SECTION 4 - POWER PACKAGE

AIR CLEANERS

DESCRIPTION AND LOCATION (Figure 1)

The standard air cleaners are rectangular boxes mounted at the front of the superstructure just below the bottom panels on one or both sides of the engine.

The optional rock guards are steel plates mounted above the air cleaners designed to deflect falling rocks and debris.

The optional vacuator valves are special rubber components attached to the specially modified dust cups on the bottom of the air cleaner.

OPERATION (Figure 1)

The air cleaner supplies clean, filtered air to the engine. As the engine runs, its demand for air creates a vacuum in the intake assembly and causes air to be drawn into the air inlet on the cleaner assembly. Air from the inlet is drawn through a series of tubes inside of the lower or tube body assembly (6) that are designed to create a cyclone action and separate out foreign material. As air passes downward in the outer portion of the tubes, it goes into a circular motion. At the bottom of the outer tubes, the air enters the lower plenum chamber, then is immediately pulled upward through the inner portion of the tubes. The swirling motion and abrupt change in direction causes much of the heavier dust and debris in the air to be removed and deposited in the dust cap for later disposal. Approximately 80 to 90% of the contamination is removed from the inlet air in this manner.

The pre-cleaned air is then drawn through the primary or outer main (15) filter element. The filtering material in the element collects the remaining contamination and absorbs it for future removal. Finally the air is drawn through the inner secondary or safety element (22), which is designed to serve both as a final filter and a reserve, in case of primary element failure. Clean air flows through the outlet flange (2) from the center of the safety elements, through the ducting to the inlet of the engine (usually the turbocharger inlet).

Normally the restriction in the air system (read as vacuum developed through the system) is monitored by indicators or gauges connected at taps on the engine inlet pipes between the air cleaner and the inlets to the engine (turbochargers).

The optional vacuator valves provide a means of periodically "ejecting" some of the material separated out of the air stream by the pre-cleaner assembly. During normal "power" operation, the vacuum in the system causes the valve sides to contract and seal. When changes in engine speed and power cause the vacuum levels to vary, the resulting pressure pulse causes a short term separation of the walls, rejection of material contained in the bowl, and then allows the valve to reset. Also the valve provides a second means of periodically removing loose material in the bowl without requiring normal bowl opening.

NOTE: *Special bowls, without provisions for pivoting to dump and with special mounting brackets for support, are required to accommodate the use of these valves.*

MAINTENANCE AND ADJUSTMENT

NOTE: *To prevent dust entering the engine, always turn off the engine prior to servicing any air intake components. Take precautions to prevent any dust or contamination from entering the system while working on it.*

Periodic maintenance of the air cleaner should include the following steps:

1. Check and empty each dust collector cup at least daily (more often in dusty operating conditions). The level of the dust should not be allowed to come too close (within 1 inch (25 mm)) to the pre-cleaner (Dynaclone) tube chambers.

   a. On units with the vacuator valves, squeeze each of the valves to check operation and to allow debris to escape. This may take several repetitions.

   b. Inspect the valve for evidence of clogging or damage. Clean or replace as required.

2. Inspect all air inlets for damage or obstruction. Verify that the air tap port on each outlet flange is properly plugged if not used.

3. Inspect all piping and connections for damage or leaks. Verify that all seals are tight.

4. Verify that the nuts securing the element are tight and that the elements and seals are not leaking.

5. Verify that the restriction gauges or indicators in the cab operate properly.

NOTE: *The Air Cleaner Restriction indicator is used only to indicate the service requirements of the air cleaner element (and other intake components). Under normal operating conditions, the green band is exposed in the indicator. Should the filter elements become significantly plugged or restricted, a red band will appear and remain in place until the element is serviced and the indicator is reset.*

The Air Cleaner Restriction gauge indicates the amount of restriction in the air cleaner and induction system in inches of water. Normally, the air cleaner elements should be serviced if the indicated restriction exceeds:

IMPORTANT: *This pressure is measured at rated horsepower and speed.*

12 inches of water (3.0 kPa) on MTU engine equipped units.

20 inches of water (5.0 kPa) on Detroit Diesel engine equipped units.

25 inches of water (6.2 kPa) on Cummins engine equipped units.

IMPORTANT: *If one or more gauges indicate unusually low readings, it may indicate a leak in the air induction system. Check the system before continuing operation of the vehicle.*

When need of service is indicated, the elements may be changed as follows:

NOTE: *The air cleaner assembly need not be removed from the vehicle to change elements.*

1. Remove the primary filter element as follows:

a. Park the vehicle in a SAFE POSITION. It must be secured by means other than the friction brake system.

b. Turn the engine off.

c. Clean all dirt, dust, and debris from the element cover and air cleaner assembly.

d. Remove the wing nut, washer, and gasket.

e. Remove the primary or outer element from the assembly.

NOTE: *Do not remove a filter for inspection as this will do more harm than good.*

(1) Gently move the end of the filter back and forth to effectively break the seal formed between the filter and the outer tube.

(2) Be careful not to allow entrapped material to fall from the element or damage the element in any way.

NOTE: *To prevent dust from entering the air cleaner, the safety element should not be removed while servicing the primary element. If the element is not immediately being replaced, cover the opening until the replacement is made.*

(3) Never "tap" a filter to clean it as this may damage the filter and the seals.

NOTE: *Deeply embedded dirt is not released by tapping. It is always safer to keep operating until a new filter can be installed.*

f. Using a clean cloth, wipe the filter sealing surface and the inside of the outlet tube.

NOTE: *Contaminant on the sealing surface could hinder an effective seal and allow leakage. Be careful nc damage the sealing area on the tube.*

g. Inspect and service the element as required.

NOTE: *A streak of dust on the clean side of the filter may be a tell-tale sign of leakage and should be found and corrected before replacing with new elements.*

h. Repeat steps a through d for the other primary element.

2. If the secondary or inner safety element requires changing, it may be removed as follows:

NOTE: *This element should be changed on a regularly schedule basis or only if damaged, dirty, or when the safety element service indicator dot is red, indicating a large restriction in the element. This indicator serves as a locking nut that secures the inner element. Normal recommendation is replace every third time the primary element is changed.*

a. Remove the cotter pin and safety element service indicator from the inner element assembly.

b. Remove the cover, safety element, and gaske

c. Remove all dust and contamination lodged in the cleaner assembly, ducts, and sealing surfaces. Use extra

care to ensure that no contamination enters the clean air chamber or inlet tubes in the air induction system.

d. Replace the element as soon as possible to minimize the possibility of contamination entering the system. If the element is not being replaced immediately, carefully seal the unit to prevent the contamination of the interior surfaces.

NOTES:

1. The function of the secondary or safety element is to increase the air cleaning system's overall reliability and effectiveness. In order to maximize reliability and system effectiveness, the safety element should not be cleaned. If the safety element becomes restricted, it should be discarded and replaced.

2. It is typically recommended that the safety element be changed every third time the primary element is changed.

⚠ CAUTION

Never use an air cleaner without both filter elements installed and in good condition.

3. If the safety (inner) element has been removed, it may be installed as follows:

a. Prior to installation:

(1) Inspect the new filter carefully, paying attention to the inside of the open end which is the sealing area.

NOTES:

1. Never install a damaged, dented or bunched filter.
2. New filters may have a dry lubricant on the seal to aid in installation.

(2) Inspect all gaskets and surfaces to be clean and free of damage. Replace if required.

NOTE: *Replace any cover gaskets, making sure that no piece of the old gasket remains in the housing and the gasket is not worn.*

b. Insert the new filter element carefully. Seat the filter by hand; making certain that it is completely seated into the housing.

NOTES:

1. The critical sealing area will stretch slightly, adjust itself, and distribute the sealing pressure evenly.
2. To complete a tight seal, apply pressure by hand to the outer rim of the filter, not the flexible center.
3. Never use the service cover to push the filter into place as this could cause damage to the housing and leaks.

c. Install the gasket, washer, and safety element indicator or locking nut. Be sure a good seal is formed at all points.

⚠ CAUTION

Proper seal of these gaskets is very important. If these gaskets are damaged or show signs of leakage, they must be replaced.

NOTE: *If the cover contacts the filter before it is fully in place, remove the cover and push the filter (by hand) further into the air cleaner. The cover should go on with no extra force.*

d. Reset service indicators or gauges (if the truck is so equipped).

e. Check all connections and system components for damage or leakage.

NOTE: *The Dynaclone or pre-cleaner tube may also be cleaned. For detailed instructions on cleaning, refer to the instructions in Inspection and Repair.*

4. Install the primary filter elements as follows:

a. Prior to installation:

(1) Inspect the new filter carefully, paying attention to the inside of the open end which is the sealing area.

NOTES:

1. Never install a damaged, dented or bunched filter.
2. New filters may have a dry lubricant on the seal to aid in installation.

(2) Inspect all gaskets and surfaces to be clean and free of damage. Replace if required.

NOTE: *Replace any cover gaskets, making sure that no piece of the old gasket remains in the housing and the gasket is not worn.*

b. Insert the new filter element carefully. Seat the filter by hand; making certain that it is completely seated into the housing.

NOTES:
1. The critical sealing area will stretch slightly, adjust itself, and distribute the sealing pressure evenly.
2. To complete a tight seal, apply pressure by hand to the outer rim of the filter, not the flexible center.
3. Never use the service cover to push the filter into place as this could cause damage to the housing and leaks.

c. Install the gasket, washer, and wing nut over the cover. Be sure a good seal is formed at all points.

⚠ CAUTION

Proper seal of these gaskets is very important. If these gaskets are damaged or show signs of leakage, they must be replaced.

NOTE: *If the cover contacts the filter before it is fully in place, remove the cover and push the filter (by hand) further into the air cleaner. The cover should go on with no extra force.*

d. Reset service indicators or gauges (if the truck is so equipped).

e. Check all connections and system components for damage or leakage.

NOTE: *The Dynaclone or pre-cleaner tube may also be cleaned. For detailed instructions on cleaning, refer to the instructions in Inspection and Repair.*

REMOVAL

NOTE: *The air cleaner assembly need not be removed from the truck to perform maintenance in the form of element changing or tube cleaning.*

1. Park the truck in a SAFE POSITION. It must be secured by means other than the friction brake system.

2. Disconnect the intake piping from the air cleaner assembly. Seal the air cleaner assembly and intake pipes to prevent dust from entering.

3. Support the air cleaner assembly by cable or suitable device. Be sure the cables cannot damage the assembly during removal.

4. Remove the bolts that secure the assembly to the rear braces.

5. Remove the bolts that secure the assembly to the superstructure.

6. Lower to ground level. Be careful during handling not to damage any components.

DISASSEMBLY

The pre-cleaning section may be removed from the filter assembly as follows:

1. Open and empty each of the dust caps on the assembly.

2. Remove the capscrews securing the filtration and the pre-cleaning sections.

3. Separate the sections.

INSPECTION AND REPAIR

The unit may be serviced as follows:

1. Clean all metal components with clean solvent and wipe dry. Inspect for evidence of damage or leakage. Repair or replace as required.

2. Inspect all gaskets, seals and vacuator valves (if so equipped) for evidence of wear, leakage, or damage. Repair or replace as required.

3. Inspect the elements as outlined in Maintenance and Adjustment. Replace as required.

4. Inspect the pre-cleaner tubing. Replace if damaged. If cleaning is required, proceed as follows:

NOTES:
1. The tube should be thoroughly cleaned yearly or at least every engine overhaul period. More frequent cleaning may be required if contaminated by oil or sludge caused by a broken oil line, etc.
2. Never steam clean the tubes.

a. Light dust plugging of the tubes can be removed with a stiff fiber brush, then blown with compressed air from the bottom and/or the inlet area.

⚠ DANGER

Do not use a wire brush. Both the primary a safety elements should always be installed when cleaning the tubes. This prevents dirt from entering the clean air chamber.

TROUBLESHOOTING

PROBLEM	POSSIBLE CAUSES	CORRECTIVE ACTION
Dirt entering engine	Leaks in inlet ducting or air cleaner housing	Inspect, repair, or replace as required.
	Filtration elements not properly sealing	
	Holes in filtration elements	
Filter elements require constant changing	Dirty or dust environment	Reduce the contamination in the operating environment.
	Precleaning (Dynaclone) tubes not functioning properly	Inspect, clean, repair or replace as required.
	Elements are holding air due to moisture, oil or carbon build-up, etc.	
Low engine power (usually accompanied by black smoke)	Filtration elements are contaminated causing restriction	Inspect and service elements as required.
	Restriction in inlet ducting	Inspect, repair or replace as required.

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b. Heavy plugging may require washing as follows:

(1) Submerge the tube section in a solution, e.g., Donaldson D-1400, and warm water - 150°F (66°C) maximum.

(2) Soak for 30 minutes, then agitate for an additional 15 minutes.

(3) Rinse clean with clear water and dry thoroughly.

(4) If plugging is severe, use a solution of Oakite 202 (50% Oakite and 50% water) and follow steps 2 and 3.

ASSEMBLY

The pre-cleaner assembly may be installed onto the filtration assembly as follows:

IMPORTANT: *Due to the potential problems of air leaks, it is recommended that new gaskets be used each time any portion of the air cleaner is disassembled or serviced.*

1. Inspect the gasket between the assemblies. Replace if damaged or worn.

2. Align the bolt holes on the two sections.

3. Install the capscrews. Tighten sequentially in even increments to form a good seal between the assemblies, and torque to final values as required.

4. Install the dust cup assemblies if removed. Be sure all seals are in good condition.

5. Install any rain shield removed.

INSTALLATION

NOTE: *Prior to installation, verify that the air cleaner assembly and supply ducting are free of damage and that all seals are in good condition.*

1. Raise the assembly to position and install the mounting bolts.

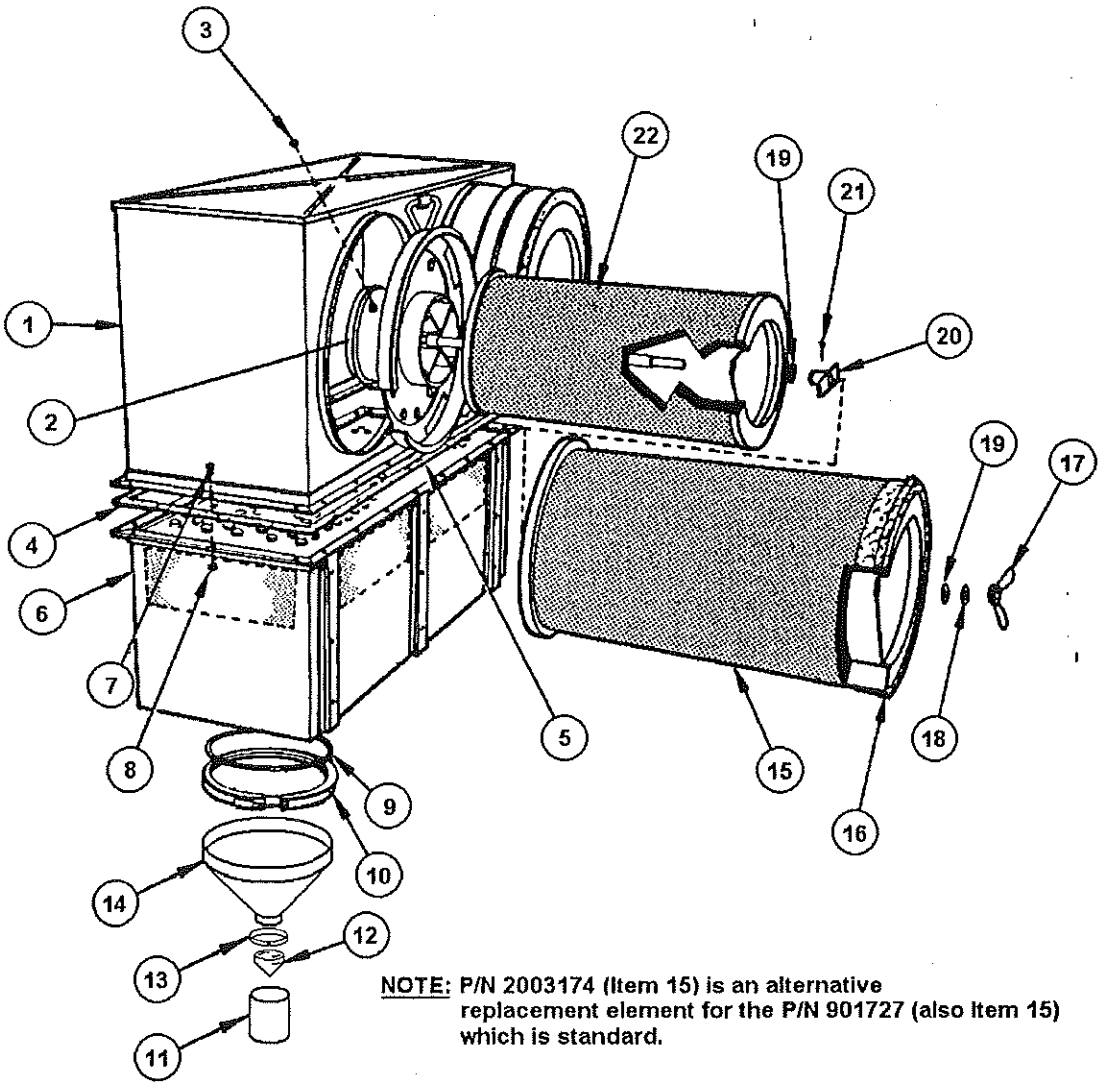
2. Install the rear braces and capscrews.

3. Connect the intake piping to the engine, air compressor service indicators, etc.

4. Inspect the entire system for leaks or damage.

5. Reset the air cleaner service indicators.

6. Start the truck engine and check again for leaks. This may be done with a solution of soapy water, or other equivalent means.



NOTE: **P/N 2003174 (Item 15) is an alternative replacement element for the P/N 901727 (also Item 15) which is standard.**

KEY			55396
01.	Filter Element Body Assembly	12.	Vacuator Valve (Optional)
02.	Outlet Flange Assembly	13.	Clamp Assembly
03.	Restriction Adapter	14.	Dust Cup (special version for vacuator valves)
04.	Gasket	15.	Primary Element Assembly
05.	Gasket	16.	Gasket
06.	Tube Body Assembly	17.	Wing Nut
07.	Bolt	18.	Clip
08.	Flange Nut	19.	Gasket Washer
09.	O-ring	20.	Safety Element Indicator (or nut)
10.	Bowl Clamp Assembly	21.	Cotter Pin
11.	Protective Tube (With item 12)	22.	Secondary Element Assembly

FIGURE 1 – TYPICAL DONALDSON SRG AIR CLEANER

EXHAUST ASSEMBLY - DUMP BODY HEATING

DESCRIPTION

The dump body heating exhaust assembly provides a method of routing the hot exhaust gases produced by the engine through portions of the dump body. It consists of the following:

1. Exhaust piping - rigid and flexible tubing sections form the engine turbocharger exhaust outlets to the exhaust boxes.

