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# SECTION 412-00 Climate Control System — General Information and Diagnostics

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## DESCRIPTION AND OPERATION

### Climate Control System

**⚠ WARNING:** Carbon monoxide is colorless, odorless and dangerous. If it is necessary to operate the engine with vehicle in a closed area such as a garage, always use an exhaust collector to vent the exhaust gases outside the closed area.

**⚠ WARNING:** R-134a is classified as a safe refrigerant, but misuse can make it dangerous. The following precautions must be observed.

- Always wear safety goggles when repairing an air conditioning system.
- Avoid contact with liquid refrigerant R-134a. R-134a vaporizes at approximately  $-25^{\circ}\text{C}$  ( $-13^{\circ}\text{F}$ ) under atmospheric pressure and it will freeze skin tissue.
- Never allow refrigerant R-134a gas to escape in quantity in an occupied space. R-134a is non-toxic, but it will displace the oxygen needed to support life.
- Never use a torch in an atmosphere containing R-134a gas. R-134a is non-toxic in all normal conditions, but when it is exposed to high temperatures, such as a torch flame, it decomposes. During decomposition it releases irritating and toxic gases (as described in the MSDS sheet from the manufacturer). Decomposition products are hydrofluoric acid, carbon dioxide and water.
- Do not allow any portion of the charged air conditioning system to become too hot. The pressure in an air conditioning system rises as the temperature rises and temperatures of approximately  $85^{\circ}\text{C}$  ( $185^{\circ}\text{F}$ ) can be dangerous.
- Allow the engine to cool sufficiently prior to carrying out maintenance or serious burns and injury can occur.

**NOTICE:** To avoid damaging the vehicle or A/C components, the following precautions must be observed.

- The A/C refrigerant of all vehicles must be identified and analyzed prior to refrigerant charging. Failure to do so can contaminate the shop bulk refrigerant and other vehicles.
- Do not add R-12 refrigerant to an A/C system that requires the use of R-134a refrigerant. These 2 types of refrigerant must never be mixed. Doing so can damage the A/C system.
- Charge the A/C system with the engine running only at the low-pressure side to prevent refrigerant slugging from damaging the A/C compressor.
- Use only R-134a refrigerant. Due to environmental concerns, when the air conditioning system is

drained, the refrigerant must be collected using refrigerant recovery/recycling equipment. Federal law **REQUIRES** that R-134a be recovered into appropriate recovery equipment and the process be conducted by qualified technicians who have been certified by an approved organization, such as MACS, ASI, etc. The use of a recovery machine dedicated to R-134a is necessary to reduce the possibility of oil and refrigerant incompatibility concerns. Refer to the instructions provided by the equipment manufacturer when removing refrigerant from or charging the air conditioning system.

- Refrigerant R-134a must not be mixed with air for leak testing or used with air for any other purpose above atmospheric pressure. R-134a is combustible when mixed with high concentrations of air and higher pressures.
- A number of manufacturers are producing refrigerant products that are described as direct substitutes for refrigerant R-134a. The use of any unauthorized substitute refrigerant can severely damage the A/C components. If repair is required, use only new or recycled refrigerant R-134a.

**NOTICE:** To avoid contamination of the A/C system:

- Never open or loosen a connection before recovering the refrigerant.
- When loosening a connection, if any residual pressure is evident, allow it to leak out before opening the fitting.
- Evacuate a system that has been opened to install a new component, or one that has discharged through leakage before charging.
- Seal open fittings with a cap or plug immediately after disconnecting a component from the system.
- Clean the outside of the fittings thoroughly before disconnecting a component from the system.
- Do not remove the sealing caps from a new component until ready to install.
- Refrigerant oil will absorb moisture from the atmosphere if left uncapped. Do not open an oil container until ready to use and install the cap immediately after using. Store the oil in a clean, moisture-free container.
- Install a new O-ring seal before connecting an open fitting. Coat the fitting and O-ring seal with mineral oil before connecting.
- When installing a refrigerant line, avoid sharp bends. Position the line away from the exhaust or any sharp edges that can chafe the line.
- Tighten threaded fittings only to specifications. The steel and aluminum fittings used in the refrigerant system will not tolerate overtightening.

