

# 12 Air conditioning and heating system

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## 12.1 Air conditioning and heating system

### 12.1.1 System operation

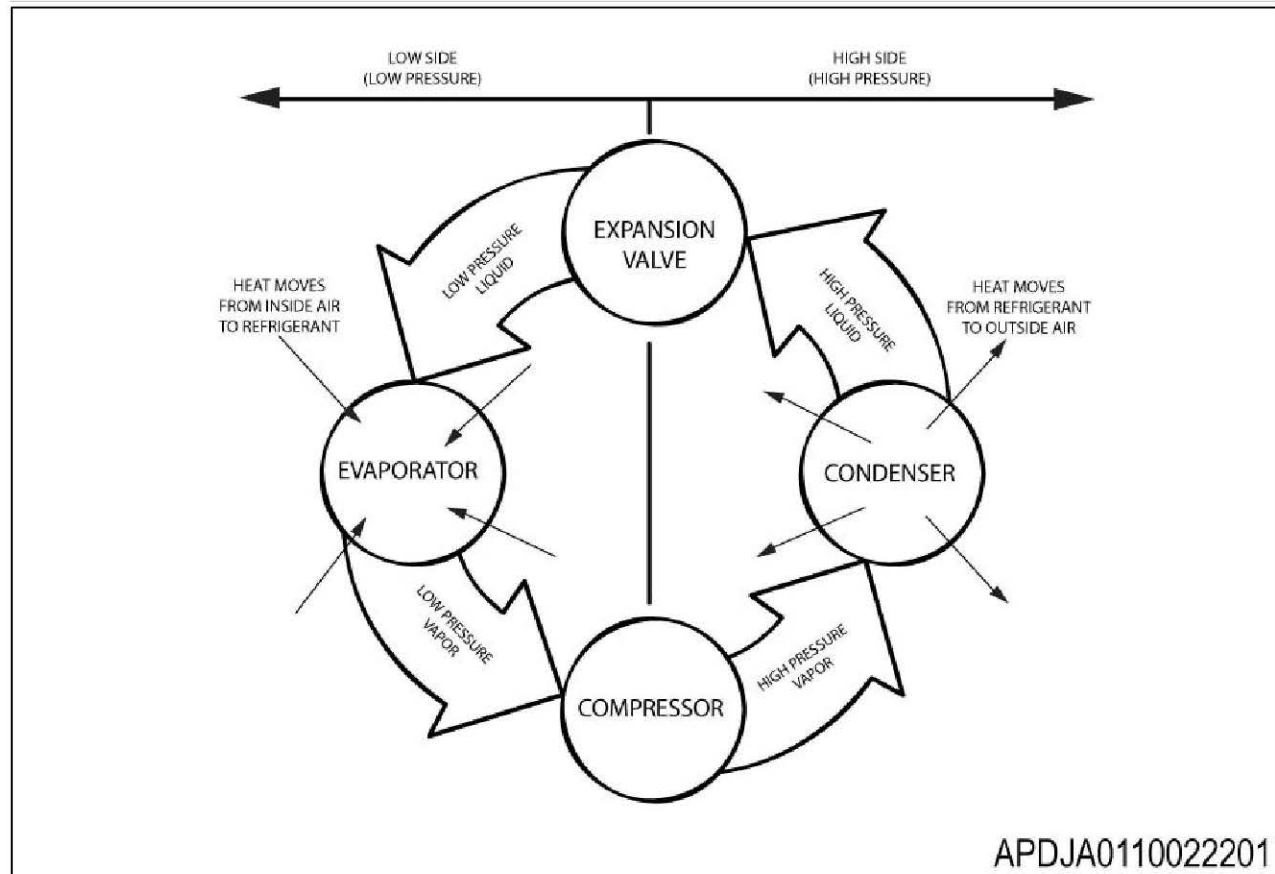


Fig. 1

The air conditioning cycle is divided into high and low pressure sides.

The high pressure side refers to the side of the system where the high pressure and the high temperature is located. The high pressure side comes out of the outlet side of the compressor. The high pressure moves through the condenser and moves to the thermal expansion valve (TXV).

The expansion valve is the dividing point between the high pressure and the low pressure sides. The low pressure side is the term for the portion of the air conditioning system in which the low pressure and low temperature is located. Low pressure moves from the expansion valve, through the evaporator, and to the inlet side of the compressor. The refrigerant is in the low pressure state.

Refrigerant in the air conditioning cycle is divided into a gas or a liquid state.

Refrigerant changes state in the condenser and the evaporator. The refrigerant enters the condenser as a vapor. The vapor cools in the condenser and changes to a liquid. The refrigerant remains a liquid through the expansion valve to the evaporator. The liquid refrigerant absorbs heat in the evaporator and boils into a vapor. The refrigerant remains a vapor through the compressor and returns to the condenser.

The compressor moves the refrigerant through the system. The refrigerant is compressed to a high pressure gas. The refrigerant is compressed to a high pressure gas and heated above ambient air temperature. The compressor moves the hot high pressure gas into the condenser where the refrigerant cools. As the refrigerant condenses into a liquid, heat is released to the condenser and air flowing through the condenser.

Liquid refrigerant flows from the condenser to the expansion valve. The expansion valve will have a small opening where the refrigerant must move. The small opening reduces the pressure of the refrigerant entering the evaporator.

Refrigerant changes to a gas and carries heat out of the cab and return to the compressor. The air moving over the evaporator surfaces is cooled by releasing heat to the refrigerant. Each time the cab air moves across the evaporator fins, the air cools. The refrigerant returns to the compressor as a low pressure gas and the cycle repeats.

When the capillary tube senses the air has cooled to a temperature selected by the operator, the capillary signals the thermostat switch to disengage the compressor clutch. The refrigerant stops moving through the system. When the temperature rises, the switch engages the clutch and the cycle starts again.

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### **12.1.2 HVAC system**

The HVAC system is located behind the operator seat.

The HVAC unit contains the following components:

- Electronic controls
- Cab pressurization
- Cab airflow moisture removal (defrost)
- Cab airflow circulation
- Cab airflow heating
- Cab airflow cooling
- AC system component circuit

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### **12.1.3 Electronic HVAC controls**

The electronic control module provides:

- Automatic temperature control
- Automatic fan control
- LED display
- On-board diagnostics
- Start-up memory
- Display for outside temperature

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### **12.1.4 Cab pressure**

The heating, ventilating, air conditioning (HVAC) provides positive air pressure in the cab to prevent unfiltered air from entering.

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### **12.1.5 Cab airflow moisture**

The HVAC system uses air-conditioning to condense the moisture in the air. The air temperature can be changed by the heating system. The condensed moisture is collected as a liquid and then drained.

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### **12.1.6 Circulation of the cab airflow**

The HVAC system needs airflow to operate correctly. The operator controls the direction and amount of airflow.

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### **12.1.7 Cab airflow increased temperature**

The air is supplied by the heater core to increase the cab air temperature. Coolant is supplied through the core.

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### **12.1.8 Cab airflow decreased temperature**

The air is supplied by the evaporator core to cool the cab air. The evaporator temperature is decreased by the refrigerant, which is supplied to the air-conditioning system.

### **12.1.9 Refrigerant system sensors**

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The two sensors monitor the refrigerant pressure:

- Pressure sensor for the high pressure side
- Pressure sensor for the low pressure side

The high pressure sensor on the high pressure side makes sure the pressure does not go too high or too low. If either occur, the compressor stops to protect the system or the clutch on the air conditioning compressor disengages to protect the system.

The pressure sensor on the low pressure side makes sure the pressure does not go too low. If the pressure goes too low, the compressor stops to protect the system or the clutch on the air conditioning compressor disengages to protect the system.

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### **12.1.10 Refrigerant pump**

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Refrigerant is moved by a pump into the air-conditioning system for a continuous cool temperature.

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### **12.1.11 Compression ( Discharge side)**

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As pressure increases, so does the temperature of the saturation. The compressor changes the refrigerant from a low pressure to a high pressure vapor. The change must occur for the latent heat of the condensation to be produced when the refrigerant is sent through the condenser.

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### **12.1.12 Temperature control switch**

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The temperature control switch includes contact points and a temperature control sensing probe called a capillary tube. Gas in the capillary tube expands or contracts according to the refrigerant temperature in the evaporator. The gas operates a bellows which works against a spring to open or close the contact points of the switch. The switch setting determines the spring tension against the bellows.

The capillary tube can be inserted between the evaporator fins or clamped to the outlet tube. Gas in the capillary tube opens or closes the contact points on the switch to turn the compressor on or off.

## 12.2 Testing and adjusting

### 12.2.1 Machine prepared troubleshooting

**WARNING:**

**Personal injury can result from contact with refrigerant.**

**The system always has pressure, including when the engine is not operating. Do not apply heat to a charged system.**

**Refrigerant contact can cause frostbite. Keep shown skin away to prevent injury.**

**Always wear protective goggles when opening refrigerant lines, including if the gauges show no refrigerant in the system,**

**Always use caution when removing a fitting, and always loosen fittings slowly. If the system continues to have pressure, evacuate and recover the refrigerant before removing the fitting.**

**Personal injury or death can result by breathing in refrigerant through a cigarette or other smoking device.**

**Breathing in the fumes released from a flame, touching refrigerant gas, can cause bodily injury or death.**

**Do no smoke while servicing the air conditioners or when refrigerant gas is around.**

**Before monitoring the HVAC system, move the machine to a level surface. Lower all the implements to the ground. Make sure the transmission is in neutral or the parking brake is engaged. Keep all other personnel away from the unit or where they are in view.**

**Refrigerant can stay in the accumulator during the recovery process. Use a non flame source heat gun to apply heat to the accumulator to help the outgas of refrigerant.**

Make a visual inspection of the complete HVAC system before starting troubleshooting.

- All charging and leak testing must be performed in an area with good airflow.
- Put a clean cloth on the open valve or connections to prevent contamination.
- Do not weld, solder, or steam clean the charged components.
- Do not put refrigerant drums in the cab or expose the drums to sunlight
- Discard open, but not used, oil that is poly alkaline glycol (PAG). Moisture will cause contamination in the oil that is not used and the A/C system.

### 12.2.2 General troubleshooting information

- A low refrigerant charge causes a loss of cooling and lubrication in the compressor. The loss results in a failure of the compressor.
- A high refrigerant charge causes a loss of cooling. A high refrigerant charge in a system contains extra liquid refrigerant that can damage the compressor. A system with a high refrigerant charge fails at a rate of two times that of a system with a low refrigerant charge.
- Too much oil in the system can cause a low refrigerant charge.
- A small amount of moisture can leak into the hoses in the R134a systems.
- When the outside temperature is above 32 °C (90 °F) or if the humidity is high, the gauge readings for a system with a low charge can show as symptoms of a system with too much charge. Gauge readings that are not correct can cause a loss of cooling and then cause compressor failure.
- Removed refrigerant cannot be weighed accurately. A 20 to 30% error can occur as a result of scales that are not accurate of devices used for recoveries.
- Check scales for precision after every 30 days or every 30 uses.
- If the system pressure rises above 0 kPa (0 psi) within five minutes of recovering a system, recover the system again until the pressure does not increase. Recovering the system again removes the accumulator of all refrigerant.
- Frost on the accumulator (if equipped) is normal. The thickness of the frost changes according to the outside temperature and the humidity.
- Do regular maintenance on the refrigerant service units and then change the vacuum pump oil.
- Connect the lines and wires to prevent damage.

- The formation of black sludge deposits in the system is a result of water contamination with the PAG oil. The contamination creates hydrofluoric acid which results in sludge. The sludge causes desiccant breakdown and compressor component damage.
- White foam during recovery is normal. The foam is from the mixing oil and refrigerant.
- The R134a system charges must be within 0.03 kg to 0.06 kg (1 oz to 2 oz) of the specified charge for the unit.
- PAG oil and ester oil must never be mixed.
- All of the O-rings should be coated with mineral oil.

**NOTE:** Do not use PAG oil on O-rings. PAG oil is hygroscopic and attracts moisture which leads to rapid degradation of the O-rings.

A loss of cooling or failure of the compressor can be caused by one or more of the following conditions:

- Low charge
- High charge
- Too much oil
- Dirty or plugged filter
- Dirty or plugged condenser

### 12.2.3 Automatic temperature control panel test

#### Test LED display

1. Turn the system off.
2. Turn the ignition on.

Test result

1. LED will briefly flash 8888

#### Speed control for blower fan

1. Turn on the HVAC system.

Test result

1. The LED must show the last set point that was selected.
2. The blower fan must be circulating air. The temperature that is selected will determine the speed of the blower. The blower must increase in relation to the difference of the temperature.

#### Push button for temperature

1. Set the temperature to the highest setting 32 degrees C (90 degrees F).
2. Set the control for the blower fan to automatic.

Test result

1. The speed of the blower fan changes to full speed.
2. The heating system will turn on.
  - a. The water valve must open.
  - b. The temperature of the supply line at the heater core must increase as the engine temperature increases.

#### Push button for temperature

1. Set the temperature to the lowest setting 15.5 degrees C (60 degrees F).
2. Set the blower to automatic.

Test result

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1. The speed of the blower fan changes to full speed.
2. A/C system turns on.
  - a. The clutch for the refrigerant compressor engages.
  - b. The temperature of the supply line at the evaporator coil decreases.

### Push button for temperature

1. Set the temperature to the same temperature of the cab.
2. Set the control for the blower fan to automatic.

Test result

1. The speed of the blower fan must change to a low speed.
2. The air conditioning system will turn on.

### Control for mode of airflow

1. Change the control for mode of airflow.

Test result

1. The airflow from the vents must change to match the control for the airflow.

### Control for mode of airflow (defrost)

1. Change the control for mode of airflow to defrost.

Test result

1. The clutch for the refrigerant compressor must engage.
2. The airflow must be directed to the vents for defrost.

## 12.2.4 Troubleshoot faults with service codes

The advanced diagnostics shows information on the automatic temperature control panel. This information is used in servicing the HVAC unit.

### Service codes

| Error code              | Problem                               |
|-------------------------|---------------------------------------|
| E00                     | No faults found                       |
| E01                     | Short circuit in the cab sensor       |
| E02                     | Open circuit in the cab sensor        |
| E03                     | Short circuit in the evaporator probe |
| E04                     | Open circuit in the evaporator probe  |
| E05*                    | Short circuit in the outlet sensor    |
| E06*                    | Open circuit in the outlet sensor     |
| E07                     | Short circuit in the ambient sensor   |
| E08                     | Open circuit in the ambient sensor    |
| E09                     | Short circuit in the water valve      |
| E10                     | Open circuit in the water valve       |
| * Not used at this time |                                       |

### 12.2.5 Enter advanced diagnostics

1. Turn the automatic control panel ON.
2. Press ON key three times to see the stored error codes.
3. Immediately press and hold the ON key for five seconds to see the active diagnostics.
4. The LED will show CAB. Temperature that is measured by the cab temperature sensor will be shown on the LED.

**NOTE:** *The display continuously updates information.*

5. Press the ON key to scroll through the available information.

The control panel can be operated in all the operations while showing the advanced diagnostics. The operator can change the set point temperature, the vent mode, and the blower fan speed.

To return the system to normal operation, turn the machine off and on again.

### 12.2.6 Troubleshoot using advanced diagnostics

Some systems can be checked with active diagnostics.

| Definition of display |                                    |
|-----------------------|------------------------------------|
| Display               | Definition                         |
| CAB                   | Cab airflow temperature            |
| EVAP                  | Evaporator core temperature        |
| A-C                   | Compressor clutch (On/Off)         |
| HEAT                  | Water valve position (0-100% open) |
| FAN                   | Blower fan duty cycle (0-100)*     |
| *100 is maximum speed |                                    |

#### Problem list

- No display
- No Blower fan
- No heat
- No cooling
- The system is putting out hot air when cooling is necessary.
- No HVAC system function
- No fan or fan operating intermittently
- The electrical actuator for the airflow is not moving or operating correctly.

#### No display

1. Turn the control panel on with the mode switch.
2. Check the display for illumination.
3. Make sure the control panel is connected correctly.
4. Check the connection of wire harness to the machine.
5. Make sure the control panel is receiving 12 volts of power.
6. Make sure the control panel has a good ground connection.

#### Solution

1. Replace the control panel.

**No blower fan**

1. Turn the blower fan to high.
2. Make sure the blower fan is connected correctly.
3. Make sure the circuit breakers and the fuses are correctly connected.
4. Make sure the HVAC unit is receiving 12 volts of power.
5. Make sure the blower motor is receiving 12 volts of power.
6. Make sure the blower motor has a good ground connection.

Solution

1. Replace the fuse or the circuit breaker.
2. Replace the blower motor.
3. Replace the electronic control module.

**No heat**

1. Turn up the heat with the control button.
2. Make sure the warm coolant is flowing to the heater core by testing the heater hoses.
3. Make sure the water valve is operating correctly.
4. Inspect the water valve for jammed components.

Solution

1. Replace the water valve.

**No cooling**

1. Turn down the heat with the control button.
2. Turn the mode switch to enable defrost.
3. Make sure the refrigerant compressor has voltage at the clutch.
4. Make sure the circuit breakers and/or the fuses are not damaged.
5. Make sure the relay for the clutch on the wire harness has voltage.
6. Make sure the system has the proper amount of refrigerant by evacuating and recharging.
7. Make sure the heater valve is closed.

Solution

1. Inspect the relay for the clutch. Replace the clutch if necessary.
2. Replace the heater valve.

**The system is putting out cool air when heat is necessary**

1. Make sure that the temperature sensor for the cab airflow is connected correctly.
2. Make sure the water valve is operating correctly.

Solution

1. Replace the temperature sensor for the cab airflow
2. replace the control module.

**The system is putting out hot air when cooling is necessary**

1. Make sure the temperature sensor for the cab airflow is connected correctly.
2. Make sure the water valve is operating correctly and the water valve is not stuck open.
3. Make sure the compressor clutch is operating correctly.

Solution

1. Replace the temperature sensor for the cab airflow.
2. Replace the control module.

**No fan or fan operating intermittently**

1. Set the rotary control for the blower fan to maximum.
2. Make sure the blower fan is connected correctly.
3. Make sure the circuit breakers or the fuses are not damaged.
4. Make sure the HVAC unit has 12 volts of power.
5. Make sure the blower motor has 12 volts when the rotary control is at maximum.

