use by trained and experienced technicians. Failure to properly maintain equipment or to follow instructions contained in the Service Manual could result in damage to the products, personal injury, property damage or death.
- When lifting parts or assemblies, make sure all slings, chains, or cables are correctly fastened, and that the load being lifted is balanced. Make sure the crane, cables, and chains have the capacity to support the weight of the load.
- Do not lift heavy parts by hand, use a lifting mechanism.
- Wear safety glasses.
- DISCONNECT THE BATTERY CONNECTOR before doing any maintenance or repair on electric lift trucks. Disconnect the battery ground cable on internal combustion lift trucks.
- Always use correct blocks to prevent the unit from rolling or falling. See HOW TO PUT THE LIFT TRUCK ON BLOCKS in the **Operating Manual** or the **Periodic Maintenance** section.
- Keep the unit clean and the working area clean and orderly.
- Use the correct tools for the job.
- Keep the tools clean and in good condition.
- Always use **HYSTER APPROVED** parts when making repairs. Replacement parts must meet or exceed the specifications of the original equipment manufacturer.
- Make sure all nuts, bolts, snap rings, and other fastening devices are removed before using force to remove parts.
- Always fasten a DO NOT OPERATE tag to the controls of the unit when making repairs, or if the unit needs repairs.
- Be sure to follow the **WARNING** and **CAUTION** notes in the instructions.
- Gasoline, Liquid Petroleum Gas (LPG), Compressed Natural Gas (CNG), and Diesel fuel are flammable. Be sure to follow the necessary safety precautions when handling these fuels and when working on these fuel systems.
- Batteries generate flammable gas when they are being charged. Keep fire and sparks away from the area. Make sure the area is well ventilated.

NOTE: The following symbols and words indicate safety information in this manual:

WARNING

Indicates a hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION

Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury and property damage.

On the lift truck, the WARNING symbol and word are on orange background. The CAUTION symbol and word are on yellow background.

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(E45-70XN) [A268]

"THE QUALITY KEEPERS"

HYSTER APPROVED PARTS

General

WARNING

DO NOT make repairs or adjustments unless you have both authorization and training. Repairs and adjustments that are not correct can make a dangerous operating condition.

DO NOT operate a lift truck that needs repairs. Report the need for repairs immediately. If repair is necessary, put a DO NOT OPERATE tag in the operator's area. Remove the key from the key switch or cover the keyless switch if lift truck is equipped with one. Disconnect the battery connector.

DO NOT work under a raised carriage. Lower the carriage or use a chain to prevent the carriage and the inner or intermediate weldments from lowering when doing maintenance. Make sure that the moving parts are attached to parts that cannot move.

CAUTION

Disposal of lubricants and fluids must meet local environmental regulations.

CAUTION

Disposal of batteries must meet local environmental regulations.

This section contains a Maintenance Schedule and the instructions for maintenance and inspection.

The Maintenance Schedule has time intervals for inspection, lubrication, and maintenance for your lift truck. The service intervals are provided in both operating hours recorded on the lift truck hourmeter, and in calendar time. Use the interval that occurs first.

The recommendation for the time intervals are for one shift of operation per day. The time intervals must be decreased from the recommendations in the Maintenance Schedule for the following conditions:

- The lift truck is used more than one shift per day.
- The lift truck must work in dirty operating conditions.
- Poor ground conditions.
- Intensive usage at high performance levels or other abnormal conditions will require more frequent servicing.

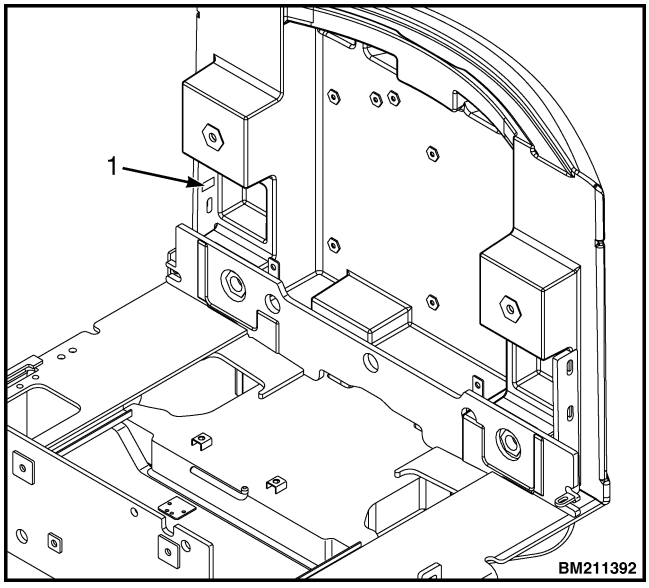
Your dealer for Hyster lift trucks will advise you on the maintenance time intervals based on their survey of the application.

Your dealer for Hyster lift trucks has the equipment and trained service personnel to do a complete program of inspection, lubrication, and maintenance. A regular program of inspection, lubrication, and maintenance will help your lift truck provide more efficient performance and operate for a longer period of time.

Some users have service personnel and equipment to do the inspection, lubrication, and maintenance shown in the Maintenance Schedule. Service Manuals are available from your dealer for Hyster lift trucks to help users who do their own maintenance.

SERIAL NUMBER DATA

The serial number code for the lift truck is on the Nameplate and stamped into front face of rear plate. See Figure 1.



1. SERIAL NUMBER

Figure 1. Stamped Serial Number

DISCHARGING THE CAPACITORS

WARNING

DO NOT make repairs or adjustments unless you have been properly trained and authorized to do so. Improper repairs and adjustments can create dangerous operating conditions. DO NOT operate a lift truck that needs repairs. Report the need for repairs to your supervisor immediately. If repair is necessary, attach a DO NOT OPERATE tag on the steering wheel and disconnect the battery.

Disconnect the battery and allow the capacitors to discharge before opening any compartment covers or inspecting or repairing the electrical system. DO NOT place tools on top of the battery. If a tool causes a short circuit, the high current flow from the battery can cause personal injury or property damage.

Some checks and adjustments are performed with the battery connected. DO NOT connect the battery until the procedure instructs you to do so. Never wear any metallic items on your fingers, arms, or neck. Metal items can accidentally make an electrical connection and cause injury.

Before performing any tests or adjustments, block the lift truck to prevent unexpected movement.

The capacitor in the transistor controller(s) can hold an electrical charge for about 10 seconds after the battery is disconnected. To prevent an electrical shock and personal injury, discharge the capacitor(s) before inspecting or repairing any component in the drive unit compartment. Make certain that the battery has been disconnected.

DO NOT short across the motor controller terminals with a screwdriver or jumper wire.

Make certain the Emergency Disconnect Switch has not been activated. This will isolate the controller and prevent the capacitors from discharging properly. The proper way to disconnect the battery is by separating the battery connectors.

1. Ensure the capacitors are discharged by performing Step 2 through Step 6 below.
2. Turn the key or keyless switch to the **OFF** position.
3. Disconnect the battery by separating the connectors.
4. Block drive wheels to prevent lift truck from moving.
5. Make sure the Emergency Disconnect Switch **HAS NOT** been activated. If the Emergency Disconnect Switch is activated, rotate the switch to the right until it pops up.
6. Press horn button. Wait 30 seconds to be sure capacitors are fully discharged.

HOW TO MOVE DISABLED LIFT TRUCK

How to Tow Lift Truck

WARNING

Use extra care when towing a lift truck if any of the following conditions exist:

- **Brakes DO NOT operate correctly.**
- **Steering does not operate correctly.**
- **Tires are damaged.**
- **Traction conditions are bad.**
- **The lift truck must be moved on a steep grade.**

If the hydraulic pump motor, which includes the steering control functions, does not operate, steering control of the lift truck can be slow. DO NOT tow the lift truck if there is no power. Poor traction can cause the disabled lift truck or towing vehicle to slide. Steep grades will require additional brake force to stop the lift truck.

Never carry a disabled lift truck unless the lift truck MUST be moved and cannot be towed. The lift truck used to carry the disabled lift truck MUST have a rated capacity equal to or greater than the weight of the disabled lift truck. The capacity must be for a load center equal to half the width of the disabled lift truck. See the Nameplate of the disabled lift truck for the approximate total weight. The forks must extend the full width of the disabled lift truck. Put the weight center of the disabled lift truck on the load center of the forks. DO NOT damage the underside of the lift truck.

1. The towed lift truck must have an operator.
2. Raise the carriage and forks approximately 300 mm (12 in.) from the surface. Install a chain to prevent the carriage and mast channels from moving.

3. Tow with another lift truck of *equal* or *greater* capacity than the disabled lift truck. Install a load of approximately half-capacity on the forks of the lift truck that is being used to tow the disabled lift truck. The half-capacity load will increase the traction of the lift truck. Keep the load as low as possible.

4. Use a towing link made of steel that fastens to the tow pins in the counterweights of both lift trucks.

5. Release the parking brake.

6. Tow the lift truck slowly.

HOW TO PUT LIFT TRUCK ON BLOCKS

How to Raise Drive Tires

WARNING

The lift truck must be put on blocks for some types of maintenance and repair. The removal of the following assemblies will cause large changes in the center of gravity: mast, drive axle, battery, or counterweight. When the lift truck is put on blocks, put additional blocks in the following positions to maintain stability:

Before removing the mast and drive axle, put blocks under the counterweight so the lift truck cannot fall backward.

Before removing the counterweight, put blocks under the mast assembly so the lift truck cannot fall forward.

The surface must be solid, even, and level when the lift truck is put on blocks. Make sure that any blocks used to support the lift truck are solid, one-piece units.

NOTE: Some lift trucks have lifting eyes. These lift points can be used to raise the lift truck so that blocks can be installed.

1. Put blocks on each side (front and back) of the steering tires to prevent movement of the lift truck. See Figure 2.

2. Put the mast in a vertical position. Put a block under each outer mast channel.

3. Tilt the mast fully forward until the drive tires are raised from the surface.

4. Put additional blocks under the frame behind the drive tires.

5. If the hydraulic system will not operate, use a hydraulic jack under the side of the frame near the front. Make sure that the jack has a capacity equal to at least half the weight of the lift truck as shown on the Nameplate.

How to Raise Steering Tires

1. Apply the Automatic Parking Brake. Put blocks on both sides (front and back) of the drive tires to prevent movement of the lift truck. See Figure 2.

2. Use a hydraulic jack to raise the steering tires. Make sure that the jack has a capacity of at least 2/3 of the total weight of the lift truck as shown on the Nameplate.

3. Put the jack under the steering axle or frame to raise the lift truck. Put blocks under the frame to support the lift truck.

HOW TO CLEAN A LIFT TRUCK

WARNING

Compressed air can move particles so that they cause injury to the user or to other personnel. Make sure that the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eyes.

CAUTION

Units may be washed with a non-heated pressure washer. Steam cleaning is not recommended in most instances, as condensation may form in electrical components causing damage or erratic behavior.

NOTE: Lift trucks used in paper applications may need cleaning beyond what is described here. Please refer to Paper Application section in the applicable Operating Manual and to available Service Gram/ Bulletin for more detail.

If it becomes necessary to clean the fork lift, follow the guidelines listed below.

1. Assure truck components are cool before starting the cleaning procedure.

2. Disconnect the battery. If an electric truck, remove the traction battery.

3. Remove accumulated debris using a compressed air line and nozzle.

4. Lightly spray a non-corrosive cleaning agent onto the areas to be cleaned. This will help loosen grime, so close contact direct spraying will not be necessary.

5. Be sure to avoid directing the spray into electrical panel compartment. Ensure over-spray does not come in contact with electrical components; DO NOT spray water directly at electrical components, wiring connectors or electrical enclosures. Even sealed connectors may allow water egress under pressure or if connector is damaged.

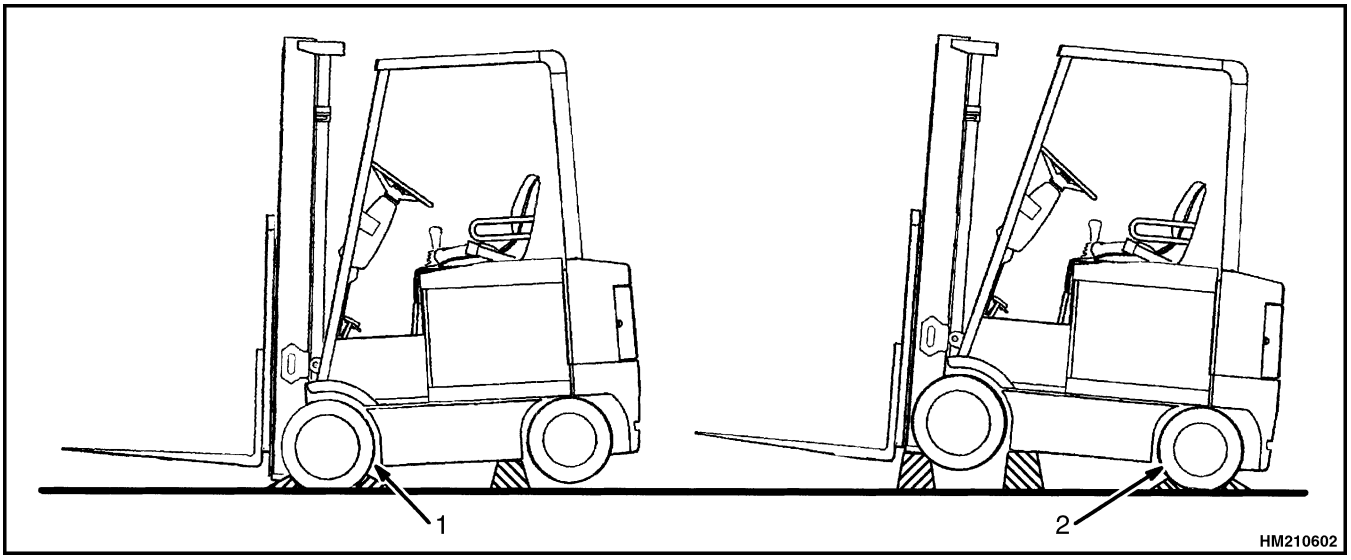
6. Avoid spraying in areas containing electrical components such as:
   - Floor Plates
   - Battery Compartment
   - Dash/cowl assembly
   - Armrests with electrical components

7. Clean the battery compartment by using a clean cloth to wash the battery with water. Dry with compressed air. Care should be taken to keep moisture at a minimum as some units have a traction or hydraulic motor directly below the battery compartment.

8. DO NOT pressure wash the battery. DO NOT use hot water. For cleaning traction batteries, refer to the Battery section of the **Service Manual**.

9. DO NOT pressure wash lift chains, sheaves or load rollers in the mast assembly. Refer to the Chains, Sheaves and Load Rollers maintenance section in the **Service Manual** for proper cleaning procedures.

10. After cleaning, immediately run the lift truck to dry out components.



1. DRIVE TIRES
2. STEERING TIRES

Figure 2. Put Lift Trucks on Blocks

Safety Procedures When Working Near Mast

WARNING

Mast parts are heavy and can move. Distances between parts are small. Serious injury or death can result if part of the body is hit by parts of the mast or the carriage.

- **Never put any part of the body into or under the mast or carriage unless all parts are completely lowered or a safety chain is installed. Also make sure that the power is OFF and the key is removed. Put a DO NOT OPERATE tag in the operator's compartment.**
- **Be careful of the forks. When the mast is raised, the forks can be at a height to cause an injury.**
- **DO NOT climb on the mast or lift truck at any time. Use a ladder or personnel lift to work on the mast.**
- **DO NOT use blocks to support the mast weldments nor to restrain their movement.**
- **Mast repairs require disassembly and removal of parts and can require removal of the mast or carriage. Follow the repair procedures in the applicable Service Manual section for the mast.**

The following procedures must be used when inspecting or working near the mast. Additional precautions and procedures can be required when repairing or removing the mast. See the correct Service Manual section for the specific mast being repaired.

WHEN WORKING NEAR THE MAST ALWAYS:

1. Lower the mast and carriage completely. Push the lift/lower control lever forward and make sure there is no movement in the mast. Make sure that all parts of the mast that move are fully lowered.

   OR

2. If parts of the mast must be in raised position, install a safety chain to restrain the moving parts of the mast. Connect moving parts to a part that does not move. Follow these procedures:

   a. Put the mast in a vertical position.

   b. Raise the mast to align the bottom crossmember of the weldment that moves in the outer weldment with a crossmember on the outer weldment. On the two-stage and free-lift mast, the moving part is the inner weldment. On teh three-stage mast, it is the intermediate weldment. On the four-stage mast it is the first intermediate weldment. See Figure 3.

   c. Use a 9.4 mm (0.370 in.) (3/8 inch) minimum safety chain with a hook to fasten the crossmembers together so the movable member cannot lower. Put the hook on the back side of the mast. Make sure the hook is completely engaged with a link in the chain. Make sure the safety chain does not touch lift chains or chain sheaves, tubes, hoses, fittings, or other parts on the mast.

   d. Lower the mast until there is tension in the safety chain and the free-lift cylinder (free-lift and three-stage masts only) is completely retracted. Install a **DO NOT REMOVE** tag on the safety chain(s).

   e. Install another safety chain, 9.4 mm (0.370 in.) minimum, between the top or bottom crossmember of the carriage and a crossmember on the outer weldment.

3. Apply the parking brake, shut off the power and remove the key. Put a **DO NOT OPERATE** tag in the operator's compartment. Disconnect battery connector.

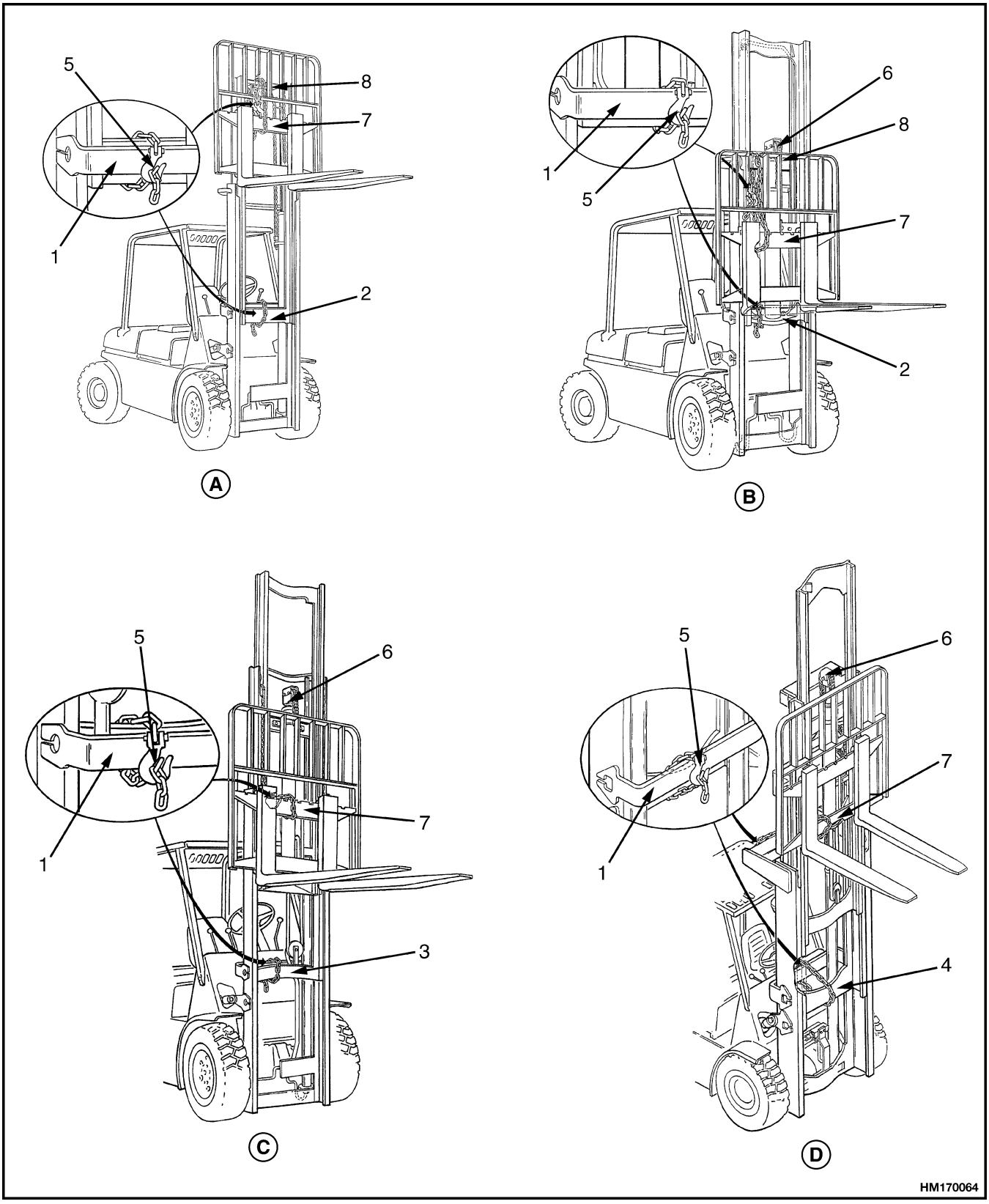


Figure 3. Two-Stage, Free-Lift, Three-Stage, and Four-Stage Masts

Legend for Figure 3.

NOTE: ILLUSTRATION FOR REFERENCE ONLY.

A. TWO-STAGE MAST
B. FREE-LIFT MAST
C. THREE-STAGE MAST
D. FOUR-STAGE MAST

1. OUTER WELDMENT
2. INNER WELDMENT
3. INTERMEDIATE WELDMENT
4. FIRST INTERMEDIATE WELDMENT
5. HOOK
6. FREE-LIFT CYLINDER
7. CROSSMEMBER
8. CROSSMEMBER

Maintenance Schedule

The Maintenance Schedule has time intervals for inspection, lubrication, and maintenance for your lift truck. The service intervals are provided in both operating hours recorded on the lift truck hourmeter, and in calendar time. The recommendation is to use the interval that comes first. The approximate locations of the items indicated in the Maintenance Schedule are shown in Figure 4 and Figure 5.

The Maintenance Schedule has the maximum service intervals for usage under normal conditions. Inspect and lubricate more frequently if the lift truck operates in dirty, dusty, wet, or difficult conditions.

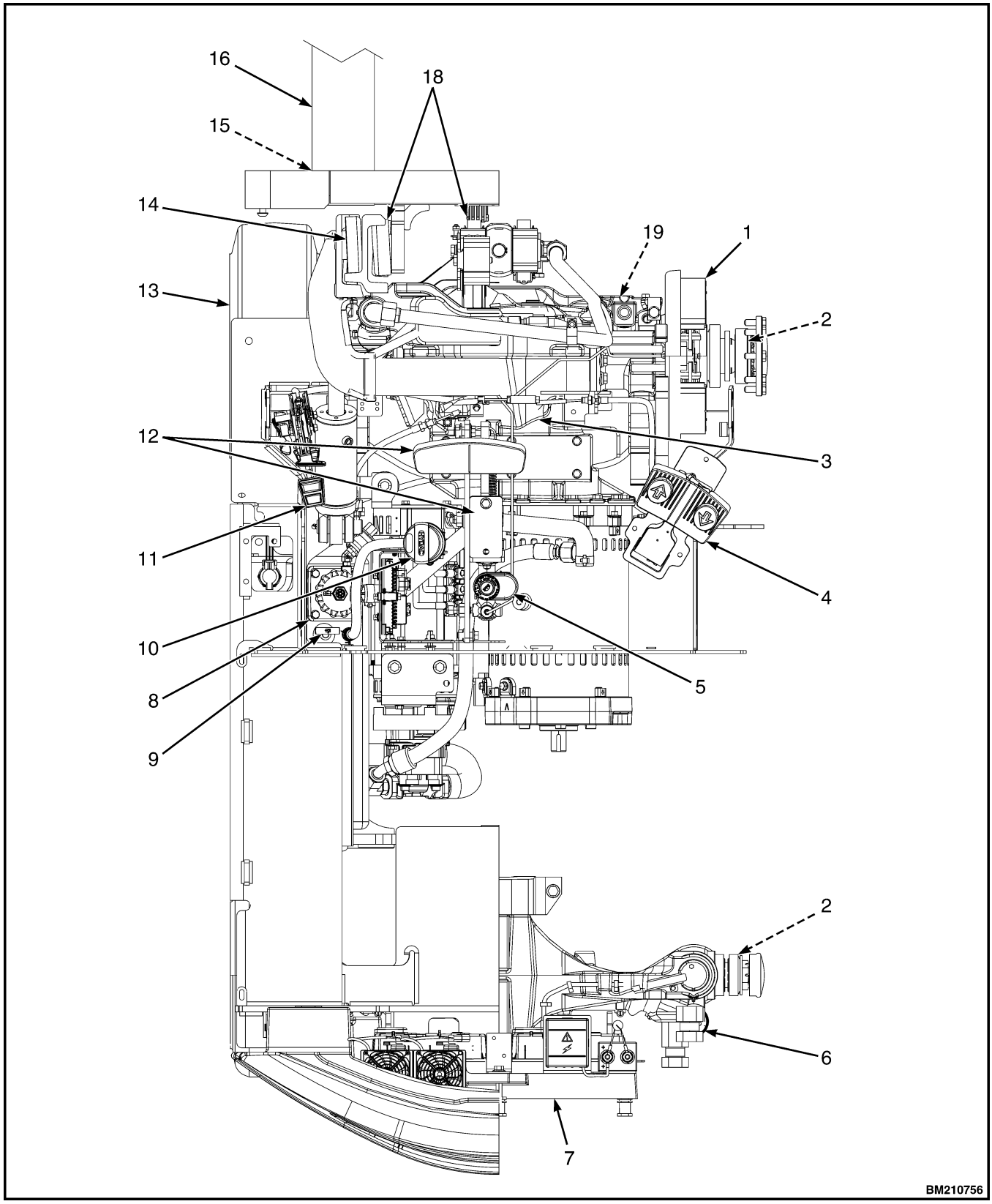


Figure 4. Maintenance Points, Lift Trucks Manufactured Before September, 2012

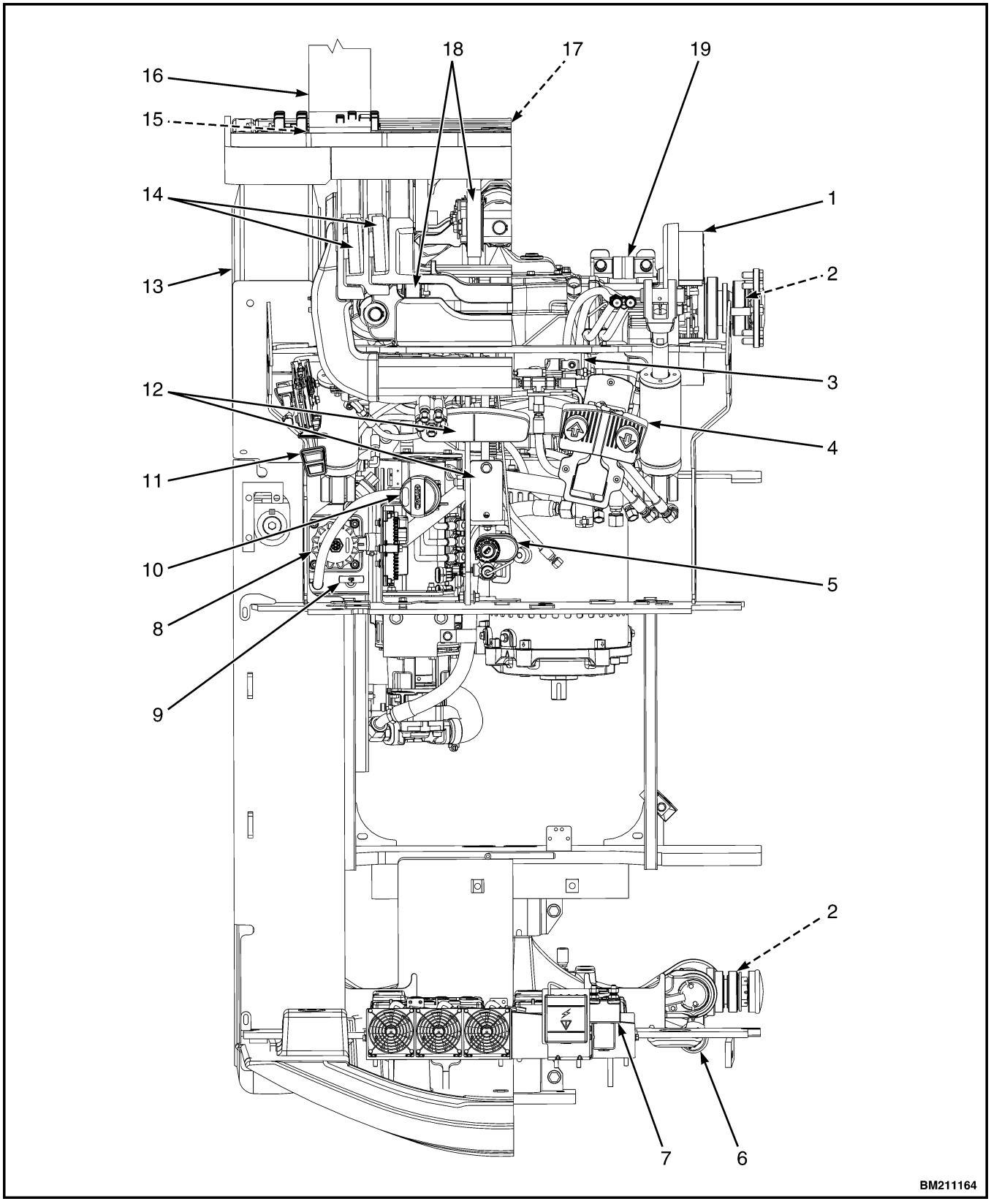


Figure 5. Maintenance Points, Lift Trucks Manufactured After September, 2012

Table 1. Maintenance Schedule

Item No.	Item	8 hr/ Daily	500 hr/ 3mo	2000 hr/ 1 yr	4000 hr/ 2 yr	Procedure or Quantity	Specification
13	Tires	X				Check condition.	
11	Parking Brake	X CIL				Check operation.	
1	Service Brake	X				Check operation.	See **Parts Manual.**
5	Brake Fluid	CIL	X	C		0.18 liter (0.4 pt).	Use SAE J-1703 (DOT 3) brake fluid.
3	Differential and Speed Reducer	X				Check for leaks.	
18	Lift Chains	X				Check condition/ lube if necessary. See **NOTE 3**.	SAE 30W engine oil.
16	Forks	X	X	X		Check condition/ replace if necessary.	
4	Direction and Speed Control Pedals	X				Check operation. Lubricate as necessary.	Use multipurpose grease. See **NOTE 1**.
9	Hydraulic Oil (Total Capacity - Nylon Tank)	X			C	32.0 liter (34.0 qt). See **NOTE 7**.	-18 to 38°C (0 to 100°F) hydraulic oil ISO VG46.
9	Hydraulic Oil (Total Capacity - Metal Tank)	X			C	35.0 liter (37.0 qt). See **NOTE 7**.	-18 to 38°C (0 to 100°F) hydraulic oil ISO VG46.
	Horn, Lights, and Alarm	X				Check operation.	
	Oil Leaks	X				Check for leaks.	
	Safety Labels	X				Replace as necessary.	See **Parts Manual.**
	Battery	X				Check condition.	See **NOTE 4**.
	Hood Latch	X				Lubricate as necessary. Check operation.	Use multipurpose grease. See **NOTE 1**.
	Steering Column Tilt Memory Lever	X				Lubricate as necessary. Check operation.	Use multipurpose grease. See **NOTE 1**.
	Seat Belt and Seat Rails	X CIL				Lubricate as necessary. Check operation.	Use multipurpose grease. See **NOTE 1**.
11	Parking Brake Adjustment		X			Adjust as necessary.	Must hold a full capacity load on a 15% grade.
19	Pivots (Mast)		L			2 fittings, lubricate as required.	Use multipurpose grease. See **NOTE 1**.

X=Check C=Change L=Lubricate CIL=Check Indicator Light during operation

Table 1. Maintenance Schedule (Continued)

Item No.	Item	8 hr/ Daily	500 hr/ 3mo	2000 hr/ 1 yr	4000 hr/ 2 yr	Procedure or Quantity	Specification
14	Mast Sliding Surfaces		L			Lubricate as required. See **NOTE 5**.	Use multipurpose grease. See **NOTE 1**.
17	Integral Sideshift Carriage		L			2 fittings. See **NOTE 5**.	Use multipurpose grease. See **NOTE 1**.
17	Integral Sideshift Carriage Fork Positioner		L			Lubricate as required. 2 fittings. See **NOTE 2**.	Use multipurpose grease. See **NOTE 1**.
	Operator Presence System Check	X	X			Check operation.	
	Header Hoses, Hose Fittings and Clamps	X	X			Inspect for kinked, flattened, stiff, or charred hoses.	Replace if necessary.
3	Differential and Speed Reducer		X			4.8 liter (5.0 qt) Check oil level.	Use gear lube SAE 80W or gear oil SAE 80W-90 (Chevron) or equivalent.
	Tilt Cylinder Rod End Pins	X	L				Use multipurpose grease. See **NOTE 1**.
11	Parking Brake		L			Lubricate linkage. See **NOTE 2**.	Use silicone spray, Hyster P/N 328388.
12	Brake Pedal Linkage and Shafts		L			Lubricate linkage and shafts. See **NOTE 2**.	Use multipurpose grease. See **NOTE 1**.
18	Lift Chains		L			Check stretch and lubricate. See **NOTE 2** and **NOTE 3**	SAE 30W engine oil.
18	Lift Chains		X			Check adjustment and length. See **NOTE 2**.	
15	Fork Pins and Guides	X	L			Lubricate as necessary.	SAE 30W engine oil.
10	Hydraulic Tank Breather		X	C		Clean or replace. See **NOTE 2**.	See **Parts Manual.**
17	Integral Side-Shift Carriage (Upper/Lower Bearings)		X			Check wear/ 4 bearings. See **NOTE 5**.	2.5 mm (0.098 in.) minimum thickness.
17	Integral Sideshift Carriage		X			Check for wear and clearance See **NOTE 2**.	0.76 mm (0.03 in.) minimum wear limit
X=Check C=Change L=Lubricate CIL=Check Indicator Light during operation							

Table 1. Maintenance Schedule (Continued)

Item No.	Item	8 hr/ Daily	500 hr/ 3mo	2000 hr/ 1 yr	4000 hr/ 2 yr	Procedure or Quantity	Specification
	Lower Mounting Hooks						
7	Contactor		X			Check condition.	See **Parts Manual.**
6	Steering King Pins		L			4 fittings, lubricate as required See **NOTE 2**.	Use multipurpose grease See **NOTE 1**.
	Hinges, Levers, Linkage, Pedals, Seat Rails, and Latches		L			Lubricate as required. See **NOTE 2**.	Use multipurpose grease. See **NOTE 1**.
17	Integral Side-Shift Carriage (Upper/Lower Bearings)			C		Replace bearings/ 4 bearings.	2.5 mm (0.098 in.) minimum thickness. See **Parts/Service Manual.**
1	Service Brakes			X		Check condition.	See **Parts Manual.** Minimum thickness 1.0 mm (0.04 in.).
2	Wheel Bearings Steer and Drive Wheels			L		Check grease.	Use multipurpose grease. See **NOTE 1**.
8	Hydraulic Oil Filter			C		1 filter. See **NOTE 2** and **NOTE 7**.	See **Parts Manual.**
3	Differential and Speed Reducer			C		Change oil. 4.8 liter (5.0 qt).	Use gear lube SAE 80W or gear oil SAE 80W-90 (Chevron) or equivalent.
18	Lift Chains			X, L		Remove lift chains to clean and lubricate.	SAE 30W engine oil.
	Steering Position Sensor				X	Check sensor assembly and column gear teeth.	Replace sensor or column gear as required.
	Telescopic Steering Column				L	Lubricate	Use manual steering gear grease. See **NOTE 6**.

NOTE 1: Multipurpose grease with 2 to 4% Molybdenum Disulfide.

NOTE 2: Recommended service intervals are based on a normal application in a clean environment. Applications involving contaminated environments such as high levels of air borne debris (dust and waste paper); chemical or abrasive compounds; poor ground conditions; intensive usage at high performance levels; or other abnormal conditions will require more frequent servicing. At your request your Hyster Yale dealer will advise you of the appropriate service intervals based on an application survey.

NOTE 3: Lubricate if dry or at first sign of visible surface rust

X=Check C=Change L=Lubricate CIL=Check Indicator Light during operation

Table 1. Maintenance Schedule (Continued)

Item No.	Item	8 hr/ Daily	500 hr/ 3mo	2000 hr/ 1 yr	4000 hr/ 2 yr	Procedure or Quantity	Specification
NOTE 4: Equalization charge is required approximately each month. Lithium-ion batteries do not require equalization charge. Consult your battery dealer regarding the charging requirements of your battery.							
NOTE 5: Maximize life of surface by lubricating every 250 hours for first 1000 hours.							
NOTE 6: Multipurpose lithium base grease.							
NOTE 7: Hydraulic oil sampling and analysis is a recommended practice. See **Hydraulic Cleanliness Procedures** 1900SRM1620 for oil cleanliness and water content guidelines. For lift trucks operating in heavy duty applications or highly contaminated environments, take oil samples every 500 hours. Normal Operating conditions may allow for less frequent oil sampling. Oil sampling should be done just prior to all oil and filter changes.							
X=Check C=Change L=Lubricate CIL=Check Indicator Light during operation							

Maintenance Procedures Every 8 Hours or Daily

WARNING

DO NOT operate a lift truck that needs repairs. Report the need for repairs immediately. If repair is necessary, put a DO NOT OPERATE tag in the operator's area. Remove the key from the key switch or cover the keyless switch

Inspect the lift truck after every eight hours or daily before use. Put the lift truck on a level surface. Lower the carriage and forks and turn the key or keyless switch to the **OFF** position. Apply the parking brake. Remove the floor mat and floor plate and inspect for leaks and conditions that are not normal. Clean any oil spills. Make sure that lint, dust, paper and other materials are removed from the compartments. Make the additional checks as described in the following paragraphs of
How to Make Checks With Key or Keyless Switch OFF and
How to Make Checks With Key or Keyless Switch ON.

HOW TO MAKE CHECKS WITH KEY OR KEYLESS SWITCH OFF

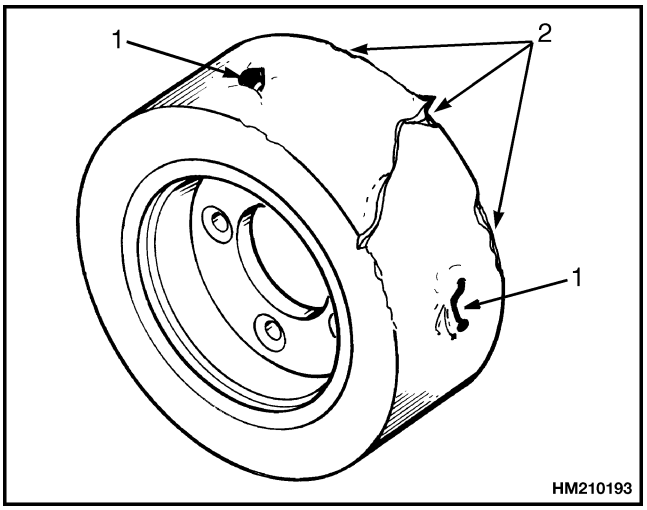
Tires and Wheels

Inspect the tires for wire, rocks, glass, pieces of metal, holes, cuts and other damage. Remove any object that will cause damage. Check for loose or missing hardware. Remove any wire strapping or other material that is wrapped around the axle. See Figure 6.

Forks

General

NOTE: Forks must be removed and installed by trained personnel.



1. CHECK FOR DAMAGE AND REMOVE NAILS, GLASS, METAL, AND OTHER OBJECTS
2. MAKE EDGES SMOOTH

Figure 6. Tires Check

The identification of a fork describes how the fork is connected to the carriage. These lift trucks have hook forks.

Inspect

WARNING

DO NOT try to correct fork tip alignment by bending the forks or adding shims. Replace bent forks.

Never repair damaged forks by heating or welding. Forks are made of special steel using special procedures. Replace damaged forks. Forks are to be replaced only in sets and not individually.

1. Inspect the forks for cracks and wear. Check that the fork tips are aligned as shown in Figure 7. Check that the bottom of the fork is not worn (item 4 in Figure 7).

CAUTION

Remove fork latch pins if adding a fork positioner attachment. Damage to forks and other carriage components can occur if fork latch pins are not removed prior to using attachment.

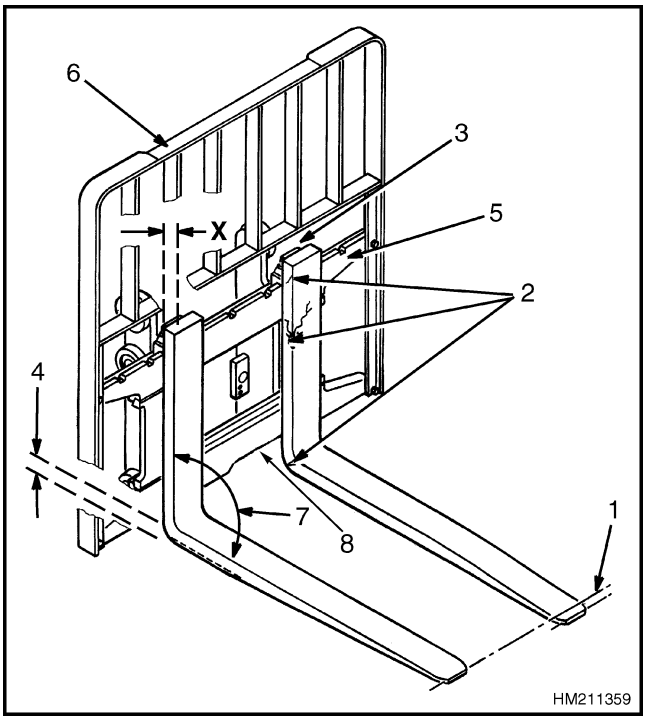
2. Replace any damaged or broken parts that are used to keep the forks locked in position. See Figure 13.

3. Inspect fork wear. Ensure the heel wear is not more than 10% of original thickness. If fork wear is more than 10%, the fork must be replaced or rerated. Perform the fork wear inspection using a BOL256N1 caliper ruler, Hyster P/N 4092984 , as follows. See Figure 8.

   a. Determine the normal thickness of the "N" of the fork using the scale or ruler portion of the caliper ruler. Measurement has to be done on the fork shank using the caliper ruler.

   b. Position the caliper at the end of the heel internal radius (item 4, Figure 7) with the opening corresponding to the measure thickness of the fork shank in Step a above (e.g. N 1.75 use N 1.75 opening). This is typically the section of the fork where wear is the greatest. Note that the opening distance has been reduced by 10% from the nominal thickness.

   c. If the fork enters the opening, it is mandatory to replace it. DANGER OF BREAKING. Furthermore, a 10% reduction in fork blade thickness results in 20% reduction in operating capacity.



Fork Tip Alignment	
Length of Forks	**3% Dimension**
914 mm (36 in.)	27 mm (1.08 in.)
1016 mm (40 in.)	30 mm (1.20 in.)
1067 mm (42 in.)	32 mm (1.26 in.)
1207 mm (47.5 in.)	36 mm (1.42 in.)
1219 mm (48 in.)	37 mm (1.46 in.)
1372 mm (54 in.)	41 mm (1.61 in.)
1524 mm (60 in.)	46 mm (1.81 in.)
1829 mm (72 in.)	55 mm (2.17 in.)

1. TIP ALIGNMENT (MUST BE WITHIN 3% OF FORK LENGTH)
2. CRACKS
3. LATCH
4. HEEL OF FORK (MUST BE 90% OF DIMENSION X)
5. CARRIAGE
6. LOAD BACKREST EXTENSION
7. MAXIMUM ANGLE 93°
8. FORK REMOVAL NOTCH

Figure 7. Forks Check

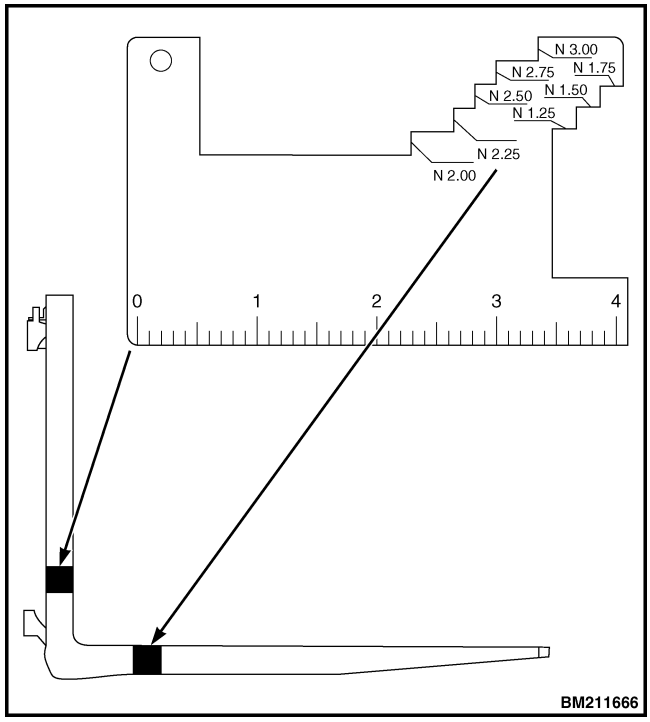


Figure 8. Fork Wear Check

Remove

WARNING

DO NOT try to move a fork without a lifting device. The forks can weigh 45 to 115 kg (99 to 254 lb).

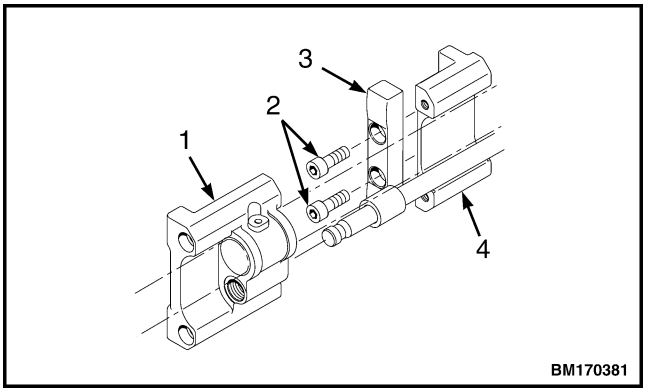
CAUTION

Remove fork latch pins if adding a fork positioner attachment. Damage to forks and other carriage components can occur if fork latch pins are not removed prior to using attachment.

NOTE: Forks are to be replaced in sets and not individually.

NOTE: If lift truck is equipped with a fork positioner attachment, perform Step 1 and Step 2. If lift truck is not equipped with a fork positioner attachment, go to Step 2.

NOTE: Depending on the size and configuration of the forks installed on the lift trucks equipped with a fork positioner, there may be a spacer bar between the inner and outer fork carriers. See Figure 9.



1. OUTER FORK CARRIER
2. CAPSCREW
3. SPACER BAR*
4. INNER FORK CARRIER

*spacer bar used on 1067 mm (42 in.) class ii carriages.

Figure 9. Fork Carrier Spacer Bar

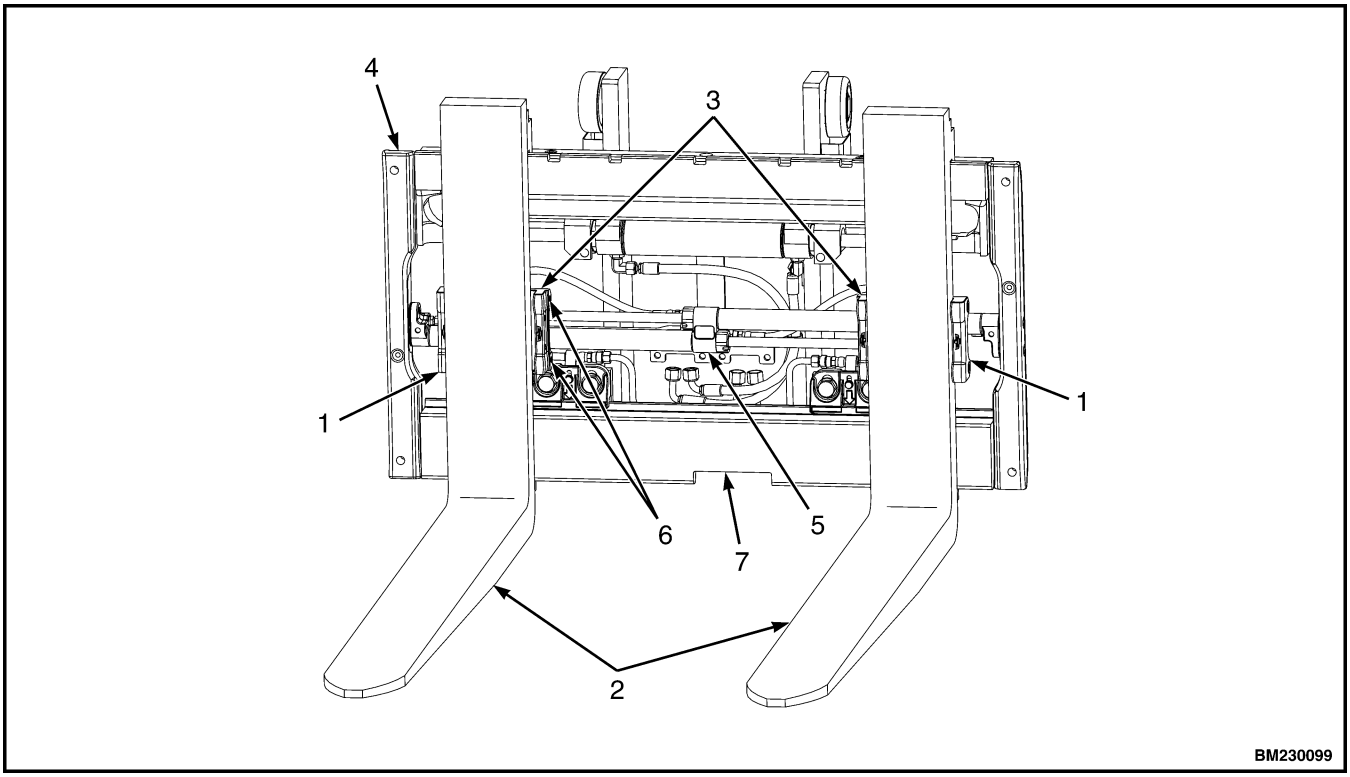
1. Lower carriage and remove four capscrews from inner fork carriers. Slide inner fork carriers down cylinder shell to remove forks. See Figure 10 and Figure 11 .

2. A fork can be removed from the carriage for replacement of the fork or other maintenance. Slide a hook fork to the fork removal notch on the carriage.

3. See Figure 10 or Figure 11 for lift trucks equipped with a fork positioner attachment.

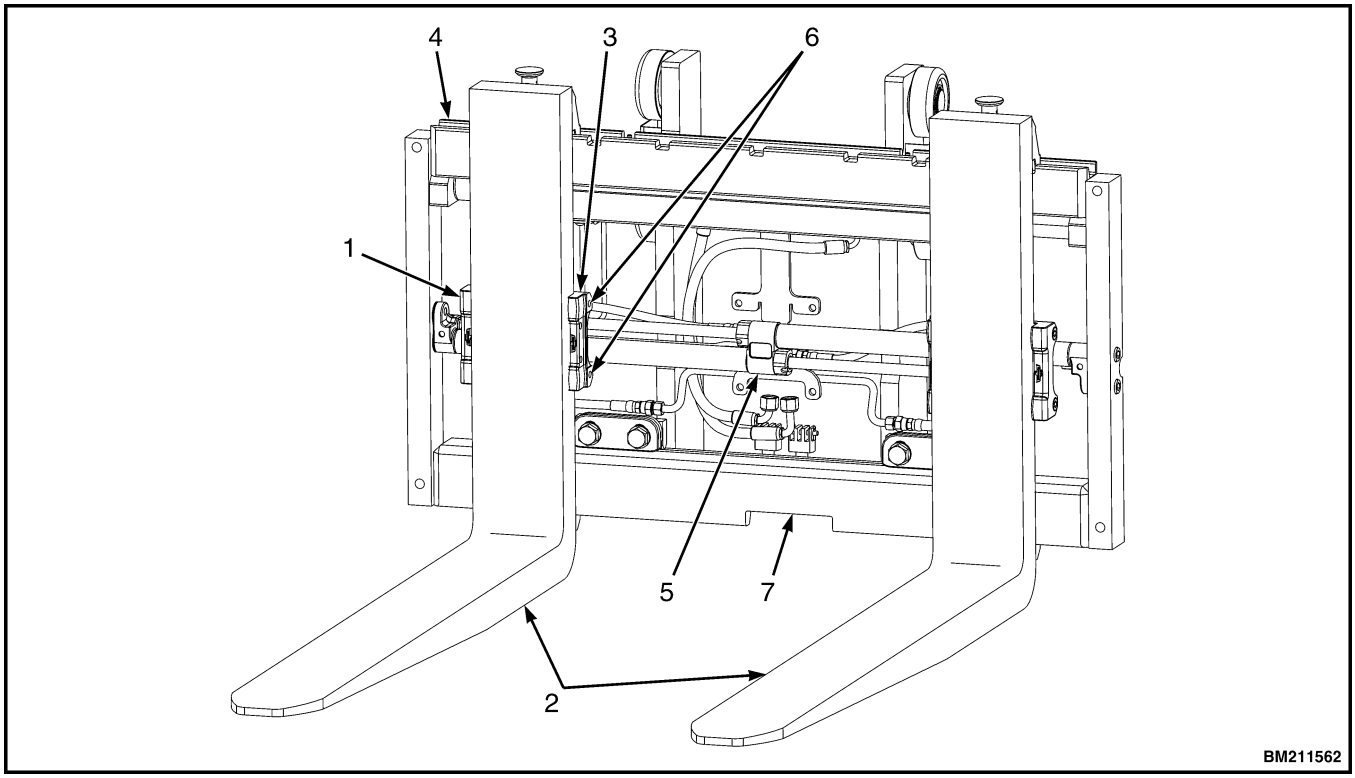
4. See Figure 7 for lift trucks not equipped with a fork positioner attachment.

Lower the fork onto blocks so that the lower fork hook moves through the fork removal notch. See Figure 12. Lower the carriage further so that the top fork hook is disengaged from the top carriage bar. Move carriage away from the fork or use a lifting device to move the fork away from the carriage.



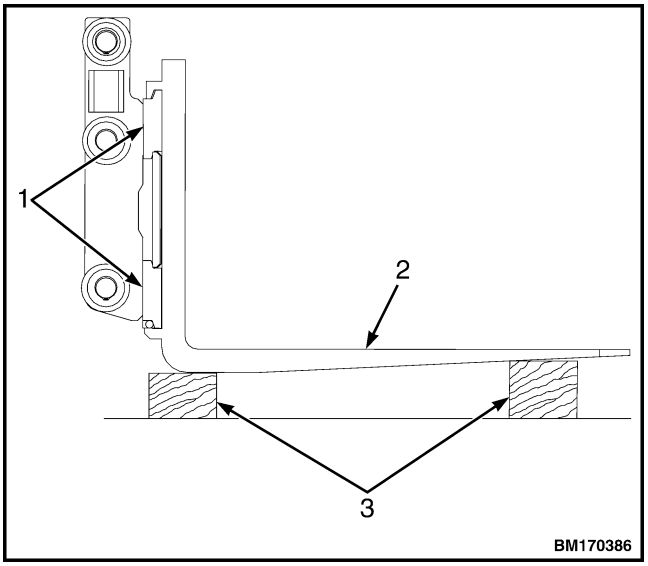
1. OUTER FORK CARRIER
2. FORKS
3. INNER FORK CARRIER
4. SIDESHIFT CARRIAGE ASSEMBLY
5. FORK POSITIONER
6. CAPSCREWS
7. FORK REMOVAL NOTCH

Figure 10. Fork Removal, Lift Trucks Equipped With Fork Positioner Prior to December, 2016



1. OUTER FORK CARRIER
2. FORKS
3. INNER FORK CARRIER
4. SIDESHIFT CARRIAGE ASSEMBLY
5. FORK POSITIONER
6. CAPSCREWS
7. FORK REMOVAL NOTCH

Figure 11. Fork Removal, Lift Trucks Equipped With Fork Positioner After December, 2016



1. CARRIAGE BARS
2. HOOK FORK
3. BLOCKS

Figure 12. Remove Hook Fork

Install

WARNING

DO NOT try to move a fork without a lifting device. The forks can weigh 45 to 115 kg (99 to 254 lb).

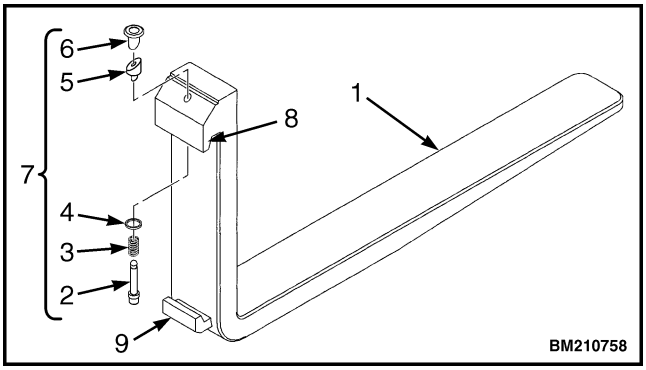
CAUTION

Remove fork latch pins if adding a fork positioner attachment. Damage to forks and other carriage components can occur if fork latch pins are not removed prior to using attachment.

NOTE: Forks are to be replaced only in sets and not individually.

NOTE: If lift truck is not equipped with fork positioner attachment, go to Step 1. If lift truck is equipped with a fork positioner attachment, go to Step 2.

1. Move fork and carriage so that top fork hook can engage top carriage bar. Raise carriage to move lower fork hook through fork removal notch. Slide fork on carriage so that both upper and lower fork hooks engage carriage. Engage lock pin with notch in top carriage bar. See Figure 13.



NOTE: ONLY LIFT TRUCK MODELS NOT EQUIPPED WITH A FORK POSITIONER ATTACHMENT USE FORK LOCK PIN ASSEMBLY TO LOCK FORK IN POSITION.

1. FORK
2. LOCK PIN
3. SPRING
4. WASHER
5. WEDGE
6. KNOB
7. LOCK PIN ASSEMBLY
8. TOP FORK HOOK
9. LOWER FORK HOOK

Figure 13. Fork Lock Pin Assembly

2. Install forks to outer fork carriers. Secure inner fork carriers to outer fork carriers using four capscrews. Tighten capscrews to 35 N•m (25 lbf ft). See Figure 10 or Figure 11.

Adjustment

NOTE: During adjustment of forks, the heel of forks should not be touching the ground.

NOTE: The procedures below apply only to lift trucks not equipped with fork positioner attachment.

The forks are connected to carriage by hooks and lock pins. See Figure 13. These lock pins are installed through top fork hooks and fit into slots in top carriage bar. Adjust forks as far apart as possible for maximum support of the load. Hook forks will slide along carriage bars to adjust for the load to be lifted. Raise lock pin in each fork to slide fork on carriage bar. Make sure lock pin is engaged in carriage bar to lock fork in position after adjustment is made.

Inspection of Mast, Carriage, Header Hoses, Lift Chains, and Attachments

WARNING

Lower the lift mechanism completely. Never allow any person under a raised carriage. DO NOT put any part of your body in or through the lift mechanism unless all parts of the mast are completely lowered and the lift truck traction motor is OFF.

1. Inspect the welds on the mast, cylinders, and carriage for cracks. Make sure that the capscrews and nuts are tight.

2. Inspect the channels for wear in the areas where the rollers travel. Inspect the rollers for wear or damage.

3. Inspect the load backrest extension for cracks and damage.

4. If the lift truck is equipped with a sideshift carriage or attachment, inspect the parts for cracks and wear. Make sure the parts that fasten the sideshift carriage or attachment to the carriage are in good condition.

WARNING

Always wear the proper protective equipment including eye protection and petroleum-resistant gloves when handling hydraulic oil. Thoroughly wash oil from exposed areas of skin as soon as possible.

WARNING

Never check for leaks by putting hands on hydraulic lines or components under pressure. Hydraulic oil under pressure can be injected into the skin.

5. Visually inspect hoses/fittings for hydraulic leaks; hose covers for cuts, cracks, or exposed reinforcement; defective/broken clamping devices or sheaves; and proper tracking during operation. Adjust/repair/replace hose/components as necessary.

6. Check that lift chains are correctly lubricated. Use SAE 30W engine oil to lubricate lift chains.

7. Inspect the lift chains for cracks or broken links and worn or turned pins. Lift chains must be replaced as a set. See Figure 14.

NOTE: Chain anchor pins MUST be replaced anytime chains are replaced.

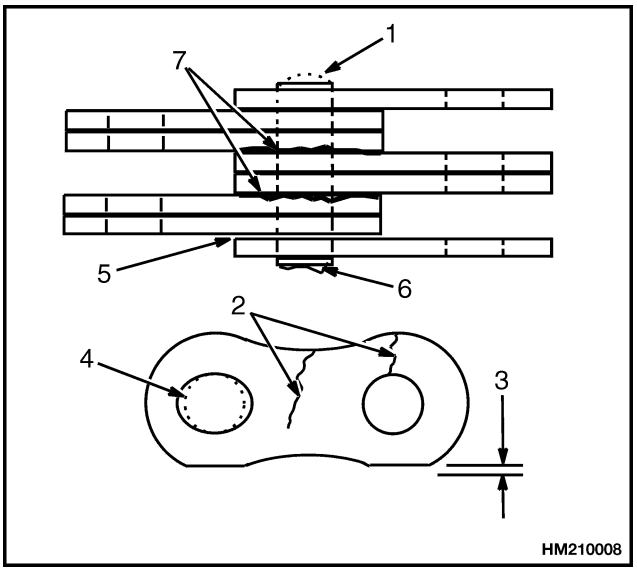
8. Inspect the chain anchors and pins for cracks and damage.

9. Make sure the lift chains are adjusted so that they have equal tension. **Adjustments or replacement of the lift chains must be done by authorized personnel.**

Safety Labels

WARNING

Safety labels are installed on the lift truck to provide information about possible hazards. It is important that all safety labels are installed on the lift truck and can be read.



1. WORN PIN
2. CRACKS
3. EDGE WEAR (MAXIMUM 5% OF NEW)
4. HOLE WEAR
5. LOOSE LEAVES
6. DAMAGED PIN
7. CORROSION

Figure 14. Lift Chains Check

Check that all safety labels are installed in the correct locations on the lift truck. See the **Parts Manual** or the service manual section **Frame** 0100SRM1342 for the correct locations of the safety labels.

Steering Column Adjustments

Make sure the steering column adjustment features are functioning properly. If lift truck is equipped with the optional telescoping steering column, make sure the tilt memory and telescoping features are operating correctly. The tilt memory lever must **NOT** allow the column to move unless the tilt memory lever is released. See Figure 15.

Tilt Adjust Feature

The column tilt angle should be locked in position whenever the tilt position lever is released. Use multipurpose grease as shown in the Maintenance Schedule and lubricate the lever and pivots as needed.

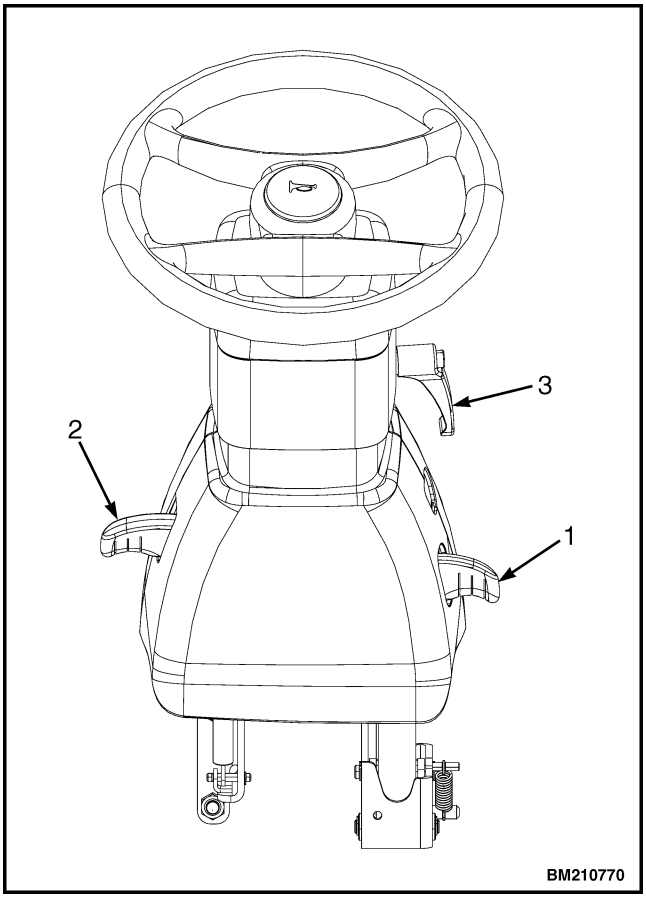
Tilt Memory Feature

After the tilt memory lever is released, tilt the column down until the column locks into position. The column should remain locked in place and **NOT** move. Use multipurpose grease as shown in the Maintenance Schedule and lubricate the lever and pivots as needed.

Telescopic Feature

NOTE: DO NOT use multipurpose grease to lubricate the sliding surfaces of the telescopic column.

When the telescopic column locking handle is tightened to 6 N•m (53 lbf in), the steering wheel should remain locked in place. Use multipurpose grease as shown in the Maintenance Schedule and lubricate the lever and pivots as needed.



NOTE: OPTIONAL TELESCOPIC STEERING COLUMN SHOWN.

1. TILT POSITION LEVER
2. TILT POSITION (OPTIONAL TILT MEMORY) LEVER
3. TELESCOPIC COLUMN LOCKING HANDLE

Figure 15. Steering Column Tilt Memory Lever

Operator Restraint System

There is an indicator icon on the display panel for the seat belt. The icon is **ON** as described in the **Operating Manual**. The indicator icon can help the operator remember to fasten the seat belt.

NOTE: The seat belt may be either black or red.

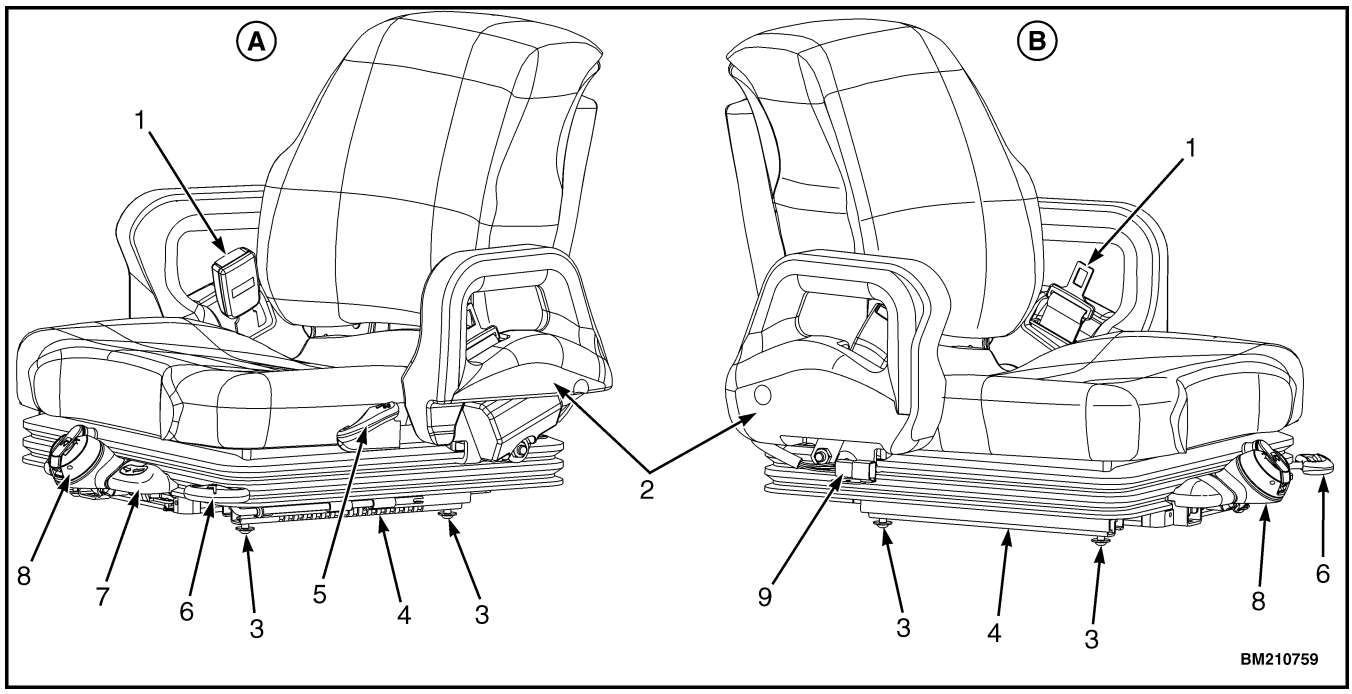
The lift trucks covered in this **Service Manual** can be equipped with one of three seat belt configurations:

- Seat belt with no operational interlock.
- Seat belt with operational interlock. Seat belt must be fastened for lift truck to start or travel.
- Seat belt with sequencing interlock. Operator must be in the seat, and the seat belt must be fastened, before lift truck will operate. This seat belt is used with the Optional Operator Presence System.

See the **Operating Manual** for more information on these seat belt types.

The seat belt, hip restraint brackets, and the seat and seat mounting components are the parts of the operator restraint system. If the lift truck is equipped with manual hydraulic control levers, the control lever assembly and latch are also part of the operator restraint system. Each item must be checked to make sure it is attached securely, functions correctly and is in good condition. See Figure 16.

Make sure the seat rails are not loose. The seat rails must lock securely in position, but move freely when unlocked. The seat rails must be securely attached to the mounting surface. See Figure 16.



NOTE: STANDARD SEAT SHOWN. AN OPTIONAL SWIVEL SEAT IS AVAILABLE. SWIVEL SEAT ARRANGEMENT IS THE SAME. HIP RESTRAINTS FOR LIFT TRUCKS WITH MANUAL HYDRAULIC SYSTEM SHOWN.

A. LEFT VIEW

B. RIGHT VIEW

1. SEAT BELT
2. HIP RESTRAINT BRACKET
3. MOUNTING HARDWARE
4. SEAT RAILS
5. BACKREST ANGLE ADJUSTMENT LEVER
6. FORWARD/BACKWARD ADJUSTMENT LEVER
7. RIDE POSITION INDICATOR
8. WEIGHT ADJUSTMENT KNOB
9. SEAT HARNESS

Figure 16. Seat Components and Operator Restraint System

Emergency Locking Retractor (ELR)

When the ELR style seat belt is properly buckled across the operator, the belt will permit slight operator repositioning without activating the locking mechanism. If the truck tips over, travels off a dock, or comes to a sudden stop, the locking mechanism will be activated and hold the operator's lower torso in the seat. See Figure 16.

A seat belt that is damaged, worn, or does not operate properly will not provide protection when it is needed. The end of the belt must fasten correctly in the latch. The seat belt must be in good condition. Replace the seat belt if it is damaged or worn.

The following seat belt operation checks must be performed three times before replacing the seat belt assembly:

- With the hood closed and in the locked position, pull the seat belt slowly from the retractor assembly. Make sure the seat belt pulls out and retracts smoothly. If the seat belt does not pull out of the retractor assembly the internal latch may be locked. Pull firmly on the seat belt and hold for a moment to remove slack from the belt in the retractor. Release the seat belt. Seat belt will retract and the internal latch will unlock. If the seat belt cannot be pulled from the retractor assembly or the belt will not retract, replace the seat belt assembly.
- With the hood closed and in the locked position, pull the seat belt with a sudden jerk. Make sure the seat belt will not pull from the retractor assembly. If the seat belt can be pulled from the retractor when it is pulled with a sudden jerk, replace the seat belt assembly.
- With the hood in the open position, make sure the seat belt will not pull from the retractor assembly. If the seat belt can be pulled from the retractor, with the hood in the open position, replace the seat belt assembly.

Seat Adjustments

Seat Position Adjustment (Standard Seat)

Fore and aft adjustment - it is recommended that the seat be adjusted so that the thigh is horizontal to the ground in order to achieve the best ergonomic position.

Seat Position Adjustment (Swivel Seat)

- The seat swivels 12 degrees to the right to allow the operator a more ergonomic position when driving in reverse.
- The seat swivels 5 degrees to the left to allow easier exit of the truck.
- The neutral position is shown in Figure 17.

Seat Adjustment for Operator Weight

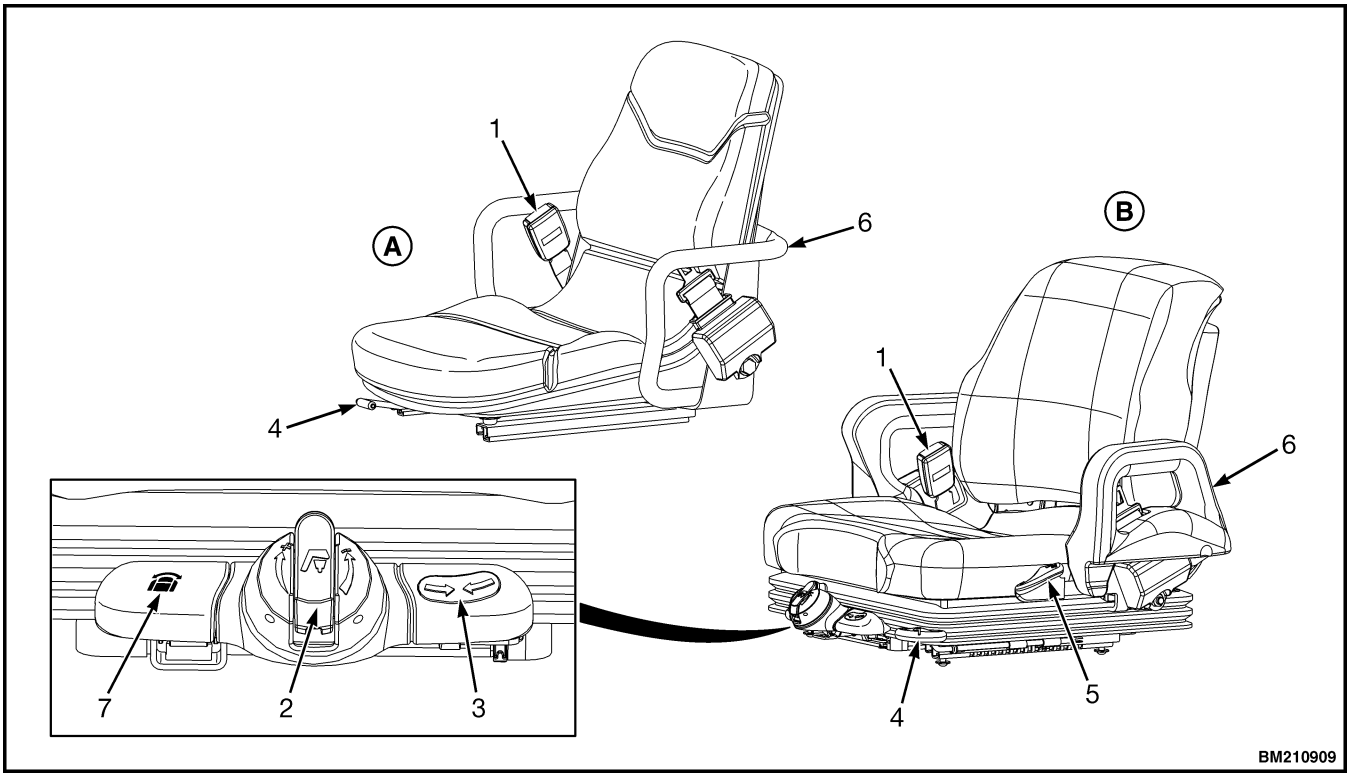
CAUTION

A major cause for high Whole Body Vibration is caused by the operator not adjusting the seat to his/her weight.

NOTE: It is important to adjust the weight setting for each operator.

NOTE: The seat is designed for a maximum weight of 135 kg (298 lb).

- The target is for the "ride indicator" to fall between the arrows when the operator sits upright on the seat with the feet positioned on the pedals. This ensures that the operator is set at the midpoint of the 80 mm (3.5 in.) suspension. See Figure 17.
- The handle can be turned as shown to increase or decrease the weight resistance, pull handle out before turning. As handle is turned the "stiffness" of the suspension can be felt to increase or decrease depending on which way the handle is turned.



A. STANDARD, NON SUSPENSION SEAT

B. FULL SUSPENSION SEAT

1. SEAT BELT
2. WEIGHT ADJUSTMENT KNOB
3. RIDE POSITION INDICATOR
4. FORWARD/BACKWARD ADJUSTMENT LEVER
5. BACKREST ANGLE ADJUSTMENT LEVER
6. ARMREST
7. SWIVEL LATCH RELEASE LEVER

Figure 17. Seat Adjustment

Battery Restraint System

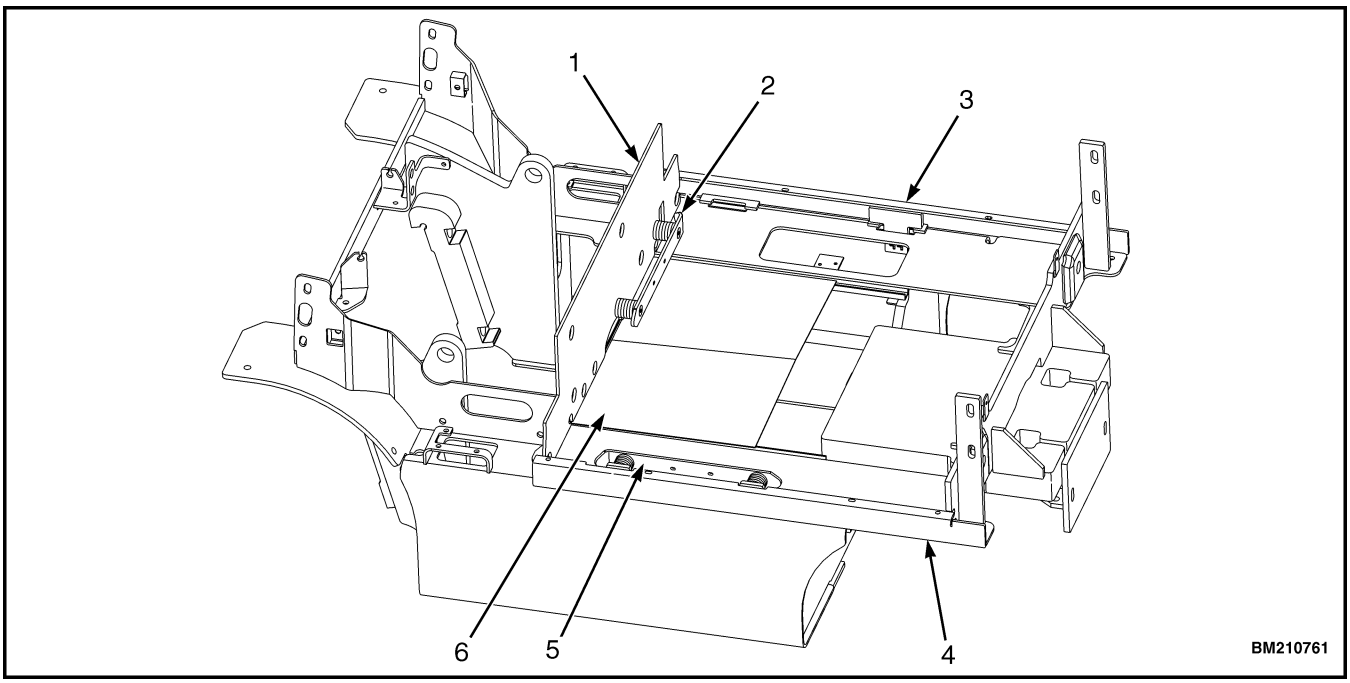
WARNING

The hood latch mechanism and battery restraint system must operate correctly before a lift truck is operated.

The battery restraint system is made up of front and side spacer plates and the right and left side battery covers (or battery gate if lift truck is equipped with optional side rollers). See Figure 18 and Figure 19. The hood and hood latch mechanism also help keep the battery within the battery compartment if a tipover occurs. The hood can be raised for access to the battery. Gas springs help raise and hold the hood in the up position.

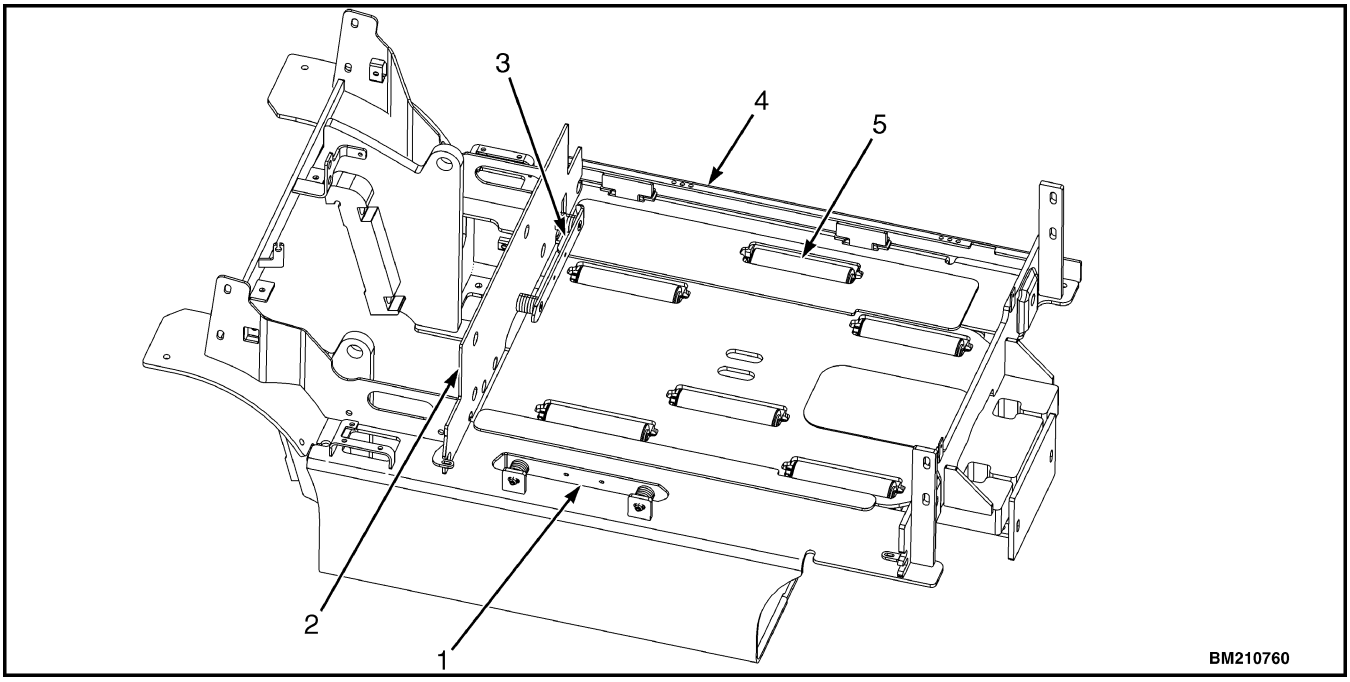
The front and side spacer plates are adjustable. The front spacer plate helps prevent the battery from moving forward and backward. The side spacer plate prevents side-to-side movement of the battery.

The battery restraint system must function so that the operator restraint system can operate correctly. Operation of the battery restraint system requires that the maximum movement allowed for the battery is 13 mm (0.50 in.) in any horizontal direction. This will reduce the risk of operator injury in a truck tipover. An adjustable battery spacer plate prevents the front-to-back movement of the battery. Batteries for this series of lift trucks must all have the same length dimension to just fit the battery compartment width. For correct battery sizes, see the **Operating Manual.**



1. FRONT BULKHEAD
2. FRONT SPACER PLATE
3. RIGHT SIDE BATTERY COVER
4. LEFT SIDE BATTERY COVER
5. SIDE SPACER PLATE
6. BATTERY PLATE

Figure 18. Standard Battery Restraint System



1. SIDE SPACER PLATE
2. FRONT BULKHEAD
3. FRONT SPACER PLATE
4. BATTERY GATE
5. SIDE ROLLER

Figure 19. Optional Battery Restraint System, With Side Rollers and Battery Gate

To raise the hood, perform the following:

1. Use the tilt memory lever and tilt the steering column all the way up. See Figure 15.

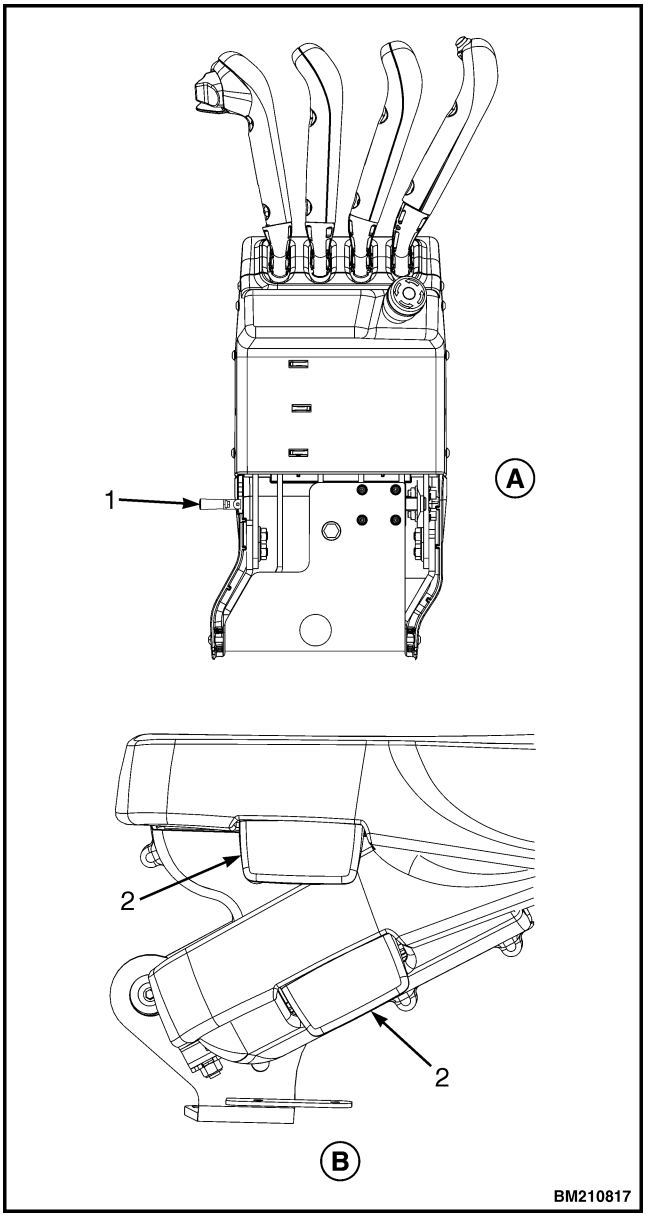
2. Slide the seat all the way back, and if necessary, move the armrest all the way back if lift truck is equipped with E-Hydraulic control levers. See Figure 20.

3. If lift truck is equipped with manual hydraulic levers, pull the release latch for the control lever assembly (see Figure 20) and move the assembly to the forward position before raising the hood.

CAUTION

Be careful while raising the hood. Injury to personnel may occur depending on lift truck overhead guard/cab height and hood configuration.

NOTE: The hood can be raised from either side of the lift truck. Pull the hood release lever. The hood release lever is spring loaded. Use a sling and crane to hold the hood in the up position.



A. MANUAL CONTROL LEVERS
B. E-HYDRAULIC CONTROL MINI-LEVERS

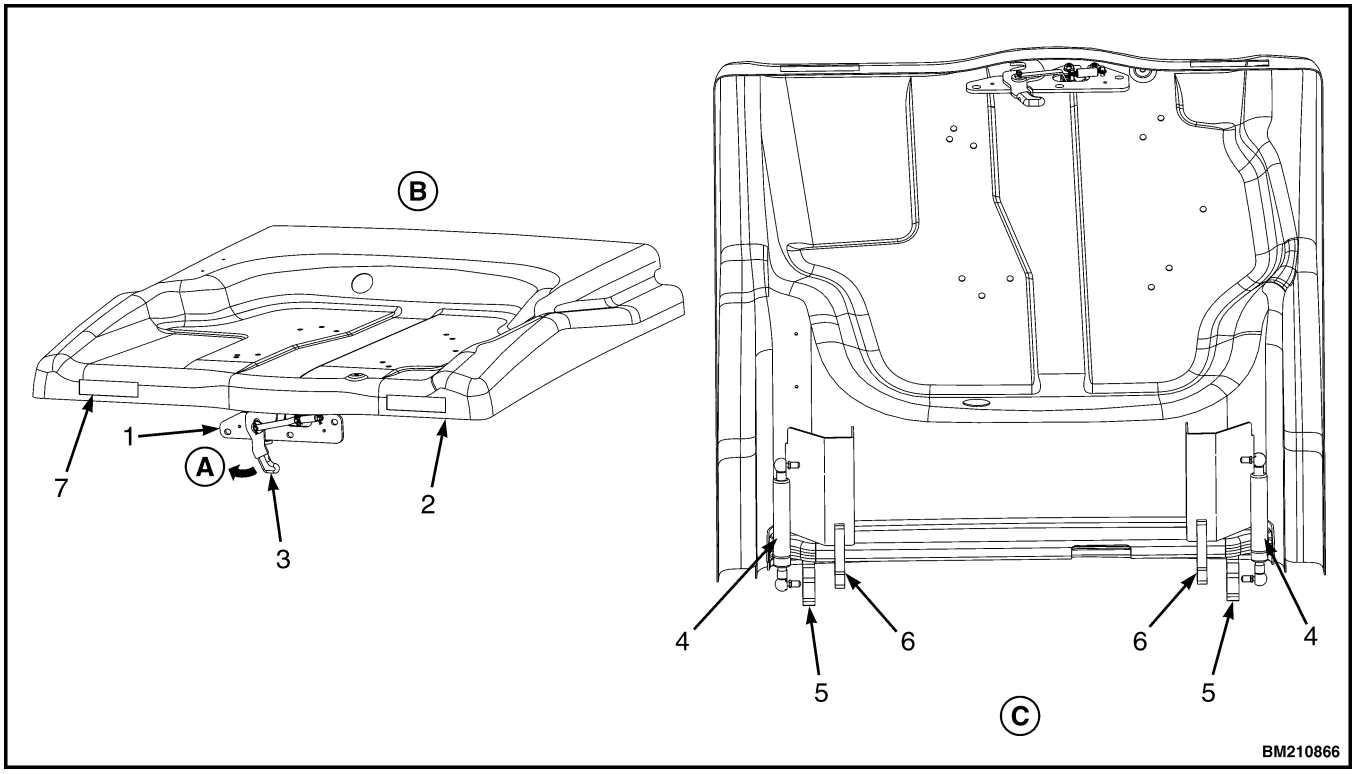
1. MANUAL CONTROL LEVERS RELEASE LATCH
2. E-HYDRAULIC CONTROL MINI-LEVERS ADJUSTMENT HANDLES

Figure 20. Hydraulic Control Levers Release

4. From the left side of the lift truck, push the hood release handle out towards the right side of the truck to unlatch the hood. If hood is opened from right side of truck, pull hood release handle towards the right side of the truck to unlatch the hood. Place hand in plastic pocket provided (above item 2 in Figure 21 or Figure 22) and raise hood to the up position. See Figure 21 or Figure 22.

5. To close hood, pull down on the hood until the latch clicks. Try to lift the hood to make sure hood is fastened correctly.

The battery must have the front and side spacer plates correctly adjusted to prevent any horizontal movement of more than 13 mm (0.50 in.).

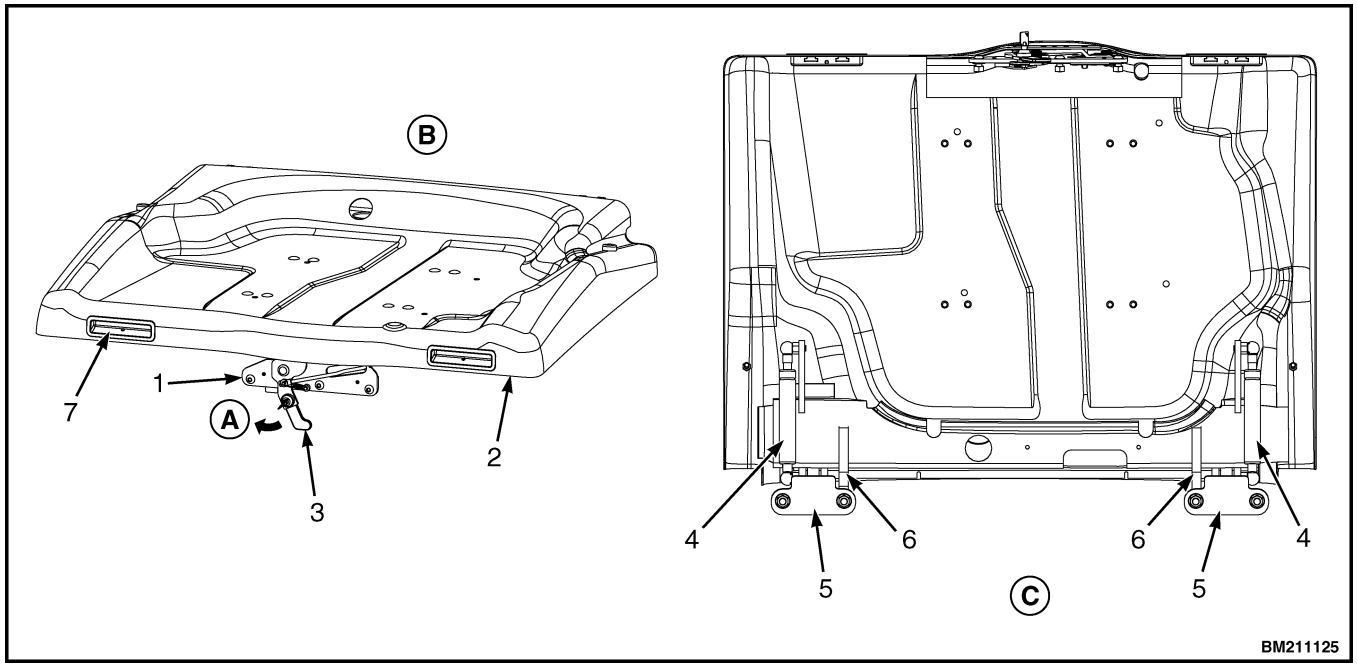


NOTE: 1015 mm (40 in.) HOOD SHOWN. GAS-CONTROLLED STRUT ORIENTATION MAY BE DIFFERENT FROM SHOWN.

A. RELEASE DIRECTION
B. FRONT VIEW
C. BOTTOM VIEW

1. LATCH ASSEMBLY
2. HOOD
3. HOOD RELEASE LEVER
4. GAS SPRING
5. HOOD HINGE
6. BATTERY STOPPER

Figure 21. Hood and Hood Latch Components, Lift Trucks Manufactured Before June, 2012



NOTE: 700 mm (27.6 in.) HOOD SHOWN. GAS-CONTROLLED STRUT ORIENTATION MAY BE DIFFERENT FROM SHOWN.

A. RELEASE DIRECTION
B. FRONT VIEW
C. BOTTOM VIEW

1. LATCH ASSEMBLY
2. HOOD
3. HOOD RELEASE LEVER
4. GAS SPRING
5. HOOD HINGE
6. BATTERY STOPPER

Figure 22. Hood and Hood Latch Components, Lift Trucks Manufactured After June, 2012

Battery

WARNING

Never put tools or other metal on the battery. Metal on the battery can cause a short circuit and possible damage or injury.

The acid in the electrolyte can cause injury. If the electrolyte is spilled, use water to flush the area. Make the acid neutral with a solution of sodium bicarbonate (soda). Acid in the eyes must be flushed with water immediately.

Batteries generate explosive fumes. Keep the vents in the caps clean. Keep sparks or open flames away from the battery area. Do not make a spark from the battery connections.

Disconnect the battery when doing maintenance.

NOTE: There can be one of three types of batteries. One type has removable cell caps. Another type has sealed cells. The third is a lithium-ion battery. The sealed batteries and lithium-ion batteries require a different charger, and the electrolyte level or specific gravity cannot be checked and water cannot be added to the electrolyte.

Make sure that the voltage and the weight of the battery are correct as shown on the Nameplate. See the **Operating Manual** to check for correct battery dimensions.

Keep the battery case, top cover and the area for the battery clean and painted. Leakage from the battery and corrosion can cause a malfunction in the electric controls of the lift truck. Use a water and sodium bicarbonate (soda) solution to clean the battery and the battery area. Keep the top of the battery clean, dry and free of corrosion.

Make sure the battery is charged and has the correct voltage and ampere hour rating for the lift truck. See the Nameplate.

Inspect the battery case, connector and cables for damage, cracks or breaks. See the battery dealer in the area to repair any damage.

On batteries with cell caps, check the level of the electrolyte daily on a minimum of one cell. Add only distilled water, as necessary, to all cells that do not have the correct electrolyte level. The correct level is halfway between the top of the plates and the bottom of the fill hole.

Hydraulic System

WARNING

At operating temperature the hydraulic oil is HOT. DO NOT permit the oil to contact the skin and cause a burn.

WARNING

Always wear the proper protective equipment including eye protection and petroleum-resistant gloves when handling hydraulic oil. Thoroughly wash oil from exposed areas of skin as soon as possible.

CAUTION

DO NOT permit dirt to enter the hydraulic system when the oil level is checked or the filter is changed.

Never operate the pump without oil in the hydraulic system. The operation of the hydraulic pump without oil will damage the pump.

NOTE: The dipstick is located under the floor mat and floor plate, on the left side of the operator compartment.

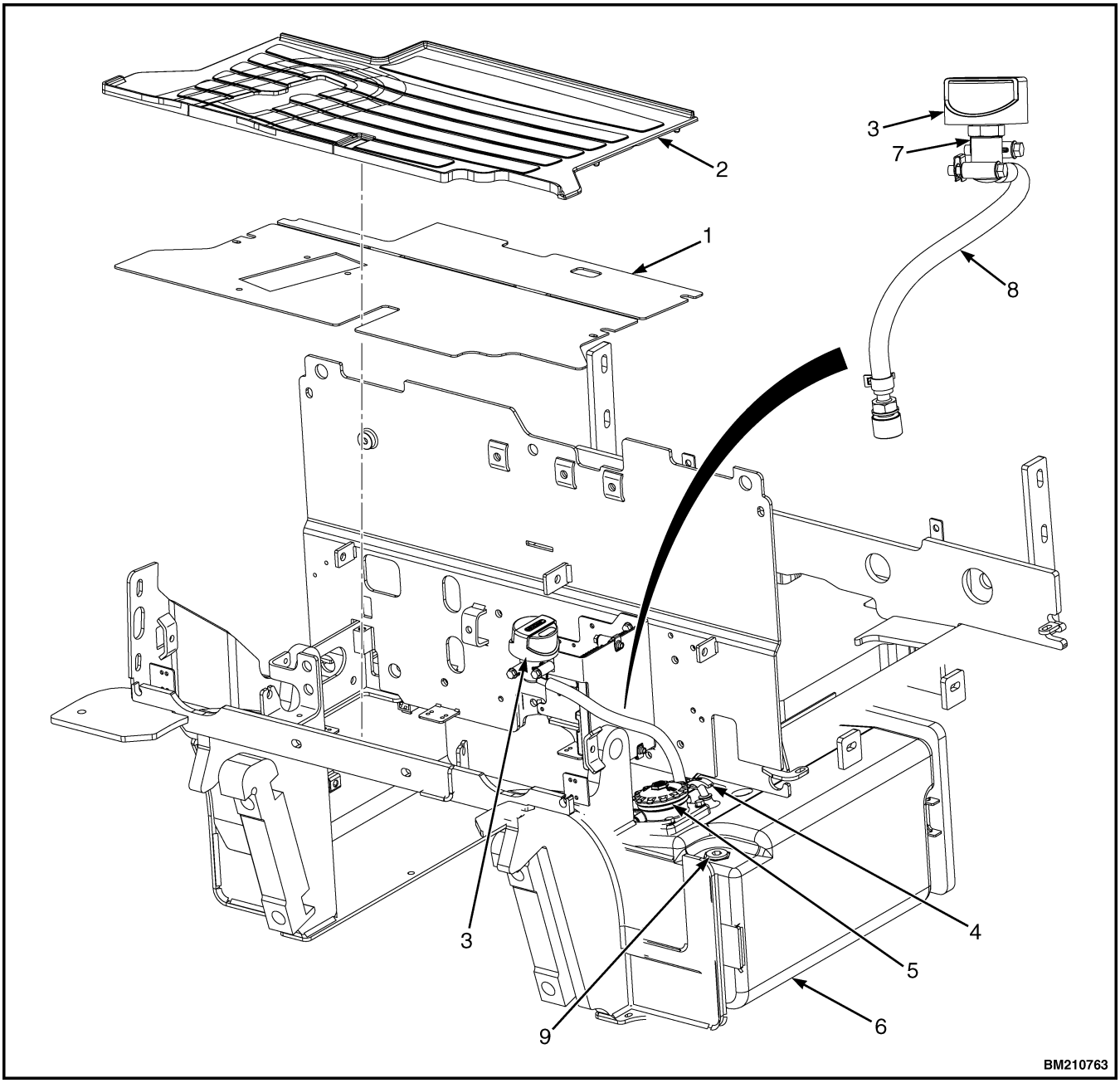
Turn lift truck power **OFF** and wait one minute before checking the hydraulic oil level.

Remove the floor mat and floor plate for access to the dipstick. See Figure 23.

Check the hydraulic oil level when the oil is at operating temperature, the carriage is lowered, the mast is vertical, and the key or keyless switch is in the **OFF** position. Add hydraulic oil, shown in Maintenance Schedule, only as needed. If more hydraulic oil is added than the MAX level, the hydraulic oil will leak from the breather during operation.

Inspect the hydraulic system for leaks and damaged or loose components. Check the condition of the hydraulic hoses for serviceability by inspecting for cracks or other obvious damage. Check to insure that the hydraulic hoses are not leaking. If any hose is leaking, report it to maintenance for repair.

Install the floor plate and floor mat when inspection is completed. See Figure 23.



1. FLOOR PLATE
2. FLOOR MAT
3. HYDRAULIC BREATHER
4. HYDRAULIC OIL DIPSTICK
5. HYDRAULIC OIL FILTER
6. HYDRAULIC TANK
7. BREATHER ADAPTER
8. BREATHER HOSE

Figure 23. Hydraulic System Check

HOW TO MAKE CHECKS WITH KEY OR KEYLESS SWITCH ON

WARNING

FASTEN YOUR SEAT BELT! The seat belt is installed to help the operator stay on the truck if the lift truck tips over. IT CAN ONLY HELP IF IT IS FASTENED.

Make sure the area around the lift truck is clear before moving the lift truck. Be careful when making the checks.

Horn, Lights, and Backup Alarm

1. Check the operation of the horn by pressing the horn button on the steering wheel. The horn will operate when the key or keyless switch is in any position. If lift truck is equipped with E-Hydraulic controls, there is another horn button located on the armrest.

   If lift truck is equipped with a battery compartment that is either 847 mm (33.3 in.), 933 mm (36.7 in.), or 1015 mm (39.9 in.) in size, there is an handle on the right side of the hood with a horn button on it. All lift truck models covered in this **Service Manual** can be equipped with one of the battery compartment sizes mentioned above.

   If the lift truck is equipped with a battery compartment that is either 700 mm (27.5 in.) or 786 mm (30.9 in.) in size, there is a handle on the right overhead guard leg with a horn button on it. Only lift truck models E45-50XN (A268) can be equipped with the battery compartment size mentioned above.

   See the Operating Manual for locations of horn buttons.

2. If lift truck is equipped with lights and a strobe light, check the operation of the lights and strobe light by using the appropriate rocker switch, located on the right side of the steering column. See the **Operating Manual**. The lights and strobe light will operate when the key or keyless switch is either **ON** or **OFF**.

3. Lift trucks manufactured after November, 2014, may be equipped with an option that automatically turns the front lights on whenever the key or keyless switch is turned on and go off when the key or keyless switch is turned off. These lift trucks may also be equipped with a rear drive light that is activated whenever the lift truck travels in the reverse direction or reverse is selected with either the MONOTROL pedal or direction control switch.

   There are no switches on the dash panel if truck is equipped with these options. Check the operation of the front lights by turning the key or keyless switch to the **ON** position to ensure lights come on. To check the operation of the rear drive light, select reverse and drive the lift truck is the reverse direction to check and see if the rear drive light comes on when the lift truck travels in the reverse direction.

4. Check the backup alarm on lift trucks equipped with a direction control switch by sitting in the seat and turning the key or keyless switch to the **ON** position. Pushing down on the direction control switch to put it in reverse will sound the alarm.

5. Check the backup alarm on lift trucks equipped with a MONOTROL pedal by sitting in the seat, turning the key or keyless switch to the **ON** position and pressing the reverse arrow on the MONOTROL pedal.

Motion Alarm

If equipped, check the motion alarm by sitting in the seat, turning the key or keyless switch to the **ON** position, and putting the lift truck in motion.

Steering System

WARNING

Because the lift truck has hydraulic power steering, steering can be difficult when the power steering pump is not operating.

Make sure that the steering system operates smoothly and provides good steering control.

Service Brakes

WARNING

Loss of fluid from the brake fluid reservoir indicates a leak. Repair the brake system before using the lift truck. Replace the brake fluid in the system if there is dirt, water or oil in the system.

NOTE: Some lift trucks are used in operations where the automatic adjusters can be slow to adjust the brake shoes. If the brakes need adjustment, operate the lift truck in forward and reverse 10 times. Apply the brake pedal firmly, but do not cause the wheels to slide. If the automatic adjusters do not adjust the brake shoes, a qualified service person must check the operation and condition of the brakes.

NOTE: Lift trucks manufactured after June, 2012 have a removable floor plate and DO NOT require any tools to remove.

There is an indicator icon on the display panel for the brake fluid level. The icon is illuminated as described in the **Operating Manual.** If the icon is illuminated during operation, the fluid in the reservoir for the brake master cylinder is too low. Add brake fluid and check for leaks. The reservoir is under the brake pedal and floor plate. See Figure Maintenance Points, Lift Trucks Manufactured Before September, 2012 and Figure Maintenance Points, Lift Trucks Manufactured After September, 2012 . Clean the area around the fill cap so that no dirt enters the reservoir.

Check the operation of the service brakes. Push on the brake pedal. The brakes must be applied before the pedal reaches the floor plate. The brake pedal must stop firmly and must not move slowly down after the brakes are applied. The brakes must apply equally to both drive wheels with no noticeable pull to either side.

Parking Brake

There is an indicator icon on the display panel for the parking brake. The icon is illuminated as described in the **Operating Manual**. If the parking brake is not applied and the operator leaves the seat or turns the key or keyless switch to the **OFF** position, an alarm will sound for approximately 60 seconds. This is only on manually applied parking brakes, not the Automatic Parking Brake option.

ALWAYS apply the parking brake when leaving the seat.

Make sure the service brakes operate correctly before checking the operation of the parking brake. Check the operation of the parking brake. The parking brake, when in good condition and correctly adjusted, will hold a lift truck with a capacity load on a 15% grade [a slope that increases 1.5m in 10m (1.5 ft increase in 10 ft)]. If parking brake requires adjustment, notify service personnel.

Hydraulic Control Levers and Pedals

Check that the hydraulic control levers for the mast and attachment operate as described in the **Operating Manual.** The brake pedals are checked as described in the preceding Service Brakes and Parking Brake paragraphs with the operation of the brakes.

Direction and Speed Control Pedals

Check that the direction and speed control pedals operated as described in the **Operating Manual.** Lubricate the MONOTROL pedal or accelerator pedal joints as needed. See the Maintenance Schedule.

Lift System Operation

WARNING

NEVER work under a raised carriage or forks. Lower the carriage or use chains on the mast weldments and carriage so that they cannot move. Make sure the moving parts are attached to a part that does not move.

DO NOT try to locate hydraulic leaks by putting hands on pressurized hydraulic components. Hydraulic oil can be injected into the body by pressure.

NOTE: Some parts of the mast move at different speeds during raising and lowering.

Slowly raise and lower the mast several times without a load. The mast components must raise and lower smoothly in the correct sequence. The carriage raises first, then the inner weldment and intermediate weldment (three-stage masts only).

The inner and intermediate weldments and the carriage must lower completely.

Raise the forks 1 m (3 ft), with a capacity load. The inner weldment and carriage must raise smoothly. Lower the forks. All moving components must lower smoothly.

With the load lowered, tilt the mast backward and forward. The mast must tilt smoothly and both tilt cylinders must stop evenly.

Check that the controls for the attachment operate the functions of the attachment. See the symbols by each of the controls. Make sure all of the hydraulic lines are connected correctly and do not leak.

Oil Leaks

WARNING

DO NOT try to locate hydraulic leaks by putting hands on pressurized hydraulic components. Hydraulic oil can be injected into the body by pressure.

Visually check the hydraulic system, steering system, brake system and drive axle unit assembly for leaks.

Maintenance Procedures Every 500 Hours or Three Months

NOTE: Perform the checks in the Maintenance Procedures Every 8 Hours or Daily section prior to performing the procedures in this section.

FORKS

NOTE: Forks must be removed and installed by trained personnel.

The identification of a fork describes how the fork is connected to the carriage. These lift trucks have hook forks.

Inspect

WARNING

DO NOT try to correct fork tip alignment by bending the forks or adding shims. Replace bent forks.

Never repair damaged forks by heating or welding. Forks are made of special steel using special procedures. Replace damaged forks. Forks are to be replaced only in sets and not individually.

1. Inspect the forks for cracks and wear. Check that the fork tips are aligned as shown in Figure 24. Check that the bottom of the fork is not worn (item 4 in Figure 24).

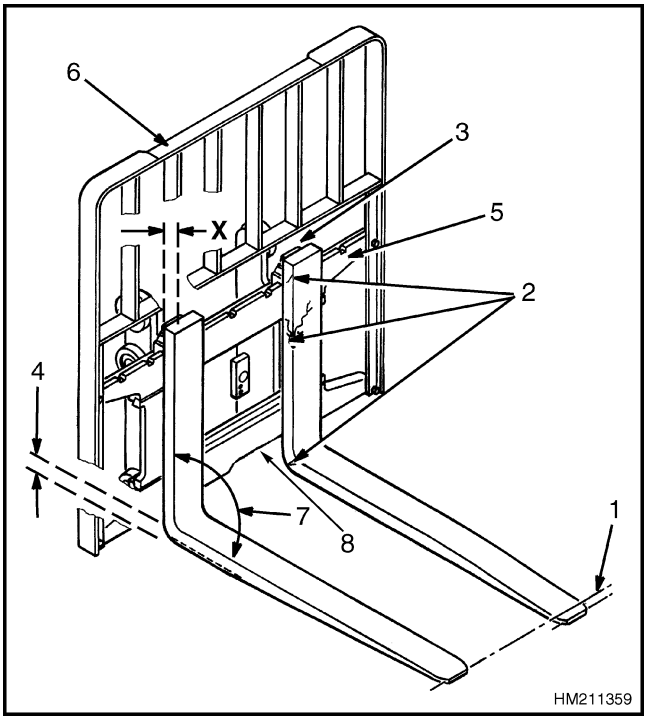
2. Replace any damaged or broken parts that are used to keep the forks locked in position.

3. Inspect fork wear. Ensure the heel wear is not more than 10% of original thickness. If fork wear is more than 10%, the fork must be replaced or rerated. Perform the fork wear inspection using a BOL256N1 caliper ruler, Hyster P/N 4092984 , as follows. See Figure 25.

   a. Determine the normal thickness of the "N" of the fork using the scale or ruler portion of the caliper ruler. Measurement has to be done on the fork shank using the caliper ruler.

   b. Position the caliper at the end of the heel internal radius (item 4, Figure 24) with the opening corresponding to the measure thickness of the fork shank in Step a above (e.g. N 1.75 use N 1.75 opening). This is typically the section of the fork where wear is the greatest. Note that the opening distance has been reduced by 10% from the nominal thickness.

   c. If the fork enters the opening, it is mandatory to replace it. DANGER OF BREAKING. Furthermore, a 10% reduction in fork blade thickness results in 20% reduction in operating capacity.



Fork Tip Alignment	
Length of Forks	**3% Dimension**
914 mm (36 in.)	27 mm (1.08 in.)
1016 mm (40 in.)	30 mm (1.20 in.)
1067 mm (42 in.)	32 mm (1.26 in.)
1207 mm (47.5 in.)	36 mm (1.42 in.)
1219 mm (48 in.)	37 mm (1.46 in.)
1372 mm (54 in.)	41 mm (1.61 in.)
1524 mm (60 in.)	46 mm (1.81 in.)
1829 mm (72 in.)	55 mm (2.17 in.)

1. TIP ALIGNMENT (MUST BE WITHIN 3% OF FORK LENGTH)
2. CRACKS
3. LATCH DAMAGE
4. HEEL OF FORK (MUST BE 90% OF DIMENSION X)
5. CARRIAGE
6. LOAD BACKREST EXTENSION
7. MAXIMUM ANGLE 93°
8. FORK REMOVAL NOTCH

Figure 24. Forks Check

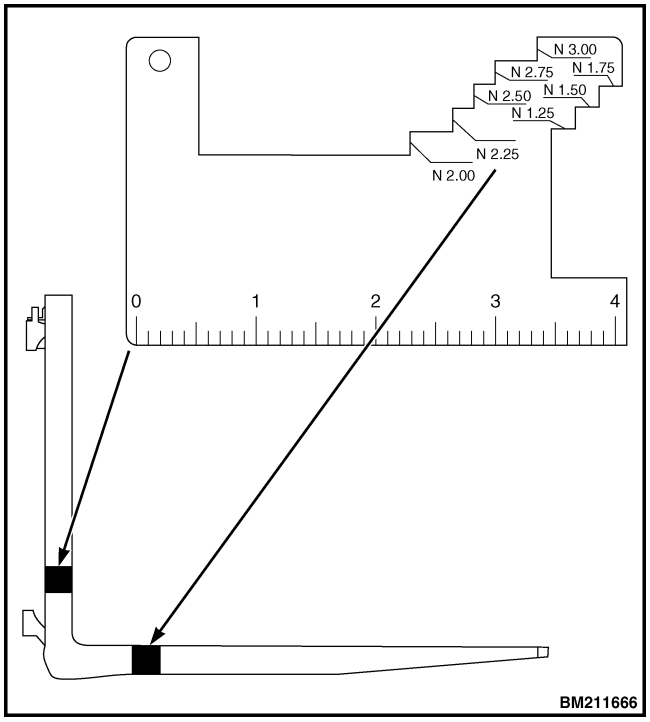
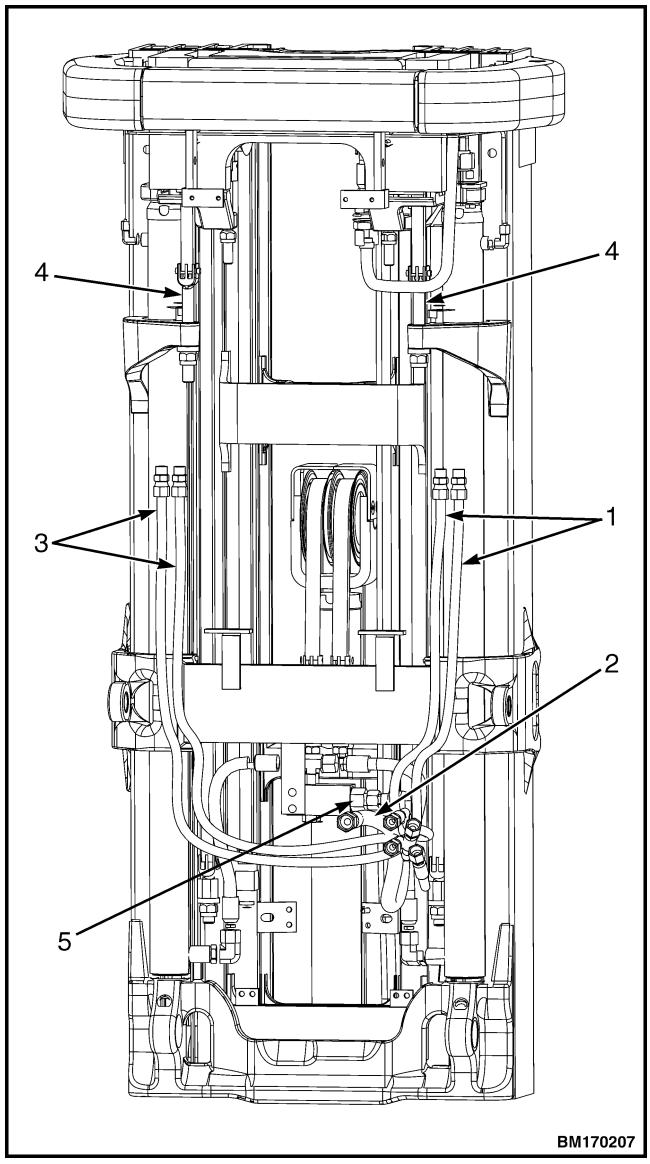


Figure 25. Fork Wear Check

HEADER HOSE CHECKS

Inspect for kinked, crushed, flattened, or twisted hoses; hard, stiff or charred hoses; hose fitting slippage; proper hose tensioning. See Figure 26. Adjust/repair/replace hoses/components as necessary. See for the procedures.



NOTE: FOUR-STAGE FULL FREE-LIFT MAST SHOWN.

1. THIRD FUNCTION HOSE
2. LIFT FUNCTION HOSE
3. FOURTH FUNCTION HOSE
4. CHAIN ANCHORS
5. LOWERING CONTROL VALVE

Figure 26. Header Hoses

MAST LUBRICATION

WARNING

Cleaning solvents can be flammable and toxic and can cause skin irritation. When using cleaning solvents, always follow the recommendations of the manufacturer.

When working on or near the mast, see Safety Procedures When Working Near Mast in this service manual.

Metal particles can fall into the eyes during the operation of the mast. Failure to remove these particles can cause eye injury. Remove metal particles that are attached to the edges of mast parts with a disc sander if necessary. Always wear hearing protection, gloves, and eye protection when using a disc sander.

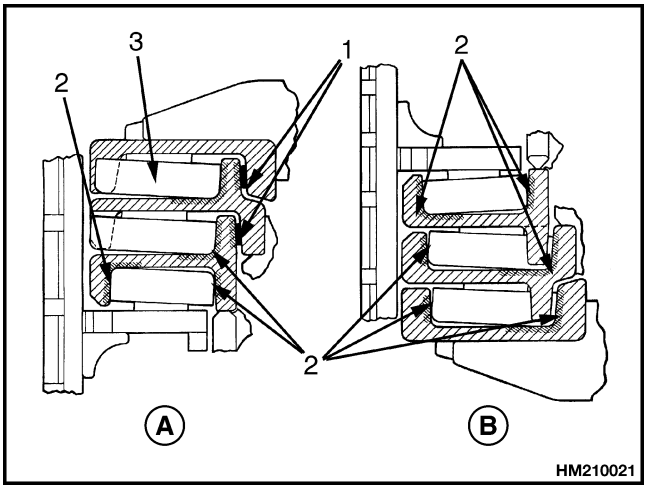
CAUTION

DO NOT use steam or high-pressure water to clean the load rollers or the lift chains. Steam and high-pressure water can remove the lubrication from the bearings in the load rollers. Water in the bearings of the sheaves and the link pins of chains can also shorten the service life of these parts.

NOTE: Some applications will require more frequent cleaning and lubrication of the mast assembly. DO NOT use a lubricant spray on the surfaces of the mast channels where the load rollers make contact. The use of the correct lubricant is important. Use multipurpose grease (Hyster Part Number 3020381), or an equivalent grease, with 2 to 4 percent molybdenum disulfide. The load rollers and sheaves have sealed bearings and do not need additional lubrication.

1. Clean the mast assembly. Inspect the mast channels in the areas where the rollers travel. If there are loose particles or metal particles that are attached to the edges of mast parts, remove these particles.

2. Lubricate the sliding surfaces and the load roller surfaces along the *full length* of the channels as shown in Figure 27. Only apply lubricant to surfaces that are clean and dry. Only apply lubricant to the darker areas as indicated by (1) and (2) in Figure 27.



NOTE: MAST IS DIFFERENT, BUT LUBRICATION AREAS ARE THE SAME.

A. UPPER LOAD ROLLERS
B. LOWER LOAD ROLLERS

1. LUBRICATE STRIP BEARINGS SURFACES
2. LUBRICATE LOAD ROLLER SURFACES
3. LOAD ROLLER

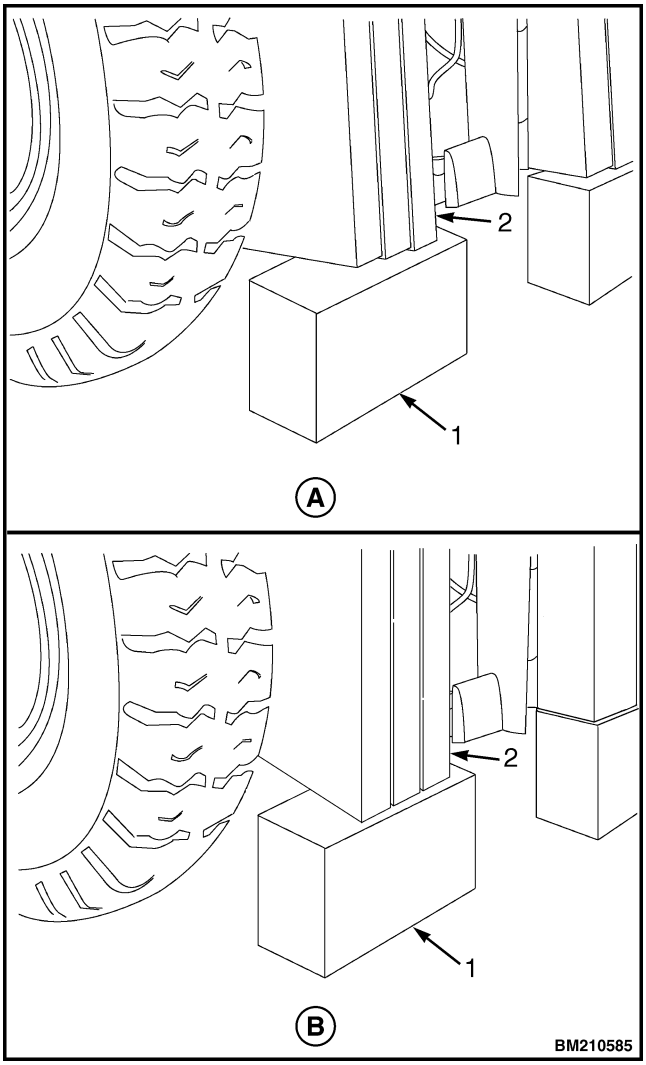
Figure 27. Mast Lubrication

NOTE: When lubricating the mast mounting/pivot pins, the load must be removed from the normal contact surface to allow grease to properly lubricate the normal contact surfaces of the mast bushings.

3. Raise the carriage about 61 cm (2 ft), and tilt the mast fully back. Place blocks under the outer mast channels to within 13 mm (0.5 in.) of the channels. See Figure 28.

4. Tilt the mast fully forward. See Figure 28.

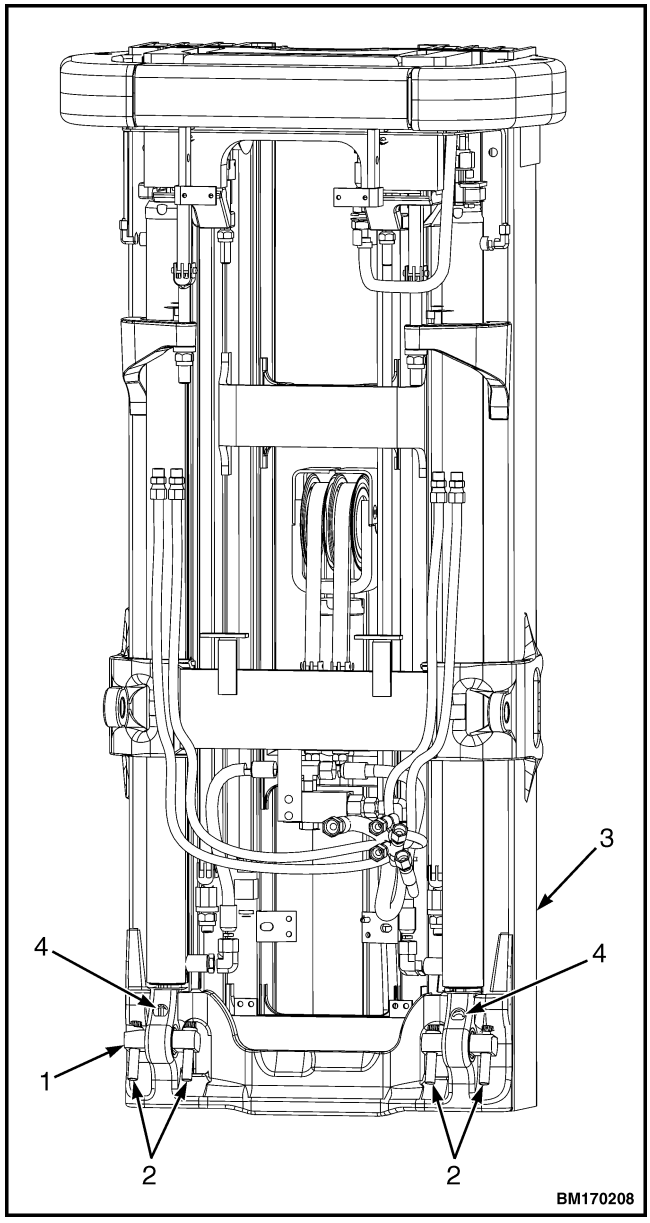
5. Lubricate the mast pivot bushings at grease fittings on outer mast. Use multipurpose grease shown in the Maintenance Schedule.



A. MAST TILTED FULLY BACK
B. MAST TILTED FULLY FORWARD

1. BLOCK
2. MAST

Figure 28. Blocking the Mast



NOTE: FOUR-STAGE FULL FREE-LIFT MAST SHOWN.

1. PIVOT PIN
2. CAPSCREW
3. OUTER MAST
4. GREASE FITTING

Figure 29. Pivot Pin Lubrication

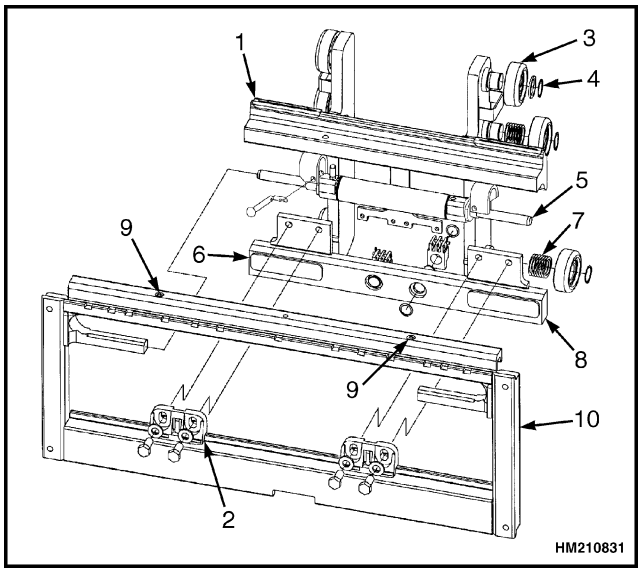
6. Tilt mast fully back. Remove the blocks from under the channels.

7. If an integral sideshift carriage is installed, lubricate sliding surfaces at lube fittings with multipurpose grease shown in the Maintenance Schedule.

   See Figure 30 for early model lift trucks equipped with an integral sideshift carriage.

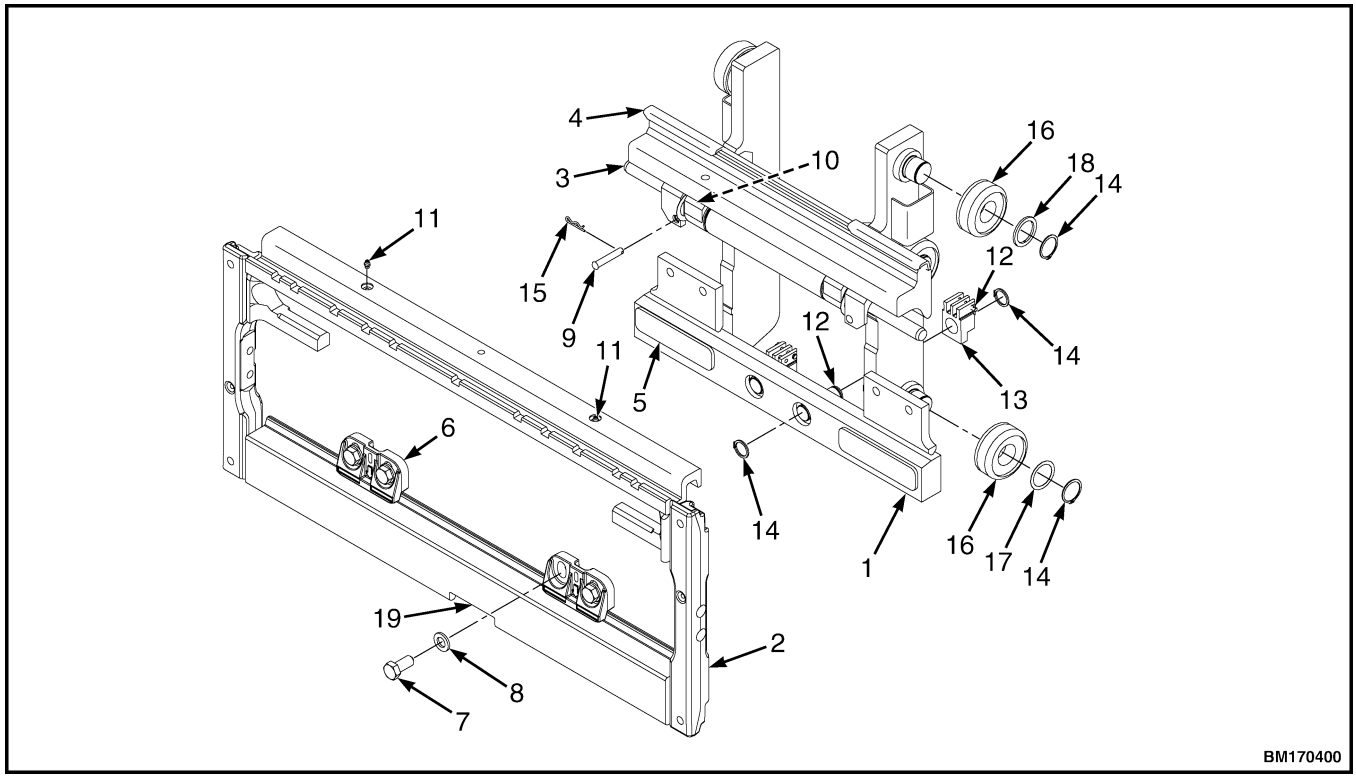
   See Figure 31 for later model lift trucks equipped with an integral sideshift carriage.

   See Figure 32 for lift trucks equipped with an integral sideshift carriage with fork positioner attachment.



1. UPPER BEARINGS
2. LOWER HOOK
3. LOAD ROLLER
4. SNAP RING
5. SIDESHIFT CYLINDER
6. LOWER BEARINGS
7. SHIMS
8. INNER CARRIAGE
9. LUBE FITTING
10. OUTER FRAME

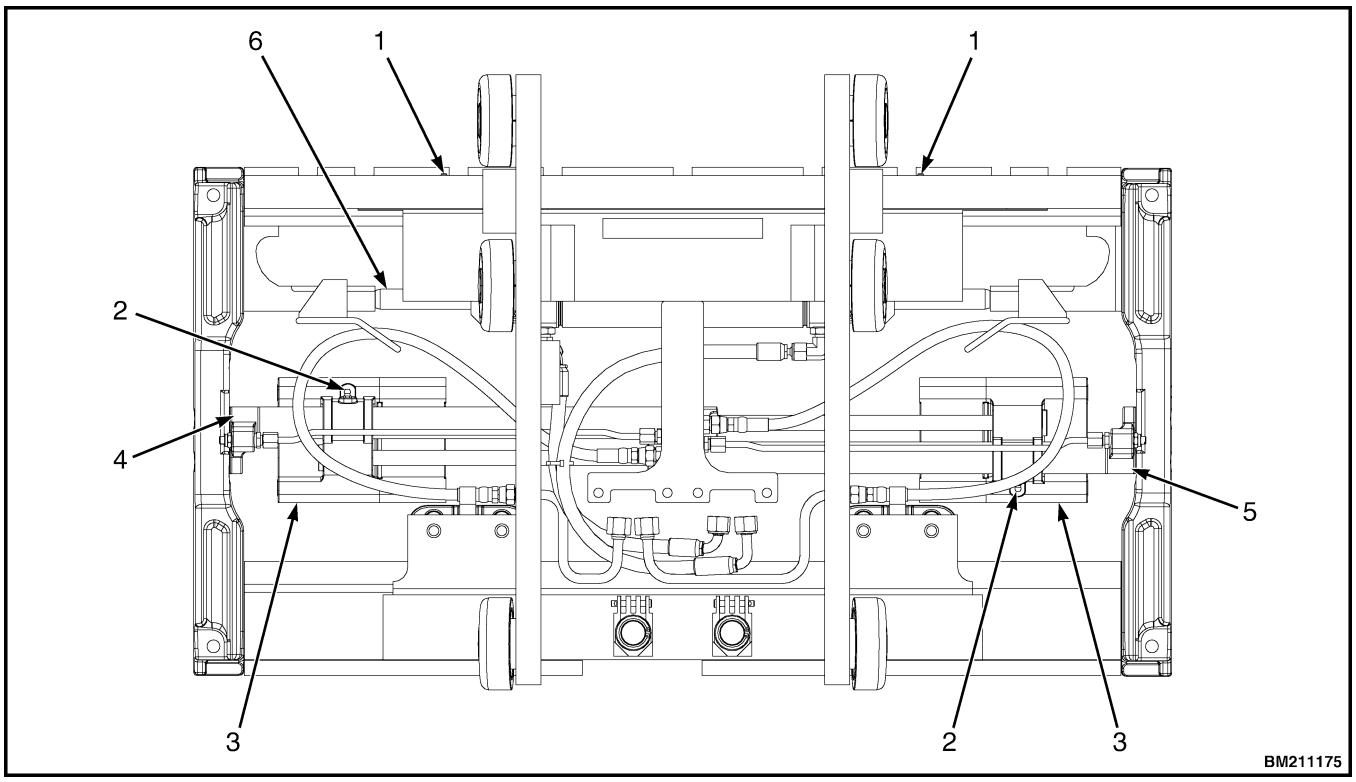
Figure 30. Sideshift Carriage, Early Lift Truck Models



1. INNER FRAME
2. OUTER FRAME
3. SIDESHIFT CYLINDER
4. UPPER BEARING
5. LOWER BEARING
6. LOWER HOOK
7. CAPSCREW
8. WASHER
9. CLEVIS PIN
10. PIN
11. LUBE FITTING
12. PIN
13. CHAIN ANCHOR
14. SNAP RING
15. COTTER PIN
16. LOAD ROLLER
17. SHIMS
18. SPACER
19. FORK REMOVAL NOTCH

Figure 31. Sideshift Carriage, Later Model Lift Trucks

8. If a fork positioner is installed, lubricate sliding surface at lube fittings with multipurpose grease shown the Maintenance Schedule. See Figure 32.



NOTE: LUBRICATION POINTS FOR FORK POSITIONER MANUFACTURED PRIOR TO DECEMBER, 2016 SHOWN. LUBRICATION POINTS FOR FORK POSITIONER MANUFACTURED AFTER DECEMBER, 2016 SIMILAR.

1. LUBE FITTING, SIDESHIFT CARRIAGE
2. LUBE FITTING, FORK POSITIONER
3. FORK CARRIER
4. UPPER FORK POSITIONER CYLINDER
5. LOWER FORK POSITIONER CYLINDER
6. INTEGRAL SIDESHIFT CYLINDER

Figure 32. Fork Positioner Lubrication

PARKING BRAKE ADJUSTMENT

1. With park brake cables assembled and the park brake in released position. Apply an initial load of 383 N (86 lbf) to parking brake pedal. This value must be set to hold at 15% grade for 500 hour interval. Remove the floor mat and floor plate. Readjust cable tension adjuster fitting and secure with jam-nuts to take up the slack. See Figure 33.

2. With the lift truck on a level surface, repeat Step 1 until the necessary tension is achieved.

3. Adjust the park brake tension to hold the lift truck on 15% grade with rated load. Tighten the cable tension adjuster fitting and the jam-nut to secure the adjustments. The adjustments should provide the lift truck a 15% grade hill hold at rated load.

4. When adjustment is complete, install the floor plate and floor mat.

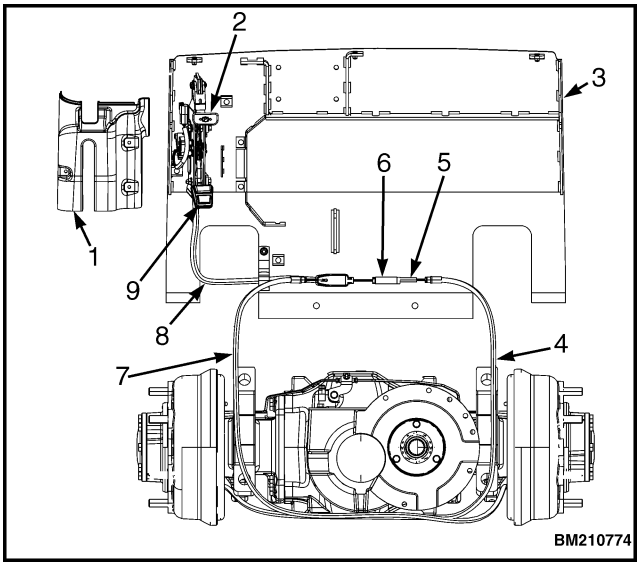
BRAKE FLUID CHECK

Master Cylinder Fluid Check

WARNING

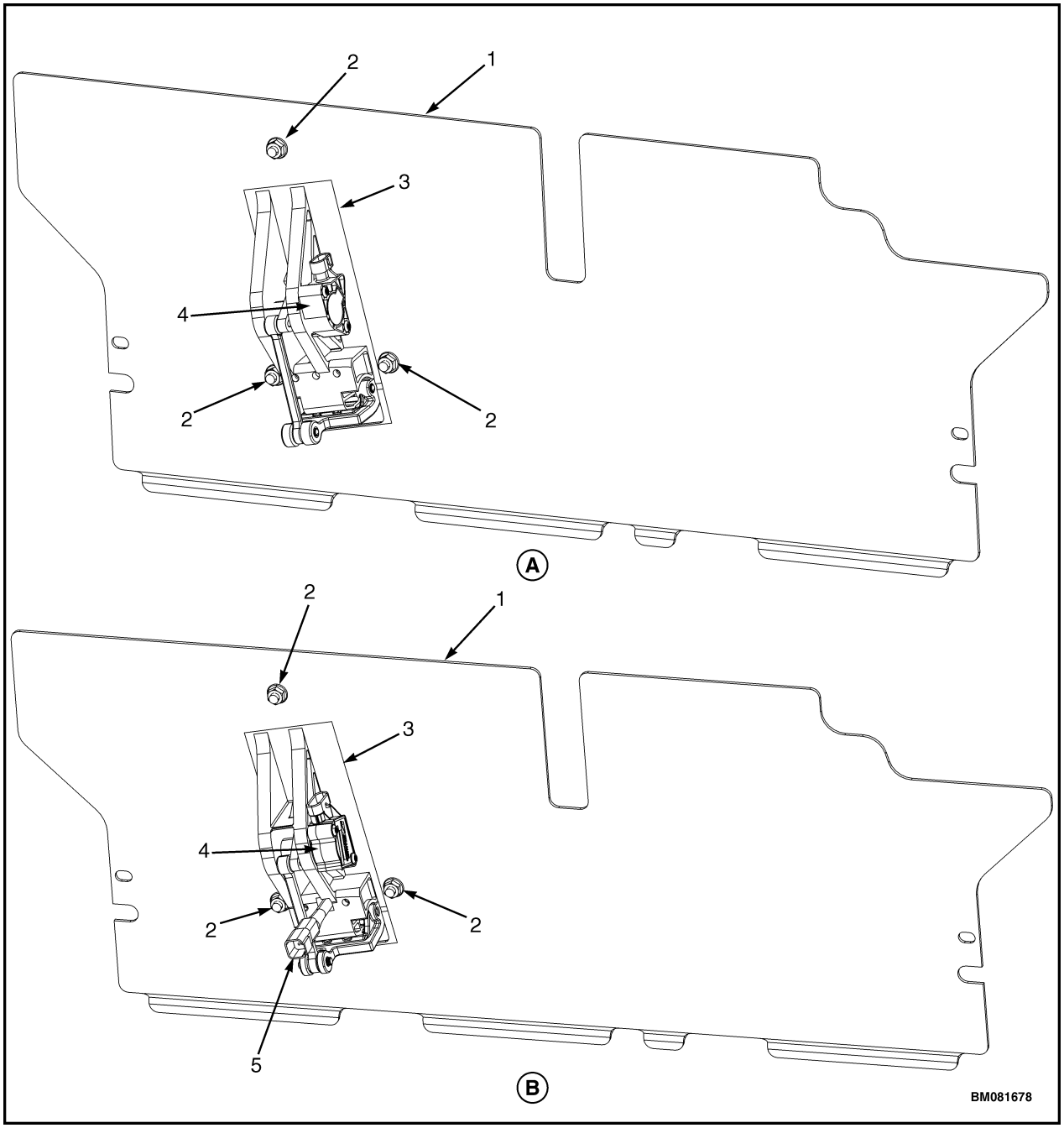
Loss of fluid from the master cylinder indicates a leak. This condition can cause brake failure, resulting in material damage or personal injury. Repair the brake system before returning to service if a leak is suspected. See Brake System 1800SRM1359 **for procedures to repair the brake system. Drain and flush the service brake system when contaminated by dirt, water, or other unapproved fluids.**

1. Remove the floor mat. Lift floor plate up enough to disconnect the accelerator pedal or MONOTROL® pedal. See Figure 34. Remove floor plate with the accelerator pedal or MONOTROL® pedal still attached for access to master cylinder reservoir.



1. PARKING BRAKE COVER
2. PARKING BRAKE RELEASE HANDLE
3. COWL
4. PARKING BRAKE CABLE (LEFT SIDE)
5. JAM NUT
6. CABLE TENSION ADJUSTMENT FITTING
7. PARKING BRAKE CABLE (RIGHT SIDE)
8. PARKING BRAKE CABLE
9. PARKING BRAKE PEDAL

Figure 33. Parking Brake Adjustment



NOTE: FLOOR MAT REMOVED FOR CLARITY.

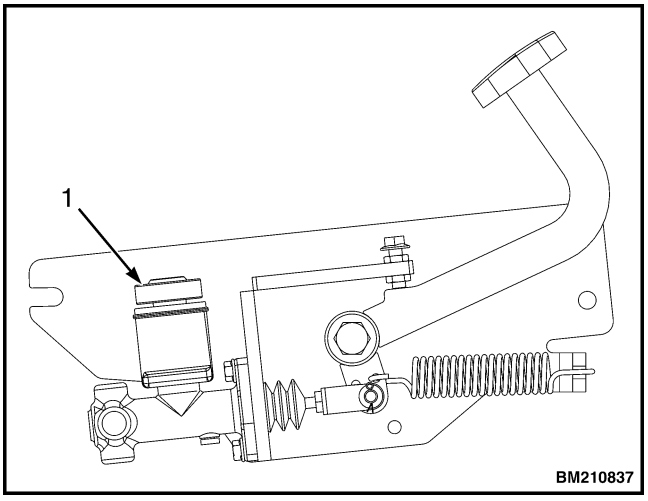
A. STANDARD ACCELERATOR PEDAL

B. MONOTROL® PEDAL

1. FLOOR PLATE
2. CAPSCREW AND NUT
3. PEDAL BASE
4. ACCELERATOR PEDAL POSITION SENSOR
5. MONOTROL® PEDAL CONNECTOR

Figure 34. Removing Floor Plate and Accelerator or MONOTROL® Pedal

2. Check the level of the brake fluid in the reservoir for the master cylinder is at the MAX level. Add brake fluid (DOT3) if required. The reservoir is mounted on top of the master cylinder, under the brake pedal and floor plate. See Figure 35. Add brake fluid and check for leaks. See the Maintenance Schedule.



1. MASTER CYLINDER RESERVOIR

Figure 35. Brake Fluid Level Check

3. Check the operation of the service brakes. Push on the brake pedal. The brakes must be applied before the pedal reaches the floor plate. The brake pedal must stop firmly and must not move slowly down after the brakes are applied. The brakes must apply equally to both drive wheels with no noticeable pull to either side. The service brakes are automatically adjusted as the brakes are applied when the lift truck changes directions.

4. When brake fluid level check is completed, connect the accelerator pedal or MONOTROL® pedal and install floor plate and floor mat. See Figure 34.

OPERATOR PRESENCE SYSTEM CHECK

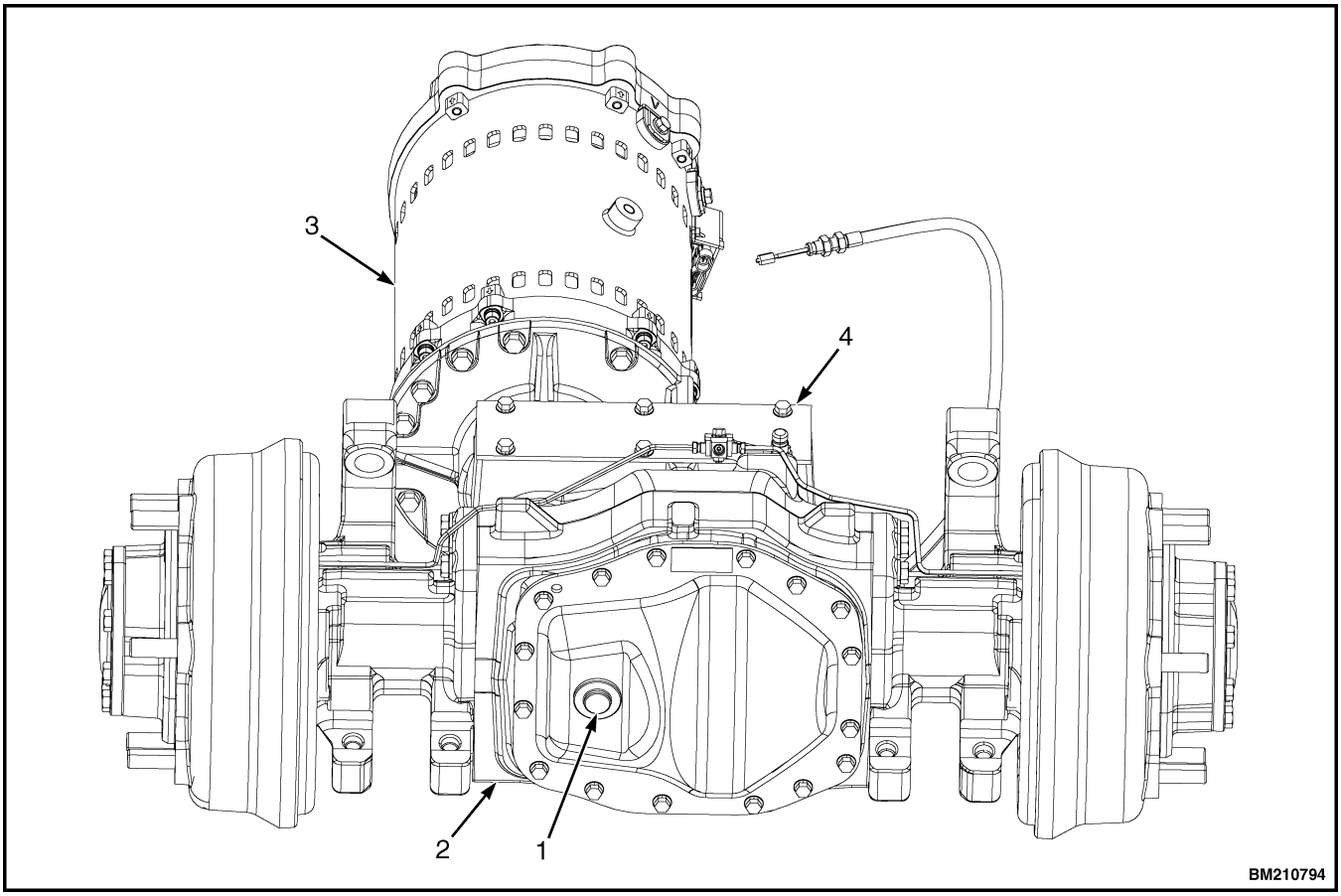
Check the operation of the Operator Presence System (OPS). Turn the lift truck power **ON** while sitting in the seat. Once lift truck power is **ON**, get up off the seat. If the OPS is working correctly, a switch in the operator's seat will automatically disable all hydraulic and electrical functions. If the lift truck can travel forward or backward, or the hydraulic functions operate, when the operator is not on the seat, the OPS system is not working properly. See the section **Electrical System** 2200SRM1369 to replace the seat switch that makes up the OPS system. See the **Operating Manual** for more information on how the OPS works.

DIFFERENTIAL AND SPEED REDUCER

WARNING

DO NOT work under a raised carriage. Lower the carriage or use a chain to prevent the carriage and the inner or intermediate weldments from lowering when doing maintenance. Make sure that the moving parts are attached to parts that cannot move.

Remove the fill plug and visually check the oil level at the fill hole. If the oil level is below the lower edge of the fill hole, the oil level is to low. See Figure 36. Add oil slowly at the fill hole. Fill until oil is just below the lower edge of the fill hole. The oil must flow through the bearings to the speed reducer, so filling slowly to the correct level is necessary. Install the fill plug once the correct level has been reached.

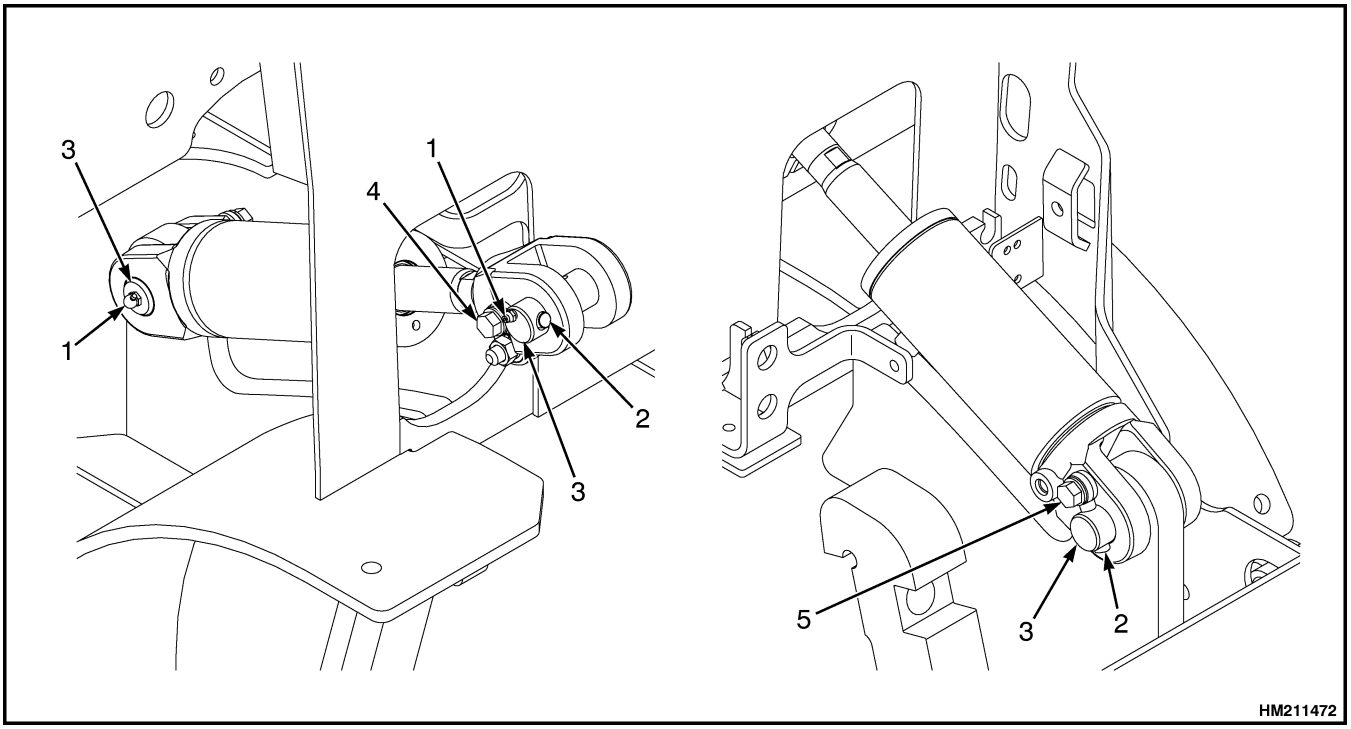


1. FILL PLUG/HOLE
2. DIFFERENTIAL
3. TRACTION MOTOR
4. SPEED REDUCER

Figure 36. Differential and Speed Reducer

TILT CYLINDER ROD END PINS

Lubricate the tilt cylinder rod end pins with multipurpose grease shown in the Maintenance Schedule. See Figure 37.



NOTE: STANDARD TILT CYLINDER WITHOUT OPTIONAL BOOT SHOWN. TILT CYLINDER WITH OPTIONAL BOOT IS SIMILAR.

1. LUBE FITTING
2. ANCHOR PIN
3. PIN
4. CAPSCREW
5. CAPSCREW

Figure 37. Tilt Cylinder Rod End Pins Lubrication

LIFT CHAINS

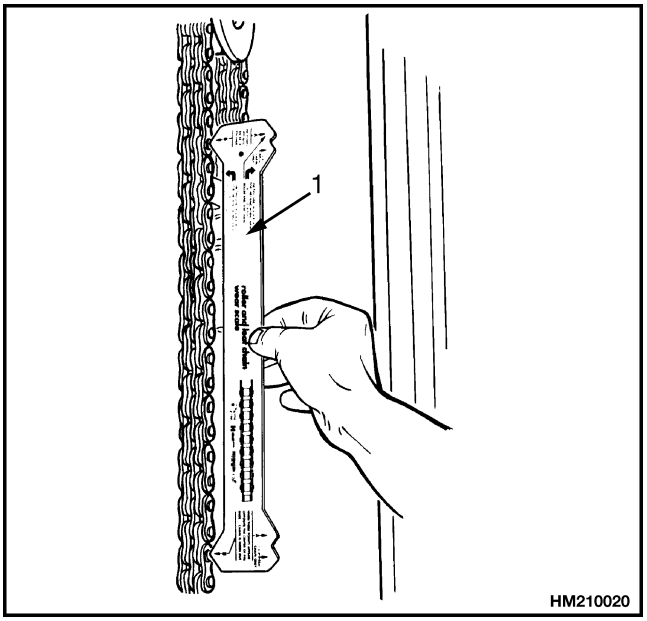
Wear Check

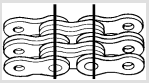
WARNING

DO NOT repair a worn or damaged lift chain. Replace a worn or damaged lift chain with a new chain. If a pair of lift chains is used in the mast, both lift chains must be replaced.

If a section of chain is 3 percent longer than a similar section of new chain, the chain is worn and must be replaced. Check the chain at a section of chain that goes over a chain sheave. If a chain scale is available (Hyster Part No. 599737) , check the lift chains as shown in Figure 38. If a chain scale is not available, measure 20 links of chain. Measure from the center of a pin to the center of another pin 20 links away. Compare the length with the chart in Figure 38. Replace the chain if the length of 20 links of the worn section is more than the WEAR LIMIT.

Inspect the lift chains for edge wear. Make sure the edge wear of the chain is not greater than 5 percent compared to a chain link that is not worn. See Figure 39.

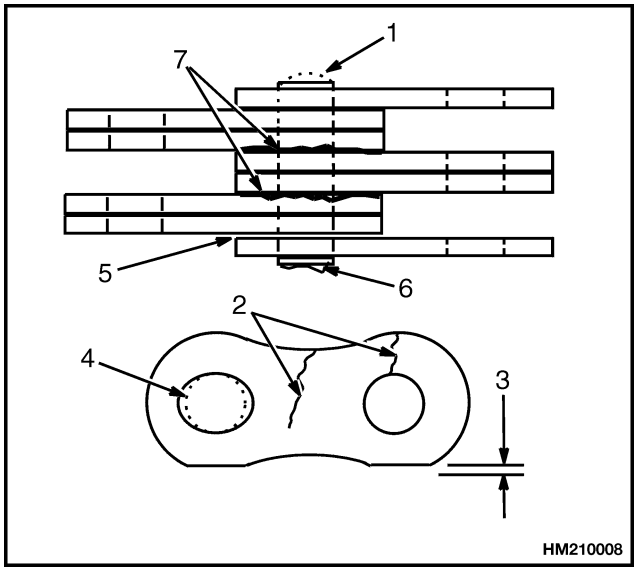


Pitch 	Total length of 20 links (pitch) of new chain	Wear Limit The maximum length of 20 links.
12.7 mm (0.50 in.)	254.0 mm (10.0 in.)	261.6 mm (10.3 in.)
15.9 mm (0.63 in.)	317.5 mm (12.5 in.)	327.0 mm (12.9 in.)
19.1 mm (0.75 in.)	381.0 mm (15.0 in.)	392.4 mm (15.4 in.)
25.4 mm (1.00 in.)	508.0 mm (20.0 in.)	523.25 mm (20.6 in.)
31.8 mm (1.25 in.)	635.0 mm (25.0 in.)	654.1 mm (25.75 in.)
44.5 mm (1.75 in.)	889.0 mm (35.0 in.)	915.7 mm (36.05 in.)
50.8 mm (2.00 in.)	1016.0 mm (40.0 in.)	1046.5 mm (41.2 in.)

NOTE: THE INSTRUCTIONS FOR MEASURING CHAIN WEAR ARE SHOWN ON THE CHAIN WEAR SCALE.

1. CHAIN WEAR SCALE

Figure 38. Lift Chains Check



1. WORN PIN
2. CRACKS
3. EDGE WEAR (MAXIMUM 5% OF NEW)
4. HOLE WEAR
5. LOOSE LEAVES
6. DAMAGED PIN
7. CORROSION

Figure 39. Lift Chains Check

LIFT CHAIN LUBRICATION

WARNING

When working on or near the mast, see Safety Procedures When Working Near Mast in this SRM .

DO NOT repair worn or damaged lift chains. If a lift chain is worn or damaged, both lift chains must be replaced.

NOTE: Perform this maintenance only if not performing the 2000 hour or Yearly maintenance procedures, otherwise go to the Maintenance Procedures Every 2000 Hours or Yearly for lift chain lubrication procedures.

Lubricate lift chains with SAE 30W engine oil. The best procedure is to remove the chains from the lift truck and soak them in engine oil. Be sure to clean any dirt or grease from chains before lubricating. DO NOT USE STEAM TO CLEAN THE LIFT CHAINS.

FORK PINS AND GUIDES

CAUTION

Remove fork latch pins if adding a fork positioner attachment. Damage to forks and other carriage components can occur if fork latch pins are not removed prior to using attachment.

NOTE: The information below applies only to lift trucks not equipped with fork positioner attachment.

Lubricate the fork pins and guides with clean 10W-30 motor oil as shown in the maintenance schedule. If the lift truck is used in dirty, dusty, or difficult conditions, lubrication of the fork pins and guides may be required more frequently. Inspect the forks for wear. See the fork inspection procedures in the Maintenance Procedures Every 8 Hours or Daily section.

CHECK UPPER AND LOWER BEARINGS, INTEGRAL SIDESHIFT CARRIAGE

1. Lower the carriage completely and remove the forks.

2. Remove the backrest and the lower mounting hooks from the sideshift carriage.

3. Use a crane with a capacity of at least 450 kg (1000 lb) to lift the outer frame away from the inner carriage.

4. Clean the bearing areas. Inspect the sideshift bearings for wear as follows:

   a. If either upper bearing is worn to less than 2.5 mm (0.098 in.) thickness, replace both upper bearings by driving the upper bearings out of the carriage bar.

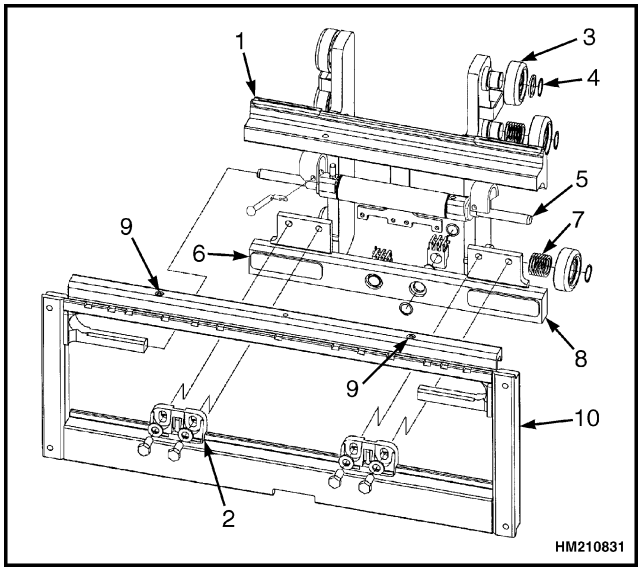
      See Figure 40 for early model lift trucks.

      See Figure 41 for later model lift trucks.

   b. If either lower bearing is worn to less than 2.5 mm (0.098 in.) thickness, replace both lower bearings by prying the lower bearings from the lower carriage bar.

      See Figure 40 for early model lift trucks equipped with an integral sideshift carriage.

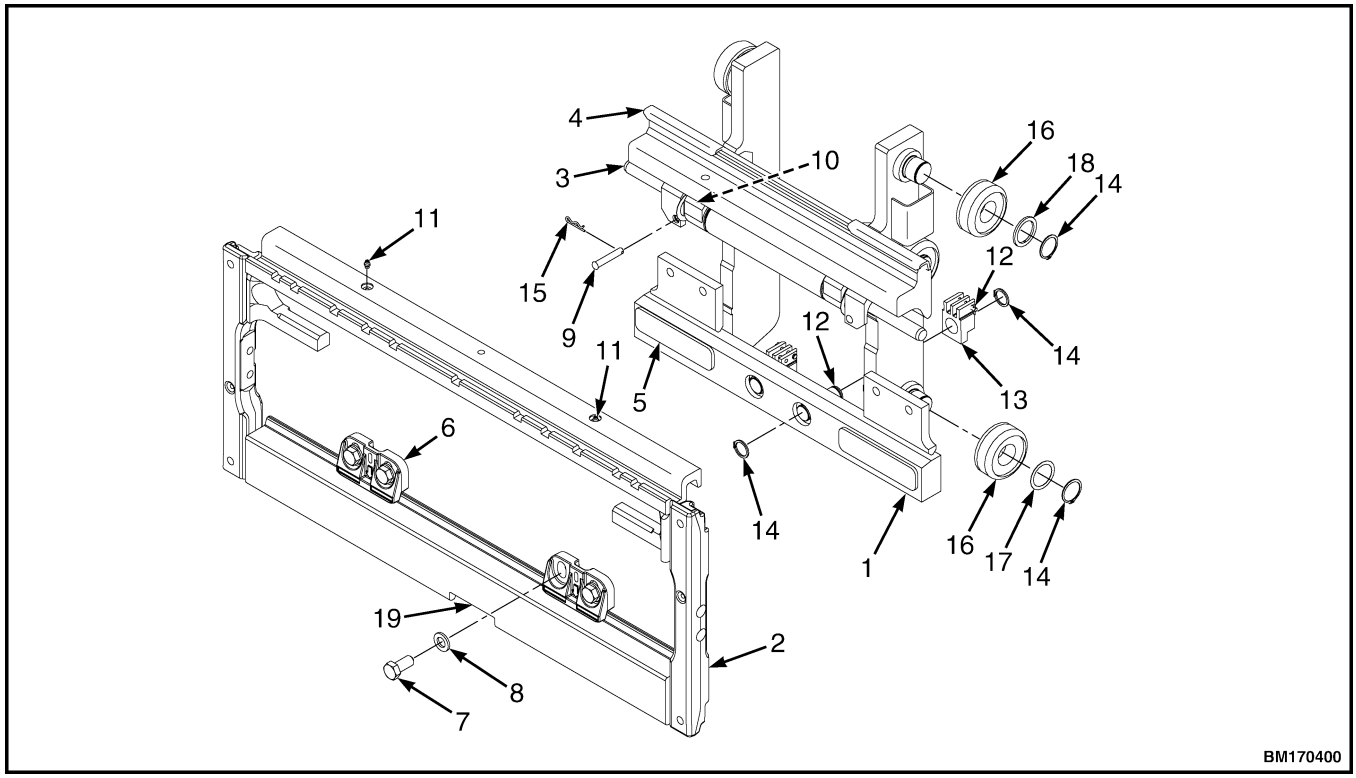
      See Figure 41 for later model lift trucks equipped with an integral sideshift carriage.



NOTE: TWO- AND THREE-STAGE FULL FREE-LIFT CARRIAGE SHOWN.

1. UPPER BEARING
2. LOWER HOOK
3. LOAD ROLLER
4. SNAP RING
5. SIDESHIFT CYLINDER
6. LOWER BEARING
7. SHIMS
8. INNER CARRIAGE
9. LUBE FITTING
10. OUTER FRAME

Figure 40. Integral Sideshift Carriage, Early Lift Truck Models



1. INNER FRAME
2. OUTER FRAME
3. SIDESHIFT CYLINDER
4. UPPER BEARING
5. LOWER BEARING
6. LOWER HOOK
7. CAPSCREW
8. WASHER
9. CLEVIS PIN
10. PIN
11. LUBE FITTING
12. PIN
13. CHAIN ANCHOR
14. SNAP RING
15. COTTER PIN
16. LOAD ROLLER
17. SHIMS
18. SPACER
19. FORK REMOVAL NOTCH

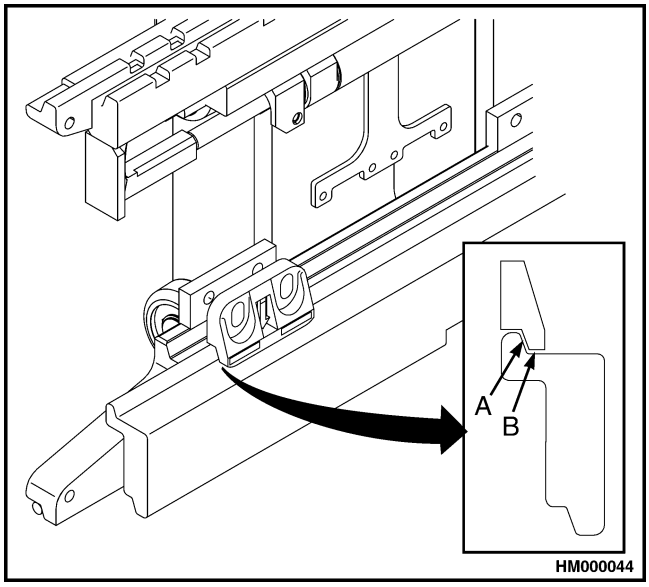
Figure 41. Sideshift Carriage, Later Model Lift Trucks

CHECK LOWER MOUNTING HOOK, INTEGRAL SIDESHIFT CARRIAGE

Inspect the lower mounting hooks for wear. Replace the hooks if they are worn beyond the wear limit. The wear limit clearance range is 0.76 mm (0.03 in.) minimum and 1.52 mm (0.06 in.) maximum. See **A** in Figure 42.

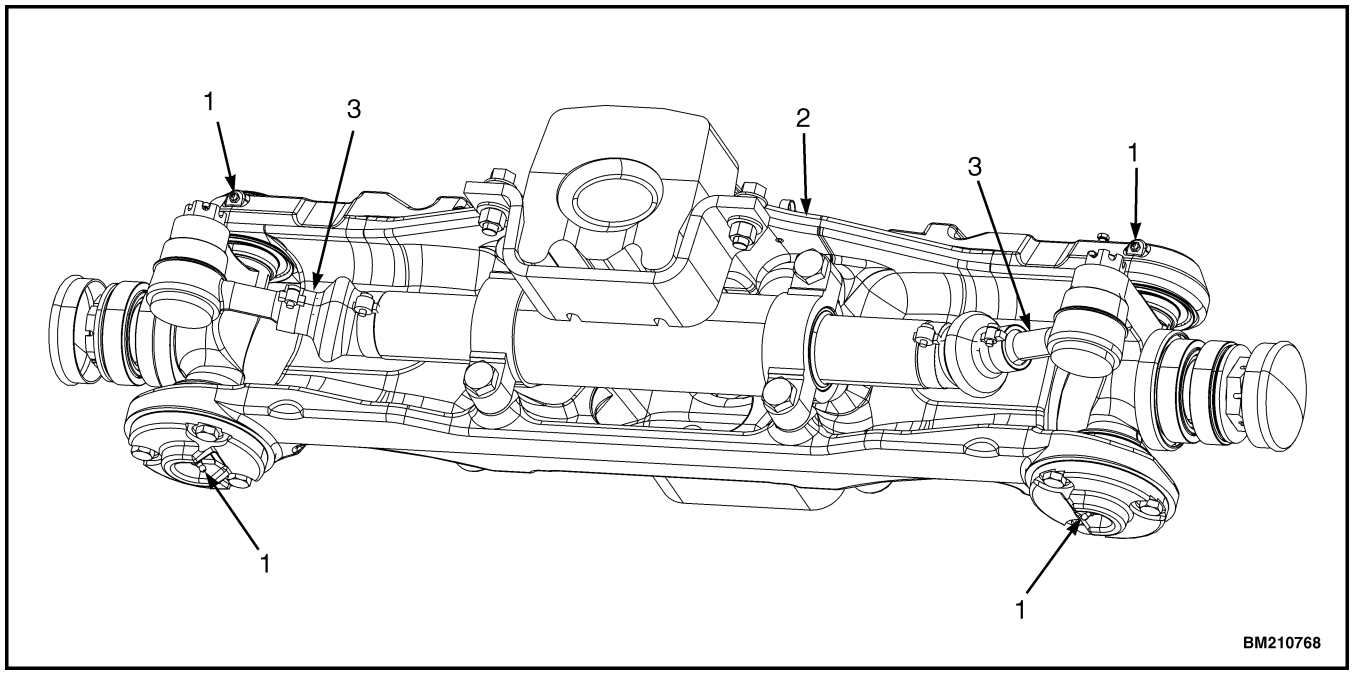
STEERING KING PINS

Lubricate the steering king pins with multipurpose grease. See the Maintenance Schedule for grease specifications. More frequent lubrication may be required if lift truck operates in a dirty, dusty. or contaminated environment or under intensive or difficult conditions. See Figure 43.



A. WEAR LIMIT - 0.76 mm (0.03 in.) MINIMUM AND 1.52 mm (0.06 in.) MAXIMUM.
B. CLEARANCE ADJUSTMENT - 0.76 mm (0.03 in.) MINIMUM AND 1.52 mm (0.06 in.) MAXIMUM.

Figure 42. Lower Mounting Hooks Wear Limit and Clearance Adjustment



1. LUBE FITTING
2. STEER AXLE
3. ROD ENDS

Figure 43. Lubricate Steering King Pins

HYDRAULIC TANK BREATHER, CHECK

NOTE: When inspecting or cleaning the breather, do not disassemble it. The breather element is a non serviceable part. If it is damaged, replace with a new breather element. See **Parts Manual**.

1. Remove the floor mat. Lift floor plate up enough to disconnect the accelerator pedal or MONOTROL® pedal. See Figure 34. Remove floor plate with the accelerator pedal or MONOTROL® pedal still attached for access to master cylinder reservoir.

WARNING

Compressed air can move particles so that they cause injury to the user or to other personnel. Make sure that the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eyes.

CAUTION

Direct air pressure on the filter element can cause damage. Direct air pressure away from filter element.

2. Using compressed air, remove any dirt and debris in the area around the hydraulic tank breather. See Figure 44.

WARNING

Cleaning solvents can be flammable and toxic, and can cause skin irritation. When using cleaning solvents, always follow the recommendations of the manufacturer.

3. Remove hydraulic tank breather from breather hose. Wash breather in solvent and use compressed air to dry.
4. Inspect hydraulic tank breather. If hydraulic tank breather is worn or damaged, replace with new hydraulic tank breather. See the **Parts Manual.** If breather is not worn or damaged, install clean hydraulic tank breather onto hydraulic tank breather hose.

The hydraulic tank breather cap allows air to enter the hydraulic tank when the hydraulic oil is pumped out to the cylinders. When the hydraulic oil returns to the tank, air is expelled through the hydraulic breather cap. A filter in the cap protects the hydraulic system from particles of dirt and other contaminants. If the filter becomes excessively dirty, air flow can be restricted, causing pressures and vacuums to build inside the tank. If air flow becomes restricted through the hydraulic breather cap, replace the assembly. Keep the hydraulic tank area clean and **DO NOT** overfill the hydraulic tank. See Figure 44.

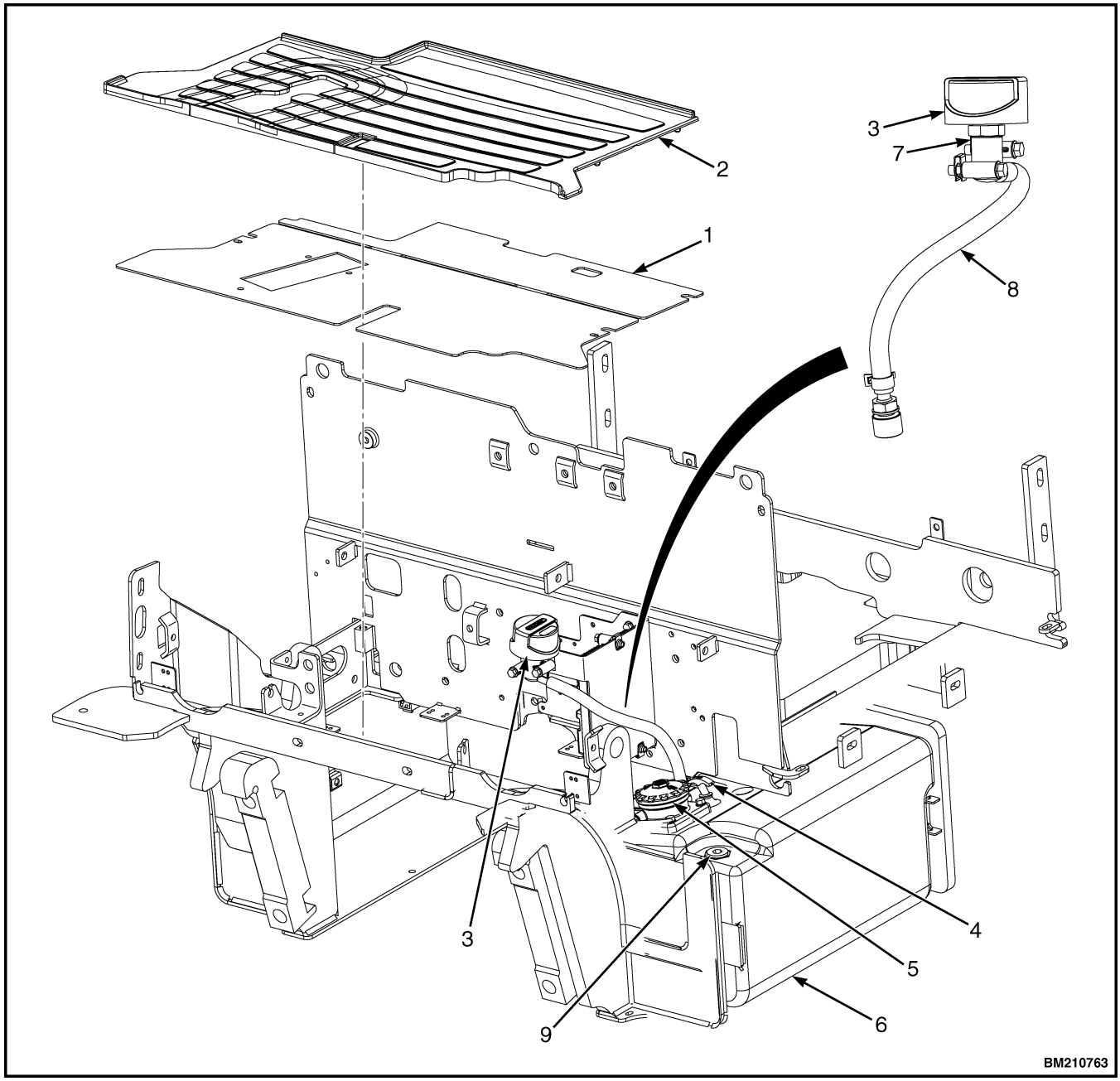
5. When inspection is completed, connect the accelerator pedal or MONOTROL® pedal and install floor plate and floor mat. See Figure 34.

OTHER LUBRICATION

Lubricate hinges, pins, linkages, cables, pedals, and lever joints as necessary. Use multipurpose grease as shown in the
Maintenance ScheduleMaintenance Schedule.

HYDRAULIC CONTROL LEVERS

Lubricate the hydraulic control levers as required. Use silicone lubricant spray (Hyster Part No. 328388) .



1. FLOOR PLATE
2. FLOOR MAT
3. HYDRAULIC TANK BREATHER
4. HYDRAULIC OIL DIPSTICK
5. HYDRAULIC OIL FILTER
6. HYDRAULIC TANK
7. BREATHER ADAPTER
8. BREATHER HOSE

Figure 44. Hydraulic Tank Breather Check

CONTACTOR

WARNING

Disconnect the battery connector to prevent injury from electric shock before you make any inspections or repairs to the contactor.

Discharge the capacitors when you make any electrical inspections or repairs inside of the electrical compartment.

1. Disconnect the battery and discharge the capacitors. See Discharging the Capacitors in the General section of this manual. Attach a tag to truck battery connector stating DO NOT CONNECT BATTERY. Remove the key, or cover the keyless switch if truck is equipped with one.

2. Remove capscrews from counterweight cover and remove counterweight cover from counterweight.

   See Figure 45 for lift trucks manufactured before September, 2012

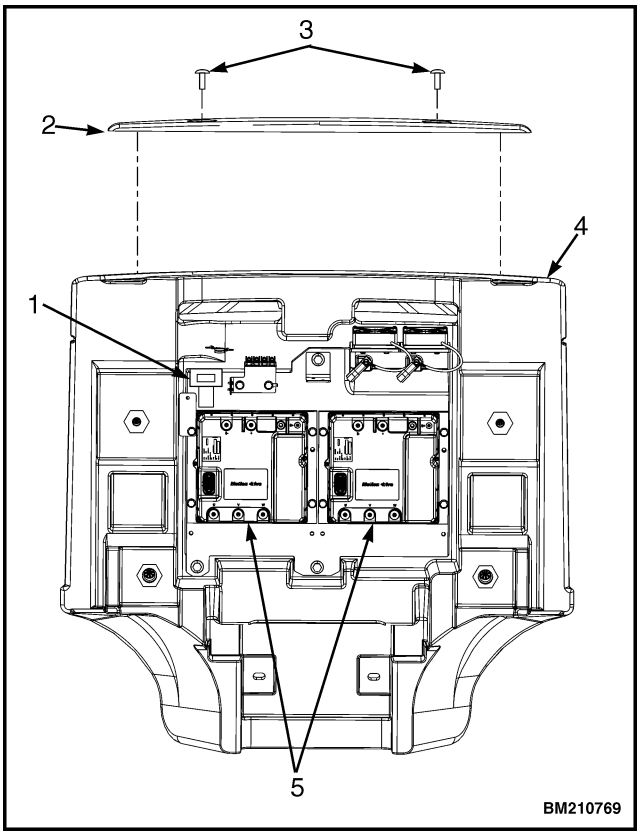
   See Figure 46 for lift trucks manufactured after September, 2012

   See Figure 47 for lift trucks manufactured after November, 2014

3. Inspect the contactor. The contacts are made of a special silver alloy. The contacts will look black and rough from normal operation. This condition does not cause problems with the operation of the lift truck. Cleaning is not necessary. DO NOT USE A FILE ON THE CONTACTS. DO NOT LUBRICATE THE CONTACTS.

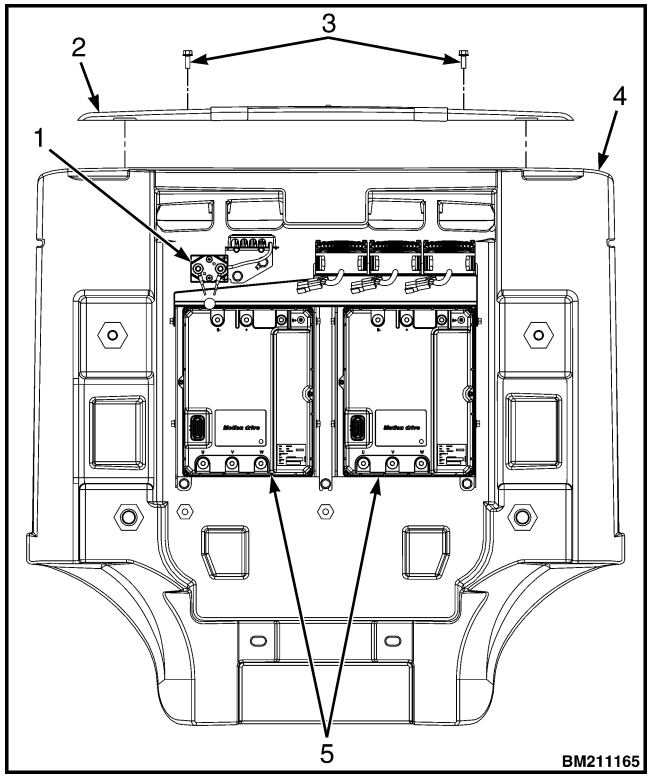
4. Install the counterweight cover to counterweight using two capscrews.

5. Remove the DO NOT CONNECT BATTERY tag from truck battery connector and reconnect the battery. If lift truck is equipped with a keyless start switch, remove cover from switch.



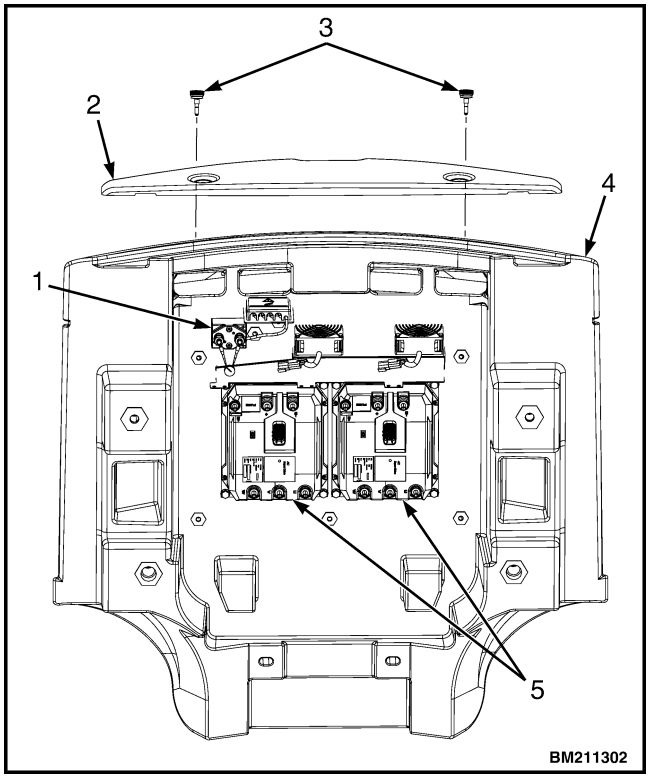
1. CONTACTOR
2. COUNTERWEIGHT COVER
3. CAPSCREWS
4. COUNTERWEIGHT
5. CONTROL PANELS

Figure 45. Check Contactor, Lift Trucks Manufactured Before September, 2012



1. CONTACTOR
2. COUNTERWEIGHT COVER
3. CAPSCREWS
4. COUNTERWEIGHT
5. CONTROL PANELS

Figure 46. Check Contactor, Lift Trucks Manufactured After September, 2012



1. CONTACTOR
2. COUNTERWEIGHT COVER
3. CAPSCREWS
4. COUNTERWEIGHT
5. CONTROL PANELS

Figure 47. Check Contactor, Lift Trucks Manufactured After November, 2014

Maintenance Procedures Every 2000 Hours or Yearly

Perform the
Maintenance Procedures Every 8 Hours or Daily
and
Maintenance Procedures Every 500 Hours or Three Months prior to performing the procedures in this section.

HYDRAULIC SYSTEM

Hydraulic Filter Element, Replace

WARNING

At operating temperature, the hydraulic oil is HOT. DO NOT permit the hot oil to touch the skin and cause a burn.

CAUTION

DO NOT permit dirt to enter the hydraulic system when the oil level is checked or the filter is changed. Dirt can cause damage to the components of the hydraulic system.

Never operate the hydraulic pump without oil in the hydraulic system. The operation of the hydraulic pump without oil will damage the pump.

CAUTION

Disposal of lubricants and fluids must meet local environmental regulations.

1. Put lift truck on a level surface and lower the carriage. Remove the floor mat and floor plate. See Figure 49.

2. Unscrew and remove filter lid with spring and O-ring from head. See Figure 48.

NOTE: Have a container large enough to hold the filter assembly and allow for hydraulic oil draining from element.

3. Remove the hydraulic filter element from the filter housing and place into the container. Cover the head to prevent any foreign materials from getting into the hydraulic tank.

4. Install the new hydraulic filter element into filter housing.

5. Lubricate new O-ring with clean hydraulic oil and install it on head. Inspect spring and filter lid. If worn or damaged, replace with new parts. See **Parts Manual.**

6. Install spring and filter lid onto head. Tighten filter lid to 13.6 N•m (120 lbf in). See Figure 48.

CAUTION

Additives may damage the hydraulic system. Before using additives, contact your local Hyster dealer.

7. Turn lift truck power **ON**, operate hydraulic functions, and check for leaks. Turn lift truck power **OFF** and check hydraulic oil level. Add oil if necessary. Use hydraulic oil shown in the Maintenance Schedule.

   If using filtered oil: remove tank level sensor or tank level sensor plug and add oil.

   If using non-filtered oil: remove filter lid and pour hydraulic oil into tank through filter housing; install filter lid, tighten lid to 13.6 N•m (120 lbf in).

8. Install the floor plate and floor mat. See Figure 49.

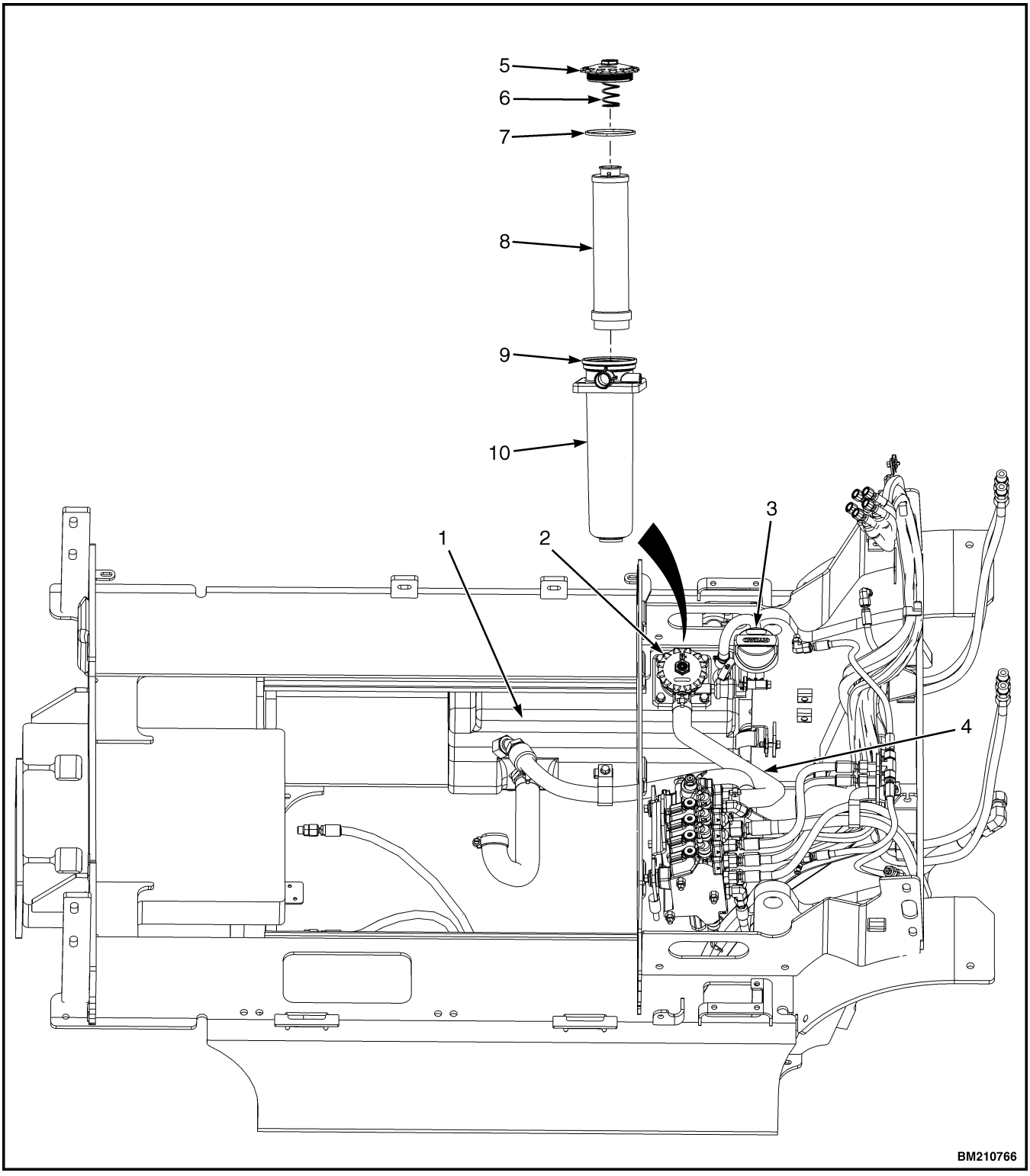


Figure 48. Hydraulic Filter Assembly

Legend for Figure 48.

NOTE: HYDRAULIC BREATHER HOSE NOT SHOWN FOR EASE OF VIEWING HYDRAULIC FILTER PLACEMENT

1. HYDRAULIC TANK
2. HYDRAULIC FILTER
3. HYDRAULIC TANK BREATHER
4. RETURN HOSE
5. HYDRAULIC FILTER LID
6. SPRING
7. O-RING
8. HYDRAULIC FILTER ELEMENT
9. HEAD
10. FILTER HOUSING

Hydraulic Tank Breather, Change

1. Remove the floor mat and floor plate for access to the hydraulic tank breather. See Figure 49.

WARNING

Compressed air can move particles so that they cause injury to the user or to other personnel. Make sure that the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eyes.

CAUTION

Direct air pressure on the filter element can cause damage. Direct air pressure away from filter element.

2. Using compressed air, remove any dirt and debris in the area around the hydraulic tank breather.

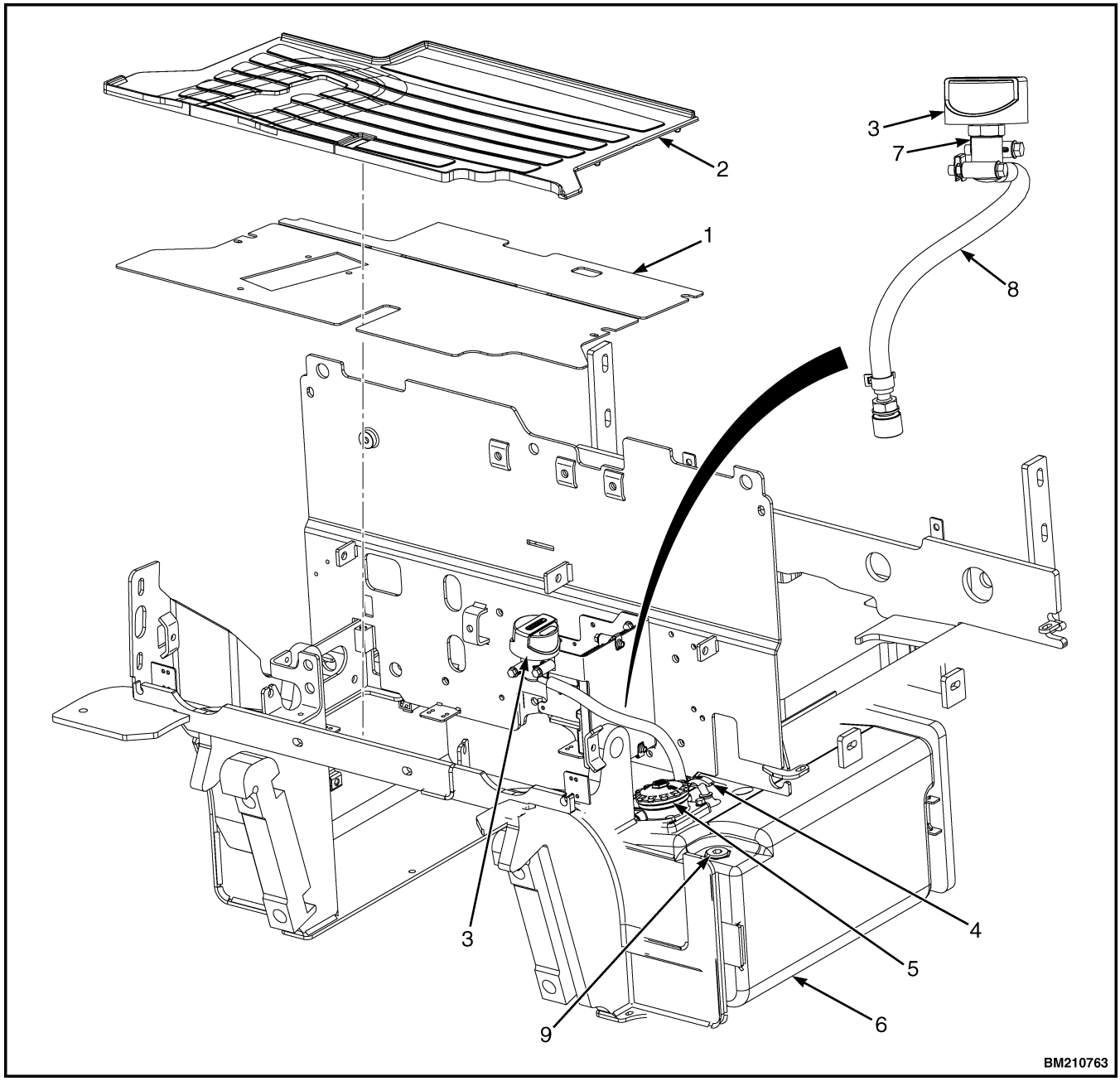
WARNING

Cleaning solvents can be flammable and toxic, and can cause skin irritation. When using cleaning solvents, always follow the recommendations of the manufacturer.

3. Remove the hydraulic tank breather from breather hose. Wash breather in solvent and use compressed air to dry. See Figure 49.

4. Inspect the hydraulic tank breather. If hydraulic tank breather is worn or damaged, replace with new hydraulic tank breather. See the **Parts Manual**. If hydraulic tank breather is not worn or damaged, install clean hydraulic tank breather onto hydraulic tank breather hose.

5. Install the floor plate and floor mat. See Figure 49. Turn lift truck power **ON** and check for leaks in the hydraulic system.



1. FLOOR PLATE
2. FLOOR MAT
3. HYDRAULIC BREATHER
4. HYDRAULIC OIL DIPSTICK
5. HYDRAULIC OIL FILTER
6. HYDRAULIC TANK
7. BREATHER ADAPTER
8. BREATHER HOSE

Figure 49. Hydraulic Tank Breather

SERVICE BRAKES

WARNING

Brake linings contain fibers. Breathing the dust from these brake linings can be a cancer or lung disease hazard. DO NOT create dust! DO NOT clean brake parts with compressed air or by brushing. Use vacuum equipment approved for asbestos dust or follow the cleaning procedure in this section. When the brake drums are removed, do not create dust.

DO NOT sand, grind, chisel, hammer, or change linings in any way that will create dust. Any changes to brake linings must be done in a restricted area with special ventilation. Protective clothing and a respirator must be used.

Cleaning Procedures:

1. Do not release brake lining dust from the brake linings into the air when the brake drum is removed.

CAUTION

DO NOT use an oil solvent to clean the wheel cylinder. Use a solvent approved for cleaning of brake parts. DO NOT permit oil or grease in the brake fluid or on the brake linings.

2. Use a solvent approved for cleaning of brake parts to wet the lining dust. Follow the instructions and cautions of the manufacturer for the use of the solvent. If a solvent spray is used, do not create brake lining dust with the spray.

3. When the brake lining dust is wet, clean the parts. Put any cloth or towels in a plastic bag or an airtight container while they are still wet. Put a **DANGEROUS FIBERS** warning label on the plastic bag or airtight container.

4. Any cleaning cloths that will be washed must be cleaned so fibers are not released into the air.

NOTE: Some lift trucks are used in operations where the automatic adjusters can be slow to adjust the brake shoes. If the brakes need adjustment, operate the lift truck in forward and reverse 10 times. Apply the brake pedal firmly, but do not cause the wheels to slide. If the automatic adjusters do not adjust the brake shoes, a qualified service person must check the operation and condition of the brakes.

Check the brake lining [minimum thickness 1.0 mm (0.40 in.)] and parts of the brake assembly for wear or damage. If the brake linings or brake shoes are worn or damaged, they must be replaced. Brake shoes must be replaced in complete sets. Inspect the brake drums for cracks or damage. Check backing plate mounting hardware and torque. Replace any damaged parts. See **Brake System** 1800SRM1359 for the procedures on replacing the brakes.

DIFFERENTIAL AND SPEED REDUCER OIL CHANGE

WARNING

DO NOT work under a raised carriage. Lower the carriage or use a chain to prevent the carriage and the inner or intermediate weldments from lowering when doing maintenance. Make sure that the moving parts are attached to parts that cannot move.

CAUTION

Disposal of lubricants and fluids must meet local environmental regulations.

1. Remove the drain plug on the left side (right side facing the differential housing) and drain oil into container. Make sure container is the correct capacity. See the Maintenance Schedule. The drain plug is in the differential housing, near the bottom. See Figure 50.

NOTE: The oil drains slowly since it must flow through the bearings from the speed reducer to the differential housing.

2. Install the drain plug after the oil has completely drained.

WARNING

Cleaning solvents can be flammable and toxic, and can cause skin irritation. When using cleaning solvents, always follow the recommendations of the manufacturer.

WARNING

Compressed air can move particles so that they cause injury to the user or to other personnel. Make sure that the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eyes.

3. Remove breather and clean in solvent. See Figure 49. Dry breather with compressed air. Inspect the breather. If it is worn or damaged, replace with new breather. See the **Parts Manual.**.

4. Install breather. Add oil slowly at the fill plug. See Figure 50. Fill until oil just starts to flow out of the fill plug hole. The oil must flow through the bearings to the speed reducer, so filling slowly is necessary to reach the correct oil level. See Maintenance Schedule for oil specifications.

BRAKE FLUID REPLACEMENT

Perform the following procedure to remove used brake fluid from the brake system.

WARNING

Small amounts of water in the brake system can cause reduced braking performance if the water reaches the wheel cylinder areas. DO NOT allow water entry. Ensure that the sealed reservoir lid is properly replaced.

On lift trucks with dry brake drive axles, only use SAE J-1703 (DOT 3) brake fluid in the master cylinder.

1. Ensure that the master cylinder reservoir is filled with brake fluid at all times.

2. Put one end of a rubber hose on the bleeder screw of the wheel cylinder. Put the other end of the hose into a container.

3. Loosen bleeder screw at the wheel cylinder one turn so that the used brake fluid can be removed from the brake system. Slowly push the brake pedal, and hold it at the end of stroke. Close the bleeder screw. Release the brake pedal.

NOTE: The new brake fluid will be easily recognized, as the color will be more clear than the used fluid which will be darker.

4. Repeat Step 1 through Step 3 until there is new brake fluid in the container.

5. Check the level of brake fluid in reservoir for maser cylinder during the procedure. Keep brake fluid at correct level.

6. Repeat the procedure for the other wheel cylinder.

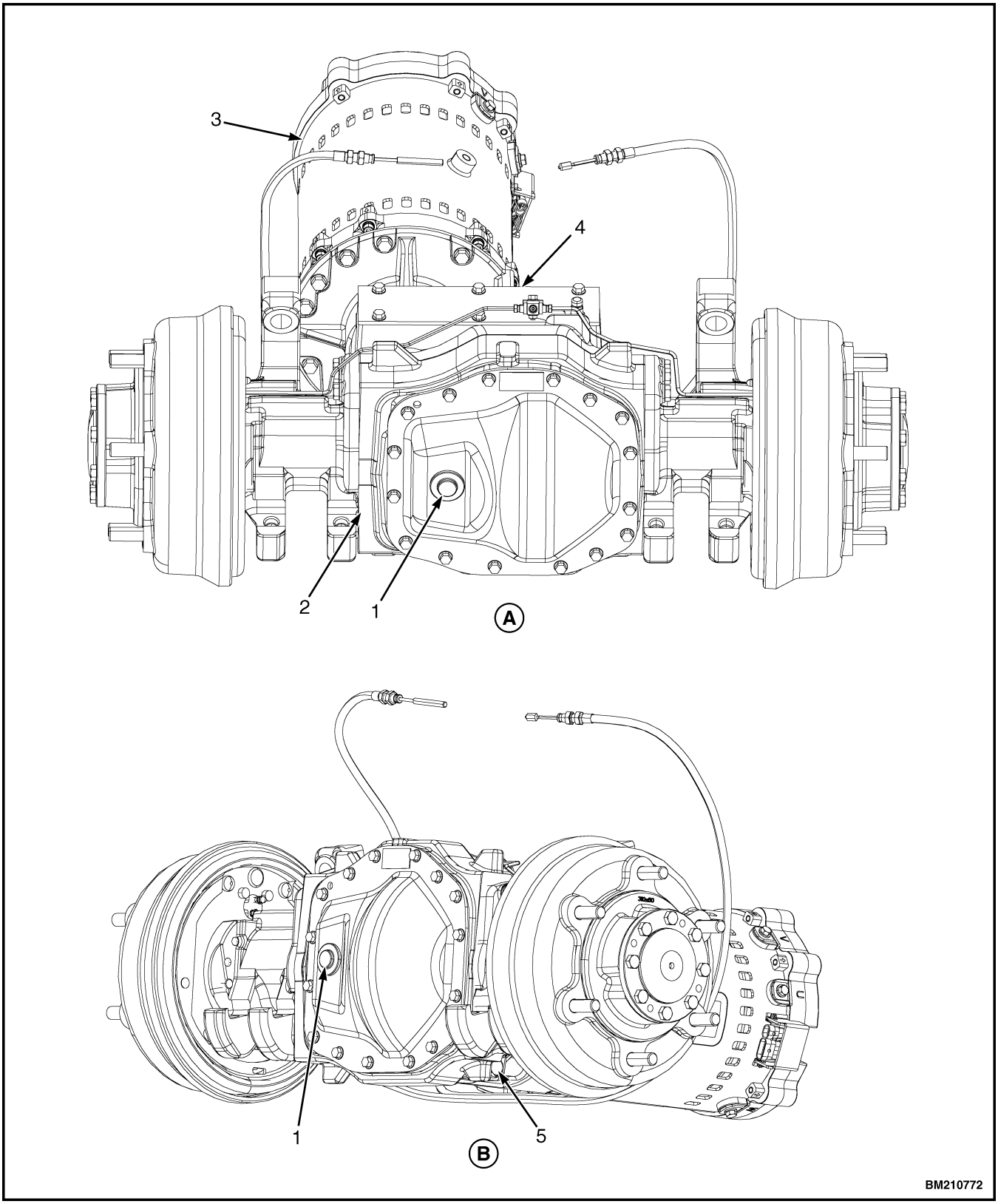


Figure 50. Differential and Speed Reducer

Legend for Figure 50.

A. FRONT VIEW

1. FILL PLUG
2. DIFFERENTIAL
3. TRACTION MOTOR

B. SIDE VIEW

4. SPEED REDUCER
5. DRAIN PLUG

FORKS, INSPECT

WARNING

DO NOT try to correct fork tip alignment by bending the forks or adding shims. Replace bent forks.

Never repair damaged forks. DO NOT heat, weld, or bend forks. Forks are made of special steel using special methods. Replace damaged forks as a complete set.

1. Inspect the forks for cracks and wear. Check that fork tips are aligned as shown in Figure 51. Check that bottom of fork is not work (item 4, Figure 51).

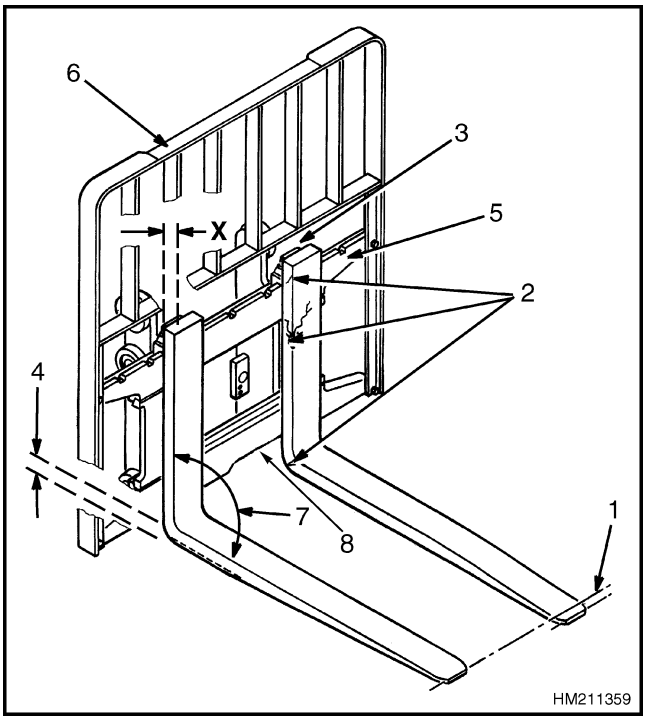
2. Replace any damaged or broken parts that are used to keep forks locked in position.

3. Inspect fork wear. Ensure heel wear is not more than 10% of original thickness. If fork wear is more than 10%, fork must be replaced or rerated. Perform fork wear inspection using a BOL256N1 caliper ruler Hyster P/N 4092984 as follows. See Figure 52.

a. Determine normal thickness of "N" of fork using scale or ruler portion of caliper ruler. Measurement has to be done on fork shank using caliper ruler.

b. Position caliper at end of heel internal radius (item 4, Figure 51) with opening corresponding to measured thickness of fork shank in Step a above. (e.g. for N 1.75 use N 1.75 opening). This is typically the section of fork where wear is greatest. Not that opening distance has been reduced by 10% from nominal thickness.

c. If fork enters the opening, it is mandatory to replace it. DANGER OF BREAKING. Furthermore, a 10% reduction in fork blade thickness results in 20% reduction in operating capacity.



Fork Tip Alignment	
Length of Forks	**3% Dimension**
914 mm (36 in.)	27 mm (1.08 in.)
1016 mm (40 in.)	30 mm (1.20 in.)
1067 mm (42 in.)	32 mm (1.26 in.)
1207 mm (47.5 in.)	36 mm (1.42 in.)
1219 mm (48 in.)	37 mm (1.46 in.)
1372 mm (54 in.)	41 mm (1.61 in.)
1524 mm (60 in.)	46 mm (1.81 in.)
1829 mm (72 in.)	55 mm (2.17 in.)

1. TIP ALIGNMENT (MUST BE WITHIN 3% OF FORK LENGTH)
2. CRACKS
3. LATCH DAMAGE
4. HEEL OF FORK (MUST BE 90% OF DIMENSION X)
5. CARRIAGE
6. LOAD BACKREST EXTENSION
7. MAXIMUM ANGLE 93°
8. FORK REMOVAL NOTCH

Figure 51. Forks Check

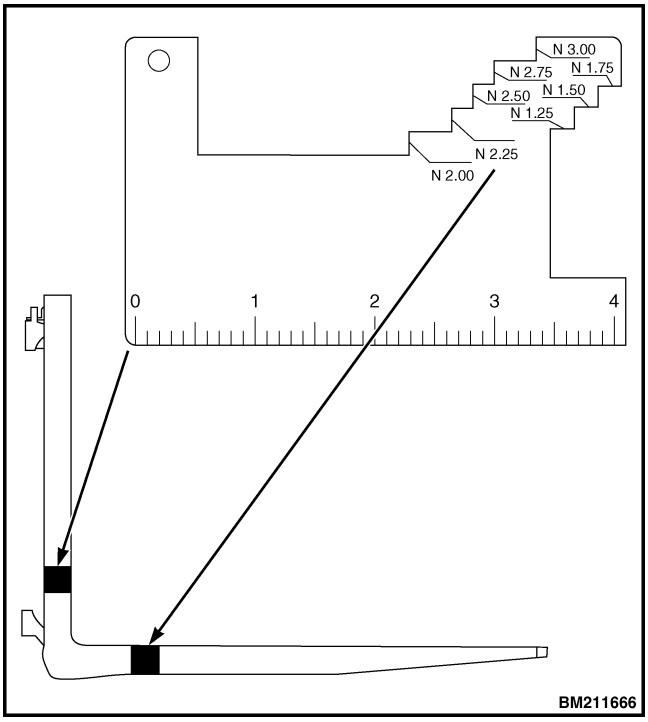


Figure 52. Fork Wear Check

INTEGRAL SIDESHIFT CARRIAGE, REPLACE UPPER AND LOWER BEARINGS

Replace all four bearings regardless of wear. See the section
Check Upper and Lower Bearings, Integral Sideshift Carriage of this manual for the procedures.

LIFT CHAINS

WARNING

Cleaning solvents can be flammable and toxic and can cause skin irritation.

When using cleaning solvents, always follow the recommendations of the manufacturer.

Compressed air can move particles so they cause injury to the user or to other personnel. Make sure that the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eyes.

NOTE: Cleaning and lubrication of lift chains will be needed more frequently in very dirty, dusty, or contaminated applications.

Remove the lift chains. Clean the lift chains by soaking them in a solvent that has a petroleum base for at least 30 minutes. Use compressed air to completely dry the chains when they are clean.

Lubricate the lift chains by soaking them in SAE 30W engine oil for at least 30 minutes. Remove the chains from the oil. Hang the chains for one hour so excess oil will drain from the chains.

WHEEL BEARINGS

Steer Wheels, Lubrication

Lubricate the wheel bearings in the hubs for the steer wheels with multipurpose grease as shown in the Maintenance Schedule. See **Steering Axle** 1600SRM1360 for the procedures.

Drive Wheels, Lubrication

Lubricate the inner wheel bearings in the hubs for the drive axle with multipurpose grease as shown in the Maintenance Schedule. See **Drive Axle, Speed Reducer, and Differential** 1300SRM1366 for the procedures.

Maintenance Procedures Every 4000 Hours Or Two Years

Perform the
Maintenance Procedures Every 8 Hours or Daily,
Maintenance Procedures Every 500 Hours or Three Months, and
Maintenance Procedures Every 2000 Hours or Yearly prior to performing the procedures in this section.

HYDRAULIC OIL, CHANGE

Put the lift truck on a level surface. Lower the mast. Put a drain pan with a capacity of approximately 32.0 liter (33.8 qt) for nylon tank or
35.0 liter (37.0 qt) for metal tank under the hydraulic tank.

1. Remove the hydraulic oil drain plug from the bottom of the hydraulic tank. See Figure 53. When oil has completely drained, install drain plug.

2. Remove the floor mat and floor plate for access to the hydraulic filter housing. See Figure 54.

CAUTION

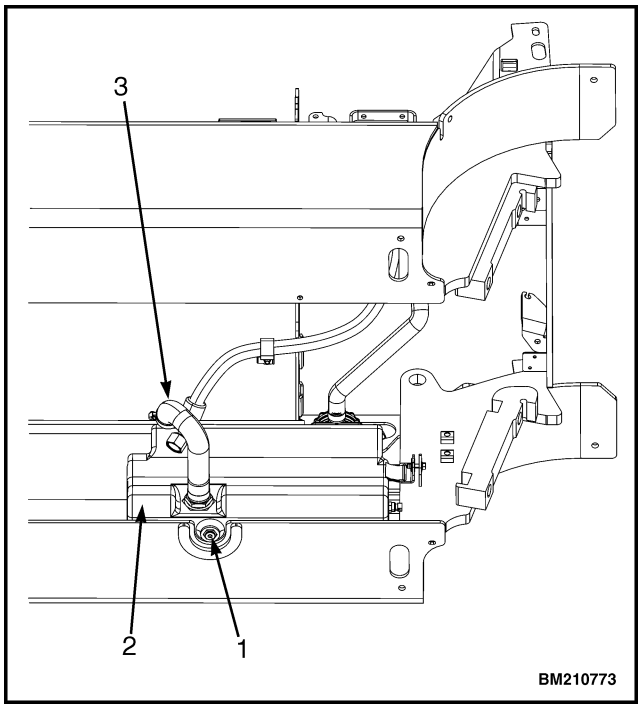
Additives may damage the hydraulic system. Before using additives, contact you local Hyster dealer.

NOTE: Before adding new hydraulic oil, be sure that a new hydraulic oil filter element is installed.

3. **If using filtered oil**: remove tank level sensor or tank level sensor plug and add oil. **If using non-filtered oil:** remove filter lid and pour hydraulic oil through filter element; install filter lid. See the Maintenance Schedule for specified hydraulic oil.

4. Install the floor plate and floor mat. Turn lift truck power **ON** and check for leaks in the hydraulic system.

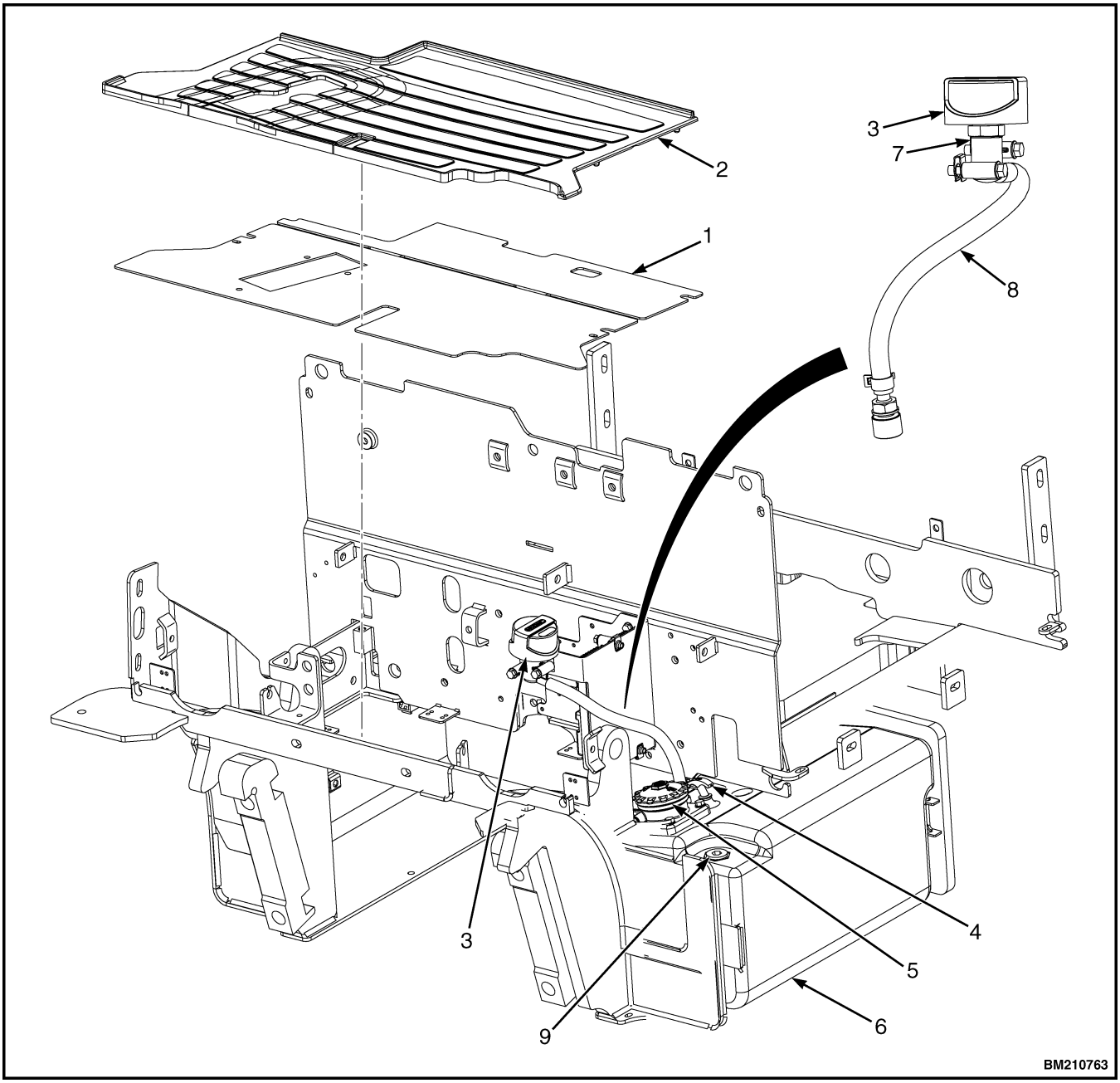
5. Turn lift truck power **ON**, operate hydraulic functions, and check for leaks. Turn lift truck power OFF and check hydraulic oil level. Add oil if necessary. **If using filtered oil:** remove tank level sensor or tank level sensor plug and add oil. **If using non-filtered oil**: remove filter lid and pour hydraulic oil into talk through filter element; install filter lid. See Maintenance Schedule for specified hydraulic oil.



NOTE: MAJOR COMPONENTS OF HYDRAULIC SYSTEM REMOVED FOR CLARITY (BOTTOM VIEW OF LIFT TRUCK).

1. HYDRAULIC OIL DRAIN PLUG
2. HYDRAULIC TANK
3. SUCTION HOSE

Figure 53. Drain Hydraulic Oil



1. FLOOR PLATE
2. FLOOR MAT
3. HYDRAULIC BREATHER
4. HYDRAULIC OIL DIPSTICK
5. HYDRAULIC OIL FILTER
6. HYDRAULIC TANK
7. BREATHER ADAPTER
8. BREATHER HOSE

Figure 54. Add Hydraulic Oil

STEERING DIRECTION SENSOR INSPECTION

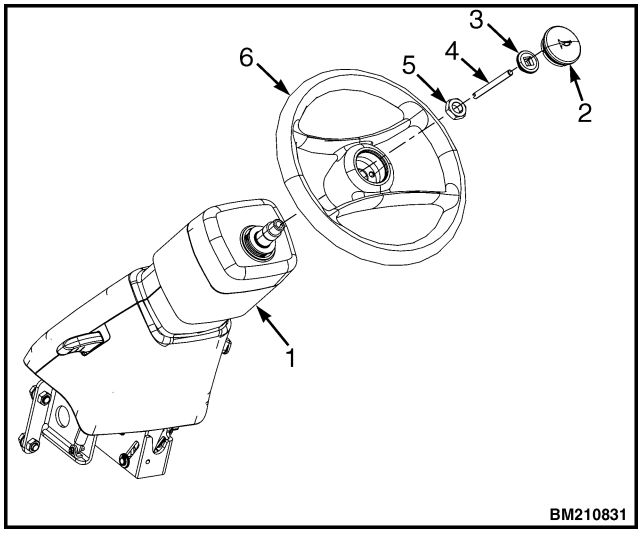
Fixed Steering Column

NOTE: Tag all electrical connectors during removal to aid in installation.

1. Disconnect battery connector. Discharge the capacitors. See Discharging the Capacitors in the General section of this manual.

2. Remove horn button, nut, and rod from steering wheel. See Figure 55.

3. Remove hex nut and steering wheel from steering column. If necessary, use puller tool to remove steering wheel. See Figure 55.



NOTE: TELESCOPIC STEERING COLUMN SHOWN.

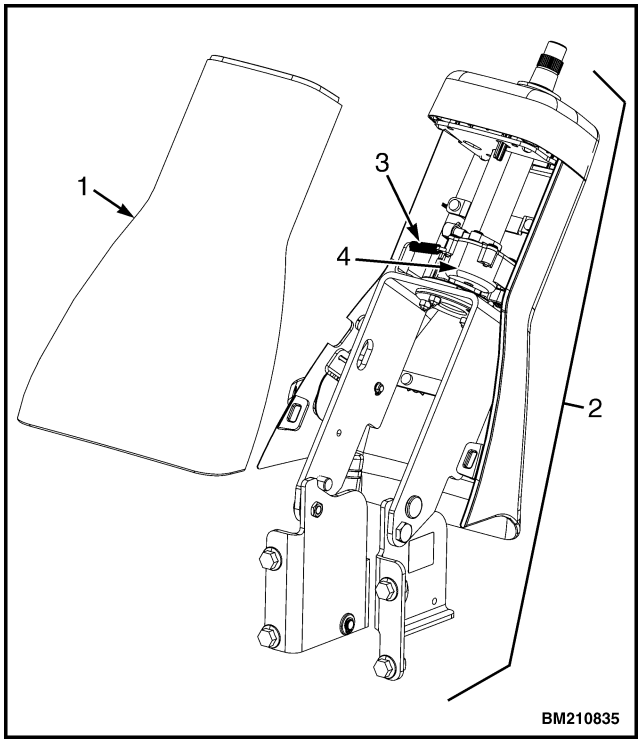
1. STEERING COLUMN
2. HORN BUTTON
3. NUT
4. ROD
5. HEX NUT
6. STEERING WHEEL

Figure 55. Steering Wheel

4. Remove steering column upper cover by pressing from both sides near the bottom and pulling up. Clips should remain attached to cover. See Figure 56.

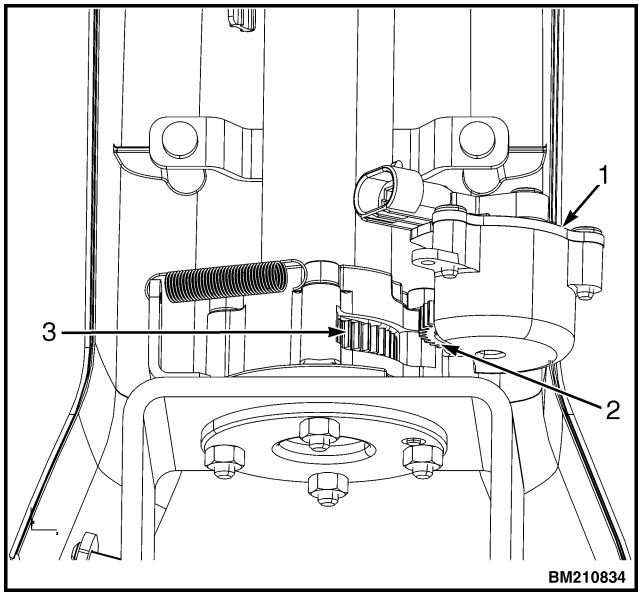
5. Disconnect spring from sensor assembly. See Figure 56.

6. Swing open sensor assembly. It will only swing 30° with the lower cover installed. See Figure 57.



1. STEERING COLUMN UPPER COVER
2. FIXED STEERING COLUMN
3. SPRING
4. SENSOR ASSEMBLY

Figure 56. Fixed Steering Column Covers



1. SENSOR ASSEMBLY
2. MAGNET GEAR TEETH
3. COLUMN GEAR TEETH

Figure 57. Steering Gears

7. Inspect magnet gear teeth. See Figure 57. Replace sensor assembly if magnet teeth are cracked or missing. See **Electrical System** 2200SRM1369 for sensor replacement procedures.

8. Connect battery connector, turn lift truck **ON**, and rotate steering column to fully inspect column gear teeth. See Figure 57. Replace column gear if teeth are cracked or missing. See **Steering System** 1600SRM1363 for column gear replacement procedure. Disconnect battery connector.

9. Swing sensor assembly back to original position.

10. Connect spring to sensor assembly.

11. Install steering column upper cover by pressing from both sides and pushing against lower cover until snapped in place. See Figure 56.

12. Install steering wheel and hex nut onto steering column. See Figure 55. Tighten hex nut to 40 to 54 N•m (30 to 40 lbf ft).

13. Install rod, nut, and horn button onto steering wheel. See Figure 55.

14. Connect battery connector.

Telescopic Steering Column

NOTE: Tag all electrical connectors during removal to aid in installation.

1. Disconnect battery connector. Discharge the capacitors. See Discharging the Capacitors in the General section of this manual.

2. Remove horn button, nut, and rod from steering wheel. See Figure 55.

3. Remove hex nut and steering wheel from steering column. If necessary, use puller tool to remove steering wheel. See Figure 55.

4. Telescope steering column to fully **UP** position.

5. Remove steering column top cover, by pressing both sides near the bottom and pulling up. Clips should remain attached to cover. See Figure 58.

6. Remove steering column telescoping cover from telescopic steering column. See Figure 58.

7. Remove capscrew, washer, and steering column upper cover from telescopic steering column. See Figure 58.

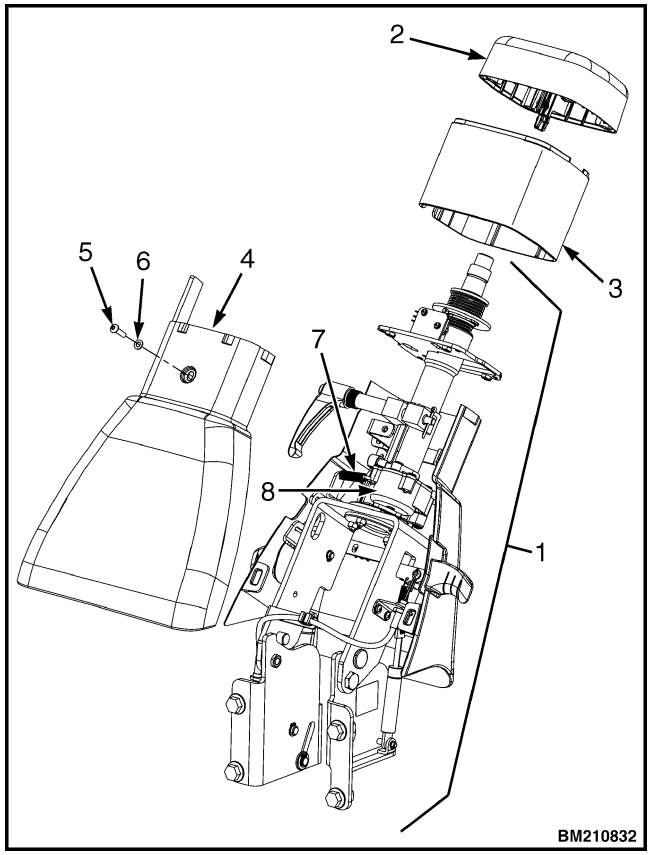
8. Disconnect spring from sensor assembly. See Figure 58.

9. Swing open sensor assembly. It will only swing 30° with the lower cover installed. See Figure 57.

10. Inspect magnet gear teeth. See Figure 57. Replace sensor assembly if magnet teeth are cracked or missing. See **Electrical System** 2200SRM1369 for sensor replacement procedures.

11. Reconnect battery connector, turn lift truck **ON**, and rotate steering column to fully inspect column gear teeth. See Figure 57. Replace column gear if teeth are cracked or missing. See **Steering System** 1600SRM1363 for column gear replacement procedure. Disconnect battery connector.

12. Swing sensor assembly back to original position.



1. TELESCOPIC STEERING COLUMN
2. STEERING COLUMN TOP COVER
3. STEERING COLUMN TELESCOPING COVER
4. STEERING COLUMN UPPER COVER
5. CAPSCREW
6. WASHER
7. SPRING
8. SENSOR ASSEMBLY

Figure 58. Telescopic Steering Column Covers

13. Connect spring to sensor assembly.

14. Install steering column upper cover, washer, and capscrew onto telescopic steering column. See Figure 58.

15. Install steering column telescoping cover onto telescopic steering column. See Figure 58.

16. Install steering column top cover, by pressing down onto telescopic steering column. See Figure 58.

17. Lower telescopic steering column to fully **DOWN** position.

18. Install steering wheel and hex nut onto steering column. See Figure 55. Tighten hex nut to 40 to 54 N•m (30 to 40 lbf ft).

19. Install rod, nut, and horn button onto steering wheel. See Figure 55.

20. Connect battery connector.

TELESCOPIC STEERING COLUMN LUBRICATION

NOTE: Tag all electrical connectors during removal to aid in installation.

1. Disconnect battery connector. Discharge the capacitors. See Discharging the Capacitors in the General section of this manual.

2. Remove horn button, nut, and rod from steering wheel. See Figure 55.

3. Remove hex nut and steering wheel from telescopic steering column. If necessary, use puller tool to remove steering wheel. See Figure 55.

4. Telescope column to fully **UP** position.

5. Remove steering column top cover from telescopic steering column by pressing both sides near the bottom and pulling up. Clips should remain attached to cover. See Figure 58.

6. Remove steering column telescoping cover from telescopic steering column. See Figure 58.

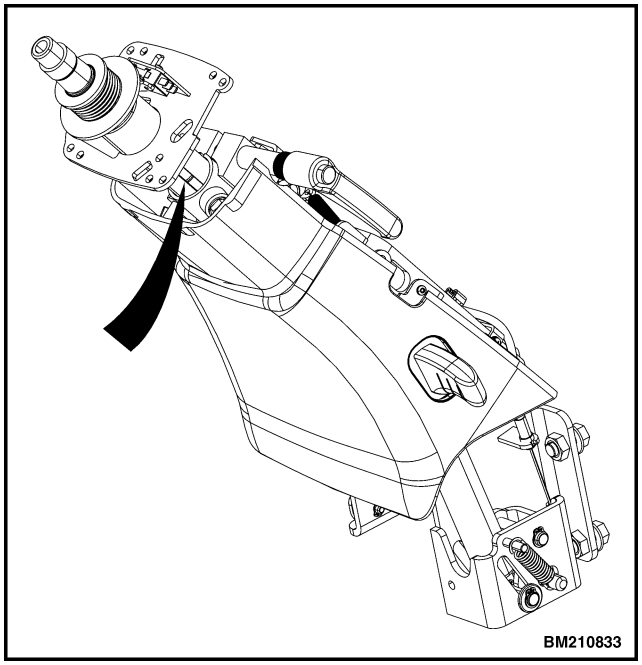
7. Remove capscrew, washer, and steering column upper cover from telescopic steering column. See Figure 58.

8. Lubricate telescopic steering column with manual steering gear grease. See Figure 59. See Maintenance Schedule.

9. Install steering column upper cover, washer, and capscrew onto telescopic steering column. See Figure 58.

10. Install steering column telescoping cover onto telescopic steering column. See Figure 58.

11. Install steering column top cover, by pressing down onto telescoping cover. See Figure 58.



NOTE: BOLD ARROW INDICATES GREASE APPLICATION LOCATION.

Figure 59. Telescopic Steering Column Lubrication

12. Lower telescopic steering column to fully **DOWN** position.
13. Install steering wheel and hex nut onto telescopic steering column. See Figure 55. Tighten hex nut to 40 to 54 N•m (30 to 40 lbf ft).
14. Install rod, nut, and horn button onto steering wheel. See Figure 55.
15. Connect battery connector.

Battery Maintenance

HOW TO CHARGE BATTERY

WARNING

The acid in the electrolyte can cause injury. If electrolyte is spilled, use water to flush the area. Make the acid neutral with a solution of sodium bicarbonate (soda) and water. Acid in the eyes must be immediately flushed with water.

Batteries generate explosive fumes when they are being charged. Keep fire, sparks and burning material away from the battery charger area. Prevent sparks from the battery connectors.

Charge batteries only in the special area for charging batteries. When charging the batteries, keep the vent caps clean. The battery charger area must have ventilation so that explosive fumes are removed. Open the hood over the battery or remove the cover if the battery has a cover.

Disconnect the battery when doing cleaning and maintenance.

CAUTION

Never connect the battery charger plug to the plug of the lift truck. You can damage the traction control circuit. Make sure the charger voltage is the correct voltage for the battery.

Use only battery chargers approved by the battery manufacturer or dealer.

CAUTION

Always make sure the color in the window of the charger connector is the same as the color in the window of the battery connector.

NOTE: This series of trucks can have one of three types of batteries. One type has removable cell caps. A green key for battery voltage shows in the window of the battery connector for batteries with cell caps. Another type has sealed cells and the electrolyte cannot be checked. A gray key for battery voltage shows in the window of the battery connector for sealed batteries. The third type is a lithium-ion battery. Sealed batteries and lithium-ion batteries require a different charger.

NOTE: Many installations have battery chargers that can follow a program to automatically charge a battery according to recommendations of the battery manufacturer. Use the recommendations of the battery manufacturer for charging the battery.

Correct use of the hydrometer and proper operation of the battery charger is important. See Figure 60. Follow the instructions of the charger manufacturer. Never let the battery discharge below the minimum value given by the battery manufacturer. A fully charged battery will have a specific gravity of 1.265 to 1.310 at 25°C (77°F). See Figure 60. Never charge a battery at a rate that will raise the electrolyte temperature above 49°C (120°F). Never let a battery stay discharged for long periods.

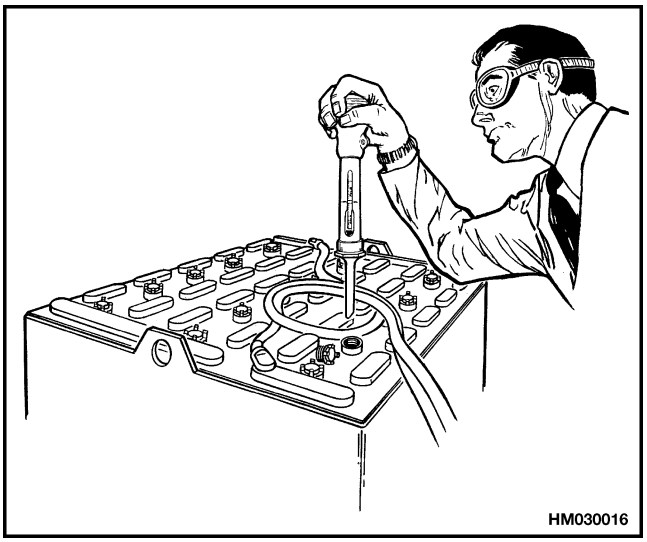
Normal Charge: This charge is normally given to a battery that is discharged from normal operation. Many customers charge the battery at regular intervals that depend on use. This procedure will keep the battery correctly charged if the battery is not discharged below the limit. Always use a hydrometer to check the battery if the battery is charged at regular intervals and has cell caps. Frequent charging of a battery that has a 2/3 or more charge can decrease the life of the battery.

Equalizing Charge: This charge is at a low rate and balances the charge in all of the cells. The equalizing charge is normally given approximately once a month. It is a charge at a slow rate for three to six hours in addition to the regular charging cycle. Do not give an equalizing charge more than once a week. The most accurate specific gravity measurements for a charged battery will be after an equalizing charge.

If the specific gravity difference is more than 0.020 between cells of the battery after an equalizing charge, there can be a defective cell. Consult your battery dealer.

Lithium-ion batteries do not require an equalization charge. Consult your battery dealer regarding the charging requirements for your battery.

Also, see the service manual section **Industrial Battery** 2240SRM0001, for additional information on the charging and maintenance of a battery.



Specific Gravity Reading	Electrolyte Temp.	Correction Points	Correct Value
1.210	31°C (87°F)	+0.003	1.213
1.210	27°C (80°F)	+0.001	1.211
1.210	25°C (77°F)	0.000	1.210
1.210	18°C (64°F)	-0.004	1.206
+0.001 or -0.001 for each 2 degree C from the 25° base value.			

NOTE: CHECK ONLY BATTERIES THAT DO NOT HAVE SEALED CELLS.

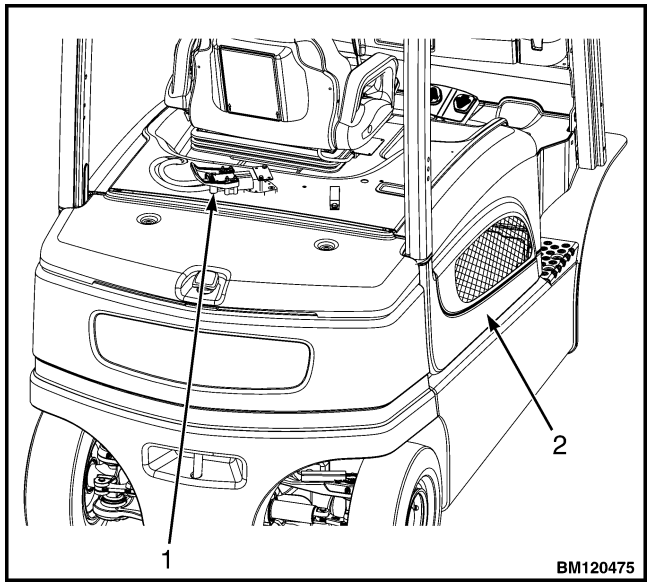
Figure 60. Check Specific Gravity

Rapid Charge

On lift truck equipped with the Rapid Charge System, the battery is charged during operator breaks or when lift truck is not being used. The Rapid Charge System provides extended operation with a single battery. Connect or disconnect from Rapid Charge System using connector shown in Figure 61.

Features of the Rapid Charge System include:

- Battery connector externally mounted for easy access.
- Vented side covers for improved battery cooling.
- Requires rapid charge vented battery and sealed battery fan box with thermostat.



1. RAPID CHARGE CONNECTOR
2. VENTED SIDE COVER

Figure 61. Rapid Charge System

HOW TO CHANGE BATTERIES

General

WARNING

Batteries are heavy and can cause injury. Use care to avoid injury. A single trained operator should perform the battery exchange while other personnel remain clear. DO NOT put hands, arms, feet and or legs between the battery and solid objects.

Make sure the capacity of the crane and spreader bar is greater than the weight of the battery. The weight of the battery is normally shown on the battery case. The maximum battery weight is shown on the lift truck Nameplate. The spreader bar must NOT be made of metal or it must have insulated straps.

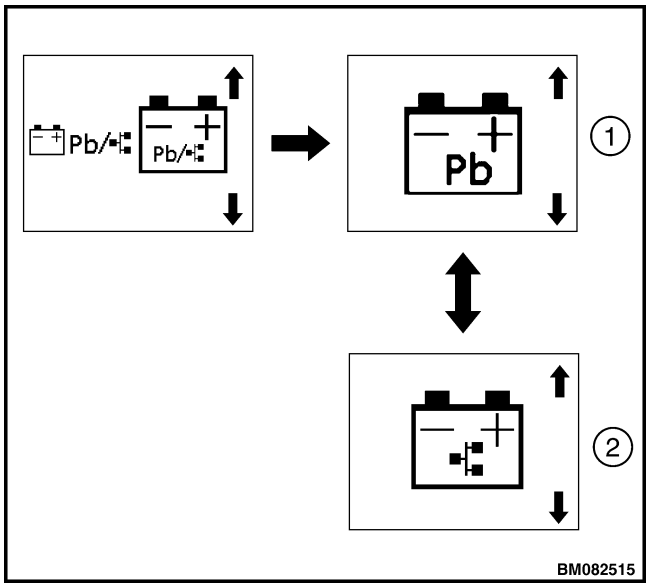
The replacement battery must fit the battery area correctly. Adjust the front spacer plate to prevent battery movement in the battery compartment. Make sure that the battery voltage and weight of the replacement battery is correct as shown on the Nameplate.

Before connecting the battery, make sure the key or keyless switch is in the OFF position and the parking brake is set.

When changing the batteries, make sure that the battery settings on the truck match the type of battery installed. The battery settings can be viewed and changed on the **Battery Settings** screen on the display.

CAUTION

Batteries must be discarded or recycled according to local environmental regulations.



1. LEAD-ACID BATTERY SETTING
2. LITHIUM-ION BATTERY SETTING

Figure 62. Battery Settings Screen

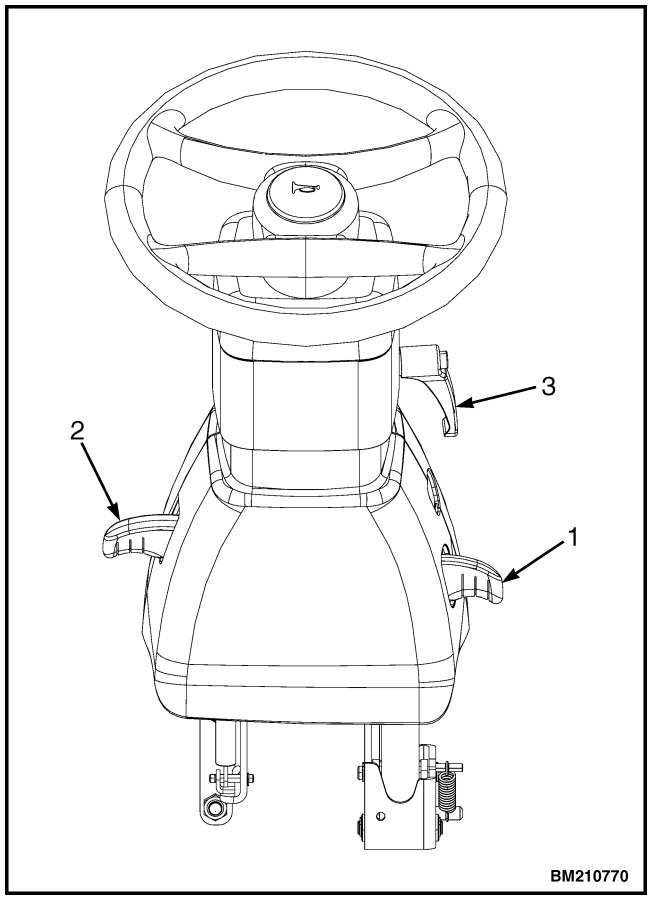
Before removing the battery, observe previous **WARNING** and **CAUTION**.

Remove the Battery

1. Using the tilt memory lever, tilt the steering column fully upright. See Figure 63.

NOTE: MLM (mini-levers) must be fully back and fully down.

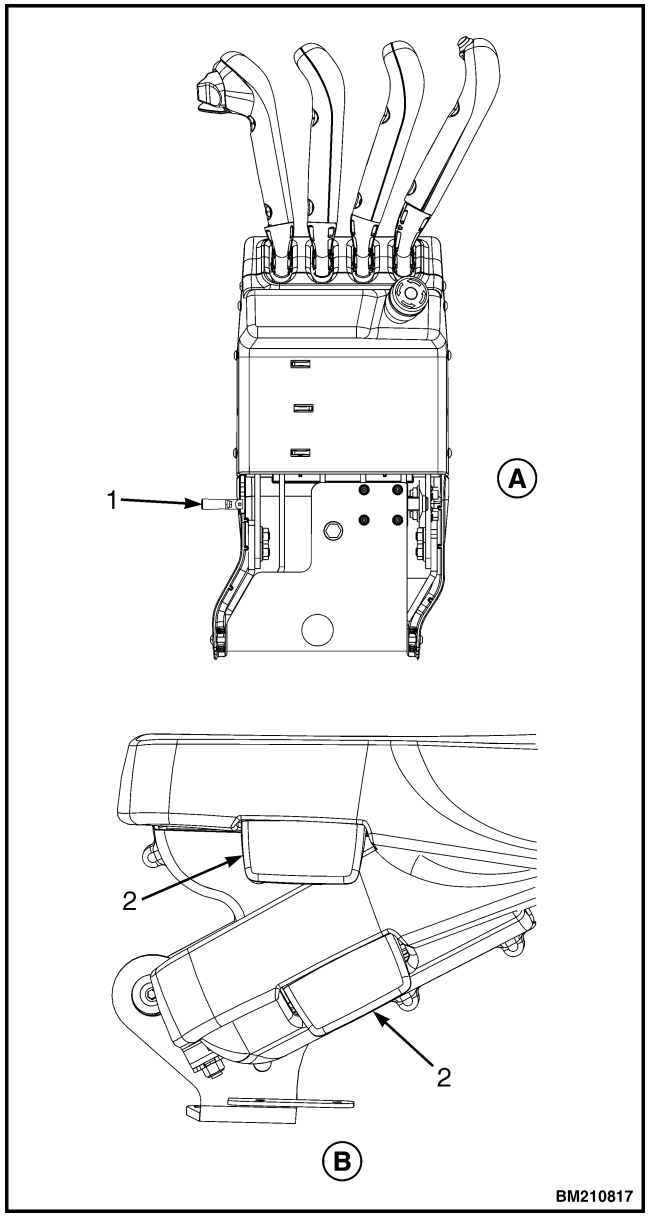
2. If lift truck is equipped with manual hydraulic control levers, release the latch for the control lever assembly and move the assembly to the forward position. On lift trucks equipped with E-Hydraulic control mini-levers, move the armrest all the way back to raise the hood. See Figure 64.



NOTE: OPTIONAL TELESCOPIC STEERING COLUMN SHOWN.

1. TILT POSITION LEVER
2. TILT POSITION (OPTIONAL TILT MEMORY) LEVER
3. TELESCOPIC COLUMN LOCKING HANDLE

Figure 63. Steering Column Tilt Memory Lever



A. MANUAL CONTROL LEVERS
B. E-HYDRAULIC CONTROL MINI-LEVERS

1. MANUAL CONTROL LEVERS RELEASE LATCH
2. E-HYDRAULIC CONTROL MINI-LEVERS ADJUSTMENT HANDLES

Figure 64. Hydraulic Control Lever Release

CAUTION

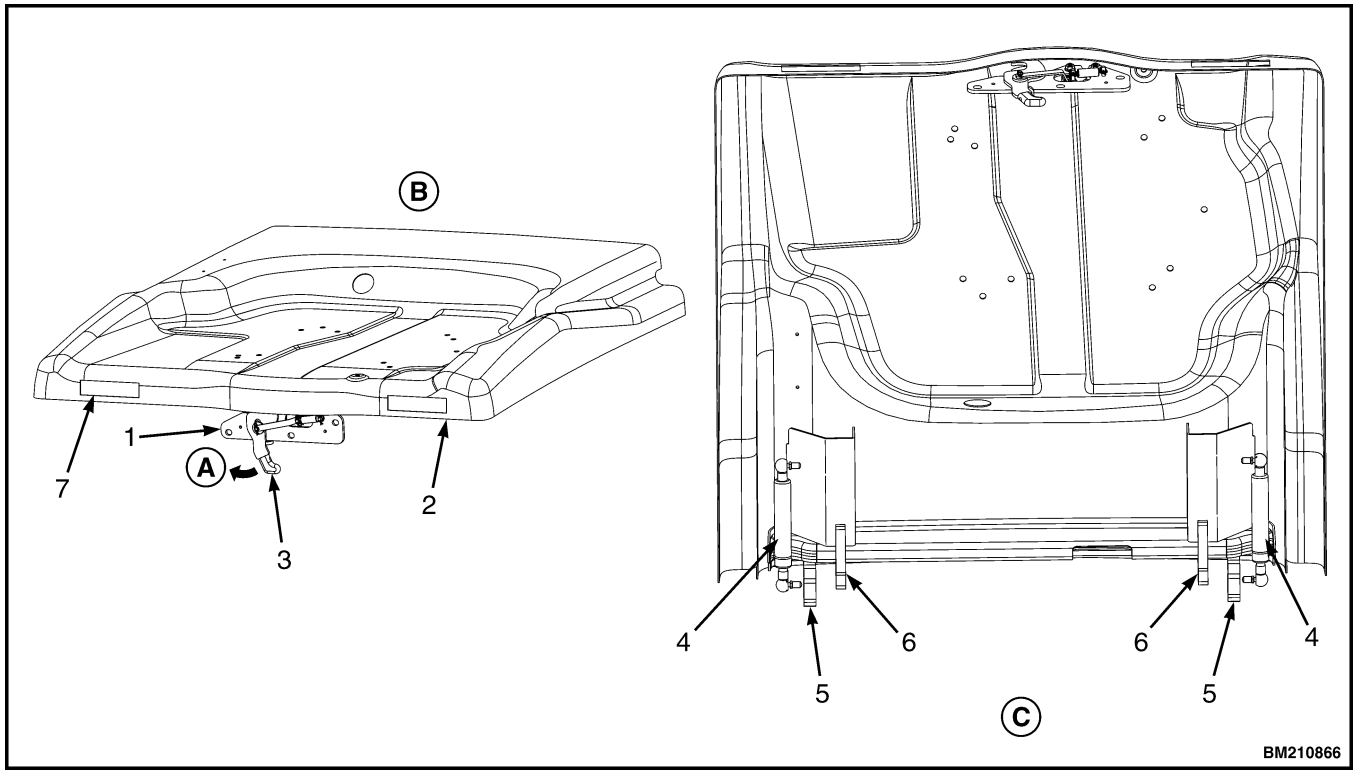
Be careful while raising the hood. Injury to personnel may occur depending on lift truck overhead guard/cab height and hood configuration.

NOTE: The hood can be raised from either side of the lift truck. Pull the hood release lever. The hood release lever is spring loaded. Use a sling and crane to hold the hood in the up position.

3. Slide the seat all the way back. From the left side of the lift truck, push the hood release handle out toward the right side of the truck to unlatch the hood. If hood is opened from right side of truck, pull hood release handle toward the right side of the truck to unlatch the hood. Place hand in plastic pocket provided and raise hood to the up position.

See Figure 65 for lift trucks manufactured before June, 2012

See Figure 66 for lift trucks manufactured after June, 2012

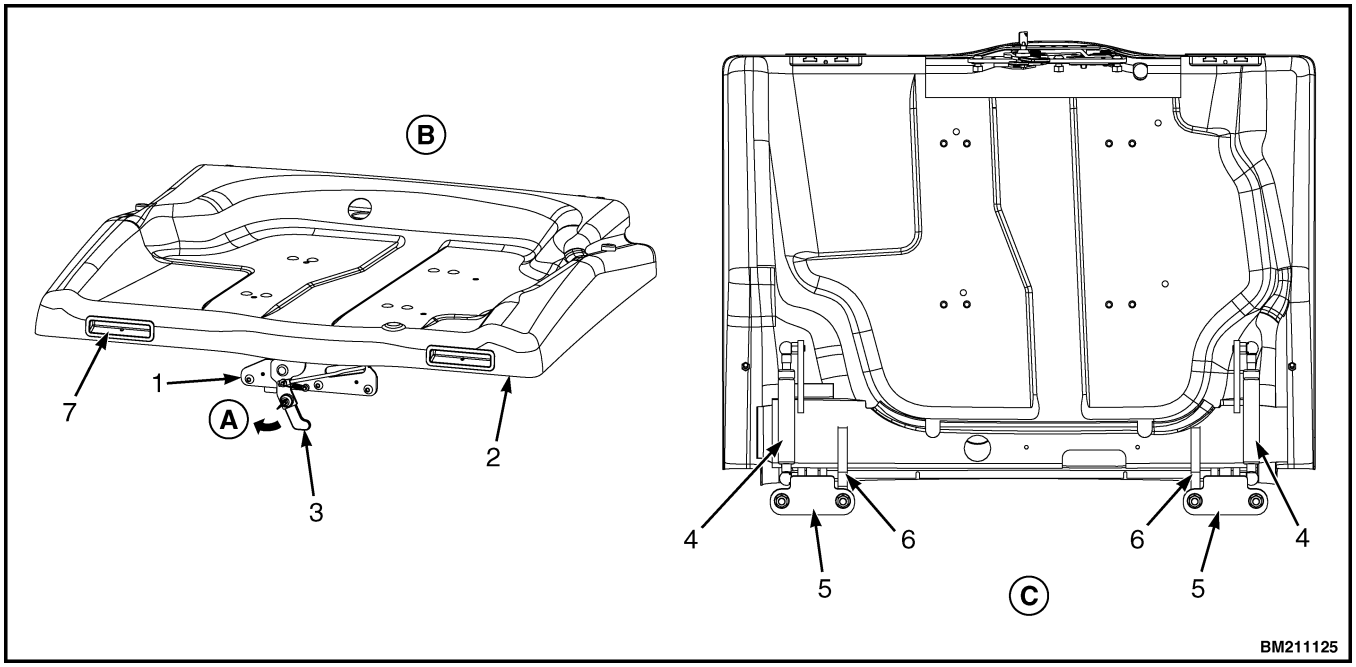


NOTE: 1015 mm (40 in.) HOOD SHOWN. GAS-CONTROLLED STRUT ORIENTATION MAY BE DIFFERENT FROM SHOWN.

A. RELEASE DIRECTION
B. FRONT VIEW
C. BOTTOM VIEW

1. LATCH ASSEMBLY
2. HOOD
3. HOOD RELEASE LEVER
4. GAS SPRING
5. HOOD HINGE
6. BATTERY STOPPER

Figure 65. Hood and Hood Latch Components, Lift Trucks Manufactured Before June, 2012



NOTE: 700 mm (27.6 in.) HOOD SHOWN. GAS-CONTROLLED STRUT ORIENTATION MAY BE DIFFERENT FROM SHOWN.

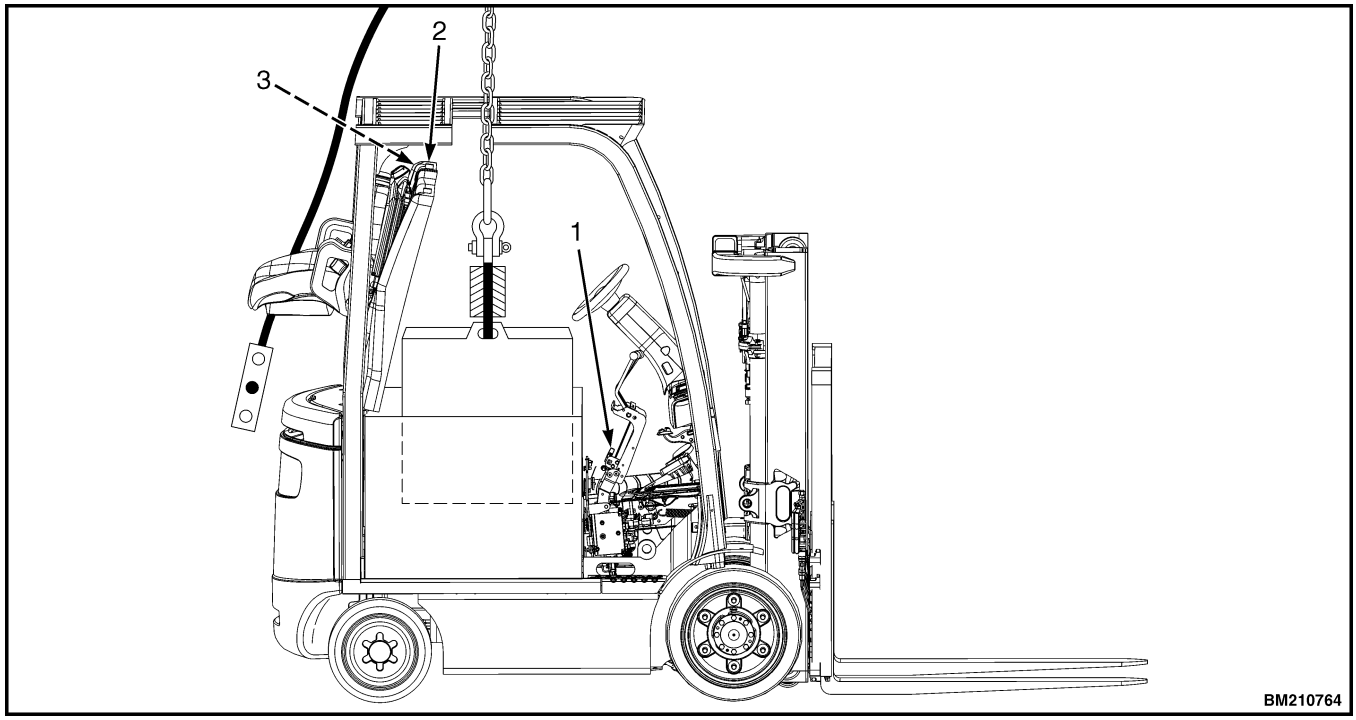
A. RELEASE DIRECTION
B. FRONT VIEW
C. BOTTOM VIEW

1. LATCH ASSEMBLY
2. HOOD
3. HOOD RELEASE LEVER
4. GAS SPRING
5. HOOD HINGE
6. BATTERY STOPPER

Figure 66. Hood and Hood Latch Components, Lift Trucks Manufactured After June, 2012

4. Disconnect the battery connector and move it to a position where it will not be damaged during battery removal. If lift truck is equipped with side panels, remove them.

5. If lift truck is equipped with a standard battery removal system, use a spreader bar and crane to lift the battery from the lift truck. See Figure 67.



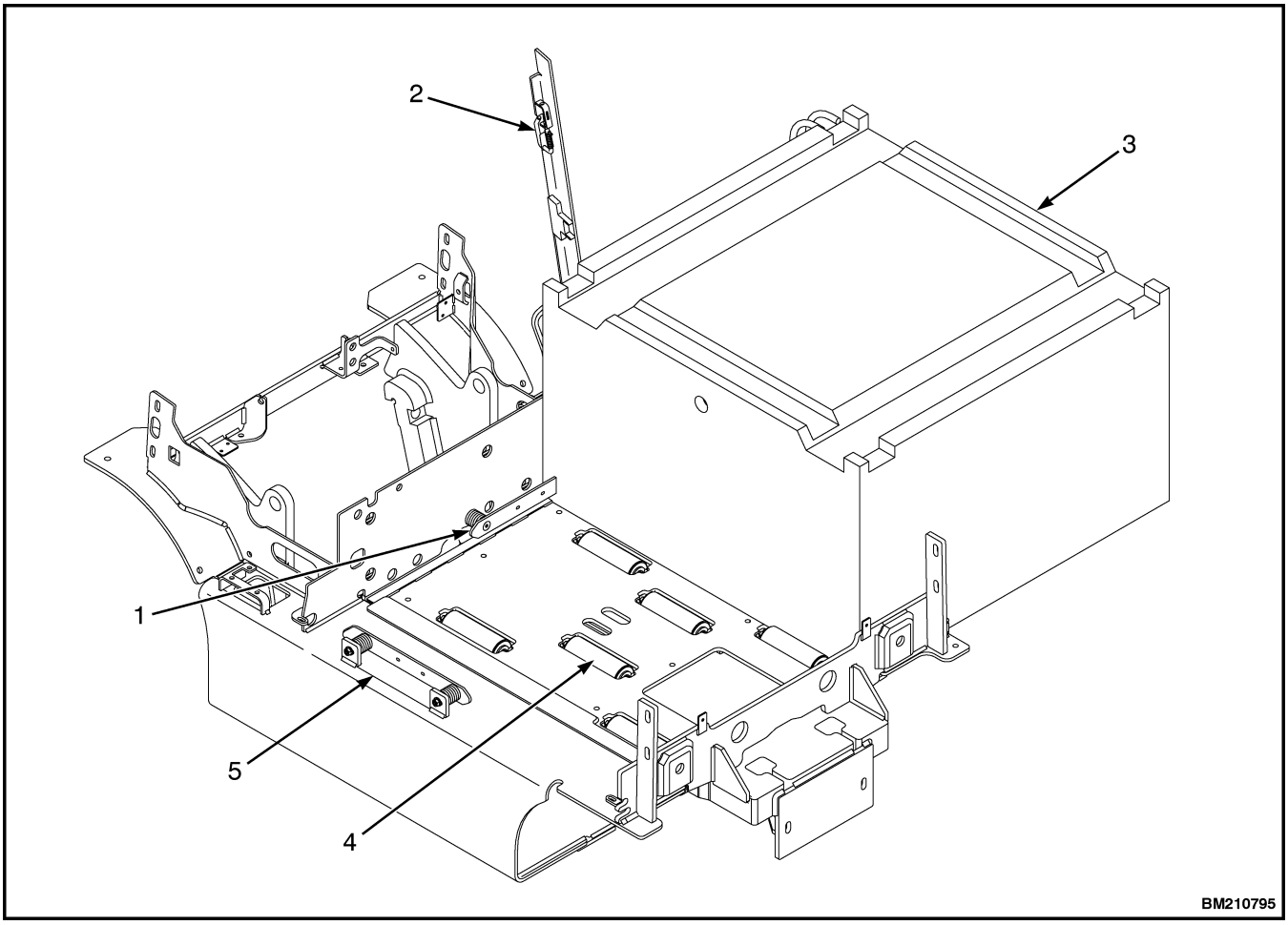
1. CONTROL LEVERS RELEASE HANDLE
2. LATCH STRIKER
3. SEAT ADJUSTMENT HANDLE

Figure 67. Battery Removal, Standard Battery Removal System

WARNING

Be sure that any platform used to slide the battery onto can support the weight of the battery. See the Nameplate for battery weight. Serious injury to personnel and damage to the lift truck and battery can result if the platform cannot support the weight of the battery.

6. If lift truck is equipped with an optional side battery removal system with side rollers, unlatch the battery gate in the back and lift to the up position and slide the battery out of the battery compartment onto a suitable platform that can support the weight of the battery. See Figure 68.



1. FRONT SPACER PLATE
2. BATTERY GATE
3. BATTERY
4. SIDE ROLLER
5. SIDE SPACER PLATE

Figure 68. Battery Removal, Optional Side Battery Removal System

Install the Battery

WARNING

Correct operation of the battery restraint system requires that the battery does not move more than 13 mm (0.50 in.). Make sure the battery spacer plates are correctly adjusted. Serious injury to personnel can occur if battery spacer plates are not adjusted correctly.

1. When a replacement battery is installed, make sure the battery fits the battery compartment width with a maximum of 13 mm (0.50 in.) clearance in both side-to-side and fore-aft direction. See Figure 69.

   If lift truck is equipped with a standard battery restraint system, use a spreader bar and crane and install battery into lift truck. See Figure 67.

2. If lift truck is equipped with an optional battery restraint system with side rollers, slide the battery off of the support platform and onto the rollers that are in the battery compartment. Close the battery gate. See Figure 68.

3. Adjust the front spacer plate by adding or removing spacers to prevent the battery from moving more than a total of 13 mm (0.50 in.) forward or backward. There must be enough clearance for battery removal.

4. If lift truck is equipped with optional side battery removal system with side rollers, adjust the side spacer plate by adding or removing spacers to prevent the battery from moving more than a total of 13 mm (0.50 in.) side to side. There must be enough clearance for battery removal.

5. Connect the battery connector.

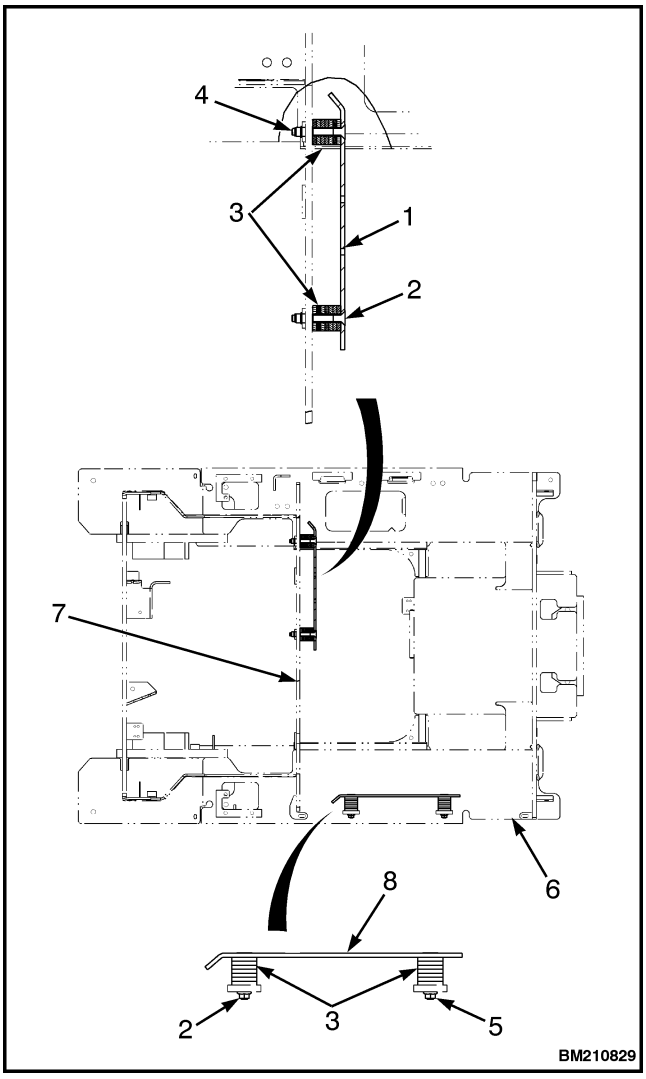
6. Install the side panels.

NOTE: The hood must be closed to engage the latch.

7. To close hood, pull down on the hood until the latch clicks. Try to lift the hood to make sure hood is fastened correctly. Slide seat to desired position.

8. If lift truck is equipped with E-Hydraulic mini-levers, adjust the armrest if it was moved prior to raising the hood.

If lift truck is equipped with manual hydraulic control levers, pull release lever out and move the control level assembly into position over the hood. Release the release lever to lock control lever assembly into place. See Figure 64.



1. FRONT SPACER PLATE
2. CAPSCREW
3. SPACER
4. INSERT
5. NUT
6. FRAME
7. FRONT BULKHEAD
8. SIDE SPACER PLATE

Figure 69. Battery Compartment Spacer Plate

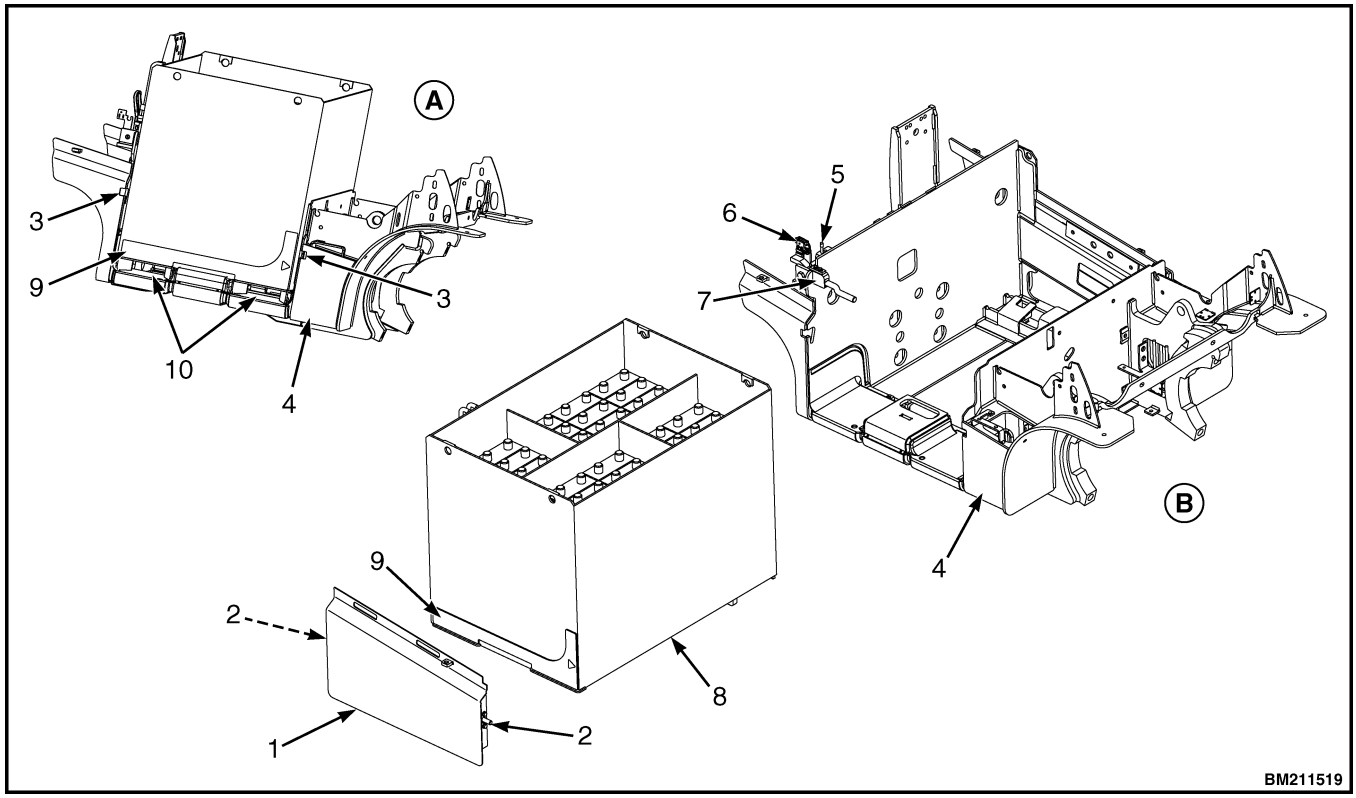
How to Change Batteries, Forklift Removal System

WARNING

To avoid injury and to prevent damage to battery and lift truck, be sure that any lift truck used to remove the battery from another lift truck has enough lifting capacity to safely remove the battery. See the Nameplate for lifting capacity.

1. Follow steps below for battery removal:

1. Before removing the battery, the hood must be raised to the full upright position. See the procedure outlined in How to Change Batteries.
2. Disconnect the battery connector and move it to a position where it will not be damaged during battery remove/install.
3. If lift truck is equipped with hinged battery door, ensure steer wheels of the battery replacement lift truck are straight and centered to avoid contact with the hinged battery door.
4. Remove the battery gate by lifting until the bracket rods slide sideways through the notches in the frame channel. See Figure 70.
5. If lift truck is equipped with hinged battery door, open hinged door by lifting up on door release lever and opening battery door. See Figure 71.
6. Swing hinged battery door as far as possible (150°) until it locks in open position.
7. Slide the lever by pushing the pin, and rotate battery retention plate to the **UP** position.
8. Ensure forks of lift truck are spaced to insert into fork pockets. See Figure 70.
9. If the forks are longer than 1000 mm (39.4 in.), remove the forward fork stop following steps below:
    1. Remove the battery from the tray using a crane and spreader bar.
    2. Raise or turn tray upside down.
    3. Remove nut, washer, bolt, and forward fork stop. See Figure 72.
    4. Lower or turn tray right side up.
    5. Install the battery in the tray.
10. Insert forks until the end rests against the fork stop. See Figure 72.
11. Raise the forks approximately 120 mm (4.72 in.) to clear the frame.
12. Tilt mast back to ensure battery is level.
13. Reverse lift truck until tray is clear of the battery compartment.
14. Lower tray with battery so that the support plates are on the ground. See Figure 72.
15. Lower forks and move lift truck forward until the battery is positioned against the face of the forks.
16. Lift forks and transport tray with battery to battery charging/ storage area.
17. Lower tray with battery so that the support plates are on the ground. See Figure 72.



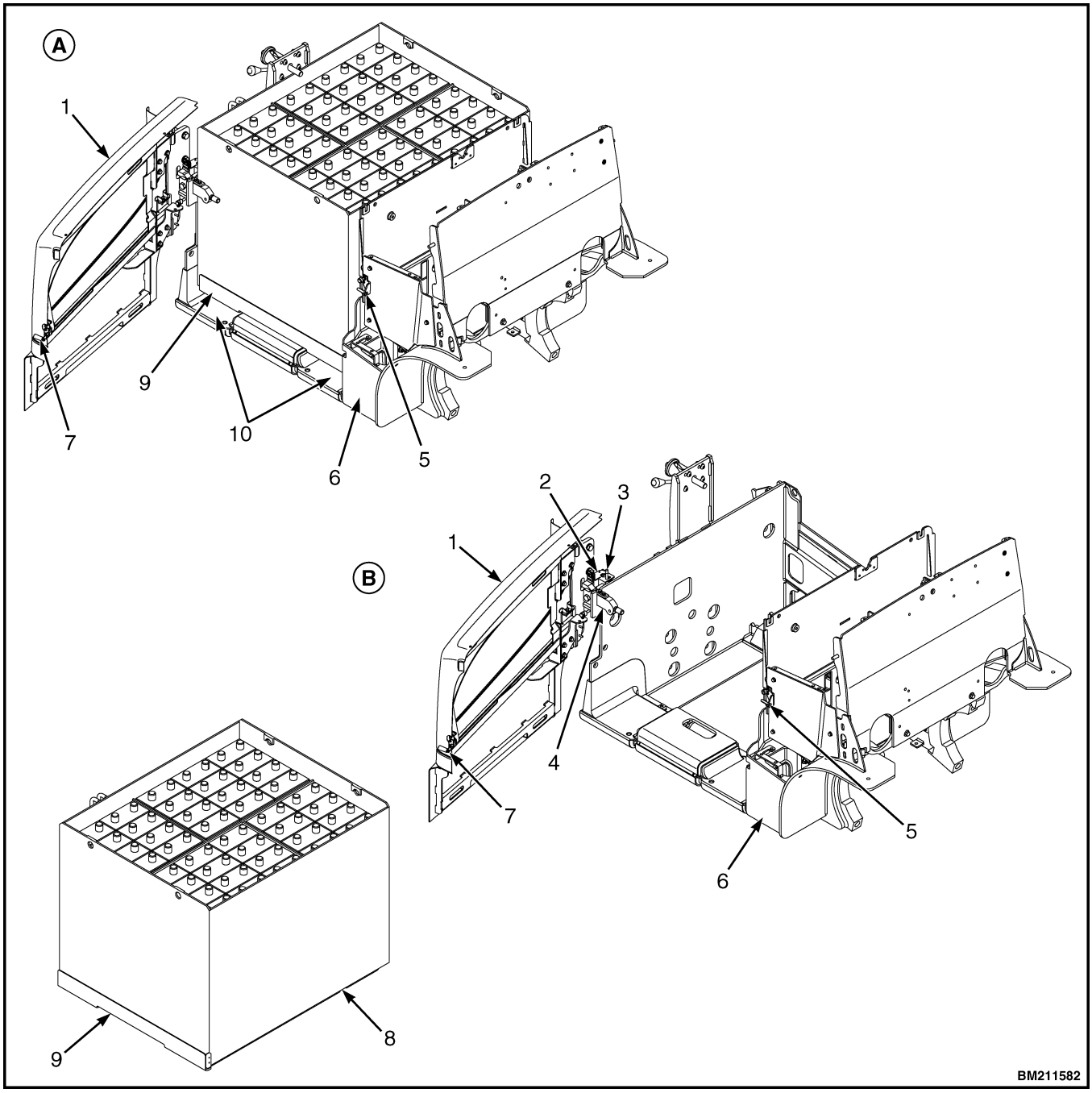
NOTE: LIFT TRUCK WITH EARLY BATTERY RETENTION PLATE SHOWN. LATE BATTERY RETENTION PLATE SIMILAR.

A. BATTERY LOADED

B. BATTERY UNLOADED

1. BATTERY GATE
2. BRACKET ROD
3. NOTCH
4. RIGHT FRAME CHANNEL
5. PIN
6. LEVER
7. BATTERY RETENTION PLATE
8. BATTERY TRAY, FORK REMOVAL
9. BATTERY
10. FORK POCKETS

Figure 70. Battery Fork Removal with Lift Out Battery Door



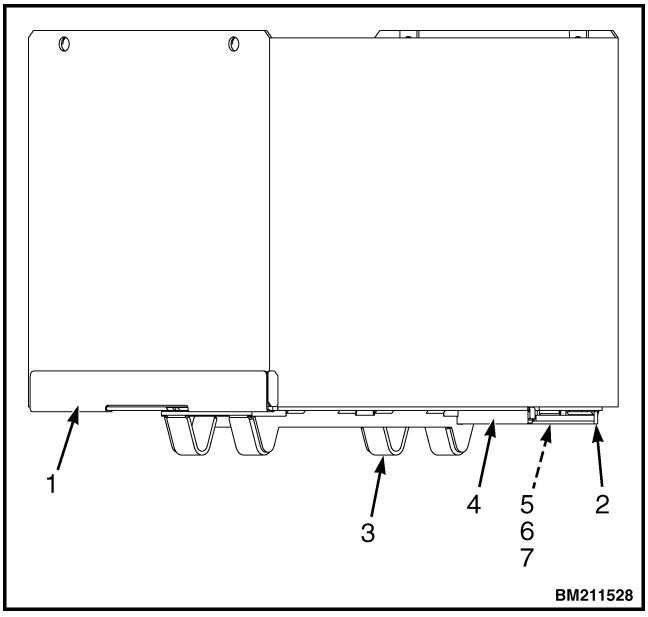
A. BATTERY LOADED

1. HINGED BATTERY DOOR
2. PIN
3. LEVER
4. BATTERY RETENTION PLATE
5. LATCH

B. BATTERY UNLOADED

6. RIGHT FRAME CHANNEL
7. RELEASE LEVER
8. BATTERY
9. BATTERY TRAY, FORK REMOVAL
10. FORK POCKETS

Figure 71. Battery Fork Removal with Hinged Battery Door



1. TRAY
2. FORK STOP
3. SUPPORT PLATES
4. FORWARD FORK STOP
5. NUT
6. WASHER
7. BOLT

Figure 72. Forklift Battery Tray

2. Follow steps below for battery installation:

1. Ensure steer wheels of the battery replacement lift truck are straight and centered to avoid contact with the hinged battery door.
2. Open the hinged door as wide as possible (150 degrees).
3. Using lift truck raise tray with battery from the ground. Make sure battery is positioned against face of forks.
4. Transport tray with battery to lift truck requiring battery installation.
5. Set tray with battery on the ground and reverse lift truck until forks clear forward fork stop or fork stop.
6. Raise forks slightly and pull forward until forks hit fork stop or forward fork stop.
7. Lift tray, make sure forks are centered in fork pockets and tray with battery centered in compartment. Ensure battery is level.
8. Move lift truck forward, place tray in compartment, lower battery and reverse lift truck out of the way.
9. Connect battery connector.
10. Secure battery retention mechanism.
11. Install battery gate.
12. If lift truck is equipped with hinged battery door, push hinged battery door to release tension on door spring and then close and latch hinged battery door.

Lift and Tilt System Leak Check

LIFT CYLINDERS LEAK CHECK

WARNING

Never allow any person under a raised carriage. Do not put any part of your body in or through the lift mechanism unless all parts of the mast are completely lowered, the key is in the OFF position, and the key is removed.

Before making any repairs, use chains on the mast weldments and carriage so that they cannot move. Make sure the moving parts are attached to the parts that cannot move.

DO NOT try to find hydraulic leaks by putting your hand on hydraulic components under pressure.

Hydraulic oil can be injected into the body by pressure.

During test procedures for the hydraulic system, fasten the load to the carriage with chains to prevent it from falling. Keep all personnel away from the lift truck during the tests.

1. Operate the hydraulic system. Put a capacity load on the forks and raise and lower the load several times. Lower the load and tilt the mast forward and backward several times. Check for leaks.

2. Raise the carriage and load so that the rods of the main lift cylinders extend at least 60 cm (2 ft). If the carriage lowers slowly with the control valve in the NEUTRAL position, there are leaks inside the hydraulic system. The maximum speed that the carriage is allowed to lower is 50 mm (2 in.) per 10 minutes when the hydraulic oil is 30°C (86°F). If the oil temperature is 70°C (160°F), the maximum speed that the carriage can lower is 150 mm (6 in.) per 10 minutes.

3. If the leak rate is greater than the above specifications, check the lift cylinders for internal leaks. Remove the load from the forks. Install a gate valve in the supply line between the main control valve and the mast. Put a capacity load on the forks again. Raise the carriage and load so that the rods of the main lift cylinders extend at least 0.60 m (2 ft). Close the gate valve. If the carriage or mast weldments lower slowly, the seals in the lift cylinders are worn.

4. If the carriage and mast weldments do not move, open the gate valve and check for movement again. If the carriage lowers when the gate valve is open, check for leaks in the hydraulic lines or fittings. If no leaks are found, the main control valve may have a defect. See the service manual section **Main Control Valves** 2000SRM1334 for procedures to repair the main control valve, or the **Parts Manual** to replace the main control valve. Remove the load from the forks.

TILT CYLINDER LEAK CHECK

To check the tilt system for hydraulic leaks, see the service manual section **Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564)** 2100SRM1382 for the procedures.

Lift Chain Adjustments

WARNING

When working on or near the mast, see Safety Procedures When Working Near Mast in this section.

Never allow anyone under a raised carriage. DO NOT put any part of your body in or through the lift mechanism unless all parts of the mast are completely lowered and the power is OFF.

DO NOT try to find hydraulic leaks by putting your hand on hydraulic components under pressure. Hydraulic oil can be injected into the body by the pressure.

During test procedures for the hydraulic system, fasten the load to the carriage with chains to prevent it from falling. Keep all personnel away from the lift truck during the tests.

When the lift chains are correctly adjusted:

- The tension will be the same on each chain of the chain set. Check tension by pushing on both chains at the same time.
- The chain length will be correct.
- The chains must travel freely through the complete cycle.

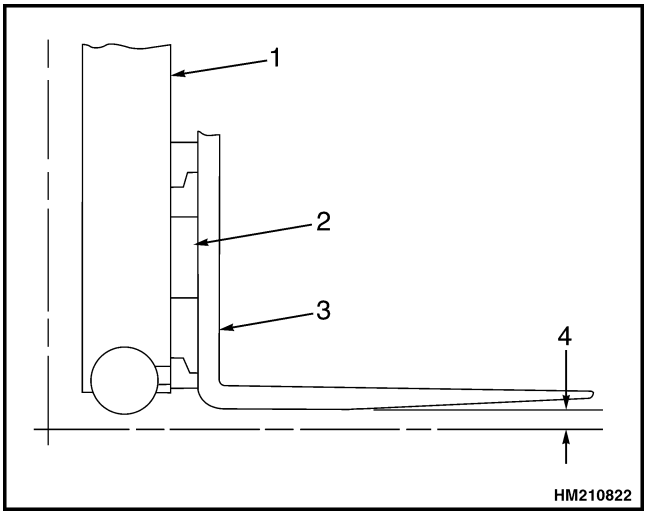
NOTE: When the lift chain adjustments are complete, make sure the threads on the nuts of the chain anchors are completely engaged. Inspect the torque of the prevailing torque nut (locknut) used to adjust the chain anchor with every lift chain adjustment. After carriage and or mast section(s) are adjusted for proper ground clearance, prevent the carriage and or mast section(s) from fully lowering (see Safety Procedures When Working Near Mast). With slack chain(s), check locknut torque. If 2.5 N•m (22.1 lbf in) for ½-20, 4.5 N•m (39.8 lbf in) for 5/8-18 nuts, 6.0 N•m (53.1 lbf in) for 3/4-16 of torque cannot be reached; replace locknut. The chain anchors, after adjustment, must be able to move on their mountings.

1. When adjusting lift chains on forklift trucks equipped with either pin- or hook-type forks installed, go to Step 2. If forklift truck is normally equipped with a hook-type carriage and has an attachment without forks, go to Step 3.

NOTE: Prior to performing adjustment procedures, make sure the forklift truck is parked on a level surface and the mast is in the vertical position.

2. Adjust chain anchors which support the carriage until the bottom of the fork heel is 12 +3.0/−6.0 mm (0.47 +0.12/−0.24 in.) above floor level. See Figure 73.

3. Adjust chain anchors which support the carriage until the bottom of the lower carriage bar is above the floor level as shown in Table 2. See Figure 74.

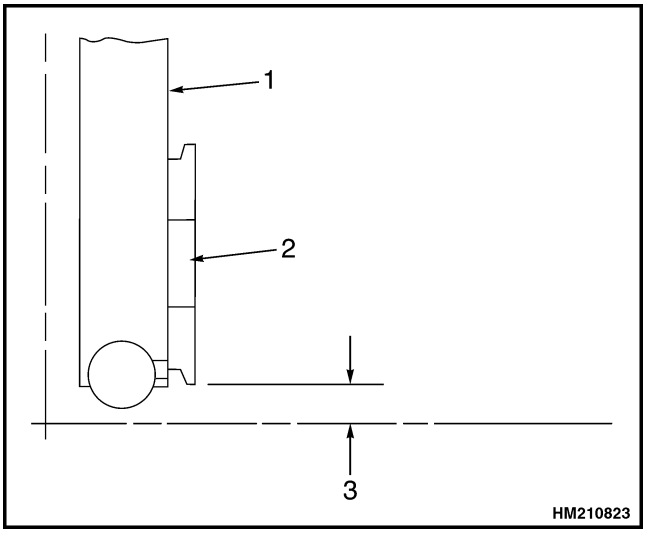


1. MAST
2. CARRIAGE
3. FORK
4. HEEL OF FORK IS 12 +3.0/−6.0 mm (0.47 +0.12/−0.24 in.) ABOVE FLOOR LEVEL.

Figure 73. Lift Chain Adjustment, Hook- or Pin-Type Forks

Table 2. Hook-Type Carriage Chain Adjustment

Class II and III	82.5 ±3 mm (3.25 ±0.12 in.)
Class IV	133.5 ±3 mm (5.26 ±0.12 in.)



1. MAST
2. CARRIAGE
3. DISTANCE FROM FLOOR TO LOWER CARRIAGE BAR

Figure 74. Lift Chain Adjustment, Hook-Type Carriage

Welding Repairs

WARNING

Welding can cause a fire or an explosion. Always follow the instructions in the Frame section of the Service Manual if a hydraulic tank must be welded. Make sure there is no fuel, oil, or grease near the weld area. Make sure there is good ventilation in the area where the welding must be done.

DO NOT heat, weld, or bend forks. Forks are made of special steel using special methods. Get information from your dealer for Hyster lift trucks before welding on a mast.

WARNING

Forklift frames and components may be painted with a catalyzed paint, such as polyurethane or a two-part primer. Welding, burning, or other heat sufficient to cause thermal decomposition of the paint may release isocyanates. These chemicals are allergic sensitizers to the skin and respiratory tract and overexposure may occur without odor warning. Should work be performed, utilize good industrial hygiene practices including removal of all paint (prime and finish coats) to the metal around the area to be welded, local ventilation, and/or supplied-air respiratory protection.

CAUTION

When an arc welder is used, always disconnect the battery connector on the lift truck. This action will prevent damage to the motor controllers.

Connect the ground clamp for the arc welder as close as possible to the weld area. This action will prevent damage to a bearing from the large current from the welder.

NOTE: Remove all electronic controllers prior to arc welding on these lift trucks. The removal procedures for the electronic controllers are outlined in **Electrical System** 2200SRM1369.

All welding repairs require special welding instructions and to get information from your dealer for Hyster lift trucks before welding on truck. If an acetylene or arc welder is used, do the procedures in the previous **WARNING** and **CAUTION**.

Overhead Guard Changes

WARNING

Do not operate the lift truck without the overhead guard correctly fastened to the lift truck.

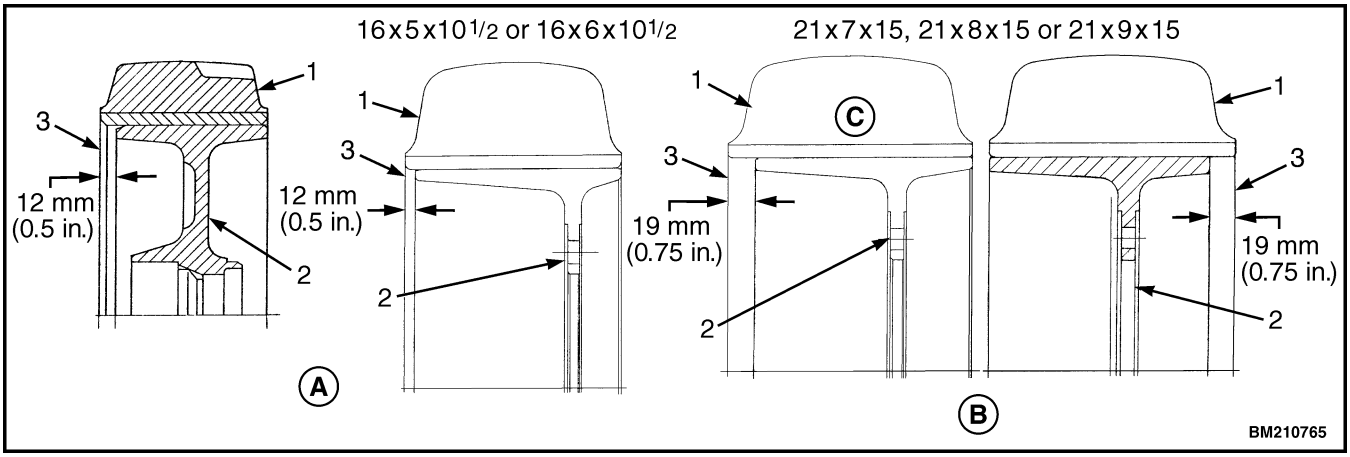
Do not make changes to the overhead guard by welding or drilling. Welding or drilling holes that are too big in the wrong location can reduce the strength of the overhead guard. See your dealer for Hyster lift trucks before making any changes to the overhead guard.

Observe previous **WARNING** before doing any changes to overhead guard.

Wheels and Tires

General

The lift trucks covered in this **Service Manual** are equipped with solid rubber tires (often called cushion tires) that are pressed onto the rim. See Figure 75.



A. STEERING TIRES AND WHEELS
B. DRIVE TIRES AND WHEELS
C. WIDE TREAD

1. OUTSIDE OF SOLID RUBBER TIRE
2. WHEEL
3. OVERHANG

Figure 75. Wheel and Tires

Remove Wheels From Lift Truck

WARNING

The type of tire is shown on the Nameplate. Make sure the Nameplate is correct for the type of tires on the lift truck.

Wheels must be changed and tires repaired by trained personnel only.

Always wear safety glasses.

Lift truck tires and wheels are very heavy. Use caution when removing or installing tires and wheels or personal injury may occur.

NOTE: Solid rubber tires made from softer or harder material can be installed as optional equipment. The tread on solid rubber tires can be either smooth or it can have lugs. DO NOT mix types of tires or tread on lift truck.

1. Raise the lift truck as described in How to Put Lift Truck on Blocks in General section of this manual.

2. Remove the wheel nuts and remove the wheel from the lift truck. Lift truck wheels are heavy.

Remove and Install Tire on Wheel

NOTE: Make sure the tires are installed on the wheels so that the outside edges of the tire and wheel are as shown in Figure 75. Also check the Nameplate of the lift truck for the correct tire size and tread width.

1. The correct tools, equipment, and a press ring must be used for each size of wheel. Use a press to push the wheel from the rim and tire. The capacity of the press must be approximately 355 to 1779 kN (80,000 to 400,000 lb). For the tire sizes, see the Nameplate.

2. When the drive wheels are installed on the lift truck, tighten the wheel nuts to 340 to 380 N•m (251 to 280 lbf ft).

3. The steering wheels are fastened to the spindle of the steering axle with a large castle nut. Make sure the inner and outer bearings are correctly lubricated with grease. Install the inner bearing assembly and wheel on the spindle. Install the outer bearing cone and castle nut.

4. Tighten the castle nuts of the steer wheel spindles to 68 N•m (50 lbf ft) while rotating the wheel in each direction at EACH installation. Loosen castle nuts 1/4 turn. Pull and push at top of wheel to check for movement (end play). If there is movement, tighten castle nut to 3 N•m (27 lbf in).

5. Install cotter pins at the nearest alignment positions. If cotter pin cannot be installed, tighten the castle nut to the first position where the cotter pin can be installed. Install caps for bearings. Additional torque checks are not required.

Adhesives and Sealants

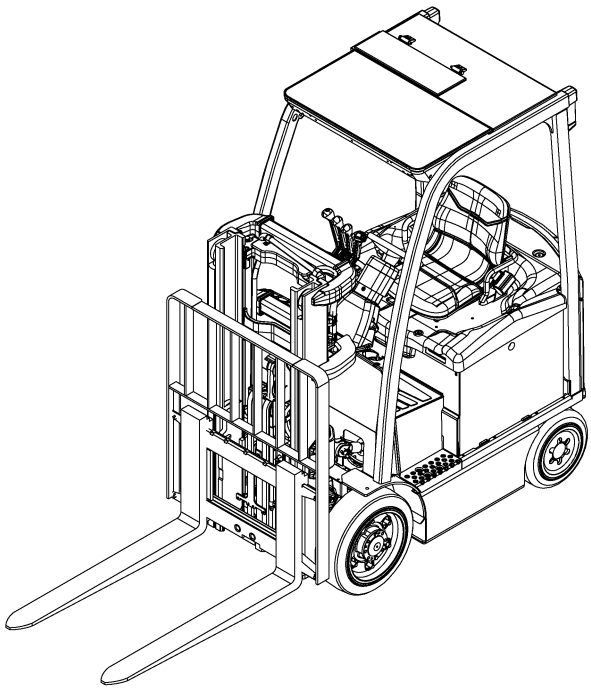
Hyster Part No.	Loctite® Part No.	Description	Size
360387	222	Small Screw Threadlock (Purple)	50 ml (1.7 oz)
318702*	242	Removable Threadlock (Blue)	10 ml (0.34 oz)
226414*	271	High Strength Threadlock (Red)	10 ml (0.34 oz)
318996	277	High Viscosity Threadlock (Red)	50 ml (1.7 oz)
318650	290	Low Viscosity Threadlock (Green)	0.6 ml (0.02 oz)
251099	290	Low Viscosity Threadlock (Green)	50 ml (1.7 oz)
355844*	422	SuperBonder® Adhesive	3 ml (0.1 oz)
350830	515	Gasket Eliminator (Purple)	6 ml (0.2 oz)
313022*	515	Gasket Eliminator (Purple)	50 ml (1.7 oz)
273338*	567	Pipe Sealant with Teflon® (White)	50 ml (1.7 oz)
318705	595	Super Flex® Silicone	100 ml (3.4 oz)
318701*	609	Retaining Compound	10 ml (0.34 oz)
341959	680	Retaining Compound	50 ml (1.7 oz)
226415		Primer T - Aerosol	177 ml (6 oz)
316865		Antiseize Compound	476 ml (16 oz)
360053		Chisel Gasket Remover (10 Aerosol cans per case)	536 ml (18 oz)
318700*		Adhesive & Sealant Kit (Contains one each of * items)	

Loctite®, Super Flex®, and SuperBonder® are registered trademarks of the Loctite Corporation. Teflon® is a registered trademark of Du Pont de Nemours Co. Inc.

NOTES

CAPACITIES AND SPECIFICATIONS

E2.2-3.5XN (E45-70XN) [A268]



HYSTER

PART NO. 1688883

8000 SRM 1374

SAFETY PRECAUTIONS
MAINTENANCE AND REPAIR

- The Service Manuals are updated on a regular basis, but may not reflect recent design changes to the product. Updated technical service information may be available from your local authorized Hyster® dealer. Service Manuals provide general guidelines for maintenance and service and are intended for use by trained and experienced technicians. Failure to properly maintain equipment or to follow instructions contained in the Service Manual could result in damage to the products, personal injury, property damage or death.
- When lifting parts or assemblies, make sure all slings, chains, or cables are correctly fastened, and that the load being lifted is balanced. Make sure the crane, cables, and chains have the capacity to support the weight of the load.
- Do not lift heavy parts by hand, use a lifting mechanism.
- Wear safety glasses.
- DISCONNECT THE BATTERY CONNECTOR before doing any maintenance or repair on electric lift trucks. Disconnect the battery ground cable on internal combustion lift trucks.
- Always use correct blocks to prevent the unit from rolling or falling. See HOW TO PUT THE LIFT TRUCK ON BLOCKS in the **Operating Manual** or the **Periodic Maintenance** section.
- Keep the unit clean and the working area clean and orderly.
- Use the correct tools for the job.
- Keep the tools clean and in good condition.
- Always use **HYSTER APPROVED** parts when making repairs. Replacement parts must meet or exceed the specifications of the original equipment manufacturer.
- Make sure all nuts, bolts, snap rings, and other fastening devices are removed before using force to remove parts.
- Always fasten a DO NOT OPERATE tag to the controls of the unit when making repairs, or if the unit needs repairs.
- Be sure to follow the **WARNING** and **CAUTION** notes in the instructions.
- Gasoline, Liquid Petroleum Gas (LPG), Compressed Natural Gas (CNG), and Diesel fuel are flammable. Be sure to follow the necessary safety precautions when handling these fuels and when working on these fuel systems.
- Batteries generate flammable gas when they are being charged. Keep fire and sparks away from the area. Make sure the area is well ventilated.

NOTE: The following symbols and words indicate safety information in this manual:

WARNING

Indicates a hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION

Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury and property damage.

On the lift truck, the WARNING symbol and word are on orange background. The CAUTION symbol and word are on yellow background.

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This section is for the following models:

E2.2-3.5XN (E45-70XN) [A268]

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"THE QUALITY KEEPERS"

HYSTER APPROVED PARTS

Counterweights

Model	* mm (* in.)	Weight
*Approximate battery compartment lengths (identifies frame size).		
E2.2XN (E45XN)	786 mm (31 in.)	571 kg (1259 lb)
E2.2XN (E45XN) and E2.5XN (E50XN)	847 mm (33 in.)	
E2.2XN (E45XN)	700 mm (28 in.)	764 kg (1684 lb)
E2.5XN (E50XN)	786 mm (31 in.)	
E2.75XN (E55XN)	847 mm (33 in.)	
E3.2XN (E65XN)	1015 mm (40 in.)	
E2.5XN (E50XN)	700 mm (28 in.)	948 kg (2090 lb)
E3.0XN (E60XN)	847 mm (33 in.)	
E3.2XN (E65XN)	933 mm (37 in.)	
E3.5XN (E70XN)	1015 mm (40 in.)	

Hydraulic System

Table 1. Manual Hydraulic Control Valve

Item	Specification
Relief Valve Pressure Oil Temperature	50 to 65°C (122 to 149°F)
Relief Valve Pressure E2.2-2.75XN (E45-55XN)	
Primary at Pump Pressure Gauge Port	21.9 ±0.48 MPa (3177.3 ±69.6 psi)
Relief Valve Pressure E3.0-3.5XN (E60-70XN)	
Primary at Pump Pressure Gauge Port	23.9 ±0.48 MPa (3466.4 ±69.6 psi)
Relief Valve Pressure E2.2-3.5XN (E45-70XN)	
Secondary at tilt or auxiliary port	15.5 ±0.48 MPa (2248.1 ±69.6 psi)
Secondary at Pump Pressure Gauge Port	16.5 ±0.48 MPa (2398 ±69.6 psi)

Table 2. E-Hydraulic Control Valve

Item	Specification
Relief Valve Pressure Oil Temperature	50 to 65°C (122 to 149°F)
Relief Valve Pressure E2.2-2.75XN (E45-55XN)	
Primary at Pump Pressure Gauge Port	21.9 ±0.48 MPa (3177.3 ±69.6 psi)
Relief Valve Pressure E3.0-3.5XN (E60-70XN)	
Primary at Pump Pressure Gauge Port	23.9 ±0.48 MPa (3466.4 ±69.6 psi)
Relief Valve Pressure E2.2-3.5XN (E45-70XN)	
Secondary at tilt or auxiliary port	15.5 ±0.48 MPa (2248.1 ±69.6 psi)
Secondary at Pump Pressure Gauge Port	16.5 ±0.48 MPa (2398 ±69.6 psi)

Steering System

SPECIFICATIONS

Item	Specification
Steering Oil Temperature	50 to 65°C (122 to 149°F)
Inside Tire angle	82°
Number of Turns on Steer Wheel	4.2
Steer Relief Pressure at Pressure Line of SCU	11.0 ±0.3 MPa (1595.4 ±43.5 psi)
Steering Cylinder Stroke	169.2 mm (6.6 in.)
Steering Time at Idle	3.0 sec

TURNING RADIUS

Model	Turning Radius
700 mm (28 in.) Battery Compartment	
E2.2XN (E45XN)	1735 mm (68 in.)
E2.5XN (E50XN)	1757 mm (69 in.)
786 mm (31 in.) Battery Compartment	
E2.2XN (E45XN)	1825 mm (72 in.)
E2.5XN (E50XN)	1825 mm (72 in.)
847 mm (33 in.) Battery Compartment	
E2.2XN (E45XN)	1884 mm (74 in.)
E2.5XN (E50XN)	1884 mm (74 in.)
E2.75XN (E55XN)	1893 mm (75 in.)
E3.0XN (E60XN)	1915 mm (75 in.)

Model	Turning Radius
933 mm (37 in.) Battery Compartment	
E3.2XN (E65XN)	2008 mm (79 in.)
1015 mm (40 in.) Battery Compartment	
E3.2XN (E65XN)	2074 mm (82 in.)
E3.5XN (E70XN)	2094 mm (82 in.)

Wheels and Tires

Item	Specification
Torque - Wheel Nuts, Drive Tires	340 to 380 N•m (251 to 280 lbf ft)
Torque - Steering Wheel Bearing Nut**	
Initial Torque	68 N•m (50 lbf ft)
Final Torque	3 N•m (27 lbf in)
Drive Tires*	
E2.2-2.75XN (E45-55XN)	21 × 7 × 15
E3.0-3.2XN (E60-65XN)	21 × 8 × 15
E3.5XN (E70XN)	21 × 9 × 15
Steer Tires*	
E2.2-2.75XN (E45-55XN)	16 × 5 × 10.5
E3.0-3.2XN (E60-65XN)	16 × 6 × 10.5
E3.5XN (E70XN)	16 × 7 × 10.5
*Smooth, lug tread; standard, and non-marking, compound	
See **Steering Axle 1600SRM1360 for correct procedure.	

Battery Specifications

Table 3. Model TrucksE2.2-3.5XN (E45-70XN) (A268)

Model	Minimum Compartment Size Length × Width	Battery Size Min/Max		Weight		Maximum Battery Height
		Length	Width	Minimum	Maximum	
E2.2XN-E2.5XN (E45 XN-E50XN)	695 x 987 mm (27.4 x 38.9 in.)	681 to 691 mm (26.8 to 27.2 in.)	978 to 983 mm (38.5 to 38.7 in.)	1050 kg (2314 lb)	1500 kg (3307 lb)	585 mm (23.0 in.)
E45XN-E50XN	781 x 987 mm (30.7 x 38.9 in.)	739/777 mm (29.1/30.6 in.)	978/983 mm (38.5/38.7 in.)	1150 kg (2535 lb)	1600 kg (3527 lb)	585 mm (23.0 in.)
E2.2XN-E3.0XN (E45 XN-E60XN)	842 x 987 mm (33.1 x 38.9 in.)	800/838 mm (31.5/32.9 in.)	978/983 mm (38.5/38.7 in.)	1317 kg (2903 lb)	1771 kg (3904 lb)	585 mm (23.0 in.)
E65XN	928 x 987 mm (36.5 x 38.9 in.)	900/924 mm (35.4/36.4 in.)	978/983 mm (38.5/38.7 in.)	1410 kg (3108 lb)	1860 kg (4100 lb)	585 mm (23.0 in.)
E3.2-3.5XN (E70XN)	1010 x 987 mm (39.8 x 38.9 in.)	1001/1006 mm (39.4/39.6 in.)	978/983 mm (38.5/38.7 in.)	1550 kg (3417 lb)	2000 kg (4409 lb)	585 mm (23.0 in.)

NOTE: Tolerances of the battery compartment are +3 and −0 mm (+0.12 and −0 in.). The battery size column shows the size range that will permit the battery to still fit into a battery compartment.

NOTE: Battery compartment length is front to back. Width is side to side. The "length" dimension of the battery must fit within the battery compartment front-to-back dimension with a clearance of 0 to 13 mm (0 to 0.5 in.) maximum. Battery width must fit within the battery compartment side-to-side dimension.

WARNING

The battery must fit the battery compartment so that the battery restraint system will operate correctly. Use only batteries with the correct length shown in this table. Adjust the spacer plate to prevent the battery from moving more than 13 mm (0.5 in.) forward or backward.

Capacities

Item	Specification
Hydraulic System (Full Mark on Dipstick)*	
Drain and Refill	29.7 liter (31.4 qt)
Usable Oil	20.8 liter (22.0 qt)
Differential/Speed Reducer	
E2.2-3.5XN (E45-70XN)	4.8 liter (5.1 qt)
Brake Fluid	
E2.2-3.5XN (E45-70XN)	0.18 liter (0.4 pt)
Hydraulic Pump**	
Displacement	22.0 cm^3/rev (1.34 $in.^3$/rev)
System Relief Pressure	20.6 MPa (2987.8 psi)
Max Peak Pressure	24.5 MPa (3553.4 psi)
Speed	300 to 3000 RPM
Inlet Pressure	−20 to +49 kPa (−3 to +7 psi)
*Check after all air is removed from the system and with the mast fully lowered. **Oil temperature at 80 to 100°C (176 to 212°F)	

Tilt Angles

Tilt Angles: Measure with lift truck on level ground and in unloaded condition.

Forward	Tolerance (Ref)	Back	Tolerance
10°	+1°, −0.5°	5°	+0°, −0.5°
5°	+1°, −0.5°	5°	+0°, −0.5°
5°	+1°, −0.5°	4°	+0°, −0.5°

NOTE: With reference to mast mounting assembly drawings, section B-B dimension "X" must not exceed 20 mm (0.8 in.) in all rod end configurations.

Back tilt tolerance must be obtained for all rod end configurations.

In some truck/tire configurations, some rod end configurations may not achieve the "ref only" forward tilt tolerance. But forward tilt is still satisfactory.

Maximum Carriage and Tilt Creep Rates

Hydraulic Oil Temperature/Mast Tilt Rate							
Lift Truck Model	Hydraulic Oil Temperature		Maximum Vertical Creep at Carriage		Maximum Tilt Creep		
					Mast Angle	Cylinder Stroke	
	°C	°F	mm/min	in./min	Deg/Min	mm/min	in./min
All Models	20	68	2.2	0.086	0.10	0.88	0.035
	30	86	3.3	0.130	0.15	1.32	0.05
	40	104	6.3	0.247	0.29	2.56	0.10
	50	122	10.0	0.394	0.47	4.14	0.16
	60	140	14.6	0.575	0.68	5.99	0.24

Mast Speeds

Table 4. Lift/Lower Speed, Standard Performance, 36 Volts

Model	Mast	Lowering Speed m/sec (ft/sec)		Lifting Speed m/sec (ft/sec)	
		No Load	Rated Load	No Load	Rated Load
E2.2XN (E45XN)	Two-Stage LFL	0.51 m (1.67 ft)	0.57 m (1.87 ft)	0.51 m (1.67 ft)	0.30 m (0.98 ft)
	Two-Stage FFL	0.46 m (1.51 ft)	0.52 m (1.70 ft)	0.47 m (1.54 ft)	0.30 m (0.98 ft)
	Three-Stage FFL	0.47 m (1.54 ft)	0.54 m (1.77 ft)	0.48 m (1.57 ft)	0.30 m (0.98 ft)
	Four-Stage FFL	0.39 m (1.28 ft)	0.45 m (1.48 ft)	0.49 m (1.61 ft)	0.30 m (0.98 ft)
E2.5XN (E50XN)	Two-Stage LFL	0.51 m (1.67 ft)	0.57 m (1.87 ft)	0.51 m (1.67 ft)	0.28 m (0.92 ft)
	Two-Stage FFL	0.46 m (1.51 ft)	0.54 m (1.77 ft)	0.47 m (1.54 ft)	0.29 m (0.95 ft)
	Three-Stage FFL	0.47 m (1.54 ft)	0.55 m (1.55 ft)	0.48 m (1.57 ft)	0.29 m (0.95 ft)
	Four-Stage FFL	0.39 m (1.28 ft)	0.46 m (1.51 ft)	0.49 m (1.61 ft)	0.29 m (0.95 ft)

Table 4. Lift/Lower Speed, Standard Performance, 36 Volts (Continued)

Model	Mast	Lowering Speed m/sec (ft/sec)		Lifting Speed m/sec (ft/sec)	
		No Load	Rated Load	No Load	Rated Load
E2.75XN (E55XN)	Two-Stage LFL	0.51 m (1.67 ft)	0.58 m (1.90 ft)	0.51 m (1.67 ft)	0.27 m (0.89 ft)
	Two-Stage FFL	0.46 m (1.51 ft)	0.55 m (1.55 ft)	0.47 m (1.54 ft)	0.29 m (0.95 ft)
	Three-Stage FFL	0.47 m (1.54 ft)	0.56 m (1.84 ft)	0.48 m (1.57 ft)	0.28 m (0.92 ft)
	Four-Stage FFL	0.39 m (1.28 ft)	0.46 m (1.51 ft)	0.49 m (1.61 ft)	0.29 m (0.95 ft)
E3.0XN (E60XN)	Two-Stage LFL	0.46 m (1.51 ft)	0.56 m (1.84 ft)	0.47 m (1.54 ft)	0.25 m (0.82 ft)
	Two-Stage FFL	0.37 m (1.21 ft)	0.52 m (1.70 ft)	0.42 m (1.38 ft)	0.25 m (0.82 ft)
	Three-Stage FFL	0.40 m (1.31 ft)	0.53 m (1.74 ft)	0.43 m (1.41 ft)	0.25 m (0.82 ft)
	Four-Stage FFL	0.39 m (1.28 ft)	0.46 m (1.51 ft)	0.49 m (1.61 ft)	0.29 m (0.95 ft)
E3.2XN (E65XN)	Two-Stage LFL	0.46 m (1.51 ft)	0.56 m (1.84 ft)	0.47 m (1.54 ft)	0.24 m (0.79 ft)
	Two-Stage FFL	0.37 m (1.21 ft)	0.53 m (1.74 ft)	0.42 m (1.38 ft)	0.24 m (0.79 ft)
	Three-Stage FFL	0.40 m (1.31 ft)	0.54 m (1.77 ft)	0.43 m (1.41 ft)	0.24 m (0.79 ft)
	Four-Stage FFL	0.39 m (1.28 ft)	0.46 m (1.51 ft)	0.49 m (1.61 ft)	0.29 m (0.95 ft)
E3.5XN (E70XN)	Two-Stage LFL	0.46 m (1.51 ft)	0.58 m (1.90 ft)	0.47 m (1.54 ft)	0.23 m (0.75 ft)
	Two-Stage FFL	0.37 m (1.21 ft)	0.54 m (1.77 ft)	0.42 m (1.38 ft)	0.23 m (0.75 ft)
	Three-Stage FFL	0.40 m (1.31 ft)	0.56 m (1.84 ft)	0.43 m (1.41 ft)	0.23 m (0.75 ft)
	Four-Stage FFL	0.39 m (1.28 ft)	0.46 m (1.51 ft)	0.49 m (1.61 ft)	0.29 m (0.95 ft)

Table 5. Lift/Lower Speed, Standard Performance, 48 Volts

Model	Mast	Lowering Speed m/sec (ft/sec)		Lifting Speed m/sec (ft/sec)	
		No Load	Rated Load	No Load	Rated Load
E2.2XN (E45XN)	Two-Stage LFL	0.51 m (1.67 ft)	0.57 m (1.87 ft)	0.53 m (1.74 ft)	0.40 m (1.31 ft)
	Two-Stage FFL	0.46 m (1.51 ft)	0.52 m (1.70 ft)	0.63 m (2.10 ft)	0.41 m (1.35 ft)
	Three-Stage FFL	0.47 m (1.54 ft)	0.54 m (1.77 ft)	0.63 m (2.10 ft)	0.40 m (1.35 ft)
	Four-Stage FFL	0.39 m (1.28 ft)	0.45 m (1.48 ft)	0.63 m (2.10 ft)	0.40 m (1.35 ft)
E2.5XN (E50XN)	Two-Stage LFL	0.51 m (1.67 ft)	0.57 m (1.87 ft)	0.63 m (2.10 ft)	0.38 m (1.25 ft)
	Two-Stage FFL	0.46 m (1.51 ft)	0.54 m (1.77 ft)	0.63 m (2.10 ft)	0.39 m (1.28 ft)
	Three-Stage FFL	0.47 m (1.54 ft)	0.55 m (1.55 ft)	0.63 m (2.10 ft)	0.39 m (1.28 ft)
	Four-Stage FFL	0.39 m (1.28 ft)	0.46 m (1.51 ft)	0.63 m (2.10 ft)	0.38 m (1.25 ft)
E2.75XN (E55XN)	Two-Stage LFL	0.51 m (1.67 ft)	0.58 m (1.90 ft)	0.63 m (2.10 ft)	0.36 m (1.18 ft)
	Two-Stage FFL	0.46 m (1.51 ft)	0.55 m (1.55 ft)	0.63 m (2.10 ft)	0.38 m (1.25 ft)
	Three-Stage FFL	0.47 m (1.54 ft)	0.56 m (1.84 ft)	0.63 m (2.10 ft)	0.37 m (1.21 ft)
	Four-Stage FFL	0.39 m (1.28 ft)	0.46 m (1.51 ft)	0.63 m (2.10 ft)	0.38 m (1.25 ft)
E3.0XN (E60XN)	Two-Stage LFL	0.46 m (1.51 ft)	0.56 m (1.84 ft)	0.59 m (1.94 ft)	0.33 m (1.10 ft)
	Two-Stage FFL	0.37 m (1.21 ft)	0.52 m (1.70 ft)	0.55 m (1.80 ft)	0.33 m (1.10 ft)
	Three-Stage FFL	0.40 m (1.31 ft)	0.53 m (1.74 ft)	0.57 m (1.87 ft)	0.33 m (1.10 ft)
	Four-Stage FFL	0.39 m (1.28 ft)	0.46 m (1.51 ft)	0.63 m (2.10 ft)	0.38 m (1.25 ft)

Table 5. Lift/Lower Speed, Standard Performance, 48 Volts (Continued)

Model	Mast	Lowering Speed m/sec (ft/sec)		Lifting Speed m/sec (ft/sec)	
		No Load	Rated Load	No Load	Rated Load
E3.2XN (E65XN)	Two-Stage LFL	0.46 m (1.51 ft)	0.57 m (1.87 ft)	0.59 m (1.94 ft)	0.32 m (1.05 ft)
	Two-Stage FFL	0.37 m (1.21 ft)	0.53 m (1.74 ft)	0.55 m (1.80 ft)	0.32 m (1.05 ft)
	Three-Stage FFL	0.40 m (1.31 ft)	0.54 m (1.77 ft)	0.57 m (1.87 ft)	0.32 m (1.05 ft)
	Four-Stage FFL	0.39 m (1.28 ft)	0.46 m (1.51 ft)	0.63 m (2.10 ft)	0.38 m (1.25 ft)
E3.5XN (E70XN)	Two-Stage LFL	0.46 m (1.51 ft)	0.58 m (1.90 ft)	0.59 m (1.94 ft)	0.31 m (1.02 ft)
	Two-Stage FFL	0.37 m (1.21 ft)	0.54 m (1.77 ft)	0.55 m (1.80 ft)	0.31 m (1.02 ft)
	Three-Stage FFL	0.40 m (1.31 ft)	0.56 m (1.84 ft)	0.57 m (1.87 ft)	0.31 m (1.02 ft)
	Four-Stage FFL	0.39 m (1.28 ft)	0.46 m (1.51 ft)	0.63 m (2.10 ft)	0.38 m (1.25 ft)

Table 6. Lift/Lower Speed Enhanced Performance, 48 Volts

Model	Mast	Lowering Speed m/sec (ft/sec)		Lifting Speed m/sec (ft/sec)	
		No Load	Rated Load	No Load	Rated Load
E2.2XN (E45XN)	Two-Stage LFL	0.51 m (1.67 ft)	0.57 m (1.87 ft)	0.72 m (2.36 ft)	0.52 m (1.70 ft)
	Two-Stage FFL	0.46 m (1.51 ft)	0.52 m (1.70 ft)	0.66 m (2.17 ft)	0.50 m (1.64 ft)
	Three-Stage FFL	0.47 m (1.54 ft)	0.54 m (1.77 ft)	0.68 m (2.23 ft)	0.51 m (1.67 ft)
	Four-Stage FFL	0.39 m (1.28 ft)	0.45 m (1.48 ft)	0.69 m (2.26 ft)	0.51 m (1.67 ft)
E2.5XN (E50XN)	Two-Stage LFL	0.51 m (1.67 ft)	0.57 m (1.87 ft)	0.72 m (2.36 ft)	0.49 m (1.61 ft)
	Two-Stage FFL	0.46 m (1.51 ft)	0.54 m (1.77 ft)	0.66 m (2.17 ft)	0.47 m (1.54 ft)
	Three-Stage FFL	0.47 m (1.54 ft)	0.55 m (1.80 ft)	0.68 m (2.23 ft)	0.48 m (1.57 ft)
	Four-Stage FFL	0.39 m (1.28 ft)	0.46 m (1.51 ft)	0.69 m (2.26 ft)	0.48 m (1.57 ft)

Table 6. Lift/Lower Speed Enhanced Performance, 48 Volts (Continued)

Model	Mast	Lowering Speed m/sec (ft/sec)		Lifting Speed m/sec (ft/sec)	
		No Load	Rated Load	No Load	Rated Load
E2.75XN (E55XN)	Two-Stage LFL	0.51 m (1.67 ft)	0.58 m (1.90 ft)	0.72 m (2.36 ft)	0.47 m (1.54 ft)
	Two-Stage FFL	0.46 m (1.51 ft)	0.55 m (1.80 ft)	0.66 m (2.17 ft)	0.45 m (1.48 ft)
	Three-Stage FFL	0.47 m (1.54 ft)	0.56 m (1.84 ft)	0.68 m (2.23 ft)	0.46 m (1.51 ft)
	Four-Stage FFL	0.39 m (1.28 ft)	0.46 m (1.51 ft)	0.69 m (2.26 ft)	0.48 m (1.57 ft)
E3.0XN (E60XN)	Two-Stage LFL	0.46 m (1.51 ft)	0.56 m (1.84 ft)	0.63 m (2.10 ft)	0.42 m (1.38 ft)
	Two-Stage FFL	0.37 m (1.21 ft)	0.52 m (1.70 ft)	0.59 m (1.94 ft)	0.41 m (1.35 ft)
	Three-Stage FFL	0.40 m (1.31 ft)	0.53 m (1.74 ft)	0.60 m (1.97 ft)	0.41 m (1.35 ft)
	Four-Stage FFL	0.39 m (1.28 ft)	0.46 m (1.51 ft)	0.69 m (2.26 ft)	0.48 m (1.57 ft)

Table 6. Lift/Lower Speed Enhanced Performance, 48 Volts (Continued)

Model	Mast	Lowering Speed m/sec (ft/sec)		Lifting Speed m/sec (ft/sec)	
		No Load	Rated Load	No Load	Rated Load
E3.2XN (E65XN)	Two-Stage LFL	0.46 m (1.51 ft)	0.57 m (1.87 ft)	0.63 m (2.10 ft)	0.40 m (1.31 ft)
	Two-Stage FFL	0.37 m (1.21 ft)	0.53 m (1.74 ft)	0.59 m (1.94 ft)	0.39 m (1.28 ft)
	Three-Stage FFL	0.40 m (1.31 ft)	0.54 m (1.77 ft)	0.60 m (1.97 ft)	0.39 m (1.28 ft)
	Four-Stage FFL	0.39 m (1.28 ft)	0.46 m (1.51 ft)	0.69 m (2.26 ft)	0.48 m (1.57 ft)
E3.5XN (E70XN)	Two-Stage LFL	0.46 m (1.51 ft)	0.58 m (1.90 ft)	0.63 m (2.10 ft)	0.37 m (1.21 ft)
	Two-Stage FFL	0.37 m (1.21 ft)	0.54 m (1.77 ft)	0.59 m (1.94 ft)	0.37 m (1.21 ft)
	Three-Stage FFL	0.40 m (1.31 ft)	0.56 m (1.84 ft)	0.60 m (1.97 ft)	0.37 m (1.21 ft)
	Four-Stage FFL	0.39 m (1.28 ft)	0.46 m (1.51 ft)	0.69 m (2.26 ft)	0.48 m (1.57 ft)

Table 7. Lift/Lower Speed, Enhanced Performance, 80 Volts

Model	Mast	Lowering Speed m/sec (ft/sec)		Lifting Speed m/sec (ft/sec)	
		No Load	Rated Load	No Load	Rated Load
E2.2XN (E45XN)	Two-Stage LFL	0.51 m (1.67 ft)	0.57 m (1.87 ft)	0.72 m (2.36 ft)	0.52 m (1.70 ft)
	Two-Stage FFL	0.46 m (1.51 ft)	0.52 m (1.70 ft)	0.66 m (2.17 ft)	0.50 m (1.64 ft)
	Three-Stage FFL	0.47 m (1.54 ft)	0.54 m (1.77 ft)	0.68 m (2.23 ft)	0.51 m (1.67 ft)
	Four-Stage FFL	0.39 m (1.28 ft)	0.45 m (1.48 ft)	0.69 m (2.26 ft)	0.51 m (1.67 ft)
E2.5XN (E50XN)	Two-Stage LFL	0.51 m (1.67 ft)	0.57 m (1.87 ft)	0.72 m (2.36 ft)	0.49 m (1.61 ft)
	Two-Stage FFL	0.46 m (1.51 ft)	0.54 m (1.77 ft)	0.66 m (2.17 ft)	0.47 m (1.54 ft)
	Three-Stage FFL	0.47 m (1.54 ft)	0.55 m (1.55 ft)	0.68 m (2.23 ft)	0.48 m (1.57 ft)
	Four-Stage FFL	0.39 m (1.28 ft)	0.46 m (1.51 ft)	0.69 m (2.26 ft)	0.48 m (1.57 ft)

Table 7. Lift/Lower Speed, Enhanced Performance, 80 Volts (Continued)

Model	Mast	Lowering Speed m/sec (ft/sec)		Lifting Speed m/sec (ft/sec)	
		No Load	Rated Load	No Load	Rated Load
E2.75XN (E55XN)	Two-Stage LFL	0.51 m (1.67 ft)	0.58 m (1.90 ft)	0.72 m (2.36 ft)	0.47 m (1.54 ft)
	Two-Stage FFL	0.46 m (1.51 ft)	0.55 m (1.55 ft)	0.66 m (2.17 ft)	0.45 m (1.48 ft)
	Three-Stage FFL	0.47 m (1.54 ft)	0.56 m (1.84 ft)	0.68 m (1.57 ft)	0.46 m (0.92 ft)
	Four-Stage FFL	0.39 m (1.28 ft)	0.46 m (1.51 ft)	0.69 m (2.26 ft)	0.48 m (1.57 ft)
E3.0XN (E60XN)	Two-Stage LFL	0.46 m (1.51 ft)	0.56 m (1.84 ft)	0.63 m (2.10 ft)	0.42 m (1.38 ft)
	Two-Stage FFL	0.37 m (1.21 ft)	0.52 m (1.70 ft)	0.59 m (1.94 ft)	0.41 m (1.35 ft)
	Three-Stage FFL	0.40 m (1.31 ft)	0.53 m (1.74 ft)	0.60 m (1.97 ft)	0.41 m (1.35 ft)
	Four-Stage FFL	0.39 m (1.28 ft)	0.46 m (1.51 ft)	0.69 m (2.26 ft)	0.48 m (1.57 ft)
E3.2XN (E65XN)	Two-Stage LFL	0.46 m (1.51 ft)	0.57 m (1.87 ft)	0.63 m (2.10 ft)	0.40 m (1.31 ft)
	Two-Stage FFL	0.37 m (1.21 ft)	0.53 m (1.74 ft)	0.59 m (1.94 ft)	0.39 m (1.28 ft)
	Three-Stage FFL	0.40 m (1.31 ft)	0.53 m (1.74 ft)	0.60 m (1.97 ft)	0.39 m (1.28 ft)
	Four-Stage FFL	0.39 m (1.28 ft)	0.46 m (1.51 ft)	0.69 m (2.26 ft)	0.48 m (1.57 ft)
E3.5XN (E70XN)	Two-Stage LFL	0.46 m (1.51 ft)	0.58 m (1.90 ft)	0.63 m (2.10 ft)	0.37 m (1.21 ft)
	Two-Stage FFL	0.37 m (1.21 ft)	0.54 m (1.77 ft)	0.59 m (1.94 ft)	0.37 m (1.21 ft)
	Three-Stage FFL	0.40 m (1.31 ft)	0.56 m (1.84 ft)	0.60 m (1.97 ft)	0.37 m (1.21 ft)
	Four-Stage FFL	0.39 m (1.28 ft)	0.46 m (1.51 ft)	0.69 m (2.26 ft)	0.48 m (1.57 ft)

Torque Specifications

FRAME

Overhead Guard
66 N•m (49 lbf ft)
66 N•m (49 lbf ft)

Counterweight
755 N•m (557 lbf ft)
90 N•m (67 lbf ft)

Traction Motor to Mounting Flange
38 to 48 N•m (28 to 35 lbf ft)

DRIVE AXLE

Wheel Nuts
340 to 380 N•m (251 to 280 lbf ft)

Axle Shaft to Drive Hub Capscrews M12 × 1.75 × 35 (16 each side)
90 to 99 N•m (66 to 73 lbf ft)

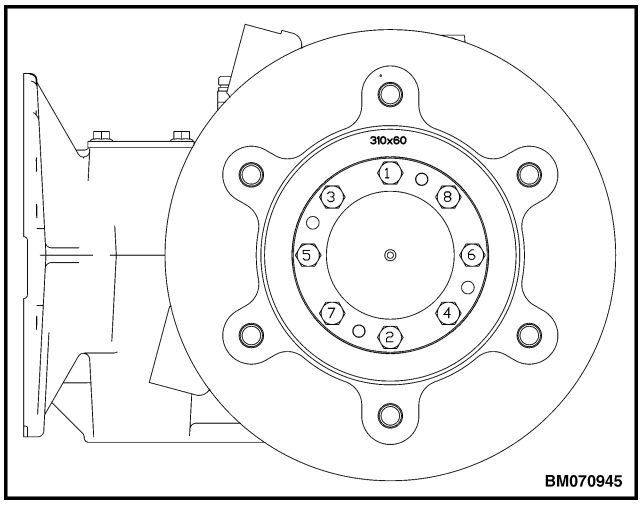


Figure 1. Tightening Sequence - Hub Capscrews

Drive Axle Mounting Bolts
755 to 830 N•m (557 to 612 lbf ft)

Axle Hangers to Drive Axle Housing Capscrews
90 to 99 N•m (66 to 73 lbf ft)

Brake Assembly to Axle Mount Capscrews
255 to 306 N•m (lbf ft)

DIFFERENTIAL AND SPEED REDUCER

Bearing Cap Capscrews for Differential Bearings (4)
225 to 270 N•m (166 to 199 lbf ft)

Center Section Cover Capscrews
19 to 23 N•m (168 to 204 lbf in)

Differential Case Half Capscrews (Speed Reducer)
125 to 145 N•m (92 to 107 lbf ft)

Differential Assembly Capscrews (Speed Reducer)
152 to 167 N•m (112 to 123 lbf ft)

Bearing Retainer Capscrews (Speed Reducer)
19 to 23 N•m (168 to 204 lbf in)

Pinion Nut (Speed Reducer)
530 to 645 N•m (391 to 476 lbf ft)
370 to 410 N•m (273 to 302 lbf ft)

Pinion Shaft Rotating Torque (Speed Reducer)
4 to 6 N•m (35 to 53 lbf in)

BRAKE SYSTEM

Back Plate Lock Bolts
255 to 306 N•m (188 to 226 lbf ft)

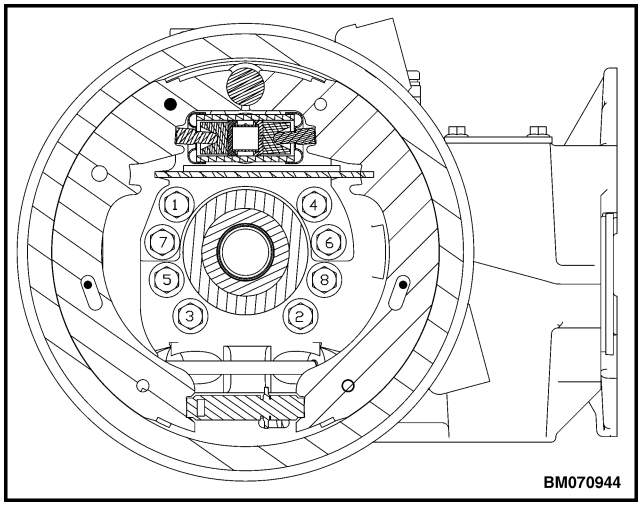


Figure 2. Tightening Sequence - Lock Bolts

Wheel Bearing Lock Nut
14 to 18 N•m (124 to 159 lbf in)
175 to 215 N•m (129 to 159 lbf ft)
14 to 18 N•m (124 to 159 lbf in)

Wheel Cylinder to Back Plate Capscrew
18 to 27 N•m (159 to 239 lbf in)

Master Cylinder Push Rod Lock Nut
15 to 17 N•m (133 to 150 lbf in)

Master Cylinder to Mounting Plate Nuts
19 N•m (168 lbf in)

Brake Sensor
23 to 28 N•m (203 to 247 lbf in)

Brake Pedal Lock Nut
15 to 17 N•m (133 to 150 lbf in)

Brake Pedal Assembly to Bracket Capscrew
165 N•m (122 lbf ft)

STEERING AXLE

Axle to Mount Brackets Capscrews
90 N•m (66 lbf ft)

Steering Cylinder to Axle Capscrews
225 to 280 N•m (166 to 206 lbf ft)

Bearing Cap Capscrews
44 N•m (32 lbf ft)

Castle Nut, Wheel Nut (2)
Initial 68 N•m (50 lbf ft) while rotating wheel.
Loosen, then 3 N•m (25 lbf in)

Castle Nut to Tie Rod Assembly
163 N•m (120 lbf ft)

MASTS

Sideshift Carriage
325 ±30 N•m (240 ±25 lbf ft)
165 ±15 N•m (120 ±12 lbf ft)
195 N•m (144 lbf ft)

Capscrews, Hanger Caps
Mast to Mount Pivot Pins270 N•m (199 lbf ft)

Main Lift Cylinder Mount Capscrews
40 N•m (30 lbf ft)

Lowering Control Valve Housing to Mast Capscrews
18 N•m (159 lbf in)

Sheave Assembly Capscrews (13)
66 N•m (49 lbf ft)

Header Hose Clamp Hardware (12)
8 N•m (71 lbf in)

Free Lift Cylinder Bracket Capscrews
53 N•m (39 lbf ft)

Header Hose Strap Clamp Capscrews
4-Stage Full Free-Lift
18 N•m (13 lbf ft)

Hose Sheave Axle Capscrews and Sheave Nuts
4-Stage Full Free-Lift
57 N•m (39 lbf ft)

Roller Guide Capscrews and Nuts
4-Stage Full Free-Lift
8 N•m (71 lbf in)

Intermediate Channel Block Capscrews
4-Stage Full Free-Lift
18 N•m (13 lbf ft)

Tilt Rod End Capscrews (2)
38 N•m (28 lbf ft)

Tilt Cylinder Mount to Outer Mast Capscrew
90 N•m (66 lbf ft)

TILT CYLINDERS

Tilt Rod End Capscrews (2)
38 N•m (28 lbf ft)

Tilt Cylinder Mount to Outer Mast Capscrew
90 N•m (66 lbf ft)

HYDRAULIC PUMP AND MOTOR

Motor Mount Capscrews
12 N•m (106 lbf in)

Pump to Motor Capscrews
25 N•m (221 lbf in)

Pump Flange Head Screws
88 to 98 N•m (65 to 72 lbf ft)

Coupling Setscrews
11 to 13 N•m (97 to 115 lbf in)

Pressure Line Fitting to Hydraulic Pump
49 to 59 N•m (36 to 44 lbf ft)

Suction Hose Adapter to Hydraulic Pump
91 to 100 N•m (67 to 74 lbf ft)

Motor Power Cable Nuts
24 N•m (212 lbf in)

HYDRAULIC TANK

Drain Plug
40 N•m (30 lbf ft)

Temperature Sensor
19 to 21 N•m (168 to 186 lbf in)

Suction Strainer
135 N•m (100 lbf ft)

Filter Housing Capscrews
10 N•m (86 lbf in)

Fitting
45 N•m (33 lbf ft)

Tank Level Sensor
45 N•m (33 lbf ft)

Pressure Switch to Filter Housing
25 N•m (221 lbf in)

Breather Adapter Mounting Capscrews
25 N•m (221 lbf in)

HYDRAULIC CONTROL VALVES

Manual Valve

Tie Rod Nuts
18 to 20 N•m (156 to 180 lbf in)

Position Sensor Connector Nut
18 to 20 N•m (156 to 180 lbf in)

Steer Load Sense Fitting
16 N•m (142 lbf in)

Diagnostic Fitting
16 N•m (142 lbf in)

Main Relief Valve
27 N•m (20 lbf ft)

Compensator Plug
47 N•m (35 lbf ft)

Small Port Plugs
13.5 N•m (119 lbf in)

Medium Port Plugs
65 N•m (48 lbf ft)

Large Port Plugs
60 to 72 N•m (44 to 53 lbf ft)

Manual Lowering Valve
54 N•m (40 lbf ft)

Lift Port Plug - Long
27 N•m (20 lbf ft)

Lift Port Plug - Short
54 N•m (40 lbf ft)

Tilt Relief Cartridge
27 N•m (20 lbf ft)

End Auxiliary Port Plugs
14 N•m (124 lbf in)

Position Sensor Capscrews
4.7 N•m (42 lbf in)

Spool Lock Solenoid
7.5 N•m (66 lbf in)

Manual Handles and Levers

Outer Capscrews
1.36 to 1.65 N•m (11.9 to 14.6 lbf in)

Manual Valve Covers

Lower Cover Capscrews
2.82 to 3.16 N•m (24.95 to 27.97 lbf in)

Front Cover Capscrews
2.82 to 3.16 N•m (24.95 to 27.97 lbf in)

E-Hydraulic Valve

Tie Rod Nuts
19 to 22 N•m (168 to 195 lbf in)

Elbow Fitting
16 N•m (142 lbf in)

Main Relief Valve
27 N•m (20 lbf ft)

Port Option Plug
54 N•m (40 lbf ft)

Manual Lowering Valve
54 N•m (40 lbf ft)

Tilt Relief Valve
27 N•m (20 lbf ft)

Tilt Section Plug
27 N•m (20 lbf ft)

Lift Section Plug
27 N•m (20 lbf ft)

Pilot Cartridge
65 N•m (45 lbf ft)

Connector Jam Nuts
7 to 11 N•m (62 to 97 lbf in)

Solenoids
5 N•m (48 lbf in)

Traction Motor Power Cable Capscrews (3)
10 N•m (89 lbf in)

Hydraulic Pump Motor Capscrews (3)
16 N•m (142 lbf in)

Static Strap Capscrew (1)
15 to 17 N•m (133 to 150 lbf in)

Battery Connector to Line Contactor Nut (1)
14 to 15 N•m (124 to 133 lbf in)

ELECTRICAL SYSTEM

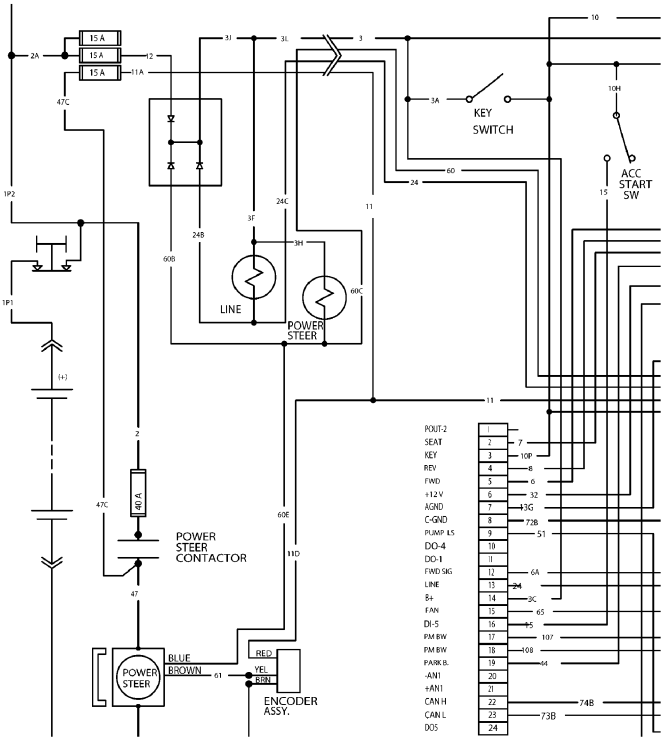
Controller Power Cable Capscrews M8 x 1.25 (10)
18 to 21 N•m (159 to 186 lbf in)

Adhesives and Sealants

Hyster Part No.	Loctite® Part No.	Description	Size
264159	515	HCE-98 Adhesive	
383789	24231	Removable Threadlock (Blue)	50 ml (1.7 oz)

DIAGRAMS

E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) [A099];
E2.2-3.5XN (E45-70XN) [A268];
E1.6-2.0XN (E30-40XN) [A269];
J2.2-3.5XN (J45-70XN) [A276];
J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) [A970]



HYSTER

SAFETY PRECAUTIONS
MAINTENANCE AND REPAIR

- The Service Manuals are updated on a regular basis, but may not reflect recent design changes to the product. Updated technical service information may be available from your local authorized Hyster® dealer. Service Manuals provide general guidelines for maintenance and service and are intended for use by trained and experienced technicians. Failure to properly maintain equipment or to follow instructions contained in the Service Manual could result in damage to the products, personal injury, property damage or death.
- When lifting parts or assemblies, make sure all slings, chains, or cables are correctly fastened, and that the load being lifted is balanced. Make sure the crane, cables, and chains have the capacity to support the weight of the load.
- Do not lift heavy parts by hand, use a lifting mechanism.
- Wear safety glasses.
- DISCONNECT THE BATTERY CONNECTOR before doing any maintenance or repair on electric lift trucks. Disconnect the battery ground cable on internal combustion lift trucks.
- Always use correct blocks to prevent the unit from rolling or falling. See HOW TO PUT THE LIFT TRUCK ON BLOCKS in the Operating Manual or the Periodic Maintenance section.
- Keep the unit clean and the working area clean and orderly.
- Use the correct tools for the job.
- Keep the tools clean and in good condition.
- Always use HYSTER APPROVED parts when making repairs. Replacement parts must meet or exceed the specifications of the original equipment manufacturer.
- Make sure all nuts, bolts, snap rings, and other fastening devices are removed before using force to remove parts.
- Always fasten a DO NOT OPERATE tag to the controls of the unit when making repairs, or if the unit needs repairs.
- Be sure to follow the WARNING and CAUTION notes in the instructions.
- Gasoline, Liquid Petroleum Gas (LPG), Compressed Natural Gas (CNG), and Diesel fuel are flammable. Be sure to follow the necessary safety precautions when handling these fuels and when working on these fuel systems.
- Batteries generate flammable gas when they are being charged. Keep fire and sparks away from the area. Make sure the area is well ventilated.

NOTE: The following symbols and words indicate safety information in this manual:

WARNING

Indicates a hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION

Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury and property damage.

On the lift truck, the WARNING symbol and word are on orange background. The CAUTION symbol and word are on yellow background.

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This section is for the following models:

E4.0-5.5XN, E5.0XNS (E80-120XN, E100XNS) [A099];
E2.2-3.5XN (E45-70XN) [A268];
E1.6-2.0XN (E30-40XN) [A269];
J2.2-3.5XN (J45-70XN) [A276];
J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) [A970]

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"THE
QUALITY
KEEPERS"

HYSTER
APPROVED
PARTS

DIAGRAMS AND SCHEMATICS

GENERAL NOTES:

ALL PARTS ARE SHOWN IN THE NORMAL POSITION,
FOR THE FOLLOWING CONDITION:
- UNIT STOPPED
- BATTERY DISCONNECTED
- OPERATOR IS OFF THE UNIT
- STEERING IS SET FOR STRAIGHT TRAVEL
- ALL SWITCHES ARE SHOWN IN THE STATIC POSITION

YOUR MODEL MAY NOT HAVE ALL THE OPTIONS SHOWN IN THIS SCHEMATIC.

ALL UNUSED TERMINALS AND CONNECTORS MUST BE SECURED TO A MAIN WIRE HARNESS.

• LETTER VARIES

CONNECTOR/S AND TERMINAL/S NAMING CONVENTION:

CPS01/VSM CONT	CRP01/VSM CONT
C = CONNECTOR	C = CONNECTOR
P = PLUG	R = RECEPTACLE
S = SOCKET	P = PIN
01 = SEQUENTIAL NUMBER	01 = SEQUENTIAL NUMBER
VSM CONT = DESTINATION	VSM CONT = DESTINATION

TF01	TR01
T = TERMINAL	T = TERMINAL
F/M = FEMALE OR MALE	R/FK = RING OR FORK
01 = SEQUENTIAL NUMBER	01 = SEQUENTIAL NUMBER
VSM CONT = DESTINATION	VSM CONT = DESTINATION

PREFIX -V- IN FRONT OF CPS, CRP, TF/M, TR, TFK INDICATES OF THE VENDOR COMPONENT.

CAN BUSS I.D. LEGEND:

900 CAN BUSS Lo WIRE COLOR GREEN (GRN)
901 CAN BUSS Hi WIRE COLOR YELLOW (YEL)
GREEN AND YELLOW WIRES ARE TWISTED TOGETHER

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ABBREVIATIONS USED IN THIS DOCUMENT

ACCELERATOR	ACC	OPTION	OPT
ASSEMBLY	ASSY	OVER HEAD GUARD	OHG
ALTERNATING CURRENT	AC	ORANGE	ORN
AMERICAS	AM	PARK BRAKE	P/B
AUXILIARY	AUX	POSITION	POSN
BACK-UP	B/U	POSITIVE	POS
BATTERY	BAT	PRESSURE	PRESS
BLACK	BLK	PRIMARY	PRI
BLUE	BLU	PRINTED CIRCUIT BOARD	PCB
BRAKE	BRK	REAR	RR
BROWN	BR	RELAY	RLY
CONNECTOR	CONN	RESISTOR	R/RES
CONTACTOR	K	REVERSE	REV
CONVERTER	CONV	RIGHT	RT
DIRECTIONAL CONTROL SWITCH	DCS	RIGHT HAND	RH
ELECTRIC	ELEC	SECOND	SEC
EMERGENCY STOP	E-STOP	SELECTOR	SEL
EUROPE	EUR	SERVICE	SERV
FORWARD	FWD	SIGNAL	SIG
FRONT	FR	SOLENOID	SOL
FUSE	FU	STANDARD	STD
GRAY	GY	STEERING	STEER
GREEN	GRN	SWITCH	SW
GROUND	GND	TEMPERATURE	TEMP
HYDRAULIC	HYD	TERMINATION	TERM
INDICATOR	INO	TRANSMISSION	TRANS
INTERLOCK	INTLK	VALVE	VL
LEFT HAND	LH	VEHICLE SYSTEM MANAGER	VSM
LIGHT	LGT	WHEEL	WHL
LOWER	LWR	WHITE	WHT
MAIN	MN	YELLOW	YEL
MANUAL	MAN	SEQUENCE	SEQ
MINI LEVER MODULE	MLM		
MOTOR	MTR		
NEGATIVE	NEG		
NORMALLY OPEN HELD CLOSE	NOHC		

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Figure 1. Wiring Diagram/Schematic (Sheet 1 of 26)

CONNECTOR DESIGNATION	FUNCTIONAL DESCRIPTION	1-2 CBB LOCATED ON PAGE	2-3 CBB LOCATED ON PAGE	2-3 DBB LOCATED ON PAGE	4-5 CBB LOCATED ON PAGE	4-5 DBB LOCATED ON PAGE
CPS-1	VSM	5,6,11	5,6,11	5,6,8,12	5,6,11	5,6,8,12
CPS-2	VSM	4,6,11,13,15,16	4,6,11,13,15,16	4,6,12,14-16	4,6,11,13,15,16	4,6,12,14-16
CPS-3	RT TRACTION MTR CONTROLLER (RT = #1)	7, 20	7, 19	10, 20, 21	9, 22	10, 22
CPS-4	LT TRACTION MTR CONTROLLER (LF = #2)		19	8, 20, 21		8, 22
CPS-5	PUMP CONTROLLER	11,13, 20	11,13	12,14, 20	11,13, 22	12,14, 22
CPS8	TILT POSITION SENSOR	6	6	6	6	6
CPS10	LIFT PRESS SENSOR	6	6	6	6	6
CPS11	SERV BRK PRES SENSOR	5	5	5	5	5
CPS12	PARK BRK POSITION	6	6			6
CPS14	HYD OIL TEMP SENSOR	5	5	5	5	5
CPS15	PARK BRK HARNESS	7	7			
CPS16	PARK BRK MODULE	7	7			
CPS17	PARK BRK SOL	7	7			
CPS20	DISPLAY	6	6	6	6	6
CPS21	DISPLAY FREEZER TEMP	6	6	6	6	6
CPS28	DIAGNOSTICS	5	5	5	5	5
CPS29	ACC PEDAL POSN SENSOR	5	5	5	5	5
CPS31	STEER AXLE SENSOR	6	6	6	6	6
CPS34	LH FRONT SIG	16	16	16	16	16
CPS35	TURN SIG SWITCH	16	16	16	16	16
CPS45	WASHER MTR			18		18
CPS47	FRONT WIPER MTR			18		18
CPS48	RR WIPER/WASHER			18		18
CPS49	RR WIPER MTR			18		18
CPS50	CAB HEATER POWER			18		18
CPS52	MLM/JOYSTICK/ARM REST	13,17	13,17	14,17	13,17	14,17
CPS54	SEAT HARNESS	5,11	5,11	5,12,14	5,11	5,12,14
CPS55	SEAT HARNESS	5,11	5,11	5,12	5,11	5,12
CPS56	SEAT OCCUPANCY SENSOR	5,11	5,11	5,12	5,11	5,12
CPS57	SEAT BELT SWITCH	5	5	5	5	5
CRP57	SEAT BELT SWITCH	5	5	5	5	5
CPS61	PUMP MOTOR TEMP SENSOR	11,13	11,13	12,14	11,13	12,14
CPS64	HANDLEVER DIRECTION SENSOR	6	6	6	6	6
CPS65	DIRECTION SENSOR MONOTROL	6	6	6	6	6
CPS66	HYD FILTER PRESS SW	4	4	4	4	4
CPS70	HYD OIL LEVEL SENSOR	5	5	5	5	5
CPS71	ACCUMULATOR PRESS SW			8		8
CPS72B	MLM E-STOP SW	13	13	14	13	14
CPS74	E-HYD VL UPPER COILS	13	13	14	13	14
CPS75	E-HYD VL LOWER COILS	13	13	14	13	14
CPS78	STEER WHL POSN SENSOR	5	5	5	5	5
CPS87	STROBE LGT	15	15	15	15	15
CPS90	DC-DC CONVERTER	15	15	15	15	15
CPS91	AUX DC-DC CONVERTER	18	18	18	18	18
CPS94	CONTROLLER FAN PUMP		19	20, 21		22
CPS95	CONTROLLER FAN TRACTION	20	19	20, 21	22	22
CPS97	FAN					22
CRP97	FAN					22
CPS102	BAT GATE MAG SW (B)	4	4	4	4	4
CPS103	RT FR WORK LGT	15	15	15	15	15
CPS104	LT FR WORK LGT	15	15	15	15	15
CPS105	LH RR TAIL LGT ASSY	16	16	16	16	16
CPA106	RT RR TAIL LGT ASSY	16	16	16	16	16
CPS107	CAB DOME LIGHT	15	15	15	15	15
CPS112	BACK UP ALARM	15	15	15	15	15
CPS114	OHG HORN SW	4	4	4	4	4
CPS116	RR WORK LGT	15	15	15	15	15
CPS128	STEER MAKEUP VL (SYNCHRO STEER)		11,13	12,14	11,13	12,14
CPS131	TURN SIGNAL HARNESS	16	16	16	16	16
CPS132	STEER COLUMN HARNESS	5	5	5	5	5
CPS133	SYNCHRONOUS STEER HARNESS		11,13	12,14	11,13	12,14
CPS135	DISPLAY HARNESS	6	6	6	6	6
CPS137	MAIN HARNESS	15,16	15,16, 19	15,16, 20	15,16	15,16
CPS138	LGT OPTION HARN	15,16	15,16	15,16	15,16	15,16
CPS142	TERMINATING RESISTOR	5	5		5	
CPS146	PUMP MTR SPEED SENSOR	11,13	11,13	12,14	11,13	12,14
CPS148	IMPACT SENSOR	18	18	18	18	18
CPS151	HORN ASM	4	4	4	4	4
CPS152	LF SPEED SENSOR TRACTION	7	7	8	9	8
CPS153	RT SPEED SENSOR TRACTION			10		10
CPS154	LF MOTOR TEMP SENSOR TRACTION	7	7	8	9	8
CPS155	RT MOTOR TEMP SENSOR TRACTION			10		10
CPS156	LF CONTROLLER FAN TRACTION		19	20, 21		
CPS157	RT CONTROLLER FAN TRACTION	20	19	20, 21	22	22
CPS158	CONTROLLER FAN TRACTION				22	22

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Figure 1. Wiring Diagram/Schematic (Sheet 2 of 26)

CONNECTOR DESIGNATION	FUNCTIONAL DESCRIPTION	1-2 CBB LOCATED ON PAGE	2-3 CBB LOCATED ON PAGE	2-3 DBB LOCATED ON PAGE	4-5T CBB LOCATED ON PAGE	4-5 DBB LOCATED ON PAGE
CPSI60	MAN HYD INTLK COIL	11	11	12	11	12
CPSI61	MAN HYD INTLK COIL	11	11	12	11	12
CPSI62	MAN HYD SPOOL POSN SENSOR	11	11	12	11	12
CPSI66	RH FRONT SIGNAL	16	16	16	16	16
CPSI80	TO DISPLAY/LGT HARNESS	15,16	15,16	15,16	15,16	15,16
CPSI90	CLAMP COIL-SW	4	4	4	4	4
CPSI91	CLAMP COIL	11	11	12	11	12
CPSI92	M-HYD HARNESS	4,6	4,6	4,6,12	4,6	4,6,12
CPSI93	PARK BRAKE SOL			10	9	10
CPSI94	PARK BRAKE DIODE MODULE			10	9	10
CPS203	REAR WIPER/ WASHER SWITCH	18	18	18	18	18
CRP205	TAIL/WORK LIGHT SW	15	15	15	15	15
CRP206	REAR WORK LIGHT SW	15	15	15	15	15
CRSI10	BRAKE LIGHT RLY	15	15	15	15	15
CRS208	KEY_SW_RLY	6	6	6	6	6
CPS208	FRONT WIPER/ WASHER SWITCH	18	18	18	18	18
CRS209	E-HYD ENABLE	13	11,13	12,14	11,13	12,14
CRS210	REVERSE RLY	15	15	15	15	15
CPS211	LIGHT SW	15,16	15,16	15,16, 20	15,16	15,16
CRP211	TO LIGHT CHASSIS MAIN HARNESS			23		23
CRS214	PUMP FAN CONTROL RELAY			23	22	22
CRS215	TRACTION FAN CONTROL RELAY			23	22	22
CPS216	AUX DC-DC OUTPUT	18	18	18	18	18
CPS217	AUX DC-DC OUTPUT	18	18	18	18	18
CRS217	LIGHT CONTROL RELAY			23		
CPS220	TO CRP220	15	15	23	15	23
CRP220	TO CPS220	15	15	23	15	23
CRS220	FLASHER	16	16	16	16	16
CPS221	FAN DIODE			20	19	22
CRP221	FAN DIODE			20	19	22
CPS310	SEAT BELT SEQUENCE MODULE	5	5	5	5	5
FU1	CONTROL POWER 5AMP	4	4	4	4	4
FU2	FUSED BAT POWER (15AMP)	4	4	4	4	4
FU3	FUSED BAT POWER (15AMP)	4	4	4	4	4
FU4	SPARE (15AMP)	4	4	4	4	4
FU5	AUX PLUG (15AMP)	18	18	18	18	18
FU6	SYNCHRONOUS STEER (5AMP)	4	4	4	4	4
FU8	FRONT WIPER MOTOR (5AMP)			18		18
FU9	WASHER MOTOR (5AMP)			18		18
FU10	REAR WIPER MOTOR (5AMP)			18		18
FU11	CAB HEATER (25A)			18		18
FU12	FR TRACTION CONTROLLER POWER (500A)			8		8
FU15	FUSE (5 AMP)			23		
FU16	FUSE (5 AMP)			23		
TF03/04	BRK FLUID LEVEL SENSOR	5	5	5	5	5
TF*	LINE CONTACTOR	4	4	4	4	4

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Figure 1. Wiring Diagram/Schematic (Sheet 3 of 26)

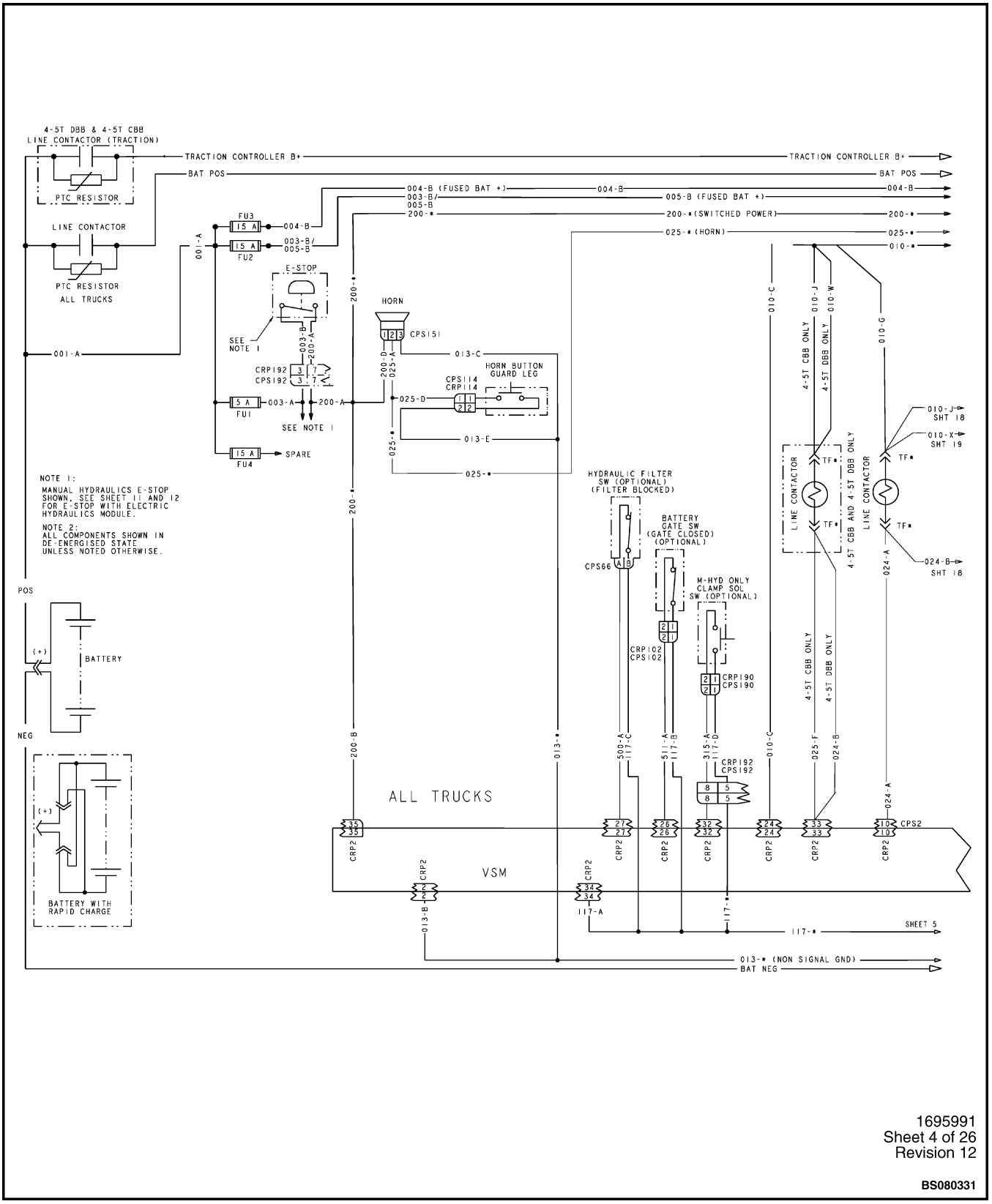

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Figure 1. Wiring Diagram/Schematic (Sheet 4 of 26)

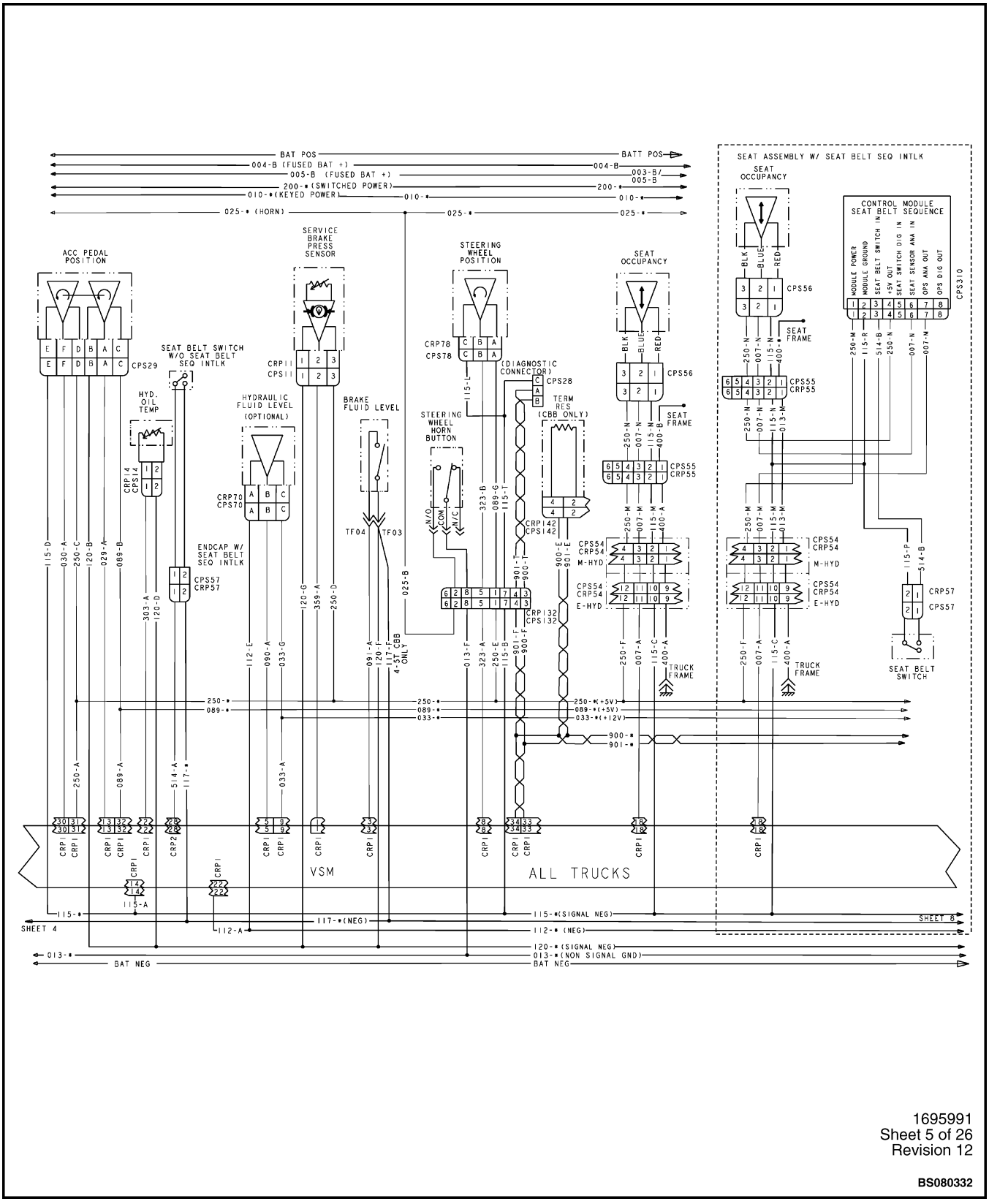

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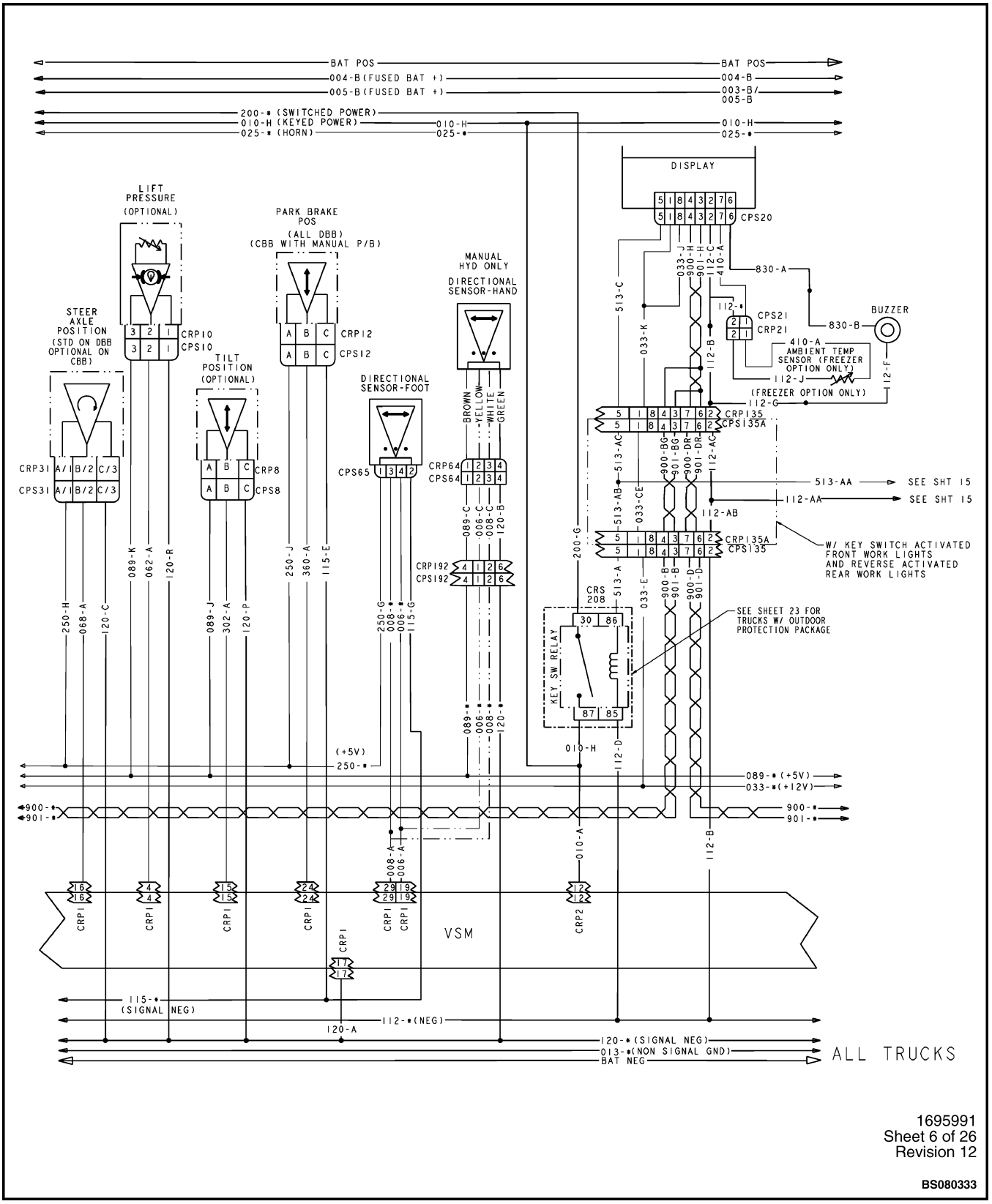
Figure 1. Wiring Diagram/Schematic (Sheet 5 of 26)



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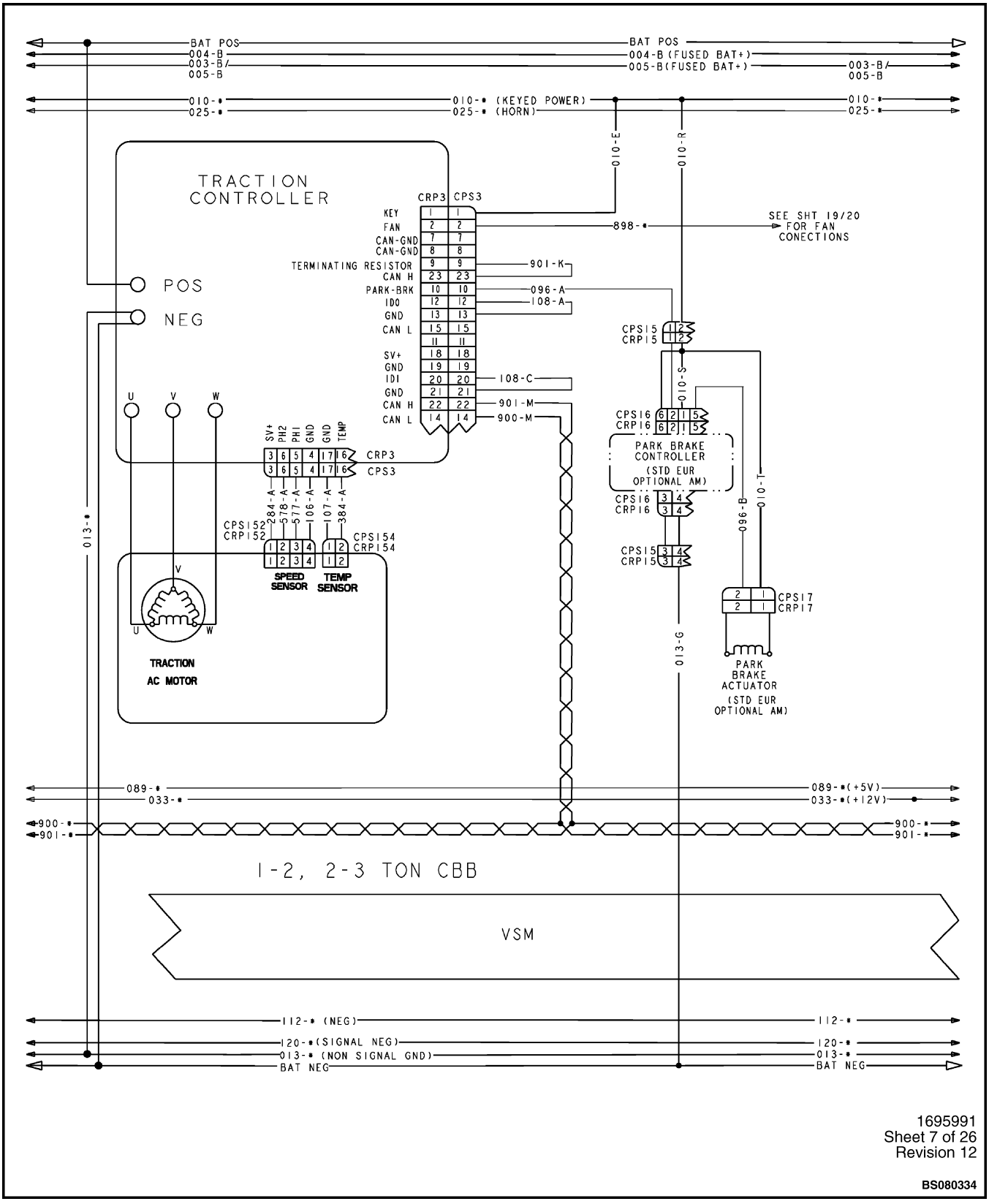

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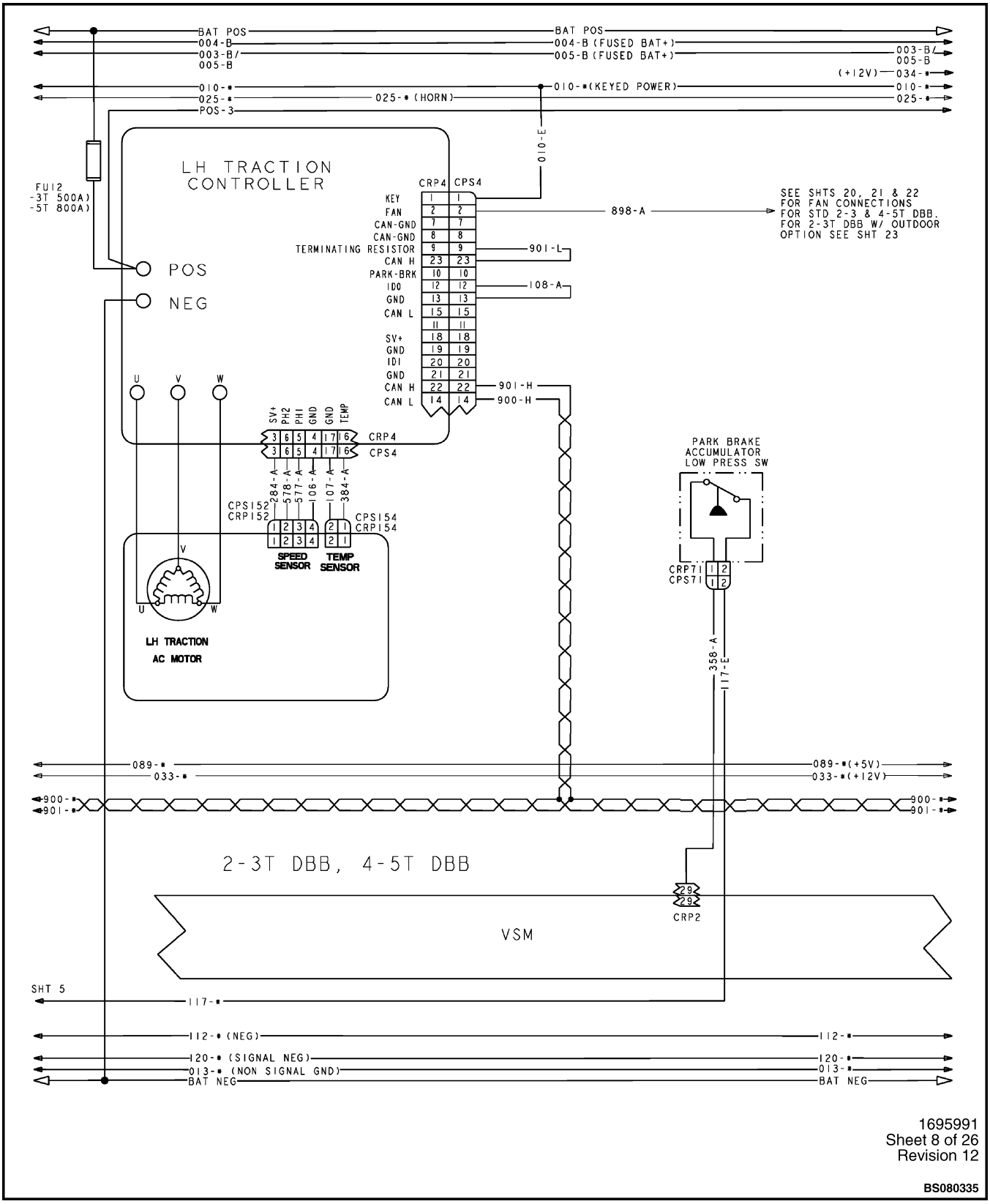


Figure 1. Wiring Diagram/Schematic (Sheet 8 of 26)

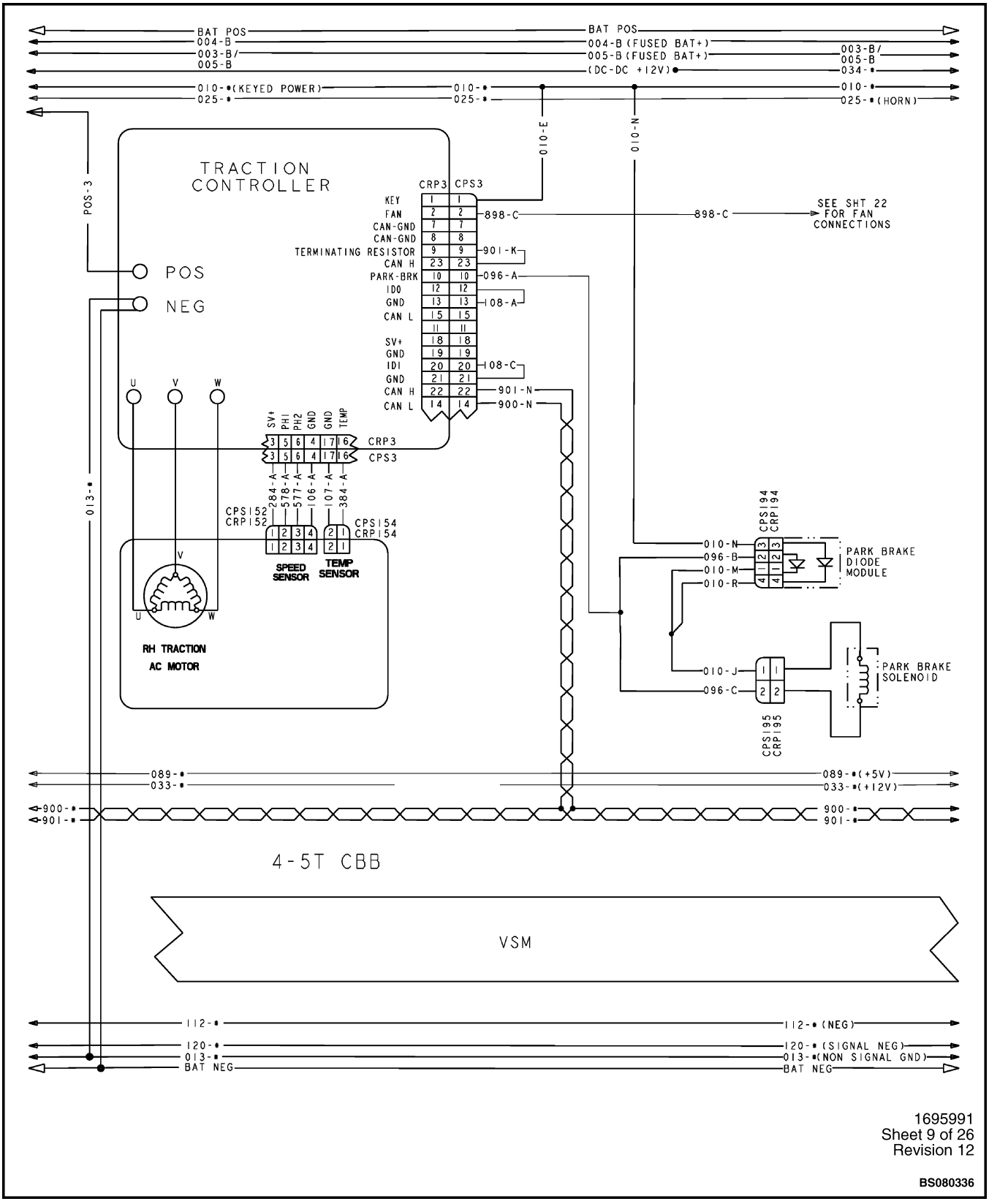


Figure 1. Wiring Diagram/Schematic (Sheet 9 of 26)

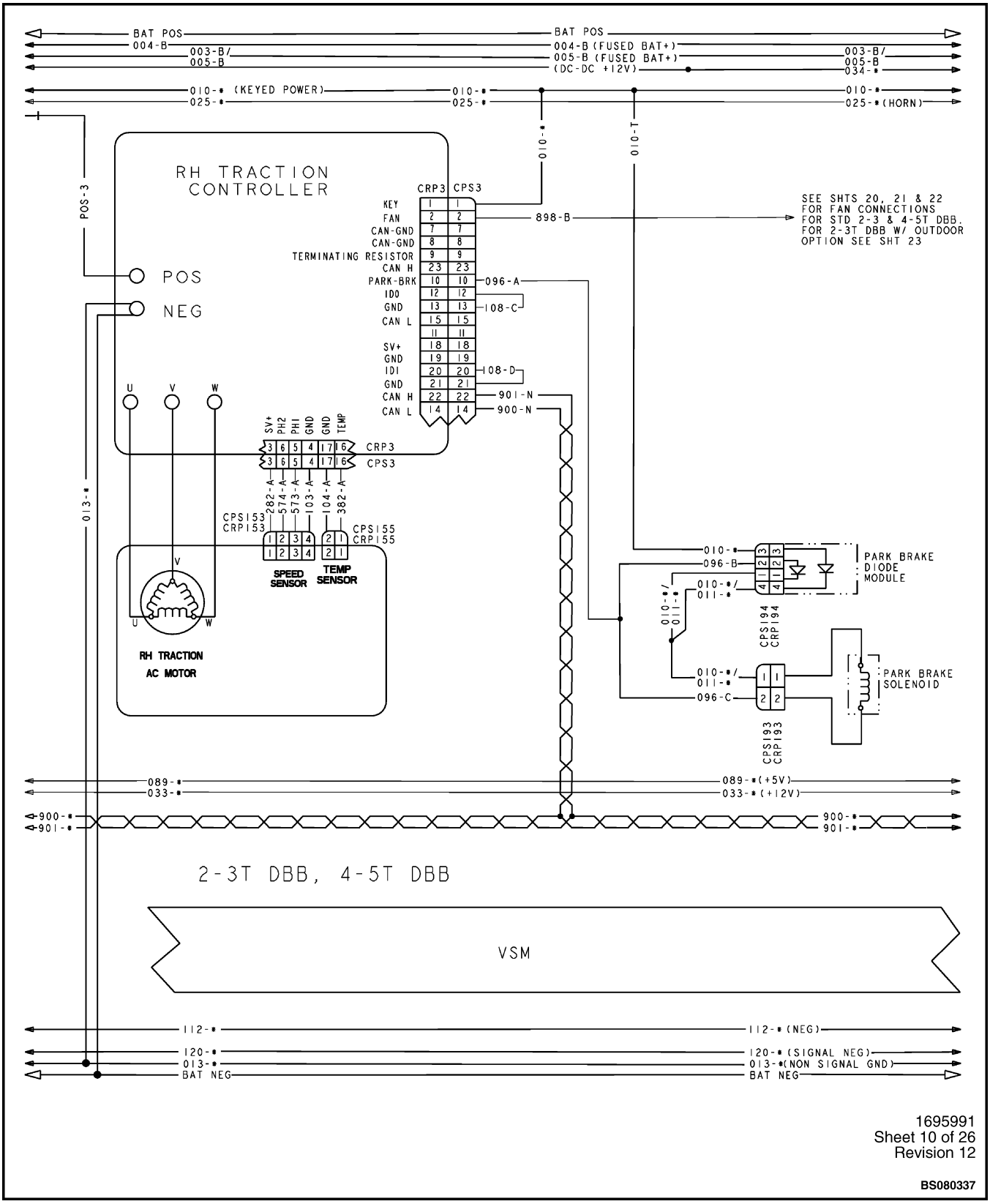
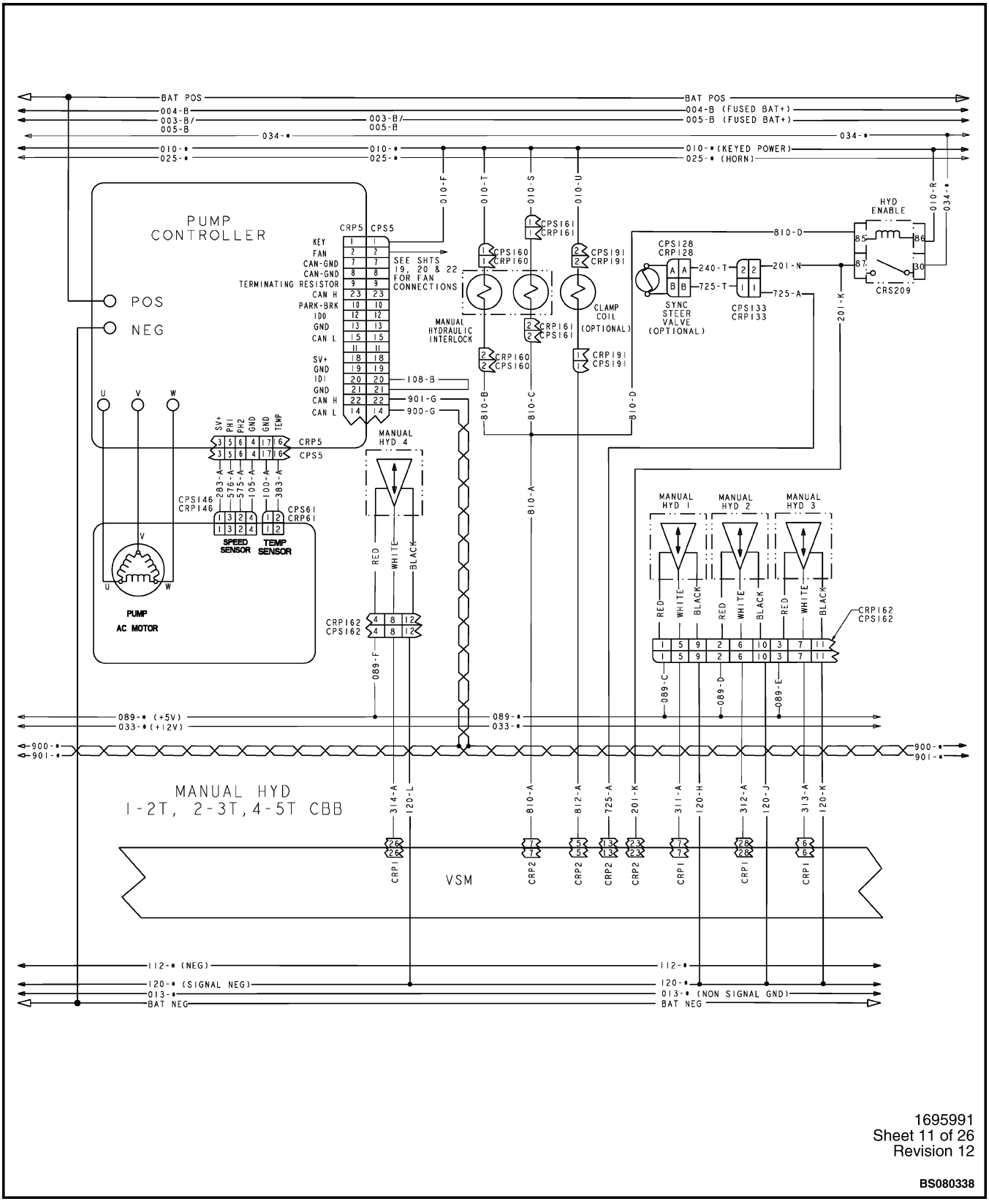


Figure 1. Wiring Diagram/Schematic (Sheet 10 of 26)



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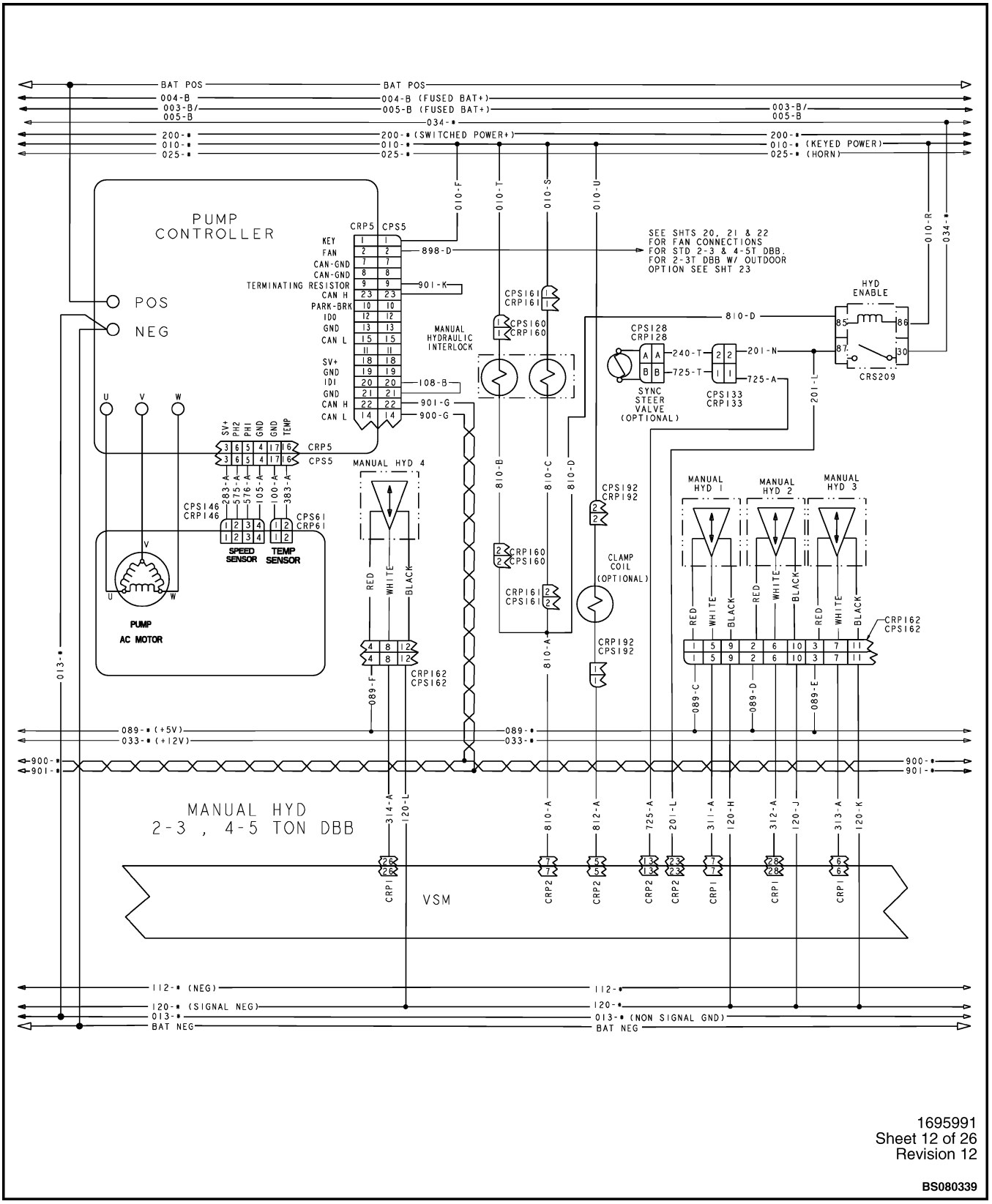

Figure 1. Wiring Diagram/Schematic (Sheet 12 of 26)

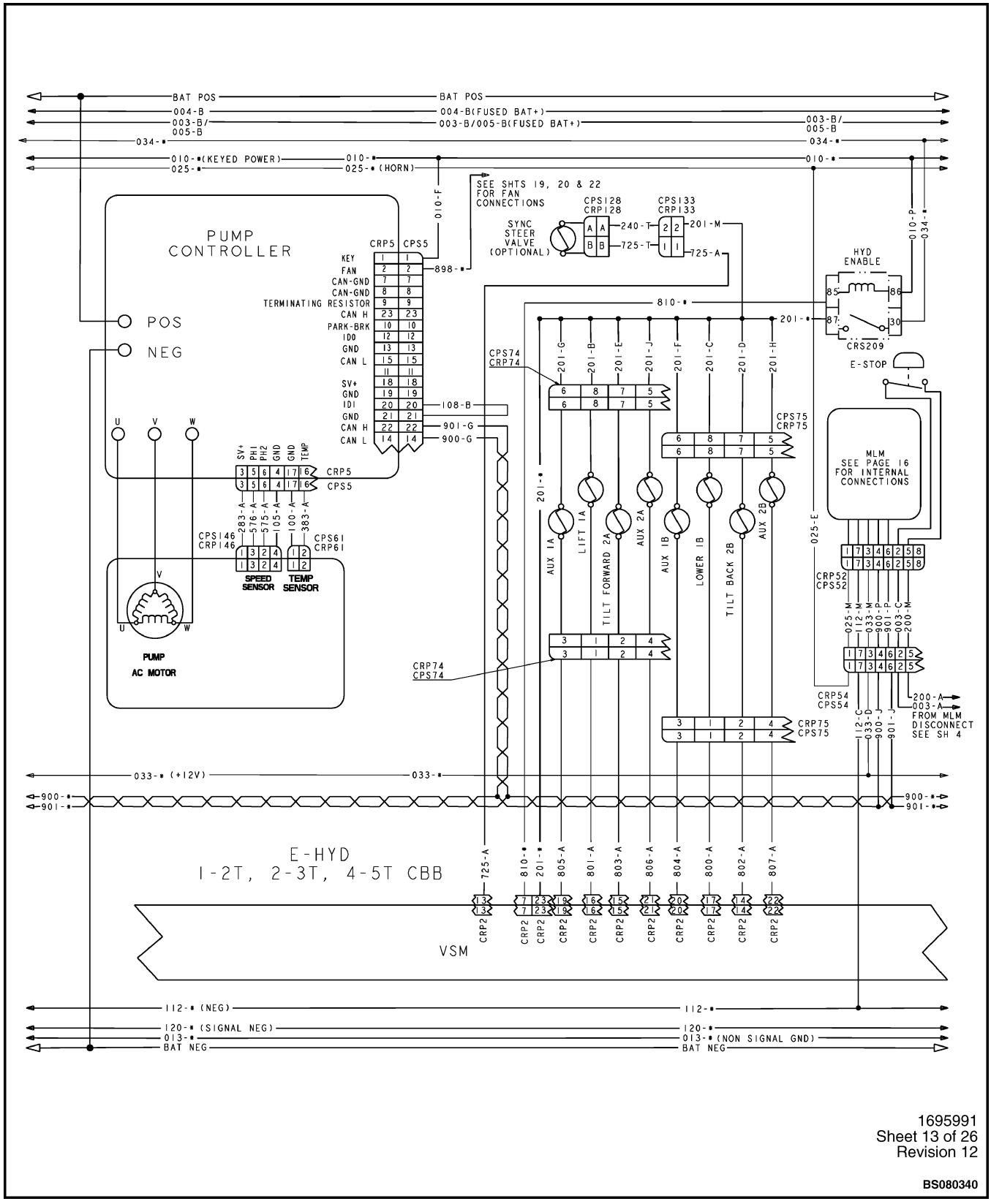

Figure 1. Wiring Diagram/Schematic (Sheet 13 of 26)

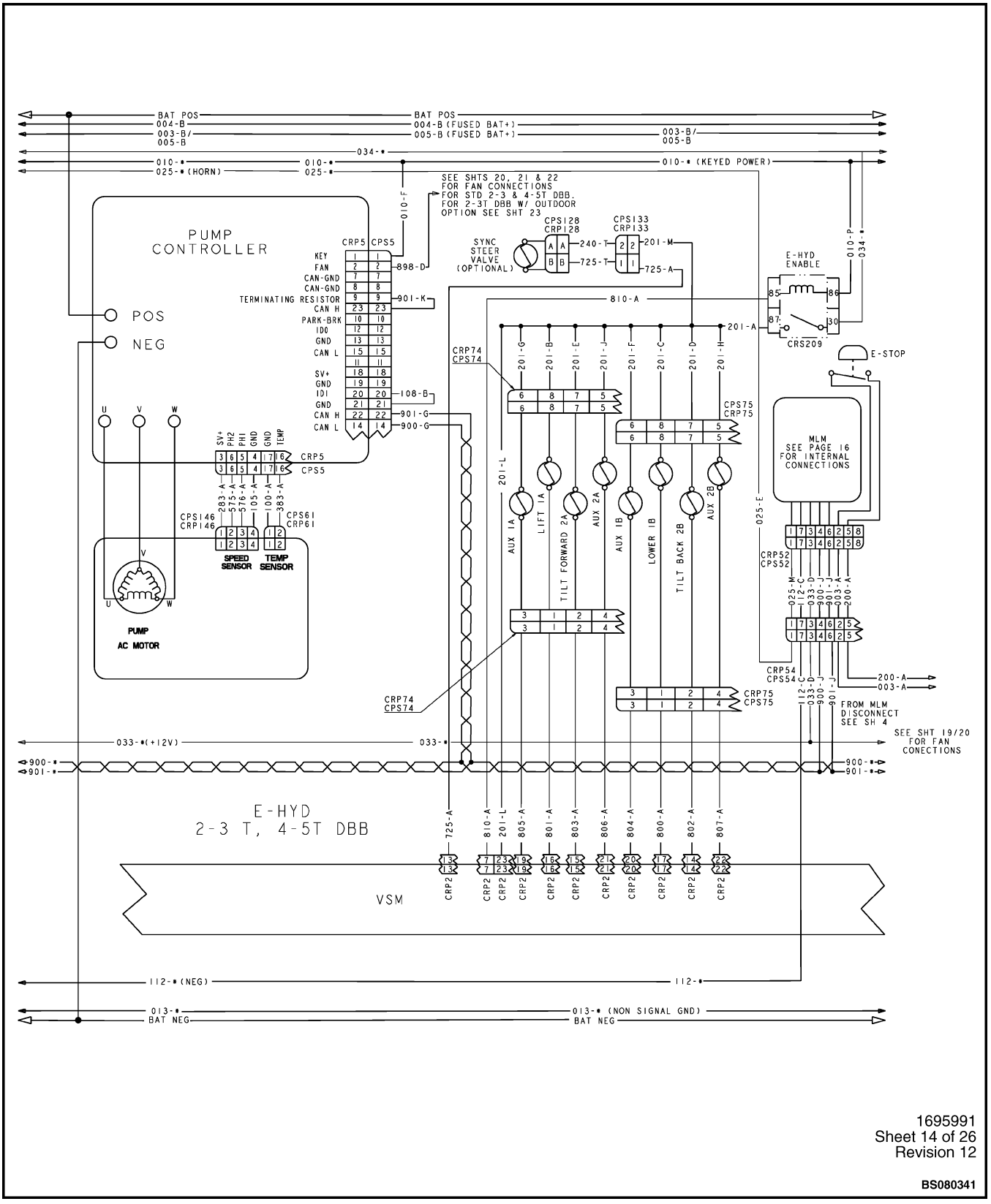

Figure 1. Wiring Diagram/Schematic (Sheet 14 of 26)

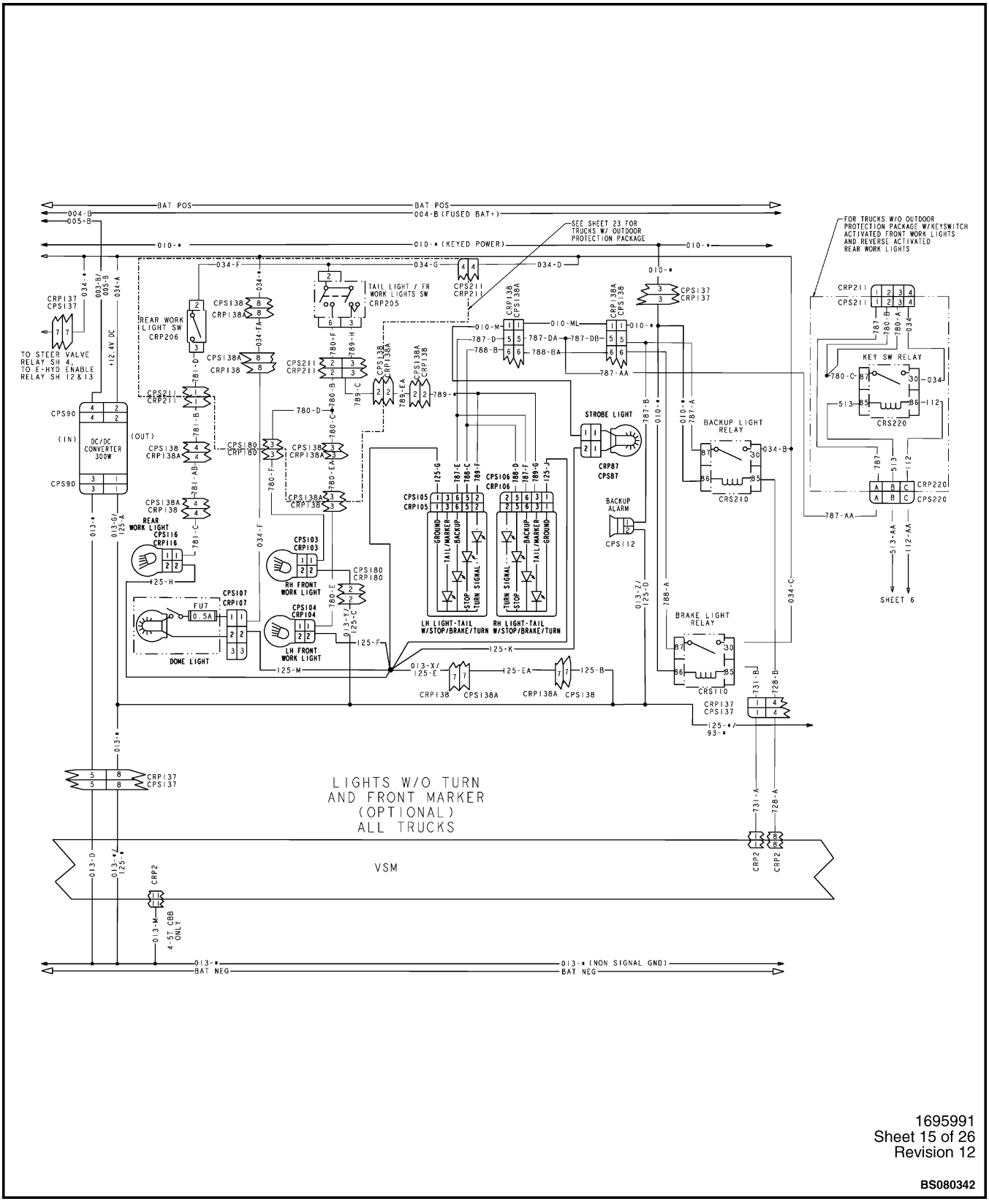

Figure 1. Wiring Diagram/Schematic (Sheet 15 of 26)

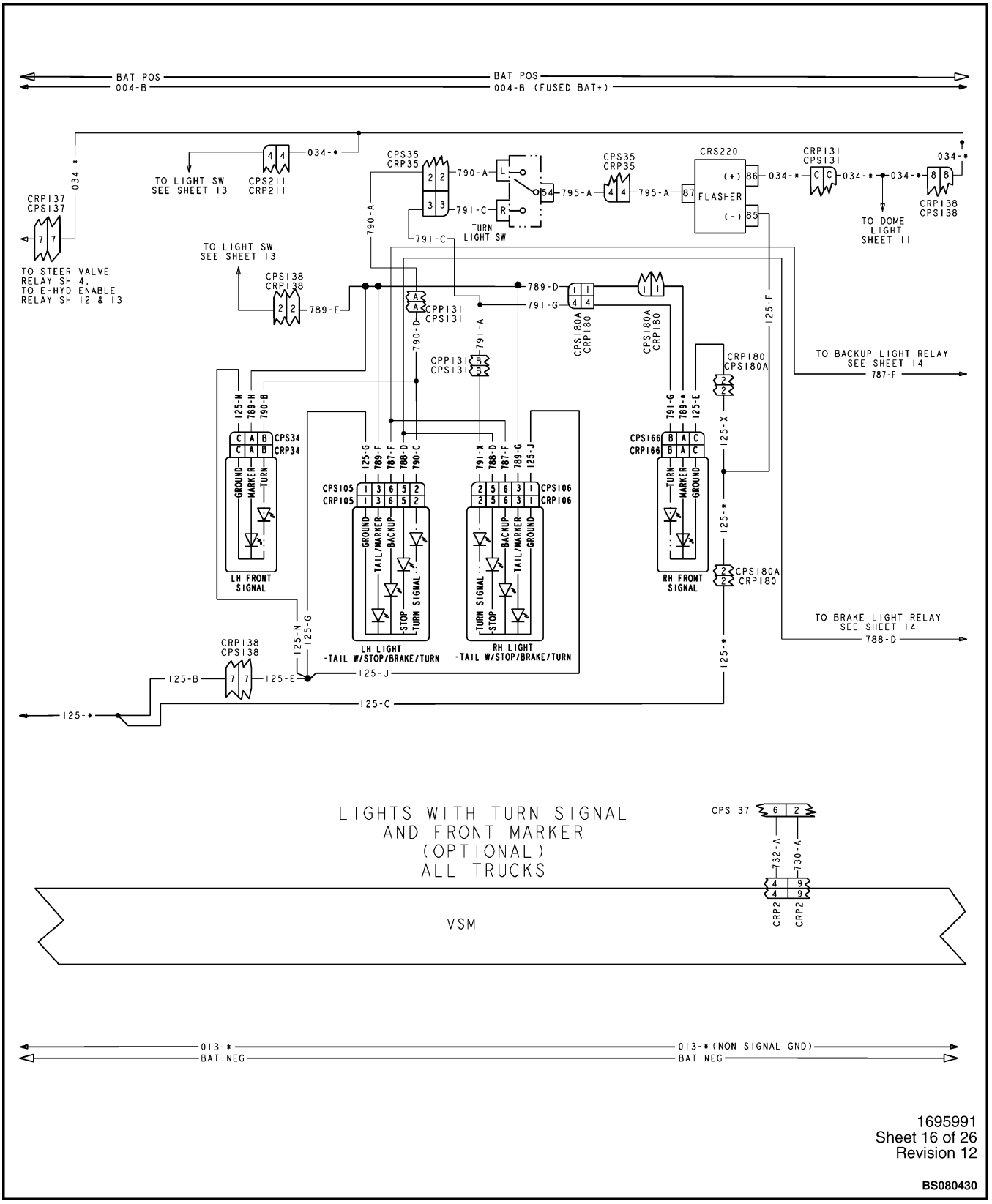

Figure 1. Wiring Diagram/Schematic (Sheet 16 of 26)

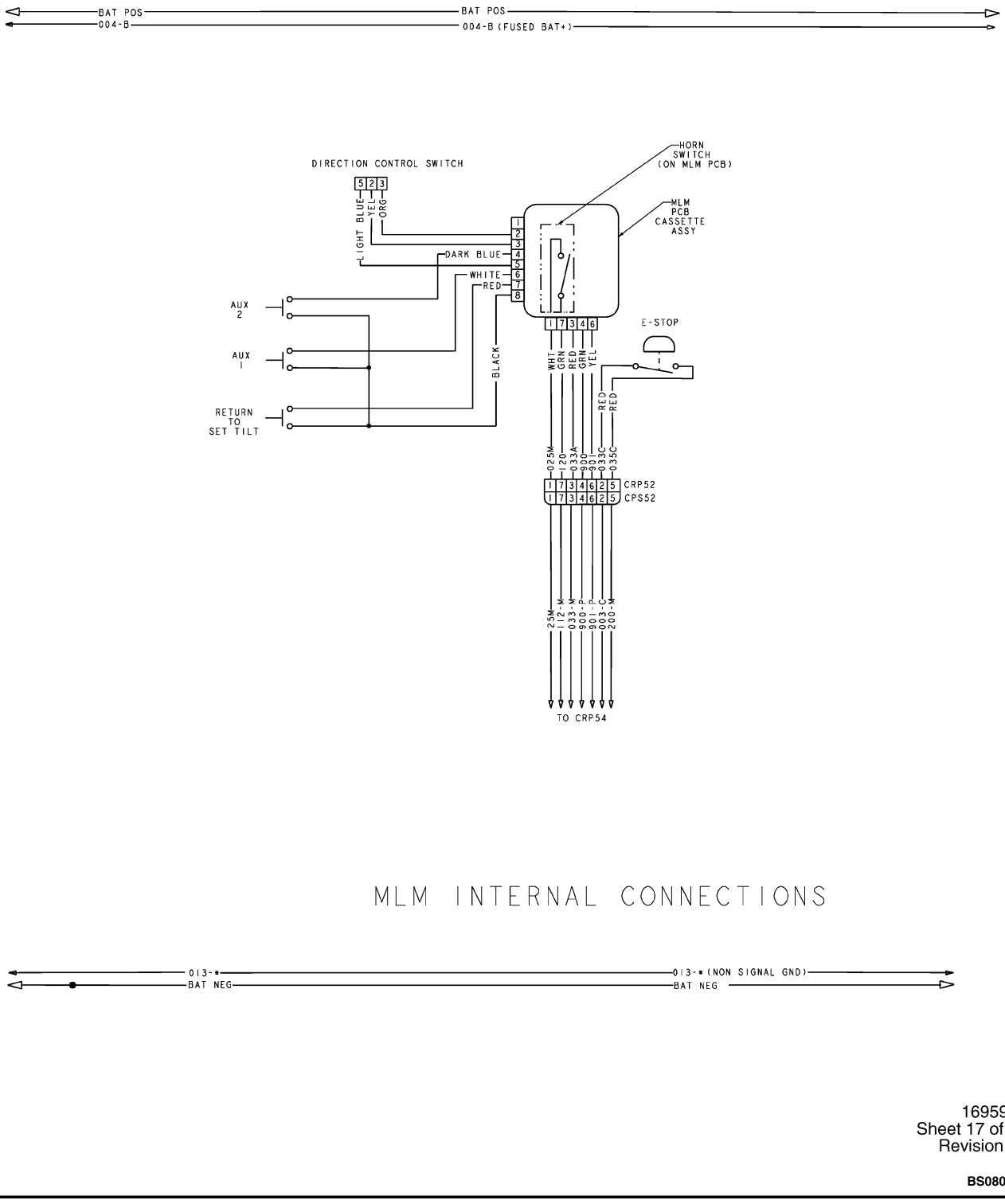

Figure 1. Wiring Diagram/Schematic (Sheet 17 of 26)

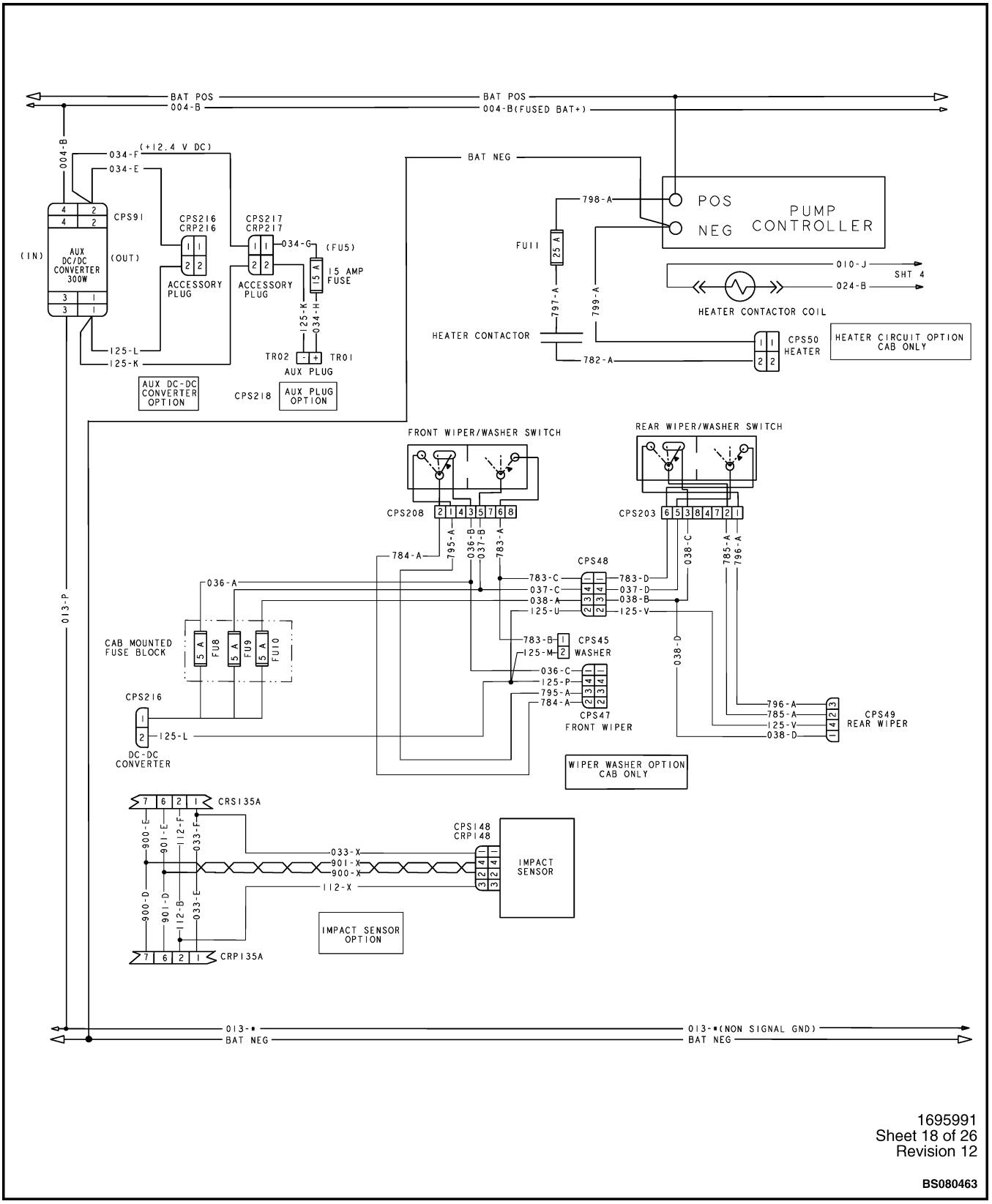

Figure 1. Wiring Diagram/Schematic (Sheet 18 of 26)