## DESCRIPTION AND OPERATION(Continued)

- When disconnecting a fitting, use a wrench on both halves of the fitting to prevent twisting the refrigerant lines or tubes.
- Do not open a refrigerant system or uncap a new component unless it is as close as possible to room temperature. This will prevent condensation from forming inside a component that is cooler than the surrounding air.

The electronic manual temperature control (EMTC) system heats or cools the vehicle depending on the function and temperature selected.

- The function selected on the climate control assembly determines heating or cooling, air distribution and enables blower motor operation.
- The temperature control setting determines the air temperature.
- The blower motor setting varies the blower motor speed.

### Principles of Operation

There are 4 main principles involved with the basic theory of operation:

- Heat transfer
- Latent heat of vaporization
- Relative humidity
- Effects of pressure

#### Heat Transfer

If 2 substances of different temperature are placed near each other, the heat in the warmer substance will transfer to the colder substance.

#### Latent Heat of Vaporization

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

#### Relative Humidity

The amount of moisture (water vapor content) that the air can hold is directly related to the air temperature. The more heat there is in the air, the more moisture the air can hold. The lower the moisture content in the air, the more comfortable you feel. Removing the moisture from the air lowers its relative humidity and improves personal comfort.

#### Effects of Pressure on Boiling or Condensation

As the pressure is increased on a liquid, the temperature at which the liquid boils (converts to gas) also increases. Conversely, when the pressure on a liquid is reduced, its boiling point is also reduced. When in the gas state, an increase in pressure causes an increase in temperature, while a decrease in pressure will decrease the temperature of the gas.

### Compressor Anti-Slugging Strategy

Liquid refrigerant may accumulate in the A/C compressor under certain conditions. To alleviate damage to the A/C compressor, compressor anti-slugging strategy (CASS) is utilized.

CASS is initiated only under specific conditions:

- When the ignition is OFF for more than 8 hours
- When the ambient temperature is above -4°C (25°F)
- When battery voltage is above 8.5 volts during engine cranking

When these conditions are present, the powertrain control module (PCM) will activate the A/C control relay prior to cranking of the engine. The A/C control relay engages the A/C compressor for approximately 4-15 A/C compressor revolutions or a maximum of 2 seconds (depending upon vehicle application), allowing the liquid refrigerant to be pushed from the A/C compressor. CASS is initiated by the PCM regardless of the function selector switch position or the EATC system settings.

### The Refrigerant Cycle

During stabilized conditions (air conditioning system shutdown), the refrigerant is in a vaporized state and pressures are equal throughout the system. When the A/C compressor is in operation it increases pressure on the refrigerant vapor, raising its temperature. The high-pressure and high-temperature vapor is then released into the top of the condenser core.

The condenser core, being close to ambient temperature, causes the refrigerant vapor to condense into a liquid when heat is removed by ambient air passing over the fins and tubing. The now liquid refrigerant, still at high pressure, exits from the bottom of the condenser core and enters the inlet side of the evaporator core orifice.

The evaporator core orifice is the restriction in the refrigerant system that creates the low pressure drop in the evaporator core and separates the high and low pressure sides of the A/C system. As the liquid refrigerant leaves this restriction, its pressure and boiling point are reduced.

The liquid refrigerant is now at its lowest pressure and temperature. As it passes through the evaporator core, it absorbs heat from the passenger compartment airflow passing over the plate/fin sections of the evaporator core. This addition of heat causes the refrigerant to boil (convert to gas). The now cooler passenger compartment air can no longer support the same humidity level of the warmer air and this excess moisture condenses on the exterior of the evaporator coils and fins and drains outside the vehicle.