2. Exhaust box assemblies - spring loaded mechanical devices mounted on the truck frame.

OPERATION

Hot exhaust gases from the engine are utilized to warm the panels in the dump body. This assists in preventing the accumulation of moisture and freezing of materials in and to the dump body.

The exhaust gases are routed from the engine turbocharger to the two exhaust boxes mounted on the truck main frame rails near the front end of the dump body. In normal operation with the dump body lowered, the gases flow through the box and seal assemblies and into the runners under the body. There it is routed through the passages until it exits at the rear of the dump body.

When the dump body is raised, the spring loaded moveable portion of the exhaust boxes extends until it reaches the end of its travel. During this movement the exhaust flow is redirected and allowed to exit downward though an alternative passage. This directs the exhaust noise and gases away from the operator's cab.

When the body is again lowered, the gaskets on the moveable assemblies contact and align with the openings in the dump body runners reforming the seal. As movement continues, the gases are again directed through the exhaust boxes and dump body.

MAINTENANCE AND ADJUSTMENT

Periodic maintenance of the system should include the following:

1. Park the truck in a SAFE POSITION. It must be secured by means other than the trucks friction brake system.

2. Stop the engine.

3. Clean the exhaust system and verify that the exhaust piping is not damaged or leaking anywhere.

4. Verify that all mounting hangers are secure.

5. Verify that all piping connections are clamped securely.

6. Verify that all exhaust blanket assemblies are in place and free of damage. Repair or replace as required.

NOTE: *The blankets should be installed with the seams pointed upward and not aligned with those on adjacent blankets*

7. Verify that the exhaust box assemblies are free of damage and securely mounted on the frame assembly.

8. Clean the areas near the springs and moveable assemblies so that the movement is free.

9. Test the system as follows:

a. Start the engine allow to operate at idle.

b. Verify that with the dump body fully lowered, the exhaust gases travel through the exhaust piping, boxes and dump body assemblies.

c. Raise the dump body.

d. Verify that as the body rises, the exhaust gases are diverted properly through the exhaust boxes.

e. Lower the body and recheck the exhaust path.

10. If required to properly seal on the dump body, the exhaust box installation can be aligned as follows:

Never work under or around the truck unless the dump body is secured in places at all times it is not resting on the frame.

a. Verify that all of the dump body pads are properly shimmed.

b. Verify that the dump body sets squarely on the frame.

c. Compress the plunger spring on each of the exhaust boxes until the holes in the sides of the plunger walls line up with the holes in the exhaust box.

d. Insert a pin or capscrew through the holes to secure the plunger in place.

e. Align the exhaust box outlet with the holes in the dump body runner.

f. Shim any gaps between the exhaust box and the mounting plate.

g. Install the mounting bolts.

h. Remove the pins from the plungers in the exhaust boxes.

j. Install the exhaust pipes to the exhaust boxes.

k. Test the system's operation as outlined previously.

SERVICE

This is limited to repairing damaged or leaking components as required.

KEY					A84260
01	Left Exhaust Box	12	Capscrew	23	Exhaust Blanket
02	Right Exhaust Box	13	Locknut	24	Exhaust Elbow
03	Brace	14	Capscrew (Grade 8)	25	Exhaust Elbow
04	Exhaust Pipe	15	Lockwasher	26	Jam Nut
05	Exhaust Elbow	16	Flatwasher	27	Exhaust Blanket
06	Clamp	17	Right Mounting Plate	28	Center Ring
07	Tubing	18	Tube Support	29	V-Band Clamp
08	Tube Support	19	Not Used	30	Exhaust Blanket
09	Angle Clip	20	Exhaust Blanket	31	Exhaust Blanket
10	Self Tapping Bolt	21	Exhaust Blanket	32	Left Mounting Plate
11	Capscrew	22	Exhaust Blanket		

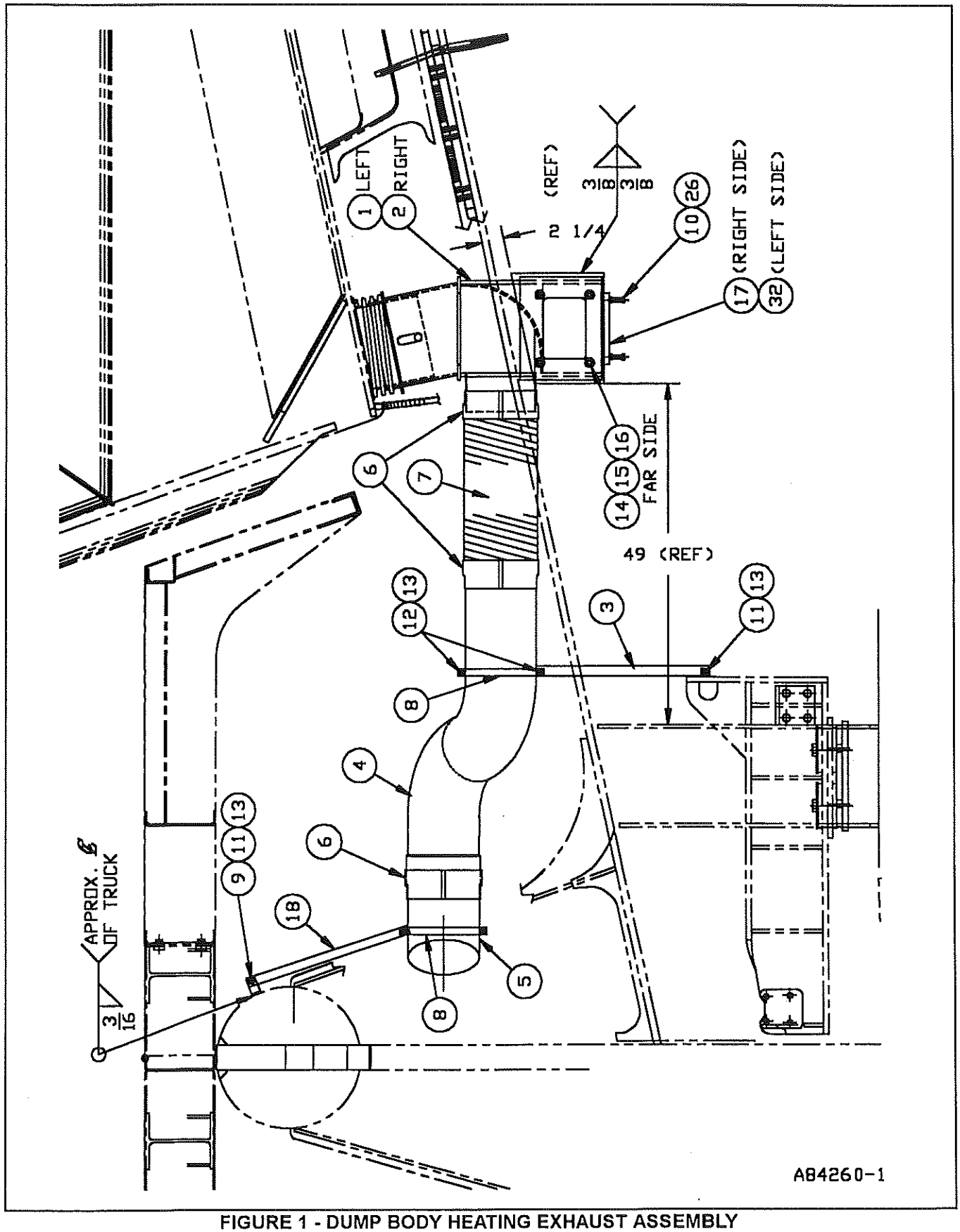


FIGURE 1 - DUMP BODY HEATING EXHAUST ASSEMBLY

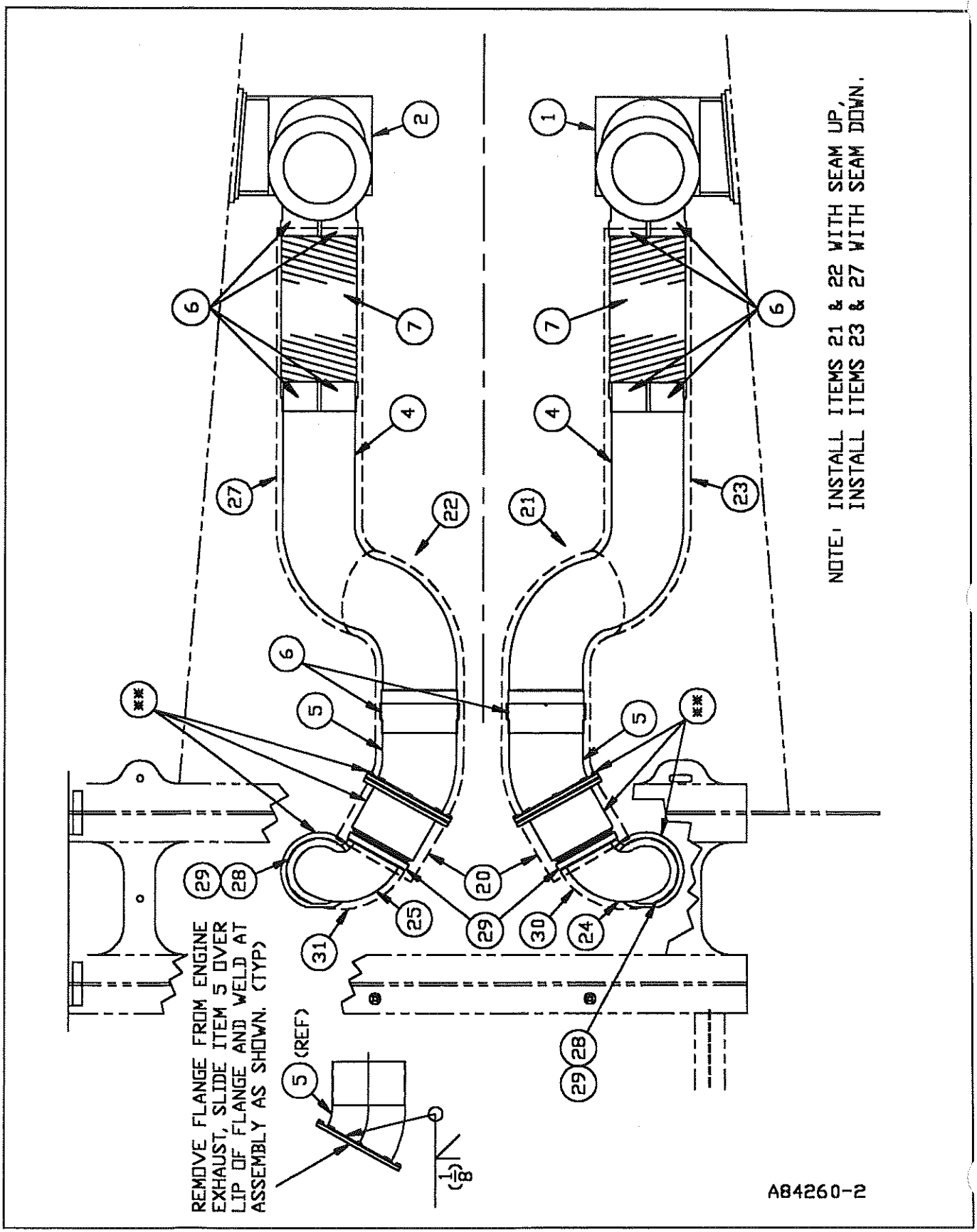


FIGURE 1 - DUMP BODY HEATING EXHAUST ASSEMBLY - CONTINUED

EXHAUST ASSEMBLY - MUFFLERS

DESCRIPTION

The exhaust assembly provides a method of routing the noise and the exhaust gases produced by the engine away from the cab and reduce its outlet volume. It consists of the following:

1. Exhaust piping - rigid and flexible tubing sections form the engine turbocharger exhaust outlets to the exhaust mufflers.

2. Exhaust mufflers - specially assembled silencer assemblies mounted to the right rear of the engine assembly.

OPERATION

The exhaust gases are routed from the engine turbocharger to the two muffler assemblies mounted near the right fender assembly. Their special construction reduces the overall sound output and directs it away from the operating equipment.

MAINTENANCE AND ADJUSTMENT

Periodic maintenance of the system should include:

1. Park the truck in a SAFE POSITION. It must be secured by means other than the trucks friction brake system.

2. Stop the engine.

3. Clean the exhaust system and verify that the exhaust piping is not damaged or leaking anywhere.

4. Verify that all mounting hangers are secure.

5. Verify that all piping connections are clamped securely.

6. Verify that all exhaust blanket assemblies are in place and free of damage. Repair or replace as required.

NOTE: *The blankets should be installed with the seams pointed upward and not aligned with those on adjacent blankets.*

SERVICE

This is limited to repairing damaged or leaking components as required.