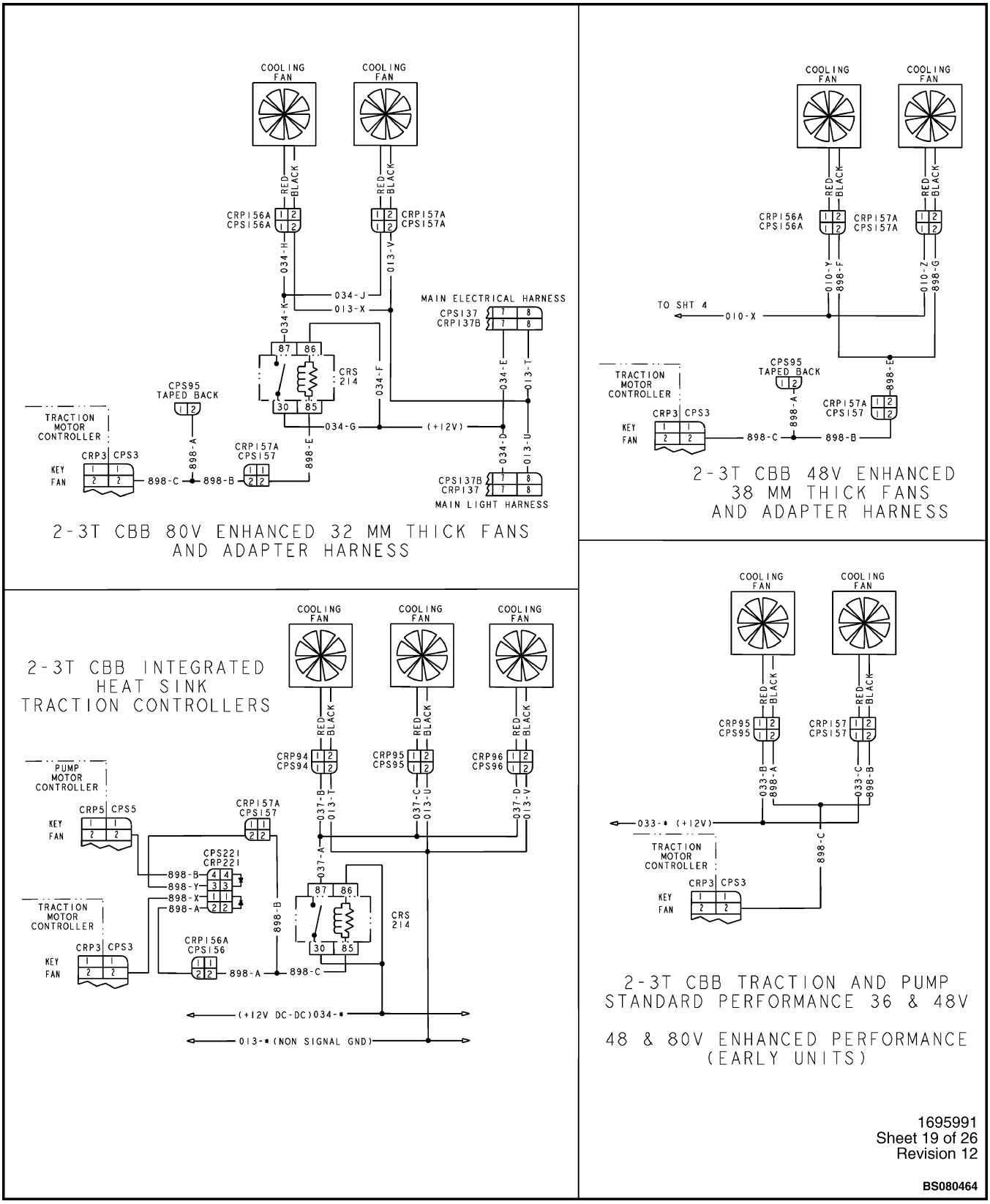

Figure 1. Wiring Diagram/Schematic (Sheet 19 of 26)

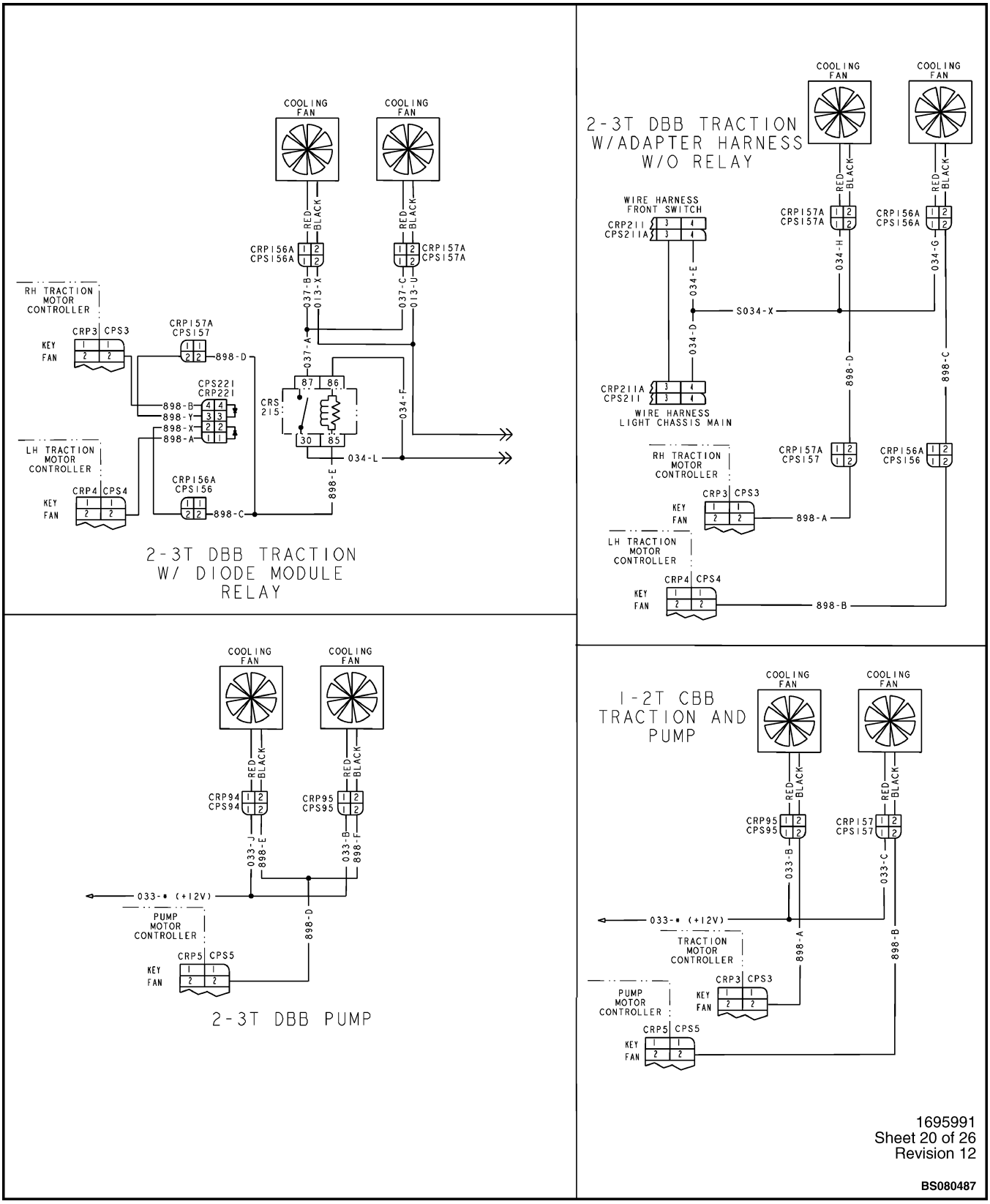

Figure 1. Wiring Diagram/Schematic (Sheet 20 of 26)

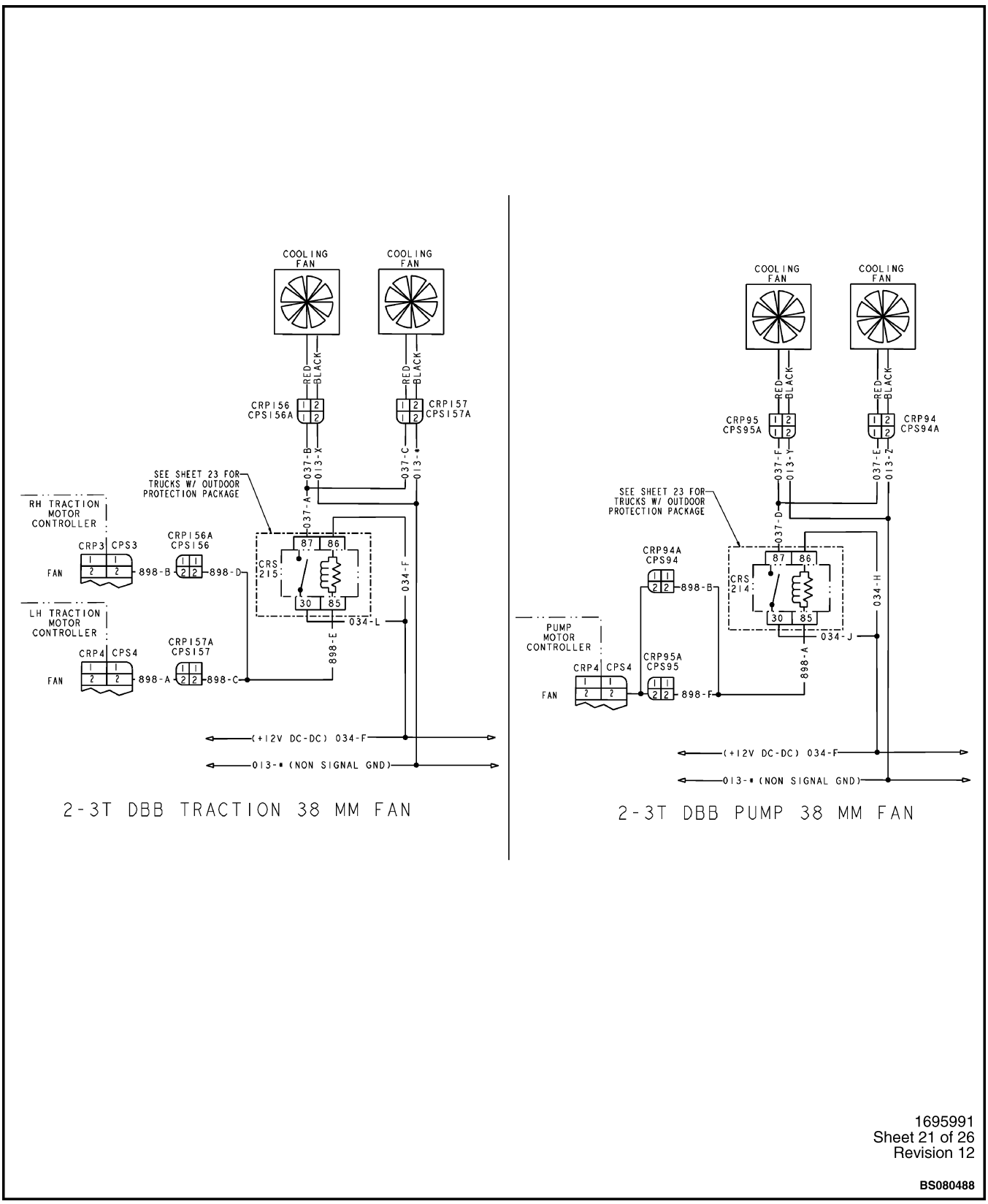

Figure 1. Wiring Diagram/Schematic (Sheet 21 of 26)

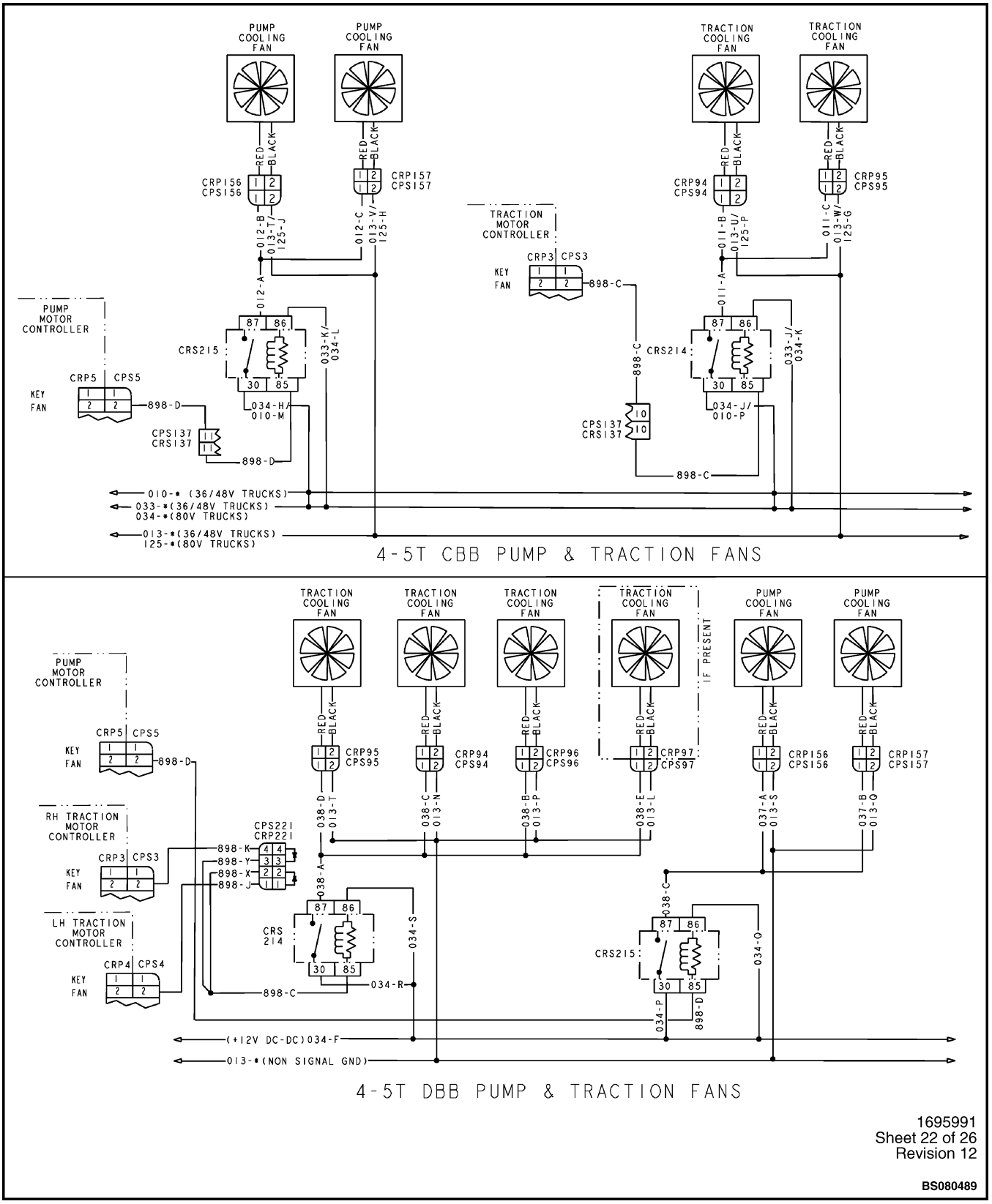

Figure 1. Wiring Diagram/Schematic (Sheet 22 of 26)

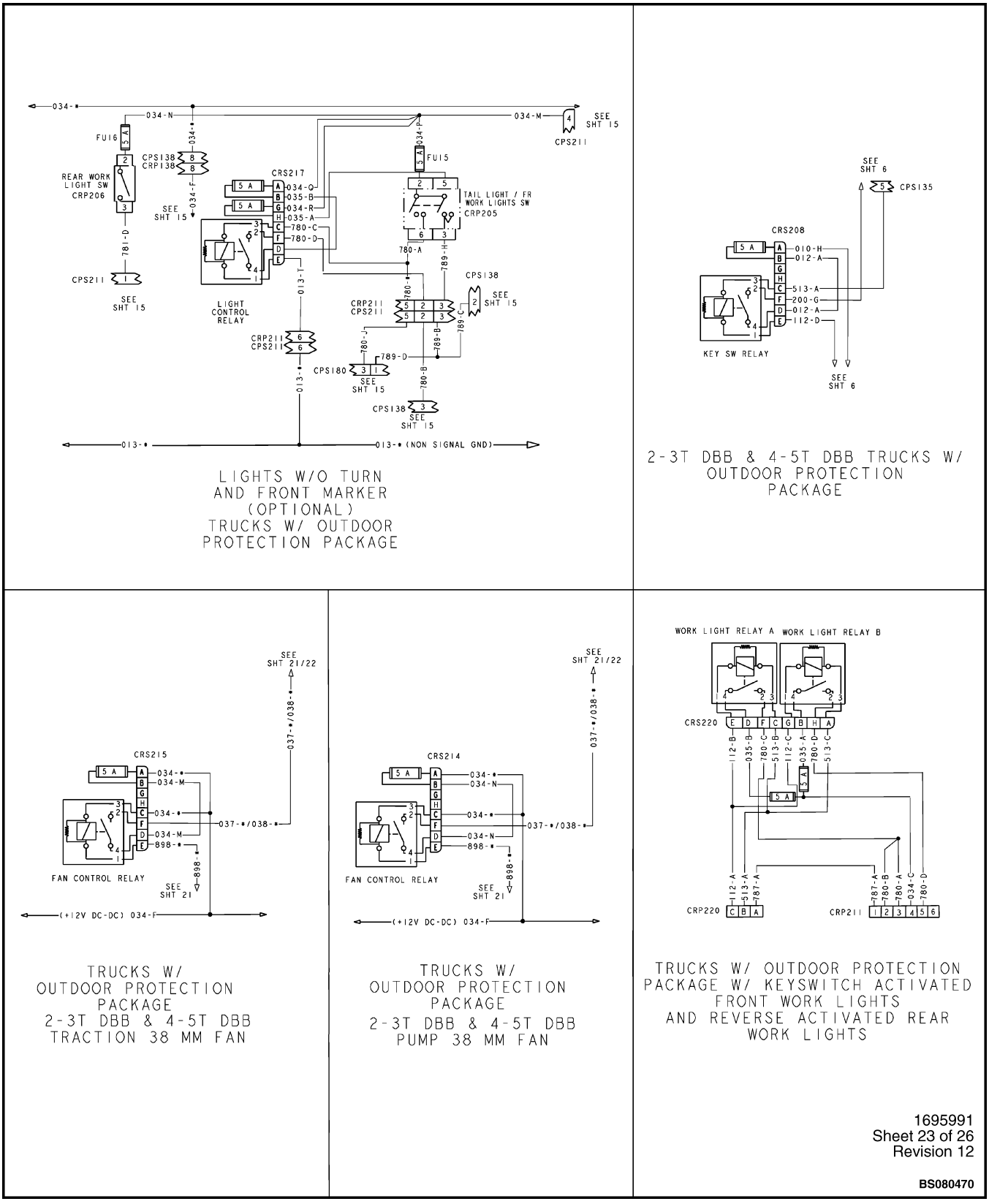

Figure 1. Wiring Diagram/Schematic (Sheet 23 of 26)

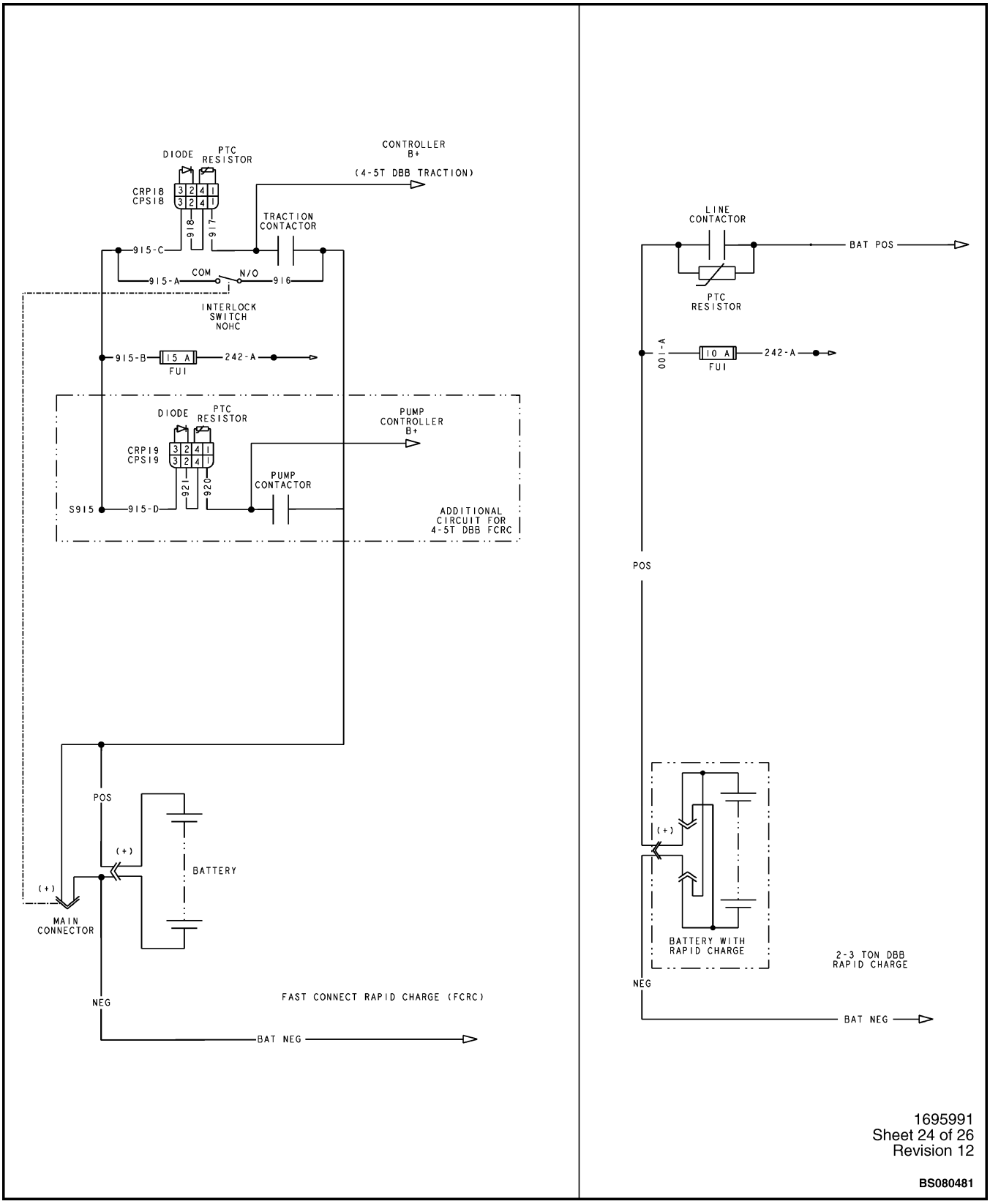

Figure 1. Wiring Diagram/Schematic (Sheet 24 of 26)

MAIN LIGHT AND MAIN ELECTRICAL HARNESSES - MY2014												
	1-2T CBB	2-3T CBB		2-3T DBB			4-5T CBB		4-5T DBB			
				STANDARD	W/ OUTDOOR PROTECTION				STANDARD	W/ OUTDOOR PROTECTION		
	36/48V	36/48V	80V	80V			36V/48V	80V	80V			
MAIN ELEC W/ E-HYDRAULICS	8816819	8816826		8812037	8811733		8816872		8812060	8817021		
MAIN ELEC W/ MANUAL HYDRAULICS	8816815	8816827		8812038	8811734		8816823		8812059	8817020		
MAIN LIGHTS CHASSIS HARNESS	8801041	8807413	8806805	8805883	8807639		8807518	8800707	N/A			
B/U ALARM/STROBE W/OUT DC-DC HARNESS	8802984	8807448		N/A			8804874		N/A			
TURN SIGNAL HARNESS	8804685	8804107		8804277			8804107		8802838			
WIRE HARNESS - DC/DC CONVERTER	8536974	8536974		8807926			8805110		8802378			
AUX PLUG HARNESSES	8803207	8800440		8800441			8807204		8800441			
SYNCHRONOUS STEERING HARNESS	N/A	8540234		8800003			8804453		8800003			
FAST CONNECT RAPID CHARGE	N/A	N/A		8812771			N/A		8817143			
FRONT SWITCH HARNESS	8817664	8817664		8817664	8818144		8817664		8817664	8818144		
INTERFACE HARNESS	8818106	8818143		8818169			8818170		8817171			

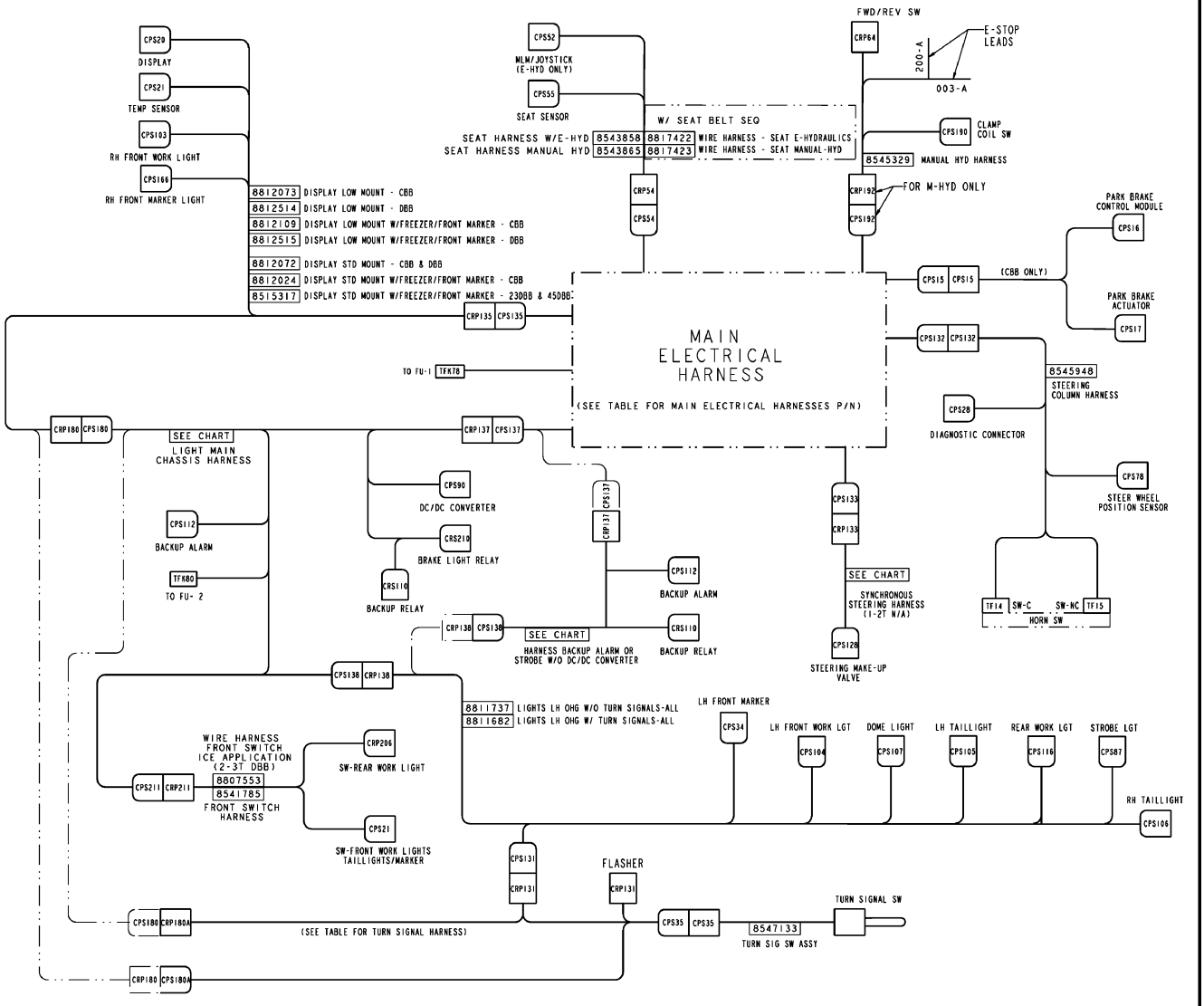

Figure 1. Wiring Diagram/Schematic (Sheet 25 of 26)

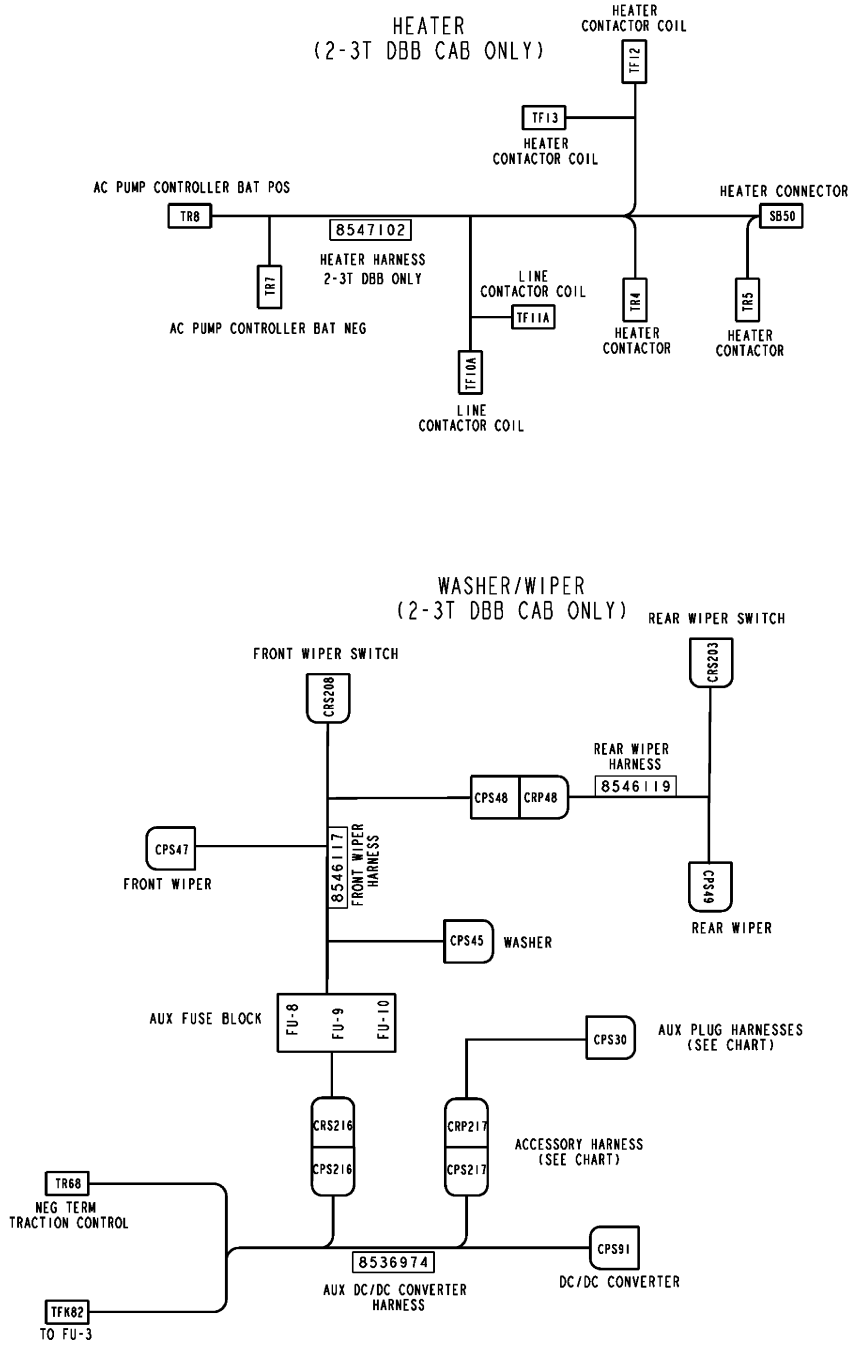

Figure 1. Wiring Diagram/Schematic (Sheet 26 of 26)

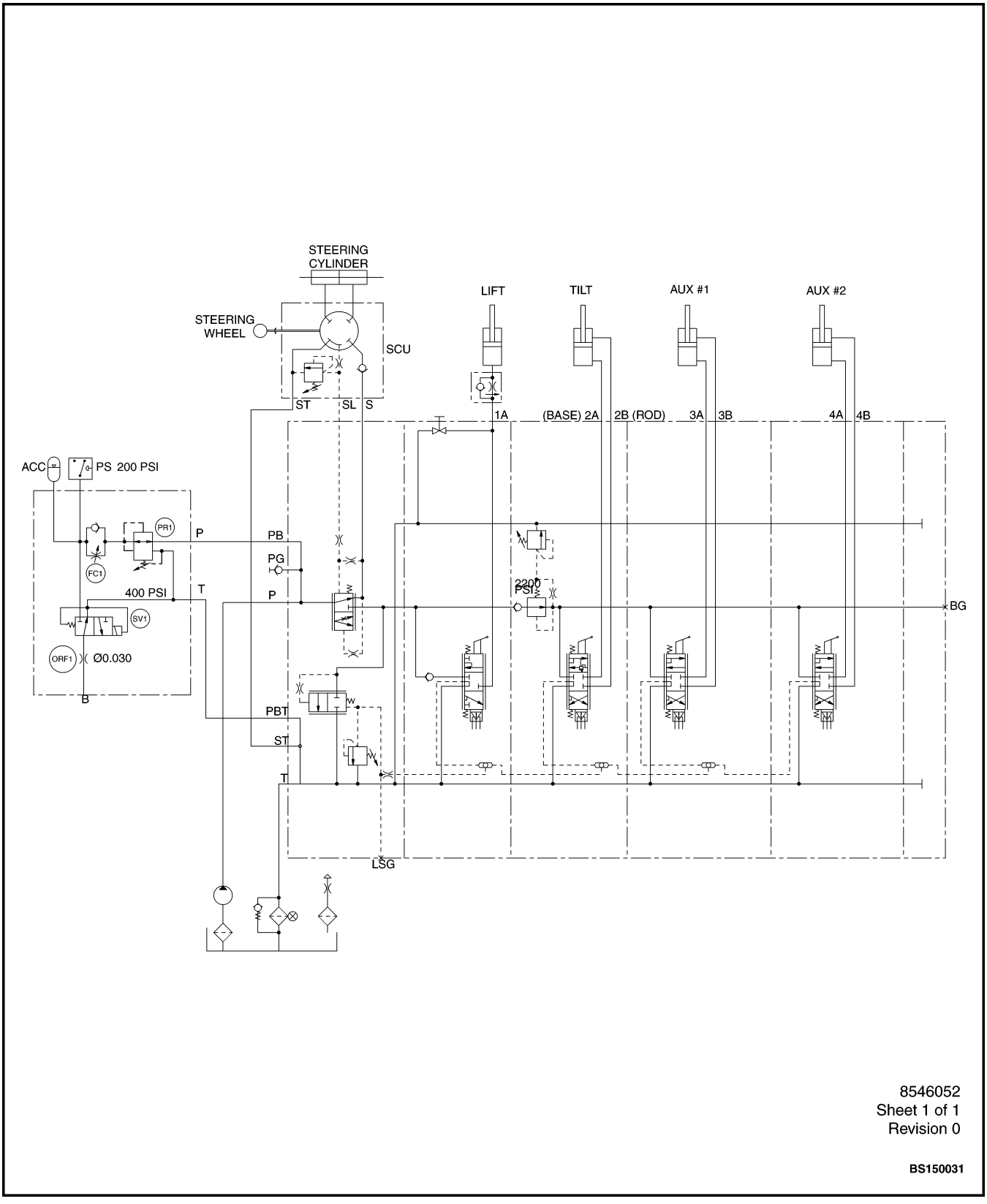

Figure 2. Manual Hydraulic Control Valve Schematic for J2.2-3.5XN (J45-70XN) (A276) (Built Prior to February, 2010)

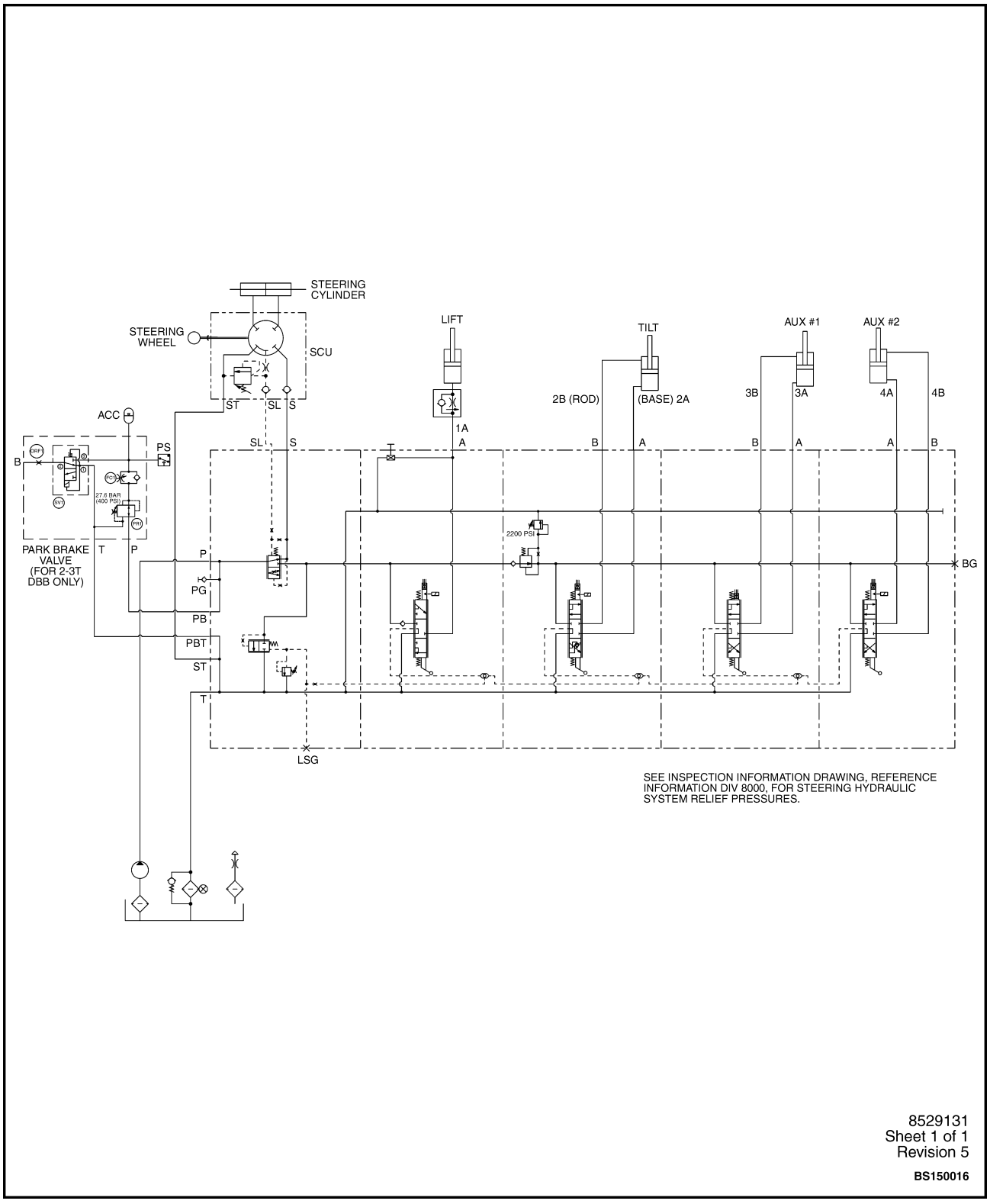

Figure 3. Manual Hydraulic Control Valve Schematic for E2.2-3.5XN (E45-70XN) (A268) and J2.2-3.5XN (J45-70XN) (A276) (Built After February, 2010)

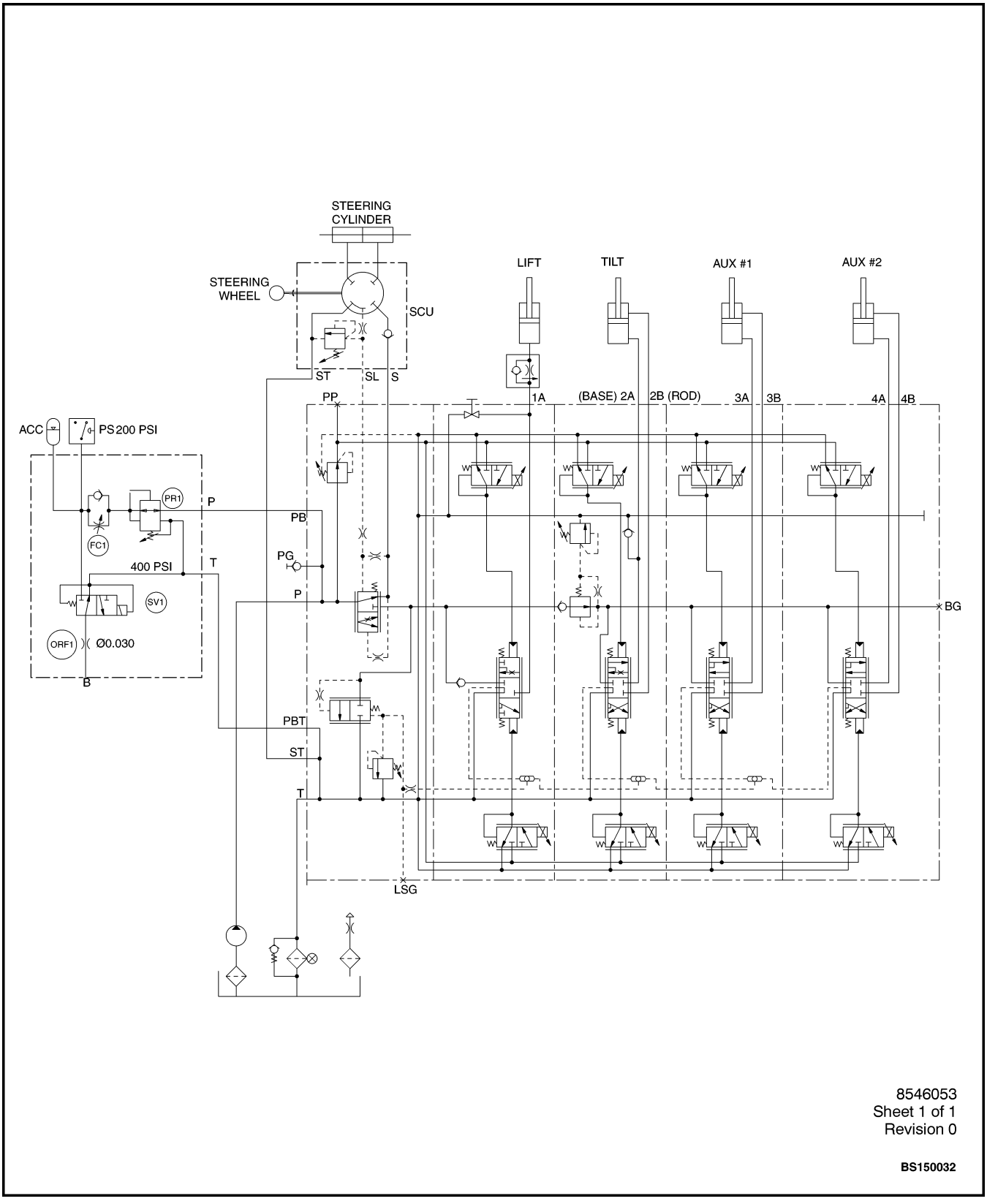

Figure 4. E-Hydraulic Control Valve Schematic for J2.2-3.5XN (J45-70XN) (A276) (Built Prior to February, 2010)

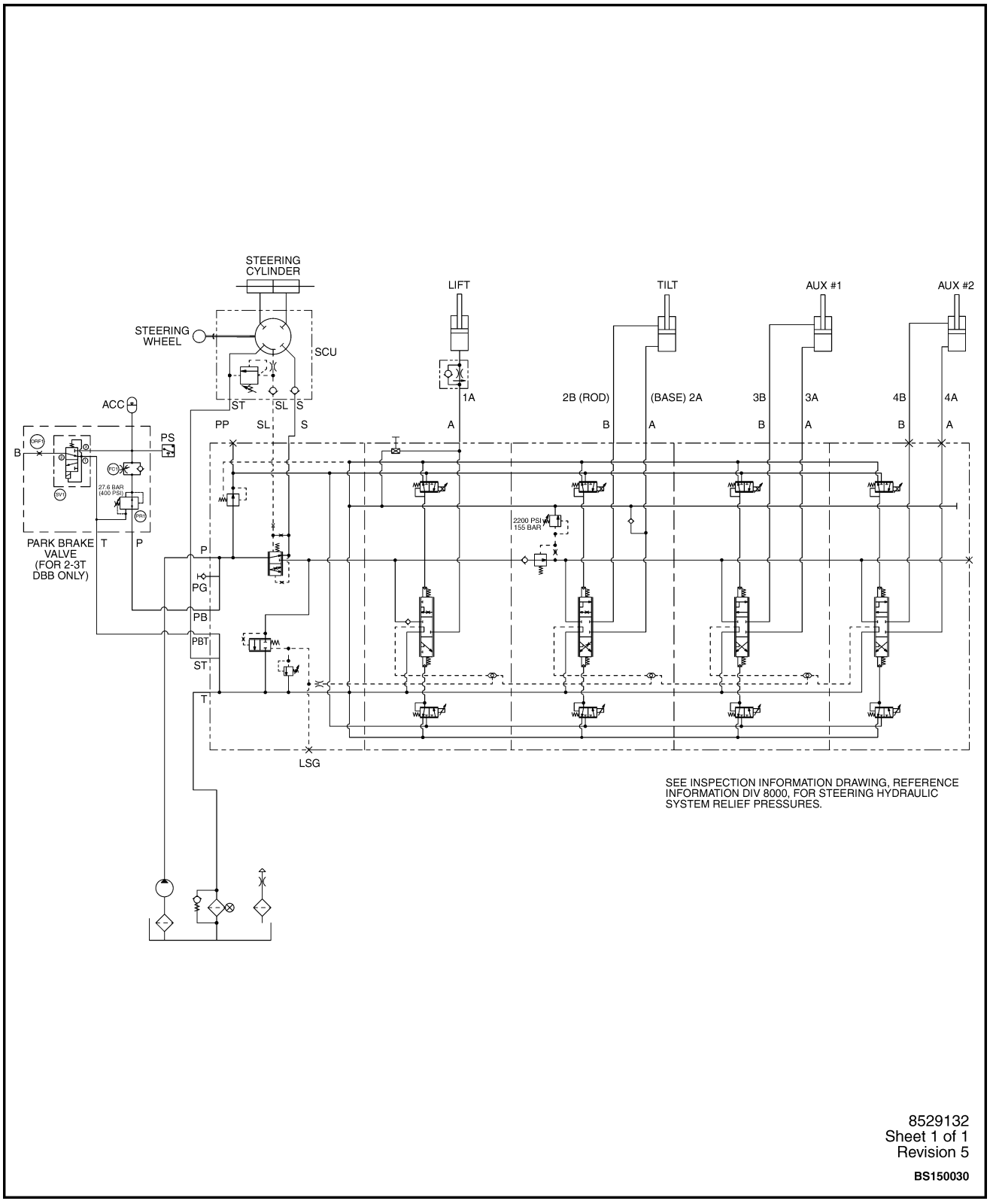

Figure 5. E-Hydraulic Control Valve Schematic for E2.2-3.5XN (E45-70XN) (A268) and J2.2-3.5XN (J45-70XN) (A276) (Built After February, 2010)

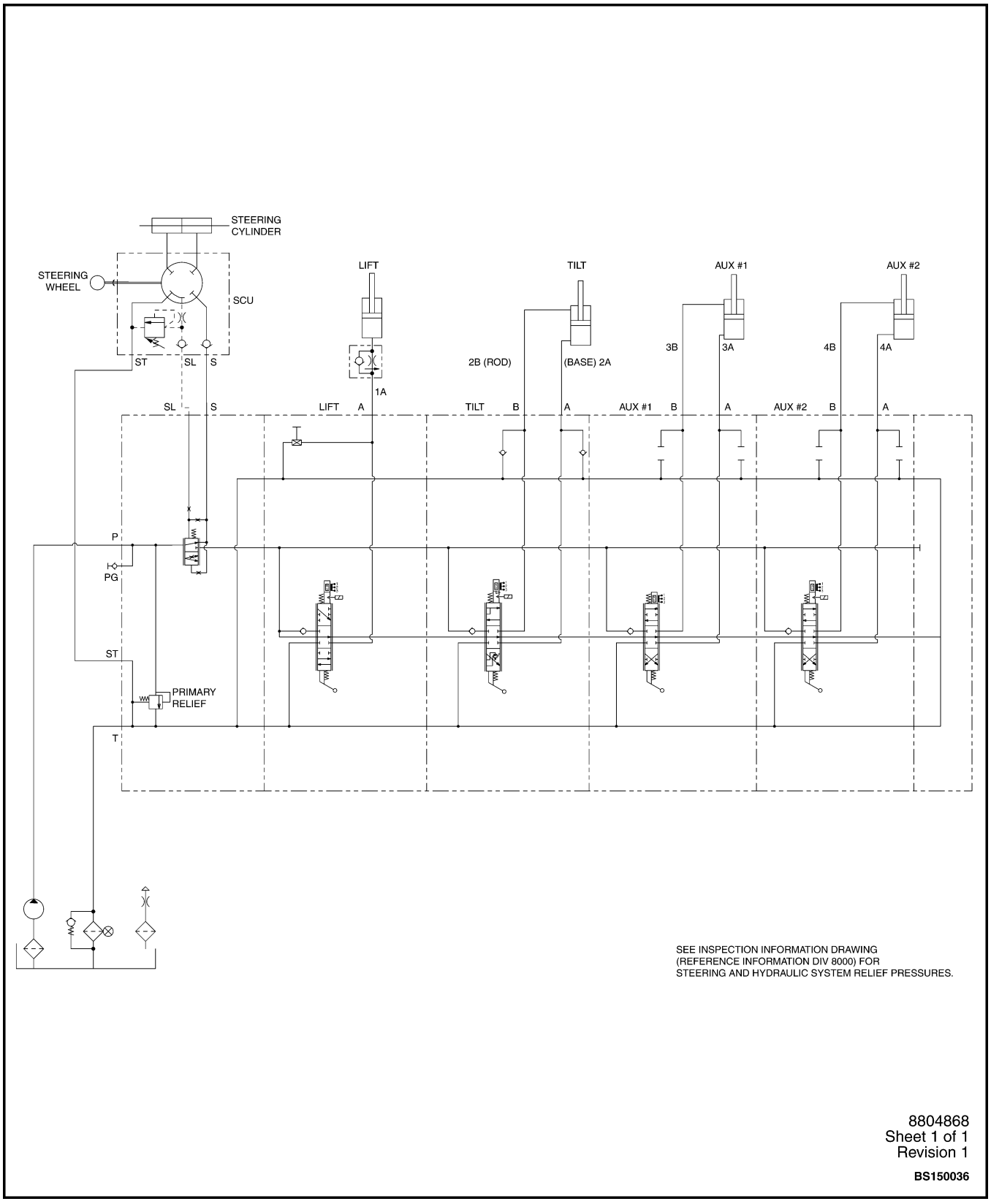

Figure 6. Manual Hydraulic Control Valve Schematic for E1.6-2.0XN (E30-40XN) (A269)

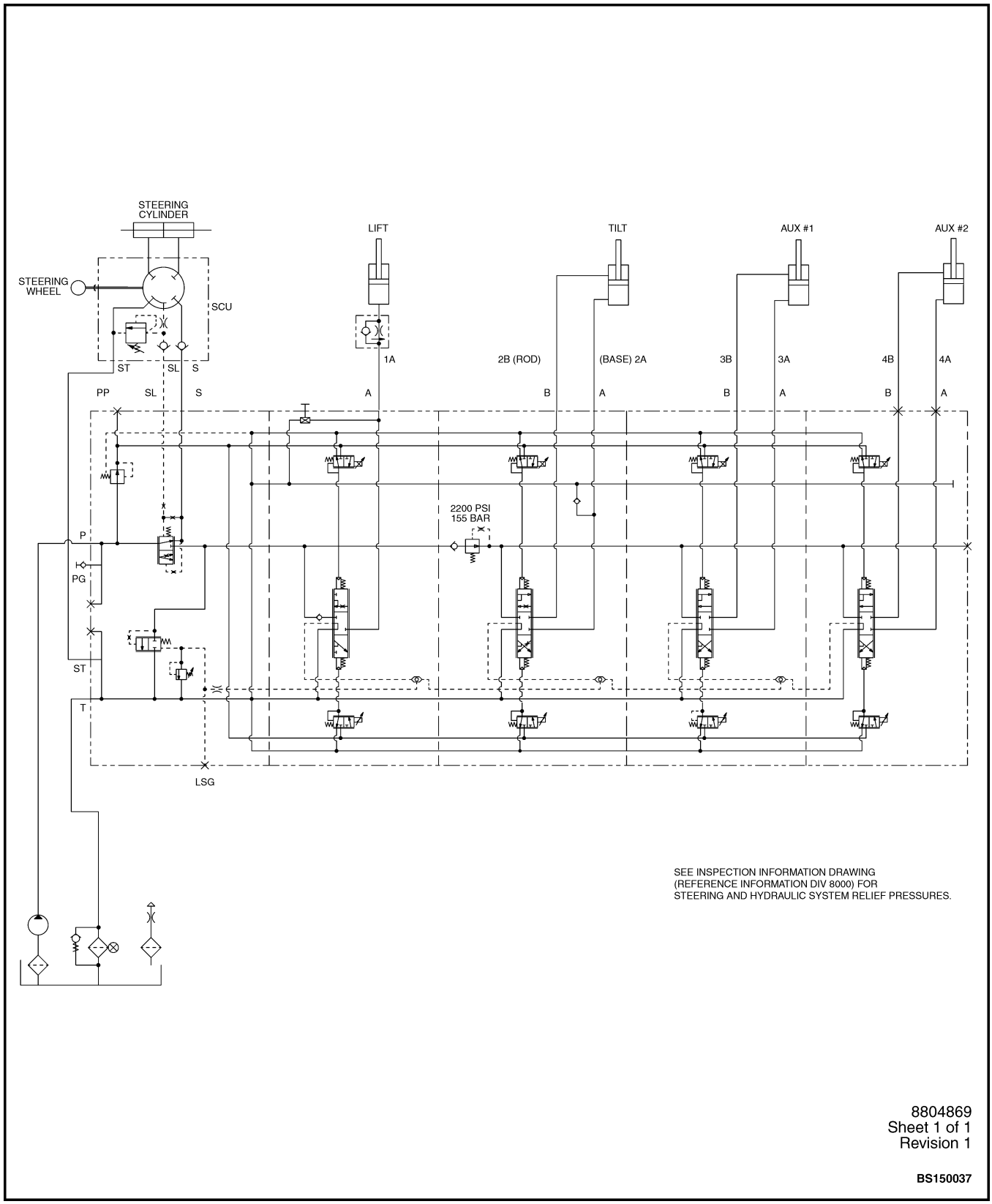

Figure 7. E-Hydraulic Control Valve Schematic for E1.6-2.0XN (E30-40XN) (A269)

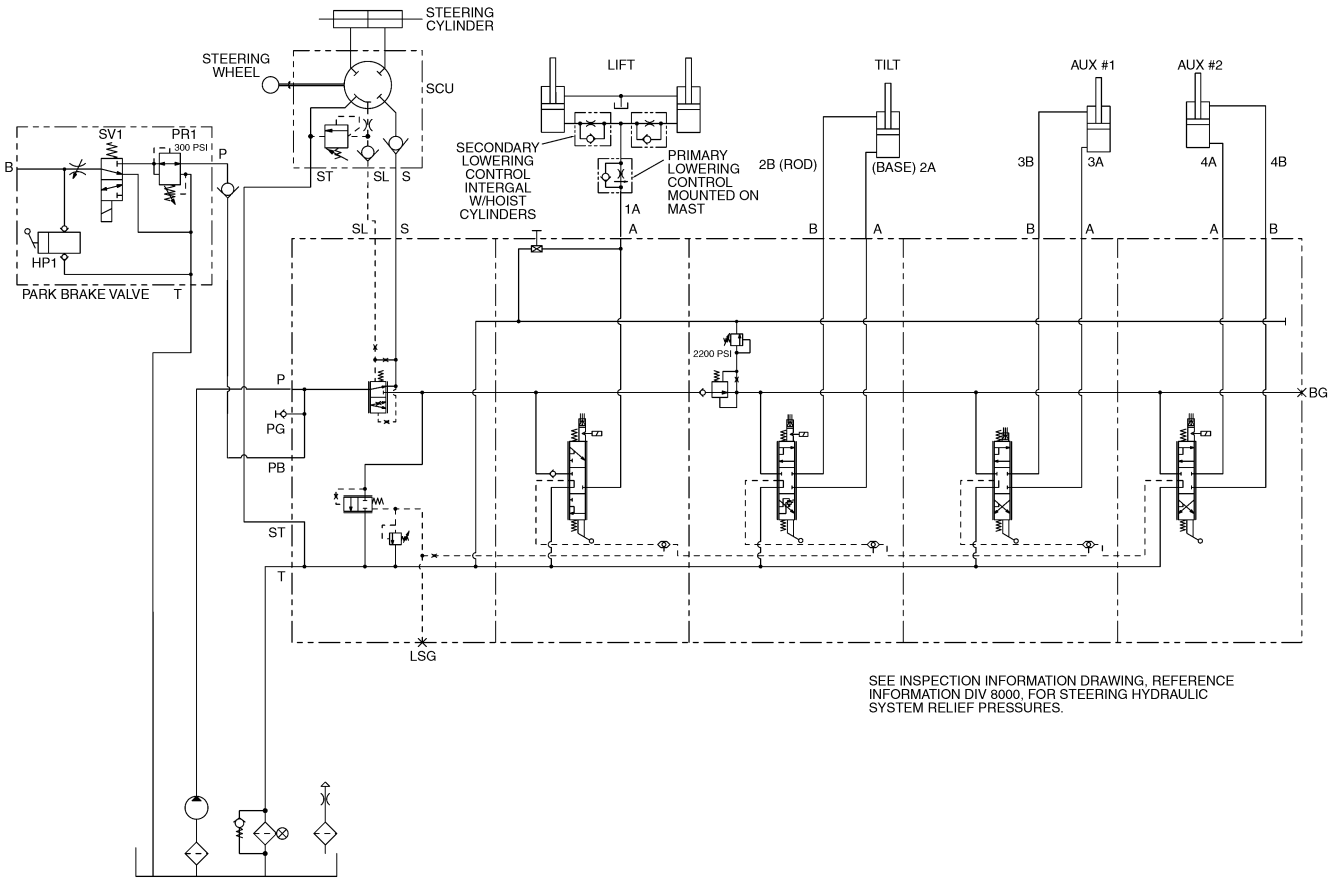

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Figure 8. Manual Hydraulic Schematic for J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

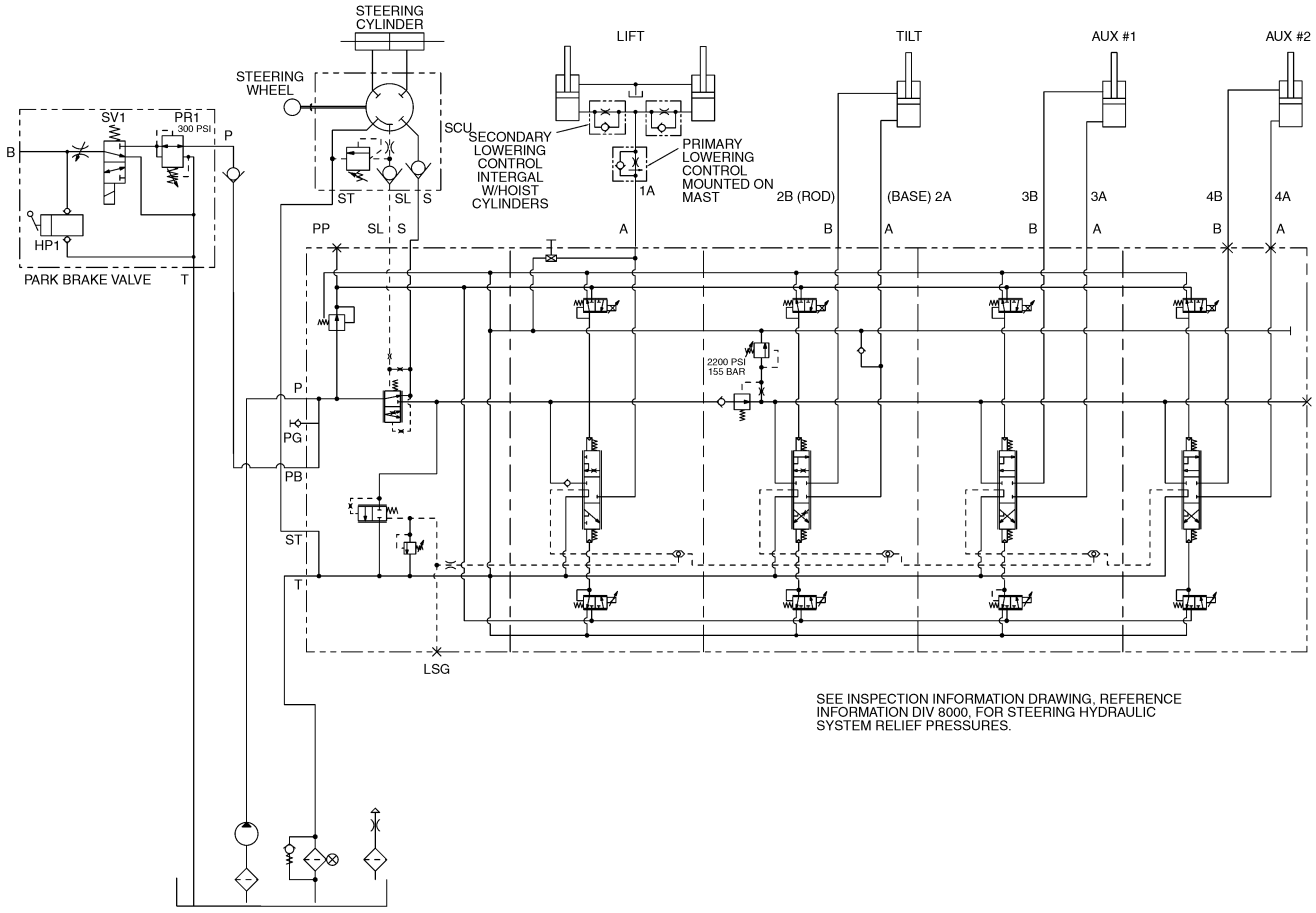

Figure 9. E-Hydraulic Schematic for J4.0-5.0XN, J5.0-5.5XN6 (J80-120XN, J100XNL) (A970)

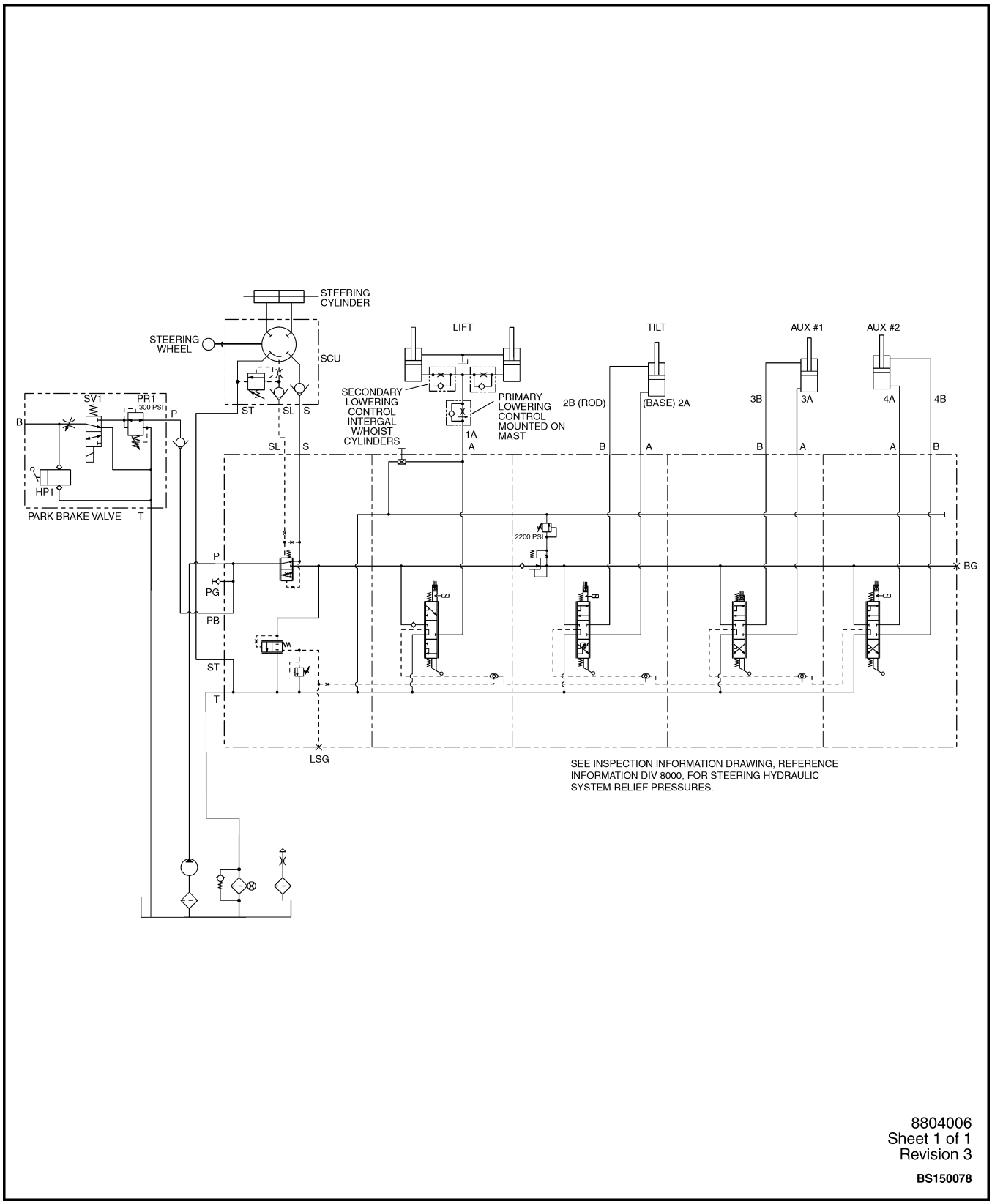

Figure 10. Manual Hydraulic Schematic for E4.0-5.5XN, E4.5XNS (E80-120XN, E100XNS) (A099)

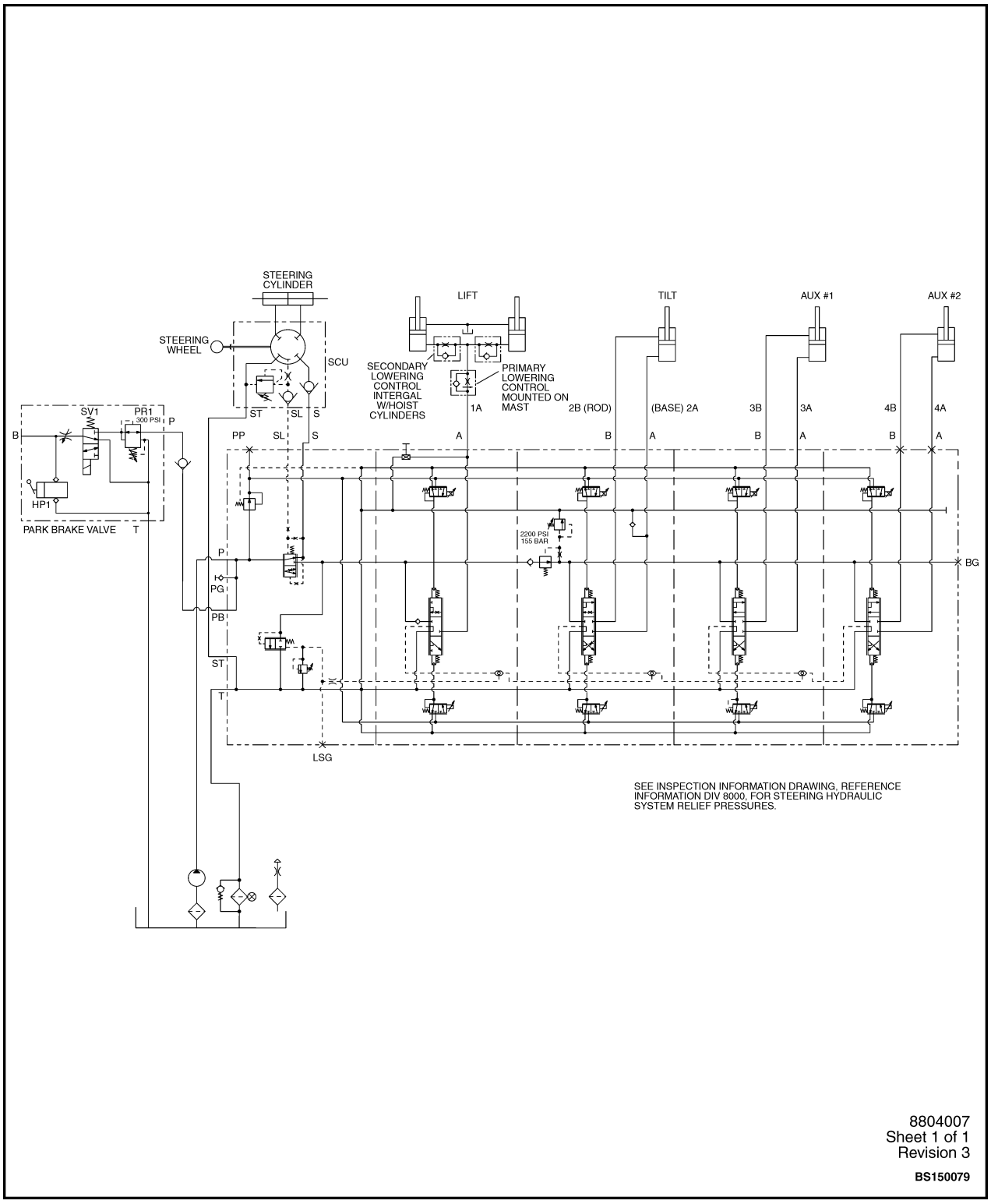

Figure 11. E-Hydraulic Schematic for E4.0-5.5XN, E4.5XNS (E80-120XN, E100XNS) (A099)

DIAGNOSTIC TROUBLESHOOTING MANUAL

E2.2-3.5XN (E45-70XN) [A268];
E1.6-2.0XN (E30-40XN) [A269];
J2.2-3.5XN (J45-70XN) [A276];
J1.6-2.0XN (J30-40XN) [A935];
J4.0-5.0XN (J80-100XN) [A970];
A1.3XNT, A1.5XNT (A25XNT, A30XNT) [D203];
J1.5-2.0XNT (J30-40XNT) [K160];
E4.0-5.5XN, E5.0XNS (E80-120XV, E100XNS) [A099]

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HYSTER

PART NO. 1688885 **9000 SRM 1377**

Safety Precautions TROUBLESHOOTING PROCEDURES

- The Service Manuals are updated on a regular basis, but may not reflect recent design changes to the product. Updated technical service information may be available from your local authorized Hyster® dealer. Service Manuals provide general guidelines for maintenance and service and are intended for use by trained and experienced technicians. Failure to properly maintain equipment or to follow instructions contained in the Service Manual could result in damage to the products, personal injury, property damage or death.
- When lifting parts or assemblies, make sure all slings, chains, or cables are correctly fastened, and that the load being lifted is balanced. Make sure the crane, cables, and chains have the capacity to support the weight of the load.
- Do not lift heavy parts by hand, use a lifting mechanism.
- Wear safety glasses.
- DISCONNECT THE BATTERY CONNECTOR before doing any maintenance or repair on electric lift trucks. Disconnect the battery ground cable on internal combustion lift trucks.
- Always use correct blocks to prevent the unit from rolling or falling. See HOW TO PUT THE LIFT TRUCK ON BLOCKS in the **Operating Manual** or the **Periodic Maintenance** section.
- Keep the unit clean and the working area clean and orderly.
- Use the correct tools for the job.
- Keep the tools clean and in good condition.
- Always use **HYSTER APPROVED** parts when making repairs. Replacement parts must meet or exceed the specifications of the original equipment manufacturer.
- Make sure all nuts, bolts, snap rings, and other fastening devices are removed before using force to remove parts.
- Always fasten a DO NOT OPERATE tag to the controls of the unit when making repairs, or if the unit needs repairs.
- Be sure to follow the **WARNING** and **CAUTION** notes in the instructions.
- Gasoline, Liquid Petroleum Gas (LPG), Compressed Natural Gas (CNG), and Diesel fuel are flammable. Be sure to follow the necessary safety precautions when handling these fuels and when working on these fuel systems.
- Batteries generate flammable gas when they are being charged. Keep fire and sparks away from the area. Make sure the area is well ventilated.

NOTE: The following symbols and words indicate safety information in this manual:

WARNING

Indicates a condition that can cause immediate death or injury!

CAUTION

Indicates a condition that can cause property damage!

On the lift truck, the WARNING symbol and word are on orange background. The CAUTION symbol and word are on yellow background.

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This section is for the following models:

E2.2-3.5XN (E45-70XN) [A268];
E1.6-2.0XN (E30-40XN) [A269];
J2.2-3.5XN (J45-70XN) [A276];
J1.6-2.0XN (J30-40XN) [A935];
J4.0-5.0XN (J80-100XN) [A970];
A1.3XNT, A1.5XNT (A25XNT, A30XNT) [D203];
J1.5-2.0XNT (J30-40XNT) [K160];
E4.0-5.5XN, E5.0XNS (E80-120XV, E100XNS) [A099]

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How To Use This Troubleshooting Manual

GENERAL INSTRUCTIONS AND SAFETY INFORMATION

WARNING

DO NOT add to or modify the lift truck. Any modification that affects the safe operation of the truck cannot be undertaken without written authorization of the Hyster company.

Any change to the lift truck, the tires, or its equipment can change the lifting capacity. The lift truck must be rated as equipped and the nameplate must show the new rating capacity.

WARNING

The technician must be aware of, and follow, all general safety precautions that are published in the Operating Manual and that are posted as Safety Decals on and in the lift truck.

Before starting, the technician should be familiar with certain policies, requirements, and instructions used in the troubleshooting procedures. Using the troubleshooting procedures correctly helps the technician to perform the procedure safely and prevents damage to the machine and support equipment.

HOW TO USE DIAGNOSTIC TROUBLESHOOTING MANUAL

Manual Layout:

Sections: The manual is divided into eight sections, each representing a major system, functional area, or specific operation on the lift truck.

- 9010 – Operational Diagnostic Procedures
- 9025 – Traction Motor
- 9030 – Electrical System
- 9035 – Drive Axle/Unit
- 9050 – Hydraulic Systems
- 9060 – Operator's Station
- 9070 – Front End (Mast) and Chassis
- 9080 – Supplementary Data

Groups: The sections of the manual are further subdivided into groups, where applicable, that identify specific functions, operating criteria, or maintenance tasks.

- 01 – Introduction to the Troubleshooting Manual
- 03 – General Maintenance/Diagnostic Data
- 05 – Operational Checkout
- 10 – Principles of Operation
- 20 – Diagnostic Trouble Codes
- 30 – Observed Symptoms
- 33 – Observed Symptoms – Gear Pump
- 43 – Test and Adjustments – Gear Pump
- 50 – Abbreviation and Acronyms
- 55 – Icons and Graphics
- 70 – Fault Mode Indicator Reference

For Diagnostic Trouble Code listings, see Electrical System, General Maintenance and Diagnostic Data, Diagnostic Trouble Codes, Page 9030-03-6.

NOTE: Not all groups will appear in all sections.

Supplementary Data: The supplementary data section of the manual includes information and data that apply to many sections or groups and is stored here for access by all users of the manual. This data includes, but is not limited to:

- Abbreviations and Acronyms
- Special Tools List
- Fault Mode Indication Reference Table
- Supplier Specification Data

GENERAL INSTRUCTIONS

1 Become familiar with the content, layout, and access provisions of data in this manual. This will improve your efficiency and decrease the time required to resolve the problems.

2 Use all sections of the manual for relevant information on the subject system.

3 Once you begin a troubleshooting procedure, do not skip steps.

4 If you reach the end of a procedure without resolving the problem and you are not directed to another procedure contact Resident Service Engineering through the Contact Management System.

5 Do not limit yourself, remember to apply your own experience and knowledge to assist in resolving the problems, but do not compromise safety in doing so.

6 Most of the cross-reference data in the manual will be electronically linked for rapid and easy access. Use the links wherever the cursor highlights an item as a linkable option.

As an example of this linking option:

Assume that during a procedure or test, it is necessary to refer to a different section of manual, in this case, the Light Circuit Check in the Operational Checkout part of this manual.

The instruction would read, "refer to, or see" followed by text identifying what the reference is (for hard-copy, paper manual use). When the cursor is placed over the text, it will then indicate that it is active, and left-clicking will direct the system to take you directly to that reference.

Try it using the process below:

See Operational Diagnostic Procedures, Operational Checkout, Page 9010-05-4.

When you have reviewed the reference document or manual, and need to return to the troubleshooting procedure, the "BACK" button will permit you to do this.

Service Manual Lookup

The following service manuals are referenced throughout this manual. Be sure to have the correct service manual for your lift truck model.

AC Motor Repair 0620SRM1385

- E2.2-3.5XN (E45-70XN) (A268)
- E1.6-2.0XN (E30-40XN) (A269)
- J2.2-3.5XN (J45-70XN) (A276)
- J4.0-5.0XN (A970)
- J1.5-2.0XNT (J30-40XNT) (K160)
- J1.6-2.0XN (J30-40XN) (A935)
- E4.0-5.5XN, 5.0XNS (E80-120XN, E100XNS) (A099)

AC Motor Repair 0620SRM1515

- A1.3-1.5XNT (A25XNT, A30XNT) (D203)

Brake System 1800SRM1332

- J1.5-2.0XNT (J30-40XNT) (K160)
- J1.6-2.0XN (J30-40XN) (A935)

Brake System 1800SRM1359

- E2.2-3.5XN (E45-70XN) (A268)

Brake System 1800SRM1438

- E1.6-2.0XN (E30-40XN) (A269)

Brake System 1800SRM1518

- A1.3-1.5XNT (A25XNT, A30XNT) (D203)

Capacities and Specifications 8000SRM1340

- J1.5-2.0XNT (J30-40XNT) (K160)

Capacities and Specifications 8000SRM1374

- E2.2-3.5XN (E45-70XN) (A268)

Capacities And Specifications 8000SRM1375

- J2.2-3.5XN (J45-70XN) (A276)

Capacities and Specifications 8000SRM1376

- J1.6-2.0XN (J30-40XN) (A935)

Capacities and Specifications 8000SRM1443

- E1.6-2.0XN (E30-40XN) (A269)

Capacities and Specifications 8000SRM1527

- A1.3-1.5XNT (A25XNT, A30XNT) (D203)

Capacities and Specifications 8000SRM1542

- J4.0-5.0XN (A970)

Capacities and Specifications 8000SRM1578

- E4.0-5.5XN, 5.0XNS (E80-120XN, E100XNS) (A099)

Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564) 2100SRM1382

- E2.2-3.5XN (E45-70XN) (A268)
- J2.2-3.5XN (J45-70XN) (A276)
- J1.5-2.0XNT (J30-40XNT) (K160)
- J1.6-2.0XN (J30-40XN) (A935)
- J4.0-5.0XN (A970)
- E4.0-5.5XN, 5.0XNS (E80-120XN, E100XNS) (A099)

Cylinder Repair (Mast S/N B551, B555, B559) 2100SRM1440

- E1.6-2.0XN (E30-40XN) (A269)

Cylinder Repair (Mast S/N A270, A271, A272, C661, C662, C663) 2100SRM1521

- A1.3-1.5XNT (A25XNT, A30XNT) (D203)

Diagrams 8000SRM1341

- J1.5-2.0XNT (J30-40XNT) (K160)
- J1.6-2.0XN (J30-40XN) (A935)

Diagrams 8000SRM1384

- E2.2-3.5XN (E45-70XN) (A268)
- E1.6-2.0XN (E30-40XN) (A269)
- J2.2-3.5XN (J45-70XN) (A276)
- J4.0-5.0XN (A970)
- E4.0-5.5XN, 5.0XNS (E80-120XN, E100XNS) (A099)

Diagrams 8000SRM1528

- A1.3-1.5XNT (A25XNT, A30XNT) (D203)

Drive Axle Repair 1300SRM1575

- E4.0-5.5XN, 5.0XNS (E80-120XN, E100XNS) (A099)

Drive Axle, Speed Reducer, and Differential 1300SRM1366

- E2.2-3.5XN (E45-70XN) (A268)
- E1.6-2.0XN (E30-40XN) (A269)

Electrical System 2200SRM1337

- J1.5-2.0XNT (J30-40XNT) (K160)
- J1.6-2.0XN (J30-40XN) (A935)

Electrical System 2200SRM1369

- E2.2-3.5XN (E45-70XN) (A268)
- E1.6-2.0XN (E30-40XN) (A269)
- J2.2-3.5XN (J45-70XN) (A276)
- J4.0-5.0XN (A970)

- E4.0-5.5XN, 5.0XNS (E80-120XN, E100XNS) (A099)

Electrical System 2200SRM1524

- A1.3-1.5XNT (A25XNT, A30XNT) (D203)

Frame 0100SRM1329

- J1.5-2.0XNT (J30-40XNT) (K160)
- J1.6-2.0XN (J30-40XN) (A935)

Frame 0100SRM1342

- E2.2-3.5XN (E45-70XN) (A268)
- E1.6-2.0XN (E30-40XN) (A269)
- J2.2-3.5XN (J45-70XN) (A276)
- J4.0-5.0XN (A970)
- E4.0-5.5XN, 5.0XNS (E80-120XN, E100XNS) (A099)

Frame 0100SRM1514

- A1.3-1.5XNT (A25XNT, A30XNT) (D203)

Hydraulic System 1900SRM1333

- J1.5-2.0XNT (J30-40XNT) (K160)
- J1.6-2.0XN (J30-40XN) (A935)

Hydraulic System 1900SRM1367

- E2.2-3.5XN (E45-70XN) (A268)
- E1.6-2.0XN (E30-40XN) (A269)
- J2.2-3.5XN (J45-70XN) (A276)
- J4.0-5.0XN (A970)
- E4.0-5.5XN, 5.0XNS (E80-120XN, E100XNS) (A099)

Hydraulic System 1900SRM1519

- A1.3-1.5XNT (A25XNT, A30XNT) (D203)

Hydraulic Cleanliness Procedures 1900SRM1620

ALL LIFT TRUCK MODELS

Industrial Battery 2240SRM0001

ALL LIFT TRUCK MODELS

Load Axle 1300SRM1516

- A1.3-1.5XNT (A25XNT, A30XNT) (D203)

Main Control Valves 2000SRM1334

- E2.2-3.5XN (E45-70XN) (A268)
- J2.2-3.5XN (J45-70XN) (A276)
- J4.0-5.0XN (A970)
- E4.0-5.5XN, 5.0XNS (E80-120XN, E100XNS) (A099)
- J1.5-2.0XNT (J30-40XNT) (K160)
- J1.6-2.0XN (J30-40XN) (A935)

Main Control Valves 2000SRM1439

- E1.6-2.0XN (E30-40XN) (A269)

Main Control Valves 2000SRM1520

- A1.3-1.5XNT (A25XNT, A30XNT) (D203)

Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564) 4000SRM1338

- E2.2-3.5XN (E45-70XN) (A268)
- J2.2-3.5XN (J45-70XN) (A276)

Mast Repair (S/N A270, A271, A272) 4000SRM1386

- J1.5-2.0XNT (J30-40XNT) (K160)
- J1.6-2.0XN (J30-40XN) (A935)

Mast Repair (S/N C661, C662, C663, C665) 4000SRM1405

- J1.5-2.0XNT (J30-40XNT) (K160)
- J1.6-2.0XN (J30-40XN) (A935)

Mast Repair (S/N B551, B555, and B559) 4000SRM1441

- E1.6-2.0XN (E30-40XN) (A269)

Mast Repair (S/N A270, A271, C662, and C663) 4000SRM1525

- A1.3-1.5XNT (A25XNT, A30XNT) (D203)

Mast Repair (S/N A626-27, A751-52, B590-91, and B749-54) 4000SRM1540

- J4.0-5.0XN (A970)

Mast Repairs (S/N A551, A555, A559, A751, A752, B586, B587, B588, B590, B591, B749, B750, B751, B752, and B754) 4000SRM1576

- E4.0-5.5XN, 5.0XNS (E80-120XN, E100XNS) (A099)

Operator's Cab 0100SRM1446

- E2.2-3.5XN (E45-70XN) (A268)
- J2.2-3.5XN (J45-70XN) (A276)
- J4.0-5.0XN (A970)
- J1.5-2.0XNT (J30-40XNT) (K160)
- J1.6-2.0XN (J30-40XN) (A935)
- A1.3-1.5XNT (A25XNT, A30XNT) (D203)

Periodic Maintenance 8000SRM1339

- J1.5-2.0XNT (J30-40XNT) (K160)

Periodic Maintenance 8000SRM1364

- E2.2-3.5XN (E45-70XN) (A268)

Periodic Maintenance 8000SRM1372

- J2.2-3.5XN (J45-70XN) (A276)

Periodic Maintenance 8000SRM1373

- J1.6-2.0XN (J30-40XN) (A935)

Periodic Maintenance 8000SRM1442

- E1.6-2.0XN (E30-40XN) (A269)

Periodic Maintenance 8000SRM1541

- J4.0-5.0XN (A970)

Periodic Maintenance 8000SRM1526

- A1.3-1.5XNT (A25XNT, A30XNT) (D203)

Periodic Maintenance 8000SRM1577

- E4.0-5.5XN, 5.0XNS (E80-120XN, E100XNS) (A099)

Steering Axle 1600SRM1360

- E2.2-3.5XN (E45-70XN) (A268)
- E1.6-2.0XN (E30-40XN) (A269)
- J2.2-3.5XN (J45-70XN) (A276)
- J1.6-2.0XN (J30-40XN) (A935)
- J4.0-5.0XN (A970)
- E4.0-5.5XN, 5.0XNS (E80-120XN, E100XNS) (A099)

Steering System 1600SRM1331

- J1.5-2.0XNT (J30-40XNT) (K160)

Steering System 1600SRM1363

- E2.2-3.5XN (E45-70XN) (A268)
- E1.6-2.0XN (E30-40XN) (A269)
- J2.2-3.5XN (J45-70XN) (A276)
- J1.6-2.0XN (J30-40XN) (A935)
- J4.0-5.0XN (A970)
- E4.0-5.5XN, 5.0XNS (E80-120XN, E100XNS) (A099)

Steering System 1600SRM1517

- A1.3-1.5XNT (A25XNT, A30XNT) (D203)

Transaxle 1300SRM1330

- J1.5-2.0XNT (J30-40XNT) (K160)
- J1.6-2.0XN (J30-40XN) (A935)

Transaxle 1300SRM1370

- J2.2-3.5XN (J45-70XN) (A276)

Transaxle 1300SRM1539

- J4.0-5.0XN (A970)

User Interface Service Technician 2200SRM1336

ALL LIFT TRUCK MODELS

User Interface Supervisor 2200SRM1335

ALL LIFT TRUCK MODELS

Wire Harness Repair 2200SRM1128

ALL LIFT TRUCK MODELS

Conventional Battery Box (CBB) Units

CONVENTIONAL BATTERY BOX (CBB) UNITS

The Operator's seat is higher due to the position of the battery box which sits above the axles for these units. See Figure 9000-01-1.

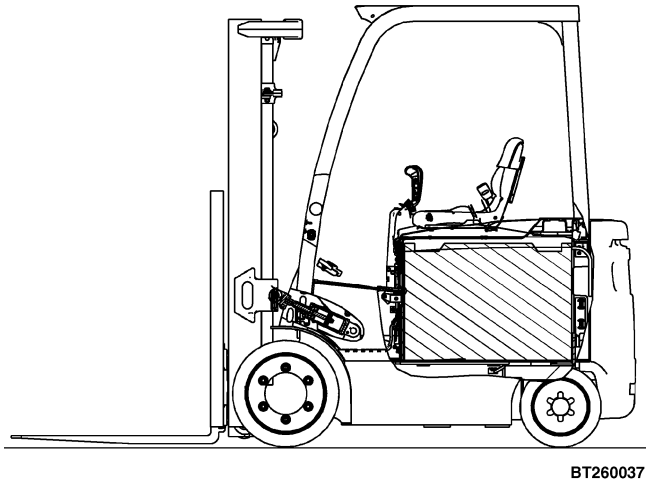

Figure 9000-01-1. Conventional Battery Box

Hyster Unit Code	European Model Designation	America Model Designation
A269	E1.6-2.0XN	E30-40XN
A268	E2.2-3.5XN	E45-70XN
A099	E4.0-5.5XN, E4.5XNS	E80-120XN, E100XNS

DROP BATTERY BOX (DBB) UNITS

The battery is “dropped” between the front and rear axles (or wheels) for these units. See Figure 9000-01-2.

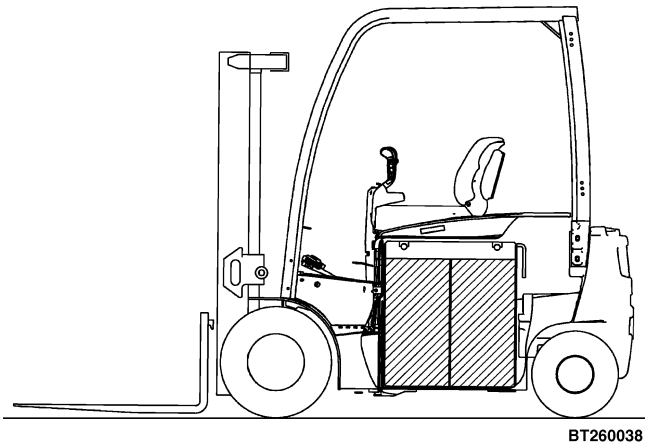

Figure 9000-01-2. Drop Battery Box

Hyster Unit Code	European Model Designation	America Model Designation
D203	A1.3XNT, A1.5XNT	A25XNT, A30XNT
K160	J1.5-2.0XNT	J30-40XNT
A935	J1.6-2.0XN	J30-40XN
A276	J2.2-3.5XN	J45-70XN
A970	J4.0-5.0XN	J80-100XN

FOC2 Software Updates

FOC2 SOFTWARE UPDATES

FOC2 traction controllers with software versions 112 or newer, follow troubleshooting procedures in this manual. For FOC2 traction controllers with older software versions (like 107, 108), refer to Table 9000-01-1.

Checking Version Information Using Display

To verify controller version using the display, perform the following procedures:

1. Turn key to ON position.
2. Enter service password.

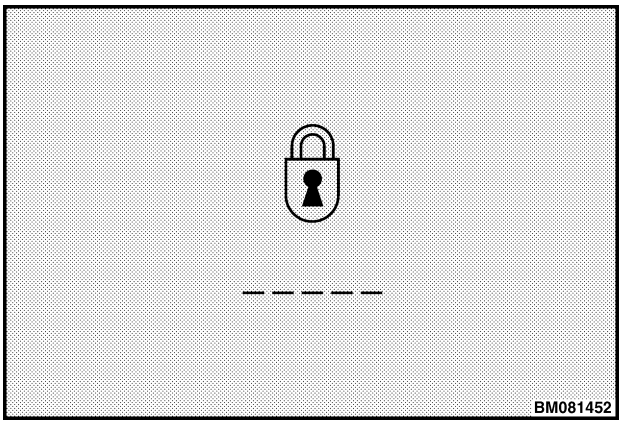

Figure 9000-01-1. Service Password

3. Scroll left or right to locate ***Truck Status***.

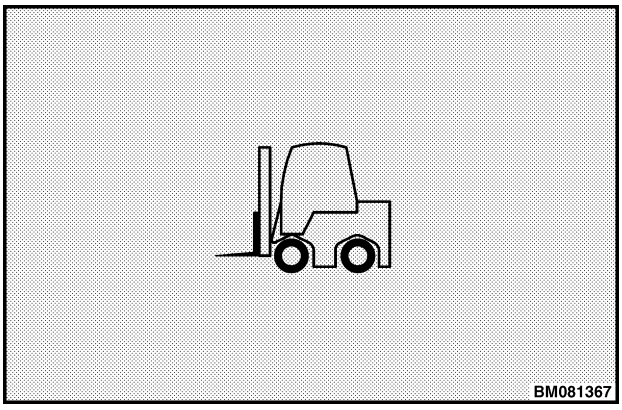

Figure 9000-01-2. Truck Status

4. Scroll up or down to ***Traction 1***.
5. Check software version or Software ID.

Checking Version Information Using PC Service Tool

To verify controller version using the PC Service Tool, perform the following procedures:

1. Launch PC Service Tool.
2. Connect to truck.
3. Select ***Diagnostics*** tab.
4. Scroll down and located ***Truck Information***.
5. Check Software ID.

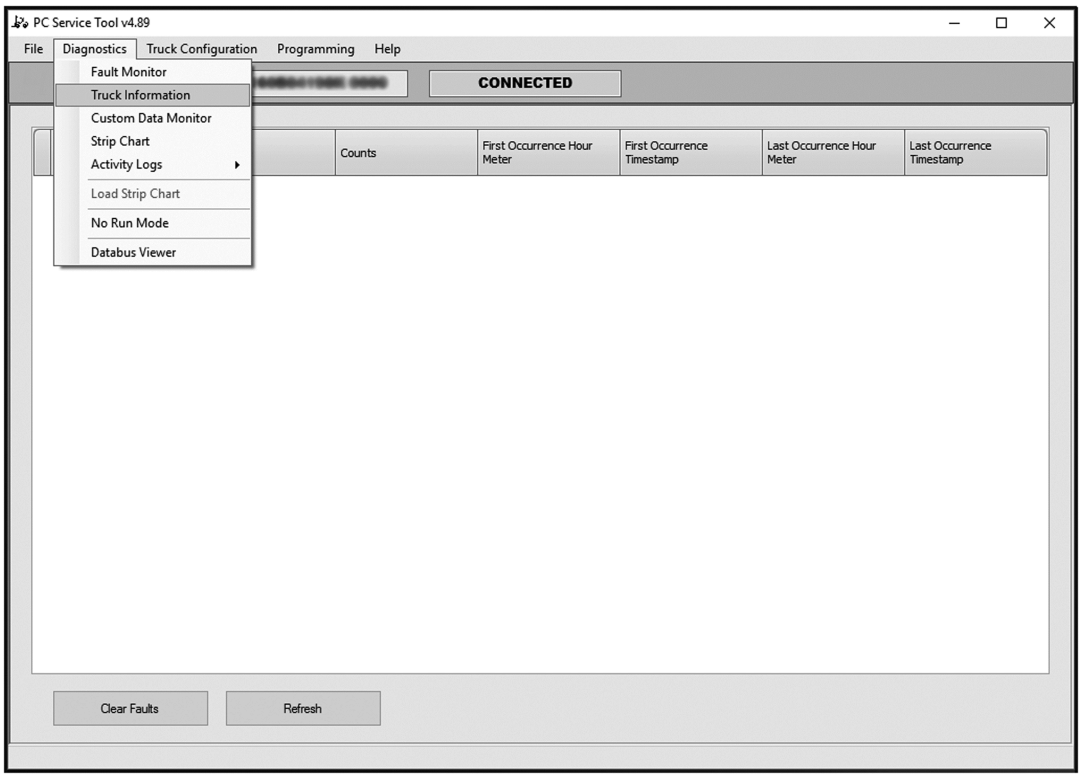

Figure 9000-01-3. Truck Information

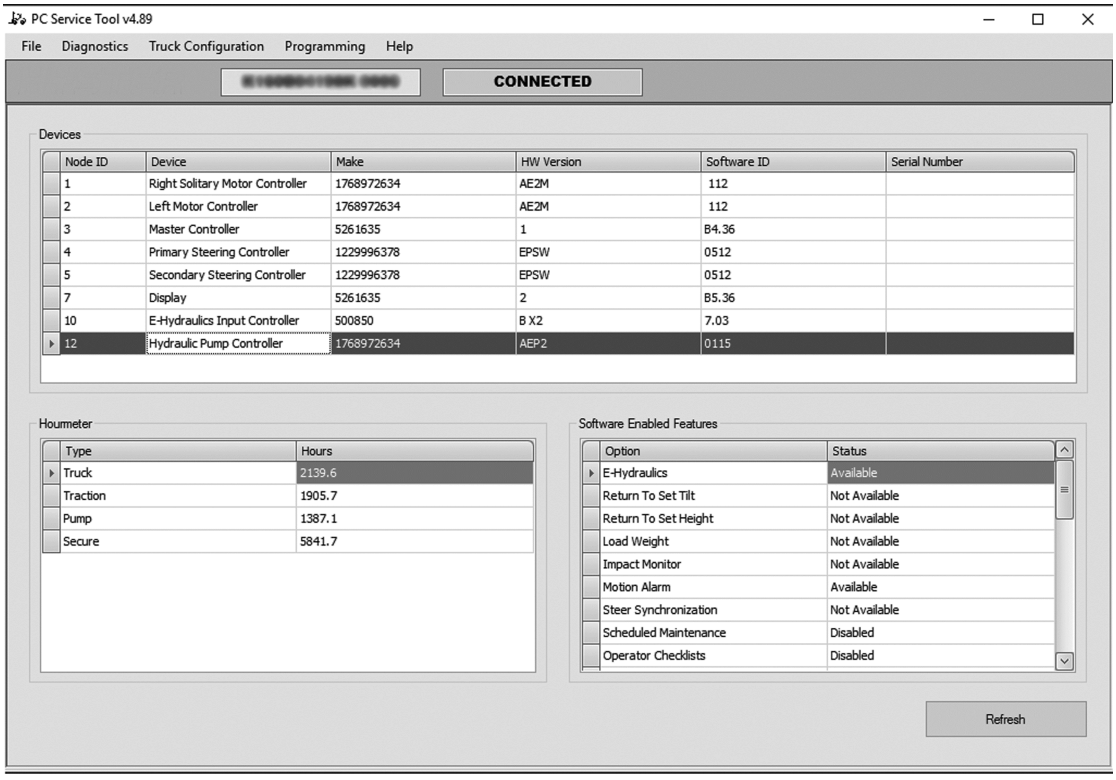

Figure 9000-01-4. Version / Software ID

DTC Support (Versions 107,108)

Table 9000-01-1. FOC2 DTCs (Versions 107 / 108)

DTC	PROBABLE CAUSES	TROUBLESHOOTING PROCEDURE
65288	Fault is triggered when watchdog signal is not in the correct status	There is a hardware fault internal to the controller. Replace the controller.
65293	The EEPROM is not storing the parameters correctly, or faulty data is being read from EEPROM.	There is a fault with the internal EEPROM. Replace the controller.
65297	The overvoltage protection circuit has been damaged.	Replace the controller.
65299	External voltage source is connected to B+ post, key line is grounded, or voltage is being sunk into external component.	Check to ensure that only battery voltage is applied to B+ post and key input
65310	Short to frame or ground to the motor due to external contaminants or harness issues.	Ensure there is no short to ground or frame to the motor. Voltage between phases and B- should be 9V-15V. Rekey and check if alarm clears.
65311	Short to battery to the motor due to external contaminants or harness issue.	Ensure there is no short to B+ to the motor. Voltage between phases and B- should be 9V-15V. Rekey and check if alarm clears.
65317	Contactor is closed without being driven by the controller.	Check to ensure contactor is not stuck in closed position.
65318	1) Contactor failure 2) Controller failure	1) Check if contactor will close with correct applied voltage. Replace contactor if it does not close. 2) Ensure that low side of contactor is brought to ground reference when controller should drive contactor. Replace controller if it does not.
65333	Current feedback sensors read a value out of expected range when no current is applied.	Check harness to ensure no extraneous shorts to current sources outside of controller.
65340	Capacitors are damaged internal to controller, or connection to B+ post is not steady battery voltage.	If connection to B+ post is not steady battery voltage, replace controller.
65342	Controller internal temperature has exceeded 85 degrees C (185 degrees F).	Allow controller to cool by keying off vehicle.
65345	Motor temperature exceeded safe operating range.	Allow motor to cool by keying off vehicle.
65346	Battery voltage is too low for safe operation for the battery.	Charge or replace the vehicle battery.
65354	The contactor is shorted due to a harness short or damage to the internal driver.	Ensure there is no short to the contactor in the harness, otherwise replace the controller.
65355	The negative side of the contactor is shorted to B+ or the driver is damaged.	Ensure there is no short to the contactor in the harness, otherwise replace the controller.
65360	Both a forward and a reverse command are given simultaneously.	Remove either forward or reverse command to the controller.
65362	There is a problem reading a phase from the encoder.	Check the connections to the encoder. If they are good replace the encoder.
65481	Mismatched software between master and slave.	Reprogram the slave micro controller.
65486	1) Motor phase shorted to battery. 2) Controller failure.	1) Check motor phases for shorts to battery. Voltage between phases and B- should be 9V-15V. 2) Replace the controller.

Table 9000-01-1. FOC2 DTCs (Versions 107 / 108) (Continued)

DTC	PROBABLE CAUSES	TROUBLESHOOTING PROCEDURE
65487	1) High resistance in cables or at terminals. 2) Motor phase shorted to ground. 3) Controller failure	1) Check motor cables for opens. Voltage between phases and B- should be 9V-15V. 2) Check shorts of motor connections to grounds. 3) Replace the controller.
65488	The EEPROM is not storing the parameters correctly, or faulty data (garbage) is being read from EEPROM.	There is a fault with the internal EEPROM. Replace the controller.
65489	Fault appears after clearing EEPROM	No troubleshooting needed. Not a fault.
65490	Bad software or damage to volatile memory.	Reinstall software. If this does not correct issue, replace controller.
65491	It appears when encoder frequency shows less than 0.6 Hz with commanded frequency of >=20 Hz and applied frequency of >= 1.5 Hz.	Check the connections to the encoder. If they are good, replace the encoder after ensuring the wheel is able to turn without mechanical interference.
65492	Possible failure in slave micro controller.	Replace the controller.
65493	Communication failure between master controller and slave controller.	Replace the controller.
65498	Faulty motor thermal sensor.	Replace motor thermal sensor.
65500	Bad connection at Key input.	Check key input in harness. Rekey the controller.
65503	1) Short in wiring to downstream loads on main contactor coil. 2) Controller failure.	1) Check connector integrity, wiring, and devices supplied by the main contactor. 2) Replace the controller.
65504	Bad CAN connection or issue with other Node.	Check CAN wires in harness and ensure other nodes are communicating properly.
65510	Hardware failure.	Replace the controller.
65511	Hardware failure.	Replace the controller.
65512	It appears when the parameters (poles and impulses) of the encoder (in hardware setting) are not correctly set.	Verify the parameters are correct for the type of encoder that is being used.
65513	Fault occurs if the short circuit protection detects a short circuit and shuts down the power stage.	Replace the controller.
65515	Damage to coil short detection.	Replace the controller.
65516	The controller has not been current tuned.	Controller should be tuned by a Zapi technician.
65517	1) Incorrect software loaded. 2) Controller failure.	1) Reprogram the controller. 2) Replace the controller.
65519	1) Incorrect software loaded. 2) Controller failure.	1) Reprogram the controller. 2) Replace the controller.
65521	Faults occur when parameters in master do not match parameters in slave.	Verify the parameters in the slave match the ones in the master controller.
65522	Parameter transfer which occurs when a parameter has changed in the master has not occurred at key on.	Rekey the controller. If this does not remove the alarm, reinstall software. If this does not fix the issue, replace the controller.
65525	This is caused by a problem with the tuned motor parameters.	Ensure the correct motor parameters are set within the controller.

Table 9000-01-1. FOC2 DTCs (Versions 107 / 108) (Continued)

DTC	PROBABLE CAUSES	TROUBLESHOOTING PROCEDURE
65526	1) Problem with harness where low side of aux coil is shorted to B+. 2) Problem with aux driver in controller	1) Verify no shorts in harness at low side of aux coil. 2) Replace controller.
65527	The controller has entered motor tuning mode.	Replace the controller.
65528	Fault with CAN lines or CAN transceiver inside controller.	Check CAN connections. If there is no problem the controller should be replaced.
65529	Truck hours exceeded service hour requirements.	Service the truck and reset maintenance reminders.
65530	Issue with thermal sensor inside the controller.	Replace the controller.
65531	1) Battery is wrong voltage, too low, or high. 2) SET BATT parameter incorrectly set.	1) Change or replace battery. 2) Change SET BATT parameter to correct value.
65532	A fault is triggered when the motor phase voltages are out of permitted range.	Replace the controller.
65533	The motor and controller are not tuned	1) Reprogram the controller. 2) Replace the controller.
65534	1) Problem with harness where low side of aux coil is shorted to -Batt or ground. 2) Problem with aux driver in controller.	1) Verify no shorts in harness at low side of aux coil. 2) Replace the controller.

SECTION 9010

OPERATIONAL DIAGNOSTIC PROCEDURES

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Group 05
Operational Checkout

Operational Checkout Procedures

These procedures are designed so technicians can make a quick check of the operation of the machine while sitting in operator's seat.

WARNING

Be sure to read the warnings prior to performing the checkout procedures.

WARNING

Before operating the lift truck, FASTEN YOUR SEAT BELT.

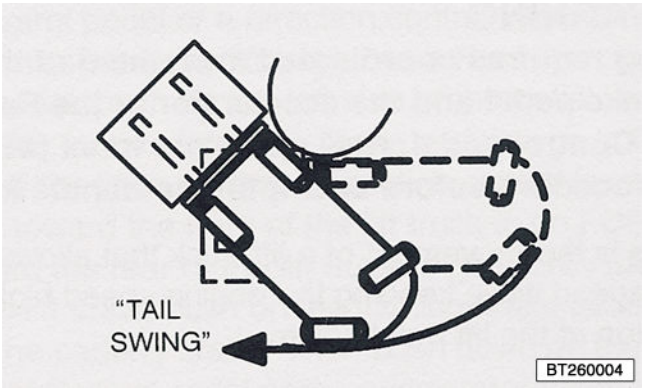
There are a number of operations, if not performed carefully, that can cause the lift truck to tip. If you have not read the WARNING page in front of the Operating Manual, do so NOW. As you study the following information about how to properly operate a lift truck, remember the Warnings.

WARNING

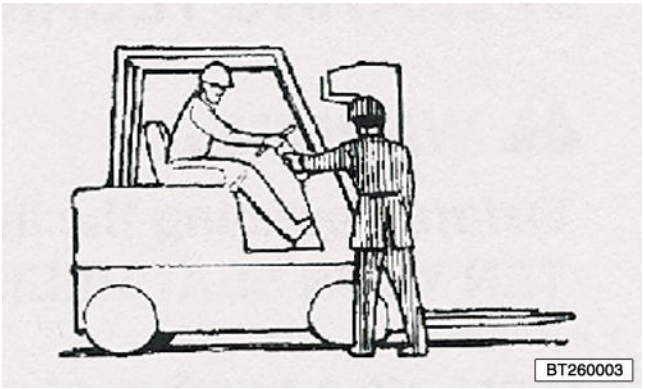
Mast parts are heavy and can move. Distances between parts are small. Serious injury or death can result if part of the body is hit by parts of the mast or the carriage.

- **Never put any part of the body into or under the mast or carriage unless all parts are completely lowered or a safety chain is installed. Also make sure the power is OFF and the key is removed. Fasten a DO NOT OPERATE tag in the operator's compartment.**
- **Be careful of the forks. When the mast is raised, the forks can be at a height that may cause an injury.**
- **DO NOT climb on the mast or lift truck at any time. Use a ladder or personnel lift to work on the mast.**
- **DO NOT use blocks to support the mast weldments nor to restrain their movement.**
- **Mast repairs require disassembly and removal of parts and can require removal of the mast or carriage. Follow the repair procedures in the correct Service Manual for the mast.**

Adequate space is required to do the driving checks. Some checks require the lift truck and other major components to be at operating temperature.



Before performing the operational checkout, complete the INSPECTION BEFORE OPERATION in the **Operating Manual**.



Before starting operational checkout, talk to the operator and check Diagnostic Trouble Codes (DTC) using the Display Panel (DP). See Troubleshooting Guidelines and Procedures. All DTCs must be corrected or cleared before starting this checkout.

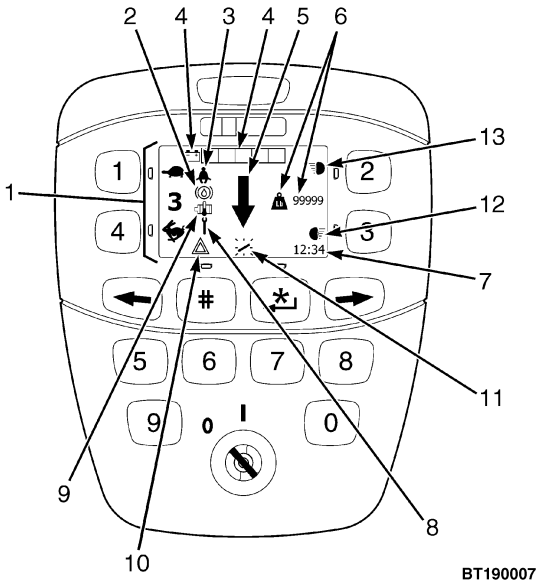
No special tools or gauges are needed. Always start sequence from left to right. Before doing check, read each check completely.

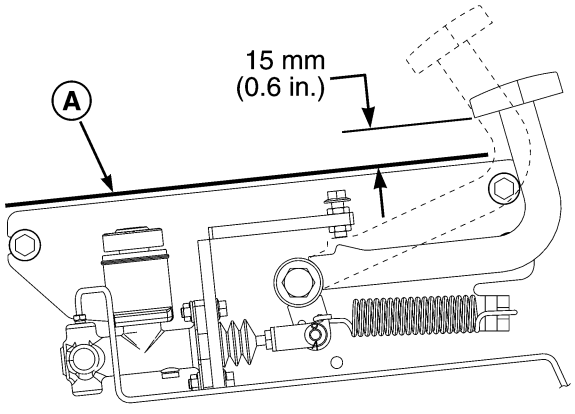
At the end of each check, a question is asked:

- If the answer indicates the check is OK, you will be instructed to go to next check.
- If the answer indicates that the check is not OK, you will be given a required SRM repair or be linked to the test to perform.

When a problem is found, stop operational checkout and correct it before going to the next check. Repeat check after repair to confirm repair was successful before proceeding with the remaining checks.

CHECK	PROCEDURE	ACTION
Key Icon Illuminated	Turn Keyless Start Switch or Key Switch to **ON** position with park brake applied. ***Does the Key Icon appear on the Display and remain illuminated?***	**YES:** Shut key **OFF**. Wait 30 seconds for power cycling then turn key **ON**. Key icon should not stay lit. **NO:** Display power is OK. Go to next step.
Wrench Icon Illuminated	Turn Keyless Start Switch or Key Switch to **ON** position with park brake applied. ***Does the Wrench Icon appear on the Display and remain illuminated?***	**YES:** Reinstall newest version of software. See **User Interface Supervisor** 2200SRM1335 or **User Interface Service Technician** 2200SRM1336. **NO:** Display power is OK. Go to next step.
Display Panel (DP) Check	1. Turn key or keyless switch to **ON** position. 2. Check display for any DTCs. See Electrical System, General Maintenance and Diagnostic Data, Diagnostic Trouble Codes, Page 9030-03-6. ***Are any DTCs displayed?***	**YES:** Refer to Electrical System, General Maintenance and Diagnostic Data, Diagnostic Trouble Codes, Page 9030-03-6. **NO:** DTCs are OK. Go to next check.
Battery Settings	1. Navigate to the **Battery Settings** screen and verify selected battery type. ***Does the battery setting match battery type installed on truck?***	**YES:** Battery setting OK, proceed to next step. **NO:** Change battery setting to match battery type installed in the truck.
Operator Presence System Check	**NOTE:** This procedure requires Service Password. Operator presence sensor requires a minimum of 45.4 kg (100 lb) to actuate. 1. While operator is in seat, power truck **ON**. 2. See Display Panel Flowchart. At the Display Panel, Enter Main Display, enter password, scroll to Diagnostics, **Enter**. 3. Scroll to Seat Symbol **Enter**. Read display.	**YES:** Continue with this procedure. **NO:** Go to DTC 12816, Seat Sensor Out of Range Low (OORL) or DTC 12819 and troubleshoot per procedure.

CHECK	PROCEDURE	ACTION
	Does display show 1.4 volts or greater? *Continue:* While operator is out of seat, power truck **ON**. ***Does display show less than 0.8 volts?*** **NOTE:** BEFORE PROCEEDING TO NEXT CHECK, RETURN TO SEAT AND FASTEN SEAT BELT.	**YES:** Operator presence sensor is OK. Go to next check. **NO:** Operator presence sensor has failed. Replace seat sensor. See **Electrical System** 2200SRM1337.
Display Backlight and Icon Power Check	 1. INDICATOR LIGHT, PERFORMANCE MODE 2. WARNING LIGHT, LOW BRAKE FLUID 3. WARNING LIGHT, FASTEN SEAT BELT 4. INDICATOR LIGHT, BATTERY DISPLAY INDICATOR (BDI) 5. INDICATOR LIGHT, DIRECTION INDICATORS 6. INDICATOR LIGHT, LOAD WEIGHT 7. INDICATOR LIGHT, SYSTEM TIME 8. WARNING LIGHT, SERVICE DUE LIGHT 9. WARNING LIGHT, MOTOR TEMPERATURE HIGH WARNING 10. INDICATOR LIGHT, HAZARD FLASHERS 11. INDICATOR LIGHT, STEER ANGLE 12. INDICATOR LIGHT, FRONT WORK LIGHTS 13. INDICATOR LIGHT, REAR WORK LIGHTS Turn Keyless Start Switch or Key Switch to **ON** position with park brake applied. ***Do the Display Backlight and icons appear on the LCD screen?***	**YES:** Display power is OK. Go to next step. **NO:** See No Display/No Truck Operation.

CHECK	PROCEDURE	ACTION
	NOTE: Fasten seat belt, icon will turn off after 10 seconds. *Continue:*	
Light Circuit Check	1. Turn front and rear work light switches ON. ***Do lights turn on?***	**YES:** Go to next check. **NO:** Refer to Observed Symptom, Lights Inoperative.
Horn Circuit Check	**NOTE:** There can be up to three horn buttons on the lift truck: 1. Steering Wheel 2. Right Rear Grab Handle 3. MLM Armrest Press horn button. ***Does horn sound?***	**YES:** Horn is OK. Go to next check. **NO:** Refer to Observed Symptoms, Observed Symptoms, Horn Failure, Page 9030-30-33.
Backup Alarm Check (If equipped)	1. With lift truck running, apply service brake. 2. Release park brake. 3. Select reverse direction. ***Does backup alarm sound?***	**YES:** Back up alarm is OK. Go to next check. **NO:** Check wiring connections.
Heater Check (If equipped)	1. Turn key switch to **ON** position. 2. Check display for any error codes. ***Are any error codes displayed?***	**YES:** Correct error codes. See **Electrical System** 2200SRM1337 or **Electrical System** 2200SRM1369 . **NO:** Heater is okay. Go to next check.
Brake Pedal Check	 BT260036 A. TOP OF FLOOR MAT 1. With lift truck running, release park brake. 2. Depress and hold brake pedal with approximately 45.4 kg (100 lb) force.	**YES:** Brake adjustment is OK. Go to next check. **NO:** Adjust brakes. see **Brake System** 1800SRM1332.

CHECK	PROCEDURE	ACTION
	3. Measure pedal distance from floor mat as shown in the illustration. ***Does brake pedal remain at least 15 mm (0.6 in.) off floor mat?***	
Park Brake Sensor Check	1. With lift truck running, release park brake. 2. Slowly apply park brake and note when park brake display comes ON. ***Does display come on before park brake reaches first click of engagement?***	**YES:** Park brake sensor is OK. Go to next check. **NO:** Adjust park brake, see **Brake System** 1800SRM1332.
Park Brake Check	 BT260002 **WARNING** **Ensure load is secured so it will not move when mast is tilted fully forward.** 1. Stop lift truck in an uphill direction with rated load on 15% grade or less, and apply park brake. 2. Shut lift truck **OFF** and note if machine remains static. 3. Start lift truck and remove rated load. 4. Position lift truck with No Load in a downhill direction, on 15% grade or less, and apply park brake. 5. Shut lift truck **OFF** and note if machine remains static. ***Does machine remain static on grade in both directions?***	**YES:** Park brake is OK. Go to next check. **NO:** Adjust park brake, see **Brake System** 1800SRM1332.
Brake and Axle Drag Check	**NOTE:** Move truck to level surface before performing the following steps. 1. Raise lift truck until drive tires are off ground. Support lift truck using suitable shop standard. (See "How to Raise Drive Tire" procedure in **Operating Manual**.)	**YES:** Repair brakes. See **Brake System** 1800SRM1359. **NO:** Brakes are OK. Continue with this procedure.

CHECK	PROCEDURE	ACTION
	2. Shut lift truck **OFF** and release park brake. Handle provided under floor plate to manually release the park brake. 3. Check brakes for dragging. ***Are the brakes dragging?***	
	Continue: Manually turn one tire by hand. ***Does the tire turn with moderate force and does the other tire turn in the opposite direction?***	**YES:** Axle is OK. Adjust park brake back to correct setting. Go to next check. **NO:** If opposite wheel does not turn, differential is damaged. If equipped, remove differential cover and inspect. See **Transaxle** 1300SRM1330.
Priority Flow Divider Valve Check	1. Turn steering wheel to right axle stop and then back to left axle stop in one continuous cycle while raising lift carriage. ***Does carriage lift speed decrease while steering?***	**YES:** Continue with this procedure. **NO:** If no steering, flow divider spool is stuck. Remove, clean, and inspect spool. Depending on your lift truck see, **Main Control Valves** 2000SRM1334 or **Main Control Valves** 2000SRM1439.
	Continued: 2. Release steering wheel. ***Does carriage lift speed increase when not steering?***	**YES:** Flow divider is OK. Go to next check. **NO:** Inspect and clean relief valves. Depending on your lift truck see, **Main Control Valves** 2000SRM1334 or **Main Control Valves** 2000SRM1439.
Mast Cushion Check - Free Lift Cylinder	**NOTE:** This check applies to free lift cylinders. 1. Raise forks at maximum lift speed with no load. 2. When free cylinder reaches top of stroke, observe transition to main lift cylinder phase and speed of free lift rod during transition. ***Does free lift rod speed slow and does hissing sound come from top of cylinder, with no audible impact at top of stroke?***	**YES:** Free lift is OK. Go to next check. **NO:** Remove oil fill port screw at top of free lift cylinder; add 100 cc (3.40 oz) of hydraulic oil. Depending on your lift truck see, **Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564)** 2100SRM1382 or **Cylinder Repair (Mast S/N B551, B555, B559)** 2100SRM1440.

CHECK	PROCEDURE	ACTION
Lift Drift Check	Ensure the following before starting procedure: • Truck operating on flat surface. • Hydraulic oil at operating temperature. **WARNING** **Ensure load is secured so it will not move when mast is tilted fully forward.** • Secured capacity load on forks. 1. Install angle meter on mast and position mast at approximately 90° angle to ground. 2. Raise mast until approximately 75 mm (3 in.) of main lift cylinder rods are exposed on mast. Record this measurement. 3. Shut lift truck **OFF**. 4. After 5 minutes, measure mast main lift cylinder drop. ***Does main lift cylinder rod retract more than 50 mm (2 in.)?***	**YES:** Go to Lift Cylinder Leakage Test to isolate if problem is in cylinder or control valve. **NO:** Main cylinder drift is OK. Continue with this procedure.
	Continue: 5. Raise free lift cylinder approximately 75 mm (3 in.) and mark cylinder rod to record movement. 6. After 5 minutes, measure free lift cylinder drop. ***Does free lift drop more than 50 mm (2 in.)?***	**YES:** Go to Lift Cylinder Leakage Test to isolate if problem is in cylinder or control valve. **NO:** Free lift drift is OK. Go to next check.
Lift/Tilt Mast Adjustment Check	Ensure the following before starting procedure: • Truck operating on flat surface. • Adequate overhead clearance to raise forks to maximum height. • No load on forks. 1. Raise forks to maximum height. ***Does the top sections of mast kick to one side at maximum height?***	**YES:** Shim lift cylinders. See **Mast Repair (S/N A270, A271, A272)** 4000SRM1386. **NO:** Mast cylinder is adjusted OK. Continue with this procedure.
	Continue: 2. Slowly tilt the mast full forward and then full backward at maximum height and observe movement of mast. ***Does the top sections of mast make noise during tilting and show excessive movement of mast sections?***	**YES:** Shim and adjust mast. See **Mast Repair (S/N A270, A271, A272)** 4000SRM1386. **NO:** Mast shimming is OK. Go to next check.

CHECK	PROCEDURE	ACTION
Tilt Function Drift Check	Ensure the following before starting procedure: • Truck operating on flat surface. • Hydraulic oil at operating temperature. **WARNING** **Ensure load is secured so it will not move when mast is tilted fully forward.** • Secured capacity load on forks. 1. Raise mast approximately 300 mm (12 in.) off floor. 2. Install angle meter on mast and position mast at approximately 90° angle to ground. 3. Ensure lift truck is **OFF**. 4. After 5 minutes, measure mast angle and compare to original reading. ***Does mast tilt drift more than 2 degrees in 5 minutes?***	**YES:** Go to Tilt Cylinder Leakage Test to confirm if cylinder or control valve is leaking. **NO:** Tilt drift is OK. Go to next check.
Tilt Racking Check	Actuate mast back tilt function until hydraulic valve goes over relief. ***Do both sides of mast stop evenly?***	**YES:** Tilt stops are adjusted OK. Go to next check. **NO:** Adjust tilt stops. See **Mast Repair (S/N A270, A271, A272)** 4000SRM1386.
Tilt Function, Tilt Lock Piston	**WARNING** **Ensure load is secured so it will not move when mast is tilted fully forward.** 1. Put secured capacity load on forks and raise forks approximately 1 m (3 ft). 2. Tilt load back to tilt stop. 3. Move tilt lever to tilt forks forward full stroke and observe speed. ***Can tilt speed be controlled?***	**YES:** Tilt lock is OK. Go to next check. **NO:** Repair tilt lock piston valve in tilt spool. Depending on your lift truck see, **Main Control Valves** 2000SRM1334 or **Main Control Valves** 2000SRM1439.
Mast Cushion Check - Main Lift Cylinder	Ensure the following before starting procedure: • Truck operating on flat surface. • Adequate overhead clearance to raise forks to maximum height. **WARNING** **Ensure load is secured so it will not move when mast is tilted fully forward.**	**YES:** Piston ring is OK. Go to next check. **NO:** Inspect and clean piston ring. Depending on your lift truck see, **Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564)**

CHECK	PROCEDURE	ACTION
	• Secured capacity load on forks. 1. Raise forks to maximum height of main lift cylinders. 2. Lower forks as fast as possible and observe cylinder rod as main lift cylinders reach bottom of stroke. ***Does fork speed slow and does a hissing sound come from cylinder at bottom of stroke?***	2100SRM1382 or **Cylinder Repair (Mast S/N B551, B555, B559)** 2100SRM1440.
Mast Channel Check	**NOTE:** This is a visual check of the mast to determine if parts are worn or out of adjustment. 1. Raise mast to full height without load and shut lift truck **OFF**. 2. Inspect outer and inner channels for wear pattern and gouging. 3. Move forks to lowered position. 4. Inspect the inner channel wear pattern for wear or gouging. ***Do channels show signs of excess wear?***	**YES:** Repair mast channels. See **Mast Repair (S/N A270, A271, A272)** 4000SRM1386. **NO:** Mast wear is OK. Continue with this procedure.
	Continue: 5. Inspect spacing between channels. ***Is the channel spacing even on each side?***	**YES:** Channel spacing is OK. Go to next check. **NO:** Adjust or repair mast. See **Mast Repair (S/N A270, A271, A272)** 4000SRM1386.
Mast Mounting Check	1. Move mast to lowered position and shut lift ruck **OFF**. 2. Inspect the mounting hardware at axle. 3. Push the top of mast by hand while off the lift truck and note any movement of lift truck. **NOTE:** If the mast mounting is loose, mast will move without moving truck frame. ***Is the mast mounting loose?***	**YES:** Inspect and repair mast mounting. See **Mast Repair (S/N A270, A271, A272)** 4000SRM1386. **NO:** Mast mounting is OK. Go to next check.
Chain and Header Hose Adjustment Check	Ensure the following before starting procedure: • Truck operating on flat surface. • Hydraulic oil at operating temperature. • No load on forks. 1. Install angle meter on mast and position mast at approximately 90° angle to ground. 2. Raise and lower forks through two complete lift cycles. 3. Lower forks to lowest position.	**YES:** Adjust lift chains. See **Mast Repair (S/N A270, A271, A272)** 4000SRM1386. **NO:** Chains are adjusted OK. Continue with this procedure.

CHECK	PROCEDURE	ACTION
	NOTE: The carriage safety stop does not make contact at full extension, but that a minimum gap of 6 mm (0.25 in.) remains. **NOTE:** The correct fork height adjustment is approximately 6 mm (0.25 in.) off floor. ***Does the heel of forks touch the floor?*** *Continue:* 4. Look at condition of hoses as they go over sheaves. ***Are the hoses compressed?*** *Continue:* 5. Inspect contact of hoses with any crossmember or load backrest near sheave area. ***Are the hoses contacting any crossmember or the load backrest?***	**YES:** Adjust header hoses. See **Mast Repair (S/N A270, A271, A272)** 4000SRM1386. **NO:** Hose tension is OK. Continue with this procedure. **YES:** Adjust header hoses. **NO:** Hose adjustment is OK. Go to next check.
Chain Sheave Check	1. Lower forks. Shut lift truck **OFF**. 2. Inspect wear pattern on chain sheaves. ***Does sheave show a wear pattern without side wear?***	**YES:** Chain sheaves are OK. Go to next check. **NO:** Replace chain sheaves. See **Mast Repair (S/N A270, A271, A272)** 4000SRM1386.
Carriage Adjustment Check	1. Lower forks to approximately 50 mm (2 in.) off ground. Shut lift truck **OFF**. 2. Rock the carriage frame side to side. ***Does carriage move more than 0.5 mm (0.020 in.) at tightest point?***	**YES:** Adjust or repair carriage bearings. See **Mast Repair (S/N A270, A271, A272)** 4000SRM1386. **NO:** Carriage adjustment is OK. Go to next check.
Carriage Adjustment Check (Standard and Integral Side Shift)	1. Lower forks. Shut lift truck **OFF**. 2. Inspect wear on carriage stop. ***Does carriage stop show a wear pattern on it?***	**YES:** Chains are out of adjustment. See **Mast Repair (S/N A270, A271, A272)** 4000SRM1386. **NO:** Checks complete.
Steering Relief Valve Low Pressure Check	1. Turn key switch to **ON** position. 2. Position steer axle wheels straight to start check. 3. Turn steering wheel stop-to-stop in both directions. ***Does steer axle wheels turn stop-to-stop without stopping?***	**YES:** Relief pressure is OK. Go to next check. **NO:** If steer axle wheels do not turn stop-to-stop, pressure is too low. Adjust steering relief pressure. Go to Steering Relief Pressure Test and Adjustment.

SECTION 9025

TRACTION MOTOR

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Group 10
Principles of Operation

Traction Motor

PRINCIPLES OF OPERATION

All electric forklift trucks covered by this manual use three-phase alternating current (AC) induction traction motors. AC motors are all very similar motors used across the product line, but do vary in some ways. This Principles of Operation will identify the significant differences.

The AC induction motor is an electrical device which uses an AC current provided to a wire wound stator supplied by a DC to AC inverter to induce north and south magnetic poles to an internal rotating device in a controlled environment. The reaction between the internal rotor and stator creates a push-pull effect on the rotor causing the rotor to turn, creating a force to do mechanical work.

In lift trucks the DC current is provided by the lead acid battery. The DC (direct current) voltage is changed to AC (alternating current) by the traction motor controller. By changing the frequency of the AC power to the motor, the motor speed can be controlled. This job is done by the traction motor controller. The controller also manages the direction of the motor and thus the lift truck. It works in conjunction with the VSM.

A speed sensor is used to detect and communicate the speed and direction of the rotor to the controller. This is done by sending electric pulses on two separate channels to the controller. The controller knows the direction of the motor by which channel's signal it receives first. It knows the speed by the frequency of the pulses. The controller's software continually monitors this information. Using this feedback, the AC motor control system can provide regenerative braking, controlled acceleration and deceleration. By changing the frequency of the AC power to the motor, which is also managed by the motor controller, the motor speed can be controlled.

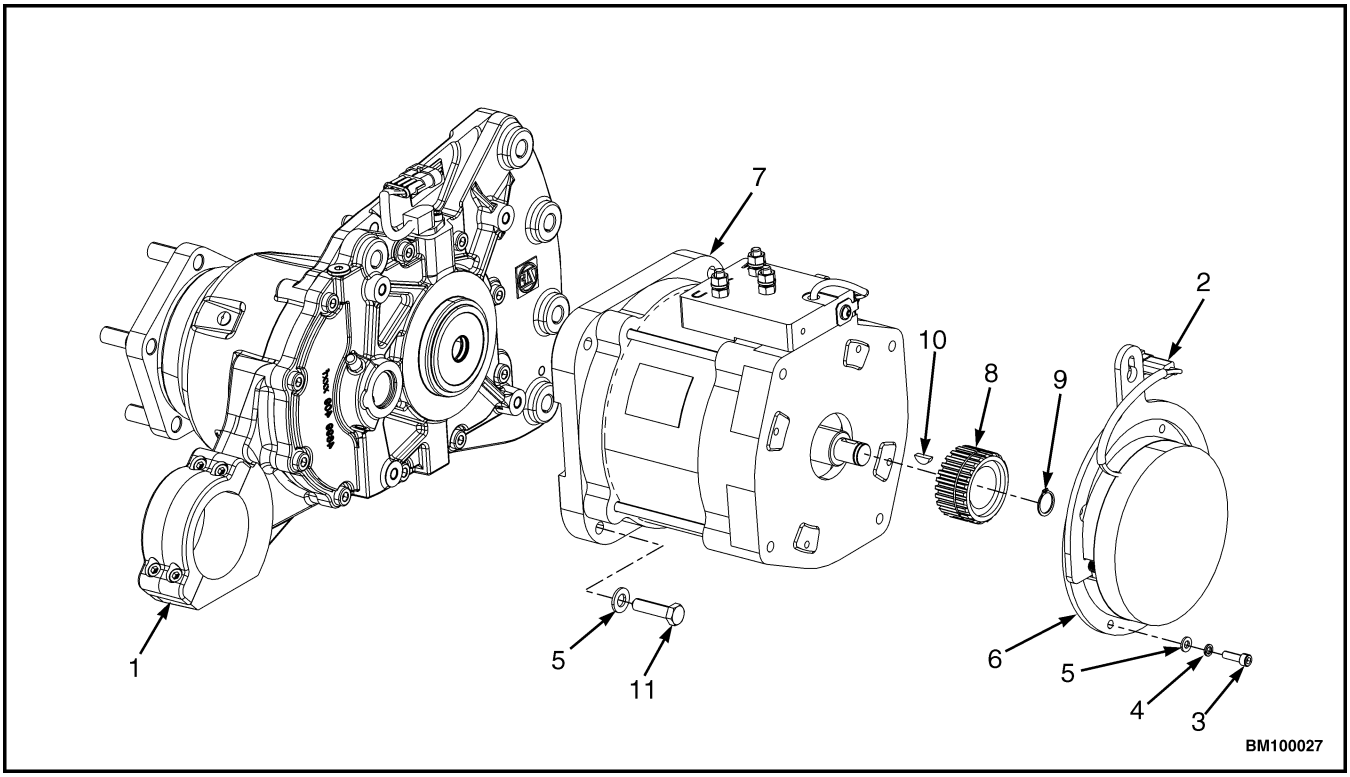
These AC motors have a temperature sensor built into the stator to monitor motor temperature and provide continual temperature feedback to the thermal management system. That system is designed to protect components from failure due to overheating. If the motor winding temperature reaches its specified limit, the VSM signals the traction controller to reduce the motor performance or may even disable traction to protect the motor. When the traction system components are in thermal management, there is no affect on the hydraulic system performance. The connector for this temperature sensor is serviceable, but the sensor itself is not.

The rotor shaft extends out each side of the traction motor. The drive end head interfaces to the drive unit or drive axle, depending upon configuration. For lift trucks A935, A268, A269, and A099 a short, round section of the shaft protrudes from the non-drive end head of the motor. This end supports the parking brake hub using a woodruff key and a snap ring. There is a bearing between the motor and the parking brake. The parking brake is replaceable.

UL safety rated EE traction motors are available as an option on these forklifts. These motors have covered vent holes and are only a part of the necessary equipment required for the EE safety rating.

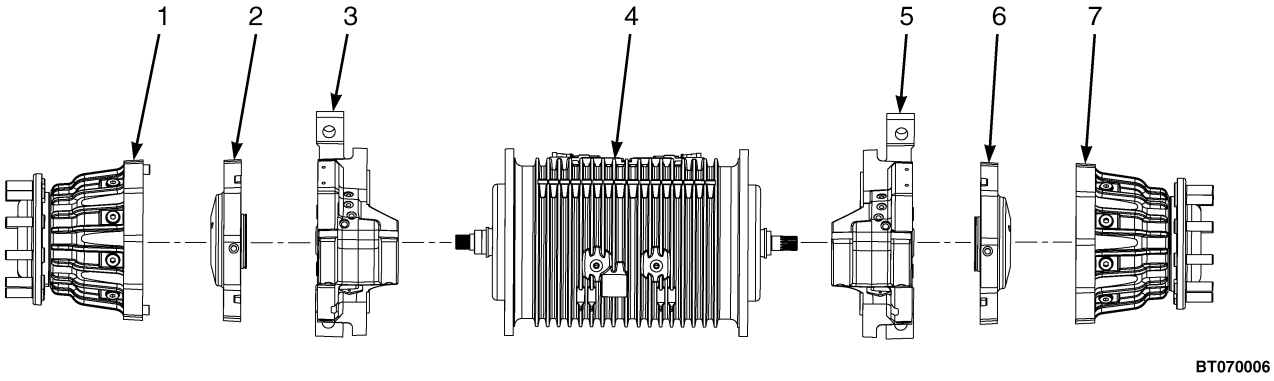
Traction motors are long life components and very low maintenance. They have no motor brushes. The motor bearings, rotor, stator and speed sensor are serviceable.

The traction motors vary depending upon the configuration of your forklift. Lift truck model D203 uses a traction motor vertically mounted to the drive unit. The drive unit is refered to as the Master Drive Unit (MDU). For further information on the MDU see MASTER DRIVE UNIT. The model designation K160, A935, A276 and A970 use two traction motors and two motor controllers. A motor is mounted to a drive unit on each side of the vehicle and powers the drive tires. The speed sensor for these motors is physically located on the drive unit housing, not on the motor. See Figure 9025-10-1.



1. TRANSMISSION
2. PARKING BRAKE WIRE HARNESS
3. SOCKET HEAD CAPSCREW
4. LOCKWASHER
5. WASHER
6. PARKING BRAKE
7. TRACTION MOTOR
8. SPLINED HUB
9. SNAP RING
10. WOODRUFF KEY
11. TRACTION MOTOR MOUNTING CAPSCREW

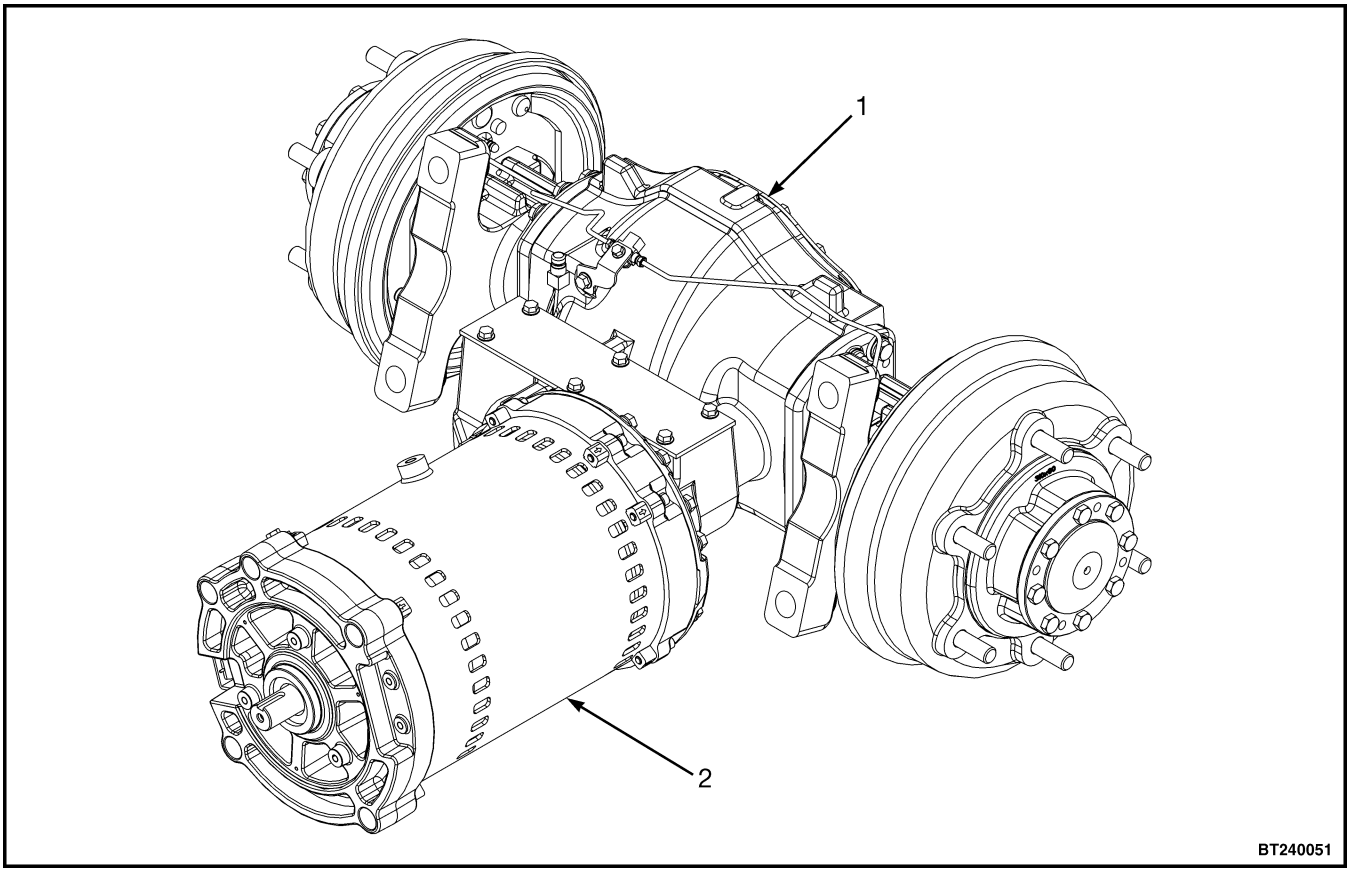
Figure 9025-10-1. Transaxle Assembly J1.5-2.0XNT (J30-J40XNT) (K160) J1.6-2.0XN (A935)



1. RIGHT SIDE TRANSMISSION OUTPUT
2. RIGHT SIDE GEARBOX
3. RIGHT COVER HOUSING
4. TRACTION MOTORS
5. LEFT COVER HOUSING
6. LEFT SIDE GEARBOX
7. LEFT SIDE TRANSMISSION OUTPUT

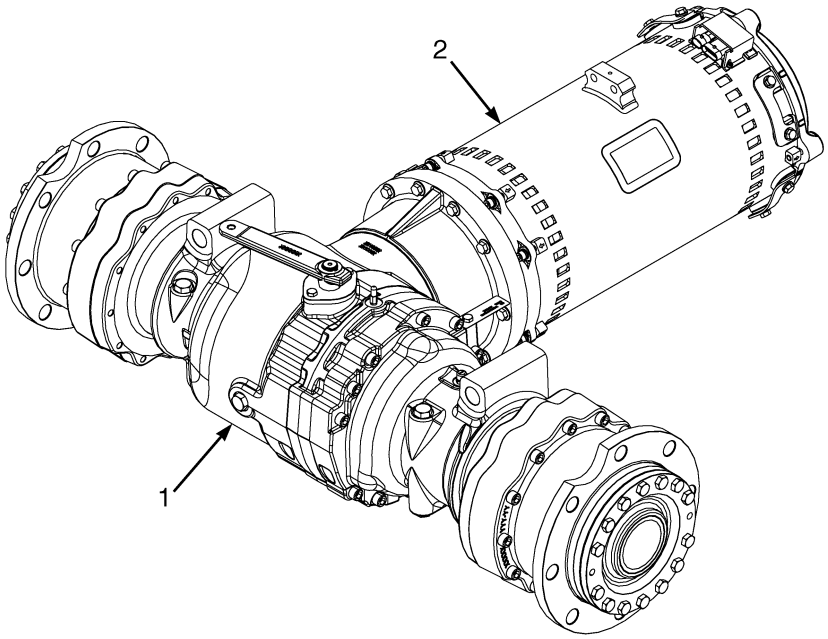
Figure 9025-10-2. Transaxle Assembly J4.0-5.0XN (A970)

The model designation A268, A269 and A099 uses only one traction motor and one traction controller. It is mounted perpendicular to the drive axle. The speed sensor for this motor is located on the motor itself. See Figure 9025-10-3.



1. TRANSMISSION
2. TRACTION MOTOR

Figure 9025-10-3. Transmission Mounting for Lift Truck Models E2.2-3.5XN (E45-70XN) (A268) and E1.6-2.0XN (E30-40XN) (A269)

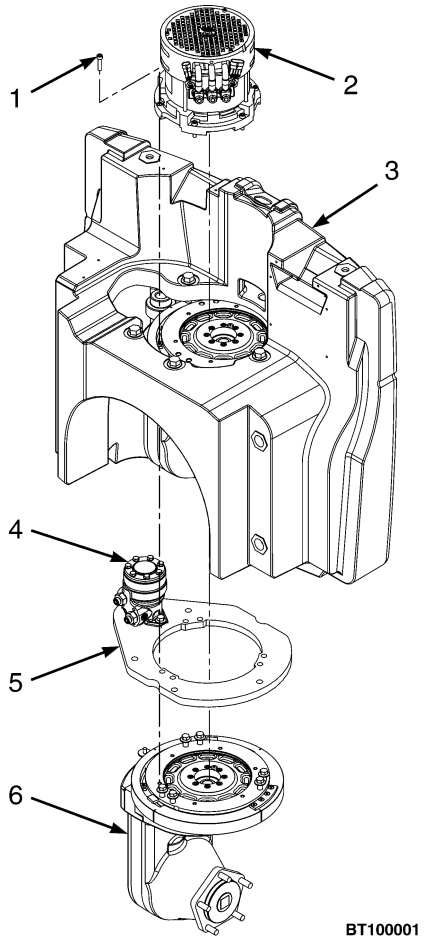


1. DRIVE AXLE
2. TRACTION MOTOR

Figure 9025-10-4. Transmission Mounting for Lift Truck Models E4.0-5.5XN (E80-120XN) (A099)

MASTER DRIVE UNIT

The heart of the traction system is the master drive unit (MDU). A stationary traction motor eliminates the power cables from the traction motor to the traction controller from rotating or flexing. The MDU features an integrated pinion with a splined motor to MDU coupling. The support bearings and pinion are integral to the MDU eliminating the potential of damaging the gears when assembling the motor to the MDU. By integrating the pinion, the gear mesh can be better controlled resulting in a quieter MDU. The splined coupling allows for quick removal and installation of the traction motor.



1. CAPSCREW
2. TRACTION MOTOR
3. COUNTERWEIGHT
4. STEER MOTOR
5. PLATE
6. MASTER DRIVE UNIT

Figure 9025-10-5. Master Drive Unit

NOTES

Group 30
Observed Symptoms

Poor Tractive Performance

POSSIBLE CAUSE

A. INCORRECT SPEED LIMIT SET.
B. SPEED LIMITING ENABLED.
C. FAILED CHECKLIST ITEM.
D. INCORRECT STEER POSITION SENSOR CALIBRATION.
E. INCORRECT MOTOR CONTROLLER SETTINGS IN CONFIGURATION DATA FILE (CDF).
F. E-BOOST ACTIVE.
G. MOTOR PHASE SHORTED TO FRAME.
H. INCORRECT MOTOR INSTALLED.

CAUSE A - INCORRECT SPEED LIMIT SET.

PROCEDURE OR ACTION:

WARNING
Unexpected movement of the lift truck can cause injury or death. Do not operate the lift truck until problem has been repaired.

1. Adjust speed limit setting on Display Panel. If problem still present go to CAUSE B.

CAUSE B - SPEED LIMITING ENABLED.

PROCEDURE OR ACTION:

1. Verify optional speed limiting is correctly set on Display Panel. See the appropriate **User Interface, Service Technician**SRM . If problem is still present, go to CAUSE C.

CAUSE C - FAILED CHECKLIST ITEM.

PROCEDURE OR ACTION:

1. Review checklist history and run check as required. Lift truck will not operate correctly until all checklist item requirements have been satisfied.
   Have all checklist requirements been satisfied?
   YES: Go to CAUSE D.
   NO: Perform necessary actions to fulfill checklist requirements. If checklist requirements have been satisfied and the problem is still present, go to CAUSE D.

CAUSE D - INCORRECT STEER POSITION SENSOR CALIBRATION.

PROCEDURE OR ACTION:

1. Rerun calibration procedure on the steering position sensor. Refer to the appropriate **Calibration**SRM .
   Did re-calibrating steering position sensor resolve issue?
   YES: Problem resolved. Resume operation.
   NO: Go to CAUSE E.

CAUSE E - INCORRECT MOTOR CONTROLLER SETTINGS IN CONFIGURATION DATA FILE (CDF).

PROCEDURE OR ACTION:

1. Go to Hypass Online and download a new CDF from the software options.
2. Install new CDF into lift truck's controller and test drive lift truck.
   Is problem still present?
   YES: Go to CAUSE F.
   NO: Issue resolved. Resume operation.

CAUSE F - E-BOOST ACTIVE.

PROCEDURE OR ACTION:

1. Make sure the service brakes are not locked up or dragging. See the appropriate **Brake System**SRM . Use the Display Panel to verify e-Boost is not interfering with the traction motor. If e-Boost is active, deactivate it.
   Is the problem still present?
   YES: Go to CAUSE G.
   NO: Issue resolved. Resume operation.

CAUSE G - MOTOR PHASE SHORTED TO FRAME.

PROCEDURE OR ACTION:

1. Turn lift truck power **OFF**.
2. Disconnect battery.
3. Disconnect power cables to tractions motor.
4. Change DMM to ohms scale. Verify zero reading.
5. Measure continuity between each power terminal of the traction motor and ground.
   Is resistance low or close to zero ohms?
   YES: Replace traction motor with new traction motor.
   NO: Go to CAUSE H.

CAUSE H - INCORRECT MOTOR INSTALLED.

PROCEDURE OR ACTION:

1. Check that the part number of traction motor is the correct part number for the lift truck. If the part number is not correct, use the correct traction motor.

END SYMPTOM

SECTION 9030

ELECTRICAL SYSTEM

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DTC 64991 - FOC2 Contactor Coil Shorted..... 9030-20-580
DTC 64806 - FOC2 Traction Controller Contactor Open.....9030-20-580
DTC 64805 - FOC2 Traction Controller Contactor Closed..... 9030-20-580
DTC 64842 - FOC2 Traction Controller Contactor Driver Shorted High.....9030-20-580
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DTC 65021 - FOC2 Traction Controller Field Oriented Control KO.....9030-20-589
DTC 64979 - FOC2 Traction Controller Rotor Stall..... 9030-20-590
DTC 64988 - FOC2 Traction Controller Vkey OFF Shorted..... 9030-20-593
DTC 64787 - FOC2 Traction Controller DC Bus High and Key Voltage Low.....9030-20-593
DTC 65032 - Watchdog (Slave).....9030-20-597
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DTC 65077 - FOC2 Traction Controller Standby Current Too High.....9030-20-601
DTC 65086 - FOC2 Thermal Protection..... 9030-20-602
DTC 65106 - FOC2 Encoder Error..... 9030-20-604
DTC 64850 - FOC2 Encoder Error..... 9030-20-604
DTC 65232 - EEPROM KO (Slave).....9030-20-607
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DTC 65254 - FOC2 W.D. SYNCRO..... 9030-20-609
DTC 65259 - FOC2 Coil_Short_HW_KO.....9030-20-610
DTC 65261 - FOC2 Analog Input..... 9030-20-612
DTC 65263 - FOC2 Controller Mismatch.....9030-20-612
DTC 65266 - FOC2 SP Mismatch..... 9030-20-612
DTC 65270 - FOC2 Aux Drive Open..... 9030-20-613
DTC 65278 - FOC2 Aux Driver Short..... 9030-20-613
DTC 65528 - FOC2 No CAN Message.....9030-20-615
DTC 65272 - FOC2 No CAN Message.....9030-20-615
DTC 65341 - Controller Internal Temperature OORL..... 9030-20-618
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Group 03

General Maintenance and Diagnostic Data

Troubleshooting Guidelines and Procedures

TROUBLESHOOTING GUIDELINES

The troubleshooting procedures that will be encountered in this manual require that the individual be familiar with certain policies, requirements, and instructions before starting any of the procedures. These are included to assure the safety of the technician performing the tasks, simplify the procedures, and prevent damage to the machine and supporting equipment.

WARNING

All safety precautions for working on and around powered vehicles must be observed and maintained. (Refer to Operating or Repair Manual.)

1. Initial conditions will be with the vehicle power OFF and park brake set, unless directed otherwise.

2. The Diagnostic Trouble Code (DTC) Chart includes:This number is the number displayed in the Liquid Crystal Display (LCD) section of the Display Panel (DP). In addition to active faults that will be displayed on the LCD, the system is capable of displaying fault history data that is stored in the VSM and other controller units, if equipped.These fault history logs are accessible to service level technicians. See Troubleshooting Procedures for directions on how to access fault history logs.
   - Diagnostic Trouble Code
   - A brief description of the fault/symptom
   - Page number of applicable Troubleshooting Procedures
   - VSM Fault Log
   - Traction Controller 1 and 2 Fault Log
   - HYDR PUMP Controller Fault Log
   - LIGHT Controller Fault Log
   - MLM Fault Log
   - IMPACT Fault Log
   - DISPLAY Fault Log

3. Abbreviations and Acronyms will be defined when first used in a procedure. They are also listed and defined in Abbreviations and Acronyms that accompanies this document.

4. Most procedures will require the use of a Digital MultiMeter (DMM) and associated probes. The service technician should be familiar with the operation, range scales, polarity selection, and measurement techniques.

   a. Unless otherwise directed, the **RED** probe of the DMM will always be connected to the point indicated as **(+)** and the **BLACK** probe will always be connected to the point indicated as **(-)**.

   b. When performing a continuity check, all signal circuits should be equal or less than 0.5 ohms. At the start of troubleshooting procedures, verify that the DMM will display 0 ohms when the resistance scale is selected and the probes are shorted together. If the DMM display indicates a value less than 1 ohm and that value is consistently repeated, it may be considered as the zero value. Resistance readings during testing will require correction by this small value. If the DMM display is not correct or is greater than 1 ohm, have the meter calibrated/serviced.

   c. In some improved DMMs, when the test probes are shorted together, a momentary push-button switch will re-zero the meter scale and maintain that zero position as a reference until the meter is turned off. If this feature is available, be sure to re-zero each time meter power is cycled.

d. Probing the back of connectors for obtaining in-line voltage measurements requires a special probe extension for the meter probes. Failure to use this tool can result in damage to the integrity of the connector seal and may cause a failure in the harness/connector assembly. See **Wire Harness Repair** 2200SRM1128.

5. Most electrical problems will be harness related:

- Connectors not fully engaged and locked
- Connector pins not fully inserted
- Circuit repairs incorrectly wired at connectors
- Damaged connector pins

6. Major component service tips:

a. Vehicle System Manager (VSM):

- Connectors are keyed and color coded
- Non-serviceable part
- Last replaceable item in troubleshooting procedures
- Do not transfer VSMs or Display Panel from other trucks
- Always confirm VSM/Display Panel and lift truck serial numbers match before doing any servicing

7. When troubleshooting electrical/electronic faults and symptoms:

a. Verify that the connector is properly engaged and that connector security clips, tabs, and other locking devices are properly attached.

b. Visually examine the connectors and harness termination points for “pushed” or “recessed” pins or sockets.

c. The Electric Truck Battery Negative and Positive are isolated from the Vehicle Frame. Unless directed in a Procedure, no measurements will be made using the vehicle frame as an electrical path.

d. Before opening any connector or removing any wires from their termination point, disconnect the circuits from the battery as directed in the procedure. Trucks are equipped with a Emergency Disconnect Switch. Pushing the emergency disconnect switch in until it clicks, disconnects the power supply to the lift truck.

NOTE: The Electrical System Schematic referenced in this manual will be supplied in Diagrams. Verify that this data is current and the revisions are up to date before making any changes or alterations to the truck wiring.

Prior to making any corrections or changes to the wiring, verify that the wire number and color coincide with the information on the referenced schematics, wiring diagrams, or special instructions, if any.

NOTE: There may be customer options and equipment installed on the lift trucks by third-party services that do not comply with the standard wiring specifications and standards. Suppliers are encouraged to follow these standards for circuits when possible.

8. The chassis wiring used in these vehicles conforms to the electrical circuit identification standard ES-1359 and in addition to surface marked ID circuit numbers, generally utilizes the colors that are indicated below.

a. Red = Battery level power circuits

b. Black = Heavy current grounds

c. Green = Signal Grounds

d. White = Other circuits

e. Twisted Pair (preferred CAN option)

- Yellow = CANbus Hi
- Green = CANbus Lo

f. Twisted Pair (non-preferred CAN option)

- White = CAN-Hi
- White = CAN-Lo

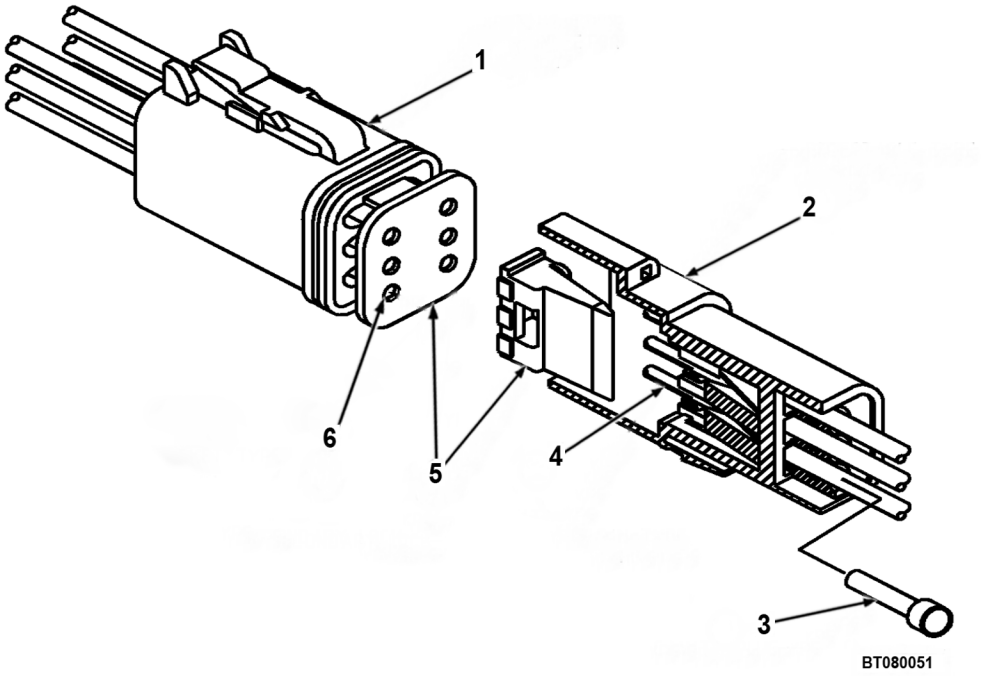
g. Orange = 5 volt

h. Pink = 12 volt

9. Connectors used on schematics and reference drawings are identified as follows: See Figure 9030-03-1 in this section.

a. **CPSXXX** -- **Connector Plug Socket (CPS)**, with **XXX** being the identity number.

b. **CRPXXX** -- **Connector Receptacle Pin (CRP)**, with **XXX** being the identity number.



1. PLUG TYPE CONNECTOR BODY
2. RECEPTACLE TYPE CONNECTOR BODY
3. CAVITY PLUG
4. PIN-TYPE TERMINAL
5. SECONDARY LOCK
6. SOCKET TYPE TERMINAL

Figure 9030-03-1. Typical DT Series Connector

10. At the completion of a Troubleshooting Procedure, verify the following:

a. All components removed for replacement, test or access purposes have been correctly reinstalled.

b. All electrical connections are restored.

c. If operational test or checkout is to be performed, make sure operating area is free of personnel, obstructions, and ground hazards.

d. Vehicle is in proper location and configuration for safe operation.

e. Support equipment and tools are removed and properly stored.

f. If operation is complete and the lift truck is to be stored or shut down, verify:

(1) Mast/Carriage/Forks are properly positioned.

(2) By pushing the emergency disconnect switch down until it clicks, disconnects the power supply to the lift truck.

(3) Cab (if equipped) is closed and secured.

TROUBLESHOOTING PROCEDURES

This section describes the general process of identification, location, structure, and performance of the troubleshooting procedures that are included in this manual.

Troubleshooting Procedures, Identification

The various procedures are identified by the fault characteristic.

Troubleshooting Procedures, Location

Once a DTC number has been displayed, indicating a fault has been detected, the operator/service technician can review the DTC chart in this section to determine where the appropriate troubleshooting procedure is located.

The reported DTCs are listed in numerical order, along with the DTC title description of the detected fault. DTCs are also stored in the Fault Logs, where a history of repeat failures is maintained, until cleared by an authorized service technician.

When working from an Integrated Electronic Technical Manual (IETM) format, clicking on the DTC index number, or the page in the Table of Contents, will link you to the applicable procedure in section 9030-20. If working from a hardcopy (paper) manual, this capability is not available.

NOTE: Access to the following Fault Log menus requires Service password.

NOTE: The only Fault Logs available for display are those for the controllers installed in your lift truck, as defined in the VSM's Configuration Data File (CDF)

Access to Fault History Codes — Fault Logs store a history of DTCs within a specific controller file. These fault logs are accessible through the Display Panel main menu. At the Display Panel menu enter the supervisor password, scroll to Diagnostics, **ENTER**, and scroll to appropriate fault log. See Display Menu Flowchart.

Troubleshooting Procedures, Structure

The structure or makeup of the troubleshooting procedures is generally the same for all entries. The procedures are graphical in nature with some text explanation below the relevant graphic. In the text explanation symbols are used wherever possible. See Icon Glossary for definitions.

Minor differences in the beginning of a procedure are determined by whether the procedure has:

- A single fault code with a single schematic diagram
- A single fault code with multiple schematic diagrams

  In this instance, the technician will have to select the appropriate schematic based on the DTC and the lift truck type/configuration.
- Multiple fault codes with a single or multiple schematic diagram(s)
- A single fault code with no schematic diagrams, used when only the operational check and replacement procedures are employed in the procedure.

Troubleshooting procedures include several elements.

- **DTC** number(s) which this procedure applies to.
- **DTC** Identification e.g. Seat Sensor.
- **CHECK** List - Determines if the Fault is still active and helps identify the Possible Cause.
- POSSIBLE CAUSES
- MAIN SCHEMATIC
- OPERATIONAL CHECKS

NOTE: If key icon remains illuminated after software is installed, shut key **OFF**. Wait 30 seconds for power cycling then turn key **ON**. Key icon should not stay lit.

- Verify the DTC is still a valid fault. If the DTC is cleared during the power cycling, it may not have been a hard failure and if it does not reoccur on the display, there is no method of identifying or troubleshooting the problem.

  If this situation occurs randomly or reoccurs frequently with the same DTC, access and review the fault history log for that group to determine the frequency of failure and the last reported time it occurred. This information can be helpful in isolating intermittent problems when known conditions under which it occurred can be repeated.
- The operational check will also direct the technician to the proper cause in the procedure, based on truck/system configuration, other symptoms, and advise the user if any special conditions are required (i.e. Operate the truck until it has reached normal temperature, recharge the battery before proceeding etc.).
- The operational check is also performed to verify that the problem has been corrected and that the components and devices have been restored to an operating condition.

The next item that appears in the procedure is the **CAUSE A**. This introduces the troubleshooter to the first sequence of tests or measurements to follow. Continuing through the procedure in the step-by-step directions will lead the user to:

- Additional possible causes
- Replacement/repair instructions
- Correction of the fault
- Operational check of the repaired/replaced device

It must be noted that Service Manual factory directions discourage probing of the connectors using any type of wire or pin and that resistance or continuity measurements of these connections should only be done with the appropriate service tool and breakout connectors.

Following through the procedure, the next items are the **DIAGRAMS** that support the troubleshooting and provide relevant data for wiring, connectors, power, signal and other reference data. These will enable the troubleshooter to measure, verify, and make critical decisions leading to the root cause. The diagrams may include:

- A mini-schematic of the suspect circuit
- Wire identification and circuit function
- Connector pin-out locators
- Special reference data for device or component

Troubleshooting Procedures, Performance

It is important to remember the basics of troubleshooting when checking the electronically reported faults. Prior to starting any of the listed procedures, it is recommended that the items listed below be reviewed. These may help to isolate the problem, eliminate some steps or enforce the procedure that has been identified. These items are:

- **LOOK** — Are there any observable symptoms, visual evidence or obvious conditions that could result in, or contribute to, the reported fault.

  Are the displayed Icons due to Interlocks? See **User Interface Supervisor** 2200SRM1335 or **User Interface Service Technician** 2200SRM1336 .

- **LISTEN** — If the lift truck can be operated with the reported problem, are there any unusual noises or vibrations that could result in, or contribute to, the reported fault.
- **TOUCH OR SMELL** — High operating temperatures and excessive wear can sometimes produce an odor or visual evidence that can be linked to other faults or conditions.
- In general, let your senses and your experience assist you in resolving the problem in the most efficient manner. Ask yourself:
  - What is required for this device or operation to function correctly?
  - Where are the devices/parts located?
  - Has this problem been reported before? If so, how frequently? Use the fault history logs to help identify repeated problems. This can be very helpful in analyzing faults of an intermittent nature which may be difficult to duplicate.
  - Has repair work, disassembly or other maintenance work been performed on suspect device or system recently?
- Once these questions have been considered, proceed with the DTC resolution as per the procedure, using any additional information to assist in resolving the discrepancy.

Troubleshooting Procedures, Final

DTCs are stored in the FAULT CODE LOGS, where a history of repeat failures is maintained, until cleared by an authorized service technician. All DTCs are to be cleared prior to operating the lift truck. Fault code logs should only be cleared once the data is recorded by a authorized service technician. See Display Menu Flowchart.

NOTE: Motor/Motor Controller Fault Logs cannot be cleared. Once the Motor Controller Log is full, DTCs are removed on a First In, First Out (FIFO) basis.

Diagnostic Trouble Codes

DIAGNOSTIC TROUBLE CODES

The Diagnostic Trouble Codes that appear in the table that follows are those codes that have been stored in the memory of the VSM or in certain cases the Display Panel or other Controllers. They will be displayed via the Display Panel upon detection and will remain in the applicable fault history logs until service intervention clears the logs.

The DTC list is comprised of the DTC number and a brief description of the fault item.

Diagnostic Trouble Code (DTC) Chart

DTC	DESCRIPTION	PAGE NO.
None	No Display/No Truck Operation	9030-30-1
None	Motor Controller Fan Failure	9030-30-9
None	Motor/Motor Controller Temperature Sensor Failure	9030-30-22
4096	Hydraulic Calibration Required	9030-20-378
4098	Steer Axle Calibration	9030-20-37
4112	Incorrect Lever 1 Installed	9030-20-182
4113	Incorrect Lever 2 Installed	9030-20-182
4114	Incorrect Lever 3 Installed	9030-20-182
4115	Incorrect Lever 4 Installed	9030-20-182
4116	Incorrect Lever 5 Installed	9030-20-182
4117	FOC Configuration Mismatch	9030-20-554
8704	Display Internal LCD Backlight	9030-20-194
8705	Display Internal LCD Heater	9030-20-194
8786	Brake Coil Shorted	9030-20-286
8960	Lift	9030-20-116
8964	Lower	9030-20-116
8968	Tilt Forward	9030-20-116
8972	Tilt Back	9030-20-116
8976	AC Current – Over Current	9030-20-319
8978	Aux 1A	9030-20-116
8980	Aux 1B	9030-20-116
8984	Aux 2A	9030-20-116
8988	Aux 2B	9030-20-116
8992	Synchronous Steering Coil Current	9030-20-417
9000	Diverter Valve	9030-20-232
9004	E Hyd Enable	9030-20-232
9008	Clamp Solenoid (Optional)	9030-20-232
9012	Acc 2 Relay	9030-20-232
9012	ACC 2 Current OORH	9030-20-421
9016	Forward Relay	9030-20-232
9020	Reverse Relay	9030-20-232
9024	AC Current – Short Circuit	9030-20-319
9026	Spare 1 Relay	9030-20-232
9028	Spare 2 Relay	9030-20-232
9032	Main Contactor	9030-20-232
9036	2nd Contactor	9030-20-232
9040	Display Buzzer Output	9030-20-226
9041	Display Keyswitch Output	9030-20-200
9045	Internal Error - Software	9030-20-506
12332	Data Incorrect	9030-20-110
12545	Battery OORH	9030-20-86

Diagnostic Trouble Code (DTC) Chart (Cont)

DTC	DESCRIPTION	PAGE NO.
12546	Battery OORL	9030-20-86
12576	Motor Voltage Not OK	9030-20-302
12576	DC Bus Charging Timeout	9030-20-387
12592	Capacitor Charge	9030-20-254
12800	Directional Select A	9030-20-67
12801	Directional Select A	9030-20-71
12802	Direction Select Data Incorrect – Direction Signals Incorrect	9030-20-344
12804	Directional Select B	9030-20-67
12805	Directional Select B	9030-20-71
12806	Direction Select – Data Incorrect 2 + Direction Devices Installed	9030-20-350
12807	Direction Select Data Incorrect - No DCS Source	9030-20-353
12808	Accelerator Pedal Position A	9030-20-11
12809	Accelerator Pedal Position A	9030-20-15
12810	Accelerator Pedal Position B	9030-20-11
12811	Accelerator Pedal Position B	9030-20-15
12812	Accelerator Pedal Position A to B	9030-20-20
12813	Foot Brake Position Rationality	9030-20-552
12816	Seat Sensor	9030-20-77
12817	DC Bus Hi – Software Detected	9030-20-387
12818	DC Bus Hi – Hardware Detected	9030-20-387
12819	Seat Sensor	9030-20-81
12820	Steering Wheel Position	9030-20-28
12821	Steering Wheel Position	9030-20-32
12824	Steering Axle Position	9030-20-28
12825	Steering Axle Position	9030-20-32
12831	Park Brake Position	9030-20-62
12832	Park Brake Position	9030-20-58
12833	DC Bus Low – Hardware/Software	9030-20-387
12834	Aux Driver Short to Bat (-) Brake Coil Open Circuit	9030-20-286
12835	Aux Driver Open Circuit Excess Current	9030-20-286
12836	Service Brake Pressure	9030-20-1
12836	Brake Pedal Sensor A OORL	9030-20-552
12837	Service Brake Pressure	9030-20-6
12837	Brake Pedal Sensor A OORH	9030-20-552
12840	Mast Tilt Position	9030-20-58
12841	Mast Tilt Position	9030-20-62
12844	Load Weigh Pressure	9030-20-1
12845	Load Weigh Pressure	9030-20-6
12852	Hydraulic Temperature	9030-20-41
12853	Hydraulic Temperature	9030-20-44
12856	Manual Hyd 1	9030-20-101
12857	Manual Hyd 1	9030-20-105
12860	Manual Hyd 2	9030-20-101
12861	Manual Hyd 2	9030-20-105
12864	Manual Hyd 3	9030-20-101
12865	Manual Hyd 3	9030-20-105
12868	Manual Hyd 4	9030-20-101
12869	Manual Hyd 4	9030-20-105
12872	Hydraulic Fluid Level	9030-20-49
12873	Hydraulic Fluid Level	9030-20-54

Diagnostic Trouble Code (DTC) Chart (Cont)

DTC	DESCRIPTION	PAGE NO.
12876	Brake Pedal Sensor B OORL	9030-20-552
12877	Brake Pedal Sensor B OORH	9030-20-552
12928	Display Temperature Sensor (Freezer Option Only)	9030-20-226
12929	Display Temperature Sensor (Freezer Option Only)	9030-20-226
12934	Display Internal LCD Backlight	9030-20-194
12935	Display Internal LCD Backlight	9030-20-194
12936	Display Internal LCD Heater	9030-20-194
12937	Display Internal LCD Heater	9030-20-194
12938	Display Buzzer Output	9030-20-226
12939	Display Buzzer Output	9030-20-226
12940	Display Keyswitch Output	9030-20-200
12941	Display Keyswitch Output	9030-20-200
13056	5V OORL	9030-20-95
13057	5V OORH	9030-20-95
13058	5V Internal Supply Out of Range	9030-20-507
13060	VSM 12V OORL	9030-20-185
13061	VSM 12V OORH	9030-20-185
13070	Keyswitch Data Incorrect	9030-20-200
13104	Sensor Ground Current OORH	9030-20-508
13312	Lift	9030-20-122
13316	Lower	9030-20-122
13320	Tilt Forward	9030-20-122
13324	Tilt Back	9030-20-122
13328	Aux 1A	9030-20-122
13332	Aux 1B	9030-20-122
13336	Aux 2A	9030-20-122
13340	Aux 2B	9030-20-122
13344	Synch Steering Coil Open Circuit	9030-20-419
13352	Diverter Valve	9030-20-237
13356	Hyd Enable	9030-20-237
13360	Acc 1 Relay	9030-20-237
13364	Acc 2 Relay	9030-20-237
13368	Motion Relay	9030-20-237
13372	Reverse Relay	9030-20-237
13376	Spare 1 Relay	9030-20-237
13380	Brake Light Relay Short to B(-) or Open	9030-20-237
13384	Main Contactor	9030-20-237
13388	2nd Contactor	9030-20-237
16912	Motor Temperature High	9030-20-361
16912	Motor Temperature OORH	9030-20-520
16913	Motor Temperature Sensor Open Circuit	9030-20-512
16914	Motor Temperature Sensor Short Circuit	9030-20-516
17168	Controller/Heatsink Temperature High	9030-20-361
17184	Controller Internal Temperature OORH	9030-20-619
17232	Controller Internal Temperature OORL	9030-20-618
20753	15 Volt Supply Low Voltage	9030-20-382
20755	5 Volt Supply Low/High Voltage	9030-20-382
21008	Current Sensor Offset Calibration Error	9030-20-373
21520	Aux Driver Current High	9030-20-406
21521	Fan Driver Current OORH	9030-20-524

Diagnostic Trouble Code (DTC) Chart (Cont)

DTC	DESCRIPTION	PAGE NO.
21522	Automatic Park Brake Driver Current OORH	9030-20-529
21569	Contactor Open	9030-20-243
21570	Contactor Closed	9030-20-243
21760	VSM BOOT_BLOCK Checksum failure	9030-20-212
21761	CDF_Checksum_failure	9030-20-212
21762	VSM APPLICATION_SOFTWARE Checksum failure/Error	9030-20-212
21764	VSM EEPROM Checksum failure/Error	9030-20-212
21766	VSM EEPROM Cell failure Write Error	9030-20-212
21776	Internal Error - Hardware	9030-20-527
21792	VSM Serial Number Error	9030-20-212
21830	MLM EEPROM Write Error	9030-20-175
21834	MLM Sensor 1 Out of Range	9030-20-175
21835	MLM Sensor 2 Out of Range	9030-20-175
21836	MLM Sensor 3 Out of Range	9030-20-175
21837	MLM Sensor 4 Out of Range	9030-20-175
22032	Display EEPROM Checksum Error	9030-20-194
22033	Display Cell Write Error	9030-20-194
22528	Display Button *	9030-20-194
22529	Display Button #	9030-20-194
22530	Display \ Arrow	9030-20-194
22531	Display] Arrow	9030-20-194
22532	Display Button 1	9030-20-194
22533	Display Button 2	9030-20-194
22534	Display Button 3	9030-20-194
22535	Display Button 4	9030-20-194
22536	Display Button 5	9030-20-194
22537	Display Button 6	9030-20-194
22538	Display Button 7	9030-20-194
22539	Display Button 8	9030-20-194
22540	Display Button 9	9030-20-194
22541	Display Button 0	9030-20-194
25104	Sensor Fault	9030-20-273
25105	Temperature Sensor Failure	9030-20-361
25106	Park Brake Solenoid and Fan Driver Current High	9030-20-406
25344	MLM Checksum Error	9030-20-175
29216	Speed Sensor High Current	9030-20-531
29217	Speed Sensor Not Connected	9030-20-533
29232	Sensor Supply Reference voltage Out of Range	9030-20-528
29233	Sensor Supply Circuit Out of Range	9030-20-535
29248	Speed Sensor Feedback	9030-20-25
29456	Sensor Fault	9030-20-261
29456	Sensor Fault	9030-20-273
29536	Loss of Speed Sensor Channel A	9030-20-25
29552	Loss of Speed Sensor Channel B	9030-20-537
33024	CAN Communication Failure	9030-20-336
33025	VSM to Display	9030-20-127
33025	VSM to Display	9030-20-142
33025	VSM to Display	9030-20-160
33026	VSM to Traction 1 (Right)	9030-20-127

Diagnostic Trouble Code (DTC) Chart (Cont)

DTC	DESCRIPTION	PAGE NO.
33026	VSM to Traction 1 (Right)	9030-20-142
33026	VSM to Traction 1 (Right)	9030-20-160
33027	VSM to Traction 2 (Left)	9030-20-127
33027	VSM to Traction 2 (Left)	9030-20-142
33027	VSM to Traction 2 (Left)	9030-20-160
33029	VSM to Pump	9030-20-127
33029	VSM to Pump	9030-20-142
33029	VSM to Pump	9030-20-160
33034	VSM to MLM (DCS)	9030-20-127
33034	VSM to MLM (DCS)	9030-20-142
33034	VSM to MLM (DCS)	9030-20-160
33035	VSM to Impact	9030-20-127
33035	VSM to Impact	9030-20-142
33035	VSM to Impact	9030-20-160
33036	VSM to CAN Reserved 1	9030-20-127
33036	VSM to CAN Reserved 1	9030-20-142
33036	VSM to CAN Reserved 1	9030-20-160
33037	VSM to CAN Reserved 2	9030-20-127
33037	VSM to CAN Reserved 2	9030-20-142
33037	VSM to CAN Reserved 2	9030-20-160
33038	VSM to CAN Reserved 3	9030-20-127
33038	VSM to CAN Reserved 3	9030-20-142
33038	VSM to CAN Reserved 3	9030-20-160
33040	Various CAN Errors	9030-20-556
33050	E-Steer CAN Communications Failure Right	9030-20-502
33051	E-Steer CAN Communications Failure Left	9030-20-502
33056	Display Internal CAN Failure	9030-20-194
33057	Display to VSM	9030-20-127
33057	Display to VSM	9030-20-142
33057	Display to VSM	9030-20-160
33057	Display Communications Error with VSM	9030-20-194
64776	Watchdog	9030-20-558
64781	FOC2 Traction Controller EEPROM Checksum Failure	9030-20-559
64781	EEPROM KO	9030-20-572
64785	FOC2 Traction Controller Motor U-V Phase Voltage Measurement Fault (Logic Failure #3)	9030-20-560
64787	FOC2 Traction Controller DC Bus High and Key Voltage Low	9030-20-593
64798	FOC2 Traction Controller Operating Nominal Motor Voltage Low	9030-20-562
64799	FOC2 Traction Controller Operating Nominal Motor Voltage High	9030-20-562
64805	FOC2 Traction Controller Contactor Closed	9030-20-580
64806	FOC2 Traction Controller Contactor Open	9030-20-580
64821	FOC2 Traction Controller Standby Current Too High	9030-20-565
64828	FOC2 Traction Controller DC Bus Capacitor Charge Timeout	9030-20-566
64830	FOC2 Traction Controller Motor Temperature High	9030-20-619
64833	FOC2 Traction Motor Temperature Above Limit	9030-20-569
64842	FOC2 Traction Controller Contactor Driver Shorted High	9030-20-580
64843	FOC2 Traction Controller Contactor Driver Shorted Low	9030-20-580
64850	FOC2 Encoder Error	9030-20-604
64969	FOC2 Traction Controller Wrong Slave Version	9030-20-546
64974	FOC2 Traction Controller Initial Nominal Motor Voltage High	9030-20-562

Diagnostic Trouble Code (DTC) Chart (Cont)

DTC	DESCRIPTION	PAGE NO.
64975	FOC2 Traction Initial Nominal Motor Voltage Low	9030-20-562
64976	EEPROM KO	9030-20-572
64978	FOC2 Controller Wrong RAM Memory	9030-20-573
64979	FOC2 Traction Controller Rotor Stall	9030-20-590
64980	FOC2 Traction Controller Waiting for Slave Node Response	9030-20-574
64981	FOC2 Traction Controller Hardware Fault	9030-20-575
64986	FOC2 Traction Motor Temperature Sensor KO	9030-20-576
64988	FOC2 Traction Controller Vkey OFF Shorted	9030-20-593
64991	FOC2 Contactor Coil Shorted	9030-20-580
64992	FOC2 Traction Controller Waiting for Node	9030-20-577
64999	FOC2 Traction Controller No Slave Enabled	9030-20-546
65001	FOC2 Power Transistor Shorted	9030-20-559
65003	FOC2 coil_short_hw_ko	9030-20-559
65004	FOC2 Current Gain	9030-20-580
65005	Analog Input	9030-20-582
65007	FOC2 Traction Controller Mismatch	9030-20-546
65009	FOC2 Traction Controller Master To Slave Parameter Check Mismatch	9030-20-574
65010	FOC2 Traction Controller Parameter Transfer	9030-20-546
65013	FOC2 Traction Controller IQ Mismatch	9030-20-583
65014	FOC2 Traction Controller Aux Driver Short	9030-20-421
65015	FOC2 Traction Controller Data Acquisition	9030-20-584
65016	FOC2 Traction Controller No CAN Message	9030-20-577
65018	FOC2 Traction Controller Thermic Sensor KO	9030-20-588
65021	FOC2 Traction Controller Field Oriented Control KO	9030-20-589
65022	FOC2 Traction Controller Aux Driver Short	9030-20-421
65032	Watchdog (Slave)	9030-20-597
65043	FOC2 DC Bus High / Key Voltage Low	9030-20-598
65077	FOC2 Traction Controller Standby Current Too High	9030-20-601
65086	FOC2 Thermal Protection	9030-20-602
65106	FOC2 Traction Controller Encoder Error	9030-20-25
65106	FOC2 Encoder Error	9030-20-604
65232	EEPROM KO (Slave)	9030-20-607
65234	FOC2 Controller Wrong RAM Memory (Slave)	9030-20-608
65236	FOC2 Waiting Master	9030-20-609
65253	FOC2 Output Mismatch	9030-20-559
65254	FOC2 W.D. SYNCRO	9030-20-609
65259	FOC2 Coil_Short_HW_KO	9030-20-610
65261	FOC2 Analog Input	9030-20-612
65263	FOC2 Controller Mismatch	9030-20-612
65266	FOC2 SP Mismatch	9030-20-612
65270	FOC2 Aux Drive Open	9030-20-613
65272	FOC2 No CAN Message	9030-20-615
65278	FOC2 Aux Driver Short	9030-20-613
65280	Controller Failure	9030-20-312
65288	Electric Steer Loss of Communication Between the Primary and Secondary Controller	9030-20-423
65293	Electric Steer System Controller EEPROM Checksum Failure	9030-20-424
65296	Motor U-W Phase Voltage Measurement Fault	9030-20-428
65297	Electric Steer Controller Motor U-V Phase Voltage Measurement Fault	9030-20-430
65299	Controller Logic Failure	9030-20-218
65310	VMN Low	9030-20-548

Diagnostic Trouble Code (DTC) Chart (Cont)

DTC	DESCRIPTION	PAGE NO.
65311	VMN High	9030-20-548
65312	Motor Phase Voltage Out of Range	9030-20-434
65317	Contactor Closed	9030-20-243
65318	Contactor Open	9030-20-243
65333	Electric Steer Controller Standby Current Too High	9030-20-436
65333	Standby Current High	9030-20-548
65340	Electric Steer Controller DC Bus Capacitor Charge Timeout	9030-20-437
65341	Controller Temperature Above Limit	9030-20-440
65341	Controller Internal Temperature OORL	9030-20-618
65341	Controller Internal Temperature OORH	9030-20-619
65342	Thermal Protection / Motor Temperature High	9030-20-619
65345	Electric Steer Motor Temperature Above Limit	9030-20-441
65346	Battery Low	9030-20-539
65350	Controller Internal Error	9030-20-444
65350	Motor Phase W Current OORL	9030-20-460
65351	Motor Phase V Current OORL	9030-20-462
65352	Motor W-V Phase Voltage Measurement Fault	9030-20-432
65353	Motor Phase U Current OORL	9030-20-464
65354	Driver Shorted High	9030-20-243
65355	Driver Shorted Low	9030-20-243
65362	Encoder Error	9030-20-25
65362	Encoder Error	9030-20-537
65378	Steering Wheel Position Error	9030-20-473
65481	Wrong Slave Version	9030-20-546
65486	Initial VMN High	9030-20-548
65487	Electric Steer Initial Nominal Motor Voltage Low	9030-20-445
65488	Electric Steer Controller EEPROM KO	9030-20-446
65489	Controller Internal Error	9030-20-459
65490	Electric Steer Primary and Secondary Controller Version Mismatch	9030-20-447
65491	Electric Steer TFD Current within Range but Lower than Expected	9030-20-475
65492	Electric Steer Controller Internal Error	9030-20-448
65493	Electric Steer Default Parameter Restore	9030-20-449
65494	Rapid Change in Steering Wheel Position	9030-20-469
65495	Controller Internal Error	9030-20-450
65496	Controller Internal Error	9030-20-451
65496	TFD Resistance Out of Range	9030-20-477
65498	Electric Steer Controller Software Mismatch	9030-20-458
65500	Electric Steer Steering Motor Locked	9030-20-483
65501	Controller Internal Error	9030-20-452
65503	Electric Steer Rapid Change in Steer Axle Position	9030-20-497
65504	Waiting for Node	9030-20-550
65505	Controller Internal Error	9030-20-453
65508	Steer Axle Position Mismatch	9030-20-489
65511	No Slave Enabled	9030-20-546
65512	Wrong Encoder Set	9030-20-25
65512	Wrong Encoder Set	9030-20-537
65513	Power MOS Shorted	9030-20-296
65515	Electric Steer Controller TFD Short to battery Negative	9030-20-479
65516	Electric Steer Controller TFD Stand-by Current OORH	9030-20-481
65517	Electric Steer Controller Internal Error	9030-20-454

Diagnostic Trouble Code (DTC) Chart (Cont)

DTC	DESCRIPTION	PAGE NO.
65519	Controller Mismatch	9030-20-546
65521	Electric Steer Controller Steer Axle Slow Response	9030-20-486
65522	Parameter Transfer	9030-20-546
65524	Electric Steer Primary and Secondary Parameter Mismatch	9030-20-501
65525	Electric Steer Controller Internal Error	9030-20-455
65526	Aux Driver Open	9030-20-421
65527	No CAN Communication	9030-20-329
65527	Loss of CAN Communication	9030-20-502
65528	Electric Steer Wheel Sensor Output Mismatch	9030-20-471
65528	FOC2 No CAN Message	9030-20-615
65529	Check Up Needed	9030-20-541
65530	Electric Steer Controller Internal Error	9030-20-456
65531	Controller Initialization Test Failed	9030-20-466
65532	Steer Axle Sensor Output Mismatch	9030-20-493
65533	Electric Steer Controller Internal Error	9030-20-457
65534	Aux Driver Short	9030-20-421
95360	Forw + Back	9030-20-542
95520	Key Switch Voltage OORL	9030-20-425

Wiring Reference Data

NOTE: When troubleshooting the electrical wiring harness for your lift truck, the wire connectors may be different but the pin numbers for the connectors are the same between the different connectors.

Function/Circuit Identification — A standard numbering and color-coding system is used in the lift truck wiring. This system will simplify repairs. The Electrical Circuit Identification Specification is ES-1359. The ID data is described in Table 9030-03-1.

Each circuit Function ID has a number from 1 through 999, as indicated in the Table 9030-03-1.If a circuit function does not meet one of the preassigned numbers, and its function is unique within the truck series and option, then a number from the “Non-Standard Functions” range may be used.

- A circuit labeled with a single numerical Function ID shall be electrically equivalent throughout the harness (physically connected through splices or connectors).
- Wires which are connected only through an internal connection in a controller shall have separate Function ID numbers.
- Wire Function ID numbers will be stamped at 50mm intervals along the wire length.
- The Function IDs are assigned into groups as shown in the table. Unless noted otherwise, specific functions are to be preassigned to unique Function IDs.

Table 9030-03-1. Circuit Group Identification

Function/Group	Number Range
Grounds (IDs not preassigned within this range)	101-149
Current sense ground	150-199
Switched B+ (IDs not preassigned within this range)	200-239
Fused B+ (IDs not preassigned within this range)	240-249
Regulated Power 5V (IDs not preassigned within this range)	250-279
Regulated Power 12V	280-299
Analog Inputs – hydraulics / mast	300-319
Analog Inputs – chassis	320-339
Analog Inputs – powertrain	340-399
Analog Inputs – CAB / OHG	400-419
Reserved for additional analog inputs	420-499
Digital inputs – hydraulics / mast	500-509
Digital inputs – chassis	510-539
Digital inputs – powertrain	540-559
Digital inputs – CAB / OHG	560-569
Encoder inputs	570-599
Reserved for additional digital inputs	600-699
Digital outputs – hydraulics / mast	700-719
Digital outputs – chassis	720-749
Digital outputs – powertrain	750-779

Table 9030-03-1. Circuit Group Identification (Continued)

Function/Group	Number Range
Digital outputs – CAB /OHG	780-799
PWM outputs – hydraulics / mast	800-829
PWM outputs – chassis	830-839
PWM outputs – powertrain	840-889
PWM outputs – CAB / OHG	890-899
Communications (eg., CANbus)	900-909
Non-Standard functions	910-999

Wiring Color Codes — The colors used to identify the lift truck wiring, in addition to the surface marked circuit ID data, are identified in Table 9030-03-2. Many Diagrams and Schematics in this book can be viewed and printed in color. If not printed or viewed in color refer to the electrical circuit identification located on schematic circuits. When viewing a color version of the diagrams and schematics, the white chassis wires are seen as yellow. Other wires are shown in colors similar to actual colors, i.e., tan shows as yellow. Use circuit identification for true wire color. MONOTROL® , wiring to sensors and other applications vary with respect to wire colors.

Symbol Definitions

Type "S", Identifies information for UL Safety rated trucks.

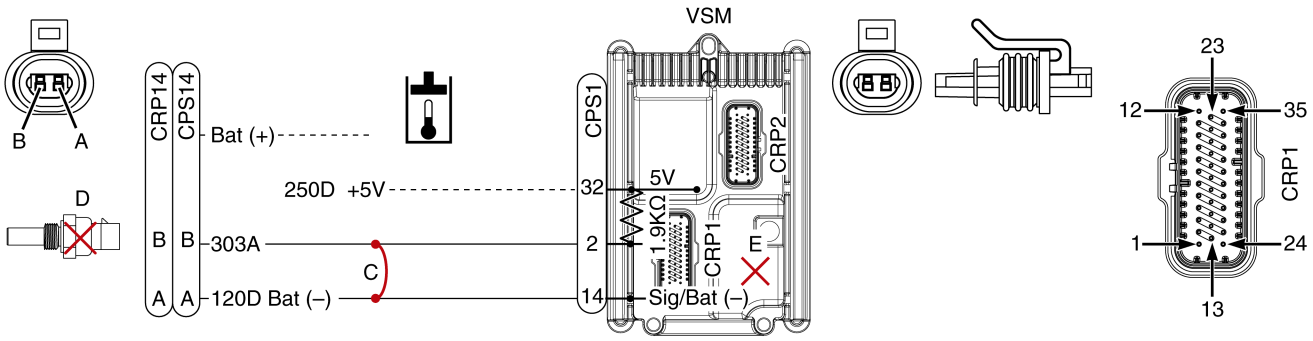
Arrow Symbols, Go to specified page of schematic. Page number is located in the “hexagon symbol” on schematic.

---x, Go to specified sheet of diagram. Sheet number is located in lower right corner of figure.

Circuit Segment Suffix Letter — A circuit ID has a segment suffix letter as required (splices or passing through a connector). Each circuit ID is unique and each circuit ID has a suffix. The circuit connects to all other wires in the vehicle with the same circuit ID number. For example, 42-A will be connected to 42-B, 42-J, etc. Function ID numbers appear with suffix letters, the base number is not used by itself. For example, when labeling a circuit #42, start with “42-A” rather than “42”. Suffix letters should be assigned from “A” to “Z” (but “Q” and “V” are not used). Additional branches beyond “Z” to be assigned as “AA”, AB”, etc. If a Suffix is used, the parts of the circuit identification number will be separated by dashes. For example:

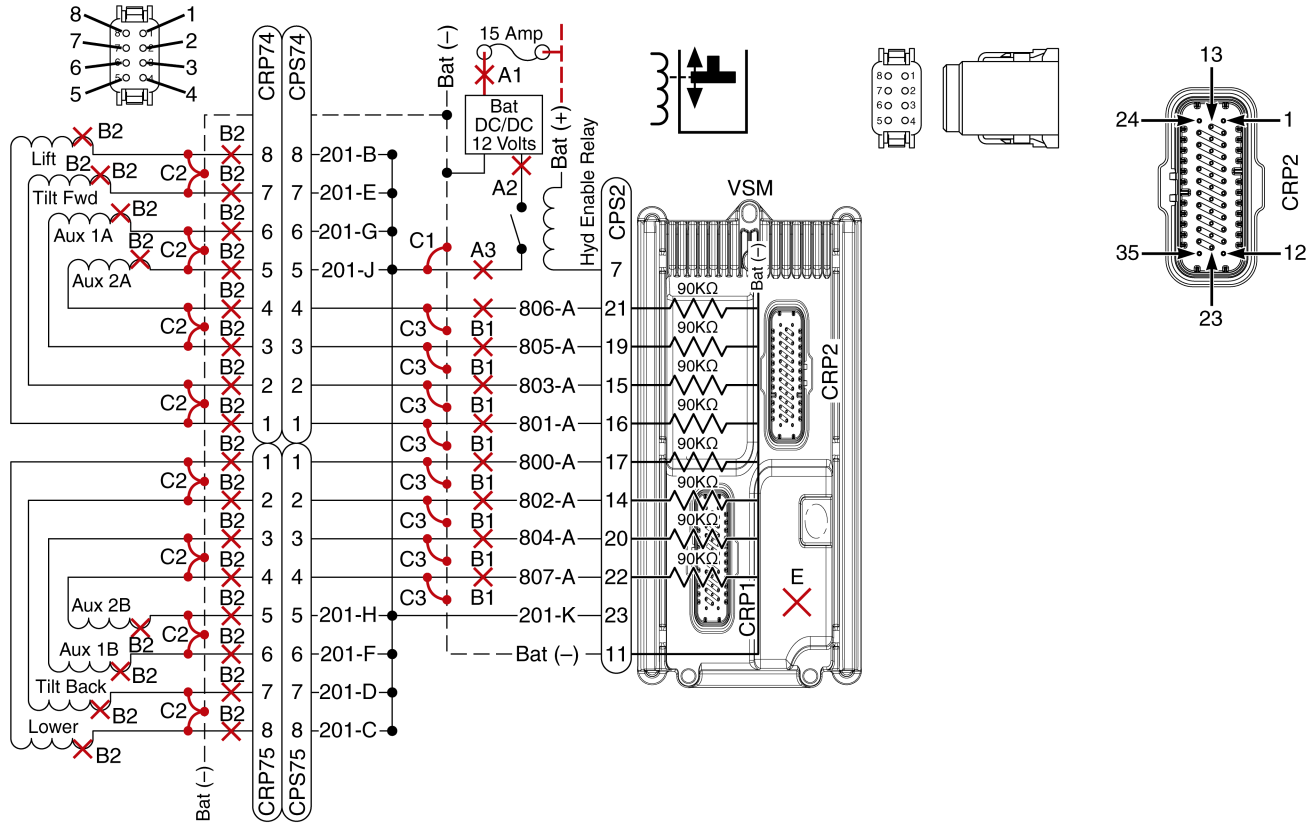
Table 9030-03-2. Hyster Wiring Color Codes

Color	Use/Function
Red	Battery-level power circuits
Black	Heavy current grounds
Green	Signal grounds
White	Other circuits
Twisted Pair (Yellow/ Green) Yellow Green	Preferred CAN Option CAN-Hi CAN-Lo
Twisted Pair (Yellow/ Green) White White	Non-Preferred CAN Option CAN-Hi CAN-Lo



- WIRE # 751 (RED), SEGMENTED, SUFFIX LETTERS A, O, P
- WIRE # 870 (WHITE), NON-SEGMENTED, SUFFIX LETTER A
- WIRE #S 383, 384 (WHITE), NON-SEGMENTED, TWISTED PAIR, SUFFIX LETTER A (SHOWN WITH SHIELD THAT TERMINATES AT PIN B2)

Figure 9030-03-2. Single Wiring Sample Circuit



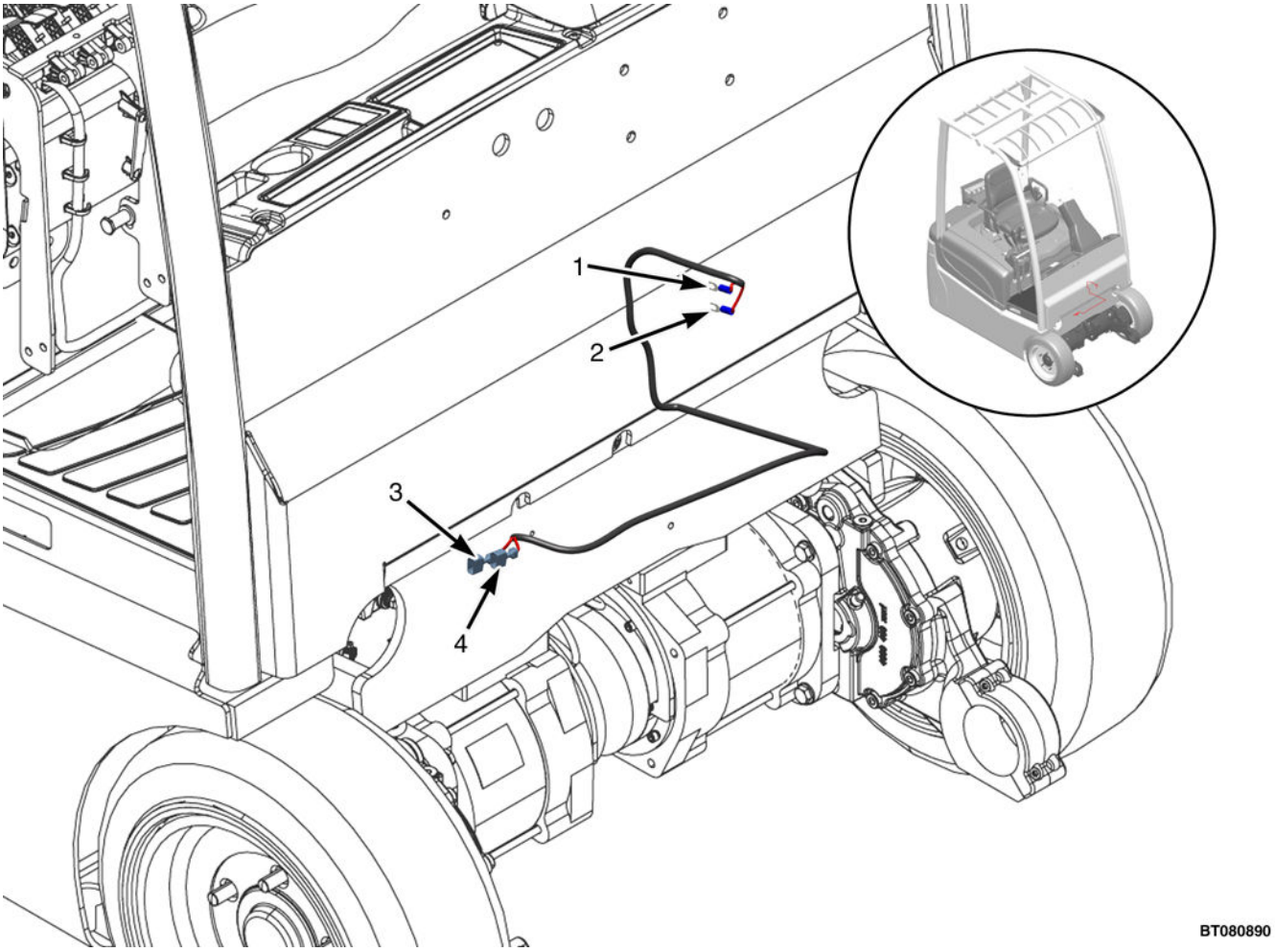
- WIRE # 751 (RED), SEGMENTED, SUFFIX LETTERS A, O, P
- WIRE # 870, 871 (WHITE), NON-SEGMENTED, SUFFIX LETTER A
- WIRE #S 383, 384, 387, AND 388 (WHITE), NON-SEGMENTED, TWISTED PAIR, SUFFIX LETTER A (SHOWN WITH SHIELD THAT TERMINATES AT PIN B2)

Figure 9030-03-3. Dual Wiring Sample Circuit

Harness Assembly Data

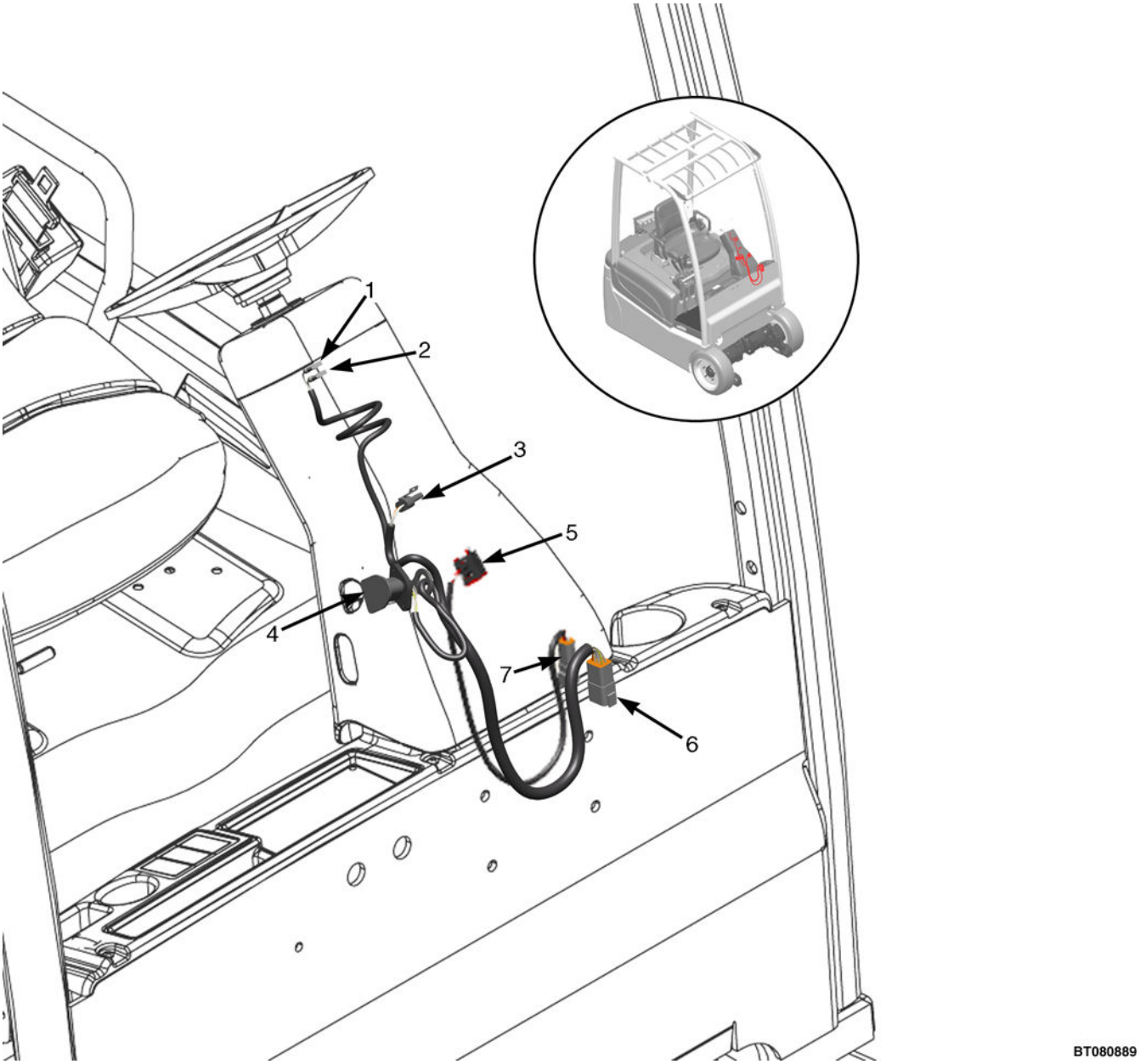
This section depicts the lift truck harness assemblies with their respective connector identifications. The harnesses are arranged as follows:

- Wire Harness – Auxiliary Key Switch Figure 9030-03-4
- Wire Harness Steering Figure 9030-03-5
- Display Wire Harness Standard Figure 9030-03-6
- Display Wire Harness Freezer Figure 9030-03-7
- Wire Harness Main Electro – Hydraulic Figure 9030-03-8
- Wire Harness Main Manual – Hydraulic Figure 9030-03-9
- Wire Harness Front Switch Figure 9030-03-10
- Wire Harness Back Up Alarm Strobe w/o Conv.Figure 9030-03-11
- Wire Harness Lights LH - OHG Figure 9030-03-12
- Wire Harness Manual Hydraulics Figure 9030-03-13
- Wire Harness Display Freezer Figure 9030-03-14
- Wire Harness Turn Signal Figure 9030-03-15
- Wire Harness Synchro Steer Figure 9030-03-16
- Wire Harness Park Brake Figure 9030-03-17
- Wire Harness LH OHG w/Turn Signals Figure 9030-03-18
- Wire Harness Steering Column Figure 9030-03-19
- Wire Harness Lights w/OHG - RH Figure 9030-03-20
- Wire Harness Lights Chassis Main Figure 9030-03-21
- Wire Harness Seat E-Hydraulic Figure 9030-03-22
- Wire Harness Seat Manual-Hydraulic Figure 9030-03-23
- Wire Harness Main w/Manual – Hydraulic Figure 9030-03-24
- Wire Harness Main w/E – Hydraulic Figure 9030-03-25



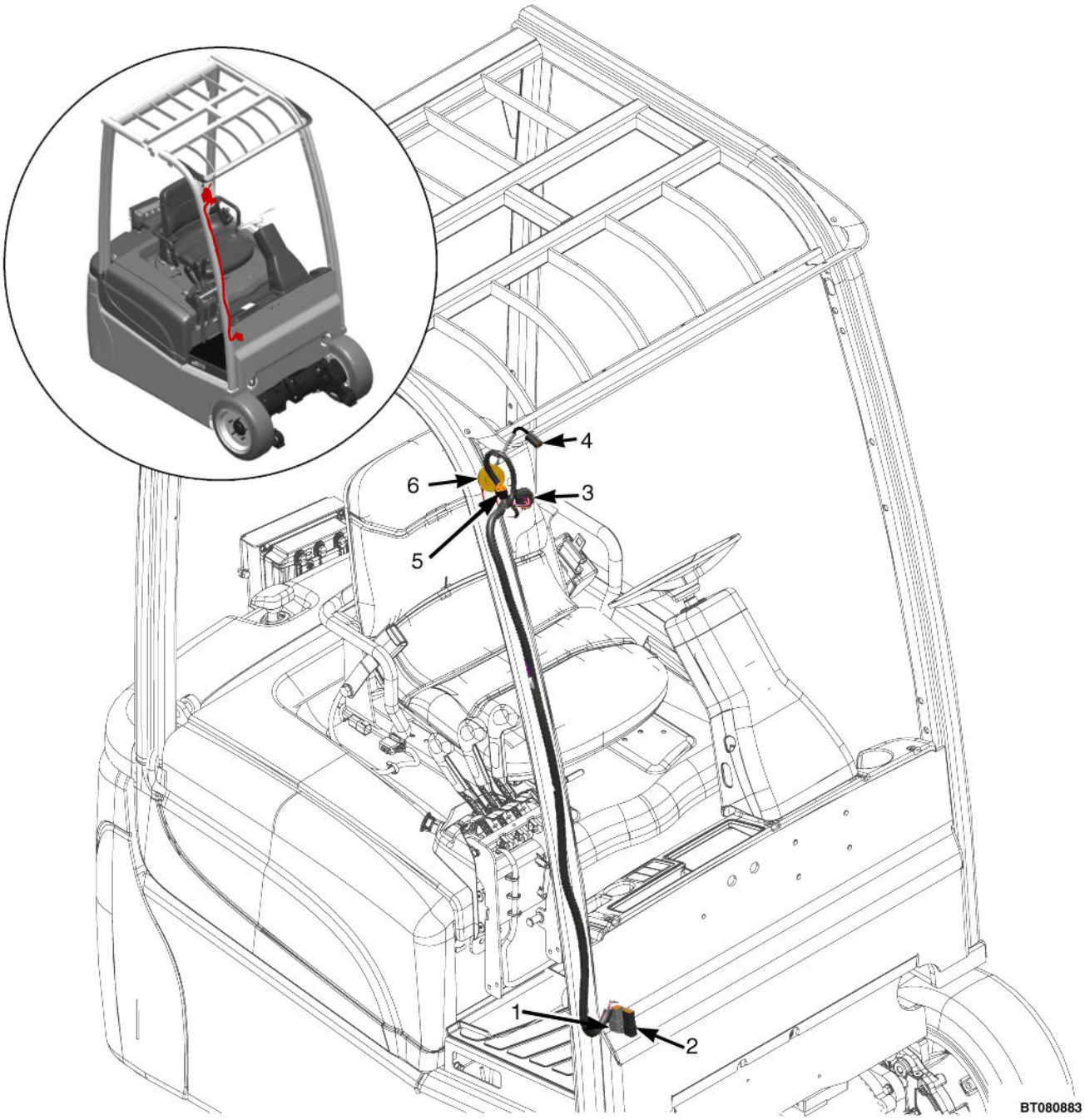
1. T115 FUSE BLOCK
2. T116 FUSE BLOCK
3. T114 KEY SWITCH
4. T113 KEY SWITCH

Figure 9030-03-4. J1.5-2.0XNT (J30-40XNT) (K160) ; Wire Harness – Auxiliary Key Switch



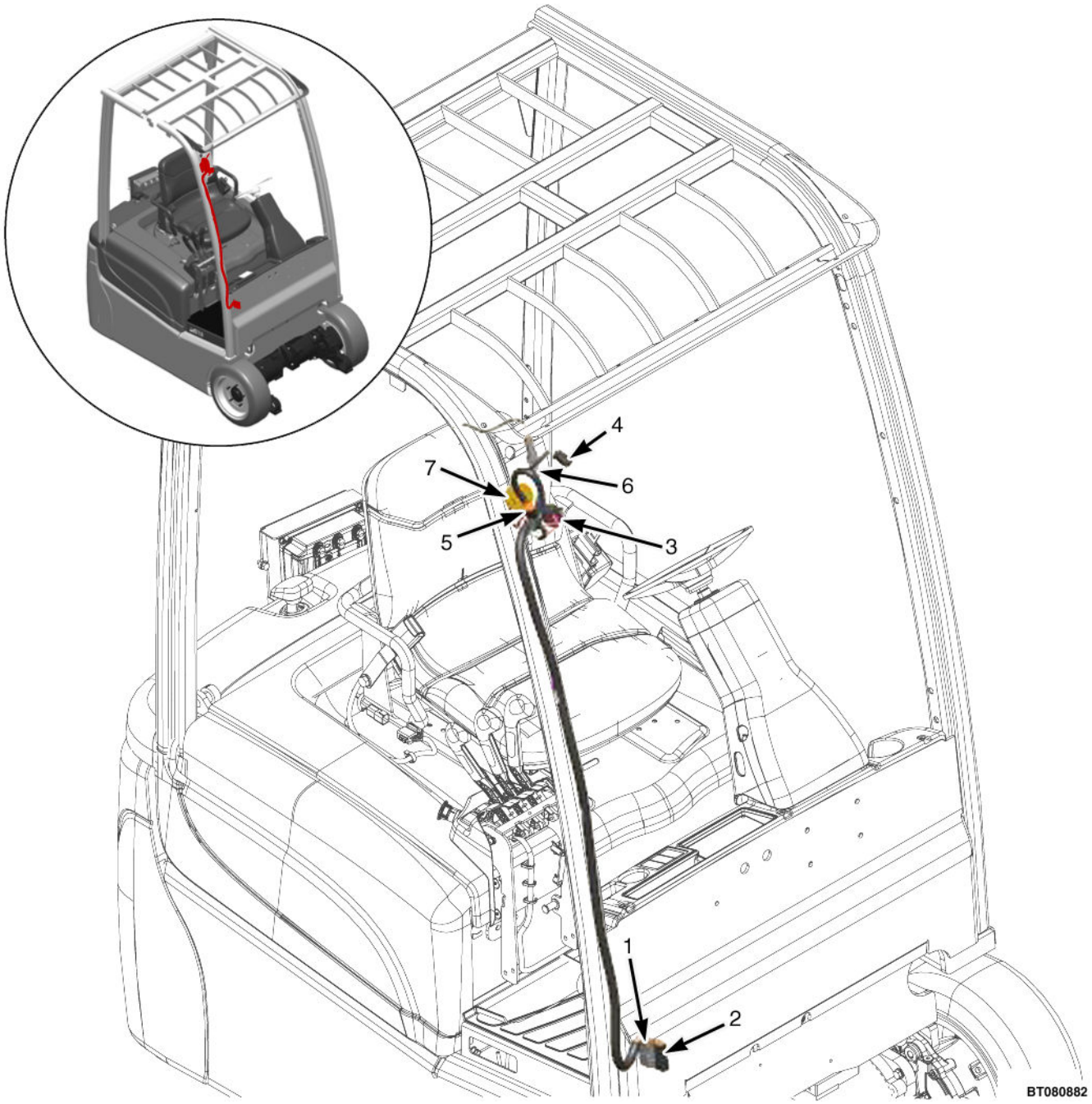
1. TF15 HORN SWITCH NO
2. TF14 HORN SWITCH C
3. CPS78 STEERING WHEEL POSITION SENSOR
4. CPS28 DIAGNOSTIC CONNECTION
5. CPS128 STEER MAKE-UP VALVE
6. CRP132 MAIN HARNESS
7. CRP133 MAIN HARNESS

Figure 9030-03-5. J1.5-2.0XNT (J30-40XNT) (K160) ; Wire Harness Steering



1. CRP135 MAIN HARNESS
2. CRP180 MAIN HARNESS
3. CPS20 DISPLAY
4. CPS103 RIGHT FRONT WORK LIGHT
5. CPS166 RIGHT FRONT MARKER LIGHT
6. BUZZER

Figure 9030-03-6. J1.5-2.0XNT (J30-40XNT) (K160) ; Display Wire Harness Standard



1. CRP135 MAIN HARNESS
2. CRP180 MAIN HARNESS
3. CPS20 DISPLAY
4. CPS103 RIGHT FRONT WORK LIGHT
5. CPS166 RIGHT FRONT MARKER LIGHT
6. CPS165 TEMPERATURE SENSOR
7. BUZZER

Figure 9030-03-7. J1.5-2.0XNT (J30-40XNT) (K160) ; Display Wire Harness Freezer

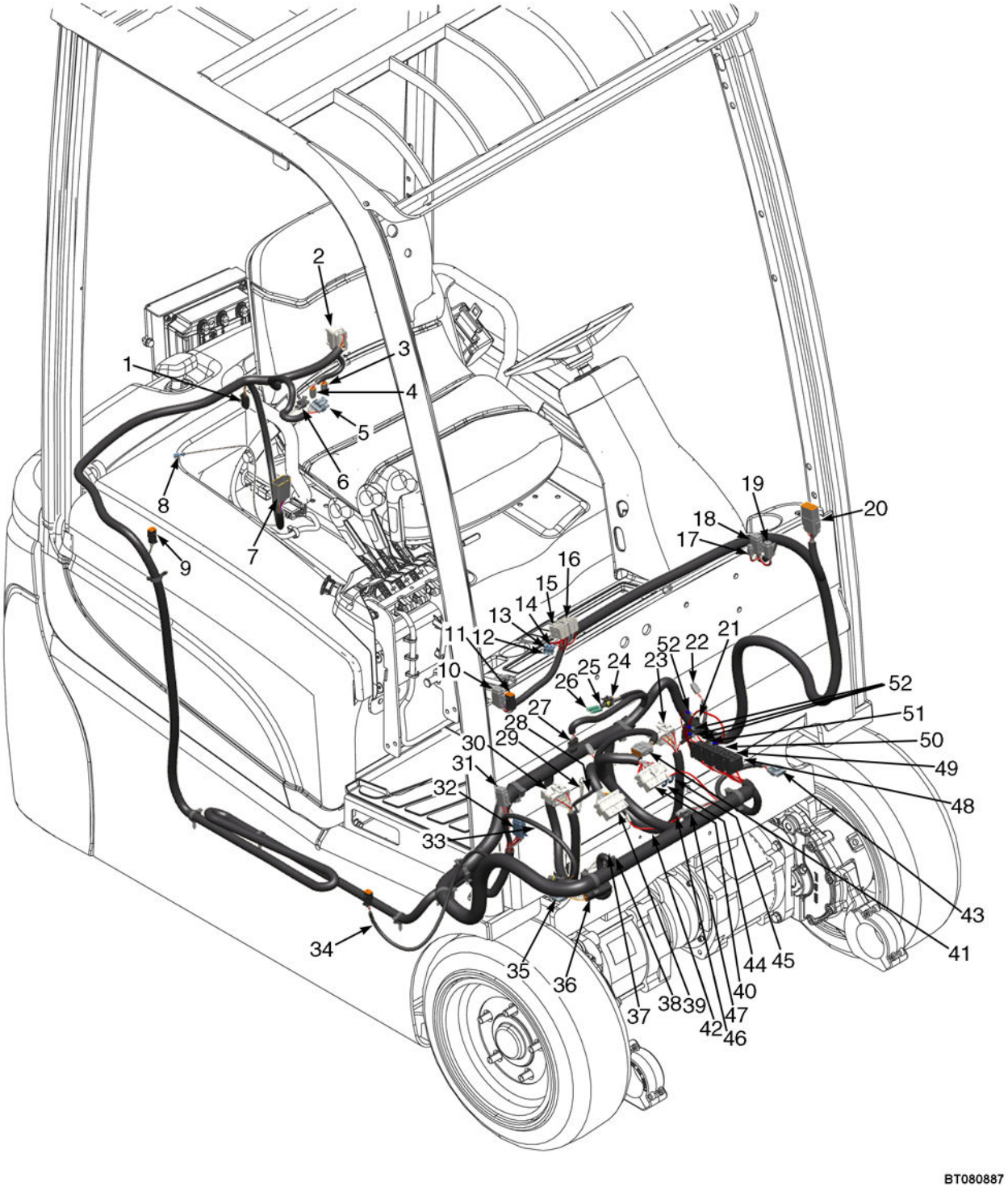


Figure 9030-03-8. J1.5-2.0XNT (J30-40XNT) (K160) ; Wire Harness Main Electro – Hydraulic

Legend for Figure 9030-03-8

1. CPS31A STEER AXLE HARNESS
2. CPS5 PUMP CONTROLLER
3. CPS95B HYDRAULIC COOLING FAN
4. CPS95A HYDRAULIC CONTROLLER COOLING FAN
5. CPS146 MOTOR SPEED SENSOR
6. CPS61 MOTOR TEMPERATURE SENSOR
7. CRP52-55 MLM SEAT HARNESS
8. TF67 ESD HYDRAULIC TANK
9. CPS114 OHG HORN SWITCH
10. CPS135 DISPLAY HARNESS
11. CPS180 DISPLAY LIGHT HARNESS
12. TF72 FLASHER −
13. TF71 FLASHER +
14. TF70 FLASHER L
15. CRP206 RR WORK LIGHT SWITCH
16. CRP205 NO MARK LIGHT SWITCH
17. CPS133 STEER MAKE UP VALVE
18. CPS132 STEER HARNESS
19. CPS134 TURN SIGNAL SWITCH
20. CPS138 LIGHT OPTION HARNESS
21. CPS90 DC-DC CONVERTER
22. CPS157 LEFT CONTROL COOLING FAN
23. CPS4 LEFT TRACTION MOTOR CONTROLLER
24. CPS11 SERV. BRAKE SENSOR
25. TBF3 BRAKE FLUID LEVEL SENSOR
26. TBF4 BRAKE FLUID LEVEL SENSOR
27. CPS151 HORN ASM
28. CPS156 RIGHT CONTROL COOLING FAN
29. TR65 B-CONT.
30. CPS3 RIGHT TRACTION MOTOR CONTROLLER
31. CPS74 E HYDRAULIC VALVE UPPER COILS
32. CPS75 E HYDRAULIC VALVE LOWER COILS
33. CPS10 LIFT PRESSURE SENSOR
34. CPS102 BATTERY GATE MAGNETIC SWITCH
35. CPS153 RIGHT TRACTION MOTOR SPEED SENSOR
36. CRP8 TILT POSITION SENSOR
37. CPS24 RIGHT ELECTRIC BRAKE
38. CPS155 RIGHT TRACTION MOTOR TEMPERATURE SENSOR
39. CPS1 VSM
40. CPS2 VSM
41. CPS272 ACCELERATOR JUMPER
42. TR3 MN CONTACT BATTERY +
43. CPS152 LEFT TRACTION SPEED SENSOR
44. TF11 MN CONTROLLER COIL
45. TF10 MN CONTROLLER COIL
46. CPS26 LEFT ELECTRIC BRAKE
47. CPS154 LEFT TRACTION MOTOR SENSOR
48. CRS110 BRAKE LIGHT RELAY
49. CRS209 E HYDRAULIC EN-RELAY
50. CRS210 BACK UP LIGHT RELAY
51. CRS208 KEY SWITCH RELAY
52. FUSES

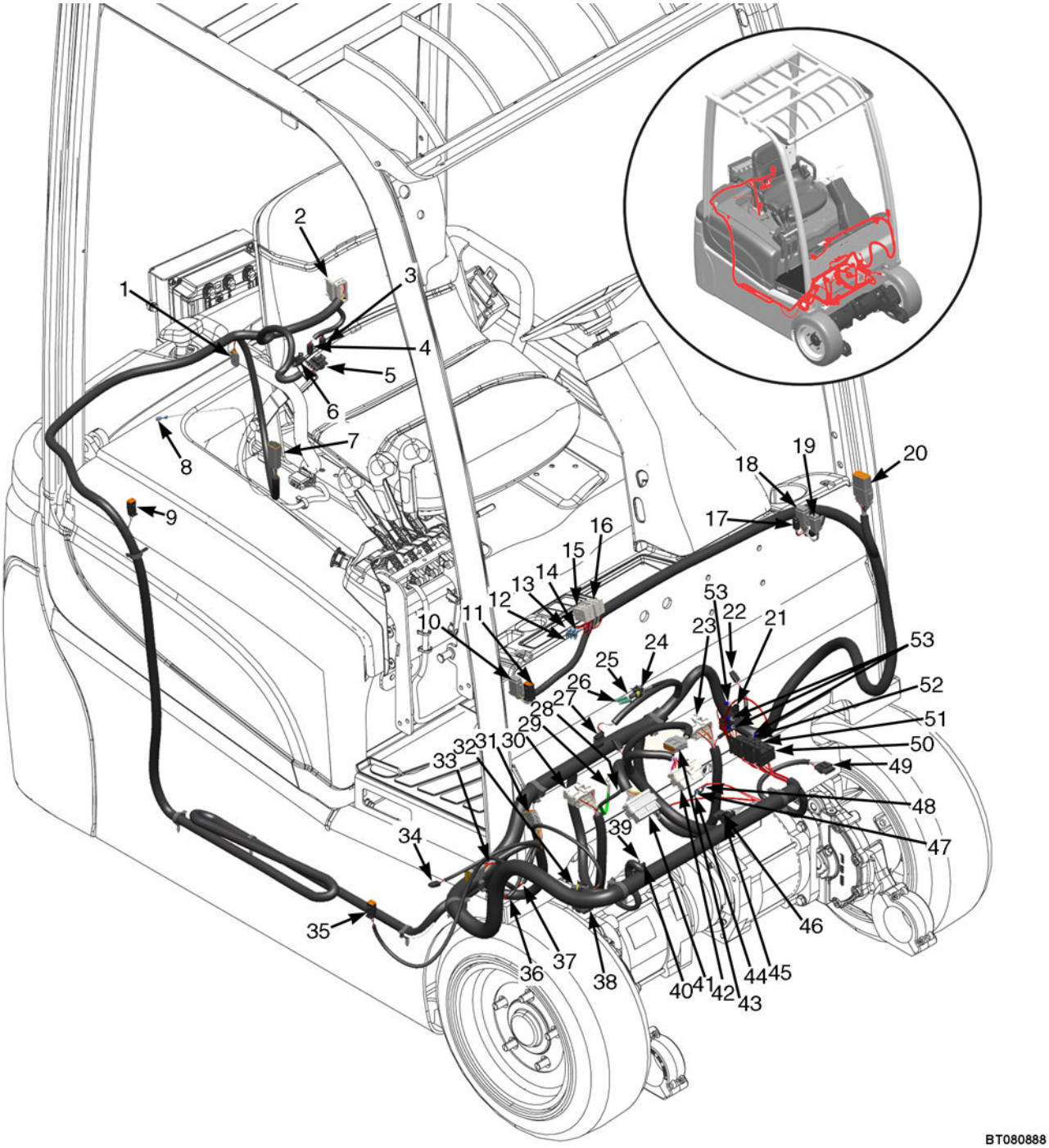
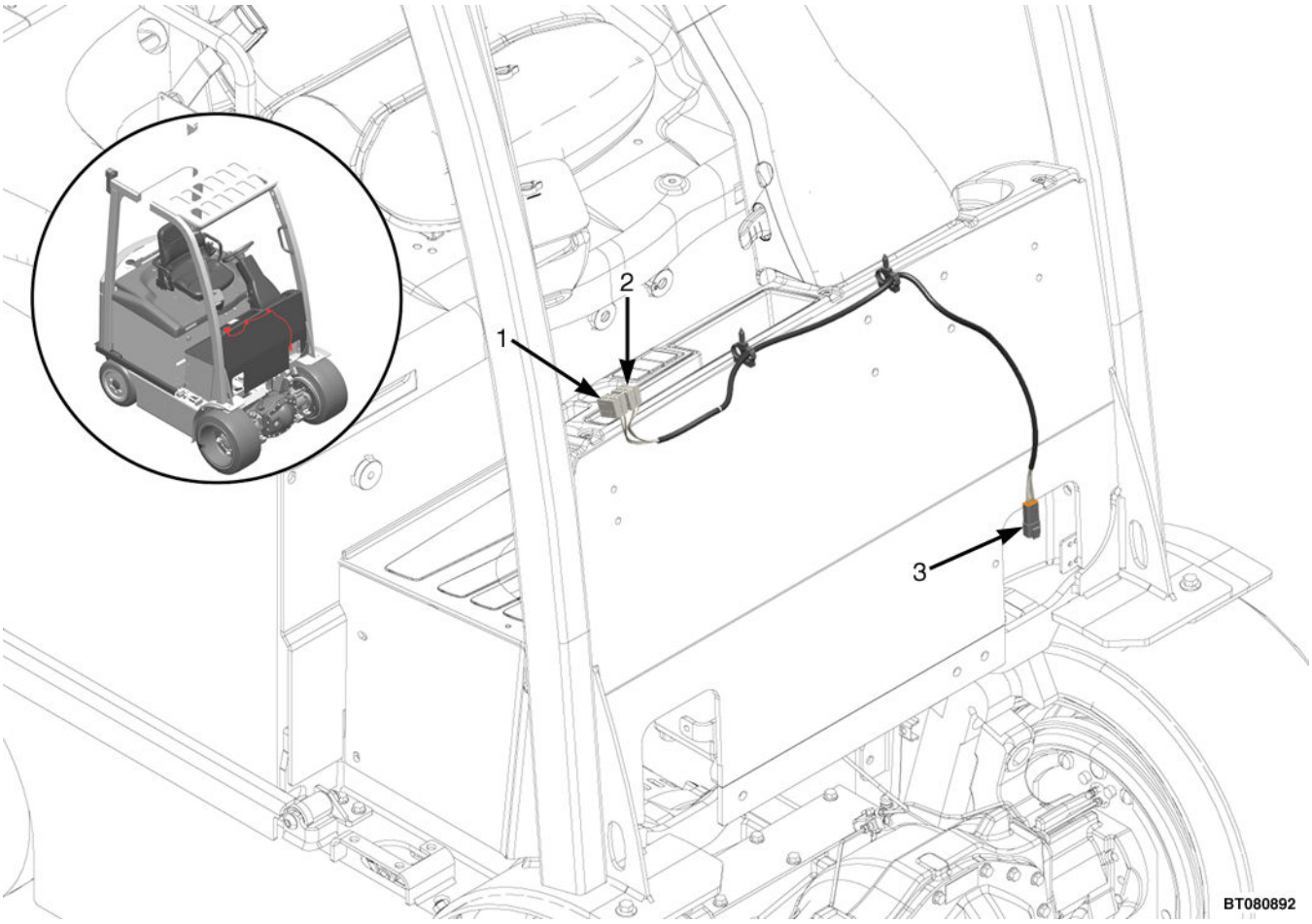


Figure 9030-03-9. J1.5-2.0XNT (J30-40XNT) (K160) ; Wire Harness Main Manual – Hydraulic

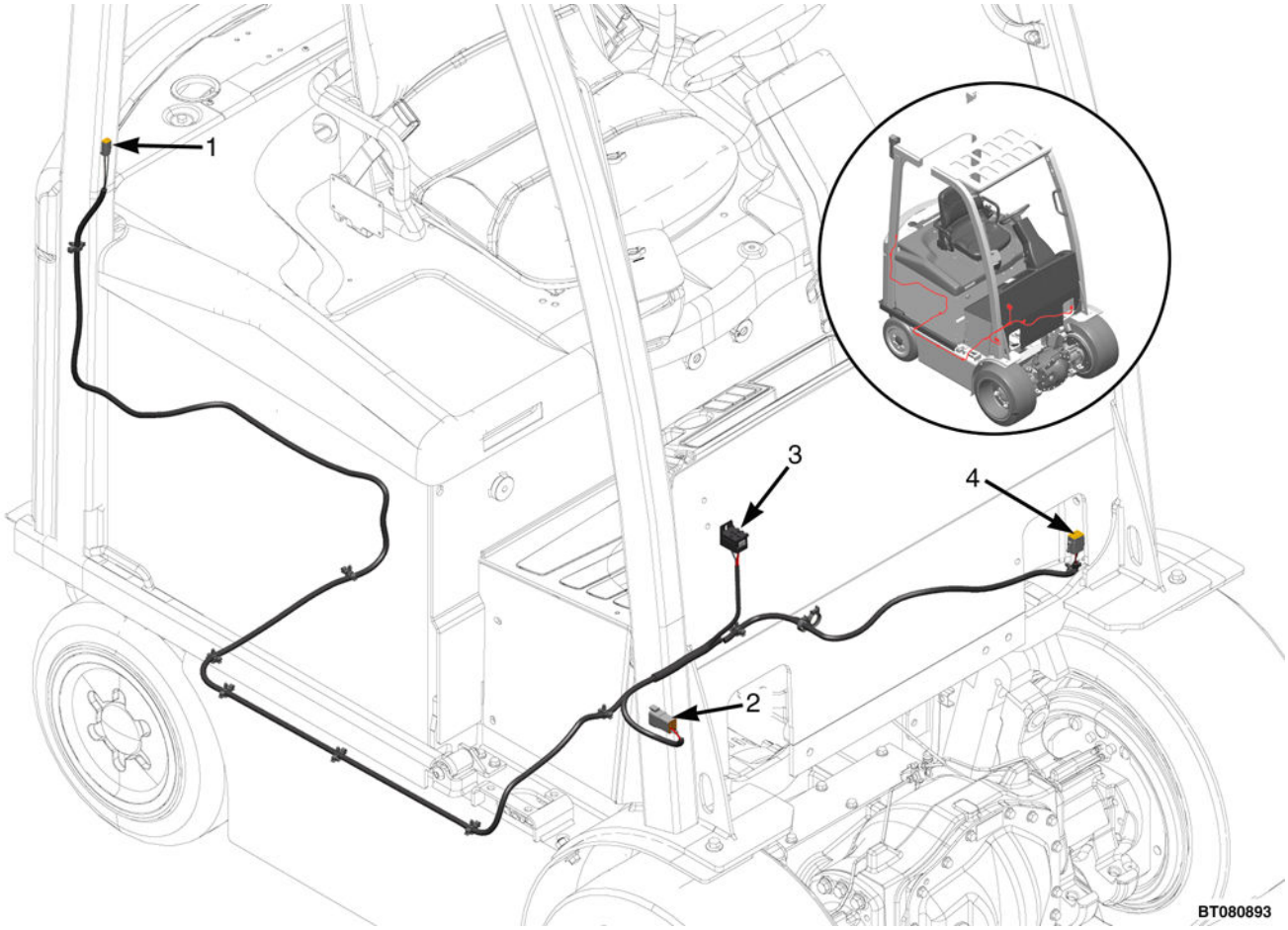
Legend for Figure 9030-03-9

1. CPS31A STEER AXLE HARNESS
2. CPS5 PUMP CONTROLLER
3. CPS95B HYDRAULIC COOLING FAN
4. CPS95A HYDRAULIC CONTROLLER COOLING FAN
5. CPS146 MOTOR SPEED SENSOR
6. CPS61 MOTOR TEMPERATURE SENSOR
7. CRP52-55 MLM SEAT HARNESS
8. TF67 ESD HYDRAULIC TANK
9. CPS114 OHG HORN SWITCH
10. CPS135 DISPLAY HARNESS
11. CPS180 DISPLAY LIGHT HARNESS
12. TF72 FLASHER (-)
13. TF71 FLASHER (+)
14. TF70 FLASHER (L)
15. CRP206 RR WORK LIGHT SWITCH
16. CRP205 NO MARK LIGHT SWITCH
17. CPS133 STEER MAKE UP VALVE
18. CPS132 STEER HARNESS
19. CPS134 TURN SIGNAL SWITCH
20. CPS138 LIGHT OPTION HARNESS
21. CPS90 DC-DC CONVERTER
22. CPS157 LEFT CONTROL COOLING FAN
23. CPS4 LEFT TRACTION MOTOR CONTROLLER
24. CPS11 SERV. BRAKE SENSOR
25. TBF3 BRAKE FLUID LEVEL SENSOR
26. TBF4 BRAKE FLUID LEVEL SENSOR
27. CPS151 HORN ASM
28. CPS156 RIGHT CONTROL COOLING FAN
29. TR65 B-CONT.
30. CPS3 RIGHT TRACTION MOTOR CONTROLLER
31. CPS162 MANUAL HYDRAULIC SPOOL POSITION SENSOR
32. CPS10 LIFT PRESSURE SENSOR
33. CPS192 TO MAN. HYDRAULIC
34. CPS190B CLAMP INTERLOCK COIL
35. CPS102 BATTERY GATE MAGNETIC SWITCH
36. CPS160B SPOOL INTERLOCK SOLENOID 2
37. CPS160A SPOOL INTERLOCK SOLENOID 1
38. CPS153 RIGHT TRACTION MOTOR SPEED SENSOR
39. CPS155 RIGHT TRACTION MOTOR TEMPERATURE SENSOR
40. CPS24 RIGHT ELECTRIC BRAKE
41. CPS1 VSM
42. CPS2 VSM
43. CPS272 ACCELERATOR JUMPER
44. TR3 MN CONTACT BATTERY +
45. CPS154 LEFT TRACTION MOTOR SENSOR
46. CPS26 LEFT ELECTRIC BRAKE
47. TF11 MN CONTROLLER COIL
48. TF10 MN CONTROLLER COIL
49. CPS152 LEFT TRACTION SPEED SENSOR
50. CRS110 BRAKE LIGHT RELAY
51. CRS210 BACK UP LIGHT RELAY
52. CRS208 KEY SWITCH RELAY
53. FUSES



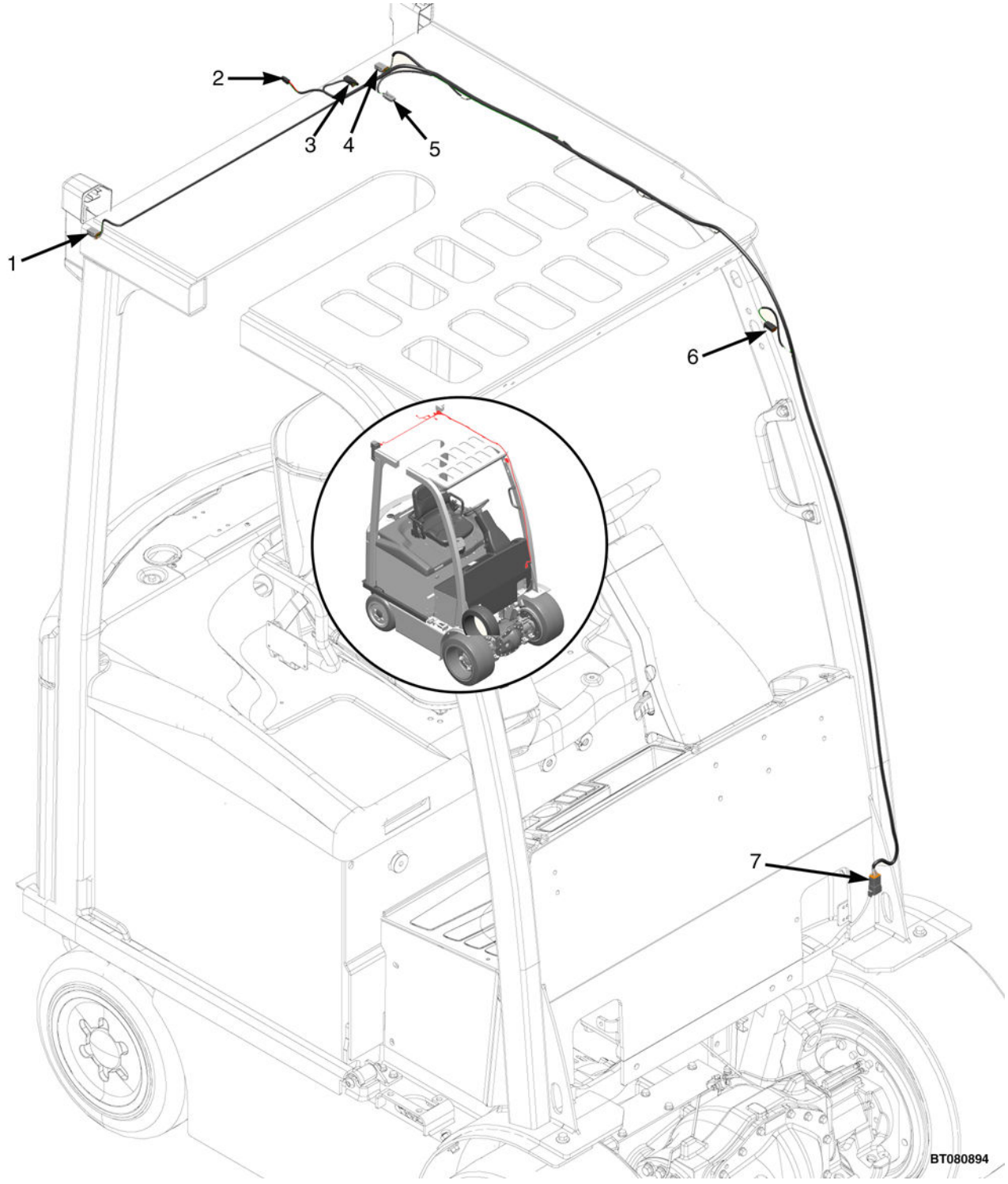
1. CRP206 REAR WORK LIGHT
2. CRP205 FRONT WORK LIGHT/TAIL LIGHT
3. CRP211 HARNESS-LIGHT CHASSIS MAIN

Figure 9030-03-10. E2.2-3.5XN (E45-70XN) (A268); J2.2-3.5XN (J40-70XN) (A276) Wire Harness – Front Switch



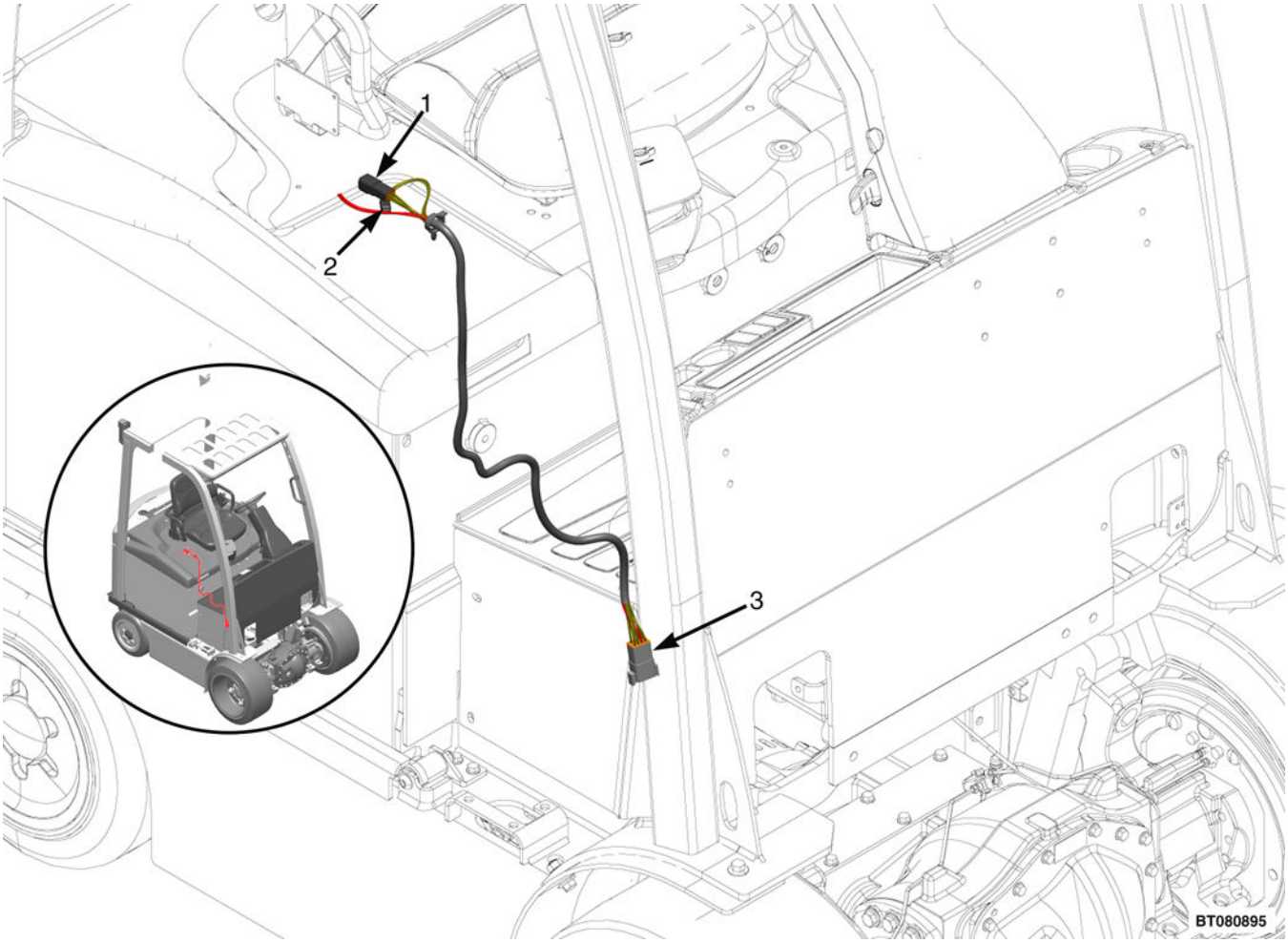
1. CRP112 BACK UP ALARM
2. CRP137 MAIN HARNESS
3. CRP210 REVERSE RELAY
4. CRP138 LIGHT OPTION HARNESS

Figure 9030-03-11. E2.2-3.5XN (E45-70XN) (A268); J2.2-3.5XN (J40-70XN) (A276) Wire Harness – Back Up Alarm Strobe w/o Conv.



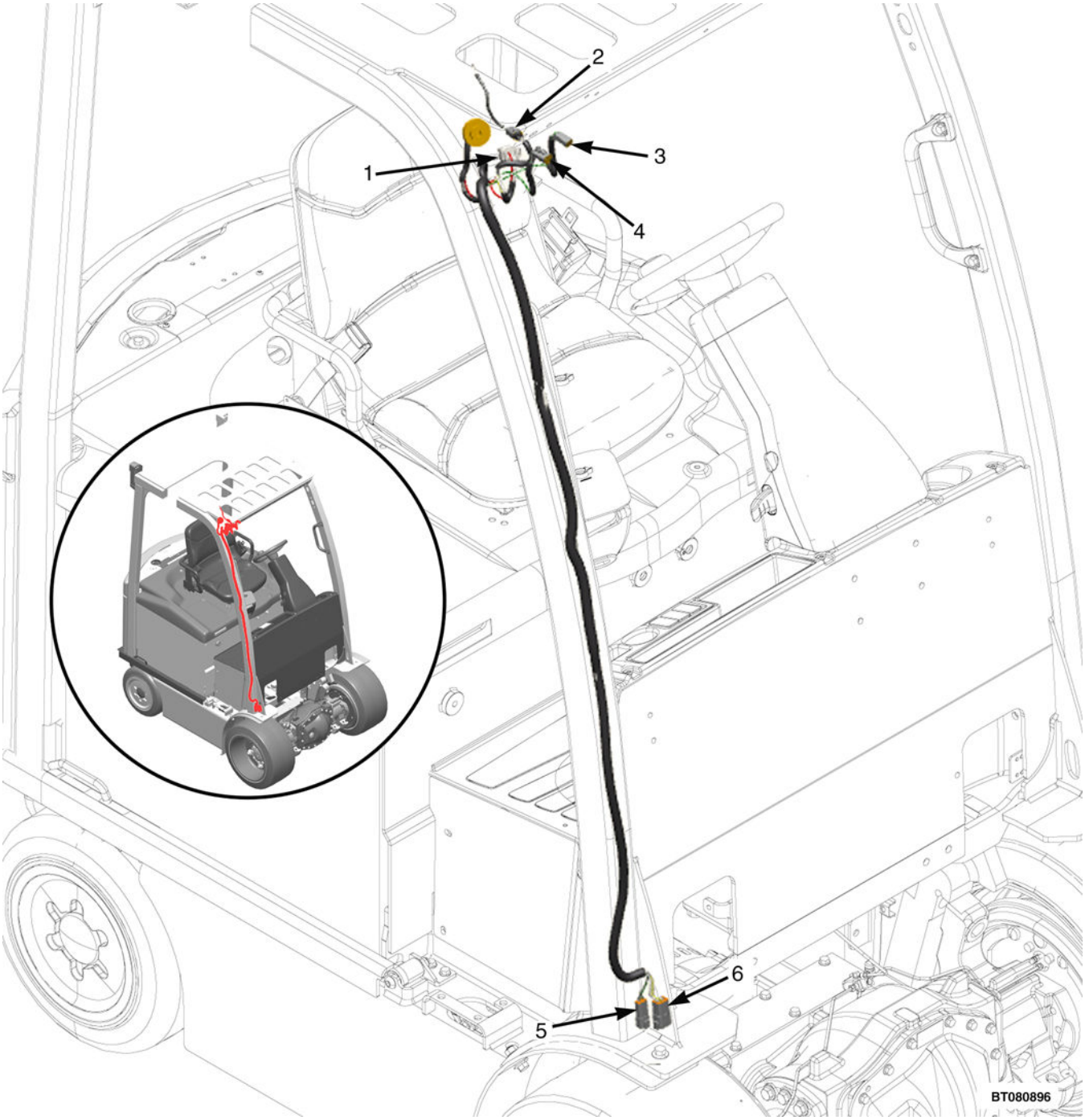
1. CPS106 TAIL LIGHT RH
2. CPS87 STROBE LIGHT
3. CPS116 REAR WORK LIGHT
4. CPS105 TAIL LIGHT LH
5. CPS107 DOME LIGHT W/SWITCH
6. CPS104 WORK LIGHT FRONT LH
7. CRP138 MAIN LIGHT HARNESS

Figure 9030-03-12. E2.2-3.5XN (E45-70XN) (A268); J2.2-3.5XN (J40-70XN) (A276) Wire Harness Lights LH - OHG



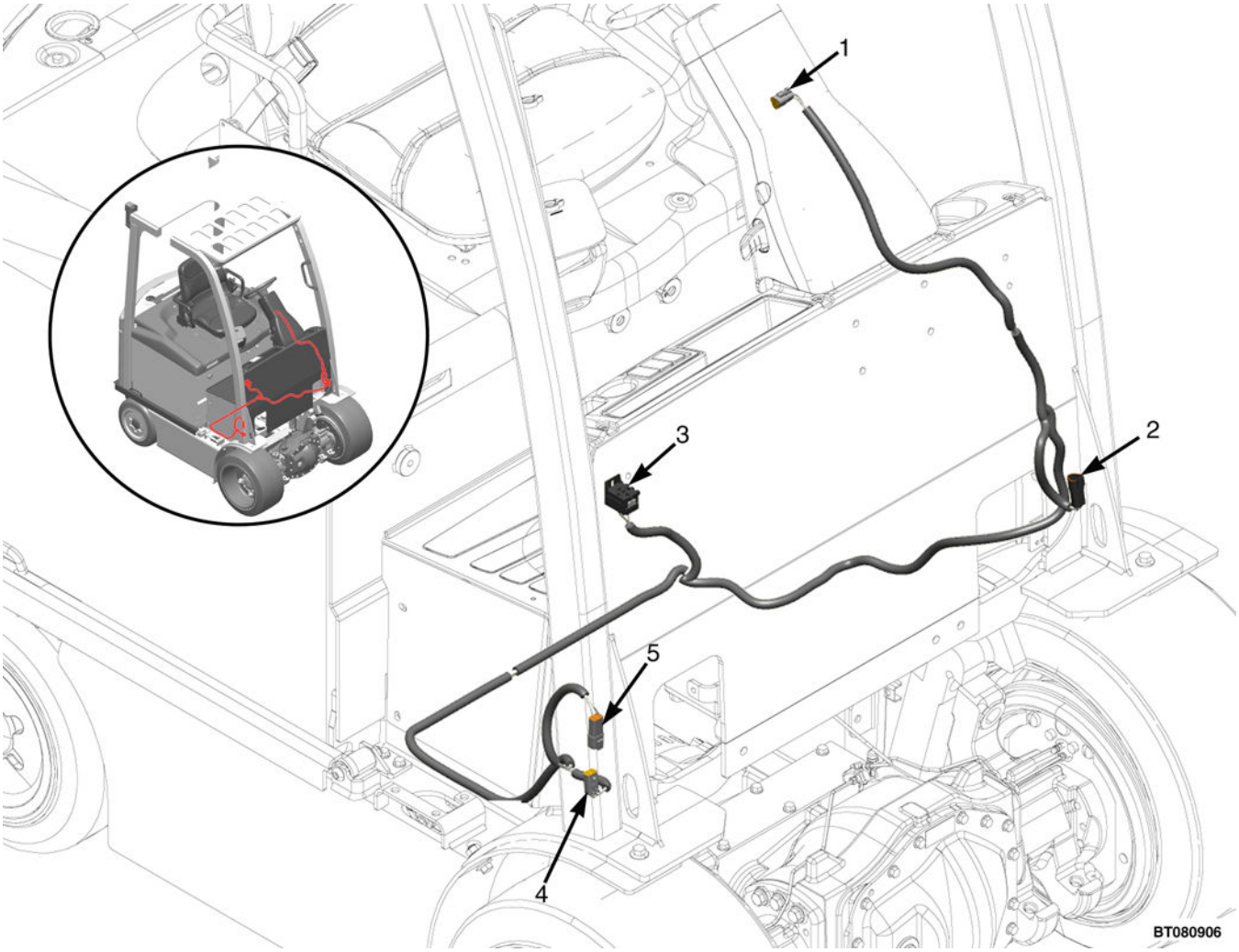
1. CRP64 FWD/REV SWITCH
2. CRS196 CLAMP COIL SWITCH
3. CRP129 TO MAIN HARNESS

Figure 9030-03-13. E2.2-3.5XN (E45-70XN) (A268); J2.2-3.5XN (J40-70XN) (A276) Wire Harness Manual Hydraulics



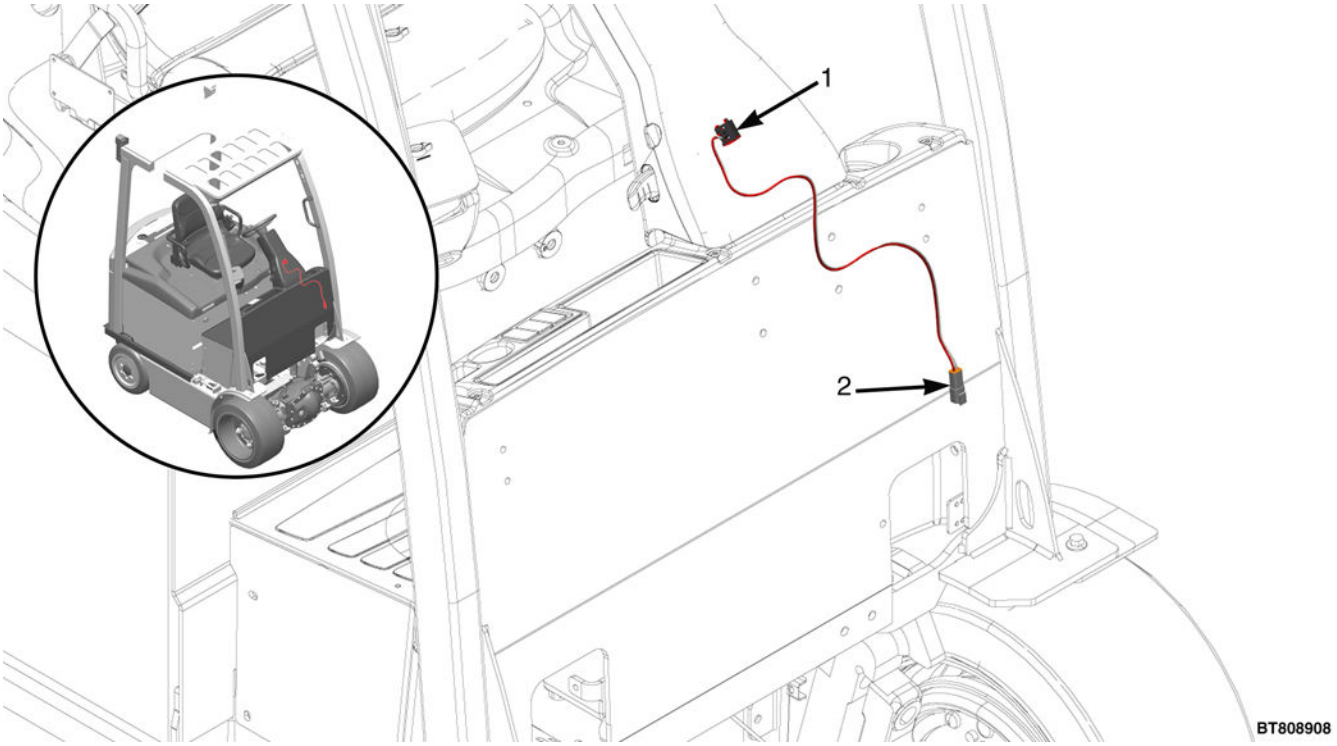
1. CPS20 DISPLAY W/KEY SWITCH
2. CPS21 WIRE HARNESS TEMPERATURE SENSOR
3. CPS103 RH FRONT WORK LIGHT
4. CPS166 FRONT MARKER RH
5. CRP180 MAIN LIGHTS HARNESS
6. CRP135 MAIN HARNESS

Figure 9030-03-14. E2.2-3.5XN (E45-70XN) (A268); J2.2-3.5XN (J40-70XN) (A276) Wire Harness Display Freezer



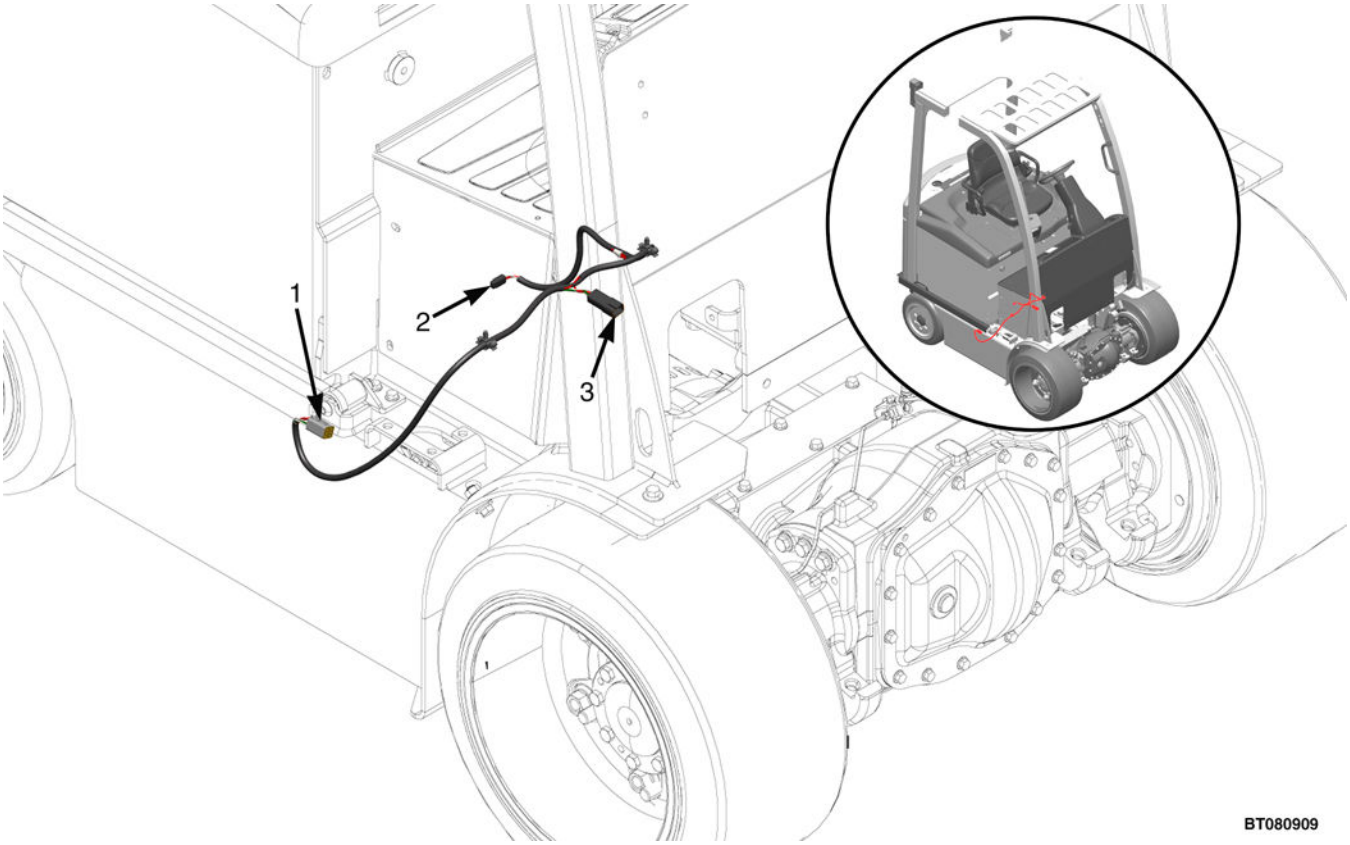
1. CPS35 TO TURN SIGNAL SWITCH HARNESS
2. CRP131 WIRE HARNESS LH -OHG W/TURN SIGNALS
3. CRS220 FLASHER
4. CPS180A TO DISPLAY FREEZER HARNESS
5. CRP180A TO LIGHT MAIN HARNESS

Figure 9030-03-15. E2.2-3.5XN (E45-70XN) (A268); J2.2-3.5XN (J40-70XN) (A276) Turn Wire Harness Signal



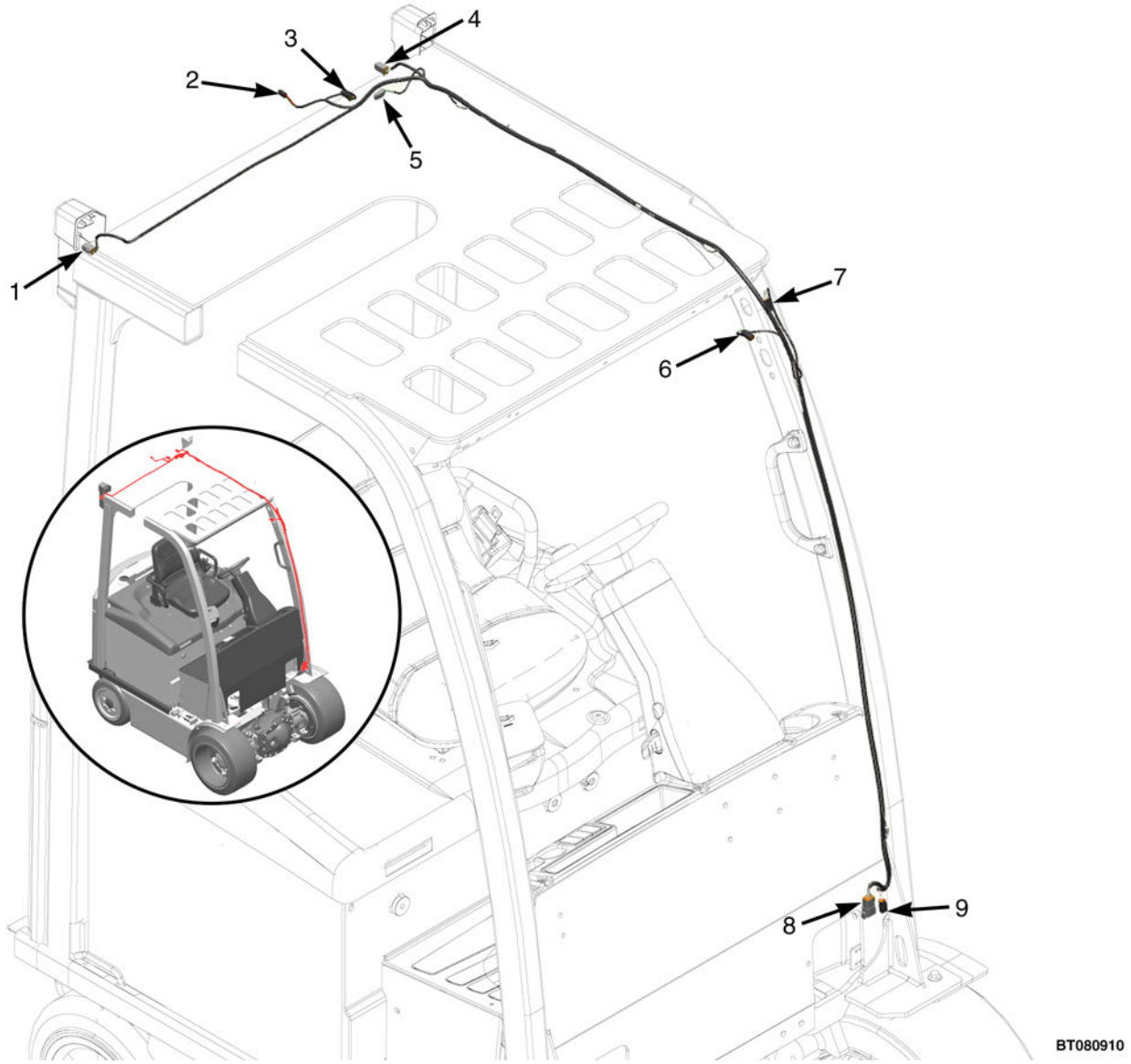
1. CPS128 STEER MAKEUP VALVE
2. CRP133 MAIN HARNESS

Figure 9030-03-16. E2.2-3.5XN (E45-70XN) (A268); J2.2-3.5XN (J40-70XN) (A276) Wire Harness Synchro Steer



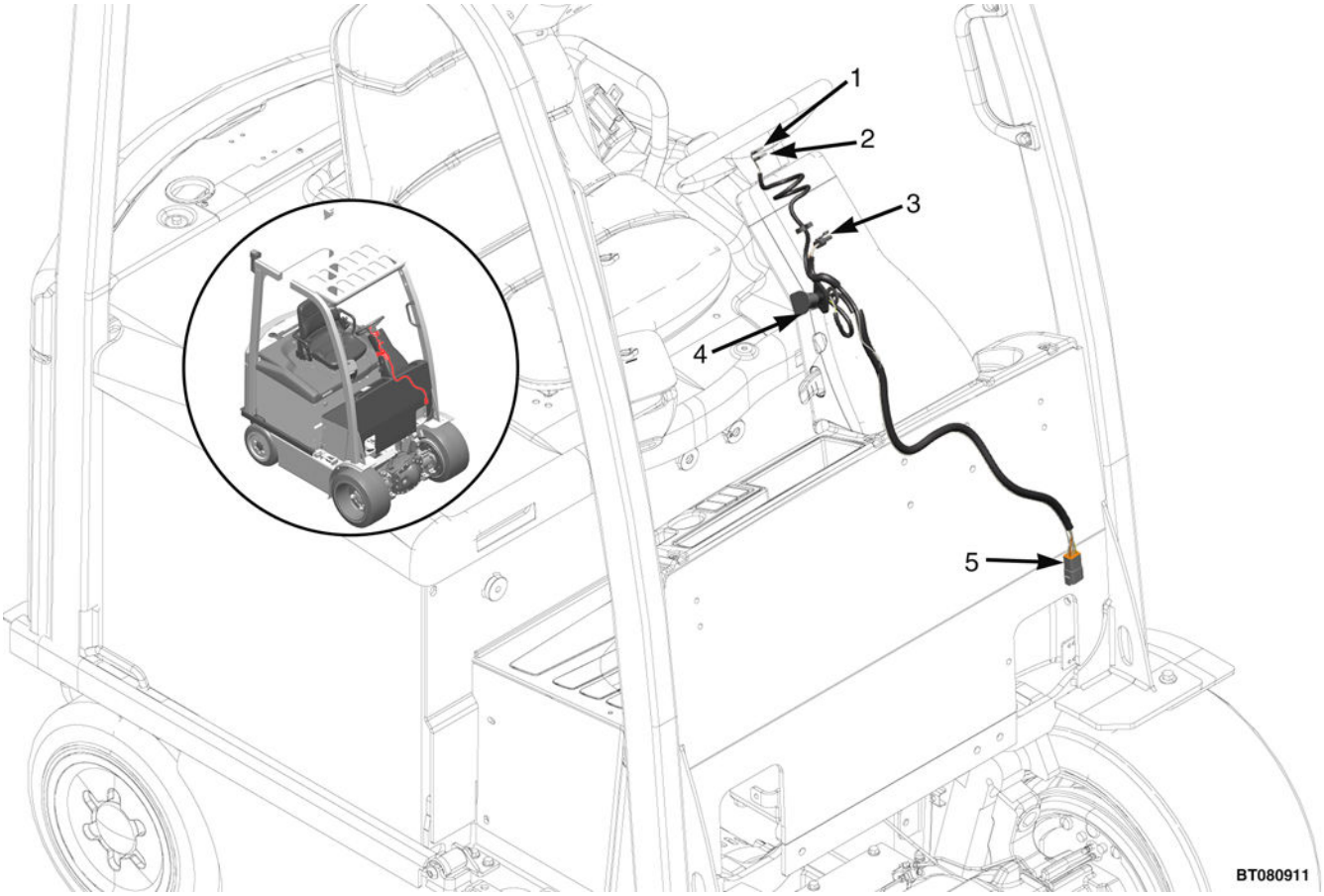
1. CPS16 PARK BRAKE MODULE
2. CRS17 PARK BRAKE SOLENOID
3. CRP15 MAIN HARNESS

Figure 9030-03-17. E2.2-3.5XN (E45-70XN) (A268); J2.2-3.5XN (J40-70XN) (A276) Wire Harness Park Brake



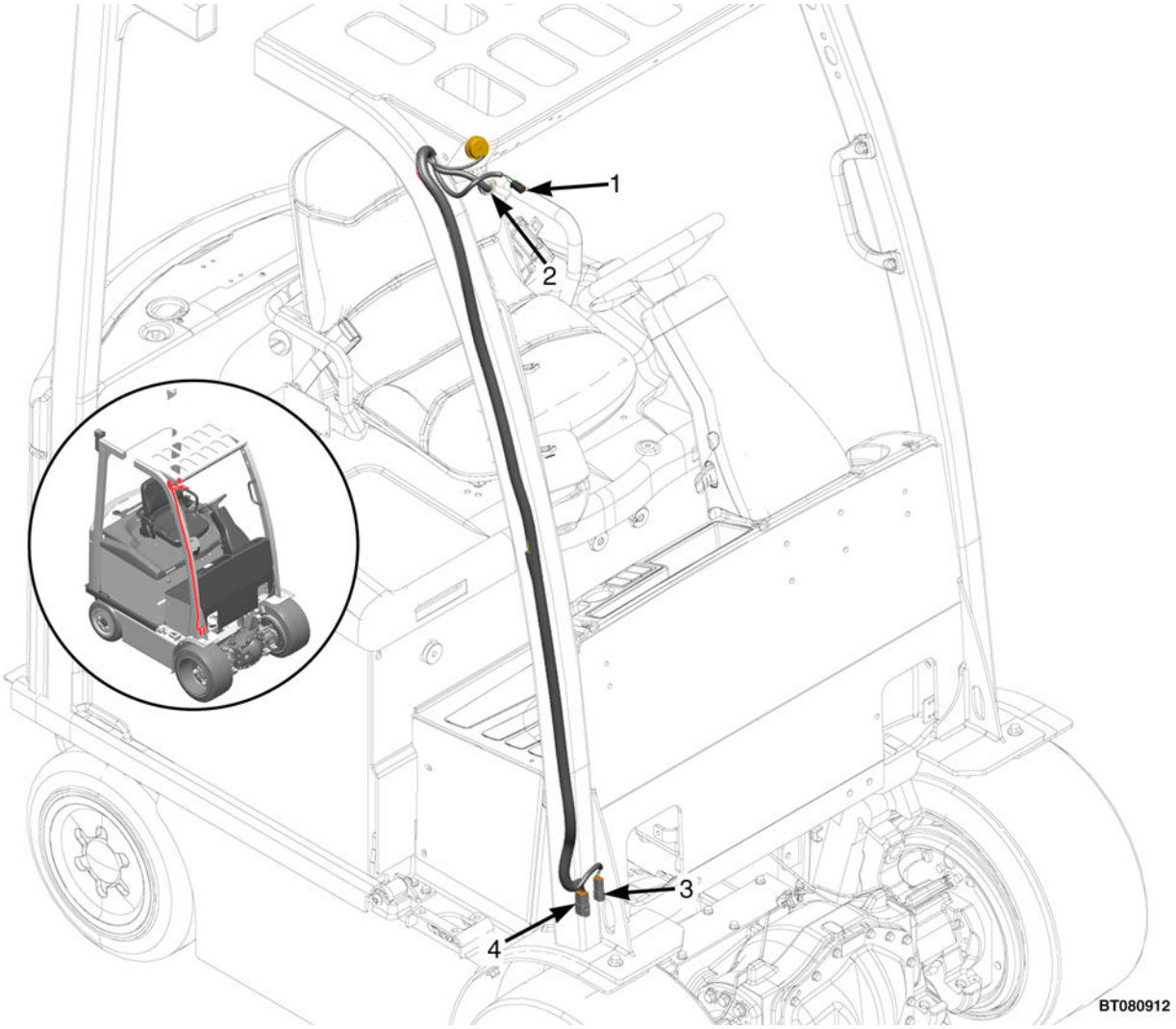
1. CPS106 TAIL LIGHT RH
2. CPS87 STROBE LIGHT
3. CPS116 REAR WORK LIGHT
4. CPS105 TAIL LIGHT LH
5. CPS107 DOME LIGHT
6. CPS104 WORK LIGHT FRONT LH
7. CRP34 LH FRONT MARKER
8. CRP138 MAIN LIGHT HARNESS
9. CPS131 TO TURN SIGNAL HARNESS

Figure 9030-03-18. E2.2-3.5XN (E45-70XN) (A268); J2.2-3.5XN (J40-70XN) (A276) Wire Harness - LH OHG w/Turn Signals



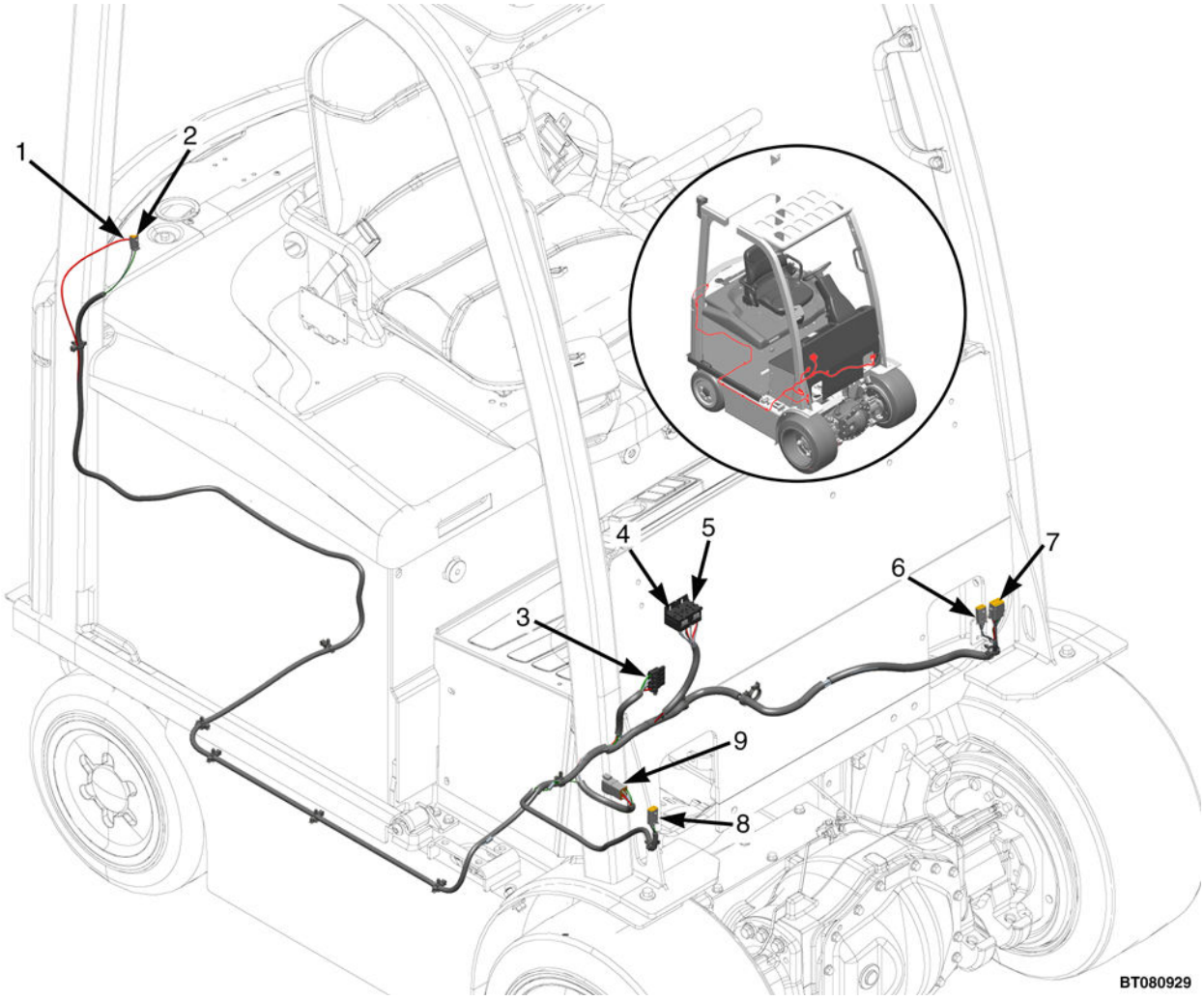
1. TF15 HORN SWITCH NO
2. TF14 HORN SWITCH C
3. CPS78 STEER WHEEL POSITION SENSOR
4. CPS28 DIAGNOSTIC CONNECTOR
5. CRP132 MAIN HARNESS

Figure 9030-03-19. E2.2-3.5XN (E45-70XN) (A268); J2.2-3.5XN (J40-70XN) (A276) Wire Harness Steering Column



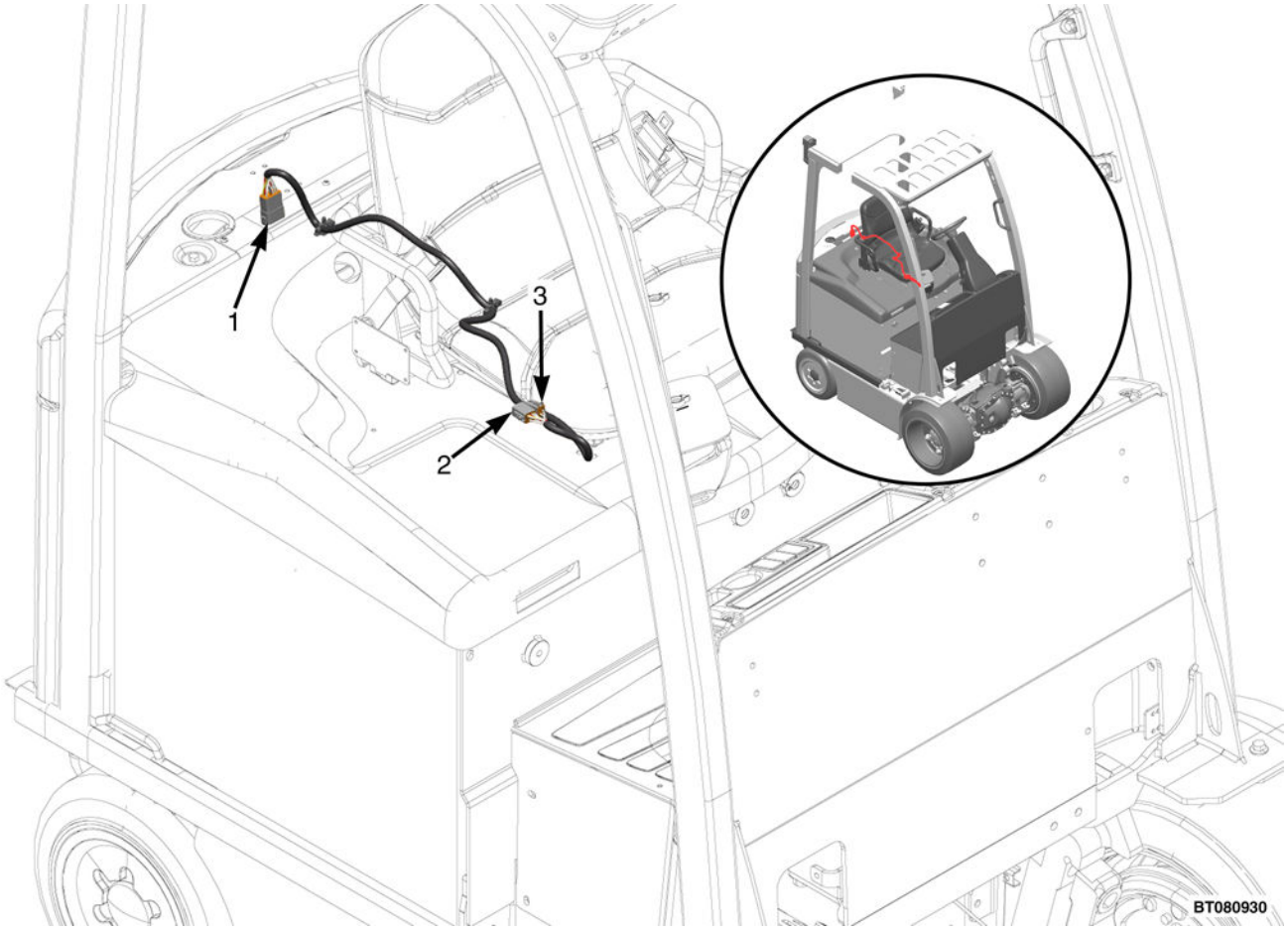
1. CPS103 WORK LIGHT FRONT RH
2. CPS20 DISPLAY W/KEY SWITCH
3. CRP135 DISPLAY HARNESS
4. CRP180 DISPLAY LIGHT HARNESS

Figure 9030-03-20. E2.2-3.5XN (E45-70XN) (A268); J2.2-3.5XN (J40-70XN) (A276) Wire Harness Lights w/OHG - RH



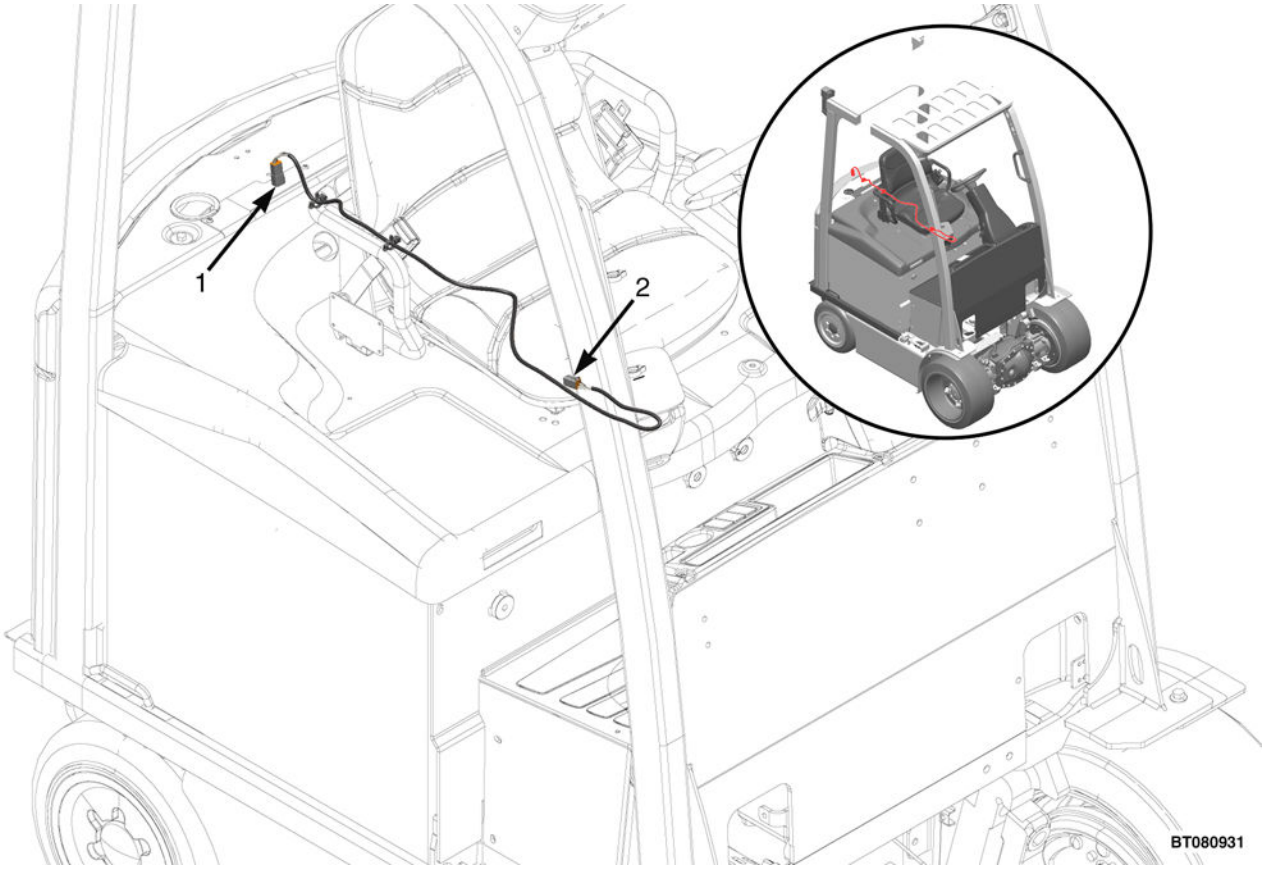
1. TFK80 FUSE 2
2. CPS112 BACK UP ALARM
3. CPS90 DC - DC CONVERTER
4. CRS210 BRAKE LIGHT RELAY
5. CRS110 REVERSE RELAY
6. CPS138 WIRE HARNESS LIGHTS LH - OHG
7. CPS211 HARNESS LIGHT SWITCH
8. CPS180 DISPLAY LIGHT HARNESS
9. CRP137 MAIN HARNESS

Figure 9030-03-21. E2.2-3.5XN (E45-70XN) (A268); J2.2-3.5XN (J40-70XN) (A276) Wire Harness Lights Chassis Main



1. CRP54 MAIN HARNESS
2. CPS52 MLM SEAT HARNESS
3. CPS55 SEAT SENSOR

Figure 9030-03-22. E2.2-3.5XN (E45-70XN) (A268); J2.2-3.5XN (J40-70XN) (A276) Wire Harness Seat E-Hydraulic



1. CRP54 MAIN HARNESS
2. CRP55 SEAT HARNESS

Figure 9030-03-23. E2.2-3.5XN (E45-70XN) (A268); J2.2-3.5XN (J40-70XN) (A276) Wire Harness Seat Manual-Hydraulic

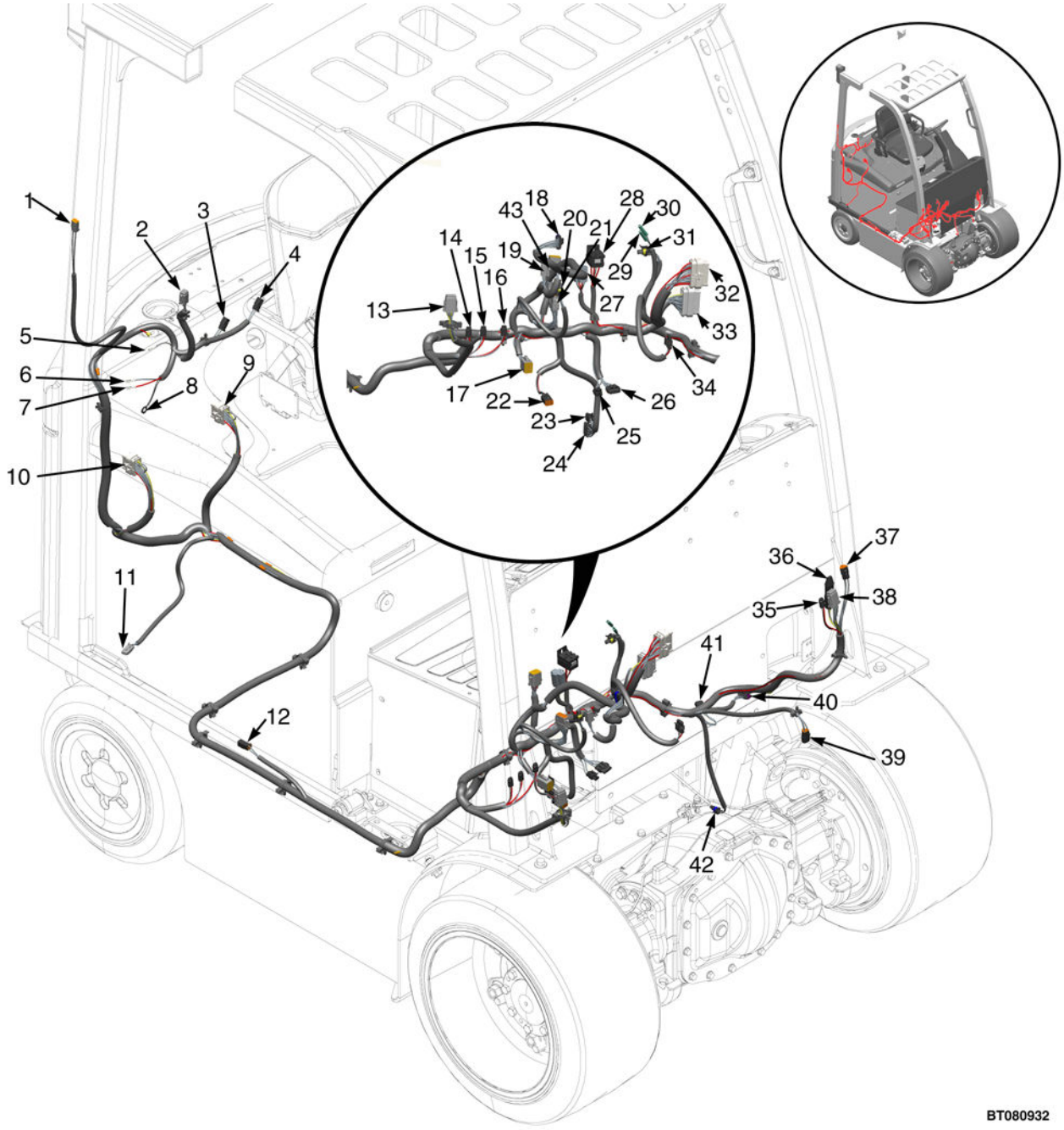


Figure 9030-03-24. E2.2-3.5XN (E45-70XN) (A268); J2.2-3.5XN (J40-70XN) (A276) Wire Harness Main w/ Manual – Hydraulic

Legend for Figure 9030-03-24

1. CPS114 OHG HORN SWITCH
2. CPS54 SEAT HARNESS
3. CPS157 CONTROLLER FAN
4. CPS95 CONTROLLER FAN
5. TFK78 FUI
6. TF10 MAIN CONNECTOR COIL
7. TF11 MAIN CONNECTOR COIL
8. TR65 NEGATIVE TERMINAL TRACTION CONTROLLER
9. CPS5 PUMP CONTROLLER
10. CPS3 TRACTION MOTOR CONTROLLER
11. CPS31 STEER AXLE SENSOR
12. CPS102 BATTERY GATE MAGNETIC SWITCH
13. CPS135 DISPLAY HARNESS
14. CPS191 CLAMP COIL
15. CPS161 MANUAL HYDRAULIC COIL
16. CPS160 MANUAL HYDRAULIC COIL
17. CPS137 LIGHT OPTION HARNESS
18. CPS29 ACCELERATOR PEDAL POSITION SENSOR
19. CPS65 DIRECTION SELECT SENSOR
20. CPS10 LIFT PRESSURE
21. CPS162 MANUAL HYDRAULIC SPOOL POSITION SENSOR
22. CPS15 PARK BRAKE
23. CPS154 TRACTION MOTOR TEMPERATURE SENSOR
24. CPS152 TRACTION MOTOR SPEED SENSOR
25. CPS61 PUMP MOTOR TEMPERATURE SENSOR
26. CPS146 PUMP MOTOR SPEED SENSOR
27. CRS212 SYNC. STEER VALVE RELAY
28. CRS208 KEY SWITCH RELAY
29. TF04 BRAKE FLUID LEVEL
30. TF03 BRAKE FLUID LEVEL
31. CPS11 SERVICE BRAKE PRESSURE SENSOR
32. CPS2 VSM
33. CSP1 VSM
34. CPS151 HORN ASSEMBLY
35. CPS133 SYNC. STEER VALVE HARNESS
36. CPS142 TERMINATION RESISTOR
37. CPS512 PARK BRAKE POSITION
38. CPS132 STEER HARNESS
39. CPS8 TILT POSITION SENSOR
40. CPS70 HYD. OIL LEVEL SENSOR
41. CPS66 HYD. FILTER PRESSURE SWITCH
42. CPS14 HYD. OIL TEMPERATURE SENSOR
43. CPS192 MANUAL HYD. HARNESS

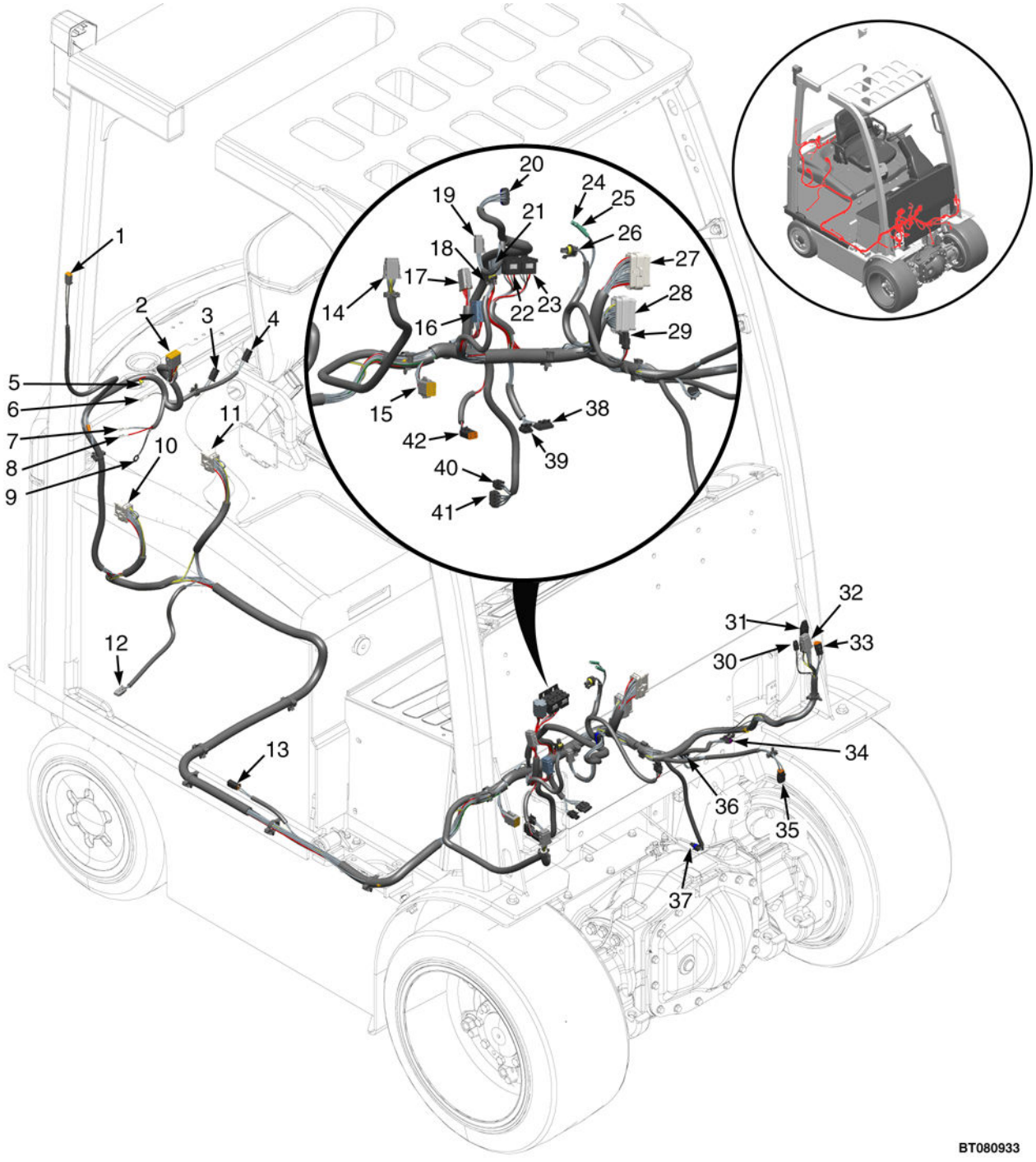
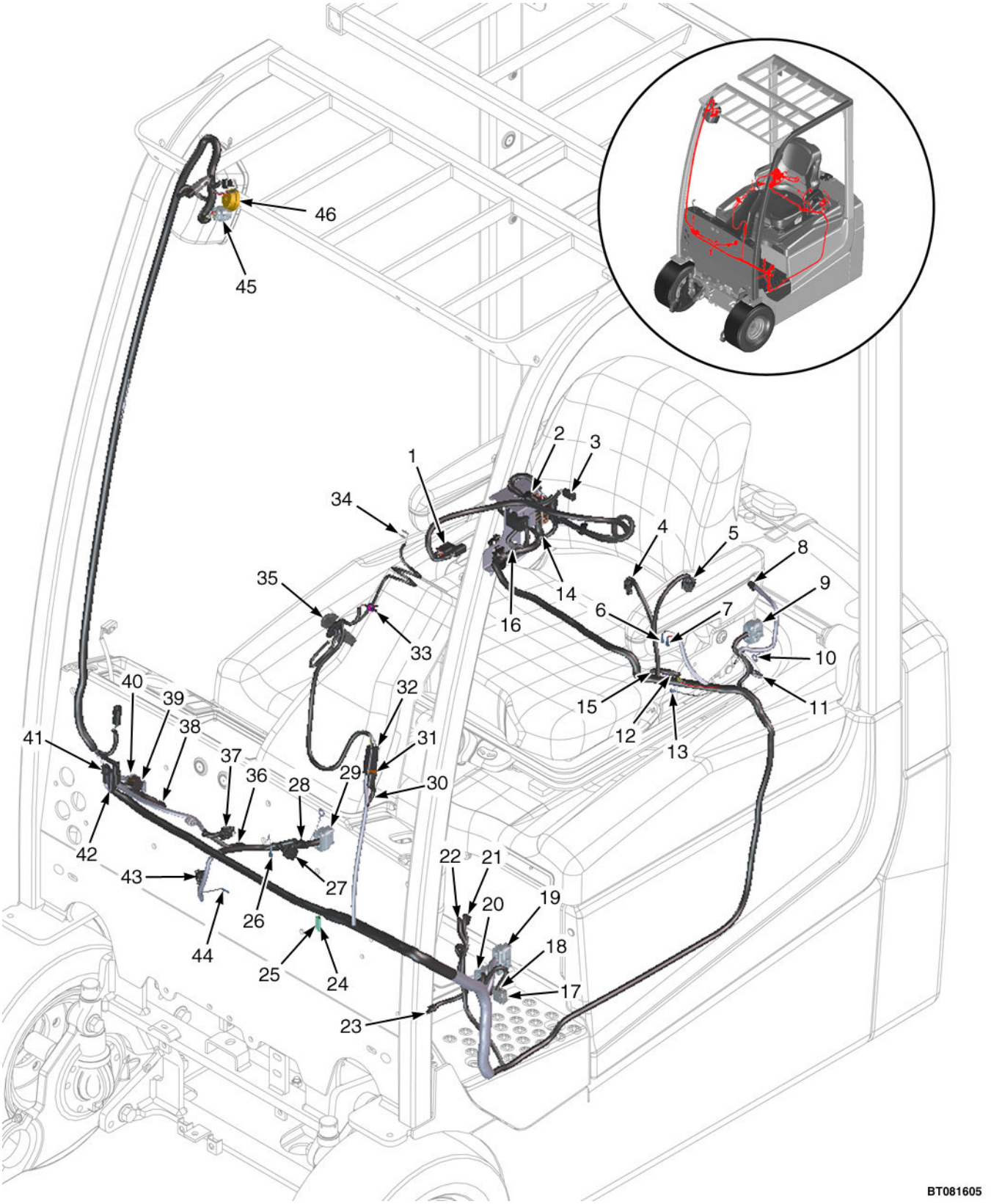


Figure 9030-03-25. E2.2-3.5XN (E45-70XN) (A268); J2.2-3.5XN (J40-70XN) (A276) Wire Harness Main w/E – Hydraulic

Legend for Figure 9030-03-25

1. CPS114 OHG HORN SWITCH
2. CPS54 SEAT HARNESS
3. CPS157 CONTROLLER FAN
4. CPS95 CONTROLLER FAN
5. TFK78 FUI
6. TFK67 ESD TRUCK FRAME
7. TF10 MAIN CONNECTOR COIL
8. TF11 MAIN CONNECTOR COIL
9. TR65 NEGATIVE TERMINAL TRACTION CONTROLLER
10. CPS3 TRACTION MOTOR CONTROLLER
11. CPS5 PUMP CONTROLLER
12. CPS31 STEER AXLE SENSOR
13. CPS102 BATTERY GATE MAGNETIC SWITCH
14. CPS135 DISPLAY HARNESS
15. CPS137 LIGHT OPTION HARNESS
16. CPS75 E-HYDRAULIC LOWER COIL
17. CPS74 E-HYDRAULIC UPPER COIL
18. CPS10 LIFT PRESSURE
19. CPS65 DIRECTION SELECT SENSOR
20. CPS29 ACCELERATOR PEDAL POSITION SENSOR
21. CRS208 KEY SWITCH RELAY
22. CRS212 SYNC. STEER VALVE RELAY
23. CRS209 E-HYDRAULIC ENABLE RELAY
24. TF03 BRAKE FLUID LEVEL
25. TF04 BRAKE FLUID LEVEL
26. CPS11 SERVICE BRAKE PRESSURE SENSOR
27. CPS2 VSM
28. CSP1 VSM
29. CPS151 HORN ASSEMBLY
30. CPS133 SYNC. STEER VALVE HARNESS
31. CPS142 TERMINATION RESISTOR
32. CPS132 STEER HARNESS
33. CPS512 PARK BRAKE POSITION
34. CPS70 HYD. OIL LEVEL SENSOR
35. CPS8 TILT POSITION SENSOR
36. CPS66 HYD. FILTER PRESSURE SWITCH
37. CPS14 HYD. OIL TEMPERATURE SENSOR
38. CPS146 PUMP MOTOR SPEED SENSOR
39. CPS61 PUMP MOTOR TEMPERATURE SENSOR
40. CPS152 TRACTION MOTOR SPEED SENSOR
41. CPS154 TRACTION MOTOR TEMPERATURE SENSOR
42. CPS15 PARK BRAKE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1. CPS114 OHG HORN SWITCH
2. CRP54 PREMIUM SEAT HORN SWITCH
3. CRP57 SEAT BELT SWITCH HARNESS
4. CPS154 TRACTION MOTOR TEMPERATURE SENSOR
5. CPS152 TRACTION MOTOR SPEED SENSOR
6. TF11 MAIN CONTACTOR COIL
7. TF10 MAIN CONTACTOR COIL
8. CPS94 TRACTION CONTROLLER FAN
9. CPS3 TRACTION CONTROLLER
10. B(-) STUD TRACTION CONTROLLER
11. CPS87 STROBE CONNECTOR
12. TS65 FRAME GROUND B(-)
13. TFK78 FUSE FU1
14. CRS208 KEY SWITCH RELAY
15. CPS31 STEER AXLE POSITION SENSOR
16. CRS210 REVERSE RELAY
17. CPS6 VSM CONNECTOR
18. CPS7 VSM CONNECTOR
19. CPS1 VSM CONNECTOR
20. CPS2 VSM CONNECTOR
21. CPS96 PUMP CONTROLLER FAN
22. CPS95 PUMP CONTROLLER FAN
23. CPS14 HYDRAULIC OIL TEMPERATURE SENSOR
24. TF04 BRAKE FLUID LEVEL
25. TF03 BRAKE FLUID LEVEL
26. TS67 B(-) PUMP MOTOR
27. CPS146 PUMP MOTOR SOLENOID
28. CPS61 PUMP MOTOR TEMPERATURE SENSOR
29. CPS5 PUMP CONTROLLER
30. CRP12 PARK BRAKE SWITCH CONNECTOR
31. CPS12 PARK BRAKE SWITCH CONNECTOR
32. CRP132 STEER HARNESS CONNECTOR
33. CPS78 STEER WHEEL POSITION SENSOR
34. TF15 / TF14 HORN SWITCH
35. CPS28 DIAGNOSTIC CONNECTOR
36. CPS29 ACC PEDAL POSITION SENSOR
37. CPS65 DIRECTION SELECTOR SENSOR
38. CPS160-161 HYDRAULIC COIL CONNECTORS
39. CPS162 HYDRAULIC SPOOL SENSOR
40. CPS192 MANUAL LEVER HARNESS
41. CRP135 DISPLAY HARNESS
42. CRP136 SIG. DISPLAY HARNESS
43. CPS151 HORN CONNECTOR
44. B(-) HORN GND
45. CPS20 DISPLAY CONNECTOR
46. KEY SWITCH

Figure 9030-03-26. A1.3XNT, A1.5XNT (A25XNT, A30XNT) [D203] Main Harness Assembly

NOTES

Group 10
Principles of Operation

Electrical System

GENERAL DESCRIPTION

The major components in the electrical system are shown in Figure 9030-10-27, Figure 9030-10-28, Figure 9030-10-29, Figure 9030-10-30, and Figure 9030-10-32.

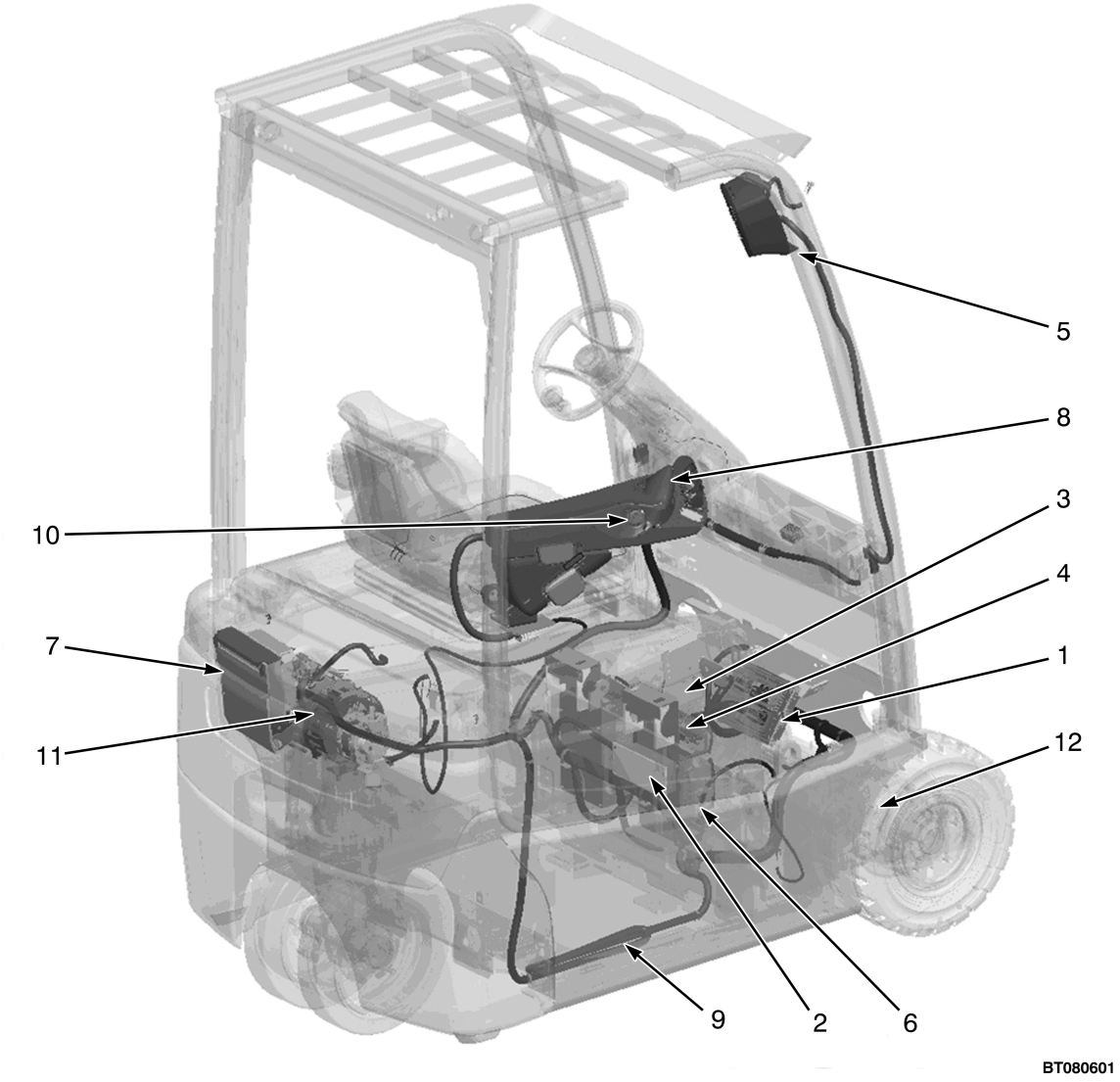
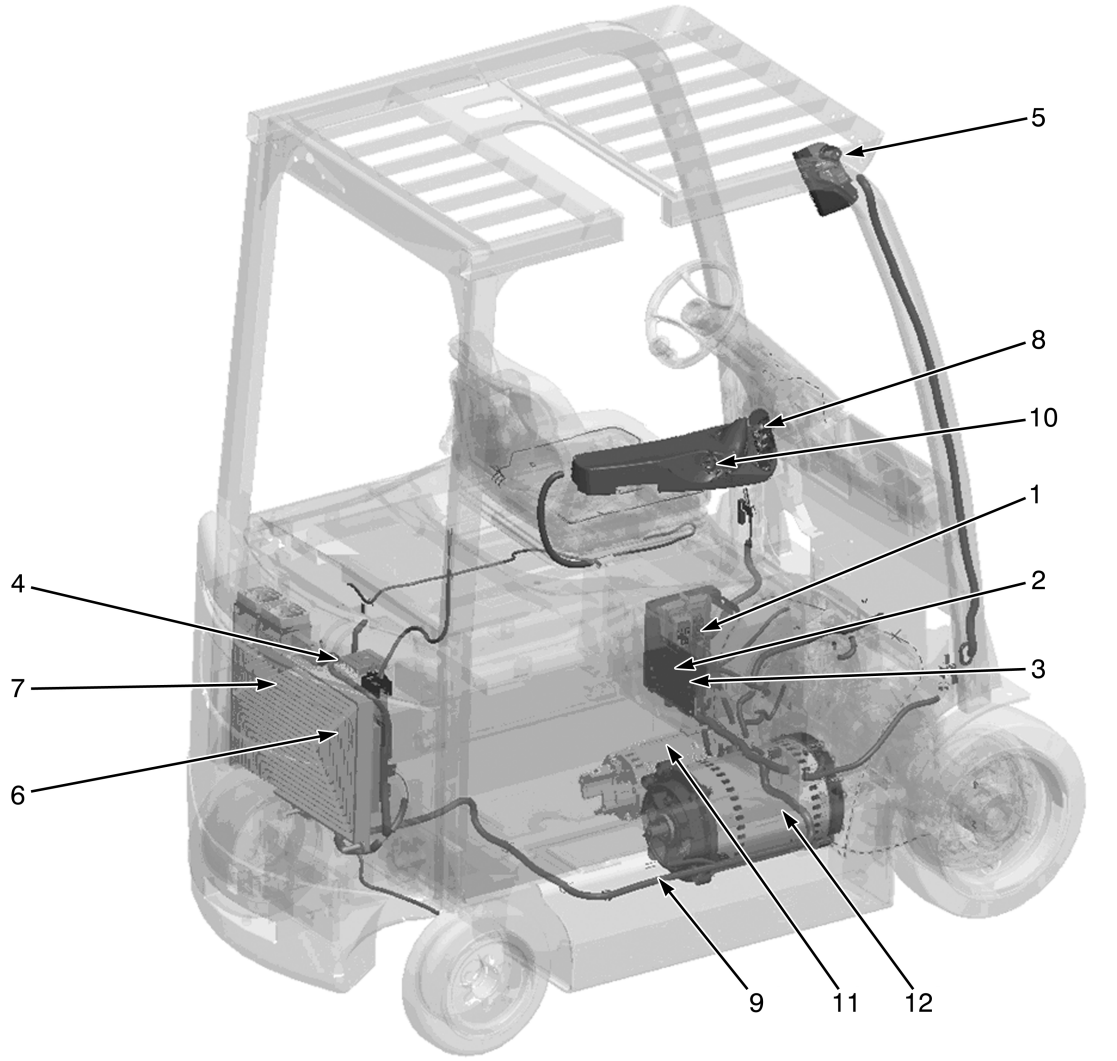


Figure 9030-10-27. J1.5-2.0XNT (J30-40XNT) (K160) and J1.6-2.0XN (J30-40XN) (A935)

Legend for Figure 9030-10-27

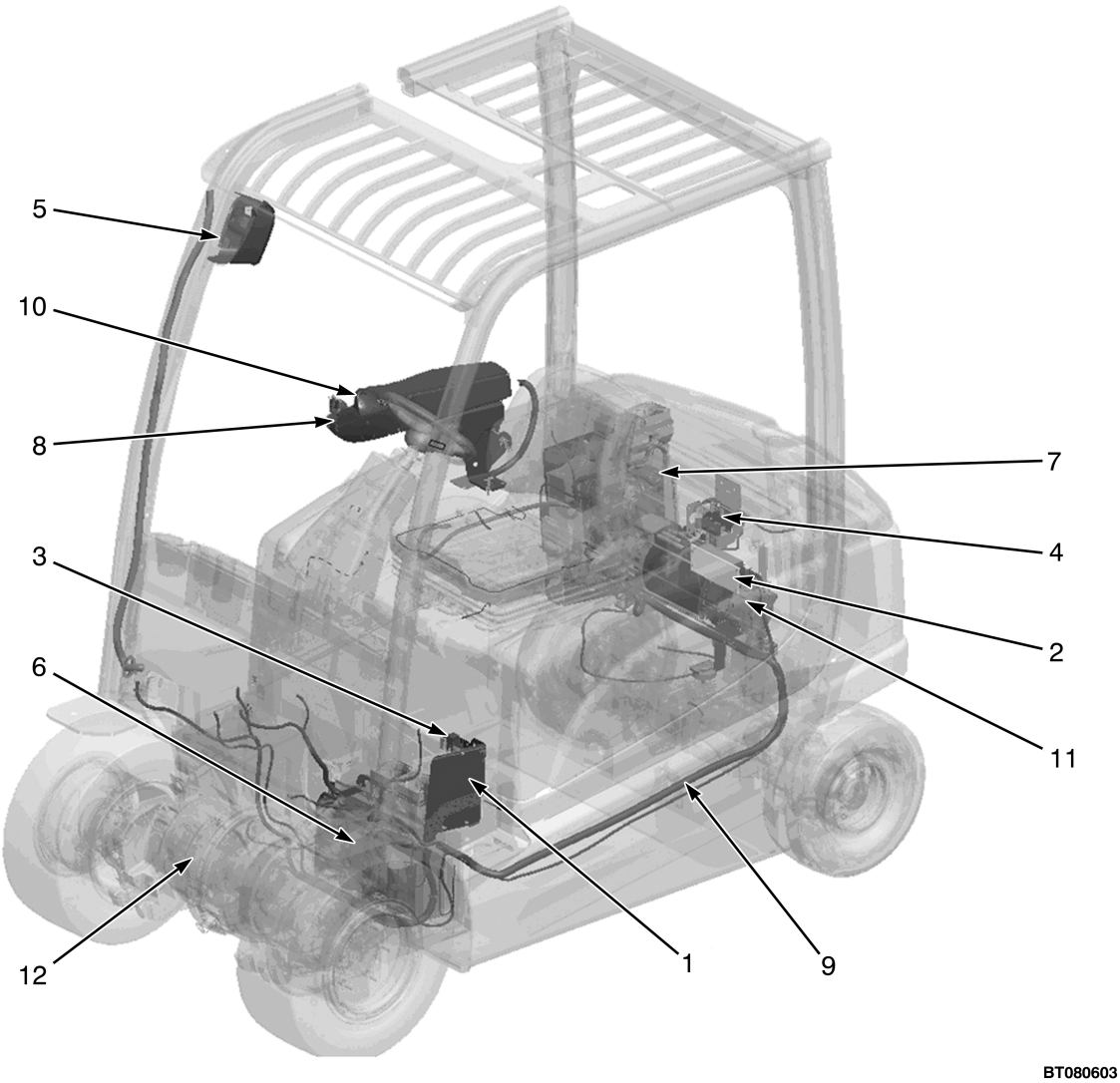
NOTE: J1.5-2.0XNT (J30-40XNT) (K160) IS SHOWN AND THE J1.6-2.0XN (J30-40XN) (A935) IS SIMILAR.

1. VSM
2. DC/DC CONVERTER
3. RELAYS
4. MAIN CONTACTOR AND FUSES
5. DISPLAY
6. TRACTION MOTOR CONTROLLER
7. PUMP MOTOR CONTROLLER
8. MINI-LEVER MODULE (MLM)
9. MAIN CHASSIS HARNESS
10. EMERGENCY STOP
11. PUMP MOTOR
12. TRACTION MOTOR



1. VSM
2. DC/DC CONVERTER
3. RELAYS
4. MAIN CONTACTOR AND FUSES
5. DISPLAY
6. TRACTION MOTOR CONTROLLER
7. PUMP MOTOR CONTROLLER
8. MINI-LEVER MODULE (MLM)
9. MAIN CHASSIS HARNESS
10. EMERGENCY STOP
11. PUMP MOTOR
12. TRACTION MOTOR

Figure 9030-10-28. E2.2-3.5XN (E45-70XN) (A268)



NOTE: J2.2-3.5XN (J45-70XN) (A276) SHOWN. J4.0-5.0XN (J80-100 XN) (A970) IS SIMILAR.

1. VSM
2. DC/DC CONVERTER
3. RELAYS
4. MAIN CONTACTOR AND FUSES
5. DISPLAY
6. TRACTION MOTOR CONTROLLERS
7. PUMP MOTOR CONTROLLER
8. MINI-LEVER MODULE (MLM)
9. MAIN CHASSIS HARNESS
10. EMERGENCY STOP
11. PUMP MOTOR
12. TRACTION MOTORS

Figure 9030-10-29. J2.2-3.5XN (J40-70XN) (A276) and J4.0-5.0XN (J80-100 XN) (A970)

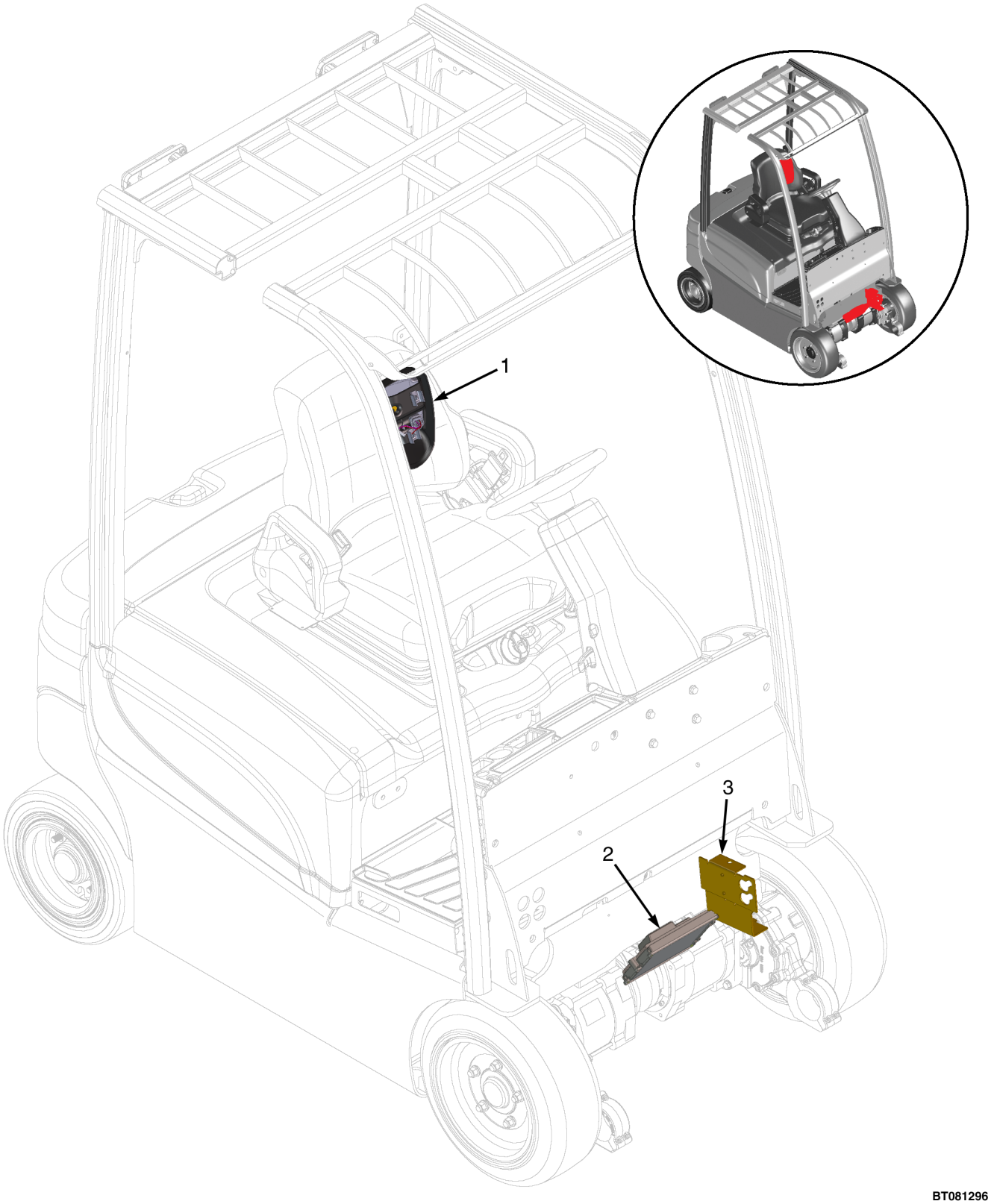


Figure 9030-10-30. J1.6-2.0XN (J30-40XN) (A935) and J1.5-2.0XNT (J30-40XNT) (K160)

Legend for Figure 9030-10-30

NOTE: J1.6-2.0XN (J30-40XN) (A935) IS SHOWN AND J1.5-2.0XNT (J30-40XNT) (K160) IS SIMILAR.

1. DISPLAY
2. VSM
3. FUSE PANEL

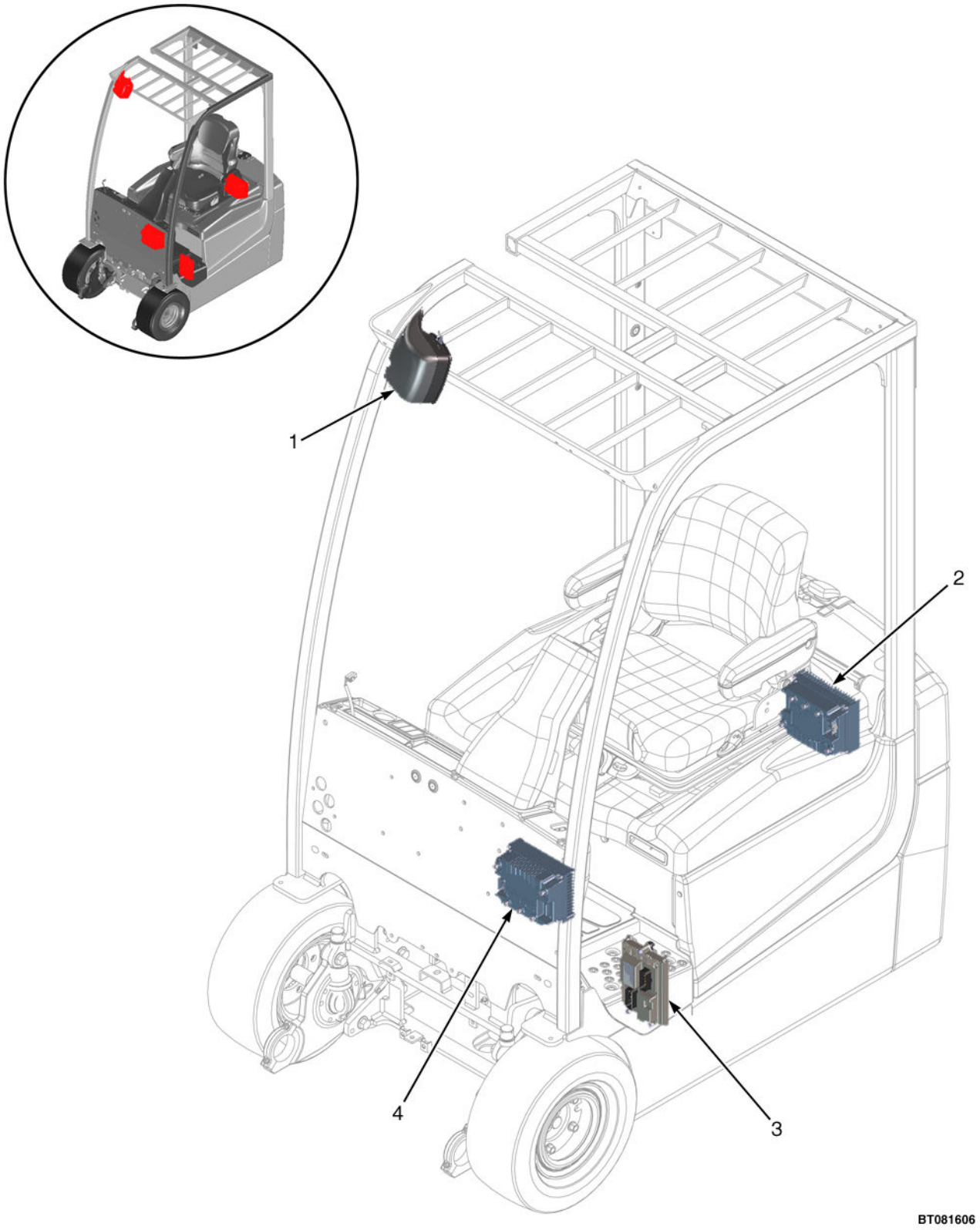


Figure 9030-10-31. A1.3XNT, A1.5XNT (A25XNT, A30XNT) [D203] Controller Locations

Legend for Figure 9030-10-31

1. DISPLAY
2. TRACTION CONTROLLER
3. VSM
4. PUMP CONTROLLER

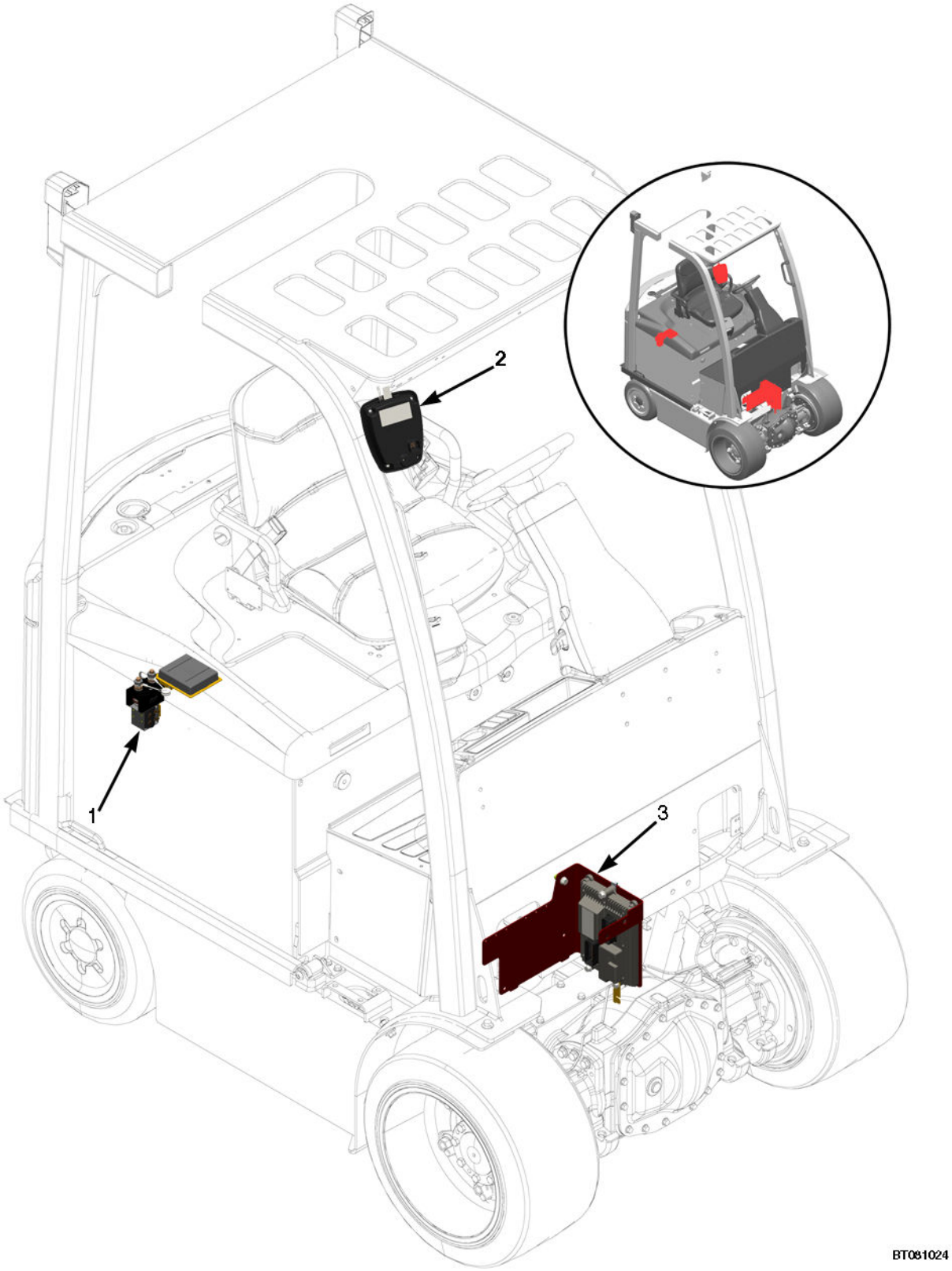


Figure 9030-10-32. E2.2-3.5XN (E45-70XN) (A268)

Legend for Figure 9030-10-32

1. CONTACTOR AND FUSE PANEL
2. DISPLAY
3. VSM

The truck's electrical system directly controls and monitors every electrical component in the truck. See Figure 9030-10-33 which shows the interconnection between various components in the system.

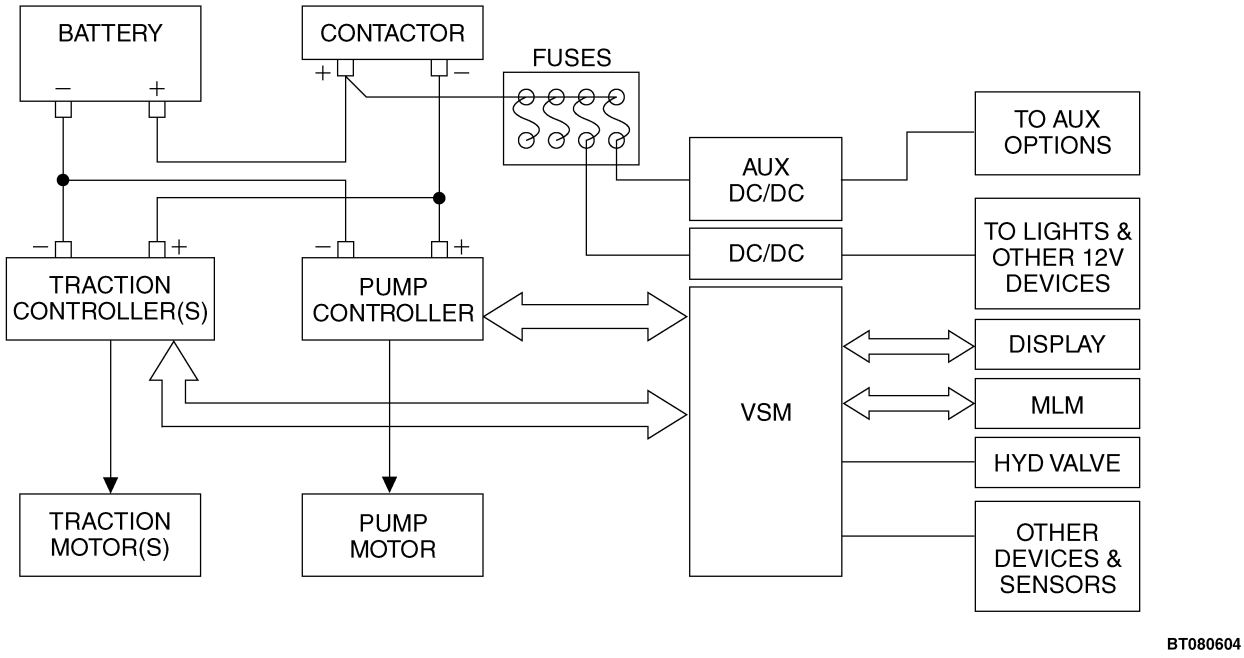


Figure 9030-10-33. System Block Diagram

The lift truck contains components as listed below; Component location on truck may vary with the different platforms.

Battery

- Deep-cycle, multi-cell, lead acid battery.
- Voltage ranges 24/36/48/72/80 volts with different Ah ratings based on customer applications.
- The battery is located below the hood in the battery compartment area.

Contactor

The contactors used are single pole single throw normally open contactors. The contactors are available in UL-E and UL-EE options.

Fuses

- The main fuses are 15 Amp fast acting ceramic tubes with nickel plated brass end cap construction.
- The contactor and fuses are assembled together on a single bracket.
- Other fuses are located adjacent to the devices they are protecting.

Relays

The relays used are 12V and 24V having high contact rating, high temperature and quick connect design. Following are the relays provided in the truck:

- Standard Relays:
  - Key Switch Relay (12V)
  - E-Hyd Enable Relay (24V) (Only on E-Hydraulic Trucks)
- Optional Relays:
  - Reverse Relay (24V)
  - Brake Light Relay (24V)
  - Flasher (Turn Signal Option) Relay (12V)

Wire Harnesses

Fundamental to the operation of the truck, the wire harnesses have been designed to ensure trouble free, reliable electrical operation, and ease of service. This has been achieved through the following:

- Harness retention clips and brackets used for consistent routing and clean appearance.
- Constructed with ultrasonically welded splices and protective conduit.

- High quality sealed connectors with locks are used instead of spade type connectors and unsealed connections wherever possible.
- Standardized wire colors and circuit identification.

DC/DC Converter

The DC/DC converter is connected permanently to the batteries of the lift truck.

The DC/DC converter regulated voltage outputs. The DC/DC converter helps provide unmatched levels of efficiency with thermal protection for lights, horns, wipers, communication equipment, and charging auxiliary batteries.

Operator Interface

Display

The display panel is located on the upper portion of the right front overhead guard leg. It is the main operator interface providing operator input through the push buttons and outputs to the operator through messages and warning icons. It also provides onboard diagnostics and setup to a qualified technician through password protection. See Figure 9030-10-34. There are two display options available Standard Temperature and Freezer (Arctic) Temperature. Keyed and Keyless Power on is also an option.

Figure 9030-10-34. Display

Controllers

Vehicle System Manager (VSM)

The Vehicle System Manager (VSM) is a microprocessor powered controller which controls and monitors directly or indirectly every electrical device on the truck. The VSM power inputs are protected for overvoltage, reverse polarity, electrostatic discharge and short to battery. VSM outputs are protected for short to battery, short to ground, electro static discharge and transients. There are two versions of the VSM. One is for Manual Hydraulics, and one is for the E-Hydraulics configuration. See Figure 9030-10-35.

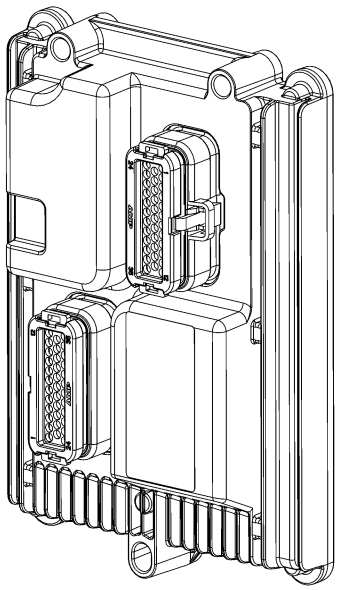


Figure 9030-10-35. Vehicle System Manager (VSM)

Motor Controllers

Motor controllers are used to provide Traction and Pump motors with power and control signals. Traction and Pump motors are controlled individually by separate controllers. These controllers are linked to VSM via CANbus which provides control signals to controllers. See Figure 9030-10-36 or Figure 9030-10-37.

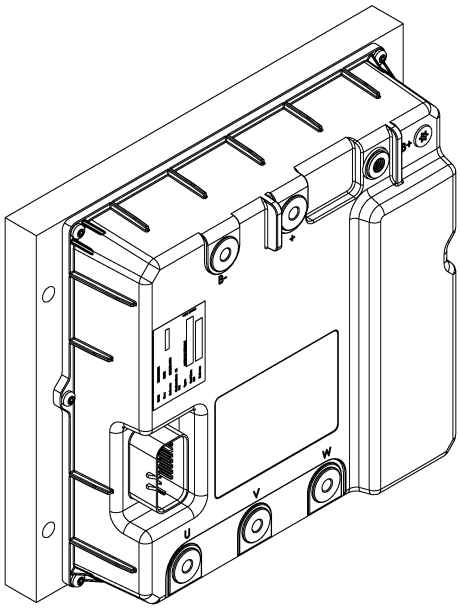


Figure 9030-10-36. Motor Controller for Four Wheel Applications

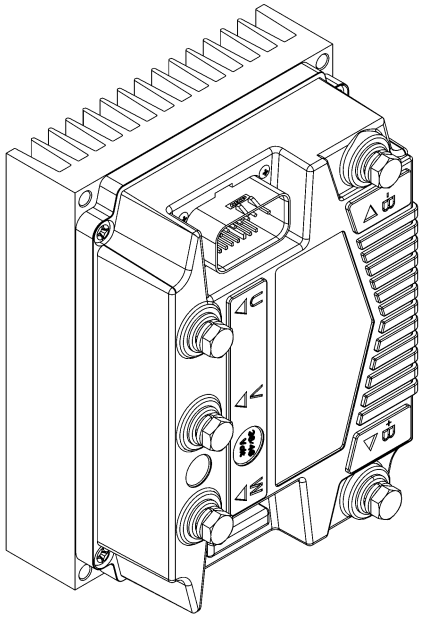


Figure 9030-10-37. Motor Controller for Three Wheel Applications

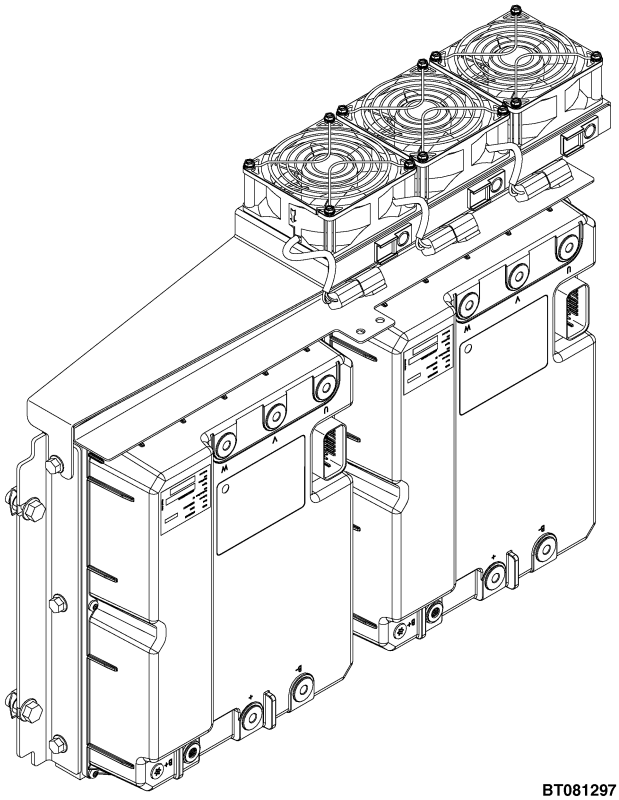


Figure 9030-10-38. Motor Controllers with Integrated Heat Sink

E-Hydraulics Mini Levers Module (MLM)

The electro hydraulic systems for all electric rider forklift trucks include a mini-lever module (MLM). The MLM consists of analog (levers) and digital (switch) inputs that command various hydraulic and truck functions. The hydraulic functions which are controlled by the MLM are lift/lower, tilt and up to three auxiliary functions. Auxiliary functions are used for operating “forklift attachments” such as a sideshift, rotator, clamp, push/pull, etc. See E-Hydraulic System Interface.

The truck utilizes CANopen communications, CAN 2.0B hardware, to link the control system components. Multiple packets of information can be sent on this bus, an operation commonly known as Multiplexing. See Figure 9030-10-39 which shows components connected through CANbus.

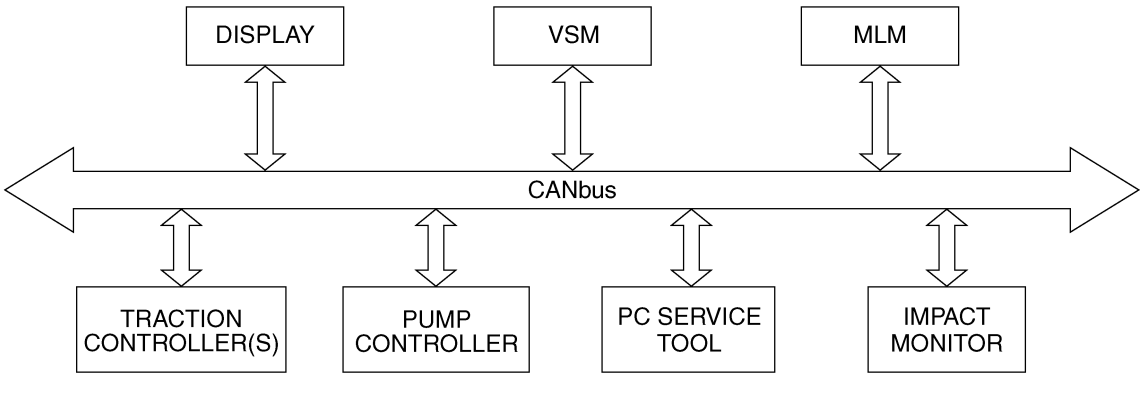


Figure 9030-10-39. CAN Network Diagram

The CANbus consists of a twisted pair of wires. Each of the twisted wires is uniquely color-coded.

Yellow = CAN Hi

Green = CAN Lo

Typical characteristics of data on the CANbus are:

- Each wire broadcasts a mirror image of the other to insure signal integrity.
- Each CAN connected device receives and broadcasts messages.
- The message data, if viewed with an oscilloscope, would look like the signal trace shown in Figure 9030-10-40.

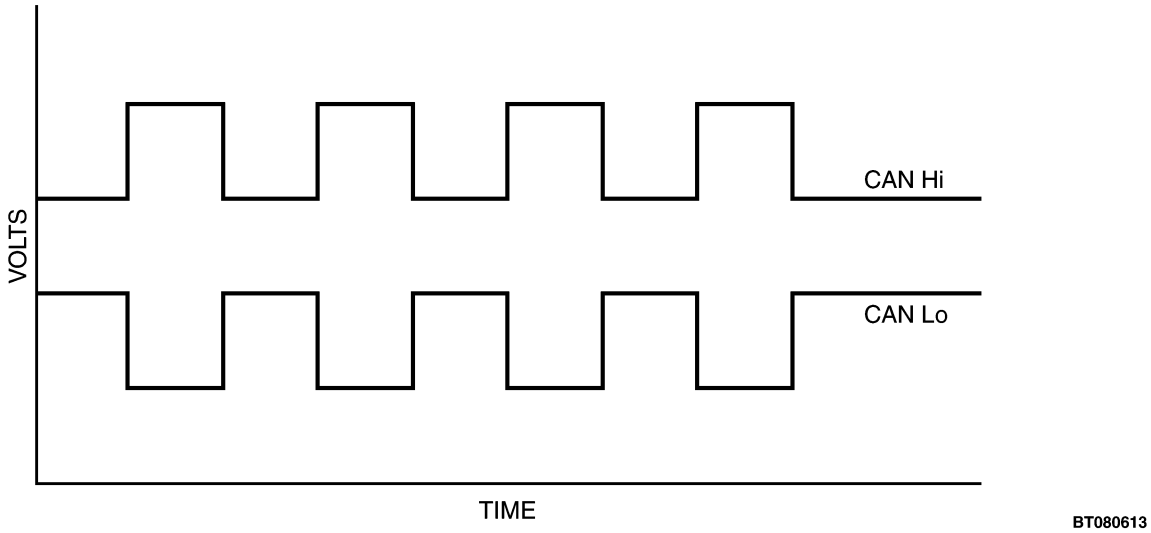


Figure 9030-10-40. Typical CAN Signals

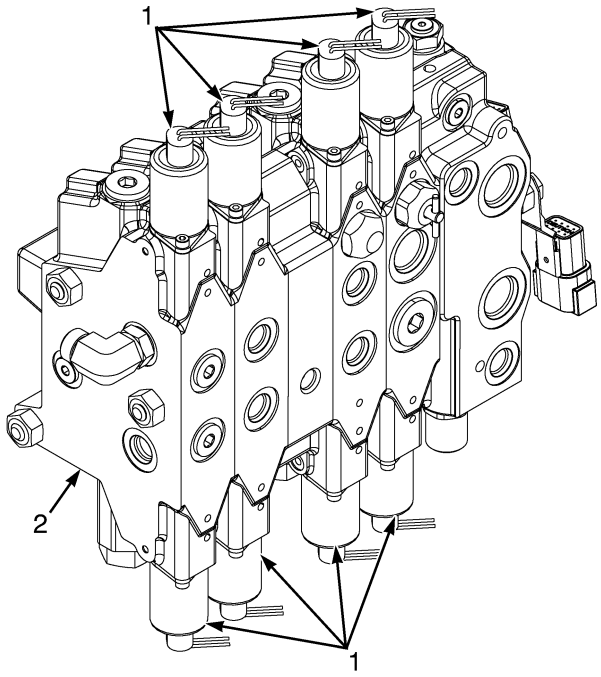
System Controlled Outputs

The various controllers provide electrical outputs to various devices to control variable functions; some of them are described below.

Valve Coils

There are two different valve options available E-Hydraulic and Manual.

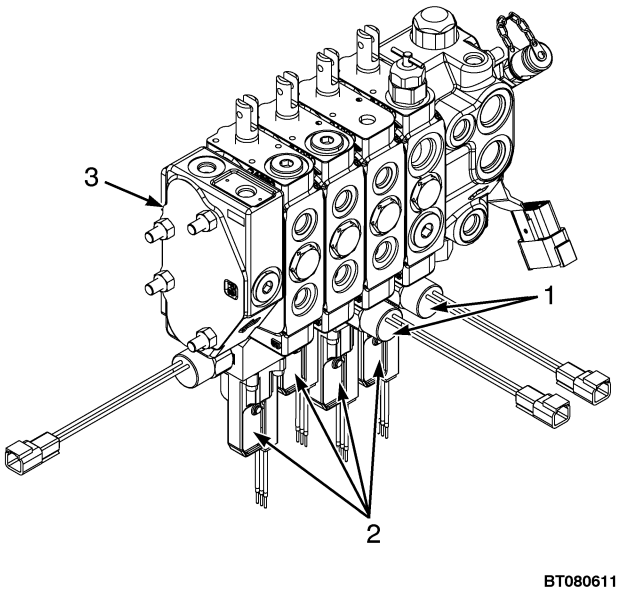
- E-Hydraulic valve spool displacement is accomplished by applying an electrical signal to a solenoid located on either end of the valve section. These solenoids receive Pulse Width Modulated (PWM) signals from the VSM which provide proportional control of the spool. See Figure 9030-10-41.



1. E-HYDRAULIC SOLENOIDS
2. E-HYDRAULIC VALVE

Figure 9030-10-41. E-Hydraulic Valve

- In Manual valves the spool displacement is accomplished by manual levers. The position sensors provided on the valve monitors the position of the valve spool and produce a variable output signal relative to how far the spool has traveled from its neutral position. The output signal from the sensor is used by the VSM to vary the hydraulic pump flow. The manual valve is provided with Operator presence solenoids (OPS) which allows valve operation only if operator is present on the seat. See Figure 9030-10-42.



1. OPS LOCKOUT SOLENOIDS
2. SPOOL POSITION SENSORS
3. MANUAL HYDRAULIC VALVE

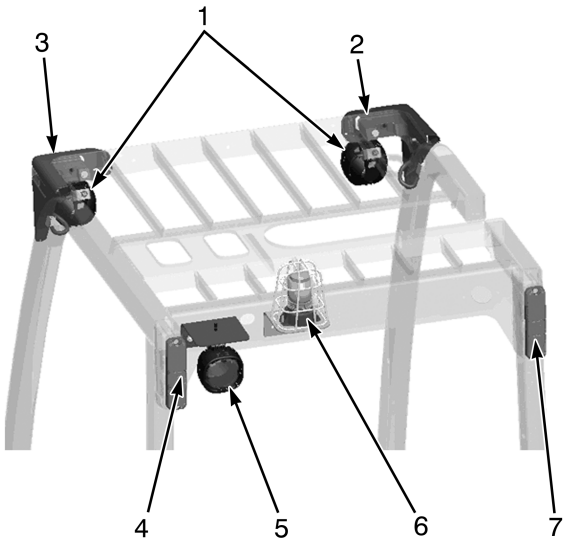
Figure 9030-10-42. Manual Hydraulic Valve

Lights and Backup Alarm

The work lights are 35/55 watt halogen lights. A premium LED 37 or 55 watt work light package is also offered. Tail lights, front-marker and strobe lights are all LED lights and are used in both the incandescent and LED work light options.

Depending on your lift truck and further information pertaining to lights and schematics, see **Diagrams** 8000SRM1341 or **Diagrams** 8000SRM1384.

See Figure 9030-10-43, which shows general locations of different lights used. They may vary depending upon your lift truck.



1. FRONT WORK LIGHTS
2. RH FRONT MARKER LIGHTS
3. LH FRONT MARKER LIGHTS
4. LH TAIL LIGHT
5. REAR WORK LIGHT
6. STROBE LIGHT
7. RH TAIL LIGHT

Figure 9030-10-43. Light Location

Cab options

Some of the lift trucks are equipped with following options:

- Washer/ Front-Rear Wipers
- Cab Heater
- Dome Light

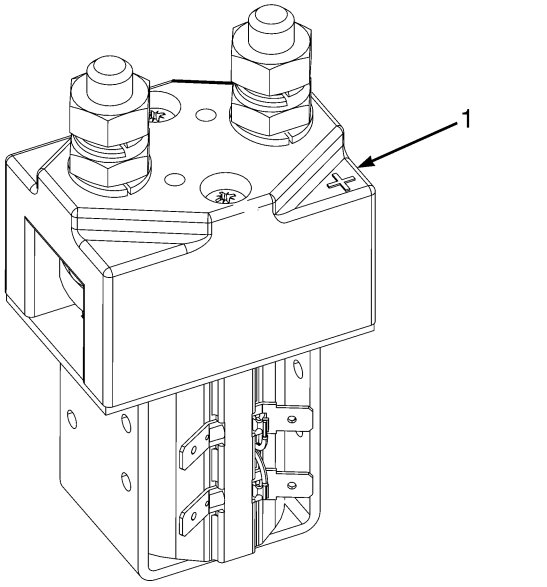
PRINCIPLES OF OPERATION, COMPONENTS

Power Distribution

Contactor

The Contactor is an electrically controlled switch used to supply main power to the lift truck's motion system. It consists of a set of high current contacts to carry battery power. These contacts are closed by an electromagnetic coil which when energized by the control system sends battery power to the motor controllers and other battery operated devices.

One of the main terminals of the contactor is connected to battery power and the other terminal is connected to the motor controllers. In order for the coil to operate there are certain interlock conditions which need to be fulfilled. Once all conditions are met the VSM provides a signal to the coil. When the operator turns on the Key or Keyless Power to ON (both are located on display), the key switch relay is energized on and the main contactor coil is energized closing its contacts. See Figure 9030-10-44.



1. CONTACTOR

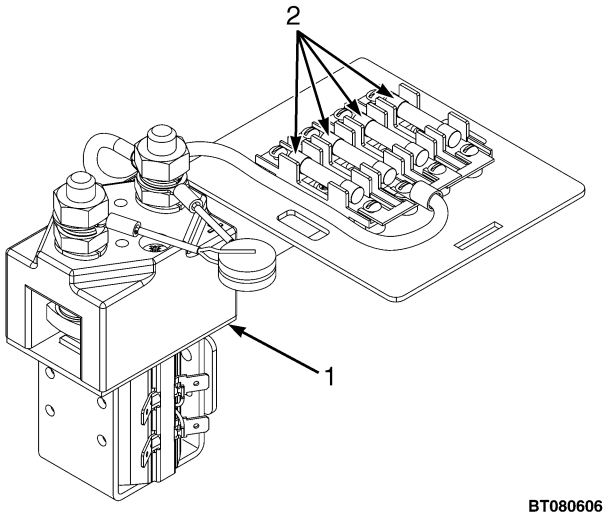
Figure 9030-10-44. Contactor (EE Type Shown)

Positive Temperature Coefficient (PTC)

The PTC thermistor ensures that the motor controller drive capacitors are charged when the battery is connected and prior to the contactor being operated. This prevents damage to the contactor contacts due to large capacitive inrush currents.

Fuses

The fuses used are 15 Amp fuses. They are typically used to connect the Emergency Disconnect Switch circuits, Primary DC/DC converter and Auxiliary DC/DC converter to battery power. One 5 Amp fuse is used for the Key Switch and E-Stop. See Figure 9030-10-45. See Figure 9030-10-46.



1. CONTACTOR
2. FUSES

Figure 9030-10-45. Fuse and Contactor Assembly

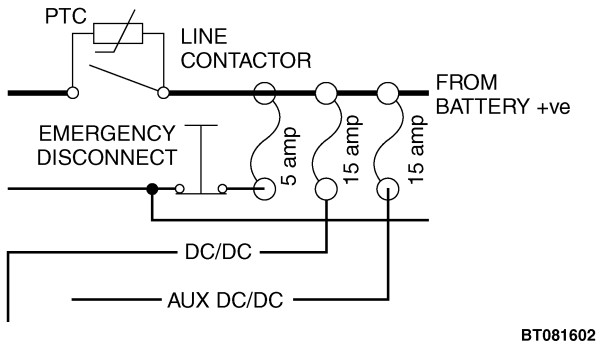


Figure 9030-10-46. Power Circuit Diagram

Relays

Key Switch Relay: Upon turning on the key or keyless switch located on Display panel, key switch relay gets energized and provides power to components to which it is connected. See Figure 9030-10-47.

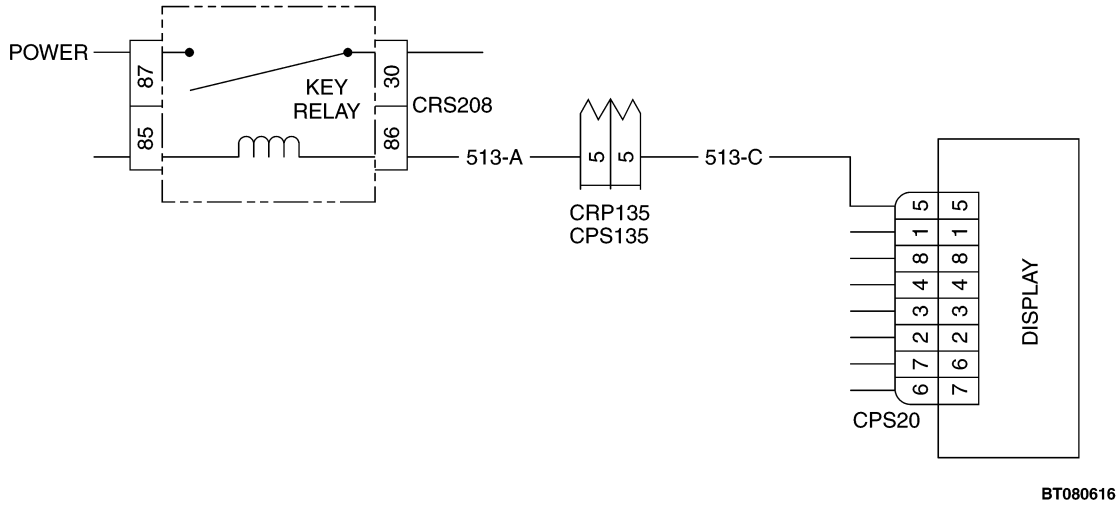


Figure 9030-10-47. Key Switch Relay Diagram

E-Hydraulic Enable Relay: This relay is available on lift trucks with E-Hydraulic option and is controlled by the VSM and gets activated whenever operators send input to VSM via E-Hydraulic input device. It provides 12V power to E-Hyd coils. See Figure 9030-10-48.

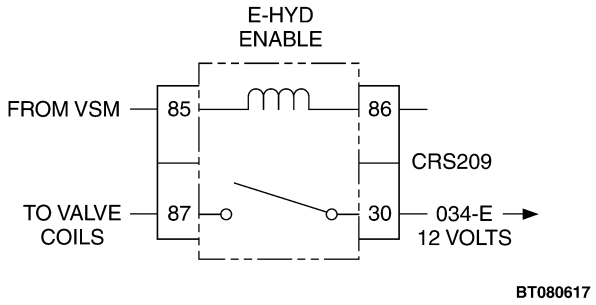


Figure 9030-10-48. E-Hyd Enable Relay Circuit

Backup Light Relay (Optional): This device is controlled by the VSM and gets activated after detecting the selection of reverse direction. See Figure 9030-10-49.

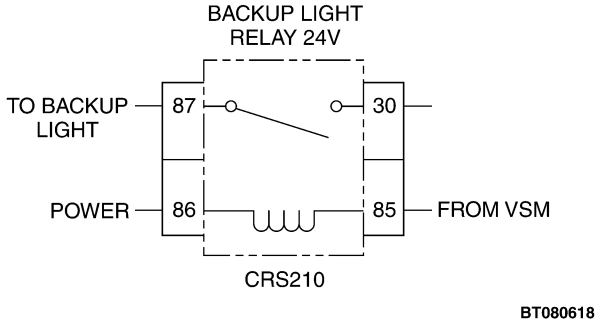


Figure 9030-10-49. Backup Light Relay Circuit

Brake Light Relay (Optional): This is controlled by the VSM and gets activated after brake is applied. See Figure 9030-10-50.

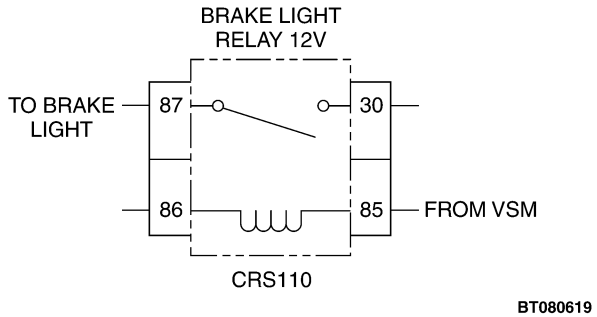


Figure 9030-10-50. Brake Light Relay Circuit

Motion Relay (Optional): This relay is activated via the user interface with supervisor password and energizes whenever lift truck is operational in any direction that is selected.

Operator Interface

Display

The display is the most important operator interface in the lift truck. The display is protected for reverse voltage up to -16 volts, short to 16 volts and battery negative, transients, ESD up to 8,000 volts and electromagnetic interference (EMI) up to 100 volts/meter. The display gets 12V power from VSM; also it is linked to VSM via CANbus. The Display has two controlled outputs: the Buzzer and the Key Switch Relay. The following Figure 9030-10-51 shows how display is connected into the system.

Upon turning on the Key or Keyless switch which is located on display, the key switch relay gets energized and in turn provides power to following components:

- Main Contactor Coil
- Supplementary Contactor Coil (if equipped)
- Traction Controller
- Pump Controller
- Park Brake Controller (if equipped)
- Park Brake Solenoid (if equipped)
- Manual Hydraulic Clamp Coil (if equipped)
- Manual Hydraulic Interlock/E-Hydraulic Enable Relay
- 5th Function Hydraulic Diverter Valve (if equipped)
- Reverse/Backup Light Relay (if equipped)
- Brake Light Relay (if equipped)
- Accessory Relays (if equipped)

After the key is switched on the display screen turns on all pixels and blackens the screen for ½ second. After performing the screen check the system will transition to one of the following screens:

- The Password screen if the Operator Passwords are enabled
- If Operator Passwords are not enabled then the system transitions to the Operator Checklist Screen if the Operator Checklist function is enabled and the system was not powered off through the auto-power down feature.
- If the Operator Checklist function is not enabled (or the system was last powered off through the auto-power off function) and the Operator Passwords function is not enabled then the system transitions to the Operating Screen.

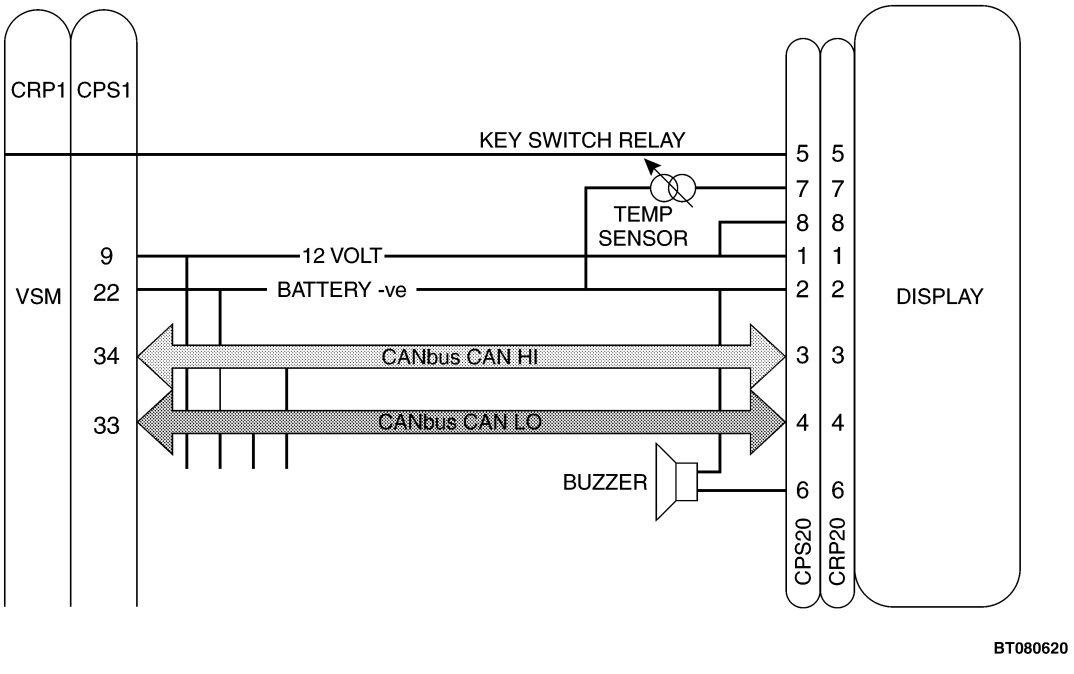


Figure 9030-10-51. Display CAN Connections

The operating Screen displays several warning and information icons, these include:

- Performance Mode
- Seat Belt Warning
- Low Brake Fluid Warning
- Thermal Management
- Service Due (Optional)
- Direction/Park Brake Indicator
- Steer Angle (Optional)
- Time of Day
- Battery Charge
- Diagnostic Trouble Codes

E-Steer

Description

There is no mechanical linkage or hydraulic hose between the steering wheel and the steer axle of the E-Steer system. A sensor driven by the steering wheel communicates operator input to the steer motor controller. The steer motor drives the steer axle in the direction and to the position commanded by the steer motor controller. Actual steer axle position feedback is input to the steer motor controller from the steer axle position sensor mounted on the steer motor. The E-Steer system uses this sensor to calibrate steer axle center point.

Steer Controller and Motor

The steer axle in the E-Steer system is driven by an AC induction motor coupled to the steer axle gearbox. The steer motor controller is mounted directly to the motor. The steer motor controller communicates to the VSM on the CANbus network..

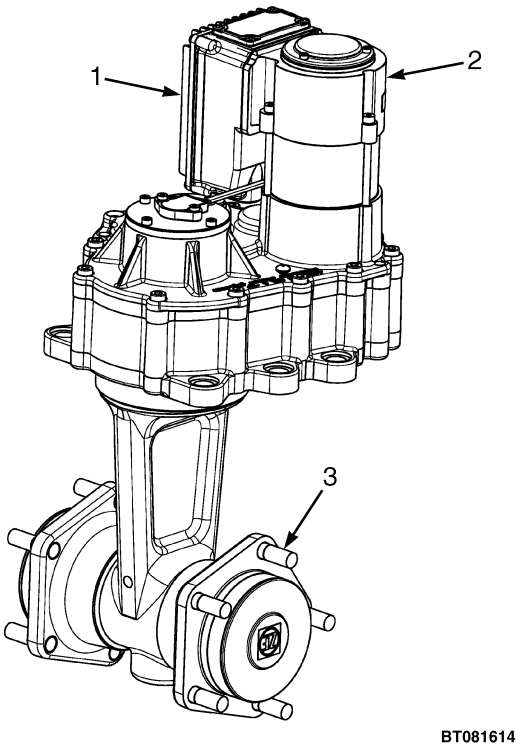
Position Sensor

The steer axle position sensor sends steer axle position feedback to the E-Steer motor controller. The steer axle position sensor is mounted on the steer motor.

TFD (Tactile Feedback Device)

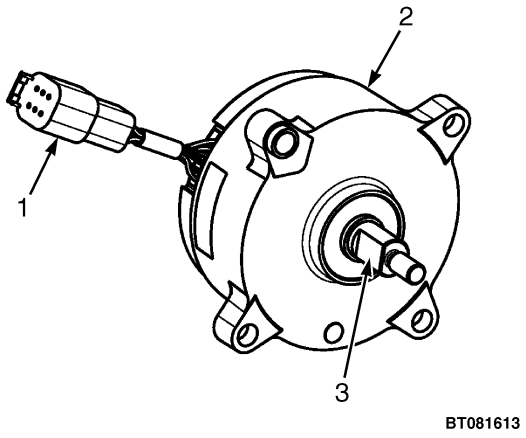
The TFD steering unit provides bearing support, steering position sensing, communication, and variable resistive steering torque. The TFD, located below the steering wheel, senses operation by a hall-effect steering sensor and transmits the steering position to the steer controller. The steer controller uses proximity sensor input to determine the preferred steering response.

The operator will experience torque feedback in response to steering input. The TFD will simulate steer resistance by energizing a magnetically responsive material against a fixed stator. This material is a magneto rheological fluid, or MR fluid, providing a smooth and quiet steering feel.



1. STEER CONTROLLER
2. STEER MOTOR
3. STEER AXLE

Figure 9030-10-52. Steer Axle Assembly



1. TFD COIL CONNECTOR
2. TFD (TACTILE FEEDBACK DEVICE)
3. INPUT SHAFT

Figure 9030-10-53. TFD Assembly

Controllers

Vehicle System Manager (VSM):

1. The VSM is the Master Controller of the truck. It receives input from:
   - The Operator (Via Display)
   - Sensors
   - Controlled Devices
2. This allows the VSM to analyze, and determine the controls of most of the lift trucks electrically controlled functions. The VSM is also programmed to detect truck malfunctions and provide feedback to the operator and service technician in the form of:
   - Display Messages
   - Display Warning Icons
   - Audible Warnings
   - A Change in truck operations (Decelerate, Shutdown)
3. The VSM can be viewed as a box containing multiple inputs and outputs, see Table 9030-10-3.
4. Inputs are connected to:
   - Sensors
   - Switches
   - Control lines from other devices
   - Voltage supplies
5. Outputs are connected to:
   - Contactor
   - Relays
   - E-Hyd Valve coils
   - Lights
   - Solenoids
6. The VSM communicates to multiple devices over CAN:
   - Motor Controllers
   - Display
   - MLM
   - Impact Sensor
   - PCST

Table 9030-10-3. VSM Connection

CPS1			CPS2		
Pin #	**Circuit Description**	**Signal**	**Pin #**	**Circuit Description**	**Signal**
1	Foot brake pressure	AI	1	Brake Light Relay	PWM
2	Hydraulic Temperature	AI	2	Battery -	P
3	Brake Fluid Level	AI	3		
4	Lift Pressure	AI	4	Aux 3 (Fifth Function) Diverter	PWM
5	Hydraulic Oil Level	AI	5	Manual Hydraulic Clamp	PWM
6	Manual Hydraulic #3	AI	6	Manual RTST Valve	PWM
7	Manual Hydraulic #1	AI	7	Hydraulic Enable	PWM
8	Steering Wheel Position	AI	8	Reverse Relay	PWM
9	12V Supply	LP	9	Motion Relay	PWM

DI-L = Digital Input (Switch to B-); DI-H = Digital Input (Switch to B=); P= Power; PWM = Pulse Width Modulated Output; PWM-C = Pulse Width Modulated Output with Current Feedback; AI = Analog Input; QI = Quadrature Input; CAN = CAN Bus; F = Flyback; LP = Low Voltage Power

Table 9030-10-3. VSM Connection (Continued)

CPS1			CPS2		
Pin #	**Circuit Description**	**Signal**	**Pin #**	**Circuit Description**	**Signal**
10			10	Main Contactor	PWM
11			11	Battery - (if equipped) **E-Hydraulic Only**	P
12			12	Keyswitch Input	DI-H
13	Accelerator Pedal Pos A	AI	13	Synchronous Steering (if equipped) **E-Hydraulic Only**	PWM-C
14	Analog Return	LP	14	Tilt B (if equipped) **E-Hydraulic Only**	PWM-C
15	Tilt Position	AI	15	Tilt A (if equipped) **E-Hydraulic Only**	PWM-C
16	Steer Axle Position	AI	16	Lift (if equipped) **E-Hydraulic Only**	PWM-C
17	Analog Return	LP	17	Lower (if equipped) **E-Hydraulic Only**	PWM-C
18	Operator Presence Switch	AI	18		
19	Direction Select 2	AI	19	Aux 1A (if equipped) **E-Hydraulic Only**	PWM-C
20	Analog Return	LP	20	Aux 1B (if equipped) **E-Hydraulic Only**	PWM-C
21			21	Aux 2A (if equipped) **E-Hydraulic Only**	PWM-C
22	12V Return	LP	22	Aux 2B (if equipped) **E-Hydraulic Only**	PWM-C
23	Manual RTST Override Input	DI-L	23	E-Hydraulic Flyback (if equipped) **E-Hydraulic Only**	F
24	Park Brake Position	AI	24	Keyswitch Flyback	F
25	Lift Height Position	AI	25		
26	Manual Hydraulic #4	AI	26	Battery Gate	DI-L
27			27	Hydraulic Filter	DI-L
28	Manual Hydraulic #2	AI	28	Seatbelt Switch	DI-L
29	Direction Select 1	AI	29	Hydraulic Brake Pressure Switch	DI-L
30	Accelerator Pedal Pos B	AI	30	Traction/Hydraulic Enable	DI-L
31	5V Supply	LP	31	Speed Limit Override	DI-L
32	5V Supply	LP	32	Manual Hydraulic Clamp Switch	DI-L
33	CAN Low	CAN	33	Supplementary Contactor	PWM
34	CAN High	CAN	34	Switch Return	LP
35			35	Battery +	P

DI-L = Digital Input (Switch to B-); DI-H = Digital Input (Switch to B=); P= Power; PWM = Pulse Width Modulated Output; PWM-C = Pulse Width Modulated Output with Current Feedback; AI = Analog Input; QI = Quadrature Input; CAN = CAN Bus; F = Flyback; LP = Low Voltage Power

Motor Controller

The traction and Hydraulic pump motor controllers have been separated and provide power and control signals to their respective motors.

Traction Motor Controller: Each traction motor is controlled by a separate controller which gets its power from the battery and provides power and control signals to the motor. The controller is also connected by CANbus to VSM which monitors various operating parameters of the motor. Both speed and winding temperature are monitored and adjusted to provide optimum performance.

The accelerator pedal, directional switch, and brake pressure sensor signals to the VSM which are sent by CAN to the motor controllers to provide speed, and directional control. In addition to this motor winding temperature and speed are inputs to the controllers. The diagram below shows interconnection between a traction motor and its controller. See Figure 9030-10-54.

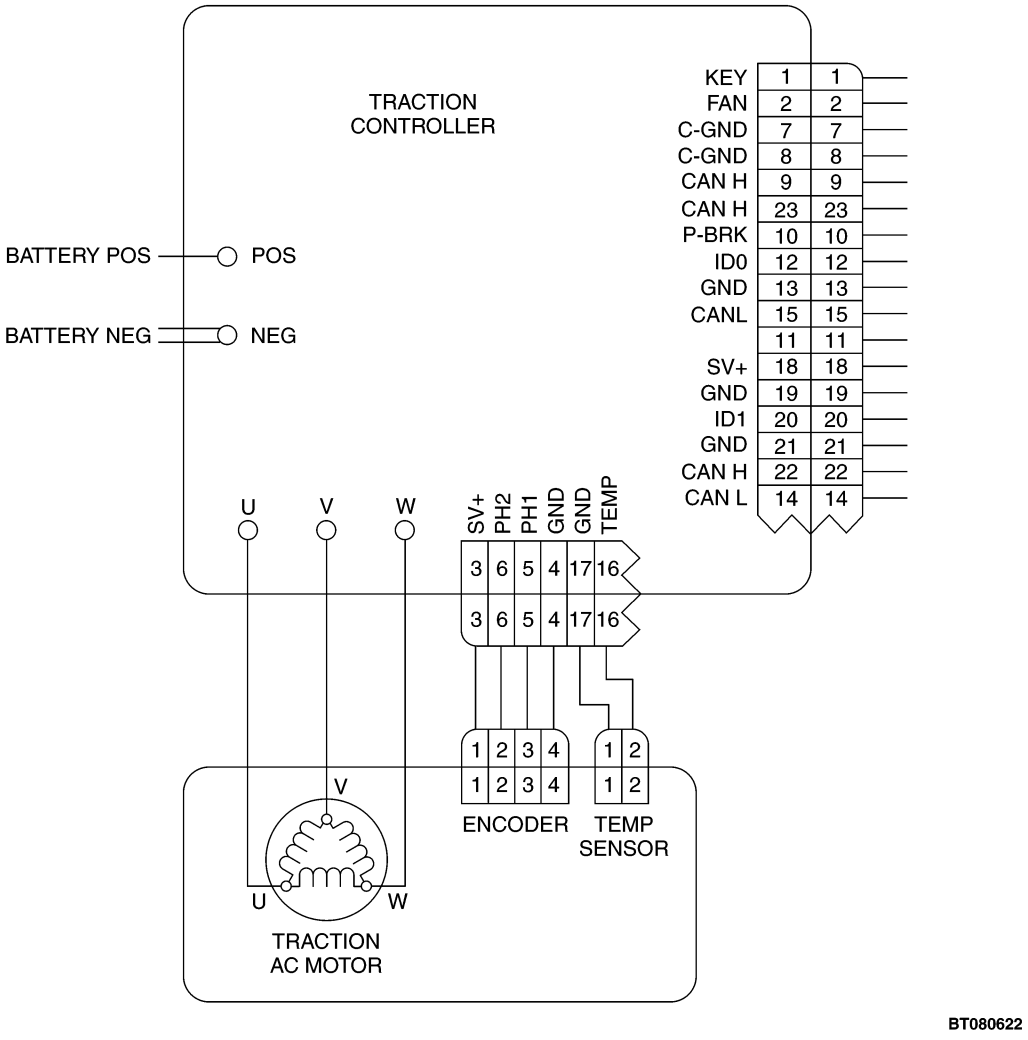


Figure 9030-10-54. Traction Motor and Controller Connections

Hydraulic Pump Motor Controller: This motor is controlled by a separate controller, which gets its power from the battery and provides power and control signals to the hydraulic pump motor. In addition to the controller the VSM oversees motor configuration and monitoring responsibilities to ensure the motor runs within given operating parameters. Both speed and winding temperature are monitored and adjusted to provide optimum performance. The following diagram shows interconnection between pump motor and its controller.

Inputs from the hydraulic control valves go to the VSM which then communicate what required flow is needed to meet the requested function. This is communicated over the CAN to the controller to provide the needed motor speed for a given hydraulic flow. The diagram below shows interconnection between pump motor and its controller. See Figure 9030-10-55.

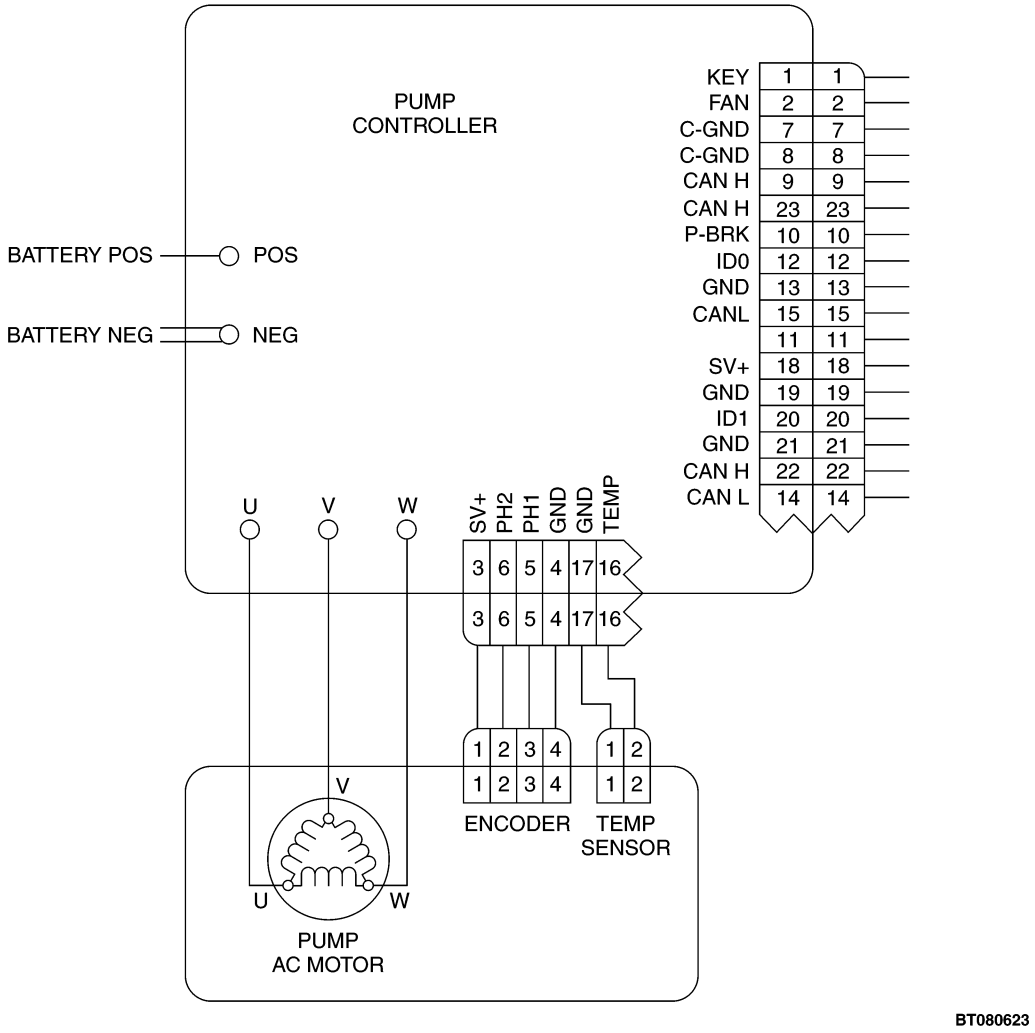


Figure 9030-10-55. Hydraulic Pump Motor and Controller Connections

E-Hydraulics Mini Levers Module (MLM)

The E-Hydraulic mini lever module is a controller assembly that includes operator input levers and button(s). These levers and buttons provide analog and digital inputs to the E-Hydraulic input device. The E-Hydraulic input device then formats the information into a predefined protocol and broadcasts the operator inputs to the VSM via the CANbus. Inputs from the hydraulic control valves go to the VSM which communicate what required flow is needed to meet the requested function. This is communicated over the CANbus to the pump controller to provide the needed pump motor speed.

PRINCIPLES OF OPERATION, SYSTEM

Battery (Plug-In)

The power is supplied to the system after connecting the battery. The following components are connected to the battery voltage

- The primary and auxiliary DC/DC converter which in turn provides 12V power to components to which they are connected
- The VSM which in turn provides 12V power to display and E-Hydraulics Mini Levers Module (MLM)
- Various relays and contactor
- The motor controllers are only connected to the battery after the key is turned on. The system is powered to an non-operational state until the operator turns on the key.

Key ON and Operation

When the key or keyless switch is turned **ON**, the display wakes up and initiates the power up sequence, as mentioned in Operator Interface. The VSM is programmed and wired to detect certain conditions before allowing the vehicle to be started.

1. Interlocks:
   - Operator presence in the seat
   - Accelerator pedal in released position
   - All hydraulic controls must be in neutral state
   - Battery gate switch closed (If applicable)
   - No other operational faults
2. Upon satisfying above mentioned parameters the following events take place:
   - Contactor closes and provides power to the system
   - Motor controllers become operational
   - Hydraulic system becomes operational and begin to give hydraulic steering flow

Sensors

The sensors are divided into 5 functional groups. Most are supplied from a VSM 5 volt sources. The exception is the ultrasonic hydraulic level sensor which operates on 12 volts. If a sensor signal falls below or exceeds programmed values, a failure condition or a warning will be given to the operator.

The functional groups are:

1. Speed (Hall Sensor Technology):
   - Pump motor
   - Traction motor
2. Pressure :
   - Service Brake Pressure
   - Mast Pressure
3. Position - Rotary and Linear:
   - Park brake
   - Accelerator Pedal Position
   - Operator presence
   - Return To Set Tilt (Tilt Position)
   - Mast height (Optional)
   - Manual hydraulic spool position
   - Steer wheel
   - Steer axle (Optional)
   - Direction control selector
4. Temperature:
   - Traction motor
   - Pump motor
   - Hydraulic oil (Optional)
   - Display temperature (Optional)
5. Level/Miscellaneous:
   - Hydraulic filter (Optional)
   - Hydraulic oil level
   - Impact sensor

These functional groups have common signal output characteristics:

1. Speed (4-wire devices):
   - Operating voltage = 12 Volts
   - Variable frequency (Zero to Max speed)
2. Pressure and Position (3-wire devices):
   - Operating voltage = 5 Volts
   - Variable output voltage, 0.5 volts to 4.5 volts, Zero to Full scale
3. Temperature (2-wire device):
   - Operating voltage = 5 Volts
   - Variable resistance, NTC (Increase in temperature results in decrease of resistance)
4. Level/Miscellaneous:
   - Ultrasonic
   - Reed Switch

Sensor Operation Technology

1. Hall Effect (Position): This technology uses a sensor that can detect the strength of a magnetic field or in case of rotation, the angle of the magnetic field in relative to the sensor. Moving the magnet closer or further away from the sensor varies the output voltage. For rotation the output varies based on magnetic field angle.
2. Hall Effect (Speed): This uses the same principle as described in the position sensor but uses the presence and absence of gear teeth to change the strength of the magnetic field. This causes a variable voltage that is used to operate a transistor switch output providing a pulse train that is proportional to speed.
3. Pressure: These devices use a strain gauge or capacitive sense element that generates a microvolt signal which is proportional to the pressure applied. This signal is amplified to provide an output voltage that varies between 0.5 and 4.5 Vdc in proportion to pressure changing from zero to maximum. The output is the same irrespective of the different application pressure ranges of the sensors.
4. Temperature: These devices have the same Negative Temperature Coefficient (NTC) Thermistor element in different packages. Heating of this element changes the element resistance. Higher temperature = Lower Resistance. These sensors are connected in series with a pull up resistor connected to 5 volts. The other end of the sensor is connected to Battery negative, effectively forming a variable voltage divider that the VSM can read and then interpret as a temperature reading.
5. Ultrasonic: This device uses ultrasonic waves which radiate out until they hit an object and return. The time of the cycle determines the distance and/or level. See **Diagrams** 8000SRM1528.

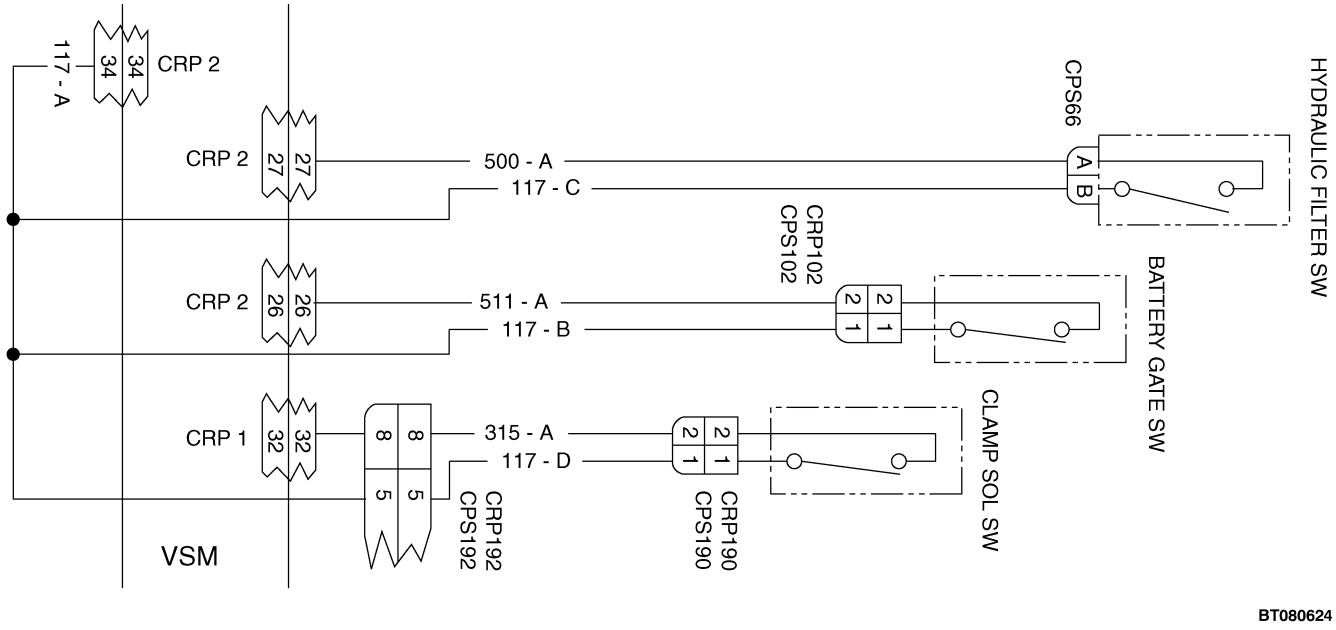


Figure 9030-10-56. Switch Connections

Table 9030-10-4. Motor Temperature Sensor

(°C)	(°F)	Nominal Resistance (?)
-40	-40	359
-30	-22	391
-20	-4	424
-10	14	460
0	32	498
10	50	538
20	68	581
30	86	626
40	104	672
50	122	722
60	140	773
70	158	826
80	176	882
90	194	940
100	212	1000
110	230	1062
120	248	1127
130	266	1194
NOTE: Measured resistance should be within ±5% of specified Nominal Resistance (?)		

Table 9030-10-4. Motor Temperature Sensor (Continued)

(°C)	(°F)	Nominal Resistance (?)
140	284	1262
150	302	1334
160	320	1407
170	338	1482
180	356	1560
190	374	1640
200	392	1722
NOTE: Measured resistance should be within ±5% of specified Nominal Resistance (?)		

Switches

The switches are used for following applications:

- Hydraulic filter pressure
- Battery gate
- Clamp solenoid

Depending on your lift truck and further information pertaining to switches and schematics, see **Diagrams** 8000SRM1341 or **Diagrams** 8000SRM1384.

Outputs

Relays

1. ON/OFF Operation

2. Programmed for a specific maximum current

3. The following faults are detectable

- Short to Battery
- Short to Ground
- Open circuit

E-Hydraulic Valve

1. Valve coil is controlled in following manner

a. Pulse Width Modulated (PWM) signal controls the valve opening, and therefore flow. (Higher duty cycle results in higher fluid flow).

b. Each E-Hydraulics valve is independently controlled and current monitored

c. The following faults are detectable:

- Short to Battery
- Short to Ground
- Open circuit
- Current above or below normal

2. Hydraulics operation is also disabled for the following conditions:

a. Operator presence in seat is not detected

b. Circuit Failures in Valve Wiring/ Connectors/ Valve coils and Valve coil drivers. See Figure 9030-10-57.

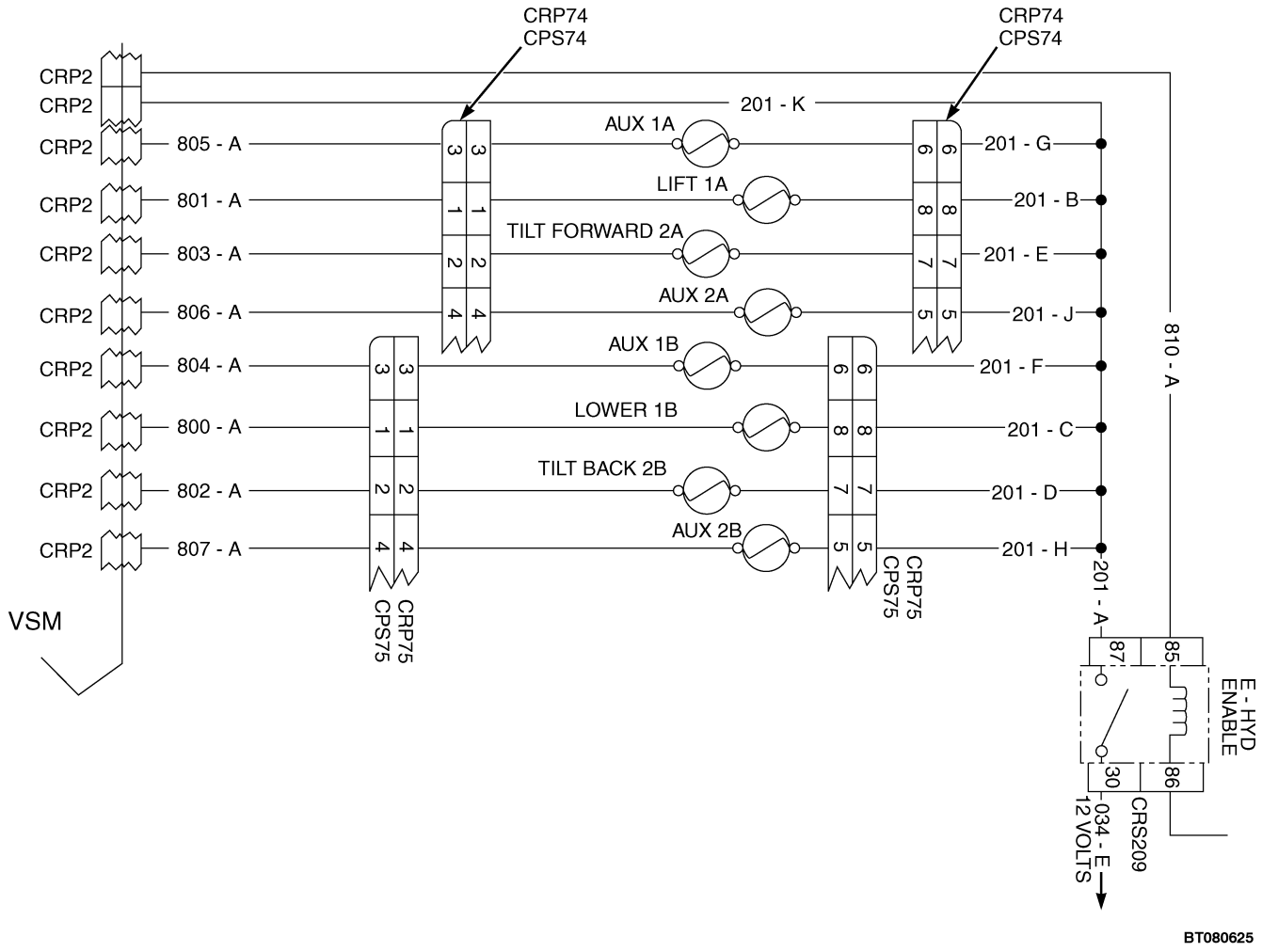


Figure 9030-10-57. Hydraulic Valve Coil Diagram

Cab Devices

All CAB devices are operated from unswitched or switched battery circuits using the device's own ON/OFF switches

- Front/Rear Wiper
- Washer
- Cab light
- Cab Heater

Lights and Backup Alarm

1. Tail Light/Front Work Lights

a. The Tail light/front work lights can be turned ON or OFF by using a switch which is located on Dash panel. See Figure 9030-10-58.

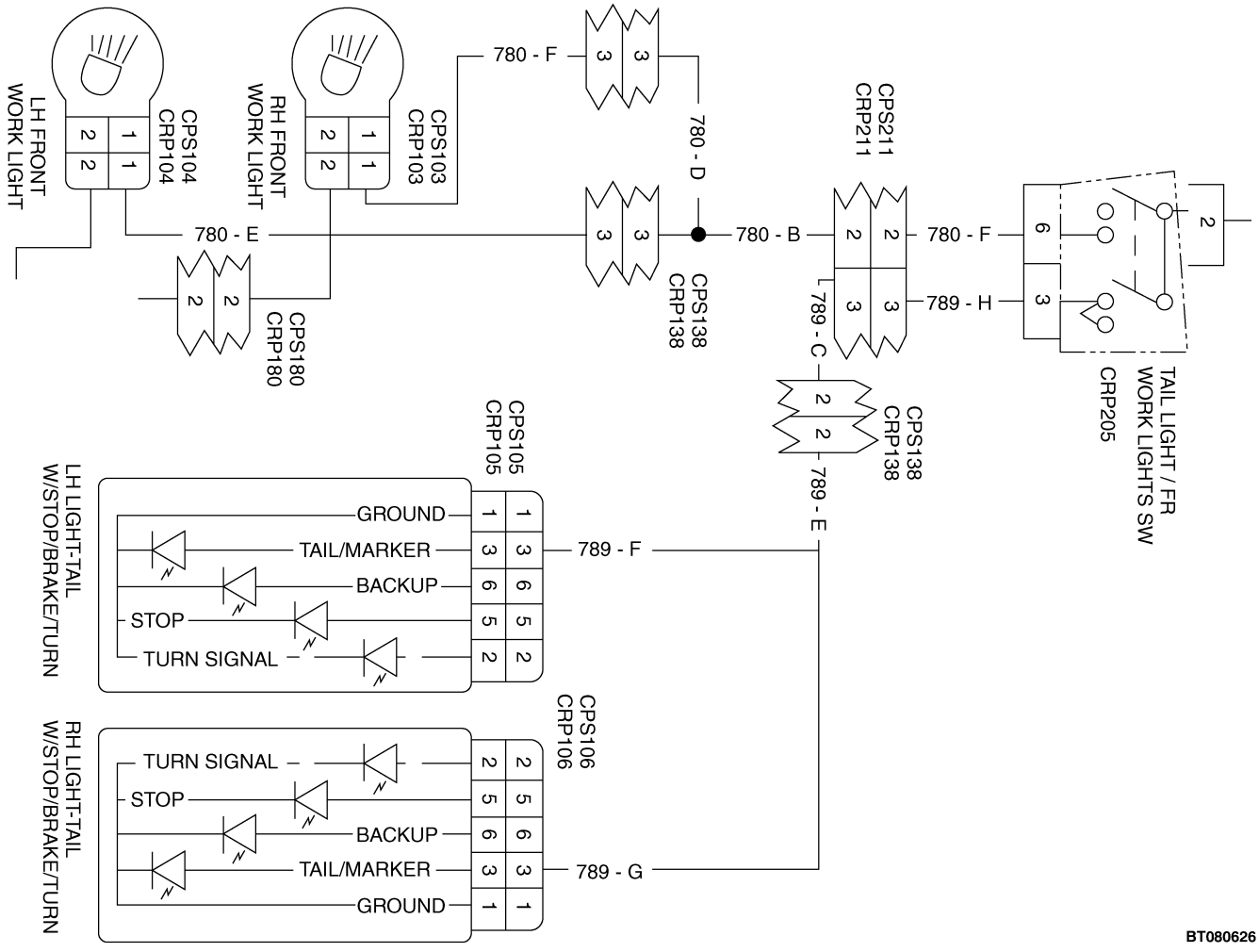


Figure 9030-10-58. Work/Marker Lights Diagram

2. Rear Work Lights

a. The rear work lights can be turned ON or OFF by using switch which is located on Dash panel or automatically controlled by the reverse relay. See Figure 9030-10-59.

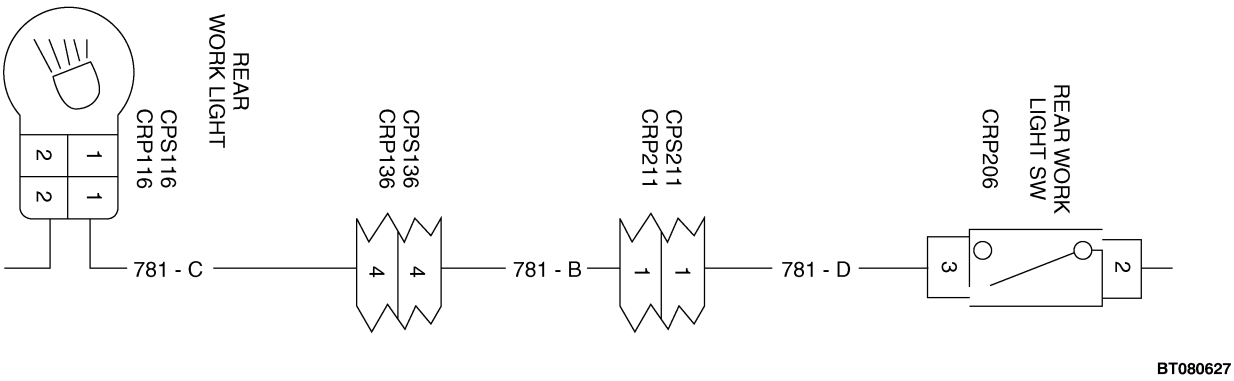


Figure 9030-10-59. Rear Work Lights Diagram

3. Strobe Light

a. The Strobe light becomes operational whenever key switch relay is turned on. See Figure 9030-10-60.

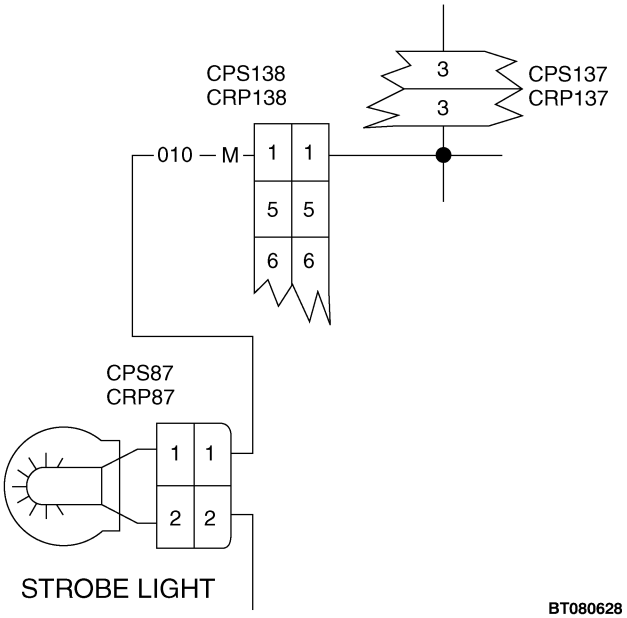


Figure 9030-10-60. Strobe Light Diagram

4. Backup Light and Alarm

a. The Backup light and Alarm are controlled by the VSM detecting the selection of reverse direction. The circuit is designed to allow a customer to connect their desired audible warning device. See Figure 9030-10-61.

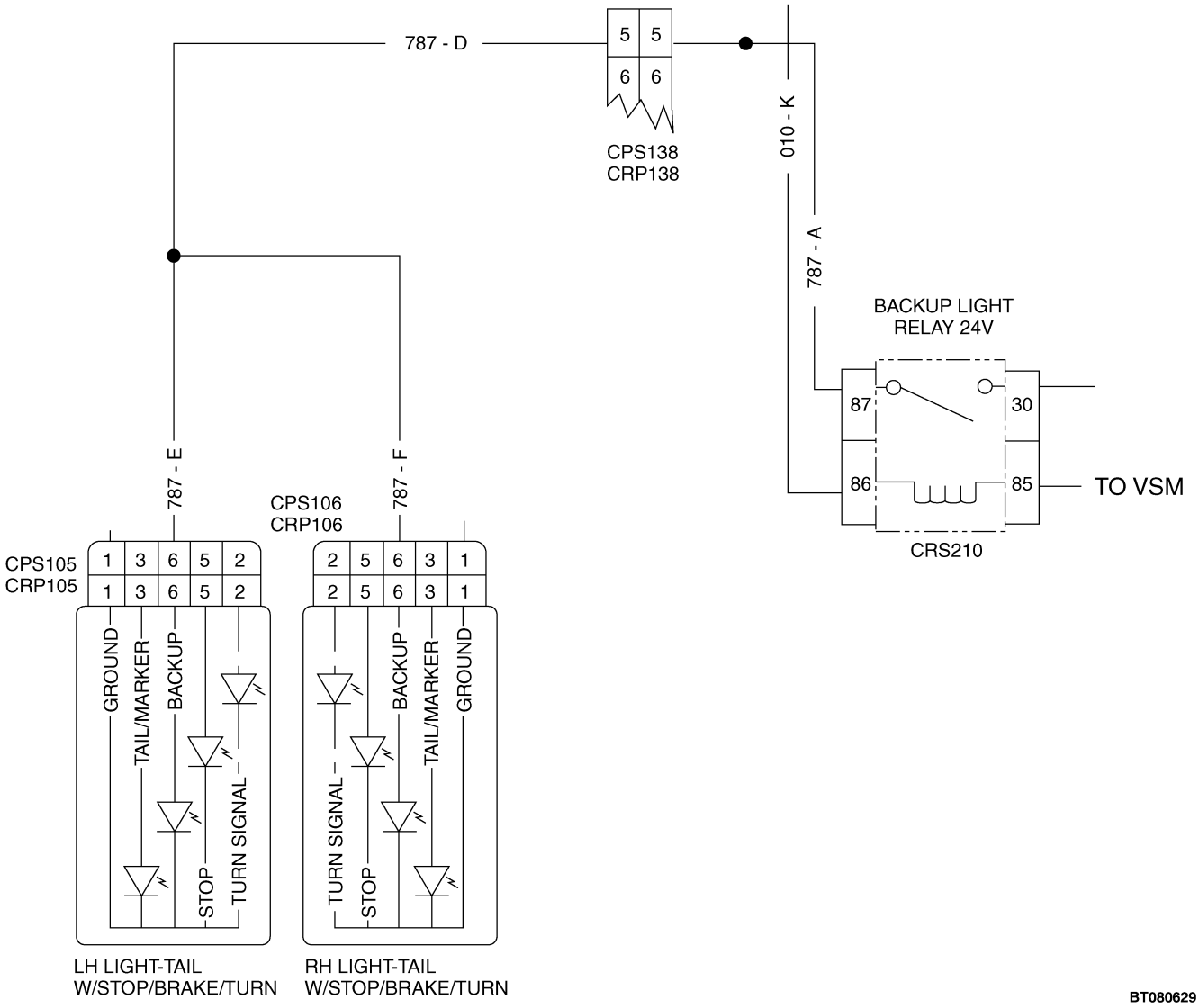


Figure 9030-10-61. Backup Light Diagram

5. Brake Light

a. This light is controlled by the VSM detecting the pressure in the brake pressure sensor when the brake is applied. See Figure 9030-10-62.

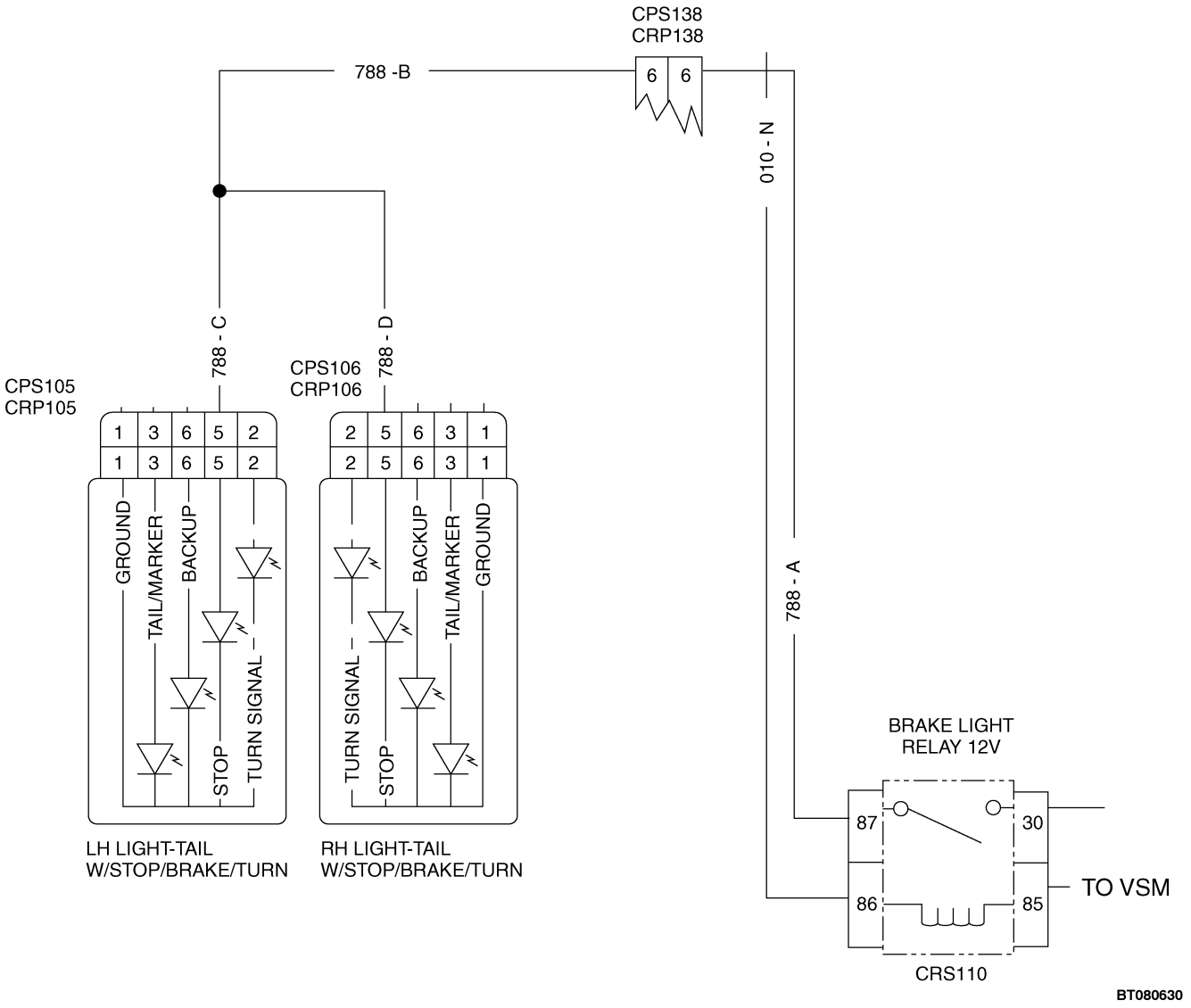
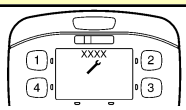


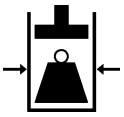
Figure 9030-10-62. Brake Light Diagram

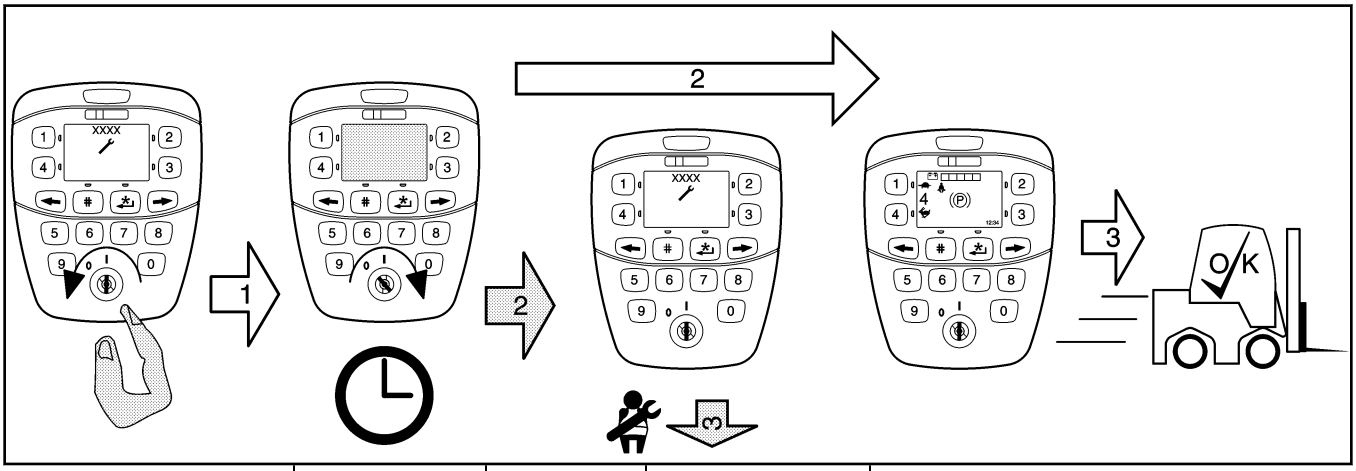
Group 20
Diagnostic Trouble Codes

Load Weigh/Service Brake Pressure Sensor Out of Range Low (OORL)



DTC 12844 DTC 12836
Load Weigh Service Brake
Pressure Pressure

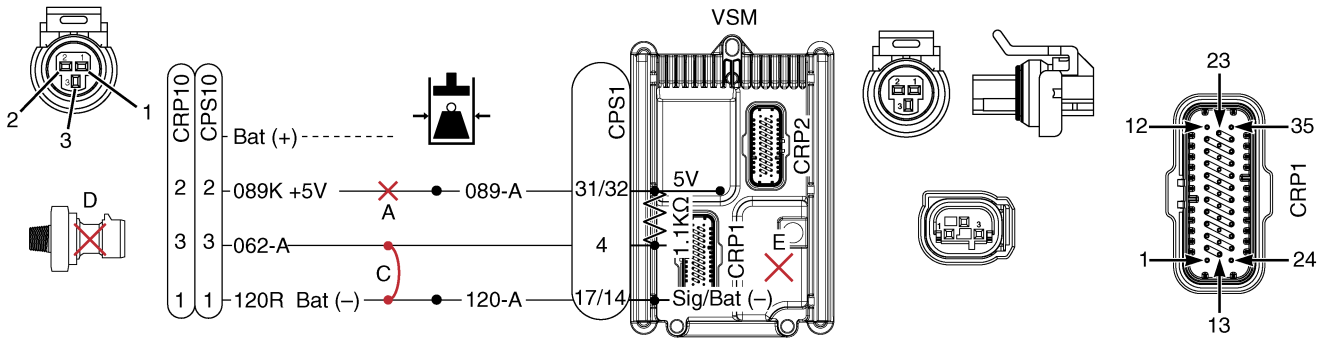




Power **OFF**→	Wait **30 seconds**→	Power **ON**→	Fault remains. Service required. Go to Component Operational Check.	No fault→	Resume operation

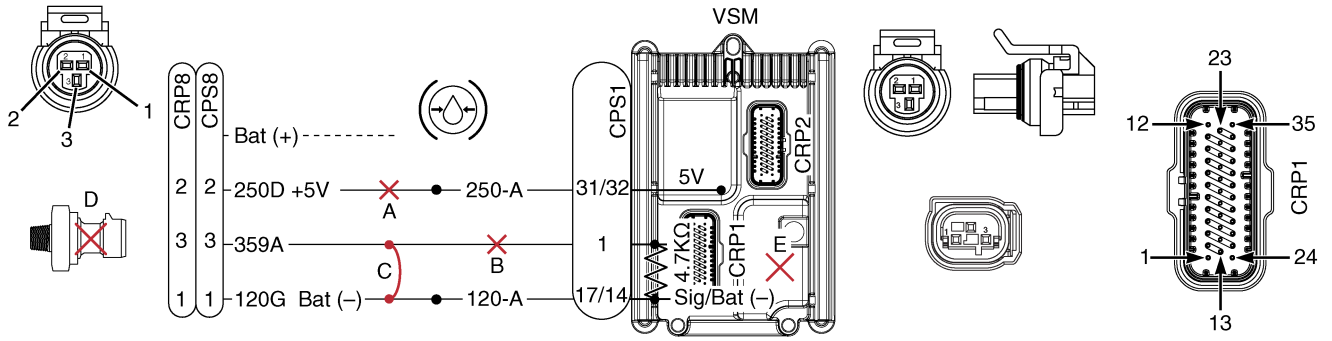
POSSIBLE CAUSE X = Open Circuit/Fail) = Short Circuit

LOAD WEIGH PRESSURE CAUSES A B C D E > ?

