CONTENTS

ILLUSTRATIONS

1. HEATING AND AIR CONDITIONING SYSTEM OVERVIEW

The vehicle is equipped with a central HVAC system. Air flow and controls divide the vehicle in two areas: driver's area and passengers' 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 rear ventilator and through normal air-tightness losses.

NOTE

Air conditioning

Air conditioning is the artificial treatment of air to render the living conditions of persons more comfortable and healthful. Complete air conditioning involves adjustment and control of following operations performed on the air supply :

1) heating or cooling;
2) dehumidification;
3) ventilation;
4) Filtering;

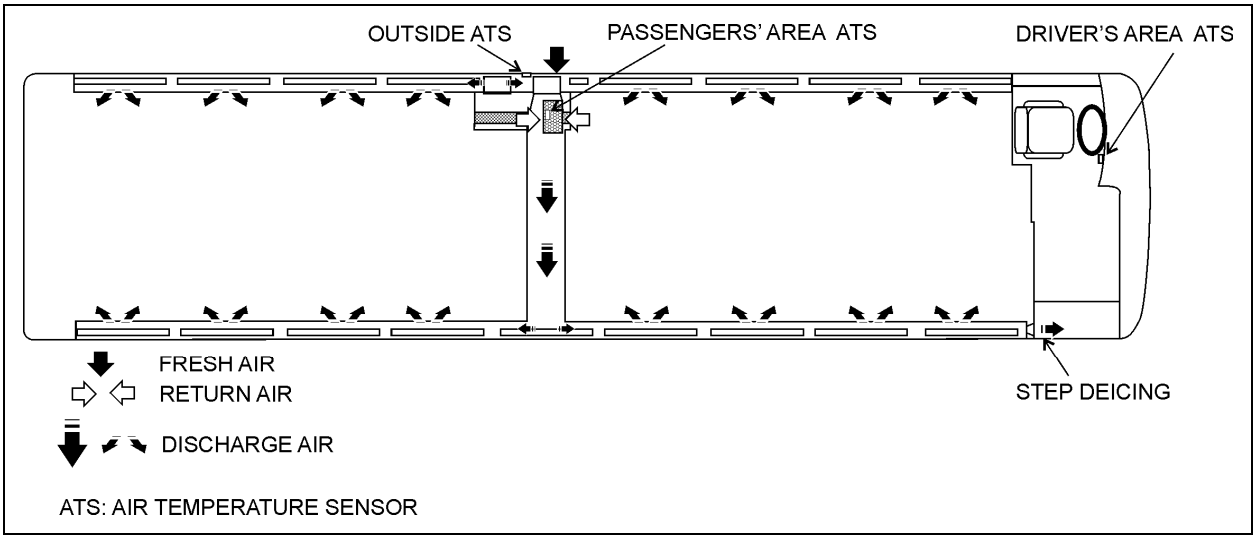


FIGURE 1: PASSENGERS' UNIT AIR CIRCULATION 22308

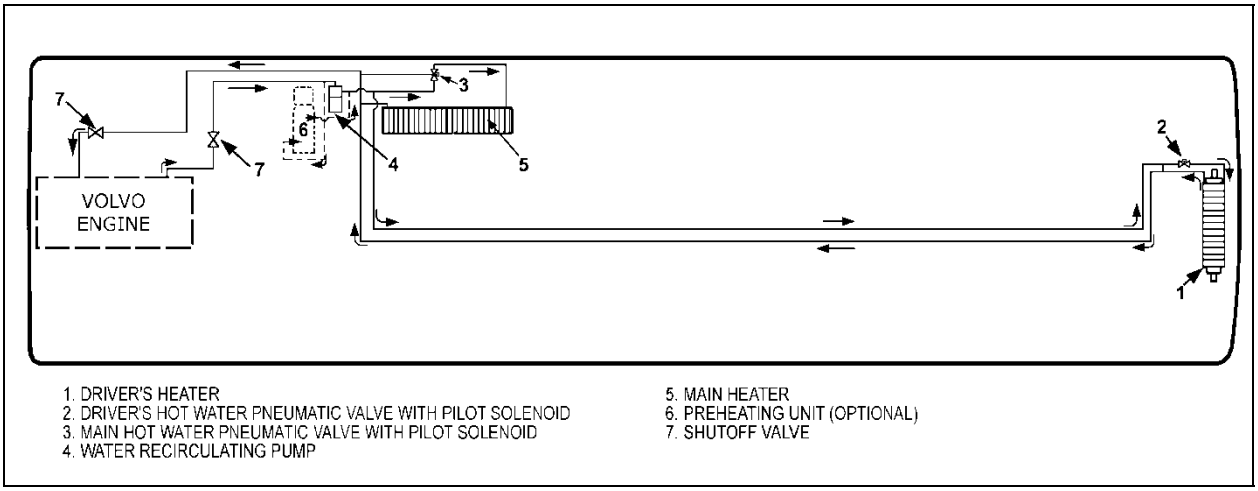


