

SECTION 22: HEATING AND AIR CONDITIONING

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1. HEATING AND AIR CONDITIONING

The interior of the vehicle is pressurized by its Heating, Ventilation, Air Conditioning (HVAC) system. Two HVAC systems are available: Small HVAC System and Central HVAC System.

If the vehicle is equipped with a Central HVAC System; air flow and controls divide the vehicle in two areas: driver's area and passengers' or cabin area. The interior of the vehicle should always be slightly pressurized to prevent dust and moisture from entering vehicle. Each section has its own fresh air, returning air and discharge air ducting. The exhaust is mainly done through the lavatory ventilator (if equipped) and through normal air-tightness losses.

2. AIR CIRCULATION WITH CENTRAL HVAC SYSTEM

2.1 DRIVER'S AREA

Fresh air is taken from a plenum underneath the front service compartment and enters the mixing box through an ON/OFF damper. Return air is taken through the base of the dashboard panel utility compartments into the mixing box. Mixed air goes through cooling and heating coils, fans and discharge ducts.

Both right and left discharge ducts defrost one half of the windshield. The driver can also divert some air flow to the console, from which he can direct air to his knees and/or upper body with adjustable HVAC air registers and to his feet with the appropriate button (see Figure 1 and Owner's or Operator's manual).

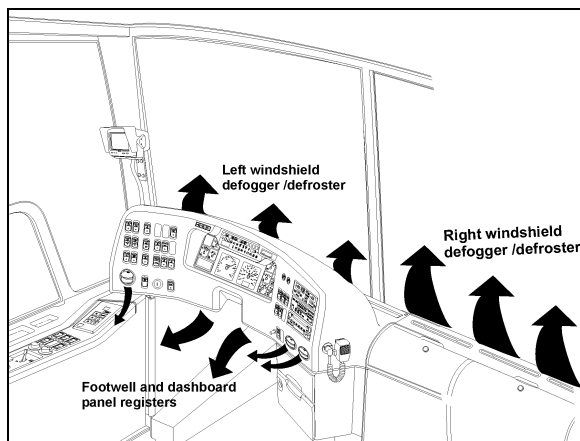


FIGURE 1: DRIVER'S AIR CIRCULATION 22307

X3-45 coaches are also equipped with a windshield upper section de-icing system. Also, one additional air register is located in the

driver's area but supplied by the passengers' air ducting system. It is installed in the stepwell for step de-icing.

2.2 CABIN OR PASSENGERS' AREA

Fresh air enters the vehicle on the L.H. side, through a damper located inside the evaporator compartment door (Figure 2). The damper can be fully opened for normal operation or closed for extreme weather or highly polluted areas (Refer to the Owner's or Operator's Manual for more details). The recirculation REC button is located on the HVAC control unit. Press down the button to partially close the fresh air damper. Return air is drawn from inside the vehicle through the register air duct located on L.H. side of vehicle (Figure 3).

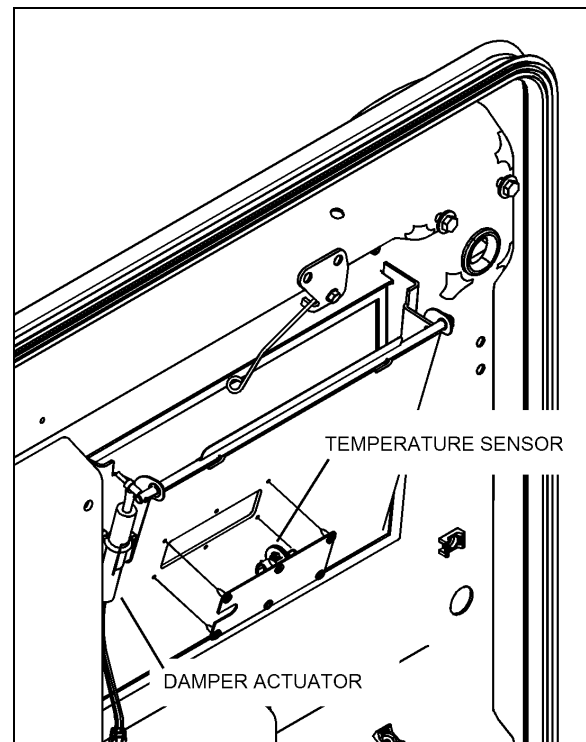
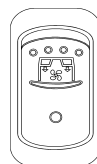


FIGURE 2: PASSENGERS' AREA FRESH AIR DAMPER 22302_A

A double blower fan unit, which is activated by the evaporator motor, draws mixed air through an air filter, cooling and heating coils, then forces this air in the ventilation ducts along the walls, and finally exhausts it just below side windows.



X3-45 coaches are also equipped with an overhead compartment ventilation system, a three-position switch (OFF - 1st speed - 2nd speed) located on R.H. dashboard panel controls the speed of both fans.

Return air is drawn just below the middle side windows through an air filter into the overhead

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compartment fan; discharge air is fed to the rotating registers through the ventilation duct (Figure 4).

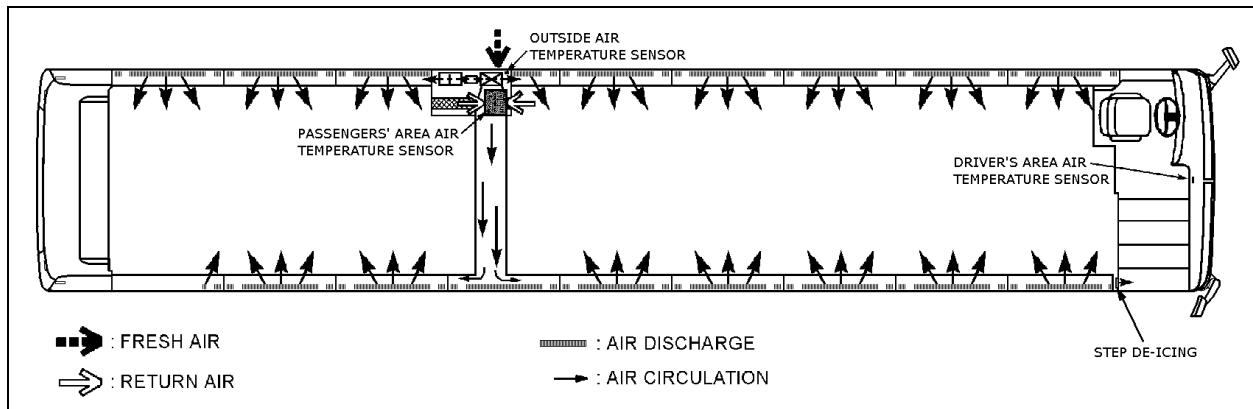


FIGURE 3: CENTRAL HVAC SYSTEM AIR CIRCULATION

22308

The overhead compartment air registers are used to control air flow for the passenger seats. There is one register per seat to direct air flow by pointing or rotating register. Open or close register to adjust air flow.

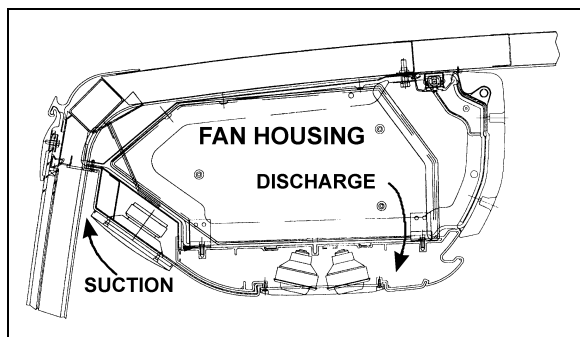


FIGURE 4: PASSENGERS OVERHEAD COMPARTMENT VENTILATION SYSTEM

22211

3. AIR CIRCULATION WITH SMALL HVAC SYSTEM

Fresh air is taken from a plenum behind the front bumper and enters the mixing box through an adjustable damper. Returning air is taken through the right console into the mixing box. The recirculation REC button is located on the HVAC control unit (Figure 5). Mixed air goes through cooling and heating coils, fans and discharge ducts.

Both right and left discharge ducts defrost/defog one half of the windshield. The driver can divert his air flow to the dashboard, from which he can direct vent to his upper body with adjustable HVAC register and to his feet with the appropriate button (see Figure 1 and Owner's manual).

4. SMALL HVAC SYSTEM OPERATION

Only the temperature in the driver's area is controlled by the HVAC control unit mounted on the R.H. dashboard panel (Figure 5).

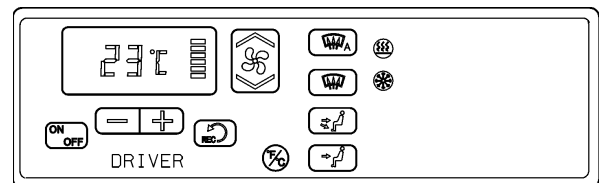


FIGURE 5: SMALL HVAC SYSTEM CONTROL UNIT

22184

Using the Up/Down type switch sets the fan speed and the speed chosen is displayed on the HVAC control unit.

NOTE

The driver's area air temperature sensor is located behind the grill of the R.H. side console.

NOTE

The outside air temperature sensor is located behind the front bumper on the L.H. side.

5. CENTRAL HVAC SYSTEM OPERATION

To operate the air conditioning system when vehicle is stationary, engine should run at fast idle. During operation of the air conditioning system, windows should be kept closed and door not left open longer than necessary. In order to prevent battery discharge, HVAC system will not operate if vehicle charging system is not working properly.

5.1 DRIVER'S SECTION OPERATION

The temperature control in the driver's area is provided directly by the L.H. portion of the HVAC control unit mounted on the R.H. dashboard panel (Figure 5).

The driver's HVAC section piping is paralleled with the cabin or passengers HVAC section piping. Both sections use the same refrigerant and coolant, and are linked to the same condenser and compressor, even if they are individually controlled. It requires the passengers HVAC section to engage the A/C compressor magnetic clutch. Consequently, the driver's section cannot be operated in the A/C mode alone.

NOTE

The driver's HVAC section turns on automatically at starting of the engine and uses the settings that were kept in memory before turning off of the system.

The A/C compressor starts automatically when the two following conditions are satisfied:

1. The outside temperature is above 32°F (0°C).
2. The cabin or passenger's area temperature has reached 7°F (4°C) under the set point.



Using the Up/Down type switch sets the fan speed and the speed chosen is illustrated on the window display.

NOTE

Upon starting, if the outside temperature is above 32°F (0°C) and then drops below 32°F (0°C), the compressor will keep running up to a temperature of 15°F (-9°C) to prevent condensation from forming on the windows.

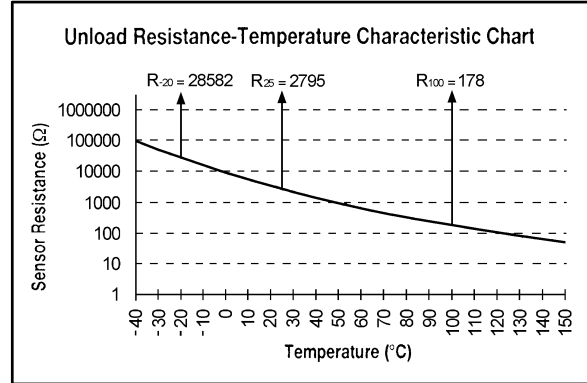
NOTE

To perform a test of the driver's section windshield defroster, it is possible to run the system without running the engine.

The following 2% error chart and table can be used to troubleshoot the driver's area air temperature sensor and the outside air temperature sensor.

NOTE

The driver's area air temperature sensor is located behind the grill of the R.H. side console (Refer to Figure 15).



Temp °C	Temp °F	Resistance Ohms
-40	-40	100865
-35	-31	72437
-30	-22	52594
-25	-13	38583
-20	-4	28582
-15	5	21371
-10	14	16120
-5	23	12261
0	32	9399
5	41	7263
10	50	5658
15	59	4441
20	68	3511
25	77	2795
30	86	2240
35	95	1806
40	104	1465
45	113	1195
50	122	980
55	131	808
60	140	670
65	149	559
70	158	468
75	167	394
80	176	333
85	185	283
90	194	241
95	203	207
100	212	178
105	221	153
110	230	133
115	239	115
120	248	100
125	257	88
130	266	77
135	275	68
140	284	60
145	293	53
150	302	47

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5.2 PASSENGERS' SECTION OPERATION

The R.H. portion of the HVAC control unit enables the selection of the temperature in the cabin or passenger's area (refer to the Owner's or Operator's Manual for details).



FIGURE 6: CENTRAL HVAC SYSTEM CONTROL UNIT

Temperature control is provided in conjunction with a thermistor sensor inside register duct, located on L.H. side of vehicle (Figs. 3 & 7).

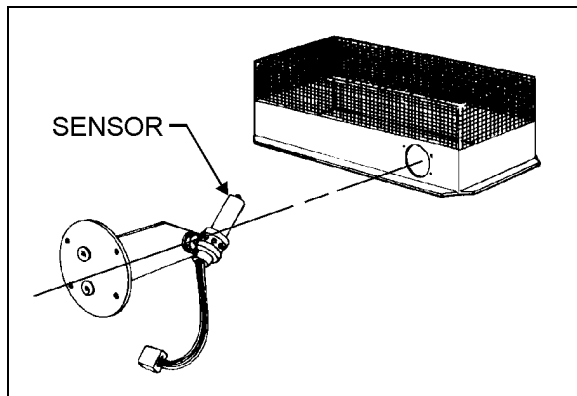


FIGURE 7: THERMISTOR SENSOR

The flow of water to the vehicle's main heater core is controlled by a pneumatic water valve which varies the cycling rate depending on selected temperature. A red LED, located on HVAC control unit, illuminates when heating mode is selected. A green LED illuminates when compressor clutch is in operation.

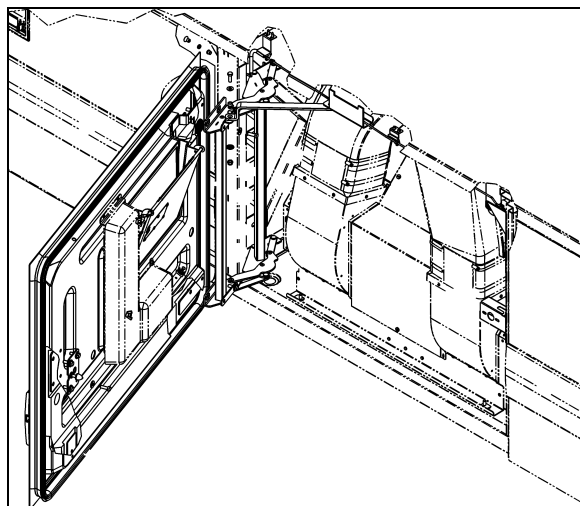


FIGURE 8: EVAPORATOR COMPARTMENT 22301_A

The evaporator fan motor, located in the evaporator compartment, is protected by a 90 amps, manually-resettable (CB3 or CB4) circuit breaker located on the rear junction panel and is accessible from the engine compartment curb-side door, on R.H. side of the vehicle (refer to Section 06, "Electrical System" in this manual for details).

The condenser coil mounted on the opposite side of the evaporator is ventilated by four axial fans. The fan motors are protected by a manually-resettable 70 amp circuit breaker (CB 5 or CB7) mounted on the rear junction panel and accessible from the engine compartment curb-side door.

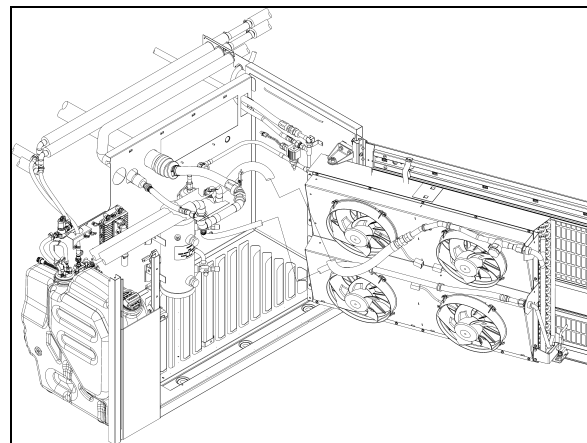


FIGURE 9: CONDENSER COMPARTMENT 22299

Furthermore, the following relays, diodes and multiplex module are located in the evaporator compartment (Figure 9). They are mounted in the HVAC junction box located inside the evaporator compartment door on top of the fan housing.

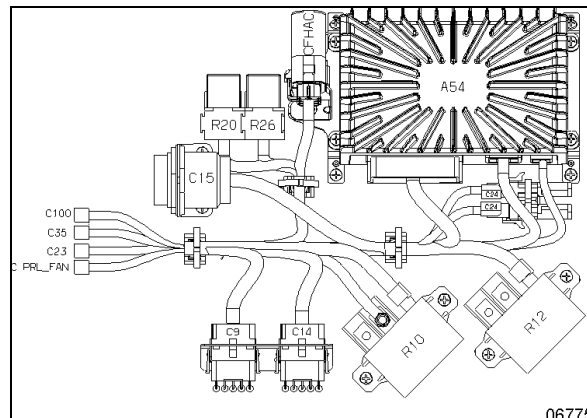


FIGURE 10: A/C JUNCTION BOX 06775

A/C Junction Box			
Multiplex Module			
A54	I/O-B		
Relays			
R10	Condenser Fan Sp. 2		
R12	Evaporator Fan		
R20	Water Pump Relay		
R26	Water Pre Heat Relay		
Diodes			
D9	HVAC		
D11	Pass. Liq. Sol.	D17	Lugg. 5 th Compt
D19	Lugg. 2 nd Compt	D20	Lugg. 1 st Compt
D25	Evap. Fan	D30	Water Pump
D73	Opt.	D80	Opt.

5.3 OVERHEAD COMPARTMENT A/C (OPT.)

On X3-45 coaches, optional A/C evaporator coils may be added to the existing air system of both overhead compartments. These components allow a wider temperature range in the passenger's area. The three-position rocker switch used to control the fans also controls the A/C system.

6. HVAC UNIT MAINTENANCE

No special maintenance is required on the passengers, driver's and auxiliary HVAC units, with the exception of cleaning their respective coils and air filters, plus periodic inspection for broken drains, hoses and charging of system.

NOTE

Squeeze rubber discharge tubes located underneath the appropriate compartment to eliminate the accumulated water and dirt when you make routine maintenance.

6.1 COIL CLEANING

Check the external surface of the coil at regular intervals for dirt or any foreign matter.

For the driver's HVAC unit, remove the grill and the access panels and back flush the coil from inside (Figure 11).

For the passengers' section evaporator coil, remove the access panel and back flush the coil (Figure 12 & Figure 13) every 12,500 miles (20 000 km) or once a year, whichever comes first.