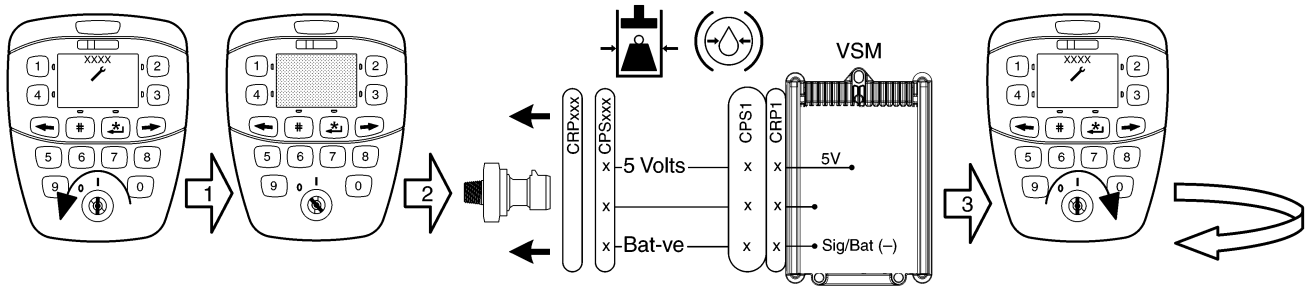


Load Weigh/Service Brake Pressure Sensor Out of Range Low (OORL) (Cont)

SERVICE BRAKE PRESSURE CAUSES A B C D E > ?

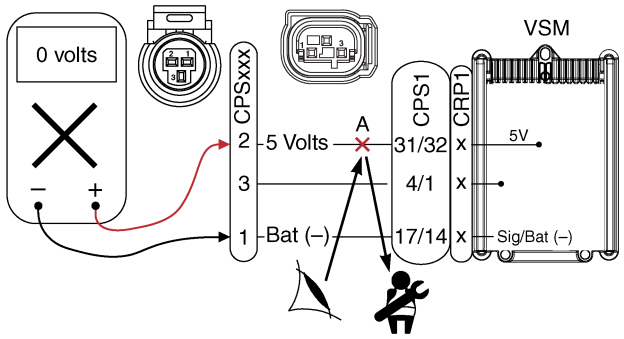


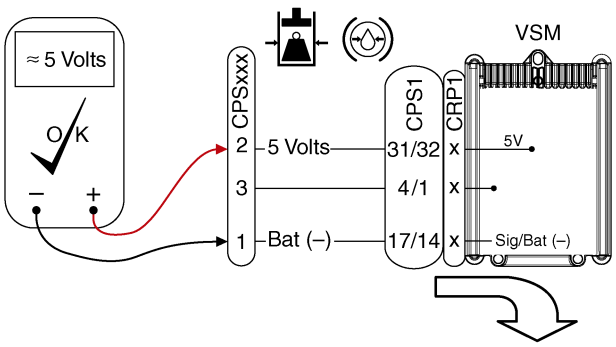
CAUSE A



Power **OFF**→	Disconnect sensor→	Power **ON**→	?

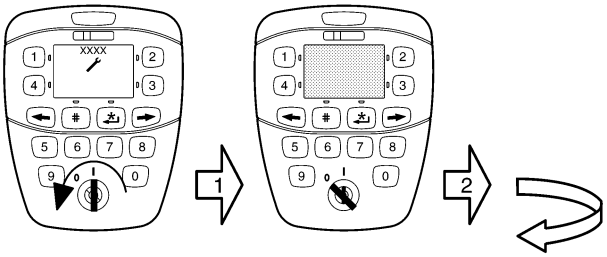
CAUSE A1 CHECK VOLTAGE





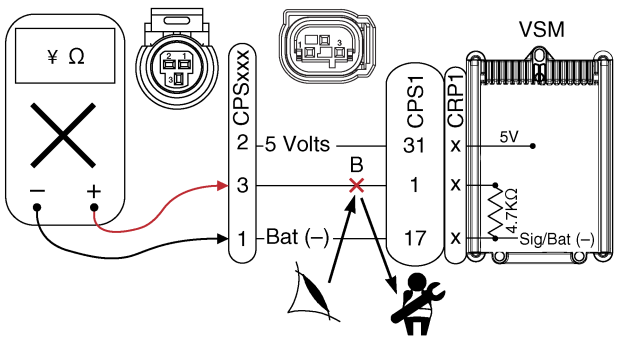
0 Volts = Open circuit→Find↑**OPEN** circuit. Repair OPEN Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	˜ 5 Volts =	**OK** For Service Brake Pressure, go to CAUSE A. For Load Weigh Pressure, go to CAUSE B.

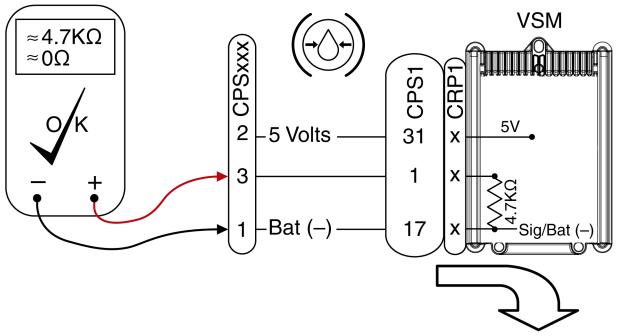
Load Weigh/Service Brake Pressure Sensor Out of Range Low (OORL) (Cont)



Power **OFF**→ ?

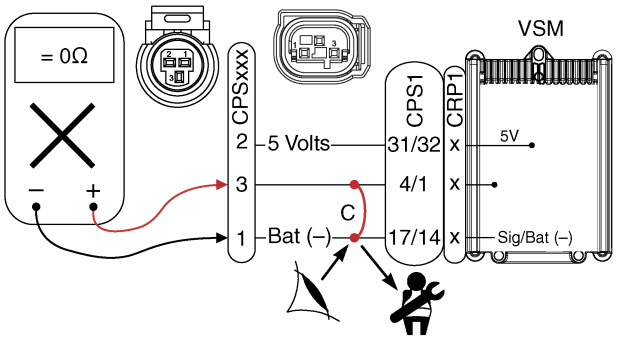
CAUSE B CHECK RESISTANCE - Ω - OHMS

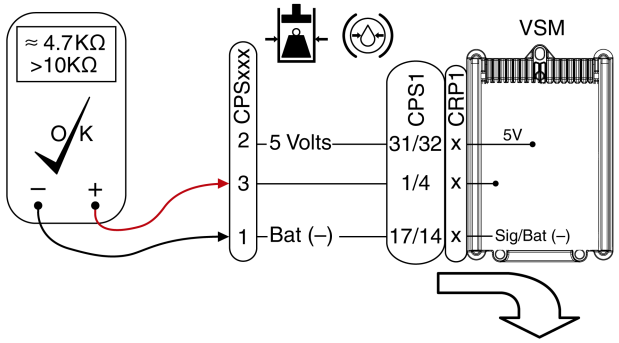




8 ? = Open circuit→Find↑**OPEN** circuit	˜ 4.7K? =	**OK**	Go to CAUSE C.
Repair OPEN circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	˜ 0 ? =		?

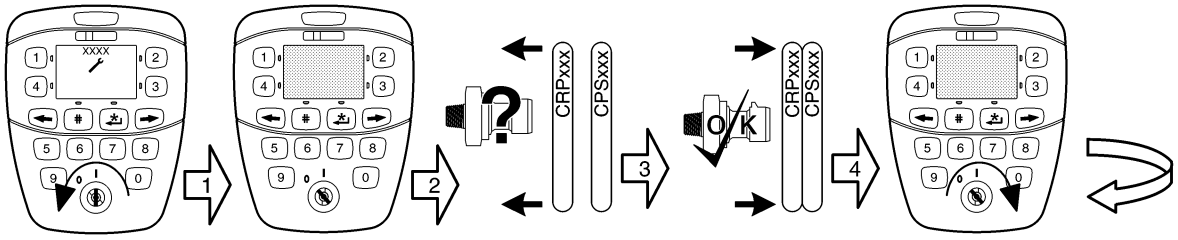
CAUSE C CHECK RESISTANCE - Ω - OHMS



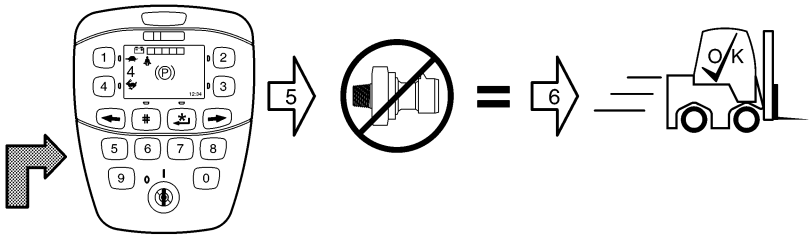


= 0 ? = Short circuit→Find↑**Short** circuit	˜ 4.7K? =	**OK**	For Service Brake Pressure, ?
Repair Short circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	> 10K? =	**OK**	For Load Weigh Pressure, ?

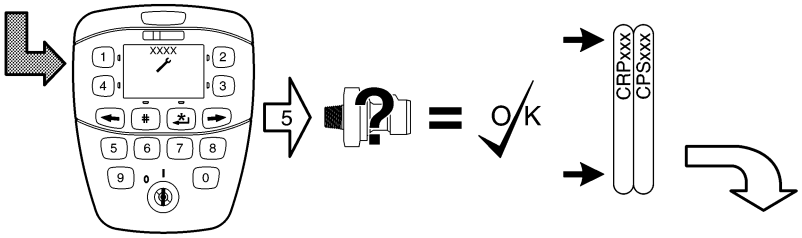
Load Weigh/Service Brake Pressure Sensor Out of Range Low (OORL) (Cont)
CAUSE D



Power **OFF**→ | Disconnect sensor.→ Install new sensor.→ **Do not discard** | Power **ON**→ | ?



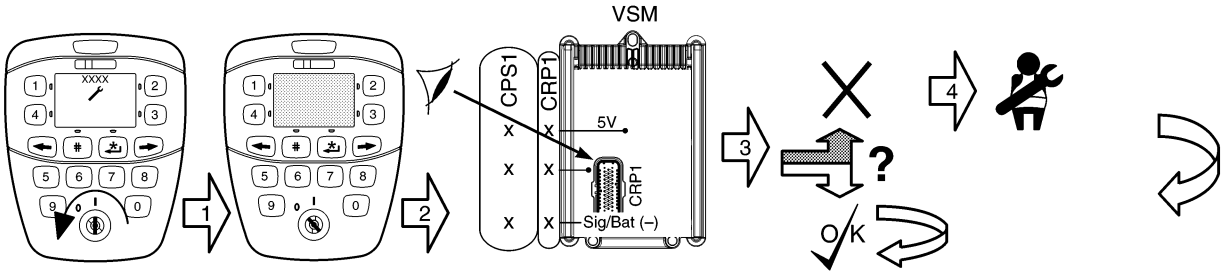
? | Fault DTC gone→ | Old sensor faulty→ | Resume operation



Fault DTC present→ | Old sensor OK/Reinstall old sensor→ | ?

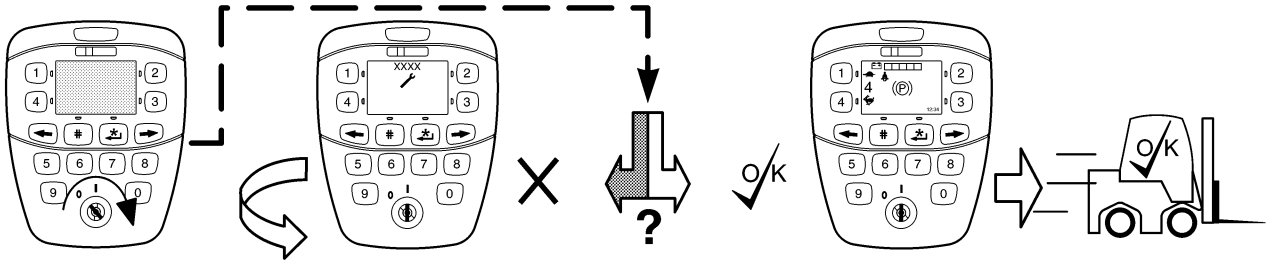
Load Weigh/Service Brake Pressure Sensor Out of Range Low (OORL) (Cont)

CAUSE E



Power **OFF**→	Inspect VSM Connections→	Go to Step 1.	Not OK Correct/Repair→?

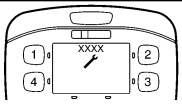
CAUSE E1



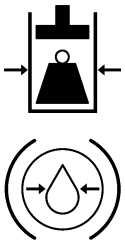
Retest - Power **ON**→	**NO**→Go to VSM Controller Check	Is fault DTC gone? **NO**←**YES**→	Fault corrected→Continue operation.

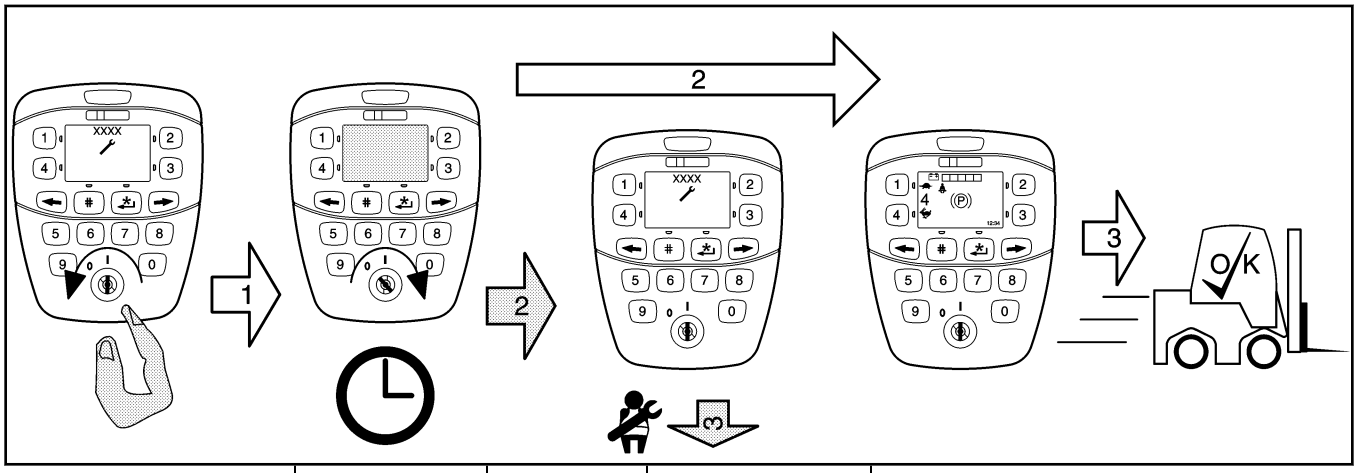
END FAULT

Load Weigh/Service Brake Pressure Sensor Out of Range High (OORH)



DTC 12845 DTC 12837
Load WeighService Brake
Pressure Pressure

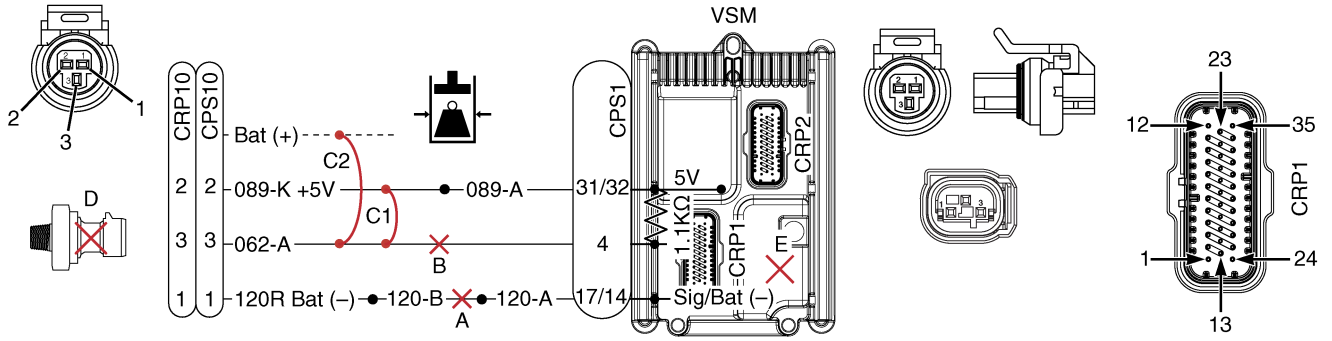




Power **OFF**→	Wait **30 seconds**→	Power **ON**→	Fault remains. Service required. Go to Component Operational Check.	No fault→	Resume operation

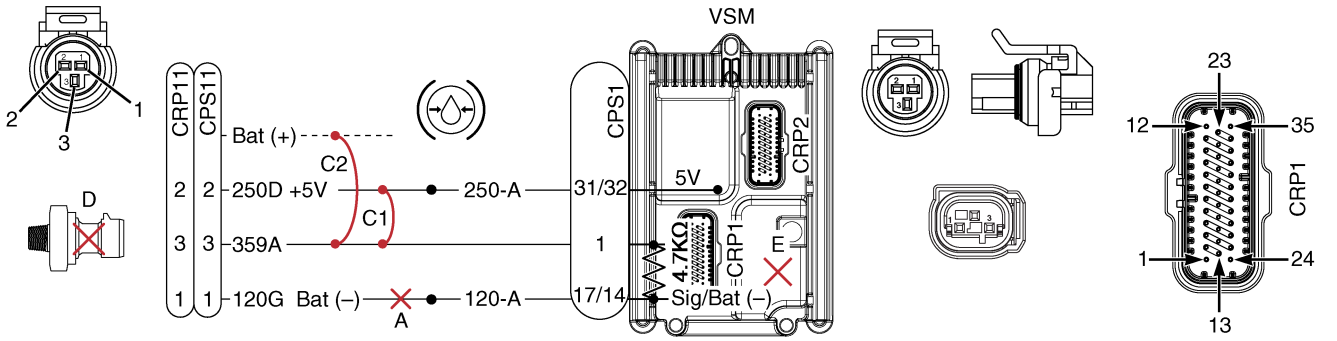
POSSIBLE CAUSE X = Open Circuit/Fail) = Short Circuit

LOAD WEIGH PRESSURE CAUSES A B C D E > ?

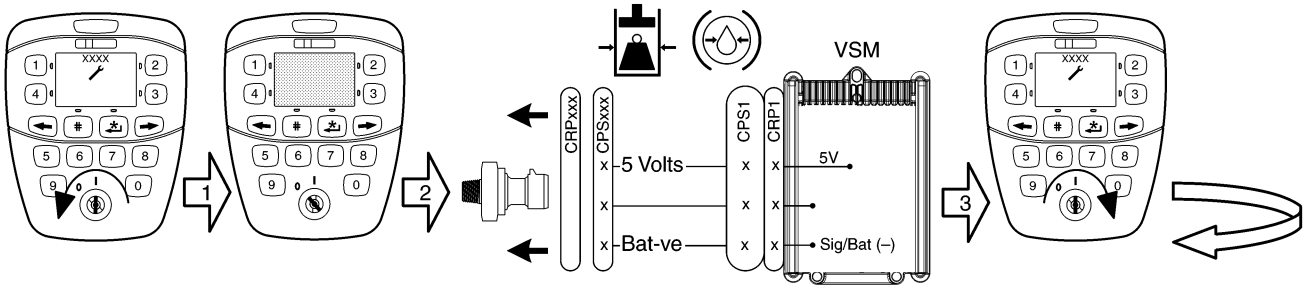


Load Weigh/Service Brake Pressure Sensor Out of Range High (OORH) (Cont)

SERVICE BRAKE PRESSURE CAUSES A B C D E > ?

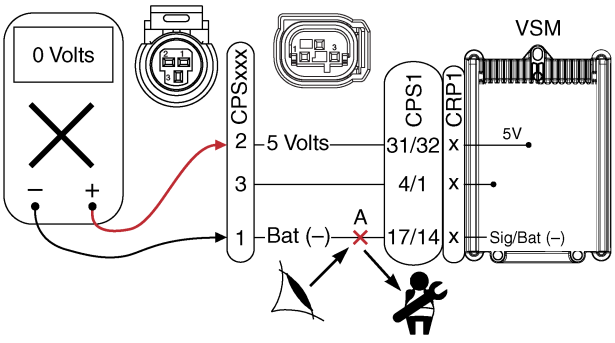


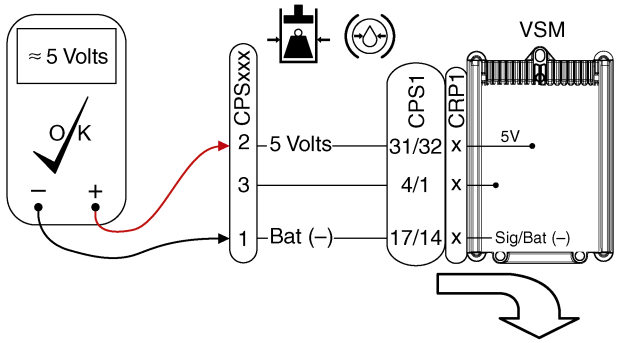
CAUSE A



Power **OFF**→ | Disconnect sensor→ | Power **ON**→ | ?

CAUSE A1 CHECK VOLTAGE

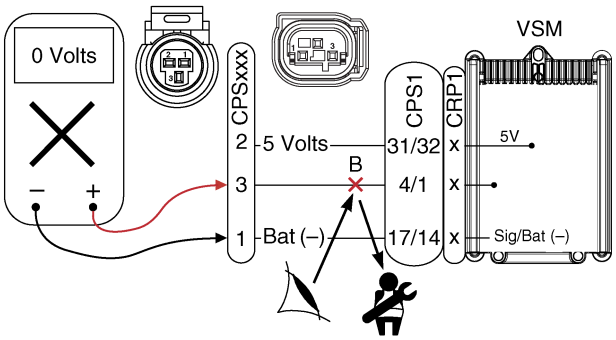


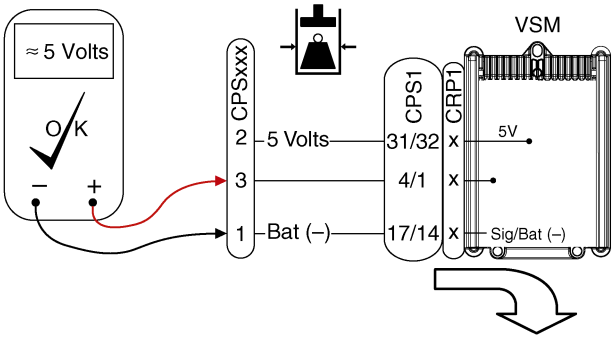


0 Volts = Open circuit→Find↑**OPEN** circuit.	˜ 5 Volts = **OK**	For Load Weigh Pressure, go to CAUSE A
Repair OPEN Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.		For Service Brake Pressure, go to CAUSE B

Load Weigh/Service Brake Pressure Sensor Out of Range High (OORH) (Cont)

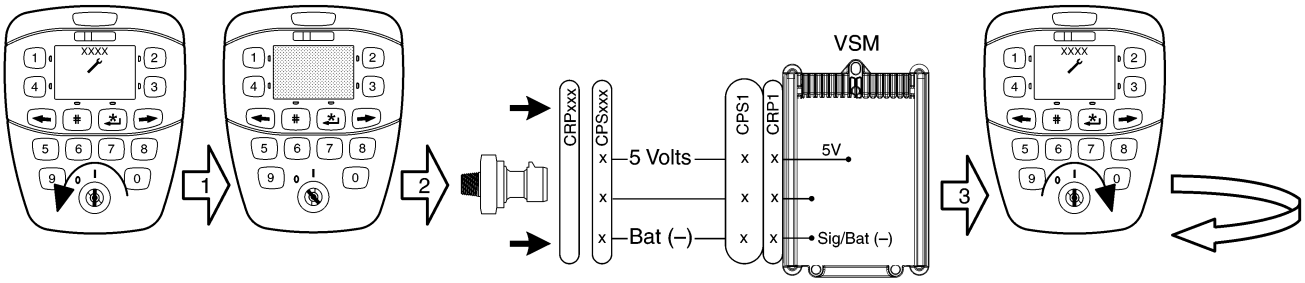
CAUSE B — CHECK VOLTAGE





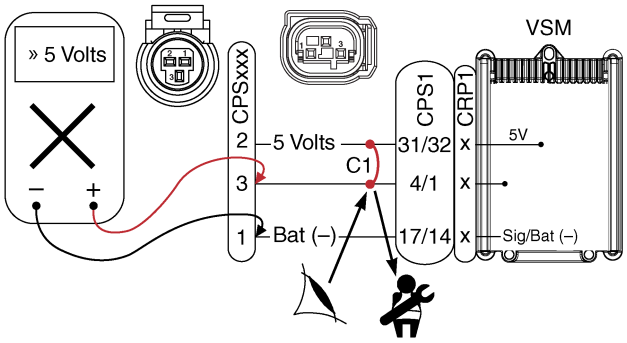
0 Volts = Open circuit→Find↑**OPEN** circuit.	˜ 5 Volts =	**OK** Go to CAUSE B.
Repair OPEN Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.		

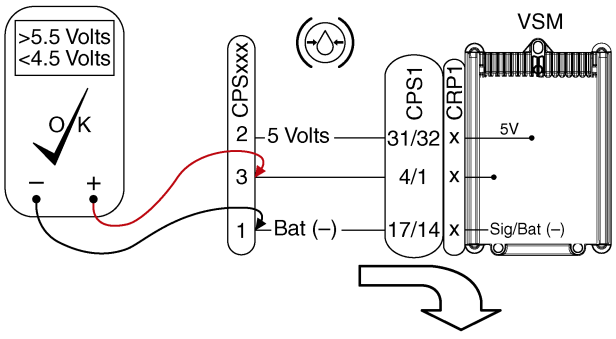
CAUSE C



Power **OFF**→	Reconnect sensor→	Power **ON**→	?

CAUSE C1 — CHECK VOLTAGE

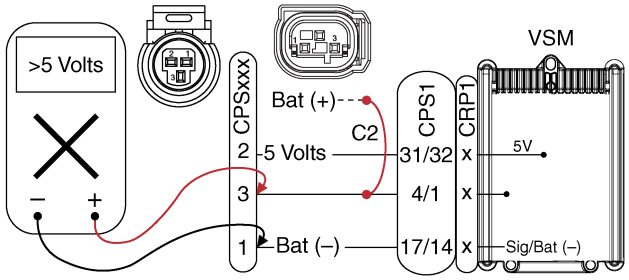


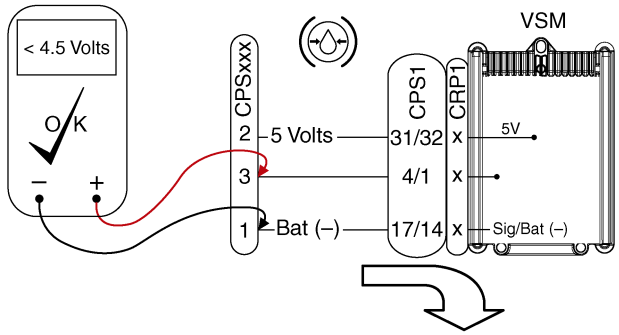


˜ 5 Volts = Short circuit→Find↑**Short** circuit.	> 5.5 volts		Go to Step 2
Repair Short Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	< 4.5 volts =	OK	Go to CAUSE C

Load Weigh/Service Brake Pressure Sensor Out of Range High (OORH) (Cont)

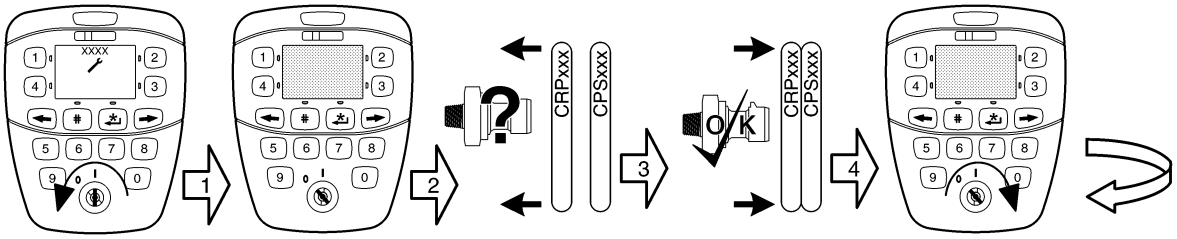
CAUSE C2 CHECK VOLTAGE





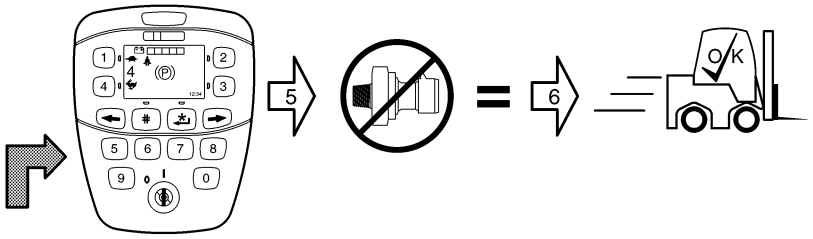
> 5.5 volts = Short circuit→Find↑**Short** circuit to another voltage source.	< 4.5 volts =	**OK**	Go to CAUSE C.
Repair Short circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.			

CAUSE D

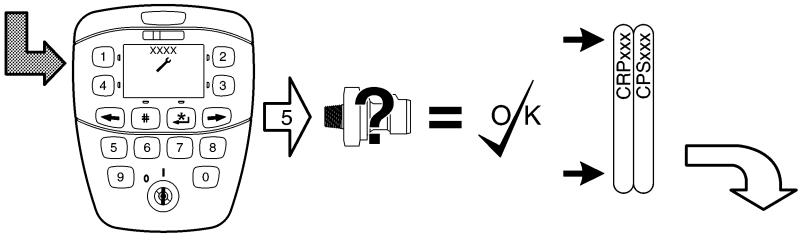


Power **OFF**→	Disconnect sensor.→ Install new sensor.→ **Do not discard**	Power **ON**→	?

Load Weigh/Service Brake Pressure Sensor Out of Range High (OORH) (Cont)

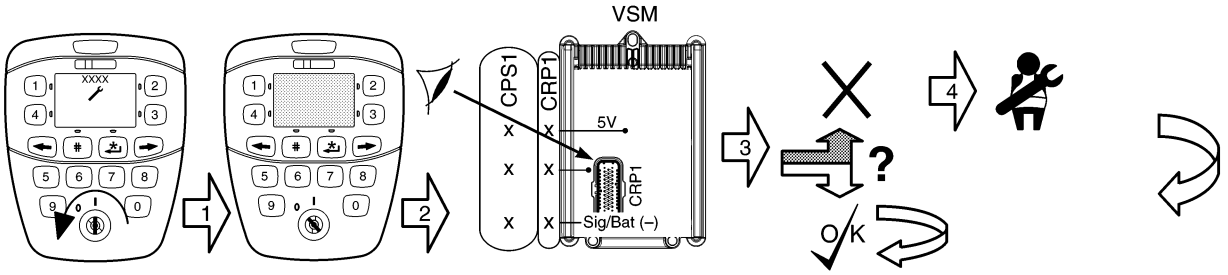


?	Fault DTC gone→	Old sensor faulty→	Resume operation



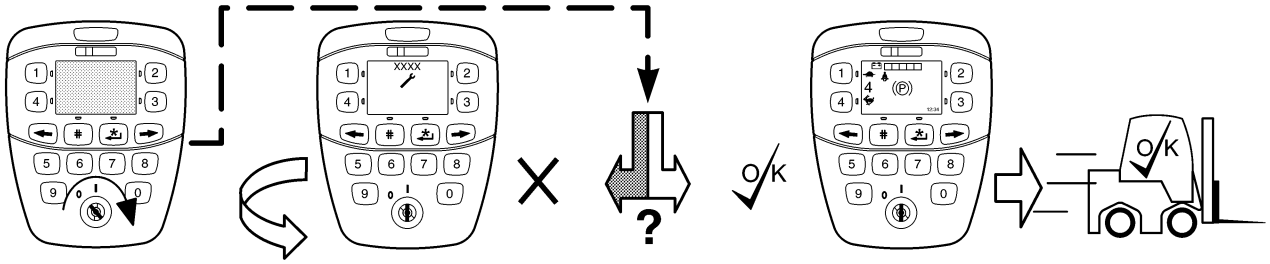
	Fault DTC present→	Old sensor OK/Reinstall old sensor→	Go to CAUSE D.

CAUSE E



Power **OFF**→	Inspect VSM Connections→	Go to Step 1.	Not OK Correct/ Repair→Go to Step 1.

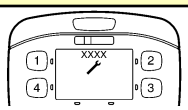
CAUSE E1



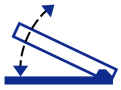
Retest - Power **ON**→	**NO**→Go to VSM Controller Check	Is fault DTC gone? **NO**←**YES**→	Fault corrected→Continue operation.

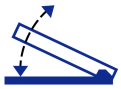
END FAULT

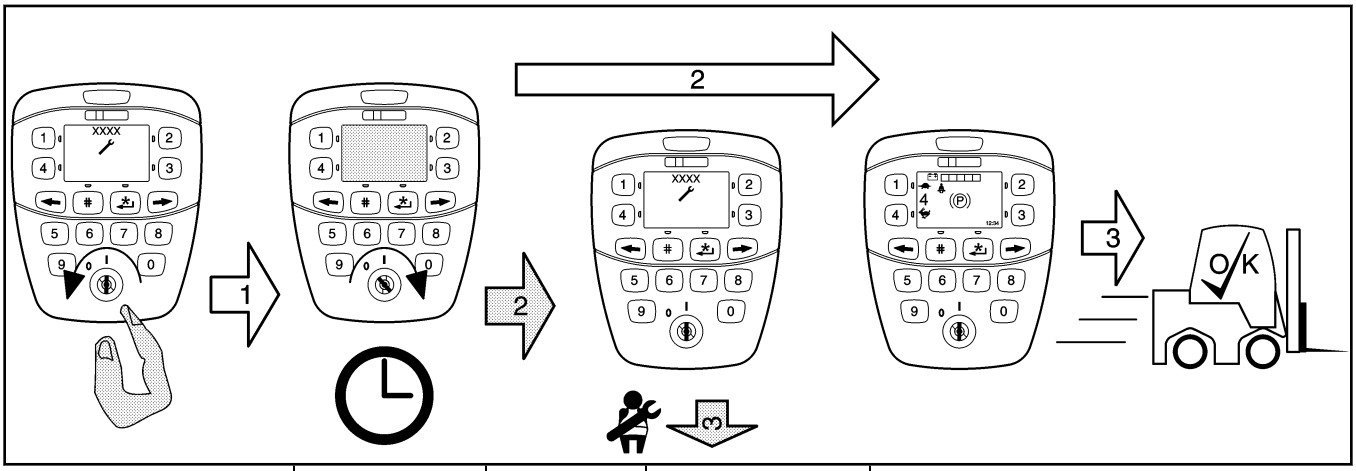
Accelerator Pedal Position A/B Out of Range Low (OORL)



DTC 12808 **DTC 12810**
Accelerator Pedal Position A **Accelerator Pedal Position B**



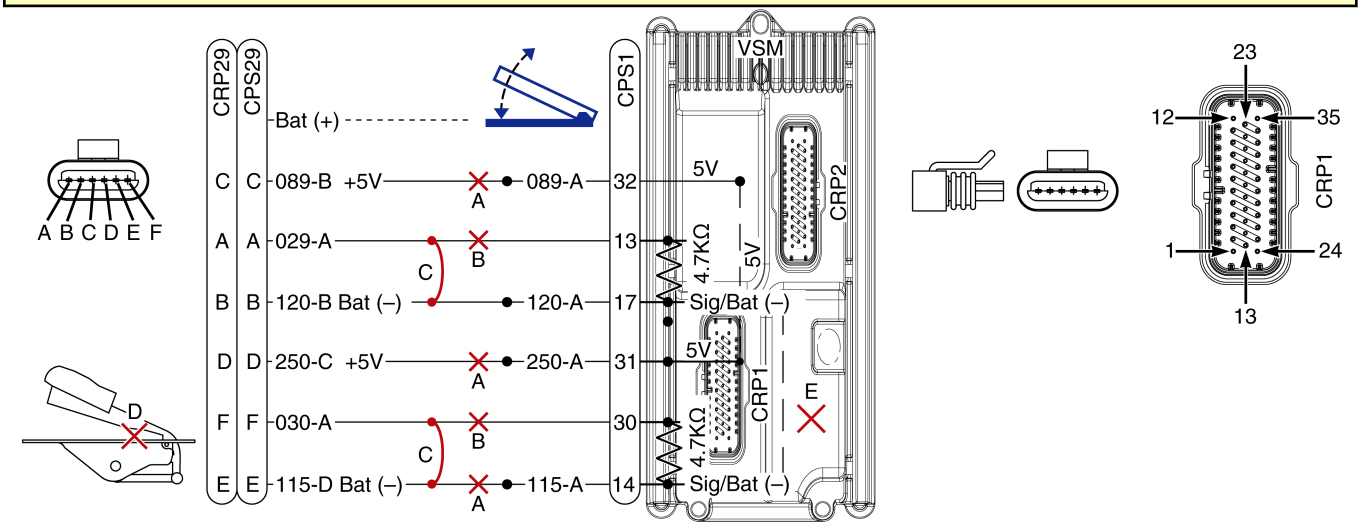




Power **OFF**→	Wait **30 seconds**→	Power **ON**→	Fault remains. Service required. Go to Component Operational Check.	No fault→	Resume operation

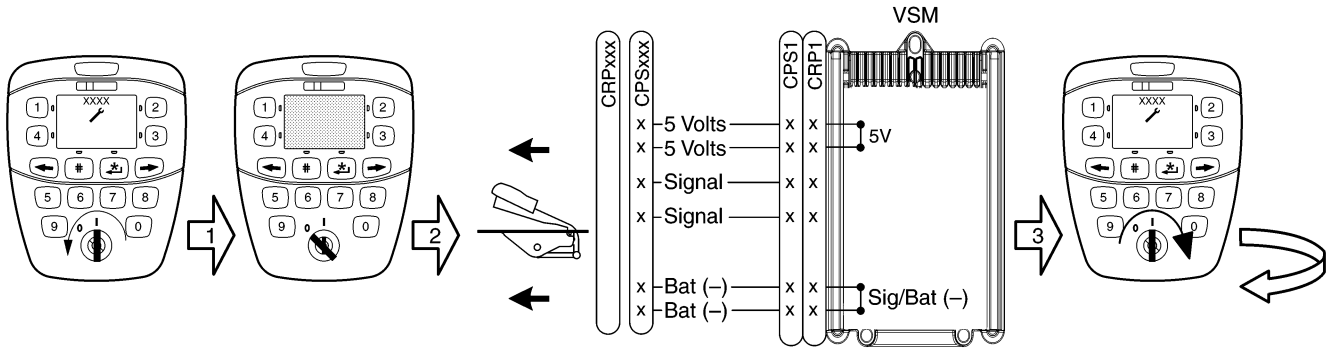
POSSIBLE CAUSE X = Open Circuit/Fail) = Short Circuit

ACCELERATOR PEDAL POSITION A/B CAUSES A B C D E > ?



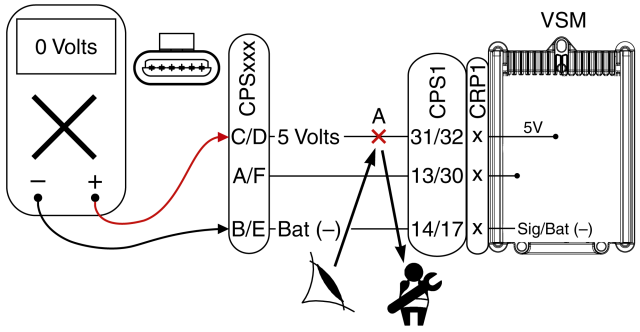
Accelerator Pedal Position A/B Out of Range Low (OORL) (Cont)

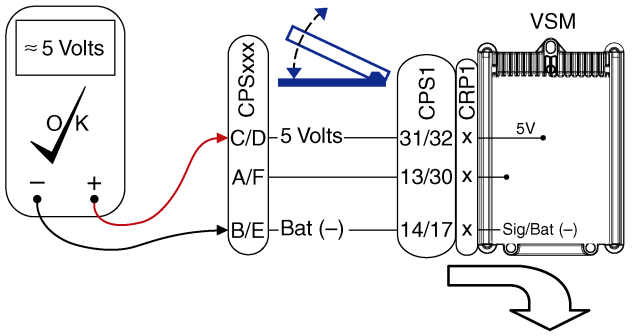
CAUSE A



Power **OFF**→ | Disconnect sensor→ | Power **ON**→ | ?

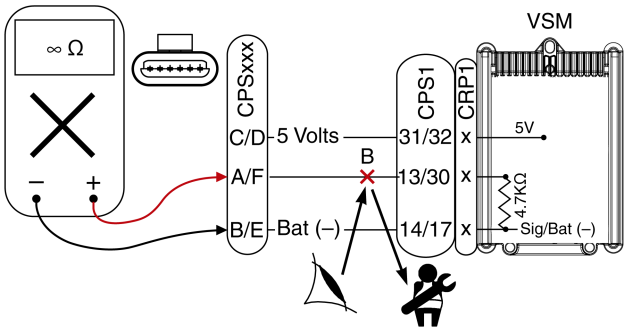
CAUSE A1 CHECK VOLTAGE

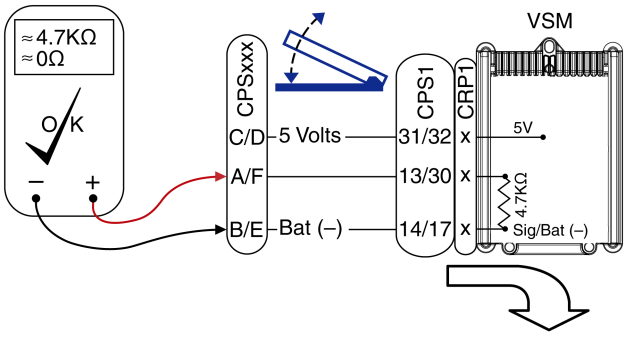




0 Volts = Open circuit→Find↑**OPEN** circuit.	˜ 5 Volts =	**OK**	Go to CAUSE A.
Repair OPEN Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.			

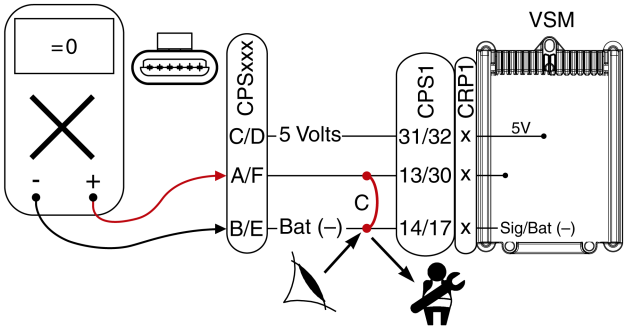
CAUSE B CHECK RESISTANCE - Ω - OHMS





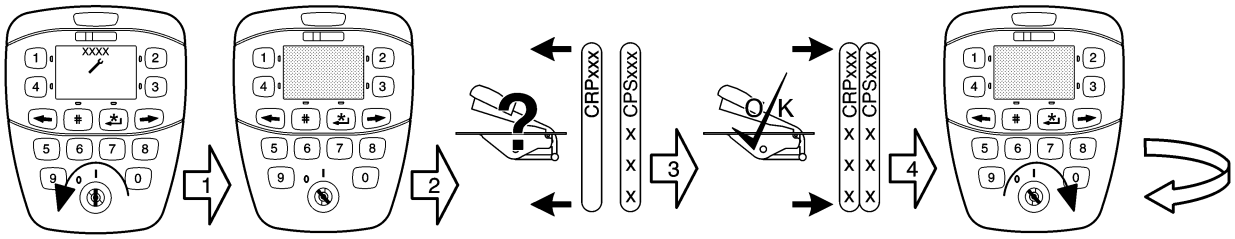
8 ? = Open circuit→Find↑**OPEN** circuit	˜ 4.7K? =	**OK**	Go to CAUSE C
Repair OPEN circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	˜ 0 ? =		Go to CAUSE B

Accelerator Pedal Position A/B Out of Range Low (OORL) (Cont)	
CAUSE C **CHECK RESISTANCE - Ω - OHMS**	

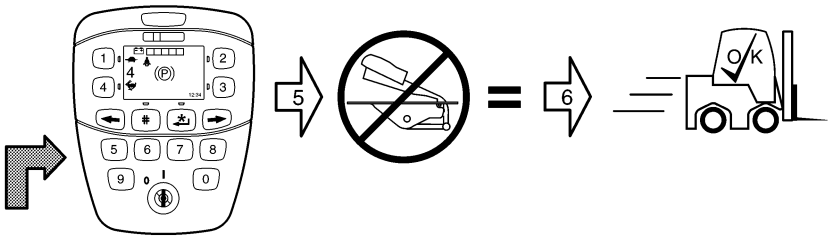


0 ? = Short circuit→Find↑**Short** circuit	
Repair Short circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	

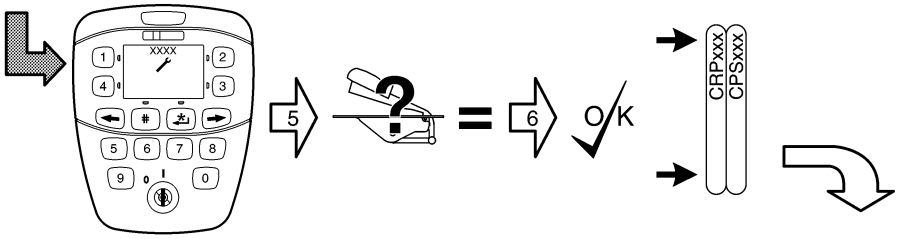
CAUSE D



Power **OFF**→	Disconnect sensor.→ Install new sensor.→ **Do not discard**	Power **ON**→	?



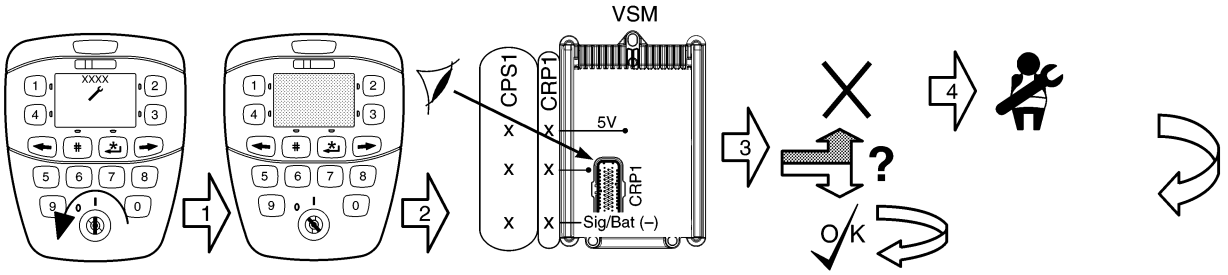
?	Fault DTC gone→	Old sensor faulty→	Resume operation



Fault DTC present→	Old sensor OK/Reinstall old sensor→	Go to CAUSE D.

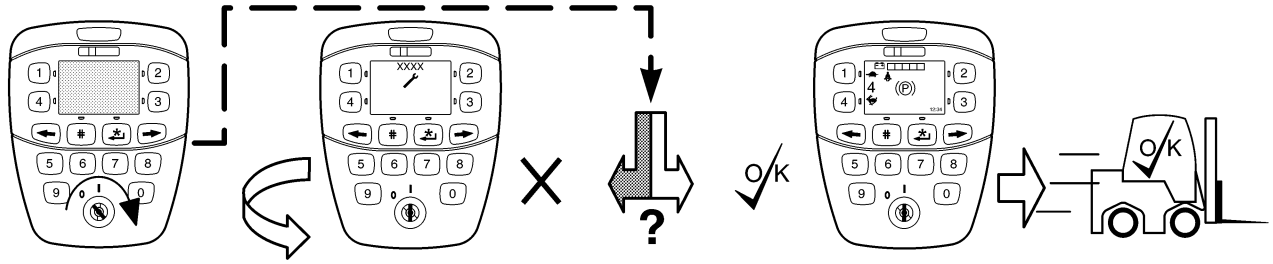
Accelerator Pedal Position A/B Out of Range Low (OORL) (Cont)

CAUSE E



Power **OFF**→	Inspect VSM Connections→	OK - Go to Step 1.	Not OK →Correct/Repair Go to Step 1.

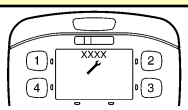
CAUSE E1



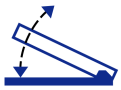
Retest - Power **ON**→	**NO**→Go to VSM Controller Check	Is fault DTC gone? **NO**←**YES**→	Fault corrected→Continue operation.

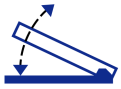
END FAULT

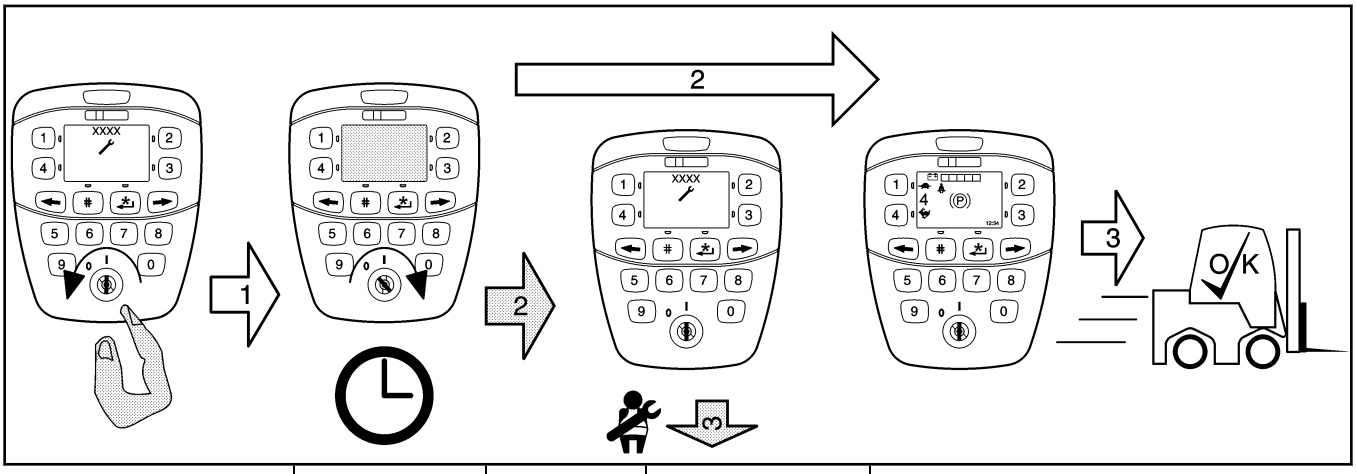
Accelerator Pedal Position A/B Out of Range High (OORH)



DTC 12809 **DTC 12811**
Accelerator Pedal Position A **Accelerator Pedal Position B**



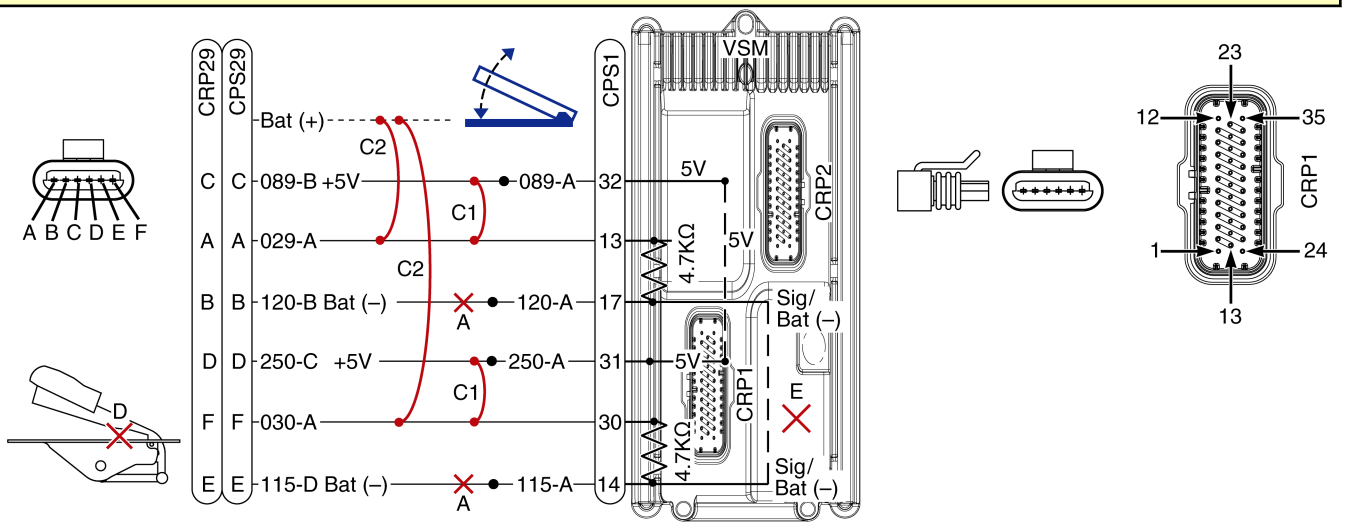




Power **OFF**→	Wait **30 seconds**→	Power **ON**→	Fault remains. Service required. Go to Component Operational Check.	No fault→	Resume operation

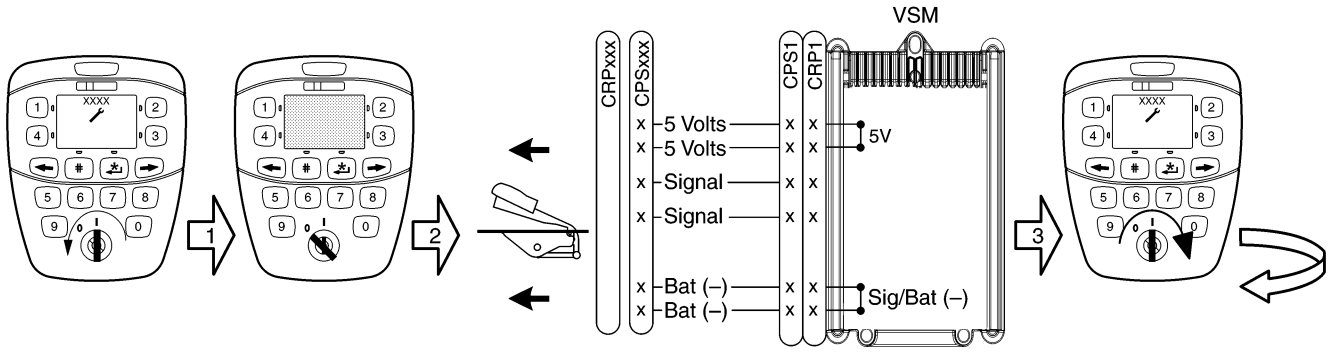
POSSIBLE CAUSE X = Open Circuit/Fail) = Short Circuit

ACCELERATOR PEDAL POSITION A/B CAUSES A B C D E > ?



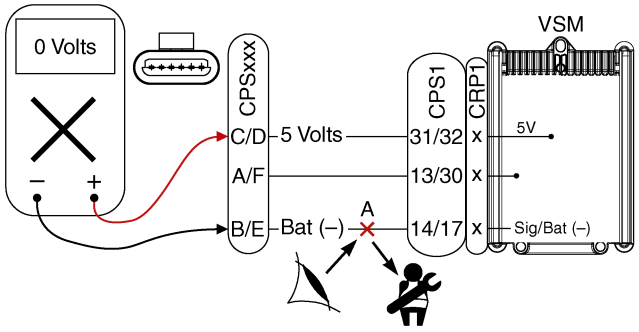
Accelerator Pedal Position A/B Out of Range High (OORH) (Cont)

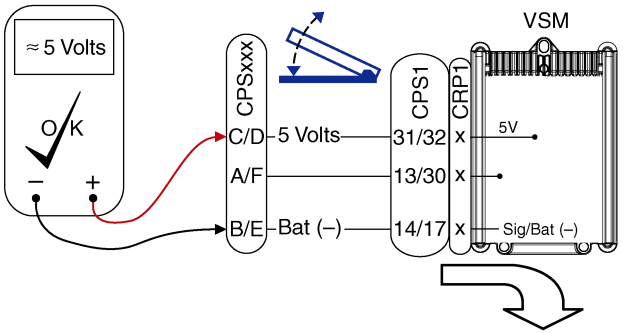
CAUSE A



Power **OFF**→ | Disconnect sensor→ | Power **ON**→ | ?

CAUSE A1 CHECK VOLTAGE





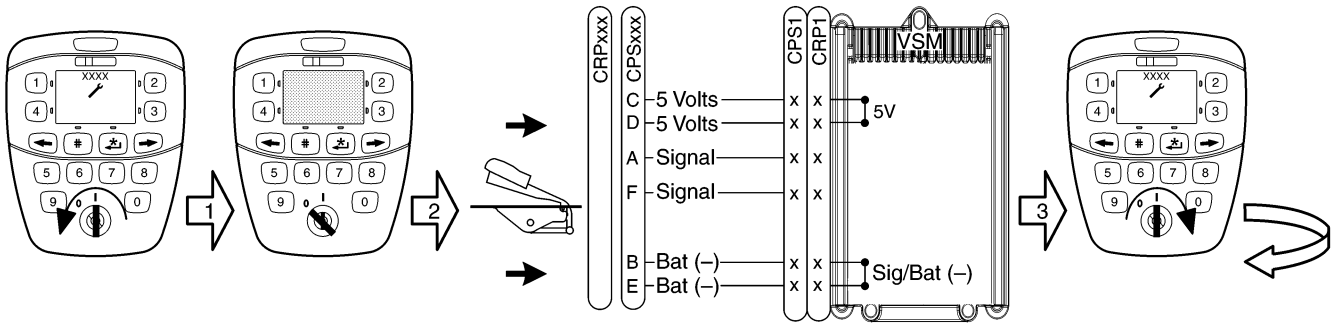
0 Volts = Open circuit→Find↑**OPEN** circuit.	˜ 5 Volts = **OK**	Go to CAUSE B.
Repair OPEN Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.		

CAUSE B

Not Applicable

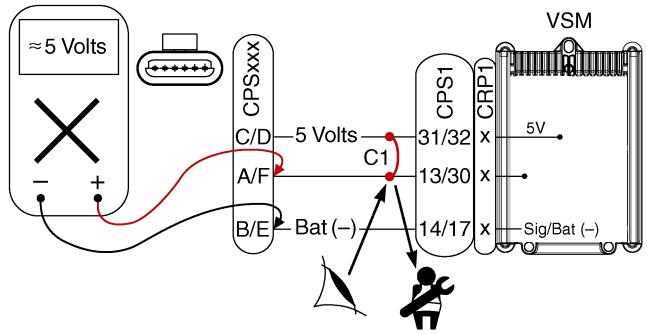
Accelerator Pedal Position A/B Out of Range High (OORH) (Cont)

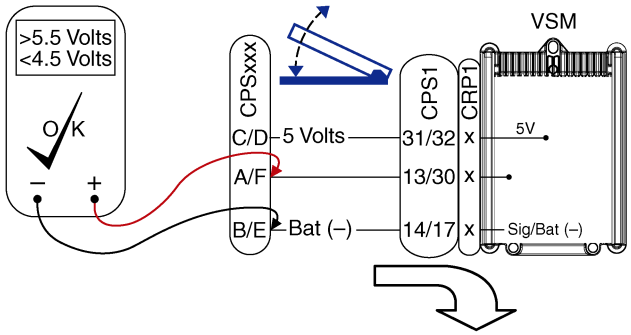
CAUSE C



Power **OFF**→	Reconnect sensor→	Power **ON**→	?

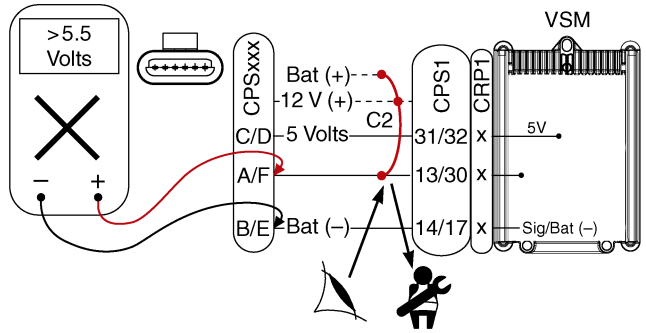
CAUSE C1 CHECK VOLTAGE

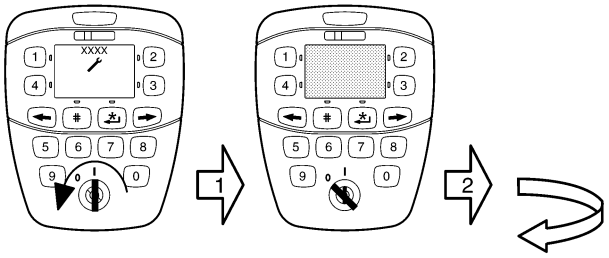




˜ 5 Volts = Short circuit→Find↑**Short** circuit.	> 5.5 volts **OK**	Go to Step 2
Repair Short Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	< 4.5 volts =	Go to CAUSE C

CAUSE C2

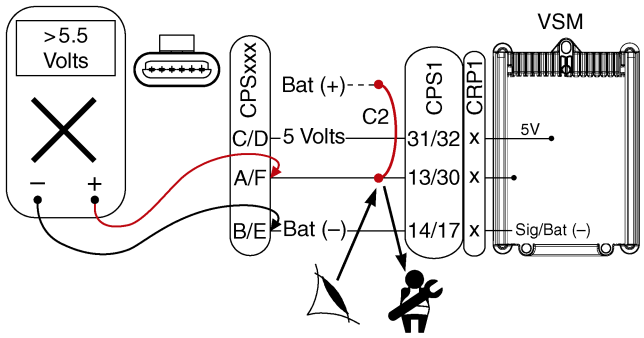


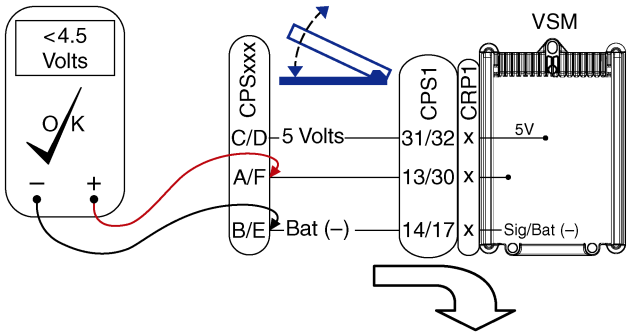


> 5.5 Volts = Short circuit→Find↑**Short** circuit.	Power **OFF** ?
Repair Short Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	

Accelerator Pedal Position A/B Out of Range High (OORH) (Cont)

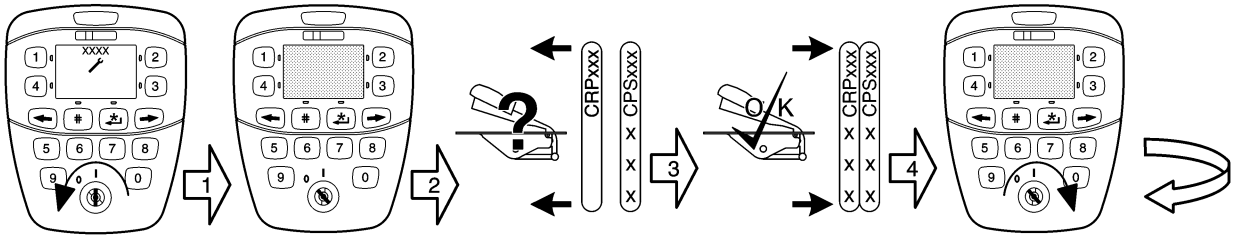
CAUSE C3 UNSWITCHED VOLTAGES





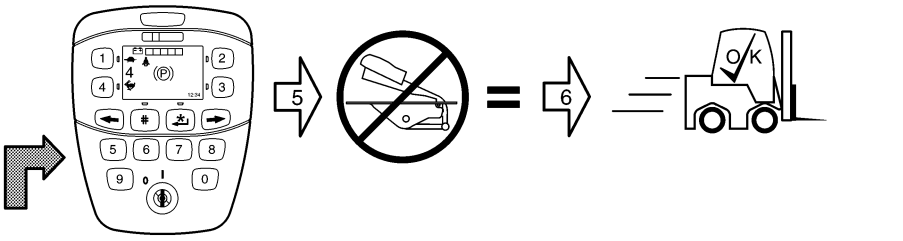
> 5.5 Volts = Short circuit→Find↑**Short** circuit.	< 4.5 volts = **OK** Go to CAUSE C
Repair Short Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	

CAUSE D

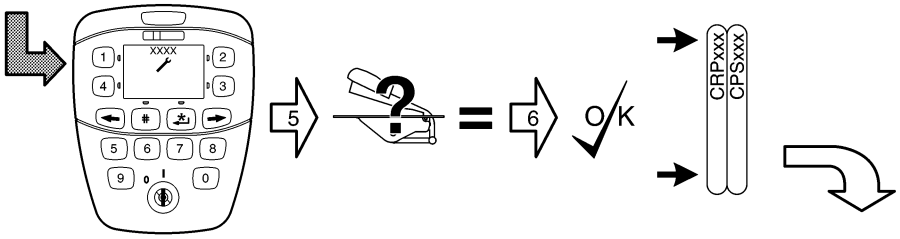


Power **OFF**→	Disconnect sensor.→ Install new sensor.→ **Do not discard**	Power **ON**→	?

Accelerator Pedal Position A/B Out of Range High (OORH) (Cont)

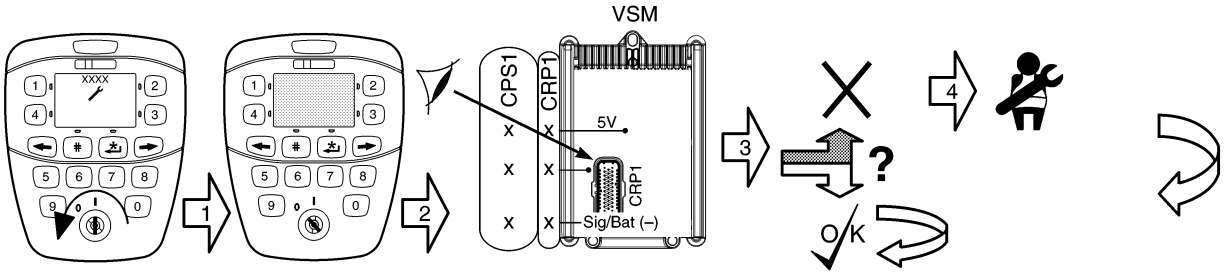


?	Fault DTC gone→	Old sensor faulty→	Resume operation



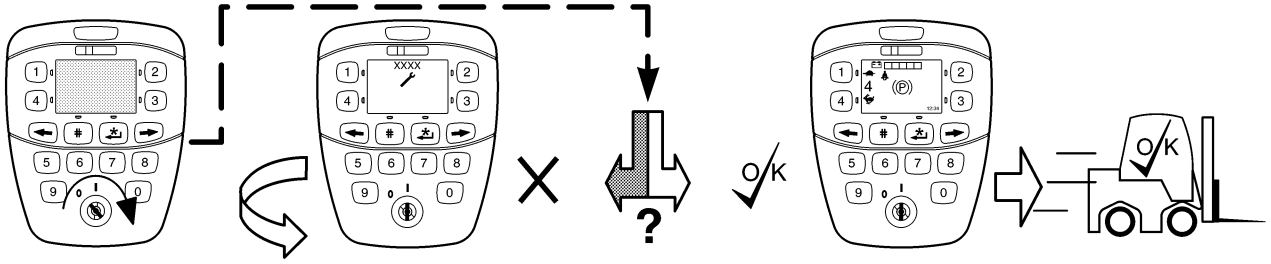
Fault DTC present→	Old sensor OK/Reinstall old sensor→	Go to CAUSE D.

CAUSE E



Power **OFF**→	Inspect VSM Connections→	OK - Go to Step 1.	Not OK Correct/Repair→Go to Step 1.

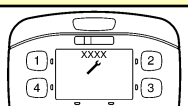
CAUSE E1



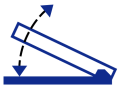
Retest - Power **ON**→	**NO**→Go to VSM Controller Check	Is fault DTC gone? **NO**←**YES**→	Fault corrected→Continue operation.

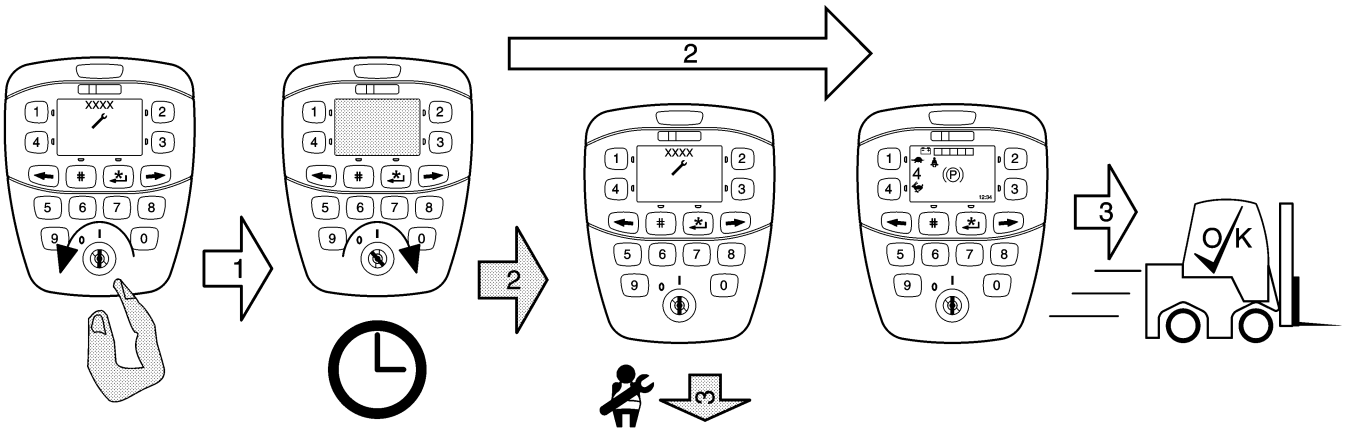
END FAULT

Accelerator Pedal Position A/B Data Incorrect



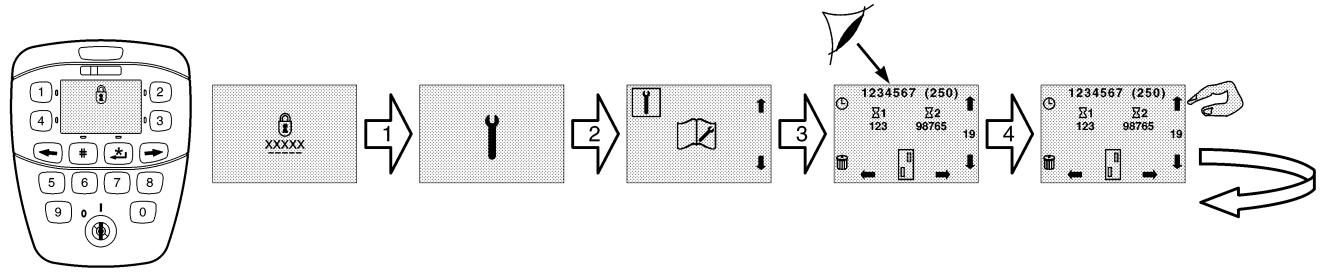
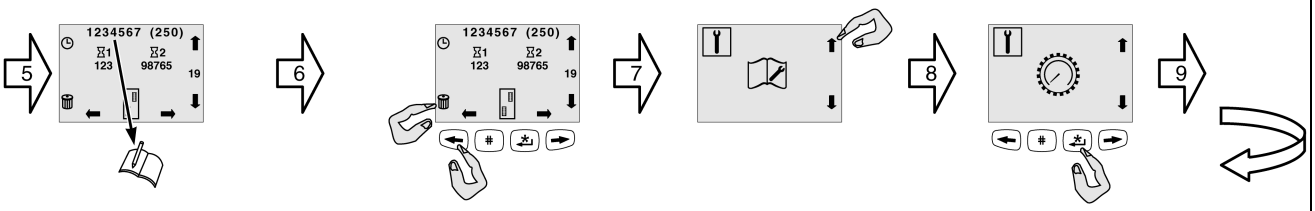
DTC 12812
Accelerator Pedal Position A to B





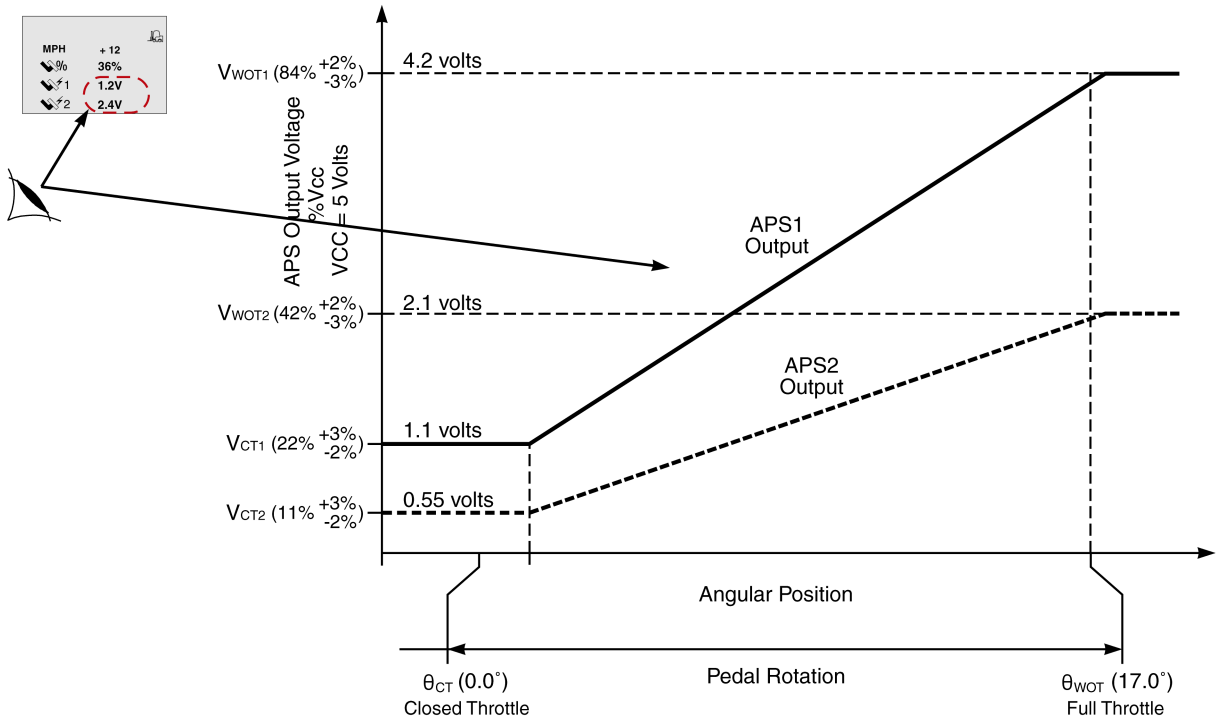
Power **OFF**→	Wait **30 seconds**→	Power **ON**→	Fault remains. Service required. Go to Component Operational Check.	No fault→	Resume operation

QUICK CHECK X = Open Circuit/Fail) = Short Circuit

Accelerator Pedal Position A/B Data Incorrect (Cont)	
Check 1 FAULT LOG CODE Review - Go to Display Menu	
Note: DTC 12812 can be caused by the same conditions that caused DTCs 12808 to 12811	
Check VSM Fault Logs→Go to Check 1↑Are these codes present?↓	
YES→See Accelerator Pedal Position A/B Out of Range Low (OORL) or Accelerator Pedal Position A/B Out of Range High (OORH)	NO→Go to Check 1↑
	
Enter Service Password→Diagnostic→FAULT LOGs→VSM/MLM Fault Logs→View all VSM/MLM DTCs→?	
	
All VSM/MLM DTCs	Erase all VSM/MLM DTCs→☜Exit Fault Log→↑↓Speedometer ☞*

Accelerator Pedal Position A/B Data Incorrect (Cont)

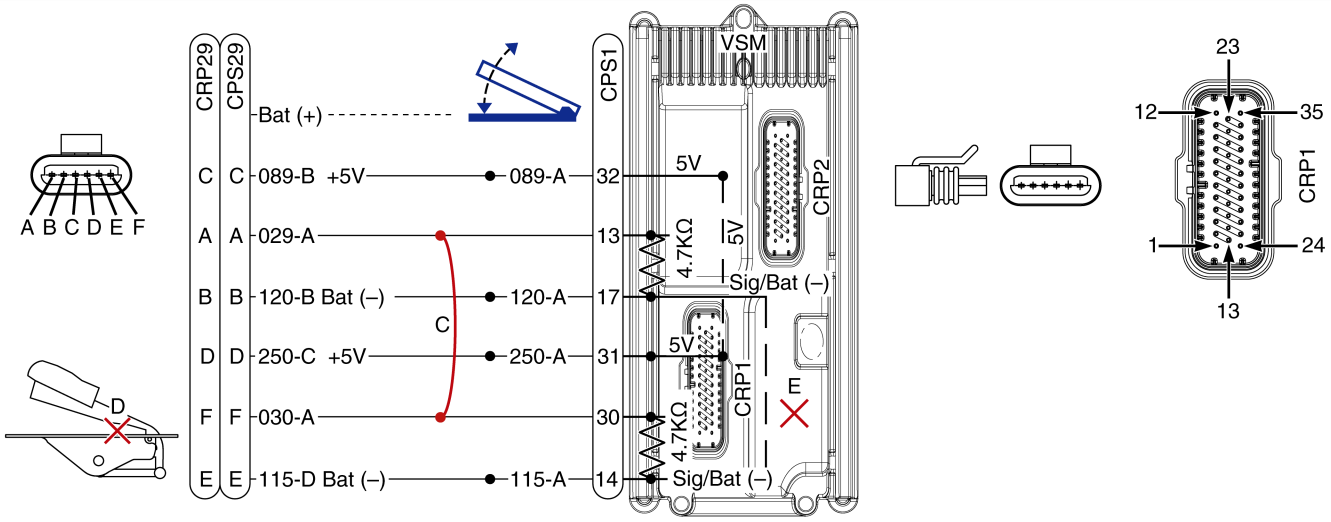
Check 2



Does Sensor APS2 Volts = Sensor APS1 Volts = DTC 12812?
YES →CAUSE B NO→Resume Operation
Does (Sensor APS2 Volts x 2) - Sensor APS1 Volts = > 0.60 volts for more than 2 seconds = DTC 12812?
YES→CAUSE C NO→Resume Operation

POSSIBLE CAUSES X = Open Circuit/Fail) = Short Circuit

ACCELERATOR PEDAL POSITION A/B CAUSES A B C D E > ?



CAUSE A

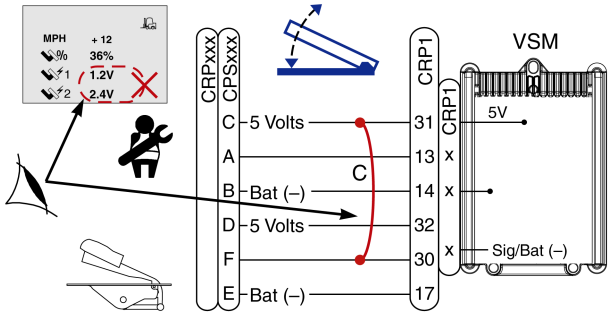
Not Applicable

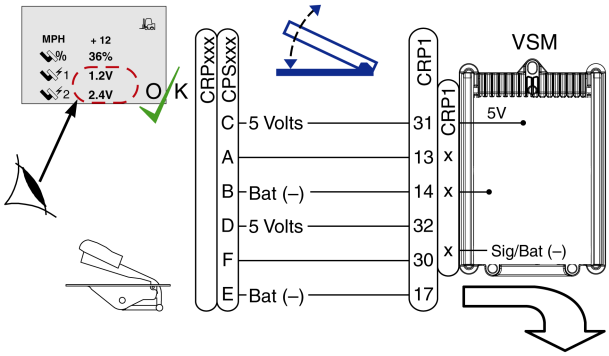
Accelerator Pedal Position A/B Data Incorrect (Cont)

CAUSE B

Not Applicable

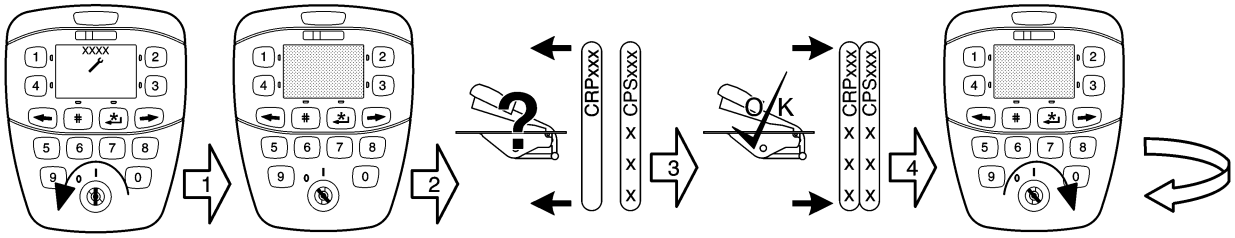
CAUSE C





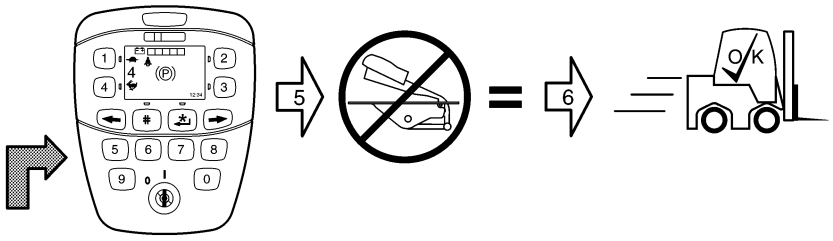
If 2 = 1 = Short circuit→Find↑**Short** circuit	If 2 = (2x1) = OK→CAUSE C↓
Find/Repair Short circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	
Reconnect→Use Display Diagnostics to validate→Test OK→YES→Resume OperationNO→CAUSE C↓	

CAUSE D

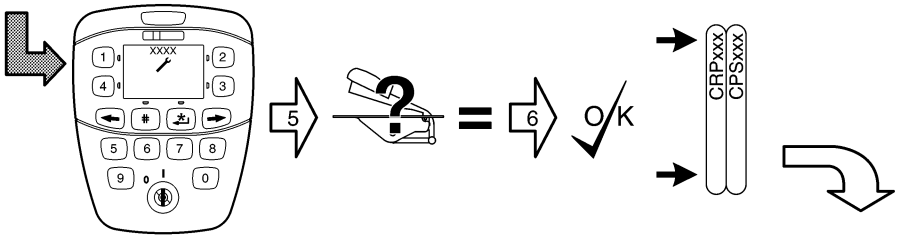


Power **OFF**→	Disconnect sensor.→ Install new sensor.→ **Do not discard**	Power **ON**→	?

Accelerator Pedal Position A/B Data Incorrect (Cont)

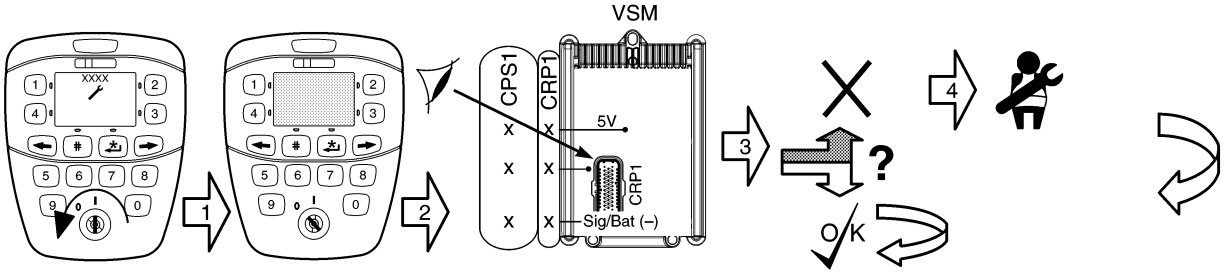


?	Fault DTC gone→	Old sensor faulty→	Resume operation



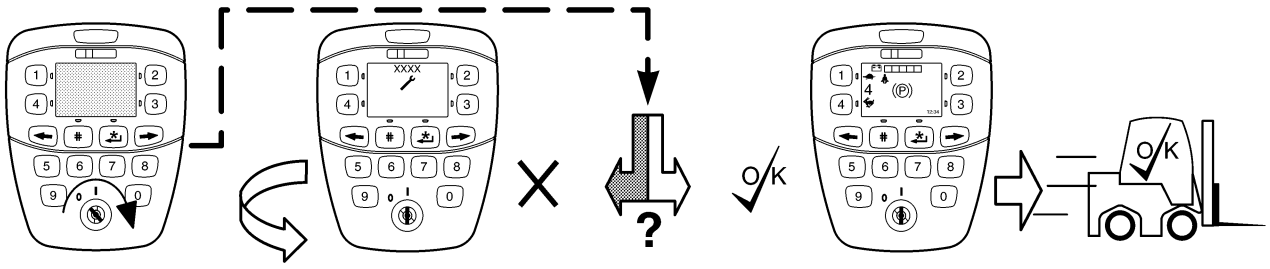
	Fault DTC present→	Old sensor OK/Reinstall old sensor→	Go to CAUSE D.

CAUSE E



Power **OFF**→	Inspect VSM Connections→	OK - Go to Step 1.	Not OK →Correct/Repair Go to Step 1.

CAUSE E1



Retest - Power **ON**→	**NO**→Go to VSM Controller Check	Is fault DTC gone? **NO**←**YES**→	Fault corrected→Continue operation.

END FAULT

CODES

DTC 29536 - Loss of Speed Sensor Channel A
DTC 65362 - Encoder Error
DTC 65512 - Wrong Encoder Set
DTC 65106 - FOC2 Traction Controller Encoder Error
DTC 29248 - Speed Sensor Feedback

POSSIBLE CAUSE

A. SPEED SENSOR WIRING FAULT
B. SPEED SENSOR FAULT
C. CONTROLLER FAULT

NOTE
Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. **NOTE:** If DTC 65512 is set, verify parameters are correct for type of encoder. If parameter matches encoder type, continue with the following procedures.
2. DTC 65106 may require software updates. Prior to performing troubleshooting procedures, verify controller is at the latest revision level. FOC2 Software Updates.
3. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to next step.Step 4
   NO: Problem not verified, resume operation.
4. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to next step.CAUSE A

CAUSE A - SPEED SENSOR WIRING FAULT

PROCEDURE OR ACTION:

1. Disconnect the speed sensor connector and measure voltage between encoder 5 volt supply and B(-).
   Is voltage 5 ± 0.5 Vdc?
   YES: Proceed to next step.Step 2
   NO: Inspect circuit 284A or 282-A for open or short.
2. Measure voltage between 5 volt supply circuit and ground circuit.
   Is voltage 5 ± 0.5 Vdc?
   YES: Proceed to next step.Step 3
   NO: Inspect ground circuit 106-A or 103-A for open or short.
3. Disconnect traction controller connector and measure resistance between the following signal circuits:
   - Traction controller connector, socket 6 and speed sensor connector, socket 2.
   - Traction controller connector, socket 5 and speed sensor connector, socket 3.

   Is resistance <1 ohm?
   YES: Connect the speed sensor and traction controller connectors and proceed to next step.CAUSE B
   NO: Inspect encoder signal circuits or open or source of excessive resistance.

CAUSE B - SPEED SENSOR FAULT

PROCEDURE OR ACTION:

1. Using the PC Service Tool, locate and observe the speed sensor count signal.
   Does encoder provide accurate count signal during operation?
   YES: Proceed to next step.CAUSE C
   NO: Replace faulty speed sensor.

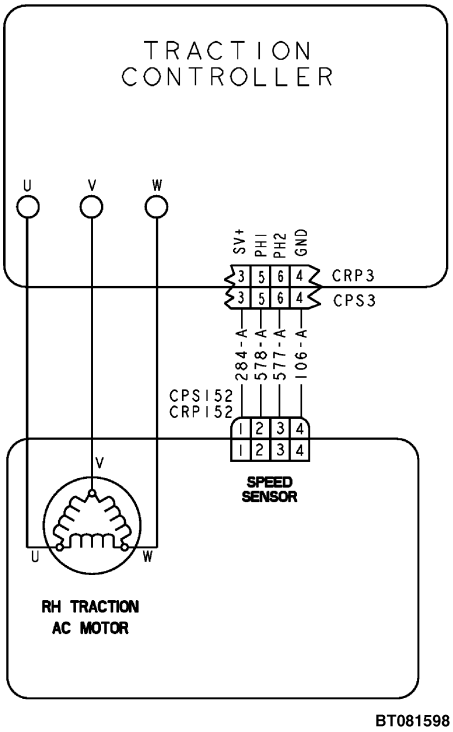
CAUSE C - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

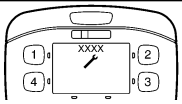
DIAGRAMS



Troubleshooting Scenes

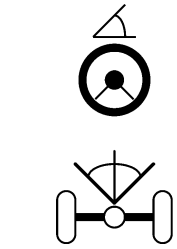
END FAULT

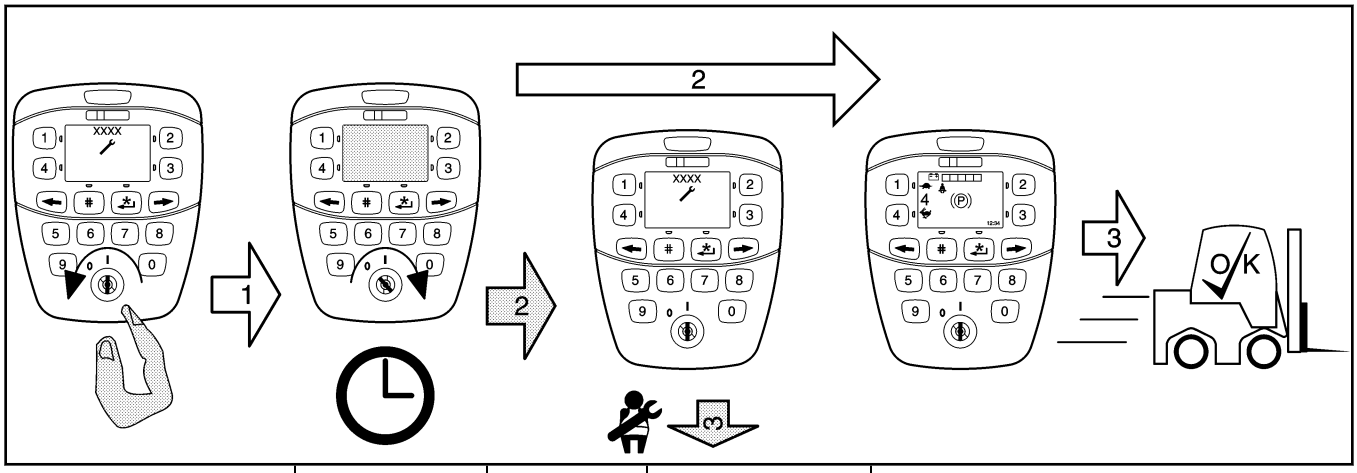
Steering Wheel/Steering Axle Position Sensor Out of Range Low (OORL)



DTC 12820 Steering Wheel Position

DTC 12824 Steering Axle Position

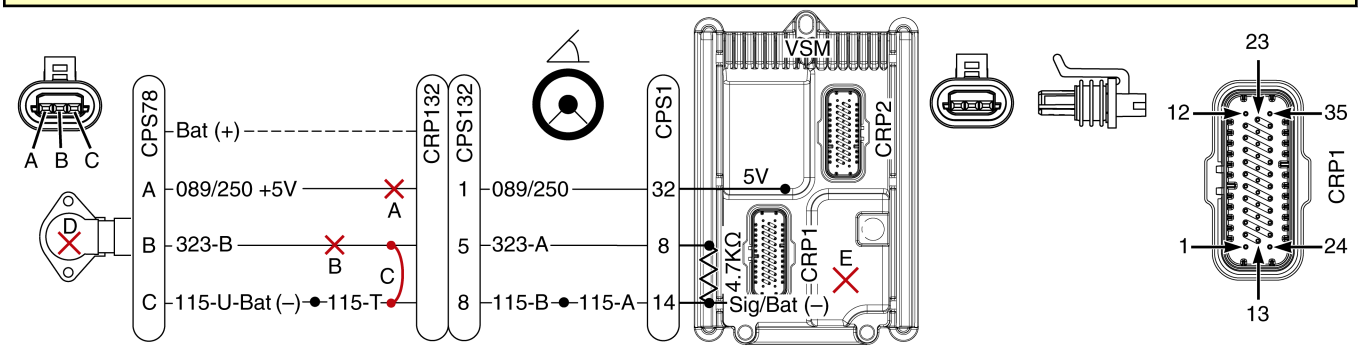




Power **OFF**→	Wait **30 seconds**→	Power **ON**→	Fault remains. Service required. Go to Component Operational Check.	No fault→	Resume operation

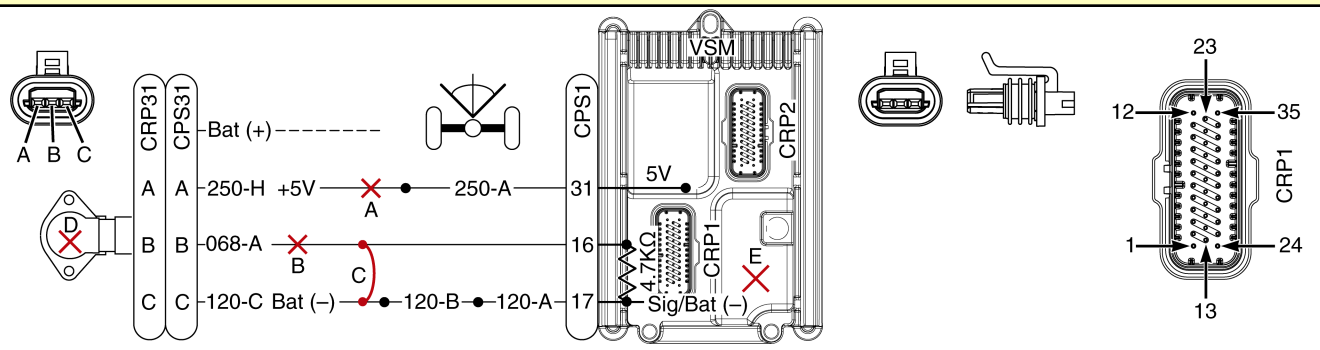
POSSIBLE CAUSE X = Open Circuit/Fail) = Short Circuit

STEERING WHEEL POSITION CAUSES A B C D E > ?

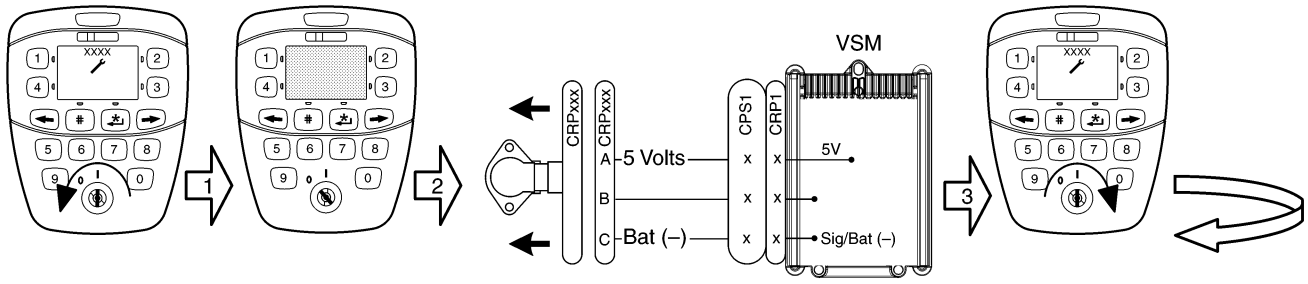


Steering Wheel/Steering Axle Position Sensor Out of Range Low (OORL) (Cont)

STEERING AXLE POSITION CAUSES A B C D E > ?

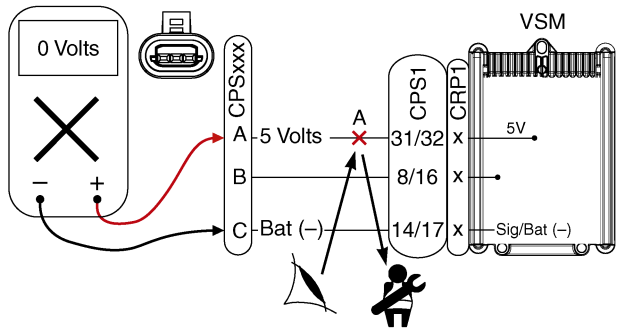


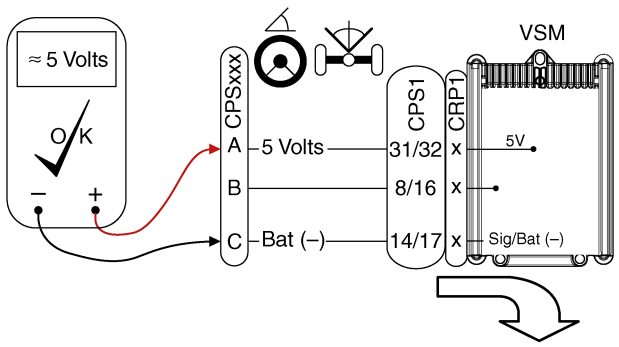
CAUSE A



Power **OFF**→	Disconnect sensor→	Power **ON**→	?

CAUSE A1 CHECK VOLTAGE

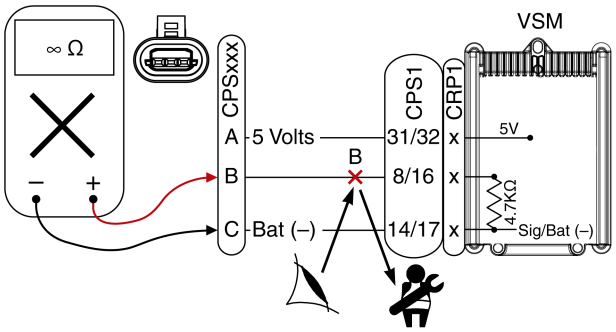


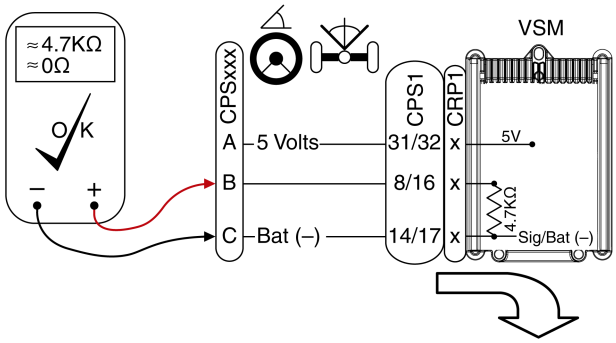


0 Volts = Open circuit→Find↑**OPEN** circuit.	˜ 5 Volts = **OK** Go to CAUSE A
Repair OPEN Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	

Steering Wheel/Steering Axle Position Sensor Out of Range Low (OORL) (Cont)

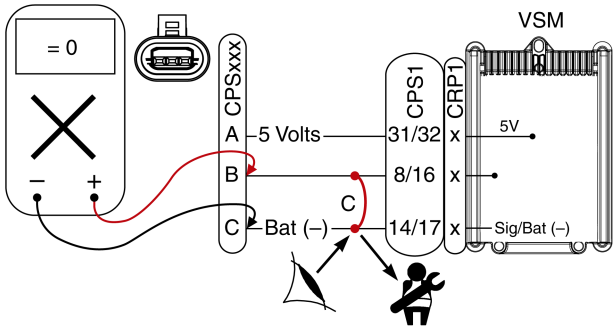
CAUSE B CHECK RESISTANCE - Ω - OHMS





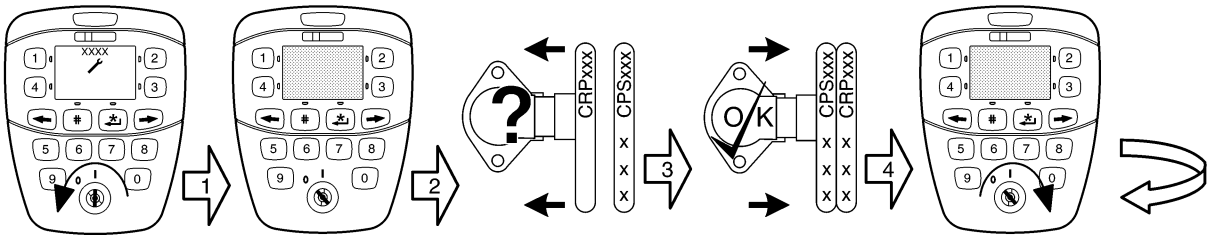
8 ? = Open circuit→Find↑**OPEN** circuit	˜ 4.7K? =	**OK**	Go to CAUSE C
Repair OPEN circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	˜ 0 ? =		Go to CAUSE B

CAUSE C CHECK RESISTANCE - Ω - OHMS



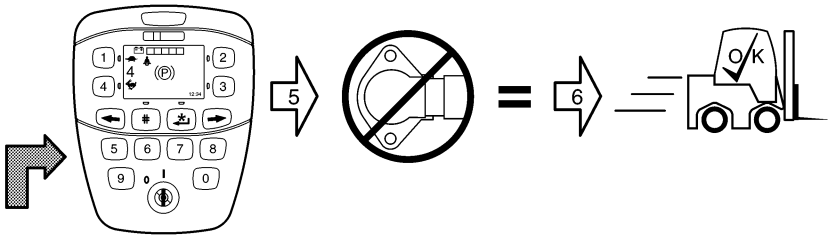
0 ? = Short circuit→Find↑**Short** circuit	
Repair Short circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	

CAUSE D

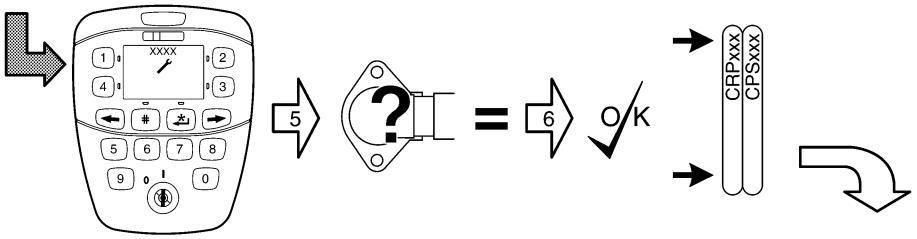


Power **OFF**→	Disconnect sensor.→ Install new sensor.→ **Do not discard**	Power **ON**→	?

Steering Wheel/Steering Axle Position Sensor Out of Range Low (OORL) (Cont)

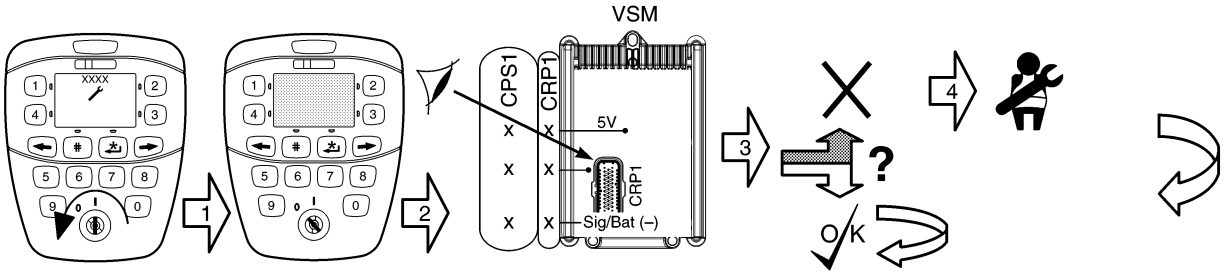


?	Fault DTC gone→	Old sensor faulty→	Resume operation



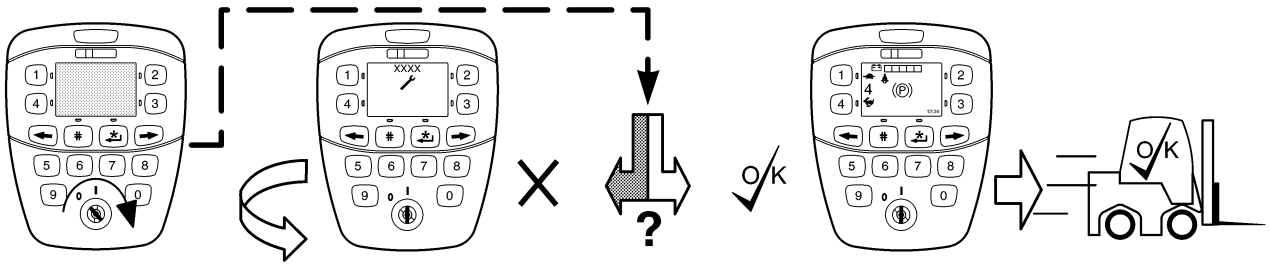
	Fault DTC present→	Old sensor OK/Reinstall old sensor→	Go to CAUSE D.

CAUSE E



Power **OFF**→	Inspect VSM Connections→	OK - Go to Step 1.	Not OK Correct/Repair→Go to Step 1.

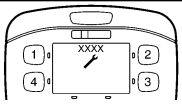
CAUSE E1



Retest - Power **ON**→	**NO**→Go to VSM Controller Check	Is fault DTC gone? **NO**←**YES**→	Fault corrected→Continue operation.

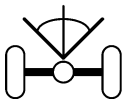
END FAULT

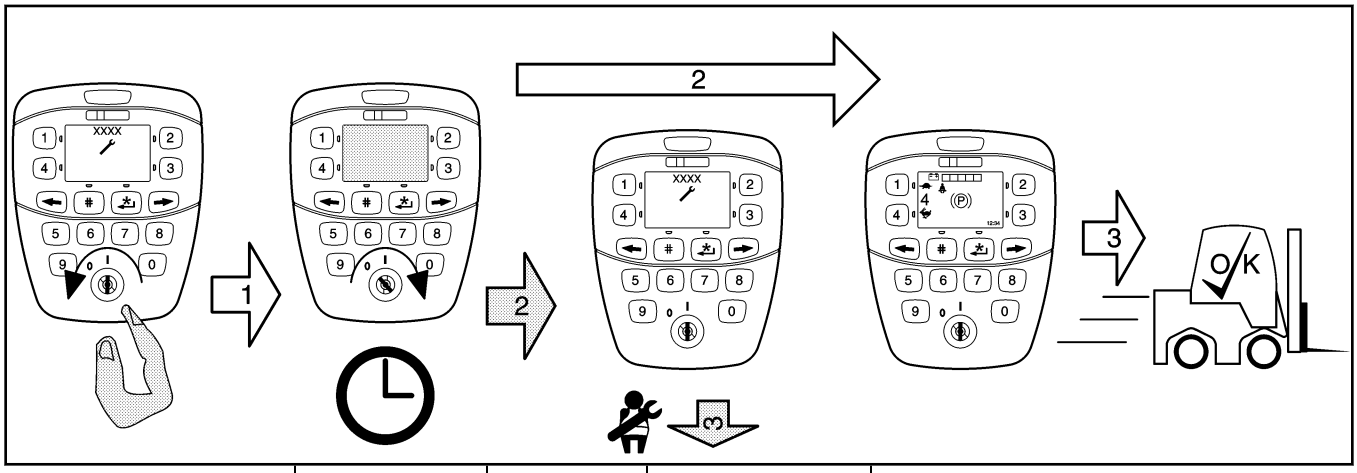
Steering Wheel/Steering Axle Position Sensor Out of Range High (OORH)



DTC 12821 Steering Wheel Position

DTC 12825 Steering Axle Position

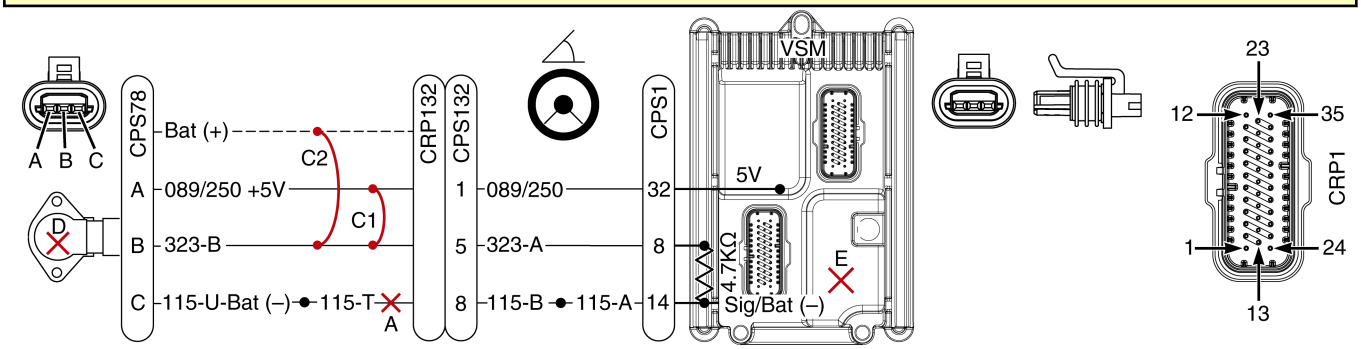




Power **OFF**→	Wait **30 seconds**→	Power **ON**→	Fault remains. Service required. Go to Component Operational Check.	No fault→	Resume operation

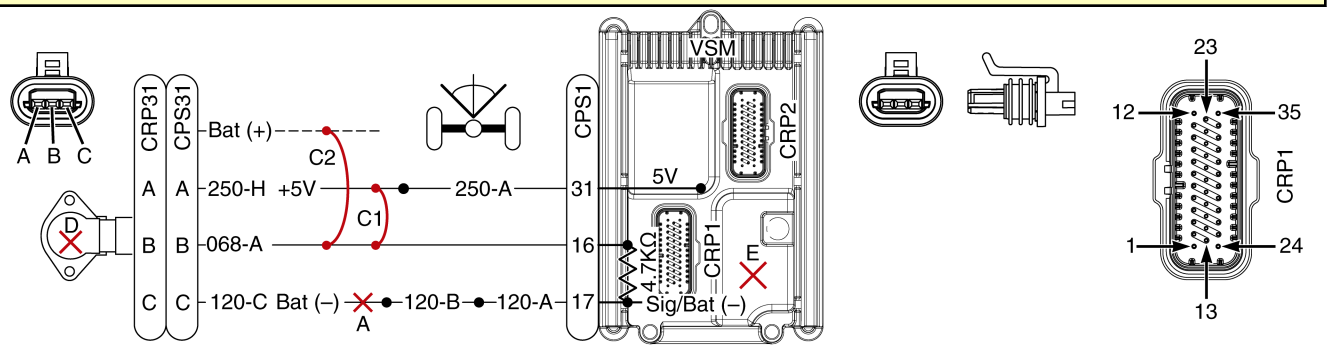
POSSIBLE CAUSE X = Open Circuit/Fail) = Short Circuit

STEERING WHEEL POSITION CAUSES A B C D E > ?

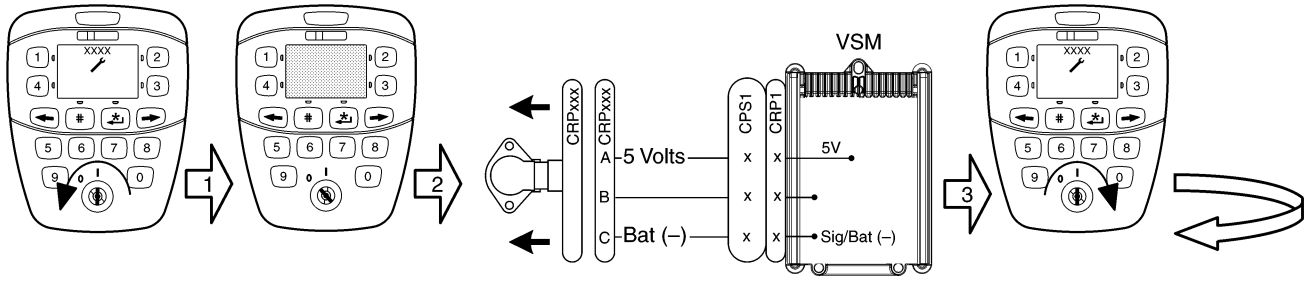


Steering Wheel/Steering Axle Position Sensor Out of Range High (OORH) (Cont)

STEERING AXLE POSITION CAUSES A B C D E > ?

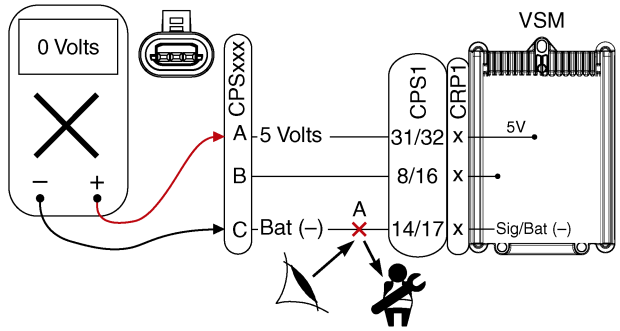


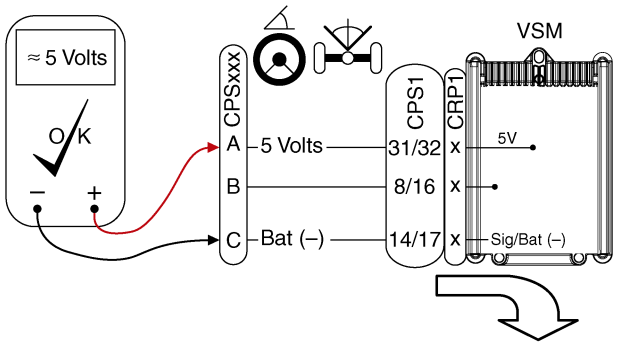
CAUSE A



Power **OFF**→	Disconnect sensor→	Power **ON**→	Go to next step.

CAUSE A1 CHECK VOLTAGE





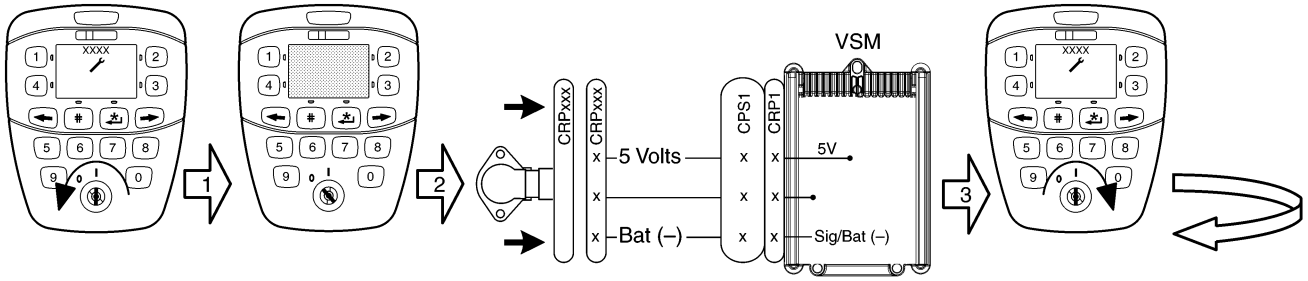
0 Volts = Open circuit→Find↑**OPEN** circuit.	~ 5 Volts =	**OK** Go to CAUSE B
Repair OPEN Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.		

CAUSE B

Not Applicable

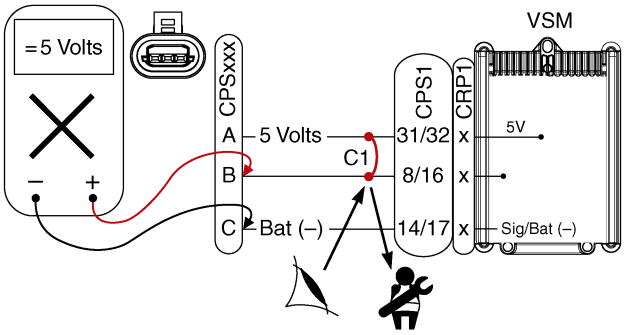
Steering Wheel/Steering Axle Position Sensor Out of Range High (OORH) (Cont)

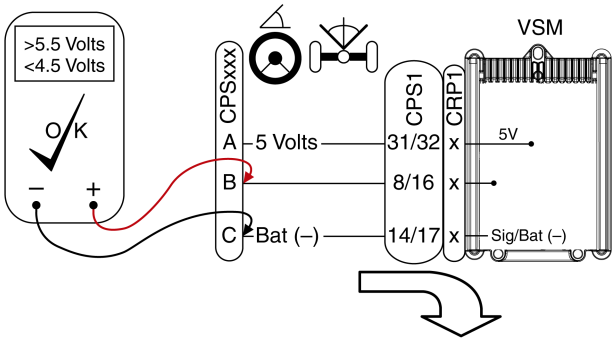
CAUSE C



Power **OFF**→	Reconnect sensor→	Power **ON**→	Go to next step.

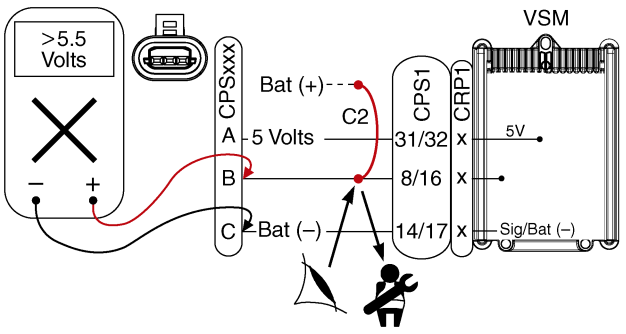
CAUSE C1 CHECK VOLTAGE

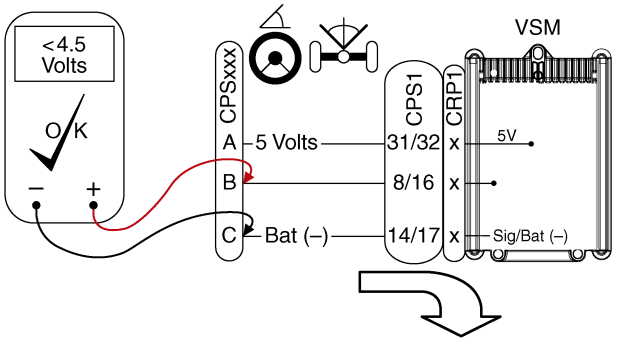




= 5 Volts = Short circuit→Find↑**Short** circuit.	> 5.5 volts,		Go to Step 2
Repair Short Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	< 4.5 volts =	OK	Go to CAUSE C

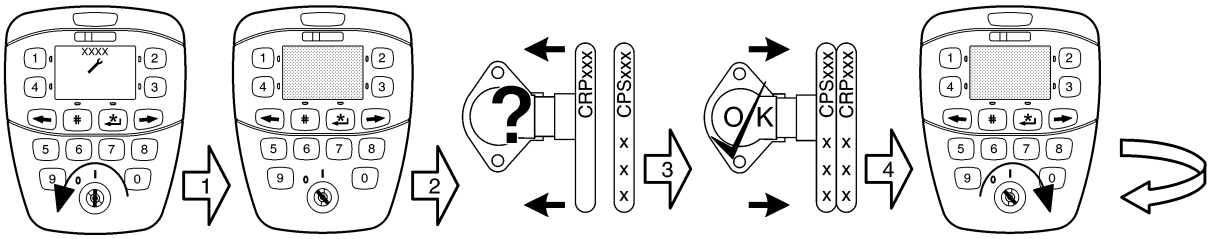
CAUSE C2 CHECK VOLTAGE



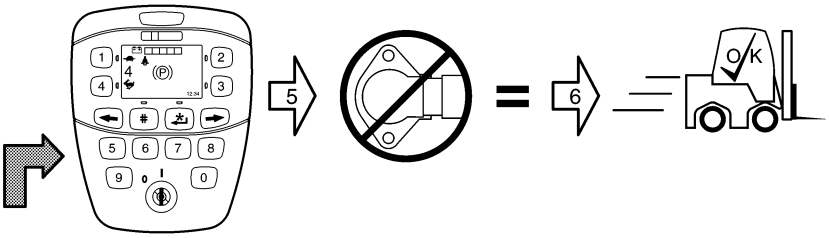


> 5.5 volts = Open circuit→Find↑**OPEN** circuit.	< 4.5 Volts =	OK	Go to CAUSE C
Repair OPEN Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.			

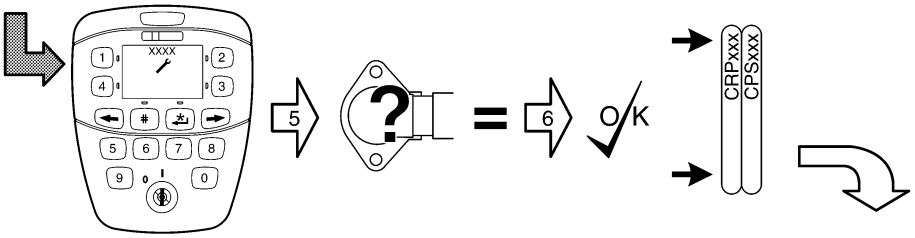
Steering Wheel/Steering Axle Position Sensor Out of Range High (OORH) (Cont)
CAUSE D



Power **OFF**→ | Disconnect sensor.→ Install new sensor.→ **Do not discard** | Power **ON**→ | Go to next step.



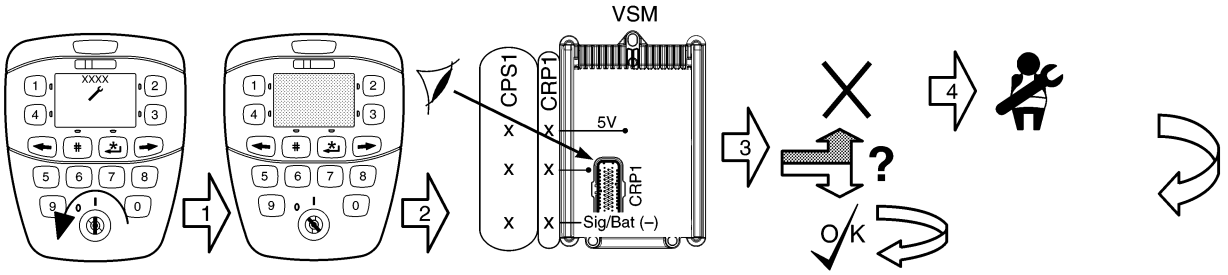
? | Fault DTC gone→ | Old sensor faulty→ | Resume operation



Fault DTC present→ | Old sensor OK/Reinstall old sensor→ | Go to CAUSE D.

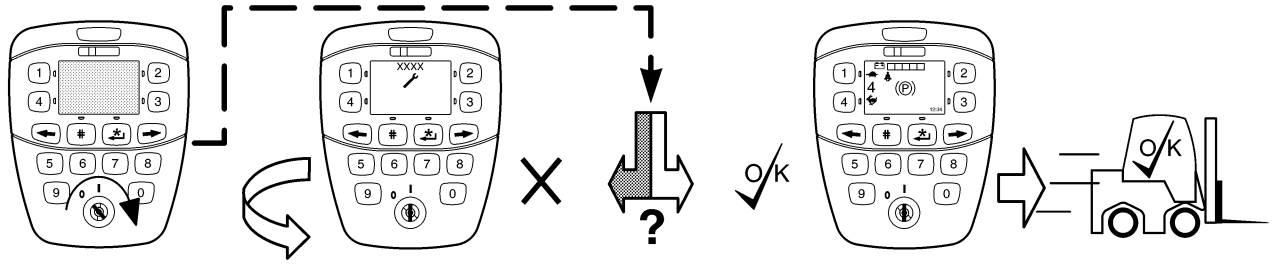
Steering Wheel/Steering Axle Position Sensor Out of Range High (OORH) (Cont)

CAUSE E



Power **OFF**→	Inspect VSM Connections→	OK - Go to Step 1.	Not OK Correct/Repair→Go to Step 1.

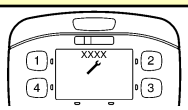
CAUSE E1



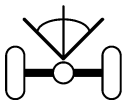
Retest - Power **ON**→	**NO**→Go to VSM Controller Check	Is fault DTC gone? **NO**←**YES**→	Fault corrected→Continue operation.

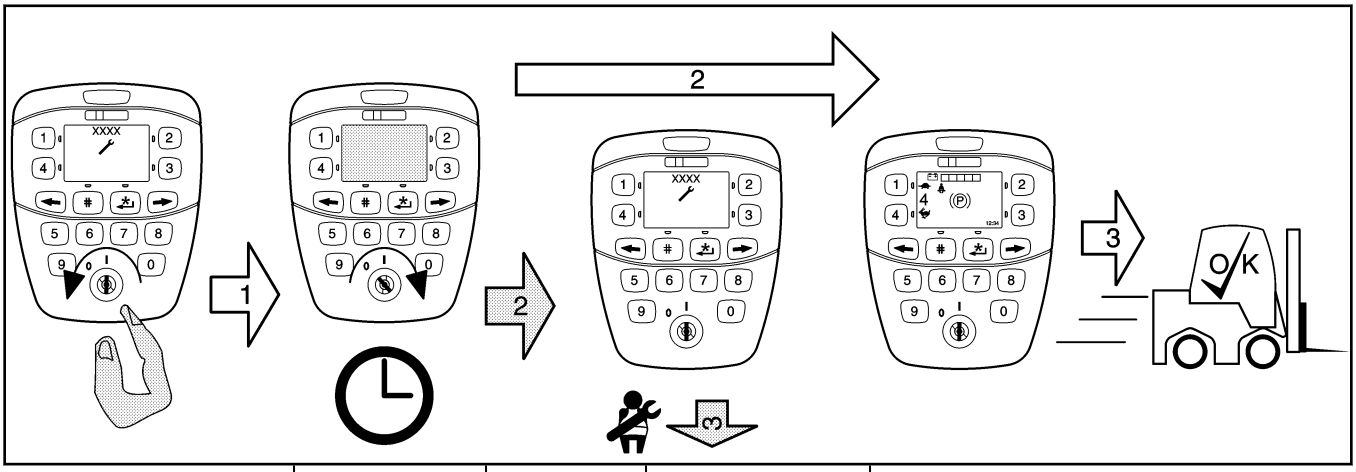
END FAULT

Steer Axle Calibration Required



DTC 4098
Steer Axle Calibration



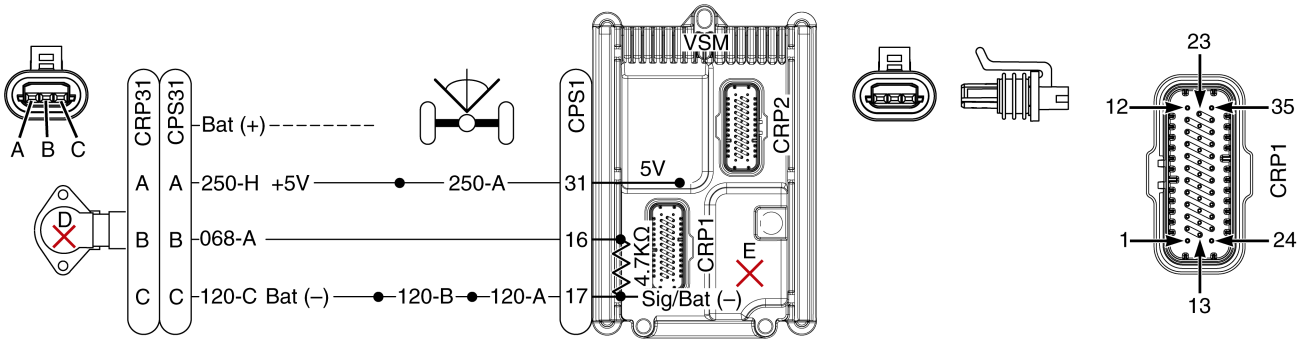


Power **OFF**→	Wait **30 seconds**→	Power **ON**→	Fault remains. Service required. Go to Component Operational Check.	No fault→	Resume operation

POSSIBLE CAUSE X = Open Circuit/Fail) = Short Circuit

STEERING AXLE CALIBRATION CAUSES A B C D E > ?

Faulty Steer System/Faulty Sensor/New Sensor Installed
VSM

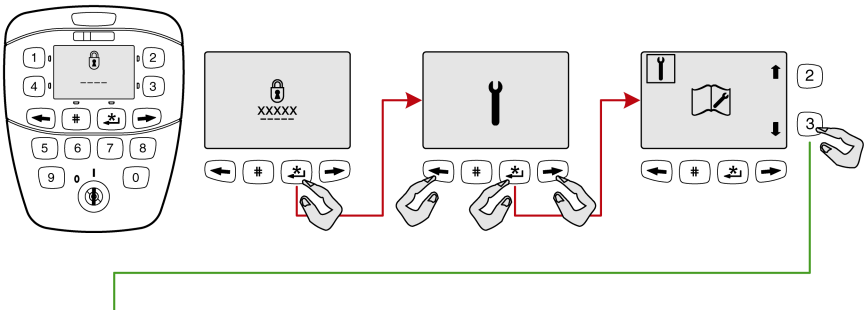
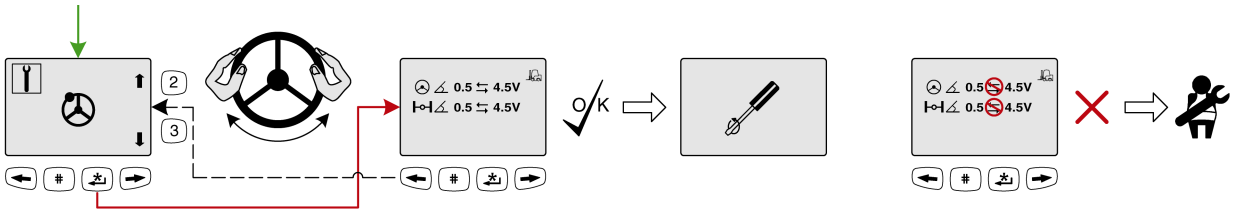
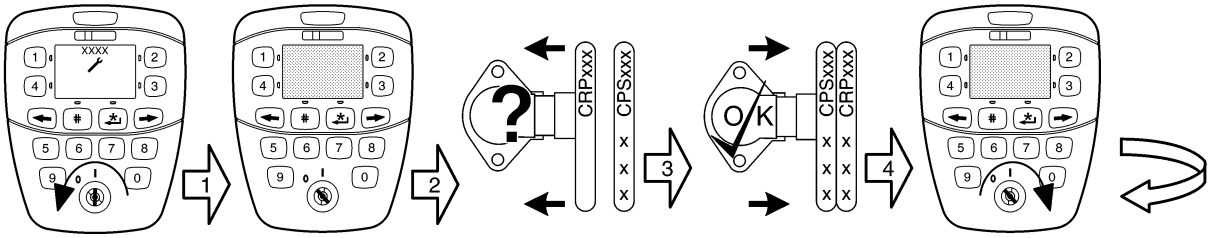


CAUSE A

Not Applicable

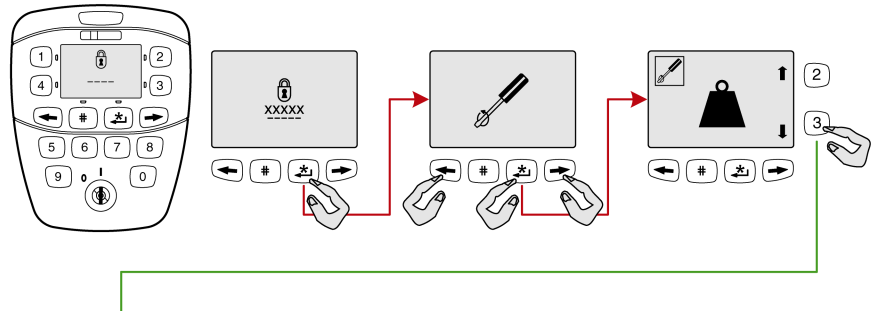
CAUSE B

Not Applicable

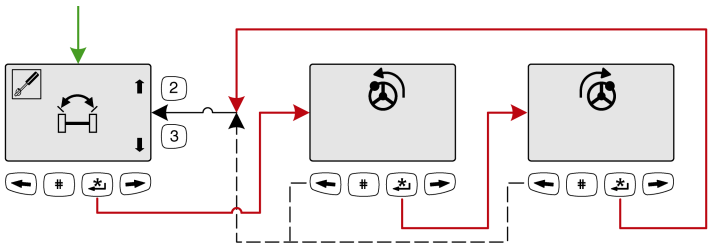
Steer Axle Calibration Required (Cont)
CAUSE C
Not Applicable
CAUSE D
Calibration Process--Go to Display Menu

Enter SERVICE Password→☞*DDiagnostics→☞*ESteering Sensor
CAUSE D1
Steering Sensor Values

1. ☞*→Rotate steering wheel #Values vary>0.5V <4.5V = V→Proceed with Calibration→Step 3↓
2. ☞*→Rotate steering wheel #Values =the same = X=Steer Mechanism/Faulty Sensor→Go to 3↓
3. Check Steer Mechanism Operation→Mechanism V→Step 2↓Mechanism XGo to 4↓
4. See **Steering System** 1600SRM1331/**Steering System** 1600SRM1363 repair.
CAUSE D2
Steer Sensor(s) Replacement

1. Power **OFF**→Disconnect sensor **Do not discard**.→Install new sensor→Power **ON**→Go to 2↓
2. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.

Steer Axle Calibration Required (Cont)

CAUSE D3

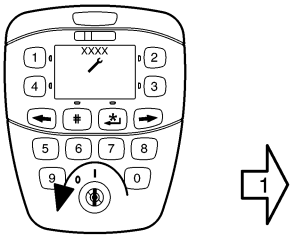


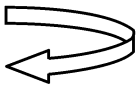
Enter SERVICE Password→☞*DCalibration→☞*ESteering Axle



☞*	Rotate Fully CCW ☞*	Rotate Fully CW ☞*	Step 4↓

CAUSE D4

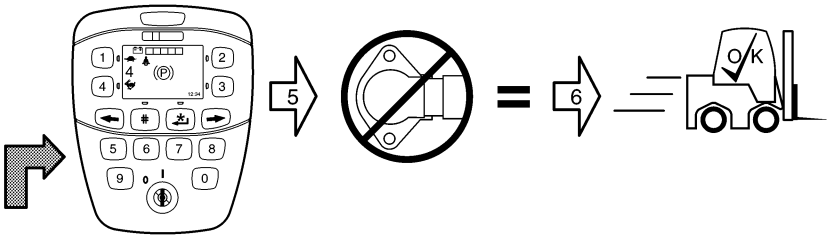




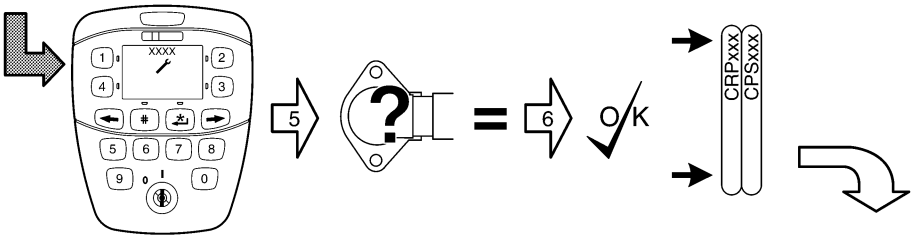
Power **OFF**→	Power **ON**→		Step 5↓

Steer Axle Calibration Required (Cont)

CAUSE D5

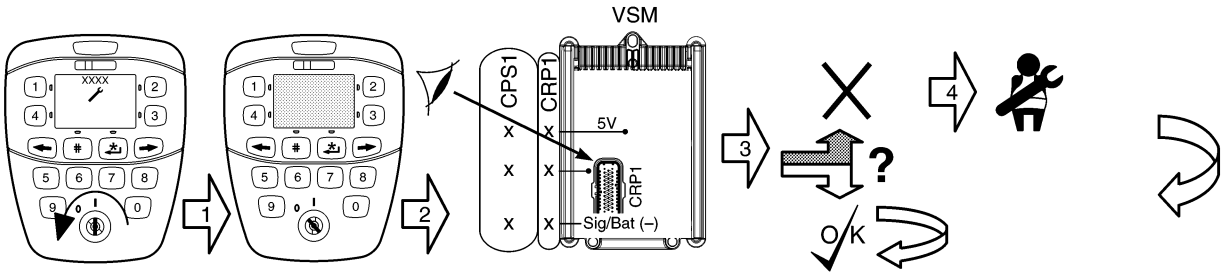


?	Fault DTC gone→	Old sensor faulty→	Resume operation



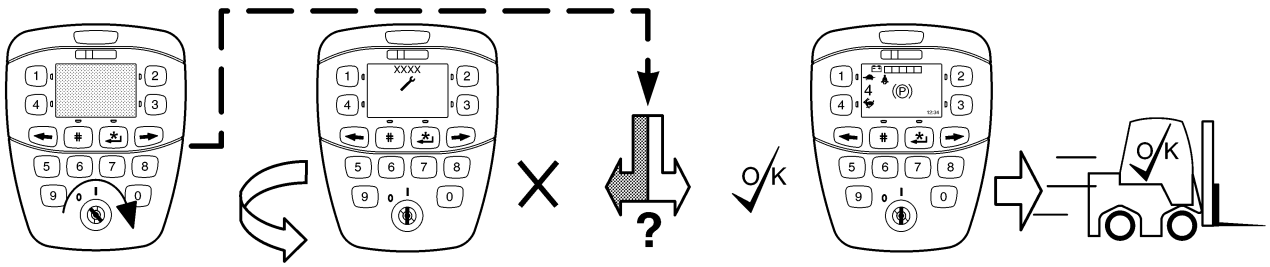
	Fault DTC present→	Old sensor OK/Reinstall old sensor→	Go to CAUSE D.

CAUSE E



Power **OFF**→	Inspect VSM Connections→	OK - Go to Step 1.	Not OK Correct/Repair→Go to Step 1.

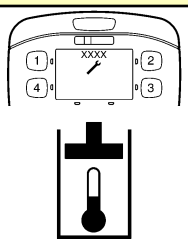
CAUSE E1



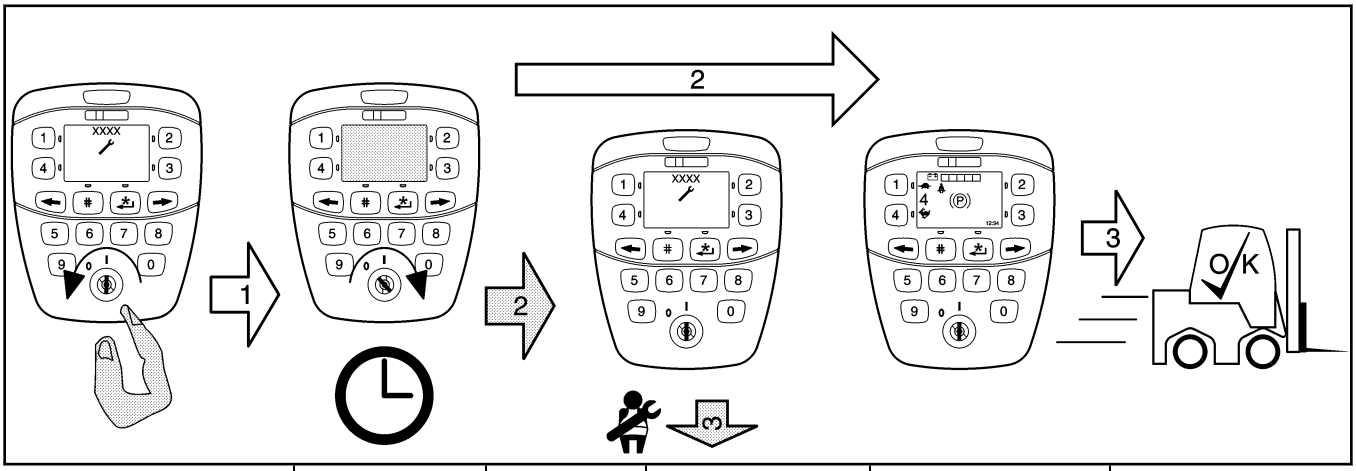
Retest - Power **ON**→	**NO**→Go to VSM Controller Check	Is fault DTC gone? **NO**←**YES**→	Fault corrected→Continue operation.

END FAULT

Hydraulic Temperature Sensor Out of Range High (OORL)



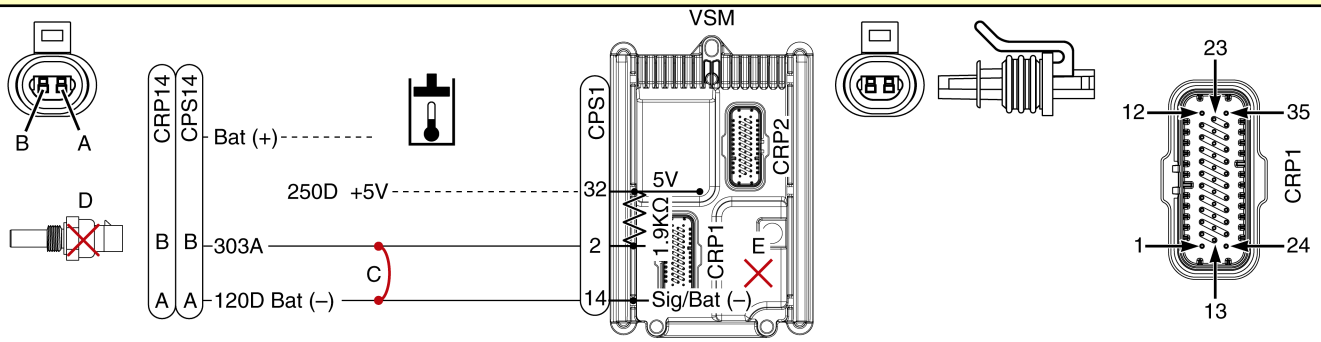
DTC 12852
Hydraulic Temperature



Power **OFF**→	Wait **30 seconds**→	Power **ON**→	Fault remains. Service required. Go to Component Operational Check.	No fault→	Resume operation

POSSIBLE CAUSE X = Open Circuit/Fail) = Short Circuit

HYDRAULIC TEMPERATURE CAUSES A B C D E > ?



CAUSE A

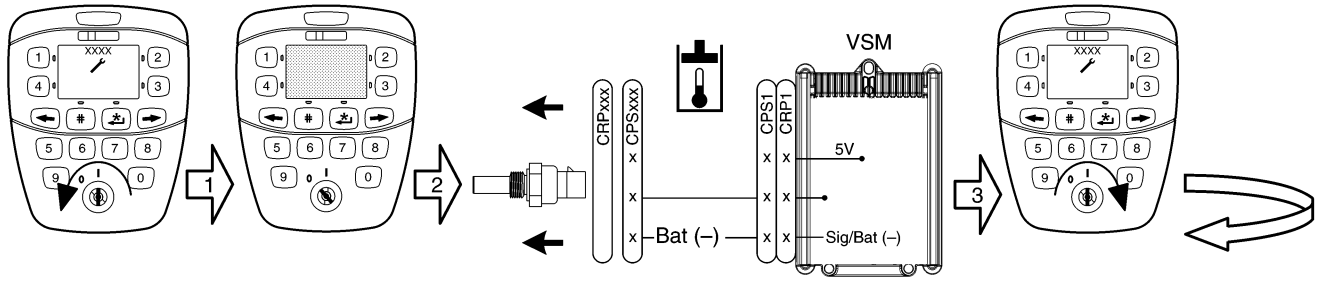
Not Applicable

CAUSE B

Not Applicable

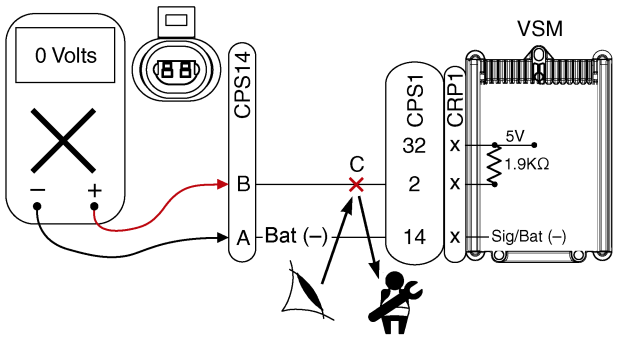
Hydraulic Temperature Sensor Out of Range High (OORL) (Cont)

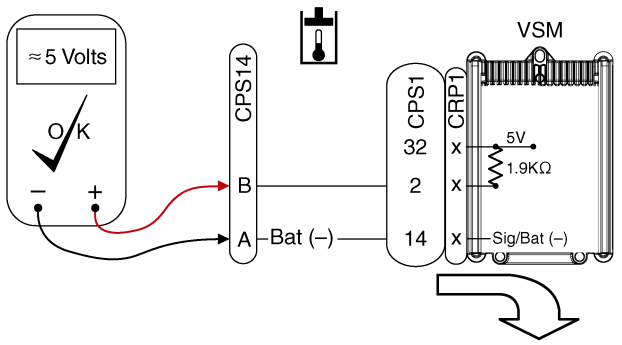
CAUSE C



Power **OFF**→	Disconnect sensor→	Power **ON**→	Go to next step.

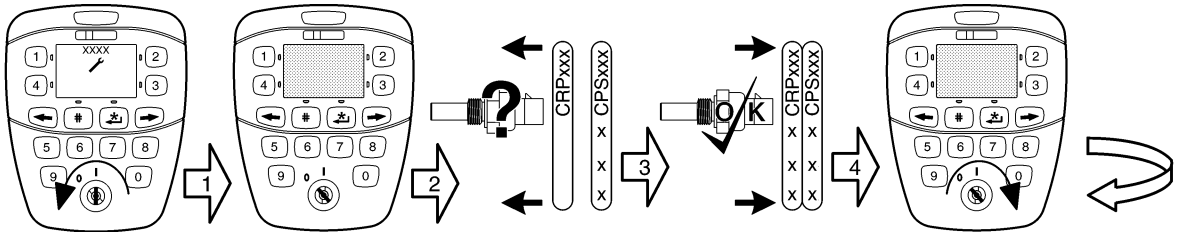
CAUSE C1 CHECK VOLTAGE





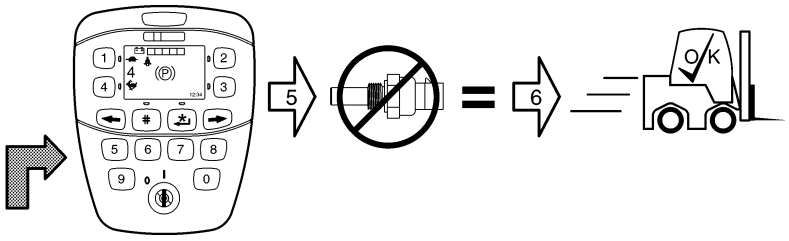
0 Volts = Short circuit→Find↑**Short** circuit.	˜ 5 Volts =	**OK**	Go to CAUSE C
Repair Short Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.			

CAUSE D

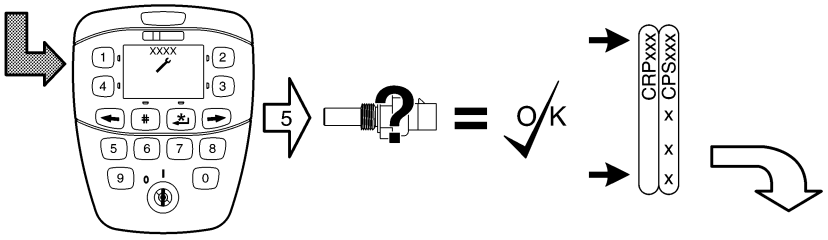


Power **OFF**→	Disconnect sensor.→ Install new sensor.→ **Do not discard**	Power **ON**→	Go to next step.

Hydraulic Temperature Sensor Out of Range High (OORL) (Cont)

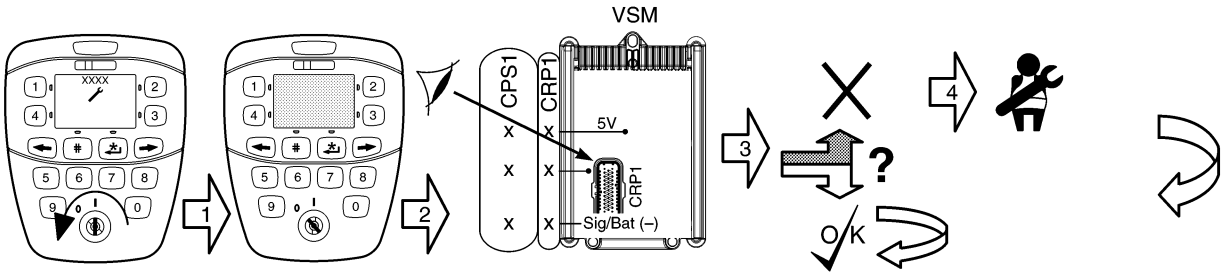


?	Fault DTC gone→	Old sensor faulty→	Resume operation



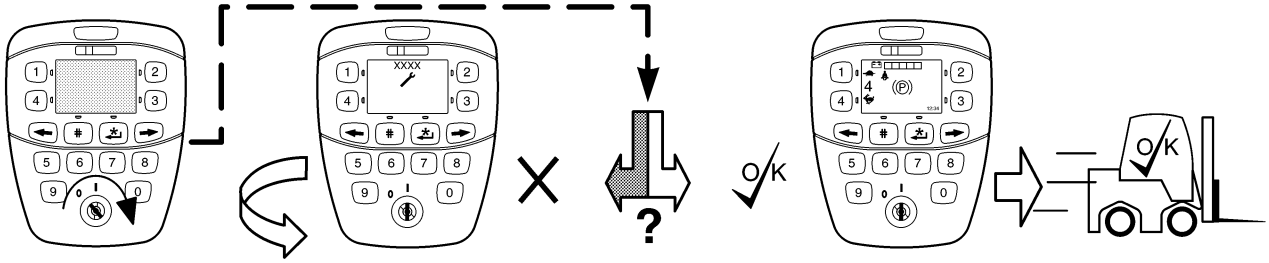
Fault DTC present→	Old sensor OK/Reinstall old sensor→	Go to CAUSE D.

CAUSE E



Power **OFF**→	Inspect VSM Connections→	Go to Step 1.	Not OK Correct/Repair→Go to Step 1.

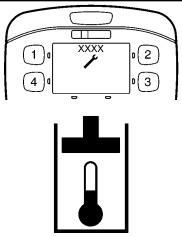
CAUSE E1



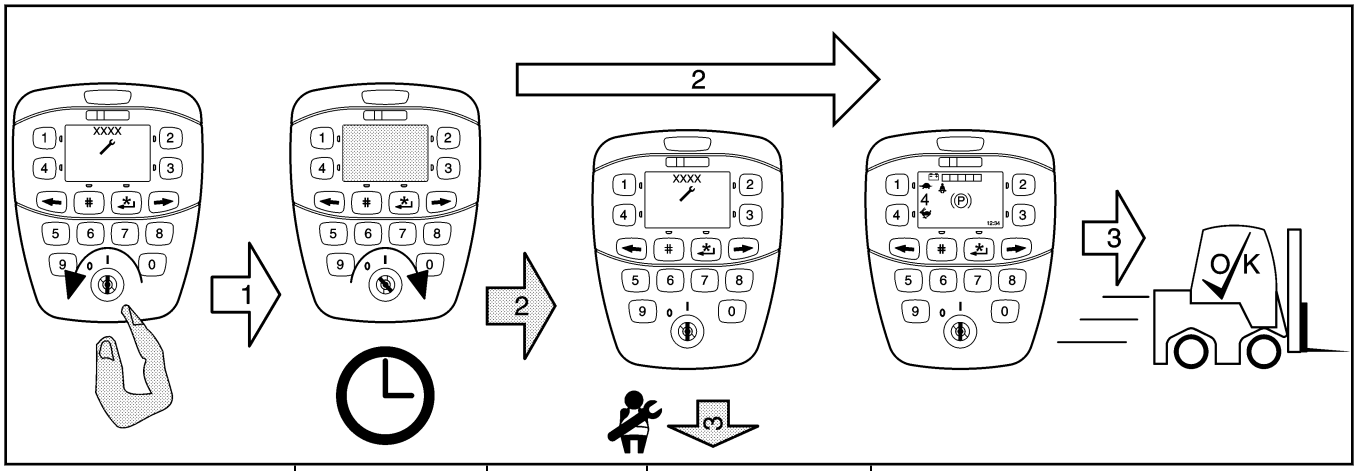
Retest - Power **ON**→	**NO**→Go to VSM Controller Check	Is fault DTC gone? **NO**←**YES**→	Fault corrected→Continue operation.

END FAULT

Hydraulic Temperature Sensor Out of Range High (OORH)



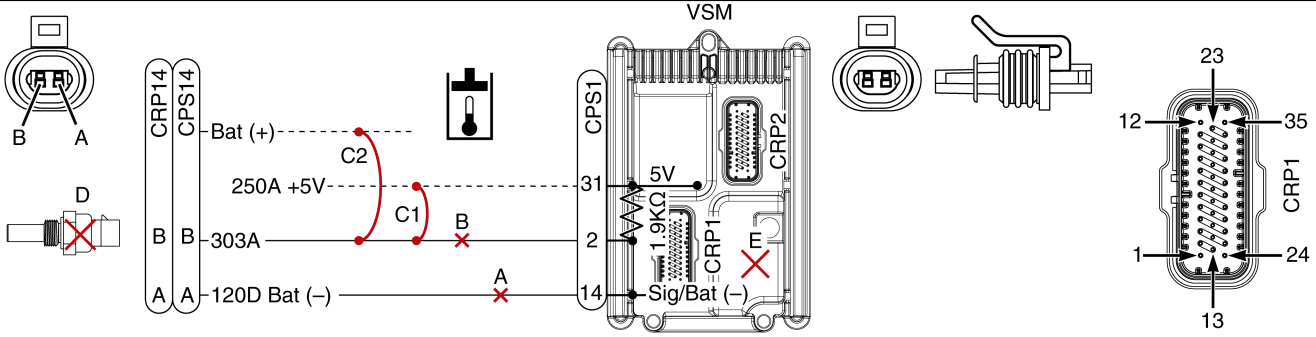
DTC 12853
Hydraulic
Temperature



Power **OFF**→	Wait **30 seconds**→	Power **ON**→	Fault remains. Service required. Go to Component Operational Check.	No fault→	Resume operation

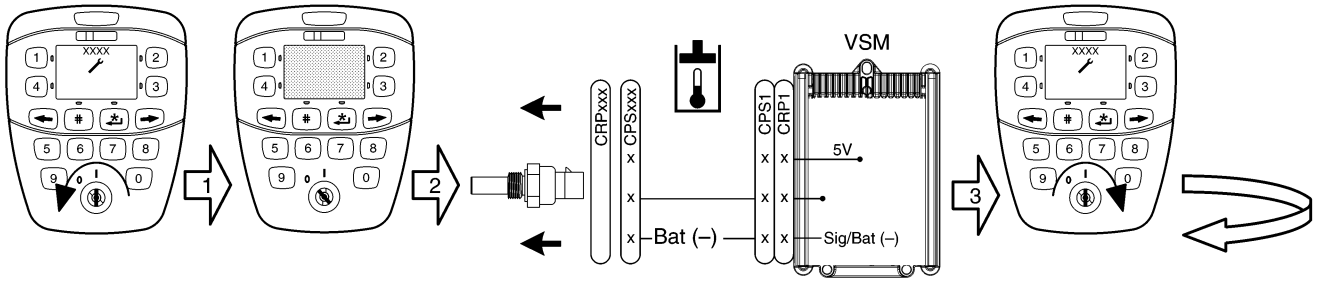
POSSIBLE CAUSE X = Open Circuit/Fail) = Short Circuit

HYDRAULIC TEMPERATURE CAUSES A B C D E > ?



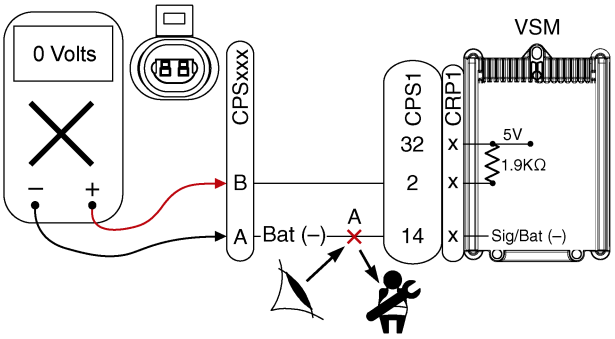
Hydraulic Temperature Sensor Out of Range High (OORH) (Cont)

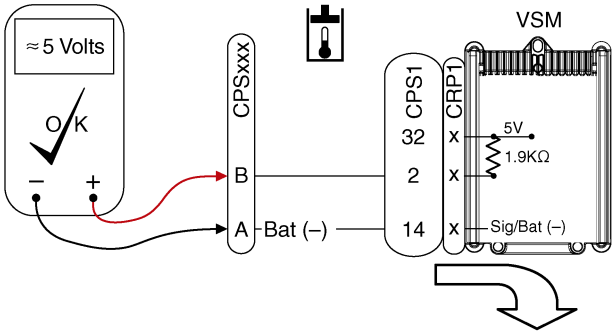
CAUSE A



Power **OFF**→	Disconnect sensor→	Power **ON**→	Go to next step.

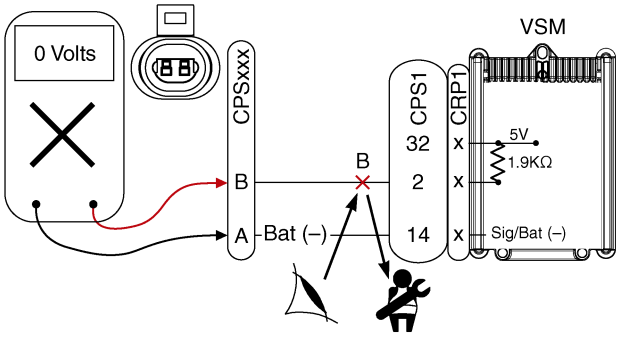
CAUSE A1 CHECK VOLTAGE

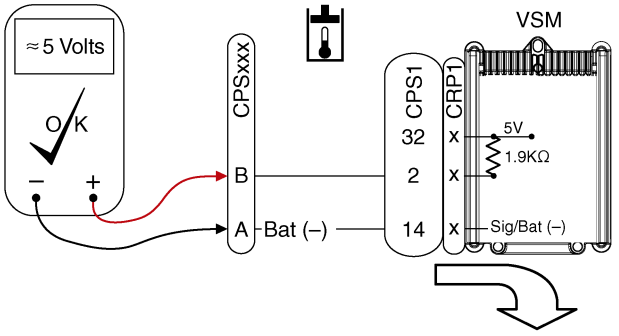




0 Volts = Open circuit→Find↑**OPEN** circuit.	˜ 5 Volts = **OK**	Go to CAUSE A
Repair OPEN Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.		

CAUSE B CHECK VOLTAGE

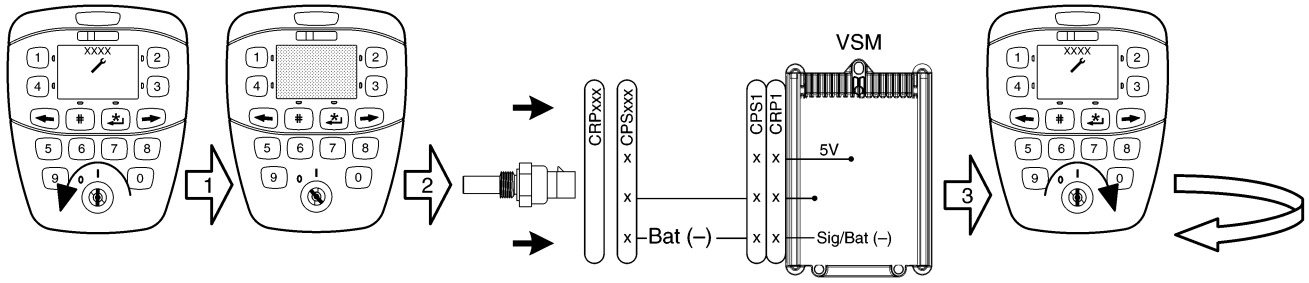




0 Volts = Open circuit→Find↑**OPEN** circuit.	˜ 5 Volts = **OK**	Go to CAUSE B
Repair OPEN Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.		

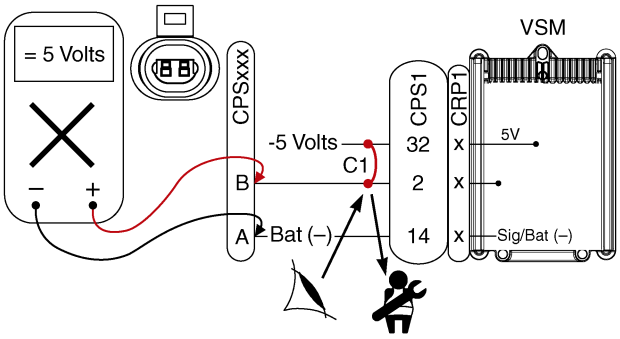
Hydraulic Temperature Sensor Out of Range High (OORH) (Cont)

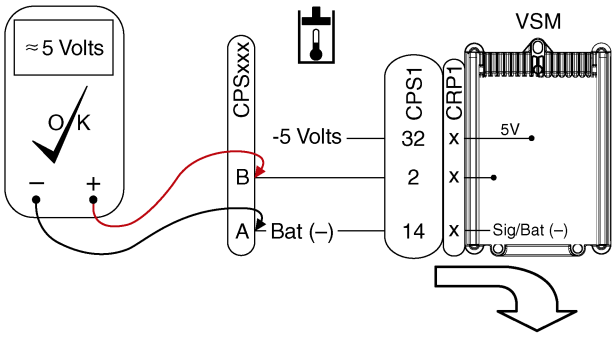
CAUSE C



Power **OFF**→	Reconnect sensor→	Power **ON**→	Go to next step.

CAUSE C1 CHECK VOLTAGE

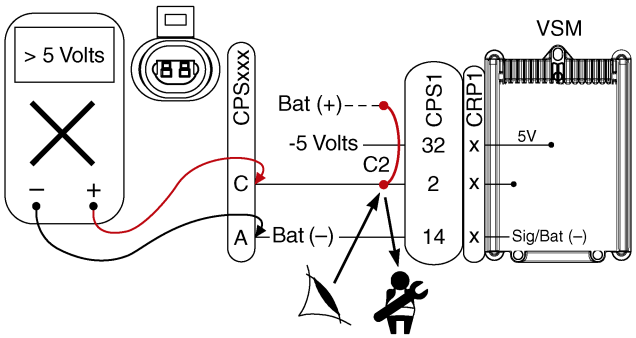


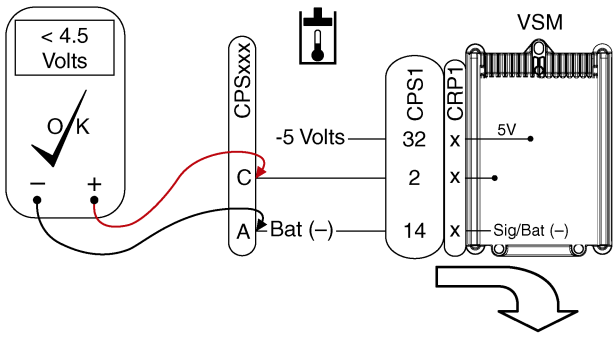


= 5 Volts = Short circuit→Find↑**Short** circuit.	> 5.5 volts		Go to Step 2
Repair Short Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	< 4.5 volts =	**OK**	Go to CAUSE C

CAUSE C2 CHECK VOLTAGE

Switched and Unswitched

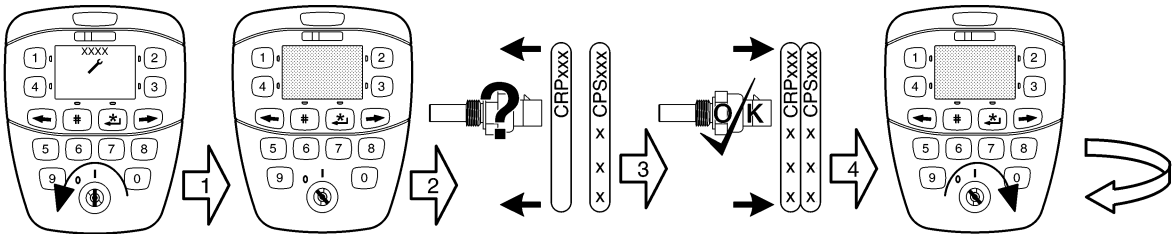




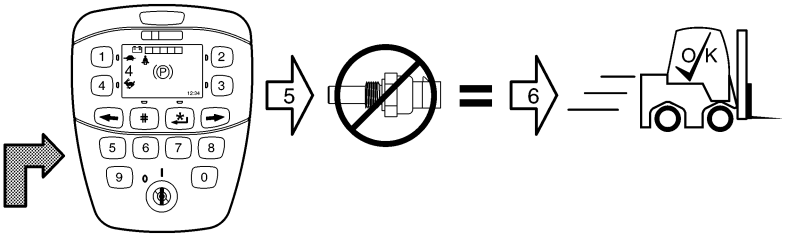
> 5.5 volts = Short circuit→Find↑**Short** circuit to another voltage source.	< 4.5 volts =	**OK**	Go to CAUSE C.
Repair Short circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.			

Hydraulic Temperature Sensor Out of Range High (OORH) (Cont)

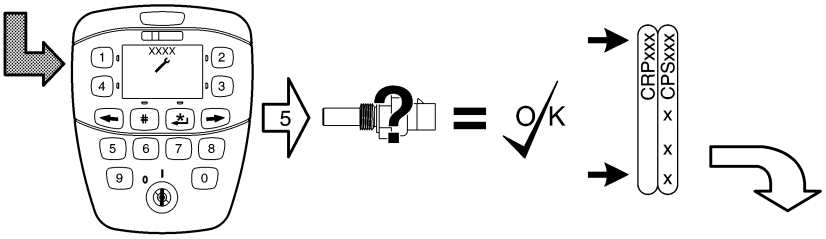
CAUSE D



Power **OFF**→	Disconnect sensor.→ Install new sensor.→ **Do not discard**	Power **ON**→	Go to next step.



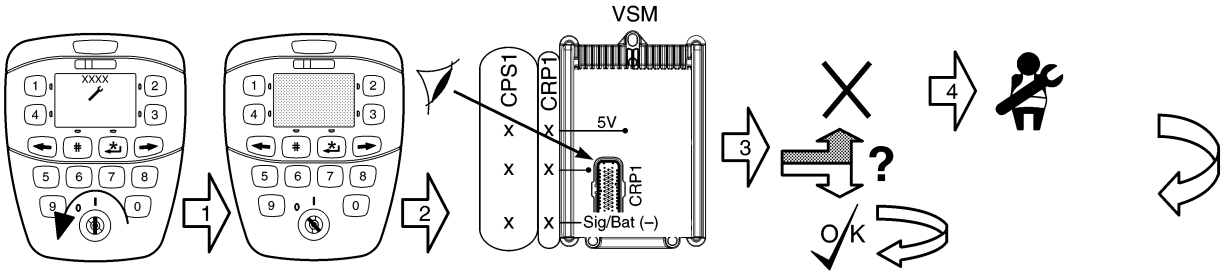
?	Fault DTC gone→	Old sensor faulty→	Resume operation



Fault DTC present→	Old sensor OK/Reinstall old sensor→	Go to CAUSE D.

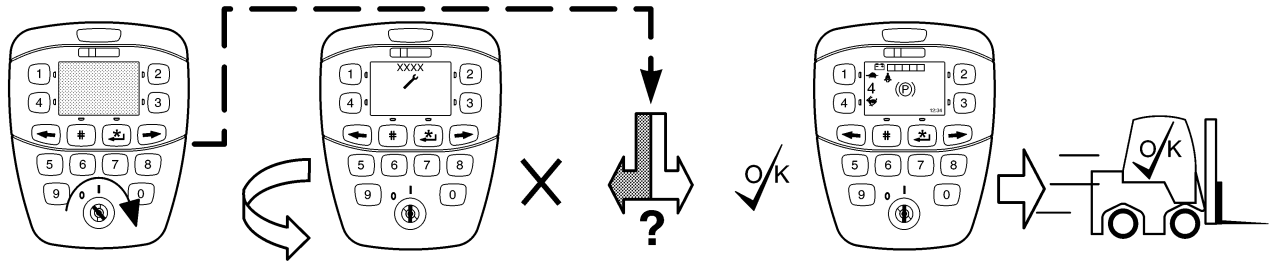
Hydraulic Temperature Sensor Out of Range High (OORH) (Cont)

CAUSE E



Power **OFF**→	Inspect VSM Connections→	Go to Step 1.	Not OK Correct/ Repair→Go to Step 1.

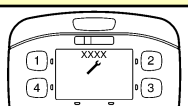
CAUSE E1



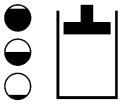
Retest - Power **ON**→	**NO**→Go to VSM Controller Check	Is fault DTC gone? **NO**←**YES**→	Fault corrected→Continue operation.

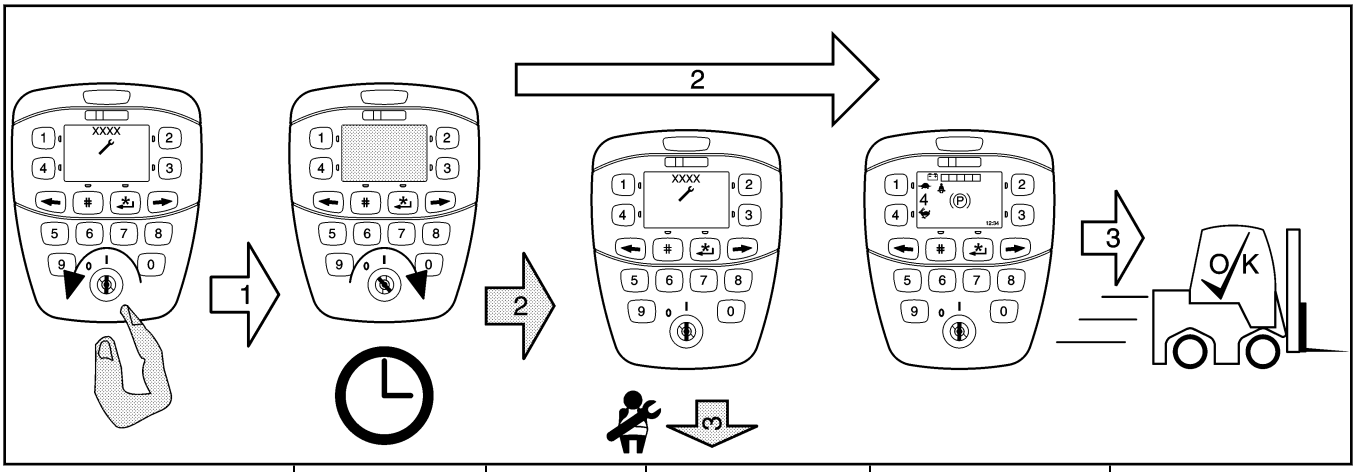
END FAULT

Hydraulic Fluid Level Sensor Out Of Range Low (OORL)



DTC 12872
Hydraulic Fluid Level

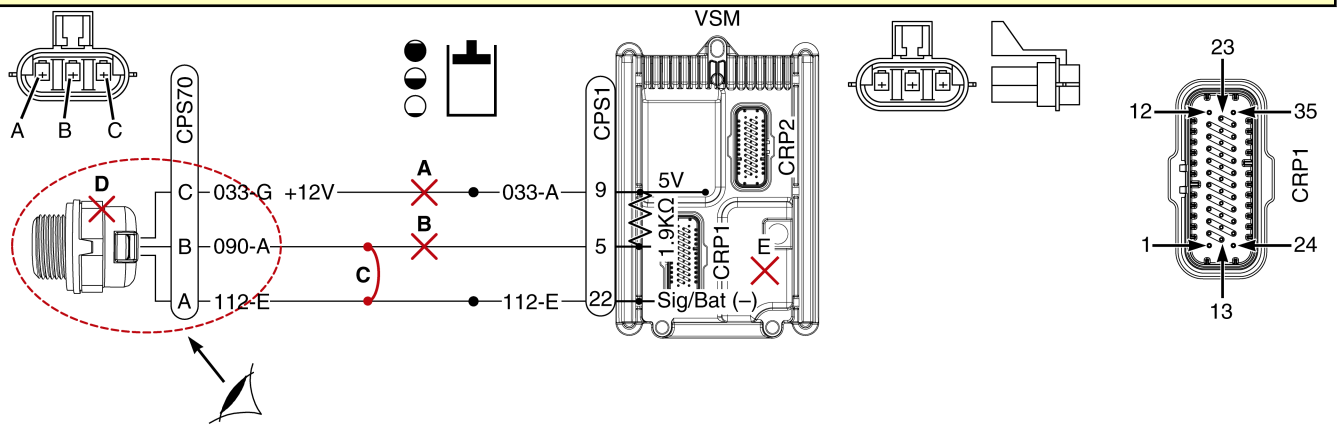




Power **OFF**→	Wait **30 seconds**→	Power **ON**→	Fault remains. Service required. Go to Component Operational Check.	No fault→	Resume operation

POSSIBLE CAUSE X = Open Circuit/Fail) = Short Circuit

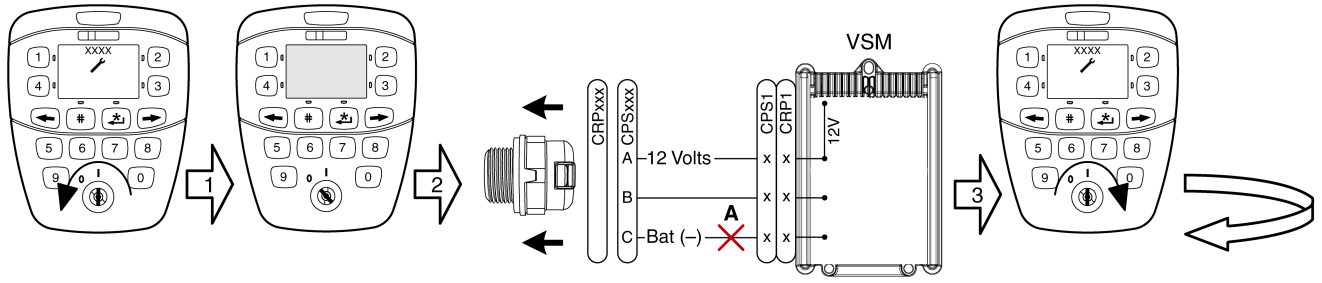
HYDRAULIC FLUID LEVEL CAUSES A B C D E > ?



NOTE: If the CDF setting is for a sensor but the sensor is not connected, then a DTC code will be displayed.
Check that the sensor is present and the harness connection is OK.

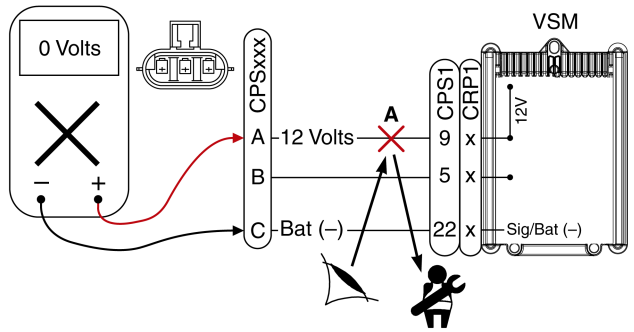
Hydraulic Fluid Level Sensor Out Of Range Low (OORL) (Cont)

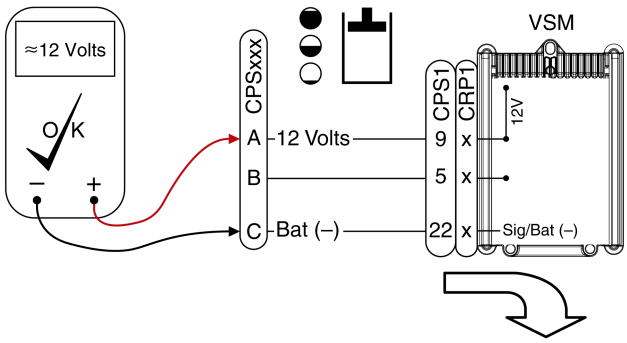
CAUSE A



Power **OFF**→	Disconnect sensor→	Power **ON**→	Go to next step.

CAUSE A1 CHECK VOLTAGE

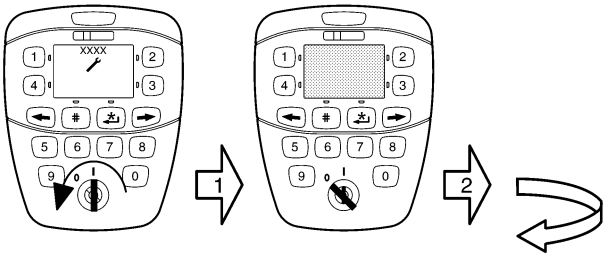




0 Volts = Open circuit→Find↑**Open** circuit.	˜ 12Volts =	**O K**→	Go to CAUSE A↓
Repair Open Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.			

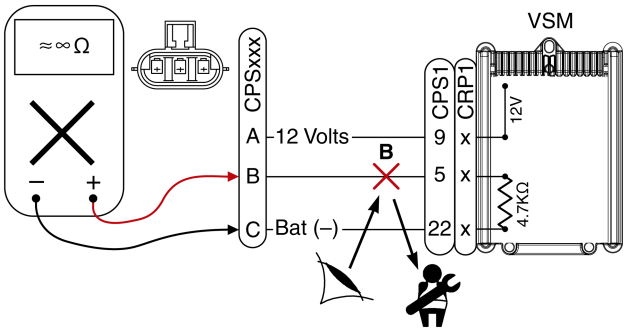
Hydraulic Fluid Level Sensor Out Of Range Low (OORL) (Cont)

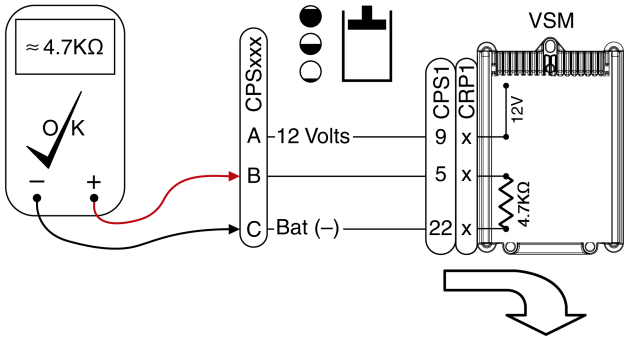
CAUSE B



Power **OFF**→ ?

CAUSE B1 CHECK RESISTANCE - Ω - OHMS

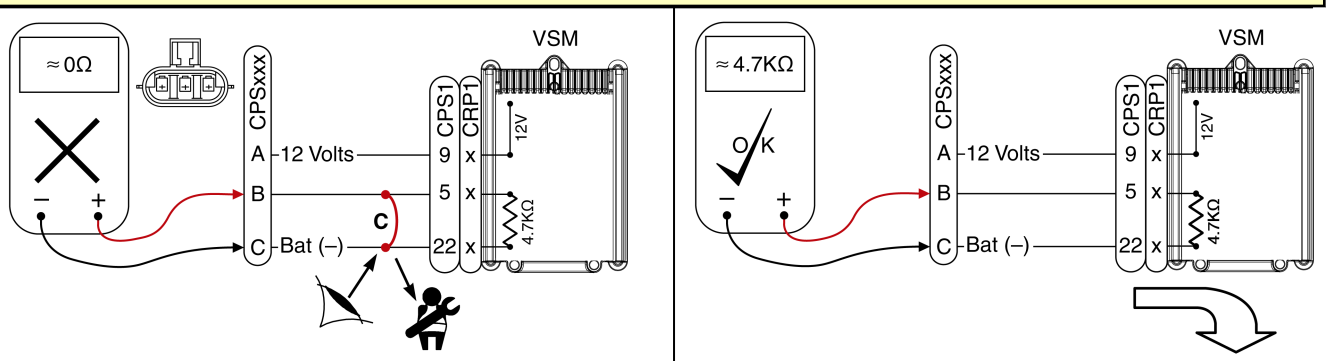




1. 8 ? = Open circuit→Find↑**OPEN** circuit→Go to 3↓	˜ 4.7K? =	**OK**	Go to CAUSE C.↓
2. 0? = Short circuit→Go to CAUSE B↓			
3. Repair OPEN circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.Go to 4↓			
4. Repair 🛠→Retest→Step 1↓			

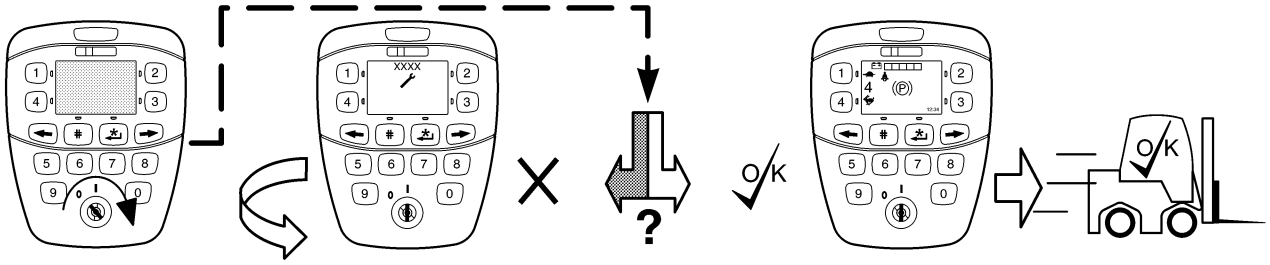
Hydraulic Fluid Level Sensor Out Of Range Low (OORL) (Cont)

CAUSE C — CHECK RESISTANCE - Ω - OHMS



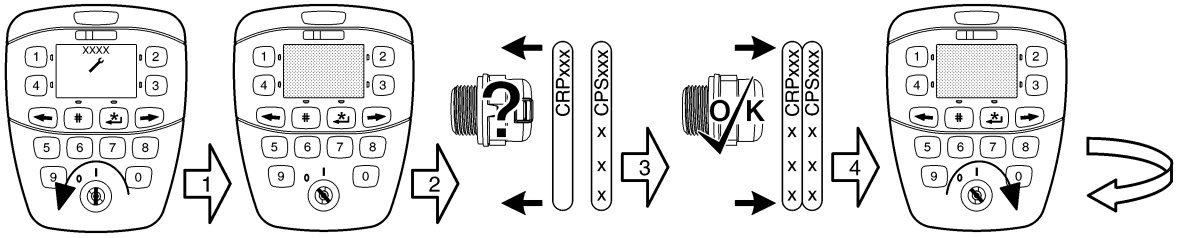
1. 0? = Short circuit→Find↑**Short** circuitGo to 2↓	˜ 4.7K? = **OK** Go to CAUSE C.↓
2. Repair Short circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.Go to 3↓	
3. Repair 🛠→Retest→Step 1↓	

CAUSE C1



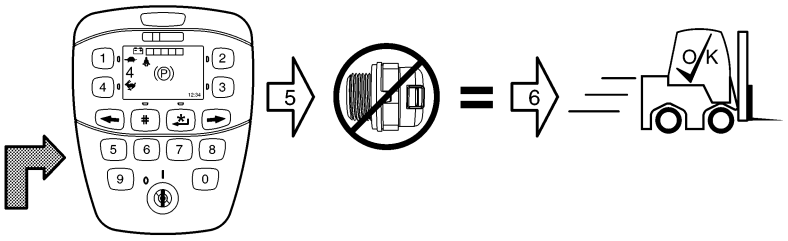
Retest - Power **ON**→	**NO**→Go to CAUSE C	Is fault DTC gone? **NO**←**YES**→	Fault corrected→Continue operation.

CAUSE D

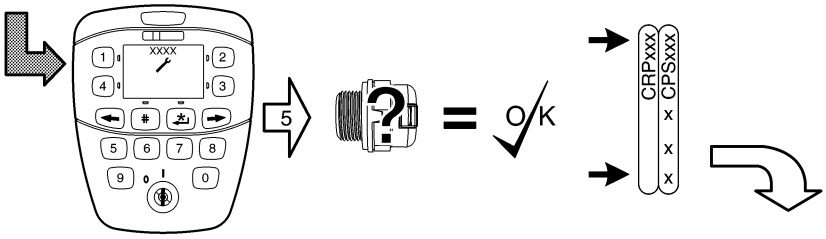


Power **OFF**→	Disconnect sensor.→ Install new sensor.→ **Do not discard**	Power **ON**→	Go to next step.

Hydraulic Fluid Level Sensor Out Of Range Low (OORL) (Cont)

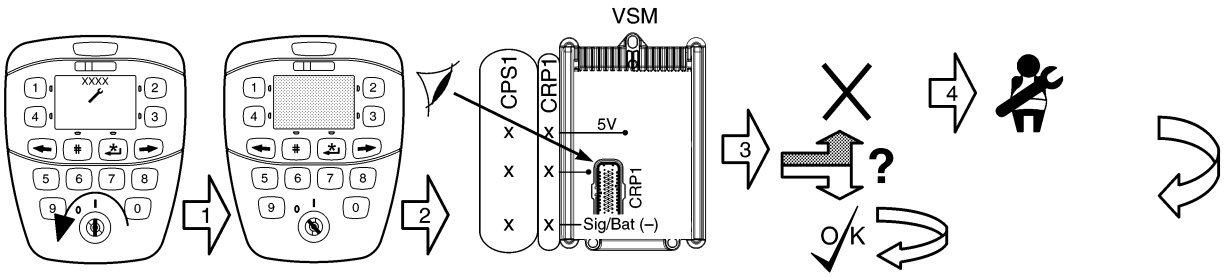


?	Fault DTC gone→	Old sensor faulty→	Resume operation



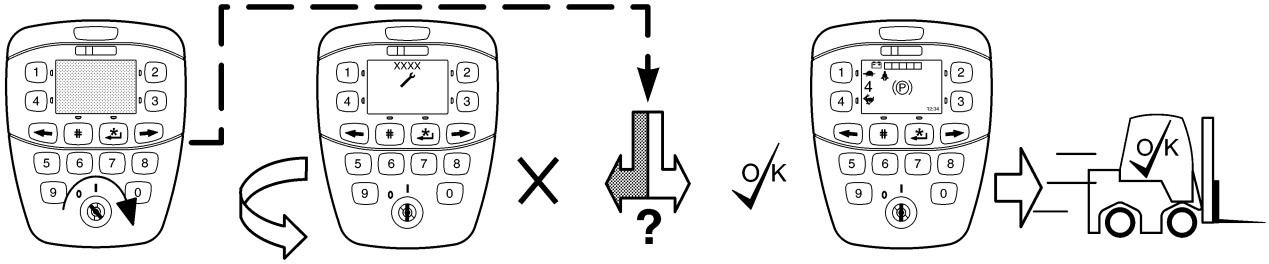
	Fault DTC present→	Old sensor OK/Reinstall old sensor→	Go to CAUSE D.

CAUSE E



Power **OFF**→	Inspect VSM Connections→	Go to Step 1.	Not OK Correct/Repair→Go to Step 1.

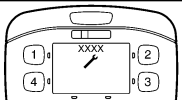
CAUSE E1



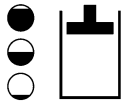
Retest - Power **ON**→	**NO**→Go to VSM Controller Check	Is fault DTC gone? **NO**←**YES**→	Fault corrected→Continue operation.

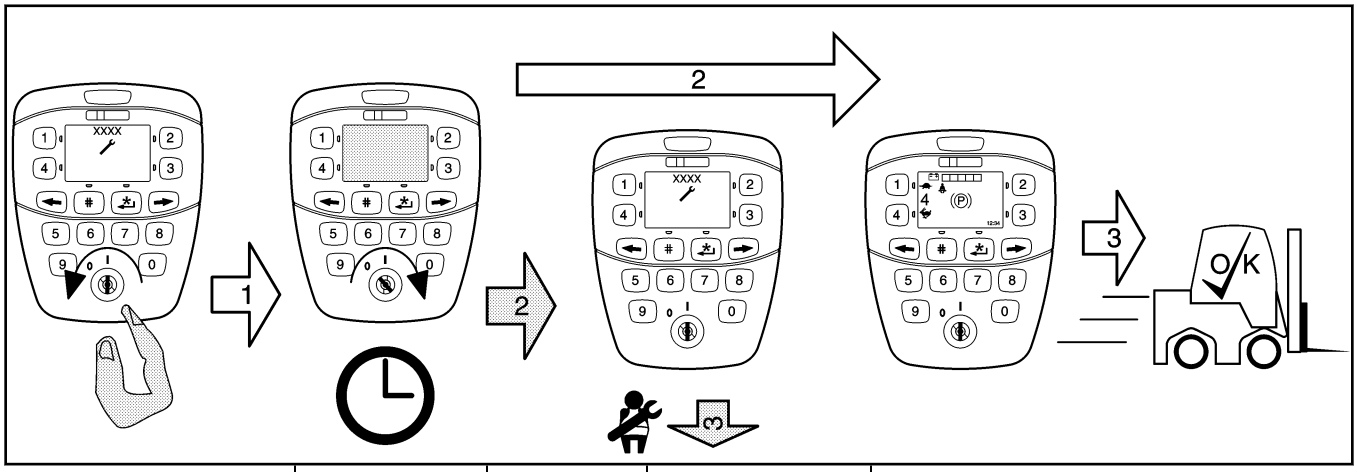
END FAULT

Hydraulic Fluid Level Sensor Out Of Range High (OORH)



DTC 12873
Hydraulic Fluid Level

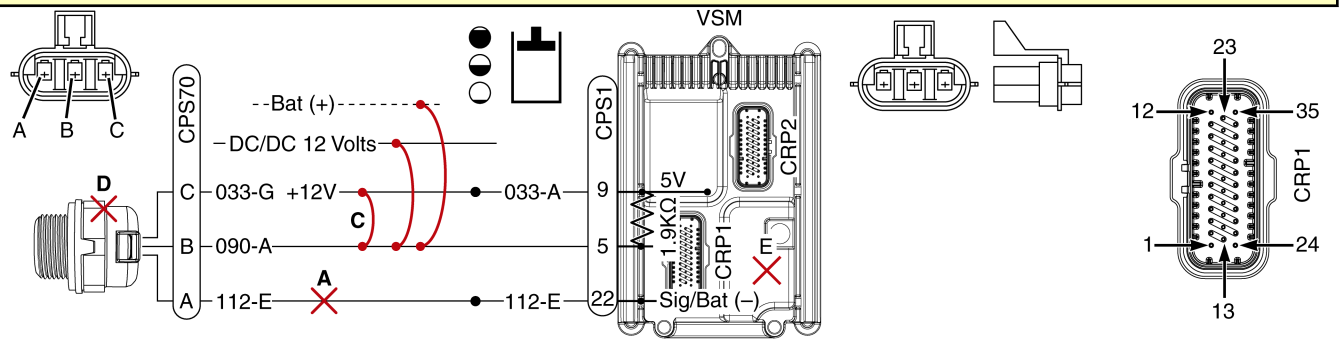




Power **OFF**→	Wait **30 seconds**→	Power **ON**→	Fault remains. Service required. Go to Component Operational Check.	No fault→	Resume operation

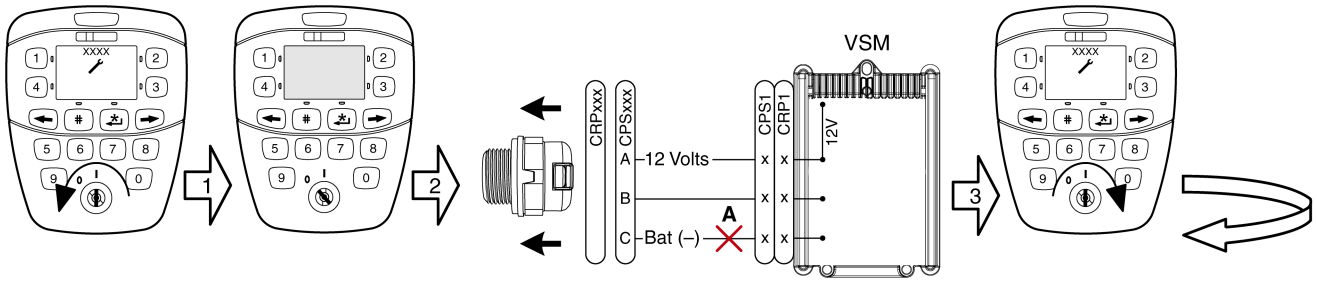
POSSIBLE CAUSE X = Open Circuit/Fail) = Short Circuit

HYDRAULIC TEMPERATURE CAUSES A B C D E > ?



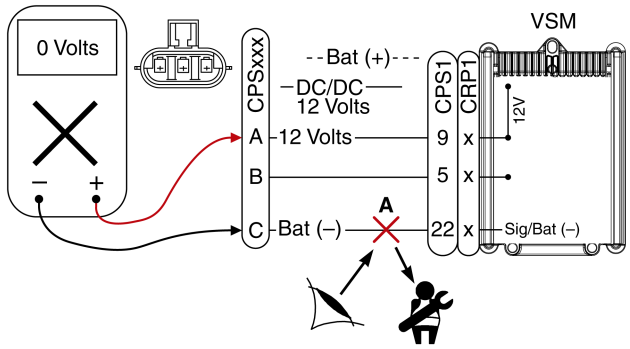
Hydraulic Fluid Level Sensor Out Of Range High (OORH) (Cont)

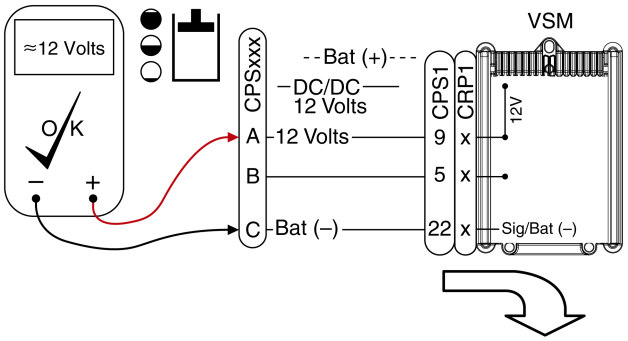
CAUSE A



Power **OFF**→	Disconnect sensor→	Power **ON**→	Go to A1.↓

CAUSE A1 CHECK VOLTAGE





0 Volts = Open circuit→Find↑**OPEN** circuit.	˜ 12 Volts =	**OK** Go to CAUSE B

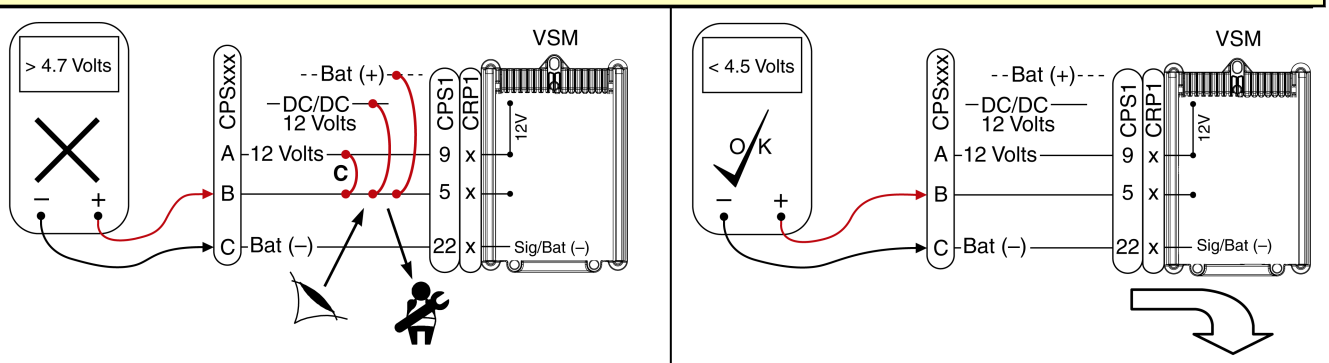
Repair OPEN Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.

CAUSE B

Not Applicable

Hydraulic Fluid Level Sensor Out Of Range High (OORH) (Cont)

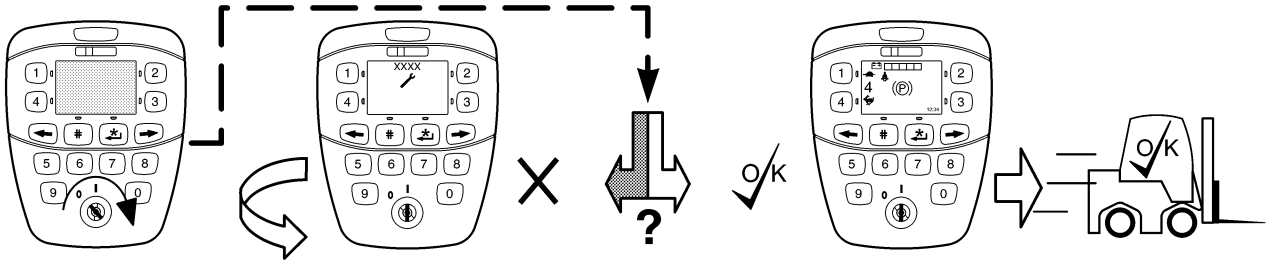
CAUSE C



> 4.7 Volts = Short circuit→Find↑**Short** circuit.	< /= 4.5 Volts =	**OK**	Go to CAUSE C

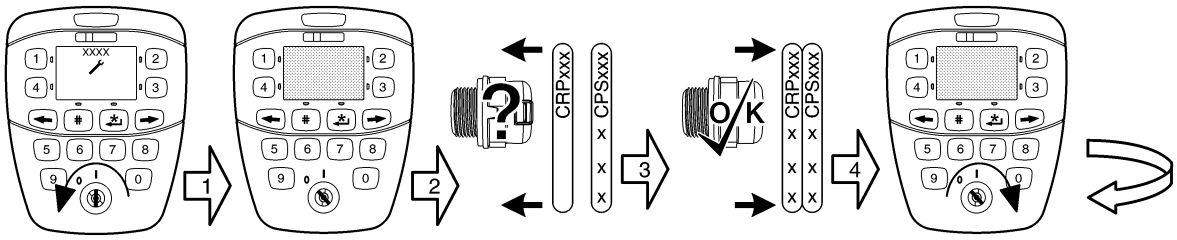
Repair OPEN Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.

CAUSE C1



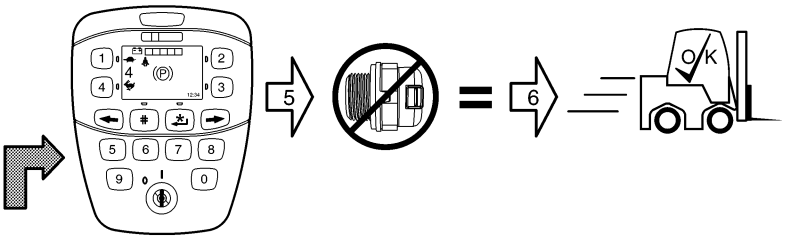
Retest - Power **ON**→	**NO**→Go to CAUSE C	Is fault DTC gone? **NO**←**YES**→	Fault corrected→Continue operation.

CAUSE D

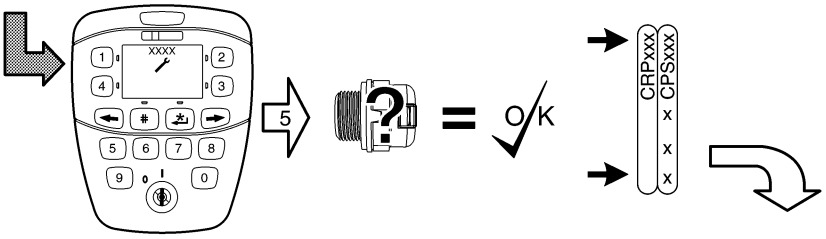


Power **OFF**→	Disconnect sensor.→ Install new sensor.→ **Do not discard**	Power **ON**→	Go to next step.↓

Hydraulic Fluid Level Sensor Out Of Range High (OORH) (Cont)

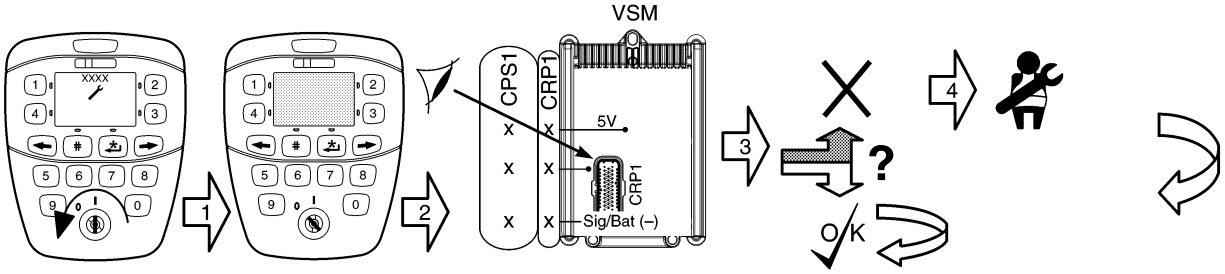


?	Fault DTC gone→	Old sensor faulty→	Resume operation



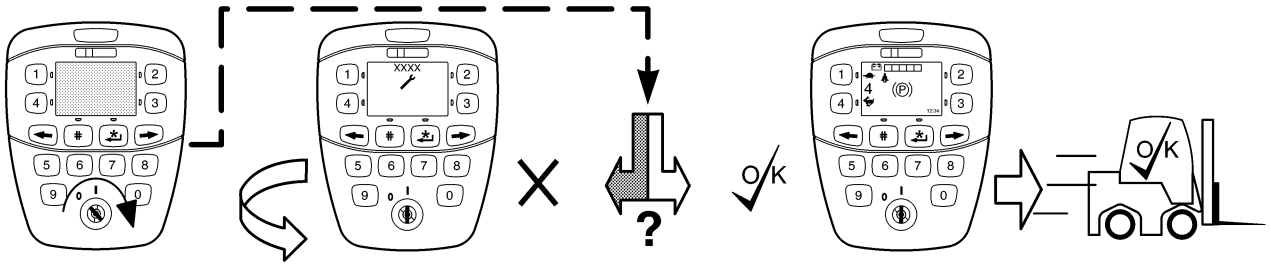
	Fault DTC present→	Old sensor OK/Reinstall old sensor→	Go to CAUSE D.

CAUSE E



Power **OFF**→	Inspect VSM Connections→	Go to Step 1.	Not OK Correct/ Repair→Go to Step 1.

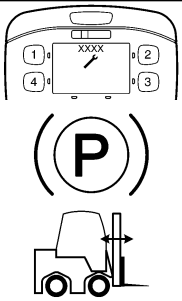
CAUSE E1



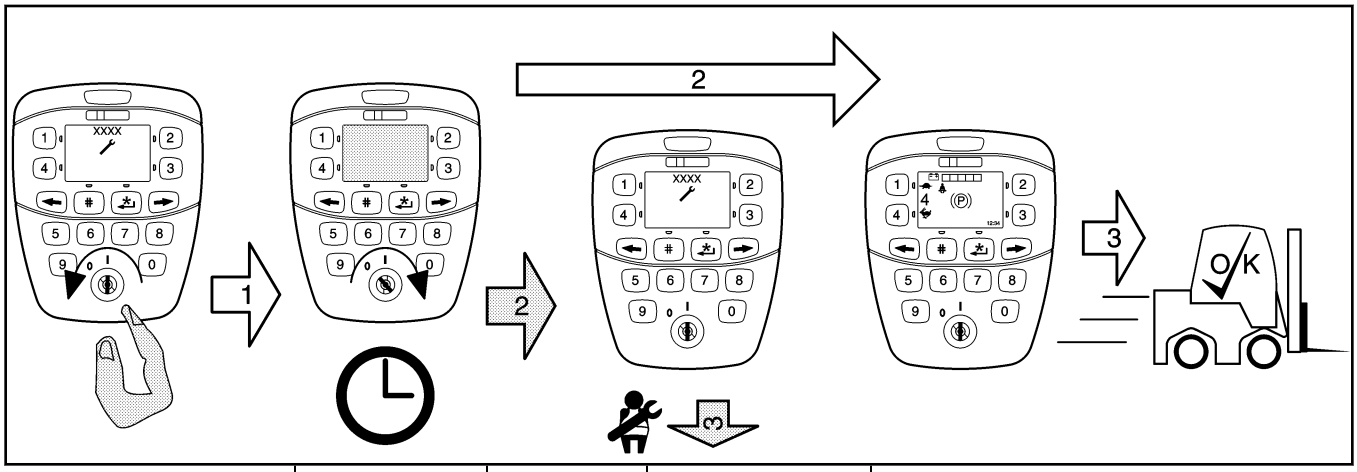
Retest - Power **ON**→	**NO**→Go to VSM Controller Check	Is fault DTC gone? **NO**←**YES**→	Fault corrected→Continue operation.

END FAULT

Park Brake/Mast Tilt Position Sensor Out of Range Low (OORL)



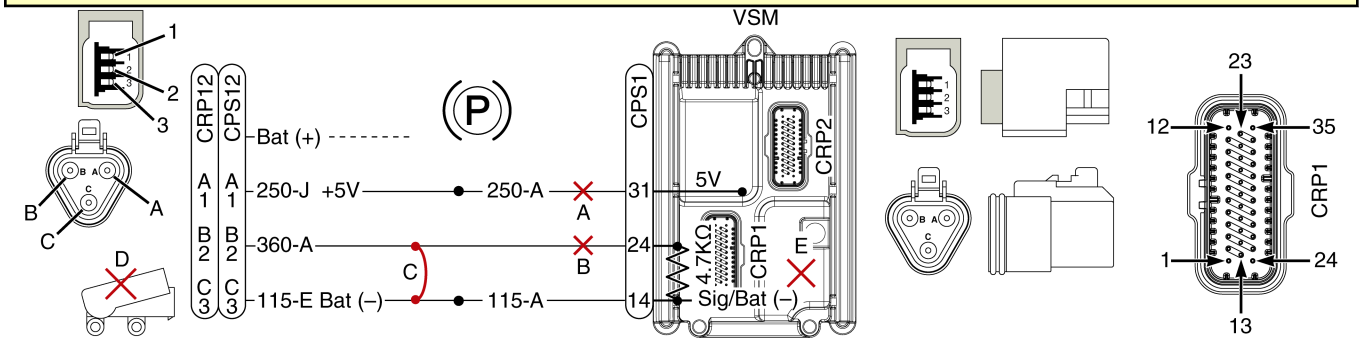
DTC 12832 **DTC 12840**
Park Brake Position **Mast Tilt Position**



Power **OFF**→	Wait **30 seconds**→	Power **ON**→	Fault remains. Service required. Go to Component Operational Check.	No fault→	Resume operation

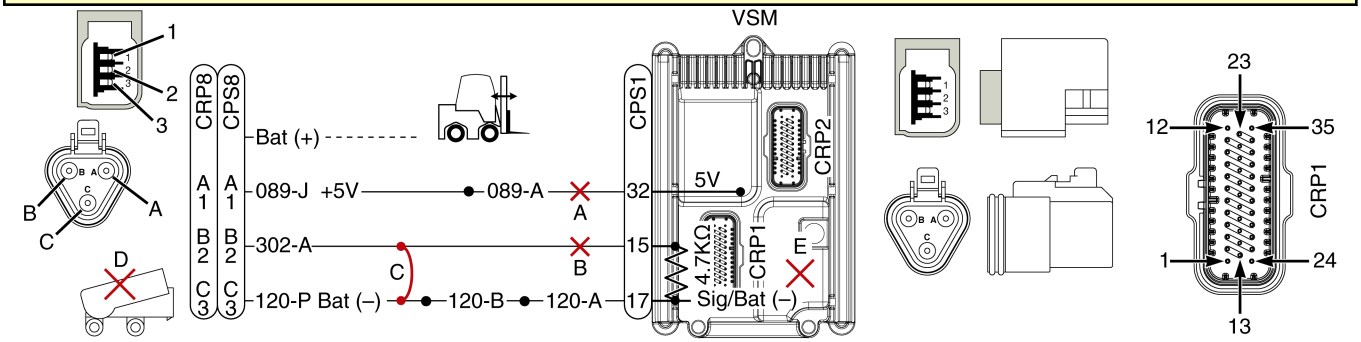
POSSIBLE CAUSE X = Open Circuit/Fail) = Short Circuit

PARK BRAKE POSITION CAUSES A B C D E > ?

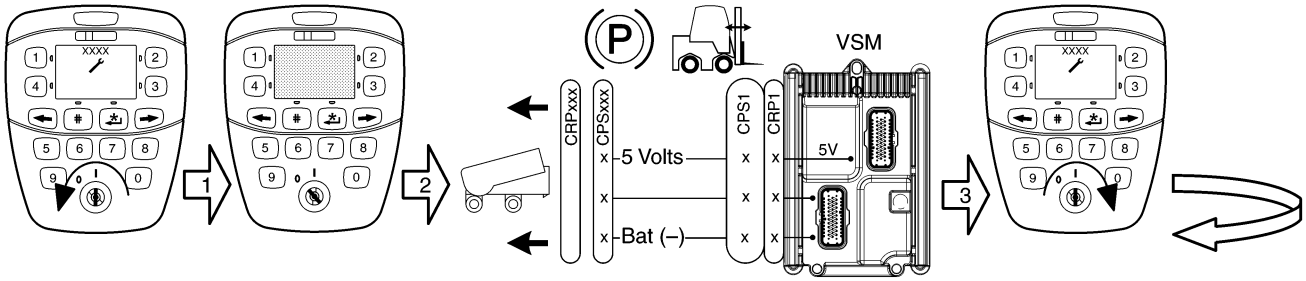


Park Brake/Mast Tilt Position Sensor Out of Range Low (OORL) (Cont)

MAST TILT POSITION CAUSES A B C D E > ?

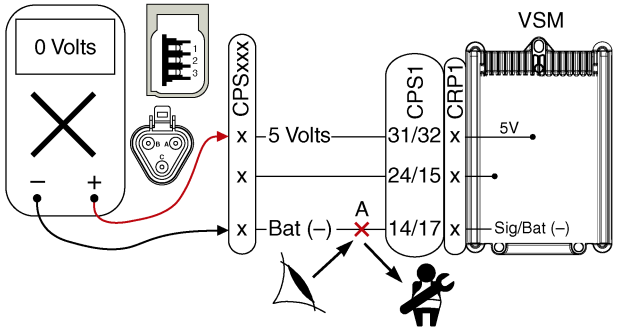


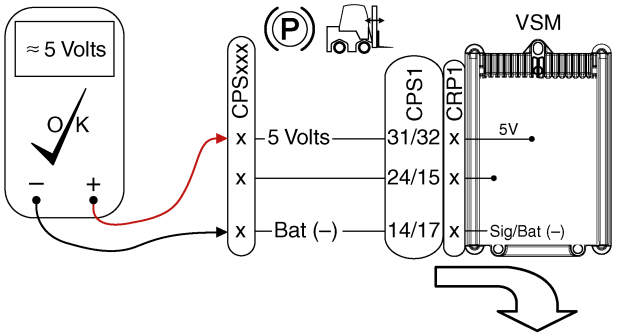
CAUSE A



Power **OFF**→	Disconnect sensor→	Power **ON**→	Go to next step.

CAUSE A1 CHECK VOLTAGE

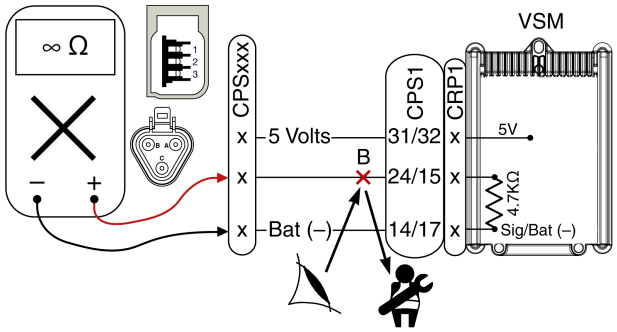


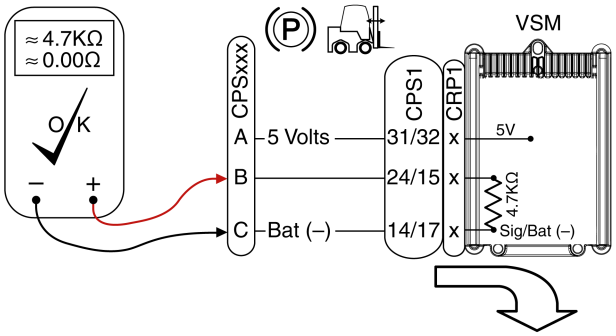


0 Volts = Open circuit→Find↑**OPEN** circuit.	˜ 5 Volts = **OK**	Go to CAUSE A.
Repair OPEN Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.		

Park Brake/Mast Tilt Position Sensor Out of Range Low (OORL) (Cont)

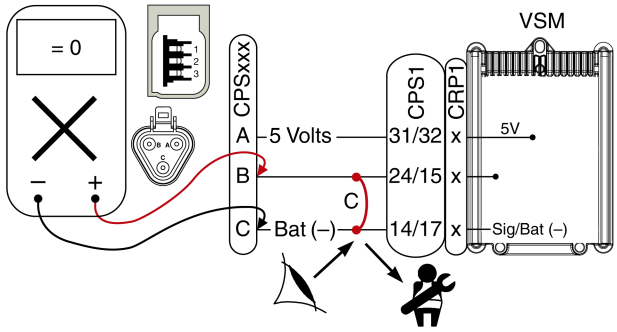
CAUSE B — CHECK RESISTANCE - Ω - OHMS





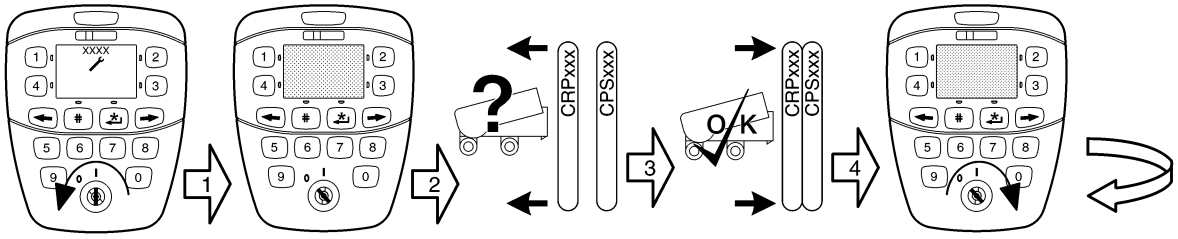
8 ? = Open circuit→Find↑**OPEN** circuit	˜ 4.7K? =	**OK**	Go to CAUSE C
Repair OPEN circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	˜ 0 ? =		Go to CAUSE B

CAUSE C — CHECK RESISTANCE - Ω - OHMS



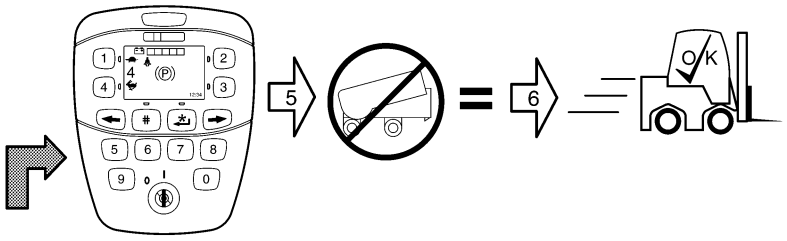
0 ? = Short circuit→Find↑**Short** circuit	
Repair Short circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	

CAUSE D

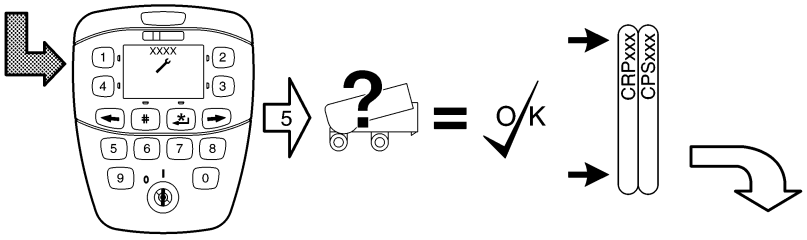


Power **OFF**→	Disconnect sensor.→ Install new sensor.→ **Do not discard**	Power **ON**→	Go to next step.

Park Brake/Mast Tilt Position Sensor Out of Range Low (OORL) (Cont)

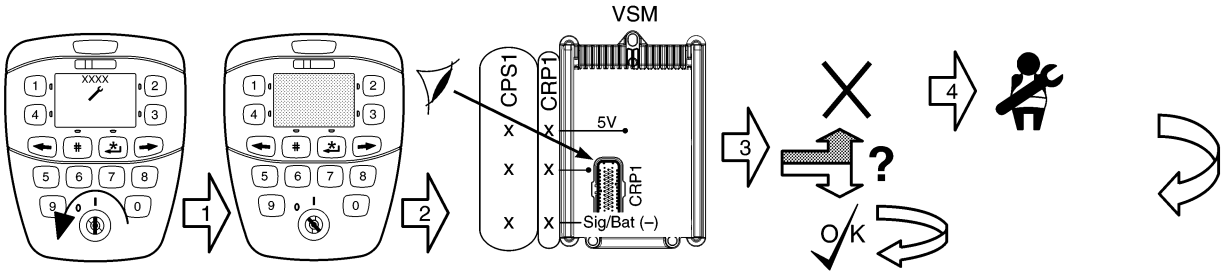


?	Fault DTC gone→	Old sensor faulty→	Resume operation



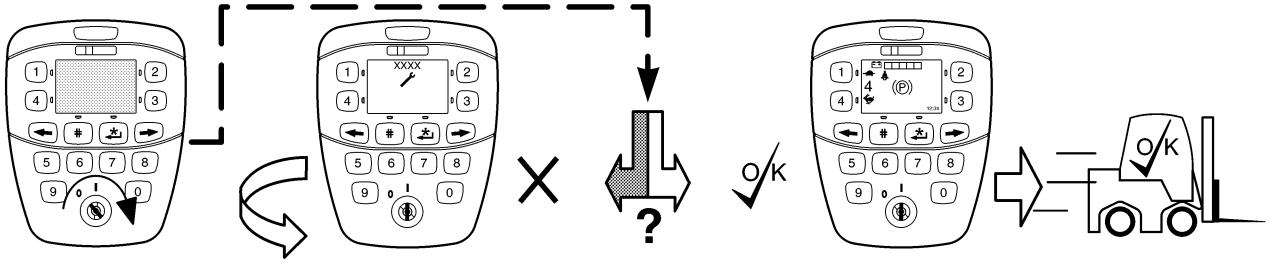
Fault DTC present→	Old sensor OK/Reinstall old sensor→	Go to CAUSE D.

CAUSE E



Power **OFF**→	Inspect VSM Connections→	Go to Step 1.	Not OK Correct/Repair→Go to Step 1.

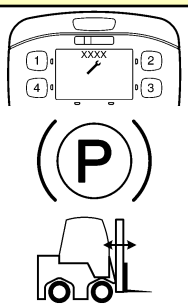
CAUSE E1



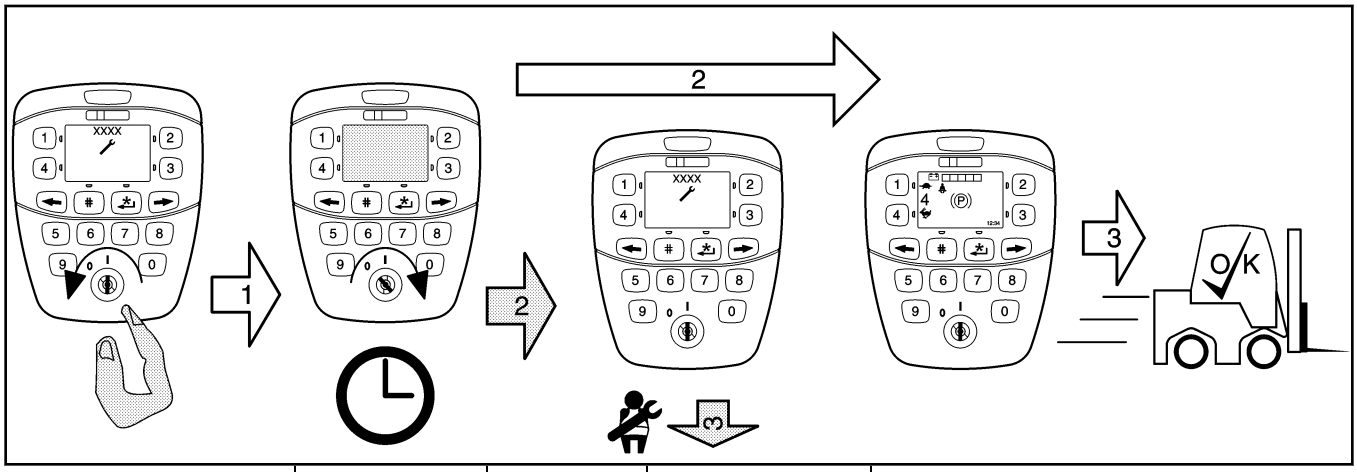
Retest - Power **ON**→	**NO**→Go to VSM Controller Check	Is fault DTC gone? **NO**←**YES**→	Fault corrected→Continue operation.

END FAULT

Park Brake/Mast Tilt Position Sensor Out of Range High (OORH)



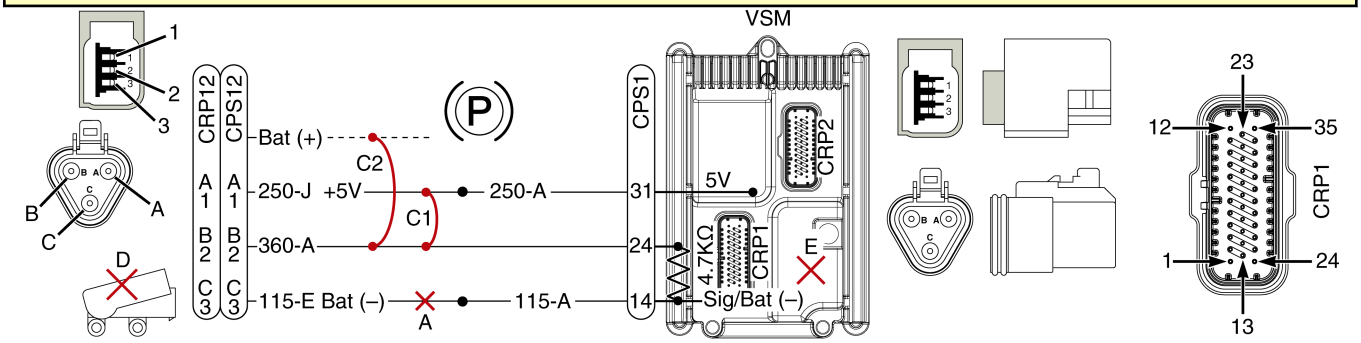
DTC 12831 **DTC 12841**
Park Brake Position **Mast Tilt Position**



Power **OFF**→	Wait **30 seconds**→	Power **ON**→	Fault remains. Service required. Go to Component Operational Check.	No fault→	Resume operation

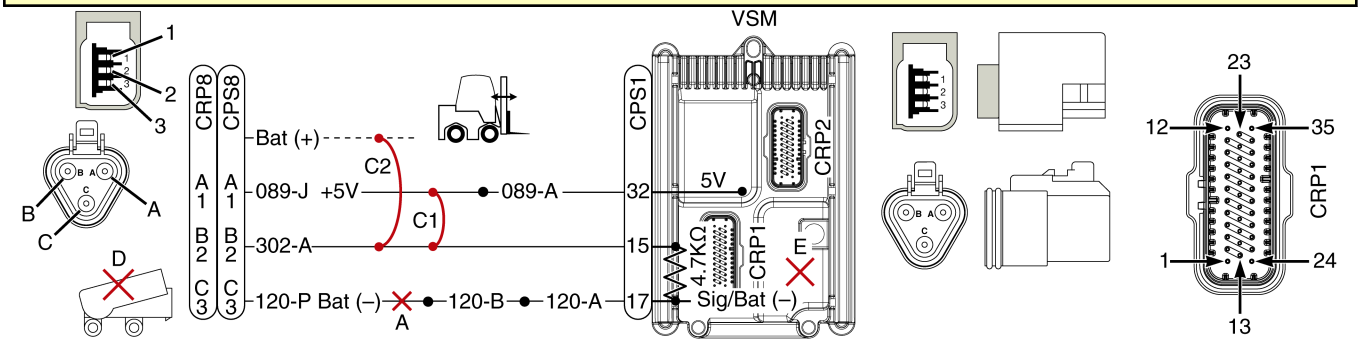
POSSIBLE CAUSE X = Open Circuit/Fail) = Short Circuit

PARK BRAKE POSITION CAUSES A B C D E > ?

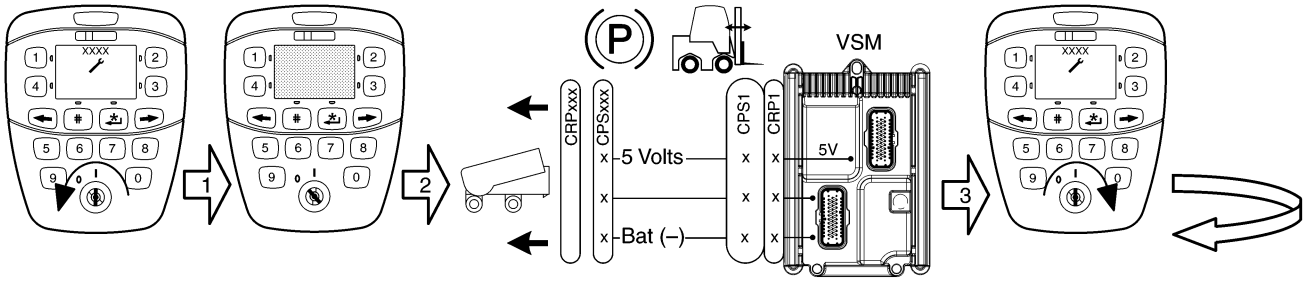


Park Brake/Mast Tilt Position Sensor Out of Range High (OORH) (Cont)

MAST TILT POSITION CAUSES A B C D E > ?

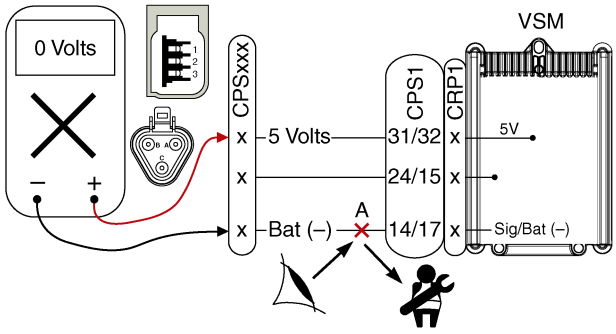


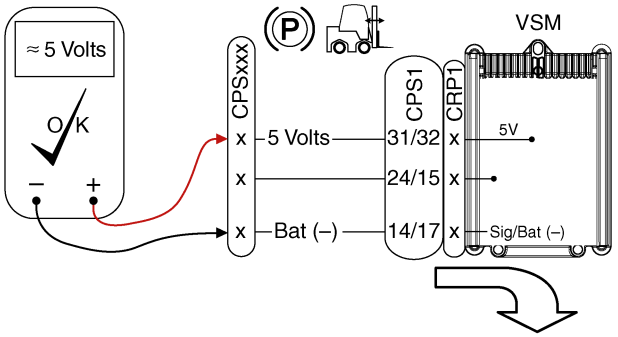
CAUSE A



Power **OFF**→	Disconnect sensor→	Power **ON**→	Go to next step.

CAUSE A1 CHECK VOLTAGE





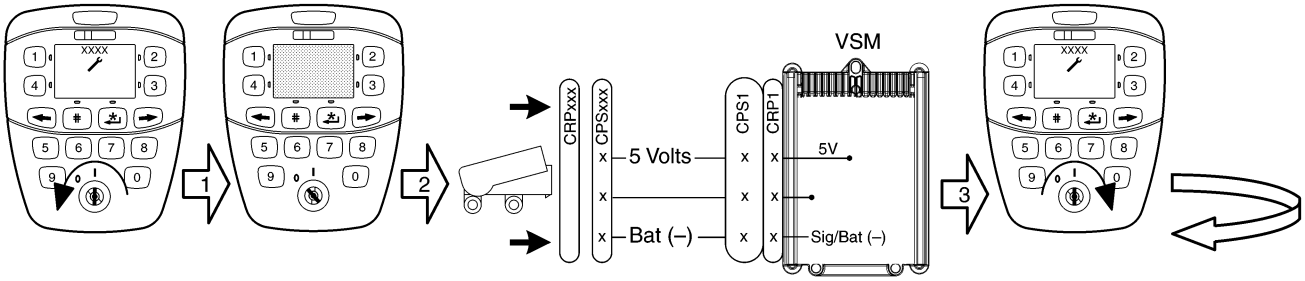
0 Volts = Open circuit→Find↑**OPEN** circuit.	~ 5 Volts =	**OK** Go to CAUSE B.
Repair OPEN Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.		

CAUSE B

Not Applicable

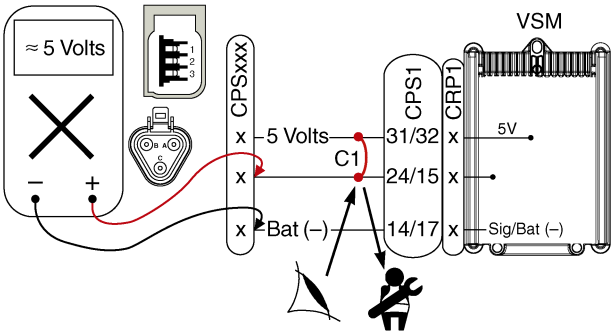
Park Brake/Mast Tilt Position Sensor Out of Range High (OORH) (Cont)

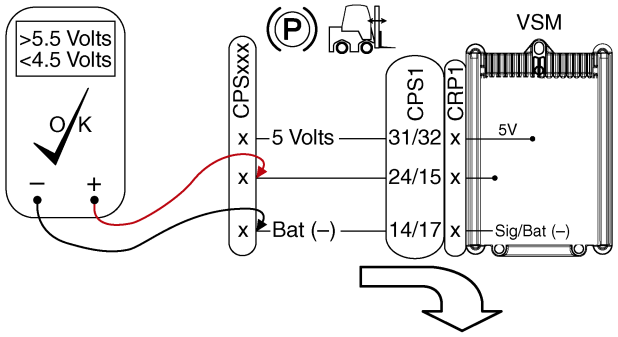
CAUSE C



Power **OFF**→	Reconnect sensor→	Power **ON**→	Go to next step.

CAUSE C1 CHECK VOLTAGE

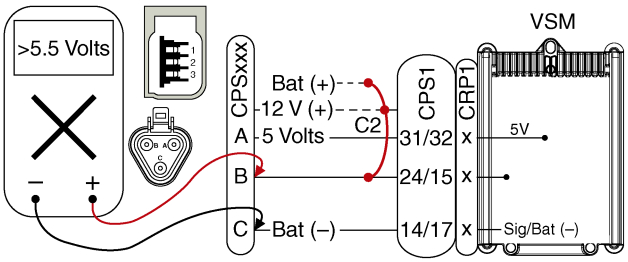


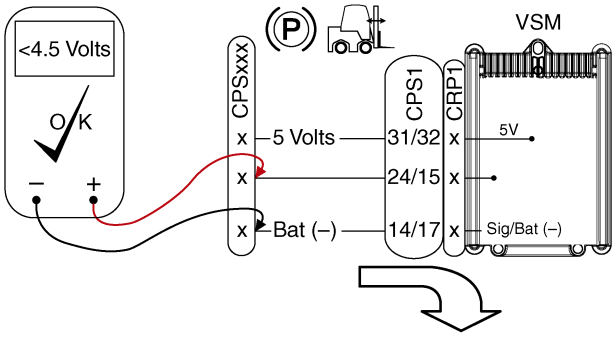


5 Volts = Short circuit→Find↑**Short** circuit.	> 5.5 volts		Go to Step 2
Repair Short Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	< 4.5 volts =	**OK**	Go to CAUSE C

CAUSE C2 CHECK VOLTAGE

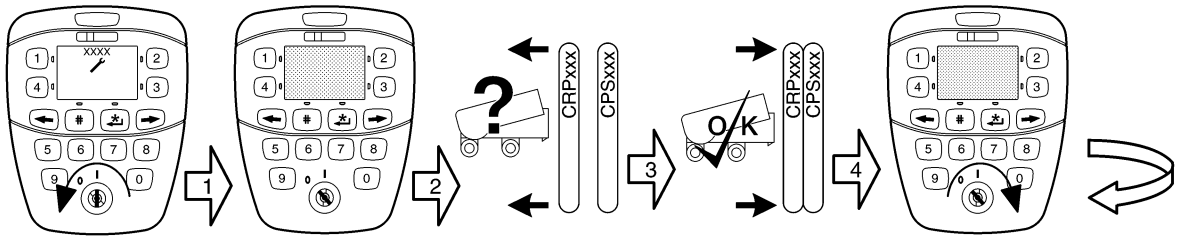
Switch and Unswitched



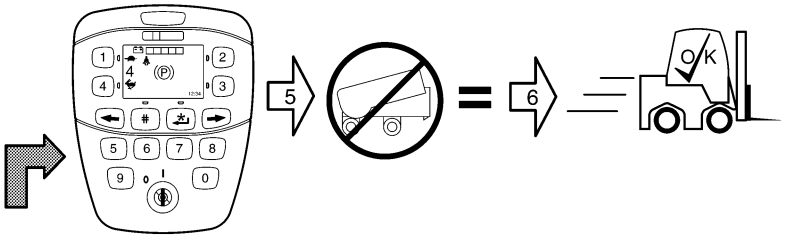


> 5.5 volts = Short circuit→Find↑**Short** circuit to another voltage source.	< 4.5 volts =	**OK**	Go to CAUSE C.
Repair Short circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.			

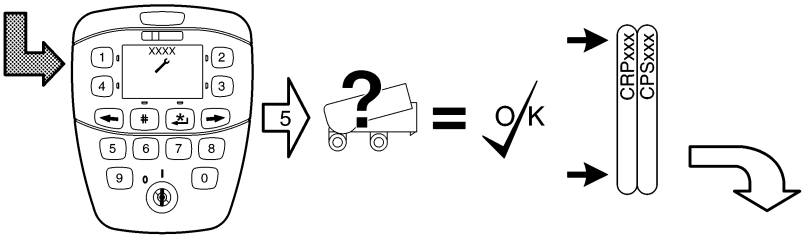
Park Brake/Mast Tilt Position Sensor Out of Range High (OORH) (Cont)
CAUSE D



Power **OFF**→	Disconnect sensor.→ Install new sensor.→ **Do not discard**	Power **ON**→	Go to next step.



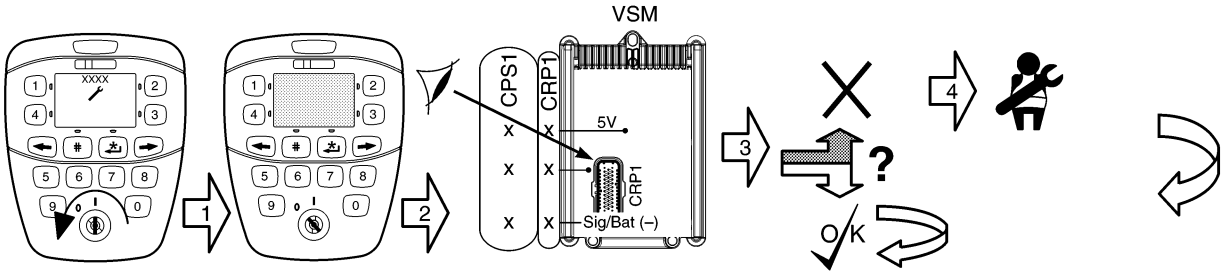
?	Fault DTC gone→	Old sensor faulty→	Resume operation



Fault DTC present→	Old sensor OK/Reinstall old sensor→	Go to CAUSE D.

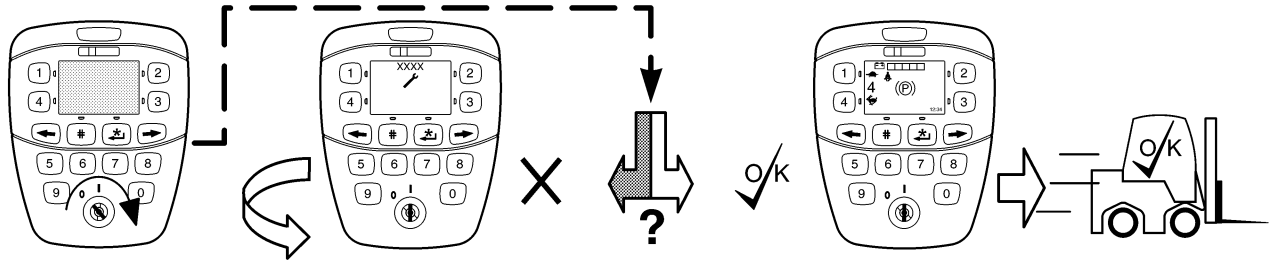
Park Brake/Mast Tilt Position Sensor Out of Range High (OORH) (Cont)

CAUSE E



Power **OFF**→	Inspect VSM Connections→	Go to Step 1.	Not OK Correct/Repair→Go to Step 1.

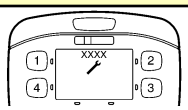
CAUSE E1



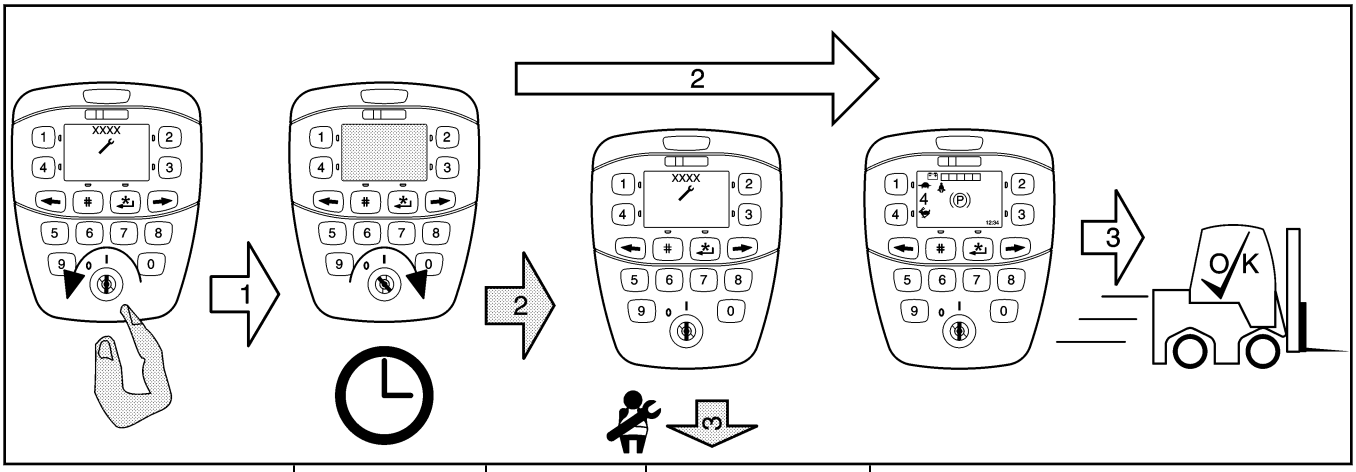
Retest - Power **ON**→	**NO**→Go to VSM Controller Check	Is fault DTC gone? **NO**←**YES**→	Fault corrected→Continue operation.

END FAULT

Travel Direction Select - Foot Pedal/Manual Hydraulic Out of Range Low (OORL)



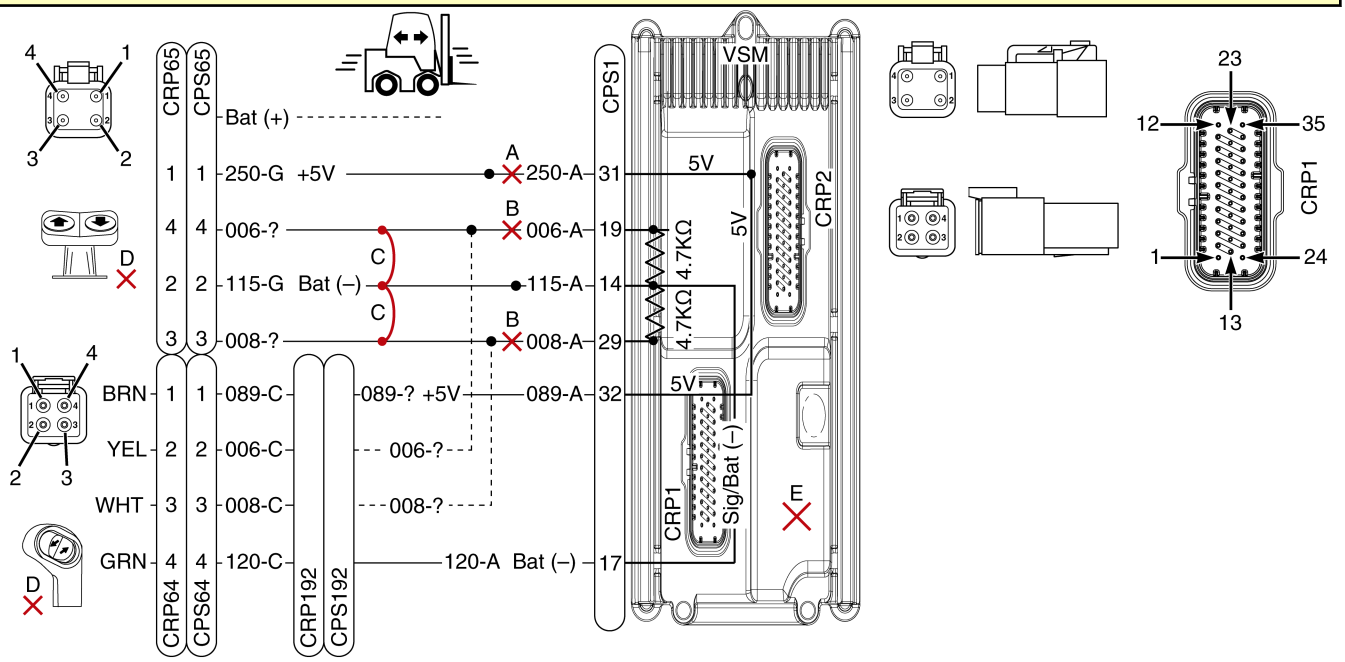
DTC 12800 **DTC 12804**
Directional Select ADirectional Select B



Power **OFF**→	Wait **30 seconds**→	Power **ON**→	Fault remains. Service required. Go to Component Operational Check.	No fault→	Resume operation

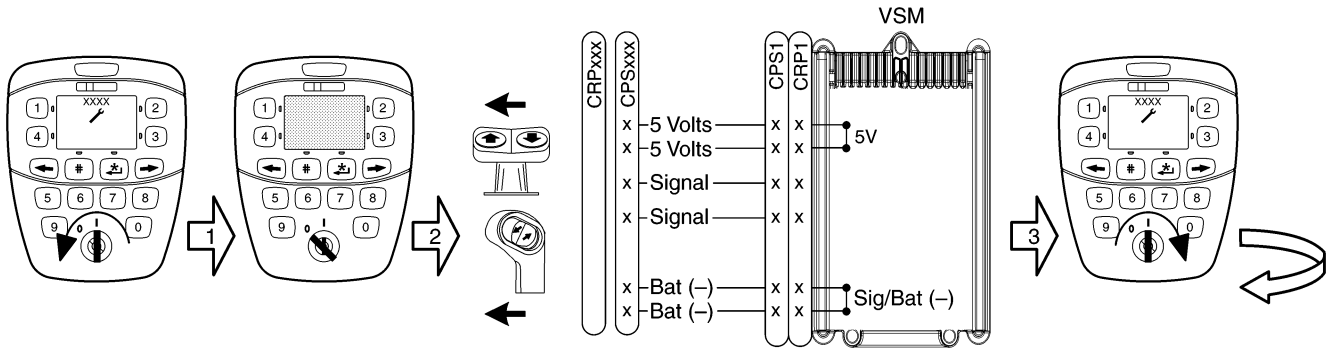
POSSIBLE CAUSE X = Open Circuit/Fail) = Short Circuit

DIRECTIONAL SELECT A/B CAUSES A B C D E > ?



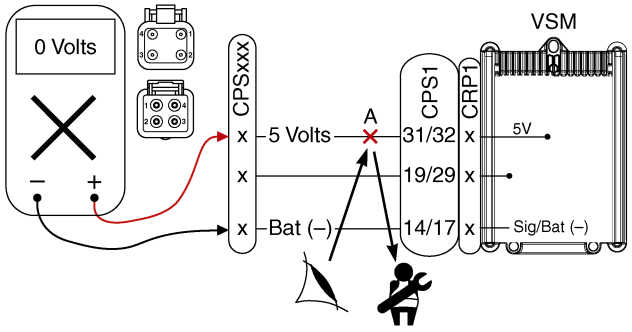
Travel Direction Select - Foot Pedal/Manual Hydraulic Out of Range Low (OORL) (Cont)

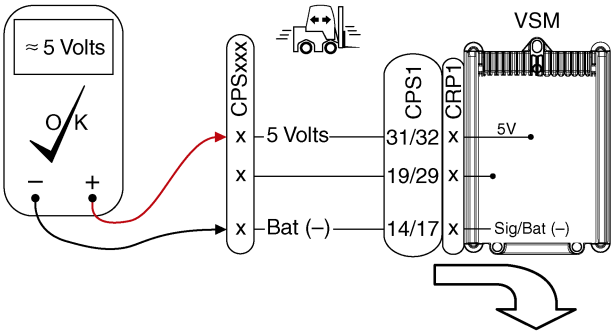
CAUSE A



Power **OFF**→	Disconnect sensor→	Power **ON**→	Go to next step.

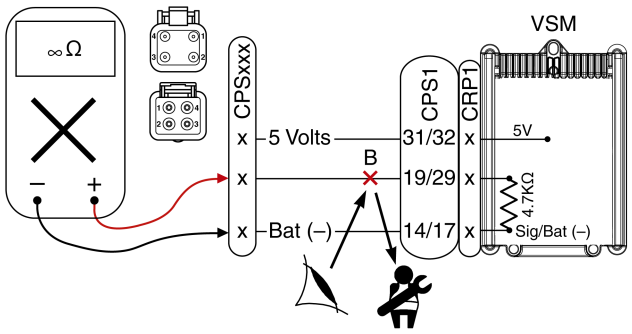
CAUSE A1 CHECK VOLTAGE

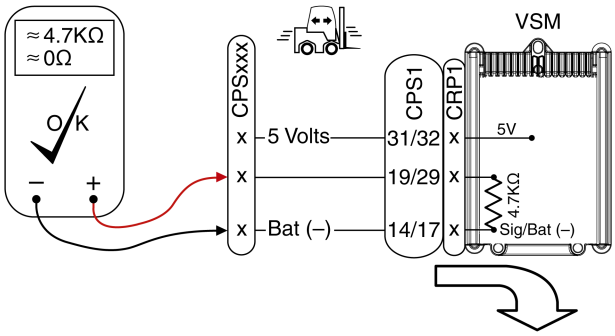




0 Volts = Open circuit→Find↑**OPEN** circuit.	˜ 5 Volts = **OK**	Go to CAUSE A.
Repair OPEN Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.		

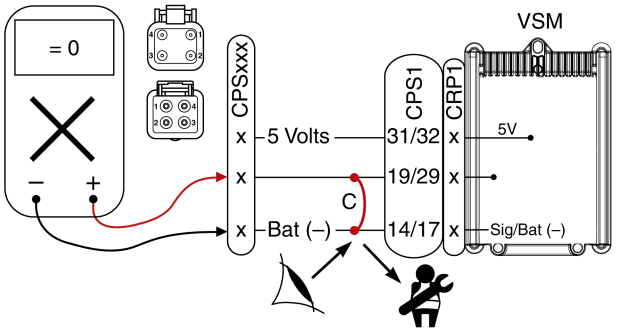
CAUSE B CHECK RESISTANCE - Ω - OHMS





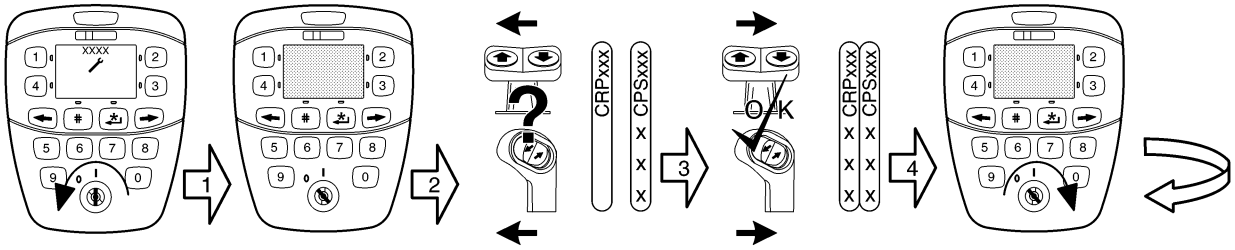
8 ? = Open circuit→Find↑**OPEN** circuit	˜ 4.7K? =	**OK**	Go to CAUSE C
Repair OPEN circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	˜ 0? =		Go to CAUSE B

Travel Direction Select - Foot Pedal/Manual Hydraulic Out of Range Low (OORL) (Cont)	
CAUSE C	**CHECK VOLTAGE**

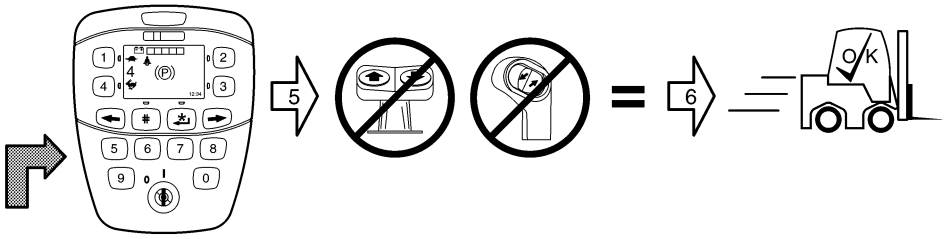


0 ? = Short circuit→Find↑**Short** circuit	
Repair Short circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	

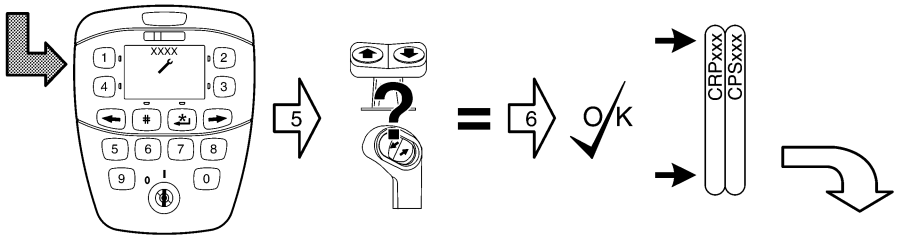
CAUSE D



Power **OFF**→	Disconnect Pedal or Hyd Lever.→ Install new component.→ **Do not discard**	Power **ON**→	Go to next step.



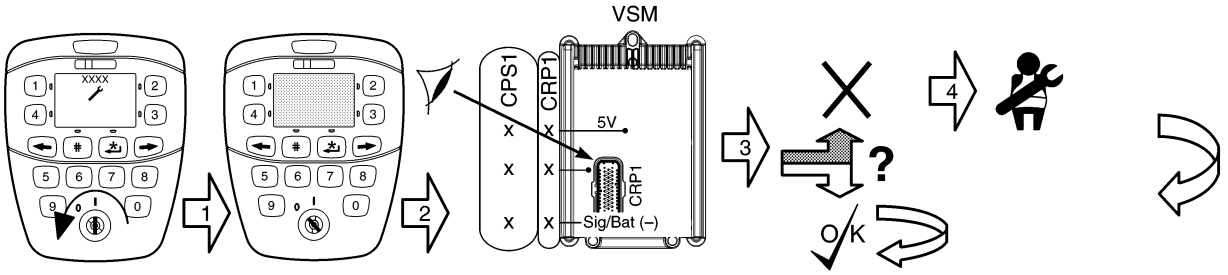
?	Fault DTC gone→	Old sensor faulty→	Resume operation



Fault DTC present→	Old sensor OK/Reinstall old sensor→	Go to CAUSE D.

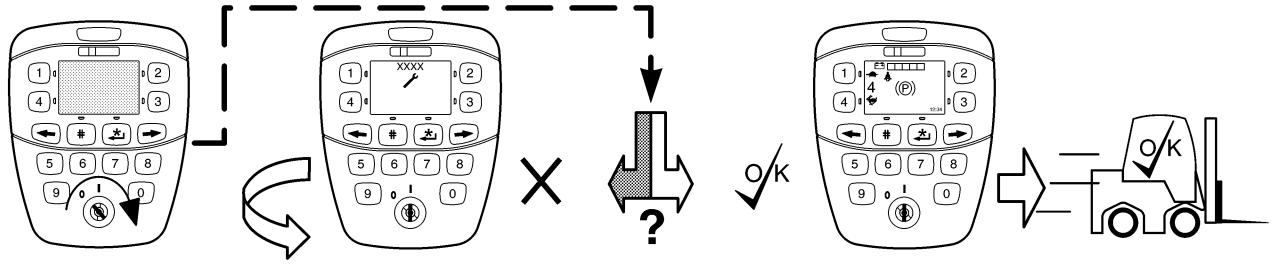
Travel Direction Select - Foot Pedal/Manual Hydraulic Out of Range Low (OORL) (Cont)

CAUSE E



Power **OFF**→	Inspect VSM Connections→	OK - Go to Step 1.	Not OK →Correct/Repair Go to Step 1.

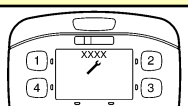
CAUSE E1



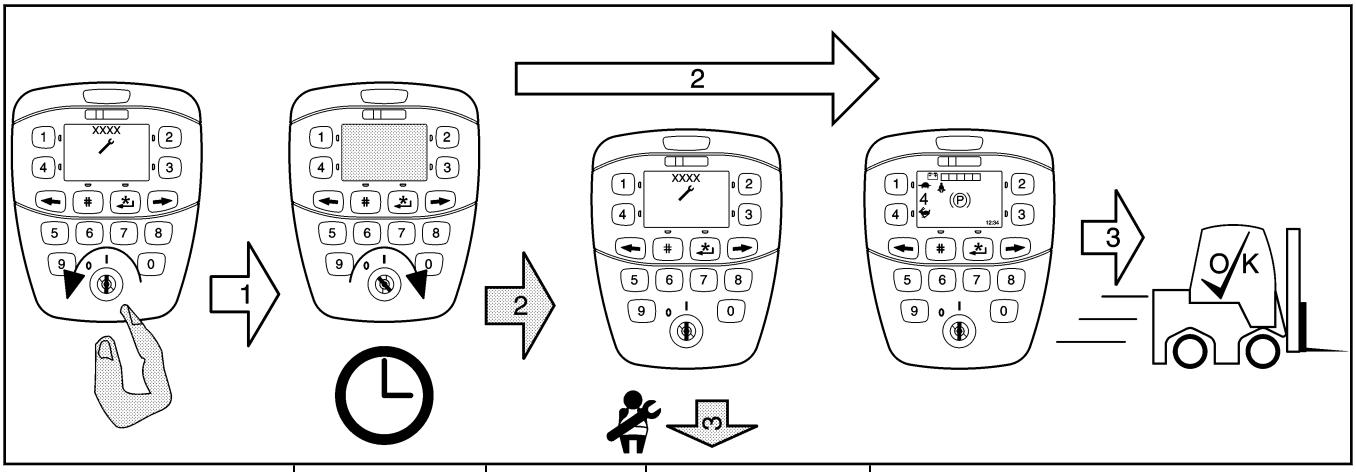
Retest - Power **ON**→	**NO**→Go to VSM Controller Check	Is fault DTC gone? **NO**←**YES**→	Fault corrected→Continue operation.

END FAULT

Travel Direction Select - Foot Pedal/Manual Hydraulic Out of Range High (OORH)



DTC 12801 **DTC 12805**
Directional Select A **Directional Select B**

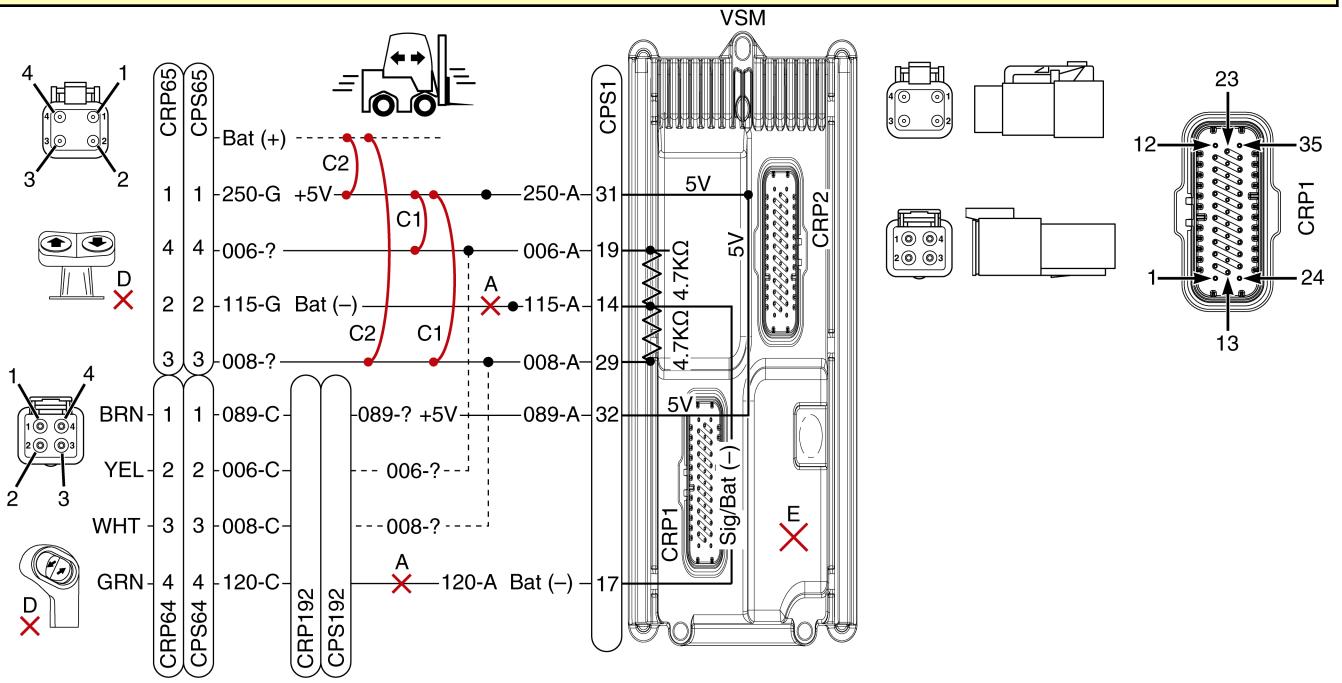


Power **OFF**→	Wait **30 seconds**→	Power **ON**→	Fault remains. Service required. Go to Component Operational Check.	No fault→	Resume operation

POSSIBLE CAUSE X = Open Circuit/Fail) = Short Circuit

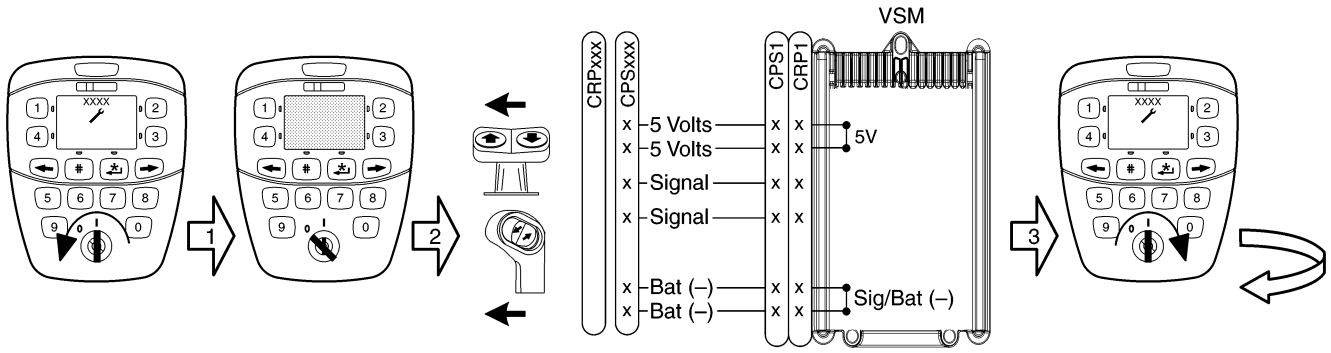
Travel Direction Select - Foot Pedal/Manual Hydraulic Out of Range High (OORH) (Cont)

DIRECTIONAL SELECT A/B CAUSES A B C D E > ?



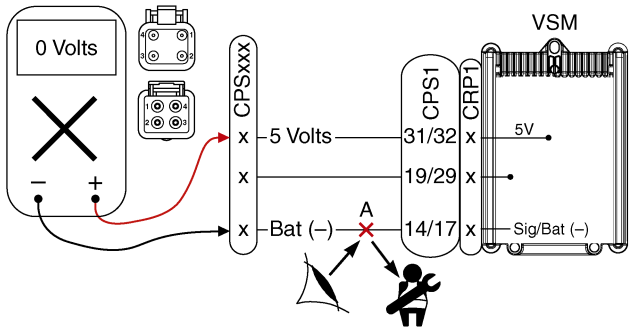
Travel Direction Select - Foot Pedal/Manual Hydraulic Out of Range High (OORH) (Cont)

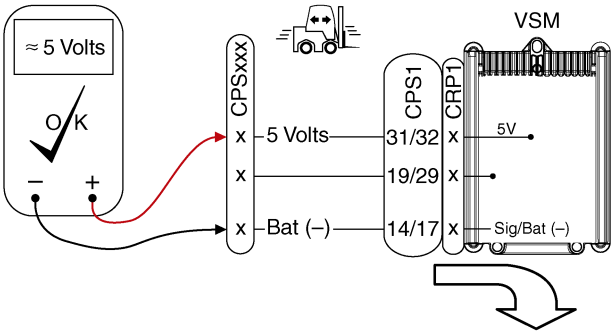
CAUSE A



Power **OFF**→	Disconnect sensor→	Power **ON**→	?

CAUSE A1 CHECK VOLTAGE





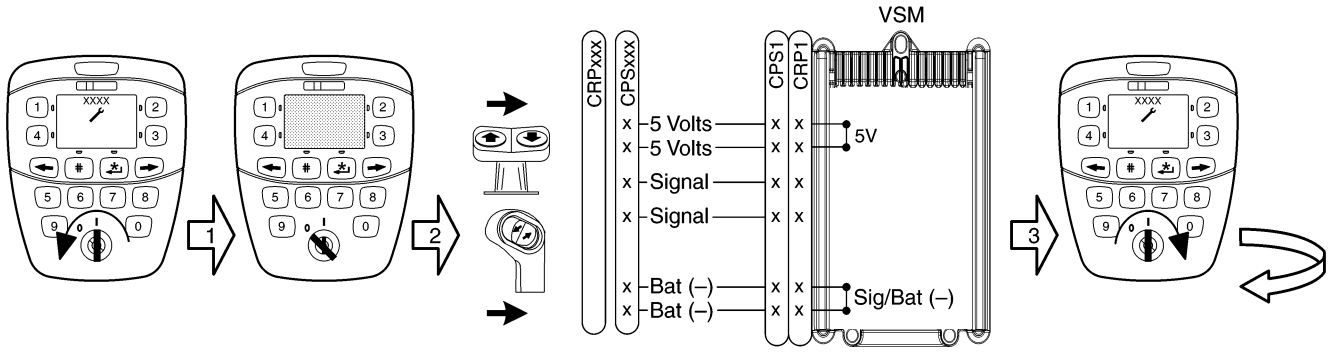
0 Volts = Open circuit→Find↑**OPEN** circuit.	˜ 5 Volts = **OK**	Go to CAUSE B.
Repair OPEN Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.		

CAUSE B

Not Applicable

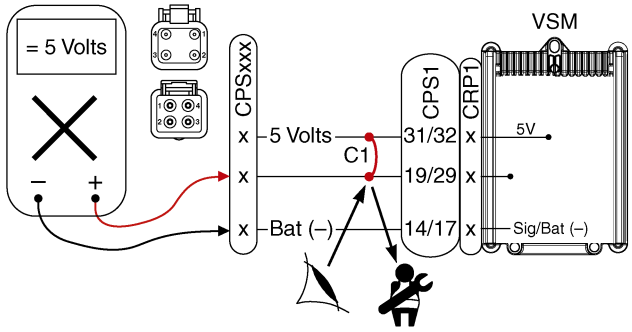
Travel Direction Select - Foot Pedal/Manual Hydraulic Out of Range High (OORH) (Cont)

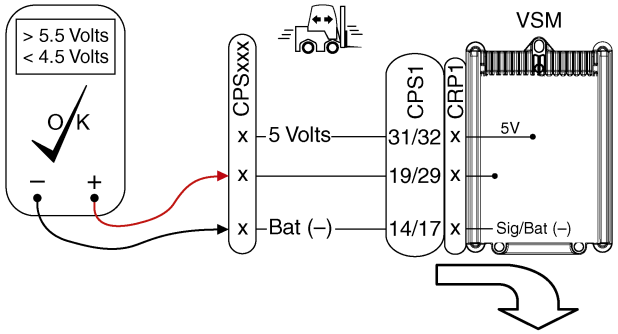
CAUSE C



Power **OFF**→	Reconnect sensor→	Power **ON**→	?

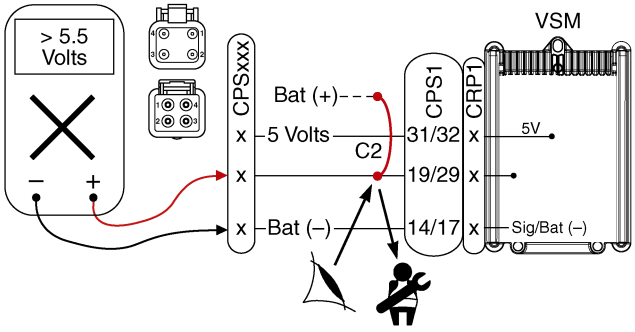
CAUSE C1 CHECK VOLTAGE

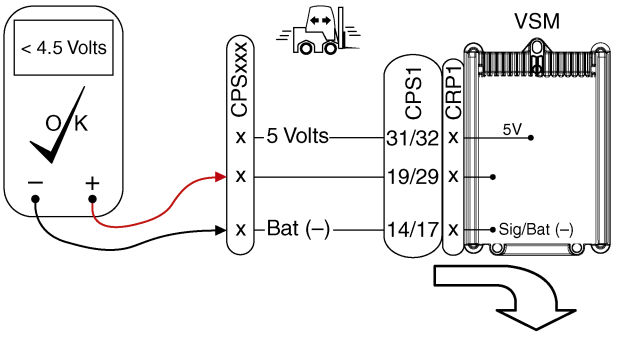




5 Volts = Short circuit→Find↑**Short** circuit.	> 5.5 Volts		Go to Step 2
Repair Short Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	< 4.5 volts =	**OK**	Go to CAUSE C

CAUSE C2 CHECK VOLTAGE

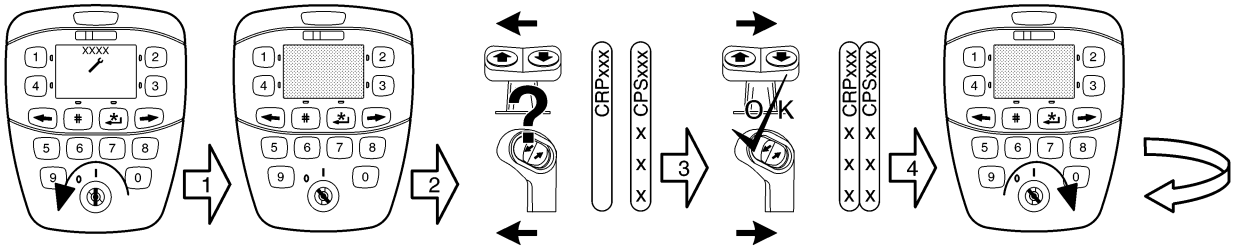




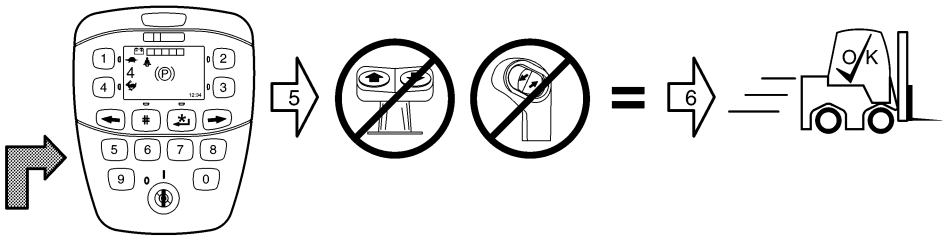
> 5.5 Volts = Short circuit→Find↑**Short** circuit to another voltage source.	< 4.5 volts =	**OK**	Go to CAUSE C.
Repair Short Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.			

Travel Direction Select - Foot Pedal/Manual Hydraulic Out of Range High (OORH) (Cont)

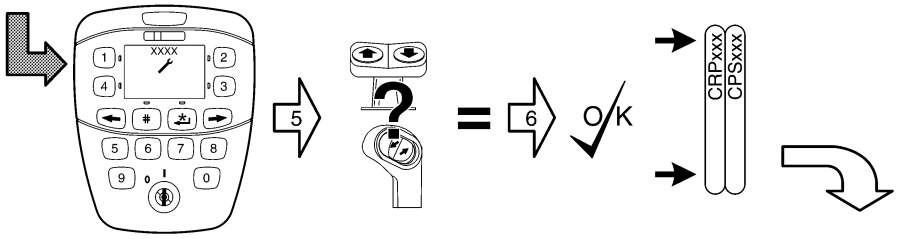
CAUSE D



Power **OFF**→ | Disconnect Pedal or Hyd Lever.→ Install new component.→ **Do not discard** | Power **ON**→ | Go to next step.



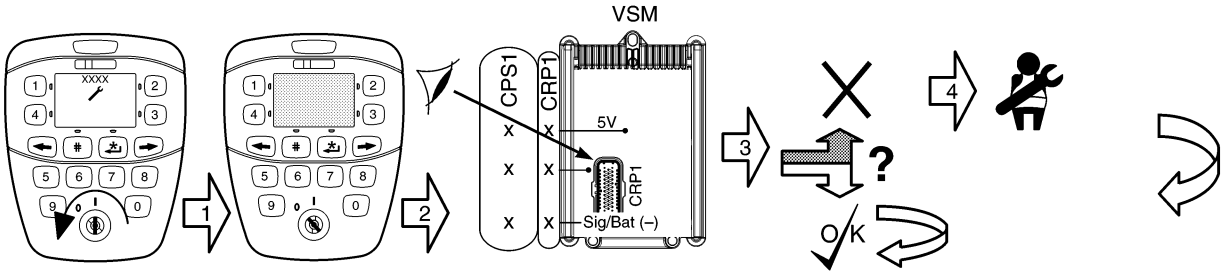
? | Fault DTC gone→ | Old sensor faulty→ | Resume operation



Fault DTC present→ | Old sensor OK/Reinstall old sensor→ | Go to CAUSE D.

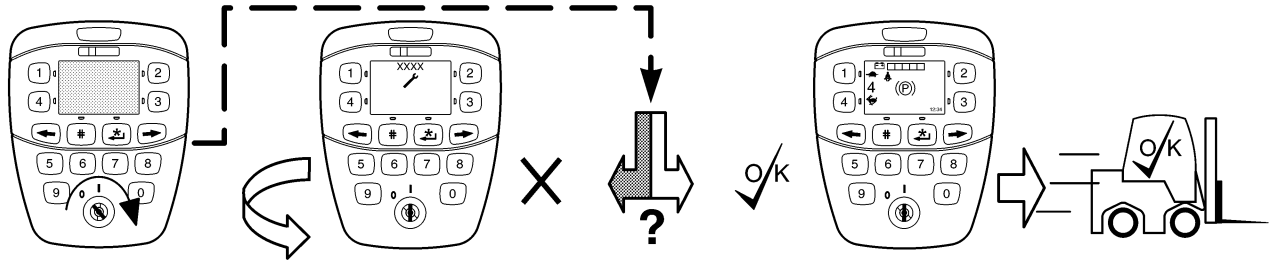
Travel Direction Select - Foot Pedal/Manual Hydraulic Out of Range High (OORH) (Cont)

CAUSE E



Power **OFF**→	Inspect VSM Connections→	Go to Step 1.	Not OK Correct/Repair→Go to Step 1.

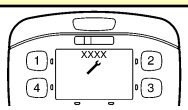
CAUSE E1



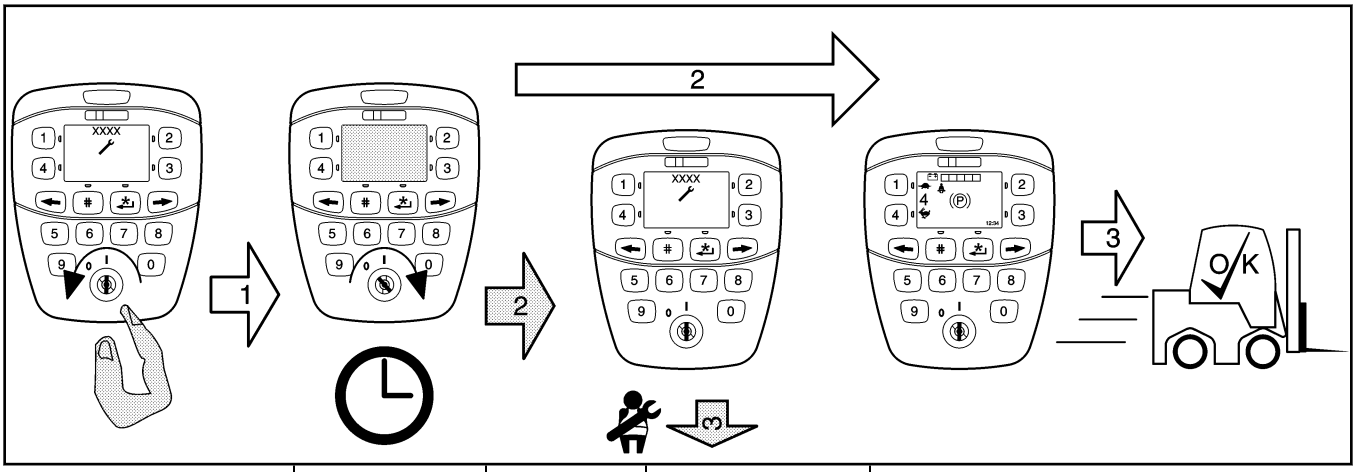
Retest - Power **ON**→	**NO**→Go to VSM Controller Check	Is fault DTC gone? **NO**←**YES**→	Fault corrected→Continue operation.

END FAULT

Seat Sensor Out of Range Low (OORL)



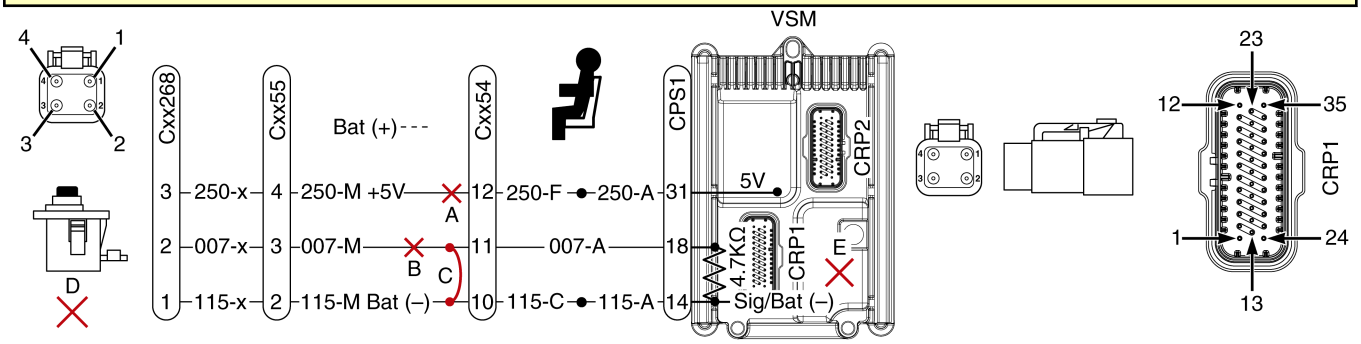
DTC 12816
Seat Sensor



Power **OFF**→	Wait **30 seconds**→	Power **ON**→	Fault remains. Service required. Go to Component Operational Check.	No fault→	Resume operation

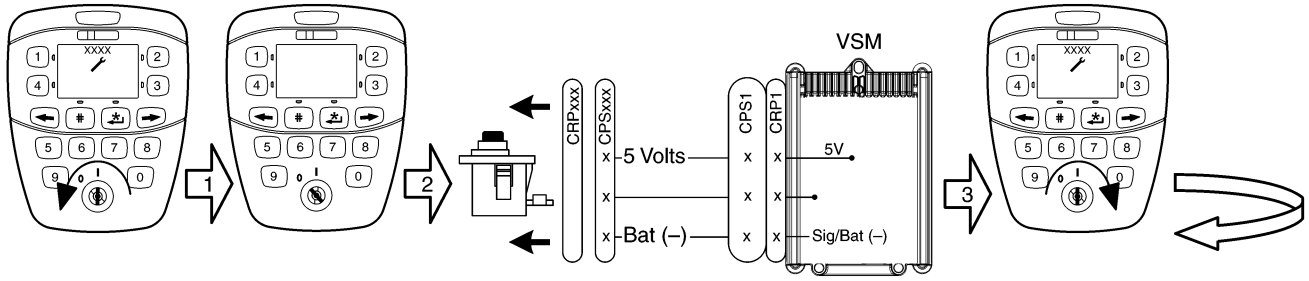
POSSIBLE CAUSE X = Open Circuit/Fail) = Short Circuit

SEAT SENSOR CAUSES A B C D E > ?



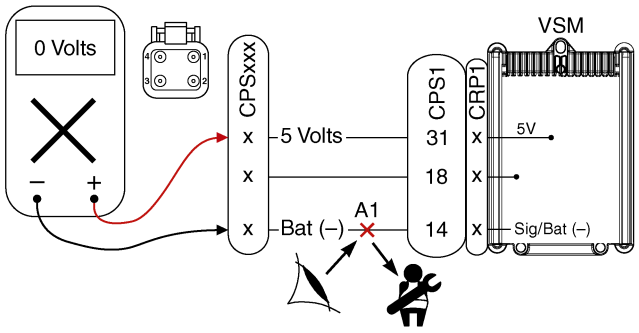
Seat Sensor Out of Range Low (OORL) (Cont)

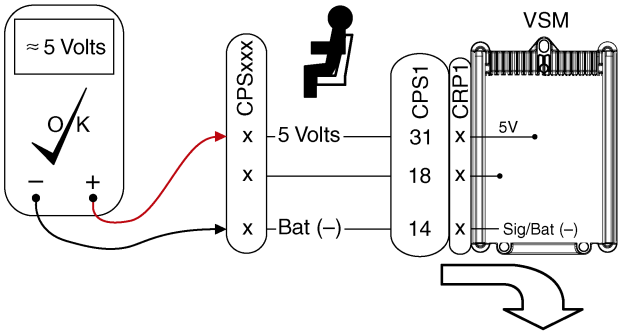
CAUSE A



Power **OFF**→	Disconnect sensor→	Power **ON**→	Go to next step.

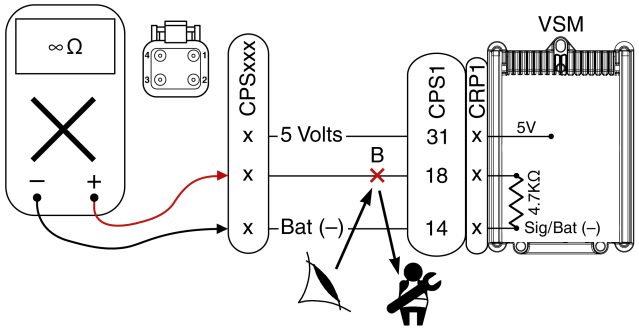
CAUSE A1 CHECK VOLTAGE

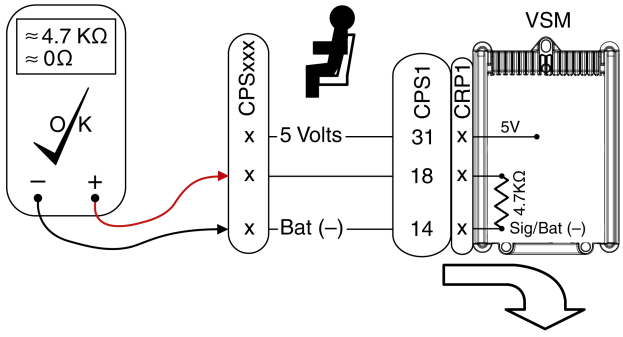




0 Volts = Open circuit→Find↑**OPEN** circuit.	˜ 5 Volts = **OK**	For Service Brake Pressure, go to CAUSE A
Repair OPEN Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.		For Load Weigh Pressure, go to CAUSE B

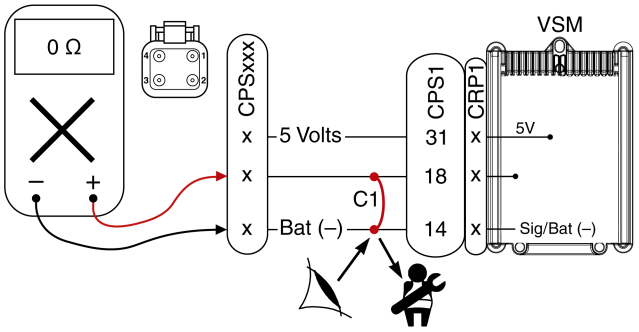
CAUSE B CHECK RESISTANCE - Ω - OHMS





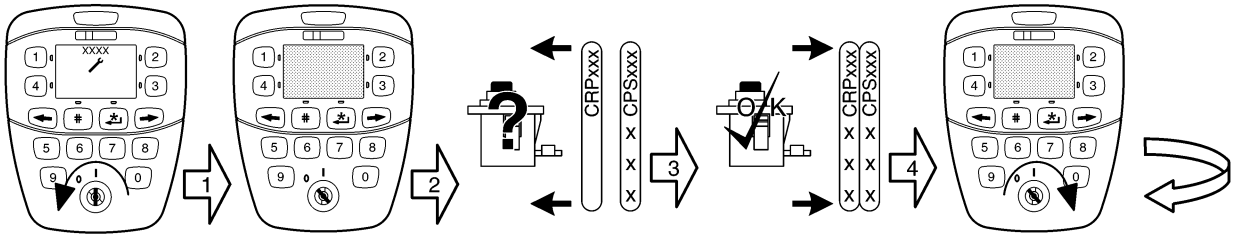
8 ? = Open circuit→Find↑**OPEN** circuit	˜ 4.7K? = **OK**	Go to CAUSE C
Repair OPEN circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	˜ 0 ? =	Go to CAUSE B

Seat Sensor Out of Range Low (OORL) (Cont)	
CAUSE C **CHECK RESISTANCE - Ω - OHMS**	

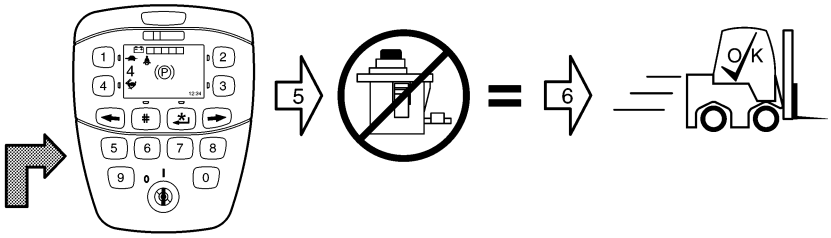


0 ? = Short circuit→Find↑**Short** circuit	
Repair Short circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	

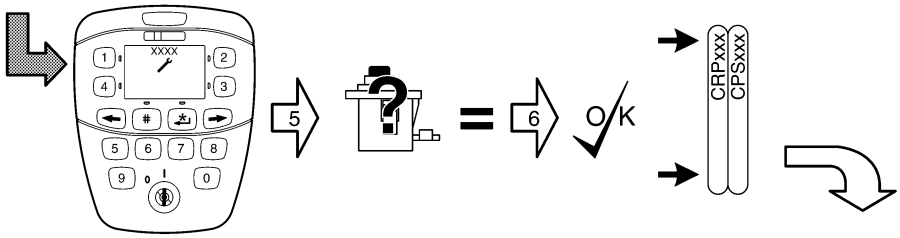
CAUSE D



Power **OFF**→	Disconnect sensor.→ Install new sensor.→ **Do not discard**	Power **ON**→	Go to next step.



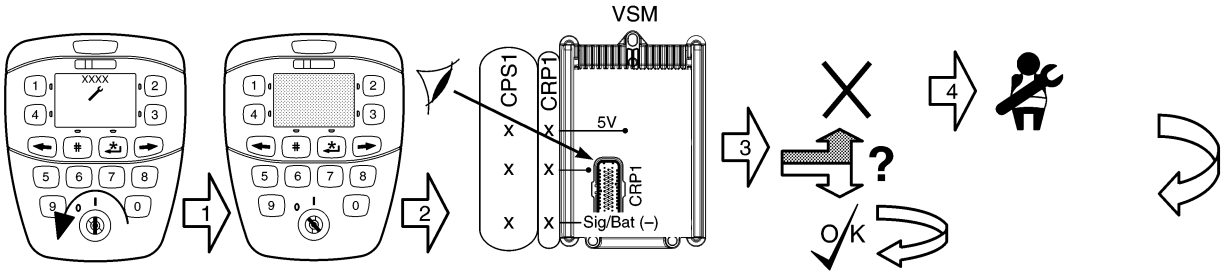
?	Fault DTC gone→	Old sensor faulty→	Resume operation



Fault DTC present→	Old sensor OK/Reinstall old sensor→	Go to CAUSE D.

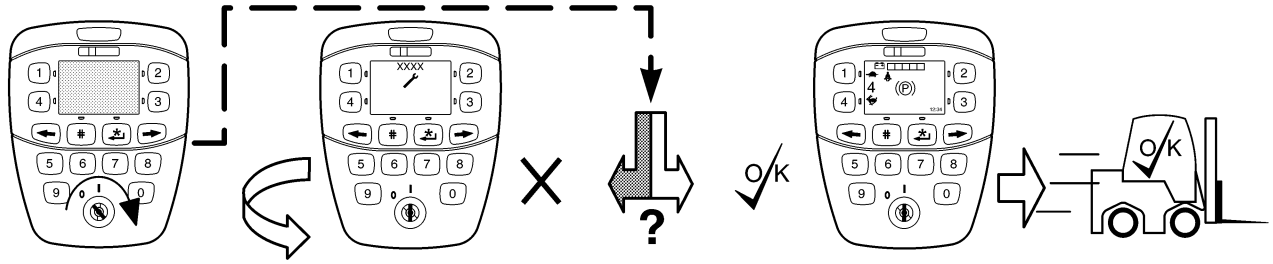
Seat Sensor Out of Range Low (OORL) (Cont)

CAUSE E



Power **OFF**→	Inspect VSM Connections→	Go to Step 1.	Not OK Correct/Repair→Go to Step 1.

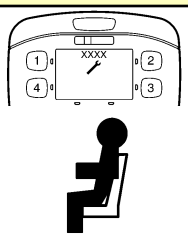
CAUSE E1



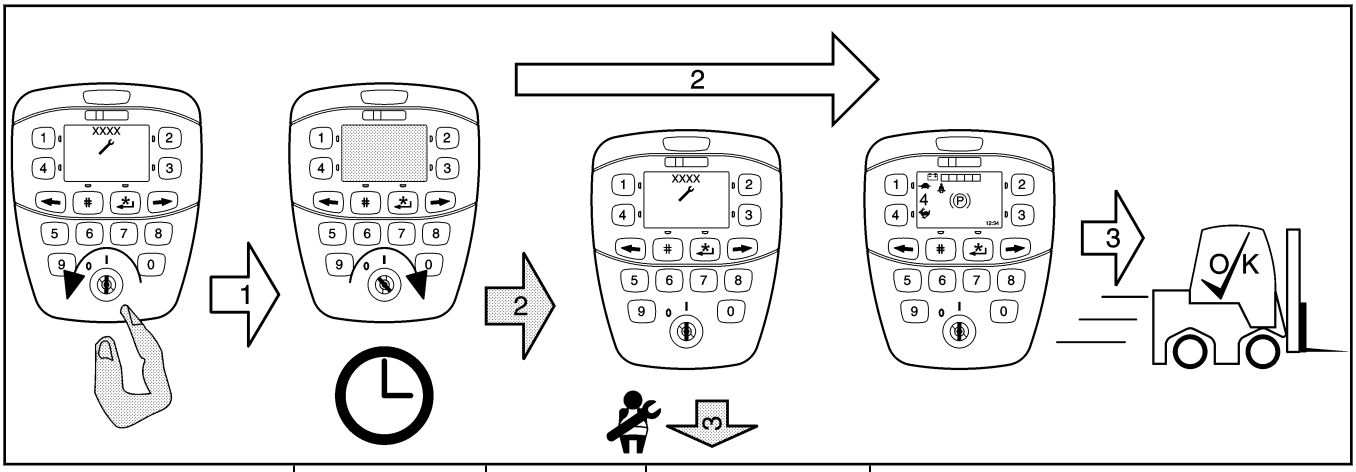
Retest - Power **ON**→	**NO**→Go to VSM Controller Check	Is fault DTC gone? **NO**←**YES**→	Fault corrected→Continue operation.

END FAULT

Seat Sensor Out of Range High (OORH)



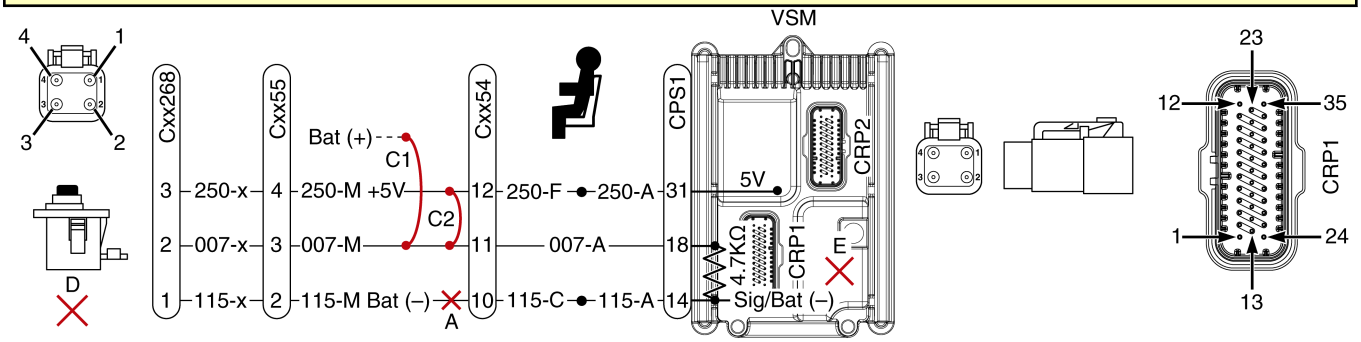
DTC 12819
Seat Sensor



Power **OFF**→	Wait **30 seconds**→	Power **ON**→	Fault remains. Service required. Go to Component Operational Check.	No fault→	Resume operation

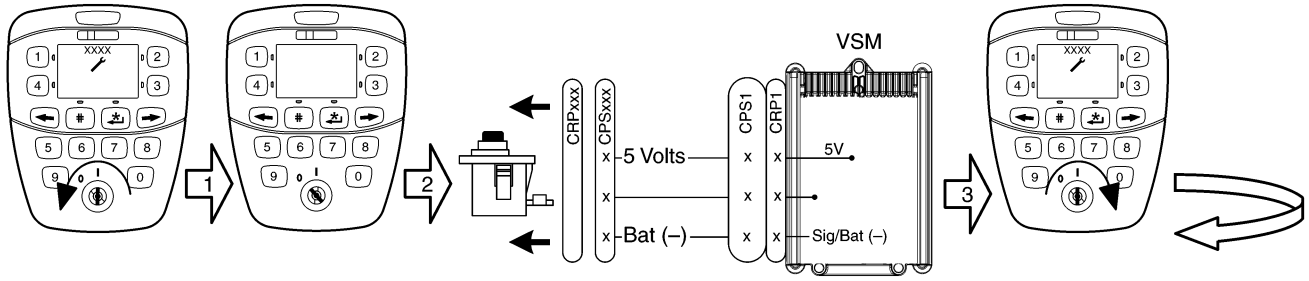
POSSIBLE CAUSE X = Open Circuit/Fail) = Short Circuit

LOAD WEIGH PRESSURE CAUSES A B C D E > ?



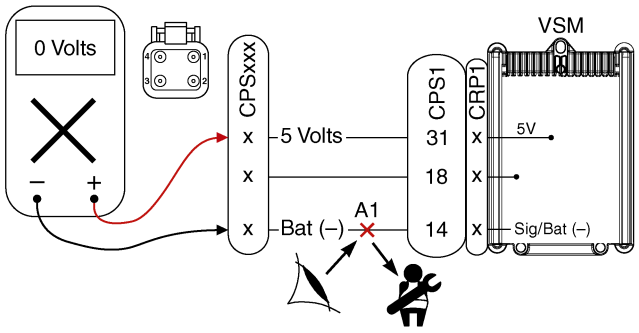
Seat Sensor Out of Range High (OORH) (Cont)

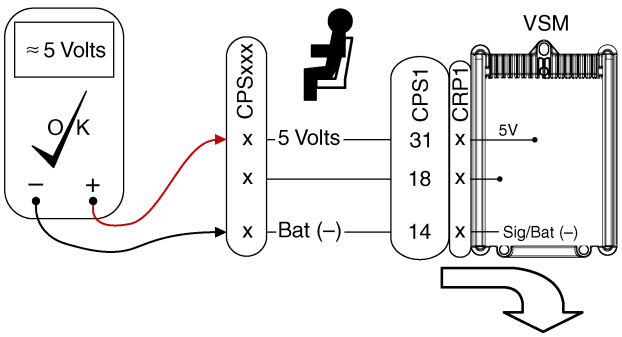
CAUSE A



Power **OFF**→	Disconnect sensor→	Power **ON**→	Go to next step.

CAUSE A1 CHECK VOLTAGE





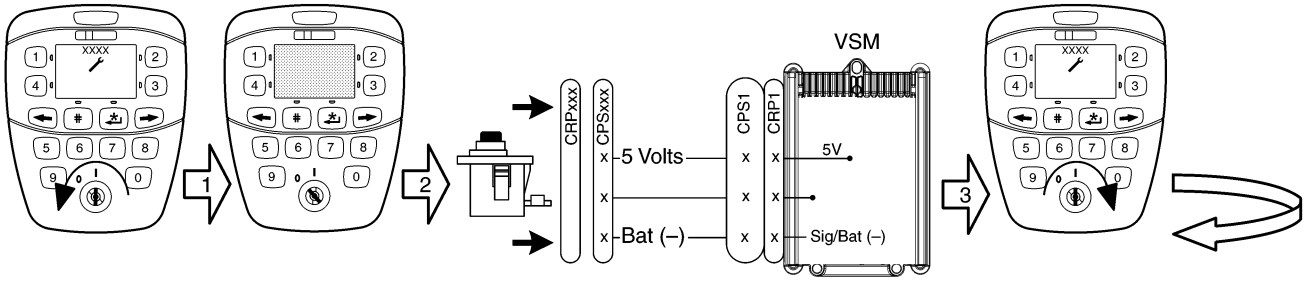
0 Volts = Open circuit→Find↑**OPEN** circuit.	˜ 5 Volts = **OK**	Go to CAUSE B
Repair OPEN Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.		

CAUSE B

Not Applicable

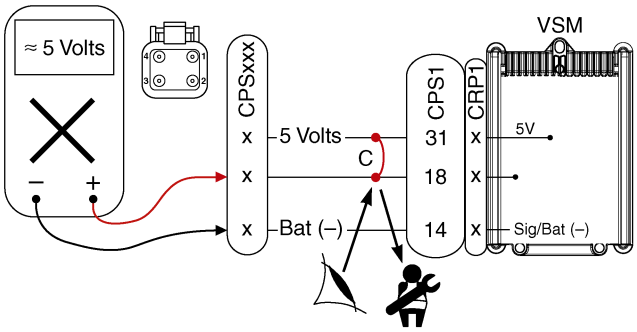
Seat Sensor Out of Range High (OORH) (Cont)

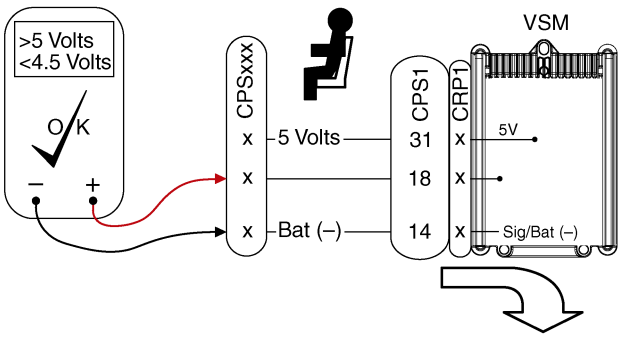
CAUSE C



Power **OFF**→	Reconnect sensor→	Power **ON**→	Go to next step.

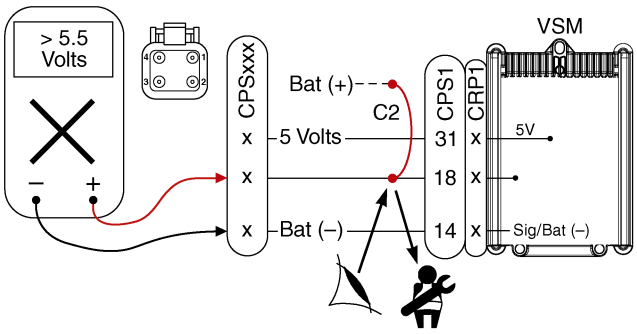
CAUSE C1 CHECK VOLTAGE

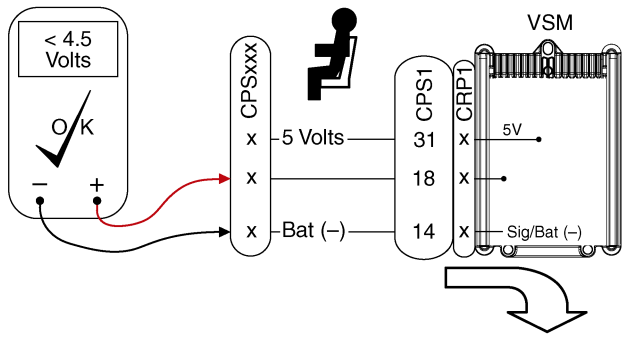




5 Volts = Short circuit→Find↑**Short** circuit.	> 5.5 volts =	**OK**	Go to Step 2
Repair Short Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	< 4.5 volts =		Go to CAUSE C

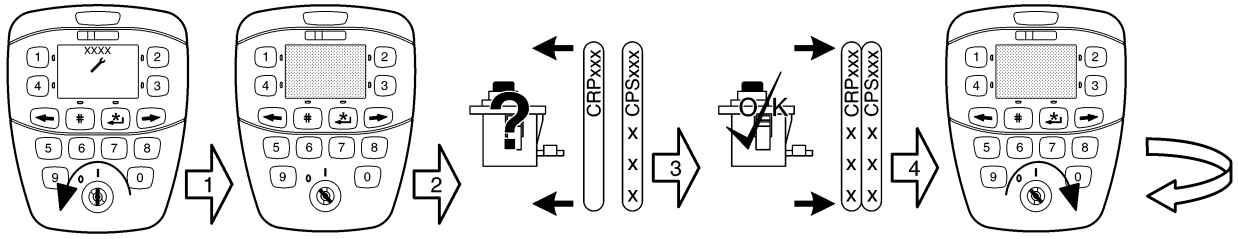
CAUSE C2 CHECK VOLTAGE



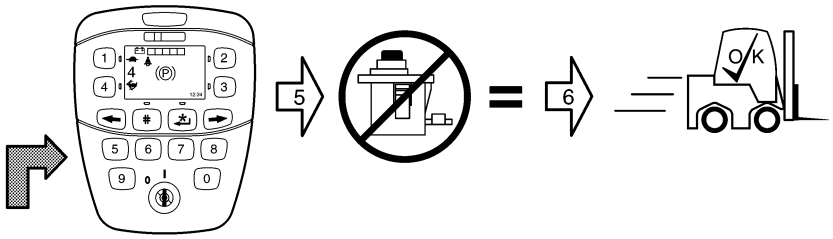


> 5.5 volts = Short circuit→Find↑**Short** circuit to another voltage source.	< 4.5 volts =	**OK**	Go to CAUSE C
Repair Short circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.			

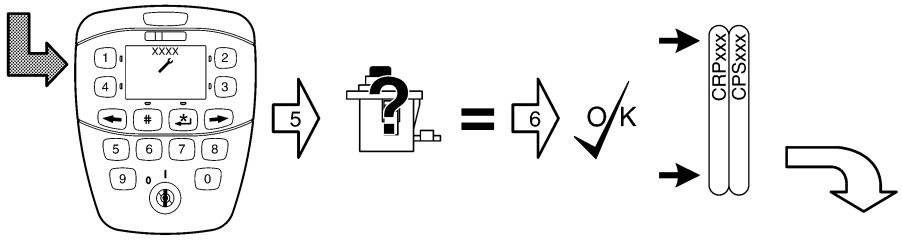
Seat Sensor Out of Range High (OORH) (Cont)
CAUSE D



Power **OFF**→ | Disconnect sensor.→ Install new sensor.→ **Do not discard** | Power **ON**→ | Go to next step.



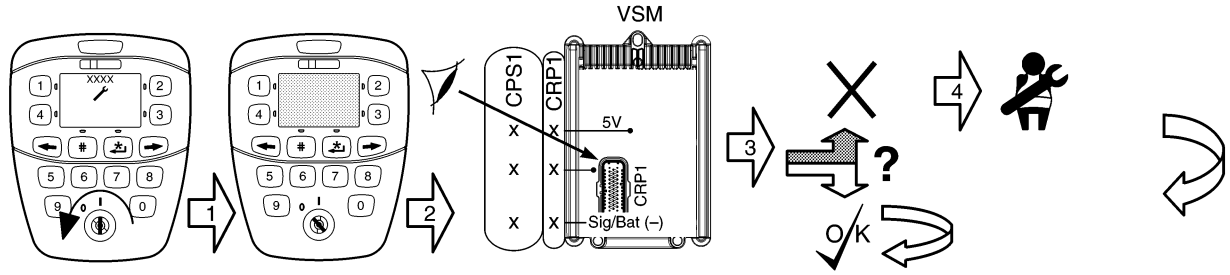
? | Fault DTC gone→ | Old sensor faulty→ | Resume operation



Fault DTC present→ | Old sensor OK/Reinstall old sensor→ | Go to CAUSE D.

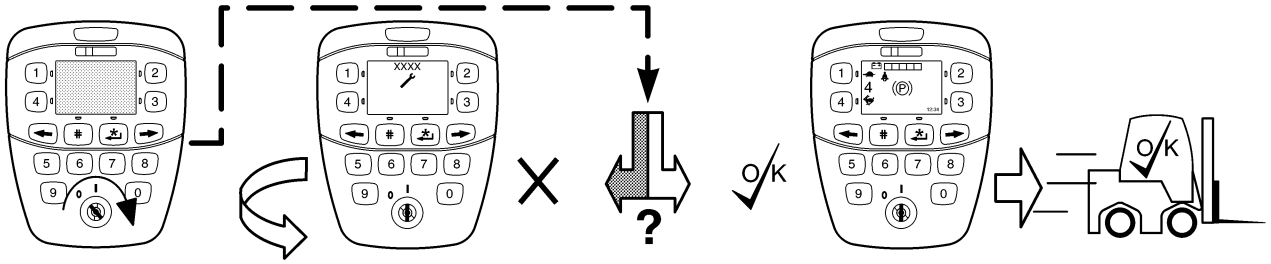
Seat Sensor Out of Range High (OORH) (Cont)

CAUSE E



Power **OFF**→	Inspect VSM Connections→	Go to Step 1.	Not OK Correct/Repair→Go to Step 1.

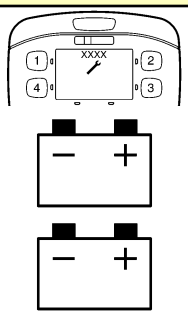
CAUSE E1



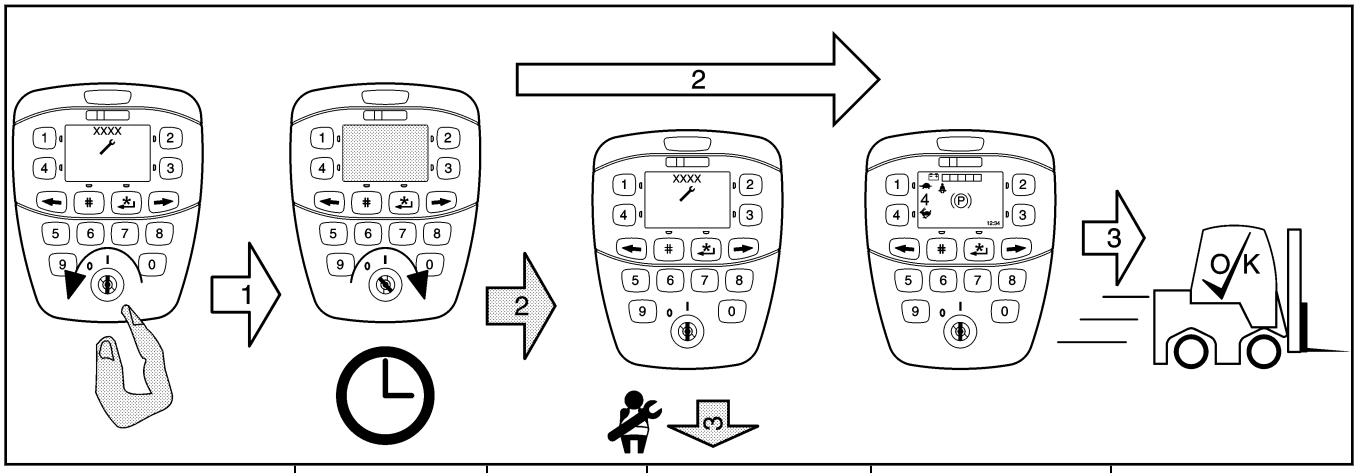
Retest - Power **ON**→	**NO**→Go to VSM Controller Check	Is fault DTC gone? **NO**←**YES**→	Fault corrected→Continue operation.

END FAULT

Battery OORH/OORL



DTC 12545 DTC 12546
Battery OORHBattery OORL



Power **OFF**→	Wait **30 seconds**→	Power **ON**→	Fault remains. Service required. Go to Component Operational Check.	No fault→	Resume operation

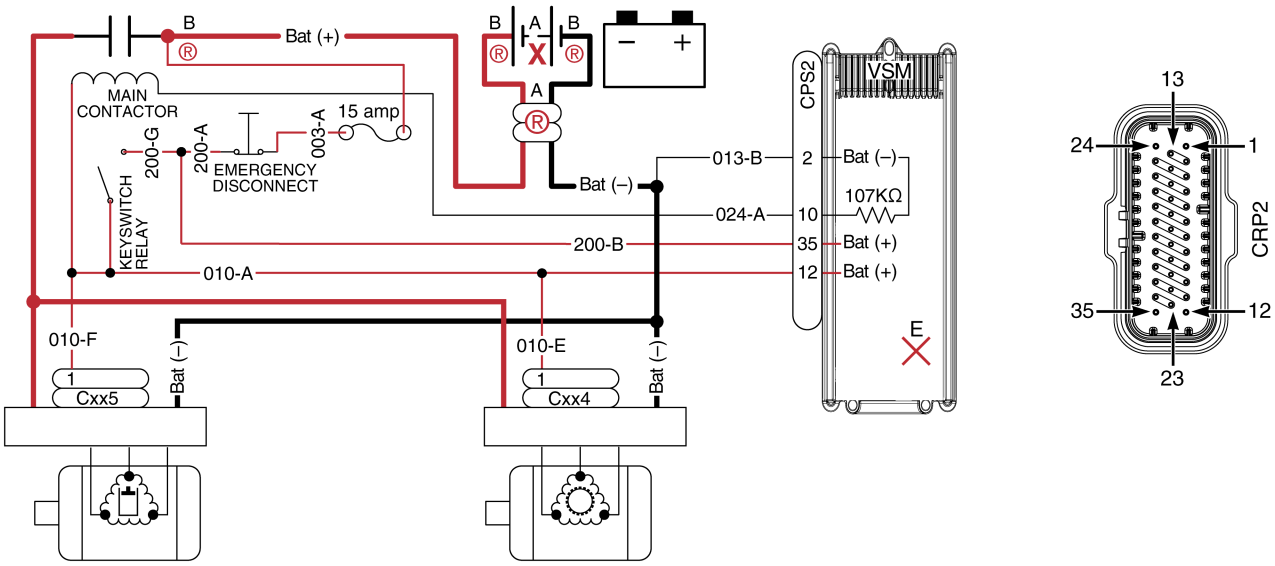
POSSIBLE CAUSE X = Open Circuit/Fail) = Short Circuit

CBB 4 WHEEL CAUSES A B C D E > ?

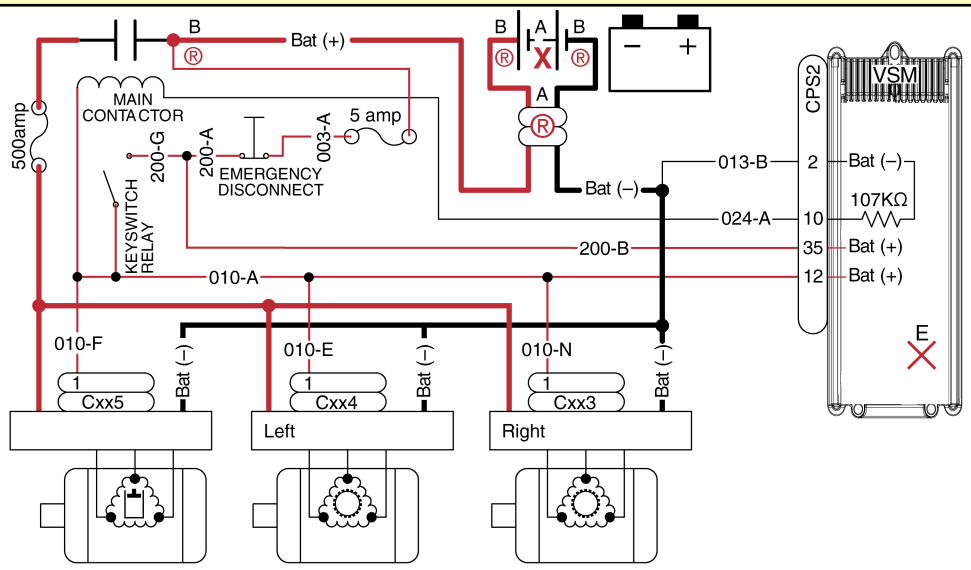
Possible Causes (OORL) Wrong Battery/Discharged Battery/Faulty Battery/ ® = High Resistance

Battery OORH/OORL (Cont)

Possible Causes (OORH) Wrong Battery Installed/ ® = High Resistance

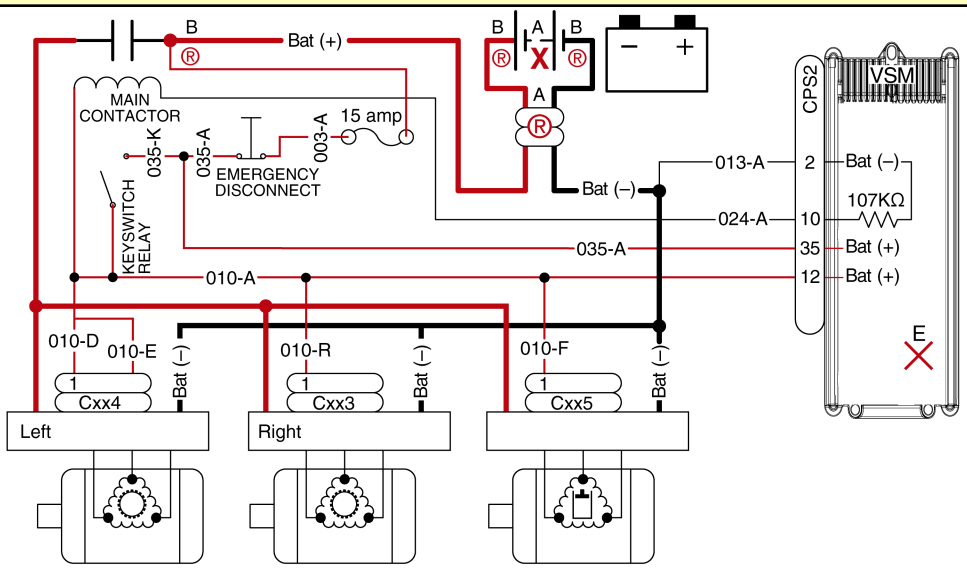


A935 K160 HIGH RESISTANCE CONNECTIONS CAUSES A B C D E > ?



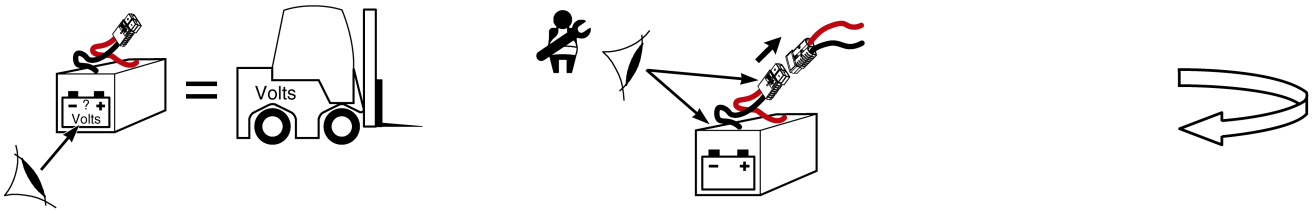
Battery OORH/OORL (Cont)

CBB 3 WHEEL HIGH RESISTANCE CONNECTIONS CAUSES A B C D E > ?



CAUSE A

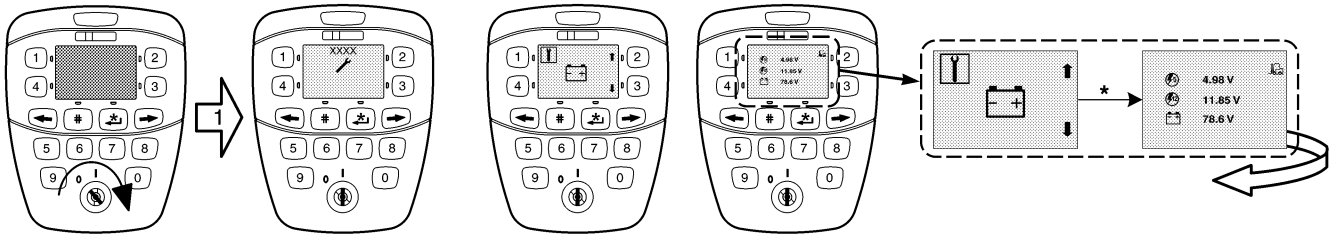
Battery OORH/OORL



Check that correct voltage battery is installed →	Perform battery maintenance, see **Operating Manual**→	?

STEP A1

OORH/OORL



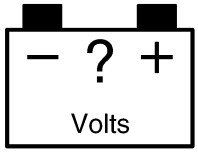
Power **ON**→	Go to Diagnostic→See Display Menu Flowchart	Battery/Supply→View Battery Value	?

Battery OORH/OORL (Cont)

STEP A2

Battery OORL

NOTE: OOR Code is set if OOR condition is present for longer than 1 second.

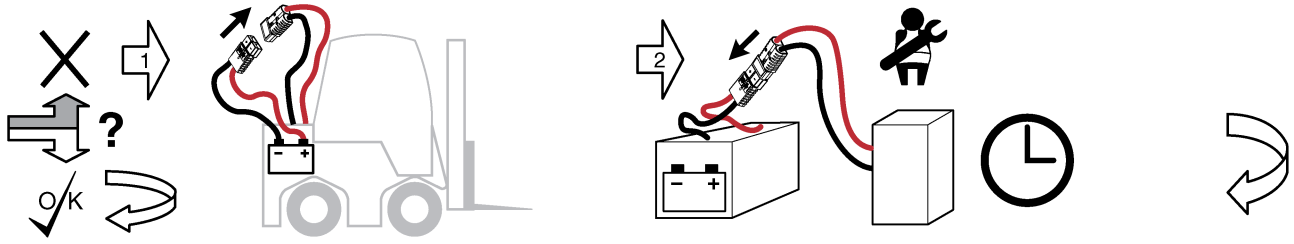


Battery Voltage				
Nominal	36	48	72	80
Fully Charged	39.6	52.8	79.2	88
˜< OORL	44.4	66.6	74	40
˜ OORH	43.2	57.6	86.4	96

Is battery voltage ˜ < OORL value for correct battery→ ?

STEP A3

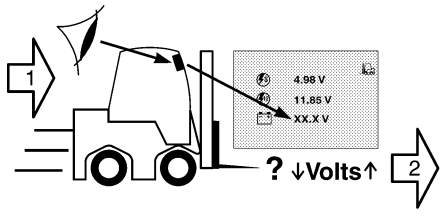
Battery OORL



NO (v)→?	**YES** (X) Recharge battery→	See **Operating Manual** for charge time	?

STEP A4

Battery OORL/OORH

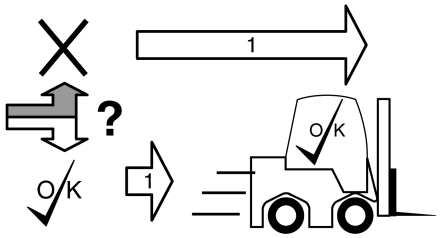


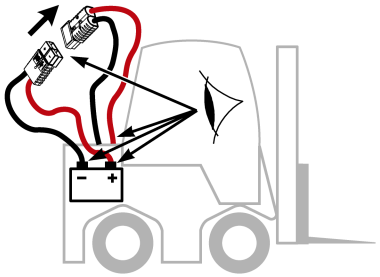
Battery Voltage				
Nominal	36	48	72	80
Fully Charged	40	53	79	88
˜< OORL	33.3	44.4	66.6	74
˜> OORH	43.2	57.6	86.4	96

Operate truck→All functionsMonitor battery voltage→Is battery voltage going?↓< OORL or ↑> OORH value for correct battery→?

Battery OORH/OORL (Cont)
STEP A5

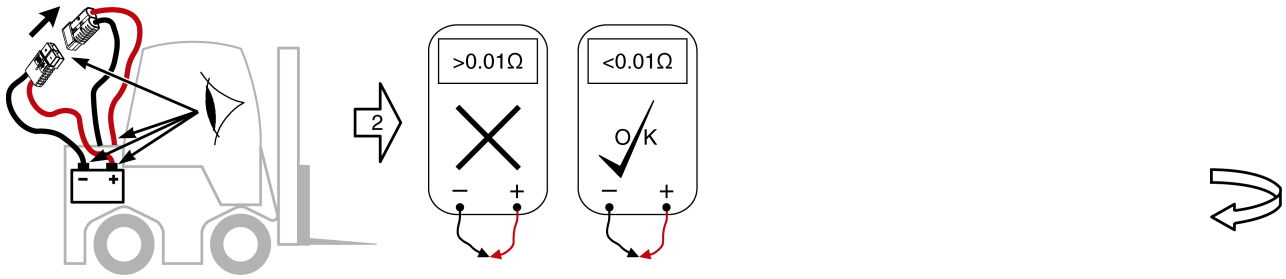
Battery OORH/OORL





YES (X) Inspect All Battery Connections for Corrosion/ High Resistance→?
NO (v) →Go to Step 4

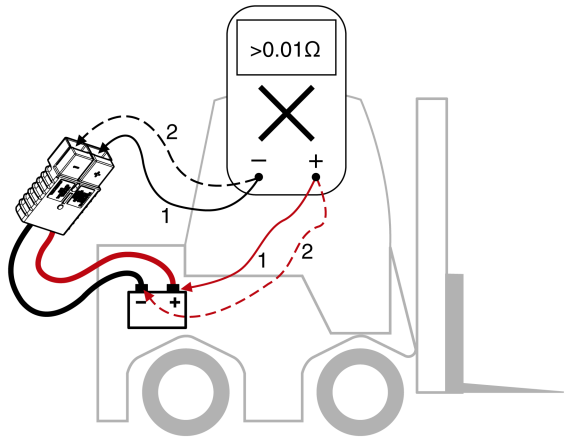
Battery OORH/OORL (Cont)
CAUSE B
NOTE: High Resistance in Wiring and Connections will cause **High Voltage** drops (OORL) when subjected to **High Current** Draw
NOTE: High Resistance in Wiring and Connections will cause **High Voltage** peaks (OORH) when subjected to **High Current** Regen

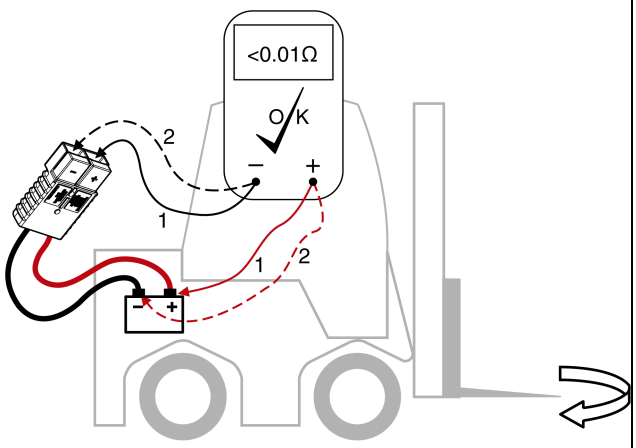


Disconnect battery→	Set meter to lowest ? scale→	Check lead resistance < 0.01?	?

STEP B1	**CHECK RESISTANCE - Ω - OHMS**

Battery OORH/OORL

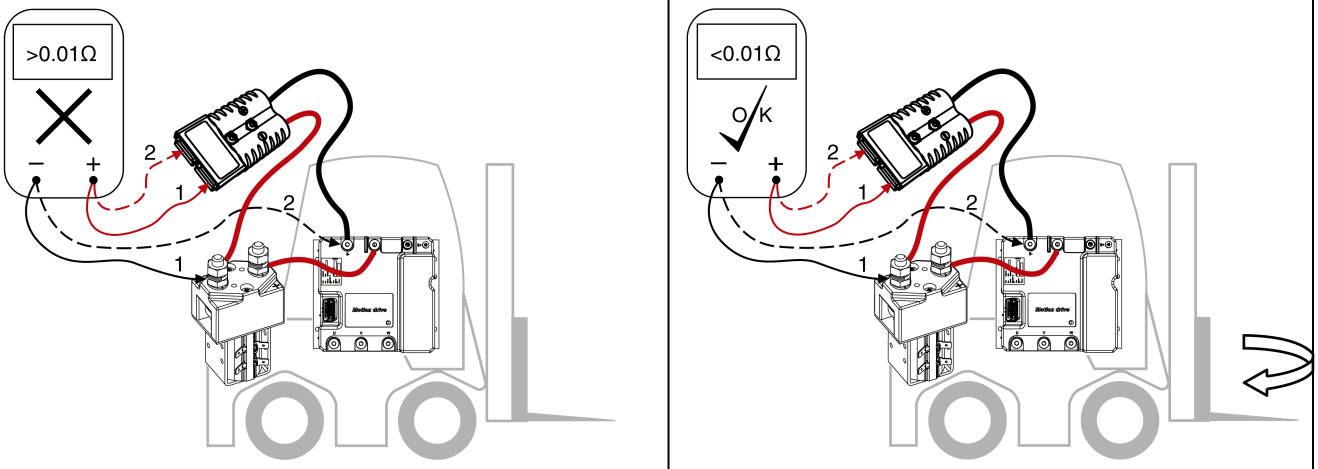




Check resistance between the Battery (+) and (-) terminals and the Battery Connector (+) and (-) Terminals	
1. > 0.01? Replace battery leads/connector terminal↓	
2. > 0.01? Replace battery leads/connector terminal→	< 0.01? Connection OK→?

Battery OORH/OORL (Cont)

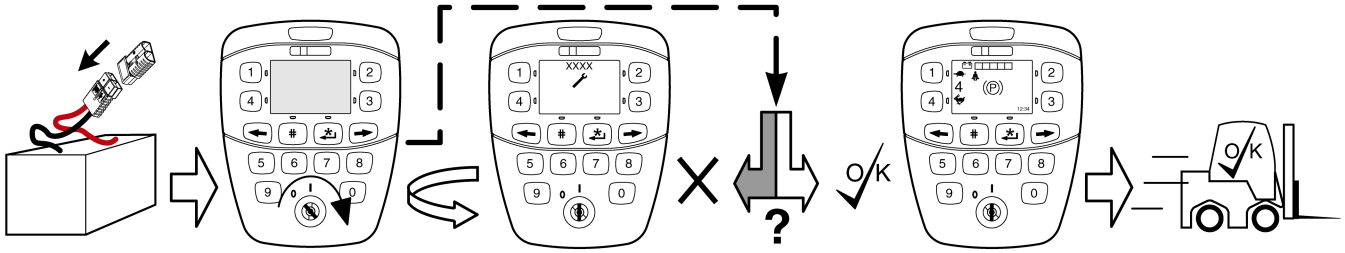
STEP B2



Check Resistance between the Bat (+) Connector and the Contactor Stud/Bat (-) Connector and Bat (-) to System	
1. > 0.01? →Replace battery leads/connector terminal↓	
2. > 0.01? →Replace battery leads/connector terminal→	< 0.01? →Connection OK?

STEP B3

Battery OORH/OORL

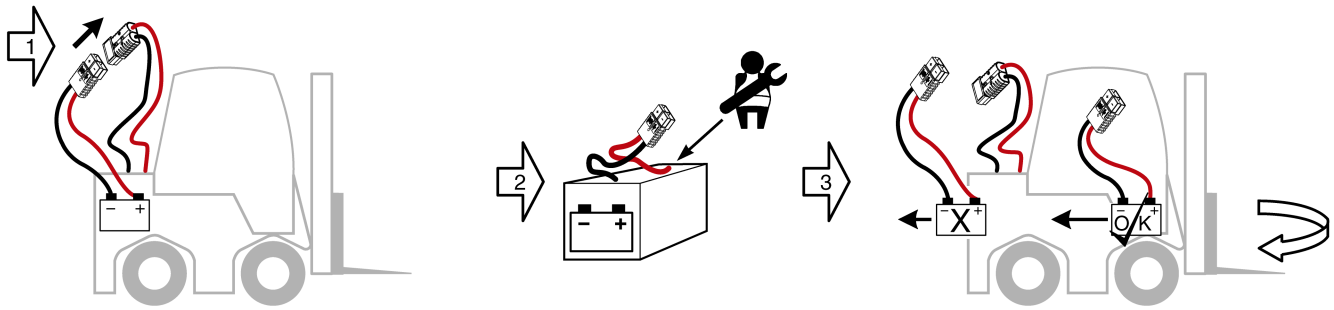


Reconnect battery	Retest Power **ON**	**NO**→?	Is DTC gone? **NO YES**→	Fault Corrected→	Continue operation

Battery OORH/OORL (Cont)

STEP B4

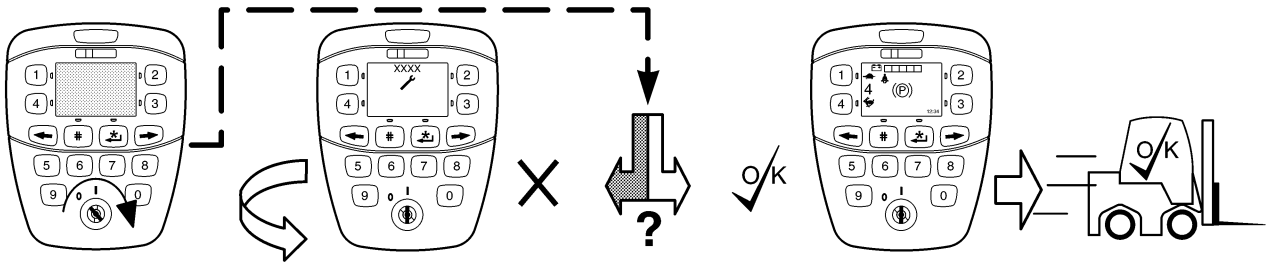
Battery OORH/OORL



Possible Battery Cell Failure→Perform Battery Cell Test→See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.

If a cell failure is detected replace Battery→ | ?

STEP B5



Retest Power **ON** **NO**→? | Is DTC gone? **NO YES**→ | Fault Corrected→ | Continue operation

CAUSE C

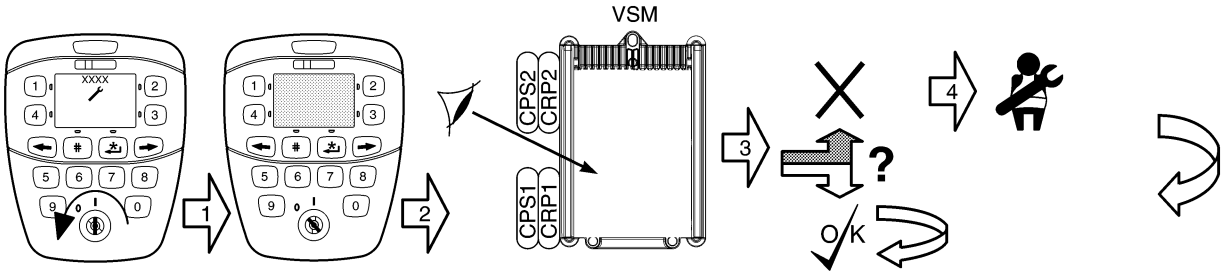
Not Applicable

CAUSE D

Not Applicable

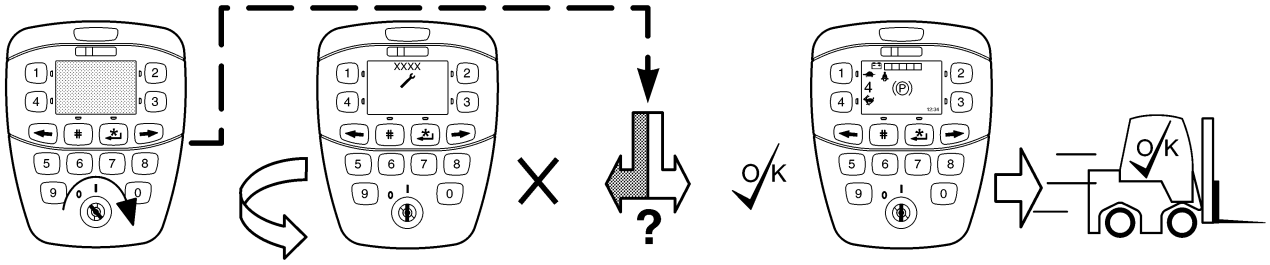
Battery OORH/OORL (Cont)

CAUSE E



Power **OFF**→	Inspect VSM Connections→	Go to Step 1	Not OK Correct/Repair→Go to Step 1

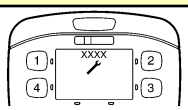
CAUSE E1



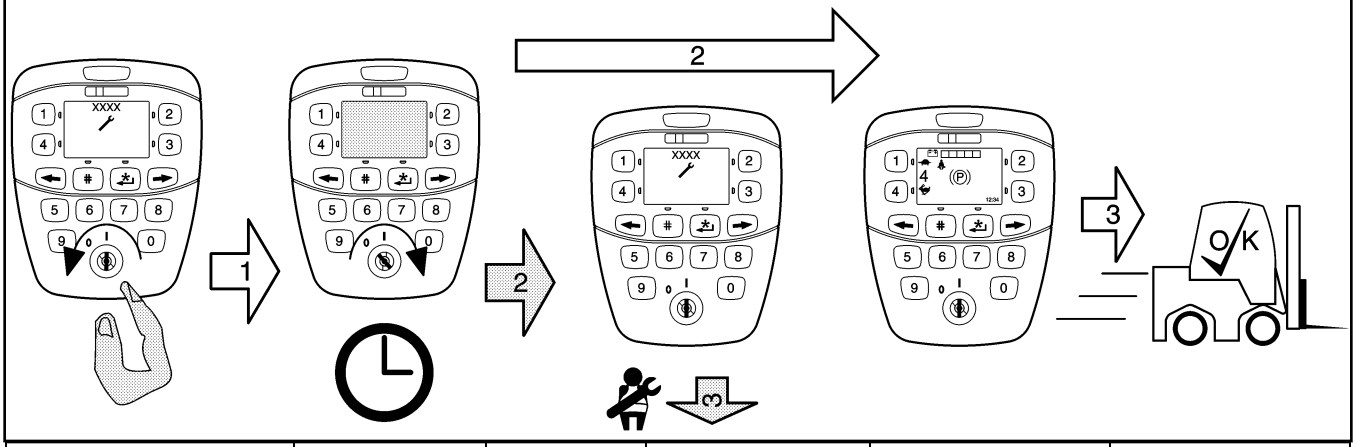
Retest - Power **ON**→	**NO**→Go to VSM Controller Check	Is DTC gone?**NO** **YES**	Fault corrected→Continue operation.

END FAULT

VSM 5 Volt Supply (OORL) (OORH)



DTC 13056DTC 13057
5V OORL 5V OORH



Power **OFF**→	Wait **30 seconds**→	Power **ON**→	Fault remains. Service required. Go to Component Operational Check.	No fault→	Resume operation

WARNING

Any VSM 5 volt powered Device will be damaged by a Short to Battery (+) condition and possibly by a Short to 12 volts (+).

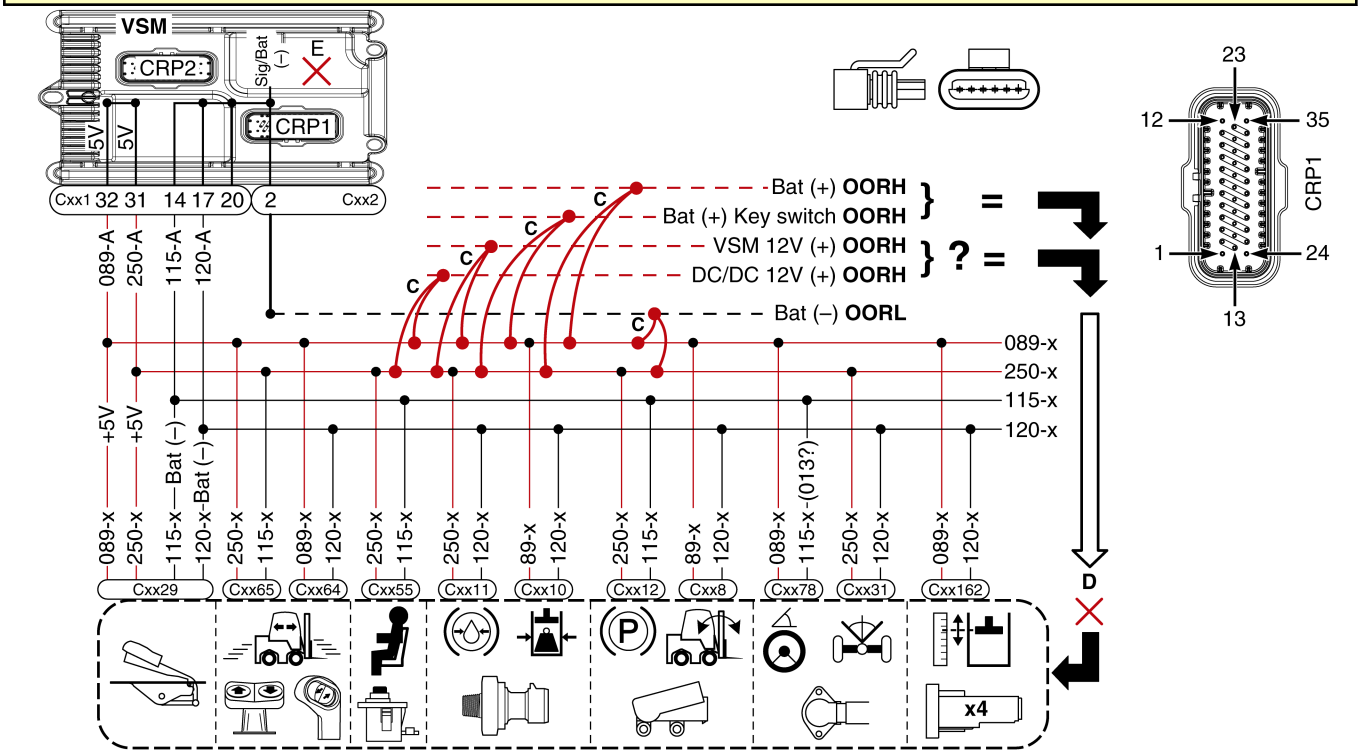
WARNING

All VSM 5 volt powered devices will need to be checked for correct operation and probably replaced.

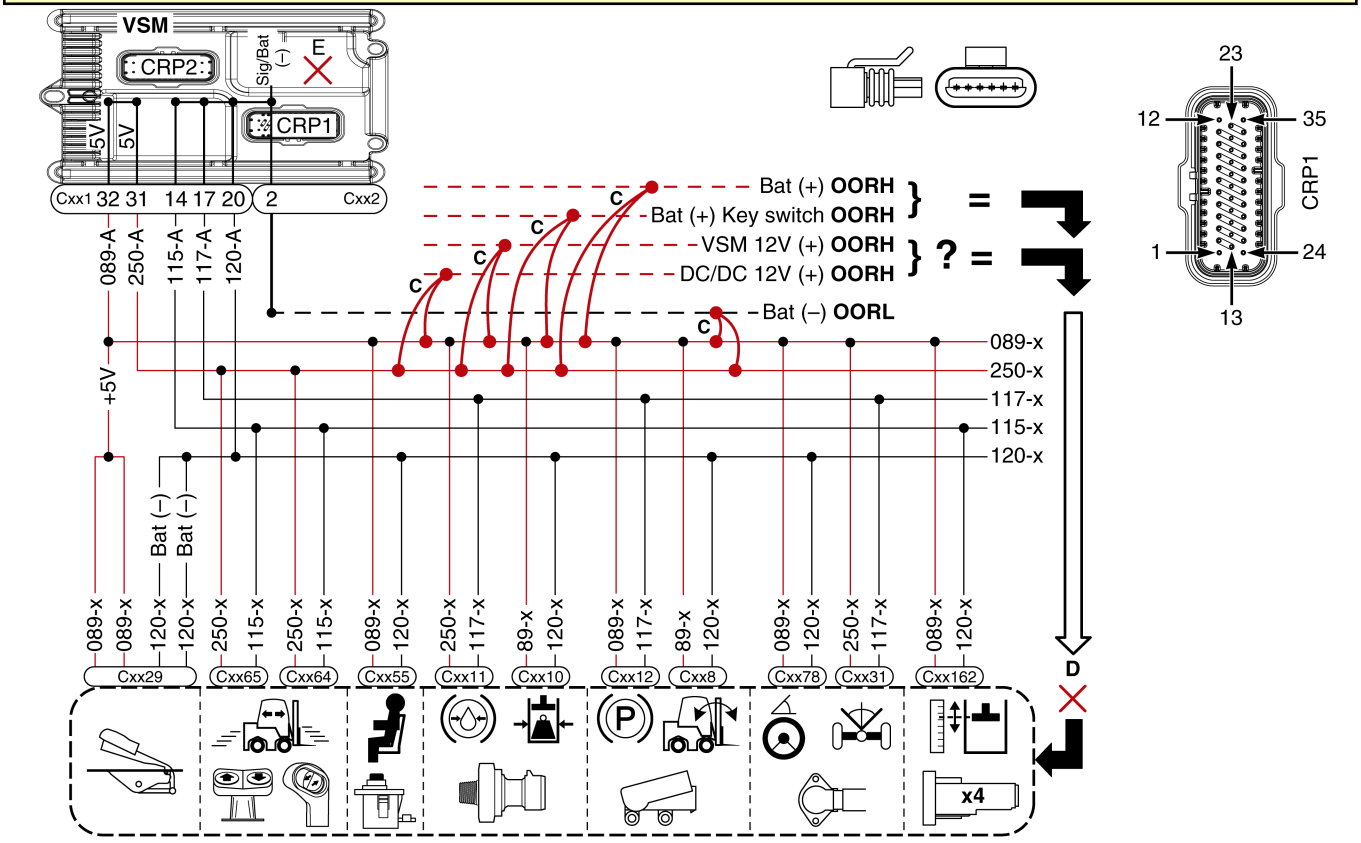
POSSIBLE CAUSE X = Open Circuit/Fail) = Short Circuit

VSM 5 Volt Supply (OORL) (OORH) (Cont)

DBB/CBB 4 WHEEL 5 VOLT SUPPLY CAUSES A B C D E > ?



CBB 3 WHEEL 5 VOLT SUPPLY CAUSES A B C D E > ?



VSM 5 Volt Supply (OORL) (OORH) (Cont)

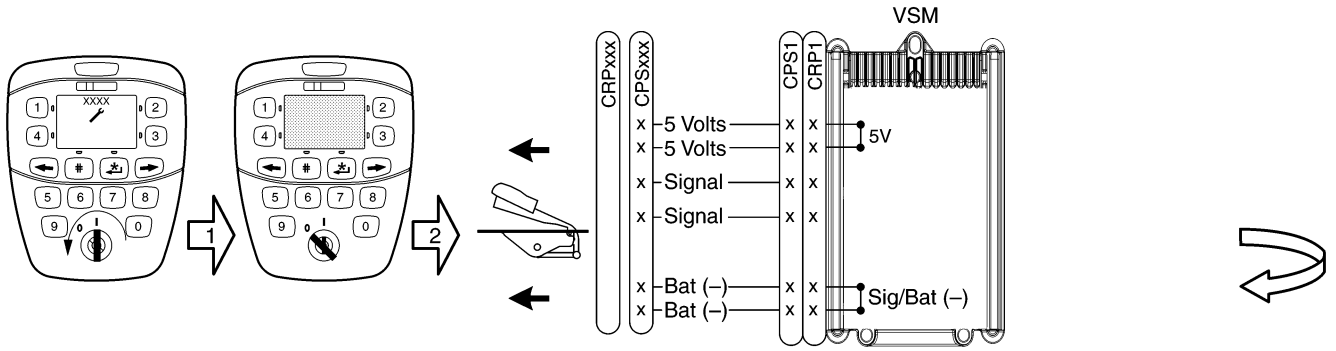
CAUSE A

Not Applicable

CAUSE B

Not Applicable

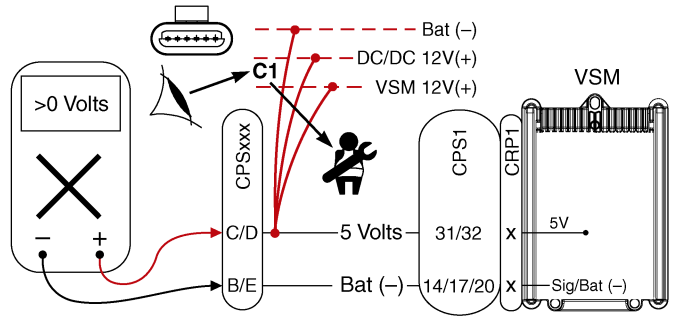
CAUSE C

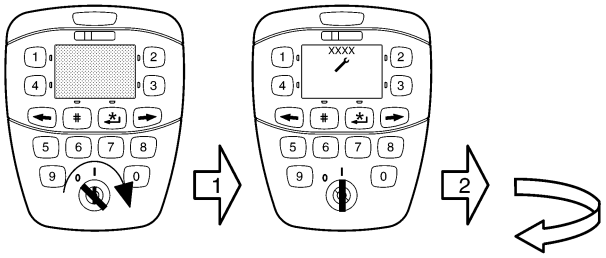


Power **OFF**→	Disconnect Accelerator Pedal sensor→		Go to Step 1

CAUSE C1 UNSWITCHED VOLTAGES

5 Volt OORH





˜ 0 Volts = OK →Go to Step 2→	Power **ON**→ Go to Step 2

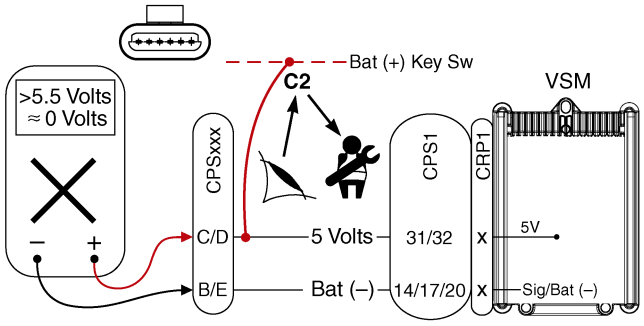
> 0 Volts = Short Circuit→Bat (+) or 12v (+) Find ↑ Short circuit.

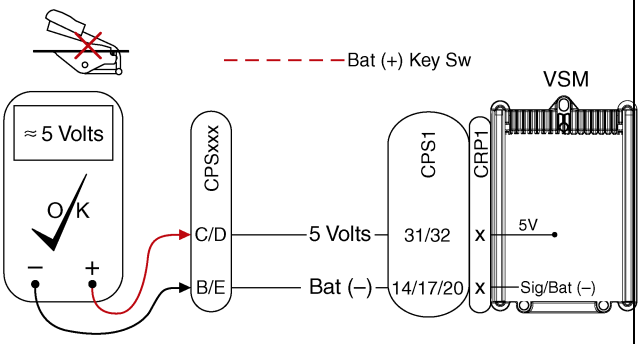
Repair Short circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.Check all 5 volt devices →Go to CAUSE C

VSM 5 Volt Supply (OORL) (OORH) (Cont)

CAUSE C2

5 Volt OORH

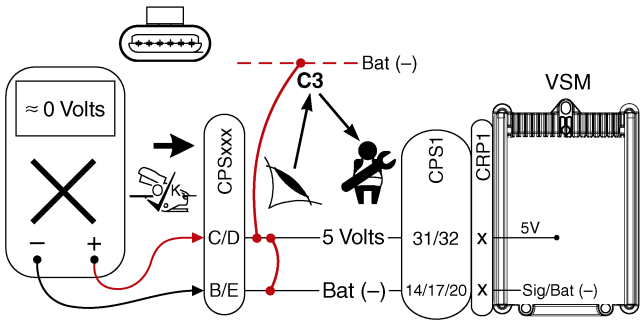


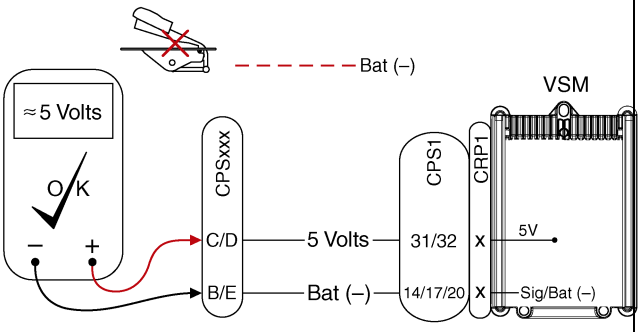


˜ 0 Volts = Short to bat (-) →Go to Step 3→	˜ 5 Volts = Faulty Accelerator Pedal →Go CAUSE C↓
> 5.5 Volts = Short Circuit→Bat (+) or 12v (+)Find ↑ Short circuit↓	
Repair Short circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.Check all 5 volt devices →Go to CAUSE C	

CAUSE C3

5 Volt OORL

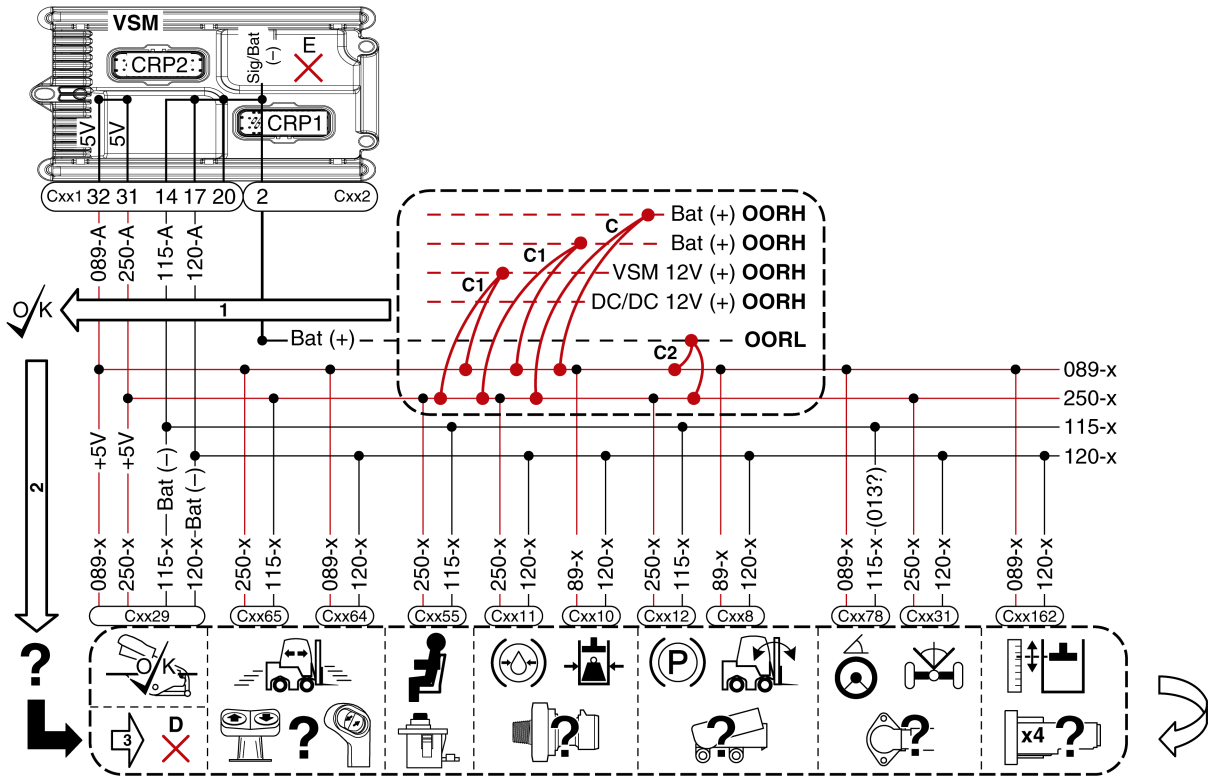




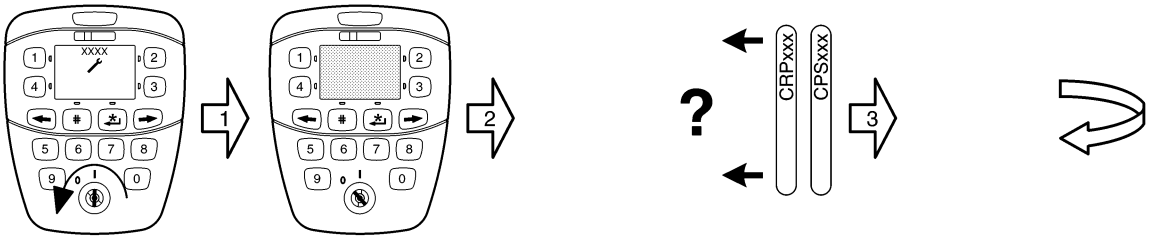
˜ 0 Volts = Short circuit →Bat (-) →Find ↑Short circuit	˜ 5 Volts = Faulty Accelerator Pedal →Replace – Go CAUSE D↓
Repair Short circuit, See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.→Check all 5 volt devices →	Go CAUSE D↓
Reconnect Accelerator Pedal→	Go CAUSE D↓

VSM 5 Volt Supply (OORL) (OORH) (Cont)

CAUSE D



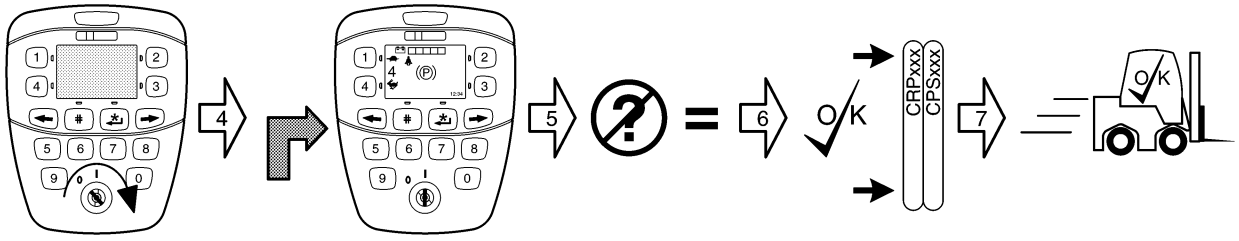
CAUSE D1



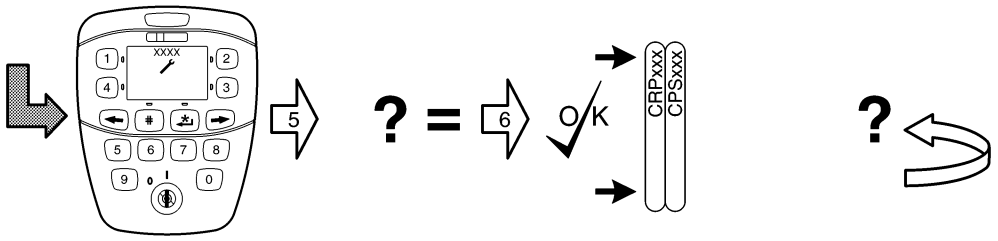
Power **OFF**→	Disconnect next 5 volt Sensor→	**Do Not Discard**	Go to Step 2.

VSM 5 Volt Supply (OORL) (OORH) (Cont)

CAUSE D2

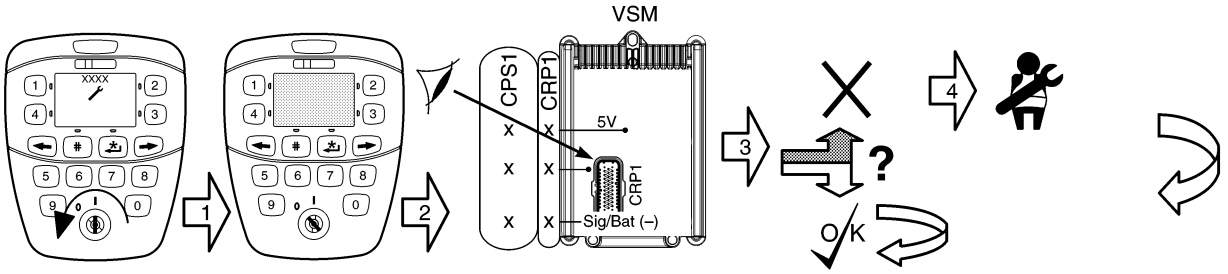


?	Power **ON**→	5 Volt Fault DTC gone→	Old sensor faulty→	Install New sensor→	Resume operation



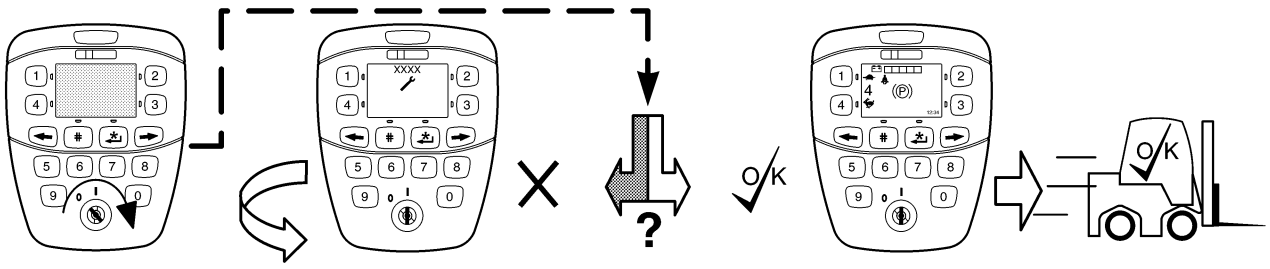
Original Fault DTC present→	Old sensor OK/Reinstall old sensor→	Go to Next Sensor. Repeat CAUSE C All Sensors tested OK. Go to CAUSE D	

CAUSE E



Power **OFF**→	Inspect VSM Connections→	Go to Step 1.	Not OK Correct/Repair→Go to Step 1.

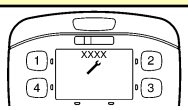
CAUSE E1



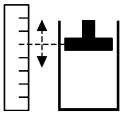
Retest - Power **ON**→	**NO**→Go to VSM Controller Check	Is fault DTC gone? **NO**←**YES**→	Fault corrected→Continue operation.

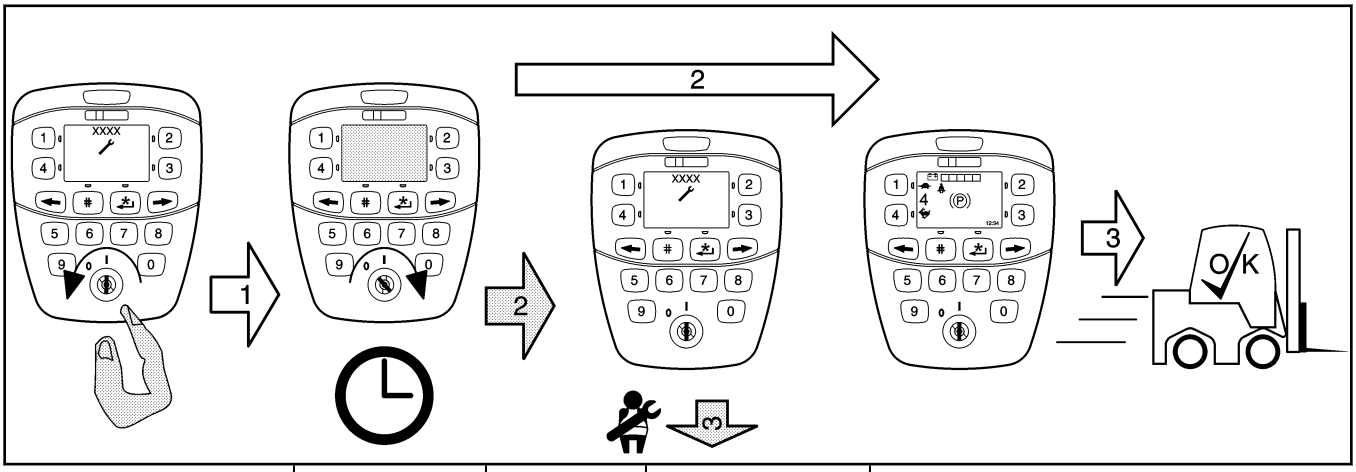
END FAULT

Manual Hydraulic Position Sensors Out Of Range Low (OORL)



DTC 12856 DTC 12860 DTC 12864 DTC 12868
Manual Hyd 1Manual Hyd 2Manual Hyd 3Manual Hyd 4

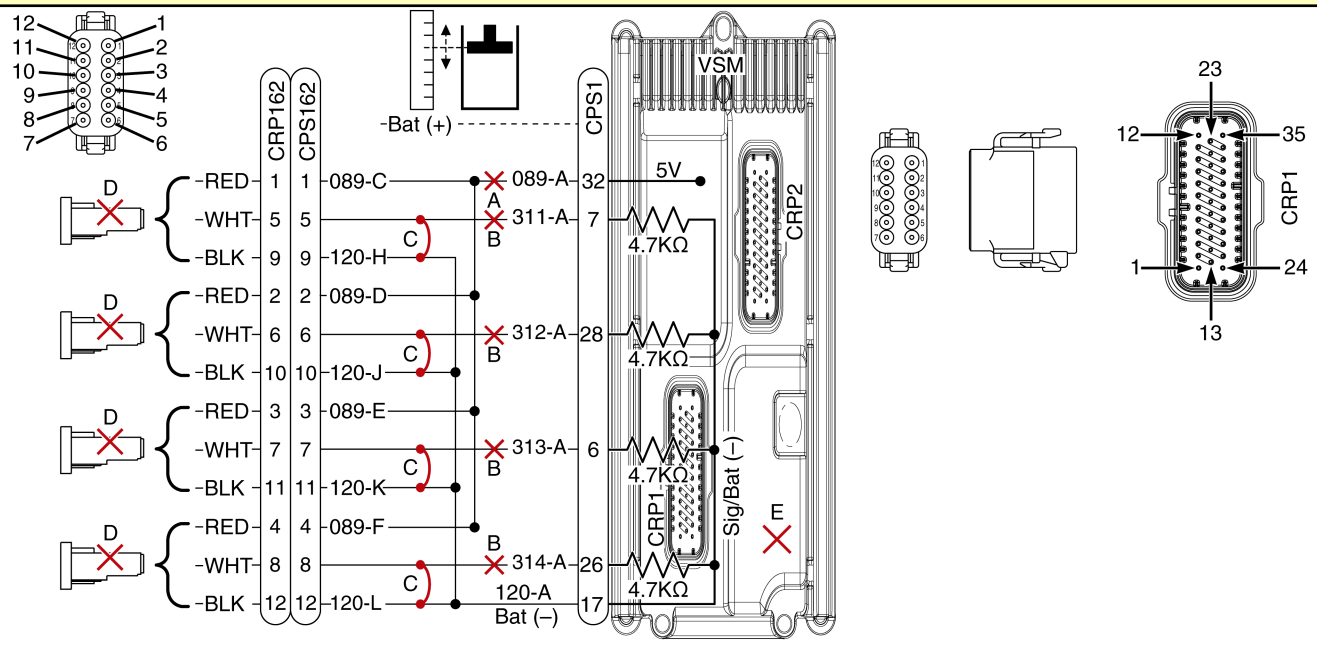




Power **OFF**→	Wait **30 seconds**→	Power **ON**→	Fault remains. Service required. Go to Component Operational Check.	No fault→	Resume operation

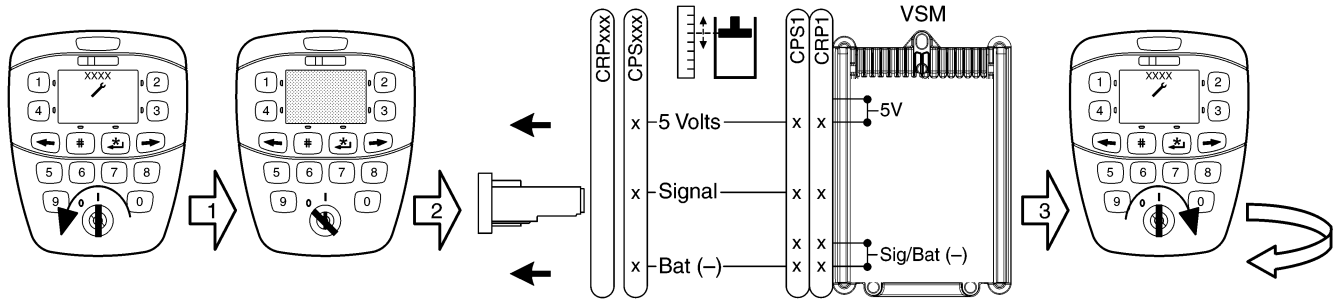
POSSIBLE CAUSE X = Open Circuit/Fail) = Short Circuit

MANUAL HYDRAULIC POSITION SENSOR CAUSES A B C D E > ?



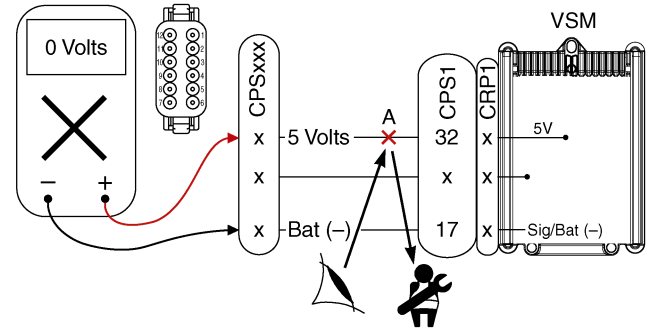
Manual Hydraulic Position Sensors Out Of Range Low (OORL) (Cont)

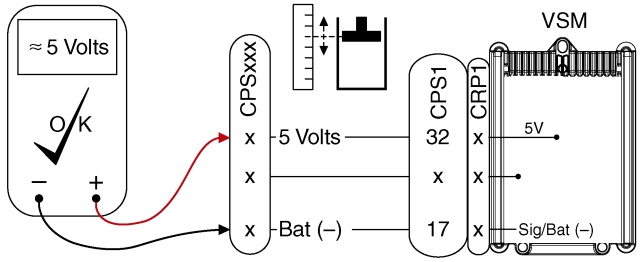
CAUSE A



Power **OFF**→	Disconnect sensor→	Power **ON**→	Go to next step.

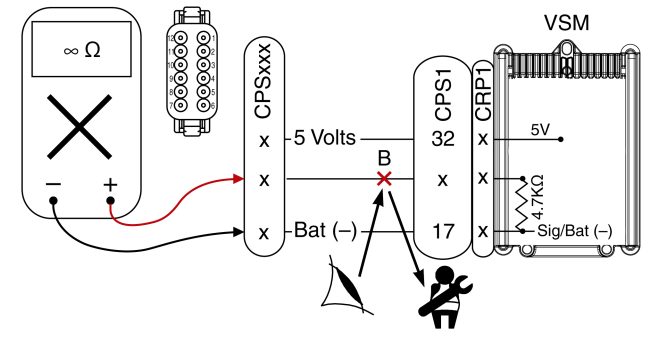
CAUSE A1 CHECK VOLTAGE

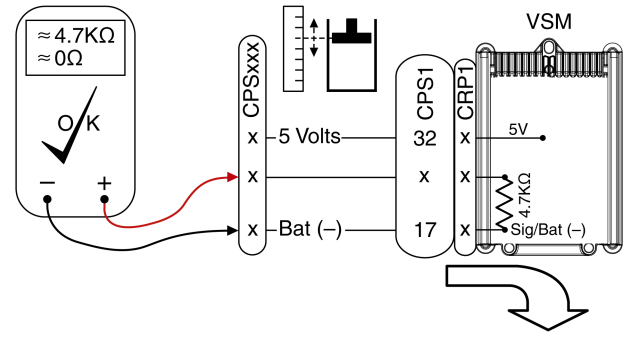




0 Volts = Open circuit→Find↑**OPEN** circuit.	˜ 5 Volts =	**OK**	Go to CAUSE A
Repair OPEN Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.			

CAUSE B CHECK RESISTANCE - Ω - OHMS

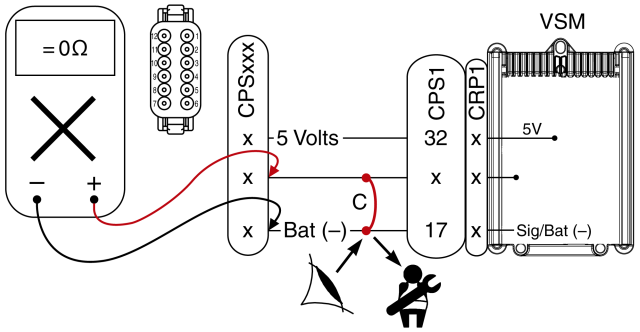




8 ? = Open circuit→Find↑**OPEN** circuit	˜ 4.7K? =	**OK**	Go to CAUSE C
Repair OPEN circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	˜ 0 ? =		Go to CAUSE B

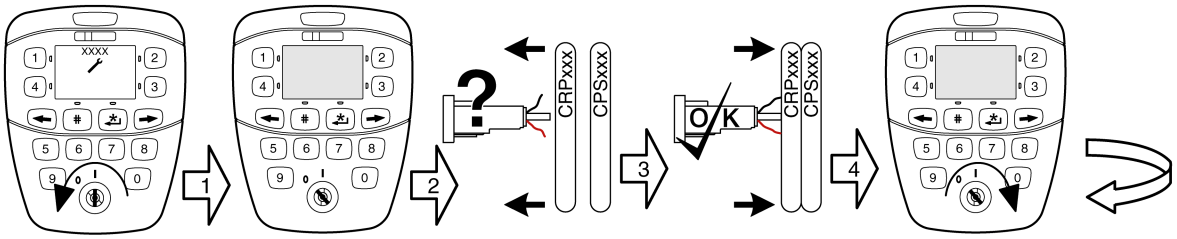
Manual Hydraulic Position Sensors Out Of Range Low (OORL) (Cont)

CAUSE C

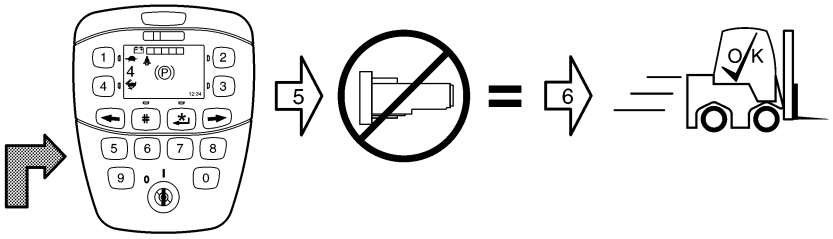


0 ? = Short circuit→Find↑**Short** circuit	
Repair Short circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	

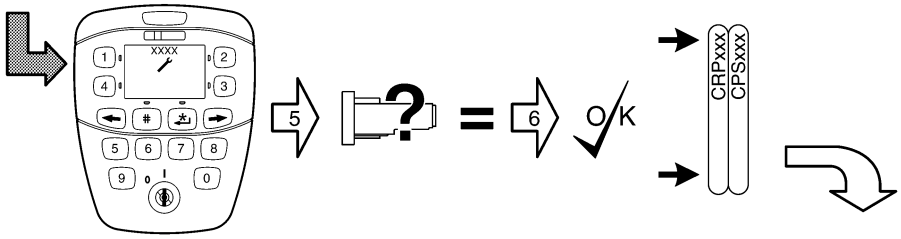
CAUSE D



Power **OFF**→	Disconnect sensor.→ Install new sensor.→ **Do not discard**	Power **ON**→	Go to next step.



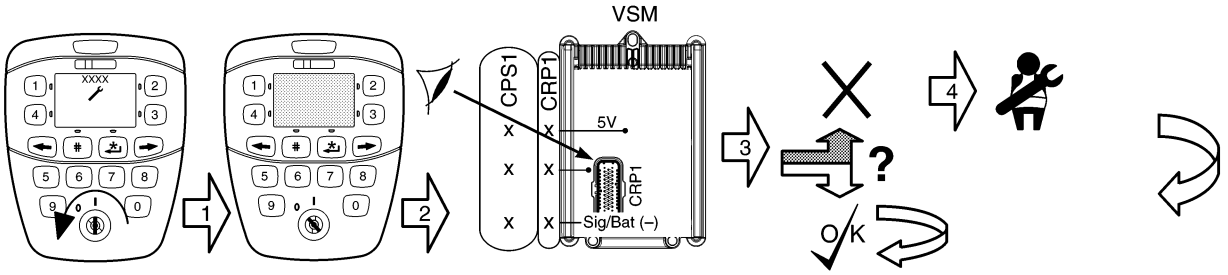
?	Fault DTC gone→	Old sensor faulty→	Resume operation



Fault DTC present→	Old sensor OK/Reinstall old sensor→	Go to CAUSE D.

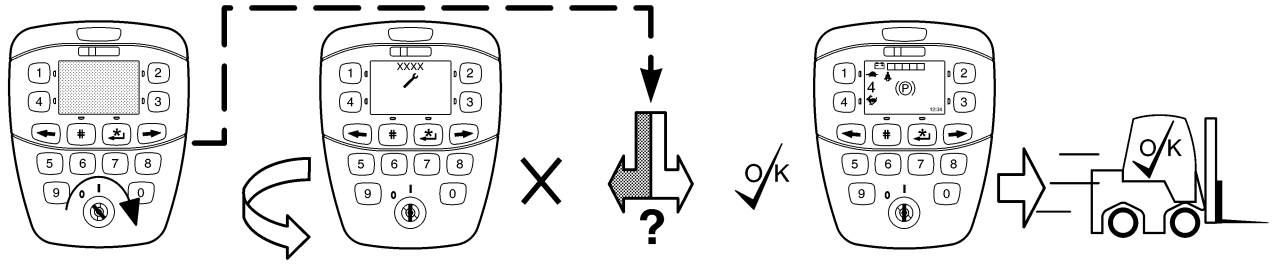
Manual Hydraulic Position Sensors Out Of Range Low (OORL) (Cont)

CAUSE E



Power **OFF**→	Inspect VSM Connections→	OK - Go to Step 1.	Not OK →Correct/Repair Go to Step 1.

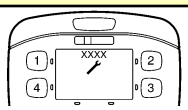
CAUSE E1



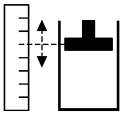
Retest - Power **ON**→	**NO**→Go to VSM Controller Check	Is fault DTC gone? **NO**←**YES**→	Fault corrected→Continue operation.

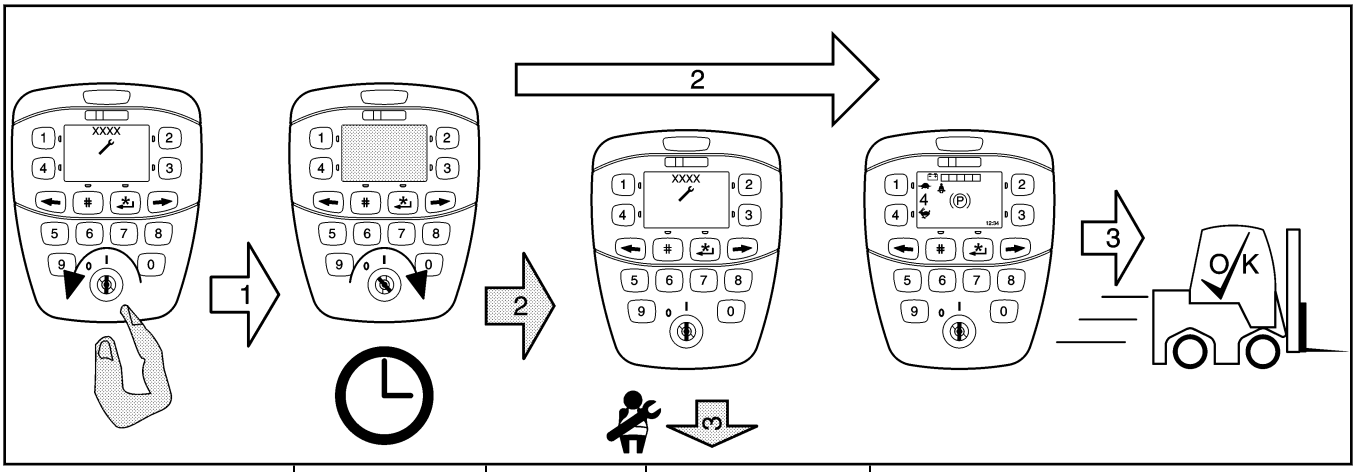
END FAULT

Manual Hydraulic Position Sensor Out Of Range High (OORH)



DTC 12857 DTC 12861 DTC 12865 DTC 12869
Manual Hyd 1Manual Hyd 2Manual Hyd 3Manual Hyd 4

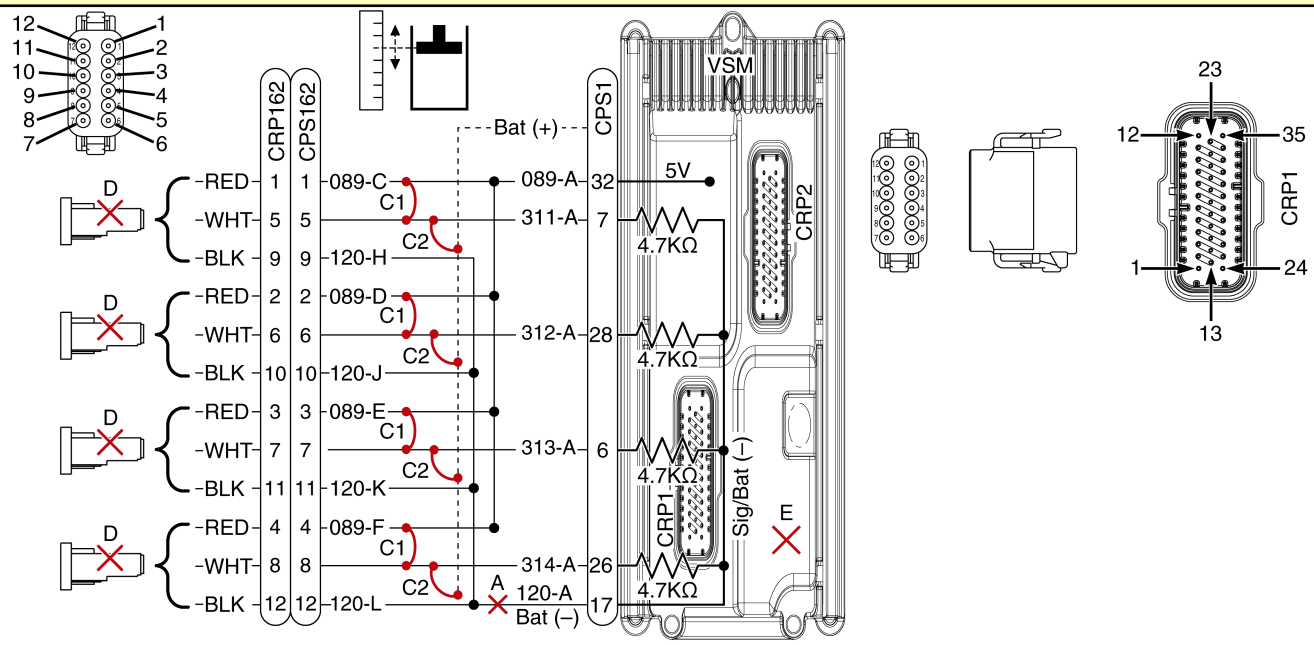




Power **OFF**→	Wait **30 seconds**→	Power **ON**→	Fault remains. Service required. Go to Component Operational Check.	No fault→	Resume operation

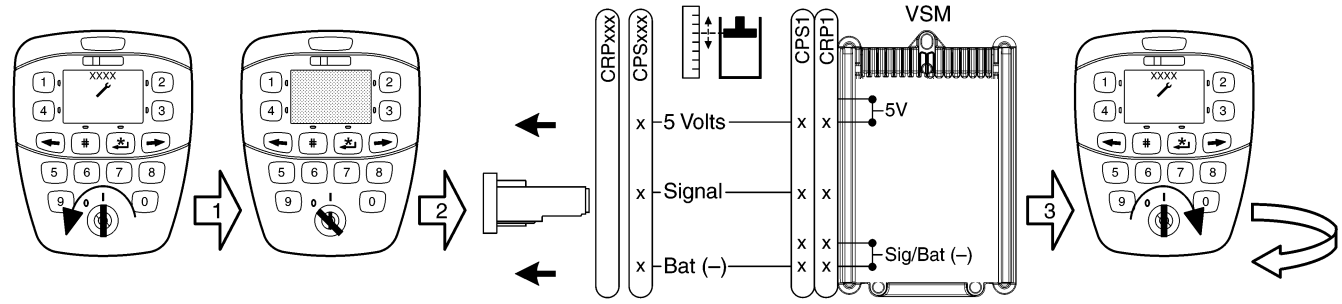
POSSIBLE CAUSE X = Open Circuit/Fail) = Short Circuit

ACCELERATOR PEDAL POSITION A/B CAUSES A B C D E > ?



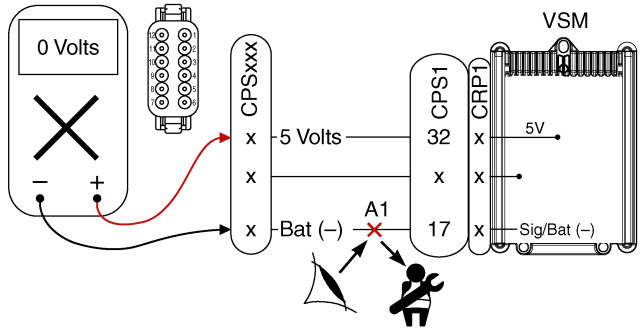
Manual Hydraulic Position Sensor Out Of Range High (OORH) (Cont)

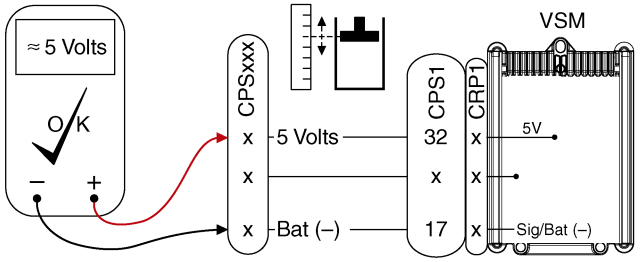
CAUSE A



Power **OFF**→	Disconnect sensor→	Power **ON**→	Go to next step.

CAUSE A1 CHECK VOLTAGE





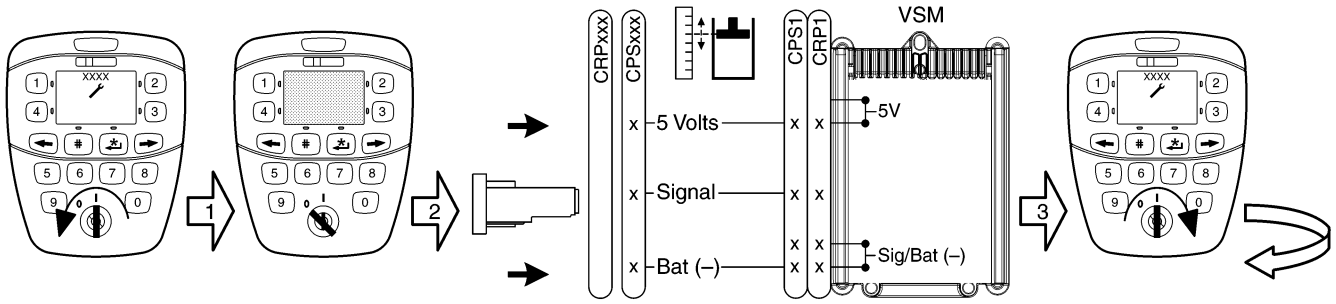
0 Volts = Open circuit→Find↑**OPEN** circuit.	˜ 5 Volts = **OK**	Go to CAUSE B
Repair OPEN Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.		

CAUSE B

Not Applicable

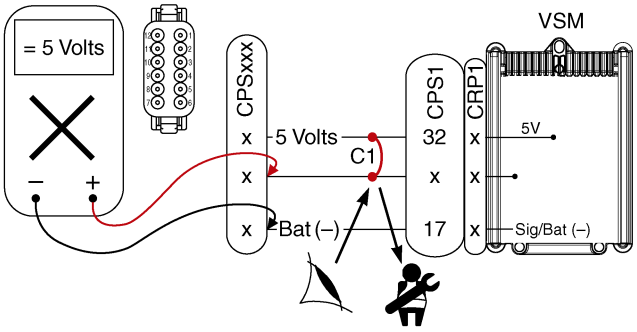
Manual Hydraulic Position Sensor Out Of Range High (OORH) (Cont)

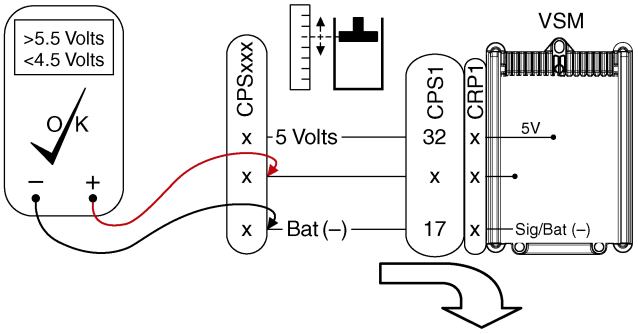
CAUSE C



Power **OFF**→	Reconnect sensor→	Power **ON**→	Go to next step.

CAUSE C1 — CHECK VOLTAGE

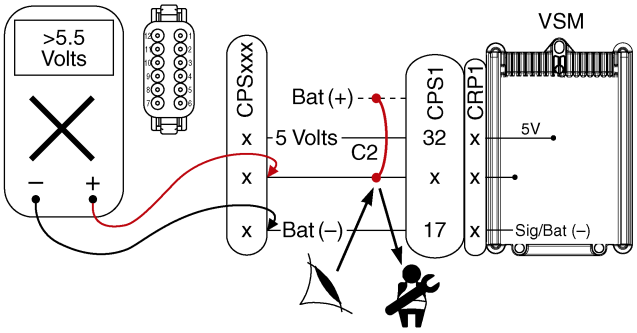


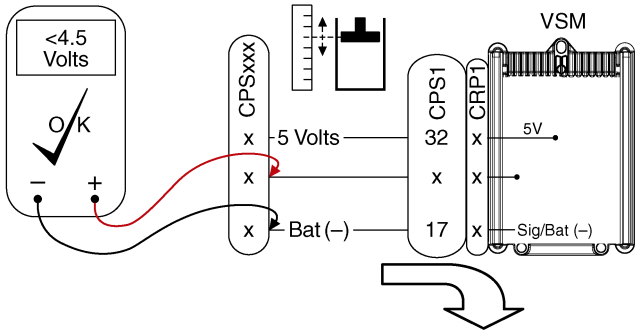


5 Volts = Short circuit→Find↑**Short** circuit.	> 5.5 Volts		Go to Step 2.
Repair Short Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	< 4.5 volts =	**OK**	Go to CAUSE C.

CAUSE C2 — CHECK VOLTAGE

Switched and Unswitched

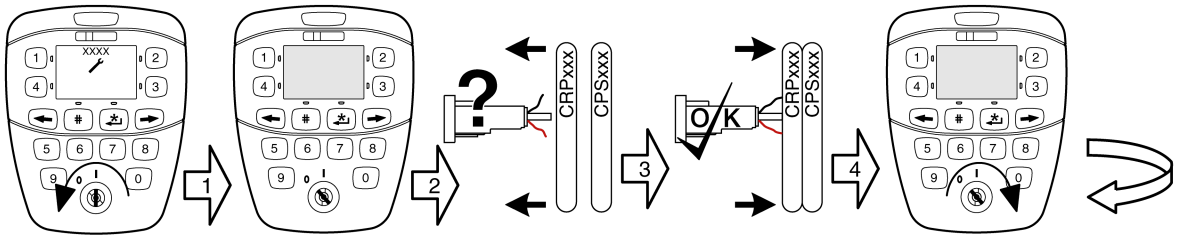




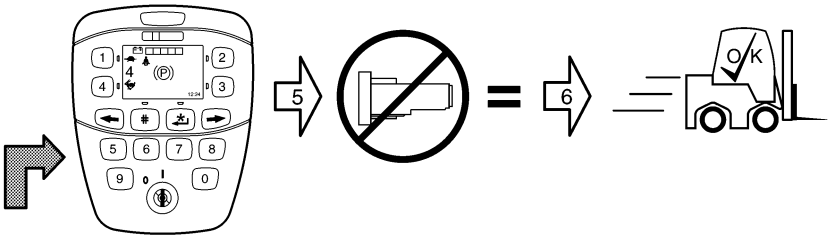
> 5.5 Volts = Short circuit→Find↑**Short** circuit to another voltage source.	< 4.5 volts =	**OK**	Go to CAUSE C.
Repair Short Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.			

Manual Hydraulic Position Sensor Out Of Range High (OORH) (Cont)

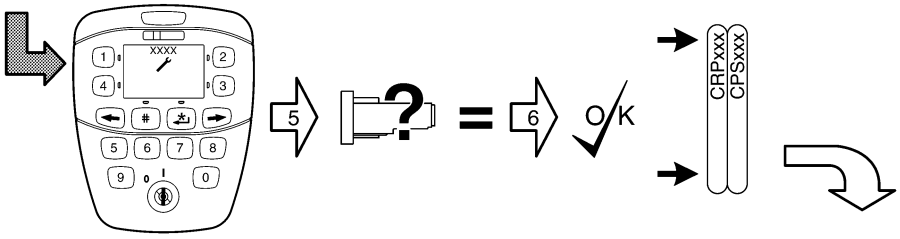
CAUSE D



Power **OFF**→ | Disconnect sensor.→ Install new sensor.→ **Do not discard** | Power **ON**→ | Go to next step.



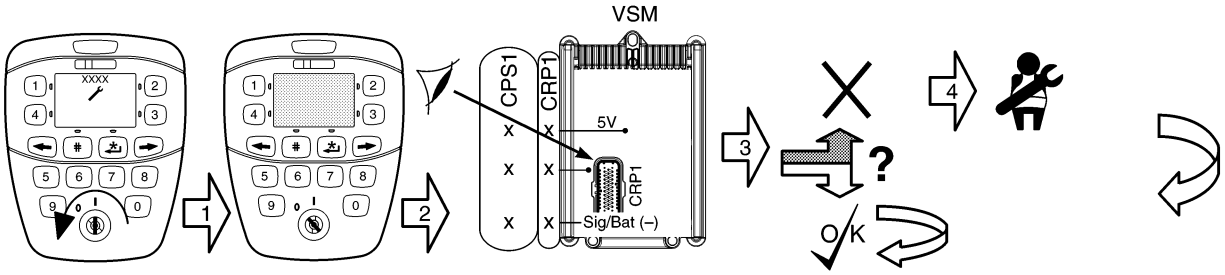
? | Fault DTC gone→ | Old sensor faulty→ | Resume operation



Fault DTC present→ | Old sensor OK/Reinstall old sensor→ | Go to CAUSE D.

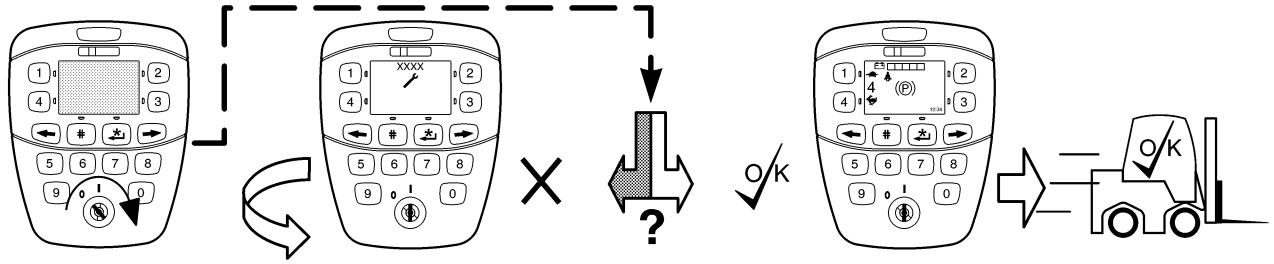
Manual Hydraulic Position Sensor Out Of Range High (OORH) (Cont)

CAUSE E



Power **OFF**→	Inspect VSM Connections→	Go to Step 1.	Not OK Correct/Repair→Go to Step 1.

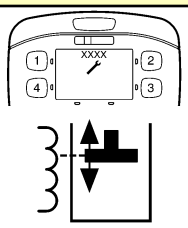
CAUSE E1



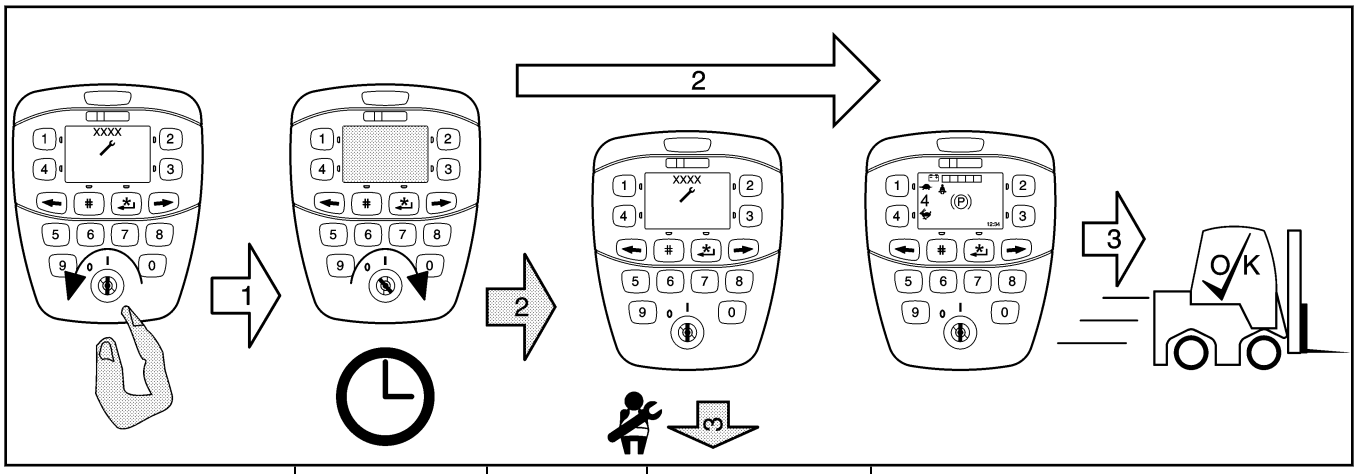
Retest - Power **ON**→	**NO**→Go to VSM Controller Check	Is fault DTC gone? **NO**←**YES**→	Fault corrected→Continue operation.

END FAULT

E-Hydraulic Enable System Data Incorrect



DTC 12332
Data Incorrect

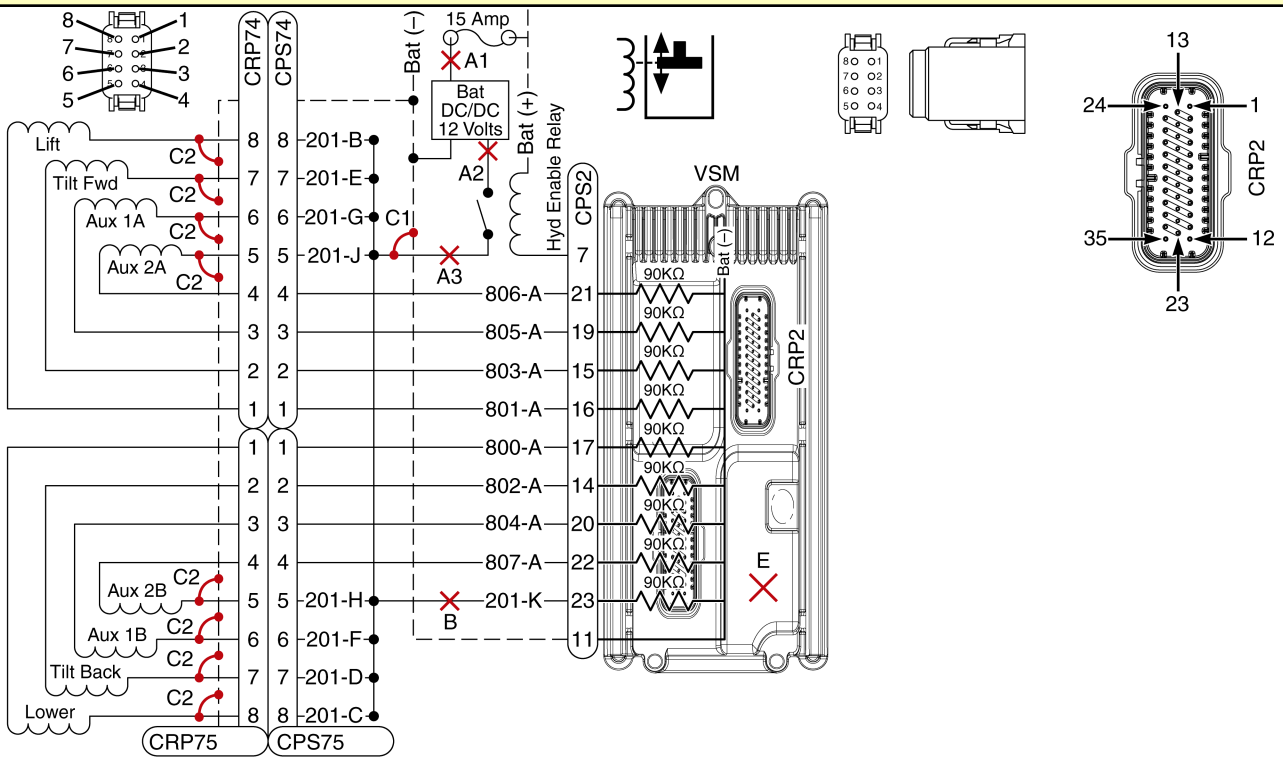


Power **OFF**→	Wait **30 seconds**→	Power **ON**→	Fault remains. Service required. Go to Component Operational Check.	No fault→	Resume operation

POSSIBLE CAUSE X = Open Circuit/Fail) = Short Circuit

E-Hydraulic Enable System Data Incorrect (Cont)

E-HYDRAULIC ENABLE SYSTEM DATA INCORRECT CAUSES A B C D E > ?

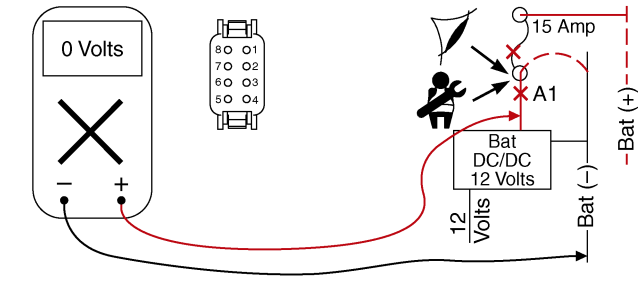


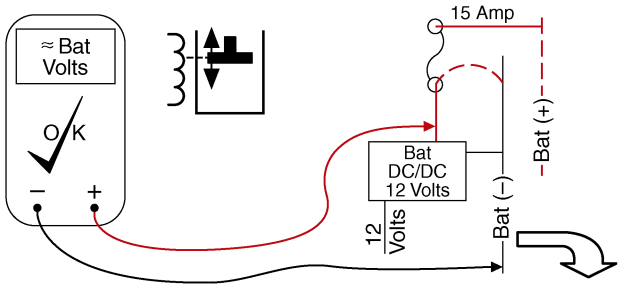
CAUSE A

Not Applicable

CAUSE A1 CHECK VOLTAGE

NOTE: Locate DC/DC Convertor - Check DC/DC Voltage Input

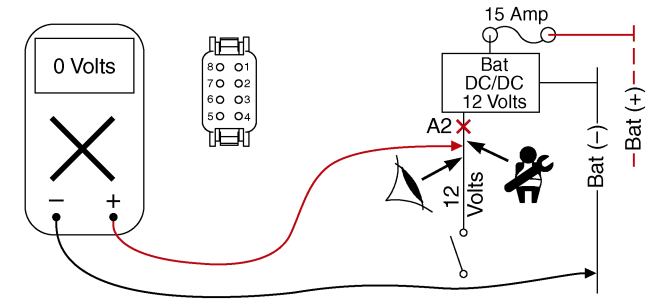


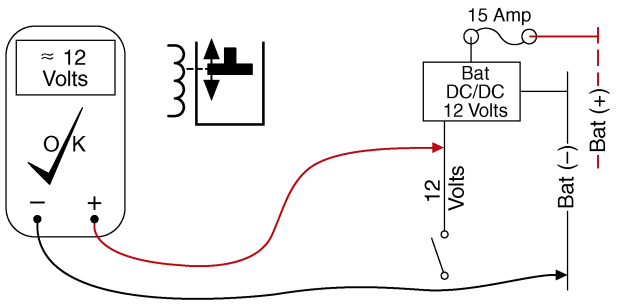


0 Volts = Open circuit/Blown fuse↑→	˜ Bat Volts = **OK** Go to Step 2
Find**OPEN** circuit or **SHORT** circuit that blew the fuse.	
Repair OPEN Circuit/SHORT Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	

E-Hydraulic Enable System Data Incorrect (Cont)	
CAUSE A2	**CHECK VOLTAGE**

NOTE: Check DC/DC Voltage Output

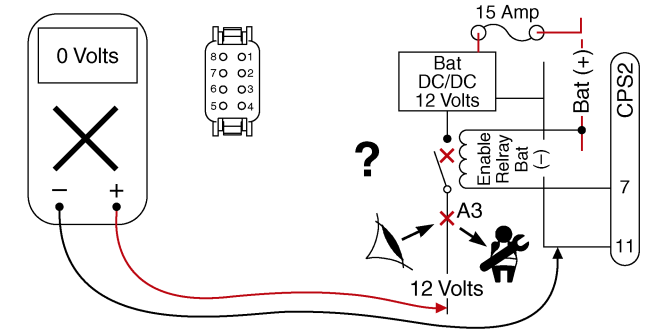


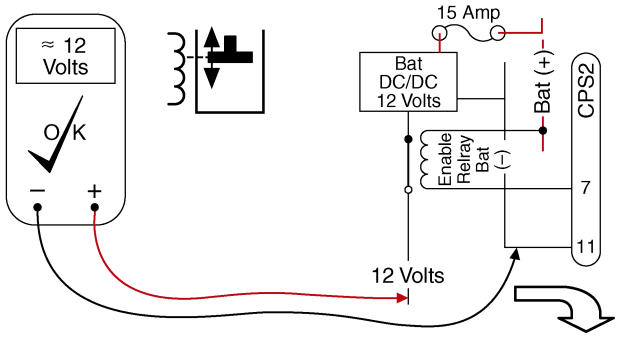


0 Volts = Open circuit/DC/DC failure↑→Find**OPEN** circuit.	˜ 12 Volts = **OK** Go to Step 3
Repair OPEN Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369. No wiring**OPEN** circuit.→ Replace **DC/DC convertor**.	

CAUSE A3	**CHECK VOLTAGE**

NOTE: Occupy Seat - Operate any Hyd Function - Check Voltage out on Enable Relay

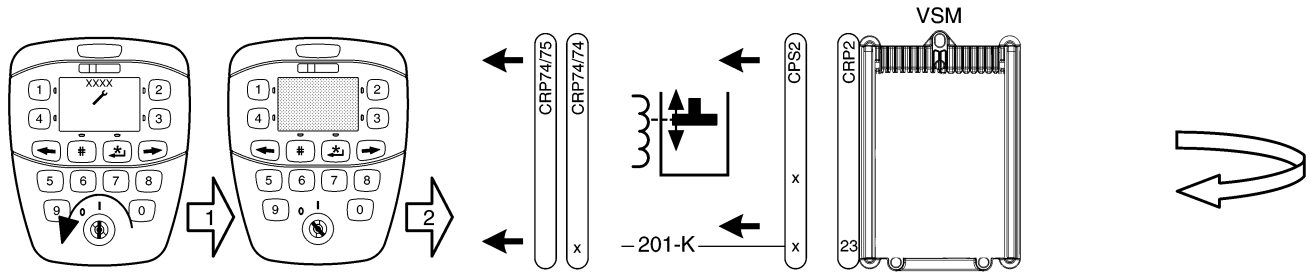




0 Volts = Open circuit/Relay Contacts↑→Find**OPEN** circuit.	˜ 12 Volts = **OK** Go to CAUSE D
Repair OPEN Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369. No Wiring OPEN Circuit.→Replace **Enable Relay**.	

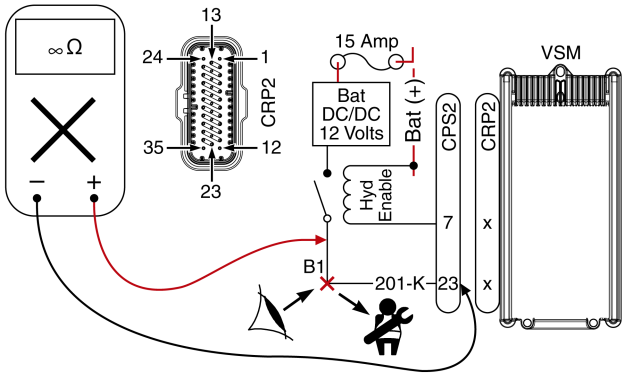
E-Hydraulic Enable System Data Incorrect (Cont)

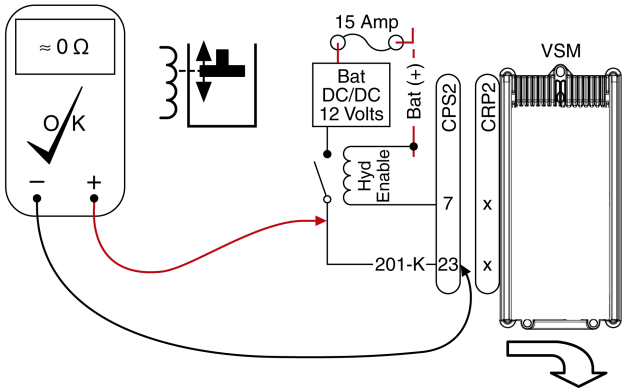
CAUSE B



Power **OFF**→	Disconnect Coil Connector→	Disconnect VSM Connector CPS2→	Go to next step.

CAUSE B1 CHECK RESISTANCE - Ω - OHMS





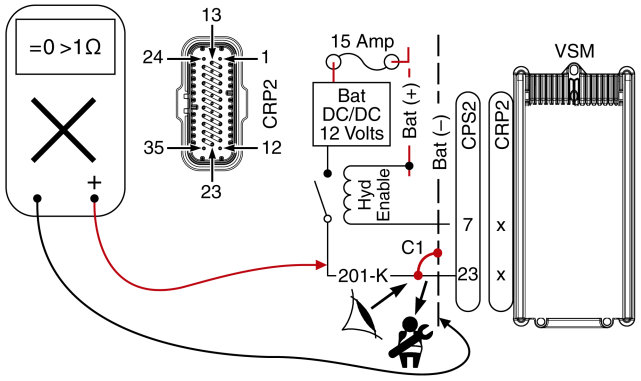
8 ? = Open circuit→Find↑**OPEN** circuit.→	˜ 0 ? =	**OK**	Go to Step 1
Repair OPEN Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.			

