Group Index, Alphabetical

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Contents

Thermodynamic Principles

Air conditioning works by removing heat and humidity from the air in the passenger compartment. This is accomplished through three thermodynamic principles; the principles and how they work in a vehicle are described below.

Heat Transfer

Heat always moves from warm areas to cold ones. Cold does not move from cold areas to warm ones. Air conditioners work by absorbing heat and carrying it away, not by generating cold air, although since the heat has been absorbed from it, the air coming from an air conditioner feels cold.

If two objects, one hot, one cold, are near each other, the heat energy in the warmer object will always travel to the lower heat energy area of the cooler object, until they are equal temperature. Higher energy flows to low energy; low energy never flows to high energy.

The British Thermal Unit (BTU) is used to determine the amount of heat transferred from one object to another. One BTU is the amount of heat energy required to raise the temperature of 1 pound (0.45 kg) of water 1°F (0.55°C).

For example, to raise the temperature of 1 pound (0.45 kg) of water from 32°F to 212°F (0°C to 100°C), one BTU must be added for 1°F (0.55°C) rise in temperature, a total of 180 BTUs. Conversely, in order to lower the temperature of 1 pound (0.45 kg) of water from 212°F to 32°F (100°C to 0°C), 180 BTUs must be removed from the water.

Latent Heat of Vaporization

As a liquid boils, it absorbs heat without raising the temperature of the resulting gas. When gas condenses, changing back to a liquid, it gives off heat without lowering the temperature of the resulting liquid.

For example, when a container holding 1 pound (0.45 kg) of water at 32°F (0°C) is heated, the temperature of the water rises 1°F (0.55°C) with each BTU energy that the water absorbs. After it absorbs 180 BTUs, raising its temperature 180°F (100°C), the water reaches a temperature of 212°F (100°C). This is the boiling point of water at standard sea level conditions.

Even though it continues absorbing more heat, the water temperature cannot go above 212°F (100°C) so that as it boils, it changes from liquid water to the vapor commonly called steam. It continues to absorb heat and boil until the entire pound of water has passed off into the atmosphere as steam. Under normal conditions the steam rapidly gives off its heat to the surrounding air, but it rises from the water at a temperature of 212°F (100°C).

In other words, the water and vapor temperatures can rise only 180°F (from 32°F to 212°F [0°C to 100°C]) at sea level pressure, even though many more than 180 BTUs are absorbed. The heat absorbed by the liquid in the process of boiling dissipates from the vapor into the cooler surrounding air, and the vapor condenses back to water.

The heat transferred as substances change their physical state, such as water boiling to vapor, and vapor condensing back to water, is called the latent (or hidden) heat of vaporization. Latent heat varies widely among various materials.

Water has a latent heat of vaporization of 970 BTUs and a boiling point of 212°F (100°C). This means that 1 pound (0.45 kg) of water at 212°F (100°C), will absorb 970 BTUs when changing completely to vapor at 212°F (100°C). Conversely, the vapor will give off 970 BTUs when condensing back to water at 212°F (100°C).

This heat energy transfer, occurring when a liquid boils or a vapor condenses, is a basic principle of all conventional refrigeration systems.

For a liquid to be a refrigerant, it must also have a low boiling point. That is, the temperature at which it boils must be lower than the temperature of the substance to be cooled.

R–134a is a TFT refrigerant, less damaging to the atmosphere than CFC refrigerants such as R12. R–134a has a temperature/pressure relationship which makes it suitable for vehicle air conditioning systems.

Effect of Pressure on Boiling or Condensation

Refrigerant circulates through part of the air conditioning system under high pressure. It expands to a lower pressure vapor in the evaporator, then flows to the refrigerant return port in the compressor. As pressures in the closed refrigerant circuit vary, the temperature of the refrigerant also varies: as pressure increases, temperatures increase; as the pressure decreases, temperatures decrease. In its low pressure gaseous state in the evaporator, a good refrigerant such as R–134a absorbs a large amount of heat from the cab, and carry the heat to the condenser where it transfers into the outside air.

Heating, Ventilation and Air Conditioning (HVAC) System General Description

Stated simply, the air conditioning system operates by circulating refrigerant between two heat transfer units. The unit in the cab absorbs heat from the air in the cab, and the one in front of the radiator gets rid of the heat from the cab, into the outside air. Both units consist of coiled tubing, covered with fins so they transfer heat most efficiently.

The heat transfer unit in the cab is called the evaporator. It is mounted in the dashboard, next to the blower fan. It absorbs heat out of the air in the cab and transfers it to the refrigerant, which carries the heat away. The other heat transfer unit, called the condenser, is usually mounted low in the front end of the vehicle. Hot refrigerant from the evaporator circulates to it, and gives off the stored heat to the air being pulled in by the engine cooling fan and the vehicle's forward movement.

Inside the cab, the blend air heating, ventilating, and air conditioning (HVAC) system uses a brushless blower motor to circulate temperature-controlled air through the cab. The rate of airflow is controlled by a multi-speed fan switch.

The temperature control switch on the climate control panel sets the desired temperature in the cab.

The air selection switch on the control panel controls ducting air from the blower through the cab. On vehicles with air conditioning, a recirculation button on the control panel allows the driver to recirculate the air in the cab and prevent fresh outside air from entering the system.

Recirculation mode helps to warm or cool the cab more quickly, but the cab tends to build more humidity and fog the windows in recirculation mode. Allowing fresh air to enter the system and circulate helps defog the cab.

On vehicles built prior to May 2, 2003, the system automatically returns to the fresh air mode and the recirculation light turns off, after being in the recirculation mode for 20 minutes. Pushing the recirculation button again returns the system to recirculation mode for another 20 minutes. If the recirculation button is pressed in recirculation mode before 20 minutes have passed, the system will switch to the fresh air mode.

On vehicles built from May 2, 2003, the system automatically enters partial recirculation mode for five minutes, to bring some fresh air into the cab. After five minutes in partial recirculation mode, the system will automatically resume full recirculation for another 20 minutes. The full and partial recirculation cycle will repeat as long as the system remains in recirculation mode. If the recirculation button is pressed when the system is in either recirculation mode, recirculation mode will be canceled. There may be a slight change in the sound within the cab as the system goes into, and out of, partial recirculation mode.

Description of Components

Actuator

The actuator is a combined motor and gearbox which drives the levers and doors within the HVAC assembly. Movement of the levers and doors is controlled by the settings on the climate control panel. A proportional feedback signal is returned from each actuator to the control panel to provide current position information. There are three actuators on the HVAC assembly: a temperature blend actuator, a recirculation actuator, and an air distribution actuator.

Binary Switch

A binary switch disengages the refrigerant compressor clutch, to protect the compressor from harmful operating conditions. It performs two functions.

- If refrigerant system pressure falls too low, the binary switch disengages the compressor clutch. This happens when falling pressure drops below 25.6 to 31.2 psig (177 to 215 kPa). Normal compressor operation resumes when the pressure rises to 25.7 to 34.3 psig (177 to 236 kPa).

- If the refrigerant system pressure rises above 426.5 to 483.5 psig (2941 to 3334 kPa), the binary switch shuts off the compressor clutch. When system pressure falls back to 313 to 426 psig (2158 to 2937 kPa), the compressor resumes operation.

Blower Motor

The brushless blower motor forces air through the HVAC evaporator, and through the duct work into the cab.

Climate Control Panel (control head)

The fan switch, air selection switch, and the temperature control switch are mounted on the climate control panel, which is also called the control head. On HVAC systems with air conditioning, the air recirculation button is mounted on the climate control panel.

The climate control panel is controlled by a microprocessor and backlit with LEDs (light-emitting diodes).

Condenser

In the condenser, the hot refrigerant gas coming from the compressor turns back into liquid. As it condenses to liquid, the refrigerant gives off the heat it has carried out of the cab. The heat goes out through the condenser tubing and cooling fins, to the air currents created by the engine fan and vehicle movement.

Evaporator

Because the evaporator is an area of low pressure in the system, the boiling point of the refrigerant falls, which helps it absorb heat from the tubing walls and fins of the coils. As it absorbs heat, liquid refrigerant quickly boils and turns into a gas.

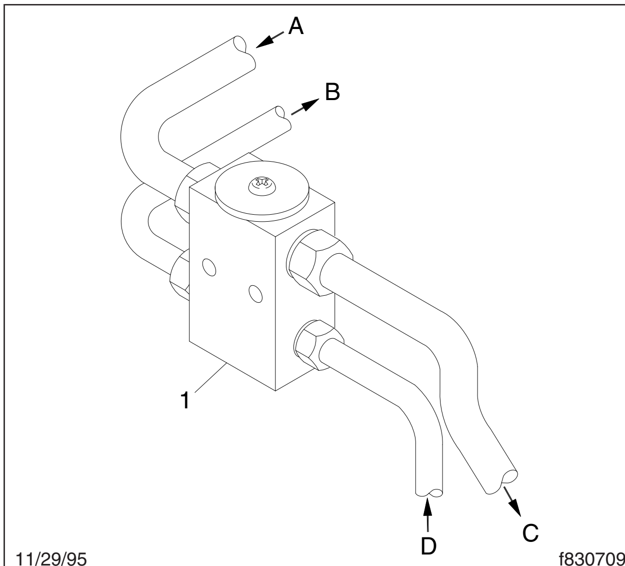
As heat is absorbed through the outside surfaces of the evaporator, air passing over the unit loses its heat to these cooler surfaces. Moisture in the air condenses on the outside of the evaporator and drains off as water, dehumidifying the air in the cab.

Evaporator Probe

The temperature of the evaporator is monitored by a variable resistance temperature probe. As the temperature of the evaporator increases, the temperature probe resistance decreases. The evaporator temperature probe is connected to the control head, which controls operation of the refrigerant compressor through the bulkhead module in order to prevent the evaporator core from freezing. When the evaporator temperature reaches 38.3°F (3.5°C), the control head sends a message to the bulkhead module to disengage the refrigerant compressor clutch. The refrigerant compressor will not resume operation until the temperature has risen above 40.1°F (4.5°C).

Expansion Valve

The expansion valve divides the high and low pressure areas of the refrigerant system. high pressure liquid refrigerant from the receiver-drier passes through the expansion valve, and moves into the low pressure area of the evaporator. See **Fig. 1** and **Fig. 2**.

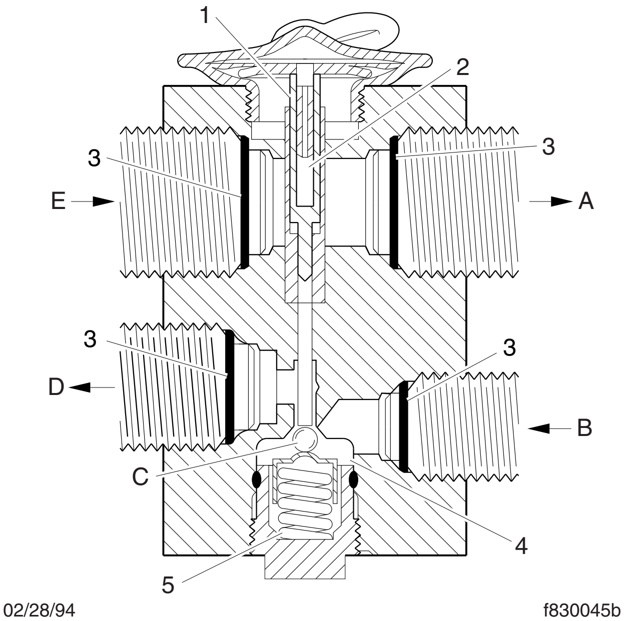


A. From the evaporator
B. To the evaporator
C. To the refrigerant compressor
D. From the receiver-drier

1. Expansion Valve

Fig. 1, Expansion Valve Refrigerant Lines

General Information



A. To the compressor
B. From the receiver-drier
C. Bleed at the ball seat
D. To the evaporator
E. From the evaporator

1. Internal Equalization Passage
2. Temperature Sensor
3. O-Ring
4. Metering Orifice
5. Ball and Spring

Fig. 2, Expansion Valve

The expansion valve proportions the flow rate of refrigerant according to the rate of evaporation in the evaporator. If the amount of liquid in the evaporator drops off, the temperature of the gas going to the compressor rises. This causes a sensor tube in the expansion valve to react to the temperature changes, which causes an orifice in the valve to open or close. Through the orifice, liquid refrigerant is metered into the evaporator.

Fan Cycling Switch

Located on the receiver-drier, the fan cycling switch sends a ground signal to the ECM (electronic control module) to keep the fan turned off, and takes away the ground to engage the fan. The fan will come on if the refrigerant pressure is greater than 300 ±10 psi (2070 kPa ±70 kPa). The fan turns off when the pressure drops below 250 ±10 psi (1725 kPa ±70 kPa).

Heater Core

The heater core is a convoluted tube covered with fins. When the water valve is open, warm engine coolant flows through the heater core tube, heating the tube and fins. The blower motor blows air through the finned tube and into the cab, to heat the cab.

Receiver-Drier

The receiver-drier is a reservoir and filter for liquid refrigerant. It also removes water and acids from the refrigerant. The water-absorbing material (desiccant) in the unit helps stop blockages caused by moisture forming in the expansion valve and other parts of the system.

Refrigerant

Refrigerant is the chemical that absorbs heat from the air in the cab and release it to the air outside the cab.

During compressor operation, refrigerant constantly changes from a gas to a liquid, then back to a gas, depending on whether it is absorbing heat (boiling) in the low pressure evaporator, or releasing absorbed heat in the high pressure condenser.

Refrigerant Compressor

"Heat" in the low pressure gas of the evaporator does not feel warm to the touch, because liquid refrigerant boils at a temperature much lower than the temperature at which water turns to ice. By touch, the "heated" gas in the coils is very cold. As a result, there is the problem of how to remove heat from subfreezing gas using outside air that may be higher than 100°F (38°C).

With a refrigerant compressor, low pressure gas from the evaporator can be squeezed into a much smaller space. When the gas is compressed, the heat it contains becomes concentrated. In this way, the gas is made hotter than the outside air without adding heat.

If the system pressure rises above 550 ± 50 psi (3792 ± 345 kPa), a pressure relief valve will vent, disengaging the compressor clutch until the pressure drops to 400 psi (2758 kPa).

A second purpose of the compressor is to move refrigerant through the system.

Definition of Terms

Refer to the following terms for a better understanding of the heater and air-conditioning system.

Air Conditioner A system used to control the temperature, humidity, and movement of air in the cab.

Air Cylinder Air-operated device used to open or close vents through which air is pushed into the cab by the blower.

Ambient Air Temperature The temperature of air around an object or the outside temperature.

Binary Switch This switch disengages the refrigerant compressor clutch to protect the compressor from harmful operating conditions.

Blower Motor A blower motor forces air through the HVAC assembly and through the duct work.

Blower Resistor Block Assembly Inline resistors that control the amount of voltage going to the blower motor. By controlling the voltage, you can control the fan speed.

Boiling Point The temperature at which a liquid changes to a gas. The boiling point varies with pressure.

Bulk Charging Use of large containers of refrigerant for charging a refrigerant system. Normally used for charging empty systems.

Charge A specific amount of refrigerant or oil by volume or weight. Also the act of placing an amount of refrigerant or oil into the air conditioning system.

Clutch Cycling Switch (Thermostatic Switch) Engages or disengages the compressor depending on changes in evaporator temperature.

Condensate Water taken from the air, which forms on the outer surface of the evaporator.

Condenser A heat exchanger that is used to remove heat from refrigerant, changing it from a high pressure hot gas to a high pressure warm liquid. Typically the condenser is mounted in front of the radiator.

Contaminants Anything other than refrigerant or refrigerant oil in the system. Usually means water, dirt, or air in the system.

Dehumidify To remove water from the air at the evaporator.

Dehydrate To remove all traces of moisture from the refrigerant system. This process occurs during evacuation.

Desiccant A drying agent used in the receiver-drier to remove moisture and maintain an extremely dry state.

Discharge Line Connects the refrigerant compressor outlet to the condenser inlet.

Discharge Pressure High-side pressure, or condensing pressure, of the refrigerant being discharged from the compressor.

Discharge Service Valve A device that allows high-side pressure to be checked and other service operations to be performed. This valve is located between the receiver-drier and the expansion valve.

Drive Pulley A pulley attached to the front of the engine crankshaft. It drives the compressor clutch pulley with a belt.

Duct A passageway for the transfer of air from one point to another.

Evacuate To place a high vacuum in the refrigeration system to remove air, and dehydrate, or remove traces of moisture.

Evaporate A change of state from a liquid to a gas.

Evaporator A component in which liquid refrigerant changes to a gas after it absorbs heat from the air. Also removes some moisture from the cab air.

Expansion Valve A device that causes a pressure-drop of the refrigerant and also regulates its flow.

Flooding A condition caused by too much liquid refrigerant going into the evaporator. Usually caused by an expansion valve that is stuck open.

Flushing A process of passing liquid refrigerant through an air conditioner component to remove dirt and water from the part. Liquid refrigerant removes heavy contamination, such as gritty dirt and large dirt buildup.

Freeze-Up Failure of a unit to operate properly because of ice forming at the expansion valve orifice or on the evaporator.

General Information

Heater Core A part of the heating system through which hot engine coolant flows to provide heat to the cab, or to adjust the temperature produced by the air conditioner.

Humidity The amount of water vapor in the air.

Hydraulic Lock The return of liquid refrigerant to the compressor, which could destroy the unit.

Leak Detector Any device used to detect refrigerant leaks in a refrigerant system.

Liquid Line high pressure liquid refrigerant is carried back to the evaporator from the condenser by the liquid line to repeat the evaporation/condensation cycle.

Liquid Pressure Pressure of refrigerant in the liquid line from the condenser to the expansion device.

Low Head Pressure High-side pressure that is lower than normal due to a system problem.

Low Suction Pressure Low-side pressure that is lower than normal due to a system problem.

Magnetic Clutch An electrical coupling device used to engage or disengage the compressor.

Manifold Designed to control refrigerant flow for system test purposes. It is used with manifold gauges.

Manifold Gauge A calibrated instrument used for measuring system pressures.

Manifold Gauge Set A manifold that is complete with gauges and charging hoses and is used to measure or test pressure.

Micron A metric unit of length equal to one-millionth of a meter. This unit of measure is used to measure vacuum drawn from a refrigerant system by a vacuum pump.

Nitrogen A colorless, odorless, dry, inert gas.

Opacity A measure of contamination of refrigerant oil in the compressor. Fresh refrigerant oil is clear; when contaminated, it appears cloudy or may have fine particles held in suspension.

Overcharge Too much refrigerant or oil in the system.

Polyalkylene Glycol (PAG) A highly refined synthetic oil used in R–134a air conditioning systems.

Polyol Ester (POE) A highly refined synthetic oil used in R–134a air conditioning systems.

PSIA Pounds per square inch, absolute pressure. Pressure exerted by the air at sea level. Atmospheric pressure is usually measured with a mercury barometer.

PSIG Gauge pressure, relative to the local atmosphere. At sea level, 0 PSIG is about 14.7 PSIA, which is standard atmospheric pressure. But in Denver, which is at about 5000 feet altitude, standard atmospheric pressure and PSIG are about 12.5 PSIA. It is possible to have a negative gauge pressure, indicating a vacuum.

Receiver-Drier A combination desiccant, filter, and storage container for liquid refrigerant.

Recovery Removal of the refrigerant from the air conditioning system.

Recycling Removal of contaminants and moisture from R–134a using a recovery and recycling station.

Refrigerant–134a (R–134a) The cooling agent used in automotive air conditioning systems. The chemical name for R–134a is tetrafluoroethane.

Refrigerant Compressor A device used to draw low pressure refrigerant gas from the evaporator and squeeze it into a high-temperature, high pressure gas. A second purpose of the compressor is to move refrigerant through the system.

Refrigeration Cycle The complete circulation of refrigerant through an air conditioning system, accompanied by changes in temperature and pressure.

Relative Humidity The actual water content of the air in relation to the total water the air can hold at a given temperature.

Resistor A voltage-dropping device, usually wire wound, for controlling fan speed.

Sensor A temperature- or pressure-sensing unit that is used to sense air temperatures or pressures, and provide a control voltage for operation of automatic temperature control units.

Suction Line The line connecting the evaporator outlet to the compressor inlet.

Suction Pressure Compressor inlet pressure or the system’s low-side pressure.

Suction Service Valve A device that allows low-side pressure to be checked and other service operations to be performed. This valve is located between the evaporator and the compressor.

Suction Side The low pressure area of the system, extending from the expansion valve to the compressor inlet.

Thermistor A vacuum pressure sensor that is used to measure, in microns of mercury, the internal system vacuum level after evacuation.

Thermostatic Vacuum Gauge A high-vacuum gauge sensitive to pressures ranging from atmospheric pressure to less than 1 micron of mercury, with scales reading from 25,000 microns to 1 micron of mercury.

Thermostatic Switch A temperature-sensitive switch used to control system temperature and prevent evaporator freeze-up. It does this by controlling the compressor's clutch operation.

Undercharge A system low on refrigerant resulting in lack of cooling and possible compressor damage.

Vacuum Refers to pressure that is less than atmospheric pressure.

Vacuum Pump A mechanical device used to evacuate and create a high vacuum in the refrigerant system.

Vacuum Pump Oil Water soluble oil used in some vacuum pumps to absorb moisture from the refrigerant system.

Vapor The gaseous state of a material.

Water Regulating Valve The mechanically or electronically controlled valve, used for controlling the flow of coolant to the heater core.

Principles of Operation

In a blend air system, the heater core is always filled with hot water. Air enters the HVAC assembly through the blower and blows through the evaporator. If the refrigerant compressor is engaged, the air is cooled by moving the heat from it into the evaporator, where the refrigerant absorbs the heat and carries it away. The temperature blend doors then direct the air through or around the heater core, depending on the climate control settings. The temperature blend doors are used to blend the correct amount of cold and hot air to reach the desired temperature. The temperature blend, air distribution, and recirculation levers and doors are controlled by actuators.

Air Conditioner

When the air conditioner is on, the compressor squeezes the refrigerant into a high-pressure, high-temperature gas. High pressure raises the condensation point of refrigerant gas, which allows the condenser to change it to a liquid. After it is compressed, refrigerant gas passes out of the discharge port of the compressor and on to the condenser.

At the condenser, air passing over the fins absorbs heat from the hot refrigerant gas. As the gas cools, it changes back to a liquid. The liquid moves to the receiver-drier, which filters it and removes traces of moisture and acids.

From the receiver-drier, liquid refrigerant moves to the expansion valve, which meters the flow into the evaporator and acts as a boundary between the high- and low-pressure sides of the system. The metered release of the expansion valve greatly drops the pressure of the liquid, causing it to expand. The pressure drop lowers the boiling point of the refrigerant and causes it to evaporate quickly, as it absorbs heat from air passing over the evaporator. The resulting cool air is forced into the cab by the blower. The heated refrigerant gas is drawn back into the compressor where the cycle is repeated.

Safety Precautions

Whenever repairs are made to any air conditioner parts that hold R–134a refrigerant, you must recover, flush (if contaminated), evacuate, charge, and leak test the system. In a good system, refrigerant lines are always under pressure and you should disconnect them only after the refrigerant charge has been recovered (discharged) at the service valves.

Refrigerant R–134a is safe when used under the right conditions. Always wear safety goggles and non-leather gloves while recovering, evacuating, charging, and leak testing the system. Do not wear leather gloves. When refrigerant gas or liquid contacts leather, the leather will stick to your skin.

WARNING

Use care to prevent refrigerant from touching your skin or eyes because liquid refrigerant, when exposed to the air, quickly evaporates and will freeze skin or eye tissue. Serious injury or blindness could result if you come in contact with liquid refrigerant.

Refrigerant splashed in the eyes should be rinsed with lukewarm water, not hot or cold. Do not rub the eyes. Apply a light bandage and contact a physician right away.

Refrigerant splashed on the skin should be rinsed with lukewarm water, not hot or cold. Do not rub the skin. Apply a light coat of a nonmedicated ointment, such as petroleum jelly. Contact a physician right away.

R–134a refrigerant does not burn at ambient temperatures and atmospheric pressure. However, it can be combustible at pressures as low as 5.5 psig (139 kPa absolute) at 350°F (177°C) when mixed with air concentrations that are greater than 60 percent.

WARNING

R–134a air conditioning systems should not be pressure tested or leak tested with compressed air. Combustible mixtures of air and R–134a may form, resulting in a fire or explosion that could cause personal injury or property damage.

Always work in an area where there is a constant flow of fresh air when the system is recovered, evacuated, charged, and leak tested. R–134a vapors have a slightly sweet odor that is difficult to detect. Frequent leak checks and air monitoring equipment are recommended to ensure a safe working environment.

IMPORTANT: When servicing an R–134a air conditioning system, use only service equipment certified to meet the requirements of SAE J2210 (R–134a recycling equipment). The equipment should be operated only by qualified personnel who are familiar with the recycling station manufacturer's instructions.

Because of its very low boiling point, refrigerant must be stored under pressure. To prevent the refrigerant containers from exploding, never expose them to temperatures higher than 125°F (52°C).

On R–134a refrigerant systems, polyalkylene glycol (PAG) oil is used in the compressor. When handling PAG oil, observe the following guidelines:

- Keep the oil free of contaminants.
- Do not expose the air conditioning system or the PAG oil container to air for more than five minutes. PAG oil has a high moisture absorption capacity and the oil container should be immediately sealed after each use.
- Use care when handling. Spilled oil could damage painted surfaces, plastic parts, and other components such as drive belts.
- Never mix PAG oil with other types of refrigerant oil.

Replacement

IMPORTANT: Daimler Trucks North America LLC does not recommend the use of any type of coolant system sealer or leak stop product.

1. Turn off the engine, apply the brakes, and chock the tires.
2. Disconnect the batteries at the negative terminals or at the battery shutoff switch.
3. Remove the air cleaner. For instructions, see **Section 09.01**, Subject 110.
4. Remove the surge tank. For instructions, see **Section 20.01**, Subject 130.
5. Remove the Torx® capscrew that attaches the coolant lines to the heater core. Remove the coolant lines from the heater core.
6. Remove the following dash panels inside the cab. See **Fig. 1**. For instructions, see **Section 60.08**.
    - lower HVAC cover
    - trim plate panel
    - cup holder panel
    - right-hand dash panel
7. Remove the capscrews that attach the temperature blend actuator to the HVAC assembly and remove the temperature blend actuator. See **Fig. 2**.
8. Remove the capscrews that attach the HVAC wiring harness to the HVAC assembly.
9. If the original heater core is being replaced, use a sharp utility knife to cut within the groove on the heater core access panel. Remove and discard the heater core access panel. See **Fig. 3**.

    If there is a heater core service cover in front of the heater core, remove the service cover.

WARNING

Failure to wear protective gloves could result in serious skin cuts due to the sharp edges on the heater core fins.

IMPORTANT: A small amount of antifreeze may be present in the heater core. Protect the interior of the vehicle to prevent any damage from an antifreeze spill.