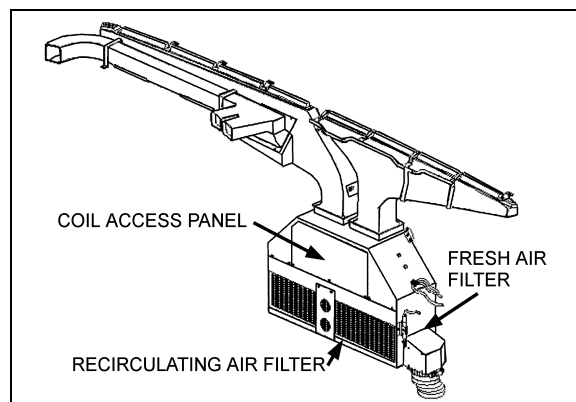


FIGURE 11: DRIVER'S HVAC UNIT COIL ACCESS PANEL

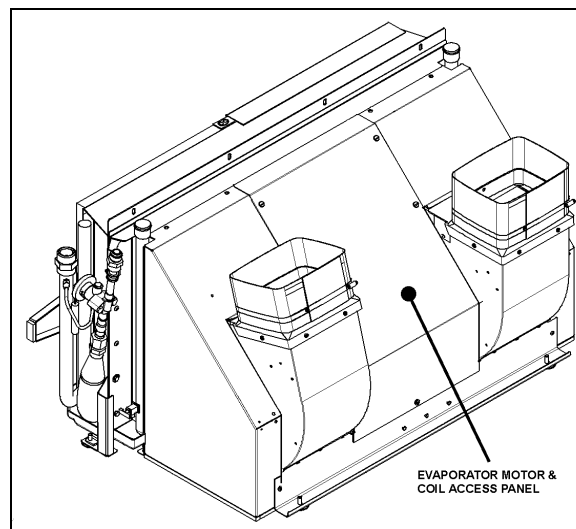


FIGURE 12: EVAPORATOR COIL ACCESS PANEL (TYPICAL)

22309

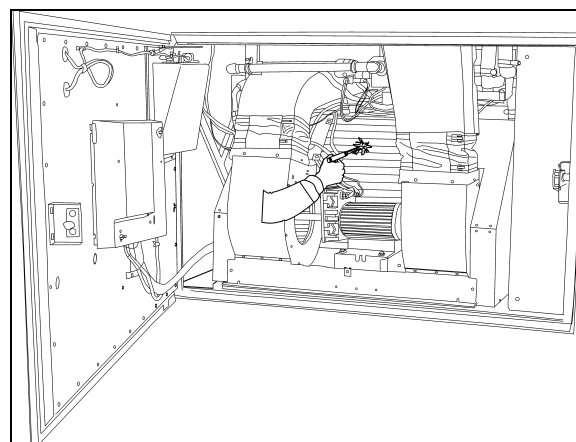


FIGURE 13: EVAPORATOR COIL CLEANING

22373

For the condenser coil, back flush the coil (Figure 14) every 6,250 miles (10 000 km) or twice a year, whichever comes first.

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CAUTION

Use a water jet or water mixed with low air pressure to clean the coil.



CAUTION

Direct the pressure straight through the coil to prevent bending of fins and do not use extremely high pressure. Do not use hot water, steam or caustic soap.

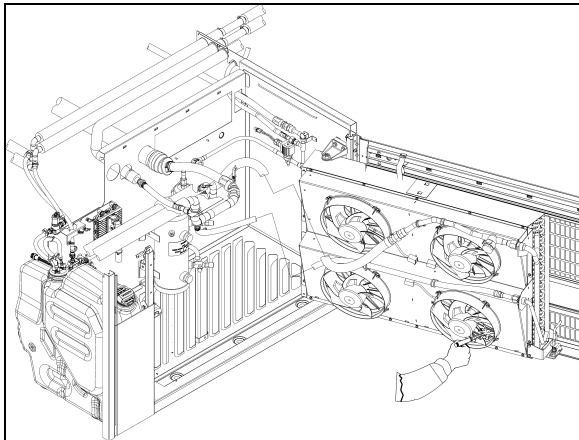


FIGURE 14: CONDENSER COMPARTMENT

22311

6.2 DRIVER'S SECTION AIR FILTERS

The driver HVAC system is located behind the dashboard's R.H. side lateral plastic panel. To gain access to the A/C filters, unscrew the R.H. lateral console's grill located at the top step of the entrance door steps, remove the plastic cover and slide out the recirculating air and fresh air filters. To clean filters back flush with water, then dry with air, every 12,500 miles (20 000 km) or once a year, whichever comes first (Figure 15 & Figure 16).

NOTE

If the windshield is continuously fogged, check that the driver's air filter is not clogged.

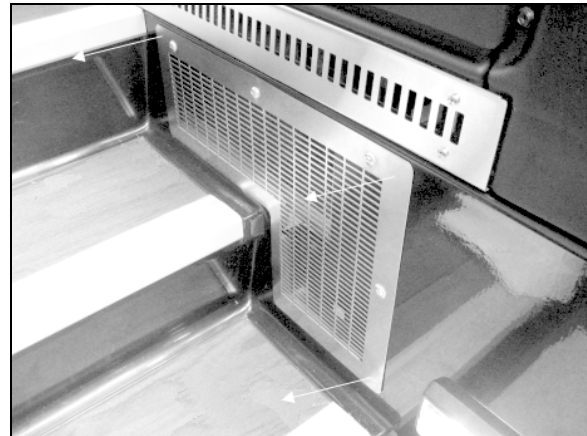


FIGURE 15: DRIVER'S SECTION ACCESS GRILL

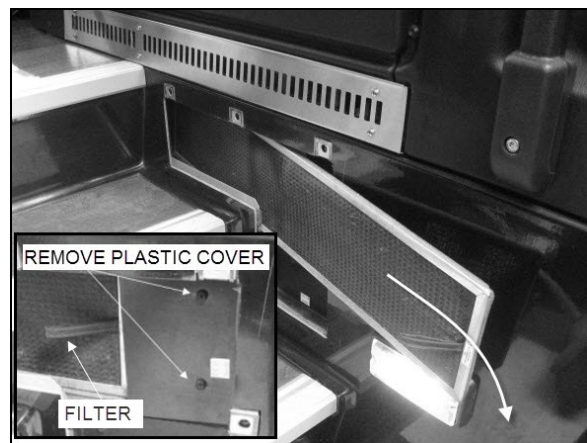


FIGURE 16: REMOVING DRIVER'S SECTION AIR FILTERS

6.3 PASSENGERS' SECTION AIR FILTER

The cabin or passengers' section air filter is located in the evaporator compartment above the Evaporator coil and fans (Figure 17).

Open access panel by turning the three quarter-turn screws, and slide out filter. To clean filter, back flush with water or soapy water, then dry with air every 12,500 miles (20 000 km) or once a year, whichever comes first.

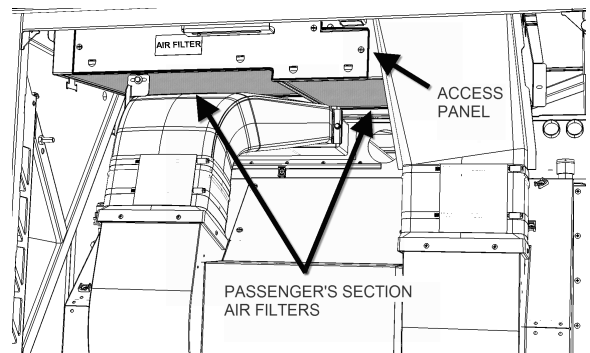



FIGURE 17: PASSENGERS' SECTION AIR FILTER

22375

 **CAUTION**
Do not use high pressure water jet to avoid damaging filter.

 **CAUTION**
Be sure not to reverse filter upon installation.

6.4 OVERHEAD COMPARTMENT FAN AIR FILTER

On X3-45 coaches, A/C evaporator coils may be installed in both overhead compartment air systems, only the air filters are serviceable. The air filters are accessible from inside the overhead compartments. Slide out the filters, then back flush with water, dry with air and replace. This procedure should be done every 12,500 miles (20,000 km) or once a year, whichever comes first.

If A/C units were installed, ball valves are added on supply and return lines in the engine compartment. They have a service port to evacuate the A/C overhead compartment circuit. When work has to be done on an evaporator coil unit, it will be easier to remove it and repair it on a bench.

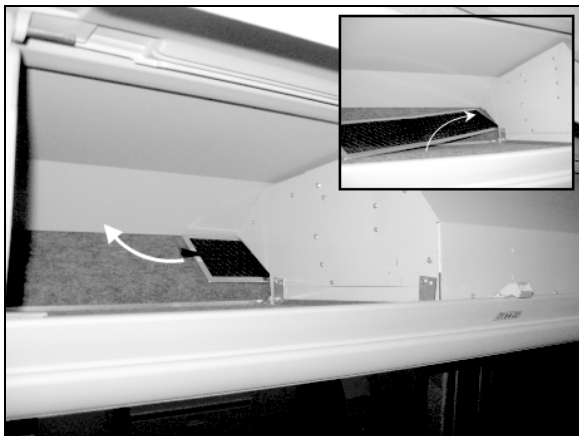


FIGURE 18: OVERHEAD COMPARTMENT FAN AIR FILTER

7. HVAC SYSTEM PARTICULARITIES, TESTING AND TROUBLESHOOTING

Before undertaking any troubleshooting on the HVAC system, study the appropriate wiring diagrams to get a complete understanding of the HVAC components circuitry, read and understand section 06:ELECTRICAL of this manual under "Troubleshooting And Testing The

Multiplex Vehicles" and "Test Mode For Switches And Sensors". The information included in these paragraphs is required for troubleshooting the HVAC system on Multiplex vehicles.

7.1 HVAC SYSTEM AND TEST MODE FOR SWITCHES AND SENSORS

When in switch/sensor test mode (see Section 06: ELECTRICAL for complete information), the A/C compressor HI and LO pressure values are displayed one after the other instead of the outside temperature in the telltale panel LCD display. This feature can be used when the vehicle is traveling to check the A/C compressor pressure values.

NOTE

When starting the A/C compressor wait 5 seconds before checking pressures in order to give the system a chance to build its pressure. During the first 5 seconds after startup, the compressor is active on 4 cylinders and the A/C valve is open regardless of the pressure readings.

In test mode, with the parking brake applied and the passenger set point set to a value higher than 64°F (18°C), the hot water circulating pump is not set to OFF as it would normally do when the outside temperature gets above 50°F (10°C). This feature allows verification of the pump when inside a garage. This is also useful when working on the heating system to remove air pockets trapped in the system.

If you do need to shut-off the hot water circulating pump for an A/C cooling test in switch/sensor test mode, set the passenger set point temperature to the minimum 64°F (18°C).

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7.2 HVAC SYSTEM AND TEST MODE FOR ELECTRIC MOTORS

The test mode allows testing the motors and electric contactors without the need to have the engine running (see Section 06: ELECTRICAL under "TEST MODE FOR ELECTRICAL MOTORS" for complete information).

Use this test mode for testing of the condenser motors, the A/C compressor clutch activation, right unloader, evaporator motor, water pump, hot water solenoid valve and overhead compartment air register fan.

7.3 MODES OF OPERATION

Conditions for engaging the 2 nd speed on the evaporator motor (cooling demand).	The 2 nd speed engages if the cabin or passenger's area temperature is 1 degree above the set point and it revert to speed 1 if the temperature gets equal or below the set point.
Conditions for hot water recirculating pump activation (heating demand).	The pump turns to OFF if the outside temperature is above 50°F (10°C), when there is less demand for heating. Note: To test pump operation, it is possible to keep it active even if the outside temperature is above 50°F (10°C). See paragraph 7.2 HVAC SYSTEM AND TEST MODE FOR ELECTRIC MOTORS.
The compressor unloader operation is based on pressure and on the difference between the passenger's area temperature and set point.	<p>2 right compressor cylinders:</p> <p>Stop if: Driver's or passenger's area temperature is less than 0.2°C degree above the set point or if compressor discharge pressure is above 280 psi, or if compressor input pressure is below 23 psi.</p> <p>Restart if: Cabin or passenger's area temperature is 0.7°C or more above the set point and compressor discharge pressure is less than 220 psi and compressor pressure input pressure is above 32 psi.</p>
The A/C deactivation pressure is 320 psi.	<p>In case of high pressure, the analog pressure sensor connected to the Multiplex module deactivates the compressor.</p> <p>There is also a « Pressure switch » adjusted to 350 PSI that acts to stop the compressor in the instance that the Multiplex module fails.</p>

7.4 HVAC SYSTEM TROUBLESHOOTING

Problem/Symptom	Probable Causes	Actions
No temperature control in the cabin or passenger area Passenger temperature display indicates two dashes "--"	Problem with the temperature sensor located in the evaporator compartment air intake or the sensor wiring	Instruct the driver to manually control the temperature by playing with the passenger set point. Set above 22°C (72°F) to heat and below 22° C (72°F) to cool
Defroster fan not functioning	Module A47 is not powered or is faulty	<ol style="list-style-type: none"> 1. Check the SYSTEM DIAGNOSTIC menu of the message center display (MCD). Select FAULT DIAGNOSTIC and ELECTRICAL SYSTEM. The message "Voltage Module A47, Value too Low, Active" confirms a power problem on the module 2. Check / reset circuit breaker CB2 or CB6 3. Check / replace fuse F5 4. Use the air release valves near the entrance door and in the front service compartment to lock / unlock the door
HVAC condenser fans not functioning in speed 1	Circuit breaker CB5 or CB7 was manually tripped and not reset Seized bearing Bad wiring	Check / reset circuit breaker CB5 or CB7
HVAC condenser fans not functioning in speed 1	Module A54 is not powered or is faulty	<ol style="list-style-type: none"> 1. Check the SYSTEM DIAGNOSTIC menu of the message center display (MCD). Select FAULT DIAGNOSTIC and ELECTRICAL SYSTEM. The message "Voltage Module A54, Value too Low, Active" confirms a power problem on the module 2. Check / reset circuit breaker CB5 or CB7 3. Check / replace fuse F67 , F68
HVAC condenser fans not functioning in speed 2	Circuit breaker CB5 or CB7 was manually tripped and not reset Seized bearing Bad wiring	Check / reset circuit breaker CB5 or CB7
Defroster fan is functioning but no heat or cooling available in the driver's area	Module A46 is not powered or is faulty Faulty speed control Bad wiring	<ol style="list-style-type: none"> 1. Check the SYSTEM DIAGNOSTIC menu of the message center display (MCD). Select FAULT DIAGNOSTIC and ELECTRICAL SYSTEM. The message "Voltage Module A46, Value too Low, Active" confirms a power problem on the module. 2. Check / reset circuit breaker CB1 or CB7 3. Check / replace fuse F12

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Problem/Symptom	Probable Causes	Actions
The A/C compressor clutch does not engage	Module A52 is not powered or is faulty	<ol style="list-style-type: none"> 1. Check the SYSTEM DIAGNOSTIC menu of the message center display (MCD). Select FAULT DIAGNOSTIC and ELECTRICAL SYSTEM. The message "Voltage Module A52, Value too Low, Active" confirms a power problem on the module 2. Check / reset circuit breaker CB5 or CB7. 3. Check / replace fuse F65
Evaporator fan not functioning	Circuit breaker CB3 or CB4 tripped Module A54 is not powered or is faulty	<ol style="list-style-type: none"> 1. Check / reset circuit breaker CB3 or CB4 2. Check the SYSTEM DIAGNOSTIC menu of the message center display (MCD). Select FAULT DIAGNOSTIC and ELECTRICAL SYSTEM. The message "Voltage Module A54, Value too Low, Active" confirms a power problem on the module 3. Check / reset circuit breaker CB4 or CB5 4. Check / replace fuse F67 , F68

8. CENTRAL AIR CONDITIONING SYSTEM

The schematic of Figure 19 shows the A/C systems and their components.

The central system is equipped with a 4 cylinder, 4NFCY Bitzer compressor with an air conditioning capacity of 7½ tons. The receiver tank and filter dryer are mounted inside the condenser compartment.

X3-45 VIP and XLII Bus Shells may be supplied with a central or small A/C system (Figure 19 and Figure 35). For vehicles equipped with a small A/C system, refer to paragraph 10: SMALL AIR CONDITIONING SYSTEM AND COMPONENTS further in this section.

8.1 A/C CYCLE

Refrigeration may be defined as "the transfer of heat from a place where it is not wanted to a place where it is unobjectionable". Components required for a closed circuit refrigeration system are shown in Figure 19.

The air conditioning system used on X series vehicles is of the "Closed" type using "R-134a".

1. The refrigerant flowing to the compressor is compressed to high pressure and reaches a temperature higher than the surrounding air. It is passed through the air-cooled fins and tubes of the condenser causing the hot, high

pressure gas to be condensed into a liquid form.

2. The liquid refrigerant flows to the receiver tank, then passes through a filter dryer where moisture, acids and dirt are removed and then through a moisture indicator which indicates if any moisture is present in the system.
3. By its own pressure, the liquid refrigerant flows through a thermal expansion valve where the pressure drop causes the refrigerant to vaporize in a vapor-liquid state at a low temperature pressure.
4. The cold low pressure refrigerant passes through the passengers and the driver's evaporator coils which absorbs heat from the air passing over the fins and tubes, and changes into gas. In this form, the refrigerant is drawn into the compressor to repeat the air conditioning cycle.
5. The success of the air conditioning system depends on retaining the conditioned air within the vehicle. All windows and intake vents should be closed. An opening of approximately 8 in² (5162 mm²) could easily neutralize the total capacity of the system.
6. Other causes of inadequate cooling are dirty coils or filter. Dirt acts as insulation and is also serves as a restriction to the air flow.

7. The refrigeration load is not constant and varies. It is also affected by outside temperature, relative humidity, passenger load, compressor speed, the number of stops, etc.
8. The compressor will load or unload depending on operating conditions.

8.2 REFRIGERANT

The A/C system of this vehicle has been designed to use Refrigerant 134a as a medium. Regardless of the brand, only R-134a must be used in this system. The chemical name for this refrigerant is Ethane, 1, 1, 1, 2-Tetrafluoro.

DANGER

Refrigerant in itself is nonflammable, but if it comes in contact with an open flame, it will decompose.

8.2.1 Procurement

Refrigerant is shipped and stored in 30 and 100 pound (13,6 and 45 kg) metal cylinders. Approximately 24 pounds (10,9 kg) are used in the central system. If vehicle is equipped with an auxiliary A/C system, then approximately 5.5 lbs (2,5 kg) will be needed.

It will be impossible to draw the entire refrigerant out of the cylinder. However, the use of warm water when charging the system will assure the extraction of a maximum amount of refrigerant from the cylinder.

8.2.2 Precautions in Handling Refrigerant

1. Do not leave refrigerant cylinder uncapped.
2. Do not subject cylinder to high temperatures, do not weld or steam clean near system or cylinder.
3. Do not fill cylinder completely.
4. Do not discharge vapor into an area where a flame is exposed.
5. Do not expose the eyes to liquid refrigerant.

All refrigerant cylinders are shipped with a heavy metal screw cap. The purpose of the cap is to protect the valve and safety plug from damage. It is a good practice to replace the cap after each

use of the cylinder for the same reason. If the cylinder is exposed to the sun's radiant heat pressure increase resulting may cause release of the safety plug or the cylinder may burst.

For the same reason, the refrigerant cylinder should never be subjected to excessive temperature when charging a system. The refrigerant cylinder should be heated for charging purposes by placing it in 125°F (52°C) water. Never heat above 125°F (52°C) or use a blowtorch, radiator, or stove to heat the cylinder. Welding or steam cleaning on or near any refrigerant line or components of the A/C system could build up dangerous and damaging pressures in the system.

If a small cylinder is ever filled from a large one, never fill the cylinder completely. Space should always be allowed above the liquid for expansion. Weighing cylinders before and during the transfer will determine the fullness of the cylinders.

WARNING

One of the most important precautions when handling refrigerant consists in protecting the eyes. Any liquid refrigerant which may accidentally escape is approximately -40°F (-40°C). If refrigerant comes in contact with the eyes, serious injury could result. Always wear goggles to protect the eyes when opening refrigerant connections.

8.2.3 Treatment in Case of Injury

If liquid refrigerant comes in contact with the skin, treat the injury as if the skin was frost-bitten or frozen. If liquid refrigerant comes in contact with the eyes, consult an eye specialist or doctor immediately. Give the following first aid treatment:

1. Do not rub the eyes. Splash eyes with cold water to gradually bring the temperature above the freezing point.
2. Apply drops of sterile mineral oil (obtainable at any drugstore) in the eyes to reduce the possibility of infection. The mineral oil will also help in absorbing the refrigerant.