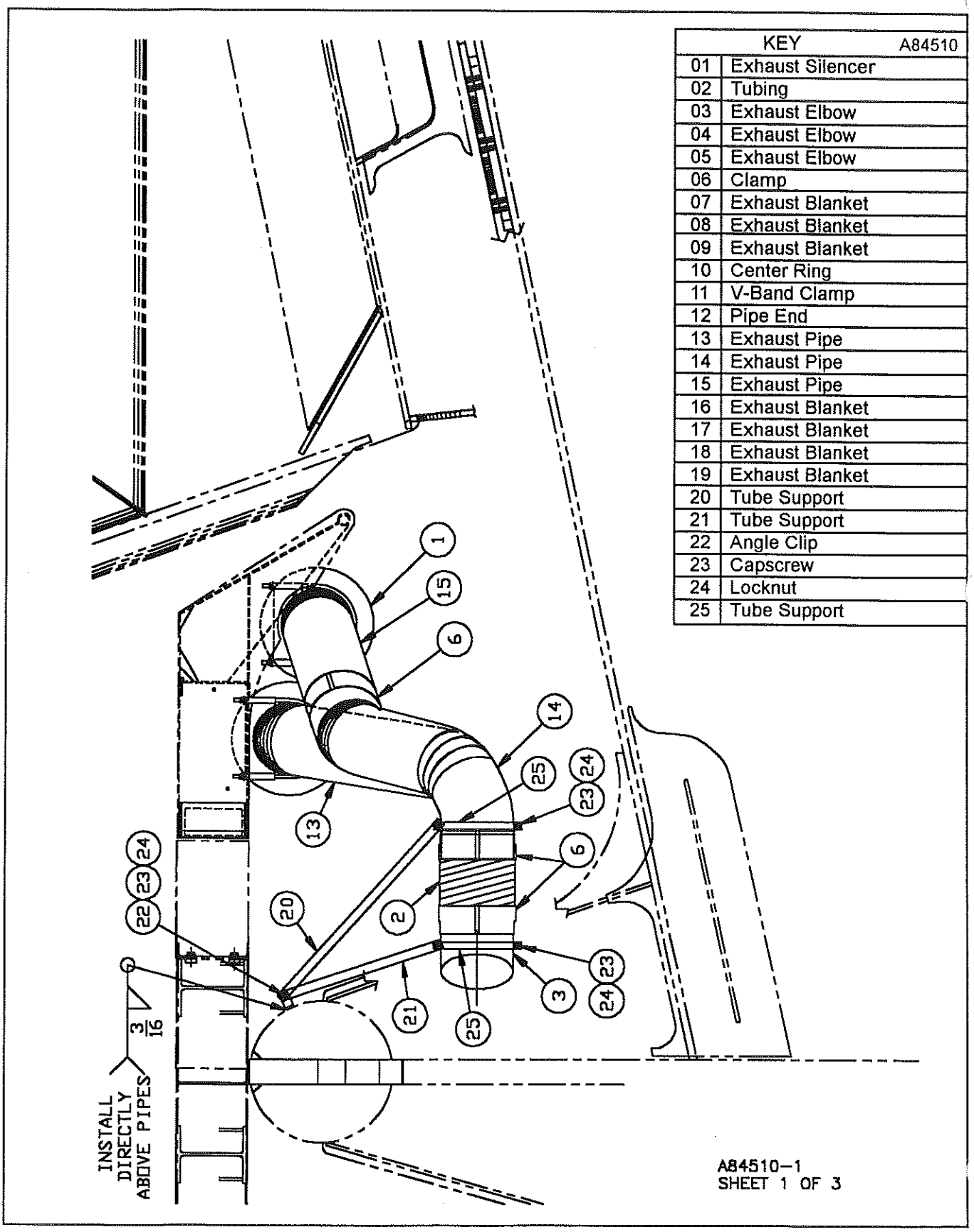


FIGURE 1 - MUFFLER EXHAUST ASSEMBLY

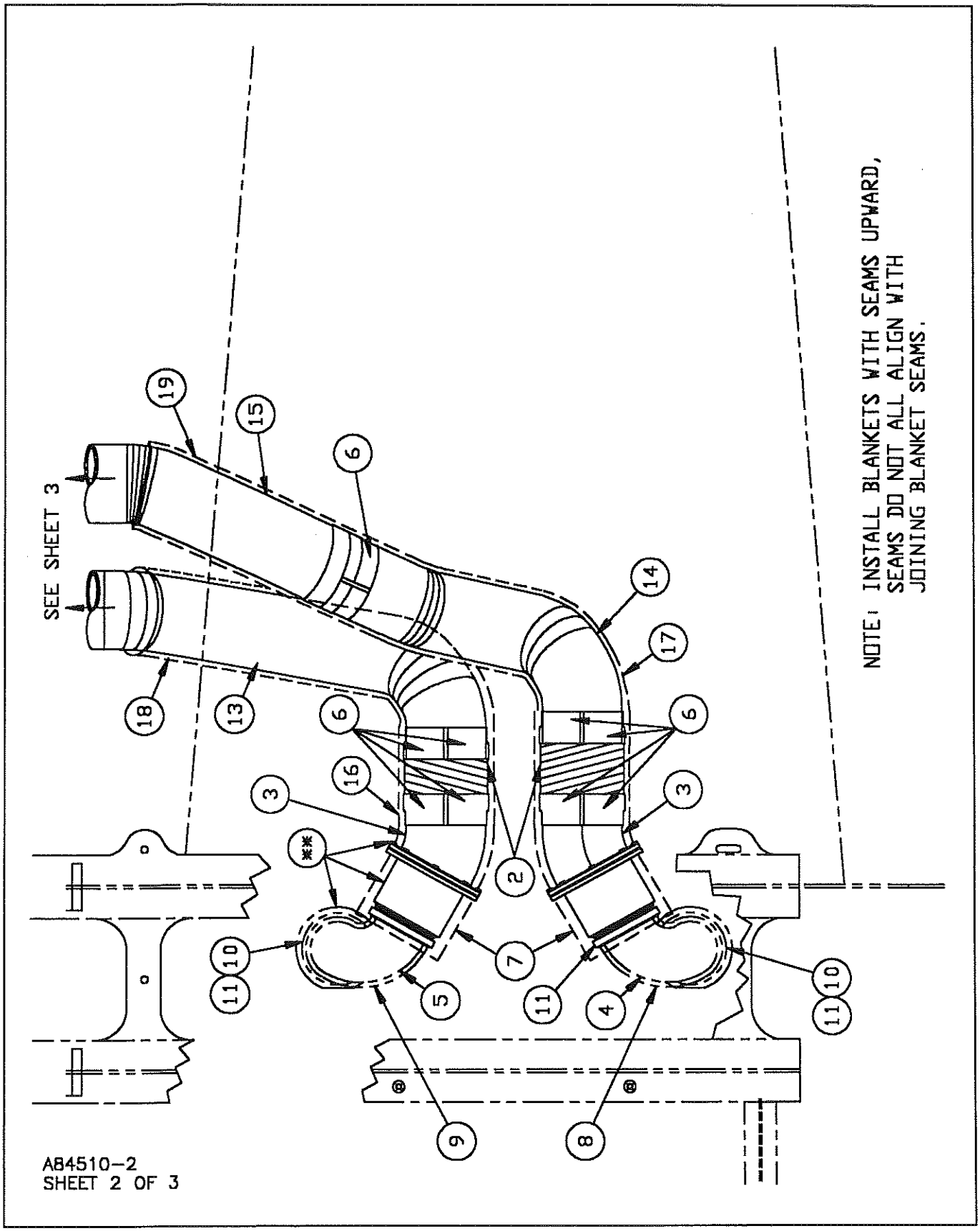


FIGURE 1 - MUFFLER EXHAUST ASSEMBLY - CONTINUED

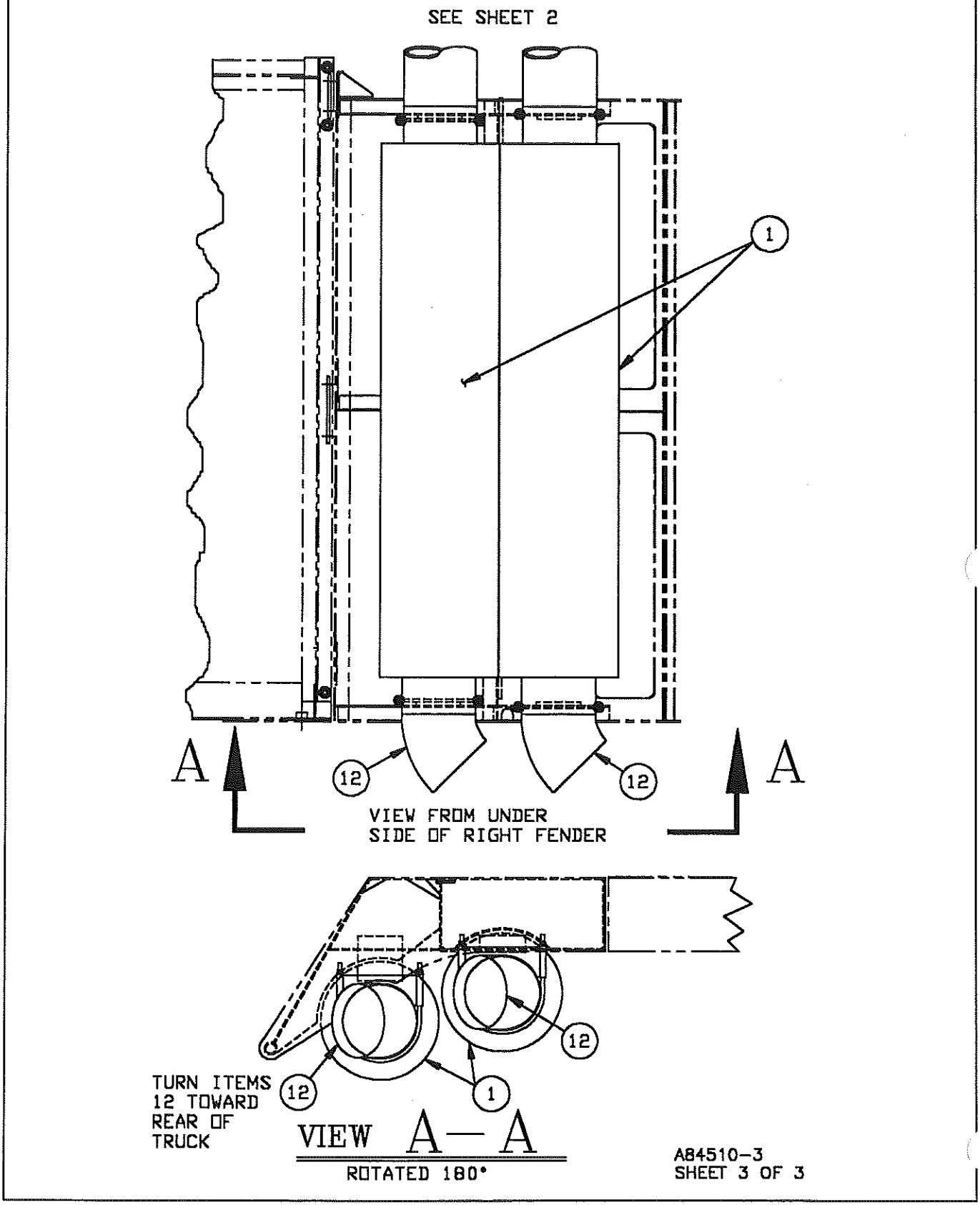


FIGURE 1 - MUFFLER EXHAUST ASSEMBLY - CONTINUED

COOLING SYSTEM
TRUCKS EQUIPPED WITH SEPARATE COOLING MODULES

DESCRIPTION AND LOCATION

The cooling system consists of the following:

1. Engine mounted

a. Coolant pump - supplies a positive flow of coolant from the lower portion of the radiator to the engine and circulates it through internal lines.

b. Thermostat - regulates the flow of coolant through the engine to maintain engine operating temperatures within the maximum and minimum limits.

c. Oil coolers - remove heat from the engine oil by transferring it to the engine coolant.

d. Coolant heaters (optional) - preheat the coolant to aid in cold weather starting.

e. Radiator fan - supplies a flow of air through the radiator to assist the thermostat in cooling in warm environment conditions, or under large loads.

f. Optional radiator pressurization system - a pressure regulator adjusted to 10 psi (70 kPa) provides air from a separate system to maintain pressure in the cooling system.

NOTE: *This option is mandated on some engine configurations and in some operating environments.*

g. Filters - filter the foreign material from the coolant, soften the water and incorporate corrosive inhibitors by releasing chemical into the coolant, and provide galvanic protection by providing sacrificial metal.

2. Radiator mounted

a. Radiator - transfers the heat from the engine coolant to the surrounding air through a series of fins.

b. Fan shroud assembly - improves the efficiency of the movement of cooling air through the radiator core assembly by improving the overall efficiency of the fan. Also it serves as protection for and from the fan when used in conjunction with the attached fan guard assembly.

c. Hood and grille assembly - provided as an integral part of the radiator/cooling module assembly.

3. Miscellaneous

a. Hoses and tubing - allow for the transfer of coolant between the engine, radiator, and other assemblies.

OPERATION

Internal combustion engines produce heat by burning fuel in the cylinders. Only a portion of this heat is converted to mechanical energy. The heat which has not been converted to mechanical energy must be removed from the engine in a controlled manner so as to protect the metal of the engine from damage. In order to maintain peak engine efficiency the engine temperatures must be maintained within a limited operating range, the primary function of the cooling system.

Efficient transfer of heat from the engine to the coolant and from the coolant to the radiator requires the interior surfaces of engine cooling passages and the radiator to be free of mineral scale, corrosion, petroleum, contaminates, and deposits resulting from chemical incompatibility. These materials form an insulating layer on metal surfaces and greatly reduce the rate of heat transfer.

NOTE: *Air bubbles in the coolant have a similar effect.*

Normally the cooling system operates under pressure, created by the expansion of the coolant during its warming from cool to operating temperature. If the cap is removed (e.g. to check coolant level) once there is pressure in the system, the system will not be able to fully re-pressurize until allowed to cool to ambient pressure. This could adversely affect operation of the cooling system.

To prevent this loss of pressure, an auxiliary pressurization system is often installed which provides regulated pressure typically 10 psi (70 kPa) pneumatic system to maintain pressure in the system at all times during operation.

SERVICE

Periodic service should include the following steps:

TROUBLESHOOTING

PROBLEM	POSSIBLE CAUSES	CORRECTIVE ACTION
Engine coolant temperature excessively high	Low coolant level	Fill system to proper level. Check for leaks.
	Obstruction in radiator core	Remove obstruction and clean radiator fins.
	Defective fan drive	Repair or replace as required.
	Improper functioning of water pump	Repair or replace as required.
	Improper thermostat opening	Replace thermostat.
	Internal plugging of core tubes	Flush entire cooling system - - additional cleaning as required.
	Improper operation of shutters or clutching fan	Repair or replace as required.
	Air or exhaust gases in coolant	Determine where gases are entering the system. Correct leak.
	Defective temperature indicator	Adjust or replace as required.
	Collapsed hose between radiator and engine (NOTE: May be internal)	Check condition of hoses - - cold and with truck warmed and engine running. Repair or replace as required.
	Engine not running properly	Check engine settings including injector size and timing. Adjust or repair as required.
	Dirt covering exterior of engine and radiator	Clean exteriors. (The dirt lowers the heat transfer rate.)
	Improper radiator size	Check the radiator size recommended for the application.
Engine coolant temperature too low	Improper operation of thermostat (not closing or leakage)	Replace thermostat.
	Improper operation of shutters	Repair or replace as required.
	Lack of pressure cap	Check operation of pressure cap. Replace as required.

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TROUBLESHOOTING

PROBLEM	POSSIBLE CAUSES	CORRECTIVE ACTION
Low coolant level	External leaks 1. Loose clamps, faulty hose or pipes 2. Radiator 3. Gaskets 4. Drain cocks 5. Seals (water pump, thermostat) 6. Engine or air compressor gaskets 7. Engine accessories	Repair or replace as required.
	Internal leaks 1. Engine or air compressor (into cylinders) 2. Injector sleeves 3. Porous cylinder head 4. Engine accessories	Repair or replace as required.
	Overflow 1. Overfilled radiator 2. Faulty pressure cap 3. Plugged radiator core 4. Dirt in system 5. Combustion gases entering system displacing coolant 6. Excessive intake air temperature 7. Improperly routed fill line	Repair or replace as required.

⚠ WARNING

Use extreme care when removing the radiator cap or other cooling system components. Remove slowly, only after the engine has cooled. The sudden release of pressure from a heated cooling system can result in the loss of coolant and possible injury (scalding) from the hot liquid.

1. Check the engine coolant level in the radiator as follows:

a. If the truck is equipped with an optional auxiliary pressurization system, disable the system (to prevent accidental activation) as required.

b. Open the metal cover over the cap.

c. Press the pressure release feature in the cap or cover the cap with a rag and slowly turn it to the first detent stop. Let any system pressure vent to atmosphere.

d. When the system pressure is fully exhausted, rotate and remove the radiator cap.

e. The coolant should be at level approximately even with the bottom of the radiator cap neck. If low, fill with the designated fluid prior to starting the truck. If coolant system is empty, remove flare cap on radiator and verify both tank sections are full.

NOTE: *Refer to the engine manufacturer's maintenance and service manual for the proper formulation of coolant. Always use the required antifreeze and inhibitors and follow the recommendations on service intervals and maintenance.*

f. Inspect the radiator cap gasket. Replace if necessary.

g. If possible, pressure test the cap assembly to ensure proper operation.

h. Install the caps and tighten securely. Close and securely fasten the cover plate.

2. Check the condition of the coolant. Refer to the engine manufacturer's maintenance and service manuals for the test requirements. If a change of coolant is required, proceed as follows:

a. Open all radiator and engine drain cocks as instructed in the engine manufacturer's manual.

b. Remove the radiator cap. This will speed the draining process by allowing air into the system to replace the coolant.

c. Flush the cooling system if required. Follow the recommendations of the engine and radiator manufacturer.

⚠ CAUTION

Chemical cleaning should always be performed first. Back-flushing should be done only if chemical cleaning is not satisfactory. Reverse or back-flushing forces a flow of liquid in the direction opposite to normal flow which loosens and removes scale and contaminant deposits that otherwise may remain lodged in the system, but it can also cause the system to clog at a later date.

NOTE: *If a flushing gun is not available, use a combination of water and air hoses as a substitute.*

d. Attach a hose at the top of the radiator to direct water away from the area and into the proper drain or storage container.

e. Fill the radiator with water from the gun.

f. Apply air pressure gradually until a pressure of 10 to 20 psi (70 to 140 kPa) is obtained.

⚠ CAUTION

Exceeding this pressure may cause damage to cooling system components.

g. Alternately fill with water and flush with air until the water exiting from the top is clean.

NOTE: *Short, quick blasts of air may be used to dislodge material if care is taken not to exceed the 20 psi (140 kPa) maximum pressure.*

h. Remove, clean and inspect the radiator cap. All deposits should be removed.

3. Verify the operation of the radiator pressurization system as follows:

a. Stop the engine. Turn off the Master Switch.

b. Remove the radiator cap (as outlined previously in these instructions) or use an equivalent means to relieve any residual pressure in the cooling system. Reinstall the cap.

c. Remove the air hose from the outlet and end of the check valve, and install a 0 to 60 psi (0 to 420 kPa) pressure gauge with bleed off provision into check valve outlet.

d. Verify that the air pressure gauge reads 40 psi (275 kPa).

e. Turn on the Master Switch and all circuit breakers. Take whatever action is required to allow air to flow to the radiator.

f. Verify that the pressure gauge on the check valve reads 10 +/- 1 psi (70 +/- 7 kPa).

g. Stop the flow of air to the system. Verify that the gauge remains at 10 +/- 1 psi (70 +/- 7 kPa). If not, find the leak and repair or replace.

NOTE: *Verify that the leakage is not through the check valve or radiator core.*

h. If adjustment is required adjust the pressure regulator as required then repeat steps through g.

i. Relieve all pressure in the cooling system as outlined previously.

j. Remove the gauge and reconnect all hoses.

4. Check all hoses and connections for leaks or damage.

5. Check the engine lubricating oil level. Oil levels too low or too high can cause overheating and possible loss of coolant.

6. Check for coolant in the oil and water in the oil. If either case is found, determine the cause and correct.

7. Check the fan for damaged or bent blades. Repair or replace as required.

8. Inspect the radiator for bent core fins or accumulation of road debris.

9. Check for leaks in the system.

RADIATOR COOLING MODULE

DESCRIPTION AND LOCATION (Figures 8 and 9)

The cooling module is an assembly which includes a radiator that consists of a number of series of separate cooling tubes mounted between top and bottom reservoirs. This finned tube assembly is mounted at the front of the truck between the grille and the cooling fan.

The hood side curtain and expanded metal grille assemblies are included in the cooling module.

OPERATION

The heated coolant from the engine enters the radiator through the inlet located at the top. The water then flows down through the finned copper tubes to the lower reservoir. While in the tubes, the heat is transferred from the water to the tubes and fins which in turn transfer it to the air moving through the radiator. The coolant exits the radiator through the outlet in the lower reservoir, returning to the engine to cycle again.

The radiator is constructed in a manner that allows each of the tubes to function independently. If a tube is damaged or plugged, it may be removed and replaced without removing the radiator.

MAINTENANCE AND ADJUSTMENT

Periodic maintenance should include the following steps:

1. Check the level of coolant in the radiator. Follow the instructions on the cooling system in Section 4 - Power Package.

2. Check the radiator exterior for accumulation of dirt and debris. This foreign material will reduce the radiator's capacity to transfer heat to the air. Clean as required.

NOTE: *If there is any doubt as to procedure or equipment, try the method on a single tube first or contact your Unit Rig representative.*

a. Blow out the loose material using high pressure air, typically first blowing from the air exit side toward the inlet side, then reverse the flow.

IMPORTANT: *The air should be sprayed straight into the core and not at an angle.*

b. Use a high pressure hot water washer with up to 1200 psi (8 275 kPa).

(1) Starting with the nozzle held closely to the fins near the top on the air exit side, working on a small area.

IMPORTANT: *The water flow should be sprayed straight into the core and not at an angle.*

(2) Continue washing from the top down until the exiting water is clean.

(3) Repeat on the opposite side.

IMPORTANT: *Many radiator shops use a high alkaline soap, caustic soda, or chemical additives to their boil-out tank which attach solders. If a tube is soaked in such a solution, the solder bond between the finning and tubes will be adversely affected. If it is known that the particular solution used is not harmful to solder, then it will not hurt the solder on the tube. Be sure to completely rinse the cleaned tube or core in clean water after removing from the boil-out tank.*

3. Inspect the radiator interior for accumulation of dirt and debris. This foreign material will reduce the radiator's capacity to transfer heat to the air. Clean as required.

IMPORTANT: *Corrosion, silicate gelling, and other forms of contamination can have a great adverse affect on the operation of the radiator and entire cooling system. Consult your antifreeze supplier, engine manufacturer, and Unit Rig representative on recommendations to eliminate or reduce these conditions.*

4. If so equipped, verify the operation of the radiator pressurization system as outlined in the module on the Cooling System in Section 4 - Power Package.

5. Inspect the inlet and outlet fittings and hoses. If loose or showing evidence of deterioration, repair or replace as required.

6. Inspect the fan shroud, guards and other accessories installed on the radiator. It should be firmly attached to the radiator and in good condition. Repair or replace as required.

7. Inspect the crossbraces. They should be tensioned evenly without distorting the radiator assembly.

8. Inspect all mounting points. The rubber shock mount should be pliable and in good condition. The support arms should be properly adjusted to support the radiator evenly on each side - not to place it in a twisting bind. The lower mounting points should be tight and in good repair. Repair or replace as required.

REMOVAL (Figure 8)

NOTE: *It is not necessary to remove the radiator to replace individual core tubes. These may be replaced with the radiator in place. Refer to the instructions on Disassembly and Assembly in this module for this procedure.*

The radiator may be removed as follows:

1. Park the truck in a SAFE POSITION. It must be secured by means other than the truck's friction brake system.

2. Release all pressure from the cooling system as outlined in the instructions in Section 4 - Power Package.

3. Drain all coolant from the radiator and engine assembly.

4. Disconnect all hoses attached to the radiator. (See Figure 9.) Mark these hoses to aid in reassembly.

5. Remove the hood assembly as outlined in the instructions in Section 2 - Structure.

6. Disconnect and remove the radiator top brace assembly.

7. Support the radiator assembly by means of the lifting hose provided in the radiator side channels.

8. Remove the hardware that secures the radiator to the main frame assembly.

9. Remove the radiator assembly from the truck, taking care not to damage the radiator core on the radiator fan assembly.