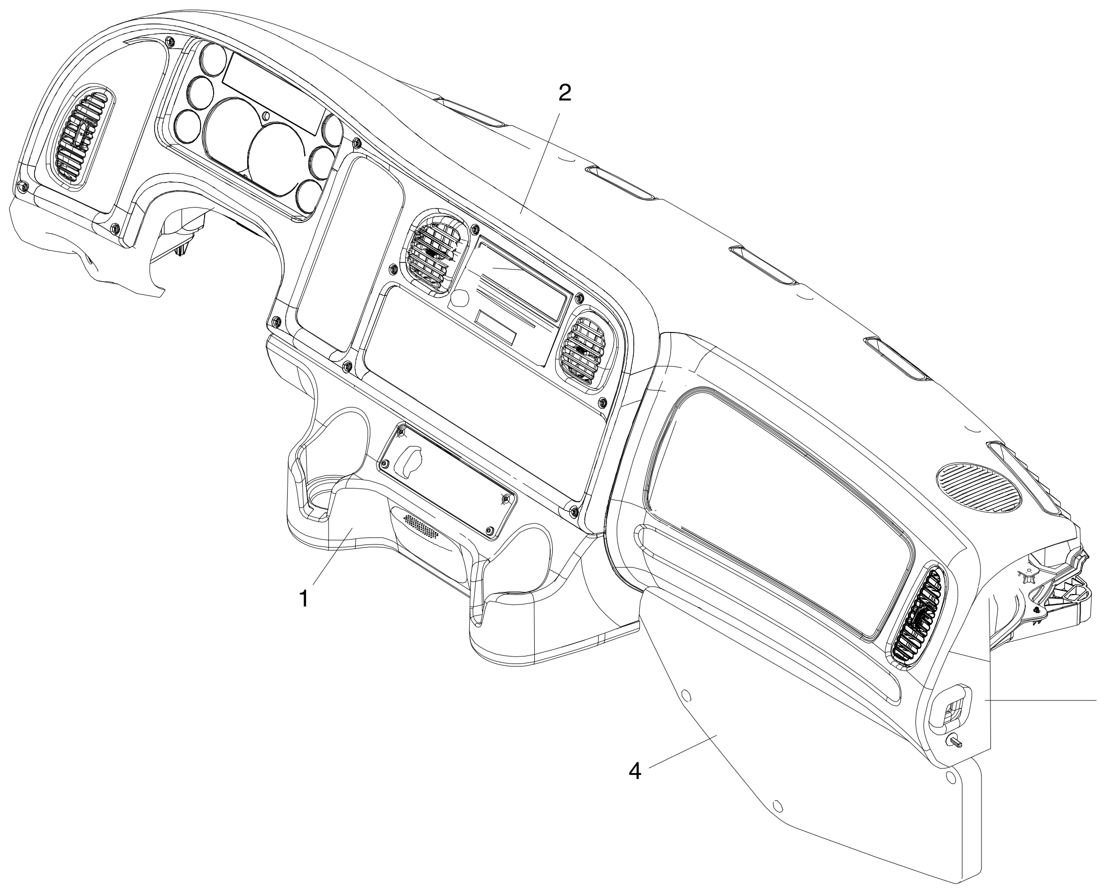
10. Wearing protective gloves, remove the heater core and drain any remaining coolant from the heater core.
11. Remove any debris or coolant that may be in the heater core housing.
12. Wearing protective gloves, install a new heater core in the HVAC assembly.

CAUTION

Do not overtorque the capscrew. Overtorquing the capscrew may crack the heater core.

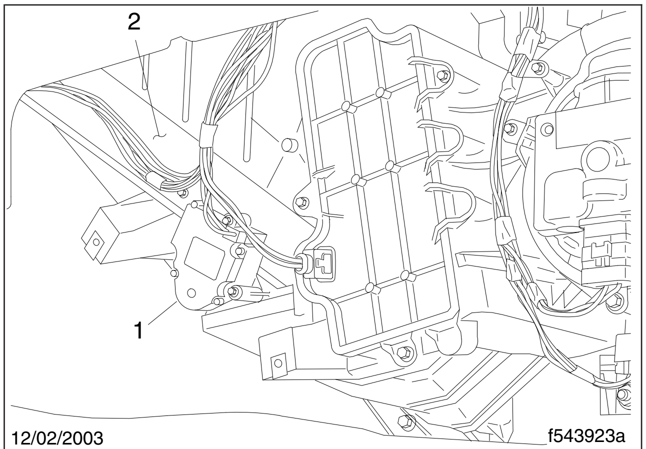
13. Using a Torx capscrew, attach the coolant lines to the heater core and torque the capscrew 30 lbf·in (340 N·cm).
14. Attach the heater core service cover to the HVAC assembly.
15. Using capscrews, attach the HVAC wiring harness to the heater core service cover, securing both the wiring harness and the cover.
16. Using capscrews, attach the actuator to the heater core service cover and the HVAC assembly.
17. Install the dash panels. For instructions, see **Section 60.08**.
18. Install the surge tank. For instructions, see **Section 20.01**, Subject 130.
19. Install the air cleaner. For instructions, see **Section 09.01**, Subject 110.
20. Connect the batteries at the negative terminals or at the battery shutoff switch.
21. Remove the chocks from the tires.

Heater Core Replacement



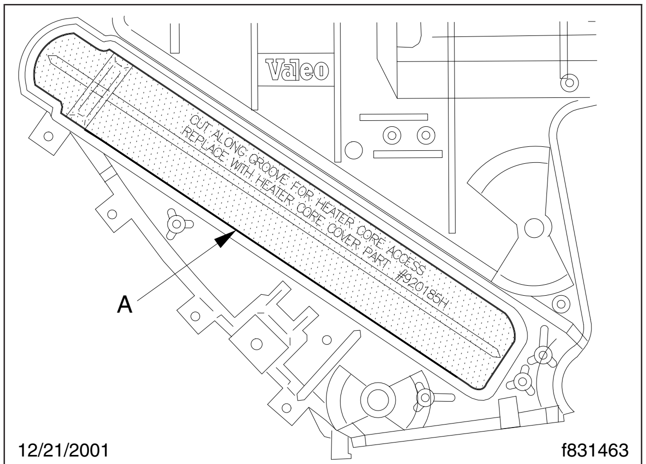
1. Cup Holder Panel
2. Trim Plate Panel
3. Right-Hand Dash Panel
4. Lower HVAC Cover

Fig. 1, Dash Panels



1. Temperature Blend Actuator
2. Heater Core Service Cover

Fig. 2, HVAC Assembly



A. Cut within the groove on the heater core access panel.

Fig. 3, Heater Core Access Panel

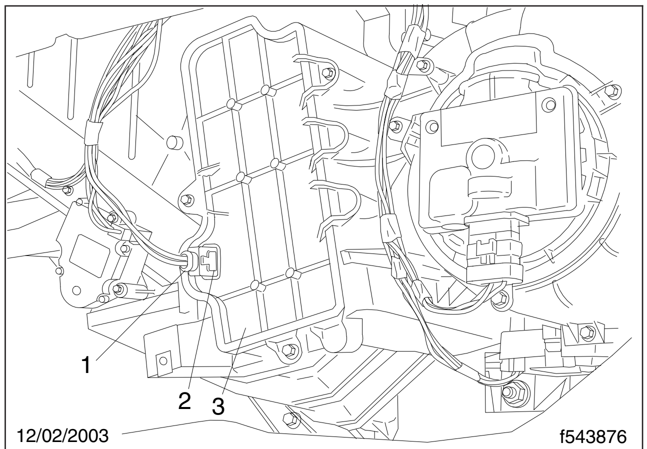
Evaporator Replacement

Replacement

1. Turn off the engine, apply the brakes, and chock the tires.
2. Open the hood.
3. Recover the refrigerant from the air conditioning system. For instructions, see **Subject 220**.
4. Remove the air cleaner. For instructions, see **Section 09.01**, Subject 110.
5. Remove the surge tank. For instructions, see **Section 20.01**, Subject 130.
6. Remove the capscrew that attaches the refrigerant lines to the expansion valve and remove the refrigerant lines. Quickly cap the refrigerant lines.

IMPORTANT: Under no circumstances should the refrigerant lines remain uncapped for longer than five minutes. Water and dirt can damage the refrigerant system. Do not blow shop air through refrigerant lines since shop air is wet (humid).

7. Remove the capscrews that attach the expansion valve to the evaporator lines.
8. Remove the lower HVAC cover inside the cab. For instructions, see **Group 60**.
9. Rotate the evaporator probe counterclockwise and pull the evaporator probe out of the evaporator service cover. See **Fig. 1**.
10. Remove the capscrews that attach the evaporator service cover to the HVAC assembly. Remove the evaporator service cover.
11. Remove the filter and the evaporator.
12. Remove the expansion valve from the evaporator.
13. Make sure the new evaporator is covered with the evaporator liner and the evaporator grommet is installed on the evaporator.
14. Uncap the evaporator lines.
15. Using only Mini Stat-O-Seals, replace the Mini Stat-O-Seals on the evaporator lines. Do not lubricate the Mini Stat-O-Seals prior to installation.
16. Using capscrews, install the expansion valve on the evaporator lines. Torque the capscrews 35 lbf·in (395 N·cm).
17. Install the evaporator in the HVAC assembly.



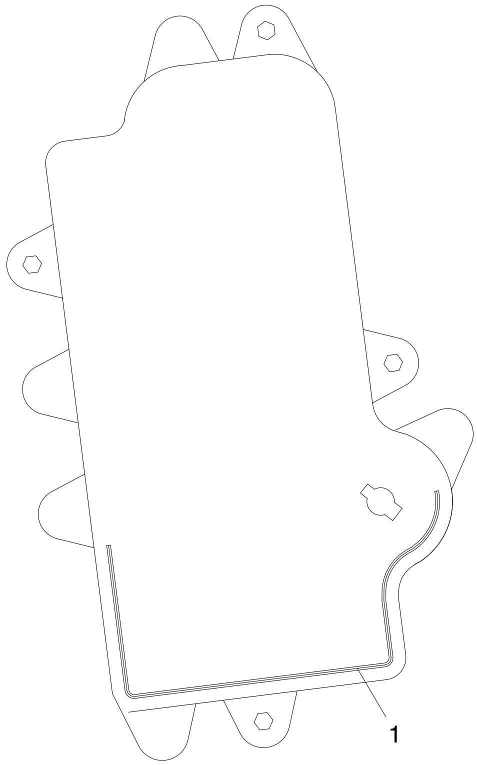
1. Evaporator Probe Wiring Harness
2. Evaporator Probe
3. Evaporator Service Cover

Fig. 1, Evaporator Probe and Service Cover

18. Uncap the refrigerant lines.
19. Using only Mini Stat-O-Seals, replace the Mini Stat-O-Seals on the refrigerant lines. Do not lubricate the Mini Stat-O-Seals prior to installation.
20. Connect the refrigerant lines to the expansion valve. Torque the capscrew on the retaining plate 11 to 15 lbf·ft (15 to 20 N·m).
21. Remove the condensate seal from the lower portion of the evaporator service cover, and install a new condensate seal in the same location on the service cover. See **Fig. 2**.
22. Using capscrews, attach the evaporator service cover to the HVAC assembly.

    If a tapped hole that is used to mount the evaporator service cover to the HVAC assembly becomes stripped, drill a new hole in one of the alternative mounting locations on the HVAC assembly. Use a 1/4-inch (6-mm) drill bit to make a new tapped hole. See **Fig. 3**.
23. Install the evaporator probe in the evaporator service cover.
24. Attach the lower HVAC cover to the dash panel. For instructions, see **Group 60**.
25. Install the surge tank. For instructions, see **Section 20.01**, Subject 130.
26. Install the air cleaner. For instructions, see **Section 09.01**, Subject 110.

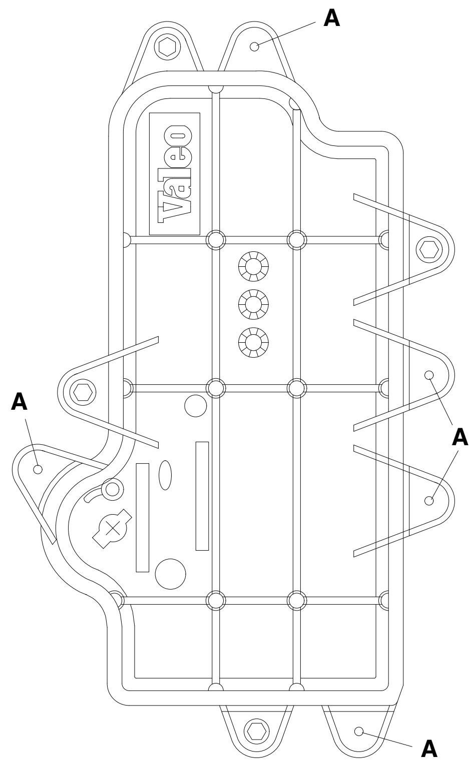
Evaporator Replacement



1. Condensate Seal

Fig. 2, Evaporator Service Cover

27. Evacuate and charge the air conditioning system with refrigerant. For instructions, see **Subject 220** of this section. Be sure to add refrigerant oil to the compressor to replace that which is lost when the system is recovered. See **Section 83.01**, Subject 130.
28. Return the hood to the operating position.
29. Remove the chocks from the tires.



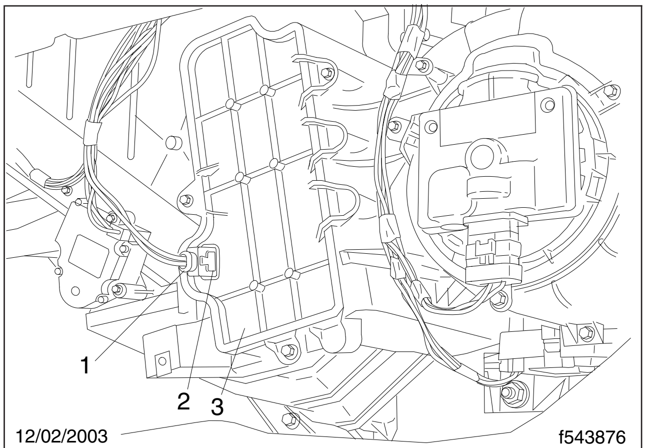
A. Drill a tapped hole in any of these alternative mounting locations.

Fig. 3, Evaporator Service Cover

Evaporator Probe Replacement

Replacement

1. Turn off the engine, apply the brakes, and chock the tires.
2. Remove the lower HVAC cover. For instructions, see **Group 60**.
3. Press the metal retainer on the wiring harness connector to disconnect the wiring harness from the evaporator probe. See **Fig. 1**.



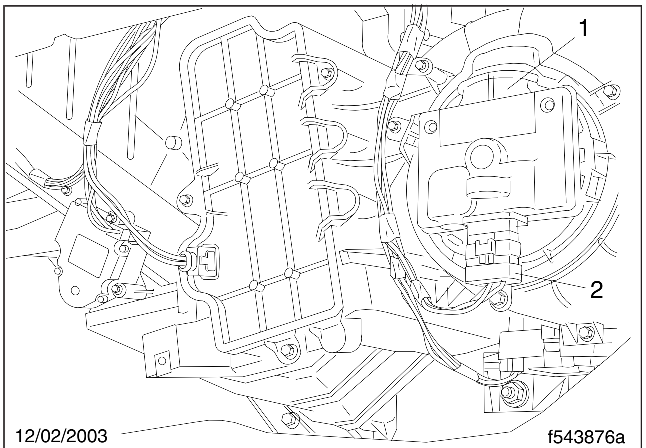
1. Evaporator Probe Wiring Harness Connector
2. Evaporator Probe
3. Evaporator Service Cover

Fig. 1, Evaporator Probe

4. Rotate the evaporator probe counterclockwise and pull the evaporator probe out of the evaporator service cover.
5. Install a new evaporator probe in the evaporator service cover.
6. Attach the wiring harness to the evaporator probe.
7. Attach the lower HVAC cover to the dash panel. For instructions, see **Group 60**.
8. Remove the chocks from the tires.

Replacement

1. Turn off the engine, apply the brakes, and chock the tires.
2. Disconnect the batteries.
3. Remove the lower HVAC cover. For instructions, see **Group 60**.
4. Disconnect the wiring harness from the blower motor. See **Fig. 1**.



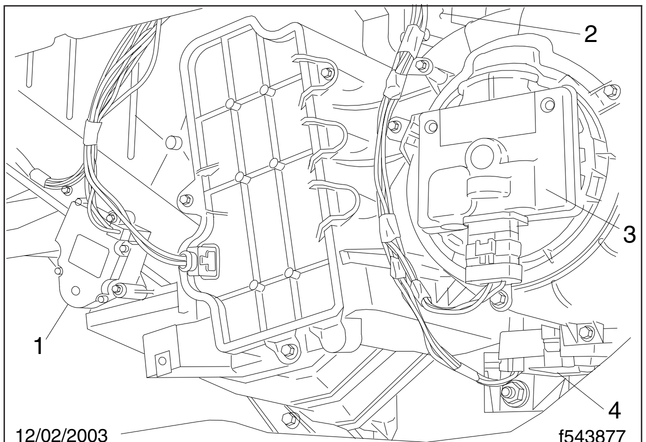
1. Blower Motor
2. Blower Motor Wiring Harness

Fig. 1, Blower Motor

5. Remove the capscrews that attach the blower motor to the HVAC assembly and remove the blower motor.
6. Using capscrews, install the new blower motor on the HVAC assembly.
7. Attach the wiring harness to the blower motor.
8. Attach the lower HVAC cover to the dash panel. For instructions, see **Group 60**.
9. Connect the batteries.
10. Remove the chocks from the tires.

Temperature Blend Actuator Replacement

1. Turn off the engine, apply the brakes, and chock the tires.
2. Remove the lower HVAC cover. For instructions, see **Group 60**.
3. Disconnect the wiring harness from the temperature blend actuator. See **Fig. 1**.



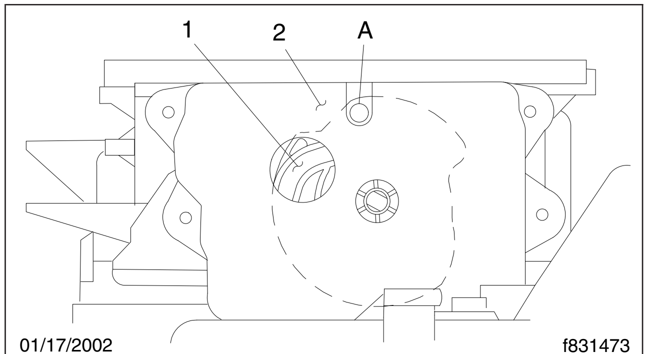
1. Temperature Blend Actuator
2. Air Distribution Actuator
3. Blower Motor
4. Recirculation Actuator

Fig. 1, Actuators

4. Remove the capscrews that attach the actuator to the HVAC assembly and remove the actuator.
5. Using capscrews, install the new actuator on the HVAC assembly. Make sure that the actuator is correctly aligned on the door extension.
6. Attach the wiring harness to the temperature blend actuator.
7. Attach the lower HVAC cover to the dash panel. For instructions, see **Group 60**.
8. Remove the chocks from the tires.

Air Distribution Actuator Replacement

1. Turn off the engine, apply the brakes, and chock the tires.
2. Remove the lower HVAC cover. For instructions, see **Group 60**.
3. Disconnect the wiring harness from the air distribution actuator. See **Fig. 1**.
4. Remove the capscrews that attach the actuator to the mounting plate and remove the actuator.
5. Before installing a new actuator, rotate the cam behind the mounting plate so that the alignment hole in the cam is aligned with the hole in the HVAC assembly. See **Fig. 2**.



A. Align the hole in the cam with the hole in the HVAC assembly.

1. Cam
2. Mounting Plate

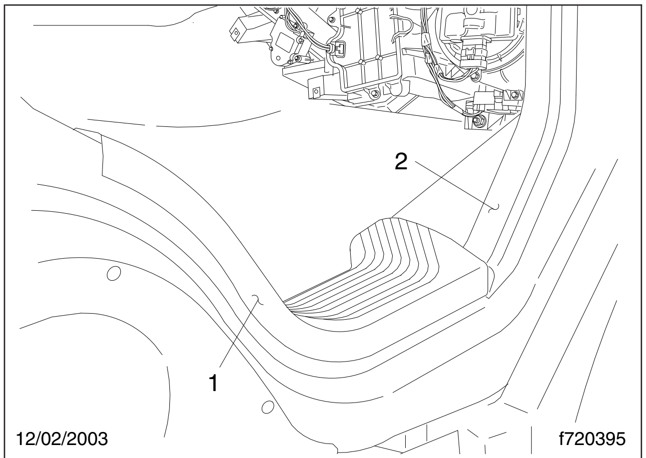
Fig. 2, Cam Alignment for the Air Distribution Actuator

IMPORTANT: If the alignment hole in the cam is not aligned with the hole in the HVAC assembly, the actuator could be installed with the cam 180 degrees from the correct position. Incorrect alignment of the cam will prevent the air distribution doors from operating correctly.

6. Using capscrews, install the new actuator on the mounting plate. Make sure that the actuator is correctly aligned on the door extension.
7. Attach the wiring harness to the air distribution actuator.
8. Attach the lower HVAC cover to the dash panel. For instructions, see **Group 60**.
9. Remove the chocks from the tires.

Recirculation Actuator Replacement

1. Turn off the engine, apply the brakes, and chock the tires.
2. Remove the lower HVAC cover. For instructions, see **Group 60**.
3. Disconnect the wiring harness from the recirculation actuator. See **Fig. 1**.
4. Remove the tread plate cover. See **Fig. 3**.



1. Tread Plate Cover 2. A-Pillar Cover

Fig. 3, A-Pillar and Tread Plate Covers

5. Remove the A-pillar cover.
6. Remove the capscrews that attach the actuator to the HVAC assembly and remove the actuator.
7. Using capscrews, install the actuator on the HVAC assembly. Make sure that the actuator is correctly aligned on the door extension.
8. Attach the wiring harness to the recirculation actuator.
9. Attach the A-pillar cover to the cab floor.
10. Attach the tread plate cover to the cab floor.
11. Attach the lower HVAC cover to the dash panel. For instructions, see **Group 60**.
12. Remove the chocks from the tires.

Heater and Air Conditioner Assembly or Heater Assembly Replacement

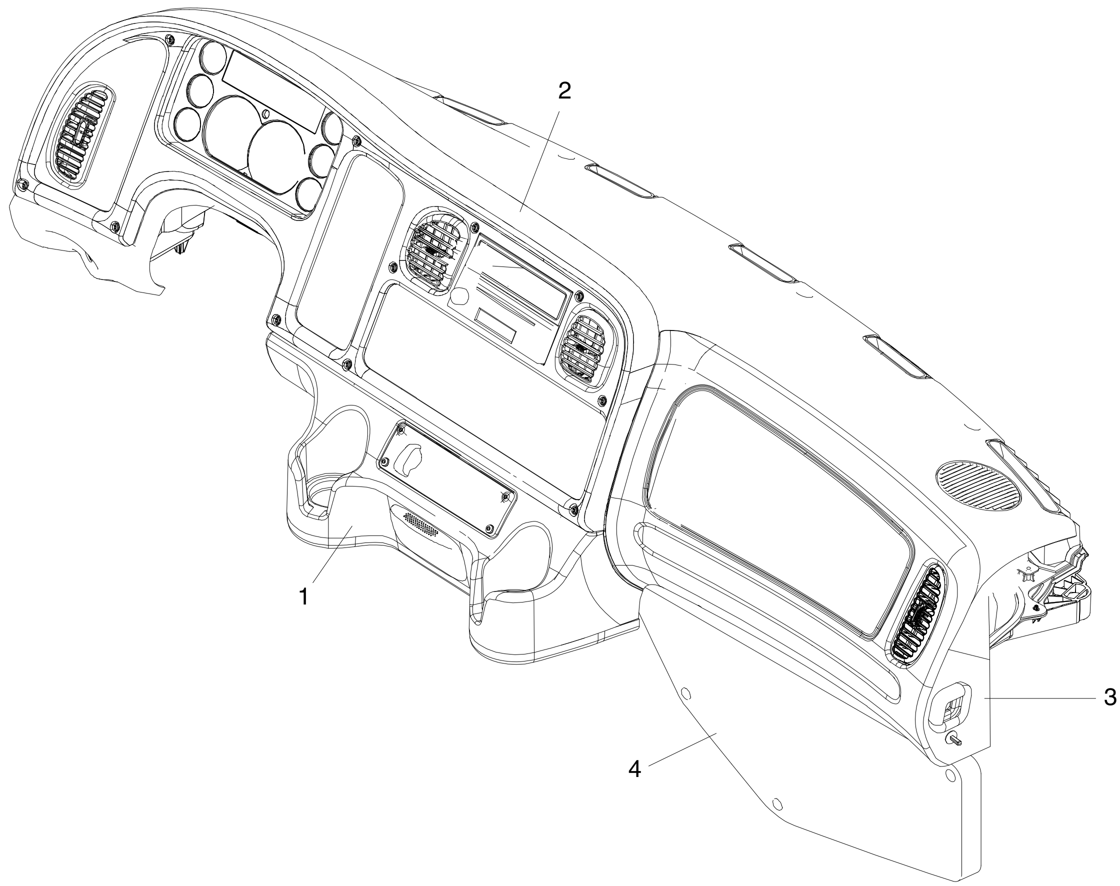
Replacement

1. Turn off the engine, apply the brakes, and chock the tires.
2. Disconnect the batteries.
3. Remove the surge tank. For instructions, see **Section 20.01**, Subject 130.
4. Remove the air cleaner. For instructions, see **Section 09.01**, Subject 110.
5. If equipped with an air conditioner, recover the refrigerant from the air conditioning system. For instructions, see **Section 83.00**, Subject 220.
6. Remove the Torx® capscrew that attaches the coolant lines to the heater core and remove the coolant lines.
7. Remove the capscrew that attaches the refrigerant lines to the expansion valve and remove the refrigerant lines. Quickly cap the refrigerant lines.

IMPORTANT: Under no circumstances should the refrigerant lines remain uncapped for longer than five minutes. Water and dirt can damage the refrigerant system. Do not blow shop air through the refrigerant lines since shop air is wet (humid).

8. Remove the following dash panels inside the cab. See **Fig. 1**. For instructions, see **Section 60.08**.
    - lower HVAC cover
    - trim plate panel
    - cup holder panel
    - right-hand dash panel
9. Disconnect the two HVAC wiring harnesses.
10. Remove the capscrews, nuts, and washers that attach the heater and air conditioner assembly or heater assembly to the dash and frontwall and remove the assembly.
11. Using capscrews, nuts, and washers, attach the new heater and air conditioner assembly or heater assembly to the dash and frontwall. Torque the capscrews 72 to 96 lbf·in (810 to 1080 N·cm). Torque the nuts 18 to 19 lbf·ft (24 to 26 N·m).
12. Connect the two HVAC wiring harnesses.
13. Using only Mini Stat-O-Seals, replace the Mini Stat-O-Seals on the refrigerant lines. Do not lubricate the Mini Stat-O-Seals prior to installation.
14. Using a capscrew, attach the refrigerant lines to the expansion valve. Torque the capscrew on the retaining plate 11 to 15 lbf·ft (15 to 20 N·m).
15. Using a Torx capscrew, attach the coolant lines to the heater core.
16. Install the dash panels. For instructions, see **Section 60.08**.
17. Install the surge tank. For instructions, see **Section 20.01**, Subject 130.
18. Install the air cleaner. For instructions, see **Section 09.01**, Subject 110.
19. Connect the batteries.
20. Remove the chocks from the tires.