## DESCRIPTION AND OPERATION(Continued)

The suction accumulator is designed to remove moisture from the refrigerant and to prevent any liquid refrigerant that may not have been vaporized in the evaporator core from reaching the A/C compressor. The A/C compressor is designed to pump refrigerant vapor only, as liquid refrigerant will not compress and can damage the A/C compressor.

The refrigerant cycle is now repeated with the A/C compressor again increasing the pressure and temperature of the refrigerant.

The A/C cycling switch interrupts compressor operation before the external temperature of the evaporator core gets low enough to cause the condensed water vapor (excess humidity) to turn to ice. It does this by monitoring low side line pressure. It is known that a refrigerant pressure of

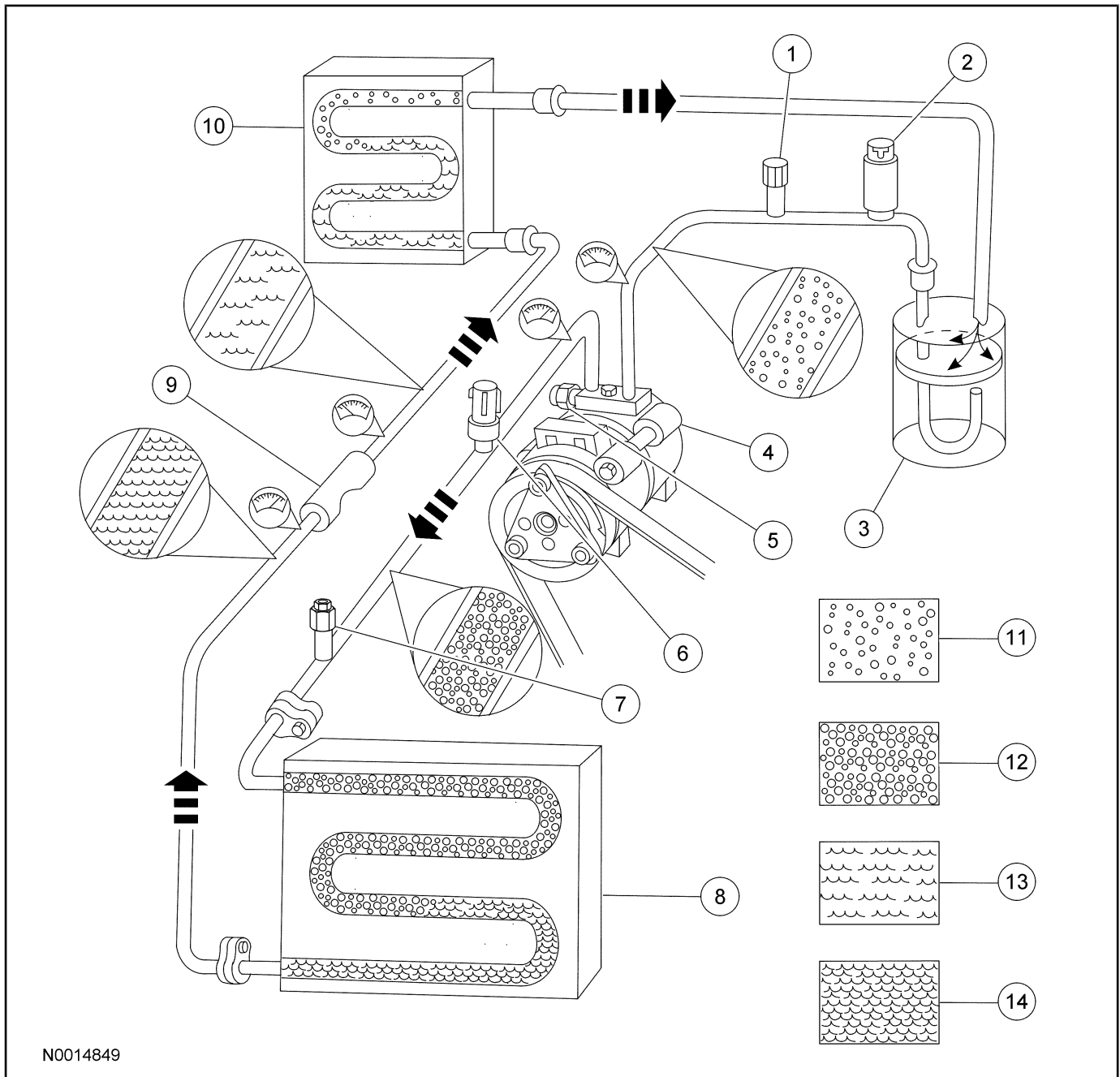
approximately 210 kPa (30 psi) will yield an operating temperature of 0°C (32°F). The A/C cycling switch controls system operation in an effort to maintain this temperature.