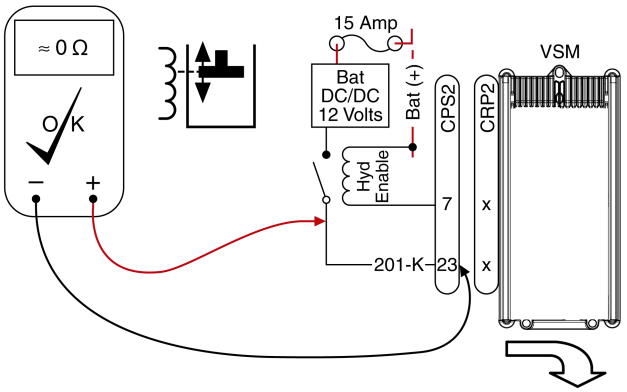
E-Hydraulic Enable System Data Incorrect (Cont)

CAUSE C

Not Applicable

CAUSE C1 CHECK RESISTANCE - Ω - OHMS

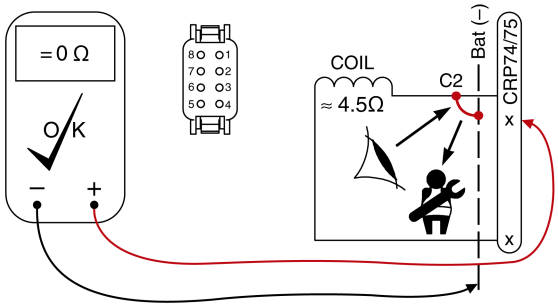


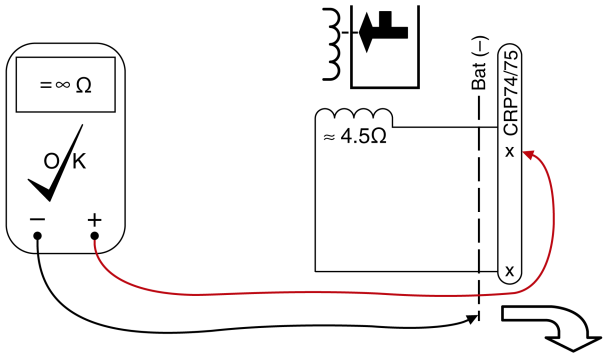


0 ? to 1 ? = Short circuit→Find↑**Short** circuit.→	> 1 ? =	**OK**	Reconnect all connections, go to CAUSE D

Repair Short Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.

CAUSE C2 CHECK RESISTANCE - Ω - OHMS





0 ? = Short circuit→Find↑**Short** circuit.→	8 ? =	**OK**	Reconnect all connections, go to CAUSE D

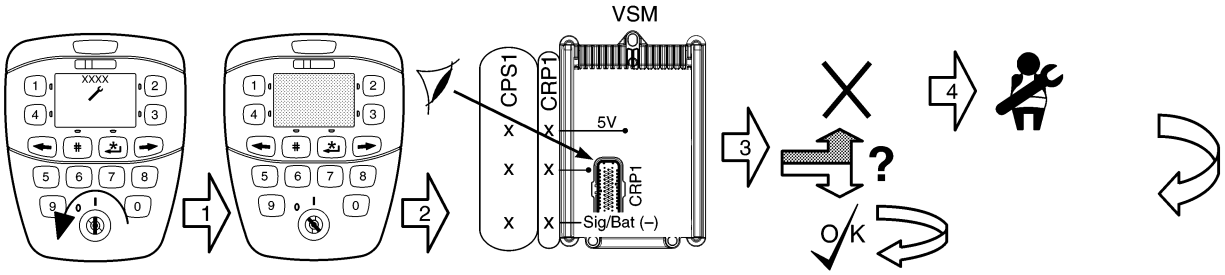
Repair Short Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.

CAUSE D

Not Applicable

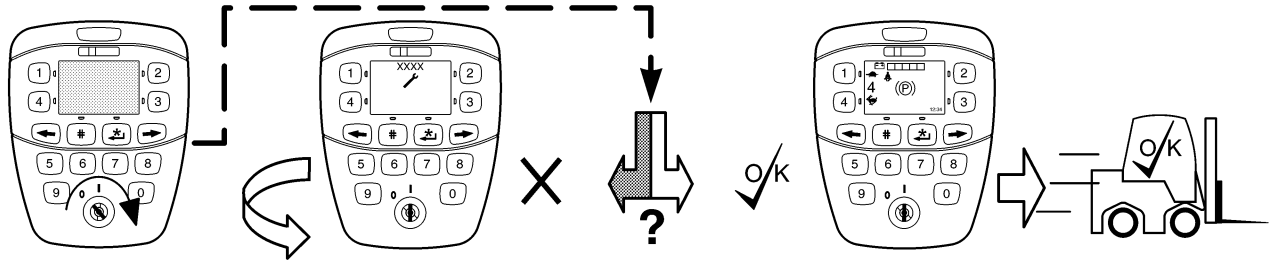
E-Hydraulic Enable System Data Incorrect (Cont)

CAUSE E



Power **OFF**→	Inspect VSM Connections→	Go to Step 1.	Not OK Correct/Repair→Go to Step 1.

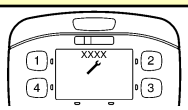
CAUSE E1



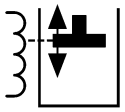
Retest - Power **ON**→	**NO**→Go to VSM Controller Check	Is fault DTC gone? **NO**←**YES**→	Fault corrected→Continue operation.

END FAULT

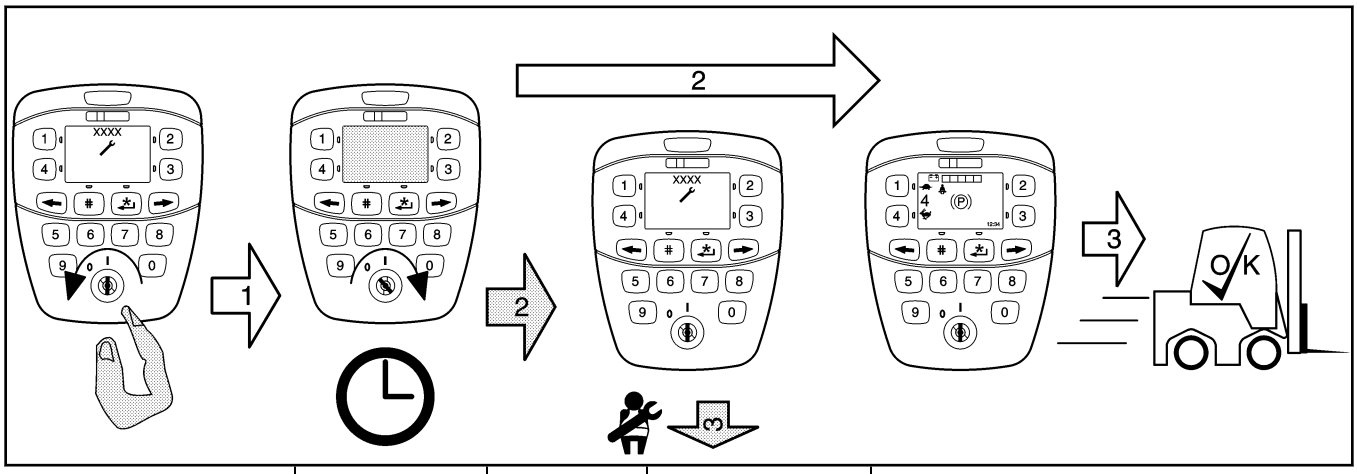
E-Hydraulic Coils Short To Battery Positive (STBP)



DTC 8960 Lift **DTC 8964 Lower** **DTC 8968 Tilt Forward** **DTC 8972 Tilt Back**



DTC 8978 Aux 1A **DTC 8980 Aux 1B** **DTC 8984 Aux 2A** **DTC 8988 Aux 2B**

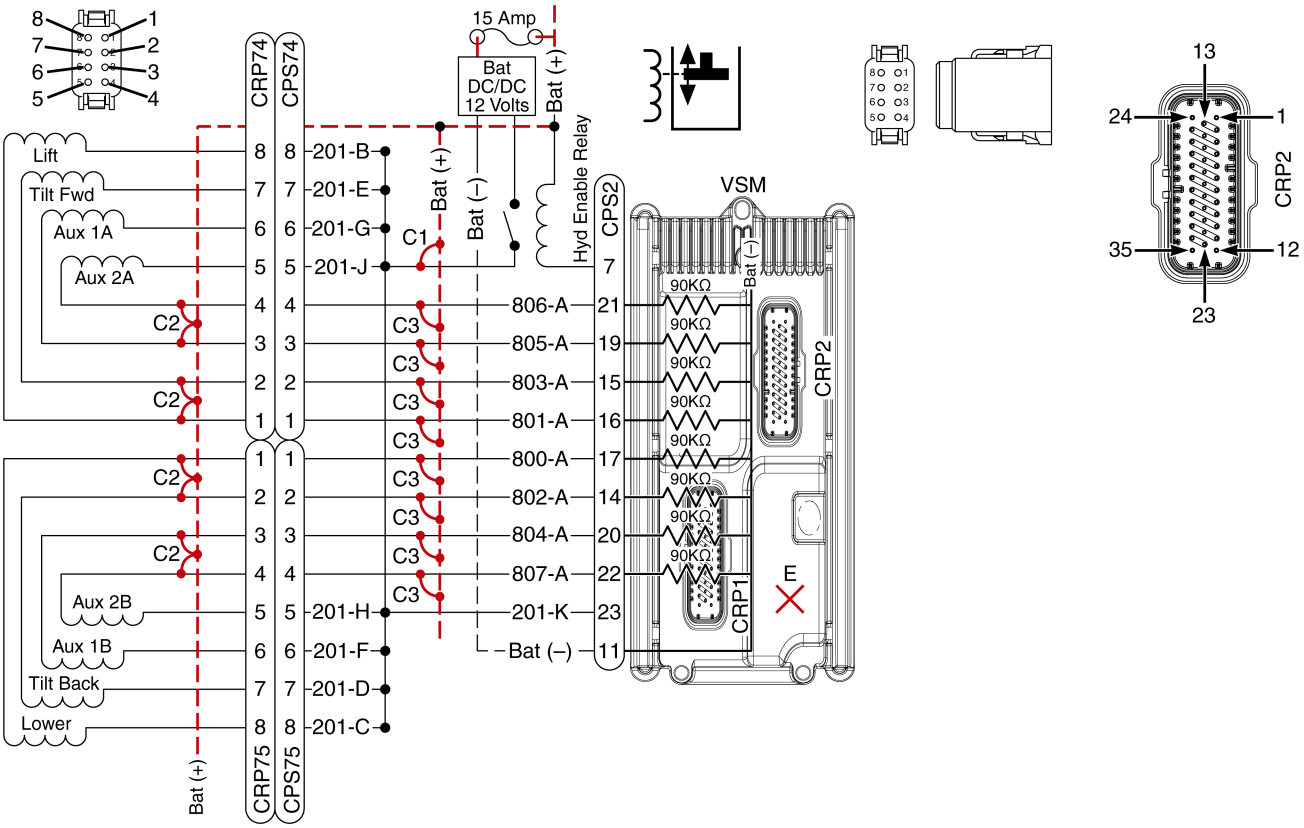


Power **OFF**→	Wait **30 seconds**→	Power **ON**→	Fault remains. Service required. Go to Component Operational Check.	No fault→	Resume operation

POSSIBLE CAUSE X = Open Circuit/Fail) = Short Circuit

E-Hydraulic Coils Short To Battery Positive (STBP) (Cont)

E-HYDRAULIC ENABLE SYSTEM DATA INCORRECT CAUSES A B C D E > ?



CAUSE A

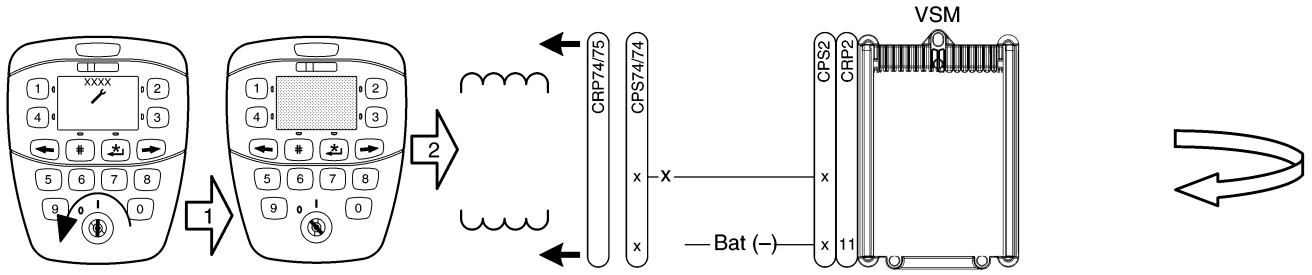
Not Applicable

CAUSE B

Not Applicable

E-Hydraulic Coils Short To Battery Positive (STBP) (Cont)

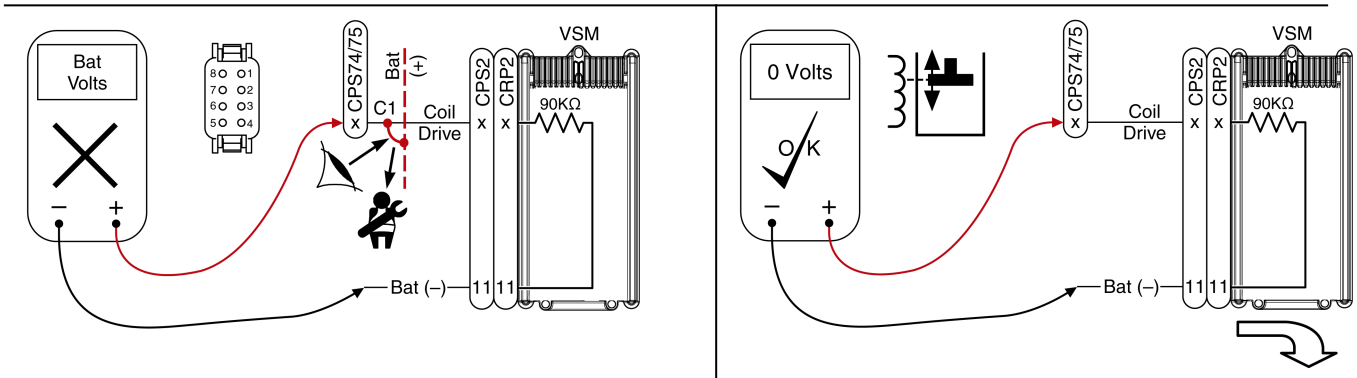
CAUSE C



Power **OFF**→	Disconnect coil connectors→		Go to next step.

CAUSE C1 UNSWITCHED VOLTAGES

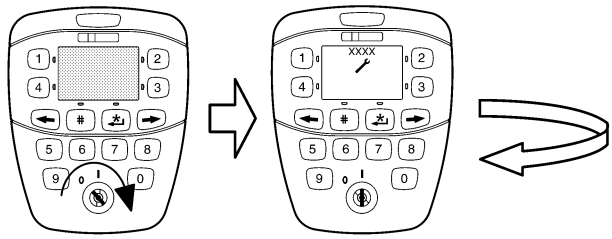
NOTE: Coil Driver Short to Unswitched Battery



Bat Volts = Short circuit→Find↑**SHORT** circuit.→	~ 0 Volts =	**OK**	Go to Step 2
Repair SHORT Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.			

CAUSE C2

NOTE: Coil Driver Short to Switched Battery

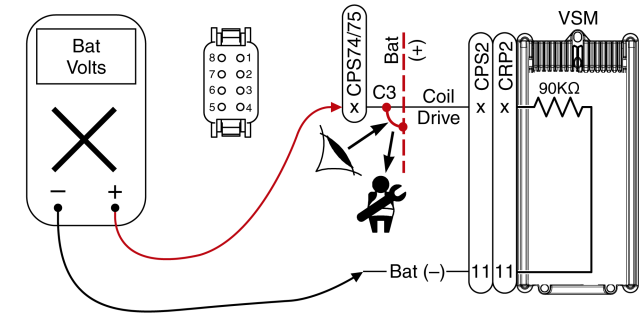


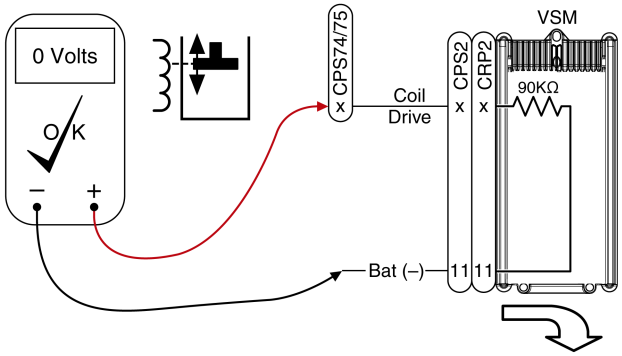
Power **ON**→	Go to next step.

E-Hydraulic Coils Short To Battery Positive (STBP) (Cont)

CAUSE C3

NOTE: Coil Driver Short to Switched Battery

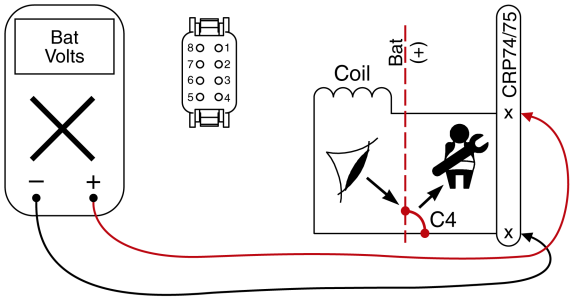


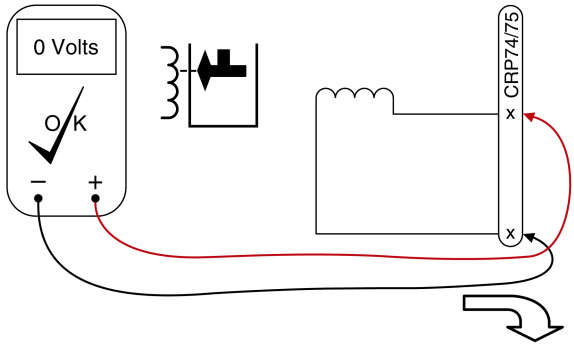


Bat Volts = Short circuit→Find↑**SHORT** circuit →	˜ 0 Volts = **OK** Go to Step 4
Repair SHORT Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	

CAUSE C4

NOTE: Short to Switched Battery



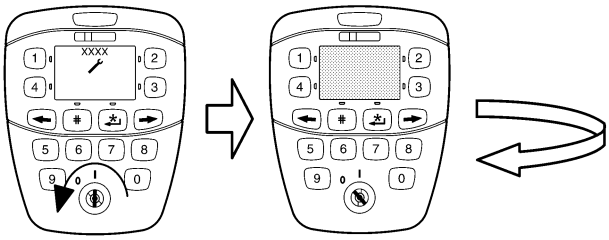


Bat Volts = Short circuit→Find↑**SHORT** circuit →	˜ 0 Volts = **OK** Go to Step 5
Repair SHORT Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	

E-Hydraulic Coils Short To Battery Positive (STBP) (Cont)

CAUSE C5 UNSWITCHED VOLTAGES

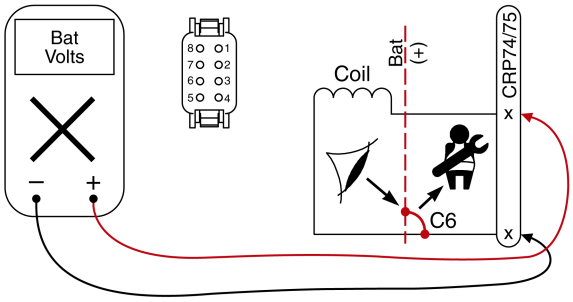
NOTE: Short to Unswitched Battery

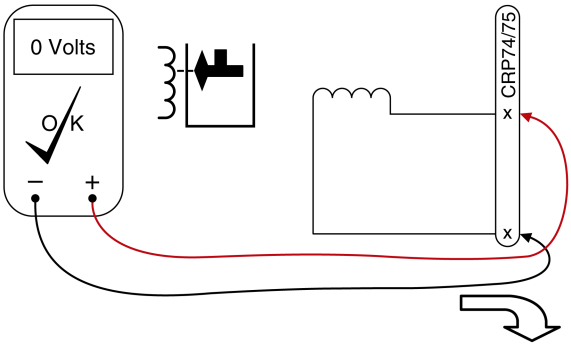


Power **OFF**→ ?

CAUSE C6 UNSWITCHED VOLTAGES

NOTE: Short to Unswitched Battery





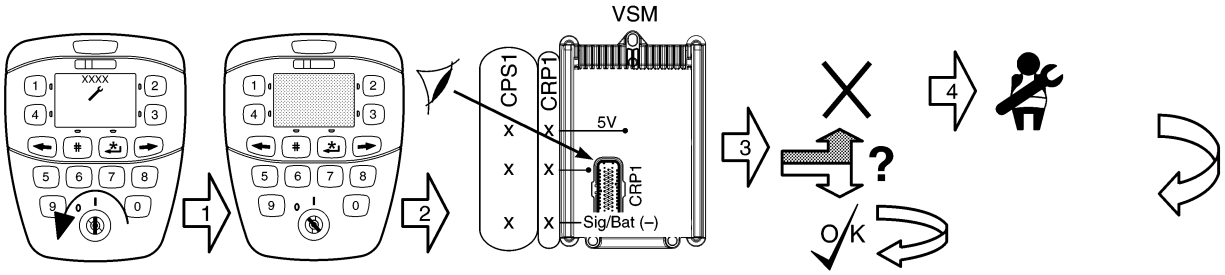
Bat Volts = Short circuit→Find↑**SHORT** circuit →	˜ 0 Volts =	**OK**	Go to CAUSE D
Repair Open Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.			

CAUSE D

Not Applicable

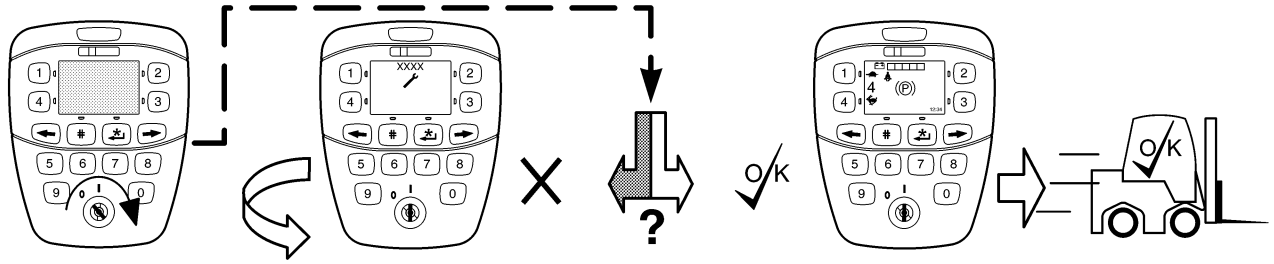
E-Hydraulic Coils Short To Battery Positive (STBP) (Cont)

CAUSE E



Power **OFF**→	Inspect VSM Connections→	Go to Step 1.	Not OK Correct/Repair→Go to Step 1.

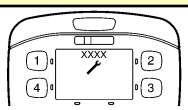
CAUSE E1



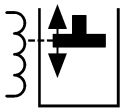
Retest - Power **ON**→	**NO**→Go to VSM Controller Check	Is fault DTC gone? **NO**←**YES**→	Fault corrected→Continue operation.

END FAULT

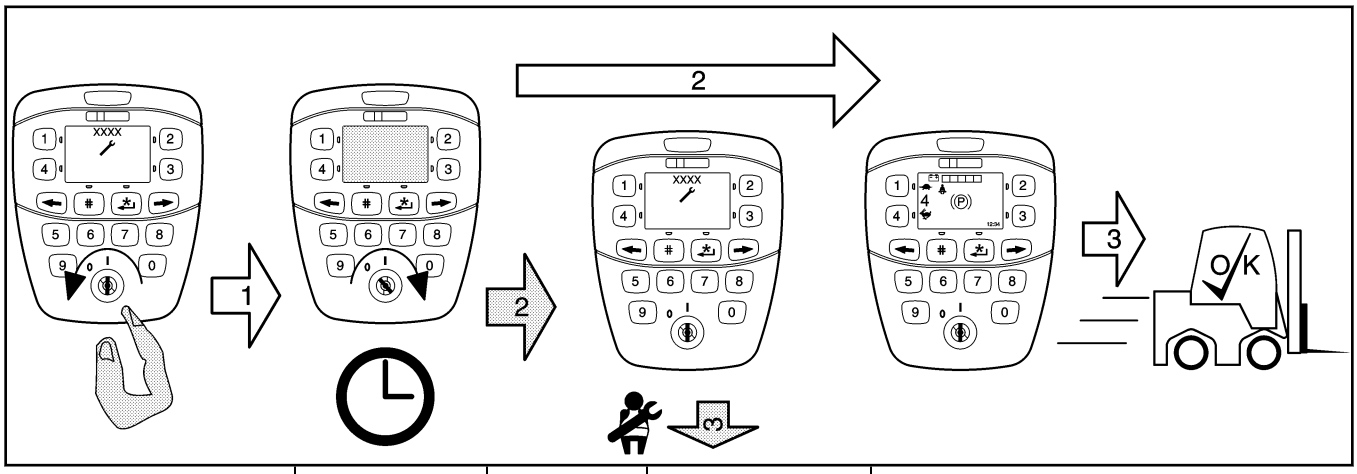
E-Hydraulic Coils Short To Battery Negative (STBN)/Open Circuit (OC)



DTC 13312 Lift **DTC 13316 Lower** **DTC 13320 Tilt Forward** **DTC 13324 Tilt Back**



DTC 13328 Aux 1A **DTC 13332 Aux 1B** **DTC 13336 Aux 2A** **DTC 13340 Aux 2B**

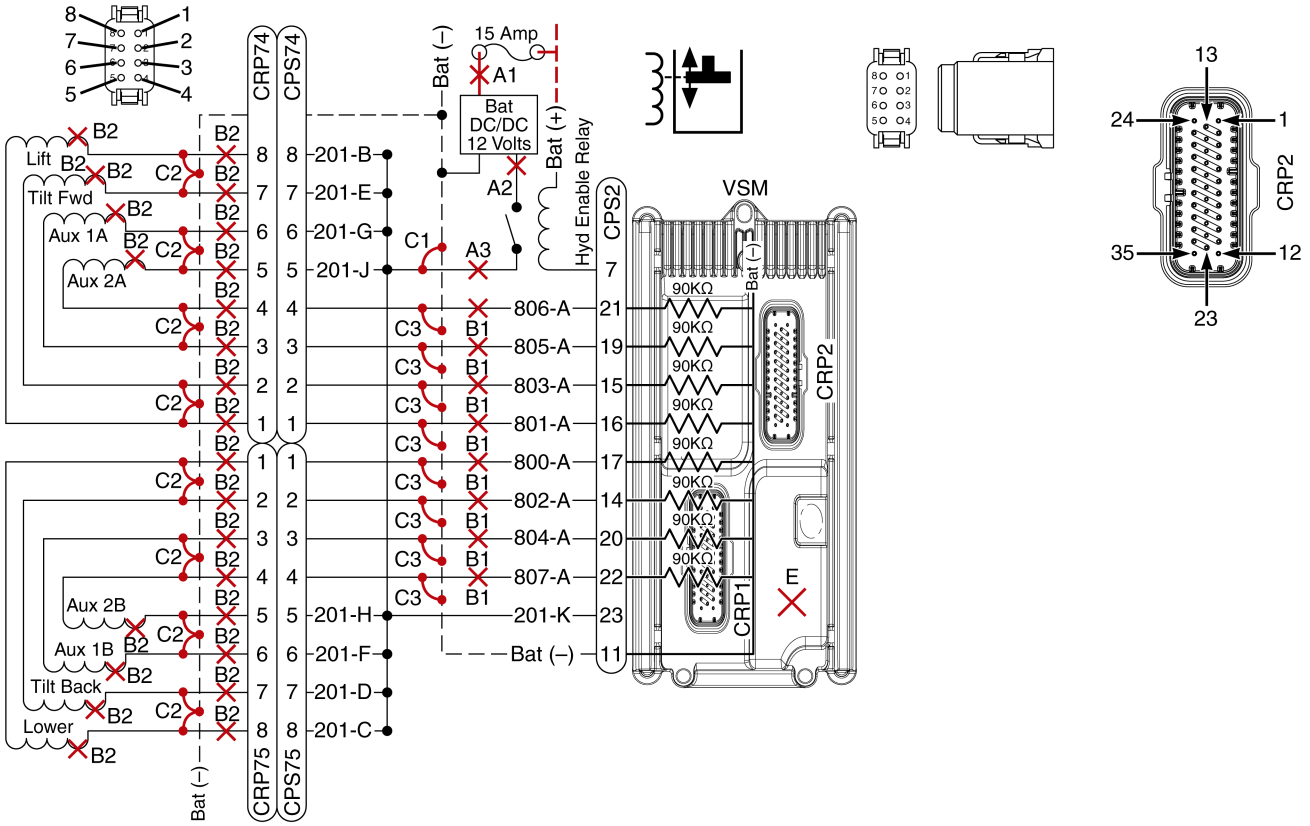


Power **OFF**→	Wait **30 seconds**→	Power **ON**→	Fault remains. Service required. Go to Component Operational Check.	No fault→	Resume operation

POSSIBLE CAUSE X = Open Circuit/Fail) = Short Circuit

E-Hydraulic Coils Short To Battery Negative (STBN)/Open Circuit (OC) (Cont)

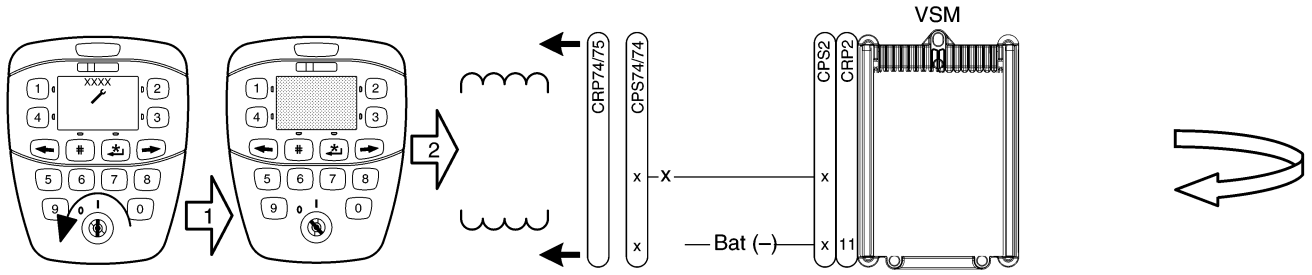
E-HYDRAULIC COILS (STBN)/(OC) CAUSES A B C D E > ?



CAUSE A

For causes A1, A2, and A3, go to DTC 12332 in E-Hydraulic Enable System Data Incorrect.

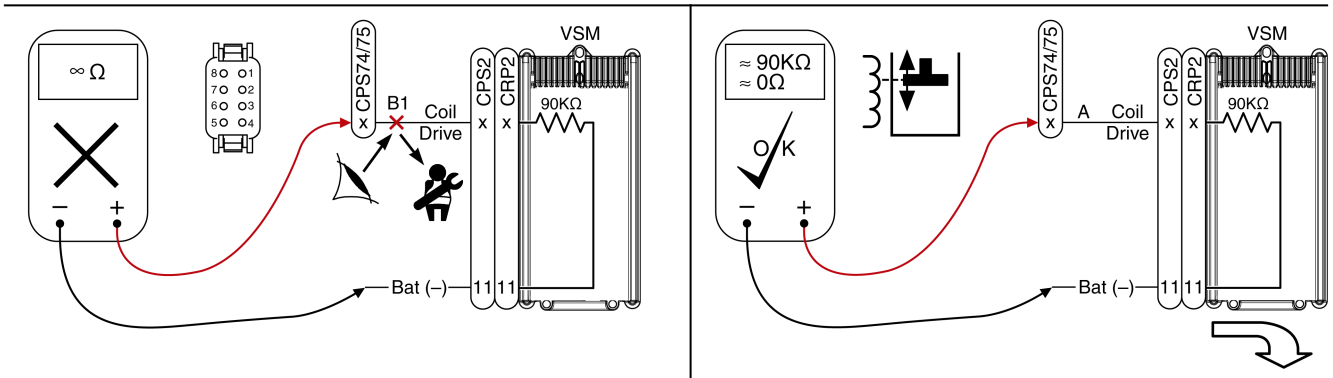
E-Hydraulic Coils Short To Battery Negative (STBN)/Open Circuit (OC) (Cont)
CAUSE B



Power **OFF**→	Disconnect coil connectors→		Go to next step.

CAUSE B1	**CHECK RESISTANCE - Ω - OHMS**

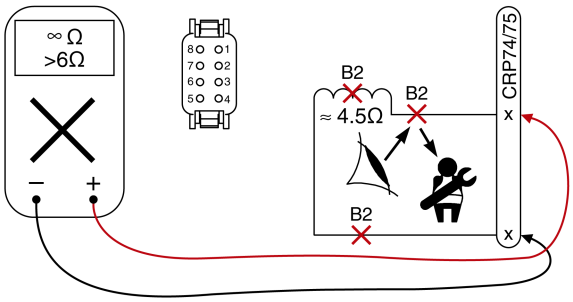
NOTE: Open Circuit - Coil Connector To VSM

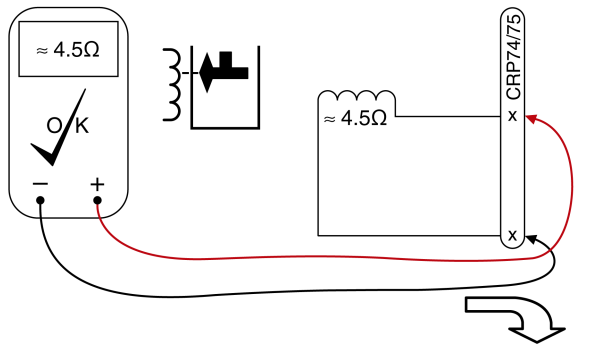


8Ω = Open circuit→Find↑**OPEN** circuit→	˜ 90kΩ =	**OK**	Go to Step 2
Repair OPEN circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	˜ 0Ω =		Go to Step 3

E-Hydraulic Coils Short To Battery Negative (STBN)/Open Circuit (OC) (Cont)	
CAUSE B2	**CHECK RESISTANCE - Ω - OHMS**

NOTE: Open Circuit - Coil Connections To Coil





8Ω = Open circuit→Find↑**OPEN** circuit→	˜4.5Ω ± 1.5Ω =	**OK**	Go to Step 2
Repair OPEN circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369. > 6Ω < 3Ω = Faulty Coil→ Replace**Coil**→Repair OPEN circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.			

CAUSE C

Go to Step 1

CAUSE C1	**CHECK RESISTANCE - Ω - OHMS**

For DC/DC volt Short to Battery, go to DTC 12332 in E-Hydraulic Enable System Data Incorrect.

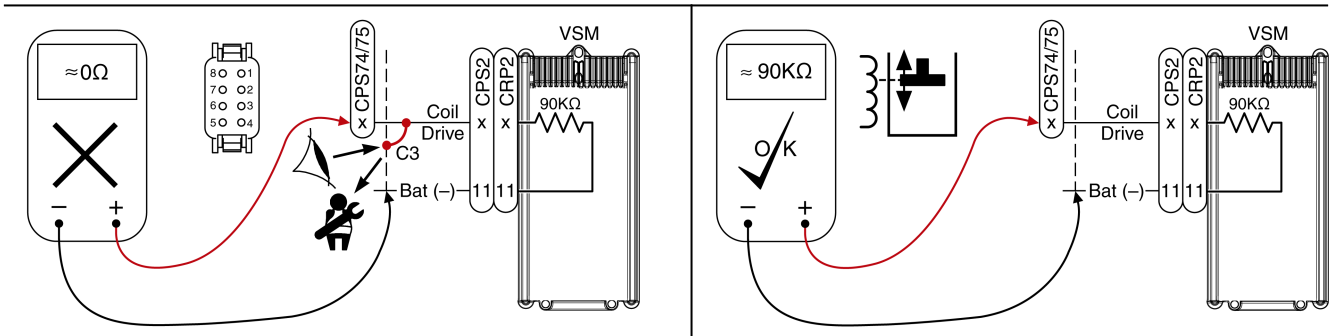
CAUSE C2	**CHECK RESISTANCE - Ω - OHMS**

For DC/DC volt Short to Battery, go to DTC 12332 in E-Hydraulic Enable System Data Incorrect.

E-Hydraulic Coils Short To Battery Negative (STBN)/Open Circuit (OC) (Cont)

CAUSE C3 — CHECK RESISTANCE - Ω - OHMS

NOTE: Short to Bat (-) Coil Driver Connectional

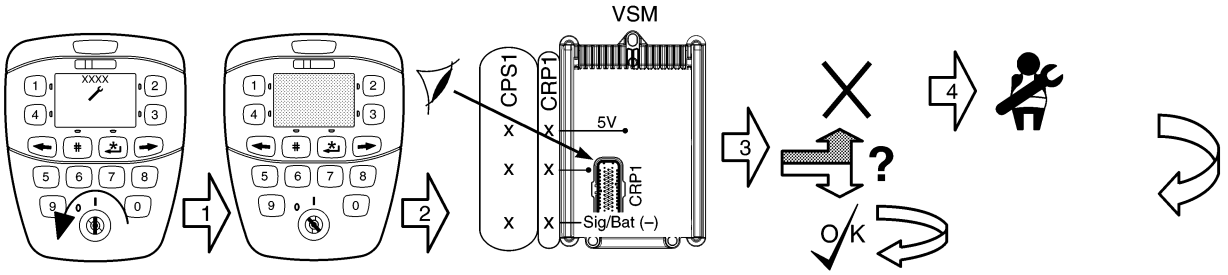


0 Ω = Short circuit→Find↑**Short** circuit→	˜ 90kΩ =	**OK**	Go to CAUSE D
Repair Short circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.			

CAUSE D

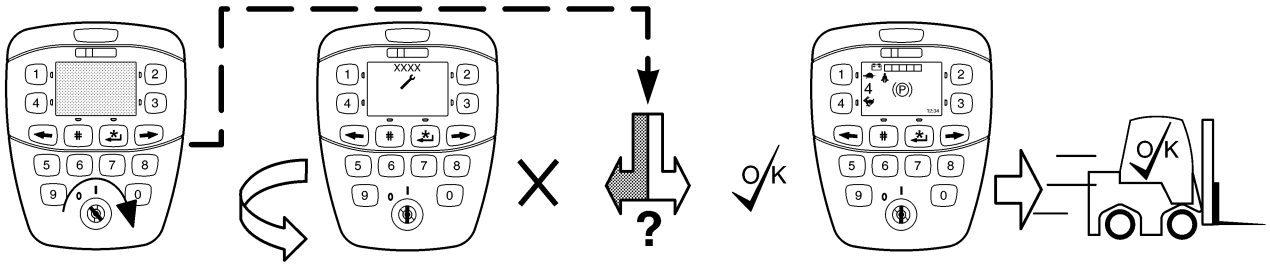
Not Applicable

CAUSE E



Power **OFF**→	Inspect VSM Connections→	Go to Step 1.	Not OK Correct/Repair→Go to Step 1.

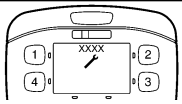
CAUSE E1



Retest - Power **ON**→	**NO**→Go to VSM Controller Check	Is fault DTC gone? **NO**←**YES**→	Fault corrected→Continue operation.

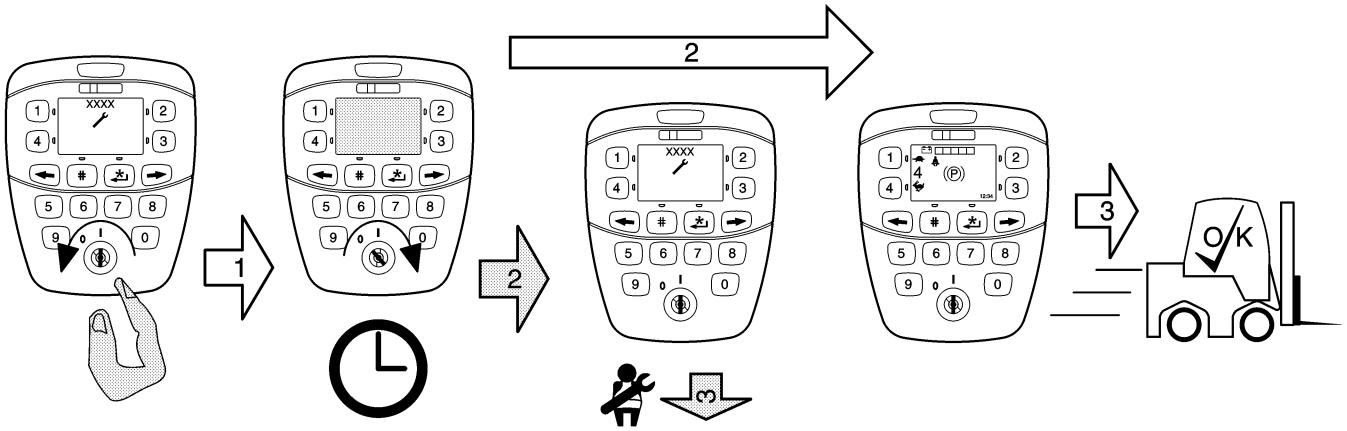
END FAULT

A935 – K160 CAN Communication Failure (Cont)



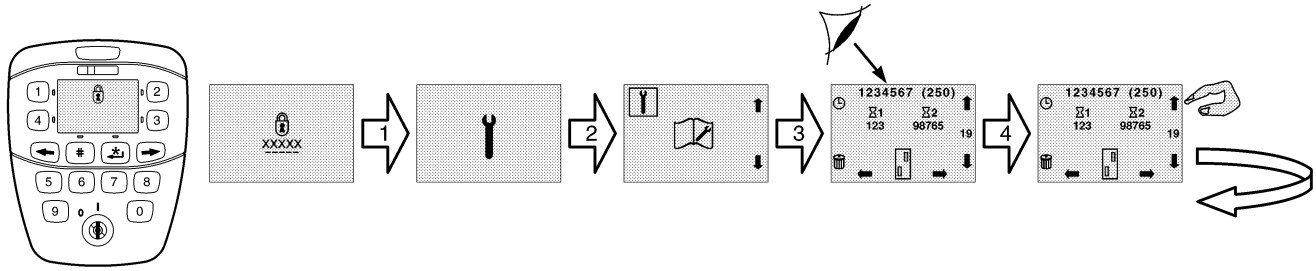
Fault Codes

DTC 33025 **VSM to Display**	**DTC 33026** **VSM to Traction 1 (Right)**	**DTC 33027** **VSM to Traction 2 (Left)**	**DTC 33029** **VSM to Pump**
DTC 33034 **VSM to MLM (DCS)**	**DTC 33035** **VSM to Impact**	**DTC 33036** **VSM to CAN Reserved 1**	**DTC 33037** **VSM to CAN Reserved 2**
DTC 33038 **VSM to CAN Reserved 3**	**DTC 33057** **Display to VSM**		

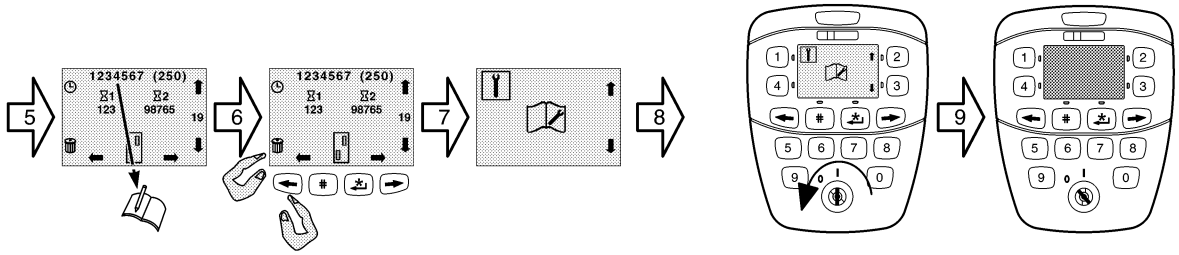


A935 – K160 CAN Communication Failure (Cont)				
Power **OFF**→	Wait **30 seconds**→	Power **ON**→	Fault remains. Service required. Go to Quick Check.	No fault→Resume Operation

FAULT LOG DTC Review – Go to Display Menu



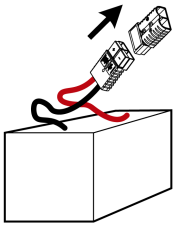
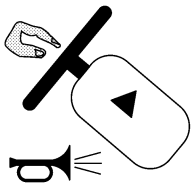
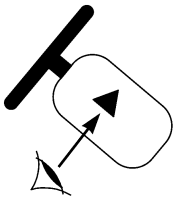
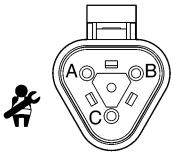
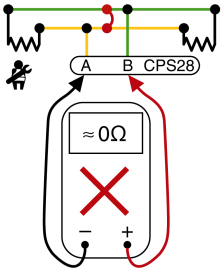
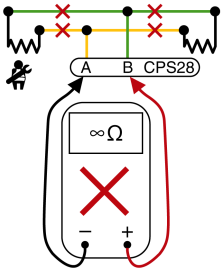
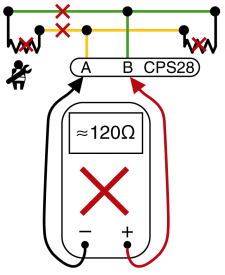
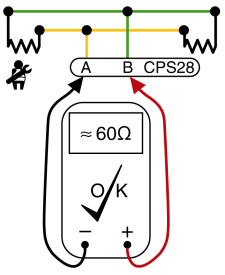
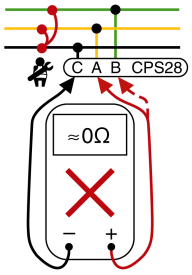
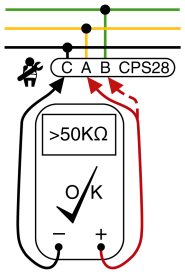
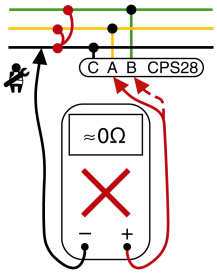
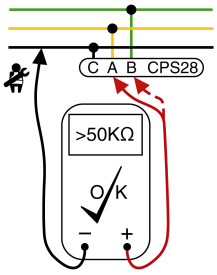
Enter SERVICE Password→	Diagnostics→	Fault Logs→	VSM Fault Logs→	View all VSM DTCs→?



NOTE: FOC1 (Part No. 8809255) and FOC2 (Part No. 8820249) controllers are physically the same but can be identified by part number.

all VSM DTCs	Multiple VSM DTCs→Erase VSM DTCs→Exit Fault Log→Power **OFF**→**Quick Check**↓	
Single DTC→Specific Device Fault Log→	Device DTCs→	Erase Device DTCs↓
Emergency Stop Switch→**OFF**→Wait 30 seconds→**ON**→?↓Recheck Single Device Fault Logs↓		
DTCs Present→ DTCs→Power **OFF**→Go to Single Device TSP↓	DTCs Gone→Resume Operation	

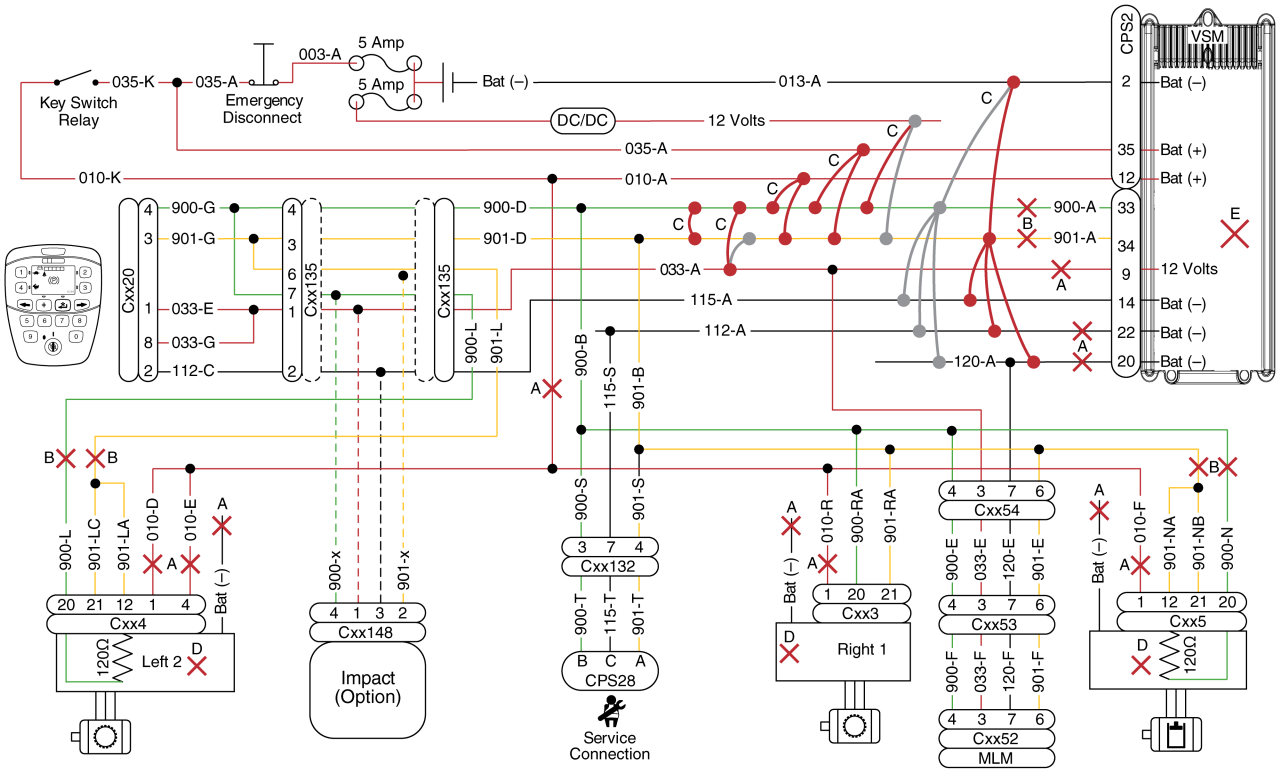
QUICK CHECK X = Open Circuit/Fail) = Short Circuit

A935 – K160 CAN Communication Failure (Cont)			
			
Disconnect Battery	Disconnect Battery and Sound Horn to Discharge Capacitors.Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342.	Locate Diagnostic Connector CPS 28	Service Connection
			
Short Circuit CAN Hi/CAN Lo Go to Step 1, All CAN Device DTCs	Open Circuit CAN Hi/CAN Lo Go to CAUSE 0, Multiple CAN Device DTCs	Open Circuit CAN Hi/ CAN Lo Termination Resistor Go to CAUSE A, Intermittent DTCs	Circuit OK Go to Step 2, Single CAN Device DTC: **Approx. 40Ω for FOC2 Controllers**
			
CAN Hi Short Circuit Bat (-) Go to Step 2, All CAN Device DTCs CAN Lo STB (-), No DTC Go to Step 2, No DTC	CANbus Circuit OK Go to Step 2, Single CAN Device DTC	CAN Hi Short Circuit Bat (+) All CAN Device DTCs Go to Step 3, CAN Hi Short to 12/5 (+) No DTC CAN Lo Short Circuit Bat (+) All CAN Device DTCs Go to Step 3,	CANbus Circuit OK Go to Step 2, Single CAN Device DTC
SINGLE DEVICE DTC→Fault is isolated to a SINGLE CANbus Connected Device and its Supply Connections			
MULTIPLE DEVICE DTCs →Faults that affect some but not all CANbus Devices→Typically Open Circuits			
ALL DEVICE DTCs→Faults that affect all of the CANbus connected devices→Typically Short Circuits			

A935 – K160 CAN Communication Failure (Cont)
POSSIBLE CAUSES X = Open Circuit/Fail) = Short Circuit
CAUSES A B C D E > ?

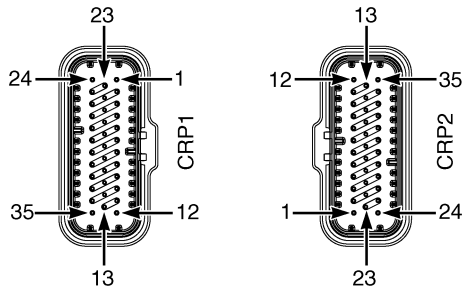
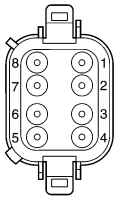
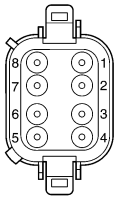
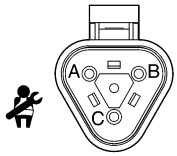
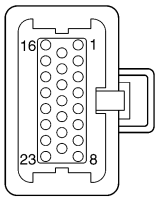
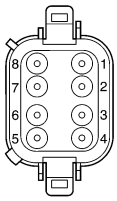
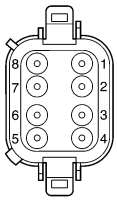
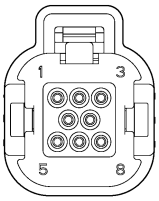
Table 9030-20-5. Main Schematic

Open Circuit – Termination Resistor/CAN Hi/CAN Lo/Key Switch Supply/Device Supply/ CAUSES A, B
CAN Short to – Bat (-)/12volt Bat (+)/Shorted CAN Hi to CAN Lo/Device Failure CAUSES C, D, E



A935 – K160 CAN Communication Failure (Cont)
CONNECTORS

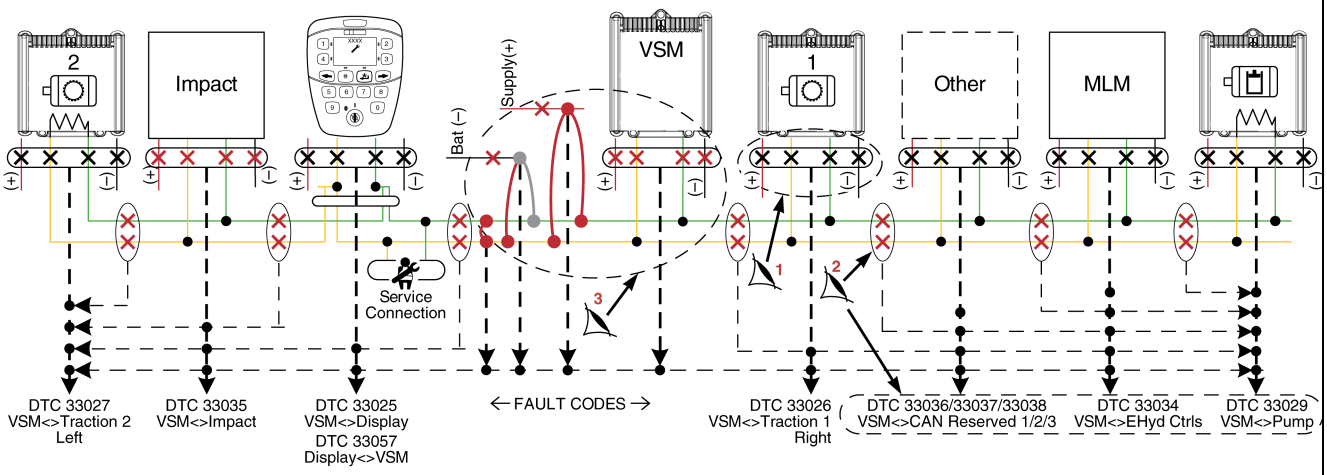
Table 9030-20-6. Device Connectors

			
VSM Cxx 1 and Cxx 2	Main Seat Cxx 52 and 54	Impact Device Cxx 148	Service Connector Cxx 28
			
Traction/Pump Controller Cxx 3, 4, and 5	MLM Cxx 52	Display Harness Cxx 135	Display Cxx 20

A935 – K160 CAN Communication Failure (Cont)

CAUSE A

CAN Hi/CAN Lo Single Device DTC (Black X) vs Multiple DTCs (Red X)



1, 2, and 3 are examples of possible Causes

1. Single DTC→Indicated Device Connections/Device Fail→Step 1

1. Single DTC above →Open Circuit on Device Supply (+) or Bat (-) or Open Circuit on Sub Circuit Wiring→Step 3

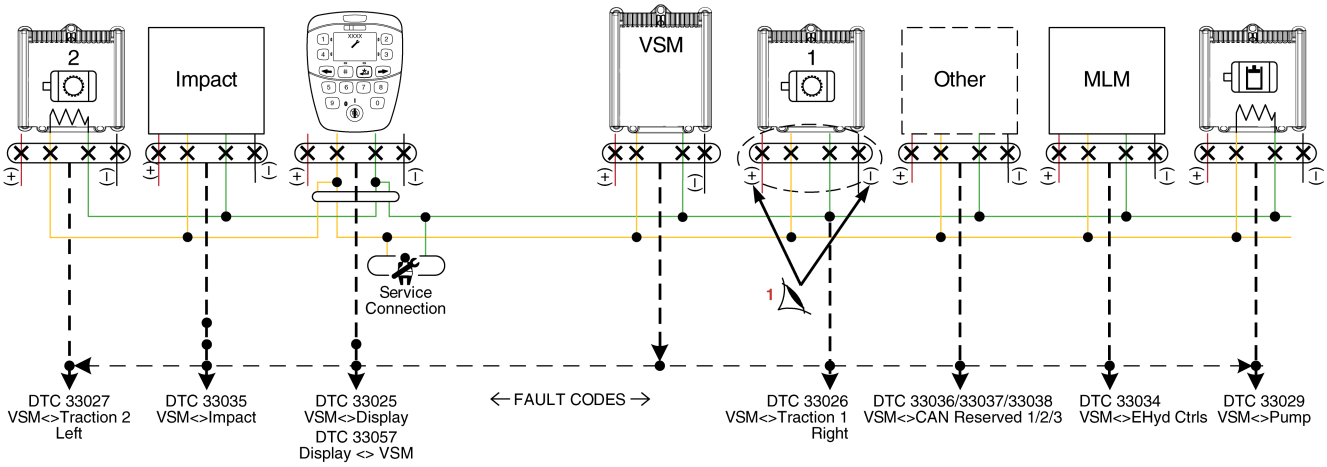
2. Multiple DTCs→Fault Log→DTC/Device closest to VSM↑→= Open circuit between DTC Device and VSM→Step 3

3. All DTCs above→Open Circuit on Device Supply (+) Bat (-)→= Supply Failure/Open Circuit Main Supply Circuit→Step 3

3. All DTCs above→Open/Short Circuit on VSM CANbus→= Open Circuit→Step 3 – Short Circuit→CAUSE B

STEP A1

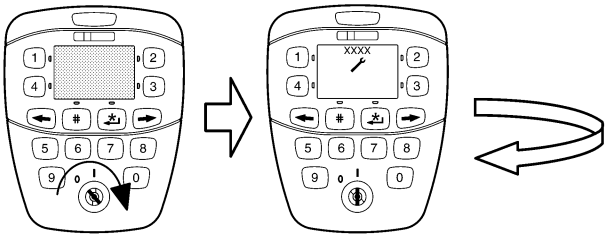
CAN Hi/ CAN Lo Single Device DTC - Locate Device



1. Example Only→Single DTC→Indicated Device Connections/Device Fail→ of Step 2

A935 – K160 CAN Communication Failure (Cont)

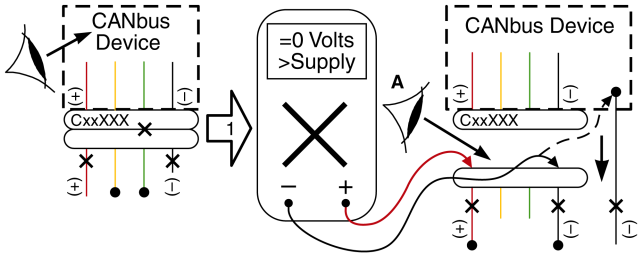
STEP A2

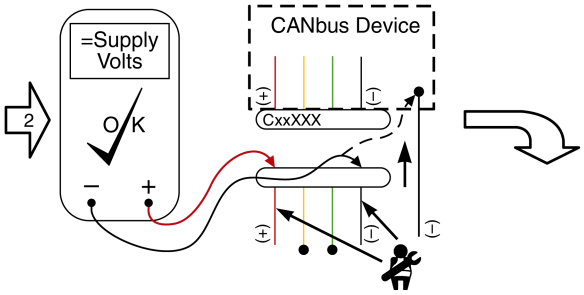


Power **ON**→Step 3

STEP A3

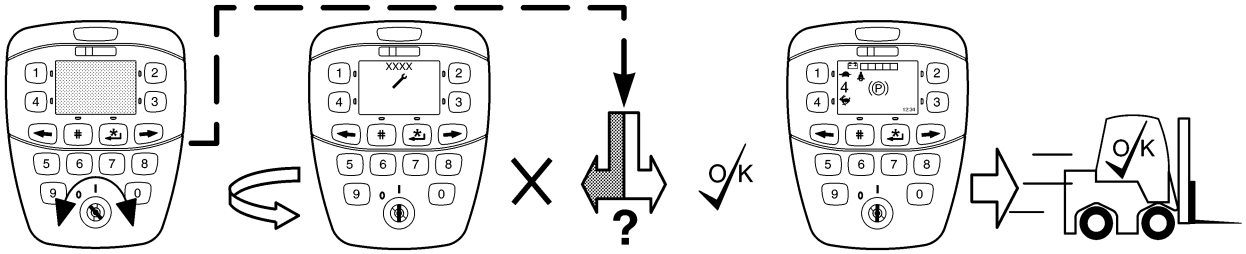
Single Device DTC Open Circuit Supply Voltage





1. Locate Device→Check connection→Not OK, Go to 4↓	1. Connection OK→Go to 2↓
2. = 0 Volts = Open Circuit Supply/(+) or (-) →Go to 4↓	2. =Supply Volts = OK→Step 1↓
3. > Supply Volts →Check for Shorts to a higher supply source→Repair→CAUSE C as CAN Device may be damaged	
4. Reference **Main Schematic** - Find/Repair Open Circuit See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→Recheck Voltage↑→Step 4↓	

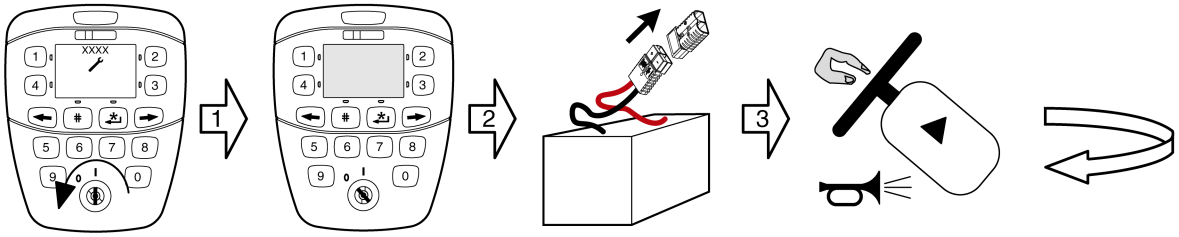
STEP A4



Retest - Power **OFF** Power **ON**	**NO**→CAUSE A	Is fault DTC gone?**NO** **YES**←→	Fault corrected→Continue operation

A935 – K160 CAN Communication Failure (Cont)

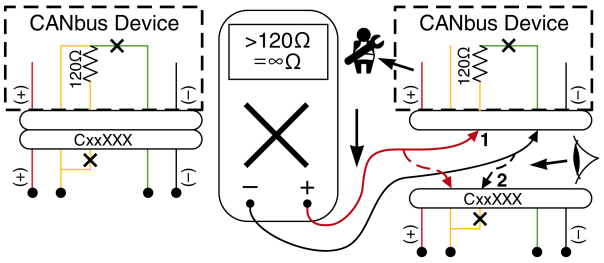
CAUSE B

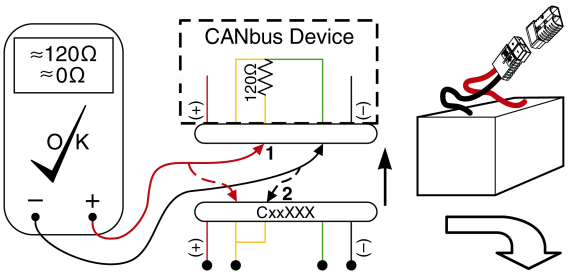


Power **OFF**→	Disconnect Battery and Sound Horn to Discharge Capacitors.→Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342→.	Go to Step 1

STEP B1

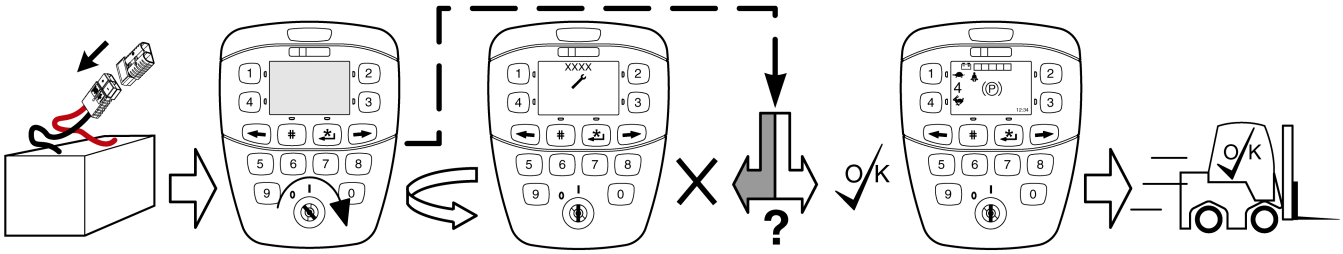
Single Device DTC Open Circuit CAN Hi or CAN Lo





Locate Device→Check Connection→Not OK, Go to 4↓	Connections OK→Reconnect→Go to Step 2
Device with Termination Resistor→Locate and Disconnect ↓	See **Device Connectors**
1. > 120? = Open Circuit Termination Resistor →Go to 3↓	1. ˜ 120? = OK Go to 2 ↓
2. = 8? = Open Circuit →Go to 4↓	2. ˜ 0? = OK Go to 3 ↓
3. **Replace Device**→CAUSE C↓	
4. Find/Repair Open Circuit, See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→Recheck?↑→Reconnect→Step 2↓	

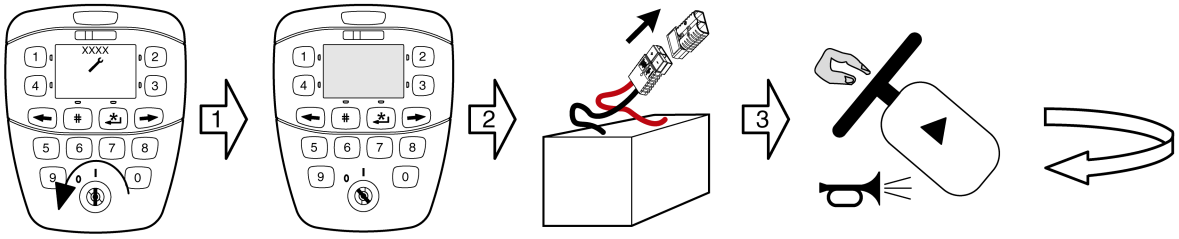
STEP B2



Reconnect Battery	Retest - Power **ON**	**NO**→Step 3,	Is fault DTC gone?**NO** **YES**	Fault corrected→Continue operation

A935 – K160 CAN Communication Failure (Cont)

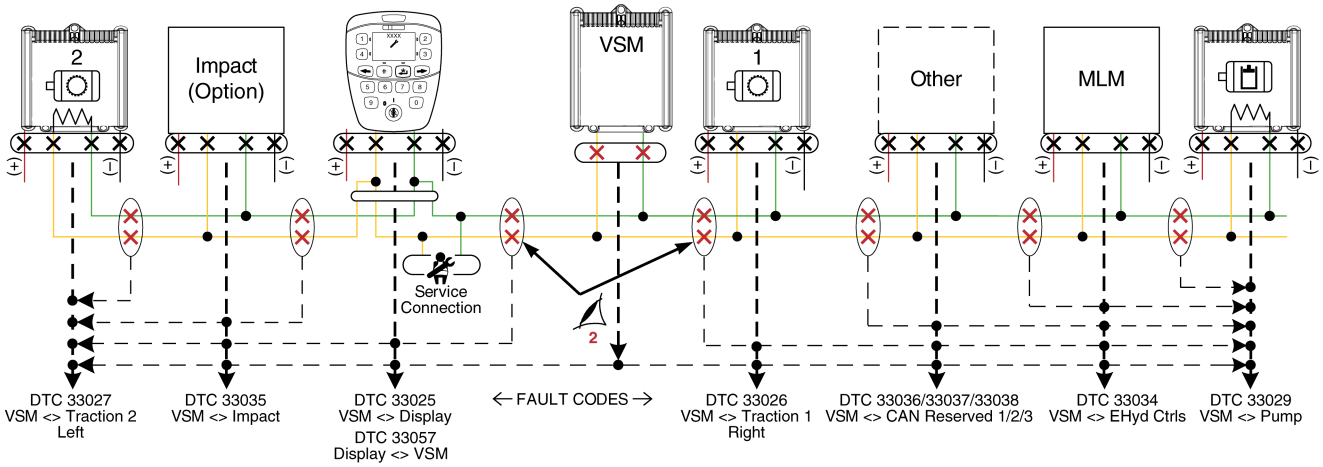
STEP B3



Power **OFF**→	Disconnect Battery and Sound Horn to Discharge Capacitors.→Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342→.	Go to Step 4

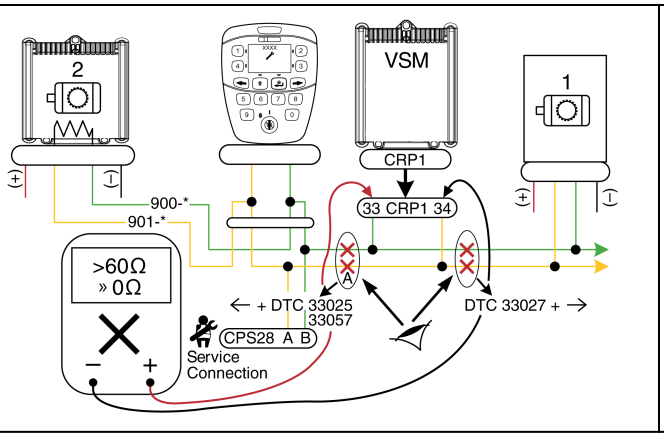
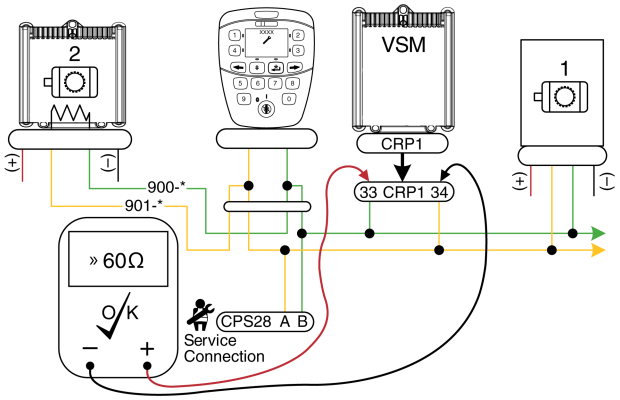
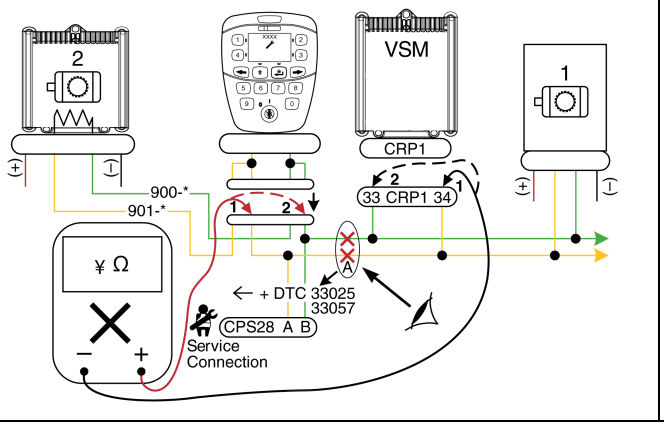
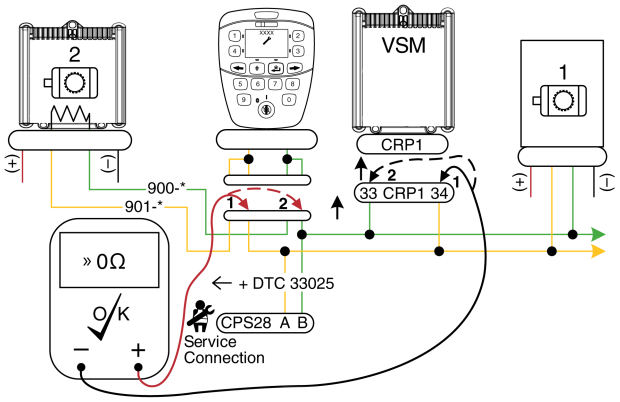
STEP B4

Multi CAN Device DTCs Display > Open Circuit CAN Hi to CAN Lo



Example Only→Multiple DTCs→Fault Log→DTC/Device closest to VSM

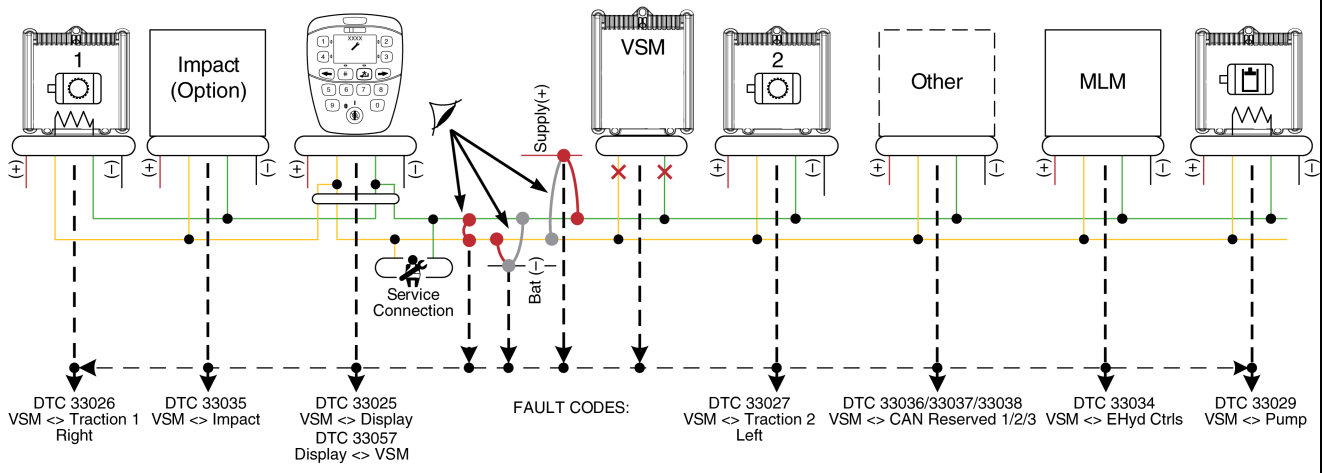
Open circuit is between DTC Device and VSM→, Step 5↓

A935 – K160 CAN Communication Failure (Cont)	
STEP B5	
Multi Device DTCs Open Circuit CAN Hi or CAN Lo	
	
The above is an Example Only	
Disconnect VSM CPS1→Measure ?	See **Device Connectors**
> 60? to 8? = CAN Hi/Lo Open Circuit Step 6↓	˜ 0? →CAUSE B↓ ˜ 60? = OK→CAUSE B↓
STEP B6	
	
The above is an Example Only	
Locate Device to Right or Left of Indicated Open Circuit→	Disconnect →See **Device Connectors**↓
1. 8? = CAN Hi Open Circuit→Go to 3↓	1. ˜ 0? = OK →CAUSE B↓
2. 8? = CAN Lo Open Circuit→Go to 3↓	2. ˜ 0? = OK →CAUSE B↓
3. Find/Repair Short Circuit, See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369Recheck ?→Reconnect→Retest→CAUSE B↓	

A935 – K160 CAN Communication Failure (Cont)

CAUSE C

All CAN Device DTCs Displayed > CAN Hi/CAN Lo Short Circuit together/Supply (+) or (-)



All DTCs→Open Circuit to VSM →Step 5↑

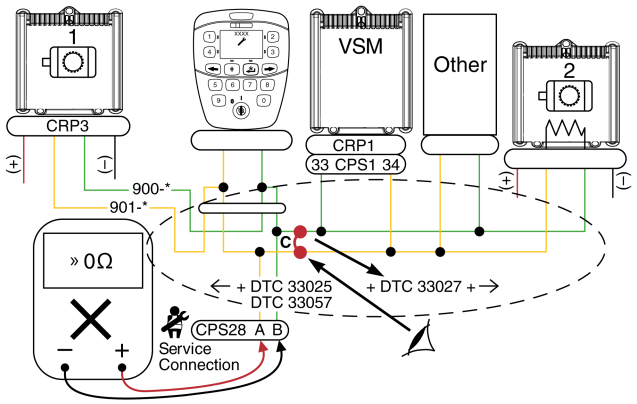
All DTCs→Short Circuit CAN Hi to CAN Lo →Step 1↓

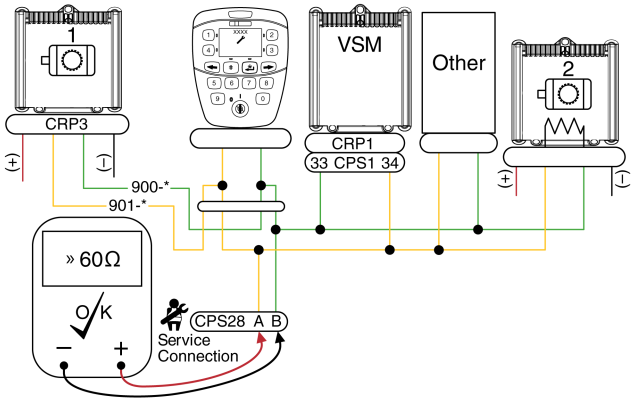
All DTCs→Short Circuit CAN Hi to (-) Supply Sources →Step 2↓No DTCs→Short Circuit CAN Lo to (–-) Supply Sources

All DTCs→Short Circuit CAN Lo to (+) Supply Sources→Step 3↓No DTCs→Short Circuit CAN Hi to (+) Supplies (5, 12 volt)

STEP C1

All Device DTCs Short Circuit CAN Hi to CAN Lo



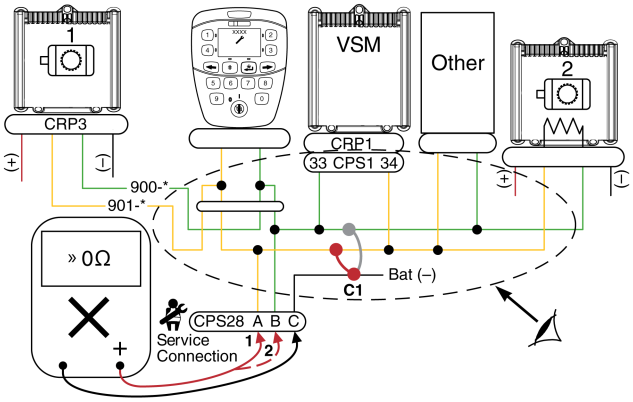


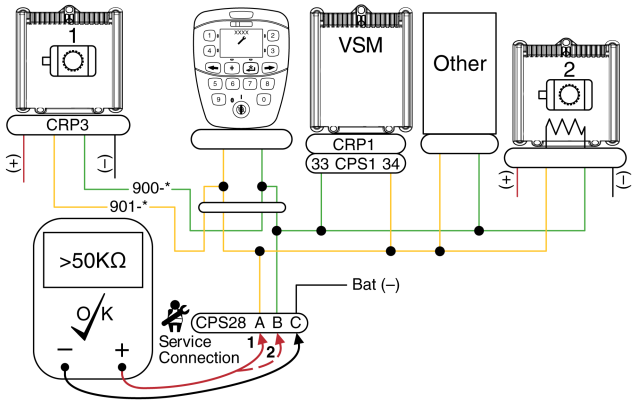
Locate Service Connection →Measure ?	See **Device Connectors**↓
1. = 0? CAN Hi/Lo Short Circuit→Go to 2↓	1. ˜ 60? = OK →Step 2↓
2. Inspect Accessible Harness Areas for Insulation Damage then Inaccessible Harness Areas. Focus on Bend Edges and Pinch Points, Go to 3↓	
3. Find/Repair Short Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369 Re-check ?→Reconnect→Retest→Step 5↓	

A935 – K160 CAN Communication Failure (Cont)

STEP C2

All Device DTCs Short Circuit CAN Hi to Bat (-)CAN Lo to Bat (-) will not Produce a DTC



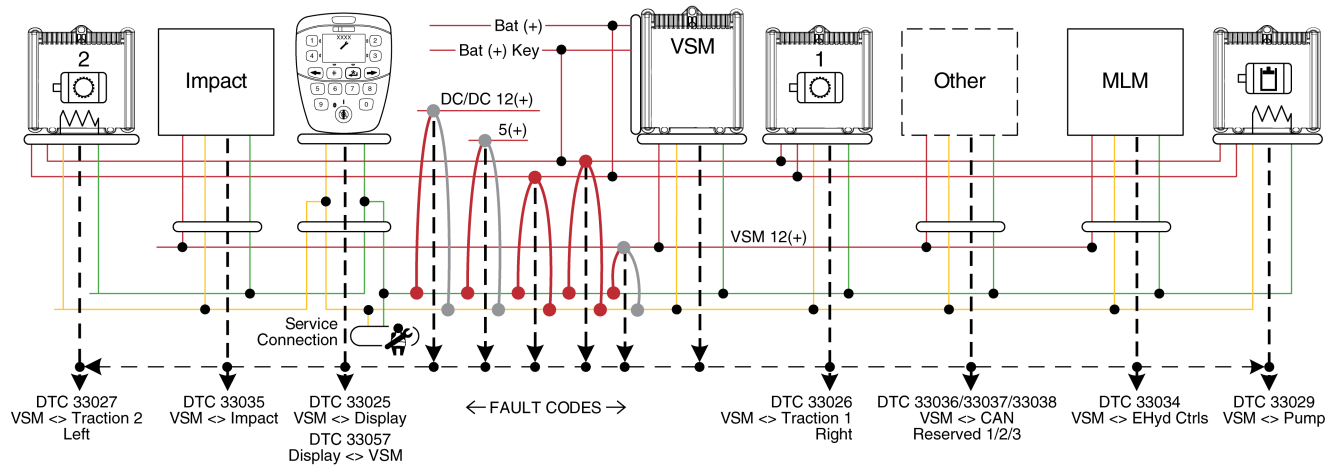


1. 0? = CAN Hi Short Circuit. Go to 3↓	1. > 50K? = OK, Go to 3↓
2. 0? = CAN Lo Short Circuit. Go to 3↓	2. > 50K? = OK, Go to 3 ↓

3. Find/Repair Short Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369 Re-check ?→Reconnect→Retest, →Step 5

STEP C3

Multiple CAN Device DTCs Displayed > (+) Supply Short Circuit to CAN Hi or CAN Lo



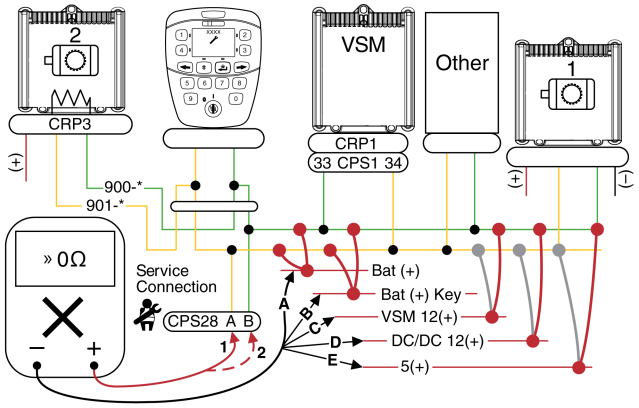
All DTCs→Short Circuit CAN Lo to (+) Supply Sources.

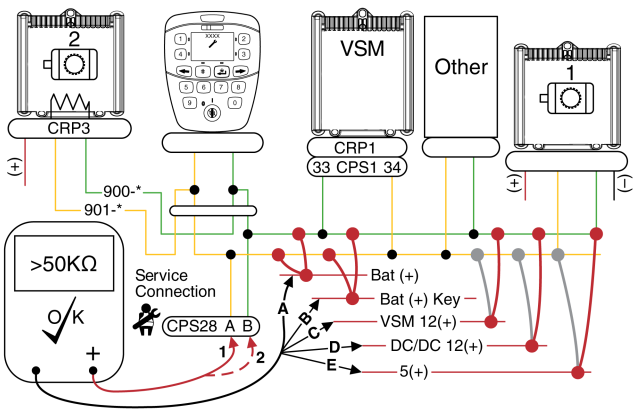
All DTCs→Short Circuit CAN Hi to (+) Supply Sources.No DTCs for a Short to (+)12 Volts or (+) 5 Volts

A935 – K160 CAN Communication Failure (Cont)

STEP C4

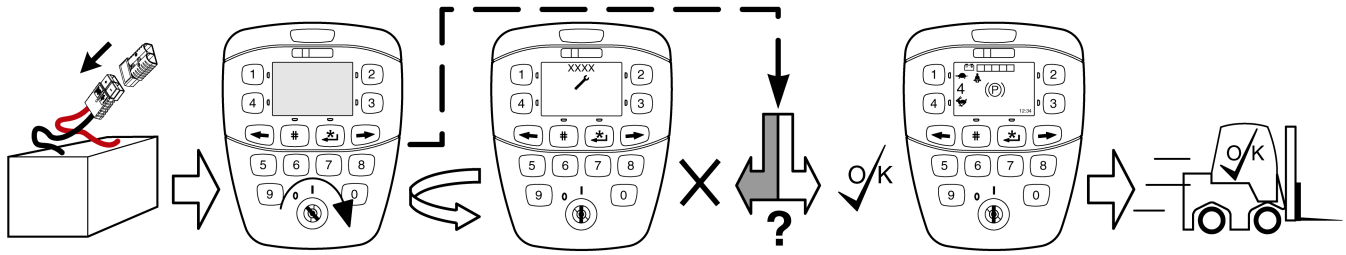
All Device DTCs Short Circuit Supply (+) to CAN Hi or CAN Lo





1. A, B, C, D, and E = 0? = CAN Hi Short Circuit, Go to 3↓	1. A, B, C, D, and E > 50K? = OK→, Step 5↓
2. A, B, C, D, and E = 0? = CAN Lo Short Circuit, Go to 3↓	2. A, B, C, D, and E > 50K? =OK→Step 5↓
3. Find/Repair Short Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369 Re-check ?→Reconnect→Retest→Step 5↓	

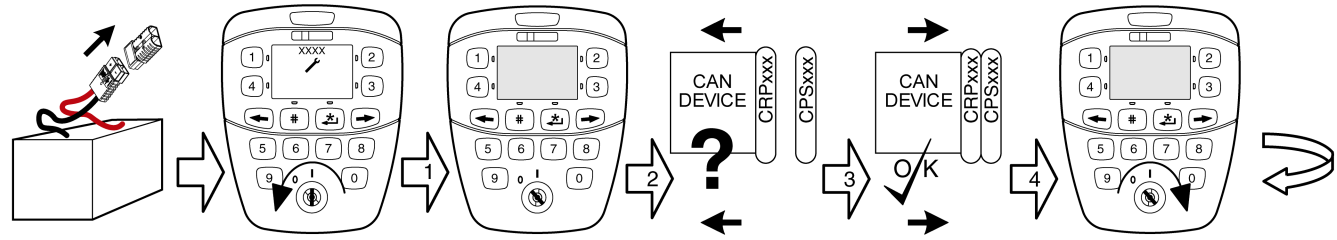
STEP C5



Reconnect Battery	Retest - Power **ON**	**NO**→Go to CAUSE C	Is fault DTC gone?**NO** **YES**	Fault corrected→Continue operation

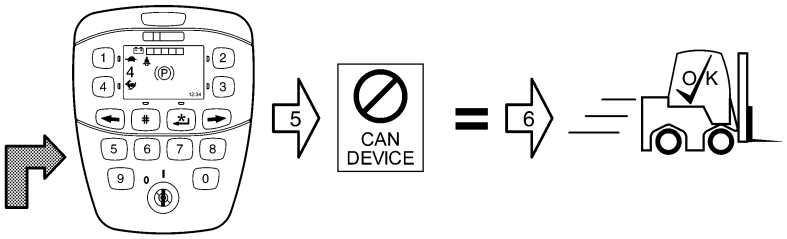
A935 – K160 CAN Communication Failure (Cont)

CAUSE D

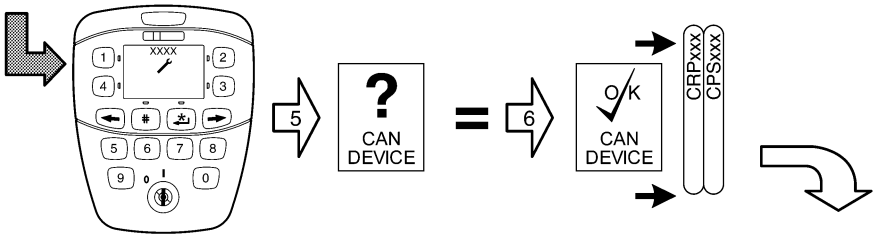


Disconnect Battery To Replace Motor Controller	Power **OFF**	Disconnect CAN Device→Do Not Discard	Install New CAN Device	Power **ON**→Go to Step 1

STEP D1



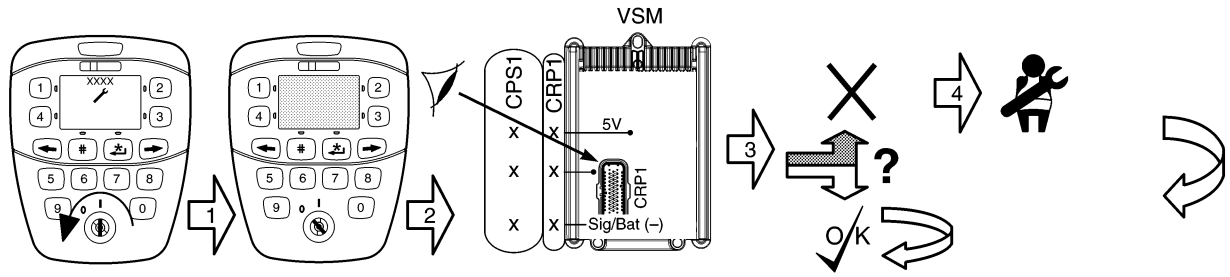
?	Fault DTC gone→	Old device faulty→	Resume operation



Fault DTC present→	Old Device OK/Reinstall Old Device→	Go to CAUSE D.

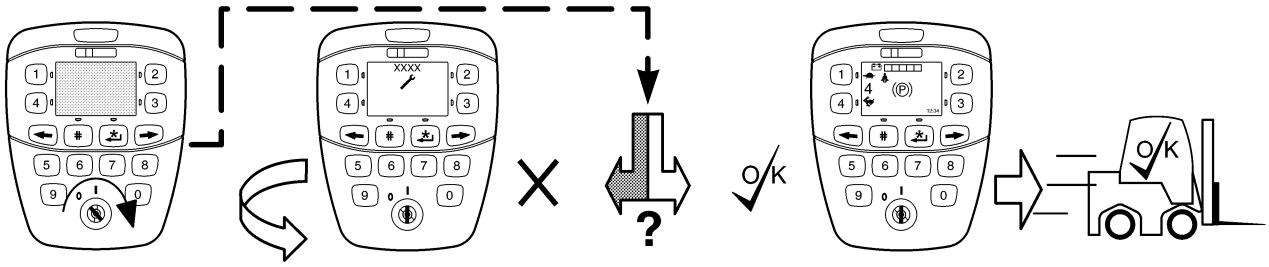
A935 – K160 CAN Communication Failure (Cont)

CAUSE E



Power **OFF**→	Inspect VSM Connections→	Go to Step 1	Not OK Correct/Repair→Go to Step 1

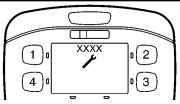
STEP E1



Retest - Power **ON**→	**NO**→Go to VSM Controller Check	Is fault DTC gone?**NO** **YES**	Fault corrected→Continue operation

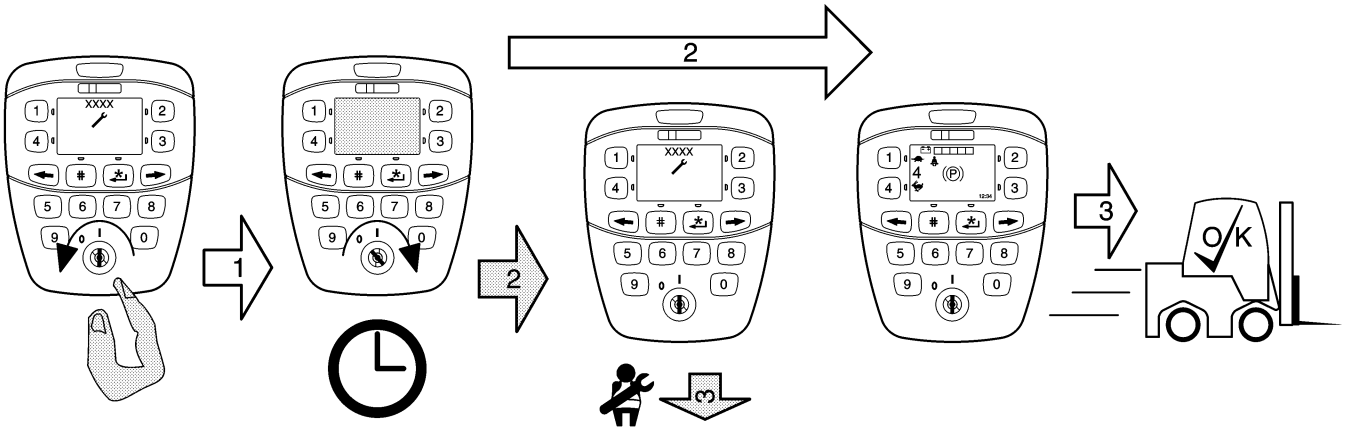
END FAULT

CBB 4 Wheel CAN Communication (Cont)

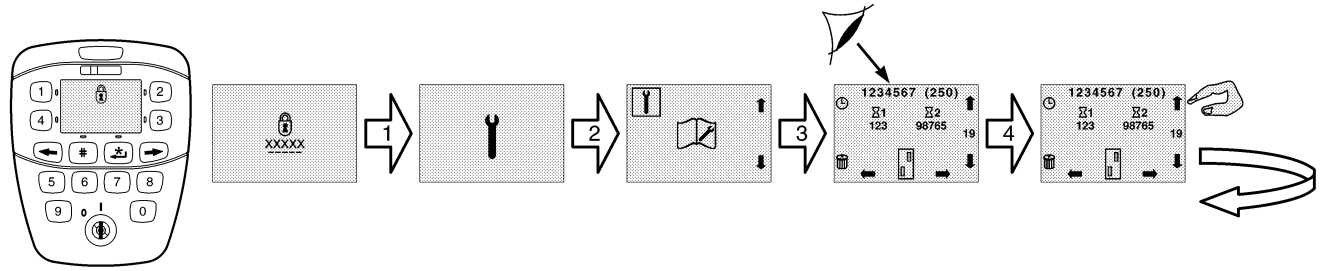


Fault Codes

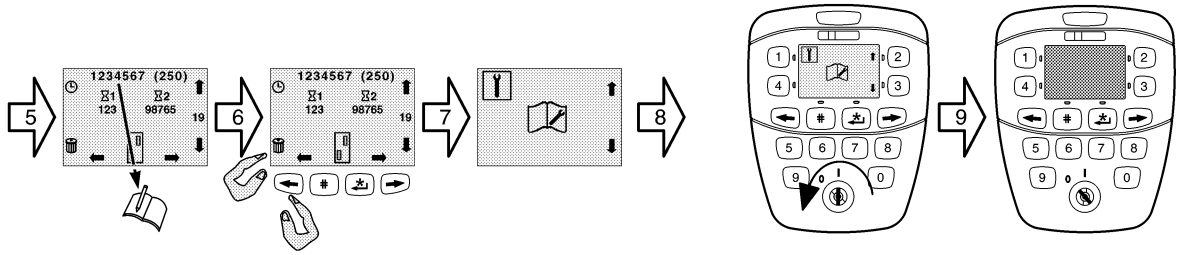
DTC 33025 **VSM to Display**	**DTC 33026** **VSM to Traction 1 (Right)**	**DTC 33027** **VSM to Traction 2 (Left)**	**DTC 33029** **VSM to Pump**
DTC 33034 **VSM to MLM (DCS)**	**DTC 33035** **VSM to Impact**	**DTC 33036** **VSM to CAN Reserved 1**	**DTC 33037** **VSM to CAN Reserved 2**
DTC 33038 **VSM to CAN Reserved 3**	**DTC 33057** **Display to VSM**		



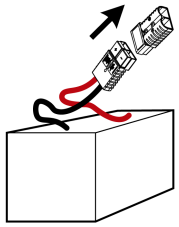
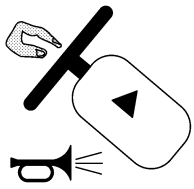
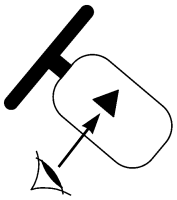
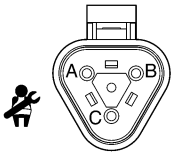
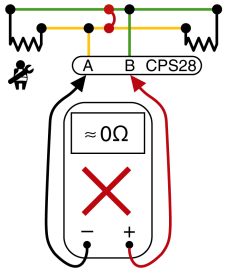
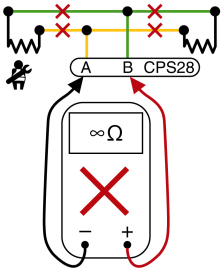
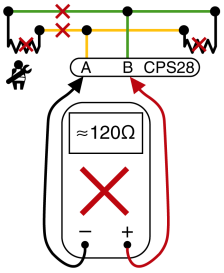
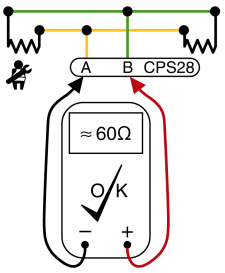
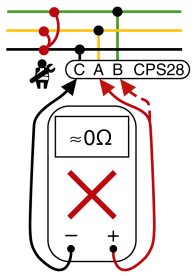
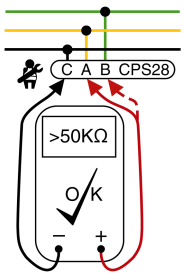
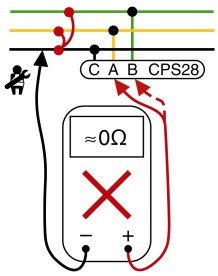
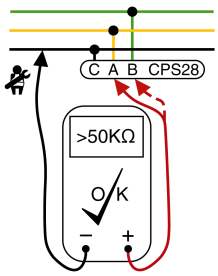
CBB 4 Wheel CAN Communication (Cont)				
Power **OFF**→	Wait **30 seconds**→	Power **ON**→	Fault remains. Service required. Go to Quick Check.	No fault→Resume Operation
FAULT LOG DTC Review – Go to Display Menu				



Enter SERVICE Password→	Diagnostics→	Fault Logs→	VSM Fault Logs→	View all VSM DTCs→?



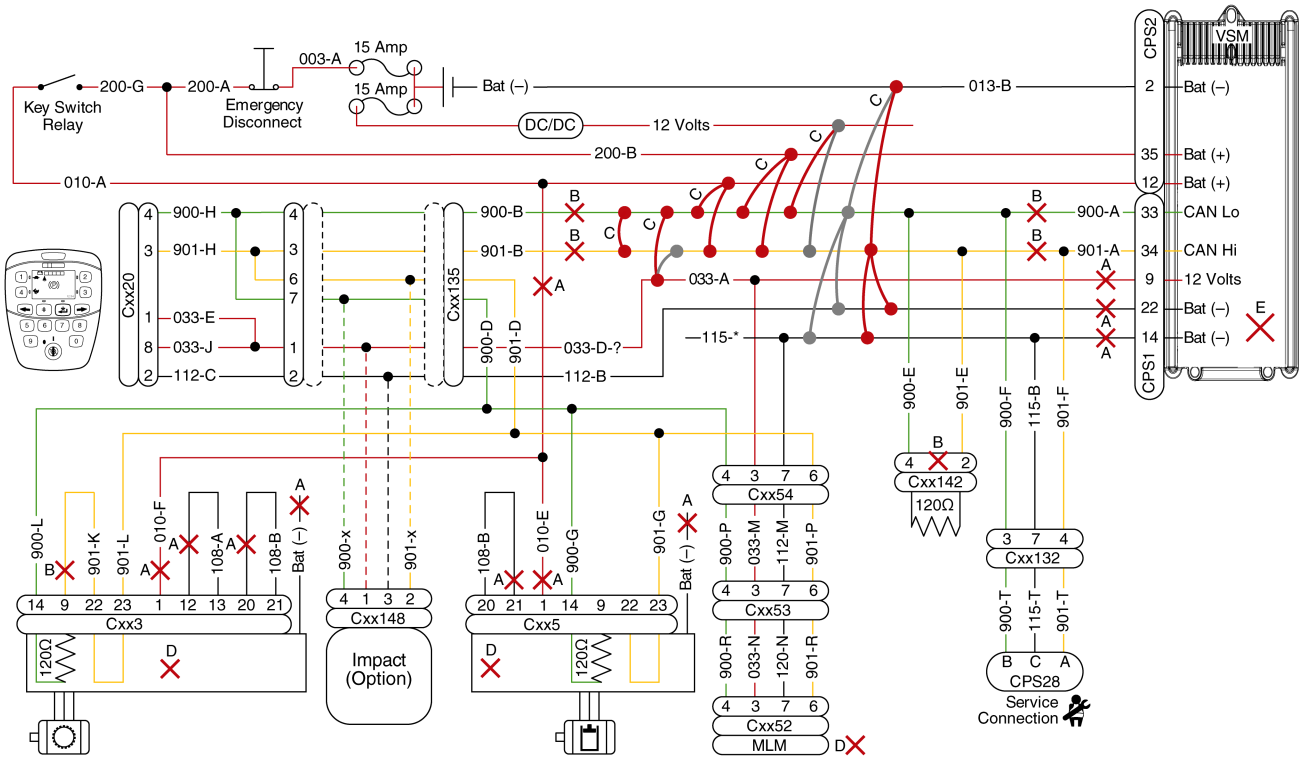
📄✍ all VSM DTCs	Multiple VSM DTCs→Erase VSM DTCs→Exit Fault Log→Power **OFF**→**Quick Check**↓		
Single DTC→Specific Device Fault Log→		📄✍ Device DTCs→	Erase Device DTCs↓
Emergency Stop Switch→**OFF**→Wait 30 seconds→**ON**→?↓Recheck Single Device Fault Logs↓			
DTCs Present→📄✍ DTCs→Power **OFF**→Go to Single Device TSP↓		DTCs Gone→Resume Operation	
QUICK CHECK X = Open Circuit/Fail) = Short Circuit			

CBB 4 Wheel CAN Communication (Cont)			
			
Disconnect Battery	Disconnect Battery and Sound Horn to Discharge Capacitors.Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342.	Locate Diagnostic Connector CPS 28	Service Connection
			
Short Circuit CAN Hi/CAN Lo Go to Step 1, All CAN Device DTCs	Open Circuit CAN Hi/CAN Lo Go to CAUSE 0, Multiple CAN Device DTCs	Open Circuit CAN Hi/ CAN Lo Termination Resistor Go to CAUSE A, Intermittent DTCs	Circuit OK Go to Step 2, Single CAN Device DTC
			
CAN Hi Short Circuit Bat (-) Go to Step 2, All CAN Device DTCs CAN Lo STB (-), No DTC Go to Step 2, No DTC	CANbus Circuit OK Go to Step 2, Single CAN Device DTC	CAN Hi Short Circuit Bat (+) All CAN Device DTCs Go to Step 3, CAN Hi Short to 12/5 (+) No DTC CAN Lo Short Circuit Bat (+) All CAN Device DTCs Go to Step 3,	CANbus Circuit OK Go to Step 2, Single CAN Device DTC
SINGLE DEVICE DTC→Fault is isolated to a SINGLE CANbus Connected Device and its Supply Connections			
MULTIPLE DEVICE DTCs →Faults that affect some but not all CANbus Devices→Typically Open Circuits			
ALL DEVICE DTCs→Faults that affect all of the CANbus connected devices→Typically Short Circuits			
POSSIBLE CAUSES X = Open Circuit/Fail) = Short Circuit			

CBB 4 Wheel CAN Communication (Cont)
CAUSES A B C D E > ?

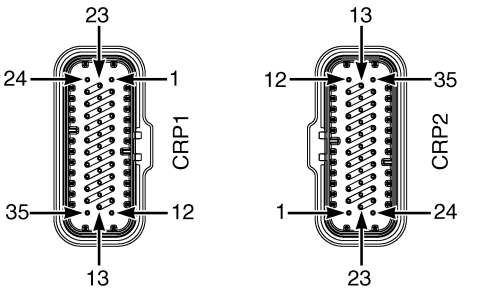
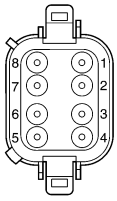
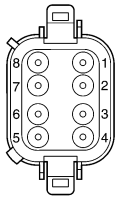
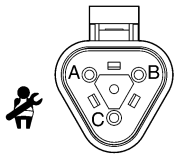
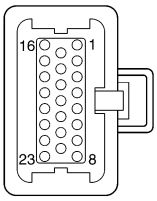
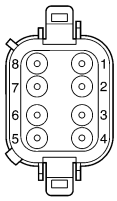
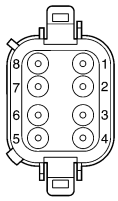
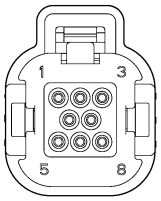
Table 9030-20-7. Main Schematic

Open Circuit – Termination Resistor/CAN Hi/CAN Lo/Key Switch Supply/Device Supply/ CAUSES A, B
CAN Short to > Bat (-)/12volt Bat (+)/Shorted CAN Hi to CAN Lo/Device Failure CAUSES C, D, E >?



CBB 4 Wheel CAN Communication (Cont)
CONNECTORS

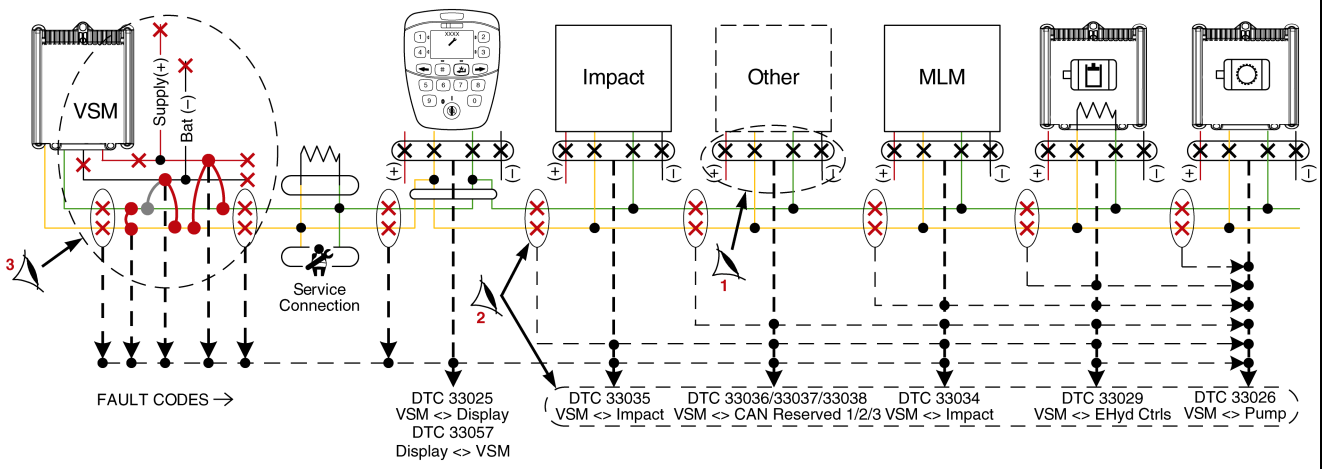
Table 9030-20-8. Device Connectors

			
VSM Cxx 1 and Cxx 2	Main Seat Cxx 52 and 54	Impact Device Cxx 148	Service Connector Cxx 28
			
Traction/Pump Controller Cxx 3, 4, and 5	MLM Cxx 52	Display Harness Cxx 135	Display Cxx 20

CBB 4 Wheel CAN Communication (Cont)

CAUSE A

CAN Hi/CAN Lo Single Device DTC (Black X) vs Multiple DTCs (Red X)



1, 2, and 3 are examples of possible Causes

1. Single DTC→Indicated Device Connections/Device Fail→Step 1

1. Single DTC above →Open Circuit on Device Supply (+) or Bat (-) or Open Circuit on Sub Circuit Wiring→Step 3

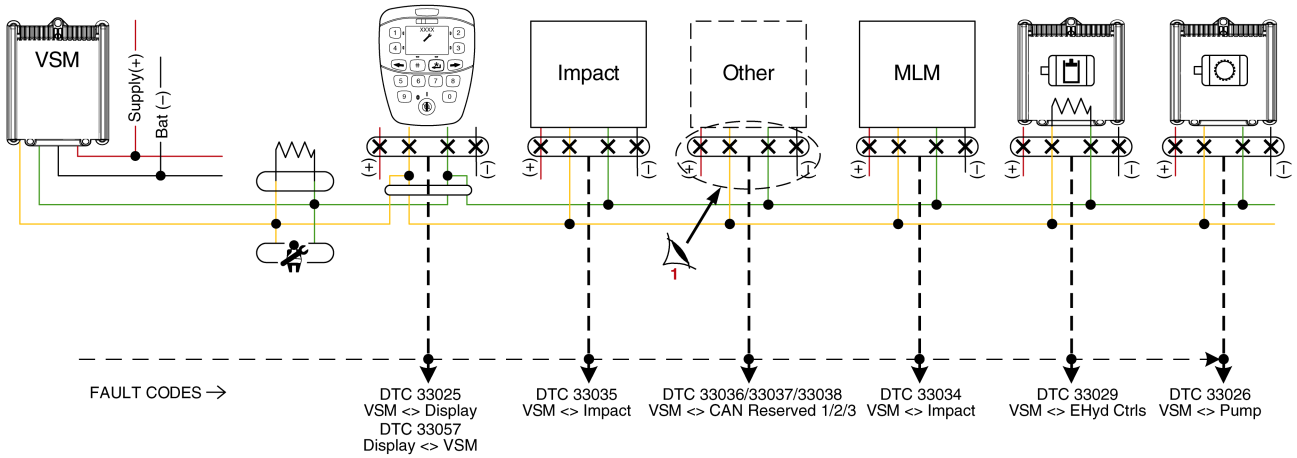
2. Multiple DTCs→Fault Log→DTC/Device closest to VSM↑→= Open circuit between DTC Device and VSM→Step 3

3. All DTCs above→Open Circuit on Device Supply (+) Bat (-)→= Supply Failure/Open Circuit Main Supply Circuit→Step 3

3. All DTCs above→Open/Short Circuit on VSM CANbus→= Open Circuit→Step 3 – Short Circuit→CAUSE B

STEP A1

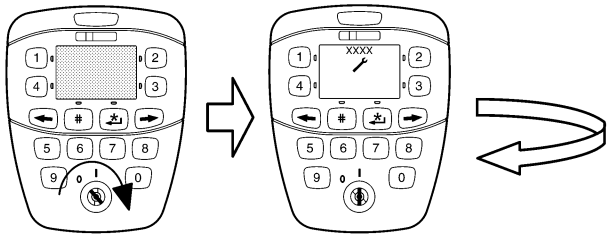
CAN Hi/ CAN Lo Single Device DTC - Locate Device



1. Example Only→Single DTC→Indicated Device Connections/Device Fail→Step 2↓

CBB 4 Wheel CAN Communication (Cont)

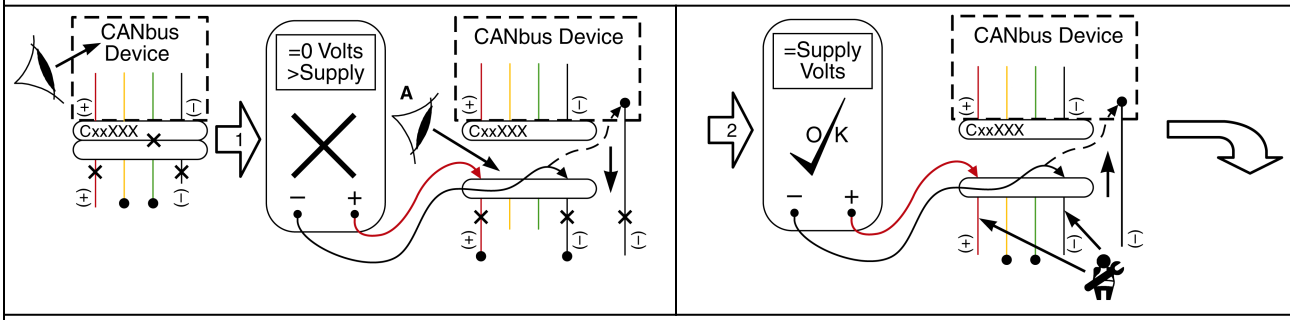
STEP A2



Power **ON**→Step 3

STEP A3

Single Device DTC Open Circuit Supply Voltage



NOTE: Motor Controllers Require Battery Removal. Only do this if either or both Motor Controller DTCs as Displayed

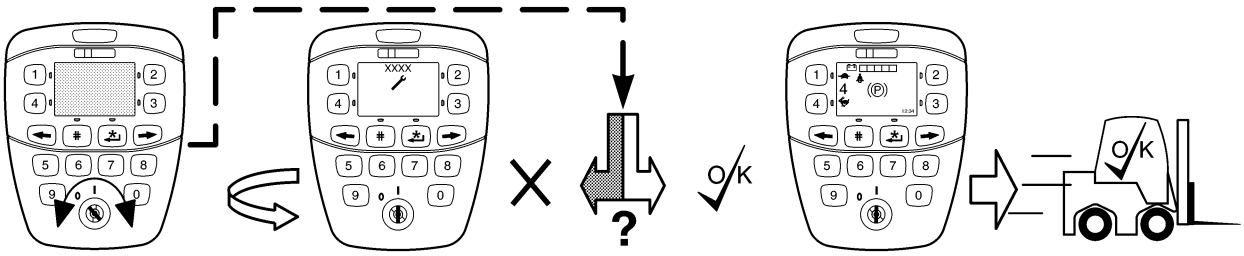
NOTE: If Fault Log shows Multiple DTCs = Possible Open Circuit Supply (+) (-) other than at the Device

1. Locate Device→Check connection→Not OK, Go to 4↓	1. Connection OK→Go to 2↓
2. = 0 Volts = Open Circuit Supply/(+) or (-) →Go to 4↓	2. =Supply Volts = OK→Step 1↓

3. > Supply Volts →Check for Shorts to a higher supply source→Repair→CAUSE C as CAN Device may be damaged

4. Reference **Main Schematic** - Find/Repair Open Circuit See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→Recheck Voltage↑→Step 4↓

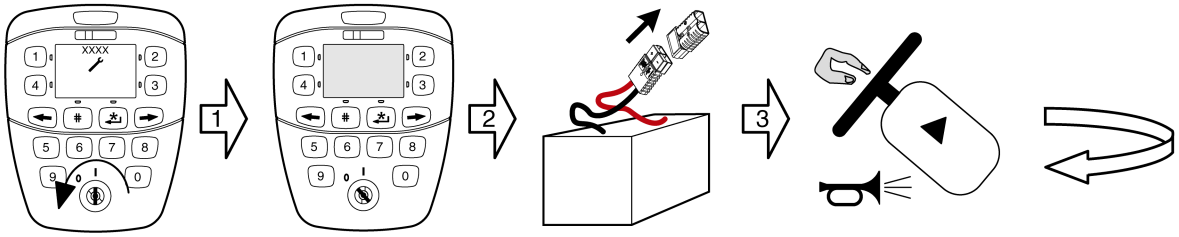
STEP A4



Retest - Power **OFF** Power **ON**	**NO**→CAUSE A	Is fault DTC gone?**NO** **YES**←→	Fault corrected→Continue operation

CBB 4 Wheel CAN Communication (Cont)

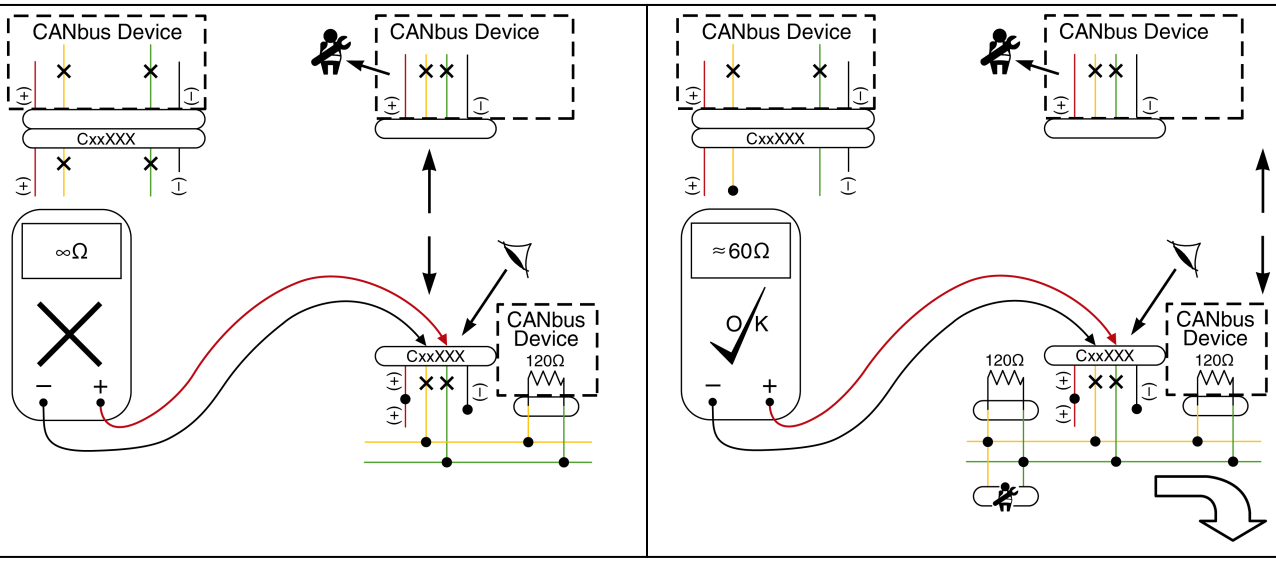
CAUSE B



Power **OFF**→	Disconnect Battery and Sound Horn to Discharge Capacitors.→Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342→.	Go to Step 1

STEP B1

Single Device DTC Open Circuit CAN Hi or CAN Lo – Motor Devices, See Step 2.

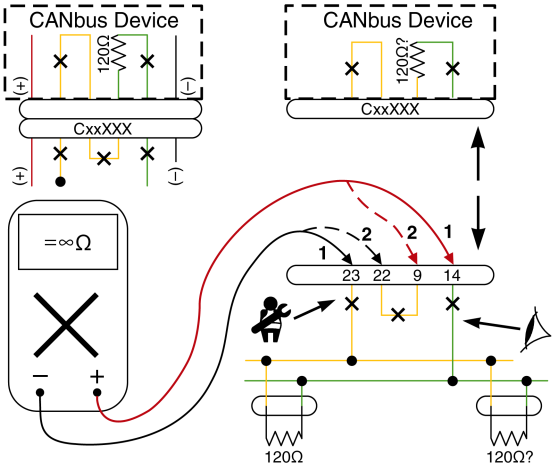
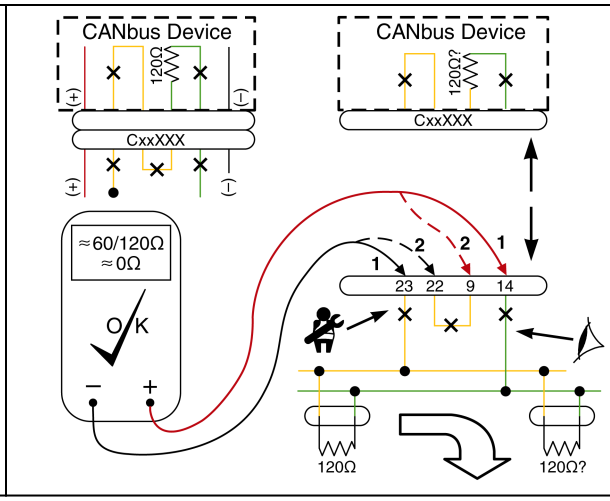


Locate Device→Disconnect→Check Connection→Measure ? →Go to 1↓

1. 8? = Open Circuit CAN Device to Harness→Go to 2↓	1. ˜ 60? = OK →**CAN Device Faulty**Go to CAUSE C↓

2. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→Go to 3↓

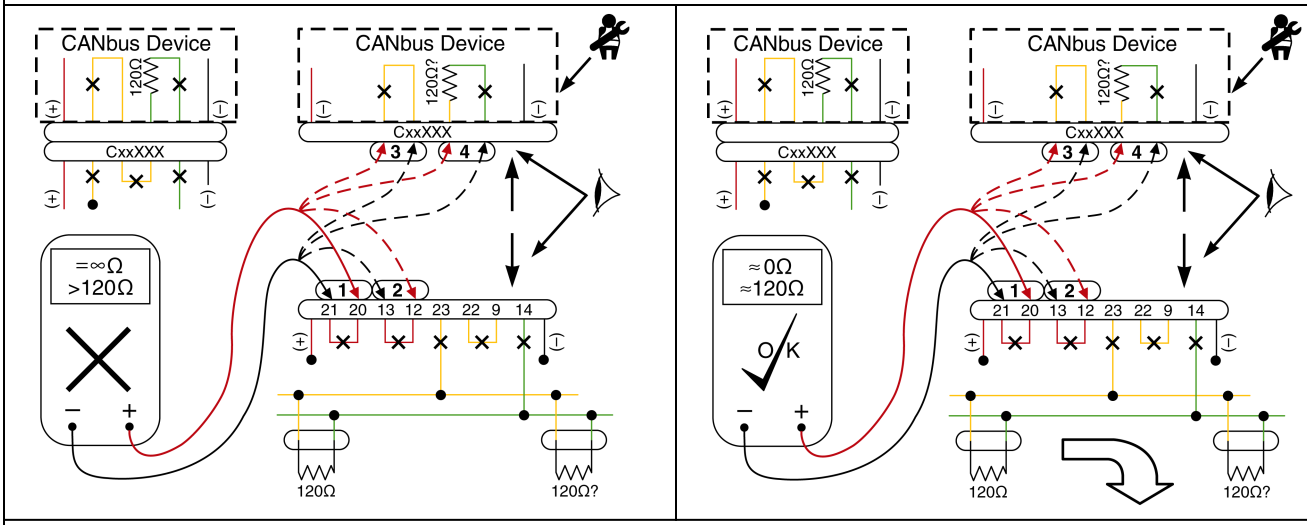
3. Recheck ?↑→Reconnect→Step 2↓

CBB 4 Wheel CAN Communication (Cont)	
STEP B2	
Single Device DTC Open Circuit CAN Hi or CAN Lo – Motor Device with Termination Resistor shown	
	
Locate Device→Disconnect→Check Connection→Measure ? →Go to 1↓	
1. 8? = Open Circuit CAN Device to Harness→Go to 3↓	1. ˜ 60?/120? = OK →**CAN Device Faulty**Go to CAUSE C↓
2. 8? = Open Circuit →Go to 3↓	2. ˜ 0? = OK Reconnect Device →Go to 3↓
3. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→Go to 4↓	
4. Recheck ?↑→Reconnect→Step 2↓	

CBB 4 Wheel CAN Communication (Cont)

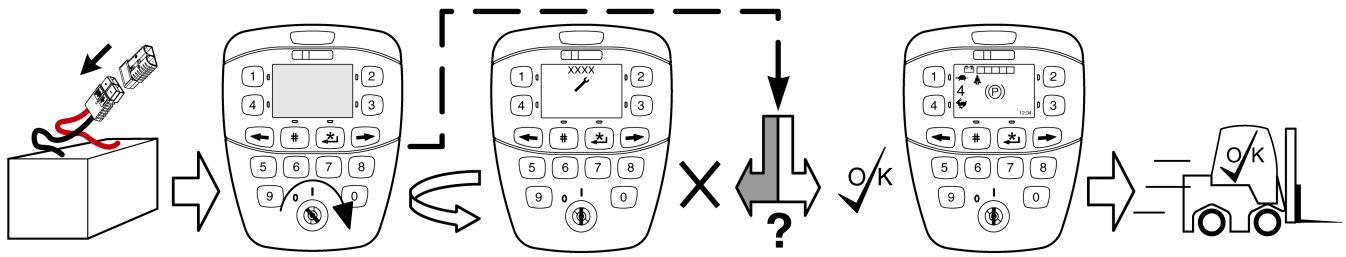
STEP B3

Single Device DTC Open Circuit CAN Hi or CAN Lo – Motor Device with Termination Resistor shown



Locate Device→Disconnect→Check Connection→Measure ? →Go to 1↓	
1. 8? = Open Circuit Motor Controller Loop(s)→Go to 5↓	1. ˜ 0? = OK →Go to 3↓
2. 8? = Open Circuit Motor Controller Loop(s)→Go to 5↓	2. ˜ 0? = OK →Go to 3↓
3. 8? = Open Circuit →Go to CAUSE C↓	3. ˜ 0? = OK Reconnect Device →Go to 4↓
4. > 120? = Open Circuit Termination Resistor→Go to CAUSE C↓	4. ˜ 120? = OK Reconnect Device →Go to Step 4↓
5. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→Go to 6↓	
6. Recheck ?↑→Reconnect→Step 4↓	

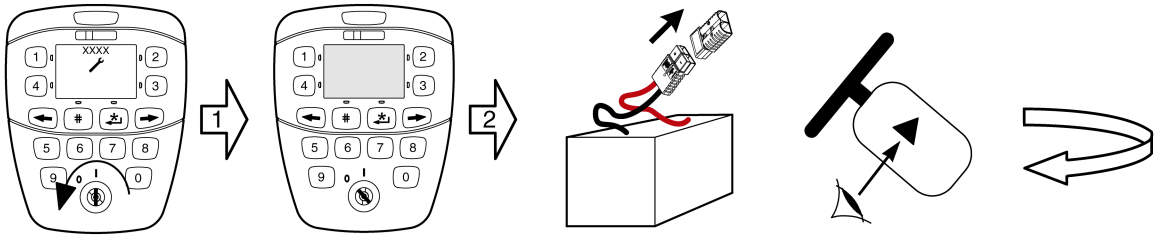
STEP B4



Reconnect Battery	Retest - Power **ON**	**NO**→?	Is fault DTC gone?**NO** **YES**	Fault corrected→Continue operation

CBB 4 Wheel CAN Communication (Cont)

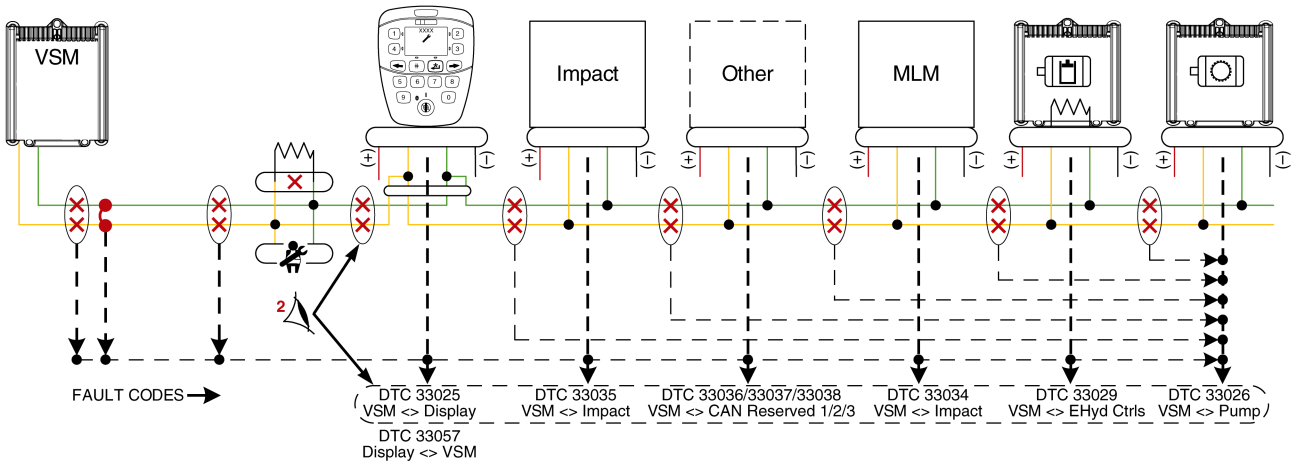
STEP B5



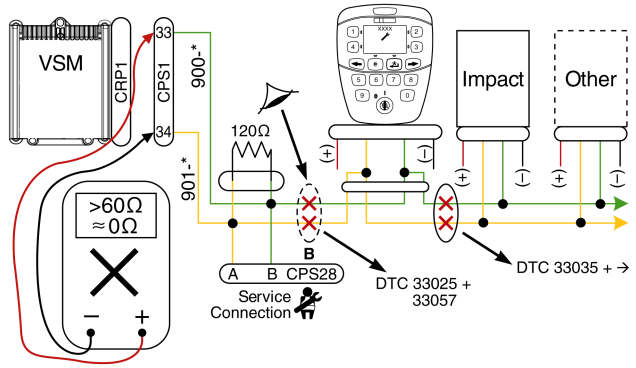
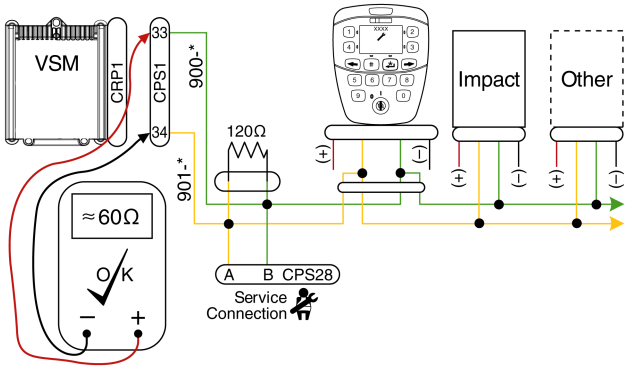
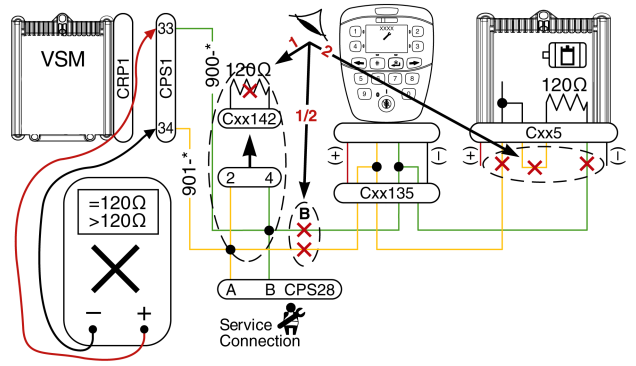
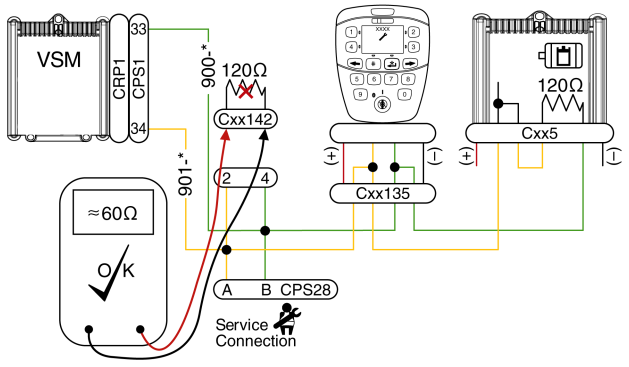
Power **OFF**→	Disconnect Battery and Sound Horn to Discharge Capacitors.→Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342→.	Go to Step 4

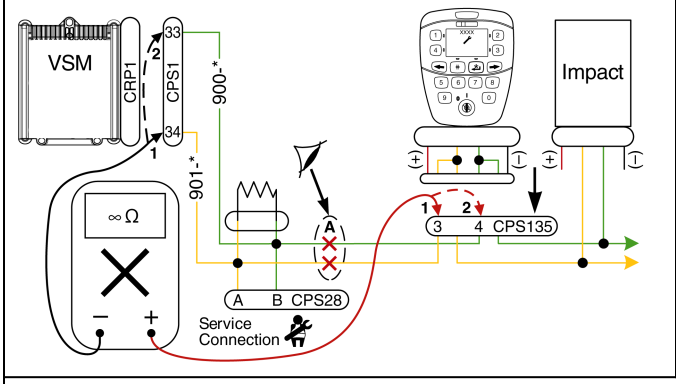
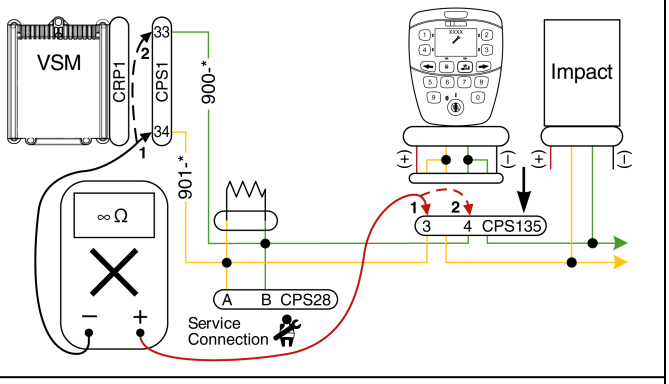
STEP B6

Multi CAN Device DTCs Display > Open Circuit CAN Hi to CAN Lo



Example Only→Multiple DTCs→Fault Log→DTC/Device closet to VSM
Open circuit is between DTC Device and VSM→Step 5↓

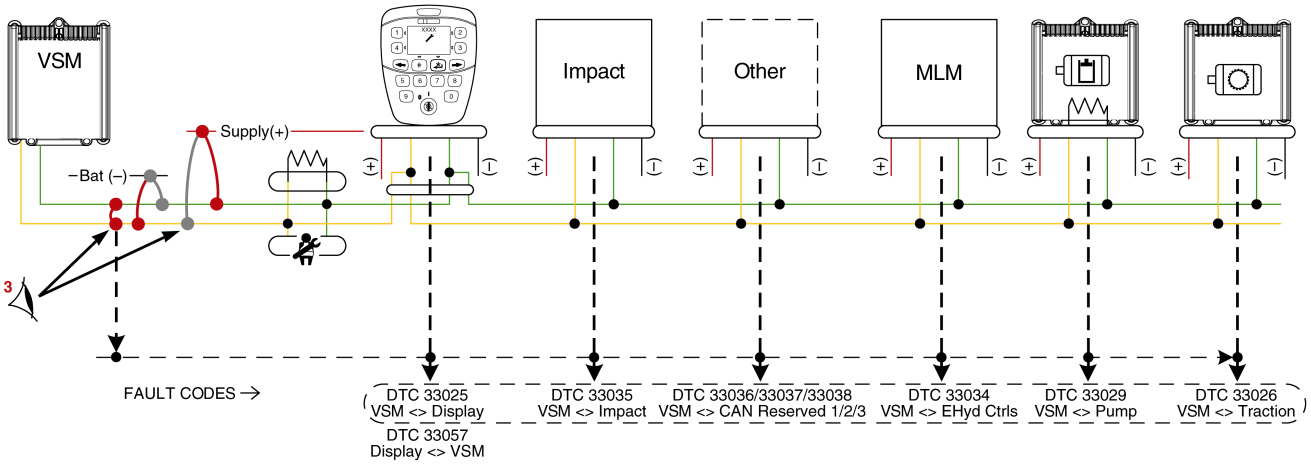
CBB 4 Wheel CAN Communication (Cont)	
STEP B7	
Multi Device DTCs Open Circuit CAN Hi or CAN Lo	
	
The above is an Example Only	
Disconnect VSM CPS1→Measure ?	See **Device Connectors**
> 60? to 8? = Termination Resistor/CAN Hi/Lo Open Circuit Step 6↓	˜ 60? = OK→CAUSE B↓
> 60? to 8? = Termination Resistor/CAN Hi/Lo Open Circuit Step 6↓˜ 0?→CAUSE B↓	
STEP B8	
	
Disconnect Termination Resistor Connector Cxx 42	
1. = 120? = Faulty Connections/Wiring/ to Termination Resistor or Faulty Termination Resistor→Go to 3↓	
2. >120? = Faulty Connections/Wiring/ Pump Controller→Step 7↓	
3. Measure Termination Resistor ?	
4. >120? = Faulty Resistor→Replace→Recon-nect→Retest ?→	4. = 120?→Step 7↓

CBB 4 Wheel CAN Communication (Cont)	
STEP B9	
	
The above is an Example Only	
Locate Device to Right or Left of Indicated Open Circuit→	Disconnect →See **Device Connectors**↓
1. 8? = CAN Hi Open Circuit→Go to 3↓	1. ˜ 0? = OK →CAUSE B↓
2. 8? = CAN Lo Open Circuit→Go to 3↓	2. ˜ 0? = OK →CAUSE B↓
3. Find/Repair Short Circuit, See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369Recheck ?→Reconnect→Retest→CAUSE B↓	

CBB 4 Wheel CAN Communication (Cont)

CAUSE C

All CAN Device DTCs Displayed > CAN Hi/CAN Lo Short Circuit together/Supply (+) or (-)



All DTCs→Open Circuit to VSM →Step 5↑

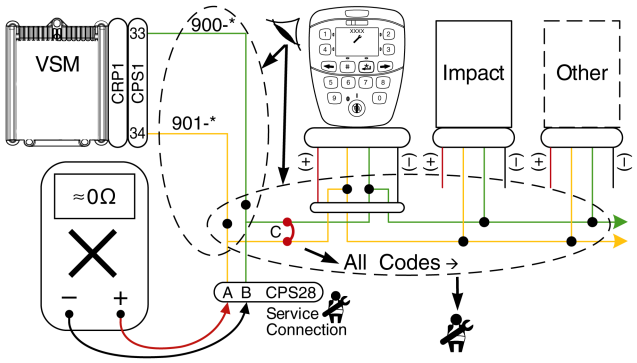
All DTCs→Short Circuit CAN Hi to CAN Lo →Step 1↓

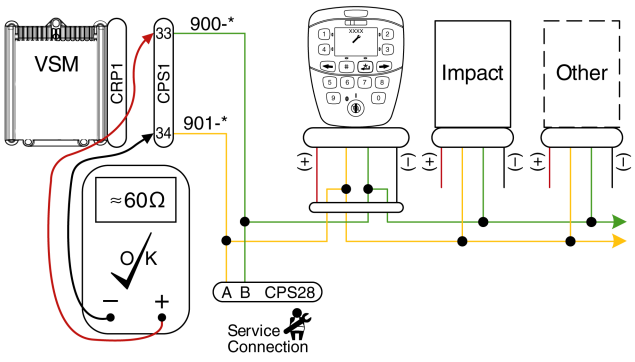
All DTCs→Short Circuit CAN Hi to (-) Supply Sources →Step 2↓No DTCs→Short Circuit CAN Lo to (–-) Supply Sources

All DTCs→Short Circuit CAN Lo to (+) Supply Sources→Step 3↓No DTCs→Short Circuit CAN Hi to (+) Supplies (5, 12 volt)

STEP C1

All Device DTCs Short Circuit CAN Hi to CAN Lo



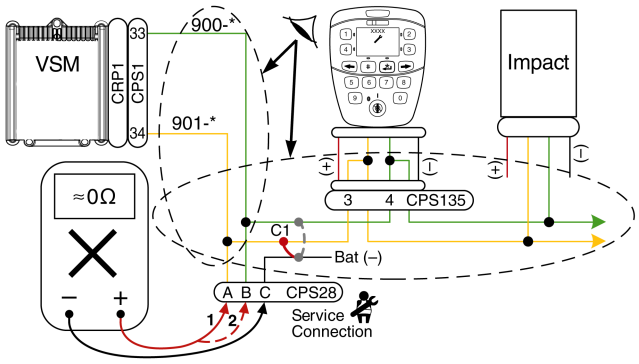


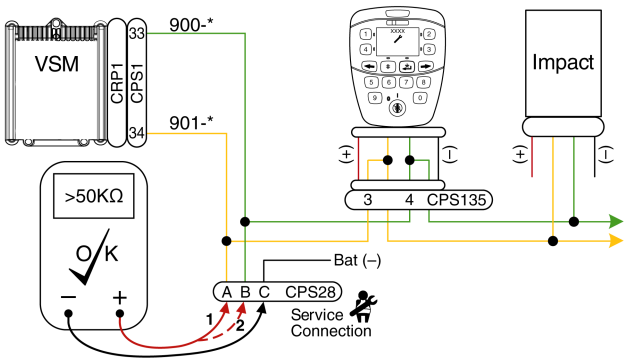
Locate Service Connection →Measure ?	See **Device Connectors**↓
1. = 0? CAN Hi/Lo Short Circuit→Go to 2↓	1. ˜ 60? = OK →Step 2↓
2. Inspect Accessible Harness Areas for Insulation Damage then Inaccessible Harness Areas. Focus on Bend Edges and Pinch Points, Go to 3↓	
3. Find/Repair Short Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369 Re-check ?→Reconnect→Retest→Step 5↓	

CBB 4 Wheel CAN Communication (Cont)

STEP C2

All Device DTCs Short Circuit CAN Hi to Bat (-)CAN Lo to Bat (-) will not Produce a DTC



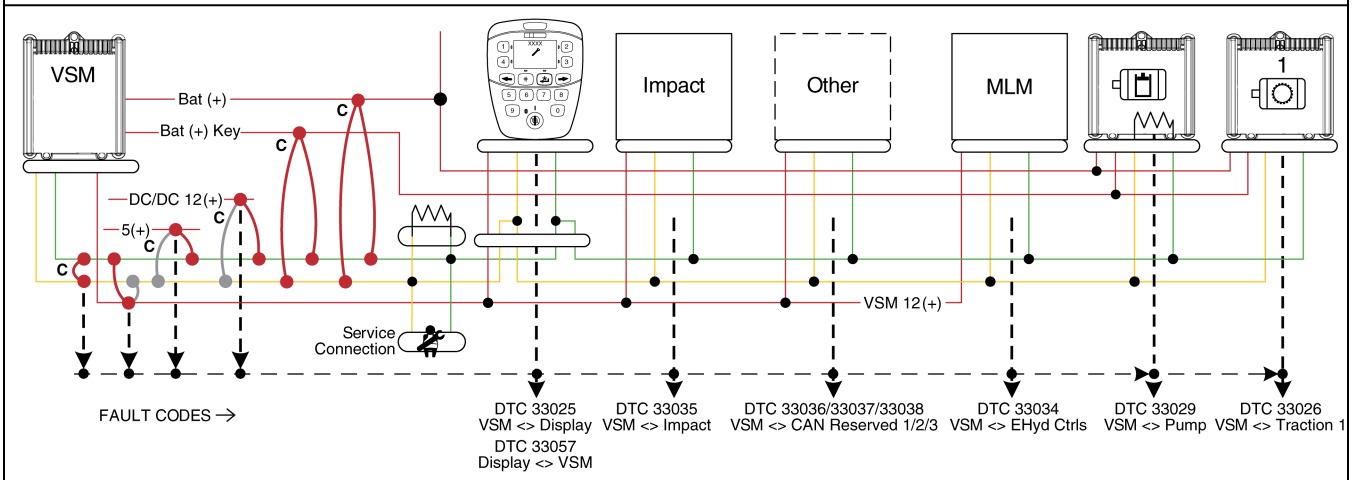


1. 0? = CAN Hi Short Circuit. Go to 3↓	1. > 50K? = OK, Go to 3↓
2. 0? = CAN Lo Short Circuit. Go to 3↓	2. > 50K? = OK, Go to 3 ↓

3. Find/Repair Short Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369 Re-check ?→Reconnect→Retest, →Step 5

STEP C3

Multiple CAN Device DTCs Displayed > (+) Supply Short Circuit to CAN Hi or CAN Lo



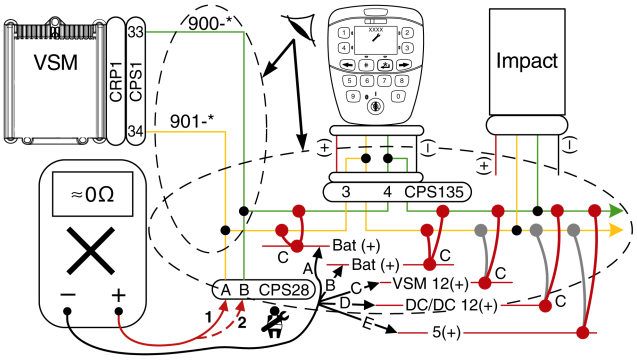
All DTCs→Short Circuit CAN Lo to (+) Supply Sources.

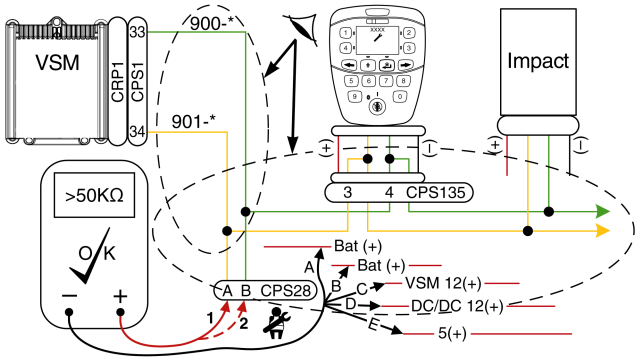
All DTCs→Short Circuit CAN Hi to (+) Supply Sources.No DTCs for a Short to (+)12 Volts or (+) 5 Volts

CBB 4 Wheel CAN Communication (Cont)

STEP C4

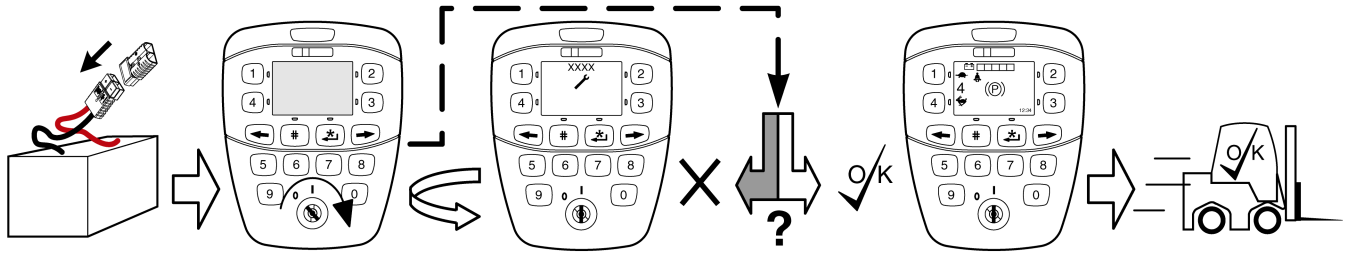
All Device DTCs Short Circuit Supply (+) to CAN Hi or CAN Lo





1. A, B, C, D, and E = 0? = CAN Hi Short Circuit, Go to 3↓	1. A, B, C, D, and E > 50K? = OK→, Step 5↓
2. A, B, C, D, and E = 0? = CAN Lo Short Circuit, Go to 3↓	2. A, B, C, D, and E > 50K? =OK→Step 5↓
3. Find/Repair Short Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369 Re-check ?→Reconnect→Retest→Step 5↓	

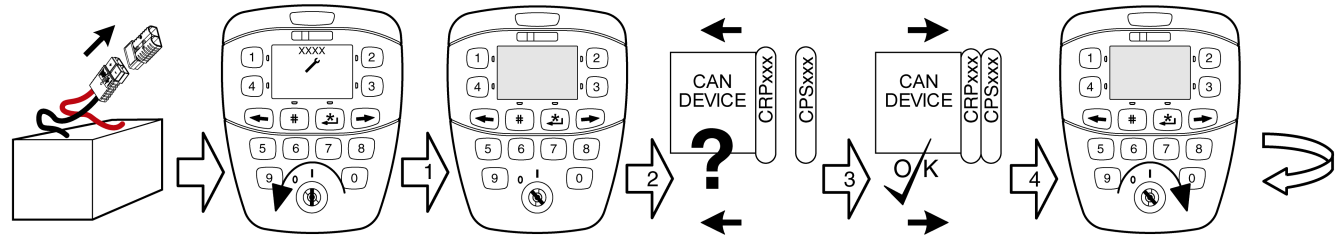
STEP C5



Reconnect Battery	Retest - Power **ON**	**NO**→Go to CAUSE C	Is fault DTC gone?**NO** **YES**	Fault corrected→Continue operation

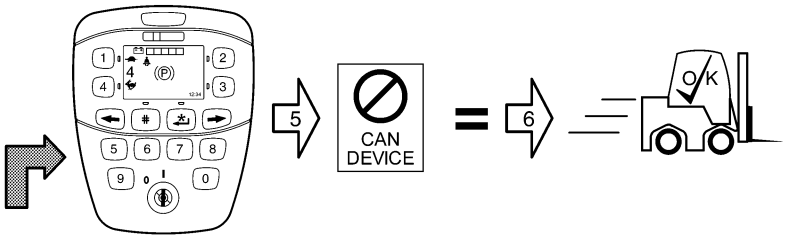
CBB 4 Wheel CAN Communication (Cont)

CAUSE D

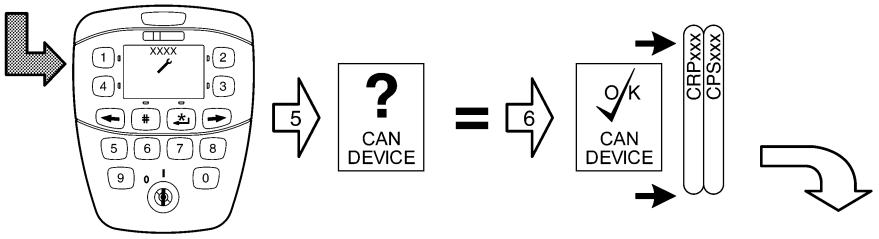


Disconnect Battery To Replace Motor Controller	Power **OFF**	Disconnect CAN Device→Do Not Discard	Install New CAN Device	Power **ON**→Go to Step 1

STEP D1



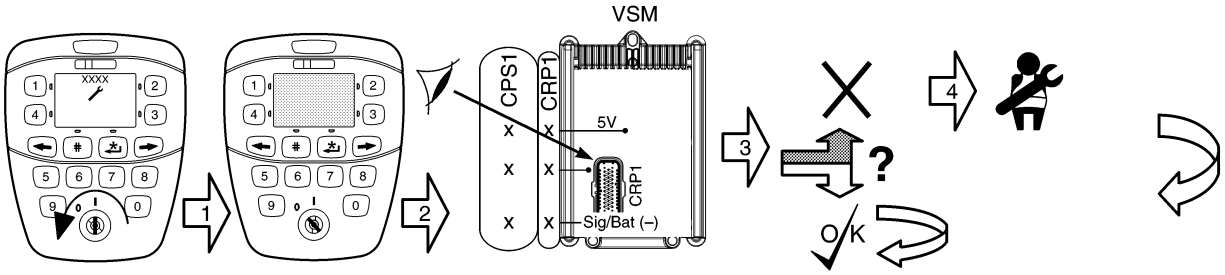
?	Fault DTC gone→	Old device faulty→	Resume operation



Fault DTC present→	Old Device OK/Reinstall Old Device→	Go to CAUSE D.

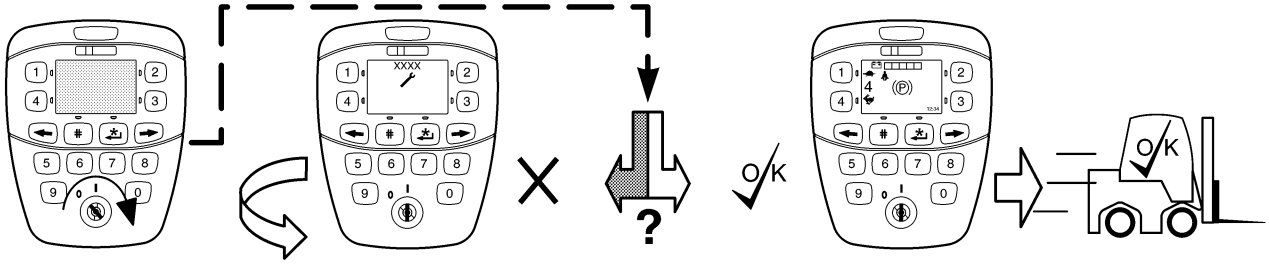
CBB 4 Wheel CAN Communication (Cont)

CAUSE E



Power **OFF**→	Inspect VSM Connections→	Go to Step 1	Not OK Correct/Repair→Go to Step 1

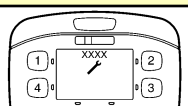
STEP E1



Retest - Power **ON**→	**NO**→Go to VSM Controller Check	Is fault DTC gone?**NO** **YES**	Fault corrected→Continue operation

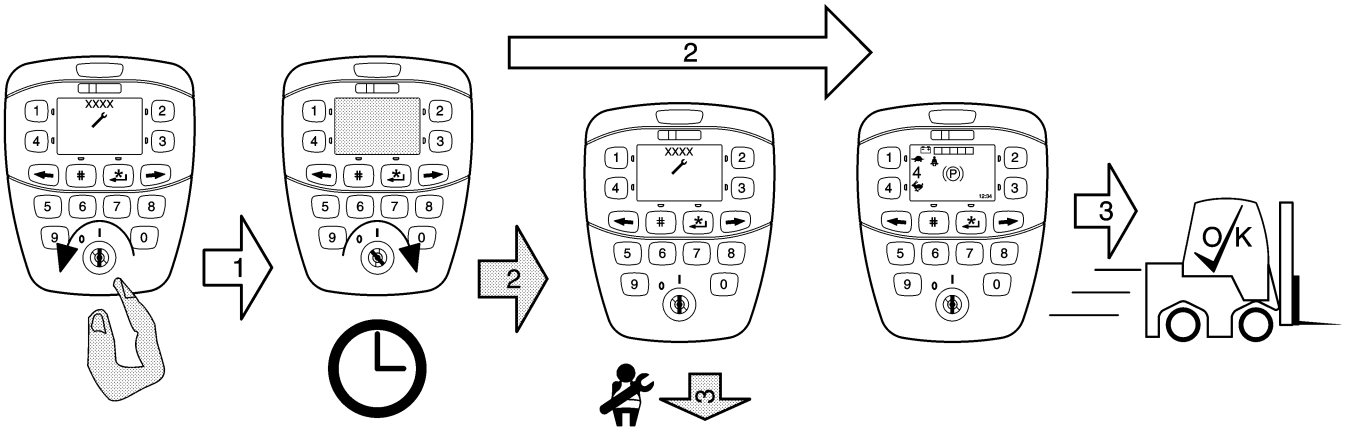
END FAULT

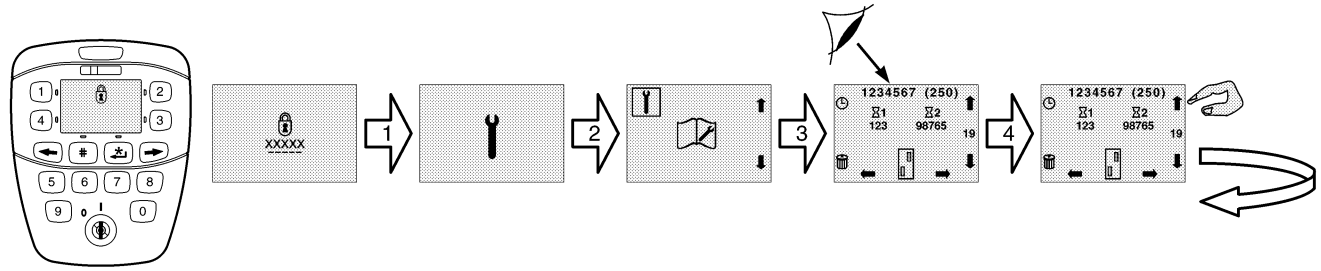
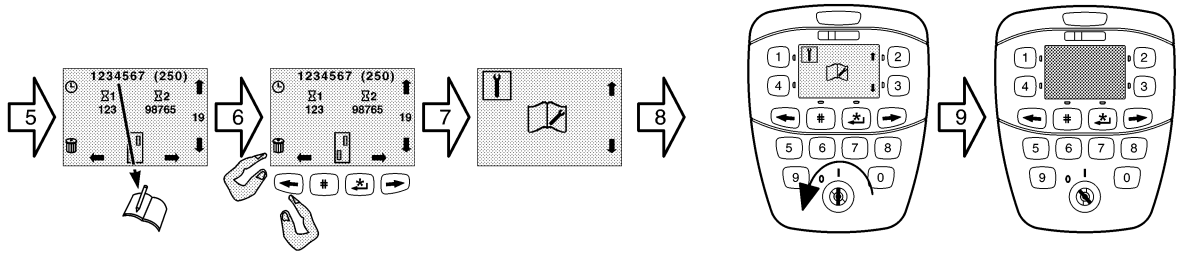
DBB 4 Wheel CAN Communication (Cont)

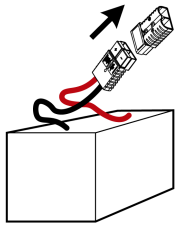
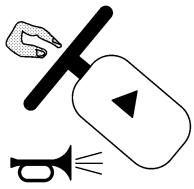
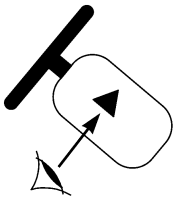
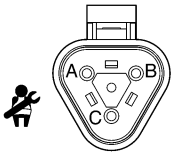
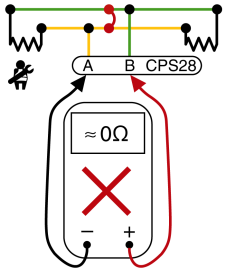
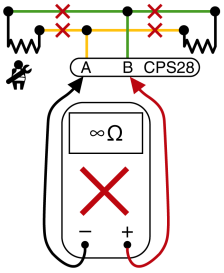
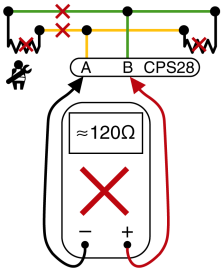
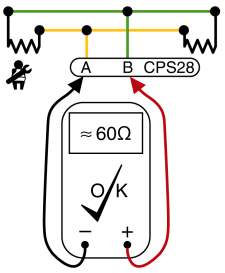
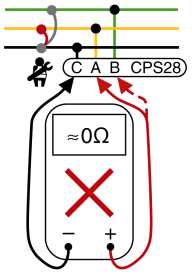
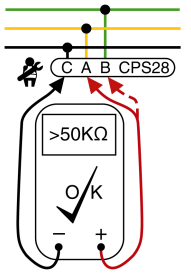
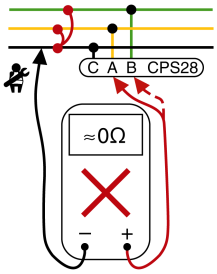
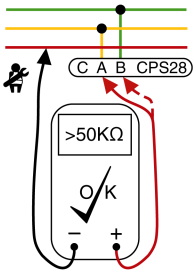


Fault Codes

DTC 33025 **VSM to Display**	**DTC 33026** **VSM to Traction 1 (Right)**	**DTC 33027** **VSM to Traction 2 (Left)**	**DTC 33029** **VSM to Pump**
DTC 33034 **VSM to MLM (DCS)**	**DTC 33035** **VSM to Impact**	**DTC 33036** **VSM to CAN Reserved 1**	**DTC 33037** **VSM to CAN Reserved 2**
DTC 33038 **VSM to CAN Reserved 3**	**DTC 33057** **Display to VSM**		



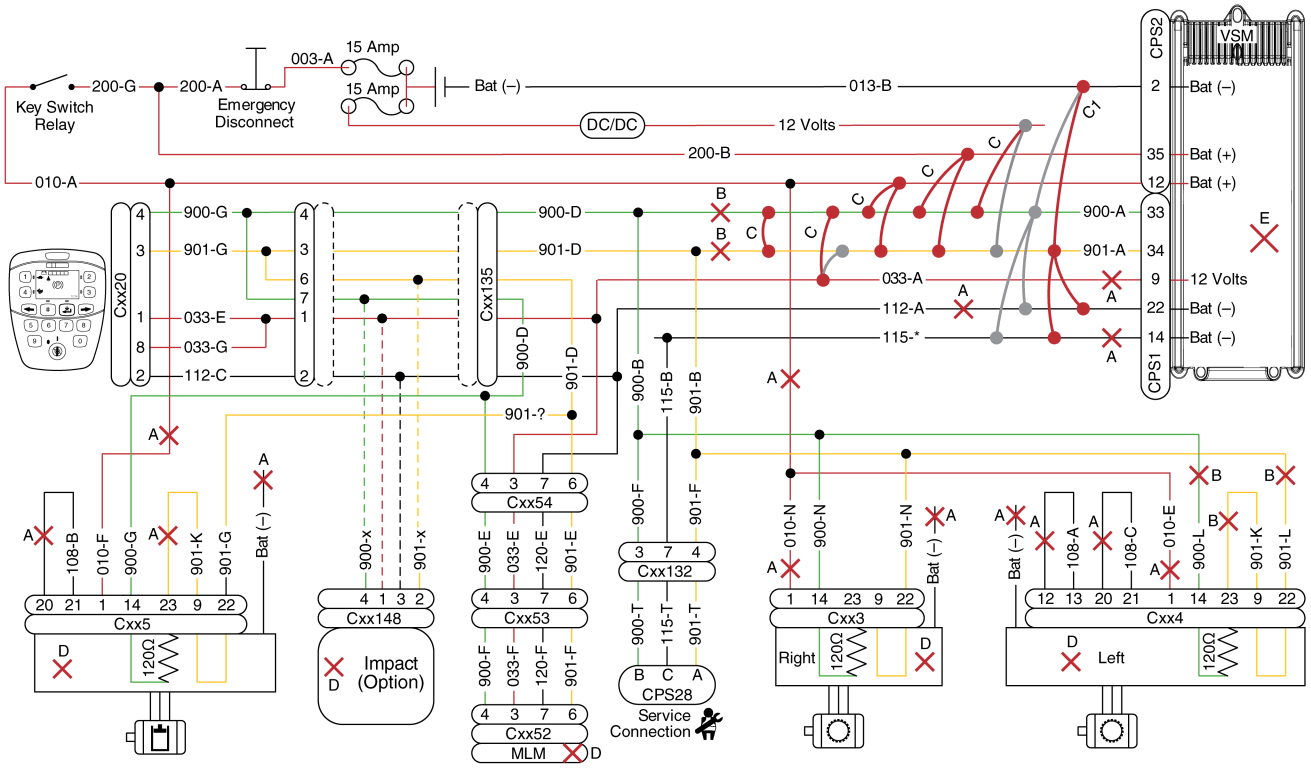
DBB 4 Wheel CAN Communication (Cont)				
Power **OFF**→	Wait **30 seconds**→	Power **ON**→	Fault remains. Service required. Go to Quick Check.	No fault→Resume Operation
FAULT LOG DTC Review – Go to Display Menu				
				
Enter SERVICE Password→	Diagnostics→	Fault Logs→	VSM Fault Logs→	View all VSM DTCs→?
				
📄✍ all VSM DTCs	Multiple VSM DTCs→Erase VSM DTCs→Exit Fault Log→Power **OFF**→**Quick Check**↓			
Single DTC→Specific Device Fault Log→	📄✍ Device DTCs→	Erase Device DTCs↓		
Emergency Stop Switch→**OFF**→Wait 30 seconds→**ON**→?Recheck Single Device Fault Logs↓				
DTCs Present→📄✍ DTCs→Power **OFF**→Go to Single Device TSP↓	DTCs Gone→Resume Operation			
QUICK CHECK X = Open Circuit/Fail) = Short Circuit				

DBB 4 Wheel CAN Communication (Cont)			
			
Disconnect Battery	Disconnect Battery and Sound Horn to Discharge Capacitors.Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342.	Locate Diagnostic Connector CPS 28	Service Connection
			
Short Circuit CAN Hi/CAN Lo Go to Step 1, All CAN Device DTCs	Open Circuit CAN Hi/CAN Lo Go to CAUSE 0, Multiple CAN Device DTCs	Open Circuit CAN Hi/ CAN Lo Termination Resistor Go to CAUSE A, Intermittent DTCs	Circuit OK Go to Step 2, Single CAN Device DTC
			
CAN Hi Short Circuit Bat (-) Go to Step 2, All CAN Device DTCs CAN Lo STB (-), No DTC Go to Step 2, No DTC	CANbus Circuit OK Go to Step 2, Single CAN Device DTC	CAN Hi Short Circuit Bat (+) All CAN Device DTCs Go to Step 3, CAN Hi Short to 12/5 (+) No DTC CAN Lo Short Circuit Bat (+) All CAN Device DTCs Go to Step 3,	CANbus Circuit OK Go to Step 2, Single CAN Device DTC
SINGLE DEVICE DTC→Fault is isolated to a SINGLE CANbus Connected Device and its Supply Connections			
MULTIPLE DEVICE DTCs →Faults that affect some but not all CANbus Devices→Typically Open Circuits			
ALL DEVICE DTCs→Faults that affect all of the CANbus connected devices→Typically Short Circuits			
POSSIBLE CAUSES X = Open Circuit/Fail) = Short Circuit			

DBB 4 Wheel CAN Communication (Cont)
CAUSES A B C D E > ?

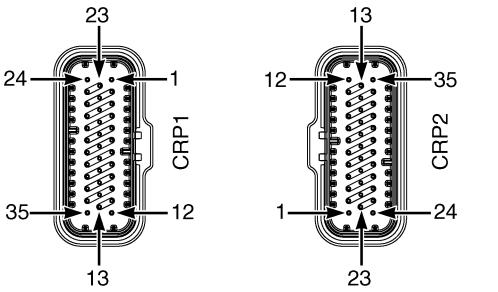
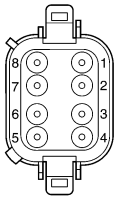
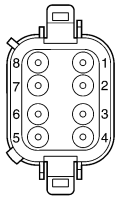
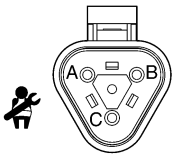
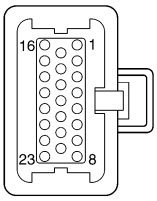
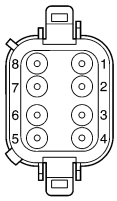
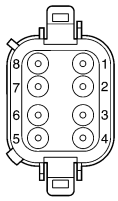
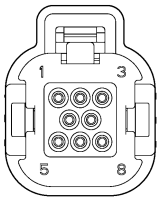
Table 9030-20-9. Main Schematic

Open Circuit – Termination Resistor/CAN Hi/CAN Lo/Key Switch Supply/Device Supply/ CAUSES A, B
CAN Short to – Bat (-)/12volt Bat (+)/Shorted CAN Hi to CAN Lo/Device Failure CAUSES C, D, E



DBB 4 Wheel CAN Communication (Cont)
CONNECTORS

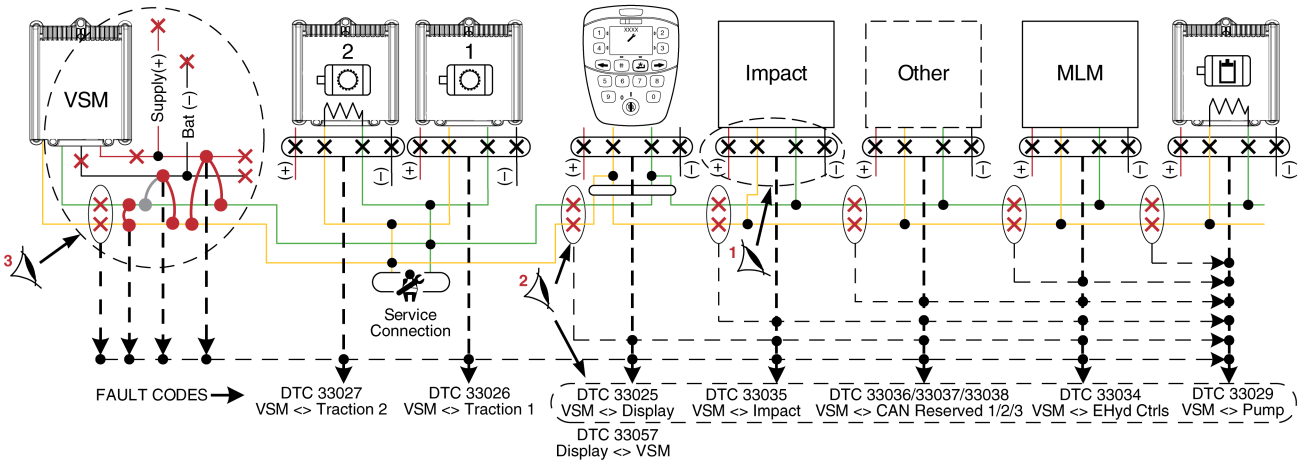
Table 9030-20-10. Device Connectors

			
VSM Cxx 1 and Cxx 2	Main Seat Cxx 52 and 54	Impact Device Cxx 148	Service Connector Cxx 28
			
Traction/Pump Controller Cxx 3, 4, and 5	MLM Cxx 52	Display Harness Cxx 135	Display Cxx 20

DBB 4 Wheel CAN Communication (Cont)

CAUSE A

CAN Hi/CAN Lo Single Device DTC (Black X) vs Multiple DTCs (Red X)



1, 2, and 3 are examples of possible Causes

1. Single DTC→Indicated Device Connections/Device Fail→Step 1

1. Single DTC above →Open Circuit on Device Supply (+) or Bat (-) or Open Circuit on Sub Circuit Wiring→Step 3

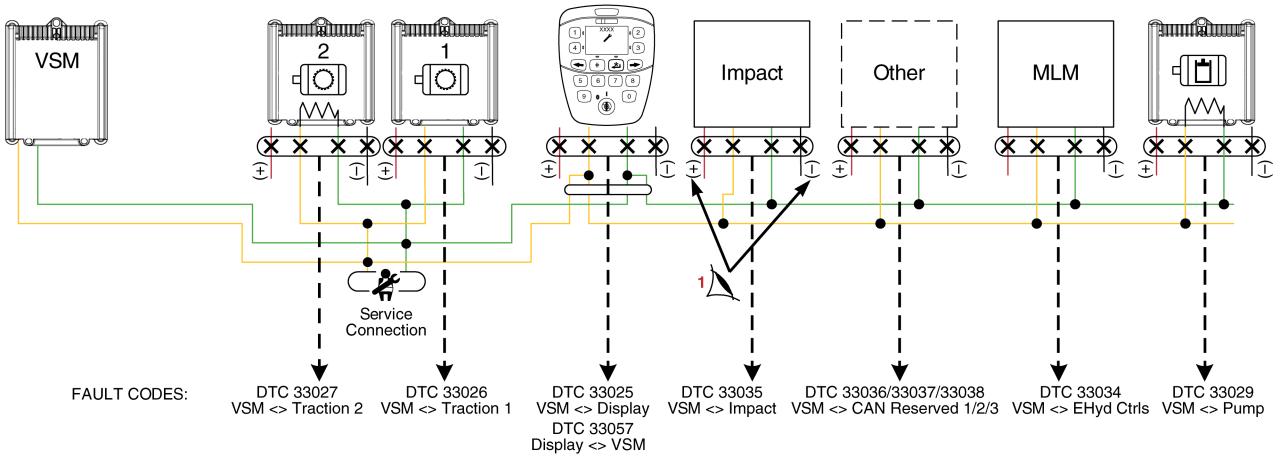
2. Multiple DTCs→Fault Log→DTC/Device closest to VSM↑→= Open circuit between DTC Device and VSM→Step 3

3. All DTCs above→Open Circuit on Device Supply (+) Bat (-)→= Supply Failure/Open Circuit Main Supply Circuit→Step 3

3. All DTCs above→Open/Short Circuit on VSM CANbus→= Open Circuit→Step 3 – Short Circuit→CAUSE B

STEP A1

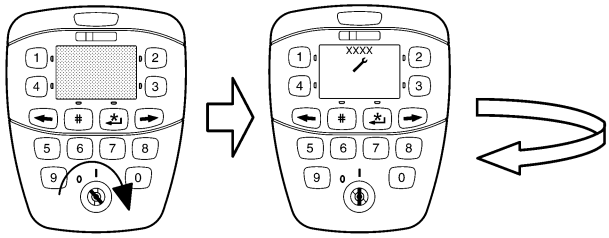
CAN Hi/ CAN Lo Single Device DTC - Locate Device



1. Example Only→Single DTC→Indicated Device Connections/Device Fail→?

DBB 4 Wheel CAN Communication (Cont)

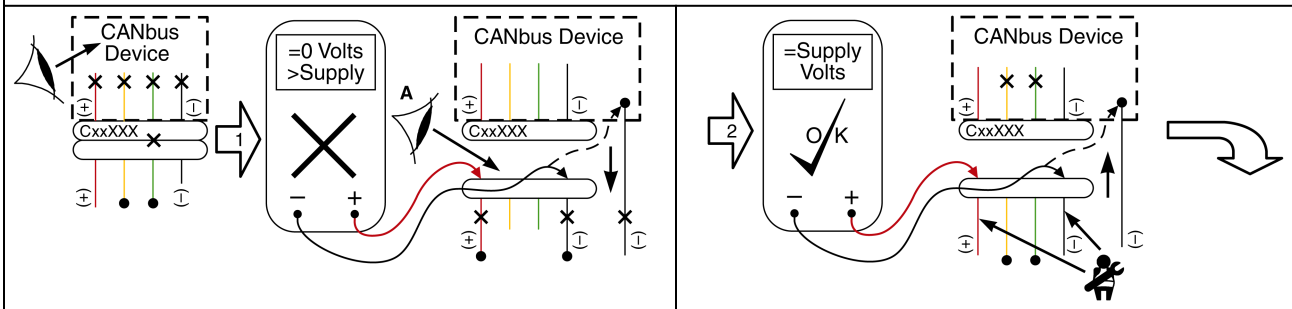
STEP A2



Power **ON**→?

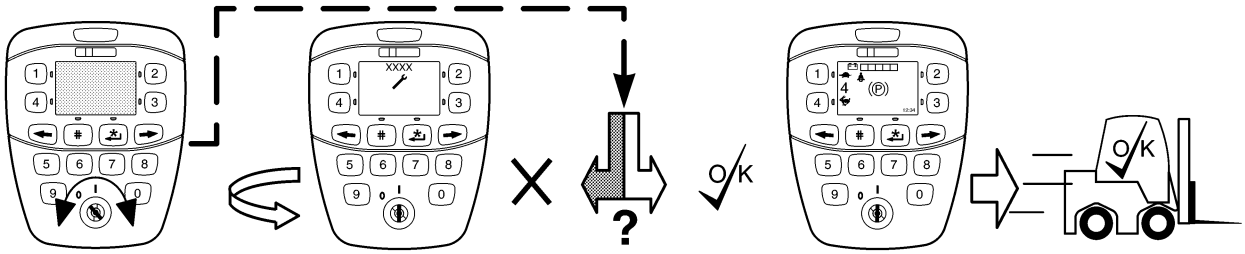
STEP A3

Single Device DTC Open Circuit Supply Voltage



1. Locate Device→Check connection→Not OK, Go to 4↓	1. Connection OK→Go to 2↓
2. = 0 Volts = Open Circuit Supply/(+) or (-) →Go to 4↓	2. =Supply Volts = OK→Step 1↓
3. > Supply Volts →Check for Shorts to a higher supply source→Repair→CAUSE C as CAN Device may be damaged	
4. Reference **Main Schematic** - Find/Repair Open Circuit See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→Recheck Voltage↑→Step 4↓	

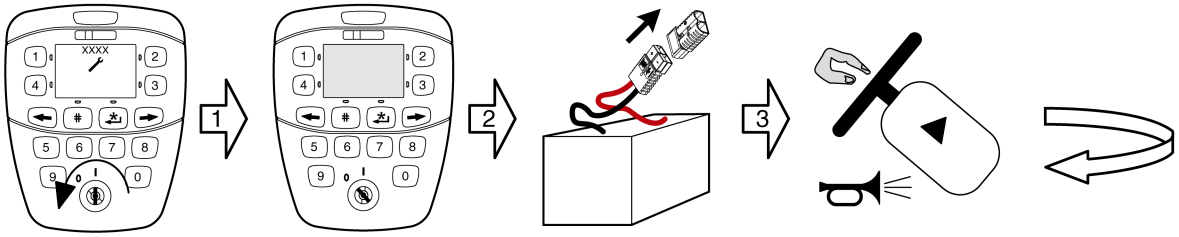
STEP A4



Retest - Power **OFF** Power **ON**	**NO**→?	Is fault DTC gone?**NO** **YES**	Fault corrected→Continue operation

DBB 4 Wheel CAN Communication (Cont)

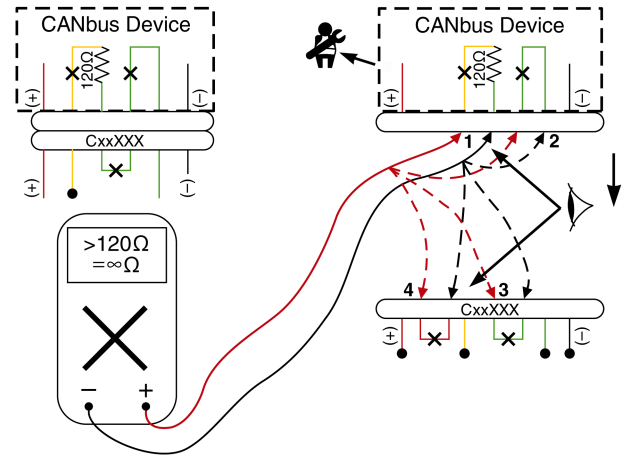
CAUSE B

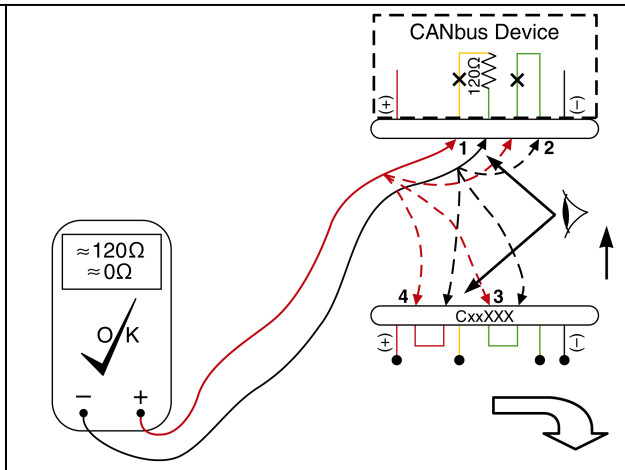


Power **OFF**→	Disconnect Battery and Sound Horn to Discharge Capacitors.→Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342→.	?

STEP B1

Single Device DTC Open Circuit CAN Hi or CAN Lo

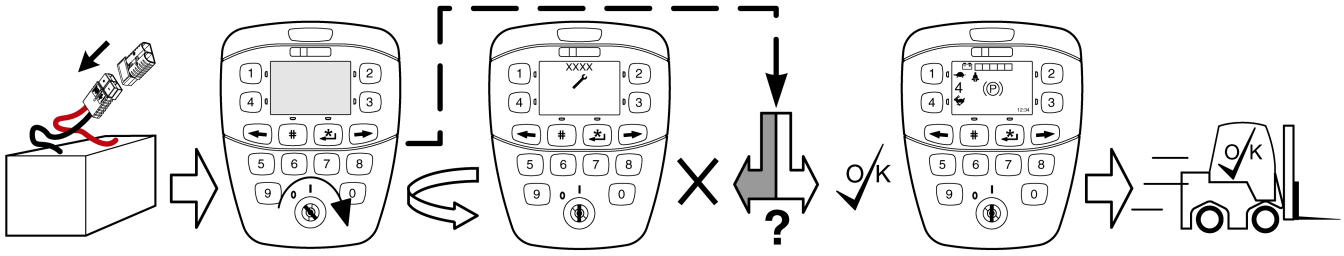




Locate Device→Check Connection→Not OK, Go to 6↓	Connections OK→Reconnect→Go to Step 2
Device with Termination Resistor→Locate and Disconnect ↓	See **Device Connectors**
1. > 120? = Open Circuit Termination Resistor →Go to 5↓	1. ˜ 120? = OK Go to 2 ↓
2. = 8? = Open Circuit →Go to 5↓	2. ˜ 0? = OK Go to 3 ↓
3. = 8? = Open Circuit →Go to 6↓	3. ˜ 0? = OK Reconnect Device↓
4. Motor Controller ID Loop(s) = 8? = Open Circuit→Go to 6↓	4. Reference **Main Schematic** ˜ 0? = OK Reconnect Device ↓
5. **Replace Device**→CAUSE C↓	
6. Find/Repair Open Circuit, See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→Recheck?↑→Reconnect→?	

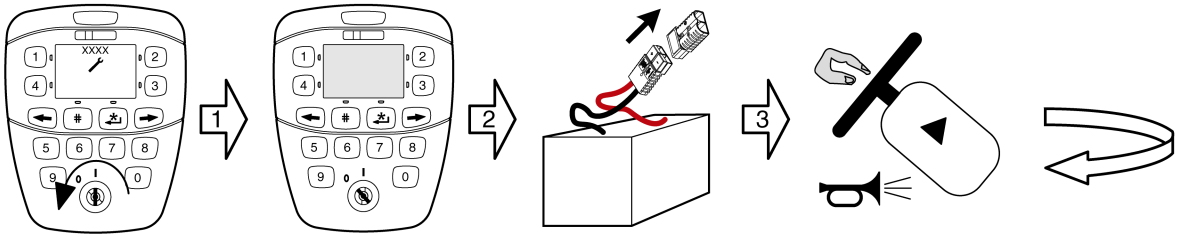
DBB 4 Wheel CAN Communication (Cont)

STEP B2



Reconnect Battery	Retest - Power **ON**	**NO**→?	Is fault DTC gone?**NO** **YES**	Fault corrected→Continue operation

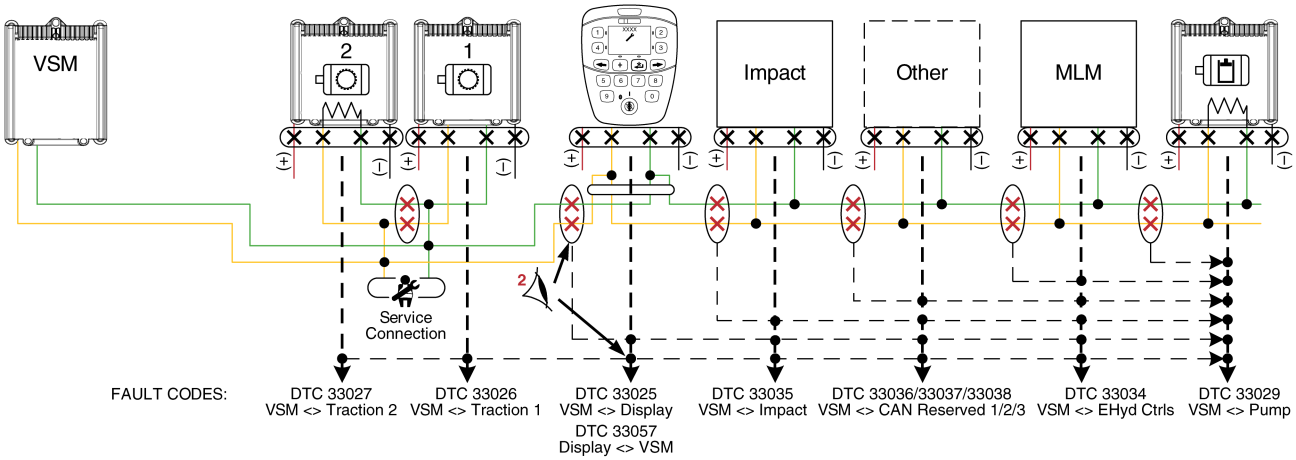
STEP B3



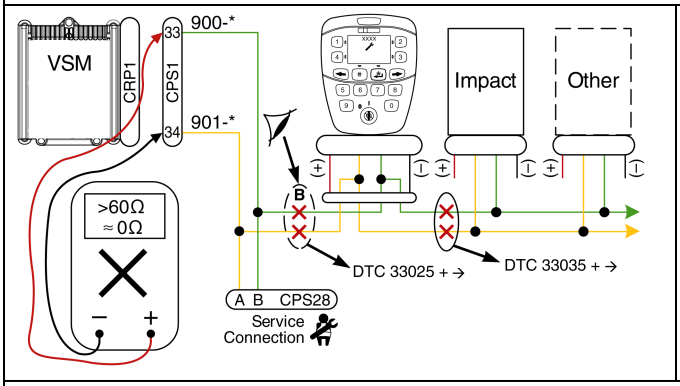
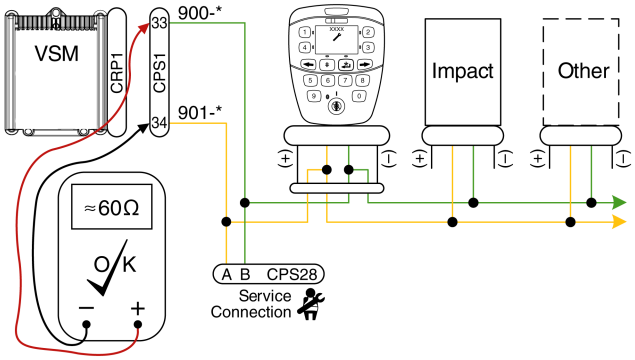
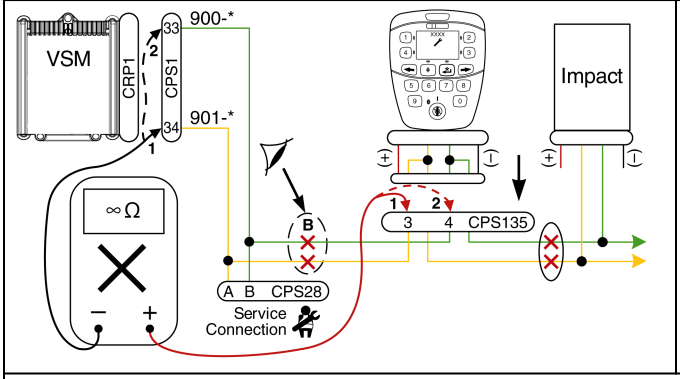
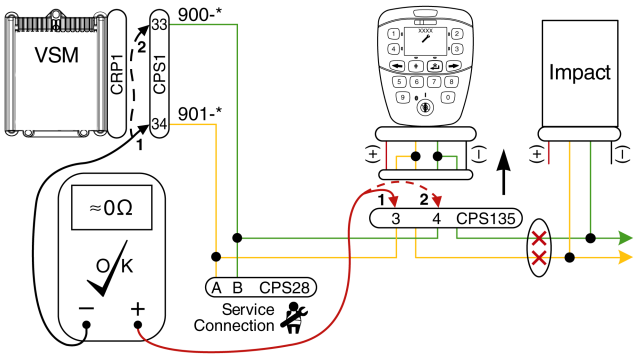
Power **OFF**→	Disconnect Battery and Sound Horn to Discharge Capacitors.→Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342→.	?

STEP B4

Multi CAN Device DTCs Display > Open Circuit CAN Hi to CAN Lo



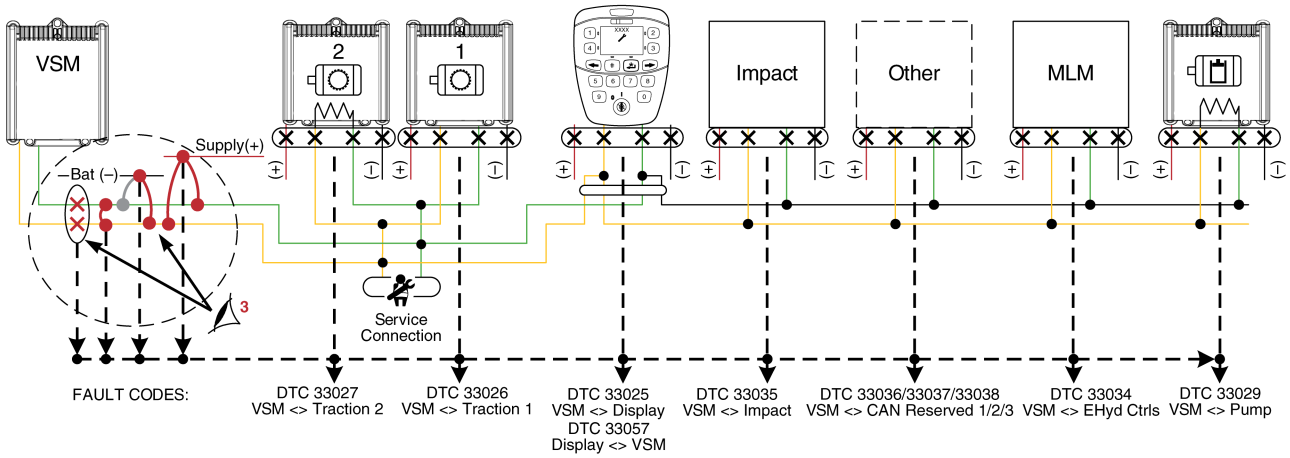
Example Only→Multiple DTCs→Fault Log→DTC/Device closet to VSM
Open circuit is between DTC Device and VSM→?

DBB 4 Wheel CAN Communication (Cont)	
STEP B5	
Multi Device DTCs Open Circuit CAN Hi or CAN Lo	
	
The above is an Example Only	
Disconnect VSM CPS1→Measure ?	See **Device Connectors**
> 60? to 8? = CAN Hi/Lo Open Circuit ?	˜ 0? = →CAUSE B↓˜ 60? = OK→CAUSE B↓
STEP B6	
	
The above is an Example Only	
Locate Device to right or Left of Indicated Open Circuit	
1. 8? = CAN Hi Open Circuit→Go to 3↓	1. ˜0? = OKCAUSE B↓
2. 8? = CAN Hi Open Circuit→Go to 3↓	2. ˜0? = OKCAUSE B↓
4. Find/Repair Short Circuit, See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→Re-check?→→Reconnect→Retest→?	

DBB 4 Wheel CAN Communication (Cont)

CAUSE C

All CAN Device DTCs Displayed > CAN Hi/CAN Lo Short Circuit together/Supply (+) or (-)



All DTCs→Open Circuit to VSM →Step 5↑

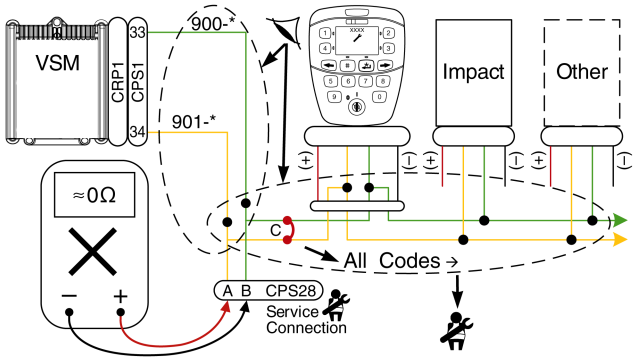
All DTCs→Short Circuit CAN Hi to CAN Lo →Step 1↓

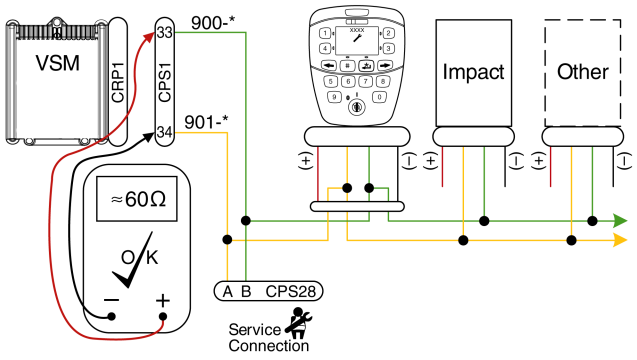
All DTCs→Short Circuit CAN Hi to (-) Supply Sources →Step 2↓No DTCs→Short Circuit CAN Lo to (–) Supply Sources

All DTCs→Short Circuit CAN Lo to (+) Supply Sources→Step 3↓No DTCs→Short Circuit CAN Hi to (+) Supplies (5, 12 volt)

STEP C1

All Device DTCs Short Circuit CAN Hi to CAN Lo



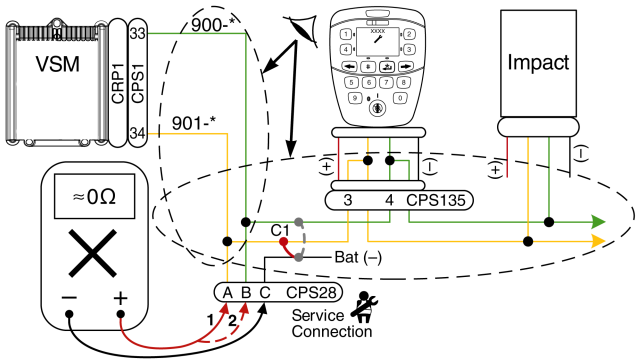


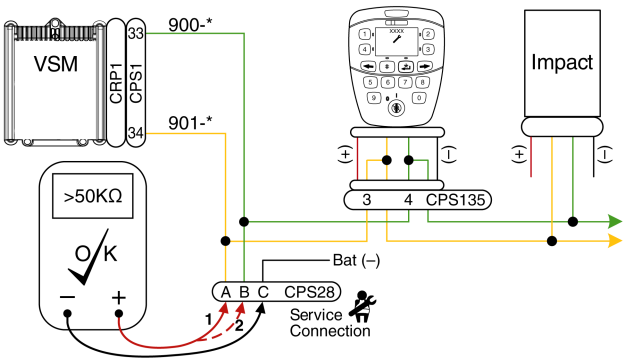
Locate Service Connection →Measure ?	See **Device Connectors**↓
1. = 0? CAN Hi/Lo Short Circuit→Go to 2↓	1. ˜ 60? = OK →Step 2↓
2. Inspect easily Accessible Harness Areas for Insulation Damage then Inaccessible Harness Areas. Focus on Bend Edges and Pinch Points, ?	
3. Find/Repair Short Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369 Re-check ?→Reconnect→Retest→?	

DBB 4 Wheel CAN Communication (Cont)

STEP C2

All Device DTCs Short Circuit CAN Hi to Bat (-)CAN Lo to Bat (-) will not Produce a DTC



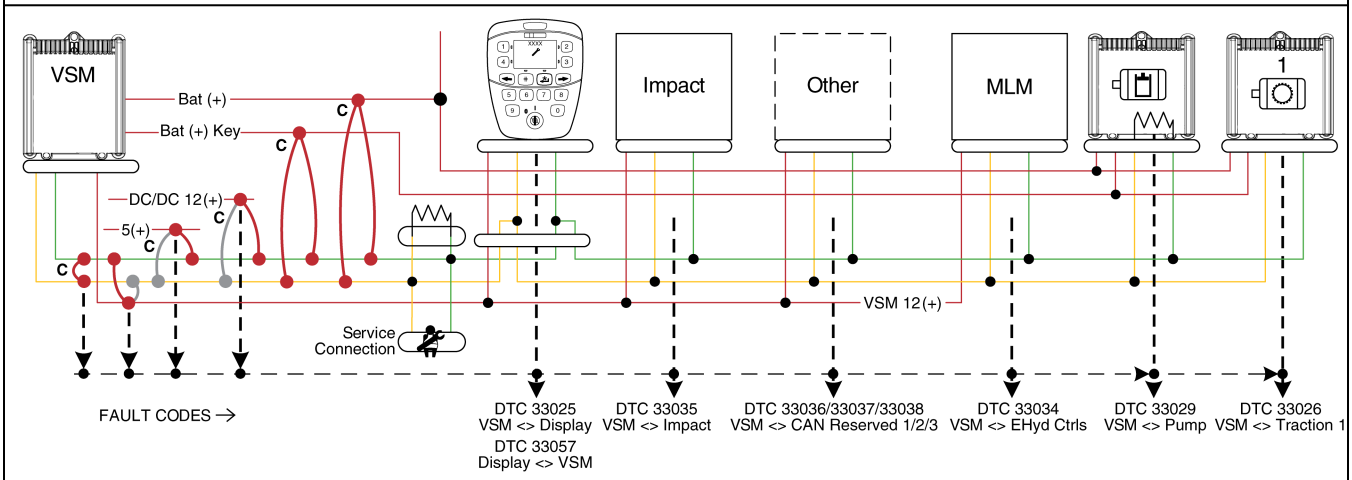


1. 0? = CAN Hi Short Circuit. Go to 3↓	1. > 50K? = OK, Go to 3↓
2. 0? = CAN Lo Short Circuit. Go to 3↓	2. > 50K? = OK, Go to 3 ↓

3. Find/Repair Short Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369 Re-check ?→Reconnect→Retest, →Step 5

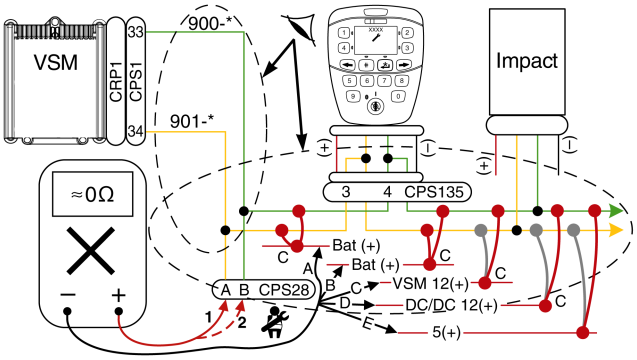
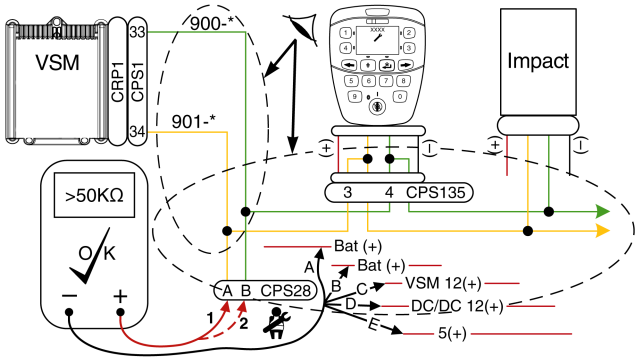
STEP C3

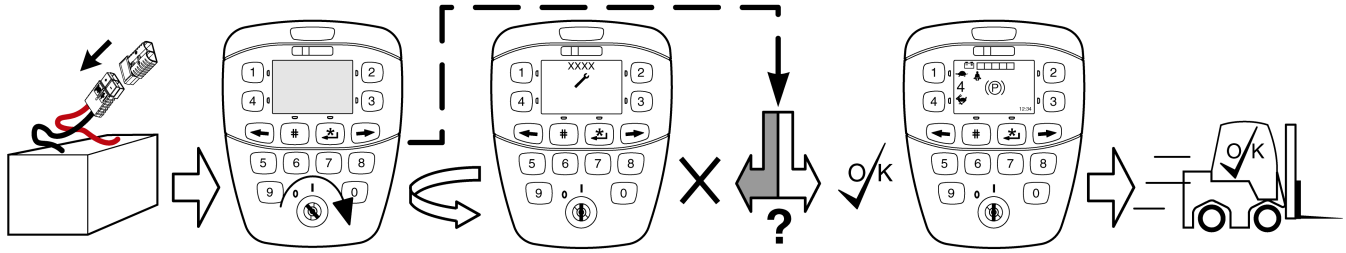
Multiple CAN Device DTCs Displayed > (+) Supply Short Circuit to CAN Hi or CAN Lo



All DTCs→Short Circuit CAN Lo to (+) Supply Sources.

All DTCs→Short Circuit CAN Hi to (+) Supply Sources.No DTCs for a Short to (+)12 Volts or (+) 5 Volts

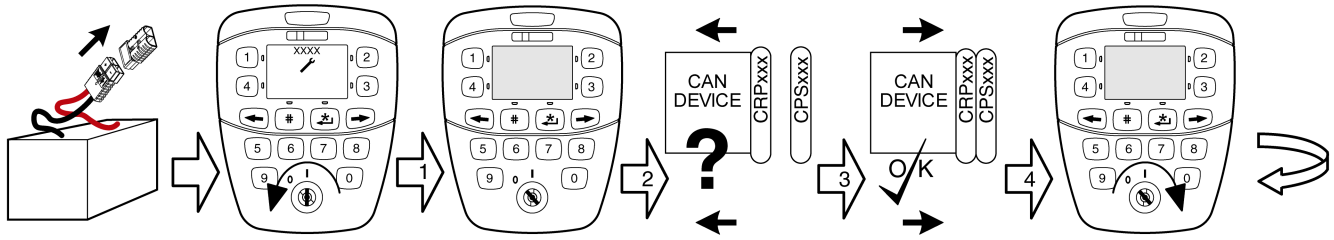
DBB 4 Wheel CAN Communication (Cont)	
STEP C4	
All Device DTCs Short Circuit Supply (+) to CAN Hi or CAN Lo	
	
1. A, B, C, D, and E = 0? = CAN Hi Short Circuit, Go to 3↓	1. A, B, C, D, and E > 50K? = OK→?
2. A, B, C, D, and E = 0? = CAN Lo Short Circuit, Go to 3↓	2. A, B, C, D, and E > 50K? =OK→?
3. Find/Repair Short Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369 Re-check ?→Reconnect→Retest→?	
STEP C5	



Reconnect Battery	Retest - Power **ON**	**NO**→Go to ?	Is DTC gone?**NO** **YES**→	Fault corrected→Continue operation

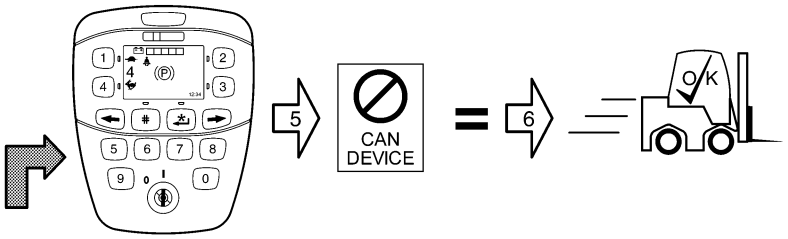
DBB 4 Wheel CAN Communication (Cont)

CAUSE D

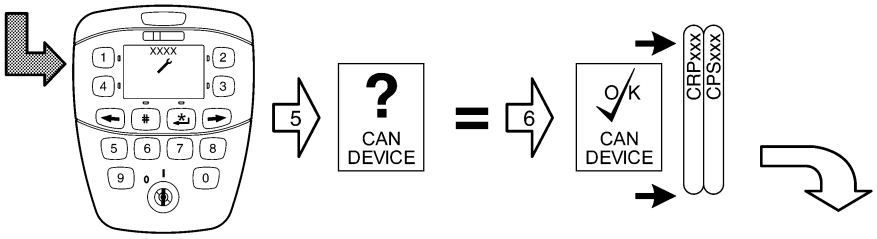


Disconnect Battery To Replace **Motor Controller**	Power **OFF**	Disconnect CAN Device→Do Not Discard	Install New CAN Device	Power **ON**→?

STEP D1



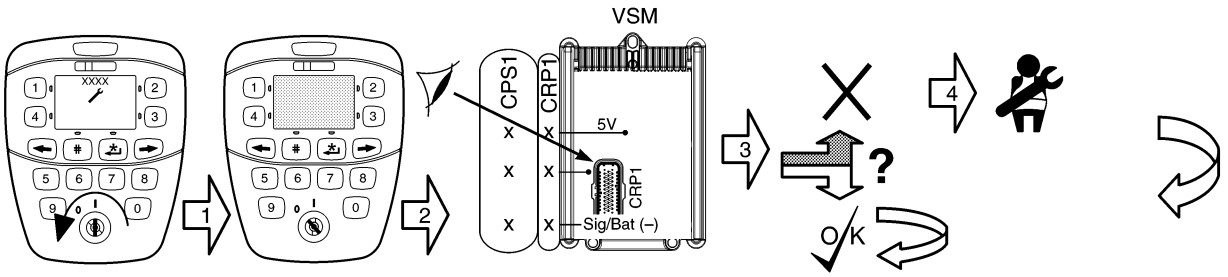
?	Fault DTC gone→	Old device faulty→	Resume operation



Fault DTC present→	Old Device OK/Reinstall Old Device→	?

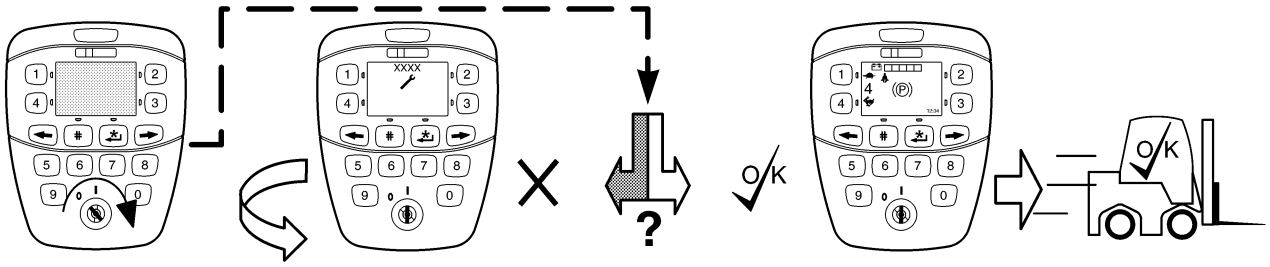
DBB 4 Wheel CAN Communication (Cont)

CAUSE E



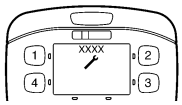
Power **OFF**→	Inspect VSM Connections→	Go to Step 1	Not OK Correct/Repair→Go to Step 1

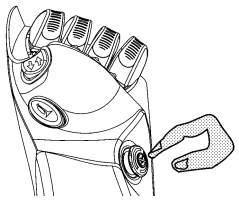
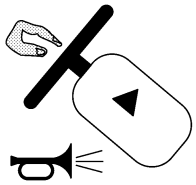
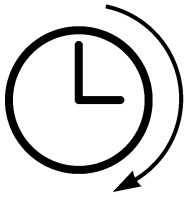
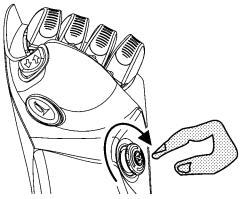
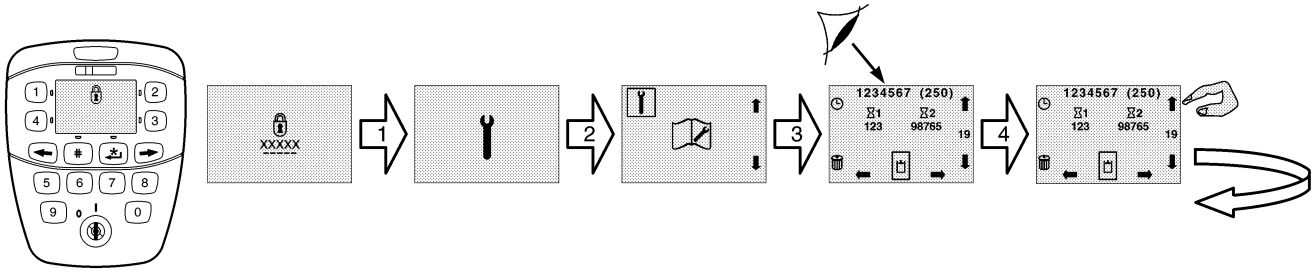
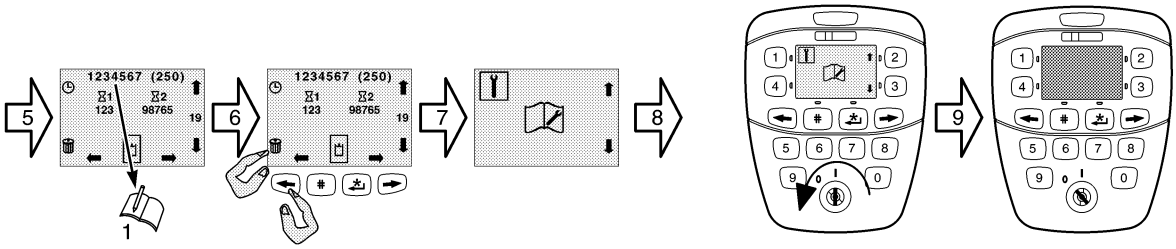
STEP E1

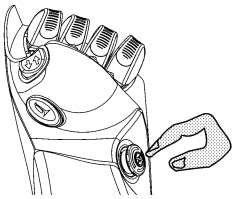
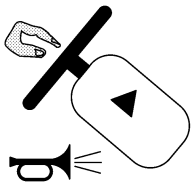
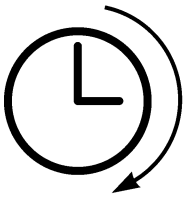
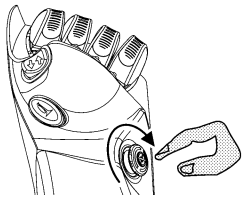
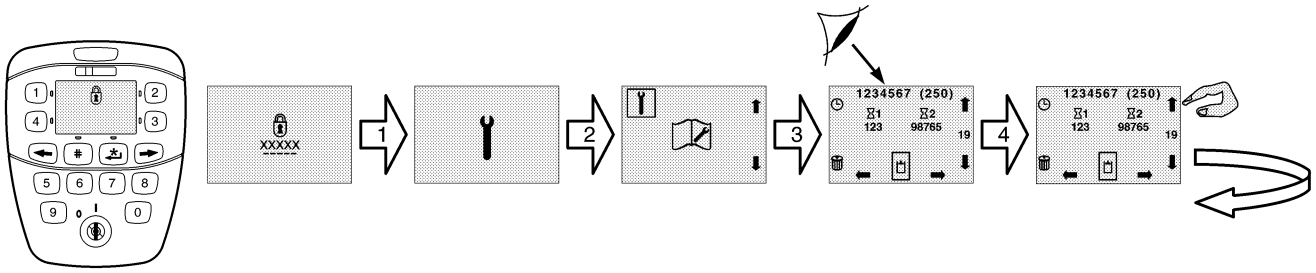
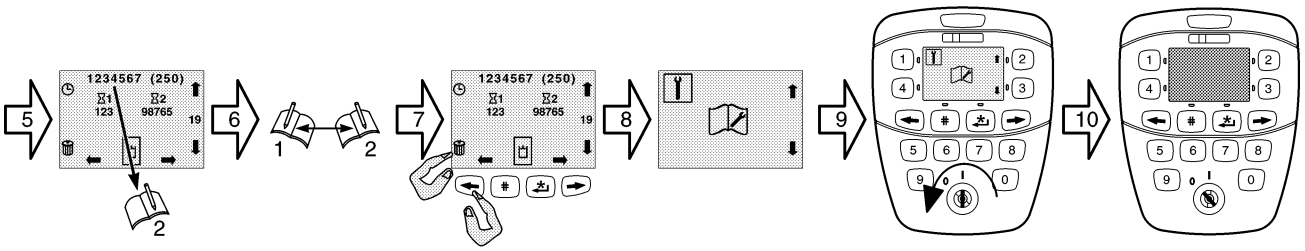
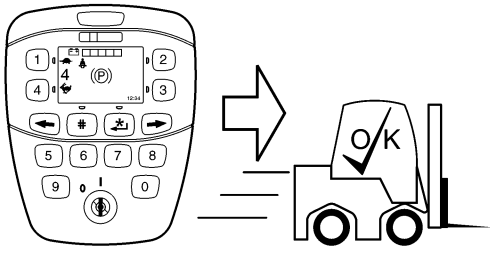


Retest - Power **ON**→	**NO**→Go to VSM Controller Check	Is fault DTC gone?**NO** **YES**←→	Fault corrected→Continue operation

END FAULT

MLM Failure (Cont)				
 Fault Codes	DTC 21830 MLM EEPROM Write Error	DTC 21834 MLM Sensor 1 Out of Range	DTC 21835 MLM Sensor 2 Out of Range	DTC 21836 MLM Sensor 3 Out of Range
	DTC 21837 MLM Sensor 4 Out of Range	DTC 25344 MLM Checksum Error		
QUICK CHECK X = Open Circuit/Fail) = Short Circuit				

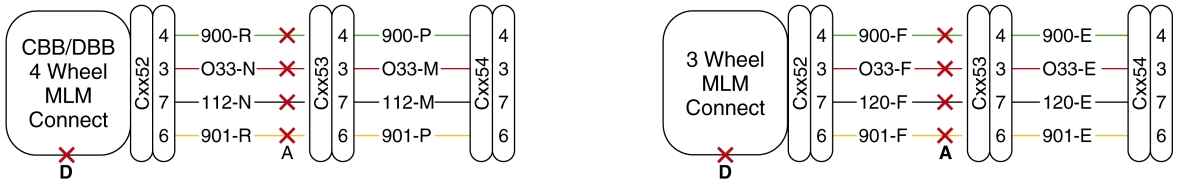
MLM Failure (Cont)			
DTC 21834	MLM Sensor 1 Out of Range		→CAUSE C↓
DTC 21835	MLM Sensor 2 Out of Range		→CAUSE C↓
DTC 21836	MLM Sensor 3 Out of Range		→CAUSE C↓
DTC 21837	MLM Sensor 4 Out of Range		→CAUSE C↓
DTC 25344	MLM Checksum Error	DTC 33034 Display	→CAUSE 0↓
DTC 21830	MLM EEPROM Write Error	DTC 33034 Display	→CAUSE 0↓
Check 1			
			
Push in Emergency Stop	Disconnect Battery and Sound Horn to Discharge Capacitors.Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342.	Wait 30 seconds	Release Emergency Stop
FAULT LOG CODE Review - Go to Display Menu			
			
Enter Service Password→Diagnostic→FAULT LOGs→VSM/MLM Fault Logs→View all VSM/MLM DTCs→?			
			
All VSM/MLM DTCs	Erase all VSM/MLM DTCs→Exit Fault Log		Power OFF↓

MLM Failure (Cont)			
Check 2			
			
Push in Emergency Stop	Disconnect Battery and Sound Horn to Discharge Capacitors.Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342.	Wait 30 seconds	Release Emergency Stop
			
Enter Service Password→Diagnostic→FAULT LOGs→VSM/MLM Fault Logs→View all VSM/MLM DTCs→?			
			
VSM/MLM DTCs→Compare VSM/MLM DTCs Check 1 & 2→Erase all VSM/MLM DTCs→Exit Fault Log↓			
MLM 21834, 21835, 21836, & 21837→		Power OFF→CAUSE C	
33034 VSM DTC Only→		Power OFF→CAUSE 0	
No DTCs→?			
			
No Fault→Resume Operation			

MLM Failure (Cont)

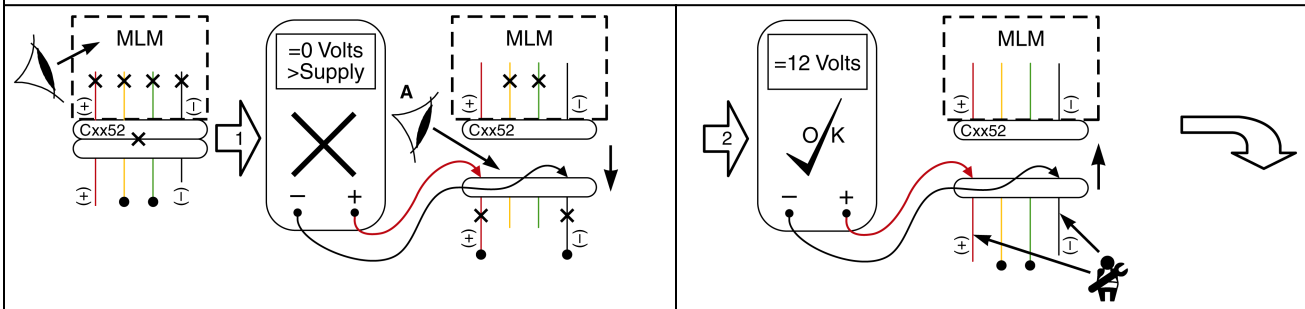
CAUSE A

Table 9030-20-11. Main Schematic

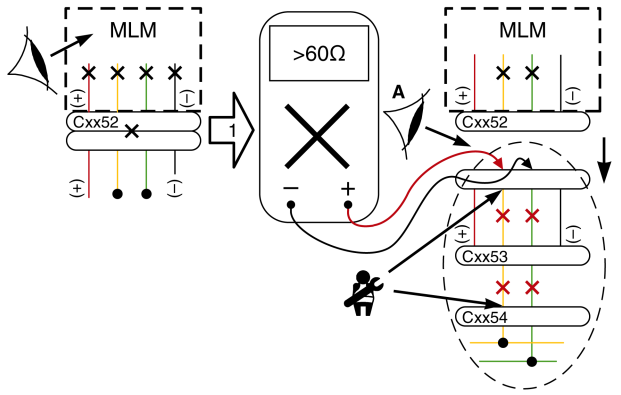
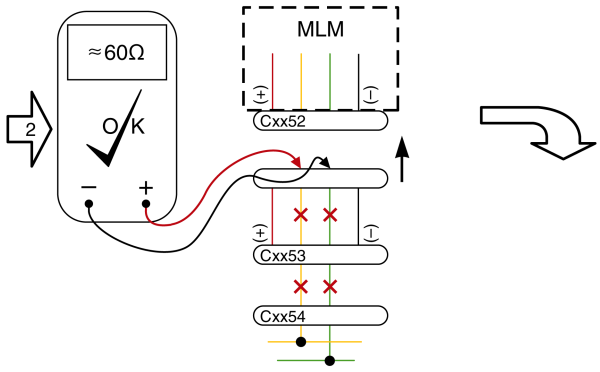


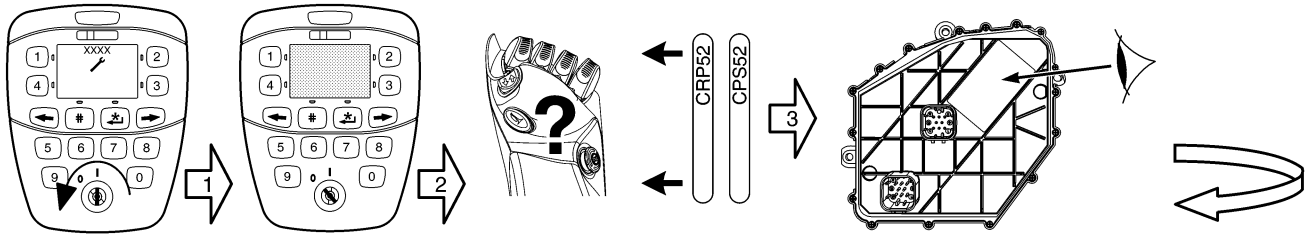
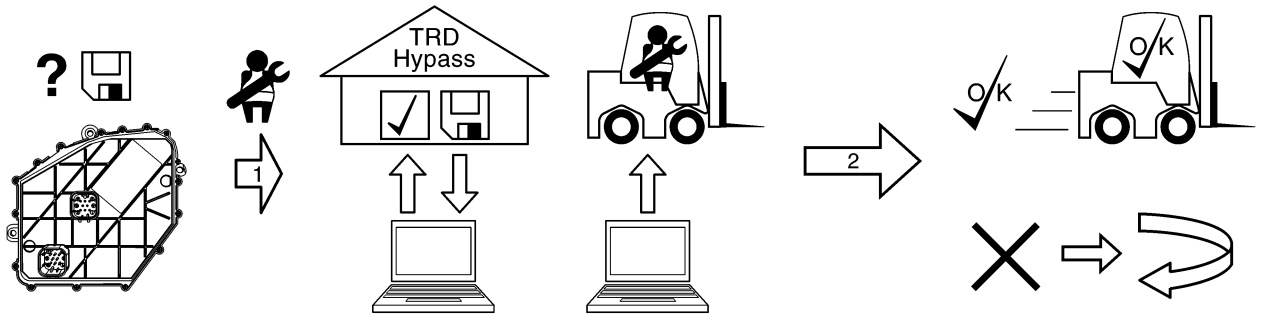
STEP A1

MLM Open Circuit Supply Voltage



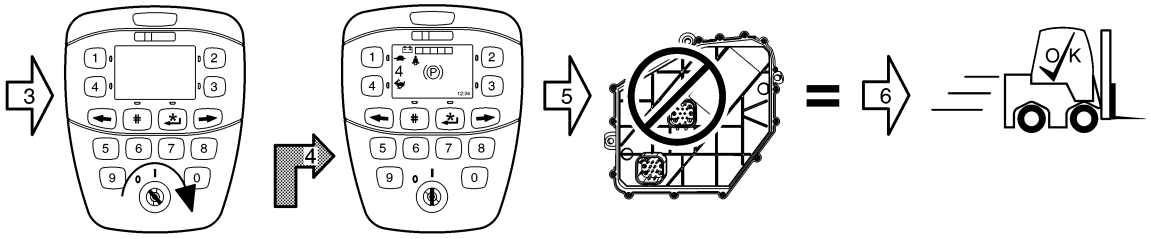
1. Locate Device→Check Connections→Not OK Go to 4↓	1. Connections OK→Go to 2↓
2. =0 Volts = Open Circuit→Supply/(+) or (-)→Go to 4↓	2. = Supply Volts= OK→Step 2↓
3. > Supply Volts→Check for Shorts to a Higher Supply Source→Repair→CAUSE C as MLM may be damaged.	
4. Reference Table 9030-20-11→ - Find/Repair OPEN Circuit See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→ReCheck Voltage↑	

MLM Failure (Cont)	
STEP A2	
MLM Open Circuit CAN Hi/CAN Lo	
	
1. Locate Device→Check Connections→Not OK Go to 4↓	1. Connections OK→Go to 2↓
2. > 60? = Open Circuit→CAN Hi/CAN Lo→Go to 4↓	2. CAN Hi/CAN Lo Connections = OK→CAUSE C↓
3. Reference Table 9030-20-11→ - Find/Repair OPEN Circuit See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→Go to 4↓	
4. ReCheck ?↑→Repeat Check 2↑?	
CAUSE B	
Not Applicable	
CAUSE C	
Not Applicable	

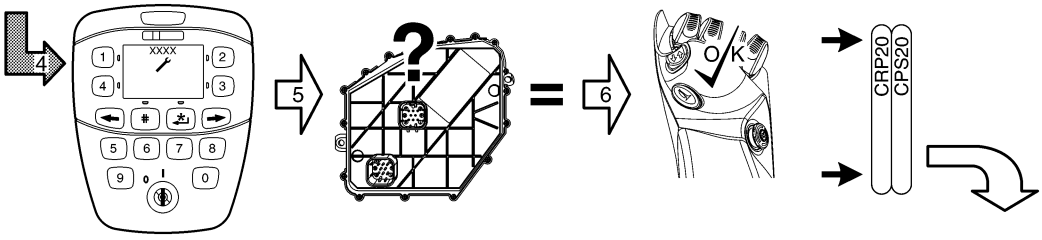
MLM Failure (Cont)
CAUSE D

Power **OFF**→Remove and Replace MLM PCB Cassette Assembly→See **Electrical System** 2200SRM1337/ **Electrical System** 2200SRM1369↓
Check Replacement MLM 🖫 Version→See Label Information→Step 2↓
STEP D1

1. Go to TRD/Hypass Online /Software.?? Is Replacement Cassette Software Version the Latest Version
2. **NO**→Download the latest Application 🖫→Install on truck→See 4↓→Step 2↓
3. **YES**→Test New Installation→Step 2↓
4. **WARNING:** Keyswitch must be **OFF** during reprogramming

MLM Failure (Cont)

STEP D2

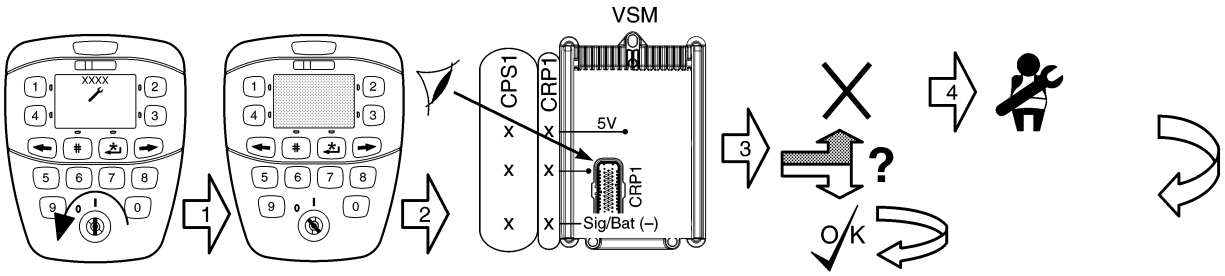


Power **ON**→	**?** DTCs gone→	Original MLM Cassette faulty→	Resume operation



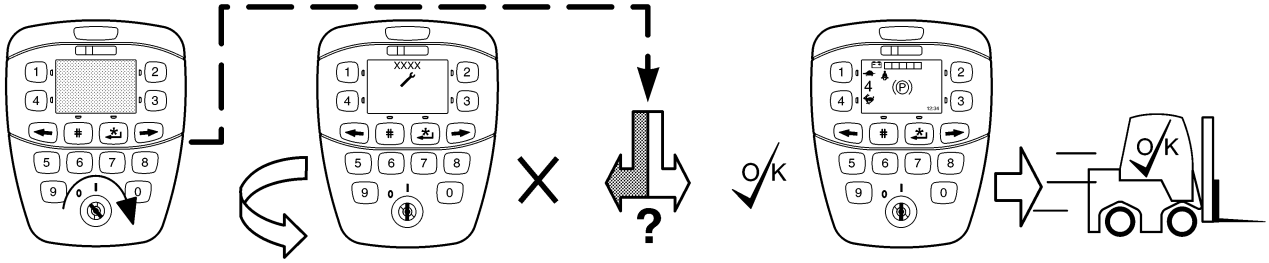
DTCs Still Present→	Original MLM Cassette OK/Reinstall Original Cassette→?	

CAUSE E



Power **OFF**→	Inspect VSM Connections→OK Step 1	Not OK Correct/Repair→Step 1

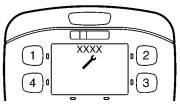
STEP E1



Retest - Power **ON**→	**NO**→Go to VSM Controller Check	Is fault DTC gone?**NO** **YES**←→	Fault corrected→Continue operation.

END FAULT

MLM Incorrect Lever Installed (Cont)



Fault Codes

DTC 4112	DTC 4113	DTC 4114	DTC 4115
Incorrect Lever 1 Installed	Incorrect Lever 2 Installed	Incorrect Lever 3 Installed	Incorrect Lever 4 Installed

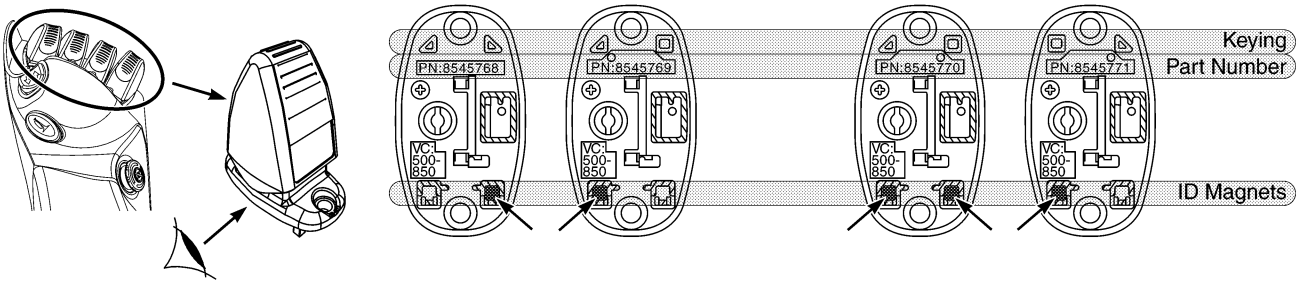
DTC 4116
Incorrect Lever 5 Installed

QUICK CHECK X = Open Circuit/Fail) = Short Circuit

Check 1

Is Truck Lever Hardware Configuration Correct With Software Configuration?

Standard↓Dual Function↓ Clamp↓ Monentary↓(RTST)



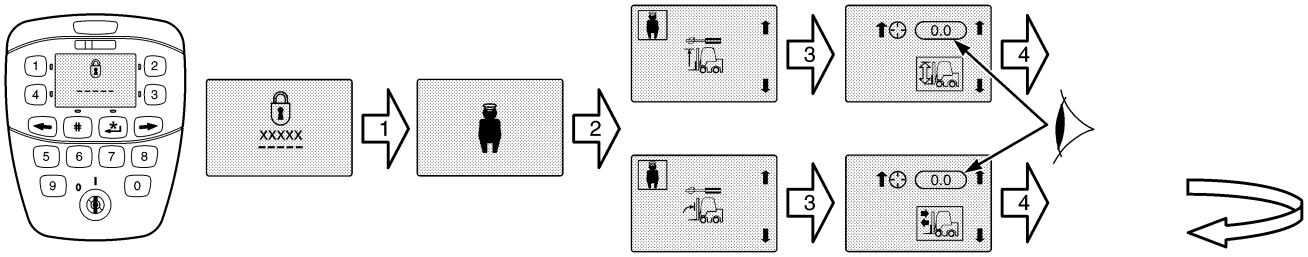
Remove Lever(s)→Check Base Information

If Incorrect Install Correct Lever(s)

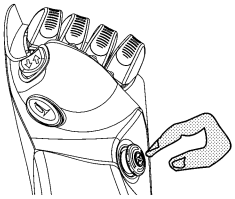
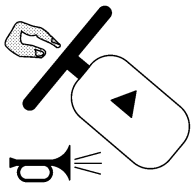
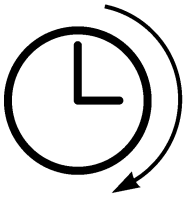
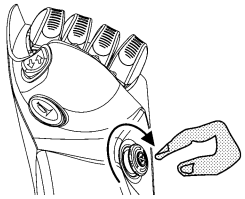
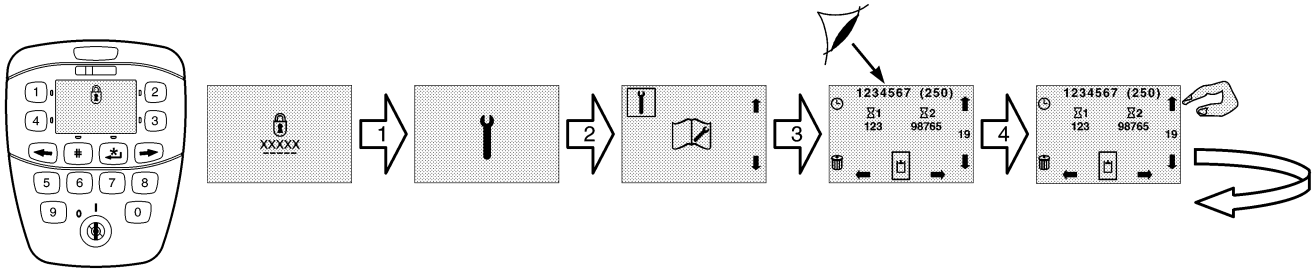
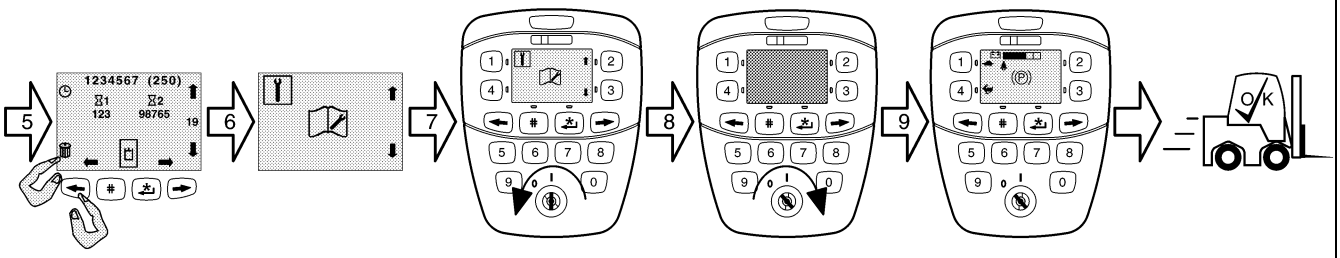
Check 2

?DTC for Lever 1 or Lever 2→Truck Setup→Review RTST Setup Procedures

Standard Lever Installation→Timer should be set to zero?

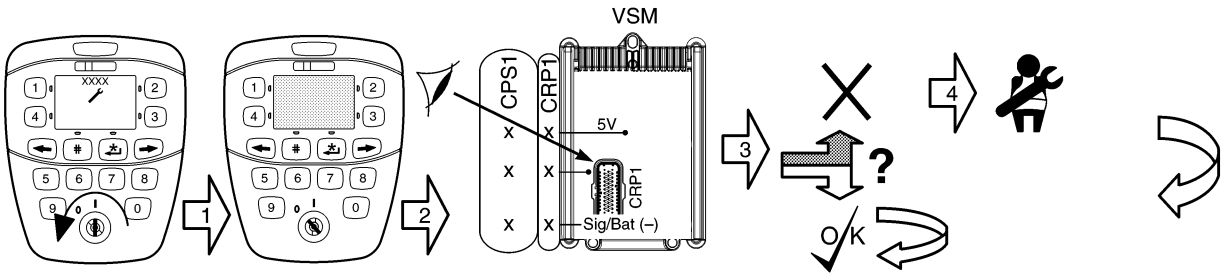


Enter Service Password→Truck Setup→RTST→? Timer Value = 0 for Standard Levers→**NO**↓

MLM Incorrect Lever Installed (Cont)			
→Reset Timer to Zero→See Display Menu Flowchart for next step			
Check 3			
			
Push in Emergency Stop	Disconnect Battery and Sound Horn to Discharge Capacitors.Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342.	Wait 30 seconds	Release Emergency Stop
DTC FAULT LOG CODE Review - Go to Display Menu			
			
Enter Service Password→Diagnostic→FAULT LOGs→VSM/MLM Fault Logs→View all VSM/MLM DTCs→?			
			
Erase all VSM/MLM DTCs→Exit Fault Log→Power OFF/Power ON→No DTCs→Resume Operation			
Same DTCs Return→Configuration File Incorrect→Go to CAUSE D			
CAUSE A			
Not Applicable			
CAUSE B			
Not Applicable			
CAUSE C			
Not Applicable			
CAUSE D			
Not Applicable			

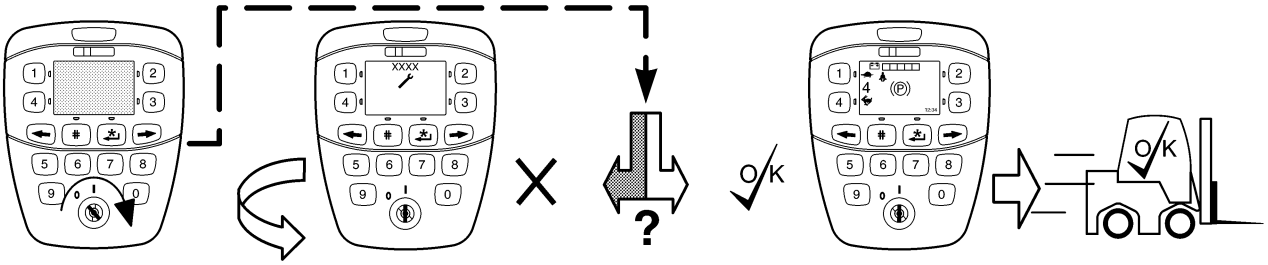
MLM Incorrect Lever Installed (Cont)

CAUSE E



Power **OFF**→	Inspect VSM Connections→OK Step 1	Not OK Correct/Repair→Step 1

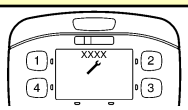
STEP E1



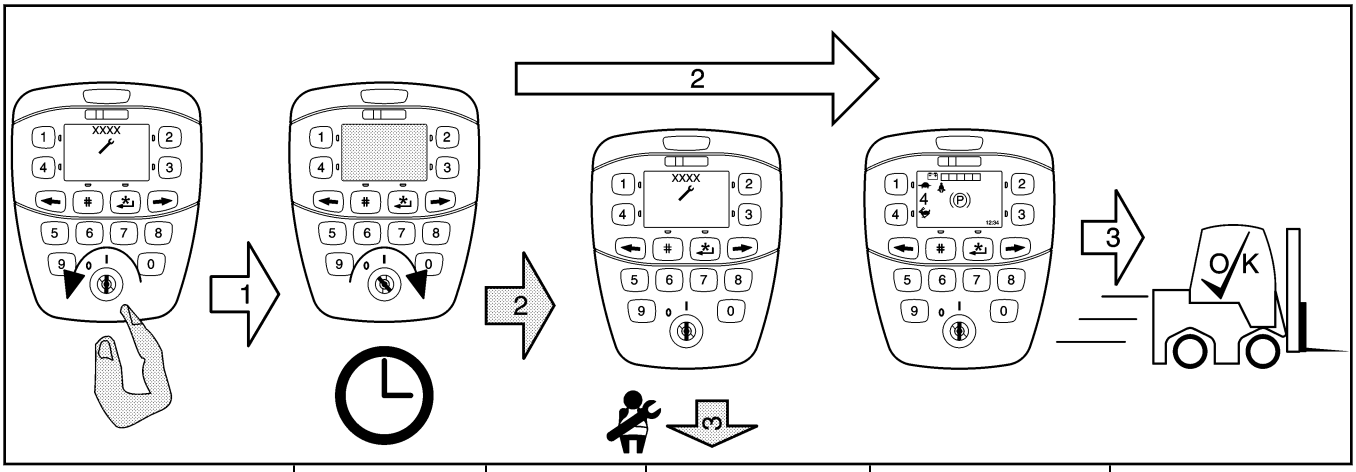
Retest - Power **ON**→	**NO**→Go to VSM Controller Check	Is fault DTC gone?**NO** **YES**←→	Fault corrected→Continue operation.

END FAULT

VSM 12 Volts Supply OORL/OORH



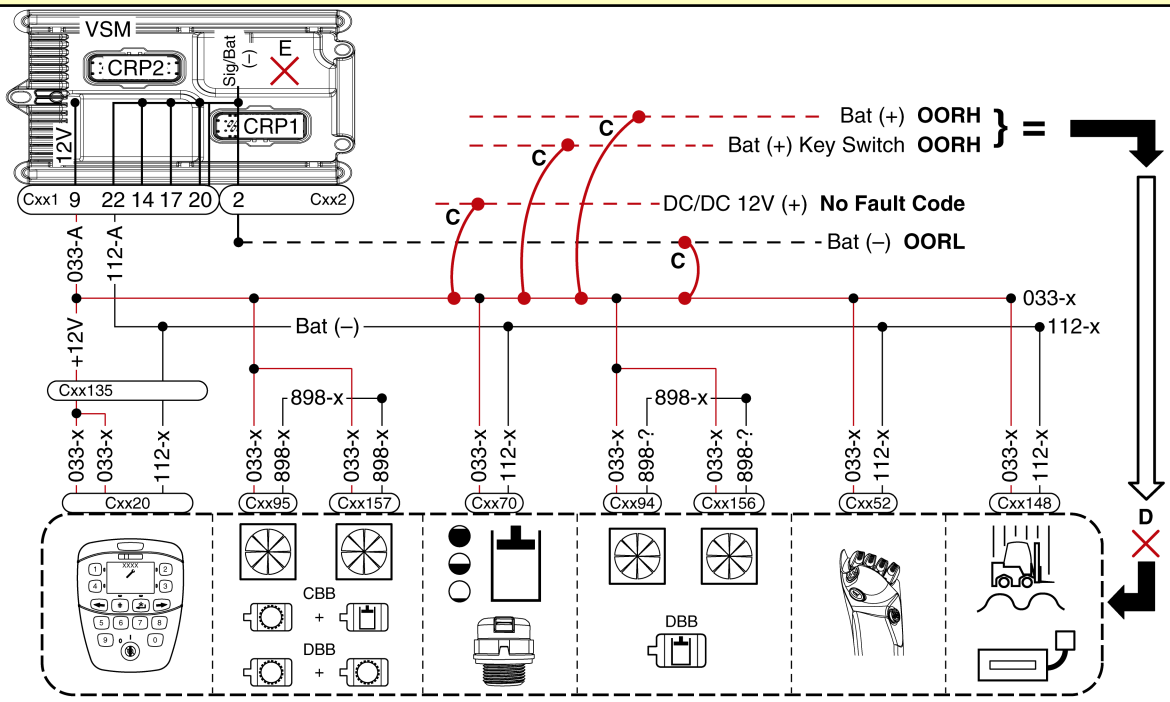
DTC 13060 DTC 13061
VSM 12V OORLVSM 12V OORH



Power **OFF**→	Wait **30 seconds**→	Power **ON**→	Fault remains. Service required. Go to Component Operational Check.	No fault→	Resume operation

POSSIBLE CAUSE X = Open Circuit/Fail) = Short Circuit

DBB/CBB 4 WHEEL VSM 12 VOLT SUPPLY CAUSES A B C D E > ?



The addition of Non Approved 12 Volt Devices other than those listed on the schematics may cause an OORL condition

VSM 12 Volts Supply OORL/OORH (Cont)

WARNING

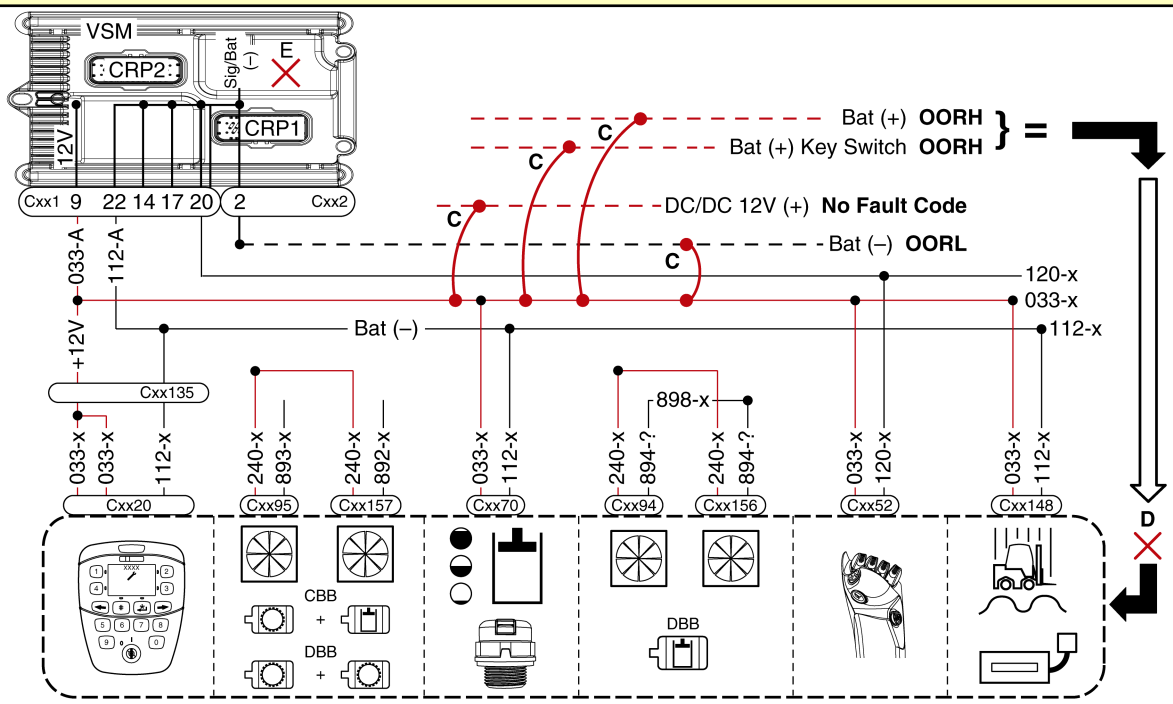
No Display Fault Code will be visible for a Short To Battery(+) [STB(+)] OORH condition as the Display will be Inoperative

For a STB (+) Fault Codes will only be visible on the PC Service Tool

Any VSM 12 volt powered Device that is turned on, will be damaged by a STB(+) condition, except for the Display

All VSM 12 volt powered devices will need to be checked for correct operation and probably replaced

CBB 3 WHEEL VSM 12 VOLT SUPPLY CAUSES A B C D E > ?



WARNING

No Display Fault Code will be visible for a Short To Battery(+) [STB(+)] OORH condition as the Display will be Inoperative

For a STB (+) Fault Codes will only be visible on the PC Service Tool

Any VSM 12 volt powered Device that is turned on, will be damaged by a STB(+) condition, except for the Display

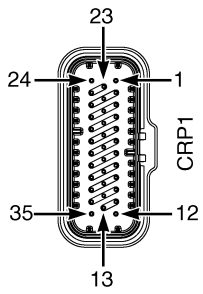
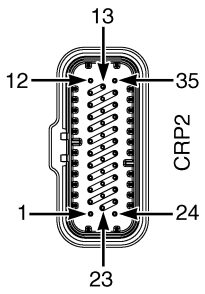
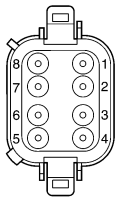
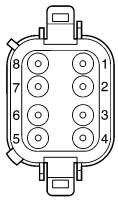
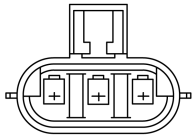
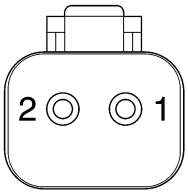
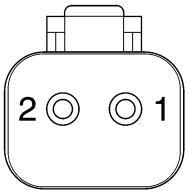
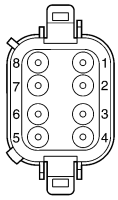
All VSM 12 volt powered devices will need to be checked for correct operation and probably replaced

A Breakout Connection for Cxx 135 is recommended for this TSP. See Table 9030-20-12 for Connector location

VSM 12 Volts Supply OORL/OORH (Cont)

CONNECTORS

Table 9030-20-12. Device Connectors

 			
VSM Cxx 1 & 2		Display Cxx 20 &135	MLM Cxx 52
			
Hydraulic Level Cxx 70	Cxx 94 & 156	Cxx 95 & 157	Impact Device Cxx 148

CAUSE A

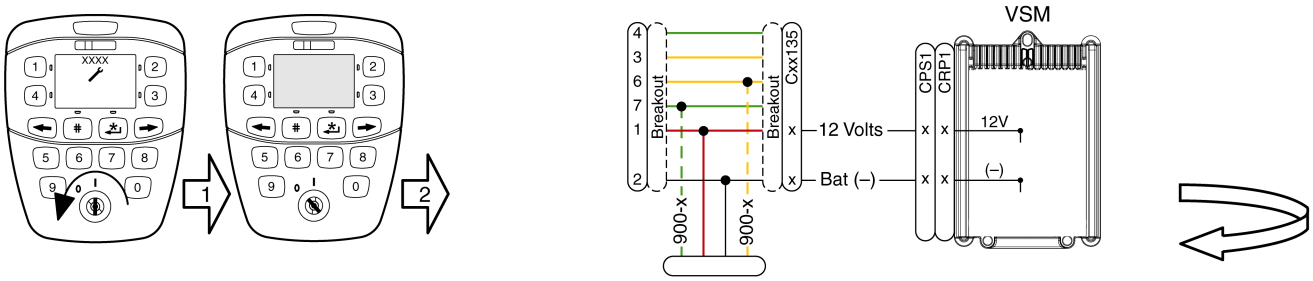
Not Applicable

CAUSE B

Not Applicable

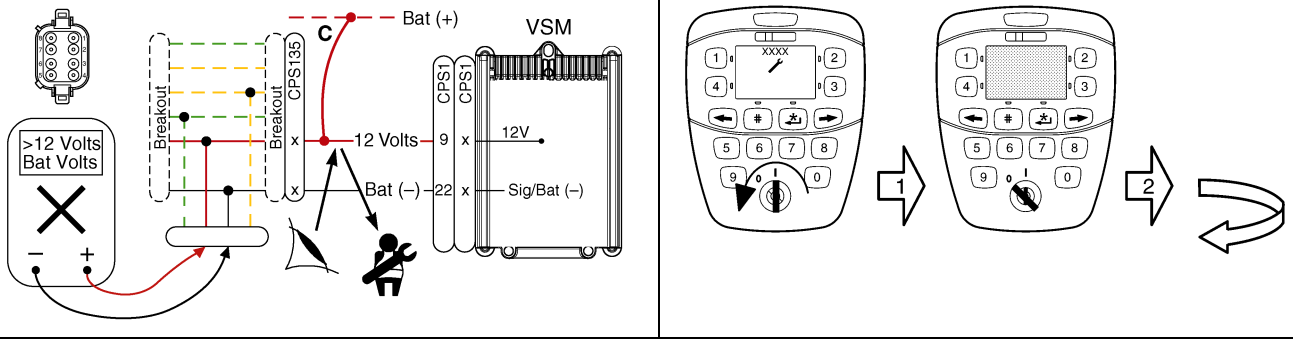
VSM 12 Volts Supply OORL/OORH (Cont)

CAUSE C



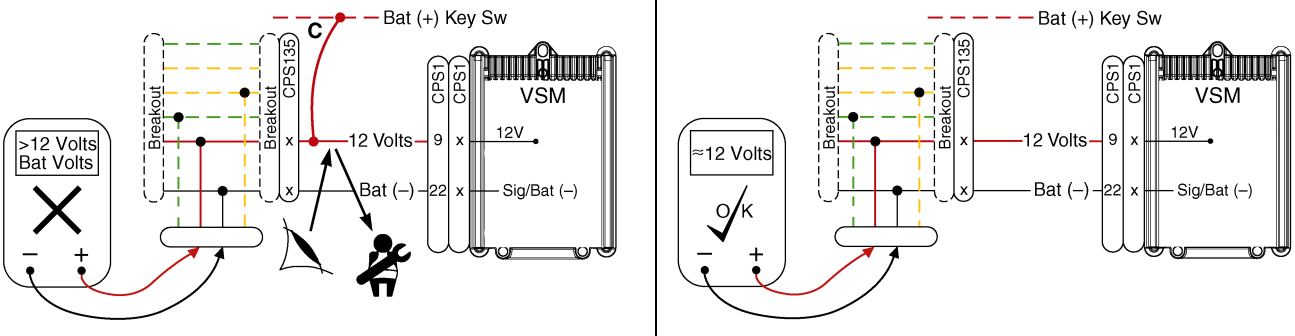
Power **OFF**→	Disconnect Connector Cxx 135 and Install Breakout→		Go to Step 1

STEP C1 UNSWITCHED VOLTAGES



1. ˜ 0 Volts→Step 4↓	
2. ˜ 12 Volts→	Power **ON**→Go to 2↓
3. ˜ Bat Volts = Short Circuit to Unswitched Bat (+)→Go to 4↓	
4. Find/Repair Short Circuit, See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→ ReCheck Voltage↑→Reconnect Go to 5↓	
5. Check correct operation of all 12 volt Devices except Display→CAUSE C↓	

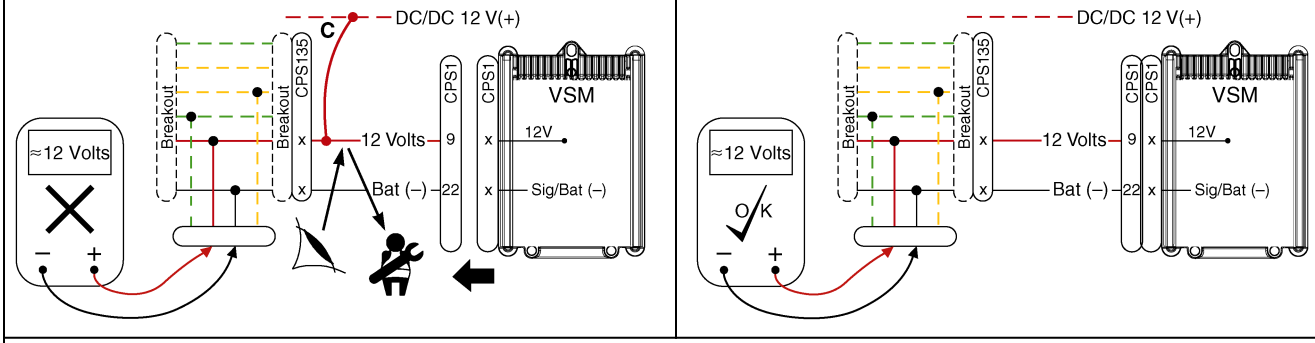
STEP C2



1. ˜ 12 Volts→	˜ 12 Volts →Step 3, CAUSE B↓
2. ˜ Bat Volts = Short Circuit to Switch Bat (+)→Go to 3↓	
3. Find/Repair Short Circuit, See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→ ReCheck Voltage↑→Reconnect Go to 4↓	
4. Check correct operation of all 12 volt Devices except Display→CAUSE C↓	

VSM 12 Volts Supply OORL/OORH (Cont)

STEP C3



1. Disconnect VSM CPS1

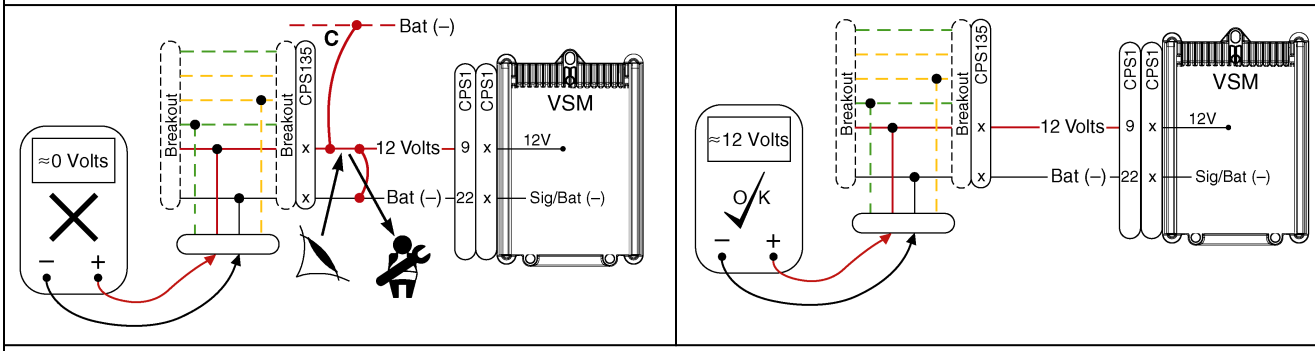
2. ˜ 12 Volts = Short Circuit→DC/DC 12 Volts (+), Go to 3↓

3. Find/Repair Short Circuit, See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→ ReCheck Voltage↑Fault Remains →Reconnect→Go to 4↓

Check correct operation of all 12 volt Devices except Display→CAUSE C↓

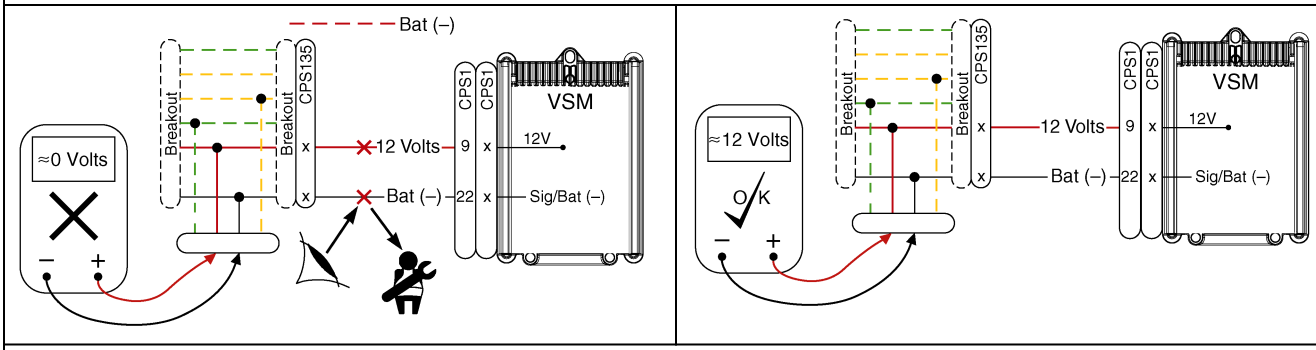
STEP C4

OORL



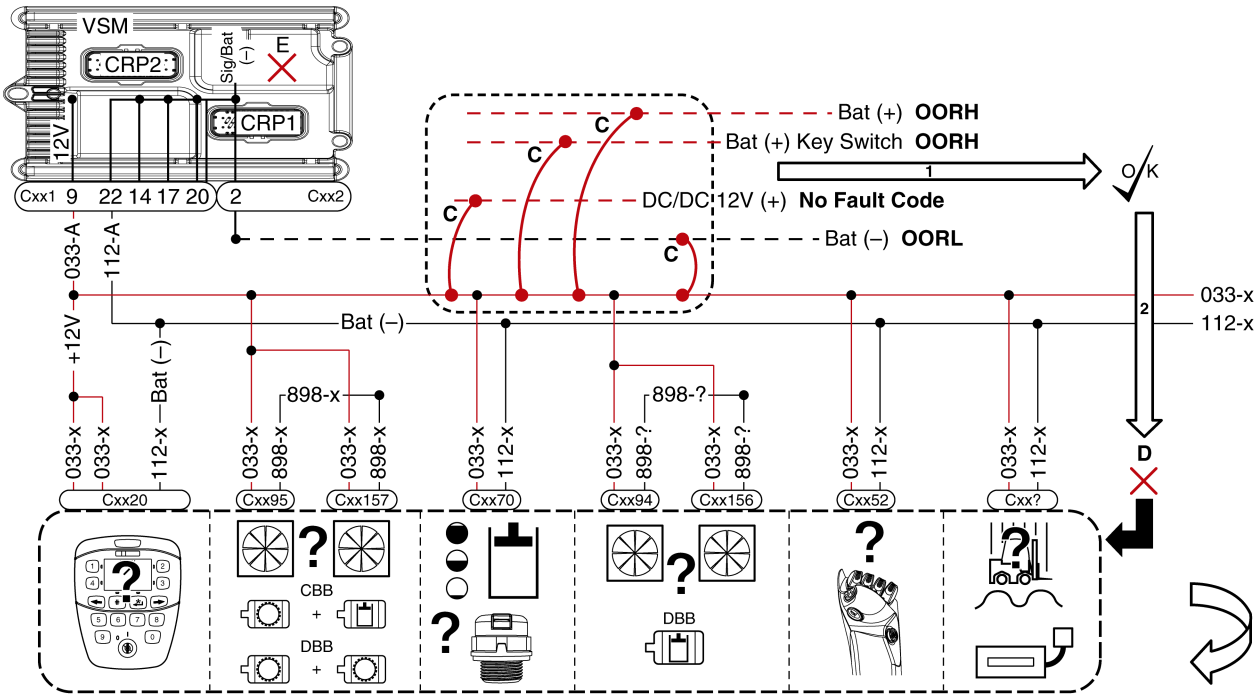
1. ˜ 0 Volts = Short Circuit→Bat (-)→Find/Repair Short Circuit→Go to 2↓

2. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→ ReCheck Voltage↑Fault Remains →Reconnect Cxx 135 →CAUSE C↓

VSM 12 Volts Supply OORL/OORH (Cont)
STEP C5
OORL – No 12 volt Device Operation→No Fault Code

1. ˜ 0 Volts = No 12 volt Device operation→This will not Cause a Fault Code
2. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→ ReCheck Voltage↑Fault Remains →Reconnect Cxx 135 →CAUSE C↓

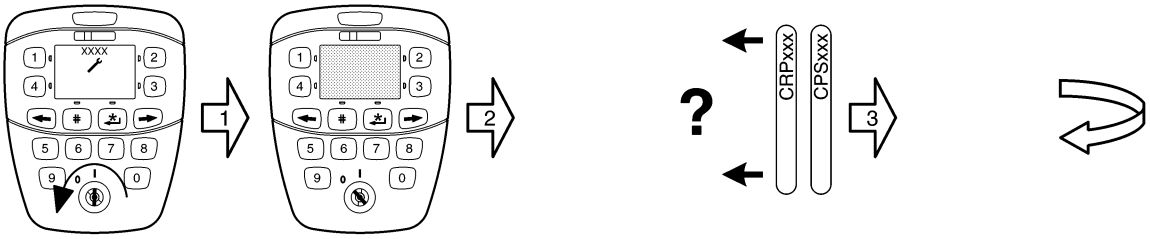
VSM 12 Volts Supply OORL/OORH (Cont)

CAUSE D



1. Shorted Devices that are switched on by a control device will not cause a problem until operated by the control device. E,g.. Motor Controller Fans
2. 3 Wheel Fans are not supplied with 12 volts
3. Only approved 12 volt devices are allowed to be connected to this supply

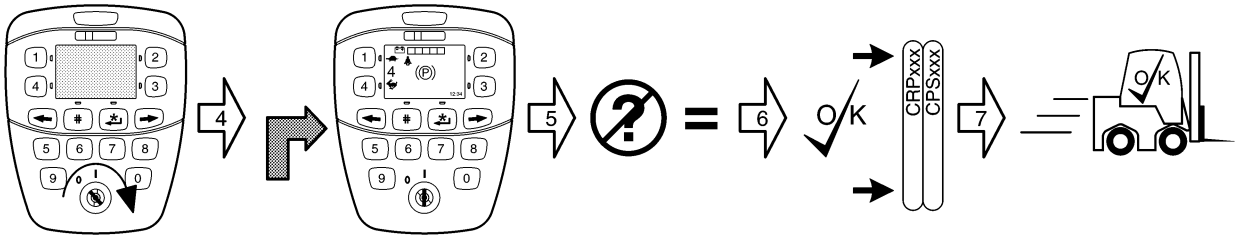
STEP D1



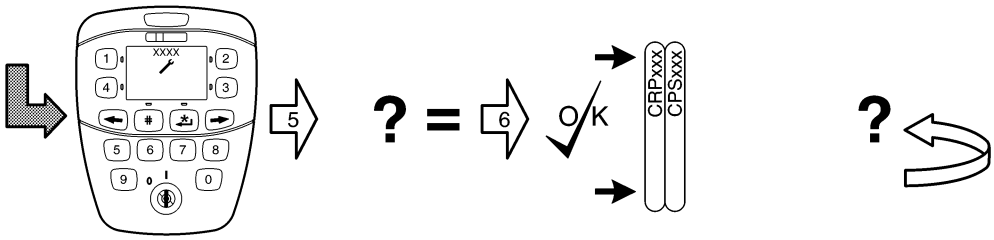
Power **OFF**→ | Disconnect 12 volt Device→**Do Not Discard** | Go to Step 2, CAUSE C

VSM 12 Volts Supply OORL/OORH (Cont)

STEP D2

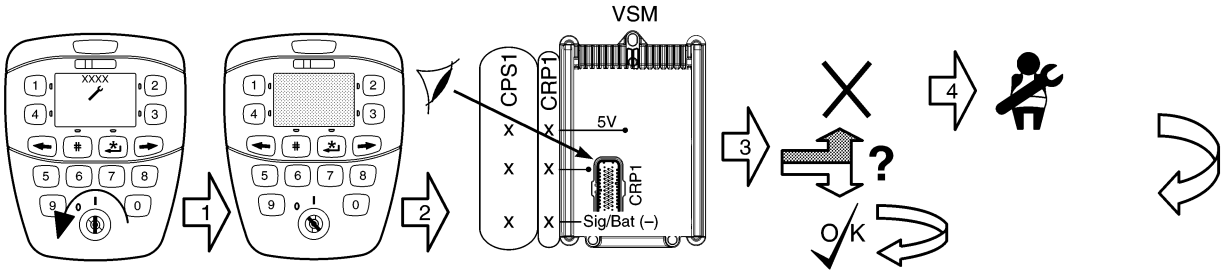


? 12 Volt Fault DTC gone→	Old device faulty→	Old device faulty→Install New Device	Resume operation



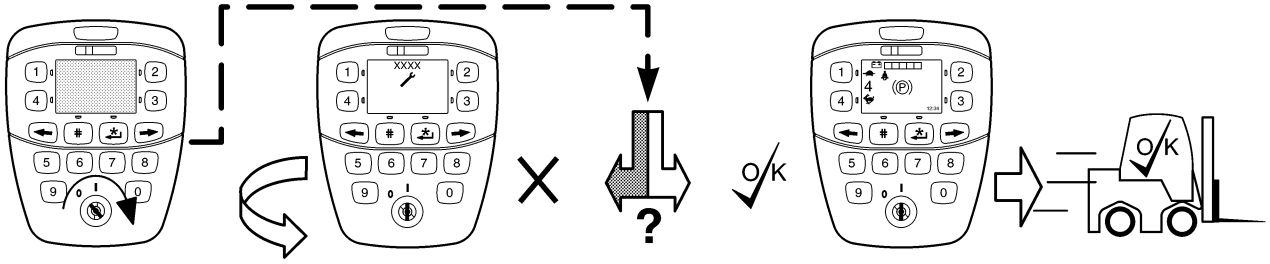
Original Fault DTC present→	Old Device OK/Reinstall Old Device→	Go to Next Device, Repeat CAUSE CAll Devices Tested OK, go to CAUSE D

CAUSE E



Power **OFF**→	Inspect VSM Connections→	Go to Step 1.	Not OK Correct/Repair→Go to Step 1.

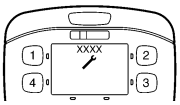
STEP E1



Retest - Power **ON**→	**NO**→Go to VSM Controller Check	Is fault DTC gone? **NO**←**YES**→	Fault corrected→Continue operation.

VSM 12 Volts Supply OORL/OORH (Cont)

END FAULT

Display Internal Failure (Cont)			
	DTC 22032 Display EEPROM Checksum Error	DTC 22033 Display Cell Write Error	DTC 33056 Display Internal CAN Failure	DTC 33057 Display Communications Error with VSM
				
Fault Codes	DTC 8704 Display Internal LCD Backlight	DTC 12934 Display Internal LCD Backlight	DTC 12935 Display Internal LCD Backlight	DTC 8705 Display Internal LCD Heater
	DTC 12936 Display Internal LCD Heater	DTC 12937 Display Internal LCD Heater	DTC 22528 Display Button *	DTC 22529 Display Button #
	DTC 22530 Display \ Arrow	DTC 22531 Display | Arrow	DTC 22532 Display Button 1	DTC 22533 Display Button 2
	DTC 22534 Display Button 3	DTC 22535 Display Button 4	DTC 22536 Display Button 5	DTC 22537 Display Button 6
	DTC 22538 Display Button 7	DTC 22539 Display Button 8	DTC 22540 Display Button 9	DTC 22541 Display Button 0
QUICK CHECK X = Open Circuit/Fail) = Short Circuit				

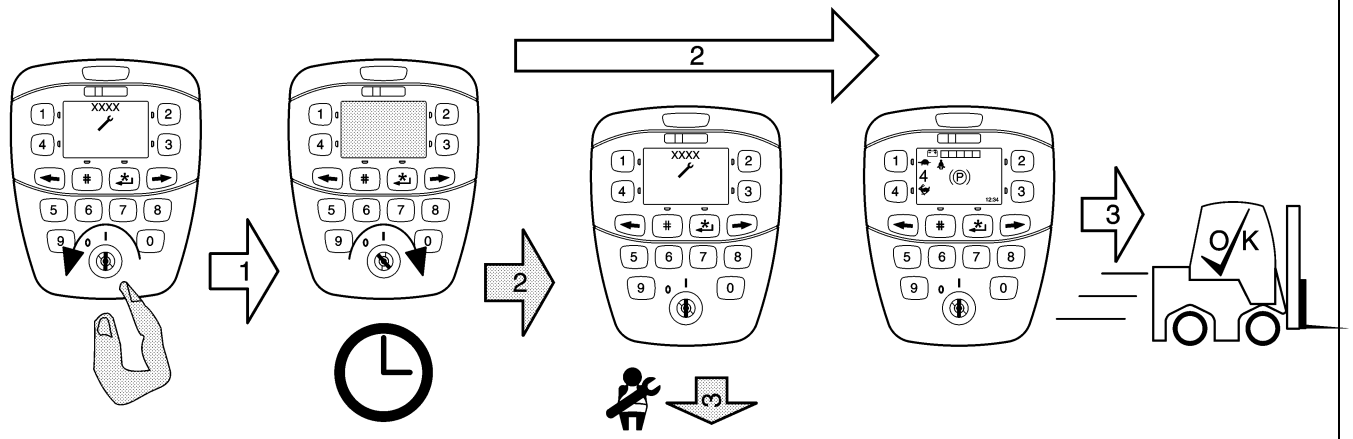
Display Internal Failure (Cont)

Table 9030-20-13. Display Internal Failure Fault DTCs

DTC 22032	Display EEPROM Checksum Error		→CAUSE C↓
DTC 22033	Display Cell Write Error		→CAUSE C↓
DTC 33056	Display Internal CAN Failure		→CAUSE C↓
DTC 33057	Display Communications Error with VSM	→See CAN Communication TSPs	
DTC 8704	Display Internal LCD Backlight	STB (-)/Current OORH	→CAUSE C↓
DTC 12934	Display Internal LCD Backlight	STB (+)	→CAUSE C↓
DTC 12935	Display Internal LCD Backlight	Open Circuit	→CAUSE C↓
DTC 8705	Display Internal LCD Heater	STB (-)/Current OORH	→CAUSE C↓
DTC 12936	Display Internal LCD Heater	STB (+)	→CAUSE C↓
DTC 12937	Display Internal LCD Heater	Open Circuit	→CAUSE C↓
DTC 22528	Display Button *	Button Stuck	→CAUSE C↓
DTC 22529	Display Button #	Button Stuck	→CAUSE C↓
DTC 22530	Display \Arrow	Button Stuck	→CAUSE C↓
DTC 22531	Display] Arrow	Button Stuck	→CAUSE C↓
DTC 22532	Display Button 1	Button Stuck	→CAUSE C↓
DTC 22533	Display Button 2	Button Stuck	→CAUSE C↓
DTC 22534	Display Button 3	Button Stuck	→CAUSE C↓
DTC 22535	Display Button 4	Button Stuck	→CAUSE C↓
DTC 22536	Display Button 5	Button Stuck	→CAUSE C↓
DTC 22537	Display Button 6	DTC 33034 Display	→CAUSE C↓
DTC 22538	Display Button 7	Button Stuck	→CAUSE C↓
DTC 22539	Display Button 8	Button Stuck	→CAUSE C↓
DTC 22540	Display Button 9	Button Stuck	→CAUSE C↓
DTC 22541	Display Button 0	Button Stuck	→CAUSE C↓
Note: No Display Visible→Use PC Service Tool→			CAUSE C↓
Note: No DTC on PC Service Tool→Possible Key Switch Failure→			CAUSE C↓

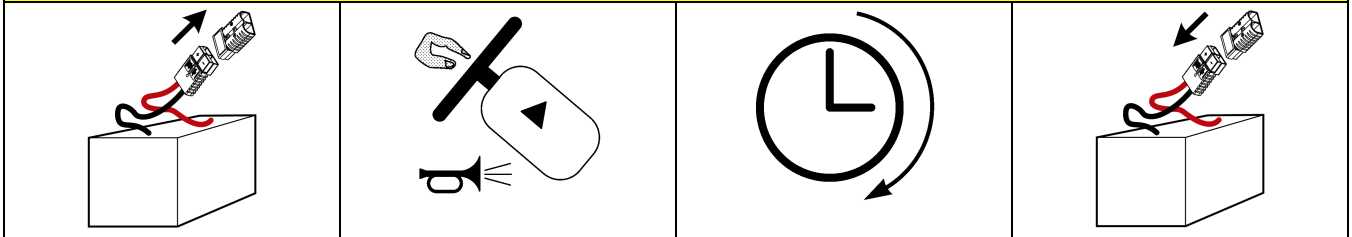
Display Internal Failure (Cont)

Check 1

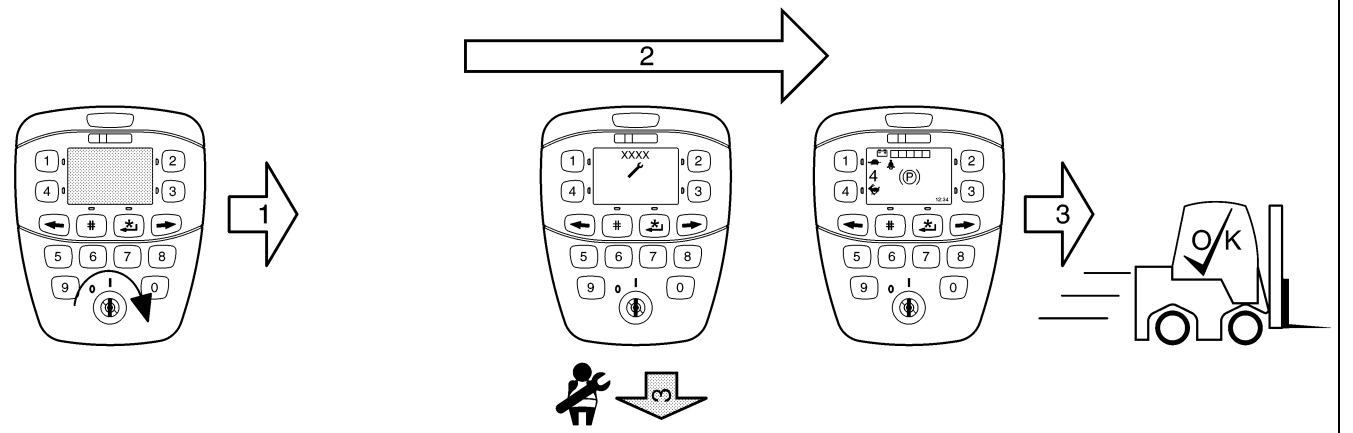


Power **OFF**→	Wait **30 seconds**→	Power **ON**→	Fault remains Service requiredGo to Check 2↓	No fault→Resume operation

Check 2



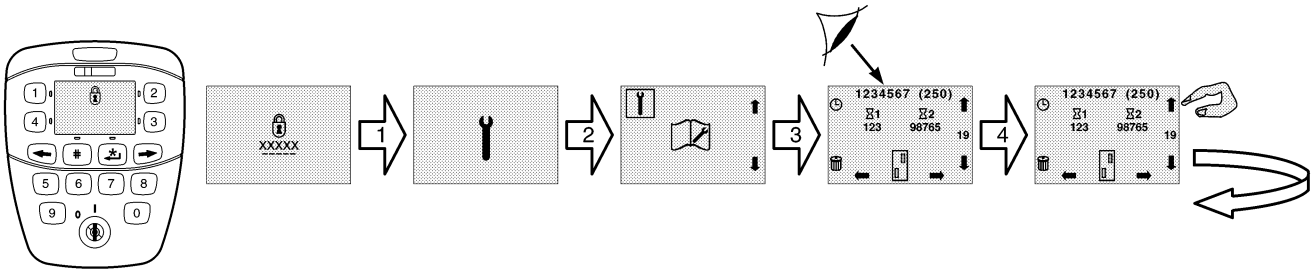
Disconnect Battery	Disconnect Battery and Sound Horn to Discharge Capacitors.Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342.	Wait 30 seconds	Reconnect Battery



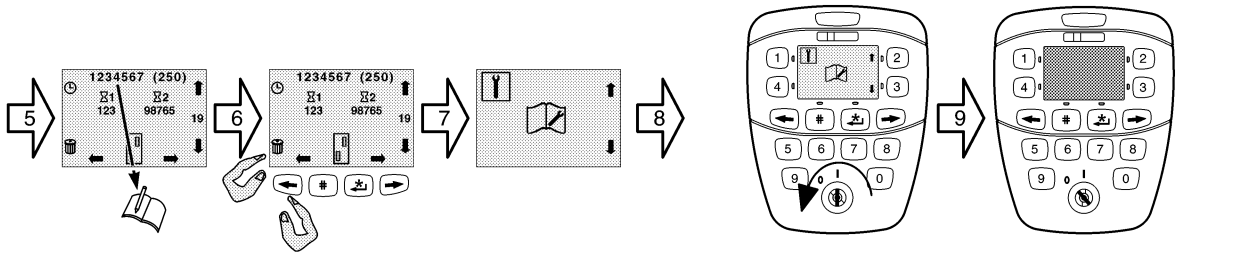
Power **ON**→	Fault Remains Service Required→	No Fault→Resume Operation

Display Internal Failure (Cont)

Check 3



Enter SERVICE Password→	Diagnostics→	FAULT LOGs→	Display FAULT LOGs→	View all Display DTCs→?



all Display DTCs→ Erase all Display DTCs→Exit Fault Log Power **OFF**→CAUSE C

CAUSE A

Not Applicable

CAUSE B

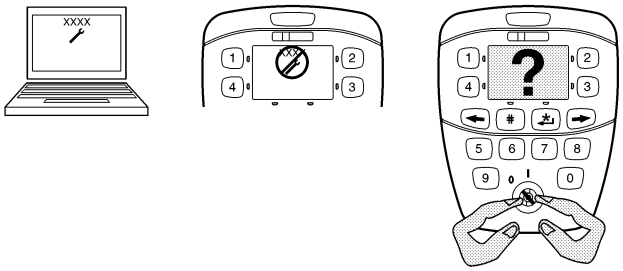
Not Applicable

CAUSE C

Not Applicable

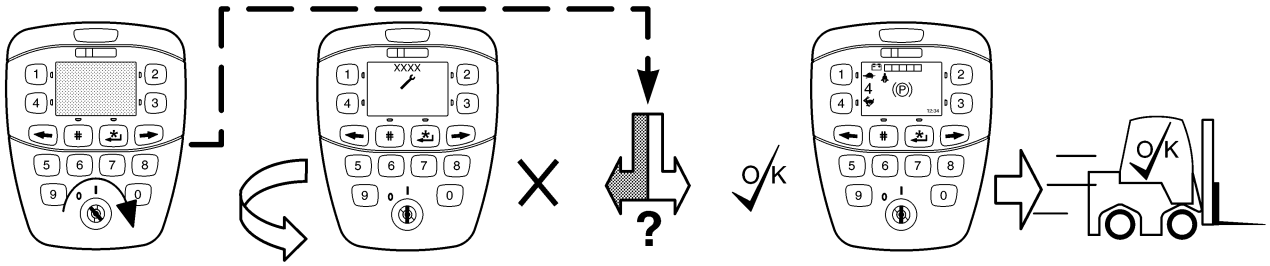
Display Internal Failure (Cont)

CAUSE D



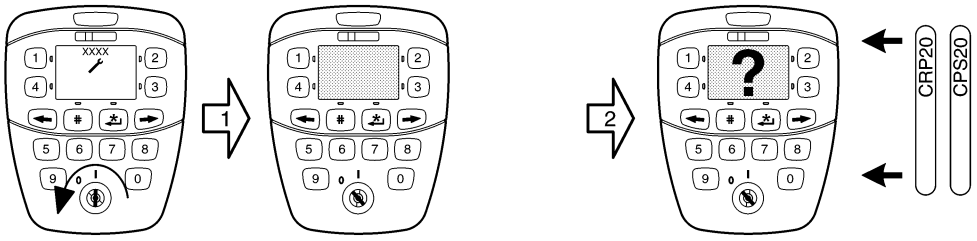
1. No Display/No PC DTCs→Possible Keyswitch Failure↓
2. Keyswitch Mechanical Operation Indicates Binding/No Turn↓
3. YES→Replace Keyswitch Barrel↓NO→Step 1↓
4. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369↓

STEP D1



Retest - Power **ON**→	**NO**→Step 2	Does Display Turn On?Is DTC gone?**NO** **YES**←→	Fault corrected→Continue operation.

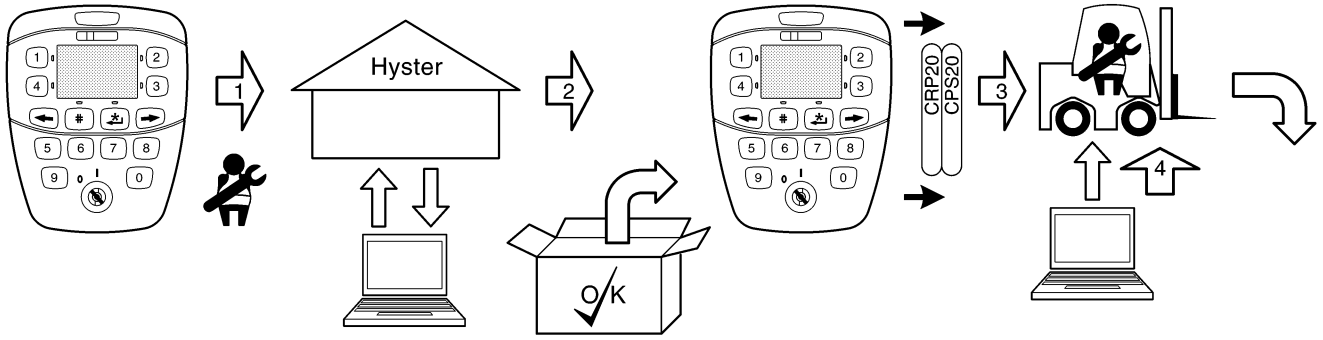
STEP D2



Power **OFF**→	Disconnect Display→Do not Discard→	Step 3↓

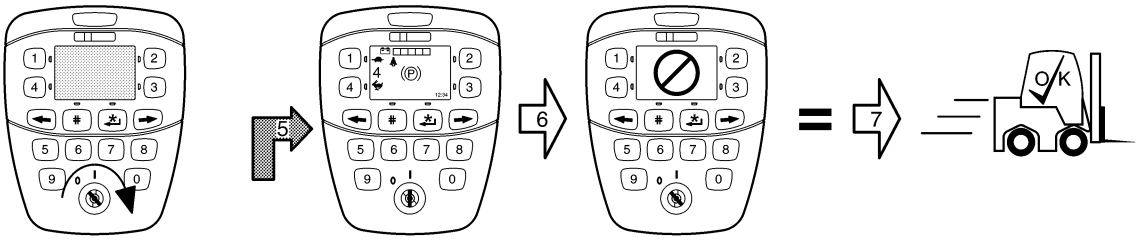
Display Internal Failure (Cont)

STEP D3

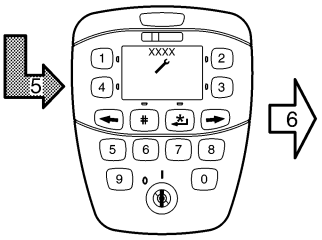


1. Download the latest **Display Application** Version→Install NEW Display→Install NEW Application →Go to 2↓

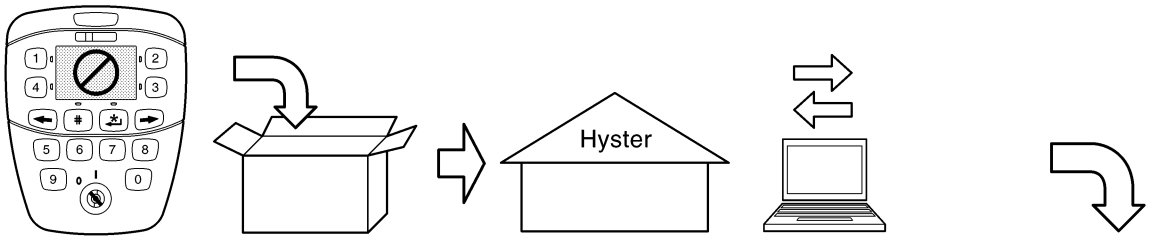
2. See **Hypass Online**, Software Resources for your truck, (Installing Display Application Software)↓



Power **ON**→**?**	DTC Gone→	Original Display Faulty→	Resume Operation



New DTC Present→	DTC TSP↓

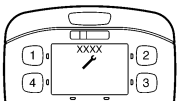


Return Faulty Display→Dealer→Factory→Failure Analysis→?? Reprogramming

END FAULT

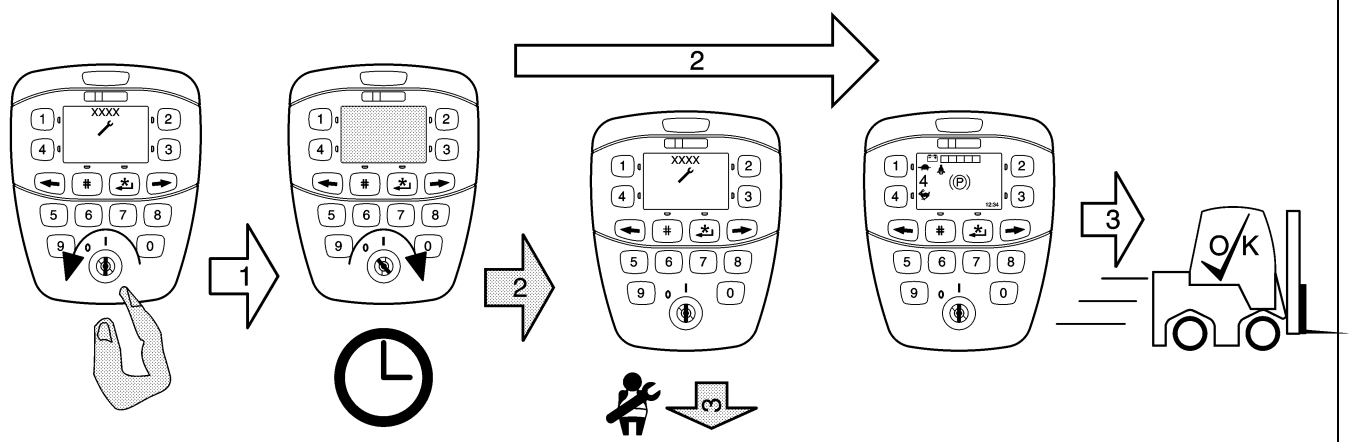
Display Failure – Keyswitch Relay Output (Cont)

DTC 9041 Display Keyswitch Output	DTC 12940 Display Keyswitch Output	DTC 12941 Display Keyswitch Output	DTC 13070 Keyswitch Data Incorrect

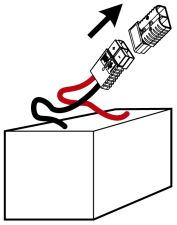
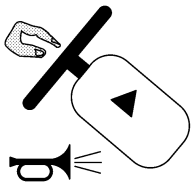
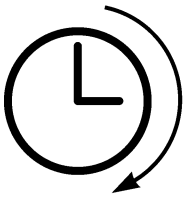
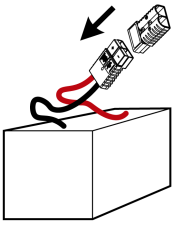
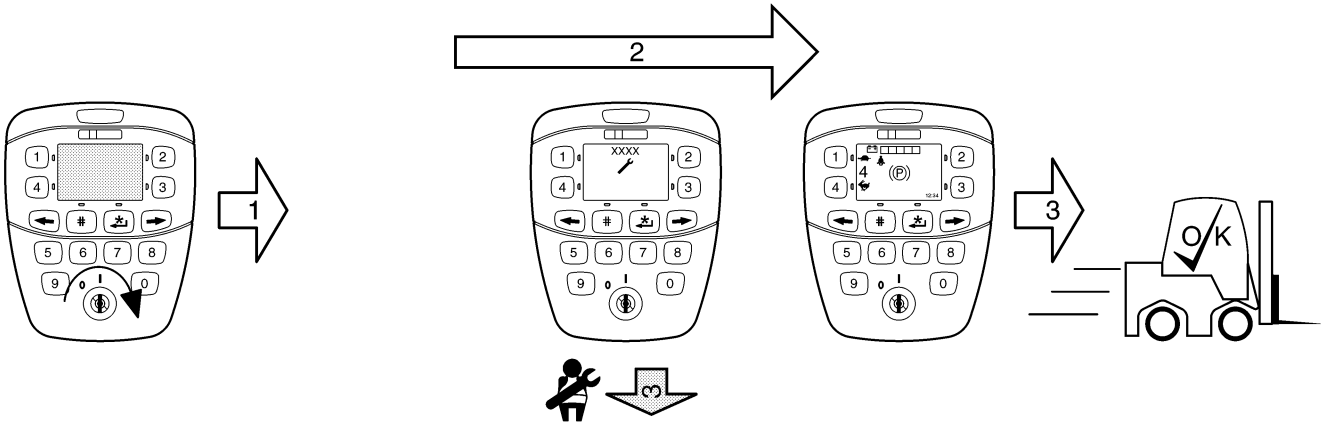


QUICK CHECK X = Open Circuit/Fail) = Short Circuit			
DTC 9041	Display Keyswitch Output	STB (-)/Current OORH	→CAUSE B↓
DTC 12940	Display Keyswitch Output	STB (+)	→CAUSE B↓
DTC 12941	Display Keyswitch Output	Open Circuit	→CAUSE B↓
DTC 13070	Display Keyswitch Data Incorrect	STB (+)	→CAUSE B↓
Note: No Display Visible→Use PC Service Tool→			CAUSE C↓
Note: No DTC on PC Service Tool→Possible Key Switch Failure→			CAUSE C↓

Check 1

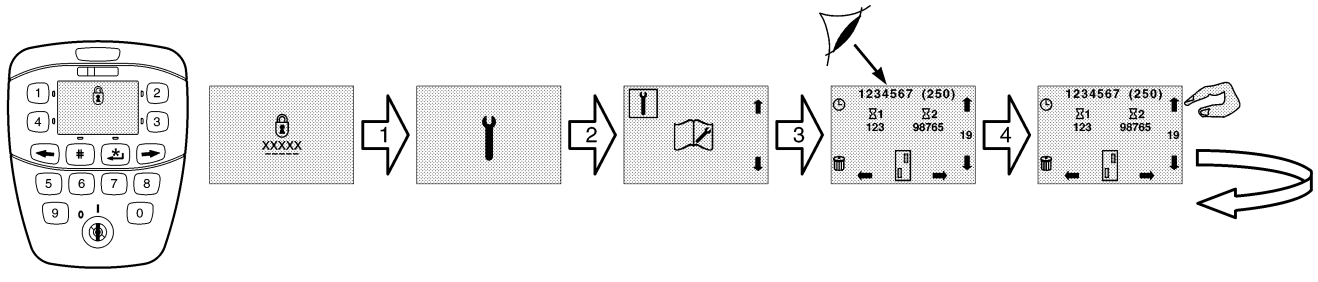


Power **OFF**→	Wait **30 seconds**→	Power **ON**→	Fault remains Service requiredGo to Check 2↓	No fault→Resume operation

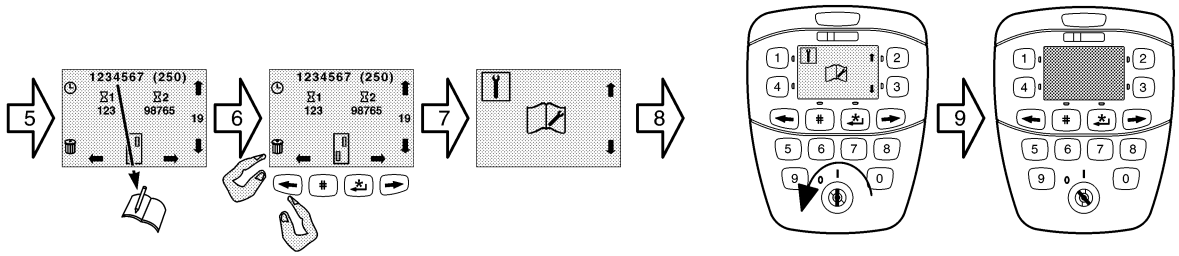
Display Failure – Keyswitch Relay Output (Cont)			
Check 2			
			
Disconnect Battery	Disconnect Battery and Sound Horn to Discharge Capacitors.Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342.	Wait 30 seconds	Reconnect Battery
			
Power **ON**→	Fault Remains Service Required→		No Fault→Resume Operation

Display Failure – Keyswitch Relay Output (Cont)

Check 3



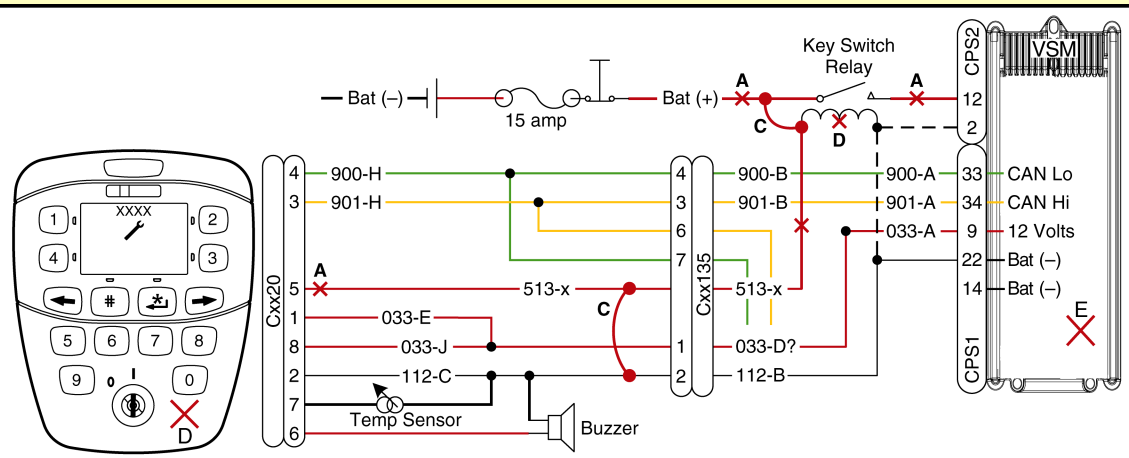
Enter SERVICE Password→	Diagnostics→	FAULT LOGs→	Display FAULT LOGs→	View all Display DTCs→?

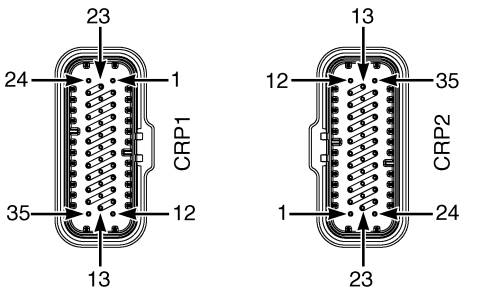


📋✍ all Display DTCs→	Erase all Display DTCs→Exit Fault Log	Power **OFF**→CAUSE C

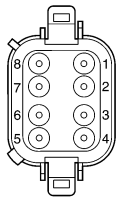
Display Failure – Keyswitch Relay Output (Cont)

CONNECTORS

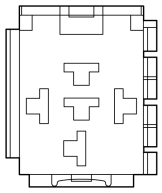




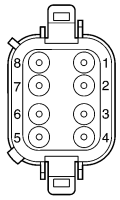
VSM Cxx 1 and Cxx 2



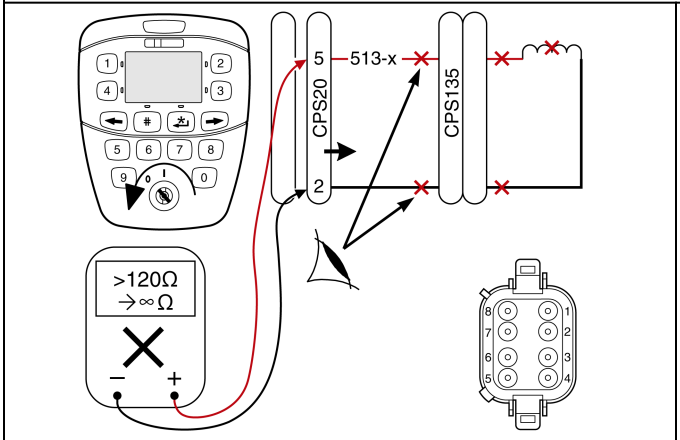
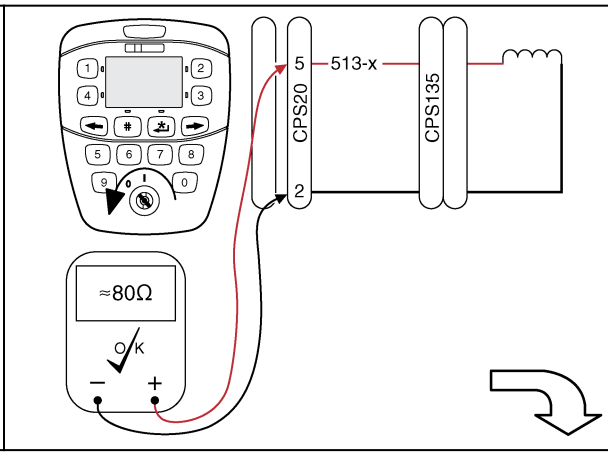
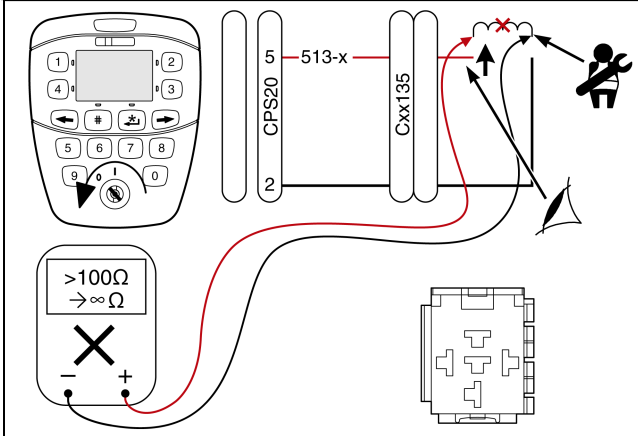
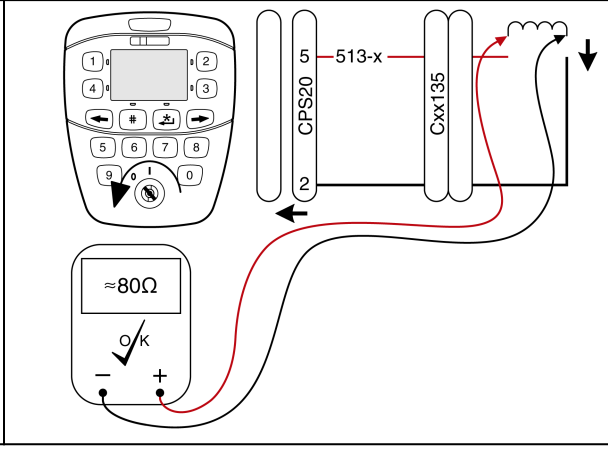
Display Cxx 20



Key Switch Relay Connector Cxx 208

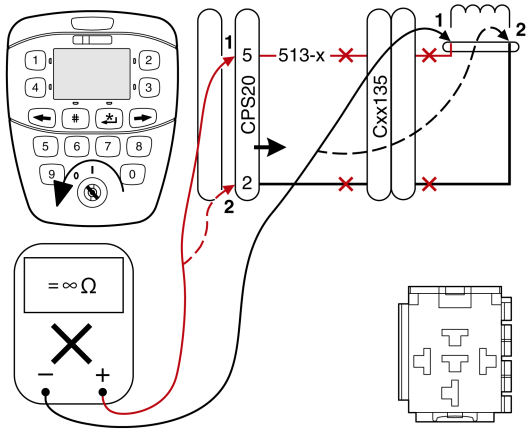


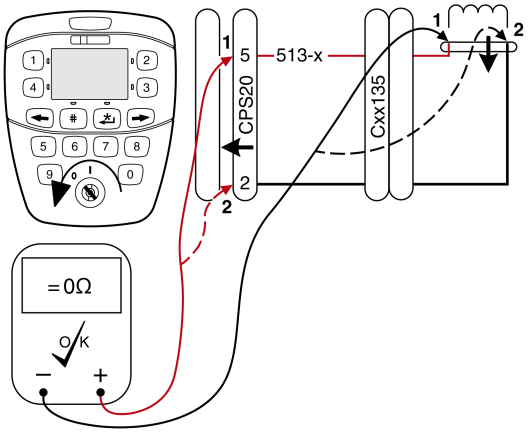
Display Cxx 135

Display Failure – Keyswitch Relay Output (Cont)	
CAUSE A	
DTC 12941 Key Switch Relay OC	
	
Remove Display and Disconnect Display Connector→Measure ?→Go to 1↓	
1. > 100? to 8? = High Resistance/Open Circuit→Go to Step 2↓	1. ˜80? = OK→Step 5↓
2. < ˜60? to 0? = Short Circuit→CAUSE B↓	2. ˜80? = OK→Step 5↓
STEP A1	
	
Remove 12 Volt Relay→Measure ?→Go to 1↓	
1. > 100? to 8? = High Resistance/Open Circuit→Go to 3↓	1. ˜80? = OK→Step 3↓
2. < ˜60? to 0? = Short Circuit→Go to 3↓	2. ˜80? = OK→Step 3↓
3. Relay Coil OPEN/SHORT Circuit→Replace Relay→ReCheck ?↑Step 1→Reconnect Display→Step 4↓	

Display Failure – Keyswitch Relay Output (Cont)

STEP A2



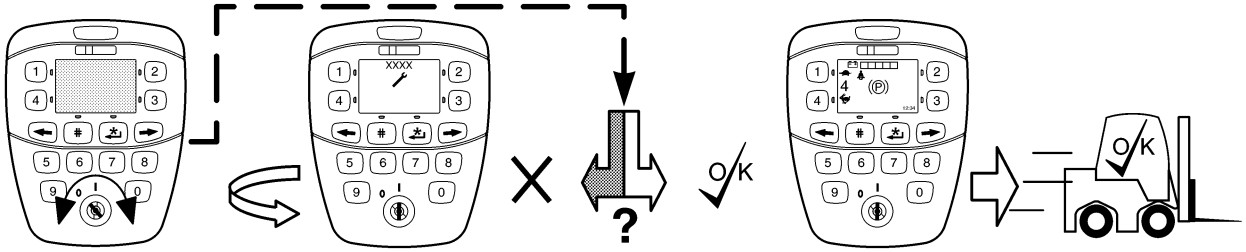


Measure ?→Go to 1↓

1. 8? = High Resistance/Open Circuit→Go to 2↓	1. ˜0? = OK→Step 4↓

2. Find/Repair OPEN Circuit See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→Re-Check ?↑Step 1→Reconnect→Step 4↓

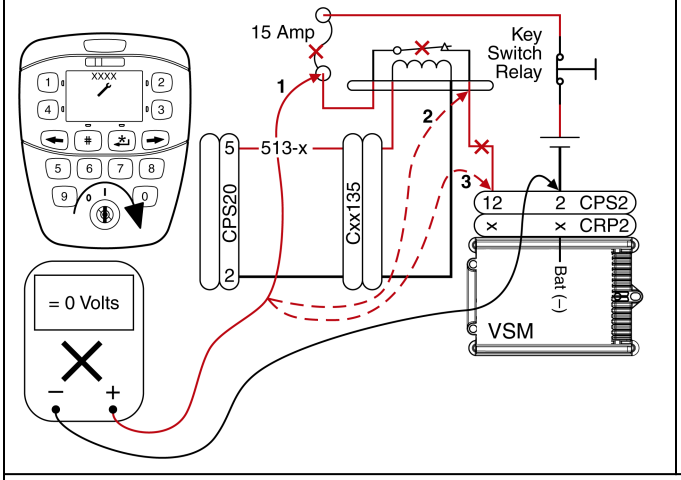
STEP A3

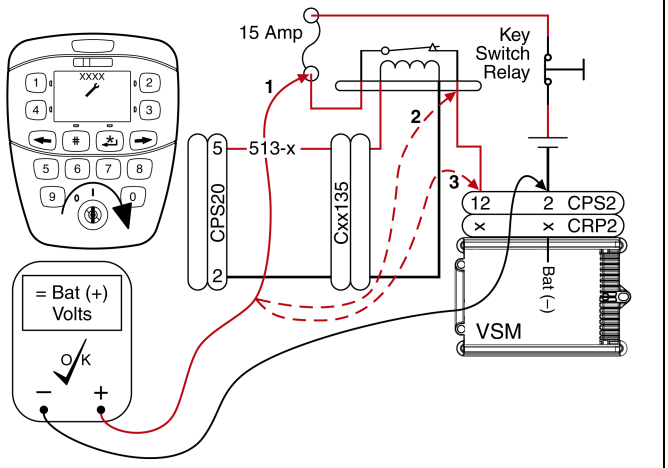


Retest - Power **OFF** Power **ON**	**NO**→Step 4	Is fault DTC gone?**NO** **YES**	Fault corrected→Continue operation

Display Failure – Keyswitch Relay Output (Cont)

STEP A4



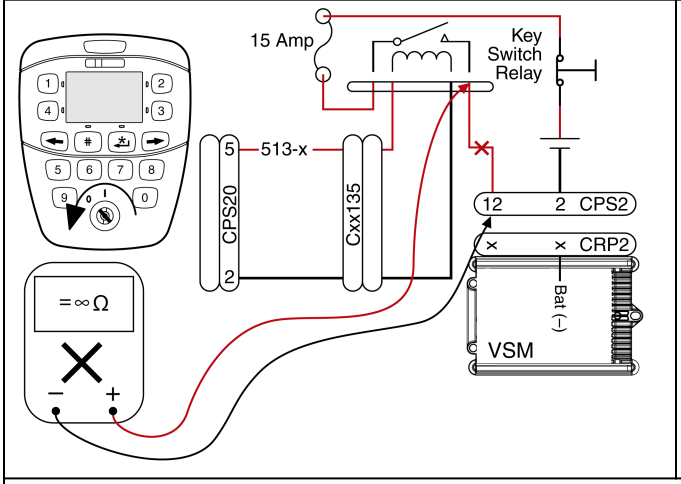


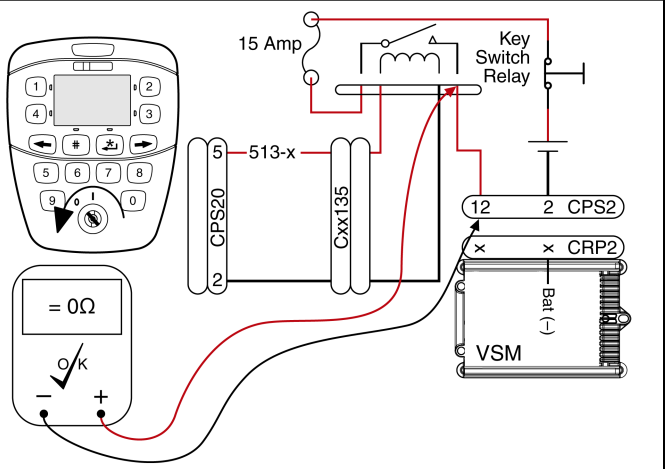
CAUTION

Do not backprobe VSM connector if Breakout Connectors are available. See Step 6 for Alternative to 3.

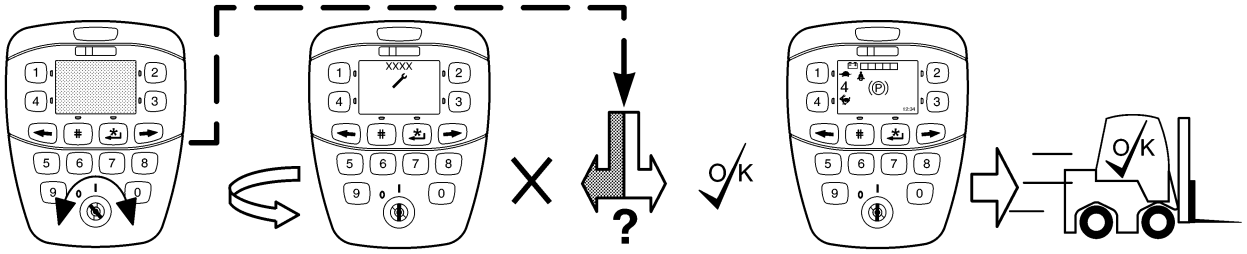
1. Turn Key Switch **ON**→Measure Volts at 1, 2, and 3→Go to 2↓	
2. 0 Volts→Open Circuit Fuse/Wiring/Relay Contacts→Go to 3↓	2. ˜ Bat (+) Volts = OK→Step 6↓
3. Find/Repair OPEN Circuit See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→Re-Check Volts↑Step 5→Reconnect→Step 6↓	

STEP A5



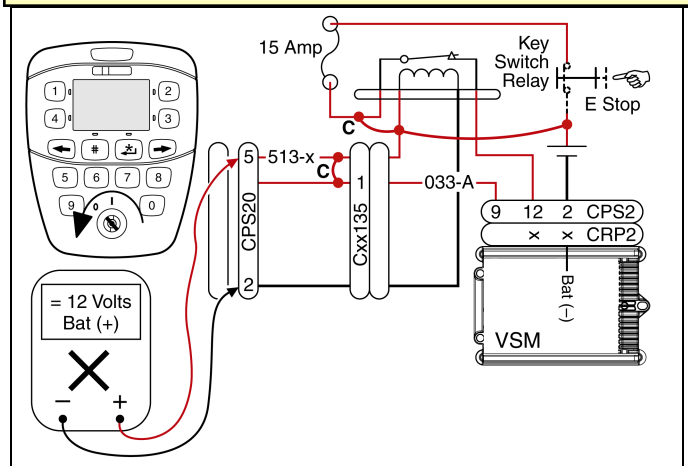


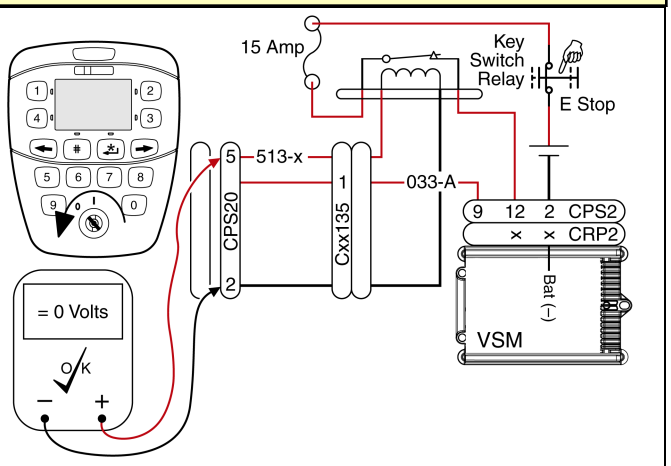
Turn Key Switch **OFF**→Disconnect Relay and VSM CPS 2→Measure ?→Go to 1↓	
1. = 8?→Open Circuit Wiring→Go to 2↓	1. ˜ 0? = OK→Step 6↓
2. Find/Repair OPEN Circuit See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→Re-Check ?↑Step 1→Reconnect→Step 6↓	

Display Failure – Keyswitch Relay Output (Cont)			
STEP A6			
			
Retest - Power **OFF** Power **ON**	**NO**→CAUSE B	Is fault DTC gone?**NO** **YES**→	Fault corrected→Continue operation
CAUSE B			
Not Applicable			

Display Failure – Keyswitch Relay Output (Cont)

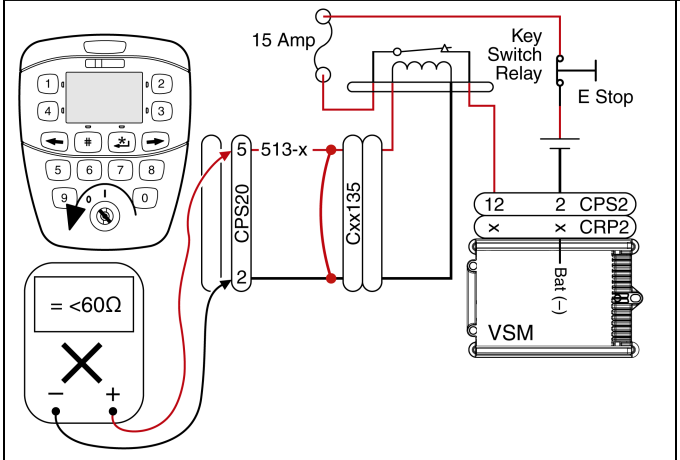
CAUSE C

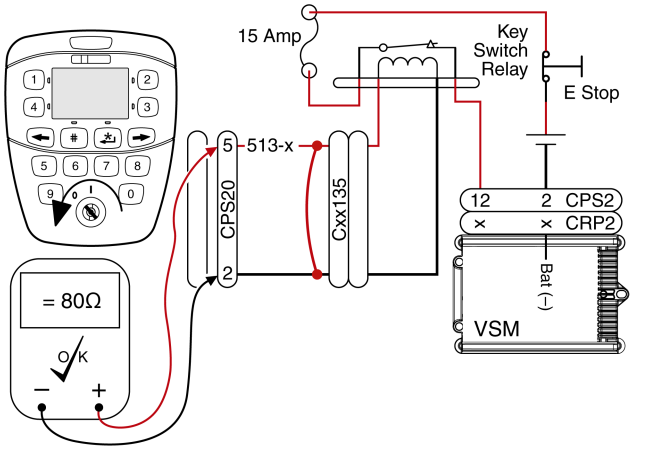




1. Turn Key Switch **OFF**→Push Emergency Stop→Remove Display and Disconnect→Measure Volts→Go to 2↓	
2. ˜ Bat (+) Volts = Short to Unswitched Bat (+) →Go to 6↓	2. 0 Volts = OK→Go to 3↓
3. Release Emergency Stop→Go to 4↓	
4. ˜ 12 Volts = Short to VSM 12 Volt Supply→Go to 6↓	4. 0 Volts = OK→Step 1↓
5. ˜ Bat (+) Volts = Short to Switched Bat (+) →Go to 6↓	
6. Find/Repair Short Circuit See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→Re-Check Volts↑→Reconnect→↓	

STEP C1

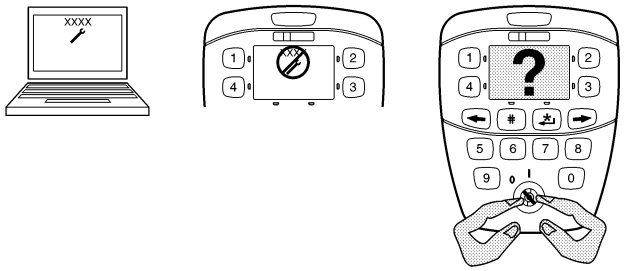




1. Turn Key Switch **OFF**→Measure ?→Go to 2↓	
2. < ˜60? = Short Circuit →Go to 3↓	2. ˜ 80? = OK→CAUSE C↓
3. Find/Repair Short Circuit See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→Re-Check ?↑→Reconnect→CAUSE C↓	

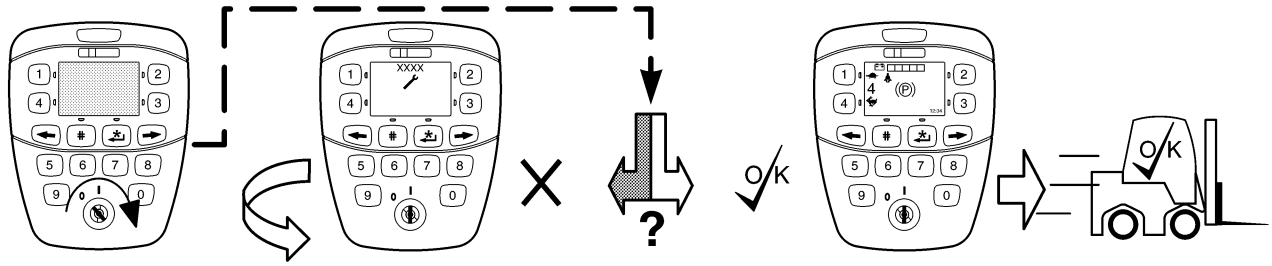
Display Failure – Keyswitch Relay Output (Cont)

CAUSE D



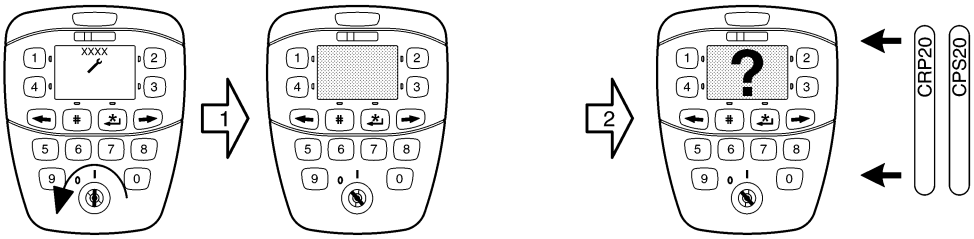
1. No Display/No PC DTCs→Possible Keyswitch Failure↓
2. Keyswitch Mechanical Operation Indicates Binding/No Turn↓
3. YES→Replace Keyswitch Barrel↓NO→Step 1↓
4. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369↓

STEP D1



Retest - Power **ON**→	**NO**→Step 2	Does Display Turn On?Is DTC gone?**NO** **YES**←→	Fault corrected→Continue operation.

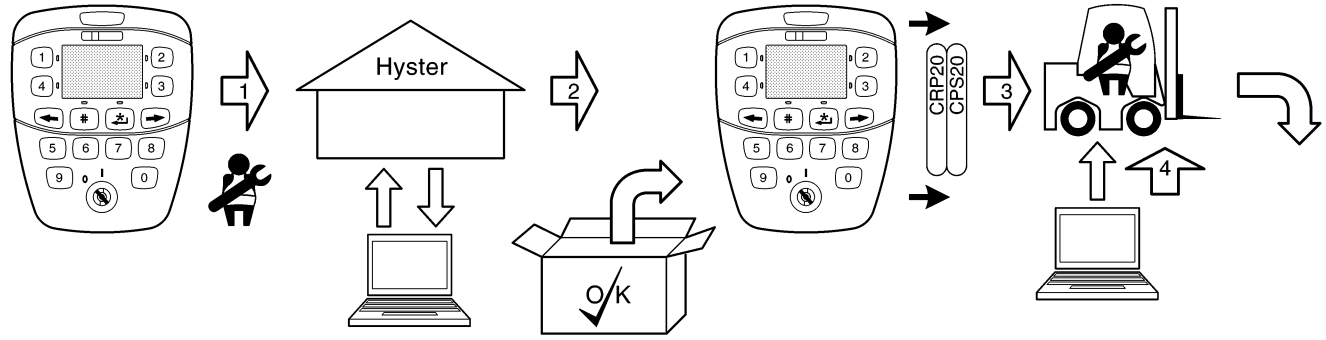
STEP D2



Power **OFF**→	Disconnect Display→Do not Discard→	Step 3↓

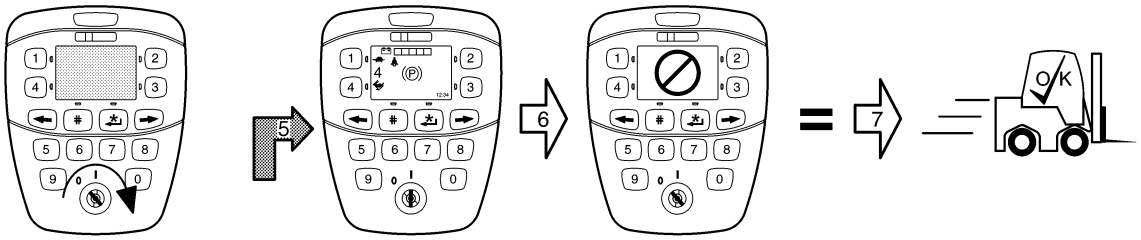
Display Failure – Keyswitch Relay Output (Cont)

STEP D3

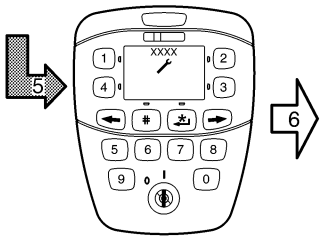


1. Download the latest **Display Application** Version→Install NEW Display→Install NEW Application →Go to 2↓

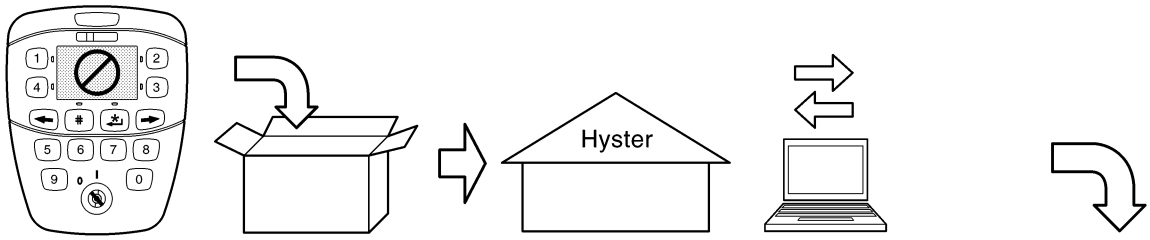
2. See **Hypass Online**, Software Resources for your truck, (Installing Display Application Software)↓



Power **ON**→**?**	DTC Gone→	Original Display Faulty→	Resume Operation



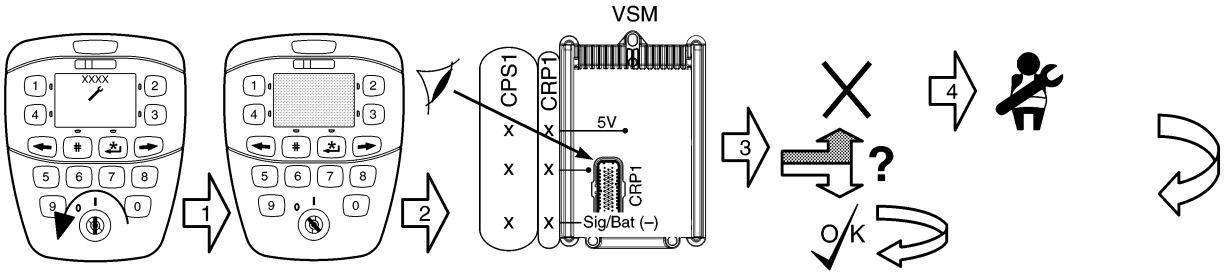
New DTC Present→	DTC TSP↓



Return Faulty Display→Dealer→Factory→Failure Analysis→?? Reprogramming

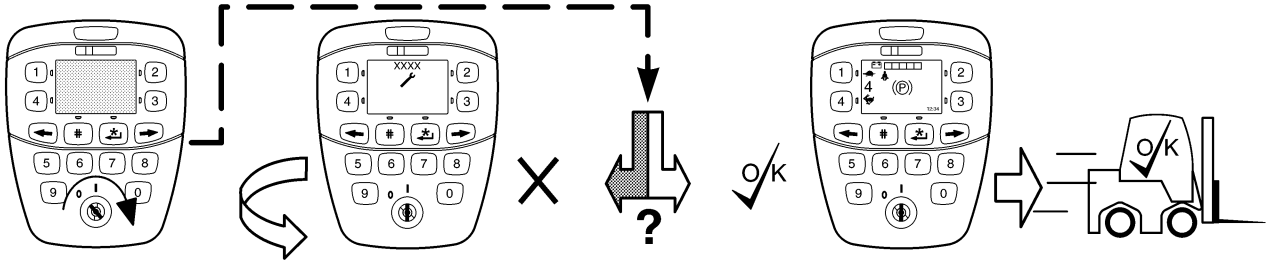
Display Failure – Keyswitch Relay Output (Cont)

CAUSE E



Power **OFF**→	Inspect VSM Connections→	Go to Step 1.	Not OK Correct/Repair→Go to Step 1.

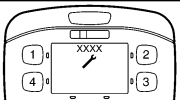
STEP E1



Retest - Power **ON**→	**NO**→Go to VSM Controller Check	Is DTC gone?**NO** **YES**←→	Fault corrected→Continue operation.

END FAULT

VSM Controller Check (Cont)



DTC 21760
VSM BOOT_BLOCK Checksum failure

DTC 21761
CDF_Checksum_failure

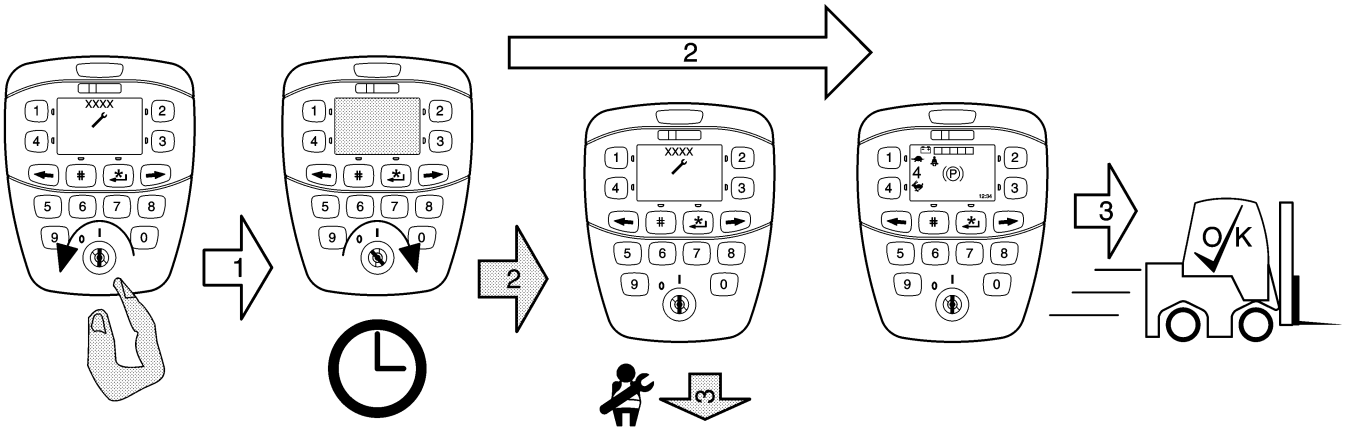
DTC 21762
VSM APPLICATION_SOFTWARE Checksum failure/Error

DTC 21764
VSM EEPROM Checksum failure/Error

Fault Codes

DTC 21766
VSM EEPROM Cell failure Write Error

DTC 21792
VSM Serial Number Error



Power **OFF**→

Wait **30 seconds**→

Power **ON**→

Fault remains. Service required. Go to Quick Check.

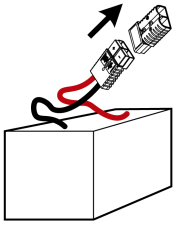
No fault→

Resume operation

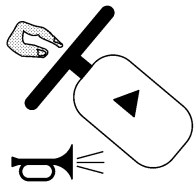
QUICK CHECK X = Open Circuit/Fail) = Short Circuit

VSM Controller Check (Cont)

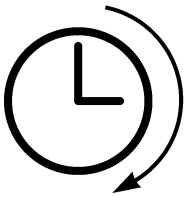
Check 1



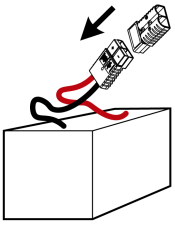
Disconnect Battery



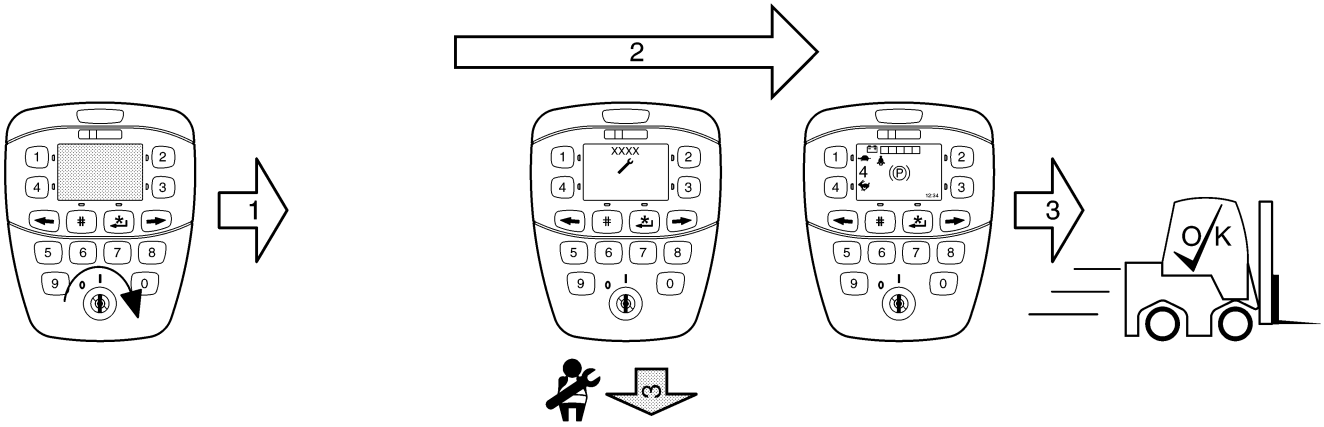
Disconnect Battery and Sound Horn to Discharge Capacitors.Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342.



Wait 30 seconds

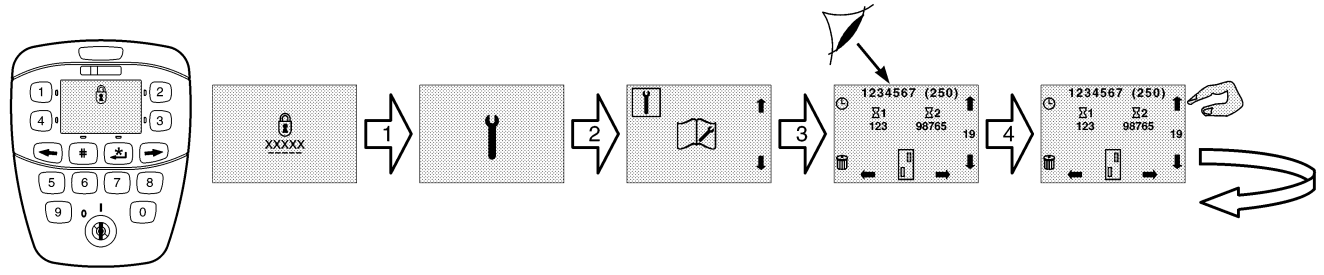


Reconnect Battery

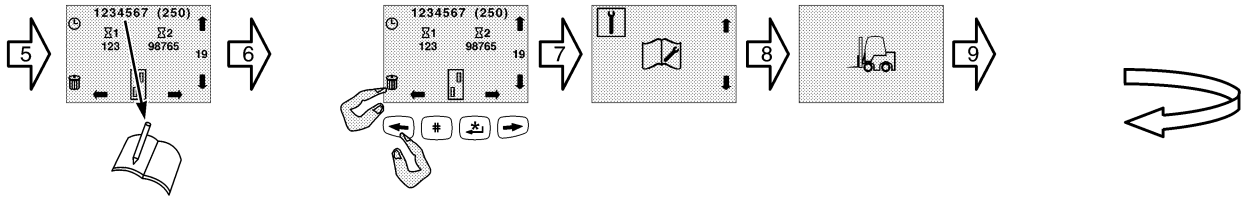


Power **ON**→	Fault remains, Service required→Go to Check 2↓	No fault→Resume operation

Check 2



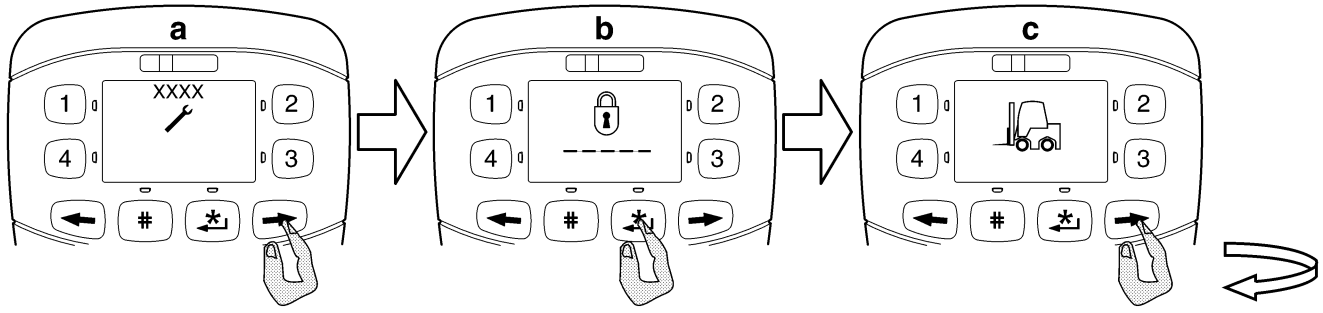
Enter Service Password→Diagnostic→FAULT LOGs→	VSM Fault LogsView all VSM DTCs→Go to next step↓



📝 all VSM DTCs	Erase all VSM DTCs→☜Exit Fault Log→	Truck Status

VSM Controller Check (Cont)		
VSM Versions→	Hardware/Software Versions→Exit Versions	Power **OFF**→Go to Next Step↓

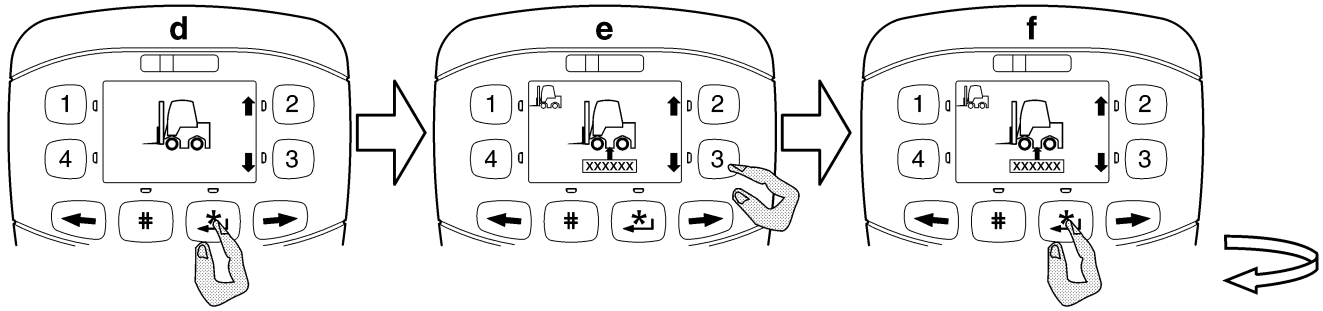
VSM Controller Check (Cont)
DTCs 21792→Step 1 VSM has been installed from another truck
DTCs 21792→Step 1 Display has been installed from another truck
DTCs 21761→Step 3, Step 1→Reprogram CDF
DTCs 21762→Step 4, Step 1→Reprogram Application Software
DTCs 21760, 21764, 21766→Step 4, Step 1→Factory Issued VSM Required
STEP A1



Scroll to Password symbol→

Enter 5 Digit Password →Press *→

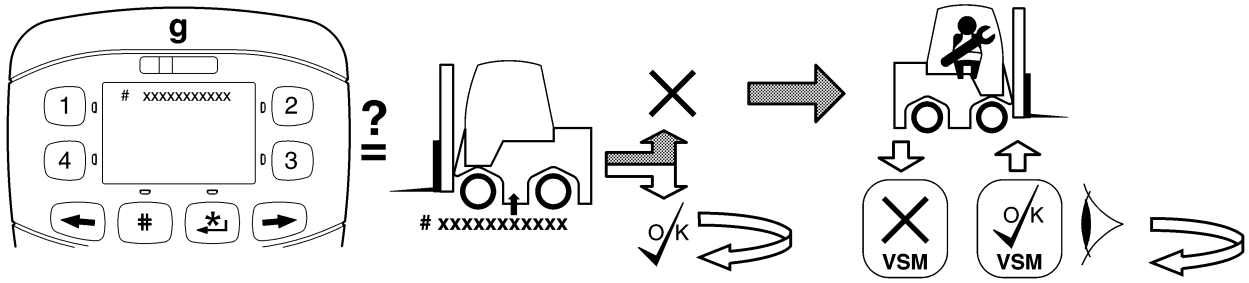
Scroll to Truck Symbol.Press *→



Press *→

Scroll to Truck Serial #→

Press *→

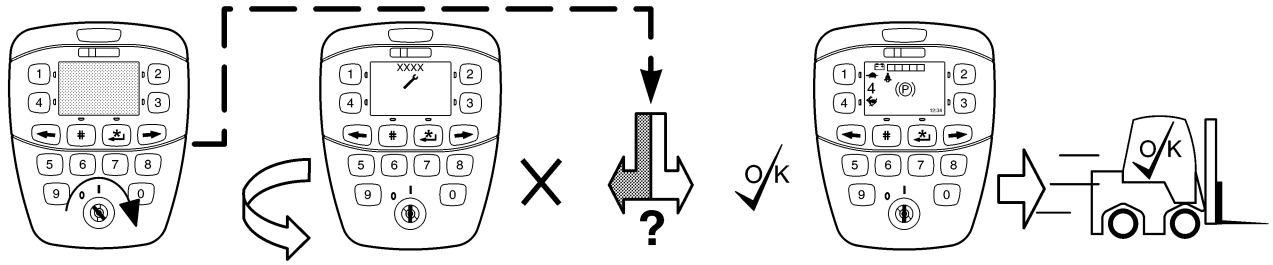


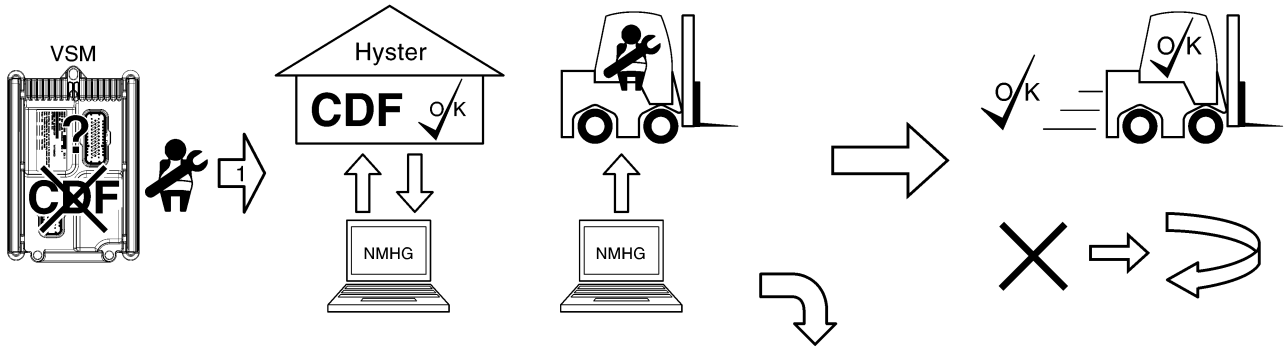
? Displayed Serial Number = the Truck Serial Number?→

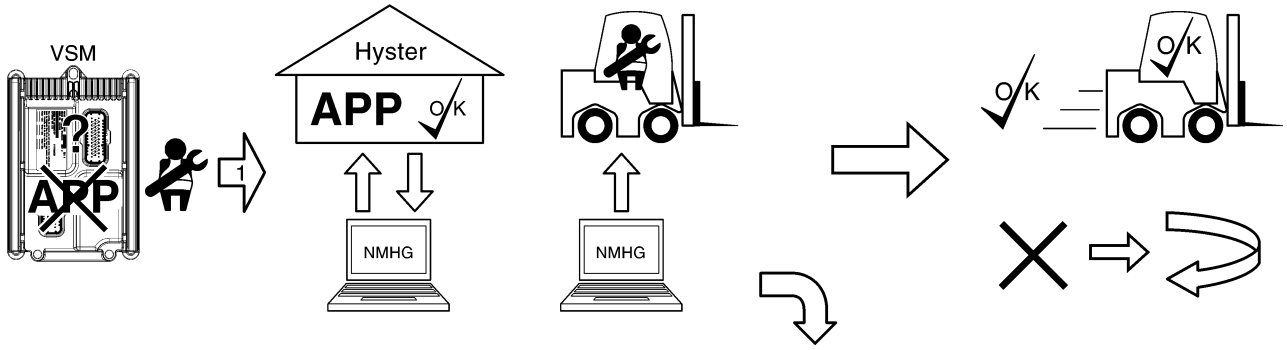
YES→Step 2↓

NO→Find/Replace with Correct VSM. See **Electrical System** 2200SRM1337/ **Electrical System** 2200SRM1369. Repair Complete.→Step 2↓

? Displayed Serial Number for VSM and Display are BLANK?→

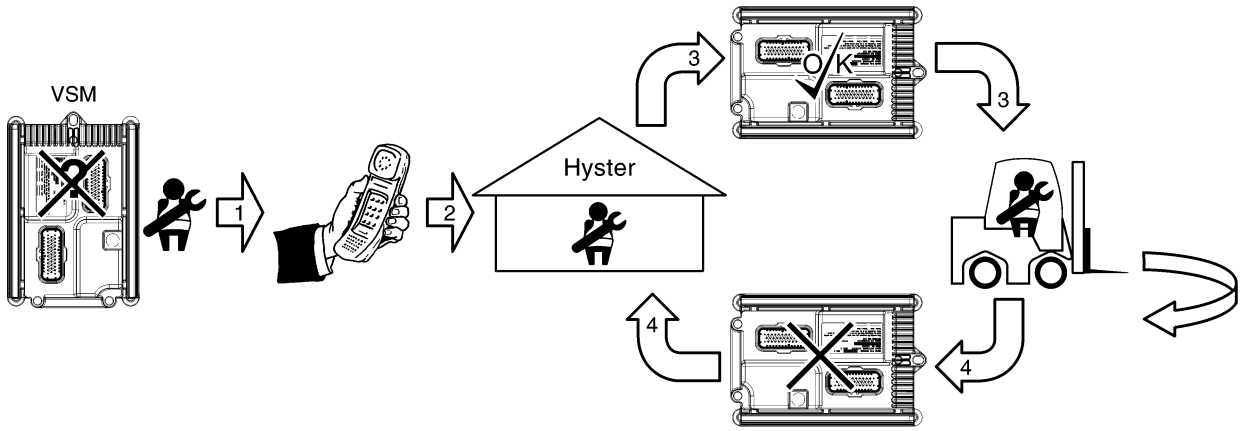
VSM Controller Check (Cont)			
STEP A2			
			
Retest - Power **ON**→	**NO**→Go to Step 3.	Is fault DTC gone?**NO** **YES**←→	Fault corrected→Continue operation.

STEP A3

1. DTC 21761↓
2. Go to Hypass Online→Software→Download new CDF→Install on Truck→Go to 3↓
3. Test→Step 6↓→OK→Resume Operation – Not OK Step 5↓

STEP A4

1. DTC 21761↓
2. Go to Hypass Online→Software→Download the latest Application Software→Install on Truck→Go to 3↓
3. Test→Step 6↓→OK→Resume Operation – Not OK Step 5↓

VSM Controller Check (Cont)

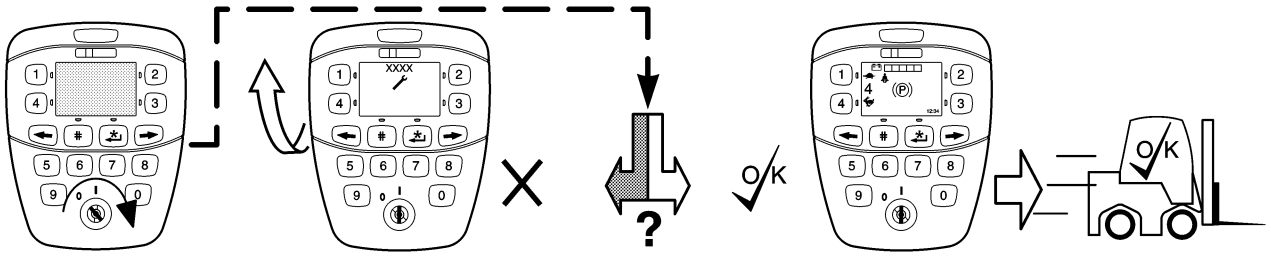
STEP A5



DTCs 21760, 21762, 21764, and 21766→

1. Replacement Approval –**Contact Hyster Resident Service.**
2. Remove and replace faulty VSM with new VSM. See **Electrical System** 2200SRM1337 or **Electrical System** 2200SRM1369.
3. Return faulty VSM to dealer.
4. Retest new installed VSM. Go to Step 6.

STEP A6



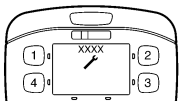
Retest - Power **ON**→	**NO**→Go to Step 3.	Is DTC gone?**NO**←**YES**→	Fault corrected→Continue operation.

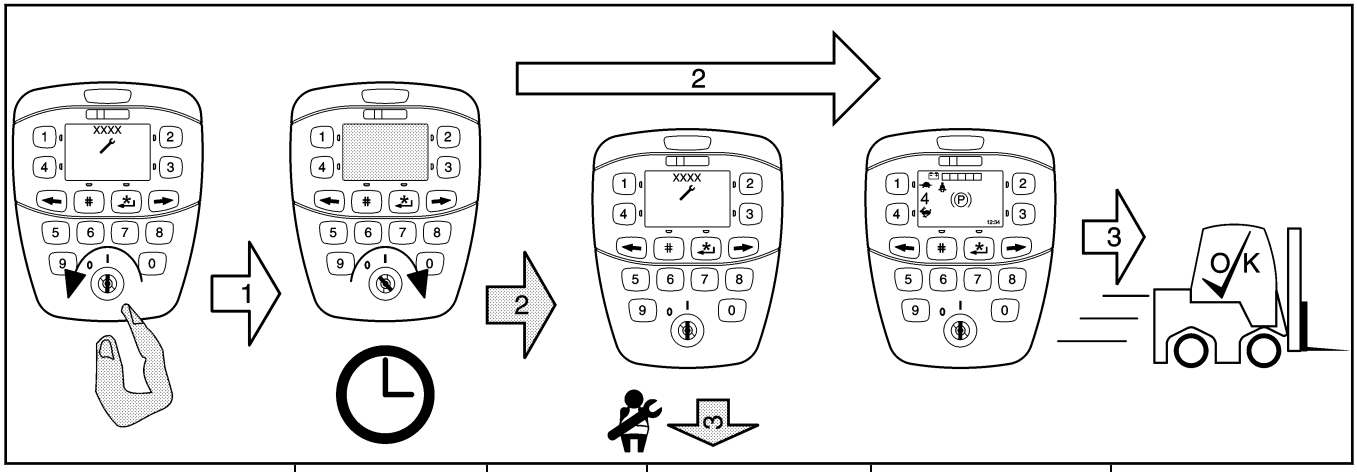
DTC LOGS: DTC logs should only be cleared once the data is 📝 by the Service Tech. See Display Menu Flowchart **– Clearing DTCs.**

END FAULT

Controller Logic Failure

DTC 65299
Controller Logic Failure



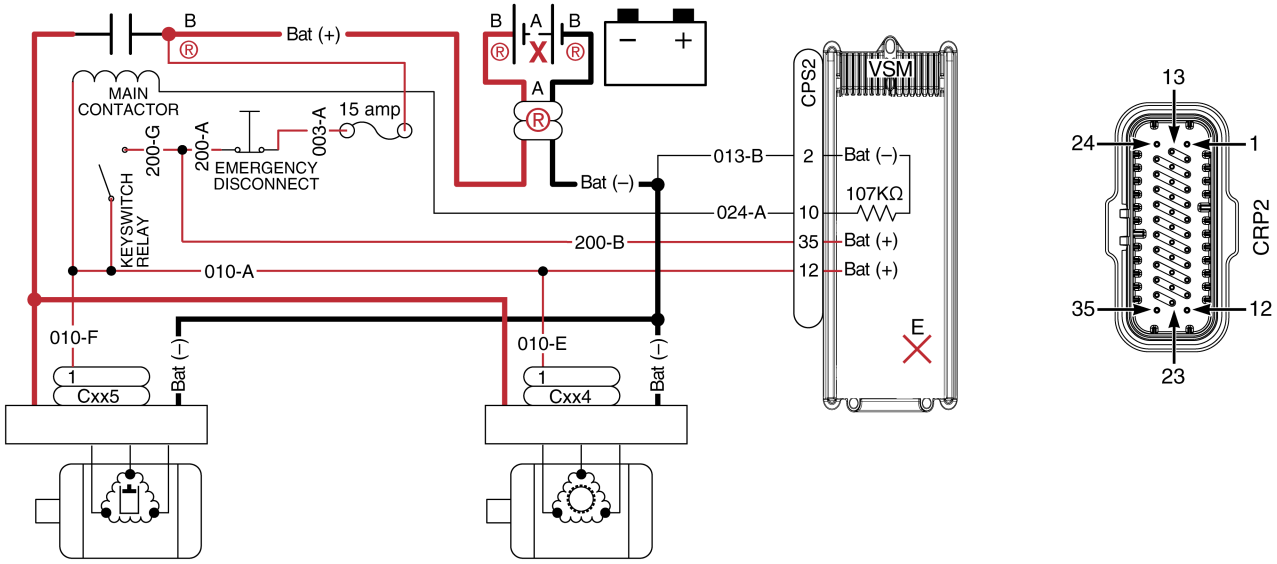


Power **OFF**→	Wait **30 seconds**→	Power **ON**→	Fault remains. Service required. Go to Component Operational Check.	No fault→	Resume operation

POSSIBLE CAUSE X = Open Circuit/Fail) = Short Circuit

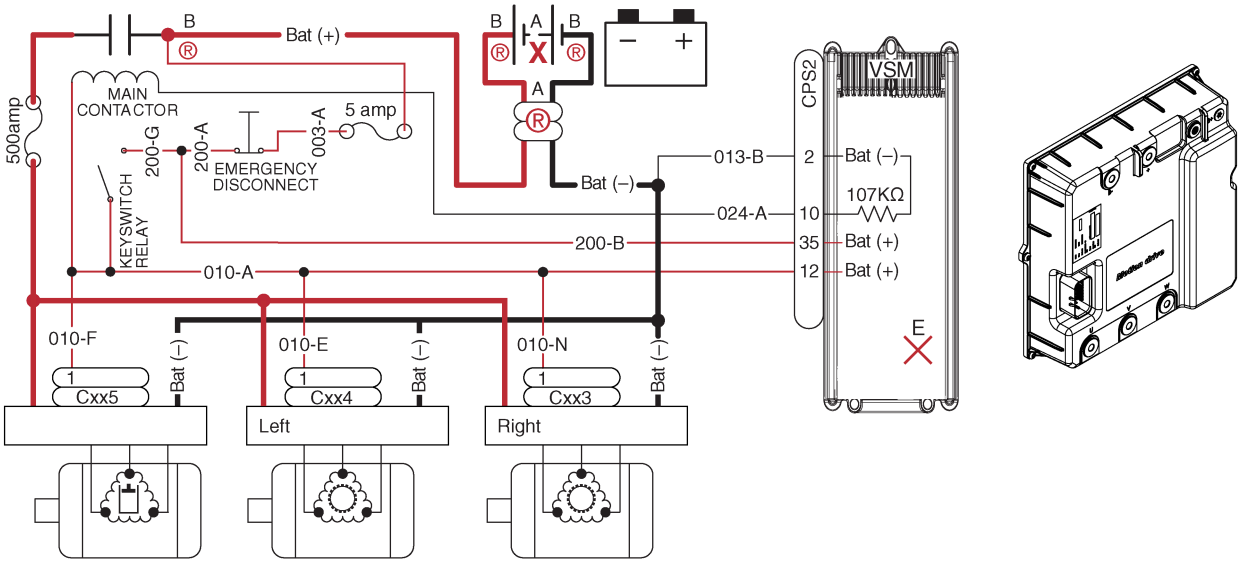
CBB 4 WHEEL CAUSES A B C D E > ?

Possible Causes Battery Voltage Below Input Threshold/ ® = High Resistance
Possible Causes Battery Voltage Above Input Threshold/ ® = High Resistance

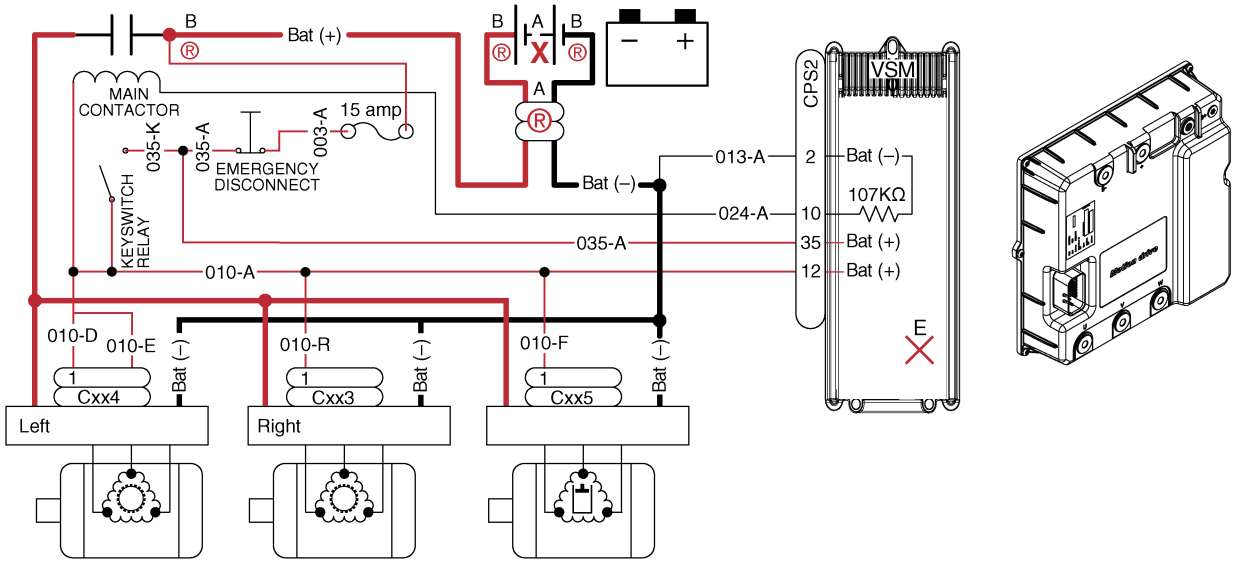


Controller Logic Failure (Cont)

DBB 4 WHEEL CAUSES A B C D E > ?



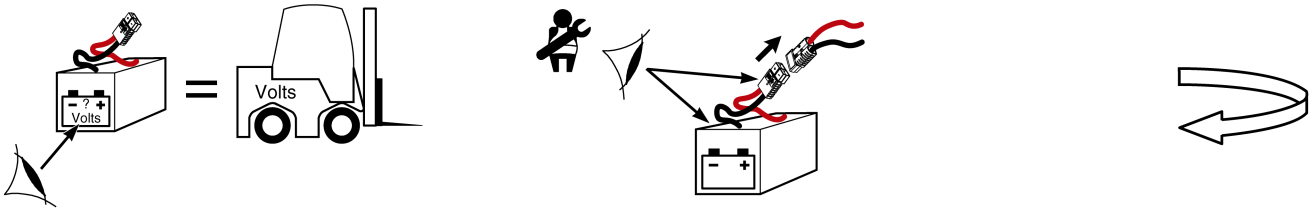
A935 K160 HIGH RESISTANCE CONNECTIONS CAUSES A B C D E > ?



Controller Logic Failure (Cont)

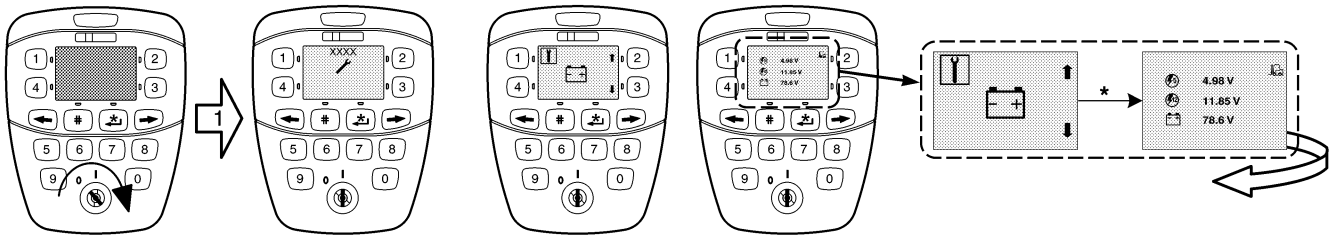
CAUSE A

Controller Detected Voltage OOR



Check that correct voltage battery is installed →	Perform battery maintenance, see **Operating Manual**→	?

STEP A1

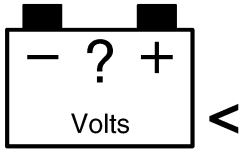


Power **ON**→	Go to Diagnostic→See Display Menu Flowchart	Battery/Supply→View Battery Value	?

STEP A2

Controller Detected Voltage OOR

NOTE: OOR Code is set if OOR condition is present for longer than 1 second.



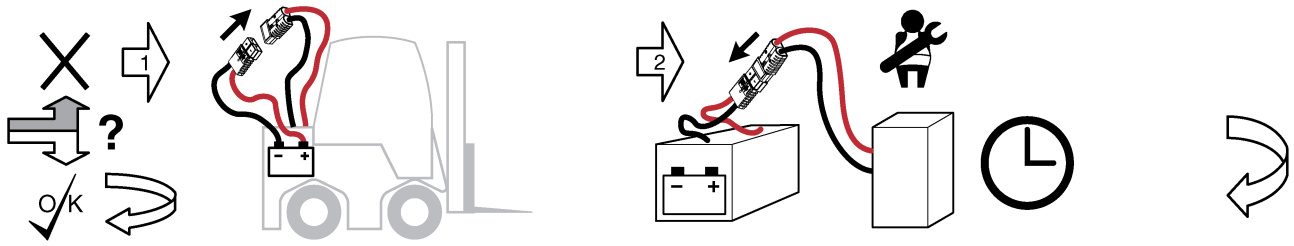
<

Controller Threshold

	24v	48v
< OORL	9	11
< OORH	45	65

Is battery voltage ˜ < OORL value for correct battery→ ?

STEP A3

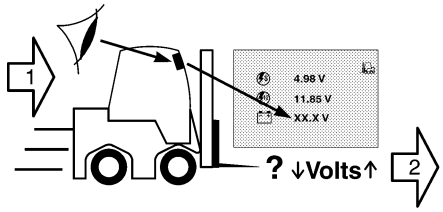


NO (v)→?	**YES** (X) Recharge battery→	See **Operating Manual** for charge time	?

Controller Logic Failure (Cont)

STEP A4

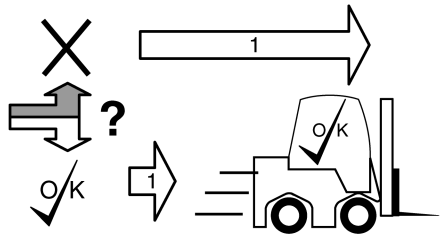
Battery OORL/OORH

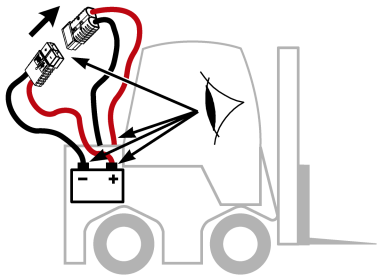


Battery Voltage				
Nominal	36	48	72	80
Fully Charged	40	53	79	88
˜< OORL	18	24	36	40
˜> OORH	48.6	57.6	97.2	108

Operate truck→All functionsMonitor battery voltage→Is battery voltage going?↓< OORL or ↑> OORH value for correct battery→?

STEP A5

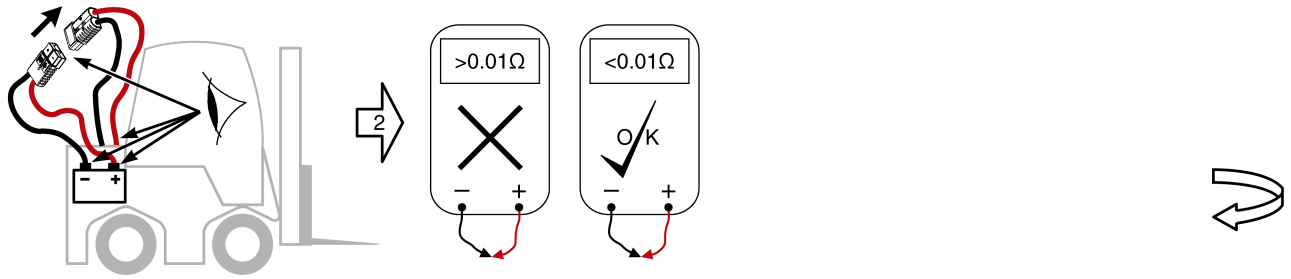




YES (X) Inspect All Battery Connections for Corrosion/ High Resistance→

NO (v) →Go to Step 4

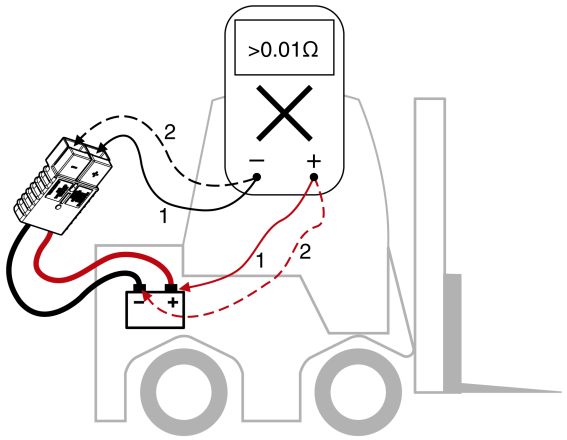
Controller Logic Failure (Cont)
CAUSE B
NOTE: High Resistance in Wiring and Connections will cause **High Voltage** drops (OORL) when subjected to **High Current** Draw
NOTE: High Resistance in Wiring and Connections will cause **High Voltage** peaks (OORH) when subjected to **High Current** Regen

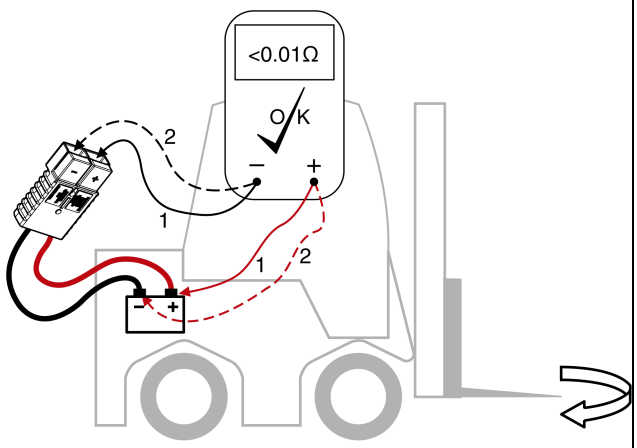


Disconnect battery→	Set meter to lowest ? scale→	Check lead resistance < 0.01?	?

STEP B1	CHECK RESISTANCE - Ω - OHMS

Battery OORH/OORL

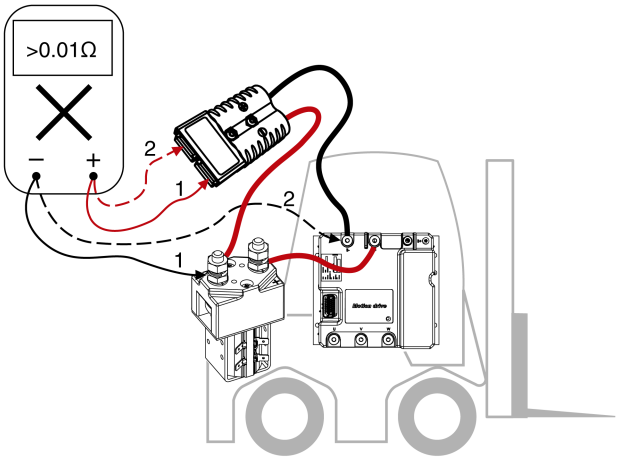


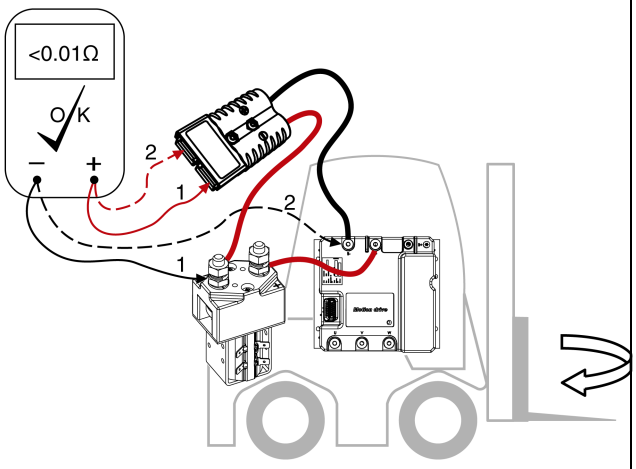


Check resistance between the Battery (+) and (-) terminals and the Battery Connector (+) and (-) Terminals	
1. > 0.01? Replace battery leads/connector terminal↓	
2. > 0.01? Replace battery leads/connector terminal→	< 0.01? Connection OK→?

Controller Logic Failure (Cont)

STEP B2

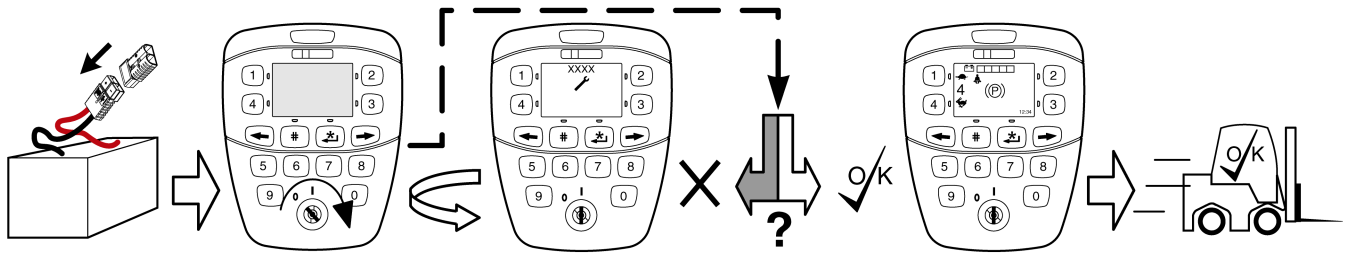




Check Resistance between the Bat (+) Connector and the Contactor Stud/Bat (-) Connector and Bat (-) to System	
1. > 0.01? →Replace battery leads/connector terminal↓	
2. > 0.01? →Replace battery leads/connector terminal→	< 0.01? →Connection OK?

STEP B3

Battery OORH/OORL

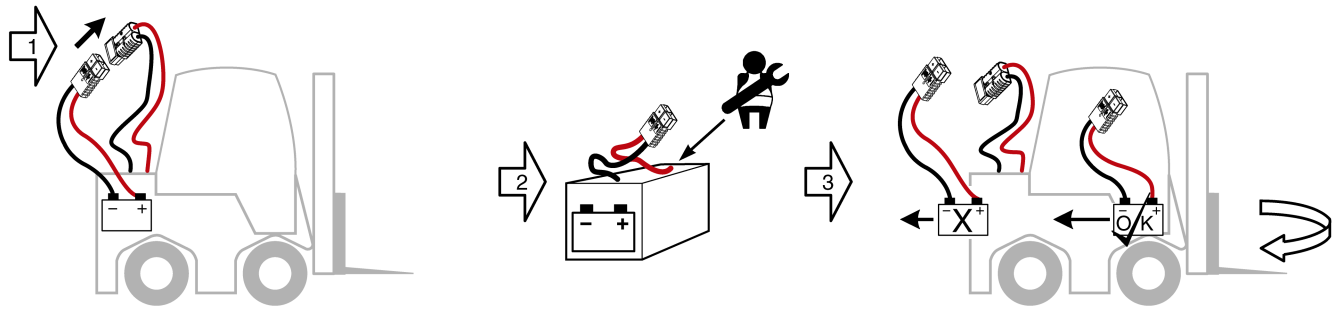


Reconnect battery	Retest Power **ON**	**NO**→?	Is DTC gone? **NO YES**→	Fault Corrected→	Continue operation

Controller Logic Failure (Cont)

STEP B4

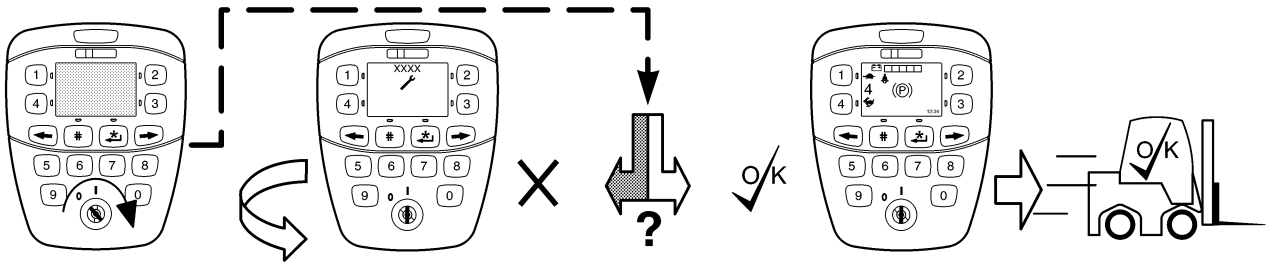
Battery OORH/OORL



Possible Battery Cell Failure→Perform Battery Cell Test→See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.

If a cell failure is detected replace Battery→	?

STEP B5



Retest Power **ON**	**NO**→?	Is DTC gone? **NO YES**→	Fault Corrected→	Continue operation

CAUSE C

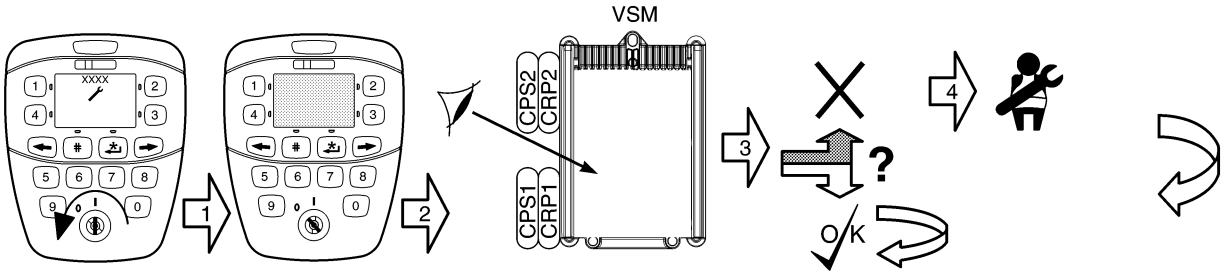
Not Applicable

CAUSE D

Not Applicable

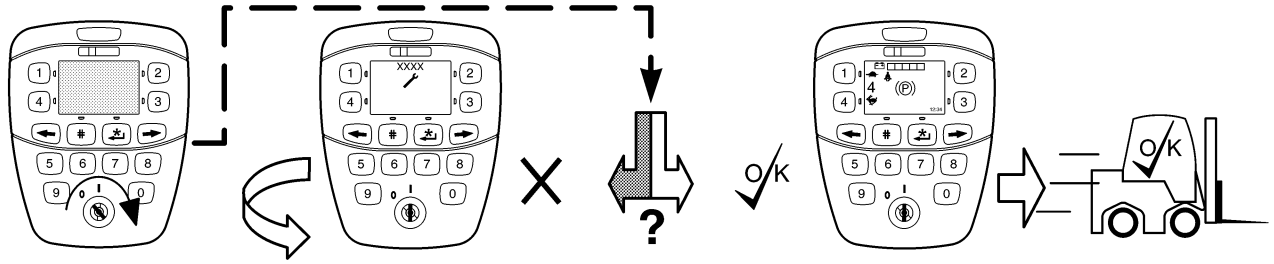
Controller Logic Failure (Cont)

CAUSE E



Power **OFF**→	Inspect VSM Connections→	Go to Step 1	Not OK Correct/Repair→Go to Step 1

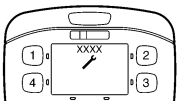
CAUSE E1



Retest - Power **ON**→	**NO**→Go to VSM Controller Check	Is DTC gone?**NO** **YES**	Fault corrected→Continue operation.

END FAULT

Display Failure – Temperature/Buzzer (Cont)



Fault Codes

DTC 12928
Display Temperature Sensor (Freezer Option Only)

DTC 12929
Display Temperature Sensor (Freezer Option Only)

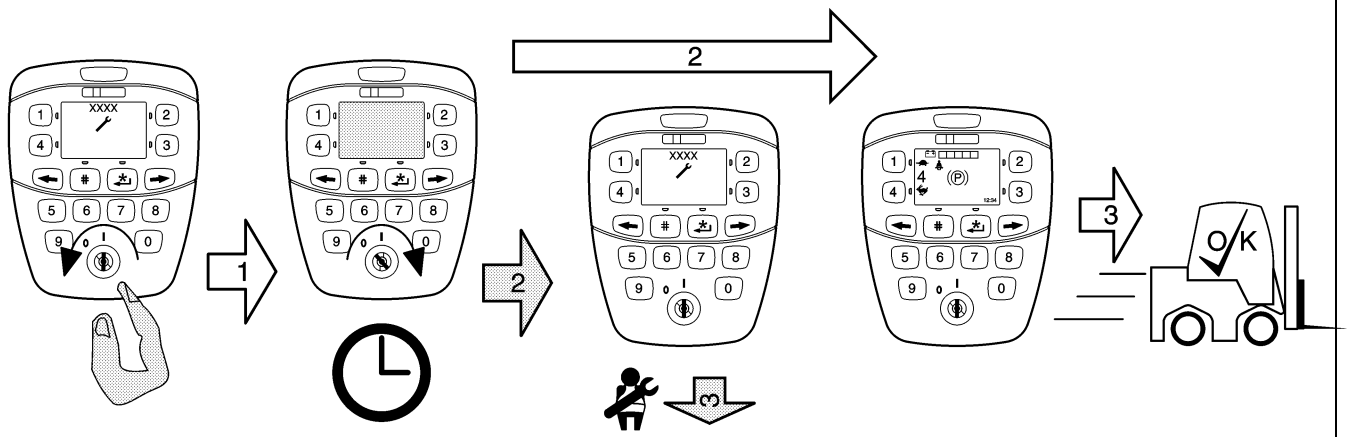
DTC 9040
Display Buzzer Output

DTC 12938
Display Buzzer Output

DTC 12939
Display Buzzer Output

QUICK CHECK X = Open Circuit/Fail) = Short Circuit			
DTC 12928	Display Temperature Sensor (Freezer Option Only)	OORL Open Circuit	→CAUSE 0↓
DTC 12929	Display Temperature Sensor (Freezer Option Only)	OORH	→CAUSE 0↓
DTC 9040	Display Buzzer Output	STB (-)/Current OORH	Code Not Active
DTC 12938	Display Buzzer Output	STB (+)	Code Not Active
DTC 12939	Display Buzzer Output	Open Circuit	Code Not Active

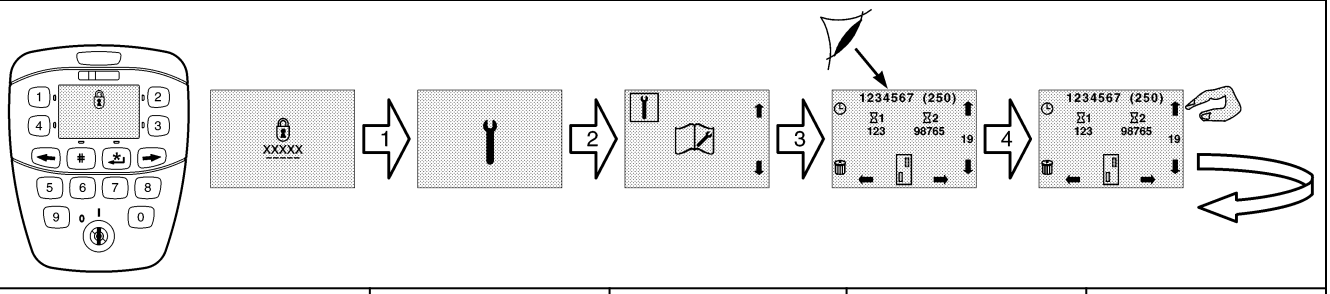
Check 1



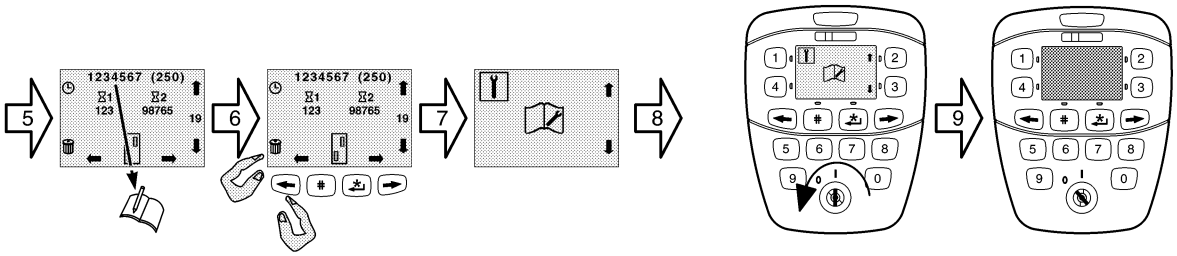
Power **OFF**→	Wait **30 seconds**→	Power **ON**→	Fault remains Service requiredGo to ↓	No fault→Resume operation

Display Failure – Temperature/Buzzer (Cont)

FAULT LOG CODE Review – Go to Display Menu



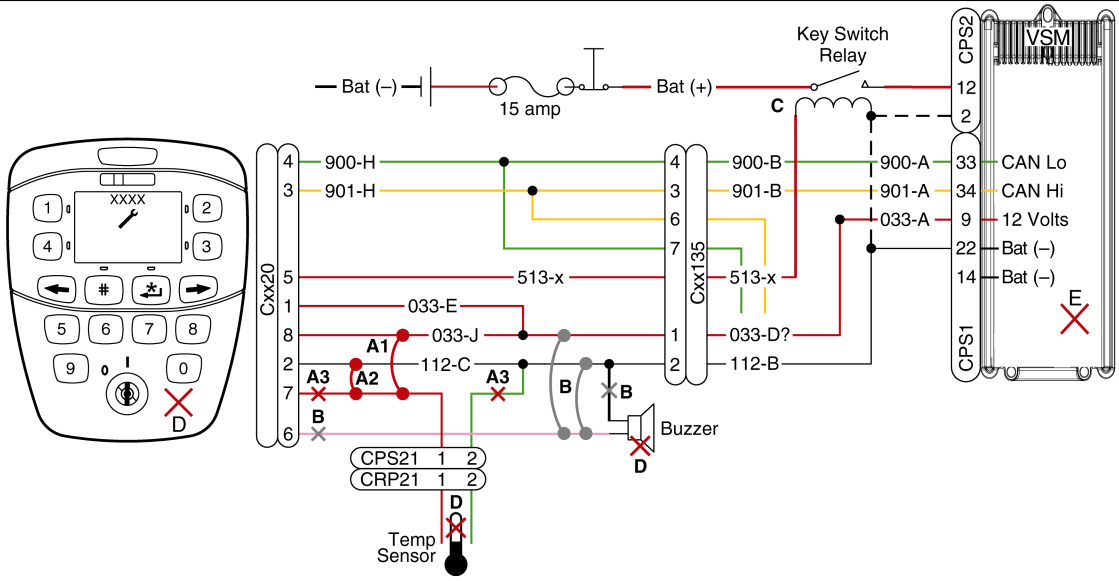
Enter SERVICE Password→	Diagnostics→	FAULT LOGs→	Display FAULT LOGs→	View all Display DTCs→?

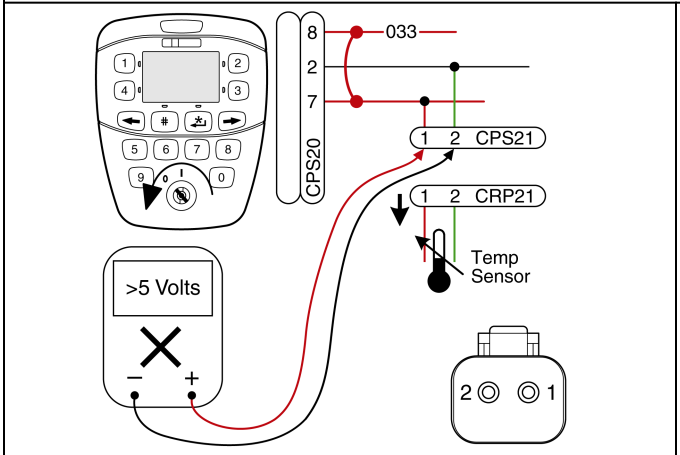
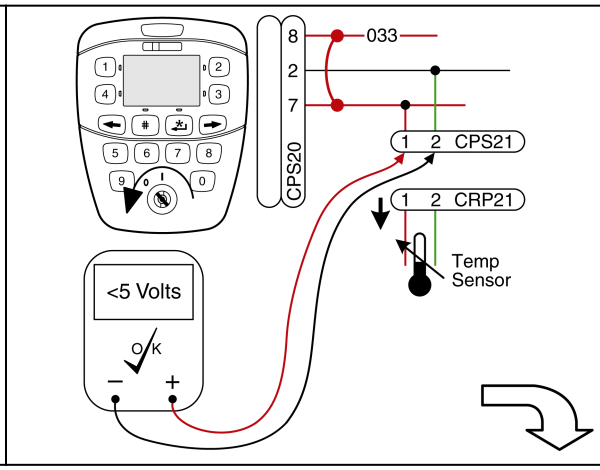
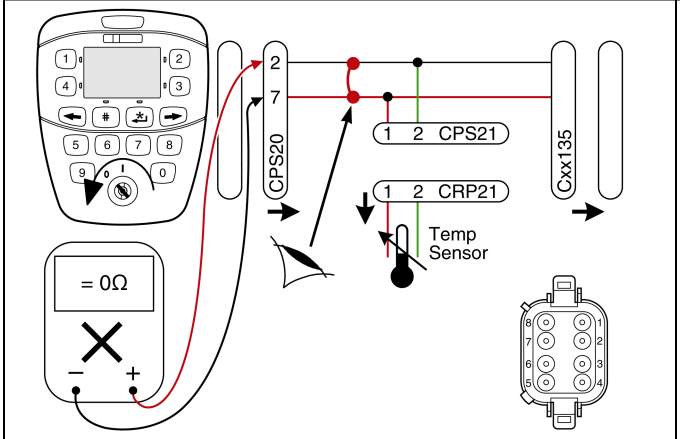
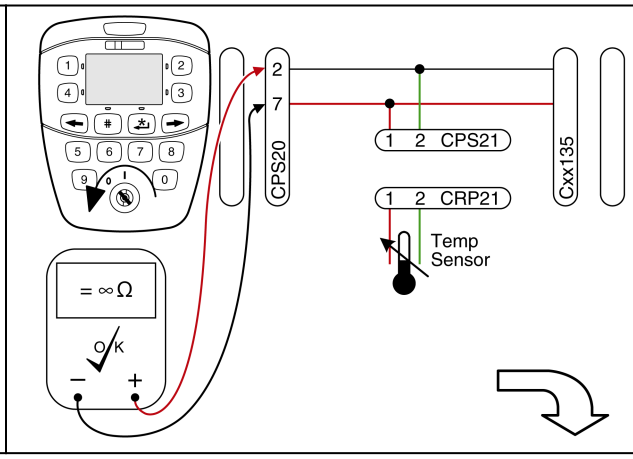


all Display DTCs→ Erase all Display DTCs→Exit Fault Log Power **OFF**→?

POSSIBLE CAUSES X = Open Circuit/Fail) = Short Circuit

CAUSES A B C D > ?

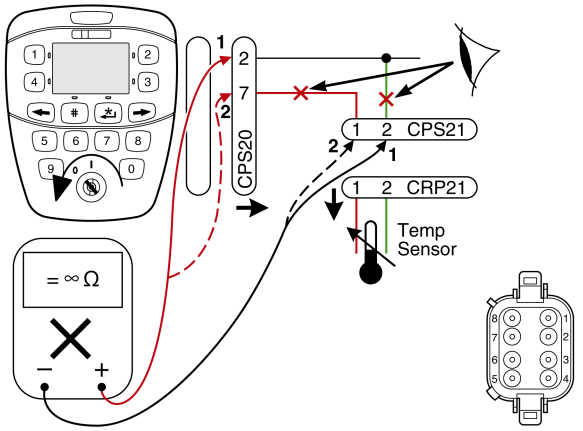


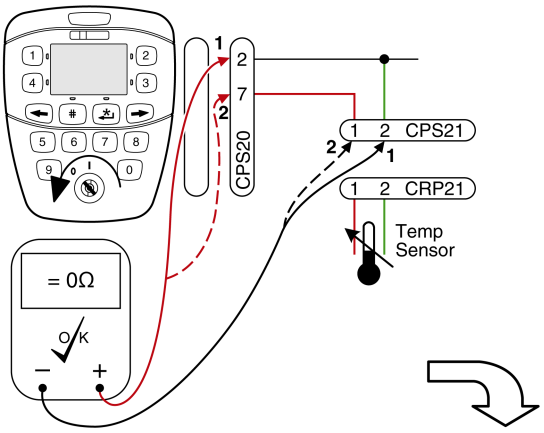
Display Failure – Temperature/Buzzer (Cont)	
CAUSE A	
DTC 12929 Temperature Sensor OORH	
	
Remove Display and Disconnect Temperature Sensor→Measure Volts→Go to 1↓	
1. > 5 volts = Short to→Go to 2↓	1. < 5 volts = OK→Step 1↓
2. Find/Repair Short Circuit See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→ ReCheck ?↑CAUSE 0→Reconnect Display→Step 3↓	
STEP A1	
DTC 12928 Temperature Sensor STB (-) OORL	
	
Disconnect connector 135→Measure ?→Go to 1↓	
1. ˜0? = Short Circuit to Bat (-)→Go to 2↓	1. =8? = OK→Step 2↓
2. Find/Repair Short Circuit See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→ ReCheck ?↑Reconnect→Step 3↓	

Display Failure – Temperature/Buzzer (Cont)

STEP A2

DTC 12928 Temperature Sensor Open Circuit OORL



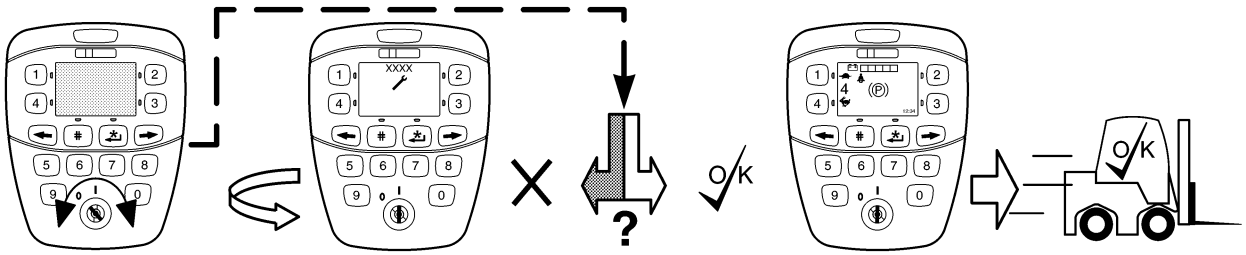


Remove Display and Disconnect Display Connector→Disconnect Temperature Sensor→Measure ? at 1 and 2→Go to 1↓

1. =8? = Open Circuit→Go to 2↓	1. ˜0? = OK→CAUSE C↓

2. Find/Repair OPEN Circuit See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→ ReCheck ?↑CAUSE 0→Reconnect →?

STEP A3



Retest - Power **OFF** Power **ON**	**NO**→?	Is fault DTC gone? **NO** ← **YES**→	?

CAUSE B

There are no active DTCs displayed for Buzzer Failure. Please refer to the Troubleshooting Electrical Symptoms for Diagnostics.

CAUSE C

Not Applicable

Display Failure – Temperature/Buzzer (Cont)

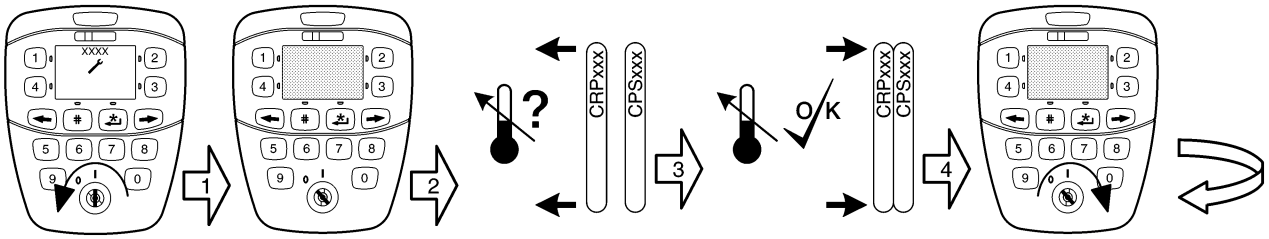
CAUSE D

Device Failure

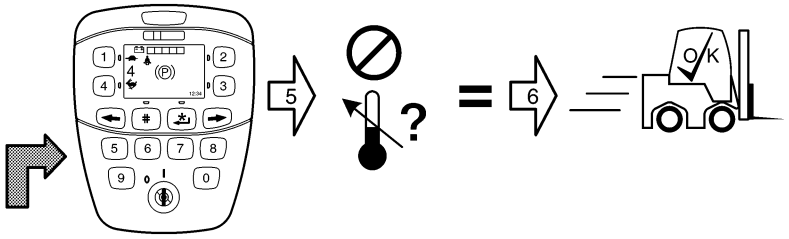
NOTE: The Temperature Sensor is Only used on Freezer configured Displays.

NOTE: The Temperature Sensor is tied to the wiring Harness behind the Display.

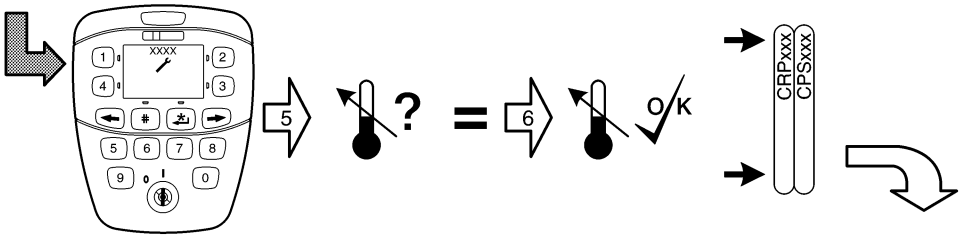
NOTE: The Temperature Sensor is NOT RESISTIVE and cannot be analyzed using a DMM.



Power **OFF**→Remove Display→	Disconnect sensor.→ Install new sensor.→ **Do not discard**	Power **ON**→	?

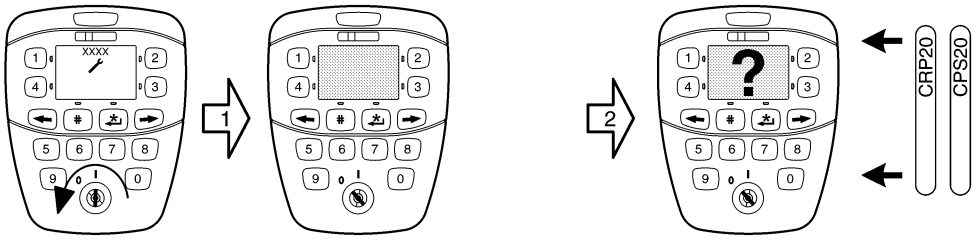


?	Fault DTC gone→	Original sensor faulty→	Resume operation



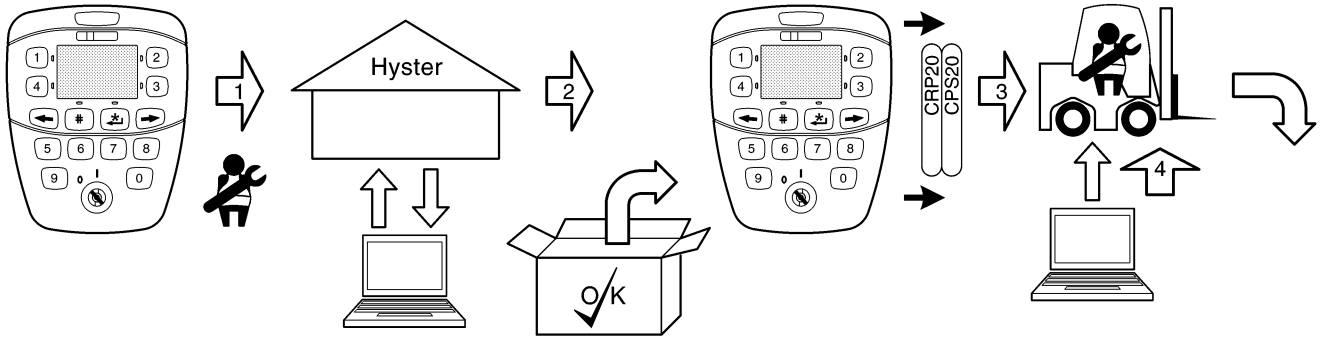
Fault DTC present→	Original sensor OK/Reinstall old sensor→	Go to Step 1.

STEP D1



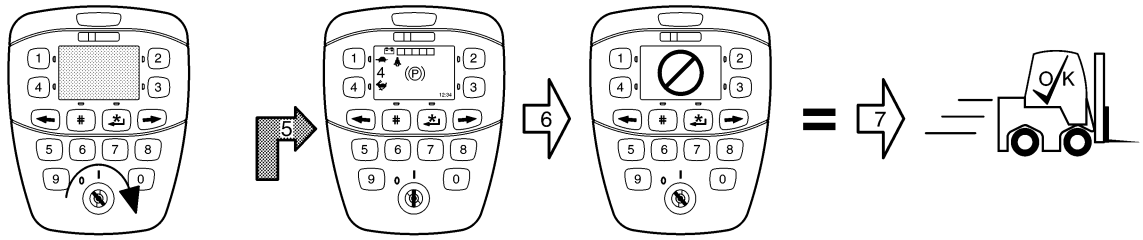
Display Failure – Temperature/Buzzer (Cont)		
Power **OFF**→	Disconnect Display→Do not Discard→	Step 2↓

STEP D2



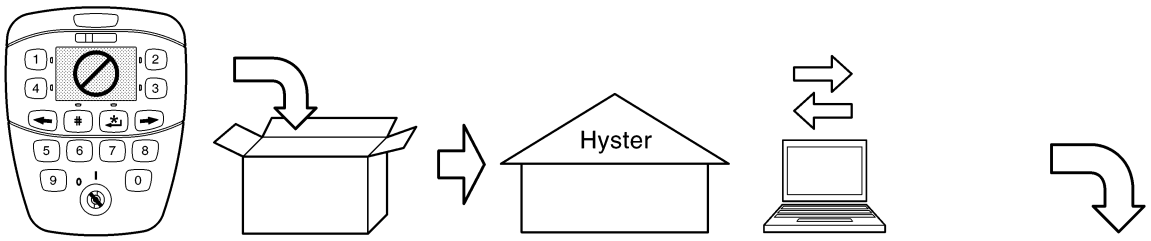
1. Download the latest **Display Application** Version→Install NEW Display→Install NEW Application →Go to 2↓
2. See **Hypass Online**, Software Resources for your truck, (Installing Display Application Software)↓

STEP D3



Power **ON**→⇳	DTC Gone→	Original Display Faulty→	Resume Operation

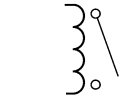
New DTC Present→	DTC TSP↓



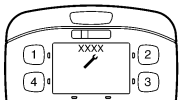
Return Faulty Display→Dealer→Factory→Failure Analysis→?? Reprogramming

END FAULT

Contactor/Relay/Valve Coil Short to Battery Positive (STBP)

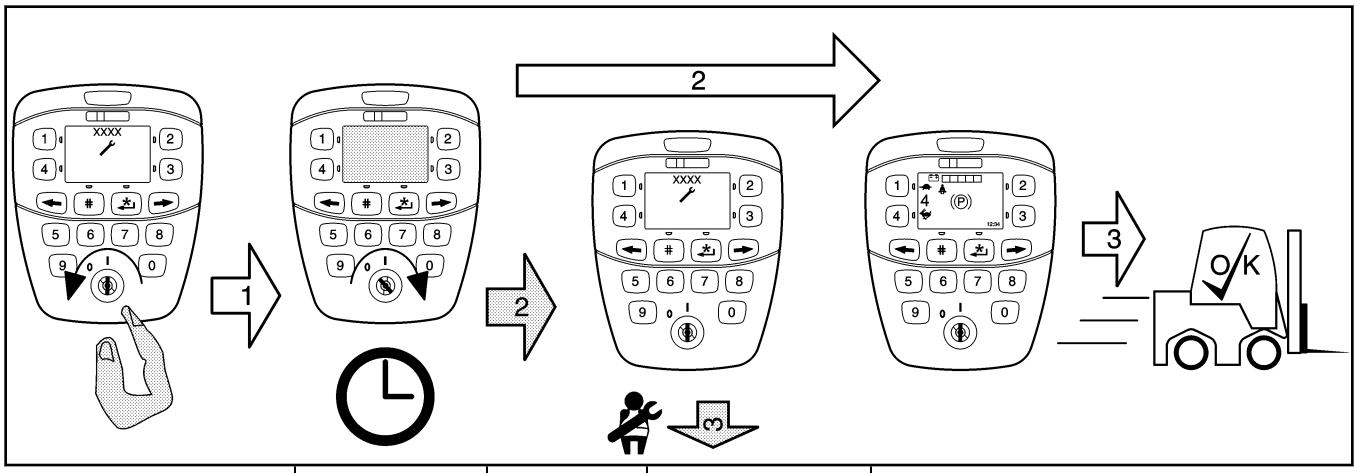


DTC 9000 **Diverter Valve**
DTC 9004 **E Hyd Enable**
DTC 9008 **Clamp Solenoid (Optional)**
DTC 9012 **Acc 2 Relay**



Fault Codes

DTC 9016 **Forward Relay**
DTC 9020 **Reverse Relay**
DTC 9026 **Spare 1 Relay**
DTC 9028 **Spare 2 Relay**
DTC 9032 **Main Contactor**
DTC 9036 **2nd Contactor**

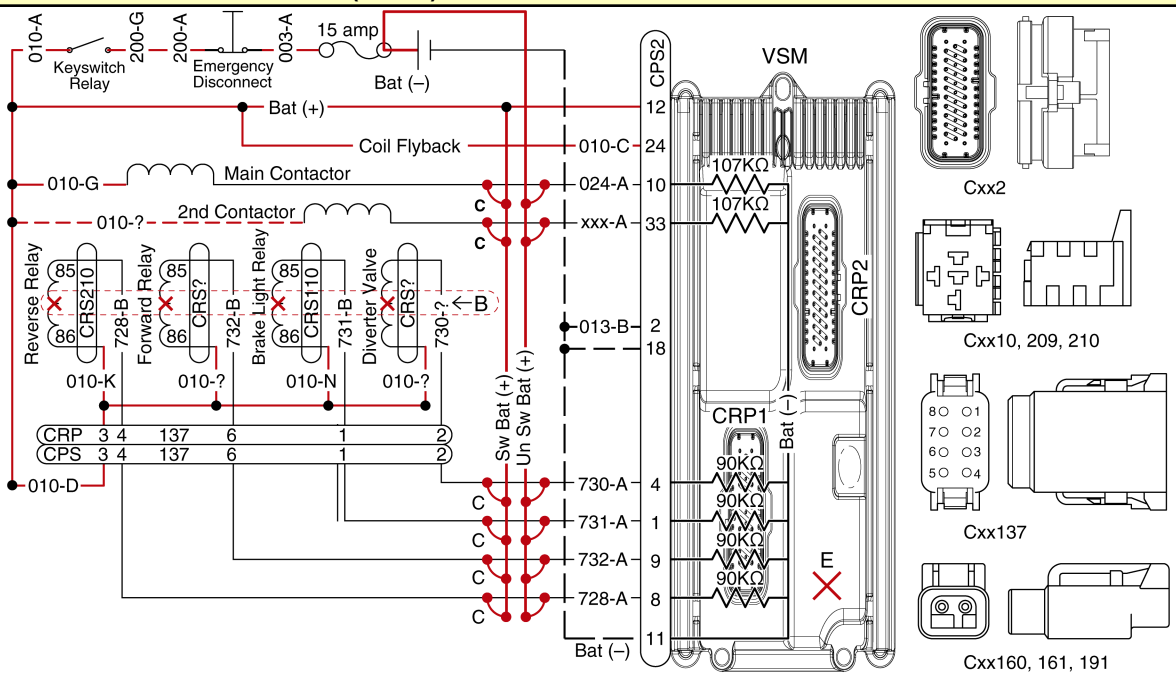


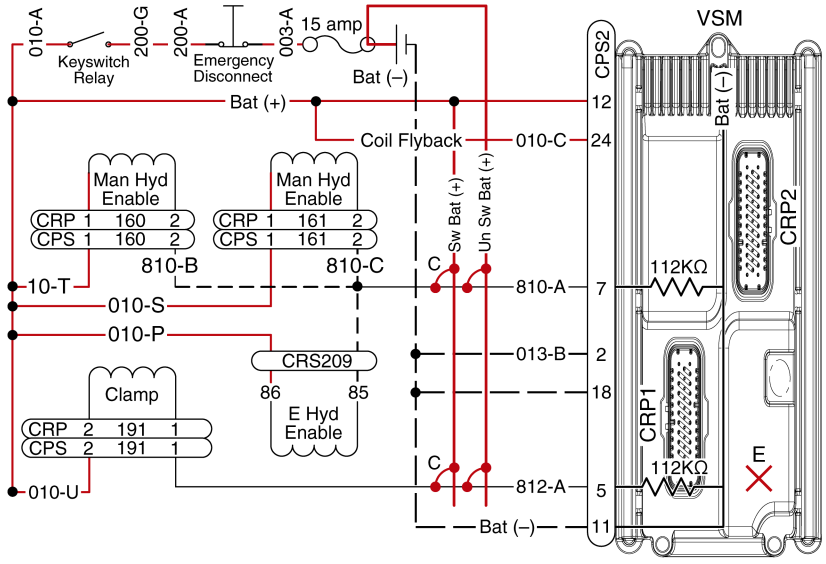
Power **OFF**→	Wait **30 seconds**→	Power **ON**→	Fault remains. Service required. Go to Component Operational Check.	No fault→	Resume operation

POSSIBLE CAUSE X = Open Circuit/Fail) = Short Circuit

Contactor/Relay/Valve Coil Short to Battery Positive (STBP) (Cont)

CONTACTOR/RELAY/VALVE COIL (STBP) CAUSES A B C D E > ?





CAUSE A

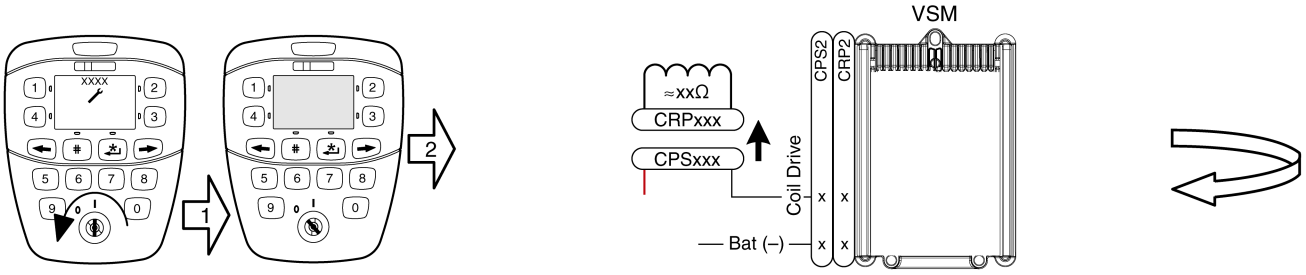
Not Applicable

CAUSE B

Not Applicable

Contactor/Relay/Valve Coil Short to Battery Positive (STBP) (Cont)

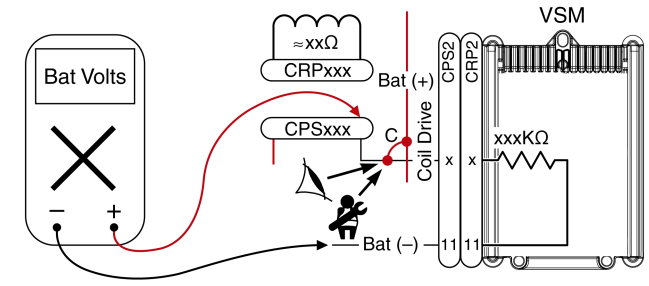
CAUSE C

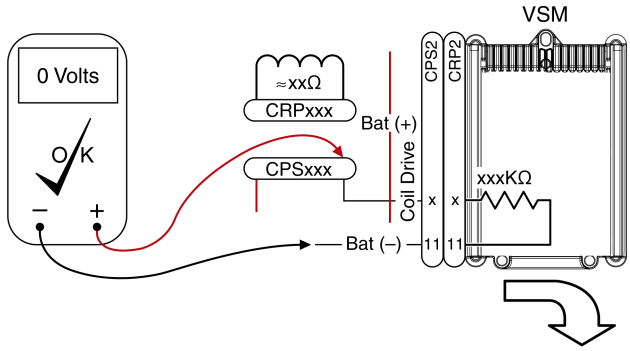


Power **OFF**→	Unplug/Disconnect Contactor/Relay/Valve Coil Indicated DTC Connection to VSM→?

STEP C1 UNSWITCHED VOLTAGES

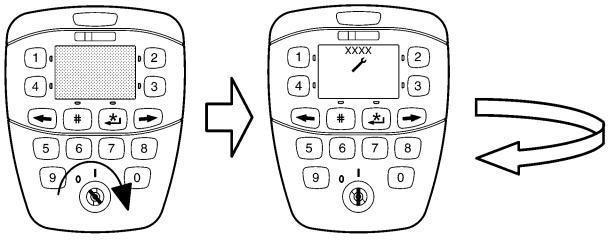
NOTE: Short Circuit to Unswitched Bat (+) Contactor/Relay/Valve Coil Connection to VSM





Bat Volts = Short circuit→Find↑**SHORT** circuit.→	˜ 0 Volts = **OK** ?
Repair SHORT Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369. See Schematic for Connection information	

STEP C2

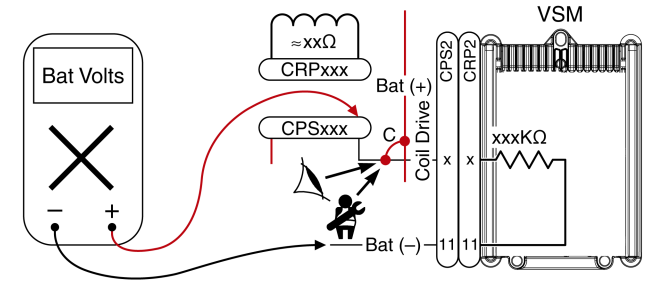


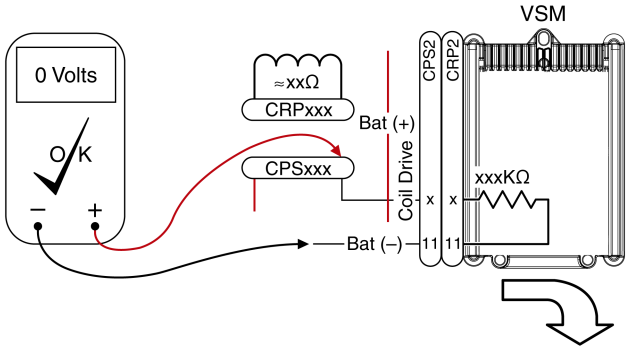
Power **ON**→?