Heater and Air Conditioner Assembly or Heater Assembly Replacement

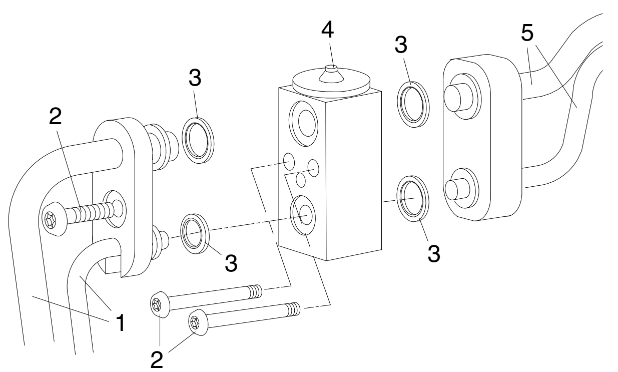


1. Cup Holder Panel
2. Trim Plate Panel
3. Right-Hand Dash Panel
4. Lower HVAC Cover

Fig. 1, Dash Panels

Replacement

1. Turn off the engine, apply the brakes, and chock the tires.
2. Open the hood.
3. Recover the refrigerant from the air conditioning system. For instructions, see **Subject 220**.
4. Remove the air cleaner. For instructions, see **Section 09.01**, Subject 110.
5. Remove the surge tank. For instructions, see **Section 20.01**, Subject 130.
6. Remove the capscrew that attaches the refrigerant lines to the expansion valve and remove the refrigerant lines. Quickly cap the refrigerant lines. See **Fig. 1**.



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1. Refrigerant Line
2. Capscrew
3. Mini Stat-O-Seal
4. Expansion Valve
5. Evaporator Line

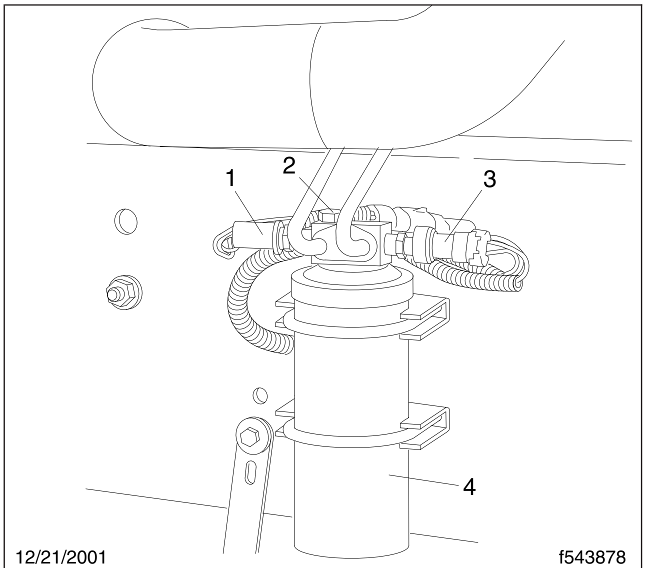
Fig. 1, Expansion Valve

IMPORTANT: Under no circumstances should the refrigerant lines remain uncapped for longer than five minutes. Water and dirt can damage the refrigerant system. Do not blow shop air through refrigerant lines since shop air is wet (humid).

7. Remove the capscrews that attach the expansion valve to the evaporator lines and remove the expansion valve. If the evaporator lines will be exposed to air for more than five minutes, cap the evaporator lines.
8. If the evaporator lines were capped, uncap the lines.
9. Using only Mini Stat-O-Seals, replace the Mini Stat-O-Seals on the evaporator side of the expansion valve. Do not lubricate the Mini Stat-O-Seals prior to installation.
10. Using two capscrews, attach the expansion valve to the evaporator lines. Torque the capscrews 35 lbf·in (395 N·cm).
11. Using only Mini Stat-O-Seals, replace the Mini Stat-O-Seals on the refrigerant lines. Do not lubricate the Mini Stat-O-Seals prior to installation.
12. Attach the refrigerant lines to the expansion valve. Torque the capscrew on the retaining plate 11 to 15 lbf·ft (15 to 20 N·m).
13. Install the surge tank. For instructions, see **Section 20.01**, Subject 130.
14. Install the air cleaner. For instructions, see **Section 09.01**, Subject 110.
15. Evacuate and charge the air conditioning system with refrigerant. For instructions, see **Subject 220**of this section.
16. Be sure to add refrigerant oil to the compressor to replace that which is lost when the system is recovered. See **Section 83.01**, Subject 130.
17. Return the hood to the operating position.
18. Remove the chocks from the tires.

Replacement

1. Turn off the engine, apply the brakes, and chock the tires.
2. Open the hood.
3. Recover the refrigerant from the air conditioning system. For instructions, see **Subject 220**.
4. Disconnect the wiring harness from the fan cycling switch and disconnect the wiring harness from the binary switch. See **Fig. 1**.



1. Fan Cycling Switch
2. Moisture Indicator
3. Binary Switch
4. Receiver-Drier

Fig. 1, Receiver-Drier

5. Remove the fan cycling switch and the binary switch from the receiver-drier.
6. Disconnect the refrigerant lines from the receiver-drier. Quickly cap the refrigerant lines.

IMPORTANT: Under no circumstances should the refrigerant lines remain uncapped for longer than five minutes. Water and dirt can damage the refrigerant system. Do not blow shop air through refrigerant lines since shop air is wet (humid).

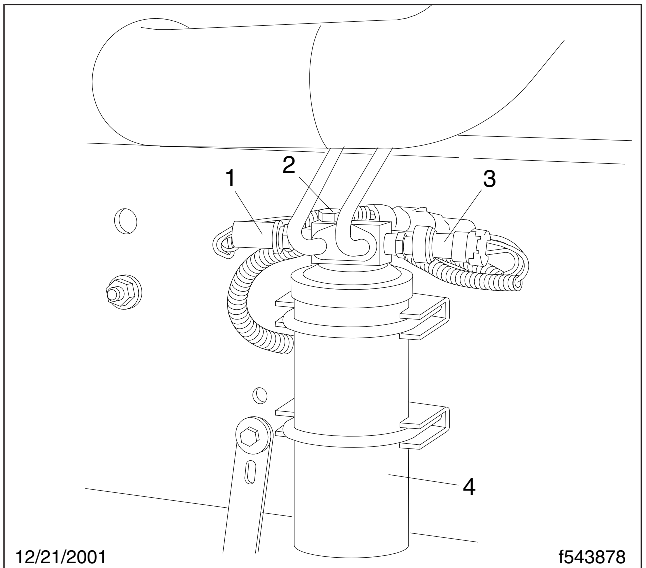
7. Remove the nuts and washers that attach the U-bolts and mounting brackets to the frame rail. Remove the receiver-drier.

IMPORTANT: If the desiccant cartridge inside the receiver-drier has fallen apart, flush the system and replace the expansion valve and the refrigerant compressor (desiccant matter can't be removed from these parts). A cartridge may fall apart from too much moisture in the system, because of poor evacuation of the system, or lack of maintenance.

8. Using U-bolts, mounting brackets, nuts, and washers, install a new receiver-drier on the frame rail.
9. Uncap the refrigerant lines.
10. Using only Mini Stat-O-Seals, replace the Mini Stat-O-Seals on the refrigerant lines. Do not lubricate Mini Stat-O-Seals prior to installation.
11. Connect the refrigerant lines to the receiver-drier. Torque the bolt on the retaining plate 11 to 15 lbf·ft (15 to 20 N·m).
12. Attach the fan cycling switch and the binary switch to the receiver-drier.
13. Attach the fan cycling wiring harness to the fan cycling switch and attach the binary switch wiring harness to the binary switch.
14. Evacuate and charge the air conditioning system with refrigerant. For instructions, see **Subject 220**.
15. Be sure to add refrigerant oil to the compressor to replace that which is lost when the system is recovered. See **Section 83.01**, Subject 130.
16. Return the hood to the operating position.
17. Remove the chocks from the tires.

Replacement

1. Turn off the engine, apply the brakes, and chock the tires.
2. Open the hood.
3. Disconnect the wiring harness from the binary switch. See **Fig. 1**.



1. Fan Cycling Switch
2. Moisture Indicator
3. Binary Switch
4. Receiver-Drier

Fig. 1, Receiver-Drier

4. Remove the binary switch.
5. Install a new binary switch on the receiver-drier.
6. Connect the wiring harness to the binary switch.
7. Return the hood to the operating position.
8. Remove the chocks from the tires.

Condenser Removal and Installation

Removal

1. Turn off the engine, apply the parking brakes, and chock the tires.
2. Remove the capscrews that attach the grille to the hood. Remove the grille.
3. Open the hood.
4. Recover the refrigerant from the air conditioning system. For instructions, see **Subject 220**.
5. Disconnect the refrigerant lines from the condenser. Quickly cap the condenser inlet and outlet ports if the condenser will be reinstalled and cap the refrigerant lines.

IMPORTANT: Under no circumstances should the refrigerant lines remain uncapped for longer than five minutes. Water and dirt can damage the refrigerant system. Do not blow shop air through refrigerant lines since shop air is wet (humid).

6. If the condenser is mounted below the charge air cooler, remove the charge air cooler. For instructions, see **Section 09.02**, Subject 100.
7. Remove the fasteners that attach the condenser to the charge air cooler or to the mounting brackets. Remove the condenser.

Installation

1. Using fasteners, install the condenser on the charge air cooler or the mounting brackets. Install and tighten the fasteners 84 to 108 lbf·in (950 to 1220 N·cm).
2. Uncap the inlet and outlet ports on the condenser and uncap the refrigerant lines.
3. Using only Mini Stat-O-Seals, replace the Mini Stat-O-Seals on the refrigerant lines. Do not lubricate Mini Stat-O-Seals prior to installation.
4. Connect the refrigerant lines to the condenser. Torque the bolt on the retaining plate 11 to 15 lbf·ft (15 to 20 N·m).
5. Evacuate and charge the air conditioning system with refrigerant. For instructions, see **Subject 220** of this section.
6. Add refrigerant oil to the compressor to replace that which is lost in the old condenser. For instructions, see **Section 83.01**, Subject 130.
7. Return the hood to the operating position.
8. Using capscrews, attach the grille to the hood.
9. Remove the chocks from the tires.

Replacement

1. Turn off the engine, apply the brakes, and chock the tires.
2. Remove the capscrews that attach the climate control panel to the cup holder panel. Pull the control panel away from the cup holder panel.
3. Disconnect the wiring harness from the control panel.
4. Connect the wiring harness to the new control panel.
5. Using capscrews, attach the control panel to the cup holder panel.
6. Remove the chocks from the tires.

Refrigerant Service Operations

Required Equipment

You will need a machine, or machines, to identify the refrigerant and to recover, evacuate, flush, and charge the refrigerant system. Ideally, it will be a single machine able to perform all the following functions:

- Identification—The machine must be able to verify the purity of the refrigerant in the air conditioning system, and should test for the presence of unapproved refrigerants.
- Recovery—The machine must be able to recover all traces of refrigerant from the air conditioning system.
- Evacuation—Ideally, the machine should have a vacuum pump rated at 6 cfm, and be maintenance free. A machine that requires maintenance is acceptable as long as it is properly maintained.
- Charging—The scale used in charging should be accurate to within ±1 ounce (30 mL).
- Flushing—Adaptors for the compressor(s), expansion device(s), and receiver-drier should be purchased or fabricated, to flush the system with refrigerant.

Refrigerant Identification

WARNING

Before doing any of the work below, read the information in Safety Precautions 100. Failure to read and understand the safety precautions, and to take necessary precautions against the dangers involved when working with refrigerant, could lead to serious personal injury.

IMPORTANT: Identify the specific type of refrigerant in the air conditioning system, if you suspect one of the following possibilities:

- Excess noncondensable gas, such as nitrogen or air, is in the system.
- An unapproved refrigerant is in the system.
- The history of refrigerant system repairs is unknown.

1. Using a high-quality refrigerant identifier and the manufacturer's instructions, attach the identifier to the vehicle and perform the test.
2. If the vehicle passes the test, it is safe to recover the refrigerant.
3. If the vehicle fails the test due to an excessive amount of noncondensable gas, recover the refrigerant system, then purge the recovery tank of the noncondensable gas.
4. If the test revealed the presence of a hydrocarbon-based refrigerant or a refrigerant other than R-134a, **do not recover the refrigerant into the general-use machine.** Recover non-R-134a refrigerant into a separate container specifically for refrigerant that must be recycled by a qualified recycling center. It is best to refer the customer to the place where the vehicle was last serviced, since properly disposing of non-134a refrigerants can be difficult and expensive.

Recovery

The recovery process removes most of the refrigerant charge in the system.

1. Turn off the engine, apply the parking brakes, chock the tires, and open the hood.
2. Remove the caps from the suction and discharge service valves.
3. If the history of refrigerant system repairs is unknown, or if you suspect that the system is charged with an unapproved refrigerant, identify the refrigerant using the "Refrigerant Identification" procedures.
4. Wearing protective goggles and nonleather gloves, attach the refrigerant recovery and charging machine hoses to the valves.

IMPORTANT: Push down firmly on the hose connectors, until they click into engagement. This ensures that the coupler is locked.

5. Follow the refrigerant recovery and charging machine manufacturer's instructions, and recover all of the refrigerant from the refrigerant system.

IMPORTANT: Always comply with all federal and local regulations regarding refrigerant recovery and disposal. You may be subject to substantial penalties for improper procedures.

6. Measure the oil recovered during the recovery process. The refrigerant system will have to be filled with the same quantity of new refrigerant oil. If the system is contaminated with moisture, all of the compressor oil must be replaced with clean oil. If the system is heavily contaminated with desiccant or grit, replace the compressor, expansion valve, and receiver-drier, and flush the condenser and evaporator(s). After the system is charged, perform a performance check to ensure that the heat exchangers are not plugged.

Evacuating

The main purpose in evacuating the refrigerant system is to remove noncondensable gases (NCG), such as nitrogen and air. The secondary purpose is to boil off free water molecules.

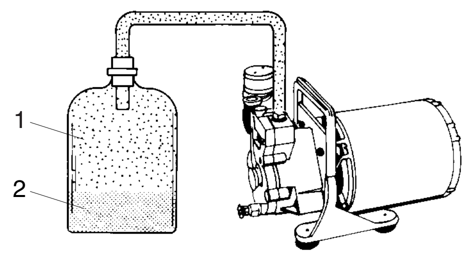
Water in the refrigerant can form ice crystals at the expansion valve. The ice crystals retard or stop the flow of refrigerant, causing a reduction or complete stoppage of cooling. As the expansion valve warms due to the lack of refrigerant, the ice melts and passes through the expansion valve. Then refrigerant will flow again, until the ice crystals re-form. The result is intermittent cooling.

Refrigerant oil has an extremely high moisture absorption capacity. Normally, the moisture picked up by the oil is passed off to the receiver-drier. If excessive moisture exists in the system, the lubricating ability of the oil is reduced, which could damage the compressor and other components.

Effects of Pressure on the Boiling Point of Water

Water boils at 212°F (100°C) at an atmospheric pressure of 14.7 psi (101 kPa), at sea level. At higher elevations the atmospheric pressure is lower, which allows water to boil at lower temperatures. See **Table 1** for boiling temperatures of water at converted pressures.

Another way to boil and remove water from the air conditioning system, is by lowering the system pressure to a vacuum, to cause the moisture to vaporize at normal ambient temperatures. A vacuum pump can reduce the pressure in the system. Since the pressure is lowest at the pump, NCG and water vapor are pulled out of the system. This process is called evacuation or dehydration. See **Fig. 1**.



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1. Vapor
2. Water

Fig. 1, Water to Vapor

Measuring Vacuum

Vacuum should be measured with an electronic thermistor vacuum gauge, which is designed for use with high vacuum pumps and can accurately read as low as 100 microns. This gauge can have an analog scale or a digital (LED or LCD) display.

The location of the vacuum gauge will affect the reading. The closer to the vacuum source, the lower the reading will be. Follow the manufacturer's instructions for proper use of the vacuum gauge.

If the pressure will not stabilize, suspect a leak. If it does stabilize at a vacuum that is too high, for example 1500 microns Hg, it is an indication of moisture and more evacuation is required.

Holding a vacuum only means that there is no leak present under a vacuum. Other leaks may exist when the system is pressurized, so a proper leak test must be performed in conjunction with holding a vacuum.

Maintaining an Oil-Lubricated Vacuum Pump

Maintenance is important for a high-vacuum pump. The oil must be changed at regular intervals to prevent moisture buildup, which will cause decreased pump performance and eventual pump failure.

Pumping down for extremely wet air conditioning systems can completely saturate the pump oil, which will require the replacement of the vacuum pump oil.

Boiling Temperatures of Water at Converted Pressures		
Boiling Temperature of Water: °F (°C)	**Absolute Pressure: psi (microns Hg)**	**Vacuum: inHg (mmHg)**
212 (100)	14.696 (759993.4)	0 (0)
205 (96)	12.770 (660400.0)	3.92 (99.6)
194 (90)	10.169 (523881.6)	9.22 (234.2)
176 (80)	6.8699 (355269.8)	15.93 (404.6)
158 (70)	4.5207 (233786.7)	20.72 (526.3)
140 (60)	2.8900 (149580.7)	24.04 (610.6)
122 (50)	1.7987 (92555.1)	26.28 (667.5)
104 (40)	1.0700 (55336.4)	27.74 (704.6)
89 (30)	0.61540 (31826.2)	28.67 (728.2)
86 (27)	0.57010 (26220.4)	28.89 (733.8)
76 (24)	0.44435 (22979.9)	29.02 (737.1)
72 (22)	0.38856 (20094.7)	29.13 (739.9)
69 (21)	0.35084 (18143.7)	29.21 (741.9)
64 (18)	0.29505 (15258.5)	29.32 (744.7)
59 (15)	0.24720 (12783.8)	29.42 (747.3)
53 (12)	0.19888 (10285.0)	29.52 (749.8)
45 (7)	0.14746 (7625.8)	29.62 (752.3)
32 (0)	0.08858 (4579.6)	29.74 (755.4)
21 (–6)	0.05293 (2738.1)	29.81 (757.2)
6 (–14)	0.02521 (1304.0)	29.87 (758.7)
–24 (–31)	0.004905 (253.7)	29.911 (759.74)
–35 (–37)	0.002544 (131.6)	29.915 (759.84)
–60 (–51)	0.0004972 (25.7)	29.9200 (759.968)
–70 (–57)	0.0002443 (12.69)	29.92050 (759.9807)
–90 (–68)	0.0000526 (2.72)	29.92089 (759.9906)

Table 1, Boiling Temperatures of Water at Converted Pressures

CAUTION

Flush the vacuum pump every fourth time it is used, and before storing for long periods of time. Acid will form and corrode the pump, if water-laden oil remains in the pump for an extended period.

Vacuum pump oil is water soluble. This helps the pump create a high vacuum, by absorbing water and sealing the pump.

Use only vacuum pump oil as a lubricant. Do not use any solvent or any other oil. Clean oil should be run through the pump, until it runs out clear. Oil should be added to the fill level indicated on the pump. Check the oil level before each use.

Evacuation Procedure

1. The system must have been recovered and the refrigerant compressor filled with the correct

amount of refrigerant oil. Replace the receiver-drier if the system conditions require it.

2. Make sure the vacuum pump has been properly maintained.
3. Wearing protective goggles and nonleather gloves, attach the refrigerant recovery and charging machine hoses, or a vacuum pump, to the valves.

IMPORTANT: Push firmly on hose connectors until they click into engagement. This ensures that they are locked.

4. Follow the refrigerant recovery and charging machine manufacturer's instructions, and evacuate the refrigerant system.
5. A minimum of 10 minutes with a 6-cfm pump should be used to evacuate the system, but a smaller pump requires a longer evacuation time. Make sure that the vacuum level reaches and maintains a point where water boils at your ambient temperature, then proceed with charging and leak testing the system.

Flushing

Flushing removes moisture-laden oil and some contamination, such as dirty oil and some particles. When a part is flushed, liquid refrigerant is forced through it. The liquid picks up the contaminants and flushes them out.

Whether to flush or replace a part depends on how much contamination there is as previously described.

Normally, the system always has pressure in it. Some loss of refrigerant from one season to the next is normal, and does not mean that the system is dirty. If refrigerant parts show signs of internal corrosion and grit, the system is contaminated.

If the system is contaminated with moisture, flush all sections of the system. Then change the oil in the compressor and replace the receiver-drier prior to evacuating and charging the system.

If the system is heavily contaminated or if desiccant has circulated through the system, replace the receiver-drier, expansion valve(s), and inspect the compressor.

Do not flush the receiver-drier or the compressor.

Flush the system in segments to lessen the chance of blowing deposits against a port.

Flush the system in the opposite direction of refrigerant flow. In other words, backflush the sections.

Flushing parts with refrigerant requires a refrigerant recovery and charging machine.

Flushing Procedure

Method 1

NOTE: Use this method when the recovery and charging machine is equipped with a flush cycle.

1. Recover the refrigerant from the air conditioning system.
2. Disconnect both ends of the line or part(s) being flushed. Tightly cap the lines to the rest of the system.

NOTE: You must remove the expansion device(s), receiver-drier, and compressor(s) when flushing. These components must be removed and bypassed when performing a system flush.

3. Install the flushing adaptors and an inline filter and follow the instructions from the manufacturer of the recovery and charging machine to perform the flush. When flushing the entire system, use an adaptor that fits where the compressor was located and backflush.
4. Remove the adaptors and bypass devices and install the expansion device(s), the compressor, and a new receiver-drier.
5. If installing the existing compressor, remove the oil in it and replace the oil with new oil. New compressors may or may not have a full charge of oil.
6. Charge the system with refrigerant and check the system performance.

Method 2

NOTE: Use this method when two recovery and charging machines are available.

1. Recover the refrigerant from the air conditioning system.
2. Disconnect both ends of the line or part(s) being flushed. Tightly cap the lines to the rest of the system.

NOTE: You must remove the expansion device(s), receiver-drier, and compressor(s) when flushing. These components must be removed and bypassed when performing a system flush.

3. Install the flushing adaptors and an inline filter. When flushing the entire system, use an adaptor that fits where the compressor was located and backflush.
4. Charge the part with 2 pounds (0.9 kg) of refrigerant or the system with 5 pounds (2.3 kg) of refrigerant, then recover the refrigerant with a second machine. It is desirable to start the recovery slightly before the charge cycle is done since this helps to push fluid through the system. Repeat the process several times until you think that all the oil has been removed.
5. Remove the adaptors and bypass devices and install the expansion device(s), the compressor(s), and a new receiver-drier.
6. If installing the existing compressor, remove the oil in it and replace the oil with new oil. New compressors may or may not have a full charge of oil.
7. Charge the system with refrigerant and check the system performance.

Oil Balancing

General Information

Compressors require refrigerant oil to function. When the air conditioning system is operating, some of the oil leaves the compressor and is circulated through the system with the refrigerant. The refrigerant oil cannot leave the system except when there is a leak, the refrigerant is recovered, or when a system part is replaced. It is important that the air conditioning system has the correct amount of refrigerant oil for proper operation. Too little oil will result in compressor failure. Too much oil will degrade the performance of the air conditioner, and cause damage to the compressor.

IMPORTANT: Whenever the air conditioning system is discharged or recovered, the recovered oil, from the charging machine, must be measured in order to know how much oil must be returned to the system. When a system component is replaced, a quantity of new oil equal to the recovered oil plus the oil coating the inside of the component must be returned to the system.

IMPORTANT: Refrigerant oil is hygroscopic (attracts moisture from its surroundings), and must not be exposed to the moisture that is present in the air. New oil must be from a container that has not been opened or that has been tightly sealed since its last use.

Tubing, funnels, or other equipment used to transfer the oil must be very clean and dry. When handling refrigerant oil:

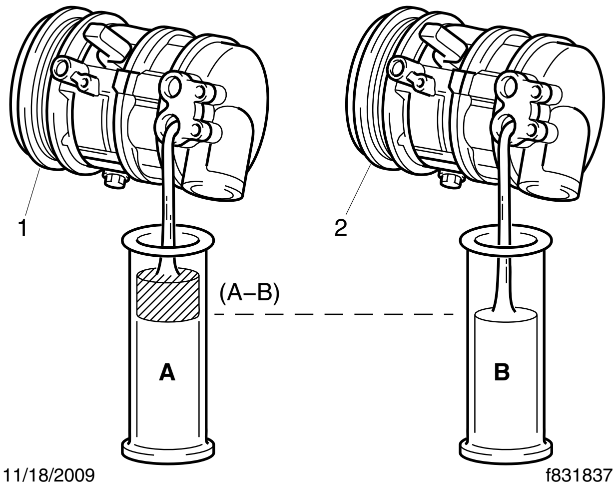
- Be sure that the oil is free of water, dust, metal powder, and other foreign substances;
- Do not mix the refrigerant oil with other types or viscosities of oil;
- Quickly seal the oil container after use. Refrigerant oil absorbs moisture when exposed to the air for any period of time.

Compressor Oil Balancing

Replacement refrigerant compressors are supplied with some refrigerant oil. If the air conditioning system has been flushed, the system will need a complete new charge of oil. If the system has not been flushed, use the following procedures to adjust the oil level, when a new compressor or other system component has been installed. The type of oil required depends on the brand of compressor used on the system. Refer to the workshop manual for the specific compressor on the vehicle being serviced for details about how the total system volume is determined. See PartsPro MOD 700 to determine the oil type and vehicle specific oil quantities.

1. Drain the remaining oil from the compressor into a clean graduated container, and note the amount. See **Fig. 2**.
2. Make note of the total volume of oil recovered.
3. Drain the oil from new compressor into a clean calibrated container, and compare the two quantities of oil.
4. Add only the amount of oil removed during recovery and from the old compressor to the system.

Refrigerant Service Operations



1. New Compressor 2 Old Compressor

Fig. 2, Oil Balancing

5. Add the new compressor oil as described in the supplier specific compressor service section of the workshop manual.

System Oil Balancing

After repairs are finished, refer to **Table 2** and use the following equation to determine the quantity of refrigerant oil that needs to be added to the system.

[Quantity Recovered] + [Quantity for All Replaced Components] = [Quantity Added to the System]

Table 2 provides the quantities of oil that need to be added to the system for each component that was replaced. Add the quantities listed in the table for each component that was replaced. Use the sum of the quantities or 6 fl oz (177 mL), whichever is less. Inject the calculated oil volume at the high-side pressure port during the refrigerant charging process.