## Solution

1. Replace the blower motor.
2. Replace the control module.

**Nothing works**

None of the following components work:

- Fan
- Compressor clutch
- Water control valve

1. Check for error code 137.
2. Make sure the control module is receiving 12 volts of power.

**NOTE:** Use a voltmeter to check the voltage. Make sure by disconnecting and connecting the DT connector on the control module. A click in the module indicates that electrical power is energizing an internal relay.

3. Make sure the serial communication ports are not damaged.
4. Make sure the control panel is connected correctly.
5. Make sure the wire harness is connected to the unit correctly.
6. Make sure pin 17 and 18 are connected securely into the DT connector on the control module. Make sure the pins are making good contact.

## Solution

1. Replace the control module.

**The electric Actuator for the mode of the airflow is not moving or operating correctly**

1. Make sure the control module is receiving electrical power.
2. Make sure there are no error codes.
3. Make sure the component for the electrical actuator is not jammed.
4. Inspect the wire harness and the connections.

## Solution

1. Replace the electrical actuator for the mode of the airflow.

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## 12.3 Basic air conditioning system testing

### 12.3.1 Visual inspection

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Before connecting the manifold gauge set to the machine, walk around the machine and check the following areas:

1. Check the condenser core face to make sure that the face is clean with clear air flow.
2. Check the condenser for possible leaks.
3. Inspect the compressor and the alternator. Inspect the fan belt condition and the tension.
4. Make sure the heater is off.
5. Check the compressor magnetic clutch operation. If the clutch does not engage, check the blower and the compressor fuses.
6. Check the blower operation. Make sure the air flows freely from the air ducts.
7. Inspect the condenser, the radiator, and the oil cooler (if equipped). The fins must not be bent, damaged or blocked with dirt or debris. Air must flow freely through the components.
8. Inspect the engine cover side screens and the front grill for dirt and debris.
9. Check the cab air filters for air flow restriction. Make sure to check the outside air filter and the recirculation air filter.
10. Inspect the lines and the hoses for damage. Check for loose fittings on all components.
11. Check the condition of all the wiring connectors.

After making the checks, install the manifold gauge set. Measure the ambient temperature before verifying a failure.

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### 12.3.2 System failure

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After connecting the gauges, if there is a failure in the system then continue through the diagnostic process.

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### 12.3.3 Test the condenser

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#### Procedure

1. Connect the manifold gauge set.
2. Start the machine.
3. Turn the AC on.
4. Put cardboard on the condenser.

#### Result

If the condenser is operating correctly, the higher gauge pressure will increase to the 350 psi range.

## 12.4 Manifold gauge set readings

### 12.4.1 Use manifold gauge test

After the test gauges have been connected to the service valves, the gauges will show the system static pressure. The the pressure changes to the ambient temperature. The higher the ambient temperature is, the higher the pressure indication will show on the gauges. Make a note of the static pressure indication to use when comparing the information to the data.

If the gauges do not record pressure, the system is empty. The system must be evacuated, charged, and tested for leaks.

If the system contains refrigerant, start the engine and let the system become stable.

#### Procedure

1. Make sure the cab heater is off.
2. Open the recirculation vent for full recirculation of the cab air.
3. Open all the louvers in the cab.
4. Make sure the transmission is in neutral and the parking brake is applied.
5. Operate the engine at 2100 rpm.
6. Set the temperature to the cold position.
7. Open the cab door to make sure the system is operating at the maximum capacity.
8. Close the engine cover.
9. Operate the system for five to ten minutes. The system will become stable for test indication.
10. Compare the gauge indications to the pressure - temperature chart in the data. If the gauge indications are in the specifications on the chart, then stop the air-conditioning system. Stop the engine, apply the parking brake, and remove the key. Disconnect the test gauges from the system.

**12.4.2 Low refrigerant charge in the system**

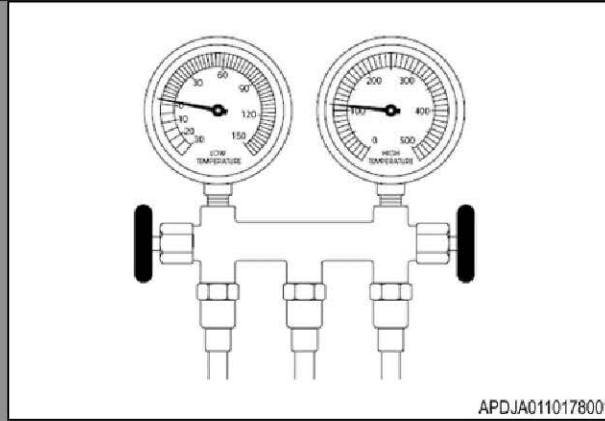


Fig. 2

**Air from the vents in the cab is not cool.**

| Cause(s)   | Solution(s)   |
|--|---|
| Refrigerant charge is not sufficient in the system | <p>Check for leaks with a leak detector.</p> <p>If a leak is found at a connection, fully evacuate the system and recharge with refrigerant.</p> <p>If a component line is leaking or bad, then recover all the refrigerant from the system. Replace the bad component. Evacuate the system, then recharge with refrigerant.</p> <p>Check the system for correct operation.</p> |

### 12.4.3 Air or moisture in the system

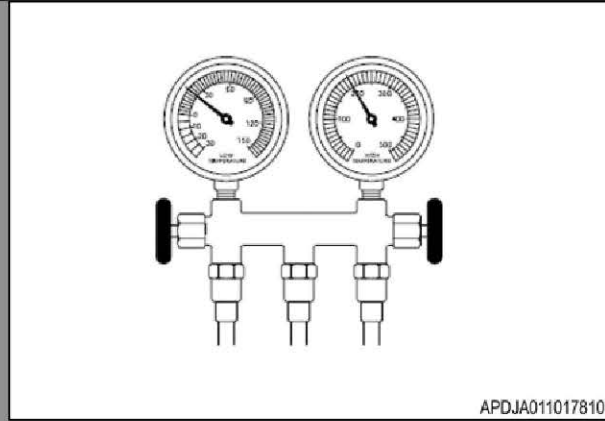


Fig. 3

The sight glass (if equipped) can be clear or show some bubbles. The air from the vents in the cab is only slightly cool.

In a cycling clutch type system with a thermostatic switch, the switch is possibly not cycling the clutch on and off. The result is the low pressure gauge will not move.

| Cause(s)                      | Solution(s)  |
|-------------------------------|--|
| Air or moisture in the system | <p>Test for leaks.</p> <p>If a leak is found, recover the refrigerant from the system and repair the leak. Flush the system and replace the receiver-drier because the desiccant will possibly be soaked with moisture. Check the compressor and then replace any refrigeration oil that was lost because of the leak. Evacuate and then recharge the system. Check the system for proper operation.</p> |

**12.4.4 Excessive air or moisture in the system**

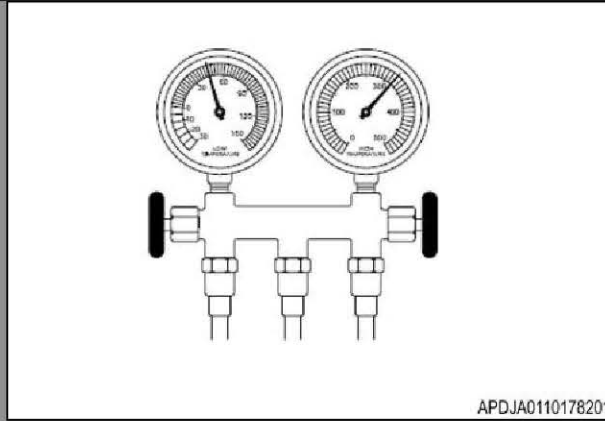


Fig. 4

**There is occasional bubbles in the sight glass (if equipped).**

**The air from the vents in the cab is only slightly cool.**

| Cause(s)  | Solution(s)  |
|---|--|
| <p>The system contains excessive air or excessive moisture.</p> | <p>Test for leaks, recover the refrigerant from the system, flush the system, and replace the receiver-drier.</p> <p>Check and replace any compressor oil that was lost because of leakage. Evacuate and then recharge the system. Check the system for correct operation.</p> |

### 12.4.5 Expansion valve stuck closed or plugged

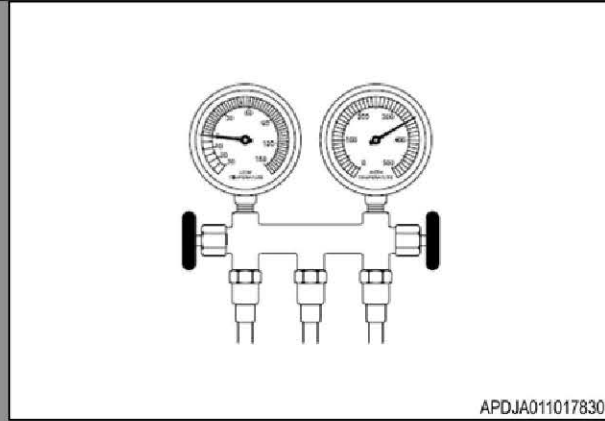


Fig. 5

Air from the vents is only slightly cool.

The expansion valve body is frosted or sweating.

| Cause(s)   | Solution(s)  |
|--|--|
| <p>The expansion valve is stuck closed or plugged.</p> | <p>test:</p> <ol style="list-style-type: none"> <li>1. Warm the diaphragm and the valve body. Engage the system and then check to see if the low pressure gauge rises.</li> <li>2. Carefully spray a small amount of nitrogen or any substance below 32 degrees F on the capillary coil or the valve diaphragm. The low side gauge needle should fall and read at a lower pressure. This step indicates the valve is part of the way open and the step closed the valve.</li> </ol> <p>Repeat the test, but first warm the valve diaphragm or the capillary in hand. If the low side gauge drops again, the valve is not stuck.</p> <ol style="list-style-type: none"> <li>3. Clean the surfaces of the evaporator outlet and the capillary coil. Make sure the coil or the bulb is attached to the evaporator outlet tube and the insulation is in position.</li> </ol> <p>Inspect the expansion valve screen. Recover the refrigerant from the system. Disconnect the inlet hose fitting from the expansion valve. Remove, clean and then replace the screen. Connect the hose.</p> <p>Any signs of contamination will require flushing the system. Replace the receiver-drier. Evacuate and recharge the system with refrigerant. Check the system for correct operation.</p> |

**NOTE:** If the expansion valve test did not cause the low pressure gauge needle to rise and to drop and if the other procedures did not correct the problem, the expansion valve is bad.

### 12.4.6 Condenser malfunction or system over charge

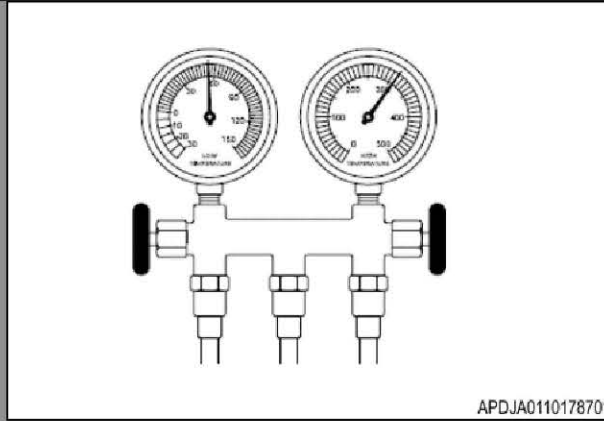


Fig. 6

APDJA0110178701

Air from the vents in the cab is possibly warm. In R-134a systems, there can be bubbles in the sight glass (if equipped). The high pressure hoses and the lines will be very hot.

#### Cause(s)

The condenser is not operating correctly or there can be an over charge in the system. There is possibly not sufficient airflow through the condenser fins during testing. An engine cooling system component malfunction can cause high pressure by blocking the airflow.

#### Solution(s)

Inspect the condenser for debris and then clean if necessary. Check the condenser is correctly mounted and there is correct clearance between the condenser and the radiator.

Check the following components:

- radiator pressure cap
- cooling system
- fan
- fan clutch
- drive belts
- radiator
- shutter assembly

Replace any bad parts. Check the system for correct operation.

If the the problem continues, the system can be over charged. Recover all the refrigerant and recharge the system. Flush the condenser or replace the condenser if necessary. Replace the receiver-drier. Connect the components and evacuate the system. Recharge the system with refrigerant. Check the system for correct operation.

### 12.4.7 Compressor malfunction

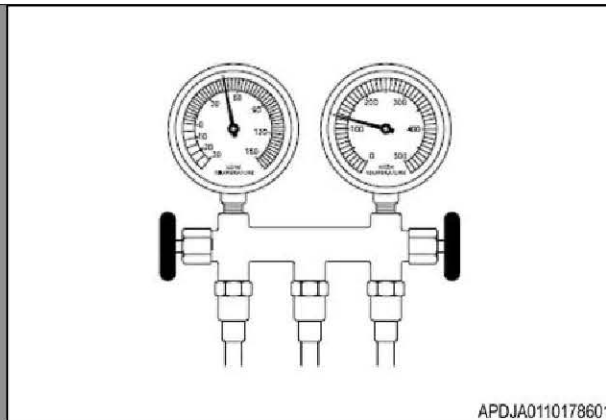


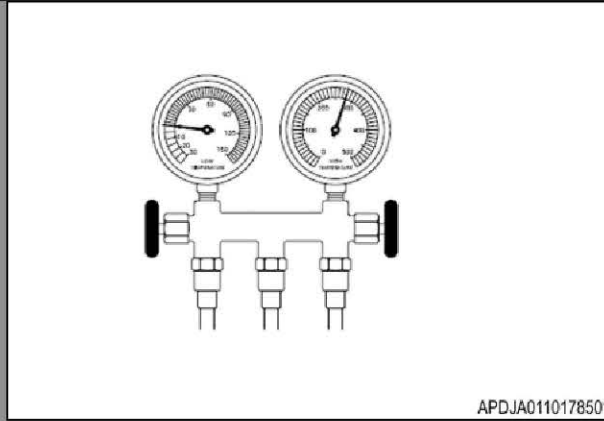
Fig. 7

**There is possible noise from the compressor during operation.**

| Cause(s)  | Solution(s)  |
|---|--|
| <p>There is bad reed valves or there is other bad compressor components. If there is no noise from the compressor, there will possibly be a worn or loose compressor clutch drive belt.</p> | <p>If a belt is worn or loose, then replace or tighten the belt. Check the system performance and the gauge readings. To inspect and service the compressor, isolate and then recover the refrigerant. Fully recover R-134a from the systems that contain schrader valves. Remove the compressor cylinder head and then check the appearance of the reed valve plate assembly. If the assembly is bad, then replace the valve plate. Install the new valve plate with new gaskets.</p> <p>If there are particles of desiccant in the compressor, then remove and replace the compressor and the receiver-drier. Flush the other system components with a flushing kit. If there are stem type valves and the compressor is isolated, then purge the remaining system of refrigerant before disconnecting the fittings. After flushing the system, assemble the components. Check the oil level in the compressor. Tighten all the connections and evacuate the system. Recharge the system with refrigerant. Check the system for correct operation.</p> |

**NOTE:** Rotary compressors have a small oil reservoir. The extra oil must be added for all installations (if equipped).

### 12.4.8 System high pressure side restriction



APDJA0110178501

Fig. 8

Air from the vents is only slightly cool.

The expansion valve body is frosted or sweating on the high pressure side hoses.

| Cause(s)   | Solution(s)  |
|--|--|
| <p>There is possibly a kink in the line. There is possibly a restriction on the high side of the system.</p> | <p>Find the the restriction in the system.<br/>                     Recover all of the refrigerant.<br/>                     Replace the bad component and the receiver-drier.<br/>                     Evacuate the system and then charge the system with refrigerant.<br/>                     Check the air conditioning system for correct operation.</p> |

### 12.4.9 Expansion valve stuck open

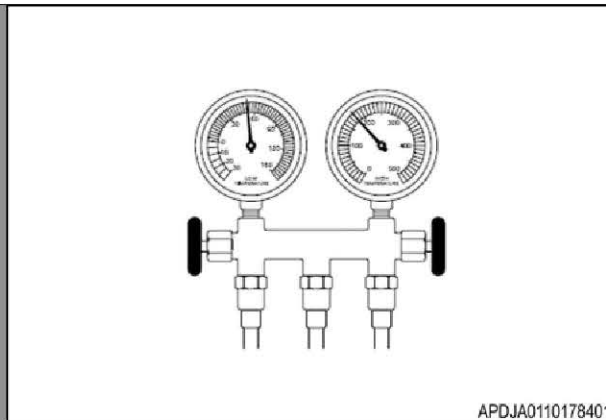


Fig. 9

Air from the vents in the cab is warm or only slightly cool.

| Cause(s)  | Solution(s)  |
|---|--|
| <p>The expansion valve is stuck open and/or the capillary tube is not making correct contact with the evaporator outlet tube. Liquid refrigerant can be flooding the evaporator, making it not possible for the refrigerant to vaporize and absorb the heat normally. In systems where TXV and sensing bulbs are accessible, check the capillary tube for correct mounting. Check there is good contact with the evaporator outlet tube. If the the TVX is not accessible, then go to the repair procedure.</p> | <p>Test:</p> <ol style="list-style-type: none"> <li>1. Operate the system on the coldest setting for a some time. Carefully spray nitrogen or another cold material on the capillary tube coil or the valve head.</li> <li>2. The low pressure side gauge needle should fall. This indicates the valve closed and is not stuck open. Repeat the test, first warm the valve diaphragm with hand.</li> <li>3. If the low side gauge shows a fall again, the valve is not stuck. Clean the surfaces of the evaporator outlet and the capillary coil. Make sure the coil is attached to to the evaporator outlet and covered with insulation material. Check the system for correct operation</li> </ol> |

If the test does not result in correct operation of the expansion valve, the valve is bad.

### 12.4.10 Thermostatic switch malfunction

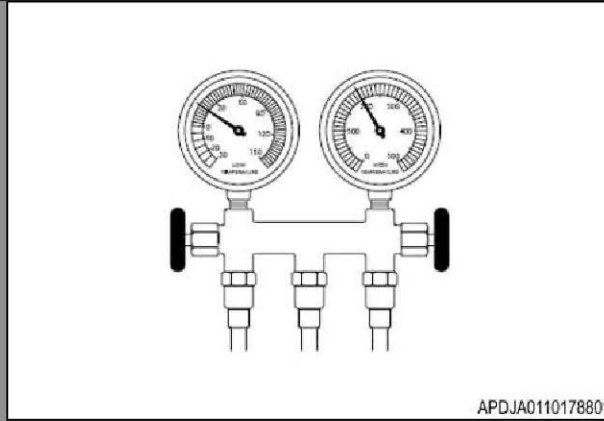


Fig. 10

The low side gauge needle can rise and fall in a very narrow range. The compressor can be cycling on and off more frequently than normal.