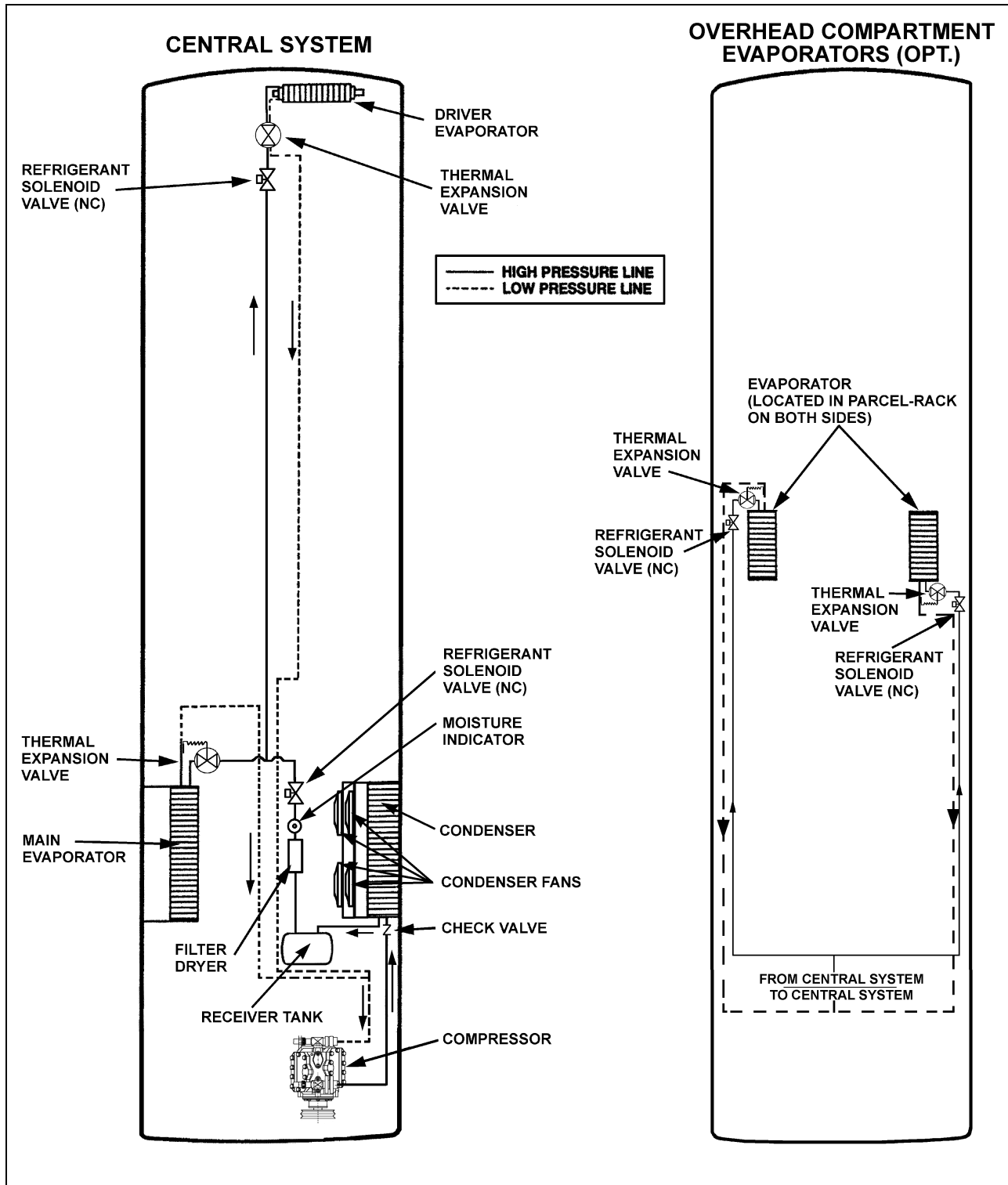



FIGURE 19: REFRIGERANT CIRCUIT (CENTRAL AND OVERHEAD COMPARTMENT)

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8.2.4 Precautions in Handling Refrigerant Lines

1. All metal tubing lines should be free of kinks, because of the resulting restrictions on the flow of refrigerant. A single kink can greatly reduce the refrigeration capacity of the entire system.
2. The flexible hose lines should never be allowed to come within a distance of 2-1/2" (6,3 cm) from the exhaust manifold.
3. Use only sealed lines from parts stock.
4. When disconnecting any fitting in the refrigeration system, the system must first be discharged of all refrigerant. However, proceed very cautiously, regardless of gauge readings. If liquid refrigerant happens to be in the line, disconnect fittings very slowly, keeping face and hands away so that no injury can occur. If pressure is noticed when fitting is loosened, allow it to bleed off very slowly.

	<p>WARNING</p>
<p>Always wear safety goggles when opening refrigerant lines.</p>	

5. Any line is opened to the atmosphere should be immediately capped to prevent entrance of moisture and dirt.
6. The use of the proper wrenches when making connections on O-ring fittings is important. The use of improper wrenches may damage the connection. The opposing fitting should always be backed up with a wrench to prevent distortion of connection lines or components. When connecting the flexible hose connections, it is important that the swaged fitting and the flare nut, as well as the coupling to which it is attached, be held at the same time using three different wrenches to prevent turning the fitting and damaging the ground seat.
7. The O-rings and seats must be in perfect condition. The slightest burr or piece of dirt may cause a leak.
8. O-rings should be coated with refrigeration oil and installed on the line before the line is inserted into the fitting to prevent damaging the O-ring. If leaks are encountered at the

couplings or connectors, no attempt should be made to correct the leaks by tightening the connections beyond the recommended torque. The O-rings are designed to seal at the specified torque and overtightening the connection does not result in a satisfactory and permanently sealed connection. The connection must be disassembled and the cause of the leak (damaged O-ring, defective lines, etc.) corrected. Use new O-ring.

8.2.5 Auxiliary System Refrigerant Lines


1. From the inside of the coach, remove the mirror located inside the lavatory to access the Y connector separating the system two sides. Also a small access panel located in front of the lavatory entrance door, near the ceiling enables to reach the R.H. side supply and return line fittings.
2. The L.H. side supply and return line fittings are accessible by removing the rearmost overhead storage compartment separator.

8.3 PUMPING DOWN

This procedure is intended to reduce refrigerant loss, on the central system only, by isolating it in the compressor and the receiver tank, as well as in their connecting line, in order to carry out repairs on other sections of the air conditioning system (lines and components).

<p><i>NOTE</i></p>
<p><i>Before attempting any repair between compressor and receiver tank, use a recovery unit to remove refrigerant from the system.</i></p>

<p><i>NOTE</i></p>
<p><i>On vehicles equipped with an auxiliary A/C system, refer to "ICE TM-16HD Service Manual".</i></p>

	<p>WARNING</p>
<p>To prevent any injury, when air conditioning system must be opened, refer to previous paragraph "PRECAUTIONS IN HANDLING REFRIGERANT".</p>	

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CAUTION


The filter dryer must be changed each time a line in the system is opened.

Procedure

1. Energize cabin or passenger section liquid solenoid valve.
2. Run the system for 10 minutes, shut it OFF, then close the receiver tank outlet valve by turning it clockwise, backseat the suction service valve on the compressor, install an appropriate pressure gauge set, and turn the valve forward ¼ turn to enable a visual check of the suction pressure.
3. Disconnect the “Low Pressure Switch” connector (mounted near the A/C compressor, and install a jumper wire.

NOTE

This jumper wire will allow the clutch to remain engaged after pressure drops below 15 psi (103,5 kPa).

4. Start the engine, press the “Passenger ON/OFF” switch then adjust (lower) temperature control  to maximum A/C.
5. Run the compressor until pressure reaches 1-2 psi (7-14 kPa).

NOTE

During this operation, care must be taken not to fill the receiver tank over the upper sight glass. If so, stop process immediately. Always allow refrigerant piping and units to warm up to the ambient air temperature before opening system or sweating will take place inside the lines.

6. Stop engine, and close compressor outlet valve by turning it clockwise until valve is properly seated.
7. Close compressor suction valve by turning it clockwise until it is properly seated.
8. Wait until pressure gauge reaches 1 to 2 psi (7 to 14 kPa). To accelerate procedure, lightly open compressor suction valve until pressure reaches this value.

8.4 ADDING REFRIGERANT (VAPOR STATE)

Addition of vapor state refrigerant is carried-out to compensate for hose permeation and shaft seal losses over a long period.

A typical sign of refrigerant low charge would be A/C lower performance experienced by the user.

Perform the usual leak inspection and correct any leaks before adding refrigerant.

8.4.1 Verification

Perform the following verifications:

- 1- A vehicle stopped for more than 4 hours should show the lower receiver tank sight glass full at room temperature or with some level if ambient temperature is high. This method is less accurate when ambient temperature gets high.
- 2- With the AC on for at least 10 minutes, the moisture indicator sight glass should be clear, not milky. The filter-dryer nearby should be near constant temperature, less than 5°F differential between inlet and outlet. A partially blocked filter will make some flash gas and give a “milky” sight glass.
- 3- At fast idle, the high side pressure should be near the following calculation: add 30° F to the ambient temperature in Fahrenheit. In the refrigerant chart, find this temperature and the corresponding saturation pressure and add 10 psi for the pressure drop between compressor and condenser.

NOTE

Calculation example:

At 70°F outside, add 30°F. In the chart, find the pressure value for a temperature of 100°F. For 134a refrigerant gas, you will find a value of 124psi. Add 10psi to this value for the compressor to condenser line, this result gives 134 psi. So a high side pressure value between 129 to 139 psi should be OK

8.4.2 Refrigerant addition

1. Install a heated refrigerant bottle at the back of the vehicle, on a scale, straight up.

Refer to section “Precautions in Handling Refrigerant” for the proper heating method.

NOTE

Use a bottle that is more than half full.

Always charge the system with the cylinder upright and the valve on top to avoid drawing liquid out of the cylinder.

2. Connect the yellow hose of your manifold gage set to the red (vapor) valve on the bottle. Connect the blue valve of the gage set on the suction side of the compressor. Connect the red valve of the gage set to the discharge side. Hoses should be purged of air at installation.



WARNING

Secure manifold gage hoses so they will not be damaged by engine belts and pulley.

3. Open the suction and discharge valve to mid-point.
4. In order to speed up the charging, unplug unloaders to keep all compressor cylinders active.
5. Let the door and hatches open and maybe open side windows to prevent cooling down the coach too rapidly. Preferably, the interior would be hot, at least over 68 F.
6. Open the condenser door, if not already done.



WARNING

If discharge pressure is above 138 psig, the condenser fans will be running. Keep hands clear of fans

7. Start engine.
8. Switch to fast idle for faster fill and battery protection.
9. Open the blue gage valve. The suction pressure should go up meaning the compressor is sucking from the tank also. If there is almost no pressure rise, the tank is too low or too cold.
10. Check the moisture indicator sight glass and the discharge pressure to meet the criteria described above.
11. When the sight glass gets clear, you can add some reserve, up to 2 pounds, as long as the high pressure does not move up.

12. When finished, close gage valves and bottle valve.
13. Before stopping the engine, check the compressor oil level and note it in the repair book as well as the amount of refrigerant added.
14. Shut down engine and backseat suction and discharge valves.
15. Remove gages and replace caps.
16. Perform a road test for final verification.

8.5 EVACUATING SYSTEM

1. Open both receiver valves by turning "out" (normal position).
2. Remove the caps from the two 90° adapters on the suction, discharge valves and connect two hoses to the vacuum.
3. Place the two compressor valves, suction and discharge, in neutral position by turning each one 3 to 4 turns "in" from the "out" position.
4. Open the solenoid valve by energizing or manually bypass.
5. Start the vacuum pump. Open the large (suction) shutoff valve and close the small vacuum gauge valve.
6. The pressure will drop to approximately 29 inches vacuum (14.2 psi or 97,9 kPa) (the dial gauge only gives a general idea of the absolute system pressure).
7. Backseat the compressor valves by turning "out" all the way.
8. Shut down the vacuum pump.
9. Remove the hoses.
10. Reinstall the caps at the suction valve take-off points.

8.5.1 Double Sweep Evacuation Procedure

1. Remove any remaining refrigerant from the system using a refrigerant recovery machine.
2. Connect the evacuation manifold, vacuum pump, hoses and micron gauge to the unit.
3. With the unit service valves closed (back seated) and the vacuum pump and the

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thermistor valves open, start the pump and draw the manifold and hoses into a very deep vacuum. Shut the vacuum pump off and see if the vacuum holds. This is to check the setup for leaks.

4. Midseat the system service valves.
5. Open the vacuum pump and the thermistor valves. Start the pump and evacuate to a system pressure of 2000 microns.
6. Close the vacuum pump and the thermistor valves, turn off the vacuum pump (closing the thermistor valve protect the valve from damage).
7. Break the vacuum with clean refrigerant (or dry nitrogen) and raise the pressure to approximately 2 PSIG. Monitor the pressure with the compound gauge.
8. Remove the refrigerant with the recovery machine.
9. Repeat steps #5 – 8 one time.
10. After the second “sweep”, change the filter drier (if you have not yet done so) and evacuate to 500 microns.
11. Evacuating the system below 500 microns on systems using the compressor may risk drawing air into the system past the carbon shaft seal.
12. Check to ensure that vacuum holds. (If the pressure continues to rise, it indicates a leak or moisture in the system).
13. Charge the system with the proper amount of refrigerant using recommended charging procedures.

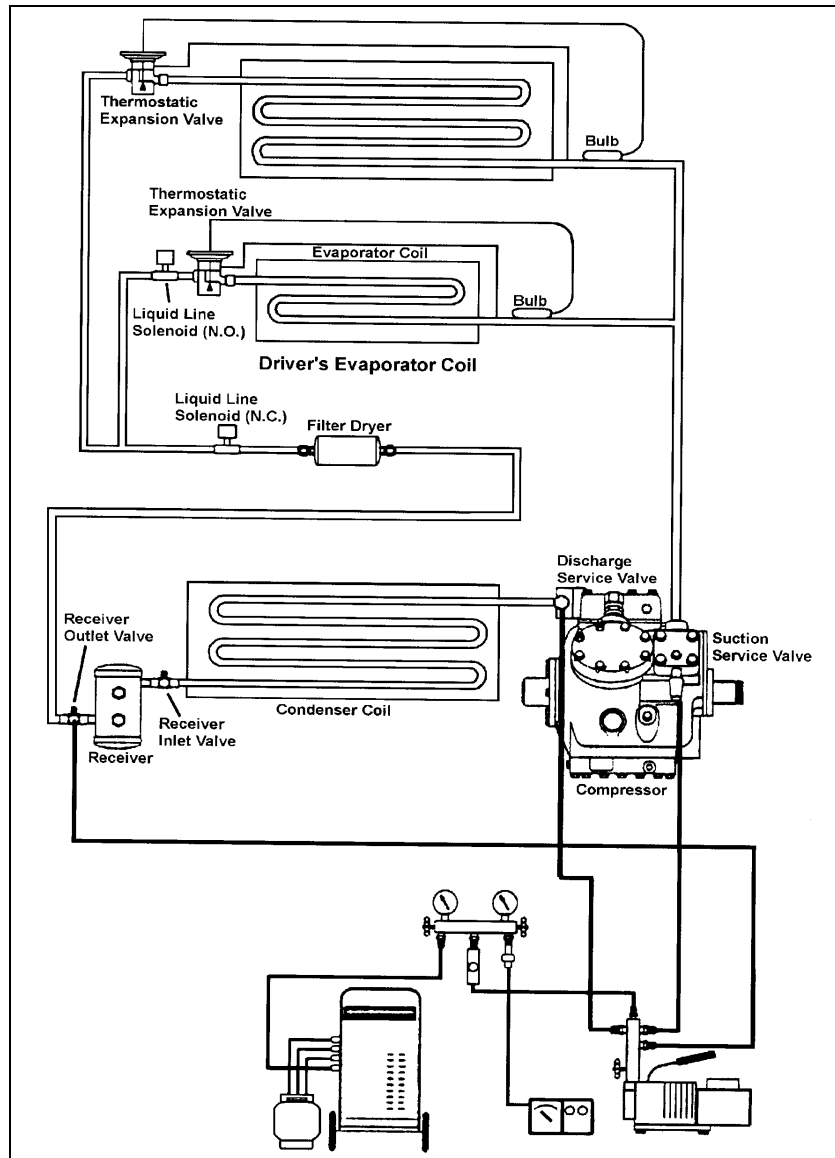


FIGURE 20: DOUBLE SWEEP EVACUATION SET-UP

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NOTE

This method will aid in preventing unnecessary system failures by ensuring that the refrigeration system is free of contaminants.

8.6 CHARGING SYSTEM

When a system has been opened or if there are any questions about the air or moisture in the system, evacuate the system. Charging of an evacuated system may be accomplished by forcing liquid R-134a directly into the receiver tank. This may be accomplished by placing the refrigerant cylinder upside down on a scale with the valves at the bottom. This ensures that only liquid will enter the receiver tank.

When charging an empty system, weigh the amount of refrigerant put into the system. This will eliminate any possibility of overfilling. A nominal charge requires 24 pounds (10,9 kg). If the vehicle is equipped with an auxiliary system, a full charge requires an additional 2 lbs (1 kg).

1. Backseat the two compressor shutoff valves ("out").
2. Install the test gauges at the shutoff valves noting that the 400 psi (2758 kPa) gauge is connected to the discharge.
3. Turn in the two shutoff valves 3 to 4 turns.
4. Open the lower receiver valve by turning "out" all the way.

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5. Backseat the upper receiver valve by turning out all the way.
6. Remove the cover cap from the service fitting in the top receiver valve.
7. Attach a charging hose to the R-134a tank. Open the tank valve slightly permitting R-134a to escape thus purging the hose of air.
8. Connect the charging hose to the service fitting.
9. Open the R-134a tank valve.
10. To build up pressure in the receiver tank, heat the receiver tank with a heating blanket.
11. Turn in the upper receiver valve several turns. The R-134a will now enter the system.
12. The proper charge of R-134a is 24 lbs (10.89 kg). When the scale indicates this amount of charge, backseat the receiver valve and close the R-134a tank valve.
13. Disconnect the charging hose. Replace the cover caps.
14. The system is now ready for operation.



CAUTION

The evacuation of the system must be made by authorized and qualified personnel only. Refer to local laws for R-134a recuperation.

8.7 REFRIGERANT SYSTEM CLEAN-OUT AFTER COMPRESSOR FAILURE

Although the vast majority of reciprocating refrigerant compressors manufactured today are extremely reliable, a small percentage do fail. These failures usually result in minor or extensive system contamination depending on the severity of the failure. When an open type compressor becomes damaged internally, this provokes small particles of bearings, steel, brass, copper, and aluminum and, in severe cases, carbonized oil, which could contaminate the system. To prevent repeated failures, the problem which caused the failure should be corrected, and depending upon the severity of the failure, the system should be thoroughly cleaned out using one of the clean-out procedures mentioned.

8.7.1 Determining Severity of Failure

The severity of compressor failure can be categorized as minor or major. A failure is considered minor when the contamination is limited to the compressor with little or no system contamination. A major failure, or burnout, results in extensive system contamination as well as compressor damage. Extensive system contamination can be determined by withdrawing a small sample of compressor oil and checking its color, odor and acidity. A Virginia Chemical "TKO" one step acid test kit is one of several compressor oil test kits that may be used. A high acid content would indicate a major failure or burnout. A small amount of refrigerant gas may be discharged. A characteristic burned odor would also indicate severe system contamination.

8.7.2 Clean-out after Minor Compressor Failure

1. Be sure to correct the problem which caused the failure.
2. Change liquid line filter dryer.
3. Run the unit for 2 hours on high speed cool only.
4. Check compressor oil level to ensure compressor is not overcharged with oil. Sometimes a significant amount of oil is pumped out of the compressor to other parts of the system when a compressor fails. This oil will return to the replacement compressor when it is started, causing an overcharge of oil in the sump of the replacement compressor. In this case, it is important that the oil level be adjusted to the proper level.
5. Withdraw a sample of the compressor oil and check its color, odor, and acidity, using instructions supplied above. If the oil is contaminated, change the oil and filter dryer, and repeat the procedure until the system is clean.