Refrigerant Oil Quantities for Replaced Components	
Add the quantities listed in this table for each component that was replaced. Use the sum of the quantities or 6 fl oz (177 mL), whichever is less.	
Component	**Quantity oz (mL)**
High Pressure Line (main A/C)	1 (30)
Low Pressure Line (main A/C)	2 (59)
High Pressure Line (auxiliary A/C)	1 (30)
Low Pressure Line (auxiliary A/C)	3 (89)
Condenser	1 (30)
Evaporator (main A/C)	3 (89)
Evaporator (auxiliary A/C)	2 (59)
Receiver-Drier	3 (89)
Minor Leak at Connector Only	0.5 (15)
Major Leak at Connector Only	2 (59)

Table 2, Refrigerant Oil Quantities for Replaced Components

Charging

NOTE: Before charging, the system must be recovered and evacuated with the recovery and charging machine connected to the service and discharge port connections.

1. Obtain enough refrigerant to fully charge the system. To determine the amount of refrigerant needed to fully charge the system, read the Air Conditioner label on the vehicle or see **Specifications 400**.
2. Charge the system on the high side following the refrigerant recovery and charging machine manufacturer's instructions.
3. While the compressor is engaged, check the duct temperature and operating pressures at the suction and discharge ports. Compare the temperature and pressures to those in **Specifications 400**. If the operating pressures are not acceptable, see **Subject 300** for troubleshooting procedures.
4. Disconnect the hoses.
5. Shut down the engine.
6. Recover the refrigerant that is in the hoses.

Leak Detection

There is only one approved method for finding refrigerant leaks on Freightliner vehicles; electronic leak detection. The UV dye that is in all systems can be used for initial checks, but an electronic leak detector should always be used to confirm that a leak exists, and to check the connection for leaks after repairs are completed.

UV Dye

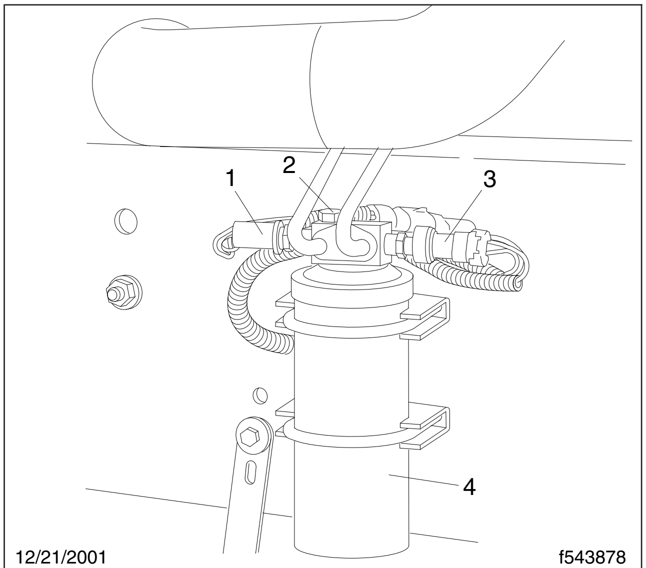
All Freightliner refrigerant systems contain UV dye for basic leak detecting. The UV dye will only show where there is residual refrigerant oil on connections and components. It can not determine if refrigerant is leaking from the system. A UV flashlight and glasses can be used according to the manufactures' instructions, to quickly inspect the refrigerant loop where ever it is possible to see the parts of the system. After noting all the potential leaks, use the electronic leak detector to confirm the existence of a leak.

Electronic Leak Detectors

Use an approved refrigerant leak detector (see the recommended tool list at accessfreightliner.com) and follow the manufacturers instructions. Operators should also be familiar with the list of "false trigger" chemicals provided by each manufacturer. Utilize the leak rate table in **83.00, Specifications 400**, to determine how severe each leak is.

Replacement

1. Turn off the engine, apply the brakes, and chock the tires.
2. Open the hood.
3. Disconnect the wiring harness from the fan cycling switch. See **Fig. 1**.



1. Fan Cycling Switch
2. Moisture Indicator
3. Binary Switch
4. Receiver-Drier

Fig. 1, Receiver-Drier

4. Remove the fan cycling switch.
5. Install a new fan cycling switch on the receiver-drier.
6. Connect the wiring harness to the fan cycling switch.
7. Return the hood to the operating position.
8. Remove the chocks from the tires.

Preliminary Checks

Before testing the operation of the air conditioning system, check the following items:

1. Make sure the drive belt on the refrigerant compressor is not damaged. Make sure the compressor mounting capscrews are tight. The capscrews should be tightened 15 to 19 lbf·ft (20 to 26 N·m).
2. Using a feeler gauge, check the refrigerant compressor for correct clutch clearance. See **Section 83.01, Subject 140** for instructions.
3. Check for broken or cut hoses. Check for loose fittings on all parts.
4. Check for road debris buildup on the condenser coil fins. Using air pressure and a whisk broom or a soapy spray of water, carefully clean off the condenser. Be careful not to bend the fins.
5. If there is not enough airflow, make sure that leaves or other debris have not entered the fresh air ports under the windshield. If debris is present, it could clog the air inlet and block airflow. Remove the debris carefully.

   Be sure that all ducts are connected to the dash outlets.

Air Conditioning System Performance Test

If the system does not operate within the following guidelines, further diagnosis and repair may be necessary.

1. Park the vehicle on a level surface and out of direct sunlight, shut down the engine, and set the parking brake. Chock the tires.
2. Open the hood.

NOTE: Print a copy of **Table 1** to record the readings taken during this procedure.

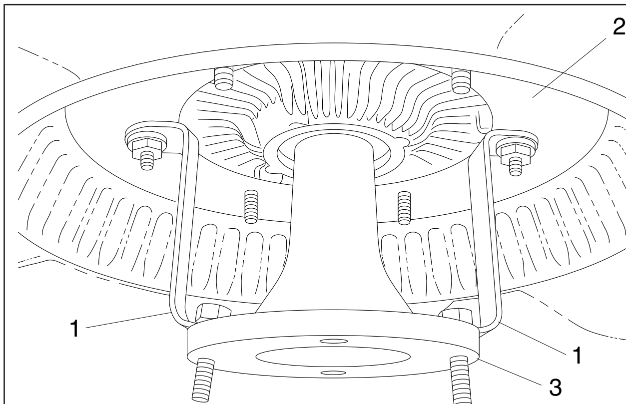
3. Record the ambient temperature and the relative humidity in **Table 1**.

WARNING

Use two brackets to lock the fan. If two brackets are not used, the bolts could shear or the fan could become unbalanced resulting in personal injury or damage to the fan.

4. Make sure the engine fan is engaged. If equipped with a viscous fan, the fan must be manually locked before testing the A/C system.

   To lock the fan, make two Z-shaped brackets similar to those shown in **Fig. 1**. Mount the brackets to the fan and hub 180 degrees apart. It is important to use two brackets to prevent vibration when testing. The brackets can be made by drilling and bending 3/4-inch x 1/8-inch (19-mm x 3-mm) mild steel strap.



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1. Z-Shaped Bracket
2. Fan
3. Hub

Fig. 1, Viscous Fan

5. Open the driver and passenger doors.
6. Connect the A/C test gauges to the refrigerant system service ports.
7. Place a thermometer in the center dash outlet.
8. Start the engine and warm it to operating temperature.
9. Set the engine speed to 1500 rpm.
10. Set the control panel to normal A/C, the recirculation to off, and the fan to the highest speed.
11. Allow time for the system to stabilize (at least 5 minutes or until the dash outlet temperature is at

minimum) then record the values in **Table 1** under the "Actual Readings" heading.

12. Refer to the appropriate temperature/pressure table in **Subject 400**. Using the recorded ambient temperature and relative humidity readings, locate the values in the temperature/pressure table and record them in **Table 1** under the "Published Readings" heading.
13. If the actual dash outlet temperature is within the range of the published values, then the system is performing satisfactorily. If the actual temperature is not within the published value, use the other readings such as high-side or low-side (suction or discharge) pressures and compressor cycling information to begin diagnosing the system.
14. If Z-shaped brackets were used to lock the viscous fan, remove the brackets.

Refrigerant Pressure Test Gauge Diagnosis

See **Table 2** for diagnosis of the system using refrigerant pressure test gauge readings. Check the specific component or condition mentioned in the Possible Cause column to help determine the cause of a problem with the system.

A/C Performance Test Data		
Test Data Item	**Published Readings (see step 12)**	**Actual Readings**
Ambient Temperature Relative Humidity (RH)		_____°F (°C) _____% RH
Center Dash Outlet Temperature	_____°F (°C) to _____°F (°C)	_____°F (°C)
High-Side Pressure	_____ psi (kPa) to _____ psi (kPa)	_____ psi (kPa)
Low-Side Pressure	_____ psi (kPa) to _____ psi (kPa)	_____ psi (kPa)
Compressor Cycling	yes/no	yes/no
Compressor On/Off Time (only if cycling)	on _____ sec off _____ sec	on _____ sec off _____ sec

Table 1, A/C Performance Test Data

System Diagnosis Using Refrigerant Pressure Readings			
Suction Pressure (low side)	**Discharge Pressure (high side)**	**Possible Cause**	**Remedy**
High	Low	Worn compressor.	Replace compressor. Be sure to identify and correct cause of failure (e.g. system contamination, incorrect oil charge, leaks, etc.)
High	Normal	Thermal expansion valve (TXV) stuck open.	Replace TXV.

System Diagnosis Using Refrigerant Pressure Readings			
Suction Pressure (low side)	Discharge Pressure (high side)	Possible Cause	Remedy
High	High	Restricted condenser air flow.	Clean bugs, dirt, and any debris or obstructions blocking airflow through the condenser. Straighten condenser fins as necessary. Make sure engine fan is working properly and that fan shroud is in place.
		Air or moisture in the refrigerant.	Recover and evacuate the system, charge system with proper amount of pure R-134a refrigerant. Replace the R/D if moisture was determined to be an issue.
		System overcharged.	Recover and evacuate the system, charge system with proper amount of pure R-134a refrigerant.
		Blockage downstream of measurement point and before expansion valve.	Remove the blockage or replace the component with the blockage as necessary. Determine cause of blockage and make further repairs as required.
Normal	Low	Improper belt tension.	Check belt tension, repair as necessary.
		Restricted suction line.	Remove the blockage or replace the component with the blockage as necessary. Determine cause of blockage and make further repairs as required.
		Worn compressor.	Replace compressor. Be sure to identify and correct cause of failure (e.g. system contamination, incorrect oil charge, leaks, etc.)
Normal	Normal	No problem found.	No action required.
Normal	High	Restricted condenser airflow.	Clean bugs, dirt, and any debris or obstructions blocking airflow through the condenser. Straighten condenser fins as necessary. Make sure engine fan is working properly and that fan shroud is in place.
		Slight over-charge.	Recover and evacuate the system, charge system with proper amount of pure R-134a refrigerant.
Low	Low	Blockage in system.	Remove the blockage or replace the component with the blockage as necessary. Determine cause of blockage and make further repairs as required.
		Low refrigerant charge.	Thoroughly leak test the system using an approved electronic detector. Repair all leaks as necessary. Charge system with proper amount of pure R-134a refrigerant.
		Frozen evaporator.	Check refrigerant charge, check evaporator probe, correct as necessary.
		Faulty thermal expansion valve (TXV).	Replace TXV.
		Faulty evaporator sensor.	Replace sensor.
Low	Normal	Blockage downstream of the measurement point and before the expansion valve.	Remove the blockage or replace the component with the blockage as necessary. Determine cause of blockage and make further repairs as required.
		Low refrigerant charge.	Thoroughly leak test the system using an approved electronic detector. Repair all leaks as necessary. Charge system with proper amount of pure R-134a refrigerant.
		Faulty evaporator sensor.	Replace sensor.

Troubleshooting

System Diagnosis Using Refrigerant Pressure Readings			
Suction Pressure (low side)	**Discharge Pressure (high side)**	**Possible Cause**	**Remedy**
Low	High	Blockage downstream of the measurement point and before the expansion valve.	Remove the blockage or replace the component with the blockage as necessary. Determine cause of blockage and make further repairs as required.
		Low charge.	Thoroughly leak test the system using approved an electronic detector. Repair all leaks as necessary. Charge system with proper amount of pure R-134a refrigerant.
		Faulty evaporator sensor.	Replace sensor.

Table 2, System Diagnosis Using Refrigerant Pressure Readings

System Troubleshooting Tables

Problem — No Fresh Air (nonrecirculation mode)

Problem — No Fresh Air (nonrecirculation mode)	
Possible Cause	**Remedy**
Mechanical problem with the recirculation door actuator.	Inspect the recirculation door actuator for obstructions or mechanical damage. Correct as necessary.
Problem with the wiring.	Refer to "Recirculation Door Actuator Circuit Tests" for diagnosis.
The control head is not working.	
The blower motor is in protection mode.	Refer to "Blower Motor Circuit Tests" for diagnosis.

Problem — Warm Airflow When the Air Conditioner is On; A/C is Not Working; or Poor Performance of A/C

Problem — Warm Airflow When the Air Conditioner is On; A/C is Not Working; or Poor Performance of A/C	
Possible Cause	**Remedy**
Low refrigerant charge in the system.	Perform a leak test. Repair any leaks, evacuate the system, replace the receiver-drier, and add a full charge of refrigerant.
Too much refrigerant in the system.	Evacuate the system, then add a full charge of refrigerant.
Moisture in the system.	If moisture is in the system, ice crystals may form and block the flow of refrigerant at the expansion valve or other places in the system. Recover the refrigerant, replace the receiver-drier, evacuate the system, and add a full charge of refrigerant.
The refrigerant compressor is not working.	The refrigerant charge is low or high.
	The refrigerant compressor clutch or drive belt needs repair or replacement.
	Refer to "A/C Clutch Circuit Tests for Diagnosing No A/C Clutch Engagement" in this subject.
Ice has formed on the evaporator coil.	Defrost the evaporator coil before resuming operation of the air conditioner. Refer to "Evaporator Probe Circuit Tests" in this subject for diagnosis.

Troubleshooting

Problem — Warm Airflow When the Air Conditioner is On; A/C is Not Working; or Poor Performance of A/C	
Possible Cause	**Remedy**
Temperature blend door actuator is not working.	Refer to "Temperature Blend Door Circuit Tests" in this subject for diagnosis.
	Mechanical problem with temperature blend door actuator.
Blockage in A/C system such as lines, evaporator, condenser, or expansion valve.	Remove the blockage.
The blower motor is in protection mode.	Refer to "Blower Motor Circuit Tests" for diagnosis.
The evaporator probe isn't working or is out of range.	Refer to "Evaporator Probe Circuit Tests" for diagnosis.

Problem — Low-Side Pressure Too Low

Problem — Low-Side Pressure Too Low	
Possible Cause	**Remedy**
The expansion valve is not working.	Check the expansion valve for blockage and function. Blockage may be due to moisture causing ice formation.
There are line or component restrictions.	Remove the restrictions.
The refrigerant charge is low.	Perform a leak test. Repair any leaks, evacuate the system, replace the receiver-drier, and add a full refrigerant charge.

Problem — High-Side Pressure Too High

Problem — High-Side Pressure Too High	
Possible Cause	**Remedy**
Airflow through the condenser is restricted.	Check for and remove dirt or debris in front of the condenser and radiator.
	Check the engine fan operation.
There is an internal restriction in the condenser indicated by ice buildup on the condenser or a cool spot on the line from the condenser to the receiver-drier.	Replace the condenser. If compressor failure recently occurred, the blockage may be due to debris from a failed compressor.
Air is in the refrigerant.	Perform a leak test. Repair any leaks, evacuate the system, replace the receiver-drier if necessary, and add a full charge of refrigerant.
The engine is overheated.	Check the engine cooling system.
Restriction in the compressor discharge line.	Replace the line.

Problem — Compressor Runs Continuously

Problem — Compressor Runs Continuously	
Possible Cause	**Remedy**
Low refrigerant charge in the system.	Perform a leak test. Repair any leaks, evacuate the system, replace the receiver-drier, and add a full charge of refrigerant.
The evaporator probe isn't working.	Refer to "Evaporator Probe Circuit Tests" for diagnosis.

Troubleshooting

Problem — Little or No Heat

Problem — Little or No Heat	
Possible Cause	**Remedy**
Low engine coolant.	Check coolant level. If low, check for source of leak and repair as necessary.
Plugged heater core.	Flush or replace the heater core as necessary.
Engine thermostat is not working.	Check to see if the engine thermostat is stuck open. Refer to **Section 20.00, Subject 300** for diagnosis.
Engine fan on all the time.	Refer to **Group 20** for diagnosis.
Mechanical problem with temperature blend door actuator.	Inspect the temperature blend door actuator for obstructions or mechanical damage. Correct as necessary.
Problem with the wiring.	Refer to "Temperature Blend Door Actuator Circuit Tests" for diagnosis.
The control head is not working.	

Problem — Water or Liquid Leaking from the Air Conditioner

Problem — Water or Liquid Leaking from the Air Conditioner	
Possible Cause	**Remedy**
The drain tubes are plugged.	Clean the drain tubes.
Heater core is leaking.	Leak test and replace the heater core if necessary.

Problem — Recirculation Mode Not Working

Problem — Recirculation Mode Not Working	
Possible Cause	**Remedy**
Air selection switch is set to full or partial defrost.	Recirculation mode is not available in any of the defrost settings. This is not a problem.
Mechanical problem with the recirculation door actuator.	Inspect the recirculation door actuator for obstructions or mechanical damage. Correct as necessary.
Problem with the wiring.	Refer to "Recirculation Door Actuator Circuit Tests" for diagnosis.
The recirculation door actuator is not working.	
The control head is not working.	

Problem — Air Selection Switch Not Working

Problem — Air Selection Switch Not Working*	
Possible Cause	**Remedy**
Mechanical problem with the air distribution door actuator.	Inspect the air distribution door actuator for obstructions or mechanical damage. Correct as necessary.
Problem with the wiring.	Refer to "Air Distribution Door Actuator Circuit Tests" for diagnosis.
The control head is not working.	

* Not able to control where the air is directed.

Problem — No Cool Vent Air on a Heater-Only System

Problem — No Cool Vent Air on a Heater-Only System	
Possible Cause	**Remedy**
Mechanical problem with the temperature blend door actuator.	Inspect the temperature blend door actuator for obstructions or mechanical damage. Correct as necessary.
Problem with the wiring.	Refer to "Temperature Blend Door Actuator Circuit Tests" for diagnosis.
The control head is not working.	

Problem — No Backlighting on the Control Head

Problem — No Backlighting on the Control Head	
Possible Cause	**Remedy**
Problem with the wiring.	Refer to "Backlighting Circuit Tests" for diagnosis.
The control head is not working.	

Problem — Blower Not Working

Problem — Blower Not Working	
Possible Cause	**Remedy**
Problem with the wiring.	Refer to "Blower Motor Circuit Tests" for diagnosis.
The control head is not working.	
A fuse is blown.	
The blower motor is not working.	

Component and System Tests

Use the following component and system tests to diagnose an HVAC problem.

Receiver-Drier

The entire length of the receiver-drier should be the same temperature to the touch. If the receiver-drier is not the same temperature, it may indicate a blockage or low charge. Any blockage can cause high head pressures.

Cooling System

Although they are not physically connected, there is a close tie between the air conditioner and the cooling system. Poor air conditioner cooling can be the result of a problem in the cooling system.

If the cooling system does not work correctly, the heat of the engine will rise to abnormal levels. The added heat will transfer to the air conditioner, other underhood parts, and could make its way into the cab. The added heat makes it necessary for the air conditioner to work harder and reduces the ability of the air conditioner to cool the air in the cab.

See **Group 20** for cooling system troubleshooting, and see the engine manufacturer's service manual for other details about cooling system problems.

Expansion Valve

Problems with the expansion valve may be caused by the valve being stuck closed or open. When the valve is stuck closed, the evaporator coil and the expansion valve will be at outside temperature. When the valve is stuck open, both the coil and the valve will be extremely cold with frost or ice buildup.

Because the expansion valve channels are very small, blockages in the system tend to be found here. The valve is very sensitive to contamination, usually from water. Less than a drop of water is all it takes to make the valve stop working. When water reaches the valve, the extreme cold that results from the pressure drop freezes the water, forming a block of ice in the valve. After the system shuts down and the valve warms, the ice melts and the valve operates again, only to be blocked again when the moisture returns and freezes.

On-and-off operation of the expansion valve means that the receiver-drier is not removing moisture from the system.

Refrigerant Compressor

Compressor problems usually show in one of four ways:

- abnormal noise
- seizure
- leakage
- low suction and discharge pressures

Resonant compressor noises are not causes for alarm. Irregular noise or rattles are likely to be caused by broken parts. To check for seizure, de-energize the magnetic clutch and see if the drive plate can be turned. If it won't turn, the compressor has seized.

Low discharge pressure may be caused by insufficient refrigerant, not enough belt tension, or a blockage somewhere in the system. These things should be checked before servicing the compressor.

Evaporator

The evaporator coils are basically trouble-free when airflow over the fins is not blocked. The filter next to the evaporator removes debris. If the filter is installed, no blockage can occur.

If a leak exists in the system and it cannot be traced to other parts or fittings, one of the evaporator coils may be damaged.

Condenser

The condenser is usually trouble-free. Normally, the temperature of the condenser outlet line is noticeably cooler than the inlet line. However, when road debris such as leaves or dirt build up, the airflow over the condenser fins is blocked. Air is not able to absorb enough heat to turn the hot refrigerant gas into a liquid. High head pressures will result. In these cases, carefully clean the outer surfaces of the condenser with compressed air or a soap and water solution. Be careful not to bend the fins.

High head pressures will also occur if the condenser tubing is abnormally bent, blocking the flow of refrigerant. Frost will appear at the point where the flow is restricted.

Less common internal blockages, such as bits of foreign material or metallic grit buildup, will stop the flow of refrigerant.

When troubleshooting a suspected condenser problem, remember that the problem may be caused by the radiator transferring high levels of heat to the condenser. See **Group 20** of this manual for cooling system troubleshooting, and see the engine manufacturer's service manual for other information about cooling system problems.

Line Restrictions

A restricted suction line causes low suction pressure at the compressor and little or no cooling. A restriction in a line between the compressor and the expansion valve can cause high discharge and low suction pressure, and insufficient cooling.

Areas of ice or frost buildup usually mean a blockage. Parts that often freeze are probably corroded or inoperative and should be replaced. Parts, such as the expansion valve, that freeze once in a while may do so because of moisture in the system. If this happens, recover the refrigerant charge, evacuate/recycle the system refrigerant, replace the receiver-drier, and recover, evacuate, and charge the system with refrigerant.

Temperature Blend Door Actuator Circuit Tests

The temperature blend door actuator controls the amount of air that is routed through the heater core. The temperature blend door actuator is controlled by the temperature control switch on the control head (climate control panel). The control head senses the door position by reading the feedback voltage from the actuator position sensor. The feedback voltage will be less than the 5V reference voltage sent by the control head to the sensor.

The target position is based on the temperature control switch setting and internal control head algorithms. The desired position is considered reached when one of the following conditions is true, although this does not necessarily mean that the position actually corresponds to the desired temperature setting (for example, if the actuator movement is limited due to an obstruction):

- The actuator's feedback position has been reached.
- The actuator is stalled for more than 1 second; the actuator feedback position does not change for more than 1 second.
- The target position corresponds to an end stop and an additional 1 second extra drive in the same direction (to guarantee sealing) has been performed.

The temperature blend door should move from one extreme position to the other when turning the temperature control switch from cold to hot or from hot to cold.

Follow the tests in **Table 3** in the sequence presented. The directions under the column "What to Do if Test Fails" are sometimes dependent on good results from previous tests. If any of the tests fail, stop and perform the specified repair or check. If the temperature blend door actuator passes the tests in **Table 3** and the actuator still does not operate properly, check for mechanical problems with the actuator.

Temperature Blend Door Actuator Circuit Tests				
Test	**Conditions**	**Test Point**	**Good Result**	**What to Do if Test Fails**
actuator motor drive circuit	key on, engine off temperature blend door actuator connector removed fan (blower) switch on low change temperature setting while observing the digital multimeter (DMM)	Measure across pins 5 and 6 of the temperature blend door actuator connector.	9V+ for about 1 second*	Check wiring between control head and temperature blend door actuator. If wiring is okay, replace the control head.
actuator position sensor reference voltage circuit	key on, engine off temperature blend door actuator connector removed	Measure between pin 7 of the temperature blend door actuator connector and the battery negative post.	5V	
actuator position sensor reference ground circuit	key on, engine off temperature blend door actuator connector removed	Measure between pin 8 of the temperature blend door actuator connector and the battery positive post.	12V*	
actuator position sensor feedback signal circuit	key on, engine off all connectors connected	Backprobe pins B11 and B5 at control head connector.	0.50V (full hot) to 4.00V (full cold)†	Check wiring between control head and temperature blend door actuator.‡ If wiring is okay, replace the actuator.‡

* The voltage should be approximately the same as the battery voltage.

† Values are approximate.

‡ It is assumed that reference voltage and ground circuits are functioning.

Table 3, Temperature Blend Door Actuator Circuit Tests

Air Distribution Door Actuator Circuit Tests

The air distribution (mode) door actuator controls the direction the air is routed through the HVAC ducts in the cab. The air distribution door actuator is controlled by the air selection switch on the control head (climate control panel). The control head senses the air distribution door position by reading the feedback voltage from the actuator position sensor. The feedback voltage will be less than the 5V reference voltage sent by the control head to the sensor.

The target position is based on the air selection switch setting and internal control head algorithms. The desired position is considered reached when one of the following conditions is true, although this does not necessarily mean that the position actually corresponds to the desired air selection setting (for example, if the actuator movement is limited due to an obstruction):

- The actuator feedback position has been reached.
- The actuator is stalled for more than 1 second; the actuator feedback position does not change for more than 1 second.
- The target position corresponds to an end stop and an additional 1 second extra drive in the same direction (to guarantee sealing) has been performed.

The air distribution door should move from one extreme position to the other when turning the air selection switch from the far left to the far right or from the far right to the far left.

Follow the tests in **Table 4** in the sequence presented. The directions under the column "What to Do if Test Fails" are sometimes dependent on good results from previous tests. If any of the tests fail, stop and perform the specified repair or check. If the air distribution door actuator passes the tests in **Table 4** and the actuator still does not operate properly, check for mechanical problems with the actuator. To quickly check for normal operation, feel for air flowing from the correct outlet in each air selection setting.

Recirculation Door Actuator Circuit Tests

The recirculation door actuator controls the source of the air, fresh or recirculated, that is routed through the HVAC ducts in the cab. The recirculation door actuator is controlled by the recirculation button on the control head (climate control panel).

Vehicles built from May 2, 2003, have partial recirculation. For information on this feature, see **Subject 050**.