The low side gauge needle can rise and fall in an above normal range as the clutch cycles. The rise and fall can be an indication that the thermostat is set to high. A new thermostat was possibly installed incorrectly.

| Cause(s)  | Solution(s)  |
|---|--|
| The thermostat switch is not working correctly or at all. | Replace the thermostatic switch. Replace the thermostat with a new one of the same type.<br><br>Put the new thermostat capillary tube at the same location. Put the seating depth between the evaporator coil fins to align to the previous depth. Connect the electrical connections. |

## 12.5 Checking the system pressure

### 12.5.1 Manifold gauge set

The manifold gauge set is an important tool to service air conditioning systems. The manifold test set is used to determine the high and the low pressures and the correct refrigerant charge. The manifold test set also lets the user to find and determine the operating efficiency. The manifold gauge set reads both the high and the low pressures at the same time. Pressures must be compared to determine correct system operation. The gauges can read in metric or in standard units. The manifold gauge set is also used to remove, to evacuate, and to refill the system.

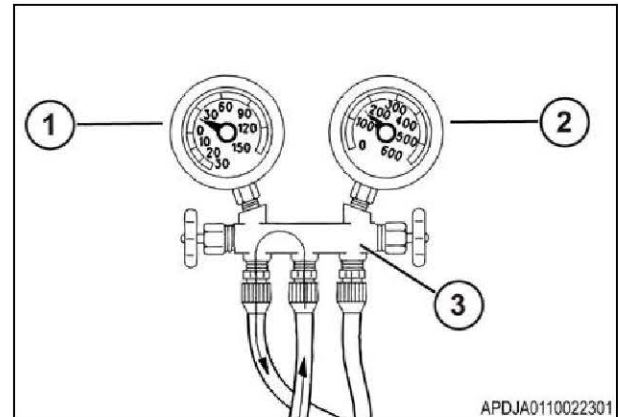


Fig. 11

The manifold gauge set has a low side compound gauge (1), a high side gauge (2), and a manifold (3) to where the gauges are connected.

### 12.5.2 Install the manifold gauge

1. Hang the manifold gauge in a convenient position.  
The hoses, the gauges, and the valves are color coded for convenience. The red hose is coupled to the high side of the system. The blue hose is coupled to the low side of the system. The center test hose (1) is yellow.



**WARNING:**  
Wear safety goggles when working with refrigerant. The hoses can contain liquid refrigerant under pressure.

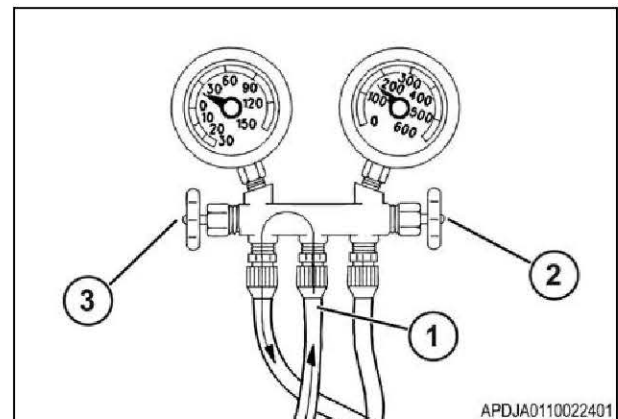


Fig. 12

2. Turn the knobs on both of the manifold valves (2) (3) clockwise to close the valves. Make sure the valves are fully closed.
3. Make sure the couplers are closed before connecting to the service valve. Turn the knob counterclockwise until the valve is finger tight to make sure the valve is closed on the couplers.
4. Put the coupler on the end of the red hose to the service valve. The service valve is on the line between the compressor and the condenser.
5. Push on the rear of the coupler while pulling on the sleeve until the coupler attaches to the service valve. Release the sleeve to lock the coupler on the service valve.
6. Pull up on the coupler without pulling up on the sleeve to make sure the coupler is correctly installed on the service valve.

7. Open the valves on both of the couplers, turn the knob clockwise until the knob stops for maximum flow.

### 12.5.3 Use manifold gauge test

After the test gauges have been connected to the service valves, the gauges will show the system static pressure. The the pressure changes to the ambient temperature. The higher the ambient temperature is, the higher the pressure indication will show on the gauges. Make a note of the static pressure indication to use when comparing the information to the data.

If the gauges do not record pressure, the system is empty. The system must be evacuated, charged, and tested for leaks.

If the system contains refrigerant, start the engine and let the system become stable.

#### Procedure

1. Make sure the cab heater is off.
2. Open the recirculation vent for full recirculation of the cab air.
3. Open all the louvers in the cab.
4. Make sure the transmission is in neutral and the parking brake is applied.
5. Operate the engine at 2100 rpm.
6. Set the temperature to the cold position.
7. Open the cab door to make sure the system is operating at the maximum capacity.
8. Close the engine cover.
9. Operate the system for five to ten minutes. The system will become stable for test indication.
10. Compare the gauge indications to the pressure - temperature chart in the data. If the gauge indications are in the specifications on the chart, then stop the air-conditioning system. Stop the engine, apply the parking brake, and remove the key. Disconnect the test gauges from the system.

### 12.5.4 Examine the air temperature

#### Procedure

1. Measure the ambient outside air temperature with a thermometer held 50 mm (2 in) in front of the condenser with the hood closed.
2. The system pressure changes with ambient temperature changes. Compare the thermometer indicator to the temperatures and the pressures shown on the pressure-temperature chart.
3. Put a thermometer in the air conditioning outlet duct nearest to the evaporator. Turn the blower to low and note the outlet air temperature. The thermometer must read 7 to 13 degrees C (45 to 55 degrees F) at approximately 20 to 25 degrees C (68 to 77 degrees F) ambient temperature.

**NOTE:** *A high ambient temperature and a high humidity will increase the outlet temperature.*

4. Examine both gauge readings at the point immediately before the clutch disengages when cycling.
5. Make a note of the gauge readings, the ambient indicator, and the outlet temperatures.
6. Use the pressure-temperature chart to compare the pressure indicator are in the range.
7. The gauge readings that are lower than the pressure-temperature chart can show a low refrigerant charge. A loss of refrigerant is one of the most common causes of the air conditioning failure.

#### Related Links

[Pressure-temperature chart](#) page 12-25

### 12.5.5 Data results

A base line performance test must be completed to find if the system is operating correctly. A last performance test must be done to make sure the correct operation after the system has been repaired. The two procedures show the system pressures and temperatures of the air that is entering the condenser. Use the pressure-temperature chart to make sure that the pressure indications are correct.

#### Related Links

[Pressure-temperature chart](#) page 12-25

### 12.5.6 Pressure-temperature chart

| Air temp entering condenser C (F)        | High side pressure kPa (psi)      | Air temp at the vent closest to evaporator C (F) | Low side pressure kPa (psi)   |
|--|-----------------------------------|--|-------------------------------|
| 20 degrees C (68 degrees F)              | 650 to 850 kPa (94 to 123 psi)    | 5 to 11 degrees C (41 to 52 degrees F)           | 10 to 110 kPa (1.5 to 16 psi) |
| 20 to 25 degrees C (68 to 77 degrees F)  | 980 to 1180 kPa (142 to 171 psi)  | 7 to 13 degrees C (45 to 55 degrees F)           | 20 to 120 kPa (2.9 to 17 psi) |
| 25 to 30 degrees C (77 to 86 degrees F)  | 1300 to 1500 kPa (189 to 218 psi) | 10 to 16 degrees C (50 to 61 degrees F)          | 40 to 140 kPa (5.8 to 20 psi) |
| 30 to 35 degrees C (86 to 95 degrees F)  | 1630 to 1830 kPa (236 to 265 psi) | 13 to 19 degrees C (55 to 66 degrees F)          | 60 to 160 kPa (9 to 23 psi)   |
| 35 to 40 degrees C (95 to 104 degrees F) | 1950 to 2150 kPa (283 to 312 psi) | 15 to 22 degrees C (59 to 72 degrees F)          | 80 to 180 kPa (12 to 26 psi)  |

The performance test must be done in the shade or an enclosure. The machine cannot be in direct sunlight immediately before evaluating the system. The ambient temperature must be a minimum 20 degrees C (68 degrees F).

Close the hood and open the cab door. Set the air conditioning to the lowest temperature setting and the blower on the highest airflow setting. Clear the condenser of any debris buildup. Clear the cab filter and the recirculation filter of any debris or replace if in poor condition. Clear the recirculation vent in the cab of any debris.

### 12.5.7 Base line performance test

The base line performance test helps determine how efficient the system is working under poor conditions.

Make sure the manifold gauge set is installed and a static pressure indication has been recorded.

#### Procedure

1. Open the cab door to make sure the system is working at maximum capacity.
2. Measure the ambient air temperature approximately 50 mm (2 in) in front of the condenser. Measure the air temperature in the vent next to the evaporator.
3. A temperature difference of 13 to 16 in degrees C (23 to 29 in degrees F) must be reached.
4. Measure the inlet and the outlet like temperature at the condenser.
5. A minimum temperature difference must be 11 in degrees C (20 in degrees F).
6. Measure the compressor housing temperature.

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7. The typical operating temperature is approximately 38 degrees C (100 degrees F) above the compressor inlet line temperature. The normal operating range will be 62 to 74 degrees C (144 to 165 degrees F).
8. Measure the inlet and the outlet line temperature at the evaporator. The evaporator is between the expansion valve and the evaporator.
9. The temperature difference must be 6 to 11 in degree C (11 to 20 in degrees F). At this temperature difference, the refrigerant will boil approximately two thirds to three quarters of the way through the evaporator.
10. The evaporator is flooded when there is no temperature difference.
11. If the temperature difference is too high, too little refrigerant is metered into the evaporator. The machine will not cool because the refrigerant boils off too quickly.

### 12.5.8 Refrigerant recovery

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Refrigerant must be removed from the system before loosening any line or removing any component containing refrigerant.

**IMPORTANT:** *It is illegal to knowingly release refrigerant to the atmosphere. Federal Clean Air Act Amendments of 1990 require that after July 1, 1992, no refrigerant must be intentionally released.*

Refrigerant must be removed with an approved refrigerant recovery station or recovery/recycling station.

A refrigerant recovery station removes refrigerant from the system and puts the refrigerant in a storage cylinder. The refrigerant that is removed must be processed before being used again.

A recover/recycling station removes, cleans, and filters refrigerant. The station also removes oil, acids, and particles from the refrigerant.

### 12.5.9 Refrigerant contamination

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Refrigerant contamination refers to the mixing of alternative refrigerants with R-134a. Contamination is a problem from the introduction of R-134a to replace R-12 refrigerant.

If the refrigerant has a contamination level of two percent or more, then put the contaminated refrigerant in a container only for contaminated refrigerant. Check with the local environment agency for regulations on the correct disposal of the contaminated refrigerant.

Identify the type of refrigerant before connecting a recovery station or a recovery/recycling station. Use a refrigerant identifier to make sure the refrigerant type. Do not mix refrigerant blends or unknown gases in a R-134a storage tank. Mixing refrigerants in a storage tank will contaminate the refrigerant.

Make sure there is no stop leak in the system before connecting a refrigerant recovery station. Stop leak will damage a recovery station or a recovery/recycle station.

### 12.5.10 Recovery

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Clean the external surfaces of the compressor and the hoses. Remove the protective caps from the service ports on the suction and the pressure hoses.

Make sure the refrigerant recovery station is plugged into a power supply. Make sure the valves on the refrigerant recovery station are closed. Turn the power to the recovery station on.

Make a record of the amount of oil that is in the oil drain container on the recovery station. Empty the oil drain container if necessary.

Press the recover key. Make sure the filters in the refrigerant recovery station are clean and correctly maintained.

**NOTE:** *See the information in the manufacturer's manual for correct filter maintenance.*

Connect the hose for the low pressure gauge to the suction port. Turn the knob clockwise to open the valve. Connect the hose for the high pressure gauge to the discharge port. Turn the knob clockwise to open the valve.

Turn the high and the low valves on the refrigerant recovery station to the recover/vacuum position.

Press the start key.

As the refrigerant is being recovered, the refrigerant moves through an oil separator. The refrigerant moves through a filter-drier before entering the refrigerant recovery container.

The compressor turns off when the recovery is complete. The low pressure gauge reads approximately 300 mm Hg (13 in. Hg). The machine automatically separates any oil from the refrigerant during the recovery process. The oil then drains into the oil drain container. Check the oil drain container and then record the amount of oil. Subtract the amount of oil before the procedure from the current amount to determine the amount of oil in the system.

**NOTE:** *The display on the recovery machine will not show an accurate amount of oil or refrigerant. The ambient temperature and the humidity can vary the amount shown.*

Wait five minutes and watch the manifold pressure gauges for a pressure rise. If the pressure rises above 0 kPa (0 psi), press the start key on the recovery unit. Wait for the compressor to turn off automatically. Repeat the procedure until the system pressure stays below 0 kPa (0 psi) for two minutes.

Press the stop key to exit the recovery cycle. Turn the high and the low valves on the recovery machine to the closed position.

The system can be repaired as necessary. The compressor oil level can be checked for the correct amount.

#### **Related Links**

[System evacuation](#) page 12-29

[Charge the system](#) page 12-35

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### **12.5.11 Moisture in a refrigerant system**

Moisture is the primary cause of failures in a refrigerant system. Moisture issues can be divided into two categories, liquid and vapor. Occasionally, liquid water is found in the system, but this is not normal. Water vapor causes the most problems in refrigeration and an A/C system.

One condition that is caused by moisture is freeze-ups in a refrigeration system. Refrigerant picks up moisture and is carried through the refrigerant lines. Moisture is a vapor that turns into ice crystals when moving through the expansion valve or the orifice tube. The ice crystals decrease the flow of the refrigerant. Flow restriction causes a deficiency in cooling.

Moisture has an acid result on metals in an A/C system. An acid result corrodes internal metal surfaces, which weaken the components and can cause a leak.

Moisture causes corrosion. Corrosion weakens internal metal surfaces until a solid material is formed. Loose pieces of corrosion mix with liquids in the system to form sludge. Sludge plugs the fine strainers, the expansion valves, and the orifice tubes. Sludge spreads corrosion through the system causing damage to the components. The damage can cause a refrigerant leak.

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### **12.5.12 Results of pressure on water boiling points**

Moisture must be removed when repairing an A/C system. Moisture is removed by reducing the internal system pressure. When the internal pressure is reduced, the boiling point of the water is also reduced. The internal system pressure must be reduced until the water boils into a vapor at the ambient temperature.

The atmospheric pressure at the sea level is 101.4 kPa (14.7 psi). Any pressure above the atmospheric pressure is referred to as the gauge pressure. Any pressure below the atmospheric pressure is referred to as the vacuum. The atmospheric pressure regulates the boiling point of water.

If the atmospheric pressure is significantly reduced inside a sealed refrigerant system, the water will vaporize. The water can vaporize even at -67 degrees C (-89 degrees F).

**12.5.13 Boiling temperature of water at converted pressures**

| Temperature C (F)               | Inches of vacuum                   | Microns        | kPa (psi)                |
|---------------------------------|------------------------------------|----------------|--------------------------|
| 100 degrees C (212 degrees F)   | 0 mm Hg (0.00 in Hg)               | 759968 microns | 101.3 kPa (14.692 psi)   |
| 96.1 degrees C (205 degrees F)  | 125 mm Hg (4.921245 in Hg)         | 535000 microns | 84.6 kPa (12.27019 psi)  |
| 90 degrees C (194 degrees F)    | 234.4 mm Hg (9.228319 in Hg)       | 525526 microns | 70.1 kPa (10.16715 psi)  |
| 80 degrees C (176 degrees F)    | 404.9 mm Hg (15.9409 in Hg)        | 355092 microns | 47.3 kPa (6.860285 psi)  |
| 70 degrees C (158 degrees F)    | 526.3 mm Hg (20.72041 in Hg) 526.3 | 233680 microns | 31.2 kPa (4.525177 psi)  |
| 60 degrees C (140 degrees F)    | 610.6 mm Hg (24.0393 in Hg)        | 149352 microns | 19.9 kPa (2.886251 psi)  |
| 50 degrees C (122 degrees F)    | 667.5 mm Hg (26.27945 in Hg)       | 92456 microns  | 12.3 kPa (1.783964 psi)  |
| 40 degrees C (104 degrees F)    | 704.9 mm Hg (27.75188 in Hg)       | 55118 microns  | 7.3 kPa (1.058775 psi)   |
| 30 degrees C (86 degrees F)     | 728.2 mm Hg (28.6692 in Hg)        | 31750 microns  | 4.2 kPa (.6091585 psi)   |
| 26.7 degrees C (80 degrees F)   | 734.6 mm Hg (28.92117 in Hg)       | 25400 microns  | 3.4 kPa (.4931283 psi)   |
| 24.4 degrees C (76 degrees F)   | 737.1 mm Hg (29.0196 in Hg)        | 22860 microns  | 3.0 kPa (.4361132 psi)   |
| 22.2 degrees C (72 degrees F)   | 739.6 mm Hg (29.11802 in Hg)       | 20320 microns  | 2.7 kPa (.3916019 psi)   |
| 20.6 degrees C (69 degrees F)   | 742.2 mm Hg (29.22038 in Hg)       | 17780 microns  | 2.4 kPa (.3480906 psi)   |
| 17.8 degrees C (64 degrees F)   | 744.7 mm Hg (29.31881 in Hg)       | 15240 microns  | 2.0 kPa (.2900755 psi)   |
| 15 degrees C (59 degrees F)     | 747.3 mm Hg (29.42117 in Hg)       | 12700 microns  | 1.7 kPa (.2465642 psi)   |
| 11.7 degrees C (53 degrees F)   | 749.8 mm Hg (29.5196 in Hg)        | 10160 microns  | 1.4 kPa (.2030528 psi)   |
| 7.2 degrees C (45 degrees F)    | 752.3 mm Hg (29.61802 in Hg)       | 7620 microns   | 1.0 kPa (.1450377 psi)   |
| 0 degrees C (32 degrees F)      | 755.4 mm Hg (29.74007 in Hg)       | 4572 microns   | .6 kPa (.08702264 psi)   |
| -6.1 degrees C (21 degrees F)   | 757.4 mm Hg (29.81881 in Hg)       | 2540 microns   | .3 kPa (.04351132 psi)   |
| -14.4 degrees C (6 degrees F)   | 758.7 mm Hg (29.86999 in Hg)       | 1270 microns   | .2 kPa (.02900755 psi)   |
| -31.1 degrees C (-24 degrees F) | 759.7 mm Hg (29.90936 in Hg)       | 254 microns    | .03 kPa (.004351132 psi) |

| Temperature C (F)               | Inches of vacuum             | Microns      | kPa (psi)                 |
|---------------------------------|------------------------------|--------------|---------------------------|
| -37.2 degrees C (-35 degrees F) | 759.8 mm Hg (29.9133 in Hg)  | 127 microns  | .02 kPa (.002900755 psi)  |
| -51.1 degrees C (-60 degrees F) | 759.9 mm Hg (29.91723 in Hg) | 25.4 microns | .003 kPa (.000435113 psi) |
| -56.7 degrees C (-70 degrees F) | 760 mm Hg (29.92117 in Hg)   | 12.7 microns | .002 kPa (.000290076 psi) |
| -67.8 degrees C (-90 degrees F) | 760 mm Hg (29.92117 in Hg)   | 2.54 microns | .0003 kPa (.000049 psi)   |

**NOTE:** The temperature in degrees F is the temperature at which the water boils at the stated vacuum. Inches of vacuum (in Hg) is the vacuum as read by the low pressure gauge on the manifold gauge set. The standard units of measurement are in inches of mercury (Hg). the metric units of measurement are in millimeters of mercury (mm Hg). The pounds per square inch (psi) is the amount of atmospheric pressure in the system above a perfect vacuum.