Contactor/Relay/Valve Coil Short to Battery Positive (STBP) (Cont)

STEP C3

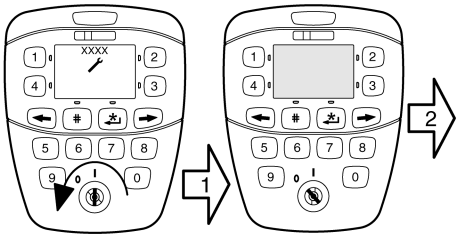
NOTE: Short Circuit to Switched Bat (+) – Contactor/Relay/Valve Coil Connection to VSM

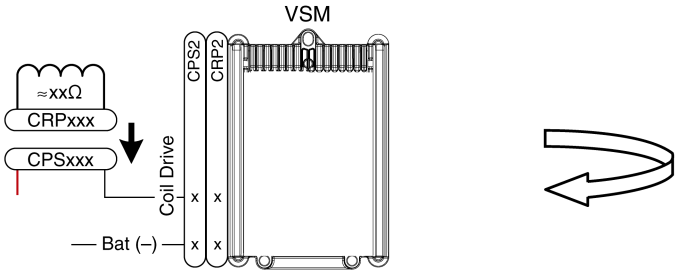




Bat Volts = Short circuit→Find↑**SHORT** circuit →	˜ 0 Volts = **OK** ?
Repair SHORT Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369. See Schematic for Connection information	

STEP C4





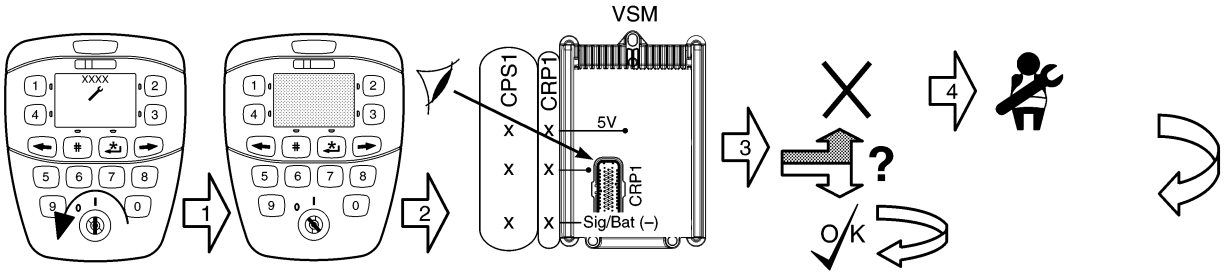
Power **OFF**→	Reconnect Contactor/Relay/Valve Coil Connections to VSM→	?

CAUSE D

Not Applicable

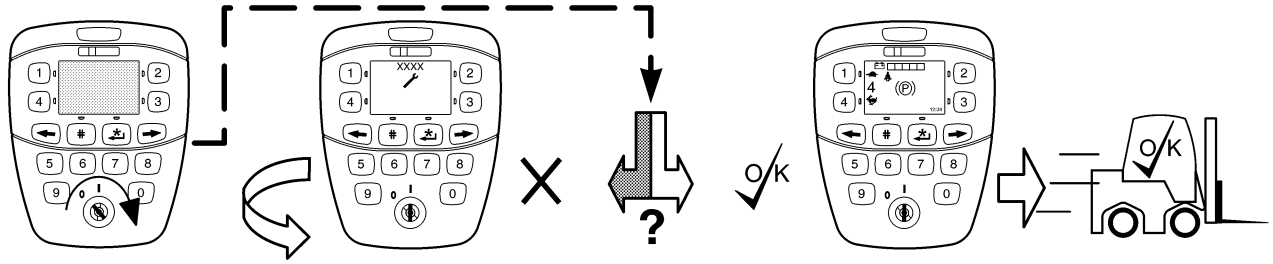
Contactor/Relay/Valve Coil Short to Battery Positive (STBP) (Cont)

CAUSE E



Power **OFF**→	Inspect VSM Connections→	Go to Step 1.	Not OK Correct/Repair→Go to Step 1.

CAUSE E1

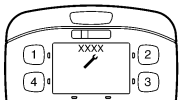


Retest - Power **ON**→	**NO**→Go to VSM Controller Check	Is fault DTC gone? **NO**←**YES**→	Fault corrected→Continue operation.

END FAULT

Contactor/Relay/Valve Coil Short to Battery Negative (STBN)/Open Circuit (OC)

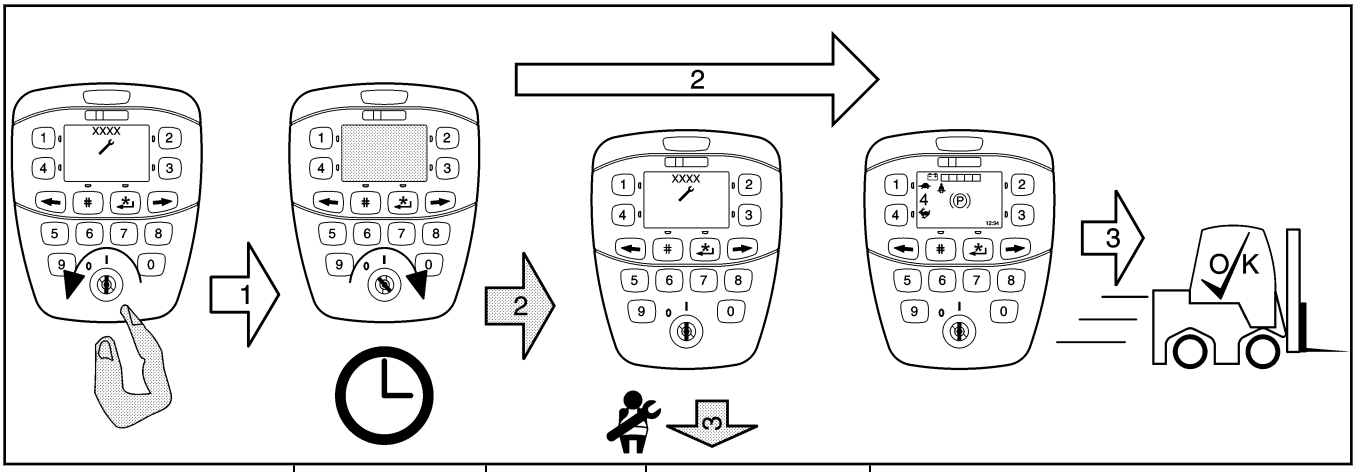
DTC 13352 Diverter Valve **DTC 13356 Hyd Enable** **DTC 13360 Acc 1 Relay** **DTC 13364 Acc 2 Relay**



Fault Codes

DTC 13368 Motion Relay **DTC 13372 Reverse Relay** **DTC 13376 Spare 1 Relay** **DTC 13380 Brake Light Relay Short to B(-) or Open**

DTC 13384 Main Contactor **DTC 13388 2nd Contactor**

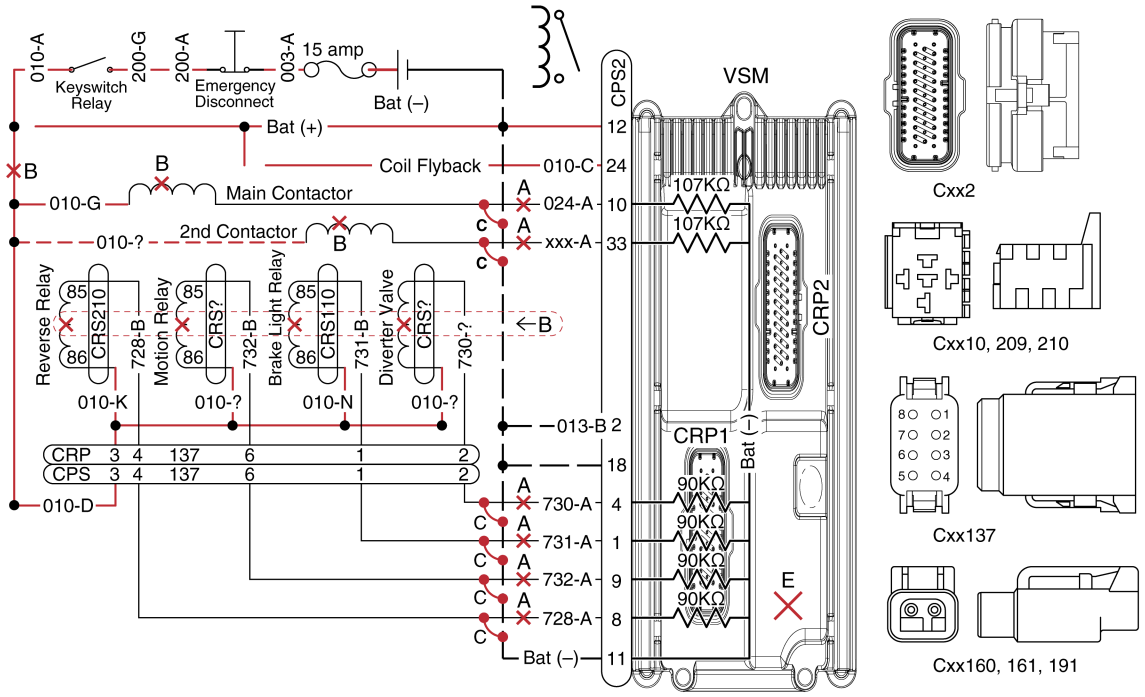


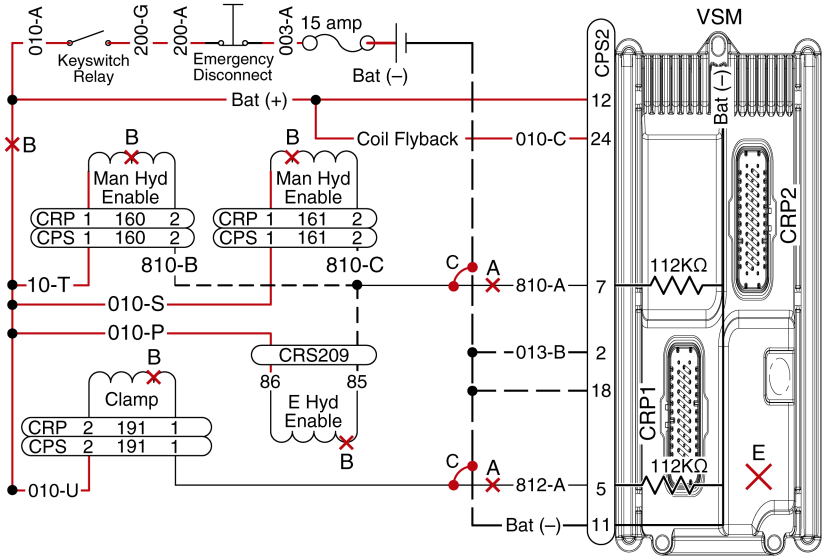
Power **OFF**→	Wait **30 seconds**→	Power **ON**→	Fault remains. Service required. Go to Component Operational Check.	No fault→	Resume operation

POSSIBLE CAUSE X = Open Circuit/Fail) = Short Circuit

Contactor/Relay/Valve Coil Short to Battery Negative (STBN)/Open Circuit (OC) (Cont)

CONTACTOR/RELAY/VALVE COILS STBN/(OC) CAUSES A B C D E > ?



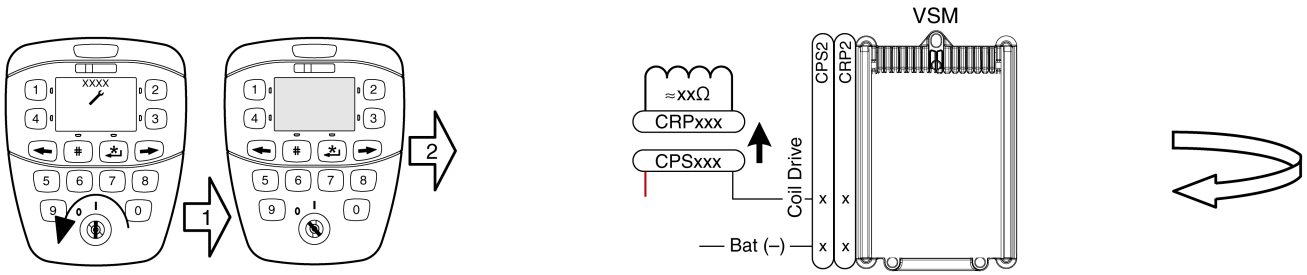


Relay/Coil Function	Coil Voltage	Coil Resistance (?)
Key Switch	12	80
Motion Direction	24	320
Reverse Direction	24	320
Brake Light	24	320
Diverter Valve	24	320

Contactor/Relay/Valve Coil Short to Battery Negative (STBN)/Open Circuit (OC) (Cont)		
Relay/Coil Function	**Coil Voltage**	**Coil Resistance (?)**
E Hyd Enable	24	320
Man Hyd Enable x 2	24	33
Clamp	24	33

CAUSE A

NOTE: Prior to performing any checks, Service Technician should verify to see if the Motion relay option or Diverter valve option is activated. (See Truck Setup Display menu- Motion Alarm/Diverter Valve). If neither device is part of the truck hardware then the function should be TURNED **OFF** to prevent false DTC conditions.

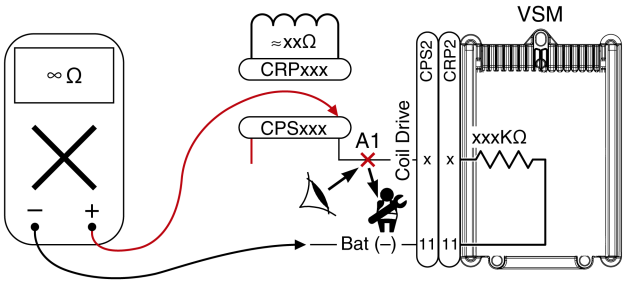


Power **OFF**→

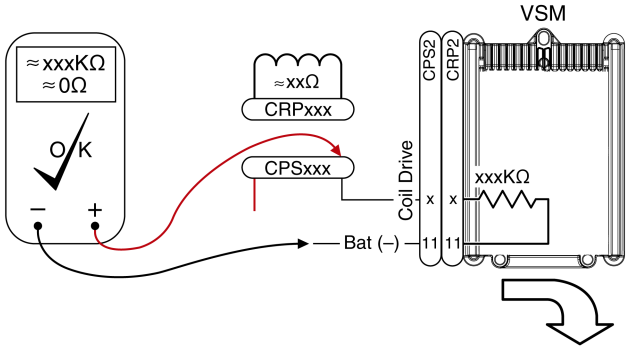
Unplug/Disconnect Contactor/Relay/Valve Coil Indicated DTC Connection to VSM→?

STEP A1 **CHECK RESISTANCE - Ω - OHMS**

Open Circuit – Contactor/Relay/Valve Coil Connection to VSM



8 ? = Open Circuit→Find↑**Open** circuit→



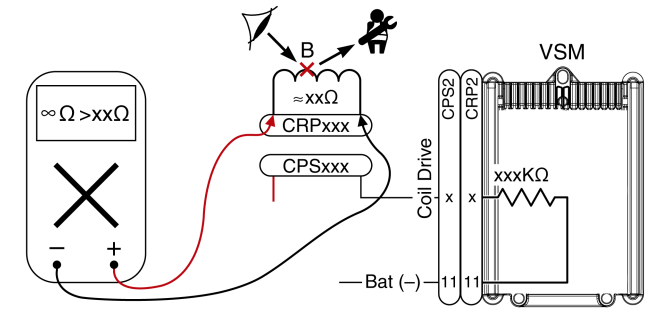
˜ Function K? =**OK**?

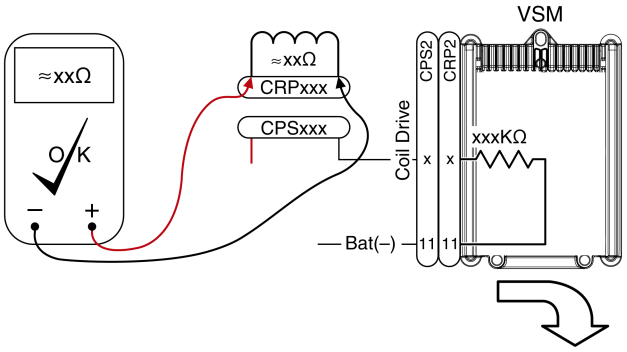
˜ 0? Go to CAUSE B

Repair OPEN Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.

Contactor/Relay/Valve Coil Short to Battery Negative (STBN)/Open Circuit (OC) (Cont)	
CAUSE B	**CHECK RESISTANCE - Ω - OHMS**

NOTE: Open Circuit – Contactor/Relay/Valve Coil Connections to Coil





8 ? = Open Circuit→Find↑**Open** circuit→	˜ xx? =→See Schematics =**OK**→?

Repair **OPEN** Circuit in wiring or Replace Open Circuit Coil/Relay ↓

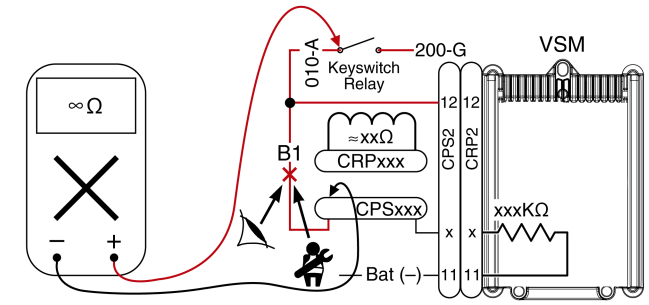
See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.

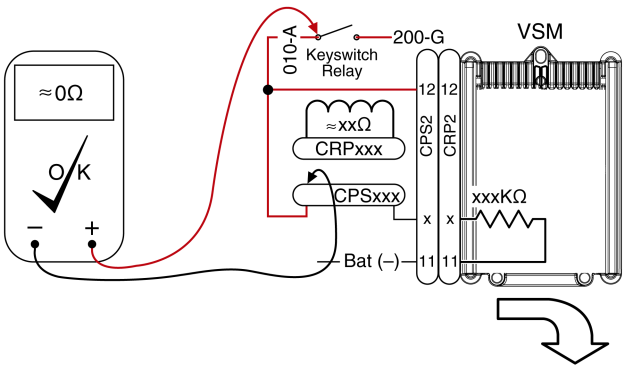
> xx ? = Faulty Coil→Replace Coil↓

See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.

STEP B1	CHECK RESISTANCE - Ω - OHMS

Open Circuit – Bat (+) Connections to Contactor/Relay/Valve Coil





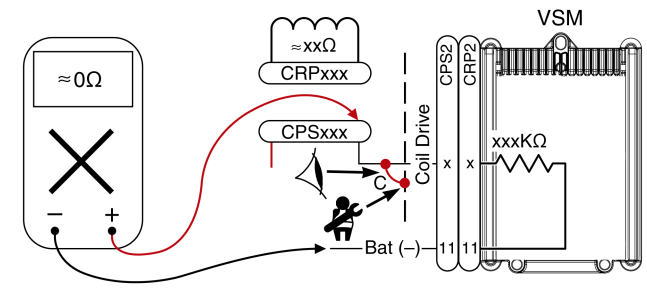
8 ? = Open Circuit→Find↑**Open** circuit→	˜ 0? =**OK**Go to CAUSE D↓

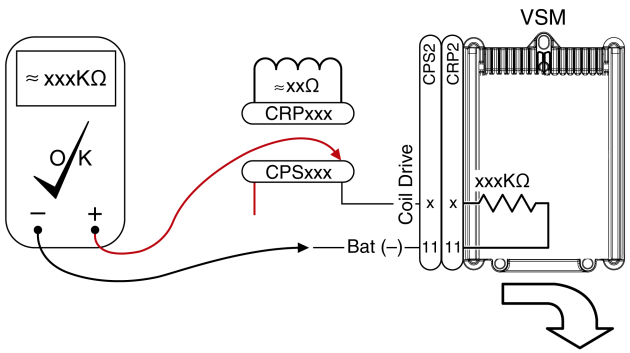
Repair OPEN Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.

Contactor/Relay/Valve Coil Short to Battery Negative (STBN)/Open Circuit (OC) (Cont)

CAUSE C

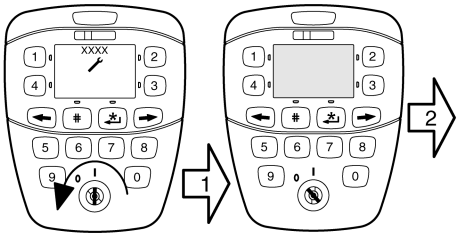
NOTE: STBN – Contactor/Relay/Valve Coil Connection to VSM

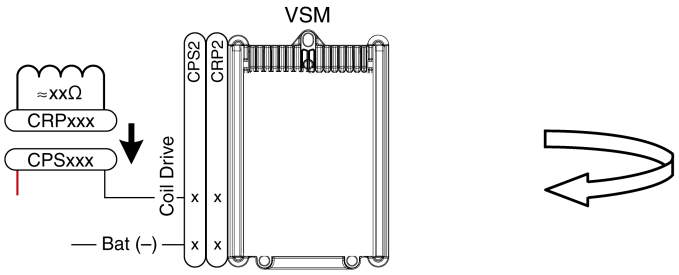




˜ 0 ? = Short Circuit→Find↑**Short** circuit→	˜ Function K? =**OK**Go to CAUSE D↓
Repair Short Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.	

STEP C1





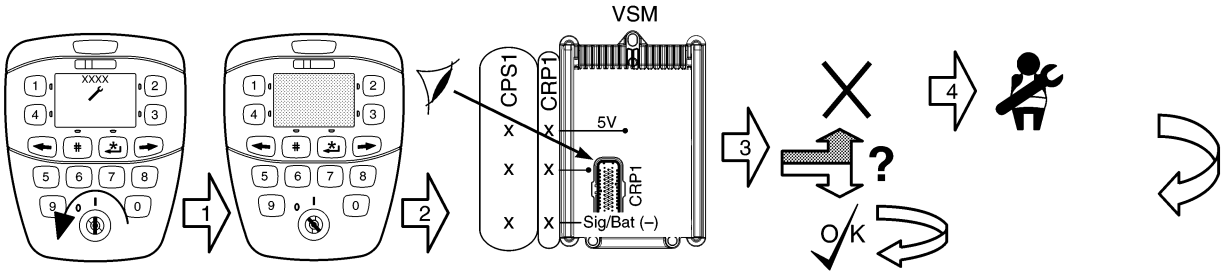
Power **OFF**→	Reconnect Contactor/Relay/Valve Coil Connections to VSM→	?

CAUSE D

Not Applicable

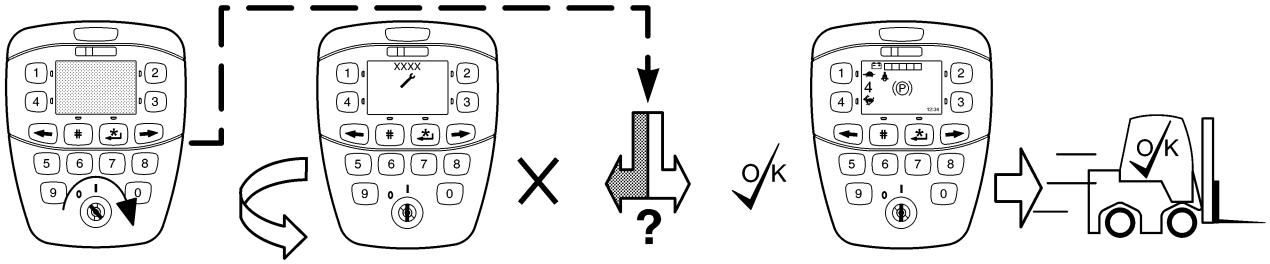
Contactor/Relay/Valve Coil Short to Battery Negative (STBN)/Open Circuit (OC) (Cont)

CAUSE E



Power **OFF**→	Inspect VSM Connections→	Go to Step 1.	Not OK Correct/Repair→Go to Step 1.

CAUSE E1



Retest – Power **ON**→	**NO**→Go to VSM Controller Check	Is DTC gone?**NO** **YES**←→	Fault corrected→Continue operation.

END FAULT

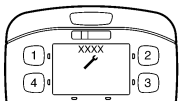
Motor Controller Contactor Failure (Cont)

DTC 21569 **Contactor Open**

DTC 21570 **Contactor Closed**

DTC 65318 **Contactor Open**

DTC 65317 **Contactor Closed**



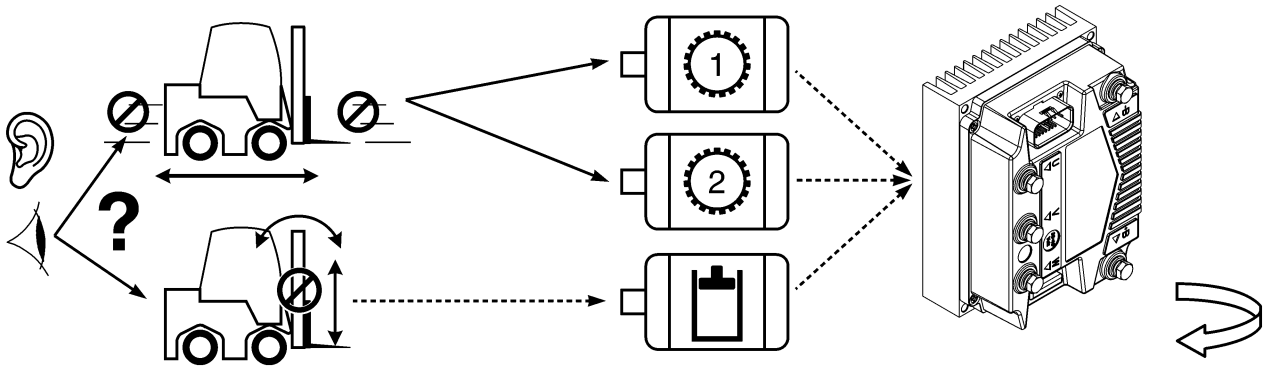
Fault Codes

DTC 65354 **Driver Shorted High**

DTC 65355 **Driver Shorted Low**

QUICK CHECK X = Open Circuit/Fail) = Short Circuit

Check 1



? No Operation?

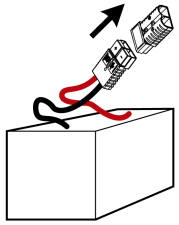
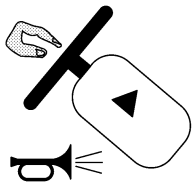
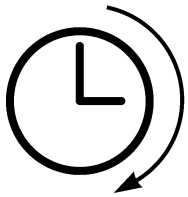
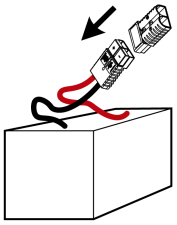
POSSIBLE CAUSES

DTC 21569Contactor Open	Low Battery/Open Circuit Connections Go to 1, 2, and 3↓	→CAUSE 0↓
DTC 21570Contactor Closed	Short Circuit Connections Go to 2 and 3↓	→CAUSE B↓
DTC 21569/21570Contactor Coil	Open/Short Circuit Connections Go to 2 and 3↓	→CAUSE 0/CAUSE B↓

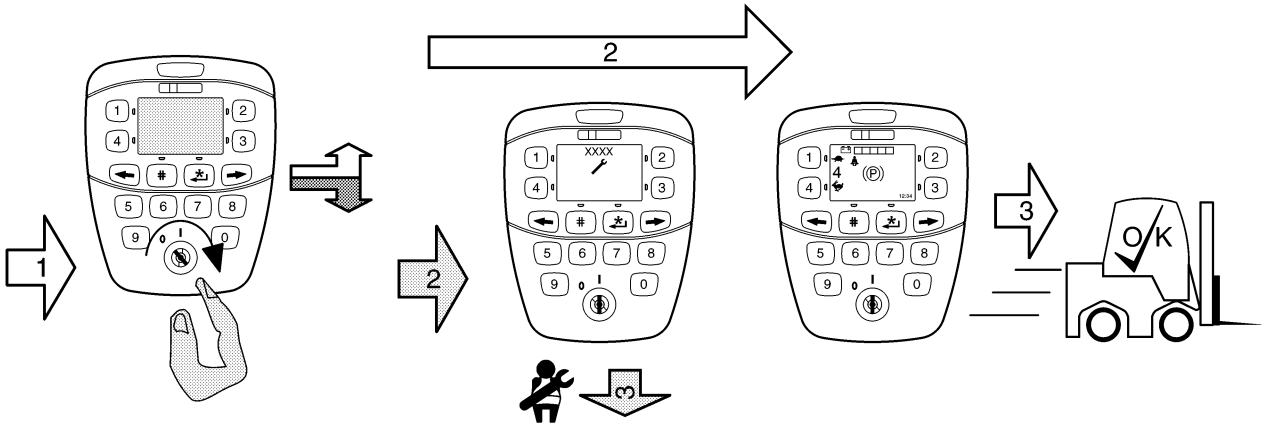
1. Go to Battery OORH/OORL
2. Go to Contactor/Relay/Valve Coil Short to Battery Positive (STBP)
3. Go to Contactor/Relay/Valve Coil Short to Battery Negative (STBN)/Open Circuit (OC)

Motor Controller Contactor Failure (Cont)

Check 2

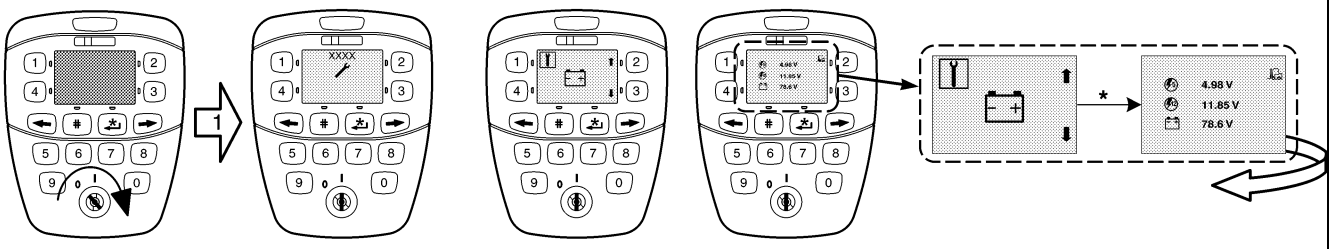
			
Disconnect Battery	Disconnect Battery and Sound Horn to Discharge Capacitors.Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342.	Wait 30 seconds	Reconnect Battery

Check 3

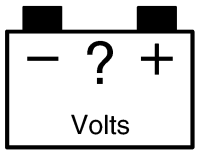


Power **ON**→	Fault Remains Service Required ?	No Fault→Resume Operation

Check 4

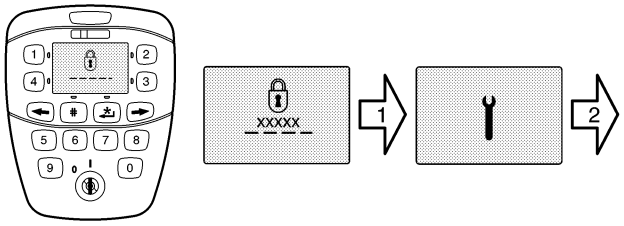


Power ON→Go to Diagnostics→Battery/Supply→View Bat Value→Go to Display Menu Flowchart↓

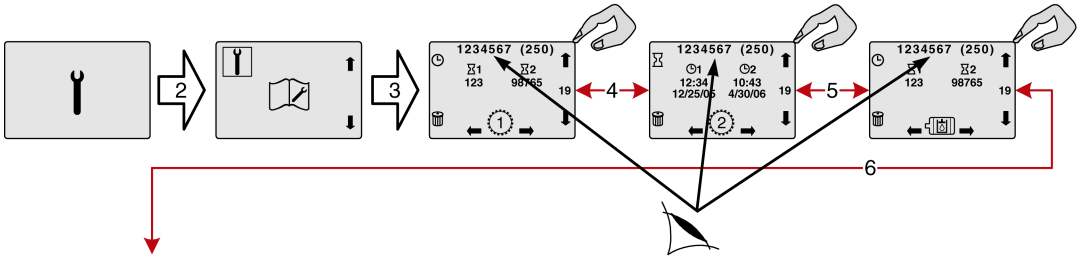
Motor Controller Contactor Failure (Cont)						
Check 5						
Battery OORL						
NOTE: OOR Code is set if OOR condition is present for longer than 1 second.						
 <	Battery Voltage					
	Nominal	36	48	72	80	
	Fully Charged	39.6	52.8	79.2	88	
	˜< OORL	18	24	36	40	
	˜ OORH	48.6	57.6	97.2	108	
Is battery voltage ˜ < OORL value for correct battery→Is Bat Voltage ˜< OORL value for Correct Battery→YES →Battery OORH/OORL→NO ?						

Motor Controller Contactor Failure (Cont)

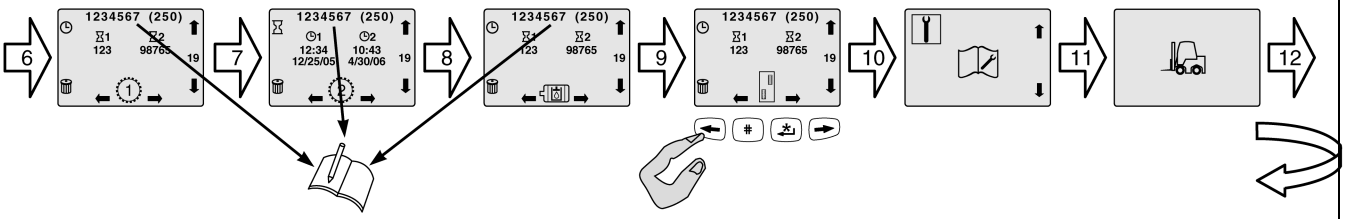
FAULT LOG Review - Go to Display Menu



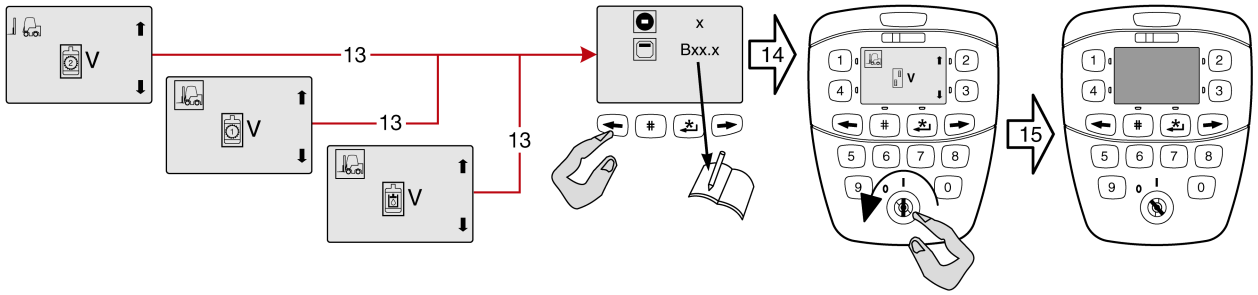
Enter Service Password→ | Diagnostics→



Diagnostic→FAULT LOGs→Motor Fault Log(s)→View all Motor DTCs→?



📝 all Motor DTCs→☜Exit Fault Log→Truck Status ?

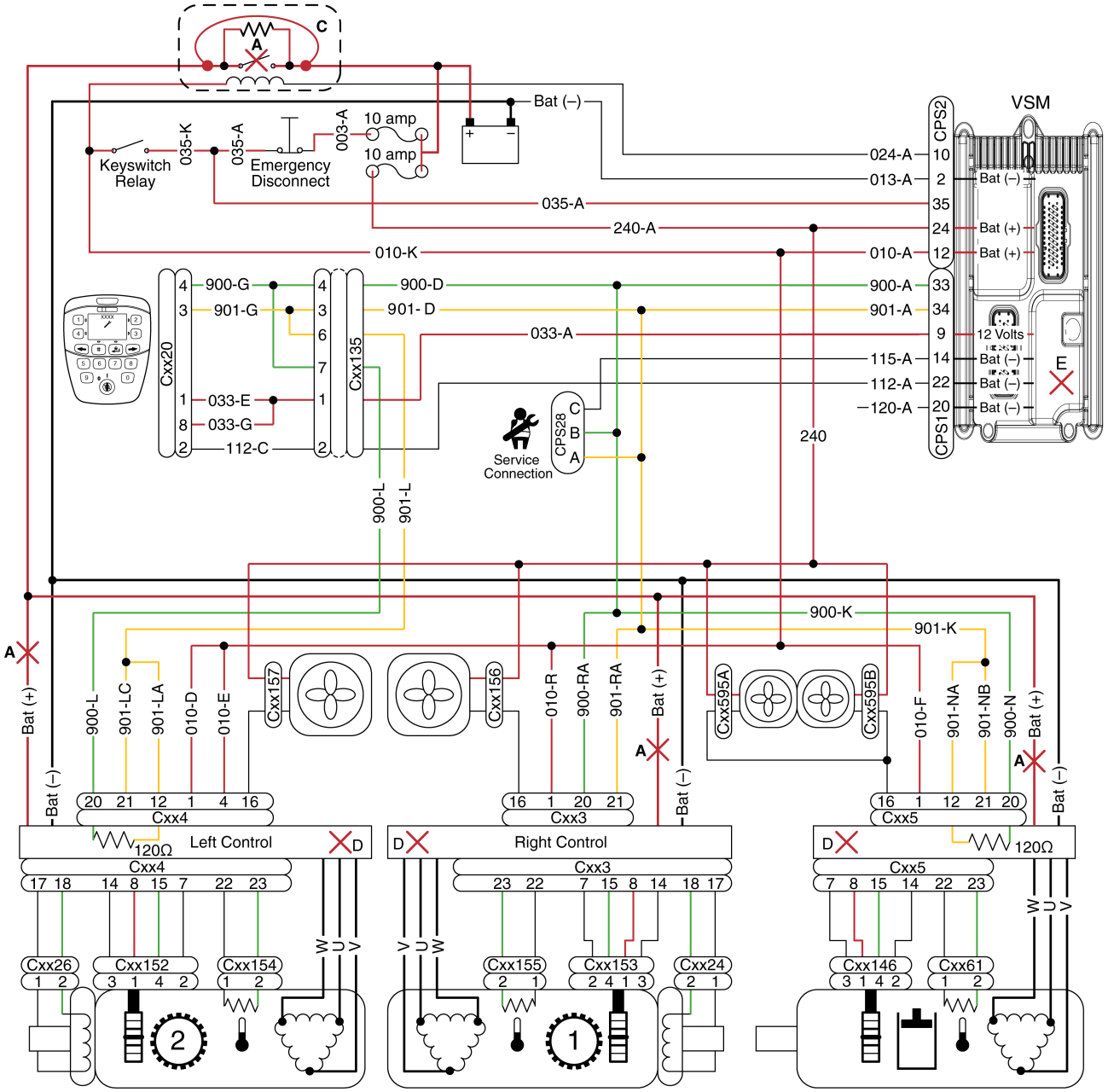


Motor Versions→📝Hardware/Software Versions→☜Exit Versions→Power **OFF**?

POSSIBLE CAUSES X = Open Circuit/Fail) = Short Circuit

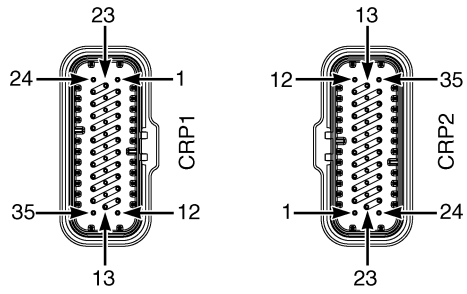
Motor Controller Contactor Failure (Cont)

MOTOR CONTROLLER CONTACTOR FAILURE CAUSES A B C D E > ?

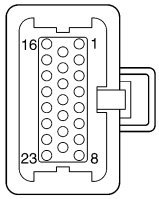


Motor Controller Contactor Failure (Cont)

CONNECTORS

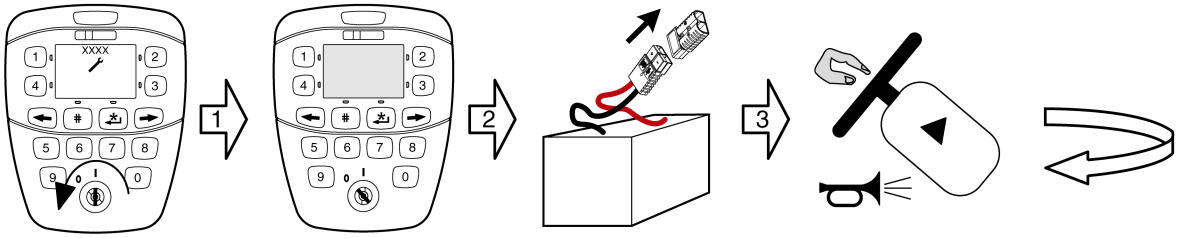


VSM Cxx 1 and Cxx 2



Traction/Pump Controller Cxx 3, 4, and 5

CAUSE A



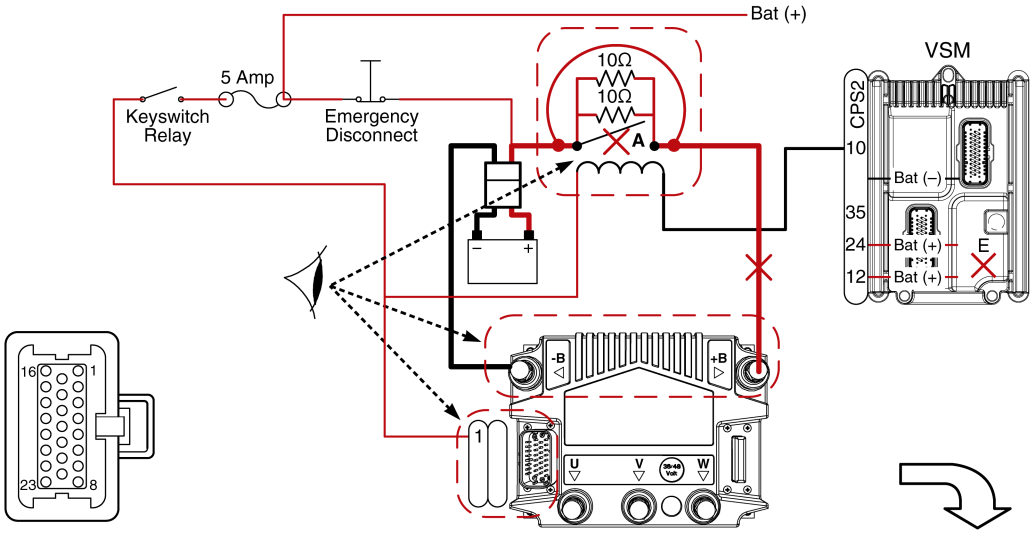
Power **OFF**→

Disconnect Battery and Sound Horn to Discharge Capacitors.→Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342→.

?

STEP A1

For any Fault DTC→Locate Device→Inspect ALL Wiring/Connections

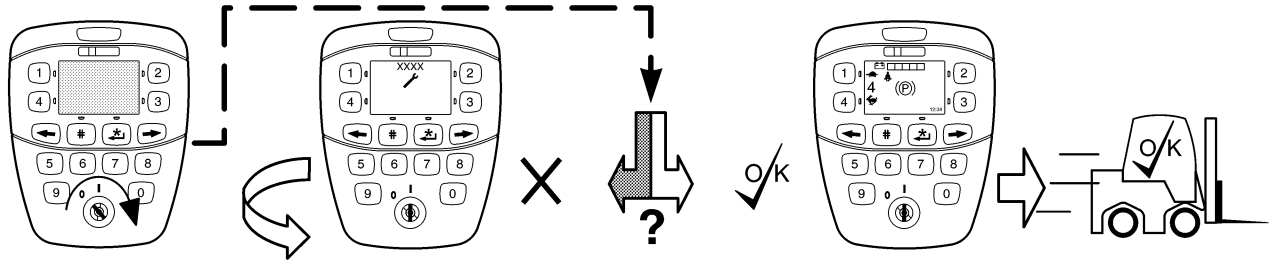


Motor Controller Contactor Failure (Cont)

STEP A2

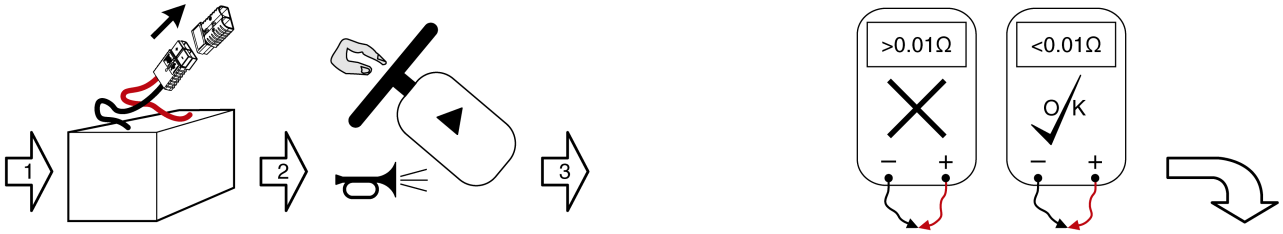
1. Inspect Contactor Top and Bottom Contacts for Pitting/Corrosion/Dirt Build-Up→Go to 2↓
2. Replace Contactor if Pitting/Corrosion is Observed→↓
3. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→Go to 4↓
4. Check all Connections→Reconnect Battery→Step 3↓

STEP A3



Retest - Power **ON**→	**NO**→?	Is fault DTC gone?**NO** **YES**←→	Fault corrected→Continue operation.

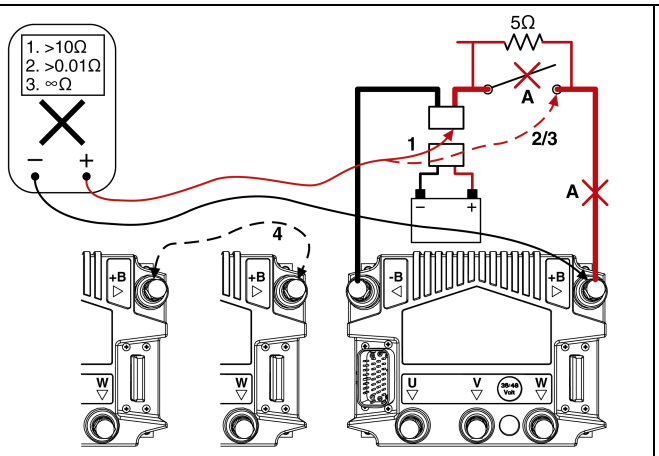
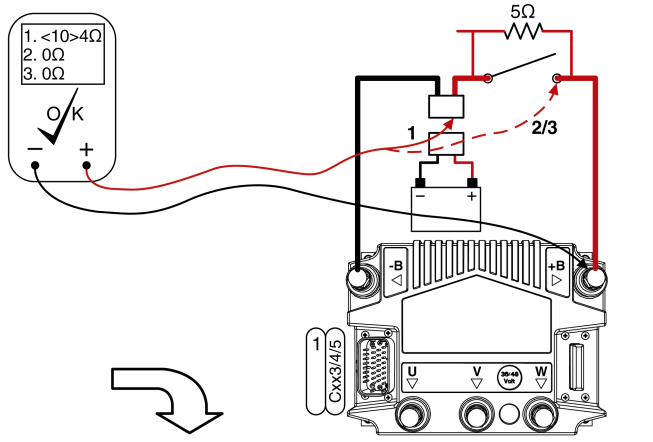
STEP A4 CHECK RESISTANCE - Ω - OHMS



Disconnect Battery and Sound Horn to Discharge Capacitors.→Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342→?

Set DMM to Lowest ?→Check Lead Resistance < 0.01?

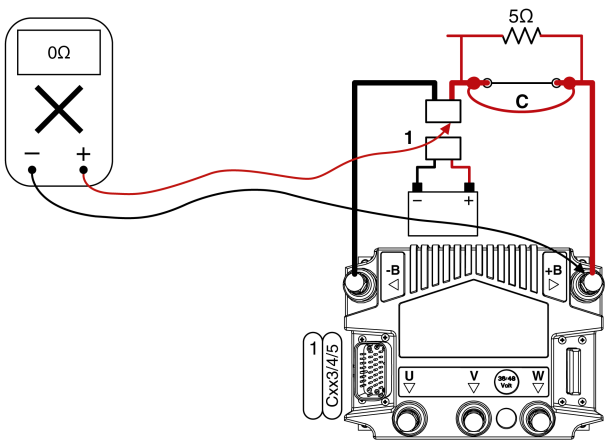
Note: If the Resistance is > 0.01? then record this as the Zero ? Value→↓

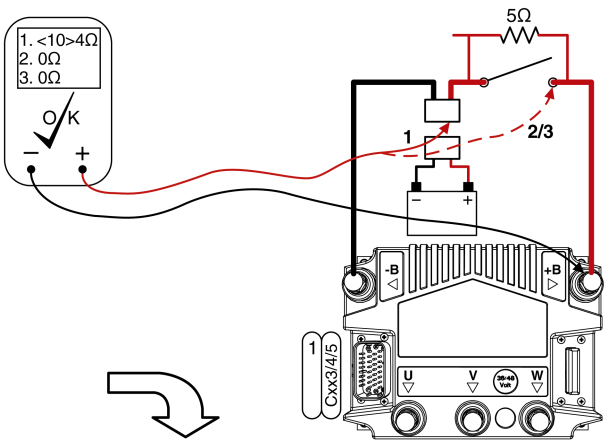
Motor Controller Contactor Failure (Cont)	
STEP A5	**CHECK RESISTANCE - Ω - OHMS**
Contactor Open	
	
1. >10 ? @ 25 °C (77 °F) = Faulty PTC→5↓0 ?→CAUSE B↓	1. <10 ? >4 ? = OK→Go to 2↓
2. > Zero Value +0.01 = High Resistance→Go to 5↓	2. ˜0 ? = OK→Go to 4↓
3. 8 ? = Open Circuit→Go to 5↓	3. ˜0 ? = OK→Go to 4↓
4. Repeat 2 & 3 on other Motor Controllers↑→Go to 5↓	
5. Find/Repair High Resistance Open Circuit→Go to 7↓	
6. Replace PTC(s)→Go to 7↓	
7. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→	
8. Recheck ?↑→ Reconnect→Test→CAUSE B↓	
CAUSE B	
Not Applicable	

Motor Controller Contactor Failure (Cont)

CAUSE C

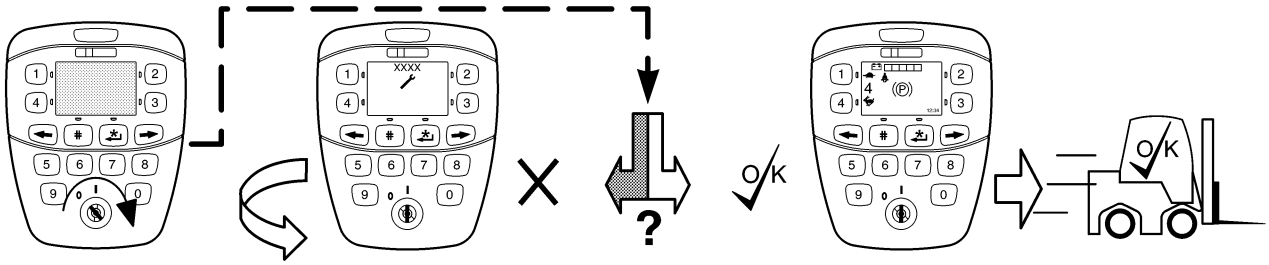
Contactor Closed





1. 0 ? = Shorted PTC/Welded Contacts→Go to 2↓	1. >4 ? <10 ? = OK→CAUSE C↓
2. Disconnect PTC→Recheck ?↓	
3. 8 ? = Shorted PTC Go to 4↓0 ? = Welded Contacts→Go to 5↓	
4. Replace PTC(s)→Go to 6↓	
5. Replace Contactor→Go to 6↓	
6. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→	
7. Recheck ?↑→ Reconnect→Test↓	

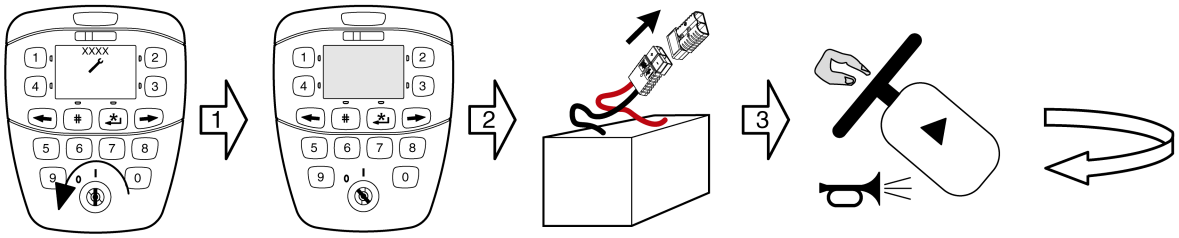
STEP C1



Retest - Power **ON**→	**NO**→?	Is fault DTC gone?**NO** **YES**←→	Fault corrected→Continue operation.

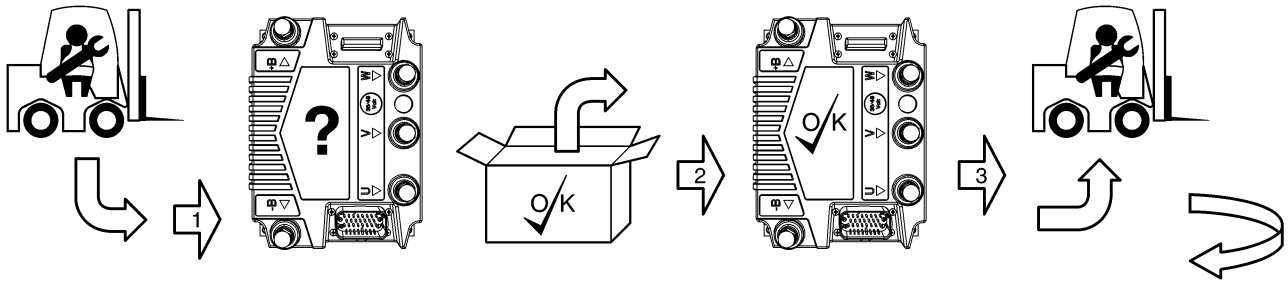
Motor Controller Contactor Failure (Cont)

CAUSE D



Power **OFF**→	Disconnect Battery and Sound Horn to Discharge Capacitors.→Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342→.	?

STEP D1

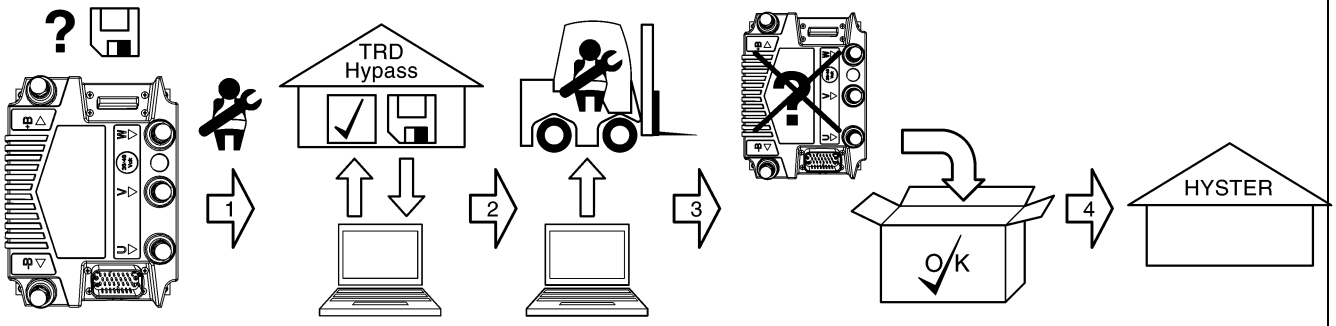


Remove and Replace Faulty Motor Controller↓

See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369↓

Check Replacement Controller 🖫 Version→See Label Information→Step 2↓

STEP D2



1. Go to TRD/Hypass Online /Software.?? Is Replacement Controller Application Software Version the Latest Version??

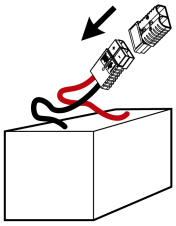
2. **NO**→Download the latest Application 🖫→Install on truck→Step 3↓

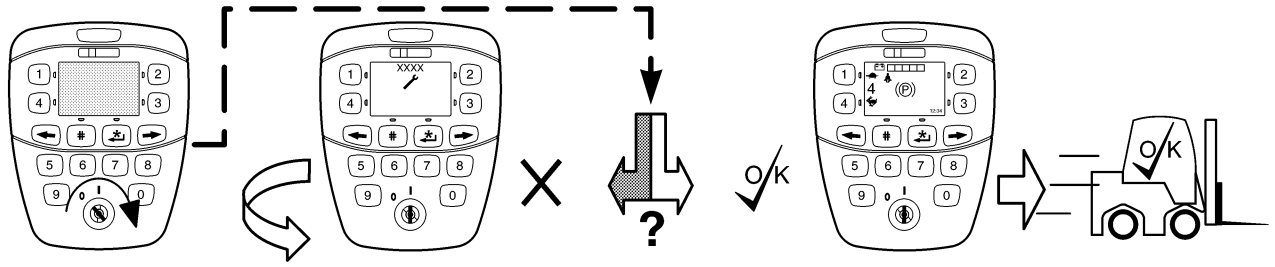
3. **YES**→Test New Installation→↓Step 3↓

4. Return Faulty Display→Dealer→Factory→Failure Analysis→?? Reprogramming

Motor Controller Contactor Failure (Cont)

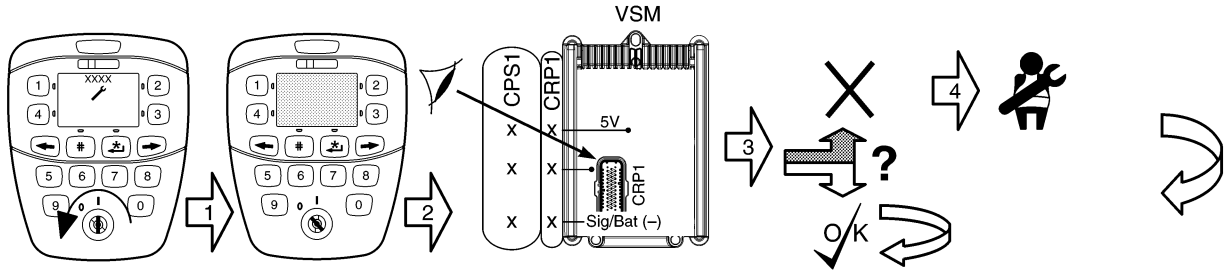
STEP D3





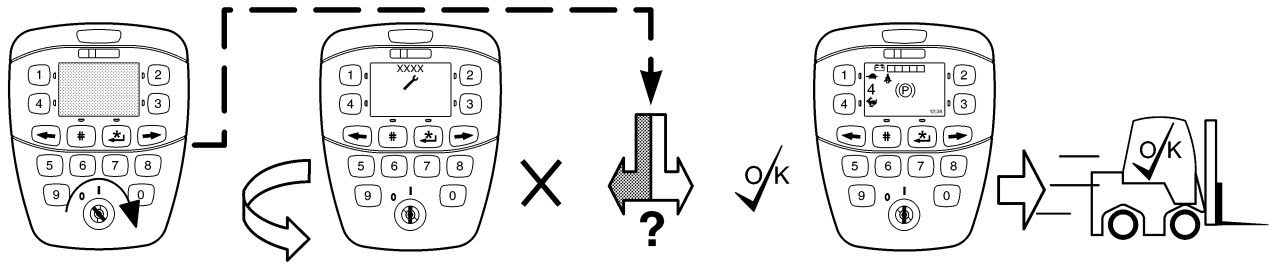
Retest - Power **ON**→	**NO**→?	Is fault DTC gone?**NO** **YES**←→	Fault corrected→Continue operation.

CAUSE E



Power **OFF**→	Inspect VSM Connections→OK Step 1	Not OK Correct/Repair→Step 1

STEP E1



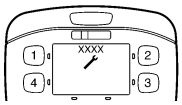
Retest - Power **ON**→	**NO**→Go to VSM Controller Check	Is fault DTC gone?**NO** **YES**←→	Fault corrected→Continue operation.

DTC LOGS: DTC logs should only be cleared once the data is by the Service Tech. See Display Menu Flowchart **- Clearing DTCs.**

END FAULT

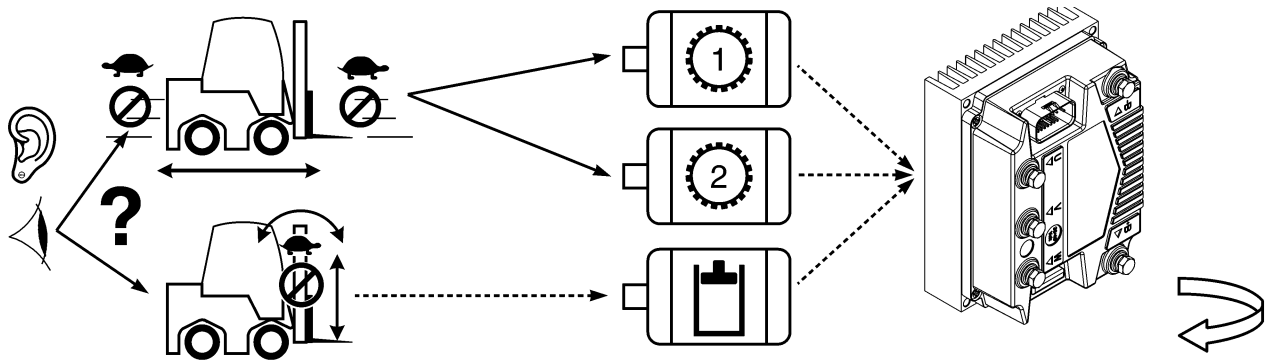
A935 – K160 D203 Motor Controller Capacitor Failure (Cont)

DTC 12592
Capacitor Charge



QUICK CHECK X = Open Circuit/Fail) = Short Circuit

Check 1

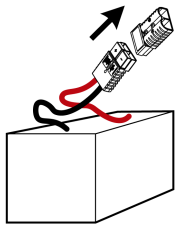
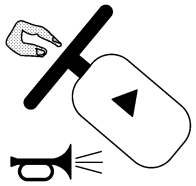
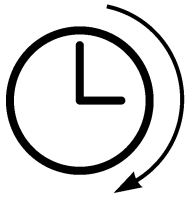
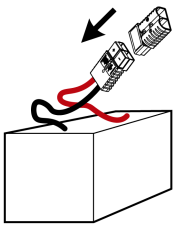


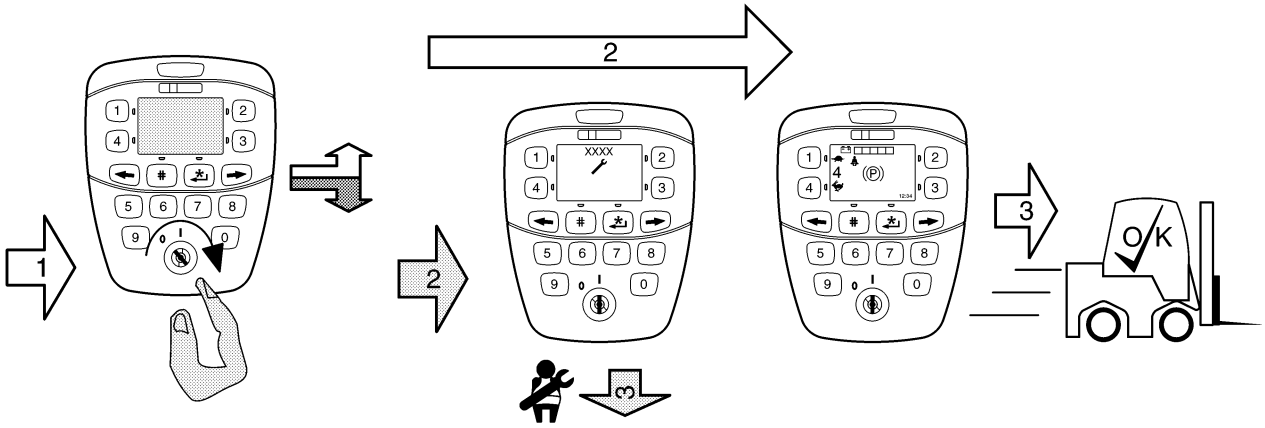
? Function Failure/Reduced Performance/Uncommanded Continuous Operation?

POSSIBLE CAUSES

1. Motor Controller Connections/Wiring High Resistance?→	→CAUSE 0↓
2. Motor Controller(s) Failure?→	→CAUSE C↓

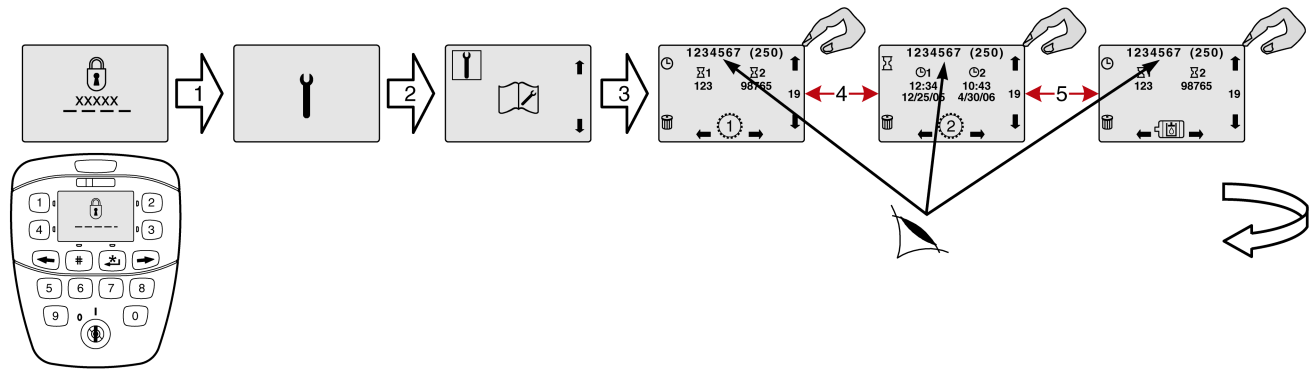
Check 2

			
Disconnect Battery and Sound Horn to Discharge Capacitors.Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342.	Wait 30 seconds	Reconnect Battery	

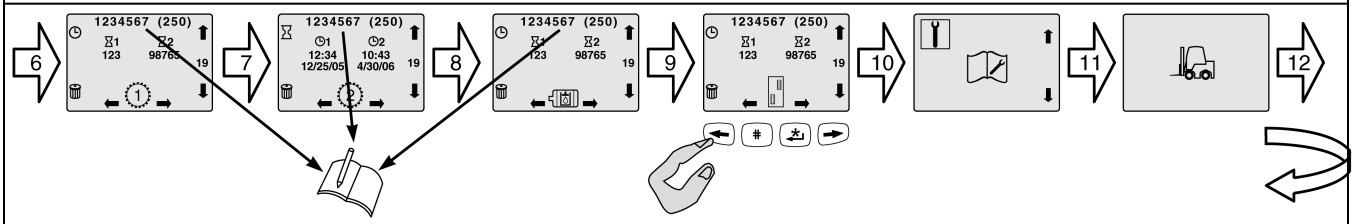
A935 – K160 D203 Motor Controller Capacitor Failure (Cont)		
Check 3		
		
Power **ON**→	Fault Remains Service Required ?	No Fault→Resume Operation

A935 – K160 D203 Motor Controller Capacitor Failure (Cont)

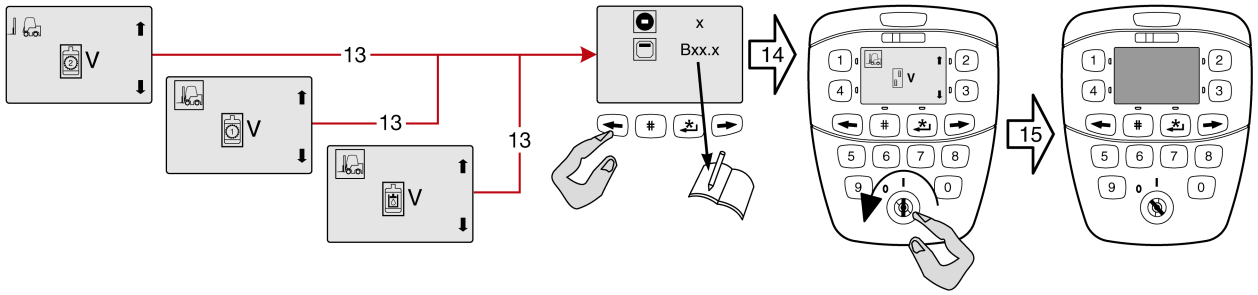
FAULT LOG Review - Go to Display Menu



Enter SERVICE Password→Diagnostic→FAULT LOGs→Motor Fault Log(s)→View all Motor DTCs→?



all Motor DTCs→Exit Fault Log→Truck Status ?



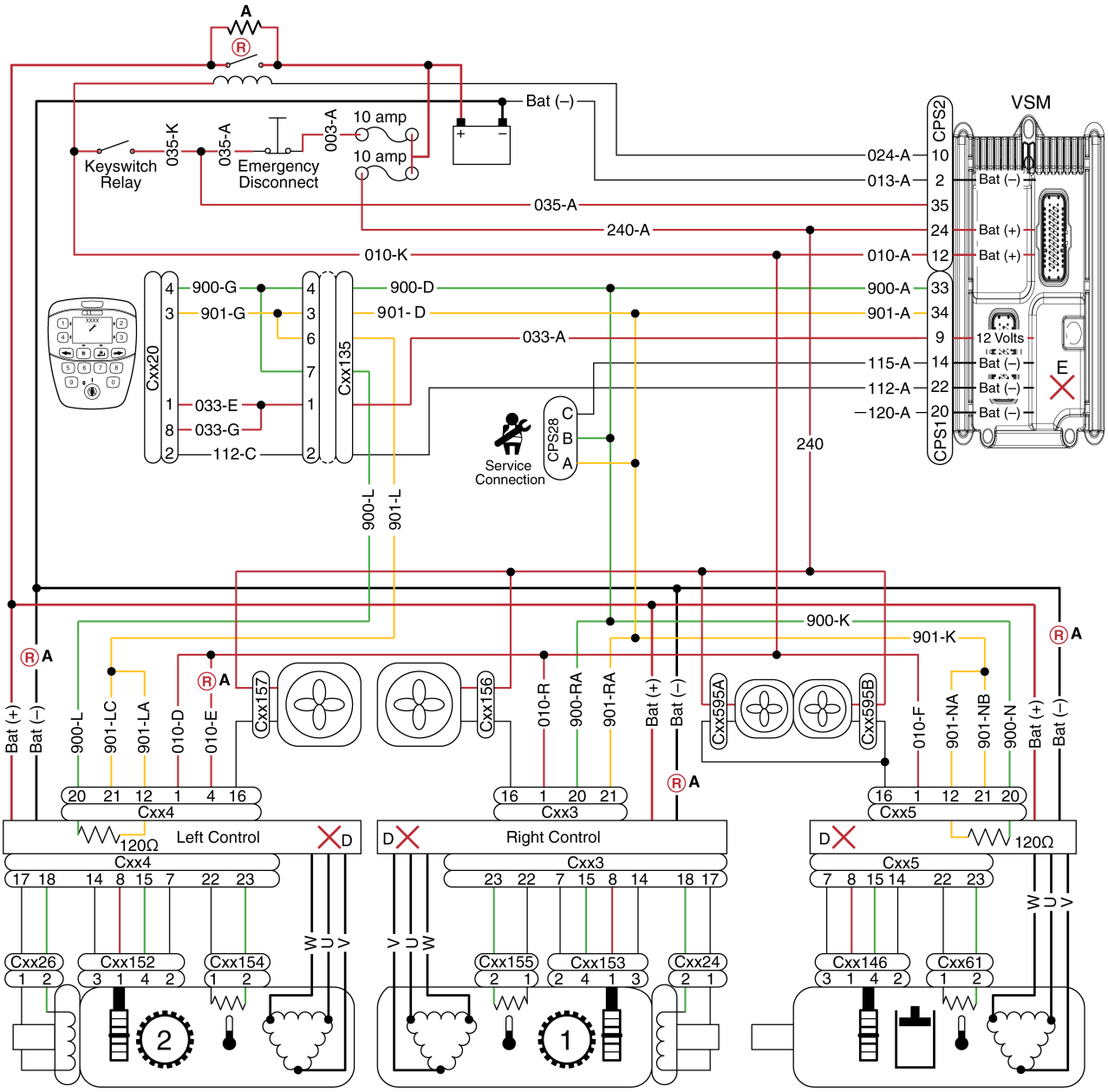
NOTE: Fault Logs will indicate which Motor/Motor Controller has the faulty Component/Connection

Motor Versions→Hardware/Software Versions→Exit Versions→Power **OFF**?

POSSIBLE CAUSES X = Open Circuit/Fail) = Short Circuit

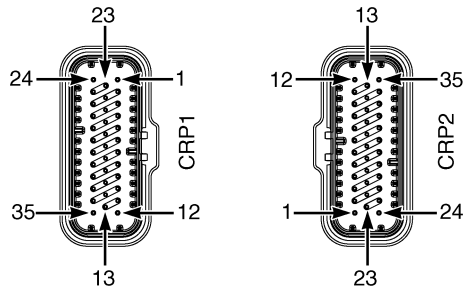
A935 – K160 D203 Motor Controller Capacitor Failure (Cont)

MOTOR CONTROLLER CAPACITOR FAILURE CAUSES A B C D E > ?

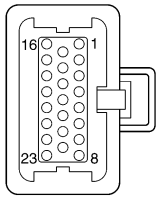


A935 – K160 D203 Motor Controller Capacitor Failure (Cont)

CONNECTORS

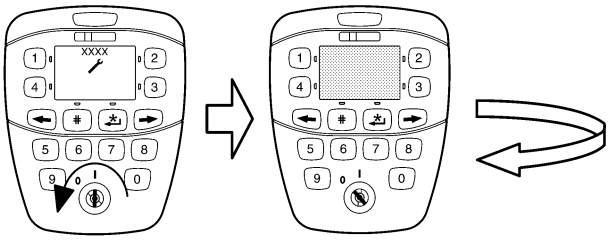


VSM Cxx 1 and Cxx 2



Traction/Pump Controller Cxx 3, 4, and 5

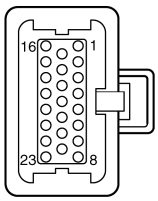
CAUSE A

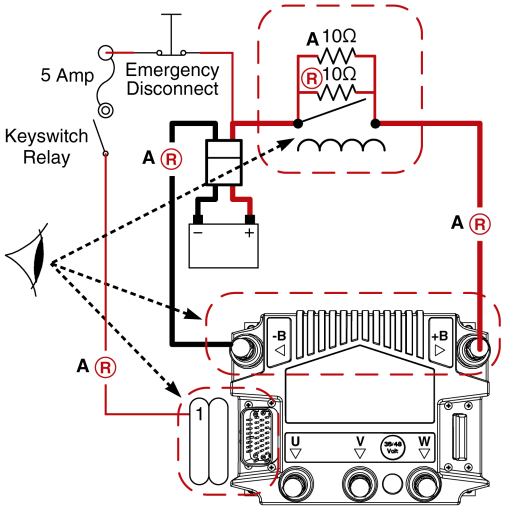


Power **OFF**→ ?

STEP A1

For any Fault DTC→Locate Device→Inspect ALL Wiring/ConnectionsSee Motor Controller Contactor Failure





CAUSE B

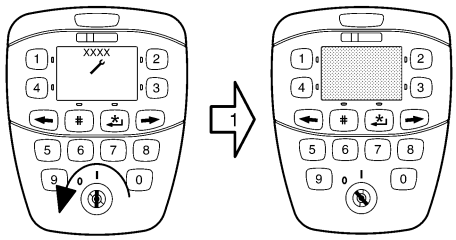
Not Applicable

CAUSE C

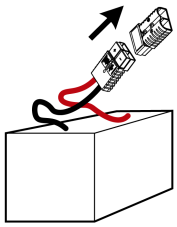
Not Applicable

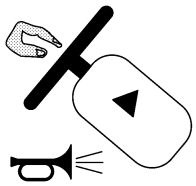
A935 – K160 D203 Motor Controller Capacitor Failure (Cont)

CAUSE D



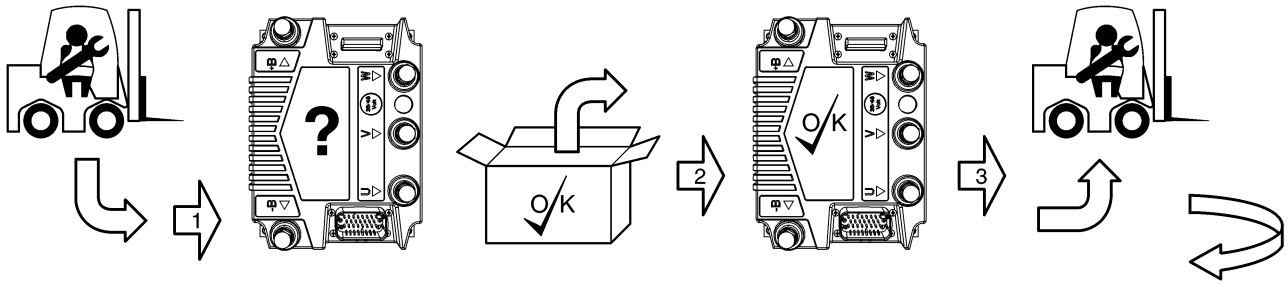
Power **OFF**→





Disconnect Battery and Sound Horn to Discharge Capacitors.→Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342→.

STEP D1

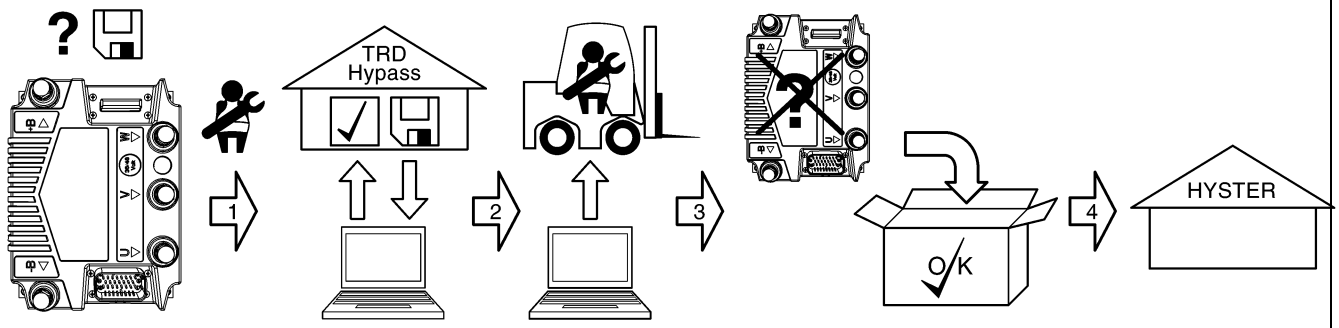


Remove and Replace Faulty Motor Controller↓

See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369↓

Check Replacement Controller 🖫 Version→See Label Information→Step 2↓

STEP D2



1. Go to TRD/Hypass Online /Software.?? Is Replacement Controller Application Software Version the Latest Version??

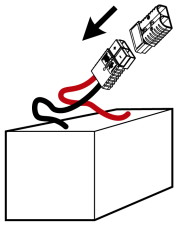
2. **NO**→Download the latest Application 🖫→Install on truck→Step 3↓

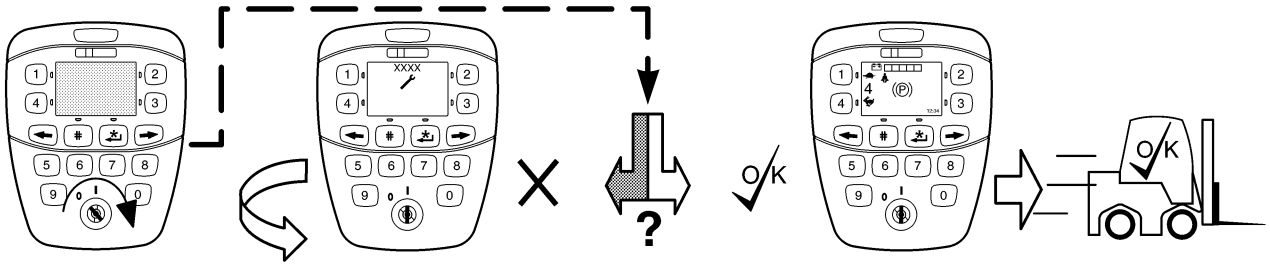
3. **YES**→Test New Installation→↓Step 3↓

4. Return Faulty Display→Dealer→Factory→Failure Analysis→?? Reprogramming

A935 – K160 D203 Motor Controller Capacitor Failure (Cont)

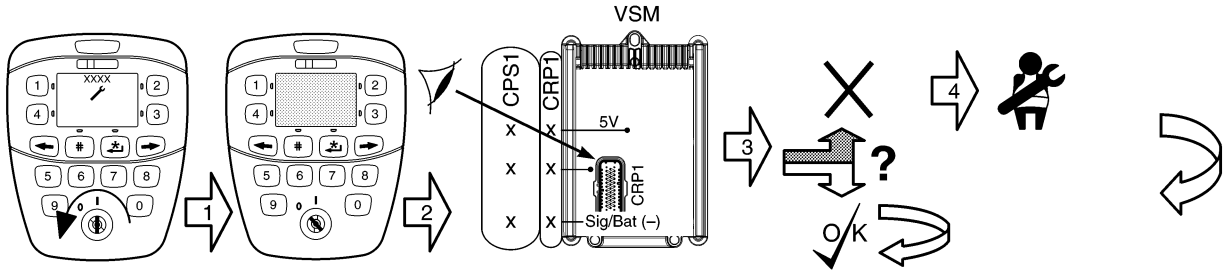
STEP D3





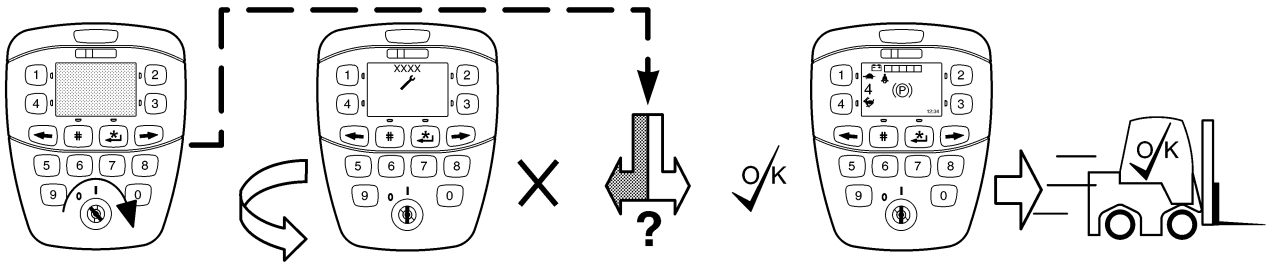
Retest - Power **ON**→	**NO**→?	Is fault DTC gone?**NO** **YES**←→	Fault corrected→Continue operation.

CAUSE E



Power **OFF**→	Inspect VSM Connections→OK Step 1	Not OK Correct/Repair→Step 1

STEP E1



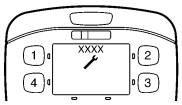
Retest - Power **ON**→	**NO**→Go to VSM Controller Check	Is fault DTC gone?**NO** **YES**←→	Fault corrected→Continue operation.

DTC LOGS: DTC logs should only be cleared once the data is by the Service Tech. See Display Menu Flowchart **- Clearing DTCs.**

END FAULT

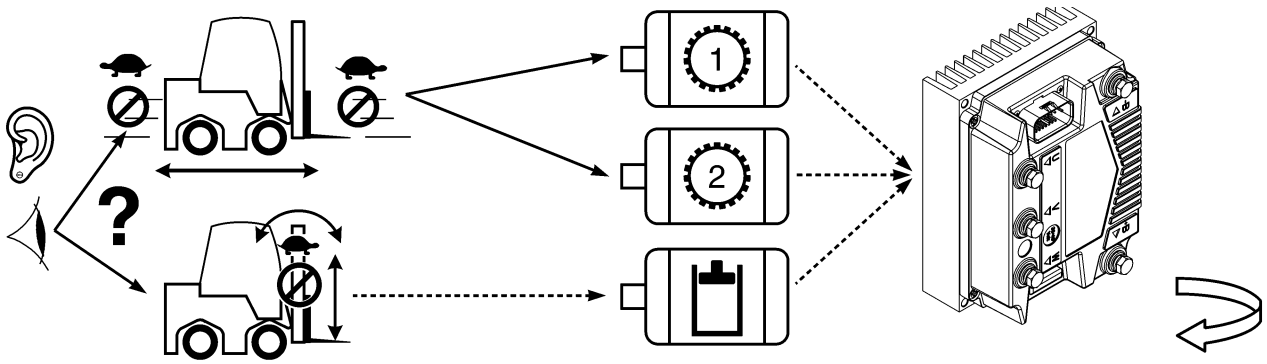
A935 – K160 D203 Motor Speed Sensor Failure (Cont)

DTC 29456
Sensor Fault



QUICK CHECK X = Open Circuit/Fail) = Short Circuit

Check 1

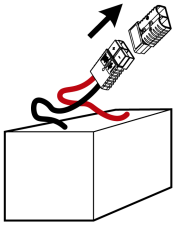
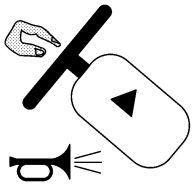
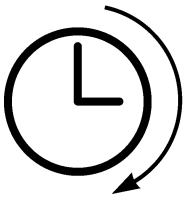
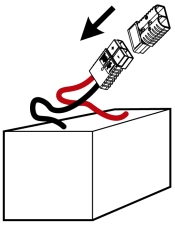


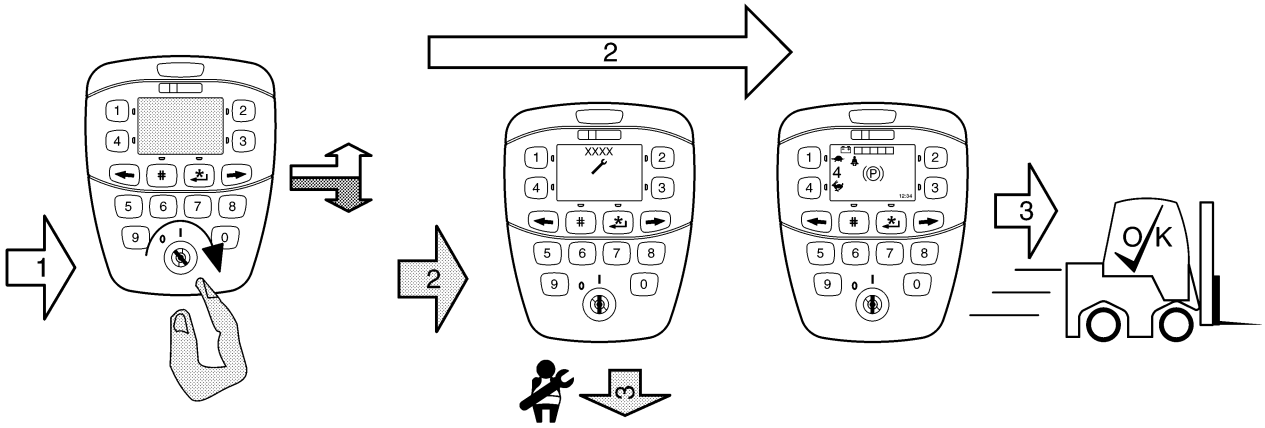
?No Traction/Hydraulic Operation?

POSSIBLE CAUSES

1. Speed Sensor/Motor Controller Connections/Wiring?→
2. Speed Sensor Failure?→
3. Brake Drag and/or Axle Lockup?→Go to Brake and Axle Drag Check, Operational Checkout.↓
4. Motor Controller(s) Failure ?→
5. Motor Failure ?→

Check 2

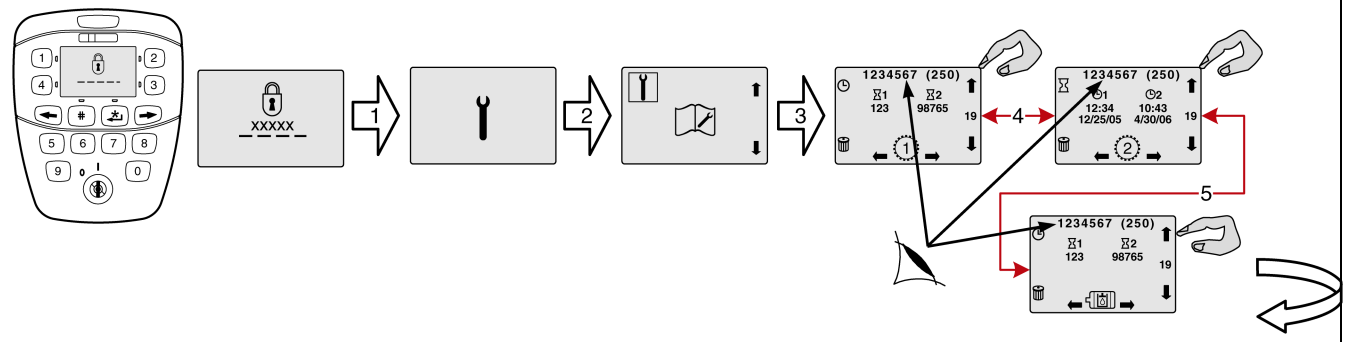
			
Disconnect Battery and Sound Horn to Discharge Capacitors.Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342.	Wait 30 seconds	Reconnect Battery	

A935 – K160 D203 Motor Speed Sensor Failure (Cont)		
Check 3		
		
Power **ON**→	Fault Remains Service Required ?	No Fault→Resume Operation

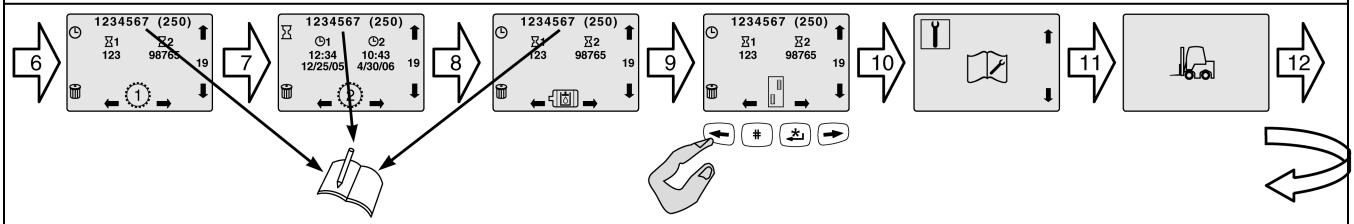
A935 – K160 D203 Motor Speed Sensor Failure (Cont)

Check 4

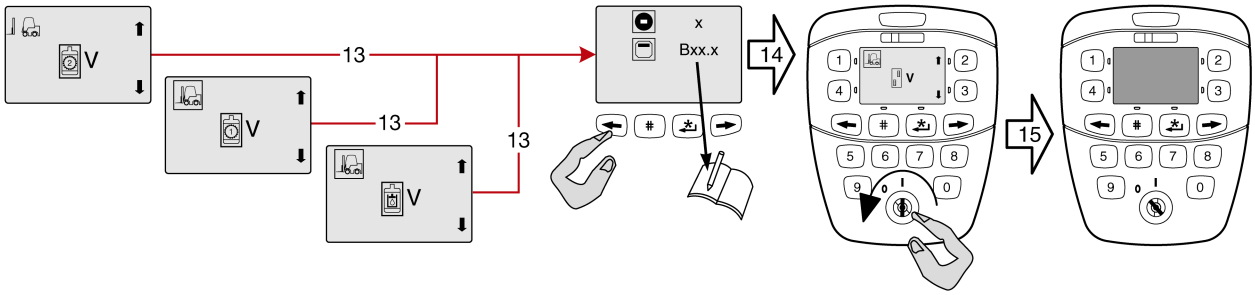
FAULT LOG Review - Go to Display Menu



Enter Service Password→Diagnostic→FAULT LOGs→Motor Fault Log(s)→View all Motor DTCs→?



📋✍ all Motor DTCs→☜Exit Fault Log→Truck Status ?

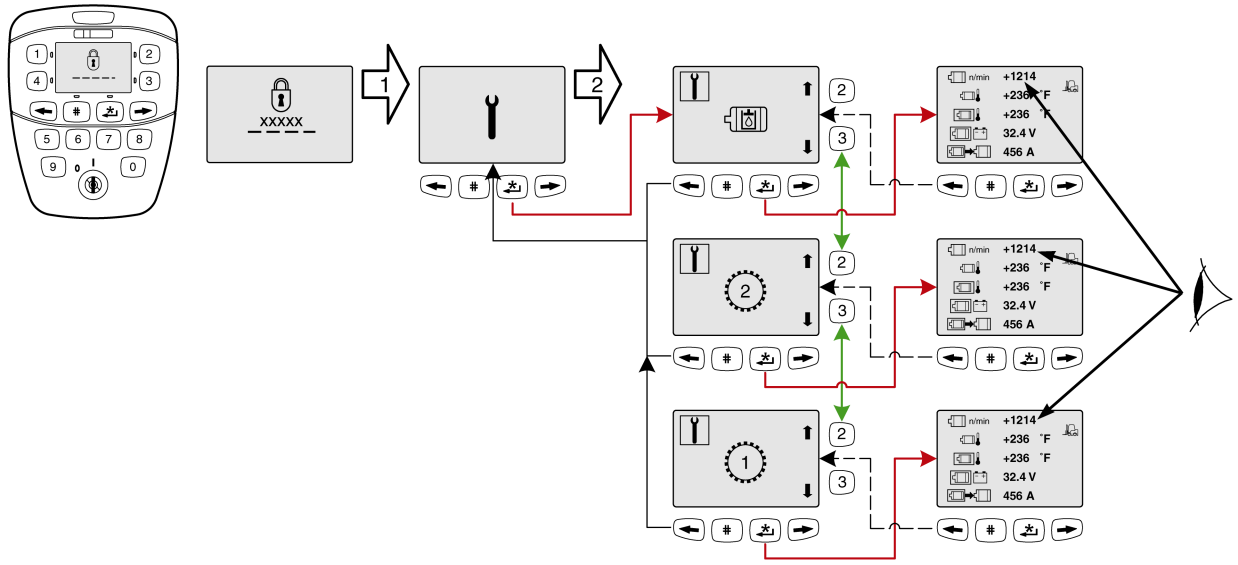


Motor Versions→📋✍Hardware/Software Versions→☜Exit Versions→Power **OFF**?

NOTE: Fault Logs will indicate which Motor/Motor Controller has the faulty Component/Connection

A935 – K160 D203 Motor Speed Sensor Failure (Cont)

Diagnostics Speed Sensor Analysis – Use to Validate Correct Sensor Operation after Repairs

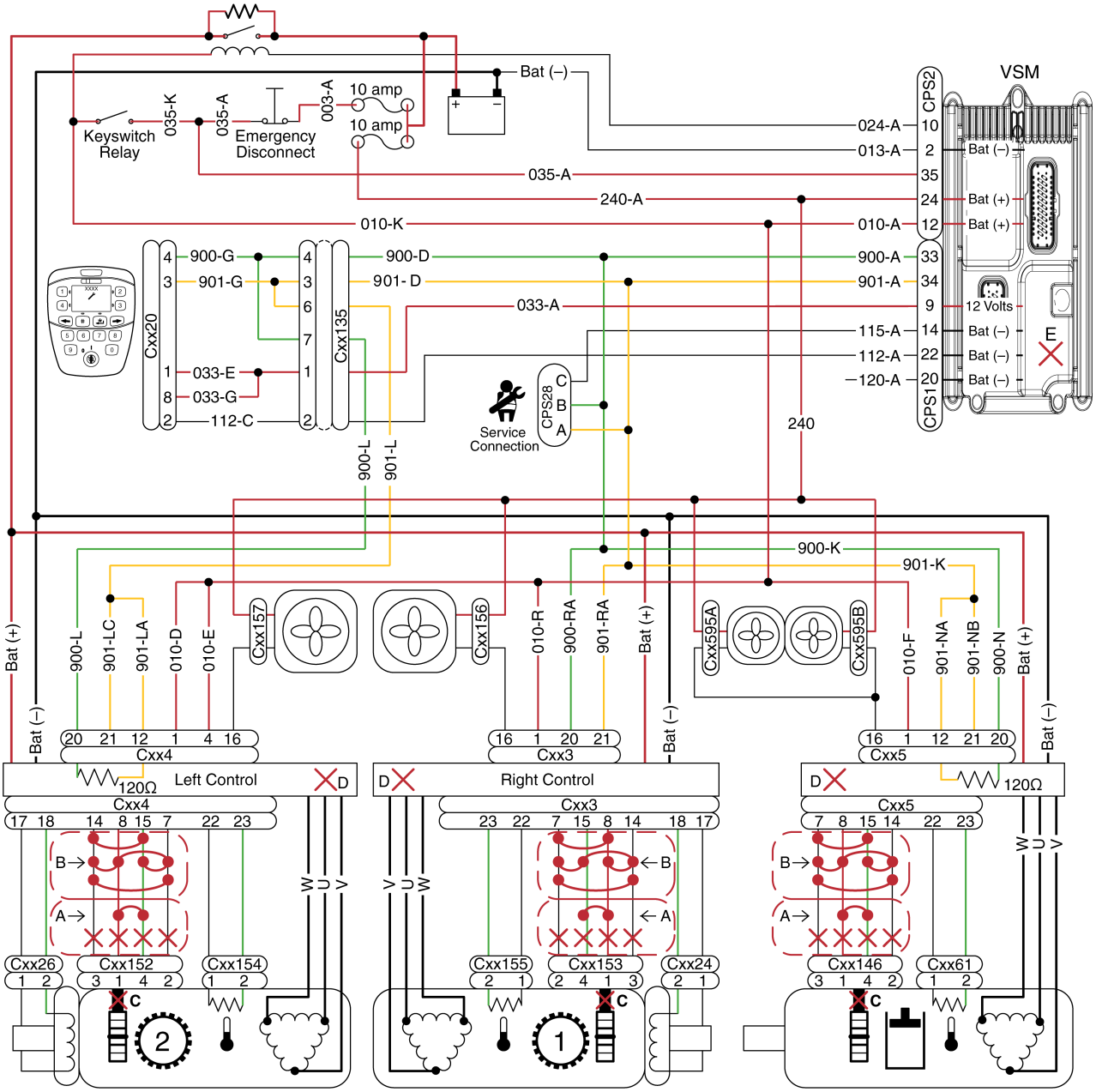


NOTE: If Motor Operation is Disabled then no speed will be displayed

POSSIBLE CAUSES X = Open Circuit/Fail) = Short Circuit

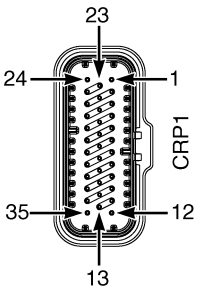
A935 – K160 D203 Motor Speed Sensor Failure (Cont)

WHEEL MOTOR SPEED SENSOR FAILURE CAUSES A B C D E > ?

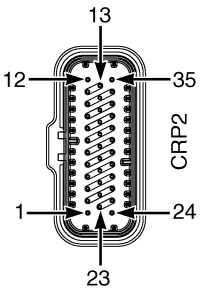


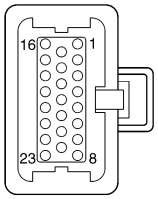
A935 – K160 D203 Motor Speed Sensor Failure (Cont)

CONNECTORS

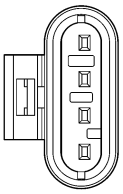


VSM Cxx 1 and Cxx 2



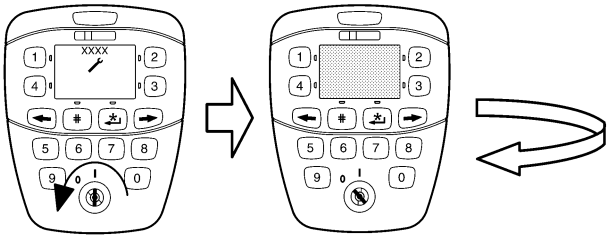


Traction/Pump Controller Cxx 3, 4, and 5



Speed Sensor Motor Connector Cxx 146, 152, and 153

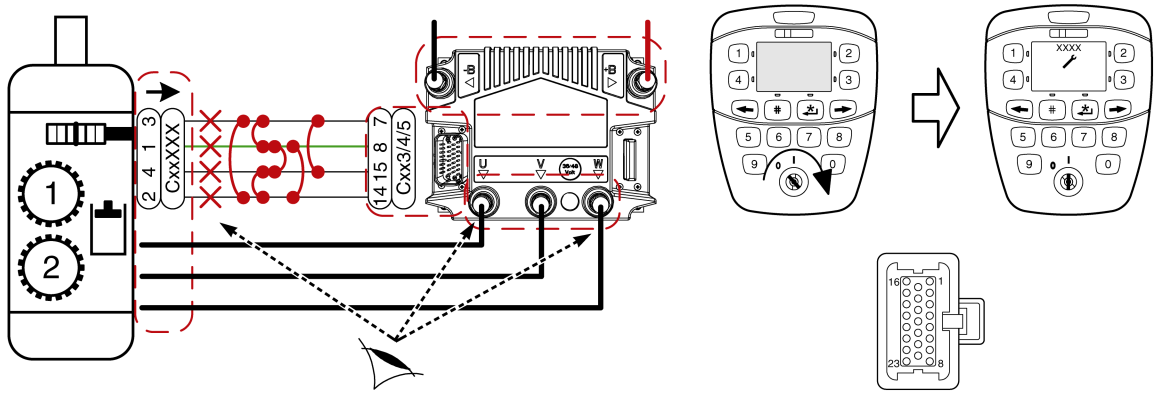
CAUSE A



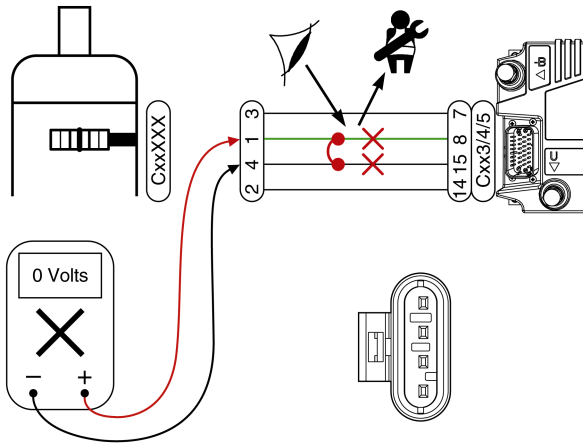
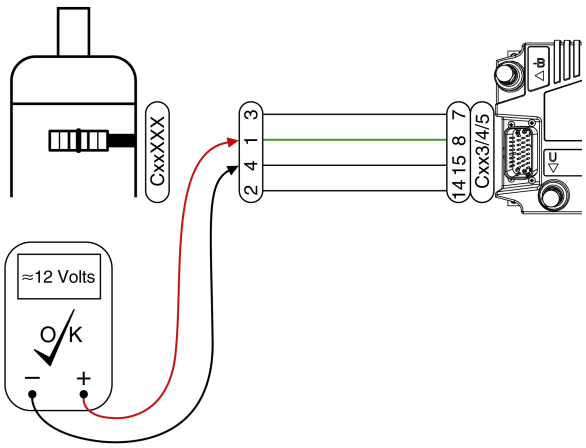
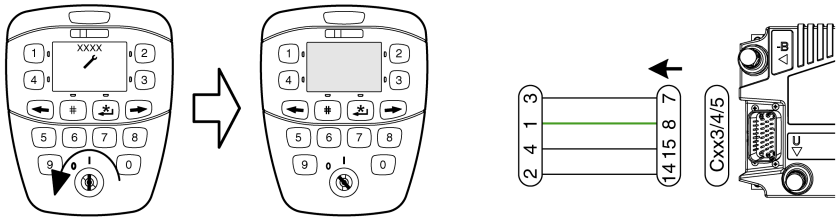
Power **OFF**→ ?

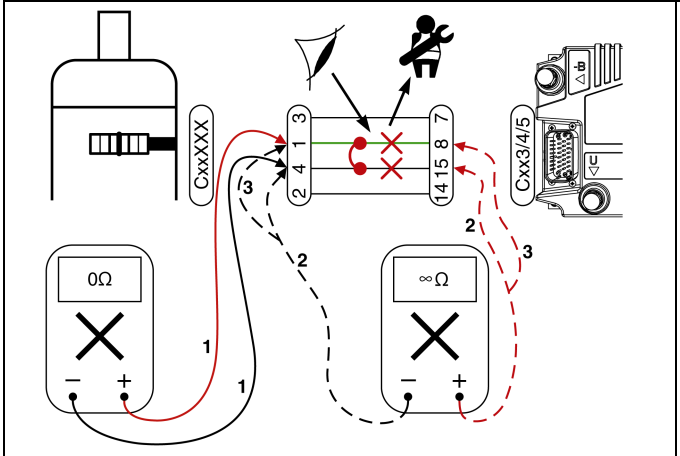
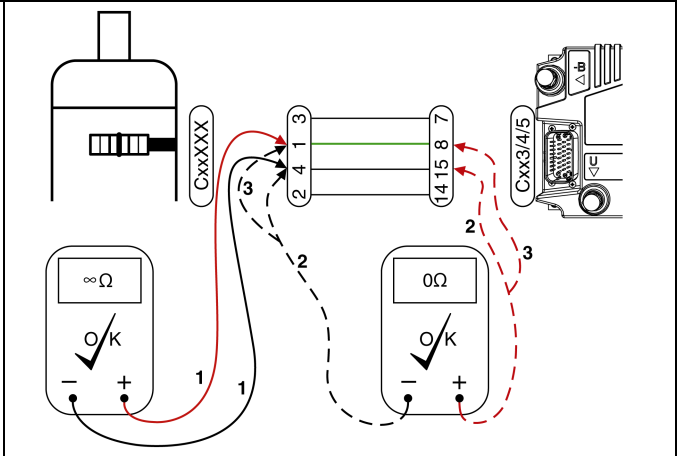
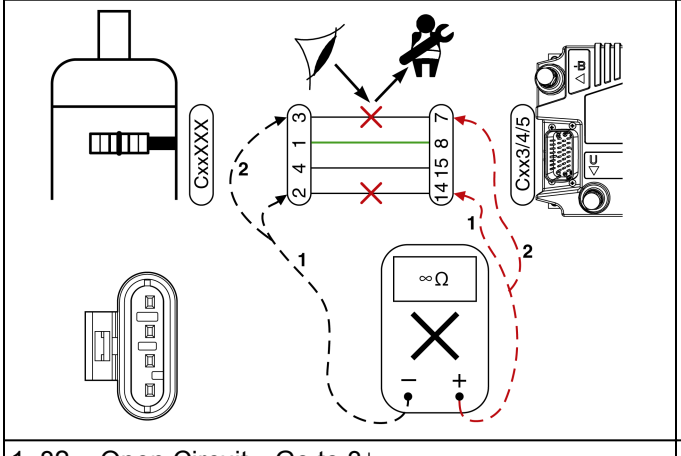
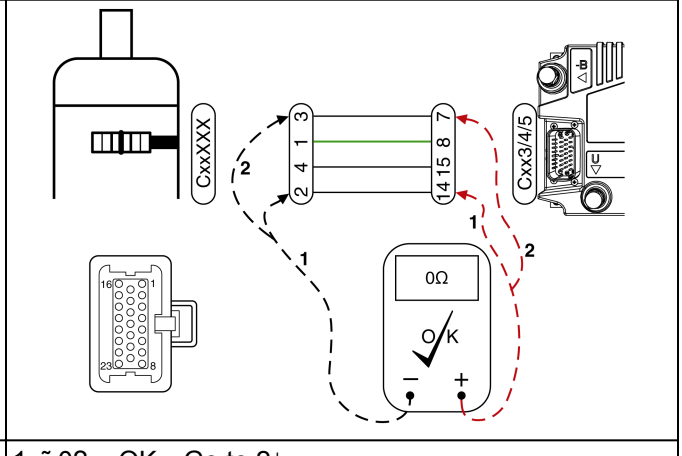
STEP A1

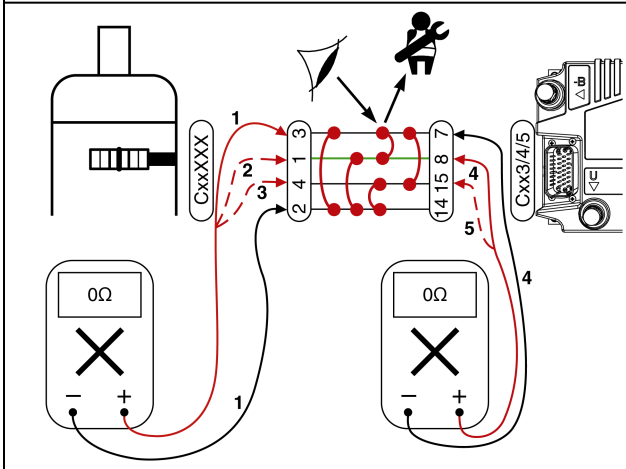
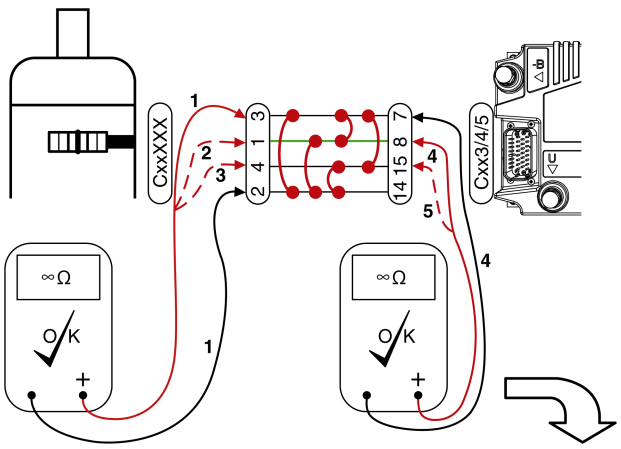
For any Fault DTC→Locate Device→Inspect ALL Wiring/Connections

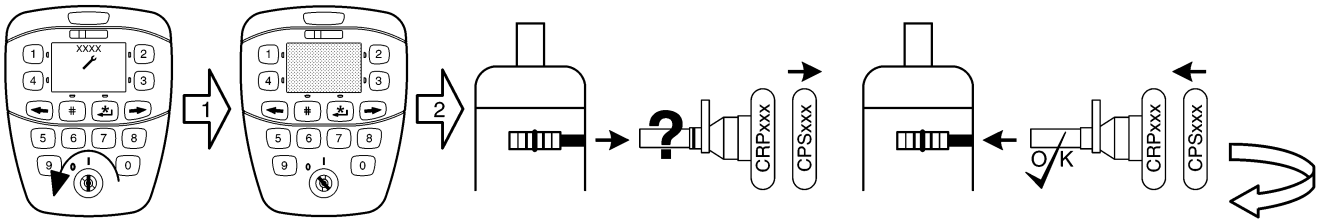
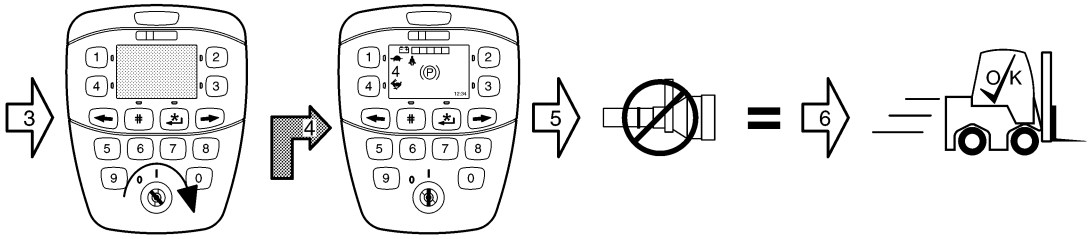
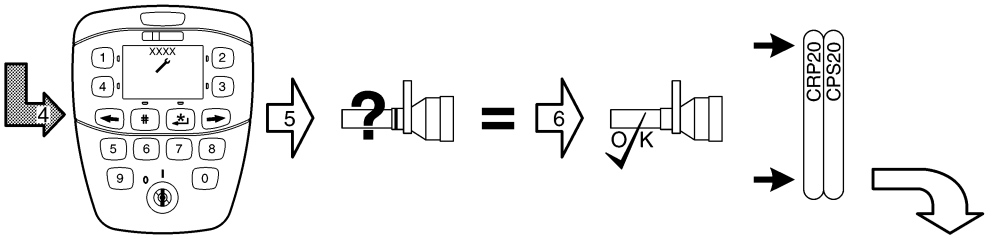


Disconnect Cxx XXX as indicated from the Fault Logs→Power **ON**↓

A935 – K160 D203 Motor Speed Sensor Failure (Cont)	
STEP A2	**CHECK VOLTAGE**
Speed Sensor Supply	
	
1. 0 Volts = Open/Short Circuit→Step 3↓	1 ˜ 12 Volts = OK→Step 3↓Step 5↓
2. Bat Volts = Short to Bat (+)→CAUSE A↓	2. ˜ 12 Volts = OK→Step 3↓Step 5↓
STEP A3	**CHECK RESISTANCE - Ω - OHMS**
	
Power **OFF**→Disconnect Cxx 3, 4, or 5 as indicated from the Fault Logs→	

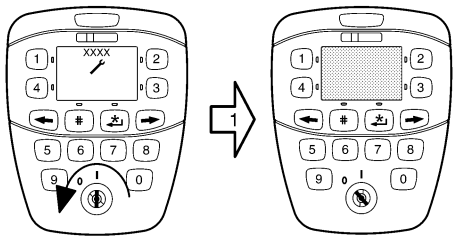
A935 – K160 D203 Motor Speed Sensor Failure (Cont)	
STEP A4	**CHECK RESISTANCE - Ω - OHMS**
Speed Sensor Connections	
	
1. 0? = Short Circuit→Go to 4↓	1 ˜ 8? = OK→Go to 2↓
2. 8? = Open Circuit→Go to 4↓	2. ˜ 0? = OK→Go to 3↓
3. 8? = Open Circuit→Go to 4↓	3. ˜ 0? = OK→CAUSE A↓
4. Find/Repair Short/Open Circuit See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→	
5. Recheck ?↑→ Reconnect→Use Display Diagnostics to validate→Test OK→YES→Resume Opera-tionNo→CAUSE A↓	
STEP A5	**CHECK RESISTANCE - Ω - OHMS**
Speed Sensor Connections	
	
1. 8? = Open Circuit→Go to 3↓	1. ˜ 0? = OK→Go to 2↓
2. 8? = Open Circuit→Go to 3↓	2. ˜ 0? = OK→CAUSE A↓
3. Find/Repair Open Circuit See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→	
4. Recheck ?↑→ Reconnect→Use Display Diagnostics to validate→Test OK→YES→Resume Opera-tionNo→CAUSE A↓	

A935 – K160 D203 Motor Speed Sensor Failure (Cont)	
CAUSE B	
Speed Sensor Connections	
	
1. 0? = Short Circuit→Go to 6↓	1. ˜ 8? = OK→Go to 2↓
2. 0? = Short Circuit→Go to 6↓	2. ˜ 8? = OK→Go to 3↓
3. 0? = Short Circuit→Go to 6↓	3. ˜ 8? = OK→Go to 4↓
4. 0? = Short Circuit→Go to 6↓	4. ˜ 8? = OK→Go to 5↓
5. 0? = Short Circuit→Go to 6↓	5. ˜ 8? = OK→CAUSE B↓
6. Find/Repair Short Circuit See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→Go to 7↓	
7. Recheck ?↑→ Reconnect→Use Display Diagnostics to validate→Test OK→YES→Resume OperationNo→CAUSE B↓	

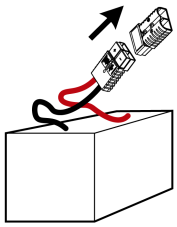
A935 – K160 D203 Motor Speed Sensor Failure (Cont)			
CAUSE C			
Sensor Failure			
			
Power **OFF**→		Remove/Replace Motor Speed Sensor↓	
See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→Step 1↓			
STEP C1			
			
Power **ON**→⇳	DTCs Gone→	Original Sensor Faulty→	Resume Operation
			
	DTCs Present→	Original Sensor OK/Reinstall Original Sensor→CAUSE C↓	

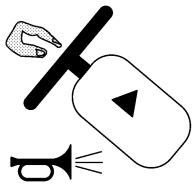
A935 – K160 D203 Motor Speed Sensor Failure (Cont)

CAUSE D



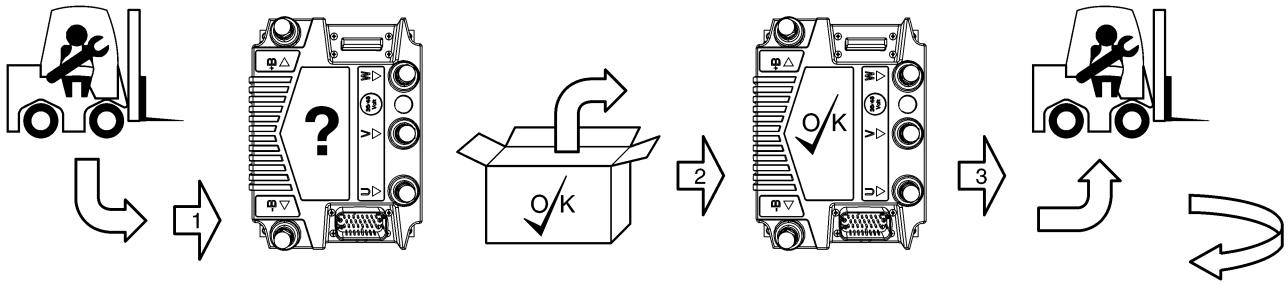
Power **OFF**→





Disconnect Battery and Sound Horn to Discharge Capacitors.→Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342→.

STEP D1

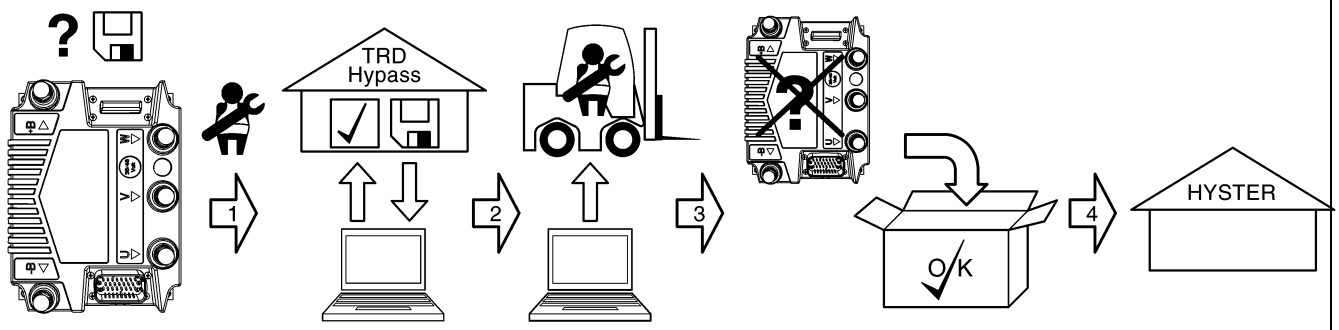


Remove and Replace Faulty Motor Controller↓

See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369↓

Check Replacement Controller 🖫 Version→See Label Information→Step 2↓

STEP D2



1. Go to TRD/Hypass Online /Software.?? Is Replacement Controller Application Software Version the Latest Version??

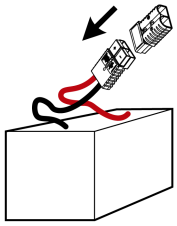
2. **NO**→Download the latest Application 🖫→Install on truck→Step 3↓

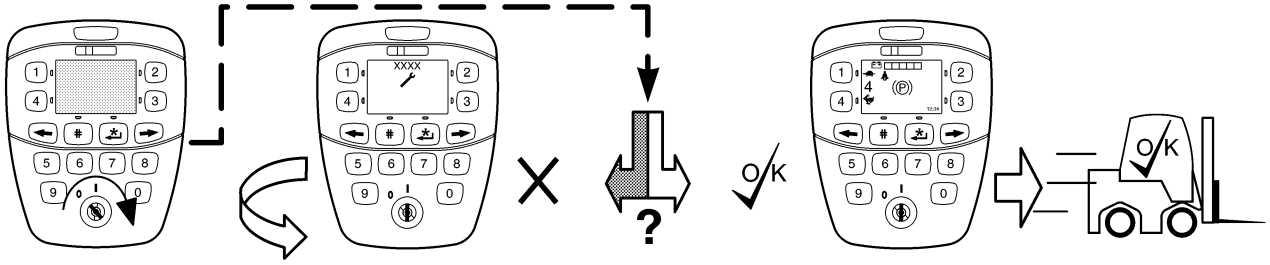
3. **YES**→Test New Installation→↓Step 3↓

4. Return Faulty Display→Dealer→Factory→Failure Analysis→?? Reprogramming

A935 – K160 D203 Motor Speed Sensor Failure (Cont)

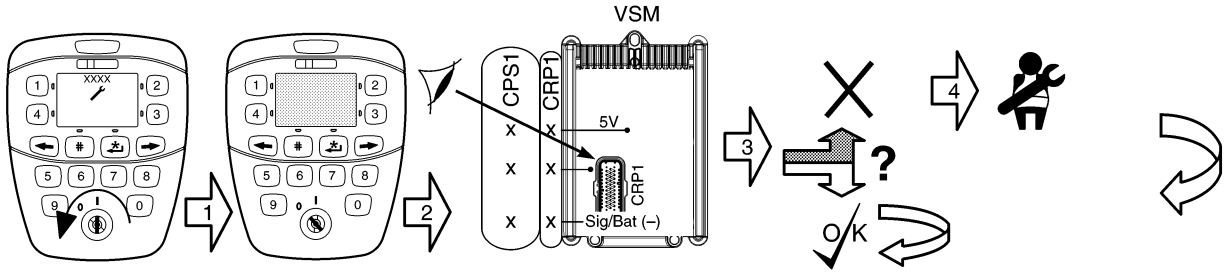
STEP D3





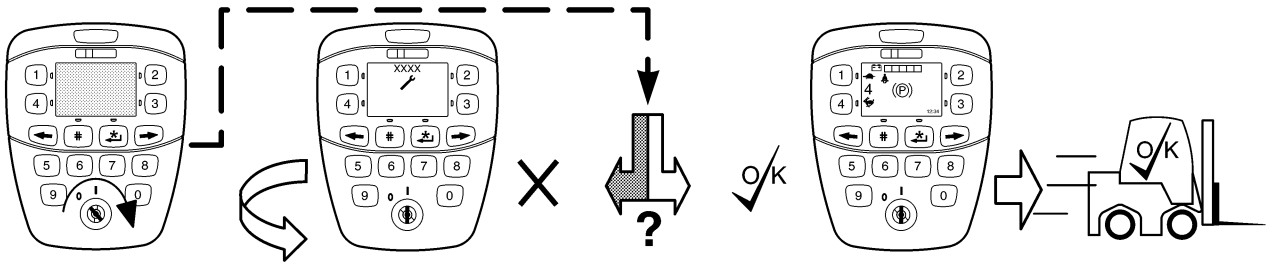
Retest - Power **ON**→	**NO**→?	Is fault DTC gone?**NO** **YES**←→	Fault corrected→Continue operation.

CAUSE E



Power **OFF**→	Inspect VSM Connections→OK Step 1	Not OK Correct/Repair→Step 1

STEP E1

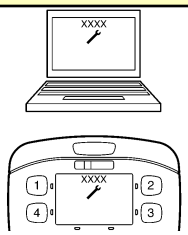


Retest - Power **ON**→	**NO**→Go to VSM Controller Check	Is fault DTC gone?**NO** **YES**←→	Fault corrected→Continue operation.

DTC LOGS: DTC logs should only be cleared once the data is by the Service Tech. See Display Menu Flowchart **- Clearing DTCs.**

END FAULT

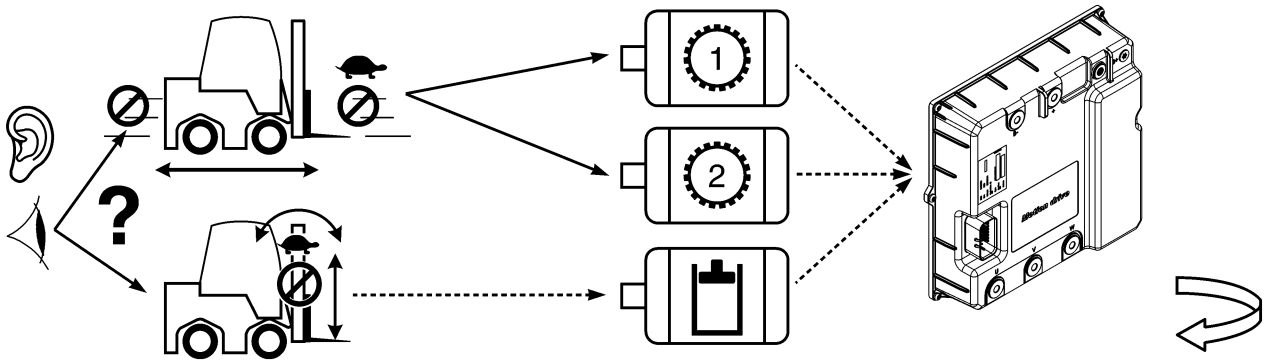
CBB/DBB Motor Speed Sensor Failure (Cont)



DTC 25104 DTC 29456
Sensor FaultSensor Fault

QUICK CHECK X = Open Circuit/Fail) = Short Circuit

Check 1



?No Traction/Hydraulic Truck Operation?

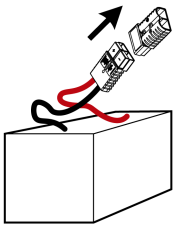
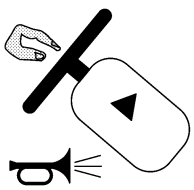
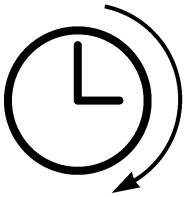
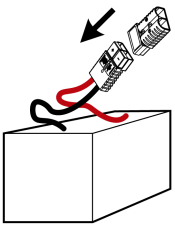
POSSIBLE CAUSES

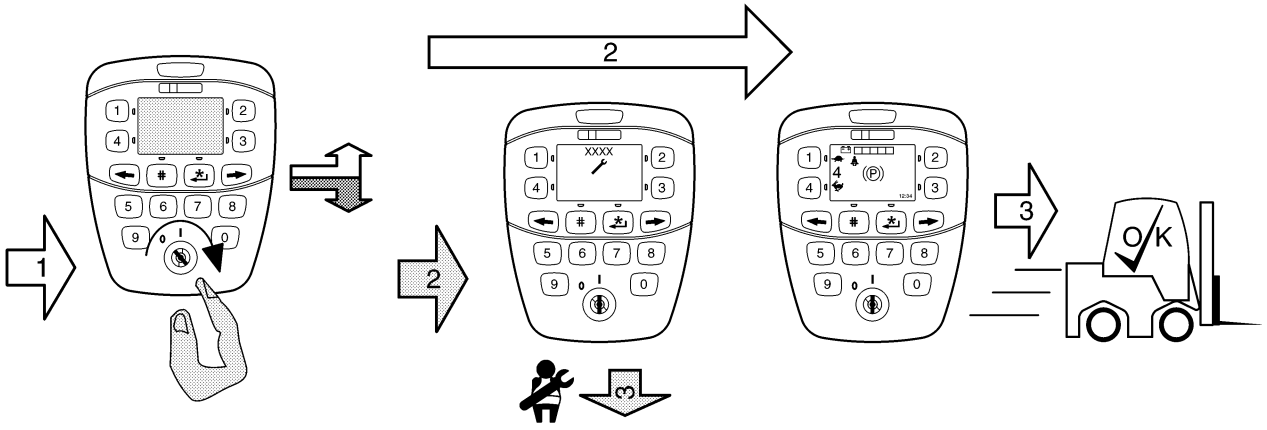
1. Speed Sensor/Motor Controller Connections/Wiring?→
2. Speed Sensor Failure?→
3. Motor Controller(s) Failure ?→
4. Motor Failure ?→

WARNING

The CBB Truck requires the removal of the battery to access the Controllers and Motors

Check 2

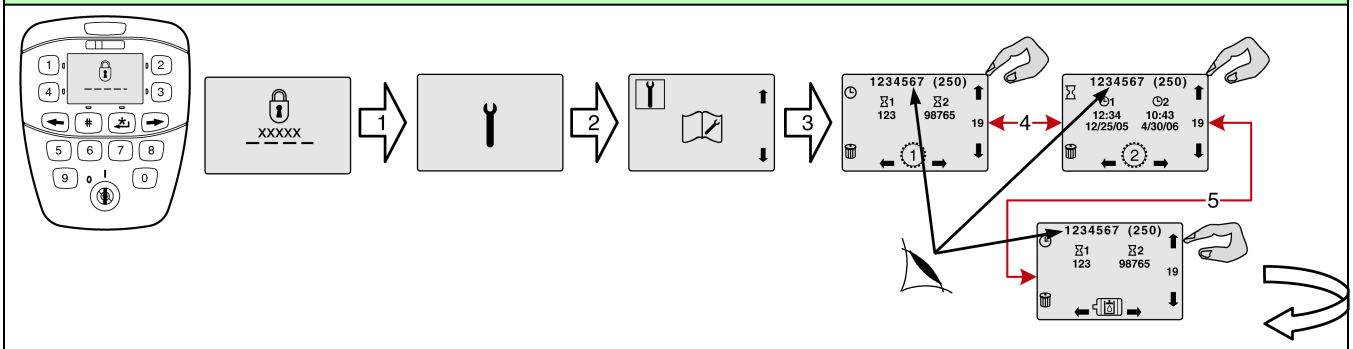
			
Disconnect Battery and Sound Horn to Discharge Capacitors.Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342.		Wait 30 seconds	Reconnect Battery

CBB/DBB Motor Speed Sensor Failure (Cont)		
Check 3		
		
Power **ON**→	Fault Remains Service Required ?	No Fault→Resume Operation

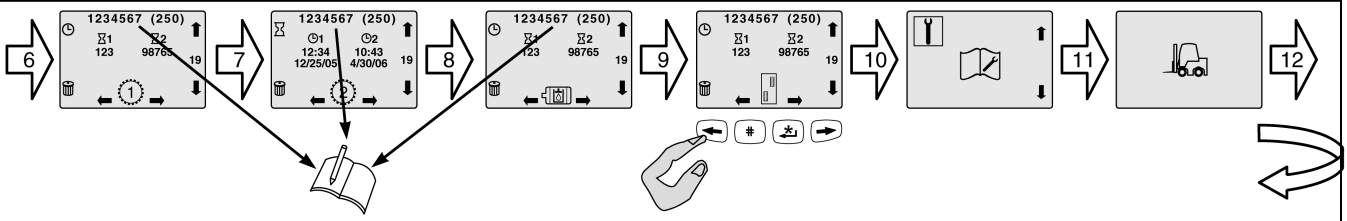
CBB/DBB Motor Speed Sensor Failure (Cont)

Check 4

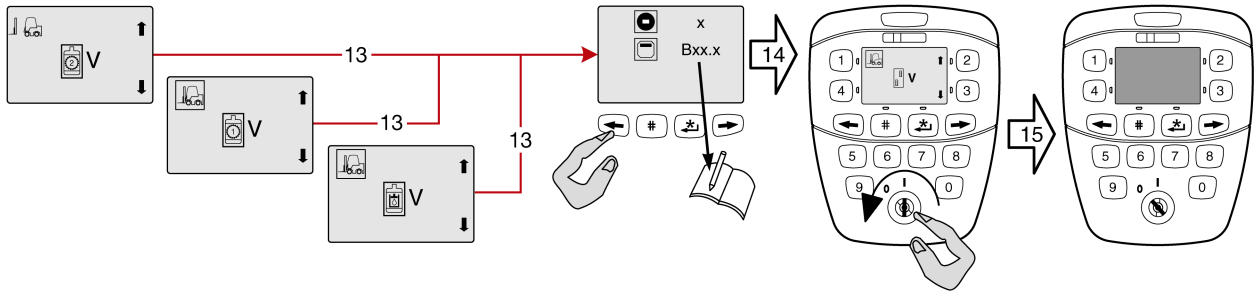
FAULT LOG Review - Go to Display Menu



Enter Service Password→Diagnostic→FAULT LOGs→Motor Fault Log(s)→View all Motor DTCs→?



all Motor DTCs→Exit Fault Log→Truck Status ?

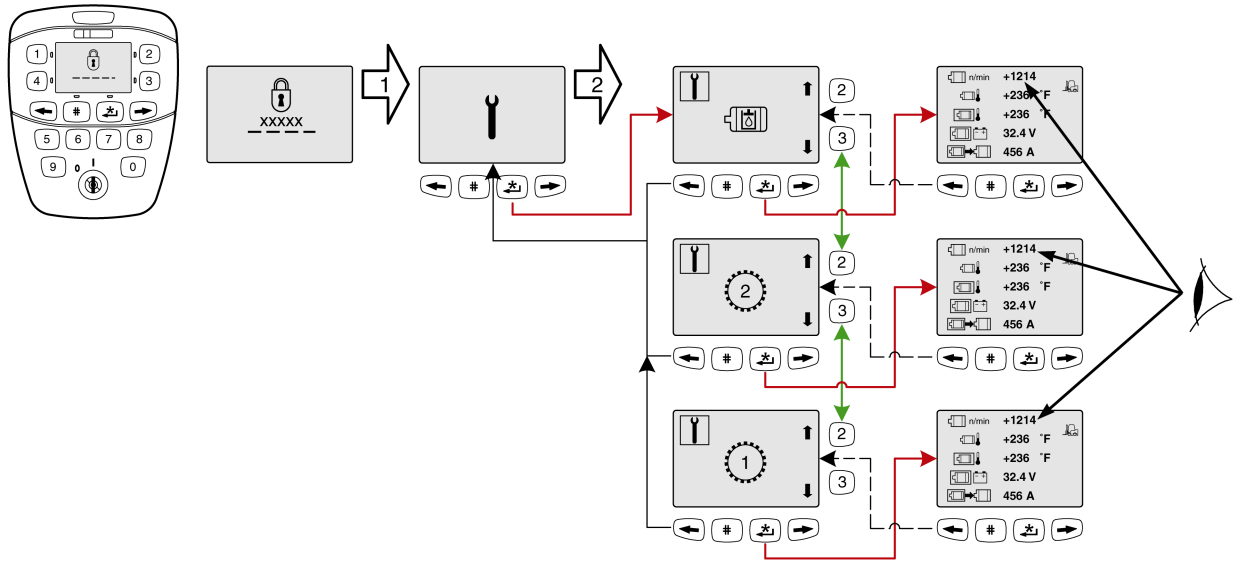


Motor Versions→Hardware/Software Versions→Exit Versions→Power **OFF**?

NOTE: Fault Logs will indicate which Motor/Motor Controller has the faulty Component/Connection

CBB/DBB Motor Speed Sensor Failure (Cont)

Diagnostics Speed Sensor Analysis – Use to Validate Correct Sensor Operation after Repairs

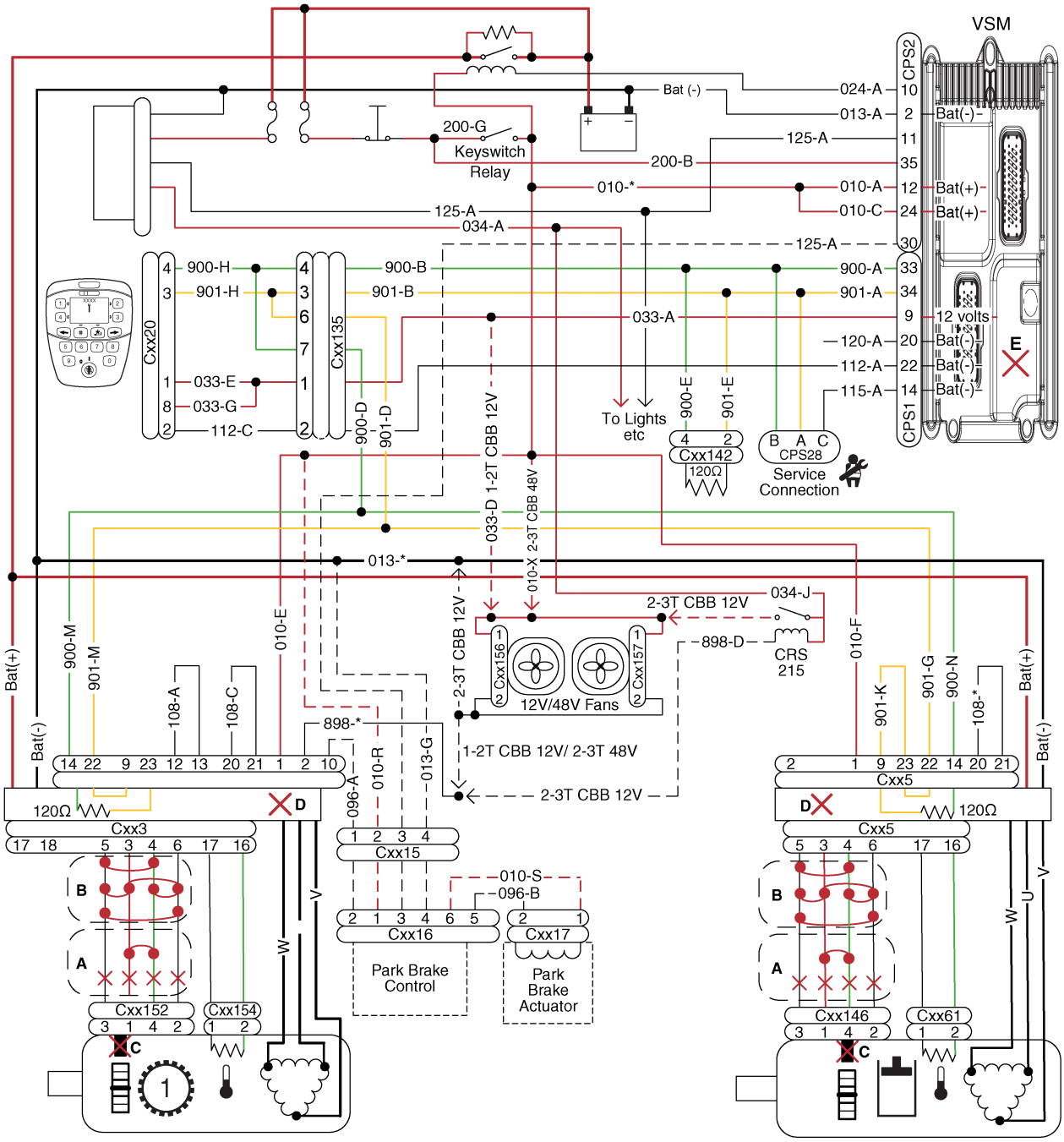


NOTE: If Motor Operation is Disabled then no speed will be displayed

POSSIBLE CAUSES X = Open Circuit/Fail) = Short Circuit

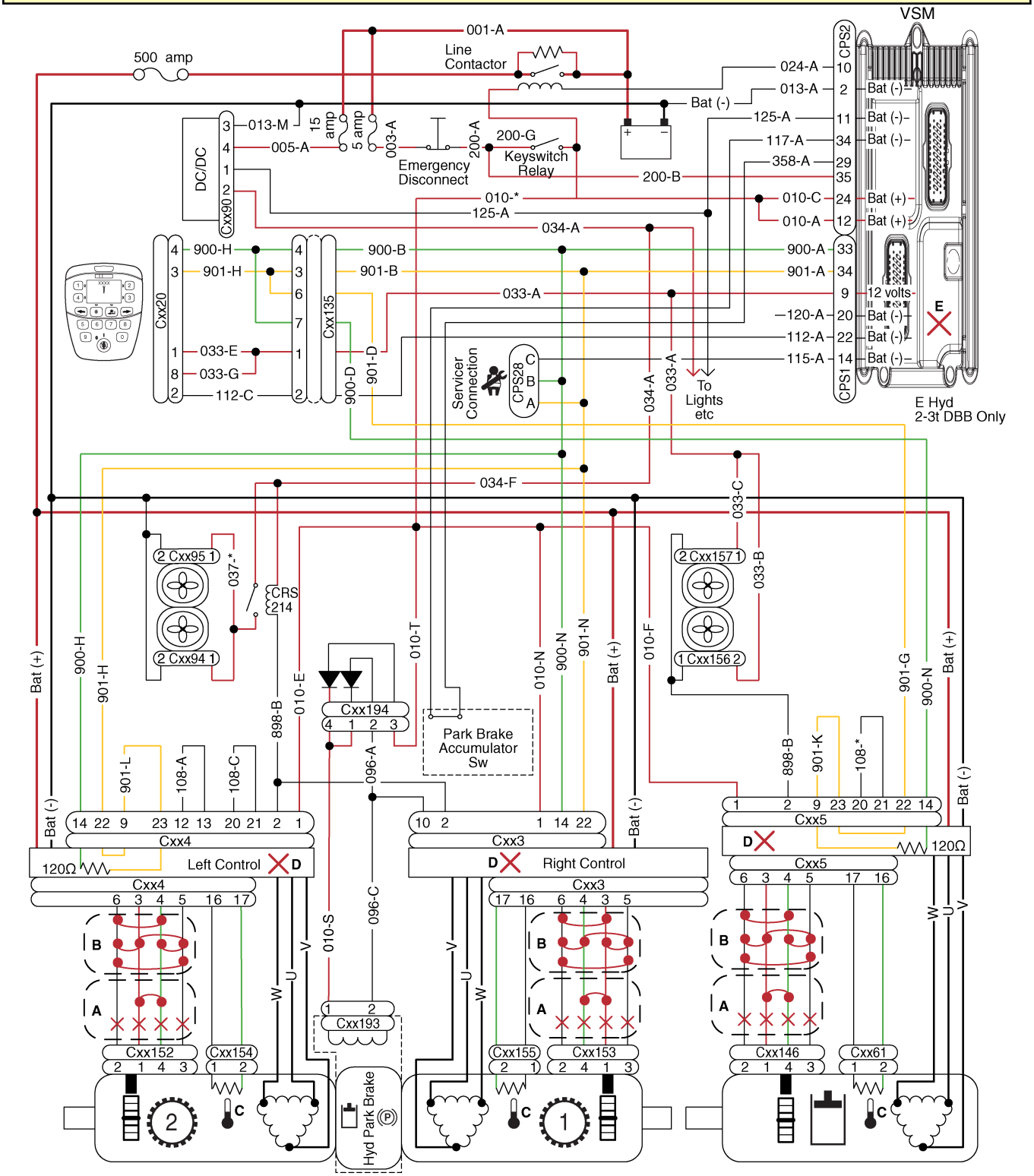
CBB/DBB Motor Speed Sensor Failure (Cont)

1.5 – 2.0 TON CBB SCHEMATIC CAUSES A B C D E > ?



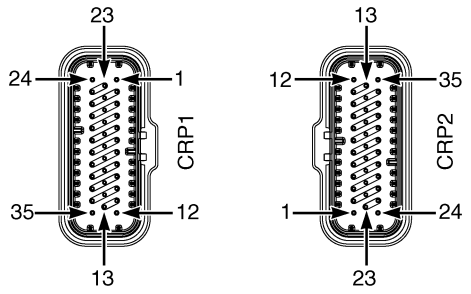
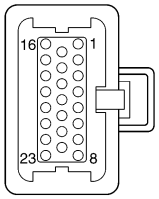
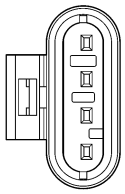
CBB/DBB Motor Speed Sensor Failure (Cont)

2.2 – 3.5 TON DBB SCHEMATIC CAUSES A B C D E > ?

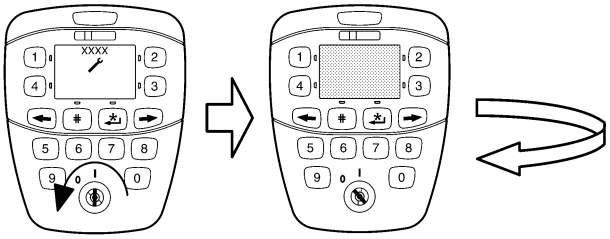


CBB/DBB Motor Speed Sensor Failure (Cont)

CONNECTORS

		
VSM Cxx 1 and Cxx 2	Traction/Pump Controller Cxx 3, 4, and 5	Speed Sensor Motor Connector Cxx 146, 152, and 153

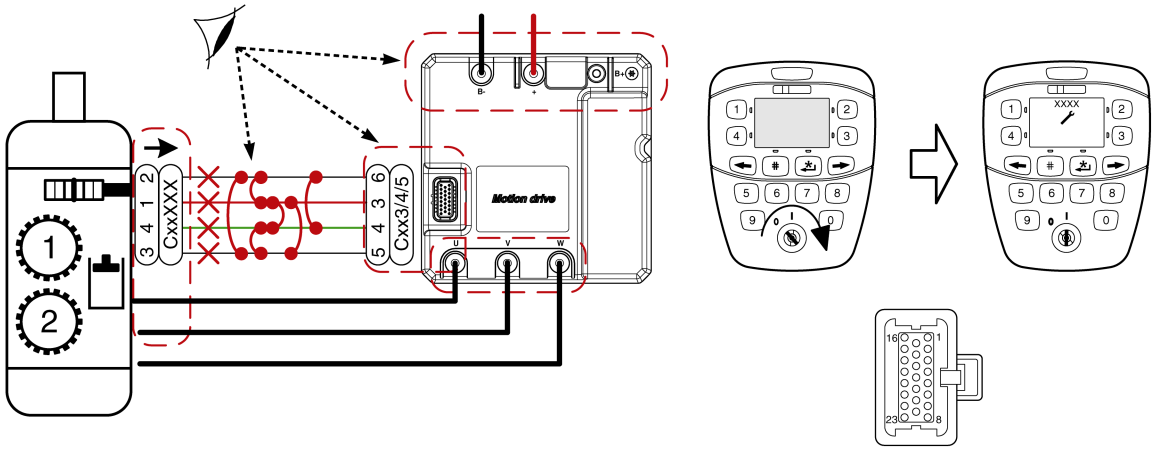
CAUSE A



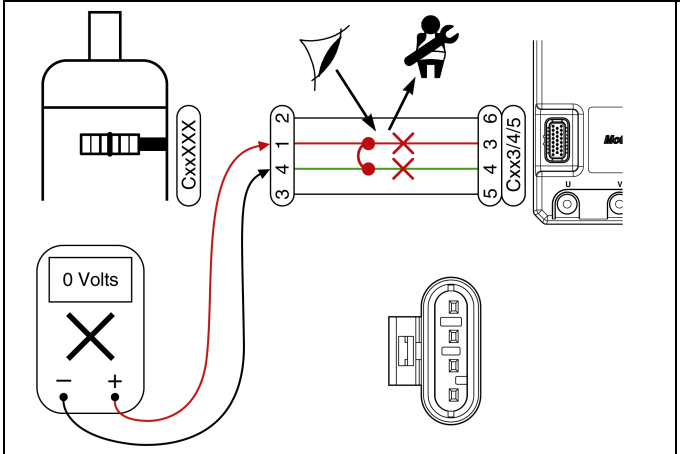
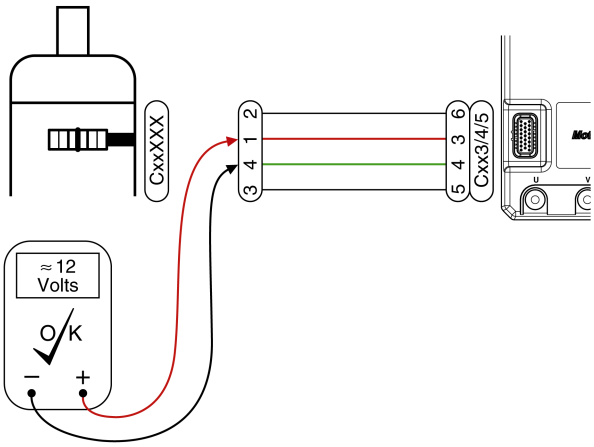
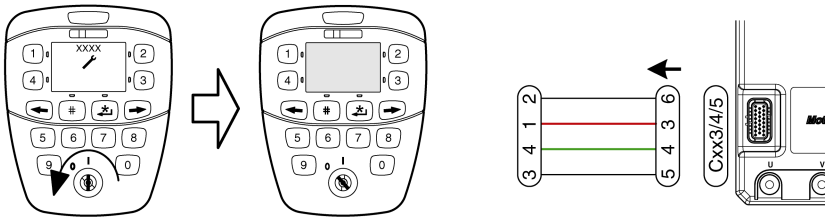
Power **OFF**→ ?

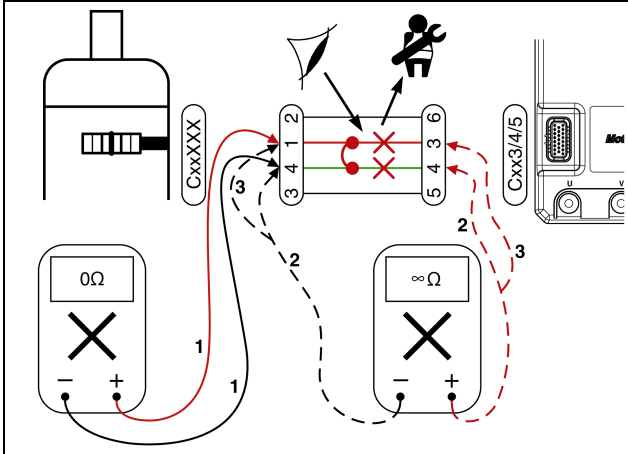
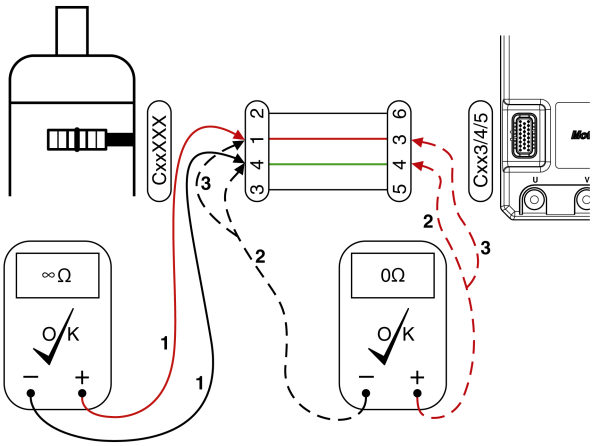
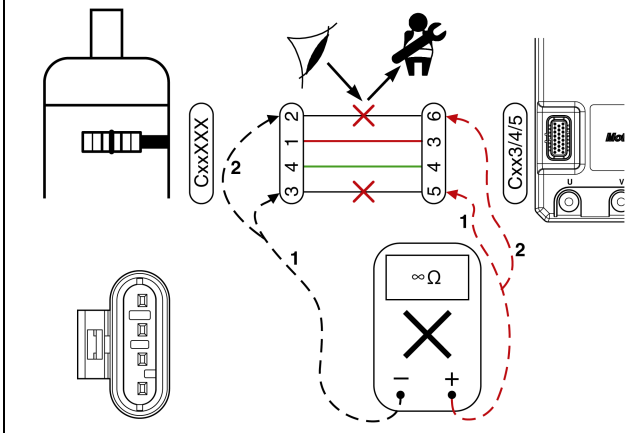
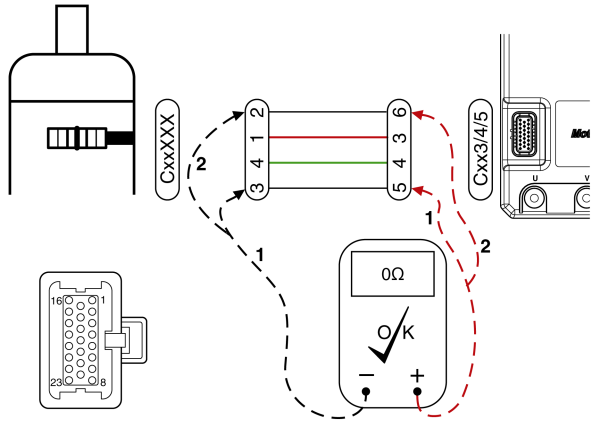
STEP A1

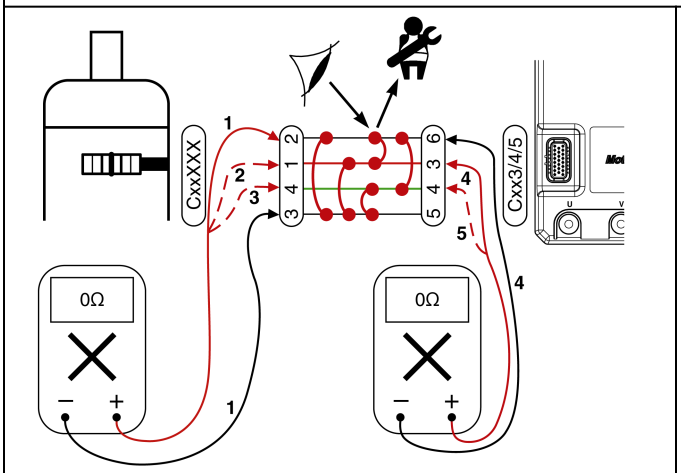
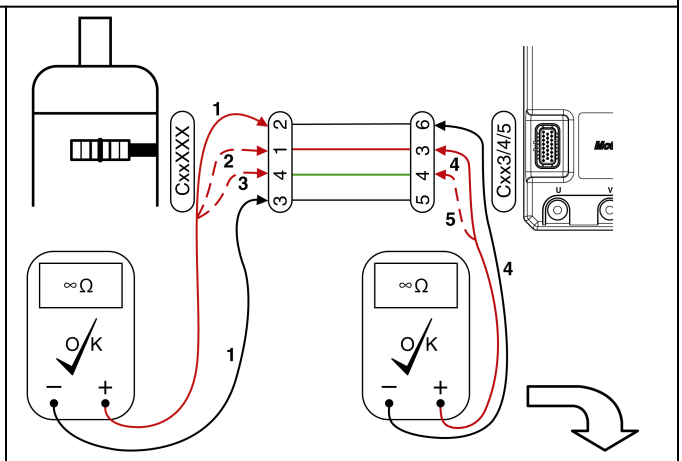
For any Fault DTC→Locate Device→Inspect ALL Wiring/Connections



Disconnect Cxx XXX as indicated from the Fault Logs→Power **ON**↓

CBB/DBB Motor Speed Sensor Failure (Cont)	
STEP A2	**CHECK VOLTAGE**
Speed Sensor Supply	
	
1. 0 Volts = Open/Short Circuit→Step 3↓	1 ˜ 12 Volts = OK→Step 3↓Step 5↓
2. Bat Volts = Short to Bat (+)→CAUSE A↓	2. ˜ 12 Volts = OK→Step 3↓Step 5↓
STEP A3	
	
Power **OFF**→Disconnect Cxx 3, 4, or 5 as indicated from the Fault Logs→	

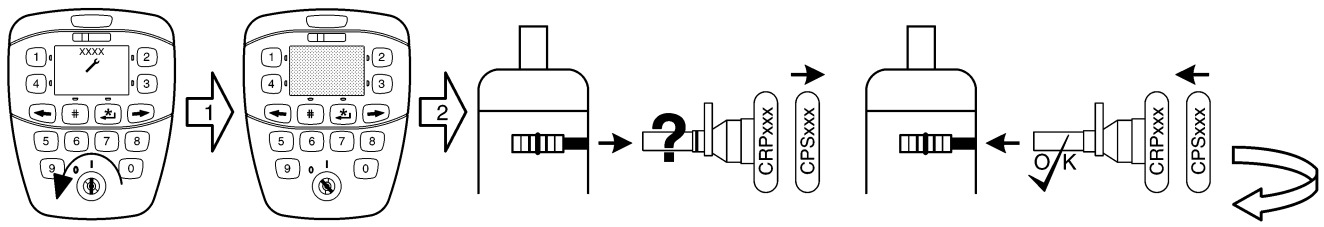
CBB/DBB Motor Speed Sensor Failure (Cont)	
STEP A4	**CHECK RESISTANCE - Ω - OHMS**
Speed Sensor Connections	
	
1. 0? = Short Circuit→Go to 4↓	1 ˜ 8? = OK→Go to 2↓
2. 8? = Open Circuit→Go to 4↓	2. ˜ 0? = OK→Go to 3↓
3. 8? = Open Circuit→Go to 4↓	3. ˜ 0? = OK→CAUSE A↓
4. Find/Repair Short/Open Circuit See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→	
5. Recheck ?↑→ Reconnect→Use Display Diagnostics to validate→Test OK→YES→Resume Opera-tionNO→CAUSE A↓	
STEP A5	**CHECK RESISTANCE - Ω - OHMS**
Speed Sensor Connections	
	
1. 8? = Open Circuit→Go to 3↓	1. ˜ 0? = OK→Go to 2↓
2. 8? = Open Circuit→Go to 3↓	2. ˜ 0? = OK→CAUSE A↓
3. Find/Repair Open Circuit See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→	
4. Recheck ?↑→ Reconnect→Use Display Diagnostics to validate→Test OK→YES→Resume Opera-tionNO→CAUSE A↓	

CBB/DBB Motor Speed Sensor Failure (Cont)	
CAUSE B	
Speed Sensor Connections	
	
1. 0? = Short Circuit→Go to 6↓	1. ˜ 8? = OK→Go to 2↓
2. 0? = Short Circuit→Go to 6↓	2. ˜ 8? = OK→Go to 3↓
3. 0? = Short Circuit→Go to 6↓	3. ˜ 8? = OK→Go to 4↓
4. 0? = Short Circuit→Go to 6↓	4. ˜ 8? = OK→Go to 5↓
5. 0? = Short Circuit→Go to 6↓	5. ˜ 8? = OK→CAUSE B↓
6. Find/Repair Short Circuit See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→Go to 7↓	
7. Recheck ?↑→ Reconnect→Use Display Diagnostics to validate→Test OK→YES→Resume OperationNO→CAUSE B↓	

CBB/DBB Motor Speed Sensor Failure (Cont)

CAUSE C

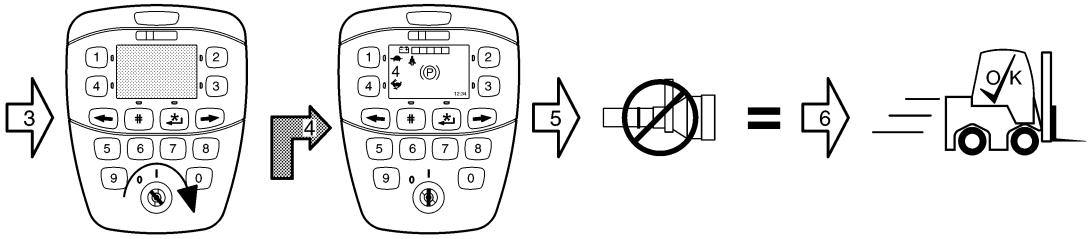
Sensor Failure



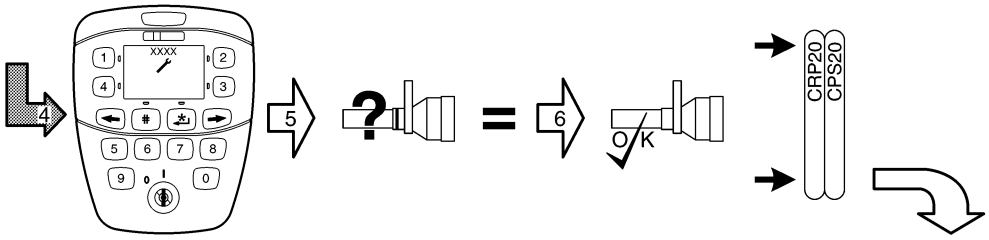
Power **OFF**→ Remove/Replace Motor Speed Sensor↓

See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→Step 1↓

STEP C1



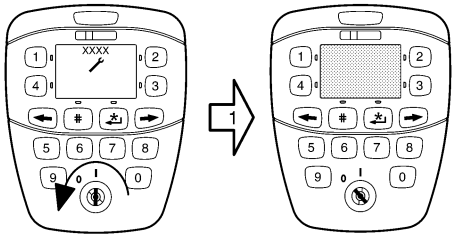
Power **ON**→⇳	DTCs Gone→	Original Sensor Faulty→	Resume Operation

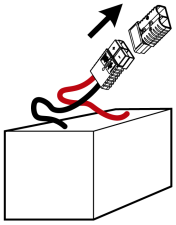


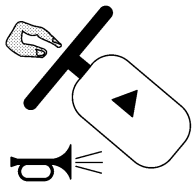
	DTCs Present→	Original Sensor OK/Reinstall Original Sensor→CAUSE C↓

CBB/DBB Motor Speed Sensor Failure (Cont)

CAUSE D



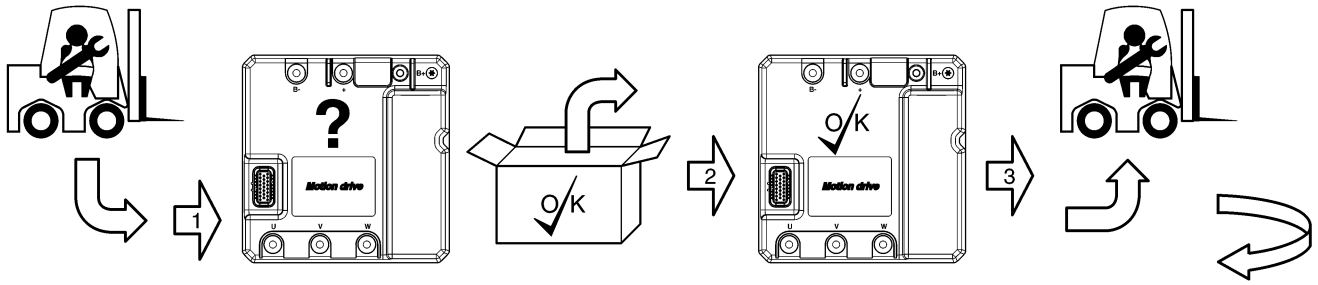




Power **OFF**→

Disconnect Battery and Sound Horn to Discharge Capacitors.→Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342→.

STEP D1

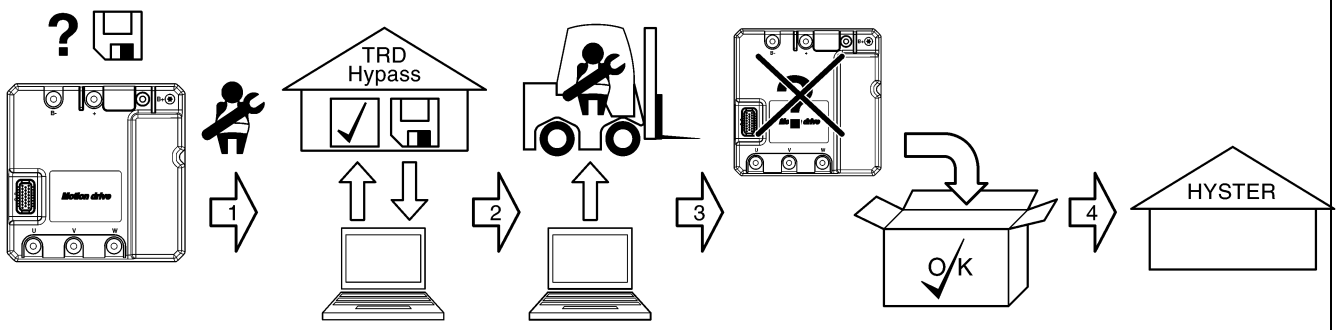


Remove and Replace Faulty Motor Controller↓

See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369↓

Check Replacement Controller 🖫 Version→See Label Information→Step 2↓

STEP D2



1. Go to TRD/Hypass Online /Software.?? Is Replacement Controller Application Software Version the Latest Version??

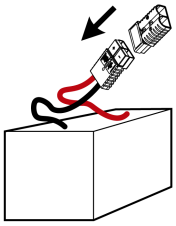
2. **NO**→Download the latest Application 🖫→Install on truck→Step 3↓

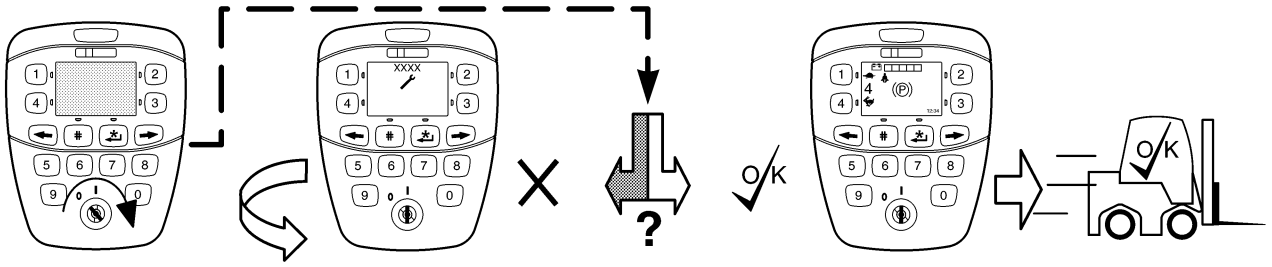
3. **YES**→Test New Installation→↓Step 3↓

4. Return Faulty Display→Dealer→Factory→Failure Analysis→?? Reprogramming

CBB/DBB Motor Speed Sensor Failure (Cont)

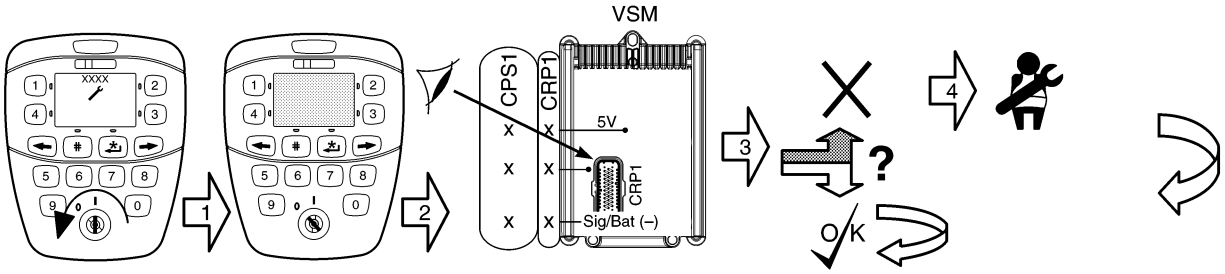
STEP D3





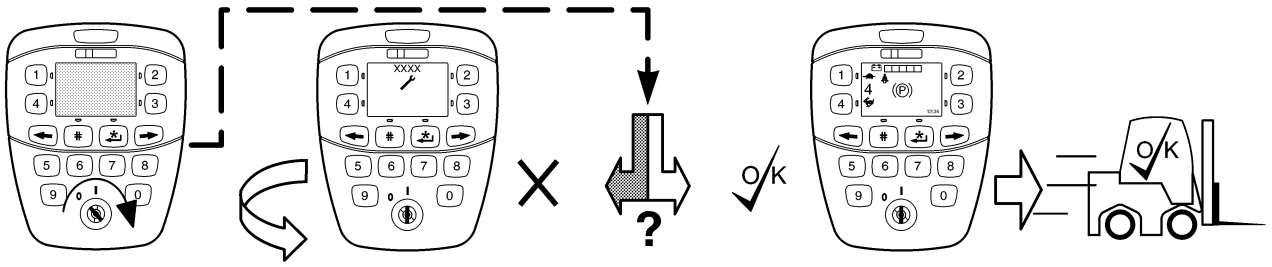
Retest - Power **ON**→	**NO**→?	Is fault DTC gone?**NO** **YES**←→	Fault corrected→Continue operation.

CAUSE E



Power **OFF**→	Inspect VSM Connections→OK Step 1	Not OK Correct/Repair→Step 1

STEP E1



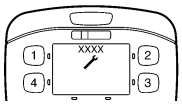
Retest - Power **ON**→	**NO**→Go to VSM Controller Check	Is fault DTC gone?**NO** **YES**←→	Fault corrected→Continue operation.

DTC LOGS: DTC logs should only be cleared once the data is by the Service Tech. See Display Menu Flowchart **- Clearing DTCs.**

END FAULT

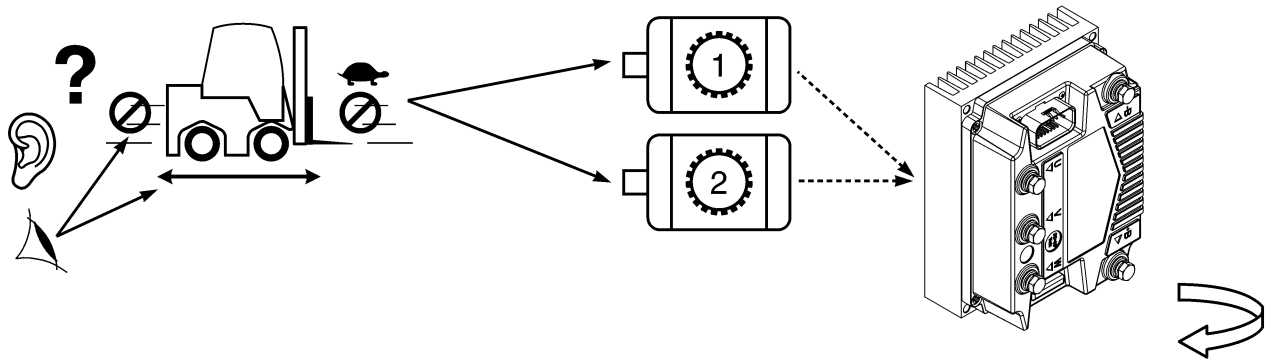
A935 – K160 Motor Auto Brake Failure (Cont)

DTC 8786 **DTC 12834** **DTC 12835**
Brake Coil Shorted **Aux Driver Short to Bat (-)** **Aux Driver Open Circuit**
Brake Coil Open Circuit **Excess Current**



QUICK CHECK X = Open Circuit/Fail) = Short Circuit

Check 1

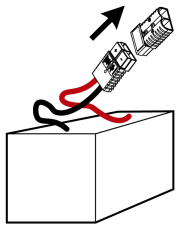
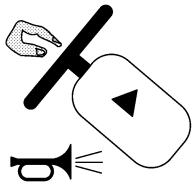
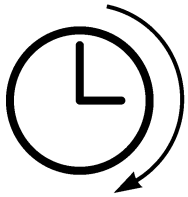
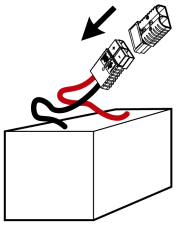


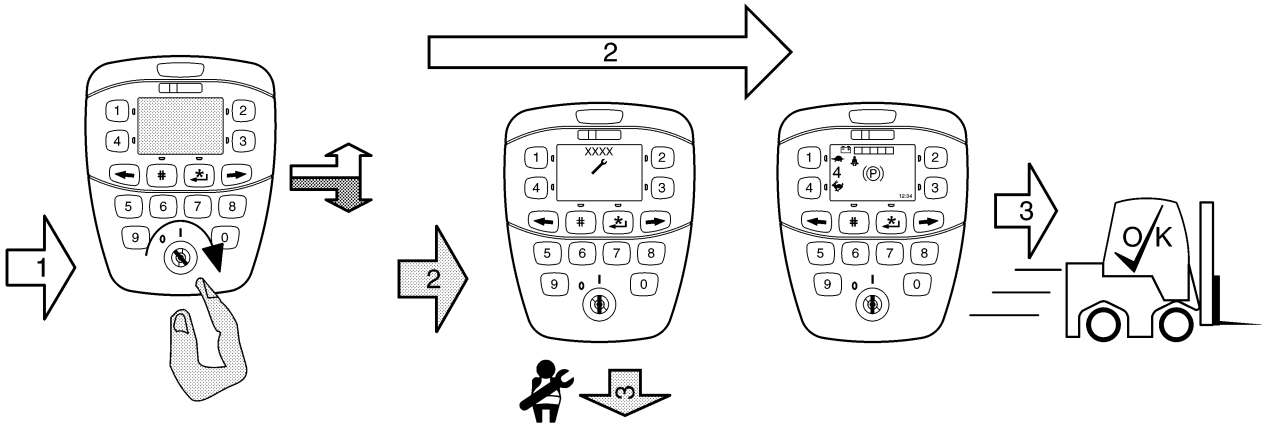
?Brake does not Release when Traction is Commanded?

POSSIBLE CAUSES

DTC 12834	Aux Driver Short to Bat (-) Brake Coil Open Circuit		→CAUSE 0↓
DTC 12835	Aux Driver Open Circuit Excess Current	No Current/> 5 amps driver current	→CAUSE 0↓
DTC 8786	Brake Coil Shorted	> 5.3 amps driver current	→CAUSE 0↓
Motor Controllers Fail-ure?→		Driver Failure	→CAUSE C↓

Check 2

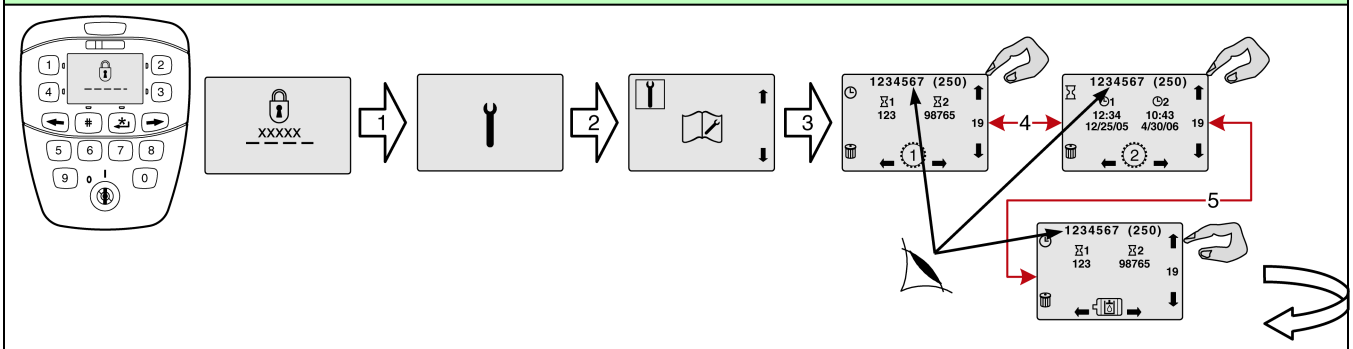
			
Disconnect Battery and Sound Horn to Discharge Ca-pacitors.Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342.		Wait 30 seconds	Reconnect Battery

A935 – K160 Motor Auto Brake Failure (Cont)		
Check 3		
		
Power **ON**→	Fault Remains Service Required ?	No Fault→Resume Operation

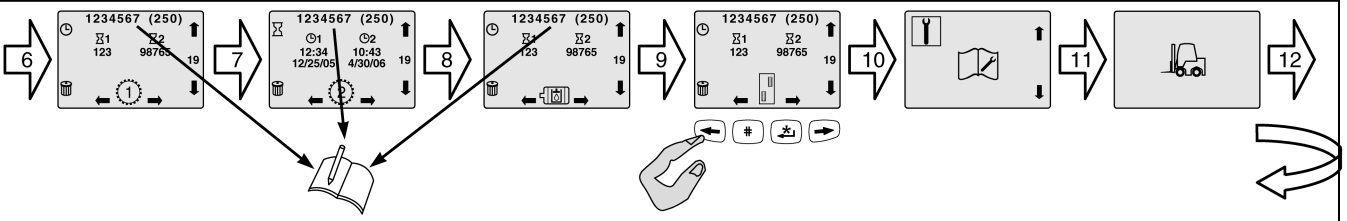
A935 – K160 Motor Auto Brake Failure (Cont)

Check 4

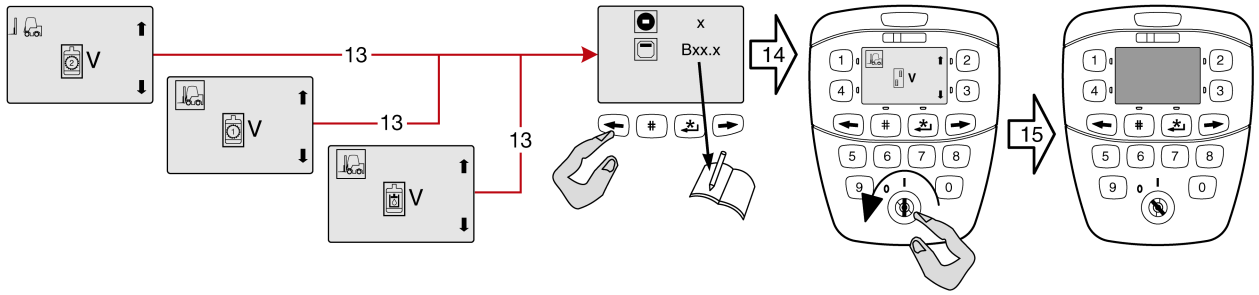
FAULT LOG Review - Go to Display Menu



Enter Service Password→Diagnostic→FAULT LOGs→Motor Fault Log(s)→View all Motor DTCs→?



all Motor DTCs→Exit Fault Log→Truck Status ?

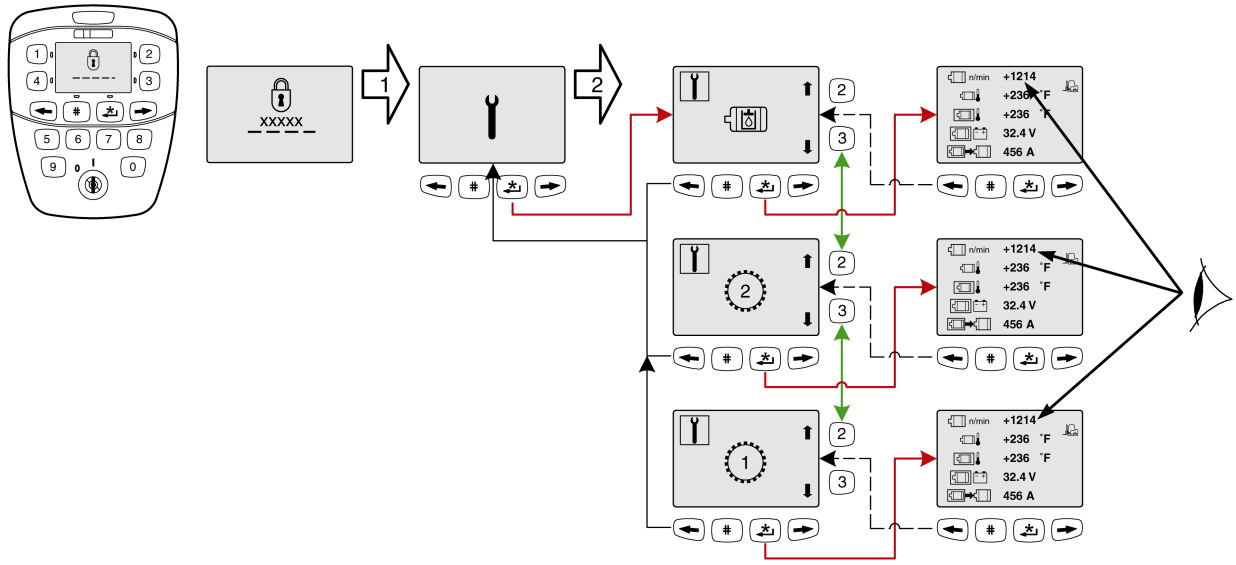


Motor Versions→Hardware/Software Versions→Exit Versions→Power **OFF**?

NOTE: Fault Logs will indicate which Motor/Motor Controller has the faulty Component/Connection

A935 – K160 Motor Auto Brake Failure (Cont)

Diagnostics Speed Sensor Analysis – Use to Validate Correct Sensor Operation after Repairs

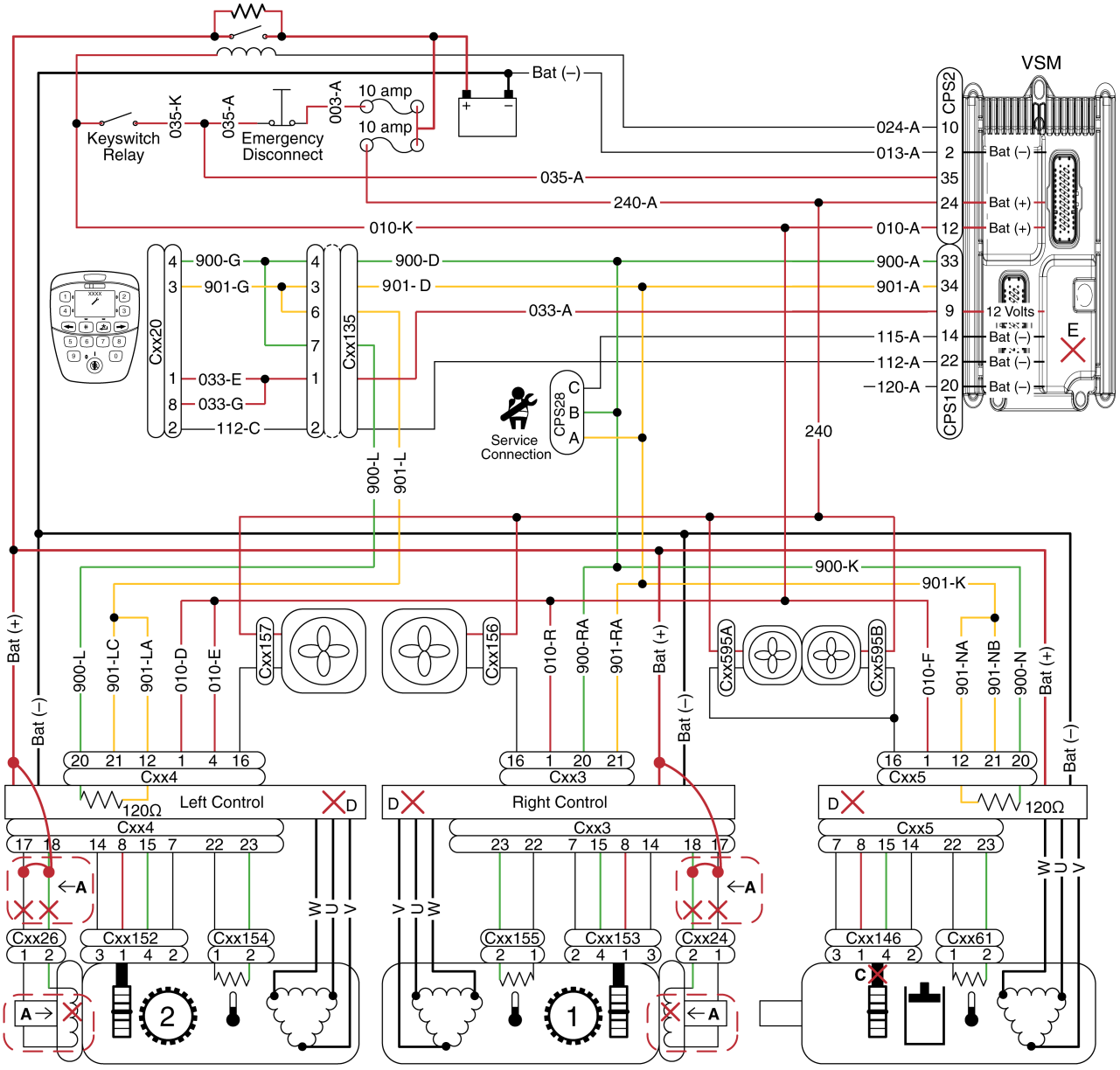


Note: If Motor Operation is Disabled then no speed will be displayed

POSSIBLE CAUSES X = Open Circuit/Fail) = Short Circuit

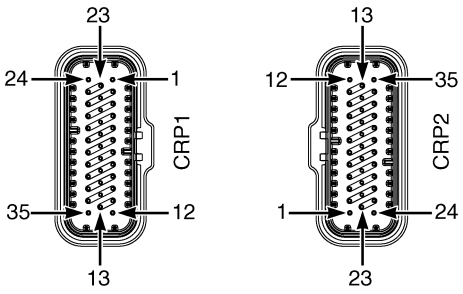
A935 – K160 Motor Auto Brake Failure (Cont)

WHEEL MOTOR AUTO BRAKE FAILURE CAUSES A B C D E > ?

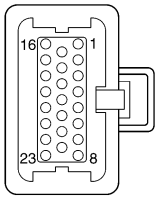


A935 – K160 Motor Auto Brake Failure (Cont)

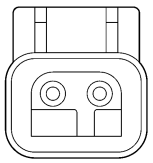
CONNECTORS



VSM Cxx 1 and Cxx 2



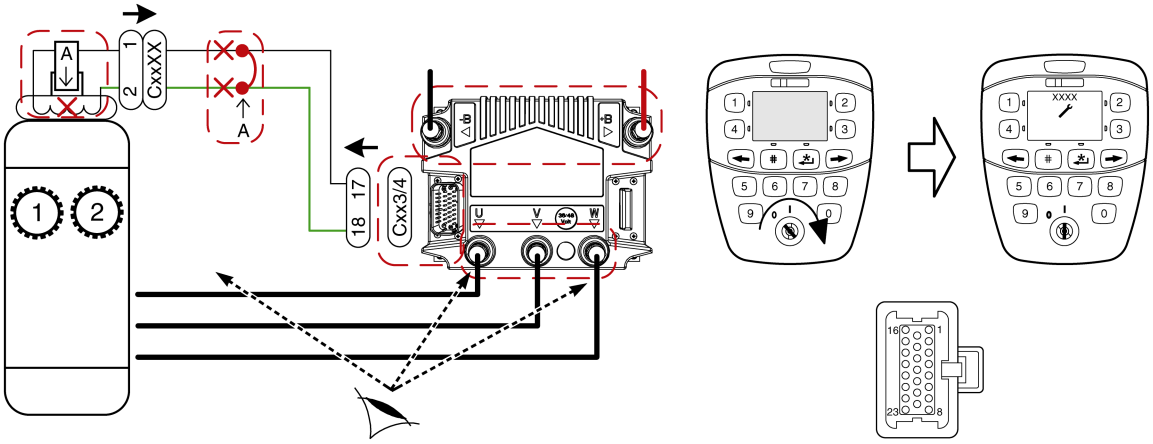
Traction/Pump Controller Cxx 3, 4, and 5



Auto Brake Motor Connectors Cxx 24 and 26

CAUSE A

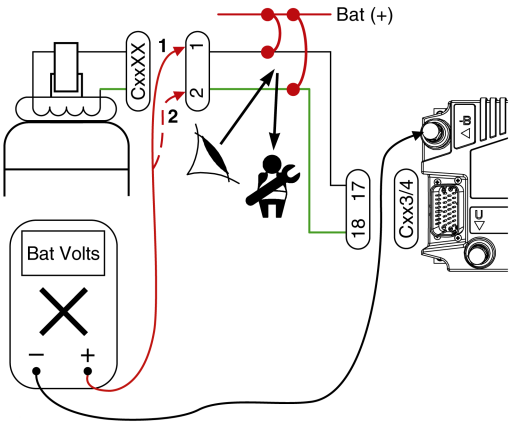
For any Fault DTC→Locate Device→Inspect ALL Wiring/Connections

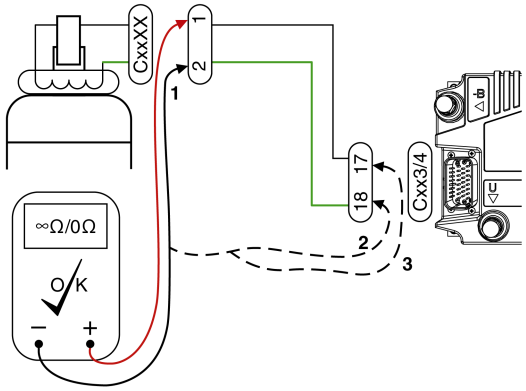


Disconnect Cxx and Cxx 3 or 4 as indicated from the Fault Logs→Power **ON**↓

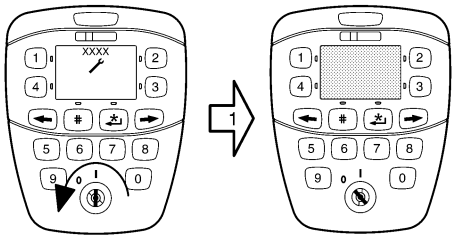
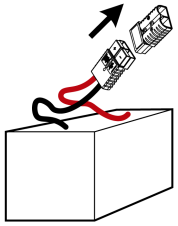
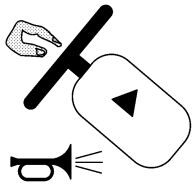
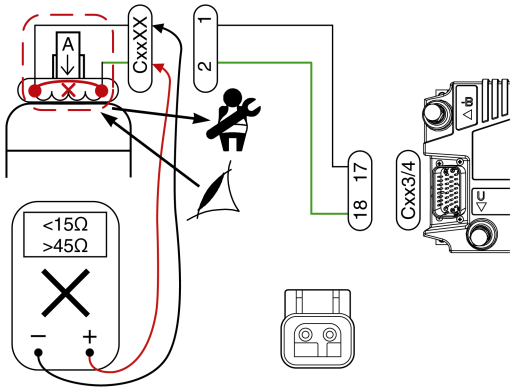
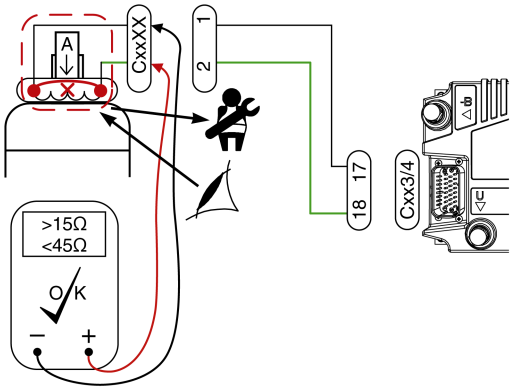
STEP A1

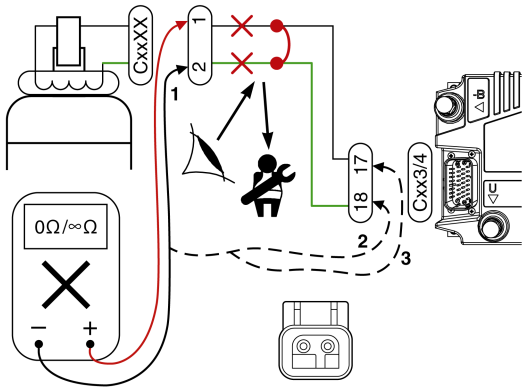
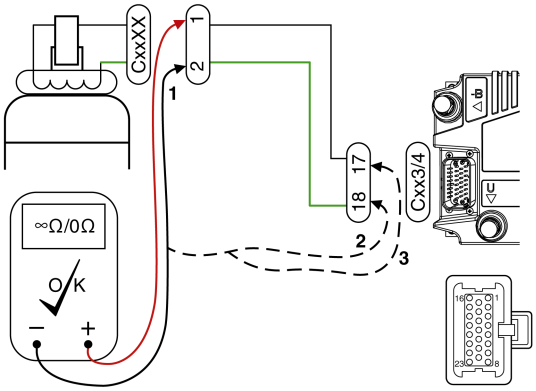
Auto Brake Short Circuit to Bat (+)





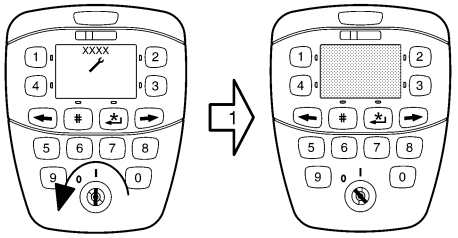
1. Short to Bat (+)→Go to 2↓	1 0 Volts = OK→Go to 2↓
2. Short to Bat (+)→Go to 3↓	2. 0 Volts = OK→Step 2↓
3. Recheck ?↑→ Reconnect→Test→No DTCs→YES→Resume OperationNo→Step 2↓	

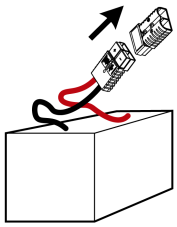
A935 – K160 Motor Auto Brake Failure (Cont)		
STEP A2		
		
Power **OFF**→	Disconnect Battery and Sound Horn to Discharge Capacitors.→Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342→.	
STEP A3	**CHECK RESISTANCE - Ω - OHMS**	
Auto Brake Coil Open/Short Circuit		
		
1. <15 ? > 45 ?= Faulty Coil→Go to 2↓	1 >15 ? < 45 ?= OK Coil→Go to Step 4↓	
2. Replace Auto Brake→See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→		
3. Recheck ?↑→ Reconnect→Test→No DTCs→YES→Resume OperationNo→Step 4↓		

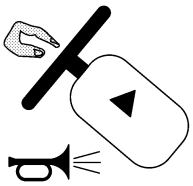
A935 – K160 Motor Auto Brake Failure (Cont)	
STEP A4	**CHECK RESISTANCE - Ω - OHMS**
Auto Brake Connections Open/Short Circuit	
	
1. 0? = Short Circuit→Go to 4↓	1. ˜ 8? = OK→Go to 2↓
2. 8? = Open Circuit→Go to 4↓	2. ˜ 0? = OK→Go to 3↓
3. 8? = Open Circuit→Go to 4↓	3. ˜ 0? = OK→CAUSE C↓
4. Find/Repair Short/Open Circuit See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→	
5. Recheck ?↑→ Reconnect→Test→No DTCs→YES→Resume OperationNo→CAUSE C↓	
CAUSE B	
Not Applicable	
CAUSE C	
Not Applicable	

A935 – K160 Motor Auto Brake Failure (Cont)

CAUSE D



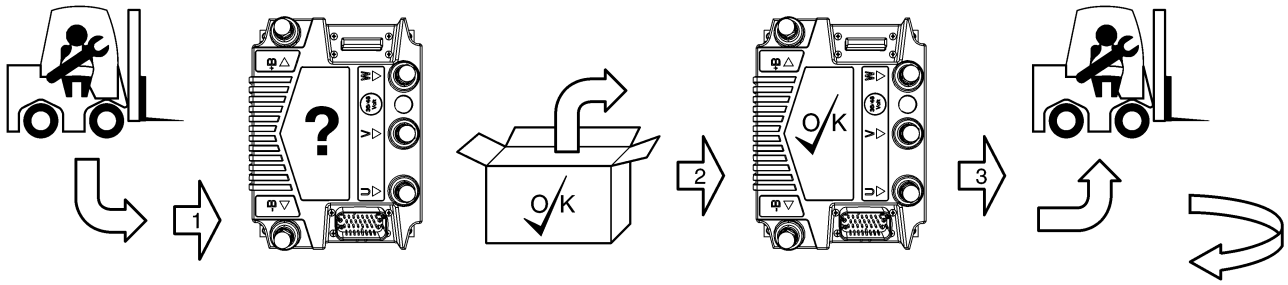




Power **OFF**→

Disconnect Battery and Sound Horn to Discharge Capacitors.→Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342→.

STEP D1

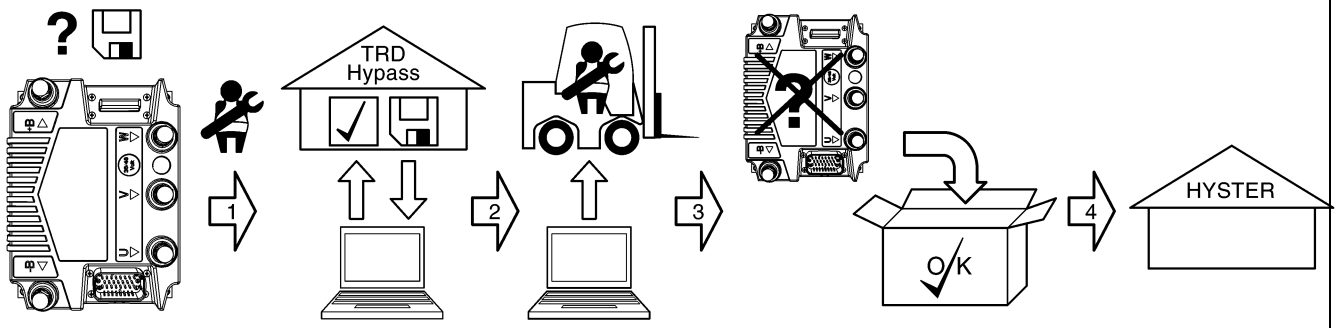


Remove and Replace Faulty Motor Controller↓

See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369↓

Check Replacement Controller 🖫 Version→See Label Information→Step 2↓

STEP D2



1. Go to TRD/Hypass Online /Software.?? Is Replacement Controller Application Software Version the Latest Version??

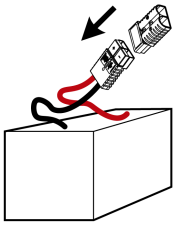
2. **NO**→Download the latest Application 🖫→Install on truck→Step 3↓

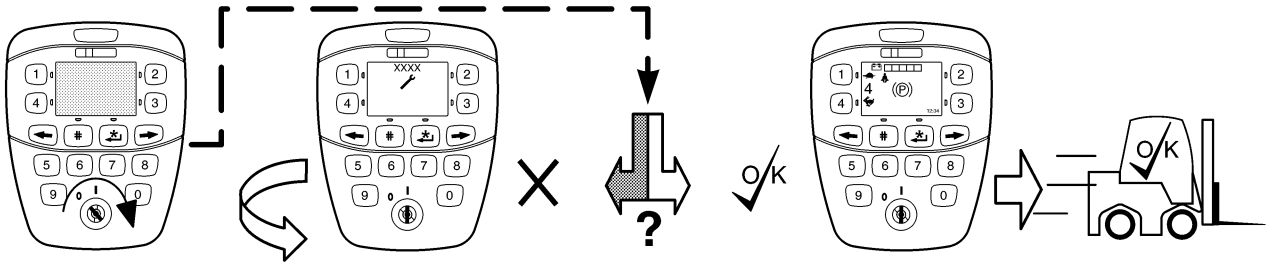
3. **YES**→Test New Installation→↓Step 3↓

4. Return Faulty Controller→Dealer→Factory→Failure Analysis→?? Reprogramming

A935 – K160 Motor Auto Brake Failure (Cont)

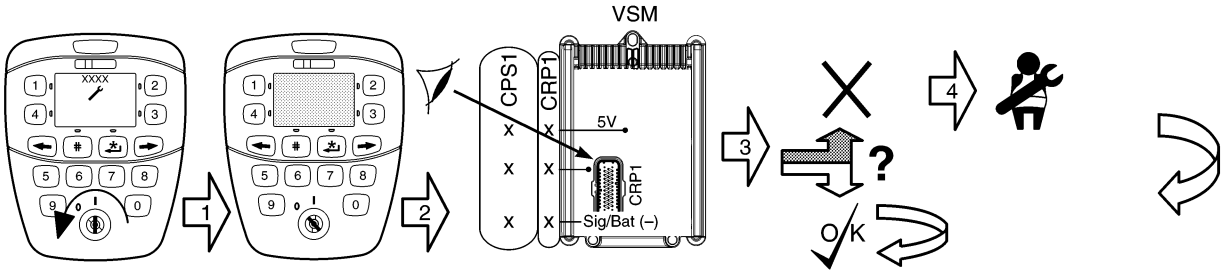
STEP D3





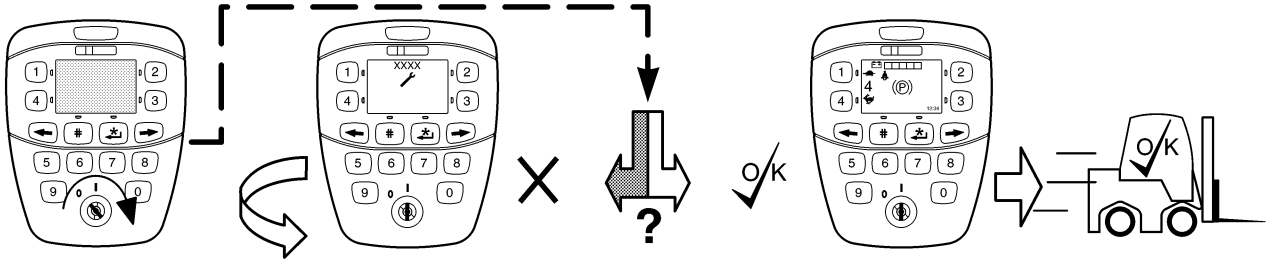
Retest - Power **ON**→	**NO**→?	Is fault DTC gone?**NO** **YES**←→	Fault corrected→Continue operation.

CAUSE E



Power **OFF**→	Inspect VSM Connections→OK Step 1	Not OK Correct/Repair→Step 1

STEP E1



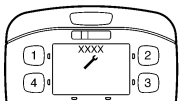
Retest - Power **ON**→	**NO**→Go to VSM Controller Check	Is fault DTC gone?**NO** **YES**←→	Fault corrected→Continue operation.

DTC LOGS: DTC logs should only be cleared once the data is by the Service Tech. See Display Menu Flowchart **- Clearing DTCs.**

END FAULT

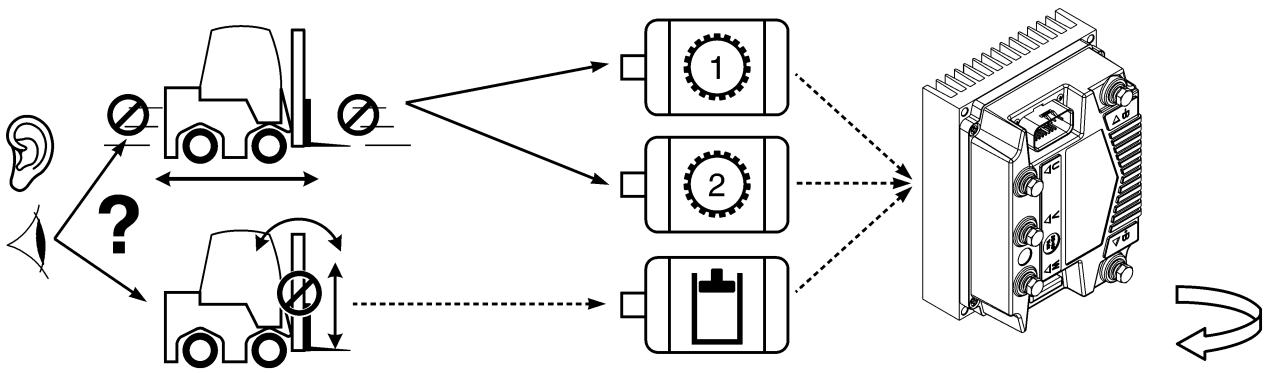
A935 – K160 D203 Motor Controller Power Mosfet Failure (Cont)

DTC 65513
Power MOS Shorted



QUICK CHECK X = Open Circuit/Fail) = Short Circuit

Check 1

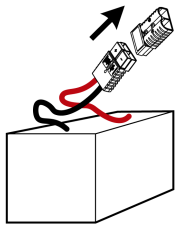
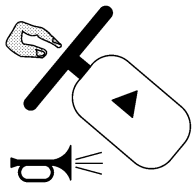
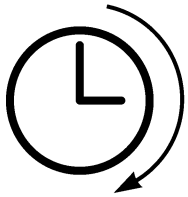
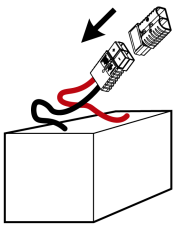


? No Traction/Hydraulics Truck Operation ?

Possible Causes

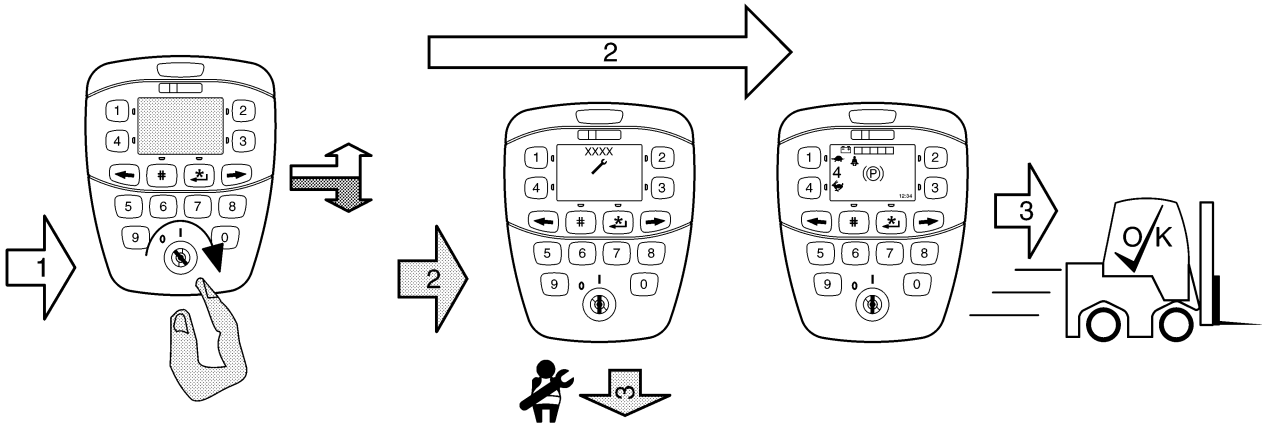
Motor Controller(s) Failure ?→	→CAUSE C↓

Check 2

			
Disconnect Battery and Sound Horn to Discharge Capacitors.Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342.		Wait 30 seconds	Reconnect Battery

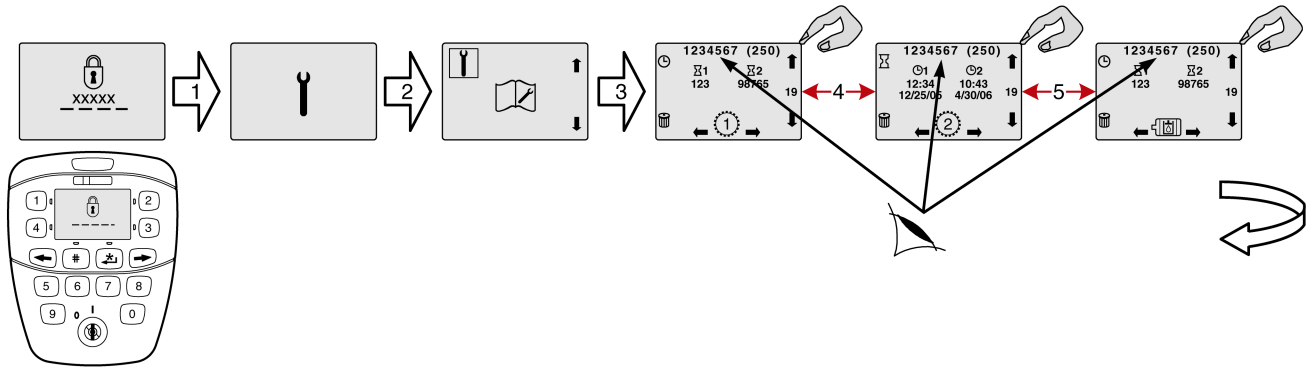
A935 – K160 D203 Motor Controller Power Mosfet Failure (Cont)

Check 3

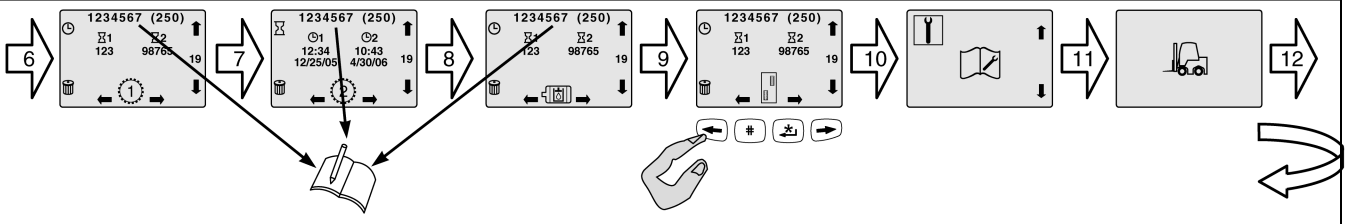


Power **ON**→	Fault Remains Service Required ?	No Fault→Resume Operation

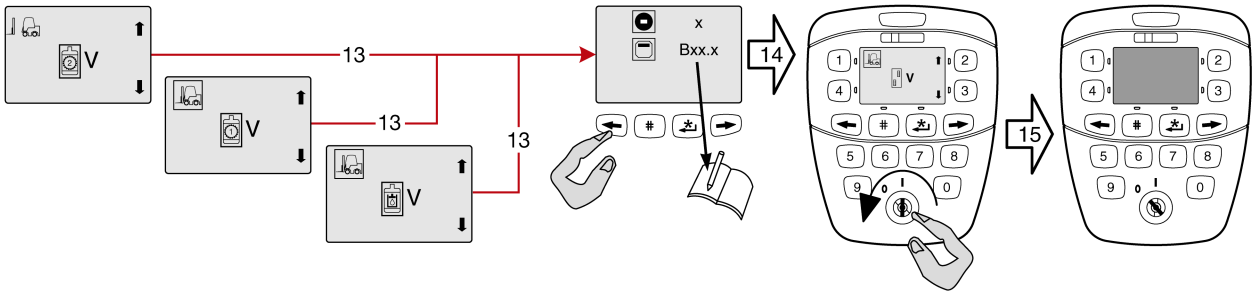
FAULT LOG Review - Go to Display Menu



Enter SERVICE Password→Diagnostic→FAULT LOGs→Motor Fault Log(s)→View all Motor DTCs→?



📝 all Motor DTCs→☜Exit Fault Log→Truck Status ?

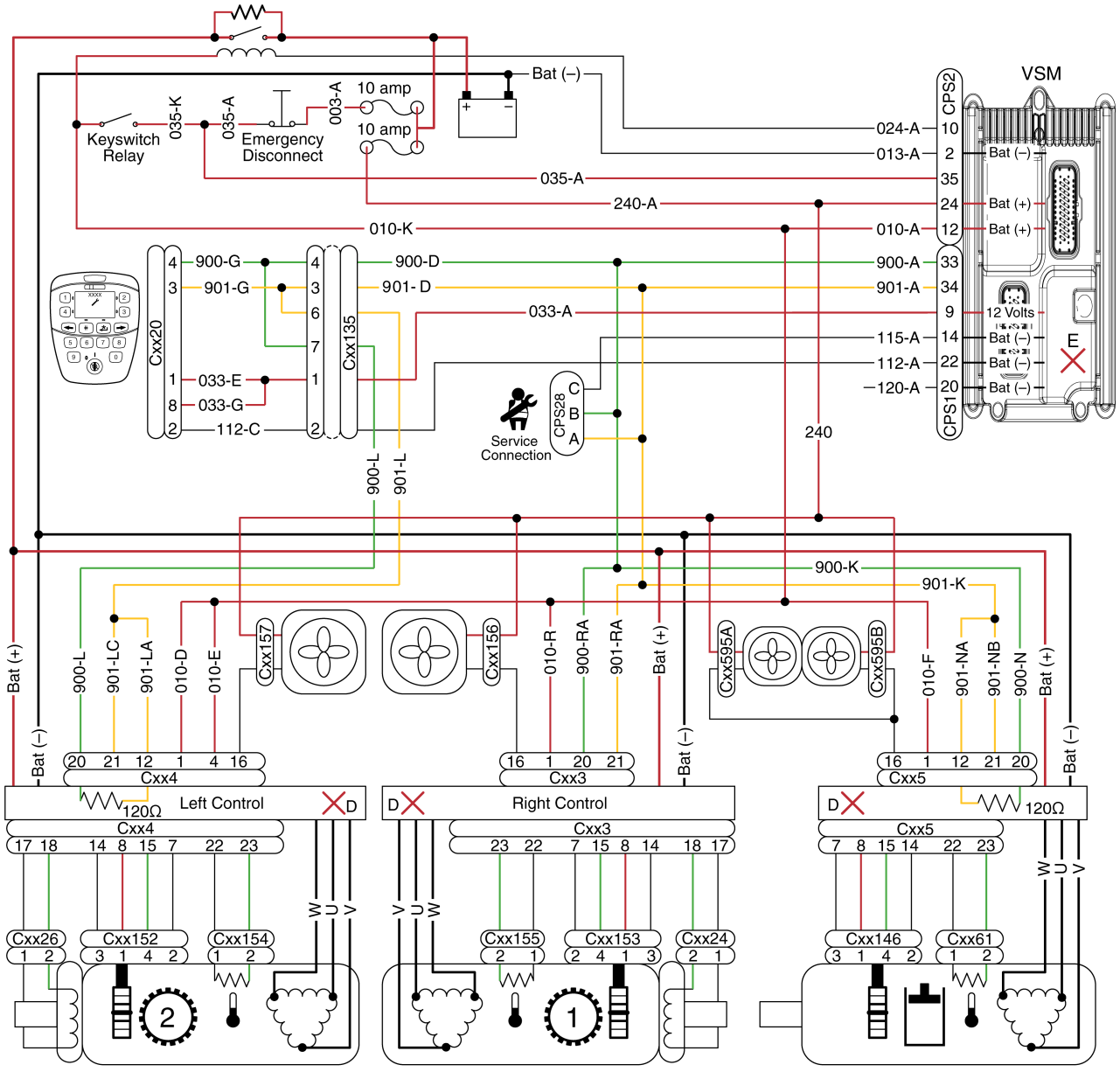


Motor Versions→📝Hardware/Software Versions→☜Exit Versions→Power **OFF**?

A935 – K160 D203 Motor Controller Power Mosfet Failure (Cont)

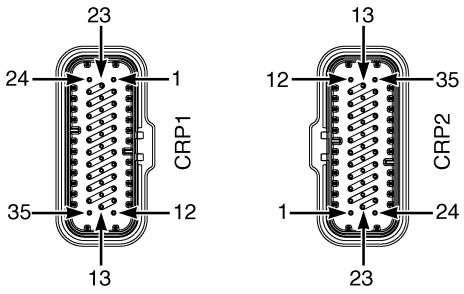
POSSIBLE CAUSES X = Open Circuit/Fail) = Short Circuit

MOTOR CONTROLLER POWER MOSFET FAILURE CAUSES A B C D E > ?

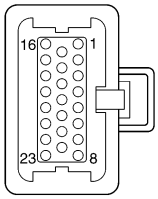


A935 – K160 D203 Motor Controller Power Mosfet Failure (Cont)

CONNECTORS



VSM Cxx 1 and Cxx 2



Traction/Pump Controller Cxx 3, 4, and 5

CAUSE A

Not Applicable

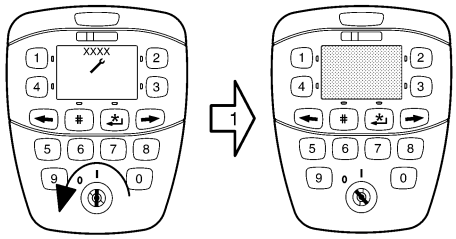
CAUSE B

Not Applicable

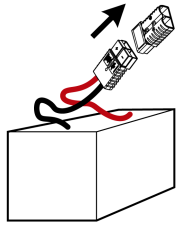
CAUSE C

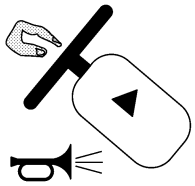
Not Applicable

CAUSE D



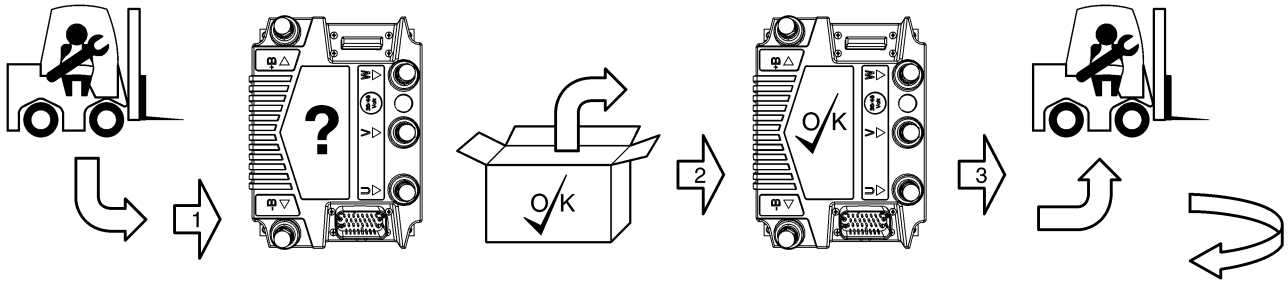
Power **OFF**→





Disconnect Battery and Sound Horn to Discharge Capacitors.→Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342→.

STEP D1



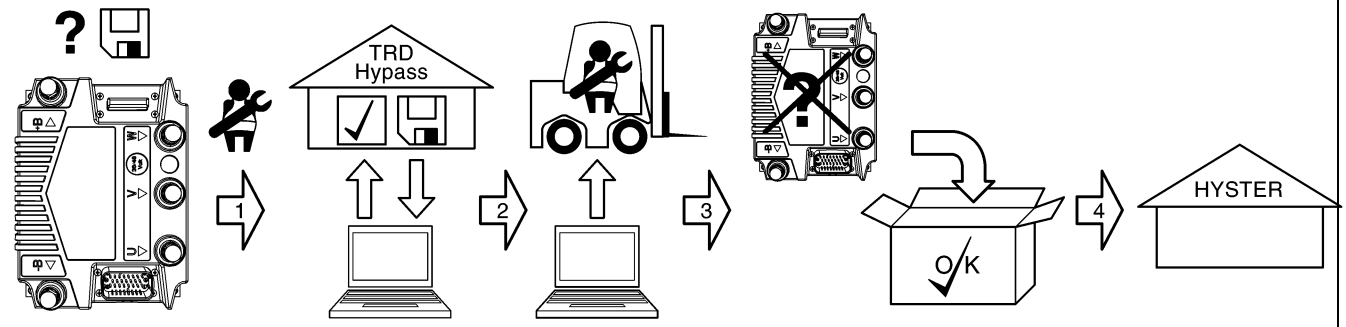
Remove and Replace Faulty Motor Controller↓

See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369↓

Check Replacement Controller 🖫 Version→See Label Information→Step 2↓

A935 – K160 D203 Motor Controller Power Mosfet Failure (Cont)

STEP D2



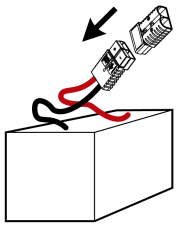
1. Go to TRD/Hypass Online /Software.?? Is Replacement Controller Application Software Version the Latest Version??

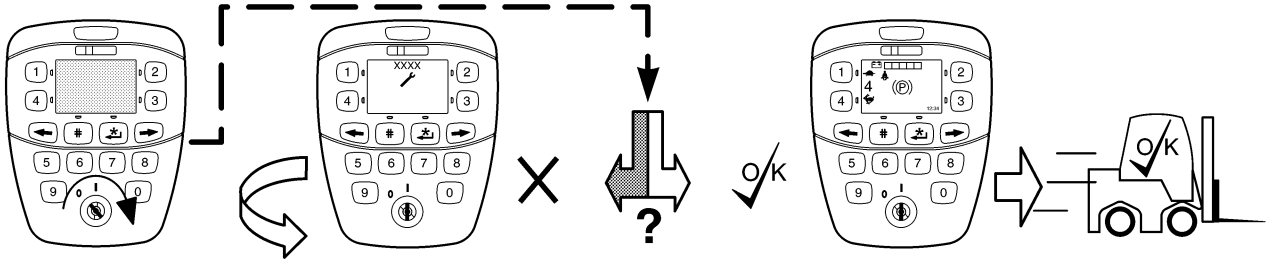
2. **NO**→Download the latest Application 🖫→Install on truck→Step 3↓

3. **YES**→Test New Installation→↓Step 3↓

4. Return Faulty Display→Dealer→Factory→Failure Analysis→?? Reprogramming

STEP D3

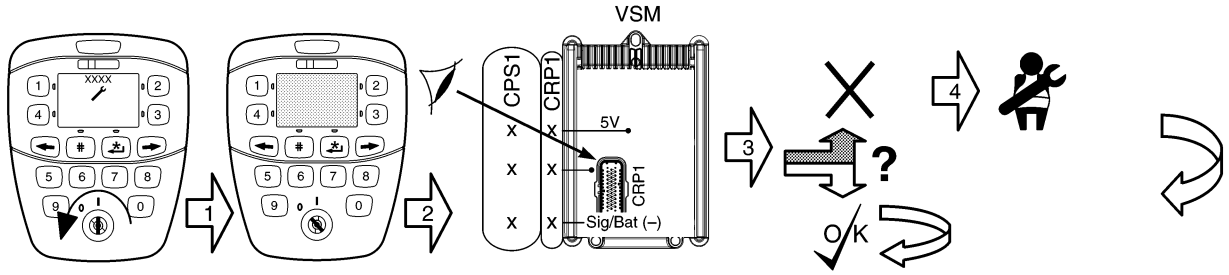




Retest - Power **ON**→	**NO**→?	Is fault DTC gone?**NO** **YES**←→	Fault corrected→Continue operation.

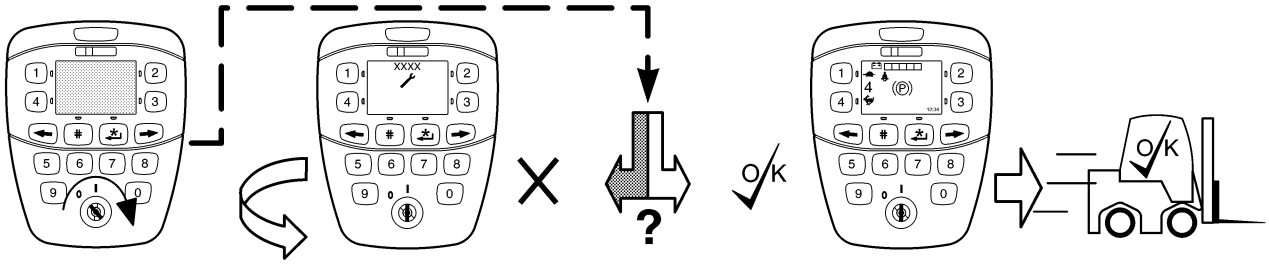
A935 – K160 D203 Motor Controller Power Mosfet Failure (Cont)

CAUSE E



Power **OFF**→	Inspect VSM Connections→OK Step 1	Not OK Correct/Repair→Step 1

STEP E1



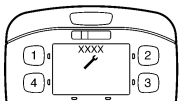
Retest - Power **ON**→	**NO**→Go to VSM Controller Check	Is fault DTC gone?**NO** **YES**←→	Fault corrected→Continue operation.

DTC LOGS: DTC logs should only be cleared once the data is by the Service Tech. See Display Menu Flowchart **- Clearing DTCs.**

END FAULT

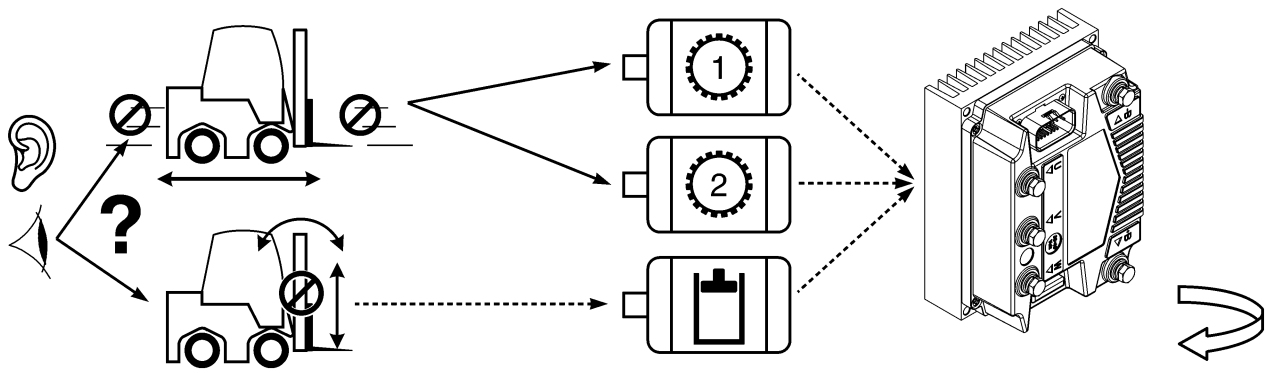
A935 – K160 D203 Motor/Motor Controller Failure(Cont)

DTC 12576
Motor Voltage Not OK



QUICK CHECK X = Open Circuit/Fail) = Short Circuit

Check 1

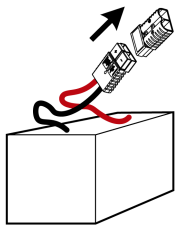
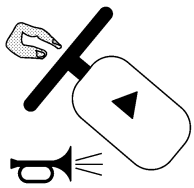
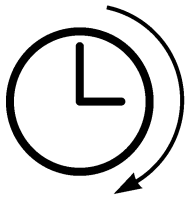
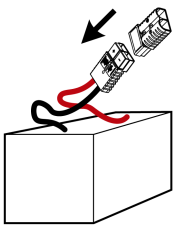


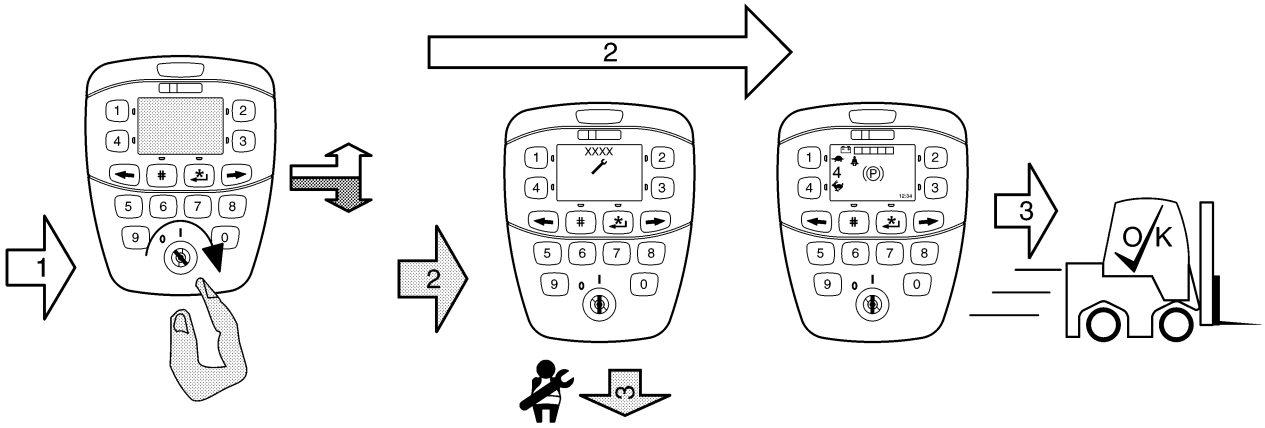
? No Traction/Hydraulic Truck Operation ?

POSSIBLE CAUSES

Motor to Motor Controller Connections/Wiring→High Resistance?→	→CAUSE 0↓
Motor Windings Failure Open Circuit?→	→CAUSE 0↓
Motor Windings Short to Frame?→	→CAUSE B↓
Motor Controller(s) Failure?→	→CAUSE C↓

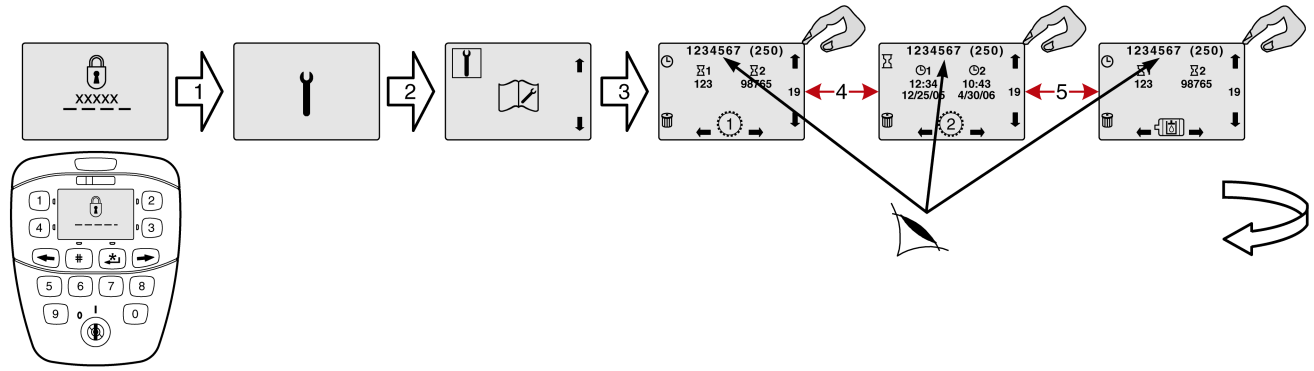
Check 2

			
Disconnect Battery and Sound Horn to Discharge Capacitors.Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342.		Wait 30 seconds	Reconnect Battery

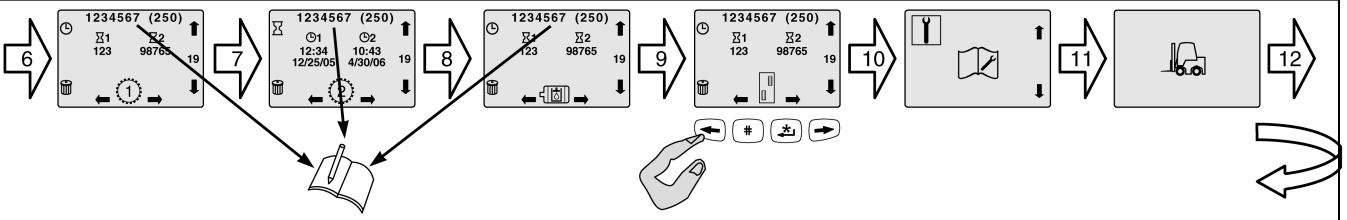
A935 – K160 D203 Motor/Motor Controller Failure (Cont)		
Check 3		
		
Power **ON**→	Fault Remains Service Required ?	No Fault→Resume Operation

A935 – K160 D203 Motor/Motor Controller Failure (Cont)

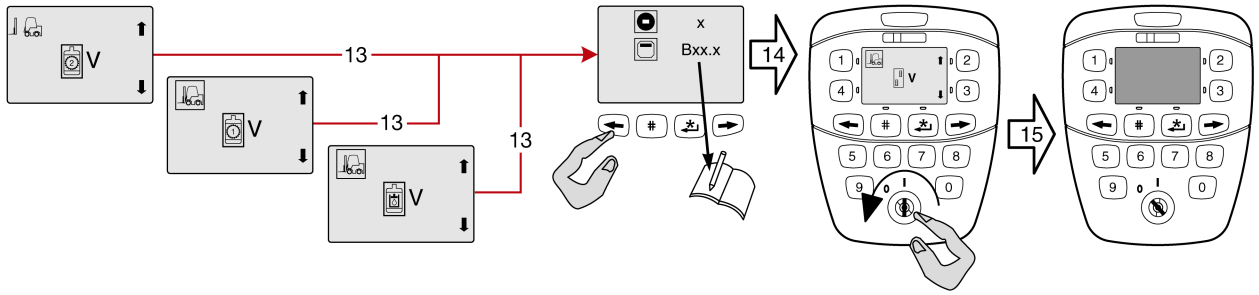
FAULT LOG Review - Go to Display Menu



Enter Service Password→Diagnostic→FAULT LOGs→Motor Fault Log(s)→View all Motor DTCs→?



📋✍ all Motor DTCs→☜Exit Fault Log→Truck Status ?



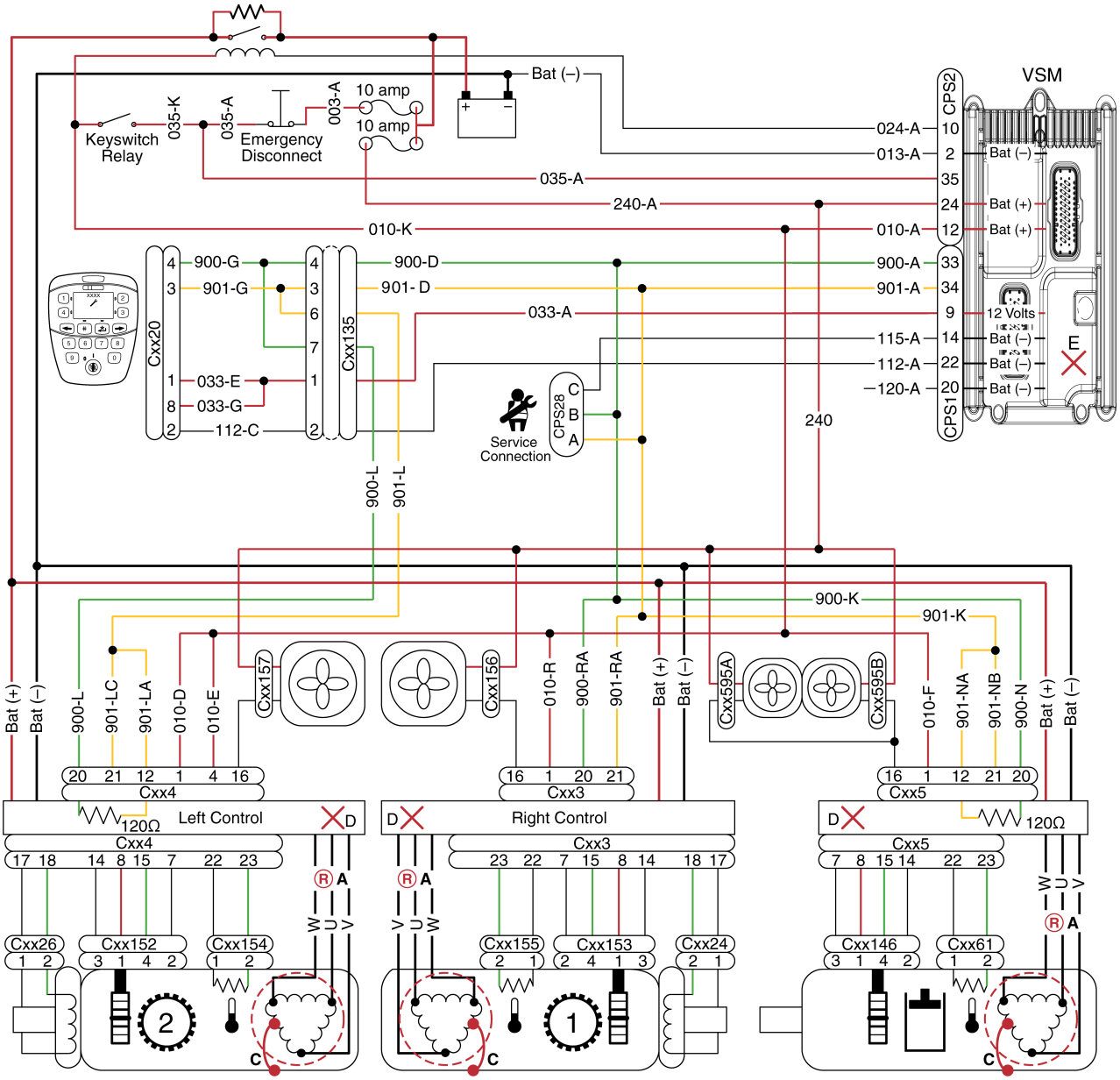
Motor Versions→📋✍Hardware/Software Versions→☜Exit Versions→Power **OFF**?

NOTE: Fault Logs will indicate which Motor/Motor Controller has the Faulty Component/Connection

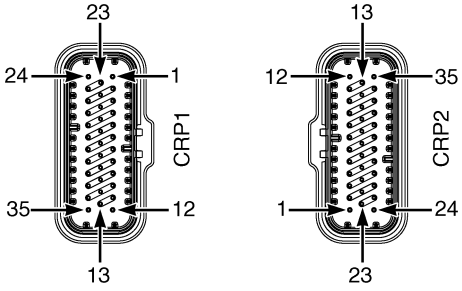
POSSIBLE CAUSES X = Open Circuit/Fail) = Short Circuit

A935 – K160 D203 Motor/Motor Controller Failure (Cont)

MOTOR/MOTOR CONTROLLER FAILURE CAUSES A B C D E > ?



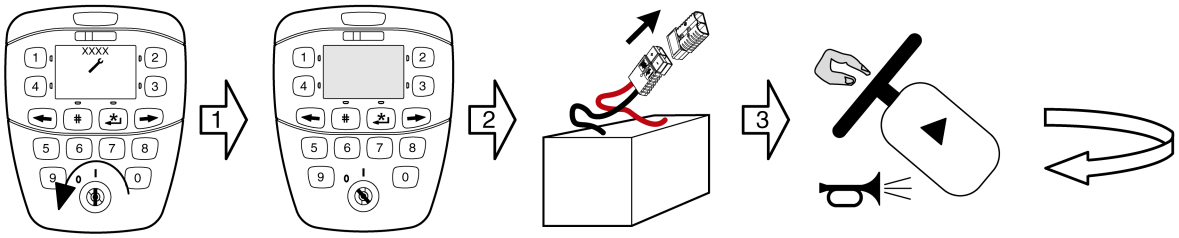
CONNECTORS



VSM Cxx 1 and Cxx 2

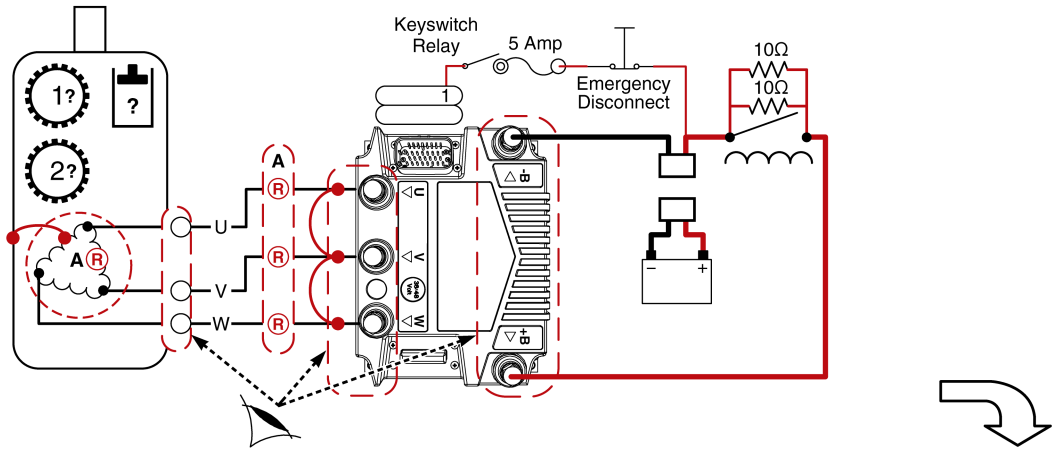
A935 – K160 D203 Motor/Motor Controller Failure (Cont)

CAUSE A



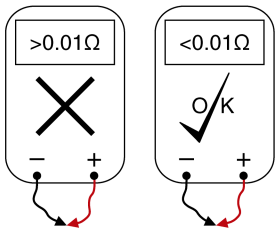
Power **OFF**→	Disconnect Battery and Sound Horn to Discharge Capacitors.→Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342→.	?

STEP A1



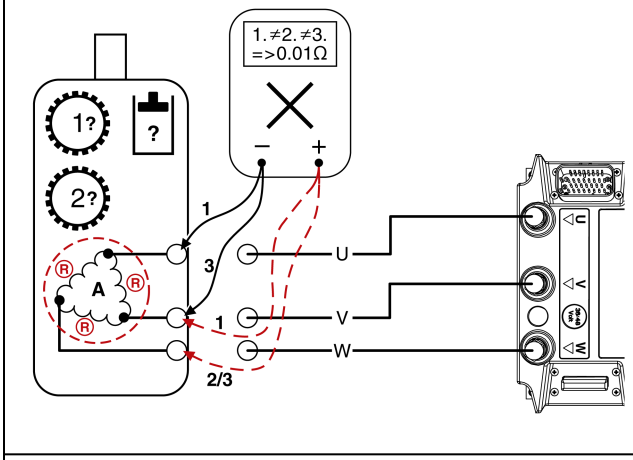
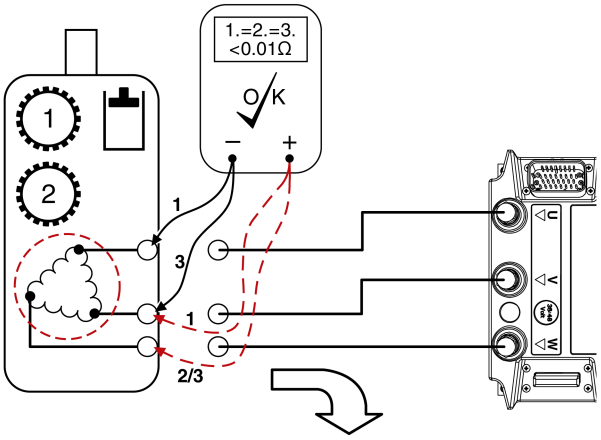
For any Fault DTC→Locate Device↓
Inspect ALL Wiring/Connections for Open Circuits/Corrosion/Bridging between adjacent Terminals

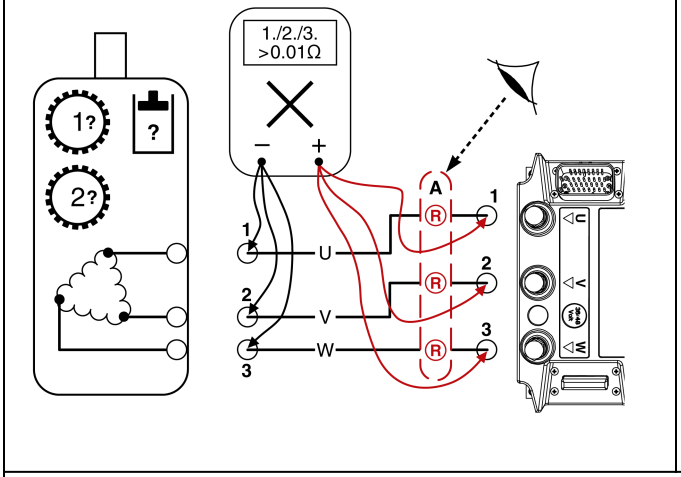
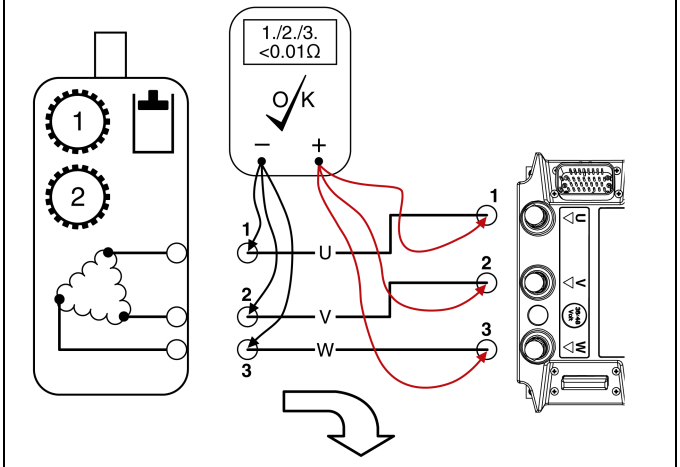
STEP A2



1. Set DMM to Lowest ?→Check Lead Resistance <0.01?

Note: If the Resistance is >0.01? then record this as the Zero ? Value→Step 3↓

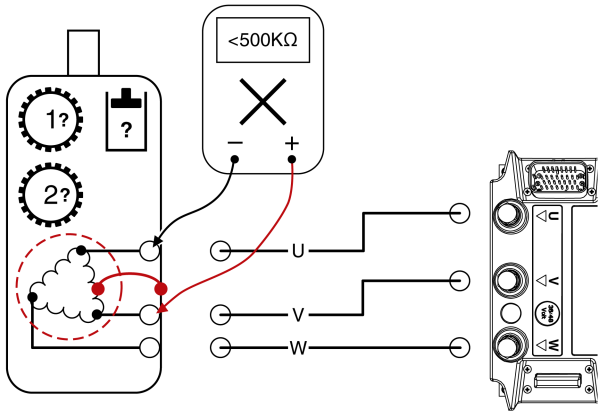
A935 – K160 D203 Motor/Motor Controller Failure (Cont)	
STEP A3	**CHECK RESISTANCE - Ω - OHMS**
Motor Coils	
	
Disconnect Motor connections W, V, U on Motor System indicated in Fault Log↓	
1. Measure ?→Go to 2↓	
2. Measure ?→Go to 3↓	
3. Measure ?→Go to 4↓	
4. 1 ? 2 ? 3 = > 0.01? + Zero Value→Go to 5↓	4. 1 = 2 = 3 < 0.01? + Zero Value→Step 4↓
5. Motor Faulty→Replace MotorGo to 6↓	
6. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→	
7. Recheck ?↑→ Reconnect→Test→?DTCs? YES→Step 4↓ NO→Resume Operation	

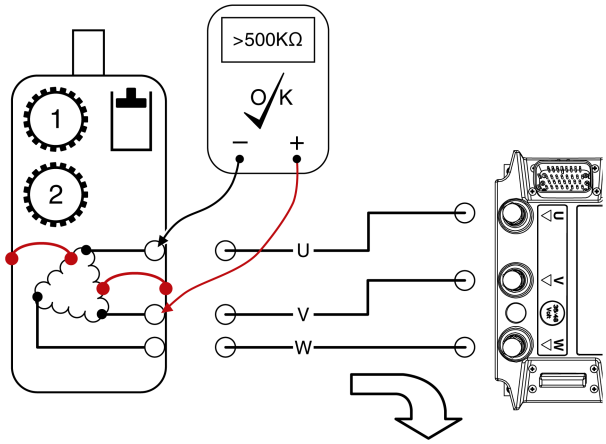
A935 – K160 D203 Motor/Motor Controller Failure (Cont)	
STEP A4	**CHECK RESISTANCE - Ω - OHMS**
Motor Coils	
	
Disconnect Motor connections W, V, U on Controller↓	
1. Measure ?→Go to 2↓	
2. Measure ?→Go to 3↓	
3. Measure ?→Go to 4↓	
4. 1 ? 2 ? 3 > 0.01? + Zero Value→Go to 5↓	4. 1 = 2 = 3 < 0.01? + Zero Value→CAUSE B↓
5. Wiring/Connector(s) Faulty→ReplaceGo to 6↓	
6. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→	
7. Recheck ?↑→ Reconnect→Test→?DTCs? YES→CAUSE B↓ NO→Resume Operation	
CAUSE B	
Not Applicable	

A935 – K160 D203 Motor/Motor Controller Failure (Cont)

CAUSE C

Motor Windings to Motor Case





Measure ? between Case and any Motor Terminal

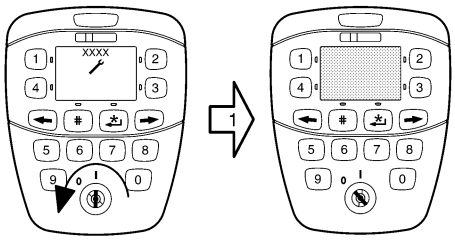
1. < 500K?→Go to 2↓	1. > 500K?→CAUSE C↓

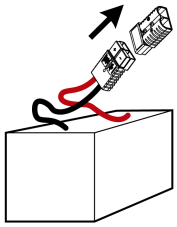
2. Short to Case→Replace Motor→Go to 3↓

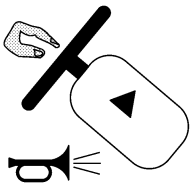
3. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→

4. Recheck ?↑→ Reconnect→Test→?DTCs? YES→CAUSE C↓ NO→Resume Operation

CAUSE D

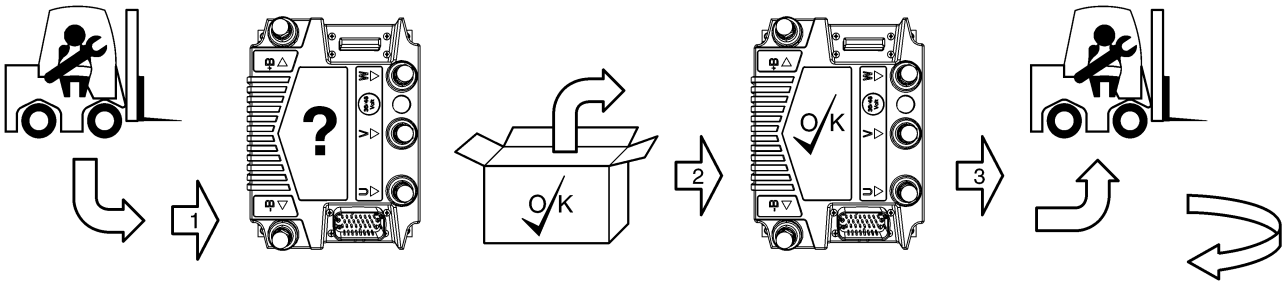






Power **OFF**→	Disconnect Battery and Sound Horn to Discharge Capacitors.→Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342→.

STEP D1



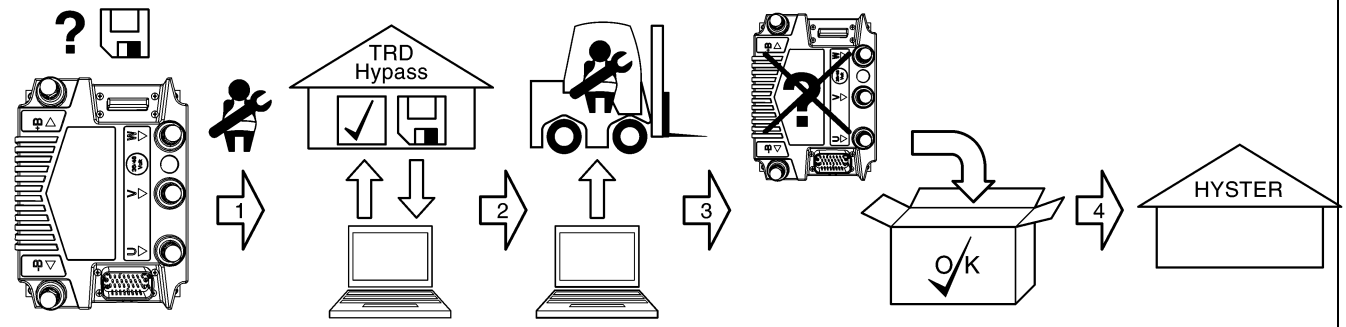
Remove and Replace Faulty Motor Controller↓

See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369↓

Check Replacement Controller 🖫 Version→See Label Information→Step 2↓

A935 – K160 D203 Motor/Motor Controller Failure (Cont)

STEP D2



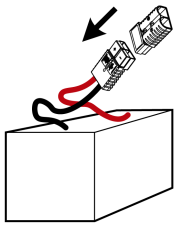
1. Go to TRD/Hypass Online /Software.?? Is Replacement Controller Application Software Version the Latest Version??

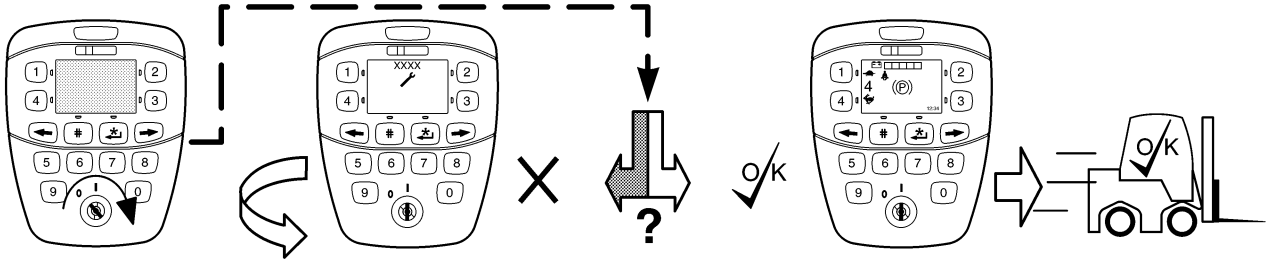
2. **NO**→Download the latest Application 🖫→Install on truck→Step 3↓

3. **YES**→Test New Installation→↓Step 3↓

4. Return Faulty Display→Dealer→Factory→Failure Analysis→?? Reprogramming

STEP D3

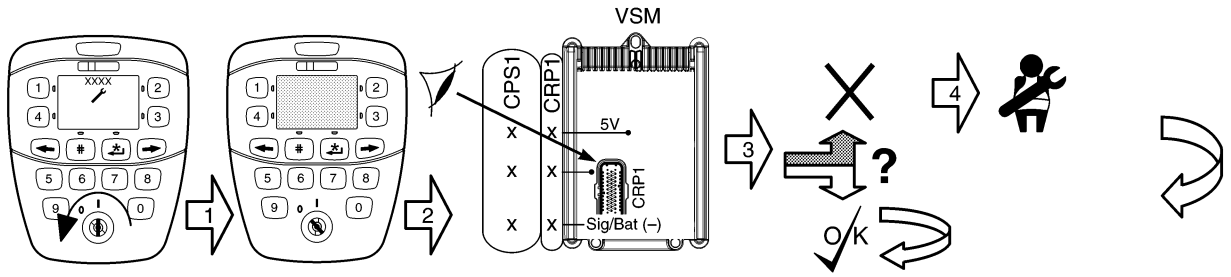




Retest - Power **ON**→	**NO**→?	Is fault DTC gone?**NO** **YES**←→	Fault corrected→Continue operation.

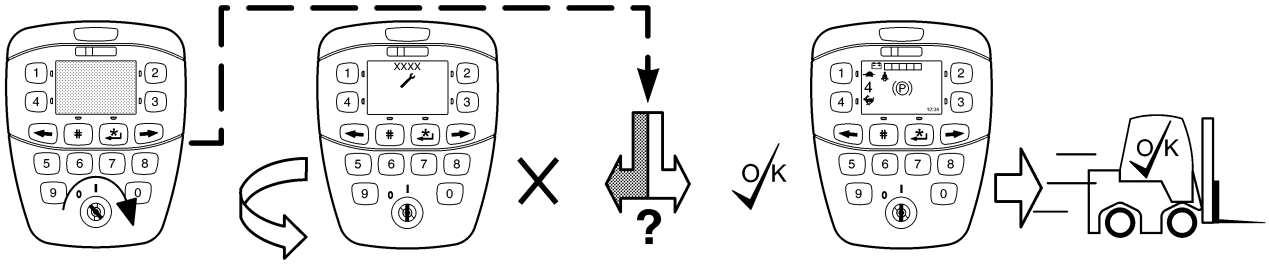
A935 – K160 D203 Motor/Motor Controller Failure (Cont)

CAUSE E



Power **OFF**→	Inspect VSM Connections→OK Step 1	Not OK Correct/Repair→Step 1

STEP E1



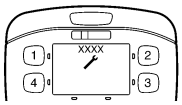
Retest - Power **ON**→	**NO**→Go to VSM Controller Check	Is fault DTC gone?**NO** **YES**←→	Fault corrected→Continue operation.

DTC LOGS: DTC logs should only be cleared once the data is by the Service Tech. See Display Menu Flowchart **- Clearing DTCs.**

END FAULT

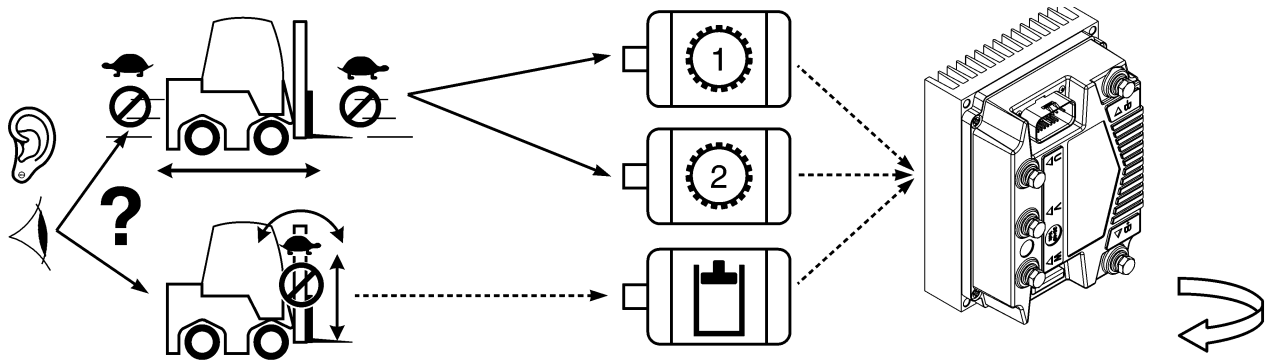
A935 – K160 D203 Motor Controller Failure (Cont)

DTC 65280
Controller Failure



QUICK CHECK X = Open Circuit/Fail) = Short Circuit

Check 1

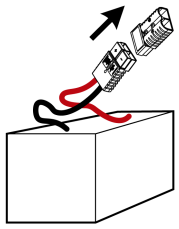
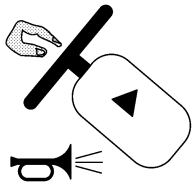
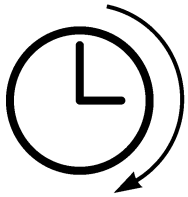
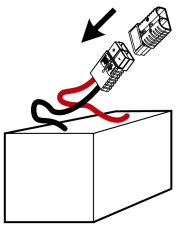


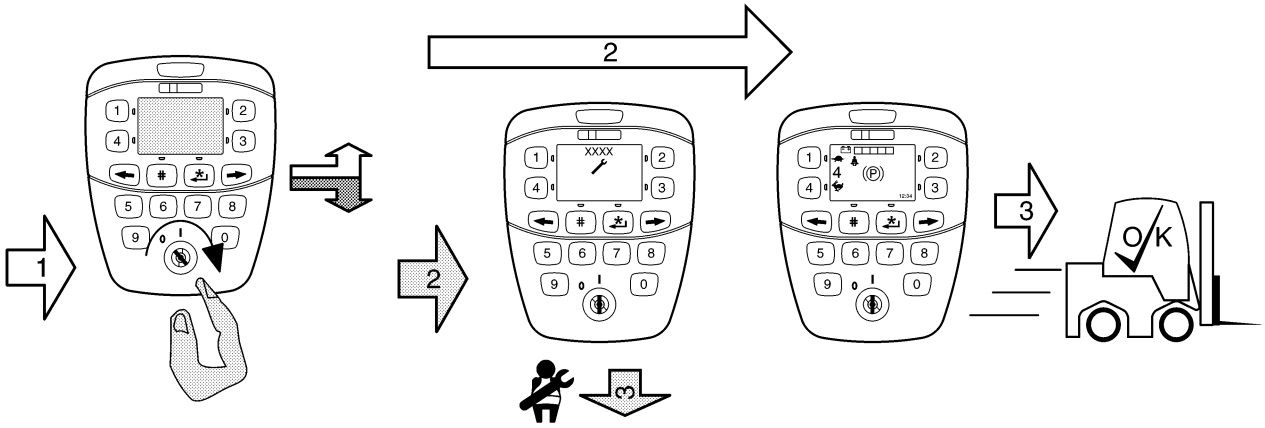
? Function Failure/Reduced Performance/Uncommanded Continuous Operation?

POSSIBLE CAUSES

1. Motor Controller Connections/Wiring High Resistance?→	→CAUSE 0↓
2. Motor Controller(s) Failure?→	→CAUSE C↓

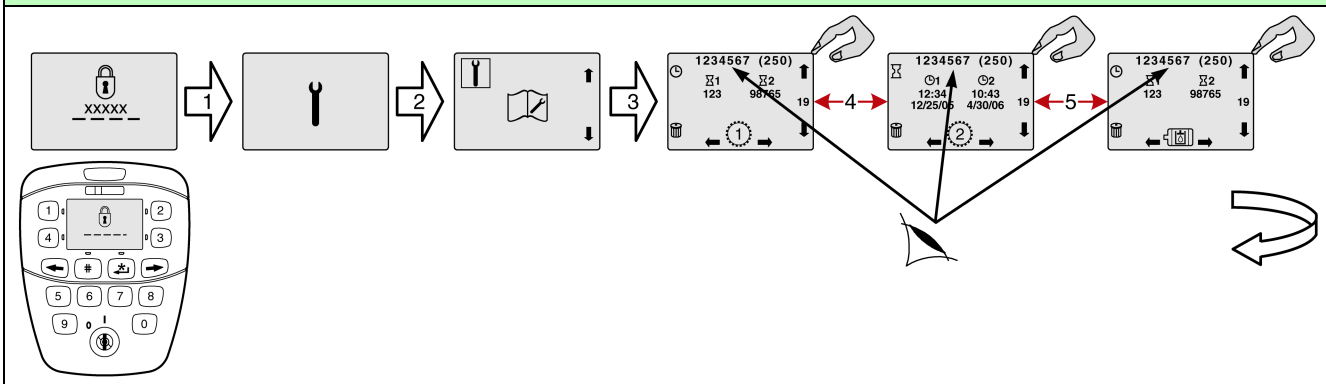
Check 2

			
Disconnect Battery and Sound Horn to Discharge Capacitors.Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342.		Wait 30 seconds	Reconnect Battery

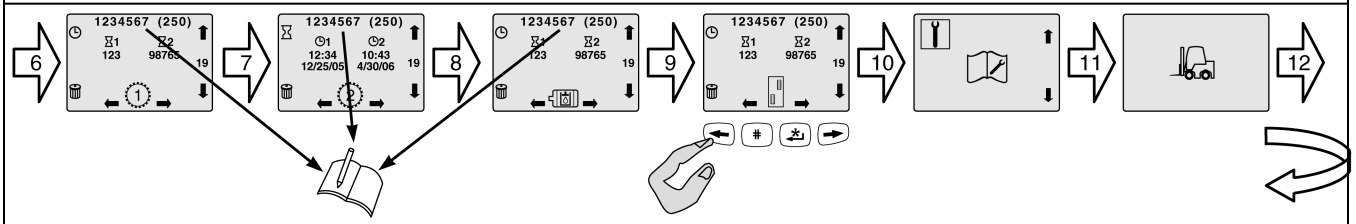
A935 – K160 D203 Motor Controller Failure (Cont)		
Check 3		
		
Power **ON**→	Fault Remains Service Required ?	No Fault→Resume Operation

A935 – K160 D203 Motor Controller Failure (Cont)

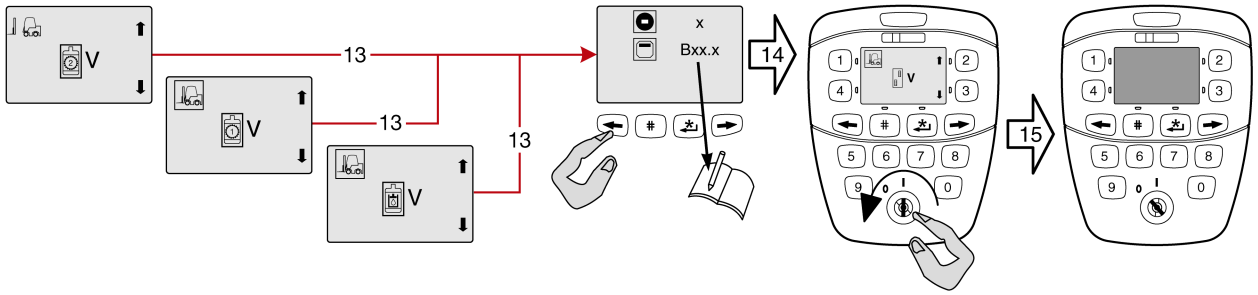
FAULT LOG Review - Go to Display Menu



Enter SERVICE Password→Diagnostic→FAULT LOGs→Motor Fault Log(s)→View all Motor DTCs→?



📋✍ all Motor DTCs→☜Exit Fault Log→Truck Status ?



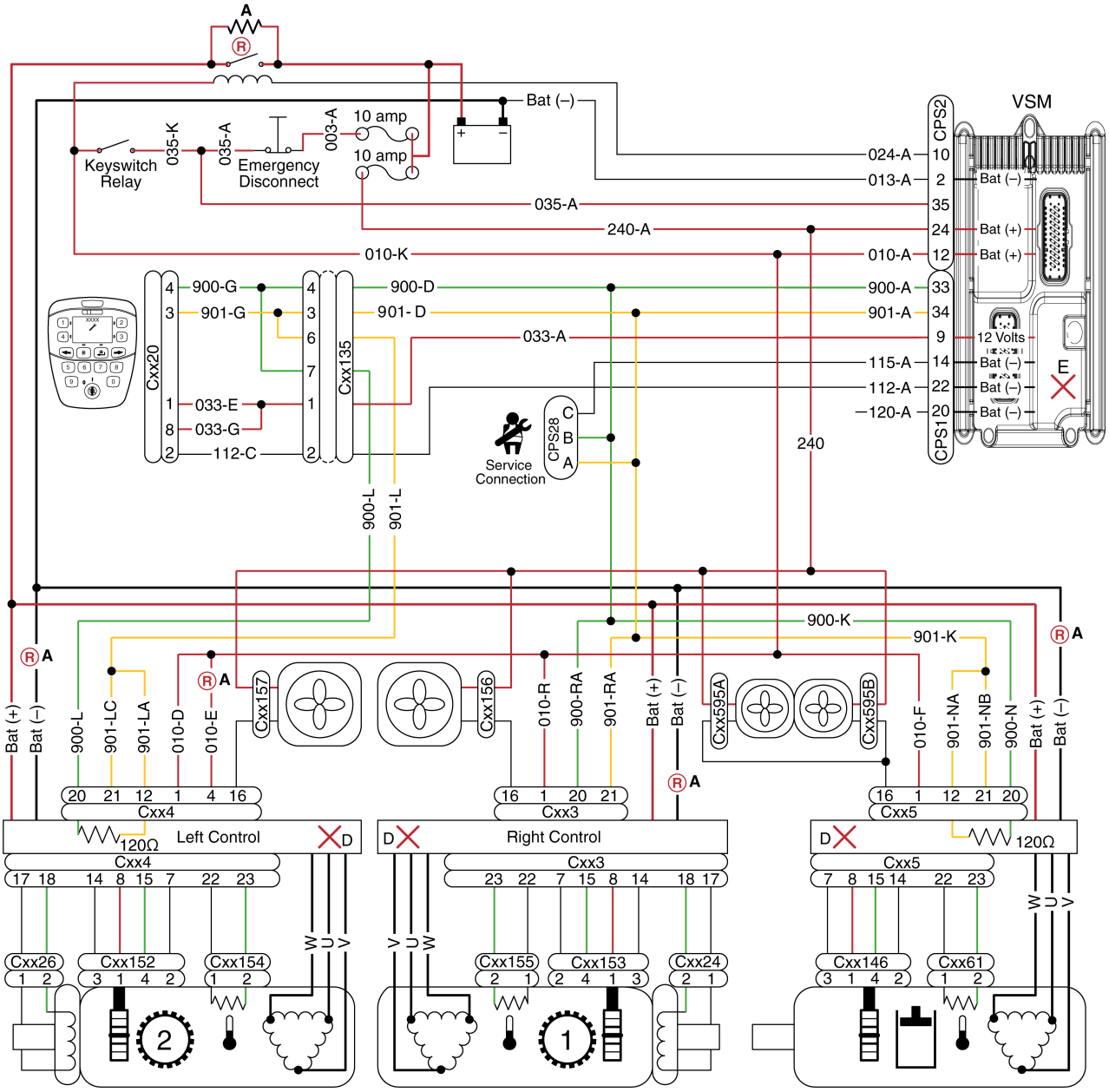
NOTE: Fault Logs will indicate which Motor/Motor Controller has the faulty Component/Connection

Motor Versions→📋✍Hardware/Software Versions→☜Exit Versions→Power **OFF**?

POSSIBLE CAUSES X = Open Circuit/Fail) = Short Circuit

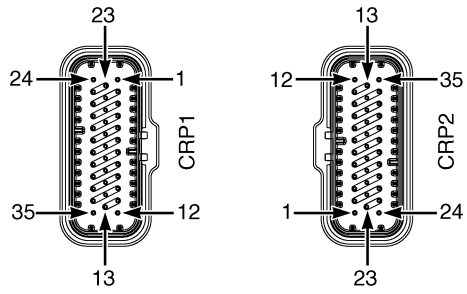
A935 – K160 D203 Motor Controller Failure (Cont)

MOTOR CONTROLLER CAPACITOR FAILURE CAUSES A B C D E > ?

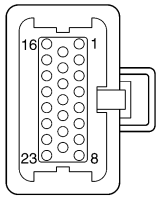


A935 – K160 D203 Motor Controller Failure (Cont)

CONNECTORS

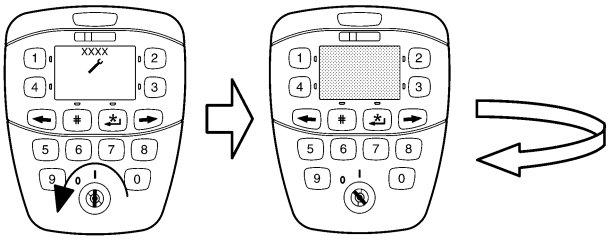


VSM Cxx 1 and Cxx 2



Traction/Pump Controller Cxx 3, 4, and 5

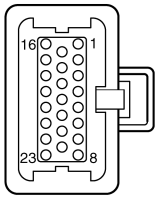
CAUSE A

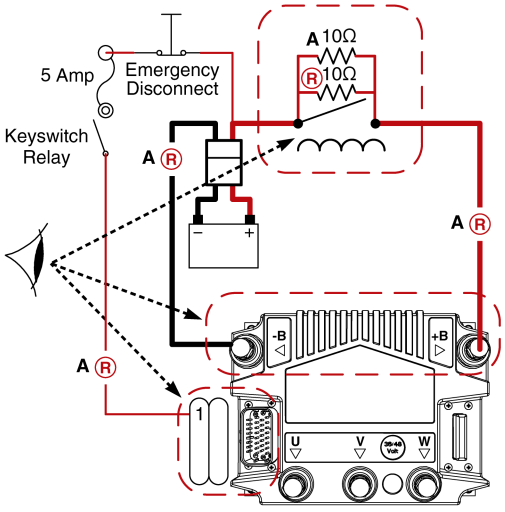


Power **OFF**→ ?

STEP A1

For any Fault DTC→Locate Device→Inspect ALL Wiring/ConnectionsSee Motor Controller Contactor Failure





CAUSE B

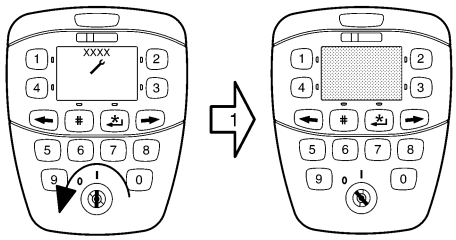
Not Applicable

CAUSE C

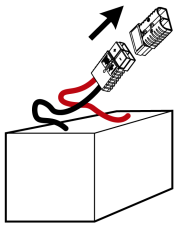
Not Applicable

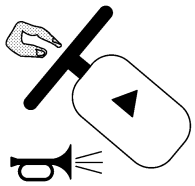
A935 – K160 D203 Motor Controller Failure (Cont)

CAUSE D



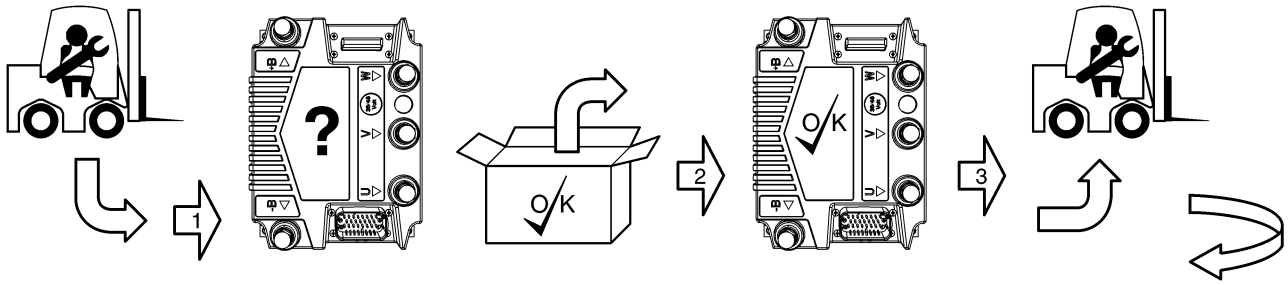
Power **OFF**→





Disconnect Battery and Sound Horn to Discharge Capacitors.→Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342→.

STEP D1

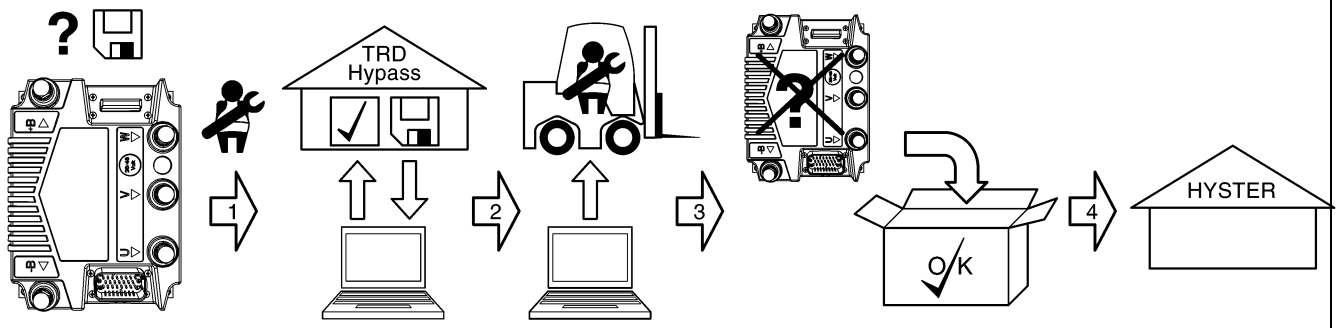


Remove and Replace Faulty Motor Controller↓

See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369↓

Check Replacement Controller 🖫 Version→See Label Information→Step 2↓

STEP D2



1. Go to TRD/Hypass Online /Software.?? Is Replacement Controller Application Software Version the Latest Version??

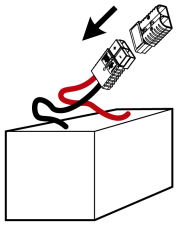
2. **NO**→Download the latest Application 🖫→Install on truck→Step 3↓

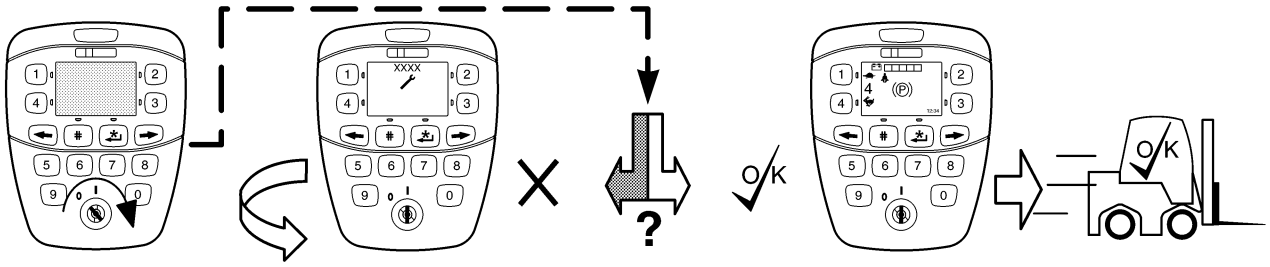
3. **YES**→Test New Installation→↓Step 3↓

4. Return Faulty Display→Dealer→Factory→Failure Analysis→?? Reprogramming

A935 – K160 D203 Motor Controller Failure (Cont)

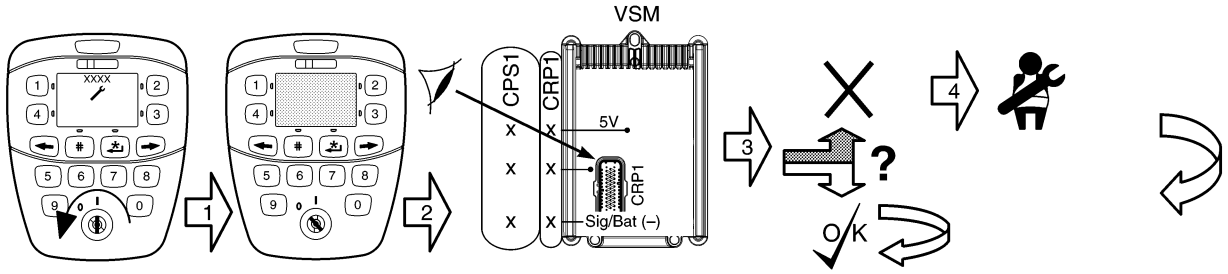
STEP D3





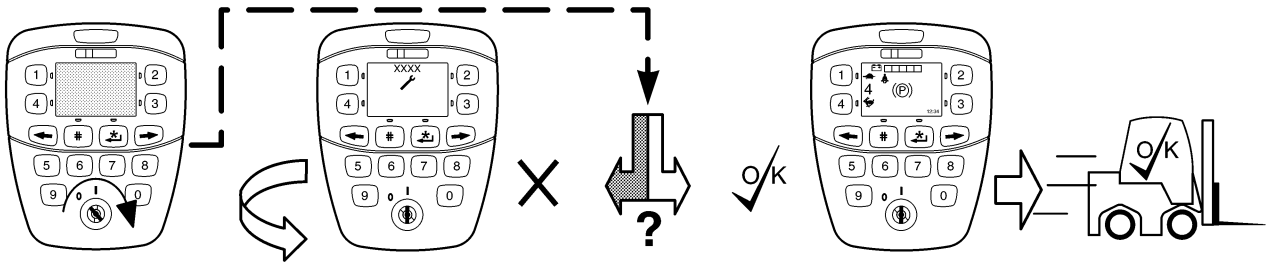
Retest - Power **ON**→	**NO**→?	Is fault DTC gone?**NO** **YES**←→	Fault corrected→Continue operation.

CAUSE E



Power **OFF**→	Inspect VSM Connections→OK Step 1	Not OK Correct/Repair→Step 1

STEP E1

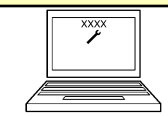


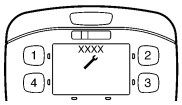
Retest - Power **ON**→	**NO**→Go to VSM Controller Check	Is fault DTC gone?**NO** **YES**←→	Fault corrected→Continue operation.

DTC LOGS: DTC logs should only be cleared once the data is by the Service Tech. See Display Menu Flowchart **- Clearing DTCs.**

END FAULT

CBB/DBB Motor/Motor Controller Failure (Cont)

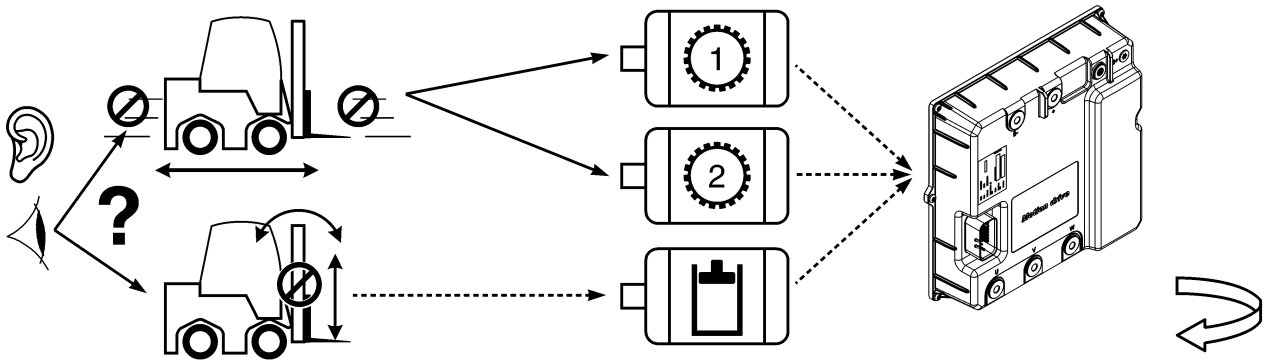




DTC 8976 **DTC 9024**
AC Current – Over Current **AC Current – Short Circuit**

QUICK CHECK X = Open Circuit/Fail) = Short Circuit

Check 1

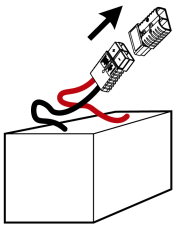
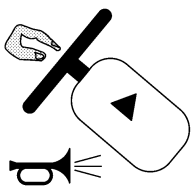
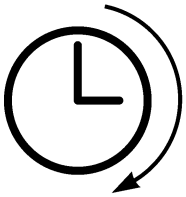
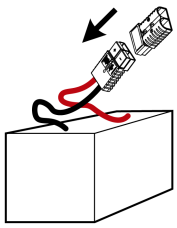


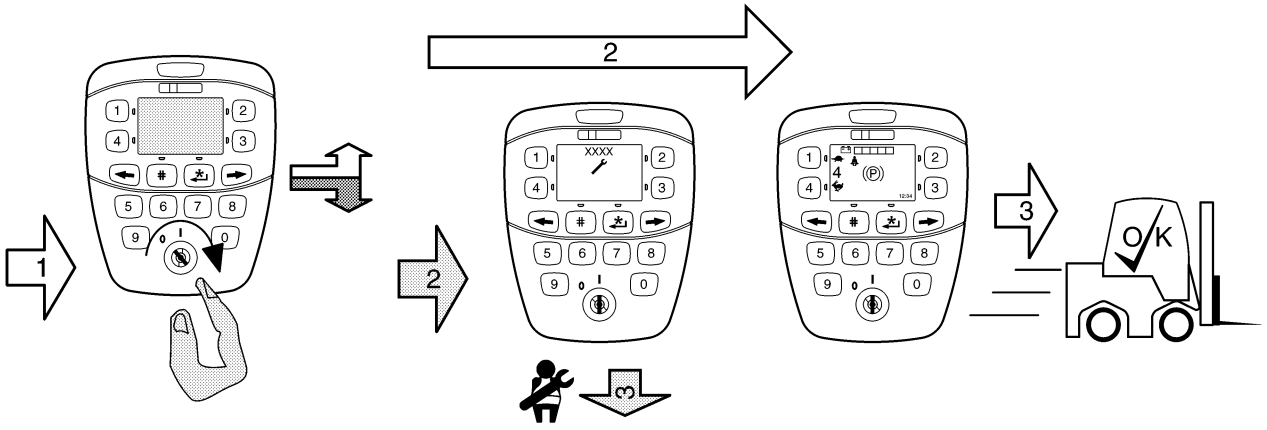
? No Traction/Hydraulic Truck Operation ?

POSSIBLE CAUSES	
Motor to Motor Controller Connections/Wiring→High Resistance?→	→CAUSE 0↓
Motor Windings Failure Open Circuit?→	→CAUSE 0↓
Motor Windings Short to Frame?→	→CAUSE B↓
Motor Controller(s) Failure?→	→CAUSE C↓

WARNING
The CBB Truck requires the removal of the battery to access the Controllers and Motors

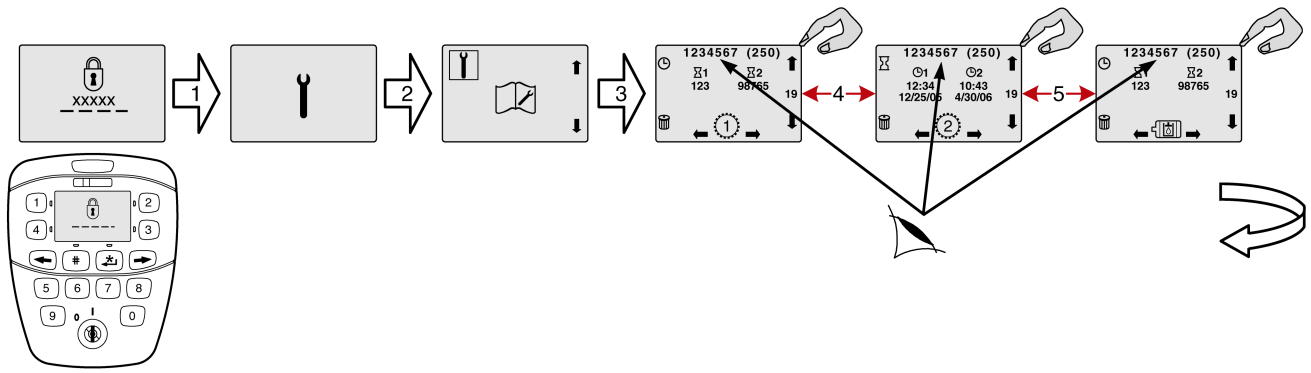
Check 2

			
Disconnect Battery	Sound Horn to Discharge Capacitors	Wait 30 seconds	Reconnect Battery

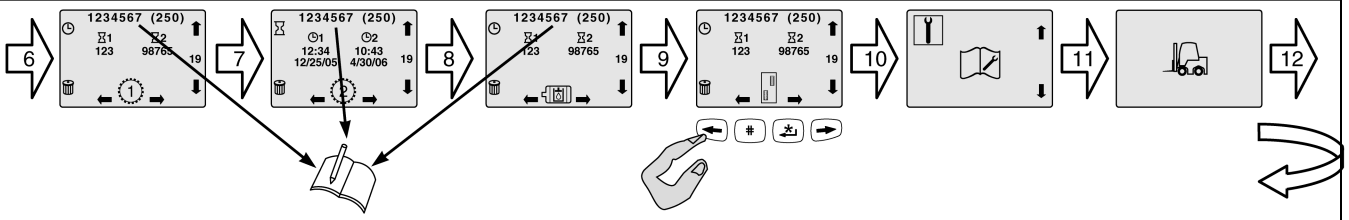
CBB/DBB Motor/Motor Controller Failure (Cont)		
Check 3		
		
Power **ON**→	Fault Remains Service Required ?	No Fault→Resume Operation

CBB/DBB Motor/Motor Controller Failure (Cont)

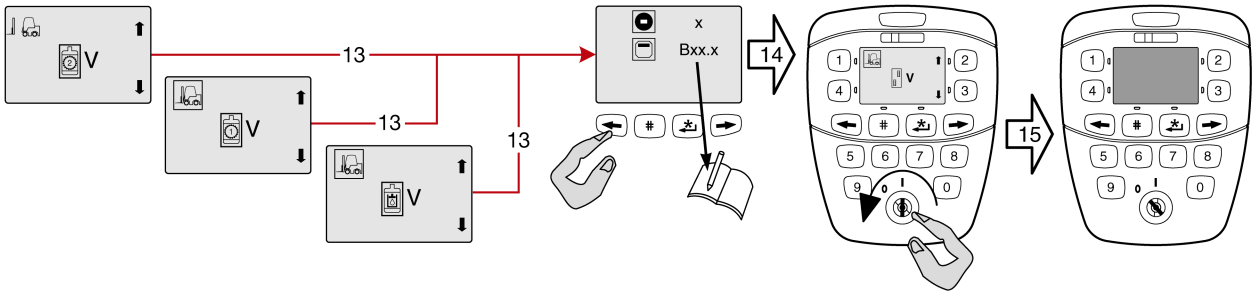
FAULT LOG Review - Go to Display Menu



Enter Service Password→Diagnostic→FAULT LOGs→Motor Fault Log(s)→View all Motor DTCs→?



📝 all Motor DTCs→☜Exit Fault Log→Truck Status ?



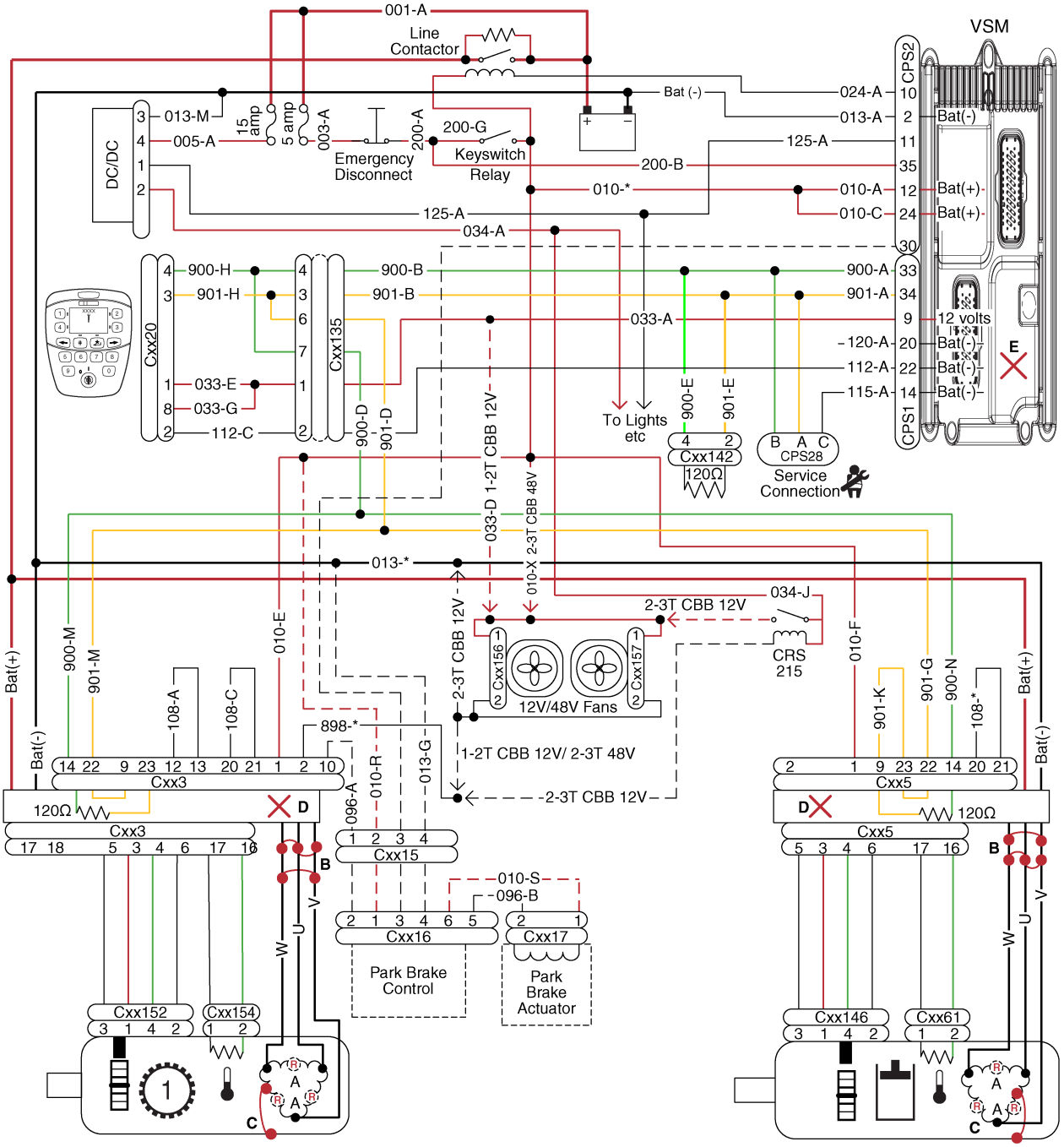
Motor Versions→📝Hardware/Software Versions→☜Exit Versions→Power **OFF**?

NOTE: Fault Logs will indicate which Motor/Motor Controller has the Faulty Component/Connection

POSSIBLE CAUSES X = Open Circuit/Fail) = Short Circuit

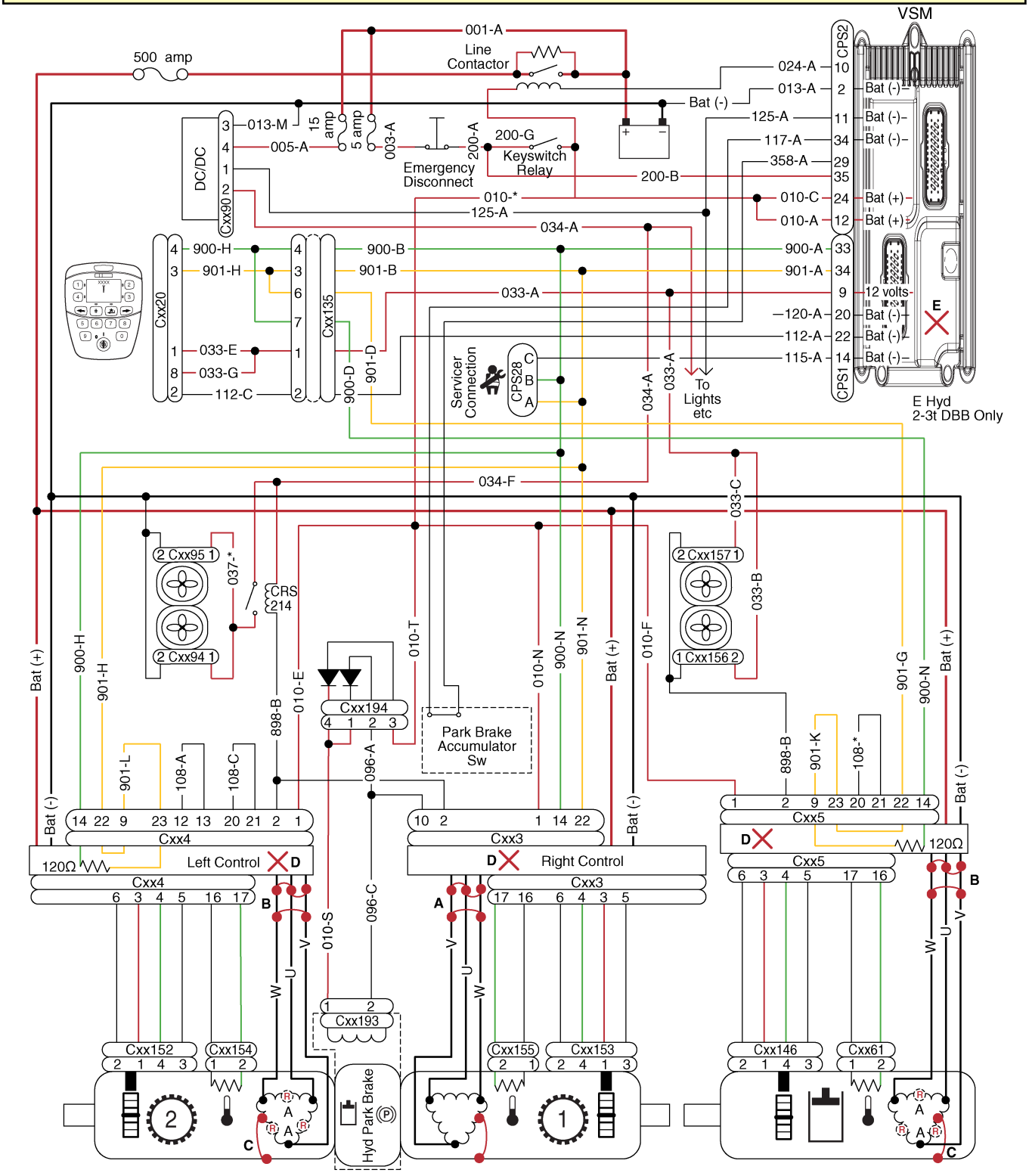
CBB/DBB Motor/Motor Controller Failure (Cont)

1.5 – 2.0 TON CBB SCHEMATIC CAUSES A B C D E > ?



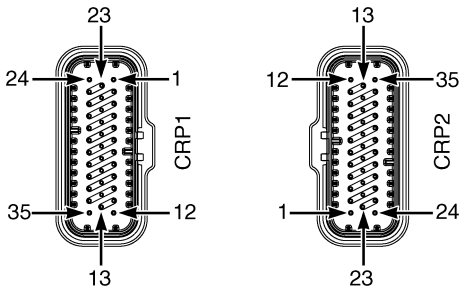
CBB/DBB Motor/Motor Controller Failure (Cont)

2.2 – 3.0 TON DBB SCHEMATIC CAUSES A B C D E > ?



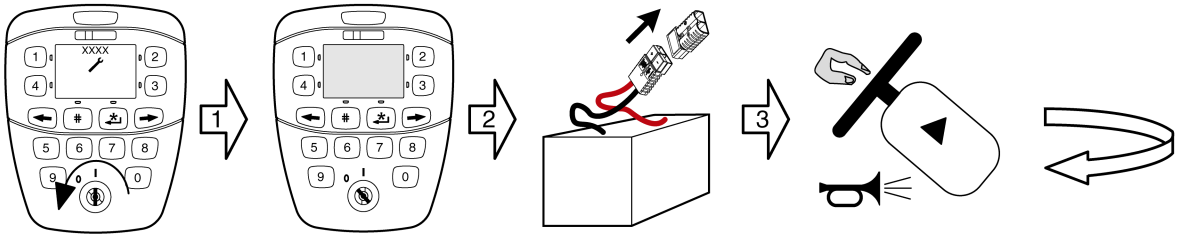
CBB/DBB Motor/Motor Controller Failure (Cont)

CONNECTORS



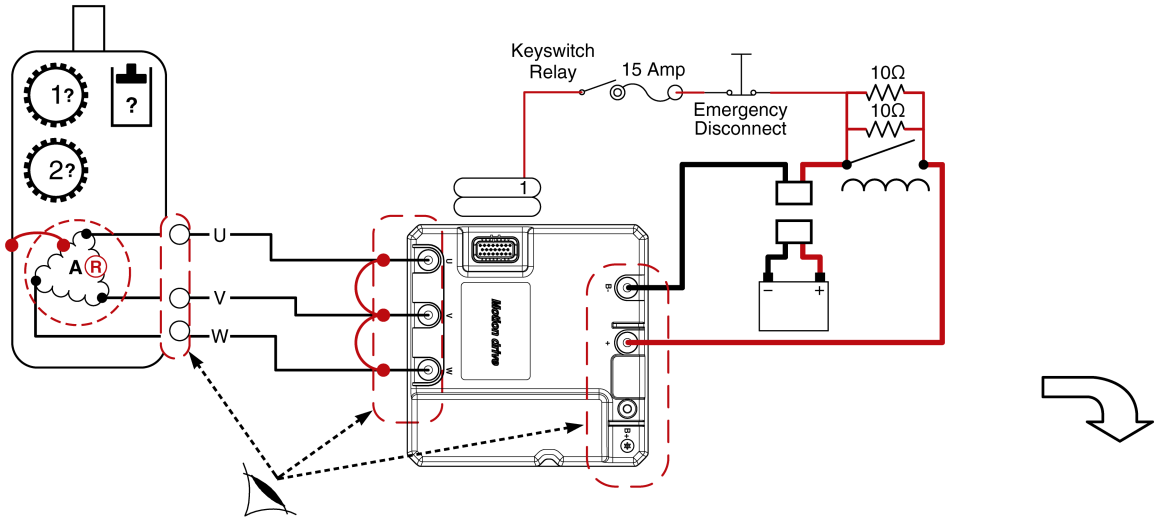
VSM Cxx 1 and Cxx 2

CAUSE A

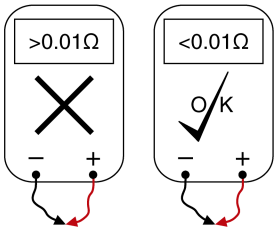
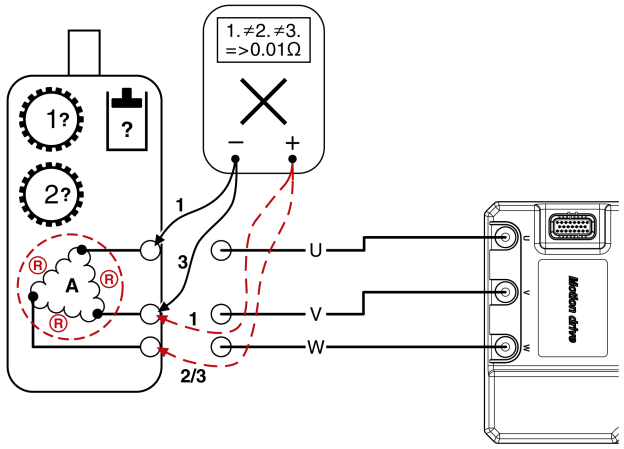
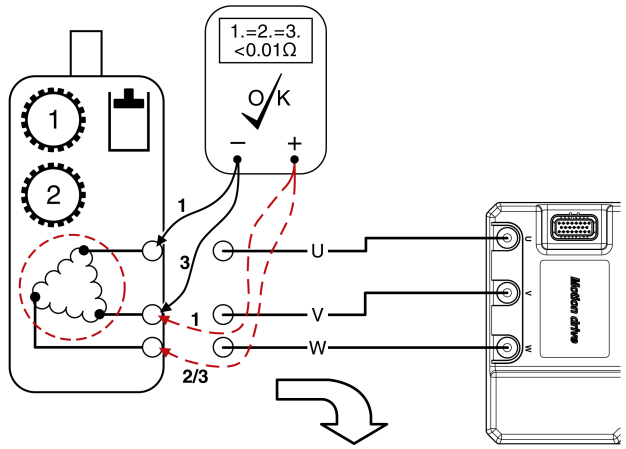


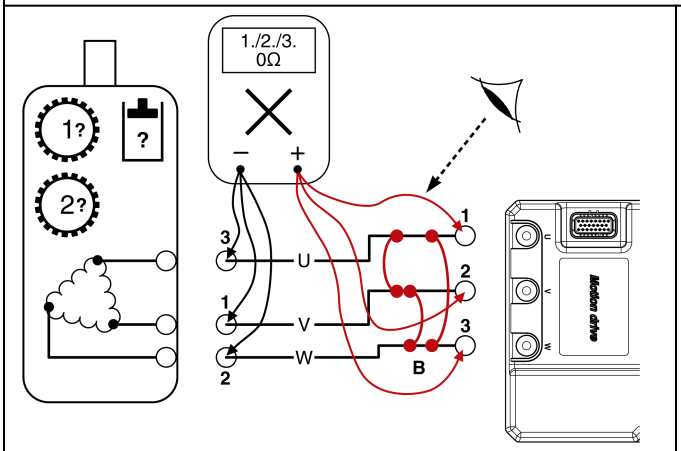
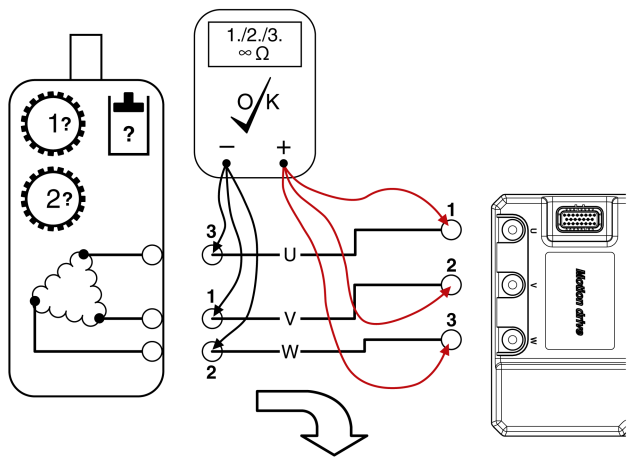
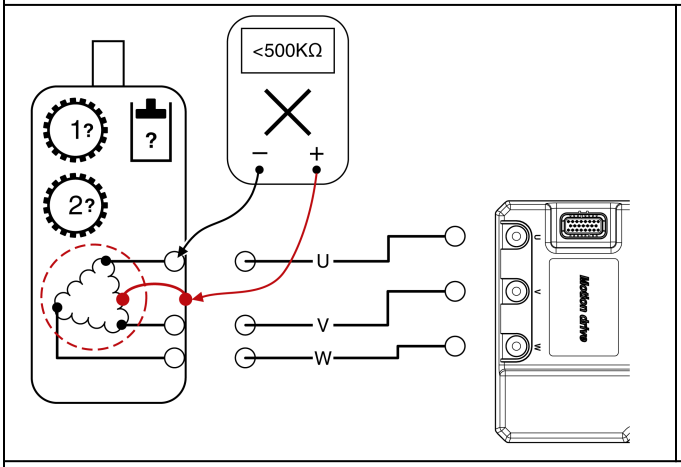
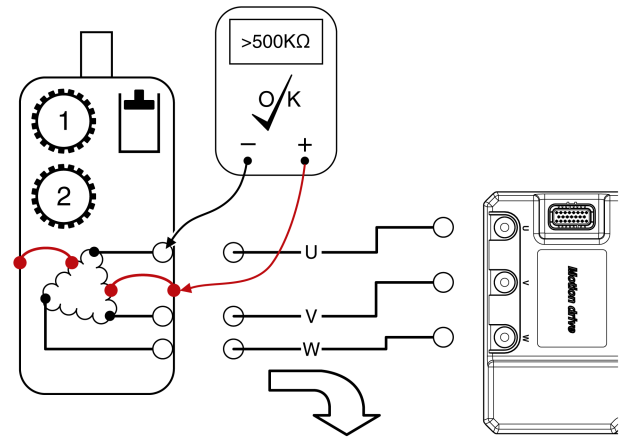
Power **OFF**→ | Disconnect Battery→Sound Horn to Discharge Capacitors→ | ?

STEP A1



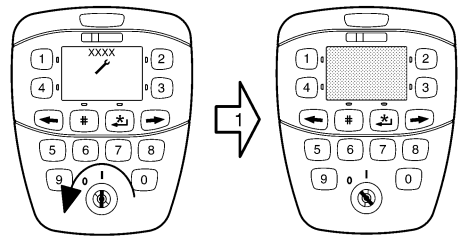
For any Fault DTC→Locate Device↓
Inspect ALL Wiring/Connections for Open Circuits/Corrosion/Bridging between adjacent Terminals

CBB/DBB Motor/Motor Controller Failure (Cont)	
STEP A2	
	
1. Set DMM to Lowest ?→Check Lead Resistance <0.01?	
Note: If the Resistance is >0.01? then record this as the Zero ? Value→Step 3↓	
STEP A3 **CHECK RESISTANCE - Ω - OHMS**	
Motor Coils	
	
Disconnect Motor connections W, V, U on Motor System indicated in Fault Log↓	
1. Measure ?→Go to 2↓	
2. Measure ?→Go to 3↓	
3. Measure ?→Go to 4↓	
4. 1 ? 2 ? 3 = > 0.01? + Zero Value→Go to 5↓	4. 1 = 2 = 3 < 0.01? + Zero Value→CAUSE A↓
5. Motor Faulty→Replace MotorGo to 6↓	
6. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→Go to 7↓	
7. Recheck ?↑→ Reconnect→Test→?DTCs? YES→CAUSE A↓ NO→Resume Operation	

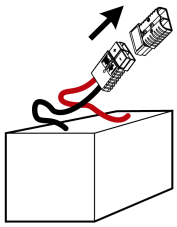
CBB/DBB Motor/Motor Controller Failure (Cont)	
CAUSE B	
Motor/Controller Connections	
	
Disconnect Motor connections W, V, U on Controller↓	
1. Measure ?→Go to 2↓	
2. Measure ?→Go to 3↓	
3. Measure ?→Go to 4↓	
4. 1./2./3. 0?→Go to 5↓	4. 1./2./3. 8?→CAUSE B↓
5. Wiring/Connector(s) Faulty→ReplaceGo to 6↓	
6. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→Go to 7↓	
7. Recheck ?↑→ Reconnect→Test→?DTCs? YES→CAUSE B↓ NO→Resume Operation	
CAUSE C	
Motor Windings to Motor Case	
	
Measure ? between Case and any Motor Terminal	
1. < 500K?→Go to 2↓	1. > 500K?→CAUSE C↓
2. Short to Case→Replace Motor→Go to 3↓	
3. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→Go to 4↓	
4. Recheck ?↑→ Reconnect→Test→?DTCs? YES→CAUSE C↓ NO→Resume Operation	

CBB/DBB Motor/Motor Controller Failure (Cont)

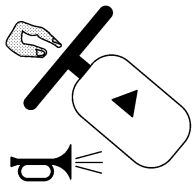
CAUSE D



Power **OFF**→

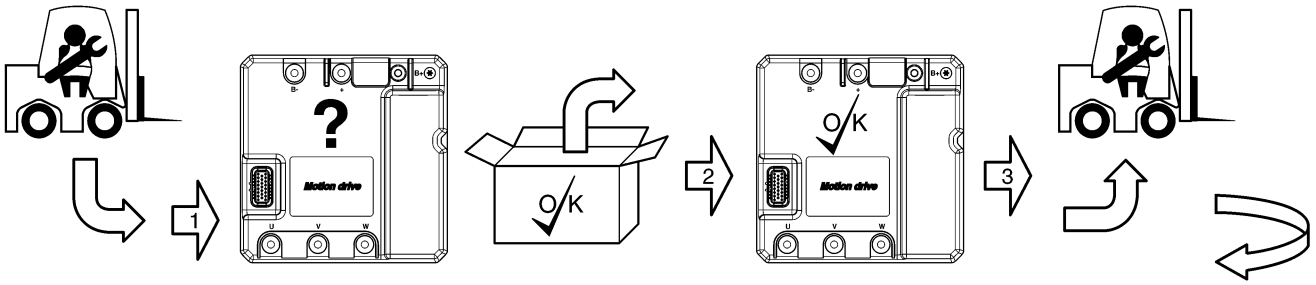


Disconnect Battery



Sound Horn to Discharge Capacitors

STEP D1

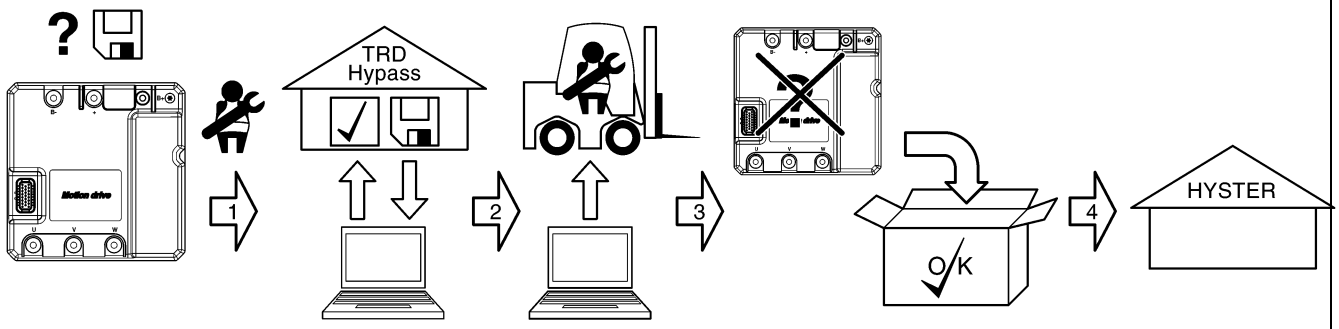


Remove and Replace Faulty Motor Controller↓

See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369↓

Check Replacement Controller 🖫 Version→See Label Information→Step 2↓

STEP D2



1. Go to TRD/Hypass Online /Software.?? Is Replacement Controller Application Software Version the Latest Version??

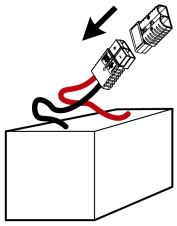
2. **NO**→Download the latest Application 🖫→Install on truck→Step 3↓

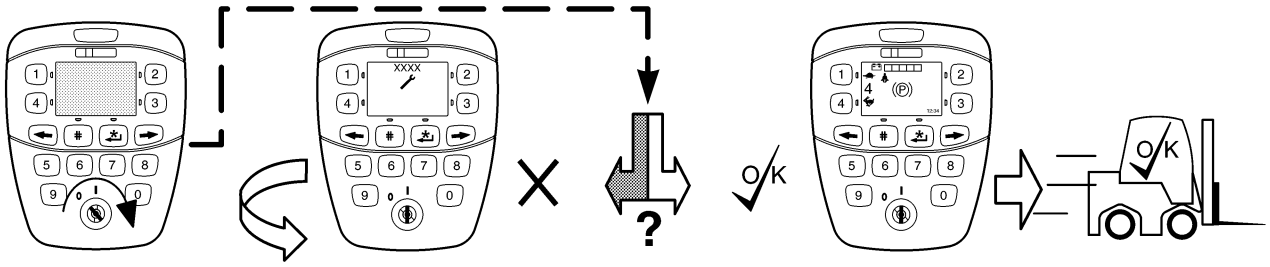
3. **YES**→Test New Installation→↓Step 3↓

4. Return Faulty Display→Dealer→Factory→Failure Analysis→?? Reprogramming

CBB/DBB Motor/Motor Controller Failure (Cont)

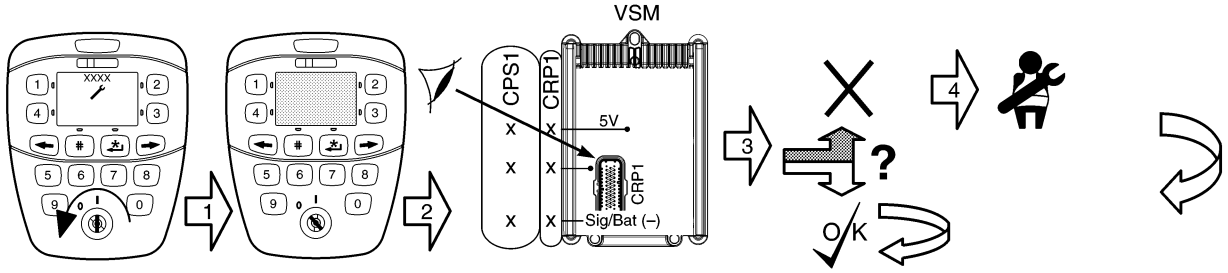
STEP D3





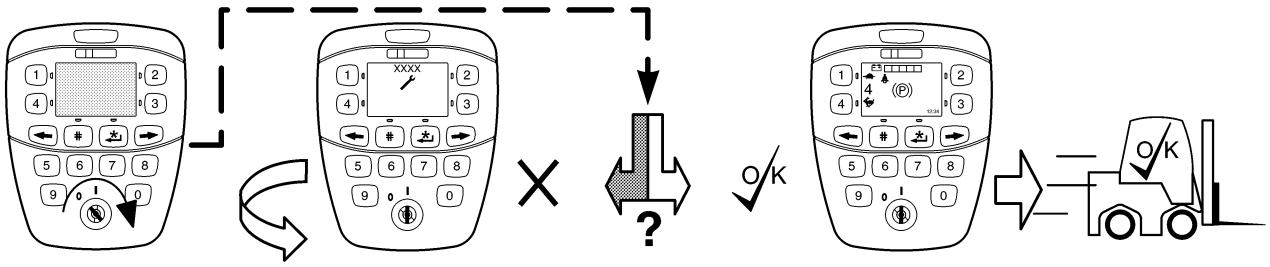
Retest - Power **ON**→	**NO**→?	Is fault DTC gone?**NO** **YES**←→	Fault corrected→Continue operation.

CAUSE E



Power **OFF**→	Inspect VSM Connections→OK Step 1	Not OK Correct/Repair→Step 1

STEP E1



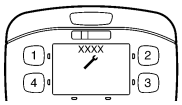
Retest - Power **ON**→	**NO**→Go to VSM Controller Check	Is fault DTC gone?**NO** **YES**←→	Fault corrected→Continue operation.

DTC LOGS: DTC logs should only be cleared once the data is by the Service Tech. See Display Menu Flowchart **- Clearing DTCs.**

END FAULT

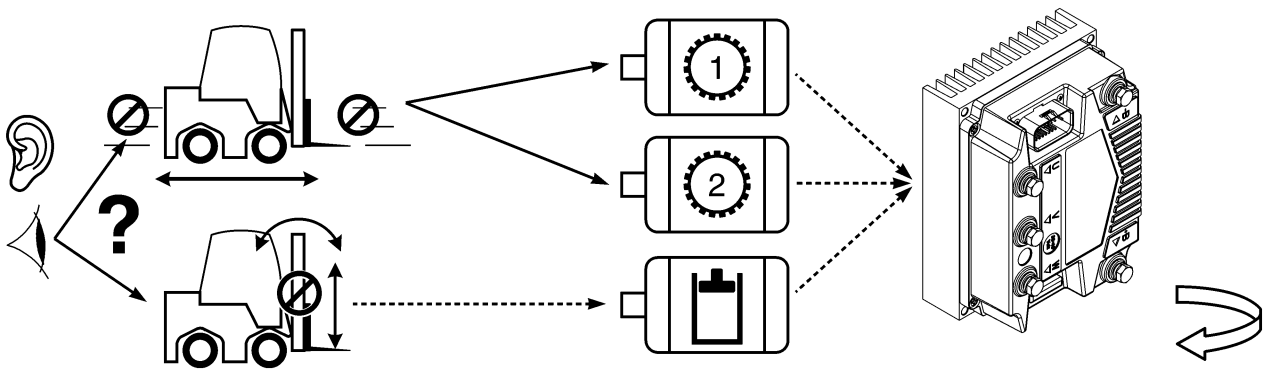
A935 – K160 D203 Motor Controller CAN Communication Failure (Cont)

DTC 65527
No CAN Communication



QUICK CHECK X = Open Circuit/Fail) = Short Circuit

Check 1

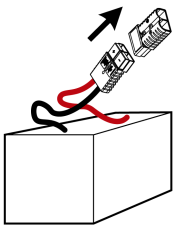
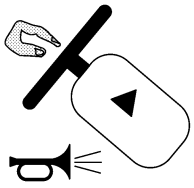
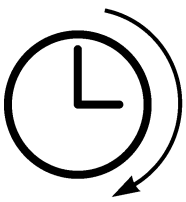
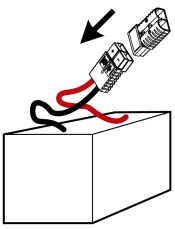


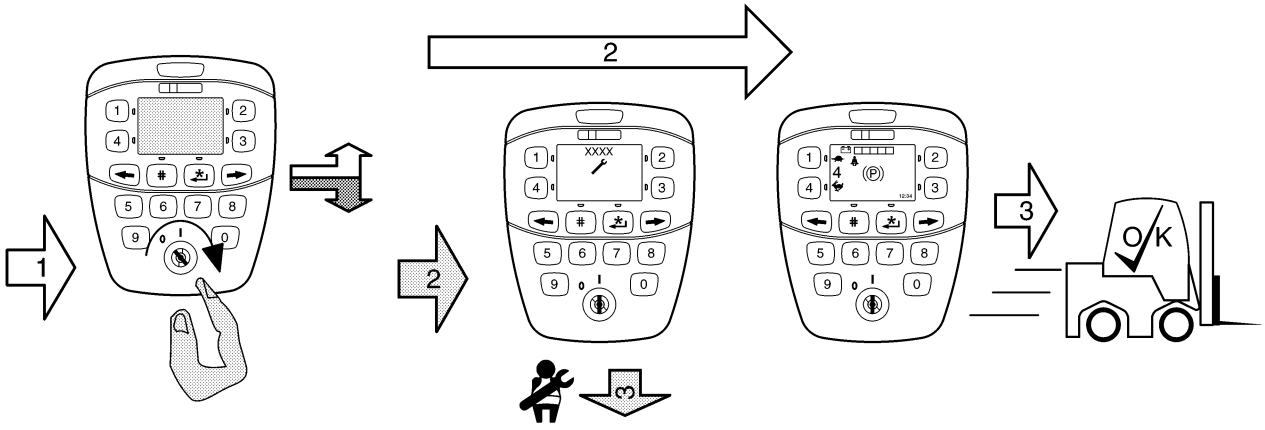
? No Traction/Hydraulic Truck Operation ?

POSSIBLE CAUSES

Motor Controller Connections/Wiring Open/ Short Circuit→	A935 – K160 CAN Communication Failure
Motor Controller(s) Failure?→	→CAUSE C↓

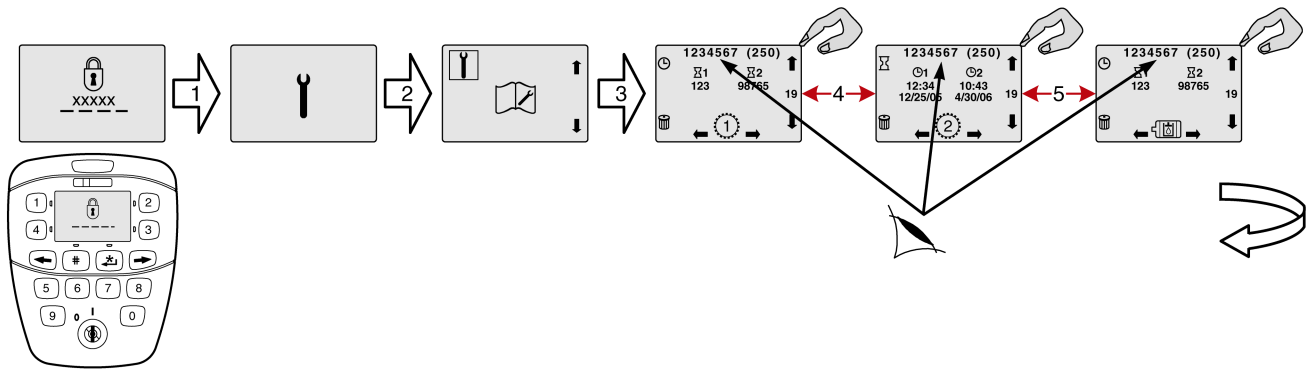
Check 2

			
Disconnect Battery and Sound Horn to Discharge Capacitors.Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342.		Wait 30 seconds	Reconnect Battery

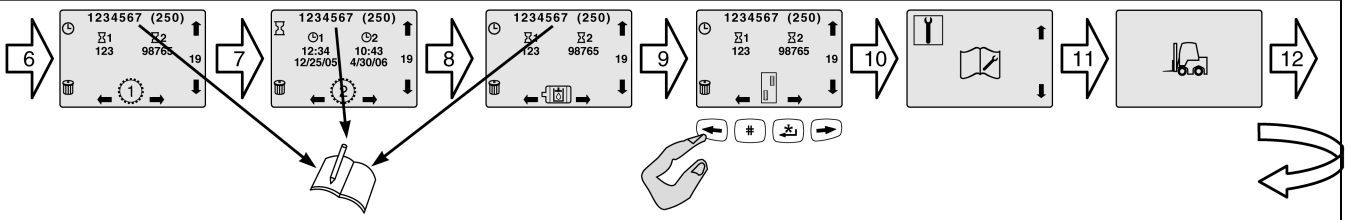
A935 – K160 D203 Motor Controller CAN Communication Failure (Cont)		
Check 3		
		
Power **ON**→	Fault Remains Service Required ?	No Fault→Resume Operation

A935 – K160 D203 Motor Controller CAN Communication Failure (Cont)

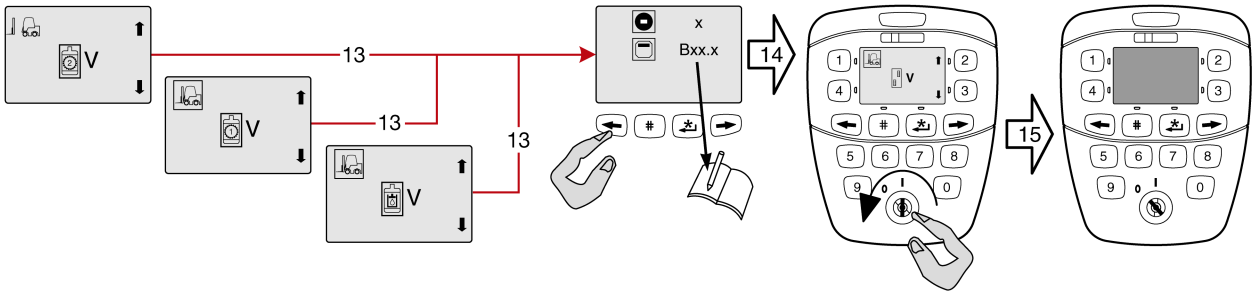
FAULT LOG Review - Go to Display Menu



Enter Service Password→Diagnostic→FAULT LOGs→Motor Fault Log(s)→View all Motor DTCs→?



📝 all Motor DTCs→☜Exit Fault Log→Truck Status ?



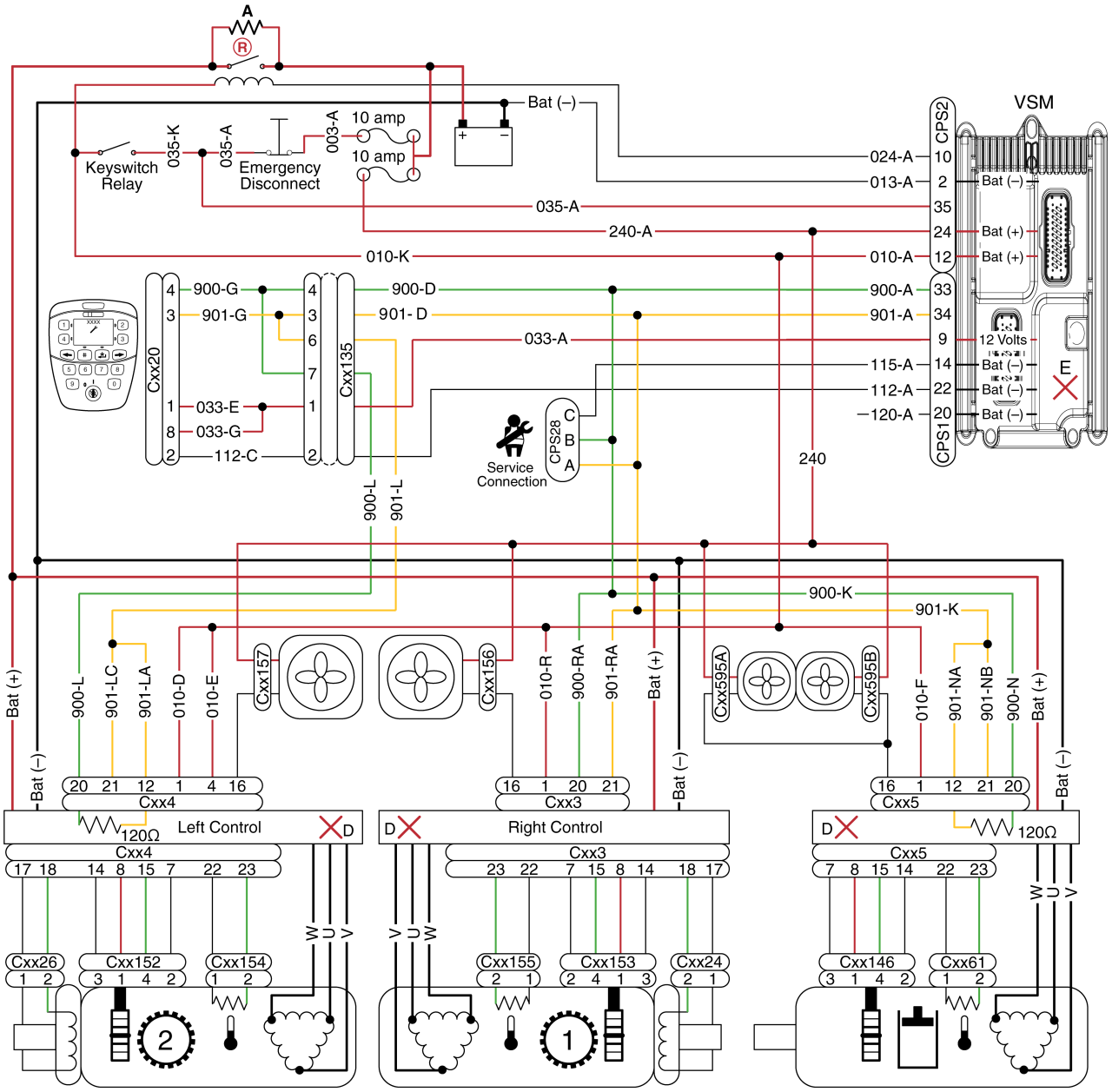
Motor Versions→📝Hardware/Software Versions→☜Exit Versions→Power **OFF**?

NOTE: Fault Logs will indicate which Motor/Motor Controller has the Faulty Component/Connection

POSSIBLE CAUSES X = Open Circuit/Fail) = Short Circuit

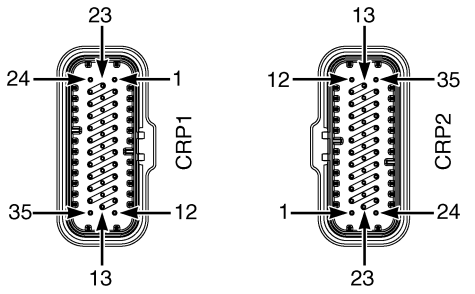
A935 – K160 D203 Motor Controller CAN Communication Failure (Cont)

MOTOR CONTROLLER CAN COMMUNICATION FAILURE CAUSES A B C D E > ?

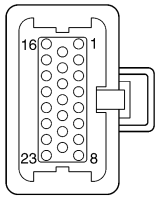


A935 – K160 D203 Motor Controller CAN Communication Failure (Cont)

CONNECTORS



VSM Cxx 1 and Cxx 2



Traction/Pump Controller Cxx 3, 4, and 5

CAUSE A

See A935 – K160 CAN Communication Failure

CAUSE B

Not Applicable

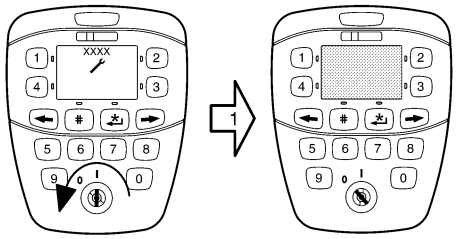
CAUSE C

Not Applicable

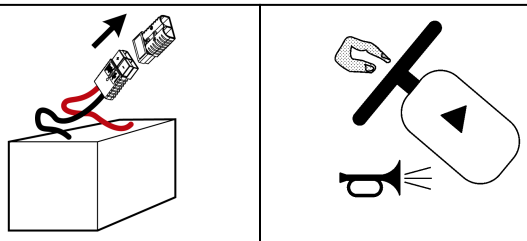
CAUSE D

WARNING

Do not do CAUSE C until CAUSE 0 is complete.

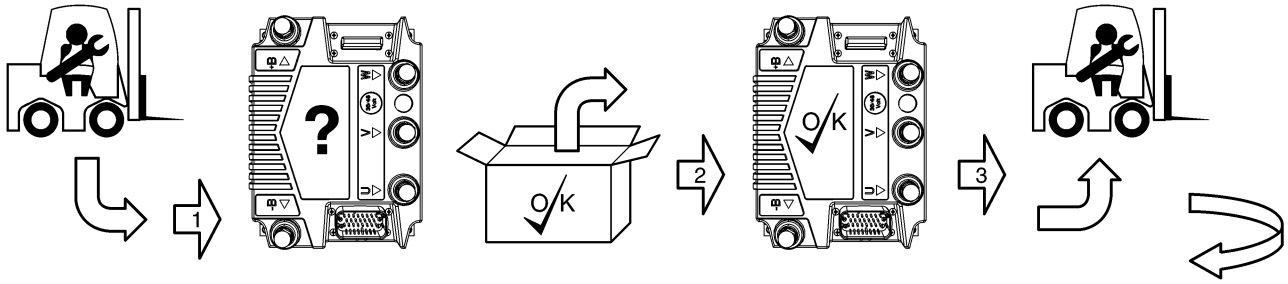


Power **OFF**→



Disconnect Battery and Sound Horn to Discharge Capacitors.→Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342→.

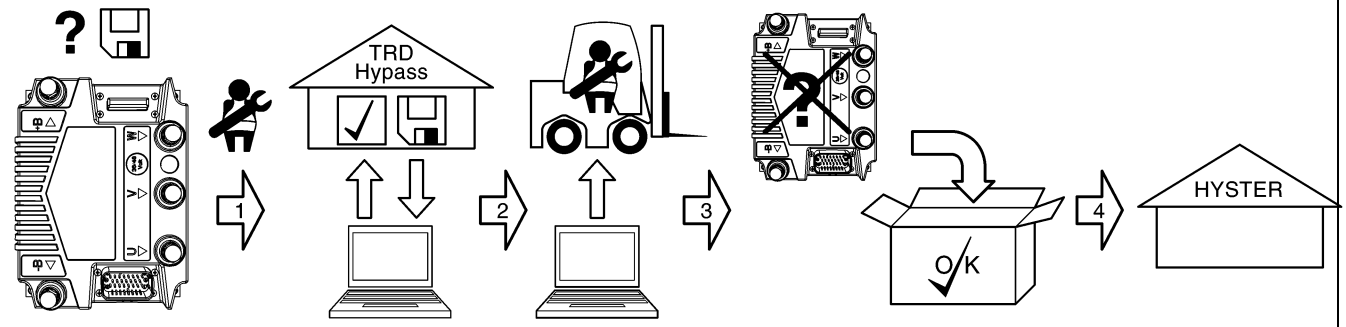
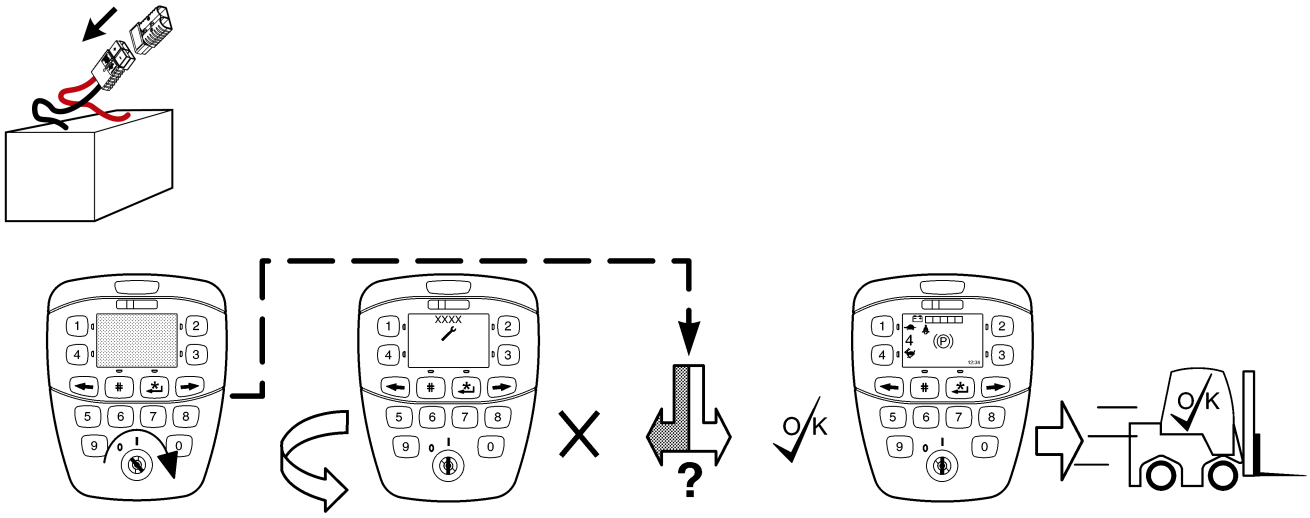
STEP D1



Remove and Replace Faulty Motor Controller↓

See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369↓

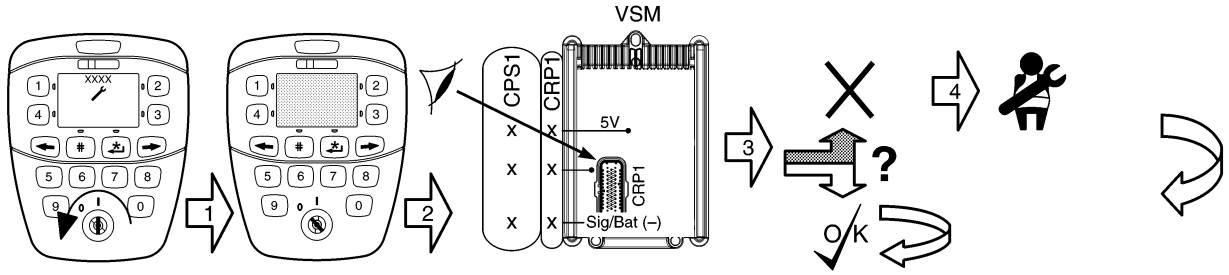
Check Replacement Controller 🖫 Version→See Label Information→Step 2↓

A935 – K160 D203 Motor Controller CAN Communication Failure (Cont)
STEP D2

1. Go to TRD/Hypass Online /Software.?? Is Replacement Controller Application Software Version the Latest Version??
2. **NO**→Download the latest Application 🖫→Install on truck→Step 3↓
3. **YES**→Test New Installation→↓Step 3↓
4. Return Faulty Display→Dealer→Factory→Failure Analysis→?? Reprogramming
STEP D3


Retest - Power **ON**→	**NO**→?	Is fault DTC gone?**NO** **YES**←→	Fault corrected→Continue operation.

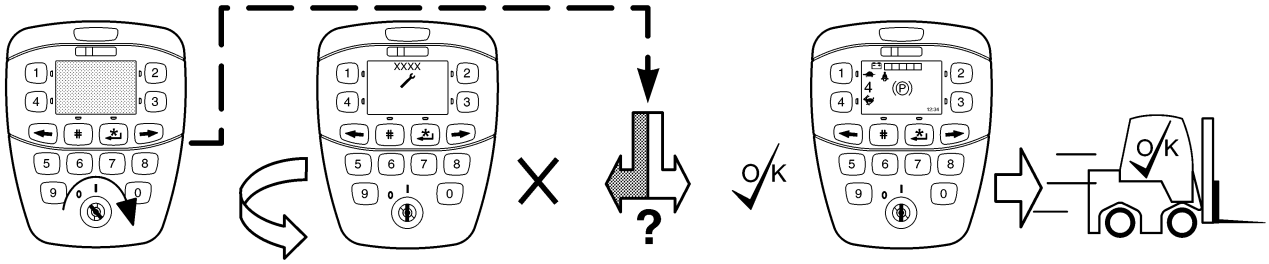
A935 – K160 D203 Motor Controller CAN Communication Failure (Cont)

CAUSE E



Power **OFF**→	Inspect VSM Connections→OK Step 1	Not OK Correct/Repair→Step 1

STEP E1



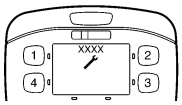
Retest - Power **ON**→	**NO**→Go to VSM Controller Check	Is fault DTC gone?**NO** **YES**←→	Fault corrected→Continue operation.

DTC LOGS: DTC logs should only be cleared once the data is by the Service Tech. See Display Menu Flowchart **- Clearing DTCs.**

END FAULT

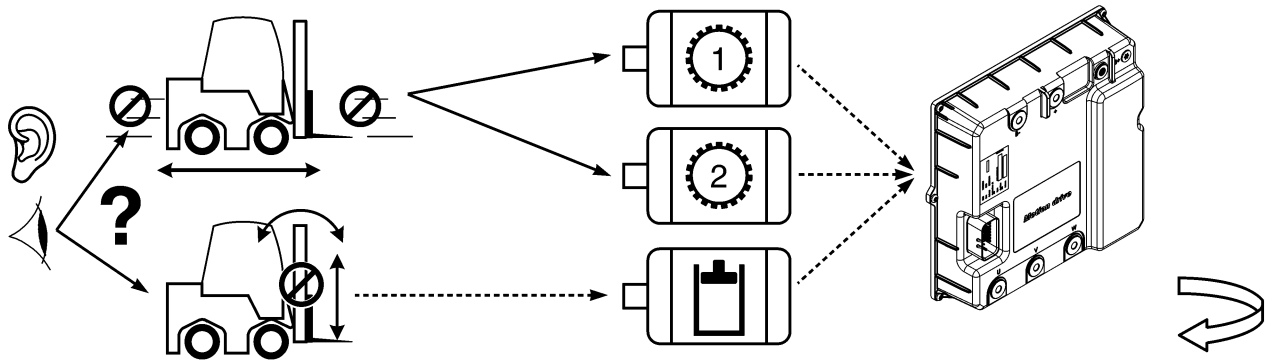
CBB/DBB Motor Controller CAN Communication Failure (Cont)

DTC 33024
CAN Communication Failure



QUICK CHECK X = Open Circuit/Fail) = Short Circuit

Check 1



? No Traction/Hydraulic Truck Operation ?

POSSIBLE CAUSES

1. Motor Controller Connections/Wiring – Open/Short Circuit→Go to 1a or 1b↓

1a. CAN Communication Failure. See CBB 4 Wheel CAN Communication→

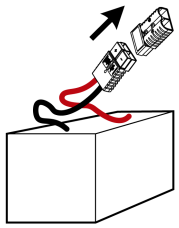
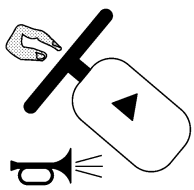
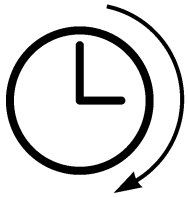
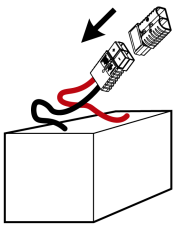
1b. CAN Communication Failure. See DBB 4 Wheel CAN Communication→

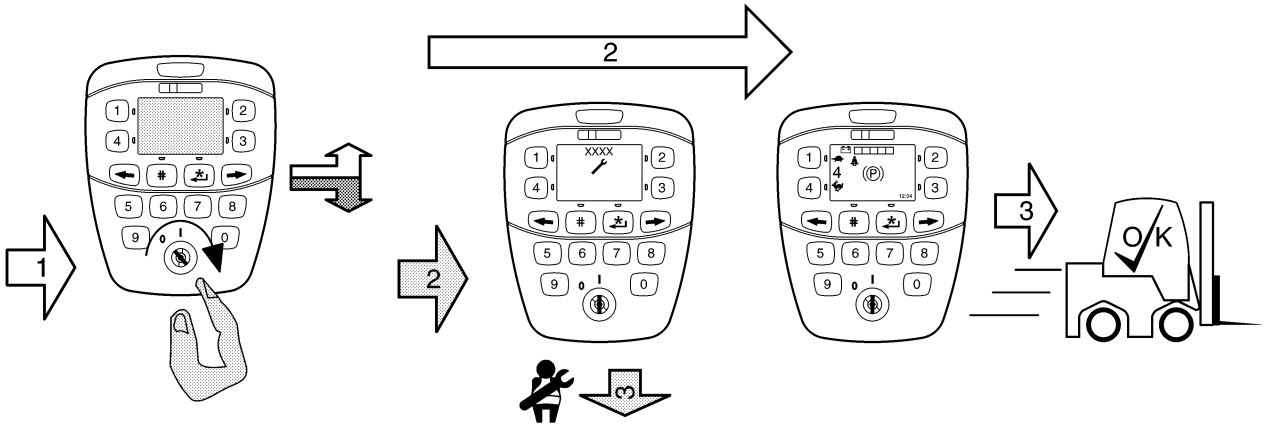
2. Motor Controller(s) Failure?→CAUSE C↓

WARNING

The CBB Truck requires the removal of the battery to access the Controllers and Motors

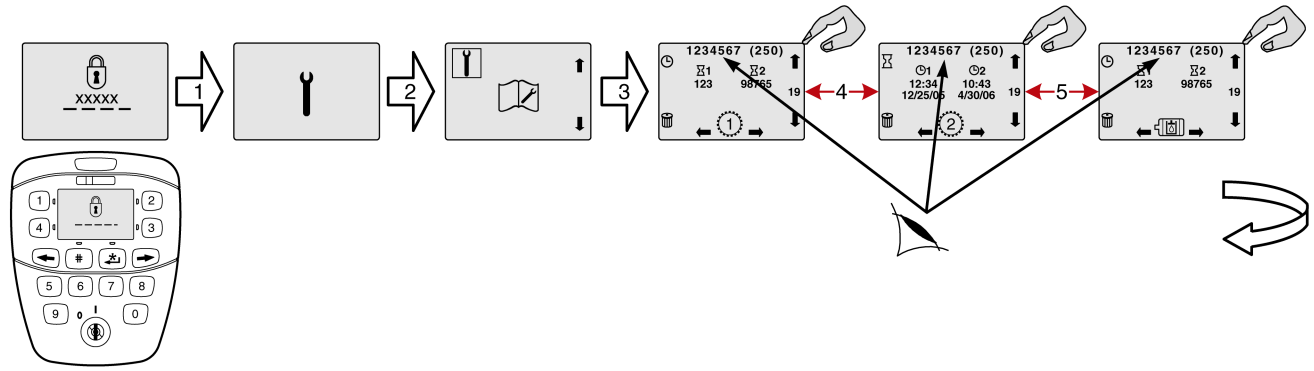
Check 2

			
Disconnect Battery and Sound Horn to Discharge Capacitors.Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342.	Wait 30 seconds	Reconnect Battery	

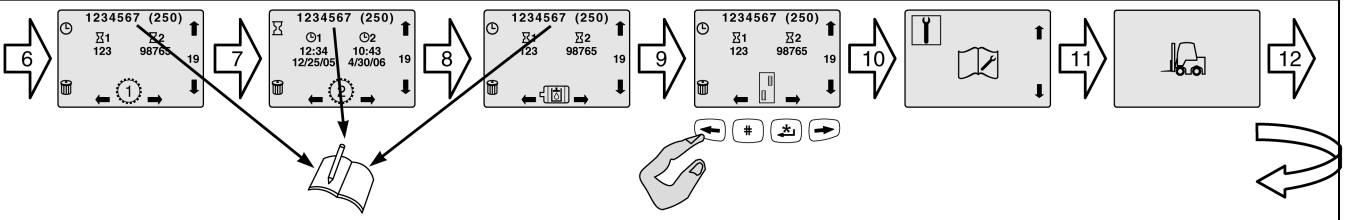
CBB/DBB Motor Controller CAN Communication Failure (Cont)		
Check 3		
		
Power **ON**→	Fault Remains Service Required ?	No Fault→Resume Operation

CBB/DBB Motor Controller CAN Communication Failure (Cont)

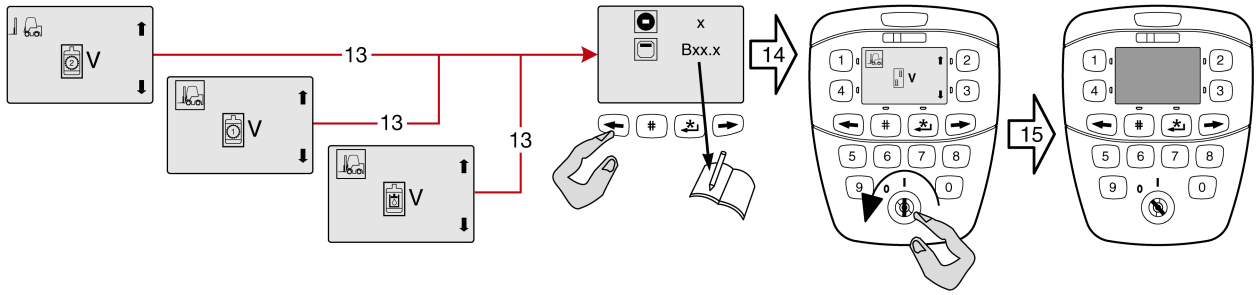
FAULT LOG Review - Go to Display Menu



Enter Service Password→Diagnostic→FAULT LOGs→Motor Fault Log(s)→View all Motor DTCs→?



📝 all Motor DTCs→☜Exit Fault Log→Truck Status ?



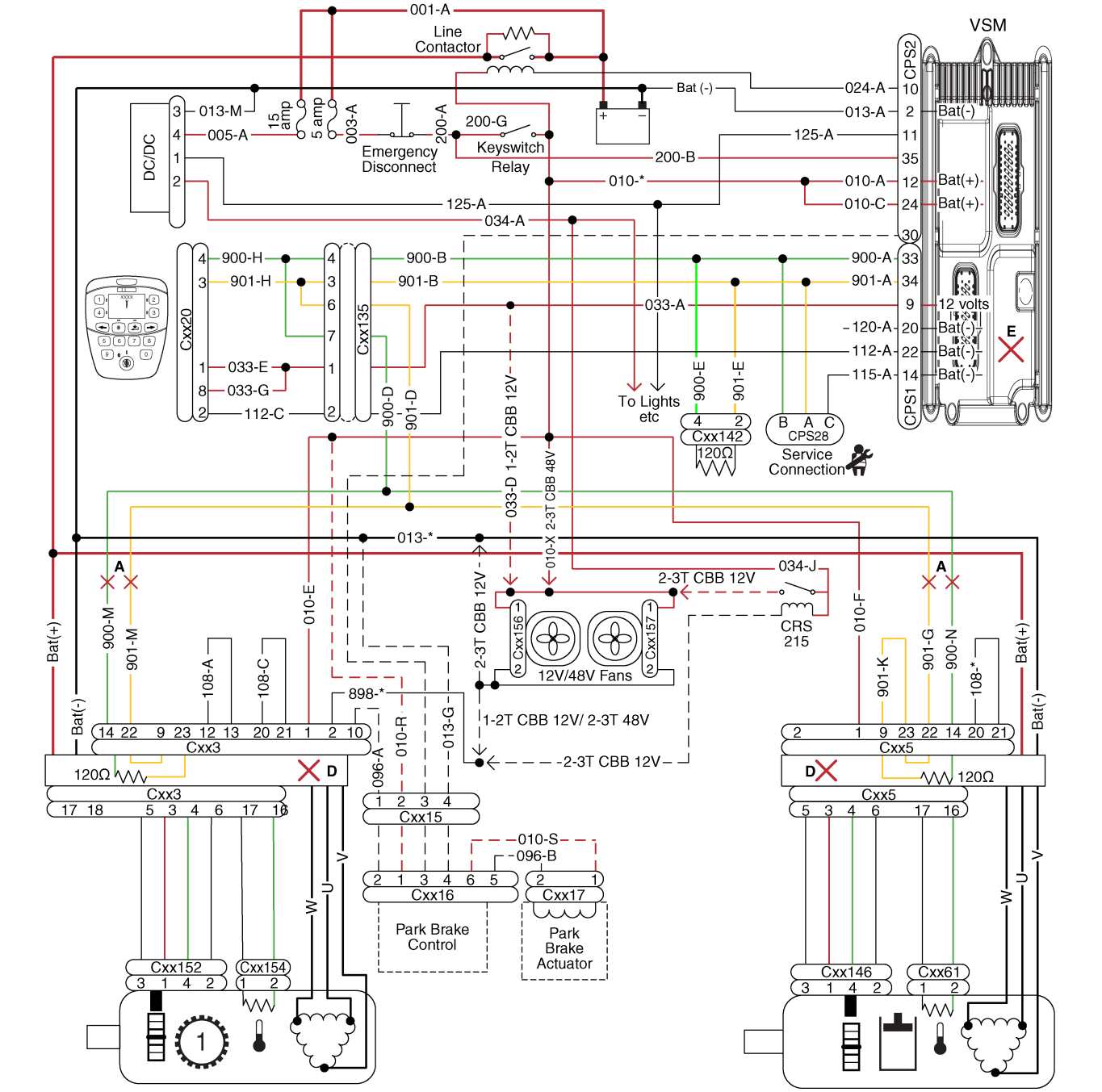
Motor Versions→📝Hardware/Software Versions→☜Exit Versions→Power **OFF**?

NOTE: Fault Logs will indicate which Motor/Motor Controller has the Faulty Component/Connection

POSSIBLE CAUSES X = Open Circuit/Fail) = Short Circuit

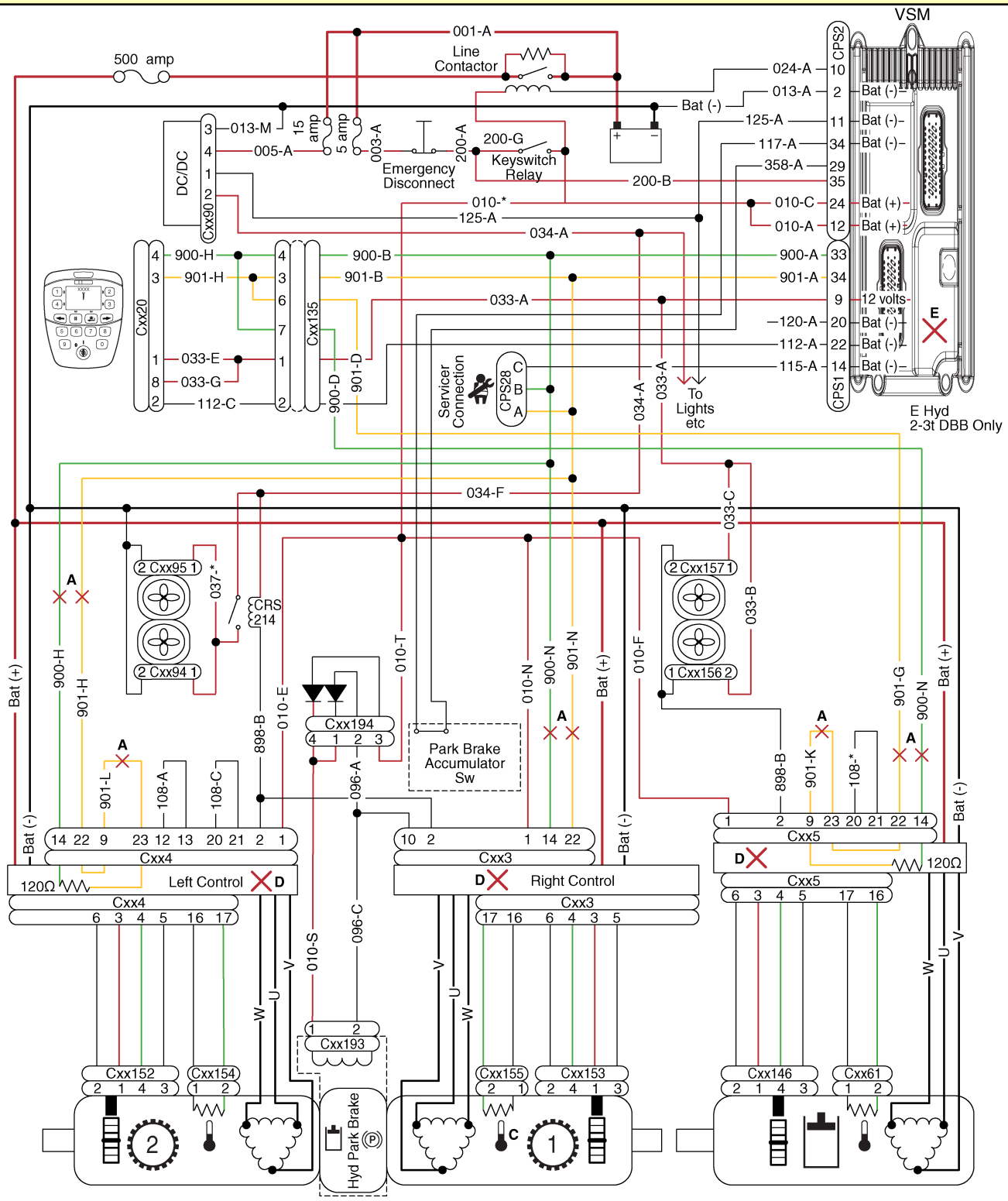
CBB/DBB Motor Controller CAN Communication Failure (Cont)

1.5 – 2.0 CBB SCHEMATIC CAUSES A B C D E > ?



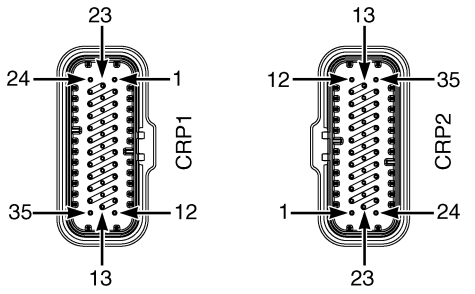
CBB/DBB Motor Controller CAN Communication Failure (Cont)

2.2 – 3.0 DBB SCHEMATIC CAUSES A B C D E > ?

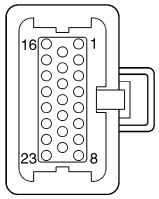


CBB/DBB Motor Controller CAN Communication Failure (Cont)

CONNECTORS



VSM Cxx 1 and Cxx 2



Traction/Pump Controller Cxx 3, 4, and 5

CAUSE A

See CBB 4 Wheel CAN Communication or DBB 4 Wheel CAN Communication

CAUSE B

Not Applicable

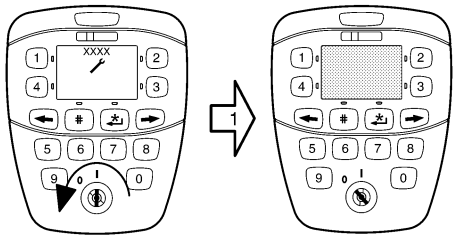
CAUSE C

Not Applicable

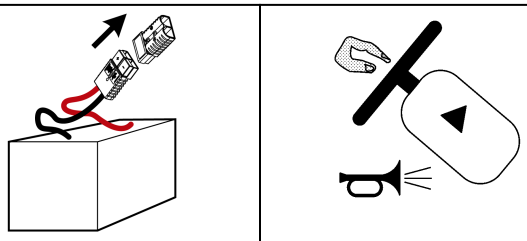
CAUSE D

WARNING

Do not do CAUSE C until CAUSE 0 is complete.

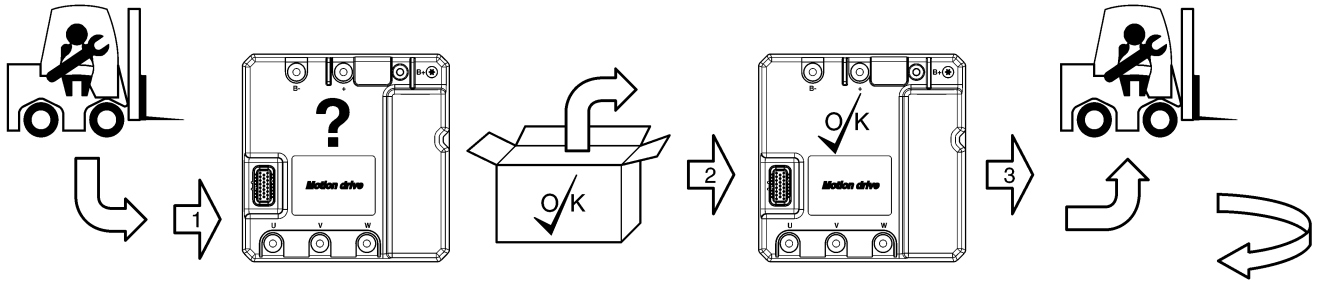


Power **OFF**→



Disconnect Battery and Sound Horn to Discharge Capacitors.→Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342→.

STEP D1



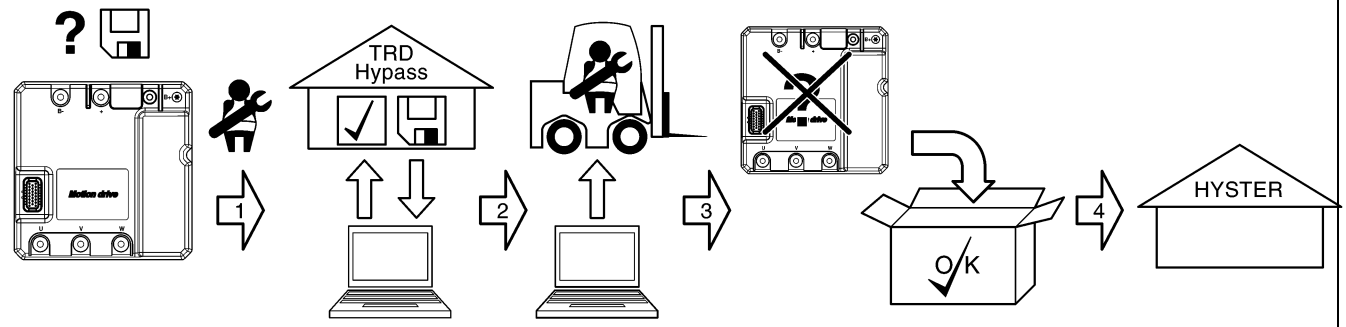
Remove and Replace Faulty Motor Controller↓

See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369↓

Check Replacement Controller 🖫 Version→See Label Information→Step 2↓

CBB/DBB Motor Controller CAN Communication Failure (Cont)

STEP D2



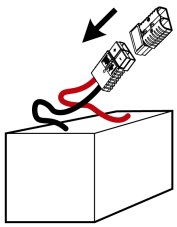
1. Go to TRD/Hypass Online /Software.?? Is Replacement Controller Application Software Version the Latest Version??

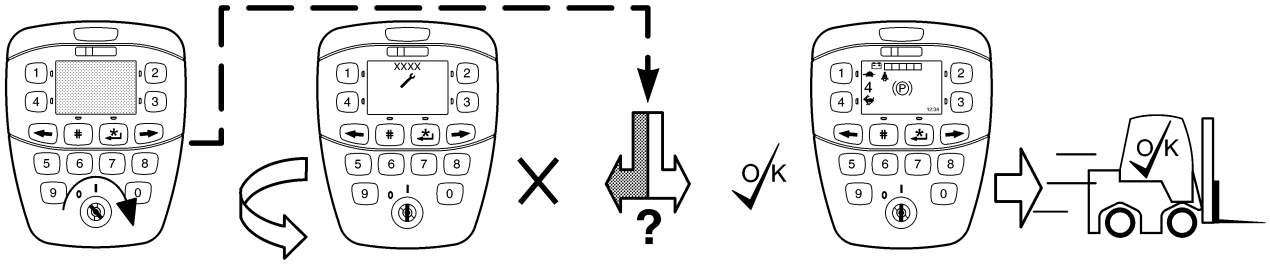
2. **NO**→Download the latest Application 🖫→Install on truck→Step 3↓

3. **YES**→Test New Installation→↓Step 3↓

4. Return Faulty Display→Dealer→Factory→Failure Analysis→?? Reprogramming

STEP D3

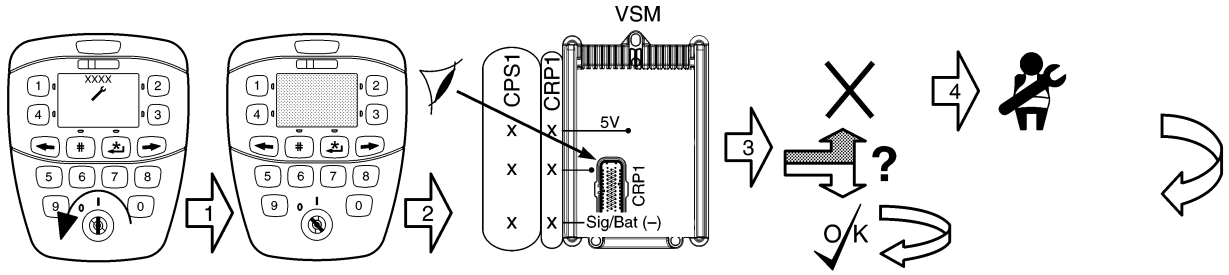




Retest - Power **ON**→	**NO**→?	Is fault DTC gone?**NO** **YES**←→	Fault corrected→Continue operation.

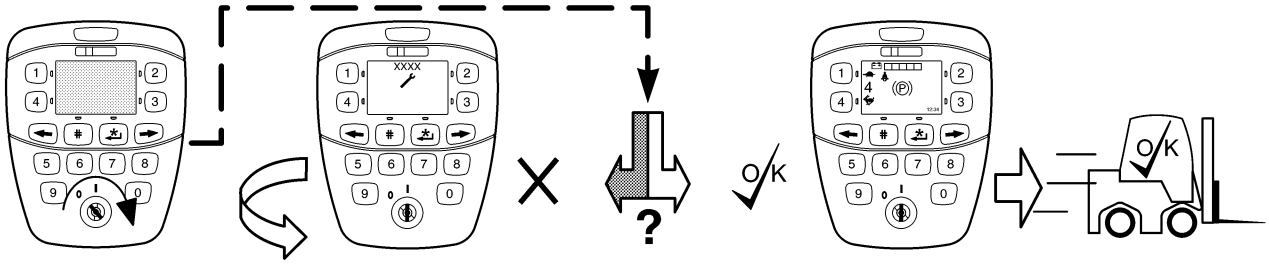
CBB/DBB Motor Controller CAN Communication Failure (Cont)

CAUSE E



Power **OFF**→	Inspect VSM Connections→OK Step 1	Not OK Correct/Repair→Step 1

STEP E1

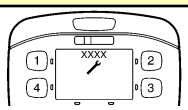


Retest - Power **ON**→	**NO**→Go to VSM Controller Check	Is fault DTC gone?**NO** **YES**←→	Fault corrected→Continue operation.

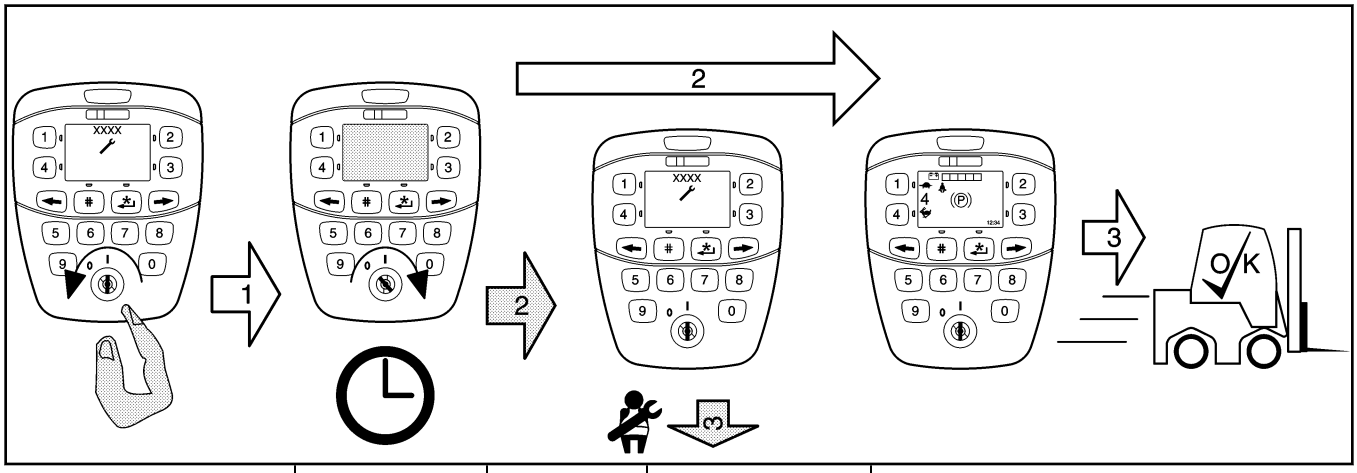
DTC LOGS: DTC logs should only be cleared once the data is by the Service Tech. See Display Menu Flowchart **- Clearing DTCs.**

END FAULT

Travel Direction Select Incorrect



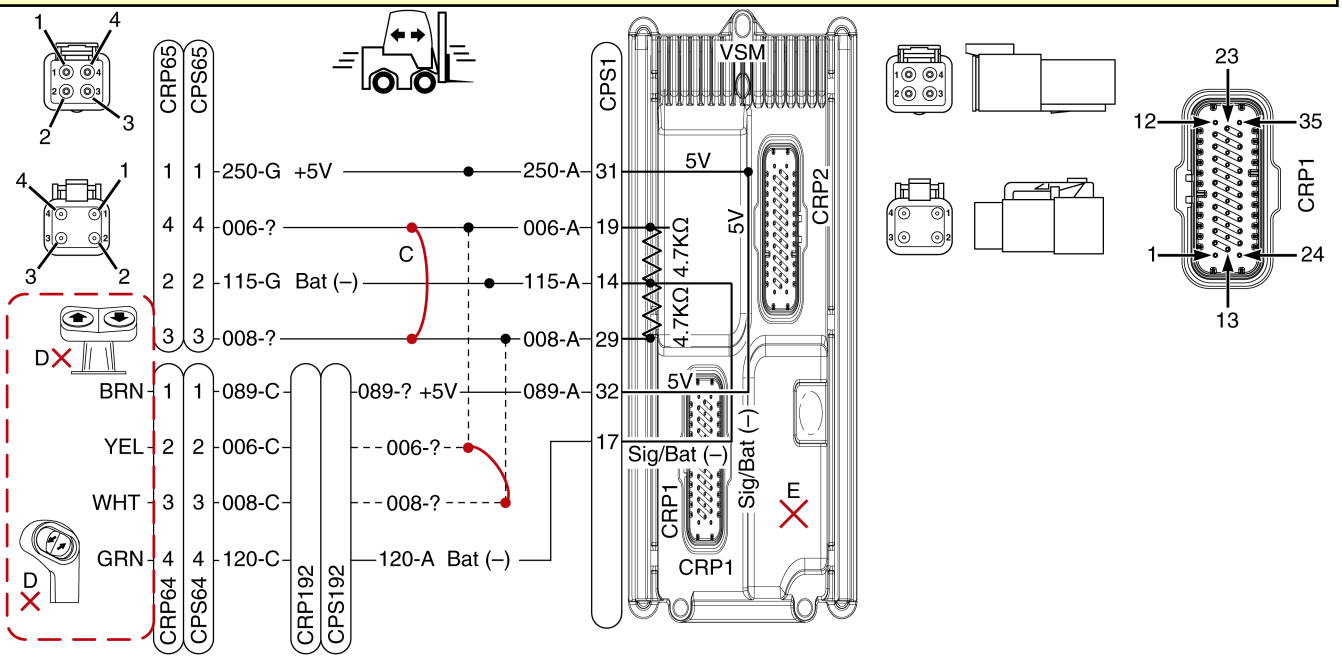
DTC 12802
Direction Select Data Incorrect – Direction Signals Incorrect



Power **OFF**→	Wait **30 seconds**→	Power **ON**→	Fault remains. Service required. Go to Component Operational Check.	No fault→	Resume operation

POSSIBLE CAUSE X = Open Circuit/Fail) = Short Circuit

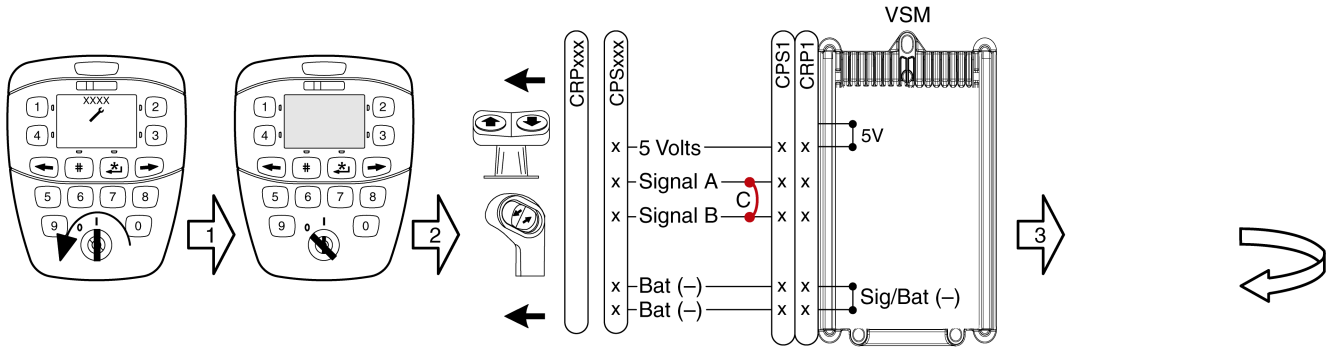
TRAVEL DIRECTION SELECT INCORRECT CAUSES A B C D E > ?



CAUSE A

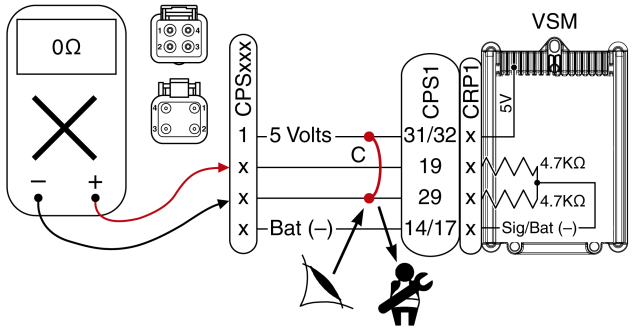
Not Applicable

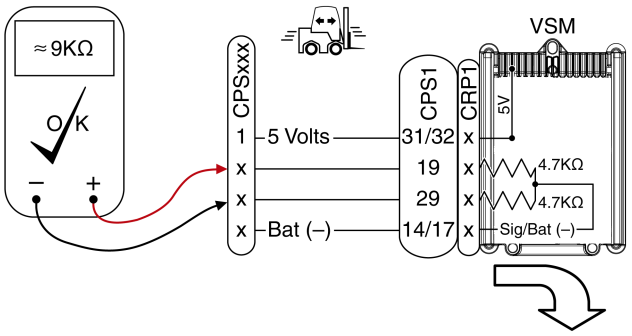
Travel Direction Select Incorrect (Cont)
CAUSE B
Not Applicable
CAUSE C



Power **OFF**→	Disconnect sensor→	?

STEP C1	**CHECK RESISTANCE - Ω - OHMS**





0 ? = Short circuit↑Find→**Short** circuit.	˜ 9K? =	**OK**	Go to CAUSE C.?

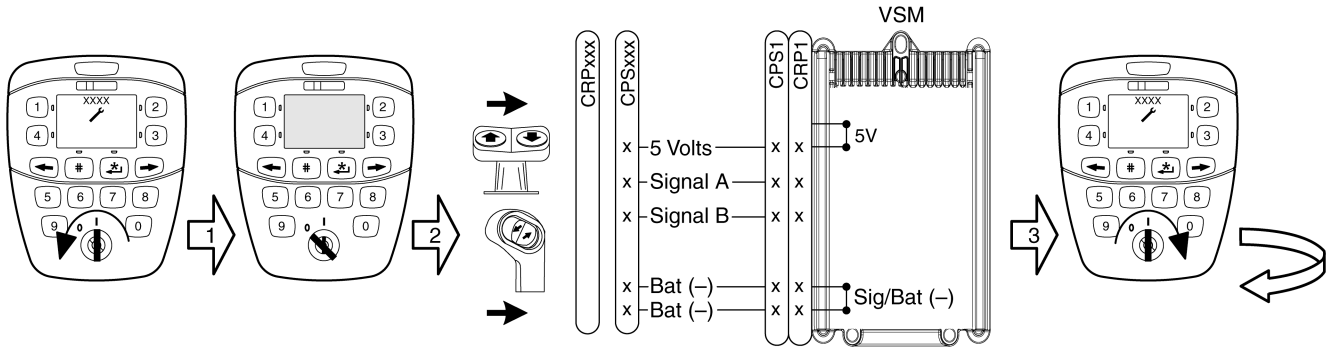
Repair OPEN Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369.→

Recheck ?↑→Reconnect→Test OK→YES→Resume OperationNO→CAUSE C↓

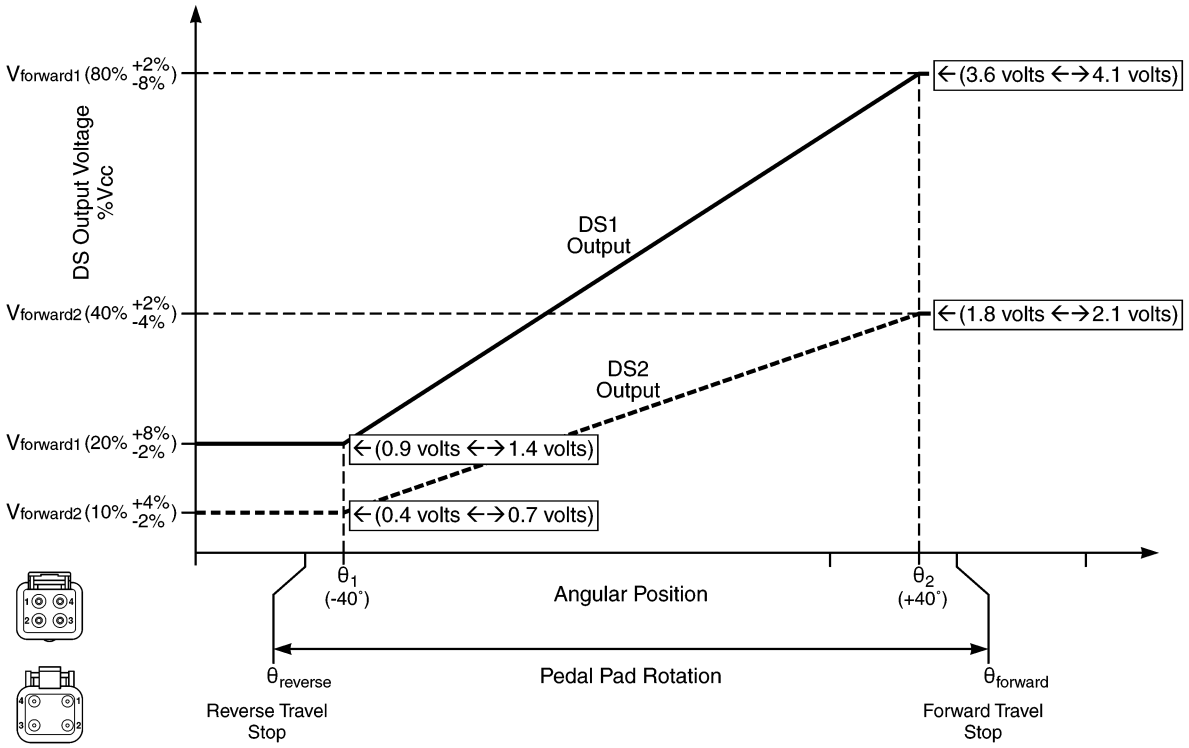
Recheck ?↑→Reconnect→Use Display Diagnostics to validate→Test OK→YES→Resume Opera-tionNO→CAUSE C↓

Travel Direction Select Incorrect (Cont)

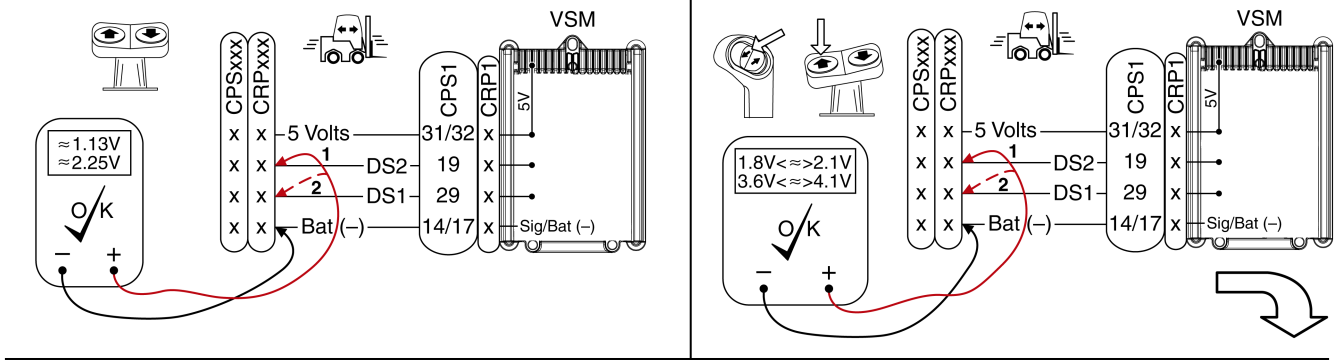
CAUSE D



Power **OFF**→ | Reconnect sensor→ | Power **ON**→ | Step 1?



STEP D1



Travel Direction Select Incorrect (Cont)

1. Measure Pedal Neutral Voltage DS2 and DS1

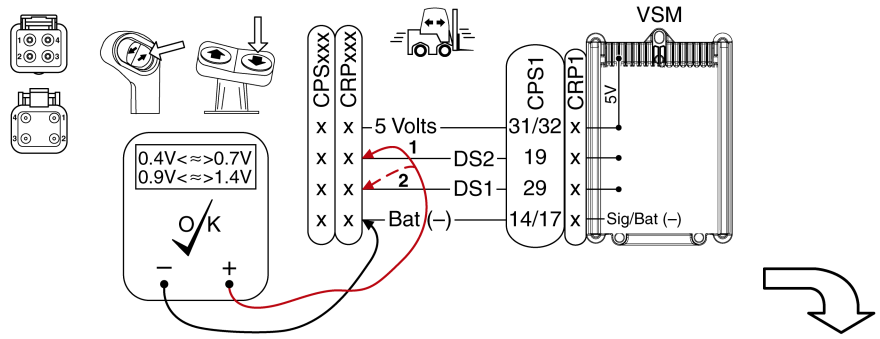
? DS2 (1.13V ± 2%) volts ˜ ½ DS1 (2.25V ± 2%) volts?→YES→Go to 2 NO →Go to 3↓

2. Select FORWARD Position – Foot DCS or Man Hyd DCS and Measure voltage at points 1 & 2

? DS2 (1.8 ? ?2.1)volts ˜ ½ DS1(3.6 ? ?4.1)volts ?→YES→Go to Step 2NO →Go to Step 3↓

Note: >4.9 Volts→Go to Travel Direction Select - Foot Pedal/Manual Hydraulic Out of Range High (OORH)→
Note: <0.31 Volts→Go to Travel Direction Select - Foot Pedal/Manual Hydraulic Out of Range Low (OORL)→

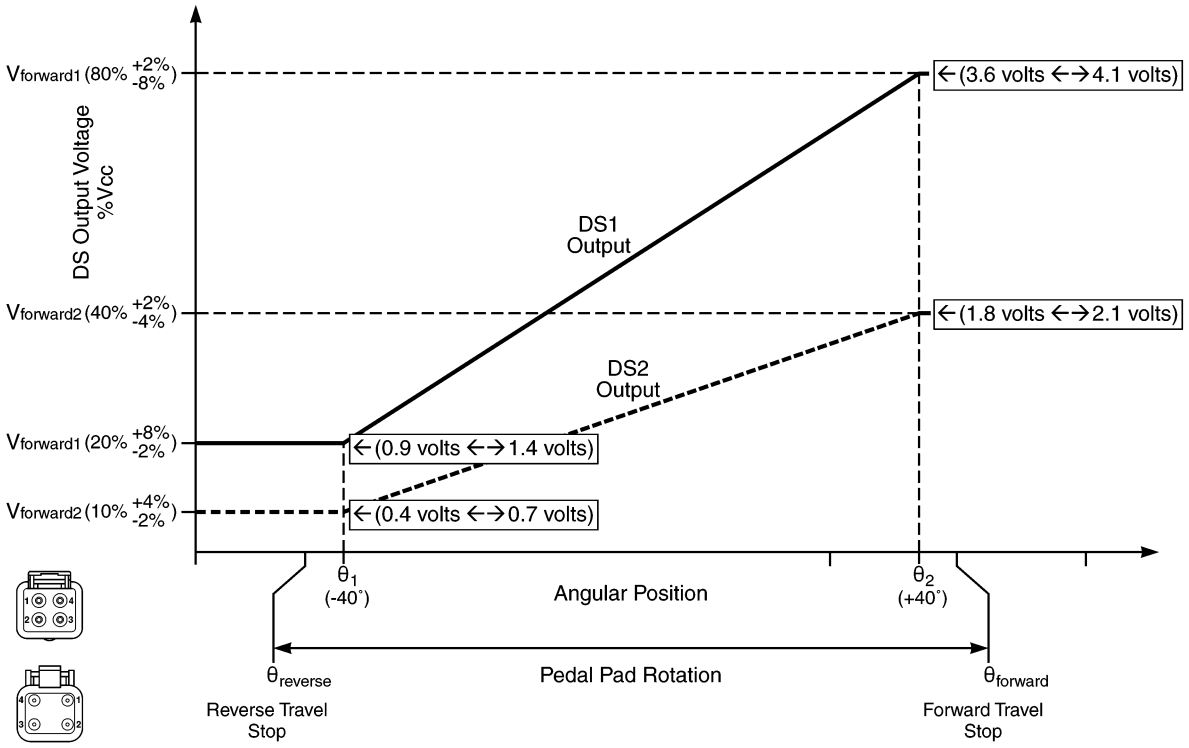
STEP D2 **CHECK VOLTAGE**



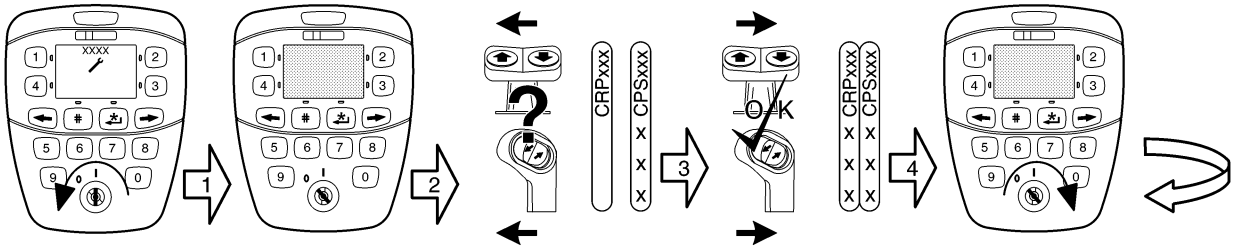
1. Select REVERSE Position – Foot DCS or Man Hyd DCS and Measure voltage at points 1 & 2

2. ? DS2 (0.9 ? ?1.4)volts ˜ ½ DS1(0.4 ? ?0.7)volts ?→YES→Go to CAUSE DNO →Go to Step 3↓

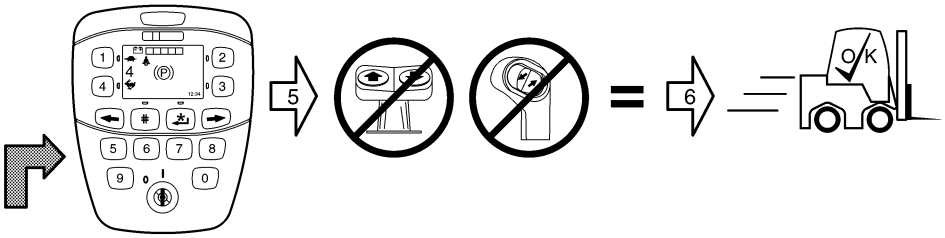
Note >4.9 Volts→Go to Travel Direction Select - Foot Pedal/Manual Hydraulic Out of Range High (OORH)→
Note <0.31 Volts→Go to Travel Direction Select - Foot Pedal/Manual Hydraulic Out of Range Low (OORL)→



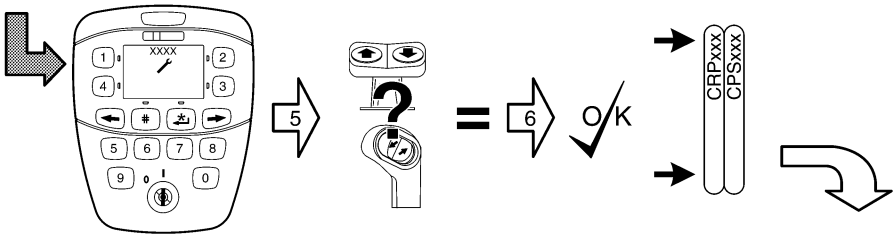
Travel Direction Select Incorrect (Cont)	
STEP D3	**CHECK VOLTAGE**



Power **OFF**→ | Reconnect sensor→ | Power **ON**→ | Go to next step.



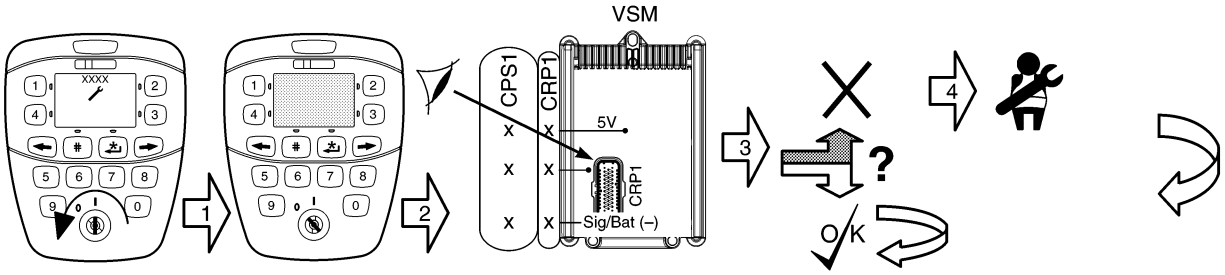
? | Fault DTC gone→ | Old sensor faulty→ | Resume operation



Fault DTC present→ | Old sensor OK/Reinstall old sensor→ | Go to CAUSE D.

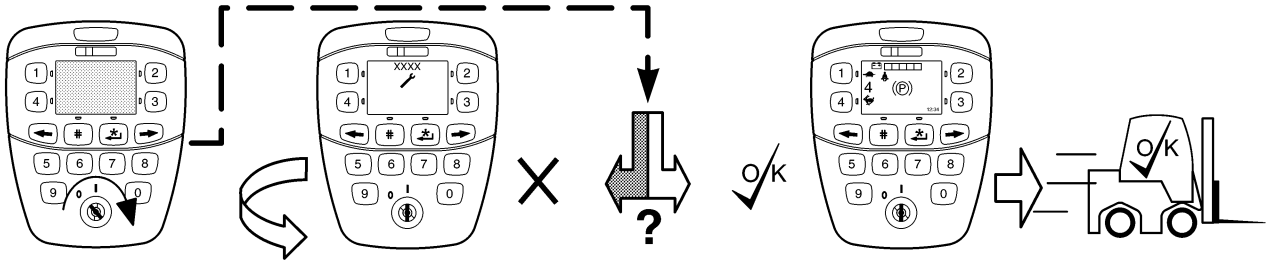
Travel Direction Select Incorrect (Cont)

CAUSE E



Power **OFF**→	Inspect VSM Connections→	Go to Step 1.	Not OK Correct/Repair→Go to Step 1.

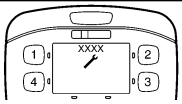
CAUSE E1



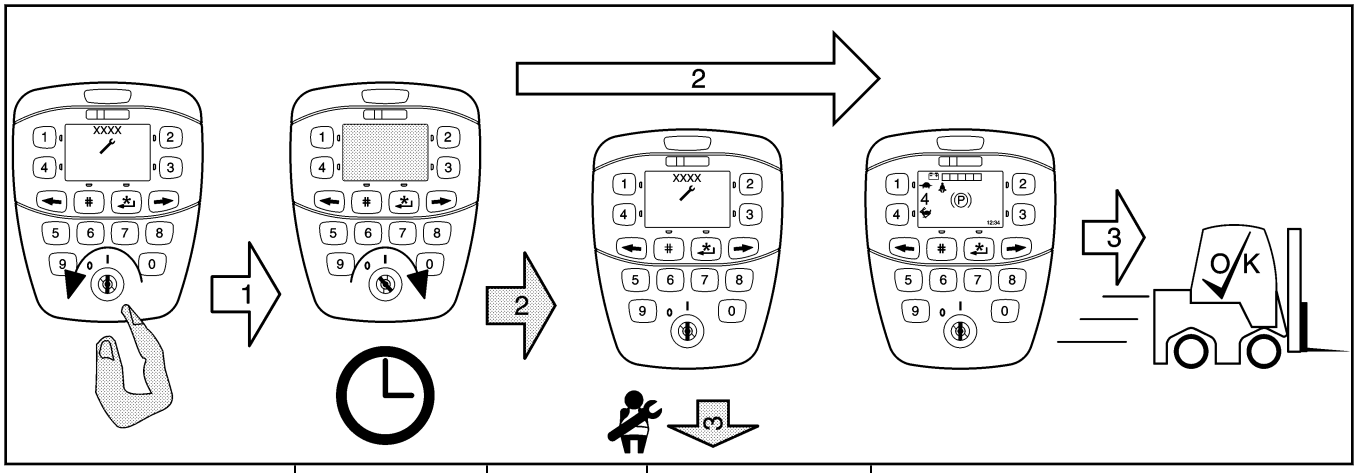
Retest - Power **ON**→	**NO**→Go to VSM Controller Check	Is fault DTC gone? **NO**←**YES**→	Fault corrected→Continue operation.

END FAULT

Travel Direction Select Data Incorrect – 2 Sources



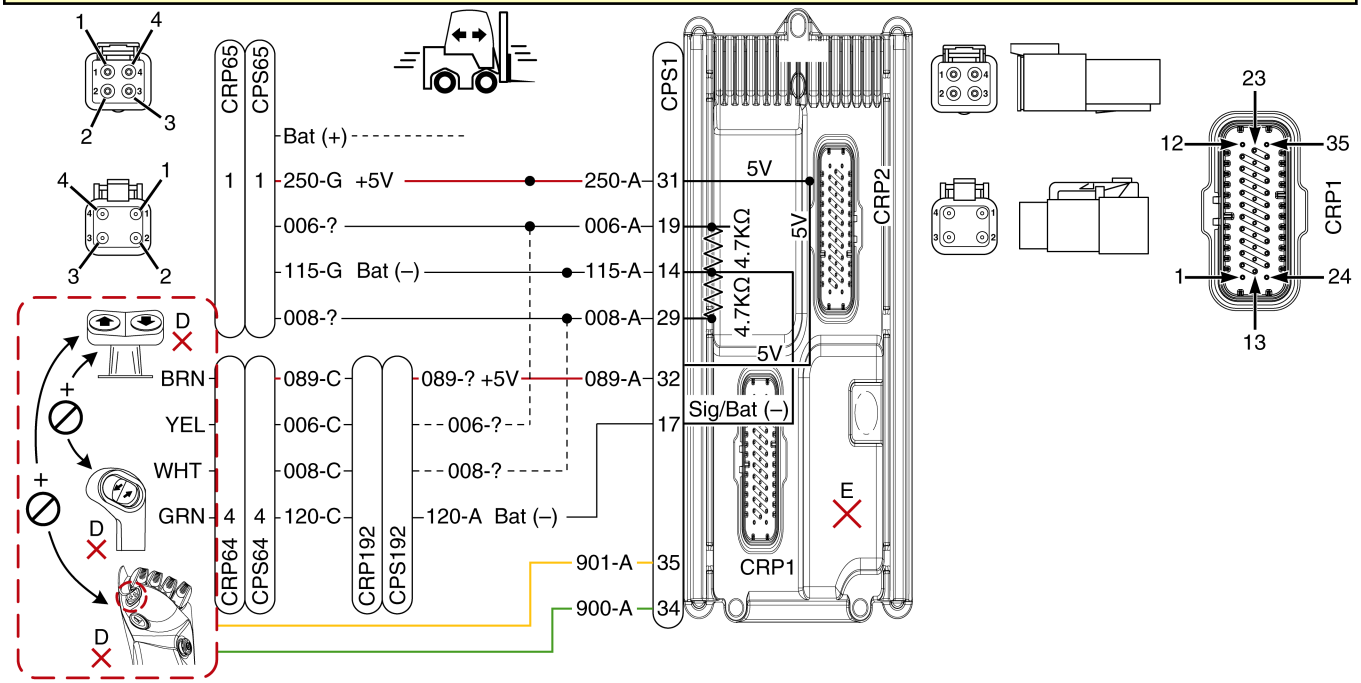
DTC 12806
Direction Select – Data Incorrect 2 + Direction Devices Installed



Power **OFF**→	Wait **30 seconds**→	Power **ON**→	Fault remains. Service required. Go to Component Operational Check.	No fault→	Resume operation

POSSIBLE CAUSE X = Open Circuit/Fail) = Short Circuit

TRAVEL DIRECTION SELECT DATA INCORRECT CAUSES A B C D E > ?



Travel Direction Select Data Incorrect – 2 Sources (Cont)

WARNING

The Fault DTC will be displayed if more than one Direction Control Device is installed.

CAUSE A

Not Applicable

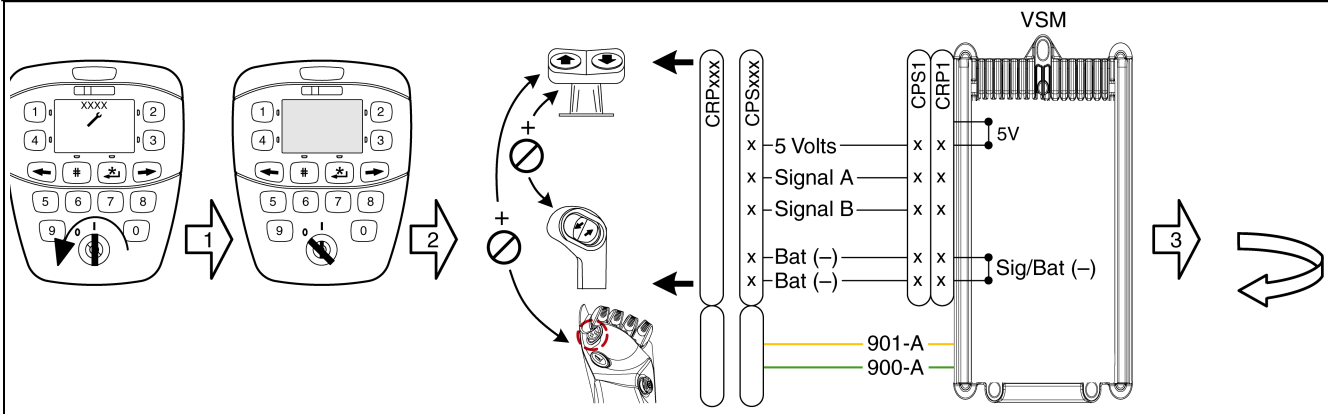
CAUSE B

Not Applicable

CAUSE C

Not Applicable

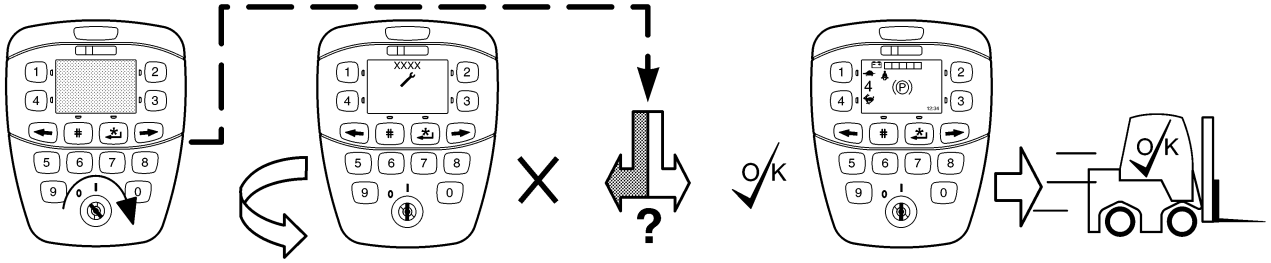
CAUSE D



Power OFF→Locate and Disconnect Incorrect Direction Selection Device→Step 1?

For MLM see **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→

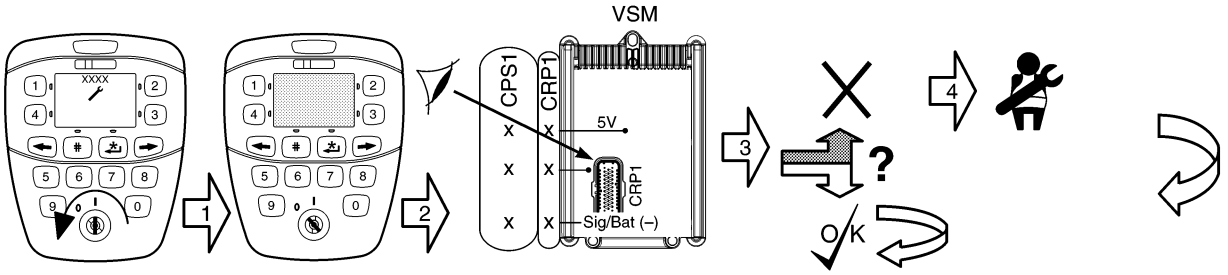
STEP D1



Retest - Power **ON**→	**NO**→Go to CAUSE D	Is fault DTC gone? **NO**←**YES**→	Fault corrected→Continue operation.

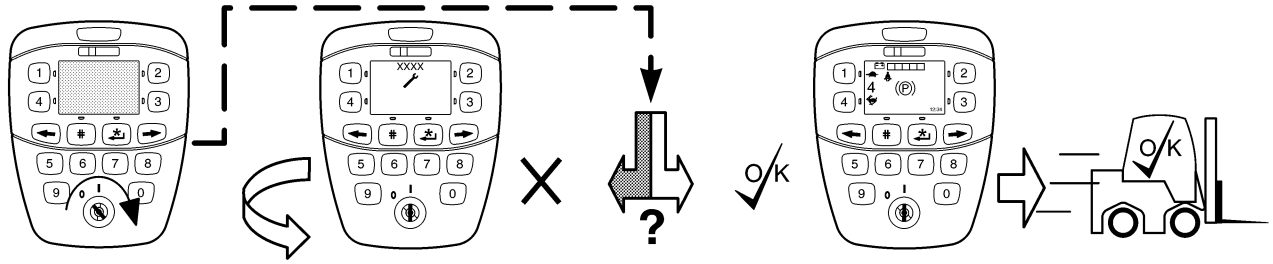
Travel Direction Select Data Incorrect – 2 Sources (Cont)

CAUSE E



Power **OFF**→	Inspect VSM Connections→	Go to Step 1.	Not OK Correct/Repair→Go to Step 1.

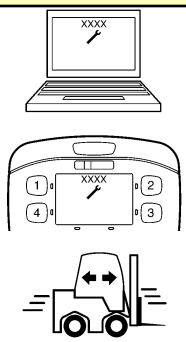
CAUSE E1



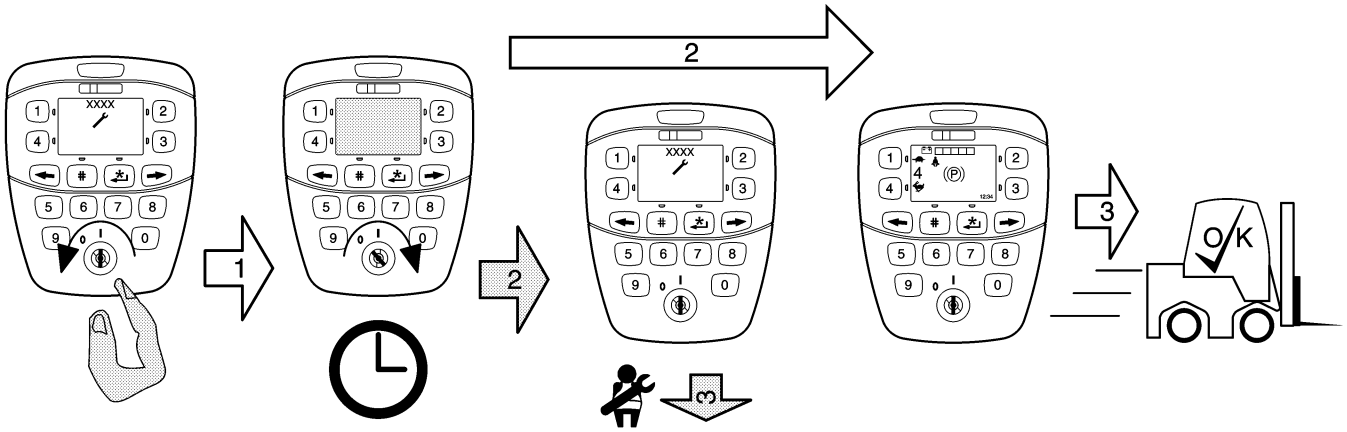
Retest - Power **ON**→	**NO**→Go to VSM Controller Check	Is fault DTC gone? **NO**←**YES**→	Fault corrected→Continue operation.

END FAULT

Direction Select Data Incorrect - No DCS Source (Cont)



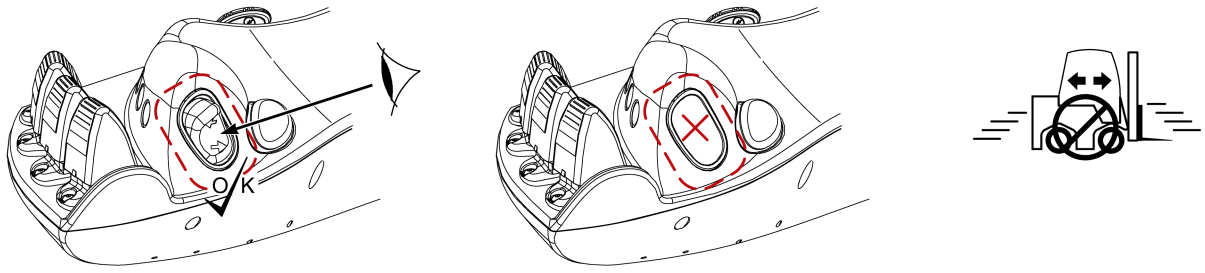
DTC 12807
Direction Select Data Incorrect - No DCS Source



Power **OFF**→	Wait **30 seconds**→	Power **ON**→	Fault remains. Service required. Go to Component Operational Check.	No fault→	Resume operation

QUICK CHECK X = Open Circuit/Fail) = Short Circuit

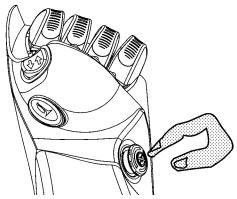
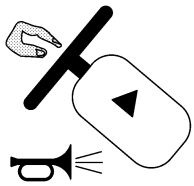
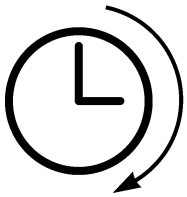
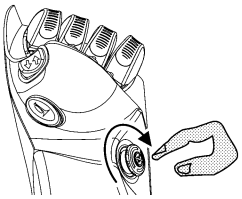
Check 1



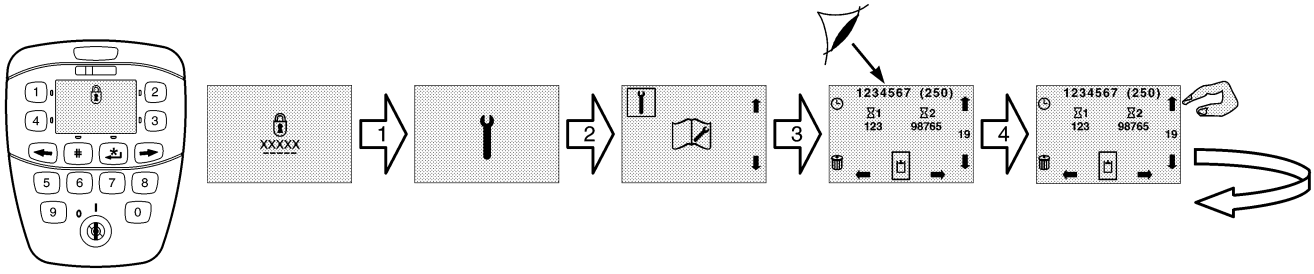
1. Is there any other DCS devices installed except the armrest DCS?
2. YES→Check 2NO→Go to 3↓
3. Is DCS installed on the armrest?YES→Check 2NO→Obtain and Install DCS→Go to 4↓
4. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369↓
5. Test new DCS→Function OK/DTC gone→YES→Resume OperationNO→Check 2↓

Direction Select Data Incorrect - No DCS Source (Cont)

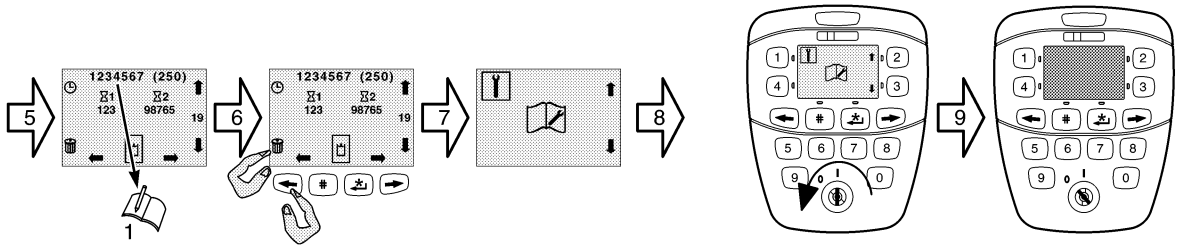
Check 2

			
Push in Emergency Stop	Disconnect Battery and Sound Horn to Discharge Capacitors.Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342.	Wait 30 seconds	Release Emergency Stop

FAULT LOG CODE Review - Go to Display Menu



Enter Service Password→Diagnostic→FAULT LOGs→VSM/MLM Fault Logs→View all VSM/MLM DTCs→?