The control rules for the recirculation mode are as follows:

- The recirculation mode is not available in the defrost settings.
- The default at power up is fresh air unless the fan switch is in the off position. When the fan switch is in the off position, the recirculation mode is the default mode, but the LED is not illuminated.
- When the recirculation mode is enabled, it will remain on until one of the following occurs:
  - the air selection switch is moved to a defrost mode
  - the recirculation button is pressed
  - the ignition is cycled
  - 20 minutes have passed and the recirculation timer has expired

NOTE: On vehicles built prior to May 2, 2003, the recirculation mode is canceled until the recirculation button is pressed again. On vehicles built from May 2, 2003, the system enters partial recirculation mode for five minutes, then resumes full recirculation mode for 20 minutes. This cycle repeats as long as the system remains in recirculation mode.

The control head senses the recirculation door position by reading the feedback voltage from the actuator position sensor. The feedback voltage will be less than the 5V reference voltage sent by the control head to the sensor.

The target position is based on the recirculation button setting and internal control head algorithms. The desired position is considered reached when one of the following conditions is true, although this does not necessarily mean that the position actually corresponds to the desired recirculation button setting (for example, if the actuator movement is limited due to an obstruction):

- The actuator’s feedback position has been reached.
- The actuator is stalled for more than 1 second; the actuator feedback position does not change for more than 1 second.
- The target position corresponds to an end stop and an additional 1 second extra drive in the same direction (to guarantee sealing) has been performed.

The recirculation door should move from one extreme position to the other when the recirculation button is pressed on and then pressed off.

Perform the tests in Table 5 in the sequence presented. The directions under the column "What to Do if Test Fails" are sometimes dependent on good results from previous tests. If any of the tests fail, stop and perform the specified repair or check. If the recirculation door actuator passes the tests in Table 5 and the actuator still does not operate properly, check for mechanical problems with the actuator. To quickly check for normal operation, set the fan switch to high and listen for a change in the sound of the blower near the HVAC unit while pressing the recirculation button on and off. The blower will be louder when recirculation is enabled.

Air Distribution Door Actuator Circuit Tests				
Test	**Conditions**	**Test Point**	**Good Result**	**What to Do if Test Fails**
actuator motor drive circuit	key on, engine off air distribution door actuator connector removed fan (blower) speed on low change the air selection setting while observing the digital multimeter (DMM)	Measure across pins 5 and 6 of the air distribution door actuator connector.	9V+ for about 1 second*	Check wiring between control head and air distribution door actuator. If wiring is okay, replace the control head.
actuator position sensor reference voltage circuit	key on, engine off air distribution door actuator connector removed	Measure between pin 10 of the air distribution door actuator connector and the battery negative post.	5V	
actuator position sensor reference ground circuit	key on, engine off air distribution door actuator connector removed	Measure between pin 8 of the air distribution door actuator connector and the battery positive post.	12V*	
actuator position sensor feedback signal circuit	key on, engine off all connectors connected	Backprobe pins B10 and B5 at control head connector.	0V (far right) to 5V (far left)	Check wiring between control head and air distribution door actuator.† If wiring is okay, replace the actuator.†

* The voltage should be approximately the same as the battery voltage.

† It is assumed that reference voltage and ground circuits are functioning.

Table 4, Air Distribution Door Actuator Circuit Tests

Recirculation Door Actuator Circuit Tests				
Test	**Conditions**	**Test Point**	**Good Result**	**What to Do if Test Fails**
actuator motor drive circuit	key on, engine off recirculation door actuator connector removed fan (blower) speed on low change the recirculation setting while observing the digital multimeter (DMM)	Measure across pins 5 and 6 of the recirculation door actuator connector.	9V+ for about 1 second*	Check wiring between control head and recirculation door actuator. If wiring is okay, replace the control head.
actuator position sensor reference voltage circuit	key on, engine off recirculation door actuator connector removed	Measure between pin 10 of the recirculation door actuator connector and the battery negative post.	5V	
actuator position sensor reference ground circuit	key on, engine off recirculation door actuator connector removed	Measure between pin 8 of the recirculation door actuator connector and the battery positive post.	12V*	
actuator position sensor feedback signal circuit	key on, engine off all connectors connected	Backprobe pins A11 and B5 at control head connector.	0.8V (recirc. on) to 4.7V (recirc. off)	Check wiring between control head and recirculation door actuator.† If wiring is okay, replace the actuator.†

* The voltage should be approximately the same as the battery voltage.

† It is assumed that reference voltage and ground circuits are functioning.

Table 5, Recirculation Door Actuator Circuit Tests

Blower Motor Circuit Tests

The blower motor power and ground are supplied directly to the blower motor assembly. The blower speed is controlled by the fan switch on the control head (climate control panel). The control head sends a pulse width modulated (PWM) signal to the blower motor. The frequency of this signal is 2000 Hz. The pulse width varies with the fan switch selection.

The protection modes for the blower motor are as follows:

- Reverse Voltage Protection—The motor will not operate if the polarity of the motor leads, circuits 98F and ground, are reversed.
- Current Protection—If the motor exceeds the maximum limit, the speed will be reduced until the current is within the limits (23.5A maximum).
- Temperature Protection—If the motor's internal temperature sensor senses that the temperature is too high, the blower speed is reduced to 1000 rpm to reduce the load on the motor and a comparison is made between the sensor reading and the maximum limit. If the temperature is still too high, the blower speed is further reduced to the minimum value of approximately 500 rpm and a temperature comparison is made to the maximum. If, after the second comparison, the temperature is still too high, the motor will shut down until it has cooled sufficiently.

Perform the tests in **Table 6** in the sequence presented. The directions under the column "What to Do if Test Fails" are sometimes dependent on good results from previous tests. If any of the tests fail, stop and perform the specified repair or check. If the blower motor passes the tests in **Table 6** and the blower still does not operate properly, check the blower motor. To quickly check for normal operation, set the fan switch to high and listen for a change in the sound of the blower near the HVAC unit while pressing the recirculation button on and off. The blower will be louder when recirculation is enabled.

Blower Motor Circuit Tests				
Test	**Conditions**	**Test Point**	**Good Result**	**What to Do if Test Fails**
main power to blower motor	battery switch on (if equipped) key off blower motor connector removed	Measure between pin 4 of blower motor connector and negative battery post.	12V*	Check fuse F2 in the PDM under the hood. If the fuse is blown, check for shorted wiring or a damaged blower motor. Check for an open in circuit 98F.
blower motor ground circuit	battery switch on (if equipped) key off blower motor connector removed	Measure between pin 3 of blower motor connector and the positive battery post.	12V*	Check for an open in blower motor ground circuit.
PWM signal from control head	battery switch on (if equipped) key on, engine off blower motor connector connected change the fan (blower) speed setting on the control head and observe frequency using the digital multimeter (DMM)	Backprobe pins 4 and 5 of the blower motor connector, harness side (DMM set to measure frequency).	0 Hz fan off 0 Hz fan on high 2000 Hz all other speeds	Check circuit 338H. Check control head.
voltage drop (power circuit)	battery switch on (if equipped) key on, engine off all connectors connected fan (blower) speed on high	Backprobe pin 4 at the blower motor connector, other lead on positive battery post.	less than 0.5V	Locate high resistance or open in circuit 98F.
voltage drop (ground circuit)	battery switch on (if equipped) key on, engine off all connectors connected fan (blower) speed on high	Backprobe pin 3 at the blower motor connector, other lead on negative battery post.	less than 0.5V	Locate high resistance or open in blower motor ground circuit.
blower motor current draw	battery switch on (if equipped) key on, engine off all connectors connected fan (blower) speed on high	Use current clamp around circuit 98F or blower motor ground wire.	less than 23.5A	Check blower motor.

* The voltage should be approximately the same as the battery voltage.

Table 6, Blower Motor Circuit Tests

Evaporator Probe Circuit Tests

The evaporator temperature sensor is a resistive element, where the resistance increases as the temperature decreases. The control head (climate control panel) uses this sensor to determine the evaporator temperature. The control head uses the temperature information to determine if the A/C com-

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pressor should be engaged or not in order to prevent the evaporator core from freezing. As refrigerant flows through the evaporator, condensation will form on the surface of the evaporator. If this condensation freezes because the evaporator temperature is too low, airflow will be restricted through the core and poor cooling will result. The control head will shut off the compressor when the evaporator temperature is near the point where freezing may occur. See **Table 7** for evaporator probe temperature versus resistance values for units manufactured up to and including January 7, 2007. See **Table 8** for evaporator probe temperature versus resistance values for units manufactured on or after January 8, 2007.

Perform the tests in **Table 9** in the sequence presented. The directions under the column "What to Do if Test Fails" are sometimes dependent on good results from previous tests. If any of the tests fail, stop and perform the specified repair or check.

Evaporator Probe Temperature/Resistance (up to January 7, 2007)								
Temperature		Resistance: ohms	Temperature		Resistance: ohms	Temperature		Resistance: ohms
°F	°C		°F	°C		°F	°C	
5	–15	36,780	66	19	6500	84	29	4170
14	–10	27,830	68	20	6210	86	30	3995
23	–5	21,250	70	21	5935	88	31	3828
32	0	16,360	72	22	5673	90	32	3669
41	5	12,690	73	23	5426	91	33	3518
50	10	9927	75	24	5189	93	34	3373
59	15	7823	77	25	4964	95	35	3236
61	16	7466	79	26	4751	97	36	3104
63	17	7125	81	27	4548	99	37	2979
64	18	6805	82	28	4354	100	38	2860

Table 7, Evaporator Probe Temperature/Resistance (up to January 7, 2007)

Evaporator Probe Temperature/Resistance (from January 8, 2007)					
Temperature: °F (°C)	Resistance: ohms	Temperature: °F (°C)	Resistance: ohms	Temperature: °F (°C)	Resistance: ohms
-40 (-40)	92757	41 (5)	6998	122 (50)	993.2
-31 (-35)	66870	50 (10)	5485	131 (55)	823.2
-22 (-30)	48790	59 (59)	4330	140 (60)	685.8
-13 (-25)	35937	68 (20)	3443	149 (65)	574.2
-4 (-20)	26757	77 (25)	2757	158 70)	482.9
5 (-15)	20103	86 (30)	2221	167 (75)	408.3
14 (-10)	15252	95 (35)	1800	176 (80)	346.8
23 (-5)	11664	104 (40)	1468	185 (85)	295.6
32 (0)	9000	113 (45)	1204	—	—

Table 8, Evaporator Probe Temperature/Resistance (from January 8, 2007)

Evaporator Probe Circuit Tests				
Test	Conditions	Test Point	Good Result	What to Do if Test Fails
evaporator temperature probe	key off, engine off sensor probe removed and disconnected fill a cup with ice then add water to make an ice-water bath NOTE: use mostly ice and allow time for temperature to stabilize at 32°F (0°C) place the tip of the evaporator probe in the ice-water bath for 5 minutes before testing—leave the tip immersed while taking the resistance measurement—be sure the meter reading is stable before noting the final measurement	Measure across pins on the temperature probe.	for pre-1-8-07: 16,000 to 16,730Ω at 32°F (0°C) — for 1-8-07 on: 8910 to 9090Ω at 32°F (0°C)	Replace temperature probe.
evaporator temperature probe circuit test	battery switch on (if equipped) key on, engine off sensor probe installed, but connector is disconnected	Measure across temperature probe connector terminals.	5V	Check for an open in circuits 338K and 338GP. If wiring is okay, replace the control head.

Table 9, Evaporator Probe Circuit Tests

A/C Clutch Circuit Tests for Diagnosing No A/C Clutch Engagement

The A/C compressor clutch is controlled by the control head (climate control panel). When the control head determines that the A/C compressor is required, it grounds the A/C request input to the bulkhead module (BHM). When the BHM receives the A/C request signal from the climate control panel, it will apply power to the A/C clutch output when the following conditions are met:

- engine has been running more than 5 seconds
- battery voltage is greater than 9.25V
- low air pressure warning is not active on the ICU
- A/C clutch has not been engaged in the previous 15 seconds

NOTE: The **A/C clutch cycle timer strategy** is implemented differently, depending on BHM software versions. With BHM software version 6.1, the total A/C clutch cycle time (on + off time) is a minimum of 15 seconds. This ensures that the A/C compressor does not cycle more than 4 times per minute. With BHM software versions 6.4 and 6.5, the minimum compressor off time is 15 seconds. This means the total cycle time (on + off time) will always exceed 15 seconds. This too, ensures that the A/C compressor does not cycle more than 4 times per minute.

The BHM sends power to energize the A/C clutch. A binary switch is wired into this circuit, which will prevent the compressor clutch from engaging if the refrigerant pressure is too high or too low.

When **all** of the following conditions are met, the control head will send the A/C request signal to the bulkhead module:

- The air selection switch is in one of the A/C or defrost settings, or the recirculation mode is on.

- The fan switch is on any setting other than off.
- The evaporation sensor temperature is above 40.1°F (4.5°C).

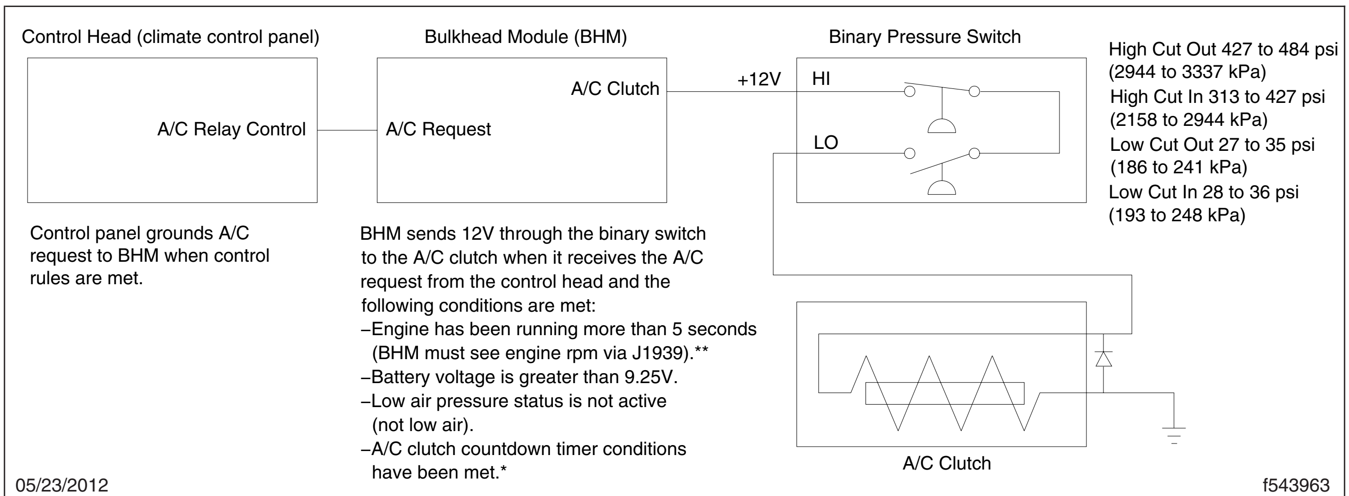
When these conditions exist, the control head sends the A/C request signal to the bulkhead module. See **Fig. 2**.

NOTE: The A/C signal will remain active until the evaporator sensor reaches 38.3°F (3.5°C), the fan is turned off, or the air selection switch is taken out of defrost or A/C mode.

See **Table 10** for the A/C clutch circuit tests. Perform the tests in **Table 10** in the sequence presented. The directions under the column "What to Do if Test Fails" are sometimes dependent on good results from previous tests. If any of the tests fail, stop and perform the specified repair or check.

NOTE: If these tests pass and the A/C clutch still will not engage, check the following:

- Make sure that the air system does not have an active low air pressure warning.
- Make sure that the battery voltage to all BHM inputs is above 9.25V.



*See **A/C clutch cycle timer strategy** note above.
**See text in this section explaining how to verify engine rpm message via J1939.
NOTE: Binary pressure switch positions indicate little or no system pressure.

Fig. 2, A/C Clutch Control Circuit

- Make sure that engine speed is available via J1939. The BHM must see engine rpm in order to engage the AC compressor. For pre-EPA 2010 vehicles, use the M2 J1939 Test Datalink Monitor the template to check for engine rpm from the engine via J1939. For EPA 2010 vehicles, make sure engine rpm registers on the tachometer.

NOTE: On pre-EPA 2010 vehicles, the engine rpm displayed on the tachometer comes from the engine via the J1587 datalink. This is why the M2 J1939 Test Datalink Monitor template must be used rather that relying on the tachometer on the ICU.

Backlighting Circuit Tests

See **Table 11** for the backlighting circuit tests. Perform the tests in **Table 11** in the sequence presented. The directions under the column "What to Do if Test Fails" are sometimes dependent on good results from previous tests. If any of the tests fail, stop and perform the specified repair or check. If all of the tests pass and the backlighting at the control head still does not operate properly, check the control head.

Fault Codes

If the A/C clutch is not working, use ServiceLink to check for fault codes. See **Table 12** and **Table 13** for a description of the fault codes.

A/C Clutch Circuit Tests for Diagnosing No A/C Clutch Engagement				
Test	**Conditions**	**Test Point/Method**	**Good Result**	**What to Do if Test Fails**
A/C request input	key on, engine on air selection switch in one of A/C settings fan (blower) speed on any setting but off connect ServiceLink and use the "A/C Clutch Function" Datalink Monitor template to see if the A/C request is seen by the BHM	ServiceLink/Datalink Monitor NOTE: Make sure the Datalink Monitor template is **not** in Test Mode. The control head should request A/C. This will cause the "A/C Request" annunciator on the template to indicate that the request is on. If the annunciator does not indicate that a request for A/C is received, check the settings on the control head before proceeding with "What to Do if Test Fails."	A/C request is received by the BHM	Perform the "Evaporator Probe Circuit Tests." Check wiring between the control head and the bulkhead module. Check for an open circuit. Check the control head. Check the bulkhead module. Try to manually ground the A/C request input while observing the template to confirm.
A/C clutch circuit*	key on, engine off connect ServiceLink and use the "A/C Clutch Function" Datalink Monitor template to manually actuate the A/C clutch output	ServiceLink/Datalink Monitor NOTE: Put the template in "Test Mode" and actuate the A/C clutch by selecting the button for "Clutch On." You should hear a distinct click when the clutch engages. The A/C clutch annunciator (BHM to clutch) should turn on when the output is energized. If this annunciator indicates that the output is on but the clutch does not engage, then the problem is in the A/C clutch circuit and not with the BHM. If the A/C clutch annunciator does not indicate that the output is energized when the output is turned on and the clutch does not engage, then the problem is with the BHM.	A/C clutch should engage	Check continuity across the binary switch. If the circuit is open, check if the refrigerant pressure is within operating range of the binary switch. (Refrigerant pressure may be very low or too high.) If pressures are okay, replace binary switch. Check for faulty wiring. Check for faulty A/C clutch ground circuit. Check for faulty A/C clutch coil (coil resistance should be 3Ω ±0.5Ω). Check for faulty BHM (see note in Test Point/Method column).

* Circuit faults with the A/C clutch output may generate bulkhead module fault codes.

Table 10, A/C Clutch Circuit Tests for Diagnosing No A/C Clutch Engagement

Backlighting Circuit Tests				
Test	**Conditions**	**Test Point**	**Good Result**	**What to Do if Test Fails**
backlighting circuit ground test	battery switch on (if equipped) key off, engine off control head connector disconnected	Measure between pin B8 of the control head connector and the positive battery post.	12V*	Check for an open in the control head ground circuit.

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Backlighting Circuit Tests				
Test	**Conditions**	**Test Point**	**Good Result**	**What to Do if Test Fails**
backlighting power test	battery switch on (if equipped) key off, engine off control head connector disconnected headlight switch on	Measure voltage between pins A2 (positive lead) and B8 (negative lead) on the control head connector while toggling the dimmer switch between full dim and full bright.	voltage should be about 1.2V at full dim and 10.8V at full bright	Check circuit 29A for an open/ short. If okay, refer to **Group 54** for further diagnosis.
backlighting pulse width modulated (PWM) signal test	battery switch on (if equipped) key off, engine off control head connector disconnected headlight switch on	Measure frequency between pins A2 and B8 on the control head connector.	400 Hz	Check circuit 29A for an open/ short. If okay, refer to **Group 54** for further diagnosis.

* The voltage should be approximately the same as the battery voltage.

Table 11, Backlighting Circuit Tests

J1587 Fault Codes, HVAC (bulkhead module related) MID 164				
MID	**SID**	**FMI**	**Fault Description**	**Action**
164	057	05	A/C clutch output open circuit (low current)	Check circuit 98A for an open circuit. Check binary switch; it may be open. If open, check for low or high refrigerant pressure. Also check the switch itself. Check A/C clutch coil for an open circuit.
		06	A/C clutch output shorted to ground (high current)	Check circuit 98A for a short to ground.

Table 12, J1587 Fault Codes, HVAC (bulkhead module related) MID 164

J1939 Fault Codes, HVAC (bulkhead module related) Source Address (SA) 33				
SA	**SPGN**	**FMI**	**Fault Description**	**Action**
33	1550	05	A/C clutch output open circuit (low current)	Check circuit 98A for an open circuit. Check binary switch; it may be open. If open, check for low or high refrigerant pressure. Also check the switch itself. Check A/C clutch coil for an open circuit.
		06	A/C clutch output shorted to ground (high current)	Check circuit 98A for a short to ground.

Table 13, J1939 Fault Codes, HVAC (bulkhead module related) Source Address (SA) 33

Refrigerant

WARNING

R–134a is the only refrigerant that is approved for use on Freightliner vehicles. Several companies offer less expensive, hydrocarbon-based refrigerant, such as propane and methane. Use of these refrigerants will void the warranty on the air conditioning system, cause damage to the air conditioning system, and possibly result in personal injury or property damage. Leaking air conditioning systems charged with hydrocarbon-based refrigerants pose a serious risk of fire or explosion under the hood, or inside the passenger compartment. No vehicle built by Freightliner Trucks can be safely charged with hydrocarbon-based refrigerants, regardless of what the refrigerant supplier states.

When servicing an air conditioning system, always use a refrigerant identifier to ensure that the system has not been charged with something other than R–134a. This should be standard practice since there is no way to tell what services have been previously performed. Identification by service technicians will help to avoid the risk of explosion and help to guard against contamination of equipment when refrigerant is recovered and recycled.

Refrigerant recovery/charge stations can be purchased from:

SPX Kent-Moore
28635 Mound Road
Warren, Michigan 48092-3499
1-800-328-6657

The vehicle's refrigerant charge level is printed on a sticker in the engine bay, on the right side of the vehicle. If the sticker is missing, check Group 83 in PartsPro (module/subgroup 700) for the proper sticker and charge information, using the vehicle's serial number.

Refrigerant Oil

IMPORTANT: Using the wrong refrigerant oil in the HVAC system will prevent proper lubrication, and may cause early failure of system components. Always verify that the correct oil is being used in the system. See **Table 1** for refrigerant oil specifications.

Refrigerant Oil Specification	
Refrigerant Oil	**Capacity**
Sanden PAG SP–20 or SP–15	10 fl oz (300 mL)

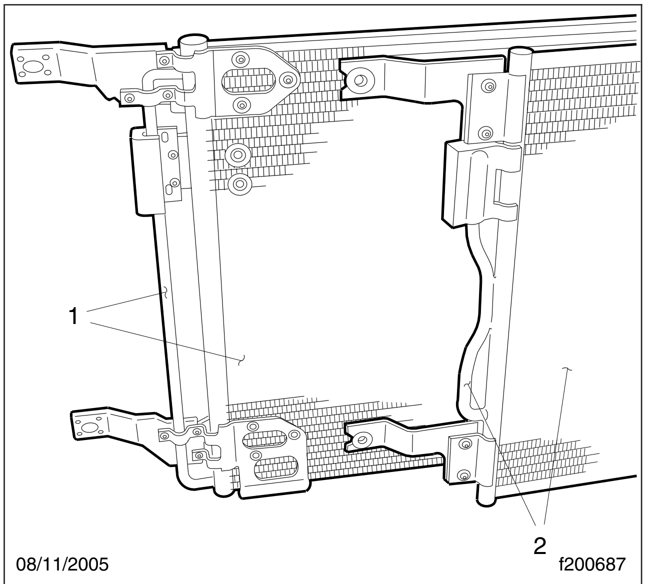
Table 1, Refrigerant Oil Specification

Temperature/Pressure Specification Tables (pre-EPA07 vehicles)

Determining Cooling Package Size

Before using the temperature/pressure specifications in **Table 2**, **Table 3**, **Table 4**, and **Table 5**, determine whether the vehicle has a small cooling package or a large cooling package, and what brand of condenser is installed. This can be done by looking at the condenser size and the condenser mounting location.

- See **Fig. 1** for an illustration that shows the difference between the Behr and Modine condensers.

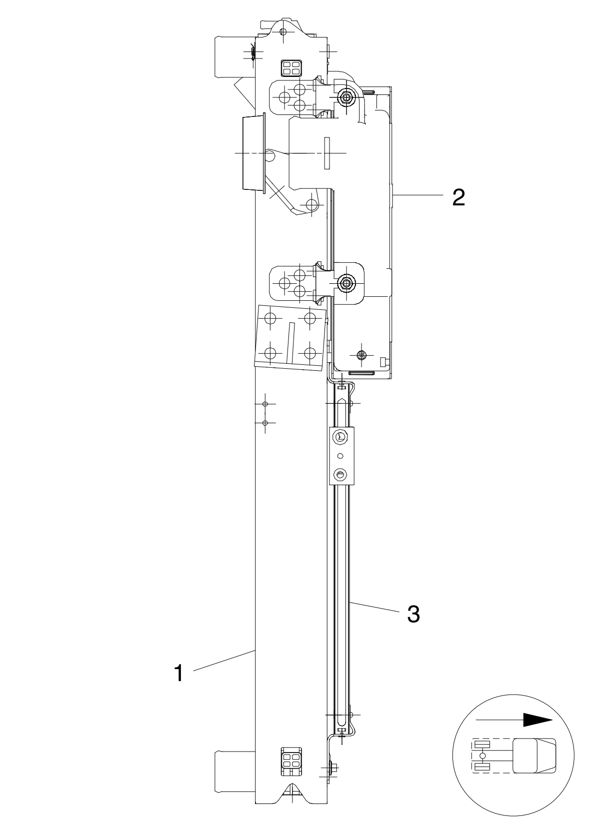


1. Behr Condenser
2. Modine Condenser

Fig. 1, Behr and Modine Condensers

Specifications

- Small Cooling Package: The condenser is mounted below the charge air cooler and does not cover the entire face of the radiator. See **Fig. 2**.