NOTE: *The thin non-ferrous fins and tubes of the radiator core sections are easily damaged. Extreme care should be used when handling the radiator.*

DISASSEMBLY (Figure 4)

The individual tubes may be removed from the radiator as follows:

NOTE: *It is not necessary to remove the radiator to replace individual core tubes. These may be replaced with the radiator in the truck.*

1. Heat the tubes and rubber seals with hot water to assist in tube removal.

2. Loosen the tube using a breaker tool (Figure 1) placed at the top and bottom, as near the seals as possible. Do not attach in the middle as this may result in the twisting or deformation of the tube.

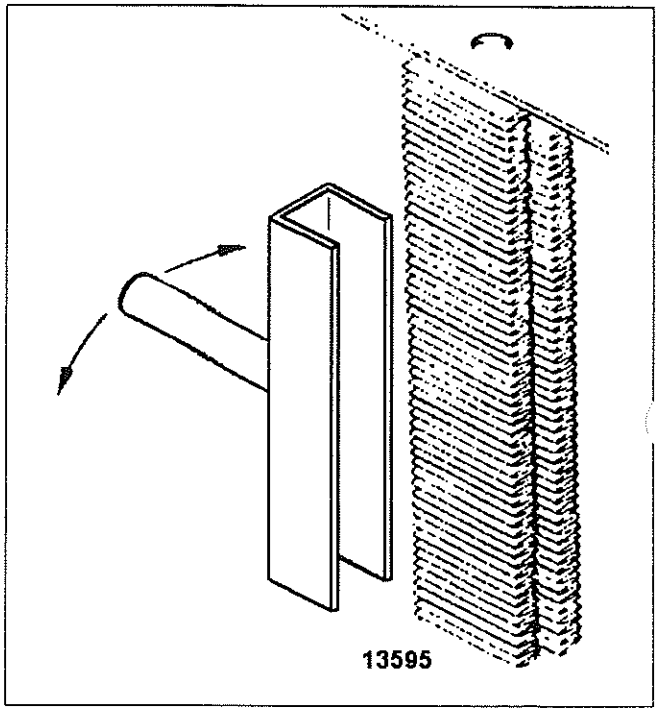


FIGURE 1 - TUBE BREAKER TOOL

3. After the tube is free, place the upper jaw of the installation tool (Figure 2) around the round portion of the tube just below the flattened portion.

4. Insert the lower jaw of the tool so that the taper of the jaw seats between the seal and metal ferrule, not on top of the seal.

5. Squeeze the handles together and raise the tube only enough to clear lower rubber grommet. (Refer to Figure 3).

6. Remove the tool and swing the tube to clear the lower seal. Pull the tube down to remove it from the upper seal.

7. Repeat the procedure for the remaining tubes.

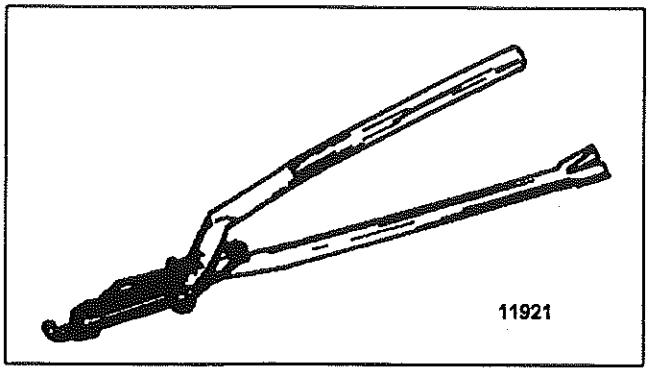


FIGURE 2 - RADIATOR TUBE INSTALLATION TOOL

⚠ CAUTION

Remove the upper tubes first when repairing radiators with split cores. The lower tubes cannot be raised for removal with upper tubes in place.

Also, care should be exercised when removing the tubes from the lower core. This is because when the tubes are in a completely raised position, the upper end may extend into the plate above, and, when the tube is swung out, it may bind, bending the upper end.

8. Remove all seals from the metal ferrules.

The radiator may be disassembled as follows:

1. Remove the fan shroud, guards, etc. by unbolting the attaching bolts.

2. Remove the radiator crossbraces.

3. Remove the top and bottom reservoir tanks by removing the attaching bolts, washers, and nuts.

4. Remove the bolts that attach the member to be removed from the side members.

5. Disassemble the remainder of the assembly as required.

INSPECTION AND REPAIR

The unit may be serviced as follows:

1. Inspect the metal ferrules for evidence of damage. Repair or replace as required.

NOTE: *The tube holes should be cleaned of foreign debris using a 3/4 inch (19 mm) wire brush in an electric or air drill or similar device.*

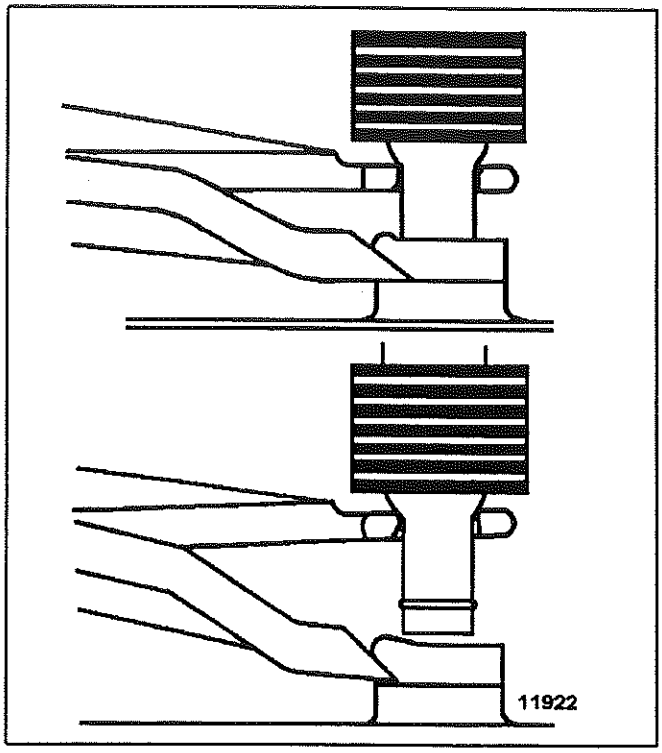


FIGURE 3 - RADIATOR TUBE REMOVAL

2. Clean all foreign material from the ferrules.

3. Clean all gasket material from sealing surfaces.

4. Repair or replace all damaged or leaking tubes. Check all repaired tubes for leakage prior to reinstalling.

5. Check the condition of the fins and tubes. Damage or accumulated dirt will reduce heat transfer and radiator efficiency. Clean, or replace as required.

a. If the original tubes are reinstalled, the tube ends must be clean of foreign materiel. Buffing with a polishing wheel and copper polish is a recommended method.

b. If the debris can not be removed by buffing:

(1) Use a wire wheel to remove the material. Use care not to mar the tube ends.

(2) Use a buffer as outlined in step a, to smooth the surface to improve installation and sealing.

IMPORTANT: *Corrosion, silicate gelling, and other forms of contamination can have a great adverse affect*

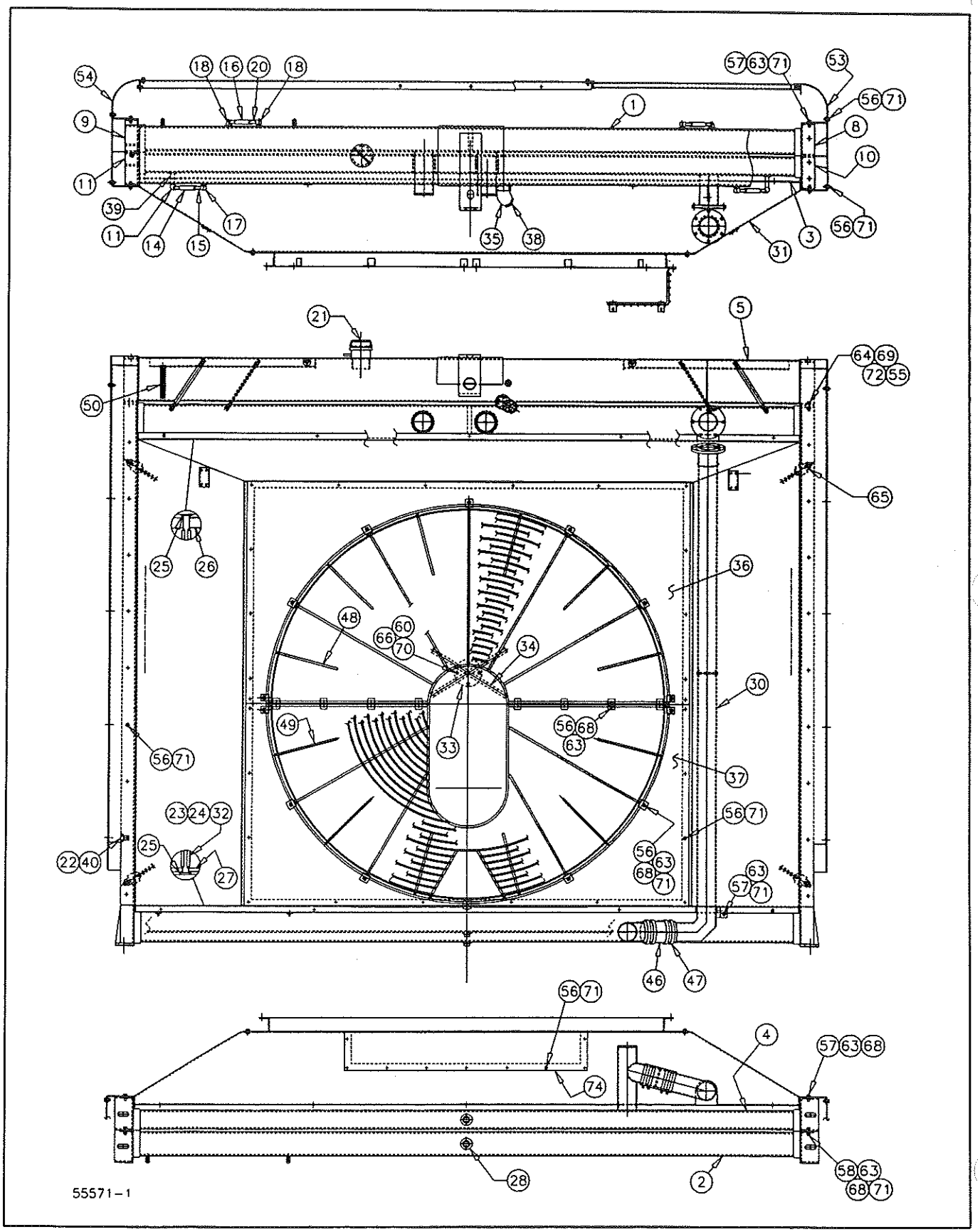


FIGURE 4 - TYPICAL RADIATOR ASSEMBLY

KEY							
01.	Tank	20.	Threaded Fitting	39.	Pipe Nipple	58.	Capscrew
02.	Tank	21.	Radiator Cap	40.	Overflow Hose Clip	59.	Capscrew
03.	Tank	22.	Overflow Hose	41.	Bracket	60.	Capscrew
04.	Tank	23.	Locking Tube Assembly	42.	Core Guard	61	Shoulder Screw
05.	Surge Tank	24.	Locking Tube	43.	Core Guard	62.	Nut
06.	Center Tank	25.	Rubber Seal	44.	Channel	63.	Nut
07.	Center Tank	26.	Top Felt Air Baffle	45.	Channel	64.	Nut
08.	Side Tank	27.	Bottom Felt Air Baffle	46.	Hose	65.	Nut
09.	Side Tank	28.	Pipe Plug	47.	Hose Clamp	66.	Nut
10.	Side Tank	29.	Fill Tube	48.	Fan Guard	67.	Lockwasher
11.	Side Tank	30.	Fill Tube	49.	Fan Guard	68.	Lockwasher
12.	Center Support	31.	Fan Shroud	50.	Sight Glass Assembly	69.	Lockwasher
13.	Center Support	32.	Tube Stay End	51.	Bracket	70.	Lockwasher
14.	Pipe Elbow	33.	Crossbrace Clamp	52.	Bracket	71.	Lockwasher
15.	Hose	34.	Crossbrace Rod	53.	Core Guard	72.	Capscrew
16.	Hose	35.	Street Elbow	54.	Core Guard	73.	Core Guard
17.	Pipe Adapter	36.	Fan Ring	55.	Flatwasher	74.	Side Fan Shroud
18.	Pipe Adapter	37.	Fan Ring	56.	Capscrew		
19.	Threaded Fitting	38.	Reducer Bushing	57.	Capscrew		

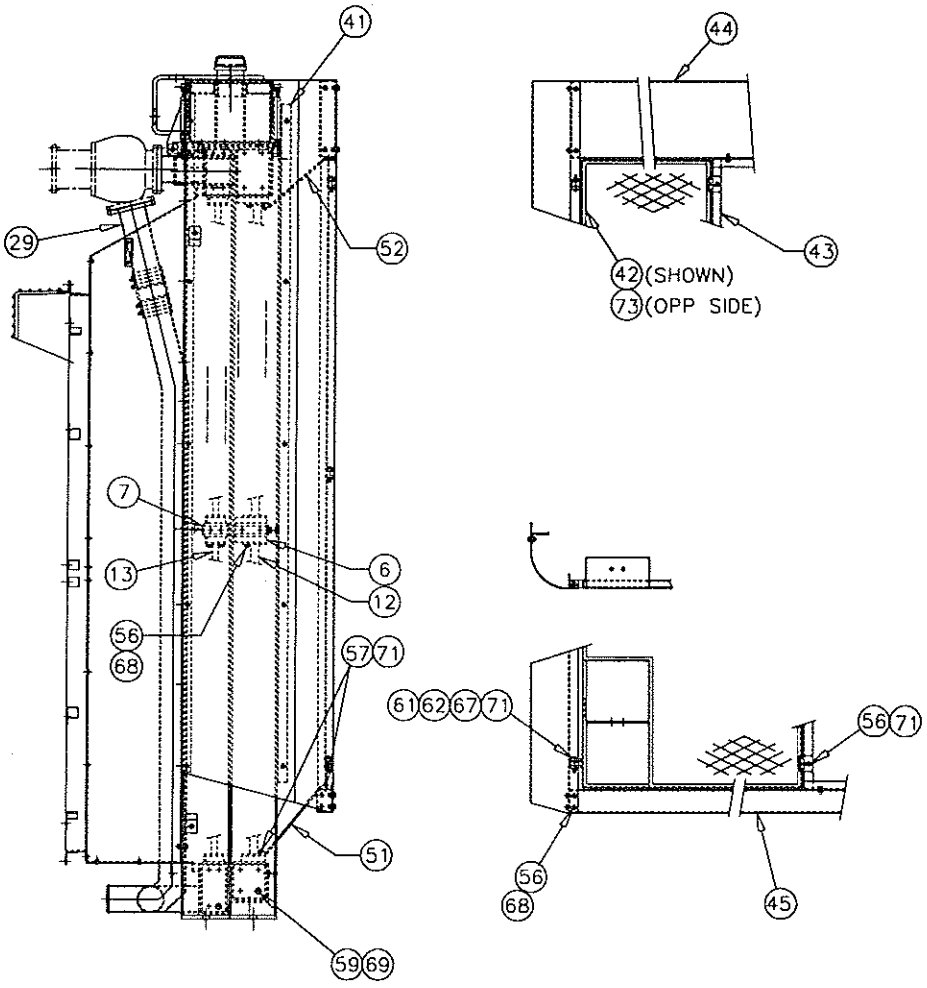


FIGURE 4 - TYPICAL RADIATOR ASSEMBLY (CONTINUED)

on the operation of the radiator and entire cooling system. Consult your antifreeze supplier, engine manufacturer, and Unit Rig representative on recommendations to eliminate or reduce these conditions.

IMPORTANT: *Many radiator shops use a high alkaline soap, caustic soda, or chemical additives to their boil-out tank which attach solders. If a tube is soaked in such a solution, the solder bond between the finning and tubes will be adversely affected. If it is known that the particular solution used is not harmful to solder, then it will not hurt the solder on the tube. Be sure to completely rinse the cleaned tube or core in clean water after removing from the boil-out tank.*

ASSEMBLY

The individual tubes may be installed in the radiator as follows:

1. Clean all foreign material from the metal ferrules.

2. Install new rubber seals in the ferrules and seat the seals firmly against the mounting face, using a small mallet.

IMPORTANT: *There is a difference in the tubes and seals used in the single upset and "new" locking tube designs. Be sure to install the correct seals for the tube being installed. The "new" seal cannot be used at the bottom of the single upset tube design. See Figure 5.*

3. Using a 1/2 inch (13 mm) diameter, soft bristle brush, coat the inside of the seals and ends of the tubes with a special lubricant (or small amounts of petroleum jelly, mineral oil, or equivalent). This will ease the installation.

4. Install the tubes starting with an inner row. Insert the end of the tube with the longest round section into the seal of the upper plate.

⚠ CAUTION

Care should be taken to minimize the angle of the tube with respect to the seal and to center the tube in the seal.

NOTE: *As outlined previously, install the lower tubes first as they cannot be raised once the upper tube is in place.*

5. Insert the other end of the tube into the seal in the corresponding hose of the lower plate. Push the tube into the seal until the bead of the tube seats on the seal or in the in the groove of the lower seal, depending upon the tube and seal assembly installed. Use the installation tool as shown in Figure 6.

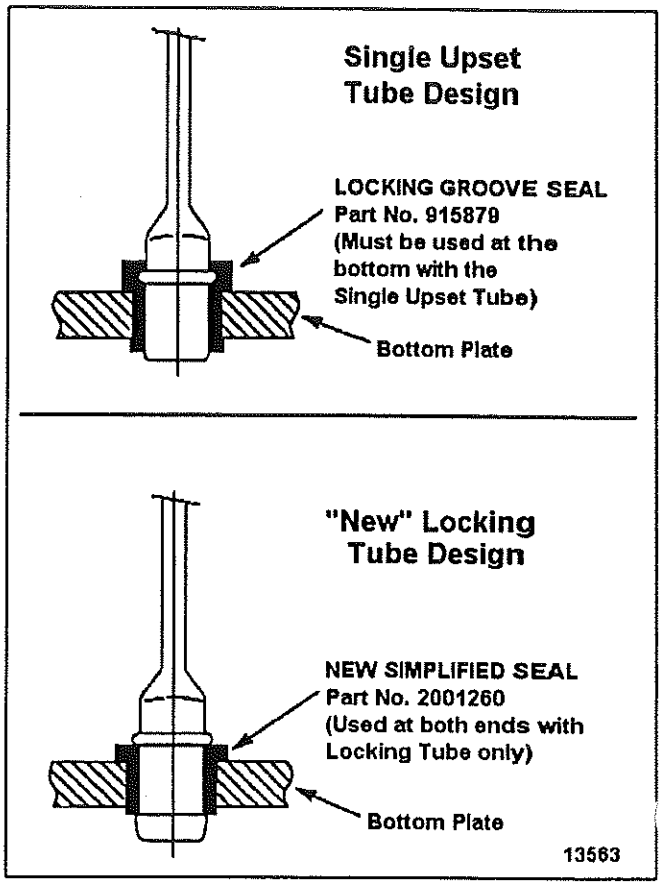


FIGURE 5 - TUBE STYLES

IMPORTANT: *Precautions should be taken to be sure that the tubes are centered correctly in the seals. When properly lubricated and centered, the tubes are easily installed, and no scuffing or tearing of the seals occurs. This scuffing or tearing could result in seal leakage.*

6. Complete the row of tubes. Make sure that the tubes are straight and aligned to ensure maximum air flow.

7. Install the individual tube stay (and stay ends if required) to interlock the tubes. The stays should be installed between each row of tubes.