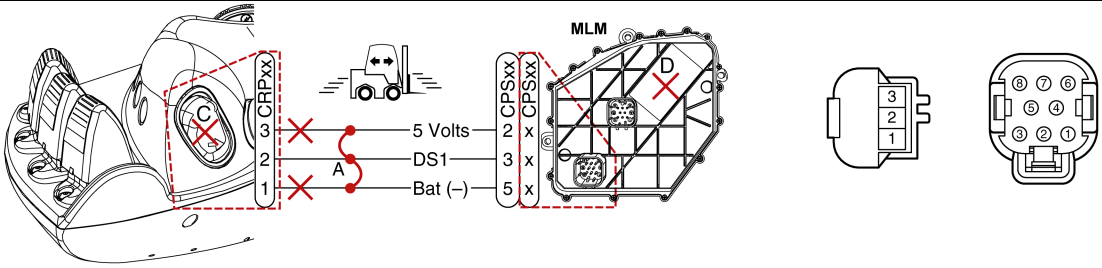
All VSM/MLM DTCs	Erase all VSM/MLM DTCs→☜Exit Fault Log	Power OFF↓

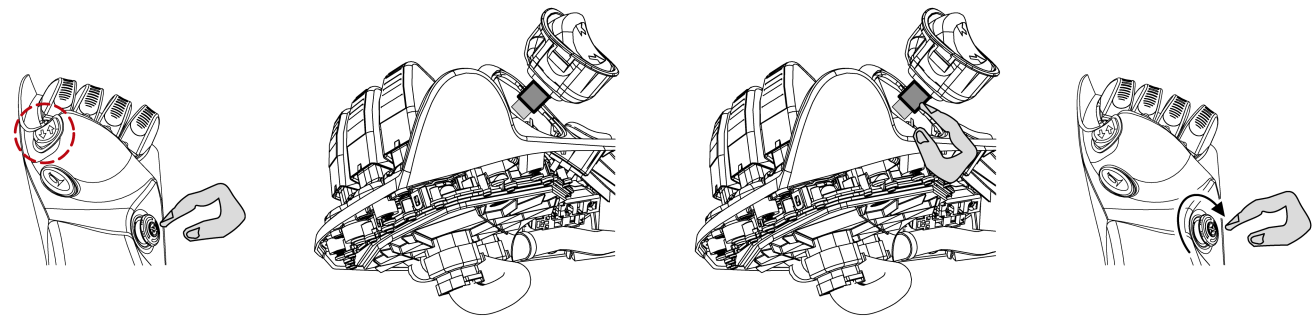
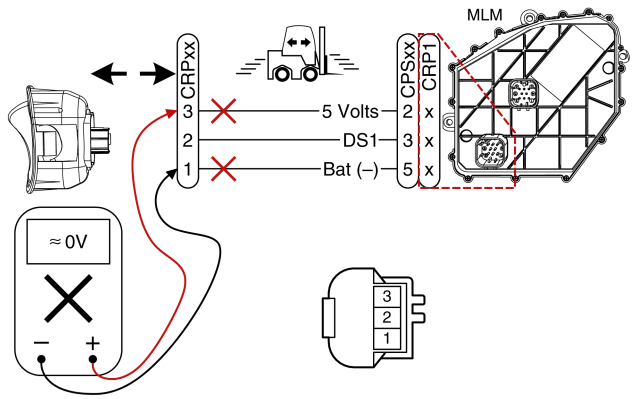
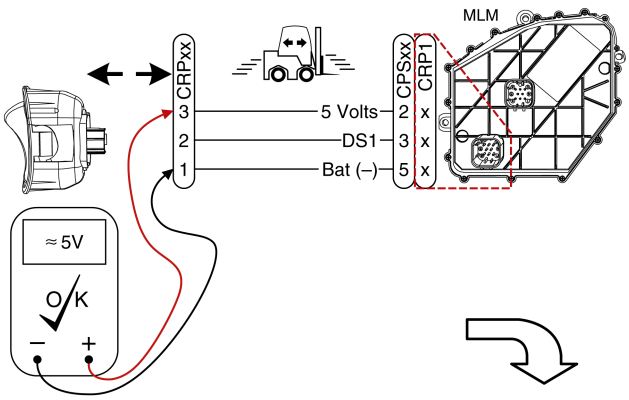
NOTE: ?DTC 33034 ?→A935 – K160 CAN Communication Failure

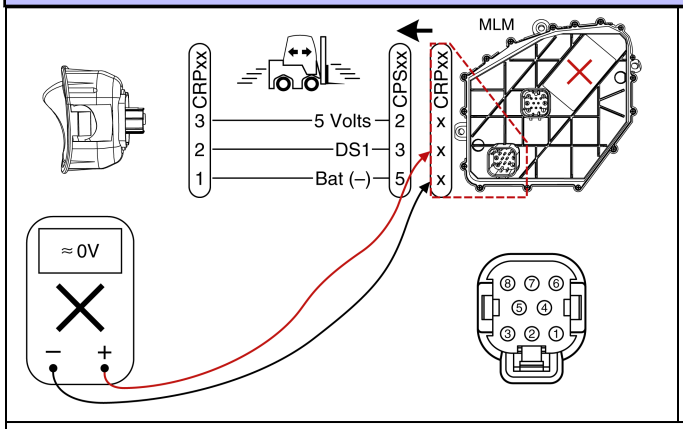
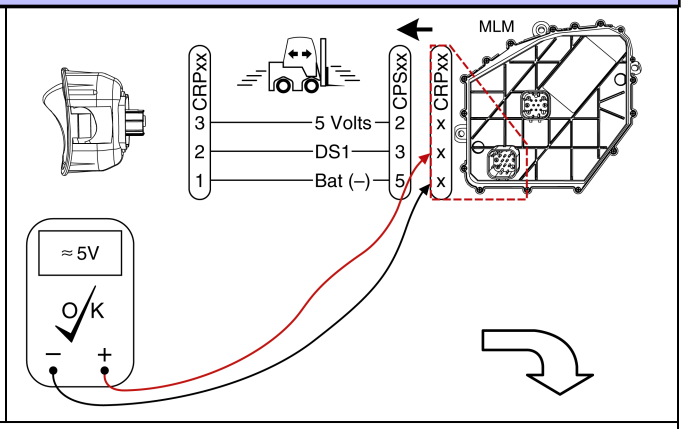
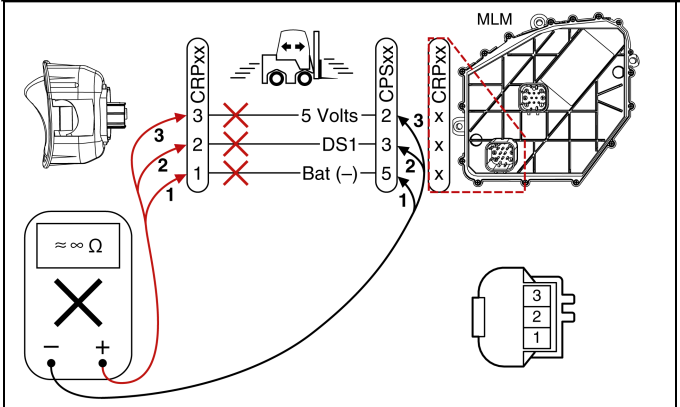
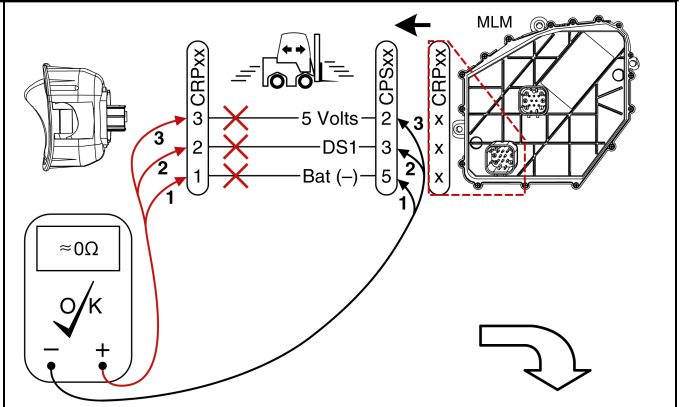
NOTE: ?DTC 12807 ?→CAUSE 0↓

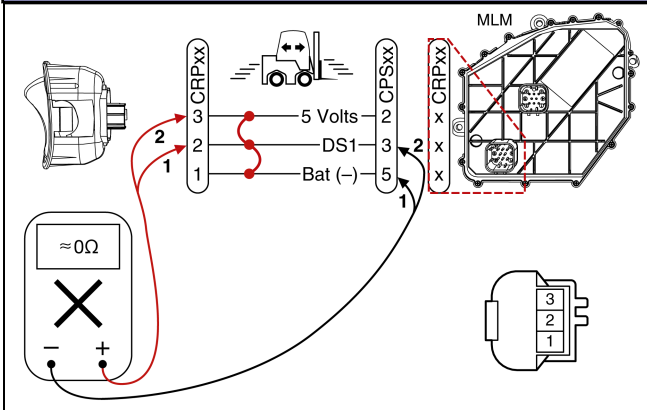
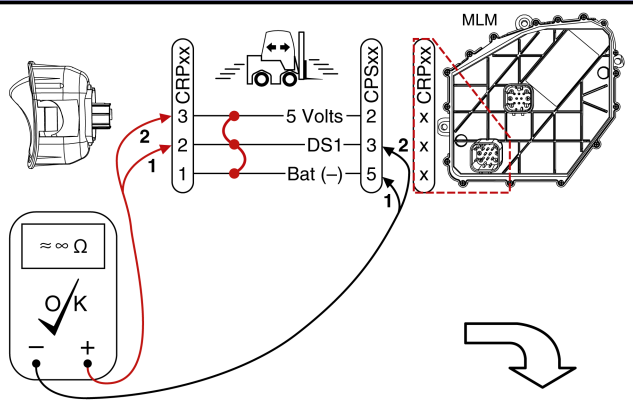
POSSIBLE CAUSES X = Open Circuit/Fail) = Short Circuit

DIRECTION SELECT DATA INCORRECT - NO DCS SOURCE CAUSES A B C D E > ?



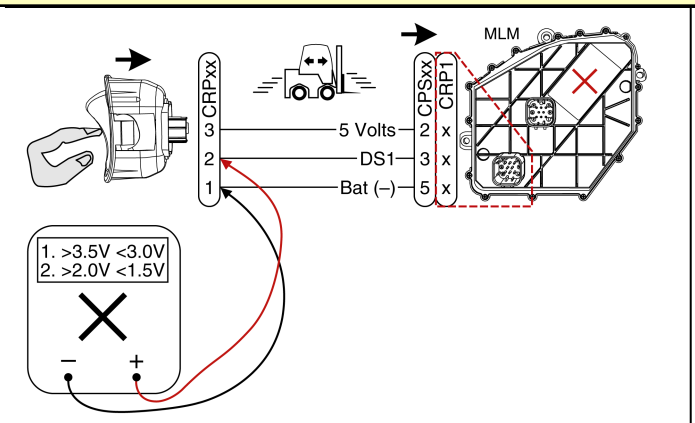
Direction Select Data Incorrect - No DCS Source (Cont)	
CAUSE A	
DCS Wiring/Connections	
	
1. Push In Emergency Stop	
2. NOTE: Do not remove PCB Cassette to Remove DCS↓	
3. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369↓	
4. Disconnect DCS from harness	
5. Release Emergency Stop	
STEP A1 **CHECK VOLTAGE**	
MLM Open Circuit CAN Hi/CAN Lo	
	
1. 0 Volts →Step 2↓	1. ˜ 5 Volts →Step 3↓

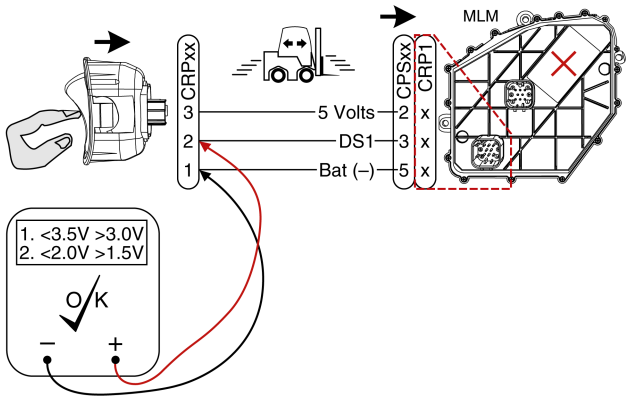
Direction Select Data Incorrect - No DCS Source (Cont)	
STEP A2	**CHECK VOLTAGE**
	
1. Disconnect Cassette Connector as Indicated→Measure Volts↓	
2. 0 Volts→Faulty MLM Cassette→CAUSE C↓	˜ 5 Volts →Step 3↓
STEP A3	
	
Disconnect Cassette Connector as Indicated→Measure ?↓	
1. 8 ?→OPEN Circuit→Go to 4↓	1. 0 ?→Go to 2↓
2. 8 ?→OPEN Circuit→Go to 4↓	2. 0 ?→Go to 3↓
3. 8 ?→OPEN Circuit→Go to 4↓	3. 0 ?→Step 4↓
4. Find/Repair OPEN Circuit→Go to 5↓	
5. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369↓	
6. Recheck ?↑→ Reconnect→Test OK→No DTCs→YES→Resume OperationNo→Step 4↓	

Direction Select Data Incorrect - No DCS Source (Cont)	
STEP A4	**CHECK RESISTANCE - Ω - OHMS**
	
1. 0?→Short Circuit→Go to 3↓	1. 8 ?→Go to 2↓
2. 0?→Short Circuit→Go to 3↓	2. 8 ?→CAUSE B↓
3. Find/Repair Short Circuit→Go to 5↓	
5. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369↓	
6. Recheck ?↑→ Reconnect→Test OK→No DTCs→YES→Resume OperationNo→CAUSE B↓	
CAUSE B	
Not Applicable	

Direction Select Data Incorrect - No DCS Source (Cont)

CAUSE C





Reconnect Cassette Connector and DCS as Indicated→Select FOWARD Position→Measure Volts↓

1. Does FORWARD Voltage DS1 = 3.25V ± 0.25 V?↓

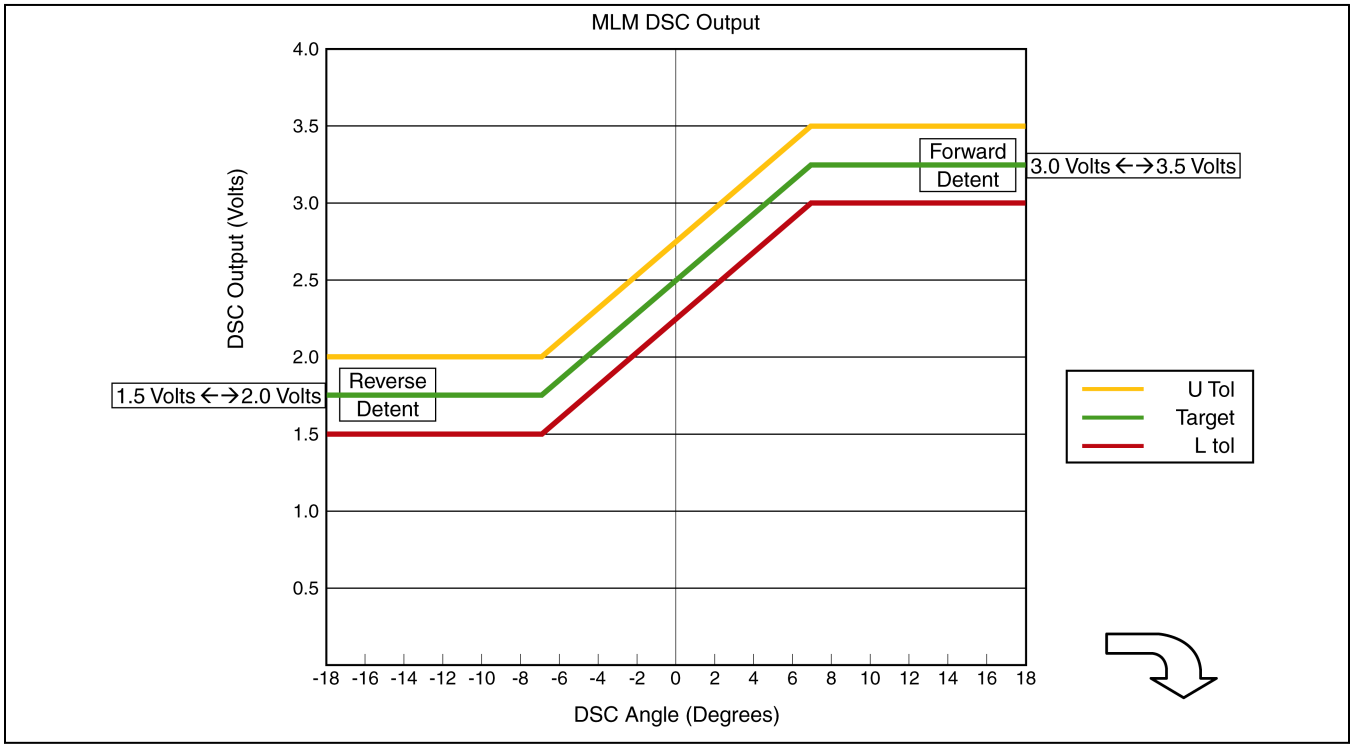
NO: Replace DSC→See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369↓

YES: Select REVERSE Position→Measure Volts→Does REVERSE Voltage DSC1 = 1.75V ± 0.25 V?↓

NO: Replace DSC→See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369↓

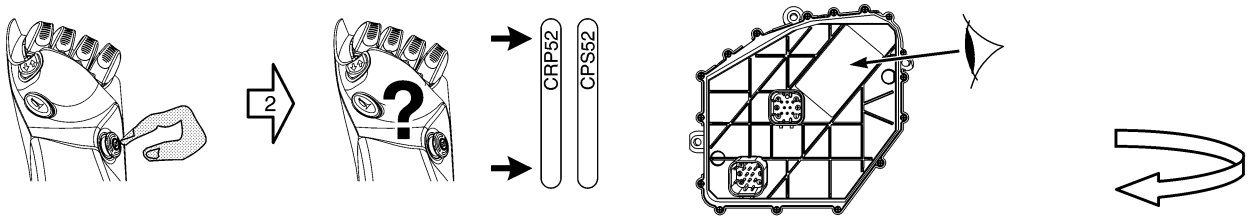
YES→Replace PCB Cassette→CAUSE C↓

Note: >4.9 Volts→Go to Travel Direction Select - Foot Pedal/Manual Hydraulic Out of Range High (OORH)→
Note: <0.31 Volts→Go to Travel Direction Select - Foot Pedal/Manual Hydraulic Out of Range Low (OORL)→



Direction Select Data Incorrect - No DCS Source (Cont)

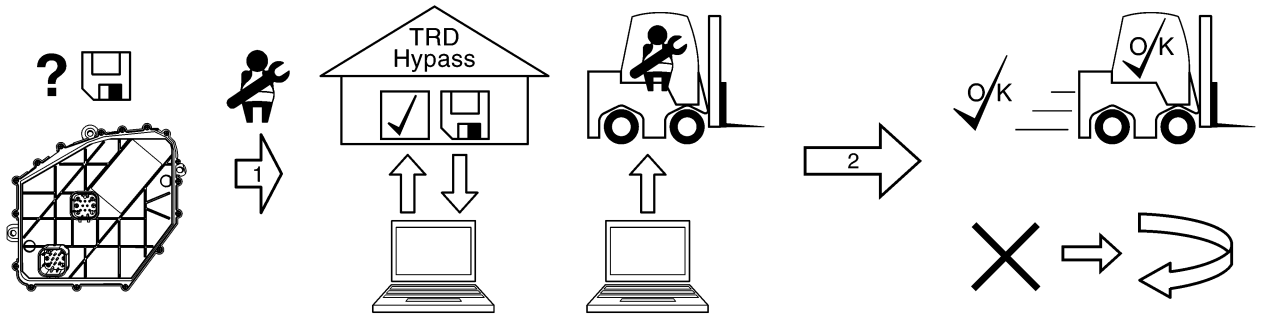
CAUSE D



Power **OFF**→Remove and Replace MLM PCB Cassette Assembly→See **Electrical System** 2200SRM1337/ **Electrical System** 2200SRM1369↓

Check Replacement MLM 🖫 Version→See Label Information→Step 1↓

STEP D1



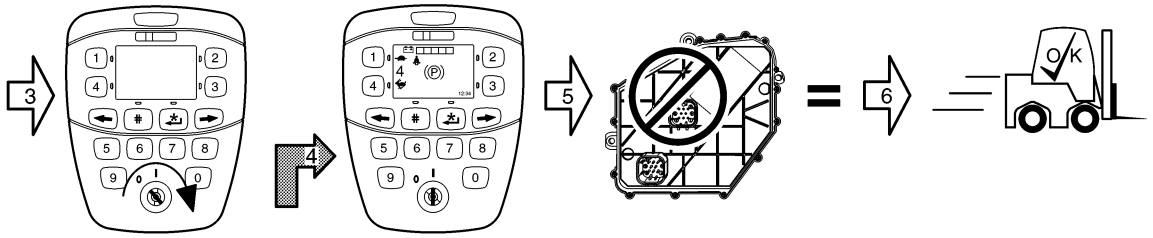
1. Go to TRD/Hypass Online /Software.?? Is Replacement Cassette Software Version the Latest Version

2. **NO**→Download the latest Application 🖫→Install on truck→Step 2↓

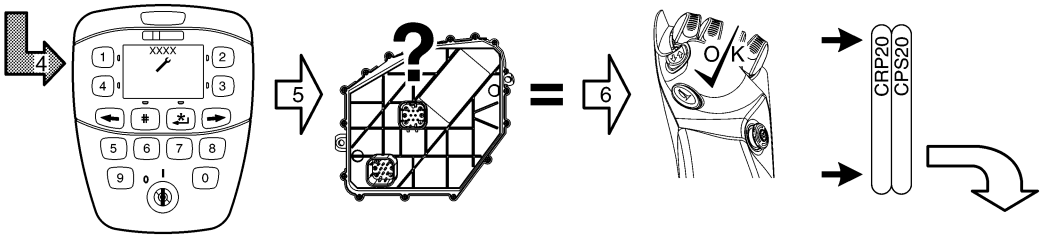
3. **YES**→Test New Installation→Step 2↓

Direction Select Data Incorrect - No DCS Source (Cont)

STEP D2

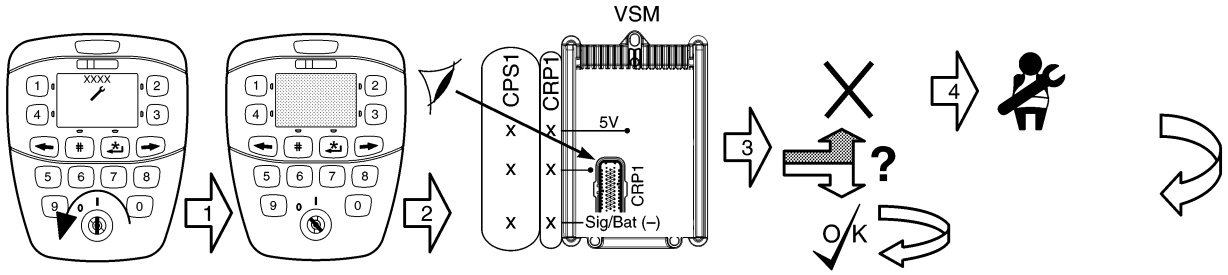


Power **ON**→ | **?** DTCs gone→ | Original MLM Cassette faulty→ | Resume operation



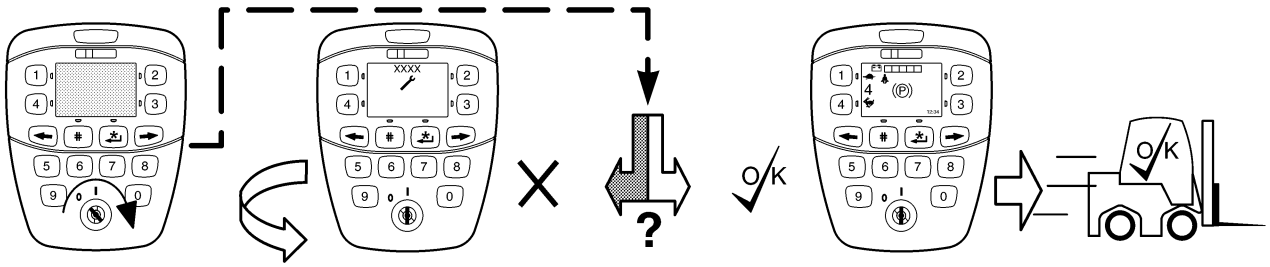
DTCs Still Present→ | Original MLM Cassette OK/Reinstall Original Cassette→?

CAUSE E



Power **OFF**→ | Inspect VSM Connections→OK Step 1 | Not OK Correct/Repair→Step 1

STEP E1

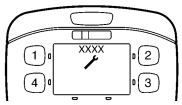


Retest - Power **ON**→ | **NO**→Go to VSM Controller Check | Is fault DTC gone?**NO** **YES**←→ | Fault corrected→Continue operation.

DTC LOGS: DTC logs should only be cleared once the data is by the Service Tech. See Display Menu Flowchart **- Clearing DTCs.**

END FAULT

CBB/DBB Motor/Motor Controller Temperature Sensor Failure (Cont)



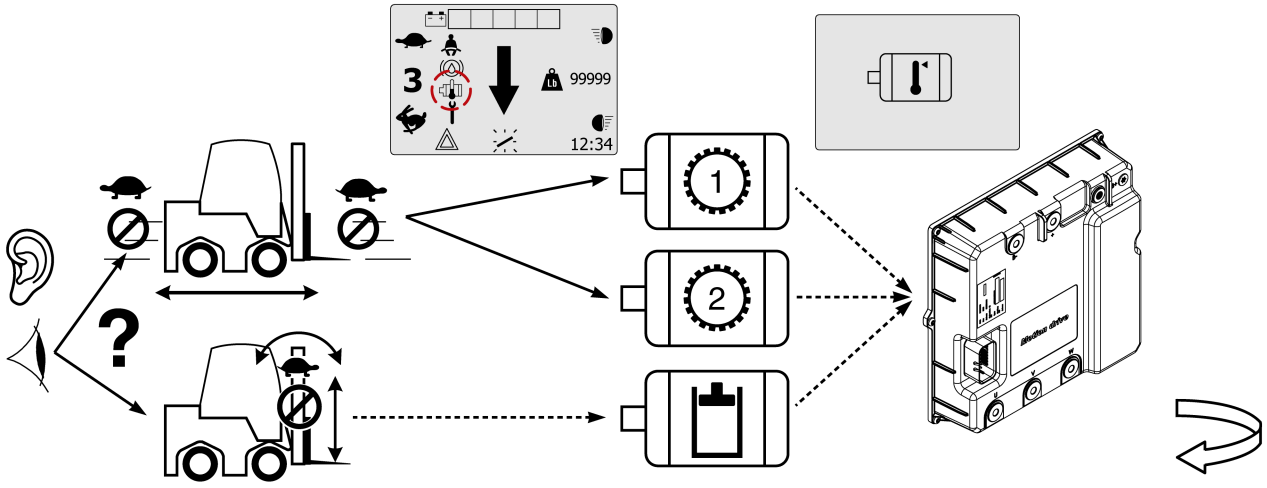
DTC 16912
Motor Temperature High

DTC 17168
Controller/Heatsink Temperature High

DTC 25105
Temperature Sensor Failure

QUICK CHECK X = Open Circuit/Fail) = Short Circuit

Check 1



? Over Temperature Icon Displayed at Power ON?

POSSIBLE CAUSES	
1. Sensor(s) – Motor/Motor Controller – Connections/Wiring?→	CAUSE 0↓
2. Sensor(s) Failure?→	CAUSE 0↓
3. Motor Controller(s) Hardware Failure?→	CAUSE C↓

Note: Hydraulic Oil Over Temperature and Sensor Issues see Hydraulic Temperature Sensor Out of Range High (OORL) Hydraulic Temperature Sensor Out of Range High (OORH)

? Over Temperature Icon Displayed during Operation/Reduced Performance/Function Failure?

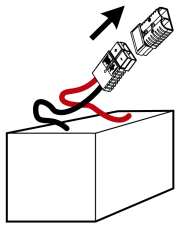
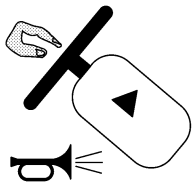
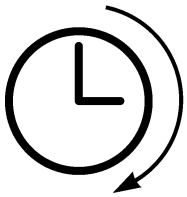
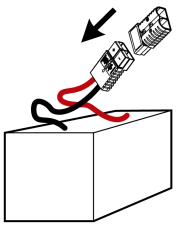
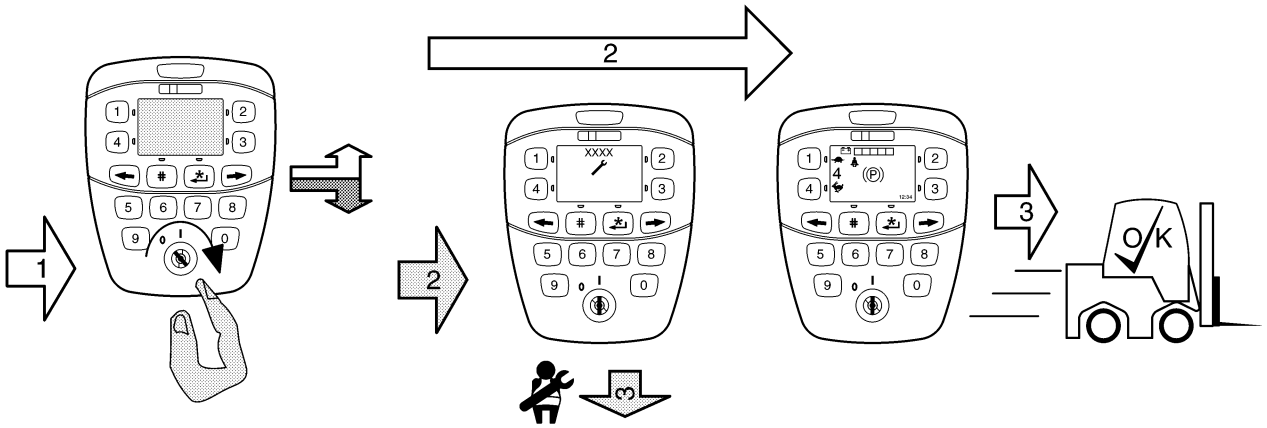
POSSIBLE CAUSES	
1. Motor/Motor Controller/Hydraulic Fluid Overheating?→	Aggressive Operation?→
2. Sensor – Motor/Motor Controller/Hyd Tank – Connections/Wiring?→	CAUSE 0↓
3. Sensor(s) Failure?→	CAUSE 0↓
4. Motor Controller(s) Failure ?→	CAUSE C↓

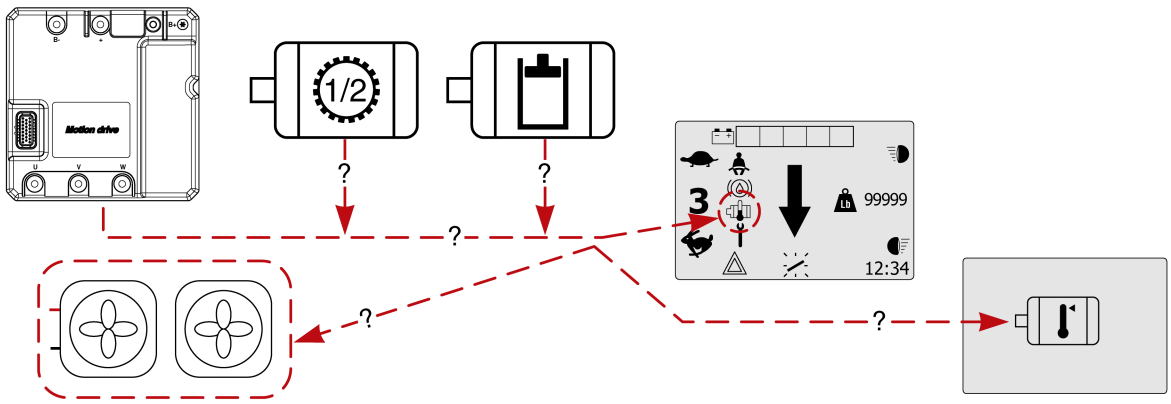
WARNING

The CBB Truck requires the removal of the battery to access the Controllers and Motors

Table 9030-20-14. Motor Controller Temperature and Silicon Temperature Sensor

Note: For further assistance on Motor Controller Temperature and Silicon Temperature Sensor readings, see Table 9030-10-4.

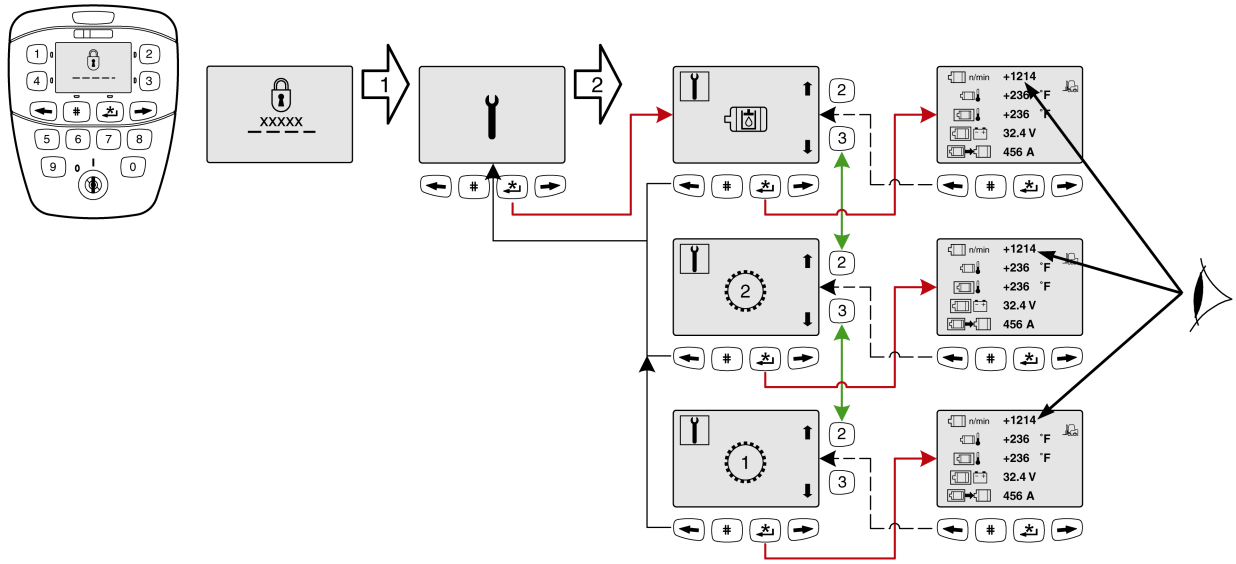
CBB/DBB Motor/Motor Controller Temperature Sensor Failure (Cont)			
Check 2			
			
Disconnect Battery and Sound Horn to Discharge Capacitors.Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342.		Wait 30 seconds	Reconnect Battery
Check 3			
			
Power **ON**→	Fault Remains Service Required ?		No Fault→Resume Operation

CBB/DBB Motor/Motor Controller Temperature Sensor Failure (Cont)
Check 4

Reduced Performance→Check Display Icons?
Motor/Motor Controller Temperature Icon On
1. Check fan operation→Are fans operating?→NO →A935 – K160D203 Motor Controller Fan FailureYES →2. ?
2. Temp Sensor/Controller to Motor connection→Open Circuit→CAUSE 0↓
3. Use the following steps for viewing Motor Temperature
Note: The Motor Temperature ICON will be displayed for any Over Temperature of Traction 1/Traction 2, Pump Motor and their associated Controllers plus Hydraulic Fluid
Note: The Diagnostics Display Menu Flowchart will show which device is overheating See Check 5
Note: The Service Tech may need to operate the truck for an extended time on a 20% grade to have this Over temperature icon(s) display again after it has been first reported

CBB/DBB Motor/Motor Controller Temperature Sensor Failure (Cont)

Check 5

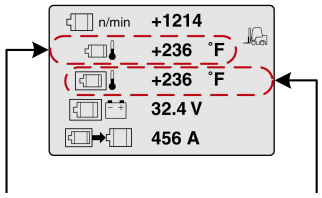
Diagnostics Temperature Analysis – Go to Display Menu Flowchart



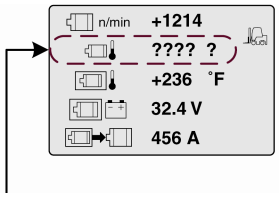
Enter Service Password→	Diagnostics→	Motor→Traction1/Traction2/ Pump→	Motor/Controller Data

Fan(s) Operation Temperature Threshold: Traction = 55°C (131°F) Pump = 65°C (149°F)

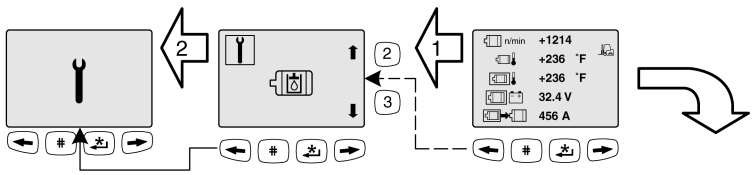
Reduced Performance: Traction = 80°C (176°F) Pump = 80°C (176°F)



Motor		Motor Controller



Invalid Temperature Signal (Traction/Pump Motor(s) Only): **Sensor Connections/Sensor Open Circuit**

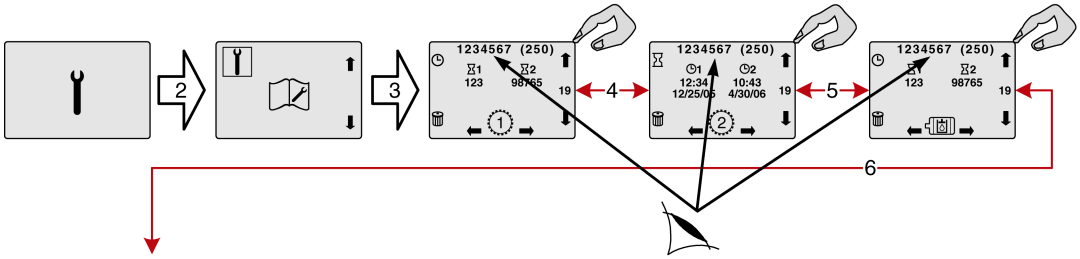


Return to Diagnostics Menu→?

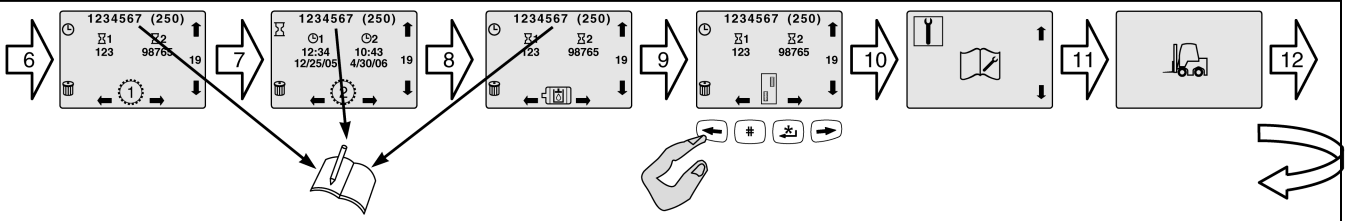
CBB/DBB Motor/Motor Controller Temperature Sensor Failure (Cont)

Check 6

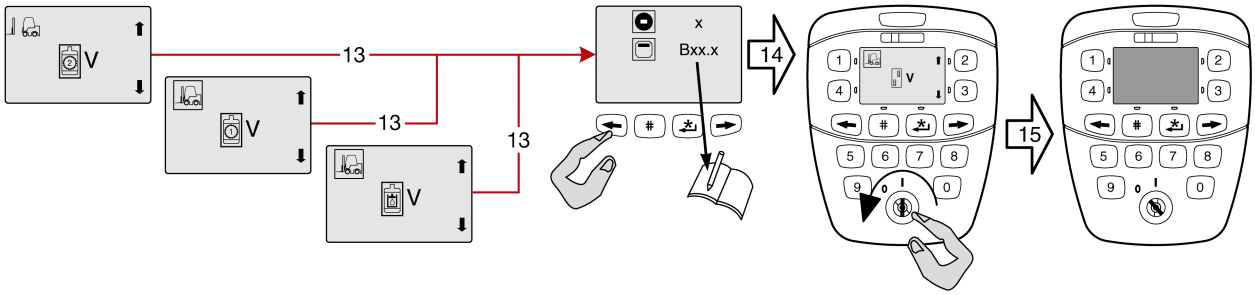
Fault Log DTC – Go to Display Menu Flowchart



Enter Service Password→Diagnostic→FAULT LOGs→Motor Fault Log(s)→View all Motor DTCs→?



📋✍ all Motor Codes→☜Exit Fault Log→Truck Status ?

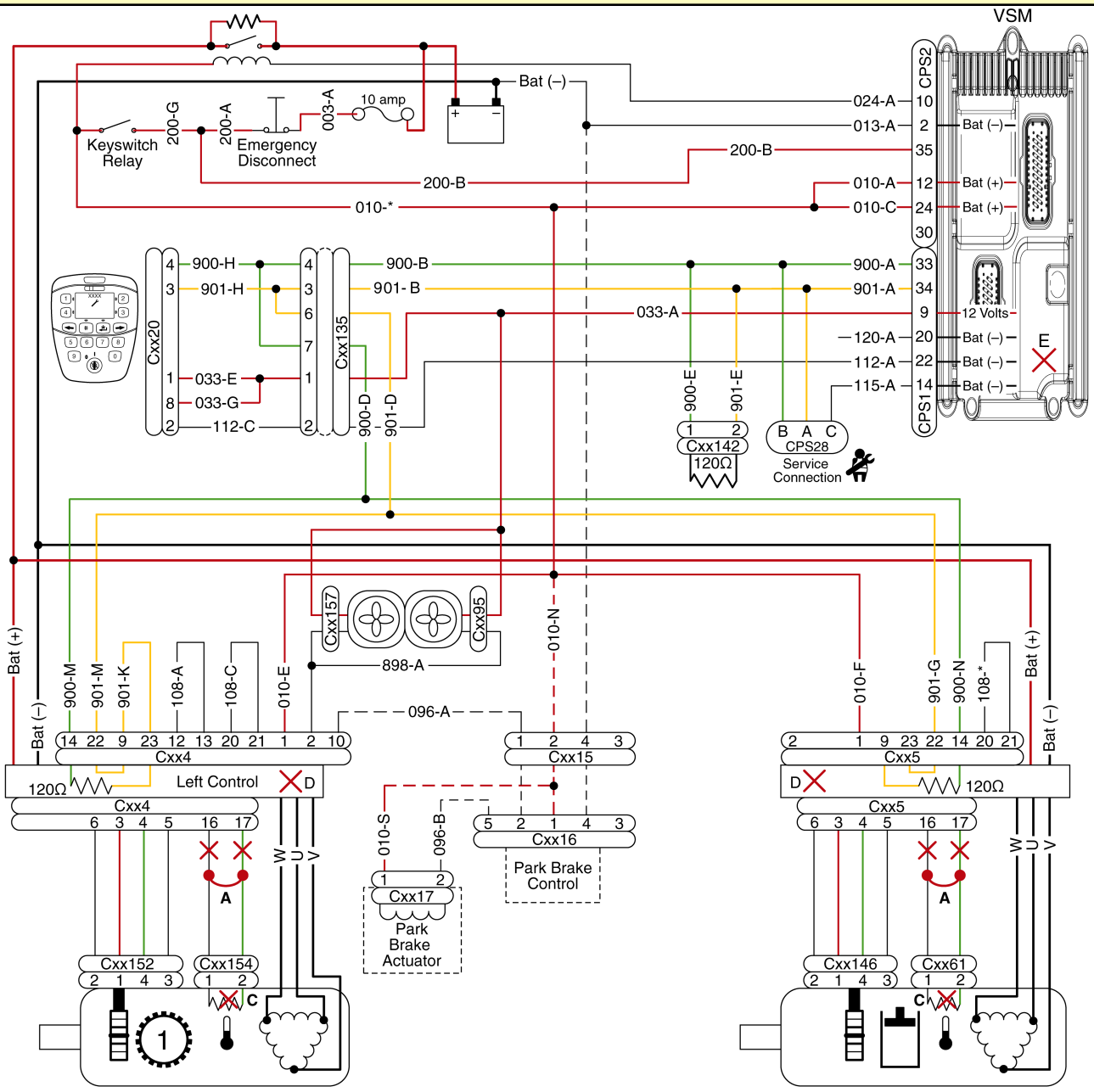


Motor Versions→📋✍Hardware/Software Versions→☜Exit Versions→Power **OFF**?

POSSIBLE CAUSES X = Open Circuit/Fail) = Short Circuit

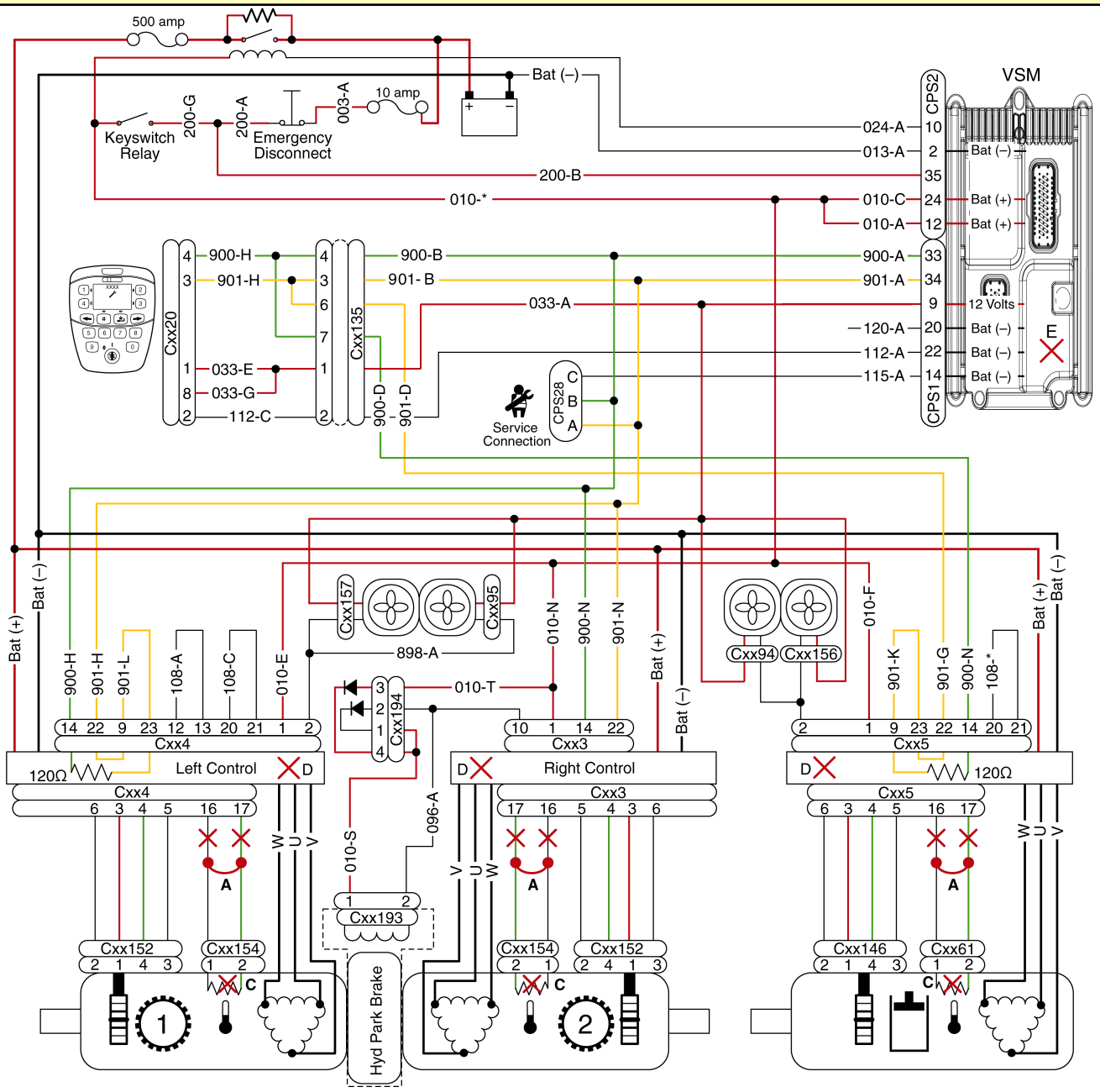
CBB/DBB Motor/Motor Controller Temperature Sensor Failure (Cont)

CBB SCHEMATIC CAUSES A B C D E > ?



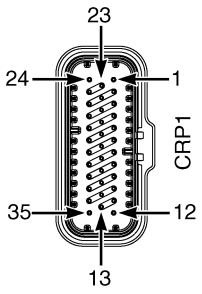
CBB/DBB Motor/Motor Controller Temperature Sensor Failure (Cont)

DBB SCHEMATIC CAUSES A B C D E > ?

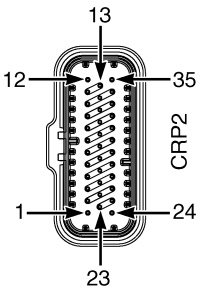


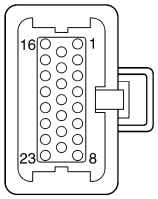
CBB/DBB Motor/Motor Controller Temperature Sensor Failure (Cont)

CONNECTORS

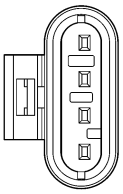


VSM Cxx 1 and Cxx 2



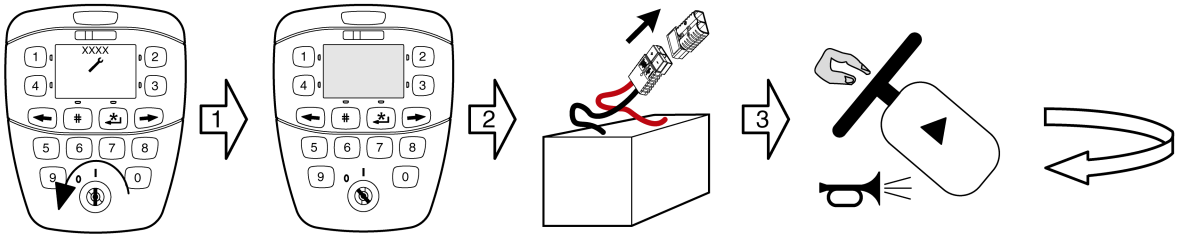


Traction/Pump Controller Cxx 3, 4, and 5



Fan Motor Connector Cxx 146, 154, and 155

CAUSE A

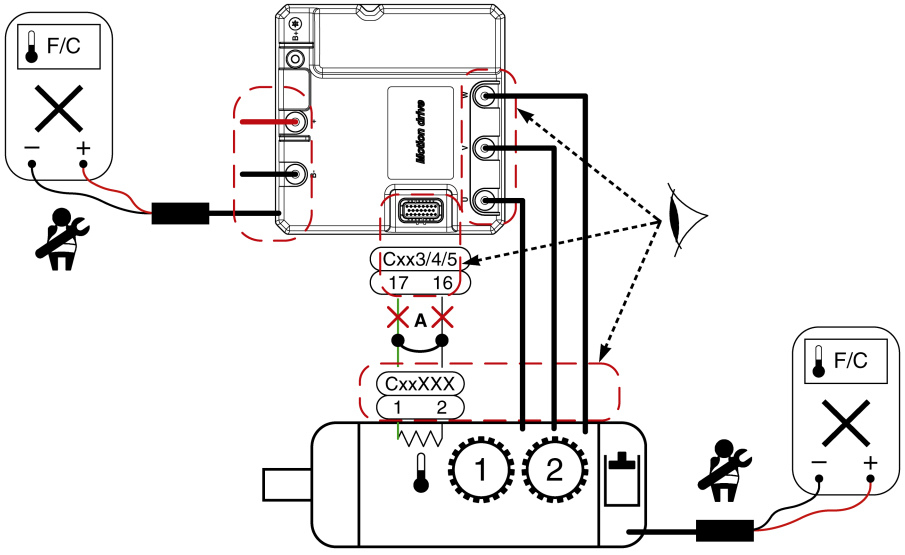


Power **OFF**→	Disconnect Battery and Sound Horn to Discharge Capacitors.→Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342→.	Go to Step 1

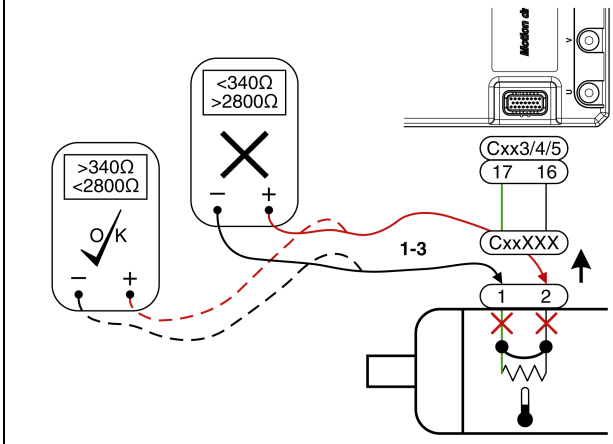
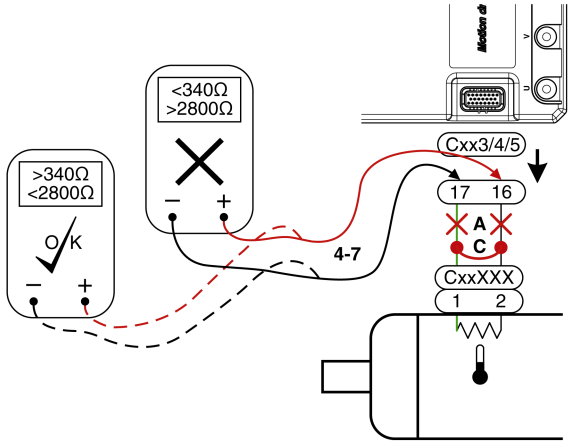
STEP A1

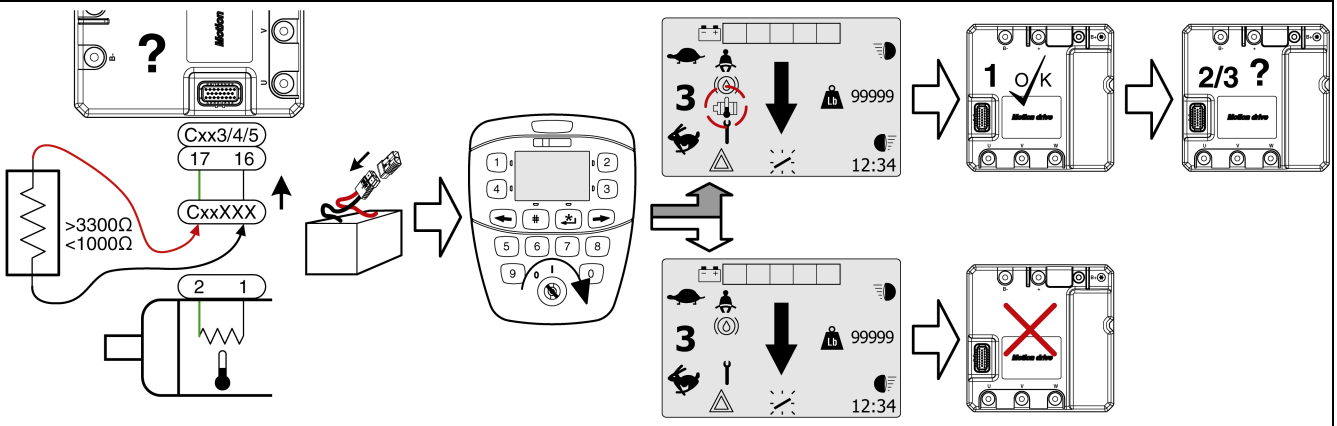
For any Fault DTC→Locate Device→Inspect ALL Wiring/Connections

A DMM Temperature probe can also be used to determine which device is overheating



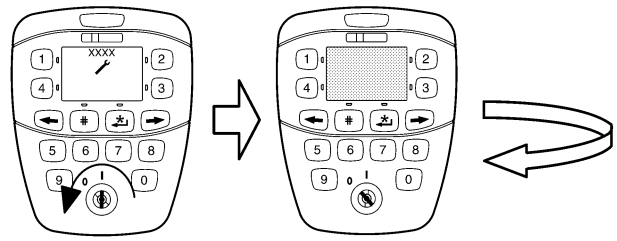
BT081046

CBB/DBB Motor/Motor Controller Temperature Sensor Failure (Cont)	
STEP A2	**CHECK RESISTANCE - Ω - OHMS**
Motor Temperature Sensor	
	
1. Disconnect Motor Connector→Measure ? as indicated→	
Note: For temperature sensor readings, see Table 9030-10-4.	
At xxx deg→ sensor ? ˜ match Temperature Chart 340? @ →-40°C (25°F) to 2791? @300°C (572°F)↓	
2. <300? to 0? = Motor Sensor Short Circuit→Go to 8↓	
3. >2800? to 8? = Motor Sensor Open Circuit/High Resistance Connection→Go to 8↓	
4. Reconnect Motor Connector↓	
5. Disconnect Controller Connector→Measure ? as indicated→See Table 9030-10-4.↓	
6. <300? to 0? = Short Circuit→Go to 9↓	
7. >2800? to 8? = Open Circuit/High Resistance Connection→Go to 9↓	
8. **Replace Motor**→Go to 10↓	
9. Find/Repair Harness OPEN/SHORT Circuit→Go to 10↓	
10. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→Go to 11↓	
11. Recheck ?↑→ Reconnect→Resume Operation	

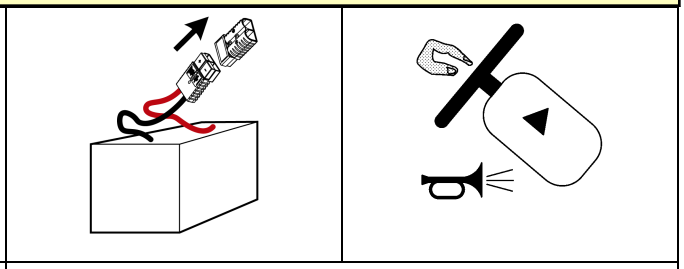
CBB/DBB Motor/Motor Controller Temperature Sensor Failure (Cont)
STEP A3
Motor Temperature Sensor (Controller Check)

1. Disconnect Motor Temperature Sensor Connector from suspect Controller→
2. Connect a ¼ watt resistor (>3300? to <10,000?) as shown
3. Reconnect Battery and all other Connectors
4. Does Over Temperature ICON Appear?↓
5. YES: Go to 7↓
6. NO: Controller is Faulty→CAUSE C↓
7. Repeat Resistor Test on other Controllers↓
8. Temperature ICON is Displayed?→YES: Controller tested OK, Go to 9→NO: Controller tested Faulty→CAUSE C↓
9. Reconnect other Motor Temperature Sensors
CAUSE B
Not Applicable
CAUSE C
Not Applicable

CBB/DBB Motor/Motor Controller Temperature Sensor Failure (Cont)

CAUSE D

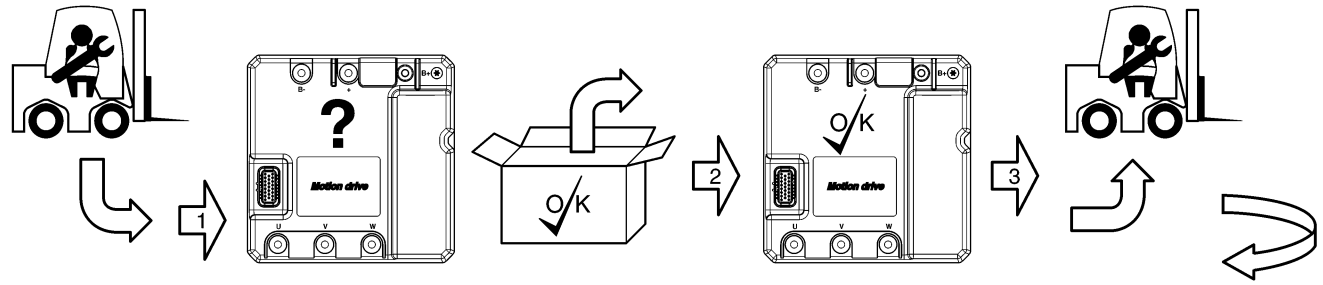


Power **OFF**→



Disconnect Battery and Sound Horn to Discharge Capacitors.→Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342→.

STEP D1

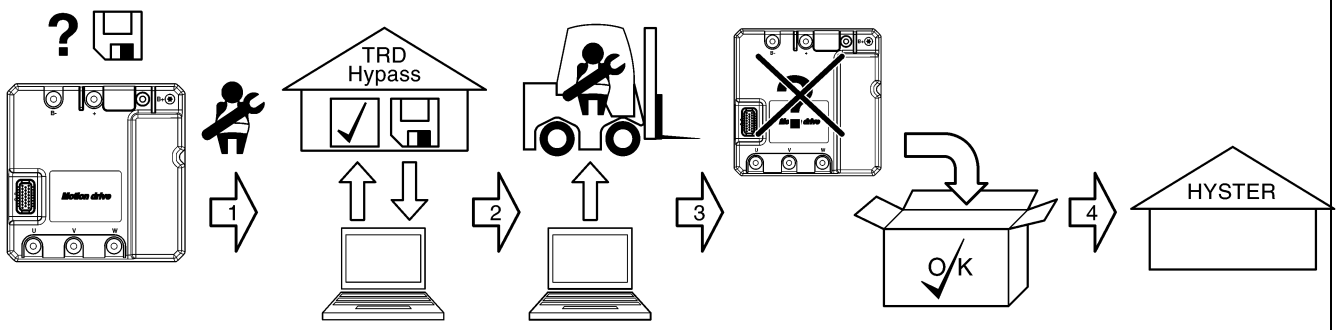


Remove and Replace Faulty Motor Controller↓

See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369↓

Check Replacement Controller 🖫 Version→See Label Information→Step 2↓

STEP D2



1. Go to TRD/Hypass Online /Software.?? Is Replacement Controller Application Software Version the Latest Version??

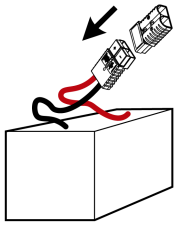
2. **NO**→Download the latest Application 🖫→Install on truck→Step 3↓

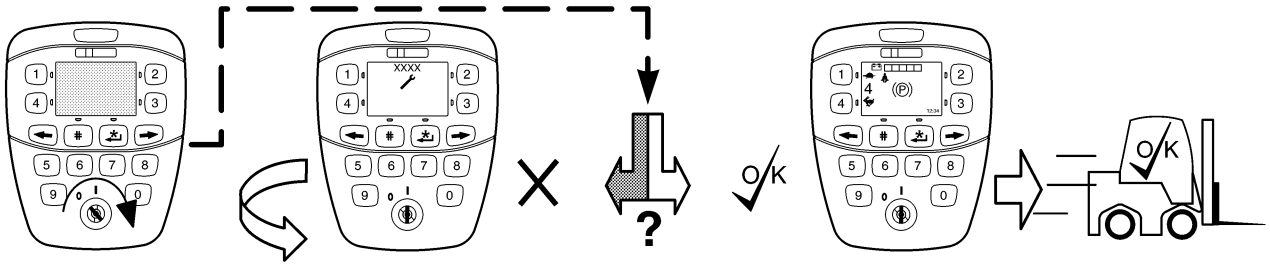
3. **YES**→Test New Installation→↓Step 3↓

4. Return Faulty Display→Dealer→Factory→Failure Analysis→?? Reprogramming

CBB/DBB Motor/Motor Controller Temperature Sensor Failure (Cont)

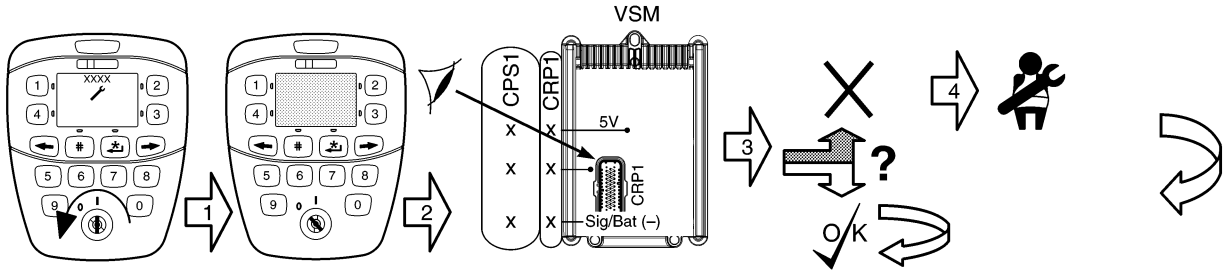
STEP D3





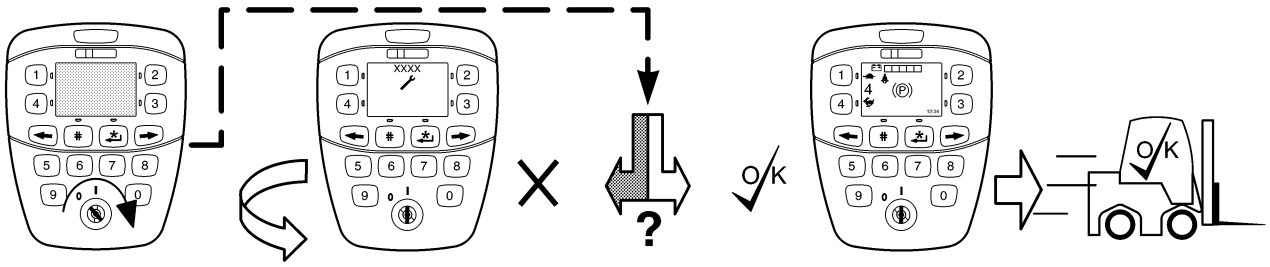
Retest - Power **ON**→	**NO**→?	Is fault DTC gone?**NO** **YES**←→	Fault corrected→Continue operation.

CAUSE E



Power **OFF**→	Inspect VSM Connections→OK Step 1	Not OK Correct/Repair→Step 1

STEP E1



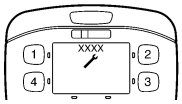
Retest - Power **ON**→	**NO**→Go to VSM Controller Check	Is fault DTC gone?**NO** **YES**←→	Fault corrected→Continue operation.

DTC LOGS: DTC logs should only be cleared once the data is by the Service Tech. See Display Menu Flowchart **- Clearing DTCs.**

END FAULT

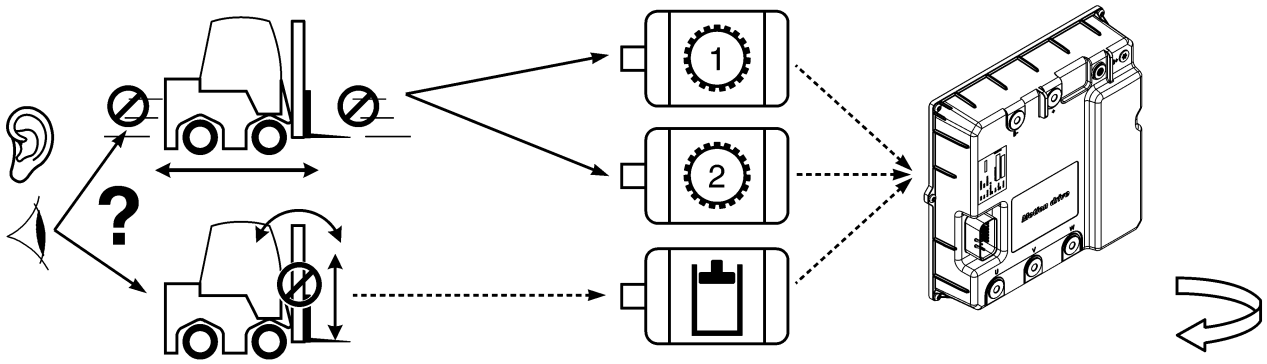
CBB/DBB Motor Controller Current Sensor Failure (Cont)

DTC 21008
Current Sensor Offset Calibration Error



QUICK CHECK X = Open Circuit/Fail) = Short Circuit

Check 1



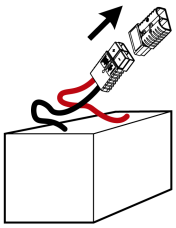
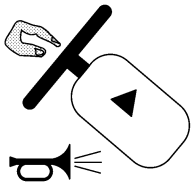
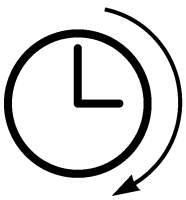
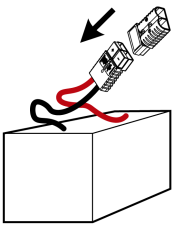
? No Traction/Hydraulics Truck Operation ?

Possible Causes

Motor Controller(s) Failure ?→	→CAUSE C↓

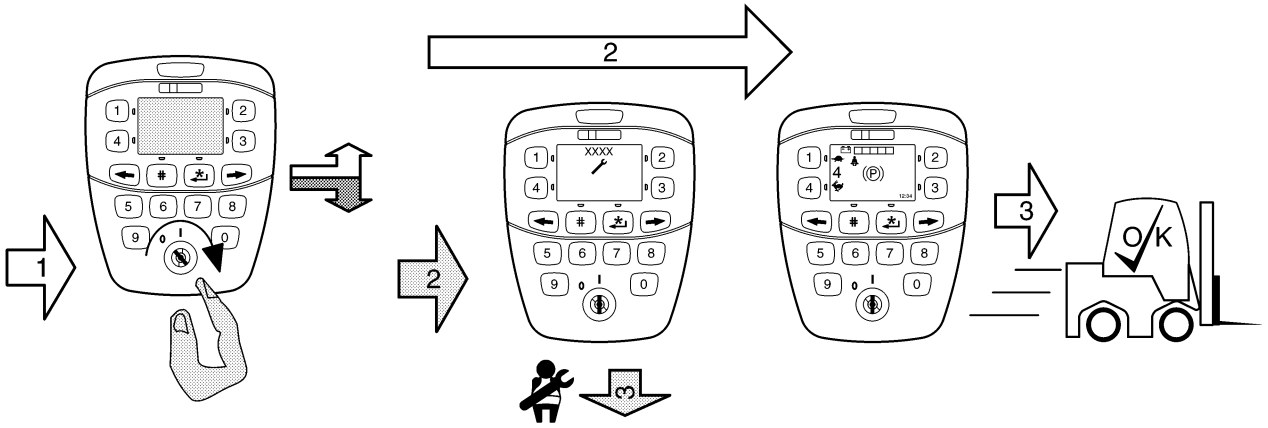
WARNING
The CBB Truck requires the removal of the battery to access the Controllers and Motors

Check 2

			
Disconnect Battery and Sound Horn to Discharge Capacitors.Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342.		Wait 30 seconds	Reconnect Battery

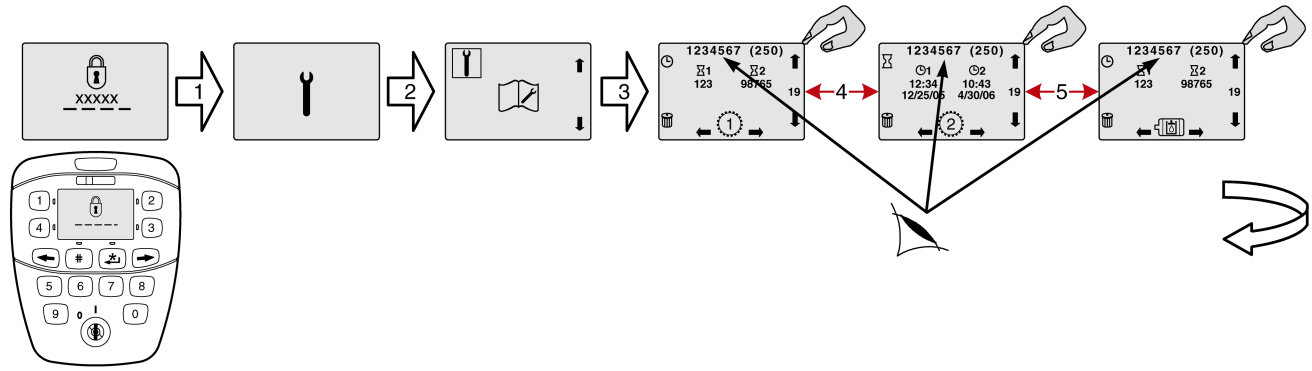
CBB/DBB Motor Controller Current Sensor Failure (Cont)

Check 3

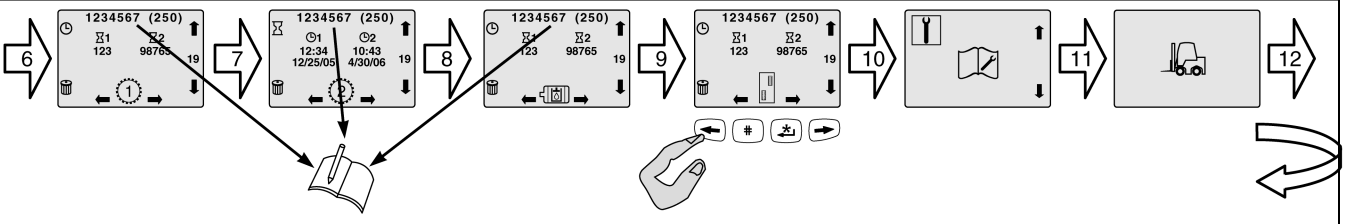


Power **ON**→	Fault Remains Service Required ?	No Fault→Resume Operation

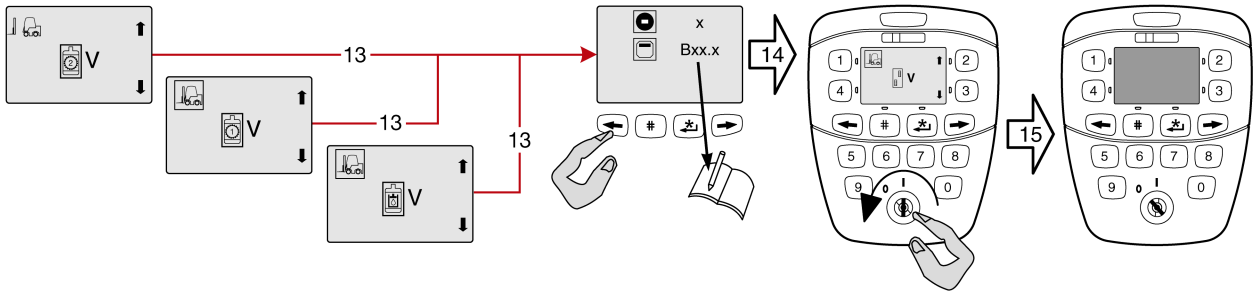
FAULT LOG Review - Go to Display Menu



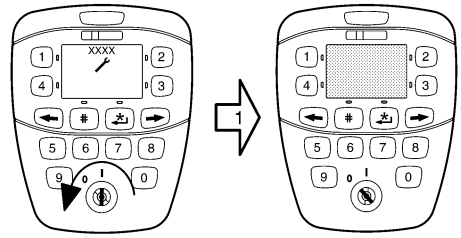
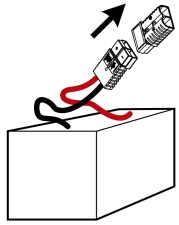
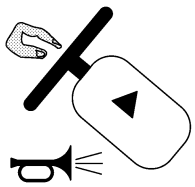
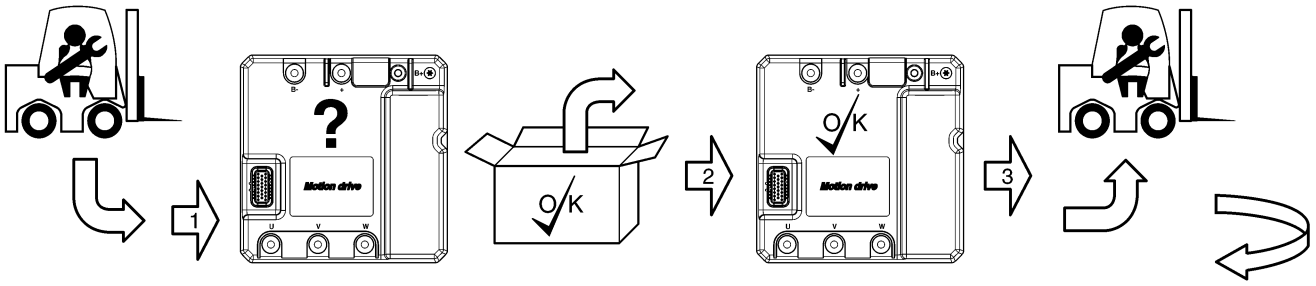
Enter SERVICE Password→Diagnostic→FAULT LOGs→Motor Fault Log(s)→View all Motor DTCs→?



📋✍ all Motor DTCs→☜Exit Fault Log→Truck Status ?

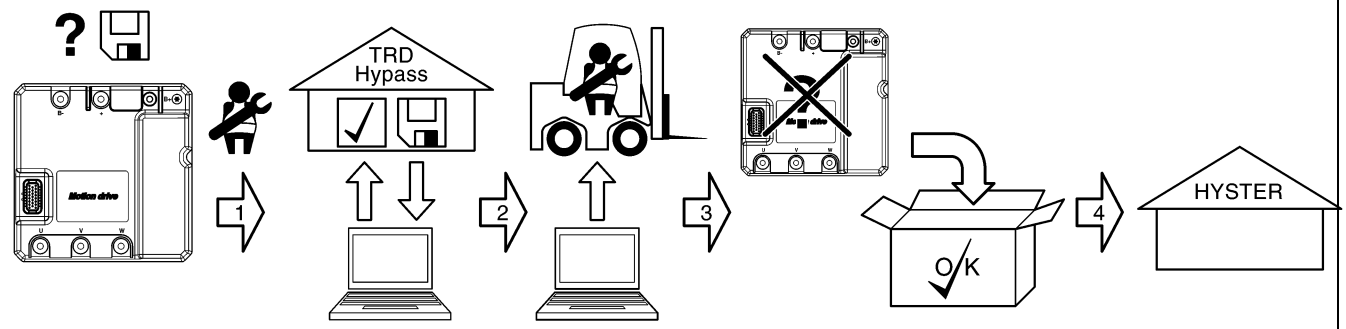


Motor Versions→📋✍Hardware/Software Versions→☜Exit Versions→Power **OFF**?

CBB/DBB Motor Controller Current Sensor Failure (Cont)		
CAUSE A		
Not Applicable		
CAUSE B		
Not Applicable		
CAUSE C		
Not Applicable		
CAUSE D		
		
Power **OFF**→	Disconnect Battery and Sound Horn to Discharge Capacitors.Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342.	
STEP D1		
		
Remove and Replace Faulty Motor Controller↓		
See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369↓		
Check Replacement Controller 🖫 Version→See Label Information→Step 2↓		

CBB/DBB Motor Controller Current Sensor Failure (Cont)

STEP D2



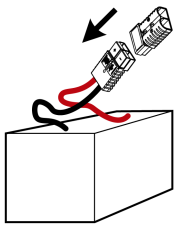
1. Go to TRD/Hypass Online /Software.?? Is Replacement Controller Application Software Version the Latest Version??

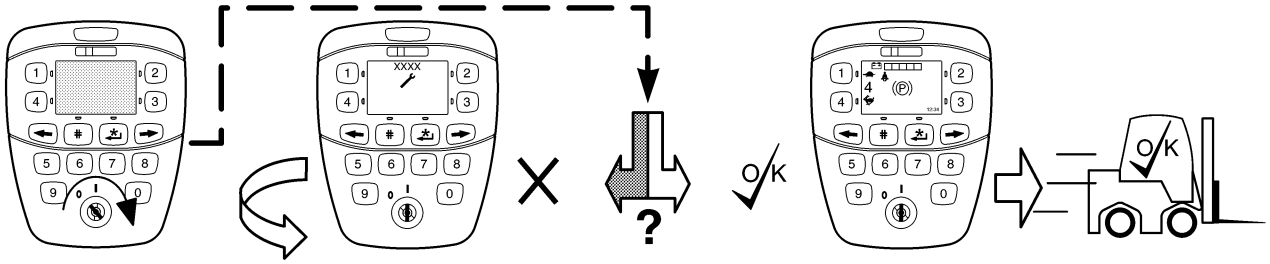
2. **NO**→Download the latest Application 🖫→Install on truck→Step 3↓

3. **YES**→Test New Installation→↓Step 3↓

4. Return Faulty Display→Dealer→Factory→Failure Analysis→?? Reprogramming

STEP D3

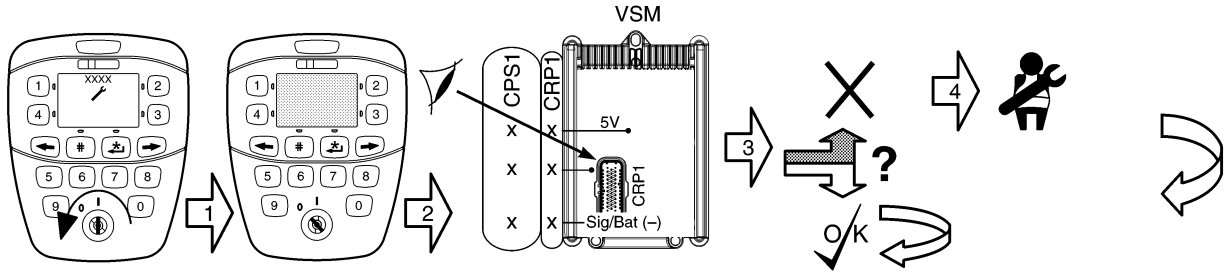




Retest - Power **ON**→	**NO**→?	Is fault DTC gone?**NO** **YES**←→	Fault corrected→Continue operation.

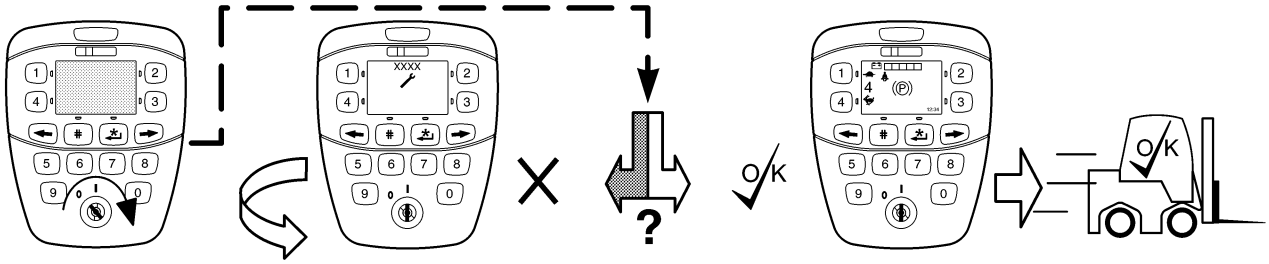
CBB/DBB Motor Controller Current Sensor Failure (Cont)

CAUSE E



Power **OFF**→	Inspect VSM Connections→OK Step 1	Not OK Correct/Repair→Step 1

STEP E1



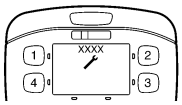
Retest - Power **ON**→	**NO**→Go to VSM Controller Check	Is fault DTC gone?**NO** **YES**←→	Fault corrected→Continue operation.

DTC LOGS: DTC logs should only be cleared once the data is by the Service Tech. See Display Menu Flowchart **- Clearing DTCs.**

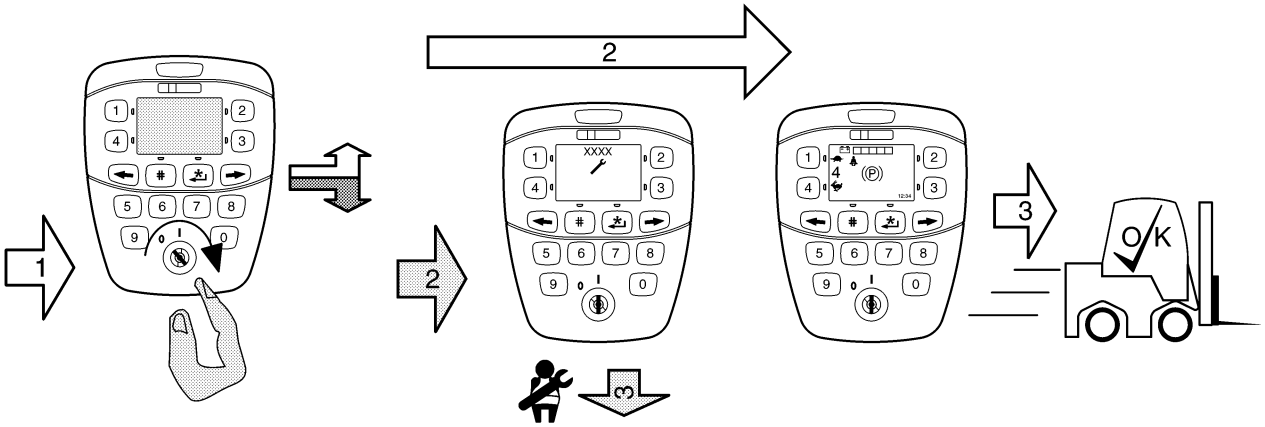
END FAULT

Hydraulic Calibration Required

DTC 4096
Hydraulic Calibration Required

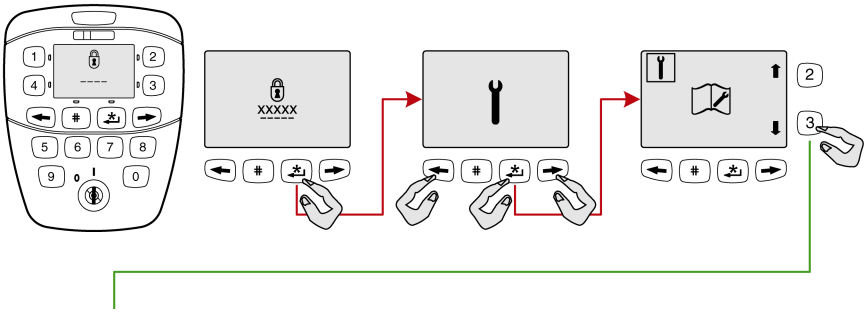


CAUSE A



Power **ON**→ Fault Remains Service Required ? No Fault→Resume Operation

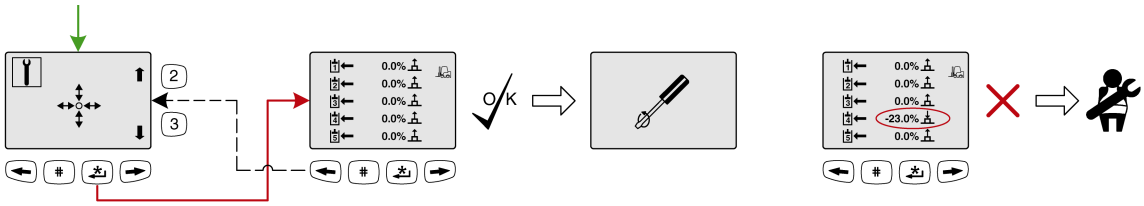
Calibration Process - Go to Display Menu



Enter Service Password→☞*	D Diagnostics →☞*	E Hydraulic Input?

Hydraulic Calibration Required (Cont)

Hydraulic Lever Sensor Input Values

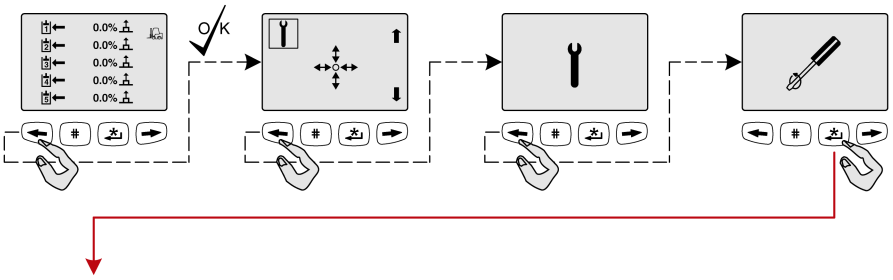


1. ☞*"Hydraulic Levers at Center position# < ± 2.5% = v" Proceed with Calibration ?

2. ☞*"Hydraulic Levers at Center position# > ± 2.5% = X = Faulty Lever Mechanism " Repair, Go to 3?

3. Manual Hydraulics Depending on your lift truck see, **Main Control Valves** 2000SRM1334 or **Main Control Valves** 2000SRM1439.

Calibration Process - Go to Display Menu



Calibration Menu

This Hydraulic Calibration Display Menu is viewable to those logged in with a supervisor or service level password.

E-Hydraulics and Manual Hydraulics Threshold Calibration: For Display Menu graphics see following pages.

1. Access Calibration Menu→Press *→Scroll to Hydraulic Calibration→Press*↓

2. Move the lever for function 1 in the A direction until the forks begin to visibly move in the A Direction.Press*
The VSM will record the setting and the Display will automatically step to the next Calibration step.E.g. 1A→1B→2A→2B.

Note: Calibration reading outside of the allowable engineering tolerances = X across the graphic. Press any key to return to the A direction graphic for the valve under calibration. Repeat calibration steps.

3. Last Calibration completed.→Display transitions back to the Calibration Maintenance Menu List.

Manual-Hydraulic: For Display Menu graphics see following pages.

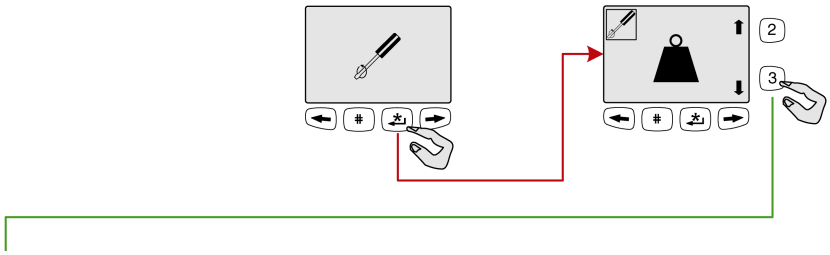
1. Access Calibration Menu→Press *→Scroll to Manual Hydraulic Valve→Press*↓

2. Move the Lift Lever first to the end of mechanical travel in one direction and then to the other endPress*
Repeat for the other Levers.
When all levers have been calibrated Press the Scroll Left Button to return to the previous Menu.

Note: If the calibration reading is outside of the allowable engineering tolerances the Display will display an X' across the graphic. Wait 3 seconds→Press*→Repeat the calibration for this Lever.

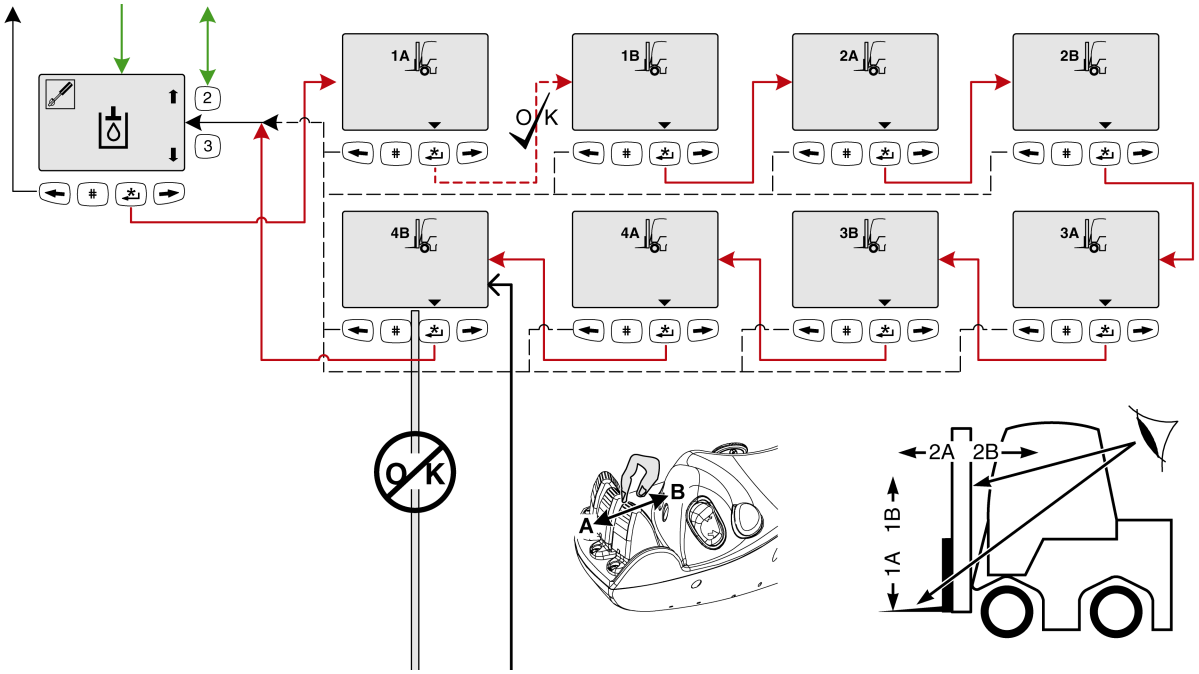
Hydraulic Calibration Required (Cont)

Calibration Process - Go to Display Menu

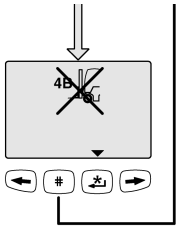


Calibration→☞*↓Hydraulic Valve Threshold

Hydraulic Valve Threshold - Manual and E-Hydraulic

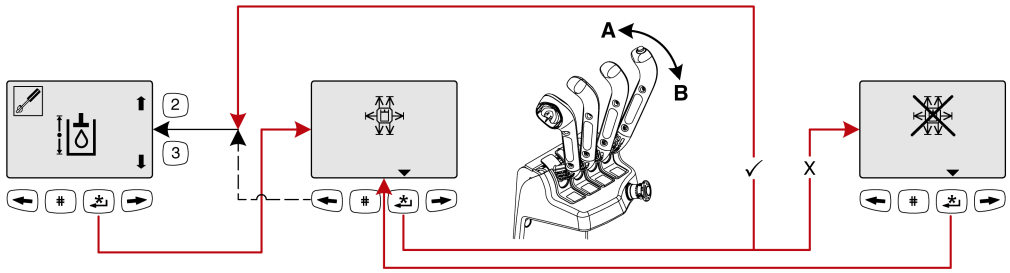


☞*	Operate Indicated Control until Hyd movement is observed ☞*	Repeat for each Function ☞*



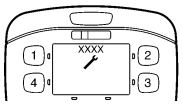
X = Calibration Failure	☞ # to Reset↑	Repeat Calibration

WARNING: X = MLM Lever operated in the wrong direction. Repeat Calibration

Hydraulic Calibration Required (Cont)
Manual Hydraulic Valve

☞*Lift/LowerG☞ * v Next Lever GX = Calibration Fail I 🗁3 seconds ☞*Repeat Calibration
FAULT DTC LOGS: DTC logs should only be cleared once the data is 🗏✍ by the Service Tech. See Display Menu Flowchart **- Clearing DTCs.**
CAUSE A
End of Task

END FAULT

CBB/DBB Motor Controller 15 – 5 Volt Internal Failure(Cont)

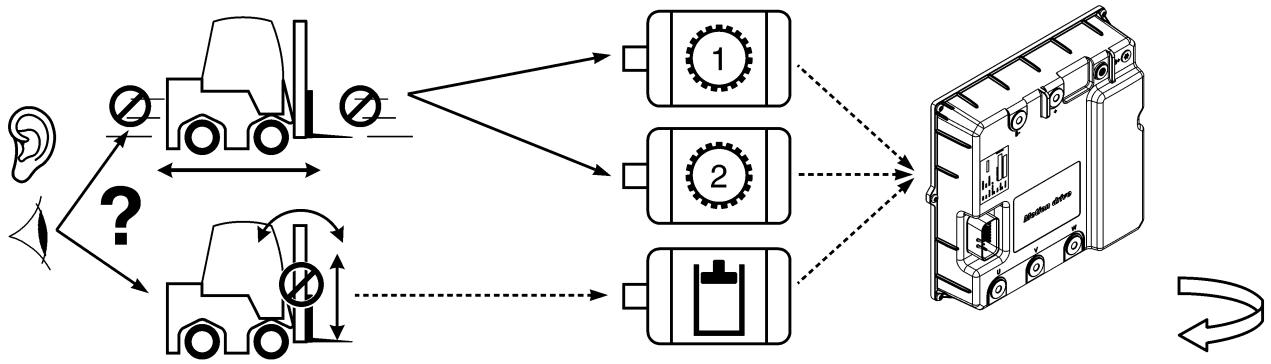


DTC 20753 **DTC 20755**

15 Volt Supply Low Voltage **5 Volt Supply Low/High Voltage**

QUICK CHECK X = Open Circuit/Fail) = Short Circuit

Check 1



? No Traction/Hydraulics Truck Operation ?

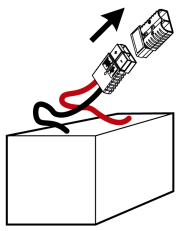
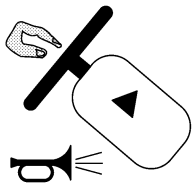
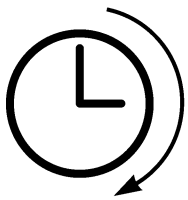
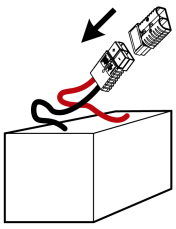
Possible Causes

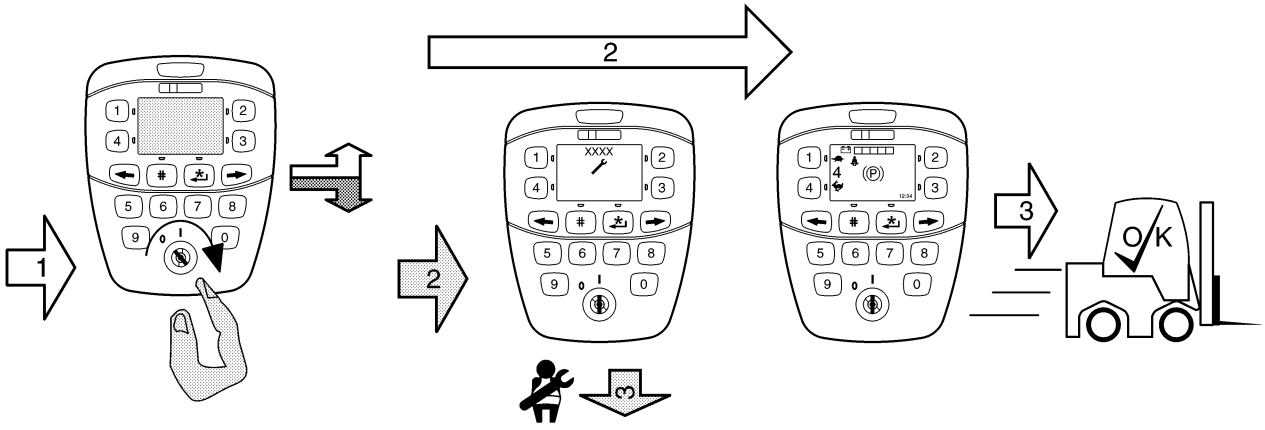
20753/20755→Motor Controller(s) Failure ?→	CAUSE C↓

WARNING

The CBB Truck requires the removal of the battery to access the Controllers and Motors

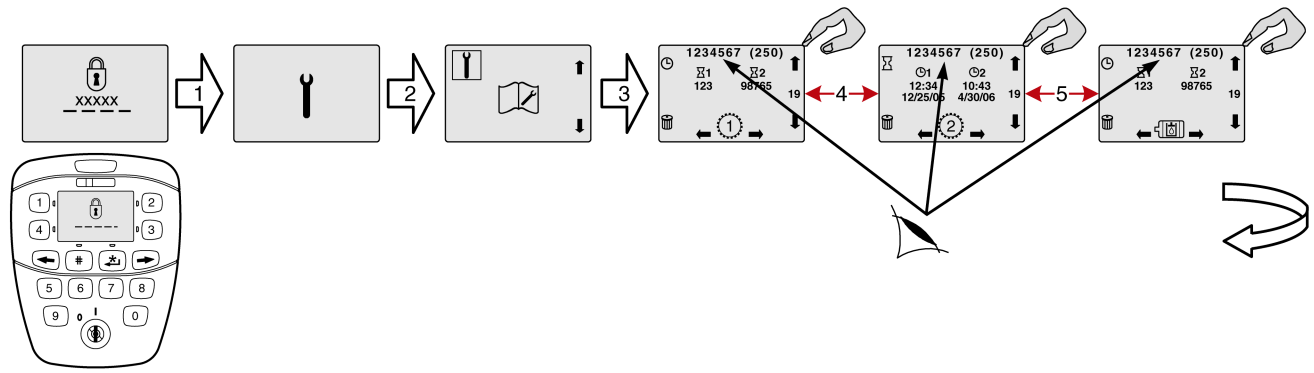
Check 2

			
Disconnect Battery and Sound Horn to Discharge Capacitors.Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342.		Wait 30 seconds	Reconnect Battery

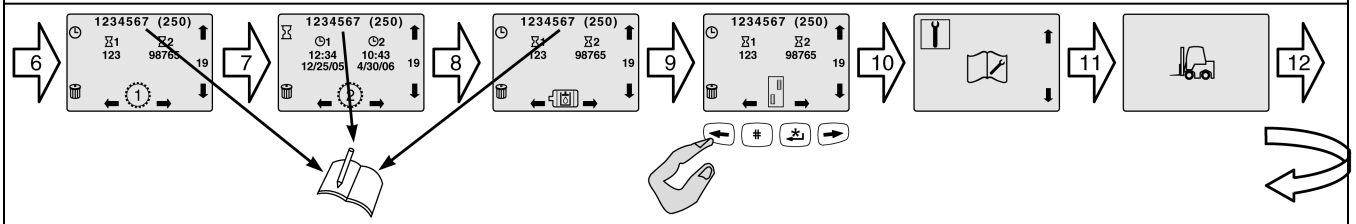
CBB/DBB Motor Controller 15 – 5 Volt Internal Failure (Cont)		
Check 3		
		
Power **ON**→	Fault Remains Service Required ?	No Fault→Resume Operation

CBB/DBB Motor Controller 15 – 5 Volt Internal Failure (Cont)

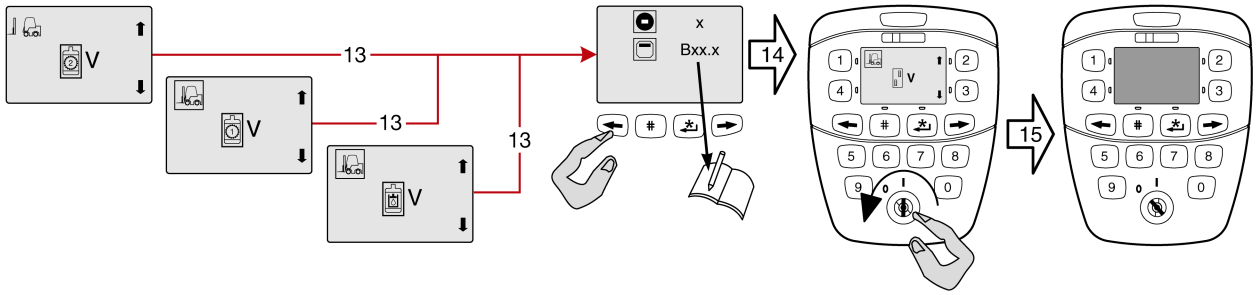
FAULT LOG Review - Go to Display Menu



Enter SERVICE Password→Diagnostic→FAULT LOGs→Motor Fault Log(s)→View all Motor DTCs→?



📝 all Motor DTCs→☜Exit Fault Log→Truck Status ?



Motor Versions→📝Hardware/Software Versions→☜Exit Versions→Power **OFF**?

NOTE: Fault Logs will indicate which Motor/Motor Controller has the faulty Component/Connection

CAUSE A

Not Applicable

CAUSE B

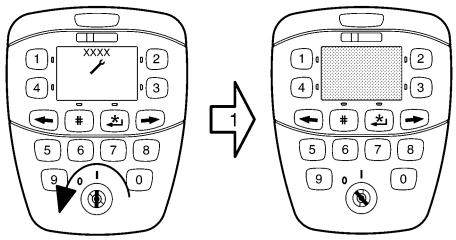
Not Applicable

CAUSE C

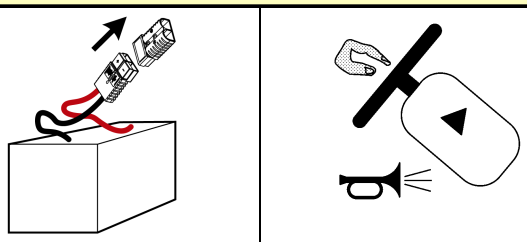
Not Applicable

CBB/DBB Motor Controller 15 – 5 Volt Internal Failure (Cont)

CAUSE D

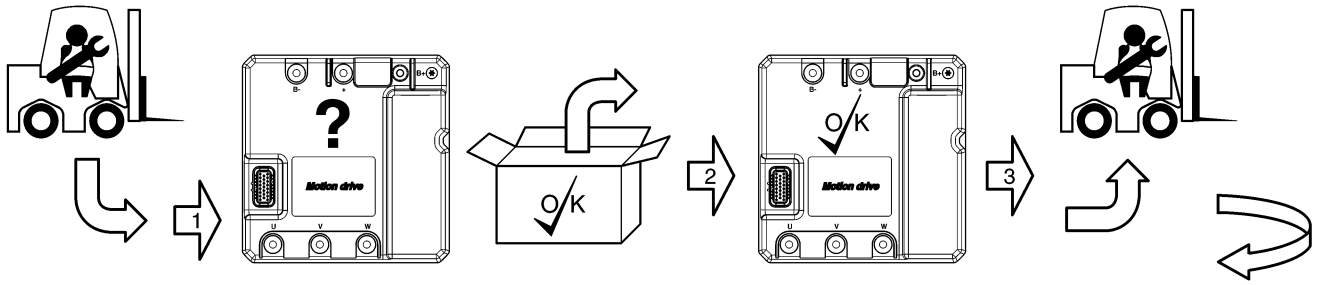


Power **OFF**→



Disconnect Battery and Sound Horn to Discharge Capacitors.Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342.

STEP D1

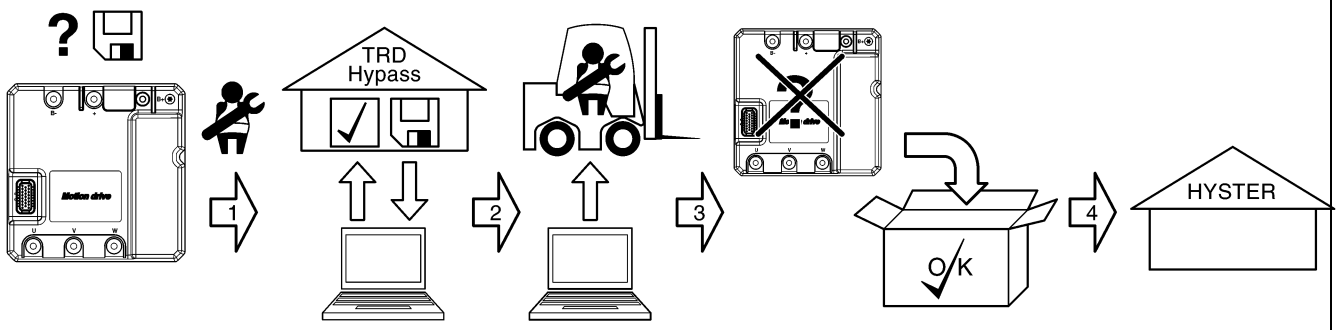


Remove and Replace Faulty Motor Controller↓

See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369↓

Check Replacement Controller 🖫 Version→See Label Information→Step 2↓

STEP D2



1. Go to TRD/Hypass Online /Software.?? Is Replacement Controller Application Software Version the Latest Version??

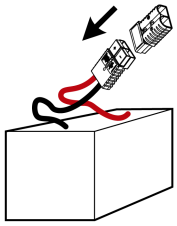
2. **NO**→Download the latest Application 🖫→Install on truck→Step 3↓

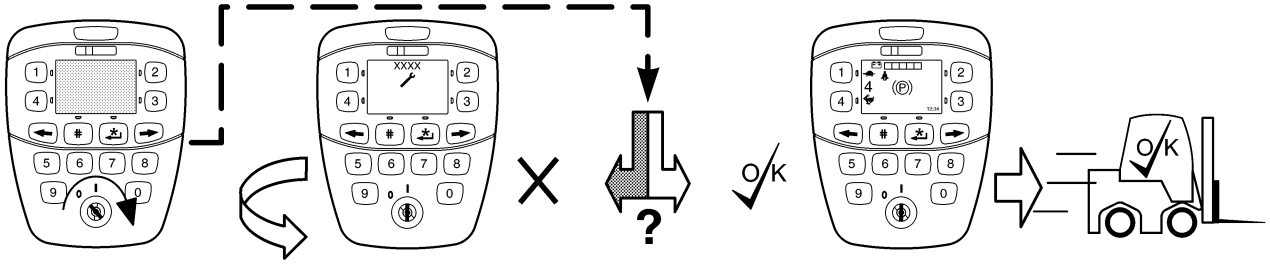
3. **YES**→Test New Installation→↓Step 3↓

4. Return Faulty Display→Dealer→Factory→Failure Analysis→?? Reprogramming

CBB/DBB Motor Controller 15 – 5 Volt Internal Failure (Cont)

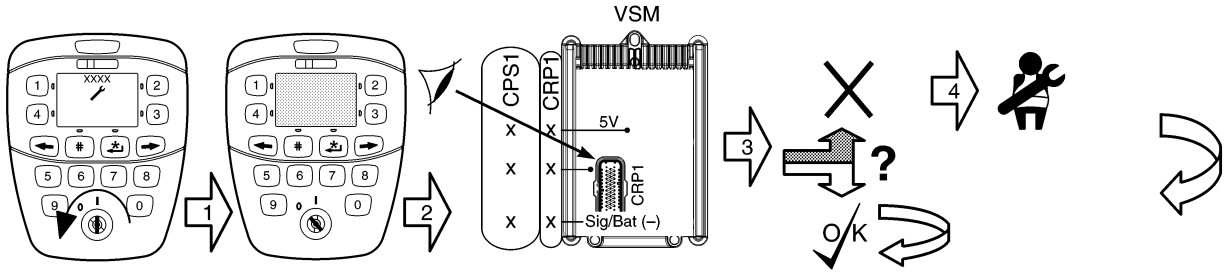
STEP D3





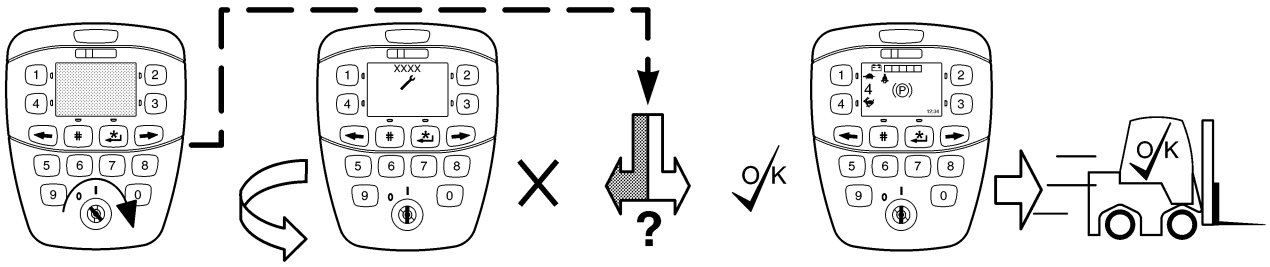
Retest - Power **ON**→	**NO**→?	Is fault DTC gone?**NO** **YES**←→	Fault corrected→Continue operation.

CAUSE E



Power **OFF**→	Inspect VSM Connections→OK Step 1	Not OK Correct/Repair→Step 1

STEP E1



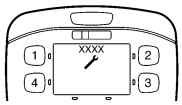
Retest - Power **ON**→	**NO**→Go to VSM Controller Check	Is fault DTC gone?**NO** **YES**←→	Fault corrected→Continue operation.

DTC LOGS: DTC logs should only be cleared once the data is by the Service Tech. See Display Menu Flowchart **- Clearing DTCs.**

END FAULT

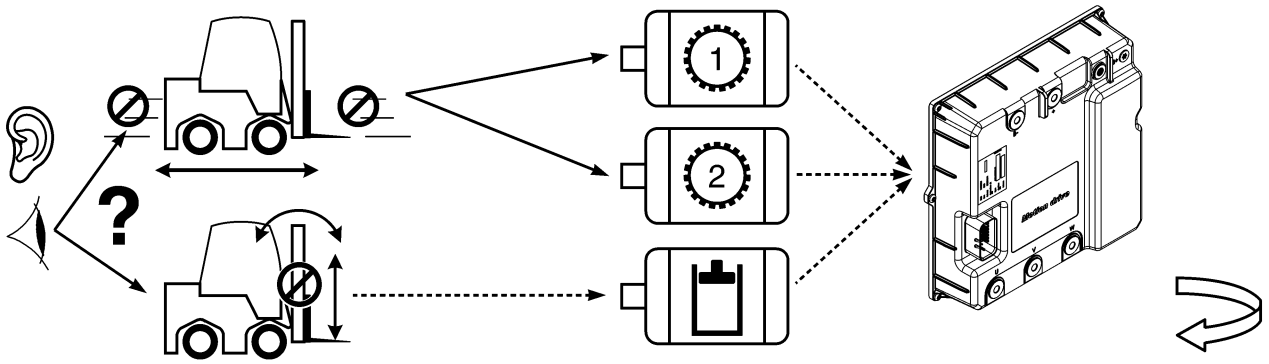
CBB/DBB Motor Controller DC Bus Low/High (Cont)

DTC 12576	DTC 12817	DTC 12818	DTC 12833
DC Bus Charging Timeout	DC Bus Hi – Software Detected	DC Bus Hi – Hardware Detected	DC Bus Low – Hardware/Software



QUICK CHECK X = Open Circuit/Fail) = Short Circuit

Check 1



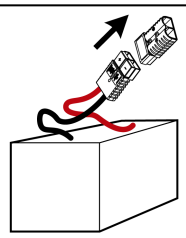
? No Operation ?

POSSIBLE CAUSES

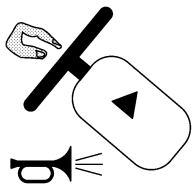
DTC 12576DC Bus Charging Timeout	Low Battery/High ® Connections→Go to 1, 2, and 3↓	→CAUSE 0↓
DTC 12817DC Bus Hi – Software Detected	Brake Torque Settings→Go to 4↓	→CAUSE B↓
DTC 12818DC Bus Hi – Hardware Detected	High ® Connections→Go to 3 and 4↓	→CAUSE 0/CAUSE B↓
DTC 12833DC Bus Low – Hardware/Software	High ® Connections→Go to 3↓	CAUSE A→↓

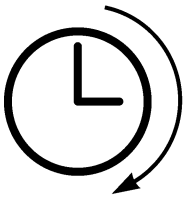
1. Go to OORL. See Battery OORH/OORL
2. PTC Failure?→
3. Motor/Motor Controller Battery Connections/Wiring – High ®/Contactor Contacts?→
4. Commanded Braking Torque (Regen) is set too High for Battery Condition

Check 2

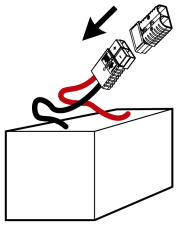


Disconnect Battery and Sound Horn to Discharge Capacitors.Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342.

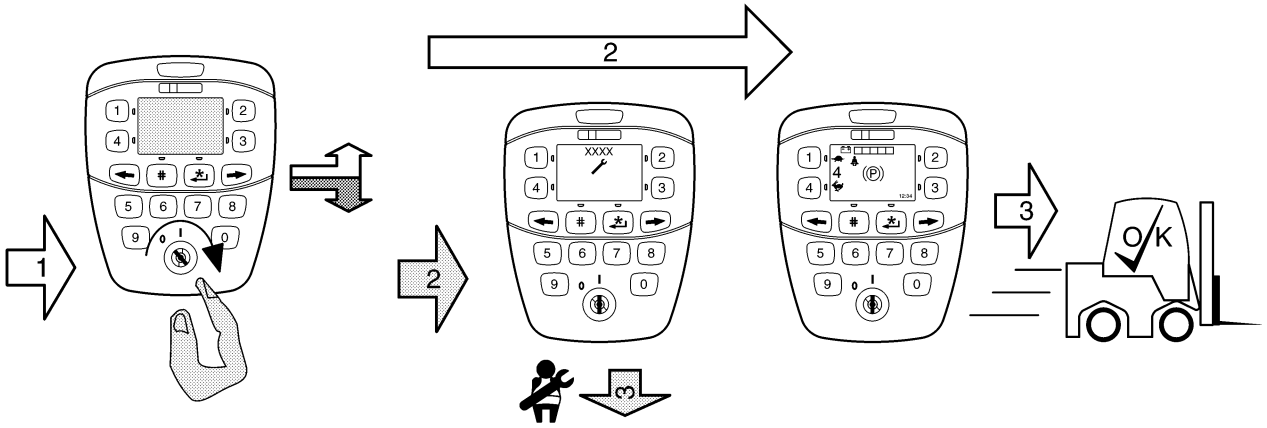
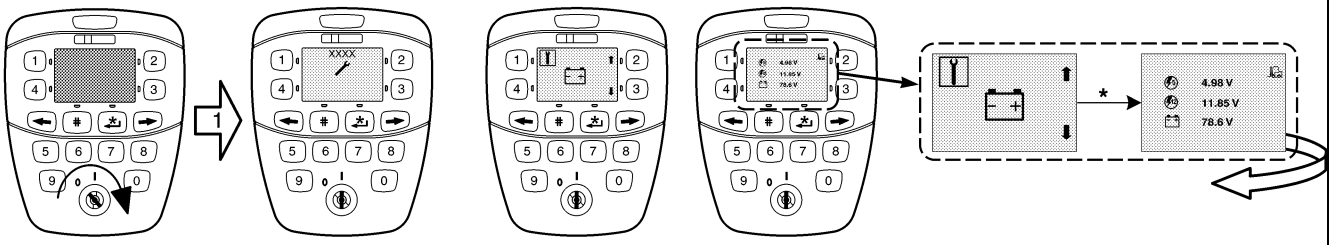




Wait 30 seconds



Reconnect Battery

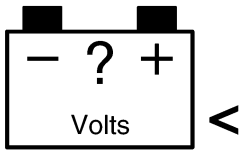
CBB/DBB Motor Controller DC Bus Low/High (Cont)		
Check 3		
		
Power **ON**→	Fault Remains Service Required ?	No Fault→Resume Operation
Check 4		
		
Power ON→Go to Diagnostics→Battery/Supply→View Bat Value→Go to Display Menu Flowchart↓		

CBB/DBB Motor Controller DC Bus Low/High (Cont)

Check 5

Battery OORL/OORH as measured by the Motor Controllers

NOTE: OOR fault is set if OOR condition is present for longer than 1 second.
NOTE: Both Motor control and VSM OOR faults may appear due to the different thresholds levels



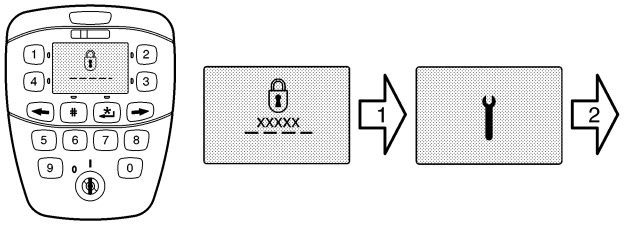
<

Battery Voltage					
Nominal	36	48	72	80	
Fully Charged	39.6	52.8	79.2	88	
˜< OORL	23	30	41	48	
˜ OORH	50	65	99	110	

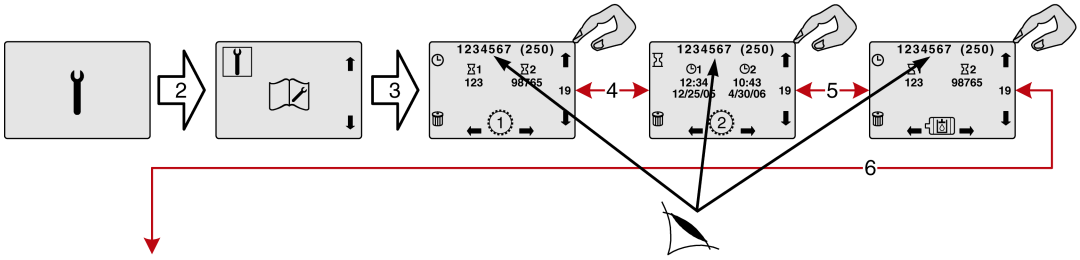
Is battery voltage ˜ < OORL value for correct battery?↓
YES →Battery OORH/OORL→Return to this Fault after Battery OORH/OORL/Retest is complete.?
NO→Check 6?

CBB/DBB Motor Controller DC Bus Low/High (Cont)

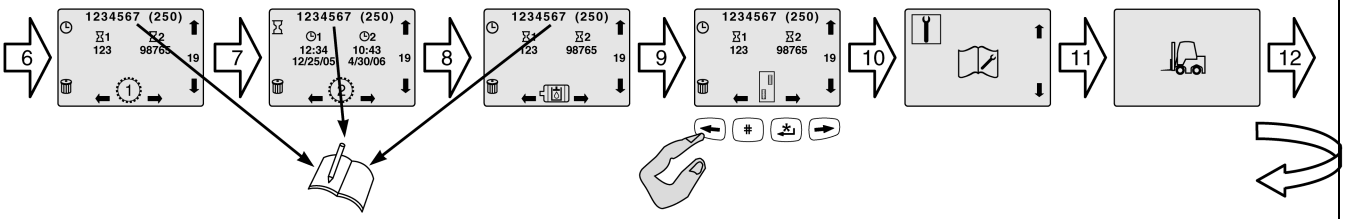
FAULT LOG Review - Go to Display Menu



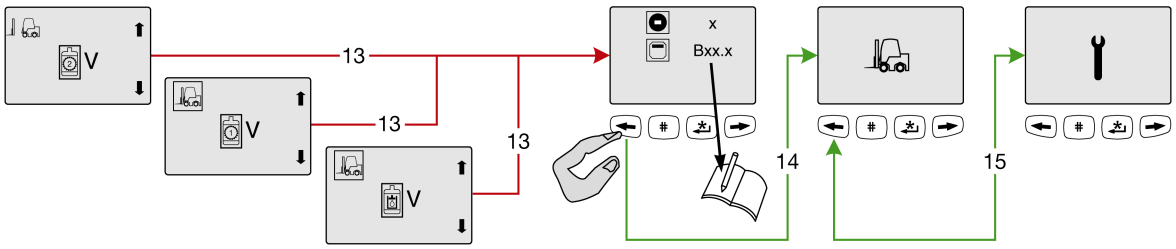
Enter Service Password→ | Diagnostics→



Diagnostic→FAULT LOGs→Motor Fault Log(s)→View all Motor DTCs→?



all Motor DTCs→Exit Fault Log→Truck Status ?



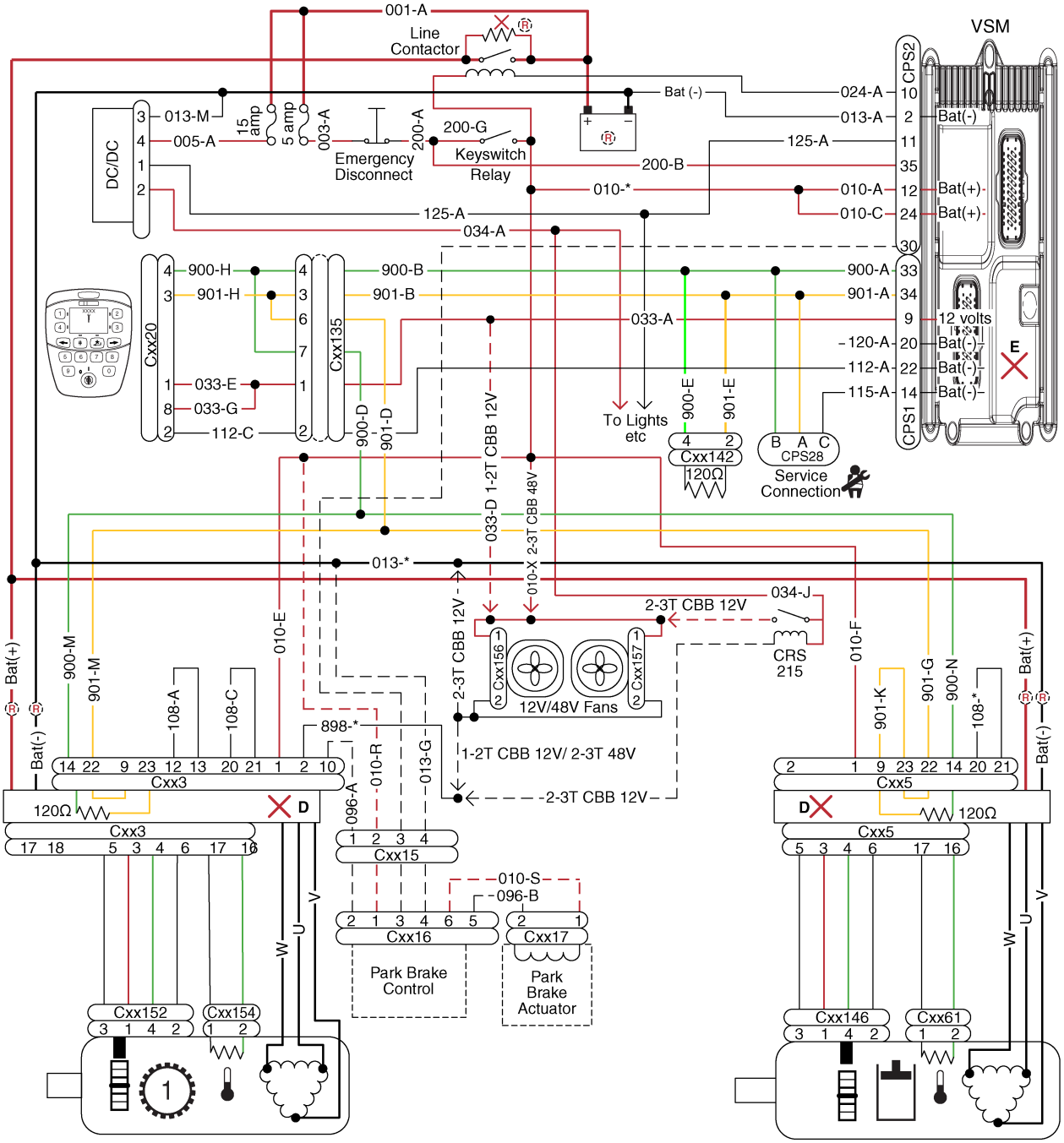
Motor Versions→Hardware/Software Versions→Exit Versions→Status→Truck Diagnostics*↓

POSSIBLE CAUSES X = Open Circuit/Fail) = Short Circuit

1.5 – 2.0 CBB SCHEMATIC CAUSES A B C D E > ?

CBB/DBB Motor Controller DC Bus Low/High (Cont)

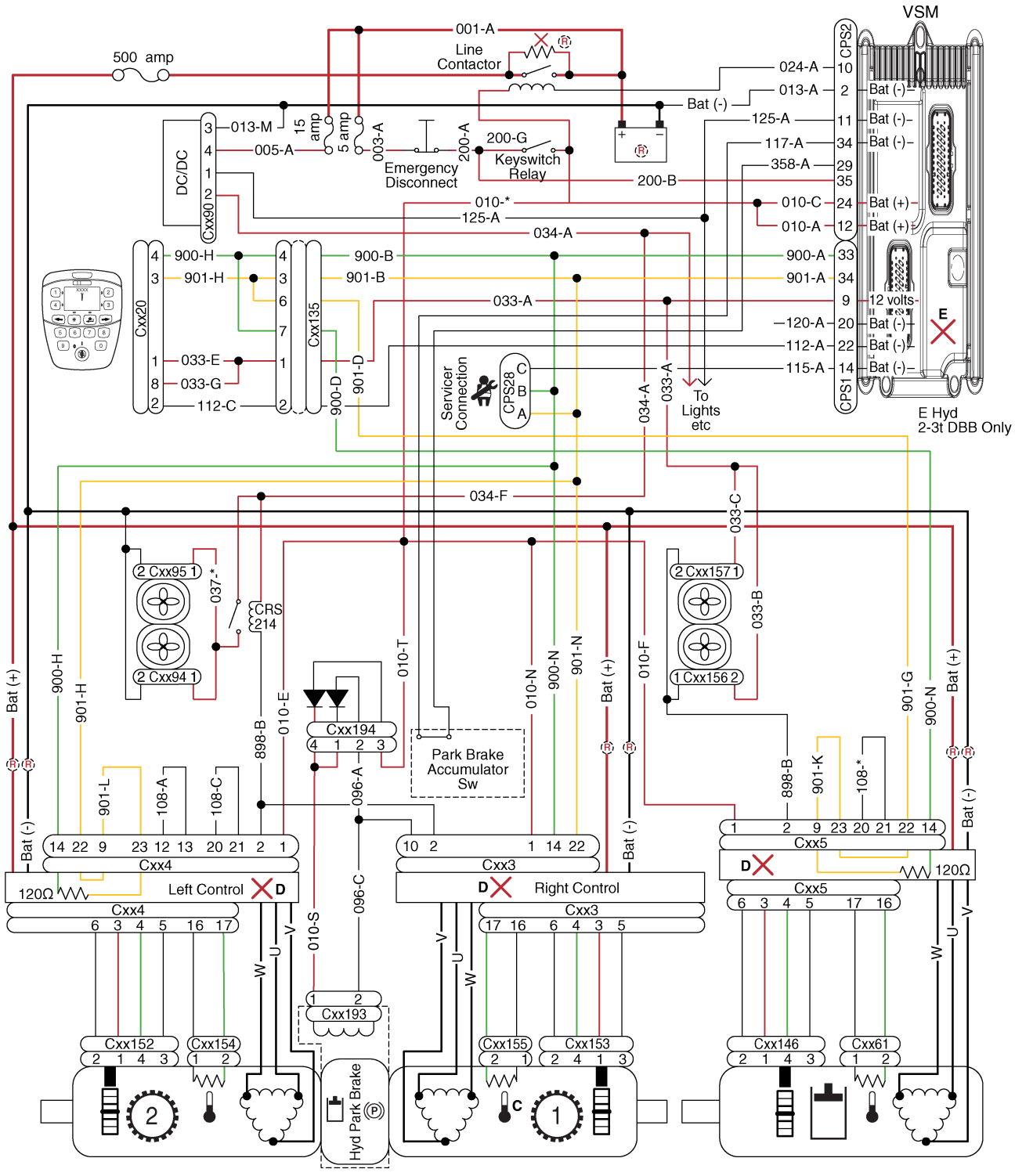
® = High Resistance Connections



2.2 – 3.0 DBB SCHEMATIC CAUSES A B C D E > ?

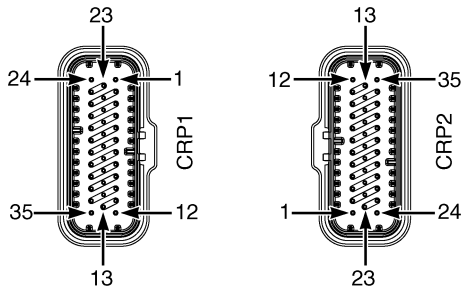
CBB/DBB Motor Controller DC Bus Low/High (Cont)

® = High Resistance Connections

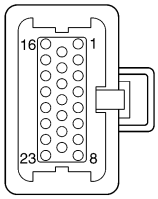


CBB/DBB Motor Controller DC Bus Low/High (Cont)

CONNECTORS

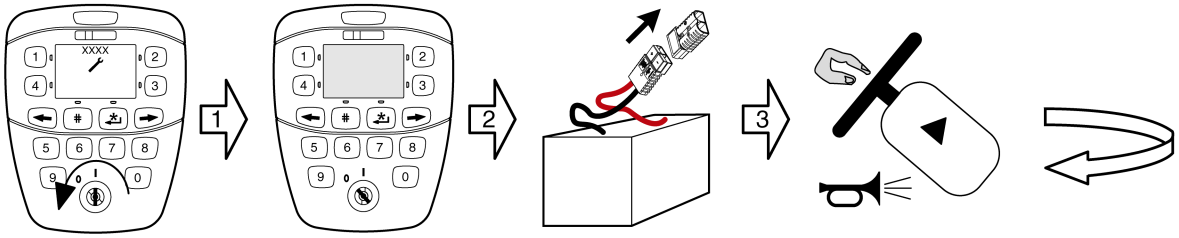


VSM Cxx 1 and Cxx 2



Traction/Pump Controller Cxx 3, 4, and 5

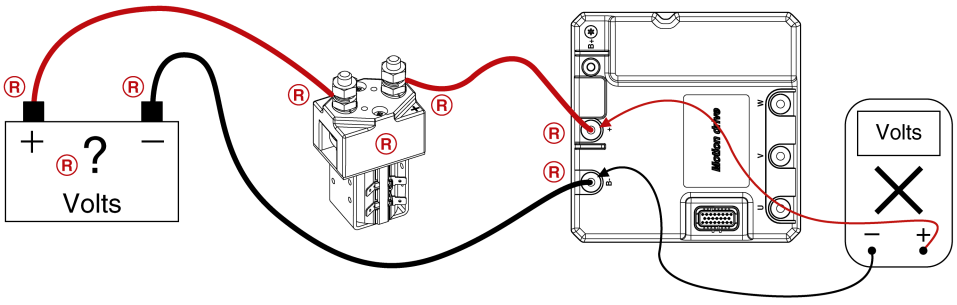
CAUSE A



Power **OFF**→	Disconnect Battery and Sound Horn to Discharge Capacitors.→Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342→.	?

STEP A1

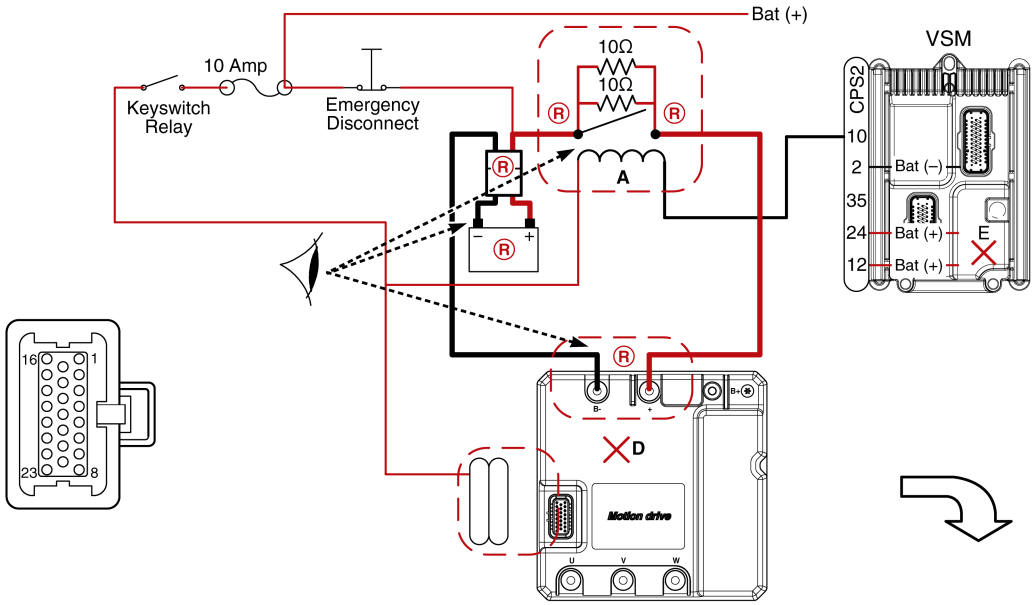
NOTE: ®Battery or Battery to Motor Controller Power Connections→all DTC Faults are possible
NOTE: High Current drawn from the battery through ® = Voltage drops = OORL
NOTE: High Current sent to the battery through ® = Voltage increases = OORH



CBB/DBB Motor Controller DC Bus Low/High (Cont)

STEP A2

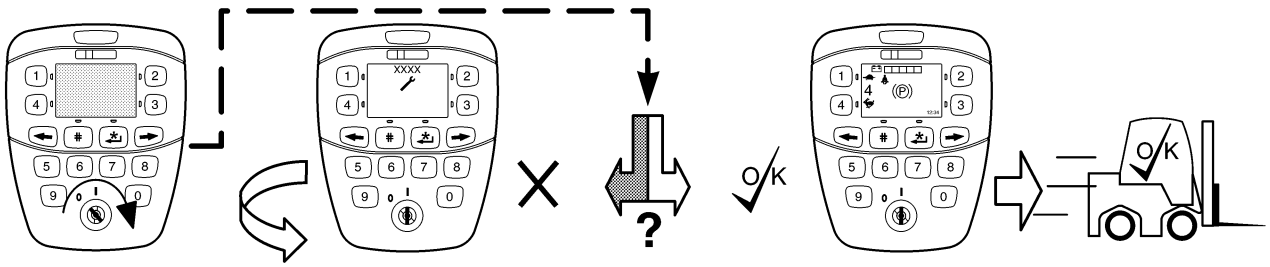
For any Fault DTCs→Locate Devices→Inspect ALL Wiring/Connections



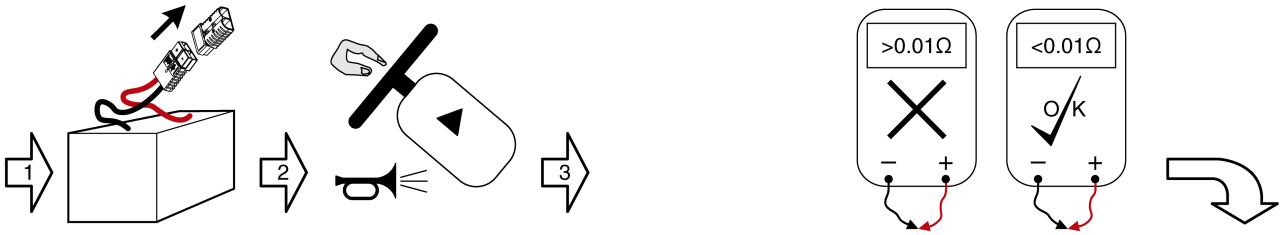
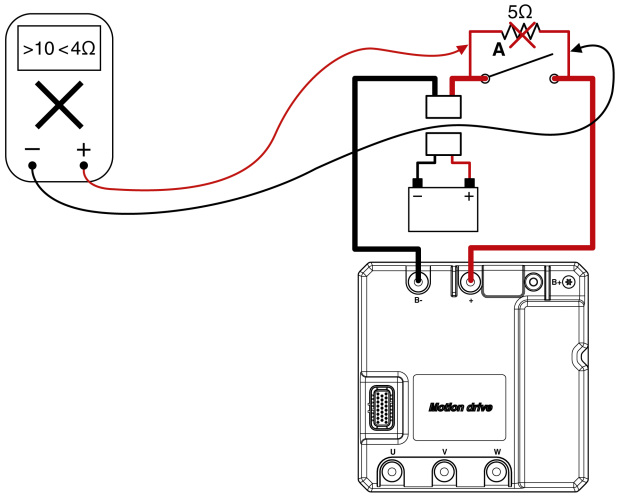
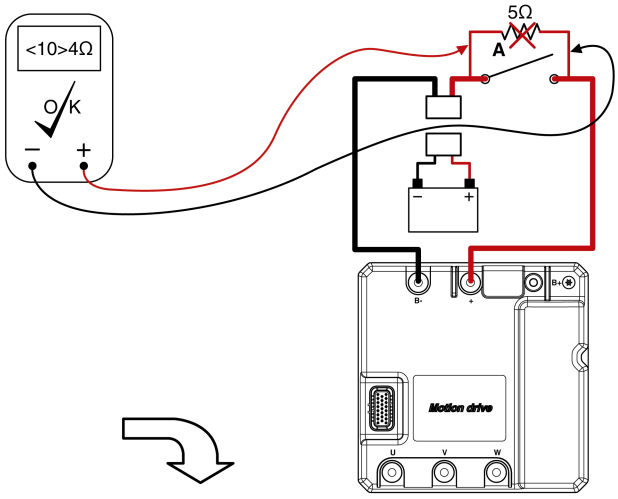
STEP A3

1. Inspect Contactor Top and Bottom Contacts for Pitting/Corrosion/Dirt Build-Up→Go to 2↓
2. Replace Contactor if Pitting/Corrosion is Observed/ Clean out any Dirt Build up↓
3. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→Go to 4↓
4. Check all Connections→Reconnect Battery→Step 4↓

STEP A4

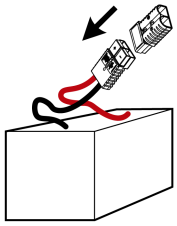


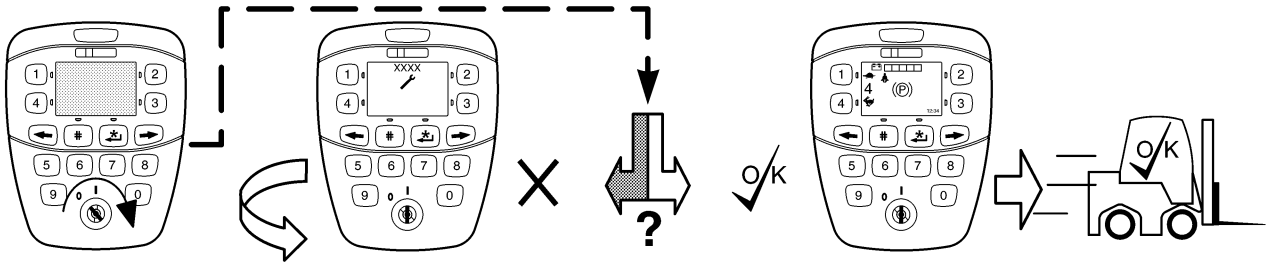
Retest - Power **ON**→	**NO**→?	Is fault DTC gone?**NO** **YES**←→	Fault corrected→Continue operation.

CBB/DBB Motor Controller DC Bus Low/High (Cont)	
STEP A5	
	
Disconnect Battery and Sound Horn to Discharge Capacitors.→Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342→.?	
Set DMM to Lowest ? scale→Check Lead Resistance < 0.01?	
Note: If the Resistance is > 0.01? then record this as the Zero ? Value→Step 6↓	
STEP A6	**CHECK RESISTANCE - Ω - OHMS**
PTC Failure	
	
1. >10 ? @ 25 °C (77 °F) = Faulty PTC→Go to 2↓	1. <10 ? >4 ? = OK→Go to 2↓
2. Replace PTC(s)→Go to 3↓	
3. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→Go to 4↓	
4. Recheck ?↑→ Reconnect→Step 7↓	

CBB/DBB Motor Controller DC Bus Low/High (Cont)

STEP A7

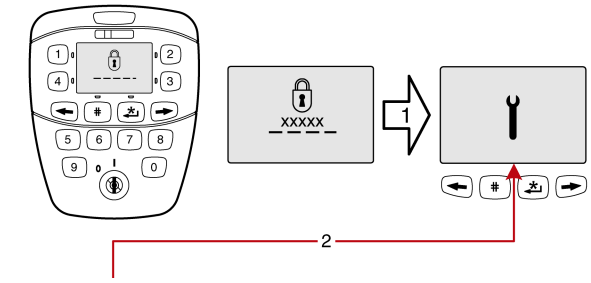




Retest - Power **ON**→	**NO**→?	Is fault DTC gone?**NO** **YES**←→	Fault corrected→Continue operation.

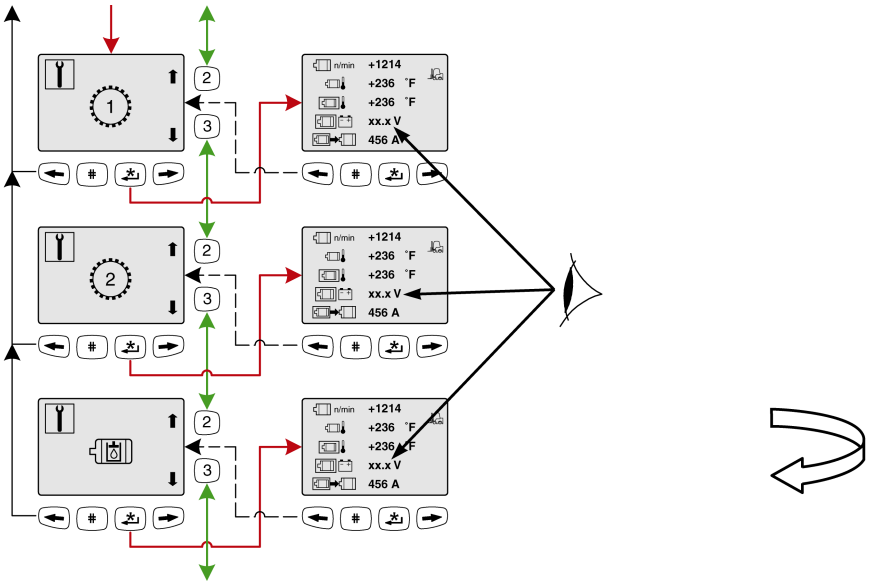
CBB/DBB Motor Controller DC Bus Low/High (Cont)

CAUSE B



Enter SERVICE Password→Diagnostics↓

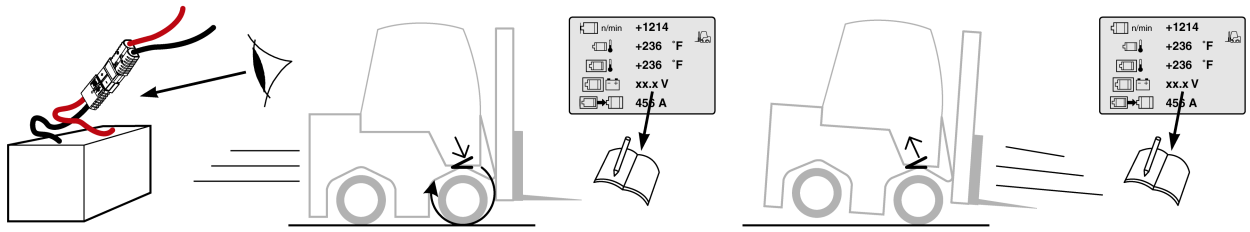
STEP B1



Scroll ↑↓Indicated Motor with Fault DTC ☞*→View Voltage→📋✍ Voltage↓

CBB/DBB Motor Controller DC Bus Low/High (Cont)

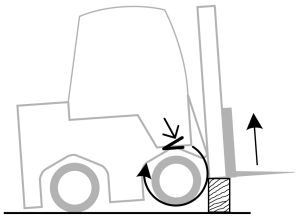
STEP B2



Battery Voltage				
Nominal	36	48	72	80
Fully Charged	39.6	52.8	79.2	88
˜ < OORL	23	30	41	48
˜ > OORH	50	65	99	110

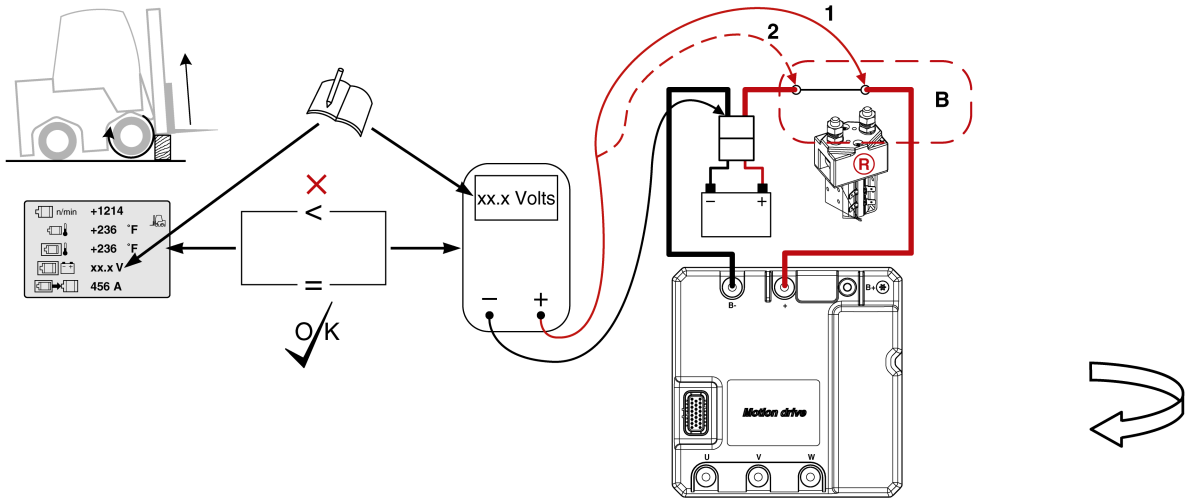
1. Ensure that the Battery has been fully charged→Check Battery connections are clean and secure.
2 Operate Truck with Maximum Acceleration in Forward Direction→ Maximum Voltage
3. Completely release acceleration pedal→Regen Braking Only→ Maximum Voltage
4. Do Minimum and Maximum Voltages exceed the OORL or OORH thresholds?
5. YES →Step 3NO→Resume Operation

STEP B3



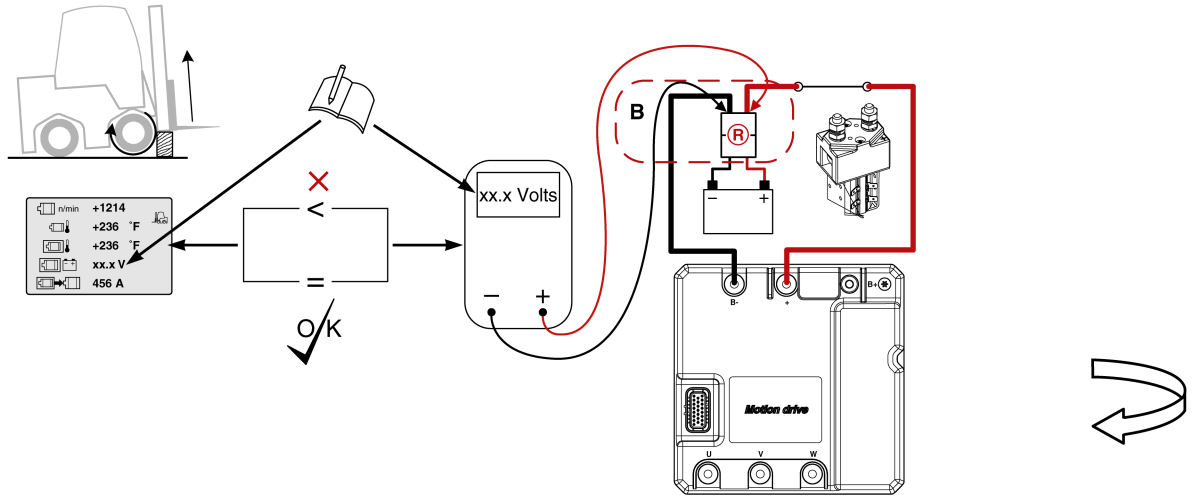
1. Elevate Truck drive wheels.**Use only approved support methodsSee Operating Manual**
2. All Hydraulic Functions need to be free to be operated.

CBB/DBB Motor Controller DC Bus Low/High (Cont)	
STEP B4	**CHECK VOLTAGE**



1. Connect DMM→Position 1→Measure Battery Volts at the Contactor terminals→ Value↓
2. Operate Traction and Hoist Hydraulics against Relief Valve→ DMM/Display Volts→Compare→Go to 2a↓
2a. Display Volts < DMM Volts < Controller Minimum?→® Connections→Go to 4↓
2b. Display Volts = DMM Volts > Controller Minimum?→Change DMM to Position 2→Repeat Step2?↑
3. Operate Traction and Hoist Hydraulics against Relief Valve→ DMM/Display Volts→Compare→Go to 3a↓
3a. Display Volts < DMM Volts < Controller Minimum?→® Contactor Contacts→Go to 4↓
3b. Display Volts = DMM Volts > Controller Minimum?→Go to 4?↓
4. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→Go to 5?↓
5. Recheck Volts↑→Test Truck→ DTC Faults? YES→Step 3↓ NO → Resume Operation→

CBB/DBB Motor Controller DC Bus Low/High (Cont)	
STEP B5	**CHECK VOLTAGE**



1. Connect DMM→Measure Battery Volts at the Connector terminals→ Value↓

2. Operate Traction and Hoist Hydraulics against Relief Valve→ DMM/Display Volts→Compare→Go to 2a↓

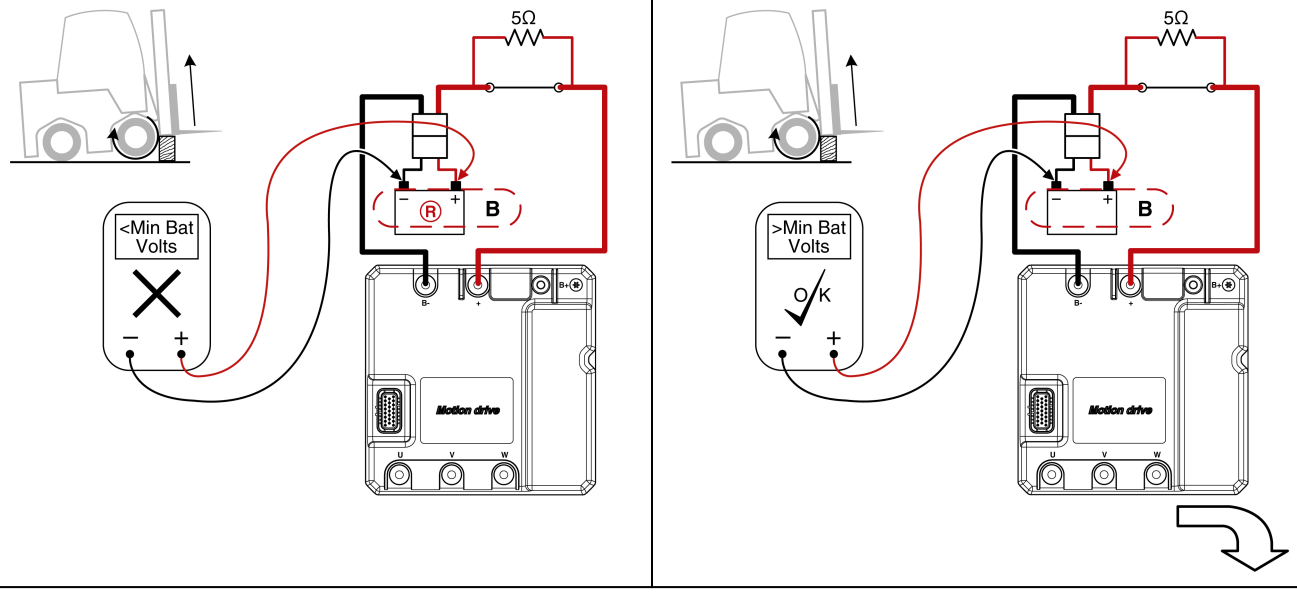
2a. Display Volts < DMM Volts < Controller Minimum?→® Connections→Go to 3↓

2b. Display Volts = DMM Volts > Controller Minimum?→Go to 3↓

3. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→Go to 4↓

4. Recheck Volts↑→Test Truck→
DTC Faults? YES→Step 6↓
NO → Resume Operation→

CBB/DBB Motor Controller DC Bus Low/High (Cont)	
STEP B6	**CHECK VOLTAGE**



1. Connect DMM as shown→Measure Battery Volts at the Battery terminals→ Value↓
2. Operate Truck Traction and Hoist Hydraulics against Relief Valve→ Lowest Battery Voltage→Compare→Go to 3↓
3. Battery Voltage < Controller Minimum?↓
4. YES Battery internal Resistance is too high→Battery Maintenance check/Replace Battery(s)→Go to 6↓
5. NO →CAUSE C↓
3. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→Go to 7↓
4. Recheck Volts↑→Test Truck→ DTC Faults? YES→CAUSE B↓ NO → Resume Operation→

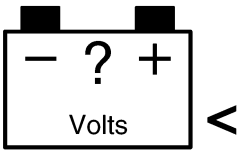
CBB/DBB Motor Controller DC Bus Low/High (Cont)

CAUSE C

Battery OORL/OORH as measured by the Motor Controllers

NOTE: OOR DTC is set if OOR condition is present for longer than 1 second.

NOTE: Both Motor control and VSM OOR DTCs may appear due to the different thresholds levels



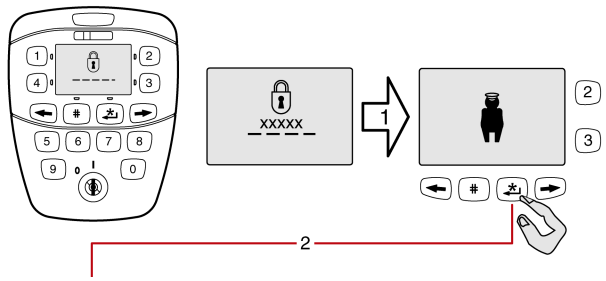
<

Battery Voltage				
Nominal	36	48	72	80
Fully Charged	39.6	52.8	79.2	88
˜ < OORL	23	30	41	48
˜ > OORH	50	65	99	110

An OORH DTC can occur if the Regen braking setting is too high

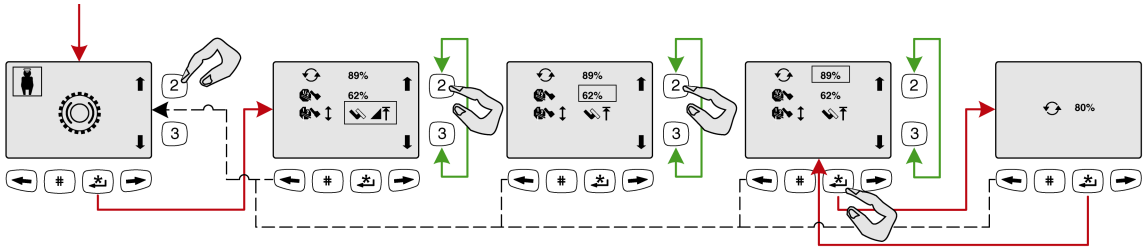
STEP C1

REGEN BRAKE SETTING Step 3 – Step 6 must be completed before making adjusted.



Enter Service Password→Truck Setup→☞*→Scroll to Braking Setup↑↓

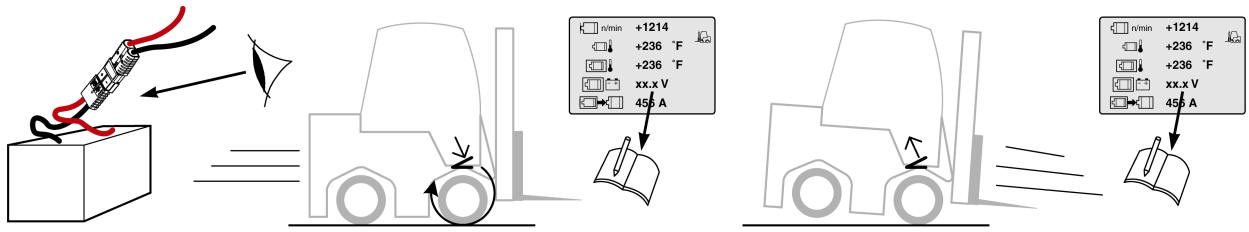
Braking Setup



☞*→Scroll to Regen Function↑↓☞* To Select→Enter Lower Value Using Number Buttons ☞*

CBB/DBB Motor Controller DC Bus Low/High (Cont)

STEP C2

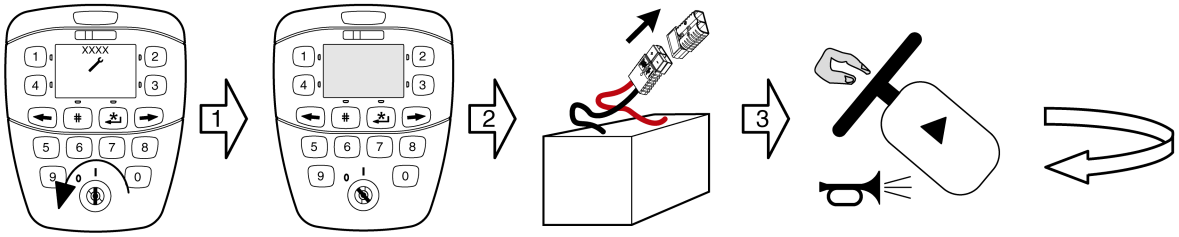


Battery Voltage				
Nominal	36	48	72	80
Fully Charged	39.6	52.8	79.2	88
˜ < OORL	23	30	41	48
˜ > OORH	50	65	99	110

1. Ensure that the Battery has been fully charged→Check Battery connections are clean and secure.
2 Operate Truck with Maximum Acceleration in Forward Direction→ Maximum Voltage
3. Completely release acceleration pedal→Regen Braking Only→ Maximum Voltage
4. Do Maximum Voltages exceed the OORH thresholds?
5. Yes→Repeat Step 1 until no fault exist.↑NO→Resume Operation

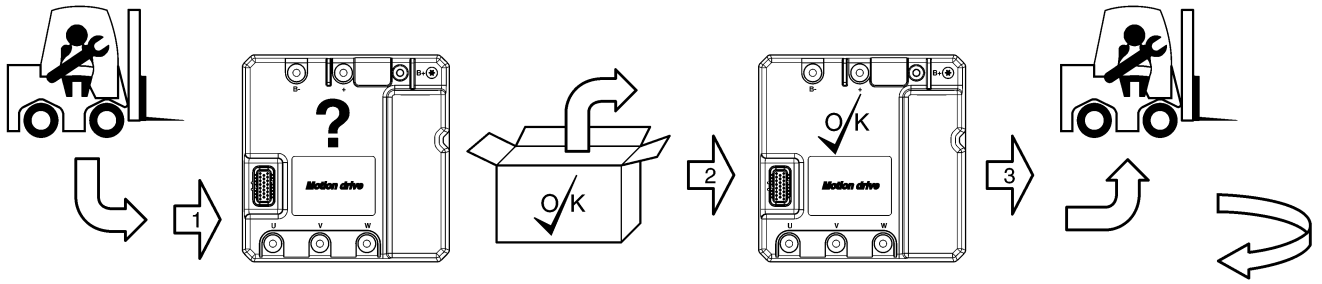
CBB/DBB Motor Controller DC Bus Low/High (Cont)

CAUSE D



Power **OFF**→	Disconnect Battery and Sound Horn to Discharge Capacitors.→Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342→.	?

STEP D1

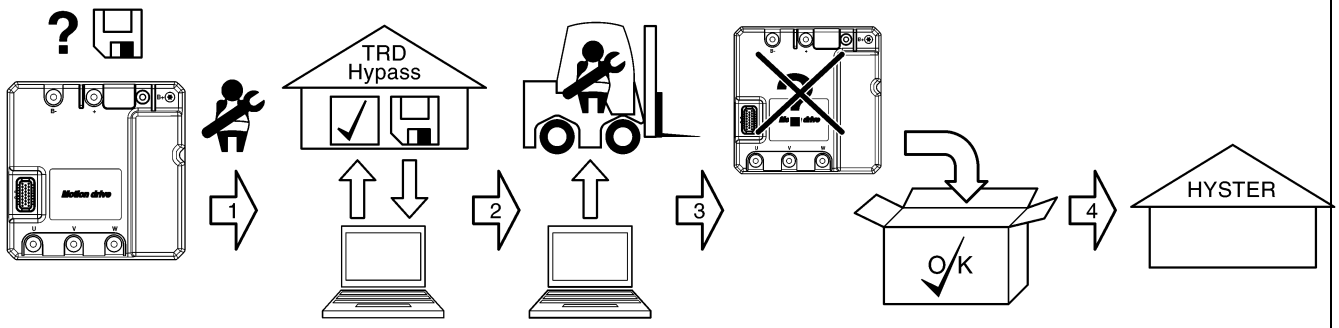


Remove and Replace Faulty Motor Controller↓

See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369↓

Check Replacement Controller 🖫 Version→See Label Information→Step 2↓

STEP D2



1. Go to TRD/Hypass Online /Software.?? Is Replacement Controller Application Software Version the Latest Version??

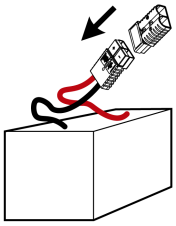
2. **NO**→Download the latest Application 🖫→Install on truck→Step 3↓

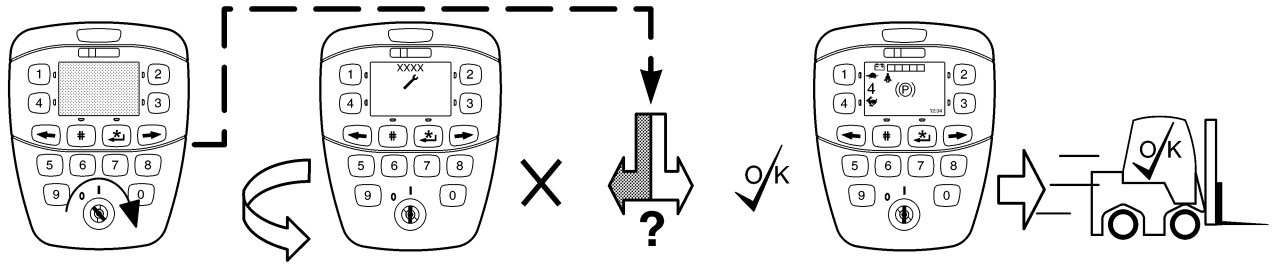
3. **YES**→Test New Installation→↓Step 3↓

4. Return Faulty Display→Dealer→Factory→Failure Analysis→?? Reprogramming

CBB/DBB Motor Controller DC Bus Low/High (Cont)

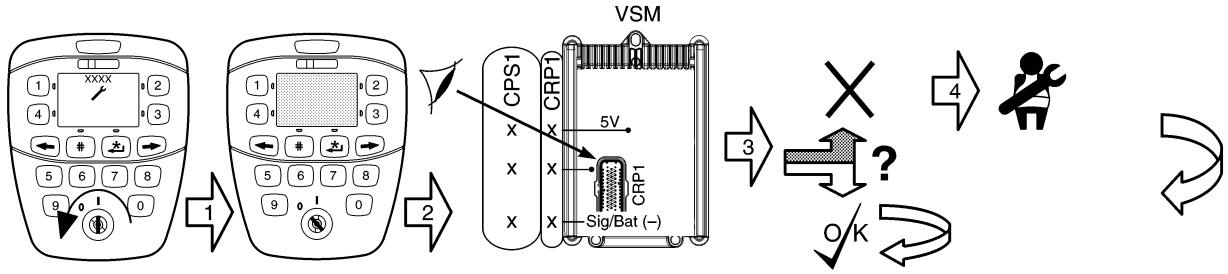
STEP D3





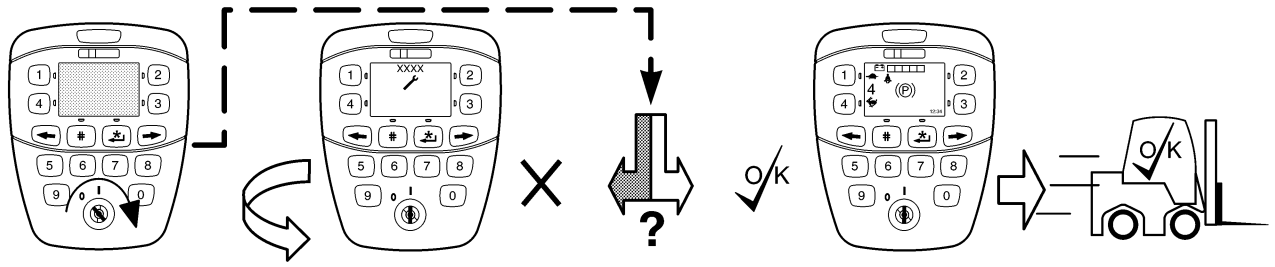
Retest - Power **ON**→	**NO**→?	Is fault DTC gone?**NO** **YES**←→	Fault corrected→Continue operation.

CAUSE E



Power **OFF**→	Inspect VSM Connections→OK Step 1	Not OK Correct/Repair→Step 1

STEP E1

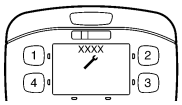


Retest - Power **ON**→	**NO**→Go to VSM Controller Check	Is fault DTC gone?**NO** **YES**←→	Fault corrected→Continue operation.

DTC LOGS: DTC logs should only be cleared once the data is by the Service Tech. See Display Menu Flowchart **- Clearing DTCs.**

END FAULT

CBB/DBB Traction Controller Driver Current High (Cont)



DTC 21520 **DTC 25106**
Aux Driver Current High **Park Brake Solenoid and Fan Driver Current High**

QUICK CHECK X = Open Circuit/Fail) = Short Circuit

It is recommended that the Display or PC Service Tool diagnostics be used as much as possible to determine the potential Motor. Motor Controller failure before starting as analysis using the CAUSE procedures,

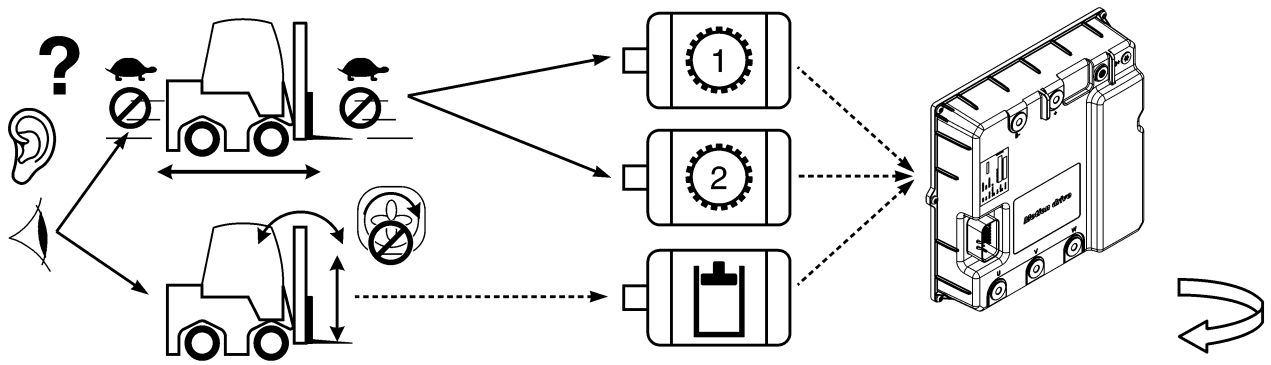
CBB Motor Controller Access requires Battery removal

CBB Auto Brake Access requires Battery removal

DBB Motor Controller Connector Access is very difficult. Use a Break-Out Harness kit

DBB/CBB Motor Controller Component Access requires Battery removal

Check 1



POSSIBLE SYMPTOMS

No/ Reduced Traction - Auto Brake Does not Release/Fan(s) do not Operate at Key **ON**

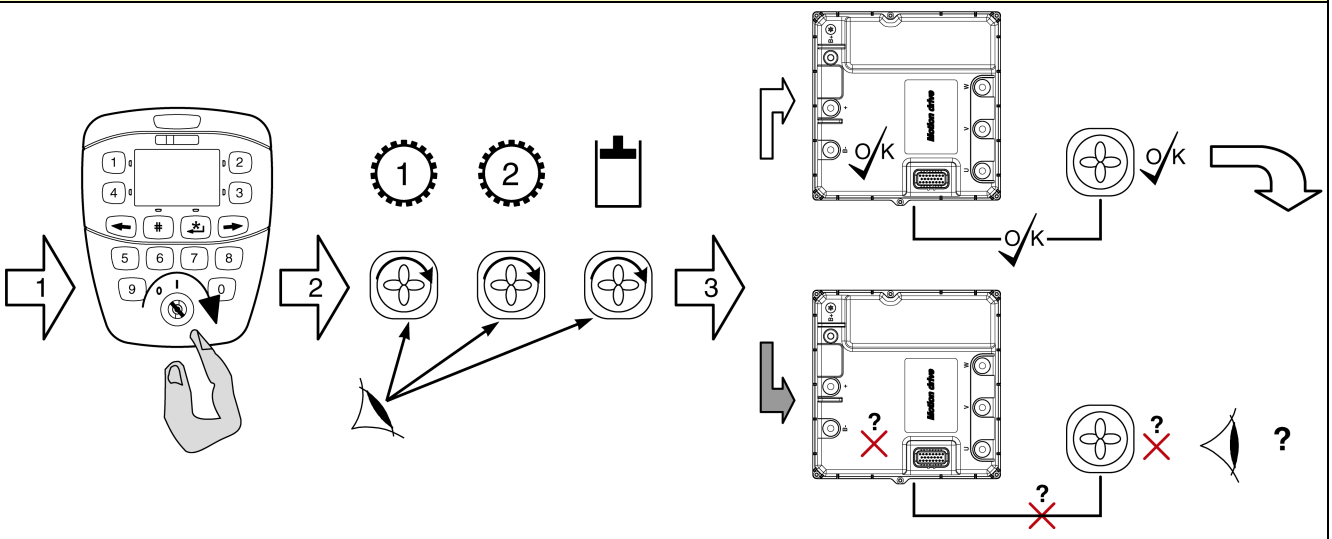
POSSIBLE CAUSES

DTC 21520	Aux Driver Short to Bat (+)	> 1 amp driver current	→CAUSE 0↓
DTC 21520	Brake Coil (DBB)/Fan Short Circuit	> 1 amp driver current	→CAUSE 0/CAUSE B↓
DTC 25106	Park Brake Coil	> 1 amp driver current	→CAUSE 0↓
DTC 25106	Cooling Fan	> 1 amp driver current	→CAUSE B↓
Motor Controller(s) Failure ?→		Driver Failure	→CAUSE C↓

Also see, Observed Symptom - Auto Brake Does not Release/Fan(s) do Not Operate at Key **ON**

CBB/DBB Traction Controller Driver Current High (Cont)

Check 2

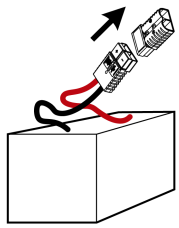


Power **ON**→

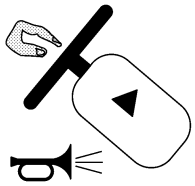
YES→Go to Check 3 →CAUSE 0↓

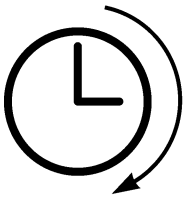
NO→Observed Symptoms - Fans do Not Operate→CAUSE B↓

Check 3

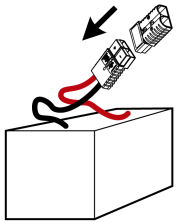


Disconnect Battery and Sound Horn to Discharge Capacitors.Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342.



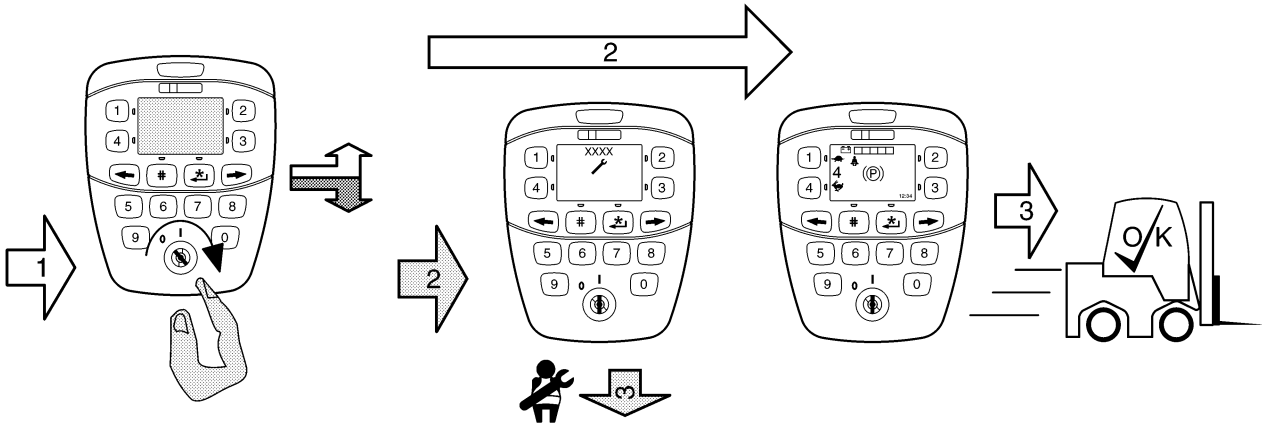


Wait 30 seconds



Reconnect Battery

Check 4

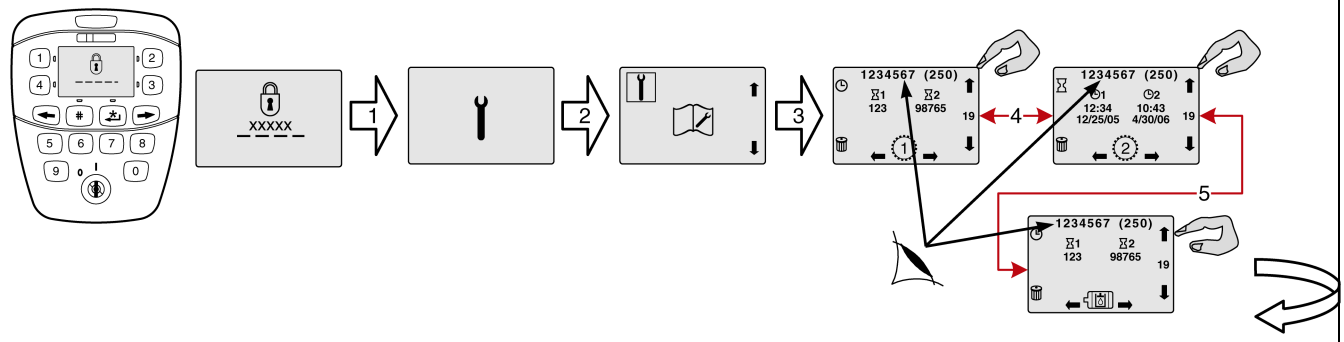


Power **ON**→	Fault Remains Service Required ?	No Fault→Resume Operation

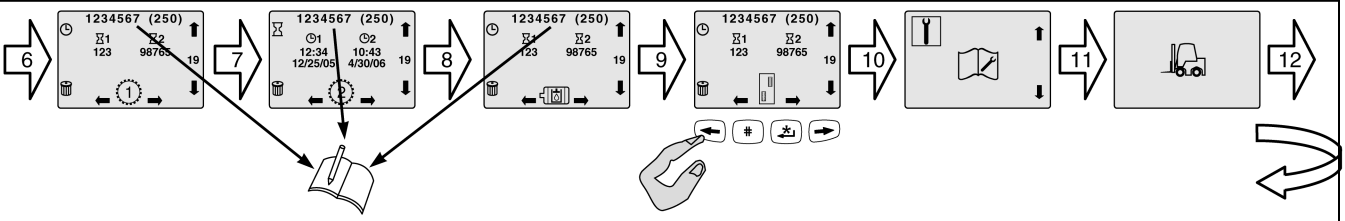
CBB/DBB Traction Controller Driver Current High (Cont)

Check 5

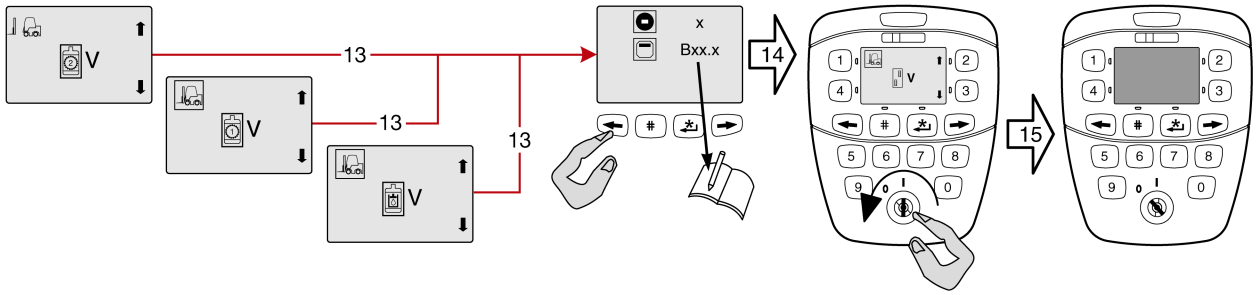
FAULT LOG Review - Go to Display Menu



Enter Service Password→Diagnostic→FAULT LOGs→Motor Fault Log(s)→View all Motor DTCs→?



📋✍ all Motor DTCs→☜Exit Fault Log→Truck Status ?



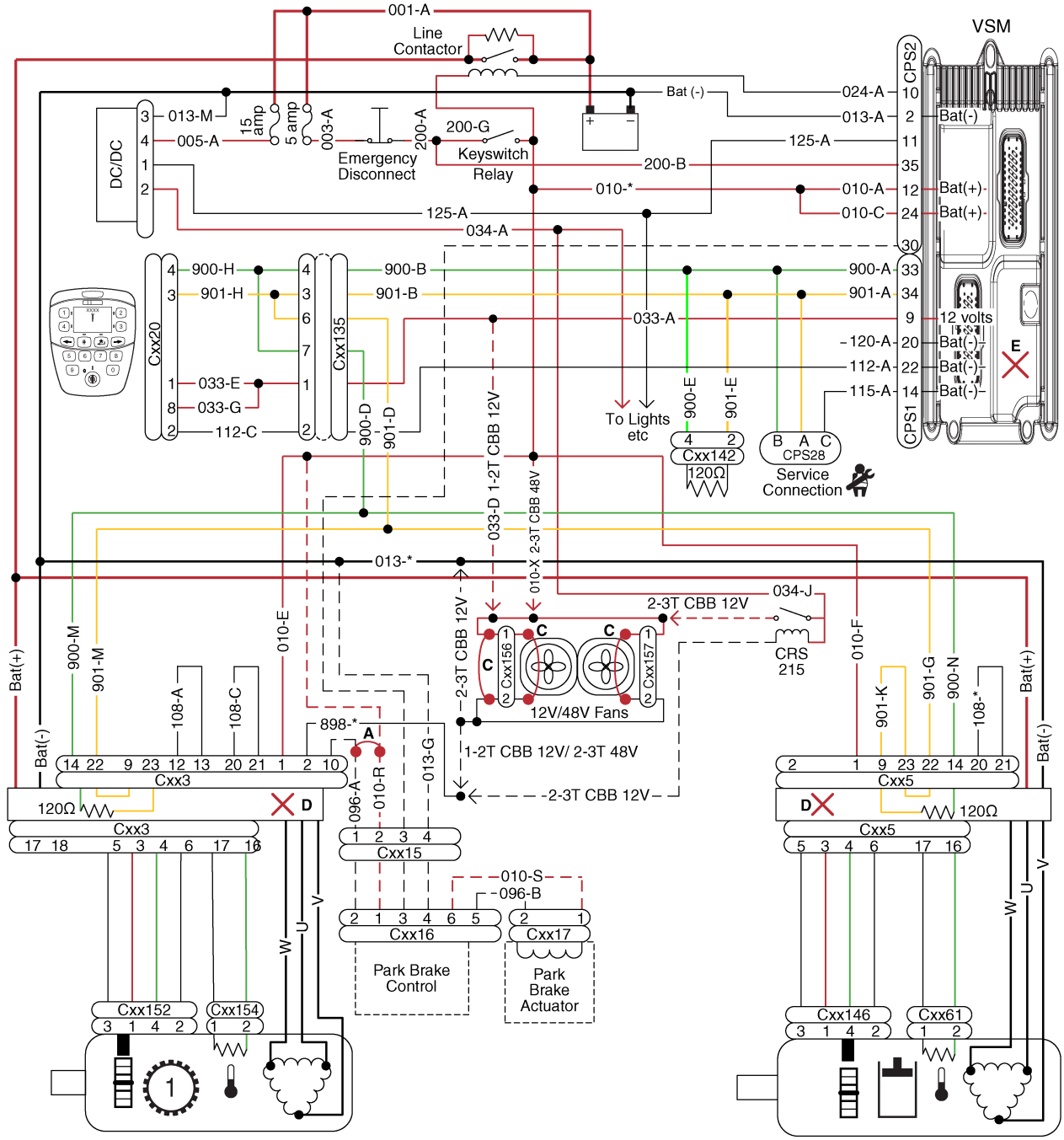
Motor Versions→📋✍Hardware/Software Versions→☜Exit Versions→Power **OFF**?

NOTE: Fault Logs will indicate which Motor/Motor Controller has the faulty Component/Connection

POSSIBLE CAUSES X = Open Circuit/Fail) = Short Circuit

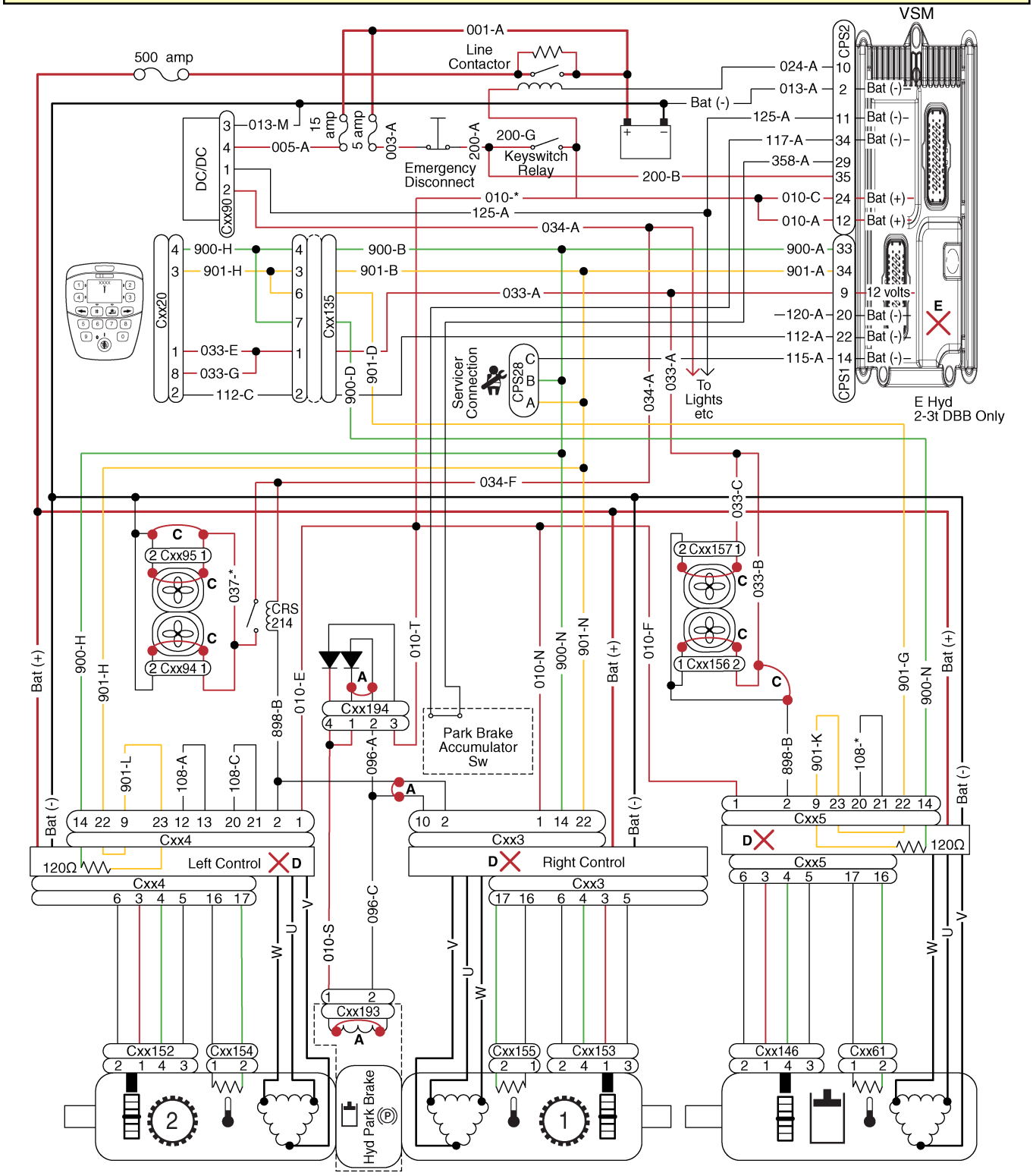
CBB/DBB Traction Controller Driver Current High (Cont)

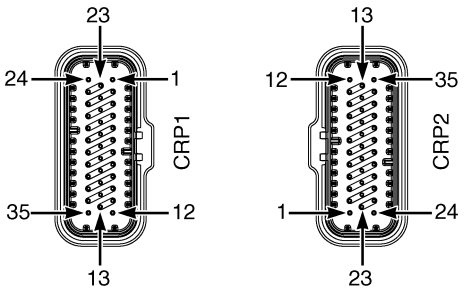
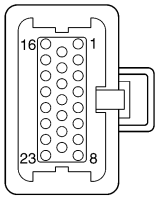
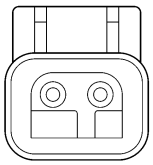
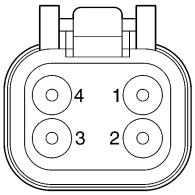
1.5 – 2.0 CBB SCHEMATIC CAUSES A B C D E > ?



CBB/DBB Traction Controller Driver Current High (Cont)

2.2 – 3.0 DBB SCHEMATIC CAUSES A B C D E > ?

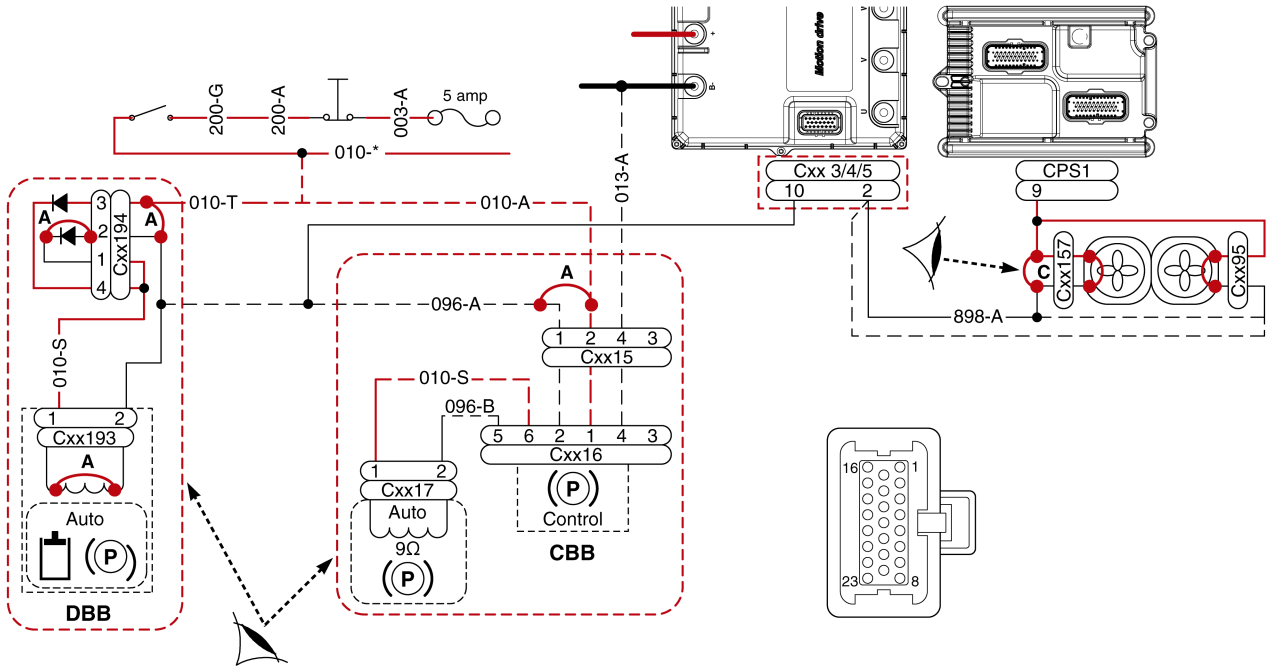


CBB/DBB Traction Controller Driver Current High (Cont)		
CONNECTORS		
		
VSM Cxx 1 and Cxx 2	Traction/Pump Controller Cxx 3, 4, and 5	Fan Connector Cxx 94, 95, 156, and 153
		
Auto Brake Motor Connector Cxx 15, 16, 17, 193, and 194		

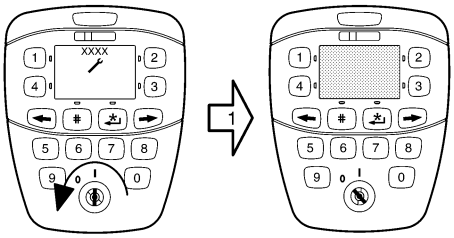
CBB/DBB Traction Controller Driver Current High (Cont)

CAUSE A

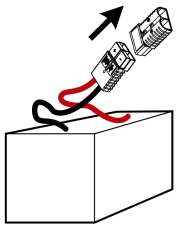
For any Fault DTC→Locate Device→Inspect ALL Wiring/Connections→

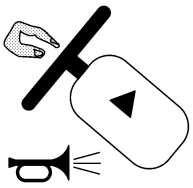


STEP A1

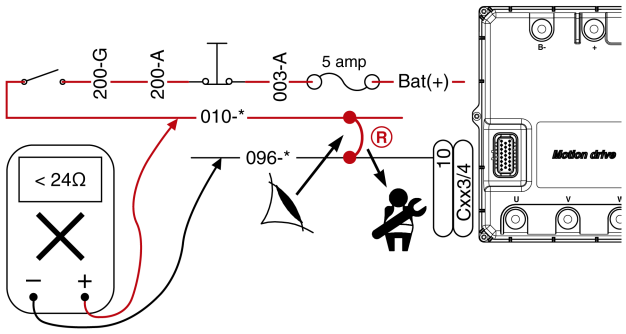
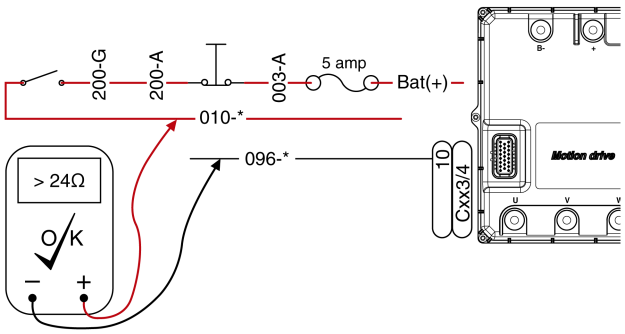
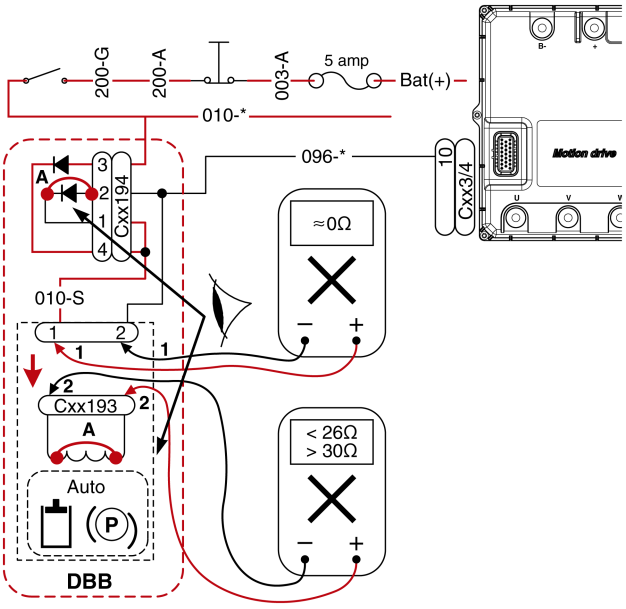
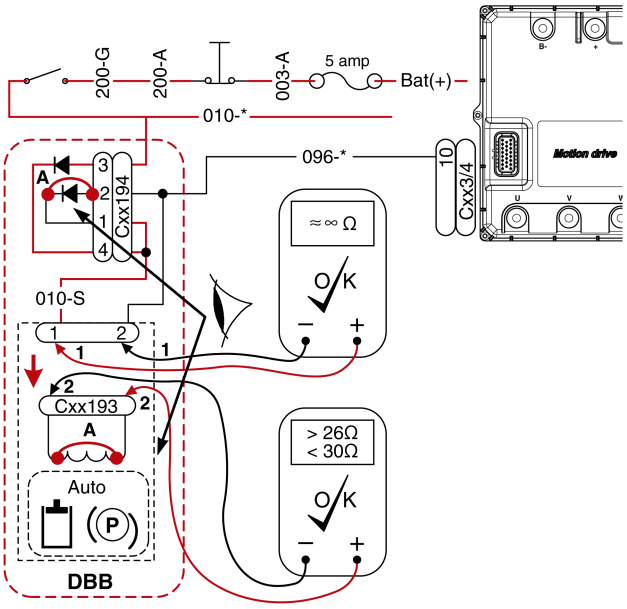


Power **OFF**→





Disconnect Battery and Sound Horn to Discharge Capacitors.Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342.

CBB/DBB Traction Controller Driver Current High (Cont)	
STEP A2	**CHECK RESISTANCE - Ω - OHMS**
Auto Brake Short Circuit to Bat (+)	
	
1. < 24 ? →Short to Bat (+)→CBB go to 2.↓DBB→Step 3→	1 > 24 ?→OK→CAUSE B↓
2. Find/Repair Short/Open Circuit See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→	
3. Recheck ?↑→ Reconnect→Test OK→YES→Resume OperationNO→CAUSE B↓	
STEP A3	**CHECK RESISTANCE - Ω - OHMS**
DBB Auto Brake Diode/Coil Short Circuit	
	
Disconnect Coil, Measure ?	
1. 0? = Short Diode→Go to 2↓	1 8? = OK→Go to 2↓
2. < 26? > 30? = Faulty Coil→Go to 4↓	2. > 26? < 30? = OK→CAUSE B↓
3. Replace Diode Pack. →Go to 5↓	
4. Replace Auto Brake Coil Assy. →Go to 5↓	
5. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→Go to 6↓	
5. Recheck ?↑→ Reconnect→Test OK→YES→Resume OperationNO→CAUSE B↓	

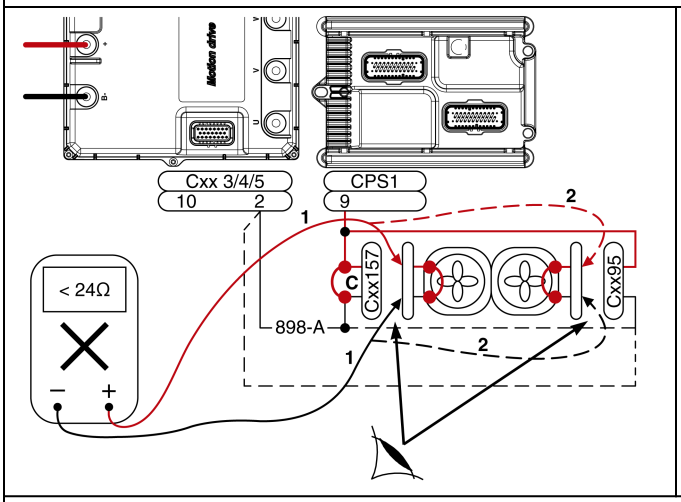
CBB/DBB Traction Controller Driver Current High (Cont)

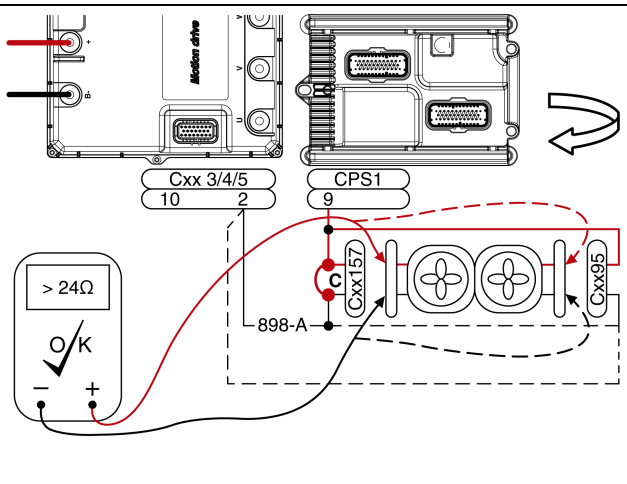
CAUSE B

Not Applicable

CAUSE C

Fan Short Circuit

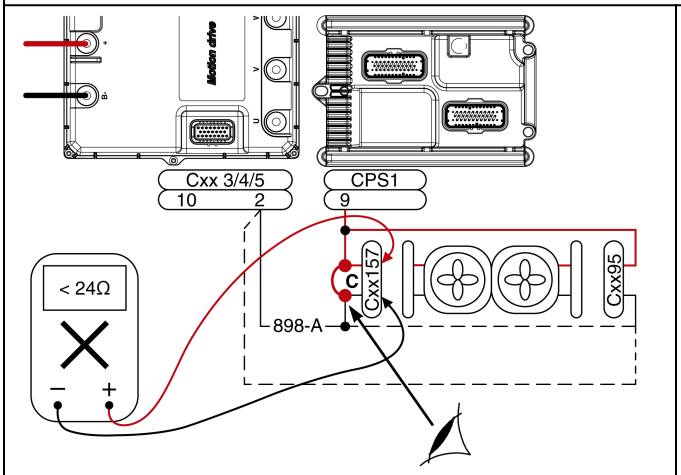


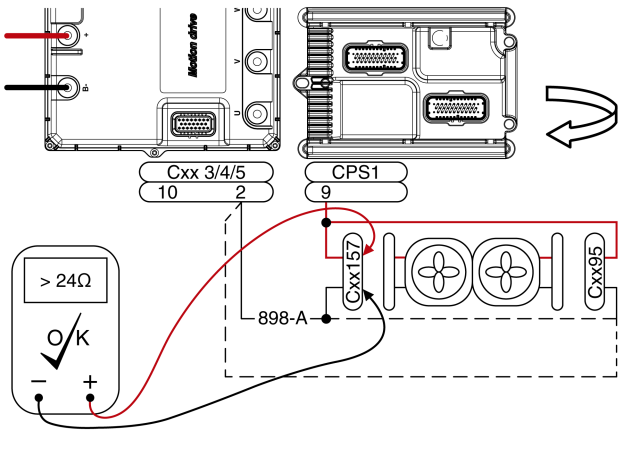


Disconnect Fans Measure ?	
1. < 24 ? →Shorted Fan→Go to 2.↓	1. > 24 ?→OK→Go to 2.↓
2. < 24 ? →Shorted Fan→Go to 2.↓	1. > 24 ?→OK→Go to Step 1.↓
2. Replace Fan. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→Go to 3↓	
3. Recheck ?↑→ Reconnect→Test OK→YES→Resume OperationNO→CAUSE C↓	

STEP C1 CHECK RESISTANCE - Ω - OHMS

Fan Harness Short Circuit

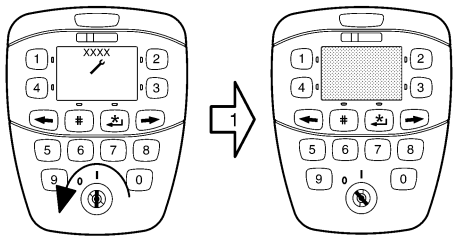




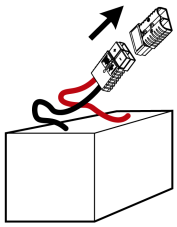
1. < 24 ? →Shorted Circuit→Go to 3.↓	1. > 24 ?→OK→Go to CAUSE C.↓
2. Find Short Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→Go to 3↓	
3. Recheck ?↑→ Reconnect→Test OK→YES→Resume OperationNO→CAUSE C↓	

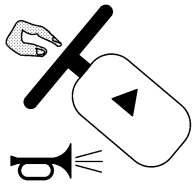
CBB/DBB Traction Controller Driver Current High (Cont)

CAUSE D



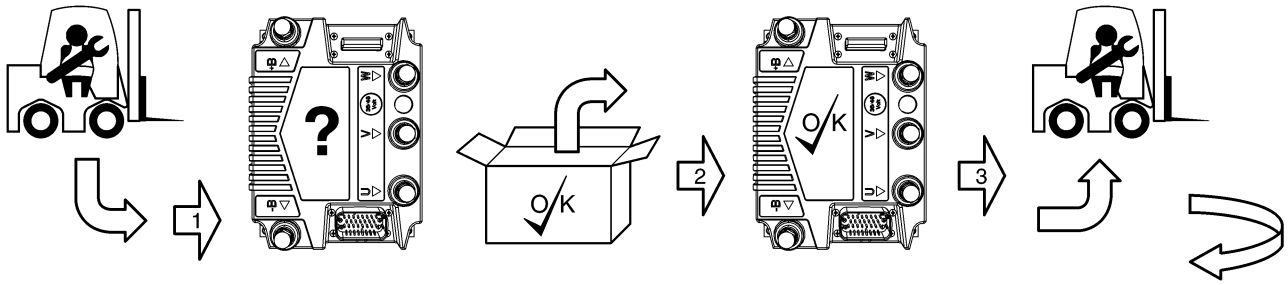
Power **OFF**→





Disconnect Battery and Sound Horn to Discharge Capacitors.Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342.

STEP D1

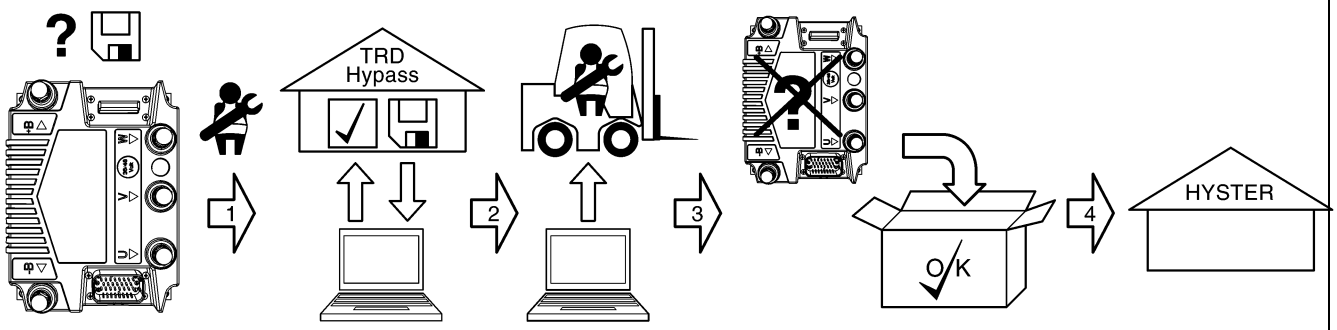


Remove and Replace Faulty Motor Controller↓

See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369↓

Check Replacement Controller 🖫 Version→See Label Information→Step 2↓

STEP D2



1. Go to TRD/Hypass Online /Software.?? Is Replacement Controller Application Software Version the Latest Version??

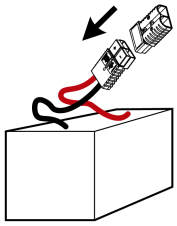
2. **NO**→Download the latest Application 🖫→Install on truck→Step 3↓

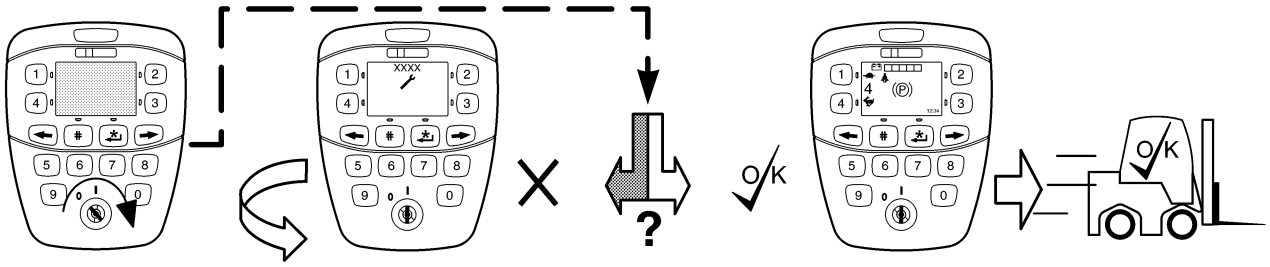
3. **YES**→Test New Installation→↓Step 3↓

4. Return Faulty Display→Dealer→Factory→Failure Analysis→?? Reprogramming

CBB/DBB Traction Controller Driver Current High (Cont)

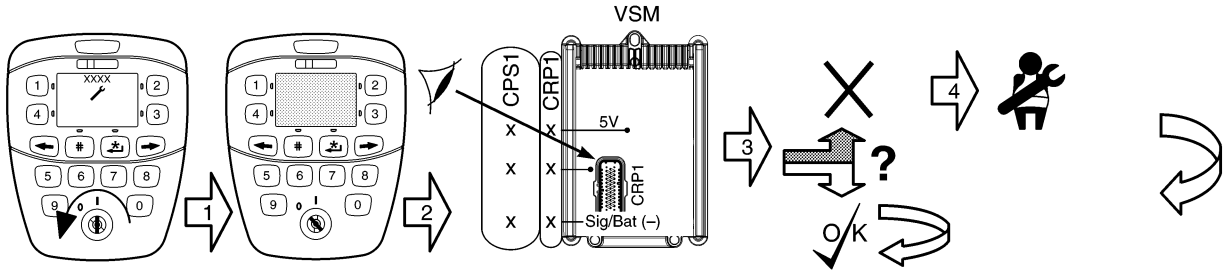
STEP D3





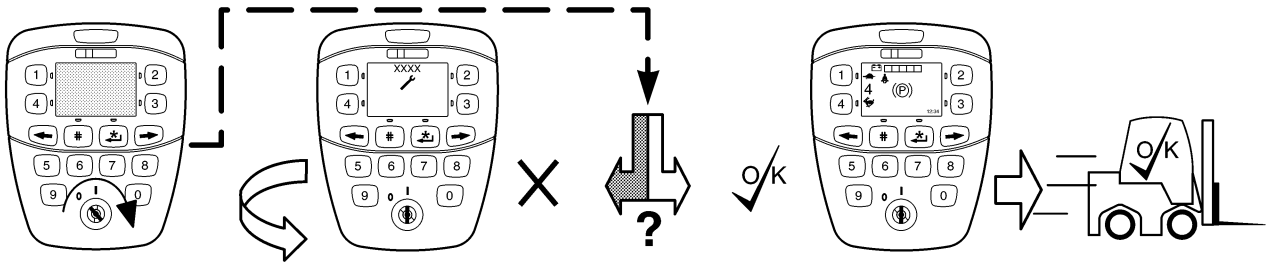
Retest - Power **ON**→	**NO**→?	Is fault DTC gone?**NO** **YES**←→	Fault corrected→Continue operation.

CAUSE E



Power **OFF**→	Inspect VSM Connections→OK Step 1	Not OK Correct/Repair→Step 1

STEP E1



Retest - Power **ON**→	**NO**→Go to VSM Controller Check	Is fault DTC gone?**NO** **YES**←→	Fault corrected→Continue operation.

DTC LOGS: DTC logs should only be cleared once the data is by the Service Tech. See Display Menu Flowchart **- Clearing DTCs.**

END FAULT

DTC 8992
Synchronous Steering Coil Current

POSSIBLE CAUSE

A. STEERING COIL WIRING FAULT

NOTE
Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

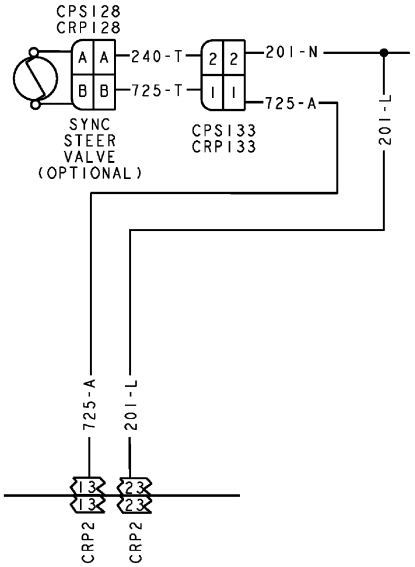
CAUSE A - STEERING COIL WIRING FAULT

PROCEDURE OR ACTION:

1. Inspect for short to B(+) between coil and VSM.
   Is short to power detected?
   YES: Repair short, clear code and retest system.
   NO: Replace faulty coil.

END POSSIBLE CAUSES

DIAGRAMS



BT081600

Troubleshooting Scenes

END FAULT

DTC 13344
Synch Steering Coil Open Circuit

POSSIBLE CAUSE

A. ACC WIRING FAULT
B. COIL FAULT

NOTE
Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - ACC WIRING FAULT

PROCEDURE OR ACTION:

1. Inspect for short to B(+) between coil and VSM.
   Is short to power detected?
   YES: Repair short, clear code and retest system.
   NO: Disconnect battery and proceed to CAUSE B.

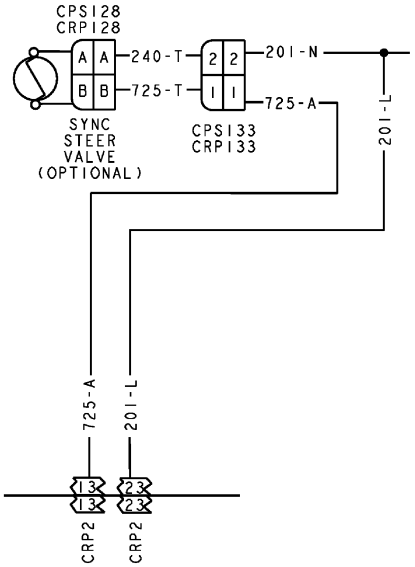
CAUSE B - COIL FAULT

PROCEDURE OR ACTION:

1. Disconnect suspected coil and measure resistance across coil terminals.
   Is resistance between 20 +/- 5 ohms?
   YES: Suspect faulty VSM.
   NO: Replace faulty coil.

END POSSIBLE CAUSES

DIAGRAMS



Troubleshooting Scenes

END FAULT

CODES

DTC 9012 - ACC 2 Current OORH
DTC 65526 - Aux Driver Open
DTC 65534 - Aux Driver Short
DTC 65014 - FOC2 Traction Controller Aux Driver Short
DTC 65022 - FOC2 Traction Controller Aux Driver Short

POSSIBLE CAUSE

A. ACC WIRING FAULT
B. COIL FAULT

NOTE
Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. DTC 65014 or 65022 may require software updates. Prior to performing troubleshooting procedures, verify controller is at the latest revision level. See FOC2 Software Updates.
2. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 3.
   NO: Problem not verified, resume operation.
3. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - ACC WIRING FAULT

PROCEDURE OR ACTION:

1. Inspect for short to B(+) between coil and VSM.
   Is short to power detected?
   YES: Repair short, clear code and retest system.
   NO: Disconnect battery and proceed to CAUSE B.

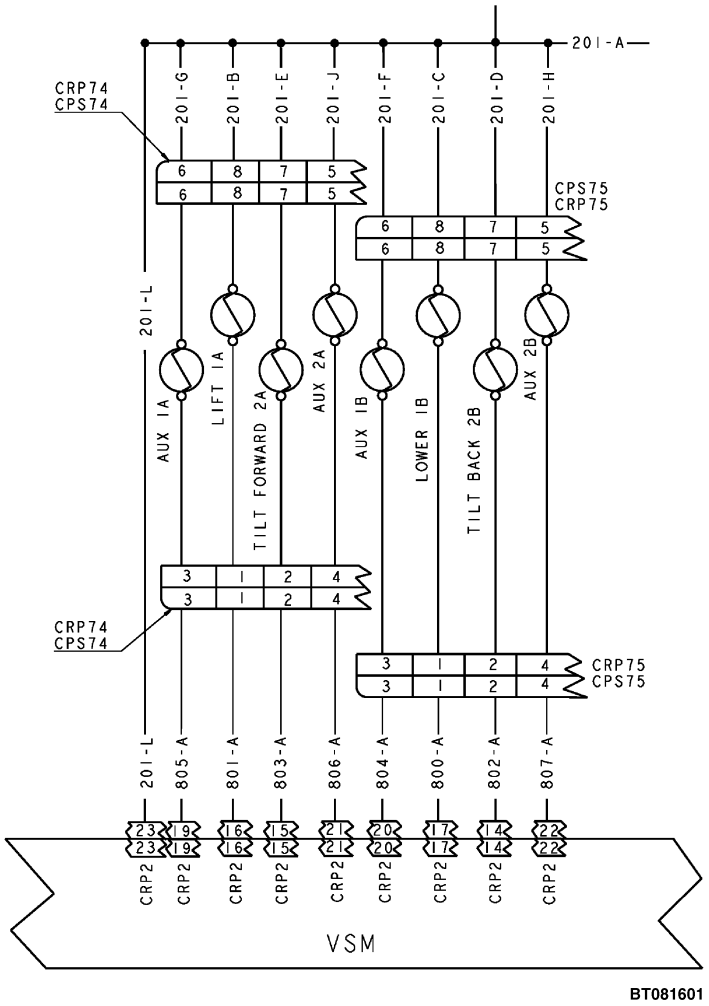
CAUSE B - COIL FAULT

PROCEDURE OR ACTION:

1. Disconnect suspected coil and measure resistance across coil terminals.
   Is resistance between 20 +/- 5 ohms?
   YES: Suspect faulty VSM.
   NO: Replace faulty coil.

END POSSIBLE CAUSES

DIAGRAMS



Troubleshooting Scenes

END FAULT

DTC 65288
Electric Steer Loss of Communication Between the Primary and Secondary Controller

POSSIBLE CAUSE

A. SOFTWARE UPDATE
B. CONTROLLER FAULT

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - SOFTWARE UPDATE

PROCEDURE OR ACTION:

1. Reprogram controller and retest system.
   Does DTC return after controller has been reprogrammed?
   YES: Proceed to CAUSE B.
   NO: No further service is required.

CAUSE B - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. If DTC returns after reprogramming, replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

END FAULT

DTC 65293
Electric Steer System Controller EEPROM Checksum Failure

POSSIBLE CAUSE

A. SOFTWARE UPDATE
B. CONTROLLER FAULT

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - SOFTWARE UPDATE

PROCEDURE OR ACTION:

1. Reprogram controller and retest system.
   Does DTC return after controller has been reprogrammed?
   YES: Proceed to CAUSE B.
   NO: No further service is required.

CAUSE B - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. If DTC returns after reprogramming, replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

END FAULT

DTC 95520
Key Switch Voltage OORL

POSSIBLE CAUSE

A. KEY INPUT WIRING FAULT
B. KEY SWITCH RELAY FAULT
C. CONTROLLER FAULT

NOTE
Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - KEY INPUT WIRING FAULT

PROCEDURE OR ACTION:

NOTE: Key in ON position.

1. Disconnect the steer motor controller connector CPS6 and measure voltage between socket 15 and B(-).
   Is voltage 12 ± 1.5 Vdc?
   YES: Proceed to CAUSE C.
   NO: Remove key switch relay 1 and proceed to CAUSE B.

CAUSE B - KEY SWITCH RELAY FAULT

PROCEDURE OR ACTION:

1. Measure voltage between the key switch relay 1, socket 86 and B(-).
   Is voltage 12 ± 1.5 Vdc?
   YES: Proceed to Step 2.
   NO: Inspect coil input circuit 513A for open or short. Inspect connector CPS135 for loose, damaged, or corroded terminals. Verify key switch operation by measuring continuity between the display connector CPS20, socket 5 and socket 1 while operating switch.
2. Measure voltage between the key switch relay 1, socket 86 and socket 85.
   Is voltage 12 ± 1.5 Vdc?
   YES: Proceed to Step 3.
   NO: Inspect relay ground circuit 013K and 013A for open or short. Inspect VSM connector CPS2 for loose, damaged, or corroded terminals.
3. Measure voltage between the key switch relay 1, socket 87 and B(-).
   Is voltage 12 ± 1.5 Vdc?
   YES: Inspect key voltage input circuit 010A for open, short, or source of excessive resistance.
   NO: Inspect relay switch input circuit 200K and 200M for open or short. Inspect connectors CRPS52-55, CRP52 for loose, damaged, or corroded terminals. Verify E-stop switch functionality by measuring continuity while operating switch.

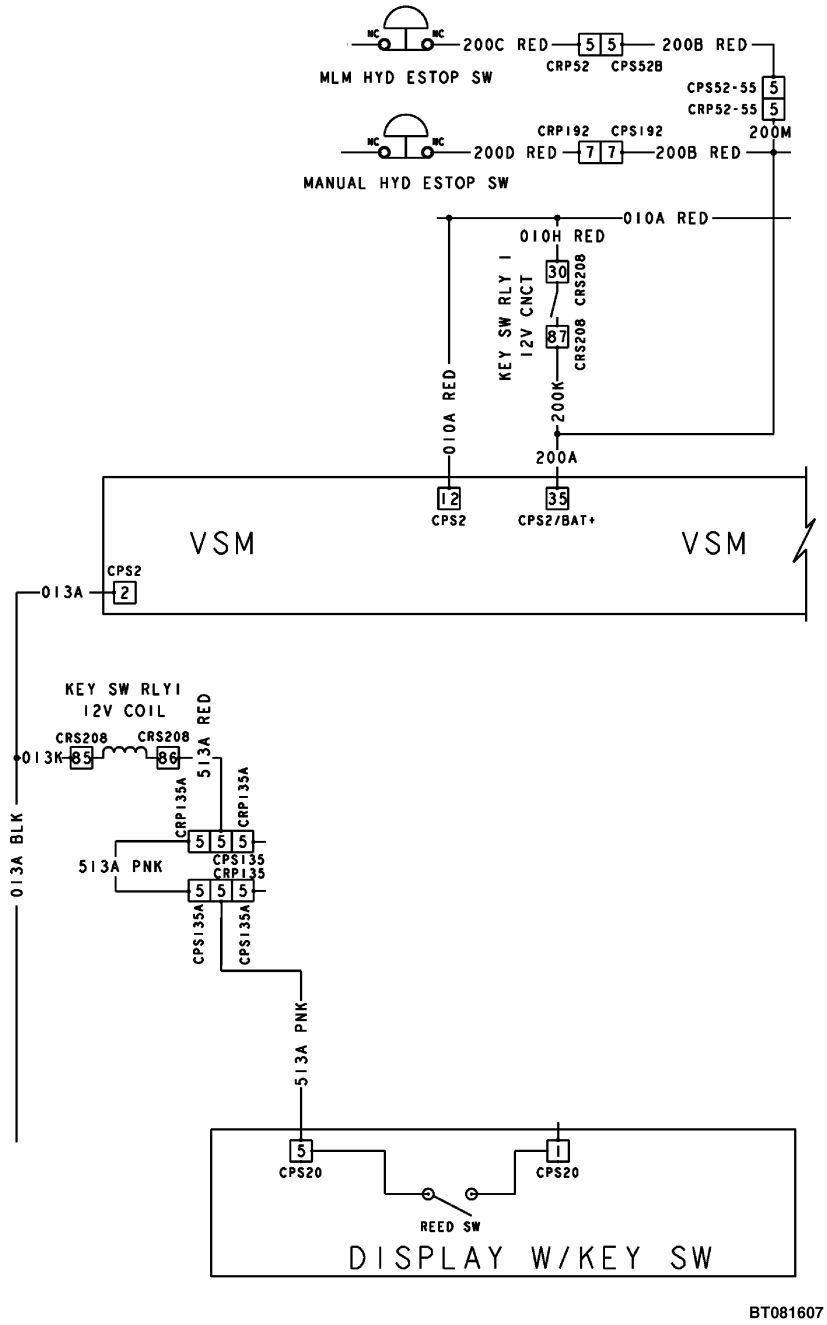
CAUSE C - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. If DTC returns, replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

DIAGRAMS



Troubleshooting Scenes

END FAULT

DTC 65296
Motor U-W Phase Voltage Measurement Fault

POSSIBLE CAUSE

A. PHASE CABLE FAULT
B. CONTROLLER FAULT

NOTE
Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - PHASE CABLE FAULT

PROCEDURE OR ACTION:

1. Disconnect individual phase cables from controller and motor. Measure resistance of individual cables.
   Is resistance between .322 and .383 ohms?
   YES: Proceed to CAUSE B.
   NO: Replace faulty phase cable.

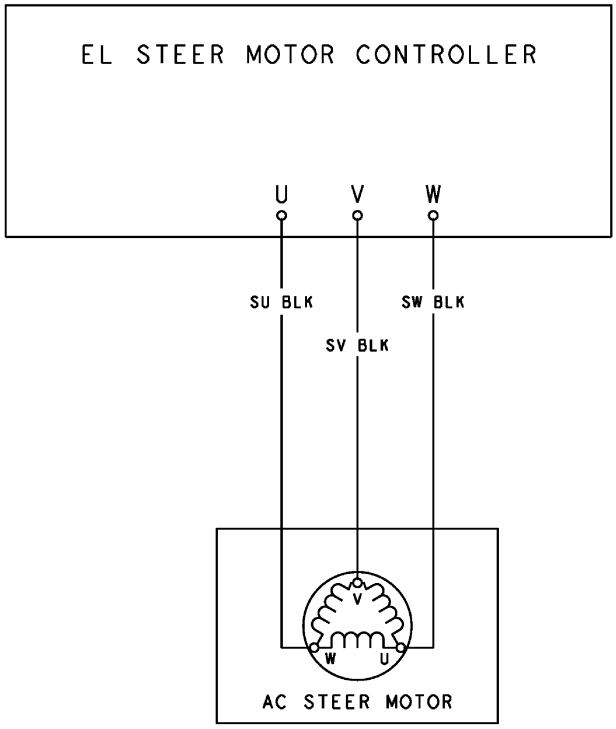
CAUSE B - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

DIAGRAMS



Troubleshooting Scenes

END FAULT

DTC 65297
Electric Steer Controller Motor U-V Phase Voltage Measurement Fault

POSSIBLE CAUSE

A. PHASE CABLE FAULT
B. CONTROLLER FAULT

NOTE
Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - PHASE CABLE FAULT

PROCEDURE OR ACTION:

1. Disconnect individual phase cables from controller and motor. Measure resistance of individual cables.
   Is resistance between .322 and .383 ohms?
   YES: Proceed to CAUSE B.
   NO: Replace faulty phase cable.

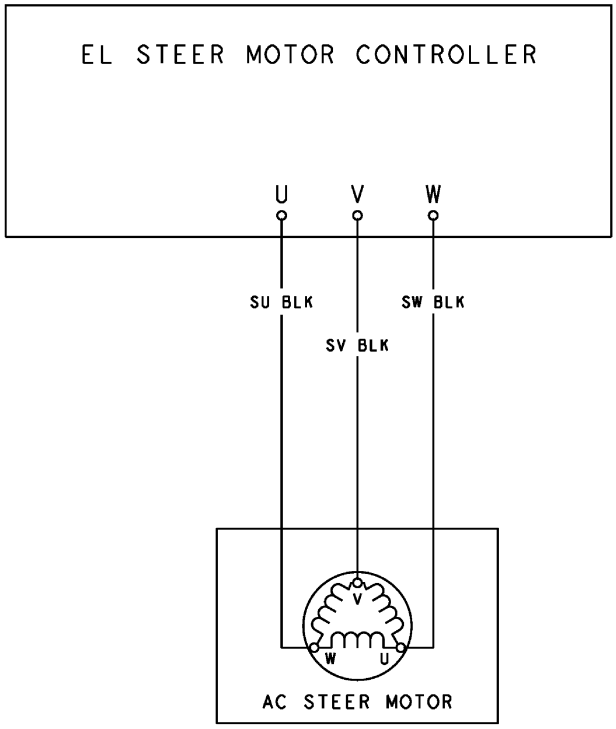
CAUSE B - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

DIAGRAMS



Troubleshooting Scenes

END FAULT

DTC 65352
Motor W-V Phase Voltage Measurement Fault

POSSIBLE CAUSE

A. PHASE CABLE FAULT
B. CONTROLLER FAULT

NOTE
Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - PHASE CABLE FAULT

PROCEDURE OR ACTION:

1. Disconnect individual phase cables from controller and motor. Measure resistance of individual cables.
   Is resistance between .322 and .383 ohms?
   YES: Proceed to CAUSE B.
   NO: Replace faulty phase cable.

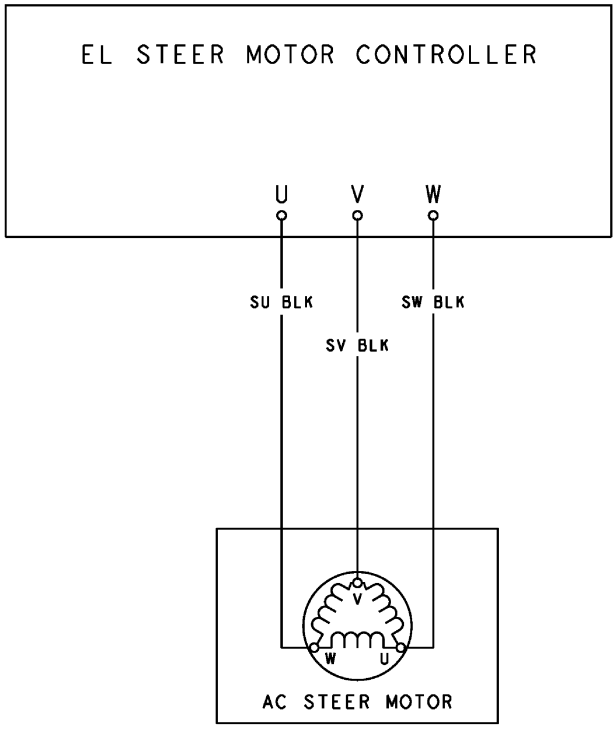
CAUSE B - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

DIAGRAMS



Troubleshooting Scenes

END FAULT

DTC 65312
Motor Phase Voltage Out of Range

POSSIBLE CAUSE

A. PHASE CABLE FAULT
B. CONTROLLER FAULT

NOTE
Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - PHASE CABLE FAULT

PROCEDURE OR ACTION:

1. Disconnect individual phase cables from controller and motor. Measure resistance of individual cables.
   Is resistance between .322 and .383 ohms?
   YES: Proceed to CAUSE B.
   NO: Replace faulty phase cable.

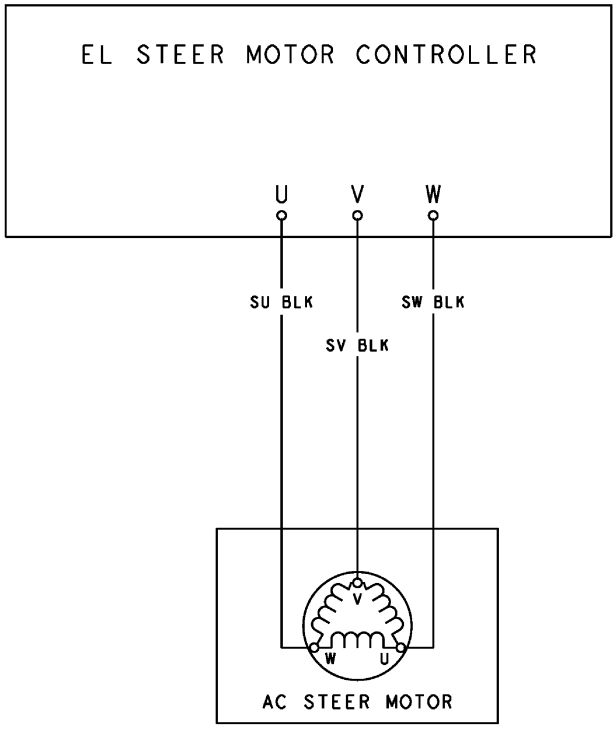
CAUSE B - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

DIAGRAMS



Troubleshooting Scenes

END FAULT

DTC 65333
Electric Steer Controller Standby Current Too High

POSSIBLE CAUSE

A. CONTROLLER FAULT

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

END FAULT

DTC 65340
Electric Steer Controller DC Bus Capacitor Charge Timeout
DC Bus voltage does not rise above 14 volts in 3.2 seconds after key ON

POSSIBLE CAUSE

A. CONTROLLER WIRING FAULT
B. CONTACTOR PTC RESISTOR FAULT
C. FAULTY FUSE
D. CONTROLLER FAULT

NOTE
Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - CONTROLLER WIRING FAULT

PROCEDURE OR ACTION:

1. Inspect power connection at appropriate controller.
   Is connection loose or damaged?
   YES: Repair connection, clear DTC, and retest system.
   NO: If only E-Steer controller is reporting DTC, proceed to CAUSE D, if more than one controller is reporting fault, proceed to CAUSE B.

CAUSE B - CONTACTOR PTC RESISTOR FAULT

PROCEDURE OR ACTION:

1. Disconnect PTC resistor and measure resistance.
   Is resistance between 5 +/- 0.5 ohms?
   YES: Proceed to CAUSE C.
   NO: Replace PTC resistor, clear DTC, and retest system.

CAUSE C - FAULTY FUSE

PROCEDURE OR ACTION:

1. Inspect appropriate fuse:
   - FU1-10A
   - FU2-10A
   - FU3-10A
   - FU4-5A

   Is fuse blown?
   YES: Inspect circuit for source of short and repair if necessary. Replace fuse, clear DTC, and retest system.
   NO: Proceed to CAUSE D.

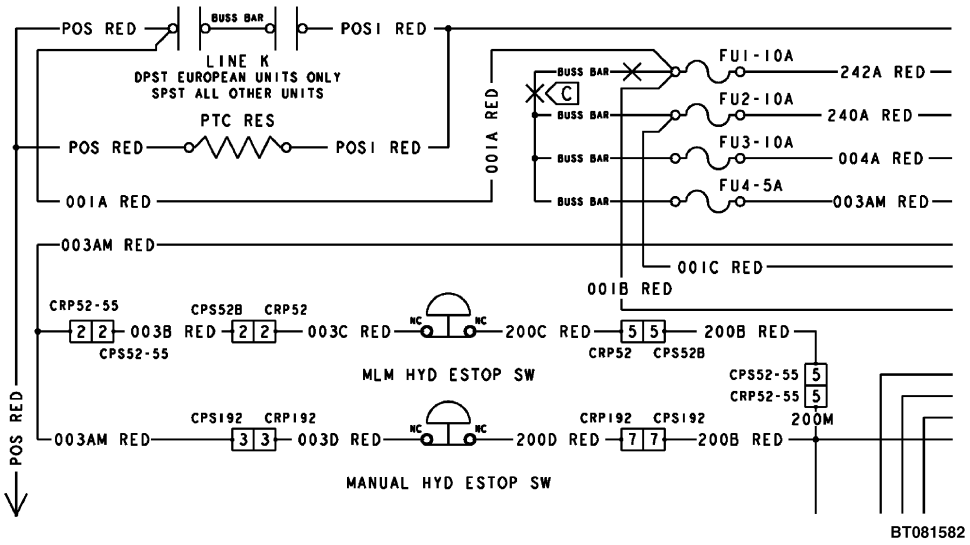
CAUSE D - CONTROLLER FAULT

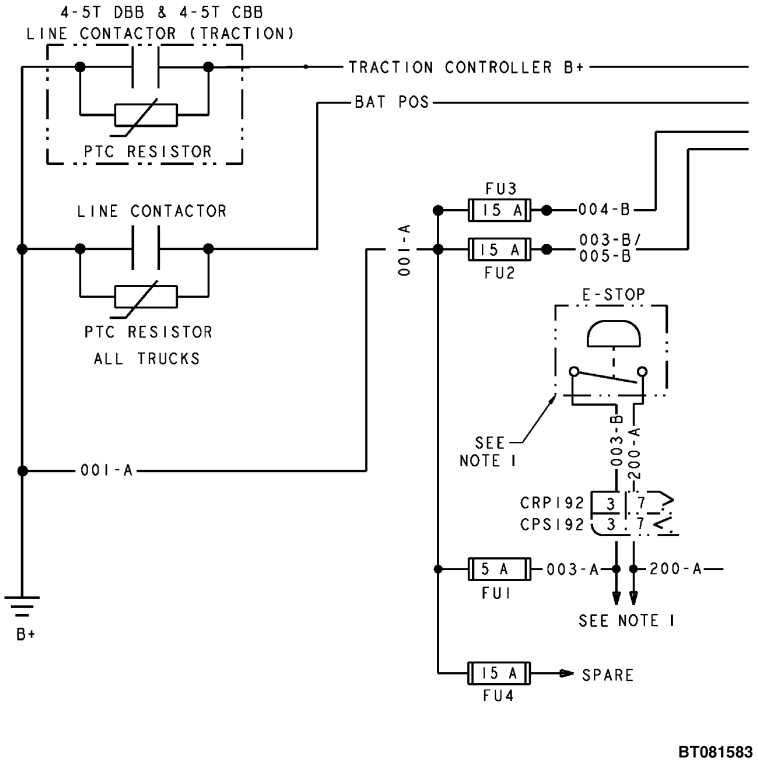
PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

DIAGRAMS





Troubleshooting Scenes

END FAULT

DTC 65341
Controller Temperature Above Limit

POSSIBLE CAUSE

A. CONTROLLER OVER TEMP
B. CONTROLLER FAULT

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - CONTROLLER OVER TEMP

PROCEDURE OR ACTION:

1. Verify actual controller or ambient temperatures are above 8080°C (176°F).
   Is controller temperature out of range?
   YES: Allow controller to cool within acceptable temperatures, clear DTC and resume operation.
   NO: Proceed to CAUSE B.

CAUSE B - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

END FAULT

DTC 65345
Electric Steer Motor Temperature Above Limit
Motor temperatures above 120°C (248°F)

POSSIBLE CAUSE

A. MOTOR OVER TEMPERATURE
B. TEMP SENSOR WIRING FAULT
C. TEMP SENSOR FAULT
D. MOTOR FAULT
E. CONTROLLER FAULT

NOTE
Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - MOTOR OVER TEMPERATURE

PROCEDURE OR ACTION:

1. Using the PC Service Tool, verify steer motor serial data and then measure actual motor temperatures. Over temp conditions are above 120°C (248°F).
   Is motor temperature out of range?
   YES: Allow motor to cool within acceptable temperatures, clear DTC and resume operation. If motor continues to overheat, proceed to CAUSE D.
   NO: Disconnect battery and proceed to CAUSE B.

CAUSE B - TEMP SENSOR WIRING FAULT

PROCEDURE OR ACTION:

1. Disconnect temperature sensor connectors from motor and controller and inspect pins and sockets.
   Is connector damage evident?
   YES: Repair connector, clear DTC and retest system.
   NO: Proceed to .
2. Measure resistance between the following:
   - Controller temp sensor connector, socket 6 and the motor temp sensor connector, socket 1.
   - Controller temp sensor connector, socket 7 and motor temp sensor connector, socket 2.

   Is resistance <1 ohm?
   YES: Proceed to CAUSE C.
   NO: Inspect appropriate temp sensor circuit for open or source of excessive resistance.

CAUSE C - TEMP SENSOR FAULT

PROCEDURE OR ACTION:

1. Measure resistance between the temp sensor connector, pin 1 and pin 2. Refer to temp sensor specification chart.
   Is resistance within specifications?
   YES: Proceed to CAUSE E.
   NO: Replace faulty temp sensor.

CAUSE D - MOTOR FAULT

PROCEDURE OR ACTION:

1. Replace faulty motor.

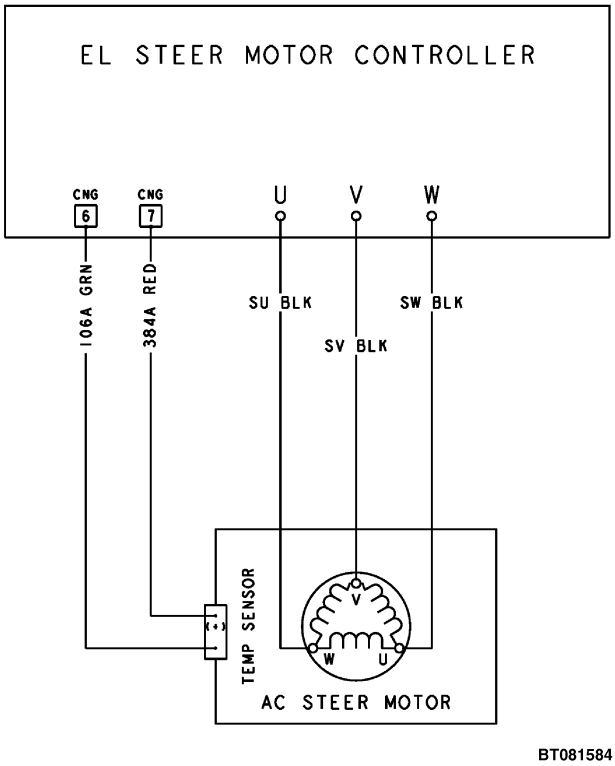
CAUSE E - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

DIAGRAMS



Troubleshooting Scenes

END FAULT

DTC 65350
Controller Internal Error
Hardware circuit limits maximum current.

POSSIBLE CAUSE

A. CONTROLLER FAULT

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

END FAULT

DTC 65487
Electric Steer Initial Nominal Motor Voltage Low

POSSIBLE CAUSE

A. SOFTWARE UPDATE
B. CONTROLLER FAULT

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - SOFTWARE UPDATE

PROCEDURE OR ACTION:

1. Reprogram controller and retest system.
   Does DTC return after controller has been reprogrammed?
   YES: Proceed to CAUSE B.
   NO: No further service is required.

CAUSE B - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. If DTC returns after reprogramming, replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

END FAULT

DTC 65488
Electric Steer Controller EEPROM KO

POSSIBLE CAUSE

A. SOFTWARE UPDATE
B. CONTROLLER FAULT

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - SOFTWARE UPDATE

PROCEDURE OR ACTION:

1. Reprogram controller and retest system.
   Does DTC return after controller has been reprogrammed?
   YES: Proceed to CAUSE B.
   NO: No further service is required.

CAUSE B - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. If DTC returns after reprogramming, replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

END FAULT

DTC 65490
Electric Steer Primary and Secondary Controller Version Mismatch

POSSIBLE CAUSE

A. SOFTWARE UPDATE
B. CONTROLLER FAULT

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - SOFTWARE UPDATE

PROCEDURE OR ACTION:

1. Reprogram controller and retest system.
   Does DTC return after controller has been reprogrammed?
   YES: Proceed to CAUSE B.
   NO: No further service is required.

CAUSE B - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. If DTC returns after reprogramming, replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

END FAULT

DTC 65492
Electric Steer Controller Internal Error

POSSIBLE CAUSE

A. SOFTWARE UPDATE
B. CONTROLLER FAULT

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - SOFTWARE UPDATE

PROCEDURE OR ACTION:

1. Reprogram controller and retest system.
   Does DTC return after controller has been reprogrammed?
   YES: Proceed to CAUSE B.
   NO: No further service is required.

CAUSE B - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. If DTC returns after reprogramming, replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

END FAULT

DTC 65493
Electric Steer Default Parameter Restore

POSSIBLE CAUSE

A. SOFTWARE UPDATE
B. CONTROLLER FAULT

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - SOFTWARE UPDATE

PROCEDURE OR ACTION:

1. Reprogram controller and retest system.
   Does DTC return after controller has been reprogrammed?
   YES: Proceed to CAUSE B.
   NO: No further service is required.

CAUSE B - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. If DTC returns after reprogramming, replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

END FAULT

DTC 65495
Controller Internal Error

POSSIBLE CAUSE

A. SOFTWARE UPDATE
B. CONTROLLER FAULT

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - SOFTWARE UPDATE

PROCEDURE OR ACTION:

1. Reprogram controller and retest system.
   Does DTC return after controller has been reprogrammed?
   YES: Proceed to CAUSE B.
   NO: No further service is required.

CAUSE B - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. If DTC returns after reprogramming, replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

END FAULT

DTC 65496
Controller Internal Error

POSSIBLE CAUSE

A. SOFTWARE UPDATE
B. CONTROLLER FAULT

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - SOFTWARE UPDATE

PROCEDURE OR ACTION:

1. Reprogram controller and retest system.
   Does DTC return after controller has been reprogrammed?
   YES: Proceed to CAUSE B.
   NO: No further service is required.

CAUSE B - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. If DTC returns after reprogramming, replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

END FAULT

DTC 65501
Controller Internal Error

POSSIBLE CAUSE

A. SOFTWARE UPDATE
B. CONTROLLER FAULT

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - SOFTWARE UPDATE

PROCEDURE OR ACTION:

1. Reprogram controller and retest system.
   Does DTC return after controller has been reprogrammed?
   YES: Proceed to CAUSE B.
   NO: No further service is required.

CAUSE B - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. If DTC returns after reprogramming, replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

END FAULT

DTC 65505
Controller Internal Error

POSSIBLE CAUSE

A. SOFTWARE UPDATE
B. CONTROLLER FAULT

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - SOFTWARE UPDATE

PROCEDURE OR ACTION:

1. Reprogram controller and retest system.
   Does DTC return after controller has been reprogrammed?
   YES: Proceed to CAUSE B.
   NO: No further service is required.

CAUSE B - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. If DTC returns after reprogramming, replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

END FAULT

DTC 65517
Electric Steer Controller Internal Error

POSSIBLE CAUSE

A. SOFTWARE UPDATE
B. CONTROLLER FAULT

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - SOFTWARE UPDATE

PROCEDURE OR ACTION:

1. Reprogram controller and retest system.
   Does DTC return after controller has been reprogrammed?
   YES: Proceed to CAUSE B.
   NO: No further service is required.

CAUSE B - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. If DTC returns after reprogramming, replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

END FAULT

DTC 65525
Electric Steer Controller Internal Error

POSSIBLE CAUSE

A. SOFTWARE UPDATE
B. CONTROLLER FAULT

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - SOFTWARE UPDATE

PROCEDURE OR ACTION:

1. Reprogram controller and retest system.
   Does DTC return after controller has been reprogrammed?
   YES: Proceed to CAUSE B.
   NO: No further service is required.

CAUSE B - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. If DTC returns after reprogramming, replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

END FAULT

DTC 65530
Electric Steer Controller Internal Error

POSSIBLE CAUSE

A. SOFTWARE UPDATE
B. CONTROLLER FAULT

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - SOFTWARE UPDATE

PROCEDURE OR ACTION:

1. Reprogram controller and retest system.
   Does DTC return after controller has been reprogrammed?
   YES: Proceed to CAUSE B.
   NO: No further service is required.

CAUSE B - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. If DTC returns after reprogramming, replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

END FAULT

DTC 65533
Electric Steer Controller Internal Error

POSSIBLE CAUSE

A. SOFTWARE UPDATE
B. CONTROLLER FAULT

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - SOFTWARE UPDATE

PROCEDURE OR ACTION:

1. Reprogram controller and retest system.
   Does DTC return after controller has been reprogrammed?
   YES: Proceed to CAUSE B.
   NO: No further service is required.

CAUSE B - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. If DTC returns after reprogramming, replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

END FAULT

DTC 65498
Electric Steer Controller Software Mismatch

POSSIBLE CAUSE

A. SOFTWARE UPDATE
B. CONTROLLER FAULT

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - SOFTWARE UPDATE

PROCEDURE OR ACTION:

1. Reprogram controller and retest system.
   Does DTC return after controller has been reprogrammed?
   YES: Proceed to CAUSE B.
   NO: No further service is required.

CAUSE B - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. If DTC returns after reprogramming, replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

END FAULT

DTC 65489
Controller Internal Error

POSSIBLE CAUSE

A. SOFTWARE UPDATE
B. CONTROLLER FAULT

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - SOFTWARE UPDATE

PROCEDURE OR ACTION:

1. Reprogram controller and retest system.
   Does DTC return after controller has been reprogrammed?
   YES: Proceed to CAUSE B.
   NO: No further service is required.

CAUSE B - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. If DTC returns after reprogramming, replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

END FAULT

DTC 65350
Motor Phase W Current OORL

POSSIBLE CAUSE

A. STEER MOTOR PHASE CABLE FAULT
B. STEER MOTOR FAULT
C. CONTROLLER FAULT

NOTE
Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - STEER MOTOR PHASE CABLE FAULT

PROCEDURE OR ACTION:

1. Disconnect the steer motor cables from the steer controller and motor. Measure continuity of individual cables to isolate fault.
   Is continuity present?
   YES: Proceed to CAUSE B.
   NO: Repair or replace faulty phase cable.

CAUSE B - STEER MOTOR FAULT

PROCEDURE OR ACTION:

1. Measure resistance between the traction motor terminals U and V.
   Is resistance between .322 and .383?
   YES: Proceed to Step 2.
   NO: Repair or replace faulty phase cable.
2. Measure resistance between the traction motor terminals U and W.
   Is resistance between .322 and .383?
   YES: Proceed to Step 3.
   NO: Repair or replace faulty phase cable.
3. Measure resistance between the traction motor terminals W and V.
   Is resistance between .322 and .383?
   YES: Proceed to CAUSE C.
   NO: Repair or replace faulty phase cable.

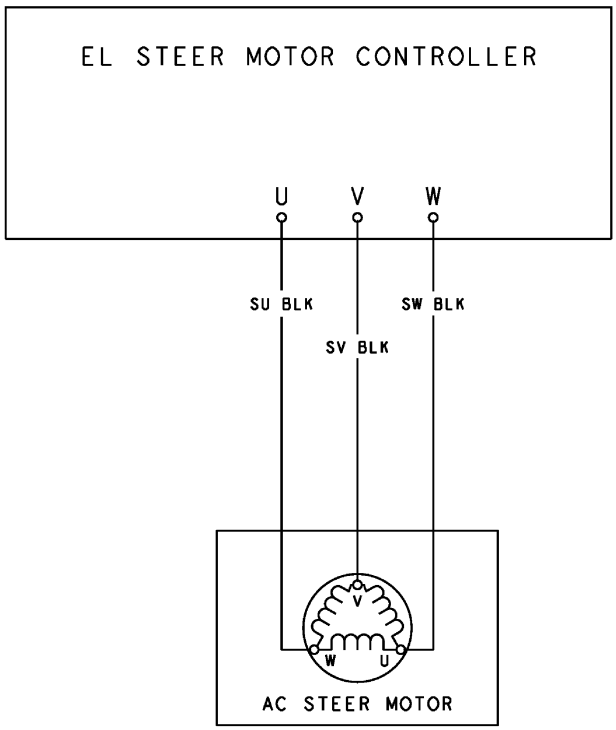
CAUSE C - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

DIAGRAMS



Troubleshooting Scene

END FAULT

DTC 65351
Motor Phase V Current OORL

POSSIBLE CAUSE

A. STEER MOTOR PHASE CABLE FAULT
B. STEER MOTOR FAULT
C. CONTROLLER FAULT

NOTE
Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - STEER MOTOR PHASE CABLE FAULT

PROCEDURE OR ACTION:

1. Disconnect the steer motor cables from the steer controller and motor. Measure continuity of individual cables to isolate fault.
   Is continuity present?
   YES: Proceed to CAUSE B.
   NO: Repair or replace faulty phase cable.

CAUSE B - STEER MOTOR FAULT

PROCEDURE OR ACTION:

1. Measure resistance between the traction motor terminals U and V.
   Is resistance between .322 and .383?
   YES: Proceed to Step 2.
   NO: Repair or replace faulty phase cable.
2. Measure resistance between the traction motor terminals U and W.
   Is resistance between .322 and .383?
   YES: Proceed to Step 3.
   NO: Repair or replace faulty phase cable.
3. Measure resistance between the traction motor terminals W and V.
   Is resistance between .322 and .383?
   YES: Proceed to CAUSE C.
   NO: Repair or replace faulty phase cable.

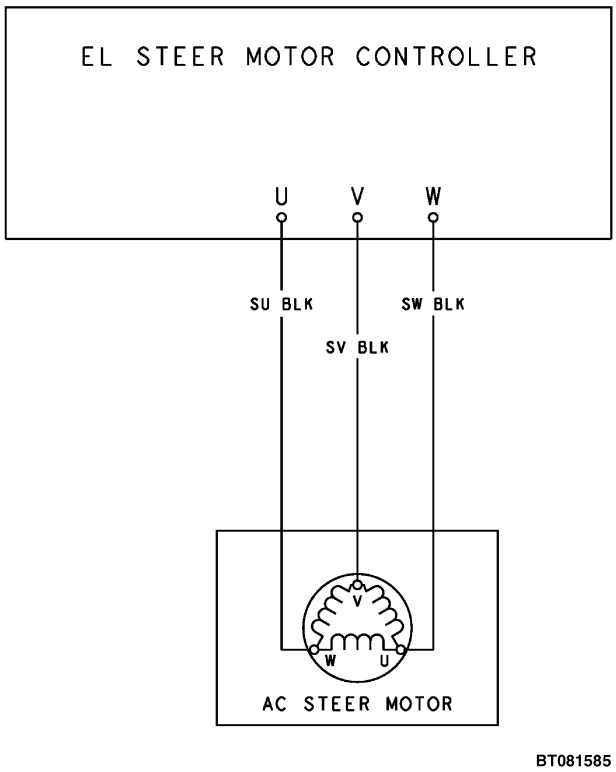
CAUSE C - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

DIAGRAMS



Troubleshooting Scenes

END FAULT

DTC 65353
Motor Phase U Current OORL

POSSIBLE CAUSE

A. STEER MOTOR PHASE CABLE FAULT
B. STEER MOTOR FAULT
C. CONTROLLER FAULT

NOTE
Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - STEER MOTOR PHASE CABLE FAULT

PROCEDURE OR ACTION:

1. Disconnect the steer motor cables from the steer controller and motor. Measure continuity of individual cables to isolate fault.
   Is continuity present?
   YES: Proceed to CAUSE B.
   NO: Repair or replace faulty phase cable.

CAUSE B - STEER MOTOR FAULT

PROCEDURE OR ACTION:

1. Measure resistance between the traction motor terminals U and V.
   Is resistance between .322 and .383?
   YES: Proceed to Step 2.
   NO: Repair or replace faulty phase cable.
2. Measure resistance between the traction motor terminals U and W.
   Is resistance between .322 and .383?
   YES: Proceed to Step 3.
   NO: Repair or replace faulty phase cable.
3. Measure resistance between the traction motor terminals W and V.
   Is resistance between .322 and .383?
   YES: Proceed to CAUSE C.
   NO: Repair or replace faulty phase cable.

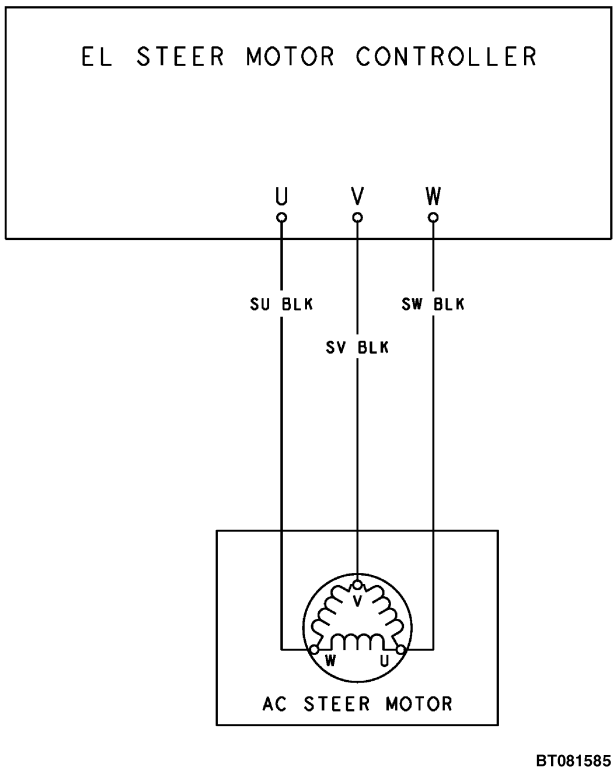
CAUSE C - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

DIAGRAMS



END FAULT

DTC 65531
Controller Initialization Test Failed

POSSIBLE CAUSE

A. BATTERY VOLTAGE MISMATCH
B. STEER MOTOR PHASE CABLE FAULT (E-STEER)
C. STEER MOTOR FAULT (E-STEER)
D. CONTROLLER FAULT

NOTE
Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - BATTERY VOLTAGE MISMATCH

PROCEDURE OR ACTION:

1. Verify battery installation.
   Is correct battery installed?
   YES: Proceed to Step 2.
   NO: Install correct battery, verify settings in setup menu. Clear DTC and retest system.
2. Verify battery setting in menu matches battery installed.
   Are settings properly configured?
   YES: If truck is equipped with E-Steer, proceed to CAUSE B. If truck is not equipped with E-Steer, proceed to CAUSE D.
   NO: Configure settings.

CAUSE B - STEER MOTOR PHASE CABLE FAULT (E-STEER)

PROCEDURE OR ACTION:

1. Disconnect the steer motor cables from the steer controller and motor. Measure continuity of individual cables to isolate fault.
   Is continuity present?
   YES: Proceed to CAUSE C.
   NO: Repair or replace faulty phase cable.

CAUSE C - STEER MOTOR FAULT (E-STEER)

PROCEDURE OR ACTION:

1. Measure resistance between the traction motor terminals U and V.
   Is resistance between .322 and .383?
   YES: Proceed to Step 2.
   NO: Repair or replace faulty phase cable.
2. Measure resistance between the traction motor terminals U and W.
   Is resistance between .322 and .383?
   YES: Proceed to Step 3.
   NO: Repair or replace faulty phase cable.
3. Measure resistance between the traction motor terminals W and V.
   Is resistance between .322 and .383?
   YES: Proceed to CAUSE D.
   NO: Repair or replace faulty phase cable.

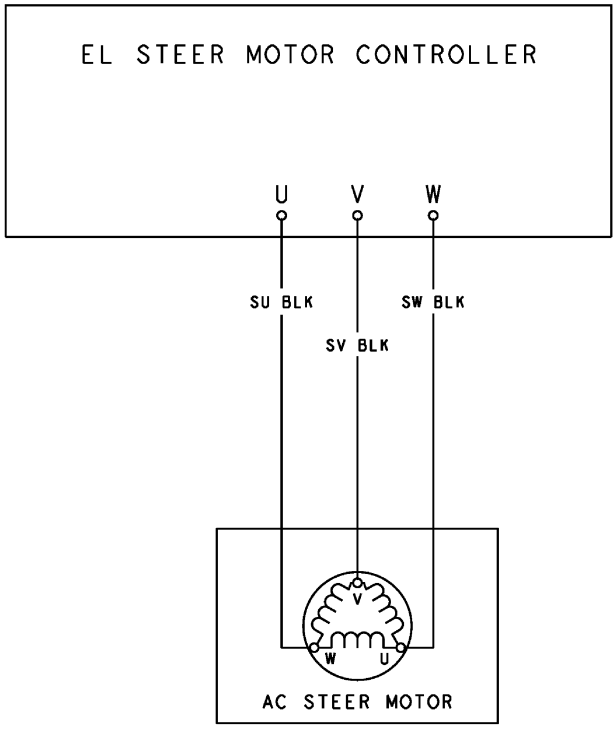
CAUSE D - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

DIAGRAMS



BT081585

Troubleshooting Scenes

END FAULT

DTC 65494
Rapid Change in Steering Wheel Position

POSSIBLE CAUSE

A. STEER SENSOR WIRING FAULT
B. STEER SENSOR FAULT
C. CONTROLLER FAULT

NOTE
Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - STEER SENSOR WIRING FAULT

PROCEDURE OR ACTION:

1. Disconnect steer sensor connector CPS78 and steer motor controller CPS6. Measure resistance between the following:
   - CPS78, socket 2 and CPS6, socket 19
   - CPS78, socket 3 and CPS6, socket 17
   - CPS78, socket 4 and CPS6, socket 20
   - CPS78, socket 1 and CPS6, socket 21

   Is resistance <1 ohm?
   YES: Proceed to CAUSE B.
   NO: Inspect appropriate circuit for open or source of excessive resistance. Inspect connector CPS132 for damage.

CAUSE B - STEER SENSOR FAULT

PROCEDURE OR ACTION:

1. Using the PC Service Tool, observe steer sensor output signals.
   Does sensor output signal match Figure 1?
   YES: Proceed to CAUSE C.
   NO: Replace faulty steer sensor.

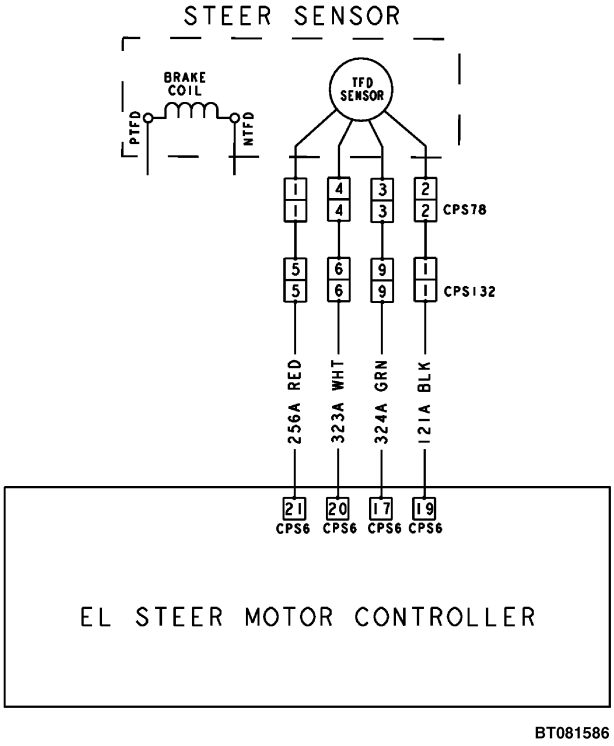
CAUSE C - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

DIAGRAMS



Troubleshooting Scenes

END FAULT

DTC 65528
Electric Steer Wheel Sensor Output Mismatch

POSSIBLE CAUSE

A. STEER SENSOR WIRING FAULT
B. STEER SENSOR FAULT
C. CONTROLLER FAULT

NOTE
Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - STEER SENSOR WIRING FAULT

PROCEDURE OR ACTION:

1. Disconnect steer sensor connector CPS78 and steer motor controller CPS6. Measure resistance between the following:
   - CPS78, socket 2 and CPS6, socket 19
   - CPS78, socket 3 and CPS6, socket 17
   - CPS78, socket 4 and CPS6, socket 20
   - CPS78, socket 1 and CPS6, socket 21

   Is resistance <1 ohm?
   YES: Proceed to CAUSE B.
   NO: Inspect appropriate circuit for open or source of excessive resistance. Inspect connector CPS132 for damage.

CAUSE B - STEER SENSOR FAULT

PROCEDURE OR ACTION:

1. Using the PC Service Tool, observe steer sensor output signals.
   Does sensor output signal match Figure 1?
   YES: Proceed to CAUSE C.
   NO: Replace faulty steer sensor.

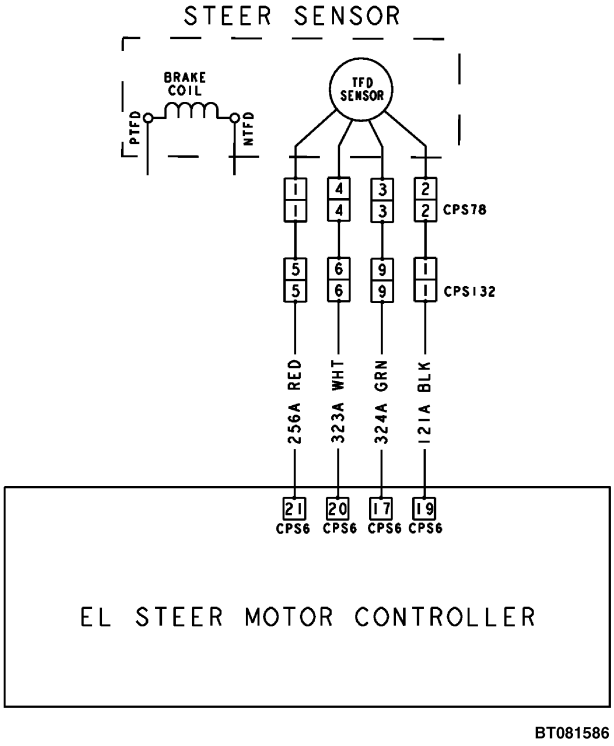
CAUSE C - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

DIAGRAMS



Troubleshooting Scenes

END FAULT

DTC 65378
Steering Wheel Position Error

POSSIBLE CAUSE

A. STEER SENSOR WIRING FAULT
B. STEER SENSOR FAULT
C. CONTROLLER FAULT

NOTE
Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - STEER SENSOR WIRING FAULT

PROCEDURE OR ACTION:

1. Disconnect steer sensor connector CPS78 and steer motor controller CPS6. Measure resistance between the following:
   - CPS78, socket 2 and CPS6, socket 19
   - CPS78, socket 3 and CPS6, socket 17
   - CPS78, socket 4 and CPS6, socket 20
   - CPS78, socket 1 and CPS6, socket 21

   Is resistance <1 ohm?
   YES: Proceed to CAUSE B.
   NO: Inspect appropriate circuit for open or source of excessive resistance. Inspect connector CPS132 for damage.

CAUSE B - STEER SENSOR FAULT

PROCEDURE OR ACTION:

1. Using the PC Service Tool, observe steer sensor output signals.
   Does sensor output signal match Figure 1?
   YES: Proceed to CAUSE C.
   NO: Replace faulty steer sensor.

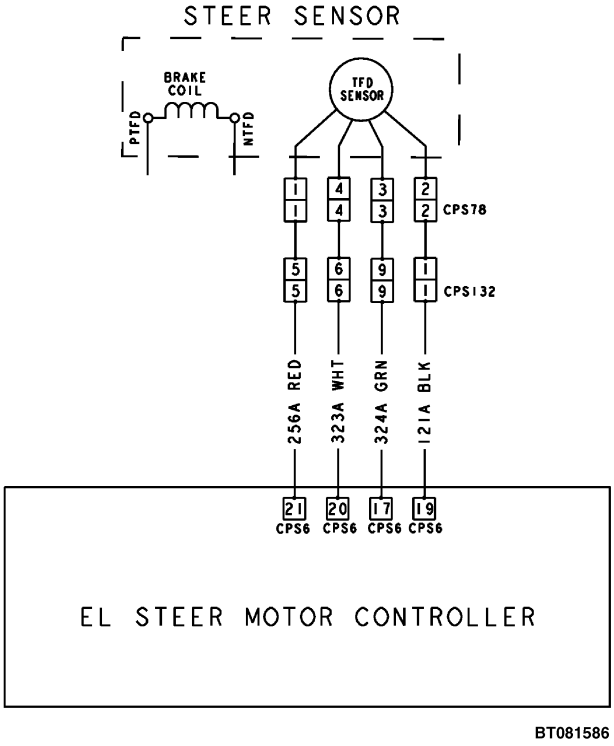
CAUSE C - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

DIAGRAMS



Troubleshooting Scenes

END FAULT

DTC 65491
Electric Steer TFD Current within Range but Lower than Expected

POSSIBLE CAUSE

A. TFD WIRING FAULT
B. TFD COIL FAULT
C. CONTROLLER FAULT

NOTE
Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - TFD WIRING FAULT

PROCEDURE OR ACTION:

1. Disconnect TFD coil connector CPS78 and measure voltage between socket 5 and B(-).
   Is voltage 12 ± 1.5 Vdc?
   YES: Disconnect battery and proceed to Step 2.
   NO: Inspect input circuit for open or short.
2. Disconnect steer controller connector CPS6 and measure resistance between socket 10 and the TFD coil connector CPS78, socket 6.
   Is resistance <1 ohm?
   YES: Proceed to CAUSE B.
   NO: Inspect ground circuit for open or source of excessive resistance.

CAUSE B - TFD COIL FAULT

PROCEDURE OR ACTION:

1. Measure resistance across TFD coil terminals.
   Is resistance 20 ± 2 ohms?
   YES: Proceed to CAUSE C.
   NO: Replace faulty TFD coil.

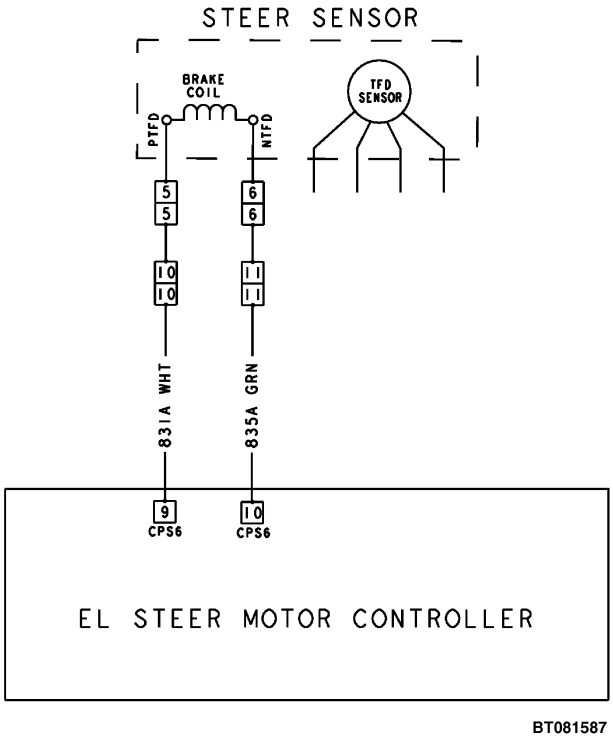
CAUSE C - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

DIAGRAMS



Troubleshooting Scenes

END FAULT

DTC 65496
TFD Resistance Out of Range

POSSIBLE CAUSE

A. TFD WIRING FAULT
B. TFD COIL FAULT
C. CONTROLLER FAULT

NOTE
Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - TFD WIRING FAULT

PROCEDURE OR ACTION:

1. Disconnect TFD coil connector CPS78 and measure voltage between socket 5 and B(-).
   Is voltage 12 ± 1.5 Vdc?
   YES: Disconnect battery and proceed to Step 2.
   NO: Inspect input circuit for open or short.
2. Disconnect steer controller connector CPS6 and measure resistance between socket 10 and the TFD coil connector CPS78, socket 6.
   Is resistance <1 ohm?
   YES: Proceed to CAUSE B.
   NO: Inspect ground circuit for open or source of excessive resistance.

CAUSE B - TFD COIL FAULT

PROCEDURE OR ACTION:

1. Measure resistance across TFD coil terminals.
   Is resistance 20 ± 2 ohms?
   YES: Proceed to CAUSE C.
   NO: Replace faulty TFD coil.

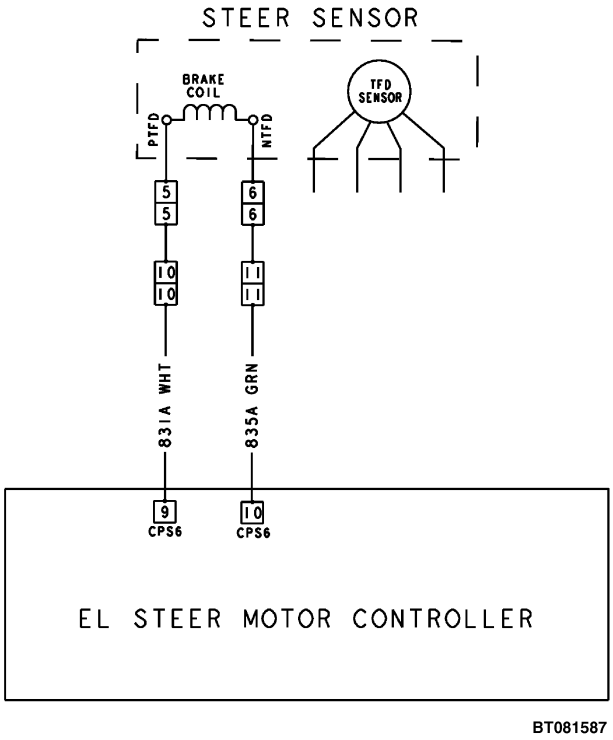
CAUSE C - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

DIAGRAMS



Troubleshooting Scenes

END FAULT

DTC 65515
Electric Steer Controller TFD Short to battery Negative

POSSIBLE CAUSE

A. TFD WIRING FAULT
B. TFD COIL FAULT
C. CONTROLLER FAULT

NOTE
Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - TFD WIRING FAULT

PROCEDURE OR ACTION:

1. Disconnect TFD coil connector CPS78 and measure voltage between socket 5 and B(-).
   Is voltage 12 ± 1.5 Vdc?
   YES: Disconnect battery and proceed to Step 2.
   NO: Inspect input circuit for open or short.
2. Disconnect steer controller connector CPS6 and measure resistance between socket 10 and the TFD coil connector CPS78, socket 6.
   Is resistance <1 ohm?
   YES: Proceed to CAUSE B.
   NO: Inspect ground circuit for open or source of excessive resistance.

CAUSE B - TFD COIL FAULT

PROCEDURE OR ACTION:

1. Measure resistance across TFD coil terminals.
   Is resistance 20 ± 2 ohms?
   YES: Proceed to CAUSE C.
   NO: Replace faulty TFD coil.

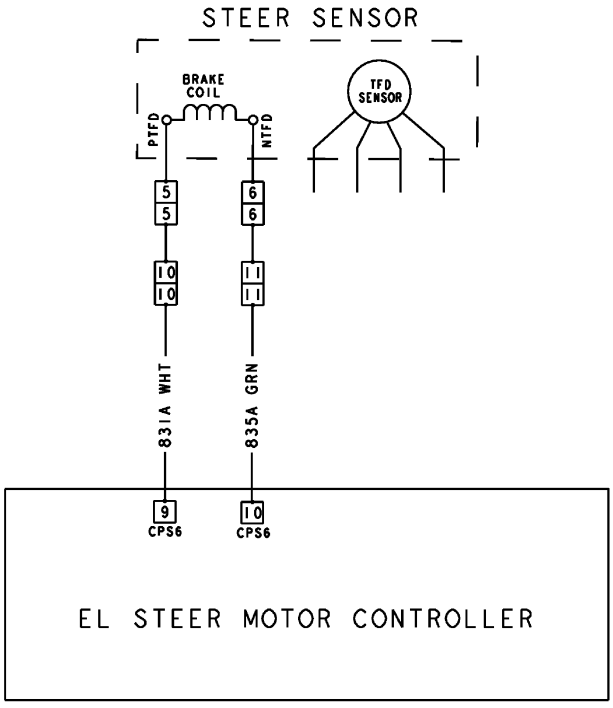
CAUSE C - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

DIAGRAMS



Troubleshooting Scenes

END FAULT

DTC 65516
Electric Steer Controller TFD Stand-by Current OORH

POSSIBLE CAUSE

A. TFD WIRING FAULT
B. TFD COIL FAULT
C. CONTROLLER FAULT

NOTE
Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - TFD WIRING FAULT

PROCEDURE OR ACTION:

1. Disconnect TFD coil connector CPS78 and measure voltage between socket 5 and B(-).
   Is voltage 12 ± 1.5 Vdc?
   YES: Disconnect battery and proceed to Step 2.
   NO: Inspect input circuit for open or short.
2. Disconnect steer controller connector CPS6 and measure resistance between socket 10 and the TFD coil connector CPS78, socket 6.
   Is resistance <1 ohm?
   YES: Proceed to CAUSE B.
   NO: Inspect ground circuit for open or source of excessive resistance.

CAUSE B - TFD COIL FAULT

PROCEDURE OR ACTION:

1. Measure resistance across TFD coil terminals.
   Is resistance 20 ± 2 ohms?
   YES: Proceed to CAUSE C.
   NO: Replace faulty TFD coil.

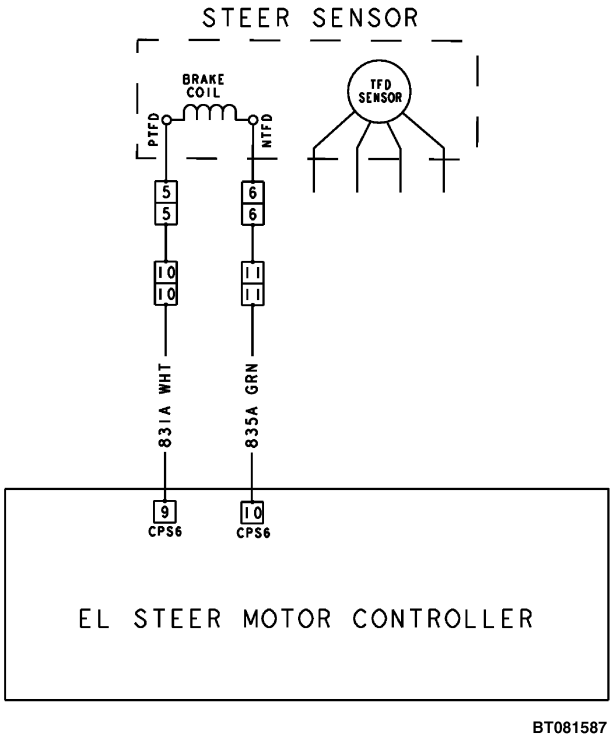
CAUSE C - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

DIAGRAMS



Troubleshooting Scenes

END FAULT

DTC 65500
Electric Steer Steering Motor Locked

POSSIBLE CAUSE

A. STEERING DAMAGE OR BINDING
B. STEER MOTOR PHASE CABLE FAULT
C. STEER MOTOR FAULT
D. CONTROLLER FAULT

NOTE
Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - STEERING DAMAGE OR BINDING

PROCEDURE OR ACTION:

1. Inspect steer wheel for obstruction or damage.
   Is damage present?
   YES: Remove obstruction or repair damage.
   NO: Disconnect battery and proceed to CAUSE B.

CAUSE B - STEER MOTOR PHASE CABLE FAULT

PROCEDURE OR ACTION:

1. Disconnect the steer motor cables from the steer controller and motor. Measure continuity of individual cables to isolate fault.
   Is continuity present?
   YES: Proceed to CAUSE C.
   NO: Repair or replace faulty phase cable.

CAUSE C - STEER MOTOR FAULT

PROCEDURE OR ACTION:

1. Measure resistance between the traction motor terminals U and V.
   Is resistance between .322 and .383 ohms?
   YES: Proceed to Step 2.
   NO: Repair or replace faulty motor.
2. Measure resistance between the traction motor terminals U and W.
   Is resistance between .322 and .383 ohms?
   YES: Proceed to Step 3.
   NO: Repair or replace faulty motor.
3. Measure resistance between the traction motor terminals W and V.
   Is resistance between .322 and .383 ohms?
   YES: Proceed to CAUSE D.
   NO: Repair or replace faulty motor.

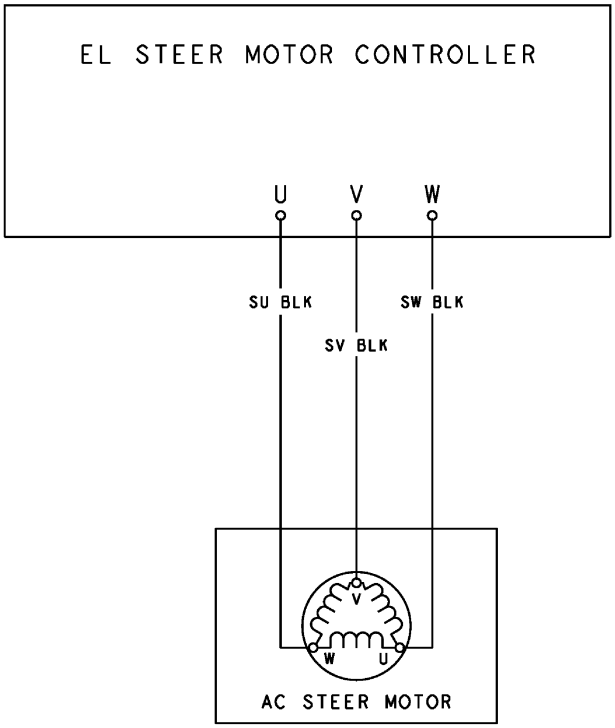
CAUSE D - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

DIAGRAMS



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END FAULT

DTC 65521
Electric Steer Controller Steer Axle Slow Response

POSSIBLE CAUSE

A. STEERING DAMAGE OR BINDING
B. STEER MOTOR PHASE CABLE FAULT
C. STEER MOTOR FAULT
D. CONTROLLER FAULT

NOTE
Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - STEERING DAMAGE OR BINDING

PROCEDURE OR ACTION:

1. Inspect steer wheel for obstruction or damage.
   Is damage present?
   YES: Remove obstruction or repair damage.
   NO: Disconnect battery and proceed to CAUSE B.

CAUSE B - STEER MOTOR PHASE CABLE FAULT

PROCEDURE OR ACTION:

1. Disconnect the steer motor cables from the steer controller and motor. Measure continuity of individual cables to isolate fault.
   Is continuity present?
   YES: Proceed to CAUSE C.
   NO: Repair or replace faulty phase cable.

CAUSE C - STEER MOTOR FAULT

PROCEDURE OR ACTION:

1. Measure resistance between the traction motor terminals U and V.
   Is resistance between .322 and .383 ohms?
   YES: Proceed to Step 2.
   NO: Repair or replace faulty motor.
2. Measure resistance between the traction motor terminals U and W.
   Is resistance between .322 and .383 ohms?
   YES: Proceed to Step 3.
   NO: Repair or replace faulty motor.
3. Measure resistance between the traction motor terminals W and V.
   Is resistance between .322 and .383 ohms?
   YES: Proceed to CAUSE D.
   NO: Repair or replace faulty motor.

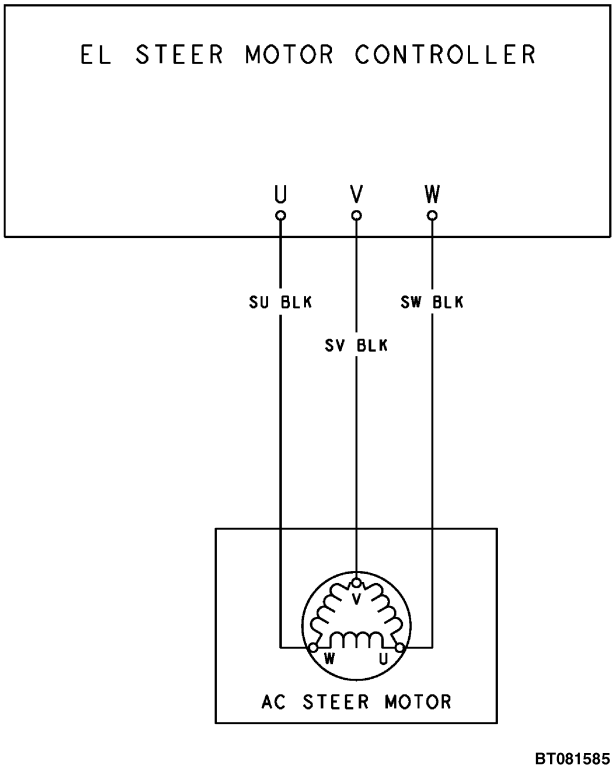
CAUSE D - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

DIAGRAMS



Troubleshooting Scenes

END FAULT

DTC 65508
Steer Axle Position Mismatch

POSSIBLE CAUSE

A. STEER AXLE SENSOR WIRING FAULT
B. STEER AXLE SENSOR FAULT
C. ENCODER FAULT
D. CONTROLLER FAULT

NOTE
Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - STEER AXLE SENSOR WIRING FAULT

PROCEDURE OR ACTION:

1. Disconnect the steer axle sensor connector CPS31 and measure voltage between socket A and B(-).
   Is voltage 5 ± 0.5 Vdc?
   YES: Proceed to Step 2.
   NO: Inspect supply circuit 089F for open or short. Inspect pigtail connector CRP31A for loose, damaged, or corroded terminals.
2. Measure voltage between the steer axle sensor connector CPS31, socket A and socket C.
   Is voltage 5 ± 0.5 Vdc?
   YES: Disconnect battery and proceed to Step 3.
   NO: Inspect ground circuit 117B for open or short. Inspect pigtail connector CRP31A for loose, damaged, or corroded terminals.
3. Disconnect VSM connector CPS1 and measure resistance between socket 16 and the steer axle sensor connector CPS31, socket B.
   Is resistance ≤ 1 ohm?
   YES: Connect steer axle sensor and proceed to CAUSE B.
   NO: Inspect input signal circuit 068A for open or source of excessive resistance. Inspect pigtail connector CRP31A, for loose, damaged, or corroded terminals.

CAUSE B - STEER AXLE SENSOR FAULT

PROCEDURE OR ACTION:

1. Measure voltage between the VSM connector CPS1, socket 16 and B(-).
   Does voltage respond to steer axle sensor movement?
   YES: Proceed to CAUSE C.
   NO: Replace faulty steer axle sensor.

CAUSE C - ENCODER FAULT

PROCEDURE OR ACTION:

1. Disconnect the steer encoder connector and measure voltage between encoder 12 volt supply and B(-).
   Is voltage 12 ± 1.5 Vdc?
   YES: Proceed to Step 2.
   NO: Inspect circuit 284A for open or short.
2. Measure voltage between 12 volt supply circuit and ground circuit.
   Is voltage 12 ± 1.5 Vdc?
   YES: Proceed to Step 3.
   NO: Inspect ground circuit 107A for open or short.
3. Disconnect steer controller connector and measure resistance between the following signal circuits:
   - Steer motor controller, socket 1 and steer encoder, socket A.
   - Steer motor controller, socket 3 and steer encoder, socket B.

   Is resistance <1 ohm?
   YES: Connect the encoder and steer controller connectors and proceed to Step 4.
   NO: Inspect encoder signal circuits for open or source of excessive resistance.
4. Using the PC Service Tool, locate and observe the steer encoder count signal.
   Does encoder provide accurate count signal during operation?
   YES: Proceed to CAUSE D.
   NO: Replace faulty steer encoder.

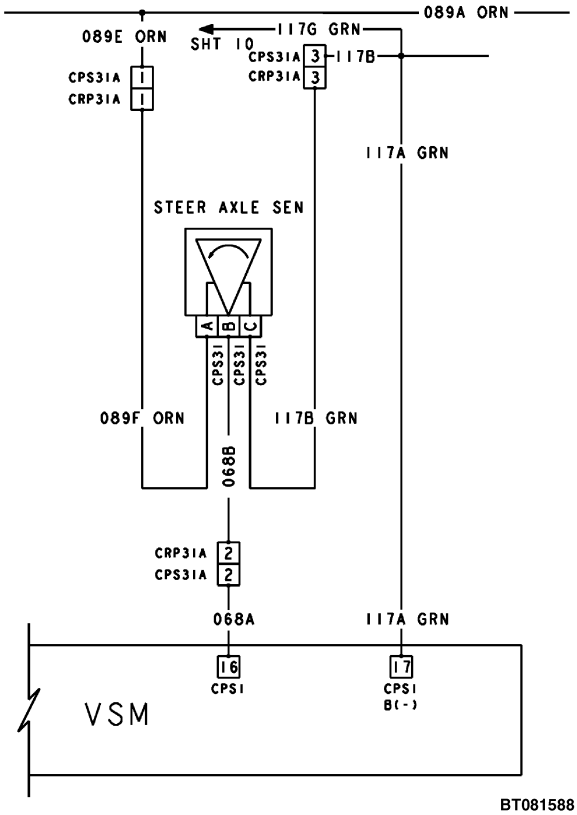
CAUSE D - CONTROLLER FAULT

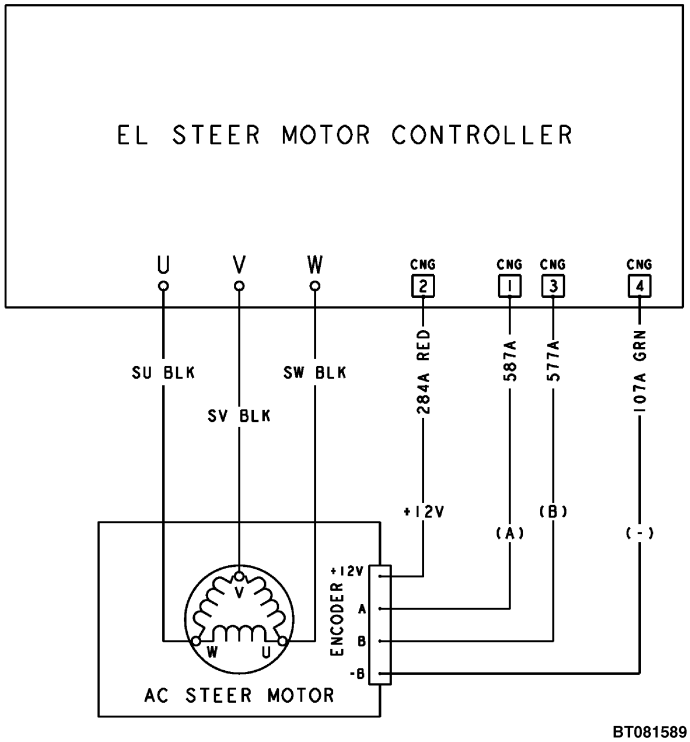
PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

DIAGRAMS





Troubleshooting Scenes

END FAULT

DTC 65532
Steer Axle Sensor Output Mismatch

POSSIBLE CAUSE

A. STEER AXLE SENSOR WIRING FAULT
B. STEER AXLE SENSOR FAULT
C. ENCODER FAULT
D. CONTROLLER FAULT

NOTE
Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - STEER AXLE SENSOR WIRING FAULT

PROCEDURE OR ACTION:

1. Disconnect the steer axle sensor connector CPS31 and measure voltage between socket A and B(-).
   Is voltage 5 ± 0.5 Vdc?
   YES: Proceed to Step 2.
   NO: Inspect supply circuit 089F for open or short. Inspect pigtail connector CRP31A for loose, damaged, or corroded terminals.
2. Measure voltage between the steer axle sensor connector CPS31, socket A and socket C.
   Is voltage 5 ± 0.5 Vdc?
   YES: Disconnect battery and proceed to Step 3.
   NO: Inspect ground circuit 117B for open or short. Inspect pigtail connector CRP31A for loose, damaged, or corroded terminals.
3. Disconnect VSM connector CPS1 and measure resistance between socket 16 and the steer axle sensor connector CPS31, socket B.
   Is voltage 5 ± 0.5 Vdc?
   YES: Connect steer axle sensor and proceed to CAUSE B.
   NO: Inspect input signal circuit 068A for open or source of excessive resistance. Inspect pigtail connector CRP31A, for loose, damaged, or corroded terminals.

CAUSE B - STEER AXLE SENSOR FAULT

PROCEDURE OR ACTION:

1. Measure voltage between the VSM connector CPS1, socket 16 and B(-).
   Does voltage respond to steer axle sensor movement?
   YES: Proceed to CAUSE C.
   NO: Replace faulty steer axle sensor.

CAUSE C - ENCODER FAULT

PROCEDURE OR ACTION:

1. Disconnect the steer encoder connector and measure voltage between encoder 12 volt supply and B(-).
   Is voltage 12 ± 1.5 Vdc?
   YES: Proceed to Step 2.
   NO: Inspect circuit 284A for open or short.
2. Measure voltage between 12 volt supply circuit and ground circuit.
   Is voltage 12 ± 1.5 Vdc?
   YES: Proceed to Step 3.
   NO: Inspect ground circuit 107A for open or short.
3. Disconnect steer controller connector and measure resistance between the following signal circuits:
   - Steer motor controller, socket 1 and steer encoder, socket A.
   - Steer motor controller, socket 3 and steer encoder, socket B.

   Is resistance <1 ohm?
   YES: Connect the encoder and steer controller connectors and proceed to Step 4.
   NO: Inspect encoder signal circuits for open or source of excessive resistance.
4. Using the PC Service Tool, locate and observe the steer encoder count signal.
   Does encoder provide accurate count signal during operation?
   YES: Proceed to CAUSE D.
   NO: Replace faulty steer encoder.

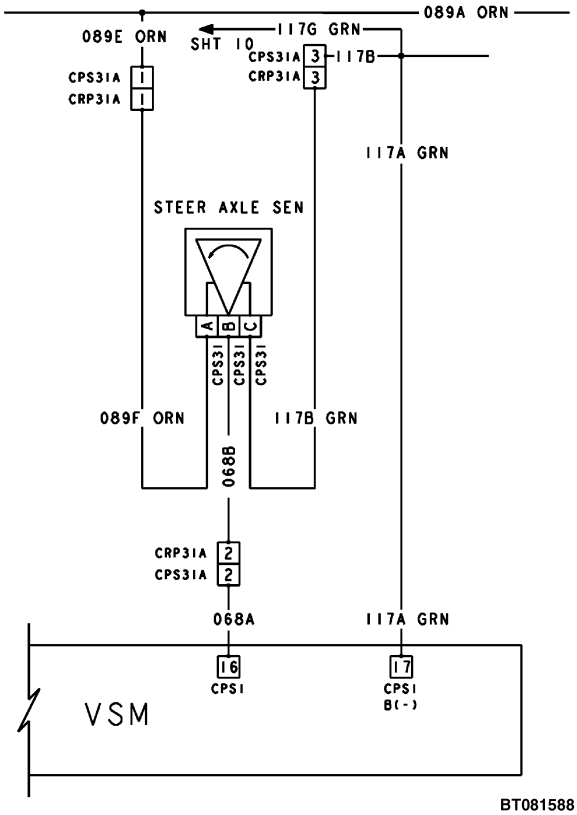
CAUSE D - CONTROLLER FAULT

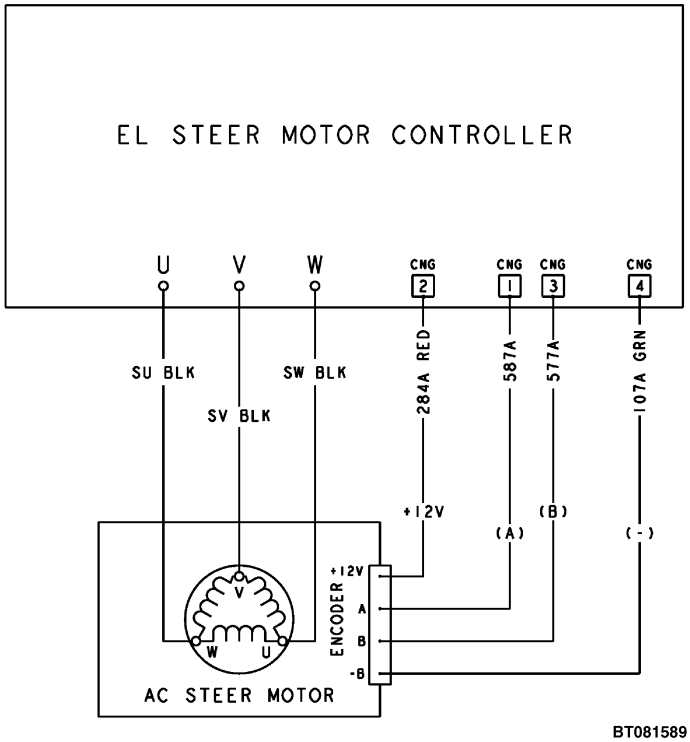
PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

DIAGRAMS





Troubleshooting Scenes

END FAULT

DTC 65503
Electric Steer Rapid Change in Steer Axle Position

POSSIBLE CAUSE

A. STEER AXLE SENSOR WIRING FAULT
B. STEER AXLE SENSOR FAULT
C. ENCODER FAULT
D. CONTROLLER FAULT

NOTE
Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - STEER AXLE SENSOR WIRING FAULT

PROCEDURE OR ACTION:

1. Disconnect the steer axle sensor connector CPS31 and measure voltage between socket A and B(-).
   Is voltage 5 ± 0.5 Vdc?
   YES: Proceed to Step 2.
   NO: Inspect supply circuit 089F for open or short. Inspect pigtail connector CRP31A for loose, damaged, or corroded terminals.
2. Measure voltage between the steer axle sensor connector CPS31, socket A and socket C.
   Is voltage 5 ± 0.5 Vdc?
   YES: Disconnect battery and proceed to Step 3.
   NO: Inspect ground circuit 117B for open or short. Inspect pigtail connector CRP31A for loose, damaged, or corroded terminals.
3. Disconnect VSM connector CPS1 and measure resistance between socket 16 and the steer axle sensor connector CPS31, socket B.
   Is voltage 5 ± 0.5 Vdc?
   YES: Connect steer axle sensor and proceed to CAUSE B.
   NO: Inspect input signal circuit 068A for open or source of excessive resistance. Inspect pigtail connector CRP31A, for loose, damaged, or corroded terminals.

CAUSE B - STEER AXLE SENSOR FAULT

PROCEDURE OR ACTION:

1. Measure voltage between the VSM connector CPS1, socket 16 and B(-).
   Does voltage respond to steer axle sensor movement?
   YES: Proceed to CAUSE C.
   NO: Replace faulty steer axle sensor.

CAUSE C - ENCODER FAULT

PROCEDURE OR ACTION:

1. Disconnect the steer encoder connector and measure voltage between encoder 12 volt supply and B(-).
   Is voltage 12 ± 1.5 Vdc?
   YES: Proceed to Step 2.
   NO: Inspect circuit 284A for open or short.
2. Measure voltage between 12 volt supply circuit and ground circuit.
   Is voltage 12 ± 1.5 Vdc?
   YES: Proceed to Step 3.
   NO: Inspect ground circuit 107A for open or short.
3. Disconnect steer controller connector and measure resistance between the following signal circuits:
   - Steer motor controller, socket 1 and steer encoder, socket A.
   - Steer motor controller, socket 3 and steer encoder, socket B.

   Is resistance <1 ohm?
   YES: Connect the encoder and steer controller connectors and proceed to Step 4.
   NO: Inspect encoder signal circuits for open or source of excessive resistance.
4. Using the PC Service Tool, locate and observe the steer encoder count signal.
   Does encoder provide accurate count signal during operation?
   YES: Proceed to CAUSE D.
   NO: Replace faulty steer encoder.

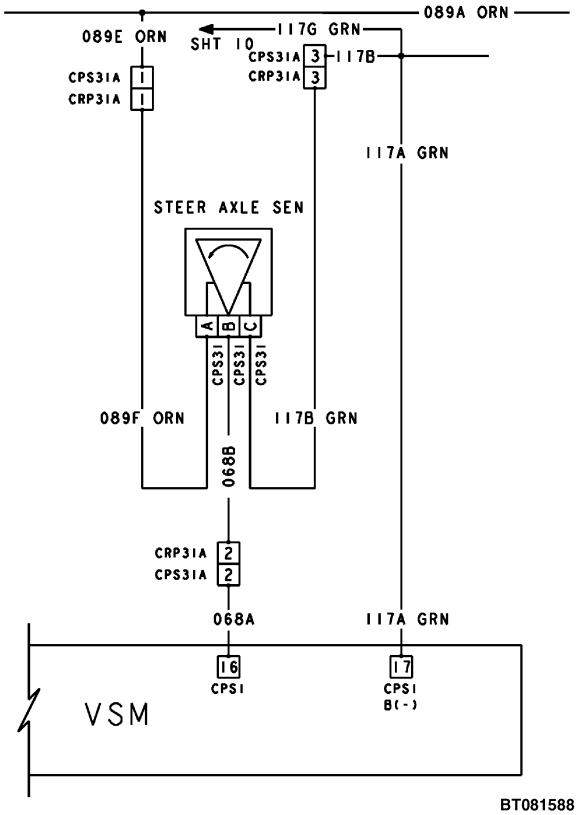
CAUSE D - CONTROLLER FAULT

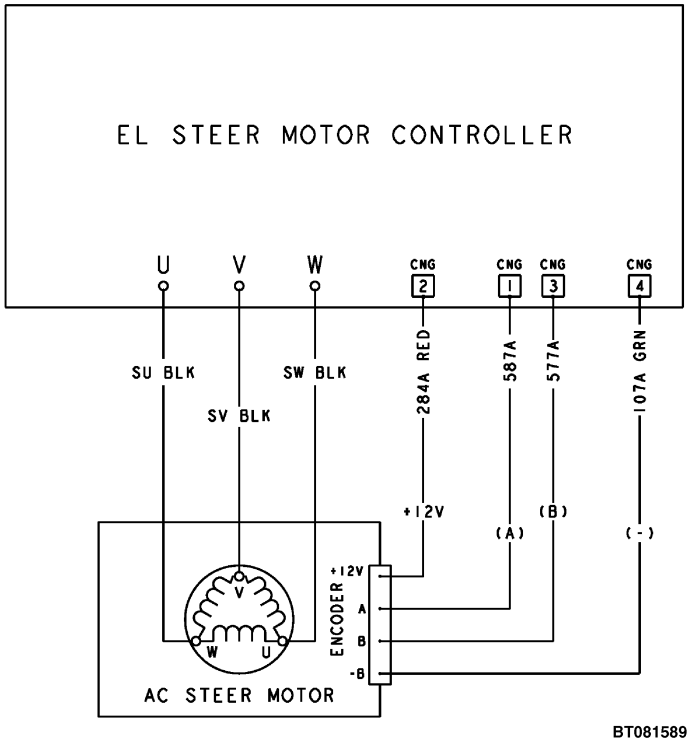
PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

DIAGRAMS





Troubleshooting Scenes

END FAULT

DTC 65524
Electric Steer Primary and Secondary Parameter Mismatch

POSSIBLE CAUSE

A. STEERING WHEEL POSITION CALIBRATION
B. SOFTWARE UPDATE
C. CONTROLLER FAULT

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - STEERING WHEEL POSITION CALIBRATION

PROCEDURE OR ACTION:

1. Perform steer wheel position calibration procedure and retest system.
   Does DTC return after steer wheel has been recalibrated?
   YES: Proceed to CAUSE B.
   NO: No further service is required.

CAUSE B - SOFTWARE UPDATE

PROCEDURE OR ACTION:

1. Reprogram controller and retest system.
   Does DTC return after controller has been reprogrammed?
   YES: Proceed to CAUSE C.
   NO: No further service is required.

CAUSE C - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. If DTC returns after reprogramming, replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

END FAULT

CODES

DTC 65527 - Loss of CAN Communication
DTC 33050 - E-Steer CAN Communications Failure Right
DTC 33051 - E-Steer CAN Communications Failure Left

POSSIBLE CAUSE

A. CANBUS FAULT
B. VSM WIRING FAULT
C. CDF VERSION
D. CONTROLLER FAULT

NOTE
Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - CANBUS FAULT

PROCEDURE OR ACTION:

1. Measure voltage between the diagnostic connector CPS28, socket A and B(-).
   Is voltage approximately 2.5 Vdc?
   YES: Proceed to Step 2.
   NO: Inspect CAN HI circuit for open or short. if voltage is 0 volts, the CAN HI circuit is shorted to ground or open. If voltage is above 5 volts, the CAN HI circuit is shorted to power.
2. Measure voltage between the diagnostic connector CPS28, socket B and B(-).
   Is voltage approximately 2.5 Vdc?
   YES: Disconnect battery and proceed to Step 3.
   NO: Inspect CAN LO circuit for open or short. If voltage is 0 volts, the CAN LO circuit is shorted to ground or open. If voltage is above 5 volts, the CAN LO circuit is shorted to power.

NOTE: The FOC2 left traction controller has an additional termination resistor. The additional resistor will cause a total CANbus resistance of 40 ohms.

3. Measure resistance between the diagnostic connector CPS28, socket A and socket B.
   Is resistance 60 ± 6 (40Ω for FOC2) ohms?
   YES: Connect battery and proceed to CAUSE B.
   NO: If resistance is 120 ohms, the CANbus has an open circuit or a missing or damage termination resistor. If resistance is 0 ohms, the CANbus circuit are shorted together.

CAUSE B - VSM WIRING FAULT

PROCEDURE OR ACTION:

1. Disconnect the VSM connector CPS2 and measure voltage between socket 35 and B(-).
   Is voltage 12 ± 1.5 Vdc?
   YES: Proceed to Step 2.
   NO: Inspect circuit 200A and 200M for open or short. Inspect connector CRP52-55 for loose, damaged, or corroded terminals.
2. Measure voltage between socket 35 and the VSM connector CPS2, socket 2.
   Is voltage 12 ± 1.5 Vdc?
   YES: Proceed to CAUSE C.
   NO: Inspect 013-A for open or short.

CAUSE C - CDF VERSION

PROCEDURE OR ACTION:

1. Using the PC Service Tool, verify current CDF version.
   Is CDF version current?
   YES: Proceed to CAUSE D.
   NO: Update CDF and retest system to verify repair.

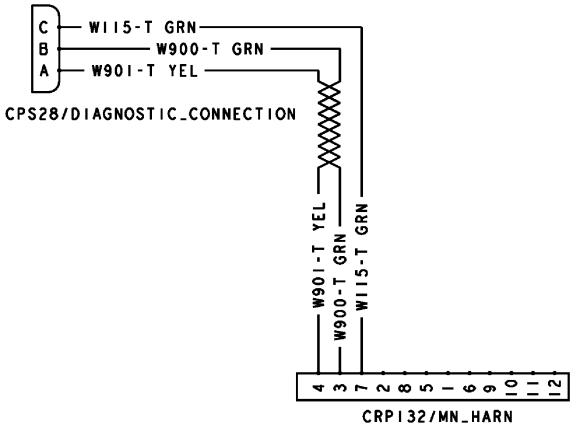
CAUSE D - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

DIAGRAMS



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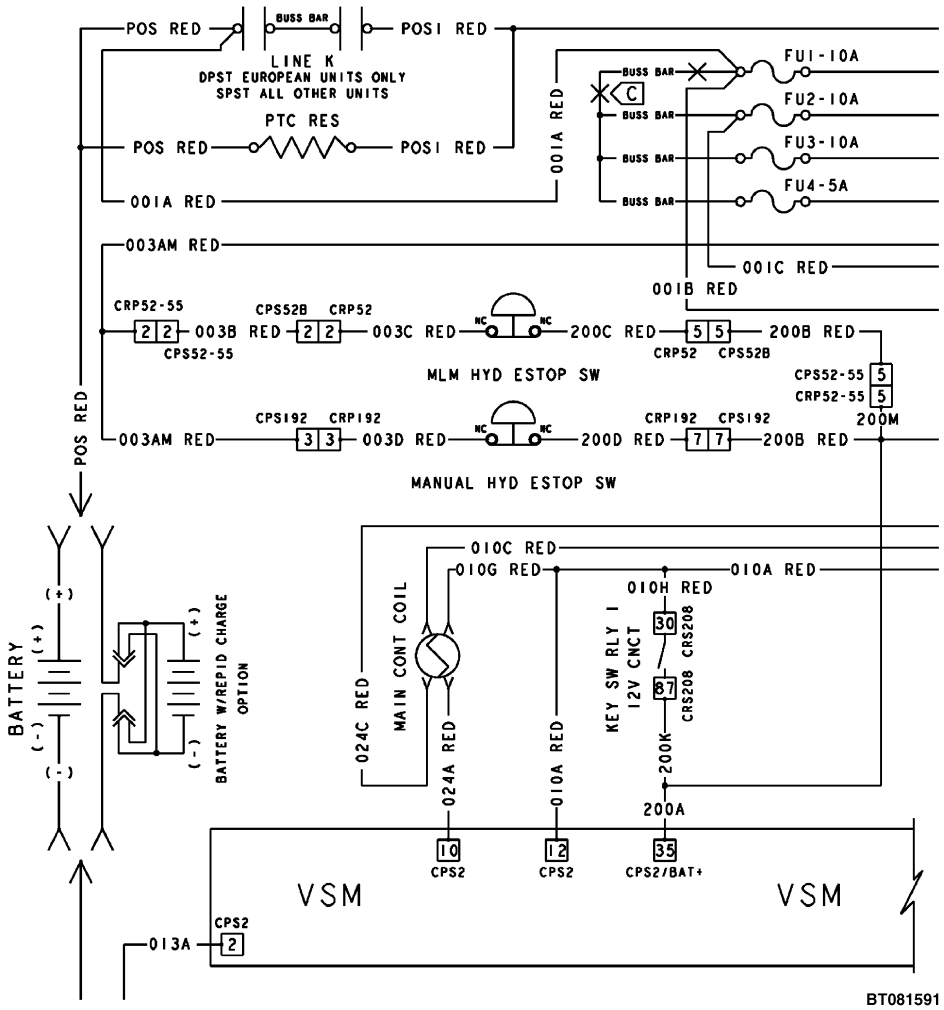

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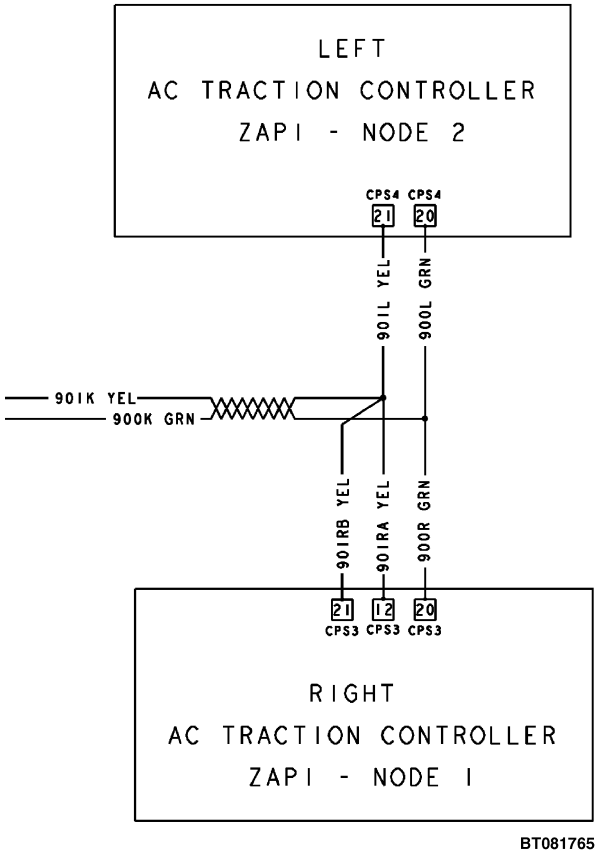


Troubleshooting Scenes

END FAULT

DTC 9045
Internal Error - Software

POSSIBLE CAUSE

A. SOFTWARE UPDATE
B. CONTROLLER FAULT

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - SOFTWARE UPDATE

PROCEDURE OR ACTION:

1. Reprogram controller and retest system.
   Does DTC return after controller has been reprogrammed?
   YES: Proceed to CAUSE B.
   NO: No further service is required.

CAUSE B - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. If DTC returns after reprogramming, replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

END FAULT

DTC 13058
5V Internal Supply Out of Range
5V supply is outside valid range.

POSSIBLE CAUSE

A. CONTROLLER FAULT

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

END FAULT

DTC 13104
Sensor Ground Current OORH

POSSIBLE CAUSE

A. SENSOR WIRING FAULT
B. SPEED SENSOR FAULT (DOES NOT APPLY TO TEMP SENSOR)
C. TEMP SENSOR FAULT (DOES NOT APPLY TO SPEED SENSOR)
D. CONTROLLER FAULT

NOTE
Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - SENSOR WIRING FAULT

PROCEDURE OR ACTION:

1. Disconnect the traction controller connector CPS3 and the temperature or speed sensor connector. Measure resistance between the following:
   - Temperature Sensor - CRS3, socket 17 and connector CRS155, socket 2
   - Speed Sensor - CRS3, socket 4 and connector CRS153, socket 4

   Is resistance <1 ohm?
   YES: Connect traction controller connector CPS3 and proceed to CAUSE B for speed sensor troubleshooting, or CAUSE C for temp sensor troubleshooting.
   NO: Inspect the speed sensor ground circuit 103-A or 106-A for open or source of excessive resistance. Inspect temperature sensor circuit 104-A or 107-A for open or source of excessive remittance.

CAUSE B - SPEED SENSOR FAULT (DOES NOT APPLY TO TEMP SENSOR)

PROCEDURE OR ACTION:

1. Measure voltage between the speed sensor connector CRP153, socket 1 and B(-).
   Is voltage 5 ± 0.5 Vdc?
   YES: Disconnect the controller connector CPS3 and proceed to Step 2.
   NO: Inspect 5 volt supply circuit 282-A or 284-A for open or short.
2. Measure resistance between the traction controller connector CRS3, socket 6 and the speed sensor connector CRP153, socket 2.
   Is resistance <1 ohm?
   YES: Proceed to Step 3.
   NO: Inspect circuit 574-A or 278-A for open or source of excessive resistance.
3. Measure resistance between the traction controller connector CRS3, socket 5 and the speed sensor connector CRP153, socket 3.
   Is resistance <1 ohm?
   YES: Replace faulty speed sensor.
   NO: Proceed to CAUSE D.

CAUSE C - TEMP SENSOR FAULT (DOES NOT APPLY TO SPEED SENSOR)

PROCEDURE OR ACTION:

1. Measure resistance across temper sensor connector CRP155, socket 1 and socket 2.
   Does resistance match temperatures (Refer to table 9030-10-4 for specification)?
   YES: Proceed to CAUSE D.
   NO: Replace faulty temperature sensor.

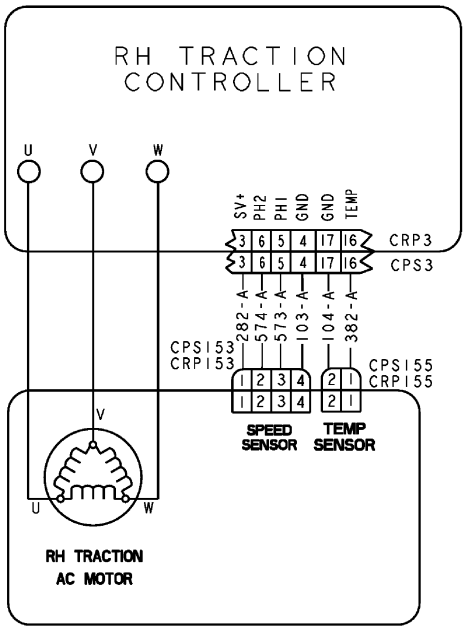
CAUSE D - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

DIAGRAMS



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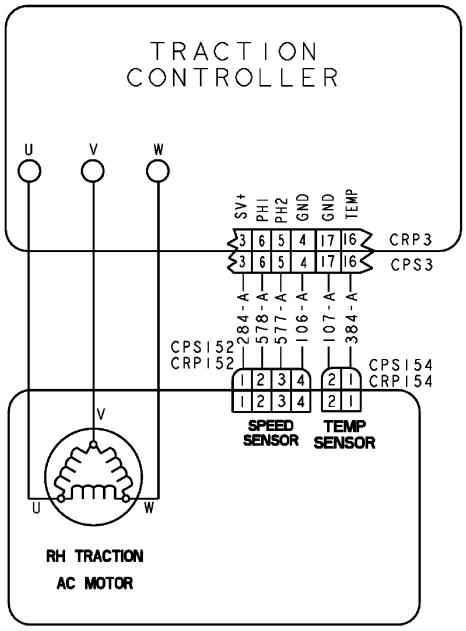

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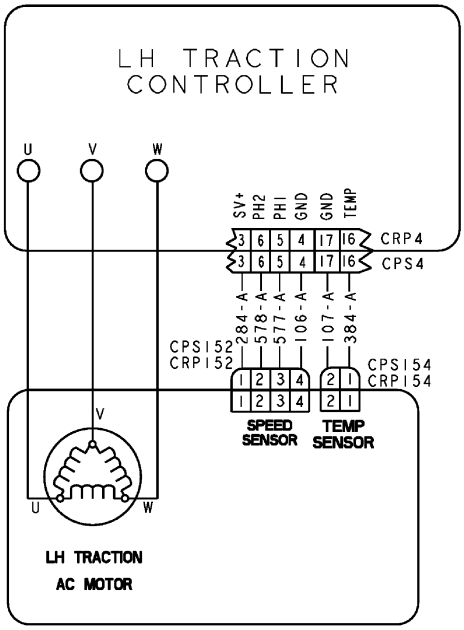

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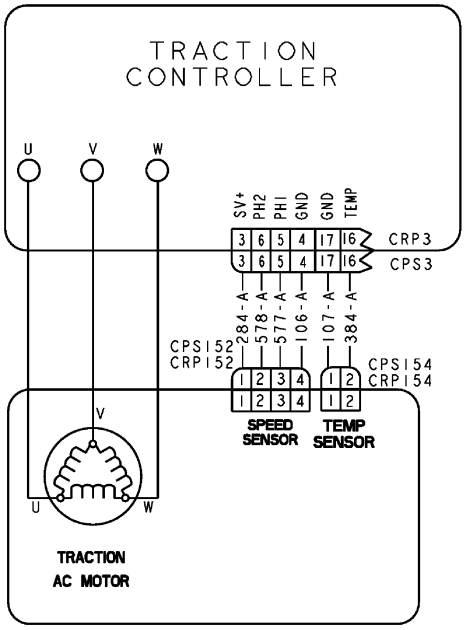

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Troubleshooting Scenes

END FAULT

DTC 16913
Motor Temperature Sensor Open Circuit

POSSIBLE CAUSE

A. SENSOR WIRING FAULT
B. SPEED SENSOR FAULT (DOES NOT APPLY TO TEMP SENSOR)
C. TEMP SENSOR FAULT (DOES NOT APPLY TO SPEED SENSOR)
D. CONTROLLER FAULT

NOTE
Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - SENSOR WIRING FAULT

PROCEDURE OR ACTION:

1. Disconnect the traction controller connector CPS3 and the temperature or speed sensor connector. Measure resistance between the following:
   - Temperature Sensor - CRS3, socket 17 and connector CRS155, socket 2
   - Speed Sensor - CRS3, socket 4 and connector CRS153, socket 4

   Is resistance <1 ohm?
   YES: Connect traction controller connector CPS3 and proceed to CAUSE B for speed sensor troubleshooting, or CAUSE C for temp sensor troubleshooting.
   NO: Inspect the speed sensor ground circuit 103-A or 106-A for open or source of excessive resistance. Inspect temperature sensor circuit 104-A or 107-A for open or source of excessive remittance.

CAUSE B - SPEED SENSOR FAULT (DOES NOT APPLY TO TEMP SENSOR)

PROCEDURE OR ACTION:

1. Measure voltage between the speed sensor connector CRP153, socket 1 and B(-).
   Is voltage 5 ± 0.5 Vdc?
   YES: Disconnect the controller connector CPS3 and proceed to Step 2.
   NO: Inspect 5 volt supply circuit 282-A or 284-A for open or short.
2. Measure resistance between the traction controller connector CRS3, socket 6 and the speed sensor connector CRP153, socket 2.
   Is resistance <1 ohm?
   YES: Proceed to Step 3.
   NO: Inspect circuit 574-A or 278-A for open or source of excessive resistance.
3. Measure resistance between the traction controller connector CRS3, socket 5 and the speed sensor connector CRP153, socket 3.
   Is resistance <1 ohm?
   YES: Replace faulty speed sensor.
   NO: Proceed to CAUSE D.

CAUSE C - TEMP SENSOR FAULT (DOES NOT APPLY TO SPEED SENSOR)

PROCEDURE OR ACTION:

1. Measure resistance across temper sensor connector CRP155, socket 1 and socket 2.
   Does resistance match temperatures (Refer to table 9030-10-4 for specification)?
   YES: Proceed to CAUSE D.
   NO: Replace faulty temperature sensor.

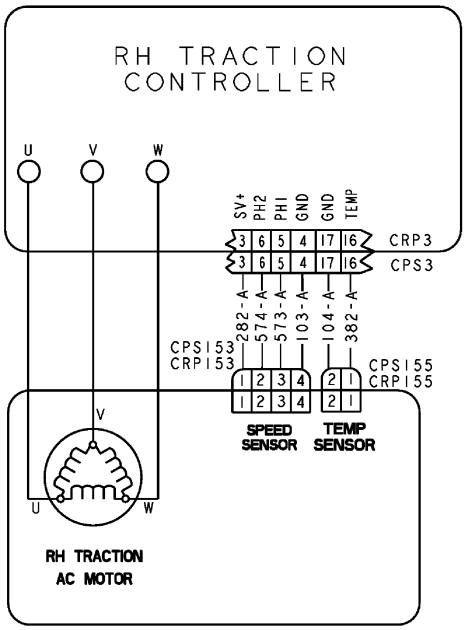
CAUSE D - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

DIAGRAMS



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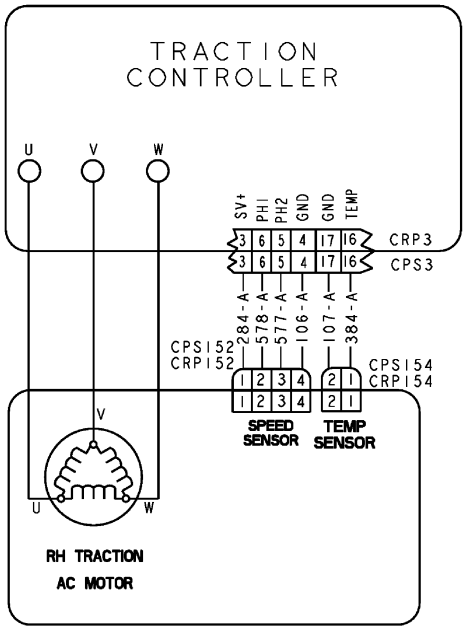

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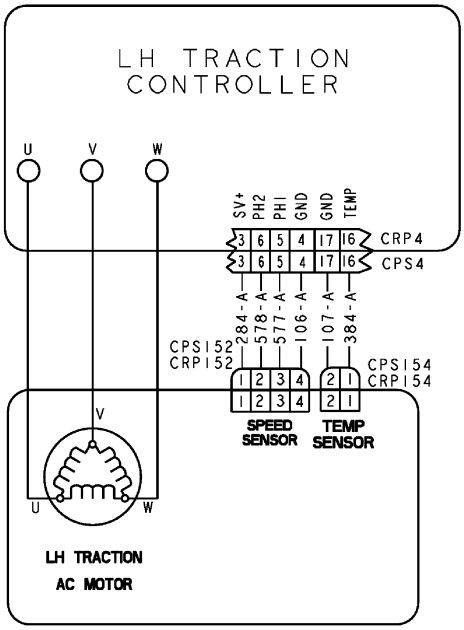

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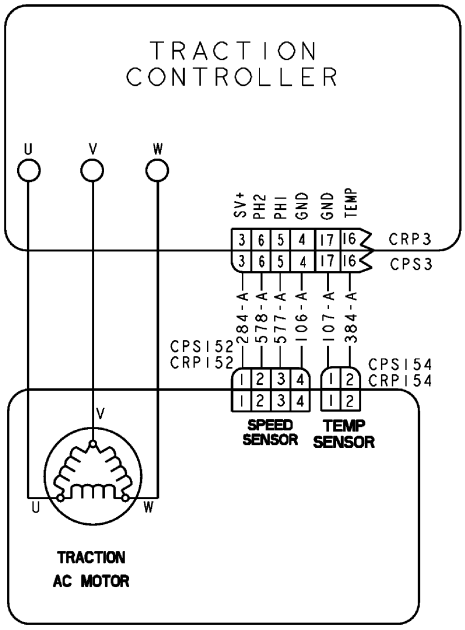

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Troubleshooting Scenes

END FAULT

DTC 16914
Motor Temperature Sensor Short Circuit

POSSIBLE CAUSE

A. SENSOR WIRING FAULT
B. SPEED SENSOR FAULT (DOES NOT APPLY TO TEMP SENSOR)
C. TEMP SENSOR FAULT (DOES NOT APPLY TO SPEED SENSOR)
D. CONTROLLER FAULT

NOTE
Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - SENSOR WIRING FAULT

PROCEDURE OR ACTION:

1. Disconnect the traction controller connector CPS3 and the temperature or speed sensor connector. Measure resistance between the following:
   - Temperature Sensor - CRS3, socket 17 and connector CRS155, socket 2
   - Speed Sensor - CRS3, socket 4 and connector CRS153, socket 4

   Is resistance <1 ohm?
   YES: Connect traction controller connector CPS3 and proceed to CAUSE B for speed sensor troubleshooting, or CAUSE C for temp sensor troubleshooting.
   NO: Inspect the speed sensor ground circuit 103-A or 106-A for open or source of excessive resistance. Inspect temperature sensor circuit 104-A or 107-A for open or source of excessive remittance.

CAUSE B - SPEED SENSOR FAULT (DOES NOT APPLY TO TEMP SENSOR)

PROCEDURE OR ACTION:

1. Measure voltage between the speed sensor connector CRP153, socket 1 and B(-).
   Is voltage 5 ± 0.5 Vdc?
   YES: Disconnect the controller connector CPS3 and proceed to Step 2.
   NO: Inspect 5 volt supply circuit 282-A or 284-A for open or short.
2. Measure resistance between the traction controller connector CRS3, socket 6 and the speed sensor connector CRP153, socket 2.
   Is resistance <1 ohm?
   YES: Proceed to Step 3.
   NO: Inspect circuit 574-A or 278-A for open or source of excessive resistance.
3. Measure resistance between the traction controller connector CRS3, socket 5 and the speed sensor connector CRP153, socket 3.
   Is resistance <1 ohm?
   YES: Replace faulty speed sensor.
   NO: Proceed to CAUSE D.

CAUSE C - TEMP SENSOR FAULT (DOES NOT APPLY TO SPEED SENSOR)

PROCEDURE OR ACTION:

1. Measure resistance across temper sensor connector CRP155, socket 1 and socket 2.
   Does resistance match temperatures (Refer to table 9030-10-4 for specification)?
   YES: Proceed to CAUSE D.
   NO: Replace faulty temperature sensor.

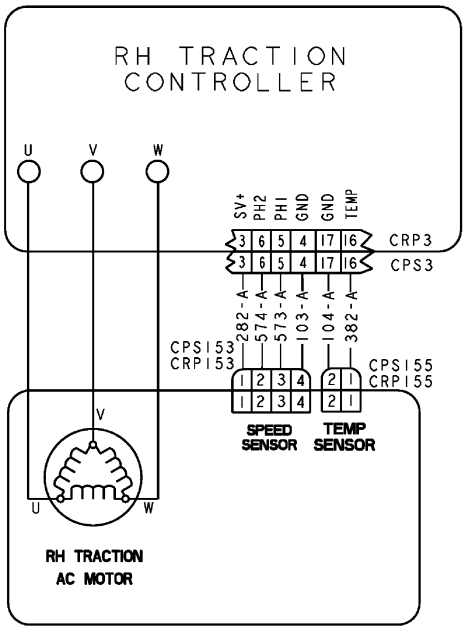
CAUSE D - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

DIAGRAMS



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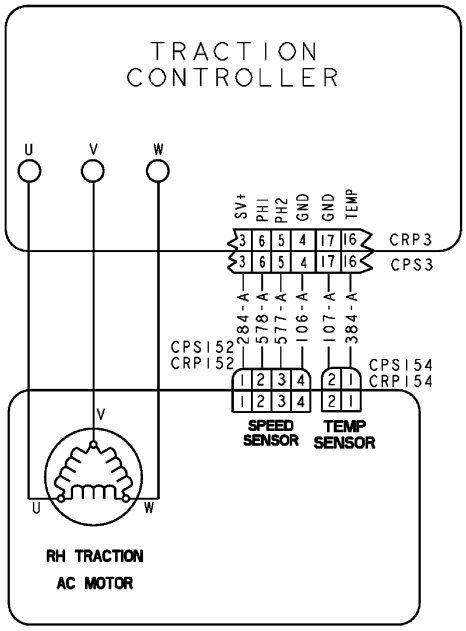

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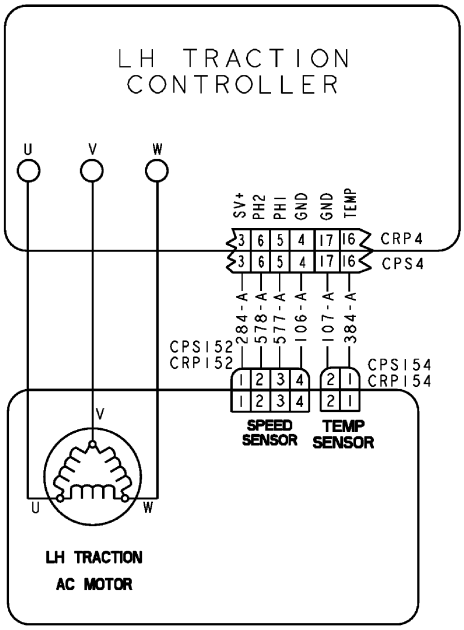

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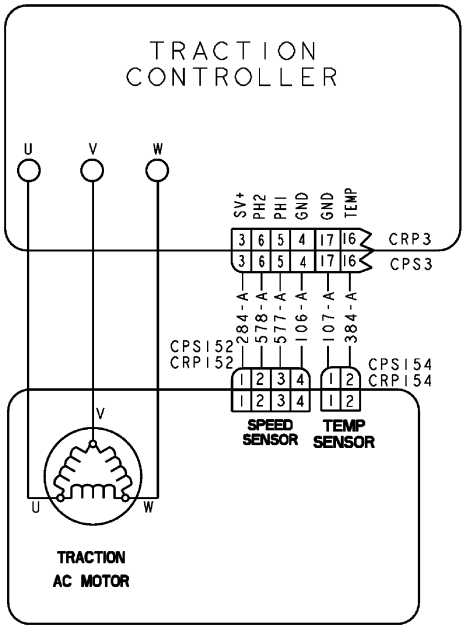

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Troubleshooting Scenes

END FAULT

DTC 16912
Motor Temperature OORH

POSSIBLE CAUSE

A. MOTOR OVER TEMP
B. TEMP SENSOR WIRING FAULT
C. TEMPERATURE SENSOR FAULT
D. MOTOR FAULT
E. CONTROLLER FAULT

NOTE
Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - MOTOR OVER TEMP

PROCEDURE OR ACTION:

1. Using the PC Service Tool, verify steer motor temperature and then measure actual motor temperatures. Over temp conditions are above 120°C (248°F).
   Is motor temperature out of range?
   YES: Allow motor to cool within acceptable temperatures, clear DTC and resume operation. If motor continues to overheat, proceed to CAUSE D.
   NO: Disconnect battery and proceed CAUSE B

CAUSE B - TEMP SENSOR WIRING FAULT

PROCEDURE OR ACTION:

1. Disconnect temperature sensor connectors from motor and controller and inspect pins/sockets.
   Is connector damage present?
   YES: Repair connector, clear DTC and retest system.
   NO: Proceed to Step 2.
2. Measure resistance between the following:
   - Controller temp sensor connector, socket 16 and motor temp sensor connector, socket 2.
   - Controller temp sensor connector, socket 17 and motor temp sensor connector, socket 1.

   Is resistance <1 ohm?
   YES: Proceed to CAUSE E.
   NO: Inspect appropriate temp sensor circuit for open or source of excessive resistance.

CAUSE C - TEMPERATURE SENSOR FAULT

PROCEDURE OR ACTION:

1. Measure resistance between the temp sensor connector pin 1 and pin 2.
   Does resistance match temperatures (Refer to table 9030-10-4 for specification)?
   YES: Proceed to CAUSE E.
   NO: Replace faulty temperature sensor.

CAUSE D - MOTOR FAULT

PROCEDURE OR ACTION:

1. Replace faulty motor.

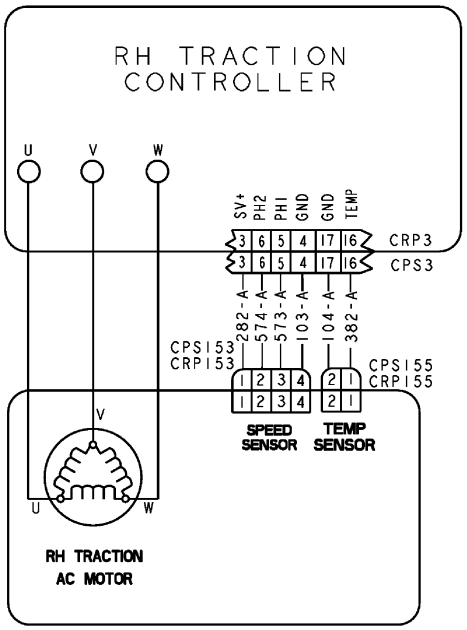
CAUSE E - CONTROLLER FAULT

PROCEDURE OR ACTION:

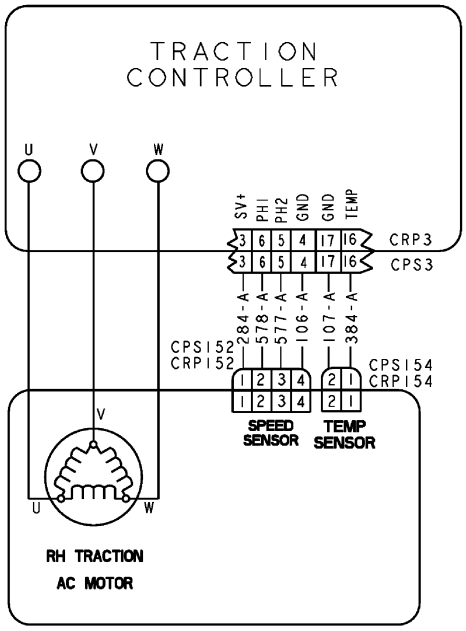
1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

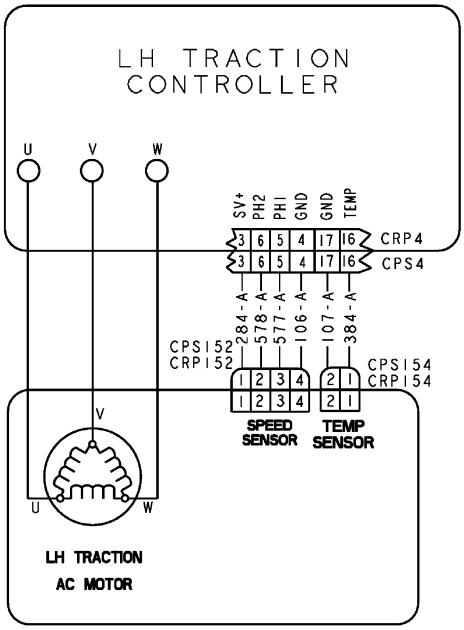
DIAGRAMS



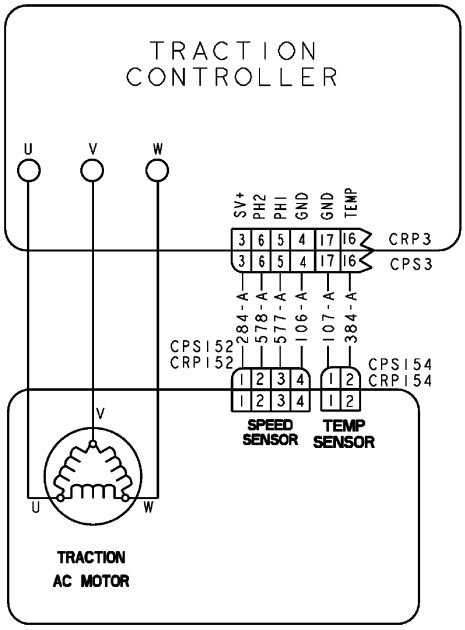
BT081592



BT081593



BT081594



BT081595

Troubleshooting Scenes

END FAULT

DTC 21521
Fan Driver Current OORH

POSSIBLE CAUSE

A. FAN WIRING FAULT
B. FAN RELAY FAULT
C. FAN FAULT
D. CONTROLLER FAULT

NOTE
Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - FAN WIRING FAULT

PROCEDURE OR ACTION:

1. Disconnect the appropriate cooling fan connector CRP156A/157A and measure voltage between socket 1 and B(-).
   Is voltage 12 ± 1.5 Vdc?
   YES: Proceed to Step 2.
   NO: Inspect appropriate voltage circuit 034-K, 034-H, and 034-J for open or short. If no wiring short is found, proceed to CAUSE B.
2. Measure voltage between the cooling fan connector CRP126A/127A, socket 1 and socket 2.
   Is voltage 12 ± 1.5 Vdc?
   YES: Proceed to CAUSE B.
   NO: Inspect fan ground circuit 013-X and 13-V for open or short.

CAUSE B - FAN RELAY FAULT

PROCEDURE OR ACTION:

1. Remove fan relay CRS214 and measure voltage between socket 86 and B(-).
   Is voltage 12 ± 1.5 Vdc?
   YES: Proceed to Step 2.
   NO: Inspect coil power supply circuit 034-F for open or short.
2. Measure voltage between the fan relay CRS214, socket 30 and B(-).
   Is voltage 12 ± 1.5 Vdc?
   YES: Proceed to Step 3.
   NO: Inspect switch power supply circuit 034-G for open or short.
3. Measure voltage between the fan relay CRS214, socket 30 and socket 85.
   Is voltage 12 ± 1.5 Vdc?
   YES: Proceed to Step 4.
   NO: Inspect ground circuit 898-E for open or short.
4. Using a jumper wire, bypass the fan relay by placing jumper wire between socket 30 and socket 87.
   Does fan operate?
   YES: Replace faulty fan relay.
   NO: Install fan relay and proceed to CAUSE C.

CAUSE C - FAN FAULT

PROCEDURE OR ACTION:

1. Replace inoperative fan.
   Is cooling fan operational?
   YES: Clear DTC and verify correct operation.
   NO: Proceed to CAUSE D.

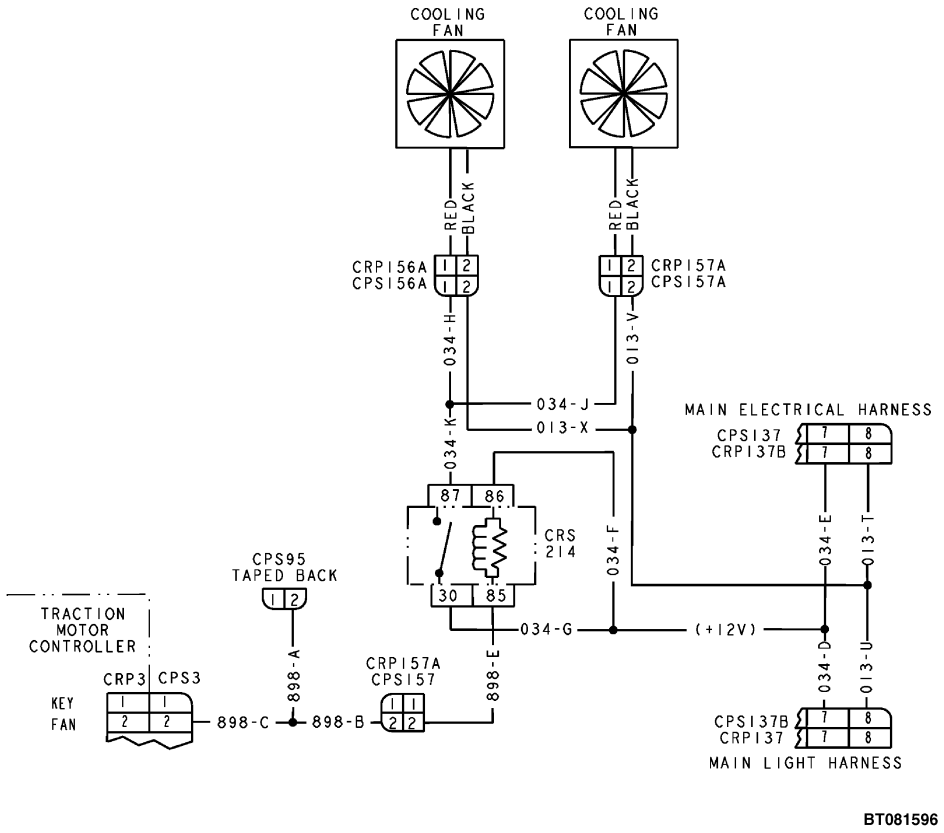
CAUSE D - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

DIAGRAMS



Troubleshooting Scenes

END FAULT

DTC 21776
Internal Error - Hardware

POSSIBLE CAUSE

A. CONTROLLER FAULT

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

END FAULT

DTC 29232
Sensor Supply Reference voltage Out of Range

POSSIBLE CAUSE

A. CONTROLLER FAULT

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

END FAULT

DTC 21522
Automatic Park Brake Driver Current OORH

POSSIBLE CAUSE

A. PARK BRAKE WIRING FAULT
B. PARK BRAKE SOLENOID FAULT
C. CONTROLLER FAULT

NOTE
Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - PARK BRAKE WIRING FAULT

PROCEDURE OR ACTION:

1. Disconnect the park brake solenoid connector CPS195 and measure voltage between socket 1 and B(-).
   Is voltage 12 ± 1.5 Vdc?
   YES: Proceed to Step 2.
   NO: Inspect supply circuit 010-J for open or short.
2. Measure voltage between the park brake solenoid connector CPS195, socket 1 and socket 2.
   Is voltage 12 ± 1.5 Vdc?
   YES: Proceed to CAUSE B.
   NO: Inspect ground circuit 096-C for open or short.

CAUSE B - PARK BRAKE SOLENOID FAULT

PROCEDURE OR ACTION:

1. Measure resistance across the park brake solenoid connector CRP195, pin 1 and pin 2.
   Is resistance XX ohms?
   YES: Proceed to CAUSE C.
   NO: Replace faulty park brake solenoid.

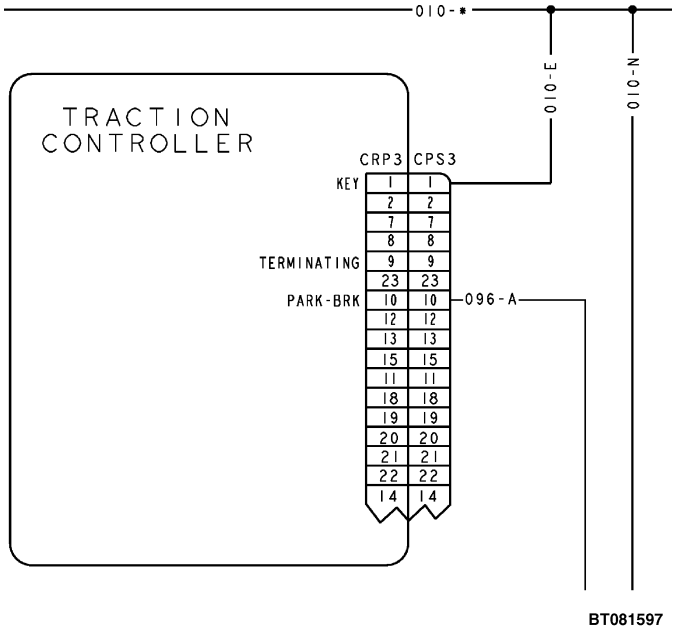
CAUSE C - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

DIAGRAMS



END FAULT

DTC 29216
Speed Sensor High Current

POSSIBLE CAUSE

A. SPEED SENSOR WIRING FAULT
B. SPEED SENSOR FAULT
C. CONTROLLER FAULT

NOTE
Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - SPEED SENSOR WIRING FAULT

PROCEDURE OR ACTION:

1. Disconnect the speed sensor connector and measure voltage between encoder 5 volt supply and B(-).
   Is voltage 5 ± 0.5 Vdc?
   YES: Proceed to Step 2.
   NO: Inspect circuit 284A or 282-A for open or short.
2. Measure voltage between 5 volt supply circuit and ground circuit.
   Is voltage 5 ± 0.5 Vdc?
   YES: Proceed to Step 3.
   NO: Inspect ground circuit 106-A or 103-A for open or short.
3. Disconnect traction controller connector and measure resistance between the following signal circuits:
   - Traction controller connector, socket 6 and speed sensor connector, socket 2.
   - Traction controller connector, socket 5 and speed sensor connector, socket 3.

   Is resistance <1 ohm?
   YES: Connect the speed sensor and traction controller connectors and proceed to CAUSE B.
   NO: Inspect encoder signal circuits or open or source of excessive resistance.

CAUSE B - SPEED SENSOR FAULT

PROCEDURE OR ACTION:

1. Using the PC Service Tool, locate and observe the speed sensor count signal.
   Does encoder provide accurate count signal during operation?
   YES: Proceed to CAUSE C.
   NO: Replace faulty speed sensor.

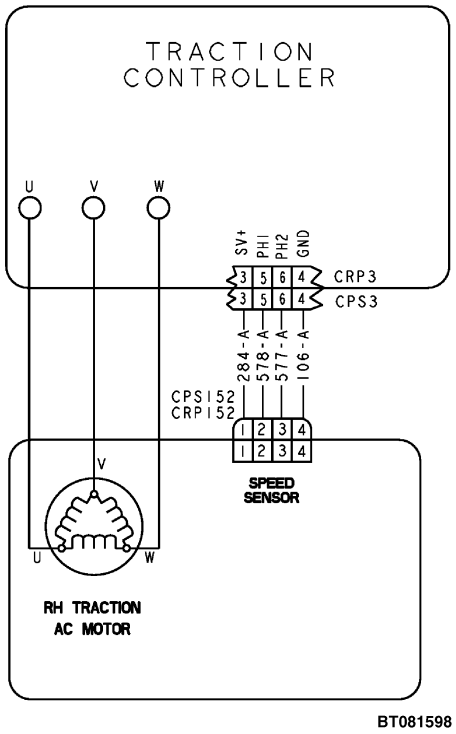
CAUSE C - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

DIAGRAMS



Troubleshooting Scenes

END FAULT

DTC 29217
Speed Sensor Not Connected

POSSIBLE CAUSE

A. SPEED SENSOR WIRING FAULT
B. SPEED SENSOR FAULT
C. CONTROLLER FAULT

NOTE
Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - SPEED SENSOR WIRING FAULT

PROCEDURE OR ACTION:

1. Disconnect the speed sensor connector and measure voltage between encoder 5 volt supply and B(-).
   Is voltage 5 ± 0.5 Vdc?
   YES: Proceed to Step 2.
   NO: Inspect circuit 284A or 282-A for open or short.
2. Measure voltage between 5 volt supply circuit and ground circuit.
   Is voltage 5 ± 0.5 Vdc?
   YES: Proceed to Step 3.
   NO: Inspect ground circuit 106-A or 103-A for open or short.
3. Disconnect traction controller connector and measure resistance between the following signal circuits:
   - Traction controller connector, socket 6 and speed sensor connector, socket 2.
   - Traction controller connector, socket 5 and speed sensor connector, socket 3.

   Is resistance <1 ohm?
   YES: Connect the speed sensor and traction controller connectors and proceed to CAUSE B.
   NO: Inspect encoder signal circuits or open or source of excessive resistance.

CAUSE B - SPEED SENSOR FAULT

PROCEDURE OR ACTION:

1. Using the PC Service Tool, locate and observe the speed sensor count signal.
   Does encoder provide accurate count signal during operation?
   YES: Proceed to CAUSE C.
   NO: Replace faulty speed sensor.

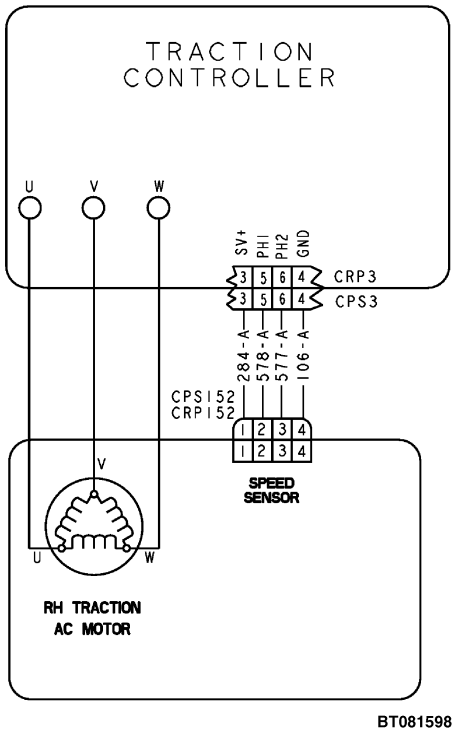
CAUSE C - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

DIAGRAMS



Troubleshooting Scenes

END FAULT

DTC 29233
Sensor Supply Circuit Out of Range

POSSIBLE CAUSE

A. SPEED SENSOR WIRING FAULT
B. SPEED SENSOR FAULT
C. CONTROLLER FAULT

NOTE
Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - SPEED SENSOR WIRING FAULT

PROCEDURE OR ACTION:

1. Disconnect the speed sensor connector and measure voltage between encoder 5 volt supply and B(-).
   Is voltage 5 ± 0.5 Vdc?
   YES: Proceed to Step 2.
   NO: Inspect circuit 284A or 282-A for open or short.
2. Measure voltage between 5 volt supply circuit and ground circuit.
   Is voltage 5 ± 0.5 Vdc?
   YES: Proceed to Step 3.
   NO: Inspect ground circuit 106-A or 103-A for open or short.
3. Disconnect traction controller connector and measure resistance between the following signal circuits:
   - Traction controller connector, socket 6 and speed sensor connector, socket 2.
   - Traction controller connector, socket 5 and speed sensor connector, socket 3.

   Is resistance <1 ohm?
   YES: Connect the speed sensor and traction controller connectors and proceed to CAUSE B.
   NO: Inspect encoder signal circuits or open or source of excessive resistance.

CAUSE B - SPEED SENSOR FAULT

PROCEDURE OR ACTION:

1. Using the PC Service Tool, locate and observe the speed sensor count signal.
   Does encoder provide accurate count signal during operation?
   YES: Proceed to CAUSE C.
   NO: Replace faulty speed sensor.

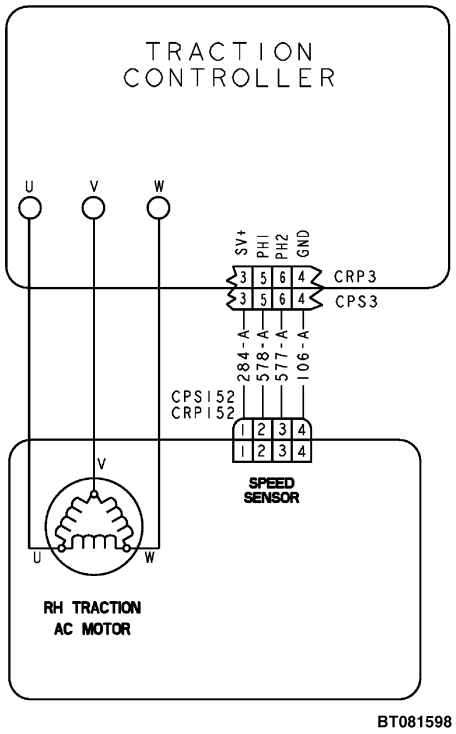
CAUSE C - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

DIAGRAMS



Troubleshooting Scenes

END FAULT

CODES

DTC 29552 - Loss of Speed Sensor Channel B
DTC 65362 - Encoder Error
DTC 65512 - Wrong Encoder Set

POSSIBLE CAUSE

A. SPEED SENSOR WIRING FAULT
B. SPEED SENSOR FAULT
C. CONTROLLER FAULT

NOTE
Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. **NOTE:** If DTC 65512 is set, verify parameters are correct for type of encoder. If parameter matches encoder type, continue with the following procedures.
2. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 3.
   NO: Problem not verified, resume operation.
3. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - SPEED SENSOR WIRING FAULT

PROCEDURE OR ACTION:

1. Disconnect the speed sensor connector and measure voltage between encoder 5 volt supply and B(-).
   Is voltage 5 ± 0.5 Vdc?
   YES: Proceed to Step 2.
   NO: Inspect circuit 284A or 282-A for open or short.
2. Measure voltage between 5 volt supply circuit and ground circuit.
   Is voltage 5 ± 0.5 Vdc?
   YES: Proceed to Step 3.
   NO: Inspect ground circuit 106-A or 103-A for open or short.
3. Disconnect traction controller connector and measure resistance between the following signal circuits:
   - Traction controller connector, socket 6 and speed sensor connector, socket 2.
   - Traction controller connector, socket 5 and speed sensor connector, socket 3.

   Is resistance <1 ohm?
   YES: Connect the speed sensor and traction controller connectors and proceed to CAUSE B.
   NO: Inspect encoder signal circuits or open or source of excessive resistance.

CAUSE B - SPEED SENSOR FAULT

PROCEDURE OR ACTION:

1. Using the PC Service Tool, locate and observe the speed sensor count signal.
   Does encoder provide accurate count signal during operation?
   YES: Proceed to CAUSE C.
   NO: Replace faulty speed sensor.

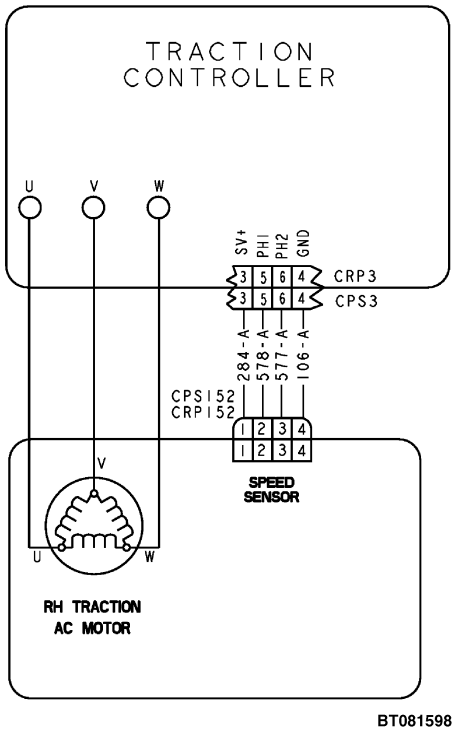
CAUSE C - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

DIAGRAMS



Troubleshooting Scenes

END FAULT

DTC 65346
Battery Low

POSSIBLE CAUSE

A. KEY INPUT OR BATTERY WIRING FAULT
B. CONTROLLER FAULT

NOTE
Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - KEY INPUT OR BATTERY WIRING FAULT

PROCEDURE OR ACTION:

NOTE: Key in ON position.

1. Disconnect the appropriate traction controller connector CPS3/CPS4. Measure voltage between controller connector CPS3/CPS4, cavity 1 and B(-).
   Is voltage 36 ± 3.5 Vdc?
   YES: Proceed to Step 2.
   NO: Inspect circuits 010LB, 010R, and 010A for open or short.

NOTE: Key in ON position.

2. Measure voltage between the appropriate traction controller B(+) terminal and B(-).
   Is voltage 36 ± 3.5 Vdc?
   YES: Proceed to CAUSE B.
   NO: Suspect faulty battery. Charge and retest system.

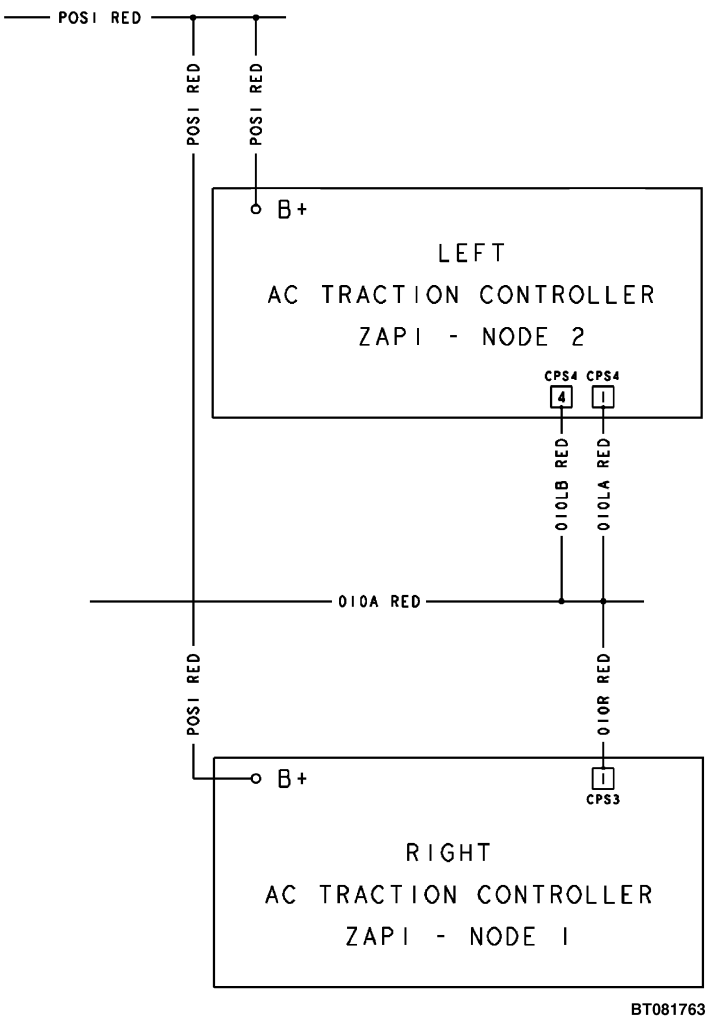
CAUSE B - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

DIAGRAMS



Troubleshooting Scenes

END FAULT

DTC 65529
Check Up Needed

POSSIBLE CAUSE

A. SERVICE NEEDED

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - SERVICE NEEDED

PROCEDURE OR ACTION:

1. Truck has exceeded hours needed for service requirements. Service truck, clear DTC, and return to operation.

END POSSIBLE CAUSES

END FAULT

DTC 95360
Forw + Back

POSSIBLE CAUSE

A. FWD / REV SELECT SWITCH WIRING FAULT
B. FWD / REV SELECT SWITCH FAULT
C. TRACTION CONTROLLER CANBUS FAULT
D. CONTROLLER FAULT

NOTE
Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - FWD / REV SELECT SWITCH WIRING FAULT

PROCEDURE OR ACTION:

NOTE: Key in ON position.

1. Disconnect the FWD / REV select switch connector CRP64 and measure voltage between cavity 1 (Harness side) and B(-).
   Is voltage 5 ± 0.5 Vdc?
   YES: Proceed to Step 2.
   NO: Inspect 5 volt supply circuit 089(250) or 250B for open or short.

NOTE: Key in ON position.

2. Measure voltage between FWD / REV select switch connector CRP64, cavity 1 and cavity 2 (Harness side).
   Is voltage 5 ± 0.5 Vdc?
   YES: Connect FWD / REV select switch connector CRP64 and proceed to Step 3.
   NO: Inspect ground circuits 120(115) or 115C for open or short.
3. Measure voltage between the FWD / REV select switch connector, cavity 3 and B(-). Place select switch in FWD position.
   Is signal 1 circuit voltage 5 ± 0.5 Vdc?
   YES: Proceed to Step 4.
   NO: Inspect signal 1 circuit 008C, 008B, and 006AB for open or short.
4. Measure voltage between the FWD / REV select switch connector, cavity 2 and B(-). Place select switch in REV position.
   Is signal 1 circuit voltage 5 ± 0.5 Vdc?
   YES: Proceed to CAUSE B.
   NO: Inspect signal 2 circuit 006A, 006B, and 006AB for open or short.

CAUSE B - FWD / REV SELECT SWITCH FAULT

PROCEDURE OR ACTION:

1. Disconnect FWD / REV select switch connector CRP64 and measure continuity between cavity 1 and cavity 3. Place select switch in FWD position.
   Is continuity present?
   YES: Proceed to CAUSE D.
   NO: Replace faulty switch.
2. Measure continuity between switch connector CRP64, cavity 1 and cavity 2. Place select switch in REV position.
   Is continuity present?
   YES: Proceed to CAUSE C.
   NO: Replace faulty switch.

CAUSE C - TRACTION CONTROLLER CANBUS FAULT

PROCEDURE OR ACTION:

NOTE: Key in ON position.

1. Disconnect the appropriate traction controller connector CPS3/CPS4. Measure voltage between cavity 20 and B(-).
   Is CAN HI voltage approximately 2.5 Vdc?
   YES: Proceed to Step 2.
   NO: Inspect CAN HI circuit for open or short. If voltage is 0 volts, the CAN HI circuit is shorted to ground or open. If voltage is above 5 volts, the CAN HI circuit is shorted to power.
2. Measure voltage between the traction controller connector CPS3/CPS4, cavity 21/12 and B(-).
   Is CAN HI voltage approximately 2.5 Vdc?
   YES: Disconnect battery and proceed to Step 3.
   NO: Inspect CAN LO circuit for open or short. If voltage is 0 volts, the CAN LO circuit is shorted to ground or open. If voltage is above 5 volts, the CAN LO circuit is shorted to power.
3. Measure resistance between the traction controller connector CPS11, socket A21 and socket A20.
   Is resistance 60 ± 6 ohms?
   YES: CAUSE D
   NO: If resistance is 120 ohms, the CANbus has an open circuit or a missing or damaged termination resistor. If resistance is 0 ohms, the CANbus circuits are shorted together.

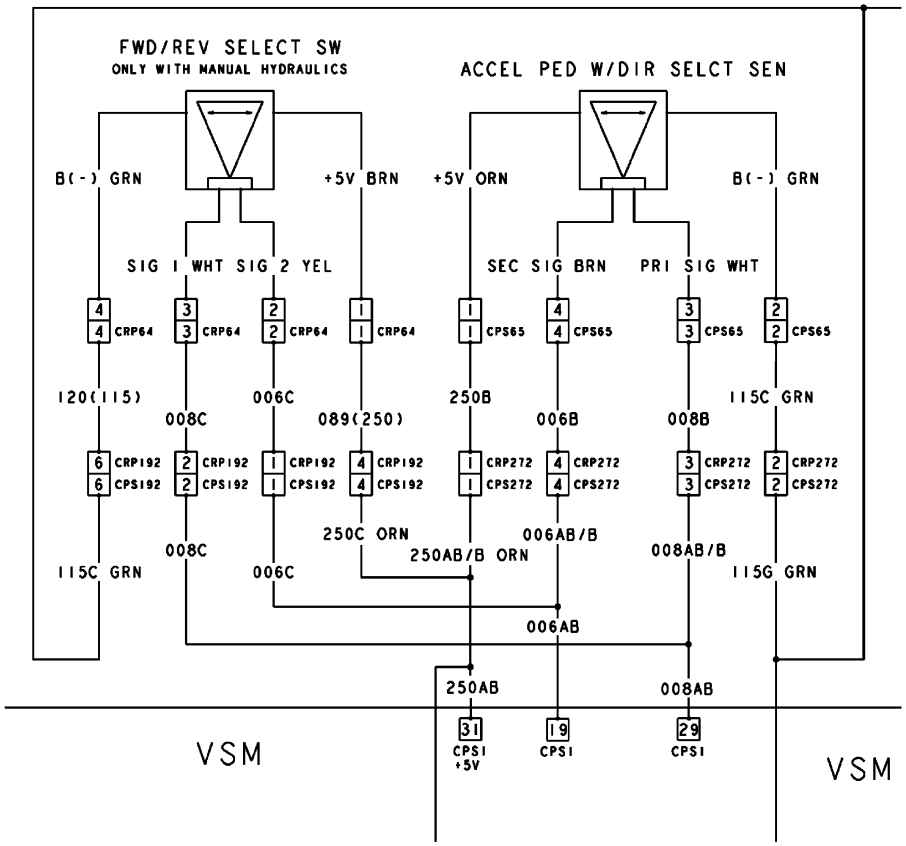
CAUSE D - CONTROLLER FAULT

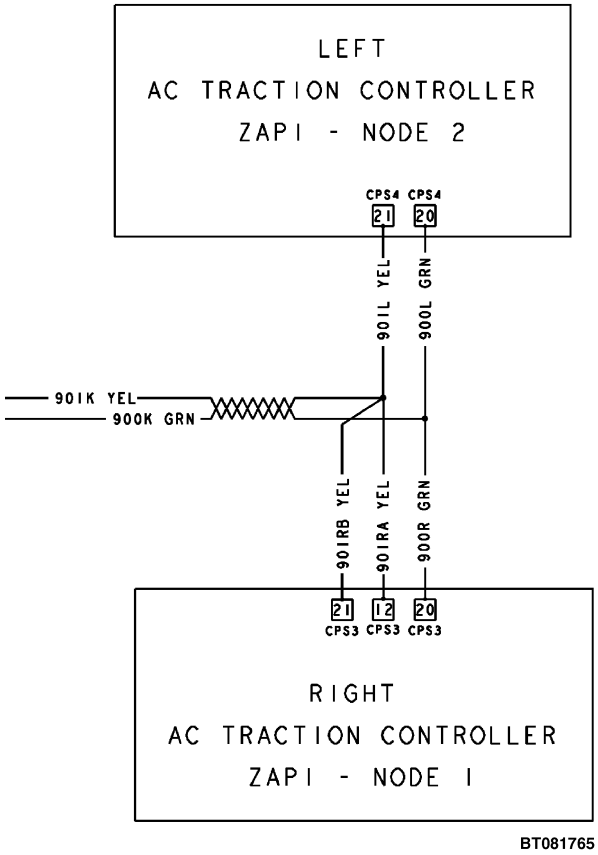
PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

DIAGRAMS


FWD/REV SELECT SW
ONLY WITH MANUAL HYDRAULICS
ACCEL PED W/DIR SELCT SEN
B(-) GRN
+5V BRN
+5V ORN
B(-) GRN
SIG 1 WHT
SIG 2 YEL
SEC SIG BRN
PRI SIG WHT
CRP64
CPS65
120(115)
008C
006C
089(250)
250B
006B
008B
115C GRN
CRP192
CPS192
CRP272
CPS272
250C ORN
006AB/B
250AB/B ORN
008AB/B
115G GRN
006AB
250AB
008AB
VSM
CPSI +5V
CPSI
VSM
BT081764



Troubleshooting Scenes

END FAULT

CODES

DTC 65481 - Wrong Slave Version
DTC 64969 - FOC2 Traction Controller Wrong Slave Version
DTC 65519 - Controller Mismatch
DTC 65007 - FOC2 Traction Controller Mismatch
DTC 65522 - Parameter Transfer
DTC 65010 - FOC2 Traction Controller Parameter Transfer
DTC 65511 - No Slave Enabled
DTC 64999 - FOC2 Traction Controller No Slave Enabled

POSSIBLE CAUSE

A. SOFTWARE FAULT
B. CONTROLLER FAULT

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. DTC 64999, 65010, 65007, or 64969 may require software updates. Prior to performing troubleshooting procedures, verify controller is at the latest revision level. See FOC2 Software Updates.
2. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 3.
   NO: Problem not verified, resume operation.
3. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - SOFTWARE FAULT

PROCEDURE OR ACTION:

1. Verify software version in both right and left traction controllers.
   Is software version the same in both controllers?
   YES: Proceed to CAUSE B.
   NO: Proceed to Step 2.
2. Reprogram controller with correct software version.
   Was reprogram successful?
   YES: Clear DTC and verify repairs.
   NO: Proceed to CAUSE B.

CAUSE B - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

END FAULT

CODES

DTC 65486 - Initial VMN High
DTC 65333 - Standby Current High
DTC 65310 - VMN Low
DTC 65311 - VMN High

POSSIBLE CAUSE

A. PHASE CABLE FAULT
B. TRACTION MOTOR FAULT
C. CONTROLLER FAULT

NOTE
Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - PHASE CABLE FAULT

PROCEDURE OR ACTION:

NOTE: Disconnect battery.

1. Disconnect the traction motor cables from the appropriate traction controller and traction motor. Measure continuity of individual cables to isolate fault.
   Is continuity present?
   YES: Proceed to CAUSE B.
   NO: Repair or replace faulty phase cable.

CAUSE B - TRACTION MOTOR FAULT

PROCEDURE OR ACTION:

1. Measure resistance between the traction motor terminals U and V.
   Is resistance between .322 and .383 ohms?
   YES: Proceed to Step 2.
   NO: Repair or replace faulty traction motor.
2. Measure resistance between the traction motor terminals U and W.
   Is resistance between .322 and .383 ohms?
   YES: Proceed to Step 3.
   NO: Repair or replace faulty traction motor.
3. Measure resistance between the traction motor terminals W and V.
   Is resistance between .322 and .383 ohms?
   YES: Proceed to CAUSE C.
   NO: Repair or replace faulty traction motor.

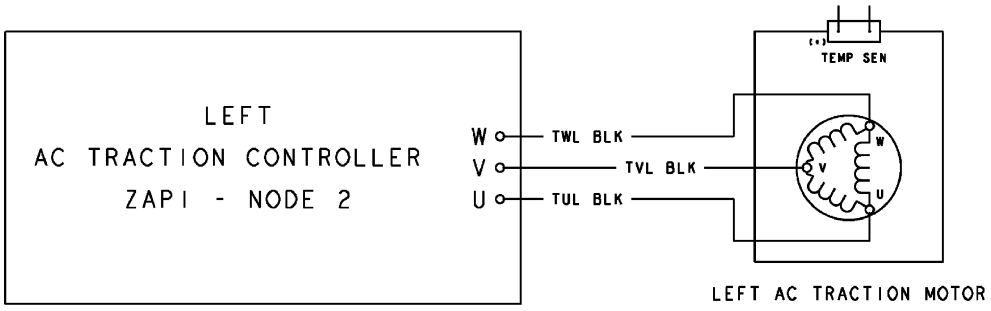
CAUSE C - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

DIAGRAMS



Troubleshooting Scenes

END FAULT

DTC 65504
Waiting for Node

POSSIBLE CAUSE

A. TRACTION CONTROLLER CANBUS FAULT
B. CONTROLLER FAULT

NOTE
Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - TRACTION CONTROLLER CANBUS FAULT

PROCEDURE OR ACTION:

NOTE: Key in ON position.

1. Disconnect the appropriate traction controller connector CPS3/CPS4. Measure voltage between cavity 20 and B(-).
   Is CAN HI voltage approximately 2.5 Vdc?
   YES: Proceed to Step 2.
   NO: Inspect CAN HI circuit for open or short. If voltage is 0 volts, the CAN HI circuit is shorted to ground or open. If voltage is above 5 volts, the CAN HI circuit is shorted to power.
2. Measure voltage between the traction controller connector CPS3/CPS4, cavity 21/12 and B(-).
   Is CAN HI voltage approximately 2.5 Vdc?
   YES: Disconnect battery and proceed to Step 3.
   NO: Inspect CAN LO circuit for open or short. If voltage is 0 volts, the CAN LO circuit is shorted to ground or open. If voltage is above 5 volts, the CAN LO circuit is shorted to power.

NOTE: The FOC2 left traction controller has an additional termination resistor. The additional resistor will cause a total CANbus resistance of 40 ohms.

3. Measure resistance between the traction controller connector CPS11, socket A21 and socket A20.
   Is resistance 60 ± 6 (40Ω for FOC2) ohms?
   YES: CAUSE B
   NO: If resistance is 120 ohms, the CANbus has an open circuit or a missing or damaged termination resistor. If resistance is 0 ohms, the CANbus circuits are shorted together.

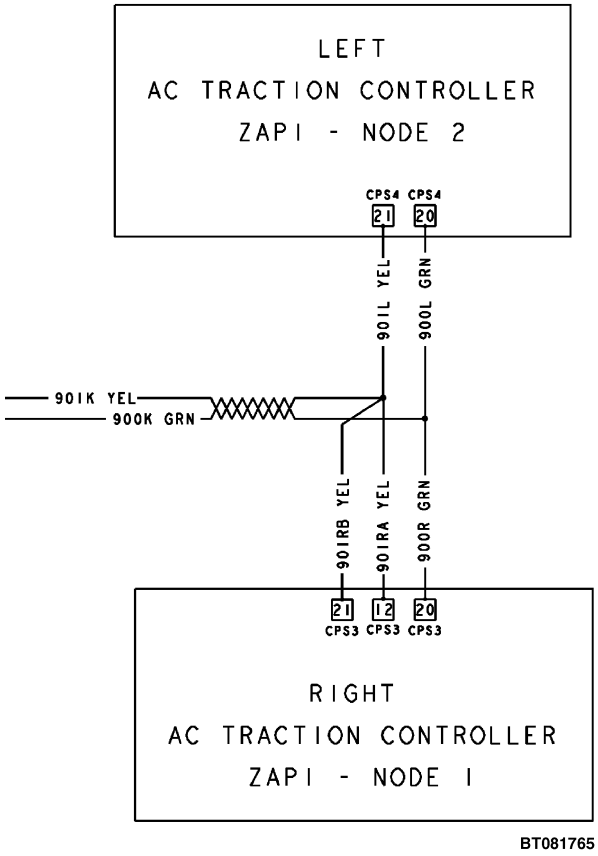
CAUSE B - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

DIAGRAMS



Troubleshooting Scenes

END FAULT

CODES

DTC 12836 - Brake Pedal Sensor A OORL
DTC 12837 - Brake Pedal Sensor A OORH
DTC 12876 - Brake Pedal Sensor B OORL
DTC 12877 - Brake Pedal Sensor B OORH
DTC 12813 - Foot Brake Position Rationality

POSSIBLE CAUSE

A. BRAKE PEDAL SENSOR WIRING FAULT
B. BRAKE PEDAL SENSOR SIGNAL FAULT
C. BRAKE PEDAL SENSOR FAULT

NOTE
Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - BRAKE PEDAL SENSOR WIRING FAULT

PROCEDURE OR ACTION:

NOTE: Key in ON position.

1. Disconnect brake pedal sensor connector CPS274, and measure voltage between cavity C/D and B(-).
   Is voltage 5 ± 0.5 Vdc?
   YES: Proceed to Step 2.
   NO: Inspect 5 volt supply circuits 250L and 250AB (Sensor A) / 089F and 089A (Sensor B) for open or short.

NOTE: Key in ON position.

2. Measure voltage between brake pedal sensor connector CPS274, cavity C/D and B/E.
   Is voltage 5 ± 0.5 Vdc?
   YES: Proceed to CAUSE B.
   NO: Inspect ground circuit 120N (Sensor A) / 115N (Sensor B) for open or short.

CAUSE B - BRAKE PEDAL SENSOR SIGNAL FAULT

PROCEDURE OR ACTION:

1. Disconnect VSM connector CPS1. Measure resistance between the following:
   - Brake pedal connector CPS274, cavity A and VSM connector CPS1, cavity 1.
   - Brake pedal connector CPS274, cavity F and VSM connector CPS1, cavity 27.

   Is resistance <1 ohm?
   YES: Proceed to CAUSE C.
   NO: Inspect appropriate brake pedal signal circuit for open, short, or source of excessive resistance.

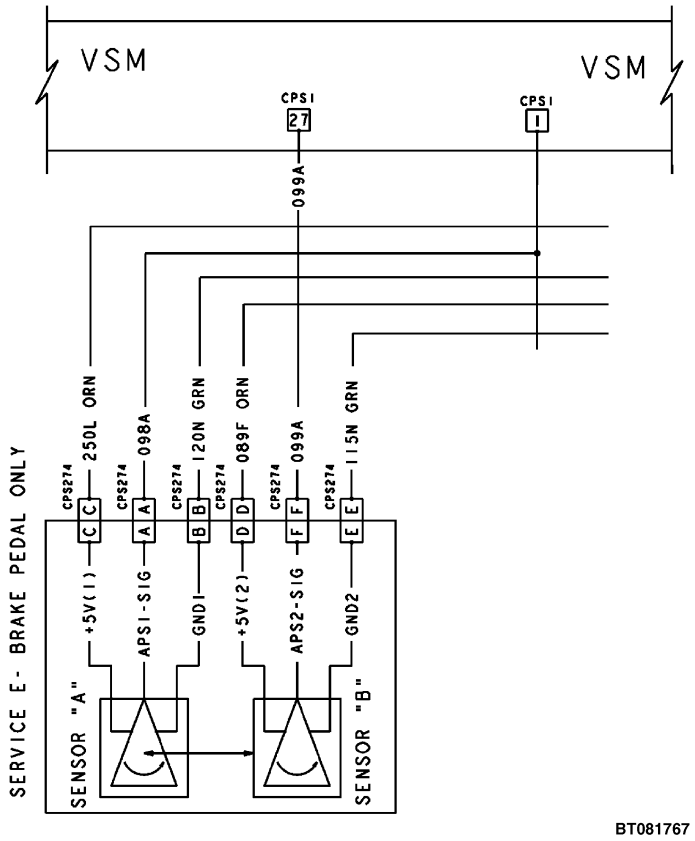
CAUSE C - BRAKE PEDAL SENSOR FAULT

PROCEDURE OR ACTION:

1. Replace faulty brake pedal sensor.

END POSSIBLE CAUSES

DIAGRAMS



Troubleshooting Scenes

END FAULT

DTC 4117
FOC Configuration Mismatch

POSSIBLE CAUSE

A. SOFTWARE CONFIGURATION FAULT
B. INCORRECT CDF SETUP
C. BAD SERVICE BRAKE POSITION SENSOR
D. CONTROLLER FAULT

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - SOFTWARE CONFIGURATION FAULT

PROCEDURE OR ACTION:

1. Locate and view traction controller version.
   Does traction 1 controller version match AE2M?
   YES: Proceed to Step 2.
   NO: Proceed to CAUSE B.
2. Verify controller is configured with electric brake option CDF.
   Is controller equipped with electric brake?
   YES: Proceed to CAUSE C.
   NO: Proceed to CAUSE D.

CAUSE B - INCORRECT CDF SETUP

PROCEDURE OR ACTION:

1. Bad CDF, disable electric brake option in CDF.

CAUSE C - BAD SERVICE BRAKE POSITION SENSOR

PROCEDURE OR ACTION:

1. Measure output voltage at brake pedal signal B.
   Is fault 12876 also present with this fault?
   YES: Proceed to Brake Pedal Sensor A OORL.
   NO: Proceed to CAUSE D.

CAUSE D - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

END FAULT

DTC 33040
Various CAN Errors

POSSIBLE CAUSE

A. CANBUS FAULT
B. SOFTWARE UPDATE
C. CONTROLLER FAULT

NOTE
Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 2.
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - CANBUS FAULT

PROCEDURE OR ACTION:

1. Measure voltage between the diagnostic connector CPS28, socket A and B(-).
   Is voltage approximately 2.5 Vdc?
   YES: Proceed to Step 2.
   NO: Inspect CAN HI circuit for open or short. if voltage is 0 volts, the CAN HI circuit is shorted to ground or open. If voltage is above 5 volts, the CAN HI circuit is shorted to power.

NOTE: The FOC2 left traction controller has an additional termination resistor. The additional resistor will cause a total CANbus resistance of 40 ohms.

2. Measure voltage between the diagnostic connector CPS28, socket B and B(-).
   Is voltage approximately 2.5 Vdc?
   YES: Disconnect battery and proceed to Step 3.
   NO: Inspect CAN LO circuit for open or short. If voltage is 0 volts, the CAN LO circuit is shorted to ground or open. If voltage is above 5 volts, the CAN LO circuit is shorted to power.
3. Measure resistance between the diagnostic connector CPS28, socket A and socket B.
   Is resistance 60 ± 6 (40Ω for FOC2) ohms?
   YES: Connect battery and proceed to CAUSE B.
   NO: If resistance is 120 ohms, the CANbus has an open circuit or a missing or damage termination resistor. If resistance is 0 ohms, the CANbus circuit are shorted together.

CAUSE B - SOFTWARE UPDATE

PROCEDURE OR ACTION:

1. Reprogram controller and retest system.
   Does DTC return after controller has been reprogrammed?
   YES: Proceed to CAUSE C.
   NO: No further service required.

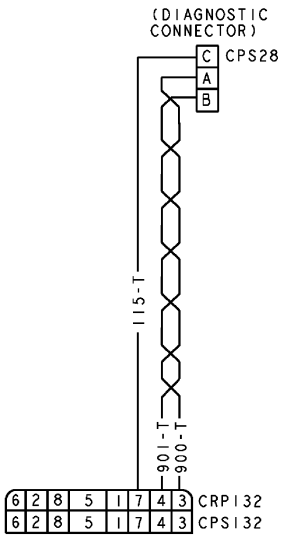
CAUSE C - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

DIAGRAMS



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Troubleshooting Scenes

END FAULT

DTC 64776
Watchdog

POSSIBLE CAUSE

A. SOFTWARE UPDATE
B. CONTROLLER FAULT

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Prior to performing troubleshooting procedures, verify controller is at the latest revision level. See FOC2 Software Updates.
2. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 3.
   NO: Problem not verified, resume operation.
3. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - SOFTWARE UPDATE

PROCEDURE OR ACTION:

1. Reprogram controller and retest system.
   Does DTC return after controller has been reprogrammed?
   YES: Proceed to CAUSE B.
   NO: No further service is required.

CAUSE B - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. If DTC returns after reprogramming, replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

END FAULT

CODES

DTC 64781 - FOC2 Traction Controller EEPROM Checksum Failure
DTC 65001 - FOC2 Power Transistor Shorted
DTC 65253 - FOC2 Output Mismatch
DTC 65003 - FOC2 coil_short_hw_ko

POSSIBLE CAUSE

A. SOFTWARE UPDATE
B. CONTROLLER FAULT

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Prior to performing troubleshooting procedures, verify controller is at the latest revision level. See FOC2 Software Updates.
2. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 3.
   NO: Problem not verified, resume operation.
3. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - SOFTWARE UPDATE

PROCEDURE OR ACTION:

1. Reprogram controller and retest system.
   Does DTC return after controller has been reprogrammed?
   YES: Proceed to CAUSE B.
   NO: No further service is required.

CAUSE B - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. If DTC returns after reprogramming, replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

END FAULT

DTC 64785
FOC2 Traction Controller Motor U-V Phase Voltage Measurement Fault (Logic Failure #3)

POSSIBLE CAUSE

A. PHASE CABLE FAULT
B. CONTROLLER FAULT

NOTE
Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Prior to performing troubleshooting procedures, verify controller is at the latest revision level. See FOC2 Software Updates.
2. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 3.
   NO: Problem not verified, resume operation.
3. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - PHASE CABLE FAULT

PROCEDURE OR ACTION:

1. Disconnect individual phase cables from controller and motor. Measure resistance of individual cables.
   Is resistance between .322 and .383 ohms?
   YES: Proceed to CAUSE B.
   NO: Replace faulty phase cable.

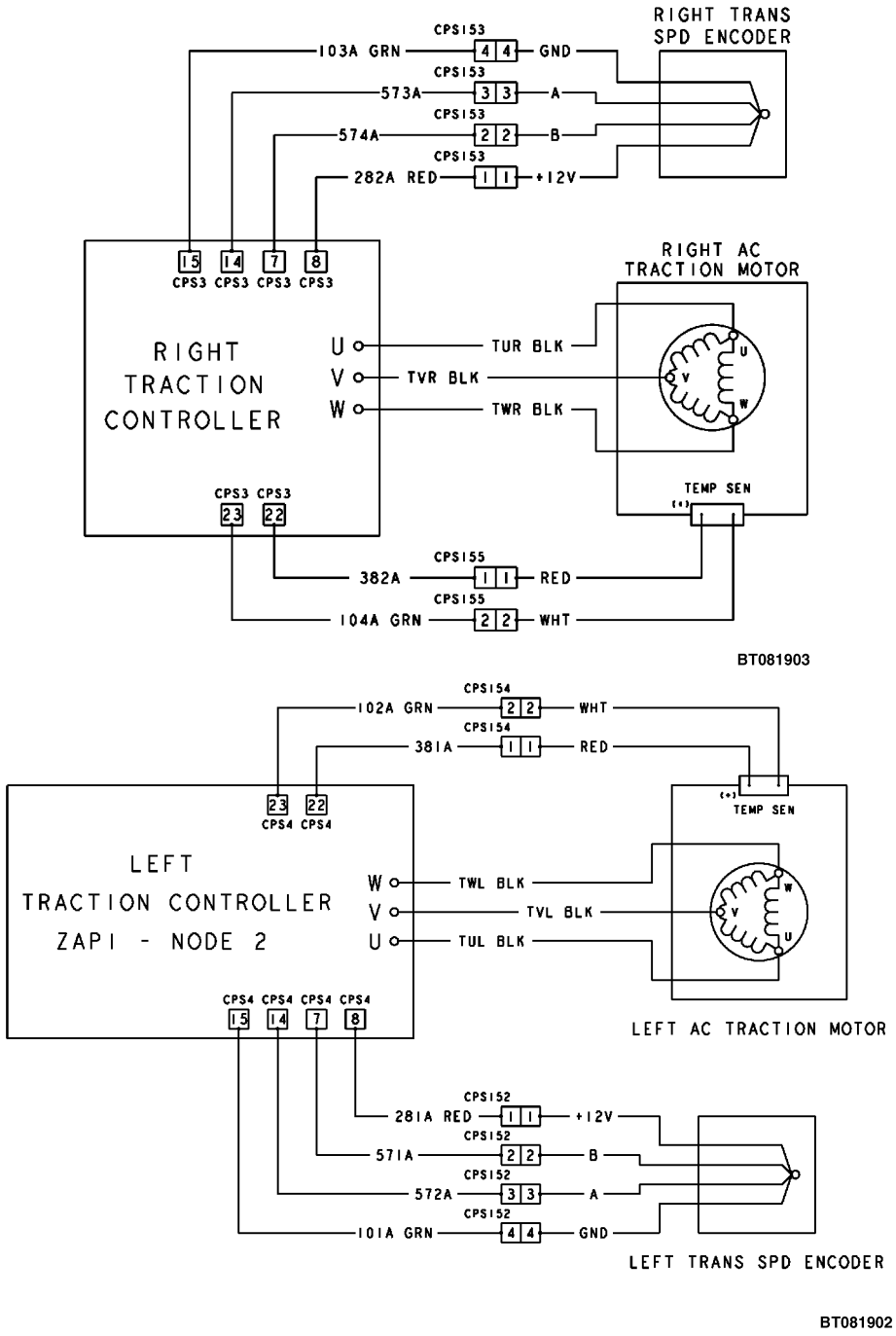
CAUSE B - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

DIAGRAMS



Troubleshooting Scenes

END FAULT

CODES

DTC 64974 - FOC2 Traction Controller Initial Nominal Motor Voltage High
DTC 64798 - FOC2 Traction Controller Operating Nominal Motor Voltage Low
DTC 64799 - FOC2 Traction Controller Operating Nominal Motor Voltage High
DTC 64975 - FOC2 Traction Initial Nominal Motor Voltage Low

POSSIBLE CAUSE

A. PHASE CABLE FAULT
B. TRACTION MOTOR FAULT
C. CONTROLLER FAULT

NOTE
Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Prior to performing troubleshooting procedures, verify controller is at the latest revision level. See FOC2 Software Updates.
2. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 3.
   NO: Problem not verified, resume operation.
3. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - PHASE CABLE FAULT

PROCEDURE OR ACTION:

NOTE: Disconnect battery.

1. Disconnect the traction motor cables from the appropriate traction controller and traction motor. Measure continuity of individual cables to isolate fault.
   Is continuity present?
   YES: Proceed to CAUSE B.
   NO: Repair or replace faulty phase cable.

CAUSE B - TRACTION MOTOR FAULT

PROCEDURE OR ACTION:

1. Measure resistance between the traction motor terminals U and V.
   Is resistance between .322 and .383 ohms?
   YES: Proceed to Step 2.
   NO: Repair or replace faulty traction motor.
2. Measure resistance between the traction motor terminals U and W.
   Is resistance between .322 and .383 ohms?
   YES: Proceed to Step 3.
   NO: Repair or replace faulty traction motor.
3. Measure resistance between the traction motor terminals W and V.
   Is resistance between .322 and .383 ohms?
   YES: Proceed to CAUSE C.
   NO: Repair or replace faulty traction motor.

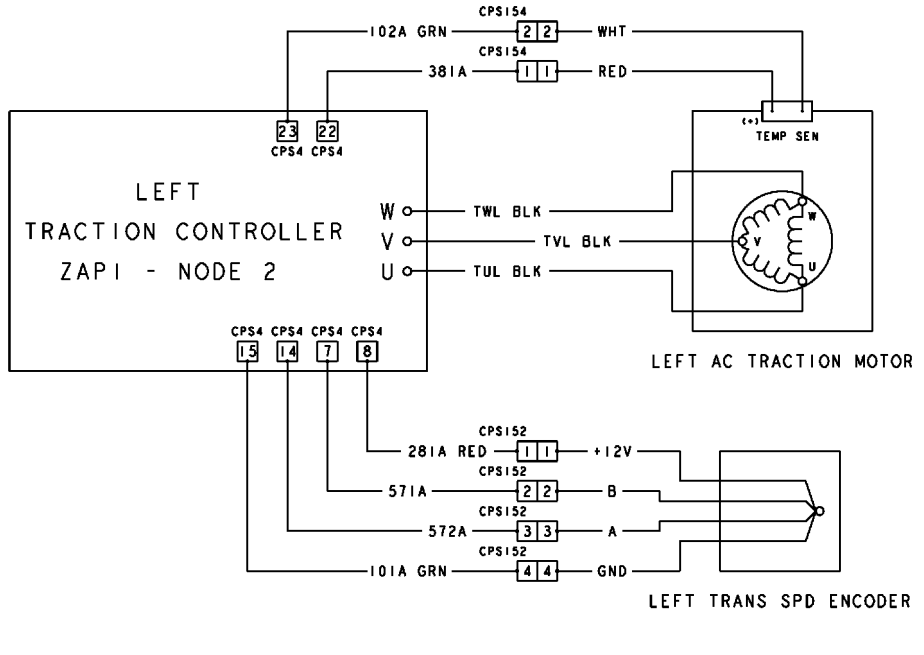
CAUSE C - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

DIAGRAMS



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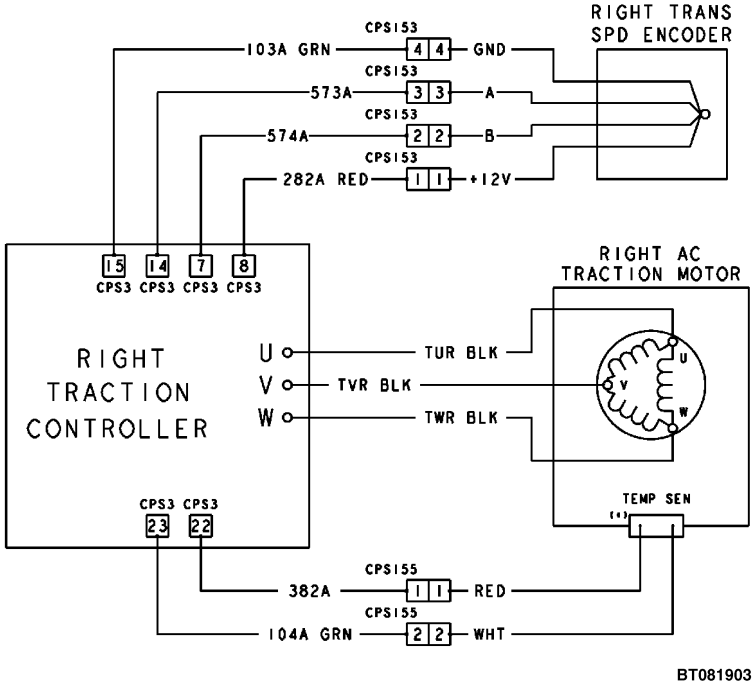

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Troubleshooting Scenes

END FAULT

DTC 64821
FOC2 Traction Controller Standby Current Too High

POSSIBLE CAUSE

A. CONTROLLER FAULT

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Prior to performing troubleshooting procedures, verify controller is at the latest revision level. See FOC2 Software Updates.
2. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 3.
   NO: Problem not verified, resume operation.
3. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

END FAULT

DTC 64828
FOC2 Traction Controller DC Bus Capacitor Charge Timeout
DC Bus voltage does not rise above 14 volts in 3.2 seconds after key ON

POSSIBLE CAUSE

A. CONTROLLER WIRING FAULT
B. CONTACTOR PTC RESISTOR FAULT
C. FAULTY FUSE
D. CONTROLLER FAULT

NOTE
Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Prior to performing troubleshooting procedures, verify controller is at the latest revision level. See FOC2 Software Updates.
2. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 3.
   NO: Problem not verified, resume operation.
3. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - CONTROLLER WIRING FAULT

PROCEDURE OR ACTION:

1. Inspect power connection at appropriate controller.
   Is connection loose or damaged?
   YES: Repair connection, clear DTC, and retest system.
   NO: If only E-Steer controller is reporting DTC, proceed to CAUSE D, if more than one controller is reporting fault, proceed to CAUSE B.

CAUSE B - CONTACTOR PTC RESISTOR FAULT

PROCEDURE OR ACTION:

1. Disconnect PTC resistor and measure resistance.
   Is resistance between 5 +/- 0.5 ohms?
   YES: Proceed to CAUSE C.
   NO: Replace PTC resistor, clear DTC, and retest system.

CAUSE C - FAULTY FUSE

PROCEDURE OR ACTION:

1. Inspect appropriate fuse:
   - FU1-10A
   - FU2-10A
   - FU3-10A
   - FU4-5A

   Is fuse blown?
   YES: Inspect circuit for source of short and repair if necessary. Replace fuse, clear DTC, and retest system.
   NO: Proceed to CAUSE D.

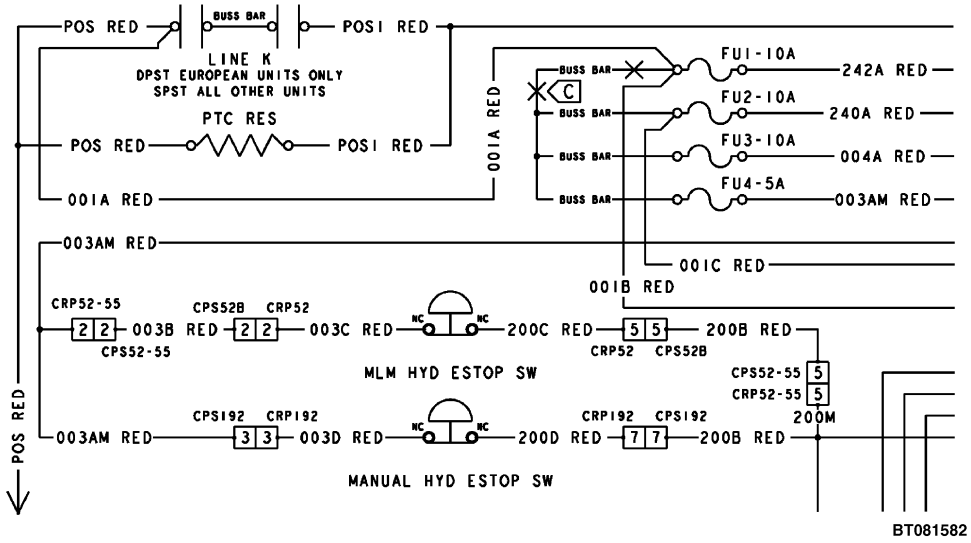
CAUSE D - CONTROLLER FAULT

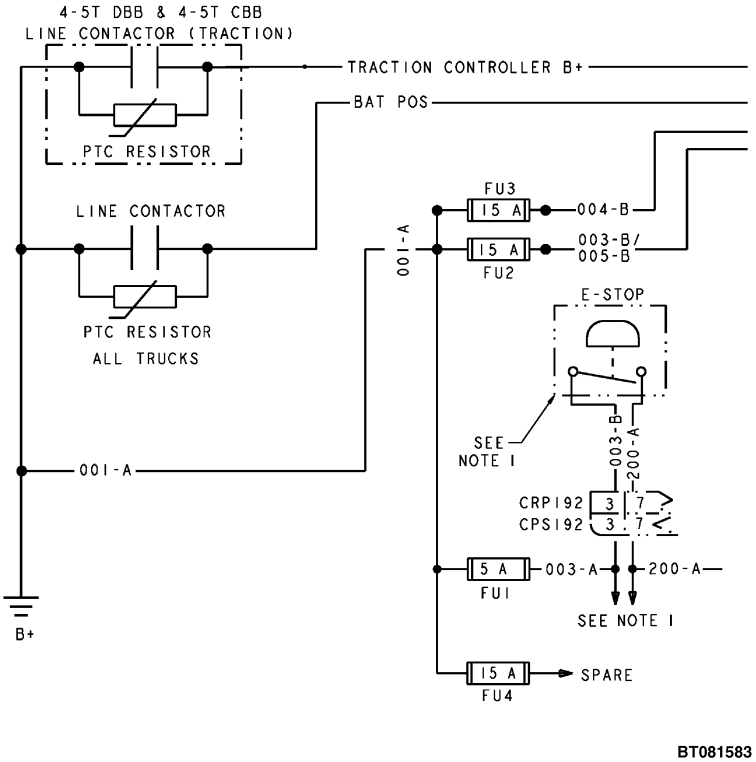
PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

DIAGRAMS





Troubleshooting Scenes

END FAULT

DTC 64833
FOC2 Traction Motor Temperature Above Limit
Motor temperatures above 120°C (248°F)

POSSIBLE CAUSE

A. MOTOR OVER TEMPERATURE
B. TEMP SENSOR WIRING FAULT
C. TEMP SENSOR FAULT
D. MOTOR FAULT
E. CONTROLLER FAULT

NOTE
Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Prior to performing troubleshooting procedures, verify controller is at the latest revision level. See FOC2 Software Updates.
2. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 3.
   NO: Problem not verified, resume operation.
3. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - MOTOR OVER TEMPERATURE

PROCEDURE OR ACTION:

1. Using the PC Service Tool, verify steer motor serial data and then measure actual motor temperatures. Over temp conditions are above 120°C (248°F).
   Is motor temperature out of range?
   YES: Allow motor to cool within acceptable temperatures, clear DTC and resume operation. If motor continues to overheat, proceed to CAUSE D.
   NO: Disconnect battery and proceed to CAUSE B.

CAUSE B - TEMP SENSOR WIRING FAULT

PROCEDURE OR ACTION:

1. Disconnect temperature sensor connectors from motor and controller and inspect pins and sockets.
   Is connector damage evident?
   YES: Repair connector, clear DTC and retest system.
   NO: Proceed to .
2. Measure resistance between the following:
   - Controller temp sensor connector, socket 6 and the motor temp sensor connector, socket 1.
   - Controller temp sensor connector, socket 7 and motor temp sensor connector, socket 2.

   Is resistance <1 ohm?
   YES: Proceed to CAUSE C.
   NO: Inspect appropriate temp sensor circuit for open or source of excessive resistance.

CAUSE C - TEMP SENSOR FAULT

PROCEDURE OR ACTION:

1. Measure resistance between the temp sensor connector, pin 1 and pin 2. Refer to temp sensor specification chart.
   Is resistance within specifications?
   YES: Proceed to CAUSE E.
   NO: Temperature sensor faulty, proceed to CAUSE D.

CAUSE D - MOTOR FAULT

PROCEDURE OR ACTION:

1. Replace faulty motor.

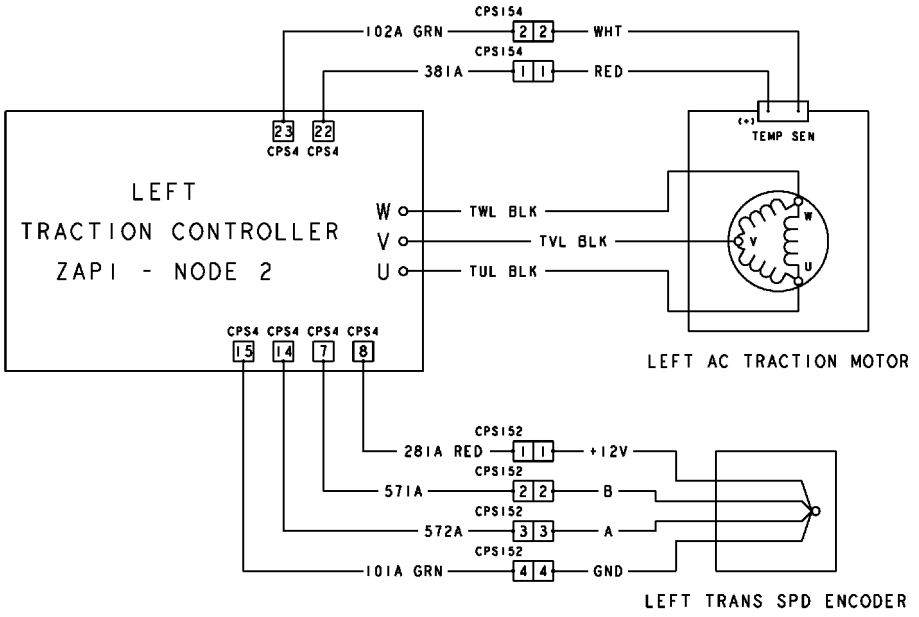
CAUSE E - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

DIAGRAMS



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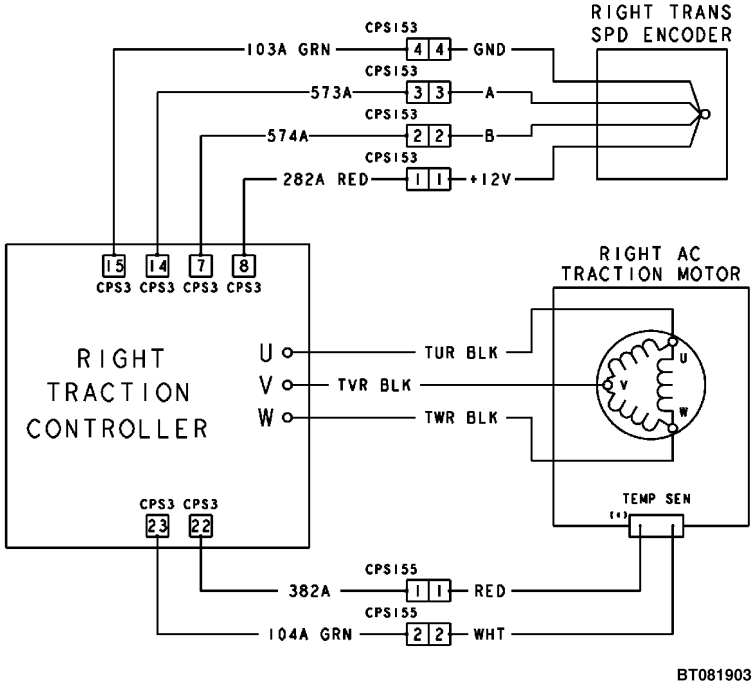

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Troubleshooting Scenes

END FAULT

CODES

DTC 64976 - EEPROM KO
DTC 64781 - EEPROM KO

POSSIBLE CAUSE

A. SOFTWARE UPDATE
B. CONTROLLER FAULT

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Prior to performing troubleshooting procedures, verify controller is at the latest revision level. See FOC2 Software Updates.
2. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 3.
   NO: Problem not verified, resume operation.
3. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - SOFTWARE UPDATE

PROCEDURE OR ACTION:

1. Reprogram controller and retest system.
   Does DTC return after controller has been reprogrammed?
   YES: Proceed to CAUSE B.
   NO: No further service is required.

CAUSE B - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. If DTC returns after reprogramming, replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

END FAULT

DTC 64978
FOC2 Controller Wrong RAM Memory.

POSSIBLE CAUSE

A. SOFTWARE UPDATE
B. CONTROLLER FAULT

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Prior to performing troubleshooting procedures, verify controller is at the latest revision level. See FOC2 Software Updates.
2. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 3.
   NO: Problem not verified, resume operation.
3. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - SOFTWARE UPDATE

PROCEDURE OR ACTION:

1. Reprogram controller and retest system.
   Does DTC return after controller has been reprogrammed?
   YES: Proceed to CAUSE B.
   NO: No further service is required.

CAUSE B - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. If DTC returns after reprogramming, replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

END FAULT

CODES

DTC 64980 - FOC2 Traction Controller Waiting for Slave Node Response
DTC 65009 - FOC2 Traction Controller Master To Slave Parameter Check Mismatch

POSSIBLE CAUSE

A. SOFTWARE UPDATE
B. CONTROLLER FAULT

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Prior to performing troubleshooting procedures, verify controller is at the latest revision level. See FOC2 Software Updates.
2. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 3.
   NO: Problem not verified, resume operation.
3. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - SOFTWARE UPDATE

PROCEDURE OR ACTION:

1. Reprogram controller and retest system.
   Does DTC return after controller has been reprogrammed?
   YES: Proceed to CAUSE B.
   NO: No further service is required.

CAUSE B - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. If DTC returns after reprogramming, replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

END FAULT

DTC 64981
FOC2 Traction Controller Hardware Fault

POSSIBLE CAUSE

A. SOFTWARE UPDATE
B. CONTROLLER FAULT

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Prior to performing troubleshooting procedures, verify controller is at the latest revision level. See FOC2 Software Updates.
2. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 3.
   NO: Problem not verified, resume operation.
3. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - SOFTWARE UPDATE

PROCEDURE OR ACTION:

1. Reprogram controller and retest system.
   Does DTC return after controller has been reprogrammed?
   YES: Proceed to CAUSE B.
   NO: No further service is required.

CAUSE B - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. If DTC returns after reprogramming, replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

END FAULT

DTC 64986
FOC2 Traction Motor Temperature Sensor KO

POSSIBLE CAUSE

A. SOFTWARE UPDATE
B. CONTROLLER FAULT

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Prior to performing troubleshooting procedures, verify controller is at the latest revision level. See FOC2 Software Updates.
2. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 3.
   NO: Problem not verified, resume operation.
3. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - SOFTWARE UPDATE

PROCEDURE OR ACTION:

1. Reprogram controller and retest system.
   Does DTC return after controller has been reprogrammed?
   YES: Proceed to CAUSE B.
   NO: No further service is required.

CAUSE B - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. If DTC returns after reprogramming, replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

END FAULT

CODES

DTC 64992 - FOC2 Traction Controller Waiting for Node
DTC 65016 - FOC2 Traction Controller No CAN Message

POSSIBLE CAUSE

A. TRACTION CONTROLLER CANBUS FAULT
B. CONTROLLER FAULT

NOTE
Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Prior to performing troubleshooting procedures, verify controller is at the latest revision level. See FOC2 Software Updates.
2. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 3.
   NO: Problem not verified, resume operation.
3. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - TRACTION CONTROLLER CANBUS FAULT

PROCEDURE OR ACTION:

NOTE: Key in ON position.

1. Disconnect the appropriate traction controller connector CPS3/CPS4. Measure voltage between cavity 20 and B(-).
   Is CAN HI voltage approximately 2.5 Vdc?
   YES: Proceed to Step 2.
   NO: Inspect CAN HI circuit for open or short. If voltage is 0 volts, the CAN HI circuit is shorted to ground or open. If voltage is above 5 volts, the CAN HI circuit is shorted to power.
2. Measure voltage between the traction controller connector CPS3/CPS4, cavity 21/12 and B(-).
   Is CAN HI voltage approximately 2.5 Vdc?
   YES: Disconnect battery and proceed to Step 3.
   NO: Inspect CAN LO circuit for open or short. If voltage is 0 volts, the CAN LO circuit is shorted to ground or open. If voltage is above 5 volts, the CAN LO circuit is shorted to power.

NOTE: The FOC2 left traction controller has an additional termination resistor. The additional resistor will cause a total CANbus resistance of 40 ohms.

3. Measure resistance between the traction controller connector CPS11, socket A21 and socket A20.
   Is resistance 60 ± 6 (40Ω for FOC2) ohms?
   YES: CAUSE B
   NO: If resistance is 120 ohms, the CANbus has an open circuit or a missing or damaged termination resistor. If resistance is 0 ohms, the CANbus circuits are shorted together.

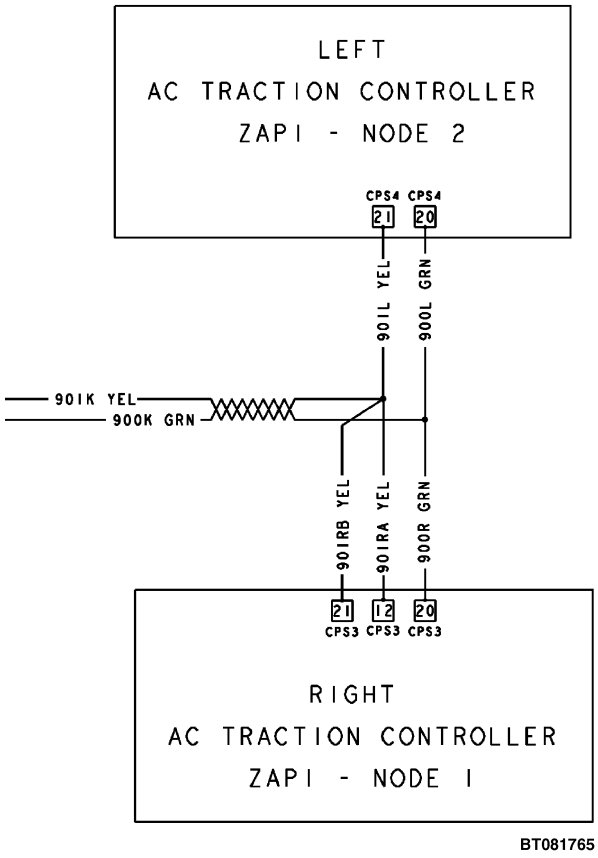
CAUSE B - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

DIAGRAMS



Troubleshooting Scenes

END FAULT

CODES

DTC 65004 - FOC2 Current Gain
DTC 64991 - FOC2 Contactor Coil Shorted
DTC 64806 - FOC2 Traction Controller Contactor Open
DTC 64805 - FOC2 Traction Controller Contactor Closed
DTC 64842 - FOC2 Traction Controller Contactor Driver Shorted High
DTC 64843 - FOC2 Traction Controller Contactor Driver Shorted Low

POSSIBLE CAUSE

A. MAIN CONTACTOR WIRING FAULT
B. MAIN CONTACTOR COIL FAULT
C. CONTROLLER FAULT

NOTE
Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Prior to performing troubleshooting procedures, verify controller is at the latest revision level. See FOC2 Software Updates.
2. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 3.
   NO: Problem not verified, resume operation.
3. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - MAIN CONTACTOR WIRING FAULT

PROCEDURE OR ACTION:

NOTE: Key in ON position.

1. Disconnect coil connector TF10 (B+) and TF11 (B-) and measure voltage between TF10 (B+) and B(-).
   Is voltage battery voltage present?
   YES: Proceed to Step 2.
   NO: Inspect input circuit for open or short.
2. Measure voltage between TF10 (B+) and TF11 (B-).
   Is voltage battery voltage present?
   YES: Proceed to CAUSE B.
   NO: Inspect ground control circuit 024A for open, short, or source of excessive resistance.

CAUSE B - MAIN CONTACTOR COIL FAULT

PROCEDURE OR ACTION:

1. Measure resistance across coil terminals.
   Is resistance 20 ± 2 ohms?
   YES: Proceed to CAUSE C.
   NO: Replace faulty coil.