The characterization of a perfect vacuum is as follows:

- The perfect vacuum equals 29.92 in a vacuum at sea level (a perfect vacuum exists in principle only).
- A perfect vacuum equals zero microns.
- A high vacuum equals low microns.
- A deep vacuum equals low microns.

The terms high vacuum and low vacuum describes the same condition inside a closed air A/C system. For A/C servicing applications, a good vacuum is defines a high vacuum or a low micron indication on the system.

### 12.5.14 Before evacuation

The oil level in the compressor must be checked. The compressor oil cannot be checked when the system is charged with refrigerant.

Be prepared to replace the receiver-drier.

Replace any missing oil in the system.

Make sure the O-rings on the service couplers on the manifold gauge set and the recovery system are in good condition.

Follow the manufacturer's procedures when using the evacuation equipment.

### 12.5.15 System evacuation

A high vacuum is a necessary service aid. A high vacuum pump can remove all the moisture from the A/C system. The vacuum pump must lower the internal system pressure so the water boils into fumes at ambient temperature. The fumes are removed from the system and then removed through the vacuum pump.

Make sure the vacuum pump has sufficient capacity to pull a high vacuum to remove moisture from the system. Use the table to find the dimension of the vacuum pump.

| System  | Vacuum pump dimension |
|---|-----------------------|
| Passenger cars                                  | 1.2 to 1.5 cfm        |
| Ag equipment, vans, RVs and residential systems | 2 to 4 cfm            |
| Tractor/trailers, busses, rooftop A/C systems   | 5 to 6 cfm            |
| Maximum 70 tons                                 | 8 to 10 cfm           |

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Vacuum is measured in inches of vacuum by the low pressure (blue) on the manifold gauge set. Vacuum is measured in microns by the thermistor gauge.

A thermistor vacuum gauge is used to measure the quantity of air and moisture in the system. The thermistor gauge gives a more accurate procedure to find when the vacuum pump removes air and moisture from the system.

The A/C system can be evacuated down below a minimum of 1000 microns. Evacuating a system less than 500 is ideal.

**NOTE:** *A digital manifold gauge set gives a more accurate vacuum indication than an analog gauge set.*

## 12.6 Refrigerant recovery

### 12.6.1 Refrigerant recovery tools

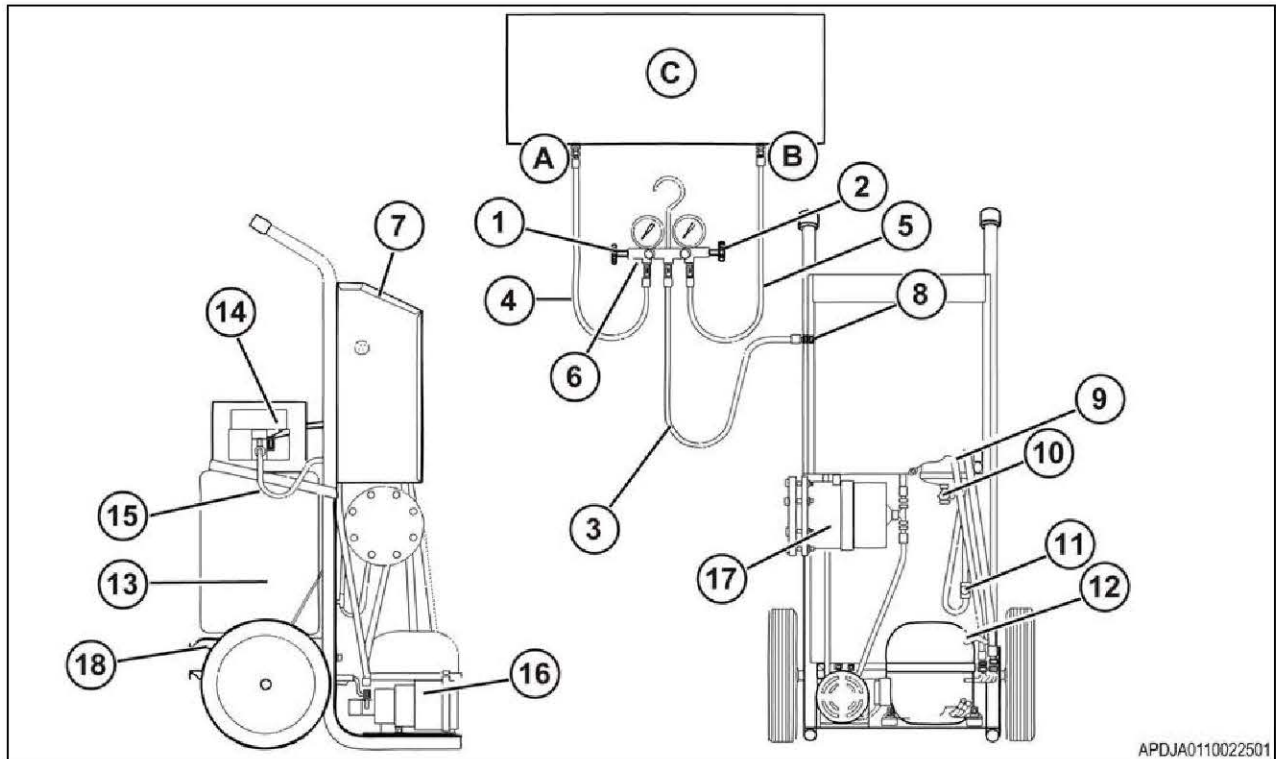


Fig. 13

- |                                    |                                      |
|------------------------------------|--------------------------------------|
| (1) Low pressure valve             | (12) Compressor                      |
| (2) High pressure valve            | (13) Refrigerant tank                |
| (3) Yellow charging hose           | (14) Blue hose (liquid)              |
| (4) Blue low pressure hose         | (15) Red hose (vapor)                |
| (5) Red high pressure hose         | (16) Refrigerant pump                |
| (6) Manifold gauge set             | (17) Filter dryer                    |
| (7) Control panel                  | (18) Scale for measuring refrigerant |
| (8) Inlet on recovery station      | (A) Low pressure side (suction)      |
| (9) Accumulator/oil separator      | (B) High pressure side (discharge)   |
| (10) Drain valve                   | (C) Refrigerant compressor           |
| (11) Pressure valve on accumulator |                                      |

**IMPORTANT:** Effective on July 1, 1992 regulations prohibit venting refrigerant into the atmosphere. Make sure to use proper procedure and environment to reclaim refrigerant from any equipment.

### 12.6.2 Refrigerant recovery

Refrigerant must be removed from the system before loosening any line or removing any component containing refrigerant.

**IMPORTANT:** It is illegal to knowingly release refrigerant to the atmosphere. Federal Clean Air Act Amendments of 1990 require that after July 1, 1992, no refrigerant must be intentionally released.

Refrigerant must be removed with an approved refrigerant recovery station or recovery/recycling station.

A refrigerant recovery station removes refrigerant from the system and puts the refrigerant in a storage cylinder. The refrigerant that is removed must be processed before being used again.

A recover/recycling station removes, cleans, and filters refrigerant. The station also removes oil, acids, and particles from the refrigerant.

---

### 12.6.3 Flush the refrigerant system

---

**IMPORTANT:** Do not use solvents or compressed air to clean system components.

Flush the system if a component failure causes metal particles or other unwanted materials to be supplied through the system.

Contamination in the system can cause a compressor to stop operating repetitively. Use the following procedure to flush the system.

#### Procedure

1. Find the type of refrigerant in the system.

**NOTE:** Use a refrigerant identifier to prevent refrigerant that is not R134a from causing contamination to the tools.

2. Remove the compressor.
3. Remove the inline dryer and the accumulator.
4. Flush the remainder of the system. Use an A/C flushing unit and flushing solution.
5. Blow out the system with dry air for five to ten minutes.
6. Replace bad components.
7. Install a new inline dryer.
8. Install a new compressor.

**NOTE:** The new compressors come with the correct quantity of refrigerant oil.

9. Evacuate the system.
10. Charge the system.

---

### 12.6.4 Test refrigerant leak with dye

---

**NOTE:** Put the black light directly below the possible leak as the refrigerant fumes are heavier than air.

**NOTE:** Leaks in the high pressure side are easier to find if the A/C system operates for five to ten minutes. Do the test immediately after the machine engine is stopped. The test must be done before the system pressures equalize. Leaks on the low pressure side are easier to find if the A/C system has been stopped for five to ten minutes. The leak test for the low pressure side is done after the system pressures equalize.

#### Procedure

1. Move the black light along the possible leak points. The black light will illuminate the dye in the refrigerant when a leak is found.

**NOTE:** Use an electronic leak detector to make sure the leaks are shown with the dye.

2. Use a refrigerant leak detector if a leak is found in the A/C system. The leak detector shows the leak that is found by the black light.

---

### 12.6.5 Test refrigerant leak with a leak detector

---

Refrigerant leak detectors can find as small as 12.0mL (0.40 fl oz) of refrigerant in the A/C system.

The system must contain a minimum 0.4 kg (0.88 lb) of refrigerant. Install the manifold gauge set to find if pressure is in the system. A leak test can be done if the system shows pressure.

**NOTE:** Put the sensor point directly below the possible leak as the refrigerant is heavier than the air.

**Procedure**

1. Move the sensor point along the possible leak at a rate of 25.4 mm (1 in) for each second.
2. If the cause of the leak is a loose fitting or connection, then system recovery is possibly not necessary. Tighten the loose connection and do the performance check procedure. If necessary, add refrigerant to the A/C system.
3. Removal or the replacement of a component can be necessary to stop a leak.

**12.6.6 Check the refrigerant compressor oil**

A special refrigerant oil is used in the A/C conditioning system. The oil mixes fully with the refrigerant to make sure all the components are lubricated. Checking the refrigerant oil in the compressor will give an indication of the amount of oil in the system.

**NOTE:** Check the compressor oil when there is a loss of oil in the system.

Probably causes for oil loss are:

- Broken refrigerant line
- Hose fitting (leaks)
- unsatisfactorily leaking the compressor seal
- component damage

**12.6.7 Refrigerant temperature/pressure chart**

Use the table to determine the pressure and the contamination level of a refrigerant container. The table can also be used for an A/C system that is not operating. The system must not operate for 10 - 12 hours. The system must not be stored in direct sun light to make the ambient temperature stable.

When a temperature measurement is not the same as the pressure on the chart, the following can occur:

- Contaminant in the system
- Incorrect refrigerant

| Relationship between temperature and pressure (R-134a Refrigerant) |                    | Relationship between temperature and pressure (R-134a Refrigerant) |                    |
|--|--------------------|--|--------------------|
| Temperature Degrees C (degrees F)                                  | Pressure kPa (psi) | Temperature Degrees C (degrees F)                                  | Pressure kPa (psi) |
| -18 C (0.0 F)  | 44 kPa (6.4 psi)   | 23 C (73.0 F)  | 519 kPa (75.3 psi) |
| -17 C (2.0 F)  | 51 kPa (7.4 psi)   | 23 C (74.0 F)  | 530 kPa (76.8 psi) |
| -16 C (4.0 F)  | 59 kPa (8.5 psi)   | 24 C (75.0 F)  | 540 kPa (78.3 psi) |
| -14 C (6.0 F)  | 66 kPa (9.6 psi)   | 24 C (76.0 F)  | 551 kPa (79.9 psi) |
| -13 C (8.0 F)  | 74 kPa (10.7 psi)  | 25 C (77.0 F)  | 562 kPa (81.5 psi) |
| -12 C (10.0 F)   | 82 kPa (11.9 psi)  | 26 C (78.0 F)  | 573 kPa (83.1 psi) |
| -11 C (12.0 F)   | 90 kPa (13.1 psi)  | 26 C (79.0 F)  | 584 kPa (84.7 psi) |
| -10 C (14.0 F)   | 99 kPa (14.3 psi)  | 27 C (80.0 F)  | 595 kPa (86.3 psi) |
| -9 C (16.0 F)  | 108 kPa (15.6 psi) | 27 C (81.0 F)  | 607 kPa (88.0 psi) |
| -8 C (18.0 F)  | 117 kPa (17.0 psi) | 28 C (82.0 F)  | 618 kPa (89.7 psi) |
| -7 C (20.0 F)  | 127 kPa (18.4 psi) | 28 C (83.0 F)  | 630 kPa (91.4 psi) |
| -6 C (21.0 F)  | 132 kPa (19.1 psi) | 29 C (84.0 F)  | 642 kPa (93.1 psi) |
| -6 C (22.0 F)  | 137 kPa (19.8 psi) | 29 C (85.0 F)  | 654 kPa (94.8 psi) |

| Relationship between temperature and pressure (R-134a Refrigerant) |                    | Relationship between temperature and pressure (R-134a Refrigerant) |                      |
|--|--------------------|--|----------------------|
| -5 C (23.0 F)  | 141 kPa (20.5 psi) | 30 C (86.0 F)  | 666 kPa (96.6 psi)   |
| -4 C (24.0 F)  | 147 kPa (21.3 psi) | 31 C (87.0 F)  | 678 kPa (98.4 psi)   |
| -4 C (25.0 F)  | 152 kPa (22.0 psi) | 31 C (88.0 F)  | 691 kPa (100.2 psi)  |
| -3 C (26.0 F)  | 157 kPa (22.8 psi) | 32 C (89.0 F)  | 703 kPa (102.0 psi)  |
| -3 C (27.0 F)  | 163 kPa (23.6 psi) | 32 C (90.0 F)  | 716 kPa (103.8 psi)  |
| -2 C (28.0 F)  | 168 kPa (24.4 psi) | 33 C (91.0 F)  | 729 kPa (105.7 psi)  |
| -2 C (29.0 F)  | 174 kPa (25.2 psi) | 33 C (92.0 F)  | 742 kPa (107.6 psi)  |
| -1 C (30.0 F)  | 179 kPa (26.0 psi) | 34 C (93.0 F)  | 755 kPa (109.5 psi)  |
| -1 C (30.0 F)  | 185 kPa (26.8 psi) | 34 C (94.0 F)  | 768 kPa (111.4 psi)  |
| 0 C (32.0 F)   | 191 kPa (27.7 psi) | 35 C (95.0 F)  | 782 kPa (113.4 psi)  |
| 1 C (33.0 F)   | 197 kPa (28.5 psi) | 36 C (96.0 F)  | 796 kPa (115.4 psi)  |
| 1 C (34.0 F)   | 203 kPa (29.4 psi) | 36 C (97.0 F)  | 809 kPa (117.4 psi)  |
| 2 C (35.0 F)   | 209 kPa (30.3 psi) | 37 C (98.0 F)  | 823 kPa (119.4 psi)  |
| 2 C (36.0 F)   | 215 kPa (31.2 psi) | 37 C (99.0 F)  | 838 kPa (121.5 psi)  |
| 3 C (37.0 F)   | 221 kPa (32.1 psi) | 38 C (100.0 F)   | 852 kPa (123.5 psi)  |
| 3 C (38.0 F)   | 228 kPa (33.0 psi) | 38 C (101.0 F)   | 866 kPa (125.6 psi)  |
| 4 C (39.0 F)   | 234 kPa (34.0 psi) | 39 C (102.0 F)   | 881 kPa (127.8 psi)  |
| 4 C (40.0 F)   | 241 kPa (34.9 psi) | 39 C (103.0 F)   | 896 kPa (129.9 psi)  |
| 5 C (41.0 F)   | 248 kPa (35.9 psi) | 40 C (104.0 F)   | 911 kPa (132.1 psi)  |
| 6 C (42.0 F)   | 254 kPa (36.9 psi) | 41 C (105.0 F)   | 926 kPa (134.3 psi)  |
| 6 C (43.0 F)   | 261 kPa (37.9 psi) | 41 C (106.0 F)   | 941 kPa (136.5 psi)  |
| 7 C (44.0 F)   | 263 kPa (38.9 psi) | 42 C (107.0 F)   | 956 kPa (138.7 psi)  |
| 7 C (45.0 F)   | 275 kPa (39.9 psi) | 42 C (108.0 F)   | 972 kPa (141.0 psi)  |
| 8 C (46.0 F)   | 283 kPa (41.0 psi) | 43 C (109.0 F)   | 988 kPa (143.3 psi)  |
| 8 C (47.0 F)   | 290 kPa (42.0 psi) | 43 C (110.0 F)   | 1004 kPa (145.6 psi) |
| 9 C (48.0 F)   | 297 kPa (43.1 psi) | 44 C (111.0 F)   | 1020 kPa (147.9 psi) |
| 9 C (49.0 F)   | 305 kPa (44.2 psi) | 44 C (112.0 F)   | 1036 kPa (150.3 psi) |
| 10 C (50.0 F)  | 312 kPa (45.3 psi) | 45 C (113.0 F)   | 1053 kPa (152.7 psi) |
| 11 C (51.0 F)  | 320 kPa (46.4 psi) | 46 C (114.0 F)   | 1069 kPa (155.1 psi) |
| 11 C (52.0 F)  | 328 kPa (47.5 psi) | 46 C (115.0 F)   | 1087 kPa (157.6 psi) |
| 12 C (53.0 F)  | 336 kPa (48.7 psi) | 47 C (116.0 F)   | 1103 kPa (160.0 psi) |
| 12 C (54.0 F)  | 344 kPa (49.9 psi) | 47 C (117.0 F)   | 1120 kPa (162.5 psi) |
| 13 C (55.0 F)  | 352 kPa (51.0 psi) | 48 C (118.0 F)   | 1138 kPa (165.1 psi) |
| 13 C (56.0 F)  | 360 kPa (52.2 psi) | 48 C (119.0 F)   | 1156 kPa (167.6 psi) |
| 14 C (57.0 F)  | 369 kPa (53.5 psi) | 49 C (120.0 F)   | 1173 kPa (170.2 psi) |
| 14 C (58.0 F)  | 377 kPa (54.7 psi) | 49 C (121.0 F)   | 1191 kPa (172.8 psi) |
| 15 C (59.0 F)  | 385 kPa (55.9 psi) | 50 C (122.0 F)   | 1209 kPa (175.4 psi) |