8. Install the top and bottom felt baffles between the first and second rows of the tubes as shown in Figure 7.

NOTE: *The top felt baffle is larger than the bottom baffle.*

9. Install the remaining rows of tubes in a similar manner.

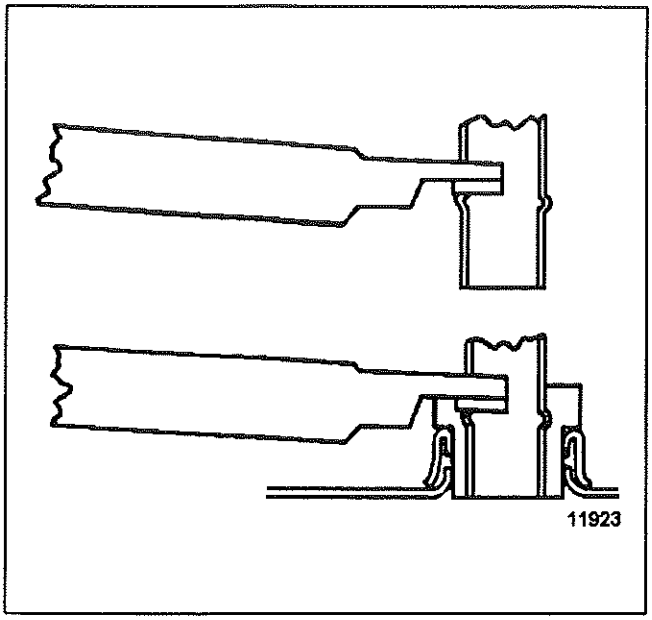


FIGURE 6 - RADIATOR TUBE REMOVAL/INSTALLATION TOOL

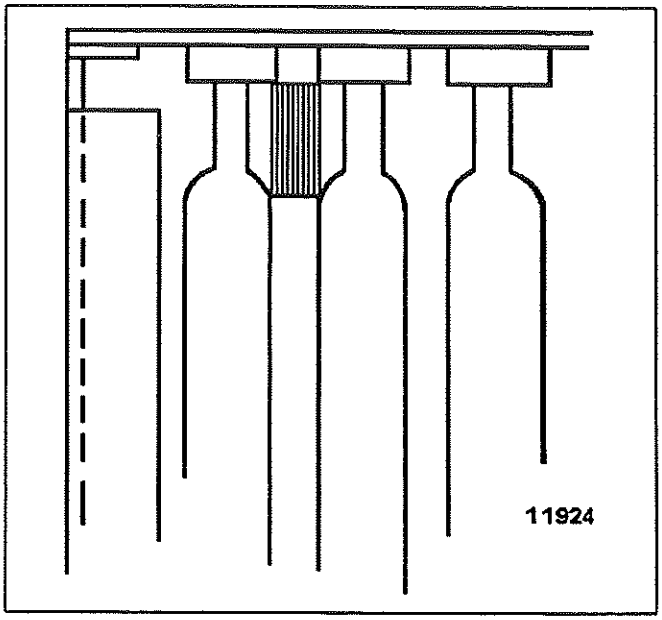


FIGURE 7 - INSTALLATION OF FELT BAFFLES

The radiator may be assembled as follows:

1. If the reservoir tanks were removed, reassemble them. Always install the core bolting straps and gaskets as shown in Figure 4.

IMPORTANT: *Use only cork neoprene gaskets soaked in light oil. Do not use any cement type sealers such as Permatex or Instant Gasket.*

2. Tighten the assembled bolts until the gasket protrudes 0.06 to 0.12 inch (1 to 3 mm). Trim off the excess gasket material.

3. Install the reservoir tanks as directed in steps 1 and 2.

4. Secure all components to the side members.

5. Install crossbrace members. Tighten each in small, 1 ft-lb (1.5 Nm), increments to a torque of 5 ft-lb. (7 Nm).

6. Install fan shroud and guards and other accessory parts.

INSTALLATION

The radiator may be installed as follows: (Figure 8)

1. Using a suitable lifting device attached to the radiator lifting brackets, position the radiator assembly on the radiator support brackets located on the front of the main frame structure.

2. Securely install the radiator with the shock mounts (9), snubbing washers (10), capscrews (3), and locknuts (4).

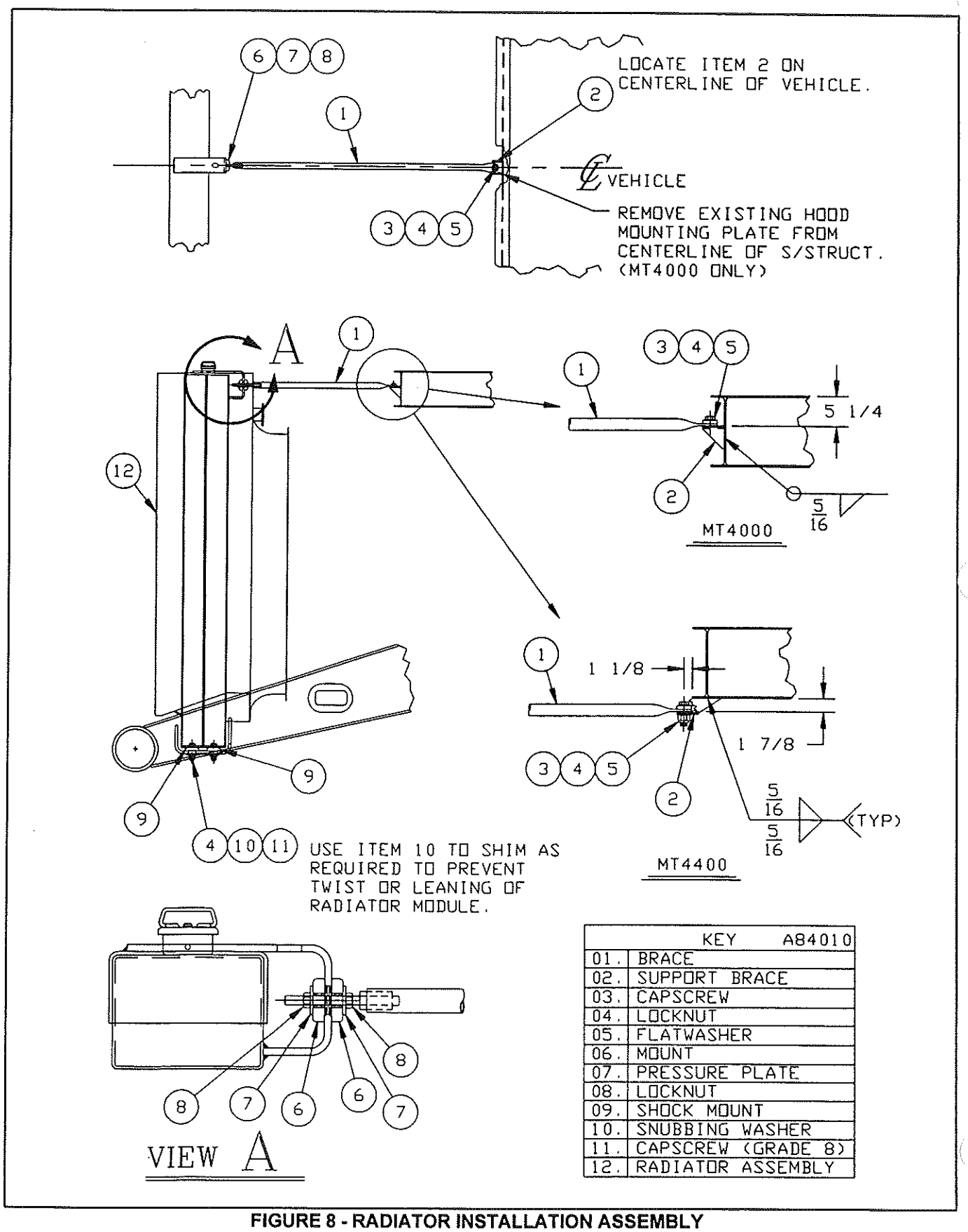
NOTE: *Use the snubbing washers to shim the radiator assembly as required to prevent the module from twisting or leaning. Do not over-tighten the locknuts to extrude or damage the rubber shock mounts.*

3. Install the upper brace assembly as shown in Figure 8. Adjust the length as required to support the radiator in the vertical position. Do not over-tighten the locknuts to extrude or damage the rubber cushion mounts on either end.

4. Install the radiator piping as outlined in Figure 9.

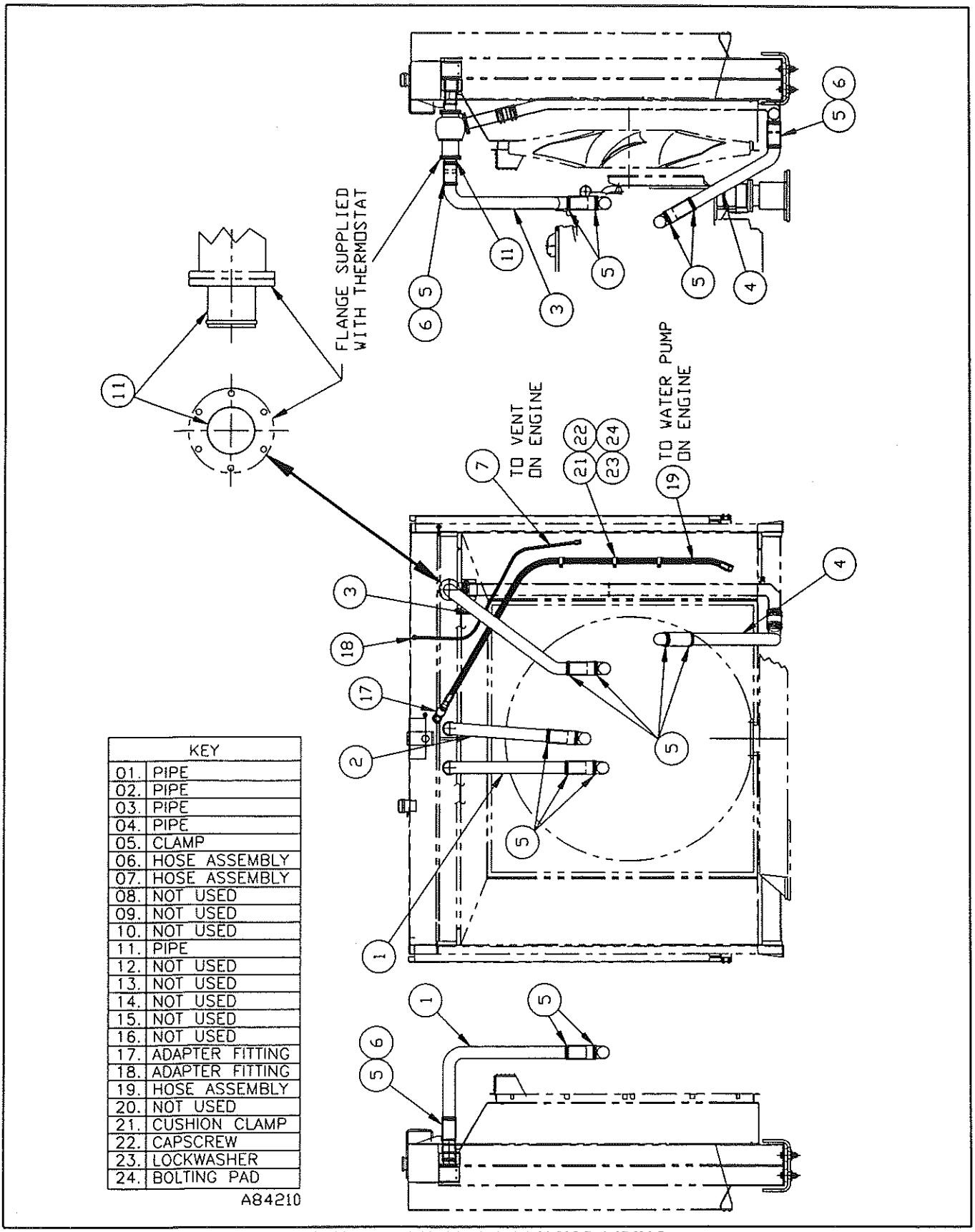
5. Install the hood assembly as outlined in the instructions in Section 2 - Structure.

6. Close all cooling system drain cocks and refill the cooling system. Check the cooling system for leaks. Follow the instructions in Section 4 - Power Package.



KEY A84010	
01.	BRACE
02.	SUPPORT BRACE
03.	CAPSCREW
04.	LOCKNUT
05.	FLATWASHER
06.	MOUNT
07.	PRESSURE PLATE
08.	LOCKNUT
09.	SHOCK MOUNT
10.	SNUBBING WASHER
11.	CAPSCREW (GRADE 8)
12.	RADIATOR ASSEMBLY

FIGURE 8 - RADIATOR INSTALLATION ASSEMBLY



KEY	
01.	PIPE
02.	PIPE
03.	PIPE
04.	PIPE
05.	CLAMP
06.	HOSE ASSEMBLY
07.	HOSE ASSEMBLY
08.	NOT USED
09.	NOT USED
10.	NOT USED
11.	PIPE
12.	NOT USED
13.	NOT USED
14.	NOT USED
15.	NOT USED
16.	NOT USED
17.	ADAPTER FITTING
18.	ADAPTER FITTING
19.	HOSE ASSEMBLY
20.	NOT USED
21.	CUSHION CLAMP
22.	CAPSCREW
23.	LOCKWASHER
24.	BOLTING PAD

A84210

FIGURE 9 - TYPICAL RADIATOR PIPING

ENGINE MODULE
MTU ENGINE EQUIPPED TRUCKS

DESCRIPTION AND LOCATION

The engine module consists of the following:
- diesel engine
- main traction alternator with in-line electrical equipment cooling blower
- 24 Vdc battery charging alternator

The engine module is mounted to the front portion of the main frame. Rubber insulation pads are mounted between the main frame and sub-frame to reduce vibration.

OPERATION

The engine module provides power for a variety of functions. The diesel engine provides power to turn the main traction alternator. The alternator, in turn, supplies electrical power to the wheelmotors. The engine module also drives the truck's hydraulic pumps, and battery charging alternator.

TROUBLESHOOTING

Refer to the appropriate manufacturer's information for detailed troubleshooting.

MAINTENANCE AND ADJUSTMENT

Periodic maintenance should include the following steps:

1. Clean the engine module assembly.

2. Check the condition of all components.

3. Verify that all mounting hardware is secure.

4. Check the condition of the rubber isolation mounting pads.

5. Check for leaks.

REMOVAL

The complete engine module may be removed from the truck as follows:

NOTE: *It is recommended that the engine module be removed with the traction alternator assembly attached.*

1. Park the truck in a SAFE POSITION. It must be secured by means other than the friction brake system.

2. Drain all pressure from the pneumatic, hydraulic, fuel, and cooling systems.

3. Remove the cooling module assembly as outlined in the information in Section 4 - Power Package.

4. Remove the hood assembly as outlined in the instructions in Section 2 - Structure.

5. Disconnect all fluid lines between the engine and other areas.

6. Disconnect the main electrical lines and cables from the alternator.

7. Remove the cooling blower ducting as required. See the information in Section 4 - Power Package.

8. Disconnect the air intake and exhaust ducting from the engine. Cover all openings to prevent contamination.

9. Remove all other lines and hoses coupled to the module.

10. Uncouple the driveshaft between the alternator and the hydraulic pump.

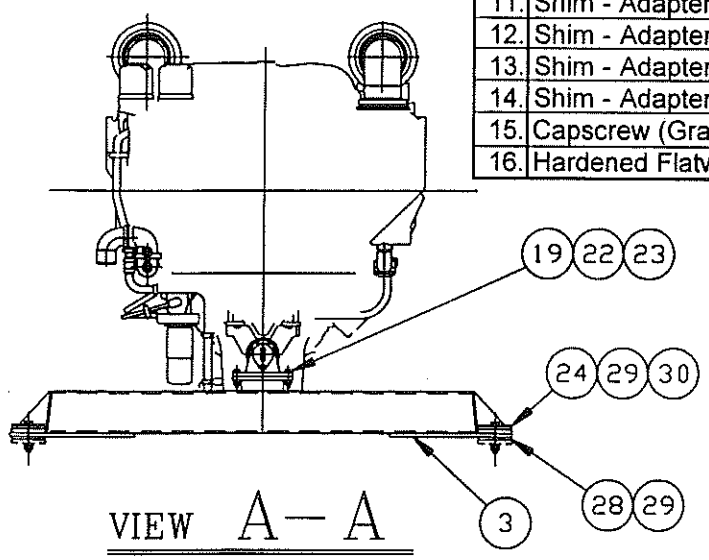
11. Remove the module from truck as follows:

NOTE: *It is recommended that a lifting device built specifically for the type of engine and truck involved (like those available from Unit Rig) be used. The use of a come-along is recommended during removal and installation, as it allows the engine to be tilted front-to-rear.*

a. Use an overhead crane or other suitable hoist with sufficient lifting capacity, and position the engine module lifting beam over the engine module. Attach the rear cables to the alternator support brackets, and the front lifting hooks to the appropriate engine or engine skid brackets.

b. Insert a come-along with a sufficient lifting capacity between the front lifting hook and the main lifting lug area.