The high side line pressure is also monitored so that A/C compressor operation can be interrupted if system pressure becomes too high. When the A/C compressor discharge pressure rises, the A/C dual function pressure switch contacts open (4.6L) or the A/C pressure transducer value changes (4.0L), disengaging the A/C compressor. When the pressure drops, operation of the A/C compressor resumes.

The A/C pressure relief valve will open and vent refrigerant to relieve unusually high system pressure.

# DESCRIPTION AND OPERATION(Continued)

## Clutch Cycling Orifice Tube Type Refrigerant System



N0014849

Item	Part Number	Description
1	19E762	A/C charge valve port (low side)
2	19E561	A/C cycling switch
3	19C836	Suction accumulator
4	19703	A/C compressor

Item	Part Number	Description
5	19D644	A/C compressor pressure relief valve
6	19D594	A/C pressure transducer (4.0L)
6	19D594	A/C dual function pressure switch (4.6L)

## DESCRIPTION AND OPERATION(Continued)

Item	Part Number	Description
7	19E762	A/C charge valve port (high side)
8	19712	Condenser core
9	19D990	Evaporator core orifice tube
10	19860	Evaporator core
11	—	Low pressure vapor
12	—	High pressure vapor
13	—	Low pressure liquid
14	—	High pressure liquid

### Climate Control System Operation

#### Electronic Manual Temperature Control System

The electronic manual temperature control (EMTC) system operation is determined by the settings on the climate control assembly. The climate control assembly includes a serviceable blower motor switch.

The blower motor switch:

- sets the blower motor speed.
- directs the blower motor path to ground through the blower motor resistor to allow blower motor operation in LO, MED LO and MED HI.
- directs the blower motor path directly to ground, bypassing the blower motor resistor, to allow blower motor operation in HI.

The A/C request switch:

- can command the A/C compressor ON when the function selector switch is in PANEL, FLOOR/PANEL, FLOOR/DEFROST and FLOOR when the A/C request switch is pressed. Indicator illuminates when A/C request switch is toggled ON.
- can command the A/C compressor OFF in FLOOR/DEFROST if RECIRC is commanded OFF.
- is inoperative in MAX A/C, OFF and DEFROST.
- indicator illuminates when the function selector switch is in MAX A/C and cannot be toggled.
- indicator does not illuminate in OFF and cannot be toggled.
- indicator in FLOOR/DEFROST and DEFROST does not change. The A/C compressor will operate regardless of indicator status if the outside air temperature is above 2°C (35°F).
- is serviced only with the climate control assembly.

The function selector switch:

- selects airflow direction.
- is serviced only with the climate control assembly.

**NOTE:** Recirculated air only is used when the electronic manual temperature control mode selector is set in the MAX A/C or OFF modes or if the RECIRC request button is selected in any mode except MAX A/C, OFF or DEFROST.

The air recirculation button:

- selects either recirculated or outside air source.
- is serviced only with the climate control assembly.

### System Airflow Description

#### Max A/C

When MAX A/C is selected:

- the air inlet door actuator closes off outside air and admits only recirculated air.
- the recirc button is disabled and the indicator is illuminated.
- the defrost door actuator is in the full closed position, directing airflow to the floor/panel door.
- the floor/panel door actuator is in the full panel position, directing airflow to the instrument panel A/C registers. A small amount of airflow from the floor duct will be present.
- blended air temperature is available.
- the A/C request button is illuminated and will be disabled.
- the A/C compressor will operate if the outside temperature is above approximately 2°C (35°F).
- the blower motor is ON.