FIGURE 2: HEATING CIRCUIT

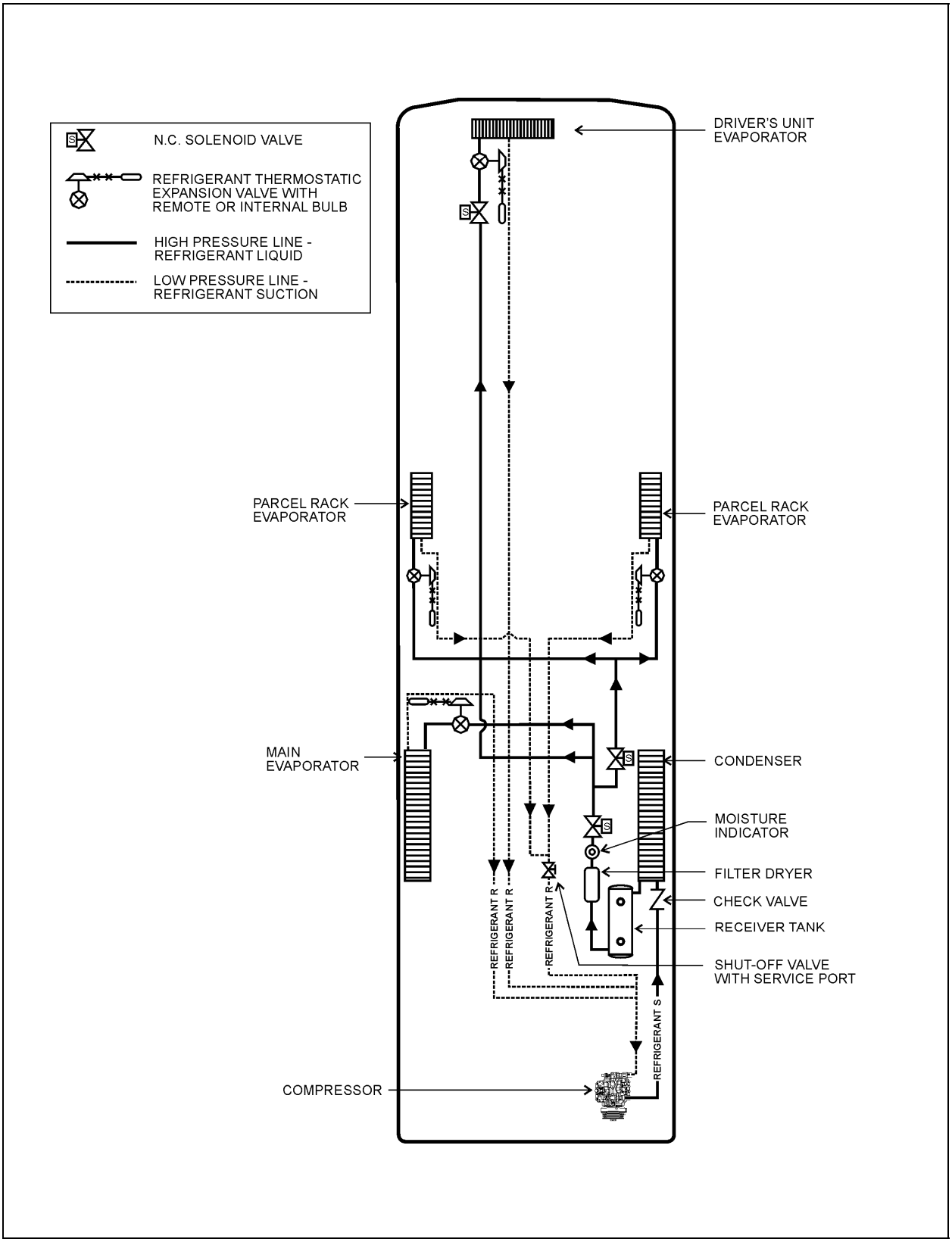


FIGURE 3: REFRIGERANT CIRCUIT 22220C

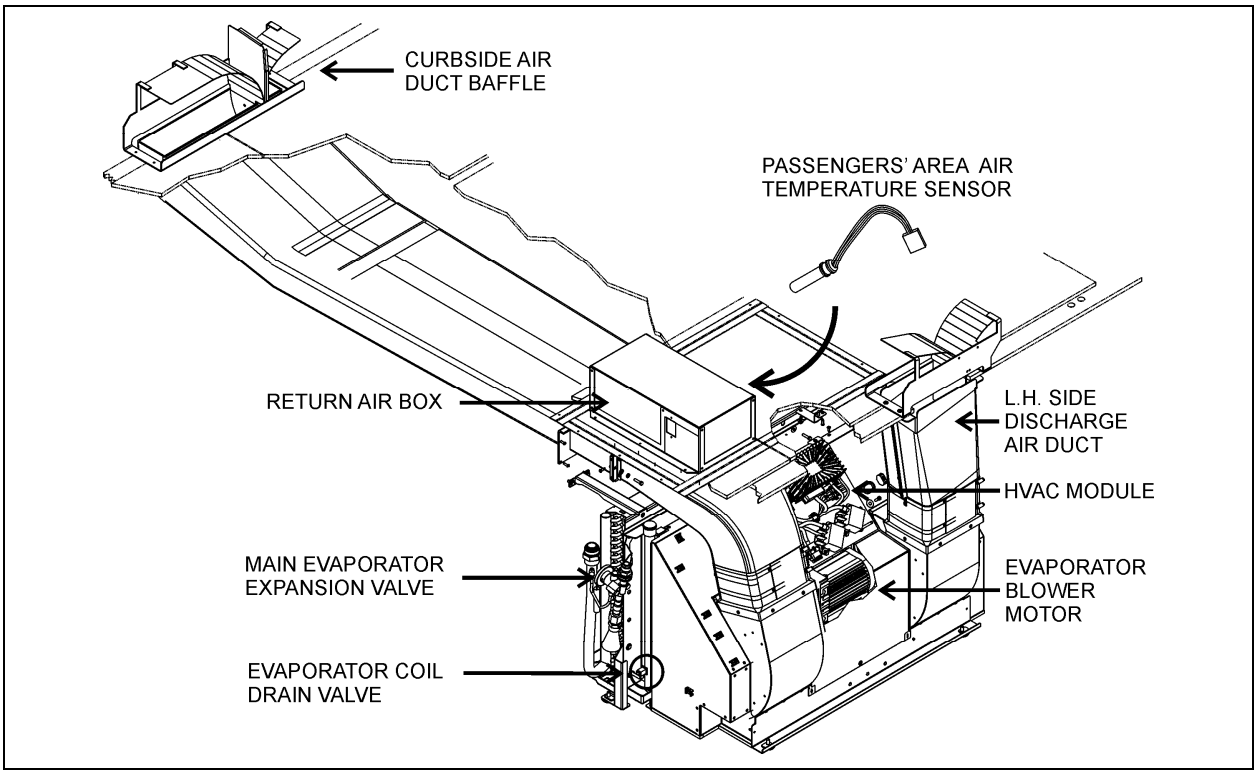


FIGURE 4: EVAPORATOR COMPARTMENT ARRANGEMENT

2. AIR CIRCULATION

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 5 and Operator's manual).

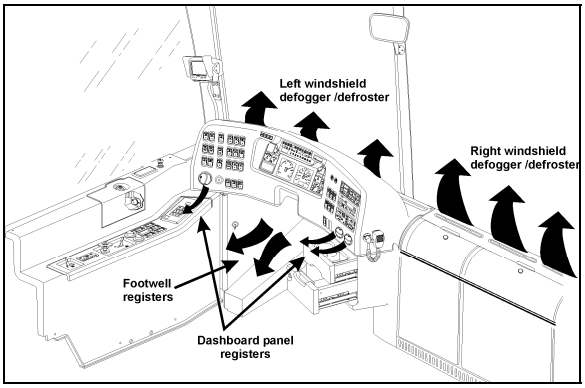


FIGURE 5: DRIVER'S AIR CIRCULATION 22307

2.2 PASSENGERS' AREA

Fresh air enters the vehicle on the L.H. side, through the recirculation damper located inside the evaporator compartment door (Figure 6). The damper can be fully opened for normal operation or closed for extreme weather or highly polluted areas (Refer to the 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 duct located on L.H. side of vehicle (Figure 1).