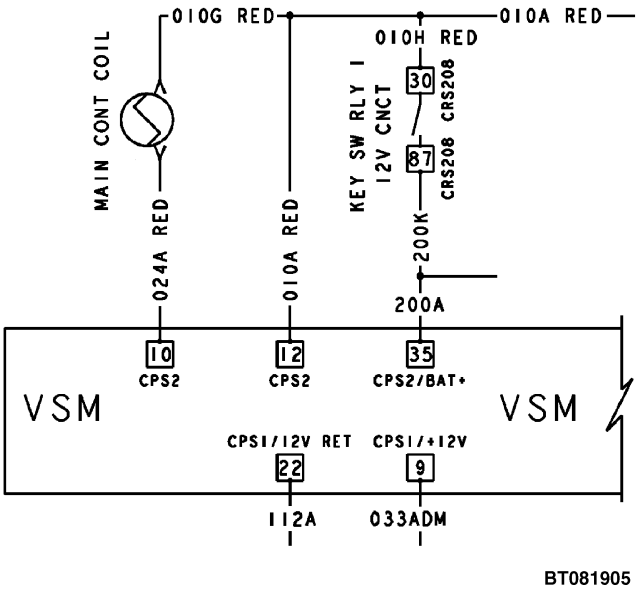
CAUSE C - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

DIAGRAMS



Troubleshooting Scene

END FAULT

DTC 65005
Analog Input

POSSIBLE CAUSE

A. SOFTWARE UPDATE
B. CONTROLLER FAULT

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Prior to performing troubleshooting procedures, verify controller is at the latest revision level. See FOC2 Software Updates.
2. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 3.
   NO: Problem not verified, resume operation.
3. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - SOFTWARE UPDATE

PROCEDURE OR ACTION:

1. Reprogram controller and retest system.
   Does DTC return after controller has been reprogrammed?
   YES: Proceed to CAUSE B.
   NO: No further service is required.

CAUSE B - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. If DTC returns after reprogramming, replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

END FAULT

DTC 65013
FOC2 Traction Controller IQ Mismatch

POSSIBLE CAUSE

A. SOFTWARE UPDATE
B. CONTROLLER FAULT

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Prior to performing troubleshooting procedures, verify controller is at the latest revision level. See FOC2 Software Updates.
2. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 3.
   NO: Problem not verified, resume operation.
3. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - SOFTWARE UPDATE

PROCEDURE OR ACTION:

1. Reprogram controller and retest system.
   Does DTC return after controller has been reprogrammed?
   YES: Proceed to CAUSE B.
   NO: No further service is required.

CAUSE B - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. If DTC returns after reprogramming, replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

END FAULT

DTC 65015
FOC2 Traction Controller Data Acquisition

POSSIBLE CAUSE

A. CANBUS FAULT
B. VSM WIRING FAULT
C. CDF VERSION
D. CONTROLLER FAULT

NOTE
Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Prior to performing troubleshooting procedures, verify controller is at the latest revision level. See FOC2 Software Updates.
2. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 3.
   NO: Problem not verified, resume operation.
3. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - CANBUS FAULT

PROCEDURE OR ACTION:

1. Measure voltage between the diagnostic connector CPS28, socket A and B(-).
   Is voltage approximately 2.5 Vdc?
   YES: Proceed to Step 2.
   NO: Inspect CAN HI circuit for open or short. if voltage is 0 volts, the CAN HI circuit is shorted to ground or open. If voltage is above 5 volts, the CAN HI circuit is shorted to power.
2. Measure voltage between the diagnostic connector CPS28, socket B and B(-).
   Is voltage approximately 2.5 Vdc?
   YES: Disconnect battery and proceed to Step 3.
   NO: Inspect CAN LO circuit for open or short. If voltage is 0 volts, the CAN LO circuit is shorted to ground or open. If voltage is above 5 volts, the CAN LO circuit is shorted to power.

NOTE: The FOC2 left traction controller has an additional termination resistor. The additional resistor will cause a total CANbus resistance of 40 ohms.

3. Measure resistance between the diagnostic connector CPS28, socket A and socket B.
   Is resistance 60 ± 6 (40Ω for FOC2) ohms?
   YES: Connect battery and proceed to CAUSE B.
   NO: If resistance is 120 ohms, the CANbus has an open circuit or a missing or damage termination resistor. If resistance is 0 ohms, the CANbus circuit are shorted together.

CAUSE B - VSM WIRING FAULT

PROCEDURE OR ACTION:

1. Disconnect the VSM connector CPS2 and measure voltage between socket 35 and B(-).
   Is voltage 12 ± 1.5 Vdc?
   YES: Proceed to Step 2.
   NO: Inspect circuit 200A and 200M for open or short. Inspect connector CRP52-55 for loose, damaged, or corroded terminals.
2. Measure voltage between socket 35 and the VSM connector CPS2, socket 2.
   Is voltage 12 ± 1.5 Vdc?
   YES: Proceed to CAUSE C.
   NO: Inspect 013-A for open or short.

CAUSE C - CDF VERSION

PROCEDURE OR ACTION:

1. Using the PC Service Tool, verify current CDF version.
   Is CDF version current?
   YES: Proceed to CAUSE D.
   NO: Update CDF and retest system to verify repair.

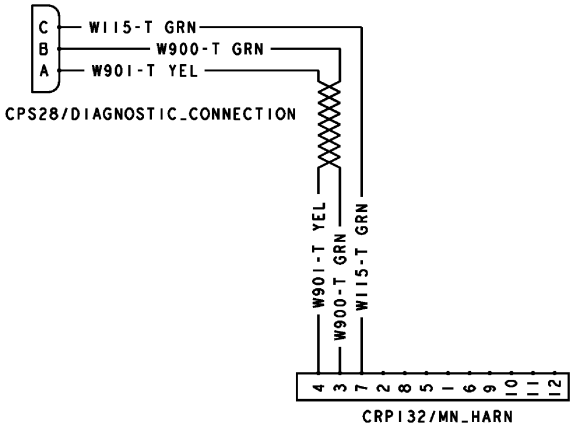
CAUSE D - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

DIAGRAMS



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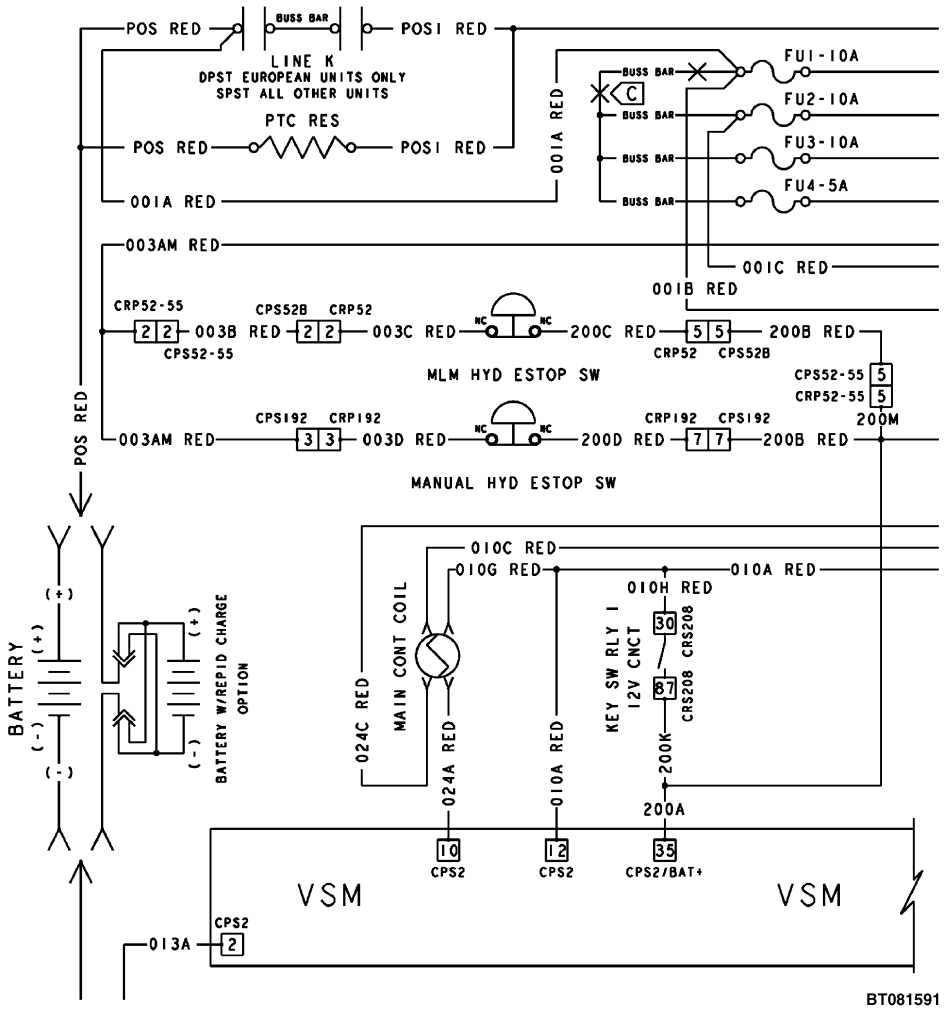

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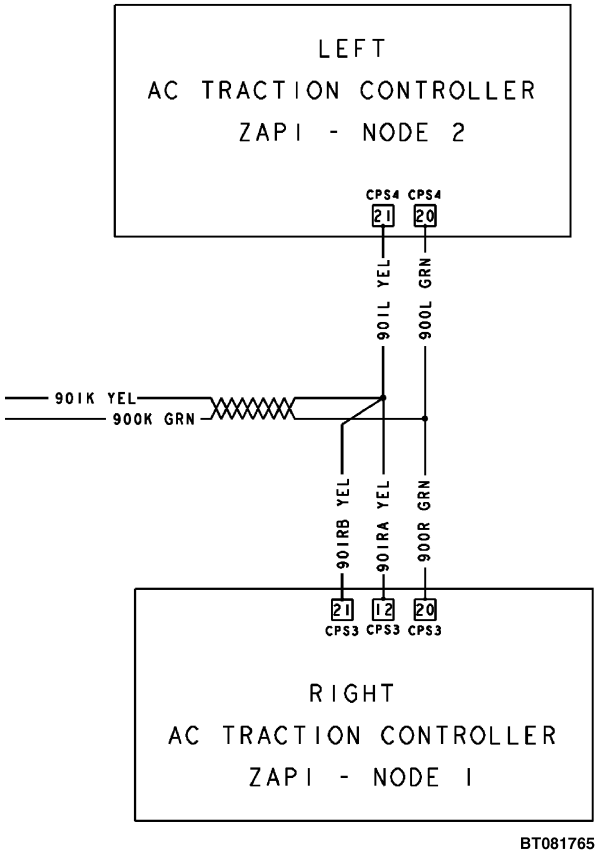


Troubleshooting Scenes

END FAULT

DTC 65018
FOC2 Traction Controller Thermic Sensor KO

POSSIBLE CAUSE

A. SOFTWARE UPDATE
B. CONTROLLER FAULT

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Prior to performing troubleshooting procedures, verify controller is at the latest revision level. See FOC2 Software Updates.
2. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 3.
   NO: Problem not verified, resume operation.
3. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - SOFTWARE UPDATE

PROCEDURE OR ACTION:

1. Reprogram controller and retest system.
   Does DTC return after controller has been reprogrammed?
   YES: Proceed to CAUSE B.
   NO: No further service is required.

CAUSE B - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. If DTC returns after reprogramming, replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

END FAULT

DTC 65021
FOC2 Traction Controller Field Oriented Control KO

POSSIBLE CAUSE

A. SOFTWARE UPDATE
B. CONTROLLER FAULT

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Prior to performing troubleshooting procedures, verify controller is at the latest revision level. See FOC2 Software Updates.
2. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 3.
   NO: Problem not verified, resume operation.
3. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - SOFTWARE UPDATE

PROCEDURE OR ACTION:

1. Reprogram controller and retest system.
   Does DTC return after controller has been reprogrammed?
   YES: Proceed to CAUSE B.
   NO: No further service is required.

CAUSE B - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. If DTC returns after reprogramming, replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

END FAULT

DTC 64979
FOC2 Traction Controller Rotor Stall

POSSIBLE CAUSE

A. SPEED SENSOR WIRING FAULT
B. SPEED SENSOR FAULT
C. CONTROLLER FAULT

NOTE
Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. **NOTE:** If DTC 64979 is set, verify parameters are correct for type of encoder. If parameter matches encoder type, continue with the following procedures.
2. Prior to performing troubleshooting procedures, verify controller is at the latest revision level. See FOC2 Software Updates.
3. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 4.
   NO: Problem not verified, resume operation.
4. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - SPEED SENSOR WIRING FAULT

PROCEDURE OR ACTION:

1. Disconnect the speed sensor connector and measure voltage between encoder 12 volt supply and B(-).
   Is voltage 12 ± 1.0 Vdc?
   YES: Proceed to Step 2.
   NO: Inspect circuit 281A or 282-A for open or short.
2. Measure voltage between 12 volt supply circuit and ground circuit.
   Is voltage 12 ± 1.0 Vdc?
   YES: Proceed to Step 3.
   NO: Inspect ground circuit 101A or 103A for open or short.
3. Disconnect traction controller connector and measure resistance between the following signal circuits:
   - Traction controller connector, socket 14 and speed sensor connector, socket A.
   - Traction controller connector, socket 14 and speed sensor connector, socket B.

   Is resistance <1 ohm?
   YES: Connect the speed sensor and traction controller connectors and proceed to CAUSE B.
   NO: Inspect encoder signal circuits or open or source of excessive resistance.

CAUSE B - SPEED SENSOR FAULT

PROCEDURE OR ACTION:

1. Using the PC Service Tool, locate and observe the speed sensor count signal.
   Does encoder provide accurate count signal during operation?
   YES: Proceed to CAUSE C.
   NO: Replace faulty speed sensor.

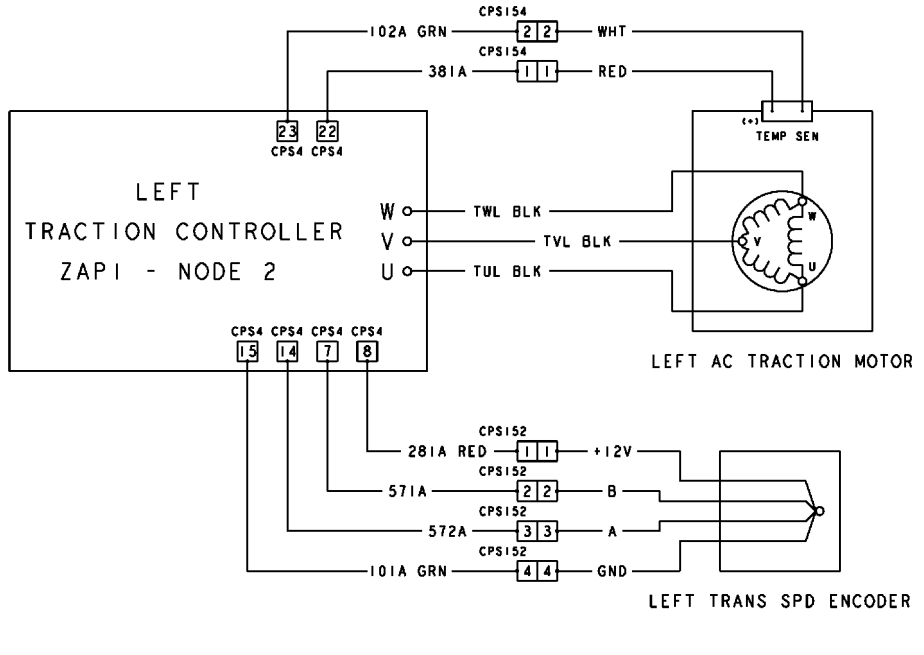
CAUSE C - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

DIAGRAMS



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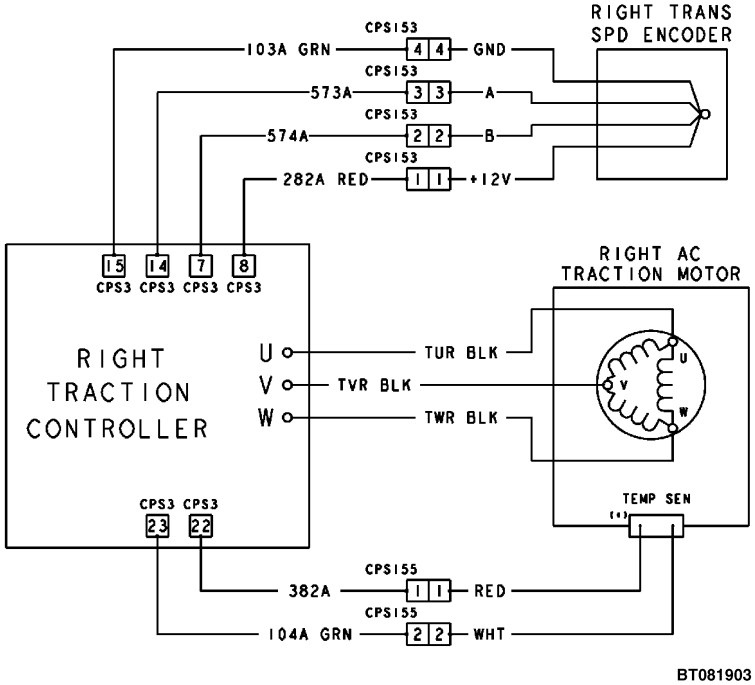


BT081903

Troubleshooting Scenes

END FAULT

CODES

DTC 64988 - FOC2 Traction Controller Vkey OFF Shorted
DTC 64787 - FOC2 Traction Controller DC Bus High and Key Voltage Low

POSSIBLE CAUSE

A. KEY INPUT WIRING FAULT
B. KEY SWITCH RELAY FAULT
C. CONTROLLER BUS / KEY VOLTAGE FAULT
D. CONTROLLER FAULT

NOTE
Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Prior to performing troubleshooting procedures, verify controller is at the latest revision level. See FOC2 Software Updates.
2. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 3.
   NO: Problem not verified, resume operation.
3. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - KEY INPUT WIRING FAULT

PROCEDURE OR ACTION:

NOTE: Key in ON position.

1. Disconnect the steer motor controller connector CPS6 and measure voltage between socket 15 and B(-).
   Is voltage 12 ± 1.5 Vdc?
   YES: Proceed to CAUSE D.
   NO: Remove key switch relay 1 and proceed to CAUSE B.

CAUSE B - KEY SWITCH RELAY FAULT

PROCEDURE OR ACTION:

1. Measure voltage between the key switch relay 1, socket 86 and B(-).
   Is voltage 12 ± 1.5 Vdc?
   YES: Proceed to Step 2.
   NO: Inspect coil input circuit 513A for open or short. Inspect connector CPS135 for loose, damaged, or corroded terminals. Verify key switch operation by measuring continuity between the display connector CPS20, socket 5 and socket 1 while operating switch.
2. Measure voltage between the key switch relay 1, socket 86 and socket 85.
   Is voltage 12 ± 1.5 Vdc?
   YES: Proceed to Step 3.
   NO: Inspect relay ground circuit 013K and 013A for open or short. Inspect VSM connector CPS2 for loose, damaged, or corroded terminals.
3. Measure voltage between the key switch relay 1, socket 87 and B(-).
   Is voltage 12 ± 1.5 Vdc?
   YES: Inspect key voltage input circuit 010A for open, short, or source of excessive resistance.
   NO: Inspect relay switch input circuit 200K and 200M for open or short. Inspect connectors CRPS52-55, CRP52 for loose, damaged, or corroded terminals. Verify E-stop switch functionality by measuring continuity while operating switch.

CAUSE C - CONTROLLER BUS / KEY VOLTAGE FAULT

PROCEDURE OR ACTION:

1. Disconnect the appropriate traction controller connector, and measure voltage between:
   - Right traction controller, socket 1 and B(-)
   - Left traction controller, socket 1 or 4 and B(-)

   Is key voltage present?
   YES: Proceed to Step 2.
   NO: Inspect the appropriate key input circuit for open or short.
2. Measure voltage at the appropriate traction controller B(+) and B(-) terminals.
   Is battery voltage present?
   YES: Proceed to CAUSE D.
   NO: Inspect BUS bar, connections, and circuits for open, short, or source of excessive resistance.

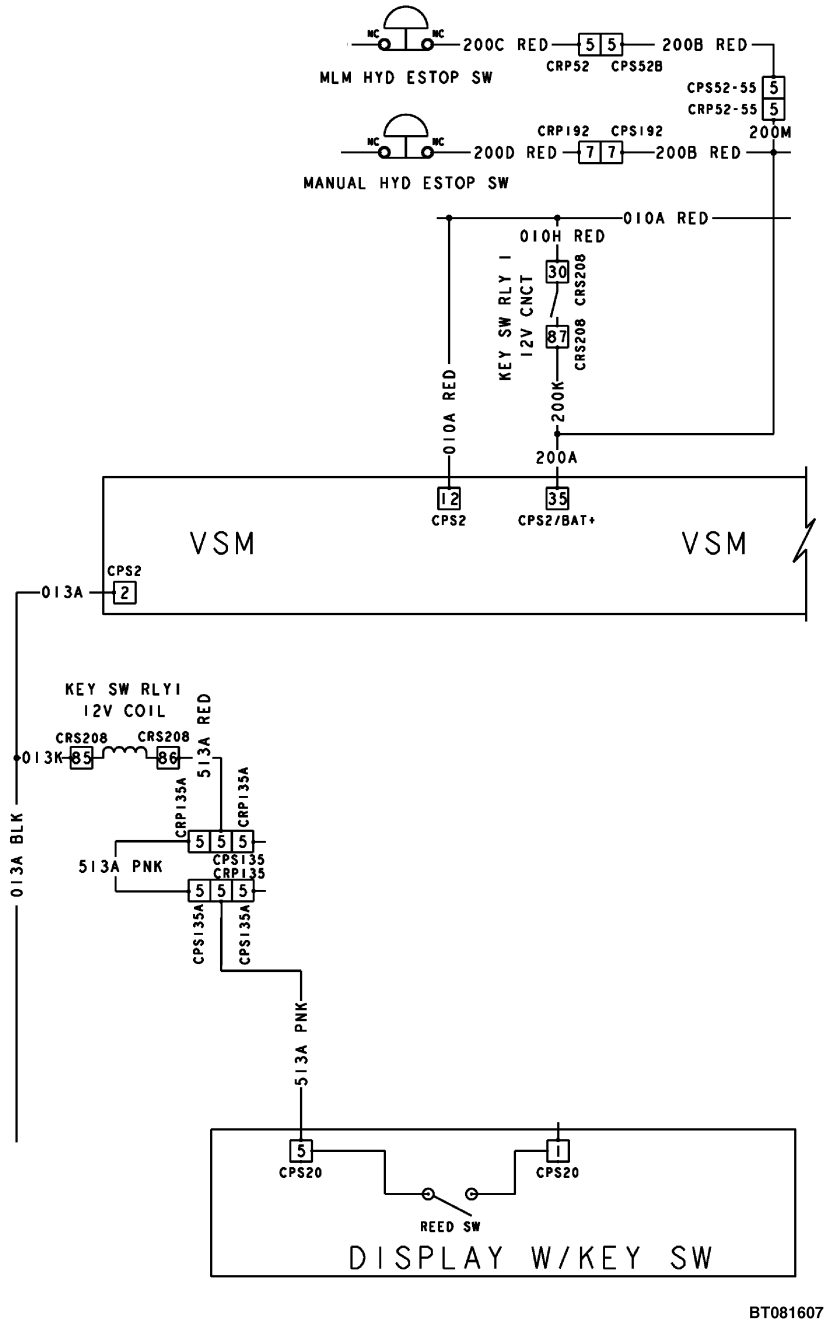
CAUSE D - CONTROLLER FAULT

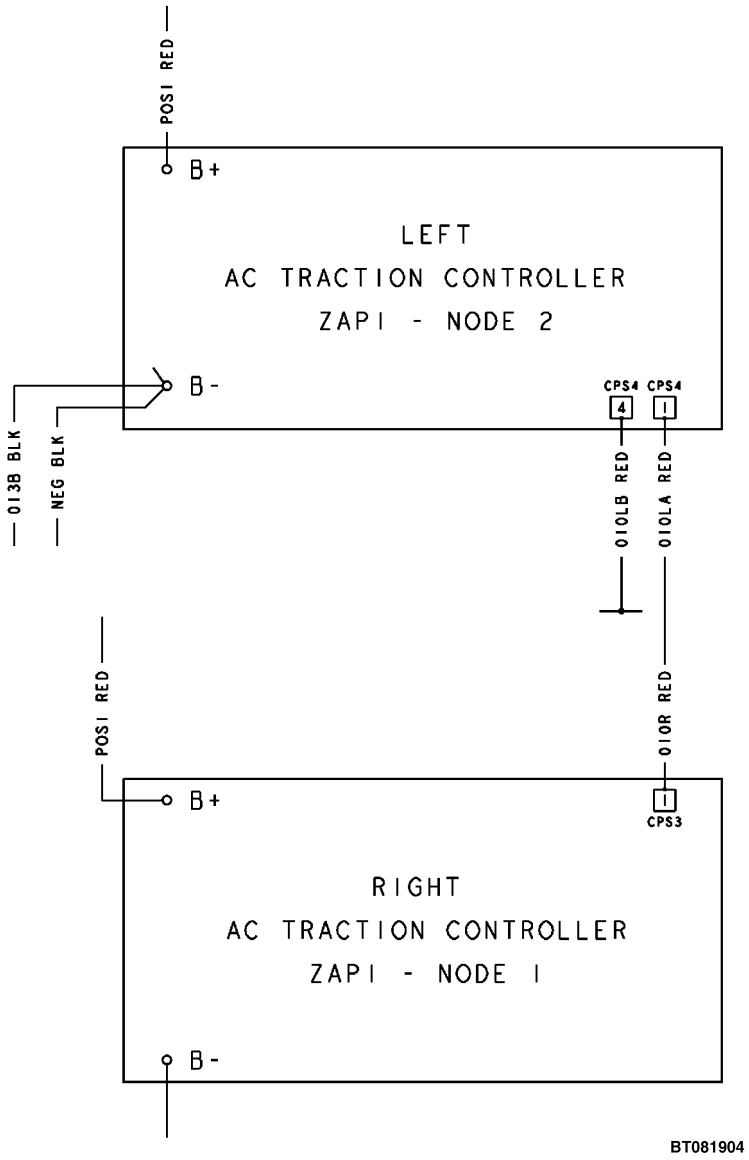
PROCEDURE OR ACTION:

1. If DTC returns, replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

DIAGRAMS


MLM HYD ESTOP SW
200C RED
CRP52
CPS52B
200B RED
CPS52-55
CRP52-55
MANUAL HYD ESTOP SW
CRP192
CPS192
200D RED
200B RED
200M
010A RED
010H RED
KEY SW RLY I
12V CNCT
CRS208
200K
200A
CPS2
CPS2/BAT+
VSM
VSM
013A
KEY SW RLYI
12V COIL
013K
513A RED
CRP135A
513A PNK
CPS135
CRP135
CPS135A
513A PNK
013A BLK
CPS20
REED SW
DISPLAY W/KEY SW
BT081607



Troubleshooting Scenes

END FAULT

DTC 65032
Watchdog (Slave)

POSSIBLE CAUSE

A. SOFTWARE UPDATE
B. SLAVE CONTROLLER FAULT

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Prior to performing troubleshooting procedures, verify controller is at the latest revision level. See FOC2 Software Updates.
2. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 3.
   NO: Problem not verified, resume operation.
3. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - SOFTWARE UPDATE

PROCEDURE OR ACTION:

1. Reprogram slave controller and retest system.
   Does DTC return after controller has been reprogrammed?
   YES: Proceed to CAUSE B.
   NO: No further service is required.

CAUSE B - SLAVE CONTROLLER FAULT

PROCEDURE OR ACTION:

1. If DTC returns after reprogramming, replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

END FAULT

DTC 65043
FOC2 DC Bus High / Key Voltage Low
Slave DC Bus voltage different than key voltage.

POSSIBLE CAUSE

A. SLAVE CONTROLLER WIRING FAULT
B. CONTACTOR PTC RESISTOR FAULT
C. FAULTY FUSE
D. SLAVE CONTROLLER FAULT

NOTE
Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Prior to performing troubleshooting procedures, verify controller is at the latest revision level. See FOC2 Software Updates.
2. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 3.
   NO: Problem not verified, resume operation.
3. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - SLAVE CONTROLLER WIRING FAULT

PROCEDURE OR ACTION:

1. Inspect power connection at appropriate controller.
   Is connection loose or damaged?
   YES: Repair connection, clear DTC, and retest system.
   NO: If only E-Steer controller is reporting DTC, proceed to CAUSE D, if more than one controller is reporting fault, proceed to CAUSE B.

CAUSE B - CONTACTOR PTC RESISTOR FAULT

PROCEDURE OR ACTION:

1. Disconnect PTC resistor and measure resistance.
   Is resistance between 5 +/- 0.5 ohms?
   YES: Proceed to CAUSE C.
   NO: Replace PTC resistor, clear DTC, and retest system.

CAUSE C - FAULTY FUSE

PROCEDURE OR ACTION:

1. Inspect appropriate fuse:
   - FU1-10A
   - FU2-10A
   - FU3-10A
   - FU4-5A

   Is fuse blown?
   YES: Inspect circuit for source of short and repair if necessary. Replace fuse, clear DTC, and retest system.
   NO: Proceed to CAUSE D.

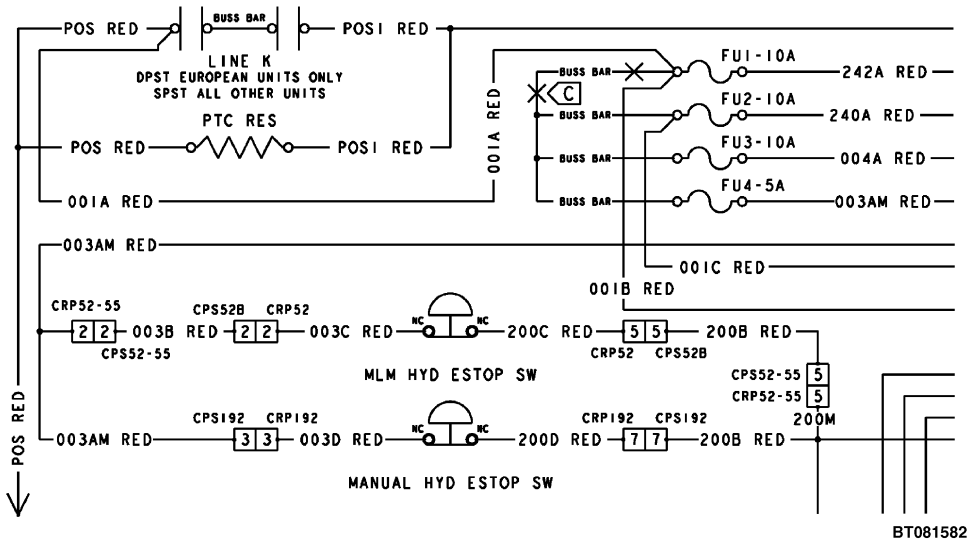
CAUSE D - SLAVE CONTROLLER FAULT

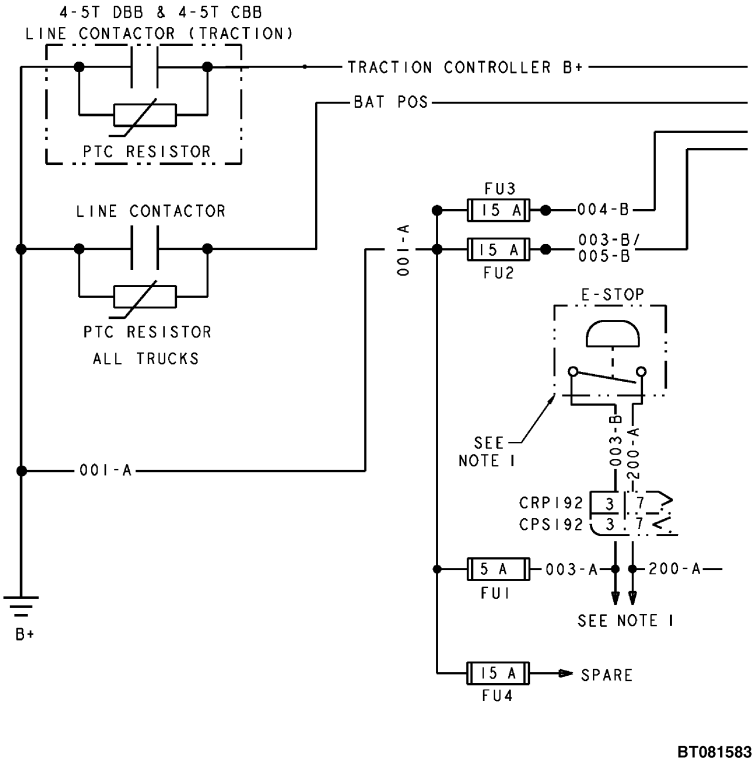
PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

DIAGRAMS





Troubleshooting Scenes

END FAULT

DTC 65077
FOC2 Traction Controller Standby Current Too High

POSSIBLE CAUSE

A. SLAVE CONTROLLER FAULT

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Prior to performing troubleshooting procedures, verify controller is at the latest revision level. See FOC2 Software Updates.
2. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 3.
   NO: Problem not verified, resume operation.
3. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - SLAVE CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

END FAULT

DTC 65086
FOC2 Thermal Protection
Slave traction controller temperatures above 85°C (185°F)

POSSIBLE CAUSE

A. SLAVE CONTROLLER OVER TEMPERATURE
B. CONTROLLER FAULT

NOTE
Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Prior to performing troubleshooting procedures, verify controller is at the latest revision level. See FOC2 Software Updates.
2. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 3.
   NO: Problem not verified, resume operation.
3. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - SLAVE CONTROLLER OVER TEMPERATURE

PROCEDURE OR ACTION:

1. Using the PC Service Tool, verify steer motor serial data and then measure actual motor temperatures. Over temp conditions are above 85°C (185°F).
   Is controller temperature out of range?
   YES: Allow controller to cool within acceptable temperatures, clear DTC and resume operation.
   NO: Disconnect battery and proceed to CAUSE B.

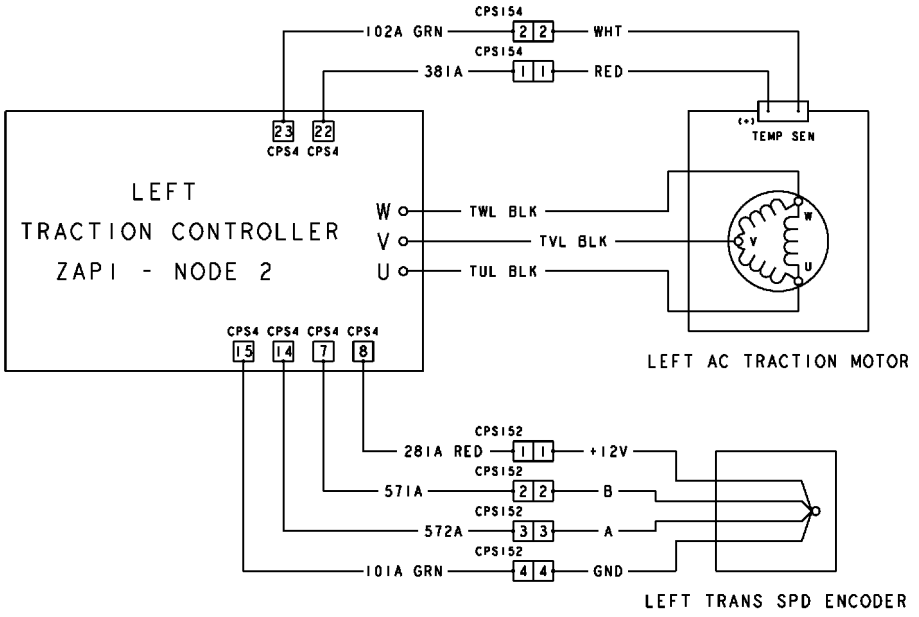
CAUSE B - CONTROLLER FAULT

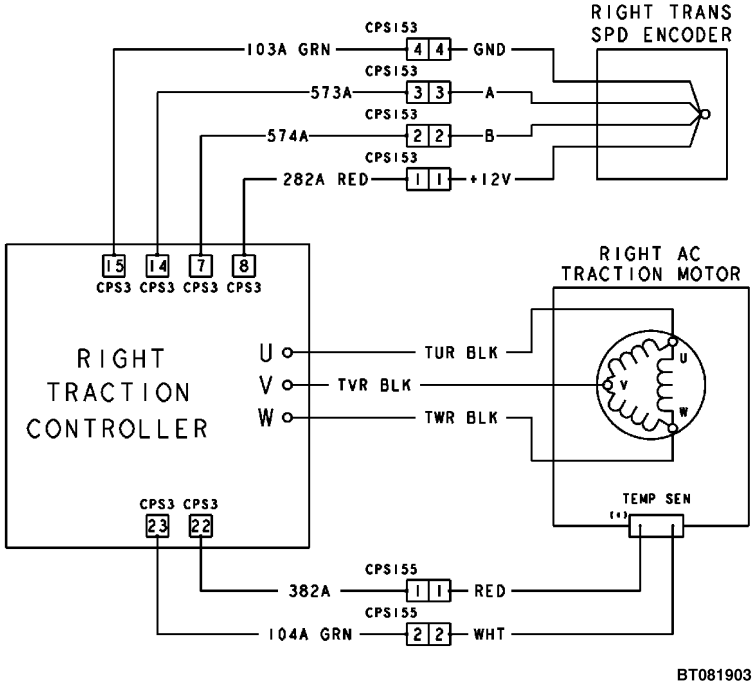
PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

DIAGRAMS





Troubleshooting Scenes

END FAULT

CODES

DTC 65106 - FOC2 Encoder Error
DTC 64850 - FOC2 Encoder Error

POSSIBLE CAUSE

A. SPEED SENSOR WIRING FAULT
B. SPEED SENSOR FAULT
C. SLAVE CONTROLLER FAULT

NOTE
Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Prior to performing troubleshooting procedures, verify controller is at the latest revision level. See FOC2 Software Updates.
2. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 3.
   NO: Problem not verified, resume operation.
3. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - SPEED SENSOR WIRING FAULT

PROCEDURE OR ACTION:

1. Disconnect the speed sensor connector and measure voltage between encoder 12 volt supply and B(-).
   Is voltage 12 ± 1.0 Vdc?
   YES: Proceed to Step 2.
   NO: Inspect circuit 281A or 282-A for open or short.
2. Measure voltage between 12 volt supply circuit and ground circuit.
   Is voltage 12 ± 1.0 Vdc?
   YES: Proceed to Step 3.
   NO: Inspect ground circuit 101A or 103A for open or short.
3. Disconnect traction controller connector and measure resistance between the following signal circuits:
   - Traction controller connector, socket 14 and speed sensor connector, socket A.
   - Traction controller connector, socket 14 and speed sensor connector, socket B.

   Is resistance <1 ohm?
   YES: Connect the speed sensor and traction controller connectors and proceed to CAUSE B.
   NO: Inspect encoder signal circuits or open or source of excessive resistance.

CAUSE B - SPEED SENSOR FAULT

PROCEDURE OR ACTION:

1. Using the PC Service Tool, locate and observe the speed sensor count signal.
   Does encoder provide accurate count signal during operation?
   YES: Proceed to CAUSE C.
   NO: Replace faulty speed sensor.

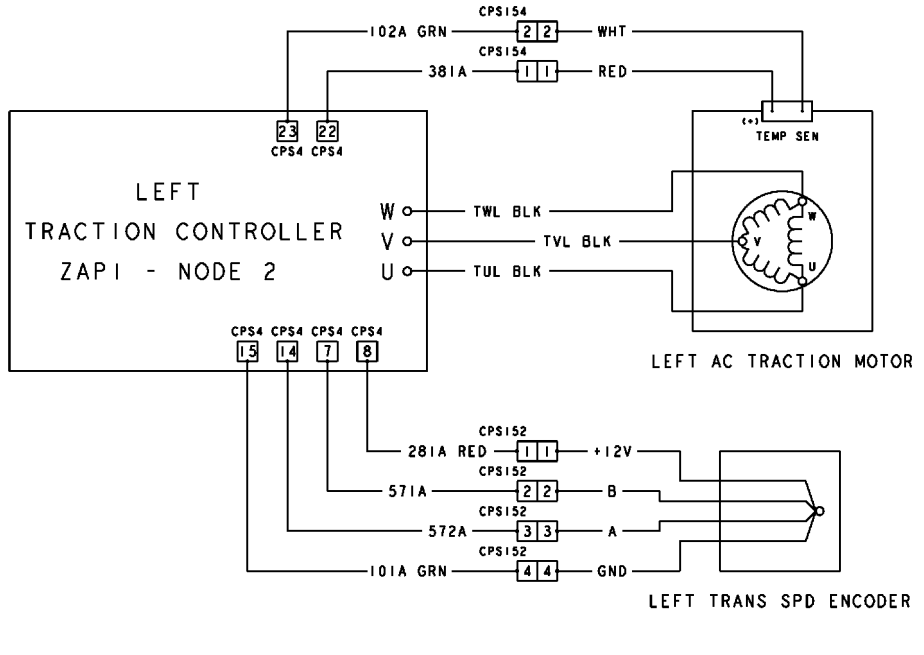
CAUSE C - SLAVE CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

DIAGRAMS



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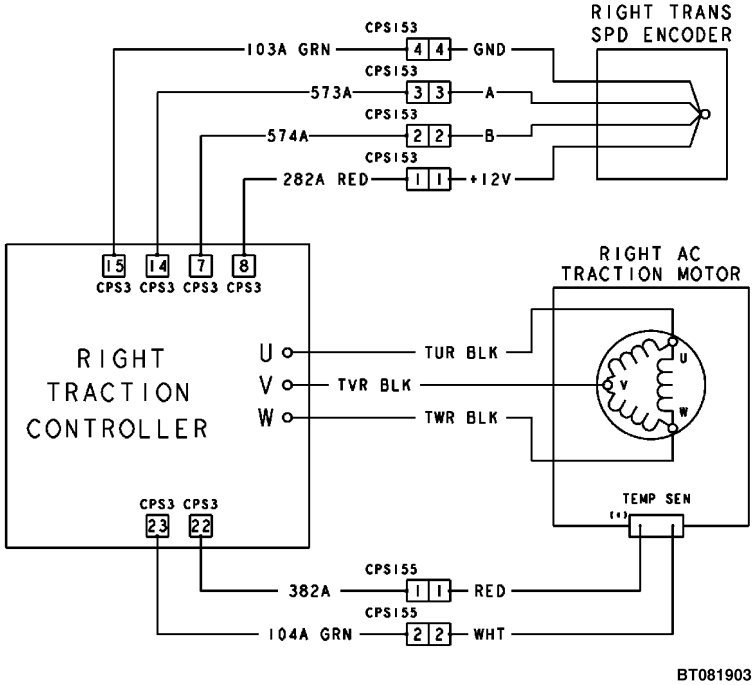


BT081903

Troubleshooting Scenes

END FAULT

DTC 65232
EEPROM KO (Slave)

POSSIBLE CAUSE

A. SOFTWARE UPDATE
B. SLAVE CONTROLLER FAULT

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Prior to performing troubleshooting procedures, verify controller is at the latest revision level. See FOC2 Software Updates.
2. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 3.
   NO: Problem not verified, resume operation.
3. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - SOFTWARE UPDATE

PROCEDURE OR ACTION:

1. Reprogram controller and retest system.
   Does DTC return after controller has been reprogrammed?
   YES: Proceed to CAUSE B.
   NO: No further service is required.

CAUSE B - SLAVE CONTROLLER FAULT

PROCEDURE OR ACTION:

1. If DTC returns after reprogramming, replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

END FAULT

DTC 65234
FOC2 Controller Wrong RAM Memory (Slave)

POSSIBLE CAUSE

A. SOFTWARE UPDATE
B. SLAVE CONTROLLER FAULT

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Prior to performing troubleshooting procedures, verify controller is at the latest revision level. See FOC2 Software Updates.
2. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 3.
   NO: Problem not verified, resume operation.
3. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - SOFTWARE UPDATE

PROCEDURE OR ACTION:

1. Reprogram controller and retest system.
   Does DTC return after controller has been reprogrammed?
   YES: Proceed to CAUSE B.
   NO: No further service is required.

CAUSE B - SLAVE CONTROLLER FAULT

PROCEDURE OR ACTION:

1. If DTC returns after reprogramming, replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

END FAULT

CODES

DTC 65236 - FOC2 Waiting Master
DTC 65254 - FOC2 W.D. SYNCRO

POSSIBLE CAUSE

A. SOFTWARE UPDATE
B. SLAVE CONTROLLER FAULT

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Prior to performing troubleshooting procedures, verify controller is at the latest revision level. See FOC2 Software Updates.
2. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 3.
   NO: Problem not verified, resume operation.
3. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - SOFTWARE UPDATE

PROCEDURE OR ACTION:

1. Reprogram controller and retest system.
   Does DTC return after controller has been reprogrammed?
   YES: Proceed to CAUSE B.
   NO: No further service is required.

CAUSE B - SLAVE CONTROLLER FAULT

PROCEDURE OR ACTION:

1. If DTC returns after reprogramming, replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

END FAULT

DTC 65259
FOC2 Coil_Short_HW_KO

POSSIBLE CAUSE

A. MAIN CONTACTOR WIRING FAULT
B. MAIN CONTACTOR COIL FAULT
C. SLAVE CONTROLLER FAULT

NOTE
Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Prior to performing troubleshooting procedures, verify controller is at the latest revision level. See FOC2 Software Updates.
2. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 3.
   NO: Problem not verified, resume operation.
3. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - MAIN CONTACTOR WIRING FAULT

PROCEDURE OR ACTION:

NOTE: Key in ON position.

1. Disconnect coil connector TF10 (B+) and TF11 (B-) and measure voltage between TF10 (B+) and B(-).
   Is voltage battery voltage present?
   YES: Proceed to Step 2.
   NO: Inspect input circuit for open or short.
2. Measure voltage between TF10 (B+) and TF11 (B-).
   Is voltage battery voltage present?
   YES: Proceed to CAUSE B.
   NO: Inspect ground control circuit 024A for open, short, or source of excessive resistance.

CAUSE B - MAIN CONTACTOR COIL FAULT

PROCEDURE OR ACTION:

1. Measure resistance across coil terminals.
   Is resistance 20 ± 2 ohms?
   YES: Proceed to CAUSE C.
   NO: Replace faulty coil.

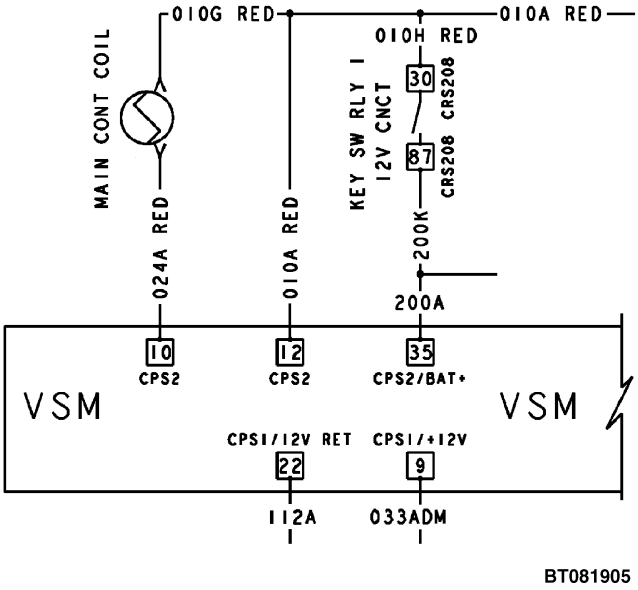
CAUSE C - SLAVE CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

DIAGRAMS



Troubleshooting Scene

END FAULT

CODES

DTC 65261 - FOC2 Analog Input
DTC 65263 - FOC2 Controller Mismatch
DTC 65266 - FOC2 SP Mismatch

POSSIBLE CAUSE

A. SOFTWARE UPDATE
B. SLAVE CONTROLLER FAULT

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Prior to performing troubleshooting procedures, verify controller is at the latest revision level. See FOC2 Software Updates.
2. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 3.
   NO: Problem not verified, resume operation.
3. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - SOFTWARE UPDATE

PROCEDURE OR ACTION:

1. Reprogram controller and retest system.
   Does DTC return after controller has been reprogrammed?
   YES: Proceed to CAUSE B.
   NO: No further service is required.

CAUSE B - SLAVE CONTROLLER FAULT

PROCEDURE OR ACTION:

1. If DTC returns after reprogramming, replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

END FAULT

CODES

DTC 65270 - FOC2 Aux Drive Open
DTC 65278 - FOC2 Aux Driver Short

POSSIBLE CAUSE

A. ACC WIRING FAULT
B. COIL FAULT

NOTE
Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Prior to performing troubleshooting procedures, verify controller is at the latest revision level. See ***FOC2 Software Updates***.
2. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 3.
   NO: Problem not verified, resume operation.
3. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - ACC WIRING FAULT

PROCEDURE OR ACTION:

1. Inspect for short to B(+) between coil and VSM.
   Is short to power detected?
   YES: Repair short, clear code and retest system.
   NO: Disconnect battery and proceed to CAUSE B.

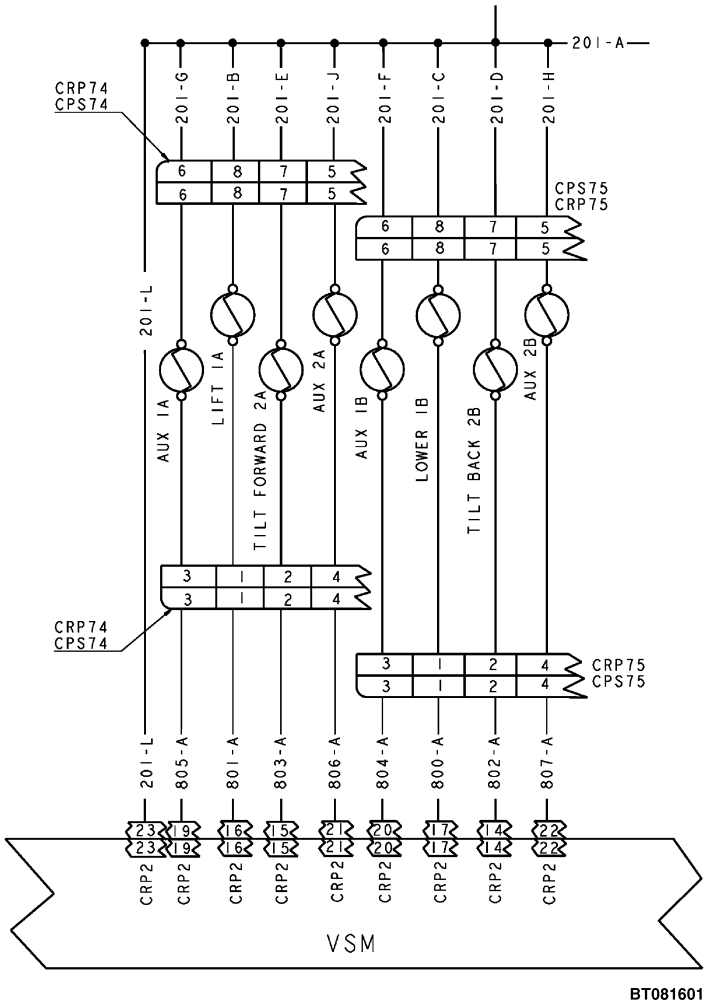
CAUSE B - COIL FAULT

PROCEDURE OR ACTION:

1. Disconnect suspected coil and measure resistance across coil terminals.
   Is resistance between 20 +/- 5 ohms?
   YES: Suspect faulty VSM.
   NO: Replace faulty coil.

END POSSIBLE CAUSES

DIAGRAMS



Troubleshooting Scenes

END FAULT

CODES

DTC 65528 - FOC2 No CAN Message
DTC 65272 - FOC2 No CAN Message

POSSIBLE CAUSE

A. TRACTION CONTROLLER CANBUS FAULT
B. SLAVE CONTROLLER FAULT

NOTE
Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Prior to performing troubleshooting procedures, verify controller is at the latest revision level. See FOC2 Software Updates.
2. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to Step 3.
   NO: Problem not verified, resume operation.
3. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to CAUSE A.

CAUSE A - TRACTION CONTROLLER CANBUS FAULT

PROCEDURE OR ACTION:

NOTE: Key in ON position.

1. Disconnect the appropriate traction controller connector CPS3/CPS4. Measure voltage between cavity 20 and B(-).
   Is CAN HI voltage approximately 2.5 Vdc?
   YES: Proceed to Step 2.
   NO: Inspect CAN HI circuit for open or short. If voltage is 0 volts, the CAN HI circuit is shorted to ground or open. If voltage is above 5 volts, the CAN HI circuit is shorted to power.
2. Measure voltage between the traction controller connector CPS3/CPS4, cavity 21/12 and B(-).
   Is CAN HI voltage approximately 2.5 Vdc?
   YES: Disconnect battery and proceed to Step 3.
   NO: Inspect CAN LO circuit for open or short. If voltage is 0 volts, the CAN LO circuit is shorted to ground or open. If voltage is above 5 volts, the CAN LO circuit is shorted to power.

NOTE: The FOC2 left traction controller has an additional termination resistor. The additional resistor will cause a total CANbus resistance of 40 ohms.

3. Measure resistance between the traction controller connector CPS11, socket A21 and socket A20.
   Is resistance 60 ± 6 (40Ω for FOC2) ohms?
   YES: CAUSE B
   NO: If resistance is 120 ohms, the CANbus has an open circuit or a missing or damaged termination resistor. If resistance is 0 ohms, the CANbus circuits are shorted together.

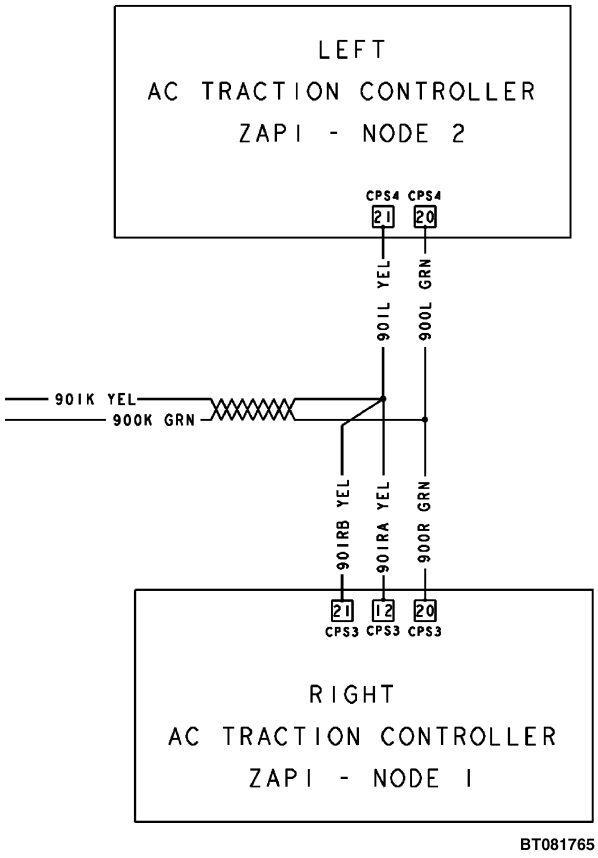
CAUSE B - SLAVE CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

DIAGRAMS



Troubleshooting Scenes

END FAULT

Controller temperatures below 45°C (113°F)

CODES

DTC 65341 - Controller Internal Temperature OORL
DTC 17232 - Controller Internal Temperature OORL

POSSIBLE CAUSE

A. CONTROLLER BELOW TEMPERATURE
B. CONTROLLER FAULT

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to next step.Step 2
   NO: Problem not verified, resume operation.
2. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to next step.CAUSE A

CAUSE A - CONTROLLER BELOW TEMPERATURE

PROCEDURE OR ACTION:

1. Using the PC Service Tool, verify controller temperature and measure actual controller temperature. Low temp conditions are below 45°C (113°F).
   Is controller temperature out of range?
   YES: Bring controller temperatures above temperature threshold, clear DTC and resume operation.
   NO: Proceed to next step.CAUSE B

CAUSE B - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

END FAULT

Thermal Management

CODES

DTC 65341 - Controller Internal Temperature OORH
DTC 65342 - Thermal Protection / Motor Temperature High
DTC 64830 - FOC2 Traction Controller Motor Temperature High
DTC 17184 - Controller Internal Temperature OORH

POSSIBLE CAUSE

A. CONTROLLER OVER TEMPERATURE
B. CONTROLLER FAULT

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. DTC 64830 may require software updates. Prior to performing troubleshooting procedures, verify controller is at the latest revision level. FOC2 Software Updates.
2. Turn power to OFF for no less than 30 seconds, and then to ON to clear displayed DTC.
   Does reported DTC reoccur?
   YES: Proceed to next step.Step 3
   NO: Problem not verified, resume operation.
3. Conduct a quick visual inspection of all connectors/wiring associated with the displayed fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate Electrical System manual.
   NO: Proceed to next step.CAUSE A

CAUSE A - CONTROLLER OVER TEMPERATURE

PROCEDURE OR ACTION:

1. Using the PC Service Tool, verify controller temperature and measure actual controller temperature. Over temp conditions are above 80°C (176°F).
   Is controller temperature out of range?
   YES: Allow controller to cool within acceptable temperatures, clear DTC and resume operation.
   NO: Proceed to next step.CAUSE B

CAUSE B - CONTROLLER FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

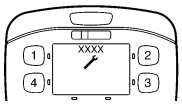
END FAULT

NOTES

Group 30
Observed Symptoms

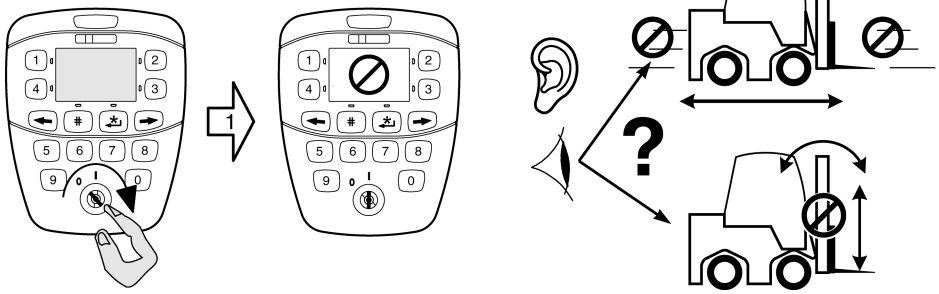
No Display/No Truck Operation

DTC None
No Display/No Truck Operation



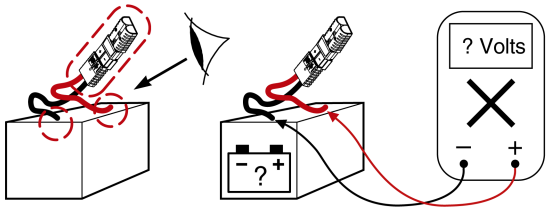
QUICK CHECK X = Open Circuit/Fail) = Short Circuit

Symptom 1 No Display/No Truck Operation



Power **ON**→No Display→No truck Operation

Check 1

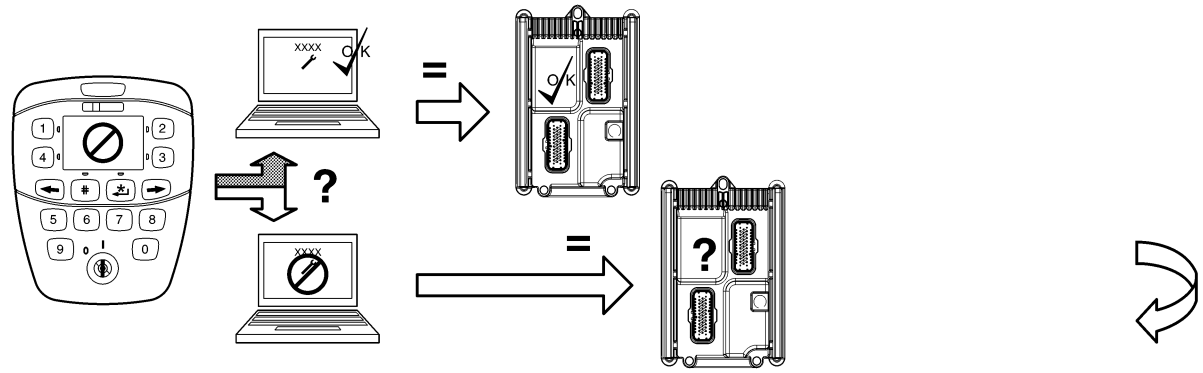


Battery Voltage					
Nominal	36	48	72	80	
Fully Charged	39.6	52.8	79.2	88	
˜< OORL	18	24	36	40	
˜ OORH	48.6	57.6	97.2	108	

1. Check Emergency Disconnect Button is Released↓
2. Check Battery Connections/Wiring↓
3. Check Battery Voltage→See Table↑
4. Battery Voltage OK→YES Check 2↓NO→See Battery Service Manual for Battery Charging Instruction?

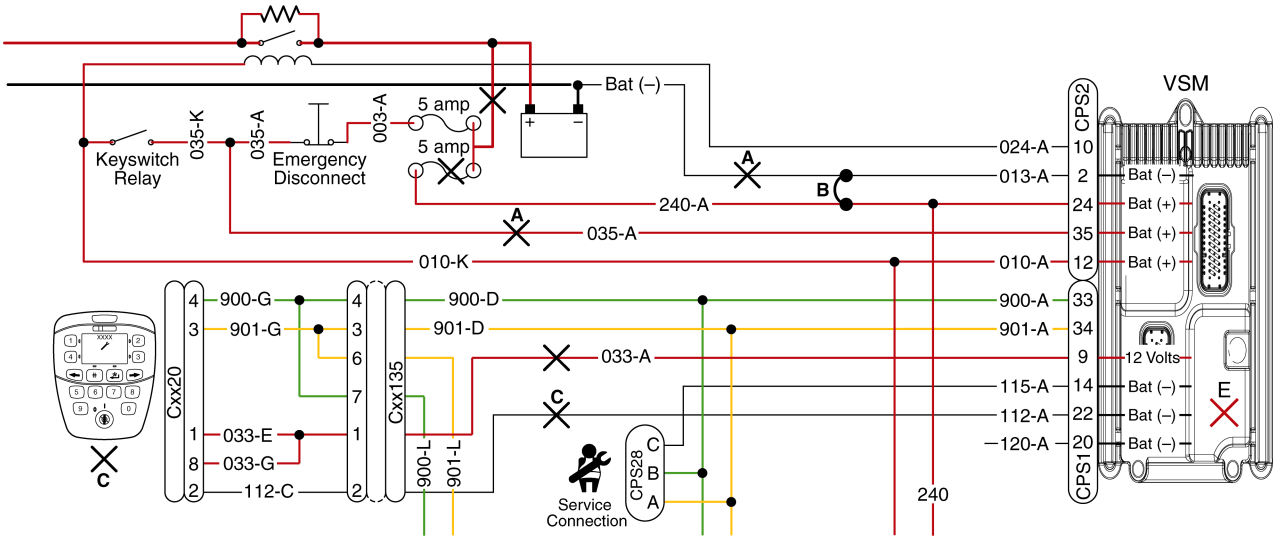
No Display/No Truck Operation (Cont)

Check 2



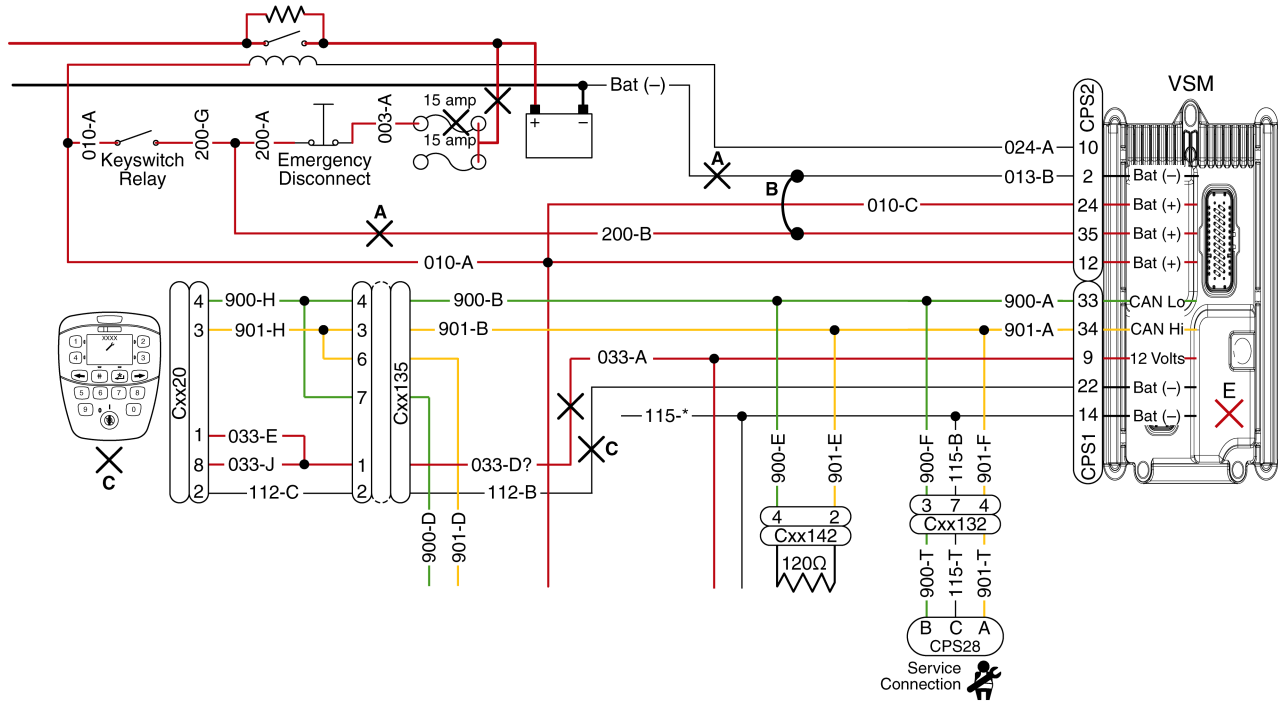
1. Use PC Service Tool to Check for DTCs↓
2. ? DTCs→YES→VSM OK→Check Display Power Connections→CAUSE B↓
3. ? DTCs→NO Check 3↓

A935/K160 Refer to **Diagrams** 8000SRM1528.

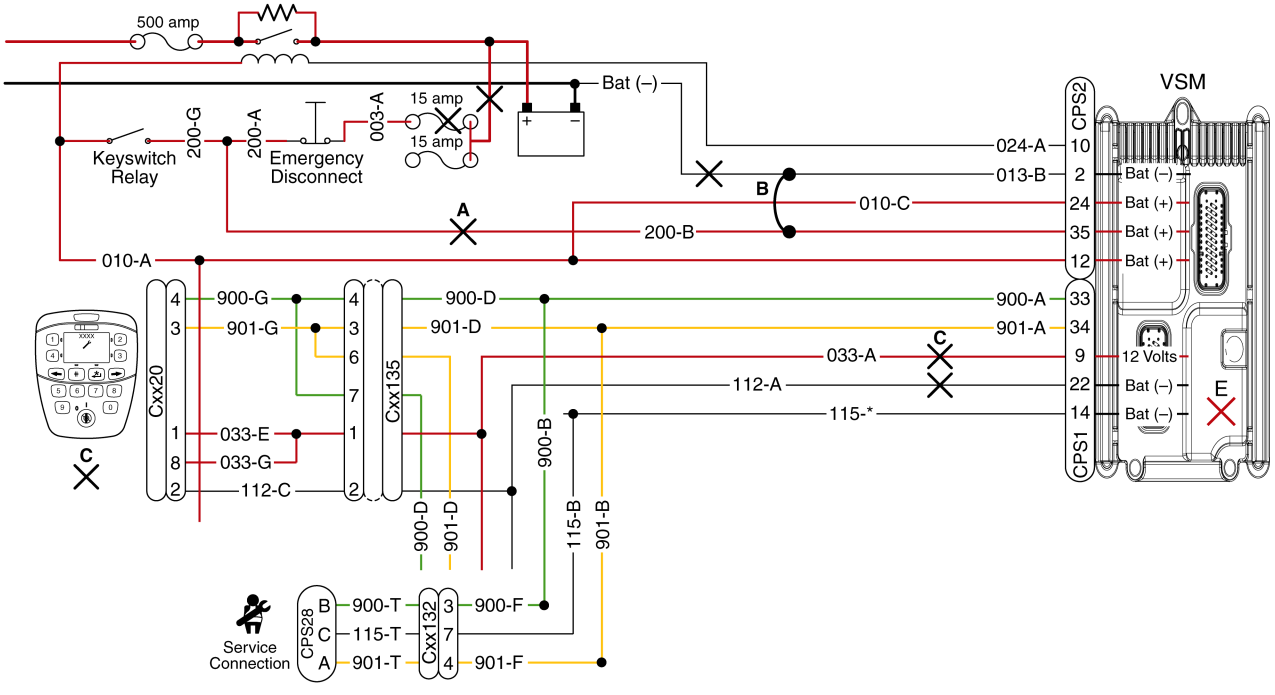


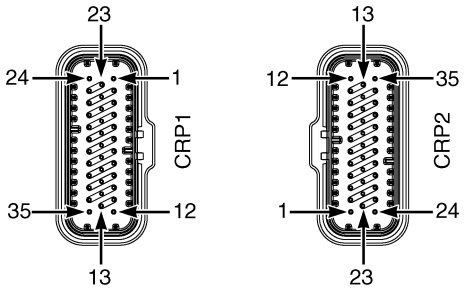
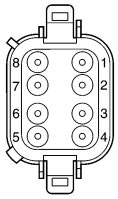
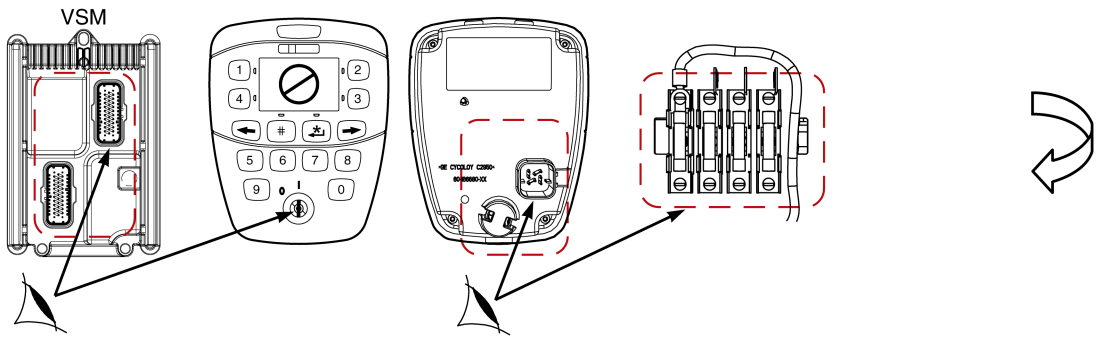
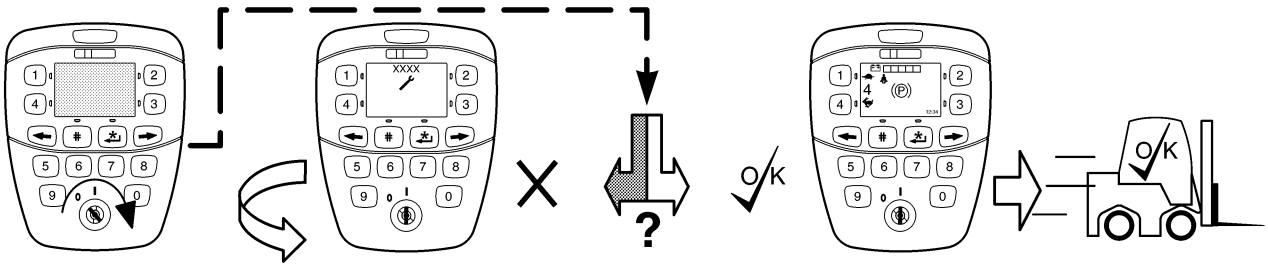
No Display/No Truck Operation (Cont)

4 Wheel CBB



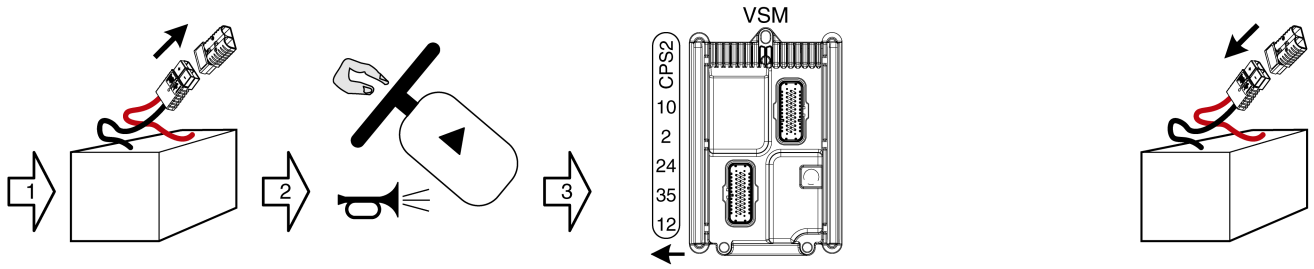
4 Wheel DBB



No Display/No Truck Operation (Cont)	
Connectors	
	
VSM Cxx 1 and Cxx 2	Display Cxx 20 and 135
For further information showing VSM/Display/Fuse location see General Description	
Check 3	
CAUTION:A Open Circuit Fuse Indicates a Short Circuit in the Wiring	
Locate the Short before replacing the fuse	
	
1. Is Key Switch Turning without binding?→YES Go to 2↓NO Go to 3 for Replacement Instructions↓	
2. Check VSM/Display Power/Fuses/Connections/Wiring→CAUSE 0↓	
3. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→	
4. Repair/Replace→Reconnect→Test→Go to Check 4↓	
Check 4	
	
Retest - Power **ON**→	**NO**→?
Does Display Turn ON?Is fault DTC gone?**NO** **YES**←→	Fault corrected→Continue operation.

No Display/No Truck Operation (Cont)

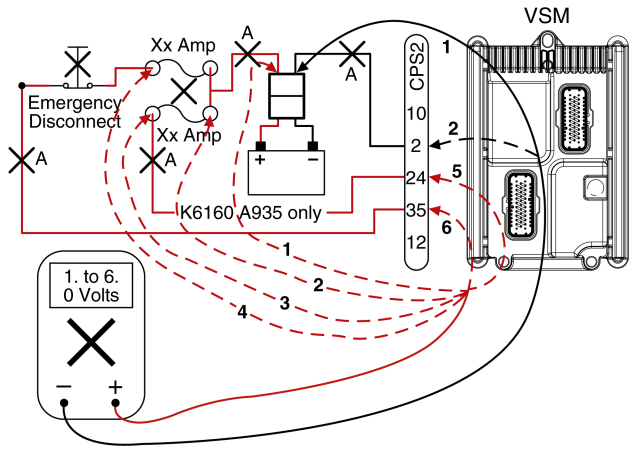
CAUSE A

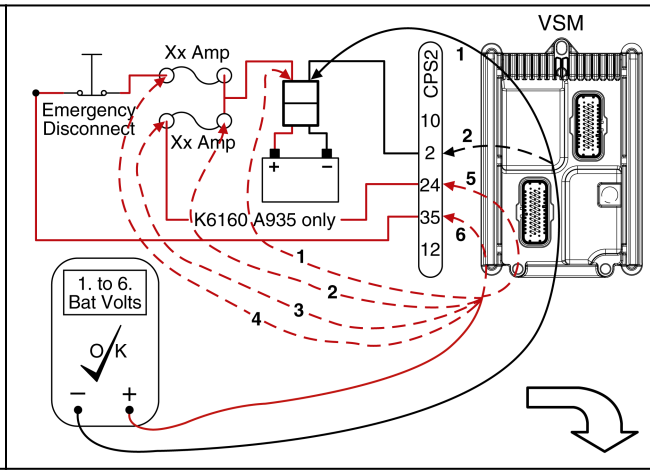


Disconnect Battery and Sound Horn to Discharge Capacitors.→Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342→. Disconnect VSM→Reconnect Battery→

STEP A1 CHECK VOLTAGE

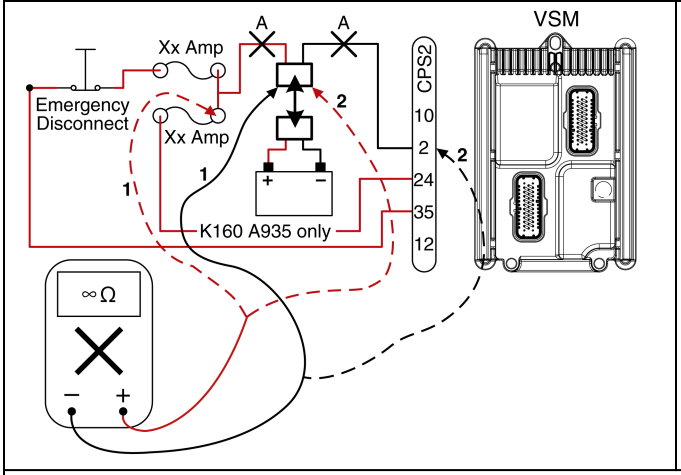
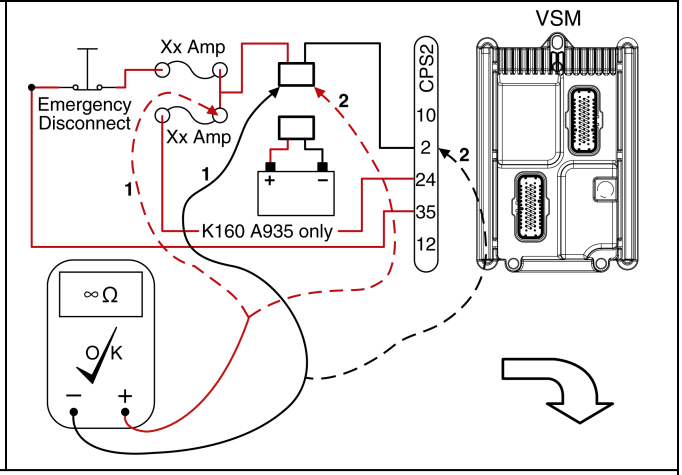
VSM Power Connections





Disconnect VSM connector CPS2 and check for Battery Volts

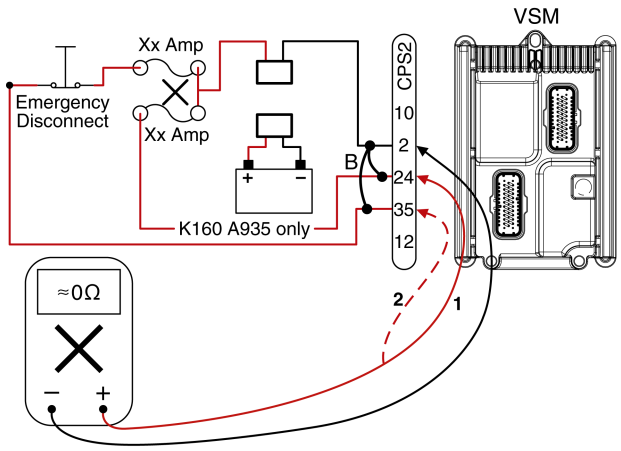
1. <18 Volts = Flat Battery↓	1. Battery Volts = OK, Go to 2↓
2. 0 Volts = Open Circuit→Step 2↓	2. Battery Volts = OK, Go to 3↓
3. 0 Volts = ☠Fuse→CAUSE A↓	3. Battery Volts = OK, Go to 4↓
4. 0 Volts = ☠Fuse→CAUSE A↓	4. Battery Volts = OK, Go to 5↓
5. 0 Volts = Open Circuit→Go to 7↓	5. Battery Volts = OK, Go to 6↓
6. 0 Volts = Open Circuit→Go to 7↓	6. Battery Volts = OK, CAUSE B↓
7. Open Circuit→Find/Repair Open Circuit, Go to 8↓	
8. Find/Repair Open Circuit See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→	
9. Recheck Volts at (+) 5 & 6 (-) 2↑→Battery Voltage Present?YES→CAUSE AResume OperationNo→Step 2↓	

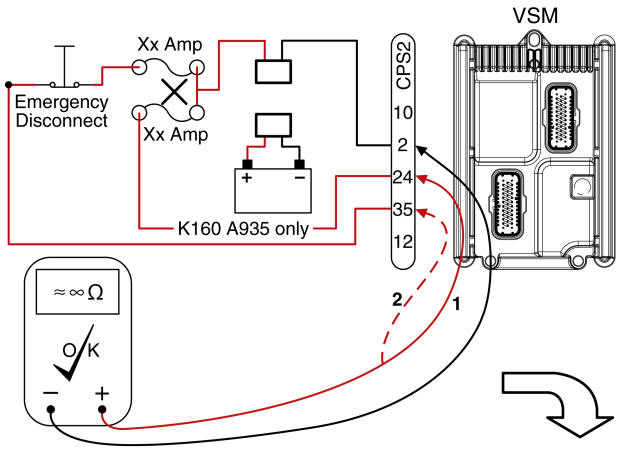
No Display/No Truck Operation (Cont)	
STEP A2	**CHECK RESISTANCE - Ω - OHMS**
VSM Power Connections Open Circuit	
	
Disconnect Battery→Check for ?	
1. 8? = Open Circuit, Go to 3↓	1. 0 ? = OK, Go to 2↓
2. 8? = Open Circuit, Go to 3↓	2. 0 ? = OK, CAUSE A↓
3. Find/Repair Open Circuit, Go to 4↓	
4. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→	
5. Recheck ? at 1 & 2↑→= 0 ??YES→Go to 6↓Resume OperationNo→Go back to 3↑	
Reconnect Battery→Test→Battery Voltage Present?Yes→Resume Operation→No→CAUSE A↓	

No Display/No Truck Operation (Cont)

CAUSE B

VSM Power Connections ☠Fuse (Short Circuit)

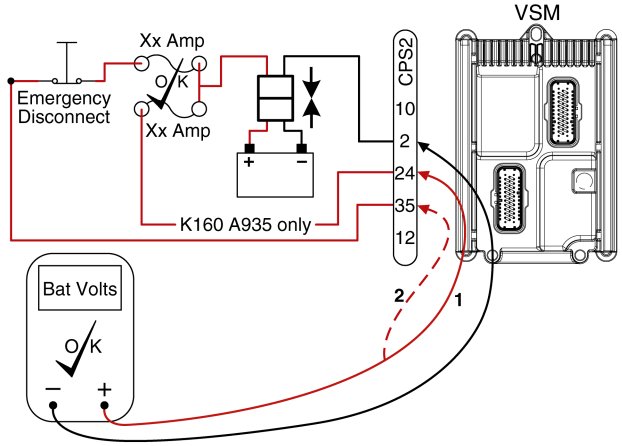


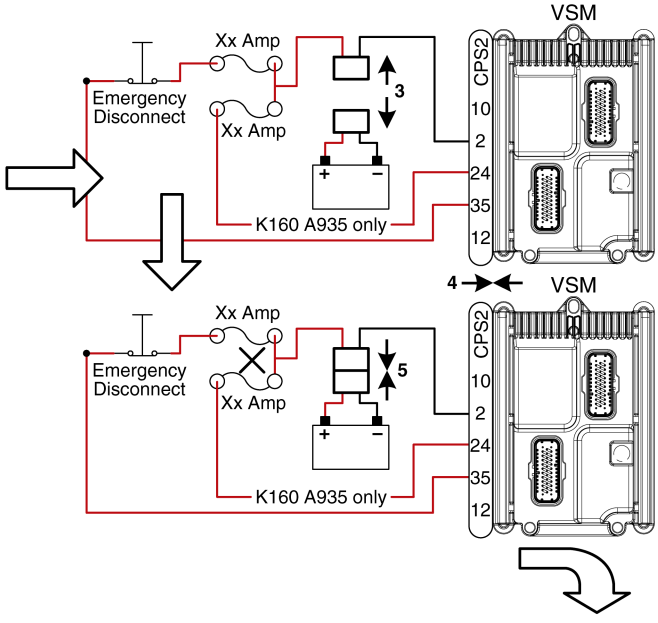


1. 0? = Short Circuit→Go to 3↓	1. 8? = OK→Go to 2↓
2. 0? = Short Circuit→Go to 3↓	2. ˜ 8? = OK→Step 2↓
3. Find/Repair Short, Circuit Go to 4↓	
4. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→Step 2↓	

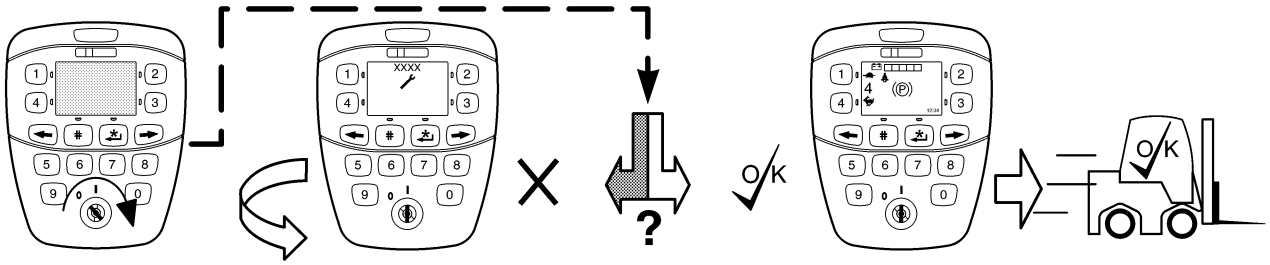
STEP B1 CHECK RESISTANCE - Ω - OHMS

VSM Power Connections Open Circuit





Replace Fuse(s)→Reconnect Battery→Check Volts→Go to 1↓
1. Battery Volts Present?Yes→Go to 2↓
2. Battery Volts Present?Yes→Go to 3↓
3. Disconnect Battery→4. Reconnect VSM→5. Reconnect Battery, Step 2↓

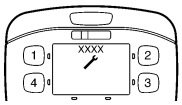
No Display/No Truck Operation (Cont)			
STEP B2			
			
Retest - Power **ON**→	**NO**→CAUSE B	Does Display Turn ON? Is fault DTC gone?**NO** **YES**←→	Fault corrected→Continue operation.

CAUSE C
DISPLAY Connection Failure
See A935 – K160 CAN Communication Failure, CBB 4 Wheel CAN Communication, and DBB 4 Wheel CAN Communication→

END FAULT

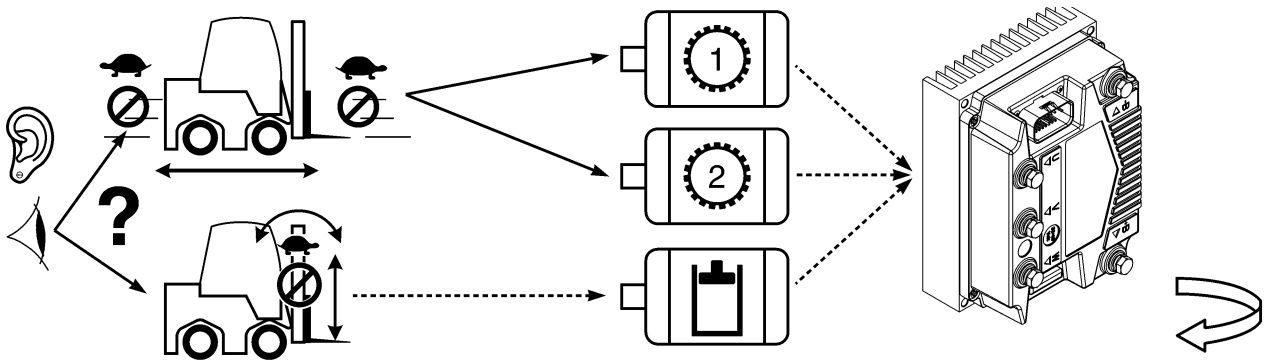
A935 – K160 D203 Motor Controller Fan Failure (Cont)

DTC None
A935 – K160 Motor Controller Fan Failure



QUICK CHECK X = Open Circuit/Fail) = Short Circuit

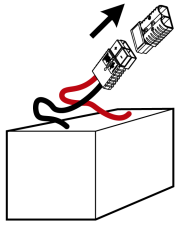
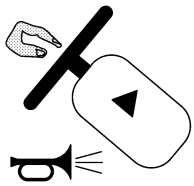
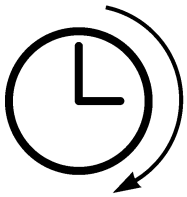
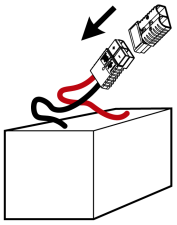
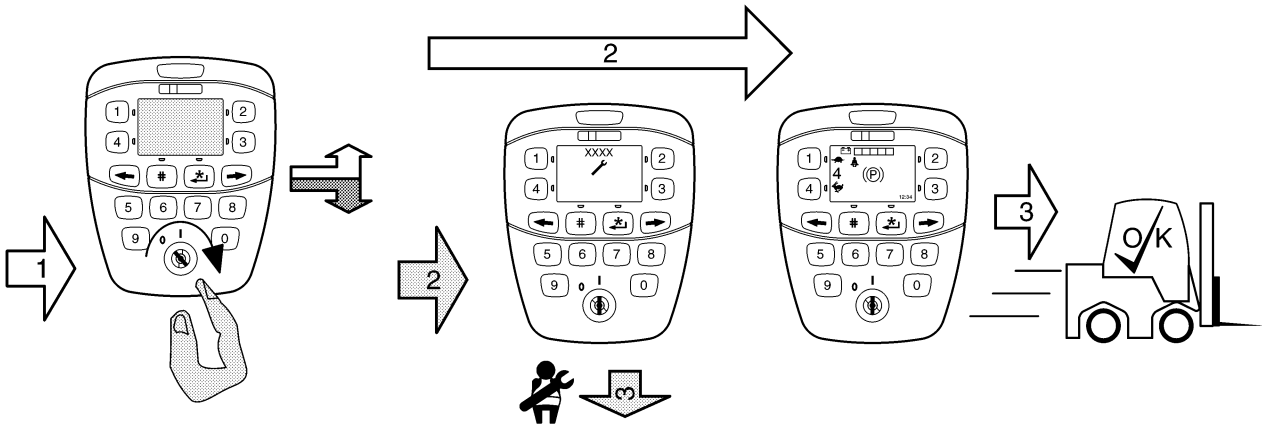
Check 1

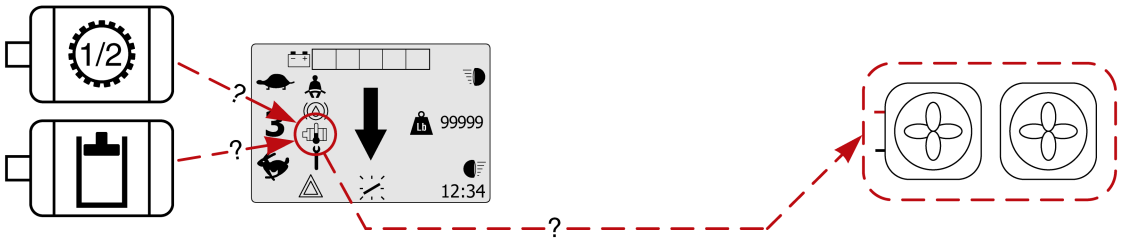


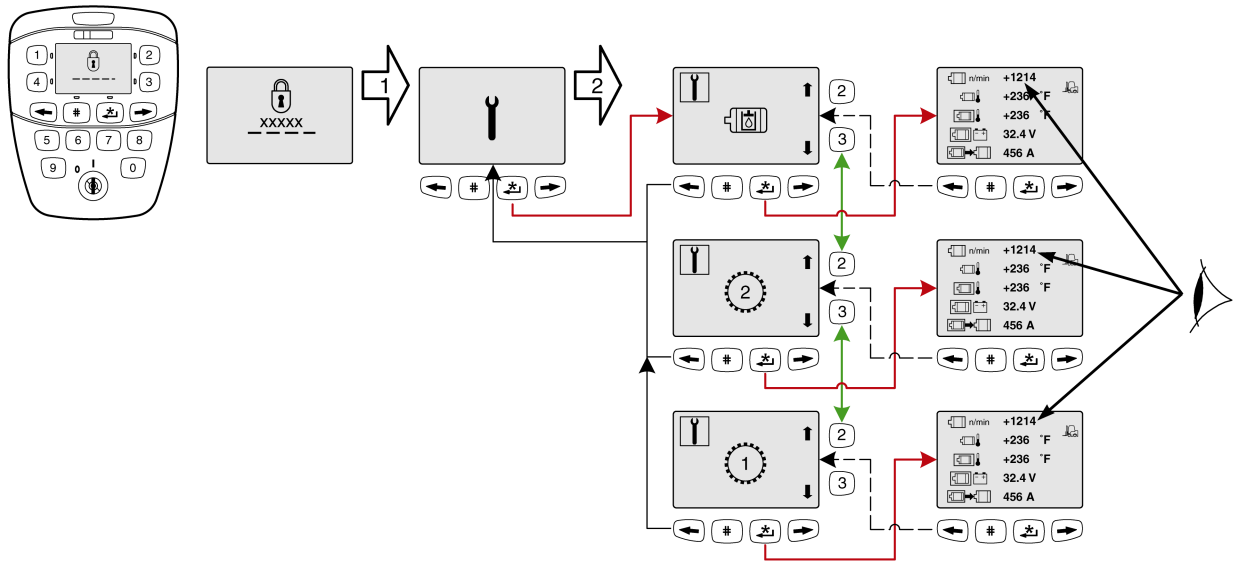
? Function Failure/Reduced Performance/Uncommanded Continuous Operation?

POSSIBLE CAUSES

1. Fan/Motor Controller Connections/Wiring ?→
2. Fan Motor Failure ?→
3. Motor Controller(s) Failure ?→

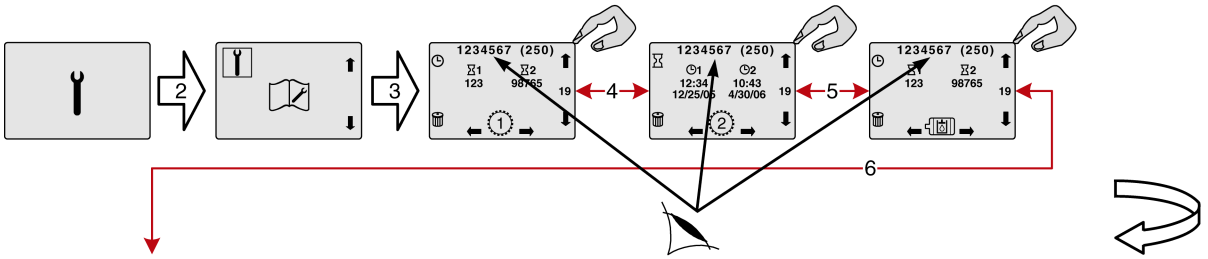
A935 – K160 D203 Motor Controller Fan Failure (Cont)			
Check 2			
			
Disconnect Battery and Sound Horn to Discharge Capacitors.Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342.		Wait 30 seconds	Reconnect Battery
Check 3			
			
Power **ON**→	Fault Remains Service Required ?	No Fault→Resume Operation	

A935 – K160 D203 Motor Controller Fan Failure (Cont)	
Check 4	
	
Reduced Performance→Check Display Icons?	
Motor/Motor Controller Temperature Icon On	
1. Check fan operation→Are fans operating?→NO →CAUSE 0YES →Go to 2?	
2. Temp Sensor/Sensor Connection→Open Circuit→A935 – K160A955 – G807D203B888 Motor/Motor Controller Temperature Sensor Failure	
3. Use the following steps for viewing Motor Temperatures	
Fan(s) Operation Temperature Threshold	**Traction = 55°C (131°F) Pump = 65°C (149°F)**
Reduced Performance:	**Traction = 80°C (176°F) Pump = 80°C (176°F)**

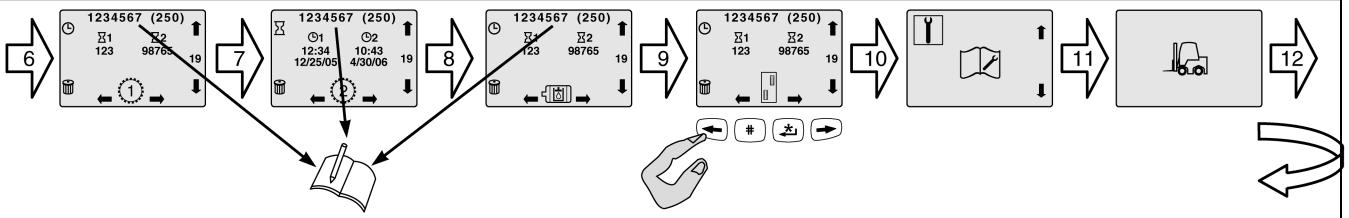
A935 – K160 D203 Motor Controller Fan Failure (Cont)		
Temperature > Operation Threshold→No Fan Operation = Faulty Fan/Fan Connections		
Check 5		
Diagnostics Temperature Analysis – Go to Display Menu Flowchart		
		
Enter Service Password→	Diagnostics→Motor→Traction1/Traction2/Pump→	Motor/Controller Data

A935 – K160 D203 Motor Controller Fan Failure (Cont)

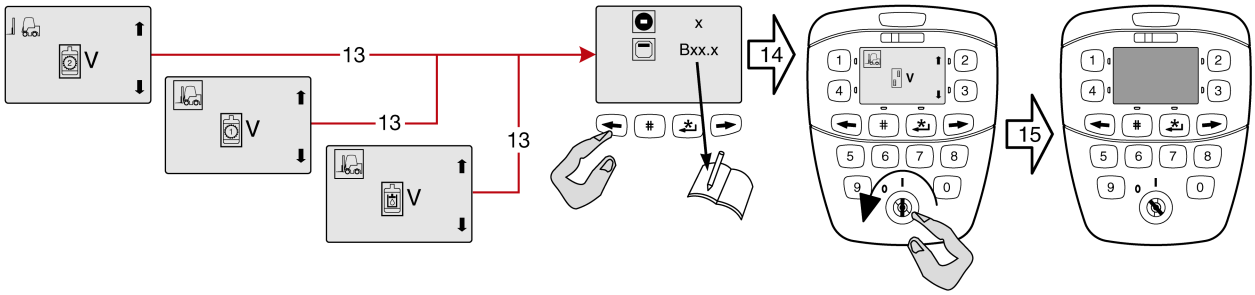
FAULT LOG Review - Go to Display Menu



Enter Service Password→Diagnostic→FAULT LOGs→Motor Fault Log(s)→View all Motor DTCs→?



all Motor DTCs→Exit Fault Log→Truck Status ?

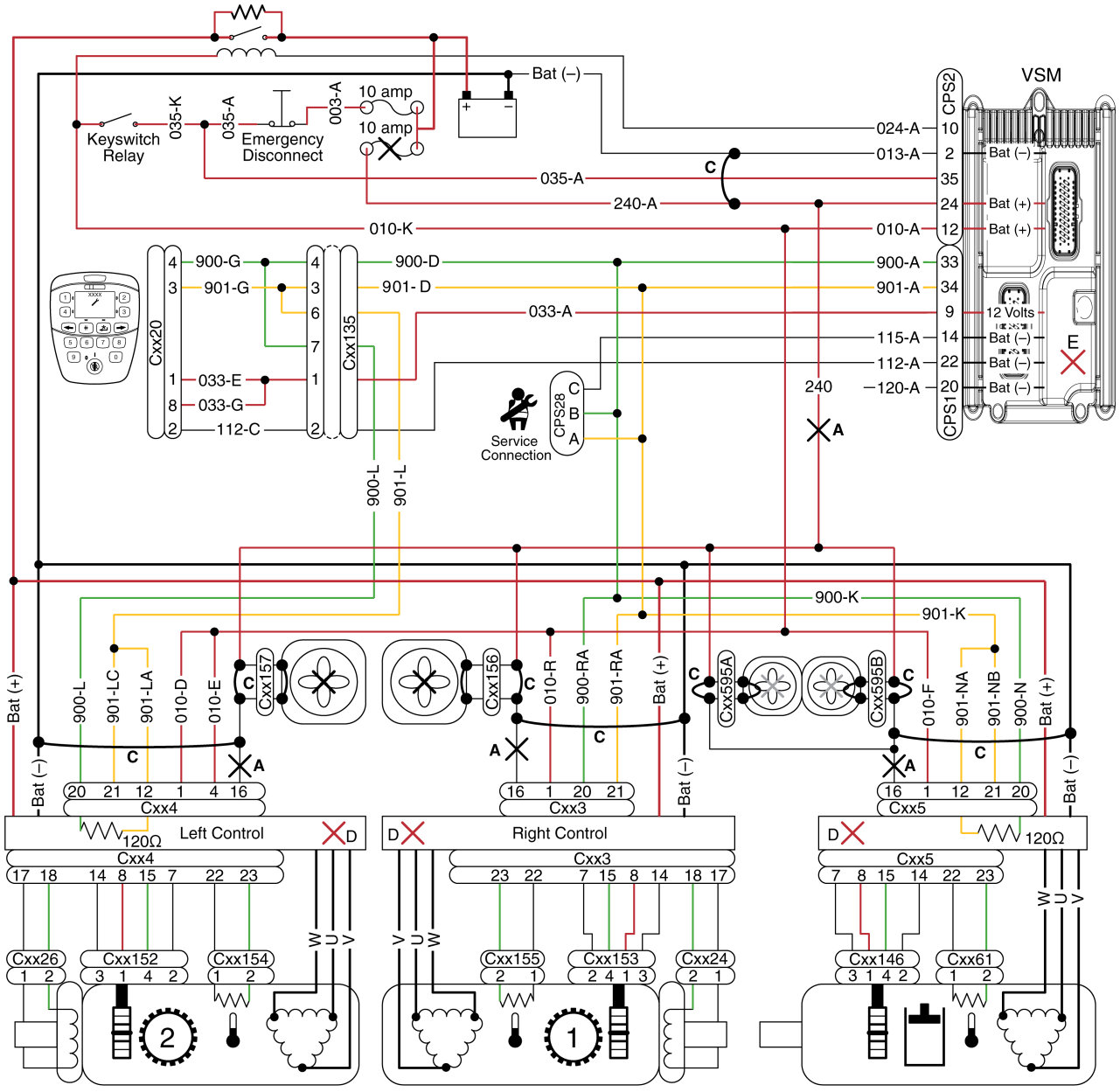


Motor Versions→Hardware/Software Versions→Exit Versions→Power **OFF**?

POSSIBLE CAUSES X = Open Circuit/Fail) = Short Circuit

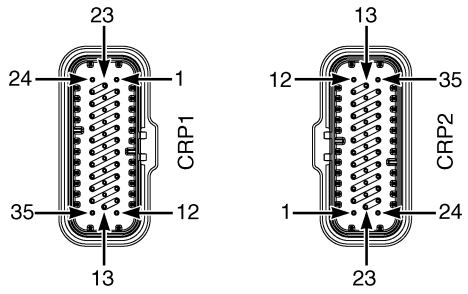
A935 – K160 D203 Motor Controller Fan Failure (Cont)

CAUSES A B C D E > ?

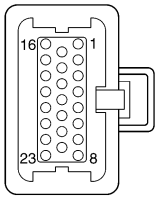


A935 – K160 D203 Motor Controller Fan Failure (Cont)

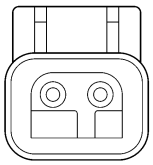
CONNECTORS



VSM Cxx 1 and Cxx 2

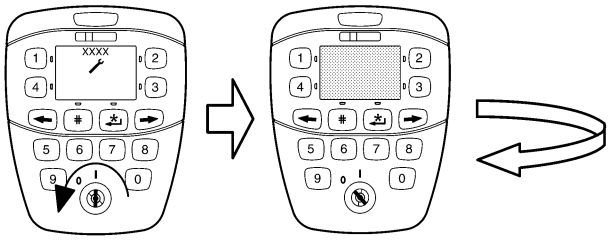


Traction/Pump Controller Cxx 3, 4, and 5



Fan Motor Connector Cxx 156, 157, 595A, 595B

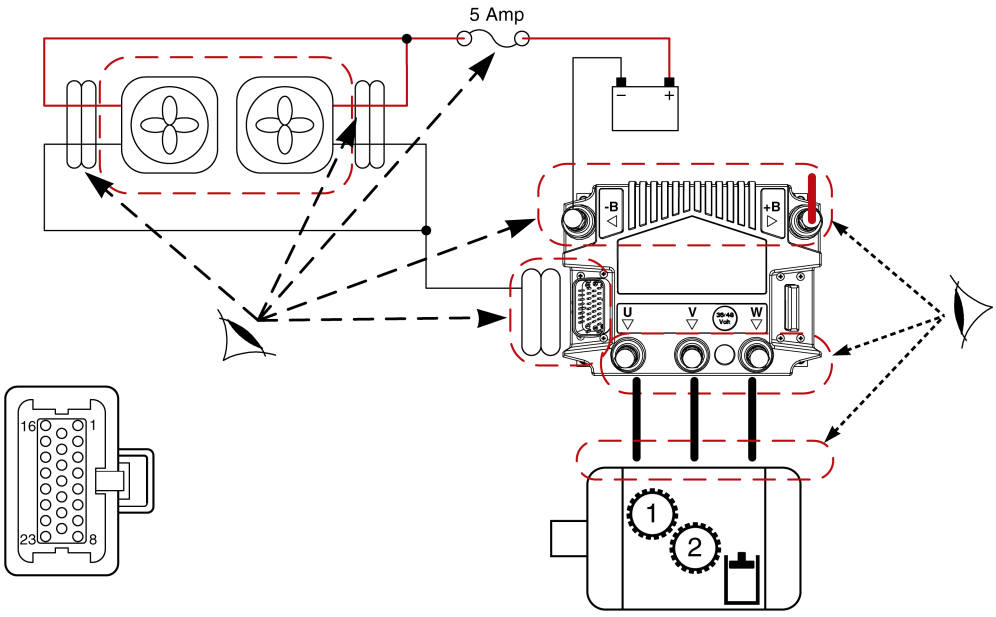
CAUSE A

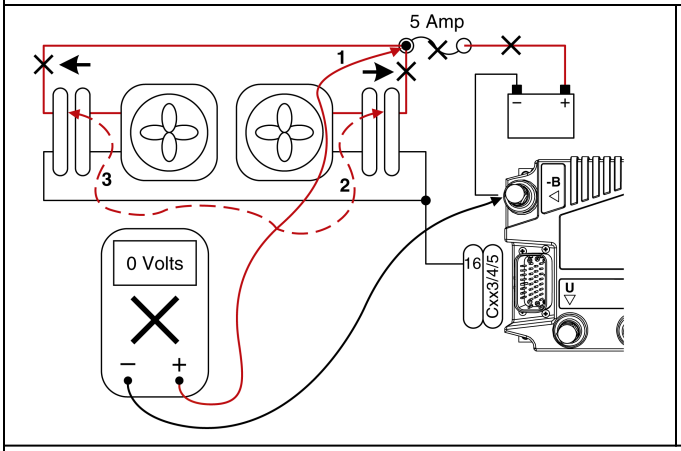
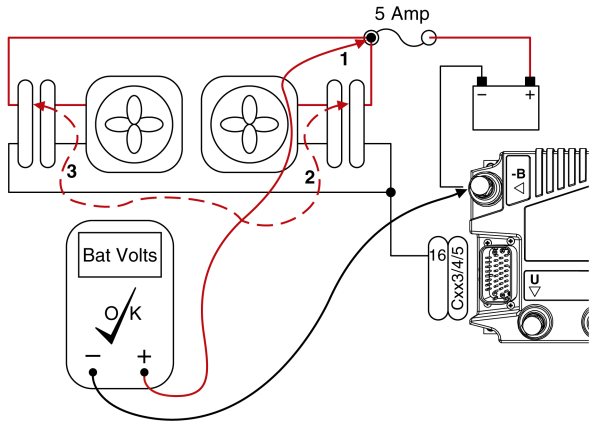
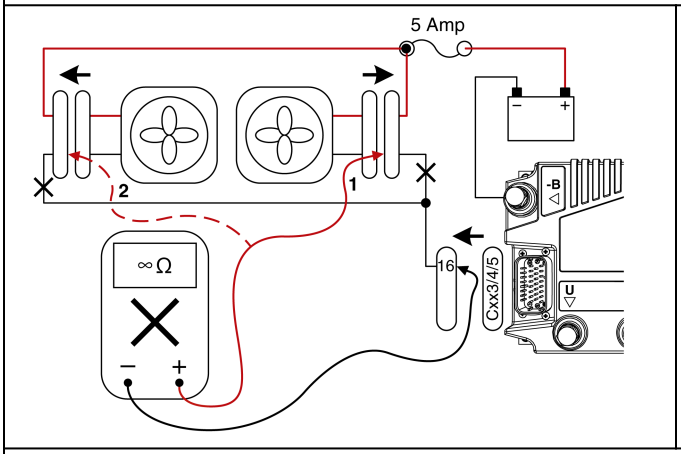
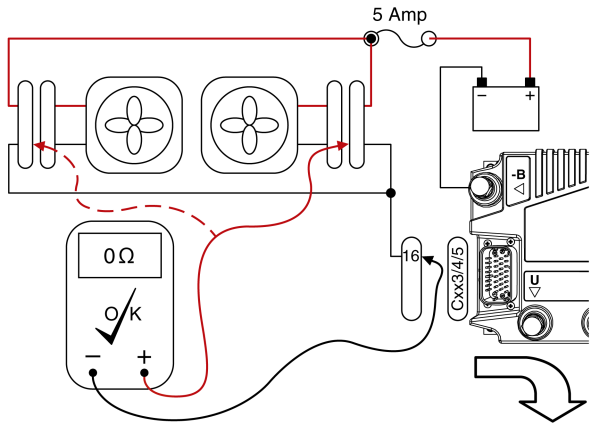


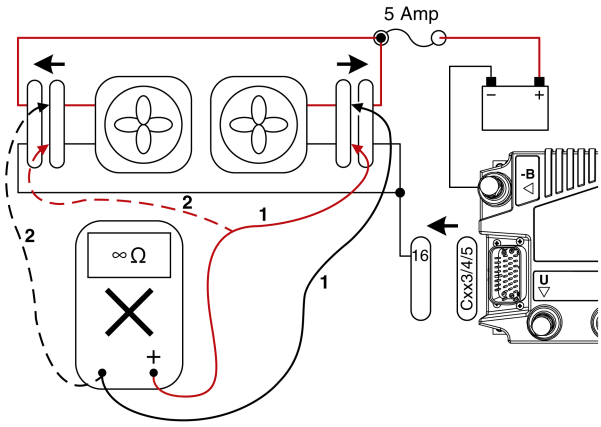
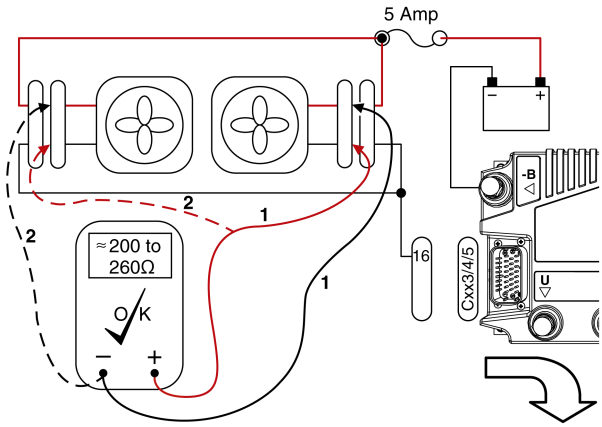
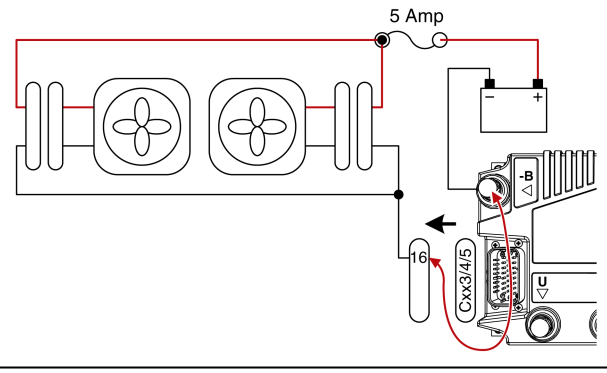
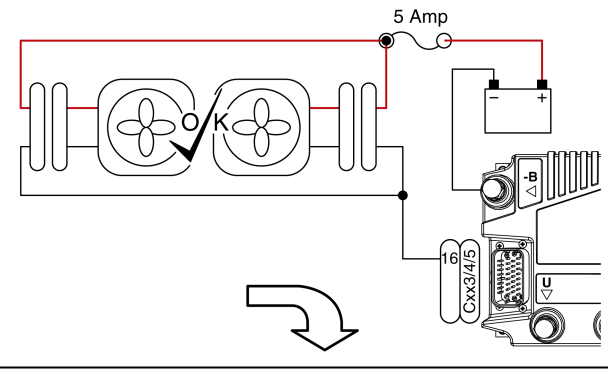
Power **OFF**→?

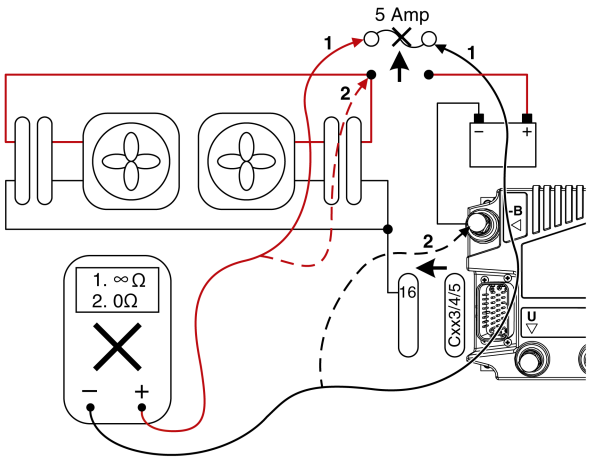
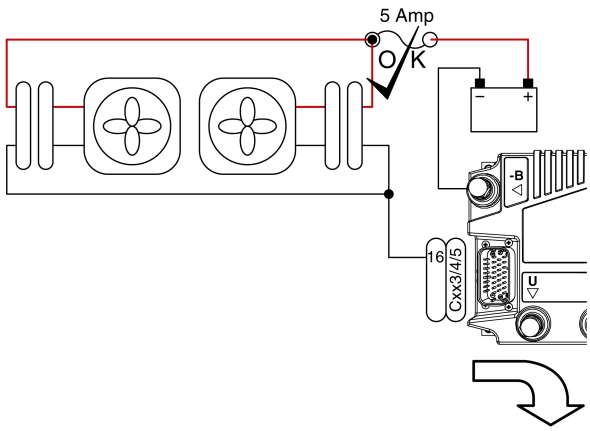
STEP A1

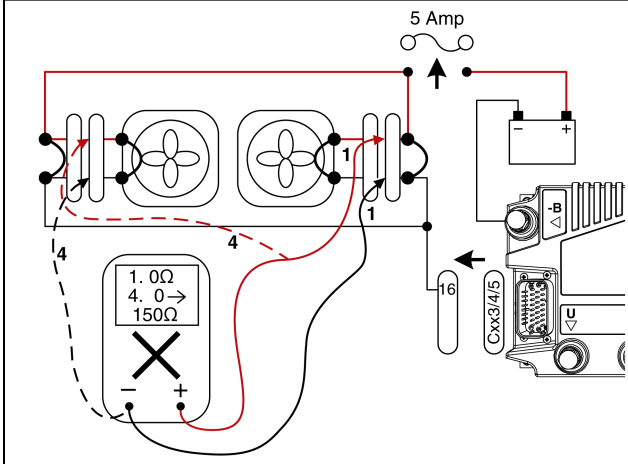
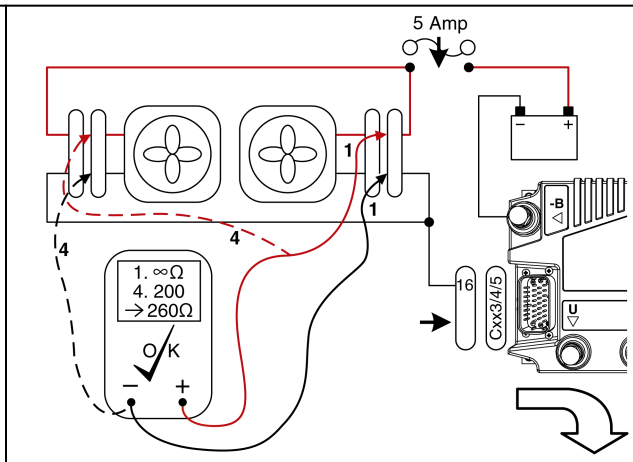
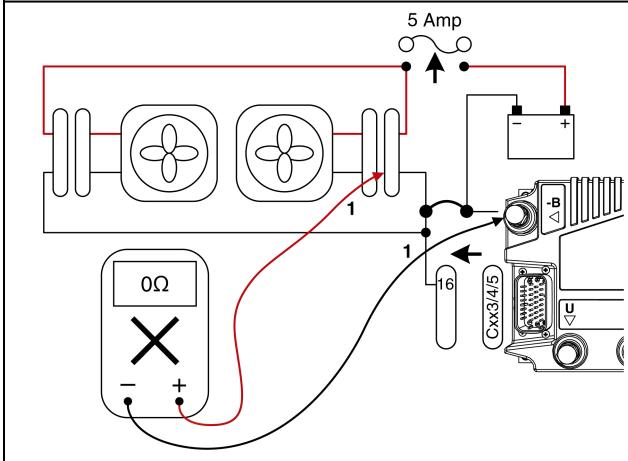
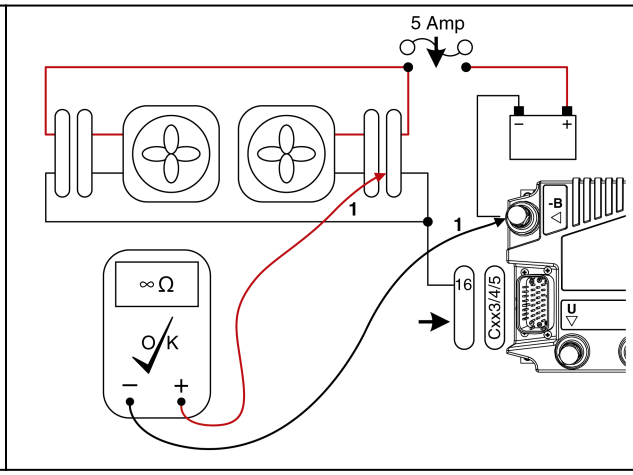
For any Fault DTC→Locate Device→Inspect ALL Wiring/Connections



A935 – K160 D203 Motor Controller Fan Failure (Cont)	
STEP A2	**CHECK VOLTAGE**
Fan Operation	
	
Disconnect Fan(s) and connect DMM as indicated↓	
1. 0 Volts = Open Circuit (Fuse)→Step 6↓	1 ˜ Bat Volts = OK Go to 2↓
2. 0 Volts = Open Circuit→Go to 4↓	2. ˜ Bat Volts = OK Go to 3↓
3. 0 Volts = Open Circuit→Go to 4↓	3. ˜ Bat Volts = OK Go to Step 3↓
4. Find/Repair Open Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→	
5. Recheck ?↑→ Reconnect→Retest→Step 5↓	
STEP A3	**CHECK RESISTANCE - Ω - OHMS**
Fan Operation	
	
Disconnect Relevant Controller and connect DMM as indicated↓	
1. 8? = Open Circuit→Go to 3↓	1 ˜ 0? = OK Go to 2↓
2. 8? = Open Circuit→Go to 3↓	2. ˜ 0? = OK Go to Step 4↓
3. Find/Repair Open Circuit. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→	
4. Recheck ?↑→ Reconnect→Retest→Step 5↓	

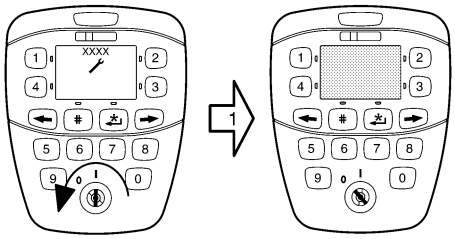
A935 – K160 D203 Motor Controller Fan Failure (Cont)	
STEP A4	**CHECK RESISTANCE - Ω - OHMS**
Fan Operation	
	
1. 8? = Open Circuit→Go to 3↓< 150?→CAUSE B↓	1 ˜ 200 to 260? = OK Go to 2↓
2. 8? = Open Circuit→Go to 3↓< 150?→CAUSE B↓	2. ˜ 200 to 260? = OK Go to Step 5↓
3. Find/Repair Open Circuit/Replace Fan See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→	
4. Recheck ?↑→ Reconnect→Retest→Step 5↓	
STEP A5	
Fan Operation Test	
	
1. Connect Fan(s) Circuit to Bat (-) as shown→Go to 2↓	
2. Fan(s) Do not operate→Go to 3↓	2. Fan(s) operate→Go to 4↓
3. Replace Fan→Retest with Jumper wire→Go to 4↓	
4. Reconnect Controller→Operate Truck (Traction/Hydraulics) for at least 10 minute↓	
5. Fan(s) operate→Resume Operation	
6. Fan(s) Do not operate→CAUSE C↓	

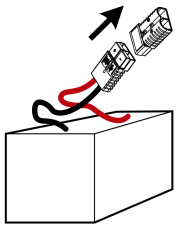
A935 – K160 D203 Motor Controller Fan Failure (Cont)	
STEP A6	**CHECK RESISTANCE - Ω - OHMS**
Fan Operationfrom Step 1	
	
1. Remove Fuse→Measure ?→8? = Fuse Open Circuit→Go to 2↓	
2. 0? = Short Circuit→Go to 3↓	
3. Find/Repair Short Circuit→Go to 4↓	
4. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→Go to 5↓	
5. Replace Fuse→Reconnect Controller→Operate Truck (Traction/Hydraulics) for at least 10 minute↓	
6. Fan(s) operate→Resume Operation	
7. Fan(s) Do not operate→CAUSE C↓	
CAUSE B	
Not Applicable	

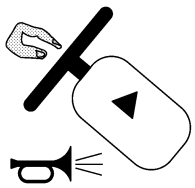
A935 – K160 D203 Motor Controller Fan Failure (Cont)
CAUSE C
Fan Operation
 
1. Remove Fuse→Measure ?→0? = Short Circuit→Go to 2↓
2. Find/Repair Short Circuit→Go to 3↓
3. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→Go to 6↓
4. From Step 30 to 150? = Fan Short Circuit→Go to 5↓
5. Replace Fan →See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→Go to 6↓
6. Replace Fuse→Reconnect Controller→Operate Truck (Traction/Hydraulics) for at least 10 minute↓
7. Fan(s) operate→Resume Operation
8. Fan(s) Do not operate→CAUSE C↓
STEP C1 **CHECK RESISTANCE - Ω - OHMS**
Fan Operation (Continuous)
 
1. Remove Fuse→Measure ?→0? = Short Circuit→Go to 2↓
2. Find/Repair Short Circuit→Go to 3↓
3. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→Go to 4↓
4. Replace Fuse→Reconnect Controller→Operate Truck (Traction/Hydraulics) for at least 10 minute↓

A935 – K160 D203 Motor Controller Fan Failure (Cont)
5. Fans Operate Continuously at Power **ON**→Faulty Controller→CAUSE C↓
6. Fans operate briefly and then don't operate until at least 1 minute of Operation→Resume Normal Operation↓

CAUSE D

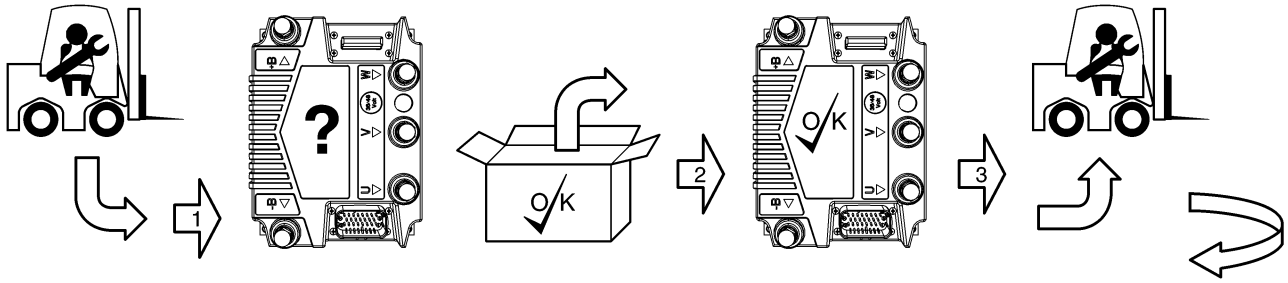






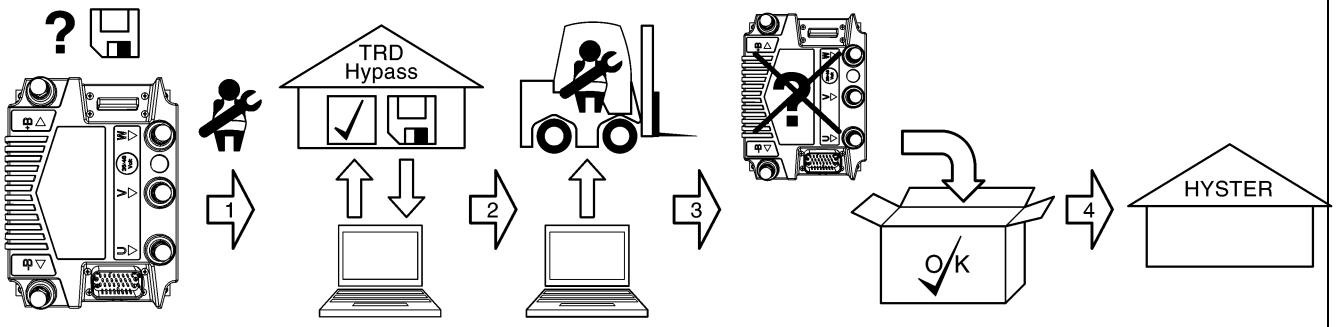
Power **OFF**→	Disconnect Battery and Sound Horn to Discharge Capacitors.Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342.

STEP D1



Remove and Replace Faulty Motor Controller↓
See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369↓
Check Replacement Controller 🖫 Version→See Label Information→Step 2↓

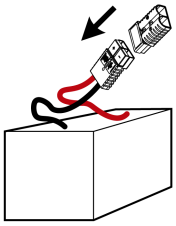
STEP D2

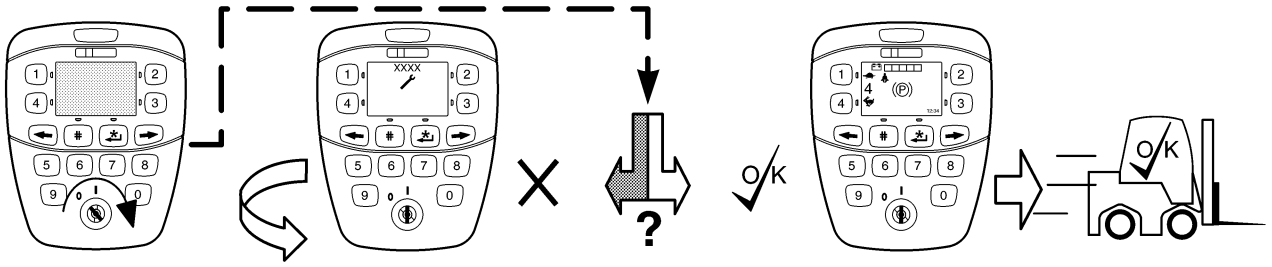


1. Go to TRD/Hypass Online /Software.?? Is Replacement Controller Application Software Version the Latest Version??
2. **NO**→Download the latest Application 🖫→Install on truck→Step 3↓
3. **YES**→Test New Installation→↓Step 3↓
4. Return Faulty Display→Dealer→Factory→Failure Analysis→?? Reprogramming

A935 – K160 D203 Motor Controller Fan Failure (Cont)

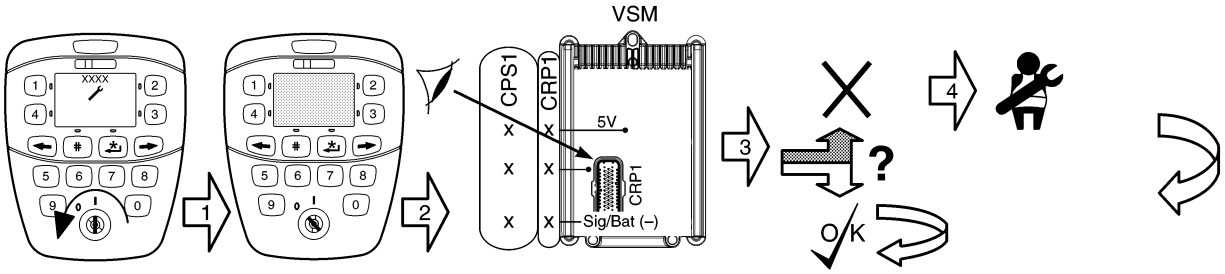
STEP D3





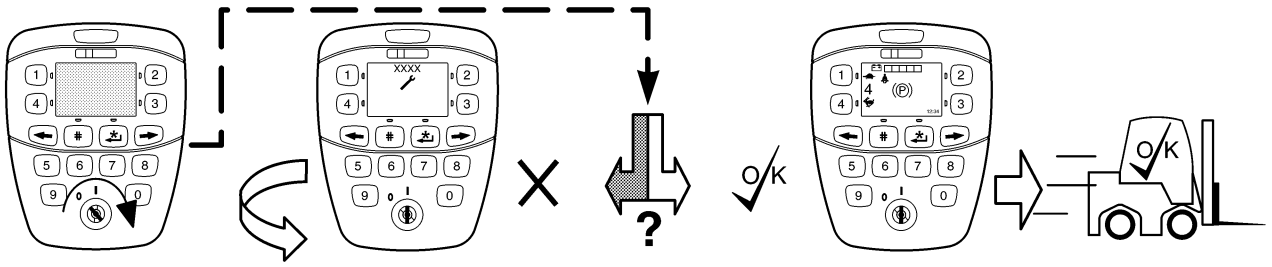
Retest - Power **ON**→	**NO**→?	Is fault DTC gone?**NO** **YES**←→	Fault corrected→Continue operation.

CAUSE E



Power **OFF**→	Inspect VSM Connections→OK Step 1	Not OK Correct/Repair→Step 1

STEP E1



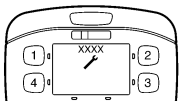
Retest - Power **ON**→	**NO**→Go to VSM Controller Check	Is fault DTC gone?**NO** **YES**←→	Fault corrected→Continue operation.

DTC LOGS: DTC logs should only be cleared once the data is by the Service Tech. See Display Menu Flowchart **- Clearing DTCs.**

END FAULT

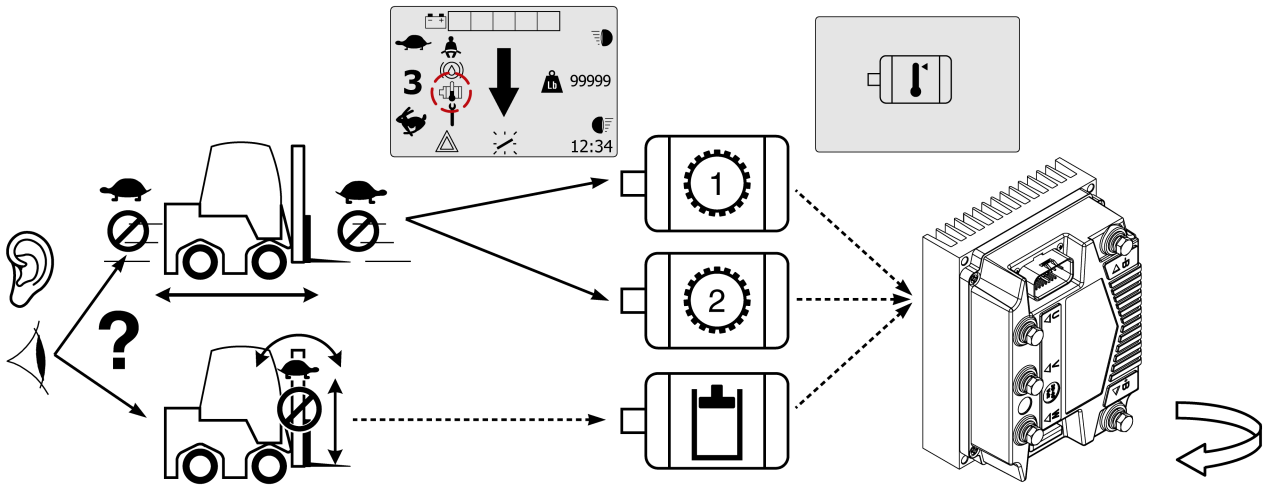
A935 – K160 D203 Motor/Motor Controller Temperature Sensor Failure (Cont)

DTC None
A935 – K160 Motor/Motor Controller Temperature Sensor Failure



QUICK CHECK X = Open Circuit/Fail) = Short Circuit

Check 1



? Over Temperature Icon Displayed at Power ON?

POSSIBLE CAUSES	
1. Sensor(s) – Motor/Motor Controller – Connections/Wiring?→	CAUSE 0↓
2. Sensor(s) Failure?→	CAUSE 0↓
3. Motor Controller(s) Hardware Failure?→	CAUSE C↓
Note: Hydraulic Oil Over Temperature and Sensor Issues seeHydraulic Temperature Sensor Out of Range High (OORL) /Hydraulic Temperature Sensor Out of Range High (OORH)	

? Over Temperature Icon Displayed during Operation/Reduced Performance/Function Failure?

POSSIBLE CAUSES	
1. Motor/Motor Controller/Hydraulic Fluid Overheating?→	Aggressive Operation?→
2. Sensor – Motor/Motor Controller/Hyd Tank – Connections/Wiring?→	CAUSE 0↓
3. Sensor(s) Failure?→	CAUSE 0↓
4. Motor Controller(s) Failure ?→	CAUSE C↓

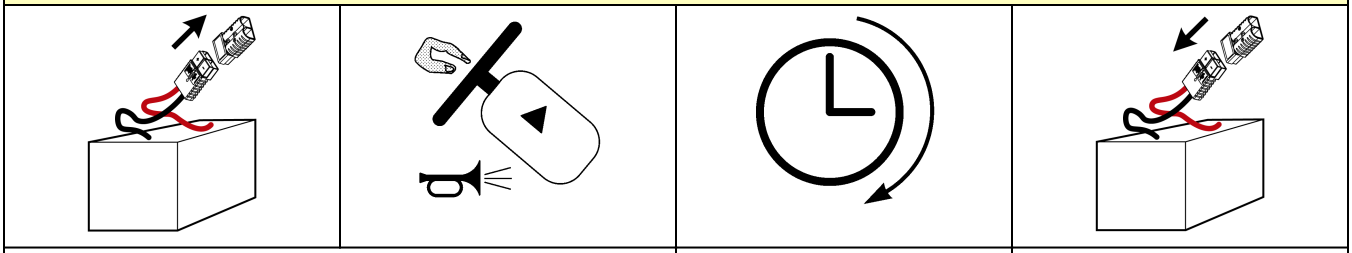
A935 – K160 D203 Motor/Motor Controller Temperature Sensor Failure (Cont)

Note: For further assistance on Silicon Temperature Sensor readings, see Motor Temperature Sensor.

Temperature Control Chart Table

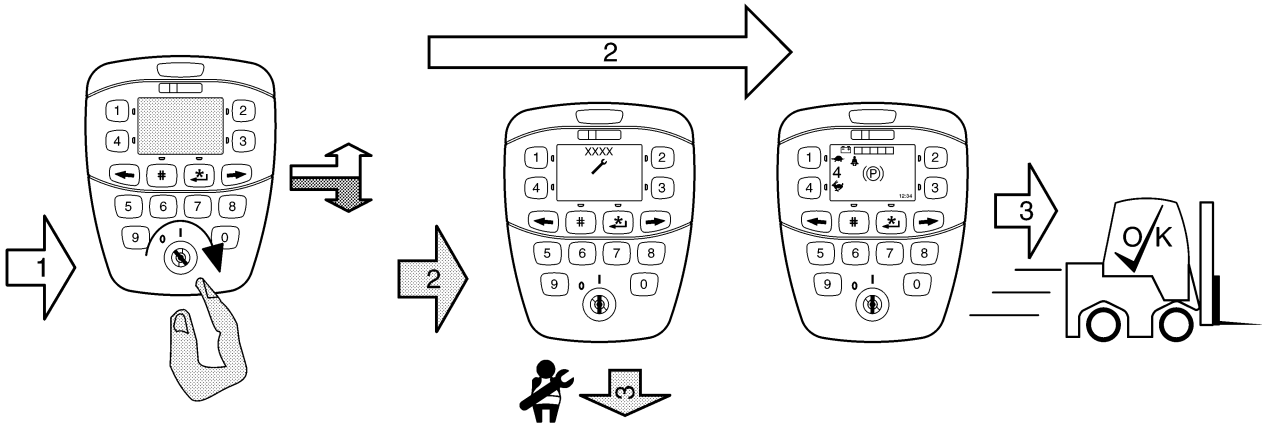
Application	Performance Cutback Start		Performance Cutback Finish		Fan ON	
	°C	°F	°C	°F	°C	°F
Traction Motor	165	329	185	365		
Traction Controller	80	176	115	239	65	149
Pump Motor	145	293	160	320		
Pump Controller	80	176	115	239	55	131
Hyd Fluid	85	185	100	212		

Check 2

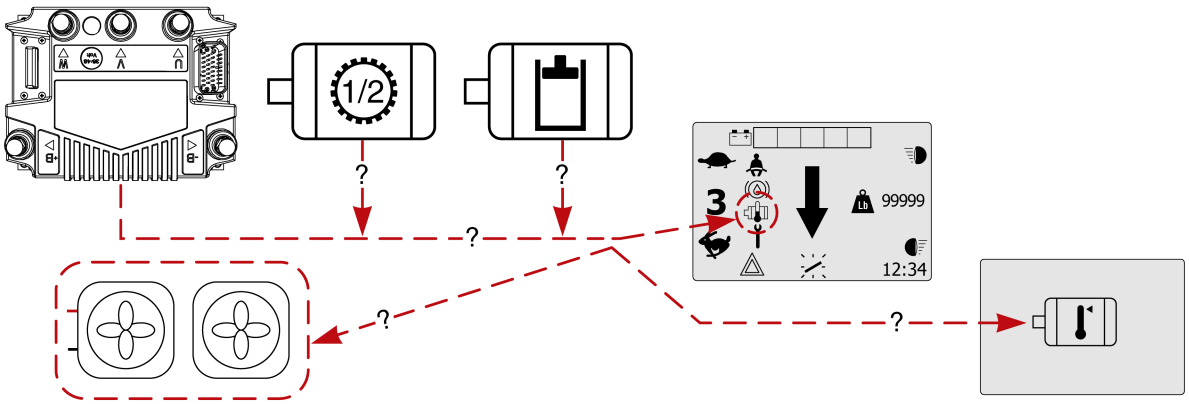


Disconnect Battery and Sound Horn to Discharge Capacitors.Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342.	Wait 30 seconds	Reconnect Battery

Check 3



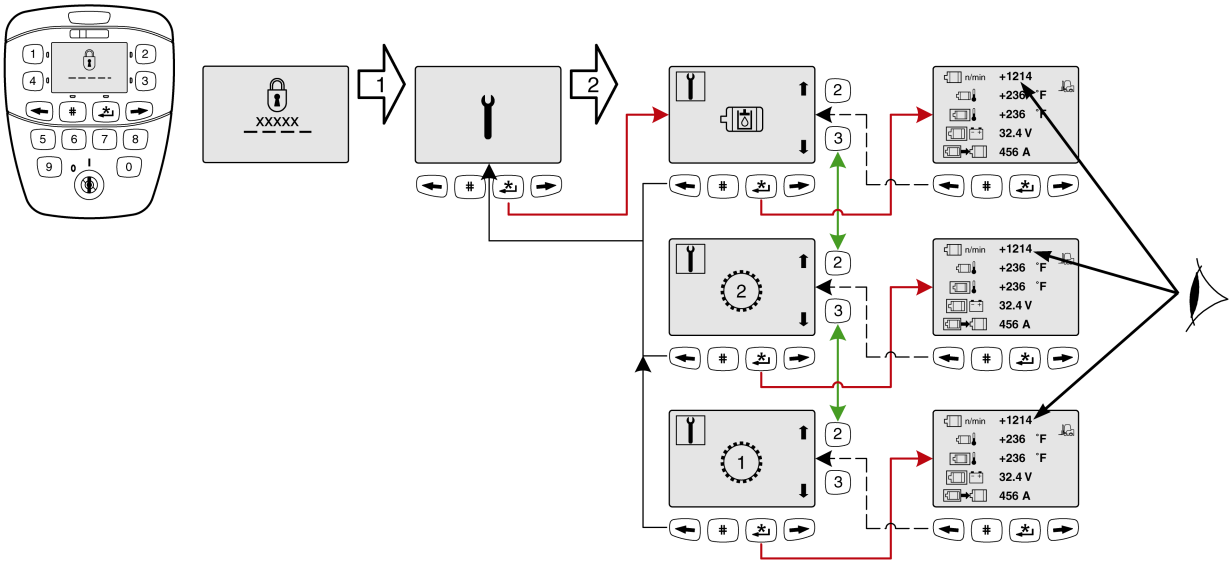
Power **ON**→	Fault Remains Service Required ?	No Fault→Resume Operation

A935 – K160 D203 Motor/Motor Controller Temperature Sensor Failure (Cont)
Check 4

Reduced Performance→Check Display Icons?
Motor/Motor Controller Temperature Icon On
1. Check fan operation→Are fans operating?→NO →A935 – K160D203 Motor Controller Fan FailureYES →2. ?
2. Temp Sensor/Controller to Motor connection→Open Circuit→CAUSE 0↓
3. Use the following steps for viewing Motor Temperature
Note: The Motor Temperature ICON will be displayed for any Over Temperature of Traction 1/Traction 2, Pump Motor and their associated Controllers plus Hydraulic Fluid
Note: The Diagnostics Display Menu Flowchart will show which device is overheating See Check 5
Note: The Service Tech may need to operate the truck for an extended time on a 20% grade to have this Over temperature icon display again after it has been first reported

A935 – K160 D203 Motor/Motor Controller Temperature Sensor Failure (Cont)

Check 5

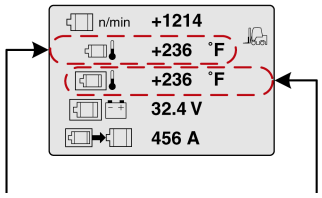
Diagnostics Temperature Analysis – Go to Display Menu Flowchart



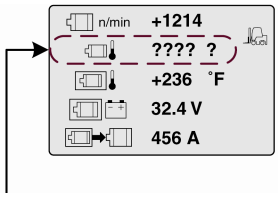
Enter Service Password→	Diagnostics→	Motor→Traction1/Traction2/ Pump→	Motor/Controller Data

Fan(s) Operation Temperature Threshold: Traction = 55°C (131°F) Pump = 65°C (149°F)

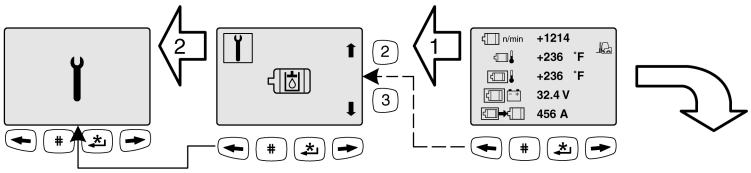
Reduced Performance: Traction = 80°C (176°F) Pump = 80°C (176°F)



Motor		Motor Controller



Invalid Temperature Signal (Traction/Pump Motor(s) Only): **Sensor Connections/Sensor Open Circuit**

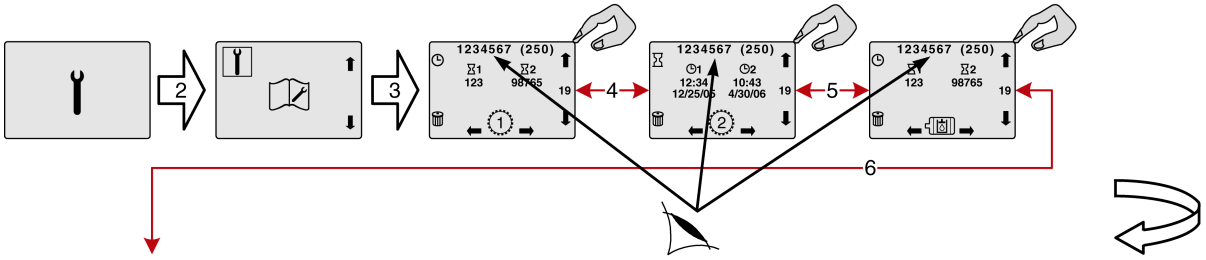


Return to Diagnostics Menu→?

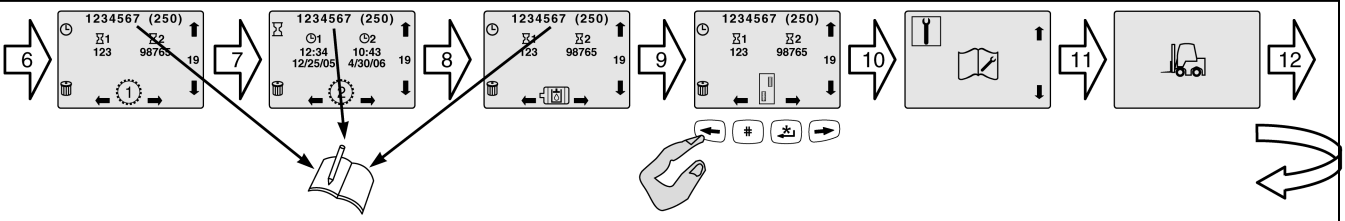
A935 – K160 D203 Motor/Motor Controller Temperature Sensor Failure (Cont)

Check 6

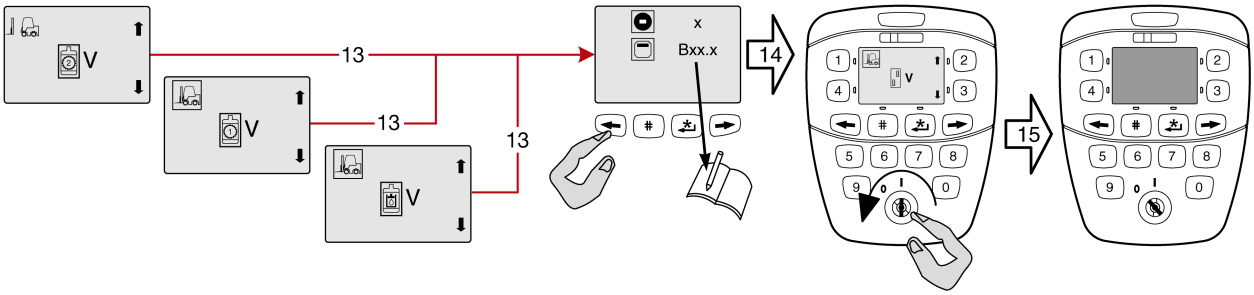
Fault Log DTC – Go to Display Menu Flowchart



Enter Service Password→Diagnostic→FAULT LOGs→Motor Fault Log(s)→View all Motor DTCs→?



all Motor Codes→ Exit Fault Log→Truck Status ?

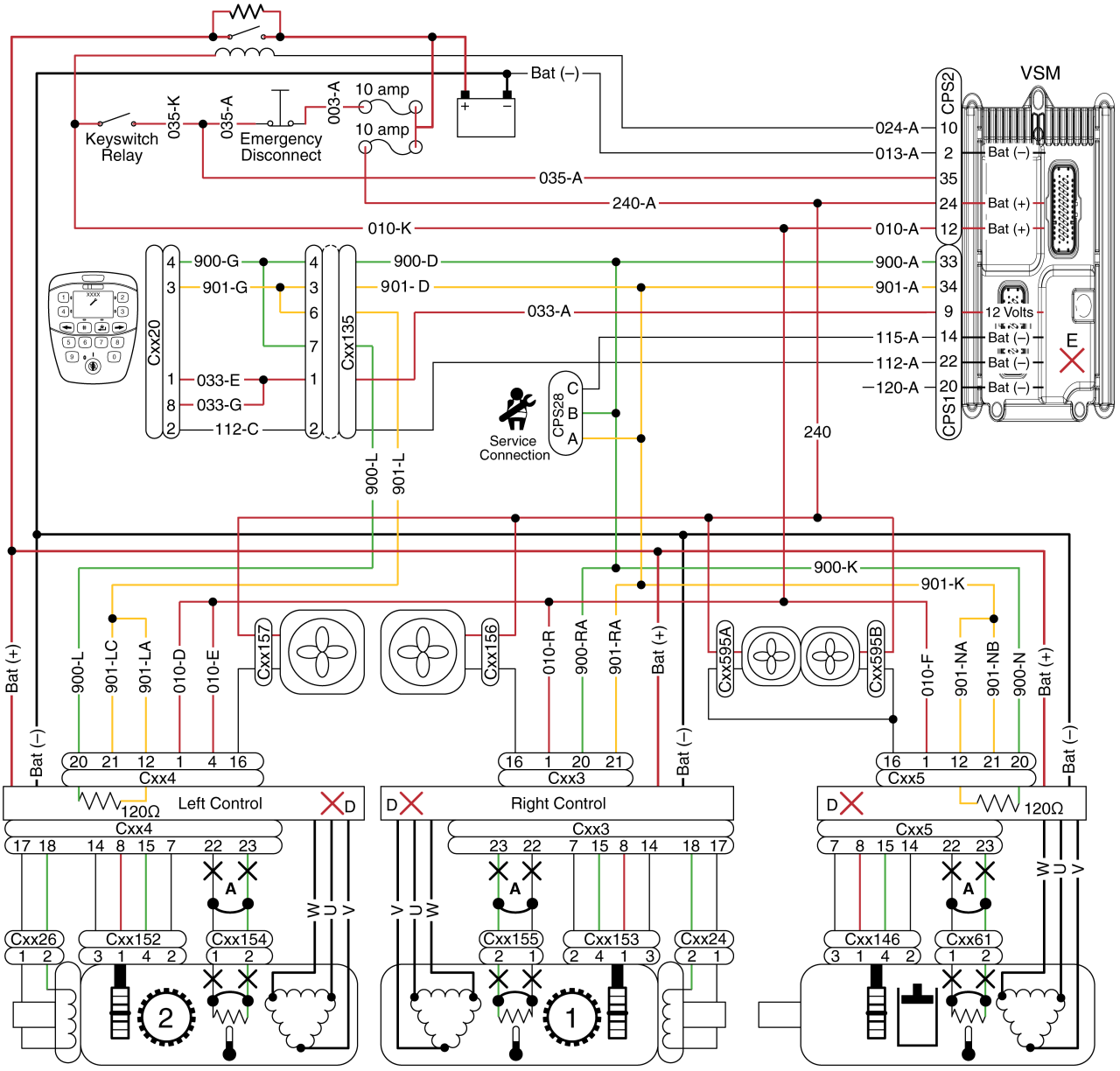


Motor Versions→ Hardware/Software Versions→ Exit Versions→Power **OFF**?

POSSIBLE CAUSES X = Open Circuit/Fail) = Short Circuit

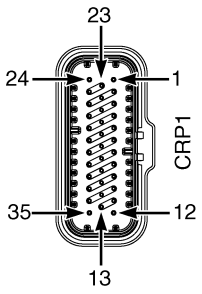
A935 – K160 D203 Motor/Motor Controller Temperature Sensor Failure (Cont)

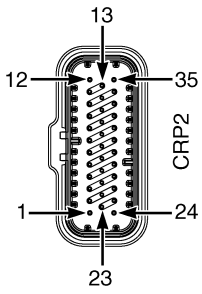
CAUSES A B C D E > ?



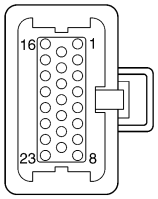
A935 – K160 D203 Motor/Motor Controller Temperature Sensor Failure (Cont)

CONNECTORS

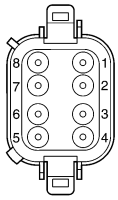




VSM Cxx 1 and Cxx 2

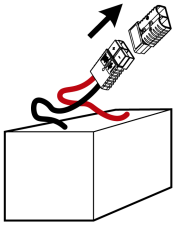


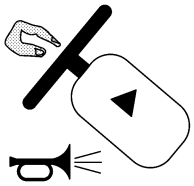
Traction/Pump Controller Cxx 3, 4, and 5



Fan Motor Connector Cxx 156, 157, 595A, and 595B

CAUSE A



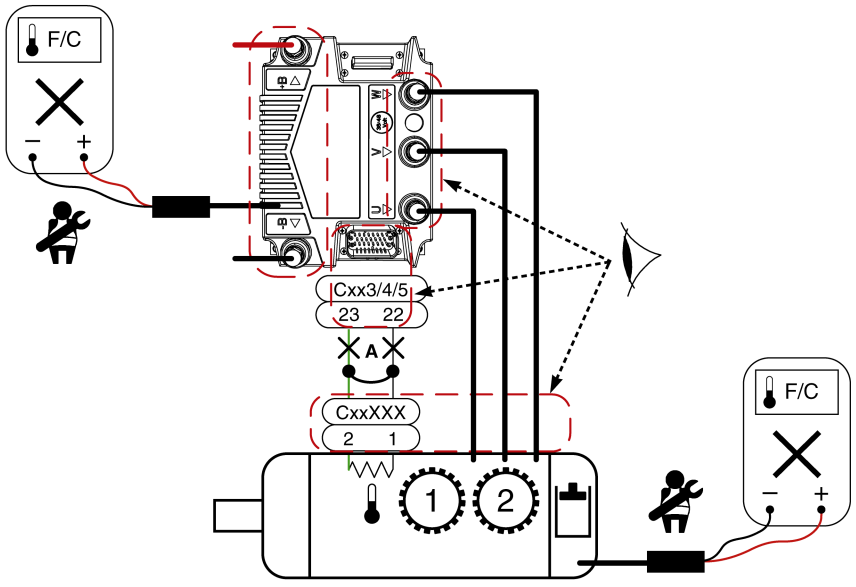


Disconnect Battery and Sound Horn to Discharge Capacitors.Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342. ?

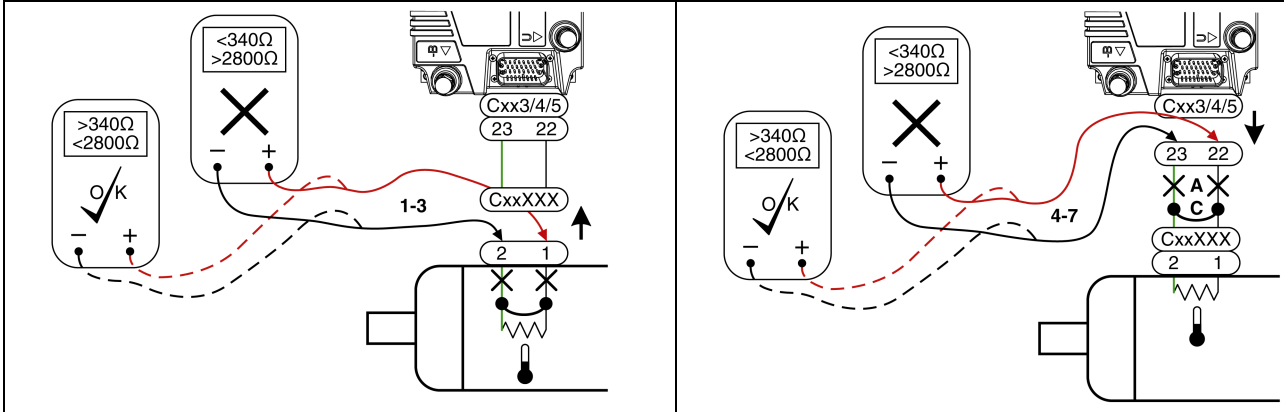
STEP A1

For any Fault DTC→Locate Device→Inspect ALL Wiring/Connections

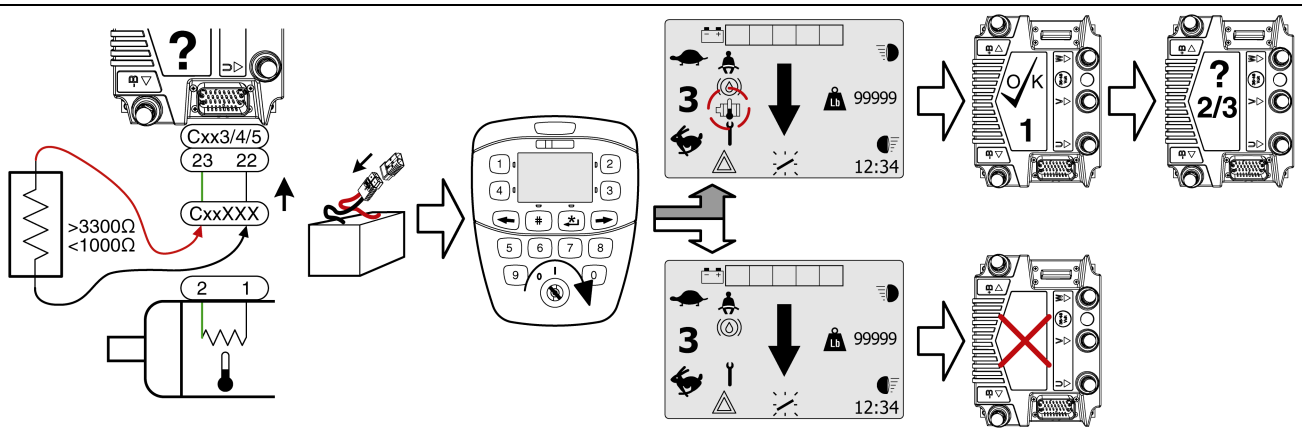
A DMM Temperature probe can also be used to determine which device is overheating



A935 – K160 D203 Motor/Motor Controller Temperature Sensor Failure (Cont)	
STEP A2	**CHECK RESISTANCE - Ω - OHMS**
Motor Temperature Sensor	

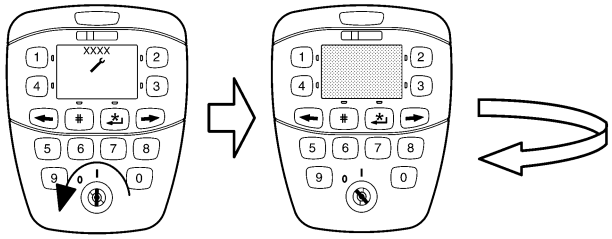


1. Disconnect Motor Connector→Measure ? as indicated→
Note: For temperature sensor readings, see Motor Temperature Sensor.
At xxx deg→ sensor ? ˜ match Temperature Chart 340? @ -40°C (25°F) to 2791? @ 300°C (572°F)→↓
2. <300? to 0? = Motor Sensor Short Circuit→Go to 8↓
3. >2800? to 8? = Motor Sensor Open Circuit/High Resistance Connection→Go to 8↓
4. Reconnect Motor Connector↓
5. Disconnect Controller Connector→Measure ? as indicated→See Temperature Sensor Chart↑↓
6. <300? to 0? = Short Circuit→Go to 9↓
7. >2800? to 8? = Open Circuit/High Resistance Connection→Go to 9↓
8. **Replace Motor**→Go to 10↓
9. Find/Repair Harness OPEN/SHORT Circuit→Go to 10↓
10. See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369→Go to 11↓
11. Recheck ?↑→ Reconnect→Resume Operation

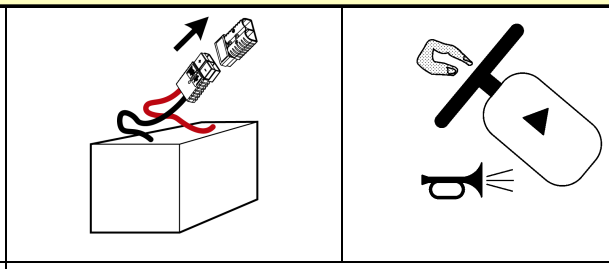
A935 – K160 D203 Motor/Motor Controller Temperature Sensor Failure (Cont)
STEP A3
Motor Temperature Sensor (Controller Check)

1. Disconnect Motor Temperature Sensor Connector from suspect Controller→
2. Connect a ¼ watt resistor (>3300? to <10,000?) as shown
3. Reconnect Battery and all other Connectors
4. Does Over Temperature ICON Appear?↓
5. YES: Go to 7↓
6. NO: Controller is Faulty→CAUSE C↓
7. Repeat Resistor Test on other Controllers↓
8. Temperature ICON is Displayed?→YES: Controller tested OK, Go to 9→NO: Controller tested Faulty→CAUSE C↓
9. Reconnect other Motor Temperature Sensors
CAUSE B
Not Applicable
CAUSE C
Not Applicable

A935 – K160 D203 Motor/Motor Controller Temperature Sensor Failure (Cont)

CAUSE D

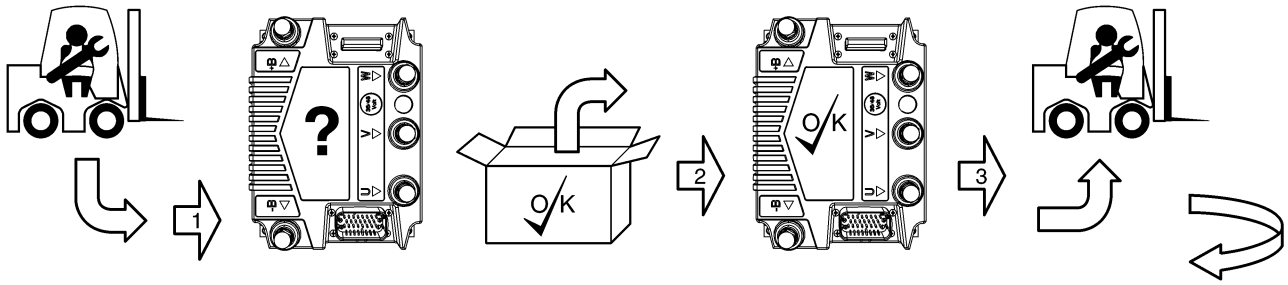


Power **OFF**→



Disconnect Battery and Sound Horn to Discharge Capacitors.Depending on your lift truck, go to **Frame** 0100SRM1329 or **Frame** 0100SRM1342.

STEP D1

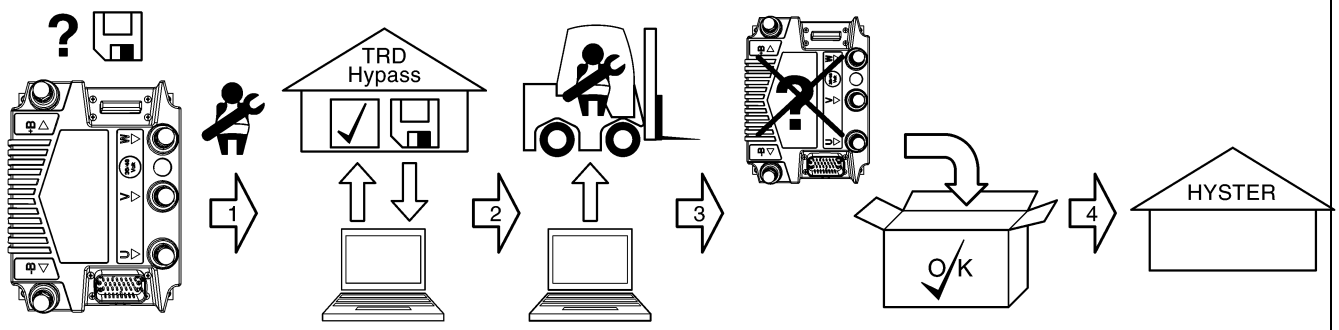


Remove and Replace Faulty Motor Controller↓

See **Electrical System** 2200SRM1337/**Electrical System** 2200SRM1369↓

Check Replacement Controller 🖫 Version→See Label Information→Step 2↓

STEP D2



1. Go to TRD/Hypass Online /Software.?? Is Replacement Controller Application Software Version the Latest Version??

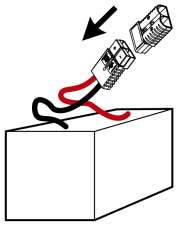
2. **NO**→Download the latest Application 🖫→Install on truck→Step 3↓

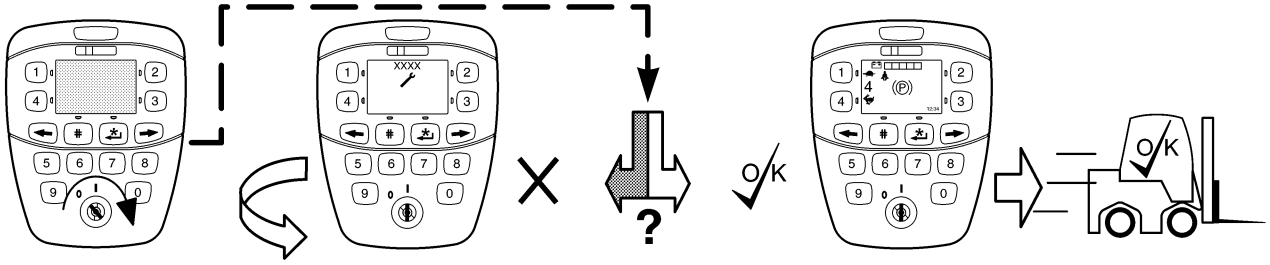
3. **YES**→Test New Installation→↓Step 3↓

4. Return Faulty Display→Dealer→Factory→Failure Analysis→?? Reprogramming

A935 – K160 D203 Motor/Motor Controller Temperature Sensor Failure (Cont)

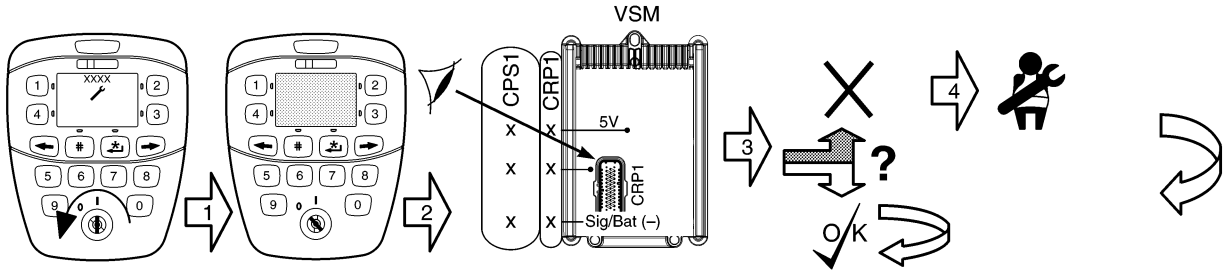
STEP D3





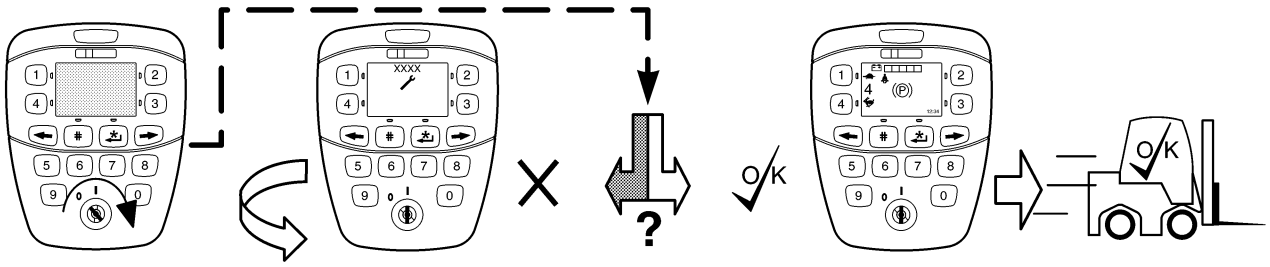
Retest - Power **ON**→	**NO**→?	Is fault DTC gone?**NO** **YES**←→	Fault corrected→Continue operation.

CAUSE E



Power **OFF**→	Inspect VSM Connections→OK Step 1	Not OK Correct/Repair→Step 1

STEP E1

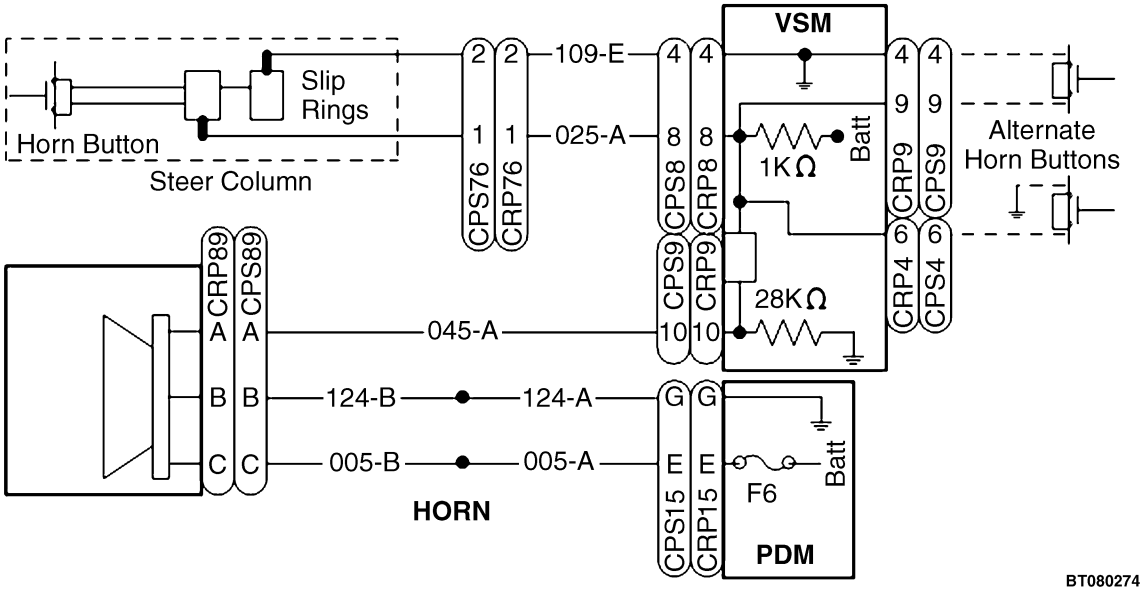


Retest - Power **ON**→	**NO**→Go to VSM Controller Check	Is fault DTC gone?**NO** **YES**←→	Fault corrected→Continue operation.

DTC LOGS: DTC logs should only be cleared once the data is by the Service Tech. See Display Menu Flowchart **- Clearing DTCs.**

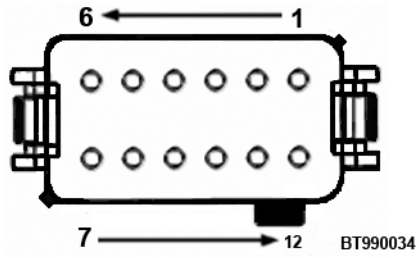
END FAULT

Horn Failure

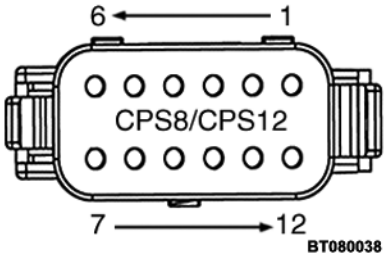


- WIRE # 005 (RED) = HORN SUPPLY
- WIRE # 045 (WHITE) = SIGNAL GROUND
- WIRE # 124 (BLACK) = HORN GROUND

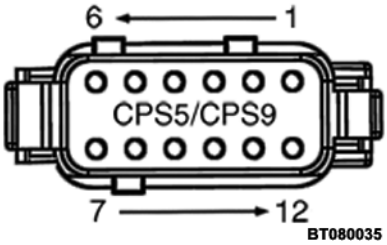
Horn Schematic



Connector CPS4

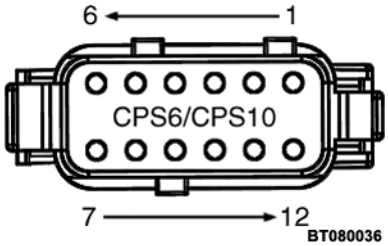


Connector CPS8

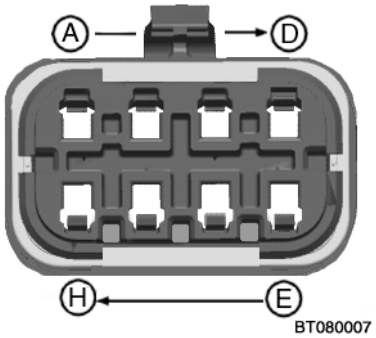


Connector CPS9

Horn Failure



Connector CPS10



Connector CPS15

POSSIBLE CAUSE

A. FUSE BLOWN

B. OPEN CIRCUIT IN WIRING HARNESS

C. HORN FAILURE

D. VSM FAILURE

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Open engine cover to gain access to batteries. See **Operating Manual**.
2. Examine connections between batteries.
   Are connections correct and secure?
   YES: Go to CAUSE A.
   NO: Connect cables, as required. Depending on your lift truck, see **Electrical System** 2200SRM1369, or **Electrical System** 2200SRM1337.

CAUSE A - FUSE BLOWN

PROCEDURE OR ACTION:

1. At the fuse access cover, open access cover.
2. Using DMM, measure voltage on both sides of fuse F6 (+) with respect to ground (-).
   Is voltage on one side of fuse less than 0.5 Vdc?
   YES: Check wiring harness for shorts between wires 005 and 124 or 005 and the vehicles frame. Repair or Replace wiring harness. Depending on your lift truck, see **Wire Harness Repair** 2200SRM1128, or Fuse 6 is blown, replace blown fuse.
   NO: Fuse 6 is OK. Go to CAUSE B.

Horn Failure

CAUSE B - OPEN CIRCUIT IN WIRING HARNESS

NOTE: If DTC 524213-4 appears, go to

PROCEDURE OR ACTION:

1. Disconnect horn at CPS 89.
2. Using DMM, measure voltage between Pin B and Pin C on CPS 89.
   Is battery voltage present?
   YES: Go to Step 3.
   NO: Check wiring harness for shorts between wires 005 and 124 for open circuit. Repair or Replace wiring harness. Depending on your lift truck, see **Wire Harness Repair** 2200SRM1128.
3. Change DMM to ohms scale. Verify DMM zero reading.
   Is the reading approximately 28??
   YES: Go to Step 4.
   NO: Wire 045 has a short to ground in the wiring harness. Repair/Replace wiring harness. Depending on your lift truck, see **Wire Harness Repair** 2200SRM1128.

NOTE: Do not disconnect wiring harness at horn button.

4. Remove only horn button from top of steering wheel. Ensure that wire is still connected.
5. Set DMM to volts scale.
6. Measure voltage on both sides of horn button terminals with respect to ground (-).
   Is battery voltage present?
   YES: Go to Step 7.
   NO: Go to Step 8.
7. Connect DMM to slip ring wires. During voltage measurement, rotate steering wheel from lock-to-lock position to test the entire slip ring surface.
   Is battery voltage present?
   YES: Repair or Replace slip ring assembly. Refer to appropriate **Frame** manual, depending on lift truck model, **Steering Column Repair** section.
   NO: Wire 025 and 109 has open circuit in wiring harness. Repair/Replace wiring harness. Depending on your lift truck, see **Wire Harness Repair** 2200SRM1128.
8. Push horn button.
   Does DMM voltage go to zero?
   YES: Go to CAUSE C.
   NO: Replace horn button.

CAUSE C - HORN FAILURE

PROCEDURE OR ACTION:

1. Connect horn at CPS 89.
2. Using a jumper wire to short circuit, connect Pin A and Pin C at CPS 89.
   Does DMM voltage go to zero?
   YES: Go to CAUSE D.
   NO: Replace horn.

CAUSE D - VSM FAILURE

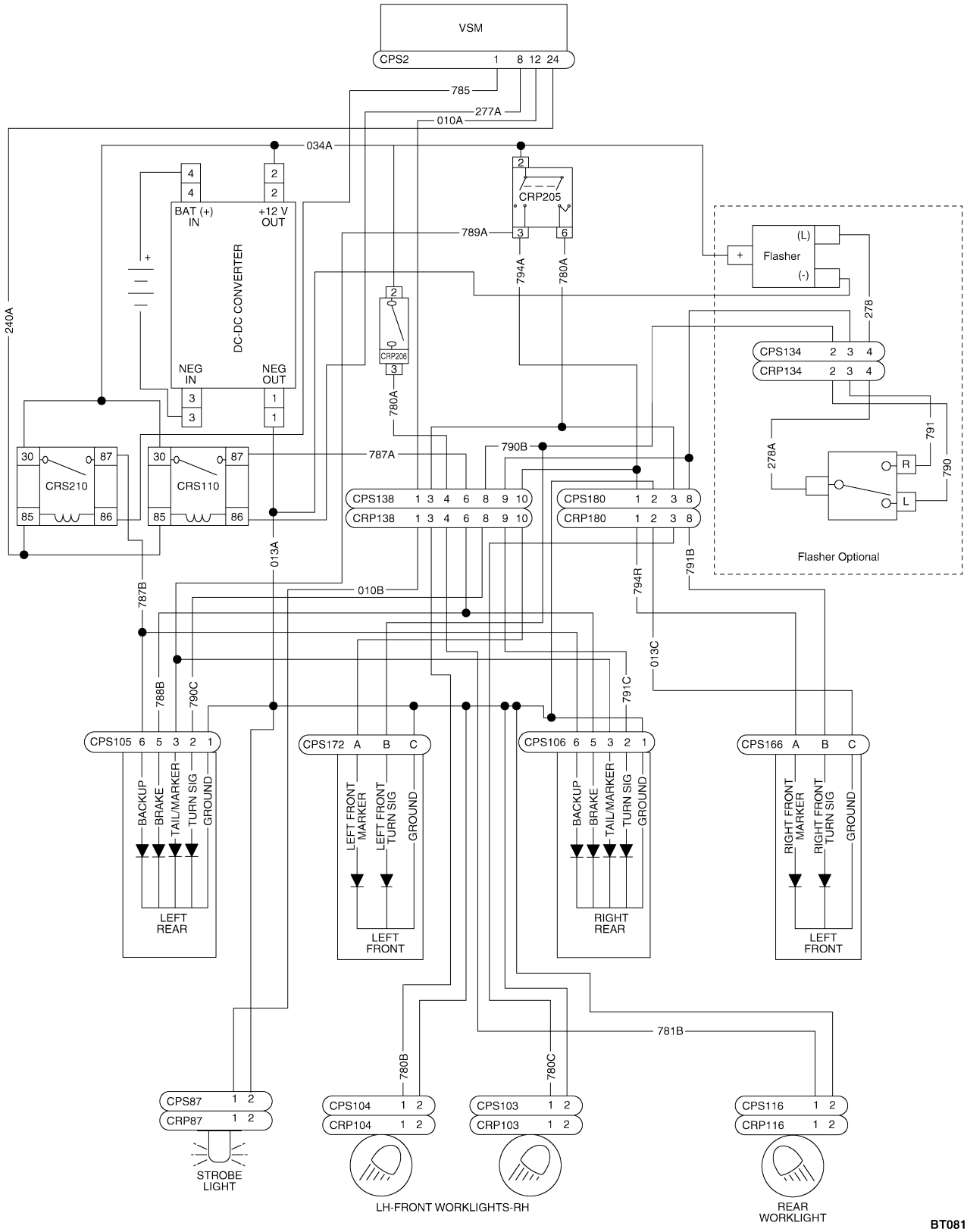
PROCEDURE OR ACTION:

1. Replace VSM. Depending on your lift truck, see **Electrical System** 2200SRM1369, or **Electrical System** 2200SRM1337.

Horn Failure

END SYMPTOM

Lights Inoperative



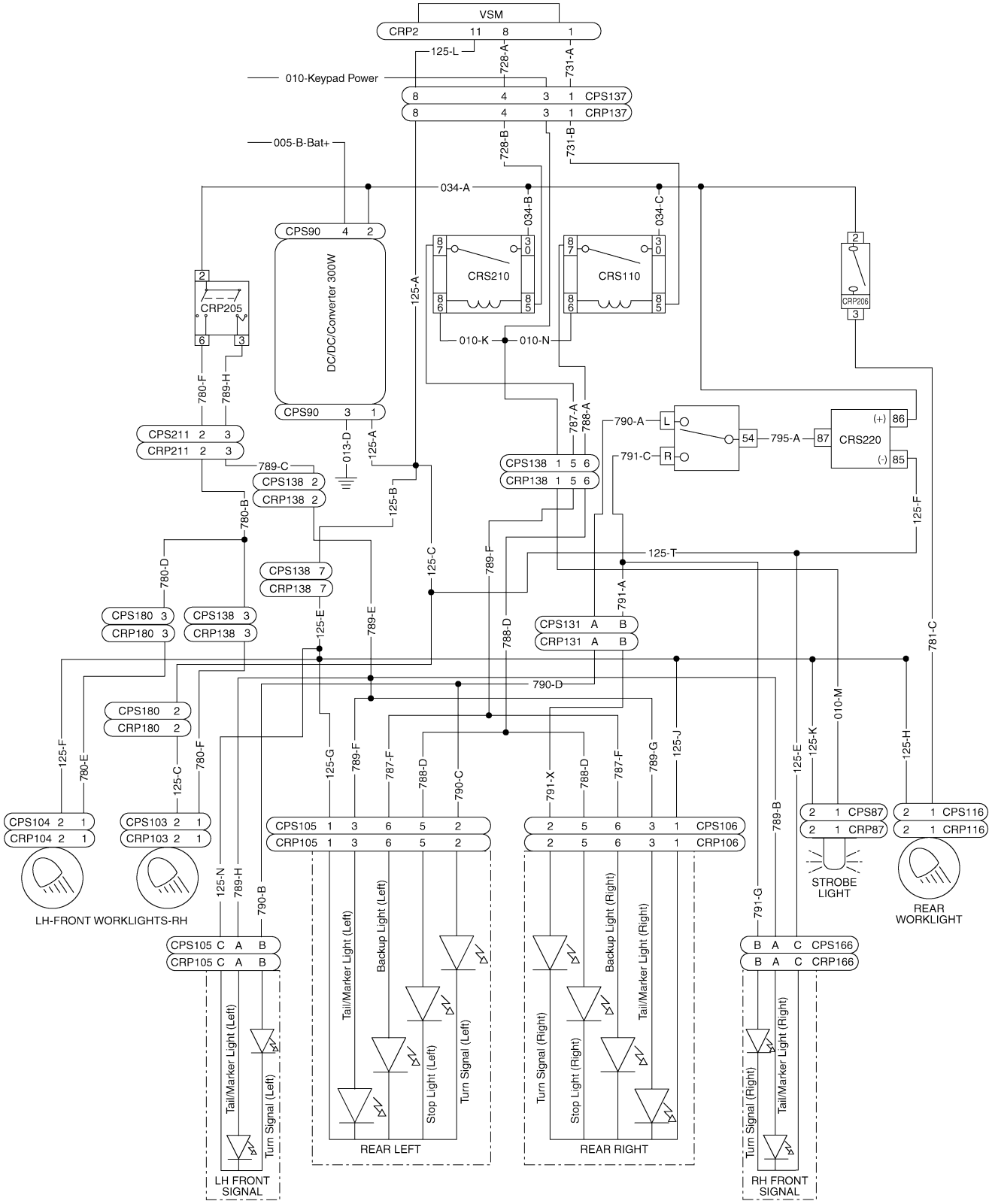
BT081291

Lights Inoperative

- WIRE # 034A, (RED)= 12 V DC/DC SOURCE
- WIRE # 013A, (BLACK)= DC/DC GROUND

3 Wheel Lift Trucks With or Without Turn Signal

Lights Inoperative

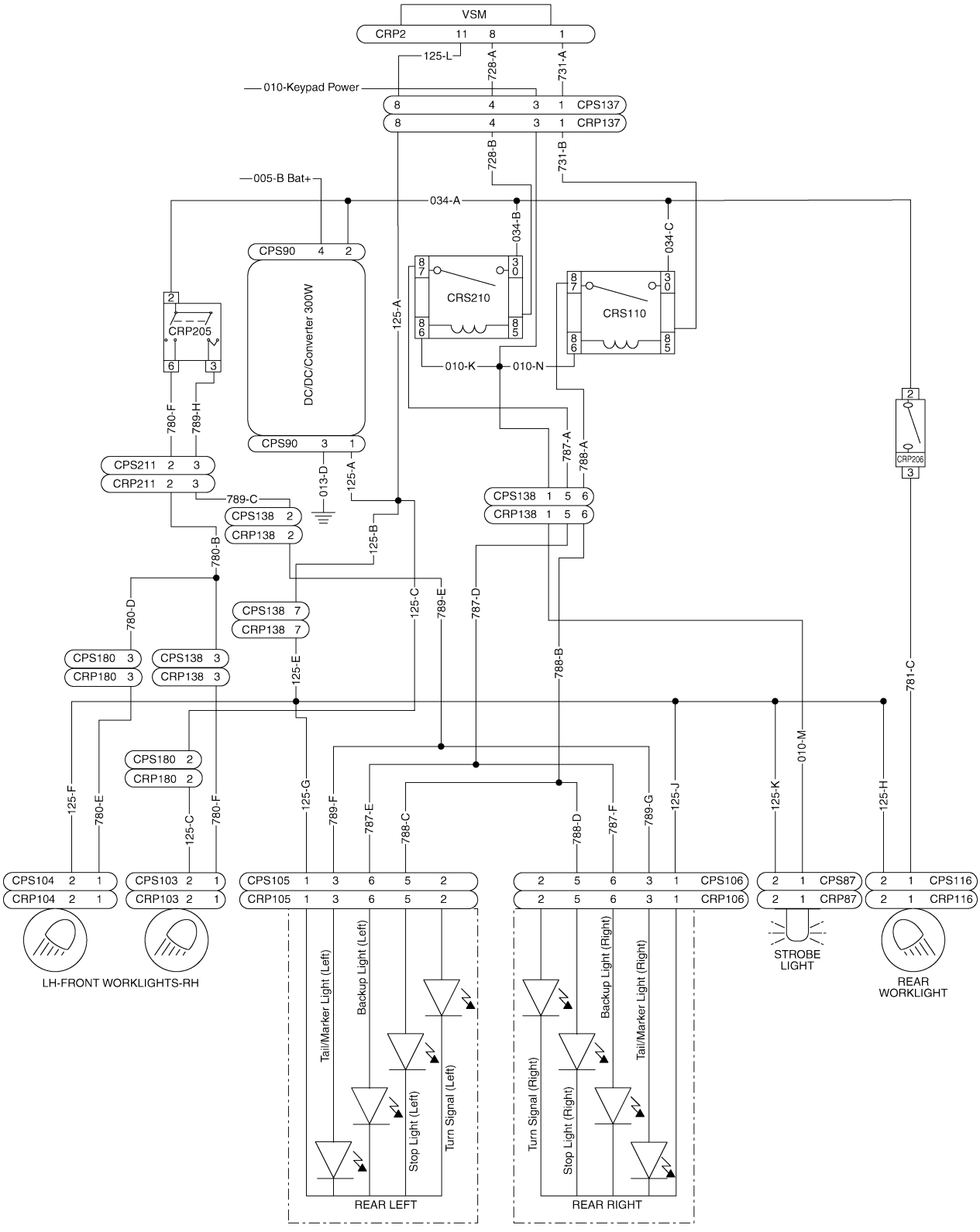


Lights Inoperative

- WIRE # 034A, (RED)= 12 V DC/DC SOURCE
- WIRE # 125A, (BLACK)= DC/DC GROUND

4 Wheel Lift Trucks With Turn Signal

Lights Inoperative

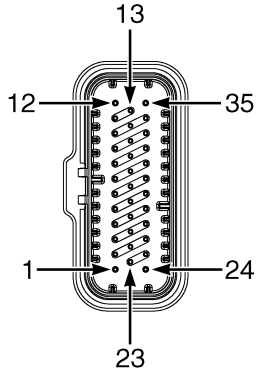


BT081293

Lights Inoperative

- WIRE # 034A, (RED)= 12 V DC/DC SOURCE
- WIRE # 125A, (BLACK)= DC/DC GROUND

4 Wheel Lift Trucks Without Turn Signal



CPS2

POSSIBLE CAUSE

A. DEFECTIVE LAMP

B. LIGHT CIRCUIT OPEN SUPPLY OR GROUND WIRE

C. POWER SUPPLY CIRCUIT FAULT

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Turn switch for light to **ON**.
   Does light operate correctly?
   YES: Problem not verified. Resume operation.
   NO: Go to CAUSE A.

CAUSE A - DEFECTIVE LAMP

PROCEDURE OR ACTION:

1. Replace lamp. Refer to the appropriate **Electrical System** manual, depending on lift truck model.
   Does light turn on?
   YES: Problem repaired. Resume operation.
   NO: Go to CAUSE B.

Lights Inoperative

CAUSE B - LIGHT CIRCUIT OPEN SUPPLY OR GROUND WIRE

PROCEDURE OR ACTION:

1. Turn cab accessory fan **ON**.
   Does accessory fan operate?
   YES: Go to Step 2.
   NO: Go to CAUSE C
2. Remove light assembly to access wire connections.
3. Using DMM, measure the voltage across the terminals of the lamp socket.
   Is voltage approximately system voltage?
   YES: Circuit voltage and ground connections are OK. Replace cab light assembly. Refer to the appropriate **Electrical System** manual, depending on lift truck model.
   NO: Go to Step 4.
4. Change DMM to ohms scale. Verify zero reading.

CAUTION

For this next measurement, make sure measurement is taken at the Black Wire. The red wire may have an applied voltage that could damage meter.

5. Measure resistance between terminal on black wire and a clean frame ground.
   Is the resistance less than 0.5 ohms?
   YES: Wire # 034A (RED) has open circuit to supply voltage. Locate and repair/replace open wire/connection. Refer to the appropriate **Wiring Harness Repair** manual, depending on lift truck model.
   NO: For three wheel lift trucks, wire # 013A (BLACK) has open circuit to ground. For four wheel lift trucks with or without turn signal, wire # 125A (BLACK) has open circuit to ground. Locate and repair/replace open wire/connection. Refer to the appropriate **Wiring Harness Repair** manual, depending on lift truck model.

CAUSE C - POWER SUPPLY CIRCUIT FAULT

PROCEDURE OR ACTION:

1. Remove floor mat and floor plate to access lighting modules, fuses, and relays mounted to front bulkhead.
2. Using DMM, measure voltage across diode (+) and the negative terminal of battery (−).
   Is the voltage on each side of diode approximately 12Vdc?
   YES: Go to Step 3.
   NO: Diode is blown. Replace defective lighting module with new lighting module.
3. Open dash cover near VSM and disconnect harness connector CPS 2.
4. Using DMM, measure voltage across pins 1(+) and 2(−) of CPS 2.
   Is voltage approximately system voltage?
   YES: Wire #034A/C (RED) has open circuit. Locate and repair/replace open wire/connection. Refer to the appropriate **Wiring Harness Repair** manual, depending on lift truck model.
   NO: Go to Step 5.
5. Move the negative (−) meter lead to a clean frame ground on the truck.
   Is voltage approximately system voltage?
   YES: For three wheel lift trucks, wire # 013A (BLACK) has open circuit. For four wheel lift trucks with or without turn signal, wire # 125A (BLACK) has open circuit. Locate and repair/replace open wire/connection. Refer to the appropriate **Wiring Harness Repair** manual, depending on lift truck model.
   NO: Wire # 034A/C (RED) has open circuit to supply voltage. Locate and repair/replace open wire/connection. Refer to the appropriate **Wiring Harness Repair** manual, depending on lift truck model.

END SYMPTOM

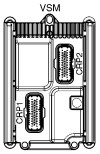
NOTES

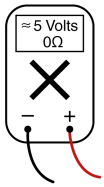
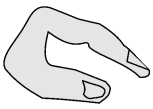
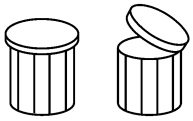
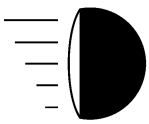
Group 55
Icons and Graphics

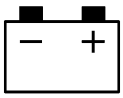
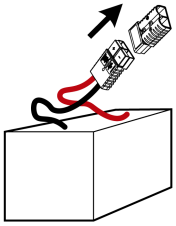
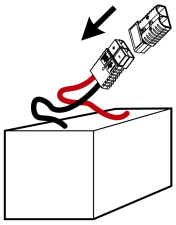
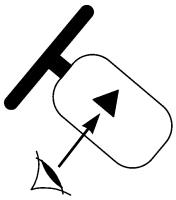
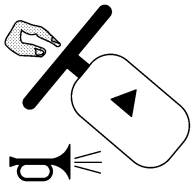
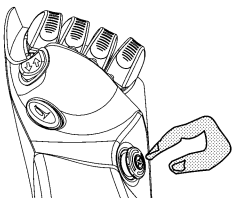
INTRODUCTION TO ICONS

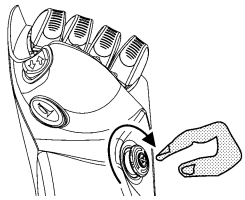
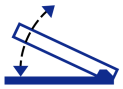
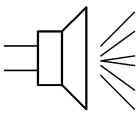
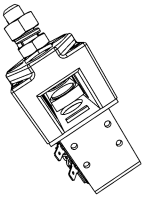
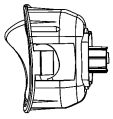
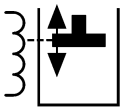
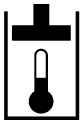
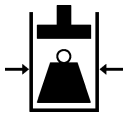
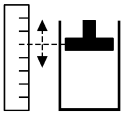
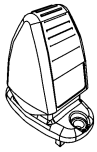
An icon is a symbol that conveys a unique meaning without words, such as an arrow. The Operating Screen on this lift truck presents information to an operator solely through the use of symbols which are mostly icons, along with some numbers and a few text characters. Icons make it possible to simultaneously display up to 12 kinds of information graphically in a small space. In addition, the use of icons reduces the difficulty of communicating with operators who speak different languages.

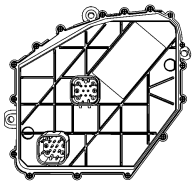
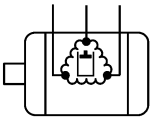
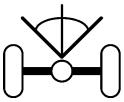
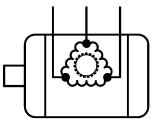
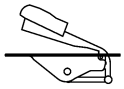
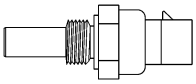
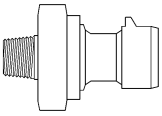
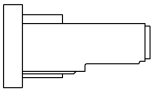
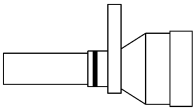
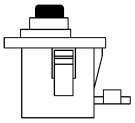
The following table, are icons used during the Diagnostic Troubleshooting Procedures. For further details on displays and icons, see **User Interface Supervisor** 2200SRM1335 or **User Interface Service Technician** 2200SRM1336 .

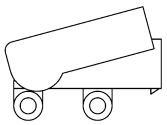
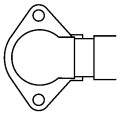
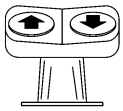
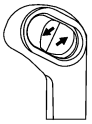
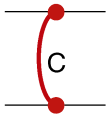
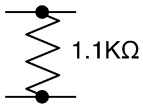
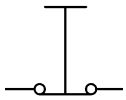
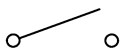
Symbols/Icons	Definition
	Display FAULT Panel
	Password Screen
	System Power OFF
	System Power ON/Display RUN Screen
	PC Service Tool
	Vehicle System Manager
	Operator Password

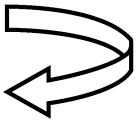
Symbols/Icons	Definition
	Supervisor Password
	Service Password
	Service Required/Fault Code
	Digital Multimeter
	Operate the Indicated Button/Key/Device
	Look For/Find
	Garbage/Junk/Rubbish Receptacle
	Operator Presence
	Park Brake
	Wait 30-Seconds
	Work Lights

Symbols/Icons	Definition
	Battery
	Battery Disconnect
	Reconnect Battery
	Locate Diagnostic Connector
	Sound Horn to Discharge Capacitors
	Fork Truck
	Travel Direction
	Mast Tilt Position
	Push in Emergency Stop

Symbols/Icons	Definition
	Release Emergency Stop
	Accelerator Pedal
	Buzzer/Audible Warning Device
	Contactor
	DCS – Directional Control Selector
	E-Hydraulic
	Hydraulic Temperature
	Load Weigh Pressure
	Manual-Hydraulic
	MLM Lever

Symbols/Icons	Definition
	MLM PCB Cassette
	Pump Motor
	Service Brake Pressure
	Steering Wheel Position
	Steering Axle Position
	Traction Motor
	Accelerator Sensor
	Hydraulic Temperature Sensor
	Load Weight Pressure Sensor
	Manual Hydraulic Position Sensor
	Motor Speed Sensor
	Operator Presence Sensor

Symbols/Icons	Definition
	Park Brake/Mast Tilt Sensor
	Steering Axle/Wheel Sensor
	Temperature Sensor
	Travel Direction Foot Pedal Sensor
	Travel Direction Manual Hydraulic Sensor
	Failure/Cause/Occurence
	Failure A/Cause A/Occurence A
	Shorted Connection/Fault e.g.C
	Resistor e.g. Value = 1.1KOhms
	Fuse – xx Amps
	Emergency Disconnect
	Coil – Relay/Contactor/Valve
	Contactor/Relay//Valve Coil
	Switch – Normally Open

Symbols/Icons	Definition
	Switch – Normally Closed
	High Resistance
	Okay/Correct
	Record
	Software
	Repair Faulty Component
	Go to Next Step
	Go to Next Step
	Go to Next Cause
	Display arrow Left
]	Display arrow Right
?	Go to next step
	Display Scroll UP/DOWN Push Buttons
G	Lift/Lower Hydraulic Lever(s)
	Not Equal
	Ohms
~	Approximately

Symbols/Icons	Definition
	Infinite Value
?	Question/Questionable Operation
=	Equal/Compare to
<	Less Than
>	Greater Than
	Dead - Destroyed – Beyond Redemption

SECTION 9035

DRIVE AXLE/UNIT

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Group 10
Principles of Operation

Drive Axle J1.5-2.0XNT (J30-40XNT) (K160) J1.6-2.0XN (A935)

DESCRIPTION

This series of lift trucks is equipped with a transaxle which consists of a drive motor, an in-line gear set drive unit, and a park brake on each drive wheel. This series of lift trucks is also equipped with a wet brake system which is located within the transaxle.

PRINCIPLES OF OPERATION

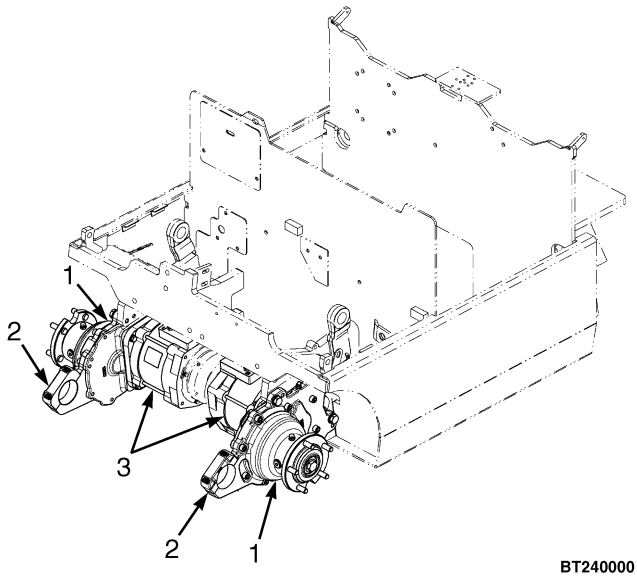
The lift truck uses two drive units. One drive unit is mounted on each side of the lift truck frame beneath the cowl. The drive unit is an in-line gear set that incorporates a wet disk service brake assembly within the drive unit. The traction motor and park brake is mounted on one side of the drive unit, and the drive wheel and tire assemblies are mounted to the other side of the drive unit. The drive unit is secured to the lift truck frame using a series of five capscrews. The drive unit housing provides the mounts needed to attach the mast to the lift truck. Power from the traction motor is transmitted to the drive unit through an internal spline in the input gear. See Figure 9035-10-1.

Drive Units

- Dual, in-line drive units are individually mounted in the frame with complete and separate traction motor and braking systems. This system allows for independent traction control for each wheel.
- The drive unit assemblies mount to the frame with five capscrews per side.
- The drive unit housings also support the mast through machined and bushed trunnion mounts. The hang-on mast mounting system, with its mounting hardware accessible from above, provides a convenient way to install/remove the mast. An easily accessible grease fitting is provided to lubricate the mast mounting and bushing.
- Wet disk brakes are designed as an integral part of the drive unit.

Brakes

- Dual, hydraulically operated, wet disk service brakes are designed into the drive unit.
- These brakes are inside the drive unit, and therefore are impervious to water and operate with no degradation of performance in these conditions.
- The master cylinder and integrated reservoir have fluid level sensor connected to a warning light on the display panel.
- Spring applied, electrically released park brake is mounted at the end of each motor. The parking brake is automatically set by the control system so that the brake is always applied whenever the truck is not moving, and no traction has been requested. A manual release mechanism has been designed into the park brake.



1. DRIVE UNIT
2. MAST MOUNTING CAPS
3. TRACTION MOTORS

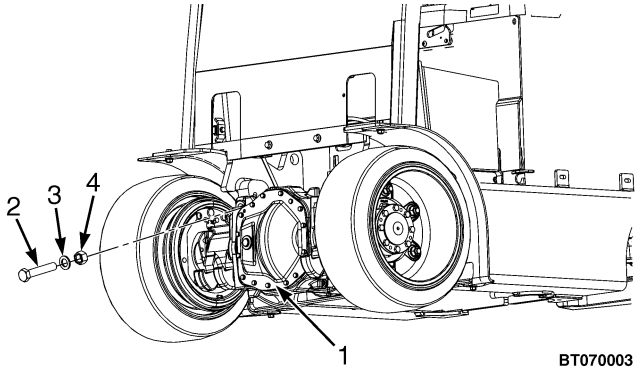
Figure 9035-10-1. Transaxle Mounting

Drive Axle E2.2-3.5XN (E40-70XN) (A268), E1.6-2.0XN E30-40XN (A269), J2.2-3.5XN (J45-70XN) (A276), E4.0-5.5XN, 5.0XNS (E80-120XN, E100XNS) (A099), And J4.0-5.0XN (A970)

DRIVE AXLE E2.2-3.5XN (E45-70XN) (A268) AND E1.6-2.0XN (E30-40XN) (A269)

DESCRIPTION

This lift truck is equipped with a conventional drive axle and uses dry service brakes. See the Dry Brake Systems section of this manual. The drive axle is fastened to the frame of the lift truck with four bolts, washers, and nuts. See Figure 9035-10-2. These lift truck models may have a manual or an automatic park brake.



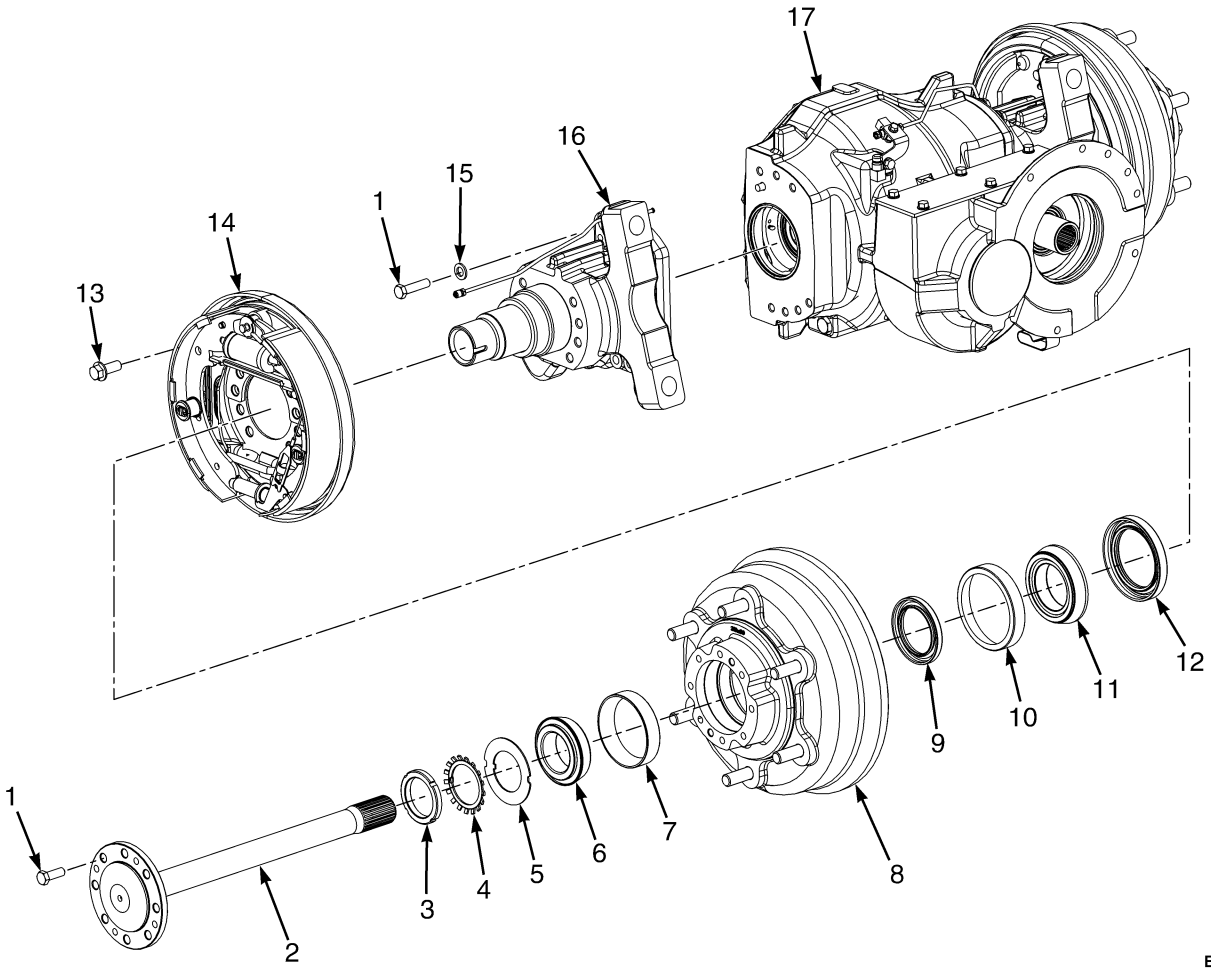
NOTE: DRIVE AXLE FOR E2.2-3.5XN (E45-70XN) (A268) SHOWN. E2.2-3.5XN (E45-70XN) (A268) E1.6-2.0XN (E30-40XN) (A269) IS SIMILAR.

1. DRIVE AXLE ASSEMBLY
2. AXLE MOUNTING BOLT
3. WASHER
4. NUT

Figure 9035-10-2. Drive Axle Mounting for Lift Truck Models E2.2-3.5XN (E45-70XN) (A268) and E1.6-2.0XN (E30-40XN) (A269)

PRINCIPLES OF OPERATION

The outer ends of the axle housings are the spindles for the wheel bearings. The cups for the tapered roller bearings are pressed into the wheel hubs. The nut on the end holds and adjusts the preload on the wheel bearings. The axle shafts are fastened to the hubs by capscrews. Studs and nuts fasten the wheel to the hub and brake drum. The back plate and brake assemblies are fastened to the axle assembly or assemblies. The center section contains the speed reducer and differential assembly. See Figure 9035-10-3. The speed reducer has a gear that engages the splines on the shaft of the traction motor. A second speed reducer gear is fastened to the pinion shaft for the differential.



NOTE: DRIVE AXLE FOR E2.2-3.5XN (E45-70XN) (A268) SHOWN. E2.2-3.5XN (E45-70XN) (A268) E1.6-2.0XN (E30-40XN) (A269) IS SIMILAR.

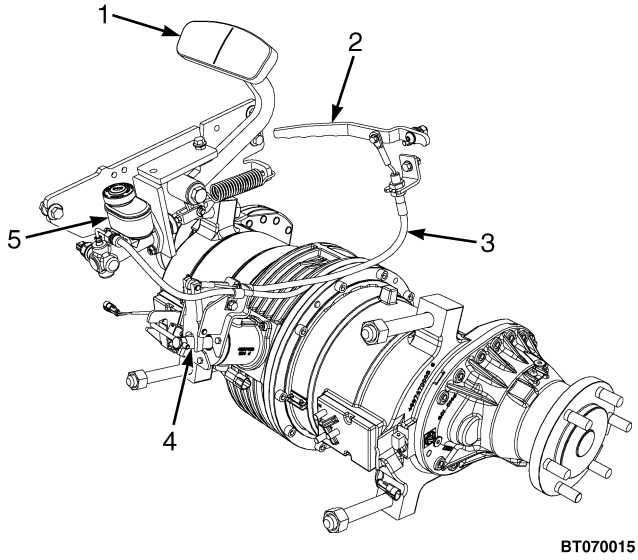
1. CAPSCREW
2. AXLE SHAFT
3. BEARING LOCK NUT
4. BEARING LOCK WASHER
5. WHEEL BEARING WASHER
6. OUTER BEARING CONE
7. OUTER BEARING CUP
8. HUB
9. OUTER SEAL
10. INNER BEARING CUP
11. INNER BEARING CONE
12. INNER SEAL
13. LOCK BOLT
14. BRAKE ASSEMBLY
15. WASHER
16. LH HANGER
17. CENTER SECTION ASSEMBLY

Figure 9035-10-3. Drive Axle Assembly for Lift Truck Models E2.2-3.5XN (E45-70XN) (A268) and E1.6-2.0XN (E30-40XN) (A269)

TRANSAXLE J2.2-3.5XN (J45-70XN) (A276)

DESCRIPTION

This transaxle is a modular rigid axle for use in front-wheel-drive electric balance-weight forklift trucks and uses wet service brakes. See the Wet Brake Systems section of this manual.



1. BRAKE PEDAL
2. PARK BRAKE MANUAL RELEASE
3. PARK BRAKE RELEASE CABLE
4. PARK BRAKE ACTUATOR
5. MASTER CYLINDER RESERVOIR

Figure 9035-10-4. Transaxle for Lift Truck Models J2.2-3.5XN (J45-70XN) (A276)

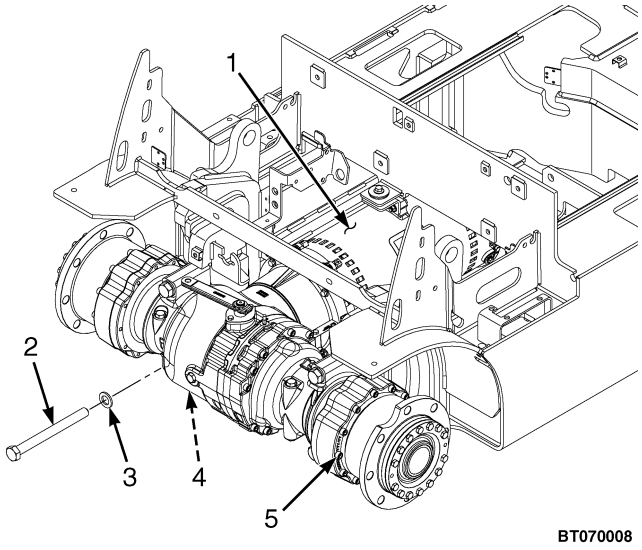
PRINCIPLES OF OPERATION

The transaxle consists of a centrally located park and service brake system, two asynchronous traction motors, and two transmissions. The drive unit is joined to the vehicle chassis and to the lift mast by means of fixtures mounted on the axle.

DRIVE AXLE E4.0-5.5XN, 5.0XNS (E80-120XN, E100XNS) (A099)

DESCRIPTION

This lift truck is equipped with a conventional drive axle and uses wet service brakes. See the Wet Brake Systems section of this manual. The drive axle is fastened to the frame of the lift truck with four bolts, washers, and nuts. See Figure 9035-10-5.

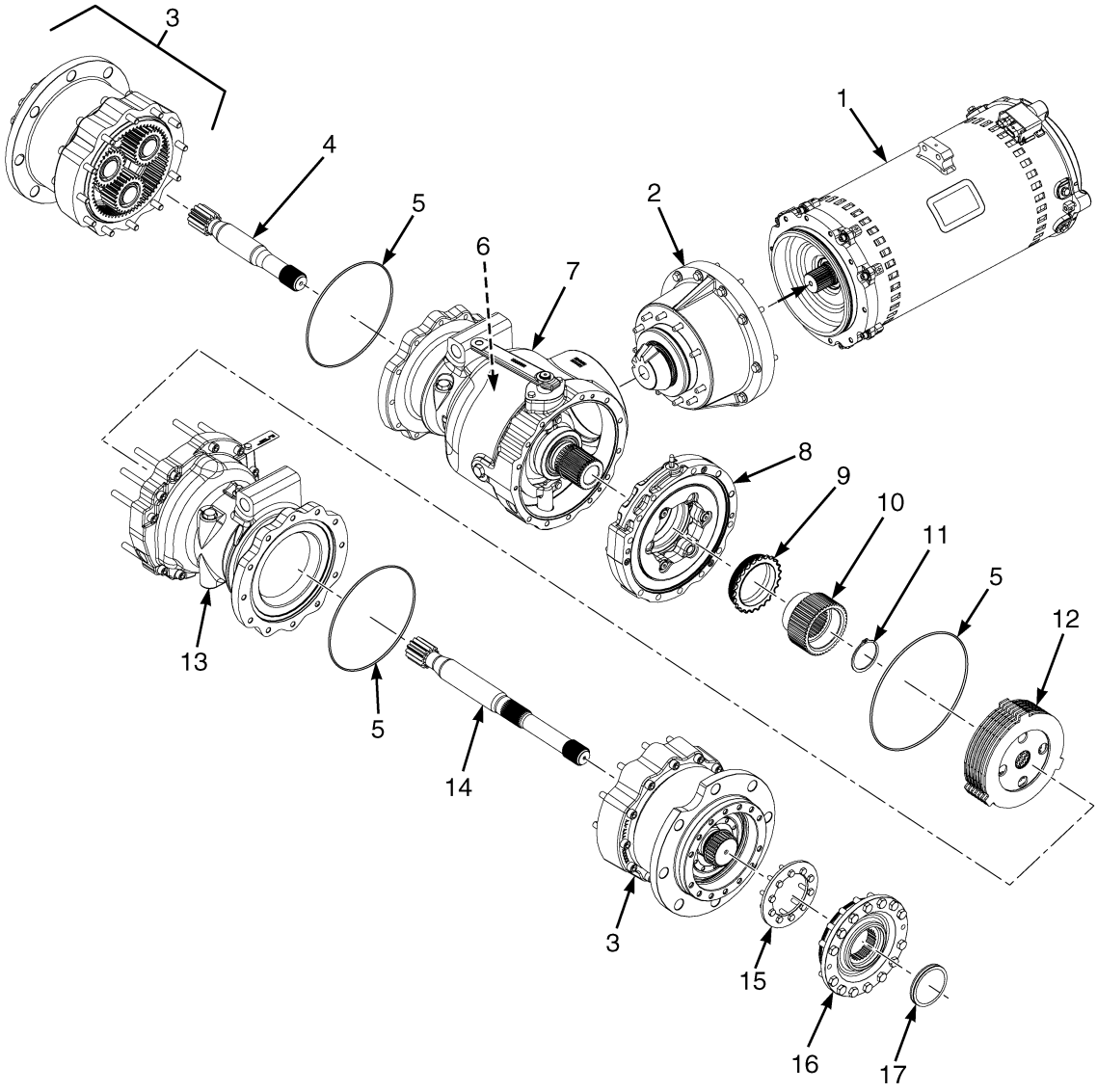


1. TRACTION MOTOR
2. AXLE MOUNTING BOLT
3. WASHER
4. NUT (NOT SHOWN)
5. DRIVE AXLE

Figure 9035-10-5. Drive Axle Mounting for Lift Truck Models E4.0-5.5XN, 5.0XNS (E80-120XN, E100XNS) (A099)

PRINCIPLES OF OPERATION

The outer ends of the axle housings are the reduction gear assemblies for the wheel hubs. The cups for the tapered roller bearings are pressed into the wheel hubs. The retaining plate on the end holds and adjusts the preload on the wheel bearings. Studs and nuts fasten the wheel to the wheel hub. Socket head capscrews fasten the reduction gear assemblies to the drive axle housing. Socket head capscrews fasten the left drive axle housing to the piston chamber and the piston chamber to the right drive axle housing. The right drive axle housing contains the differential housing and differential. Fastened to the right drive axle housing is the pinion and motor carrier. A traction motor fastened to the motor carrier supplies rotation to the pinion via a splined coupler which in turn engages the differential. See Figure 9035-10-6.



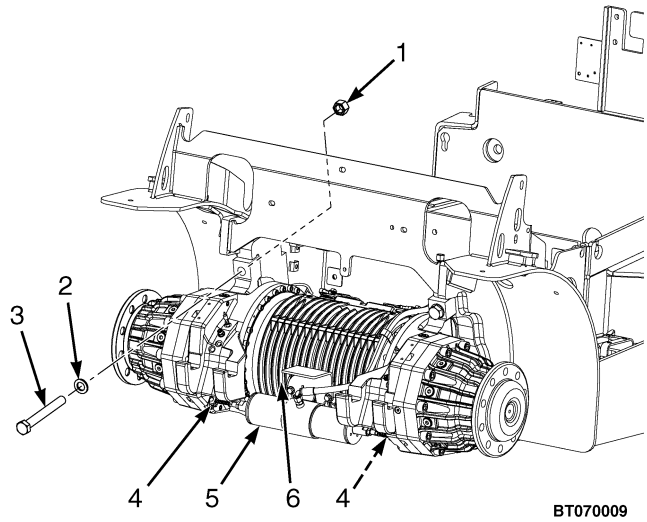
1. TRACTION MOTOR
2. PINION AND MOTOR CARRIER
3. REDUCTION GEAR ASSEMBLY
4. LEFT AXLE SHAFT
5. O-RING
6. DIFFERENTIAL HOUSING AND DIFFERENTIAL
7. RIGHT DRIVE AXLE HOUSING
8. PISTON CHAMBER
9. DIFFERENTIAL BEARING ADJUSTMENT NUT
10. COUPLER
11. SNAP RING
12. WET BRAKE DISC PACK
13. AXLE HOUSING
14. RIGHT AXLE SHAFT
15. RETAINING PLATE
16. WHEEL HUB COUPLER
17. BEARING CAP

Figure 9035-10-6. Drive Axle Assembly for Lift Truck Models E4.0-5.5XN, 5.0XNS (E80-120XN, E100XNS) (A099)

TRANSAXLE J4.0-5.0XN (J80-100XN) (A970)

DESCRIPTION

This series of lift trucks is equipped with a transaxle which consists of two drive motors, two gear boxes, two transmission output assemblies and an automatic park brake . This series of lift trucks is also equipped with a wet brake system which is located within the gear box housing. See the Wet Brake Systems section of this manual.

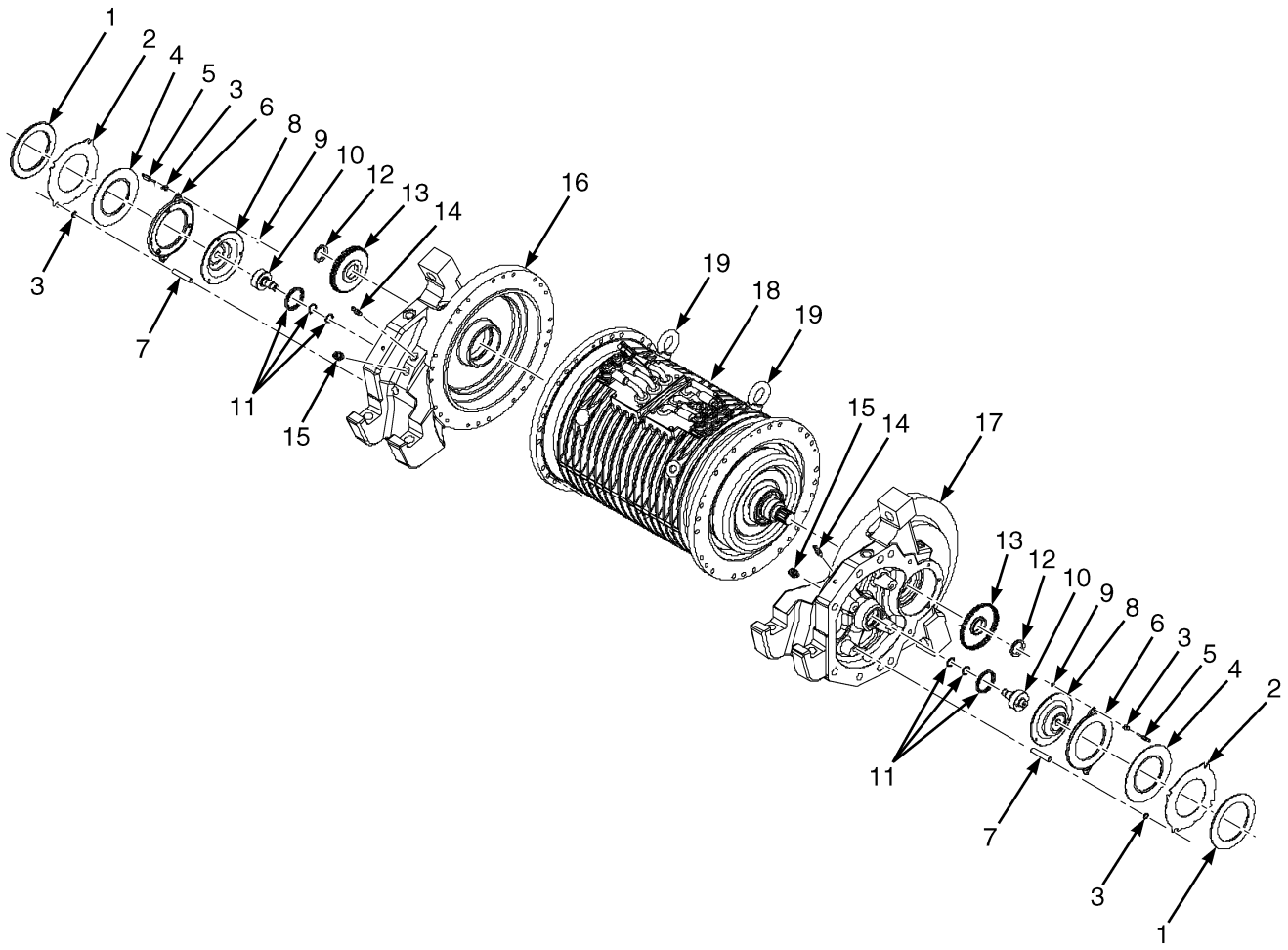


1. NUT
2. WASHER
3. CAPSCREW
4. LEVER ARM
5. PARK BRAKE ACTUATOR
6. TRACTION MOTOR HOUSING

Figure 9035-10-7. Drive Axle Mounting for Lift Truck Models J4.0-5.0XN (J80-100XN) (A970)

PRINCIPLES OF OPERATION

The lift truck uses two traction motors installed in a central traction motor housing. The traction motor housing has fins to allow the traction motors to cool. The wet brakes are contained within the gear box housing. The transaxle is mounted to the frame with four mounting bolts, washers and nuts. The transaxle housing provides the mounts needed to attach the mast to the lift truck. Power from the traction motors is transmitted to the gear box through an internal spline and on to the transmission output assembly. See Figure 9035-10-8.



1. SUPPORT DISC
2. STEEL DISC
3. SPRING
4. SEPARATOR PLATE
5. STUD
6. DISC PUSHER
7. LOCKING PIN
8. ELASTIC DISC
9. RETAINING RING
10. PISTON
11. GASKET
12. V-RING
13. PHONIC WHEEL
14. BREATHER
15. SERVICE BRAKE PIPING CONNECTOR
16. RIGHT GEAR BOX
17. LEFT GEAR BOX
18. TRACTION MOTOR
19. LIFTING EYELET

Figure 9035-10-8. Drive Axle Assembly for Lift Truck Models J4.0-5.0XN (J80-100XN) (A970)

SERVICE BRAKE SYSTEMS

Dry Brake Systems

General

The dry brake system includes the following parts: park brake, service brakes, master cylinder, and automatic park brake or manual. The manual park brake assembly contains a release handle, pedal, position sensor and cable. The service brake assembly contains the brake pedal, master cylinder, brake assembly (attached to wheel), and park brake cables. The automatic park brake assembly contains the brake (attached to the traction motor), cable, and manual override handle.

Wet Brake Systems

General

The brake systems for all wet brake axles operate on a common principal very similar to the transmission clutch packs. Rotating friction discs are interleaved with stationary separator discs within the axle housing. An annular piston forces the discs together when pressure is provided by the service brake system. An oil bath provides a shear film between the discs, greatly reducing wear of the friction material. For park brake function, an actuator and lever arm on the drive axle moves the piston instead of service brake oil pressure.

Master Cylinder

The master cylinder is designed for a single-circuit system. The master cylinder has a piston that operates in the bore of the master cylinder.

The reservoir is equipped with an indicator for low fluid level. A float in the reservoir moves up and down with the fluid level. When the fluid level is low, a magnet on the float activates a switch in the bottom of the reservoir. This switch signals the Vehicle System Manager (VSM) which illuminates an icon on the Display Panel (DP).

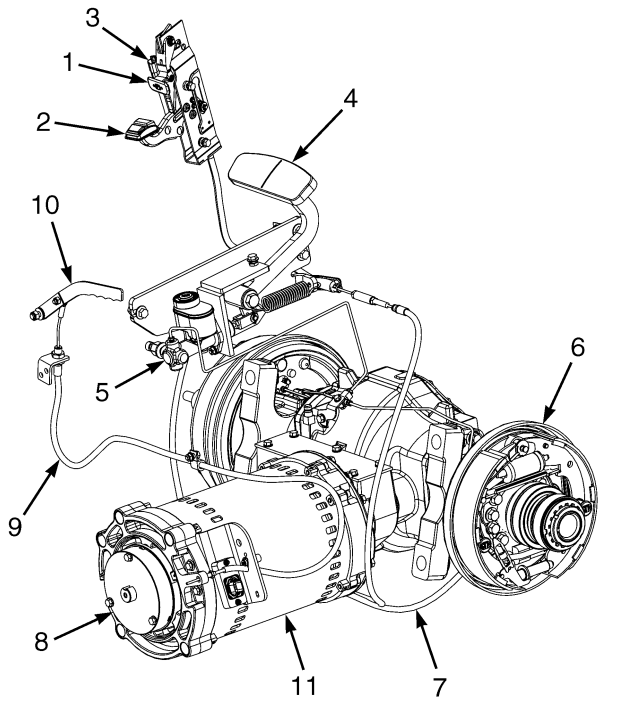
PARKING BRAKE SYSTEMS

Manual Parking Brake For Lift Truck Models E2.2-3.5XN (E45-70XN) (A268) and E1.6-2.0XN (E30-40XN) (A269)

The parking brake system uses the service brake shoes. Additional linkage activates the parking brake system. When the pedal is moved to apply the parking brake, the cables and linkage expand the brake shoes against the drums. The design of the parking brake linkage adjusts each cable so that the tension is the same when the pedal is moved to apply the parking brake. The park brake sensor is located on the left side of the park brake pedal. See Figure 9035-10-9.

Automatic Park Brake For Lift Truck Models E2.2-3.5XN (E45-70XN) (A268) , E1.6-2.0XN (E30-40XN) (A269) , J2.2-3.5XN (J45-70XN) (A276) , E4.0-5.5XN, 5.0XNS (E80-120XN, E100XNS) (A099) , and J4.0-5.0XN (J80-100XN) (A970)

On lift truck models E2.2-3.5XN (E45-70XN) (A268) and J2.2-3.5XN (J45-70XN) (A276) E1.6-2.0XN (E30-40XN) (A269) , the automatic park brake (APB) is attached to the traction motor. See Figure 9035-10-9 The automatic park brake activates at zero speed. If the driver leaves the seat; a switch notifies the operating software and the lift truck will slow to a stop. When the lift truck is stopped for a brief period, the park brake will apply automatically. When the accelerator is applied, the brake will release.

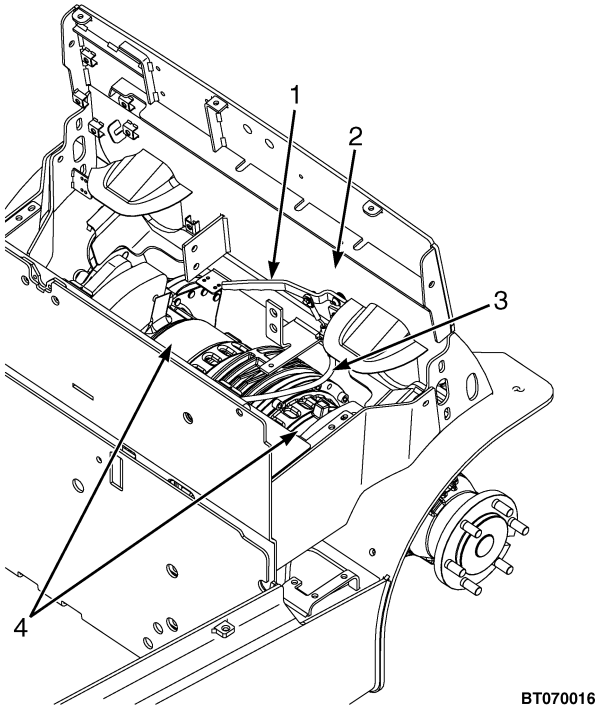


NOTE: BOTH MANUAL AND AUTOMATIC PARK BRAKE COMPONENTS SHOWN.
NOTE: DRIVE AXLE FOR E2.2-3.5XN (E45-70XN) (A268) SHOWN. E1.6-2.0XN (E30-40XN) (A269) IS SIMILAR.

1. PARK BRAKE RELEASE HANDLE (MANUAL PARK BRAKE)
2. PARK BRAKE PEDAL (MANUAL PARK BRAKE)
3. PARK BRAKE POSITION SENSOR (LEFT-HAND SIDE) (MANUAL PARK BRAKE)
4. BRAKE PEDAL
5. MASTER CYLINDER
6. BRAKE ASSEMBLY
7. PARK BRAKE CABLES
8. AUTOMATIC PARK BRAKE ASSEMBLY
9. AUTOMATIC PARK BRAKE CABLE
10. AUTOMATIC PARK BRAKE MANUAL OVERRIDE HANDLE
11. TRACTION MOTOR

Figure 9035-10-9. Brake System for Lift Truck Models E2.2-3.5XN (E45-70XN) (A268) and E1.6-2.0XN (E30-40XN) (A269)

On lift truck model A276 , the automatic parking brake is driven by a spring applied/ hydraulic release accumulator assisted actuator mounted on the drive axle. The single pole actuator engages a wedge face on a ball ramp actuator which locks the brake disc set, parking the lift truck. The parking brake is automatically set by the control system so that the brake is always applied whenever the truck is not moving, and no traction has been requested. The manual override is a handle attached to the cable and for use when the lift truck has no power. The brake is in the applied position when the handle rests against the mechanical stop. The brake is manually released by pulling the handle upright.



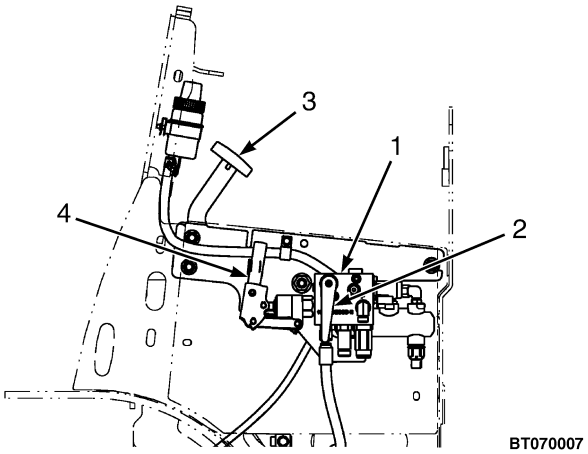
1. MANUAL OVERRIDE HANDLE
2. COWL
3. MANUAL OVERRIDE CABLE
4. TRANSAXLE

Figure 9035-10-10. Automatic Park Brake Manual Release for Lift Truck Models J2.2-3.5XN (J45-70XN) (A276)

On lift truck model A970 , the automatic parking brake is driven by a spring applied/ hydraulic release actuator mounted beneath the traction motor housing. The actuator has two opposed rods that engage right and left park brake lever arms. The lever arms mechanically apply the wet brakes, parking the lift truck. The parking brake is automatically set by the control system so that the brake is always applied whenever the truck is not moving, and no traction has been requested. A manual release mechanism has been designed into the park brake for truck repairs.

On lift truck model A099 , the automatic parking brake is driven by a spring applied/ hydraulic release actuator mounted above the traction motor. The single pole actuator engages park brake lever arm on the drive axle. The lever arm mechanically applies the wet brakes, parking the lift truck. The parking brake is automatically set by the control system so that the brake is always applied whenever the truck is not moving, and no traction has been requested. A manual release mechanism has been designed into the park brake for truck repairs.

On lift trucks A099 and A970 the manual override is on a manifold valve under the floor plate. The needle valve handle must be swung clockwise to engage the bypass. Then the manual hand pump will need to be pump approximately fifteen times to release the automatic park brake. See Figure 9035-10-11.



1. MANIFOLD VALVE
2. NEEDLE VALVE HANDLE
3. PEDAL
4. MANUAL HAND PUMP

Figure 9035-10-11. Automatic Park Brake Manual Release for Lift Truck Models J4.0-5.0XN (J80-100XN) (A970) and E4.0-5.5XN, 5.0XNS (E80-120XN, E100XNS) (A099)

For lift truck models J4.0-5.0XN (J80-100XN) (A970) and E4.0-5.5XN, 5.0XNS (E80-120XN, E100XNS) (A099) , the park brake manifold valve consists of SV1, a 2-pos / 3-way solenoid valve, in the circuit. When this valve is not energized, i.e., “normal” state, the brake actuator is connected to the tank. In this condition there is no hydraulic pressure at the B Port. Park brake actuator spring applies the park brake and the truck is not moving. See Figure 9035-10-12 for schematic.

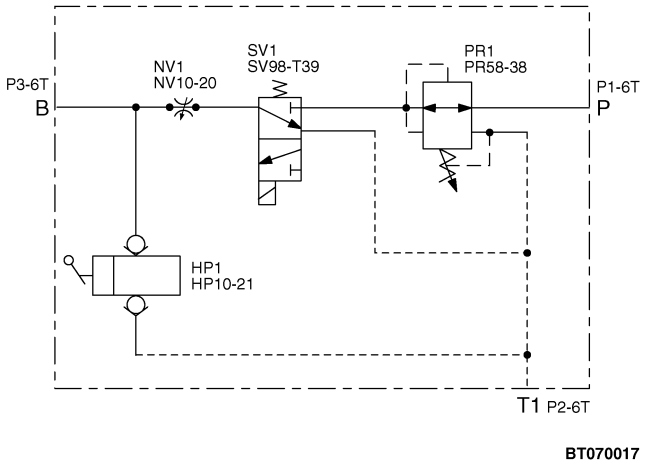


Figure 9035-10-12. Automatic Park Brake Manifold Valve for Lift Truck ModelJ4.0-5.0XN (J80-100XN) (A970) and E4.0-5.5XN, 5.0XNS (E80-120XN, E100XNS) (A099)

For lift truck models J2.2-3.5XN (J45-70XN) (A276) , the function of the accumulator (ACC1) is to store pressure and this stored pressure is used to release the Park Brake which is connected to the Port B. The Pressure Reducing Valve (PR1) reduces system pressure (from Port P) to 400 psi. Whenever a hydraulic (steering, hoist, tilt or aux) function is activated the accumulator gets charged. Steering standby flow is not sufficient to charge the accumulator. Once the accumulator is charged it can provide approximately 8-10 park brake releases before it has to be recharged. It is unlikely, but if the pressure in the accumulator drops below 200 psi it will not be able to release the park brake. In order to address this condition a pressure switch (PS1) is there to monitor the accumulator pressure. If the pressure drops below 200 psi the VSM will kick on the pump motor for a short burst to charge the accumulator.

The VSM energizes the solenoid (SV1). The pressure in the accumulator releases and holds the Park Brake. See Figure 9035-10-13 for schematic.

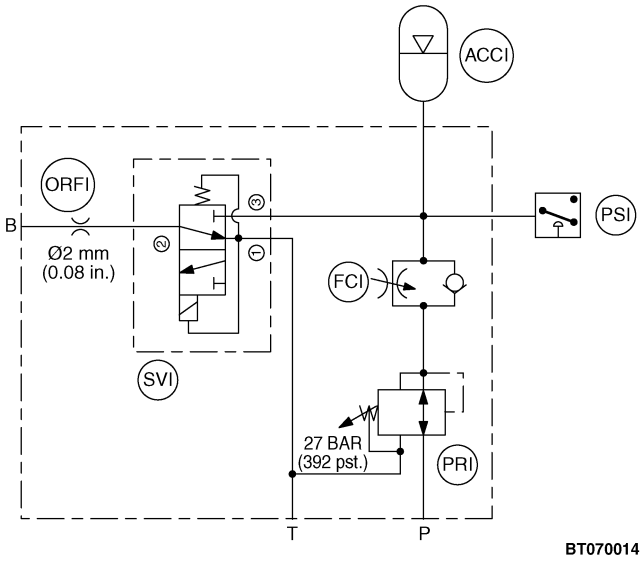


Figure 9035-10-13. Automatic Park Brake Manifold Valve for Lift Truck Model J2.2-3.5XN (J45-70XN) (A276)

MONOTROL® PEDAL

Description

The MONOTROL® pedal controls the speed of the traction motor and direction of the drive unit. There are two foot-actuated momentary-push-on switches on the left and right sides of the pedal. Pressing the left side of the pedal actuates the forward direction pedal switch. Pressing on the right side of the pedal actuates the reverse direction pedal switch. Releasing the pedal releases both pedal direction switches.

Principles of Operation

There is a small directional switch under each pad of the MONOTROL® pedal. Each switch controls one direction. If both sides of the MONOTROL® pedal are pushed at the same time no movement occurs.

NOTES

Group 30
Observed Symptoms

One Drive Wheel Will Not Move

POSSIBLE CAUSE

A. ELECTRICAL SYSTEM FAULT
B. DAMAGE TO TRACTION MOTOR.
C. DAMAGE TO GEAR REDUCTION SYSTEM IN DRIVE UNIT.

CAUSE A - ELECTRICAL SYSTEM FAULT

PROCEDURE OR ACTION:

1. Troubleshoot electrical system.
   Are any faults found during troubleshooting electrical system?
   YES: Correct faults. Depending on your lift truck, see **Electrical System** 2200SRM1369, or **Electrical System** 2200SRM1337.
   NO: Go to CAUSE B.

CAUSE B - DAMAGE TO TRACTION MOTOR.

PROCEDURE OR ACTION:

1. Inspect for damaged traction motor.
   Is traction motor apparently damaged?
   YES: Repair or replace traction motor. Depending on your lift truck, see **Transaxle** 1300SRM1330, **Transaxle** 1300SRM1370, or **Drive Axle, Speed Reducer, and Differential** 1300SRM1366.
   NO: Go to CAUSE C.

CAUSE C - DAMAGE TO GEAR REDUCTION SYSTEM IN DRIVE UNIT.

PROCEDURE OR ACTION:

1. Inspect for damaged drive unit.
   Does drive unit pass test?
   YES: Resume operation.
   NO: Replace drive unit. Depending on your lift truck, see **Transaxle** 1300SRM1330, **Transaxle** 1300SRM1370, or **Drive Axle, Speed Reducer, and Differential** 1300SRM1366.

END SYMPTOM

Noise During Operation That Is Not Normal

POSSIBLE CAUSE

A. MISSING OR LOOSE LUG NUTS
B. LOOSE DRIVE AXLE MOUNTING CAPSCREWS
C. LOW OIL LEVEL
D. BEARING DAMAGE
E. NOISE CONTINUES AFTER CORRECT OIL LEVEL
F. RING AND PINION BACKLASH IS NOT PROPER
G. NOISE CONTINUES

CAUSE A - MISSING OR LOOSE LUG NUTS

PROCEDURE OR ACTION:

1. Check for missing or loose lug nuts.
   Are any lug nuts missing or loose?
   YES: Tighten loose or missing lug nuts. Depending on your lift truck, see **Periodic Maintenance** 8000SRM1364, **Periodic Maintenance** 8000SRM1372, **Periodic Maintenance** 8000SRM1339, **Periodic Maintenance** 8000SRM1373, or **Periodic Maintenance** 8000SRM1442.
   NO: Go to CAUSE B.

CAUSE B - LOOSE DRIVE AXLE MOUNTING CAPSCREWS

PROCEDURE OR ACTION:

1. Check for loose drive axle mounting capscrews.
   Are any drive axle mounting capscrews loose?
   YES: Tighten drive axle mounting capscrew. Depending on your lift truck, see **Transaxle** 1300SRM1330, **Transaxle** 1300SRM1370, or **Drive Axle, Speed Reducer, and Differential** 1300SRM1366.
   NO: Go to CAUSE C

CAUSE C - LOW OIL LEVEL

PROCEDURE OR ACTION:

1. Check level of oil.
   Is oil level low?
   YES: Add oil to correct level. See **Operating Manual**.
   NO: Go to CAUSE E.

CAUSE D - BEARING DAMAGE

PROCEDURE OR ACTION:

1. Check for damage on bearings.
   Are bearings damaged?
   YES: Repair or replace traction motor. Depending on your lift truck, see **Transaxle** 1300SRM1330, **Transaxle** 1300SRM1370, or **Drive Axle, Speed Reducer, and Differential** 1300SRM1366.
   NO: Go to CAUSE F.

CAUSE E - NOISE CONTINUES AFTER CORRECT OIL LEVEL

PROCEDURE OR ACTION:

1. Check for wear and damage in the gear reduction system.
   Does gear reduction have wear and damage?
   YES: Repair the drive axle, speed reducer and differential assembly. See **Drive Axle, Speed Reducer, and Differential** 1300SRM1366.
   NO: Go to CAUSE D.

CAUSE F - RING AND PINION BACKLASH IS NOT PROPER

PROCEDURE OR ACTION:

1. Check the ring and pinion backlash.
   Is ring and pinion backlash within specifications?
   YES: Go to CAUSE G.
   NO: Adjust ring and pinion backlash. See **Drive Axle, Speed Reducer, and Differential** 1300SRM1366.

CAUSE G - NOISE CONTINUES

PROCEDURE OR ACTION:

1. Check to make sure that the ring and pinion is a matched gear set.
   Are the ring and pinion a matched?
   YES: Resume operation.
   NO: repair or replace ring and pinion. See **Drive Axle, Speed Reducer, and Differential** 1300SRM1366.

END SYMPTOM

Oil Leaks

POSSIBLE CAUSE

A. OIL LEAK BETWEEN DRIVE UNIT HOUSING AND COVER
B. DAMAGED O-RINGS OR OIL SEALS
C. DRAIN, LEVEL, OR FILL PLUG LOOSE
D. OIL BEING EJECTED THROUGH BREATHER DUE TO OVERFILLING

CAUSE A - OIL LEAK BETWEEN DRIVE UNIT HOUSING AND COVER

PROCEDURE OR ACTION:

NOTE: This procedure is to be performed during the initial two year warranty period for lift trucks J1.5-2.0XNT (J30-J40XNT) (K160) J1.6-2.0XN (A935)

1. Tighten housing bolts as directed in **Transaxle** 1300SRM1330, or **Transaxle** 1300SRM1370.
   Did the leak stop?
   YES: Continue lift truck operation.
   NO: Replace the drive unit. See **Transaxle** 1300SRM1330, or **Transaxle** 1300SRM1370. After the two year warranty period has expired on the above lift trucks go to CAUSE B.

CAUSE B - DAMAGED O-RINGS OR OIL SEALS

PROCEDURE OR ACTION:

NOTE: For lift trucks J1.5-2.0XNT (J30-J40XNT) (K160) J1.6-2.0XN (A935) the following procedure is to be performed only after the two year warranty period has expired.

1. Inspect O-rings and oil seals.
   Are O-rings or oil seals damaged?
   YES: Repair or replace damaged O-rings or oil seals. Depending on your lift truck, see **Transaxle** 1300SRM1330, **Transaxle** 1300SRM1370, or **Drive Axle, Speed Reducer, and Differential** 1300SRM1366.
   NO: Go to CAUSE C

CAUSE C - DRAIN, LEVEL, OR FILL PLUG LOOSE

PROCEDURE OR ACTION:

1. Inspect for loose drain, level, or fill plug.
   Is drain, level, or fill plug loose?
   YES: Tighten plug if necessary. Tighten to 22 N•m (16. lbf ft) Depending on your lift truck, see **Transaxle** 1300SRM1330, **Transaxle** 1300SRM1370, or **Drive Axle, Speed Reducer, and Differential** 1300SRM1366.
   NO: Go to CAUSE D.

CAUSE D - OIL BEING EJECTED THROUGH BREATHER DUE TO OVERFILLING

PROCEDURE OR ACTION:

1. Inspect breather for ejection of excess oil.
   Is excess oil being ejected from breather?
   YES: Remove oil drain plug and allow excess to drain until level is at bottom of oil fill plug.
   NO: Resume operation.

END SYMPTOM

Park Brake Does Not Operate Properly

POSSIBLE CAUSE

CAUSE A - PARK BRAKE ACCUMULATOR IS FAULTY.

PROCEDURE OR ACTION:

1. Bring truck to a complete stop.
2. Run tilt over relief for 15 seconds (this will fully charge the accumulator).
3. Press the accelerator pedal to move the lift truck 0.3 m (1 ft) with no hydraulic functions actuated including steering.
4. Come to a compete stop then repeat Step 3.
   Does hydraulic pump run at a fast rate for a brief period?
   YES: Replace accumulator. See **Transaxle** 1300SRM1370
   NO: Problem not Verified. Resume Operation.

Motion Inhibited

POSSIBLE CAUSE

A. TRACTION OR HYDRAULIC INTERLOCK
B. MOTOR CONTROLLER FAULTED OR NOT READY
C. KEY SWITCH
D. BRAKE LINKAGE
E. BRAKE APPLIED

CAUSE A - TRACTION OR HYDRAULIC INTERLOCK

PROCEDURE OR ACTION:

1. Check display for active interlocks.
   Is an interlock active?
   YES: Cycle the key. Check display for active interlocks.
   NO: Go to CAUSE B.

CAUSE B - MOTOR CONTROLLER FAULTED OR NOT READY

PROCEDURE OR ACTION:

1. Check operator presence.
   Is the Operator Presence system working properly?
   YES: Go to CAUSE C.
   NO: Repair or replace the Operator Presence sensor. Refer to the appropriate **Wiring Harness Repair**SRM or **Electrical System**SRM .

CAUSE C - KEY SWITCH

PROCEDURE OR ACTION:

1. Check for key switch related faults.
   Are there any key switch related faults?
   YES: Repair or replace the key switch. Refer to the appropriate **Wiring Harness Repair**SRM or **Electrical System**SRM .
   NO: Go to CAUSE D.

CAUSE D - BRAKE LINKAGE

PROCEDURE OR ACTION:

1. Check the brake linkage when motion is inhibited and there are no fault codes.
   Is the brake linkage in good condition and working properly?
   YES: Go to CAUSE E.
   NO: Repair or replace damaged or worn components. Refer to the appropriate **Transaxle or Drive Axle, Speed Reducer, and Differential** SRM .

CAUSE E - BRAKE APPLIED

PROCEDURE OR ACTION:

1. Check brake pressure sensor voltage. Without brake applied voltage should be 0.5 volts.
   Is the brake pressure sensor reading 0.5 volts without the brake applied?
   YES: Resume operation.
   NO: Replace brake pressure sensor with new sensor. Refer to the appropriate **Wiring Harness Repair**SRM or **Electrical System**SRM .

END SYMPTOM

PARK BRAKE TROUBLESHOOTING GUIDE

Symptoms	Possible Solutions	Action
Slow Park Brake Release	Check hose restrictions	Replace hoses that have been crushed or kinked.
	Check needle valve setting	Refer to the appropriate **Transaxle or Drive Axle, Speed Reducer, and Differential**SRM .
	Check solenoid valve	Refer to the appropriate **Electrical System**SRM .
	Check standby pressure	Refer to the appropriate **Main Control Valves**SRM .
	Check accelerator pedal	Refer to the appropriate **Electrical System**SRM .
	Check linkage for damage	Replace sheared clevis pins, worn or damaged cables and springs and retaining clips.
	Check actuator rod damage	Refer to the appropriate **Transaxle or Drive Axle, Speed Reducer, and Differential**SRM .
	Check actuator rod interference	Secure hoses, lines, and wires out of the way to eliminate interference.
	Check fault codes	If fault code appears, go to Electrical System, General Maintenance and Diagnostic Data, Diagnostic Trouble Codes, Page 9030-03-6.
Slow Park Brake Apply	Check needle valve setting	Refer to the appropriate **Transaxle or Drive Axle, Speed Reducer, and Differential**SRM .
	Check solenoid valve voltage, coil, contamination	Refer to the appropriate **Electrical System**SRM .
	Check Tank return hose for kinks, pinches or back pressure	Remove any excessive elbow joints or other restrictions in the tank return hose.
No Park Brake Apply	Check park brake cable for damage	Replace park brake cable if damaged.
	Check park brake cable adjustment	Refer to the appropriate **Periodic Maintenance**SRM .
	Check actuator stroke	Refer to the appropriate **Periodic Maintenance**SRM .
	Check brake pack wear	Refer to the appropriate **Periodic Maintenance**SRM .
	Check needle valve setting	Refer to the appropriate **Transaxle or Drive Axle, Speed Reducer, and Differential**SRM .

Symptoms	Possible Solutions	Action
	Check for sticking solenoid valve	Refer to the appropriate **Electrical System**SRM .
No Park Brake Apply	Check actuator rod for damage	Refer to the appropriate **Transaxle or Drive Axle, Speed Reducer, and Differential**SRM .
	Check fault codes	If fault code appears, go to Electrical System, General Maintenance and Diagnostic Data, Diagnostic Trouble Codes, Page 9030-03-6.
	Check speed sensor	Refer to the appropriate **Electrical System**SRM .
Partial Park Brake Apply	Check brake pack wear	Refer to the appropriate **Periodic Maintenance**SRM .
	Check park brake cable adjustment	Refer to the appropriate **Periodic Maintenance**SRM .
	Check for actuator damage	Refer to the appropriate **Transaxle or Drive Axle, Speed Reducer, and Differential**SRM .
	Check wheel size	See your lift trucks name plate for the appropriate tire type and size.
	Check oil type	Refer to the appropriate **Periodic Maintenance**SRM .
	Check hose leaks	Replace leaking hoses with new hoses. Make sure clamps and fittings are tight.
	Check linkage for damage	Replace sheared clevis pins, worn or damaged cables and springs and retaining clips.
No Park Brake Release	Check actuator stroke (locked)	Refer to the appropriate **Periodic Maintenance**SRM .
	Check for actuator damage	Refer to the appropriate **Transaxle or Drive Axle, Speed Reducer, and Differential**SRM .
	Check solenoid connection	Refer to the appropriate **Electrical System**SRM .
	Check solenoid valve voltage, current and coil	Refer to the appropriate **Electrical System**SRM .
	Confirm hose routing	Make sure all hoses have gradual slopes and do not interfere with moving components.
	Check needle valve setting	Refer to the appropriate **Transaxle or Drive Axle, Speed Reducer, and Differential**SRM .
	Check standby pressure	Refer to the appropriate **Main Control Valves**SRM .

Symptoms	Possible Solutions	Action
	Check accelerator pedal	Refer to the appropriate **Electrical System**SRM .
	Check fault codes	If fault code appears, go to Electrical System, General Maintenance and Diagnostic Data, Diagnostic Trouble Codes, Page 9030-03-6.
No Park Brake Release	Check pressure reducing valve	Replace the parking brake valve if a pressure of less than 2068±138 kPa (300±20 psi) is measured at the pressure port on the parking brake valve.
	Check hoses for leaks	Replace leaking hoses with new hoses. Make sure clamps and fittings are tight.
	Check actuator rod interference	Secure hoses, lines, and wires out of the way to eliminate interference.
Partial Park Brake Release	Check park brake rod interference	Secure hoses, lines, and wires out of the way to eliminate interference.
	Check needle valve setting	Refer to the appropriate **Transaxle or Drive Axle, Speed Reducer, and Differential**SRM .
	Check pressure reducing valve	Replace the parking brake valve if a pressure of less than 2068±138 kPa (300±20 psi) is measured at the pressure port on the parking brake valve.
	Check hoses for leaks	Replace leaking hoses with new hoses. Make sure clamps and fittings are tight.
	Check hose for kinks and pinches	Replace hoses that have been crushed or kinked.
	Check actuator stroke (locked)	Refer to the appropriate **Periodic Maintenance**SRM .
	Check linkage for damage	Replace sheared clevis pins, worn or damaged cables and springs and retaining clips.
Unintentional Park Brake Apply	Check speed sensor	Refer to the appropriate **Electrical System**SRM .
	Check accelerator pedal	Refer to the appropriate **Electrical System**SRM .
	Check solenoid connection	Refer to the appropriate **Electrical System**SRM .
	Check solenoid hardness connection	Refer to the appropriate **Electrical System**SRM .
	Check fault codes	If fault code appears, go to Electrical System, General Maintenance and

Symptoms	Possible Solutions	Action
		Diagnostic Data, Diagnostic Trouble Codes, Page 9030-03-6.

Symptoms	Possible Solutions	Action
Park Brake is noisy	Check actuator damage	Refer to the appropriate **Transaxle or Drive Axle, Speed Reducer, and Differential**SRM .
	Check park brake cable damage	Replace park brake cable if damaged.
	Check for actuator interference	Secure hoses, lines, and wires out of the way to eliminate interference.
	Check solenoid valve	Refer to the appropriate **Electrical System**SRM .
Park Brake judder/vibration	Check needle valve setting	Refer to the appropriate **Transaxle or Drive Axle, Speed Reducer, and Differential**SRM .
	Check solenoid valve	Refer to the appropriate **Electrical System**SRM .
	Check pressure reducing valve	Replace the parking brake valve if a pressure of less than 2068±138 kPa (300±20 psi) is measured at the pressure port on the parking brake valve.
	Check hoses leaks	Replace leaking hoses with new hoses. Make sure clamps and fittings are tight.
	Check hose kinks or pinches	Replace hoses that have been crushed or kinked.
	Check brake pack wear	Refer to the appropriate **Periodic Maintenance**SRM .

Symptoms	Possible Solutions	Action
No Manual Override	Check needle valve setting	Refer to the appropriate **Transaxle or Drive Axle, Speed Reducer, and Differential**SRM .
	Check pump prime	Refer to the appropriate **Transaxle or Drive Axle, Speed Reducer, and Differential**SRM .
	Check for leaks in hoses	Replace leaking hoses with new hoses. Make sure clamps and fittings are tight.
	Check tank return hose for kinks or pinches	Replace return hose with new return hose if kinks or pinches are found.
	Check for actuator damage	Refer to the appropriate **Transaxle or Drive Axle, Speed Reducer, and Differential**SRM .
	Check actuator stroke (locked)	Refer to the appropriate **Periodic Maintenance**SRM .
Park Brake engagement frequency too high	Confirm software setting	Refer to the appropriate **User Interface**SRM .
	Check accelerator pedal	Refer to the appropriate **Electrical System**SRM .
	Check operator presence sensor	Refer to the appropriate **Electrical System**SRM .
	Check fault codes	If fault code appears, go to Electrical System, General Maintenance and Diagnostic Data, Diagnostic Trouble Codes, Page 9030-03-6.
Park Brake engagement frequency too low	Check speed sensor	Refer to the appropriate **Electrical System**SRM .
	Check accelerator pedal	Refer to the appropriate **Electrical System**SRM .
	Check partial brake apply	Refer to Observed Symptoms, Motion Inhibited, Page 9035-30-7

SECTION 9050

HYDRAULIC SYSTEMS

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Group 10
Principles of Operation

Manual Hydraulic Main Control Valve

DESCRIPTION

The manual main control valve controls the lift, tilt, and auxiliary functions. The main control valve is installed to the right of the operator, below the floor plate.

The sections are held together with four through bolts and nuts. Each function of the main control valve is made as a separate section having a spool and valve body. Each valve body casting is the same. The control spools are different for each function. Other sections are added to the main control valve to control optional auxiliary functions.

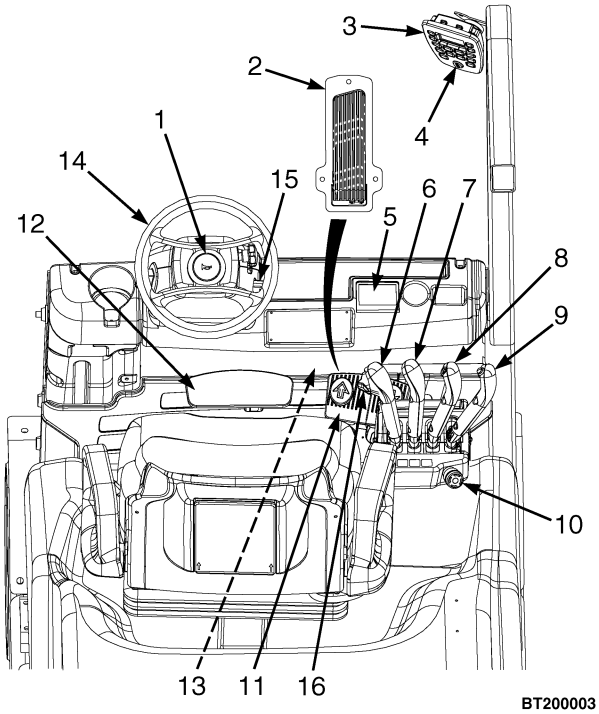
Each spool has a spring that returns the spool to the neutral position when the control lever is released. Each valve section has a check valve in the valve body. The check valve and spring is held in the valve body by the next section.

This section will cover the principles of operation for two different types of manual hydraulic control valves. The open center type valve and the closed center type valve. For the control valve used on J1.5-2.0XNT (J30-40XNT) (K160), J1.6-2.0XN (J30-40XN) (A935), and E1.6-2.0XN (E30-40XN) (A269) A1.3XNT, A1.5XNT (A25XNT, A30XNT) (D203) , see General Description (Open Center Valve). For the control valve used on E2.2-3.5XN (E45-70XN) (A268) and J2.2-3.5XN (J45-70XN) (A276) , see General Description (Closed Center Valve).

MANUAL HYDRAULIC CONTROL SYSTEM

The manual hydraulic control system controls all hydraulic functions, to include, lift/lower, tilt, and auxiliary functions. The system consists of the following components:See Figure 9050-10-1 for component location.

- Manual Hydraulic Control Valve
- Vehicle Master Controller
- Hydraulic Pump Motor Controller
- Dash Display
- Pump Motor and Fixed Displacement Gear Pump
- Operator's Seat and Armrest
- PC Based Service Software (ETACC)



1. HORN BUTTON
2. ACCELERATOR PEDAL
3. DISPLAY PANEL
4. KEY SWITCH AND KEYLESS SWITCH
5. LIGHT SWITCHES
6. LIFT/LOWER CONTROL LEVER
7. TILT CONTROL LEVER
8. CONTROL LEVER FOR AUXILIARY HYDRAULIC FUNCTIONS (3RD LEVER)
9. CONTROL LEVER FOR AUXILIARY HYDRAULIC FUNCTIONS (4TH LEVER)
10. EMERGENCY DISCONNECT SWITCH
11. DIRECTION CONTROL SWITCH
12. BRAKE PEDAL
13. AUTOMATIC PARKING BRAKE MANUAL OVERRIDE HANDLE (OPTIONAL)
14. STEERING WHEEL
15. STEERING COLUMN TILT MEMORY LEVER
16. MONOTROL® FOOT PEDAL CONTROL PEDAL

Figure 9050-10-1. Operator Station Components

The manual hydraulic main control valve incorporates an emergency (manual) lowering valve. This valve allows the operator or service technician to lower the lift truck's mast assembly if the electrical power to the lift truck is disrupted.

The vehicle master controller, manual control levers, and hydraulic pump motor controller communicate with each other via the CANbus communication system. The master controller controls the hydraulic pump motor and the control valve based upon the inputs received from the manual control levers. The master controller converts the operator's input into controlled oil flow by simultaneously commanding the hydraulic pump motor controller to deliver a specific motor speed, and by commanding the manual hydraulic valve to deliver specific valve metering. Pump speed is variable up to the maximum speed preset in the master controller for the required hydraulic function.

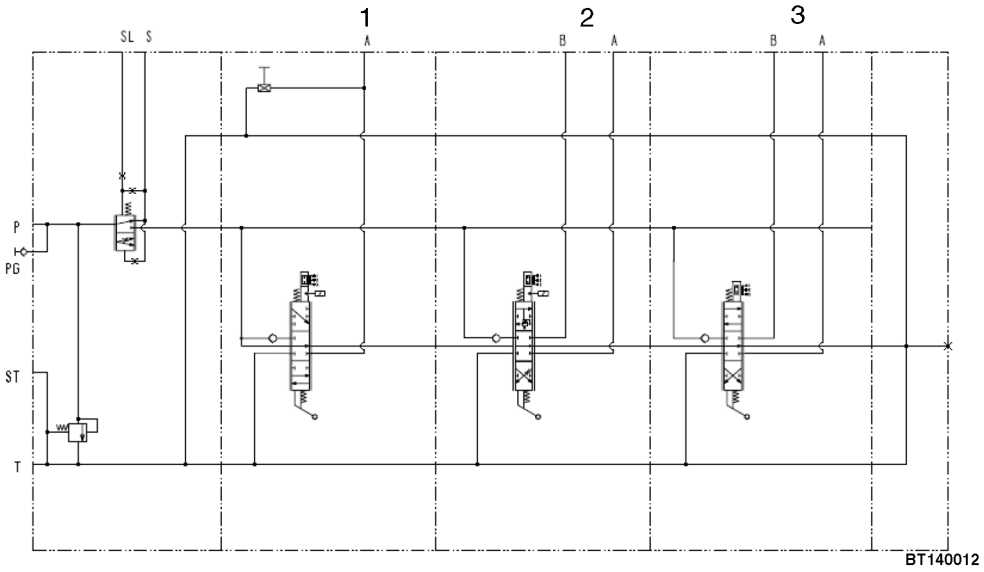
GENERAL DESCRIPTION (OPEN CENTER VALVE)

CONSTRUCTION

The valve assemblies for this application contain an inlet section, a lift section, a tilt section, an auxiliary section, and an outlet section. Some valve assemblies may include a dual (2nd) auxiliary section. All valves are assembled using tie rods and hex nuts. O-ring seals are placed between the various sections to prevent external fluid leakage between the sections.

VALVE TYPE

The valve assemblies are open-center type valve used in conjunction with a fixed displacement pump. A fixed displacement pump will provide a fixed amount of fluid with each revolution of the pump shaft. For example, if a 1 cubic inch per revolution pump is rotated at 1000 revolutions per minute, the pump output will be 1000 cubic inches per minute (1 cubic inch/rev x 1000 rev/min = 1000 cubic inches/min = 4.329 gal/min). In open center type valves, flow is passed through an open center core from the inlet port to the outlet port of the valve when all the spools are in the neutral (non-shifted) position. When a spool is shifted, flow is directed to the selected work port of the section and/or sections shifted. In open center systems fluid will follow the path of least resistance, meaning flow will be directed to the lowest load requirement when two or more valve spools are shifted. If flow is required by two or more sections at the same time, the operator generally must adjust the travel of each spool to get the desired flow rate from both work sections. See Figure 9050-10-2.



1. LIFT
2. TILT
3. AUXILIARY #1

Figure 9050-10-2. Basic Open Center Circuit

FEATURES AND OPERATION

INLET ASSEMBLY

Construction and Purpose

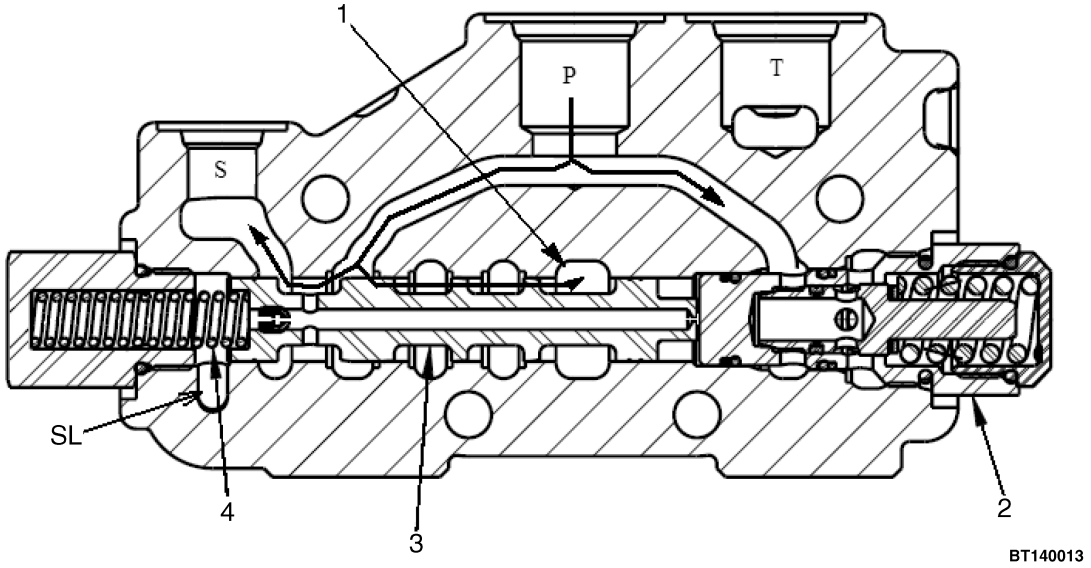
Inlet assemblies provide the majority of the port connections used to connect various lines of the hydraulic circuit to the valve. All inlet assemblies include a priority spool for the steering circuit and a main relief valve to protect the pump from over pressurization. The housing is grey iron, and the major internal components are made of various types of steel.

Porting

The inlet housing provides ports for the pump in (P), tank (T), steer supply (S), steer return (ST), steer load sense (SL), and pump pressure (PG).

Priority Steer

Pump flow is directed across the priority spool before supplying flow for any downstream demands. Therefore, the steering circuit has priority over any downstream flow demands. Priority steering is accomplished by using a normally open spring biased spool. Pump flow is directed across the priority spool to the steer port (S). If the steering control unit is not in use, there is no load sense signal communicated to the SL port from the steering control unit. The inlet pressure (PG) will increase just enough to overcome the priority spool's spring force. Since the inlet pressure is communicated to the blind end of the priority spool, via the drilled passages within the spool, the spool will shift towards the spring end and flow to the steering unit will decrease and pump flow will be directed across the priority spool into a downstream (open center) core. If there is a flow demand from the steering unit, the load sense signal coming from the steering control unit is communicated to the spring end of the spool via the SL port. This increase in pressure will cause the spool to shift towards the blind end and flow to the steer (S) port will increase to meet the demands of the steering control unit. The downstream core coming from the priority spool is directed to the open center core of the valve assembly. If none of the work section spools are shifted, total pump flow is directed through the valve assembly via the open center core, across the work section spools to the outlet (T) port. See Figure 9050-10-3.



1. OPEN CENTER CORE
2. RELIEF CARTRIDGE
3. PRIORITY STEER SPOOL
4. SPRING

Figure 9050-10-3. Cross-Sectional View of Inlet Assembly

Relief Cartridge

The primary function of a system relief valve is to prevent excessive system pressure. This valve assembly uses a direct acting relief cartridge and it is sized to pass total pump flow. The relief cartridge is in parallel with the pump inlet port. This design limits pressure to a predetermined level equal to the force generated by the relief spring. Inlet pressure is communicated through the relief body to the nose area of the poppet. When the force caused by pressure acting on the nose end of the poppet exceeds the force generated by the spring, the poppet will move towards the relief spring. Pump flow is then directed through the holes in the relief cartridge body and the poppet to the outlet side of the relief cartridge body. The outlet side of the cartridge is tied to the tank port (T) of the inlet assembly. If the pressure acting on the nose of the poppet decreases, the spring force will cause the poppet to move towards the nose end closing the outlet path. When actively relieving pressure, the inlet pressure (PG) will be slightly greater than the force generated by the relief spring.

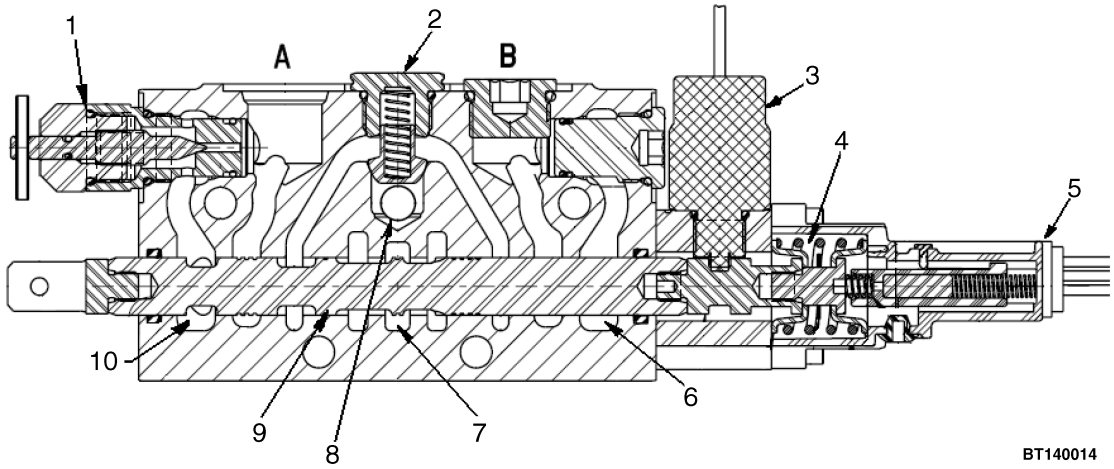
LIFT SECTION

Construction

The lift section major components include: the housing, a main spool, an operator presence solenoid (OPS), a spool position sensor, a load check valve assembly and a manual emergency lowering cartridge.

Purpose

The purpose of the lift section is to allow for extending and retracting of the vehicle's lift cylinder. The lift section uses a 3-way spool for raising and lowering the mast and incorporates an Operator Presence Solenoid (OPS) to help improve operator safety. SeeFigure 9050-10-4.



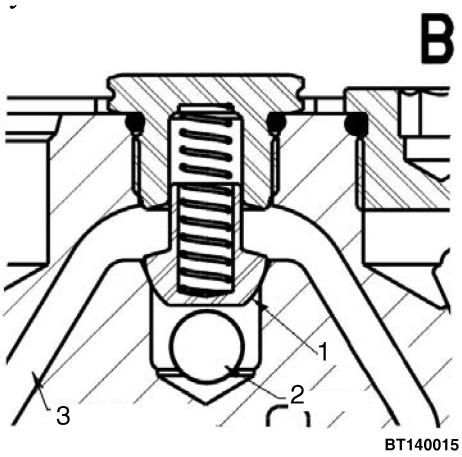
1. MAST LOWER CARTRIDGE
2. LOAD CHECK
3. OPERATOR PRESENCE SOLENOID
4. SPOOL POSITIONER
5. POSITION SENSOR
6. TANK CORE
7. OPEN CENTER CORE
8. POWER CORE
9. MAIN SPOOL
10. TANK CORE

Figure 9050-10-4. Cross-Section of Lift Section

When the spool is in neutral, flow passes through the open-center (OC) core and then to the next work section. If all the work section spools are in neutral, the flow will be directed to the tank (T) port in the inlet section. When the lift spool is shifted out of the housing, the open-center passage (OC) closes off, and flow is directed through power core at the inlet to the load check assembly into the high pressure bridge core. From the high pressure bridge core the flow is directed across metering notches of the spool, and out work port A to the lift cylinder and raises the mast. Shifting the spool into the housing from neutral connects work-port A to the tank core of the housing, thus allowing lowering of the mass. When lowering the mast, the open center core is open and directs flow to downstream functions. This allows other downstream functions to be used when lowering the mast.

Load Check

The load-check assembly prevents back flow from the work ports under heavy load conditions. If the load check assembly was absent, under a heavy load condition the load would lower or drift when the spool is actuated, until the pressure builds to a sufficient level to move the load. Some drifting may occasionally occur since the load check assembly is not a zero leak device. See Figure 9050-10-5.

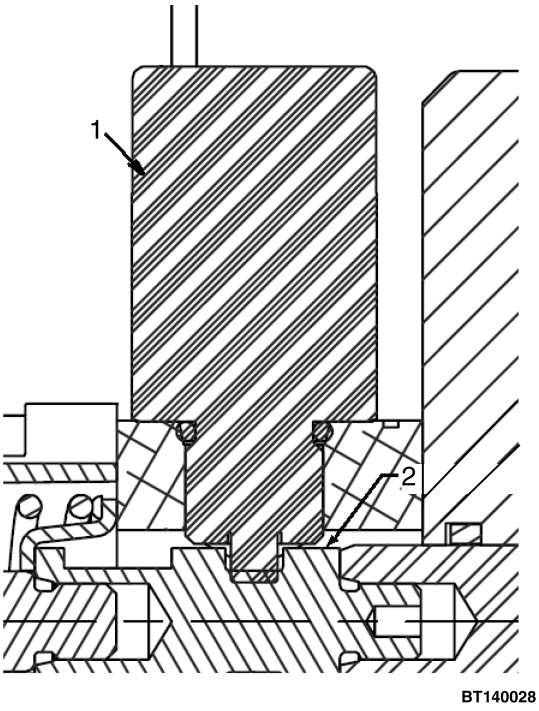


1. POPPET
2. POWER CORE
3. BRIDGE CORE

Figure 9050-10-5. Cross Section of Load Check Assembly

Operator Presence Solenoid

The Operator Presence Solenoid (OPS) has a spring loaded plunger which extends into an extension attached to the spool when de-energized. The plunger keeps the spool from moving when no electrical power is supplied to the solenoid's coil. When power is supplied to the coil, a force is generated which pulls the plunger upward and out of the spool extension. Once the plunger disengages, the spool can be moved out of its neutral position. See Figure 9050-10-6.

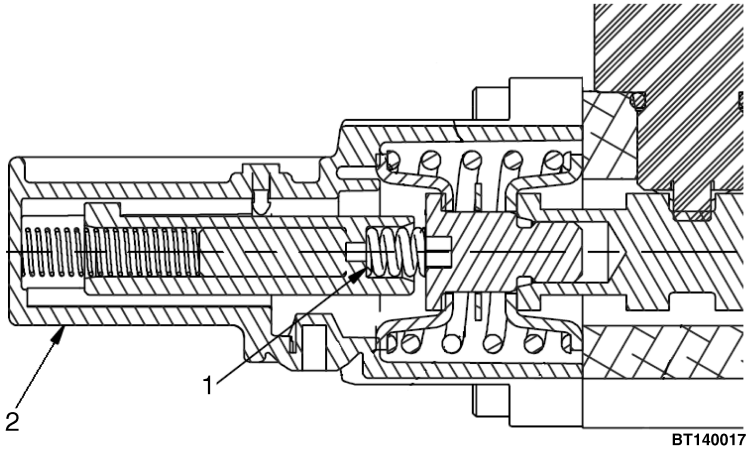


1. OPERATOR PRESENCE SOLENOID
2. SPOOL EXTENSION

Figure 9050-10-6. Cross-Section of Operator Presence Solenoid

Position Sensor Assembly

The position sensor monitors the travel of the valve spool and produces a variable output signal relative to how far the spool is from its neutral position. The vehicle's electronics supplies the sensor with a 5 volt dc signal. When the spool is in its' neutral position, the sensor output will be approximately 2.5 volts dc. As the spool is shifted from neutral, the sensor's output voltage will increase or decrease depending upon the direction of spool travel. The output signal from the sensor is used by the vehicle's electronic control system to vary the hydraulic pump flow. The intent is to meet predetermined function speed requirements. See Figure 9050-10-7.

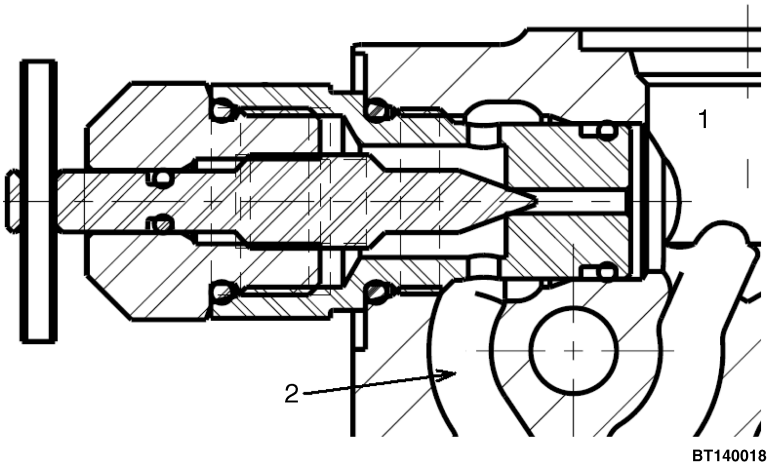


1. SPRING
2. POSITION SENSOR

Figure 9050-10-7. Cross-Section of Position Sensor

Mast Lowering Cartridge

The lift section housing incorporates a manual operated needle valve cartridge which allows the "A" work port to be directly connected to the tank core in the housing. When viewed from the lever end, turning the handle on the cartridge clockwise will shut the valve and turning it counter clockwise will open the valve. The cartridge is intended to be used only in emergency situations to lower the mast. See Figure 9050-10-8.



1. WORK PORT AREA
2. TANK CORE AREA

Figure 9050-10-8. Cross-Section of Manual Lower Valve Cartridge

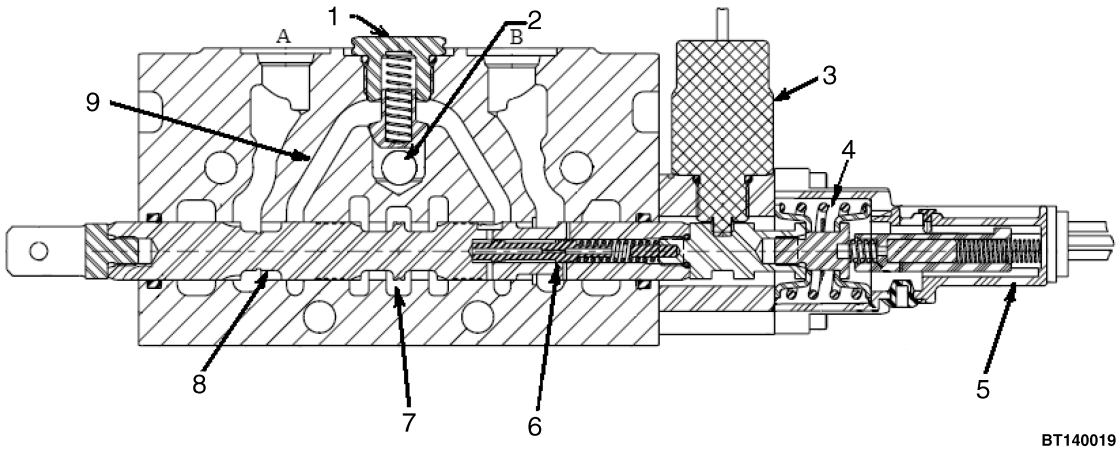
TILT SECTION

Construction

The tilt section major components include: the housing, a main spool, a tilt lock spool, an operator presence solenoid, a spool position sensor and a load check valve assembly.

Purpose

The purpose of the tilt section is to extend and retract the tilt cylinders, with an integrated “tilt-lock” shuttle spool which controls output flow when tilting the mast forward. The main function of the “tilt-lock” is that if the pump is not providing flow, the tilt cylinders will not extend. The tilt section uses a 4-way spool for tilting the mast forward and backward and incorporates an Operator Presence Solenoid (OPS) to help improve operator safety. See Figure 9050-10-9.



1. LOAD CHECK
2. POWER CORE
3. OPERATOR PRESENCE SYSTEM
4. SPOOL POSITIONER
5. POSITION SENSOR
6. TILT LOCK SHUTTLE SPOOL
7. OPEN CENTER CORE
8. MAIN SPOOL

Figure 9050-10-9. Cross-Section of Tilt Section

When the spool is in neutral, flow passes through the open-center (OC) core and then down stream to the next work section. If all the work section spools are in neutral, flow will be directed to the tank (T) port in the inlet section.

- **Tilt Backward** When the tilt spool is shifted out of the housing, the open-center (OC) core is closed off and flow is directed via the power core through the load check assembly, into the high pressure bridge core. From the high pressure bridge core the flow is directed out work port B to the rod end of the tilt cylinders. The flow from the base end of the tilt cylinders returns to the opposite work port (A), across metering notches in the main spool, and to the tank passage, thus tilting the mast backward.
- **Tilt Forward** During tilt forward operation, the internal “tilt-lock” shuttle spool helps to control unintended increases in forward tilt speed. When the tilt spool is shifted into the housing, the open-center (OC) core is closed off and flow is directed via the power core through the load check valve to the high pressure bridge core. The pressure is sensed at the base of the tilt-lock shuttle spool, sliding the shuttle spool open against the spring. From the high pressure bridge core the flow is directed out work port A to the base end of the tilt cylinders. Flow from the rod end of the tilt cylinders returns to the opposite work port (B), directed inside the main spool, and metered out through holes in the main spool to the tank core. If the pump is not providing flow, there is no pressure at the base end of the tilt-lock shuttle spool, and the shuttle spool will not move. Under this condition, if the main spool is shifted, the tilt-lock shuttle spool blocks off the internal passage of the spool, preventing flow from work port B to the tank core, therefore the mast will not tilt forward. Since these are not zero-leak devices, some cylinder drift may occur.

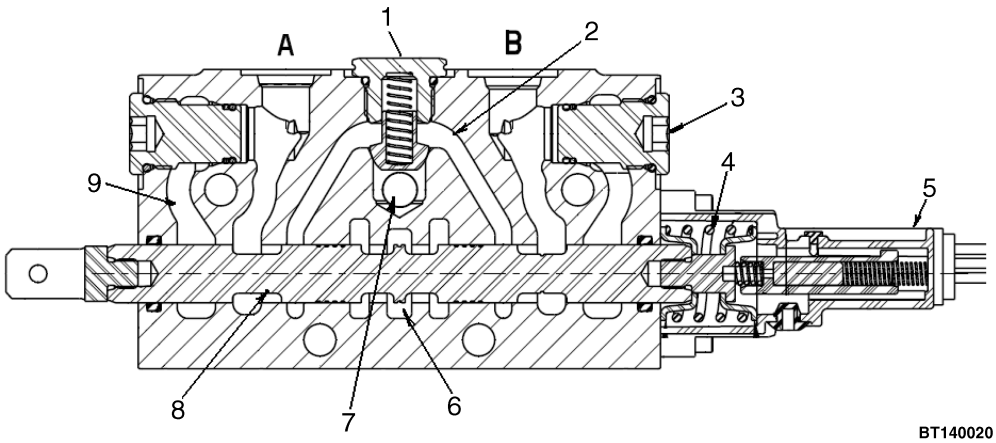
AUXILIARY AND DUAL AUXILIARY SECTION

Construction

Auxiliary and/or a dual auxiliary section major components include: the housing, a main spool, a spool position sensor, and a load check valve assembly. Some auxiliary sections may include a spool lock solenoid device which is the same as an operator presence solenoid assembly.

Purpose

The auxiliary section is used to control various attachments that can be installed on the vehicle. See Figure 9050-10-10.



1. LOAD CHECK
2. BRIDGE CORE
3. WORK PORT OPTION PLUG
4. SPOOL POSITIONER
5. POSITION SENSOR
6. OPEN CENTER CORE
7. POWER CORE
8. MAIN SPOOL

Figure 9050-10-10. Cross-Section Dual Auxiliary Section

When the spool is in neutral, flow passes through the open-center (OC) passage and downstream to the tank port of the valve.

When the spool is actuated in or out, the open-center (OC) flow path is blocked off and forces the flow through power core across the load check valve into the high pressure bridge core. From the high pressure bridge core, the oil is directed out the selected work port (3A or 3B for three-function valve, 3A, 3B, 4A, or 4B for four-function valve) to the auxiliary attachment. Oil returns from the auxiliary attachment to the opposite work port in that section and is directed to the tank passage.

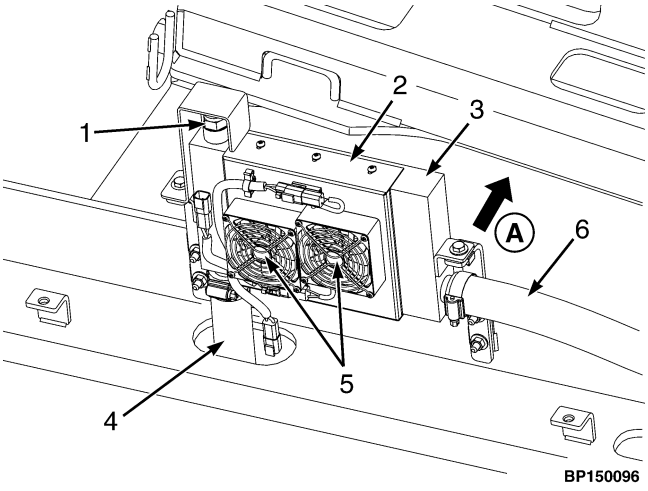
HYDRAULIC OIL COOLER

Construction and Purpose

The hydraulic oil cooler option consist of an oil cooler, hydraulic oil temperature switch, two 12 volts fans and shroud, and support bracketry. The purpose of the hydraulic oil cooler is to keep hydraulic oil temperature to the hydraulic tank no greater than 60°C (140°F).

Operation

The hydraulic oil cooler is in series with hydraulic supply circuit, between the filter assembly and main control valve. See Figure 9050-10-11. The cooling fans are triggered when the hydraulic oil temperature switch senses a hydraulic oil temperature of a 60°C (140°F).



A. DIRECTION OF AIR FLOW

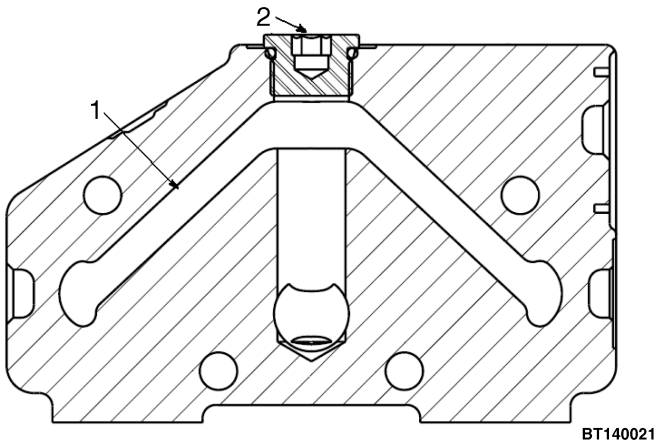
1. HYDRAULIC OIL TEMPERATURE SWITCH
2. SHROUD
3. HYDRAULIC OIL COOLER
4. RETURN HOSE- FROM MAIN CONTROL VALVE
5. FANS
6. RETURN HOSE - TO HYDRAULIC TANK

Figure 9050-10-11. Hydraulic Oil Cooler

OUTLET COVER SECTION

Construction and Purpose

The outlet cover connects the open-center to the exhaust core, and has an optional Tank port, which is plugged. The dual exhaust cores routed through the previous work-sections are joined together in the outlet. See Figure 9050-10-12.



1. TANK CORE
2. OPTIONAL TANK PORT

Figure 9050-10-12. Cross Section of Outlet Cover

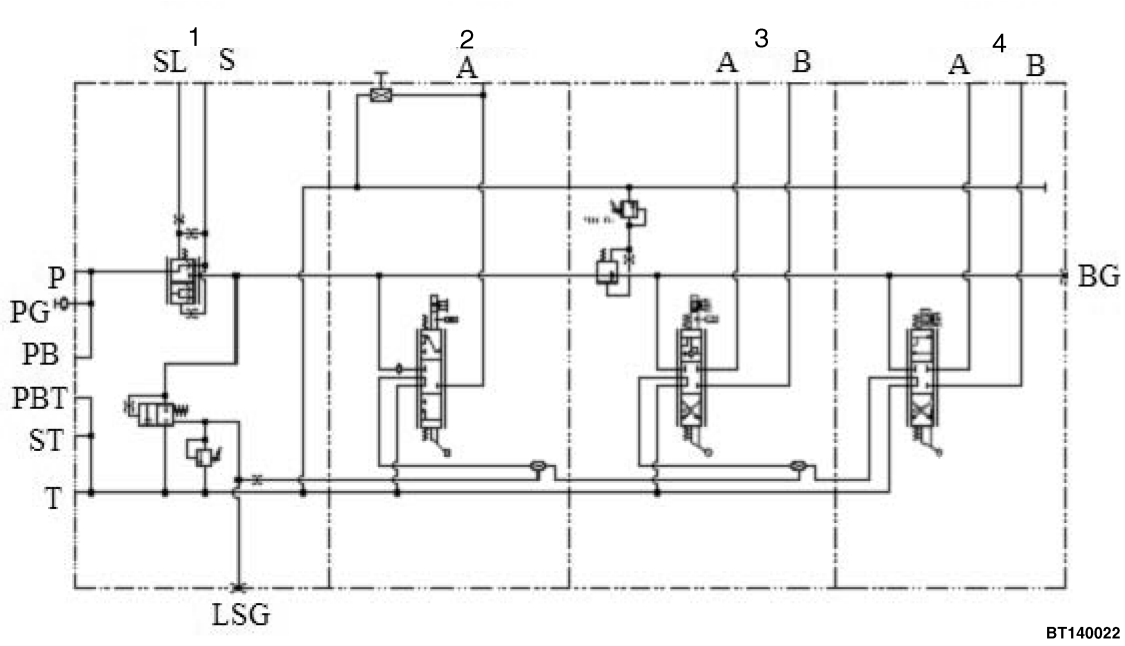
GENERAL DESCRIPTION (CLOSED CENTER VALVE)

CONSTRUCTION

Valve assemblies for this application are manually shifted. All valve assemblies include an inlet section, a lift section, a tilt section, and an auxiliary section. Some valve assemblies may include a second dual auxiliary section. All valves are assembled using tie rods and hex nuts. O-ring seals are placed between sections to prevent external fluid leakage.

VALVE TYPE

Valves supplied are closed center load sense type. The valves are used with a fixed displacement pump. A fixed displacement pump will provide a fixed (known) amount of fluid with each revolution of the pump shaft. For example, if a 1 cubic inch per revolution pump is rotated at 1000 revolutions per minute, the pump output will be 1000 cubic inches per minute (1 cubic inch/rev x 1000 rev/min = 1000 cubic inches/min = 4.329 gal/min). These load sense type valves (VAL) direct flow to a closed center passageway called a power core. Flow is blocked from going out the work ports when the main spools, located within the sections are in the neutral position. Shifting a spool directs flow to the selected work port. In these valves, internal passageways in conjunction with shuttle valves, direct the highest loads pressure signal (load sense pressure) back to an unloading spool located in the inlet. Using an unloading spool allows the use of a fixed displacement pump, but incorporates the advantages of a load sensing circuit (system pressure slightly above the load requirement and flow to match the loads' demand). If flow is simultaneously required by two or more work sections, the operator must adjust the travel of each spool to get the desired flow rate from each work section. See Figure 9050-10-13.



1. INLET
2. LIFT
3. TILT
4. AUXILIARY #1

Figure 9050-10-13. Load Sense Control Valve With Unloader and Priority Steering

FEATURES AND OPERATION

INLET ASSEMBLY

Construction and Purpose

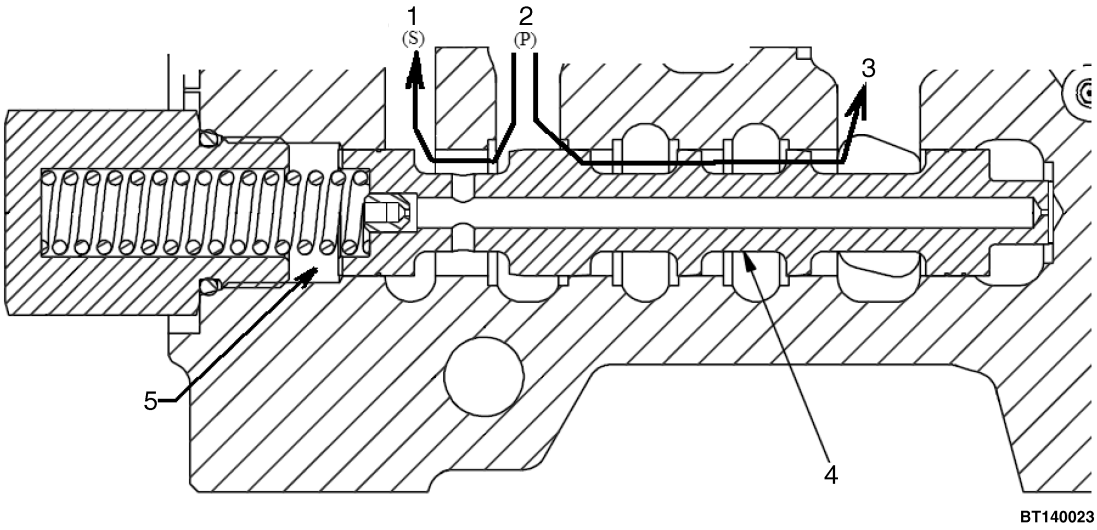
Inlet assemblies provide the majority of the porting connections to connect various lines of the hydraulic circuit. All inlet assemblies for this type of valve include a priority steering spool to control flow to the steer unit, a main relief valve to protect the pump from over pressurization, and an unloading spool to unload (dump to tank) any excess pump flow.

Porting

Port sizes vary based upon flow requirements and features within each inlet assembly. All inlets provide connections for: pump (P), tank (T), steer supply (S), steer return (ST), load sense signal coming from the steering control unit (SL), pump pressure (PG), load sense gage port (LSG) coming from the work section's shuttle circuit, and reduced pressure gage port (BG). If a hydraulic brake option is required, ports are provide for the brake supply (PB) and the brake return (PBT). Be aware that the PB port is exposed to full system pressure.

Priority Steer

Pump flow is directed across a priority spool before supplying flow to any downstream functions. The steering circuit flow demand has priority over any downstream flow requirements. Priority steering is accomplished by using a normally open spring biased spool. Pump flow is directed across the priority spool to the steer port (S). If the steering control unit is not in use, there is no load sense signal communicated to the SL port from the steering control unit. The inlet pressure (P) will increase to overcome the priority spring force. The inlet pressure is communicated to the blind end of the priority spool via the drilled passages within the spool, the spool will shift towards the spring end and flow will be directed across the spool to a downstream core leading to the unloading spool. If there is a flow demand at the steer (S) port, the load sense signal coming from the steering control unit is communicated to the spring end of the spool via the SL port. This increase in pressure will cause the spool to shift towards the blind end and flow to the steer (S) port will increase to meet the demands of the steering control unit. See Figure 9050-10-14.



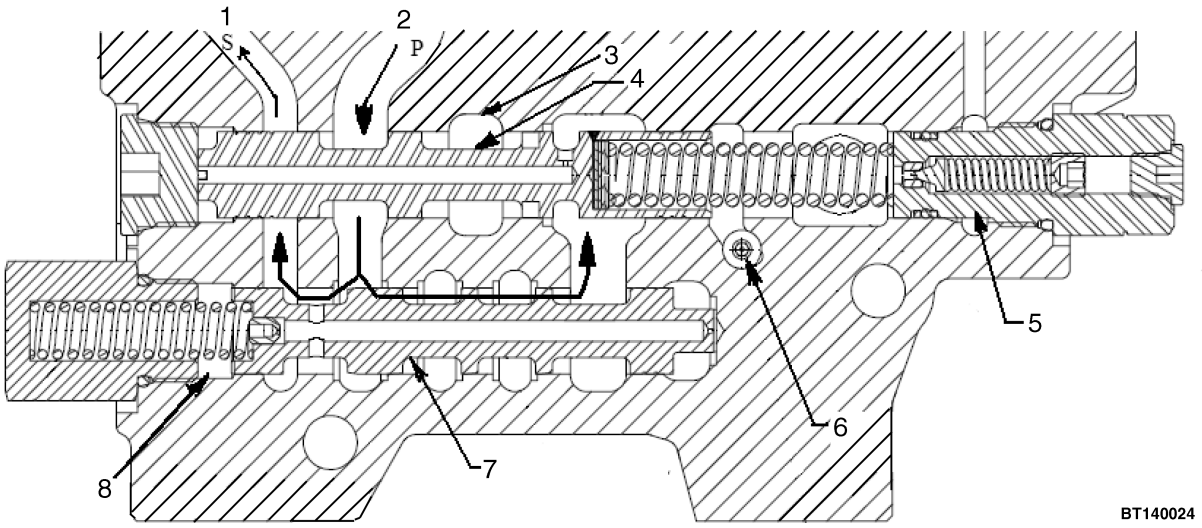
1. STEER UNIT OUTLET
2. PUMP INLET
3. UNLOADER SPOOL OUTLET
4. PRIORITY SPOOL
5. STEER LS PORT

Figure 9050-10-14. Cross-Section of Priority Steering Layout

If no work section spools are shifted, total pump flow is directed across an unloading spool to the outlet (T) port.

Unloading Spool and Relief Cartridge

The primary function of a relief cartridge is to prevent excessive system pressure. The relief cartridge works in conjunction with an unloading spool. The unloading spool directs excess flow (not required by any selected functions) back to tank (T). The advantage of this system is that a fixed (positive displacement) pump can be utilized. When there is no load from the steering control unit or the work sections, the pump will unload at a pressure which is only slightly higher than that required to overcome the forces generated by the priority spring and the unloading spring plus any pressure losses. See Figure 9050-10-15.



1. STEER UNIT OUTLET
2. PUMP INLET
3. TANK CORE AREA
4. UNLOADING SPOOL
5. LOAD SENSE RELIEF CARTRIDGE
6. LOAD SENSE ORIFICE
7. PRIORITY SPOOL
8. LS FROM STEER UNIT

Figure 9050-10-15. Cross-Section of Unloading Spool Layout

The flow from the downstream side of the priority spool is directed to the unloading spool and to the downstream work sections. Pressure at the P port side of the unloading spool is communicated to the blind end of the unloading spool via the internal pathway drilled within the spool. Pressure (PG) will rise until it overcomes the force generated by the unloading spring and the unloading spool will shift towards the spring end. Flow will then be directed across the unloading spool and into a core that connects to the tank (T) port of the inlet.

If a steering load demand is present in the priority spring chamber (LS area), the inlet pressure will rise. The priority spool will shift towards its blind end to meet the demand. If required, flow to the steer (S) port will increase and flow available to the core feeding the unloading spool will decrease. If no work section spools are shifted, the unloading spool will continue to unload any flow not required by the steering control unit to the tank (T) port.

When a downstream work function spool is shifted, internal passages (load sense shuttle circuit) of the valve assembly will communicate the pressure generated by the load at the work section port to the spring end of the unloading spool. Pump pressure will rise to meet the demand coming from the work section and the unloading spool will shift towards its blind end and restrict the amount of flow to the tank (T) port. If the pressure in the spring chamber of the unloading spool is high enough to overcome the force generated by the relief spring on the relief poppet, the poppet will open and limit the system pressure. The relief's spring chamber is vented to the tank (T) port via internal passages within the inlet housing. It should be noted that the load sense/unloading spool design does not limit the pressure in the steer control unit. The steer

control unit incorporates its own relief to control maximum pressure.

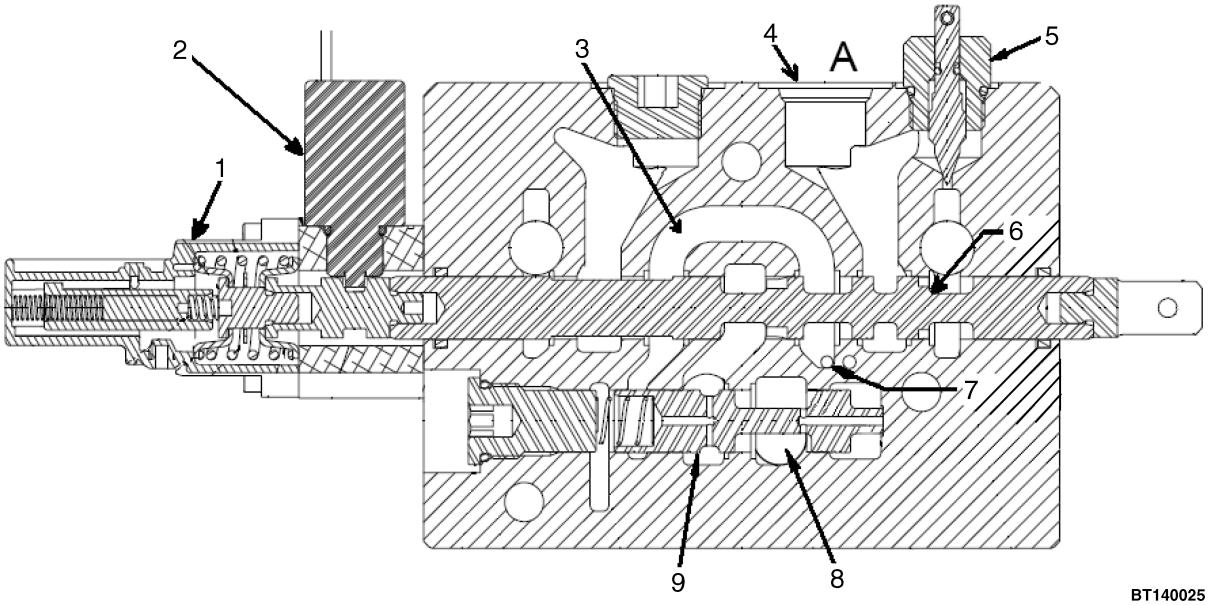
LIFT SECTION

Purpose

The purpose of the lift section housing is to allow for extending and retracting of vehicle's lift cylinder (mast).

Operation - Main Spool

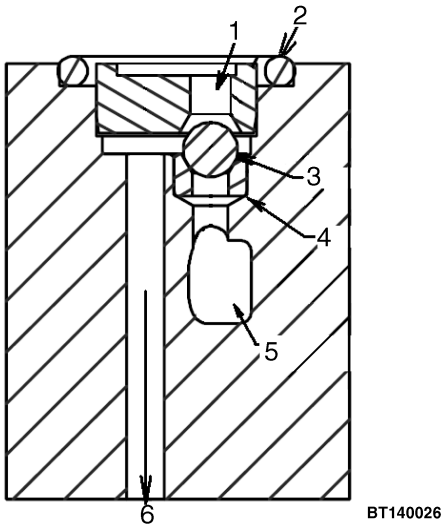
The lift section uses a 3-way spool for raising and lowering the mast. When all the spools of the valve assembly are in neutral (no flow requirement), pump flow comes into the inlet, travels across the priority spool and into the power core which directs flow to the various work sections. Since the power core is blocked (no spools shifted) at the last work section of the valve stack (thus called closed center type), flow is directed across the unloading spool, located in the inlet section to the tank (T) port. See Figure 9050-10-16.



1. POSITION SENSOR
2. OPERATOR PRESENCE SOLENOID
3. BRIDGE CORE
4. WORK PORT
5. MANUAL LOWERING VALVE
6. LIFT SPOOL
7. TO LS SHUTTLE
8. POWER CORE
9. LOAD CHECK SPOOL

Figure 9050-10-16. Cross-Section of Manual Lift Section

When the lift spool is shifted to raise the mast (spool moved outward of the housing), flow travels from the inlet via the power core, across the load check spool, across the lift spool, and out work port A. Passageways within the lift section communicate the loads' pressure back to the spring chamber of the unloading spool and the unloading spool shifts to meet the flow demand of the work section, any excess pump flow is unloaded to the tank (T) port. If more than one work section spool is shifted (downstream of lift function), a load sense shuttle circuit allows only the highest load pressure to be communicated to the unloading spool. This allows the pump pressure to raise enough to meet the highest load demand. The shuttle valve assembly is physically located within each work section on the mating face between the sections. See Figure 9050-10-17.

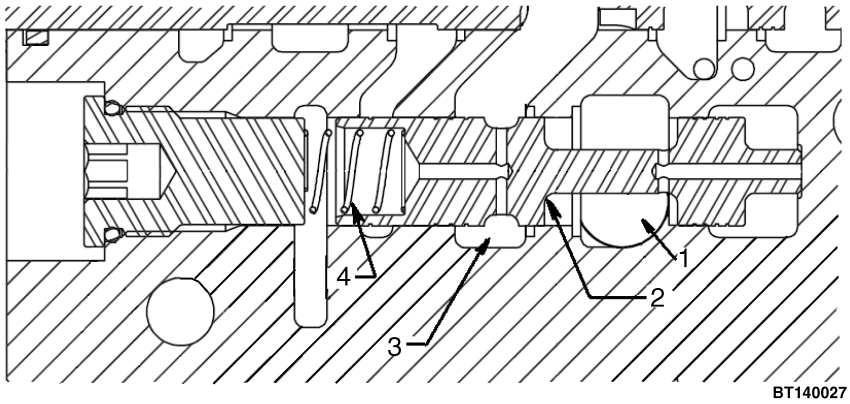


1. LS SIGNAL FROM DOWNSTREAM WORK SECTION
2. O-RING
3. SHUTTLE BALL
4. SEAT
5. FROM WORK CURRENT SECTION LS PICKUP
6. TO INLET UNLOADING SPOOL

Figure 9050-10-17. Cross-Section of Shuttle Valve Assembly

Load Check

When there is a flow demand at the work section (main spool is shifted), flow traveling through the power core will communicate the pressure within the power core to the blind end of the load check spool via holes drilled into the spool. Once the pressure is high enough to overcome the force caused by the spring at the other end of the spool, the spool will shift towards the spring end and flow will pass across the load check spool. Pressure within the downstream core (feeding the main spool) is communicated to the spring end of the spool via drilled holes within the load check spool. If the pressure on the downstream side of the load check spool increases too much, the load check spool will shift towards the blind end and flow across the check will be restricted. If pressure within the power core decreases, pressure at the blind end of the spool will decrease and the spring will try to close the check spool, thus flow across the spool will be restricted. It should be noted that the load check spool is not a zero leak device. It will not completely stop flow if a line were to break or if a leak develops between the work port and the cylinder. It will decrease the flow output to the work port, but it will not do anything to restrict the flow coming from the cylinder. The main purpose of the load check is to reduce the amount of cylinder drift when shifting the main spool from the raise to lower position. See Figure 9050-10-18.

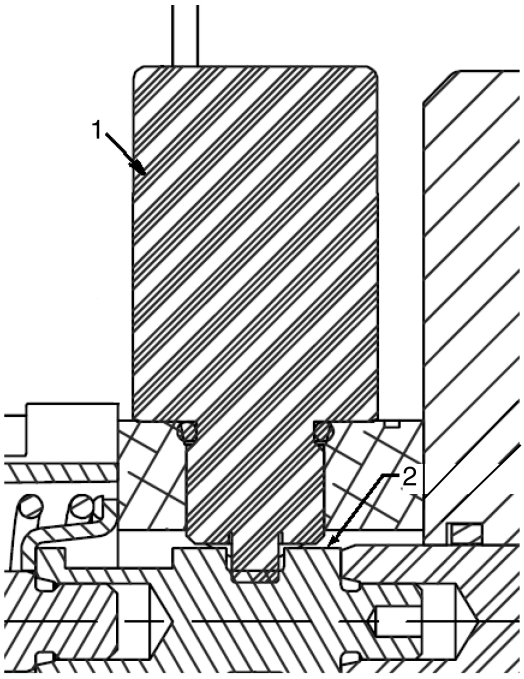


1. POWER CORE
2. LOAD CHECK SPOOL
3. DOWNSTREAM CORE
4. LOAD CHECK SPRING

Figure 9050-10-18. Cross-Section of Load Check Assembly

Operator Presence Solenoid

The Operator Presence Solenoid (OPS) has a spring loaded plunger which extends into an extension attached to the main spool. The plunger keeps the spool from moving when no electrical power is supplied to the solenoid's coil. When power is supplied to the coil, a force is generated which pulls the plunger upward and out of the spool extension. Once the plunger disengages, the spool can be moved out of its neutral position. See Figure 9050-10-19

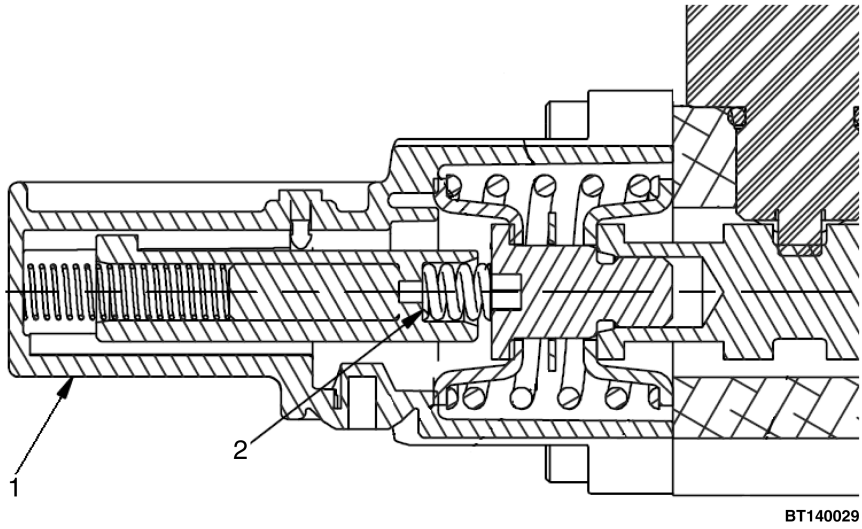


1. OPERATOR PRESENCE SOLENOID
2. SPOOL EXTENSION

Figure 9050-10-19. Cross-Section of Operator Presence Solenoid

Position Sensor

The position sensor monitors the position of the valve spool and produces a variable output signal relative to how far the spool has traveled from its neutral position. The vehicle's electronics supplies the sensor with a 5 volt DC signal. When the spool is in its neutral position, the sensor output will be approximately 2.5 volts DC. As the spool is shifted from neutral, the sensor's output voltage will increase or decrease depending upon the direction of spool travel. The output signal from the sensor is used by the vehicle's electronic control system to vary the hydraulic pump flow. The intent is to meet predetermined function speed requirements. See Figure 9050-10-20.



1. POSITION SENSOR
2. SPRING

Figure 9050-10-20. Cross-Section of Position Sensor Assembly

Mast Lowering Cartridge

The lift section housing incorporates a manual operated needle valve cartridge which allows the “A” work port to be directly connected to the tank core. When viewed from the hex end, turning the handle on the cartridge clockwise will shut the valve and turning it counter clockwise will open the valve. The cartridge is intended to be use only in an emergency situation to lower the mast. See Figure 9050-10-21.

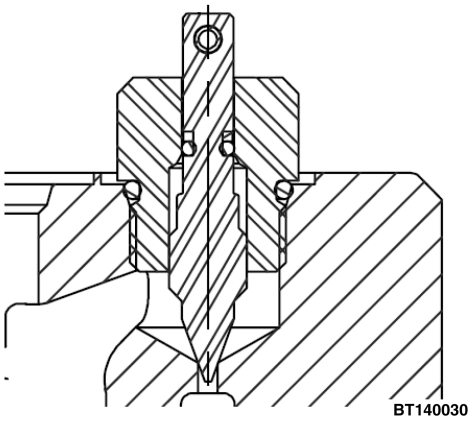


Figure 9050-10-21. Cross-Section of Manual Lowering Cartridge

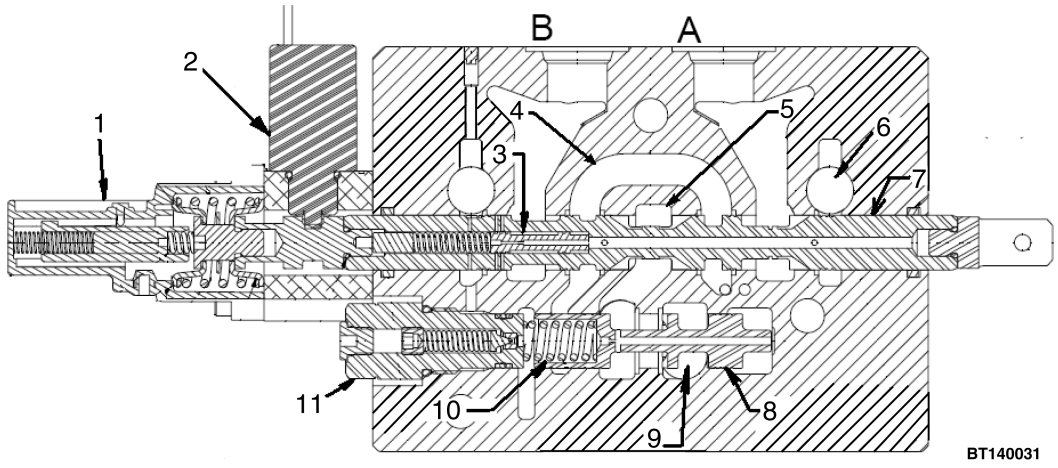
TILT SECTION

Construction and Purpose

The tilt section includes a pressure reducing valve assembly, a relief cartridge, a main spool assembly, an operator presence solenoid (OPS), a position sensor assembly, and a load sense shuttle assembly. The operator presence solenoid, the position sensor and the load sense shuttle assembly are the same as in the lift section and operate the same. The tilt section’s purpose is to allow for extending and retracting of vehicle’s tilt cylinders. The major difference in this section versus a lift section is that the load check assembly has an additional feature of a pressure reducing spool assembly and the addition of an internal “tilt-lock” shuttle spool located inside a 4-way main spool. The purpose of the pressure reducing assembly is to restrict the maximum pressure available to the tilt section and any downstream sections. The purpose of the load check feature is to prevent the forks from tilting forward before they are commanded to tilt back. The main spool’s purpose is to direct flow to the section’s work ports when the spool is shifted out of neutral. The purpose of the “tilt-lock” shuttle spool is to limit unanticipated forward tilting (runaway condition) of the mast when trying to tilt back. The tilt-lock shuttle spool also prevents forward tilt of the mast when the hydraulic pump is not running.

Operation

The pressure reducing/load check assembly consists of a spool and two springs. Flow enters the tilt section via the power core and is directed across the pressure reducing/load check spool. The pressure reducing/load check spool is held in the normally open position by the springs. Pressure downstream of the spool is communicated to both ends of the spool via the holes drilled into the pressure reducing/load check spool. Once the pressure on the blind end of the spool is high enough, it will override the force generated by the springs and the spool will shift towards the spring end, thus limiting the pressure on the downstream side of the spool to balance the force of the springs plus the pressure on the downstream side of the pressure reducing/load check spool feeding the main spool. The lighter spring is used to limit the load check pressure setting and the heavier spring is used to limit the reduced pressure setting. A relief cartridge (same as the load sense relief in the inlet assembly) is utilized to limit the maximum pressure on the downstream side of the pressure reducing spool. Since the flow in the power core is available to any sections downstream of the tilt section, pressure to sections downstream of the lift function will be limited to the setting of the relief cartridge located in the pressure reducing/load check assembly of the lift section. See Figure 9050-10-22.



1. POSITION SENSOR
2. OPERATOR PRESENCE SENSOR
3. TILT SPOOL
4. BRIDGE CORE
5. FEED CORE
6. TANK CORE
7. MAIN SPOOL
8. PRESSURE REDUCING LOAD CHECK SPOOL
9. POWER CORE
10. SPRING
11. RELIEF CARTRIDGE

Figure 9050-10-22. Cross-Section of Manual Tilt Section

Main Spool with Tilt-Lock

The section's main spool is shifted with manual input from the operator. The main spool is a 4 way type, meaning that flow is available to both the A and B work ports versus only the A port (3-way spool) in a lift section. Shifting the main spool out of the housing will pressurize work port B (tilt back) and shifting the main spool into the housing will pressurize work port A (forward tilt). The main spool assembly contains an internal "tilt-lock" spool which is active only in the tilt forward direction.

- Tilt Back

  Actuating the main spool to the tilt back position (B port pressurized) sends a load-sense signal to the unloading spool located in the inlet cover. The unloading spool in the inlet closes and flow is directed to the power core. Flow from the power core is directed across the pressure reducing/load check spool assembly and travels to the main spool via a feed core. Flow travels across the main spool into the bridge core and is directed out of work port B. This "meter-in" flow is out the B workport to the rod end of the cylinder and "meter-out" flow is from the base end of the cylinder to the A port. Return flow from the tilt cylinder(s) is routed through work port A across the main spool into the tank core of the housing. Flow in the tank core is directed through the valve sections back to the tank (T) port located in the inlet section.

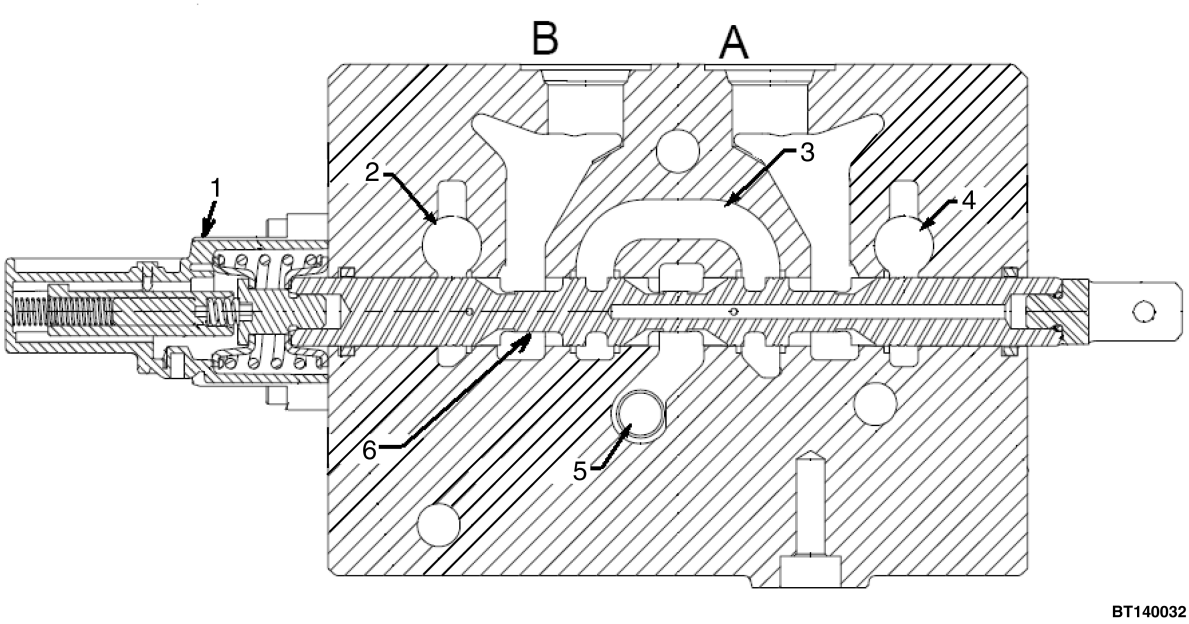
- Tilt Forward

  During tilt forward operation, the internal "tilt-lock" shuttle spool helps to control any unintended increase in forward tilt speed. When the tilt spool is shifted into the housing (A work port pressurized), the unloading spool in the inlet closes and flow becomes available to the work sections. Flow travels from the power core across the pressure reducing/load check spool into the main spool feed core. Flow travels across the main spool into the bridge core. Flow passes across the main spool and out the A work port. This flows into the base end of the cylinder is known as "meter-in" flow. Return flow from the tilt cylinder(s) is directed into the B work port. Return flow is known as "meter-out" flow. Pressure in the bridge core and the A work port is communicated through cross holes in the main spool to the blind end of the "tilt-lock" spool. The tilt spool shifts toward the spring end and flow in work port B is throttled across the tilt-lock spool into the tank core. If pressure seen at the blind end of the tilt-lock spool decreases enough, the spring will force the tilt-lock spool to shift towards the blind end and flow from work port B crossing the tilt-lock spool into the tank core will be restricted. This allows the tilt-lock spool to act like a counterbalance valve to keep the forks from running away from the meter-in supply. If the load causes the tilt to move forward too fast, the tilt-lock spool will lose the pilot signal from the meter-in supply on the opposing work port, therefore preventing movement or ultimately slowing the flow rate so the meter-in flow can maintain the proper pilot signal to the tilt-lock spool. If the pump is not providing flow, there is no pressure at the blind end of the tilt-lock spool, and the spool will not open to allow flow to the tank core. Therefore the tilt cylinder(s) should not move. Since the tilt-lock spool and the main spool are not zero-leak devices, some cylinder(s) drift may occur.

AUXILIARY AND DUAL AUXILIARY SECTIONS

Construction and Purpose

Auxiliary and dual auxiliary sections housings are constructed of grey iron and contain internal components made from various steels. The purpose of auxiliary sections is to provide flow to any auxiliary functions (attachments). When more than one auxiliary section is used, the upstream section is labeled as a dual auxiliary section. All valve assemblies contain an end (single) auxiliary section. Both types of auxiliary sections contain a 4-way main spool, a position sensor and a load sense shuttle valve. These components are the same as used on the lift and tilt sections and operate the same. Some auxiliary sections include an optional clamp lock feature. See Figure 9050-10-23.



1. POSITION SENSOR
2. TANK CORE
3. BRIDGE CORE
4. TANK CORE
5. FEED CORE
6. MAIN SPOOL

Figure 9050-10-23. Cross-Section of Auxiliary Section

Operation

Both the dual and end auxiliary sections operate the same. Input flow to all auxiliary sections are downstream of the feed core of the tilt section, therefore the maximum load pressure is limited to the setting of the relief cartridge used in conjunction with the pressure reducing/load check assembly located in the tilt section. Auxiliary sections do not contain a load check assembly. Main spools are 4-way type, shifting the spool out of the housing will pressurize work port B and shifting the spool into the housing will pressurize work port A. To regulate the output flow of a work port, the operator must position the spool until the desired flow rate is obtained. Shifting the spool out of neutral communicates a load sense signal via the internal shuttle circuit to the unloading spool in the inlet. The unloading spool will shift and direct flow to downstream functions when a load demand is present.

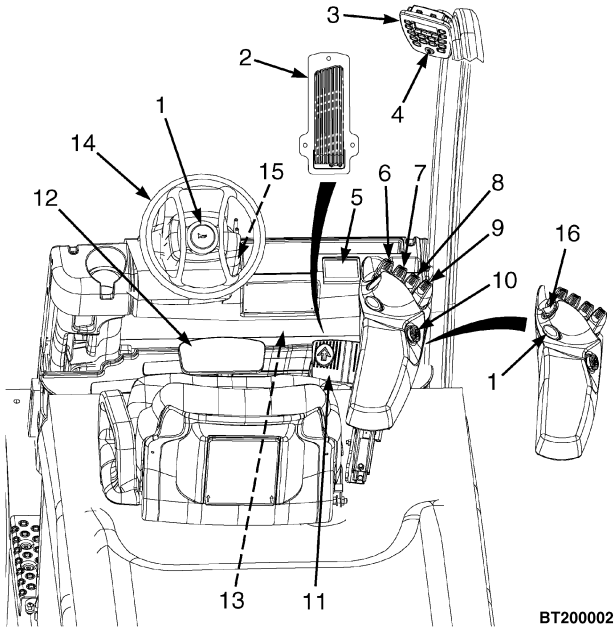
The optional clamp lock feature uses a solenoid and a plunger assembly to prevent spool movement. This feature is controlled by the vehicle's electronic controls. If there is no electric signal supplied to the coil, the plunger is forced, via an internal spring within the solenoid assembly, into a groove on the spool extension to prevent movement of the spool. The clamp lock solenoid assembly is the same part number as the operator presence solenoid used on other sections. The position sensor assembly is the same as used on other sections. End auxiliary sections contain an SAE plug (BG port) on the outside surface which connects to the power core. Pressure at this port would represent the pressure setting of the pressure reducing valve assembly located in the tilt section.

E-Hydraulic Main Control Valve

ELECTRO-HYDRAULIC CONTROL SYSTEM

The electro-hydraulic control system controls all hydraulic functions, to include, lift/lower, tilt, and auxiliary functions. The system consists of the following components:See Figure 9050-10-24 for component location.

- Electro-Hydraulic Control Valve
- Mini-Levers
- Vehicle Master Controller
- Hydraulic Pump Motor Controller
- Dash Display
- Pump Motor and Fixed Displacement Gear Pump
- Operator's Seat and Armrest
- PC Based Service Software



1. HORN BUTTON
2. ACCELERATOR PEDAL
3. DISPLAY PANEL
4. KEY SWITCH AND KEYLESS SWITCH
5. LIGHT SWITCHES
6. LIFT/LOWER CONTROL LEVER
7. TILT CONTROL LEVER
8. CONTROL LEVER FOR AUXILIARY HYDRAULIC FUNCTIONS (3RD LEVER)
9. CONTROL LEVER FOR AUXILIARY HYDRAULIC FUNCTIONS (4TH LEVER)
10. EMERGENCY DISCONNECT SWITCH
11. DIRECTION CONTROL SWITCH
12. BRAKE PEDAL
13. AUTOMATIC PARKING BRAKE MANUAL OVERRIDE HANDLE (OPTIONAL)
14. STEERING WHEEL
15. STEERING COLUMN TILT MEMORY LEVER
16. HYSTER MONOTROL® PEDAL PEDAL

Figure 9050-10-24. Operator Station Components

The electro-hydraulic main control valve controls the lift, tilt, and auxiliary functions. The electro-hydraulic control valve is installed to the right of the operator, below the floor plate. The electro-hydraulic main control valve incorporates an emergency (manual) lowering valve. This valve allows the operator or service technician to lower the lift truck's mast assembly if the electrical signal to the electro-hydraulic main control valve is disrupted.

The vehicle master controller, mini-levers, and hydraulic pump motor controller communicate with each other via the CANbus communication system. The master controller controls the hydraulic pump motor and the electro-hydraulic control valve based upon the inputs received from the mini levers. The master controller converts the operator's input into controlled oil flow by simultaneously commanding the hydraulic pump motor controller to deliver a specific motor speed, and by commanding the electro-hydraulic control valve to deliver specific valve metering. Pump speed is variable up to the maximum speed preset in the master controller for the required hydraulic function.

This section will cover the principles of operation for two different types of manual hydraulic control valves. The open center type valve and the closed center type valve. For the control valve used on J1.5-2.0XNT (J30-40XNT) (K160), J1.6-2.0XN (J30-40XN) (A935), and E1.6-2.0XN (E30-40XN) (A269) A1.3XNT, A1.5XNT (A25XNT, A30XNT) (D203) , see General Description (Open Center Valve). For the control valve used on E2.2-3.5XN (E45-70XN) (A268) and J2.2-3.5XN (J45-70XN) (A276) , see General Description (Closed Center Valve).

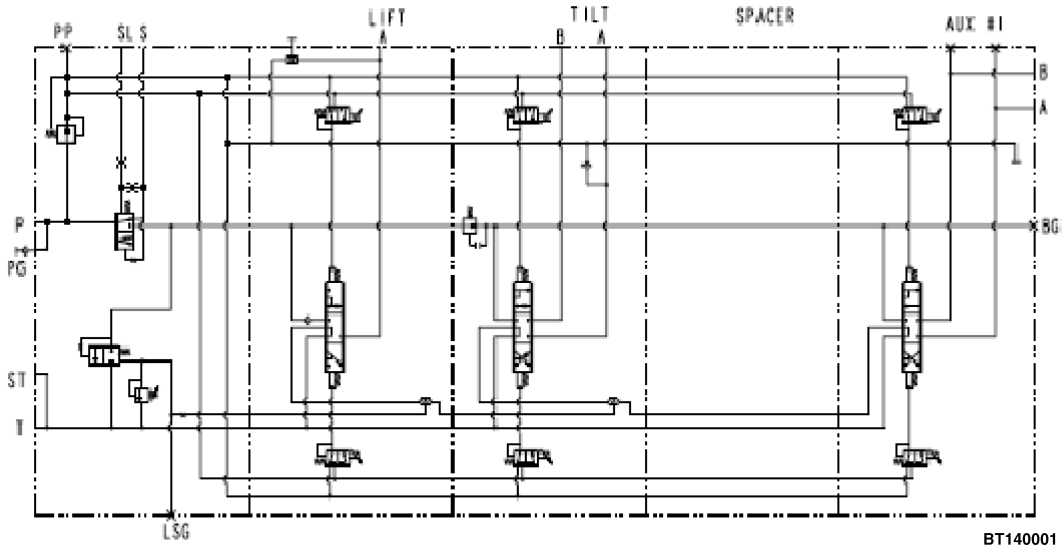
GENERAL VALVE DESCRIPTION

Construction

Valve assemblies are electro-hydraulically shifted. All valve assemblies include an inlet section, a lift section, a tilt section, and an auxiliary section. Some valve assemblies may include a second dual auxiliary section and/or a spacer section. All valves are assembled using tie rods and hex nuts. O-ring seals are placed between sections to prevent external fluid leakage.

Valve Type

Valves supplied are closed center load sense type. The valves can be used with a fixed displacement pump. A fixed displacement pump will provide a fixed (known) amount of fluid with each revolution of the pump shaft. For example, if a 1 cubic inch per revolution pump is rotated at 1000 revolutions per minute, the pump output will be 1000 cubic inches per minute (1 cubic inch/rev x 1000 rev/min = 1000 cubic inches/min = 4.329 gal/min). These load sense type valves (VAL) direct flow to a closed center passageway called a power core. Flow is blocked from going out the work ports when the main spools, located within the sections, are in the neutral position. Shifting a function’s spool is accomplished by applying an electrical signal to a solenoid located on either end of the section. Pilot pressure is supplied by the main pump, but at a reduced pressure. The pilot supply pressure is reduced through the use of a pressure reducing pilot cartridge located in the inlet. Shifting a spool directs flow to the selected work port. In these valves, internal passageways in conjunction with shuttle valves, direct the highest load’s pressure signal (load sense pressure) back to an unloading spool located in the inlet. Using an unloading spool allows the use of a fixed displacement pump, but incorporates the advantages of a load sensing circuit (system pressure slightly above the load requirement and flow to match the load's demand). If flow is simultaneously required by two or more work sections, the operator must adjust the travel of each spool to get the desired flow rate from each work section. See Figure 9050-10-25.



1. LIFT
2. TILT
3. SPACER
4. AUXILIARY 1

Figure 9050-10-25. Load Sense Control Valve With Unloader and Priority Steering

FEATURES AND OPERATION

Inlet Section

Construction and Purpose

Inlet section provides the majority of the porting connections to connect various lines of the hydraulic circuit. All inlet sections for this type of valve include a priority steering spool to control flow to the steer unit, a main relief valve to protect the pump from over pressurization, an unloading spool to unload (dump to tank) any excess pump flow and a pressure reducing pilot cartridge.

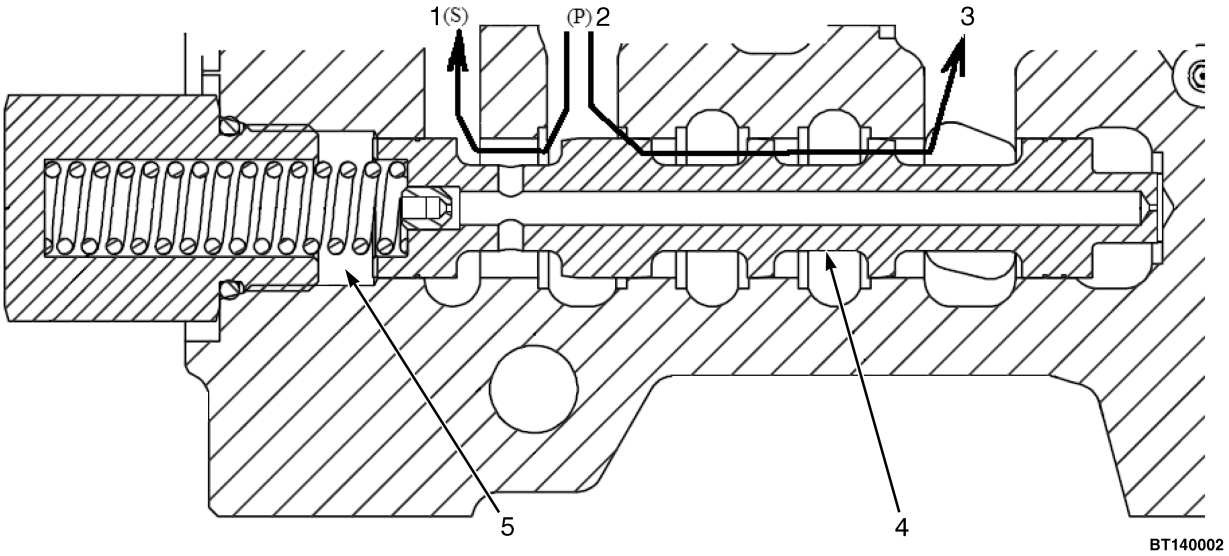
Porting

Port sizes vary based upon flow requirements and features within each inlet section. All inlets provide connections for: pump (P), tank (T), steer supply (S), steer return (ST), load sense signal coming from the steering control unit (SL), pump pressure (PG), load sense gage port (LSG) coming from the work section's shuttle circuit, reduced pressure gage port (BG) and pilot pressure (PP). If a hydraulic brake option is required, ports are provide for the brake supply (PB) and the brake return (PBT). Be aware that the PB port is exposed to full system pressure.

Priority Steer

Pump flow is directed across a priority spool before supplying flow to any downstream functions. The steering circuit flow demand has priority over any downstream flow requirements. Priority steering is accomplished by using a normally open spring biased spool. Pump flow is directed across the priority spool to the steer port (S). If the steering control unit is not in use, there is no load sense signal communicated to the SL port from the steering control unit. The inlet pressure (P) will increase to overcome the priority spring force. The inlet pressure is communicated to the blind end of the priority spool via the drilled passages within the spool, the spool will shift towards the spring end and flow will be directed across the spool to a downstream core leading to the unloading spool. If there is a flow demand at the steer (S) port, the load sense signal coming from the steering control unit is communicated to the spring end of the spool via the SL port. This increase in pressure will cause the spool to shift towards the blind end and flow to the steer (S) port will increase to meet the demands of the steering control unit. See Figure 9050-10-26.

If no work section spools are shifted, total pump flow is directed across an unloading spool to the outlet (T) port.



1. TO STEER UNIT
2. FROM PUMP
3. TO UNLOADER SPOOL
4. PRIORITY SPOOL
5. STEER LS PORT

Figure 9050-10-26. Cross Section of Priority Steering Layout

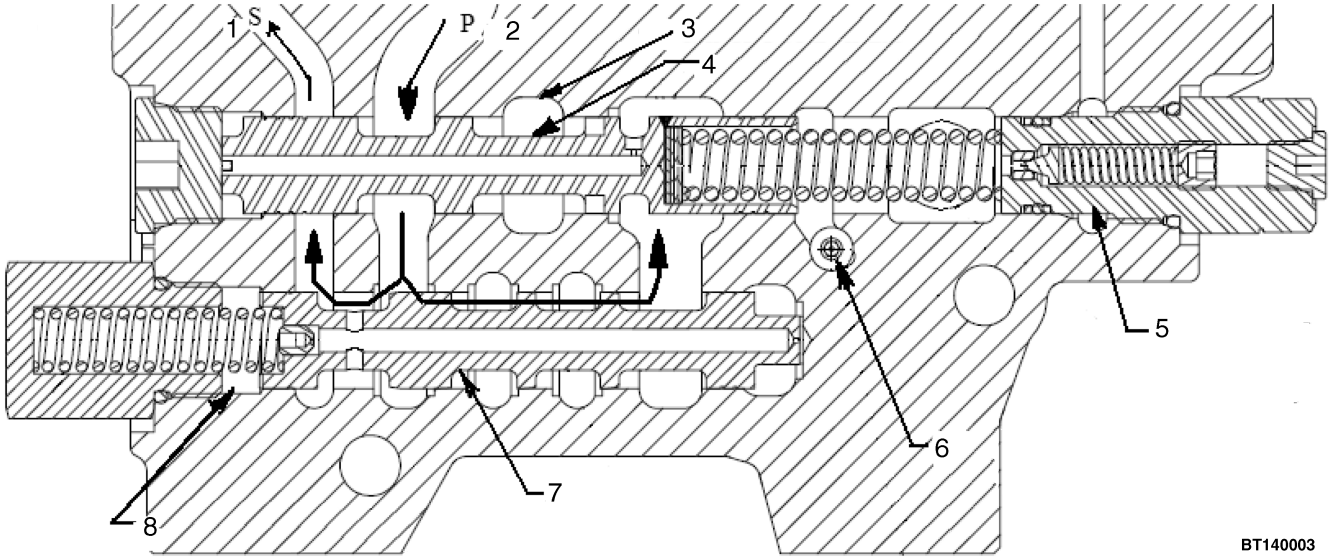
Unloading Spool and Relief Cartridge

The primary function of a relief cartridge is to prevent excessive system pressure. The relief cartridge works in conjunction with an unloading spool. The unloading spool directs excess flow (not required by any selected functions) back to tank (T). The advantage of this system is that a fixed (positive displacement) pump can be utilized. When there is no load from the steering control unit or the work sections, the pump will unload at a pressure which is only slightly higher than that required to overcome the forces generated by the priority spring and the unloading spring plus any pressure losses. See Figure 9050-10-27.

The flow from the downstream side of the priority spool is directed to the unloading spool and to the downstream work sections. Pressure at the (P) port side of the unloading spool is communicated to the blind end of the unloading spool via the internal pathway drilled within the spool. Pressure (PG) will rise until it overcomes the force generated by the unloading spring and the unloading spool will shift towards the spring end. Flow will then be directed across the unloading spool and into a core that connects to the tank (T) port of the inlet.

If a steering load demand is present in the priority spring chamber (LS area), the inlet pressure will rise. The priority spool will shift towards its blind end to meet the demand. If required, flow to the steer (S) port will increase and flow available to the core feeding the unloading spool will decrease. If no work section spools are shifted, the unloading spool will continue to unload any flow not required by the steering control unit to the tank (T) port.

When a downstream work function spool is shifted, internal passages (load sense shuttle circuit) of the valve assembly will communicate the pressure generated by the load at the work section port to the spring end of the unloading spool. Pump pressure will rise to meet the demand coming from the work section and the unloading spool will shift towards its blind end and restrict the amount of flow to the tank (T) port. If the pressure in the spring chamber of the unloading spool is high enough to overcome the force generated by the relief spring on the relief poppet, the poppet will open and limit the system pressure. The relief's spring chamber is vented to the tank (T) port via internal passages within the inlet housing. It should be noted that the load sense/unloading spool design does not limit the pressure in the steer control unit. The steer control unit incorporates its own relief to control maximum pressure.

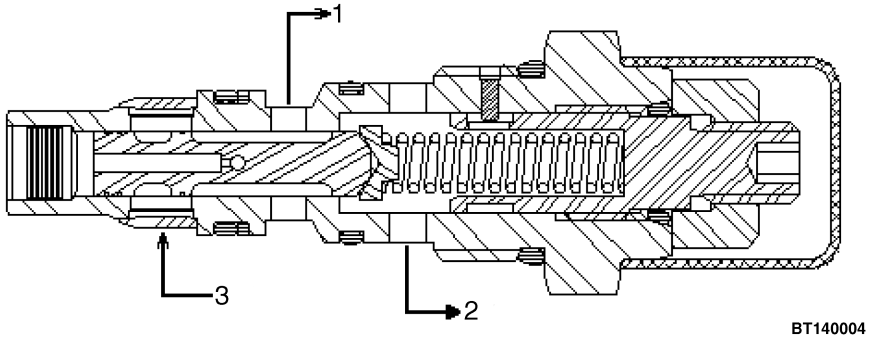


1. TO STEER UNIT
2. FROM PUMP
3. TANK CORE AREA
4. UNLOADING SPOOL
5. LOAD SENSE RELIEF CARTRIDGE
6. LOAD SENSE ORIFICE
7. PRIORITY SPOOL
8. FROM STEER UNIT

Figure 9050-10-27. Cross Section of Unloading Spool Layout

Pilot Cartridge

The pilot cartridge receives flow from the pump and maintains a constant reduced output pressure to feed the electro-hydraulic (EH) solenoids of the work sections. The supply pressure for the electro-hydraulic solenoids must be reduced because the solenoids will not withstand full system pressure. Flow enters the pilot cartridge at the IN passage and the OUT pressure is sensed at the blind end of the reducing spool through holes drilled into the spool. The pressure at the blind end of the spool will build to match the force generated by the spring. The spool will shift to the left or right to maintain a pressure equal to the force generated by the spring. The reducing spool is constantly modulating, and maintains the pilot pressure at the OUT passage based upon the spring force. Any leakage from the OUT side into the spring chamber is vented back to the tank side of the valve assembly. See Figure 9050-10-28.



1. OUT
2. TANK
3. IN

Figure 9050-10-28. Cross Section of Pilot Cartridge

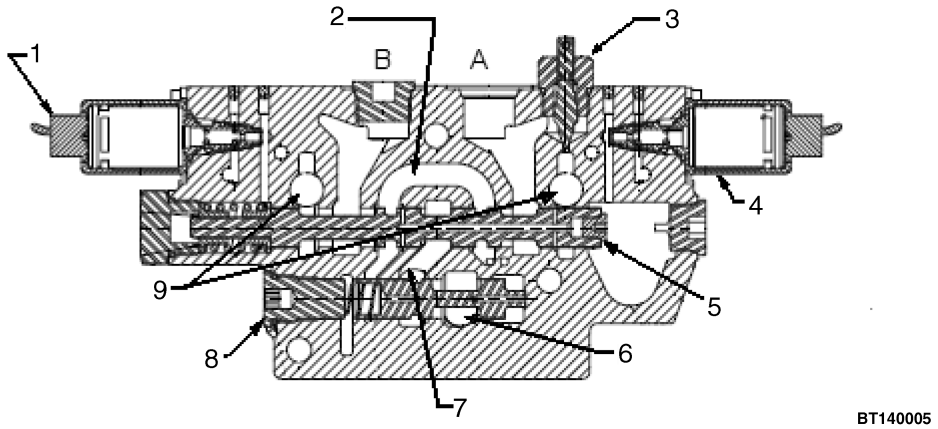
Lift Section

Construction and Purpose

The lift section's purpose is to allow for extending and retracting of vehicle's lift cylinder (mast).

Operation - Main Spool

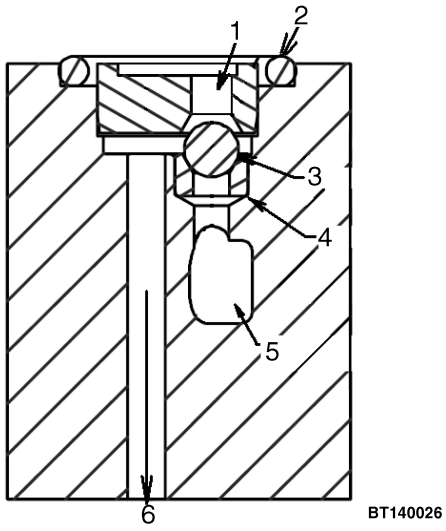
The lift section uses a 3-way spool for raising and lowering the mast. When all the spools of the valve assembly are in neutral (no flow requirement), pump flow comes into the inlet, travels across the priority spool and into the power core which directs flow to the various work sections. Since the power core is blocked (no spools shifted) at the last work section of the valve stack (thus called closed center type), flow is directed across the unloading spool, located in the inlet section to the tank (T) port. See Figure 9050-10-29.



1. EH SOLENOID
2. BRIDGE CORE
3. MAST LOWERING CARTRIDGE
4. EH SOLENOID
5. MAIN SPOOL
6. POWER CORE
7. FEED CORE
8. LOAD CHECK
9. TANK CORE

Figure 9050-10-29. Cross-Section of EH Lift Section

When the lift spool is shifted to raise the mast (solenoid on the A port side energized), flow travels from the inlet via the power core, across the load check spool, across the lift spool, and out workport A. Passageways within the lift section communicate the loads' pressure back to the spring chamber of the unloading spool and the unloading spool shifts to meet the flow demand of the work section, any excess pump flow is unloaded to the tank (T) port. If more than one work section spool is shifted (downstream of lift function), a load sense shuttle circuit allows only the highest load pressure to be communicated to the unloading spool. This allows the pump pressure to raise enough to meet the highest load demand. The shuttle valve assembly is physically located within each work section on the mating face between the sections. See Figure 9050-10-30.

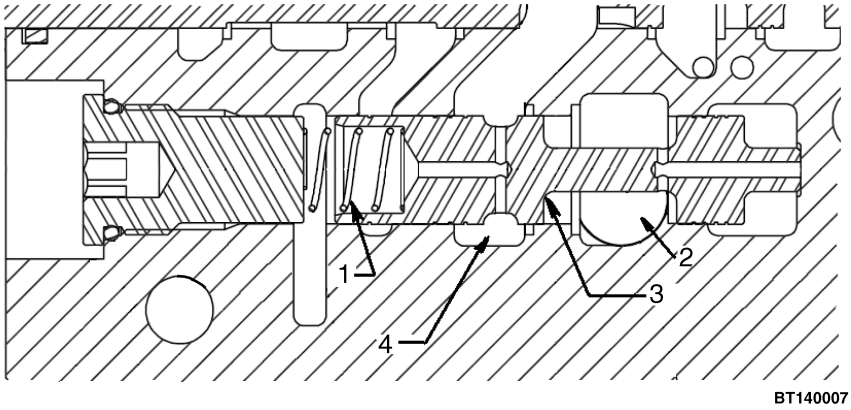


1. LS SIGNAL FROM WORK SECTION
2. O-RING
3. SHUTTLE BALL
4. SEAT
5. FROM WORK CURRENT SECTION LS PICKUP
6. TO INLET UNLOADING SPOOL

Figure 9050-10-30. Cross-Section View of Shuttle Valve Assembly

Load Check

When there is a flow demand at the work section (main spool shifted), flow traveling through the power core will communicate the pressure within the power core to the blind end of the load check spool via holes drilled into the spool. Once the pressure is high enough to overcome the force caused by the spring at the other end of the spool, the spool will shift towards the spring end and flow will pass across the load check spool. Pressure within the downstream core (feeding the main spool) is communicated to the spring end of the spool via drilled holes within the load check spool. If the pressure on the downstream side of the load check spool increases too much, the load check spool will shift towards the blind end and flow across the check will be restricted. If pressure within the power core decreases, pressure at the blind end of the spool will decrease and the spring will try to close the check spool, thus flow across the spool will be restricted. It should be noted that the load check spool is not a zero leak device. It will not completely stop flow if a line were to break or if a leak develops between the workport and the cylinder. It will decrease the flow output to the workport, but it will not do anything to restrict the flow coming from the cylinder. The main purpose of the load check is to reduce the amount of cylinder drift when shifting the main spool from the raise to lower position. See Figure 9050-10-31.



1. LOAD CHECK SPRING
2. POWER CORE
3. LOAD CHECK SPOOL
4. DOWNSTREAM CORE

Figure 9050-10-31. Cross-Section View Load Check Assembly

Mast Lowering Cartridge

The lift section housing incorporates a manually operated needle valve cartridge which allows the “A” workport to be directly connected to the tank core. When viewed from the hex end, turning the handle on the cartridge clockwise will shut the valve and turning it counter clockwise will open the valve. The cartridge is intended to be used only in an emergency situation to lower the mast. See Figure 9050-10-32.

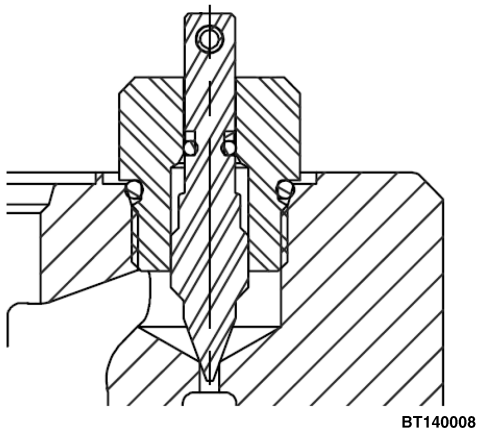
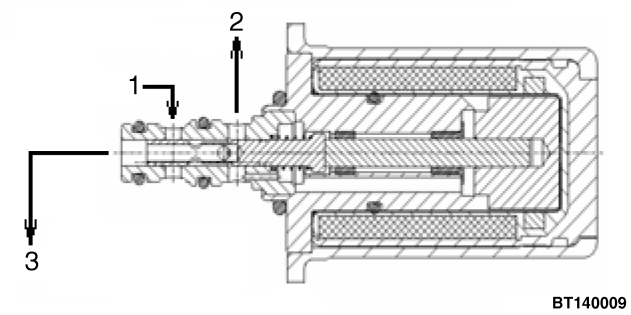


Figure 9050-10-32. Cross-Section View of Manual Lowering Cartridge

Electro-Hydraulic (EH) Solenoid

Reduced pressure flow coming from the pilot cartridge located in the inlet, is delivered to the inlet side of each electro-hydraulic (EH) solenoid via internal holes drilled into the work sections. When an electrical current is applied to the coil, a force is generated by the coil which moves the pin within the solenoid and in turn moves the spool in the solenoid assembly. As the spool moves away from the spring end of the assembly, flow is passed from the inlet side to the output side of the spool. When the force generated by the pressure acting on the spool area becomes equal to the force generated by the current acting on the pin of the solenoid, the spool will close and flow across the inlet to the outlet will stop. If the current applied to the solenoid coil is varied, the regulated output pressure will vary to maintain a force balance between the output pressure and the input current. In short, the output pressure is a function of input current.

The output pressure from the solenoid assembly is applied to the end of the main spool of the section being operated. Once the output pressure from the solenoid becomes great enough to overcome the force generated by the return spring and spool drag, the main spool will begin to shift. An increase in current at the solenoid will increase the regulated output pressure acting on the main spool and the spool will shift further. Due to metering notches located on the main spool, the flow across the main spool will increase with an increase in current applied to the solenoid. Therefore, the output flow of a work section is a function of input current to the solenoid. Thus the label of "proportional" is given to the section, since output varies as a function of input. See Figure 9050-10-33.



1. INLET
2. TANK
3. REGULATED OUTPUT PRESSURE

Figure 9050-10-33. Cross-Sectional View of Electro-Hydraulic (EH) Solenoid

Tilt Section

Construction and Purpose

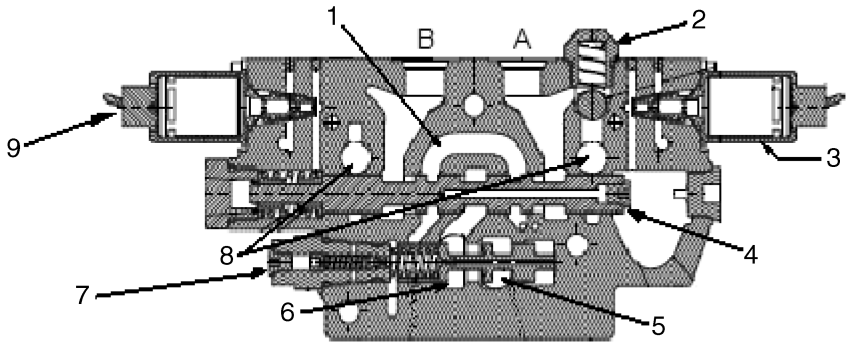
The tilt section includes a pressure reducing valve assembly, a relief cartridge, a main spool assembly, a load sense shuttle assembly, two electro-hydraulic solenoids and an anti-cavitation check. The tilt section's purpose is to allow for extending and retracting of vehicle's tilt cylinders. The major difference in this section versus a lift section is that the load check assembly has an additional feature of a pressure reducing spool assembly. The purpose of the pressure reducing assembly is to restrict the maximum pressure available to the tilt section and any downstream sections. The purpose of the load check feature is to prevent the forks from tilting forward before they are commanded to tilt back. The main spool's purpose is to direct flow to the section's workports when the spool is shifted out of neutral.

Operation

NOTE: 1-2 Ton valves do not include the relief cartridge, but they do contain the pressure reducing/load check spool. However the valve can be retrofitted with a relief cartridge kit when one may be required because of pressure limitations of auxiliary equipment.

The pressure reducing/load check assembly consists of a spool and two springs. Flow enters the tilt section via the power core and is directed across the pressure reducing/load check spool. The pressure reducing/load check spool is held in the normally open position by the springs. Pressure downstream of the spool is communicated to both ends of the spool via the holes drilled into the pressure reducing/load check spool. Once the pressure on the blind end of the spool is high enough, it will override the force generated by the springs and the spool will shift towards the spring end, thus limiting the pressure on the downstream side of the spool to balance the force of the springs plus the pressure on the downstream side of the pressure reducing/load check spool feeding the main spool. The lighter spring is used to produce the load check pressure and the heavier spring is used to regulate the reduced pressure setting. A relief cartridge (same as the load sense relief in the inlet assembly) is utilized to limit the maximum pressure on the downstream side of the pressure reducing spool. Since the flow into the offset power core is available to any sections downstream of the tilt section, pressure to sections downstream of the lift function will be limited to the setting of the relief cartridge located in the pressure reducing/load check assembly of the lift section. The anti-cavitation check, located next to the A work port

become active when the pressure within the work port is lower than the pressure in the tank core. This allows oil to pass from the tank core into the work port to keep air out of the lines and the tilt cylinder. See Figure 9050-10-34.



BT140010

1. BRIDGE CORE
2. ANTI CAVITY CHECK
3. EH SOLENOID
4. MAIN SPOOL
5. POWER CORE
6. FEED CORE
7. PRESSURE REDUCING LOAD CHECK
8. TANK CORE
9. EH SOLENOID

Figure 9050-10-34. Cross-Section of EH Tilt Section

Main Spool

The main spool is a 4-way type, meaning that flow is available to both the A and B work ports versus only the A port (3-way spool) in a lift section. Energizing the solenoid on the A work port side of the section shifts the spool to power workport A. Energizing the solenoid on the B work port side of the section shifts the spool to power work port B.

- Tilt Back

  Actuating the main spool to the tilt back position (B port pressurized) sends a load-sense signal to the unloading spool located in the inlet cover. The unloading spool in the inlet closes and flow is directed to the power core. Flow from the power core is directed across the pressure reducing/load check spool assembly and travels to the main spool via a feed core. Flow travels across the main spool into the bridge core and is directed out of work port B. Return flow from the tilt cylinder(s) is routed through work port A across the main spool into the tank core of the housing. Flow in the tank core is directed through the valve sections back to the tank (T) port located in the inlet section.

- Tilt Forward

  When the tilt spool is shifted to pressurize work port A, the unloading spool in the inlet closes and flow becomes available to the work sections. Flow travels from the power core across the pressure reducing/load check spool into the main spool feed core. Flow travels across the main spool into the bridge core. Flow passes across the main spool and out the A work port. Return flow from the tilt cylinder(s) is directed into the B work port.

Spacer Sections

Construction and Purpose

Spacer sections are used in certain valve stacks to increase the length of the valve stack to overcome mechanical structure interference on certain vehicle models. They contain drilled passageways to allow oil to pass to the next work section. The only components they contain are common plugs and section seals.

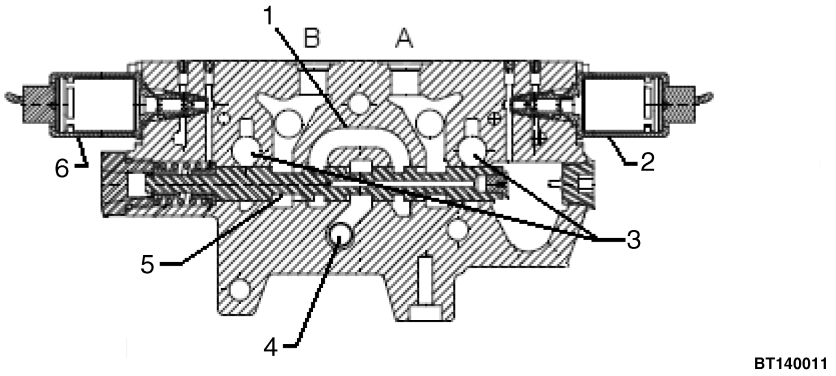
Auxiliary and Dual Auxiliary Sections

Construction and Purpose

Auxiliary and dual auxiliary sections housings are constructed of grey iron and contain internal components made from various steels. The purpose of auxiliary sections is to provide flow to any auxiliary functions (attachments). When more than one auxiliary section is used, the upstream section is labeled as a dual auxiliary section. All valve assemblies contain an end (single) auxiliary section. Both types of auxiliary sections contain a 4-way main spool, two electro-hydraulic solenoids to shift the main spool, and a load sense shuttle valve. These components are the same as used on the lift and tilt sections and operate the same. See Figure 9050-10-35.

Operation

Both the dual and end auxiliary sections operate the same. Input flow to all auxiliary sections are downstream of the feed core of the tilt section, therefore the maximum load pressure is limited to the setting of the relief cartridge used in conjunction with the pressure reducing/load check assembly located in the tilt section. Auxiliary sections do not contain a load check assembly. Main spools are 4-way type, energizing solenoid A will power the A work port. Energizing solenoid B will provide power the B work port. To regulate the output flow of a work port, the operator must position the spool until the desired flow rate is obtained. Shifting the spool out of neutral communicates a load sense signal via the internal shuttle circuit to the unloading spool in the inlet. The unloading spool will shift and direct flow to downstream functions when a load demand is present. End auxiliary sections contain an SAE plug (BG port) on the outside surface which connects to the power core. Pressure at this port would represent the pressure setting of the pressure reducing valve assembly located in the tilt section.



1. BRIDGE CORE
2. EH SOLENOID
3. TANK CORE
4. FEED CORE
5. MAIN SPOOL
6. EH SOLENOID

Figure 9050-10-35. Cross-Section of EH Auxiliary Section

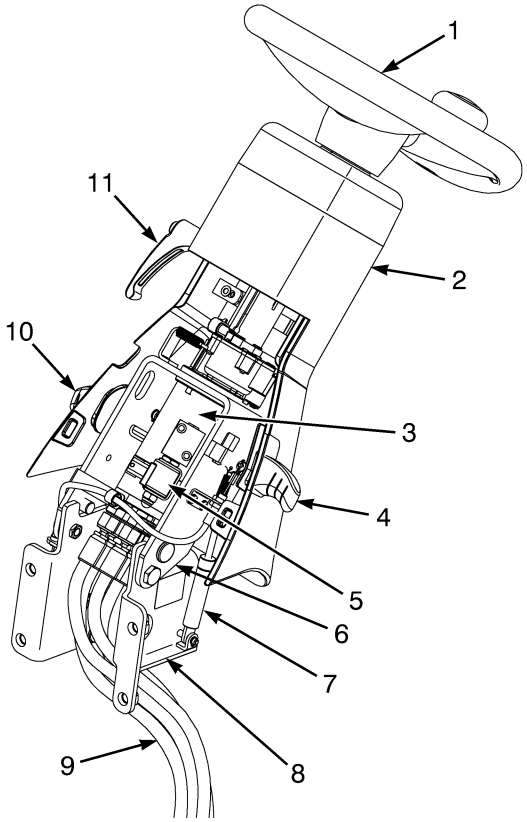
Steering System

DESCRIPTION

The steering column assembly uses a steering control unit with hose connections on the bottom of the unit to connect hydraulic hoses to the main control valve and the steering cylinder. The steering housing has mounts for the steering column and the steering control unit. The steering wheel is installed on the steering column. See Figure 9050-10-36. The housing is adjustable and is held in position by a latch. The position of the housing can be tilted up or down for operator comfort. If the lift truck is equipped with the telescopic option; the steering wheel may also be moved toward or away from the operator.

The steering system is a hydraulic system that does not have a mechanical connection between the steering wheel and the steering axle. The control of the steering is through a hydraulic circuit. See Priority Steer (E-Hydraulic Control Valve), Priority Steer (Manual Hydraulics Open Center Control Valve), or Priority Steer (Manual Hydraulics Closed Center Control Valve) as applicable for your lift truck.

If the hydraulic pump for the steering system does not operate, steering is still possible. A check valve permits the steering control unit to control the steering cylinder. The lift truck is difficult to steer when the steering pump is not operating, but the steering control unit can operate the steering cylinder and make steering possible.



1. STEERING WHEEL
2. STEERING COLUMN
3. STEERING CONTROL UNIT
4. TILT MEMORY LEVER
5. STEERING DIRECTION SENSOR
6. TILT BASE
7. STEERING COLUMN TILT CYLINDER
8. MOUNTING BASE
9. HYDRAULIC HOSES
10. TELESCOPIC COLUMN ADJUSTING LEVER
11. TELESCOPIC COLUMN LOCKING HANDLE

Figure 9050-10-36. Steering Housing Assembly

Accumulator, Piston

The steering accumulator consists of a cylinder assembly, piston assembly, and two end-caps assemblies. The cylinder assembly houses a piston assembly, and incorporates provisions for securing the end-caps. An accumulator contains a free-floating piston with liquid on one side of the piston and pre-charged nitrogen on the other side. An increase of liquid volume decreases the gas volume and increases gas pressure, which provides a work potential when the liquid is allowed to discharge.

When the steering wheel is held at relief and a hydraulic function is “suddenly” actuated to a pressure higher than steering relief (eg., system relief) the following happens:

- There is a pressure spike in the LS line which causes the priority spool to shift momentarily.
- When the priority spool shifts it momentarily opens path for working hydraulic pressure to steering P line.
- The accumulator absorbs the pressure that comes from the momentary shift of the priority spool.

The steering supply incorporates a back flow check valve. This valve is the straight adapter in the main control valve.

The accumulator in the steering control unit supply circuit is designed to cushion any impulses that are generated within the hydraulic steering system.

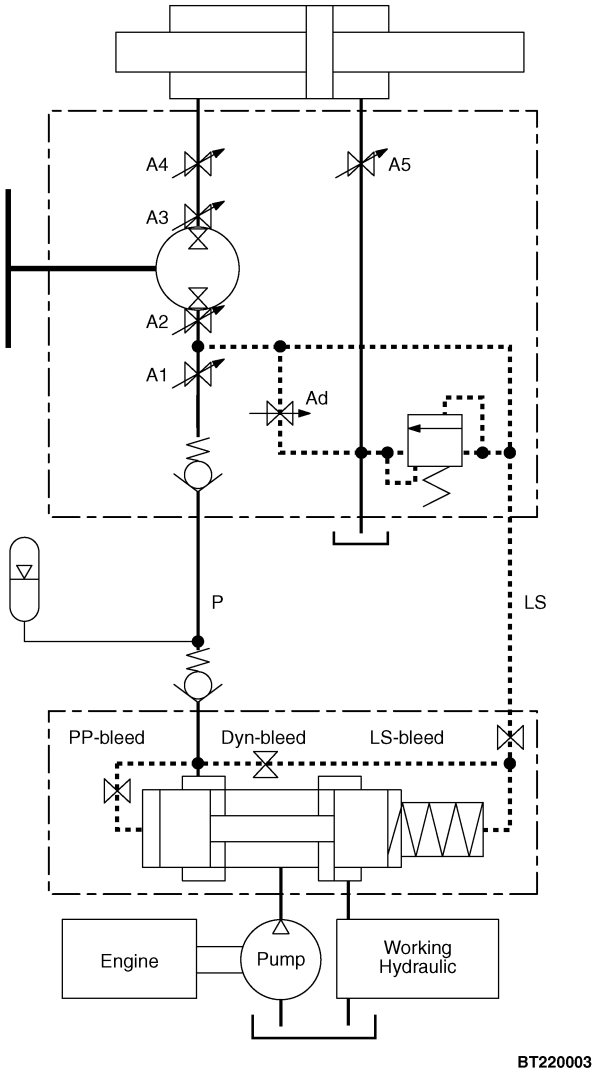
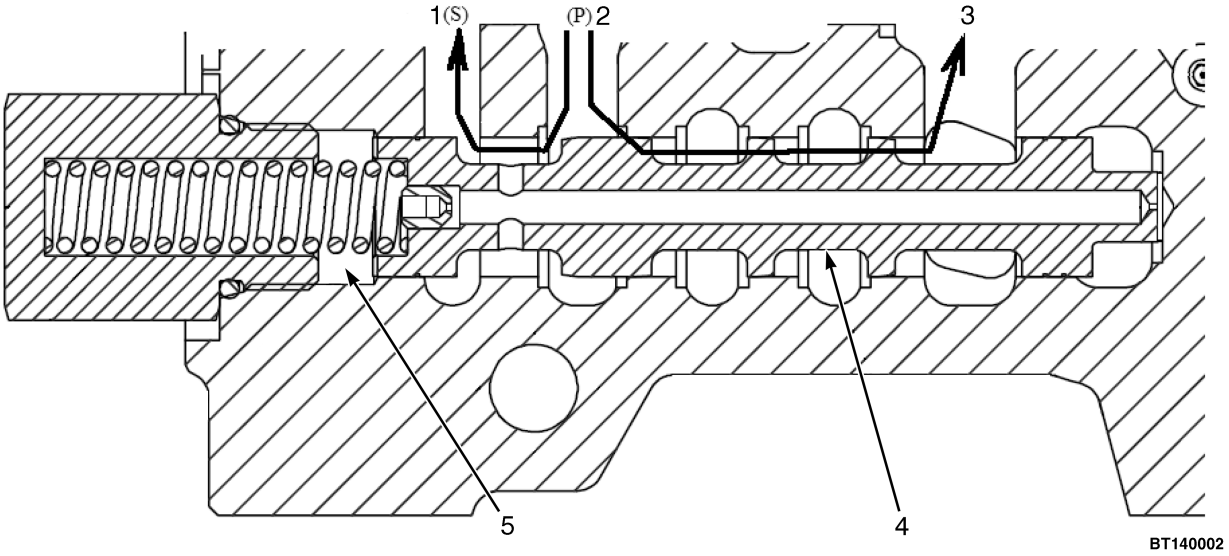


Figure 9050-10-37. Steering Accumulator Schematic

Priority Steer (E-Hydraulic Control Valve)

Pump flow is directed across a priority spool before supplying flow to any downstream functions. The steering circuit flow demand has priority over any downstream flow requirements. Priority steering is accomplished by using a normally open spring biased spool. Pump flow is directed across the priority spool to the steer port (S). If the steering control unit is not in use, there is no load sense signal communicated to the SL port from the steering control unit. The inlet pressure (P) will increase to overcome the priority spring force. The inlet pressure is communicated to the blind end of the priority spool via the drilled passages within the spool, the spool will shift towards the spring end and flow will be directed across the spool to a downstream core leading to the unloading spool. If there is a flow demand at the steer (S) port, the load sense signal coming from the steering control unit is communicated to the spring end of the spool via the SL port. This increase in pressure will cause the spool to shift towards the blind end and flow to the steer (S) port will increase to meet the demands of the steering control unit. See Figure 9050-10-38.

If no work section spools are shifted, total pump flow is directed across an unloading spool to the outlet (T) port.

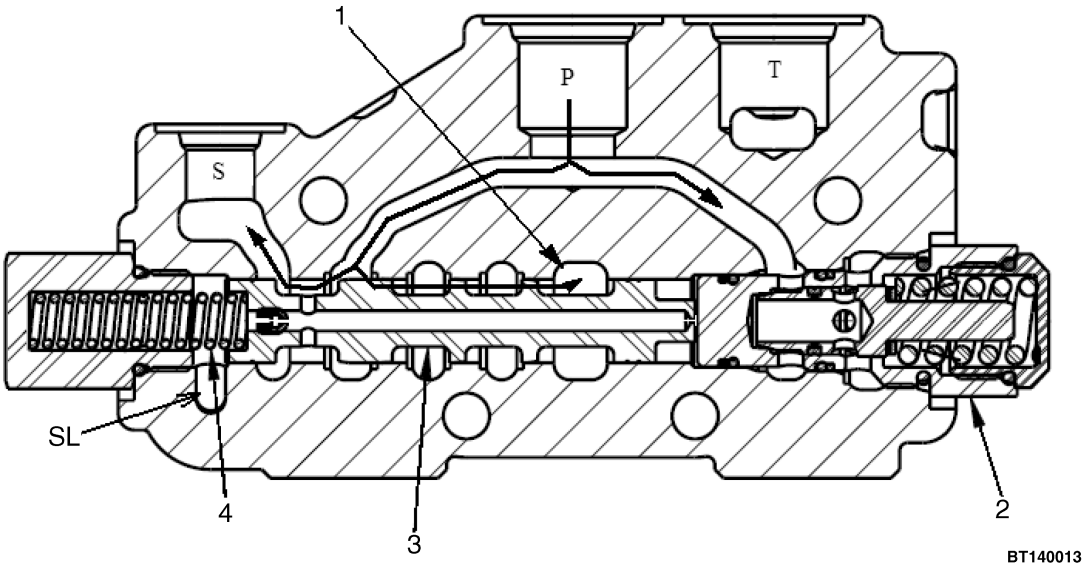


1. TO STEER UNIT
2. FROM PUMP
3. TO UNLOADER SPOOL
4. PRIORITY SPOOL
5. STEER LS PORT

Figure 9050-10-38. Cross Section of Priority Steering Layout

Priority Steer (Manual Hydraulics Open Center Control Valve)

Pump flow is directed across the priority spool before supplying flow for any downstream demands. Therefore, the steering circuit has priority over any downstream flow demands. Priority steering is accomplished by using a normally open spring biased spool. Pump flow is directed across the priority spool to the steer port (S). If the steering control unit is not in use, there is no load sense signal communicated to the SL port from the steering control unit. The inlet pressure (PG) will increase just enough to overcome the priority spool's spring force. Since the inlet pressure is communicated to the blind end of the priority spool, via the drilled passages within the spool, the spool will shift towards the spring end and flow to the steering unit will decrease and pump flow will be directed across the priority spool into a downstream (open center) core. If there is a flow demand from the steering unit, the load sense signal coming from the steering control unit is communicated to the spring end of the spool via the SL port. This increase in pressure will cause the spool to shift towards the blind end and flow to the steer (S) port will increase to meet the demands of the steering control unit. The downstream core coming from the priority spool is directed to the open center core of the valve assembly. If none of the work section spools are shifted, total pump flow is directed through the valve assembly via the open center core, across the work section spools to the outlet (T) port. See Figure 9050-10-39.



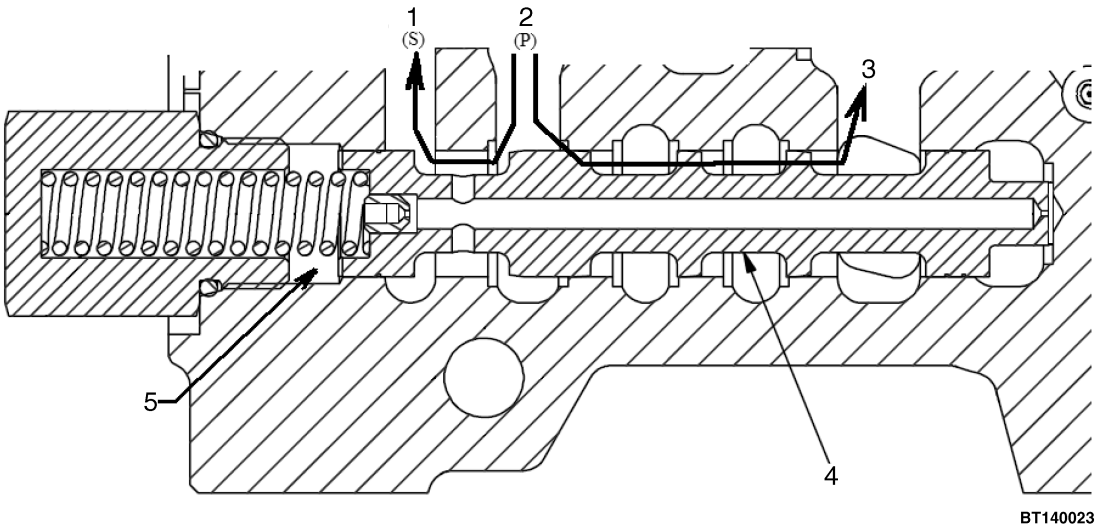
1. OPEN CENTER CORE
2. RELIEF CARTRIDGE
3. PRIORITY STEER SPOOL
4. SPRING

Figure 9050-10-39. Cross-Sectional View of Inlet Assembly

Priority Steer (Manual Hydraulics Closed Center Control Valve)

Pump flow is directed across a priority spool before supplying flow to any downstream functions. The steering circuit flow demand has priority over any downstream flow requirements. Priority steering is accomplished by using a normally open spring biased spool. Pump flow is directed across the priority spool to the steer port (S). If the steering control unit is not in use, there is no load sense signal communicated to the SL port from the steering control unit. The inlet pressure (P) will increase to overcome the priority spring force. The inlet pressure is communicated to the blind end of the priority spool via the drilled passages within the spool, the spool will shift towards the spring end and flow will be directed across the spool to a downstream core leading to the unloading spool. If there is a flow demand at the steer (S) port, the load sense signal coming from the steering control unit is communicated to the spring end of the spool via the SL port. This increase in pressure will cause the spool to shift towards the blind end and flow to the steer (S) port will increase to meet the demands of the steering control unit. See Figure 9050-10-40.

If no work section spools are shifted, total pump flow is directed across an unloading spool to the outlet (T) port.



1. STEER UNIT OUTLET
2. PUMP INLET
3. UNLOADER SPOOL OUTLET
4. PRIORITY SPOOL
5. STEER LS PORT

Figure 9050-10-40. Cross-Section of Priority Steering Layout

STEERING CONTROL UNIT (SCU) OPERATION

The steering control unit is a rotary valve operated by the steering wheel. See Figure 9050-10-41. During the steering operation, the steering control unit controls the direction and amount of oil flow to the steering cylinder. The steering cylinder in the axle actuates the steering linkage to move the steer tires. Hydraulic oil returns from the steering cylinder to the steering control unit and then to the hydraulic tank.

Turning the steering wheel actuates three main parts of the steering control unit: the spool for the control section, the sleeve for the control section, and the rotor in the metering section. When the steering wheel is not moving, the spool and sleeve are held in the **NEUTRAL** (center) position by springs. During this time, oil flows freely through the steering control unit but none flows to the steering cylinder.

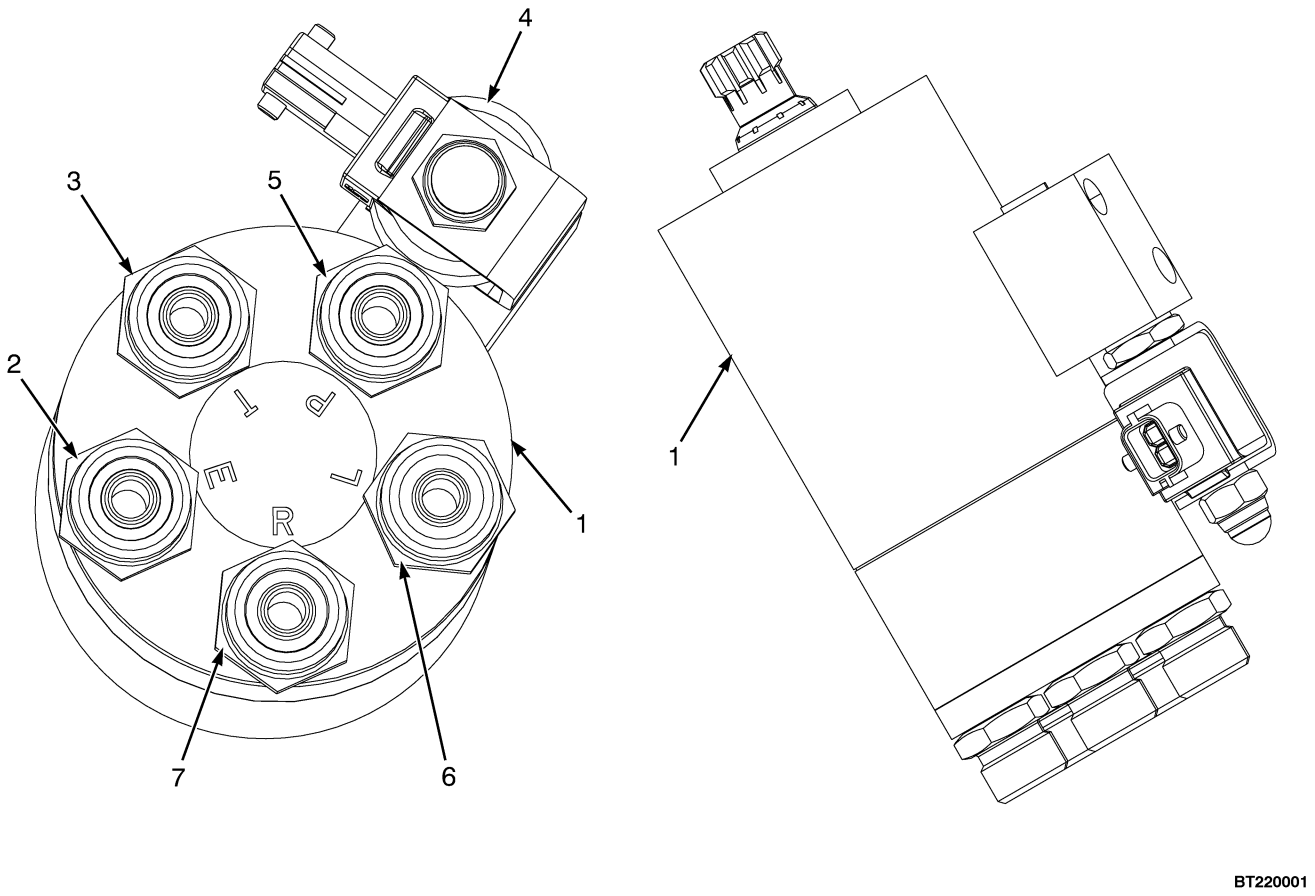
As the steering wheel is turned, the spool begins to rotate. The springs try to move the sleeve to keep the **NEUTRAL** position between the spool and sleeve. However, the necessary force to turn the rotor is greater than the pressure of the springs. The springs begin to bend, letting the spool move a small amount within the sleeve. The spool stops moving when it touches the center pin. In this position, the holes in the sleeve and the spool are aligned. Oil coming into the control unit flows to the metering section.

More rotation of the steering wheel causes the spool to rotate the pin. This action causes the rotation of the sleeve and the rotor in the metering section. The oil then flows to one side of the steering cylinder. Oil from the other side of the cylinder returns through the control section of the steering control unit.

When the steering wheel stops moving, the metering action in the metering section also stops. The **NEUTRAL** position springs return the sleeve to the **NEUTRAL** position, stopping oil flow to or from the cylinder. The pressure stays in the steering cylinder to keep the steer tires in position. Oil from the pump flows through the steering control unit to the tank or other parts of the system. To return the steer wheels to the straight position, the steering wheel must be rotated in the opposite direction. The steering control unit will operate as described, but all parts will rotate in the opposite direction.

The makeup valve (see Figure 9050-10-41) controls steering synchronization between the steering wheel and the steered wheels to ensure that the steering wheel is always in the same position relative to the steered wheels when the steered wheels are in the straight ahead direction.

Calibration procedures allow the operator to establish a spinner knob comfort position when the steered wheels are in the straight ahead position. The system will maintain this relationship between the steering wheel and steered wheels through the use of the makeup valve. The steering control unit and the steered wheels have sensors mounted on them to determine relative angles.



1. STEERING CONTROL UNIT
2. LOAD SENSE
3. RETURN TO CONTROL VALVE
4. MAKE-UP VALVE
5. SUPPLY PRESSURE
6. LEFT
7. RIGHT

Figure 9050-10-41. Steering Control Unit

Group 33
Observed Symptoms-Gear Pump

Abnormal Hydraulic Noise and/or Vibration

POSSIBLE CAUSE

A. LOW OIL LEVEL IN TANK.
B. AIR TRAPPED IN CIRCUIT.
C. SUCTION SIDE OF HYDRAULIC PUMP IS RESTRICTED.
D. HYDRAULIC PUMP LEAK AT THE INLET SUCTION HOSES.
E. HYDRAULIC PUMP IS WORN.
F. VIBRATION WITH TILT FUNCTION ONLY.
G. UNSTABLE MAIN RELIEF VALVE.
H. UNSTABLE SECONDARY RELIEF VALVE.
I. HYDRAULIC SYSTEM OVERHEATING.
J. UNSTABLE UNLOADER SPOOL.
K. UNSTABLE PRIORITY VALVE IN CONTROL VALVE INLET.

CAUSE A - LOW OIL LEVEL IN TANK.

PROCEDURE OR ACTION:

NOTE: Cavitation of a hydraulic pump will cause noise and it is caused by air in the hydraulic oil. The hydraulic pump suction oil must be free of air and unrestricted to pump.

1. Check hydraulic oil level in tank.
   Is oil at correct level?
   YES: Go to CAUSE B.
   NO: Add oil to correct level. See **Operating Manual**.

CAUSE B - AIR TRAPPED IN CIRCUIT.

PROCEDURE OR ACTION:

1. Remove air from circuit by cycling functions at one-second intervals, for E-Valve hoist and lower only. All other functions, cycle fully for 5 - 10 times. If symptom is still present, go to CAUSE C.

CAUSE C - SUCTION SIDE OF HYDRAULIC PUMP IS RESTRICTED.

PROCEDURE OR ACTION:

1. Check for restricted inlet screen.
   Is inlet screen restricted?
   YES: Clean or replace inlet screen.
   NO: Go to Step 2.
2. Check for collapsed suction hose.
   Is suction hose collapsed?
   YES: Replace suction hose.
   NO: Go to CAUSE D.

CAUSE D - HYDRAULIC PUMP LEAK AT THE INLET SUCTION HOSES.

PROCEDURE OR ACTION:

1. Look at Steering System component location drawing to identify suction hose. Depending on your lift truck, see **Steering System** 1600SRM1331 or **Steering System** 1600SRM1363.
   - Inspect suction hoses between tank and pump. Check for loose hose clamps and oil seepage.

   Is oil leaking from suction side of hydraulic pump?
   YES: Check and tighten suction hose clamps.
   NO: Go to CAUSE E.
2. Inspect hydraulic oil. Check for foaming or aeration of oil.
   Is oil foaming or aerated?
   YES: Repair suction side air leak and test oil for contamination. See Maintenance, Oil Sampling Procedure. Depending on your lift truck, see **Periodic Maintenance** 8000SRM1364, **Periodic Maintenance** 8000SRM1372, **Periodic Maintenance** 8000SRM1339, **Periodic Maintenance** 8000SRM1373, or **Periodic Maintenance** 8000SRM1442.
   NO: Go to CAUSE E.

CAUSE E - HYDRAULIC PUMP IS WORN.

PROCEDURE OR ACTION:

1. Check hydraulic pump flow. See Hydraulic Pump Flow Test in this section.
   Is hydraulic pump flow out of specifications?
   YES: Replace hydraulic pump. Depending on your lift truck, see **Hydraulic System** 1900SRM1367 or **Hydraulic System** 1900SRM1333.
   NO: Go to CAUSE F.

CAUSE F - VIBRATION WITH TILT FUNCTION ONLY.

PROCEDURE OR ACTION:

1. Inspect tilt spool and orifices for contamination or damage. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   Is tilt spool or orifices contaminated or plugged?
   YES: Clean or replace valve section.
   NO: Go to CAUSE G.

CAUSE G - UNSTABLE MAIN RELIEF VALVE.

PROCEDURE OR ACTION:

1. Install pressure gauge in hydraulic control valve. See Primary Relief Valve Test and Adjustment.
2. Operate the hoist function while observing pressure gauge.
   Does pressure fluctuate during hoist function.
   YES: Go to CAUSE H.
   NO: Go to Step 3.
3. Hold hoist function over relief.
   Does relief pressure meet test specifications?
   YES: Go to CAUSE H.
   NO: Replace relief valve. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.

CAUSE H - UNSTABLE SECONDARY RELIEF VALVE.

PROCEDURE OR ACTION:

1. Install pressure gauge in hydraulic control valve. See Secondary Relief Valve Test and Adjustment.
2. Operate a auxiliary function while observing pressure gauge.
   Does pressure fluctuate during auxiliary function.
   YES: Go to CAUSE I.
   NO: Go to Step 3.
3. Hold auxiliary function over relief.
   Does relief pressure meet test specifications?
   YES: Go to CAUSE I.
   NO: Replace relief valve. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.

CAUSE I - HYDRAULIC SYSTEM OVERHEATING.

PROCEDURE OR ACTION:

NOTE: If lift truck is equipped with Hydraulic Oil Cooler, see Hydraulic Oil Cooler Not Functioning Correctly.

1. Check temperature sensor for operation.
   Is temperature sensor working properly?
   YES: Go to CAUSE J.
   NO: Replace temperature sensor. Depending on your lift truck, see **Hydraulic System** 1900SRM1367 or **Hydraulic System** 1900SRM1333.

CAUSE J - UNSTABLE UNLOADER SPOOL.

PROCEDURE OR ACTION:

1. Inspect unloader valve for damage or contamination. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   Is unloader valve free of contamination and in good condition?
   YES: Go to CAUSE K.
   NO: Clean or replace unloader valve. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.

CAUSE K - UNSTABLE PRIORITY VALVE IN CONTROL VALVE INLET.

PROCEDURE OR ACTION:

1. Perform Operational Diagnostic Procedures, Operational Checkout, Page 9010-05-6.
   Does priority flow divider valve pass the check?
   YES: Priority flow divider valve is OK.
   NO:
   - Cannot turn steering wheel, wheel locks up. See Observed Symptoms-Gear Pump, No Steering (All Other Hydraulic Functions OK), Page 9050-33-61.
   - Steering wheel turns but fails Priority Valve Flow Divider Valve Check. Remove and clean flow divider spool. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.

END SYMPTOM

Abnormal Smell/Discoloration/Foaming of Oil

POSSIBLE CAUSE

A. HYDRAULIC SYSTEM HAS BEEN OVERHEATED.
B. HYDRAULIC FLUID CONTAMINATED OR WRONG TYPE.
C. AIR LEAK ON SUCTION SIDE OF HYDRAULIC PUMP.

CAUSE A - HYDRAULIC SYSTEM HAS BEEN OVERHEATED.

PROCEDURE OR ACTION:

NOTE: If lift truck is equipped with Hydraulic Oil Cooler, see Hydraulic Oil Cooler Not Functioning Correctly.

1. Inspect for the following:
   - Level and condition of hydraulic oil in tank
   - Valve stuck causing system to run at relief

   Are any of the above symptoms present?
   YES: Drain and refill hydraulic tank. **Periodic Maintenance** 8000SRM1364, **Periodic Maintenance** 8000SRM1372, **Periodic Maintenance** 8000SRM1339, **Periodic Maintenance** 8000SRM1373, or **Periodic Maintenance** 8000SRM1442. Repair or replace stuck valve.
   NO: Go to CAUSE B.

CAUSE B - HYDRAULIC FLUID CONTAMINATED OR WRONG TYPE.

PROCEDURE OR ACTION:

1. Check hydraulic oil for contamination and correct type.
   Is hydraulic oil contaminated or incorrect type used?
   YES: Drain and refill hydraulic tank. Depending on your lift truck see, **Periodic Maintenance** 8000SRM1364, **Periodic Maintenance** 8000SRM1372, **Periodic Maintenance** 8000SRM1339, **Periodic Maintenance** 8000SRM1373, or **Periodic Maintenance** 8000SRM1442.
   NO: Go to CAUSE C.

CAUSE C - AIR LEAK ON SUCTION SIDE OF HYDRAULIC PUMP.

PROCEDURE OR ACTION:

1. Inspect condition of hydraulic oil.
   Is the hydraulic oil foaming or aerated?
   YES: Repair leak on suction side of hydraulic pump. For [A268], E2.2-3.5XN (E45-70XN); [A276], J2.2- 3.5XN (J40-70XN); see **Hydraulic System** 1900SRM1367, For [K160], J1.5-2.0XNT (J30-40XNT); [A955] ERP16-20VF; see **Hydraulic System** 1900SRM1333.
   NO: Check service record of lift truck to see if it requires periodic maintenance.

END SYMPTOM

Cycle Times Too Fast - Fast Actuation (E-Valve)

POSSIBLE CAUSE

A. MAX FUNCTION SPEED SETTING TOO HIGH.
B. RAMP SETTING TOO HIGH FOR FUNCTION.
C. ORIFICES MISSING OR INSTALLED WRONG IN CYLINDER PORTS (ON AFTERMARKET CYLINDERS).
D. FAULTY MLCV FOR LOWERING FUNCTION ONLY.
E. UNLOADER VALVE PRODUCING TOO MUCH MARGIN PRESSURE.

CAUSE A - MAX FUNCTION SPEED SETTING TOO HIGH.

PROCEDURE OR ACTION:

1. Adjust function speed setting on Display Panel. If problem is still present, go to CAUSE B.

CAUSE B - RAMP SETTING TOO HIGH FOR FUNCTION.

PROCEDURE OR ACTION:

WARNING
Unexpected movement of hydraulic function can cause injury or death. Do not operate the lift truck until problem has been repaired.

1. Adjust function ramp setting on Display Panel. See **User Interface Service Technician** 2200SRM1336. If problem is still present, go to CAUSE C.

CAUSE C - ORIFICES MISSING OR INSTALLED WRONG IN CYLINDER PORTS (ON AFTERMARKET CYLINDERS).

PROCEDURE OR ACTION:

1. Check cycle times. See aftermarket specifications.
   Do cycle times meet specifications?
   YES: Go to CAUSE D.
   NO: Inspect and repair orifices in cylinder ports. See aftermarket Service Manuals.

CAUSE D - FAULTY MLCV FOR LOWERING FUNCTION ONLY.

PROCEDURE OR ACTION:

1. Check the lowering cycle times.
   Are the lowering cycle times too fast?
   YES: Repair or replace Mast Lowering Control Valve (MLCV). Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.
   NO: Go to CAUSE E.

CAUSE E - UNLOADER VALVE PRODUCING TOO MUCH MARGIN PRESSURE.

PROCEDURE OR ACTION:

1. Test unloader valve. See Main Control Valve Unloader Margin Test.
   Is margin pressure too high?
   YES: Replace unloader valve spool spring. Depending on your left truck, see **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   NO: Perform operational check.

END SYMPTOM

Jump/Delay In Lift or Lower Activation After Moving MLM (E-Valve)

POSSIBLE CAUSE

A. RAMP RATE NOT SET TO DESIRED LEVEL.
B. COIL NOT ATTACHED TO SOLENOID CORRECTLY.
C. AIR TRAPPED IN CIRCUIT.
D. OUTPUT THRESHOLD IS SET TOO HIGH.
E. MAST/ATTACHMENT IS BINDING.
F. STICKING UNLOADER SPOOL.
G. MAIN CONTROL VALVE LS (LOAD SENSE) RELIEF LEAKAGE.

CAUSE A - RAMP RATE NOT SET TO DESIRED LEVEL.

PROCEDURE OR ACTION:

WARNING
Unexpected movement of hydraulic function can cause injury or death. Do not operate the lift truck until problem has been repaired.

1. Adjust function ramp setting on Display Panel. See **User Interface Service Technician** 2200SRM1336. If problem is still present, go to CAUSE B.

CAUSE B - COIL NOT ATTACHED TO SOLENOID CORRECTLY.

PROCEDURE OR ACTION:

1. Inspect coil installation. Depending on your left truck, see **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   Is coil installed correctly to solenoid?
   YES: Go to CAUSE C.
   NO: Replace coil or solenoid. Coil cannot be repaired.

CAUSE C - AIR TRAPPED IN CIRCUIT.

PROCEDURE OR ACTION:

1. Remove air from circuit by cycling function at one second intervals, for E-Valve hoist and lower only. All other functions, cycle fully for 5 - 10 times. If symptom is still present, go to CAUSE D.

CAUSE D - OUTPUT THRESHOLD IS SET TOO HIGH.

PROCEDURE OR ACTION:

1. Check current at Electro-Hydraulic Valve.
   Is setting at valve correct?
   YES: Go to CAUSE E.
   NO: Decrease setting to specification or until operation is acceptable to operator.

CAUSE E - MAST/ATTACHMENT IS BINDING.

PROCEDURE OR ACTION:

1. Check for mast or attachment binding.
   Is mast or attachment binding?
   YES: Repair mast or attachment. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.
   NO: Go to CAUSE F.

CAUSE F - STICKING UNLOADER SPOOL.

PROCEDURE OR ACTION:

1. Inspect unloader valve for damage or contamination. Depending on your left truck, see **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   Is unloader free of contamination and in good condition?
   YES: Go to CAUSE G.
   NO: Clean or replace unloader valve.

CAUSE G - MAIN CONTROL VALVE LS (LOAD SENSE) RELIEF LEAKAGE.

PROCEDURE OR ACTION:

1. Check LS pressure. See Main Control Valve LS Leakage Test (E-Valve).
   Does LS pressure meet test specifications?
   YES: See Observed Symptoms-Gear Pump, Lift Function Will Not Move With MLM Movement (E-Valve), Page 9050-33-25.
   NO: Clean or replace main relief valve. Depending on your left truck, see **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.

END SYMPTOM

Jump/Delay In Auxiliary Function Actuation After Moving MLM (E-Valve)

POSSIBLE CAUSE

A. RAMP RATE NOT SET TO DESIRED LEVEL.
B. AIR TRAPPED IN CIRCUIT.
C. OUTPUT THRESHOLD IS SET TOO HIGH.
D. MAST/ATTACHMENT IS BINDING.
E. PILOT PRESSURE NOT BEING PRODUCED FAST ENOUGH.
F. STICKING VALVE SPOOL.
G. STICKING UNLOADER SPOOL.
H. VALVE SPOOL END SPRINGS TOO SOFT.

CAUSE A - RAMP RATE NOT SET TO DESIRED LEVEL.

PROCEDURE OR ACTION:

WARNING
Unexpected movement of hydraulic function can cause injury or death. Do not operate the lift truck until problem has been repaired.

1. Adjust function ramp setting on Display Panel. See **User Interface Service Technician** 2200SRM1336. If problem is still present, go to CAUSE B.

CAUSE B - AIR TRAPPED IN CIRCUIT.

PROCEDURE OR ACTION:

1. Remove air from circuit by cycling function full stroke of hydraulic hoist cylinder at one second intervals. If symptom is still present, go to CAUSE C.

CAUSE C - OUTPUT THRESHOLD IS SET TOO HIGH.

PROCEDURE OR ACTION:

1. Check current at valve. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   Is setting at valve correct?
   YES: Go to CAUSE D.
   NO: Decrease setting to specification or until operation is acceptable to operator.

CAUSE D - MAST/ATTACHMENT IS BINDING.

PROCEDURE OR ACTION:

1. Check for mast or attachment binding.
   Is mast or attachment binding?
   YES: Repair mast or attachment. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.
   NO: Go to CAUSE E.

CAUSE E - PILOT PRESSURE NOT BEING PRODUCED FAST ENOUGH.

PROCEDURE OR ACTION:

1. Inspect filter. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   Is filter clean and in good condition?
   YES: Go to CAUSE F.
   NO: Clean or replace filter.

CAUSE F - STICKING VALVE SPOOL.

PROCEDURE OR ACTION:

1. Inspect spool. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   Is spool clean and in good condition?
   YES: Go to CAUSE G.
   NO: Clean or replace spool.

CAUSE G - STICKING UNLOADER SPOOL.

PROCEDURE OR ACTION:

1. Inspect unloader valve for damage or contamination. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   Is unloader free of contamination and in good condition?
   YES: Go to CAUSE H.
   NO: Clean or replace unloader valve.

CAUSE H - VALVE SPOOL END SPRINGS TOO SOFT.

PROCEDURE OR ACTION:

1. Replace springs. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337. If problem is still present, see Observed Symptoms-Gear Pump, Auxiliary Function, Tilt Back and/or Tilt Forward Will Not Move With MLM Movement (E-Valve), Page 9050-33-40.

END SYMPTOM

Jump/Delay In Tilt Forward or Back Actuation (E-Valve)

POSSIBLE CAUSE

A. RAMP RATE NOT SET TO DESIRED LEVEL.
B. AIR TRAPPED IN CIRCUIT.
C. OUTPUT THRESHOLD IS SET TOO HIGH.

CAUSE A - RAMP RATE NOT SET TO DESIRED LEVEL.

PROCEDURE OR ACTION:

WARNING

Unexpected movement of hydraulic function can cause injury or death. Do not operate the lift truck until problem has been repaired.

1. Adjust function ramp setting on Display Panel. See **User Interface Service Technician** 2200SRM1336. If problem is still present, go to CAUSE B.

CAUSE B - AIR TRAPPED IN CIRCUIT.

PROCEDURE OR ACTION:

1. Remove air from circuit by cycling function full stroke of hydraulic hoist cylinder at one second intervals. If symptom is still present, go to CAUSE C.

CAUSE C - OUTPUT THRESHOLD IS SET TOO HIGH.

PROCEDURE OR ACTION:

1. Check current at E-Hydraulic Valve. See **Hydraulic System** 1900SRM1367.
   Is setting at valve correct?
   YES: Resume operation.
   NO: Decrease setting to specification or until operation is acceptable to operator.

END SYMPTOM

Forks Drop Slightly Before Lifting (E-Valve)

POSSIBLE CAUSE

CAUSE A - EXCESSIVE LEAKAGE IN LOAD CHECK VALVE.

PROCEDURE OR ACTION:

WARNING

Unexpected movement of hydraulic function can cause injury or death. Do not operate the lift truck until problem has been repaired.

1. Check for contamination or damage to load check valve. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   Is load check valve in good condition?
   YES: Clean lift low leak valve.
   NO: Replace lift low leak valve.

Forks Lower Without Command (E-Valve)

POSSIBLE CAUSE

A. MLM CONTROL MALFUNCTION.
B. EMERGENCY LOWER VALVE IS PARTIALLY OPEN.
C. EXCESSIVE LIFT CYLINDER LEAKAGE.

CAUSE A - MLM CONTROL MALFUNCTION.

PROCEDURE OR ACTION:

1. Ensure power is **OFF**. Operate lift/lower lever in both directions.
   Does lever exhibit any binding/stickiness or not return to center position?
   YES: Remove and replace lever. (See **Electrical System** 2200SRM1369 or **Electrical System** 2200SRM1337 .) **Note:** Inspect cassette rotary mechanism for dirt contamination.
   NO: Go to Step 2.
2. Turn Power **ON**.
3. Go to the Display Menu/Diagnostics/Hydraulics Inputs/Lever Input values.
4. Move lever(s) to full stroke position and allow to snap back to the center position.
   Does Display value = 0%?
   YES: Go to CAUSE B.
   NO: Go to Step 5.
5. Power **OFF**. Replace lift/lower lever. (See **Electrical System** 2200SRM1369 or **Electrical System** 2200SRM1337 .)
6. Retest. Turn power **ON**.
7. Go to Display Menu/Diagnostics/Hydraulics Inputs/Lever Input values.
8. Move lever(s) to full stroke position and allow to snap back to the center position.
   Does Display value = 0%?
   YES: Go to CAUSE B.
   NO: Replace MLM PCB Cassette. (See **Electrical System** 2200SRM1369 or **Electrical System** 2200SRM1337 .)
9. Retest. Turn power **ON**.
10. Go to Display Menu/Diagnostics/Hydraulics Inputs/Lever Input values.
11. Move lever(s) to full stroke position and allow to snap back to the center position.
    Display value = 0%?
    YES: Repair Complete. Resume operation.
    NO: Go to CAUSE B.

CAUSE B - EMERGENCY LOWER VALVE IS PARTIALLY OPEN.

PROCEDURE OR ACTION:

NOTE: Emergency lower valve has tee handle located on control valve. See **Operating Manual** for location and correct use.

1. Check and close valve. If problem is still present, go to CAUSE C.

CAUSE C - EXCESSIVE LIFT CYLINDER LEAKAGE.

PROCEDURE OR ACTION:

1. Do lift cylinder leakage test. See Lift Cylinder Leakage Test.
   Is there leakage in the lift cylinder?
   YES: Repair or replace lift cylinder.
   NO: Resume operation.

END SYMPTOM

Forks Raise or Actuate Without Command (E-Valve)

POSSIBLE CAUSE

A. MLM CONTROL MALFUNCTION.
B. AIR TRAPPED IN CIRCUIT.

CAUSE A - MLM CONTROL MALFUNCTION.

PROCEDURE OR ACTION:

1. Ensure power is **OFF**. Operate lift/lower lever in both directions.
   Does lever exhibit any binding/stickiness or not return to center position?
   YES: Remove and replace lever. (See **Electrical System** 2200SRM1369 or **Electrical System** 2200SRM1337 .) **Note:** Inspect cassette rotary mechanism for dirt contamination.
   NO: Go to Step 2.
2. Turn Power **ON**.
3. Go to the Display Menu/Diagnostics/Hydraulics Inputs/Lever Input values.
4. Move lever(s) to full stroke position and allow to snap back to the center position.
   Does Display value = 0%?
   YES: Go to CAUSE B.
   NO: Go to Step 5.
5. Power **OFF**. Replace lift/lower lever. (See **Electrical System** 2200SRM1369 or **Electrical System** 2200SRM1337 .)
6. Retest. Turn power **ON**.
7. Go to Display Menu/Diagnostics/Hydraulics Inputs/Lever Input values.
8. Move lever(s) to full stroke position and allow to snap back to the center position.
   Does Display value = 0%?
   YES: Go to CAUSE B.
   NO: Replace MLM PCB Cassette. (See **Electrical System** 2200SRM1369 or **Electrical System** 2200SRM1337 .)
9. Retest. Turn power **ON**.
10. Go to Display Menu/Diagnostics/Hydraulics Inputs/Lever Input values.
11. Move lever(s) to full stroke position and allow to snap back to the center position.
    Does Display value = 0%?
    YES: Repair Complete. Resume Operation.
    NO: Go to CAUSE B.

CAUSE B - AIR TRAPPED IN CIRCUIT.

PROCEDURE OR ACTION:

1. Remove air from circuit by cycling function at one-second intervals, for E-Valve hoist and lower only. All other functions, cycle fully for 5 - 10 times.

END SYMPTOM

Hydraulic Oil Cooler Not Functioning Correctly

POSSIBLE CAUSE

A. AIR FLOW THROUGH COOLER RESTRICTED OR INSUFFICIENT
B. HYDRAULIC OIL COOLER TEMPERATURE SWITCH NOT WORKING
C. HYDRAULIC OIL COOLER FANS NOT WORKING

COMPONENT OPERATIONAL CHECK

PROCEDURE OR ACTION:

1. Conduct a quick visual inspection of all connectors/wiring associated with the hydraulic oil cooler. Make sure electrical connection is a good physical connection (i.e. sockets and pins are seated correctly; connector "clicks" indicating locking tab works correctly).
   Are any of the connectors/wiring damaged?
   YES: Repair/replace connector or wiring associated with hydraulic oil cooler. Refer to appropriate **Electrical System** manual, depending on lift truck model.
   NO: Go to CAUSE A.

CAUSE A - AIR FLOW THROUGH COOLER RESTRICTED OR INSUFFICIENT

PROCEDURE OR ACTION:

1. Check the condition of the hydraulic oil cooler.
   Is the hydraulic oil cooler fan shroud broken or hydraulic oil cooler blocked not allowing air flow through the cooler?
   YES: Replace hydraulic oil cooler fan shroud and/or remove any debris or blockage restricting air flow through cooler. Clean hydraulic oil cooler and resume operation.
   NO: Go to CAUSE B.

CAUSE B - HYDRAULIC OIL COOLER TEMPERATURE SWITCH NOT WORKING

PROCEDURE OR ACTION:

1. Warm up the hydraulic oil to a minimum of 60°C (140°F). Follow procedures in Hydraulic Warm-up Procedure. Park lift truck and check condition of hydraulic cooler cooling fans.
   Do the hydraulic cooler cooling fans turn on?
   YES: Truck is operating to specification.
   NO: Go to Step 2.
2. Turn lift truck **OFF**. Bypass the hydraulic oil cooler temperature switch with a jumper wire. Turn lift truck **ON**.
   Do the hydraulic cooler cooling fans turn on?
   YES: Replace faulty hydraulic oil cooler temperature switch with a new switch. Resume operation.
   NO: Remove bypass jumper wire and return hydraulic oil cooler temperature switch to it's original condition. Go to CAUSE C.

CAUSE C - HYDRAULIC OIL COOLER FANS NOT WORKING

PROCEDURE OR ACTION:

1. Turn lift truck **OFF**. Replace the hydraulic oil cooler fan(s) with a new fan(s). Be sure to install new fans in the correct direction for air flow through oil cooler. Turn lift truck **ON** and operate lift truck until hydraulic oil temperature is HOT. Park lift truck and raise hood.
   Do the hydraulic cooler cooling fans turn on?
   YES: Repeat CAUSE A. Check the level of the hydraulic oil in the hydraulic tank. Drain/fill as needed.
   NO: Go to Step 2.
2. Using a DMM, check the condition of the power and ground circuit for the fans.
   Do the fans have a good ground and 12 volts?
   YES: Replace inoperative fans. Be sure to install new fans in the correct direction for air flow through hydraulic oil cooler.
   NO: Go to VSM 12 Volts Supply OORL/OORH.

END SYMPTOM

Intermittent Activation (E-Valve) While Commanding Function

POSSIBLE CAUSE

A. LOOSE WIRES OR CONNECTORS ON VALVE HARNESS.
B. MAST/ATTACHMENT IS BINDING.
C. CONTAMINATION IN HYDRAULIC CONTROL VALVE.

CAUSE A - LOOSE WIRES OR CONNECTORS ON VALVE HARNESS.

PROCEDURE OR ACTION:

1. Check the Display Panel for DTC.
   Is a DTC displayed?
   YES: Go to DTC diagnostic procedure.
   NO: Go to Step 2.
2. Check wire connection. See **Wire Harness Repair** 2200SRM1128. If problem is still present, go to CAUSE B.

CAUSE B - MAST/ATTACHMENT IS BINDING.

PROCEDURE OR ACTION:

1. Check for mast or attachment binding.
   Is mast or attachment binding?
   YES: Repair mast or attachment. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.
   NO: Go to CAUSE C.

CAUSE C - CONTAMINATION IN HYDRAULIC CONTROL VALVE.

PROCEDURE OR ACTION:

1. Inspect and clean control valve. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.

END SYMPTOM

Forks Tilt Forward Without Command (E-Valve)

POSSIBLE CAUSE

A. MLM CONTROL MALFUNCTION.
B. PPRV GETTING STRAY SIGNAL.
C. EXCESSIVE TILT CYLINDER LEAKAGE.
D. EXCESSIVE SPOOL LEAKAGE.
E. PISTON STUCK.
F. TILT CONTROL SPOOL DAMAGED OR LEAKING EXCESSIVELY.

CAUSE A - MLM CONTROL MALFUNCTION.

PROCEDURE OR ACTION:

1. Ensure power is **OFF**. Operate tilt lever in both directions.
   Does lever exhibit any binding/stickiness or not return to center position?
   YES: Remove and replace lever. (See **Electrical System** 2200SRM1369 or **Electrical System** 2200SRM1337 .) **Note:** Inspect cassette rotary mechanism for dirt contamination.
   NO: Go to Step 2.
2. Turn power **ON**.
3. Go to the Display Menu/Diagnostics/Hydraulics Inputs/Lever Input values.
4. Move lever(s) to full stroke position and allow to snap back to the center position.
   Does Display value = 0%?
   YES: Go to CAUSE B.
   NO: Go to Step 5.
5. Power **OFF**. Replace tilt lever. (See **Electrical System** 2200SRM1369 or **Electrical System** 2200SRM1337 .)
6. Retest. Turn power **ON**.
7. Go to Display Menu/Diagnostics/Hydraulics Inputs/Lever Input values.
8. Move lever(s) to full stroke position and allow to snap back to the center position. Observe value. Move the lever(s) to the full stroke position and hold. Observe value.
   Does Display value = 0% at the center position and 92 to 100% at the full stroke position?
   YES: Go to CAUSE B.
   NO: Replace MLM PCB Cassette. (See **Electrical System** 2200SRM1369 or **Electrical System** 2200SRM1337 .)
9. Retest. Turn power **ON**.
10. Go to Display Menu/Diagnostics/Hydraulics Inputs/Lever Input values.
11. Move lever(s) to full stroke position and allow to snap back to the center position.
    Does Display value = 0%?
    YES: Repair Complete. Resume operation.
    NO: Go to CAUSE B.

CAUSE B - PPRV GETTING STRAY SIGNAL.

PROCEDURE OR ACTION:

1. Check for proper harness installation. See **Wire Harness Repair** 2200SRM1128.
   Is valve harness installed wrong?
   YES: Install valve harness properly.
   NO: Go to Step 2.
2. Check for shorts in valve harness. See **Wire Harness Repair** 2200SRM1128.
   Does valve harness have shorts?
   YES: Repair or replace valve harness.
   NO: Go to CAUSE C.

CAUSE C - EXCESSIVE TILT CYLINDER LEAKAGE.