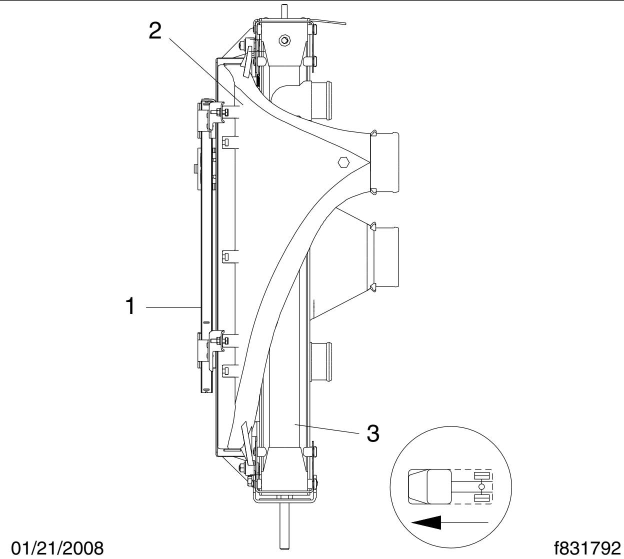
1. Radiator
2. Charge Air Cooler
3. Condenser

Fig. 2, Small Cooling Package

- Large Cooling Package: The condenser is mounted in front of the charge air cooler. See **Fig. 3**.

Determine Fins per Inch (fpi) of a Small Cooling Package Condenser

Early Business Class M2 vehicles with a small cooling package were equipped with a 14-fpi condenser. In October 2002, the 14-fpi condenser began being phased out and replaced with a 19-fpi condenser. The 14-fpi condenser may still be found on vehicles built through March 2003. For vehicles built from October 2002 through March 2003, it is necessary to determine whether the vehicle was built with a 14-fpi or 19-fpi condenser.



1. Condenser
2. Charge Air Cooler
3. Radiator

Fig. 3, Large Cooling Package

If the vehicle has a large cooling package, it is not necessary to determine the number of fins per inch on the condenser to determine which temperature/pressure specification table to use. All Business Class M2 vehicles with a large cooling package use a 14-fpi condenser.

Use the following steps to determine whether the condenser has 14 fpi or 19 fpi.

1. Locate a section on the condenser face that is free of bent fins, and place a white sheet of paper over that area.
2. Using a soft-lead pencil, rub the lead lightly on the paper to transfer the impression of the fins to the sheet of paper. Transfer the impression to obtain an area about 1 inch by 3 inches (25 mm by 76 mm) on the paper.

IMPORTANT: Be careful not to bend the fins while transferring the impression.

3. Place the sheet of paper on a clean, flat surface and place a ruler on the impression. Line the ruler up with one of the fin marks.
4. Count the number of fin marks from the zero-inch (zero-mm) mark to the two-inch (51-mm) mark on the ruler. Divide the number of fins counted by 2 to obtain the approximate number of fins per inch. For example, 29 fins divided by 2 equals 14.5 or approximately 14 fins per inch.

Temperature/Pressure Specifications for a Vehicle With a Small Cooling Package* and a 14-fpi Condenser†						
Ambient Air Temp.	Humidity (approximate)	Dash Outlet Temperature (approximate)	Service Port Pressures		A/C Compressor Status	A/C Compressor Status Comments
			High Side psi (kPa)	Low Side psi (kPa)		
70°F (21°C)	Low 25%	45–53°F (7–12°C)	77–142 (531–979)	8–31 (55–214)	Cycling	Off about 1 minute; On about 2 minutes
	High 55%	45–56°F (7–13°C)	82–181 (565–1248)	8–45 (55–310)	Cycling	Off about 1 minute; On about 4 minutes
80°F (27°C)	Low 25%	45–52°F (7–11°C)	103–176 (710–1213)	11–37 (76–255)	Cycling	Off about 1 minute; On about 5 minutes
	High 55%	50–59°F (10–15°C)	177–182 (1220–1255)	17–18 (117–124)	On	On steady
90°F (32°C)	Low 25%	51–53°F (11–12°C)	206–210 (1420–1448)	17–18 (117–124)	On	On steady
	High 55%	58–60°F (14–16°C)	225–231 (1551–1593)	23–24 (159–165)	On	On steady
100°F (38°C)	Low 25%	57–58°F (14°C)	256–258 (1765–1779)	22–23 (152–159)	On	On steady
	High 55%	67–69°F (19–21°C)	282–288 (1944–1986)	29–30 (200–207)	On	On steady

Test conditions:

- engine at 1500 rpm
- engine fan locked on (six-blade viscous with lock brackets)
- normal A/C mode, outside air
- blower speed on high, about 13.5 vdc
- cab doors open
- hood open
- parked out of direct sunlight
- no wind speed or less than 5 mph (8 km/h)
- stabilize at each point
- the condenser is mounted below the charge air cooler

* Refer to "Temperature/Pressure Specification Tables" to determine whether the vehicle has a small or large cooling package.

† Refer to "Temperature/Pressure Specification Tables" to determine the number of fins per inch on the condenser.

Table 2, Temperature/Pressure Specifications for a Vehicle With a Small Cooling Package and a 14-fpi Condenser

Specifications

Temperature/Pressure Specifications for a Vehicle With a Small Cooling Package* and a 19-fpi Condenser†						
Ambient Air Temp.	Humidity (approximate)	Dash Outlet Temperature (approximate)	Service Port Pressures		A/C Compressor Status	A/C Compressor Status Comments
			High Side psi (kPa)	Low Side psi (kPa)		
70°F (21°C)	Low 25%	43–52°F (6–11°C)	81–107 (558–738)	8–53 (55–365)	Cycling	On about 12 seconds; off about 12 seconds
	High 55%	48–55°F (9–13°C)	93–120 (641–827)	11–51 (76–352)	Cycling	On about 15 seconds; off about 8 seconds
80°F (27°C)	Low 25%	45–52°F (7–11°C)	108–144 (745–993)	9–44 (62–303)	Cycling	On about 20 seconds; off about 9 seconds
	High 55%	49–51°F (9–11°C)	140–149 (965–1027)	13–15 (90–103)	On	On steady
90°F (32°C)	Low 25%	49–50°F (9–10°C)	170–187 (1172–1289)	16–17 (110–117)	On	On steady
	High 55%	57–59°F (14–15°C)	185–191 (1276–1317)	23–24 (159–165)	On	On steady
100°F (38°C)	Low 25%	55–57°F (13–14°C)	210–220 (1448–1517)	22–23 (152–159)	On	On steady
	High 55%	66–68°F (19–20°C)	234–242 (1613–1669)	30–32 (207–221)	On	On steady

Test conditions:

- engine at 1500 rpm
- engine fan locked on (six-blade viscous with lock brackets)
- normal A/C mode, outside air
- blower speed on high
- cab doors open
- hood open
- parked out of direct sunlight
- no wind speed or less than 5 mph (8 km/h)
- stabilize at each point
- the condenser is mounted below the charge air cooler
- no wind speed or less than 5 mph (8 km/h)

* Refer to "Temperature/Pressure Specification Tables" to determine whether the vehicle has a small or large cooling package.

† Refer to "Temperature/Pressure Specification Tables" to determine the number of fins per inch on the condenser.

Table 3, Temperature/Pressure Specifications for a Vehicle With a Small Cooling Package and a 19-fpi Condenser

Temperature/Pressure Specifications for a Vehicle With a Large Cooling Package and a Behr Condenser but No Auxiliary HVAC Unit*						
Ambient Air Temp.	Humidity (approximate)	Dash Outlet Temperature (approximate)	Service Port Pressures		A/C Compressor Status	A/C Compressor Status Comments
			High Side psi (kPa)	Low Side psi (kPa)		
70°F (21°C)	Low 25%	44–53°F (7–12°C)	73–104 (503–717)	8–50 (55–345)	Cycling	On about 16 seconds; off about 32 seconds
	Medium 50%	44–52°F (7–11°C)	74–112 (510–772)	7–50 (48–345)	Cycling	On about 17 seconds; off about 19 seconds
	High 70%	46–54°F (8–12°C)	70–112 (483–772)	8–50 (55–345)	Cycling	On about 18 seconds; off about 17 seconds
80°F (27°C)	Low 25%	44–53°F (7–12°C)	87–127 (600–876)	8–47 (55–324)	Cycling	On about 24 seconds; off about 13 seconds
	Medium 50%	45–55°F (7–13°C)	90–135 (621–931)	10–49 (69–338)	Cycling	On about 40 seconds; off about 10 seconds
	High 70%	47–56°F (8–13°C)	128–134 (883–924)	14–20 (97–138)	On	On steady
90°F (32°C)	Low 25%	46–55°F (8–13°C)	110–162 (758–1117)	10–48 (69–331)	Cycling	On about 73 seconds; off about 9 seconds
	Medium 50%	48–52°F (9–11°C)	155–160 (1069–1103)	19–20 (131–138)	On	On steady
	High 70%	55–57°F (13–14°C)	167–170 (1151–1172)	22–23 (152–159)	On	On steady
100°F (38°C)	Low 25%	53–54°F (12°C)	192–196 (1324–1351)	22–23 (152–159)	On	On steady
	Medium 50%	60–62°F (16–17°C)	201–204 (1386–1407)	26–28 (179–193)	On	On steady
	High 70%	66–69°F (19–21°C)	211–214 (1455–1475)	29–30 (200–207)	On	On steady
Test conditions: engine at 1500 rpm; engine fan locked on; normal A/C mode, outside air; blower speed on high; cab doors open; hood open; parked out of direct sunlight						

* Refer to "Temperature/Pressure Specification Tables" to determine whether the vehicle has a small or large cooling package.

Table 4, Temperature/Pressure Specifications for a Vehicle With a Large Cooling Package and a Behr Condenser but No Auxiliary HVAC Unit

Specifications

Temperature/Pressure Specifications for a Vehicle With a Large Cooling Package, a Behr Condenser, and an Auxiliary HVAC Unit*							
Ambient Air Temp.	Humidity (approximate)	Dash Outlet Temperature (approximate)	Auxiliary Unit Lower Louver Temperature	Service Port Pressures		A/C Compressor Status	A/C Compressor Status Comments
				High Side psi (kPa)	Low Side psi (kPa)		
70°F (21°C)	Low 25%	43–50°F (6–10°C)	45–53°F (7–12°C)	73–114 (503–786)	14–40 (97–276)	Cycling	On about 26 seconds; off about 15 seconds
	Medium 50%	44–53°F (7–12°C)	47–54°F (8–12°C)	74–119 (510–820)	16–42 (110–290)	Cycling	On about 35 seconds; off about 13 seconds
	High 70%	45–54°F (7–12°C)	49–58°F (9–14°C)	73–120 (503–827)	16–45 (110–310)	Cycling	On about 48 seconds; off about 10 seconds
80°F (27°C)	Low 25%	46–54°F (8–12°C)	49–56°F (9–13°C)	88–143 (607–986)	18–44 (124–303)	Cycling	On about 48 seconds; off about 11 seconds
	Medium 50%	48–50°F (9–10°C)	54–56°F (12–13°C)	145–150 (1000–1034)	24–26 (165–179)	On	On steady
	High 70%	54–55°F (12–13°C)	59–61°F (15–16°C)	158–164 (1089–1131)	28–29 (193–200)	On	On steady
90°F (32°C)	Low 25%	50–51°F (10–11°C)	56–57°F (13–14°C)	177–182 (1220–1255)	25–26 (172–179)	On	On steady
	Medium 50%	58–60°F (14–16°C)	64–66°F (18–19°C)	194–199 (1338–1372)	32–34 (221–234)	On	On steady
	High 70%	62–63°F (17°C)	68–69°F (20–21°C)	195–207 (1344–1427)	35–37 (241–255)	On	On steady
100°F (38°C)	Low 25%	58–59°F (14–15°C)	64–66°F (18–19°C)	227–235 (1565–1620)	31–33 (214–228)	On	On steady
	Medium 50%	67–68°F (19–20°C)	71–72°F (22°C)	242–247 (1669–1703)	40–41 (276–283)	On	On steady
	High 70%	74–75°F (23–24°C)	79–81°F (26–27°C)	261–265 (1800–1827)	49–50 (338–352)	On	On steady

Test conditions:

- engine at 1500 rpm
- engine fan locked on
- normal A/C mode, outside air
- blower speed on high
- cab doors open
- hood open
- parked out of direct sunlight

* Refer to "Temperature/Pressure Specification Tables" to determine whether the vehicle has a small or large cooling package.

Table 5, Temperature/Pressure Specifications for a Vehicle With a Large Cooling Package, a Behr Condenser, and an Auxiliary HVAC Unit

Temperature/Pressure Specification Tables (EPA07 compliant vehicles)

Before using the temperature/pressure specifications in **Table 7**, **Table 8**, **Table 9**, and **Table 10**, determine what condenser is installed on the vehicle. To do so, identify the vehicle rating, or measure the condenser. See **Table 6** for condenser identification.

Condenser Identification: EPA07 Compliant Vehicles			
Vehicle Rating	**Condenser**	**Width: in. (cm)**	**Height: in. (cm)**
M2 106 (MD)	Valeo MD-1	27 (69)	20 (52)
M2 112 (HD)	Valeo HD-1	33 (84)	19 (48)

Table 6, Condenser Identification: EPA07 Compliant Vehicles

Day Cab with Valeo MD–1 Condenser						
Ambient Air Temp.	**Humidity (approximate)**	**Dash Outlet Temperature (approximate)**	**Service Port Pressures**		**A/C Compressor Status**	**A/C Compressor Status Comments**
			High: psi (kPa)	**Low: psi (kPa)**		
70°F (21°C)	Low 25%	51–59°F (11–15°C)	70–130 (483–896)	10–60 (69–414)	Cycling	On 6 sec; Off 9 sec
	Med 50%	53–59°F (12–15°C)	74–130 (510–896)	10–52 (69–359)	Cycling	On 6 sec; Off 10 sec
	High 70%	55–62°F (13–17°C)	75–130 (517–896)	11–58 (76–400)	Cycling	On 7 sec; Off 8 sec
80°F (27°C)	Low 25%	53–60°F (12–16°C)	92–130 (634–896)	12–56 (83–386)	Cycling	On 7 sec; Off 8 sec
	Med 50%	55–61°F (13–16°C)	90–150 (621–1034)	13–60 (90–414)	Cycling	On 11 sec; Off 7 sec
	High 70%	52°F (11°C)	143 (986)	18 (124)	On	On steady
90°F (32°C)	Low 25%	52–58°F (11–14°C)	120–160 (827–1103)	15–50 (103–345)	Cycling	On 11 sec; Off 5 sec
	Med 50%	55°F (13°C)	169 (1165)	21 (145)	On	On steady
	High 70%	61°F (16°C)	177 (1220)	25 (172)	On	On steady
100°F (38°C)	Very Low 10%	51–56°F (11–13°C)	140–185 (965–1276)	16–55 (110–379)	Cycling	On 19 sec; Off 5 sec
	Low 25%	54°F (12°C)	187 (1289)	21 (145)	On	On steady
	Medium 40%	60°F (16°C)	196 (1351)	26 (179)	On	On steady

Test conditions:

- engine at 1500 rpm
- engine fan locked on
- normal A/C mode, outside air
- blower speed on high, about 13.5 vdc
- cab doors open
- hood open
- parked out of direct sunlight
- no wind speed or less than 5 mph (8 km/h)
- stabilize at each point

Table 7, Day Cab with Valeo MD–1 Condenser

Specifications

Crew Cab with Valeo MD-1 Condenser, Behr Aux HVAC							
Ambient Air Temp: °F (°C)	**Humidity (approximate)**	**Dash Outlet Temperature (approximate)**	**Auxiliary Unit Lower Louver Temperature**	**Service Port Pressures**		**A/C Compressor Status**	**A/C Compressor Status Comments**
				High: psi (kPa)	**Low: psi (kPa)**		
70 °F (21 °C)	Low 25%	50–56°F (10–13°C)	56–60°F (13–16°C)	90–110 (621–758)	20–53 (138–365)	Cycling	On 6 sec; Off 9 sec
	Med 50%	54–60°F (12–16°C)	57–60°F (14–16°C)	95–115 (655–793)	23–53 (159–365)	Cycling	On 9 sec; Off 8 sec
	High 70%	56–63°F (13–17°C)	57–62°F (14–17°C)	95–120 (655–827)	24–50 (165–345)	Cycling	On 14 sec; Off 5 sec
80 °F (27 °C)	Low 25%	55–60°F (13–16°C)	57–61°F (14–16°C)	120–135 (827–931)	22–52 (152–359)	Cycling	On 10 sec; Off 7 sec
	Med 50%	51°F (11°C)	58°F (14°C)	140 (965)	26 (179)	On	On steady
	High 65%	52°F (11°C)	60°F (16°C)	145 (1000)	28 (193)	On	On steady
90 °F (32 °C)	Low 25%	51°F (11°C)	58°F (14°C)	170 (1172)	26 (179)	On	On steady
	Med 40%	58°F (14°C)	65°F (18°C)	175 (1207)	32 (221)	On	On steady
100 °F (38 °C)	Very Low 10%	54°F (12°C)	62°F (17°C)	190 (1310)	28 (193)	On	On steady
	Low 25%	58°F (14°C)	66°F (19°C)	195 (1344)	32 (221)	On	On steady
	Med 35%	62°F (17°C)	69°F (21°C)	200 (1379)	36 (248)	On	On steady

Test conditions:

- engine at 1500 rpm
- engine fan locked on
- normal A/C mode, outside air
- blower speed on high, about 13.5 vdc
- cab doors open
- hood open
- parked out of direct sunlight
- no wind speed or less than 5 mph (8 km/h)
- stabilize at each point

Table 8, Crew Cab with Valeo MD-1 Condenser, Behr Aux HVAC

Day Cab with Valeo HD-1 Condenser						
Ambient Air Temp: °F (°C)	Humidity (approximate)	Dash Outlet Temperature (approximate)	Service Port Pressures		A/C Compressor Status	A/C Compressor Status Comments
			High: psi (kPa)	Low: psi (kPa)		
70 (21)	Low 25%	50–56°F (10–13°C)	80–100 (552–689)	12–53 (83–365)	Cycling	On 4 sec; Off 11 sec
	Med 50%	52–56°F (11–13°C)	80–95 (552–655)	13–52 (90–359)	Cycling	On 5 sec; Off 10 sec
	High 70%	53–58°F (12–14°C)	85–105 (586–724)	14–55 (97–379)	Cycling	On 6 sec; Off 6 sec
80 (27)	Low 25%	52–58°F (11–14°C)	120–125 (827–862)	16–58 (110–400)	Cycling	On 6 sec; Off 9 sec
	Med 50%	54–60°F (12–16°C)	120–125 (827–862)	18–60 (124–414)	Cycling	On 12 sec; Off 8 sec
	High 70%	53–61°F (12–16°C)	120–135 (827–931)	19–59 (131–407)	Cycling	On 26 sec; Off 4 sec
90 (32)	Low 25%	51–57°F (12–14°C)	125–150 (862–1034)	18–59 (124–407)	Cycling	On 7 sec; Off 5 sec
	Med 50%	51°F (12°C)	155 (1069)	21 (145)	On	On steady
100 (38)	Very Low 10%	52–63°F (11–17°C)	140–170 (965–1172)	18–60 (124–414)	Cycling	On 19 sec; Off 4 sec, then On 6 sec; Off 9 sec
	Low 25%	50°F (10°C)	175 (1207)	20 (138)	On	On steady
	Med 40%	54°F (12°C)	180 (1241)	23 (159)	On	On steady
Test conditions: • engine at 1500 rpm • engine fan locked on • normal A/C mode, outside air • blower speed on high, about 13.5 vdc • cab doors open • hood open • parked out of direct sunlight • no wind speed or less than 5 mph (8 km/h) • stabilize at each point						

Table 9, Day Cab with Valeo HD-1 Condenser

Specifications

Crew Cab with Valeo HD-1 Condenser and Behr Aux HVAC							
Ambient Air Temp: °F (°C)	Humidity (approximate)	Dash Outlet Temperature (approximate)	Auxiliary Unit Lower Louver Temperature	Service Port Pressures		A/C Compressor Status	A/C Compressor Status Comments
				High: psi (kPa)	Low: psi (kPa)		
70 (21)	Low 25%	52–56°F (11–13°C)	52–55°F (11–13°C)	85–105 (586–724)	19–48 (131–331)	Cycling	On 6 sec; Off 9 sec
	Med 50%	53–58°F (12–14°C)	53–55°F (12–14°C)	90–110 (621–758)	22–50 (152–345)	Cycling	On 7 sec; Off 9 sec
	High 70%	54–60°F (12–16°C)	56–61°F (13–16°C)	95–115 (655–793)	23–53 (159–365)	Cycling	On 7 sec; Off 7 sec
80 (27)	Low 25%	54–59°F (12–15°C)	56–58°F (13–14°C)	120–140 (827–965)	23–52 (159–359)	Cycling	On 6 sec; Off 11 sec
	Med 50%	53–58°F (12–14°C)	56–59°F (13–15°C)	120–140 (827–965)	26–40 (179–276)	Cycling	On 24 sec; Off 5 sec
	High 70%	55°F (13°C)	62°F (17°C)	145 (1000)	30 (207)	On	On steady
90 (32)	Low 25%	51–58°F (11–14°C)	57–60°F (14–16°C)	135–160 (931–1103)	25–48 (172–331)	Cycling	On 36 sec; Off 5 sec
	Med 50%	60°F (16°C)	67°F (19°C)	175 (1207)	35 (241)	On	On steady
100 (38)	Very Low 10%	52°F (11°C)	61°F (16°C)	185 ()1276	27 (186)	On	On steady
	Low 25%	56°F (13°C)	64°F (18°C)	190 (1310)	31 (214)	On	On steady
	Med 40%	62°F (17°C)	69°F (21°C)	195 (1344)	36 (248)	On	On steady

Test conditions:

- engine at 1500 rpm
- engine fan locked on
- normal A/C mode, outside air
- blower speed on high, about 13.5 vdc
- cab doors open
- hood open
- parked out of direct sunlight
- no wind speed or less than 5 mph (8 km/h)
- stabilize at each point

Table 10, Crew Cab with Valeo HD-1 Condenser and Behr Aux HVAC

Torque Specifications

Table 11 shows torque specifications for Stat-O-Seal Assembly Bolts.

Stat-O-Seal Assembly Bolt Torque Specs	
HVAC Component	Torque: lbf·ft (N·m)
Refrigerant Compressor	11–15 (15–20)
Condenser	11–15 (15–20)
Receiver-Drier	11–15 (15–20)
Expansion Valve (to lines to receiver-drier)	11–15 (15–20)
Expansion Valve (small screws to evaporator lines)	35 lbf·in (395 N·cm)
Evaporator	11–15 (15–20)
Junction Block	11–15 (15–20)

Table 11, Stat-O-Seal Assembly Bolt Torque Specs

Acceptable Leak Rates

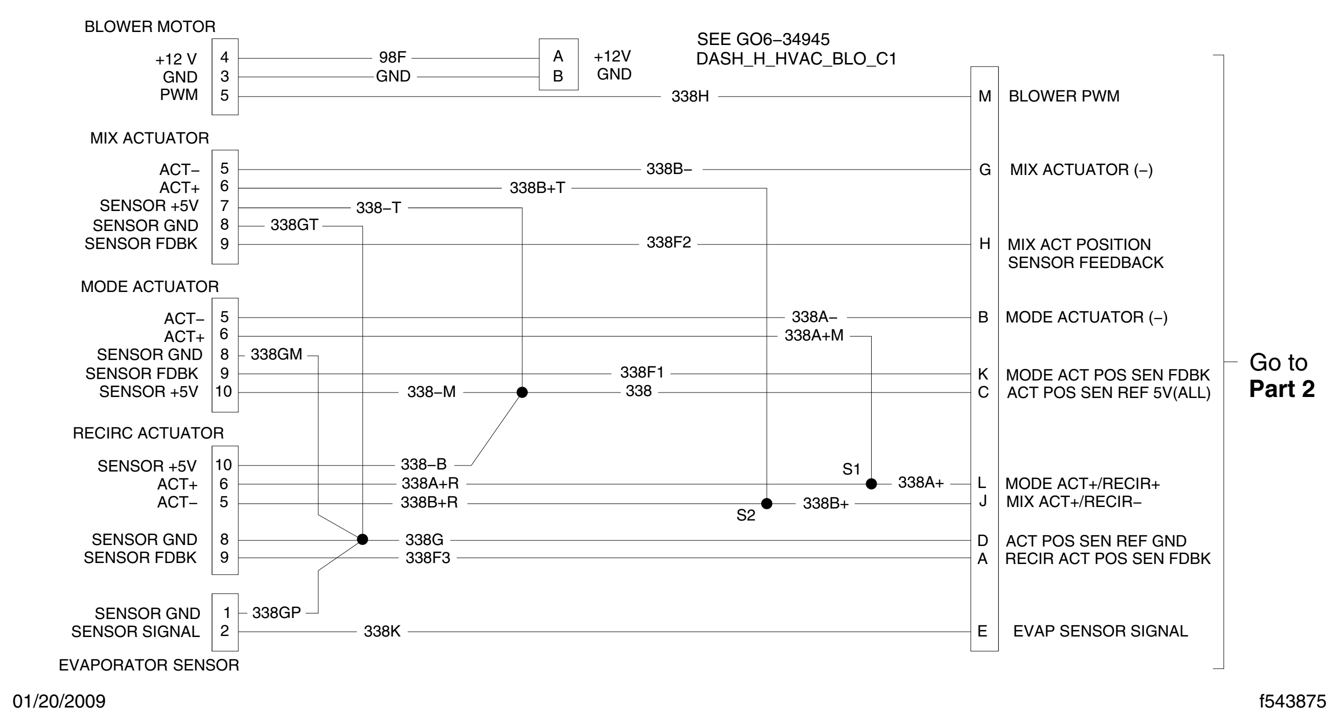
Acceptable Leak Rates by Component	
Component	**Acceptable Leak Rates**
J-Block Body	0.25 oz/yr and greater condemns these components
Evaporators (main and auxiliary)	
Condenser	
Receiver Dryer (Body)	
Lines/Hoses	
Capped Charge Ports	
Mini-Stato seal (1 - when the leak can be tied to a single seal)	
Mini-Stato seals (2 - when the leak cannot be tied to a single seal)	0.50 oz/yr and greater condemns these components
Compressor (shaft seal, housing, etc.)	
TXV (Power Valve and Super Heat Cap)	
Sensor/Switches (O-ring and crimped body connections)	

Table 12, Acceptable Leak Rates by Component

Wiring Diagrams

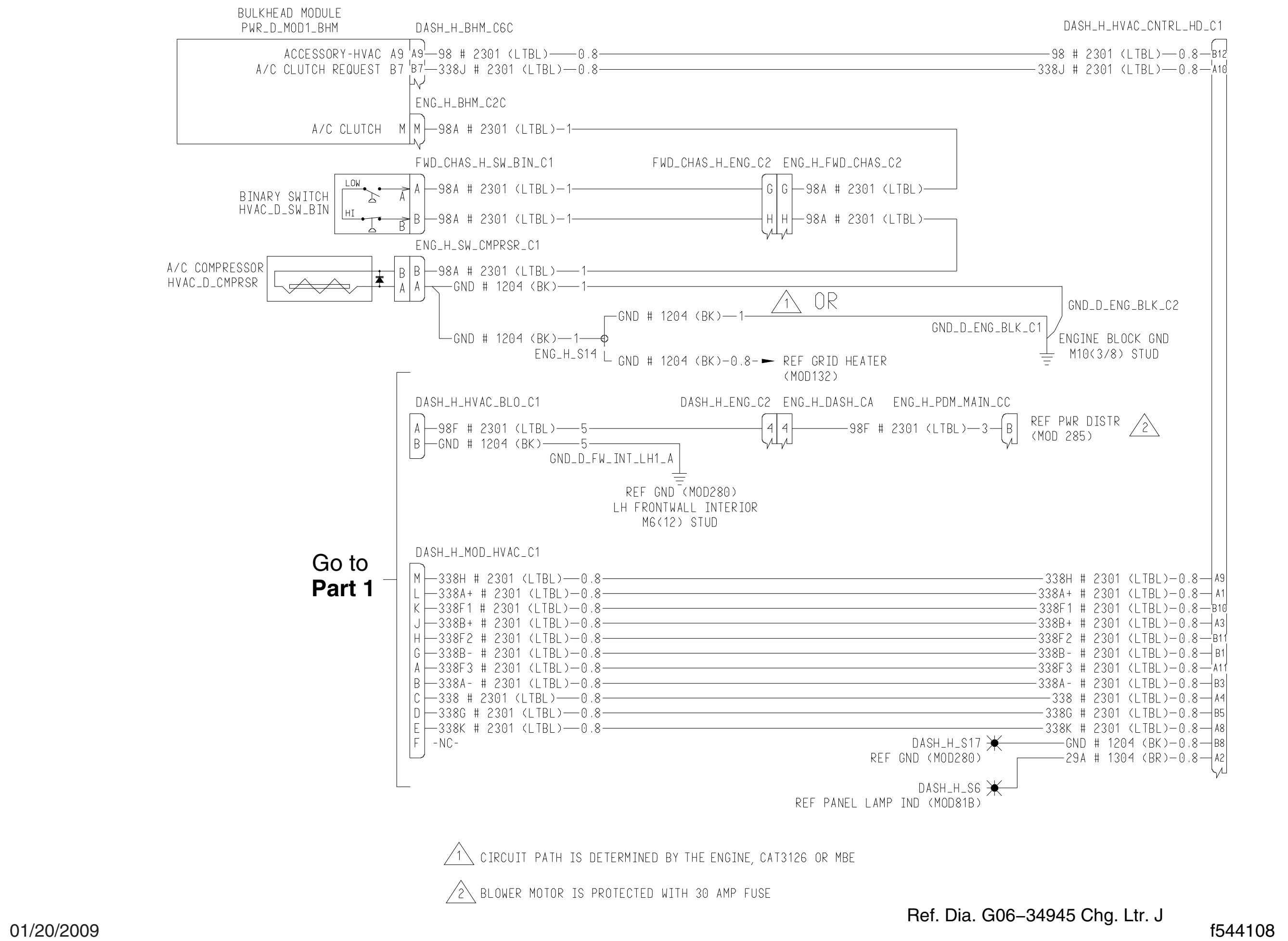
See **Fig. 4** and **Fig. 5** for the HVAC wiring diagram.