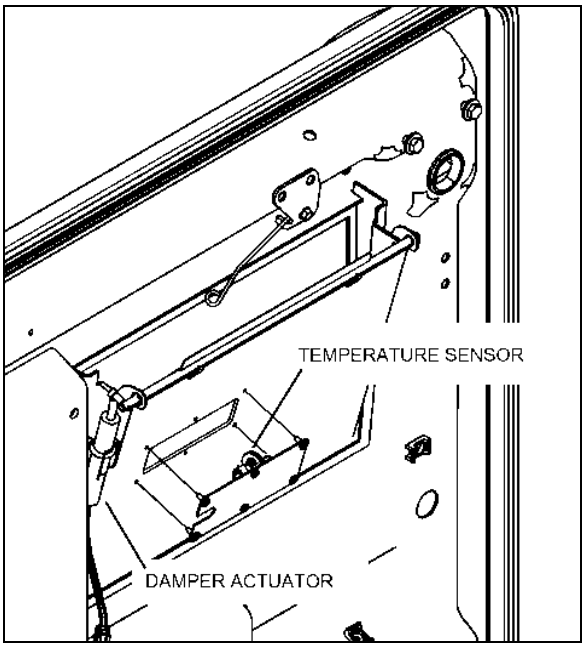


FIGURE 6: PASSENGERS' AREA FRESH AIR DAMPER 22302

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 (FIGURE 4) along the walls, and finally exhausts it just below side windows.

X3-45 Commuter coaches are also equipped with parcel rack A/C system An ON-OFF rocker switch located on R.H. dashboard panel allows activation of both fans. Return air is drawn just below the middle side windows through an air filter into the parcel rack A/C system fan. Discharge air is fed to the rotating registers through the ventilation duct (Figure 7).

The parcel rack air registers are used to control air flow for the passenger seats. Direct air flow by pointing or rotating the register. Open or close the register to adjust the air flow.

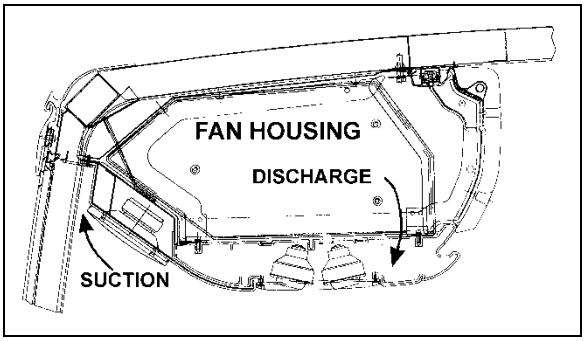


FIGURE 7: PASSENGERS' PARCEL RACK VENTILATION SYSTEM 22211

3. 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, the HVAC system will not operate if the battery voltage drops below 24 volts.

3.1 HVAC CONTROL UNIT

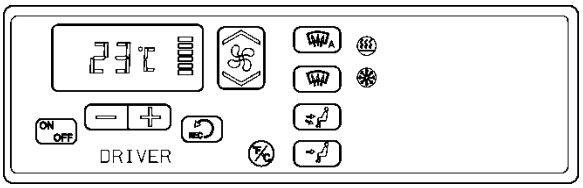
The vehicle is divided into two areas:

1 - Driver's area (driver's HVAC unit)

2 - Passengers' area (passengers' HVAC unit)

Fresh air is fed in each area and has a separate return air and discharge air duct.

Both driver and passengers HVAC units turn on automatically at starting of the engine but the driver can turn both off if desired and can then turn them back on using the ON/OFF button on the HVAC control unit.



22333

The HVAC control unit is used to control heating, ventilation, air conditioning and defroster in the driver's area only. The passengers' area HVAC unit (passengers' unit) temperature and fan speed is fully automatic. It has a preset temperature of 68°F (20°C). The temperature and fan speed cannot be changed by the driver.

NOTE
It is recommended to run engine at fast idle to operate the air conditioning system when vehicle is stationary. *This will improve A/C compressor performance and provide adequate electrical power to the multiple A/C system fans.* *When the system is running, keep roof ventilation hatch and door closed to prevent cooling loss.*

To prevent battery run-down, the central HVAC unit will not operate if the battery voltage drops below 24 volts.

When the HVAC system is in operation, park at least 4 feet from other vehicles or buildings to allow sufficient air flow through the condenser coil.

The HVAC control unit performs a self-test every time it is turned on. Codes are shown on displays or flashed on control buttons.

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 passengers' area temperature is within 7° of the set point or higher (set point is 68°F, so return air temperature must be above 61°F, at this moment, enough heat is available from the engine to warm up the area while the air conditioning will remove moisture in air and prevent fogging up of the windows).

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 down to a temperature of 15°F (-9°C) to prevent fogging up of the windows.

The driver's HVAC unit piping is paralleled with the passengers' HVAC unit piping. Both sections use the same refrigerant and hot water, and are linked to the same condenser and compressor, even if they are individually controlled. In order for the driver to have air conditioning, the passenger air conditioning system must be operating (A/C compressor must be operating).

NOTE
The driver's and passengers' HVAC unit turn on automatically at starting of the engine (multiplex receives the "engine running" signal) when the multiplex system receives an "engine running" signal.

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

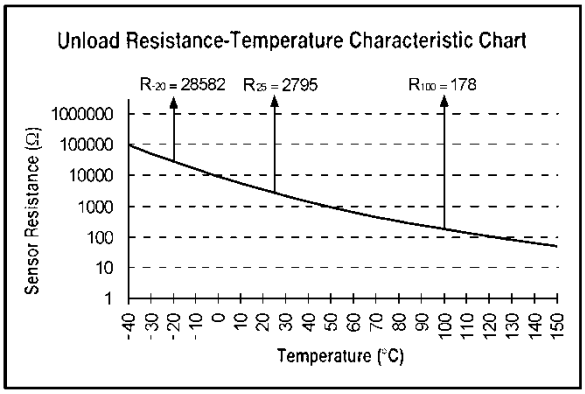
The following table can be used for troubleshooting the following temperature sensors:

NOTE

The driver's area air temperature sensor is located below the dashboard, just ahead of the driver's right knee.

1) Driver's area temperature sensor (SE21);
2) Passengers' area temperature sensor (SE25);
3) Outside air temperature sensor (SE20).

The table values are for unloaded, disconnected temperature sensor (thermistor) probed at the temperature sensor connector pins.



TEMPERATURE SENSOR		
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

3.2 PASSENGERS' SECTION OPERATION

The passengers' section has a preset temperature of 68°F (20°C).

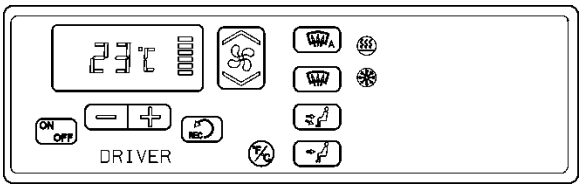


FIGURE 8: HVAC SYSTEM CONTROL UNIT

Temperature control is provided in conjunction with a thermistor sensor inside register duct, located on L.H. side of vehicle (FIGURE 3 & Figure 6).