KEY			
01.	Engine	17.	Capscrew (Grade 8)
02.	Alternator	18.	Lockwasher
03.	Engine Front Support	19.	Flatwasher
04.	Left Engine/Alternator saddle	20.	Capscrew
05.	Right Engine/Alternator Saddle	21.	Lockwasher
06.	Alternator Guard	22.	Capscrew
07.	Shim - Flywheel (0.010 in. (0.25 mm)	23.	Locknut
08.	Shim - Flywheel (0.020 in. (0.50 mm)	24.	Capscrew
09.	Shim - Flywheel (0.005 in. (0.12 mm)	25.	Capscrew
10.	Shim - Adapter (0.040 in. (1.01 mm)	26.	Lockwasher
11.	Shim - Adapter (0.060 in. (1.52 mm)	27.	Capscrew (Metric)
12.	Shim - Adapter (0.005 in. (0.12 mm)	28.	Locknut
13.	Shim - Adapter (0.010 in. (0.25 mm)	29.	Rubber Engine Mount
14.	Shim - Adapter (0.020 in. (0.50 mm)	30.	Washer
15.	Capscrew (Grade 8)	31.	Flexible Coupling
16.	Hardened Flatwasher		



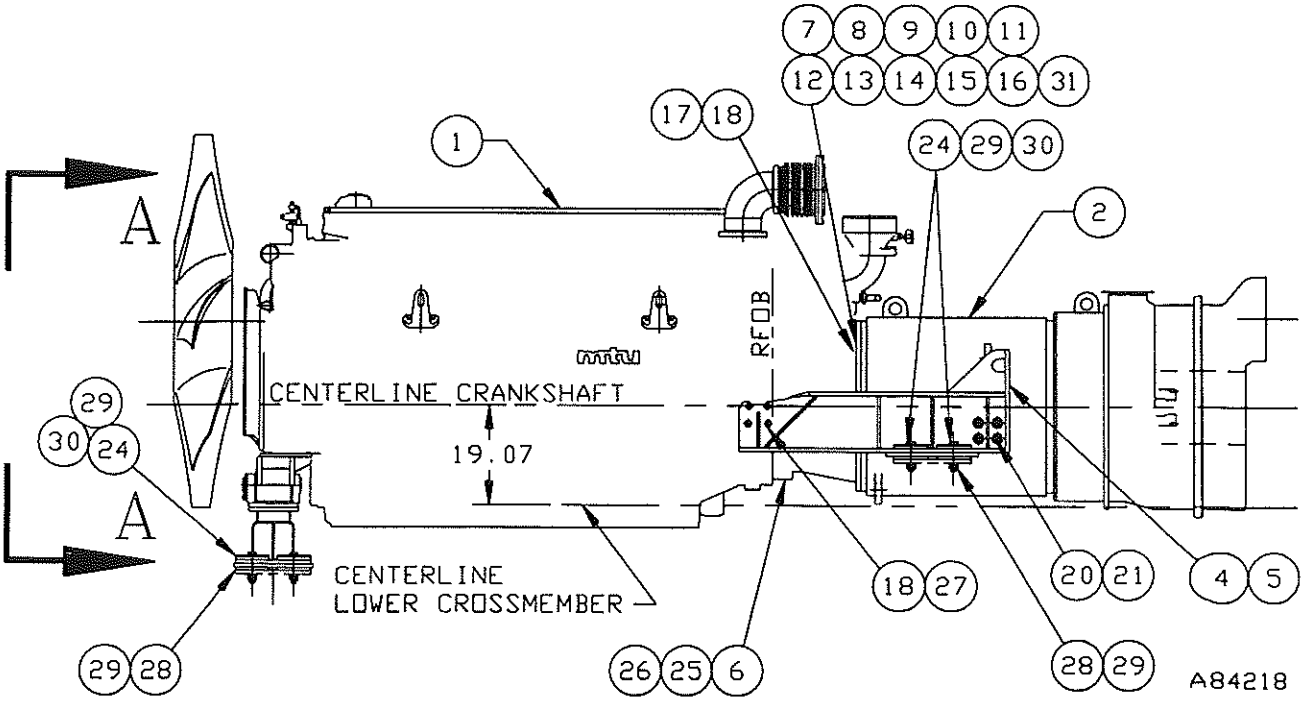


FIGURE 1 - ENGINE AND ALTERNATOR MODULE ASSEMBLY

c. Remove the mounting bolts that secure the module to the truck frame.

d. Carefully raise and remove the engine module. Use the come-along to tilt the module as required.

12. Place the engine module on suitable stands, or block it to ensure safe conditions for future work or storage.

⚠WARNING

Before beginning any work on the engine module, ensure that it is supported on suitable stands or blocking. Failure to do so may result in personal injury, equipment damage, or both.

DISASSEMBLY

The alternator may be removed from the engine as follows:

1. Install a gear adapter for engine barring into the starter access opening.

NOTE: *If the same engine and alternator are to be reassembled, mark the position of the coupling on the flywheel, and reinstall with the same "clocking."*

2. Remove the mounting brackets secured to both the engine and alternator.

3. Use the gear adapter and a ratchet to rotate the engine crankshaft. Remove the bolts that attach the armature to the flywheel. Access to the bolt is gained through the starter access opening.

4. Remove the bolts from each bracket, and remove the motor support brackets.

5. Using suitable adapters and a sling, support the alternator with a crane.

6. Remove the bolts and nuts that attach the alternator to the flywheel housing adapter.

7. Remove the alternator by moving it rearward, then lifting it clear of the engine.

NOTE: *The shims removed should be retained with the alternator. Before installation, however, it is recommended that the entire shimming procedure be followed for mounting the alternator on the engine, even if it is the same engine and alternator. This will ensure that the proper clearances are maintained.*

SERVICE

Servicing the engine module components should include the following:

1. Repair the engine and alternator as outlined in the specific manufacturer's instructions for the particular component.

2. Inspect the truck's engine air intake and exhaust piping for evidence of leakage, wear, or damage. Repair or replace as required.

3. Inspect the engine skid assembly and mounting brackets and pads of evidence of deterioration, wear, or damage. Repair or replace as required.

4. Inspect the truck's engine area for evidence of damage. Repair as required.

ASSEMBLY

The alternator may be installed on the engine as follows:

NOTE: *Special equipment and tools required to assist in assembly including:*
1. Dial Indicator with a variety of mounting feet.
2. Mounting fixtures to allow the indicator to rotate with and also measure dimensions on the flywheel.
3. An engine barring tool and related equipment to allow the engine crankshaft to be easily rotated slowly while taking measurements.
4. A special gauge bar assembly (manufactured by Unit Rig) to assist in obtaining certain measurements.
5. A 2 to 3 inch (50 to 75 mm) depth micrometer to use in conjunction with the gauge bar in acquiring the needed measurements.

It is also recommended that a worksheet of important measurements be maintained during assembly for possible future reference. An example worksheet is shown in Table 1.

1. Install the gear adapter for engine barring into starter opening on either side of engine.

2. Clean all protective coating, dirt, etc., from the flywheel assembly and flywheel housing adapter. Smooth any nicks, burrs, gouges, etc. from mounting surfaces or pilots.

3. Measure the flywheel pilot (radial) run-out as follows:

I. **ENGINE MEASUREMENTS**

A. Flywheel pilot radial run out _____ inch (mm)

(TIR - - Total Indicated Run Out)

B. Flywheel housing adapter axial (face)

_____ inch (mm) (TIR)

C. Flywheel housing adapter concentric (centered)

run out _____ inch (mm) (TIR)

II. **SHIM REQUIREMENT MEASUREMENTS**

A. Engine (flywheel) measurements

1 _____ inch (mm)
2 _____
3 _____
4 _____
Total _____ inch (mm)

Average engine measurement "A" A = _____ inch (mm)

(Divide above total by 4)

B. Alternator measurements

1. With armature at rear (bottom)

1 _____ inch (mm)
2 _____
3 _____
4 _____

2. With armature at front (lifted)

1 _____
2 _____
3 _____
4 _____
Total _____ inch (mm)

Average alternator measurement B = _____ inch (mm)

"B" (Divide total above by 8)

III. **SHIM REQUIREMENTS**

A. If dimension "B" is greater than "A", the shims are required between the flywheel housing adapter and the alternator housing.

B. If dimension "A" is greater than "B", the shims are required between the flywheel (coupler) and the armature.

C. The shim thickness to be installed is equal to the difference between the two dimensions - - a tolerance of 0.005 inch (1.5 mm) is the maximum allowed.

Shims required _____ inch (mm)

Where Located _____

13554

TABLE 1 - ENGINE/ALTERNATOR SHIMMING WORKSHEET

a. Install the dial indicator so that it will measure the flywheel pilot run-out (base on the flywheel housing adapter, indicator on flywheel, measuring the run-out on the self contained pilot ring).

b. Zero the indicator and mark the starting position. Rotate the crankshaft clockwise one complete revolution.

NOTE: *When the crankshaft is rotated one complete revolution, the dial indicator must return to zero. If it does not, either the crankshaft has shifted or the dial indicator has moved. The run-out measured is useless unless the indicator returns to zero. Repeat this step as necessary.*

c. Record the measurement. It must be within 0.015 inches (0.4 mm) TIR or must be corrected before continuing with this procedure.

4. Measure the flywheel housing adapter axial (face) run-out as follows:

a. Install the indicator so that it will measure the axial run-out (base on flywheel, indicator on adapter face), but will not be obstructed by bolt holes.

b. Zero the indicator and mark the starting position. Rotate the crankshaft clockwise one complete revolution with the barring mechanism. Observe the maximum indicator readings and record TIR.

Example: +0.005 inch (0.13 mm) and - 0.004 inch (0.10 mm) would be 0.009 inch (0.23 mm) TIR.

NOTE: *The indicator must return to zero with one complete revolution. Repeat this step if necessary.*

c. Record the measurement. It must be within 0.015 inches (0.4 mm) TIR or must be corrected before continuing with this procedure.

5. Measure the flywheel housing adapter concentric (radial) run-out as follows:

a. Install the dial indicator so that it will measure the flywheel housing adapter concentricity (base on flywheel, indicator on adapter housing inner surface), but will not be obstructed by bolt holes.

b. Zero the indicator and mark the starting position. Rotate the crankshaft clockwise one complete revolution with the barring mechanism. Observe maximum indicator readings and record TIR.

Example: +0.005 inch (0.13 mm) & -0.004 inch (0.10 mm) would be 0.009 inch (0.23 mm).

NOTE: *The indicator must return to zero with one complete revolution. Repeat this step if necessary.*

c. Record the measurement. It must be within 0.015 inches (0.4 mm) TIR or must be corrected before continuing with this procedure.

6. After ensuring that all of the engine measurements are within tolerances, measurements for determining the "A" dimension for shimming may be taken as follows:

a. Using the appropriate special gauge bar (available from Unit Rig) and the 2 to 3 inch (50 to 75 mm) depth micrometer, measure the distance between the flywheel housing adapter mounting face and the drive ring mounting face. Record four measurements: at 12, 3, 6 and 9 o'clock positions.

b. Average the four measurements. Record this dimension as "A".

7. Determine the alternator "B" measurements as follows:

a. Clean all protective coating, dirt, etc., and smooth any nicks, burrs, gouges, etc., from the mounting surfaces or pilots.

b. Using the appropriate sling, place the alternator in a vertical position with the mounting face up. Place a stand or blocks under the alternator of sufficient height to prevent the sheaves, electrical terminals, etc., from touching the floor.

NOTE: *A special stand/jig is used for engines fitted with in-line blowers. With this jig the engine can be moved around in different planes to carryout the measurements accurately for shimming purposes.*

⚠ CAUTION

Balance and lift the alternator high enough to prevent the sheaves, electrical terminals, etc., from hitting the floor. Protect the in-line blower assembly.

c. Shim the front of the armature to the approximate center of the housing by using equal shims between the armature and housing.

⚠ CAUTION

Care must be taken to ensure that the shims do not fall into the armature. It is suggested that the shims have tabs on the ends and/or be held in place by tape.

d. Measure and record the distance between the mounting face on the armature and the mounting face on the housing (with the same special gauge bar and depth micrometer specified for the engine) at four places, (12, 3, 6 and 9 o'clock positions).

e. Install two eye bolts at 180° intervals in the armature mounting face, and remove the shims between the armature and alternator housing. Attach chains to the eye bolts and lift the armature to the top or forward position. Install the shims between the armature and housing. Do not allow the shims to fall into the alternator.

⚠ DANGER

Do not lift the alternator off the stand as this may damage the bearings. Be sure the armature is at its maximum top (or forward) position, as it is most important that the armature bearing end-play be measured accurately.

f. Measure and record the alternator dimensions outlined in step b above.

g. Add the four measurements taken at each end of the travel. Calculate the average of these 8 dimensions. This dimension, called "B", is the equivalent of a measurement with the armature at the center of its end-play.

h. Remove the shims between the armature and alternator housing used to center the armature, and lower the armature into a resting position in the housing.

8. The amount of shims required is the difference between dimensions "A" and "B". If dimension "B" is greater than dimension "A", place the shims between the flywheel housing adapter and the alternator housing. If dimension "A" is greater than dimension "B", place the shims between the flywheel coupling and the alternator armature.

⚠ CAUTION

The shim stack must be measured to verify correct thickness. If tape is used to hold shims in place, it must not be left in during final assembly. Shims installed in the wrong location are worse than no shims, and probably would cause crankshaft and alternator failure due to axial pre-load.

NOTE: *The smaller shims are either one piece or 1 part number makes one piece. The larger shims require four parts to form one shim.*

9. The engine and alternator may be mated as follows:

a. Rotate the crankshaft to position dowel pins on the flywheel at 6 and 12 o'clock positions.

b. Rotate the armature to position the dowel pin holes on the armature mounting face at 6 and 12 o'clock positions.

c. Lift the alternator using a sling, and rotate it to a horizontal position.

⚠ CAUTION

Do not bump sheaves, electrical terminals, etc., on the floor while handling the alternator.

d. Move the alternator close enough to the engine to start at least two capscrews through the adapter and into the alternator. At the same time, rotate the crankshaft to align the dowel pins with the appropriate holes.

NOTE: *To ease in installation, the upper capscrews should be inserted into the flywheel housing adapter prior to mating.*

e. If the supports are still in place on the alternator, the bolts should be loose enough to not interfere with the coupling.

f. Look through the access hole in the flywheel housing to ensure the capscrew holes are aligned. Install all capscrews through the adapter and into the alternator housing.

g. Rotate the crankshaft as required to install all capscrews and washers through the flywheel and into the armature.

IMPORTANT: *Use only SAE Grade 8 capscrews or equivalent. Substitution of lower grade capscrews may result in damage to the equipment.*

h. Torque each capscrew progressively in 50 ft-lb.

(70 Nm) increments (lubricated) until a final torque of 180 to 190 ft-lb. (245 to 260 Nm) is reached. This procedure also applies to the capscrews on the flywheel/armature and those connecting the housing adapter and the alternator.

i. Install both the right and left engine skid supports.

NOTE: *The use of thread locking compound such as Loctite 242 (or equivalent) is recommended.*

j. Block the rear end of the alternator housing to help support the alternator and to allow removal of the sling.

10. Install the supports/mounting brackets, if removed.

11. If removed, install the fiberglass alternator blower cover, making sure it is indexed as instructed in the unit's assembly instructions.

12. Verify there is a 1/2 inch (13 mm) diameter drain hole in the 6 o'clock position on the rear section of the blower housing. If not, drill one.

INSTALLATION (Figure 1)

The engine module may be installed as follows:

1. Use an overhead crane or other suitable hoist, with sufficient capacity, and position the lifting device over the engine module. Attach the cables to the alternator, and the front mount to the front lifting lug on the engine or engine module skid.

2. Install a come-along with sufficient lifting capacity from the front beam to the main lifting hook.

3. Use the come-along to tilt the engine module as required. Carefully place the module into position in the main frame.

IMPORTANT: *Extra care must be taken to avoid damage to all duct work, piping, electrical lines, etc., during installation. If any damage should occur, inspect and repair immediately.*

4. Install the rubber cushioning pads and capscrews. Torque the nuts as required, but do not over compress the isolation mounts.

5. Connect the ducting to the blower and axlebox.

⚠ CAUTION

When installing the ducting, make sure that all connections form tight seals, and that all passageways are free of damage. Holes or restrictions will result in reduced cooling air flow and could cause overheating of components.

6. Connect the driveshaft between the alternator and the hydraulic pump.

7. Connect all engine air and exhaust ducting. Check all components and connections for evidence of damage or leakage. A small leak will allow enough contamination to destroy an engine.

8. Connect all electrical, fuel, air, and hydraulic connections.

9. Install the module as outlined in the instructions in Section 4 - Power Package and all hosing and wiring previously removed.

10. Install the hood and grille assemblies.

11. Verify proper fluid levels. Check for leakage and proper operation prior to placing the truck into service.

ALTERNATOR AND WHEELMOTOR COOLING

DESCRIPTION AND LOCATION

The alternator and wheelmotor cooling system provides a constant flow of air to the alternator and the wheelmotors. Important components include:

1. Air blower - dual impeller in-line blower mounted on the rear of the traction alternator. The impellers are mounted on a hub heat shrink and taper fitted to the rear of the rotor shaft. A two piece fiberglass housing completes the assembly.

2. Ducting

   a. From control box to blower inlet.

   b. From blower outlet to wheelmotors.

OPERATION

The blower provides a constant supply of cooling air to the main traction alternator and the electrical portion of the wheelmotors.

Air is drawn into the system through a large opening in the electrical components control box assembly and is drawn into the blower inlet. The system rectifier and static exciters are mounted so that their heat exchanger fins extend into the air path to aid in their cooling.

On some trucks, an auxiliary cleaning system is available to assist in pre-cleaning this air flow to minimize the ingestion of contamination into the electrical system components. In this system, a panel of Donaldson Dynaclone ducts, similar to those used in the Donaldson engine air cleaner assemblies, is installed behind the control box. As the air is pulled through these ducts, it is forced to swirl and the resulting centrifugal force causes much of the debris and dirt particles to be separated from the air flow. An independent "scavenger blower" draws a separate air flow along the tube area and exhausts the separated material out through its blower output.

The blower fan is directly coupled to the traction alternator rotor shaft. As the impeller turns, it pressurizes the air to relatively low pressure and passes it onto cooling ducts. One set of these ducts directs the air internally to the alternator itself and through the desired areas. It exits through specially designed outlet screens in the alternator housing perimeter. Another air duct routes the air into the external ductwork to the rear axlebox. There it is routed through the electrical wheelmotors, exiting through the opening in the external hub cap assemblies.

In some installations, a separate flow of the pressurized air is routed to the electrical control box assembly. The resulting air flow through the control box is designed to minimize dust and contamination ingestion and the build up of heat and other by-products to the system operation.