Specifications



Go to **Part 2** in **Fig. 5**.

Fig. 4, HVAC Wiring Diagram, Part 1



Go to **Part 1** in **Fig. 4**.

Fig. 5, HVAC Wiring Diagram, Part 2

Contents

General Information

The primary purpose of the refrigerant compressor is to draw refrigerant gas from the evaporator and compress it into high-pressure gas. High pressure raises the condensation point of refrigerant gas, which allows the condenser to change it to a liquid so that it can be used for cooling again. The secondary purpose of the compressor is to move refrigerant through the air conditioning system.

See **Fig. 1** for an illustration of the Sanden refrigerant compressor mounted on a Caterpillar 3126 engine.

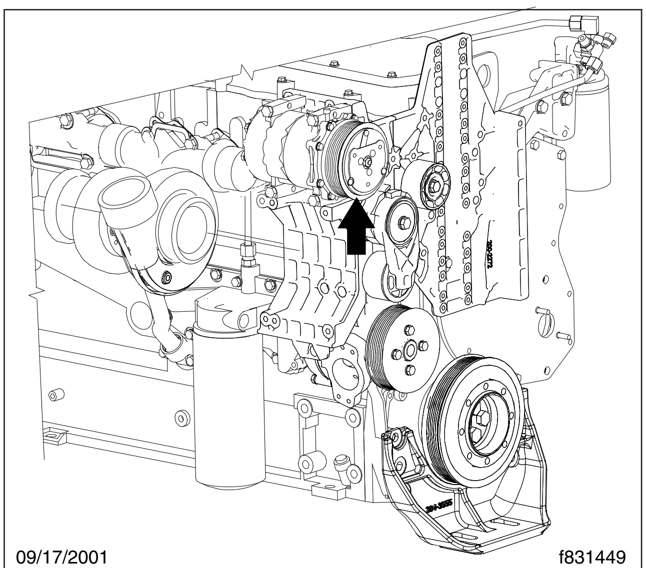


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Fig. 1, Refrigerant Compressor on a Caterpillar 3126 Engine

Safety Precautions

Whenever repairs are made to any air conditioner parts that hold R–134a refrigerant, you must recover, purge or flush (if contaminated), evacuate, charge, and leak test the system. In a good system refrigerant lines are always under pressure and you should disconnect them only after the refrigerant charge has been recovered (discharged) at the service valves.

Refrigerant R–134a is safe when used under the right conditions. Always wear safety goggles and non-leather gloves while recovering, evacuating, charging, and leak testing the system. Do not wear leather gloves. When refrigerant gas or liquid contacts leather, the leather will stick to your skin.

WARNING

Use care to prevent refrigerant from touching your skin or eyes because liquid refrigerant, when exposed to the air, quickly evaporates and will freeze skin or eye tissue. Serious injury or blindness could result if you come into contact with liquid refrigerant.

Refrigerant splashed in the eyes should be rinsed with lukewarm water, not hot or cold. Do not rub the eyes. Apply a light bandage and contact a physician right away.

Refrigerant splashed on the skin should be rinsed with lukewarm water, not hot or cold. Do not rub the skin. Apply a light coat of a nonmedicated ointment, such as petroleum jelly. Contact a physician right away.

R–134a refrigerant does not burn at ambient temperatures and atmospheric pressure. However, it can be combustible at pressures as low as 5.5 psig (38 kPa absolute) at 350°F (177°C) when mixed with air concentrations that are greater than 60 percent.

WARNING

R–134a air conditioning systems should not be pressure tested or leak tested with compressed air. Combustible mixtures of air and R–134a may form, resulting in a fire or explosion that could cause personal injury or property damage.

Always work in an area where there is a constant flow of fresh air when the system is recovered, evacuated, charged, and leak tested. R–134a vapors have a slightly sweet odor that is difficult to detect. Frequent leak checks and air monitoring equipment are recommended to ensure a safe working environment.

IMPORTANT: When servicing an R–134a air conditioning system, use only service equipment certified to meet the requirements of SAE J2210 (R–134a recycling equipment). The equipment should be operated only by qualified personnel who are familiar with the recycling station manufacturer's instructions.

Because of its very low boiling point, refrigerant must be stored under pressure. To prevent the refrigerant containers from exploding, never expose them to temperatures higher than 125°F (52°C).

On R–134a refrigerant systems, polyalkylene glycol (PAG) oil is used in the compressor. When handling PAG oil, observe the following:

- keep the oil free of contaminants
- do not expose the air conditioning system or the PAG oil container to air for long periods of time; PAG oil has a high moisture absorption capacity and the oil container should be immediately sealed after each use
- use care when handling; spilled oil could damage painted surfaces, plastic parts, and drive belts
- never mix PAG oil with other types of refrigerant oil

Preservice Checks

WARNING

Before doing any work, read the information in Safety Precautions 100. Failure to read the safety precautions and to be aware of the dangers involved when working with refrigerant could lead to serious personal injury.

Compressor problems usually show in one of four ways:

- abnormal noise
- seizure
- leakage
- low suction and discharge pressures

Resonant compressor noises are not causes for alarm. Irregular noise or rattles are likely to be caused by broken parts. To check for seizure, de-energize the magnetic clutch with the engine shut off and see if the drive plate can be turned. If it can't be turned, the compressor has seized.

Do the following checks whenever the air conditioner system is not cooling enough and the causes are unknown.

1. Be sure to check the moisture indicator to see if moisture is the cause of the problems. The air conditioner should be on when checking the indicator. It is better to check it at the end of the day.
2. Check the drive belt and mounting:
   2.1 On the drive belt look for wear, damage, or oil. If worn, oil-soaked, or damaged, remove it and install a new one. See Group 01 of this manual for instructions.
   2.2 Check the compressor mounting parts for loose fasteners, cracks, or other damage. Tighten loose fasteners to the correct torque specification. Repair or replace cracked or damaged brackets.
3. Check the wiring and connections to the compressor clutch. Replace damaged wiring and tighten loose connections.
4. Check for road debris buildup on the condenser coil fins. Using air pressure and a whisk broom or a solution of soap and water, carefully clean the condenser. Be careful not to bend the fins.
5. Check the refrigerant charge in the air conditioner system. For instructions, see Section 83.00, Subject 220 of this manual.

NOTE: For other possible causes of air conditioner problems, see Group 83 of this manual.

Refrigerant Compressor Removal and Installation

Removal

WARNING

Before doing any work, read the information in Safety Precautions 100. Failure to read the safety precautions and to be aware of the dangers involved when working with refrigerant could lead to serious personal injury.

1. Turn off the engine, apply the brakes, and chock the tires.
2. Recover the refrigerant from the air conditioning system. For instructions, see **Section 83.00**, Subject 220.
3. Remove the serpentine belt. Do not pry or roll the belt off the pulleys.
4. Disconnect the wiring harness from the compressor.
5. Disconnect the discharge and suction lines from the compressor. Quickly cap the discharge and suctions ports and the refrigerant lines.

IMPORTANT: Under no circumstances should the ports on the compressor or the refrigerant lines remain uncapped for longer than five minutes. Water and dirt can damage the refrigerant system. Do not blow shop air through refrigerant lines since shop air is wet (humid).

6. Being careful not to spill any refrigerant oil, remove the capscrews and washers that attach the refrigerant compressor to the engine and remove the compressor.

Installation

IMPORTANT: A new compressor is filled with refrigerant oil and nitrogen gas. The quantity is printed on a label attached to the compressor. When installing a new compressor on the vehicle, do all of the steps below. If installing a used compressor, disregard the first step.

1. Prepare a new compressor.
   1.1 Gently release the nitrogen gas from the discharge side of the compressor. Be careful not to let the oil flow out.
   1.2 Turn the compressor shaft several times by hand to distribute oil which has settled in the cylinder.
2. If installing a new compressor, adjust the refrigerant oil level in the new compressor. For instructions see, **Subject 130**.
3. Using capscrews and washers, install the compressor on the mounting bracket. Torque the capscrews 15 to 19 lbf·ft (20 to 26 N·m).
4. Uncap the discharge and suction ports and the refrigerant lines. Check the refrigerant lines and the discharge and suction ports. They must be clean and free of nicks, gasket residue, and other foreign material.
5. Using only Mini Stat-O-Seals, replace the Mini Stat-O-Seals on the refrigerant lines. Do not lubricate the Mini Stat-O-Seals prior to installation.
6. Connect the refrigerant lines to the compressor. Torque the retaining plate 11 to 15 lbf·ft (15 to 20 N·m).
7. Connect the wiring harness to the compressor.
8. Install the serpentine belt.
9. If installing a new compressor or if the system was without any refrigerant pressure before repairs were started, replace the receiver-drier. For instructions, see **Section 83.00**, Subject 180.

   If the compressor is not being replaced, check the moisture indicator on the receiver-drier. If it is not cobalt blue, replace the receiver-drier. For instructions, see **Section 83.00**, Subject 180.
10. Evacuate, charge, and leak test the refrigerant system. For instructions, see **Section 83.00**, Subject 220.
11. Lower the hood.
12. Remove the chocks from the tires.

WARNING

Before doing any work, read the information in Safety Precautions 100. Failure to read the safety precautions and to be aware of the dangers involved when working with refrigerant could lead to serious personal injury.

General Information

Compressors are charged with 10 fl oz (296 mL) of refrigerant oil. When the air conditioning system is operating, some refrigerant oil leaves the compressor and is circulated through the system with the refrigerant, but the refrigerant oil cannot leave the system except when there is a leak, when the refrigerant is recovered, or when a system part is replaced.

It is important that the air conditioning system has the correct amount of refrigerant oil for proper operation. Too little oil will result in compressor failure. Too much oil will degrade the performance of the air conditioner and may cause damage to the compressor.

IMPORTANT: Whenever the air conditioning system is discharged or recovered, the recovered oil, from the charging machine, must be measured in order to know how much oil must be returned to the system. When a system component is replaced, a quantity of new oil equal to the recovered oil plus the oil coating the inside of the component must be returned to the system. New oil must be from a container that has not been opened or that has been tightly sealed since its last use.

Order Sanden PAG oil SKI 7803 1997 (type SP–20) for an 8.45-ounce (250-mL) can of refrigerant oil from your local Daimler parts distribution center. Tubing, funnels, or other equipment used to transfer the oil should be very clean and dry.

When handling refrigerant oil:

- Be sure that the oil is free of water, dust, metal powder, and other foreign substances;
- Do not mix the refrigerant oil with other types or viscosities of oil;
- Quickly seal the oil container after use. Refrigerant oil absorbs moisture when exposed to the air for any period of time.

Checking and Adding Refrigerant Oil

WARNING

Do not remove the oil fill plug on the refrigerant compressor without first recovering the system. Failure to recover the system could cause uncontrolled release of high-pressure refrigerant, which can freeze skin and eye tissue causing serious injury or blindness.

1. Before beginning the refrigerant recovery process, make sure that the oil accumulator and oil drain bottle on the recovery/recycle machine are emptied of oil from previous repairs.
2. Recover all of the refrigerant from the system. See **Section 83.00, Subject 220** for instructions.
3. Drain the recovered oil into the calibrated drain bottle of the recovery/recycle machine. Record the amount of oil recovered.
4. Inspect the refrigerant oil. If the oil has any of the following characteristics, flush and charge the system with 10 fl oz (296 mL) of oil.
    - silver or black oil—indicates metal in the air conditioning system due to compressor wear
    - milky oil—may indicate moisture in the system
    - grit or debris in the oil
5. Properly dispose of the recovered oil.
6. After repairs are finished, refer to **Table 1** and use the following equation to determine the quantity of refrigerant oil that needs to be added to the system.

    [Quantity Recovered] + [Quantity for All Replaced Components] = [Quantity to add to the System]

    Table 1 provides the quantities of oil that need to be added to the system for each component that was replaced. Add the quantities listed in the table for each component that was replaced. Use the sum of the quantities or 6 fl oz (177 mL), whichever is less.

Oil Check and Adding Oil to the Compressor

Refrigerant Oil Quantities for Replaced Components	
Add the quantities listed in this table for each component that was replaced. Use the sum of the quantities or 6 fl oz (177 mL), whichever is less.	
Component	**Quantity: oz (mL)**
High Pressure Line (main A/C)	1 (30)
Low Pressure Line (main A/C)	2 (59)
High Pressure Line (auxiliary A/C)	1 (30)
Low Pressure Line (auxiliary A/C)	3 (89)
Condenser	1 (30)
Evaporator (main A/C)	3 (89)
Evaporator (auxiliary A/C)	2 (59)
Receiver-Drier	3 (89)
Minor Leak at Connector Only	0.5 (15)
Major Leak at Connector Only	2 (59)

Table 1, Refrigerant Oil Quantities for Replaced Components

7. Remove the oil fill plug on the refrigerant compressor and add the refrigerant oil. Never add more than 8 fl oz (237 mL) to the system unless the system has been flushed.
8. Evacuate, charge, and leak test the refrigerant system. See **Section 83.00, Subject 220** for instructions.

Adjusting the Refrigerant Oil Level in a New Compressor

Sanden refrigerant compressors are charged with 10 fl oz (296 mL) of refrigerant oil. If the air conditioning system has been flushed, the compressor will need a 10-ounce charge. If the system has not been flushed, use the following procedure to adjust the oil level in the compressor.

Use the "Worksheet for Adjusting the Refrigerant Oil Level in a New Compressor" shown in **Fig. 1** to adjust the refrigerant oil level in a new compressor.

Oil Check and Adding Oil to the Compressor

Worksheet for Adjusting the Refrigerant Oil Level in a New Compressor

1. Drain the oil from the old compressor.
   1.1 Remove the oil plug and drain as much oil as possible into a clean, calibrated container.
   1.2 If there are caps on the suction and discharge ports, remove them.
   1.3 Drain the oil from the suction and discharge ports into the container while turning the shaft clockwise using a socket wrench on the armature retaining nut.
   1.4 Enter the amount of oil that was drained from the compressor. 1. ☐
2. See Table 1 of this subject to determine the total amount of refrigerant oil that is needed for each component that was replaced. Enter the amount, up to 6 fl oz (177 mL), here. 2. ☐
3. Add the amounts from steps 1 and 2 and enter the total. 3. ☐
4. Subtract the total in step 3 from 10 and enter that number. For example, if the total in line 3 was six, the calculation would be 10 – 6 = 4. 4. ☐
5. Refer to the table below for the amount of oil that must be drained from the new compressor.

If the number in step 4 is:	Drain this amount from the new compressor:
a negative number(–)	2 fl oz (59 mL)
0	2 fl oz (59 mL)
1	2 fl oz (59 mL)
2	2 fl oz (59 mL)
3	3 fl oz (89 mL)
4	4 fl oz (118 mL)
5	4 fl oz (118 mL)
6	4 fl oz (118 mL)
7	4 fl oz (118 mL)
8	4 fl oz (118 mL)
9	4 fl oz (118 mL)
10	4 fl oz (118 mL)

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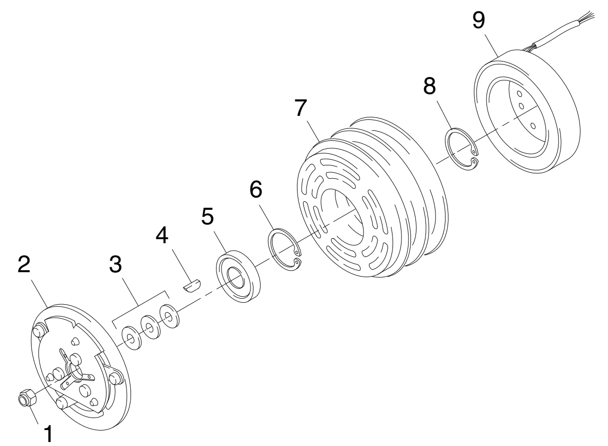
Fig. 1, Worksheet for Adjusting the Refrigerant Oil Level in a New Compressor

Clutch Assembly Removal, Inspection, and Installation

Removal

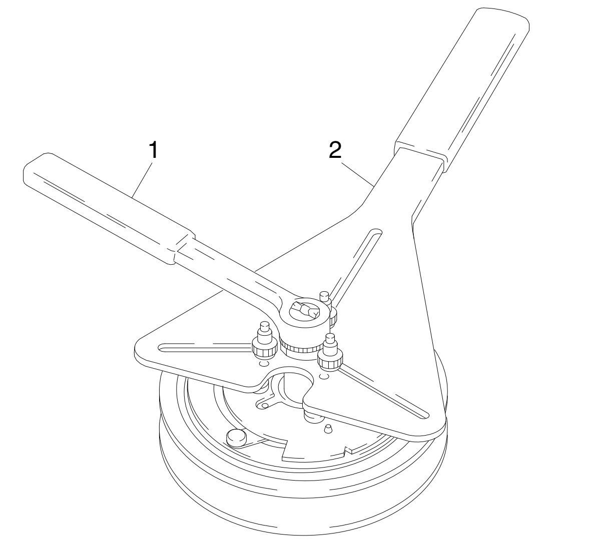
See **Fig. 1** for an illustration of the clutch assembly components.



1. Shaft Nut
2. Drive Plate
3. Clutch Shims
4. Shaft Key
5. Rotor Bearing Dust Cover
6. Rotor Snap Ring
7. Rotor Assembly
8. Field Coil Assembly Snap Ring
9. Field Coil Assembly

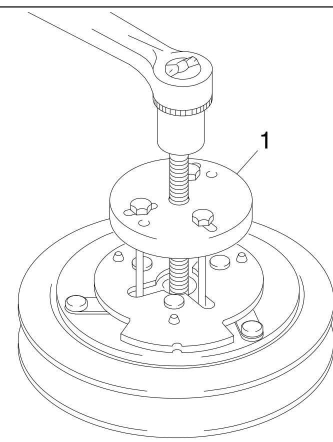
Fig. 1, Clutch Assembly

1. Remove the compressor from the vehicle. For instructions, see **Subject 120**.
2. Insert the pins of the drive plate spanner into the threaded holes of the drive plate assembly. Hold the drive plate assembly securely while removing the retaining nut. See **Fig. 2**.
3. Using the drive plate puller, install the three puller bolts into the drive plate assembly. Turn the center screw clockwise to loosen and remove the drive plate. See **Fig. 3**.
4. If equipped with a rotor bearing dust cover, remove it. Be careful not to distort the cover when removing it.
5. Use a slotted screwdriver and hammer to remove the shaft key. See **Fig. 4**.



1. Socket Wrench
2. Drive Plate Spanner

Fig. 2, Remove the Retaining Nut



1. Drive Plate Puller

Fig. 3, Remove the Drive Plate

6. Remove the clutch shims. Use a pointed tool and a small screwdriver to prevent the shims from binding on the shaft.
7. Using snap ring pliers, remove the rotor assembly snap ring.
8. Remove the rotor assembly.
   8.1 Insert the lip of the rotor puller jaws into the snap ring groove. See **Fig. 5**.

Clutch Assembly Removal, Inspection, and Installation

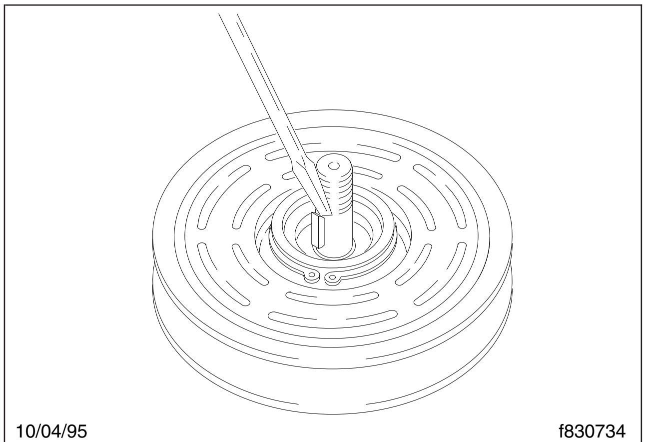
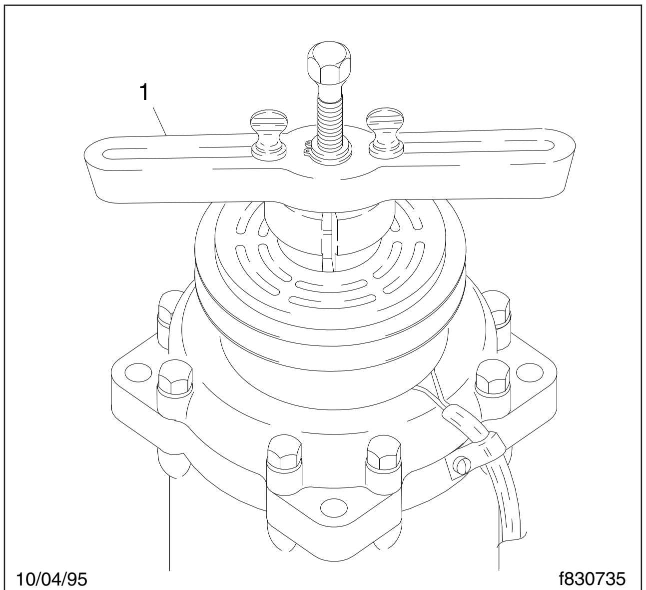


Fig. 4, Remove the Shaft Key



1. Pulley Puller

Fig. 5, Position the Rotor Puller Jaws

8.2 Place the rotor puller set over the exposed shaft.

8.3 Align the thumb screws to the puller jaws. Tighten the screws finger tight.

8.4 Using a socket wrench, turn the puller center bolt clockwise and remove the rotor assembly.

9. Remove the field coil assembly.

9.1 Remove the field coil assembly lead wire from the clamp on the compressor.

9.2 Disconnect the wiring harness.

9.3 Remove the snap ring. Then remove the field coil assembly.

Inspection

1. Inspect the drive plate assembly. If the frictional surface shows signs of damage due to too much heat, replace the drive plate assembly and the rotor assembly.
2. Check the appearance of the rotor assembly. If the frictional surface of the rotor shows signs of too much grooving due to slippage, replace both the rotor assembly and the drive plate assembly. Clean the frictional surfaces of the rotor assembly before installing it.
3. Check the field coil assembly for a loose connector and for cracked insulation. Replace it if necessary.

Installation

NOTE: When supporting the compressor in a vise, clamp only on the mounting ears, never on the body of the compressor.

1. Install the field coil assembly.

1.1 Position the coil assembly on the compressor.

1.2 Install the snap ring.

1.3 Attach the field coil assembly lead wire to the clamp on the compressor.

1.4 Connect the wiring harness.

2. Install the rotor assembly.

2.1 Position the rotor over the boss of the front housing.

2.2 Place the rotor installer ring into the bearing bore. Make sure that the edge rests only on the inner race of the bearing, not on the seal, rotor pulley, or outer race of the bearing.

2.3 Place the driver into the ring. Using a hammer or an arbor press, drive the rotor pulley down against the front housing step. See **Fig. 6**.

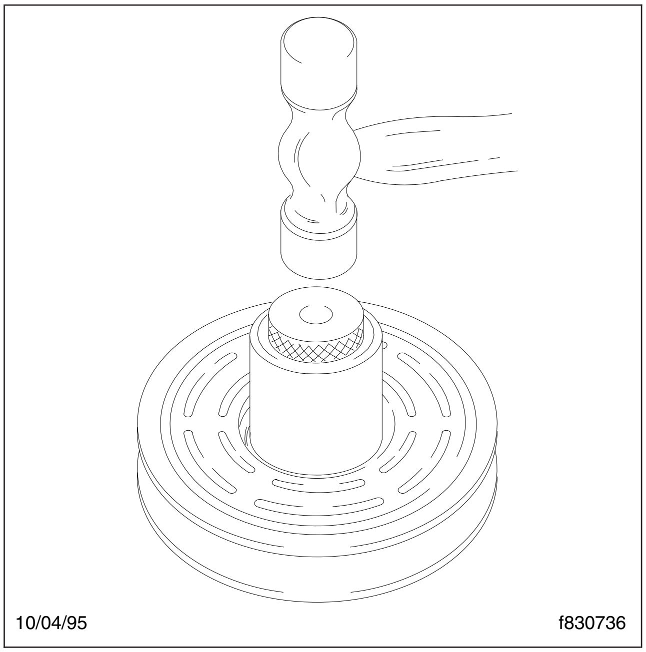


Fig. 6, Drive the Rotor Pulley Down Against the Front Housing Step

2.4 Using snap ring pliers, install the rotor bearing snap ring.

2.5 Using snap ring pliers, install the rotor retaining snap ring. If a bevel is present on the snap ring, make sure that it is facing away from the body of the compressor.