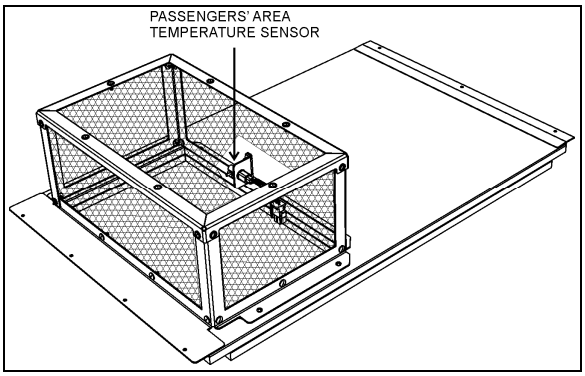


FIGURE 9: TEMPERATURE SENSOR

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.

NOTE

It is not uncommon for both the red Heat LED and the green AC LED to be illuminated at the same time. This indicates that the temperature control is requesting heat and the HVAC control is calling for compressor operation for dehumidification.

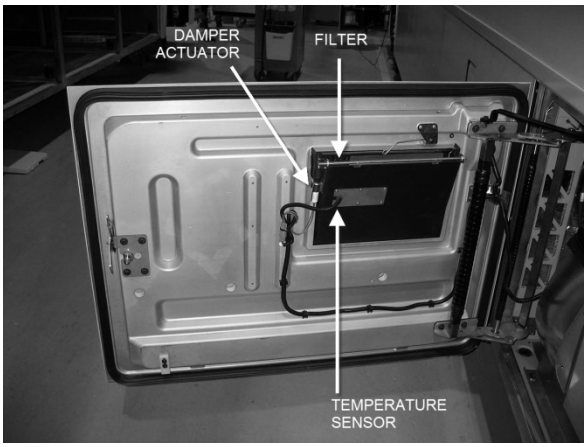


FIGURE 10: EVAPORATOR COMPARTMENT 22301

The evaporator fan motor, located in the evaporator compartment, is protected by a 90 amps, manually-resettable (CB3) 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 condenser compartment door is ventilated by four axial fans. The fan motors are protected by a manually-resettable 70 amp circuit breaker (CB7) mounted on the rear junction panel and accessible from the engine compartment curb-side door.

Furthermore, the following relays, diodes and multiplex module are located in the evaporator compartment. They are mounted in the HVAC module located inside the evaporator compartment on top of the fan housing (FIGURE 4 & FIGURE 11).

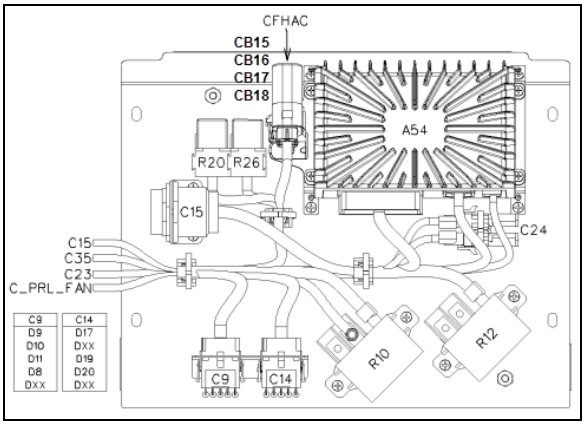


FIGURE 11: HVAC MODULE

A/C Junction Box		
Multiplex Module		
A54	I/O-B	
Relays		
R10	Condenser fan power	
R12	Evaporator fan power	
R20	Water circulating pump relay	
R26	Water Preheater Relay	
Diodes		
D8	Parcel rack Liq. Sol. Valve	
D9	Water circulating pump	
D10	Water circulating pump	
D11	Pass. Liq. Sol. Valve	
D17	3rd Bagg.Cmpt Lights	
D19	2nd Bagg.Cmpt Lights	
D20	1st Bagg.Cmpt Lights	

Relevant Breakers	
CB15	15A, Condenser fan up-fore
CB16	15A Condenser fan down-fore
CB17	15A Condenser fan up-aft
CB18	15A Condenser fan down-aft

4. HVAC UNIT BASIC MAINTENANCE

Basic maintenance required on the passengers' and driver's units consists in cleaning their respective coils and cleaning or replacing air filters.

However, periodic inspection for broken drains, hoses and charging of system should be done.

MAINTENANCE

Squeeze rubber discharge tubes located underneath the appropriate compartment to eliminate the accumulated water and dirt every three months.

4.1 COIL CLEANING

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

MAINTENANCE

For the driver's HVAC unit, remove the grill and the coil access panel. Clean the driver's unit evaporator and heater coils with low-pressure air jet every 100 000 miles, taking care not to damage fins. Clean the bottom of the defrost plenum.

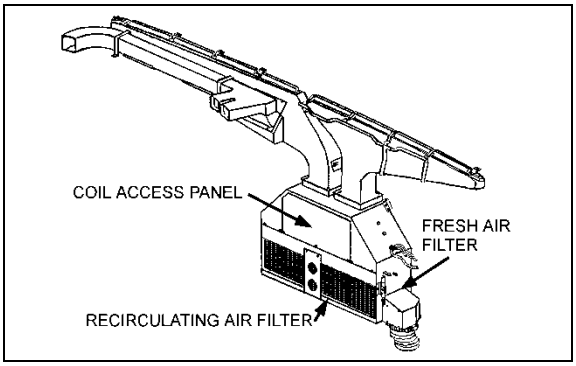


FIGURE 12: DRIVER'S HVAC UNIT COIL ACCESS PANEL

MAINTENANCE

With the air filters removed, clean the **passengers' unit** evaporator and heater coils with low-pressure air jet or a stream of low-

pressure water, every 100 000 miles. Do not use a pressure washer as this will damage the fins. Remove the air filter and brush the evaporator coil from behind.

Clean the condenser with low-pressure air jet or a stream of low-pressure water, taking care not to damage fins.

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.