8.7.3 Clean-out After Major Compressor Failure

1. Reclaim the refrigerant into a refrigerant bottle through a filter dryer to filter out contaminants.
2. Remove the failed compressor and repair it if possible.

3. Install new or repaired compressor.
4. Change the filter dryer.
5. Circulate clean R-134a or nitrogen using a pressurized metal cylinder or a reclaiming machine to clean out many of the contaminants collected in the coil valves, TXV (Thermal Expansion Valve), solenoid valves, check valves, and any other mechanical component that may have collected contaminants.
6. Evacuate and charge the system normally.
7. Run the unit for 8 hours and monitor the pressure drop across the filter dryer. Also check the liquid line dryer for signs of restriction. If the pressure drop across the filter dryer exceeds 12 to 14 psig (82,75 to 96,5 kPa) with a 40°F (5°C) evaporator coil temperature, stop the unit and change the liquid line and suction line filter dryer. After 4 or 5 hours of operation, stop the unit and replace the filter dryer.
8. After 8 hours of operation, stop the unit and remove a sample of the compressor oil and check its color, odor, and acidity, using instructions supplied above. If the oil is contaminated, replace the oil and repeat step 7. If the oil is not contaminated, change the filter dryer again and replace the moisture-liquid indicator.
9. After approximately 7 days of operation, recheck the compressor oil for cleanliness and acidity.

1. Open engine compartment rear doors and locate the belt tensioner. Release pressure and tension on belts.
2. Remove the radiator fan driving mechanism belt (Refer to Section 05: Cooling).
3. Slip the old A/C compressor belts off and the new ones on.

NOTE


Double belts must always be replaced in pairs to ensure equal distribution of load on each belt.

9. CENTRAL A/C SYSTEM COMPONENTS

9.1 COMPRESSOR (CENTRAL SYSTEM)

The compressor for the central A/C system is a Bitzer 4 cylinder 4NFCY. Refer to the "Specifications" section at the end of this chapter.

9.1.1 Belt Replacement

	DANGER
<p>Set the battery master switch to the "Off" position. For greater safety, set the engine starter selector switch in engine compartment to the "Off" position.</p>	

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9.1.2 Belt Tension Adjustment –A/C drive belt

On the mechanical tensioner, slightly slack lock bolt (A). Adjust tension by turning adjustment screw (B). Tighten the lock bolt (A) to 43 lbf-ft. to preserve adjustment.

Should the idler bearing need to be serviced, tighten shoulder bolt (C) to 74 lbf-ft. at reassembly.

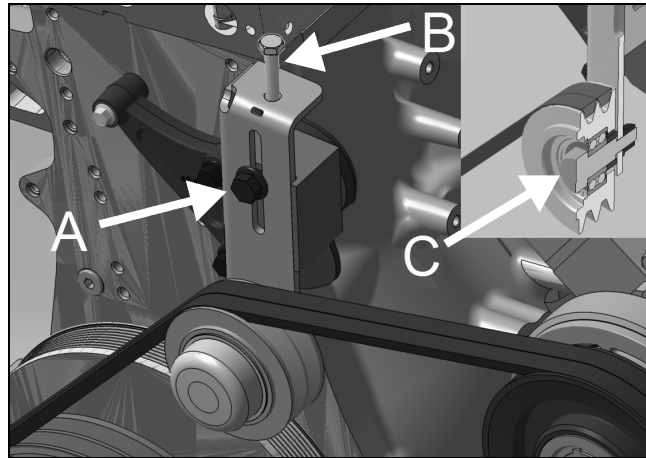


Figure 21: Tensioner on standard belt ARRANGEMENT

Belt tensions should be within the following values:

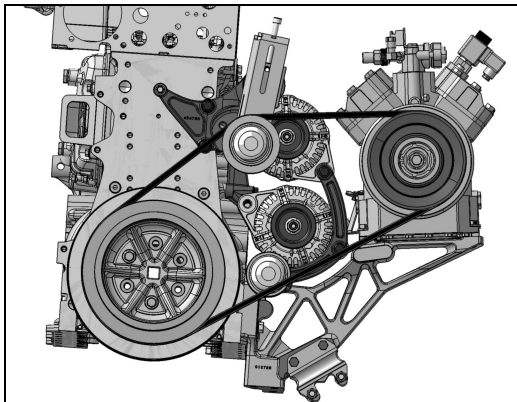


FIGURE 22: STANDARD BELT ARRANGEMENT

BX71 Double Belt

90 - 100 lbs. – new

75 - 85 lbs. - used

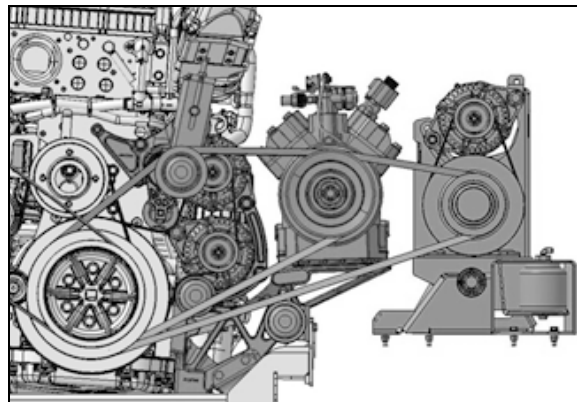


FIGURE 23: THREE ALTERNATOR BELT ARRANGEMENT

5VX810 Single Belt

150 - 160 lbs. – new

120 - 130 lbs. – used


5VX918 Single Belt to 3rd alternator

Automatic, by pneumatic tensioner.

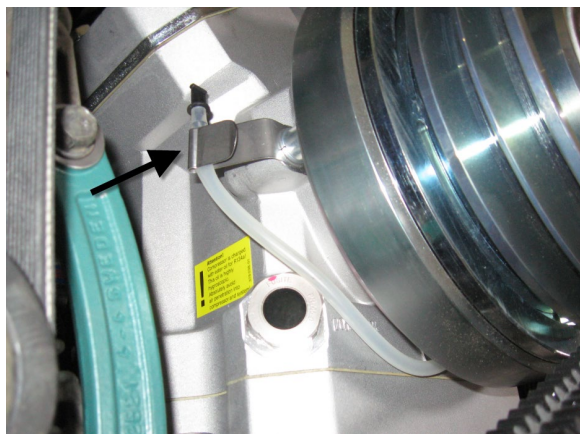
For vehicles equipped with a 3rd alternator (Fig 24), belt tensioning is applied through air bellows which is adjusted by an air pressure regulating valve (Fig 36). The correct pressure of 30 psi (207 kPa) is set at the factory. Periodically verify the pressure at the regulating valve using a pressure gauge and correct if required.

9.1.3 Compressor Maintenance

For the maintenance of the A/C compressor, see the manufacturer's instructions included at the end of this section.

 CAUTION
Use only Bitzer BSE55 (POE) oil with refrigerant 134a.

Once every 6 months empty the shaft seal oil collecting tube. This tube collects oil seeping through the felt shaft seal.



During the 250 hour run-in period of the shaft seal, an increased oil leak rate may occur.

9.1.4 Troubleshooting Guide

A preliminary check may be made by simply feeling the cylinder heads with the unit in operation at ambient temperatures of 35°F (2°C) and over. The cylinder heads are internally divided into suction and discharge valves. The lower half of the cylinder head is the suction side, and it should be relatively cool to the touch, as opposed to the hot upper discharge side. If a valve plate or head gasket is blown, or a compressor unloader is stuck open, partially compressed refrigerant vapor will be circulated between the suction and discharge sides of the head. The affected cylinder head will then have a relatively even temperature across its surface and be neither as hot as the normal discharge temperature nor as cool as the normal suction temperature.

Blown Head Gaskets

Symptom:

- * Loss of unit capacity at low temperature.
- * Even cylinder head temperature.

Cause:

- * Improperly torqued cylinder head bolts.
- * Improperly positioned gasket at assembly.
- * Warped cylinder head.
- * Severe liquid refrigerant floodback.

Blown Valve Plate Gaskets

Symptom:

- * Loss of unit capacity at medium and low temperatures.
- * Very hot cylinder head surface.
- * Higher than normal suction pressure.

Cause:

- * Improperly torqued cylinder head bolts.
- * Severe liquid refrigerant floodback.
- * Oil slugging caused by an overcharge of oil or flood starts.
- * Discharge valves not seated properly (liquid drainback during shutdown).

Broken Suction Valves

Symptom:

- * Loss of unit capacity at all temperatures.
- * Compressor unable to pull extremely low vacuum with suction service valve frontseated.

Cause:

- * Repeated liquid refrigerant floodback.
- * Flooded starts.
- * Overcharge of oil.
- * Discharge valves not seated properly (liquid drainback during shutdown).
- * Expansion valve not controlling properly.

Unloader Valve Stuck Open

Symptom:

- * Loss of unit capacity at all temperatures.
- * Higher than normal suction pressure.

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- * Even cylinder head temperature.

Cause:

- * Unloader body stem bent.
- * Foreign material binding unloader piston or plunger.

9.2 MAGNETIC CLUTCH

Refer to Bitzer Maintenance Instruction KW-540-1 at the end of this section for the description and maintenance of the magnetic clutch.

9.3 EVAPORATOR MOTOR

The evaporator motor is installed in the evaporator compartment (L.H. side of vehicle) (Figure 24). It is a 27.5 volt, 2 HP (1.5 kW) motor which activates a double blower fan unit.

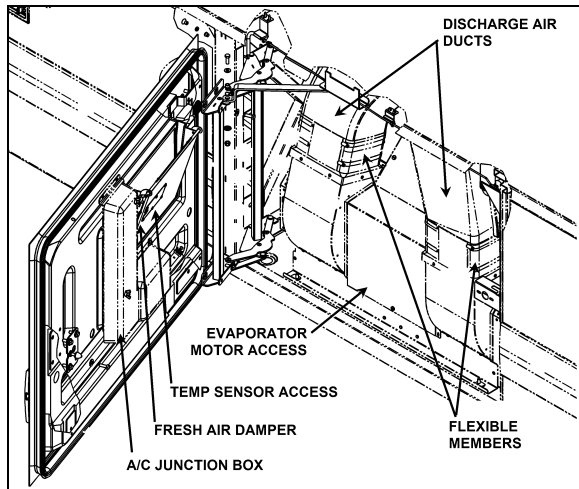


FIGURE 24: EVAPORATOR COMPARTMENT 22301_B

9.3.1 Removal

- Set the battery master switch (master cut-out) to the "OFF" position and trip circuit breakers CB3 or CB4.
- Open the last L.H. side baggage compartment door. Pull the black release button located on the L.H. side in order to unlock and open the evaporator compartment door.
- Remove the evaporator motor and coil access panel.
- Identify the L.H. side discharge duct inside compartment and remove the Phillips head screws retaining the flexible member to duct.
- Repeat step 4 for the R.H. side air duct.

- Disconnect the electrical motor speed control connections on the motor plate.
- From under the vehicle, remove the eight bolts retaining the evaporator fan motor support. Remove the complete unit from the evaporator compartment (Figure 25 & Figure 26).

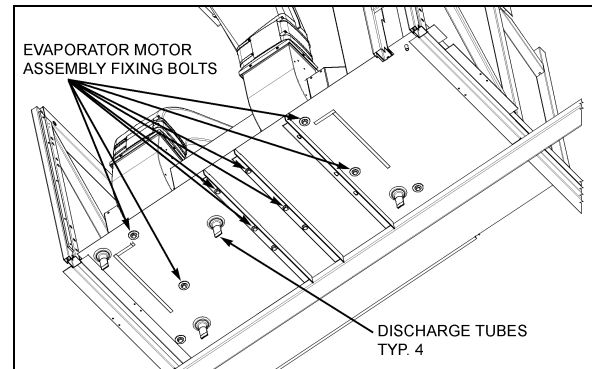


FIGURE 25: EVAPORATOR MOTOR BOLTS

22315



CAUTION

Never support evaporator motor by its output shafts while moving it.

- On a work bench, unscrew the fan square head set screws, the Phillips head screws retaining cages to support and slide out the assemblies from the evaporator motor output shaft.

9.3.2 Installation

To reinstall the evaporator motor, reverse "Evaporator Motor Removal" procedure.

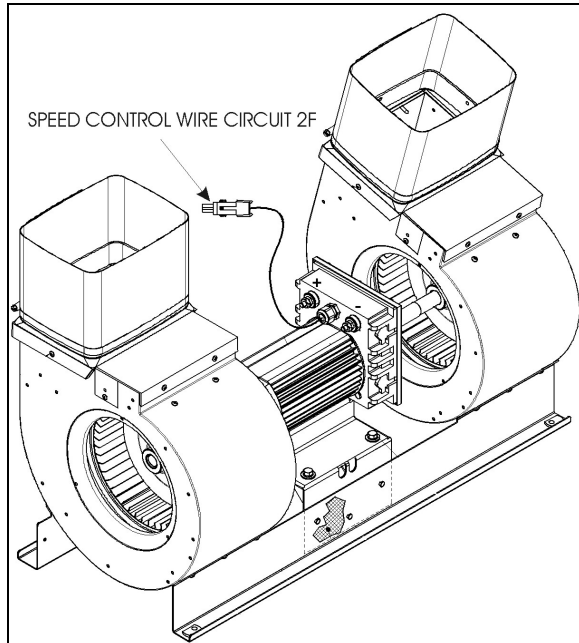


FIGURE 26: EVAPORATOR MOTOR ASSEMBLY

9.4 CONDENSER

The central A/C system condenser coil is hinge mounted on the R.H. side of the vehicle on the A/C condenser door (Figure 29). The condenser coil for vehicles equipped with an auxiliary A/C system is mounted on the outer face of engine radiator. Since condenser's purpose is to dissipate heat from the hot refrigerant, it is important to keep the cooling coils and fins clean. A clogged coil will cause high discharge pressure and insufficient cooling.

9.4.1 Condenser Fan Motors

Four brushless fan motors (Figure 28), 28.5 V - (0.6 HP - 0.42 kW) are installed in the condenser compartment on R.H. side of vehicle in order to ventilate the condenser coil. They are mounted on a support, fastened to the door. The fans pull outside air through the condenser coil and discharge it through an opening at bottom of compartment. When temperature drops inside condenser, the pressure in the refrigerant line also drops and it is, therefore, no longer required to cool condenser. Consequently, when pressure drops to 175 psi, the motors will run at half speed and if the pressure continues to drop to 120 psi, a pressure switch stops the motors so that fans do not operate needlessly. When pressure rises to 145 psi, the pressure switch reactivates the motors at half speed. If the pressure rises to 205 psi, the motors will switch to full speed.

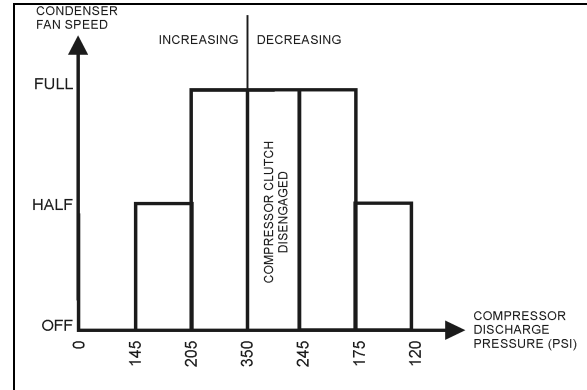


FIGURE 27: CONDENSER FAN SPEED IN RELATION WITH HIGH SIDE PRESSURE

For details about electrical wiring, refer to "A/C and Heat system" in the master wiring diagram.

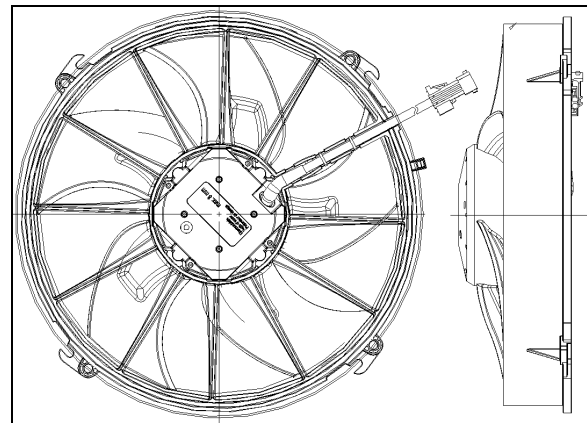


FIGURE 28: CONDENSER FAN MOTOR

22322

9.4.2 Condenser Fan Motor Removal

1. Set the battery master switch to the "Off" position.
2. Disconnect wiring from terminals on motor. Tag each wire to aid in identification at time of reconnection.
3. Remove the four hexagonal head cap screws retaining the fan motor assembly to the mounting support.
4. Remove the motor.

9.5 RECEIVER TANK

The receiver tank is located in the condenser compartment (Figure 29). The function of the receiver tank is to store the liquid refrigerant. During normal operation, the level of the refrigerant should be approximately at the mid-point of the lower sight glass.

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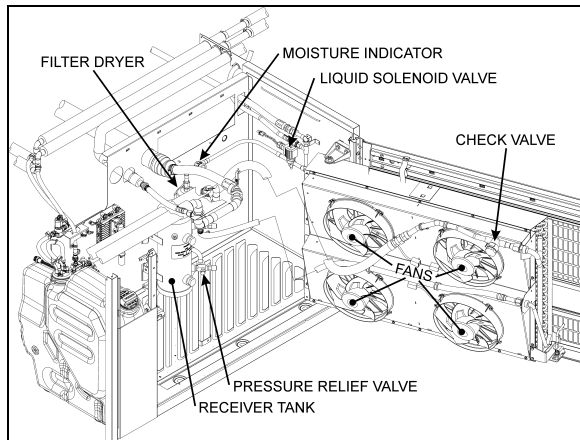


FIGURE 29: A/C CONDENSER COMPARTMENT 22323

In case of extreme pressure there will be a rise in the liquid receiver tank. A pressure relief valve will break at 450 psi (3103 kPa) and relieve the receiver tank pressure.

The receiver tank incorporates an inlet valve on the inlet side (upper section) which allows the tank to be isolated or serviced. An outlet valve on the outlet side (lower section) permits complete isolation from the rest of the system.

9.6 FILTER DRYER

A filter dryer, also located in the condenser compartment, is installed on the liquid refrigerant line after the receiver tank. It is used to absorb moisture and foreign matter from refrigerant before it reaches the expansion valves.

The filter should be replaced if the system has been opened or after a prolonged exposure, when the moisture indicator sight glass turns to pink.

A filter dryer, located close to the engine compartment L.H. side rear door, is installed on vehicles equipped with an auxiliary A/C system. Its function is similar to that of filter used on main systems. Replace only when system is opened or a problem occurs.

9.6.1 Replacement

The filter is of the disposable type. When replacement is required, remove and discard the complete unit and replace with a new unit of the same type according to this procedure:

1. Isolate the refrigerant in the receiver tank by following the "Pumping Down" procedure explained in this section
2. Change the filter dryer as a unit.

3. Add a small quantity of refrigerant R-134a to the low side of the system. Check for leaks. Return the system to normal operation.



CAUTION

Do not use carbon tetrachloride or similar solvents to clean parts. Do not use steam guns. Use mineral spirits or naphtha. All parts should be thoroughly cleaned. Use a stiff brush to wash dirt from grooves, holes, etc.



DANGER

Cleaning products are flammable and may explode under certain conditions. Always handle in a well-ventilated area.

9.6.2 Moisture Indicator

The moisture sensitive element consists of a color changing ring which is reversible from pink to blue and vice versa as the moisture content in the refrigerant changes. Pink indicates a wet refrigerant, light violet (caution) and blue indicates a dry refrigerant.