MAINTENANCE AND ADJUSTMENT

Periodic maintenance includes the following:

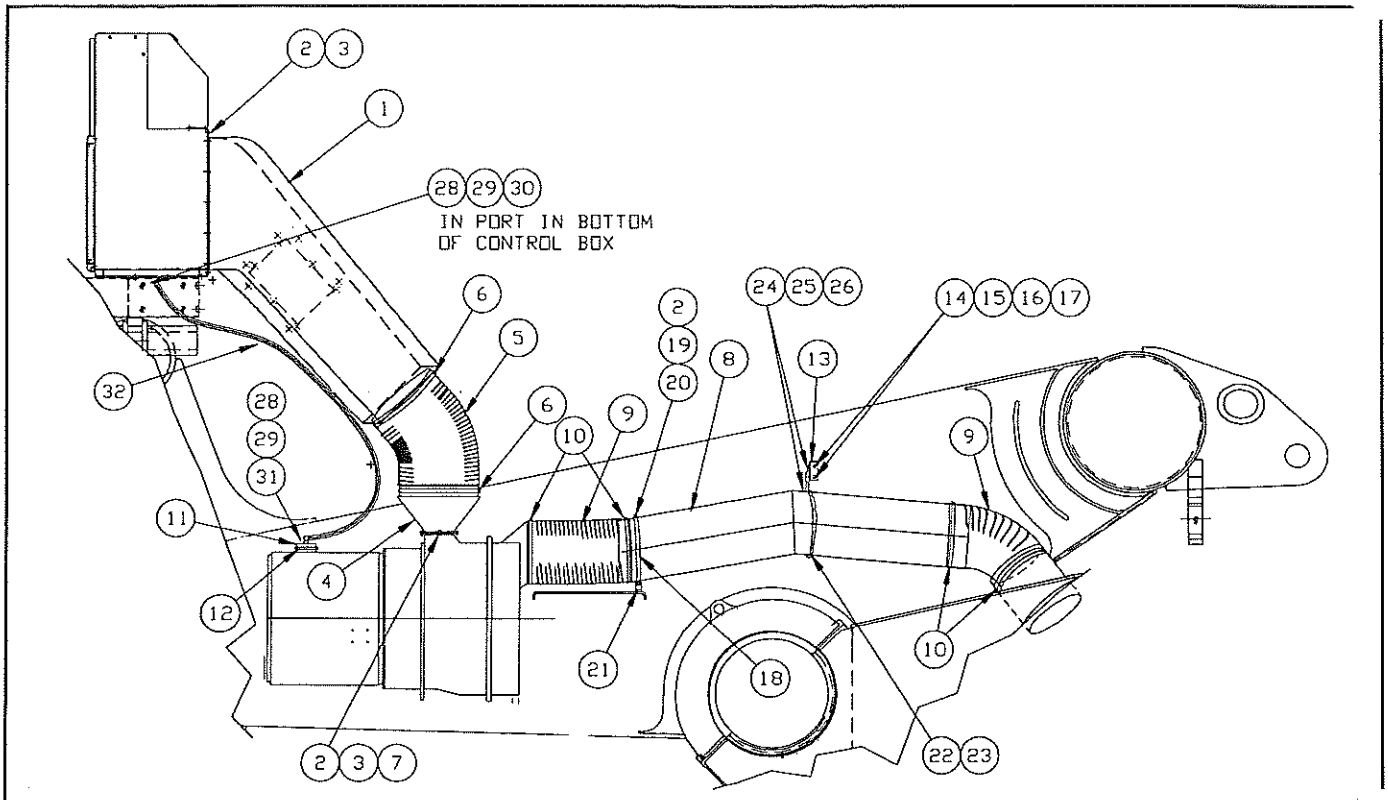
1. Inspect the blower housing for loose or missing hardware. Repair or replace as required.

2. Inspect the blower housing for evidence of damage or cracks. Repair or replace as outlined in the instructions in the electrical system manufacturers maintenance manuals.

3. Inspect all ducting to be free of damage or leakage. Repair or replace as required.

4. Verify that the 1/2 inch (12 mm) diameter drain hole at the bottom of the rear blower housing is open.

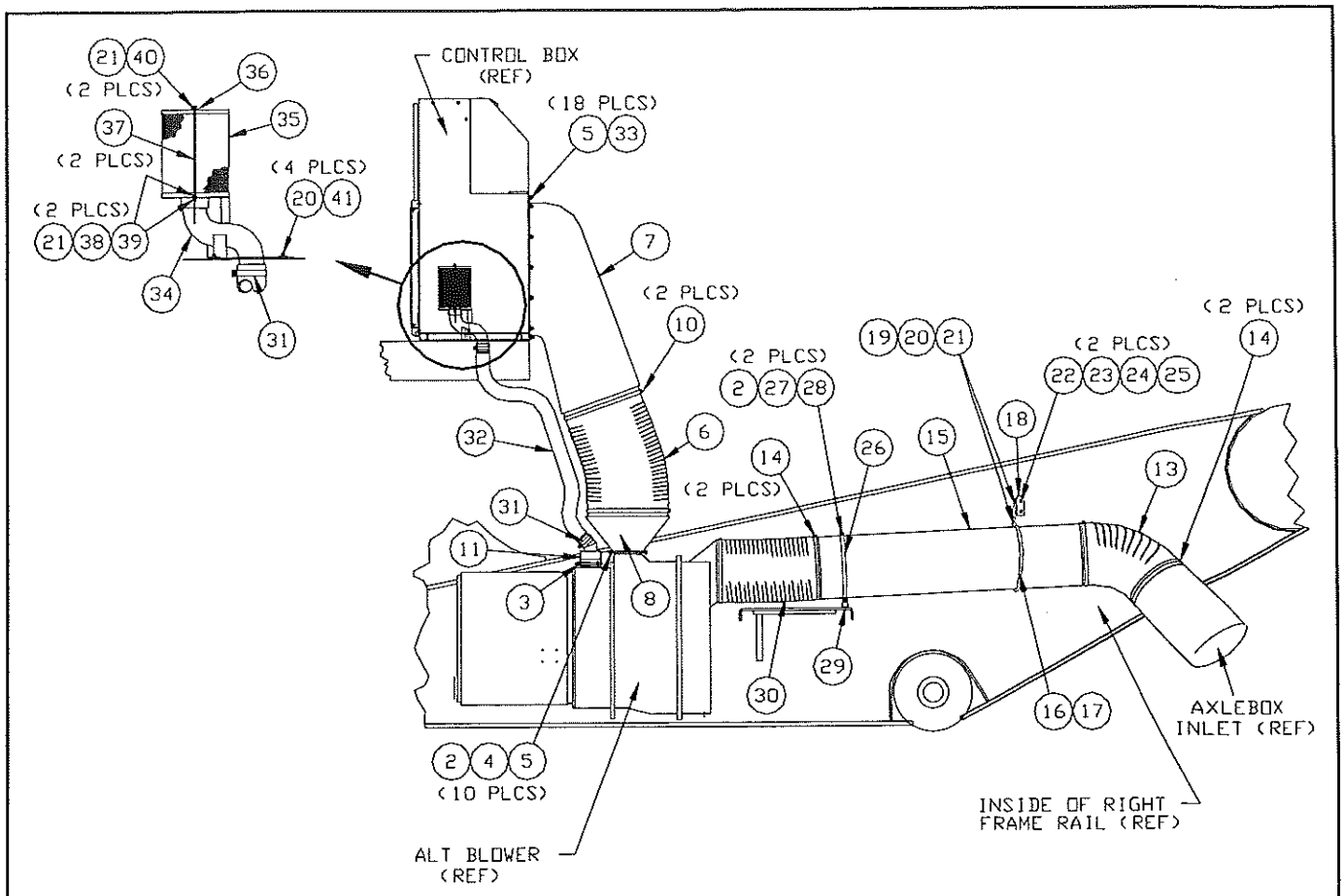
NOTE: *It is important to remember that the proper and adequate flow of air through the system is required at all times to provide the desired cooling effects. Failure to maintain these flows will result in decreased component service life.*



KEY A84212

01.	Air Duct	12.	U-bolt Clamp	23.	Heat Shrink
02.	Flatwasher	13.	Alternator Duct Support	24.	Capscrew
03.	Locknut	14.	Bolting Pad	25.	Locknut
04.	Intermediate Transition Duct	15.	Capscrew	26.	Flatwasher
05.	Flex Hose	16.	Flatwasher	27.	RTV Silicone
06.	Hose Clamp	17.	Lockwasher	28.	Pipe Fitting
07.	Capscrew	18.	Tube Support	29.	Hose Clamp
08.	Air Duct	19.	Capscrew	30.	Bushing
09.	Flexible Hose	20.	Nut	31.	Street Elbow
10.	Hose Clamp	21.	Clip	32.	Hose
11.	Alternator Cap	22.	Chain		

FIGURE 1 - ALTERNATOR AND WHEELMOTOR COOLING SYSTEM – EARLIER VERSIONS (A84212)



KEY A86189

01.	RTV Silicone Rubber	15.	Axlebox Air Duct	29.	Clip
02.	Flatwasher	16.	Chain	30.	Flexible Hose
03.	U-bolt Clamp	17.	Heat Shrink Sleeve	31.	Clamp
04.	Capscrew	18.	Air Duct Support	32.	Flexible Air Hose
05.	Locknut	19.	Capscrew	33.	Hardened Flatwasher
06.	Flexible Hose	20.	Locknut	34.	Cover Plate and Filter Mount
07.	Air Duct	21.	Flatwasher	35.	Air Filter
08.	Transition Intake Duct	22.	Bolting Pad	36.	Filter Hold-down
09.	Not Used	23.	Capscrew	37.	Hold-down Stud
10.	Hose Clamp	24.	Flatwasher	38.	Nut
11.	Alternator Cap	25.	Lockwasher	39.	Lockwasher
12.	Not Used	26.	Tube Support	40.	Wing Nut
13.	Flexible Hose	27.	Capscrew	41.	Cover Plate Washer
14.	Hose Clamp	28.	Nut	42.	Tie Wrap

FIGURE 2 — ALTERNATOR AND WHEELMOTOR COOLING SYSTEM – LATER INSTALLATIONS WITH INCREASED CONTROL BOX AIR FLOW (A86189)

ENGINE MODULE

DESCRIPTION AND LOCATION (Figure 1)

The engine module consists of the following:

1. Diesel engine.

2. Main traction alternator with in-line electrical equipment cooling blower assembly.

3. Radiator (may be mounted separately).

4. 24 Vdc battery charging alternator.

NOTE: *On some trucks, the engine skid assembly is omitted and the engine/alternator and radiator are mounted directly to the frame. With these exceptions, the information contained in this module remains the same.*

The engine module is mounted to the front portion of the main frame. Rubber insulation pads are mounted between the main frame and sub-frame to reduce vibration.

OPERATION

The engine module provides power for a variety of functions. The diesel engine provides power to turn the main traction alternator. The alternator, in turn, supplies power to the electric wheelmotors. The engine module also drives the truck's hydraulic pumps, battery charging alternator, and air compressor.

TROUBLESHOOTING

Refer to the appropriate manufacturer's information for detailed troubleshooting.

MAINTENANCE AND ADJUSTMENT

Periodic maintenance should include the following steps:

1. Clean the engine module assembly.

2. Check the condition of all components, including checking for leaks or other damage.

3. Verify that all mounting hardware is secure.

4. Check the condition of the rubber isolation mounting pads.

5. Test the power package for proper operation and power levels.

REMOVAL (Figure 1)

The complete engine module may be removed from the truck as follows:

NOTE: *It is recommended that the engine module be removed with the alternator and radiator assembly attached.*

1. Park the truck in a SAFE POSITION. It must be secured by means other than the truck's friction brake system.

2. Drain all pressure from the pneumatic, hydraulic, fuel, and cooling systems.

3. If the truck is equipped with a separate cooling system module, remove the module assembly as outlined in Section 4 - Power Package.

4. Remove the hood and grille assemblies as outlined in Section 2 - Structure.

5. Disconnect all fluid lines between the engine and other areas at the terminal assembly on the engine skid.

6. Disconnect the main electrical lines from the alternator.

7. Remove the blower ducting as required as outlined in Section 4 - Power Package.

8. Disconnect the air intake and exhaust ducting from the engine. Cover all openings to prevent contamination.

9. Remove all other lines and hoses coupled to the module.

10. Uncouple the driveshaft between the alternator and the hydraulic pump as outlined in Section 5 - Hydraulic System.

11. Remove the module from truck as follows:

NOTE: *It is recommended that a lifting device built specifically for the type of engine and truck involved (like those available from Unit Rig) be used. The use of a come-along is recommended during removal and instal-*

lation, as it allows the engine to be tilted front-to-rear.

a. Use an overhead crane or other suitable hoist with sufficient lifting capacity, and position the engine module lifting beam over the engine module. Attach the rear cables to the alternator support brackets, and the front lifting hooks to the appropriate engine or engine skid brackets.

b. Insert a come-along with a sufficient lifting capacity between the front lifting hook and the main lifting lug area.

c. Remove the mounting bolts that secure the module to the truck frame.

d. Carefully raise and remove the engine module. Use the come-along to tilt the module as required.

12. Place the engine module on suitable stands, or block it to ensure safe conditions for future work or storage.

⚠WARNING

Before beginning any work on the engine module, ensure that it is supported on suitable stands or blocking. Failure to do so may result in personal injury, equipment damage, or both.

DISASSEMBLY

The alternator may be removed from the engine as follows:

1. Install a gear adapter for engine barring into the starter access opening.

NOTE: *If the same engine and alternator are to be reassembled, mark the position of the coupling on the flywheel, and reinstall with the same "clocking".*

2. If so equipped, remove the mounting brackets secured to both the engine and alternator.

3. Use the gear adapter and a ratchet to rotate the engine crankshaft. Remove the capscrews that attach the armature to the flywheel. Access to the capscrew is gained through the starter access opening.

4. Remove the bolts from each bracket, and remove the motor support brackets.

5. Using suitable adapters and a sling, support the alternator with a crane.

6. Remove the bolts and nuts that attach the alternator to the flywheel housing adapter.

7. Remove the alternator by moving it rearward, then lifting it clear of the engine.

NOTE: *The shims removed should be retained with the alternator. Before installation, however, it is recommended that the entire shimming procedure be followed*

KEY			A84530
01.	Engine	21.	Lockwasher
02.	Main Traction Alternator	22.	Capscrew
03.	Engine Mounting Skid	23.	Not Used
04.	Left Engine/Alternator Support	24.	Not Used
05.	Right Engine/Alternator Support	25.	Not Used
06.	Mud Guard	26.	Not Used
07.	Flywheel/Rotor Shim (2 pieces make 1 part)	27.	Socket Head Capscrew
08.	Flywheel/Rotor Shim (2 pieces make 1 part)	28.	Engine Mounting Pad
09.	Flywheel/Rotor Shim (2 pieces make 1 part)	29.	Washer
10.	Flywheel/Rotor Shim (2 pieces make 1 part)	30.	Mounting Plate
11.	Flywheel/Rotor Shim (2 pieces make 1 part)	31.	Locknut
12.	Engine Housing/Alternator Shim (4 pieces make 1 part)	32.	Capscrew
13.	Engine Housing/Alternator Shim (4 pieces make 1 part)	33.	Capscrew
14.	Engine Housing/Alternator Shim (4 pieces make 1 part)	34.	Not Used
15.	Special Grade 8 Capscrew	35.	Radiator Fan
16.	Special Washer	36.	Capscrew
17.	Capscrew	37.	Lockwasher
18.	Lockwasher	38.	Fan Spacer
19.	Lockwasher	39.	Fan Spacer
20.	Capscrew		

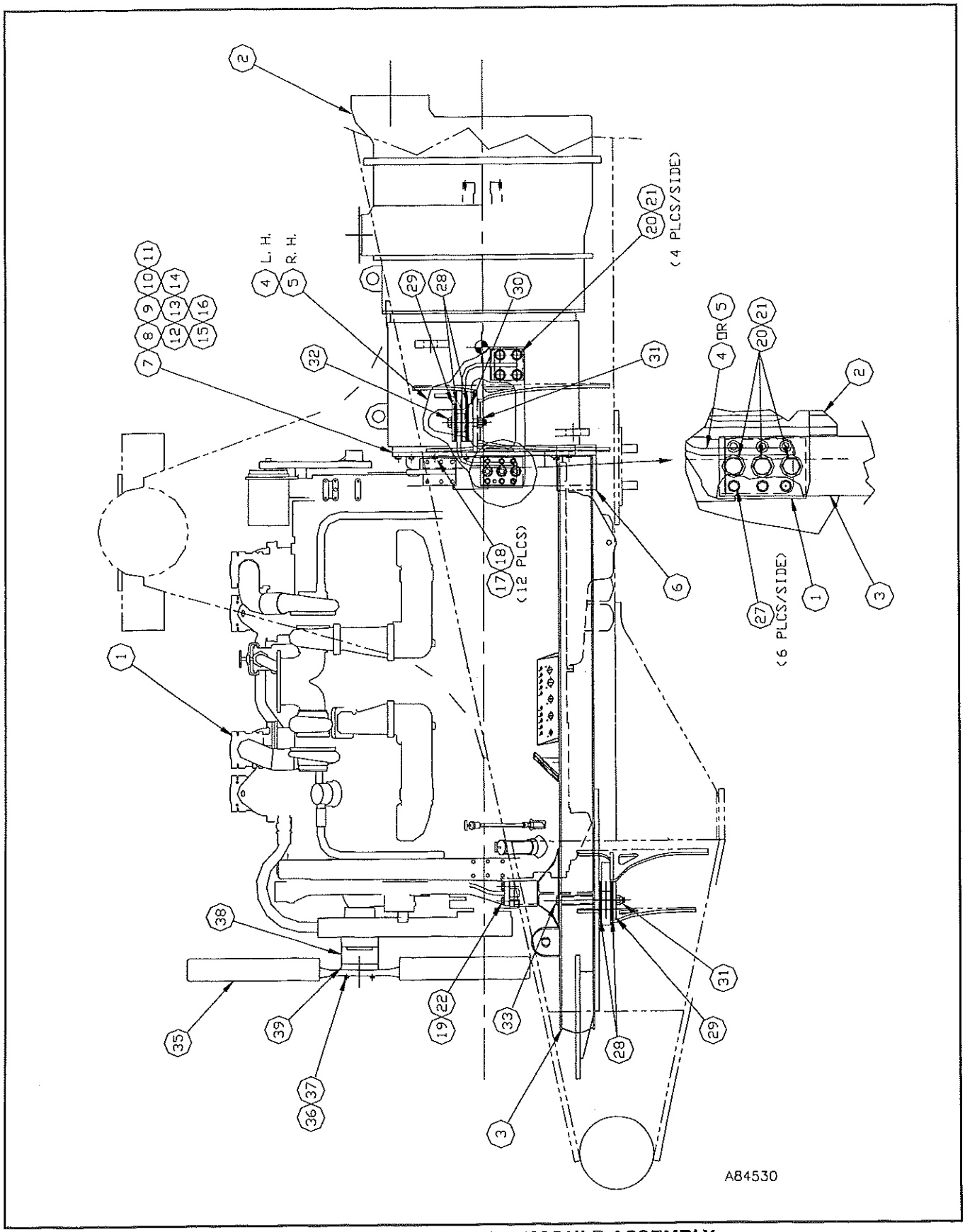


FIGURE 1 - TYPICAL ENGINE MODULE ASSEMBLY

for mounting the alternator on the engine, even if it is the same engine and alternator. This will ensure that the proper clearances are maintained.