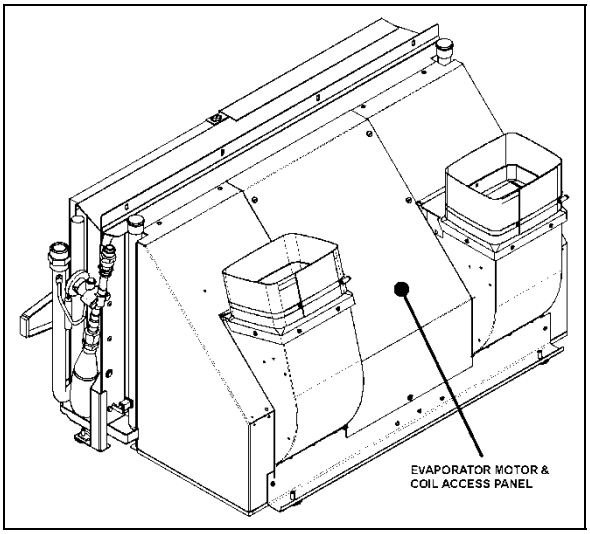


FIGURE 13: EVAPORATOR COIL ACCESS PANEL (TYPICAL) 22309

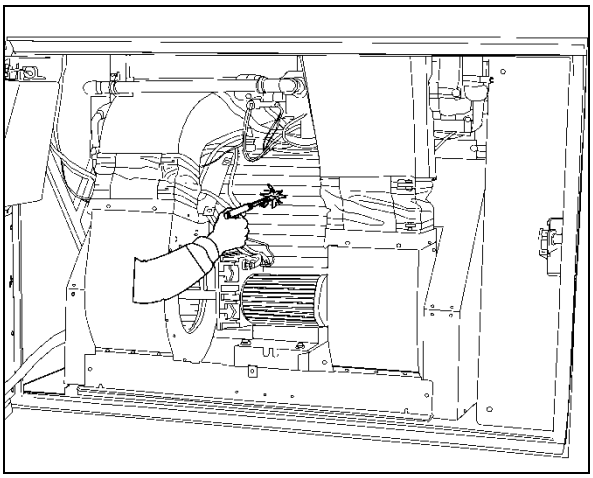


FIGURE 14: EVAPORATOR COIL CLEANING 22373

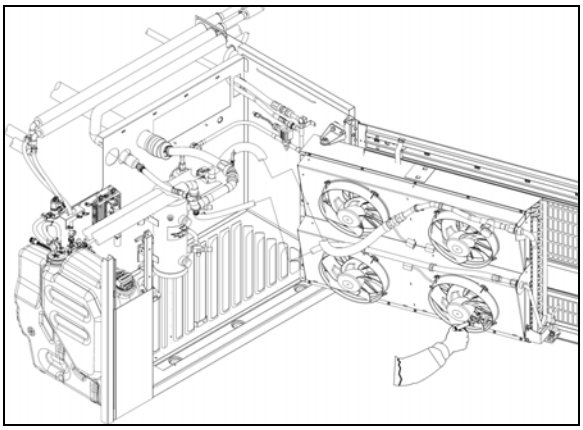


FIGURE 15: CONDENSER COMPARTMENT 22311

4.2 DRIVER'S SECTION AIR FILTERS

The driver's HVAC unit is located behind the dashboard's R.H. side panel. To gain access to the A/C filters, unscrew the grille located at the top entrance step (FIGURE 16). Unscrew the plastic cover and slide out the recirculating air filter (Figure 17). Doing so will give you access to the fresh air filter (see item 18, Figure 51).

MAINTENANCE

Back flush driver's unit air filters with water and then dry with air every 6000 miles.

NOTE

If the windshield is continuously fogged, check that :

- *the driver's unit fresh air filter is not clogged;*
- *the fresh air damper (flapper door) is open, i.e. the RECirculation button on the HVAC control unit is not engaged.*

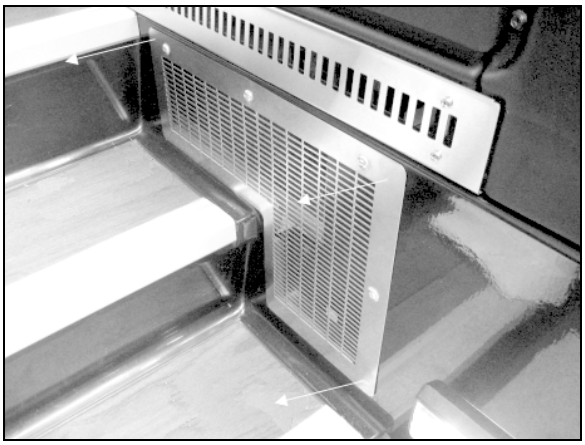


FIGURE 16: DRIVER'S HVAC UNIT ACCESS GRILL

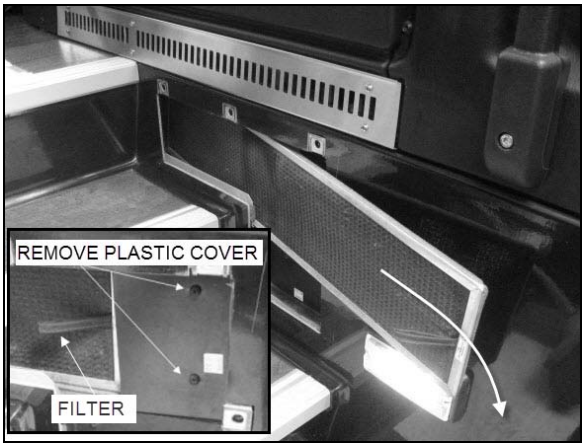


FIGURE 17: REMOVING RECIRCULATING AIR FILTER

4.3 PASSENGERS' SECTION AIR FILTER

The passengers' section air filter is located in the evaporator compartment above the Evaporator coil and fans (Figure 18).

The vehicle is fitted with disposable filters.

Open access panel by turning the quarter-turn screws, and slide out filters to exchange.

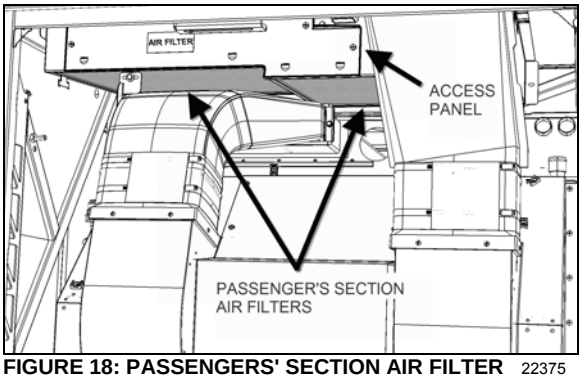


FIGURE 18: PASSENGERS' SECTION AIR FILTER 22375

MAINTENANCE

Replace filters every 6000 miles.

CAUTION

Do not use high pressure water jet to avoid damaging filter. Be sure not to reverse filter upon installation.

4.4 PARCEL RACK FAN AIR FILTER

The air filters are accessible from the two vehicle parcel racks equipped with A/C units (center of the vehicle, both side). Slide the filter in and out using the tab fixed on the side of the filter. (Figure 19)

FIGURE 19: PARCEL RACK FAN AIR FILTER

MAINTENANCE

Slide out filters, back flush with water then dry with air and reinstall. This procedure should be done every 6000 miles.

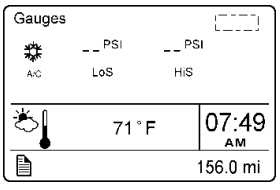
5. HVAC SYSTEM PARTICULARITIES, TESTING AND TROUBLESHOOTING

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 necessary for troubleshooting the HVAC system on Multiplex vehicles.

5.1 ON DEMAND DISPLAY OF A/C COMPRESSOR HIGH AND LOW SIDE PRESSURE

Refrigerant pressures can be displayed in the Driver Information Display (DID) by selecting "Gauges" menu and pressing the down arrow to the fifth displayed screen.