| Relationship between temperature and pressure (R-134a Refrigerant) |                    | Relationship between temperature and pressure (R-134a Refrigerant) |                      |
|--|--------------------|--|----------------------|
| 16 C (60.0 F)  | 394 kPa (57.2 psi) | 51 C (123.0 F)   | 1228 kPa (178.1 psi) |
| 16 C (61.0 F)  | 403 kPa (58.2 psi) | 51 C (124.0 F)   | 1247 kPa (180.8 psi) |
| 17 C (62.0 F)  | 412 kPa (59.8 psi) | 52 C (125.0 F)   | 1265 kPa (183.5 psi) |
| 17 C (63.0 F)  | 421 kPa (61.1 psi) | 52 C (126.0 F)   | 1285 kPa (186.3 psi) |
| 18 C (64.0 F)  | 430 kPa (62.4 psi) | 53 C (127.0 F)   | 1304 kPa (189.1 psi) |
| 18 C (65.0 F)  | 440 kPa (63.8 psi) | 53 C (128.0 F)   | 1323 kPa (191.9 psi) |
| 19 C (66.0 F)  | 450 kPa (65.2 psi) | 54 C (129.0 F)   | 1342 kPa (194.7 psi) |
| 19 C (67.0 F)  | 459 kPa (66.8 psi) | 54 C (130.0 F)   | 1362 kPa (197.6 psi) |
| 20 C (68.0 F)  | 469 kPa (68.0 psi) | 55 C (131.0 F)   | 1382 kPa (200.5 psi) |
| 21 C (69.0 F)  | 478 kPa (69.4 psi) | 56 C (132.0 F)   | 1402 kPa (203.4 psi) |
| 21 C (70.0 F)  | 488 kPa (70.8 psi) | 56 C (133.0 F)   | 1422 kPa (206.3 psi) |
| 22 C (71.0 F)  | 498 kPa (72.3 psi) | 57 C (134.0 F)   | 1443 kPa (209.3 psi) |
| 22 C (72.0 F)  | 509 kPa (73.8 psi) |  |                      |

**Labeling procedure**

Attach a cable strap label to the A/C system with a record of the system charge.

**12.6.8 Charge the system**

**NOTE:** An accurate refrigerant charge is found by the weight or the temperature of the evaporator core. Pressures cannot be used to find if the A/C system is correctly charged. Do not add or remove only part of the refrigerant.

**NOTE:** Do not charge with a liquid or with a gas through the discharge side of the system when the engine is operating.

**IMPORTANT:** The sight glass cannot be used to examine the charge the system. Refrigerant must be recovered and evacuated for a full system charge. After recovery and evacuation, charge the system with the correct quantity of refrigerant.

**NOTE:** The refrigerant moves through the lowside when the engine is operating. Do not charge liquid refrigerant through the suction side (low) of the A/C system. Charge the system with liquid through the highside when the engine is not operating.

Before charging the system, monitor the following important items:

**Procedure**

1. Condenser and evaporator:
  - Examine the condenser and the evaporator for unwanted materials.
  - Make sure the fan and blower motor for the condenser and the evaporator are operating. Examine for blockages.
2. Look for a loose belt on the compressor.
3. Clean the fresh and the recirculation filters.

4. If there is a moisture indicator on the receiver-dryer or the inline dryer, make sure to monitor it. Replace if the indicator is pink or white. A blue indicator is correct.
5. Monitor the condensation tube on the evaporator to make sure the tube is not clogged and the tube is correctly positioned.

A new receiver-dryer must have two to three hours of operation before an accurate moisture indication can be tested.

The recommended procedure for to charge the A/C system is:

- Recover the refrigerant
- Evacuate the system
- Charge the system with the correct quantity of refrigerant

### 12.6.9 Charge the system with a scale

Follow the procedures to charge the system using a refrigerant tank and a scale.

**NOTE:** The engine cannot be operating while charging the system with liquid.

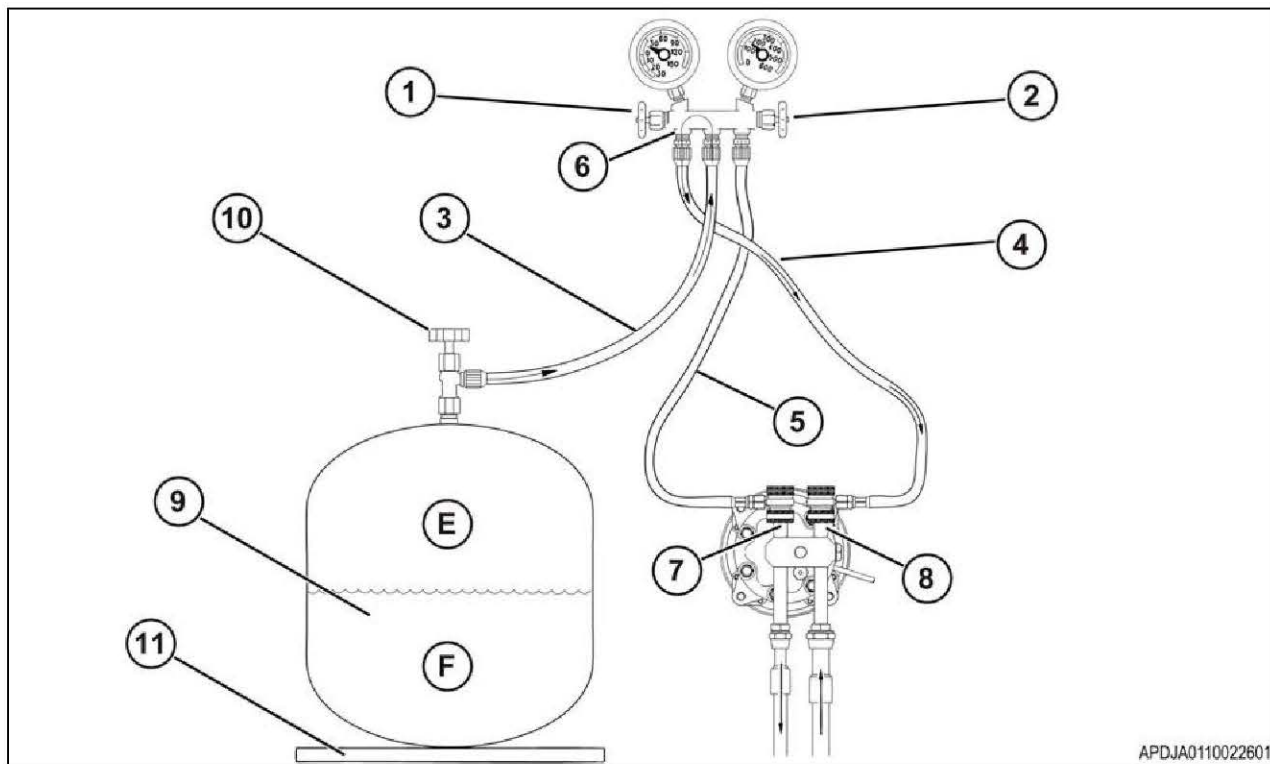


Fig. 14

- |                               |                                      |
|-------------------------------|--------------------------------------|
| (1) Low pressure valve        | (8) Service valve (suction)          |
| (2) High pressure valve       | (9) Refrigerant tank                 |
| (3) Charging hose             | (10) Refrigerant tank shut off valve |
| (4) Low pressure hose         | (11) Scale                           |
| (5) High pressure hose        | (E) Vapor                            |
| (6) Manifold gauge set        | (F) Liquid                           |
| (7) Service valve (discharge) |                                      |

1. Find the refrigerant capacity for the system.
2. Install the high and the low pressure hoses. Purge the hoses.
3. Hand tighten the charging hose from the manifold gauge set directly to the valve on the refrigerant tank. Open the valve on the top of the refrigerant tank to let the flow of refrigerant through the charging hoses to the manifold gauge set.

4. Loosening the hose at the manifold gauge set for to to three seconds. Tighten the connection to purge the air out of the lines.
5. Put the refrigerant tank on the scale so the valve is at the bottom. Monitor the weight of the tank.  
**NOTE:** A heater blanket can be necessary when charging an A/C system with a less than full refrigerant tank.
6. Opening the high pressure valve on the manifold gauge set lets the liquid refrigerant to charge the system through the high pressure side of the compressor.
7. Monitor the weight of the refrigerant tank frequently as the weight will decrease as the refrigerant enters the system. When the necessary quantity of refrigerant has entered the system. Close the valve and the high pressure valve.
8. For the correct system charge, disconnect the charging hose and do a performance check.

---

### 12.6.10 Add more refrigerant to a low charge

---

**IMPORTANT:** Failure to correctly follow the procedure can cause compressor failure. The following procedure is not recommended procedure for charging an A/C system. The recommended procedure of measuring refrigerant is by weight.

**NOTE:** The following is only applicable if the inlet air temperature at the condenser is between 21 C (70.0 F) and 32 C (90.0 F).

**IMPORTANT:** If the system has no refrigerant, evacuate the system before charging. The refrigerant charge must be measured by weight.

#### Procedure

1. Connect the manifold gauge set to discharge and service the ports on the compressor.
2. Make sure the low and the high pressure valves are closed on the manifold gauge set.
3. Turn the valve on the tank counterclockwise to release the refrigerant in the charging hose.  
**NOTE:** Make sure the cylinder of the refrigerant is up right to let the refrigerant enter the system as a gas.
4. Loosen the connection on the charging hose at the manifold gauge set for two to three seconds, then tighten the connection.
5. Start the engine and then operate the engine at 2100 rpm.
6. Rotate the temperature control to the maximum cool position. Rotate the fan switch to high.  
**NOTE:** Recovering the refrigerant and then evacuating the system is the preferred procedure for charging the A/C system. After the system is recovered and the system is evacuated, the system must be charged with the correct refrigerant quantity.
7. Open the low pressure valve on the manifold gauge set to release the refrigerant in the low pressure hose. Monitor the pressure gauge and then record the gauge indication. The indication cannot be more than the usual operating ranges during the procedure. Slowly add refrigerant until the accumulator is cool. The temperature of the vents in the cab must decrease during the procedure.
8. After the accumulator becomes cool, add 0.34 kg (0.750 lb) of refrigerant to the system for reserve. Measure the refrigerant by weight.
9. To prevent more flow of refrigerant in the compressor, close the low pressure valve. Let the system become stable for five minutes, the inlet and the outlet on the accumulator will be cool.  
**NOTE:** If the low pressure valve is opened fully, the indication will show too high until the system becomes fully charged.
10. The gauge indication for the low pressure valve will be in the correct range after charging the system. The gauge indication for the high pressure valve will be in the correct range after charging the

## 12. Air conditioning and heating system

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system. If the gauge indication is in the correct range, go to step 12. If the gauge indication is not in the correct range, go to step 11.

11. If the pressure on the suction side or the discharge pressure becomes too high, the system is overcharged. Fully close the valve on the refrigerant tank to close off the flow of refrigerant to the charging hose. Stop the engine, recover the charge and evacuate the charge. Charge the system to the correct charge.
  12. Move the A/C controls to off and stop the engine.
  13. Remove the manifold gauge set.
- 

### 12.6.11 Remove the manifold gauge set

---

Remove the charging hoses correctly to prevent a low system charge. For an accurate refrigerant charge, remove the refrigerant from the charging hoses referring to the following:

#### Procedure

1. Let the compressor continue to operate. Close the valve on the high pressure side, near the charging ports. Disconnect the high pressure hose from the A/C system.
2. Open the high and the low pressure valves at the gauge set. Refrigerant in the hoses must be removed by the compressor through the low pressure hose.
3. Close the valve on the low pressure side, near the charging ports. Disconnect the low pressure hose from the A/C system. At this time the system is charged.

**NOTE:** After removing the gauge set, cap the charging valves.

## 12.7 Air conditioning and heating system components

### 12.7.1 Remove the main serpentine belt

#### Procedure

**1. WARNING:**

*Hot components can burn. Severe personal injury can result. Let the engine and the components cool before doing maintenance.*

Park the machine on a solid level surface. Stop the engine, apply the park brake, and take the key with you.

- 2.** Put the battery disconnect switch key (1) in the off position, to close off the battery power. Remove the battery disconnect switch key.

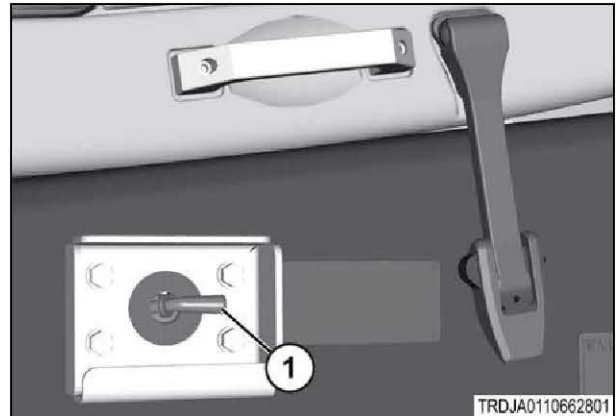


Fig. 15

**3.**



**CAUTION:**  
Safely prop open the engine cover. Closing the engine cover creates a pinch point that can cause serious bodily injury.

Release both side latches (1) and open the engine cover all the way.

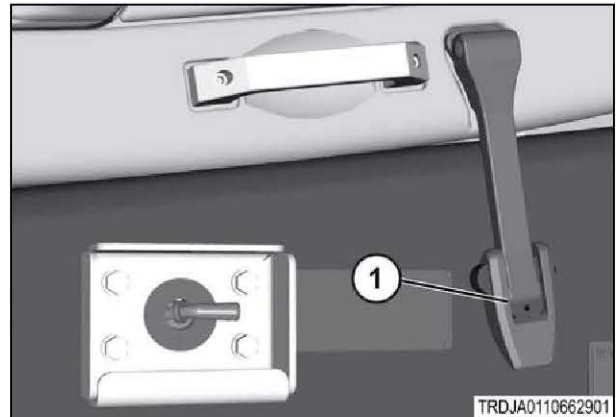


Fig. 16

- 4.** Remove the hardware (1) and the right-hand side engine screen.

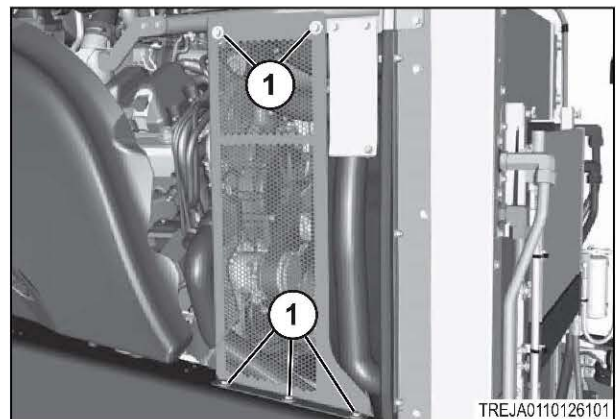



Fig. 17

5.  **WARNING:**  
Equipment or parts under spring tension can cause bodily injury. Use caution in releasing belt tension.

Install a 3/4 inch drive breaker bar into the square drive (1) of the main serpentine belt tensioner (2). Push counterclockwise and remove the main serpentine belt (3) from the pulleys. Slowly release the belt tensioner to the neutral position. Remove the breaker bar. Slide the belt over the fan to remove.

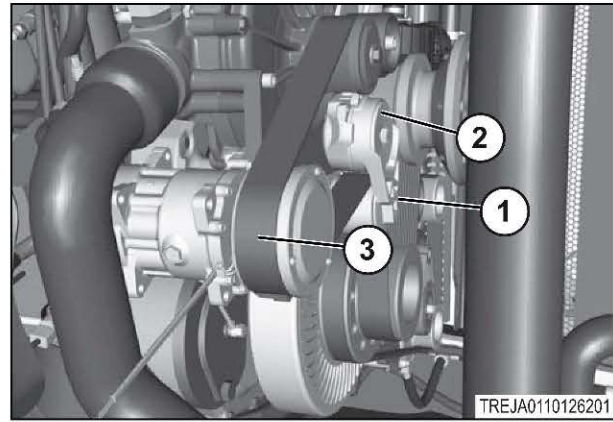


Fig. 18

## 12.7.2 Install the main serpentine belt

### Procedure

1. The main serpentine belt routing diagram.

**NOTE:**

*Some parts have been removed for clarity.*

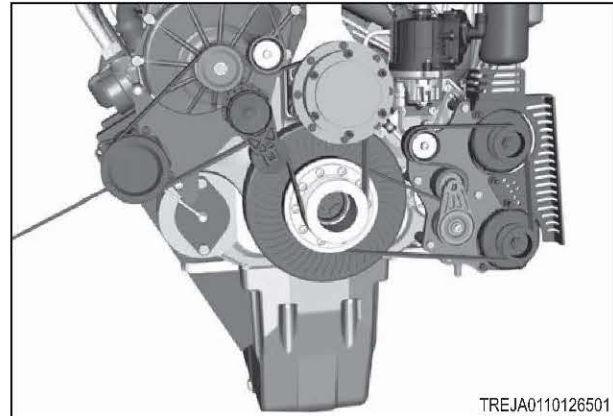



Fig. 19

2. Install the main serpentine belt (3) around the fan. Install the main serpentine belt on all the pulleys except the alternator pulley (4). Correctly seat the belt in the pulley grooves.