ASSEMBLY

The alternator may be installed on the engine as follows:

NOTE: *Special equipment and tools required to assist in assembly including:*
1. Dial indicator with a variety of mounting feet.
2. Mounting fixtures to allow the indicator to rotate with and also measure dimensions on the flywheel.
3. An engine barring tool and related equipment to allow the engine crankshaft to be easily rotated slowly while taking measurements.
4. A special gauge bar assembly (manufactured by Unit Rig) should be used to assist in obtaining certain measurements. Because of special requirements on MTU/DDC Series 4000 engines, two gauge bars are required, one for the engine and the other for the alternator measurements.
5. A 2 to 3 inch (50 to 75 mm) depth micrometer to use in conjunction with the gauge bar in acquiring the needed measurements.

It is also recommended that a worksheet of important measurements be maintained during assembly for possible future reference. An example worksheet is shown in Table 1.

1. Install the gear adapter for engine barring into starter opening on either side of engine.

2. Clean all protective coating, dirt, etc., from the flywheel assembly and flywheel housing adapter. Smooth any nicks, burrs, gouges, etc. from mounting surfaces or pilots.

3. Check the crankshaft endplay as follows:

a. Remove the crankshaft access cover.

b. Install a dial indicator on the flywheel or on the crankshaft vibration damper, so that it will measure the total fore and aft movement of the crankshaft.

c. Loosen all belts on the engine.

d. Mark the initial point of measurement on the flywheel or vibration damper.

e. Rotate the engine crankshaft one complete revolution clockwise as viewed from the rear while prying the crankshaft forward.

IMPORTANT: *Never pry on the crankshaft vibration damper; pry only on the crankshaft through the open access cover. Take care not to damage the crankshaft or other engine components while prying.*

f. Set the dial indicator at zero (pry bar relaxed) and rotate the engine crankshaft one complete revolution counterclockwise (as viewed from the rear) while prying the crankshaft rearward.

NOTE: *To get a true dial indicator reading, one full rotation of the crankshaft is required to cancel out any axial run-out. Clockwise rotation should cause the crankshaft to move forward; counterclockwise rotation should cause it to move to the rear. All references to direction are as viewed from the flywheel.*

g. Record the measurement on the dial indicator.

h. Without touching the dial indicator, rotate the engine crankshaft one complete revolution clockwise while prying the crankshaft forward. If the dial indicator does not return to zero, repeat this step.

i. Repeat this procedure several times to check the measurements.

j. Check the allowable end clearances from Table 2. If within tolerance, proceed. If not, determine the cause and correct.

4. Clean all protective coating, dirt, etc., from the flywheel assembly and flywheel housing adapter. Smooth any nicks, burrs, gouges, etc. from mounting surfaces or pilots.

5. Measure the flywheel pilot (radial) run-out as follows:

a. Move the crankshaft so that it is at the forward end of its endplay.

b. Install the dial indicator so that it will measure the flywheel pilot run-out (base on the flywheel housing adapter, indicator on flywheel), measuring the radial run-out of the self-contained pilot ring.

c. Zero the indicator and mark the starting position. Rotate the crankshaft clockwise one complete revolution.

NOTE: *When the crankshaft is rotated one complete revolution, the dial indicator must return to zero. If it does not, either the crankshaft has shifted or the dial*

I. ENGINE MEASUREMENTS

A. Crankshaft end clearance _____inch (mm)

B. Flywheel pilot radial runout _____inch (mm) (TIR--Total Indicated Runout)

C. Flywheel housing adapter axial (face) _____inch (mm) (TIR)

D. Flywheel housing adapter concentric (centered) runout_____inch (mm) (TIR)

II. SHIM REQUIREMENT MEASUREMENTS

A. Engine (flywheel) measurement (Crankshaft to rear of endplay)

1 _____ inch (mm)
2 _____
3 _____
4 _____
Total _____ inch (mm)

Average engine measurement "A" (Divide above total by 4 and add 1/2 of the crankshaft end clearance) A = _____ inch (mm)

B. Alternator measurements

1. With armature at rear (bottom)

1 _____ inch (mm)
2 _____
3 _____
4 _____

2. With armature at front (lifted)

1 _____
2 _____
3 _____
4 _____
Total _____ inch (mm)

Average alternator measurement "B" (Divide total above by 8) B = _____ inch (mm)

III. SHIM REQUIREMENTS

A. If dimension "B" is greater than "A", the shims are required between the flywheel housing adapter and the alternator housing.

B. If dimension "A" is greater than "B", the shims are required between the flywheel (coupler) and the armature.

C. The shim thickness to be installed is equal to the difference between the two dimensions--a tolerance of 0.005 inch (1.3 mm) is the maximum allowed.

Shims Required _____ inch (mm)

Where Located _____

IV. FINAL CHECK

A. Crankshaft end clearance _____inch (mm)

B. Armature end clearance _____inch (mm)

12708

TABLE - 1 - ENGINE/ALTERNATOR SHIMMING WORKSHEET

ALLOWABLE CRANKSHAFT CLEARANCES						
ENGINE	MINIMUM CLEARANCE (NEW ENGINE)		MAXIMUM CLEARANCE (NEW ENGINE)		DO NOT OPERATE IF CLEARANCE EXCEEDS	
DDC						
12V-149	0.004 inch	(0.10 mm)	0.014 inch	(0.35 mm)	0.018 inch	(0.45 mm)
16V-149	0.004 inch	(0.10 mm)	0.014 inch	(0.35 mm)	0.020 inch	(0.50 mm)
20V-149	0.007 inch	(0.17 mm)	0.016 inch	(0.40 mm)	0.020 inch	(0.50 mm)
16V-2000	0.005 inch	(0.13 mm)	0.016 inch	(0.40 mm)	----------	----------
12V-4000	0.010 inch	(0.25 mm)	0.022 inch	(0.57 mm)	----------	----------
16V-4000	0.010 inch	(0.25 mm)	0.022 inch	(0.57 mm)	----------	----------
CUMMINS						
KT/KTA 38	0.005 inch	(0.13 mm)	0.015 inch	(0.38 mm)	0.020 inch	(0.50 mm)
QSK 45	0.005 inch	(0.13 mm)	0.015 inch	(0.38 mm)	0.020 inch	(0.50 mm)
KTA/KTTA 50	0.005 inch	(0.13 mm)	0.015 inch	(0.38 mm)	0.020 inch	(0.50 mm)
QSK 60	0.005 inch	(0.13 mm)	0.015 inch	(0.38 mm)	0.020 inch	(0.50 mm)

TABLE 2 - ALLOWABLE CRANKSHAFT CLEARANCES 13423

indicator has moved. The run-out measured is useless unless the indicator return to zero. Repeat this step as necessary.

d. Record the measurement and compare with the allowable run-out from Table 3. If within tolerance, proceed. If not, determine the cause and correct.

6. Measure the flywheel housing adapter axial (face) run-out as follows:

a. Move the crankshaft so that it is at the forward end of its endplay.

b. Install the indicator so that it will measure the axial run-out (base on flywheel, indicator on adapter face), but will not be obstructed by bolt holes.

c. Zero the indicator and mark the starting position. Rotate the crankshaft clockwise one complete revolution with the barring mechanism. Observe the maximum indicator readings and record TIR.

Example: +0.005 inch (0.13 mm) and -0.004 inch (0.10 mm) would be 0.009 inch (0.23 mm) TIR.

NOTE: *The indicator must return to zero with one complete revolution. Repeat this step if necessary.*

d. Record the measurement and compare with the allowable run-out from Table 4. If within tolerance, proceed. If not, determine the cause and correct.

7. Measure the flywheel housing adapter concentric (radial) run-out as follows:

a. Move the crankshaft so that it is at the forward end of its endplay.

b. Install the dial indicator so that it will measure the flywheel housing adapter concentricity (base on flywheel, indicator on adapter housing inner surface), but will not be obstructed by bolt holes.

c. Zero the indicator and mark the starting position. Rotate the crankshaft clockwise one complete revolution with the barring mechanism. Observe maximum indicator readings and record TIR.

Example: +0.005 inch (0.13 mm) and -0.004 inch (0.10 mm) would be 0.009 inch (0.23 mm).

NOTE: *The indicator must return to zero with one complete revolution. Repeat this step if necessary.*

d. Record the measurement and compare with the allowable run-out from Table 4. If within tolerance, proceed. If not, determine the cause and correct.

8. After ensuring that all of the engine measurements are within tolerances, measurements for determining the "A" dimension for shimming may be taken as follows:

a. Locate the crankshaft at the extreme rear of its endplay by rotating the crankshaft counterclockwise while prying the rear of the crankshaft.

⚠ CAUTION

Never pry on the engine vibration damper.

b. Using the appropriate special gauge bar (available from Unit Rig) and the 2 to 3 inch (50 to 75 mm) depth micrometer, measure the distance between the flywheel housing adapter mounting face and the drive ring mounting face. Record four measurements: at 12, 3, 6 and 9 o'clock.

NOTE: *Because of special requirements on MTU/DDC Series 4000 engines, two gauge bars are required, one for the engine and the other for the alternator measurements.*

c. Average the four measurements, and add to 1/2 of the crankshaft end clearance. Record this dimension as "A". This average measurement is equal to a measurement taken with the crankshaft located at the center of its endplay.

9. Determine the alternator "B" measurements as follows:

MAXIMUM FLYWHEEL RADIAL RUNOUT		
ENGINE	**MAXIMUM ALLOWABLE FLYWHEEL RADIAL RUNOUT**	
DDC		
12V-149	0.011 inch	(0.27 mm)
16V-149	0.011 inch	(0.27 mm)
20V-149	0.011 inch	(0.27 mm)
16V-2000	0.011 inch	(0.27 mm)
12V-4000	0.008 inch	(0.20 mm)
16V-4000	0.008 inch	(0.20 mm)
CUMMINS		
KT/KTA 38	0.08 inch	(0.20 mm)
QSK 45	0.08 inch	(0.20 mm)
KTA/KTTA 50	0.007 inch	(0.17 mm)
QSK 60	0.010 inch	(0.25 mm)

TABLE 3 - MAXIMUM FLYWHEEL RADIAL RUN-OUT 13424

a. Clean all protective coating, dirt, etc., and smooth any nicks, burrs, gouges, etc., from the mounting surfaces or pilots.

b. Using the appropriate sling, place the alternator in a vertical position with the mounting face up. Place a stand or blocks under the alternator of sufficient height to prevent the sheaves, electrical terminals, etc., from touching the floor.

NOTE: *A special stand/jig is used for engines fitted with in-line blowers. With this jig the engine can be moved around in different planes to carryout the measurements accurately for shimming purposes.*

⚠ CAUTION

Balance and lift the alternator high enough to prevent the sheaves, electrical terminals, etc., from hitting the floor. Protect the in-line blower assembly (if so equipped).

MAXIMUM FLYWHEEL HOUSING ADAPTER RUNOUT				
ENGINE	MINIMUM (FACES) ALLOWABLE AXIAL (NEW ENGINE)		MAXIMUM CLEARANCE (INNER SURFACES) (NEW ENGINE)	
DDC				
12V-149	0.026 inch	(0.66 mm)	0.026 inch	(0.66 mm)
16V-149	0.026 inch	(0.66 mm)	0.026 inch	(0.66 mm)
20V-149	0.026 inch	(0.66 mm)	0.026 inch	(0.66 mm)
16V-2000	0.026 inch	(0.66 mm)	0.026 inch	(0.66 mm)
12V-4000	0.016 inch	(0.40 mm)	0.016 inch	(0.40 mm)
16V-4000	0.016 inch	(0.40 mm)	0.016 inch	(0.40 mm)
CUMMINS				
KT/KTA 38	0.010 inch	(0.25 mm)	0.020 inch	(0.51 mm)
QSK 45	0.010 inch	(0.25 mm)	0.020 inch	(0.51 mm)
KTA/KTTA 50	0.010 inch	(0.25 mm)	0.020 inch	(0.51 mm)
QSK 60 (U.R. Alt.)	0.012 inch	(0.30 mm)	0.010 inch	(0.25 mm)
QSK 60 (G.E. Alt.)	0.010 inch	(0.25 mm)	0.010 inch	(0.25 mm)

TABLE 4 - MAXIMUM FLYWHEEL HOUSING ADAPTER RUN-OUT 13425

c. Shim the front of the armature to the approximate center of the housing by using equal shims between the armature and housing.

⚠ CAUTION

Care must be taken to ensure that the shims do not fall into the armature. It is suggested that the shims have tabs on the ends and/or be held in place by tape.

d. Measure and record the distance between the mounting face on the armature and the mounting face on the housing (with the same special gauge bar and depth micrometer specified for the engine) at four places, (12, 3, 6 and 9 o'clock).

NOTE: *Because of special requirements on MTU/DDC Series 4000 engines, two gauge bars are required, one for the engine and the other for the alternator measurements.*

e. Install two eye bolts at 180° intervals in the armature mounting face, and remove the shims between the armature and alternator housing. Attach chains to the eye bolts and lift the armature to the top or forward position. Install the shims between the armature and housing. Do not allow the shims to fall into the alternator.

⚠ DANGER

Do not lift the alternator off the stand as this may damage the bearings. Be sure the armature is at its maximum top (or forward) position, as it is most important that the armature bearing endplay be measured accurately.

f. Measure and record the alternator dimensions outlined in step 7d.

g. Add the four measurements in 7f to those taken in 7d. Calculate the average of these 8 dimensions. This dimension, called "B", is the equivalent of a measurement with the armature at the center of its endplay.

h. Remove the shims between the armature and alternator housing used to center the armature, and lower the armature into a resting position in the housing.

10. The amount of shims required is the difference between dimensions "A" and "B".

a. If dimension "B" is greater than dimension "A", place the shims between the flywheel housing adapter and the alternator housing.

b. If dimension "A" is greater than dimension "B", place the shims between the flywheel coupling and the alternator armature.

⚠ CAUTION

The shim stack must be measured to verify correct thickness. If tape is used to hold shims in place, it must not be left in during final assembly. Shims installed in the wrong location are worse than no shims, and could cause crankshaft and alternator failure due to axial pre-load.

NOTE: *The smaller shims are one or two piece; the larger shims require four parts to form one shim.*

11. The engine and alternator may be mated as follows:

a. On trucks equipped with the MTU/DDC Series 4000 engine:

(1) Remove the capscrews securing the flywheel housing adapter to the flywheel housing.

(2) Install the flywheel housing adapter to the alternator frame with the appropriate shims in place if required.

b. Rotate the crankshaft to position dowel pins on the flywheel at the 6 and 12 o'clock positions.

c. Rotate the armature to position the dowel pin holes on the armature mounting face at the 6 and 12 o'clock positions.

d. Lift the alternator using a sling, and rotate it to a horizontal position.

⚠ CAUTION

Do not bump sheaves, electrical terminals, etc., on the floor while handling the alternator.

e. Move the alternator close enough to the engine to start at least two capscrews through the adapter and into the alternator. At the same time, rotate the crankshaft to align the dowel pins with the appropriate holes.

NOTES:
1. To ease in installation, the upper capscrews should be inserted into the flywheel housing adapter prior to mating.
2. On trucks equipped with MTU/DDC Series 4000 engines, the capscrews are inserted through to install the flywheel housing adapter to the flywheel housing.

f. If the supports are still in place on the alternator, the bolts should be loose enough to not interfere with the coupling.

g. Look through the access hole in the flywheel housing to ensure the capscrew holes are aligned. Install all capscrews through the adapter and into the alternator housing.

h. Rotate the crankshaft as required to install all capscrews and washers through the flywheel and into the armature.

IMPORTANT: *Use only SAE Grade 8 capscrews or equivalent. Substitution of lower grade capscrews may result in damage to the equipment.*

i. Torque each capscrew progressively in 50 ft-lb. (70 Nm) increments (lubricated) until a final torque of 180 to 190 ft-lb. (245 to 260 Nm) is reached. This procedure also applies to the capscrews on the flywheel/armature and those connecting the housing adapter and the alternator.

j. Install both the right and left engine skid supports.

k. Block the rear end of the alternator housing to help support the alternator and to allow removal of the sling.

12. As a final check to determine if the assembly is properly shimmed:

a. Install a dial indicator to measure end clearance on both the vibration damper and the armature sheave.

b. Rotate the crankshaft clockwise and pry forward.

c. Zero both dial indicators (with the pry bar relaxed) and mark the position of the reading on the damper and sheave.

d. Rotate the crankshaft counterclockwise one full turn while prying rearward as far as possible.

e. Read both indictors (with the pry bar relaxed).

NOTE: *The crankshaft movement should be the same as its original measurement; the armature shaft must have moved, but not necessarily the same amount as the crankshaft.*

f. Re-zero both indicators.

g. Rotate the crankshaft one full turn clockwise while prying forward.

h. Read both indicators (with the pry bar relaxed).

NOTE: *The crankshaft movement should be the same as it was originally and the armature shaft must have some movement, but not necessarily the same as the crankshaft. This indicates no axial pre-load; thus the assembly is properly shimmed.*

13. Install the crankshaft access cover.

14. Install the supports/mounting brackets, if removed.

15. If removed, install the fiberglass alternator blower cover, making sure it is indexed as instructed in the unit's assembly instructions.

16. Verify there is a 1/2 inch (13 mm) diameter drain hole in the 6 o'clock position on the rear section of the blower housing. If not:

a. Determine that the housings are properly oriented.

b. Drill one a hole using care not to:

(1) Contact any internal parts of the alternator assembly.

(2) Damage the fiberglass housing assembly.

INSTALLATION (Figure 1)

The engine module may be installed as follows:

1. Use an overhead crane or other suitable hoist, with sufficient capacity, and position the lifting device over the engine module. Attach the cables to the alternator and the front mount to the front lifting lug on the engine or engine module skid.

2. Install a come-along with sufficient lifting capacity from the front beam to the main lifting hook.

3. Use the come-along to tilt the engine module as required. Carefully place the module into position in the main frame.

IMPORTANT: *Extra care must be taken to avoid damage to all duct work, piping, electrical lines, etc., during installation. If any damage should occur, inspect and repair immediately.*

4. Install the rubber cushioning pads and capscrews. Torque the nuts as required, but do not over compress the isolation mounts.

5. Connect the cooling air ducting to the alternator and axlebox as outlined in Section 4 - Power Package.

⚠ CAUTION

When installing the ducting, make sure that all connections form tight seals, and that all passageways are free of damage. Holes or restrictions will result in reduced cooling air flow and could cause overheating of components.

6. Connect the driveshaft between the alternator and the hydraulic pump as outlined in Section 5 - Hydraulic System.

7. Connect all engine air and exhaust ducting. Check all components and connections for evidence of damage or leakage. A small leak will allow enough contamination to destroy an engine.

8. Connect all electrical, fuel, air, and hydraulic connections.

9. On trucks equipped with a separate cooling system module, install the module as outlined in the instructions in Section 4 - Power Package including the fan drive, and all hosing and wiring previously removed.

10. Install the hood and grille assemblies as outlined in Section 2 - Structure.

11. Verify proper fluid levels. Check the engine and electrical system for leakage and proper operation and power levels prior to placing the truck into service.