A/C Compressor Pressure

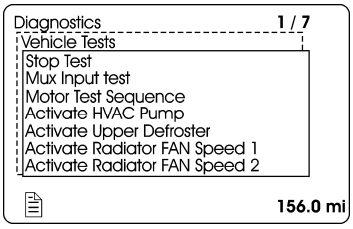


Displays the A/C compressor suction pressure value (LoS=low side) and discharge pressure value (HiS=high side).

NOTE
When starting the A/C compressor, allow enough time before checking pressures in order to give the system a chance to build its pressure. During the first 3 seconds after startup, the compressor is active on 4 cylinders and the A/C valve is open regardless of the pressure readings.

5.2 ON DEMAND ACTIVATION OF HOT WATER CIRCULATING PUMP

In Diagnostics/Vehicle Test mode on the DID, the heating system circulating pump can be turned on manually by selecting ACTIVATE HVAC PUMP command. This feature allows verification of the circulating pump when inside a garage. This is also useful when working on the heating system to remove air pockets trapped in the system.



In normal operation, the heating system circulating pump operates only when the ambient temperature is 50°F or lower.

5.3 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.

Use this test mode for testing of the condenser fans, evaporator fans, parcel rack fans, A/C compressor clutch activation, A/C compressor unloader activation, driver's unit hot water solenoid valve and refrigerant solenoid valve, passengers' unit hot water solenoid valve and refrigerant solenoid valve, water circulating pump. Refer to Section 06: ELECTRICAL under "TEST MODE FOR ELECTRICAL MOTORS" for complete information.

5.4 MODES OF OPERATION

COOLING DEMAND Conditions for engaging the 2nd speed on the evaporator motor	The 2nd speed engages if the passengers' 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.
HEATING DEMAND Conditions for hot water circulating pump activation	The pump turns ON if the outside temperature is equal or less than 50°F (10°C), when heating is more likely to be needed 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 5.2 ON DEMAND ACTIVATION OF HOT WATER CIRCULATING PUMP.
The compressor unloader operation is based on pressure and on the difference between the passengers' area temperature and set point.	**right compressor cylinders** Stop if: The passengers' area decreasing temperature becomes less than 0.4°F above the set point (68°F) or if compressor discharge pressure is above 280 psi, or if compressor suction pressure is below 23 psi. Restart if: The Passengers' area temperature is 1.3°F or more above the set point and compressor discharge pressure is less than 220 psi and compressor suction pressure is above 32 psi.
A/C compressor deactivation pressure	320 psi In case of high pressure, the high pressure transducer connected to the multiplex module deactivates the compressor There is also a 350 psi pressure switch that acts to stop the compressor in the instance that the multiplex module fails.
Compressor turns on automatically if (2 required conditions)	outside temperature is above 32°F and return air temperature in passengers' area is 61°F or above (ΔT=7° with set point)
passengers' area temperature set point	68°F

5.5 HVAC SYSTEM MULTIPLEX TROUBLESHOOTING

Problem/Symptom	Probable Causes	Actions
Defroster fan not functioning	Module A47 is not powered or is faulty Module A24 is not powered or is faulty	1. Check the Diagnostics menu of the Driver Information Display (DID). Select Fault Diagnostics and Electrical System. The message "No Response ModA47 (or ModA24), Active" indicates a power problem on the module. (A CAN network problem would show the same message but doesn't produce these symptoms). 2. Check / reset circuit breaker CB1 3. Check CB16V (VECF) 4. Probe gray connector on module to see if it is powered.
HVAC condenser fans not functioning	Circuit breaker CB7 tripped Seized bearing Bad wiring Module A54 is not powered or is faulty	1. Check / reset circuit breaker CB7 2. Check/reset CB15, CB16, CB17, CB18 on HVAC control module 3. Check / replace condenser power relay R10 (probe R10 coil power circuit 67A, should be 24 volts). 4. Check the Diagnostics menu of Driver Information Display (DID). Select Fault Diagnostics and Electrical System. The message "No Response ModA54, Active" indicates a power problem on the module. (A CAN network problem would show the same message but doesn't produce this symptom). 5. Check CB5, CB67.
HVAC condenser fans not functioning in <u>speed 1</u>	Module A42 is not powered or is faulty	1. Check the Diagnostics menu of Driver Information Display (DID). Select Fault Diagnostics and Electrical System. The message "No Response ModA42, Active" indicates a power problem on the module. (A CAN network problem would show the same message but doesn't produce this symptom). 2. Check / reset circuit breaker CB1, CB5, CB7 3. Check CB67 4. Probe gray connector on module to see if it is powered.
HVAC condenser fans not functioning in <u>speed 2</u>	Circuit breaker CB7 tripped Seized bearing Bad wiring	1. Check / reset circuit breaker CB7 2. See *HVAC condenser fans not functioning* & *HVAC condenser fans not functioning in <u>speed 1</u>* above.
Defroster fan is functioning but no heat or cooling	Module A46 is not powered or is faulty	1. Check the Diagnostics menu of Driver Information Display (DID). Select Fault

Problem/Symptom	Probable Causes	Actions
available in the driver's area	Bad wiring	Diagnostics and Electrical System. The message "No Response ModA46, Active" indicates a power problem on the module. (A CAN network problem would show the same message but doesn't produce these symptoms). 2. Check / reset circuit breaker CB1 3. Check fuse CB12V or CB13V (VECF) 4. Probe gray connector on module to see if it is powered.
The A/C compressor clutch does not engage	Module A52 is not powered or is faulty	1. Check the Diagnostics menu of Driver Information Display (DID). Select Fault Diagnostics and Electrical System. The message "No Response ModA52, Active" indicates a power problem on the module. (A CAN network problem would show the same message but doesn't produce this symptom). 2. Check / reset circuit breaker CB5 3. Check CB65V (VECR) 4. Probe gray connector on module to see if it is powered.
Evaporator fan not functioning	Circuit breaker CB3 tripped Module A54 is not powered or is faulty	1. Check / reset circuit breaker CB3 2. Check the Diagnostics menu of Driver Information Display (DID). Select Fault Diagnostics and Electrical System. The message "No Response ModA54, Active" indicates a power problem on the module. (A CAN network problem would show the same message but doesn't produce this symptom). 3. Check / reset circuit breaker CB5 4. Check CB67 5. Probe gray connector on module to see if it is powered. 6. Check / replace condenser power relay R12 (probe R12 coil power circuit 67, should be 24 volts).

6. AIR CONDITIONING SYSTEM

The schematic of FIGURE 3 shows the A/C systems and their components.

The HVAC 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.

6.1 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 3.

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 in^2 (5162 mm^2) 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.

6.2 REFRIGERANT

The A/C system of this vehicle has been designed to use R134a refrigerant. 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.

6.2.1 Procurement

Refrigerant is shipped and stored in 30 and 100 pound metal cylinders. Approximately 24 lbs are used in the HVAC system plus an additional 2.0 lbs will be needed for the parcel rack A/C system.