#### PANEL

When PANEL is selected:

- the recirc request button is enabled. If the recirc request button is selected (indicator ON), the air inlet door actuator closes off outside air from entering the passenger compartment. If the recirc request button is not selected (indicator OFF), the air inlet door actuator admits only outside air into the passenger compartment.
- the defrost door actuator is in the full closed position, directing airflow to the floor/panel door.
- the floor/panel door actuator is in the full panel position, directing airflow to the instrument panel A/C registers. A small amount of airflow from the floor duct will be present.
- blended air temperature is available.
- the A/C request button is enabled. The A/C compressor will operate and the indicator will illuminate if the A/C request button is selected and the outside temperature is above approximately 2°C (35°F).
- the blower motor is ON.

## DESCRIPTION AND OPERATION(Continued)

### PANEL/FLOOR

When PANEL/FLOOR is selected:

- the recirc request button is enabled. If the recirc request button is selected (indicator ON), the air inlet door actuator closes off outside air from entering the passenger compartment. If the recirc request button is not selected (indicator OFF), the air inlet door actuator admits only outside air into the passenger compartment.
- the defrost door actuator is in the full closed position, directing airflow to the floor/panel door.
- the floor/panel door actuator is positioned partially between the floor and panel position, directing airflow to the floor duct and the instrument panel A/C registers.
- blended air temperature is available.
- the A/C request button is enabled. The A/C compressor will operate and the indicator will illuminate if the A/C request button is selected and the outside temperature is above approximately 2°C (35°F).
- the blower motor is ON.

### OFF

When OFF is selected:

- the recirc request button is disabled.
- the air inlet door actuator closes off outside air.
- the defrost door actuator is in the full closed position and floor/panel door actuator is in the partially open position.
- the A/C request button is disabled.
- the blower motor is OFF.

### FLOOR

When FLOOR is selected:

- the recirc request button is enabled. If the recirc request button is selected (indicator ON), the air inlet door actuator closes off outside air from entering the passenger compartment. If the recirc request button is not selected (indicator OFF), the air inlet door actuator admits only outside air into the passenger compartment.
- the floor/panel door is in the floor position and the defrost door fully closes, directing airflow to the floor duct. A small amount of airflow from the defrost duct and side demisters will be present.

- blended air temperature is available.
- the A/C request button is enabled. The A/C compressor will operate and the indicator will illuminate if the A/C request button is selected and the outside temperature is above approximately 2°C (35°F).
- the blower motor is ON.

### FLOOR/DEFROST

When the FLOOR/DEFROST is selected:

- the recirc request button is enabled. If the recirc request button is selected (indicator ON), the air inlet door actuator closes off outside air from entering the passenger compartment. If the recirc request button is not selected (indicator OFF), the air inlet door actuator admits only outside air into the passenger compartment.
- the floor/panel door actuator is in the full floor position and the defrost door is partially open, directing airflow to the floor duct, the defroster duct and the side window demisters.
- blended air temperature is available.
- the A/C request button is enabled. The A/C compressor will operate and the indicator will illuminate if the A/C request button is selected and the outside temperature is above approximately 2°C (35°F).
- the blower motor is ON.

### DEFROST

When DEFROST is selected:

- the air inlet door actuator opens, admitting only outside air into the passenger compartment.
- the floor/panel door actuator is in the full floor position.
- the defrost door is in the fully open position, directing airflow to the defroster duct and side window demisters. A small amount of airflow from the floor duct will be present.
- blended air temperature is available.
- the A/C request button will illuminate and is enabled. To reduce fogging, the A/C compressor will operate automatically, regardless of indicator status, if the outside temperature is above approximately 2°C (35°F).
- the blower motor is ON.