Since temperature changes affect the solubility, color change will also vary with the refrigerant temperature. The above table shows the color change for R-134a at various moisture levels and liquid line refrigerant temperatures.

COLOR INDICATOR			
TEMPERATURE	BLUE (ppm)	LIGHT VIOLET (ppm)	PINK (ppm)
75°F (24°C)	Below 5	5-15	Above 15
100°F (38°C)	Below 10	10-30	Above 30
125°F (52°C)	Below 15	15-45	Above 45
p.p.m.= parts per million (moisture content)			

A moisture level of less than 15 p.p.m. for R-134a indicated in the blue color range of the above table is generally considered dry and safe. A color indication of light blue to light violet indicates the caution range of moisture level. For positive protection, the drying of the system should be continued until the color of the element turns to deep blue.

The liquid refrigerant is readily visible through the center opening of the moisture element where the presence of bubbles indicates a shortage of refrigerant or restriction in line.

Moisture is one of the main causes of chemical instability or contamination in air conditioning systems. If moisture is present, it can corrode the valves, condenser and evaporator coils, compressor and other components causing a malfunction and eventual failure of the system. Uncontrolled moisture in the system can result in very expensive multiple component replacements if not corrected at an early stage. The moisture indicator permits an early detection of moisture in the system and when corrected by a desiccant charge, system contamination is greatly minimized.

9.7 LIQUID REFRIGERANT SOLENOID VALVE

The flow of liquid refrigerant to the driver's and main evaporators is controlled by a normally-closed solenoid valve. The driver's liquid solenoid valve is located on the ceiling of the spare wheel and tire compartment and is accessible through the reclining bumper.

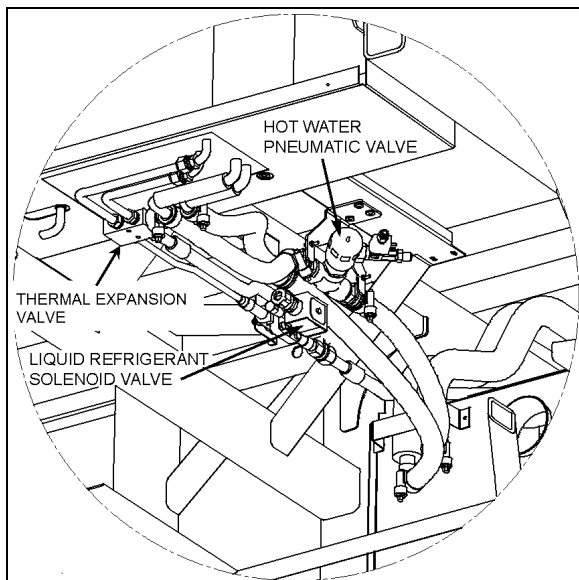


FIGURE 30: DRIVER'S EVAPORATOR LIQUID SOLENOID VALVE 22324

NOTE

An identical refrigerant solenoid valve is used on the auxiliary A/C system and is located near the auxiliary A/C unit.

9.7.1 Manual Bypass

This type of solenoid valve is equipped with a manual operating stem. The 3/16" square stem located on the bonnet is exposed when the seal cap is removed. To manually open valve, turn stem 1/2 turn counterclockwise. To manually close valve, turn stem clockwise until tight against seat. Manual stem must be in closed position for automatic electric operation.

9.7.2 Coil Replacement

1. Disconnect connector from the coil connector.
2. Take out the retaining screw at the top of the coil housing. The entire coil assembly can then be lifted off the enclosing tube.
3. Place the new coil and yoke assembly on the enclosing tube. Lay data identification plate in place.
4. Insert the coil retaining screw, rotate housing to proper position and tighten screw securely.
5. Connect connector from coil connector.

9.7.3 Valve Disassembly

1. Remove the coil as stated previously.
2. Pump down the system as stated earlier in this section.
3. Remove the four socket head screws which hold the body and bonnet together (Figure 31).
4. Carefully lift off the bonnet assembly (upper part of the valve) so that plunger will not fall out. The diaphragm can now be lifted out.

NOTE

The above procedure must be followed before brazing solder-type bodies into the line.



CAUTION

Be careful not to damage the machined faces while the valve is apart.

9.7.4 Valve Reassembly

1. Place the diaphragm in the body with the pilot port extension up.
2. Hold the plunger with the synthetic seat against the pilot port.

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3. Make sure the bonnet O-rings are in place. Lower the bonnet assembly over the plunger, making sure that the locating sleeve in the bonnet enters the mating hole in the body.
4. Insert the four socket head screws and tighten evenly.
5. Replace the coil as stated previously.
6. Add a small quantity of refrigerant R-134a to the low side of the system. Check for leaks. Return the system to normal operation.

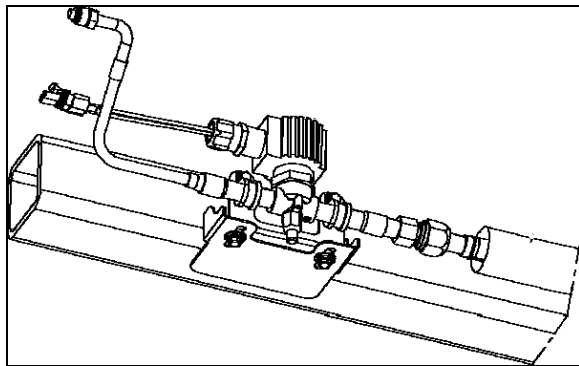


FIGURE 31: REFRIGERANT SOLENOID VALVE 22044

9.8 EXPANSION VALVE

9.8.1 Cabin or Passenger's Section HVAC Unit

The expansion valve for the cabin or passenger's section HVAC unit (Figure 32) is a thermo-sensitive valve with a remote control bulb head attached to the evaporator outlet line and is accessible by the evaporator coil access door (. The valve regulates the flow of refrigerant liquid into the evaporator coils and is controlled by the suction gas temperature leaving the evaporator. The bulb head senses the refrigerant gas temperature as it leaves the evaporator. High temperature will cause expansion and pressure on the power head and spring. Such action causes the assembly valve to open, allowing a flow of refrigerant liquid into the evaporator.

The remote bulb and power assembly is a closed system. The pressure within the remote bulb and power assembly corresponds to the saturation pressure of the refrigerant temperature leaving the evaporator and moves the valve pin in the opening direction. Opposed to this force, on the underside of the diaphragm and acting in the closing direction, is the force exerted by the superheat spring. As the temperature of the refrigerant gas at the

evaporator outlet increases above the saturation temperature corresponding to the evaporator pressure, it becomes superheated. The pressure thus generated in the remote bulb and power assembly surpasses the combined pressures of the evaporator pressure and the superheat spring, causing the valve pin to move in the opening direction. Conversely, as the temperature of the refrigerant gas leaving the evaporator decreases, the pressure in the remote bulb and power assembly also decreases and the combined evaporator and spring pressures cause the valve pin to move in the closing position.

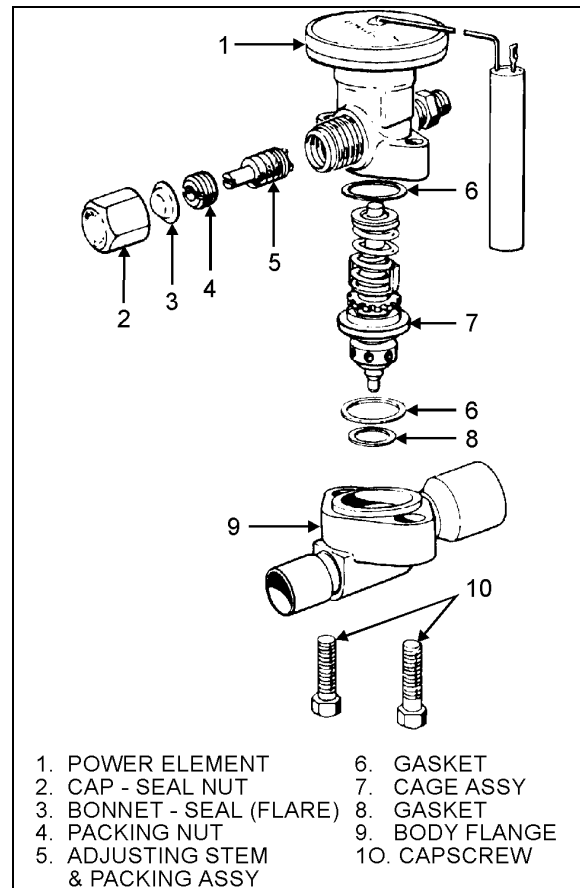


FIGURE 32: EXPANSION VALVE 22045

As the operating superheat is raised, the evaporator capacity decreases, since more of the evaporator surface is required to produce the superheat necessary to open the valve. It is obvious, then, that it is most important to adjust the operating superheat correctly and that a minimum change in superheat to move the valve pin to full open position, is of vital importance because it provides savings in both initial evaporator cost of operation. Accurate and sensitive control of the refrigerant liquid flowing

to the evaporator is necessary to provide maximum evaporator capacity under load conditions. The spring is adjusted to give 12 to 16° F (-11.1 to -8.8 ° C) of superheat at the evaporator outlet.

This ensures that the refrigerant leaving the evaporator is in a completely gaseous state when drawn into the suction side of the compressor. Liquid would damage the compressor valve, piston and heads if allowed to return in the suction line.

A vapor is said to be superheated when its temperature is higher than the saturation temperature corresponding to its pressure. The amount of the superheat is, of course, the temperature increase above the saturation temperature at the existing pressure.

As the refrigerant moves along in the evaporator, the liquid boils off into a vapor and the amount of liquid decreases until all the liquid has evaporated due to the absorption of a quantity of heat from the surrounding atmosphere equal to the latent heat of vaporization of the refrigerant. The gas continues along in the evaporator and remains at the same pressure. However, its temperature increases due to the continued absorption of heat from the surrounding atmosphere. The degree to which the gas refrigerant is superheated is related to the amount of refrigerant being fed to the evaporator and the load to which the evaporator is exposed.

Superheat Adjustment

The starting method of adjusting the superheat is to unscrew completely the main evaporator expansion valve adjusting screw, then screw in 13 turns clockwise for 134A (Figure 33). Afterwards, the following procedure should be followed:

1. Operate coach for at least one-half hour at fast idle with temperature control set at 82°F (27,7°C), Then set temperature to minimum to keep the compressor on 6 cylinders.
2. Install pressure gauge at the evaporator suction header. You may install the pressure gauge at compressor suction, but then add 3 psi to reading.

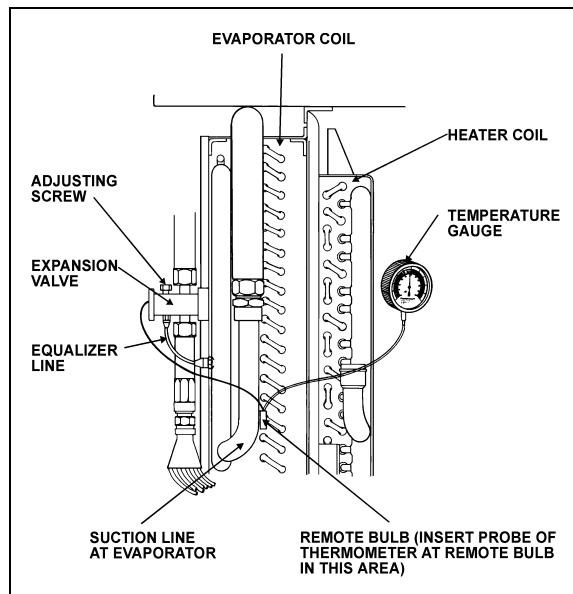


FIGURE 33: SUPERHEAT ADJUSTMENT INSTALLATION²²⁰⁴⁶

3. Install a remote reading thermometer to the evaporator outlet line near the existing remote bulb (Figure 33).
4. Apply thermostatic tape around the bulb and evaporator outlet line to get a true reading of the line temperature.
5. Block condenser if necessary to keep pressure over 150 psi.

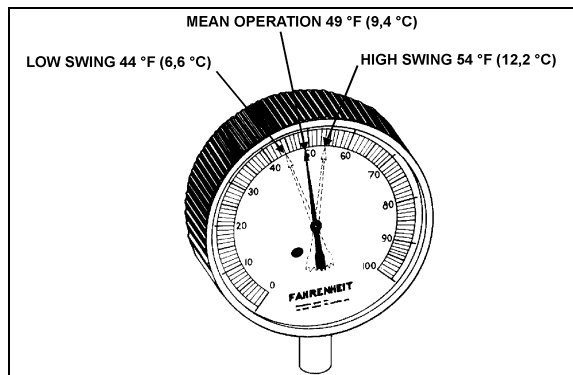


FIGURE 34: HIGH & LOW SWING TEMPERATURE AT REMOTE BULB²²⁰⁴⁷

6. Check approximately 5 readings of pressure at 2-minute intervals and convert to temperature using the temperatures & pressures table. Likewise check the temperature reading at the remote bulb at the same 2-minute intervals and record the low and high swing readings of the needle (refer to Figure 34).

Example of readings taken at Figure 34:

A/C pressure gauge	Temperature on
--------------------	----------------

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converted to temperature at expansion valve fitting	remote bulb	
40°F (4,4°C)	Low-swing 44°F (6,6°C)	High swing 54°F (12,2°C)
Formula for superheat 49°F-40°F=9°F (9,4°C-4,4°C = 5°C)	Average of low and high swing is 49°F (9,4°C)	

NOTE

The low swing of the superheat should be a minimum of 4°F (2,2°C) higher at the remote bulb and have an average of 8 to 12°F (4 to 6°C) higher range at the bulb than the fitting at the expansion valve.

NOTE

To reduce the superheat, flow of refrigerant is increased by turning adjusting screw of expansion valve lower evaporator temperature counterclockwise. To increase temperature or increase superheat, flow of refrigerant is reduced by turning adjustment screw of expansion valve clockwise.

- Regulate suction pressure to temperature reading according to temperature chart or to the R-134a temperature scale on the pressure gauge.

Example: Suction pressure 30 psi (207 kPa) converted to 32°F (0°C) on chart. If temperature reading is 40°F (4,4°C), subtract 32°F (0°C) and the result will be 8°F (4,4°C) of superheat.



CAUTION

Before proceeding to the expansion valve adjustment, check for restriction on suction side for plugged filter dryer and partially open valves. These conditions will give a high superheat.

Maintenance

- Pump down the system as previously indicated in this section.

- Disconnect the external equalizer line from the underside of the power head, and unclamp the remote control bulb from the evaporator coil outlet line.
- Remove the two cap screws holding the power assembly to the valve body flange. Lift off the power assembly and remove the cage assembly.
- When reassembling, replace with the new gaskets in proper location. Make sure the two lugs on the cage assembly fit into grooves provided in the power assembly. Do not force the valves together. The cage must fit properly before tightening the body flange. Tighten bolts evenly.
- Check for leaks.

Safety Instructions

- Make sure the valve is installed with the flow arrow on the valve body corresponding to the flow direction through the piping system.
- Before opening any system, make sure the pressure in the system is brought to and remains at the atmospheric pressure. Failure to comply may result in system damage and/or personal injury.

9.8.2 Driver's HVAC Unit

The function and operation of the expansion valve for the driver's HVAC unit are similar to the cabin or passenger's HVAC unit but no superheat adjustment is required (see Figure 19 and Figure 33).

9.9 TORCH BRAZING

Use electrode containing 35% silver.



CAUTION

When using heat near a valve, wrap with water saturated rag to prevent overheating of vital parts.



DANGER

Before welding any part of refrigeration system, make sure the area is well ventilated.

9.10 TROUBLESHOOTING

9.10.1 Expansion Valve

PROBABLE CAUSE	PROBABLE REMEDY
LOW SUCTION PRESSURE-HIGH SUPERHEAT	
EXPANSION VALVE LIMITING FLOW:	
Gas in liquid line due to pressure drop in the line or insufficient refrigerant charge.	Locate cause of line flash and correct by use of any of the following methods. Add R-134a. Replace or clean filter dryer.
Inlet pressure too low from excessive low condensing temperature. Resulting pressure difference across valve too small.	Increase head pressure. Verify pressure switch for fan speed control.
Superheat adjustment too high.	Adjust superheat as outlined under "Superheat Adjustment".
Power assembly failure or partial loss of charge.	Replace power assembly or replace valve.
Air filter screen clogged.	Clean or replace air filter screen.
Plugged lines.	Clean, repair or replace lines.
LOW SUCTION PRESSURE-LOW SUPERHEAT	
Uneven or inadequate evaporator loading due to poor air distribution or liquid flow.	Balance evaporator load distribution by providing correct air or liquid distribution.
HIGH SUCTION PRESSURE-HIGH SUPERHEAT	
Compressor discharge valve leaking.	Replace or repair valve.
HIGH SUCTION PRESSURE-LOW SUPERHEAT (DEFECTIVE UNLOADER)	
Valve superheat setting too low.	Adjust superheat as outlined under "Superheat Adjustment".
Compressor discharge valves leaking.	Replace or repair discharge valve.
Incorrect superheat adjustment.	Superheat adjustment 12 to 16°F.
FLUCTUATING DISCHARGE PRESSURE	
Insufficient charge.	Add R-134a to system.
HIGH DISCHARGE PRESSURE	
Air or non-condensable gases in condenser.	Purge and recharge system.
Overcharge or refrigerant.	Bleed to proper charge.

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PROBABLE CAUSE	PROBABLE REMEDY
Condenser dirty.	Clean condenser.

9.10.2 A/C

TROUBLE	CAUSE
Low suction pressure and frosting at dryer outlet.	Clogged filter.
Low Oil Level.	Check for oil leaks and for leaking oil seal. Do not attempt to check oil level unless system has been stabilized at least 20 minutes. See oil level verification.
Excessively cold suction line.	Loss of contact between the expansion valve bulb and the suction line or sticking of the expansion valve. Check for foreign matter and clean, repair or replace the valve.
Excessively cold suction line and noisy compressor.	Check superheat adjustment. Check remote bulb contact. Check expansion valve for sticking.
Compressor squeaks or squeals when running.	Check oil level. Replace oil seal.
Noisy or knocking compressor.	Check for broken internal parts. Overhaul if required.
Compressor vibrates.	Check and tighten compressor mounting bolts and belt tension.
Low refrigerant level	Check for refrigerant leaks and add refrigerant if required.
Suction pressure rises faster than 5 pounds per minute after shutdown.	Check compressor valve for breakage or damage.
Insufficient cooling.	Check for refrigerant leaks. Check condition of air filter and motors.
Insufficient air flow.	Dirty or iced evaporator. Dirty air filter. Blowers inactive. Clogged ducts.
No flow of refrigerant through expansion valve.	Filter dryer is clogged. Remote bulb has lost charge or expansion valve is defective.
Expansion valve hisses. Bubbles in moisture and liquid indicator.	Gas in liquid line. Add refrigerant.
Loss of capacity	Clogged filter. Obstructed or defective expansion valve.
Superheat too high.	Reset superheat adjustment. Check for clogged external equalizer line, or filter dryer.
Reduced air flow: a. Dirty or clogged air filter; b. Evaporator motor inoperative; or c. Plugged return air ducts.	Dirty or iced evaporator coil. Clean air filter screen. Check return ducts for obstructions. Check blower motor.
Frequent starting and stopping on low pressure control switch.	Lack of refrigerant. Check for leaks. Recharge.
Compressor intermittently starts and stops.	Intermittent contact in electrical control circuit. Compressor valves not in operating position.
Non-condensable in the refrigeration system.	Leak on system, system in vacuum in low temp. Specific symptom, pressure in system will not correspond to ambient temperature on shutdown. Only non-condensable will cause this.