Refrigerant charge (Approximately)

A/C system:	*24 lbs*
Parcel rack A/C system:	*2 lbs*
Total:	*26 lbs*

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

6.2.2 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 to more than 80% liquid full to allow for refrigerant expansion.
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.

6.2.3 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.

6.2.4 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 2-½" (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.

WARNING

Always wear safety goggles and gloves when opening refrigerant lines.

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 and gaskets 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.

6.3 PUMPING DOWN

This procedure is intended to reduce refrigerant loss by isolating it in the compressor and 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).

NOTE

Once this pull down procedure has been properly done, any component from the outlet hose on the receiver tank, the filter-dryer, the liquid solenoid valves, the evaporators, the expansion valves, and all lines associated with them can be serviced, ***then properly evacuated****.*

It must be noted that there is STILL refrigerant under pressure in the compressor, the discharge lines, condenser, and receiver tank and that these items cannot be serviced. To service these items, it is required to recover the refrigerant using a recovery unit.

CAUTION

The filter-dryer must be replaced after a severe system failure or if a line in the system has been opened over a prolonged period of time. The line will then have to be properly evacuated.

Best practice would be to replace the filter-dryer each time a line is opened.

NOTE

Before attempting any repair between compressor and receiver tank, use a recovery unit to remove refrigerant from the system.

WARNING

To prevent any injury, when air conditioning system must be opened, refer to previous paragraph “PRECAUTIONS IN HANDLING REFRIGERANT”.

NOTE

For this procedure to be done properly, it is assumed the proper amount of refrigerant is in the refrigeration system. If there is any doubt, use a recovery unit to recover and weight the amount of refrigerant in the system.

6.3.1 Procedure

1. Energize driver’s unit and passengers’ unit (main HVAC system) section liquid solenoid valve. To do so, connect male and female connector housings of C24 together for the passengers’ area (found on the HVAC module in evaporator compartment) and C44 for the driver's area (located on the ceiling of the spare wheel compartment). During normal use, both male and female housings of connector C24 or C44 are kept unplugged.

CAUTION

Connectors C24 & C44 must be disconnected and their caps reinstalled after this procedure. Leaving them connected will keep the driver’s, passengers’ and parcel rack liquid solenoid valves open, and result in battery draining if the vehicle remains unused for several days.

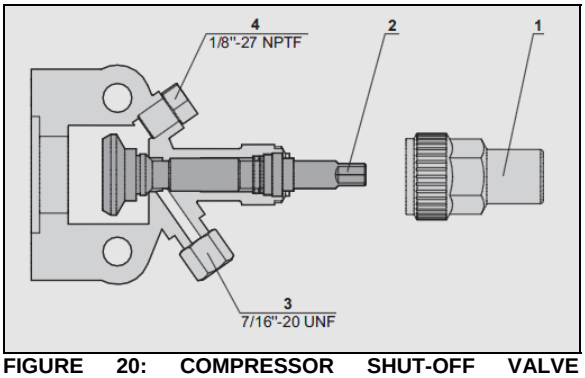


FIGURE 20: COMPRESSOR SHUT-OFF VALVE BACKSEATED POSITION (NORMAL OPERATING POSITION)

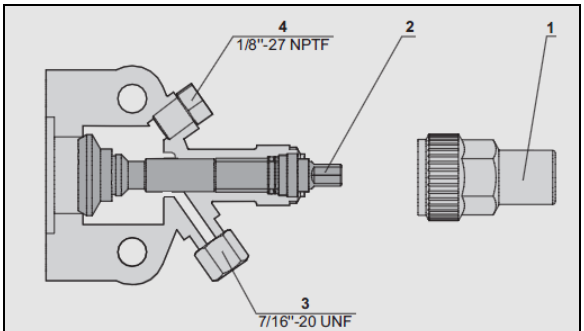


FIGURE 21: COMPRESSOR SHUT-OFF VALVE IN FRONT SEATED POSITION

2. Run the system for 10 minutes and then shut it off.
3. Close (frontseat) the receiver tank outlet shut-off valve by turning the stem clockwise (Figure 36).
4. Backseat the compressor suction shut-off valve (FIGURE 20), install an appropriate pressure gauge set on the service port and then turn the shut-off valve forward ¼ turn more or less until a visual check of the suction pressure is possible.
5. Disconnect the low pressure transducer (FIGURE 27). The multiplex system will establish a default value of 34 psig and this will allow pulling down the A/C compressor to 0 psig. **Note: the low pressure transducer must be reconnected after the pumping down operation is complete.**
6. Run the A/C compressor until suction pressure is pulled down to 0 psig.
7. Disconnect the compressor clutch to stop the compressor from pulling the system into a vacuum. Vacuum is not required. The pressure will probably slowly increase on the suction side. When it reaches 10 psig, reconnect the clutch and repeat the pull down to pull down this residual pressure. This process might need to be repeated a couple of times until the suction pressure drops and remains to 0 psig.
8. Stop the compressor.
9. Close (frontseat) the suction shut-off valve on the compressor (FIGURE 21).
10. At this point, C24 can be disconnected to isolate the section of the system located between the receiver tank outlet shut-off valve and the passengers' unit liquid solenoid valve. Doing so would be useful to perform replacement of the filter-dryer for example.

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.

6.4 LIQUID REFRIGERANT RECOVERY

Liquid recovery is performed the same way as standard vapor recovery except that liquid recovery will be done by connecting to the high side of the system. Recovering liquid is ideal for recovering large amounts of refrigerant.

1. Energize driver's unit and passengers' unit (main HVAC system) section liquid solenoid valve. To do so, connect male and female connector housings of C24 together for the passengers' area (located on the HVAC module in evaporator compartment) and C44 for the driver's area (located on the ceiling of the spare wheel compartment). During normal use, both male and female housings of connector C24 or C44 are kept unplugged.
2. Backseat (normal operating position) the compressor suction and discharge shut-off valves.
3. Connect manifold gauges on the service port and then turn the compressor shut-off valves forward just enough to enable a visual check of the suction and discharge pressure.
4. Make sure the receiver outlet shut-off valve is in backseated position (normal operating position). Connect the recovery unit hose to the receiver outlet shut-off valve service port (FIGURE 22).

FIGURE 22: RECOVERY UNIT CONNECTED TO RECEIVER SERVICE PORT

5. Perform the recovery of the refrigerant as prescribed by the recovery unit manufacturer.

6.5 EVACUATING SYSTEM

When A/C system has been opened or if there are any questions about the air or moisture in the system, evacuate the system.

Backseat (stem out) both compressor shut-off valves. Evacuate the entire system including compressor using a **vacuum pump** connected to the high and low pressure sides.

A steady vacuum (i.e. pressure does not rise within two hours) less than 0.02 psi (1.5 mbar) must be maintained once the vacuum pump is turned off.