2.6 If equipped with a rotor bearing dust cover, install the cover by gently tapping it into place.

3. Install the drive plate assembly.

3.1 Using pliers, install the shaft key. See **Fig. 7**.

3.2 Install the shims.

3.3 Align the keyway in the drive plate assembly with the shaft key. Using a driver and a hammer or an arbor press, drive the assembly down over the shaft until it bottoms on the shims. See **Fig. 8**.

3.4 Install the retaining nut. If the nut is 1/2–20, tighten it 20 to 25 lbf·ft (27 to 34 N·m).

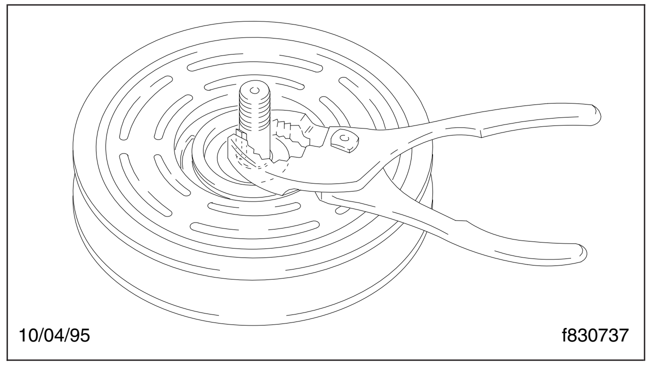


Fig. 7, Install the Shaft Key

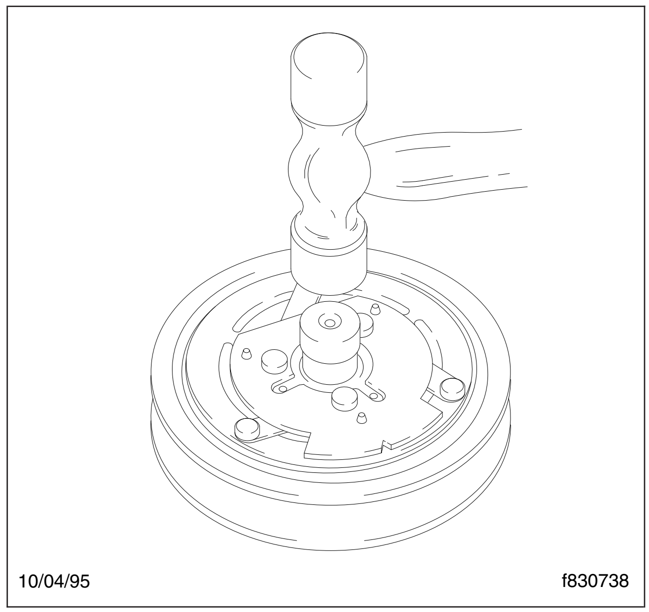


Fig. 8, Install the Drive Plate Assembly

If the nut is M8, tighten it 11 to 15 lbf·ft (15 to 21 N·m).

4. Using a feeler gauge, check that the clutch clearance is 0.016 to 0.031 inch (0.4 to 0.8 mm). See **Fig. 9**. If the gap is not even around the clutch, gently tap down at the high areas. If the overall gap is out of spec, remove the drive plate assembly and change the shims as necessary.

5. Install the compressor on the vehicle. For instructions, see **Subject 120**.

Clutch Assembly Removal, Inspection, and Installation

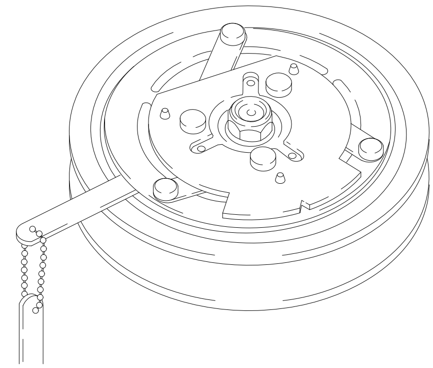


Fig. 9, Check the Clutch Clearance

Specifications

Special tools can be purchased from:

SPX Kent-Moore
28635 Mound Road
Warren, Michigan 48092-3499
800-328-6657

Mini Stat-O-Seal Assembly Bolt Torque Specs	
HVAC Component	**Torque: lbf·ft (N·m)**
Refrigerant Compressor	11–15 (15–20)
Condenser	11–15 (15–20)
Receiver-Drier	11–15 (15–20)
Expansion Valve*	11–15 (15–20)
Evaporator	11–15 (15–20)
Junction Block	11–15 (15–20)

* Torque the two small screws that attach the expansion valve–the evaporator lines at the frontwall 35 lbf·in (395 N·cm).

Table 1, Mini Stat-O-Seal Assembly Bolt Torque Specs

Contents

General Information

The compressor compresses low-temperature, low-pressure gas refrigerant gasified in the evaporator, into high-temperature, high-pressure gas refrigerant. The compressor then sends the refrigerant to the condenser.

The main purpose of the refrigerant compressor is to draw refrigerant gas from the evaporator and squeeze it into high-pressure gas. High pressure raises the condensation point of refrigerant gas, which allows the condenser to change it to a liquid so that it can be used for cooling again. A second purpose of the compressor is to move refrigerant through the air conditioning system.

Safety Precautions

Whenever repairs are made to any air conditioner parts that hold R–134a refrigerant, you must recover, purge or flush (if contaminated), evacuate, charge, and leak test the system. In a good system, refrigerant lines are always under pressure and you should disconnect them only after the refrigerant charge has been recovered (discharged) at the service valves.

Refrigerant R–134a is safe when used under the right conditions. Always wear safety goggles and non-leather gloves while recovering, evacuating, charging, and leak testing the system. Do not wear leather gloves; when refrigerant gas or liquid contacts leather, the leather will stick to your skin.

WARNING

Use care to prevent refrigerant from touching your skin or eyes, because liquid refrigerant, when exposed to the air, quickly evaporates and will freeze skin or eye tissue. Serious injury or blindness could result if you come into contact with liquid refrigerant.

Refrigerant splashed in the eyes should be rinsed with lukewarm water, not hot or cold. Do not rub the eyes. Apply a light bandage and contact a physician right away.

Refrigerant splashed on the skin should be rinsed with lukewarm water, not hot or cold. Do not rub the skin. Apply a light coat of a nonmedicated ointment, such as petroleum jelly. Contact a physician right away.

R–134a refrigerant does not burn at ambient temperatures and atmospheric pressure. However, it can be combustible at pressures as low as 5.5 psig (139 kPa absolute) at 350°F (177°C) when mixed with air concentrations that are greater than 60 percent.

WARNING

R–134a air conditioning systems should not be pressure tested or leak tested with compressed air. Combustible mixtures of air and R–134a may form, resulting in a fire or explosion, which could cause personal injury or property damage.

Always work in an area where there is a constant flow of fresh air when the system is recovered, evacuated, and charged. R–134a vapors have a slightly sweet odor that is difficult to detect. Frequent leak checks and air monitoring equipment are recommended to ensure a safe working environment.

IMPORTANT: When servicing an R–134a air conditioning system, use only service equipment certified to meet the requirements of SAE J2210 (R–134a recycling equipment). The equipment should be operated only by qualified personnel who are familiar with the recycling station manufacturer’s instructions.

Because of its very low boiling point, refrigerant must be stored under pressure. To prevent the refrigerant containers from exploding, never expose them to temperatures higher than 125°F (52°C).

On R–134a refrigerant systems, polyalkylene glycol (PAG) oil is used in the compressor. When handling PAG oil, observe the following:

- keep the oil free of contaminants
- do not expose the air conditioning system or the PAG oil container to air for more than 30 minutes; PAG oil has a high moisture absorption capacity and the oil container should be immediately sealed after each use
- use care when handling: spilled oil could damage painted surfaces, plastic parts, and other components (drive belts)
- **never** mix PAG oil with other types of refrigerant oil

WARNING

Before doing any of the work below, read the information under Safety Precautions 100. Failure to read the safety precautions and to be aware of the dangers involved when working with refrigerant, could lead to serious personal injury.

Pre-Service Checks

NOTE: Compressor problems usually show in one of four ways: abnormal noise, seizure, leakage, or low discharge pressure. Resonant compressor noises are not causes for alarm; irregular noise or rattles are likely to be caused by broken parts. To check for seizure, de-energize the magnetic clutch and see if the drive plate can be turned. If it won't turn, the compressor has seized.

Make the following checks whenever the air conditioner system is not cooling enough and the causes are unknown.

1. Check the drive belt and mounting:
   - 1.1 On the drive belt, look for wear, damage, or oil. If worn, oil-soaked, or damaged, remove it and install a new one. See the drive belt section in **Group 01** for instructions.
   - 1.2 Check the compressor mounting parts for loose fasteners, cracks, or other damage. Tighten loose fasteners to the torque value in the torque specifications table under **Specifications 400**. Repair or replace cracked or damaged brackets.
   - 1.3 Check the tension of the compressor drive belt. See the drive belt section in **Group 01** for instructions.
2. Check the wiring and connections to the compressor clutch. Replace damaged wiring and tighten loose connections.
3. Check for road debris build-up on the condenser coil fins. Using air pressure and a whiskbroom or a solution of soap and water, carefully clean the condenser; be careful not to bend the fins.

NOTE: For other possible causes of air conditioner problems, see **Section 83.00, Subject 300**, and the applicable fan clutch section in **Group 20**.

Refrigerant Compressor Removal and Installation

⚠ WARNING

Before doing any of the work below, read the information under Safety Precautions 100. Failure to read the safety precautions and to be aware of the dangers involved when working with refrigerant, could lead to serious personal injury.

Removal

1. Apply the parking brakes, and chock the tires.
2. Raise the hood.
3. Begin recovery of the refrigerant from the air conditioning system; for instructions, see **Section 83.00, Subject 220**.
4. Turn off the engine.
5. Remove the drive belt. Do not pry or roll the belt off the pulleys. See the drive belt section in **Group 01** for instructions.
6. Disconnect the wiring harness from the compressor.

NOTICE

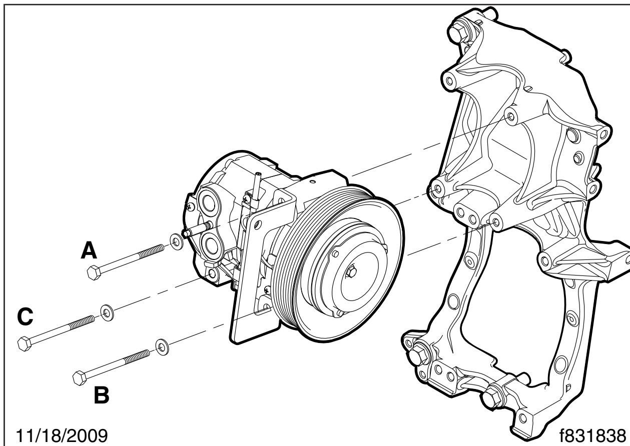
Under no circumstances should the ports on the compressor or the refrigerant lines remain uncapped for longer than five minutes. Water and dirt can damage the refrigerant system. Do not blow shop air through refrigerant lines since shop air is wet (humid).

7. After the refrigerant has been fully recovered, remove the capscrews that attach the refrigerant lines and retaining plate(s) to the compressor. Remove the refrigerant lines and the retaining plates. Remove and discard the Mini Stat-O-Seals. Cap the discharge and suction ports and the refrigerant lines.
8. Being careful not to spill any refrigerant oil, remove the capscrews and washers that attach the refrigerant compressor to the engine, and remove the compressor.

Installation

IMPORTANT: A new compressor is filled with refrigerant oil and nitrogen gas. The oil quantity is printed on a label attached to the compressor. When installing a new compressor on the vehicle, gently release the nitrogen gas from the discharge side of the compressor.

1. Adjust the refrigerant oil level in the compressor; for instructions, see **Subject 130**.
2. Position the compressor on the mounting bracket and install the capscrews and washers. Tighten 15 to 19 lbf·ft (21 to 26 N·m) in the sequence shown in **Fig. 1**.



Tighten A, then B, then C.

A. Front Top
B. Front Bottom
C. Rear

Fig. 1, Tightening Sequence (typical installation shown)

3. Uncap the discharge and suction ports and the refrigerant lines. Check the refrigerant lines and the discharge and suction ports. They must be clean and free of nicks, gasket residue, and other foreign material.
4. Install new Mini Stat-O-Seals on the refrigerant lines.
5. Attach the refrigerant lines to the compressor. Tighten the capscrew 14 to 16 lbf·ft (19 to 22 N·m).
6. Connect the wiring harness to the compressor.
7. Install the drive belt.
8. If installing a new compressor, or if the system was without any refrigerant pressure before repairs were started, replace the receiver-drier; for instructions, see **Section 83.00, Subject 180**.

Refrigerant Compressor Removal and Installation

9. Evacuate, charge, and leak test the refrigerant system; for instructions, see **Section 83.00, Subject 220**.
10. Return the hood to the operating position.

⚠ WARNING

Before doing any of the work below, read the information under Safety Precautions 100. Failure to read the safety precautions and to be aware of the dangers involved when working with refrigerant, could lead to serious personal injury.

General Information

Denso compressors require ND-8 PAG refrigerant oil. When the air conditioning system is operating, refrigerant oil can leave the compressor and circulate through the system with the refrigerant, but the refrigerant oil cannot leave the system except when there is a leak, when the refrigerant is recovered, or when a system part is replaced.

It is important that the air conditioning system has the correct amount of refrigerant oil for proper operation. Too little oil will result in compressor failure. Too much oil will degrade the performance of the air conditioner, and cause damage to the compressor.

IMPORTANT: Whenever the air conditioning system is discharged or recovered, the recovered oil, from the charging machine, must be measured in order to know how much oil must be returned to the system. When a system component is replaced, a quantity of new oil equal to the recovered oil plus the oil coating the inside of the component must be returned to the system. New oil must be from a container that has not been opened or that has been tightly sealed since its last use. Tubing, funnels, or other equipment used to transfer the oil must be very clean and dry.

When handling refrigerant oil:

- Be sure that the oil is free of water, dust, metal powder, and other foreign substances;
- Do not mix the refrigerant oil with other types or viscosities of oil;
- Quickly seal the oil container after use. Refrigerant oil absorbs moisture when exposed to the air for any period of time.

Order Denso PAG oil (ND-8OIL, P/N DII LA446963 0040) from your local Freightliner parts distribution center, it is the only acceptable oil to use in a system with a Denso compressor.

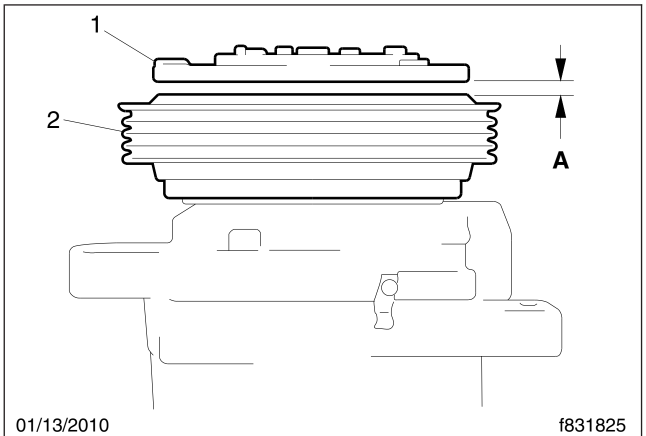
Denso Total System Oil Volume

Denso refrigerant compressors are supplied with approximately 4.5 oz. of ND-8 oil, but the vehicle configuration affects the total charge volume. If a complete new oil charge is required, the amount will be determined by the volume stated in the new compressor literature, and the volume listed in PartsPro. The two amounts will be combined to give the total oil charge required. If a complete new oil charge is not required, use the oil balancing info in **Section 83.00, Subject 220**.

Clutch Assembly Removal, Inspection, and Installation

IMPORTANT: The clutch should be replaced if it is worn.

Before replacing the clutch, check the air gap at three equally spaced points around the perimeter. The air gap should be at least 0.014 in (0.35 mm), and no greater than 0.024 inch (0.60 mm). The gap must be greater than 0.024 inch (0.60 mm) at all three points for the clutch to need replacing. See **Fig. 1**.



Check at three equally spaced points.
A. 0.014 to 0.024 in (0.35 to 0.60 mm)
1. Hub Sub-Assembly 2. Magnetic Clutch

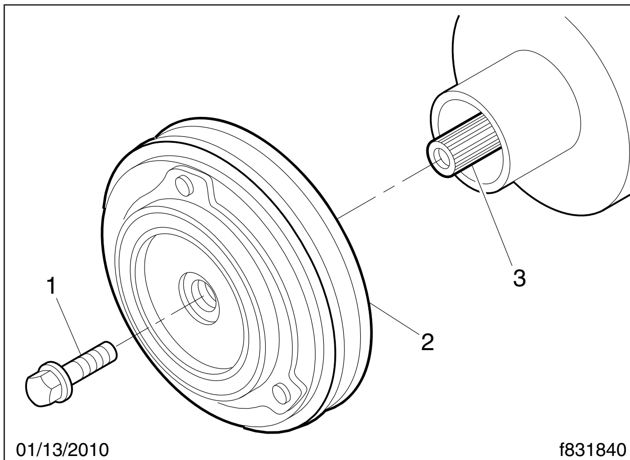
Fig. 1, Checking the Clutch Clearance

Removal

NOTE: The hub is secured with a bolt (splined shaft is used for connection with compressor).

1. Remove the compressor from the vehicle. For instructions, see **Subject 110**.
2. Remove the clutch retaining capscrew from the compressor shaft. See **Fig. 2**.
3. Remove the shims from the pressure plate. NOTE: Save the air gap shims for reassembly.

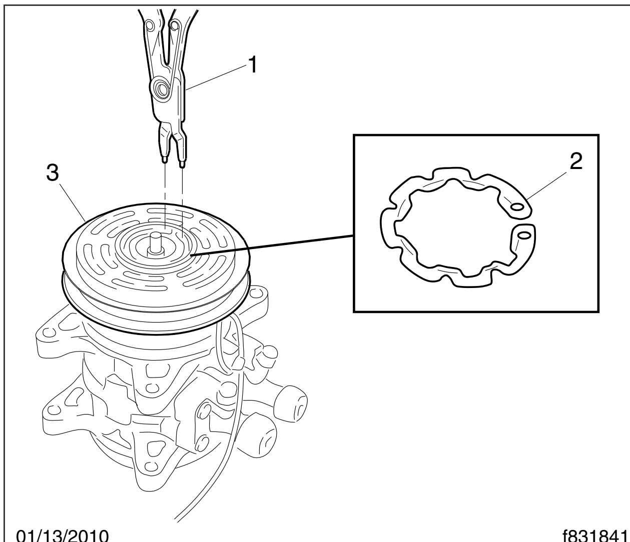
NOTE: If the rotor cannot be removed easily, tap the rotor lightly with a plastic hammer, then remove it from the compressor shaft being careful not to damage the pulley when tapping on the rotor.



1. Clutch Retaining Capscrew
2. Hub and Rotor Assembly
3. Splined Shaft

Fig. 2, Removing the Retaining Capscrew

4. Using snap ring pliers, remove the snap ring, then remove the rotor. Discard the snap ring. See **Fig. 3**.

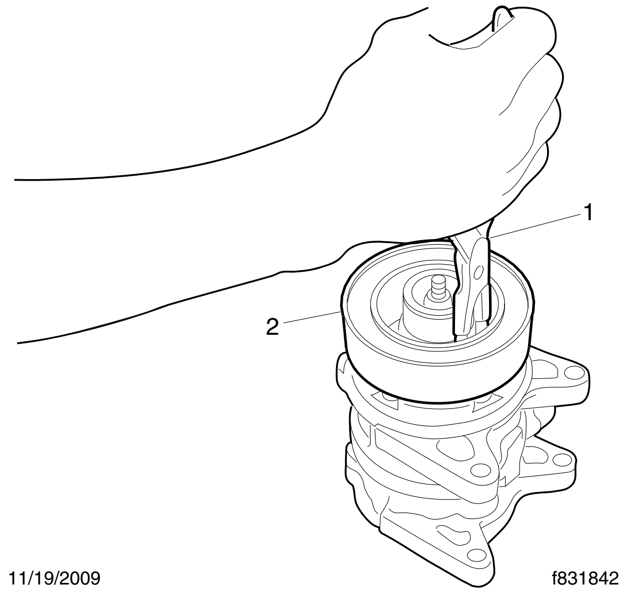


1. Snap Ring Pliers
2. Snap Ring
3. Rotor

Fig. 3, Rotor Removal

5. Using snap ring pliers, remove the snap ring, then remove the stator. Discard the snap ring. See **Fig. 4**.

Clutch Assembly Removal, Inspection, and Installation



1. Snap Ring Pliers
2. Stator

Fig. 4, Stator Removal

Inspection

After the magnetic clutch is disassembled, inspect each component and decide whether they can be reused. Refer to Table 1 for clutch inspection and recommended action.

Installation

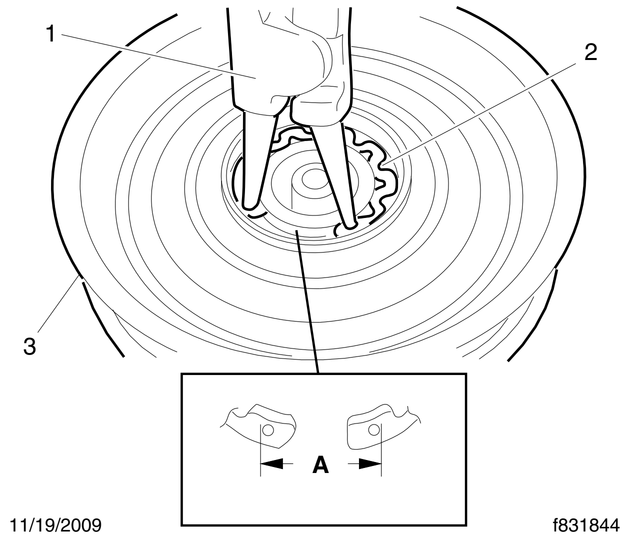
NOTICE

Excessive opening of the snap rings may weaken the fixing force of the snap ring. Maximum allowed opening must not exceed 1.2 in (30.9 mm). See Fig. 5.

1. Align the stator to the compressor housing by positioning the index pin into its indexing hole/slot.

IMPORTANT: The snap ring must be installed with the chamfered side facing up. See Fig. 6.

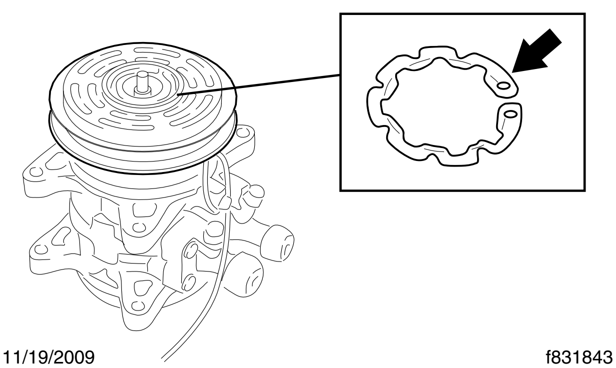
2. Secure the stator with a new snap ring. Make sure the snap ring is fully seated. See Fig. 7.
3. Install the rotor on the compressor and secure it with a new snap ring.



A. Do not exceed 1.2 in (30.9 mm).

1. Snap Ring Pliers
2. Snap Ring
3. Rotor

Fig. 5, Snap Ring Installation

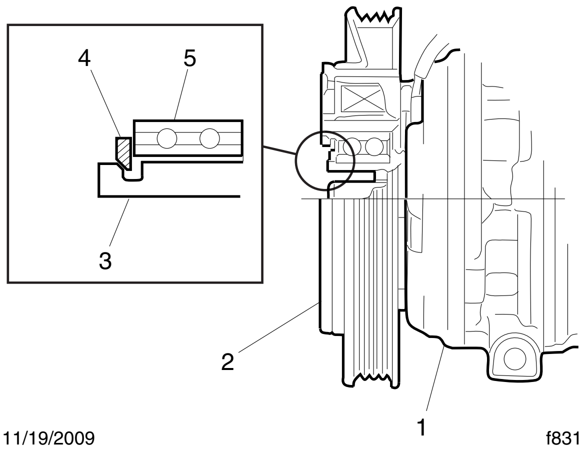


Chamfered side up.

Fig. 6, Snap Ring Installation

4. Temporarily install the hub to verify the gap clearance. See Fig. 1.
5. Check the air gap. The air gap between the hub and rotor should be 0.014 to 0.024 in (0.35 to 0.60 mm). Check the clearance at 3 locations.
6. Set the air gap clearance between the pressure plate and rotor by adding or removing compressor shaft shims so that the air gap clearance is within the specified range and distance.

Clutch Assembly Removal, Inspection, and Installation



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1. Compressor
2. Clutch Assembly
3. Compressor Shaft
4. Snap Ring
5. Bearing

Fig. 7, Seating the Snap Ring

7. Install the clutch retaining capscrew in the compressor shaft. Tighten 15 to 19 lbf·ft (21 to 26 N·m).

8. After the clutch is assembled, turn the rotor by hand to verify it does not contact either the pressure plate or stator.

Magnetic Clutch Inspection		
Part Name	**Check Point and Expected Damage**	**Action**
Hub	Dislocation or peeling of rubber.	Replace or Repair
	Roughness, burn, rust, slip or extreme wear on mating surface.	Replace
Rotor	Play, unusual sound, rust, insufficient grease or seizure of bearing.	
	Roughness, burn, rust, slip or extreme wear on mating surface.	
Stator	Burn, wire breakage or layer short circuit of stator coil. Resistance of stator coil at 68°F (20°C) should be 2.8 to 3.2 ohms.	
	Damage of deformation of rotor (pulley) groove(s).	

Table 1, Magnetic Clutch Inspection

Specifications

Special tools can be purchased from the following independent suppliers:

Classic Tool Design
31 Walnut St.
New Windsor, NY 12553
845-562-8700

Mastercool USA Inc.
One Aspen Drive
Randolph, NJ 07869
(973) 252-9119

Torque Values		
Description	Torque	
	lbf·in (N·cm)	lbf·ft (N·m)
Compressor Mounting Fasteners	—	15–19 (21–26)
Clutch Retaining Capscrew	—	22 (30)

Table 1, Torque Values

Thermal Cutout Switch Operation	
Switch Position	Temperature Range
Open	259–273°F (126–134°C)
Close	185–203°F (85–95°C)

Table 2, Thermal Cutout Switch Operation