3.  **WARNING:**  
Equipment or parts under spring tension can cause bodily injury. Use caution in releasing belt tension.

Install a 3/4 inch drive breaker bar into the square drive hole (1) on the main belt tensioner (2). Push the drive counterclockwise and install the main belt (3) on the alternator pulley (4). Correctly seat the belt in the pulley grooves. Slowly release the tension until the belt tensioner (2) makes contact with the belt. Remove the 3/4 inch drive breaker bar.

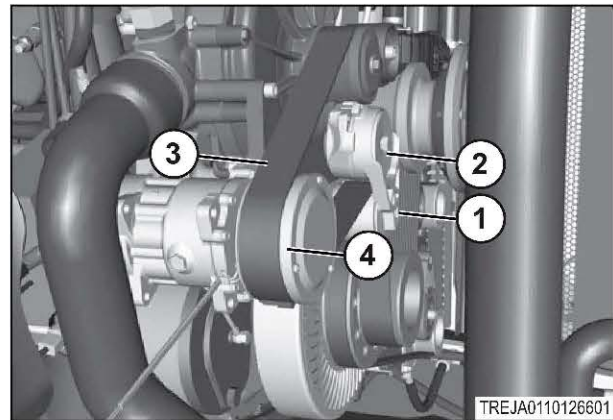


Fig. 20

**NOTE:**

*Supply enough area for the swing of the 3/4 inch breaker bar to let the belt tensioner come to a neutral position.*

4. Fasten the right-hand side engine screen to the machine with hardware (1).

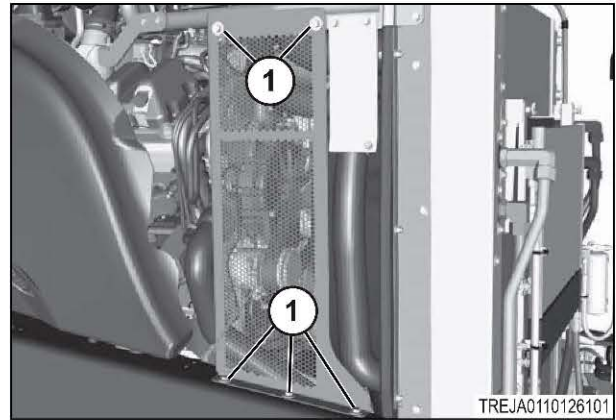


Fig. 21

5. Close the engine cover. Fasten the latch (1) to the keeper on both sides of the frame.

**IMPORTANT:**

*Make sure to fasten the latches on both sides of the engine cover.*

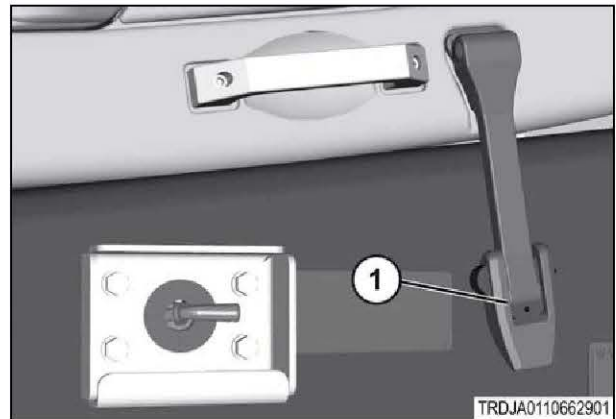


Fig. 22

6. Install the battery disconnect switch key (1).

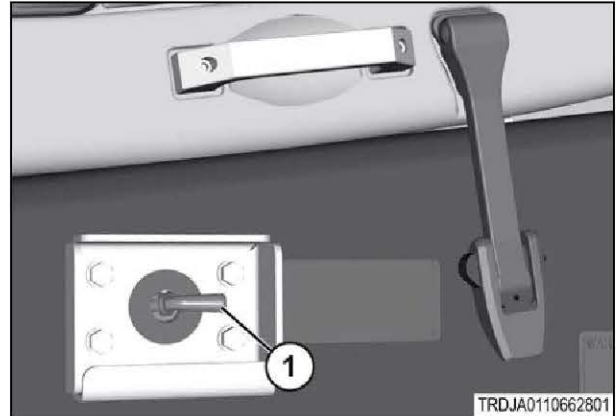


Fig. 23

7. Turn the battery disconnect switch key (1) clockwise to connect the power.

### 12.7.3 Remove the air conditioning compressor



**WARNING: Hot components can burn.**

**Severe personal injury can result.**

**Let the engine and components cool before doing maintenance.**



**WARNING: Contact with refrigerant is a hazard. Refrigerant can cause frostbite and other serious injury.**

**Serious personal injury can occur.**

**Keep face and hands away to help prevent injury. Protective goggles must be worn when refrigerant lines are opened. Release fittings slowly in an well ventilated area. Do not inhale the refrigerant.**

**NOTE:**

*Before removal, fasten identification tags on the components for correct installation at assembly. Put caps and plugs on all hoses, fittings, and ports to prevent contamination from entering the system.*

**NOTE:**

*Contain all fluids during the performance of inspection, maintenance, doing tests, adjusting, and repair of the machine. Prepare to contain fluids with the correct containers before opening any compartment or disassembling any component containing fluids. Discard fluids according to the local regulations and the laws.*

**NOTE:**

*Fully clean all components to prevent contamination from entering the system. Contamination can damage the precision components. Complete the disassembly procedures on a clean work surface. Put a clean cloth on top of the components.*

**NOTE:**

*Use only certified technicians and equipment to service the air conditioning systems.*

**NOTE:**

*When opening the air conditioning system, replace the air conditioning receiver-dryer. See the information for removing/installing the air conditioning receiver-dryer.*

**Procedure**

1. Park the machine on a solid, level surface. Stop the engine, apply the parking brake, and take the key with you.
2. Turn the battery disconnect switch key (1) counterclockwise to disconnect the battery power.

**NOTE:**

*The battery disconnect switch is shown in the off position.*

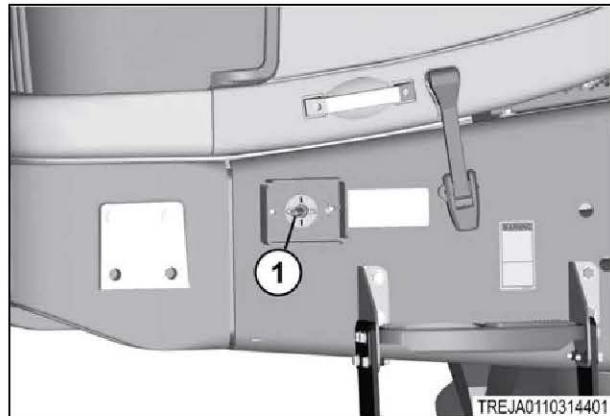


Fig. 24

3. Remove the battery disconnect switch key (1).

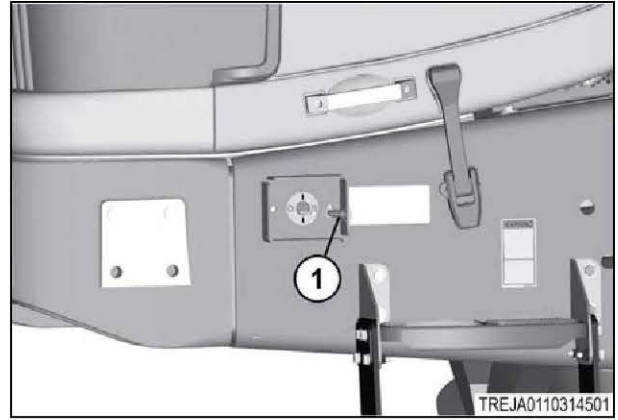



Fig. 25

4.  **CAUTION:** Safely prop open the engine cover. Closing engine cover creates a pinch point that can cause serious bodily injury.

Release both side latches (1) and open the engine cover (2) all the way.



Fig. 26

5. Remove the hardware (1, 3) and the right-hand fan guard (2).

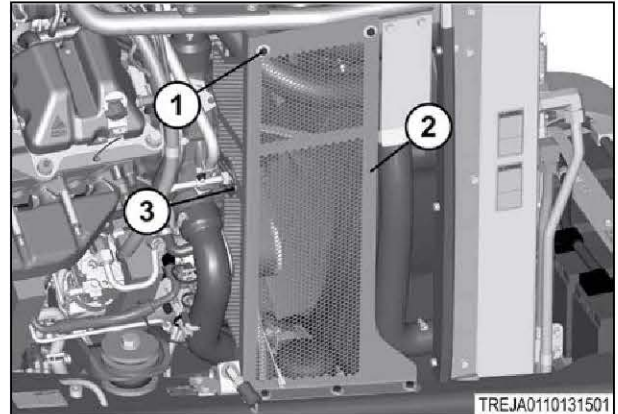



Fig. 27

6.  **WARNING:** Equipment or parts under spring tension can cause bodily injury. Use caution in releasing belt tension.

Install the correct breaker bar into the square drive (1) of the fan drive belt tensioner (2).

7. Push clockwise and remove the fan drive belt (3) from the pulleys.
8. Slowly release the fan drive belt tensioner to the neutral position.
9. Remove the breaker bar.

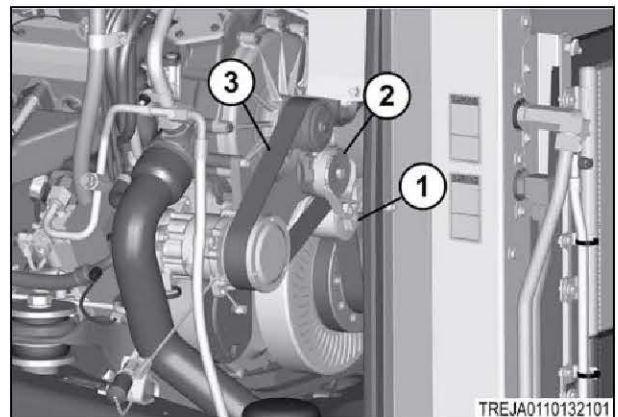


Fig. 28

12. Air conditioning and heating system

- 10. Disconnect the wire harness (1).
- 11. Disconnect the air conditioning hoses (2).

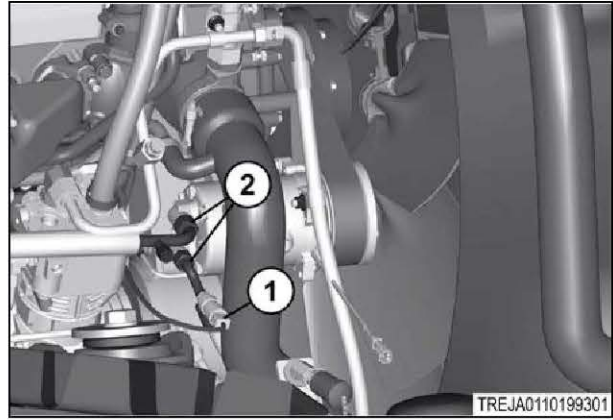


Fig. 29

- 12. Disconnect the wire harness (1).
- 13. Remove the hardware (2) and the air conditioning compressor (3).

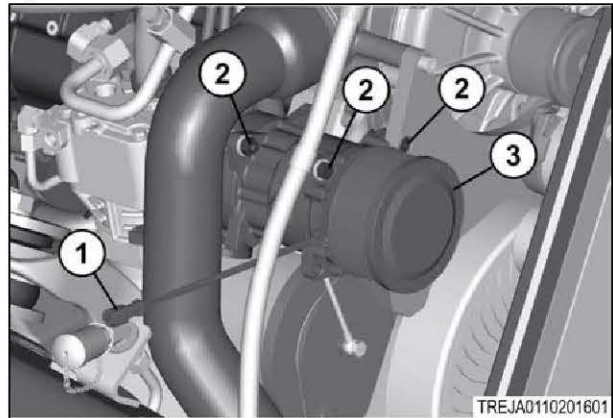


Fig. 30

**12.74 Install the air conditioning compressor**

**Procedure**

- 1. Install the air conditioning compressor (3) with the hardware (2). Connect the wire harness (1).

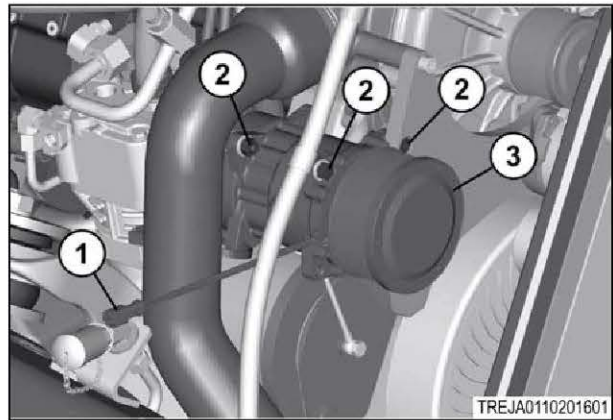


Fig. 31

2. Connect the air conditioning hoses (2) and the wire harness (1).

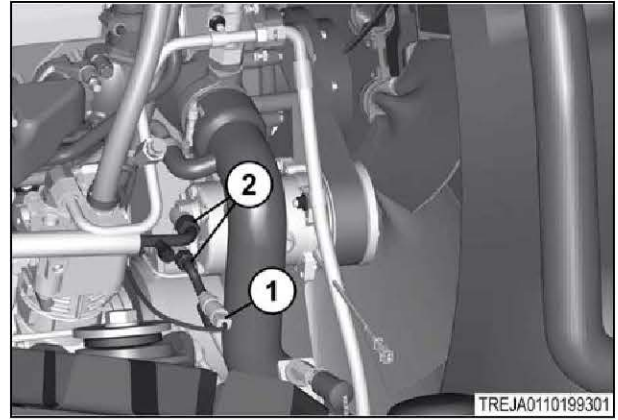



Fig. 32

3.  **WARNING:**  
Equipment or parts under spring tension can cause bodily injury. Use caution in releasing belt tension.

Install the fan drive belt. Install the correct breaker bar into the square drive (1) of the fan drive belt tensioner (2). Push clockwise and install the fan drive belt (3) to the pulleys. Slowly release the fan drive belt tensioner to the neutral position. Remove the breaker bar.

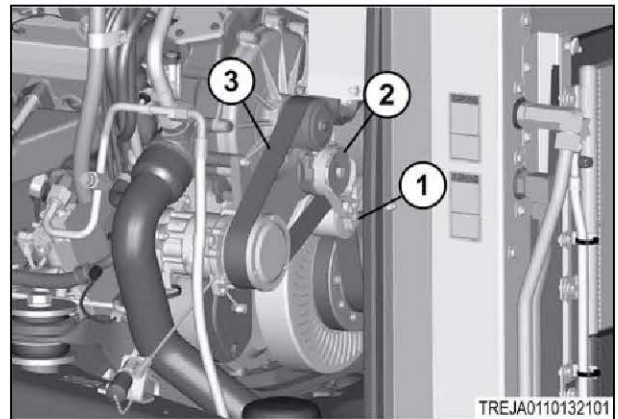


Fig. 33

4. Install the right-hand fan guard (2) with the hardware (1, 3).

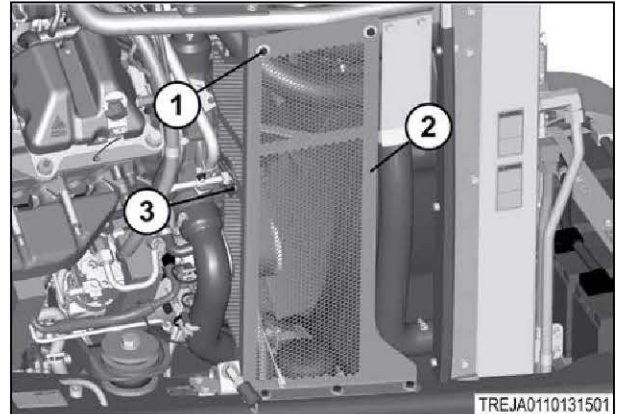


Fig. 34

5. Close the engine cover (2) and connect the two latches (1).



Fig. 35

6. Install the battery disconnect switch key (1).

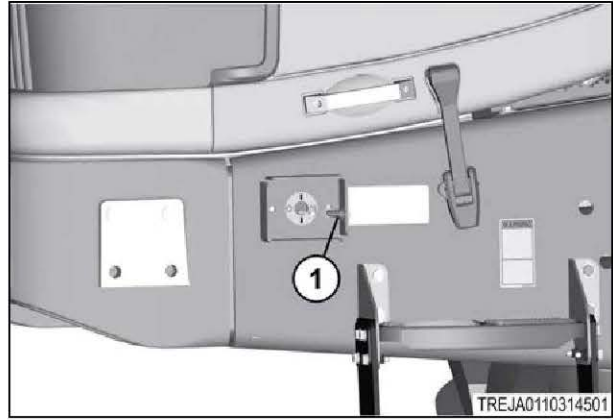


Fig. 36

7. Turn the battery disconnect switch key (1) clockwise to connect the battery power.

**NOTE:**

*The battery disconnect switch is shown in the on position.*



Fig. 37

### 12.7.5 Remove the air conditioning receiver/dryer



**WARNING: Hot components can burn.**

**Severe personal injury can result.**

**Let the engine and components cool before doing maintenance.**



**WARNING: Contact with refrigerant is a hazard. Refrigerant can cause frostbite and other serious injury.**

**Serious personal injury can occur.**

**Keep face and hands away to help prevent injury. Protective goggles must be worn when refrigerant lines are opened. Release fittings slowly in an well ventilated area. Do not inhale the refrigerant.**

**NOTE:** Before removal, fasten identification tags on the components for correct installation at assembly. Put caps and plugs on all hoses, fittings, and ports to prevent contamination from entering the system.

**NOTE:** Contain all fluids during the performance of inspection, maintenance, doing tests, adjusting, and repair of the machine. Prepare to contain fluids with the correct containers before opening any compartment or disassembling any component containing fluids. Discard fluids according to the local regulations and the laws.

**NOTE:** Fully clean all components to prevent contamination from entering the system. Contamination can damage the precision components. Complete the disassembly procedures on a clean work surface. Put a clean cloth on top of the components.