TROUBLE	CAUSE
	<p>(Example: Pressure of idle R-134a system in 80°F (26.6°C) room should be 86.4 psi (595.7 kPa). See temperature chart in this section.)</p> <p>An evaporator just does a proper cooling job without sufficient air. Shortage of air can be caused by the following:</p> <ul style="list-style-type: none"> * Dirty filters; or * Dirty coils.
<p>Testing condenser pressure.</p> <p><i>NOTE: R-134A pressure is function of the temperature variation.</i></p> <p>Example, for an exterior temperature of 100°F. Exterior temperature (100°F) + 30°F = 130°F. Refer to paragraph "10.11 Temperature & Pressure". Note the corresponding pressure for a temperature of 130°F, 199.8 psi. Read the condenser pressure, example 171.9 psi. 171.9 psi & 199.8 psi, the pressure in the condenser is inferior to the pressure corresponding to the exterior temperature, in this case the condenser pressure may be too low. Check for refrigerant leaks and add refrigerant if necessary. If the pressure corresponding to the condenser temperature is superior to the pressure corresponding to the exterior temperature, then the air cooled condenser pressure may be too high. Most frequent causes are:</p> <p>Reduced air quantity. This may be due to:</p> <ul style="list-style-type: none"> * Non-condensable in system; * Dirt on the coil; * Restricted air inlet or outlet; * Dirty fan blades; * Incorrect rotation of fan; * Fan speed too low; * Fan motor going out on overload; or * Prevailing winds. * Too much refrigerant in system. Remove refrigerant if necessary. 	

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9.11 TEMPERATURES & PRESSURES

VAPOR-PRESSURE			
TEMPERATURE		PRESSURE	
°F	°C	psi	kPa
-100	-73.3	27.8	191.7
-90	-67.8	26.9	185.5
-80	-62.2	25.6	176.5
-70	-56.7	23.8	164.1
-60	-51.1	21.5	148.2
-50	-45.6	18.5	127.6
-40	-40.0	14.7	101.4
-30	-34.4	9.8	67.6
-20	-29	3.8	26.2
-10	-23	1.8	12.4
0	-18	6.3	43.4
10	-12	11.6	80
20	-7	18.0	124.1
30	-1	25.6	176.5
40	4	34.5	237.9
50	10	44.9	309.6
60	16	56.9	392.3
70	21.1	70.7	487.5
80	27	86.4	595.7
90	32.2	104.2	718.5
100	38	124.3	857.0
110	43.3	146.8	1012.2
120	49	171.9	1185.3
130	54.4	199.8	1377.6
140	60	230.5	1589.3
150	65.6	264.4	1823.0
160	71	301.5	2078.8
170	76.7	342.0	2358.1
180	82.2	385.9	2660.8

VAPOR-PRESSURE			
TEMPERATURE		PRESSURE	
°F	°C	psi	kPa
190	87.8	433.6	2989.7
200	93.3	485.0	3344.1
210	98.9	540.3	3725.4

9.12 LEAK TESTING

Some methods such as nitrogen pressure, soap and electronic sniffer can be used for leak testing. However, the most common method used is a "Halide" torch consisting of an acetylene tank, a burner and a suction test hose. Proceed as follows:



DANGER

Do not inhale fumes from leak detector.

The flow of acetylene to the burner causes suction in the test line. Any gas refrigerant present will be drawn through the hose and into the burner where it decomposes into free acids.

These acids come in contact with the hot copper reaction plate in the burner, causing color reaction in the flame. A small concentration is indicated by a green tint and a large concentration by an intense blue. Do not confuse this change in color with the change caused by shutting off the air supply through the hose by holding the end too close to an object.

The procedure for testing is:

1. Adjust flame so that the top of the cone is approximately level or within one-half inch above the plate.
2. Probe end of suction test tube around all joints, valves, etc. When a leak has been found at a soldered joint, this section of the system must be pumped down. Do not solder as pressure will force hot solder out. If the system is empty, it is more economical to put in just enough R-134a to produce about 15 psi (103 kPa). The pressure can be raised to about 150 psi (1034 kPa) with dry nitrogen.

NOTE

This gas is put into the suction and discharge shutoff valves at the compressor. The receiver valves must be opened. If no leaks are found, dump this mixture, evacuate the system and fill with refrigerant.

10. SMALL AIR CONDITIONING SYSTEM COMPONENTS

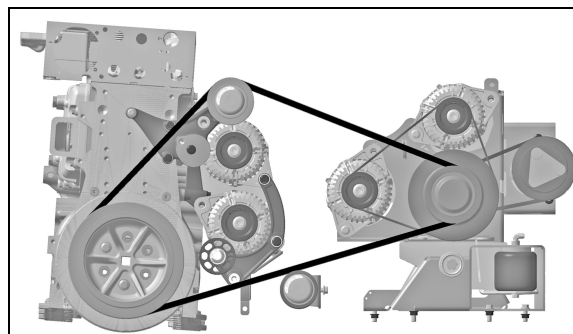


FIGURE 35: SMALL A/C BELT LAYOUT

10.1 BELT TENSION ADJUSTMENT

Belt tensioning is applied through air bellows which are adjusted by an air pressure regulating valve (Fig 37). The correct pressure of 30 psi (207 kPa) is set at the factory. Periodically verify the pressure at the regulating valve using a pressure gauge and correct if necessary

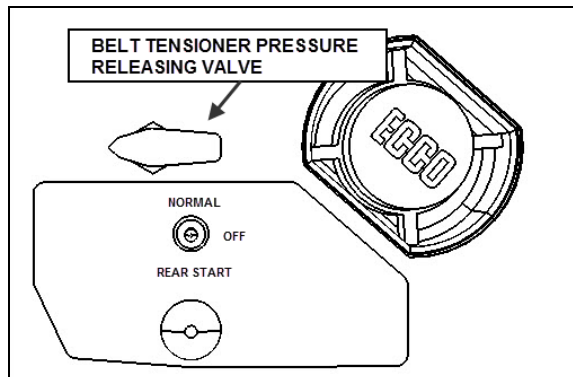


FIGURE 36: PRESSURE RELEASING VALVE

Section 22: HEATING AND AIR CONDITIONING

10.2 COMPRESSOR

Consult the small Compressor Service Manual included at the end of this section.



WARNING

Read the cautionary information in the small Compressor Service Manual included at the end of this section.

10.3 COMPRESSOR REMOVAL

10.3.1 When the compressor is operational

- * Perform the "OIL RETURN OPERATION" (Refer to paragraph 10.5).

10.3.2 When the compressor is inoperable

- * Perform the "Refrigerant Recovery" operation.
- * Slacken bolts A (Refer to figure 37).
- * Remove bolts B & C (Refer to figure 37).
- * Remove the compressor.

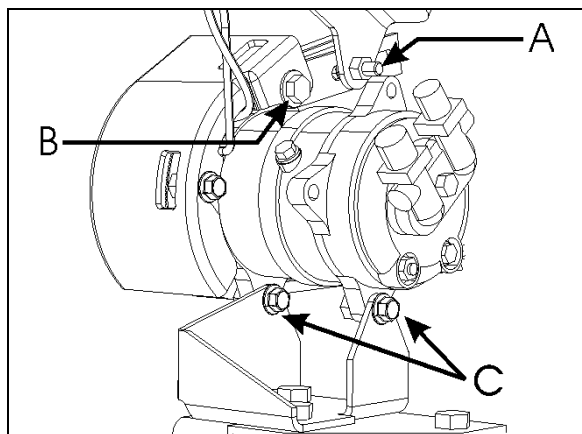


FIGURE 37: COMPRESSOR REMOVAL OR INSTALLATION 22349

10.3.3 Evacuating System Before Adding Refrigerant

When a system has been opened for repairs, change the filter dryer and evacuate the system. Vehicles equipped with a small or auxiliary A/C system must use high-pressure service port located on the other side of check valve and low-pressure port located alongside rear truss. It would be good practice to open solenoid valve.

1. Connect two hoses equipped with a micron gauge between the high-pressure service

port, the low-pressure service port and the vacuum pump.

2. With the unit service valves open and the vacuum pump valves open, start the pump and draw the manifold and hoses into a very deep vacuum (700 microns).
3. Close manifold valve
4. Shut down the vacuum pump.
5. Check to insure that vacuum holds. (If the pressure continues to rise, it indicates a leak or moisture in the system).
6. Charge the system with the proper amount of refrigerant through the service port near the check valve using recommended charging procedures.
7. Remove the hoses.

10.4 OIL ADDITION

The chart below shows the approximate amount of oil to be added to the system when replacing a component.

Component replaced	Typical amount of oil
Evaporator	50 cm ³ (1.7 ozs)
Condenser	30 cm ³ (1.0 ozs)
Filter-Dryer	10 cm ³ (0.3 ozs)

The amount of oil recovered with the refrigerant recovery should be added at the same time (25 ml of oil/lb of refrigerant)

10.5 COMPRESSOR OIL CONTAMINATION

Unlike engine oil, no cleaning agent is added to the compressor oil. Even if the compressor is run for a long time, the oil never becomes turbid as long as there is nothing wrong with the compressor or its method of use. Inspect the extracted oil for any of the following conditions:

- Dirt in the oil.
- Change to a varnish color.
- Presence of foreign substance, metal shavings, etc. in the oil. When the oil extracted from the compressor is as described above, replace the oil as follows:
 1. Clean the interior of the system with approved method (Paragraph 8.7)
 2. Replace the filter-dryer.

3. Supply with new oil as specified in ICE (International Components Engineering) Compressor Service Manual included at the end of this section.

10.6 OIL RETURN OPERATION

There is a close affinity between oil and refrigerant. During normal operation, part of the oil recirculates with the refrigerant in the system. Therefore, when checking the amount of oil in the system or replacing any system component, the compressor must be run in advance to ensure return. This procedure is as follows:

- If the amount of refrigerant in the system has decreased, charge to the proper amount.
- Start the engine and select fast idle.
- Set the fan speed to full air/full A/C and let run for 20 minutes.

SMALL A/C SYSTEM

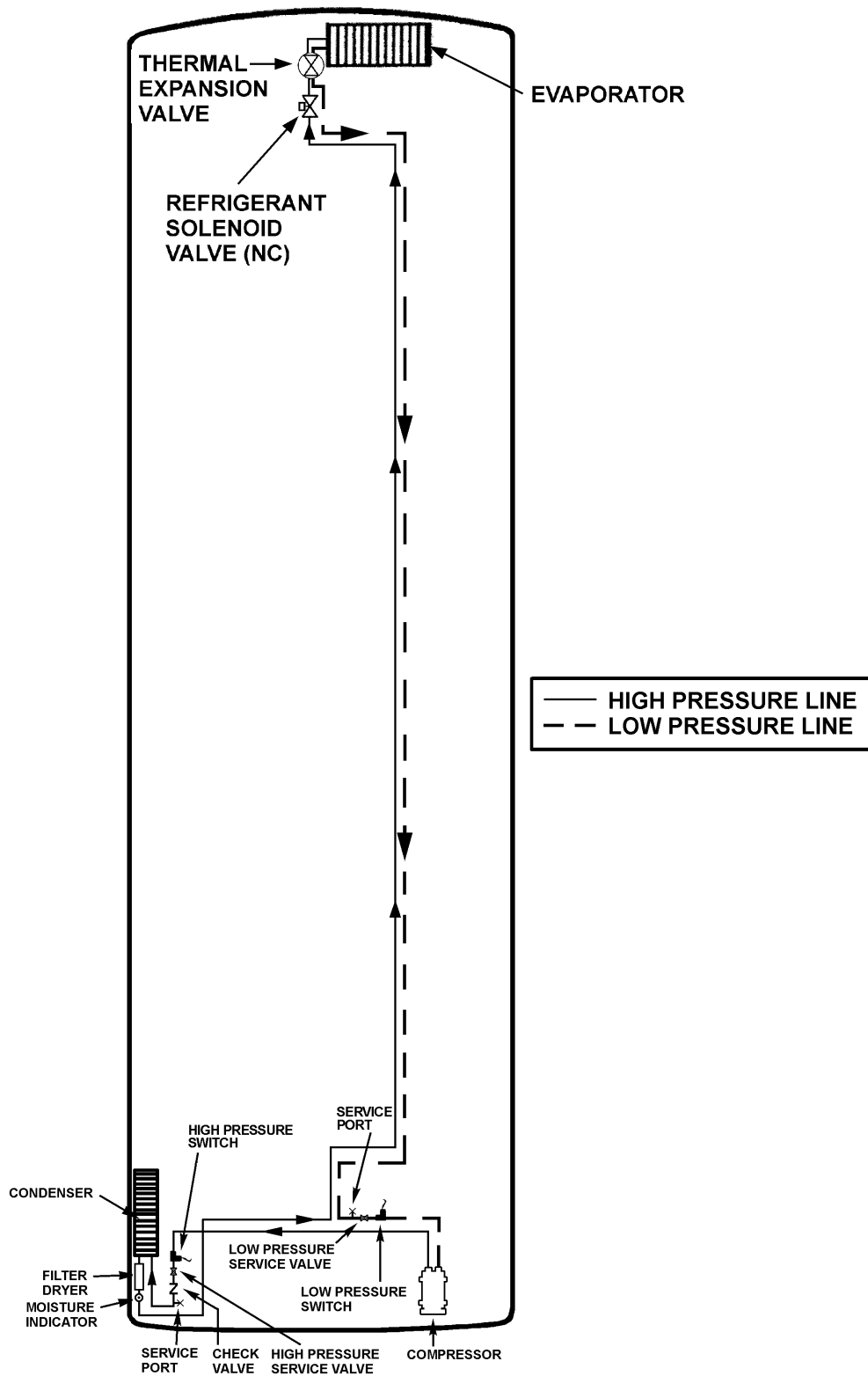


FIGURE 38: REFRIGERANT CIRCUIT (SMALL SYSTEM) 22350

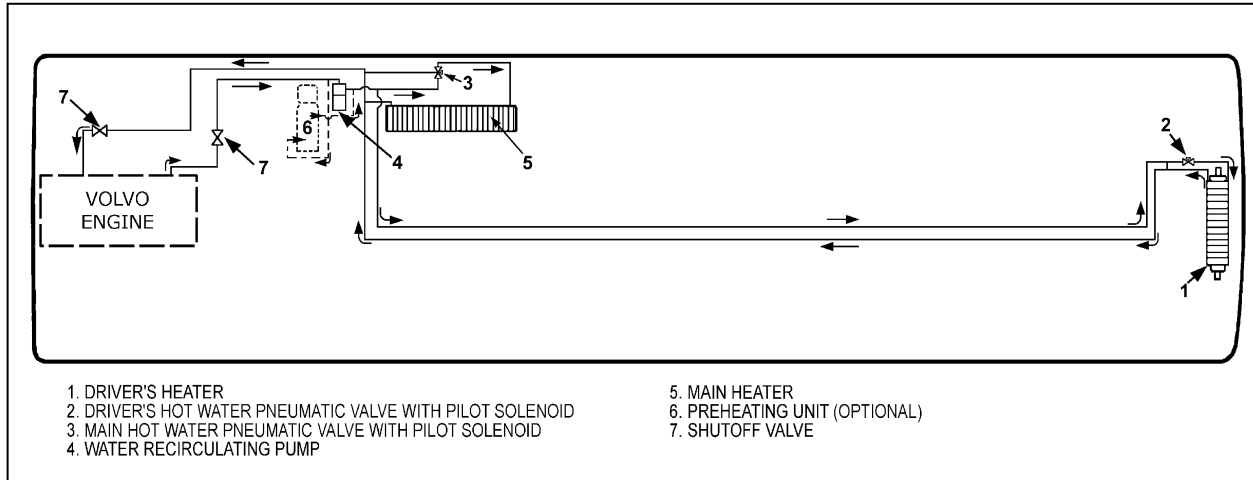


FIGURE 39: CENTRAL HEATING SYSTEM COMPONENTS

11. HEATING SYSTEM

As seen earlier in this section, the vehicle interior is pressurized by its Heating, Ventilation and Air Conditioning (HVAC) system. Two heating systems are available: Central Heating System and Small Heating System. The vehicle interior should always be slightly pressurized to prevent cold and moisture from entering. If the vehicle is equipped with a Central Heating System; air flow and controls divide the vehicle into two areas: driver's area and cabin or passenger's area.

The schematic of figure 39 shows the central heating system with its components.

In addition to the normal heating provided by the engine, a preheating system (104,000 Btu/hr) (optional) may have been installed in the vehicle.


11.1 CENTRAL HEATING SYSTEM

11.1.1 Draining Heating System

To drain the entire system, refer to Section 05, "Cooling". If only the driver's or main heater core must be drained, refer to the following instructions.

- **Draining Driver's Heater Core**

1. Stop engine and allow engine coolant to cool.
2. Locate the normally open water pneumatic valve on the ceiling of the spare wheel compartment (Figure 40), move the pilot-solenoid valve red tab to close the valve.



WARNING

Before proceeding with the following steps, check that coolant has cooled down.

3. Loosen hose clamp, install an appropriate container to recover coolant, and disconnect silicone hose from water solenoid valve.
4. From inside of vehicle, remove the two finishing panels in front of unit. Remove the three screws fixing the unit front panel. Open the manual vent located inside the HVAC unit, on the driver's side (Figure 41) to ensure an efficient draining.

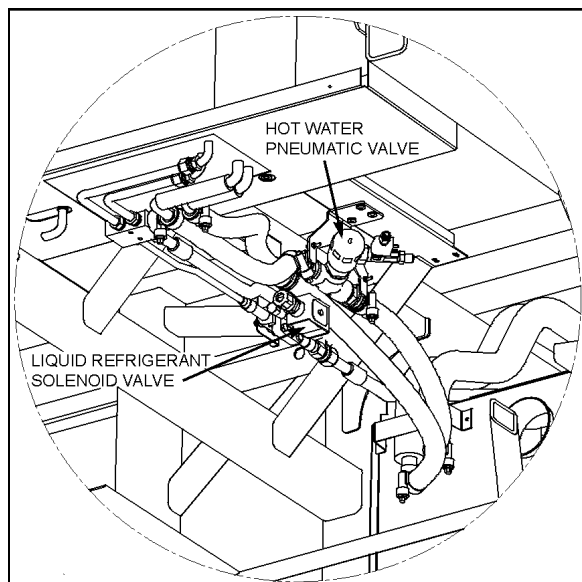


FIGURE 40: CEILING OF THE SPARE WHEEL COMPARTMENT

Section 22: HEATING AND AIR CONDITIONING

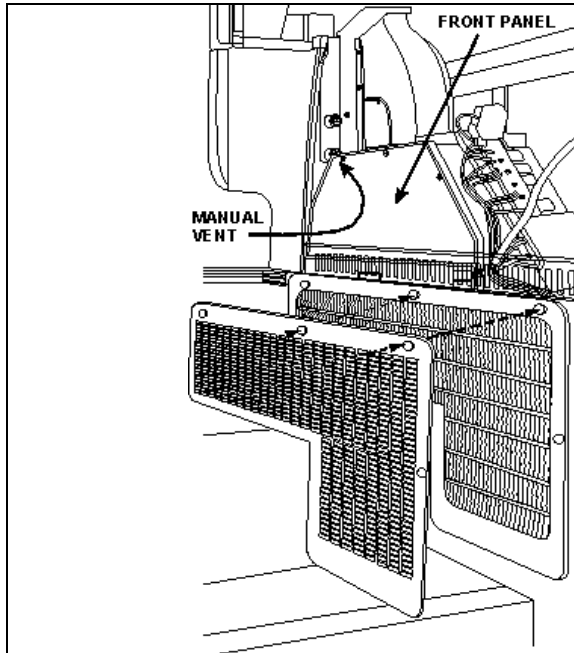


FIGURE 41: DRIVER'S HVAC UNIT

- **Draining Main Heater Core**

1. Stop engine and allow engine coolant to cool.
2. Close both heater line shutoff valves.

The valves are located in the engine compartment. One is on the L.H. side of compartment in front of the radiator and the other valve is located under the radiator fan gearbox (Figure 42).