PROCEDURE OR ACTION:

1. Do tilt cylinder leakage test. See Tilt Cylinder Leakage Test.
   Is there leakage in the tilt cylinder?
   YES: Repair or replace tilt cylinder.
   NO: Go to CAUSE D.

CAUSE D - EXCESSIVE SPOOL LEAKAGE.

PROCEDURE OR ACTION:

1. Check spool for:
   - Damage
   - Free movement
   - Debris or contamination

   Is spool and mating bore in good condition?
   YES: Go to CAUSE E.
   NO: Replace damaged parts.

CAUSE E - PISTON STUCK.

PROCEDURE OR ACTION:

1. Inspect tilt control piston. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   Does piston move freely in bore?
   YES: Go to CAUSE F.
   NO: Clean piston or replace valve section.

CAUSE F - TILT CONTROL SPOOL DAMAGED OR LEAKING EXCESSIVELY.

PROCEDURE OR ACTION:

1. Inspect valve section. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   Is spool in good condition?
   YES: See Observed Symptoms-Gear Pump, Forks Raise or Actuate Without Command (E-Valve), Page 9050-33-15.
   NO: Clean or replace spool.

END SYMPTOM

Lift/Lower Function Maximum Speed Too Slow (E-Valve)

POSSIBLE CAUSE

A. MAX FUNCTION SPEED SETTING TOO LOW.
B. RAMP SETTING TOO LOW FOR FUNCTION.
C. OUTPUT THRESHOLD IS SET TOO LOW.
D. MAST/ATTACHMENT IS BINDING.
E. MLM CONTROL MALFUNCTION.
F. MAIN RELIEF VALVE DAMAGED OR STUCK OPEN (LIFT FUNCTION ONLY).
G. EXCESSIVE PUMP LEAKAGE (LIFT FUNCTION ONLY).
H. UNLOADER NOT PRODUCING ENOUGH MARGIN PRESSURE (LIFT FUNCTION ONLY).
I. MAIN CONTROL VALVE LS (LOAD SENSE) LEAKAGE (LIFT FUNCTION ONLY).
J. FAULTY MAST LOWERING CONTROL VALVE.

CAUSE A - MAX FUNCTION SPEED SETTING TOO LOW.

PROCEDURE OR ACTION:

1. Adjust function speed setting on Display Panel. If problem is still present, go to CAUSE B.

CAUSE B - RAMP SETTING TOO LOW FOR FUNCTION.

PROCEDURE OR ACTION:

WARNING
Unexpected movement of hydraulic function can cause injury or death. Do not operate the lift truck until problem has been repaired.

1. Adjust function ramp setting on Display Panel. See **User Interface Service Technician** 2200SRM1336. If problem is still present, go to CAUSE C.

CAUSE C - OUTPUT THRESHOLD IS SET TOO LOW.

PROCEDURE OR ACTION:

1. Check current at Display Panel.
   Is setting at valve correct?
   YES: Go to CAUSE D.
   NO: Increase setting to specification or until operation is acceptable to operator.

CAUSE D - MAST/ATTACHMENT IS BINDING.

PROCEDURE OR ACTION:

1. Check for mast or attachment binding.
   Is mast or attachment binding?
   YES: Repair mast or attachment. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.
   NO: Go to CAUSE E.

CAUSE E - MLM CONTROL MALFUNCTION.

PROCEDURE OR ACTION:

1. Turn power **ON**.
2. Go to Display Menu/Diagnostics/Hydraulics Inputs/Lever Input values.
3. Move lever to full stroke position – both directions.
   Is Display value >=92%?
   YES: Go to CAUSE F.
   NO: Go to Step 4.
4. Power **OFF**. Replace lift/lower Lever(s). See **Electrical System** 2200SRM1369 or **Electrical System** 2200SRM1337 .
5. Retest. Turn power **ON**.
6. Go to Display Menu/Diagnostics/Hydraulics Inputs/Lever Input values.
7. Move lever to full stroke position – both directions.
   Is Display value >=92%?
   YES: Go to CAUSE F.
   NO: Replace MLM PCB Cassette. See **Electrical System** 2200SRM1369 or **Electrical System** 2200SRM1337 .

CAUSE F - MAIN RELIEF VALVE DAMAGED OR STUCK OPEN (LIFT FUNCTION ONLY).

PROCEDURE OR ACTION:

1. Install pressure gauge in hydraulic control valve. See Primary Relief Valve Test and Adjustment.
2. Hold lift function over relief.
   Does relief pressure meet test specifications?
   YES: Go to CAUSE G.
   NO: Replace relief valve. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.

CAUSE G - EXCESSIVE PUMP LEAKAGE (LIFT FUNCTION ONLY).

PROCEDURE OR ACTION:

1. Test hydraulic pump for excessive leakage. See Hydraulic Pump Flow Test.
   Does hydraulic pump have excessive leakage?
   YES: Repair or replace pump. See **Hydraulic System** 1900SRM1333.
   NO: Go to CAUSE H.

CAUSE H - UNLOADER NOT PRODUCING ENOUGH MARGIN PRESSURE (LIFT FUNCTION ONLY).

PROCEDURE OR ACTION:

1. Test unloader spool spring. See Main Control Valve Unloader Margin Test.
   Does unloader valve pressure meet test specifications?
   YES: Go to CAUSE I.
   NO: Replace spring.

CAUSE I - MAIN CONTROL VALVE LS (LOAD SENSE) LEAKAGE (LIFT FUNCTION ONLY).

PROCEDURE OR ACTION:

1. Check LS pressure. See Main Control Valve LS Leakage Test (E-Valve).
   Does LS pressure meet test specifications?
   YES: See Observed Symptoms-Gear Pump, Lift Function Will Not Move With MLM Movement (E-Valve), Page 9050-33-25.
   NO: Clean or replace main relief valve. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.

CAUSE J - FAULTY MAST LOWERING CONTROL VALVE.

PROCEDURE OR ACTION:

1. Inspect mast lowering control valve for blockage.
   Is mast lowering control valve blocking flow?
   YES: Repair or replace mast lowering control valve. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.
   NO: Resume operation.

END SYMPTOM

Lift Function Will Not Move With MLM Movement (E-Valve)

POSSIBLE CAUSE

A. PUMP NOT GENERATING ENOUGH FLOW.
B. LOAD IS GREATER THAN TRUCK CAPACITY.
C. MLM CONTROL MALFUNCTION.
D. EMERGENCY LOWER VALVE IS PARTIALLY OPEN.
E. LIFT SPEED IS SET AT 0%.
F. MAIN RELIEF VALVE IS SET TOO LOW.
G. MAIN RELIEF VALVE DAMAGED OR STUCK OPEN.
H. SECONDARY RELIEF VALVE DAMAGED OR STUCK OPEN.
I. MAST LOWERING CONTROL VALVE BLOCKING FLOW.
J. UNLOADER SPOOL IS STUCK OPEN.
K. MAIN CONTROL VALVE LS (LOAD SENSE) RELIEF LEAKAGE.

CAUSE A - PUMP NOT GENERATING ENOUGH FLOW.

PROCEDURE OR ACTION:

1. Do hydraulic pump flow check.
   Does pump pass check?
   YES: Pump is OK. Go to CAUSE B.
   NO: Do Hydraulic Pump Flow Test before replacing pump.

CAUSE B - LOAD IS GREATER THAN TRUCK CAPACITY.

NOTE: See Serial Number plate or **Operating Manual** for lift capacity.

PROCEDURE OR ACTION:

1. Check load weight and compare to truck capacity rating. Adjust as necessary. If problem is still present, go to CAUSE C.

CAUSE C - MLM CONTROL MALFUNCTION.

PROCEDURE OR ACTION:

1. Power **ON** and operator in seat. Operate lift/lower lever.
   Is a hydraulic interlock message displayed?
   YES: Go to Display Menu/Diagnostics/Seat (Operator Presence), then go to Step 2.
   NO: Go to CAUSE D.
2. Observe value
   Is Operator Presence sensor value greater than 1.8 volts?
   YES: Go to Display Menu/Diagnostics/Hydraulics Inputs/Lever Input values, then go to Step 3.
   NO: Go to Seat Sensor Out of Range Low (OORL).
3. Operate lift/lower lever in both directions.
   Does lever exhibit any binding/stickiness or not return to center position?
   YES: Remove and replace lever. (See **Electrical System** 2200SRM1369 or **Electrical System** 2200SRM1337 .) **Note:** Inspect cassette rotary mechanism for dirt contamination.
   NO: Go to Step 4.
4. Move lever(s) to full stroke position and allow to snap back to the center position. Observe value. Move the lever(s) to the full stroke position and hold. Observe value.
   Does Display value = 0% at the center position and 92 to 100% at the full stroke position?
   YES: Go to CAUSE D.
   NO: Go to Step 5.
5. Power **OFF**. Replace lever(s). (See **Electrical System** 2200SRM1369 or **Electrical System** 2200SRM1337 .)
6. Retest. Turn power **ON**.
7. Go to Display Menu/Diagnostics/Hydraulics Inputs/Lever Input values.
8. Move lever(s) to full stroke position and allow to snap back to the center position. Observe value. Move the lever(s) to the full stroke position and hold. Observe value.
   Does Display value = 0% at the center position and 92 to 100% at the full stroke position?
   YES: Repair complete. Resume operation.
   NO: Replace MLM PCB Cassette. (See **Electrical System** 2200SRM1369 or **Electrical System** 2200SRM1337 .)
9. Retest. Turn power **ON**.
10. Go to Display Menu/Diagnostics/Hydraulics Inputs/Lever Input values.
11. Move lever(s) to full stroke position and allow to snap back to the center position. Observe value. Move the lever(s) to the full stroke position and hold. Observe value.
    Does Display value = 0%? at the center position and 92 to 100% at the full stroke position?
    YES: Repair complete. Resume Operation.
    NO: Go to CAUSE D.

CAUSE D - EMERGENCY LOWER VALVE IS PARTIALLY OPEN.

PROCEDURE OR ACTION:

NOTE: Emergency lower valve has tee handle located on control valve. See **Operating Manual** for location and correct use.

1. Check and close valve. If problem is still present, go to CAUSE E.

CAUSE E - LIFT SPEED IS SET AT 0%.

PROCEDURE OR ACTION:

1. Check current setting of lift hydraulic function. Go to Display Menu/Truck Set-Up/Hydraulic Function.
   Is Hydraulic Function set at 0%?
   YES: Reset hydraulic function to appropriate level.
   NO: Go to CAUSE F.

CAUSE F - MAIN RELIEF VALVE IS SET TOO LOW.

PROCEDURE OR ACTION:

1. Test and adjust pressure. See Primary Relief Valve Test and Adjustment.
   Is relief set at specifications?
   YES: Go to CAUSE G.
   NO: Adjust pressure to test specifications.

CAUSE G - MAIN RELIEF VALVE DAMAGED OR STUCK OPEN.

PROCEDURE OR ACTION:

1. Remove and inspect relief valve. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   Is relief valve damaged or stuck open?
   YES: Install new relief valve. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   NO: Go to CAUSE H.

CAUSE H - SECONDARY RELIEF VALVE DAMAGED OR STUCK OPEN.

PROCEDURE OR ACTION:

NOTE: This only affects hoist circuit when a auxiliary function is activated.

1. Test and adjust pressure. See Secondary Relief Valve Test and Adjustment.
   Is relief set at specifications?
   YES: Go to CAUSE I.
   NO: Adjust pressure to test specifications.

CAUSE I - MAST LOWERING CONTROL VALVE BLOCKING FLOW.

PROCEDURE OR ACTION:

1. Inspect mast lowering control valve for blockage.
   Is mast lowering control valve blocking flow?
   YES: Repair or replace mast lowering control valve. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.
   NO: Go to CAUSE J.

CAUSE J - UNLOADER SPOOL IS STUCK OPEN.

PROCEDURE OR ACTION:

1. Inspect and repair unloader spool. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337. If problem is still present, go to CAUSE K.

CAUSE K - MAIN CONTROL VALVE LS (LOAD SENSE) RELIEF LEAKAGE.

PROCEDURE OR ACTION:

1. Check LS pressure. See Main Control Valve LS Leakage Test (E-Valve).
   Does LS pressure meet test specifications?
   YES: See Observed Symptoms-Gear Pump, Too Much MLM Movement (Deadband) to Start Function Moving (E-Valve), Page 9050-33-47.
   NO: Clean or replace main relief valve. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.

END SYMPTOM

Lift/Lower Continues To Move For Awhile After MLM Is Released (E-Valve)

POSSIBLE CAUSE

CAUSE A - RAMP SETTINGS TO HIGH/LOW FOR OPERATION.

PROCEDURE OR ACTION:

WARNING

Unexpected movement of hydraulic function can cause injury or death. Do not operate the lift truck until problem has been repaired.

1. Depending on associated hydraulic function, adjust ramp settings until operation is acceptable to operator.

Lift/Lower/Auxiliary Function Suddenly Jumps In Middle of Stroke (E-Valve)

POSSIBLE CAUSE

A. STICKING VALVE SPOOL (AUXILIARY FUNCTIONS ONLY).
B. VALVE SPOOL END SPRINGS TOO SOFT (AUXILIARY FUNCTIONS ONLY).

CAUSE A - STICKING VALVE SPOOL (AUXILIARY FUNCTIONS ONLY).

PROCEDURE OR ACTION:

1. Remove and inspect spool. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   Is the spool undamaged and moves freely in bore?
   YES: CAUSE B.
   NO: Clean or replace valve spool.

CAUSE B - VALVE SPOOL END SPRINGS TOO SOFT (AUXILIARY FUNCTIONS ONLY).

PROCEDURE OR ACTION:

1. Replace springs. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.

END SYMPTOM

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Lower Function Will Not Move With MLM Movement (E-Valve)

POSSIBLE CAUSE

A. LOWER SPEED IS SET AT 0%.
B. MLM CONTROL MALFUNCTION.

CAUSE A - LOWER SPEED IS SET AT 0%.

PROCEDURE OR ACTION:

1. Check current setting of lower hydraulic function. Go to Display Menu/Truck Set-Up/Hydraulic Function.
   Is Hydraulic Function set at 0%?
   YES: Reset hydraulic function to appropriate level.
   NO: Go to CAUSE B.

CAUSE B - MLM CONTROL MALFUNCTION.

PROCEDURE OR ACTION:

1. Power **ON** and operator in seat. Operate lift/lower Lever.
   Is a hydraulic interlock message displayed?
   YES: Go to Display Menu/Diagnostics/Seat (Operator Presence), then go to Step 2.
   NO: Go to Step 3.
2. Observe Value.
   Is Operator Presence sensor value greater than 1.8 volts?
   YES: Go to Display Menu/Diagnostics/Hydraulics Inputs/Lever Input values, then go to Step 3.
   NO: Go to Seat Sensor Out of Range Low (OORL).
3. Operate lift/lower lever in both directions.
   Does lever exhibit any binding/stickiness or not return to center position?
   YES: Remove and replace lever. (See **Electrical System** 2200SRM1369 or **Electrical System** 2200SRM1337 .) **Note:** Inspect cassette rotary mechanism for dirt contamination.
   NO: Go to Step 4.
4. Move lever(s) to full stroke position and allow to snap back to the center position. Observe value. Move the lever(s) to the full stroke position and hold. Observe value.
   Does Display value = 0% at the center position and 92 to 100% at the full stroke position?
   YES: Repair complete. Resume operation
   NO: Go to Step 5.
5. Power **OFF**. Replace lever(s). (See **Electrical System** 2200SRM1369 or **Electrical System** 2200SRM1337 .)
6. Retest. Turn power **ON**.
7. Go to Display Menu/Diagnostics/Hydraulics Inputs/Lever Input values.
8. Move lever(s) to full stroke position and allow to snap back to the center position. Observe value. Move the lever(s) to the full stroke position and hold. Observe value.
   Does display value = 0% at the center position and 92 to 100% at the full stroke position?
   YES: Repair complete. Resume operation.
   NO: Replace MLM PCB Cassette. (See **Electrical System** 2200SRM1369 or **Electrical System** 2200SRM1337 .)
9. Retest.

END SYMPTOM

Poor Metering on Lift or Lower Functions (E-Valve)

POSSIBLE CAUSE

A. AIR TRAPPED IN CIRCUIT.
B. RAMP SETTING TOO HIGH FOR FUNCTION.
C. OUTPUT THRESHOLD IS SET TOO HIGH.
D. MAST/ATTACHMENT IS BINDING.
E. MLM CONTROL MALFUNCTION.
F. MAST LOWERING CONTROL VALVE IS STICKING.
G. STICKING UNLOADER SPOOL (LIFT FUNCTION ONLY).
H. MAIN CONTROL VALVE LS (LOAD SENSE) RELIEF LEAKAGE.

CAUSE A - AIR TRAPPED IN CIRCUIT.

PROCEDURE OR ACTION:

1. Remove air from circuit by cycling function full stroke of hydraulic hoist cylinder at one second intervals. If symptom is still present, go to CAUSE B.

CAUSE B - RAMP SETTING TOO HIGH FOR FUNCTION.

PROCEDURE OR ACTION:

WARNING
Unexpected movement of hydraulic function can cause injury or death. Do not operate the lift truck until problem has been repaired.

1. Adjust function ramp setting on Display Panel. See **User Interface Service Technician** 2200SRM1336. If problem is still present, go to CAUSE C.

CAUSE C - OUTPUT THRESHOLD IS SET TOO HIGH.

PROCEDURE OR ACTION:

1. Check current at E-Hydraulic Valve.
   Is setting at valve correct?
   YES: Go to CAUSE D.
   NO: Decrease setting to specification or until operation is acceptable to operator.

CAUSE D - MAST/ATTACHMENT IS BINDING.

PROCEDURE OR ACTION:

1. Check for mast or attachment binding.
   Is mast or attachment binding?
   YES: Repair or lubricate mast or attachment. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.
   NO: Go to CAUSE E.

CAUSE E - MLM CONTROL MALFUNCTION.

PROCEDURE OR ACTION:

1. Ensure power is **OFF**. Operate lift/lower lever in both directions.
   Does lever exhibit any binding/stickiness or not return to center position?
   YES: Remove and replace lever. (See **Electrical System** 2200SRM1369 or **Electrical System** 2200SRM1337 .) **Note:** Inspect cassette rotary mechanism for dirt contamination.
   NO: Go to Step 2.
2. Turn Power **ON**.
3. Go to the Display Menu/Diagnostics/Hydraulics Inputs/Lever Input values.
4. Move lever(s) to full stroke position and allow to snap back to the center position.
   Does Display value = 0%?
   YES: Go to CAUSE F.
   NO: Go to Step 5.
5. Power **OFF**. Replace lift/lower lever. (See **Electrical System** 2200SRM1369 or **Electrical System** 2200SRM1337 .)
6. Retest. Turn power **ON**.
7. Go to Display Menu/Diagnostics/Hydraulics Inputs/Lever Input values.
8. Move lever(s) to full stroke position and allow to snap back to the center position. Observe value. Move the lever(s) to the full stroke position and hold. Observe value.
   Does Display value = 0% at the center position and 92 to 100% at the full stroke position?
   YES: Go to CAUSE F.
   NO: Replace MLM PCB Cassette. (See **Electrical System** 2200SRM1369 or **Electrical System** 2200SRM1337 .)
9. Retest.

CAUSE F - MAST LOWERING CONTROL VALVE IS STICKING.

PROCEDURE OR ACTION:

1. Inspect mast lowering control valve for proper operation. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.
   Is mast lowering control valve sticking?
   YES: Repair or replace mast lowering control valve.
   NO: Go to CAUSE G.

CAUSE G - STICKING UNLOADER SPOOL (LIFT FUNCTION ONLY).

PROCEDURE OR ACTION:

1. Inspect unloader valve for damage or contamination. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   Is unloader free of contamination and in good condition?
   YES: Go to CAUSE H.
   NO: Clean or replace unloader valve.

CAUSE H - MAIN CONTROL VALVE LS (LOAD SENSE) RELIEF LEAKAGE.

PROCEDURE OR ACTION:

1. Check LS pressure. See Main Control Valve LS Leakage Test (E-Valve).
   Does LS pressure meet test specifications?
   YES: See Observed Symptoms-Gear Pump, Lift Function Will Not Move With MLM Movement (E-Valve), Page 9050-33-25.
   NO: Clean or replace main relief valve. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.

END SYMPTOM

Auxiliary Function Continues to Move for Awhile After MLM Is Released (E-Valve)

POSSIBLE CAUSE

A. RAMP SETTINGS TO HIGH/LOW FOR OPERATION.
B. STICKING VALVE SPOOL.

CAUSE A - RAMP SETTINGS TO HIGH/LOW FOR OPERATION.

PROCEDURE OR ACTION:

WARNING

Unexpected movement of hydraulic function can cause injury or death. Do not operate the lift truck until problem has been repaired.

1. Depending on associated hydraulic function, adjust ramp settings for proper operation. See **User Interface Service Technician** 2200SRM1336. If problem is still present, go to CAUSE B.

CAUSE B - STICKING VALVE SPOOL.

PROCEDURE OR ACTION:

1. Remove and inspect spool. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   Is the spool undamaged and moves freely in bore?
   YES: Resume operation.
   NO: Clean or replace valve spool.

END SYMPTOM

Auxiliary Function Maximum Speed Too Slow (E-Valve)

POSSIBLE CAUSE

A. MAX FUNCTION SPEED SETTING TOO LOW.
B. RAMP SETTING TOO LOW FOR FUNCTION.
C. OUTPUT THRESHOLD IS SET TOO LOW.
D. MAST/ATTACHMENT IS BINDING.
E. MLM CONTROL MALFUNCTION.
F. ORIFICES INSTALLED IN CIRCUIT TOO SMALL (ON AFTERMARKET CYLINDERS).
G. MAIN RELIEF VALVE DAMAGED OR STUCK OPEN.
H. SECONDARY RELIEF VALVE DAMAGED OR STUCK OPEN.
I. PROPORTIONAL PRESSURE REDUCING VALVE TOO LOW.
J. STICKING SPOOL.
K. UNLOADER NOT PRODUCING ENOUGH MARGIN PRESSURE.
L. MAIN CONTROL VALVE LS (LOAD SENSE) RELIEF LEAKAGE.

CAUSE A - MAX FUNCTION SPEED SETTING TOO LOW.

PROCEDURE OR ACTION:

1. Adjust function speed setting on Display Panel. If problem is still present, go to CAUSE B.

CAUSE B - RAMP SETTING TOO LOW FOR FUNCTION.

PROCEDURE OR ACTION:

WARNING
Unexpected movement of hydraulic function can cause injury or death. Do not operate the lift truck until problem has been repaired.

1. Adjust function ramp setting on Display Panel. See **User Interface Service Technician** 2200SRM1336. If problem is still present, go to CAUSE C.

CAUSE C - OUTPUT THRESHOLD IS SET TOO LOW.

PROCEDURE OR ACTION:

1. Check current at Electro-Hydraulic Poppet Valve (EHPV). Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   Is setting at valve correct?
   YES: Go to CAUSE D.
   NO: Increase setting until operation is acceptable to operator.

CAUSE D - MAST/ATTACHMENT IS BINDING.

PROCEDURE OR ACTION:

1. Check for mast or attachment binding.
   Is mast or attachment binding?
   YES: Lubricate or repair mast or attachment. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.
   NO: Go to CAUSE E.

CAUSE E - MLM CONTROL MALFUNCTION.

PROCEDURE OR ACTION:

1. Turn power **ON**.
2. Go to Display Menu/Diagnostics/Hydraulics Inputs/Lever Input values.
3. Move Lever to full stroke position – both directions.
   Is Display value >=92%?
   YES: Go to CAUSE F.
   NO: Go to Step 4.
4. Power **OFF**. Replace Auxiliary Lever(s). (See **Electrical System** 2200SRM1369 or **Electrical System** 2200SRM1337 .)
5. Retest. Turn power **ON**.
6. Go to Display Menu/Diagnostics/Hydraulics Inputs/Lever Input values.
7. Move lever to full stroke position – both directions.
   Is Display value >=92%?
   YES: Go to CAUSE F.
   NO: Replace MLM PCB Cassette. (See **Electrical System** 2200SRM1369 or **Electrical System** 2200SRM1337 .)

CAUSE F - ORIFICES INSTALLED IN CIRCUIT TOO SMALL (ON AFTERMARKET CYLINDERS).

PROCEDURE OR ACTION:

1. Check cycle times. See aftermarket specifications.
   Do cycle times meet specifications?
   YES: Go to CAUSE G.
   NO: Inspect and replace orifices in cylinder ports. See aftermarket service manuals.

CAUSE G - MAIN RELIEF VALVE DAMAGED OR STUCK OPEN.

PROCEDURE OR ACTION:

1. Install pressure gauge in hydraulic control valve. See Primary Relief Valve Test and Adjustment.
2. Hold lift function over relief.
   Does relief pressure meet test specifications?
   YES: Go to CAUSE H.
   NO: Replace relief valve. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.

CAUSE H - SECONDARY RELIEF VALVE DAMAGED OR STUCK OPEN.

PROCEDURE OR ACTION:

1. Test and adjust pressure. See Secondary Relief Valve Test and Adjustment.
   Is relief set at specifications?
   YES: Go to CAUSE I.
   NO: Adjust pressure to test specifications.

CAUSE I - PROPORTIONAL PRESSURE REDUCING VALVE TOO LOW.

PROCEDURE OR ACTION:

1. Test Proportional Pressure Reducing Valve (PPRV) pressure.
   Is PPRV pressure at specifications?
   YES: Go to CAUSE J.
   NO: Clean screen on PPRV. If problem is still present, replace PPRV. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.

CAUSE J - STICKING SPOOL.

PROCEDURE OR ACTION:

1. Inspect spool. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   Is spool clean and in good condition?
   YES: Go to CAUSE K.
   NO: Clean or replace spool.

CAUSE K - UNLOADER NOT PRODUCING ENOUGH MARGIN PRESSURE.

PROCEDURE OR ACTION:

1. Test unloader spool spring. See Main Control Valve Unloader Margin Test.
   Does unloader valve pressure meet test specifications?
   YES: Go to CAUSE L.
   NO: Replace spring.

CAUSE L - MAIN CONTROL VALVE LS (LOAD SENSE) RELIEF LEAKAGE.

PROCEDURE OR ACTION:

1. Check LS pressure. See Main Control Valve LS Leakage Test (E-Valve).
   Does LS pressure meet test specifications?
   YES: Check for DTCs. See Electrical System, General Maintenance and Diagnostic Data, Diagnostic Trouble Codes, Page 9030-03-6.
   NO: Clean or replace main relief valve. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.

END SYMPTOM

Auxiliary Function or Tilt Back Moves Without Command (E-Valve)

POSSIBLE CAUSE

A. MLM CONTROL MALFUNCTION.
B. EXCESSIVE SPOOL LEAKAGE.

CAUSE A - MLM CONTROL MALFUNCTION.

PROCEDURE OR ACTION:

1. Ensure power is **OFF**. Operate lever in both directions.
   Does lever exhibit any binding/stickiness or not return to center position?
   YES: Remove and replace lever. (See **Electrical System** 2200SRM1369 or **Electrical System** 2200SRM1337 .) **Note:** Inspect cassette rotary mechanism for dirt contamination.
   NO: Go to Step 2.
2. Turn power **ON**.
3. Go to the Display Menu/Diagnostics/Hydraulics Inputs/Lever Input values.
4. Move lever(s) to full stroke position and allow to snap back to the center position.
   Does Display value = 0%?
   YES: Go to CAUSE B.
   NO: Go to Step 5.
5. Power **OFF**. Replace lever. (See **Electrical System** 2200SRM1369 or **Electrical System** 2200SRM1337 .)
6. Retest. Turn power **ON**.
7. Go to Display Menu/Diagnostics/Hydraulics Inputs/Lever Input values.
8. Move lever(s) to full stroke position and allow to snap back to the center position.
   Does Display value = 0%?
   YES: Go to CAUSE B.
   NO: Replace MLM PCB Cassette. See **Electrical System** 2200SRM1369 or **Electrical System** 2200SRM1337.
9. Retest. Turn power **ON**.
10. Go to Display Menu/Diagnostics/Hydraulics Inputs/Lever Input values.
11. Move lever(s) to full stroke position and allow to snap back to the center position.
    Does Display value = 0%?
    YES: Repair Complete. Resume operation.
    NO: Go to CAUSE B.

CAUSE B - EXCESSIVE SPOOL LEAKAGE.

PROCEDURE OR ACTION:

1. Check spool for items below. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   - Damage
   - Free movement
   - Debris or contamination

   Is spool and mating bore in good condition?
   YES: See Observed Symptoms-Gear Pump, Auxiliary Function Continues to Move for Awhile After MLM Is Released (E-Valve), Page 9050-33-35.
   NO: Replace damaged parts.

END SYMPTOM

Auxiliary Function, Tilt Back and/or Tilt Forward Will Not Move With MLM Movement (E-Valve)

POSSIBLE CAUSE

A. PUMP NOT GENERATING ENOUGH FLOW.
B. LOAD IS GREATER THAN TRUCK CAPACITY.
C. MLM CONTROL MALFUNCTION.
D. HYDRAULIC FUNCTION SPEED IS SET AT 0%.
E. SECONDARY RELIEF VALVE IS SET TOO LOW.
F. MAST/ATTACHMENT IS BINDING.
G. STUCK SPOOL IN CONTROL VALVE.
H. PROPORTIONAL PRESSURE REDUCING VALVE TOO LOW.
I. SECONDARY RELIEF VALVE DAMAGED OR STUCK OPEN.
J. MAIN RELIEF VALVE DAMAGED OR STUCK OPEN.
K. UNLOADER VALVE STUCK OPEN.
L. MAIN RELIEF LS (LOAD SENSE) STUCK OPEN.
M. MAIN CONTROL VALVE LS (LOAD SENSE) RELIEF LEAKAGE.

CAUSE A - PUMP NOT GENERATING ENOUGH FLOW.

PROCEDURE OR ACTION:

1. Do hydraulic pump flow check.
   Does pump pass check?
   YES: Pump is OK. Go to CAUSE B.
   NO: Perform Hydraulic Pump Flow Test before replacing pump.

CAUSE B - LOAD IS GREATER THAN TRUCK CAPACITY.

NOTE: See Serial Number plate or **Operating Manual** for lift capacity.

PROCEDURE OR ACTION:

1. Check load weight and compare to truck capacity rating. Adjust as necessary. If problem is still present, go to CAUSE C.

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CAUSE C - MLM CONTROL MALFUNCTION.

PROCEDURE OR ACTION:

1. Power **ON** and operator in seat. Operate lever/s.
   Is a hydraulic interlock message displayed?
   YES: Go to Display Menu/Diagnostics/Seat (Operator Presence), then go to Step 2.
   NO: Go to CAUSE D.
2. Observe value.
   Is Operator Presence sensor value greater than 1.8 volts?
   YES: Go to Display Menu/Diagnostics/Hydraulics Inputs/Lever Input values, then go to Step 3.
   NO: Go to Seat Sensor Out of Range Low (OORL).
3. Operate lever/s in both directions.
   Does lever exhibit any binding/stickiness or not return to center position?
   YES: Remove and replace lever. (See **Electrical System** 2200SRM1369 or **Electrical System** 2200SRM1337 .) **Note:** Inspect cassette rotary mechanism for dirt contamination.
   NO: Go to Next Step.
4. Move lever(s) to full stroke position and allow to snap back to the center position. Observe Value. Move the lever(s) to the full stroke position and hold. Observe Value.
   Does Display value = 0% at the center position and 92 to 100% at the full stroke position?
   YES: Go to CAUSE D.
   NO: Go to Step 5.
5. Power **OFF**. Replace lever(s). (See **Electrical System** 2200SRM1369 or **Electrical System** 2200SRM1337 .)
6. Retest. Turn power **ON**.
7. Go to Display Menu/Diagnostics/Hydraulics Inputs/Lever Input values.
8. Move lever(s) to full stroke position and allow to snap back to the center position. Observe value. Move the lever(s) to the full stroke position and hold. Observe value.
   Does Display value = 0% at the center position and 92 to 100% at the full stroke position?
   YES: Repair complete. Resume operation.
   NO: Replace MLM PCB Cassette. (See **Electrical System** 2200SRM1369 or **Electrical System** 2200SRM1337 .)
9. Retest. Turn power **ON**.
10. Go to Display Menu/Diagnostics/Hydraulics Inputs/Lever Input values.
11. Move lever(s) to full stroke position and allow to snap back to the center position. Observe value. Move the lever(s) to the full stroke position and hold. Observe value.
    Does Display value = 0%? at the center position and 92 to 100% at the full stroke position?
    YES: Repair complete. Resume operation.
    NO: Go to CAUSE D.

CAUSE D - HYDRAULIC FUNCTION SPEED IS SET AT 0%.

PROCEDURE OR ACTION:

1. Check current setting of tilt hydraulic function. Go to Display Menu/Truck Set-Up/Hydraulic Function.
   Is Hydraulic Function set at 0%?
   YES: Reset hydraulic function to appropriate level.
   NO: Go to CAUSE E.

CAUSE E - SECONDARY RELIEF VALVE IS SET TOO LOW.

PROCEDURE OR ACTION:

1. Test and adjust pressure. See Secondary Relief Valve Test and Adjustment.
   Is relief set at specifications?
   YES: Go to CAUSE F.
   NO: Adjust pressure to test specifications.

CAUSE F - MAST/ATTACHMENT IS BINDING.

PROCEDURE OR ACTION:

1. Check for mast or attachment binding.
   Is mast or attachment binding?
   YES: Lubricate or repair mast or attachment. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.
   NO: Go to CAUSE G.

CAUSE G - STUCK SPOOL IN CONTROL VALVE.

PROCEDURE OR ACTION:

1. Remove and inspect spool. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   Does the spool move freely in bore and in good condition?
   YES: Go to CAUSE H.
   NO: Repair or replace valve spool or section.

CAUSE H - PROPORTIONAL PRESSURE REDUCING VALVE TOO LOW.

PROCEDURE OR ACTION:

1. Test Proportional Pressure Reducing Valve (PPRV) pressure.
   Is PPRV pressure at specifications?
   YES: Go to CAUSE I.
   NO: Clean screen on PPRV. If problem is still present, replace PPRV. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.

CAUSE I - SECONDARY RELIEF VALVE DAMAGED OR STUCK OPEN.

PROCEDURE OR ACTION:

NOTE: This only affects hoist circuit when a auxiliary function is activated.

1. Test and adjust pressure. See Secondary Relief Valve Test and Adjustment.
   Is relief set at specifications?
   YES: Go to CAUSE J.
   NO: Adjust pressure to test specifications.

CAUSE J - MAIN RELIEF VALVE DAMAGED OR STUCK OPEN.

PROCEDURE OR ACTION:

1. Remove and inspect relief valve. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   Is relief valve damaged or stuck open?
   YES: Install new relief valve. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   NO: Go to CAUSE K.

CAUSE K - UNLOADER VALVE STUCK OPEN.

PROCEDURE OR ACTION:

1. Remove and inspect unloader spool. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   Does unloader spool move freely in bore and in good condition?
   YES: Go to CAUSE L.
   NO: Repair or replace unloader spool.

CAUSE L - MAIN RELIEF LS (LOAD SENSE) STUCK OPEN.

PROCEDURE OR ACTION:

1. Remove and inspect main relief valve. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   Is the LS relief clean and spring OK?
   YES: Go to CAUSE M.
   NO: Check for contamination. Clean or replace relief valve.

CAUSE M - MAIN CONTROL VALVE LS (LOAD SENSE) RELIEF LEAKAGE.

PROCEDURE OR ACTION:

1. Check LS pressure. See Main Control Valve LS Leakage Test (E-Valve).
   Does LS pressure meet test specifications?
   YES: See Observed Symptoms-Gear Pump, Too Much MLM Movement (Deadband) to Start Function Moving (E-Valve), Page 9050-33-47.
   NO: Clean or replace main relief valve. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.

END SYMPTOM

Tilt Forward or Tilt Back Function Continues to Move for Awhile When MLM Is Released (E-Valve)

POSSIBLE CAUSE

A. RAMP SETTINGS TO HIGH/LOW FOR OPERATION.
B. STICKING VALVE SPOOL.
C. STICKING TILT CONTROL PISTON IN TILT SPOOL.

CAUSE A - RAMP SETTINGS TO HIGH/LOW FOR OPERATION.

PROCEDURE OR ACTION:

WARNING
Unexpected movement of hydraulic function can cause injury or death. Do not operate the lift truck until problem has been repaired.

1. Depending on associated hydraulic function, adjust ramp settings for proper operation. See **User Interface Service Technician** 2200SRM1336. If problem is still present, go to CAUSE B.

CAUSE B - STICKING VALVE SPOOL.

PROCEDURE OR ACTION:

1. Remove and inspect spool. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   Is the spool undamaged and moves freely in bore?
   YES: Go to CAUSE C.
   NO: Clean or replace valve spool.

CAUSE C - STICKING TILT CONTROL PISTON IN TILT SPOOL.

PROCEDURE OR ACTION:

1. Inspect piston. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   Does piston move freely in bore?
   YES: Resume operation.
   NO: Clean piston or replace valve section.

END SYMPTOM

Tilt Forward or Tilt Back Will Not Move With MLM Movement (E-Valve)

POSSIBLE CAUSE

A. MLM CONTROL MALFUNCTION.
B. TILT SPEED IS SET AT 0%.
C. PROPORTIONAL PRESSURE REDUCING VALVE TOO LOW.
D. STUCK SPOOL IN CONTROL VALVE.

CAUSE A - MLM CONTROL MALFUNCTION.

PROCEDURE OR ACTION:

1. Power **ON** and Operator in Seat. Operate Lever/s.
   Is a hydraulic interlock message displayed?
   YES: Go to Display Menu/Diagnostics/Seat (Operator Presence), then go to Step 2.
   NO: Go to CAUSE B.
2. Observe value
   Is Operator Presence sensor value greater than 1.8 volts?
   YES: Go to Display Menu/Diagnostics/Hydraulics Inputs/Lever Input values, then go to Step 3.
   NO: Go to Seat Sensor Out of Range Low (OORL).
3. Operate lever/s in both directions.
   Does lever exhibit any binding/stickiness or not return to center position?
   YES: Remove and replace lever. See **Electrical System** 2200SRM1369 or **Electrical System** 2200SRM1337. **Note:** Inspect cassette rotary mechanism for dirt contamination.
   NO: Go to Step 4.
4. Move lever(s) to full stroke position and allow to snap back to the center position. Observe Value. Move the lever(s) to the full stroke position and hold. Observe value.
   Does Display value = 0% at the center position and 92 to 100% at the full stroke position?
   YES: Go to CAUSE B.
   NO: Go to Step 5.
5. Power **OFF**. Replace lever(s). (See **Electrical System** 2200SRM1369 or **Electrical System** 2200SRM1337. .)
6. Retest. Turn power **ON**.
7. Go to Display Menu/Diagnostics/Hydraulics Inputs/Lever Input values.
8. Move lever(s) to full stroke position and allow to snap back to the center position. Observe value. Move the lever(s) to the full stroke position and hold. Observe value.
   Does Display value = 0% at the center position and 92 to 100% at the full stroke position?
   YES: Repair complete. Resume operation.
   NO: Replace MLM PCB Cassette. See **Electrical System** 2200SRM1369 or **Electrical System** 2200SRM1337.
9. Retest. Turn power **ON**.
10. Go to Display Menu/Diagnostics/Hydraulics Inputs/Lever Input values.
11. Move lever(s) to full stroke position and allow to snap back to the center position. Observe value. Move the lever(s) to the full stroke position and hold. Observe value.
    Does Display value = 0%? at the center position and 92 to 100% at the full stroke position?
    YES: Repair complete. Resume operation.
    NO: Go to CAUSE B.

CAUSE B - TILT SPEED IS SET AT 0%.

PROCEDURE OR ACTION:

1. Check current setting of tilt hydraulic function. Go to Display Menu/Truck Set-Up/Hydraulic Function.
   Is Hydraulic Function set at 0%?
   YES: Reset hydraulic function to appropriate level.
   NO: Go to CAUSE C.

CAUSE C - PROPORTIONAL PRESSURE REDUCING VALVE TOO LOW.

PROCEDURE OR ACTION:

1. Test Proportional Pressure Reducing Valve (PPRV) pilot pressure.
   Is PPRV pressure at specifications?
   YES: Go to CAUSE D.
   NO: Clean screen on PPRV. If problem is still present, replace PPRV. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.

CAUSE D - STUCK SPOOL IN CONTROL VALVE.

PROCEDURE OR ACTION:

1. Remove, disassemble, and inspect spool. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   Does the spool move freely in bore and in good condition?
   YES: See Observed Symptoms-Gear Pump, Auxiliary Function, Tilt Back and/or Tilt Forward Will Not Move With MLM Movement (E-Valve), Page 9050-33-40.
   NO: Repair or replace valve spool or section.

END SYMPTOM

Too Much MLM Movement (Deadband) to Start Function Moving (E-Valve)

POSSIBLE CAUSE

CAUSE A - OUTPUT THRESHOLD IS SET TOO HIGH.

PROCEDURE OR ACTION:

1. Check threshold at Display Panel.
   Is setting at valve correct?
   YES:
   - For hoist/lower functions, see Observed Symptoms-Gear Pump, Jump/Delay In Lift or Lower Activation After Moving MLM (E-Valve), Page 9050-33-7.
   - For auxiliary functions, see Observed Symptoms-Gear Pump, Jump/Delay In Auxiliary Function Actuation After Moving MLM (E-Valve), Page 9050-33-9.
   - For tilt forward function, see Observed Symptoms-Gear Pump, Jump/Delay In Tilt Forward or Back Actuation (E-Valve), Page 9050-33-11.

   NO: Decrease setting to specification or until operation is acceptable to operator.

Wrong Actuation Operates or Actuation is Backward (E-Valve)

POSSIBLE CAUSE

A. WIRING HARNESS INSTALLED WRONG.
B. HYDRAULIC HOSES INSTALLED WRONG.
C. WIRING HARNESS HAS FAILED.

CAUSE A - WIRING HARNESS INSTALLED WRONG.

PROCEDURE OR ACTION:

WARNING

Unexpected movement of hydraulic function can cause injury or death. Do not operate the lift truck until problem has been repaired.

1. Inspect wiring harness. Depending on your lift truck, see **Electrical System** 2200SRM1369 or **Electrical System** 2200SRM1337 .
   Is harness installed correctly?
   YES: Go to CAUSE B.
   NO: Adjust or repair harness. See **Wire Harness Repair** 2200SRM1128.

CAUSE B - HYDRAULIC HOSES INSTALLED WRONG.

PROCEDURE OR ACTION:

1. Inspect hydraulic hose routing and correct as required. If problem is still present, go to CAUSE C.

CAUSE C - WIRING HARNESS HAS FAILED.

PROCEDURE OR ACTION:

1. Inspect harness for shorts.
   Does harness have a short?
   YES: Repair wiring harness. See **Wire Harness Repair** 2200SRM1128.
   NO: Resume operation.

END SYMPTOM

Actuation Exhibits Slight Movement in Opposite Direction Before Moving (Manual Valve)

POSSIBLE CAUSE

A. AIR WAS NOT REMOVED AFTER REPAIR TO THE HYDRAULIC SYSTEM.
B. EXCESSIVE CONTROL VALVE SPOOL OR CYLINDER LEAKAGE.

CAUSE A - AIR WAS NOT REMOVED AFTER REPAIR TO THE HYDRAULIC SYSTEM.

PROCEDURE OR ACTION:

1. Check service record of lift truck.
   Was hydraulic system repaired recently?
   YES: Check the repaired hose connections and remove air from system by cycling function full stroke of steering cylinder in each direction.
   NO: Go to CAUSE B.

CAUSE B - EXCESSIVE CONTROL VALVE SPOOL OR CYLINDER LEAKAGE.

PROCEDURE OR ACTION:

1. Identify if problem is in lift cylinder or control valve. Do Lift Cylinder Leakage Test.
   Does lift cylinder pass leakage test.
   YES: Problem is in control valve. Clean and repair. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   NO: Repair or replace lift cylinder. Depending on your lift truck see, **Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564)** 2100SRM1382 or **Cylinder Repair (Mast S/N B551, B555, B559)** 2100SRM1440.

END SYMPTOM

Auxiliary Function is Slow or Does Not Function (Manual Valve)

POSSIBLE CAUSE

A. OPERATOR PRESENCE SENSOR HAS HYDRAULIC FUNCTION LOCKED OUT.
B. PUMP NOT GENERATING ENOUGH FLOW.
C. LOAD IS GREATER THAN TRUCK CAPACITY.
D. AUXILIARY FUNCTION SPEED IS SET AT 0%.
E. SPOOL IS NOT FULLY ACTUATED.
F. SECONDARY RELIEF VALVE IS SET TOO LOW.
G. SECONDARY RELIEF VALVE DAMAGED OR STUCK OPEN.
H. MAIN RELIEF VALVE SET TOO LOW, DAMAGED, OR STUCK OPEN.
I. MAST/ATTACHMENT IS BINDING.
J. EXCESSIVE INTERNAL SPOOL LEAKAGE.

CAUSE A - OPERATOR PRESENCE SENSOR HAS HYDRAULIC FUNCTION LOCKED OUT.

PROCEDURE OR ACTION:

1. Power **ON** and operator in seat. Operate auxiliary lever.
   Is a hydraulic interlock message displayed?
   YES: Go to Display Menu/Diagnostics/Seat (Operator Presence), then go to Step 2.
   NO: Go to CAUSE B.
2. Observe value.
   Is Operator Presence sensor value greater than 1.8 volts?
   YES: Go to CAUSE B.
   NO: Go to Seat Sensor Out of Range Low (OORL).

CAUSE B - PUMP NOT GENERATING ENOUGH FLOW.

PROCEDURE OR ACTION:

1. Do hydraulic pump flow check.
   Does pump pass check?
   YES: Pump is OK. Go to CAUSE C.
   NO: Do Hydraulic Pump Flow Test before replacing pump.

CAUSE C - LOAD IS GREATER THAN TRUCK CAPACITY.

NOTE: See Serial Number plate or **Operating Manual** for lift capacity.

PROCEDURE OR ACTION:

1. Check load weight and compare to truck capacity rating. Adjust as necessary. If problem is still present, go to CAUSE D.

CAUSE D - AUXILIARY FUNCTION SPEED IS SET AT 0%.

PROCEDURE OR ACTION:

1. Depending on associated hydraulic function, adjust ramp settings for proper operation. See **User Interface Service Technician** 2200SRM1336. If problem is still present, go to CAUSE E.

CAUSE E - SPOOL IS NOT FULLY ACTUATED.

PROCEDURE OR ACTION:

1. Inspect linkage. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   Does linkage prematurely contact dash?
   YES: Repair or replace linkage.
   NO: Go to CAUSE F.

CAUSE F - SECONDARY RELIEF VALVE IS SET TOO LOW.

PROCEDURE OR ACTION:

1. Test and adjust pressure. See Secondary Relief Valve Test and Adjustment.
   Is relief set at specifications?
   YES: Go to CAUSE G.
   NO: Adjust pressure to test specifications.

CAUSE G - SECONDARY RELIEF VALVE DAMAGED OR STUCK OPEN.

PROCEDURE OR ACTION:

1. Remove and inspect relief valve. See **Hydraulic System** 1900SRM1333.
   Is relief valve damaged or stuck open?
   YES: Install new relief valve.
   NO: Go to CAUSE H.

CAUSE H - MAIN RELIEF VALVE SET TOO LOW, DAMAGED, OR STUCK OPEN.

PROCEDURE OR ACTION:

NOTE: This symptom only affects auxiliary functions when hoist function is activated.

1. Test and adjust pressure. See Primary Relief Valve Test and Adjustment.
   Is relief set at specifications?
   YES: Go to CAUSE I.
   NO: Adjust pressure to test specifications and retest. If problem is still present, replace relief valve. See **Hydraulic System** 1900SRM1333.

CAUSE I - MAST/ATTACHMENT IS BINDING.

PROCEDURE OR ACTION:

1. Check for mast or attachment binding.
   Is mast or attachment binding?
   YES: Repair mast or attachment. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.
   NO: Go to CAUSE J.

CAUSE J - EXCESSIVE INTERNAL SPOOL LEAKAGE.

PROCEDURE OR ACTION:

1. Replace spool or complete control valve. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.

END SYMPTOM

Cycle Times Too Fast - Fast Actuation (Manual Valve)

POSSIBLE CAUSE

A. ORIFICES MISSING OR INSTALLED IN WRONG CYLINDER PORTS (ON AFTERMARKET CYLINDERS).
B. FAULTY MAST LOWERING CONTROL VALVE (MLCV) FOR LOWERING FUNCTION ONLY.

CAUSE A - ORIFICES MISSING OR INSTALLED IN WRONG CYLINDER PORTS (ON AFTERMARKET CYLINDERS).

PROCEDURE OR ACTION:

1. Check cycle times. See aftermarket specifications.
   Are cycle times to specifications?
   YES: Go to CAUSE B.
   NO: Inspect and repair orifices in cylinder ports. Go to aftermarket Service Manuals.

CAUSE B - FAULTY MAST LOWERING CONTROL VALVE (MLCV) FOR LOWERING FUNCTION ONLY.

PROCEDURE OR ACTION:

1. Check the lowering cycle times.
   Are the lowering cycle times too fast?
   YES: Repair or replace MLCV. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.
   NO: Repeat lowering cycle times to make sure they are not too fast.

END SYMPTOM

Function Continues to Activate After Returning to Neutral

POSSIBLE CAUSE

A. CONTROL LINKAGE BINDING (MANUAL VALVE).
B. VALVE SPOOL STICKING IN BORE (MANUAL VALVE).
C. MLM SWITCH PROBLEM (E-VALVE).
D. SPOOL STUCK OPEN.

CAUSE A - CONTROL LINKAGE BINDING (MANUAL VALVE).

PROCEDURE OR ACTION:

WARNING
Unexpected movement of hydraulic function can cause injury or death. Do not operate the lift truck until problem has been repaired.

1. Inspect control linkage for sticking or binding. Repair or lubricate as required. If problem is still present, go to CAUSE B.

CAUSE B - VALVE SPOOL STICKING IN BORE (MANUAL VALVE).

PROCEDURE OR ACTION:

1. Inspect valve spool. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   Does valve spool move freely in bore?
   YES: Replace spool end cap centering springs. If problem is still present, go to CAUSE C.
   NO: Clean or replace valve spool.

CAUSE C - MLM SWITCH PROBLEM (E-VALVE).

PROCEDURE OR ACTION:

1. Check valve calibration.
   Is control valve calibrated correctly?
   YES: Go to CAUSE D.
   NO: Calibrate control valve.

CAUSE D - SPOOL STUCK OPEN.

PROCEDURE OR ACTION:

1. Inspect valve spool. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   Is valve spool damaged or stuck open?
   YES: Clean or replace valve spool.
   NO: Valve has excessive leakage. Replace valve spool.

END SYMPTOM

Lift Function Is Slow or Does Not Function (Manual Valve)

POSSIBLE CAUSE

A. OPERATOR PRESENCE SENSOR HAS HYDRAULIC FUNCTION LOCKED OUT.
B. PUMP NOT GENERATING ENOUGH FLOW.
C. LOAD IS GREATER THAN TRUCK CAPACITY.
D. EMERGENCY LOWER VALVE IS PARTIALLY OPEN.
E. LIFT SPEED IS SET AT 0%.
F. LIFT SPOOL IS NOT FULLY ACTUATED.
G. MAIN RELIEF VALVE IS SET TOO LOW.
H. MAIN RELIEF VALVE DAMAGED OR STUCK OPEN.
I. SECONDARY RELIEF VALVE DAMAGED OR STUCK OPEN.
J. MAST/ATTACHMENT IS BINDING.
K. EXCESSIVE INTERNAL SPOOL LEAKAGE.
L. MAST LOWERING CONTROL VALVE BLOCKING FLOW.

CAUSE A - OPERATOR PRESENCE SENSOR HAS HYDRAULIC FUNCTION LOCKED OUT.

PROCEDURE OR ACTION:

1. Power **ON** and operator in seat. Operate lift/lower lever.
   Is a hydraulic interlock message displayed?
   YES: Go to Display Menu/Diagnostics/Seat (Operator Presence), then go to Step 2.
   NO: Go to CAUSE B.
2. Observe value.
   Is Operator Presence sensor value greater than 1.8 volts?
   YES: Go to CAUSE B.
   NO: Go to Seat Sensor Out of Range Low (OORL).

CAUSE B - PUMP NOT GENERATING ENOUGH FLOW.

PROCEDURE OR ACTION:

1. Do hydraulic pump flow check.
   Does pump pass check?
   YES: Pump is OK. Go to CAUSE C.
   NO: Do Hydraulic Pump Flow Test before replacing pump.

CAUSE C - LOAD IS GREATER THAN TRUCK CAPACITY.

NOTE: See Serial Number plate or **Operating Manual** for lift capacity.

PROCEDURE OR ACTION:

1. Check load weight and compare to truck capacity rating. Adjust as necessary. If problem is still present, go to CAUSE D.

CAUSE D - EMERGENCY LOWER VALVE IS PARTIALLY OPEN.

PROCEDURE OR ACTION:

NOTE: Emergency lower valve has tee handle located on control valve. See **Operating Manual** for location and correct use.

1. Check and close valve. If problem is still present, go to CAUSE E.

CAUSE E - LIFT SPEED IS SET AT 0%.

PROCEDURE OR ACTION:

1. Check current setting of lift hydraulic function. Go to Display Menu/Truck Set-Up/Hydraulic Function.
   Is Hydraulic Function set at 0%?
   YES: Reset hydraulic function to appropriate level.
   NO: Go to CAUSE F.

CAUSE F - LIFT SPOOL IS NOT FULLY ACTUATED.

PROCEDURE OR ACTION:

1. Inspect linkage. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   Does linkage prematurely contact dash?
   YES: Repair or replace linkage.
   NO: Go to CAUSE G.

CAUSE G - MAIN RELIEF VALVE IS SET TOO LOW.

PROCEDURE OR ACTION:

1. Test and adjust pressure. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   Is relief set at specifications?
   YES: Go to CAUSE H.
   NO: Adjust pressure to test specifications.

CAUSE H - MAIN RELIEF VALVE DAMAGED OR STUCK OPEN.

PROCEDURE OR ACTION:

1. Remove and inspect relief valve. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   Is relief valve damaged or stuck open?
   YES: Install new relief valve.
   NO: Go to CAUSE I.

CAUSE I - SECONDARY RELIEF VALVE DAMAGED OR STUCK OPEN.

PROCEDURE OR ACTION:

1. Test and adjust pressure. See Secondary Relief Valve Test and Adjustment.
   Is relief set at specifications?
   YES: Go to CAUSE J.
   NO: Adjust pressure to test specifications.

CAUSE J - MAST/ATTACHMENT IS BINDING.

PROCEDURE OR ACTION:

1. Check for mast or attachment binding.
   Is mast or attachment binding?
   YES: Repair mast or attachment. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.
   NO: Go to CAUSE K.

CAUSE K - EXCESSIVE INTERNAL SPOOL LEAKAGE.

PROCEDURE OR ACTION:

1. Replace spool or complete control valve. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.

CAUSE L - MAST LOWERING CONTROL VALVE BLOCKING FLOW.

PROCEDURE OR ACTION:

1. Inspect mast lowering control valve for blockage.
   Is mast lowering control valve blocking flow?
   YES: Repair or replace mast lowering control valve. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.
   NO: Perform operational check.

END SYMPTOM

Tilt Back Function Will Not Operate (Manual Valve)

POSSIBLE CAUSE

A. OPERATOR PRESENCE SENSOR HAS HYDRAULIC FUNCTION LOCKED OUT.
B. TILT BACK SPEED IS SET AT 0%.
C. CONTROL VALVE PISTON IS STUCK IN OPEN POSITION.

CAUSE A - OPERATOR PRESENCE SENSOR HAS HYDRAULIC FUNCTION LOCKED OUT.

PROCEDURE OR ACTION:

1. Power **ON** and operator in seat. Operate tilt back lever.
   Is a hydraulic interlock message displayed?
   YES: Go to Display Menu/Diagnostics/Seat (Operator Presence), then go to Step 2.
   NO: Go to CAUSE B.
2. Observe value.
   Is Operator Presence sensor value greater than 1.8 volts?
   YES: Go to CAUSE B.
   NO: Go to Seat Sensor Out of Range Low (OORL).

CAUSE B - TILT BACK SPEED IS SET AT 0%.

PROCEDURE OR ACTION:

1. Check current setting of tilt hydraulic function. Go to Display Menu/Truck Set-Up/Hydraulic Function.
   Is Hydraulic Function set at 0%?
   YES: Reset hydraulic function to appropriate level.
   NO: Go to CAUSE C.

CAUSE C - CONTROL VALVE PISTON IS STUCK IN OPEN POSITION.

PROCEDURE OR ACTION:

1. Inspect control valve piston and exhaust orifices. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   Does the valve move freely and are exhaust orifices open?
   YES: Valve is OK. See Observed Symptoms-Gear Pump, Auxiliary Function is Slow or Does Not Function (Manual Valve), Page 9050-33-50.
   NO: Replace control valve piston.

END SYMPTOM

Tilt Forward or Tilt Back Will Not Function When Activated (Manual Valve)

POSSIBLE CAUSE

A. OPERATOR PRESENCE SENSOR HAS HYDRAULIC FUNCTION LOCKED OUT.
B. TILT SPEED IS SET AT 0%.
C. TILT CONTROL VALVE IS STUCK IN CLOSED POSITION.
D. TILT CONTROL VALVE EXHAUST HOLES PLUGGED IN VALVE.

CAUSE A - OPERATOR PRESENCE SENSOR HAS HYDRAULIC FUNCTION LOCKED OUT.

PROCEDURE OR ACTION:

1. Power **ON** and operator in seat. Operate tilt forward/back lever.
   Is a hydraulic interlock message displayed?
   YES: Go to Display Menu/Diagnostics/Seat (Operator Presence), then go to Step 2.
   NO: Go to CAUSE B.
2. Observe value.
   Is Operator Presence sensor value greater than 1.8 volts?
   YES: Go to CAUSE B.
   NO: Go to Seat Sensor Out of Range Low (OORL).

CAUSE B - TILT SPEED IS SET AT 0%.

PROCEDURE OR ACTION:

1. Check current setting of tilt hydraulic function. Go to Display Menu/Truck Set-Up/Hydraulic Function.
   Is Hydraulic Function set at 0%?
   YES: Reset hydraulic function to appropriate level.
   NO: Go to CAUSE C.

CAUSE C - TILT CONTROL VALVE IS STUCK IN CLOSED POSITION.

PROCEDURE OR ACTION:

1. Inspect tilt control valve and exhaust orifices. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   Does the control valve piston move freely and are exhaust orifices open?
   YES: Go to CAUSE D.
   NO: Clean or replace tilt control valve spool.

CAUSE D - TILT CONTROL VALVE EXHAUST HOLES PLUGGED IN VALVE.

PROCEDURE OR ACTION:

1. Inspect valve section. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   Are exhaust holes open?
   YES: Valve is OK. See Observed Symptoms-Gear Pump, Auxiliary Function is Slow or Does Not Function (Manual Valve), Page 9050-33-50.
   NO: Clean or replace valve.

END SYMPTOM

No Steering (All Other Hydraulic Functions OK)

POSSIBLE CAUSE

A. HYDRAULIC HOSES ARE NOT CONNECTED OR DAMAGED.
B. STEERING RELIEF VALVE IS SET TOO LOW.
C. TRANSAXLE/DRIVE UNIT IS BINDING.
D. PRIORITY FLOW DIVIDER VALVE IS CONTAMINATED.
E. STEERING CYLINDER PISTON SEALS ARE WORN OR DAMAGED.
F. SLEEVE AND SPOOL IN THE CONTROL UNIT WILL NOT MOVE.
G. STEERING CONTROL UNIT IS DAMAGED.

CAUSE A - HYDRAULIC HOSES ARE NOT CONNECTED OR DAMAGED.

PROCEDURE OR ACTION:

1. Look at Steering System component location drawing to identify steering hoses. Inspect hoses for wear, damage, and correct installation.
   Are steering hoses in good condition and installed correctly?
   YES: Go to CAUSE B.
   NO: Install new components as necessary.

CAUSE B - STEERING RELIEF VALVE IS SET TOO LOW.

PROCEDURE OR ACTION:

1. Perform Operational Diagnostic Procedures, Operational Checkout, Page 9010-05-10.
   Is steering relief pressure set too low?
   YES: Adjust steering relief pressure. See Steering Relief Pressure Test and Adjustment.
   NO: Go to CAUSE C.

CAUSE C - TRANSAXLE/DRIVE UNIT IS BINDING.

PROCEDURE OR ACTION:

1. Inspect transaxle/drive unit for binding.
   Is transaxle/drive unit binding?
   YES: Replace transaxle/drive unit. Depending on your lift truck, see **Transaxle** 1300SRM1330 or **Transaxle** 1300SRM1370.
   NO: Go to CAUSE D.

CAUSE D - PRIORITY FLOW DIVIDER VALVE IS CONTAMINATED.

PROCEDURE OR ACTION:

1. Perform Operational Diagnostic Procedures, Operational Checkout, Page 9010-05-6.
   Does priority flow divider valve pass the check?
   YES: Priority flow divider valve is OK. Go to CAUSE E.
   NO:
   - Cannot turn steering wheel, wheel locks up. Go to CAUSE F.
   - Steering wheel turns but fails Priority Valve Flow Divider Valve Check. Remove and clean flow divider spool. Depending on your lift truck see, **Main Control Valves** 2000SRM1334 or **Main Control Valves** 2000SRM1439.

CAUSE E - STEERING CYLINDER PISTON SEALS ARE WORN OR DAMAGED.

PROCEDURE OR ACTION:

1. Do Steering Cylinder Leakage Test.
   Does steering cylinder pass leakage test?
   YES: Cylinder is OK. Go to CAUSE G.
   NO: Remove and repair steering cylinder. Depending on your lift truck, see **Steering System** 1600SRM1331 or **Steering Axle** 1600SRM1360.

CAUSE F - SLEEVE AND SPOOL IN THE CONTROL UNIT WILL NOT MOVE.

PROCEDURE OR ACTION:

1. Turn steering wheel with engine running.
   Does steering wheel move?
   YES: Sleeve and spool are not seized. Go to CAUSE G.
   NO: Repair steering control unit. Replace components as required. Depending on your lift truck, see **Steering System** 1600SRM1331 or **Steering System** 1600SRM1363.

CAUSE G - STEERING CONTROL UNIT IS DAMAGED.

PROCEDURE OR ACTION:

1. Inspect SCU.
   Is steering control unit damaged?
   YES: Install new SCU. Depending on your lift truck, see **Steering System** 1600SRM1331 or **Steering System** 1600SRM1363.
   NO: Repair steering control unit. Replace components as required. Depending on your lift truck, see **Steering System** 1600SRM1331 or **Steering System** 1600SRM1363.

END SYMPTOM

Steering Is Slow or Difficult

POSSIBLE CAUSE

A. LOW PUMP FLOW.
B. STEERING RELIEF PRESSURE IS SET TOO LOW.
C. PRIORITY FLOW DIVIDER VALVE IS CONTAMINATED.
D. HYDRAULIC LINES ARE RESTRICTED.
E. SEAL IN THE STEERING CYLINDER LEAKS.
F. TRANSAXLE/DRIVE UNIT COMPONENTS ARE DAMAGED AND/OR BINDING.
G. SCU IS WORN, NOT ASSEMBLED CORRECTLY, OR DAMAGED.

CAUSE A - LOW PUMP FLOW.

PROCEDURE OR ACTION:

1. Do Hydraulic Pump Flow Test.
   Are other hydraulic functions OK?
   YES: Hydraulic pump output is OK. Go to CAUSE B.
   NO: Test hydraulic system relief pressure. See Primary Relief Valve Test and Adjustment.

CAUSE B - STEERING RELIEF PRESSURE IS SET TOO LOW.

PROCEDURE OR ACTION:

1. Perform Operational Diagnostic Procedures, Operational Checkout, Page 9010-05-10.
   Is steering relief pressure set too low?
   YES: Adjust steering relief pressure. See Steering Relief Pressure Test and Adjustment.
   NO: Go to CAUSE C.

CAUSE C - PRIORITY FLOW DIVIDER VALVE IS CONTAMINATED.

PROCEDURE OR ACTION:

1. Perform Operational Check, seeOperational Diagnostic Procedures, Operational Checkout, Page 9010-05-6.
   Does priority flow divider valve pass check?
   YES: Priority flow divider valve is OK. Go to CAUSE D.
   NO:
   - Flow divider valve spool is stuck. Remove and clean flow divider spool. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   - LS signal pressure is leaking away. See Steering Control Unit LS Pressure Test.

CAUSE D - HYDRAULIC LINES ARE RESTRICTED.

PROCEDURE OR ACTION:

1. Look at Steering System component. Inspect hoses for wear, damage, and correct installation.
   Are steering hoses in good condition and correctly installed?
   YES: Go to CAUSE E.
   NO: Install new hoses as necessary.

CAUSE E - SEAL IN THE STEERING CYLINDER LEAKS.

PROCEDURE OR ACTION:

1. Perform Steering Cylinder Leakage Test.
   Does steering cylinder pass leakage test?
   YES: Cylinder is OK. Go to CAUSE F.
   NO: Remove and repair steering cylinder. Depending on your lift truck, see **Steering System** 1600SRM1331 or **Steering System** 1600SRM1363 ..

CAUSE F - TRANSAXLE/DRIVE UNIT COMPONENTS ARE DAMAGED AND/OR BINDING.

PROCEDURE OR ACTION:

1. Turn steering wheel stop to stop in both directions while observing tires.
   Do tires shake or make noise while turning?
   YES: Inspect and repair damage transaxle/drive unit components. Depending on your lift truck, see **Steering System** 1600SRM1331 or **Steering System** 1600SRM1363 ..
   NO: Go to CAUSE G.

CAUSE G - SCU IS WORN, NOT ASSEMBLED CORRECTLY, OR DAMAGED.

PROCEDURE OR ACTION:

1. Inspect SCU. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   Is steering control unit damaged?
   YES: Install new SCU. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   NO: See Observed Symptoms-Gear Pump, Steering Operation Is Not Smooth, Page 9050-33-65.

END SYMPTOM

Steering Operation Is Not Smooth

POSSIBLE CAUSE

A. AIR WAS NOT REMOVED AFTER REPAIR TO THE HYDRAULIC SYSTEM.
B. STEERING RELIEF PRESSURE SET TOO LOW.
C. HYDRAULIC STEER ACCUMULATOR IS NOT WORKING PROPERLY.
D. BINDING IN STEERING COLUMN.
E. LOW PUMP FLOW.
F. FAILED CENTERING SPRINGS IN SCU.
G. STEERING CONTROL UNIT IS ASSEMBLED INCORRECTLY, DAMAGED, OR CONTAMINATED.

CAUSE A - AIR WAS NOT REMOVED AFTER REPAIR TO THE HYDRAULIC SYSTEM.

PROCEDURE OR ACTION:

1. Check service record of lift truck.
   Was hydraulic system repaired recently?
   YES: Check the repaired hose connections and remove air from system by cycling of steering cylinder full stroke in each direction.
   NO: Go to CAUSE B.

CAUSE B - STEERING RELIEF PRESSURE SET TOO LOW.

PROCEDURE OR ACTION:

1. Perform Operational Check, seeOperational Diagnostic Procedures, Operational Checkout, Page 9010-05-10.
   Is steering relief pressure set too low?
   YES: Adjust steering relief pressure. See Steering Relief Pressure Test and Adjustment.
   NO: Go to CAUSE C.

CAUSE C - HYDRAULIC STEER ACCUMULATOR IS NOT WORKING PROPERLY.

PROCEDURE OR ACTION:

1. Turn steering wheel slowly while operating a mast function over relief, then suddenly release the control lever.
   Does steering wheel jerk abruptly?
   YES: Replace the steering accumulator. See **Hydraulic System** 1900SRM1367
   NO: Go to CAUSE D.

CAUSE D - BINDING IN STEERING COLUMN.

PROCEDURE OR ACTION:

1. Turn steering wheel stop to stop with engine running at slow idle.
   Is steering shaft binding in steering column?
   YES: Inspect and repair steering column. Depending on your lift truck, see **Steering System** 1600SRM1331 or **Steering System** 1600SRM1363 ..
   NO: Go to CAUSE E.

CAUSE E - LOW PUMP FLOW.

PROCEDURE OR ACTION:

1. Do Hydraulic Pump Flow Test.
   Are other hydraulic functions OK?
   YES: Hydraulic pump output is OK. Go to CAUSE F.
   NO: Test hydraulic system relief pressure. See Primary Relief Valve Test and Adjustment.

CAUSE F - FAILED CENTERING SPRINGS IN SCU.

PROCEDURE OR ACTION:

1. Inspect SCU.
   Are the centering springs in good condition?
   YES: Springs are OK. Go to CAUSE G.
   NO: Replace centering springs. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.

CAUSE G - STEERING CONTROL UNIT IS ASSEMBLED INCORRECTLY, DAMAGED, OR CONTAMINATED.

PROCEDURE OR ACTION:

1. Inspect SCU.
   Is SCU properly assembled and clean?
   YES: Install new steering control unit. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   NO: Clean steering valve. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.

END SYMPTOM

Steering Wheel End Lock Position Cannot Be Felt by Operator

POSSIBLE CAUSE

A. ANTI-KICKBACK VALVES ARE SAME PRESSURE SETTING AS RELIEF VALVE.
B. CONTAMINATION CAUSING IMPROPER SHOCK VALVE OPERATION.

CAUSE A - ANTI-KICKBACK VALVES ARE SAME PRESSURE SETTING AS RELIEF VALVE.

PROCEDURE OR ACTION:

1. Inspect SCU.
   Are the anti-kickback valves in good condition?
   YES: Anti-kickback valves OK. Go to CAUSE B.
   NO: Replace anti-kickback valves. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.

CAUSE B - CONTAMINATION CAUSING IMPROPER SHOCK VALVE OPERATION.

PROCEDURE OR ACTION:

1. Inspect assembly of SCU.
   Is SCU properly assembled and clean?
   YES: Install new steering control unit. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   NO: Clean steering valve. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.

END SYMPTOM

Steering Wheel Turns By Itself or Does Not Return To Neutral

POSSIBLE CAUSE

A. STEERING RELIEF PRESSURE SET TOO LOW.
B. BINDING IN STEERING COLUMN OR NO RESISTANCE.
C. FAILED CENTERING SPRINGS IN SCU.
D. DEFLECTION OF SPOOL AND SLEEVE CAUSED BY HIGH SYSTEM PRESSURE.
E. STEERING CONTROL UNIT IS ASSEMBLED INCORRECTLY OR IS DAMAGED.

CAUSE A - STEERING RELIEF PRESSURE SET TOO LOW.

PROCEDURE OR ACTION:

1. Perform Operational Diagnostic Procedures, Operational Checkout, Page 9010-05-10.
   Is steering relief pressure set too low?
   YES: Adjust steering relief pressure. See Steering Relief Pressure Test and Adjustment.
   NO: Go to CAUSE B.

CAUSE B - BINDING IN STEERING COLUMN OR NO RESISTANCE.

PROCEDURE OR ACTION:

1. Turn steering wheel stop to stop with engine running at slow idle.
   Is linkage binding in steering column?
   YES: Inspect and repair steering column. Depending on your lift truck, see **Steering System** 1600SRM1331 or **Steering System** 1600SRM1363 ..
   NO: Go to CAUSE C.

CAUSE C - FAILED CENTERING SPRINGS IN SCU.

PROCEDURE OR ACTION:

1. Inspect SCU.
   Are the centering springs in good condition?
   YES: Springs are OK. Go to CAUSE D.
   NO: Replace centering springs. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.

CAUSE D - DEFLECTION OF SPOOL AND SLEEVE CAUSED BY HIGH SYSTEM PRESSURE.

PROCEDURE OR ACTION:

1. Perform Steering Relief Pressure Test and Adjustment.
   Does steering relief pass check?
   YES: Go to CAUSE E.
   NO: Adjust relief pressure. See Steering Relief Pressure Test and Adjustment.

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CAUSE E - STEERING CONTROL UNIT IS ASSEMBLED INCORRECTLY OR IS DAMAGED.

PROCEDURE OR ACTION:

1. Inspect SCU.
   Is SCU properly assembled and clean?
   YES: Install new steering control unit. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   NO: Clean steering valve. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.

END SYMPTOM

Steering Wheel Turns the Tires in the Wrong Direction

POSSIBLE CAUSE

CAUSE A - HYDRAULIC HOSES ARE NOT CONNECTED CORRECTLY AT THE STEERING CYLINDER OR AT THE SCU.

PROCEDURE OR ACTION:

1. Look at Steering System component to identify steering hoses.
   Are hoses correctly installed?
   YES: Problem is in SCU. Repair or replace SCU. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   NO: Correct steering hose routing at valve or steering cylinder.

Actuations Do Not Act Simultaneously

POSSIBLE CAUSE

A. LOW PUMP FLOW.
B. SECONDARY RELIEF VALVE SET TOO LOW.

CAUSE A - LOW PUMP FLOW.

PROCEDURE OR ACTION:

1. Check cycle times of lift function.
   Is lift function speed ok?
   YES: Go to CAUSE B.
   NO: Go to Observed Symptoms-Gear Pump, Abnormal Hydraulic Noise and/or Vibration, Page 9050-33-1.

CAUSE B - SECONDARY RELIEF VALVE SET TOO LOW.

PROCEDURE OR ACTION:

1. Test and adjust secondary relief pressure. See Secondary Relief Valve Test and Adjustment.

END SYMPTOM

Oil Leaking/Component Life Too Short

POSSIBLE CAUSE

A. HYDRAULIC OIL TANK IS OVERFILLED.
B. LOOSE OR DAMAGED HARDWARE.
C. DAMAGED O-RING/ROD SEAL.
D. HYDRAULIC RELIEF PRESSURES SET TOO HIGH.
E. HYDRAULIC FLUID CONTAMINATED OR WRONG TYPE.
F. EXCESSIVE DEBRIS IN HYDRAULIC CIRCUIT.
G. HYDRAULIC OIL TANK OPEN TO ATMOSPHERE.
H. HYDRAULICS OPERATED ABOVE RECOMMENDED OPERATING RANGE.
I. WARPED COMPONENT SECTION OF HYDRAULIC CONTROL VALVE.
J. SEALS BETWEEN VALVE SECTIONS FAILED

CAUSE A - HYDRAULIC OIL TANK IS OVERFILLED.

PROCEDURE OR ACTION:

1. Check to see if hydraulic oil tank is overfilled.
   Is hydraulic oil tank overfilled?
   YES: Drain hydraulic oil to proper level.
   NO: Go to CAUSE B.

CAUSE B - LOOSE OR DAMAGED HARDWARE.

PROCEDURE OR ACTION:

1. Locate source of oil leak by checking the following items. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   - Check torque on fittings.
   - Check torque on tie rod at valve outlet housing.
   - Check torque on hardware between SCU and valve.

   Did leak stop after checking hardware?
   YES: Problem solved.
   NO: Go to CAUSE C.

CAUSE C - DAMAGED O-RING/ROD SEAL.

PROCEDURE OR ACTION:

1. Replace damaged O-ring or rod seal. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   Is problem fixed?
   YES: Problem solved.
   NO: Go to CAUSE D.

CAUSE D - HYDRAULIC RELIEF PRESSURES SET TOO HIGH.

PROCEDURE OR ACTION:

1. Check main and secondary relief pressures. Go to Primary Relief Valve Test and Adjustment.
   Does relief pressure meet specifications?
   YES: Go to CAUSE E.
   NO: Adjust or replace relief valve.

CAUSE E - HYDRAULIC FLUID CONTAMINATED OR WRONG TYPE.

PROCEDURE OR ACTION:

1. Check hydraulic oil for contamination and correct type.
   Is hydraulic oil contaminated or incorrect type used?
   YES: Drain and refill hydraulic tank. Depending on your lift truck see, **Periodic Maintenance** 8000SRM1364, **Periodic Maintenance** 8000SRM1372, **Periodic Maintenance** 8000SRM1339, **Periodic Maintenance** 8000SRM1373, or **Periodic Maintenance** 8000SRM1442.
   NO: Go to CAUSE F.

CAUSE F - EXCESSIVE DEBRIS IN HYDRAULIC CIRCUIT.

PROCEDURE OR ACTION:

1. Check for plugged and bypassing hydraulic oil filter.
   Is hydraulic oil filter plugged and bypassing?
   YES: Clean or replace hydraulic oil filter.
   NO: Go to Step 2.
2. Check for contaminated oil.
   Is hydraulic oil contaminated?
   YES: Drain and refill hydraulic tank. Depending on your lift truck see, **Periodic Maintenance** 8000SRM1364, **Periodic Maintenance** 8000SRM1372, **Periodic Maintenance** 8000SRM1339, **Periodic Maintenance** 8000SRM1373, or **Periodic Maintenance** 8000SRM1442.
   NO: Go to CAUSE G.

CAUSE G - HYDRAULIC OIL TANK OPEN TO ATMOSPHERE.

PROCEDURE OR ACTION:

1. Check hydraulic oil tank for missing breather or missing dipstick.
   Is breather or dipstick missing from hydraulic oil tank?
   YES: Replace breather or dipstick.
   NO: Go to CAUSE H.

CAUSE H - HYDRAULICS OPERATED ABOVE RECOMMENDED OPERATING RANGE.

PROCEDURE OR ACTION:

NOTE: If lift truck is equipped with Hydraulic Oil Cooler, see Hydraulic Oil Cooler Not Functioning Correctly.

1. Inspect hydraulic components and oil for signs of excessive heat.
   Do components and oil show signs of overheating?
   YES: Replace damaged components and service hydraulic system. Depending on your lift truck see, **Periodic Maintenance** 8000SRM1364, **Periodic Maintenance** 8000SRM1372, **Periodic Maintenance** 8000SRM1339, **Periodic Maintenance** 8000SRM1373, or **Periodic Maintenance** 8000SRM1442.
   NO: Go to CAUSE I.

CAUSE I - WARPED COMPONENT SECTION OF HYDRAULIC CONTROL VALVE.

PROCEDURE OR ACTION:

1. Check hydraulic control valve for warped component section.
   Does hydraulic control valve have warped component section?
   YES: Replace hydraulic control valve. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   NO: Go to CAUSE J.

CAUSE J - SEALS BETWEEN VALVE SECTIONS FAILED

PROCEDURE OR ACTION:

1. Check hydraulic control valve for oil leakage between valve sections.
   Is oil leaking between valve sections?
   YES: Replace seals between valve sections. Depending on your left truck see, **Main Control Valves** 2000SRM1334, **Main Control Valves** 2000SRM1439, or **Electrical System** 2200SRM1337.
   NO: Seals between valve sections OK.

END SYMPTOM

Abnormal Steer Axle Noise

POSSIBLE CAUSE

A. WHEEL IS LOOSE.
B. STEER WHEEL CONTACTING STEERING AXLE OR CHASSIS.
C. TIE ROD AND/OR BUSHINGS ARE WORN.
D. WHEEL OR SPINDLE BEARING LUBRICATION IS INADEQUATE.
E. WHEEL OR SPINDLE BEARING FAILURE.
F. STEERING AXLE BUSHINGS WORN.
G. STEERING AXLE DAMAGED.

CAUSE A - WHEEL IS LOOSE.

PROCEDURE OR ACTION:

1. Inspect wheels, lug nuts, and studs for damage.
   Are wheels, lug nuts, and studs damaged or loose?
   YES: If loose, tighten wheel lugs. Repair or replace damaged parts.Depending on your lift truck see, **Periodic Maintenance** 8000SRM1364, **Periodic Maintenance** 8000SRM1372, **Periodic Maintenance** 8000SRM1339, **Periodic Maintenance** 8000SRM1373, or **Periodic Maintenance** 8000SRM1442.
   NO: Go to CAUSE B.

CAUSE B - STEER WHEEL CONTACTING STEERING AXLE OR CHASSIS.

PROCEDURE OR ACTION:

1. Inspect steer wheels, steering axle, and chassis.
   Are wheels contacting steering axle or chassis?
   YES: Repair or replace steer wheel or steering axle, or repair chassis. Depending on your lift truck, see **Steering System** 1600SRM1331 or **Steering System** 1600SRM1363 ..
   NO: Go to CAUSE C.

CAUSE C - TIE ROD AND/OR BUSHINGS ARE WORN.

PROCEDURE OR ACTION:

1. Inspect tie rod and bushing.
   Are tie rods and bushing in good condition?
   YES: Go to CAUSE D.
   NO: Repair or adjust tie rods or bushings. Depending on your lift truck, see **Steering System** 1600SRM1331 or **Steering System** 1600SRM1363 ..

CAUSE D - WHEEL OR SPINDLE BEARING LUBRICATION IS INADEQUATE.

NOTE: See **Operating Manual** for lubrication procedures.

PROCEDURE OR ACTION:

1. Lubricate wheel and spindle bearings.
   Did the bearings lack lubrication?
   YES: Service lift truck per **Operating Manual** instructions.
   NO: Go to CAUSE E.

CAUSE E - WHEEL OR SPINDLE BEARING FAILURE.

PROCEDURE OR ACTION:

1. Inspect bearings and spindle.
   Are the bearings and spindle in good condition?
   YES: If bearings are OK, go to CAUSE F.
   NO: Replace bearings and/or spindle. Depending on your lift truck, see **Steering System** 1600SRM1331 or **Steering System** 1600SRM1363 ..

CAUSE F - STEERING AXLE BUSHINGS WORN.

PROCEDURE OR ACTION:

1. Inspect steering axle bushings for wear. Depending on your lift truck, see **Steering System** 1600SRM1331 or **Steering System** 1600SRM1363 ..
   Are the steering axle bushings in good condition?
   YES: Go to CAUSE G.
   NO: Replace bushings.

CAUSE G - STEERING AXLE DAMAGED.

PROCEDURE OR ACTION:

1. Inspect steering axle for damage.
   Is steering axle in good condition?
   YES: Resume operation while monitoring systems to locate source of noise.
   NO: Repair as required. Depending on your lift truck, see **Steering System** 1600SRM1331 or **Steering System** 1600SRM1363 ..

END SYMPTOM

Abnormal Steering Wheel Vibration

POSSIBLE CAUSE

A. WORN TIRES.
B. LOW OIL LEVEL IN TANK.
C. AIR WAS NOT REMOVED AFTER REPAIR TO THE HYDRAULIC SYSTEM.
D. STEERING AXLE COMPONENTS WORN.

CAUSE A - WORN TIRES.

PROCEDURE OR ACTION:

1. Inspect tires.
   Are tires worn?
   YES: Replace tires. Depending on your lift truck see, **Periodic Maintenance** 8000SRM1364, **Periodic Maintenance** 8000SRM1372, **Periodic Maintenance** 8000SRM1339, **Periodic Maintenance** 8000SRM1373, or **Periodic Maintenance** 8000SRM1442.
   NO: Go to CAUSE B.

CAUSE B - LOW OIL LEVEL IN TANK.

PROCEDURE OR ACTION:

NOTE: Cavitation of a hydraulic pump will cause noise and it is caused by air in the hydraulic oil. The hydraulic pump suction oil must be free of air and unrestricted to pump.

1. Check hydraulic oil level in tank.
   Is oil at correct level?
   YES: Go to CAUSE C.
   NO: Add oil to correct level. See **Operating Manual**.

CAUSE C - AIR WAS NOT REMOVED AFTER REPAIR TO THE HYDRAULIC SYSTEM.

PROCEDURE OR ACTION:

1. Check service record of lift truck.
   Was hydraulic system repaired recently?
   YES: Check the repaired hose connections. Remove air from system by cycling function full stroke of steering cylinder in each direction.
   NO: Go to CAUSE D.

CAUSE D - STEERING AXLE COMPONENTS WORN.

PROCEDURE OR ACTION:

1. Operate truck to determine if vibration is hydraulic or mechanical.
   Is the vibration caused by hydraulics?
   YES: See Observed Symptoms-Gear Pump, Abnormal Hydraulic Noise and/or Vibration, Page 9050-33-1.
   NO: Repair or replace worn or damaged steer axle components. Depending on your lift truck, see **Steering System** 1600SRM1331 or **Steering System** 1600SRM1363 ..

END SYMPTOM

Back Lash/Kick Back in Steering Wheel

POSSIBLE CAUSE

A. LOOSE STEERING AXLE COMPONENTS.
B. SPLINES OR STEERING SHAFT UNIVERSAL JOINT IN STEERING COLUMN WORN OR BROKEN.
C. STEERING RELIEF PRESSURE IS NOT SET CORRECTLY.
D. FAILED CENTERING SPRINGS IN SCU.
E. STEERING CONTROL UNIT IS ASSEMBLED INCORRECTLY OR IS DAMAGED.

CAUSE A - LOOSE STEERING AXLE COMPONENTS.

PROCEDURE OR ACTION:

1. Turn steering wheel back and forth while observing steer axle wheels at slow idle.
   Do the tires respond directly to steering wheel movement?
   YES: Go to CAUSE B.
   NO: Inspect wheel studs and steering axle components for damage. Repair as required. Depending on your lift truck, see **Steering System** 1600SRM1331 or **Steering Axle** 1600SRM1360.

CAUSE B - SPLINES OR STEERING SHAFT UNIVERSAL JOINT IN STEERING COLUMN WORN OR BROKEN.

PROCEDURE OR ACTION:

1. Turn steering wheel back and forth while observing steer axle wheels at slow idle.
   Does the steer axle wheels movement match steering wheel movement in both directions?
   YES: Go to CAUSE C.
   NO: Inspect and repair steering column. Depending on your lift truck, see **Steering System** 1600SRM1331 or **Steering System** 1600SRM1363.

CAUSE C - STEERING RELIEF PRESSURE IS NOT SET CORRECTLY.

PROCEDURE OR ACTION:

1. Do steering relief pressure test.
   Is steering relief pressure set to specification?
   YES: Adjust steering relief pressure. See Steering Relief Pressure Test and Adjustment.
   NO: Go to CAUSE D.

CAUSE D - FAILED CENTERING SPRINGS IN SCU.

PROCEDURE OR ACTION:

1. Inspect SCU.
   Are the centering springs in good condition?
   YES: Springs are OK. Go to CAUSE E.
   NO: Replace centering springs. Depending on your lift truck, see **Steering System** 1600SRM1331 or **Steering System** 1600SRM1363.

CAUSE E - STEERING CONTROL UNIT IS ASSEMBLED INCORRECTLY OR IS DAMAGED.

PROCEDURE OR ACTION:

1. Inspect SCU.
   Is SCU properly assembled and clean?
   YES: Replace the SCU. Depending on your lift truck, see **Steering System** 1600SRM1331 or **Steering System** 1600SRM1363.
   NO: Repair steering control unit. Depending on your lift truck, see **Steering System** 1600SRM1331 or **Steering System** 1600SRM1363.

END SYMPTOM

NOTES

Group 43
Tests and Adjustments-Gear Pump

Hydraulic Warm-up Procedure

Use this procedure to get the hydraulic oil temperature to test specification. Install the test equipment on lift truck before starting this procedure to reduce handling of hot component or oil.

Table 9050-43-1. Test Specifications

Oil Temperature	50 - 65°C (122 - 150 °F)

Table 9050-43-2. Service Tools

Temperature Reader - Thermocouple

WARNING

Hot hydraulic oil can cause serious burns to skin. Do not touch hydraulic components or oil during test. Make sure hydraulic oil has cooled to safe temperature before installing or removing test equipment.

WARNING

Hydraulic oil under pressure can be injected into skin. Lower forks to ground and relieve all circuit pressure before removing or installing test equipment.

CAUTION

Do not permit dirt or other contaminants to enter the hydraulic system. Disconnected hoses, tubes, open valves, cylinder fittings, and ports should be protected with clean caps or plugs.

1. Install test equipment as called out in test.
2. Insert thermocouple in dipstick hole.
3. Turn key or keyless switch to the **ON** position.
4. Tilt the mast back and hold over relief for 20 seconds, then release lever. Cycle both tilt and lift cylinders to circulate oil and equalize temperature in system.
5. Read temperature and compare to temperature specifications of test to be performed.
6. Repeat Step 4 and Step 5 until oil temperature is at test specifications.

Primary Relief Valve Test and Adjustment

CAUTION

Typically, the Main Relief Valve (MRV) should NOT be adjusted in the field for general purposes. Increasing the setting of the MRV past its specified setting may damage truck.

WARNING

Hot hydraulic oil can cause serious burns to skin. Do not touch hydraulic components or oil during test. Make sure hydraulic oil has cooled to safe temperature before installing or removing test equipment.

WARNING

Hydraulic oil under pressure can be injected into skin. Lower forks to ground and relieve all circuit pressure before removing test plugs from valve.

1. Lower forks to ground and turn **OFF** key. Apply park brake.

CAUTION

Do not permit dirt or other contaminants to enter the hydraulic system. Disconnected hoses, tubes, open valves, cylinder fittings, and ports should be protected with clean caps or plugs.

2. Remove panels that cover MRV. Remove cover from diagnostic port and install pressure gauge. See Figure 9050-43-42, Figure 9050-43-43 and Figure 9050-43-45.
3. Operate the hydraulic system until the oil temperature is at test specifications. See Hydraulic Warm-up Procedure.

WARNING

Forks contacting overhead electrical wires or fixtures can cause serious injury or death. Make sure area is clear of hazards before raising forks to maximum height.

4. Raise the mast until it stops. Hold the lever and check the reading of the gauge when the relief valve opens. Compare to specifications.
5. Replace primary relief valve, if not within specification, by unscrewing the relief cartridge from the inlet section and installing a new relief cartridge.
6. Cycle lever over relief to verify the setting is within specification. Depending on your lift truck see, **Main Control Valves** 2000SRM1334 or **Main Control Valves** 2000SRM1439. .
7. Remove test equipment and reinstall cap onto diagnostic port.

Table 9050-43-3. Service Tools

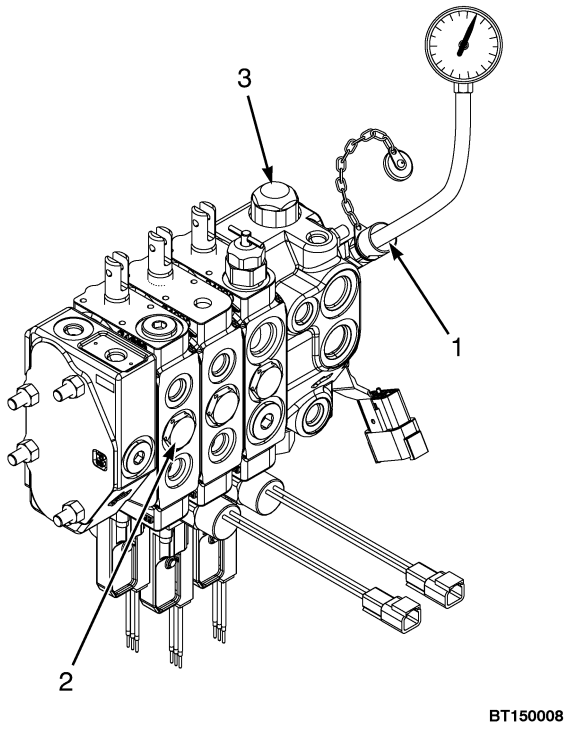
275 - 345 MPa (4000 - 5000 psi) Pressure Gauge	
Excess Flow (EF) Test Plug Port Size	SAE #4 O-ring Port (7/16-20 UNF)

Table 9050-43-4. Test Specifications

Lift Truck	Capacity	Main Relief Pressure	Pump Flow
J1.5-2.0XNT (J30-40XNT) (K160)	1.5-2.0 Tons	17.9 MPa (2596 psi)	63.6 liter/min (16.8 gal/min)
A1.3-1.5XNT (A25-30XNT) (D203 E2.2-3.5XN (E45-70XN) (A268) J2.2-3.5XN (J40-70XN) (A276)	2.2-2.75 Tons	21.9 MPa (3176 psi)	81.4 liter/min (21.5 gal/min)

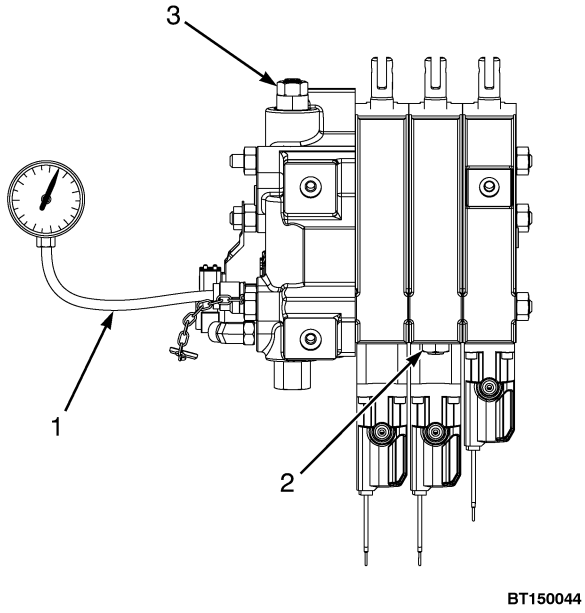
Table 9050-43-4. Test Specifications (Continued)

Lift Truck	Capacity	Main Relief Pressure	Pump Flow
E2.2-3.5XN (E45-70XN) (A268) J2.2-3.5XN (J40-70XN) (A276)	3.0-3.5 Tons	23.9 MPa (3466 psi)	81.4 liter/min (21.5 gal/min)



1. DIAGNOSTIC PORT WITH GAUGE
2. OPTIONAL SECONDARY RELIEF VALVE LOCATION
3. PRIMARY RELIEF VALVE LOCATION

Figure 9050-43-42. Manual Valve for Lift Trucks J1.5-2.0XNT (J30-40XNT) (K160) and J1.6-2.0XN (A935) Shown



1. DIAGNOSTIC PORT WITH GAUGE
2. SECONDARY RELIEF VALVE LOCATION
3. PRIMARY RELIEF VALVE LOCATION

Figure 9050-43-43. Manual Valve for Lift Trucks E2.2-3.5XN (E45-70XN) (A268) and J2.2-3.5XN (J40-70XN) (A276) Shown

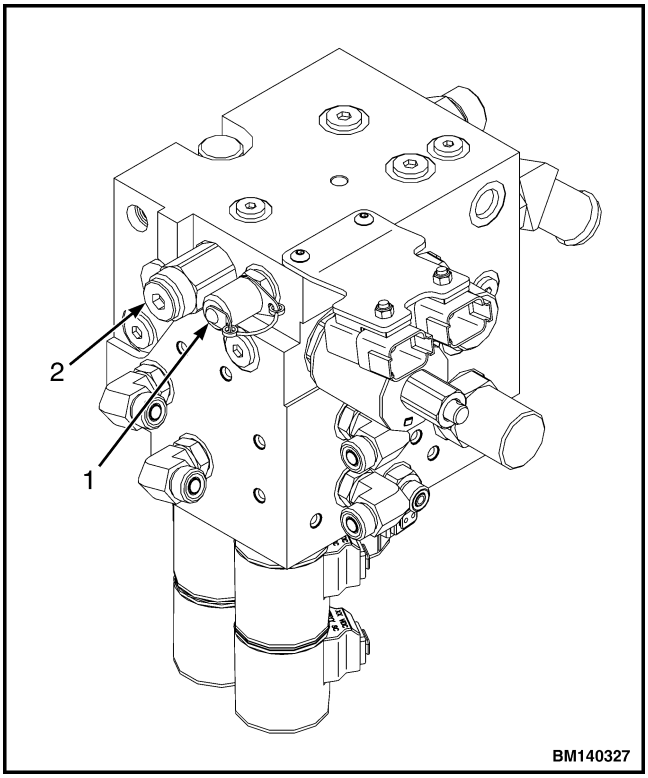
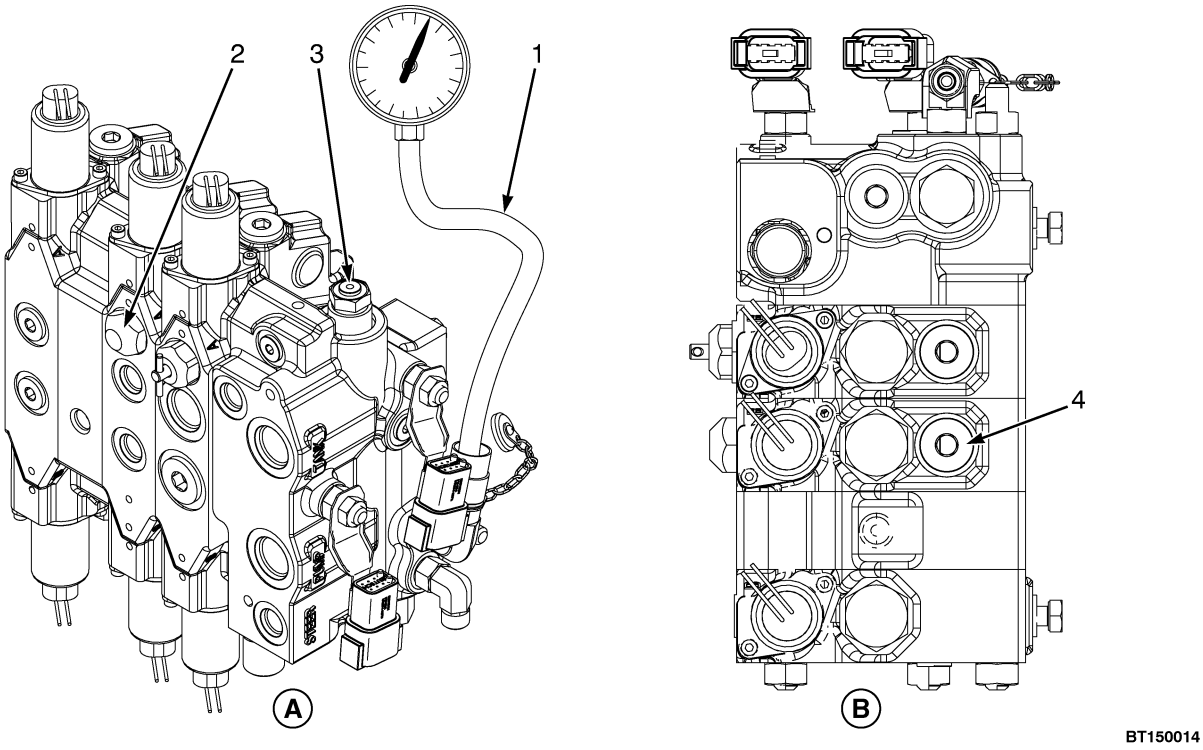


Figure 9050-43-44. E-Hydraulic Valve for Lift Trucks A1.3XNT, A1.5XNT (A25XNT, A30XNT) [D203]

Legend for Figure 9050-43-44

1. DIAGNOSTIC FITTING WITH CAP
2. PRIMARY RELIEF VALVE



A. FRONT VIEW

1. DIAGNOSTIC PORT WITH GAUGE
2. ANTI-CAVITATION CHECK

B. BOTTOM VIEW

3. PRIMARY RELIEF VALVE LOCATION
4. SECONDARY RELIEF VALVE LOCATION

Figure 9050-43-45. E-Hydraulic Valve for Lift Trucks J1.5-2.0XNT (J30-40XNT) (K160), J1.6-2.0XN (A935), E2.2-3.5XN (E45-70XN) (A268), and J2.2-3.5XN (J40-70XN) (A276) Shown

Secondary Relief Valve Test and Adjustment

It may be necessary to adjust the setting of the Optional Relief Valve (ORV) depending on what attachments are used for the auxiliary function.

NOTE: The Relief Pressure setting is the working range that the secondary relief can be set to meet requirements of attachments.

The Factory Default setting is the pressure that the secondary relief is set at the factory.

NOTE: Secondary relief valves for manual control valves on lift trucks J1.5-2.0XNT (J30-40XNT) (K160) and J1.6-2.0XN (A935) are installed into auxiliary sections for special attachments. Standard relief pressure for these lift trucks is set with primary relief valve only.

Table 9050-43-5. Test Specifications for Lift Trucks J1.5-2.0XNT (J30-40XNT) (K160) and J1.6-2.0XN (A935)

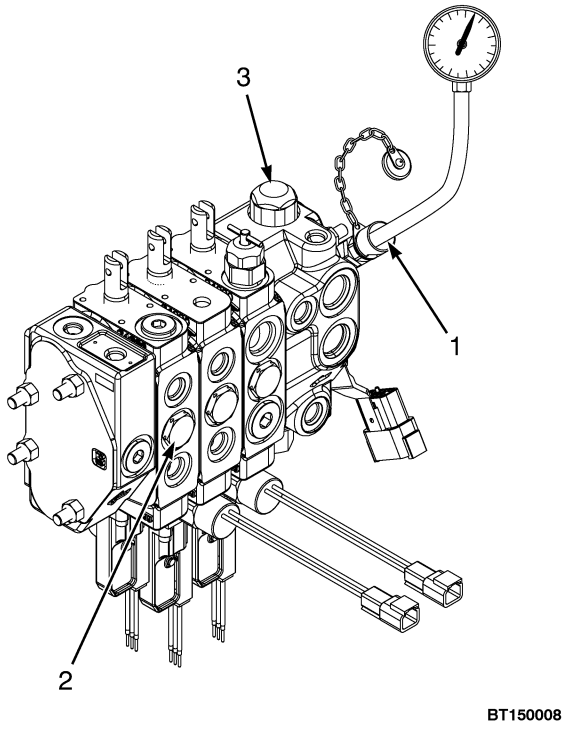
Oil Temperature	50 - 65°C (122 - 150 °F)
Secondary Relief Pressure	17.9 MPa (2596 psi)
Factory Default Setting	15.0 - 16.0 MPa (2180 - 2320 psi)

Table 9050-43-6. Test Specifications for Lift Trucks E2.2-3.5XN (E45-70XN) (A268) and J2.2-3.5XN (J40-70XN) (A276)

Oil Temperature	50 - 65°C (122 - 150 °F)
Secondary Relief Valve Setting	15.0 - 16.0 MPa (2180 - 2320 psi)
Factory Default Setting	15.0 - 16.0 MPa (2180 - 2320 psi)

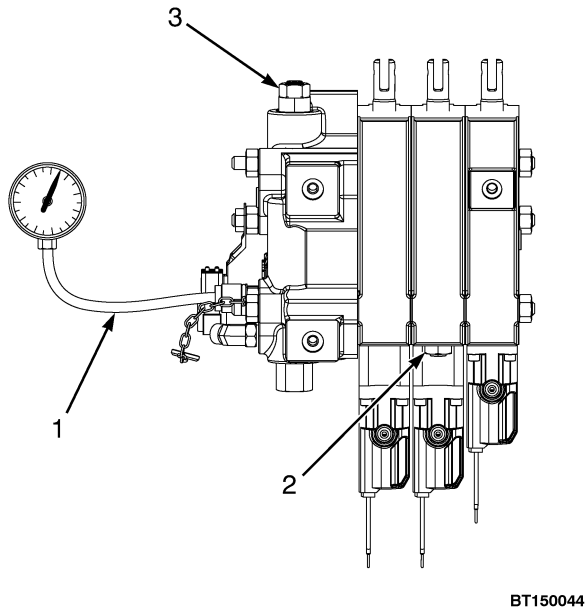
Table 9050-43-7. Service Tools

0 - 35.0 MPa (0 - 5000 psi) Pressure Gauge	
Excess Flow (EF) Test Port Plug Size	SAE #4 O-ring Port (7/16-20 UNF)



1. DIAGNOSTIC PORT WITH GAUGE
2. OPTIONAL SECONDARY RELIEF VALVE LOCATION
3. PRIMARY RELIEF VALVE LOCATION

Figure 9050-43-46. Manual Control Valve for Lift Trucks J1.5-2.0XNT (J30-40XNT) (K160) and J1.6-2.0XN (A935) Shown



1. DIAGNOSTIC PORT WITH GAUGE
2. SECONDARY RELIEF VALVE LOCATION
3. PRIMARY RELIEF VALVE LOCATION

Figure 9050-43-47. Manual Control Valve for Lift Trucks E2.2-3.5XN (E45-70XN) (A268) and J2.2-3.5XN (J40-70XN) (A276) Shown

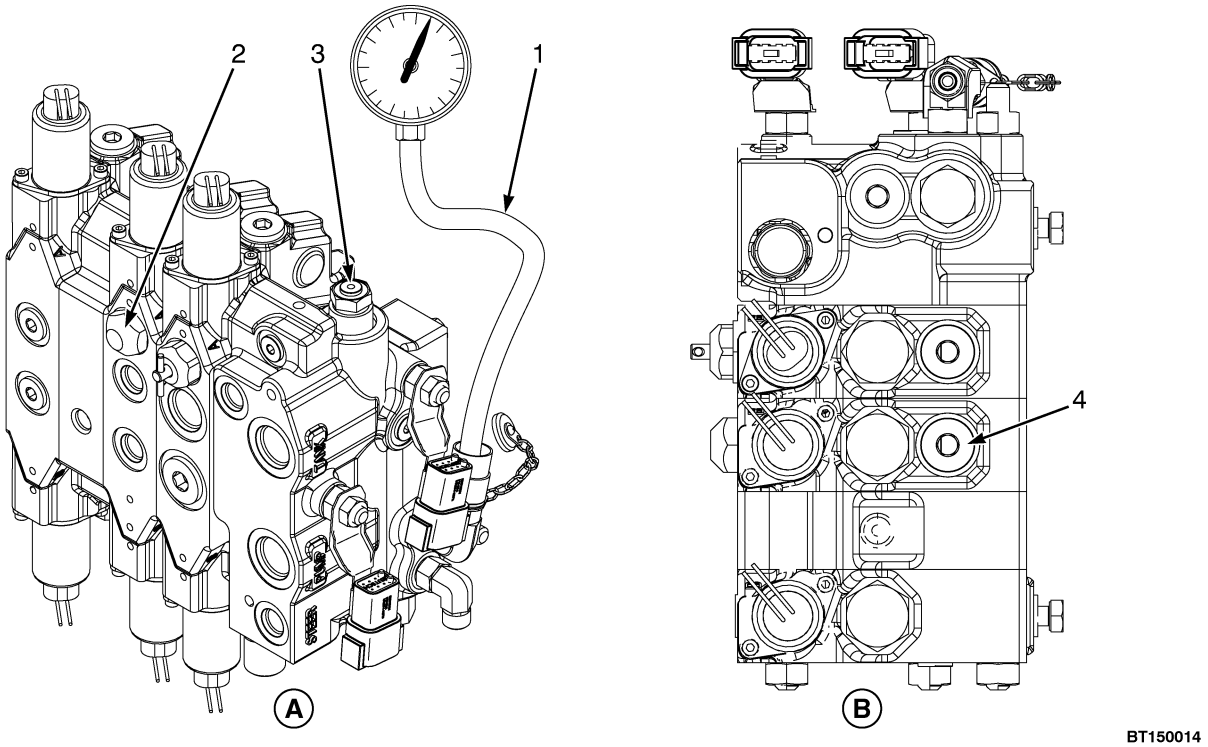
WARNING

Hot hydraulic oil can cause serious burns to skin. Do not touch hydraulic components or oil during test. Make sure hydraulic oil has cooled to safe temperature before installing or removing test equipment.

WARNING

Hydraulic oil under pressure can be injected into skin. Lower forks to ground and relieve all circuit pressure before removing test plugs from valve.

1. Lower forks to ground and turn key or keyless switch to **OFF** position. Apply park brake.



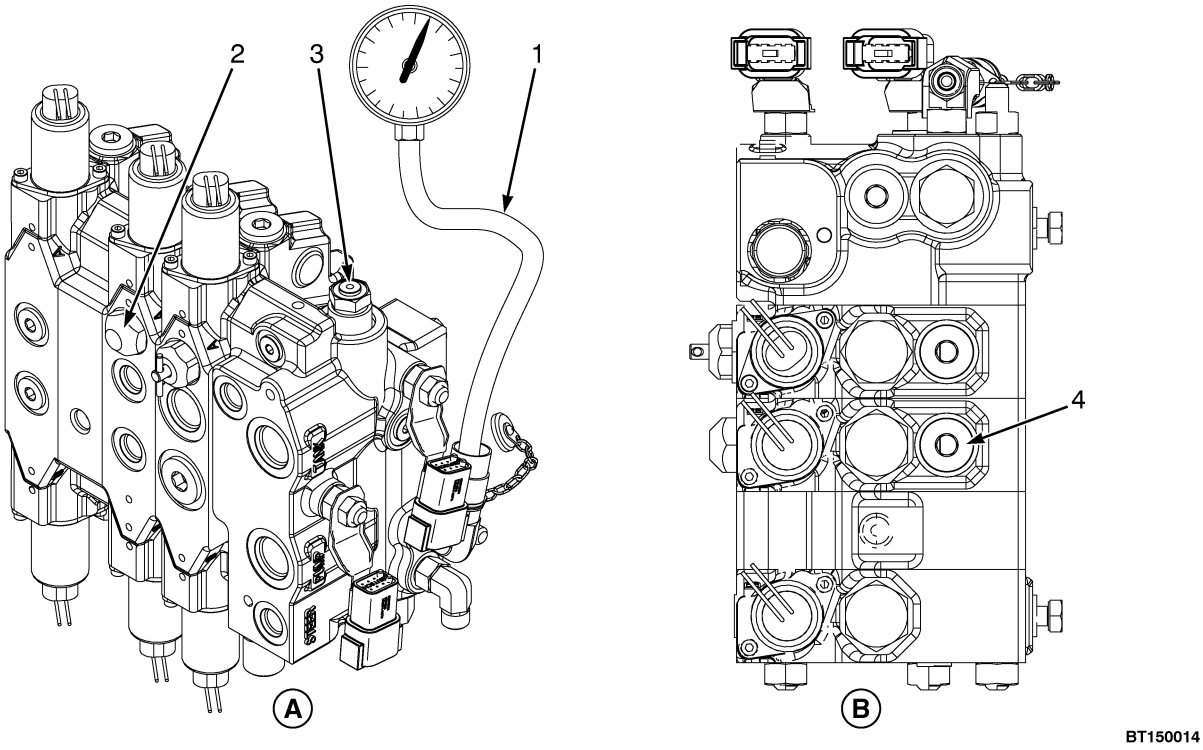
A. FRONT VIEW

1. DIAGNOSTIC PORT WITH GAUGE
2. ANTI-CAVITATION CHECK

B. BOTTOM VIEW

3. PRIMARY RELIEF VALVE LOCATION
4. OPTIONAL SECONDARY RELIEF VALVE LOCATION

Figure 9050-43-48. E-Hydraulic Control Valve for Lift Trucks J1.5-2.0XNT (J30-40XNT) (K160) , J1.6-2.0XN (A935) Shown



A. FRONT VIEW

B. BOTTOM VIEW

1. DIAGNOSTIC PORT WITH GAUGE
2. ANTI-CAVITATION CHECK
3. PRIMARY RELIEF VALVE LOCATION
4. SECONDARY RELIEF VALVE LOCATION

Figure 9050-43-49. E-Hydraulic Control Valve for Lift Trucks E2.2-3.5XN (E45-70XN) (A268) , and J2.2-3.5XN (J40-70XN) (A276) Shown

CAUTION

Do not permit dirt or other contaminants to enter the hydraulic system. Disconnected hoses, tubes, open valves, cylinder fittings, and ports should be protected with clean caps or plugs.

2. Remove covers. Install pressure gauge in control valve diagnostic port. See Figure 9050-43-46.

CAUTION

Setting relief valve above specification can cause damage to hydraulic and mechanical components of lift truck. Do not increase pressure above specifications.

3. Operate the hydraulic system until the oil temperature is at test specifications. See Hydraulic Warm-up Procedure.

4. Tilt the mast back until it stops. Hold the lever and check the reading of the gauge when the relief valve opens. Compare to test specifications.

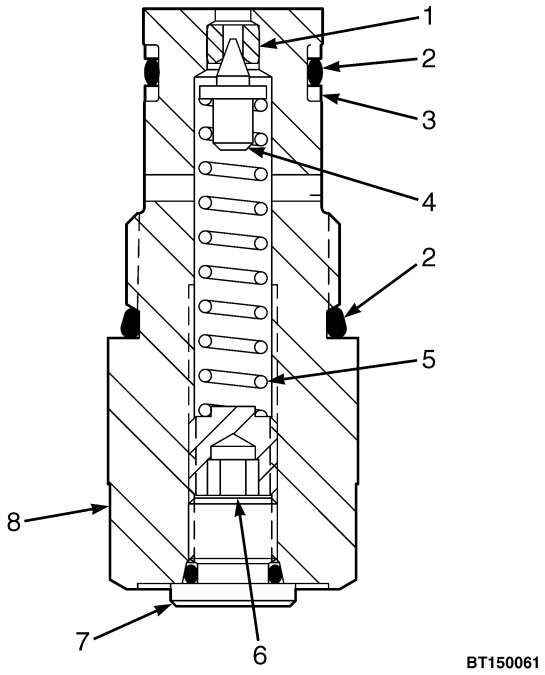
NOTE: Cycling the tilt or auxiliary function over relief after adjustment gives the relief valve spring opportunity to reposition itself inside the valve. This must be done after each adjustment until pressure is repeatable on gauge.

5. If pressure is not within specifications, remove hex plug (see Figure 9050-43-50), while holding tilt hydraulics over relief, slowly turn the adjustment screw, in (clockwise) to increase pressure, out (counterclockwise) to reduce pressure. Cycle the tilt or auxiliary control lever on and off against the relief three times to see if pressure is repeatable.

6. Insert hex plug. Cycle lever over relief a few more times to verify the setting is still correct. If setting does not stabilize, clean or replace relief valve. Depending on your lift truck see, **Main Control Valves** 2000SRM1334 or **Main Control Valves** 2000SRM1439.

7. If relief pressure cannot be maintained or adjusted up, the control valve may have contamination or have excess leakage in Load Sense (LS) circuit. See Main Control Valve LS Leakage Test (E-Valve).

8. Remove test equipment and reinstall diagnostic port cap.



1. SEAT
2. O-RING
3. BACKUP RING
4. POPPET
5. SPRING
6. ADJUSTMENT SCREW
7. HEX PLUG
8. RELIEF CARTRIDGE

Figure 9050-43-50. Optional/Secondary Relief Valve

Hydraulic Pump Flow Test

This test is done to accurately check the hydraulic pump output. This will isolate if performance problems are in hydraulic pump or elsewhere in hydraulic circuit.

NOTE: If a flowmeter is not available, use lift speed charts. Refer to the appropriate ***Capacities and Specifications*** manual to determine pump output. If lift raise times with capacity load on forks is more than 25% greater than specifications, the pump should be replaced. to determine pump output. If lift raise times with capacity load on forks is more than 25% greater than specifications, the pump should be replaced.

Table 9050-43-8. Test Specifications

Oil Temperature	50 - 65°C (122 - 150 °F)
Minimum Pump Output for Lift Truck J1.5-2.0XNT (J30-40XNT) (K160) and J1.6-2.0XN (A935)	**Pump:** 63.6 liter/min (16.8 gal/min)
Minimum Pump Output for Lift Truck E2.2-3.5XN (E45-70XN) (A268) and J2.2-3.5XN (J40-70XN) (A276)	**Pump:** 81.4 liter/min (21.5 gal/min)
Excess Flow (EF) Test Pressure	Tilt Function Over Relief (Optional/Secondary Relief Valve Setting)

Table 9050-43-9. Service Tools

125 liter/min (33 gal/min) Flowmeter, Rated at 24.0 MPa (3500 psi)	
0 - 35.0 MPa (0 - 5000 psi) Pressure Gauge	
Excess Flow (EF) Test Port Plug Size	SAE #4 O-ring Port (7/16-20 UNF)
Steering Control Valve Inlet Port Size	SAE #12 O-ring Port (1-1/16-12 UNF)

1. Lower forks to ground and turn key or keyless switch to the **OFF** position. Apply park brake.

WARNING

Hot hydraulic oil can cause serious burns to skin. Do not touch hydraulic components or oil during test. Make sure hydraulic oil has cooled to safe temperature before installing or removing test equipment.

CAUTION

Do not permit dirt or other contaminants to enter the hydraulic system. Disconnected hoses, tubes, open valves, cylinder fittings, and ports should be protected with clean caps or plugs.

2. Remove floor panels. Remove hose assembly to hydraulic pump and install flowmeter. Install hose assembly from flow meter to hydraulic pump. Install pressure gauge to the diagnostic port of control valve if flowmeter does not have internal gauge. See Figure 9050-43-51.

CAUTION

Hydraulic pump will be damaged if flowmeter gate valve is closed. Open the gate valve all the way open (counterclockwise) on the flowmeter before running lift truck.

3. Operate the hydraulic system until the oil temperature is to test specifications. See Hydraulic Warm-up Procedure.

4. Raise empty mast and hold over relief, record pump flow. Compare pump flow to specifications.

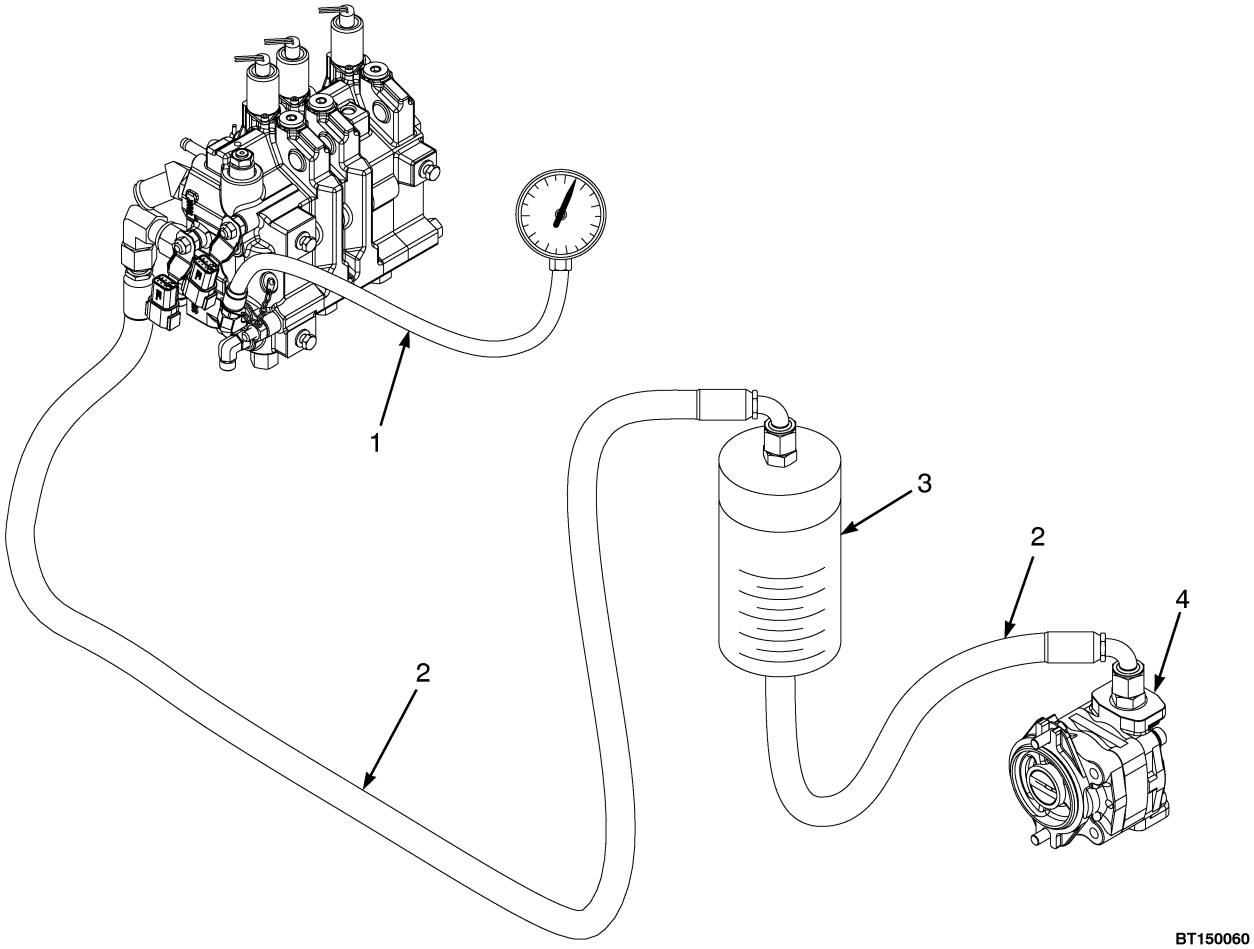
5. Return forks to ground level and turn key or keyless switch to **OFF** position.

NOTE: A collapsed suction hose or plugged suction screen in hydraulic tank could affect pump flow. Be sure to check these components before replacing pump.

6. If the flow is less than the specifications, inspect suction hoses to pump and suction screen in hydraulic tank. If they are OK then replace pump. Depending on your lift truck, see **Hydraulic System** 1900SRM1367, or **Hydraulic System** 1900SRM1333.

7. Remove test equipment, reinstall hoses and floor panel.

8. Check oil level in hydraulic tank. Add oil, as required.



NOTE: CONTROL VALVE SHOWN IS FOR LIFT TRUCKS J1.5-2.0XNT (J30-40XNT) (K160) AND J1.6-2.0XN (A935) .

1. DIAGNOSTIC PORT WITH GAUGE
2. HOSE ASSEMBLY
3. FLOWMETER
4. HYDRAULIC PUMP

Figure 9050-43-51. E-Hydraulic Pump Shown

Main Control Valve LS Leakage Test (E-Valve)

This test is done to check if there is leakage in the Load-Sense (LS) pressure circuit.

Table 9050-43-10. Test Specifications

Oil Temperature	50 - 65°C (122 - 150 °F)

WARNING

Hot hydraulic oil can cause serious burns to skin. Do not touch hydraulic components or oil during test. Make sure hydraulic oil has cooled to safe temperature before installing or removing test equipment.

WARNING

Hydraulic oil under pressure can be injected into skin. Lower forks to ground and relieve all circuit pressure before removing test plugs from valve.

1. Check hydraulic temperature. If not within specifications, see Hydraulic Warm-up Procedure. Operate until temperature is at test specifications.
2. Turn key or keyless switch to **ON** position and apply park brake.
3. Measure and record the lift rate with lift lever fully actuated at:
   - No Load
   - Rated Load
4. If the difference from specified rates in chart, it is likely that the LS passage has an internal leakage within the monoblock section. Replace the valve monoblock section. Depending on your lift truck see, **Main Control Valves** 2000SRM1334 or **Main Control Valves** 2000SRM1439.

Main Control Valve Unloader Margin Test

This test is done to check if unloader pressure margin is within test specification.

1. Lower forks to ground, turn key or keyless switch to **OFF** position, and apply park brake.

2. Remove floor plates that cover main control valve.

Table 9050-43-11. Test Specifications

Oil Temperature	50 to 65°C (122 to 150 °F)
Maximum Unloader Pressure Margin	1034 to 1138 kPa (150 to 165 psi)
Flow Rate	For [A268], E2.2-3.5XN (E45-70XN): **Primary Pump:** 81.4 liter/min (21.5 gal/min) For [A276], J2.2- 3.5XN (J40-70XN): **Primary Pump:** 81.4 liter/min (21.5 gal/min) For [K160], J1.5-2.0XNT (J30-40XNT): **Primary Pump:** 63.6 liter/min (16.8 gal/min) For [A935], J1.6-2.0XN: **Primary Pump:** 63.6 liter/min (16.8 gal/min)

Table 9050-43-12. Service Tools

0-3450 kPa (0-500 psi) Pressure Gauge

WARNING

Hot hydraulic oil can cause serious burns to skin. Do not touch hydraulic components or oil during test. Make sure hydraulic oil has cooled to safe temperature before installing or removing test equipment.

WARNING

Hydraulic oil under pressure can be injected into skin. Lower forks to ground and relieve all circuit pressure before removing test plugs from valve.

CAUTION

Do not permit dirt or other contaminants to enter the hydraulic system. Disconnected hoses, tubes, open valves, cylinder fittings, and ports should be protected with clean caps or plugs.

3. Install a hose in load sense port and the other hose in the reduced pressure port on the control valve. See Figure 9050-43-52.

NOTE: Test gauges must be calibrated. Gauge accuracy is very important for this test. A pressure differential gauge or switching block should be used so both readings are on same gauge. If you do not have this equipment, you will need to switch gauges to verify gauge readings.

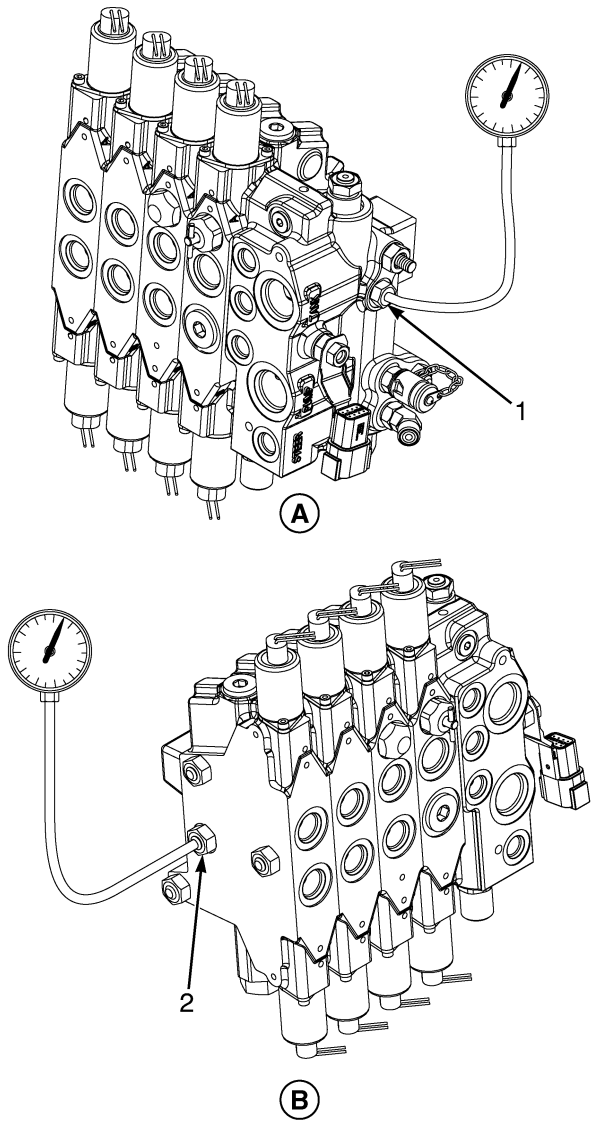
4. Check hydraulic temperature. If not within specifications, see Hydraulic Warm-up Procedure. Operate until temperature is at test specifications.

5. Measure pressure. If the pressure margin is below specification, go to Step 6.

6. If the pressure margin is below specification, proceed as follows:
   - Remove unloader spool and check for a broken spring or contamination. Depending on your lift truck see, **Main Control Valves** 2000SRM1334 or **Main Control Valves** 2000SRM1439.
   - Check main relief valve for contamination or broken spring. Depending on your lift truck see, **Main Control Valves** 2000SRM1334 or **Main Control Valves** 2000SRM1439.

7. If actions performed in Step 6 do not solve the problem, replace hydraulic control valve inlet section. Depending on your lift truck see, **Main Control Valves** 2000SRM1334 or **Main Control Valves** 2000SRM1439.

8. Remove test equipment and reinstall plugs in control valve.



NOTE: E-HYDRAULIC CONTROL VALVE FOR LIFT TRUCKS E2.2-3.5XN (E45-70XN) (A268) AND J2.2-3.5XN (J40-70XN) (A276) SHOWN.

A. LEFT VIEW
B. RIGHT VIEW

1. LOAD SENSE PORT WITH GAUGE
2. REDUCED PRESSURE PORT WITH GAUGE

Figure 9050-43-52. Unloader Valve Test Setup

E-Hydraulic Valve Leakage Test

This test is to determine if the E-Hydraulic Valve spool is damaged or if there is internal leakage between the section housing and the spool. This test should only be performed after doing the Lift Cylinder Leakage Test and leakage has been diagnosed to be in control valve.

1. Lower forks to ground, turn key or keyless switch to **ON** position and apply park brake.
2. Remove floor mats and floor plates.

WARNING

Hot hydraulic oil can cause serious burns to skin. Do not touch hydraulic components or oil during test. Make sure hydraulic oil has cooled to safe temperature before installing or removing test equipment.

WARNING

Hydraulic oil under pressure can be injected into skin. Lower forks to ground and relieve all circuit pressure before removing EHPV assembly.

CAUTION

Do not permit dirt or other contaminants to enter the hydraulic system. Disconnected hoses, tubes, open valves, cylinder fittings, and ports should be protected with clean caps or plugs.

3. Ensure that tank port is connected to the return line.

NOTE: Purge cool oil out of leakage hose until oil is 42°C (108°F) before connecting to the first work port.

NOTE: Work port leakage for port 1A must exceed 10 cc/min and ports 2A, 2B, 3A, 3B, 4A, and 4B must exceed 4 cc/min.

4. Connect "leakage" supply hose to each individual work port while spools are in neutral.
5. Operate hydraulic functions, read the pressure and compare to specifications. Disconnect "leakage" supply hose from work port.
6. Repeat Step 4 and Step 5 for each work port.
7. If the pressure is not within specification, replace control valve section. Depending on your lift truck see, **Main Control Valves** 2000SRM1334 or **Main Control Valves** 2000SRM1439.
8. Install floor plates and floor mats.
9. Lower forks to ground, turn key or keyless switch to **OFF** position and apply park brake.

Table 9050-43-13. Test Specifications

Oil Temperature	42°C (108°F) or Higher		
Maximum Leakage			
For J1.5-2.0XNT (J30-40XNT) (K160) and J1.6-2.0XN (A935) with 3-Function Control Valve	1A Port: 16.6 cc/min @ 16.8 MPa (2450 psi)	2A or 2B Port: 12.2 cc/min @ 6.8 MPa (1000 psi)	3A or 3B Port: 14.4 cc/min @ 6.8 MPa (1000 psi)
For J1.5-2.0XNT (J30-40XNT) (K160) and J1.6-2.0XN (A935) with 4-Function Control Valve	1A Port: 16.6 cc/min @ 16.8 MPa (2450 psi)	2A or 2B Port: 12.2 cc/min @ 6.8 MPa (1000 psi)	3A, 3B, 4A, or 4B Port: 14.4 cc/min @ 6.8 MPa (1000 psi)
For E2.2-3.0XN (E45-60XN) (A268) J2.2-3.0XN (J40-60XN) (A276) with 3-Function Control Valve	1A Port: 18.6 cc/min @ 19.6 MPa (2850 psi)	2A or 2B Port: 22.0 cc/min @ 8.2 MPa (1200 psi)	3A or 3B Port: 14.4 cc/min @ 6.8 MPa (1000 psi)
For E2.2-3.0XN (E45-60XN) (A268) J2.2-3.0XN (J40-60XN) (A276) with 4-Function Control Valve	1A Port: 18.6 cc/min @ 19.6 MPa (2850 psi)	2A or 2B Port: 22.0 cc/min @ 8.2 MPa (1200 psi)	3A, 3B, 4A, or 4B Port: 14.4 cc/min @ 6.8 MPa (1000 psi)
For E3.0-3.5XN (E60-70XN) (A268) J3.0-3.5XN (J60-70XN) (A276) with 3-Function Control Valve	1A Port: 21.1 cc/min @ 21.3 MPa (3100 psi)	2A or 2B Port: 22.0 cc/min @ 8.2 MPa (1200 psi)	3A or 3B Port: 14.4 cc/min @ 6.8 MPa (1000 psi)
For E3.0-3.5XN (E60-70XN) (A268) J. 30-3.5XN (J60-70XN) (A276) with 4-Function Control Valve	1A Port: 21.1 cc/min @ 21.3 MPa (3100 psi)	2A or 2B Port: 22.0 cc/min @ 8.2 MPa (1200 psi)	3A, 3B, 4A, or 4B Port: 14.4 cc/min @ 6.8 MPa (1000 psi)

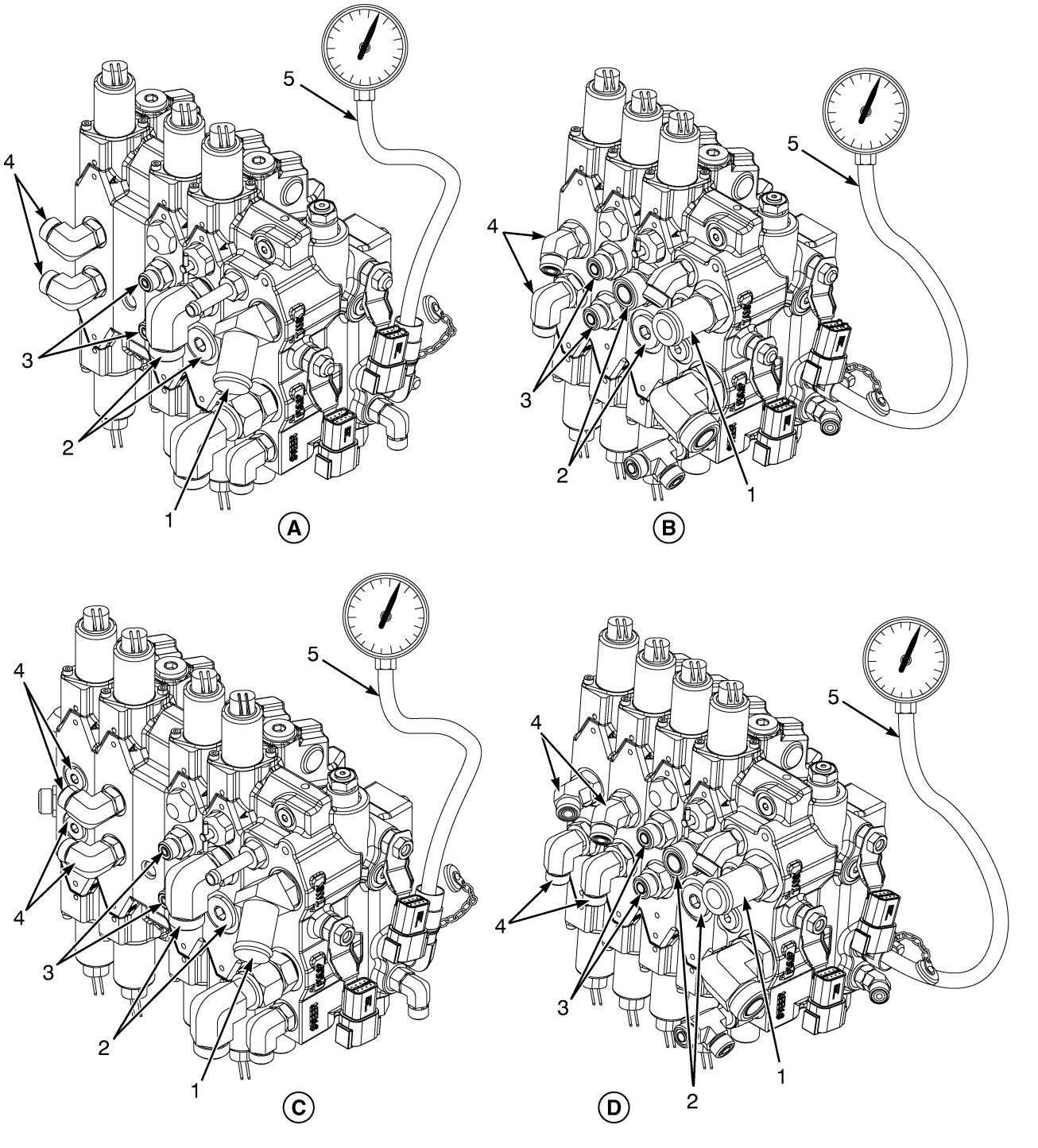


Figure 9050-43-53. E-Hydraulic Control Valve Fittings

Legend for Figure 9050-43-53

A. 3-FUNCTION CONTROL VALVE FOR LIFT TRUCK MODELS J1.5-2.0XNT (J30-40XNT) (K160) AND J1.6-2.0XN (A935)
B. 3-FUNCTION CONTROL VALVE FOR LIFT TRUCK MODELS E2.2-3.5XN (E45-70XN) (A268) AND J2.2-3.5XN (J40-70XN) (A276)
C. 4-FUNCTION CONTROL VALVE FOR LIFT TRUCK MODELS J1.5-2.0XNT (J30-40XNT) (K160) AND J1.6-2.0XN (A935)
D. 4-FUNCTION CONTROL VALVE FOR LIFT TRUCK MODELS E2.2-3.5XN (E45-70XN) (A268) AND J2.2-3.5XN (J40-70XN) (A276)

1. TANK PORT
2. 1A PORT (LIFT/LOWER)
3. 2A, 2B PORTS (TILT)
4. 3A, 3B, 4A, 4B PORTS (AUXILIARY)
5. DIAGNOSTIC PORT WITH GAUGE

Steering Relief Pressure Test and Adjustment

Table 9050-43-14. Test Specifications

Oil Temperature	50 to 65°C (122 to 150 °F)
Steering Relief Pressure	For [A268], E2.2-3.5XN (E45-70XN): 11.0 MPa (1595 psi) For [A276], J2.2- 3.5XN (J40-70XN): 12.4 MPa (1798 psi) For [K160], J1.5-2.0XNT (J30-40XNT): 7.5 MPa (1088 psi) For [A935], J1.6-2.0XN: 7.5 MPa (1088 psi)

Table 9050-43-15. Service Tools

0 - 35.0 MPa (0 to 5000 psi) Pressure Gauge
6 mm Hex wrench
8 mm Hex wrench
T-Fitting Hyster Part No. 8546398

1. Lower forks to ground and turn key or keyless switch to **OFF**. Apply park brake.

WARNING

Hot hydraulic oil can cause serious burns to skin. Do not touch hydraulic components or oil during test.

Make sure hydraulic oil has cooled to safe temperature before installing or removing test equipment.

WARNING

Hydraulic oil under pressure can be injected into skin. Lower forks to ground and relieve all circuit pressure before removing test plugs from valve.

2. Remove steering column covers, floor mat, and floor plates.

CAUTION

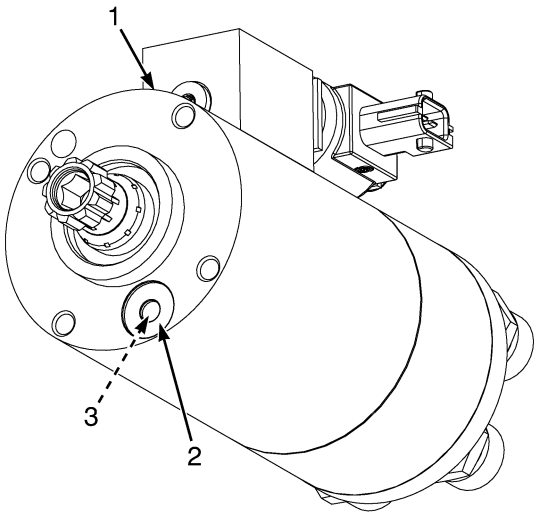
Do not permit dirt or other contaminants to enter the hydraulic system. Disconnected hoses, tubes, open valves, cylinder fittings, and ports should be protected with clean caps or plugs.

3. Connect pressure gauge to steering hose as shown in Figure 9050-43-55 and Figure 9050-43-56.

4. Operate hydraulic system until the oil temperature is at test specifications. See Hydraulic Warm-up Procedure.

5. Turn steering wheel to stop. Apply turning effort against stop, causing steering system pressure to go over relief.

6. Check pressure gauge reading. Compare reading to specifications.



1. STEERING CONTROL UNIT (SCU)
2. PLUG
3. RELIEF VALVE ADJUSTER

Figure 9050-43-54. SCU Adjustment

NOTE: Steering relief adjuster is very sensitive. Make changes in 1/8 turn increments to avoid over pressurizing system.

7. If pressure is lower or higher than specifications, perform steps below: See Figure 9050-43-54.

a. Remove steering control unit (SCU) from steering column. See **Steering System** 1600SRM1331 for lift truck model J1.5-2.0XNT (J30-40XNT) (K160) or **Steering System** 1600SRM1363 for lift truck models E2.2-3.5XN (E45-70XN) (A268) , J2.2-3.5XN (J40-70XN) (A276) , and J1.6-2.0XN (J30-40XN) (A935) for procedures.

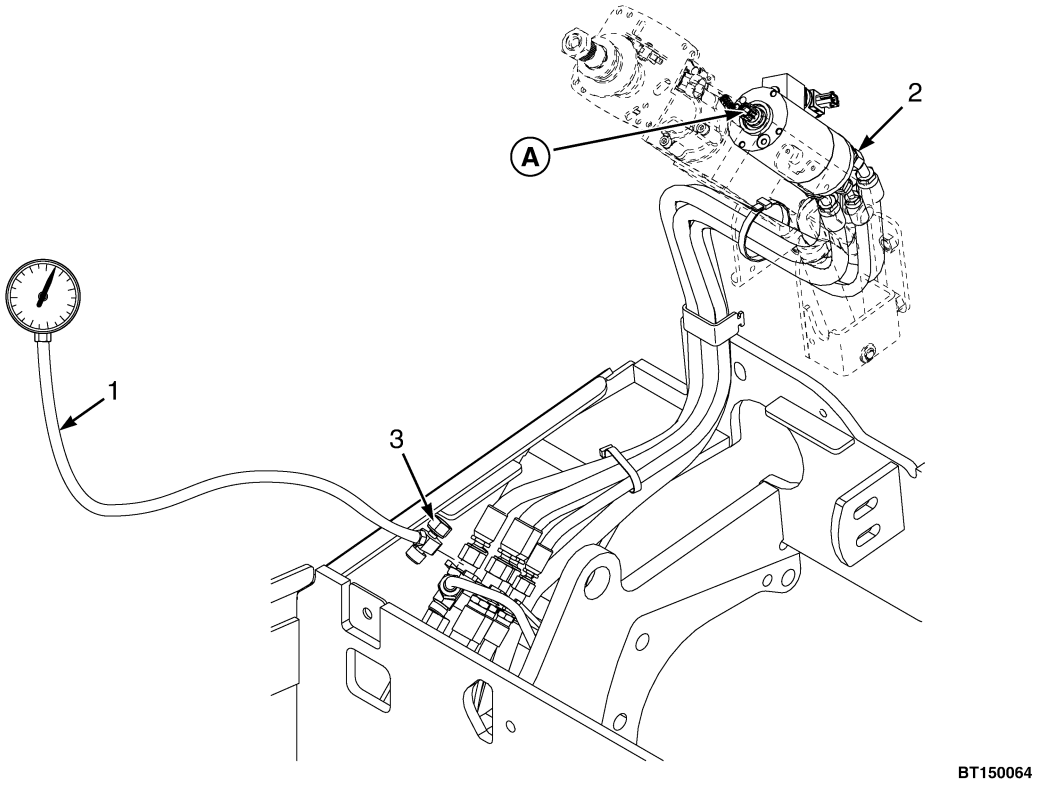
b. If pressure is less than specifications, install hex wrench (1) and turn relief valve adjuster clockwise. See Figure 9050-43-54.

c. If pressure is higher than specifications, install hex wrench (1) and turn relief valve adjuster counterclockwise. See Figure 9050-43-54.

d. Install hex wrench (2) in placement shown in Figure 9050-43-55 or Figure 9050-43-56. Apply turning effort against stop causing steering system pressure to go over relief.

e. Check pressure gauge reading. Compare reading to specifications.

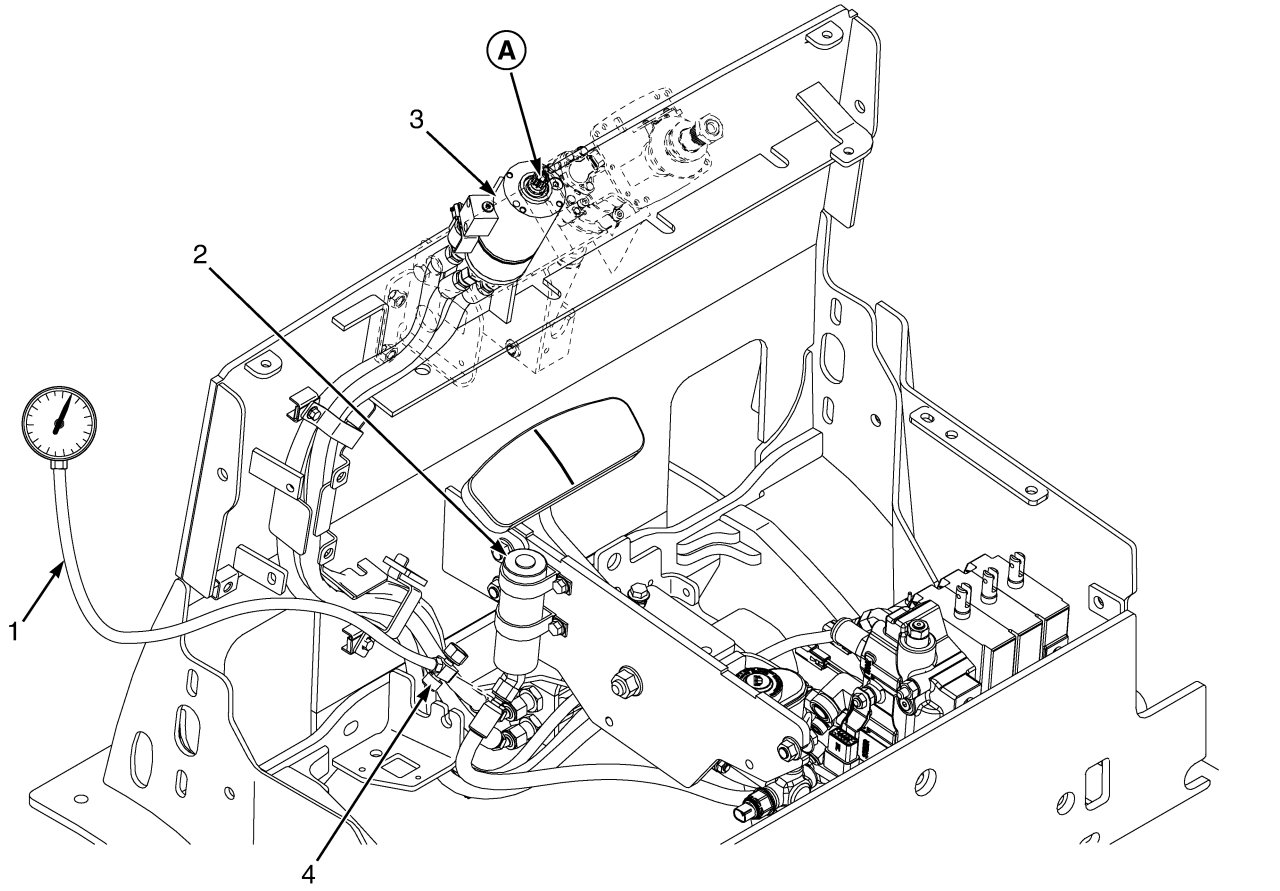
f. Repeat Step b through Step d. If pressure is to specifications, install steering control unit (SCU) onto steering column and remove test equipment. Install test port and adjuster plug.



A. PLACEMENT OF HEX WRENCH (2) TO TURN STEERING COLUMN.

1. TEST GAUGE HOSE
2. STEERING CONTROL UNIT (SCU) HOSE CONNECTIONS
3. T-FITTING

Figure 9050-43-55. Steer Relief Pressure for Lift Truck models J1.5-2.0XNT (J30-40XNT) (K160) and J1.6-2.0XN (A935)



A. PLACEMENT OF HEX WRENCH (2) TO TURN STEERING COLUMN.

1. TEST GAUGE HOSE
2. STEER ACCUMULATOR
3. STEERING CONTROL UNIT (SCU)
4. T-FITTING

Figure 9050-43-56. Steer Relief Pressure for Lift Truck models E2.2-3.5XN (E45-70XN) (A268) and J2.2-3.5XN (J40-70XN) (A276)

Steering Control Unit LS Pressure Test

This test checks if LS (Load-Sense) pressure is correct to operate the flow divider spool functions of the Steering Control Unit (SCU).

Table 9050-43-16. Test Specifications

Oil Temperature	50 - 65°C (122 - 150 °F)
Minimum LS Pressure	For [A268], E2.2-3.5XN (E45-70XN): 11.0 MPa (1595 psi) For [A276], J2.2- 3.5XN (J40-70XN): 12.4 MPa (1798 psi) For [K160], J1.5-2.0XNT (J30-40XNT): 7.5 MPa (1088 psi) For [A935], J1.6-2.0XN: 7.5 MPa (1088 psi)

Table 9050-43-17. Service Tools

Pressure differential gauge or switching block	
0 - 35.0 MPa (0 - 5000 psi) Pressure Gauge	
Steering Control Unit (SCU) "P" & "LS" Test Port Size	SAE #4 O-ring Port (7/16-20 UNF)
T-Fitting	Hyster Part No. 8546398

WARNING

Hot hydraulic oil can cause serious burns to skin. Do not touch hydraulic components or oil during test. Make sure hydraulic oil has cooled to safe temperature before installing or removing test equipment.

WARNING

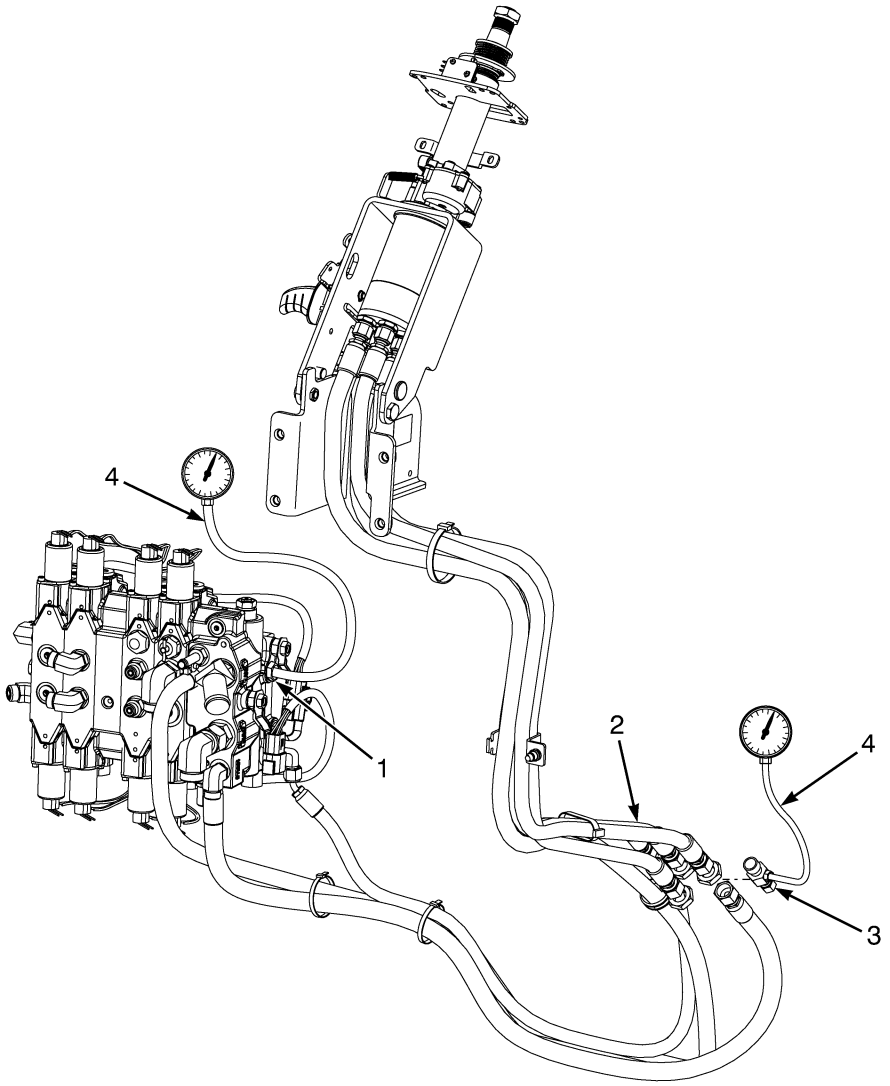
Hydraulic oil under pressure can be injected into skin. Lower forks to ground and relieve all circuit pressure before removing test plugs from valve.

1. Lower forks to ground, turn key or keyless switch to **OFF** position, and apply park brake.
2. Remove steering column covers to access Steering Control Unit (SCU); remove floor plates to access main control valve and hydraulic lines.

CAUTION

Do not permit dirt or other contaminants to enter the hydraulic system. Disconnected hoses, tubes, open valves, cylinder fittings, and ports should be protected with clean caps or plugs.

3. Install one test hose in LS port and the other test hose in fitting on (P) main pressure port hose of the SCU. See Figure 9050-43-57.
4. Check hydraulic temperature. If not within specifications. See Hydraulic Warm-up Procedure.
5. Hold steering over relief and measure relief pressure, then LS pressure and compare to specifications.
6. If LS pressure is not within specifications, remove SCU. Inspect and clean LS orifices. Depending on your lift truck see, **Main Control Valves** 2000SRM1334 or **Main Control Valves** 2000SRM1439.
7. Remove test equipment and reinstall test plugs.



BT150066

NOTE: E-HYDRAULIC CONTROL VALVE FOR LIFT TRUCK MODEL J1.5-2.0XNT (J30-40XNT) (K160) SHOWN.

1. "LS" LOAD SENSE PORT
2. "P" MAIN PRESSURE PORT HOSE
3. T-FITTING
4. TEST GAUGE HOSE

Figure 9050-43-57. SCU LS Pressure Test

Lift Cylinder Leakage Test

Hydraulic leakage causes heat and poor performance in a hydraulic system. This test is done to determine if the leakage is in the cylinder or the hydraulic control valve.

Table 9050-43-18. Test Specifications

Oil Temperature	50°C (122 °F)
Maximum Carriage Travel in 10 minutes	102 mm (4.0 in.)

Table 9050-43-19. Service Tools

Tape measure or ruler	
Ball Valve rated at 24 MPa (3500 psi) minimum	
Control Valve Lift Port Size	SAE #12 O-ring Port (1-1/16 - 12 UNF)

WARNING

Hot hydraulic oil can cause serious burns to skin. Do not touch hydraulic components or oil during test. Make sure hydraulic oil has cooled to safe temperature before installing or removing test equipment.

WARNING

Hydraulic oil under pressure can be injected into skin. Lower forks to ground and relieve all circuit pressure before removing hoses from cylinders.

1. Lower forks to ground, turn key or keyless switch to **OFF** position, and apply park brake.

CAUTION

Do not permit dirt or other contaminants to enter the hydraulic system. Disconnected hoses, tubes, open valves, cylinder fittings, and ports should be protected with clean caps or plugs.

2. Slowly loosen hose fitting to relieve pressure. Remove hose and install ball valve in the supply line between the main control valve and the lift cylinder. Open ball valve fully to allow maximum flow during warm-up procedure. See Figure 9050-43-58, Figure 9050-43-59, and Figure 9050-43-60.

3. Check hydraulic temperature. If not within specifications, see Hydraulic Warm-up Procedure.

WARNING

Lowering of forks with load can cause personal injury. Do not place body parts under load.

4. Put a capacity load on the forks, and raise and lower the load several times. Lower the load and tilt the mast forward and backward several times. Check for external cylinder or hose leaks.

5. Raise the carriage and load 2.5 m (8.2 ft). Observe load, if the carriage slowly lowers when the control valve is in the neutral position, there are leaks in the hydraulic system. Go to Step 7.

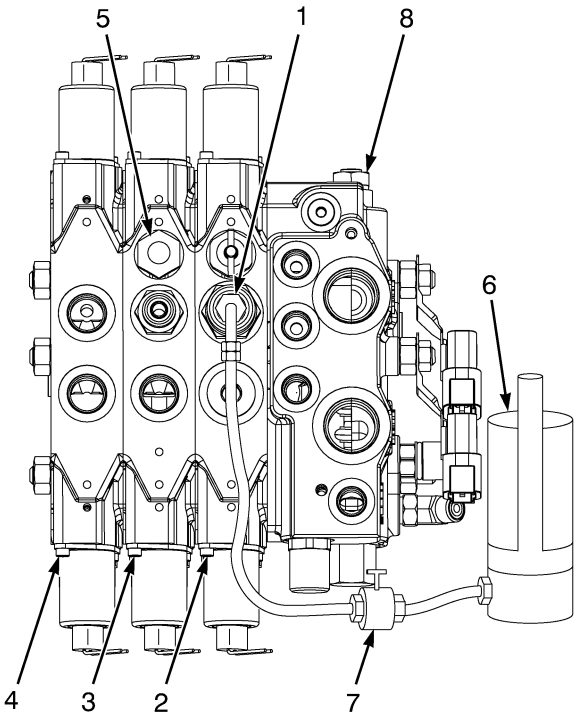
6. If carriage is not dropping fast enough for visual check, use a tape measure and record movement. Turn key or keyless switch to the **OFF** position and let truck sit for 10 minutes. If movement exceeds specifications, go to Step 7.

7. To check the lift cylinders for internal leaks, close the ball valve in the supply line between the main control valve and the mast. Let truck sit for 10 minutes and measure movement. If it does not meet specifications, the seals in the lift cylinders have leaks. Repair cylinder. Depending on your lift truck see, **Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564)** 2100SRM1382 or **Cylinder Repair (Mast S/N B551, B555, B559)** 2100SRM1440.

NOTE: Contamination in the hydraulic system can cause the control valve to leak. Remove and clean valve before replacing.

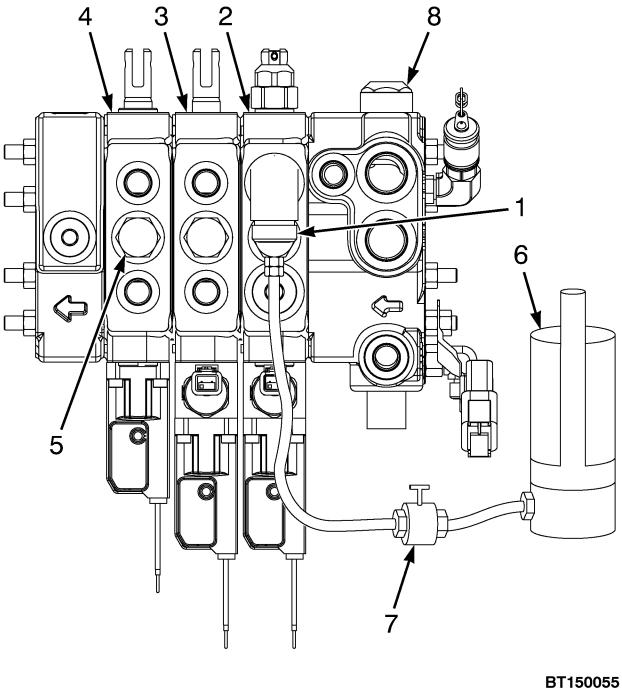
8. If the carriage does not move, open the ball valve and check the movement again. If the carriage lowers when the ball valve is open, check for leaks in the hydraulic lines and fittings. If no leaks are found, the main control valve could be worn, contaminated, or damaged. Remove and clean hydraulic control valve. Depending on your lift truck see, **Main Control Valves** 2000SRM1334 or **Main Control Valves** 2000SRM1439.

9. Remove the load from the forks and remove ball valve.



1. LIFT PORT
2. LIFT VALVE SECTION
3. TILT VALVE SECTION
4. AUXILIARY VALVE SECTION
5. OPTIONAL RELIEF VALVE LOCATION
6. LIFT CYLINDER
7. BALL VALVE
8. MAIN RELIEF VALVE

Figure 9050-43-58. Lift Cylinder Leakage Test - E-Hydraulic Control Valve



1. LIFT PORT
2. LIFT VALVE SECTION
3. TILT VALVE SECTION
4. AUXILIARY VALVE SECTION
5. OPTIONAL RELIEF VALVE LOCATION
6. LIFT CYLINDER
7. BALL VALVE
8. MAIN RELIEF VALVE

Figure 9050-43-59. Lift Cylinder Leakage Test - Manual Control Valve for Lift Trucks J1.6-2.0XNT (J30-40XNT) (K160) and J1.6-2.0XN (A935)

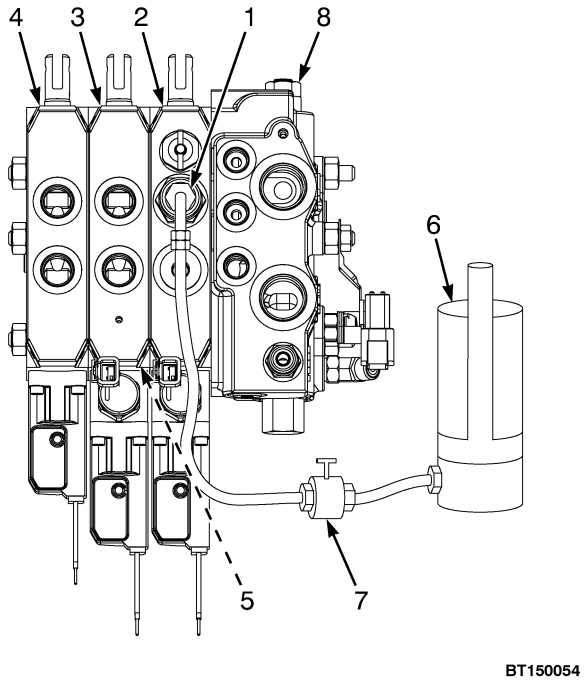


Figure 9050-43-60. Lift Cylinder Leakage Test - Manual Control Valve for Lift Trucks E2.2-3.5XN (E45-70XN) (A268) and J2.2-3.5XN (J40-70XN) (A276)

Legend for Figure 9050-43-60

1. LIFT PORT
2. LIFT VALVE SECTION
3. TILT VALVE SECTION
4. AUXILIARY VALVE SECTION
5. OPTIONAL RELIEF VALVE LOCATION
6. LIFT CYLINDER
7. BALL VALVE
8. MAIN RELIEF VALVE

Tilt Cylinder Leakage Test

Hydraulic leakage causes heat and poor performance in a hydraulic system. This test is done to determine if the leakage is in the cylinder or the hydraulic control valve.

Table 9050-43-20. Test Specifications

Oil Temperature	50°C (122 °F)
Maximum Rod Travel in 10 minutes	5° rotation of mast

Table 9050-43-21. Service Tools

Angle Meter	
Ball Valve rated at 24 MPa (3500 psi) minimum	
Tilt Valve Section Port Size	SAE #8 O-ring Port (3/4-16 UNF)

1. Lower forks to ground, turn key or keyless switch to **OFF** position, and apply park brake.

WARNING

Hot hydraulic oil can cause serious burns to skin. Do not touch hydraulic components or oil during test. Make sure hydraulic oil has cooled to safe temperature before installing or removing test equipment.

WARNING

Hydraulic oil under pressure can be injected into skin. Lower forks to ground and relieve all circuit pressure before removing hoses from cylinders.

CAUTION

Do not permit dirt or other contaminants to enter the hydraulic system. Disconnected hoses, tubes, open valves, cylinder fittings, and ports should be protected with clean caps or plugs.

2. Slowly loosen hose fitting to relieve pressure. Remove hose and install ball valve inline with hose on cylinder to be tested. Open ball valve fully to allow maximum flow during warm-up procedure.

3. Check hydraulic temperature. If not within specifications, see Hydraulic Warm-up Procedure. Operate until temperature is at test specifications.

4. Put a capacity load on the forks, and raise the capacity load to 2.5 m (8.2 ft) and lower the load several times. Lower the load and slowly tilt the mast forward to 90° to floor and backward several times.

5. Check for external cylinder or hose leaks.

6. Slowly tilt the mast forward to 90° to floor. If the mast continues to slowly tilt forward when the control valve is in the neutral position, there are leaks inside the hydraulic system. Go to Step 8.

7. If mast is not dropping forward fast enough for visual check, use angle meter to record mast movement. Stop lift truck and let machine sit for 10 minutes. If movement exceeds specifications go to Step 8.

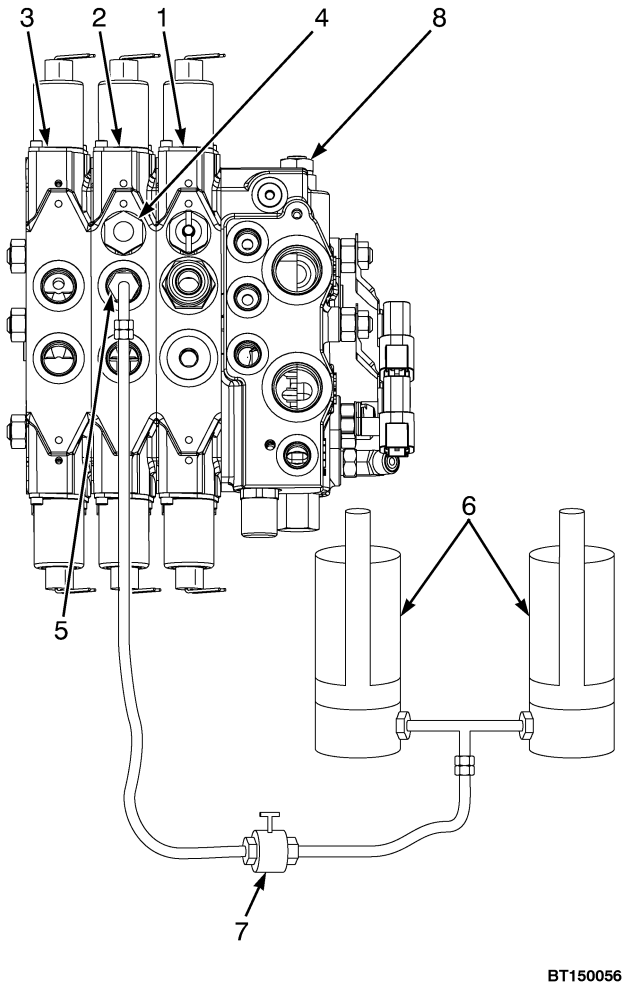
8. To check the tilt cylinders for internal leaks, close the ball valve in the supply line between the main control valve and the tilt cylinders. Measure movement and compare to specifications.

- If movement does not meet test specifications, the seals in the tilt cylinders have leaks. Repair cylinder. Depending on your lift truck see, **Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564)** 2100SRM1382 or **Cylinder Repair (Mast S/N B551, B555, B559)** 2100SRM1440.

NOTE: Contamination in the hydraulic system can cause the control valve to leak, remove and clean valve before replacement.

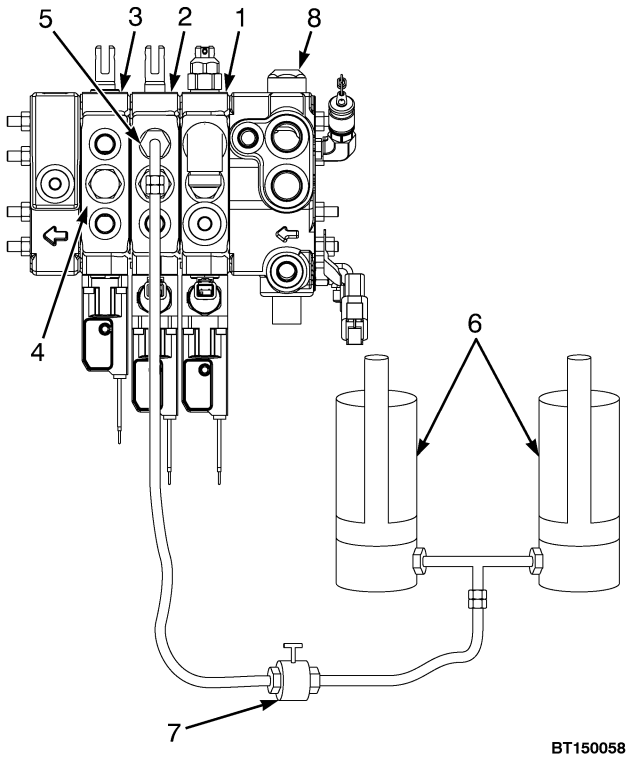
- If the mast does not move, open the ball valve and check the movement again. If the mast moves when the ball valve is open, check for leaks in the hydraulic lines and fittings. If no leaks are found, the main control valve can be worn or damaged. Remove and clean hydraulic control valve. Depending on your lift truck see, **Main Control Valves** 2000SRM1334 or **Main Control Valves** 2000SRM1439.

9. Remove the load from the forks and remove ball valve. Reconnect all hoses.



1. LIFT VALVE SECTION
2. TILT VALVE SECTION
3. AUXILIARY VALVE SECTION
4. OPTIONAL RELIEF VALVE LOCATION
5. TILT PORT
6. TILT CYLINDERS
7. BALL VALVE
8. MAIN RELIEF VALVE

Figure 9050-43-61. Tilt Cylinder Leakage Test - E-Hydraulic Control Valve



1. LIFT VALVE SECTION
2. TILT VALVE SECTION
3. AUXILIARY VALVE SECTION
4. OPTIONAL RELIEF VALVE LOCATION
5. TILT PORT
6. TILT CYLINDERS
7. BALL VALVE
8. MAIN RELIEF VALVE

Figure 9050-43-62. Tilt Cylinder Leakage Test - Manual Control Valve for Lift Trucks J1.5-2.0XNT (J30-40XNT) (K160) and J1.6-2.0XN (A935)

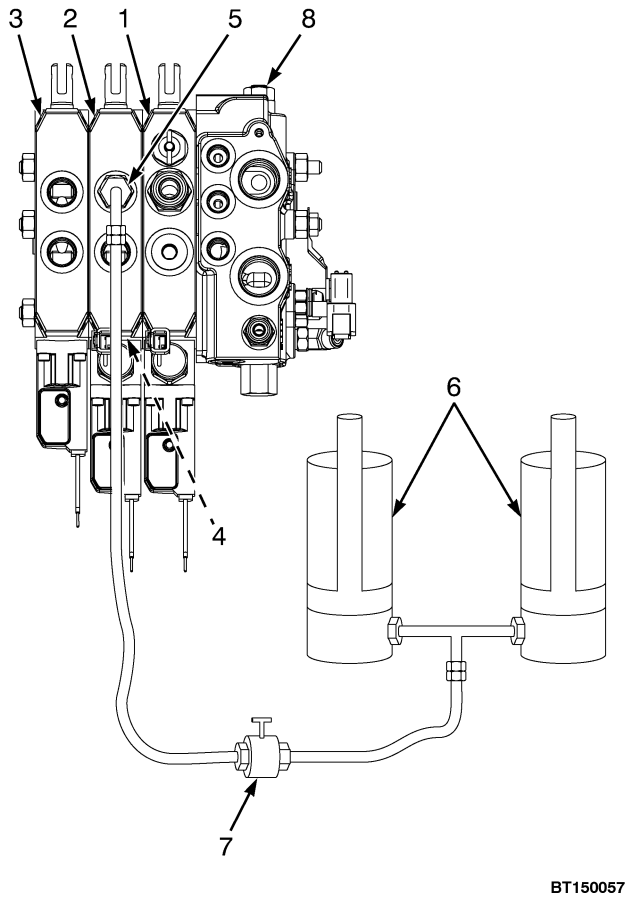


Figure 9050-43-63. Tilt Cylinder Leakage Test - Manual Control Valve for Lift Trucks E2.2-3.5XN (E45-70XN) (A268) and J2.2-3.5XN (J40-70XN) (A276)

Legend for Figure 9050-43-63

1. LIFT VALVE SECTION
2. TILT VALVE SECTION
3. AUXILIARY VALVE SECTION
4. OPTIONAL RELIEF VALVE LOCATION
5. TILT PORT
6. TILT CYLINDERS
7. BALL VALVE
8. MAIN RELIEF VALVE

Steering Cylinder Leakage Test

Cylinder leakage causes heat and poor performance in a steering system. This test is done to determine if the leakage is in the steering cylinder or the steering control unit.

Table 9050-43-22. Test Specifications

Oil Temperature	21 - 43°C (70 - 110 °F)
Maximum Leakage	10 ml (0.35 oz) Per Minute

1. Lower forks to ground and turn steering wheel until steer axle is against right axle stop. Turn key or keyless switch to **OFF** position and apply park brake.

2. Remove floor plates to expose steering cylinder hose connections.

3. Check hydraulic temperature. If not within specifications, see Hydraulic Warm-up Procedure.

Table 9050-43-23. Service Tools

Container	
Left and Right Work Port Size	SAE #8 O-ring Port (3/4-16 UNF)
T-Fitting	Hyster Part No. 8546398

WARNING

Hot hydraulic oil can cause serious burns to skin. Do not touch hydraulic components or oil during test. Make sure hydraulic oil has cooled to safe temperature before installing or removing test equipment.

WARNING

Hydraulic oil under pressure can be injected into skin. Lower forks to ground and relieve all circuit pressure before removing hoses from cylinders.

CAUTION

Do not permit dirt or other contaminants to enter the hydraulic system. Disconnected hoses, tubes, open valves, cylinder fittings, and ports should be protected with clean caps or plugs.

4. Slowly loosen left steering hose fitting that goes into SCU top left port marked (L). Remove left steering hose and keep it elevated so oil is not lost. Install O-ring Face Seal (ORFS) high pressure cap on left port fitting of SCU to seal valve against high pressure leakage when steering wheel is turned.

NOTE: Turning the steering wheel by hand with lift truck off will generate hydraulic pressure in cylinder. If leakage is noted at this lower pressure, cylinder has excessive leakage.

5. Attempt to turn the steering wheel by hand. If oil flows out of hose at noticeable rate (approximately 50% of test specification), steering cylinder needs repair. Stop test and repair steering cylinder. If no oil flow, go to Step 6.

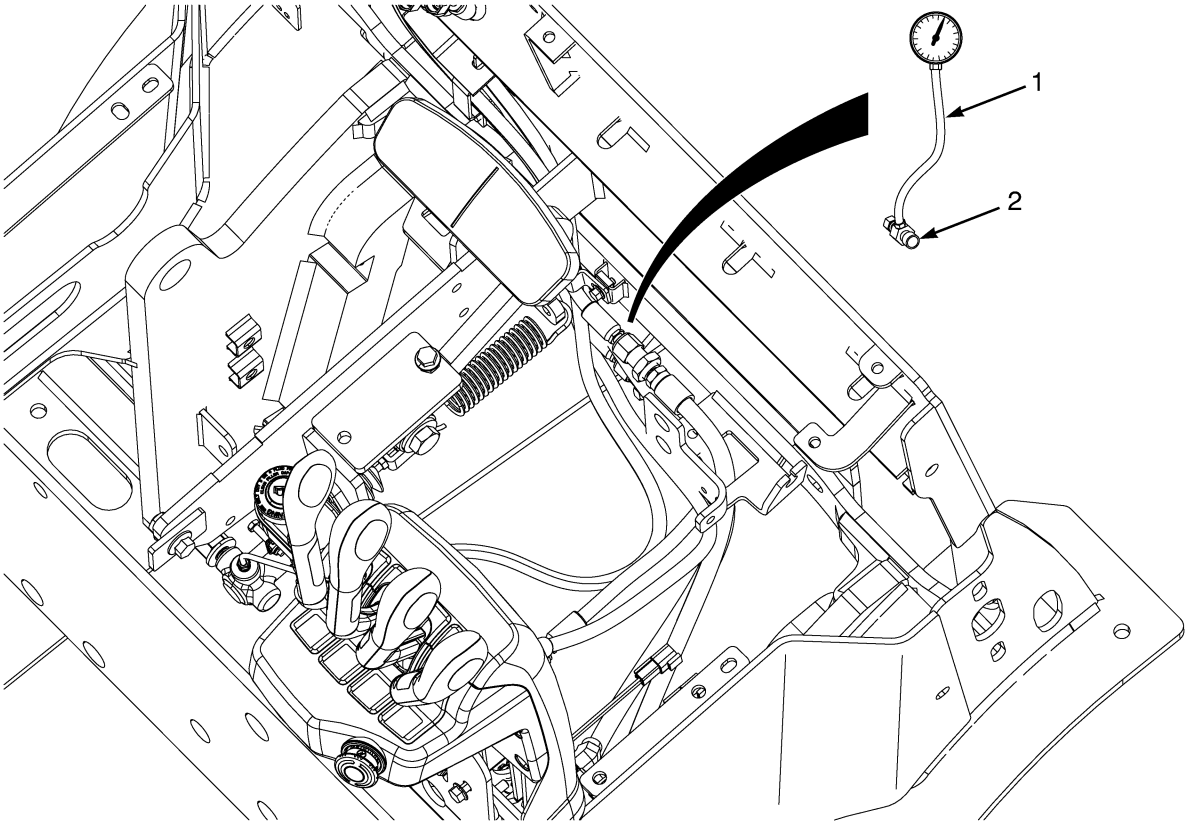
WARNING

A open steering port can expel hydraulic oil under pressure and it can be injected into skin. Seal SCU port with high pressure ORFS cap before turning lift truck on.

6. Turn key or keyless switch **ON** and hold steering against right axle stop. Measure oil after it starts to flow from end of removed steering hose for 1 minute.

7. Turn key or keyless switch to **OFF** position and compare measured oil to test specifications.
   - If leakage is below specifications, the steering cylinder is OK.
   - If leakage is more than specifications, remove and repair steering cylinder. Depending on your lift truck, see **Steering System** 1600SRM1331**Steering System** 1600SRM1363

8. Remove caps and reinstall hose and valve covers.



1. TEST GAUGE HOSE
2. FITTING

Figure 9050-43-64. Steering Cylinder Leakage Test

SECTION 9060

OPERATORS STATION

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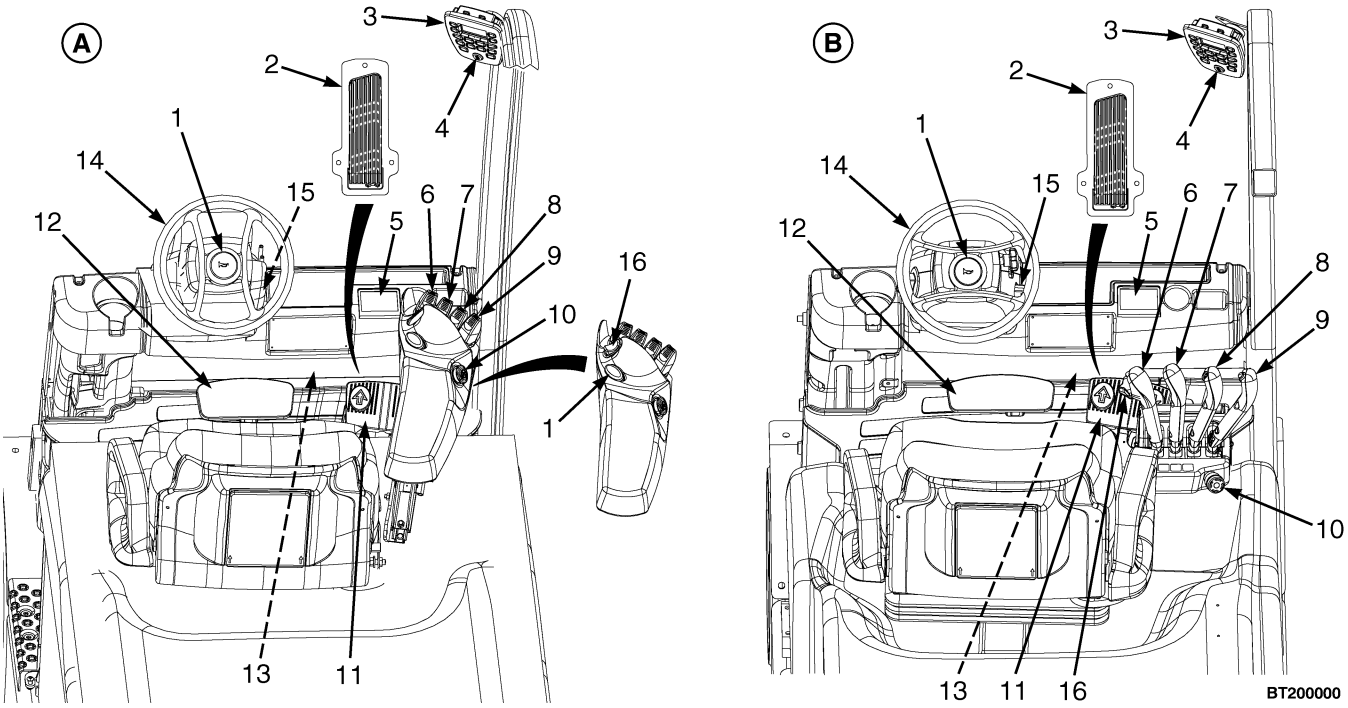
Group 10
Principles of Operation

Operator Station General Description and Principles of Operation

GENERAL DESCRIPTION AND LOCATION

The major components of the operator station for the lift truck are shown in Figure 9060-10-1. The conventional hydraulic steering, braking, and drive system elements are not included in this section. Refer to the **Operating Manual** for related information on common systems. See Figure 9060-10-1.



A. E-HYDRAULIC CONTROL

1. HORN BUTTON
2. ACCELERATOR PEDAL (OPTIONAL)
3. DISPLAY PANEL
4. KEY SWITCH OR KEYLESS SWITCH
5. LIGHT SWITCHES
6. LIFT/LOWER CONTROL LEVER
7. TILT CONTROL LEVER
8. CONTROL LEVER FOR AUXILIARY HYDRAULIC FUNCTIONS (3RD LEVER)

B. MANUAL HYDRAULIC CONTROL

9. CONTROL LEVER FOR AUXILIARY HYDRAULIC FUNCTIONS (4TH LEVER)
10. EMERGENCY DISCONNECT SWITCH
11. MONOTROL® FOOT PEDAL PEDAL (OPTIONAL)
12. BRAKE PEDAL
13. AUTOMATIC PARKING BRAKE MANUAL OVERRIDE HANDLE (OPTIONAL)
14. STEERING WHEEL
15. STEERING COLUMN TILT MEMORY LEVER
16. DIRECTION CONTROL SWITCH (OPTIONAL)

Figure 9060-10-1. Operator Station Components

The components shown in Figure 9060-10-1 include multiple options which are customer determined. These options are explained in greater detail in the appropriate sections of this manual. The indicated devices are used for various control inputs and operation of the lift truck systems.

Display Panel provides:

- Power **ON/OFF** selection
- Display and Input for menu-driven data entry, navigation, and readout
-

Manual Hydraulic Levers (if equipped) provides:

- Control of lift
- Lower
- Tilt
- Sideshift
- Fork spread functions
- Emergency disconnect switch
- Directional Control Switch (Optional)

Mini Lever Module (MLM) (if equipped) provides:

- Control of lift
- Lower
- Tilt
- Sideshift
- Fork spread functions
- Emergency disconnect switch
- Horn
- Directional Control Switch (Optional)

Vehicle System Manager (VSM) provides:

- Controls or monitors most electrical operations of the lift truck
- Safe shutdown for critical faults
- Manages operator inputs and stores operational/fault data history

Steering Wheel provides:

- The steering wheel controls the movement of the steer wheels. Rotate the steering wheel clockwise to make a right turn, and counterclockwise to make a left turn.

Horn provides

- Push the horn button to warn pedestrians and others when approaching intersections and other blind areas.
- If lift truck is equipped with E-Hydraulic controls, there is another horn button located on the armrest.

Light Switches provides rocker switches for the following light functions:

- Front Driving/Brake/Reverse/Parking lights.
- Rear Driving light and the Strobe light or Strobe light only.
- Operator Compartment light (if equipped with a cab) or Strobe light only.

Tilt Memory Lever provides:

- The ability to move the steering column so that the hood can be raised. Lift and hold the lever while moving the steering column. Release the lever when the steering column is in the desired position.

Standard Accelerator provides:

- Accelerator function for speed control on lift trucks equipped with a FWD/REV Directional Control Switch (DCS); which may be located on the armrest of lift trucks equipped with e-hydraulics, or on the lift/lower hydraulic control lever of lift trucks equipped with manual hydraulics.

MONOTROL® Pedal provides:

- Foot pedal input control for FWD or REV travel.
- Accelerator function for speed control.

The foot pedal direction control is configured with analog position sensors that input the direction command to the VSM. Pressing on the right side of the pedal selects the REV direction with corresponding backup lights and backup alarm activated. Pressing the left side of the pedal selects the FWD direction. The foot pedal direction control also serves as the accelerator pedal, pushing it down further will increase the speed of the truck in the applied direction.

Service Brake Provides:

- Includes a hydraulically operated brake mechanism at the drive wheels. These wheel brakes are controlled by movement of the brake pedal, providing braking proportional to the applied pedal force.
- When the service brake is applied, the E-Boost feature is activated. This will direct the traction system to brake the vehicle.

NOTE: Further troubleshooting procedures for park brake can be found in Park Brake Troubleshooting Guide.

Parking Brake provides:

- Mechanical brake operated through a separate pedal; it applies parking-brake mechanisms at the two drive wheels

Auto Park Brake provides:

- Automatic braking to the traction motor; slowing it down and eventually bringing it to a stop.
- If the lift truck loses power and has to be towed, there is a manual override handle that will disable the auto park brake. The manual override handle is located underneath the floor mat and floor plate and mounted to the front bulkhead.
- The auto park brake will activate under the following condition when the operator:
  - Gets up from the seat without applying the parking brake and turning the lift truck power **OFF**.
  - Takes his foot off of the accelerator pedal or **MONOTROL® Pedal (if equipped)** while the lift truck is moving.
  - The lift truck does not move for a period of 15 minutes.
  - To release the auto park brake, the operator needs to either return to the seat or depress the accelerator pedal or **MONOTROL® Pedal (if equipped)**

Display Panel

GENERAL DESCRIPTION

There is one display panel. See Figure 9060-10-2.

Display Panel Features

- Liquid Crystal Display (LCD)
- Numerical key pad
- Battery Discharge Indicator (BDI)
- Diagnostic Trouble Codes (DTC)
- System time/date
- Hourmeter for the traction motor and hydraulic pump motor.
- Performance mode selection
- Password controls
- Maintenance reminders
- System interlocks
- Operator checklist
- Preassigned operator passwords to control operator access to the lift truck.
- Four driving Performance Modes that are accessed through the key pad.
- Scheduled maintenance reminders to be programmed in and will alert the operator through an audible and visual alarm when scheduled maintenance is due.
- Operator checklist where the operator must answer YES or NO to a set of questions before the lift truck can be operated.
- Hydraulic fluid low icon. This icon will appear if the system detects low hydraulic fluid. Available with the Hydraulic Fluid Level Monitoring option.
- Hydraulic filter restriction icon. This icon will appear if the system detects a restriction in the hydraulic filter. This is an optional feature.

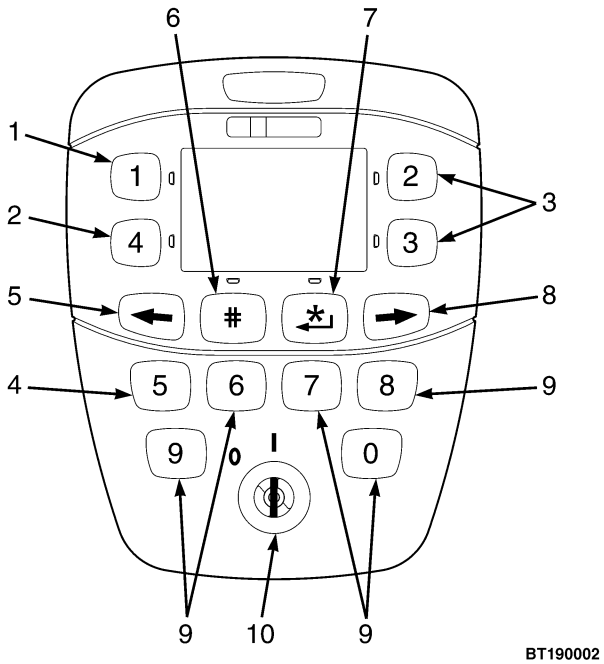


Figure 9060-10-2. Display Panel

Display Panel

WARNING

If any of the instruments, levers, or pedals do not operate as described in the following tables, report the problem immediately. Injury to personnel can occur if the instruments, levers, or pedals do not operate as described. DO NOT operate the lift truck until the problem is corrected.

The display panel is equipped with 10 numeric keys, two arrow keys (left and right arrows) and two symbol keys (the Star (*) Key and the Pound (#) Key).

If multiple keys are pressed at the same time, by default the display panel will ignore all keys. If a key has already been pressed and a second one is pressed immediately, the display panel will ignore the second key.

All key presses are accepted for a single entry and key entries cannot be repeated by holding down the key. For example, holding the 5 key down while entering a password number, will only result in one instance of 5 being entered regardless of how long the user presses the 5 key. To enter multiple 5's, the user must press the 5 key multiple times.

Each lift truck can be equipped with several different options and configurations. Depending on the equipment on the lift truck, the key functions described in Table 9060-10-1 will vary and may not apply to your lift truck.

Table 9060-10-1. Display Panel

Item No.	Item	Function
1	1 Key	When an operator is in the Password Screen, if enabled, for entering passwords, this key allows entry of the number 1 for password purposes. Once a password has been successfully entered, or if a password is not required, the display panel will go to the Operator Screen. This screen contains all the necessary components for normal operation of the lift truck. In this screen Key 1 is enabled to decrease Performance Mode; press the 1 key to go to the next lower level of performance; level 1 performance mode is the slowest and level 4 is the fastest. When an operator, if authorized, is in any of the additional menus that are available (Calibrations, Diagnostics, and Truck Setup menus) the 1 key is enabled to enter the number 1 for data entry purposes.
2	4 Key	When an operator is in the Password Screen, if enabled, for entering passwords, this key allows entry of the number 4 for password purposes. Once a password has been successfully entered, the display panel will go to the Operator Screen. This screen contains all the necessary components for normal operation of the lift truck. In this screen, Key 4 is enabled to increase Performance Mode; press the 4 key to go to the next highest level of performance; level 1 performance mode is the slowest and level 4 is the fastest. When an operator, if authorized, is in any of the additional menus that are available (Calibrations, Diagnostics, and Truck Setup menus) the 4 key is enabled to enter the number 4 for data entry purposes.

Table 9060-10-1. Display Panel (Continued)

Item No.	Item	Function
3	2 and 3 Keys	When an operator is in the Password Screen, if enabled, for entering passwords, these keys allow entry of the number 2 and 3 for password purposes. Once a password has been successfully entered, or if a password is not required, the display panel will go to the Operator Screen. When an operator, if authorized, is in any of the additional menus that are available (Calibrations, Diagnostics, and Truck Setup menus) the 2 and 3 keys allow the operator to scroll up or down within the menu. Press the 2 key to scroll up and press the 3 key to scroll down. When an operator, if authorized, is working in any of the menus, other than the Password menu, is prompted to enter a data value that contains numbers, the scrolling features of the 2 and 3 keys will be disabled and keys 2 and 3 can be used to enter numeric values. Once the numeric data value has been entered and the Enter key pressed, the scrolling feature for keys 2 and 3 will be enabled again.
4	5 Key	When an operator is in the Password Screen, if enabled, for entering passwords, this key is enabled to enter the number 5 for password purposes. Once a password has been successfully entered, or if a password is not required, the display panel will to the Operator Screen. When an operator, if authorized, is in any of the additional menus that are available (Calibrations, Diagnostics, and Truck Setup menus) the 5 key is enabled to enter the number 5 for data entry purposes.
5	Scroll Back (Left Arrow Key)	This key is used for the following functions: • Scrolling backwards through a list of possible menu selections.
6	(#) Pound Key	If the Operator Checklist is enabled on the lift truck, the (#) Pound Key is used to indicate an issue with the current item in the list. See **Operating Manual** for your lift truck to obtain more information on using the Operator Checklist. • Scrolling through a list of possible menu selections.
7	(*) Enter Key (STAR Key)	This key is used for menu entry and menu navigation. Use the (*) STAR key to select a menu to be viewed. Within the selected menu, use the (*) STAR key to select sub menus associated with the selected menu. • Scrolling through a list of possible menu selections.
8	Scroll Forward (Right Arrow Key)	This key is used for the following functions: • Scrolling forward through a list of possible menu selections.
9	6, 7, 8, 9, and 0 Keys	The 6, 7, 8, 9, and 0 keys are enabled to enter the numbers 6, 7, 8, 9, and 0 for data entry purposes.
10	Keyless Start Switch or Key Switch	The lift trucks covered in this manual can be equipped with either a key switch or keyless switch. Both options will have two positions: • **OFF** position. Deenergizes all electric circuits except for the horn. • **ON** position. Energizes all electric circuits. The key or keyless switch will be in this position during normal operation.

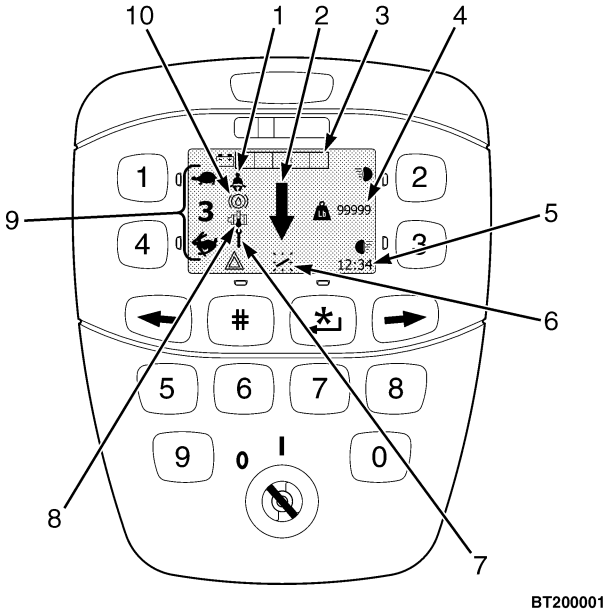
LCD Screen and Warning and Indicator Lights

The LCD screen uses a series of icons and numeric values to communicate important truck information to the operator, supervisor, and service technician.

The warning and indicator icons appear when the LCD screen is displaying the Operator Screen. The Operator Screen contains all the components necessary for normal operation of the lift truck. After 10 seconds, the seat belt, low brake fluid, service due (if equipped), motor temperature icons, and low hydraulic fluid (if equipped) will no longer be illuminated and will illuminate again only if there is a problem in that particular area. Detailed information for Warning and Indicator lights can be found in the **Operating Manual**.

The following icons are displayed at all times on the LCD screen when the truck is running, and the LCD screen is displaying the Operator Screen:See Figure 9060-10-3:

- The current performance mode the truck is operating under
- The Battery Display Indicator (BDI)
- The direction indicators showing which direction the truck is traveling in
- The neutral/park brake indicator
- The truck hourmeter
- System time



1. FASTEN SEAT BELT ICON,
2. DIRECTION INDICATOR ICON
3. BATTERY DISPLAY INDICATOR (BDI) ICON
4. LOAD WEIGHT ICON
5. SYSTEM TIME ICON
6. STEER TIRE ANGLE ICON
7. SERVICE DUE ICON
8. MOTOR TEMPERATURE HIGH WARNING ICON
9. PERFORMANCE MODE ICON
10. LOW BRAKE FLUID ICON

Figure 9060-10-3. Display Panel - LCD Screen / Warning and Information Icons

Programming - Menus

MENU

The On-Board Menu Structure is accessible while the system power is on by pressing the "*" button. If accessed without a password or by an operator password, the menu structure will automatically exit if no button presses have been detected for 30 seconds. Unless otherwise specified, menu items are only accessible with a service password. See Display Menu Flowchart for further details.

Operator Cycle Main Menu

- Operating Screen
- Password Entry
- Load Weight (Optional)
- Checklist (Optional

Supervisor/Service Cycle Main Menu

- Operating Screen
- Password Entry
- Load Weight (Optional)
- Checklist (Optional
- Activity Log
- Calibration
- Diagnostics
- Truck Set-Up
- Truck Status
- Display Adjustment

Activity Log

- Check List Log
- Password Log
- Impact Log

Calibration

- Load Weight
- Manual Hydraulic Valve
- Steer Axle
- Steer Wheel
- Hydraulic Valve Threshold
- Return to Set Tilt (RTST)

Diagnostic

- Fault Logs/Controllers/Other CAN Device
- Steering Sensor
- Battery/Other Power Supplies
- Mast Sensor
- Hydraulic Valve
- Hydraulic Inputs
- Hydraulic Pump Motor
- Brakes
- Seat (Operator Presence)
- Traction Motor 2
- Traction Motor 1
- Directional Indicator Operation
- Speedometer

Truck Set-Up

- Passwords
- Restore Defaults
- Optional Hydraulic (Diverter Valve) ON/OFF
- Rear Lamp Assembly OFF/ON
- Hydraulic Function
- Hydraulic Function 1a, 1b, 2a, 2b, 3a, 3b, 4a, 4b (E-Hydraulics Only)
- Hydraulic Function 1a, 1b, 2a, 2b, 3a, 3b, 4a, 4b (Manual Hydraulics Only
- Motion Alarm OFF/ON
- Impact Thresholds
- Auto Power OFF
- Return To Set Tilt (RTST)
- Traction Speed Limit
- Scheduled Maintenance (Deferred)
- Minimum Pump Speed
- Check List
- Impact Shutdown
- Hour Meter
- Acceleration
- BDI Adjustment
- Battery
- Braking

Truck Status

- VSM Version
- Impact Sensor Version
- Light 1 Controller Version
- Traction 2 Controller Version
- Traction 1 Controller Version
- Pump Controller Version
- Hydraulic Input Controller Version
- Hour Meters
- Serial Number
- Display Version

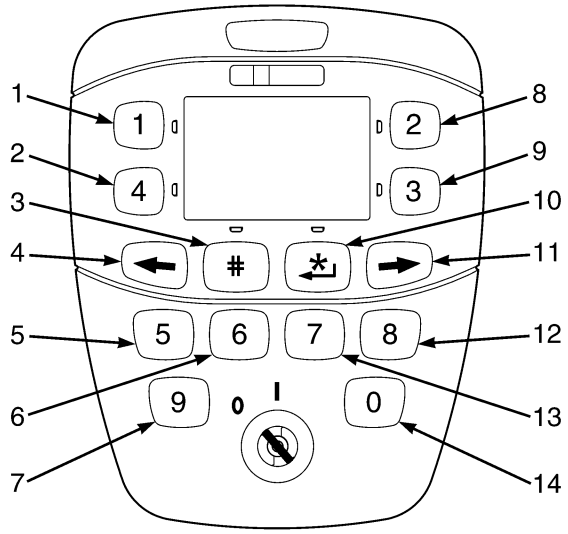
Display Adjustments

- Date/Time Format
- Units Selection (Imperial/Metric)
- Date and Time
- Daylight Savings

Display Menu Flowchart

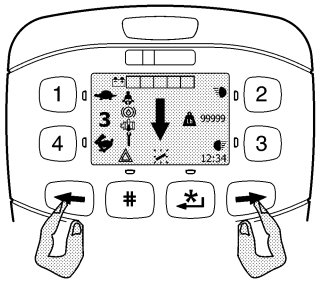
DISPLAY MENU FLOWCHART

Note: This chart indicates all available menu options for this model series. Only those options ordered on your specific truck will be displayed and accessible using the Service Level password.
DTC's are stored in the DTC LOGS, where a history of repeat failures is maintained, until cleared by an authorized service technician. All DTC's are to be cleared prior to operating the lift truck. DTC logs should only be cleared once the data is recorded by a authorized service technician.↓



1. 1/Soft Key	6. 6 Key	11. Scroll (Right Arrow Key)
2. 4/Soft Key	7. 9 Key	12. 8 Key
3. (#) Pound Key/Soft Key	8. 2/Soft Key	13. 7 Key
4. Scroll Back (Left Arrow Key)	9. 3/Soft Key	14. 0 Key
5. 5 Key	10. (*) STAR Key Select/Enter/ Accept	

DISPLAY MENU FLOWCHART (Con't)

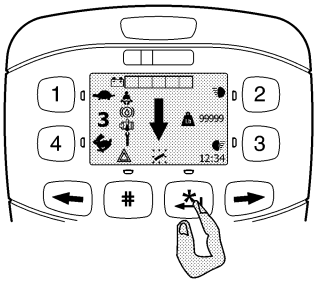


Return to Previous Menu←

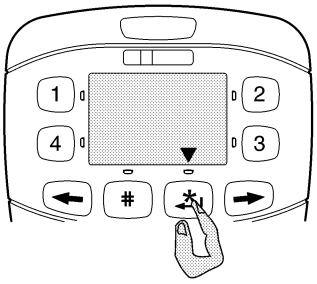
Scroll

←

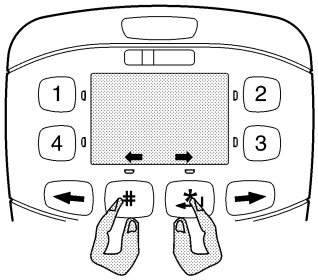
→



Select/Enter/Accept *



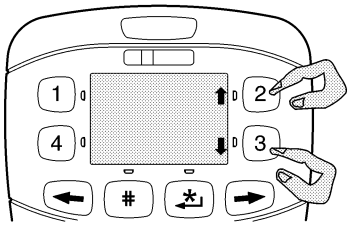
Enter/Accept *



Scroll

←

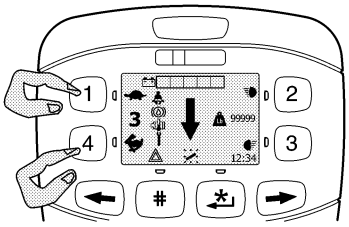
→



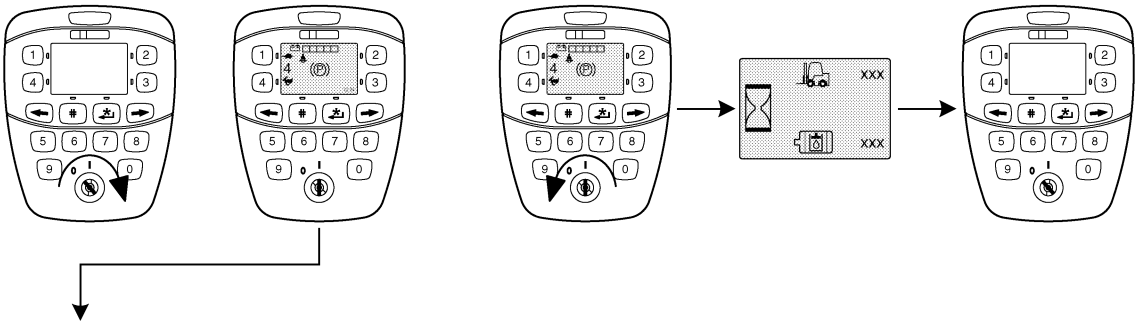
Scroll Up/Down

↑

↓



Increase/Decrease Performance



Power ON

Power OFF

Hour Meter Displayed for 5 seconds

Power ON→

Operator Cycle→

Enter Password→

Supervisor/Service Cycle→

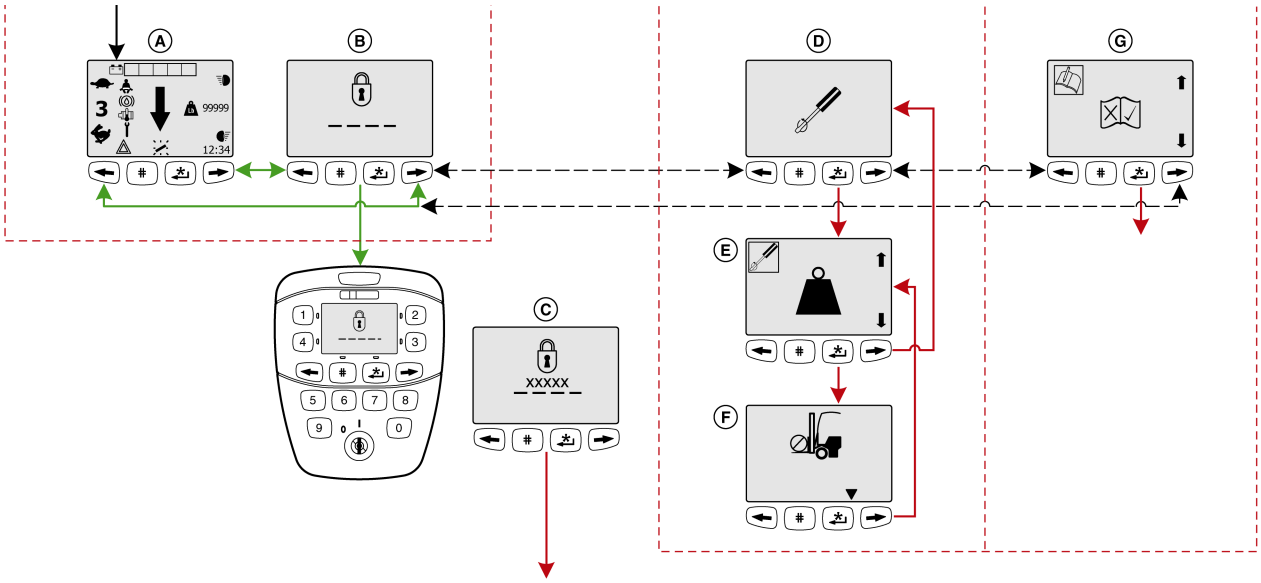
Power OFF→

Power ON→

Operator Cycle

OPERATOR CYCLE		
Legend		
A. Operating Screen	E. Load Weight	J. Display Adjustment
B. Password Entry	F. Tare Weight	K. Activity Log
C. Enter Password	G. Checklist	L. Truck Setup
D. Calibration	H. Truck Status	M. Diagnostics

Standard Load Weight Option Check List Option



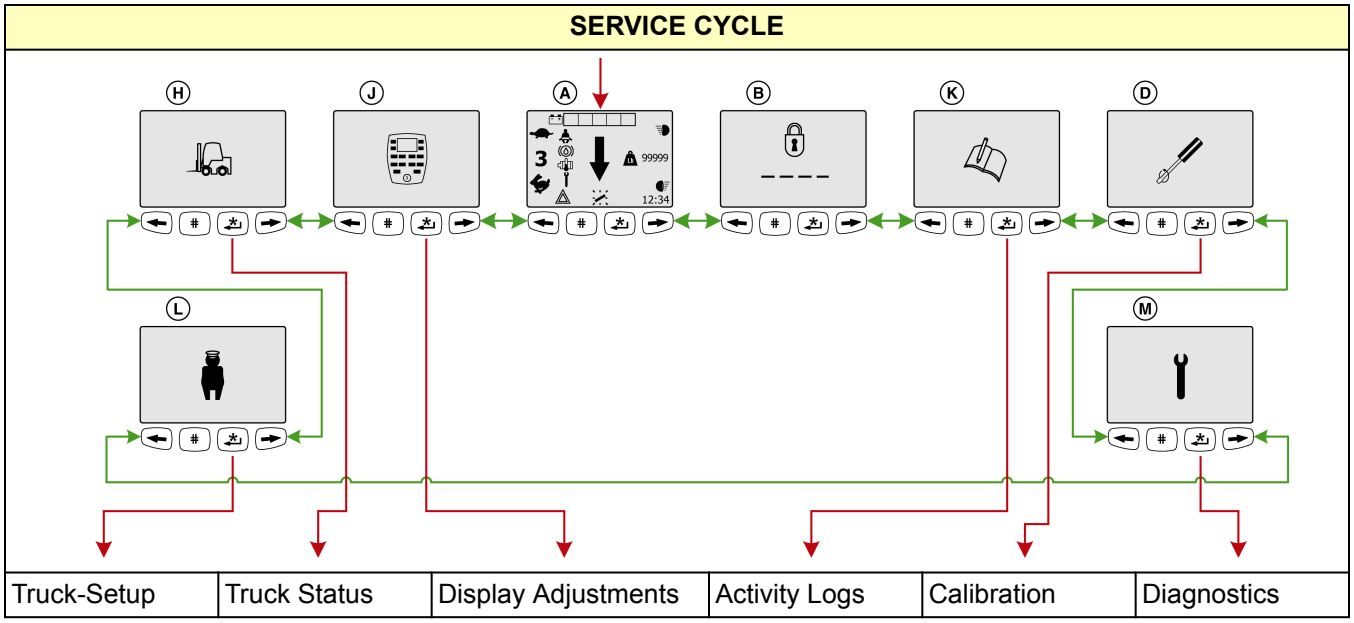
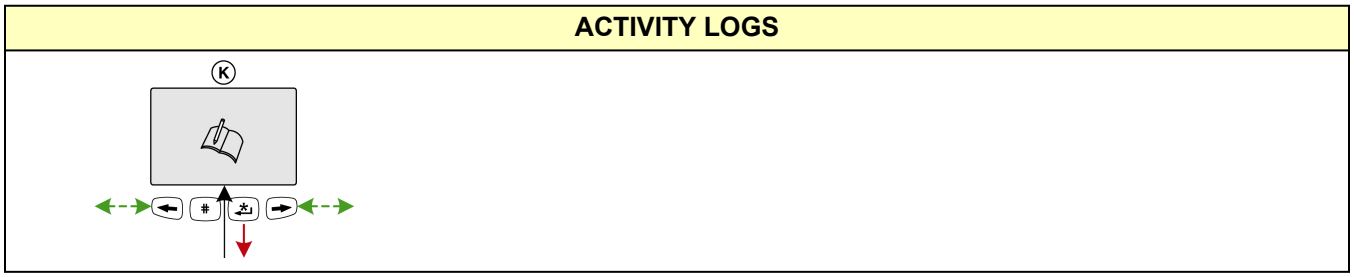
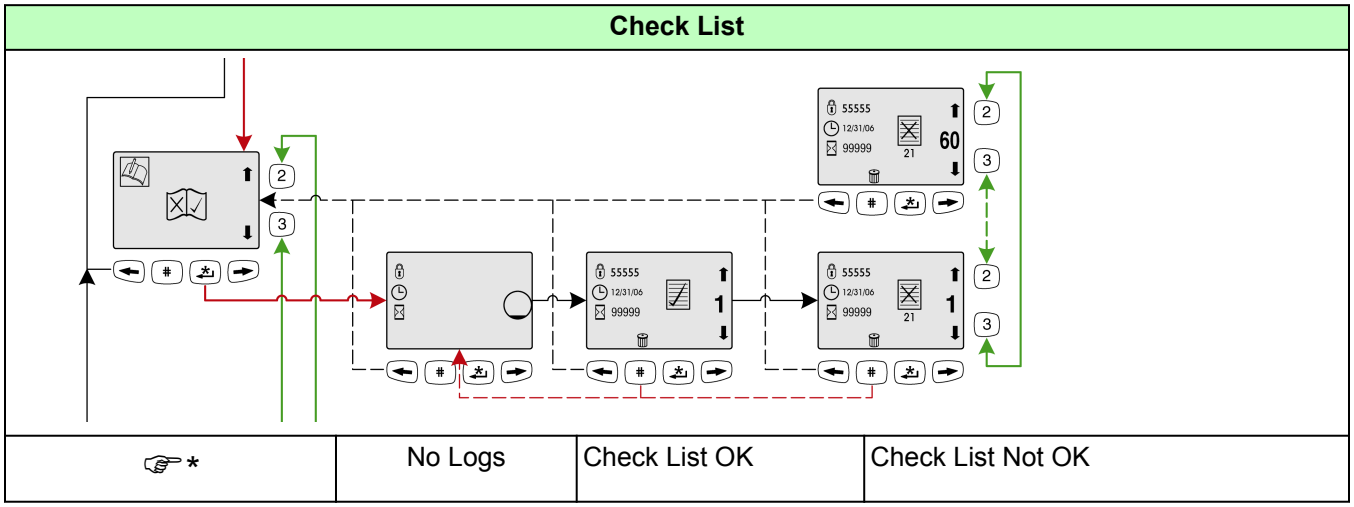
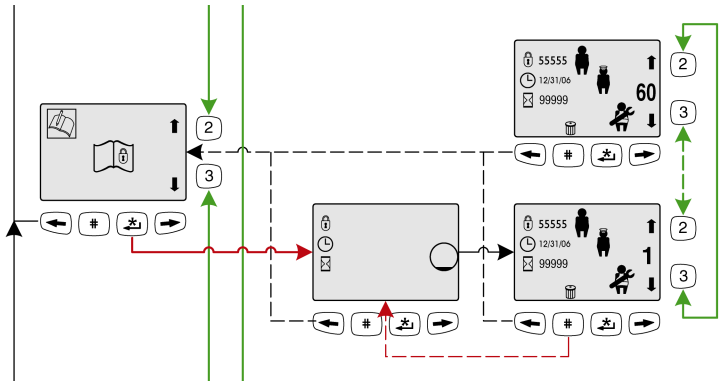


Table 9060-10-2. Activity Logs





Password Log		
		
☞*	No Logs	Operator/Supervisor/Service

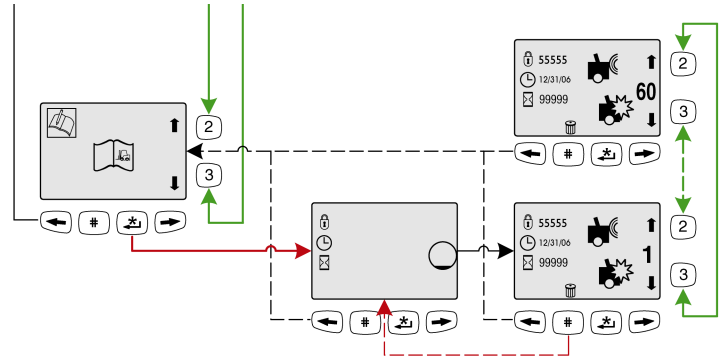
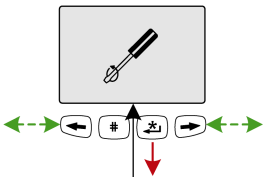
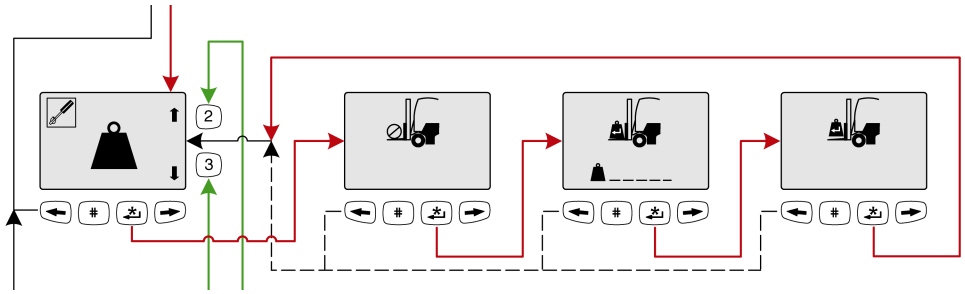
Impact Log		
		
☞*	No Logs	Soft Impact/Hard Impact

Table 9060-10-3. Calibration

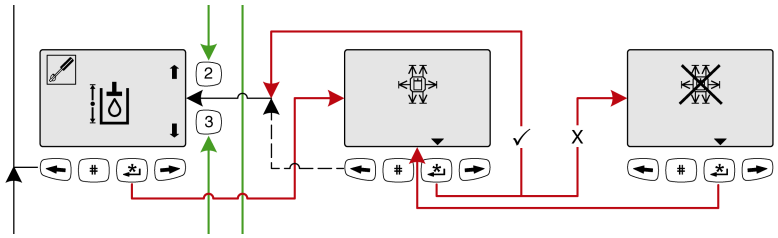
CALIBRATION


Load Weight



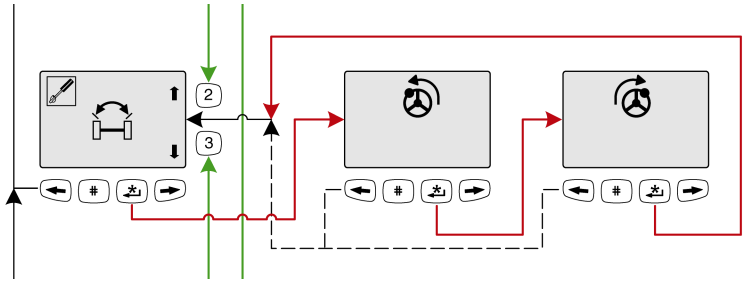
☞*	No Load Entry ☞*	Known Load Entry ☞*	Test Load Entry ☞*

Manual Hydraulic Valve



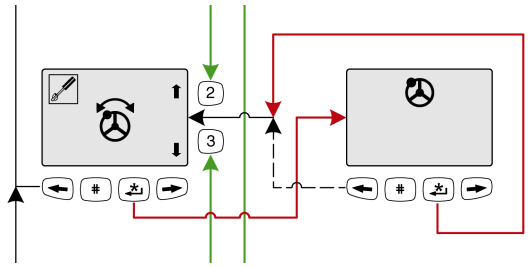
☞*	Move each lever to end of travel ☞*√	X = Calibration Fail I 📂 3 seconds ☞* Repeat Calibration

Steer Axle



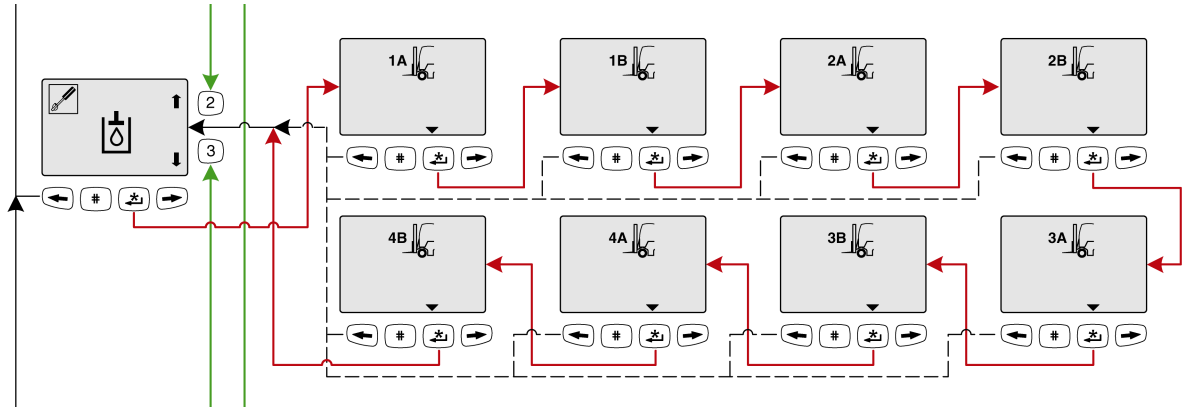
☞*	Rotate Fully CCW ☞*	Rotate Fully CW ☞*	

Steer Wheel



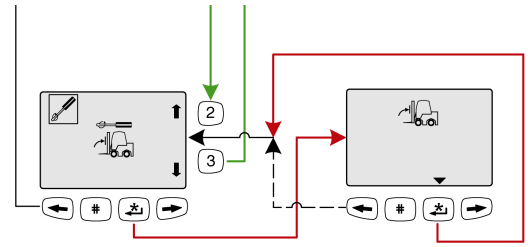
☞*	Set Steering Wheel to desired (Spinner) Position ☞*

Hydraulic Valve Threshold



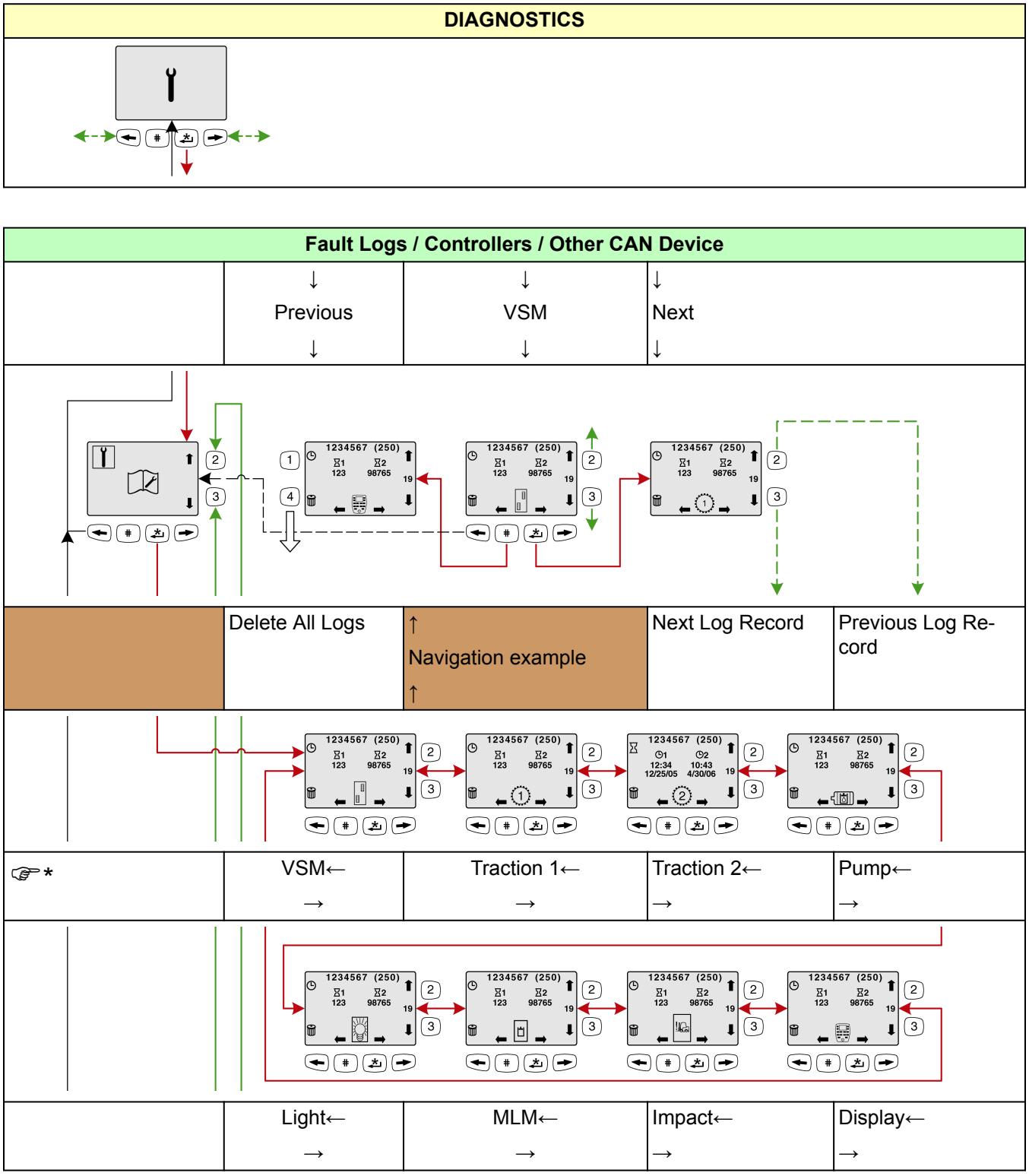
☞*	Operate Indicated Control until movement is detected ☞*	Repeat for each function ☞*

Return To Set Tilt (RTST)

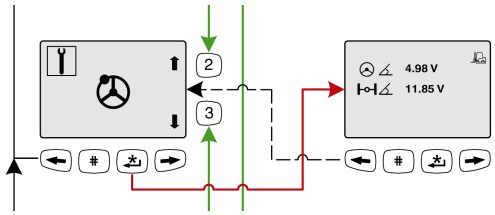


☞*	Set Tilt Angle ☞*

Table 9060-10-4. Diagnostics

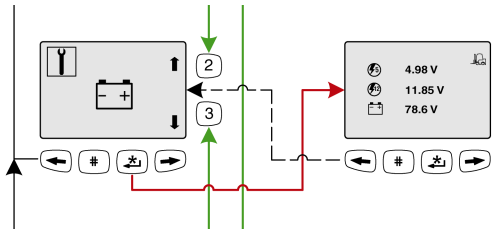


Steering Sensor



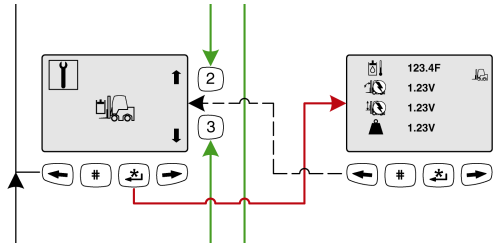
☞ *

Battery / Other Power Supplies

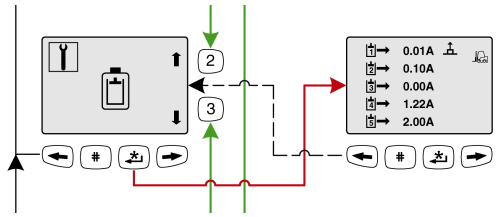


☞ *

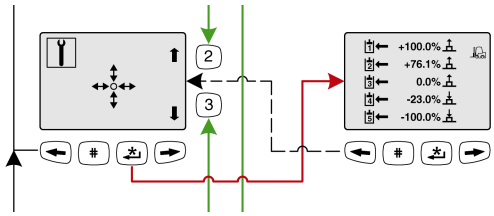
Mast Sensor



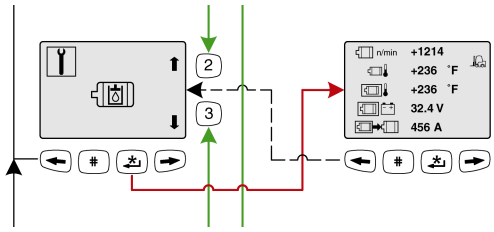
Hydraulic Valve



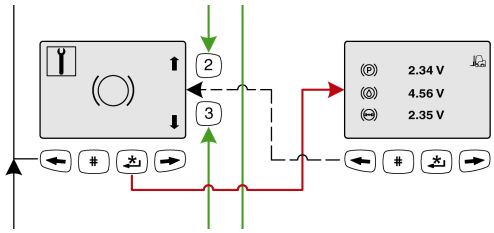
Hydraulic Inputs



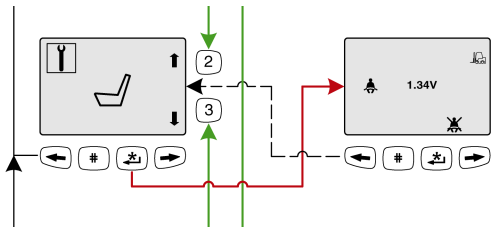
Hydraulic Pump Motor



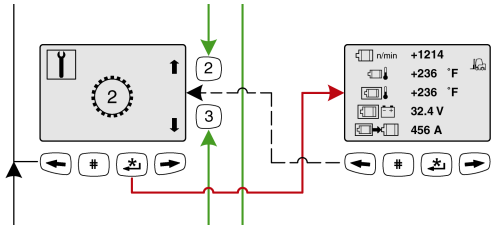
Brakes

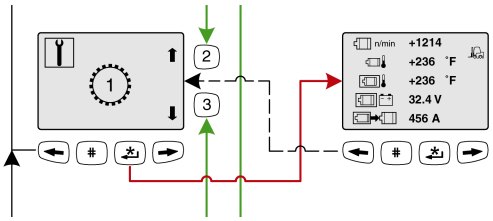


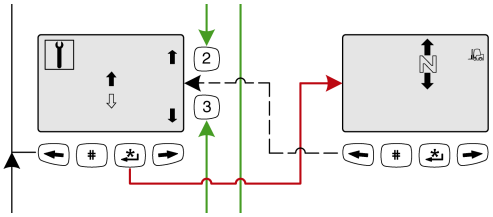
Seat (Operator Presence)



Traction Motor 2



Traction Motor 1


Directional Indication Operation


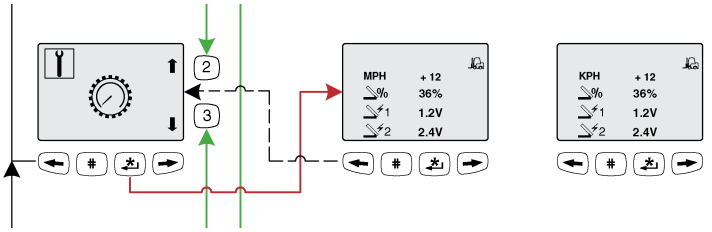
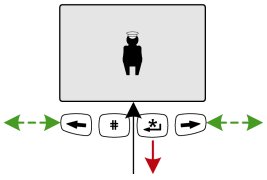
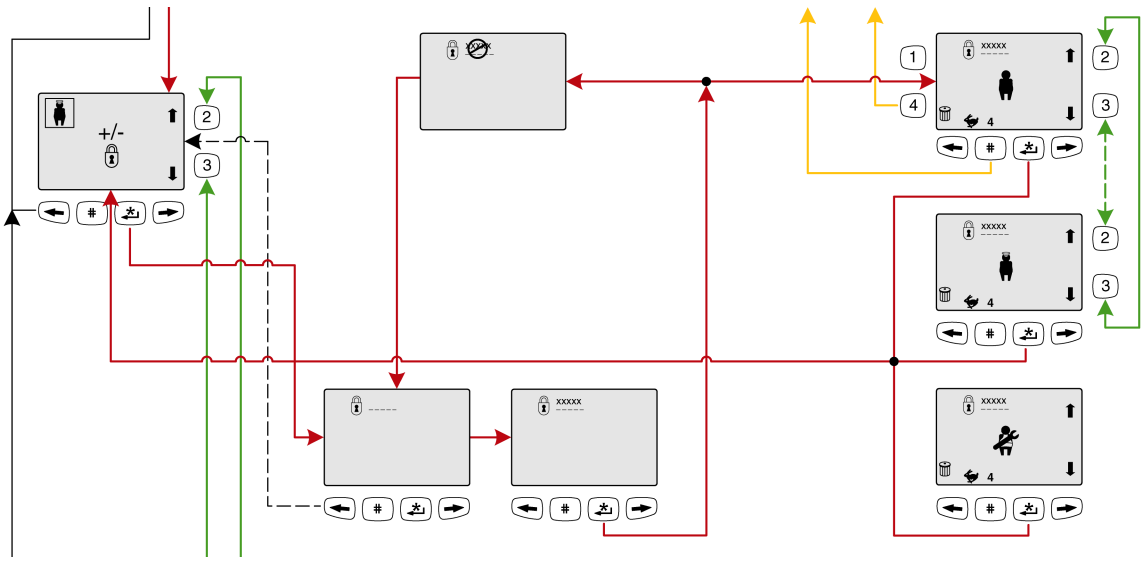
Speedometer			
			
	Imperial	Metric	

Table 9060-10-5. Truck-Setup

TRUCK SETUP


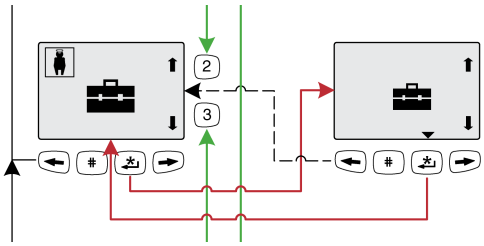
Passwords		
Incorrect Password	Set Max Performance	Delete Password

Passwords



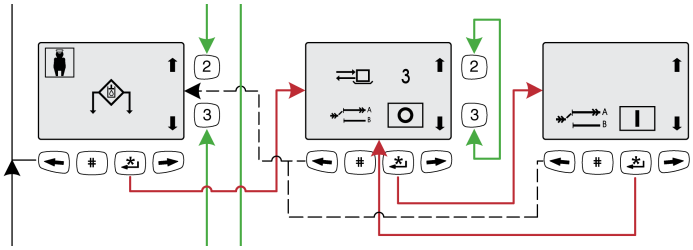
☞*	Enter / Re-Enter Password ☞*	↑ ↓ Select Operator / Supervisor / Service for Password ☞*

Restore Defaults



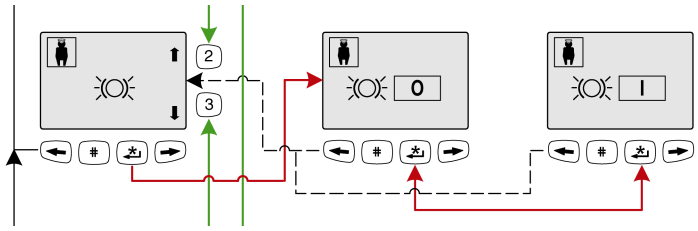
☞*To restore defaults

Optional Hydraulic (Diverter Valve) ON/OFF



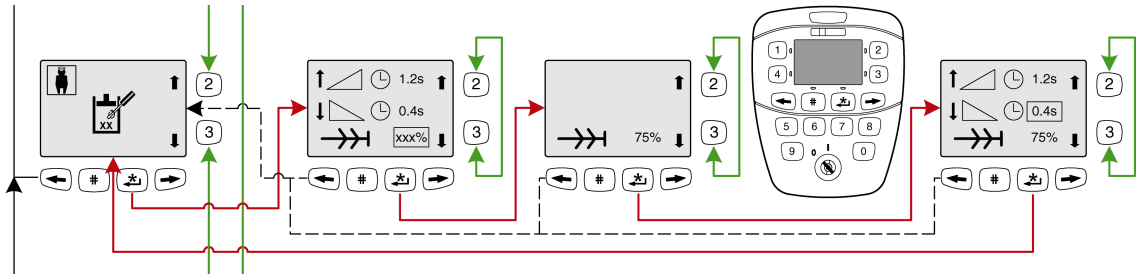
☞*	☞*☞ Valve ON/OFF	

Rear Lamp Assembly OFF/ON



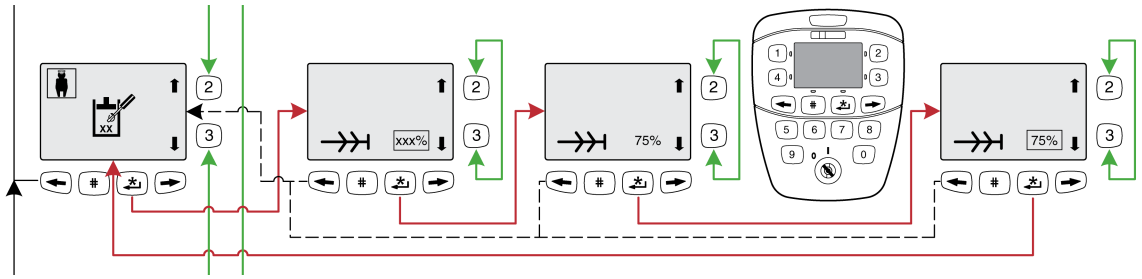
☞*	☞* Rear Lamp OFF	☞* Rear Lamp ON

Hydraulic Function 1a, 1b, 2a, 2b, 3a, 3b, 4a, 4b (E Hydraulics Only)



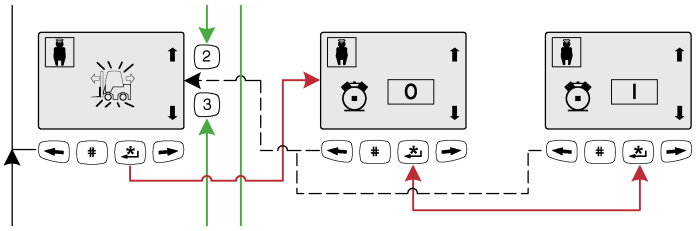
☞* Scroll to Function ↑ ↓	☞* To Select	Enter Value Using Number Buttons ☞*	Repeat for other functions

Hydraulic Function 1a, 1b, 2a, 2b, 3a, 3b, 4a, 4b (Manual Hydraulics Only)



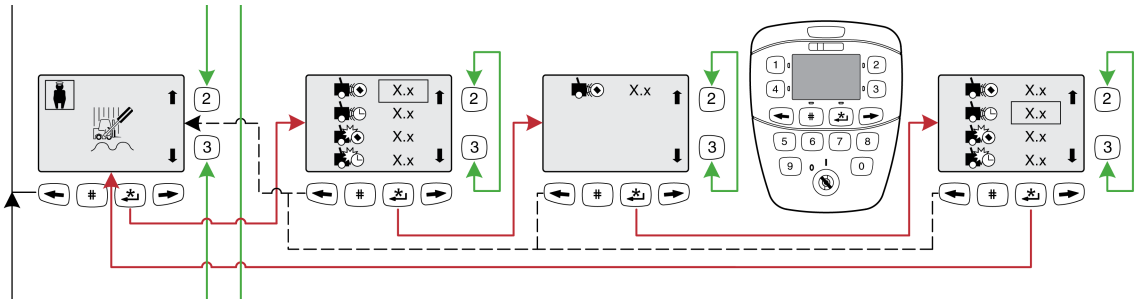
☞*	☞* Enter Value Using Number Buttons ☞*

Motion Alarm OFF/ON



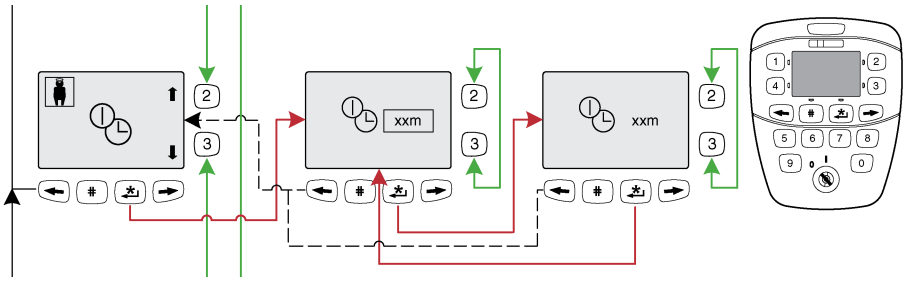
☞*	☞* Motion Alarm OFF	☞* Motion Alarm ON

Impact Thresholds



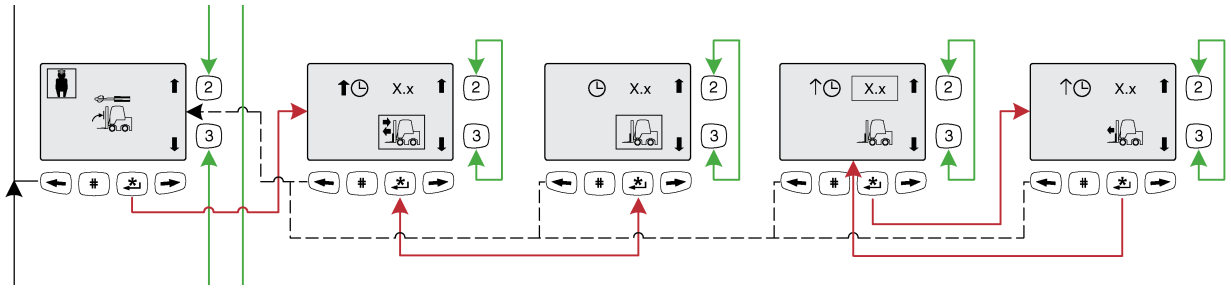
☞* Scroll to function ↑ ↓ ☞* To Select	Enter Value Using Number Buttons or Scroll ↑ ↓ ☞*	Repeat for other functions

Auto Power OFF



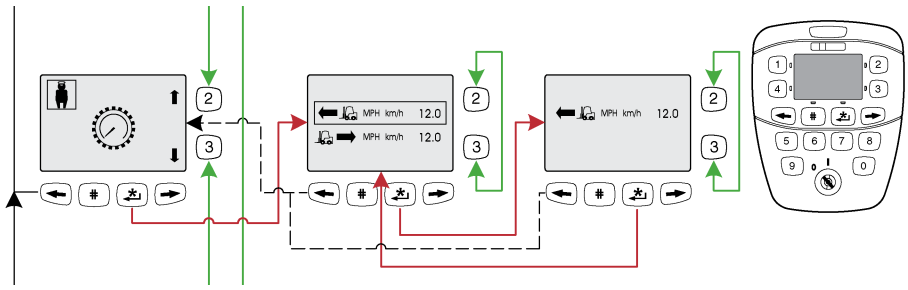
☞*	☞*Enter Value Using Number Buttons ☞*

Return To Set Tilt (RTST)



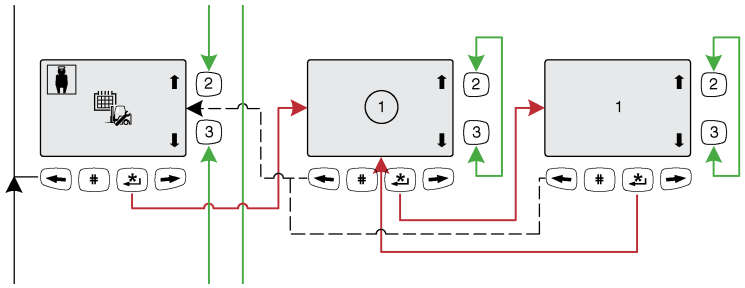
☞* Scroll to Function ↑ ↓	☞* ☞ To Select	↑ ↓ Next Function	☞* Enter Value Using Number Buttons ↑ ↓ ☞*

Traction Speed Limit

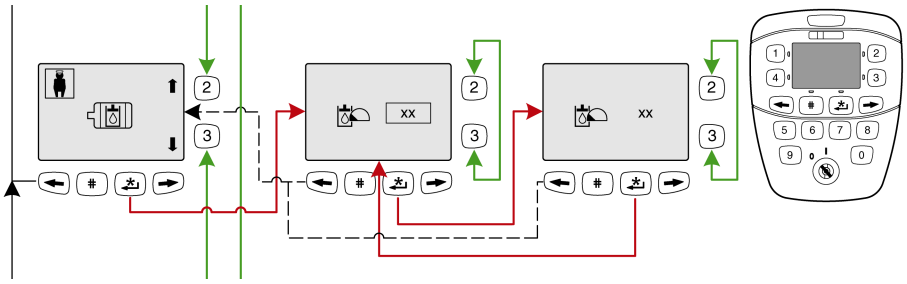


☞*	☞* Enter Value Using Number Buttons ☞*

Scheduled Maintenance

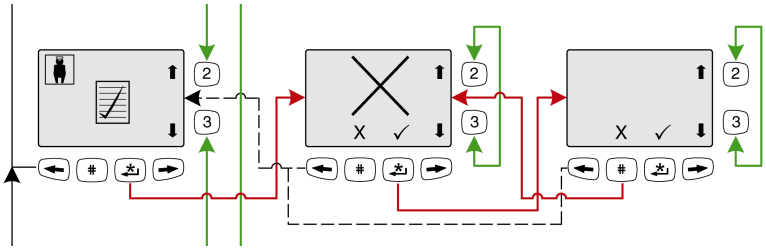


Minimum Pump Speed



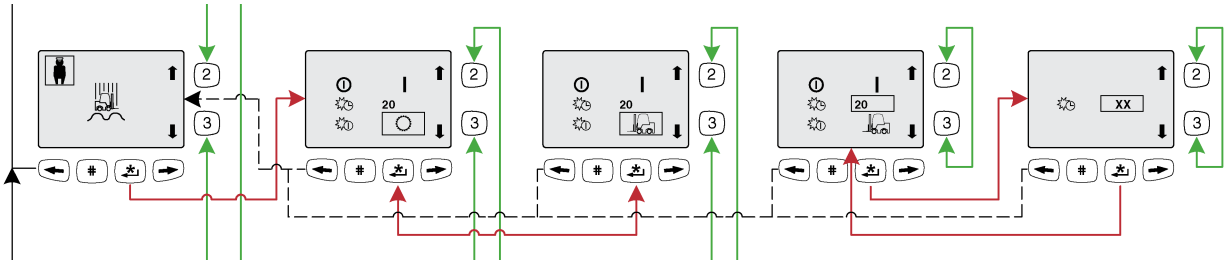
☞*	☞* Enter Value 0 % to 100 % Using Number Buttons ☞*

Check List



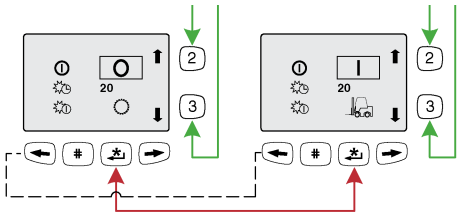
☞*	☞ ✓(*) Active ☞ X (#) Inactive	↑ ↓ Scroll to Next Check List Item

Impact Shutdown

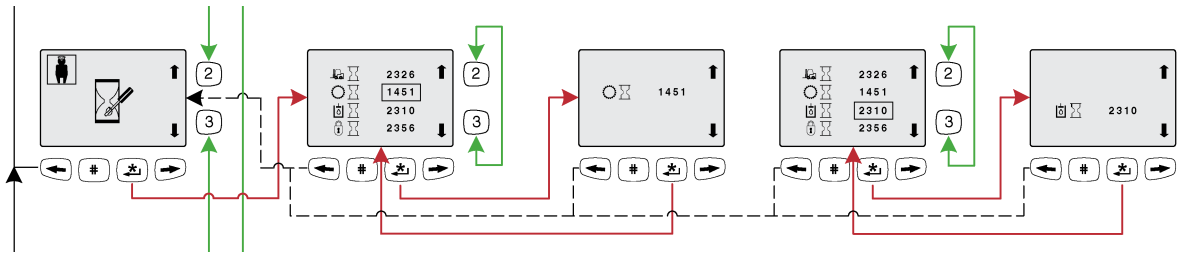


☞*Scroll to Function ↑ ↓	☞* ☞ To Select	Next Function ↑ ↓	☞* Enter Value Using Number Buttons ↑ ↓ ☞*

Impact Shutdown

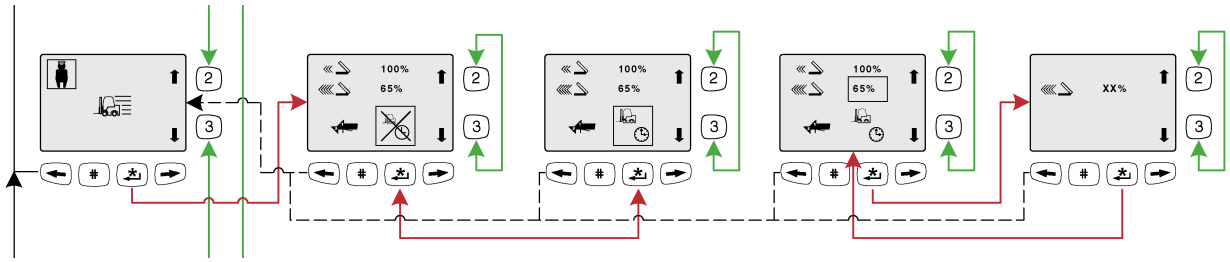


Hour Meter



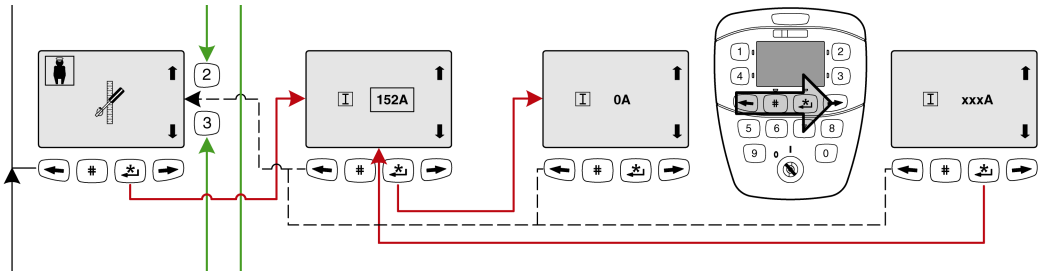
☞*Scroll to Function ↑ ↓	☞* To Select	Enter Value Using Number Buttons ☞*	Next Function ↑ ↓

Acceleration



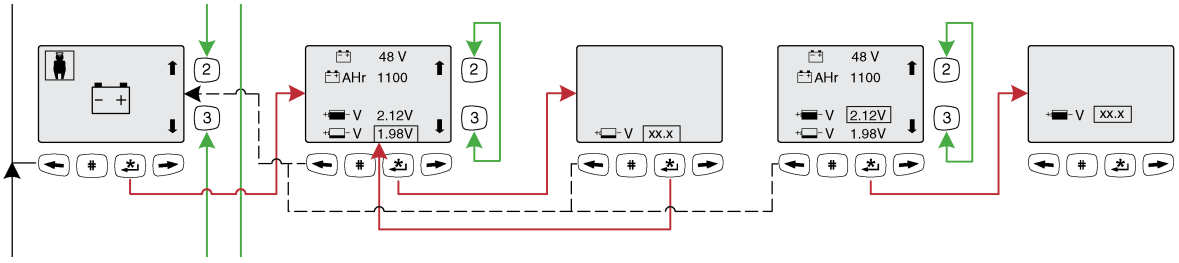
☞*Scroll to Function ↑ ↓	☞* ☞ To Select	Next Function ↑ ↓	☞* Enter Value Using Number Buttons ↑ ↓ ☞*

BDI Adjustment



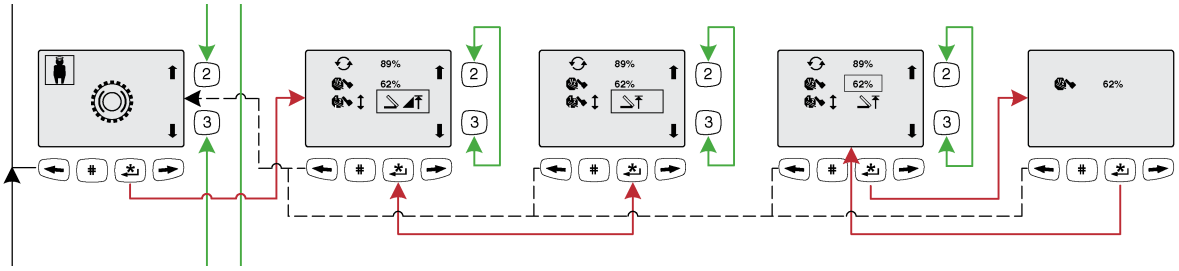
☞* Scroll to Function ↑ ↓	☞* To Select	Enter Zero then desired number using Number Buttons ☞*

Battery



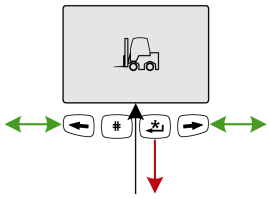
☞*Scroll to Function ↑ ↓	☞* To Select	Enter Value Using Number Buttons ☞*	Next Function ↑ ↓

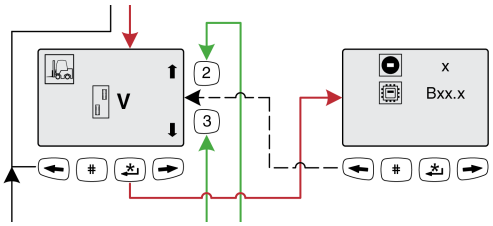
Braking

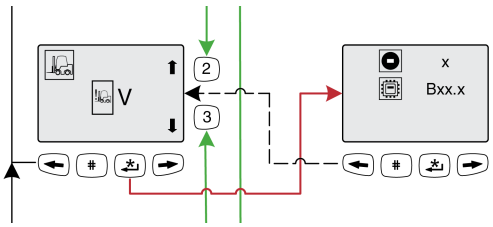


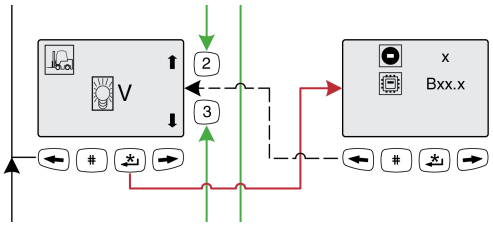
☞*Scroll to Function ↑ ↓	☞* ☜ To Select	Next Function ↑ ↓	☞* Enter Value Using Number Buttons ↑ ↓ ☞*

Table 9060-10-6. Truck Status

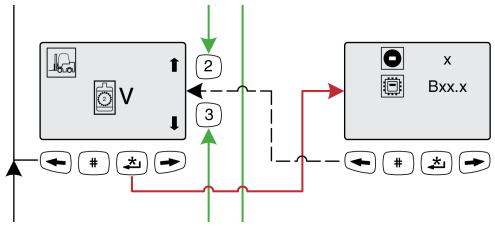
TRUCK STATUS


VSM Version

☞* Hardware/Software Versions

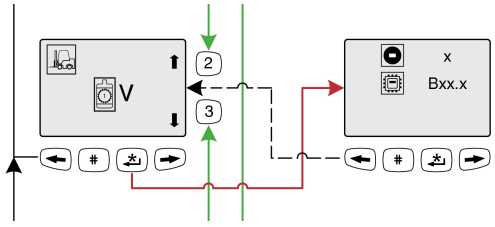
Impact Sensor Version


Light 1 Controller Version


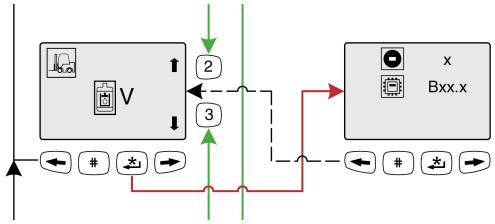
Traction 2 Controller Version



Traction 1 Controller Version

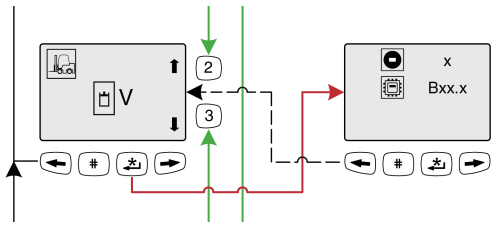


Pump Controller Version

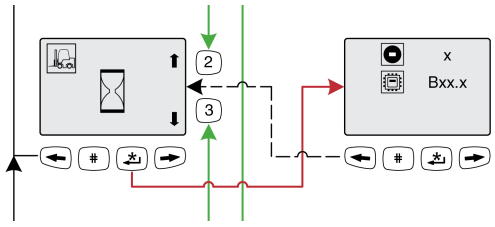


☞ *	Hardware/Software Versions	

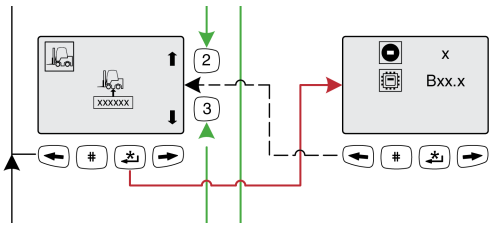
Hydraulic Input Controller Version



Hour Meters



Hour Meters		
☞*	Traction/Pump/Truck/Secure	

Serial Number

☞*

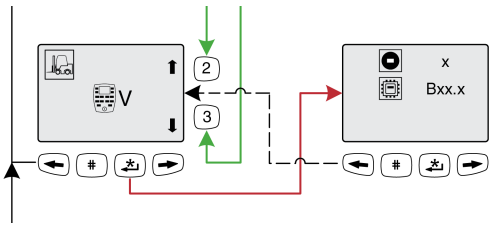
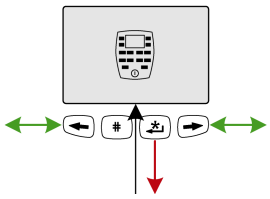
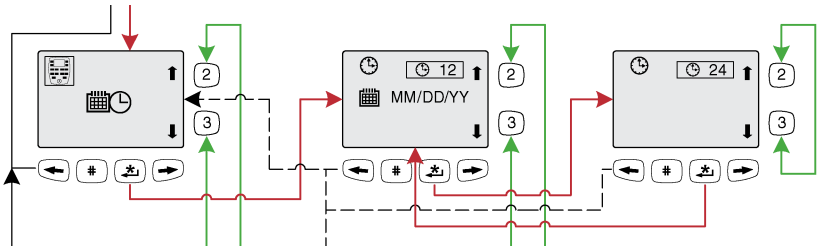
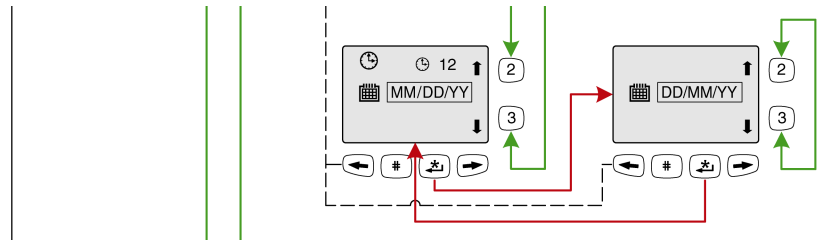
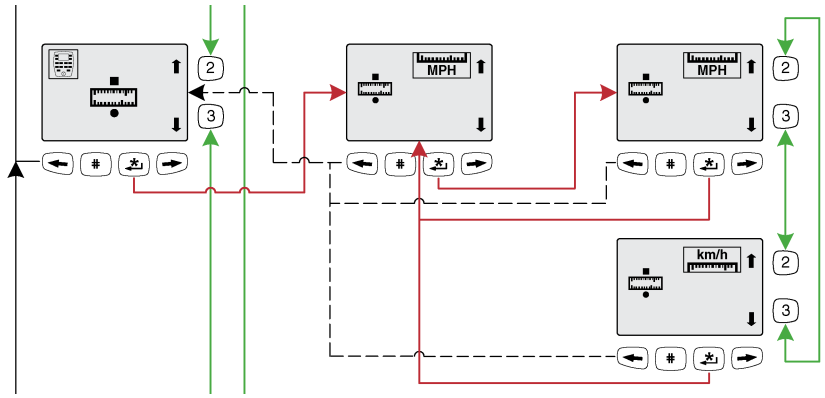
Display Version	
	
☞*	Hardware/Software Versions

Table 9060-10-7. Display Adjustments

DISPLAY ADJUSTMENTS


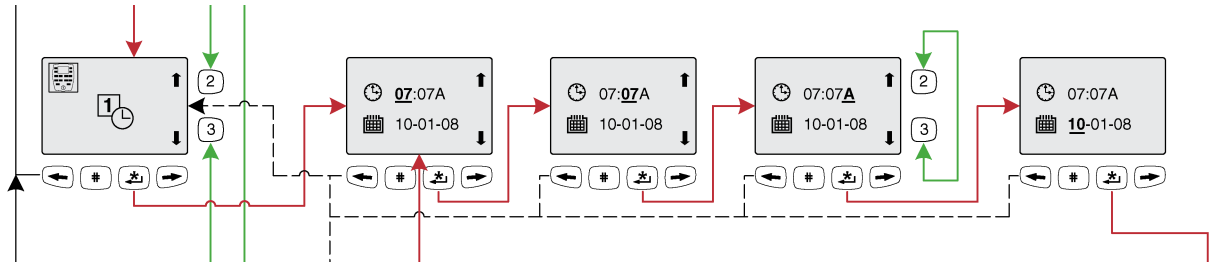
Date/Time Format		
		
☞* Scroll to Function ↑ ↓	☞* Select	Scroll ↑ ↓ 12 - 24 ☞*
		
☞* Scroll to Function↑ ↓	☞* Select	Scroll ↑ ↓ MM/DD/YY - DD/MM/YY - YY/MM/DD ☞*

Units Selection (Imperial/Metric)



☞ *	☞ *	Scroll ↑ ↓ Imperial - Metric ☞ * ←

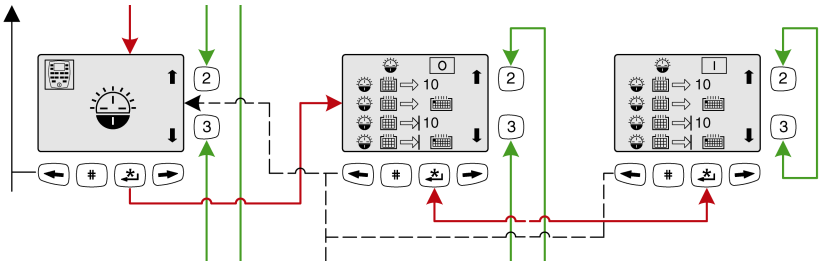
Date and Time



☞ *	Enter Hours ☞ *	Enter Minutes ☞ *	Scroll ↑ ↓ AM - PM ☞ *	Enter Month ☞ *

	* ☞ Enter Year	* ☞ Enter Day

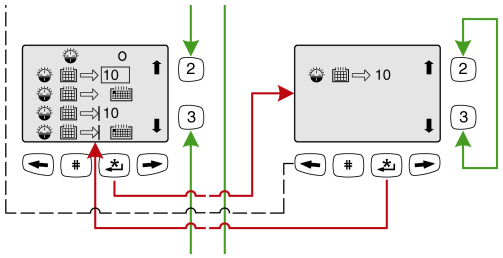
Daylight Savings



Daylight Savings OFF/ON ☞ *

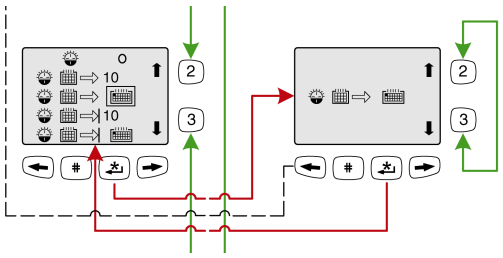
☞ * ☞

↑
↓
Scroll to other Setups



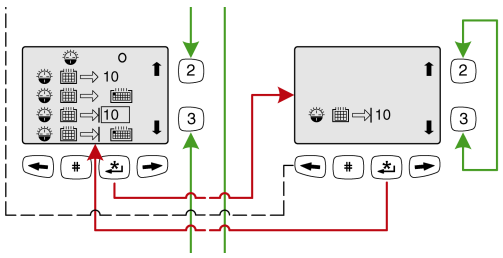
Daylight Savings Start Month ☞ *

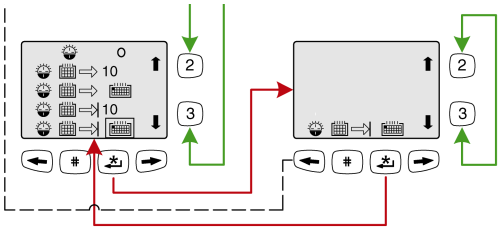
Scroll to Month
↑
↓
☞ *



Daylight Savings Start Day ☞ *

Scroll to Day
↑
↓
☞ *



Daylight Savings		
Daylight Savings End Month ☞*	Scroll to Month ↑ ↓ ☞*	
		
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Manual Hydraulic Control Levers

GENERAL DESCRIPTION

The Manual Control Levers (if installed) are used to control hydraulic operation of the mast lift/lower, tilt, and auxiliary functions.

SYSTEM COMPONENTS

The control levers are located to the right of the operator's seat. Each lever is explained below. See Figure 9060-10-4.

Lift/Lower

The lift/lower control lever is the first lever to the right of the operator's seat. Pull backward toward operator to raise the carriage and forks. Push forward to lower the carriage and forks.

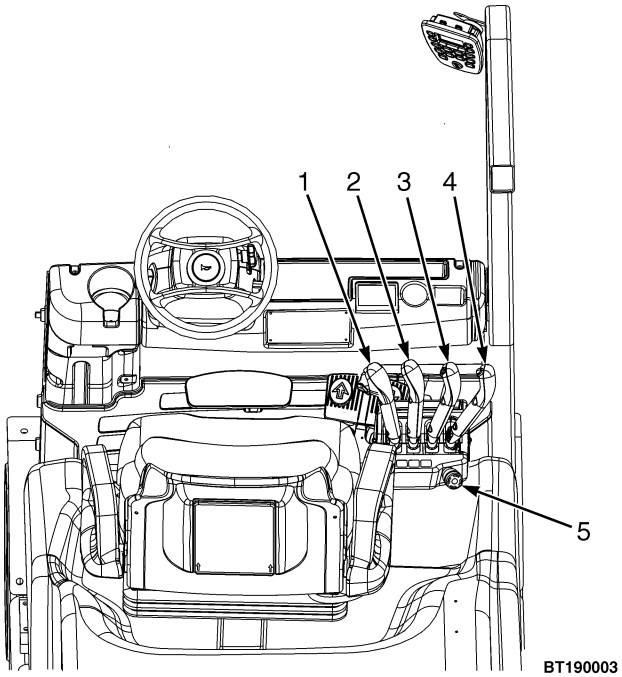
Tilt

The tilt control lever is the second lever to the right of the operator's seat. Push the lever forward to tilt the mast and forks forward. Pull the lever backward toward operator to tilt the mast and forks backward.

Auxiliary 1

The third control lever is installed to the right of the tilt control lever. This lever can have two methods of operation, depending on the attachment.

- Trucks with clamp attachment: To engage the clamp attachment, press and hold the button on the left top side of the lever and move lever forward. When finger is removed from the button, the lever is locked in the neutral position and cannot be moved. To disengage the clamp function, press the button again and move lever backward.
- Trucks without clamp attachment: The lever is operated by moving it forward and backward. The lever is spring loaded to return to the neutral position when released.



1. LIFT/LOWER CONTROL LEVER (1ST LEVER)
2. TILT CONTROL LEVER (2ND LEVER)
3. CONTROL LEVER FOR AUXILIARY HYDRAULIC FUNCTIONS (3RD LEVER)
4. CONTROL LEVER FOR AUXILIARY HYDRAULIC FUNCTIONS (4TH LEVER)
5. EMERGENCY DISCONNECT SWITCH

Figure 9060-10-4. Manual Hydraulic Control Levers

Auxiliary 2

The fourth control lever is installed to the right of the third control lever. This lever can have two methods of operation, depending on the attachment.

- Trucks with clamp attachment: To engage the clamp attachment, press and hold the button on the left top side of the lever and move lever forward. When finger is removed from the button, the lever is locked in the neutral position and cannot be moved. To disengage the clamp function, press the button again and move lever backward.
- Trucks without clamp attachment: The lever is operated by moving it forward and backward. The lever is spring loaded to return to the neutral position when released.

Emergency Disconnect Switch

NOTE: The emergency disconnect switch does not remove power to the front or rear service lights.

The emergency disconnect switch, is located behind the Auxiliary 2 lever.

The operator can disconnect all electrical power to the lift truck by pushing the emergency disconnect switch in until it clicks. To reset the emergency disconnect switch and energize the electrical circuits, the operator must turn the switch clockwise until it pops out.

E-Hydraulic System Interface

GENERAL DESCRIPTION TO E-HYDRAULIC SYSTEM INTERFACE

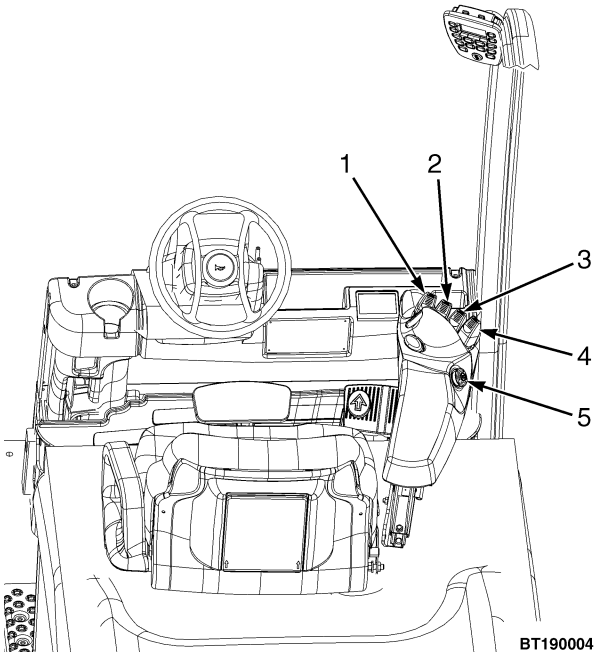
Lift trucks may be equipped with an optional Electro-Hydraulic (E-Hydraulic) system. It controls hydraulic operation of the mast lift/lower, tilt, and auxiliary functions. This E-Hydraulic option replaces the manual control levers with simple, single-handed, finger-operated electronic controls, located on the right-hand armrest. The E-Hydraulic system is controlled by the VSM that provides drive commands to the hydraulic valves based on the operator inputs. This system automatically adjusts the flow control based on conditions such as speed, load, and functions activated, etc., to provide better controllability, and flexibility with the controls necessary to operate the E-Hydraulics. The VSM also monitors the performance of the system and reports faults to the operator through the Display Panel (DP).

To operate the Mini Lever Module (MLM), the operator must be positioned on the seat.

The MLM commands are sent to the VSM through the CANbus. The VSM supplies proportional commands to drive the electro-hydraulic valves. The VSM monitors the input and outputs signals, hydraulic response, and adjust the system performance as required. Faults or interlock conflicts are detected by the VSM which sends an error message (fault codes) to the Display Panel for operator awareness and correction.

The MLM consists of up to four individual proportional levers and may have additional momentary switches.

The control levers are located on the armrest. See Figure 9060-10-5.



1. LIFT/LOWER MINI-LEVER (1ST LEVER)
2. TILT MINI-LEVER (2ND LEVER)
3. MINI-LEVER FOR AUXILIARY HYDRAULIC FUNCTIONS (3RD LEVER)
4. MINI-LEVER FOR AUXILIARY HYDRAULIC FUNCTIONS (4TH LEVER)
5. EMERGENCY DISCONNECT SWITCH

Figure 9060-10-5. E-Hydraulic Mini Lever Module

Lift/Lower

The electronic lift/lower control lever is the first mini-lever to the right of the operator's seat. Pull backward toward operator to raise the carriage and forks. Push forward to lower the carriage and forks.

Tilt

The electronic tilt control lever is the second mini-lever to the right of the operator's seat. Push the lever forward to tilt the mast and forks forward. Pull the lever backward toward operator to tilt the mast and forks backward.

Return-To-Set-Tilt (RTST)

Optional: Return-To-Set-Tilt (RTST) — The RTST option assists the operator in positioning the mast at a predetermined set point. Note that the RTST function does not provide for "hands free" activation of the tilt valve. The operator must manually control both tilt speed and direction of the mast toward the set point. When the mast is far away from the stop point, the operator is allowed to tilt at the maximum tilt flow rate. When the mast is close to the set point, the maximum tilt flow rate is limited.

If the RTST override button is not depressed before pushing the tilt lever. The RTST control soft stops the mast at the set point and disables the tilt valve even if the operator command is not at neutral. Once stopped the system waits for one of three options:

1. Return the tilt control lever back to neutral position, which places the tilt control to neutral.
2. Depress the RTST override button, which will override the RTST control and allow the tilt control to function. If the delay time is set to "continuous", the operator MUST press the override button to resume tilt control past the set point.
3. Waits for the RTST time delay of 0.1 to 3 seconds to time out, at which time the tilt control will be enabled and the mast will continue to tilt in the direction the control lever is pushed.

If the RTST override button is depressed before pushing the tilt lever, and the RTST override button is depressed for $1/20^{th}$ of a second and the tilt lever is moved out of neutral within one second of the button being released, the RTST control will not stop the mast at the set point. Once the lever is returned to neutral the override command will be cancelled and the RTST control will become active.

NOTE: The following time delay adjustments are available:

- Disable RTST
- 8 increments of time delay from 0.1 to 3.0 seconds
- "Continuous" time delay. If the time delay is set to continuous the operator MUST press the override button to resume tilt control.

A service technician may adjust the time delay.

Auxiliary 1

The third mini-lever is installed to the right of the tilt control lever. This lever can have two methods of operation, depending on the attachment.

- Trucks with clamp attachment: To engage the clamp, move the mini-lever backward. To disengage the clamp, press the override button located directly behind the mini-levers, and push the mini-lever forward.
- Trucks without clamp attachment three levers, and three function control valve: The lever is operated by moving it forward and back. The lever is spring loaded to return to the neutral position when released.
- Trucks with clamp attachment, three levers, and four function control valve: The third lever becomes a dual function lever. Move the lever forward and back to operate the auxiliary 1 function. Press and hold the lever down and move lever either forward or backward to operate the auxiliary 2 function. Remove hand from lever to disable the auxiliary 2 function and return lever to auxiliary 1 position. Do not press the override button. If the override button is pressed, the clamp will be engaged.

Auxiliary 2

NOTE: If truck is equipped with four function control valve, four levers and clamp attachment, the last (4th) lever controls clamp functions. If truck is equipped with five function control valve, four levers and clamp attachment, the clamp is the fifth function and the last (4th) lever controls clamp functions.

The fourth mini-lever is installed to the right of the control lever. This lever can have two methods of operation, depending on the attachment.

- Trucks with clamp attachment: To engage the clamp, move the mini-lever backward. To disengage the clamp, press the override button located directly behind the mini-levers, and push the mini-lever forward.

- Trucks without clamp attachment, four levers, and four function control valve: The lever is operated by moving it forward and back. The lever is spring loaded to return to the neutral position when released.
- Trucks with clamp attachment, four levers, and five function control valve: The third lever becomes a dual function lever. Move the lever forward and back to operate the auxiliary 1 function. Press and hold the lever down and move lever either forward or backward to operate the auxiliary 2 function. Remove hand from lever to disable the auxiliary 2 function and return lever to auxiliary 1 position. Do not press the override button. If the override button is pressed, the clamp will be engaged.

Emergency Disconnect Switch

NOTE: The emergency disconnect switch does not remove power to the front or rear service lights.

The emergency disconnect switch, is located on the right side of the armrest.

The operator can disconnect all electrical power to the lift truck by pushing the emergency disconnect switch in until it clicks. To reset the emergency disconnect switch and energize the electrical circuits, the operator must turn the switch clockwise until it pops out.

Lighting Control

GENERAL DESCRIPTION

WARNING

Before replacing any of the lights, fully lower the mast and tilt the mast forward until the tips of the forks touch the ground. This action will prevent the mast from lowering suddenly if the control lever is accidently moved.

Never have any metal on your fingers, arms, or neck. These metal items can cause short circuit and possible damage or injury.

CAUTION

A short circuit and damage can occur if wires are not installed correctly. Make sure wire connectors do not touch the other metal terminals or wire connectors, metal brackets, or the bracket mounting nuts. Make sure the wires are not pulled tight and are not touching other parts to damage the insulation.

There are several different options for lights used on the lift trucks. See Figure 9060-10-6. Your lift truck may not be equipped with all the lights.

The lighting control system consists of work lights, marker lights, strobe light, turn signal lights, stop/backup lights and dome light. The work lights are controlled by rocker switches located on the right side of the dash; turn signal lights are controlled by a lever on the steering column.

Front Work Lights

The front work lights rocker switch is located on the right side of the dash. The front work lights can be operated when the truck system power is **ON** or **OFF**. If the power is turned **OFF**, the work lights will continue to operate until the light switch on the dash is turned OFF.

Front Marker Lights

The front marker lights operate with the front work lights.

Front/Rear Turn Signal Lights

The front/rear turn signal lights are activated by a lever mounted on the left of the steering column. The activated signal light will continue to operate until the lever is manually returned to the center position or until system power is turned to **OFF**.

Rear Tail Lights

The rear tail light operate with the operation of the front work lights.

Rear Work Light

The rear work light switch is located on the right side of the dash. The rear work lights can only be operated when the truck system power is **ON** or **OFF**. If the power is turned **OFF**, the work lights will continue to operate until the light switch on the dash is turned OFF.

Rear Backup Lights

The rear backup lights operate when Reverse direction is selected.

Rear Stop Lights

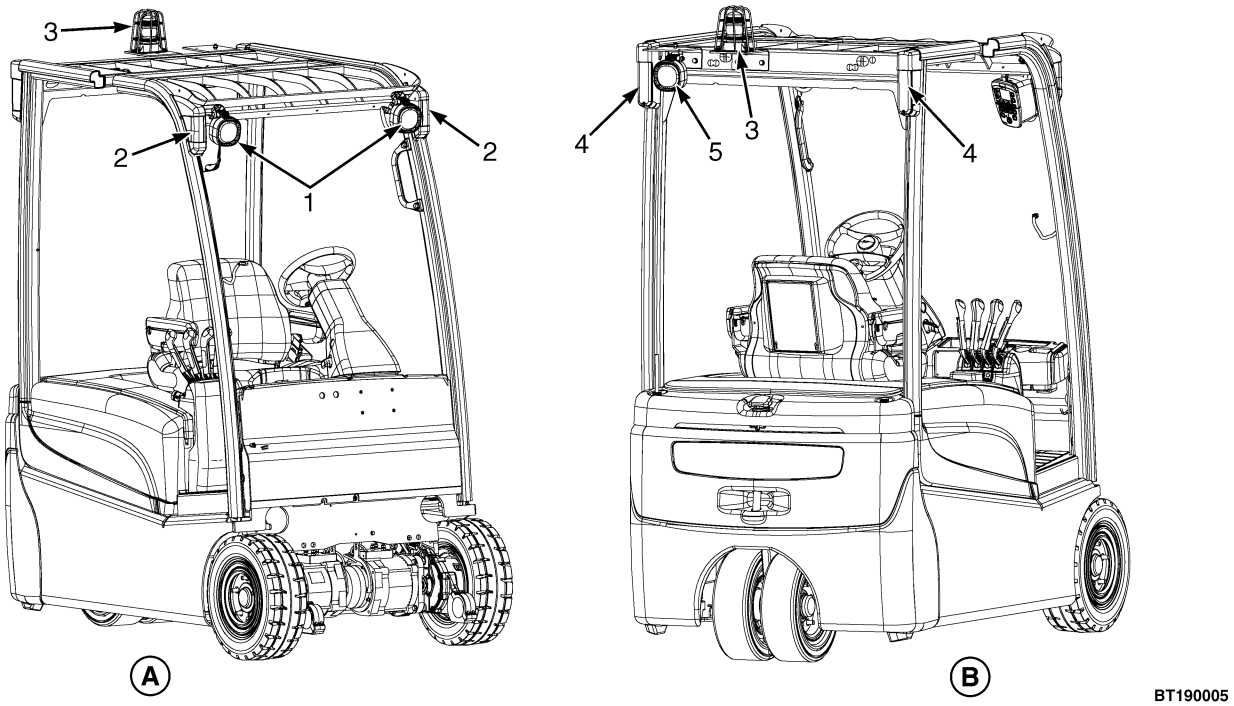
The rear stop lights operate when the brake pedal is pressed.

Strobe Light

The strobe light operate when the truck power is **ON** or when a programmed function is selected.

Dome Light

The dome light is located on the left behind the operator. There is an ON/OFF switch on the dome light. The dome light is powered through an unswitched battery source and will operate with or without system power turned **ON**.



NOTE: LIGHT LOCATION ON LIFT TRUCK MODELS E2.2-3.5XN (E45-70XN) (A268), J2.2- 3.5XN [J45-70XN] (A276), J1.5-2.0XNT (J30-40NT) (K160), AND J1.6-2.0XN (A935) ARE THE SAME. J1.5-2.0XNT (J30-40NT) (K160) IS SHOWN.

A. FRONT VIEW

B. REAR VIEW

1. FRONT WORK LIGHTS
2. FRONT MARKER/TURN SIGNAL LIGHTS*
3. STROBE LIGHT
4. LED TAIL, BACKUP, AND BRAKE LIGHTS
5. REAR WORK LIGHT

* Front marker/turn signal lights used only on J2.2- 3.5XN [J45-70XN] (A276), J1.5-2.0XNT (J30-40NT) (K160), and J1.6-2.0XN (A935) lift truck models.

Figure 9060-10-6. Lights Arrangement

Cab Panels

GENERAL DESCRIPTION

Cab panels are offered as an option with the lift truck. The cab unit consists of individual panels installed on the overhead guard using cap screws. The panels include, a roof, side doors, front and rear windows. Front and rear window wipers, and heater system are available.

Covers and Floor Plates

Various covers and floor plates provide access to components during service and securely cover areas during normal operation. Covers in the floor of the operator compartment allow access to the traction controllers, AC drive motors, service and parking brakes. A cover on the top of the counterweight provides access to the hydraulic tank, hydraulic pump and motor assembly, and the hoist controller.

Hood and Seat

Hood

The hood is a stamped steel battery cover. Two hinges at the back attach to the overhead guard.

The hood is the platform for the seat assembly and is located above the battery. It functions as a battery restraint that completely covers the battery compartment.

Seat

The seat assembly slides on seat rails that are fastened to the hood by four capscrews. A lever at the left front side of the base controls the adjustment of the seat to the forward and backward positions. Optional seats are available in cloth or vinyl with features such as non-suspension, full suspension, and limited swivel.

All seats have a seat switch installed in the bottom cushion that senses operator presence. When the operator is not on the seat, the seat switch opens and interrupts the controller stopping operation of the lift truck.

Cab Heating System

If included, the cab heater is located on the right hand door. The optional cab heater consists of the main plenum assembly, motor, fan, wiring harness, control unit with keypad, primary filter media, secondary filter media, and mounting hardware.

The fan draws outside air through the cab vent and into both filters before finally entering the plenum. A thermostat regulates operation of the electric heating element. Cab air is heated until plenum air temperature reaches a maximum of 35°C (95°F). At this maximum temperature the thermostat will automatically cut power to the element as a protective measure.

Operator keypad inputs command the control unit **ON** or **OFF**, change temperature and fan speed. Temperature settings can be adjusted in 1° increments shown on corresponding LCD screen. Operators can choose to display temperature in Celsius (C) or Fahrenheit (F). Fan speed is also adjusted using the keypad and corresponding displayed on a segmented graph.

By monitoring input voltage and current flow through components this heater will trigger error codes in the event of a malfunction. Basic onboard diagnostics guide service personnel in troubleshooting by displaying a variety of error codes. For details see **Operator's Cab** 0100SRM1446.

Control Panel

Controls the speed of the heater fan. The operator may choose to have the fan off or select from three fan speeds (low, medium, or high).

Plastic casing 85 x 72 x 25mm, for retractable or standalone mounting. 2 digits indicate selected temperature. The selected fan speed is indicated with a LED ladder.

Quartz crystal controlled microprocessor with program memory of flash type and EEPROM memory for operating parameters.

Operating voltage 12VDC from control board. Communication via RS- 485 interface. Different cable lengths up to 4m are available.

Heater Core

Functions as a heat exchanger allowing air that passes through the core to be heated. Battery power heats the elements within the core.

Heater Fan

Consists of a motor and two drum fans. Air is drawn in from outside the cab and is directed to flow across the heater core. The air is warmed by the heater core and flows out through adjustable vents located on the interior RH door housing.

24 VDC max 80W, of commutator or brush-less type. Driven by DC-DC converter with 8 speed levels at 14-24V

Wiper/Washer System

The wiper/washer system consists of the wiper motors, wiper arms, wiper blades and a washer bottle and pump. The front wiper and washer is operated by switches located on the dash. The rear wiper and washer switch is located in the headliner on the right side of the truck.

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SECTION 9070

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Group 10
Principles of Operation

Front End, Mast

DESCRIPTION

This section provides general Principles of Operation for front end components. Therefore, the illustrations used are intended to provide only a general description of front end components. Since many details and specific repair procedures, vary, depending on your lift truck, see **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441. Depending on your lift truck, the description and repair for the tilt cylinders see, **Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564)** 2100SRM1382 or **Cylinder Repair (Mast S/N B551, B555, B559)** 2100SRM1440.

The mast is used to lift a load vertically. The mast has two movements controlled by hydraulic cylinders: forward and backward tilt, and the lifting and lowering of the mast and carriage. The outer mast tilts on the pivot pins at the mast mounts. The operation of the tilt cylinders causes the mast to tilt forward and backward. The tilt cylinders are fastened between the frame of the lift truck and the outer mast. Hydraulic lift cylinders are installed vertically in the mast. The lift cylinders raise and lower the intermediate/inner masts and the carriage.

There are four types of masts available:

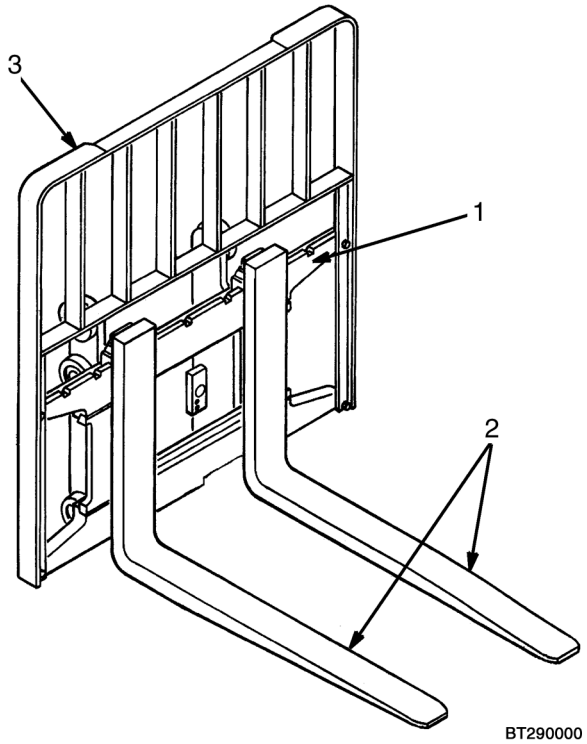
- Two-Stage Limited Free-Lift
- Two-Stage Full Free-Lift
- Three-Stage Full Free-Lift
- Four-Stage Full Free-Lift.

Each type of mast is described separately in this section.

Carriages

DESCRIPTION

The carriage is a part of the mast assembly and moves within the vertical channels of the inner weldment. Load rollers, attached to the carriage, travel in the channels of the inner weldment. Forks or other types of load handling equipment are attached to the carriage. A load backrest extension is attached to the carriage and adds support for a load that has multiple pieces. See Figure 9070-10-1.



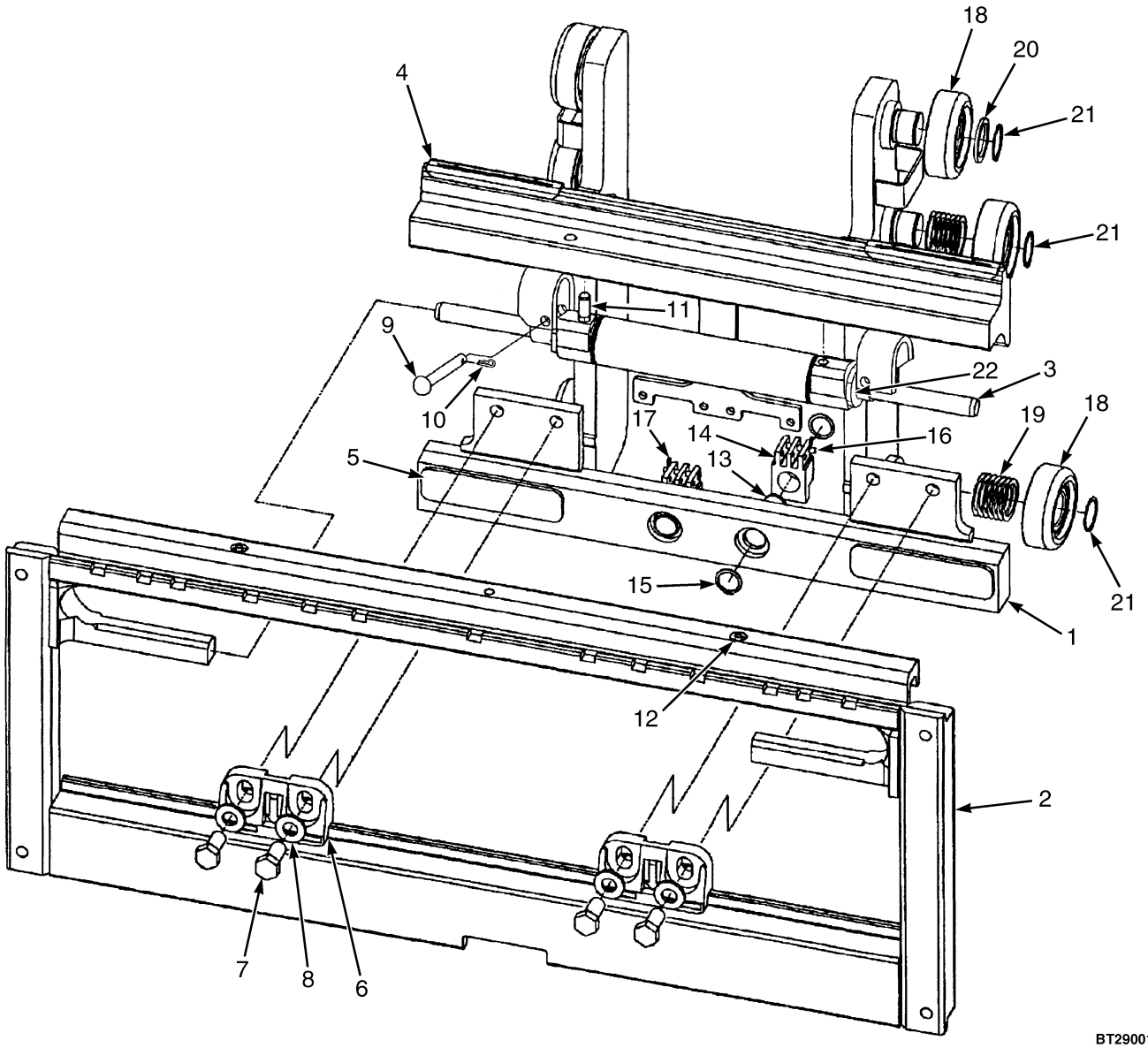
1. STANDARD CARRIAGE
2. FORKS
3. LOAD BACKREST EXTENSION

Figure 9070-10-1. Carriage

PRINCIPLES OF OPERATION

Integral Sideshift Carriage

The integral sideshift carriage lets the operator move the forks and load from side to side. This function makes it easier for the operator to align the forks with a load or align the load with a stack. The integral sideshift carriage is a complete inner carriage and outer frame assembly. The sideshift cylinder moves the outer frame assembly on the inner carriage. The fork spread control lever is the fourth manual lever. **PUSH** the lever **FORWARD** to move the forks apart. **PULL** the lever **BACKWARD** toward the operator to move the forks together. See Figure 9070-10-2.



1. INNER CARRIAGE
2. OUTER FRAME
3. SIDESHIFT CYLINDER
4. UPPER BEARING
5. LOWER BEARING
6. LOWER HOOK
7. CAPSCREW
8. WASHER
9. CLEVIS PIN
10. HAIRPIN
11. PIN
12. LUBE FITTING
13. PIN
14. CHAIN ANCHOR
15. SNAP RING
16. PIN
17. COTTER PIN
18. LOAD ROLLER
19. SHIMS
20. SPACER
21. SNAP RING
22. SPACER

Figure 9070-10-2. Integral Sideshift Carriage

Mast Mounts

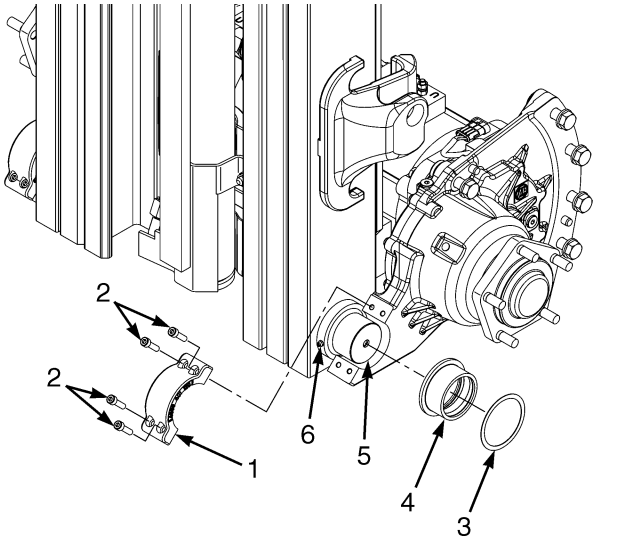
DESCRIPTION

The lower crossmember of the outer mast has castings to mount the mast mounting stubshaft. The mounting stubshafts are installed in the castings and the mast is hung on the hangers of the drive axle housing. Capscrews secure the mounting stubshaft to the drive axle housing. See Figure 9070-10-3.

The mast tilt cylinders are attached to the mast upper attachment castings using rod end fittings. Pins attach the rod end fittings to the casting and are secured with anchor pins and capscrews.

PRINCIPLES OF OPERATION

The mast and attached forks can tilt forward and backward. Tilt cylinders are fastened between the lift truck frame and the outer mast upper attachment points. The operator uses the Mini Lever Module controls to extend or retract the tilt cylinders, changing the angle of the mast that pivots on the mounting stubshafts mounted on the drive axle housing.



1. RETAINER CAP
2. CAPSCREWS
3. SHIM
4. BUSHING
5. MAST MOUNT STUBSHAFT
6. GREASE FITTING

Figure 9070-10-3. Mast Mounts

Two-Stage Full Free-Lift (FFL) Mast

DESCRIPTION

The Two-Stage Full Free-Lift Mast has an inner mast and an outer mast. See Figure 9070-10-4. It is called a full free-lift mast because the carriage can travel to the top of the inner mast without extending the inner mast. The full free-lift mast has the same load roller and strip bearing arrangements as the two-stage, limited free-lift mast.

The two main lift cylinders are installed at the back of the outer mast. The base of each lift cylinder sits in a mount on the bottom crossmember of the outer mast. The top of each lift cylinder rod fits into a guide on the top crossmember of the inner mast.

The free-lift cylinder is installed in the inner mast. Each of the lift cylinders has an internal lowering control valve. A single external lowering control valve is connected by tubing and hoses to all the lift cylinders.

The free-lift chains connect at one end to the mid-crossmember of the inner mast. Two chain sheaves are installed on a crosshead on the rod of the free-lift cylinder. The chains go over sheaves on the crosshead and connect to the carriage.

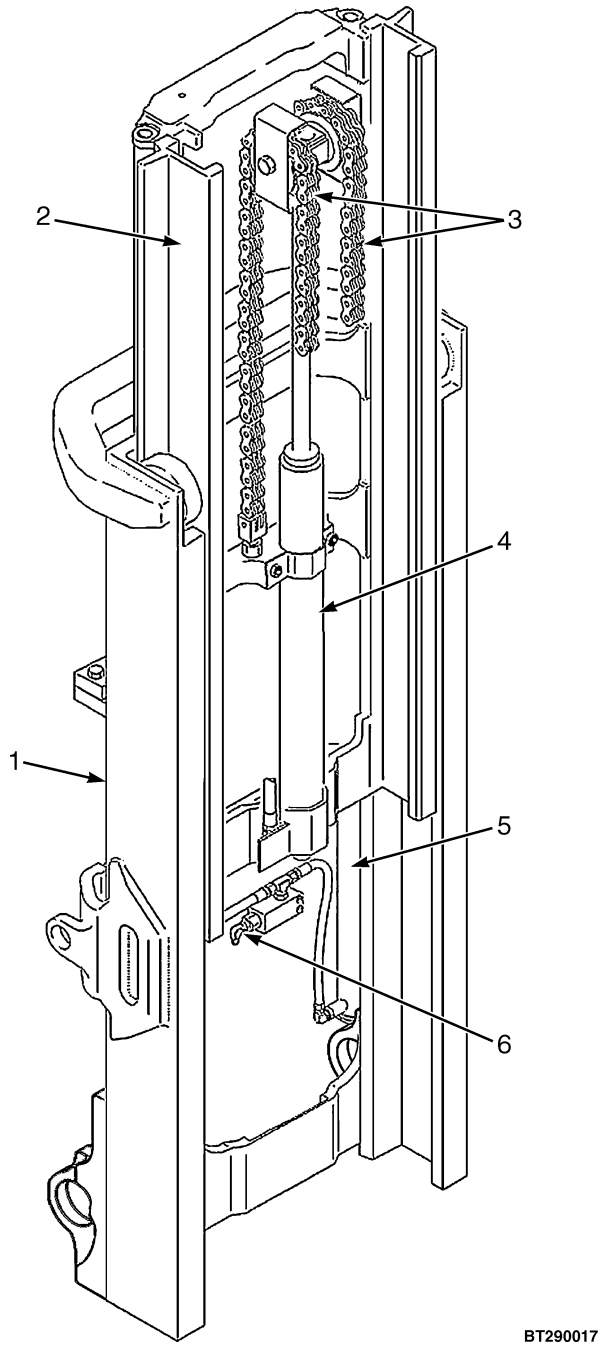


Figure 9070-10-4. Two-Stage (FFL) Mast

Legend for Figure 9070-10-4

NOTE: TYPICAL MAST ASSEMBLY IS SHOWN.

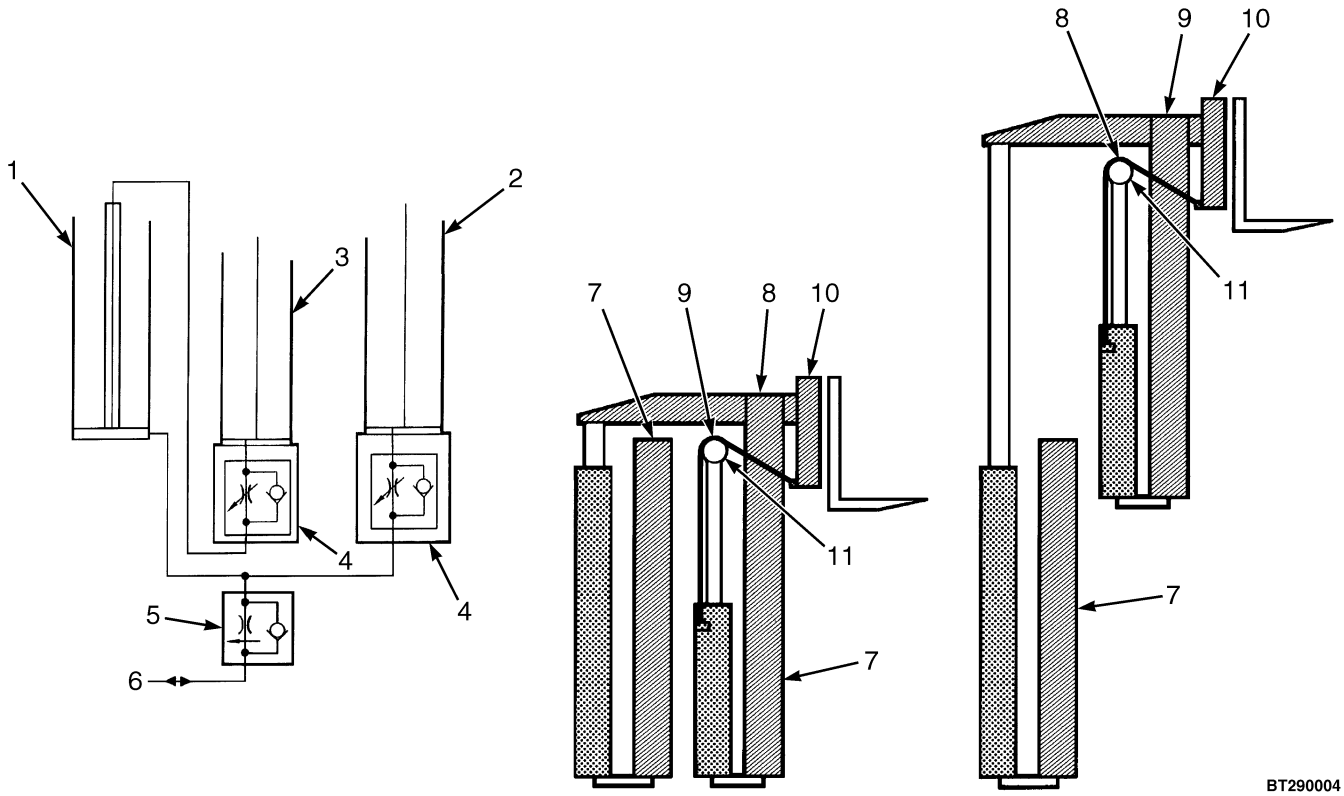
1. OUTER MAST
2. INNER MAST
3. FREE-LIFT CHAIN
4. FREE-LIFT CYLINDER
5. MAIN LIFT CYLINDER(S)
6. LOWERING CONTROL VALVE (EXTERNAL)

PRINCIPLES OF OPERATION

The three lift cylinders are connected by hoses and tubing as shown in Figure 9070-10-5. When the mast is extended, oil flows from the main control valve to the base of the main lift cylinders. The oil flows through the left-hand cylinder rod and through tubing to the base of the free-lift cylinder. The free-lift cylinder raises only the carriage. When the free-lift cylinder is fully extended, the two main lift cylinders extend the inner mast. The free-lift cylinder extends first because it has less weight to lift and a lower operating pressure. When the load is lowered, the main lift cylinders lower first because they have a greater load and a higher operating pressure. The oil flows from the main lift cylinders, through the lowering control valve to the hydraulic tank. Oil from the free-lift cylinder flows from the cylinder through tubing to the left-hand main lift cylinder rod. The oil flows from the left-hand main lift cylinder to the hydraulic tank.

The free-lift cylinder must have 150 cc (5 oz) of oil above the piston. This oil provides a hydraulic cushion when the cylinder reaches the top of its stroke. An orifice system in the piston provides the hydraulic cushioning. When the cylinder is fully extended, any excess oil above the piston is forced through the check valve in the piston.

The right-hand main lift cylinder has an orifice system in the bottom of the rod assembly. This system provides a hydraulic cushion when the cylinder reaches the bottom of its stroke.



1. RIGHT-HAND LIFT CYLINDER
2. LEFT-HAND LIFT CYLINDER
3. FREE-LIFT CYLINDER
4. LOWERING CONTROL VALVE (INTERNAL)
5. LOWERING CONTROL VALVE (EXTERNAL)
6. TO/FROM MAIN CONTROL VALVE
7. OUTER MAST
8. INNER MAST
9. FREE-LIFT CHAINS
10. CARRIAGE
11. CHAIN SHEAVES

Figure 9070-10-5. Operation of Two-Stage (FFL) Mast

Two-Stage Limited Free-Lift (LFL) Mast

DESCRIPTION

The Two-Stage Limited Free-Lift Mast has an outer mast, an inner mast, and two lift cylinders. See Figure 9070-10-6. At the base of the inner mast there is one load roller on each side. These load rollers travel along the flanges inside the outer mast channel. At the top of the outer mast there is also one load roller on each side. These load rollers travel along the flanges on the outside of the inner mast. The angle of the load rollers permits them to control the forces from the front, back, and sides of the mast. The strip bearings are installed at the top of the outer mast.

The strip bearings can be adjusted by shims to help keep the correct clearance between the outer mast and the inner mast.

The two single-stage lift cylinders are installed at the back of the outer mast. The base of each lift cylinder sits in a mount on the bottom crossmember of the outer mast. The top of each lift cylinder rod fits into a guide on the top crossmember of the inner mast. Operation of the lift cylinders extends and retracts the inner mast. See Figure 9070-10-7.

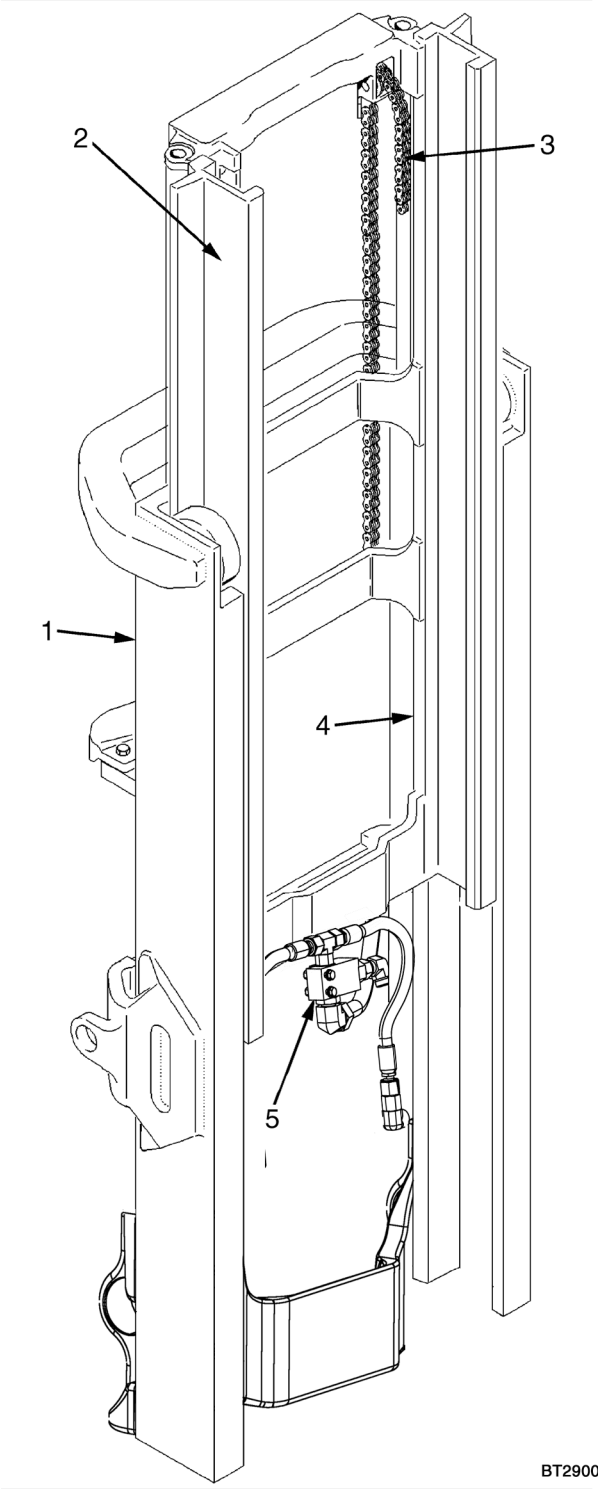


Figure 9070-10-6. Two-Stage (LFL) Mast

Legend for Figure 9070-10-6

NOTE: TYPICAL MAST ASSEMBLY IS SHOWN.

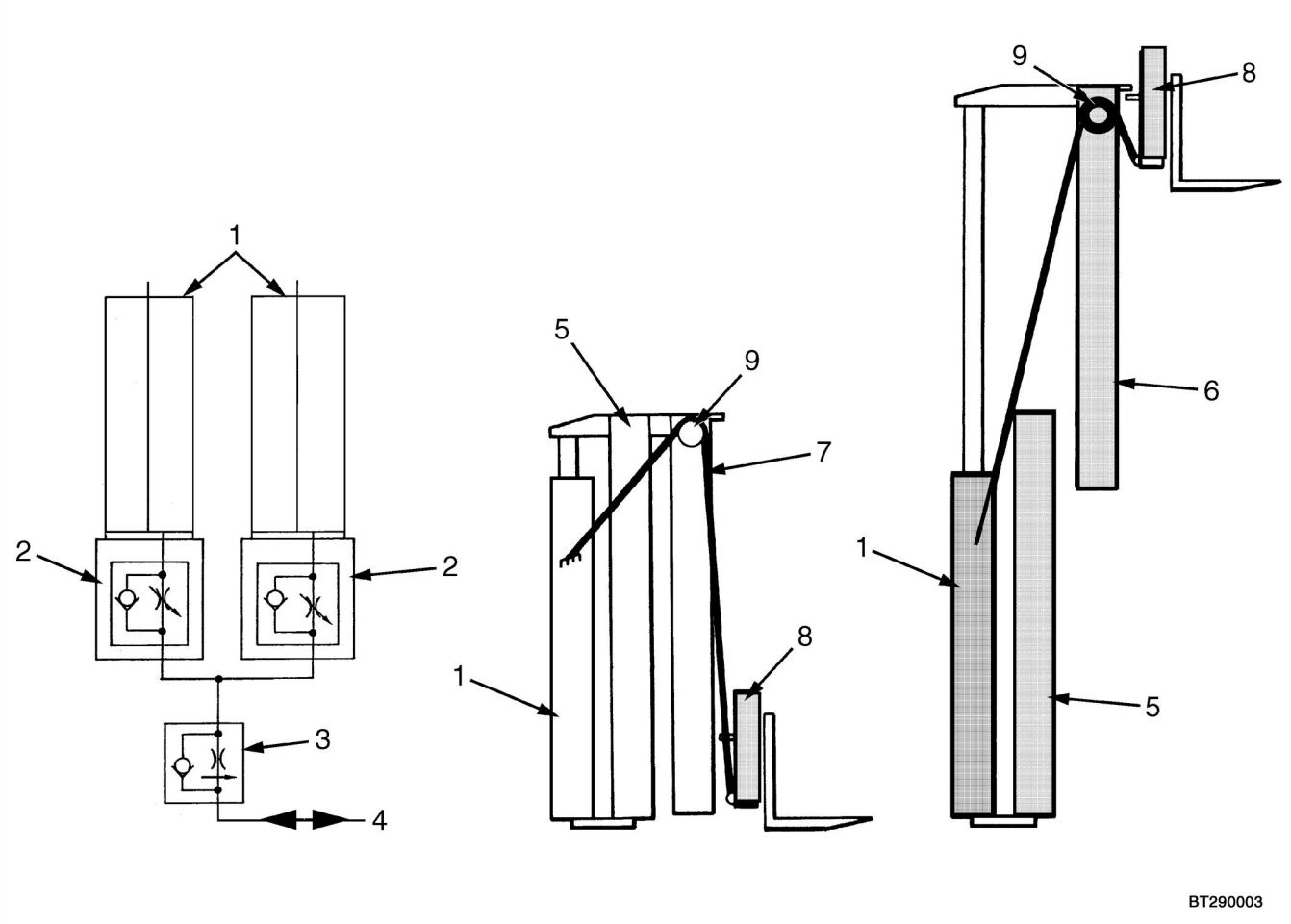
1. OUTER MAST
2. INNER MAST
3. LIFT CHAIN(S)
4. LIFT CYLINDER(S)
5. LOWERING CONTROL VALVE (EXTERNAL)

PRINCIPLES OF OPERATION

Two lift chains move the carriage. The chains fasten to mounts that are near the top of the lift cylinder shells as shown in Figure 9070-10-7. The chains go up and over the chain sheaves and connect to the carriage. The chain sheaves are installed at the top crossmember of the inner mast. When the lift cylinders extend, the lift chains transfer the force from the lift cylinders to the carriage. The inner mast and carriage raise a small amount before the overall height of the mast increases. During lifting, the inner mast moves at the same speed as the lift cylinders. The carriage moves at twice the speed of the inner mast/lift cylinders.

When the lift cylinders retract, the weight of the load, carriage, forks, load backrest extension and attachment, and inner mast pushes the oil from the lift cylinders. The oil flows from the lowering control valves in the lift cylinders, through the external lowering control valve to the hydraulic tank.

Each cylinder has a check valve in the bottom of the rod assembly. When the cylinder is fully extended, any oil above the piston is forced through the check valve.



1. LIFT CYLINDER
2. LOWERING CONTROL VALVE (INTERNAL)
3. LOWERING CONTROL VALVE (EXTERNAL)
4. TO/FROM MAIN CONTROL VALVE
5. OUTER MAST
6. INNER MAST
7. LIFT CHAINS
8. CARRIAGE
9. CHAIN SHEAVES

Figure 9070-10-7. Operation of Two-Stage (LFL) Mast

Three-Stage Full Free-Lift (FFL) Mast

DESCRIPTION

The Three-Stage Full Free-Lift Mast has three masts: outer, intermediate, and inner. See Figure 9070-10-8. Two single-stage main lift cylinders and a free-lift cylinder are used to raise the carriage and extend the intermediate and inner mast. It is called a full free-lift mast because the carriage can travel to the top of the inner mast without extending the inner mast. The masts are telescopic and have the load roller and strip bearing arrangements similar to the two-stage mast.

The load rollers are installed at the top of the outer and intermediate masts. Load rollers are also used at the bottom of the intermediate and inner masts. These load rollers travel along the flanges of the mast channels. The angle of the load rollers permits them to control the forces from the front, back, and sides of the mast. The strip bearings are installed at the top of the outer and intermediate masts and help keep the correct clearance between the masts. The load rollers and strip bearings are adjustable with shims.

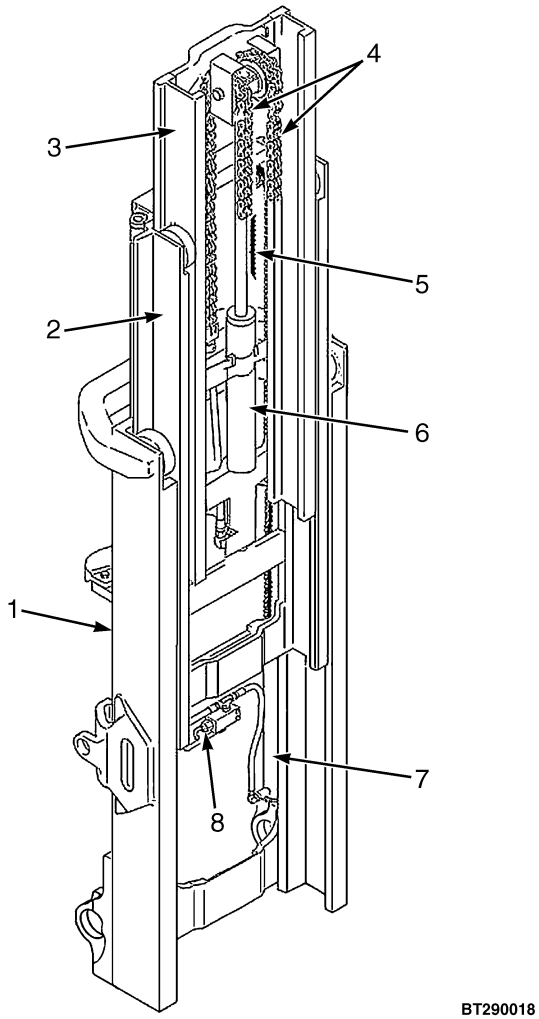
The two main lift cylinders are installed at the back of the outer mast. The base of each main lift cylinder sits in a mount on the bottom crossmember of the outer mast. The top of each main lift cylinder rod fits into a guide in the top crossmember of the intermediate mast. The free-lift cylinder is installed to the inner mast. Each lift cylinder has an internal lowering control valve. A single external lowering control valve is connected by tubing and hoses to all of the lift cylinders.

The two main lift chains are connected to mounts that are welded near the top of the main lift cylinder shells. The lift chains go over sheaves at the top of the intermediate mast and fasten at the bottom of the inner mast.

The free-lift chains connect at one end to the mid-crossmember of the inner mast. Two chain sheaves are installed on a crosshead on the cylinder rod of the free-lift cylinder. The chains go over sheaves on the crosshead and connect to the carriage.

PRINCIPLES OF OPERATION

The three hydraulic cylinders are connected by hoses and tubing as shown in Figure 9070-10-9. When the mast is extended, oil from the main control valve flows to all cylinders at the same time. The free-lift cylinder extends first because it lifts the least amount of weight and has a lower operating pressure. The free-lift cylinder raises only the carriage. After the free-lift cylinder reaches the end of its stroke, the main lift cylinders begin to extend. As the main lift cylinders extend, the intermediate mast is raised by the main lift cylinders and the inner mast is raised by the main lift chains.



NOTE: TYPICAL MAST ASSEMBLY IS SHOWN.

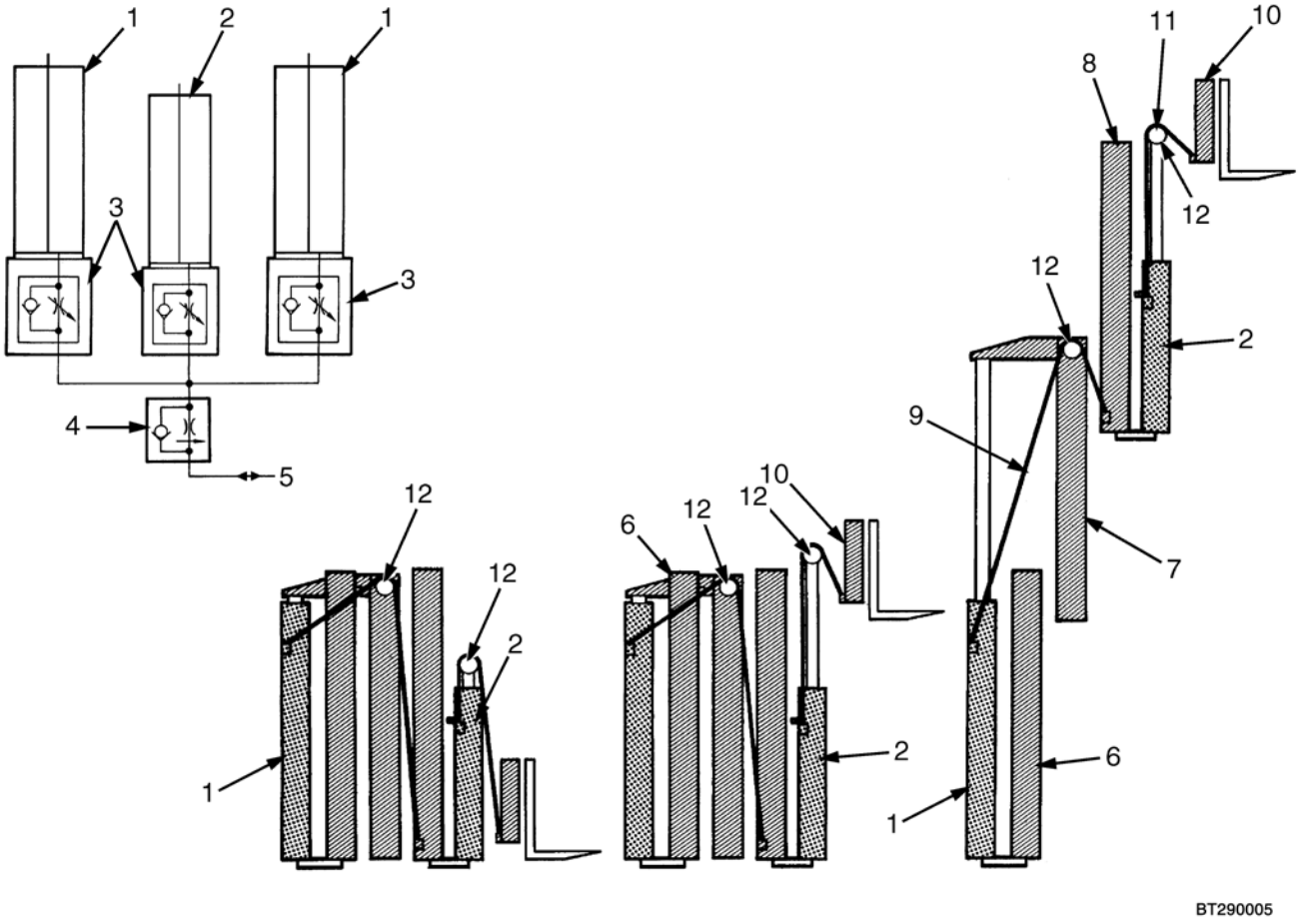
1. OUTER MAST
2. INTERMEDIATE MAST
3. INNER MAST
4. FREE-LIFT CHAIN
5. MAIN LIFT CHAIN(S)
6. FREE-LIFT CYLINDER
7. MAIN LIFT CYLINDER(S)
8. LOWERING CONTROL VALVE (EXTERNAL)

Figure 9070-10-8. Three-Stage (FFL) Mast

During lowering, the main lift cylinders lower first because they have a greater load and higher operating pressure. After the main lift cylinders have retracted, the free-lift cylinder lowers. All oil from the lift cylinders flows through the lowering control valves to the hydraulic tank.

The free-lift cylinder must have 150 cc (5 oz) of oil above the piston. This oil provides a hydraulic cushion when the cylinder reaches the top of its stroke. An orifice system in the piston provides the hydraulic cushioning. When the cylinder is fully extended, any excess oil above the piston is forced through the check valve.

Each main lift cylinder has an orifice system and a check valve in the bottom of the rod assembly. When the cylinder is fully extended, any oil between the rod end and the gland is forced through the check valve. The orifice system provides a hydraulic cushion when the cylinder reaches the bottom of its stroke.



1. LIFT CYLINDER
2. FREE-LIFT CYLINDER
3. LOWERING CONTROL VALVE (INTERNAL)
4. LOWERING CONTROL VALVE (EXTERNAL)
5. TO/FROM MAIN CONTROL VALVE
6. OUTER MAST
7. INTERMEDIATE MAST
8. INNER MAST
9. MAIN LIFT CHAINS
10. CARRIAGE
11. FREE-LIFT CHAINS
12. CHAIN SHEAVES

Figure 9070-10-9. Operation of Three-Stage (FFL) Mast

Four-Stage Full Free-Lift (FFL) Mast

DESCRIPTION

The Four-Stage Full Free-Lift (FFL) Mast has four masts: outer, first intermediate, second intermediate, and inner. See Figure 9070-10-10. Two single-stage main lift cylinders and a free-lift cylinder are used to raise the carriage and extend the intermediate and inner masts. It is called a full free-lift mast because the carriage can travel to the top of the inner mast without extending the inner mast.

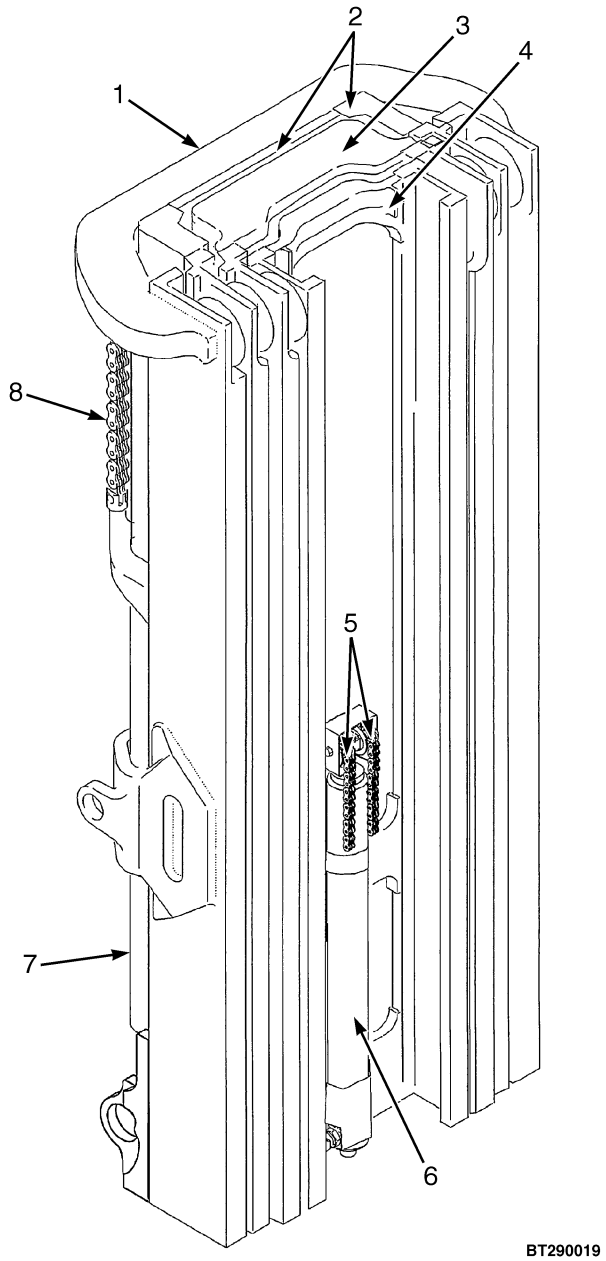
The masts are telescopic and have load roller and strip bearing arrangements similar to the three-stage mast. The load rollers are installed at the top of the outer, first, and second intermediate masts. Load rollers are also used at the bottom of the first and second intermediate masts and the inner mast. These load rollers travel along the flanges of the mast channels. The angle of the load rollers permits them to control the forces from the front, back, and sides of the mast. The strip bearings are installed at the top of the outer, first, and second intermediate masts and help keep the correct clearance between the masts. The load rollers and strip bearings are adjustable with shims.

The two main lift cylinders are installed at the back of the outer mast. The base of each main lift cylinder sits in a mount on the bottom crossmember of the outer mast. The top of each main lift cylinder rod fits into a guide in the top crossmember of the first intermediate mast. The free-lift cylinder is installed to the inner mast. The free-lift and left-hand main lift cylinder has an internal lowering control valve. A single external lowering control valve is connected by tubing and hoses to all of the lift cylinders.

The main lift chains connect to mounts that are near the top of the outer mast. The lift chains then go over sheaves at the top of the first intermediate mast and fasten at the bottom of the second intermediate mast.

The intermediate lift chains connect to mounts that are near the top of the first intermediate mast. The lift chains then go over sheaves at the top of the second intermediate mast and fasten at the bottom of the inner mast.

The free-lift chains connect at one end to the mid-crossmember of the inner mast. Two chain sheaves are installed on a crosshead on the cylinder rod of the free-lift cylinder. The chains then go over sheaves on the crosshead and connect to the carriage.



1. OUTER MAST
2. FIRST INTERMEDIATE MAST
3. SECOND INTERMEDIATE MAST
4. INNER MAST
5. FREE-LIFT CHAINS
6. FREE-LIFT CYLINDER
7. MAIN LIFT CYLINDERS
8. LIFT CHAINS

Figure 9070-10-10. Four-Stage (FFL) Mast

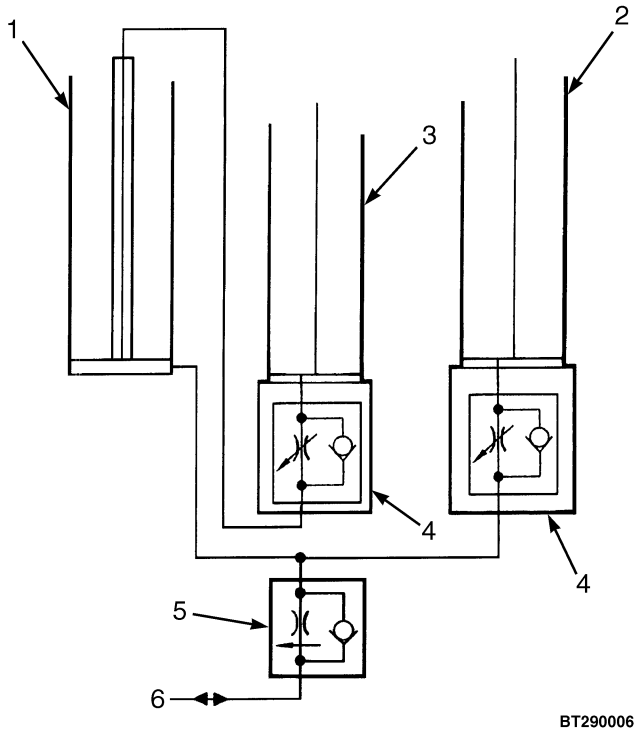
PRINCIPLES OF OPERATION

The three hydraulic cylinders are connected by hoses and tubing as shown in Figure 9070-10-11. When the mast is extended, oil flows from the main control valve to the base of the main cylinders. The oil flows through the right-hand cylinder rod and through a tube and hose to the base of the free-lift cylinder. The free-lift cylinder extends first because it lifts the least amount of weight and has a lower operating pressure. The free-lift cylinder raises only the carriage. After the free-lift cylinder reaches the end of its stroke, the main lift cylinders begin to extend. As the main lift cylinders extend, the first intermediate mast is raised by the main lift cylinders. The second intermediate and inner masts are raised by the main and intermediate lift chains. See Figure 9070-10-12.

During lowering, the main lift cylinders lower first because they have a greater load and higher operating pressure. After the main lift cylinders have retracted, the free-lift cylinder lowers. All oil from the lift cylinders flows through the lowering control valves to the hydraulic tank.

The free-lift cylinder must have 150 cc (5 oz) of oil above the piston. This oil provides a hydraulic cushion when the cylinder reaches the top of its stroke. An orifice system in the piston provides the hydraulic cushioning. When the cylinder is fully extended, any excess oil above the piston is forced through the check valve in the piston.

The left-hand main cylinder has an orifice system and check valve in the bottom of the rod assembly. The top of the right-hand cylinder is connected to the left-hand main cylinder by a tube. When the main cylinders are fully extended, any oil between the rod end and the gland is forced through the check valve in the bottom of the left-hand main cylinder. The orifice system in the bottom of the left-hand main cylinder provides a hydraulic cushion when the cylinder reaches the bottom of its stroke.



1. MAIN LIFT CYLINDER (LEFT-HAND)
2. FREE-LIFT CYLINDER
3. MAIN LIFT CYLINDER (RIGHT-HAND)
4. SECONDARY LOWERING CONTROL VALVE (EXTERNAL)
5. PRIMARY LOWERING CONTROL VALVE (EXTERNAL)
6. TO/FROM MAIN CONTROL VALVE

Figure 9070-10-11. Hydraulic Schematic for Mast Cylinders

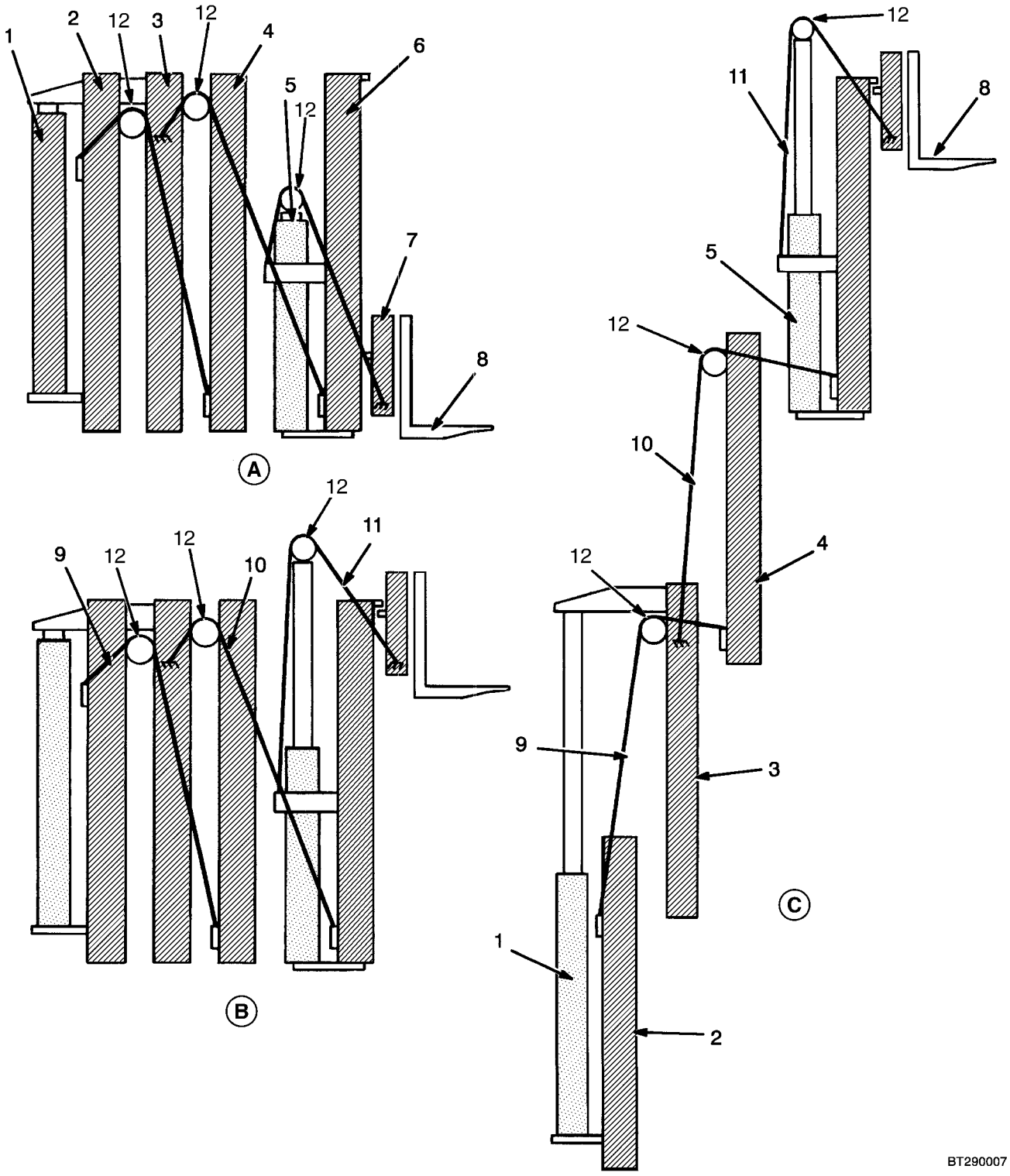


Figure 9070-10-12. Operation of Four-Stage (FFL) Mast

Legend for Figure 9070-10-12

A. LOWERED
B. FREE-LIFT
C. FULLY RAISED

1. MAIN LIFT CYLINDER
2. OUTER MAST
3. FIRST INTERMEDIATE MAST
4. SECOND INTERMEDIATE MAST
5. FREE-LIFT CYLINDER
6. INNER MAST
7. CARRIAGE
8. FORK
9. MAIN LIFT CHAINS
10. INTERMEDIATE LIFT CHAINS
11. FREE-LIFT CHAINS
12. CHAIN SHEAVES

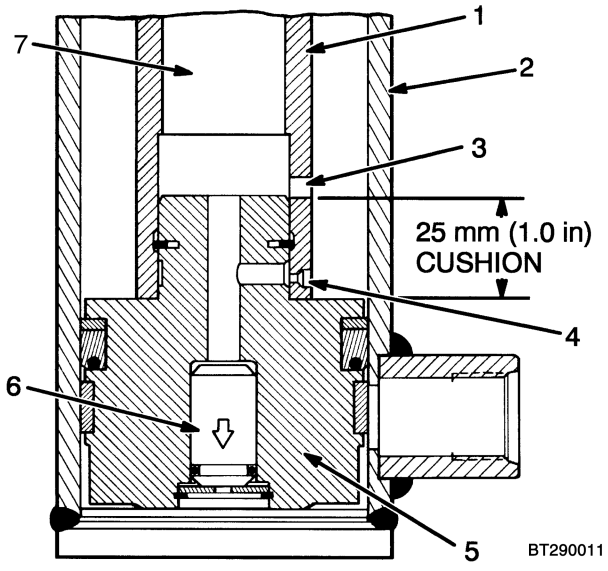
Cylinder Cushion During Lifting Sequence

DESCRIPTION

The hydraulic action at the end of the free-lift stroke provides a cushion effect for the free-lift cylinder and a smooth transition between the free-lift phase and the mast extension phase (main cylinder extension). All masts with a free-lift cylinder in this section use this design.

PRINCIPLES OF OPERATION

There is hydraulic oil on the rod side of the piston of the free-lift cylinder. When the cylinder rod extends to the last 25 mm (1.0 in.) of its stroke, the gland at the top of the cylinder closes the larger hole. During this part of the cylinder stroke, the hydraulic oil must flow through the orifice to the air cavity. This action increases the hydraulic pressure so the main lift cylinders begin to extend. See Figure 9070-10-13.



1. CYLINDER ROD
2. CYLINDER SHELL
3. LARGE ORIFICE
4. SMALL ORIFICE
5. PISTON
6. INTERNAL CHECK VALVE
7. AIR CAVITY

Figure 9070-10-13. Free-Lift Cylinder Operation

Cylinder Cushion During Lowering Sequence

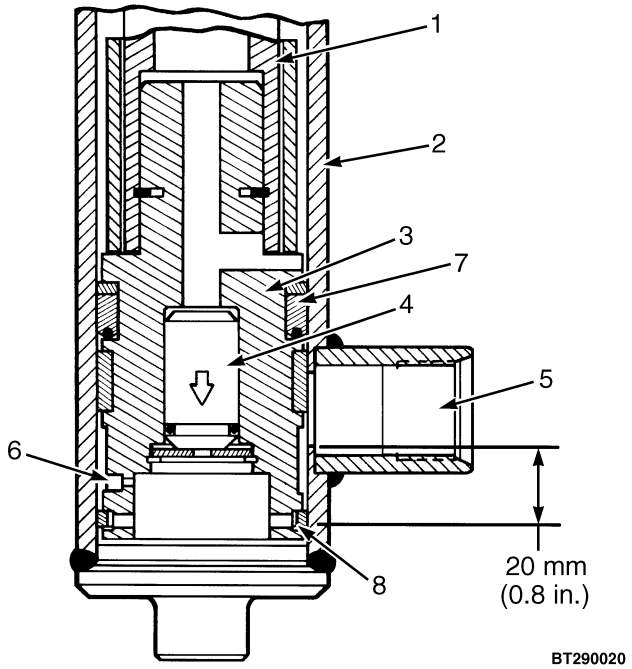
DESCRIPTION

This cushion effect prevents a sudden stop of the main cylinders, which causes smoother operation during lowering. All masts in this section, except Two-Stage Limited Free-Lift Masts, use this design in the main lift cylinders.

PRINCIPLES OF OPERATION

NOTE: An internal check valve is not used on the Two-Stage Full Free-Lift Mast.

When the main lift cylinders retract, the hydraulic oil flows out of the cylinder through the hydraulic port until the cushion ring moves past the hydraulic port. During the last 20 mm (0.79 in.) of the retraction stroke, the hydraulic oil must flow through the orifice. See Figure 9070-10-14. This action causes the cylinder rod to move much more slowly at the end of the retraction stroke.



NOTE: LEFT-HAND LIFT CYLINDER SHOWN.

1. CYLINDER ROD
2. CYLINDER SHELL
3. PISTON
4. INTERNAL CHECK VALVE
5. HYDRAULIC PORT
6. ORIFICE
7. PISTON SEAL
8. CUSHION RING

Figure 9070-10-14. Main Lift Cylinder Operation

Tilt and Sideshift Cylinders

DESCRIPTION

Tilt Cylinder

The tilt cylinders are used to move the mast forward and backward. To extend the cylinder rod (tilt forward), oil enters the tilt cylinder port behind the piston. The oil pressure pushes the cylinder rod out of the cylinder. Oil in front of the piston returns to the hydraulic tank. To retract the cylinder rod (tilt backward), the oil enters the port in front of the piston. The oil pressure pushes the cylinder rod into the tilt cylinder. The oil behind the piston returns to the hydraulic tank.

Sideshift Cylinder

The sideshift cylinder is removable for service. It is a double-acting, non-differential, piston-type cylinder, which allows the sideshift to attain the same speed moving either left or right. The cylinder also has flow restricting orifices in the ports.

Lowering Control Valves

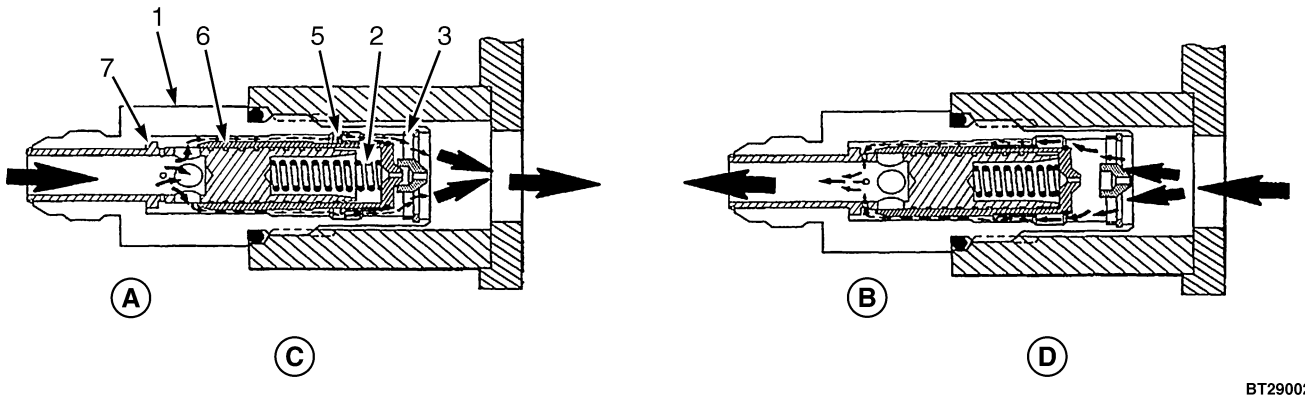
DESCRIPTION

The lowering control system permits easy entry of hydraulic oil into the cylinder during lifting, but restricts flow when rod is retracted to limit the speed at which a load maybe lowered. A pressure-compensated lowering control valve regulates the lowering speed to a more uniform value over the entire capacity range. The two types of lowering control valves used are designated as primary and secondary.

PRINCIPLES OF OPERATION

The Primary lowering control valve limits the lowering speed of the mast to a maximum controlled rate over the full range of loads. This valve is mounted externally on the middle crossmember of the outer mast. This type of lowering control valve uses these basic parts: (1) valve body, (2) spring, (3) special washer, (5) orifice sleeve, (6) plunger, and (7) main sleeve. The orifice sleeve position is controlled completely by oil flow. The plunger position is controlled by oil pressure and spring tension. During lifting, oil entering the lift cylinder goes through the center of the main sleeve to the large holes. The oil flow through the plunger and bore moves the orifice sleeve to the end of the plunger. The flange of the orifice sleeve is then aligned with the large part of the bore in the body. This alignment lets the oil flow past the orifice sleeve to the cylinder. During lowering, oil from the lift cylinder moves the orifice sleeve. The orifice sleeve moves away from the larger inner diameter area of the bore in the valve body. This movement makes a restriction to the oil flow. As the pressure increases, the plunger begins to move against the spring. The movement begins to close the openings of the large holes in the main sleeve. Additional pressure will push the plunger against the main sleeve to close the large holes completely. All the oil must then go through the small holes to the center of the main sleeve. This restriction permits the piston rod to lower only at a maximum controlled speed. See Figure 9070-10-15.

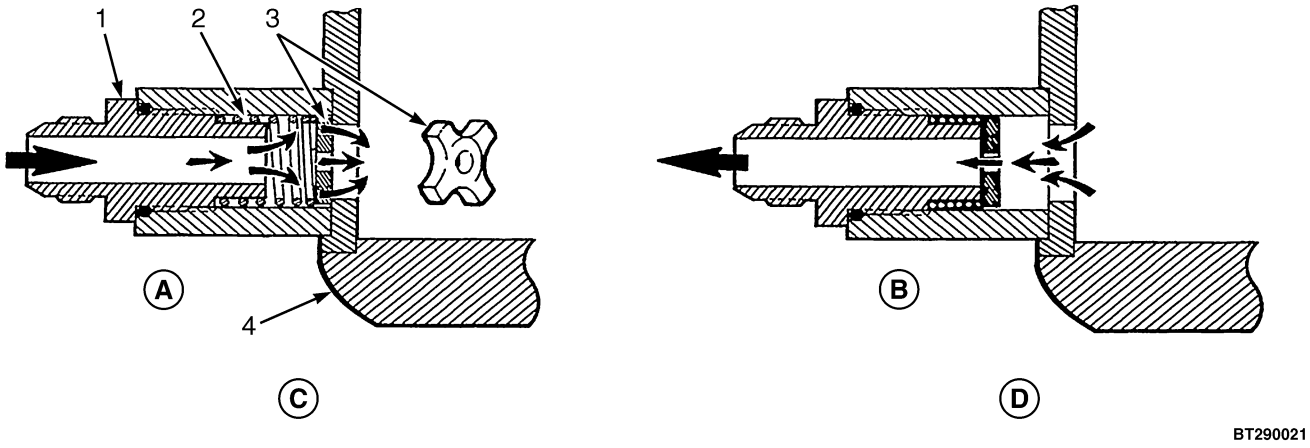
The Secondary lowering control valve is installed in each cylinder and is used only for emergency lowering. In the event an hydraulic line ruptures, this valve will lower the mast at a controlled rate. This type of lowering control valve uses these parts: (1) special fitting for the valve body, (2) spring, (3) special washer, and (4) cylinder. There is a variation in the shapes of the special washer. The volume of the hydraulic oil flowing through the inlet port controls the shape of the special washer. When the piston rod is lowered, the oil flow pushes against the special washer and spring. When the oil flow reaches the limit, the special washer is moved against the special fitting. The oil then flows only through the hole in the center of the special washer. This restriction permits the piston rod to lower only at a maximum controlled speed. See Figure 9070-10-16.



A. LIFTING
B. LOWERING
C. FREE FLOW
D. RESTRICTED FLOW

1. SPECIAL FITTING OR VALVE BODY
2. SPRING
3. SPECIAL WASHER
4. NOT SHOWN, CYLINDER (SECONDARY ONLY)
5. ORIFICE SLEEVE
6. PLUNGER
7. MAIN SLEEVE

Figure 9070-10-15. Primary Lowering Control Valve



A. LIFTING
B. LOWERING
C. FREE FLOW
D. RESTRICTED FLOW

1. SPECIAL FITTING OR VALVE BODY
2. SPRING
3. SPECIAL WASHER
4. CYLINDER (SECONDARY ONLY)

Figure 9070-10-16. Secondary Lowering Control Valve

Chassis

DESCRIPTION

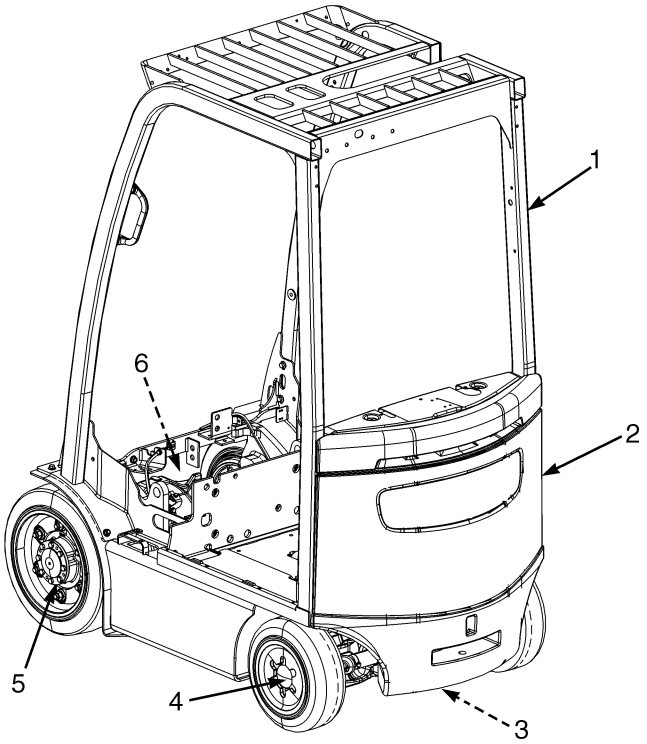
The chassis consists of the following components as shown in Figure 9070-10-17. The frame is one weldment which includes the hydraulic tank which can be accessed with removal of the counterbalance. The counterweight is attached to the frame and varies in weight depending on truck capacity.

Overhead Guard

The overhead guard is designed to provide protection to the operator from falling objects and in the event of a tip over. A high visibility design allows for an unobstructed view while maintaining structural integrity. Removal of the battery is simplified by the slot in the overhead guard. This provides access to the battery with an overhead lifting device without removing the overhead guard. See Figure 9070-10-17.

Counterweight

A one-piece, cast iron counterweight is used to offset the weight of the load and attached to the rear suspension of the lift truck. See Figure 9070-10-17.



1. OVERHEAD GUARD
2. COUNTERWEIGHT
3. STEER AXLE MOUNTS
4. STEER AXLE AND WHEEL
5. DRIVE AXLE AND WHEEL
6. DRIVE AXLE MOUNTS

Figure 9070-10-17. Chassis Component Location

Group 30
Observed Symptoms

Abnormal Channel Wear

POSSIBLE CAUSE

A. MAST DAMAGED
B. MAST CHANNELS LACK LUBRICATION
C. CHAINS ARE LOOSE OR NOT EQUAL
D. MAST IS SHIMMED INCORRECTLY
E. LOAD ROLLERS ARE NOT ROTATING FREELY WITHIN CHANNEL
F. DAMAGED OR WORN LOAD ROLLERS OR STRIP BEARINGS
G. LIFT CYLINDER BINDING

CAUSE A - MAST DAMAGED

NOTE: See **Operating Manual**.

PROCEDURE OR ACTION:

1. Visually inspect mast for damage.
   Is the mast in good condition?
   YES: Go to CAUSE B.
   NO: Repair or replace damaged components. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.

CAUSE B - MAST CHANNELS LACK LUBRICATION

PROCEDURE OR ACTION:

1. Inspect grease on mast channels.
   Is a thin coat of grease spread evenly on channels?
   YES: Go to CAUSE C.
   NO: Apply grease to mast sliding surfaces. Depending on your lift truck see, **Periodic Maintenance** 8000SRM1364, **Periodic Maintenance** 8000SRM1372, **Periodic Maintenance** 8000SRM1339, **Periodic Maintenance** 8000SRM1373, or **Periodic Maintenance** 8000SRM1442.

CAUSE C - CHAINS ARE LOOSE OR NOT EQUAL

PROCEDURE OR ACTION:

1. Inspect lift chains. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.
   Are chains adjusted correctly and in good condition?
   YES: Go to CAUSE D.
   NO: Adjust or repair chains.

CAUSE D - MAST IS SHIMMED INCORRECTLY

PROCEDURE OR ACTION:

NOTE: A mast that is shimmed too loose will cause the rollers to ride up on the flange edge and produce a flaring wear pattern.

1. Inspect mast and carriage shimming. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.
   Is mast shimmed correctly?
   YES: Go to CAUSE E.
   NO: Adjust or repair as required.

CAUSE E - LOAD ROLLERS ARE NOT ROTATING FREELY WITHIN CHANNEL

PROCEDURE OR ACTION:

1. Inspect mast channel rollers. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.
   Do the rollers rotate freely?
   YES: Go to CAUSE F.
   NO: Replace load rollers. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.

CAUSE F - DAMAGED OR WORN LOAD ROLLERS OR STRIP BEARINGS

PROCEDURE OR ACTION:

1. Inspect load rollers and strip bearings. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.
   Are the load rollers and strip bearings in good condition?
   YES: Go to CAUSE G.
   NO: Adjust, repair, or replace load rollers and strip bearings as required. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.

CAUSE G - LIFT CYLINDER BINDING

PROCEDURE OR ACTION:

1. Remove and repair cylinder. Depending on your lift truck see, **Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564)** 2100SRM1382 or **Cylinder Repair (Mast S/N B551, B555, B559)** 2100SRM1440.
2. Manually extend cylinder exterior.
   Does cylinder extend freely?
   YES: Mast is loose. See Observed Symptoms, Mast is Loose, Page 9070-30-28.
   NO: Service or replace cylinder. Depending on your lift truck see, **Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564)** 2100SRM1382 or **Cylinder Repair (Mast S/N B551, B555, B559)** 2100SRM1440.

END SYMPTOM

Abnormal Hose Wear

POSSIBLE CAUSE

A. MAST DAMAGED
B. HOSES RUBBING ON COMPONENTS
C. IMPROPER HOSE ROUTING
D. HYDRAULIC RELIEF PRESSURE SET TOO HIGH
E. TOO HIGH/LOW HYDRAULIC OIL TEMPERATURE

CAUSE A - MAST DAMAGED

NOTE: See **Operating Manual**.

PROCEDURE OR ACTION:

1. Visually inspect mast for damage.
   Is the mast in good condition?
   YES: Go to CAUSE D.
   NO: Repair or replace damaged components. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.

CAUSE B - HOSES RUBBING ON COMPONENTS

PROCEDURE OR ACTION:

1. Inspect hoses for wear and tension.
   Is hose tension correct?
   YES: Go to CAUSE C.
   NO: Adjust or replace hoses or sheaves as required. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.

CAUSE C - IMPROPER HOSE ROUTING

PROCEDURE OR ACTION:

1. Inspect and adjust lift cylinder hoses. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.
   Are the hoses in good condition and adjusted correctly?
   YES: Go to CAUSE D.
   NO: Adjust or replace hoses as required.

CAUSE D - HYDRAULIC RELIEF PRESSURE SET TOO HIGH

PROCEDURE OR ACTION:

1. Test hydraulic relief pressure. See Main System Relief Test and Adjustment. Depending on your lift truck see, **Main Control Valves** 2000SRM1334 or **Main Control Valves** 2000SRM1439.
   Is pressure within test specifications?
   YES: Go to CAUSE E.
   NO: Adjust pressure to test specifications. See Primary Relief Valve Test and Adjustment.

CAUSE E - TOO HIGH/LOW HYDRAULIC OIL TEMPERATURE

NOTE: See **Operating Manual**.

PROCEDURE OR ACTION:

1. Insure that hydraulic oil temperature is within the recommended operating range for the lift truck.

END SYMPTOM

Abnormal Mast Noise

POSSIBLE CAUSE

A. MAST DAMAGED
B. LOOSE OR MISSING MAST MOUNTING HARDWARE
C. LOOSE FORK FIT TO CARRIAGE
D. DAMAGED CHAIN SHEAVES
E. AIR IN HYDRAULIC SYSTEM
F. MAST CHANNELS LACK LUBRICATION
G. MAST MOUNTING BUSHINGS LACK LUBRICATION OR DAMAGED
H. MAST TILT BUSHINGS LACK LUBRICATION OR DAMAGED
I. CHAINS LOOSE OR NOT EQUAL
J. WORN LOAD ROLLERS OR STRIP BEARINGS
K. MAST CHANNELS ARE WORN
L. NOISY LIFT CYLINDER SEALS

CAUSE A - MAST DAMAGED

NOTE: See **Operating Manual**.

PROCEDURE OR ACTION:

1. Visually inspect mast for damage.
   Is the mast in good condition?
   YES: Go to CAUSE B.
   NO: Repair or replace damaged components. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.

CAUSE B - LOOSE OR MISSING MAST MOUNTING HARDWARE

PROCEDURE OR ACTION:

1. Inspect mast mounting hardware.
   Is hardware in good condition and torqued correctly?
   YES: Go to CAUSE C.
   NO: Replace mast mounting hardware. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.

CAUSE C - LOOSE FORK FIT TO CARRIAGE

PROCEDURE OR ACTION:

1. Inspect carriage bar and fork hooks for wear.
   Do forks fit correctly and in good condition?
   YES: Go CAUSE D.
   NO: Replace carriage or forks if worn. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.

CAUSE D - DAMAGED CHAIN SHEAVES

PROCEDURE OR ACTION:

1. Inspect chain sheaves.
   Do chain sheaves rotate freely without noise?
   YES: Go to CAUSE E.
   NO: Replace chain sheaves. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.

CAUSE E - AIR IN HYDRAULIC SYSTEM

PROCEDURE OR ACTION:

1. Inspect oil condition and level in hydraulic tank.
   Is the hydraulic oil level in the operating range and in good condition?
   YES: CAUSE F.
   NO: If oil level is low, add oil. If hydraulic oil is aerated, locate source of suction side leak and repair.

CAUSE F - MAST CHANNELS LACK LUBRICATION

PROCEDURE OR ACTION:

1. Inspect grease on mast channels.
   Is a thin coat of grease spread evenly on channels?
   YES: Go to CAUSE G.
   NO: Apply grease to mast sliding surfaces. Depending on your lift truck see, **Periodic Maintenance** 8000SRM1364, **Periodic Maintenance** 8000SRM1372, **Periodic Maintenance** 8000SRM1339, **Periodic Maintenance** 8000SRM1373, or **Periodic Maintenance** 8000SRM1442.

CAUSE G - MAST MOUNTING BUSHINGS LACK LUBRICATION OR DAMAGED

PROCEDURE OR ACTION:

1. Inspect mast bushings. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.
   Are the mast bushings greased and in good condition?
   YES: Go CAUSE H.
   NO: Lubricate mast bushings. Depending on your lift truck see, **Periodic Maintenance** 8000SRM1364, **Periodic Maintenance** 8000SRM1372, **Periodic Maintenance** 8000SRM1339, **Periodic Maintenance** 8000SRM1373, or **Periodic Maintenance** 8000SRM1442.

CAUSE H - MAST TILT BUSHINGS LACK LUBRICATION OR DAMAGED

PROCEDURE OR ACTION:

1. Inspect mast tilt bushings. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.
   Are the mast tilt bushings greased and in good condition?
   YES: Go to CAUSE I.
   NO: Lubricate mast tilt bushings. Replace as required. Depending on your lift truck see, **Periodic Maintenance** 8000SRM1364, **Periodic Maintenance** 8000SRM1372, **Periodic Maintenance** 8000SRM1339, **Periodic Maintenance** 8000SRM1373, or **Periodic Maintenance** 8000SRM1442.

CAUSE I - CHAINS LOOSE OR NOT EQUAL

PROCEDURE OR ACTION:

1. Inspect chains. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.
   Are chains adjusted correctly and in good condition?
   YES: Go to CAUSE J.
   NO: Adjust or repair chains. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.

CAUSE J - WORN LOAD ROLLERS OR STRIP BEARINGS

PROCEDURE OR ACTION:

1. Inspect load rollers and strip bearings. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.
   Are the load rollers and strip bearings in good condition?
   YES: Go to CAUSE K.
   NO: Adjust, repair, or replace load rollers and strip bearings as required.

CAUSE K - MAST CHANNELS ARE WORN

PROCEDURE OR ACTION:

1. Inspect mast channels for wear or damage. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.
   Are the mast channels in good condition?
   YES: Go to CAUSE L.
   NO: Repair or replace worn mast components.

CAUSE L - NOISY LIFT CYLINDER SEALS

NOTE: Confirm that correct hydraulic oil is being used, see **Operating Manual**.

PROCEDURE OR ACTION:

1. On 2-Stage LFL, 3-Stage FFL, and 4-Stage FFL, apply thin film of hydraulic oil on cylinder rods.
   Does the noise stop?
   YES: Remove gland and add hydraulic oil. Depending on your lift truck see, **Periodic Maintenance** 8000SRM1364, **Periodic Maintenance** 8000SRM1372, **Periodic Maintenance** 8000SRM1339, **Periodic Maintenance** 8000SRM1373, or **Periodic Maintenance** 8000SRM1442.
   NO: Install new cylinder seal. Depending on your lift truck see, **Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564)** 2100SRM1382 or **Cylinder Repair (Mast S/N B551, B555, B559)** 2100SRM1440.

END SYMPTOM

Body Panels Making Noise

POSSIBLE CAUSE

A. ATTACHING HARDWARE IS LOOSE
B. FAILED LATCHES OR HINGES

CAUSE A - ATTACHING HARDWARE IS LOOSE

PROCEDURE OR ACTION:

1. Visually inspect mounting points for damage and loose or missing hardware. Depending on your lift truck see, **Periodic Maintenance** 8000SRM1364, **Periodic Maintenance** 8000SRM1372, **Periodic Maintenance** 8000SRM1339, **Periodic Maintenance** 8000SRM1373, or **Periodic Maintenance** 8000SRM1442.
   Are body panels and attaching hardware in good condition?
   YES: Inspect and repair hinges and latches. Go to CAUSE B.
   NO: Repair or replace damaged components. Depending on your lift truck, see **Frame** 0100SRM1329 or **Frame** 0100SRM1342.

CAUSE B - FAILED LATCHES OR HINGES

PROCEDURE OR ACTION:

1. Inspect hinges and latches for correct operation.
   Are the hinges and latches in good condition?
   YES: Operating lift truck too fast on rough surface, reduce speed.
   NO: Adjust or repair latches and hinges as required. Depending on your lift truck, see **Frame** 0100SRM1329 or **Frame** 0100SRM1342.

END SYMPTOM

External Leakage From Free-Lift or Main Lift Cylinders

POSSIBLE CAUSE

A. **MAST DAMAGED**
B. **CYLINDER HOSES OR FITTINGS LOOSE OR DAMAGED**
C. **CYLINDER SEAL DAMAGE OR INCORRECT INSTALLATION**
D. **CYLINDER ROD DAMAGE**

CAUSE A - MAST DAMAGED

NOTE: See **Operating Manual**.

PROCEDURE OR ACTION:

1. Visually inspect mast for damage.
   Is the mast in good condition?
   YES: Go to CAUSE B.
   NO: Repair or replace damaged components. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.

CAUSE B - CYLINDER HOSES OR FITTINGS LOOSE OR DAMAGED

PROCEDURE OR ACTION:

1. Inspect hoses and fittings for damage and proper torque.
   Are hose and fittings in good condition and torqued correctly?
   YES: Go to CAUSE C.
   NO: Adjust or replace hoses or fittings as required. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.

CAUSE C - CYLINDER SEAL DAMAGE OR INCORRECT INSTALLATION

PROCEDURE OR ACTION:

1. Inspect lift cylinder seals.
   Are the seals in good condition and installed correctly?
   YES: Go to CAUSE D.
   NO: Adjust or replace seals as required. Depending on your lift truck see, **Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564)** 2100SRM1382 or **Cylinder Repair (Mast S/N B551, B555, B559)** 2100SRM1440.

CAUSE D - CYLINDER ROD DAMAGE

PROCEDURE OR ACTION:

1. Inspect cylinder rod for damage.
   Is cylinder rod in good condition?
   YES: Problem solved. Resume operations.
   NO: Replace cylinder rod or cylinder. Depending on your lift truck see, **Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564)** 2100SRM1382 or **Cylinder Repair (Mast S/N B551, B555, B559)** 2100SRM1440.

END SYMPTOM

FFL Mast Banging During Phasing

POSSIBLE CAUSE

A. **MAST DAMAGED**
B. **FREE-LIFT CYLINDER TOP STROKE CUSHIONING NOT OPERATING**
C. **MAIN CYLINDER CUSHION NOT OPERATING WHEN FULLY LOWERED**
D. **CARRIAGE BINDING IN INNER MAST**
E. **CARRIAGE CONTACTS STOP AT TOP OF INNER MAST**

CAUSE A - MAST DAMAGED

NOTE: See **Operating Manual**.

PROCEDURE OR ACTION:

1. Visually inspect mast for damage.
   Is the mast in good condition?
   YES: Go to CAUSE B.
   NO: Repair or replace damaged components. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.

CAUSE B - FREE-LIFT CYLINDER TOP STROKE CUSHIONING NOT OPERATING

PROCEDURE OR ACTION:

1. Confirm that cushioning oil is on top side of cylinder piston. Depending on your lift truck see, **Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564)** 2100SRM1382 or **Cylinder Repair (Mast S/N B551, B555, B559)** 2100SRM1440.
   Is cushioning oil level correct?
   YES: Go to CAUSE C.
   NO: Add oil.

CAUSE C - MAIN CYLINDER CUSHION NOT OPERATING WHEN FULLY LOWERED

PROCEDURE OR ACTION:

1. Operate lift lower and note speed as cylinder reached end of stroke.
   Does cylinder speed slow during final 25 mm (1.0 in.) of cylinder stroke?
   YES: Go to CAUSE D.
   NO: Repair or replace cylinder. Depending on your lift truck see, **Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564)** 2100SRM1382 or **Cylinder Repair (Mast S/N B551, B555, B559)** 2100SRM1440.

CAUSE D - CARRIAGE BINDING IN INNER MAST

PROCEDURE OR ACTION:

1. Observe carriage travels to the end of free lift cylinder stroke.
   Does the carriage go to end of free lift cylinder stroke?
   YES: Go to CAUSE E.
   NO: Shim carriage rollers. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.

CAUSE E - CARRIAGE CONTACTS STOP AT TOP OF INNER MAST

PROCEDURE OR ACTION:

1. Inspect free lift chains. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.
   Can lift chains be adjusted?
   YES: Adjust chains.
   NO: Replace free lift chains. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.

END SYMPTOM

High Tire Wear - Drive Axle

POSSIBLE CAUSE

A. RUNNING OVER OIL/SOLVENTS AND DEBRIS
B. LOW PNEUMATIC TIRE INFLATION
C. HIGH PNEUMATIC TIRE INFLATION
D. EXCESSIVE SPEED ON TURNS AND STOPS
E. EXCESSIVE LOADS
F. FAILED WHEEL BEARINGS

CAUSE A - RUNNING OVER OIL/SOLVENTS AND DEBRIS

PROCEDURE OR ACTION:

1. Visually inspect work area for contaminates and debris.

CAUSE B - LOW PNEUMATIC TIRE INFLATION

PROCEDURE OR ACTION:

1. Check and adjust tire inflation. See **Operating Manual**.

CAUSE C - HIGH PNEUMATIC TIRE INFLATION

PROCEDURE OR ACTION:

1. Check and adjust tire inflation. See **Operating Manual**.

CAUSE D - EXCESSIVE SPEED ON TURNS AND STOPS

PROCEDURE OR ACTION:

1. Reduce speed and spinning of wheels.

CAUSE E - EXCESSIVE LOADS

NOTE: See Serial Number plate or **Operating Manual** for lift capacity.

PROCEDURE OR ACTION:

1. Check load weight and compare to truck capacity rating.

CAUSE F - FAILED WHEEL BEARINGS

PROCEDURE OR ACTION:

1. Inspect wheel bearings.
   Are bearings in good condition?
   YES: Tires are defective. See tire manufacture for warranty.
   NO: Replace wheel bearing. Depending on your lift truck, see **Transaxle** 1300SRM1330, **Transaxle** 1300SRM1370, or **Drive Axle, Speed Reducer, and Differential** 1300SRM1366.

END SYMPTOM

High Tire Wear - Steer Axle

POSSIBLE CAUSE

A. RUNNING OVER OIL/SOLVENTS AND DEBRIS
B. EXCESSIVE SPEED ON TURNS AND STOPS
C. TURNING WITH MACHINE STOPPED OR NO LOAD ON FORKS
D. LOW PNEUMATIC TIRE INFLATION
E. HIGH PNEUMATIC TIRE INFLATION
F. FAILED WHEEL BEARINGS
G. LOOSE TIE RODS

CAUSE A - RUNNING OVER OIL/SOLVENTS AND DEBRIS

PROCEDURE OR ACTION:

1. Visually inspect work area for contaminates and debris.

CAUSE B - EXCESSIVE SPEED ON TURNS AND STOPS

PROCEDURE OR ACTION:

1. Reduce speed and spinning of wheels.

CAUSE C - TURNING WITH MACHINE STOPPED OR NO LOAD ON FORKS

PROCEDURE OR ACTION:

NOTE: Steering without load on forks puts the highest load on steer axle because of counterweight. Avoid steering wheels when not moving to reduce tire wear.

1. Steer while moving whenever possible.

CAUSE D - LOW PNEUMATIC TIRE INFLATION

PROCEDURE OR ACTION:

1. Check and adjust tire inflation. See **Operating Manual**.

CAUSE E - HIGH PNEUMATIC TIRE INFLATION

PROCEDURE OR ACTION:

1. Check and adjust tire inflation. See **Operating Manual**.

CAUSE F - FAILED WHEEL BEARINGS

PROCEDURE OR ACTION:

1. Inspect wheel bearings.
   Are bearings in good condition?
   YES: Tires are defective. See tire manufacturer for warranty.
   NO: Replace wheel bearing. Depending on your lift truck, see **Transaxle** 1300SRM1330 or **Steering Axle** 1600SRM1360.

CAUSE G - LOOSE TIE RODS

PROCEDURE OR ACTION:

1. Inspect joint where tie rods are attached to pinion assembly.
   Is the tie rod tight in bore?
   YES: See wheels appear to be tipped or misaligned.
   NO: Replace tie rod. Depending on your lift truck, see **Transaxle** 1300SRM1330 or **Steering Axle** 1600SRM1360.

END SYMPTOM

Hoses Not Tracking Correctly

POSSIBLE CAUSE

A. MAST DAMAGED
B. IMPROPER HOSE TENSION
C. IMPROPER HOSE ROUTING
D. HOSES WORN

CAUSE A - MAST DAMAGED

NOTE: See **Operating Manual**.

PROCEDURE OR ACTION:

1. Visually inspect mast for damage.
   Is the mast in good condition?
   YES: Go to CAUSE B.
   NO: Repair or replace damaged components. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.

CAUSE B - IMPROPER HOSE TENSION

PROCEDURE OR ACTION:

1. Check hose tension. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.
   Is hose tension correct?
   YES: Go to CAUSE C.
   NO: Adjust hose tension.

CAUSE C - IMPROPER HOSE ROUTING

PROCEDURE OR ACTION:

1. Inspect lift cylinder hoses. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.
   Are the hoses in good condition and adjusted correctly?
   YES: Go to CAUSE D.
   NO: Adjust or replace hoses as required.

CAUSE D - HOSES WORN

PROCEDURE OR ACTION:

1. Inspect hoses for uneven or excessive wear.
   Are hoses wearing evenly?
   YES: Locate cause of hoses wear. See Observed Symptoms, Abnormal Hose Wear, Page 9070-30-4.
   NO: Adjust or replace hoses as required. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.

END SYMPTOM

Integral Sideshift Moving Too Fast

POSSIBLE CAUSE

A. ORIFICES IN SIDESHIFT CYLINDER MISSING OR INSTALLED BACKWARD
B. ELECTRO-HYDRAULIC CONTROL VALVE OUT OF CALIBRATION

CAUSE A - ORIFICES IN SIDESHIFT CYLINDER MISSING OR INSTALLED BACKWARD

PROCEDURE OR ACTION:

CAUTION
Cylinder orifices are made from soft metal and can be easily damaged. Do not alter cylinder orifice size while cleaning.

1. Inspect cylinder port orifices. Depending on your lift truck see, **Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564)** 2100SRM1382 or **Cylinder Repair (Mast S/N B551, B555, B559)** 2100SRM1440.
   Are the orifices clean and installed correctly?
   YES: Reduce engine speed or control lever speed of movement to slow function. See **Parts Manual** to see if smaller size orifices are available.
   NO: Adjust or install orifices.

CAUSE B - ELECTRO-HYDRAULIC CONTROL VALVE OUT OF CALIBRATION

PROCEDURE OR ACTION:

1. Check electro-hydraulic control valve calibration. Install Service Tool.
   Is valve calibration correct?
   YES: Calibrate valve to operator's preference or reduce engine speed to slow function.
   NO: Resume operation.

END SYMPTOM

Integral Sideshift Not Moving or Slow

POSSIBLE CAUSE

A. NO OIL OR NOT ENOUGH OIL IN HYDRAULIC TANK
B. LINKAGE TO CONTROL VALVE DISCONNECTED OR DAMAGED (MANUAL CONTROL VALVE)
C. WIRING CONNECTOR LOOSE OR DISCONNECTED ON CONTROL VALVE (E-VALVE)
D. INTEGRAL SIDESHIFT CARRIAGE DAMAGED
E. CLAMP BLOCKS TOO TIGHT
F. CONTAMINATION OR LACK OF LUBRICATION IS BINDING BEARINGS
G. DAMAGED CARRIAGE BEARINGS
H. HOSES NOT INSTALLED CORRECTLY
I. NO OIL FLOW TO SIDESHIFT CYLINDER
J. INCORRECT HYDRAULIC RELIEF PRESSURE SETTING
K. INSUFFICIENT OIL FLOW TO CYLINDER
L. DEFECTIVE SIDESHIFT CYLINDER

CAUSE A - NO OIL OR NOT ENOUGH OIL IN HYDRAULIC TANK

NOTE: See **Operating Manual**.

PROCEDURE OR ACTION:

1. Check hydraulic tank oil level and adjust as required.

CAUSE B - LINKAGE TO CONTROL VALVE DISCONNECTED OR DAMAGED (MANUAL CONTROL VALVE)

PROCEDURE OR ACTION:

1. Inspect valve linkage.
   Is the linkage moving the valve spool full travel?
   YES: Go to CAUSE D.
   NO: Repair or adjust linkage. Depending on your lift truck see, **Main Control Valves** 2000SRM1334 or **Main Control Valves** 2000SRM1439.

CAUSE C - WIRING CONNECTOR LOOSE OR DISCONNECTED ON CONTROL VALVE (E-VALVE)

PROCEDURE OR ACTION:

1. Inspect wiring connections at valve and MLM controller.
   Are the connectors in good condition and installed correctly?
   YES: Go to CAUSE D.
   NO: Repair or replace wiring connectors. See **Wire Harness Repair** 2200SRM1128.

CAUSE D - INTEGRAL SIDESHIFT CARRIAGE DAMAGED

NOTE: See **Operating Manual**.

PROCEDURE OR ACTION:

1. Visually inspect carriage for damage.
   Is the carriage in good condition?
   YES: Go to CAUSE E.
   NO: Repair or replace damaged components. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.

CAUSE E - CLAMP BLOCKS TOO TIGHT

PROCEDURE OR ACTION:

1. Adjust clamp blocks. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.

CAUSE F - CONTAMINATION OR LACK OF LUBRICATION IS BINDING BEARINGS

PROCEDURE OR ACTION:

1. Inspect bearings. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.
   Are bearings worn or need lubrication?
   YES: Lubricate or replace bearings.
   NO: Go to CAUSE G.

CAUSE G - DAMAGED CARRIAGE BEARINGS

PROCEDURE OR ACTION:

1. Disassemble outer frame. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.
   Are bearings in good condition?
   YES: Go to CAUSE H.
   NO: Service or replace bearings.

CAUSE H - HOSES NOT INSTALLED CORRECTLY

NOTE: Check maintenance records to determine last repairs done to truck.

PROCEDURE OR ACTION:

1. Inspect hose routing and connections. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.
   Are hoses adjusted correctly and in good condition?
   YES: Go to CAUSE I.
   NO: Adjust or repair hoses.

CAUSE I - NO OIL FLOW TO SIDESHIFT CYLINDER

PROCEDURE OR ACTION:

1. Remove pin from rod end of cylinder. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.
2. Slowly operate sideshift cylinder control and observe cylinder rod movement.
   Does the cylinder rod move when controls are activated?
   YES: Install cylinder rod pin. Go to CAUSE J.
   NO: Determine if problem is in cylinder or control valve. Go to CAUSE K.

CAUSE J - INCORRECT HYDRAULIC RELIEF PRESSURE SETTING

PROCEDURE OR ACTION:

1. Test secondary relief valve pressure. Depending on your lift truck see, **Main Control Valves** 2000SRM1334 or **Main Control Valves** 2000SRM1439.
   Is the secondary relief pressure at specifications?
   YES: Go to CAUSE K.
   NO: Adjust or replace secondary relief valve.

CAUSE K - INSUFFICIENT OIL FLOW TO CYLINDER

PROCEDURE OR ACTION:

1. Perform Cycle Times. Depending on your lift truck, see **Capacities and Specifications** 8000SRM1340, **Capacities and Specifications** 8000SRM1374, **Capacities and Specifications** 8000SRM1376, **Capacities And Specifications** 8000SRM1375, or **Capacities and Specifications** 8000SRM1443.
   Is the sideshift the only hydraulic function that is slow.
   YES: Go to Step 2.
   NO: Problem is in hydraulic pump circuit. See Hydraulic Pump Flow Test.
2. Check electro-hydraulic control valve calibration. Install Service Tool.
   Is valve calibration correct?
   YES: Go to CAUSE L.
   NO: Calibrate valve to operator's preference. Depending on your lift truck see, **Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564)** 2100SRM1382 or **Cylinder Repair (Mast S/N B551, B555, B559)** 2100SRM1440.

CAUSE L - DEFECTIVE SIDESHIFT CYLINDER

PROCEDURE OR ACTION:

CAUTION

Cylinder orifices are made from soft metal and can be easily damaged. Do not alter cylinder orifice size while cleaning.

1. Inspect and clean cylinder port orifices. Depending on your lift truck see, **Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564)** 2100SRM1382 or **Cylinder Repair (Mast S/N B551, B555, B559)** 2100SRM1440.
   Are the orifices clean and installed correctly?
   YES: Remove and repair cylinder.
   NO: Adjust or replace orifices.

END SYMPTOM

Fork Positioner Not Moving or Slow

POSSIBLE CAUSE

A. NO OIL OR NOT ENOUGH OIL IN HYDRAULIC TANK
B. LINKAGE TO CONTROL VALVE DISCONNECTED OR DAMAGED (MANUAL CONTROL VALVE)
C. HYDRAULIC CONTROL VALVE CALIBRATED WRONG (E-VALVE)
D. WIRING CONNECTOR LOOSE OR DISCONNECTED ON CONTROL VALVE (E-VALVE)
E. SIDESHIFT CARRIAGE DAMAGED
F. CONTAMINATION OR LACK OF LUBRICATION IS BINDING BEARINGS
G. DAMAGED CARRIAGE BEARINGS
H. HOSES NOT INSTALLED CORRECTLY
I. NO OIL FLOW TO FORK POSITIONER CYLINDER
J. INCORRECT HYDRAULIC RELIEF PRESSURE SETTING
K. INSUFFICIENT OIL FLOW TO CYLINDER
L. DEFECTIVE FORK POSITIONER CYLINDER

CAUSE A - NO OIL OR NOT ENOUGH OIL IN HYDRAULIC TANK

NOTE: See **Operating Manual**.

PROCEDURE OR ACTION:

1. Check hydraulic tank oil level and adjust as required.

CAUSE B - LINKAGE TO CONTROL VALVE DISCONNECTED OR DAMAGED (MANUAL CONTROL VALVE)

PROCEDURE OR ACTION:

1. Inspect valve linkage.
   Is the linkage moving the valve spool full travel?
   YES: Go to CAUSE E.
   NO: Repair or adjust linkage. Refer to the appropriate **Main Control Valve**SRM .

CAUSE C - HYDRAULIC CONTROL VALVE CALIBRATED WRONG (E-VALVE)

PROCEDURE OR ACTION:

1. Check electro-hydraulic control valve calibration. Install Service Tool.
   Is valve calibration correct?
   YES: Calibrate valve to operator's preference or reduce engine speed to slow function.
   NO: Calibrate valve to operator's preference. Refer to the appropriate **Calibration Procedures**SRM .

CAUSE D - WIRING CONNECTOR LOOSE OR DISCONNECTED ON CONTROL VALVE (E-VALVE)

PROCEDURE OR ACTION:

1. Inspect wiring connections at valve and joystick/MLM controller.
   Are the connectors in good condition and installed correctly?
   YES: Go to CAUSE E.
   NO: Repair or replace wiring connectors. Refer to the appropriate **Wire Harness Repair**SRM .

CAUSE E - SIDESHIFT CARRIAGE DAMAGED

NOTE: See **Operating Manual**.

PROCEDURE OR ACTION:

1. Visually inspect carriage for damage.
   Is the carriage in good condition?
   YES: Go to CAUSE F.
   NO: Repair or replace damaged components. Refer to the appropriate **Mast Repair**SRM .

CAUSE F - CONTAMINATION OR LACK OF LUBRICATION IS BINDING BEARINGS

PROCEDURE OR ACTION:

1. Inspect bearings. Refer to the appropriate **Mast Repair**SRM .
   Are bearings worn or need lubrication?
   YES: Lubricate or replace bearings.
   NO: Go to CAUSE G.

CAUSE G - DAMAGED CARRIAGE BEARINGS

PROCEDURE OR ACTION:

1. Disassemble outer frame. Refer to the appropriate **Mast Repair**SRM .
   Are bearings in good condition?
   YES: Go to CAUSE H.
   NO: Service or replace bearings.

CAUSE H - HOSES NOT INSTALLED CORRECTLY

NOTE: Check maintenance records to determine last repairs done to truck.

PROCEDURE OR ACTION:

1. Inspect hose routing and connections. Refer to the appropriate **Mast Repair**SRM .
   Are hoses adjusted correctly and in good condition?
   YES: Go to CAUSE I.
   NO: Adjust or repair hoses.

CAUSE I - NO OIL FLOW TO FORK POSITIONER CYLINDER

PROCEDURE OR ACTION:

1. Remove pin from rod end of cylinder. Refer to the appropriate **Mast Repair**SRM .
2. Slowly operate sideshift cylinder control and observe cylinder rod movement.
   Does the cylinder rod move when controls are activated?
   YES: Install cylinder rod pin. Go to CAUSE J.
   NO: Determine if problem is in cylinder or control valve. Go to CAUSE K.

CAUSE J - INCORRECT HYDRAULIC RELIEF PRESSURE SETTING

PROCEDURE OR ACTION:

1. Test secondary relief valve pressure. Refer to the appropriate **Main Control Valve**SRM .
   Is the secondary relief pressure at specifications?
   YES: Go to CAUSE K.
   NO: Adjust or replace secondary relief valve.

CAUSE K - INSUFFICIENT OIL FLOW TO CYLINDER

PROCEDURE OR ACTION:

1. Perform Cycle Times. Refer to the appropriate **Capacities and Specifications**SRM .
   Is the sideshift the only hydraulic function that is slow.
   YES: Go to Step 2.
   NO: Problem is in hydraulic pump circuit. See Hydraulic Pump Flow Test.
2. Check electro-hydraulic control valve calibration. Install Service Tool.
   Is valve calibration correct?
   YES: Go to CAUSE L.
   NO: Calibrate valve to operator's preference. Refer to the appropriate **Calibration Procedures**SRM .

CAUSE L - DEFECTIVE FORK POSITIONER CYLINDER

PROCEDURE OR ACTION:

CAUTION

Cylinder orifices are made from soft metal and can be easily damaged. Do not alter cylinder orifice size while cleaning.

1. Inspect and clean cylinder port orifices. Refer to the appropriate **Cylinder Repair**SRM .
   Are the orifices clean and installed correctly?
   YES: Remove and repair cylinder.
   NO: Adjust or replace orifices.

END SYMPTOM

Mast is Loose

POSSIBLE CAUSE

A. MAST DAMAGED
B. LOOSE OR MISSING MAST MOUNTING HARDWARE
C. MAST NOT SHIMMED CORRECTLY
D. DAMAGED LOAD ROLLERS OR WORN STRIP BEARINGS
E. CHANNELS WORN

CAUSE A - MAST DAMAGED

NOTE: See **Operating Manual**.

PROCEDURE OR ACTION:

1. Visually inspect mast for damage.
   Is the mast in good condition?
   YES: Go to CAUSE B.
   NO: Repair or replace damaged components. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.

CAUSE B - LOOSE OR MISSING MAST MOUNTING HARDWARE

PROCEDURE OR ACTION:

1. Inspect mast mounting hardware.
   Is mounting hardware in good condition and torqued correctly?
   YES: Go to CAUSE C.
   NO: Replace mast mounting hardware. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.

CAUSE C - MAST NOT SHIMMED CORRECTLY

PROCEDURE OR ACTION:

1. Inspect mast shimming. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.
   Is the mast shimmed correctly?
   YES: Go to CAUSE D.
   NO: Shim or adjust as required.

CAUSE D - DAMAGED LOAD ROLLERS OR WORN STRIP BEARINGS

PROCEDURE OR ACTION:

1. Inspect load rollers and strip bearings. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.
   Are the load rollers and strip bearings in good condition?
   YES: Go to CAUSE E.
   NO: Adjust, repair, or replace load rollers and strip bearings as required. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.

CAUSE E - CHANNELS WORN

PROCEDURE OR ACTION:

1. Repair or replace mast components. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.

END SYMPTOM

Mast Lift Chains Are Loose

POSSIBLE CAUSE

A. MAST DAMAGED
B. DAMAGED CHAIN SHEAVES
C. INCORRECT CHAIN ADJUSTMENT

CAUSE A - MAST DAMAGED

NOTE: See **Operating Manual**.

PROCEDURE OR ACTION:

1. Visually inspect mast for damage.
   Is the mast in good condition?
   YES: Go to CAUSE C.
   NO: Repair or replace damaged components. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.

CAUSE B - DAMAGED CHAIN SHEAVES

PROCEDURE OR ACTION:

1. Inspect chain sheaves.
   Do chain sheaves rotate freely without noise?
   YES: Go to CAUSE C.
   NO: Replace chain sheaves. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.

CAUSE C - INCORRECT CHAIN ADJUSTMENT

PROCEDURE OR ACTION:

1. Inspect lift chains. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.
   Are the chains in good condition and adjusted correctly?
   YES: See Observed Symptoms, Mast or Carriage Binding, Page 9070-30-31.
   NO: Adjust or replace chain.

END SYMPTOM

Mast or Carriage Binding

POSSIBLE CAUSE

A. MAST OR CARRIAGE DAMAGED
B. MAST CHANNELS LACK LUBRICATION
C. MAST NOT SHIMMED CORRECTLY
D. CHAINS ARE LOOSE OR NOT EQUAL
E. CONTAMINATION IN CHANNELS IS BINDING LOAD ROLLERS
F. DAMAGED OR WORN LOAD ROLLERS OR STRIP BEARINGS
G. LIFT CYLINDER BINDING

CAUSE A - MAST OR CARRIAGE DAMAGED

NOTE: See **Operating Manual**.

PROCEDURE OR ACTION:

1. Visually inspect mast and carriage for damage.
   Are components in good condition?
   YES: Go to CAUSE B.
   NO: Repair or replace damaged components. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.

CAUSE B - MAST CHANNELS LACK LUBRICATION

PROCEDURE OR ACTION:

1. Inspect grease on mast channels.
   Is a thin coat of grease spread evenly on channels?
   YES: Go to CAUSE C.
   NO: Apply grease to mast sliding surfaces. Depending on your lift truck see, **Periodic Maintenance** 8000SRM1364, **Periodic Maintenance** 8000SRM1372, **Periodic Maintenance** 8000SRM1339, **Periodic Maintenance** 8000SRM1373, or **Periodic Maintenance** 8000SRM1442.

CAUSE C - MAST NOT SHIMMED CORRECTLY

PROCEDURE OR ACTION:

1. Inspect mast shimming. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.
   Is the mast shimmed correctly?
   YES: Go to CAUSE E.
   NO: Shim or adjust as required.

CAUSE D - CHAINS ARE LOOSE OR NOT EQUAL

PROCEDURE OR ACTION:

1. Inspect lift chains. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.
   Are chains adjusted correctly and in good condition?
   YES: Go to CAUSE E.
   NO: Adjust or repair chains. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.

CAUSE E - CONTAMINATION IN CHANNELS IS BINDING LOAD ROLLERS

PROCEDURE OR ACTION:

1. Inspect mast channels. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.
   Do the rollers rotate freely?
   YES: Go to CAUSE F.
   NO: Replace load rollers. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.

CAUSE F - DAMAGED OR WORN LOAD ROLLERS OR STRIP BEARINGS

PROCEDURE OR ACTION:

1. Inspect load rollers and strip bearings. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.
   Are the load rollers and strip bearings in good condition?
   YES: Go to CAUSE G.
   NO: Adjust, repair, or replace load rollers and strip bearings as required. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.

CAUSE G - LIFT CYLINDER BINDING

PROCEDURE OR ACTION:

1. Remove cylinder. Depending on your lift truck see, **Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564)** 2100SRM1382 or **Cylinder Repair (Mast S/N B551, B555, B559)** 2100SRM1440.
2. Manually extend cylinder exterior.
   Does cylinder extend freely?
   YES: Mast is loose. See Observed Symptoms, Mast is Loose, Page 9070-30-28.
   NO: Service or replace cylinder. Depending on your lift truck see, **Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564)** 2100SRM1382 or **Cylinder Repair (Mast S/N B551, B555, B559)** 2100SRM1440.

END SYMPTOM

Mast/Carriage Bounces or is Spongy

POSSIBLE CAUSE

A. MAST DAMAGED
B. AIR IN HYDRAULIC SYSTEM
C. TRAPPED AIR IN LIFT CYLINDER(S)
D. TWO-STAGE FFL MAST MAIN CYLINDERS NOT BLED OF AIR

CAUSE A - MAST DAMAGED

NOTE: See **Operating Manual**.

PROCEDURE OR ACTION:

1. Visually inspect mast for damage.
   Is the mast in good condition?
   YES: Go to CAUSE B.
   NO: Repair or replace damaged components. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.

CAUSE B - AIR IN HYDRAULIC SYSTEM

PROCEDURE OR ACTION:

1. Inspect oil condition and level in hydraulic tank.
   Is the hydraulic oil level in the operating range and in good condition?
   YES: Go to CAUSE C.
   NO:
   - If oil level is low, add oil.
   - If hydraulic oil is aerated, locate source of suction side leak and repair.

CAUSE C - TRAPPED AIR IN LIFT CYLINDER(S)

PROCEDURE OR ACTION:

1. Fully extend and lower the mast several times.
   Does the mast raise and lower without hesitation?
   YES: Go to CAUSE D.
   NO: Go to Step 2.
2. Open mast, lower valve, and operate all hydraulic functions in both directions.
3. Close mast lower valve.
4. Repeat Step 1 to see if problem has been solved.

CAUSE D - TWO-STAGE FFL MAST MAIN CYLINDERS NOT BLED OF AIR

PROCEDURE OR ACTION:

1. Bleed air from cylinders. Depending on your lift truck see, **Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564)** 2100SRM1382 or **Cylinder Repair (Mast S/N B551, B555, B559)** 2100SRM1440.

END SYMPTOM

Misphasing of Full Free-Lift Mast

POSSIBLE CAUSE

A. MAST DAMAGED
B. COLD OPERATING CONDITIONS
C. CARRIAGE IS BINDING
D. HYDRAULIC RESTRICTION TO FREE-LIFT CYLINDER
E. EXCESSIVE OIL ON TOP SIDE OF FREE-LIFT CYLINDER PISTON

CAUSE A - MAST DAMAGED

NOTE: See **Operating Manual**.

PROCEDURE OR ACTION:

1. Visually inspect mast for damage.
   Is the mast in good condition?
   YES: Go to CAUSE B.
   NO: Repair or replace damaged components. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.

CAUSE B - COLD OPERATING CONDITIONS

NOTE: See **Operating Manual**.

PROCEDURE OR ACTION:

1. Confirm that oil is at correct operating temperature. See Hydraulic Warm-up Procedure.
   Does mast misphase after oil is at operating temperature?
   YES: Go to CAUSE C.
   NO: Incorrect hydraulic oil is being used. Consult **Operating Manual** for correct grade of hydraulic oil for your operating conditions.

CAUSE C - CARRIAGE IS BINDING

PROCEDURE OR ACTION:

1. Check carriage shimming. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.
   Is carriage shimmed correctly?
   YES: Go to CAUSE D.
   NO: Adjust or repair carriage. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.

CAUSE D - HYDRAULIC RESTRICTION TO FREE-LIFT CYLINDER

PROCEDURE OR ACTION:

1. Visually inspect hoses and fittings for damage
   Are hoses and fitting in good condition?
   YES: Go to CAUSE E.
   NO: Replace damaged hoses and fittings. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.

CAUSE E - EXCESSIVE OIL ON TOP SIDE OF FREE-LIFT CYLINDER PISTON

PROCEDURE OR ACTION:

1. Raise mast to full lift height without load and hold at relief pressure for 5 seconds.
2. Recheck for misphasing.
   Does the mast still misphase?
   YES: Remove cylinder, check piston seal, and check valve. Depending on your lift truck see, **Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564)** 2100SRM1382 or **Cylinder Repair (Mast S/N B551, B555, B559)** 2100SRM1440.
   NO: Problem solved.

END SYMPTOM

Overhead Guard Loose or Damaged

POSSIBLE CAUSE

A. OVERHEARD GUARD DAMAGED
B. ATTACHING HARDWARE IS LOOSE
C. OPERATING TOO FAST OVER ROUGH FLOORS

CAUSE A - OVERHEARD GUARD DAMAGED

PROCEDURE OR ACTION:

WARNING

Death or injury can occur from falling objects. Do not operate lift truck with a damaged overhead guard.

1. Inspect overhead guard. Depending on your lift truck see, **Periodic Maintenance** 8000SRM1364, **Periodic Maintenance** 8000SRM1372, **Periodic Maintenance** 8000SRM1339, **Periodic Maintenance** 8000SRM1373, or **Periodic Maintenance** 8000SRM1442.
   Is the overhead guard in good condition?
   YES: Go to CAUSE B.
   NO: Replace overhead guard. Depending on your lift truck, see **Frame** 0100SRM1329 or **Frame** 0100SRM1342.

CAUSE B - ATTACHING HARDWARE IS LOOSE

PROCEDURE OR ACTION:

1. Visually inspect mounting points for damage and loose or missing hardware. Depending on your lift truck see, **Periodic Maintenance** 8000SRM1364, **Periodic Maintenance** 8000SRM1372, **Periodic Maintenance** 8000SRM1339, **Periodic Maintenance** 8000SRM1373, or **Periodic Maintenance** 8000SRM1442.
   Is overhead guard and attaching hardware in good condition?
   YES: Go to CAUSE C.
   NO: Repair or replace damaged components. Depending on your lift truck, see **Frame** 0100SRM1329 or **Frame** 0100SRM1342.

CAUSE C - OPERATING TOO FAST OVER ROUGH FLOORS

PROCEDURE OR ACTION:

1. Reduce speed and listen for noise.
   Does noise reduce with reduction in ground speed?
   YES: Reduce speed or install softer tires.
   NO: Depending on your lift truck, see **Frame** 0100SRM1329 or **Frame** 0100SRM1342.

END SYMPTOM

Racking During Lift

POSSIBLE CAUSE

A. MAST DAMAGED
B. MAIN LIFT CYLINDER NOT SHIMMED CORRECTLY
C. MAIN LIFT CYLINDER CHAINS LOOSE OR UNEQUAL
D. UNEQUAL MAIN LIFT CYLINDER ROD STROKE
E. LIFT CYLINDER BINDING

CAUSE A - MAST DAMAGED

NOTE: See **Operating Manual**.

PROCEDURE OR ACTION:

1. Visually inspect mast for damage.
   Is the mast in good condition?
   YES: Go to CAUSE B.
   NO: Repair or replace damaged components. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.

CAUSE B - MAIN LIFT CYLINDER NOT SHIMMED CORRECTLY

PROCEDURE OR ACTION:

1. Check cylinder shimming. Depending on your lift truck see, **Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564)** 2100SRM1382 or **Cylinder Repair (Mast S/N B551, B555, B559)** 2100SRM1440.
   Is cylinder shimmed correctly?
   YES: Go to CAUSE C.
   NO: Adjust or repair cylinder.

CAUSE C - MAIN LIFT CYLINDER CHAINS LOOSE OR UNEQUAL

PROCEDURE OR ACTION:

1. Check chains. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.
   Are the chains adjusted correctly?
   YES: Go to CAUSE D.
   NO: Adjust or replace chains.

CAUSE D - UNEQUAL MAIN LIFT CYLINDER ROD STROKE

PROCEDURE OR ACTION:

1. Operate lift and compare each cylinder rod stroke.
   Are the cylinder rod strokes equal?
   YES: Go to CAUSE E.
   NO: Replace cylinder or cylinders spacers (if equipped). Depending on your lift truck see, **Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564)** 2100SRM1382 or **Cylinder Repair (Mast S/N B551, B555, B559)** 2100SRM1440.

CAUSE E - LIFT CYLINDER BINDING

PROCEDURE OR ACTION:

1. Remove cylinder. Depending on your lift truck see, **Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564)** 2100SRM1382 or **Cylinder Repair (Mast S/N B551, B555, B559)** 2100SRM1440.
2. Manually extend cylinder.
   Does cylinder extend freely?
   YES: Cylinder is OK. See Observed Symptoms, Mast is Loose, Page 9070-30-28.
   NO: Repair or replace cylinder. Depending on your lift truck see, **Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564)** 2100SRM1382 or **Cylinder Repair (Mast S/N B551, B555, B559)** 2100SRM1440.

END SYMPTOM

Racking During Tilt

POSSIBLE CAUSE

A. MAST DAMAGED
B. TILT ROD OUT OF ADJUSTMENT
C. UNEQUAL LENGTH OF BACK TILT SPACERS

CAUSE A - MAST DAMAGED

NOTE: See **Operating Manual**.

PROCEDURE OR ACTION:

1. Visually inspect mast for damage.
   Is the mast in good condition?
   YES: Go to CAUSE B.
   NO: Repair or replace damaged components. Depending on your lift truck see, **Mast Repair (S/N A270, A271, A272)** 4000SRM1386, **Mast Repair (S/N C661, C662, C663, C665)** 4000SRM1405, **Mast Repair (S/N A551, A555, A559, B551, B555, D507, D562, D508, D563, D509, D564, D515, E509, E564)** 4000SRM1338, or **Mast Repair (S/N B551, B555, and B559)** 4000SRM1441.

CAUSE B - TILT ROD OUT OF ADJUSTMENT

PROCEDURE OR ACTION:

1. Inspect tilt rod. Depending on your lift truck see, **Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564)** 2100SRM1382 or **Cylinder Repair (Mast S/N B551, B555, B559)** 2100SRM1440.
   Is tilt rod adjusted correctly?
   YES: Go to CAUSE C.
   NO: Adjust tilt rod.

CAUSE C - UNEQUAL LENGTH OF BACK TILT SPACERS

PROCEDURE OR ACTION:

1. Inspect length of spacers. Depending on your lift truck see, **Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564)** 2100SRM1382 or **Cylinder Repair (Mast S/N B551, B555, B559)** 2100SRM1440.
   Are back tilt spacers equal?
   YES: Mast is too loose. See Observed Symptoms, Mast is Loose, Page 9070-30-28.
   NO: Adjust or replace spacers. Depending on your lift truck see, **Cylinder Repair (Mast S/N A270-72, A551, A555, A559, A626, A627, A751-52, B551, B555, B586-91, B749-54, C661-63, C665, D507-09, D515, D562-64, E509, E564)** 2100SRM1382 or **Cylinder Repair (Mast S/N B551, B555, B559)** 2100SRM1440.

END SYMPTOM

Truck Feels Unstable

POSSIBLE CAUSE

A. OPERATING WITH TOO LARGE A LOAD
B. LOW PNEUMATIC TIRE INFLATION
C. LOAD IS BEING CARRIED TOO HIGH
D. OPERATING AT TOO HIGH A SPEED
E. OPERATING OFF HARD SURFACES
F. MAST IS TOO LOOSE

CAUSE A - OPERATING WITH TOO LARGE A LOAD

NOTE: See Serial Number plate or **Operating Manual** for lift capacity.

PROCEDURE OR ACTION:

NOTE: Carrying a load that exceeds truck capacity will cause the steer axle wheels to loose contact with ground and negatively affect control of truck.

1. Check load weight and compare to truck capacity rating.

CAUSE B - LOW PNEUMATIC TIRE INFLATION

PROCEDURE OR ACTION:

1. Check and adjust tire inflation. See **Operating Manual**.

CAUSE C - LOAD IS BEING CARRIED TOO HIGH

PROCEDURE OR ACTION:

1. Carry load as low as possible to lower center of gravity and improve stability.

CAUSE D - OPERATING AT TOO HIGH A SPEED

PROCEDURE OR ACTION:

1. See **Operating Manual** for correct operating speeds.

CAUSE E - OPERATING OFF HARD SURFACES

PROCEDURE OR ACTION:

1. Operate truck only on hard surfaces.

CAUSE F - MAST IS TOO LOOSE

PROCEDURE OR ACTION:

1. See Observed Symptoms, Mast is Loose, Page 9070-30-28.

END SYMPTOM

Truck Wanders, Does Not Track Straight or Steer Well

POSSIBLE CAUSE

A. EXCESSIVE LOADS
B. LOW PNEUMATIC TIRE INFLATION
C. HIGH PNEUMATIC TIRE INFLATION
D. DAMAGED UPPER AXLE MOUNTING EAR
E. STEERING VALVE PROBLEM

CAUSE A - EXCESSIVE LOADS

NOTE: See Serial Number plate or **Operating Manual** for lift capacity.

PROCEDURE OR ACTION:

NOTE: Carrying a load that exceeds truck capacity will cause the steer axle wheels to loose contact with ground and negatively affect control of truck.

1. Check load weight and compare to truck capacity rating.

CAUSE B - LOW PNEUMATIC TIRE INFLATION

PROCEDURE OR ACTION:

1. Check and adjust tire inflation. See **Operating Manual**.

CAUSE C - HIGH PNEUMATIC TIRE INFLATION

PROCEDURE OR ACTION:

1. Check and adjust tire inflation. See **Operating Manual**.

CAUSE D - DAMAGED UPPER AXLE MOUNTING EAR

PROCEDURE OR ACTION:

NOTE: The upper axle ear can be bent if lift truck suddenly drops its load while rear steer axle wheels are off the ground.

1. Inspect axle pinion bearings vertical movement.
   Does pinion bearings have excessive endplay?
   YES: Replace axle. Depending on your lift truck, see **Transaxle** 1300SRM1330 or **Steering Axle** 1600SRM1360.
   NO: Go to CAUSE E.

CAUSE E - STEERING VALVE PROBLEM

PROCEDURE OR ACTION:

1. Check steering hydraulics. Perform Steering Control Unit LS Pressure Test.

END SYMPTOM

Wheel Studs Breaking

POSSIBLE CAUSE

A. ATTACHING HARDWARE IS LOOSE
B. WHEEL STUDS ARE OVER TORQUED

CAUSE A - ATTACHING HARDWARE IS LOOSE

PROCEDURE OR ACTION:

1. Visually inspect wheel studs for damage and loose or missing hardware. Depending on your lift truck see, **Periodic Maintenance** 8000SRM1364, **Periodic Maintenance** 8000SRM1372, **Periodic Maintenance** 8000SRM1339, **Periodic Maintenance** 8000SRM1373, or **Periodic Maintenance** 8000SRM1442.
   Do wheels and attaching hardware appear to be in good condition?
   YES: Go to CAUSE B.
   NO: Repair or replace damaged components. Depending on your lift truck, see **Transaxle** 1300SRM1330, **Transaxle** 1300SRM1370, **Steering Axle** 1600SRM1360, or **Drive Axle, Speed Reducer, and Differential** 1300SRM1366.

CAUSE B - WHEEL STUDS ARE OVER TORQUED

PROCEDURE OR ACTION:

1. Check wheel stud torque. Depending on your lift truck see, **Periodic Maintenance** 8000SRM1364, **Periodic Maintenance** 8000SRM1372, **Periodic Maintenance** 8000SRM1339, **Periodic Maintenance** 8000SRM1373, or **Periodic Maintenance** 8000SRM1442.
   Are the wheels studs at correct torque?
   YES: Check maintenance records to see what repairs were made that may have caused problem.
   NO: Replace all studs and torque correctly. Depending on your lift truck, see **Transaxle** 1300SRM1330, **Transaxle** 1300SRM1370, **Steering Axle** 1600SRM1360, or **Drive Axle, Speed Reducer, and Differential** 1300SRM1366.

END SYMPTOM

SECTION 9080

SUPPLEMENTARY DATA

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Group 50 Abbreviations and Acronyms
Abbreviations and Acronyms 9080-50-1

Group 50
Abbreviations and Acronyms

ABBREVIATIONS AND ACRONYMS

Table 9080-50-1. Abbreviations and Acronyms

Term	Definition or Description
AC	Alternating Current
ACC	Accessory
A/D	Analog to Digital
AUX	Auxiliary
BAT	Battery
Baud	A line's signaling rate, the switching speed, or number of voltage or frequency changes made per second
BIT	Smallest element of binary data storage
BDI	Battery Discharge Indicator
bit	Smallest element of binary data storage
°C	Celsius Temperature
Calbr	Adjustment to accommodate truck-to-truck variations. Typical usage in system specifications applies to software processes to "learn" and store sensor baseline or extreme values. Calibration procedures may require repeating when controllers are replaced or if a specific sensor or mounting mechanism is replaced.
CANbus	Controller Area Network bus
CBDC	Counter Balanced Development Center
CD or CD-ROM	Compact Disc Read-Only Memory - a compact disc format used to hold text, graphics and hi-fi stereo sound in excess of 650MB of data, which is equivalent to about 250,000 pages of text
CDF	Configuration Data File (previously known as Cal Data) - factory-created file defining truck configuration details, dependent on truck model and option permutations (considered unique for a given truck). Not modified by service technicians, but a replacement file (with alternate options) may be factory-generated and loaded into a truck's controller by a service technician
CO	Carbon Monoxide
COP	Computer Operating Properly
CMP	Cam Position Sensor
CPS	Connector Plug Socket
CPU	Central Processing Unit
CRC	Cyclic Redundancy Checksum
CRP	Connector Receptacle Pin
CRS	Connector Receptacle Socket

Table 9080-50-1. Abbreviations and Acronyms (Continued)

Term	Definition or Description
DC	Direct Current
DCS	Direction Control Selector
Deactivated	A feature which is not currently Activated
Defaults	The set of factory values for all truck parameters. A setup menu function can restore the default values of all parameters.
Disabled	A Software Enabled Feature which is NOT present on a given truck
DM	Diagnostic Message
DMM	Digital Multi-Meter
DP	Display Panel – equipped with 10 numeric keys, two arrow keys (left and right arrows) and two symbol keys (the Star (*) key and the pound (#) key).
DSC	Display Switch Cluster
DTC	Diagnostic Troubleshooting Code
DTM	Diagnostic Troubleshooting Manual
EDBP	Extended Drawbar Pull
EEPROM	Electronically Erasable Programmable Read Only Memory
EF	Excess Flow
EFI	Electronic Fuel Injection
EGI	Electronic Gasoline Injection
EGO	Exhaust Gas Oxygen
EHP	Electro-Hydraulic Pilot
EHPV	Electro-Hydraulic Poppet Valve
E-Hyd	Electro-Hydraulic - hydraulic option utilizing electronic inputs and electrically-driven valves to actuate hydraulic functions, as opposed to manual hydraulics using mechanical levers
Embedded	Software that is installed on Lift Truck control system
EMI	Electro-Magnetic Interference
Enabled	A Software Enabled Feature which is present on a given truck, but not necessarily Activated (i.e., purchased but not necessarily in use)
EPA	Environmental Protection Agency
EPR	Electronic Pressure Regulator
EST	Electronic Spark Timing
ETC	Electronic Throttle Control
FFL	Full-Free Lift
FIFO	First In, First Out
FOSI	Format Output Specification Instances - an instance of the Output Specification (OS) that assigns values to the style characteristics for a particular document type declaration. The FOSI uses the syntax of an SGML/XML document instance and is designed to format documents for paper delivery.
FWD	Forward travel direction command signal to system

Table 9080-50-1. Abbreviations and Acronyms (Continued)

Term	Definition or Description
GB	Gigabyte - equal to 1024 Megabytes
H	Henry - Unit of measurement of electrical inductance
HYDR	Hydraulic
Hz	Basic unit of frequency measurement, 1 Hz = 1 periodic interval in one second
IAC	Idle Air Control
IAT	Intake Air Temperature
IBPP	Inching/Brake Pedal Position
ISR	Interrupt Service Routine
kBps	KiloBytes per second
kHz	KiloHertz - common frequency measurement of Hertz X 1000
kilobit	1,000 bits
kilobyte	A standard quantity measurement for disk and diskette storage. One kilobyte of memory equals 1024 bytes (8-bit characters) of computer memory.
kg	Kilogram, equal to 1000 grams
kPa	Kilo-Paschals, metric unit of pressure measurement X 1000
kph	Kilometers per Hour
L	Liter
LAN	Local Area Network
lbf ft	Foot Pounds
lbf in	Inch Pounds
LCD	Liquid Crystal Display
LED	Light Emitting Diode
LFL	Limited Free Lift
MB	Megabyte - 1,048,576 bytes, equal to 1,024 kilobytes. The basic unit of measurement of mass storage
MDU	Master Drive Unit
MHz	Megahertz - a unit of frequency equal to 1024 kilohertz. A common method for describing the speed of a computer CPU
MIL	Malfunction Indicator Lamp
MLCV	Mast Lowering Control Valve
MLM	Mini Lever Module
mH	Milli-Henry, 1 one thousandth of a Henry
Modem	Modulator-Demodulator - a device that adapts a terminal or computer to a telephone line converting the computer’s digital pulses into audio frequencies (analog) for the telephone system and converts the frequencies back into digital pulses at the receiving side
MPH	Miles Per Hour
MRV	Main Relief Valve

Table 9080-50-1. Abbreviations and Acronyms (Continued)

Term	Definition or Description
ms	Milli-second, 1 one thousandth of a second
MSB	Most Significant Bit
NEU	Neutral travel direction command signal to system
N•m	Newton Meters
NOR	Normal
OBD	On Board Diagnostics
OC	Open Circuit - indicates an open connection or break in an electrical path
OORH	Out-Of-Range High
OORL	Out-Of-Range Low
OPS	Operator Presence System
OS	Operating System - the embedded system of instructions and applications that control the operation of the processor
Parameter	A system characteristic which may be adjusted by a technician, e.g., Auto-Deceleration, which may be set on a scale of from 1 to 10. Each parameter will also have a default value.
PC	Personal Computer
PC Tool	Any software that is installed on a PC that is used to service the lift truck control system
PCB	Printed Circuit Board
PGN	Parameter Group Number
PPRV	Proportional Pressure Reducing Valve
PTC	Positive Temperature Coefficient Resistor
RAM	Random Access Memory - the computer's primary workspace where the contents of each byte can be accessed directly without regard to the bytes before or after it
REV	Reverse travel direction command signal to system
Rev.	Revision - the issue control or version number of an item
RL	Relay
ROM	Read Only Memory
RPM	Revolutions Per Minute
RTST	Return to Set Tilt
SAE	Society of Automotive Engineers
Scroll Repeat	The repeating, incrementing, or decrementing of a displayed value when continuously pressing the scroll buttons
Scroll Wrap-around	In the setup menu, if wrap-around is specified, when extreme-adjustment values are reached while scrolling, the value shall change to the other extreme of adjustment. I.e., scrolling down to lowest point on menu shall jump back to the top of the menu.
SCU	Steering Control Unit

Table 9080-50-1. Abbreviations and Acronyms (Continued)

Term	Definition or Description
SEF	Software Enabled Function - options which are Enabled by software (either entirely or in combination with additional hardware). For all SEFs, enabling the function requires a new CDF. An SEF may be Selectable, allowing it to be Activated or Deactivated by the technician once it has been enabled, or it may be non-selectable, such that it cannot be deactivated after being enabled.
Selectable	See Software Enabled Function (SEF)
Service Pack	Software update provided by a software manufacturer to fix an error and/or improve quality
SPED	Special Products Engineering Department - responsible for options not in the standard price book, but available by special order
SPI	Serial Peripheral Interface
SPN	Suspect Parameter Number
SRM	Service Reference Manual
SRV	Secondary Relief Valve
STB	Short-To-Battery - indicates a short to a battery level voltage source
STG	Short-To-Ground - indicates a short to a ground or frame connection
STS	Short-To-Supply - indicates a short to a supply voltage source other than battery level
TBC	To Be Continued
TBD	To Be Determined
Truck Settings	The specific adjustments of the various parameters on a given truck. They may be saved to a data file through the Service PC software and copied to additional similar trucks.
TSP	Troubleshooting Procedure
USB	Universal Serial Bus - serial 4-wire connection that has advanced features over a serial port. Normally found on computers as a slotted connector configuration

NOTES