**NOTE:** Use only certified technicians and equipment to service the air conditioning systems.

**NOTE:** When opening the air conditioning system, replace the air conditioning receiver-dryer. See the information for removing/installing the air conditioning receiver-dryer.

**Procedure**

1. Park the machine on a solid, level surface.
2. Apply the parking brake, stop the engine, and take the key with you.
3. Turn the battery disconnect switch key (1) counterclockwise to disconnect the battery power.

**NOTE:** The battery disconnect switch is shown in the off position.

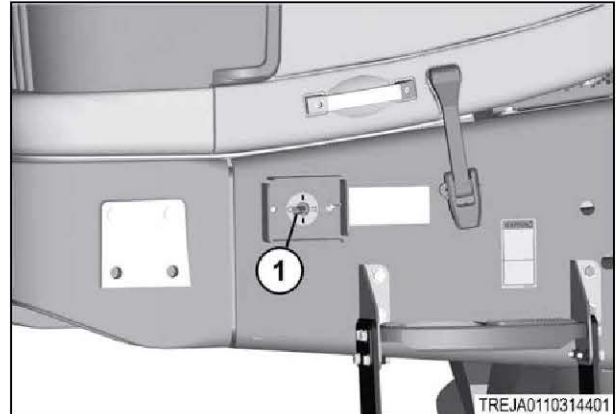


Fig. 38

4. Remove the battery disconnect switch key (1).

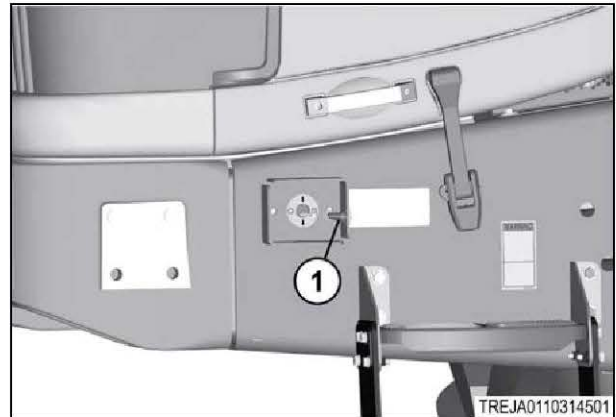



Fig. 39

5.  **CAUTION:** Safely prop open the engine cover. Closing engine cover creates a pinch point that can cause serious bodily injury.

Release both side latches (1) and open the engine cover (2) all the way.



Fig. 40

12. Air conditioning and heating system

6. Disconnect the air conditioning hoses (1) from the receiver/dryer (2).

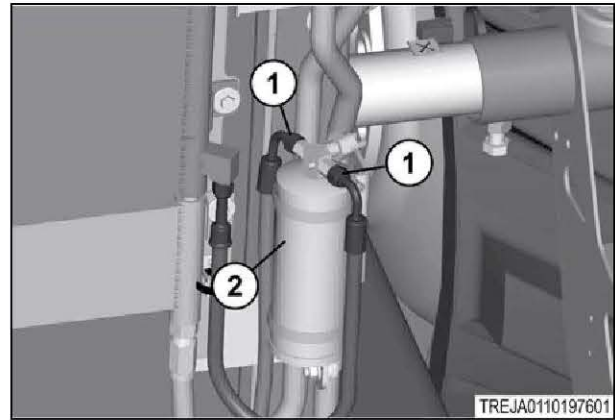


Fig. 41

7. Disconnect the wire harness (3).
8. Loosen the hose clamps (1) and remove the receiver/dryer (2).

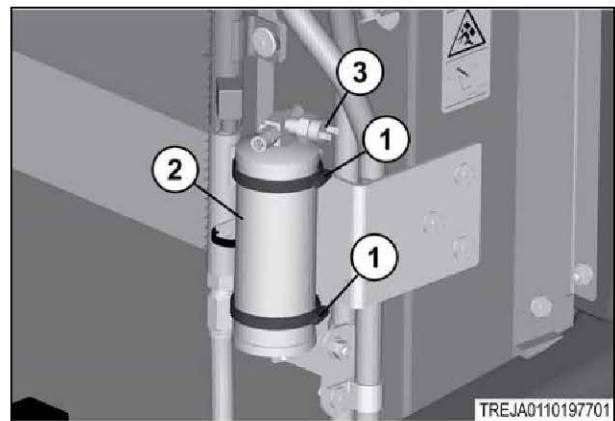


Fig. 42

9. Remove the hardware (1) and the receiver/dryer bracket (2).

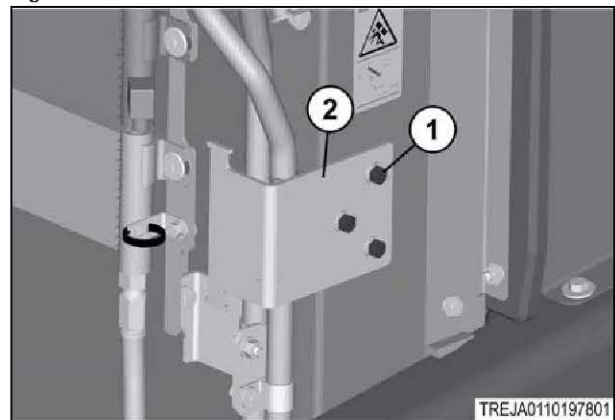


Fig. 43

### 12.7.6 Install the air conditioning receiver/dryer

**Procedure**

1. Use the hardware (1) to install the receiver/dryer bracket (2).

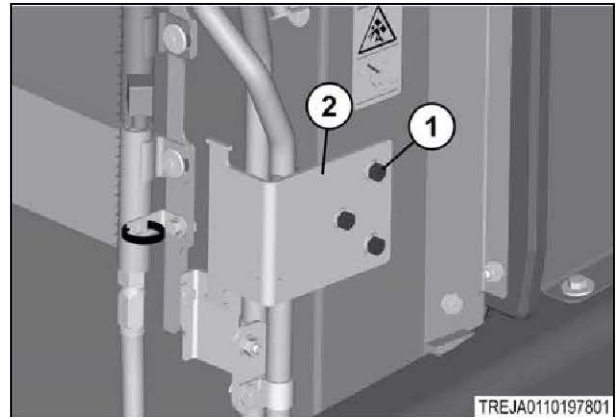


Fig. 44

2. Use the hose clamps (1) to install the receiver/dryer (2).
3. Connect the wire harness (3).

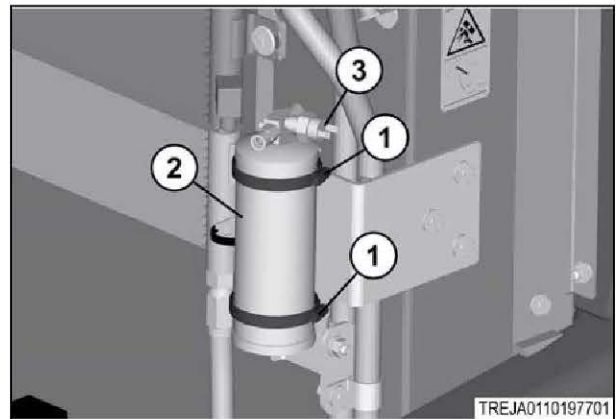


Fig. 45

4. Connect the air conditioning hoses (1) to the receiver/dryer (2).

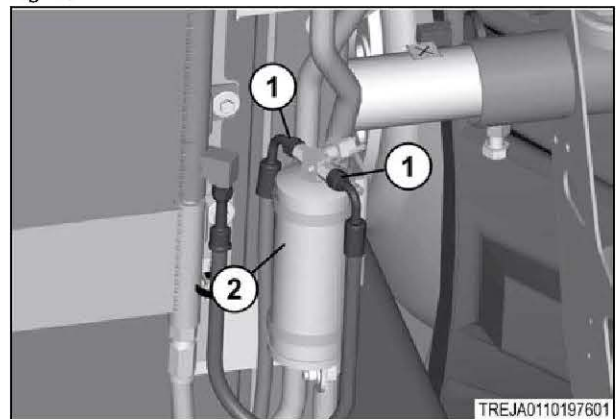


Fig. 46

12. Air conditioning and heating system

5. Close the engine cover (2) all the way and connect both side latches (1).

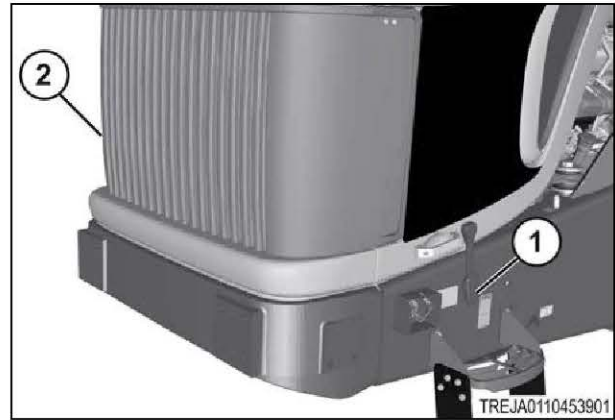


Fig. 47

6. Install the battery disconnect switch key (1).

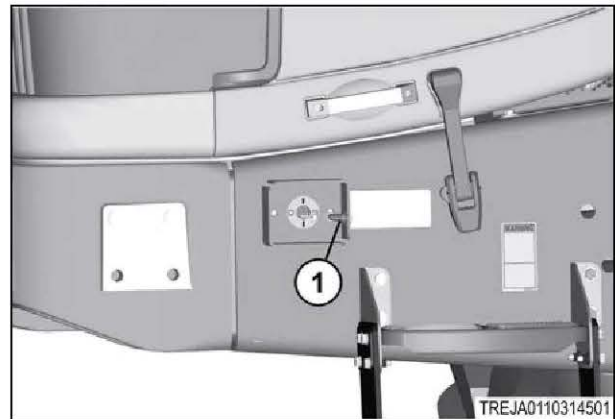


Fig. 48

7. Turn the battery disconnect switch key (1) clockwise to connect the battery power.

**NOTE:** The battery disconnect switch is shown in the on position.

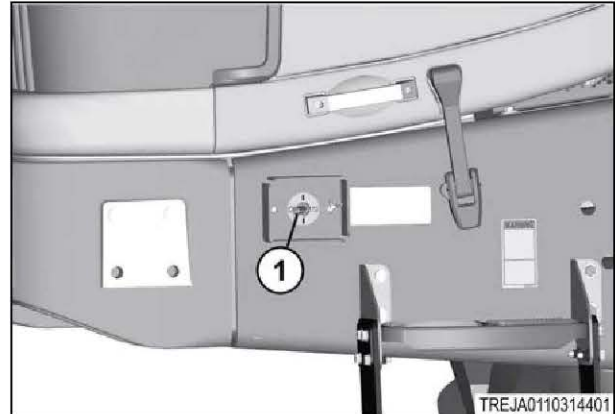


Fig. 49

### 12.7.7 Remove the manual water valve



**WARNING:** Pressurized gases or fluids can be hazards.

**Personal injury can result.**

**Relieve the pressure from the system or component before disconnecting components.**



**WARNING:** Hot components can burn.

**Severe personal injury can result.**

**Let the engine and components cool before doing maintenance.**

#### Procedure

1. Clean the external components before starting the removal procedure.

This will help in preventing dirt from entering the internal mechanism.

2. Contain all fluids during the performance of inspection, maintenance, testing, adjusting and the repair of the machine.
3. Prepare to contain fluid with the correct container before opening any compartment or disassembling any component containing fluids.
4. Discard all fluids according to the local regulations and the mandates.
5. Put identification marks on all hoses, all hose assemblies, all wires, and all the tube assemblies for installation purposes.
6. Plug all hose assemblies and all tube assemblies.

This aids in preventing fluid loss and this aids in keeping contaminants from entering the system.

7. Park the machine on a solid, level surface.
8. Apply the parking brake, stop the engine, and take the key with you.
9. Remove the hardware (1) that fastens the HVAC cover.
10. Remove the HVAC cover.

**NOTE:** Make sure the hardware (2) is installed to prevent dust contamination.

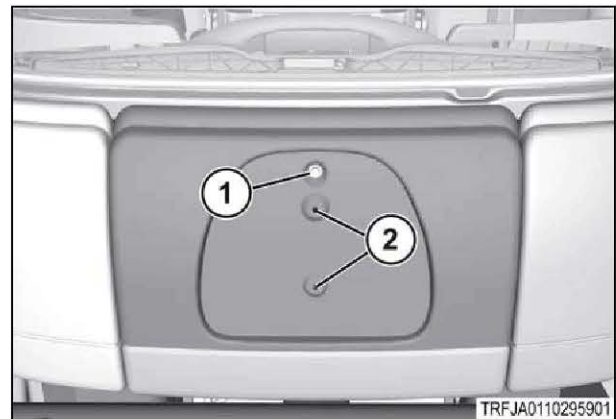


Fig. 50

11. Close the valve (1).

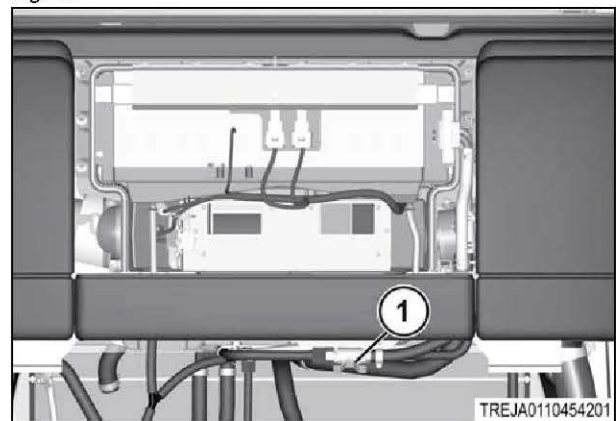


Fig. 51

12. Location (1) of the manual water valve.

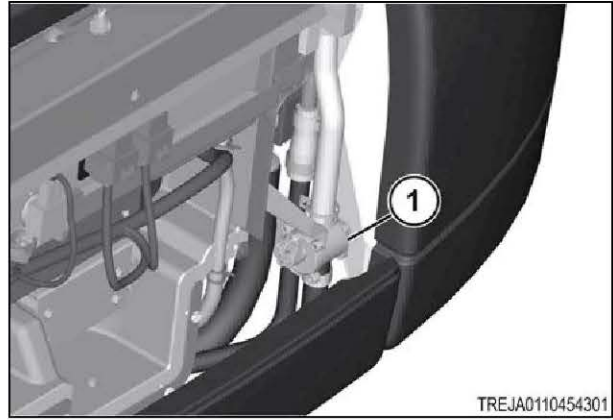


Fig. 52

13. Remove the hose fasteners (1).

**NOTE:**

*Some parts are removed for clarity.*

14. Remove the hoses (2).

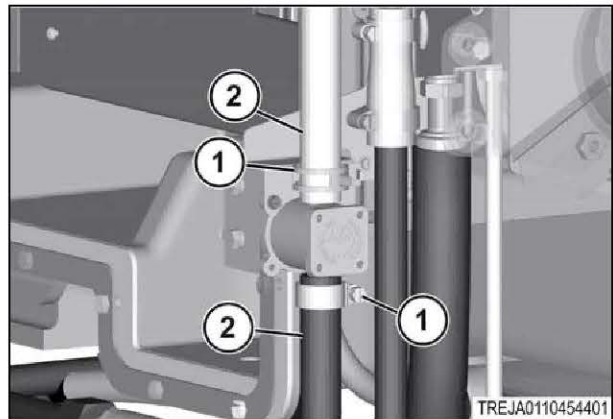


Fig. 53

15. Remove the hardware (1) that fastens the manual water valve to the bracket.

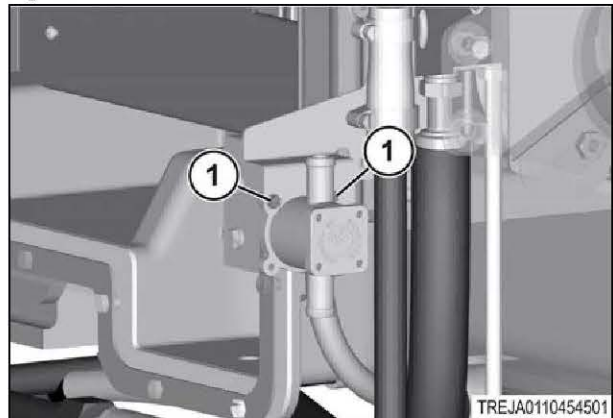


Fig. 54

16. The bracket (1) that the manual water valve mounts on.

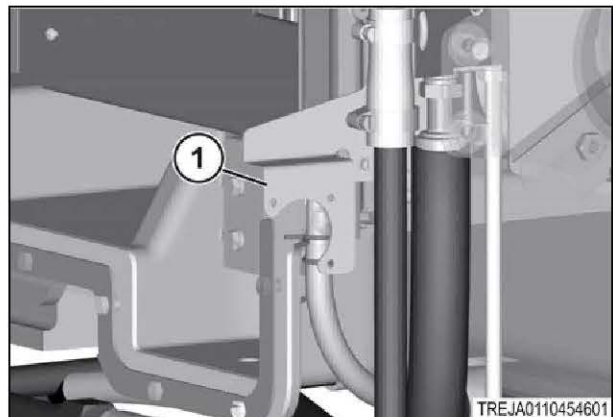


Fig. 55

### 12.7.8 Install the manual water valve



**WARNING: Hot components can burn.**

**Severe personal injury can result.**

**Let the engine and components cool before doing maintenance.**



**WARNING: Pressurized gases or fluids can be hazards.**

**Personal injury can result.**

**Relieve the pressure from the system or component before disconnecting components.**

#### Procedure

1. Clean the external components before starting the installation procedure.  
This will help in preventing dirt from entering the internal mechanism.
2. Contain all fluids during the performance of inspection, maintenance, testing, adjusting and the repair of the machine.
3. Prepare to contain fluid with the correct container before opening any compartment or disassembling any component containing fluids.
4. Discard all fluids according to the local regulations and the mandates.
5. Park the machine on a solid, level surface.
6. Apply the parking brake, stop the engine, and take the key with you.
7. Mount the manual water valve on the bracket (1).