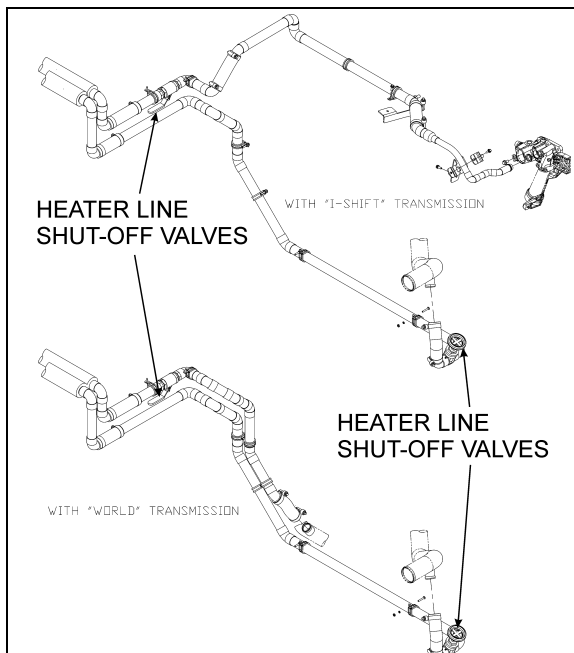


FIGURE 42: HEATER LINE SHUT-OFF VALVES

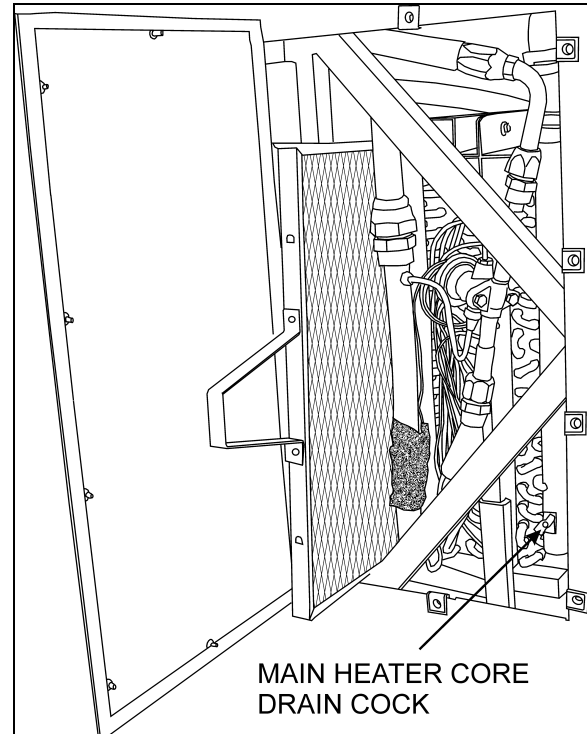


FIGURE 43: EVAPORATOR COMPARTMENT

3. The main heater core drain cock is located in the evaporator compartment. To access the valve on X Series vehicles, open baggage compartment door located in front of the evaporator compartment (L.H. side). Open access panel by turning the three quarter-turn screws.



WARNING

Before proceeding with the following steps, check that coolant has cooled down.

4. Open drain cock in bottom of heater core, you can unfasten a hose connection on top of heater core (Figure 43) in order to allow air to enter while draining.

11.1.2 Filling Heating System

1. Ensure that the drain hose is reconnected and the manual vent and drain cock are closed.
2. Open the surge tank filler cap and slowly fill the system to level of filler neck.
3. After initial filling, the water shut-off valves should be open and the water recirculating pump should be energized to assist in circulating coolant through the heating

system. To perform this operation, start the engine, switch on the HVAC control unit, both driver and cabin (passengers') sections, and set temperature to their maximum positions in order to request the heating mode in each of these sections.

4. When coolant level drops below the surge tank filler neck, slowly fill the system to level of filler neck.
5. Once the level has been stabilized, replace cap.

11.1.3 Bleeding Heating System

Whenever the heating system has been drained and refilled, or the system has run low on coolant and coolant has been added, it is necessary to bleed air from heating system. Locate the manual vent illustrated in Figure 41, and open momentarily until no air escapes from the line.

11.1.4 Soldering

Before soldering any part of the system, make sure the area is well ventilated. Use (stay clean) flux sparingly and apply solder (95-5 round wire 1/8 inch). After completing repairs, test for leaks.

When using heat at or near a valve, wrap with water saturated rag to prevent overheating of vital parts.

11.1.5 Driver's Hot Water Pneumatic Valve Assembly

• Description

The flow of hot water to the driver's heater core is controlled by a pneumatic NO water valve assembly. The valve, located at the ceiling of the spare wheel compartment, is designed so that the pilot solenoid valve, which is part of the assembly, opens and closes a port which directs air pressure to the actuator casing, thereby opening or closing the valve.

When the vehicle is operating with no current to the pilot solenoid valve, no air pressure is admitted to the actuator casing, the cylinder spring pushes up against the cylinder, thereby keeping the water valve open.

The driver's heater water valve requires a minimum amount of maintenance. The valve should be free of dirt sediment that might interfere with its operation. No other

maintenance is needed unless a malfunction occurs.

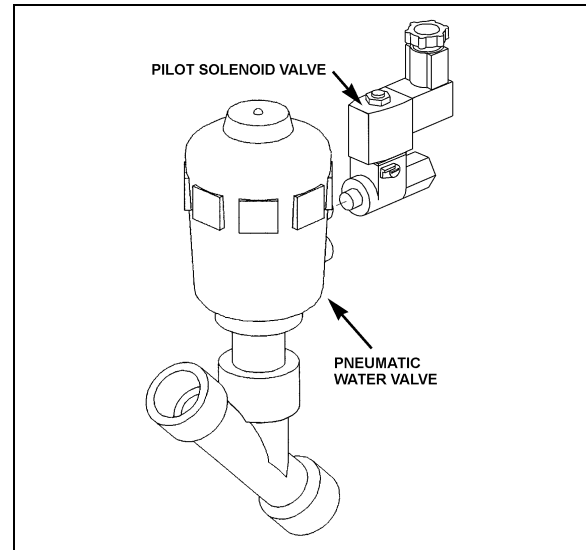


FIGURE 44: DRIVER'S HOT WATER PNEUMATIC VALVE ASSEMBLY

• Pneumatic Water Valve Disassembly

1. Shut off air supply pressure and electrical current to the pilot solenoid valve. Disconnect wires.
2. The water valve need not be removed from the line. Unscrew nipple, the actuator casing, tube, spindle and closure member can be removed (Figure 45)
3. a pair of pliers.
4. You can now access all seals for replacement

Pneumatic water valve replacement seal kits:

- * Water Side: 871311
- * Actuator Side: 871312

• Pneumatic Water Valve Reassembly

1. Assemble the actuator casing, tube, nipple, spindle and closure member.
2. Tighten the nipple in place in the body cavity as per figure 45. Fasten pilot solenoid valve to the pneumatic water valve. Reconnect air supply pressure and electrical current to the pilot solenoid valve.
3. Check for proper operation.

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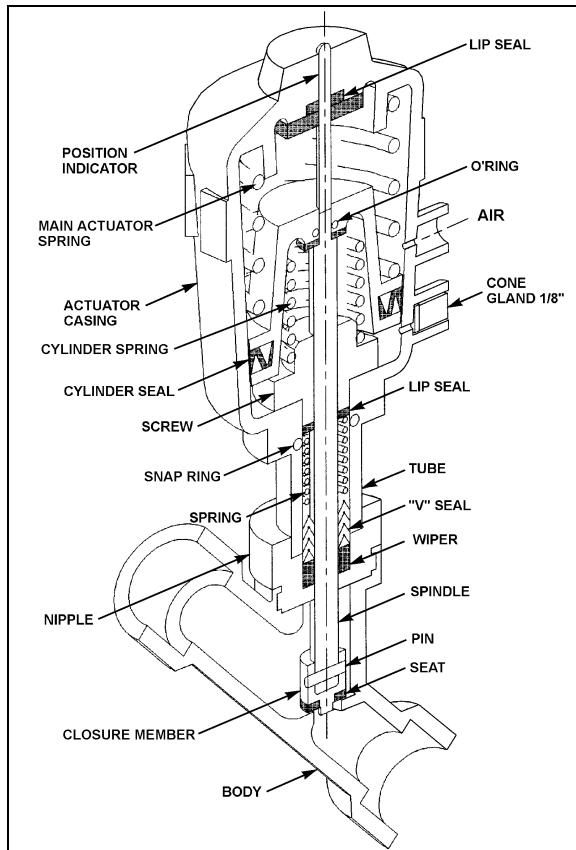


FIGURE 45: DRIVER'S PNEUMATIC WATER VALVE

- **Pilot Solenoid Valve**

1. No maintenance is needed unless a malfunction occurs.
2. A pilot solenoid valve replacement seal kit is available: 871313.

- **Valve Troubleshooting**

PROBLEM	PROCEDURE
Valve fails to close	<ol style="list-style-type: none"> 1. Check electrical supply with a voltmeter. It should agree with nameplate rating. 2. Check pressure at pilot solenoid valve inlet. It must be at least equal to the minimum pressure stamped on the nameplate. It should not go below minimum while valve is operating.
	<ol style="list-style-type: none"> 1. Check that the closure member assembly, and that main actuator and cylinder springs are free to travel.

- | | |
|--|--|
| | <ol style="list-style-type: none"> 2. Check that there is no restriction to the air escaping from the actuator casing. 3. Make sure that pilot solenoid valve operates properly. |
|--|--|

11.1.6 Central Hot Water Pneumatic Valve Assembly

- **Description**

The flow of hot water to the vehicle's central heater core is controlled by a 3-way pneumatic water valve assembly. The valve, located in the evaporator compartment, is designed so that the pilot solenoid valve, which is part of the assembly, opens and closes a port which directs air pressure to the actuator casing, thereby allowing the hot water to enter the main heater core or bypassing it.

When the vehicle is operating with no current to the pilot solenoid valve, no air pressure is admitted to the actuator casing, the cylinder spring pushes up against the cylinder, thereby allowing the hot water to enter the main heater core.

The central heater water valve requires a minimum amount of maintenance. The valve should be free of dirt sediment that might interfere with its operation. No other maintenance is needed unless a malfunction occurs.

- **Pneumatic Water Valve Disassembly**

1. Shut off air supply pressure and electrical current to the pilot solenoid valve. Disconnect wires.
2. The water valve need not be removed from the line. Unscrew nipple, the actuator casing, tube, spindle and closure member can be removed (Figure 47).
3. Remove the snap ring using a pair of pliers.

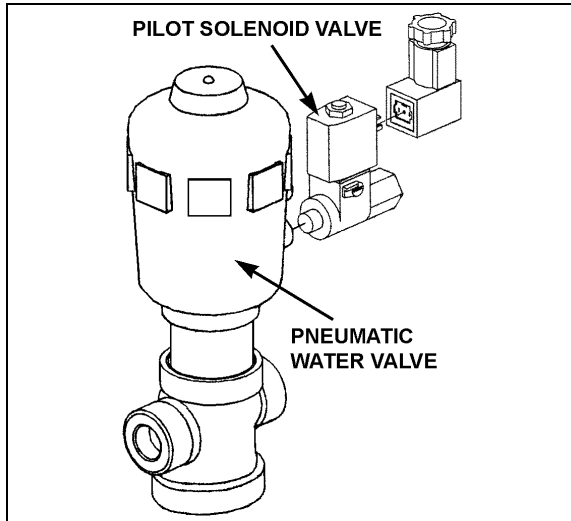


FIGURE 46: CENTRAL HOT WATER PNEUMATIC VALVE ASSEMBLY 22329

4. You can now access all seals for replacement

Pneumatic water valve replacement seal kits:

- * Water Side: 871389
- * Actuator Side: 871388

• **Pneumatic Water Valve Reassembly**

1. Assemble the actuator casing, tube, nipple, spindle and closure member.
2. Tighten the nipple in place in the body cavity as per figure 47. Fasten pilot solenoid valve to the pneumatic water valve. Reconnect air supply pressure and electrical current to the pilot solenoid valve.
3. Check for proper operation.

• **Pilot Solenoid Valve**

1. No maintenance is needed unless a malfunction occurs.
2. A pilot solenoid valve replacement seal kit is available: 871390.

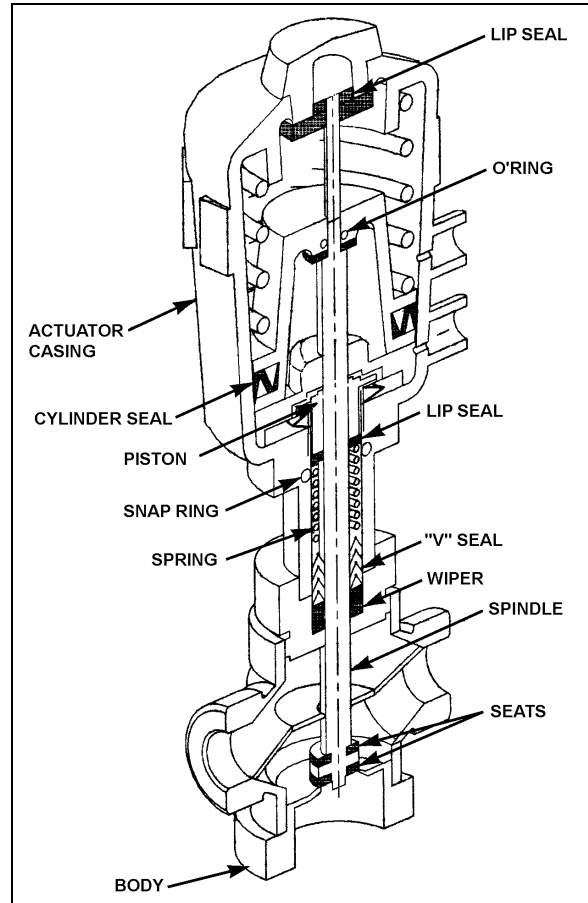


FIGURE 47: CENTRAL PNEUMATIC WATER VALVE 22330

• **Valve Troubleshooting**

PROBLEM	PROCEDURE
Valve fails to close	<ol style="list-style-type: none"> 1. Check electrical supply with a voltmeter. It should agree with nameplate rating. 2. Check pressure at pilot solenoid valve inlet. It must be at least equal to the minimum pressure stamped on the nameplate. It should not go below minimum while valve is operating.
Valve fails to open.	<ol style="list-style-type: none"> 1. Check that the closure member assembly, and that main actuator and cylinder springs are free to travel. 2. Check that there is no restriction to the air escaping from the actuator casing. 3. Make sure that pilot solenoid valve operates properly.

Section 22: HEATING AND AIR CONDITIONING

11.1.7 Water Recirculating Pump

This vehicle is provided with a water recirculating pump which is located in the engine coolant heater compartment (Figure 48). The water recirculating pump consists of a centrifugal pump and an electric motor which are mounted in a compact assembly.

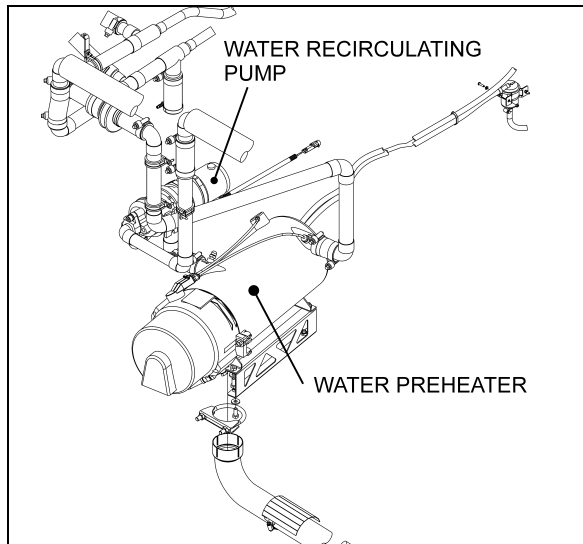


FIGURE 48: PUMP LOCATION (CENTRAL A/C) 22331

The seal less pump requires no periodic maintenance. Inspection of the pump, to determine if the pump is working properly, should be made while the pump is in operation.

If there is evidence that the pump is not operating as per specifications, the unit must be replaced completely.

• Removal

1. Stop engine and allow engine coolant time to cool.
2. Close shutoff valves. Refer to "05 COOLING" under heading "Draining Cooling System" for location of valves.
3. Disconnect the electrical wiring from the motor.



WARNING

Before proceeding with the following steps, check that coolant has cooled down.

4. Disconnect water lines from pump at flange connections. Place a container to recover the residual coolant in the line.

5. Remove the two clamps holding the pump motor to its mounting bracket. Remove the pump with the motor as an assembly.

• Installation

1. Connect water lines to the pump. Position the pump and motor assembly on the mounting bracket. Position the mounting clamps over the motor and secure with mounting bolts.
2. Connect electrical wiring to the pump motor.
3. Open shutoff valve. Refer to "05 COOLING" under heading "Draining Cooling System" for location of valves.

Fill the cooling system as previously instructed in this section under "11.2 Filling Heating System", then bleed the system as previously instructed in this section under "11.3 Bleeding Heating System".

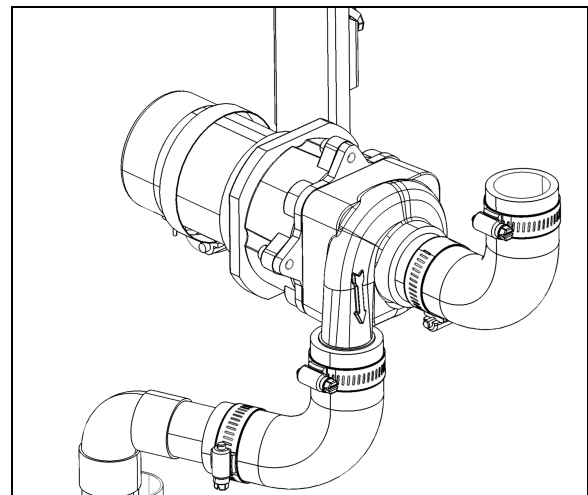


FIGURE 49: WATER RECIRCULATING PUMP (CENTRAL A/C)

11.1.8 Preheating System (Optional)

The vehicle may be equipped with the optional preheater located aft of the evaporator compartment, and accessible under left rear fender (refer to Figure 50).

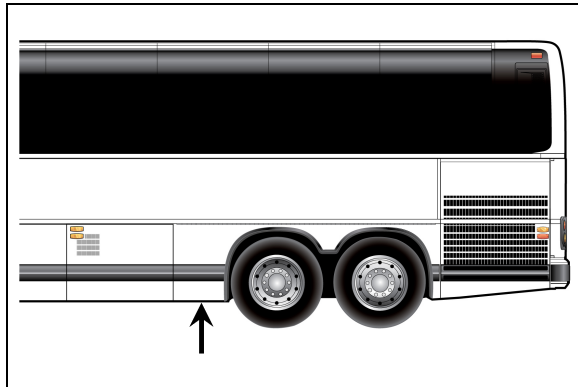


FIGURE 50: LOCATION OF PREHEATER 18607

This Auxiliary Preheating System is used for preheating and retaining the heat of water-cooled engines. It can be used before starting the engine to ease its starting and to provide immediate heat inside the vehicle upon operation of the system. It can also be used with engine running to maintain coolant heat and maintain the set temperature inside the vehicle.

The heater operates independently from the vehicle engine. It is connected to the cooling and heating circuits, the fuel system and the electrical system of the vehicle.

The pilot lamp turns on when the heater is switched on. Combustion air flows in to flush out the combustion chamber and the water circulation pump is put into operation. The fuel metering pump conveys fuel in precise doses to the combustion chamber where fuel and combustion air form a combustible mixture which is ignited by the glow plug.