#### NOTE:

*Some parts are removed for clarity.*

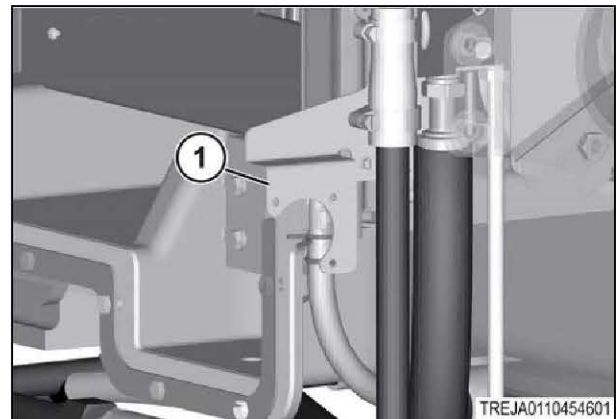


Fig. 56

8. Fasten the manual water valve to the bracket with the hardware (1) as shown.

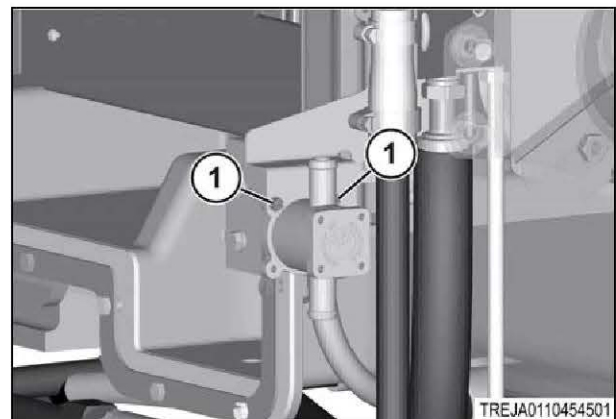


Fig. 57

12. Air conditioning and heating system

- 9. Put the hoses (2) on the manual water valve.
- 10. Fasten the hoses into position with the hose fasteners (1).

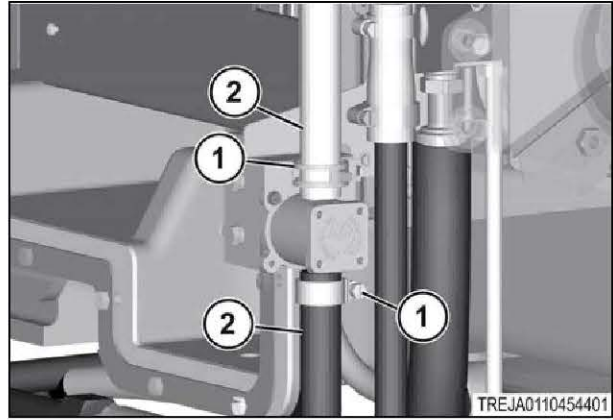


Fig. 58

- 11. Open the valve (1).

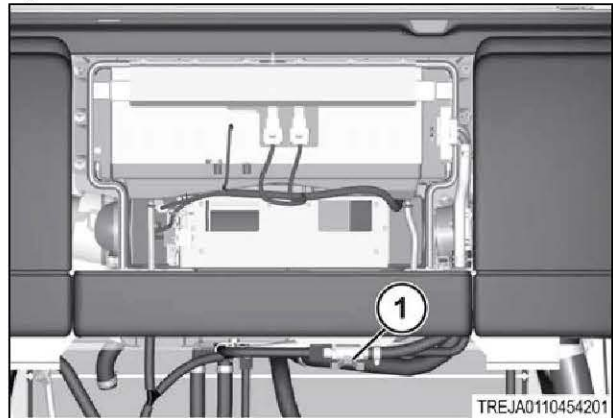


Fig. 59

- 12. Check the manual water valve (1) for any leaks.

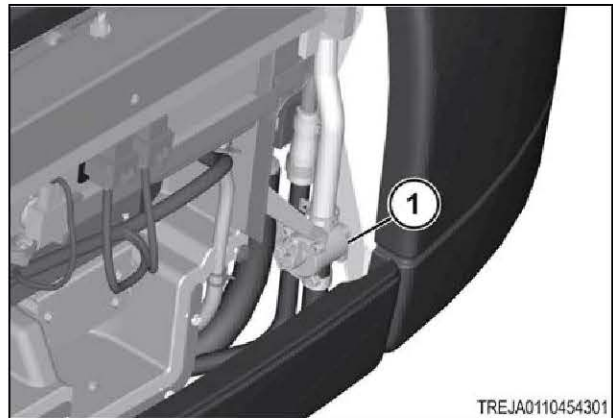


Fig. 60

- 13. Put the HVAC cover into position and fasten with the shown hardware (1).

**NOTE:** Make sure the hardware (2) is installed to prevent dust contamination.

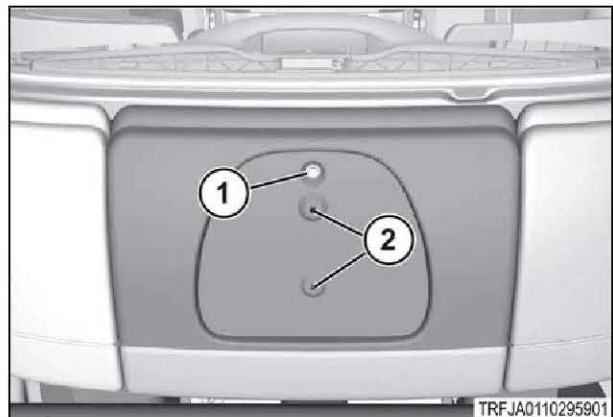


Fig. 61

### 12.7.9 Remove the electric water valve



**WARNING: Hot components can burn.**

**Severe personal injury can result.**

**Let the engine and components cool before doing maintenance.**



**WARNING: Pressurized gases or fluids can be hazards.**

**Personal injury can result.**

**Relieve the pressure from the system or component before disconnecting components.**



**WARNING: Electrical system failure.**

**Serious personal injury or major damage to equipment and components can occur.**

**Check all electrical systems and connections after working on the machine and before returning the machine to normal operation.**

#### Procedure

1. Clean the external components before starting the removal procedure.  
This will help in preventing dirt from entering the internal mechanism.
2. Contain all fluids during the performance of inspection, maintenance, testing, adjusting and the repair of the machine.
3. Prepare to contain fluid with the correct container before opening any compartment or disassembling any component containing fluids.
4. Discard all fluids according to the local regulations and the mandates.
5. Put identification marks on all hoses, all hose assemblies, all wires, and all the tube assemblies for installation purposes.
6. Plug all hose assemblies and all tube assemblies.  
This aids in preventing fluid loss and this aids in keeping contaminants from entering the system.
7. Park the machine on a solid, level surface.
8. Apply the parking brake, stop the engine, and take the key with you.
9. Remove the hardware (1) that fastens the HVAC cover.
10. Remove the HVAC cover.

**NOTE:** Make sure the hardware (2) is installed to prevent dust contamination.

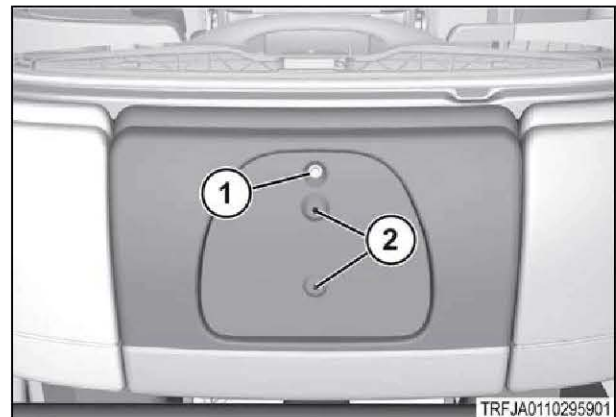


Fig. 62

11. Close the valve (1).

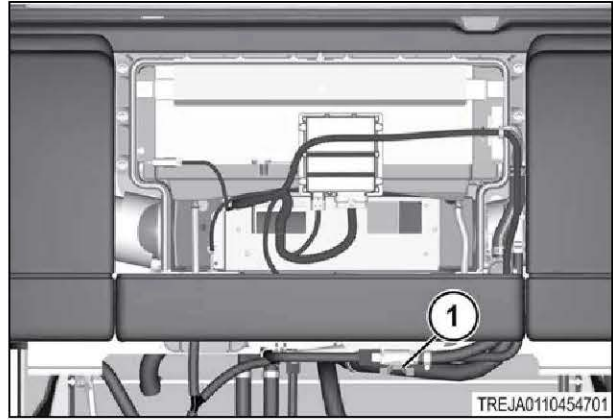


Fig. 63

12. Location (1) of the electric water valve.



Fig. 64

13. Remove the hose fasteners (1).

**NOTE:**

*Some parts are removed for clarity.*

14. Remove the hoses (2).

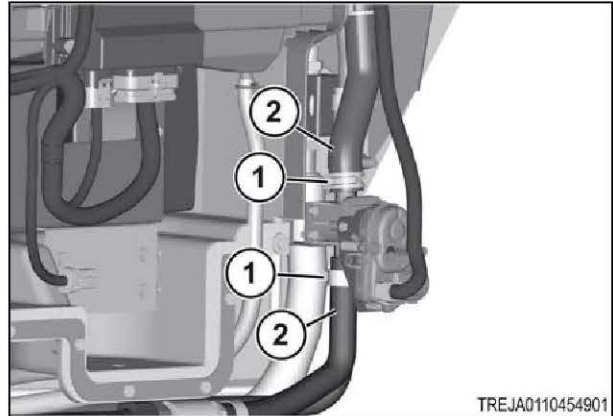


Fig. 65

15. Remove the wire harness (1).

16. Remove the hardware (2) that fastens the electric water valve to the bracket.

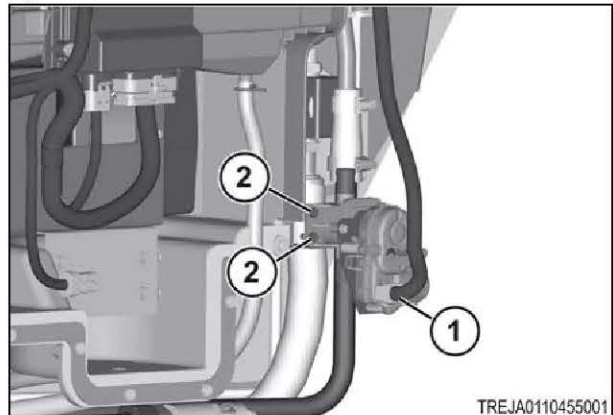


Fig. 66

17. The bracket (1) that the electric water valve mounts on.

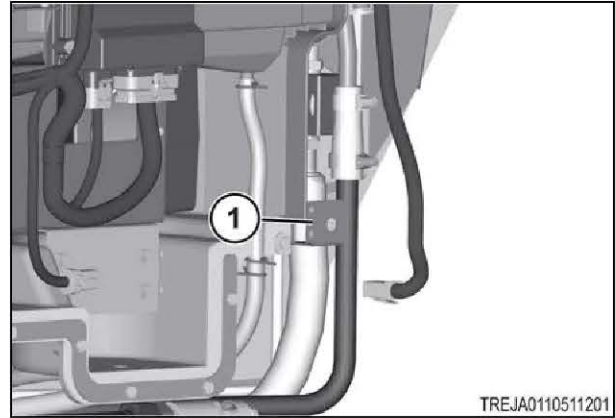


Fig. 67

### 12.7.10 Install the electric water valve



**WARNING: Hot components can burn.**

**Severe personal injury can result.**

**Let the engine and components cool before doing maintenance.**



**WARNING: Pressurized gases or fluids can be hazards.**

**Personal injury can result.**

**Relieve the pressure from the system or component before disconnecting components.**



**WARNING: Electrical system failure.**

**Serious personal injury or major damage to equipment and components can occur.**

**Check all electrical systems and connections after working on the machine and before returning the machine to normal operation.**

#### Procedure

1. Clean the external components before starting the installation procedure.  
This will help in preventing dirt from entering the internal mechanism.
2. Contain all fluids during the performance of inspection, maintenance, testing, adjusting and the repair of the machine.
3. Prepare to contain fluid with the correct container before opening any compartment or disassembling any component containing fluids.
4. Discard all fluids according to the local regulations and the mandates.
5. Park the machine on a solid, level surface.
6. Apply the parking brake, stop the engine, and take the key with you.

12. Air conditioning and heating system

7. Mount the electric water valve on the bracket (1).

**NOTE:**

*Some parts are removed for clarity.*

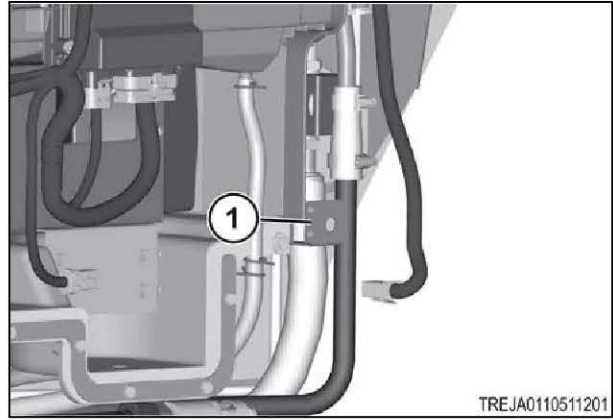


Fig. 68

8. Fasten the electric water valve to the bracket with the hardware (2) as shown.
9. Fasten the wire harness (1) to the electric water valve.

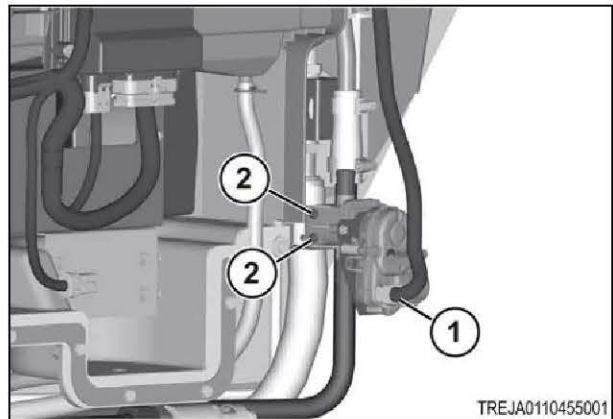


Fig. 69

10. Put the hoses (2) on the electric water valve.
11. Fasten the hoses into position with the hose fasteners (1).

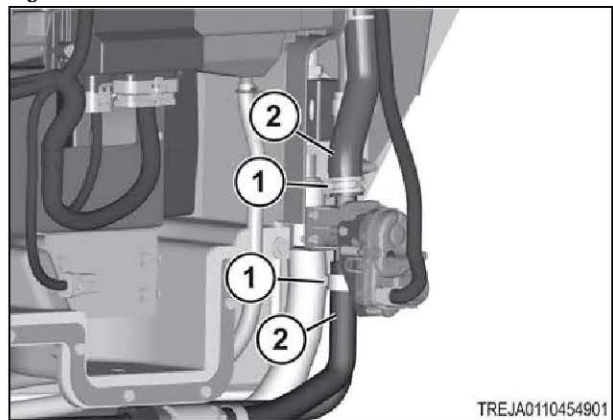


Fig. 70

12. Open the valve (1).

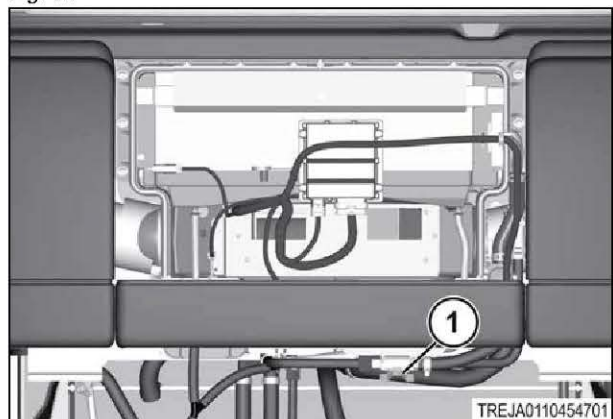


Fig. 71

13. Check the electric water valve (1) for any leaks.



Fig. 72

14. Put the HVAC cover into position and fasten with the shown hardware (1).

**NOTE:** Make sure the hardware (2) is installed to prevent dust contamination.

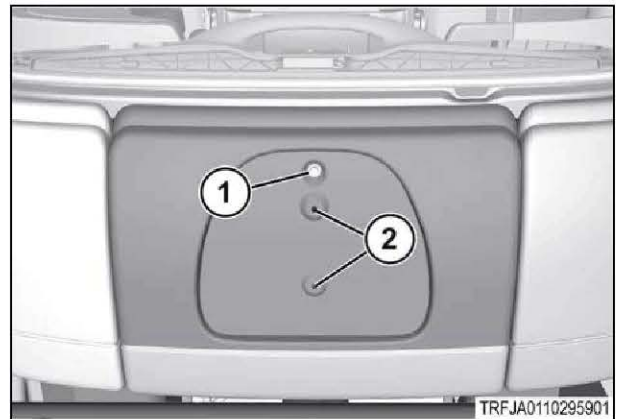


Fig. 73

**12.8 Heating and air conditioning troubleshooting**

| <b>Dust enters the cab</b>                     |   |
|--|---|
| <b>Cause(s)</b>                                | <b>Solution(s)</b>                                      |
| Unsatisfactory seal on cab air filter element. | Check condition of seal.                                |
| Plugged cab air filter.                        | Clean the cab air filter or replace the cab air filter. |
| Damaged cab air filter.                        | Replace the cab air filter.                             |
| Air is leaking into the cab.                   | Seal the air leaks.                                     |

| <b>Air flow from fan is low</b>                 |   |
|---|---|
| <b>Cause(s)</b>                                 | <b>Solution(s)</b>                        |
| Plugged cab air filter or recirculation filter. | Clean the filters or replace the filters. |
| Plugged heater core or evaporator core.         | Clean the core.                           |

| <b>Air conditioner does not cool</b>                            |   |
|---|---|
| <b>Cause(s)</b>   | <b>Solution(s)</b>  |
| The temperature set-point is adjusted too high.                 | Press the temperature down button until the desired temperature set-point.  |
| There is a small flow of air through air conditioner condenser. | Clean the radiator screen, the radiator, the oil cooler, and the air conditioner condenser.   |
| The belt for the air conditioner compressor is slipping.        | Check the belt tension. Check the condition of the belt and the pulley, if the belt tension is low.   |
| The heater control is turned on.                                | Adjust the temperature control to maximum cooling.  |
| The refrigerant is low.   | See your dealer.  |
| The heater shutoff valve.                                       | Close the valve by turning the lever clockwise, when the cab heat is no longer necessary. Open the valve by turning counterclockwise, when the cab heat is necessary. |