Once the flame sensor has signaled to the control unit that combustion has taken place correctly, the glow spark plug and ignition coil are switched off.

The hot combustion gases are diverted at the end of the flame pipe, then pass through the indirect heating surfaces of the heat exchanger and transmit their heat to the engine coolant passing through the heat exchanger.

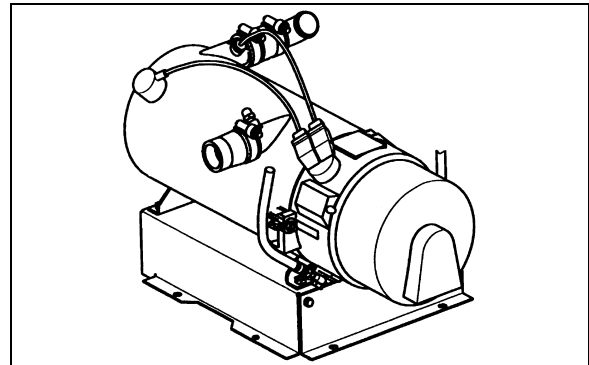


FIGURE 51: SPHEROS PREHEATER (104,000 BTU)


The heat is thermostatically controlled and operates intermittently, i.e. the switched-on times of the burner vary depending on the heat requirement. The water temperature depends on the setting of the built-in water thermostat.

The water circulation pump remains in operation as long as the heater is operating, even in the regulation intervals and during the delayed cutout of the switched-off heater. The pump can also be operated independently from the heater by means of an appropriate circuit. The heater can be switched on at any time, even during the delayed cutout period. Ignition takes place once this delay time is over.

When the heater is switched off, the fuel supply is interrupted. The flame goes out, and at the same time a delayed cutout of some 2.5 minutes begins. The combustion air still flowing flushes the remaining combustion gases out of the chamber and cools off the hot parts on the exhaust side of the heat exchanger, while the water circulation pump, still running, transmits the heat present in the heat exchanger, thus preventing local overheats. Once the delayed cutout time is over, both the combustion air blower and the water circulation pump switch off automatically. A cutout will take place in case of any failure of the preheater.

• **Preheater Fuel Filter**

The preheater fuel filter is located beside the preheater in the engine coolant heater compartment, and is accessible by opening the evaporator compartment door.

	<h2>MAINTENANCE</h2>
<p>Replace preheater fuel filter every 50,000 miles (80 000 km) or once a year, whichever comes first.</p>	

Section 22: HEATING AND AIR CONDITIONING

• Operation

Switch on the heater. The operation indicator lamp comes on and the heater motor and circulating pump begin to run. After about 10-25 seconds the solenoid valve opens and fuel is sprayed into the combustion chamber. At the same time, the electronic ignition unit produces high voltage (8000 V) and the mixture of fuel and air in the combustion chamber is ignited by the spark on the ignition electrodes. The flame is indicated by the flame detector, then the electronic ignition unit stops producing high voltage and combustion continues by itself (spark on electrodes is required only to ignite the flame). At this moment, the heater is working and producing heat.

If the heater is switched off by the on/off switch, the solenoid valve interrupts fuel supply, combustion stops and indicator lamp turns off. Combustion air fan still blows air, cleaning the combustion chamber of any fumes and cooling down the combustion chamber. Coolant circulation pumps coolant, making a purge cycle for approximately 2-3 minutes, thus protecting the heater against overheating.

If the heater is not switched off by the on/off switch, the control thermostat will switch off the heater when coolant temperature reaches $165^{\circ} \pm 6^{\circ}\text{F}$ ($75^{\circ} \pm 3^{\circ}\text{C}$) and turns it on at $154^{\circ} \pm 9^{\circ}\text{F}$ ($68^{\circ} \pm 5^{\circ}\text{C}$). During this time, the heater (combustion) is off and the indication lamp and coolant pump are on. Combustion air fan blows air for 2-3 minutes and then turns off.

• Preheating System Timer

The timer, located on L.H. lateral console is used to program the starting and stopping time of the preheating system. The system indicator light, located on the timer, illuminates when the system is functional.



CAUTION

The preheating system should not operate for more than one hour before starting engine as this could discharge batteries.



DANGER

Preheating system must not operate when vehicle is parked inside or during fuel fill stops.

NOTE

Preheating system uses the same fuel as the engine.

In case of failure:

1. Shut off and turn on again.
2. Check main circuit breaker and overheat fuse.
3. Have system repaired in a specialized shop.

• Timer Operating Instructions

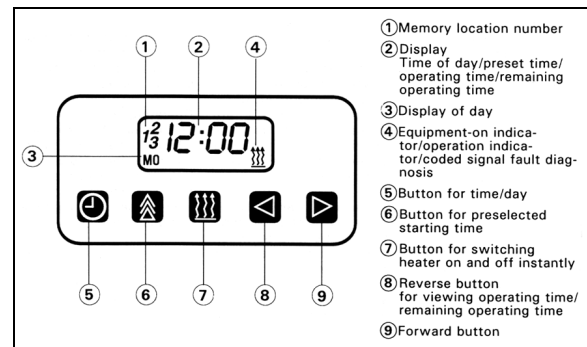


FIGURE 52: TIMER

These instructions refer to the timer illustrated in figure 52. They are the same instructions provided in the Spheros instruction booklet, provided with your vehicle.

Remaining Operating Time

The remaining operating time refers to the period of time the heater still continues to remain in operation. It may be changed while the heater is in operation.

Setting the Digital Timer

After the power has been connected, all symbols on the digital display are flashing. The time of the day and the day of the week must be set.

All flashing symbols of the timer can be set by means of the Forward (9) or Reverse (8) buttons.

When buttons (8) and (9) are pressed for more than 2 seconds, the quick digit advance mode is activated.

Setting the Time and Day of the Week

1. Press button (5) for more than 2 seconds (time display flashes).
2. Press (8) or (9) button to set the time of day.

3. Wait 5 seconds. The time of day is stored (time of week flashes).
4. Press (8) or (9) button to set the correct day of week.
5. Wait 5 seconds. The day of week is stored.

Viewing the Time (Ignition ON)

Continuous display of current time and day of the week.

Viewing the Time (Ignition OFF)

Briefly press button (5) to display current time and day for 5 seconds.

- **Switching Heater On (Instant Heating)**

With Ignition ON:

Press button (7). Heater is switched on (continuous operation) and continues to operate until button (7) is pressed again or ignition is switched off.

NOTE

If the ignition is switched off while heater is in operation, the remaining operating time of 5 minutes flashes on the display and the heater will continue to operate for this period of time.

With Ignition OFF:

Press button (7). Heater is switched on for preset operating time (the factory-set heater operating duration is 60 minutes)

- **Switching Heater Off**

Press button (7). The heater starts its after-run cycle and switches off thereafter.

Presetting Operating Duration

1. Press button (6). Memory location number flashes.

NOTE

By repeatedly pressing button (6), starting time 2 or 3 can be preset.

2. Press button (8) or (9) until correct startup time is set.
3. Wait 5 seconds. Preset starting time is stored and day of week flashes.
4. Press button (8) or (9) to select the correct startup day of week.

5. Wait 5 seconds. The startup day of week is stored.

The number of memory location remains on the display. The timer is now in the programmed mode and will switch the heater in at the preset time.

NOTE

We recommend that memory locations 1 and 2 be used for presetting times within 24 hours of setting the timer. Memory location 3 can be used for a starting time within the next 7 days of setting the timer.

Recalling Preset Times

Press (6) repeatedly until the desired memory location number and preset time are displayed.

Canceling Preset Time

Press button (6) repeatedly until no more memory location number is visible on the display.

Setting Operating Time

1. With heater off, press button (8). Operating time flashes.
2. Press button (8) or (9) to set the operating time (between 1 and 120 minutes).

The heater remains in operation for the preset time (except for continuous operation).

Setting the Remaining Operating Time

1. With heater in operation, press button (8). Remaining operating time flashes.
2. Set remaining time with button (8) or (9).
3. Wait 5 seconds. Remaining operating time is stored.

Operational Failure Symptoms via Fault/Flash code

On heaters equipped with a fault diagnosis system using coded light signals, the equipment-on indicator/operation indicator flashes. Refer to the following table.

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Failure Symptom	Probable Cause	Check and Correct
1X Flash (F 01) No combustion after completion of start up sequence.	- Fuel system - Combustion air - Electronic ignition	- Fuel level - Type of fuel being used - Fuel filter - Fuel line connections (air bubbles in fuel lines) - Fuel nozzle plugged - Air intake or exhaust, restricted or plugged - Incorrect electrode gap
2X Flashes (F 02) Flame out during burner operation no restart possible	- Fuel supply (shortage of fuel)	- Restriction in the fuel system - Fuel filter - Fuel line connections (air bubbles in fuel lines) - Type of fuel being used
3X Flashes (F 03) Low voltage for more than 20 seconds	- Electrical system	- Load test batteries - Corrosion at connections - Loose connections
4X Flashes (F 04) Flame detector recognizes false flame signal during pre-start or shut-down cycle	- Defective flame detector	- Replace flame detector
5X Flashes (F 05) Flame detector	- Wiring - Defective flame detector	- Damaged wiring, open or short circuit - Replace flame detector
6X Flashes (F 06) Temperature sensor	- Wiring - Defective temperature sensor	- Damaged wiring, open or short circuit - Replace temperature sensor
7X Flashes (F 07) Fuel solenoid valve	- Wiring - Defective solenoid valve	- Damaged or corroded wiring, open or short circuit - Replace solenoid valve
8X Flashes (F 08) Combustion air fan motor	- Wiring - Wrong RPM - Defective combustion air fan motor	- Damaged wiring, open or short circuit - Replace combustion air fan - Replace combustion air fan
9X Flashes (F 09) Circulation pump motor	- Wiring - Defective circulation pump motor	- Damaged wiring, open or short circuit - Replace circulation pump motor
10X Flashes (F 10) Temperature limiter	- Overheat condition - Coolant flow - Wiring - Defective temperature limiter	- Reset temperature limiter - Coolant level or flow restriction - Air trapped in coolant circuit - Damaged or corroded wiring, open or short circuit - Replace temperature limiter
11X Flashes (F 11) Electronic ignition coil	- Wiring - Defective electronic ignition coil	- Damaged wiring, open or short circuit - Replace electronic ignition coil
12X Flashes (F 12) Heater lock out	- 3 repeated faults/flame-outs or 5 repeated start attempts	- Reinitialize control unit by switching heater on and disconnecting power.

• Troubleshooting and Maintenance

Refer to the Spheros manual for more information.

NOTE

If there are no heater faults, the heater will go through a normal start cycle and regulate based on thermostat setting.

NOTE

Switch on the preheating system briefly about once a month, even during the warm season.



CAUTION

When welding on the vehicle, disconnect the preheater module connector in order to protect this system from voltage surges.



CAUTION

To avoid running down the batteries, do not turn on the preheating system for more than one hour before starting the engine.



DANGER

The preheating system uses the same fuel as the engine. Do not operate in a building or while refueling. Operate only in a well-ventilated area.

11.2 SMALL HEATING SYSTEM

11.2.1 Draining Heating System

To drain the entire system, refer to Section 05, "Cooling". If only the driver's HVAC unit heater core must be drained, refer to the following instructions.

- **Draining Driver's HVAC Unit Heater Core**

- a) Stop engine and allow engine coolant to cool.
- b) Locate the normally open hot water pneumatic valve on the ceiling of the spare wheel compartment (Figure 53), move the pilot-solenoid valve red tab to close the valve.



WARNING

Before proceeding with the following steps, check that coolant has cooled down.

- c) Loosen hose clamp, install an appropriate container to recover coolant, and disconnect silicone hose from hot water pneumatic valve.
- d) From inside of vehicle, remove the two finishing panels in front of unit. Remove the three screws fixing the unit front panel. Open the manual vent located inside the HVAC unit, on the driver's side (Figure 41) to ensure an efficient draining.

11.2.2 Filling Heating System

- a) Ensure that the drain hose is reconnected and the manual vent is closed.
- b) Open the surge tank filler cap and slowly fill the system to level of filler neck.

- c) After initial filling, the water valve should be open and the water recirculating pump should be energized to assist in circulating coolant through the heating system. To perform this operation, start the engine, switch on the HVAC control module and set temperature to the maximum position in order to request the heating mode.
- d) When coolant level drops below the surge tank filler neck, slowly fill the system to level of filler neck.
- e) Once the level has been stabilized, replace cap.

11.2.3 Driver's Hot Water Pneumatic Valve Assembly

The small system driver's hot water pneumatic valve assembly is similar to the one installed in a central heating system.

Refer to figure 54 for hot water pneumatic valve location and to paragraph 11.1.5 for more information.

11.2.4 Water Recirculating Pump

The small system water recirculating pump is similar to the one installed in a central heating system.

Refer to figure 54 for pump location and to paragraph 11.1.7 for more information.

Section 22: HEATING AND AIR CONDITIONING

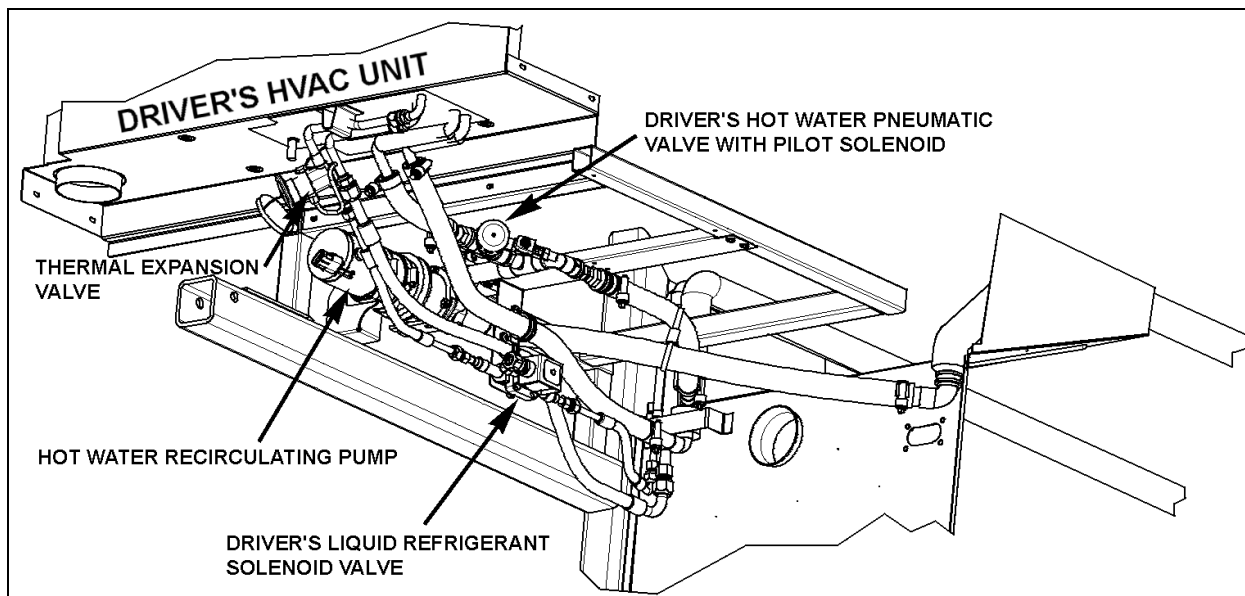


FIGURE 53: CEILING OF THE SPARE WHEEL COMPARTMENT

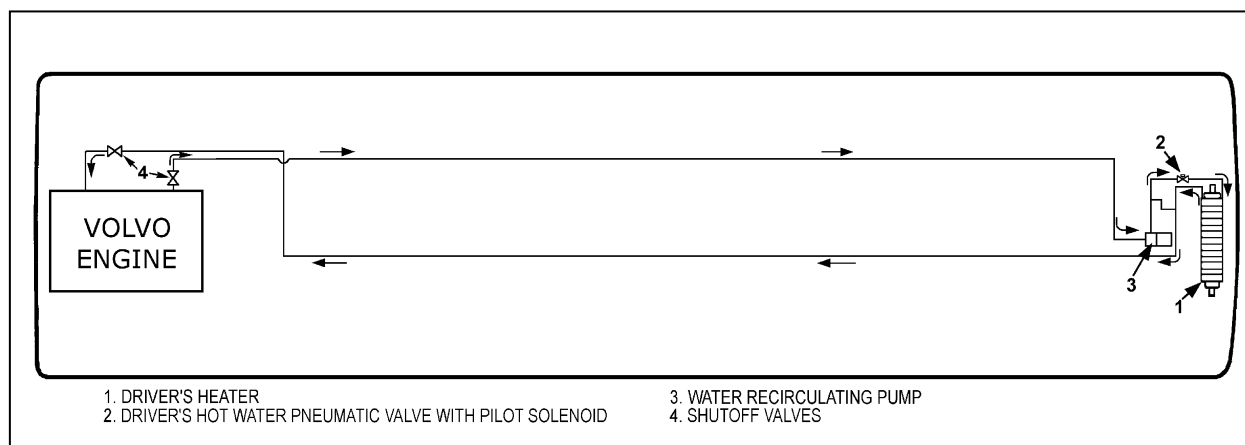


FIGURE 54: SMALL HEATING SYSTEM COMPONENTS

12. SPECIFICATIONS

Main evaporator motor

Make.....AMETEK ROTRON
 Type BRUSHLESS DC MICROPROCESSOR CONTROLLED
 Voltage 27.6 V DC
 Current draw..... 68 amps
 Horsepower 2
 Revolution 1400 & 1700 rpm
 Insulation Class F
 Motor Prevost number..... 563586

Condenser fan motors

Make..... EBMPAPST
 Type AXIAL BRUSHLESS
 Voltage 24 V DC
 Qty..... 4
 Prevost number..... 563461

Passenger's section air filter (in evaporator compartment)

Prevost number..... 871447

Driver's unit evaporator motors

Make..... MCC
 Voltage 24 V DC
 Quantity 1
 Prevost number..... 871135

Driver's unit evaporator air filters

Make..... MCC
 TYPE Recirculating air 6-1/4" x 28" Washable
 Prevost number..... 871147

Make..... MCC
 TYPE Fresh air 3-5/8" X 5-1/4" Washable
 Prevost number..... 871144

Refrigerant

Type R-134a
 Quantity (standard).....24 lbs (10.89 Kg)
 Quantity (A/C Aux. system located in overhead compartments).....4 lbs (1.8 Kg)

Section 22: HEATING AND AIR CONDITIONING

Compressor (Central system)

Make..... Bitzer
Displacement..... 41 CFM
Model, R-134a..... 4NFCY
No. of cylinders..... 4
Cylinder volume..... 39 in³ (647 cm³)
Operating speed..... 500 to 3500 rpm
Oil capacity..... 0.66 U.S. gal (2,5 liters)
Weight..... 74 lbs (33 kg)
Approved oil
Bitzer BSE55 (POE)
Prevost number..... 950001

Compressor V belt (Bitzer)

BX71 Set of 2, two Bosch alternators arrangement, Prevost Number..... 5060134
5VX810 single belt, three Bosch alternators arrangement, Prevost Number 5060127
5VX918 single belt, three Bosch alternators arrangement, Prevost Number 5060125

Magnetic clutch

Make..... Linnig
Type LA16
Voltage..... 24 V DC

A/C Compressor (Small or Auxiliary system)

Make..... ICE (International Components Engineering)
Model..... TM-16HD
Prevost number..... 950436
Approved oil OIL-ICE (PAG)
Prevost number..... 950382

Preheating system

Make..... SPHEROS
Model..... THERMO 300
Capacity..... 104 000 Btu/h (30 kW)
Heating medium Coolant
Rated voltage 24 V DC
Operating voltage 20-28 V DC
Electric power consumption (without coolant recirc. Pump)..... 110 watts
Fuel consumption..... 1,2 US gallons/hr (4,5 liters/hr)
Prevost number..... 871202