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

1. Make sure both receiver tank shut-off valves are is the normal backseated position (stem turned out).
2. Clean the area around the compressor shut-off valves.
3. Remove the blue and red caps from the service ports on suction and discharge shut-off valves. Connect two hoses to the vacuum pump.
4. Meadseat the compressor suction and discharge shut-off valves.
5. Using connector C24 and C44, energize and open the liquid solenoid valves (driver's unit, passengers' unit and parcel rack units). To do so, uncap and connect male and female connector housings of C24 together for the passengers' area (located on the HVAC module in evaporator compartment) or C44 for the driver's area (located on the ceiling of the spare wheel compartment).
6. Start the vacuum pump.
7. The pressure will drop to approximately 29 in-HG gauge vacuum.
8. Evacuate to a system pressure of 500 micron.
9. Shut down the vacuum pump. Validate that the vacuum holds. If the pressure rises, it indicates a leak.
10. Backseat the compressor shut-off valves by turning "out" all the way.
11. Remove the hoses.
12. Reinstall the red and blue caps at the suction and discharge shut-off valves service ports.
13. Disconnect C24 & C44.

6.6 ADDING VAPOR STATE REFRIGERANT

Addition of vapor state refrigerant is carried-out to compensate for hose permeation and shaft seal losses over a long period and is done from the suction side while compressor is in operation.

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.

6.6.1 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 (FIGURE 23) should be clear, not milky, without bubbles in the stream of refrigerant. Bubbles in the moisture indicator sight glass are sign of refrigerant low charge. 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.

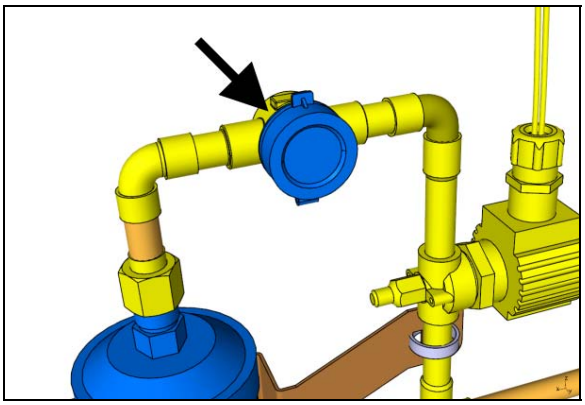


FIGURE 23: MOISTURE INDICATOR SIGHT GLASS

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 (see 7.13 Temperatures & Pressure), find this temperature and the corresponding saturation pressure and add 10 psi for the pressure drop between compressor and condenser.

Calculation example:

At 70°F outside, add 30°F. In the chart (paragraph 7.13), find the pressure value for a temperature of 100°F. For 134a refrigerant gas, you will find a value of 124 psi. Add 10 psi 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.

6.6.2 Refrigerant addition

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.

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.

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 shut-off valve service port of the compressor. Connect the red valve of the gage set to the discharge shut-off valve service port. Hoses should be purged of air at installation (evacuated).

WARNING

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

3. Midseat the compressor suction and discharge shut-off valves.
4. In order to speed up the charging, unplug the unloader to keep all compressor cylinders active.

CAUTION

When unplugging the unloader, use exceptional caution so as not to rotate the blue unloader solenoid coil on the Bitzer compressor R.H. cylinder. The aluminum cap on top of the coil may become loose; it can result in failure of the unloader stem/valve (FIGURE 30).

Make sure the aluminum cap on top of the blue unloader coil remains tight.

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.

WARNING

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

6. Start engine.
7. Switch to fast idle for faster fill and battery protection.
8. 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.
9. Check the moisture indicator sight glass and the discharge pressure to meet the criteria described above.
10. 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.
11. When finished, close gage valves and bottle valve.
12. Before stopping the engine, check the compressor oil level and note it in the repair

book as well as the amount of refrigerant added.

13. Shut down engine and backseat suction and discharge shut-off valves (FIGURE 20).
14. Remove gages and replace caps.
15. Perform a road test for final verification.

6.7 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 plus an additional 2 lbs for parcel rack A/C system**.

After charging the system, it may be necessary to add refrigerant. Vapor state refrigerant will be done from the suction side of the compressor while the compressor is in operation. Refer to 6.6 Adding Vapor State Refrigerant

1. Using connector C24 and C44, energize and open the liquid solenoid valves (driver's unit, passengers' unit and parcel rack units). To do so, uncap and connect male and female connector housings of C24 together for the passengers' area (located on the HVAC module in evaporator compartment) or C44 for the driver's area (located on the ceiling of the spare wheel compartment).
2. Backseat (stem out) the two compressor shut-off valves (FIGURE 20).
3. Install A/C pressure gauges at the compressor shut-off valves service ports (item 4, FIGURE 20).
4. Midseat the two compressor shut-off valves.
5. Ensure that the two receiver shut-off valves are in backseated position (stem out).
6. Remove the cover cap from the service port on the receiver inlet shut-off valve (Figure 36).
7. Attach an evacuated charging hose (purged from air and moisture) to the R-134a tank.
8. Connect the evacuated charging hose to the service port on the receiver tank inlet shut-off valve.
9. Open the R-134a tank valve. The refrigerant supply tank should be kept warm to allow more refrigerant to be transferred into the system. Use a heating blanket for this matter.
10. Midseat the receiver inlet shut-off valve. The R-134a will now enter the system.
11. The proper charge of R-134a is 24 lbs, to this, add 2 lbs for parcel racks A/C system. When the scale indicates this amount of charge, backseat the receiver valve and close the R-134a tank valve.
12. Disconnect the charging hose. Replace the cover caps.
13. Disconnect C24 & C44.
14. The system is now ready for operation.

6.8 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.

6.8.1 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.

6.8.2 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.

6.8.3 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 using method described earlier.
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.

7. A/C SYSTEM COMPONENTS

7.1 COMPRESSOR

The A/C compressor is a **Bitzer 4-cylinder model 4NFCY**. Refer to the "Specifications" section at the end of this chapter.

7.1.1 Belt Replacement

DANGER

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.

1. Open engine compartment rear doors and locate the belt tensioner.
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.

7.1.2 Belt Tension Adjustment –A/C drive belt

On the mechanical tensioner, slightly loosen Lock Bolt (A). Adjust tension by turning Adjustment Screw (B). Tighten the Lock Bolt (A) to 43 lbf-ft. to preserve adjustment.

CAUTION

When unplugging the unloader, use exceptional caution so as not to rotate the blue unloader solenoid coil on the Bitzer compressor R.H. cylinder. The aluminum cap on top of the coil may become loose; it can result in failure of the unloader stem/valve (FIGURE 30).

Make sure the aluminum cap on top of the blue unloader coil remains tight.

Should the idler bearing need to be serviced, tighten shoulder bolt (C) to 35 lbf-ft. at reassembly.

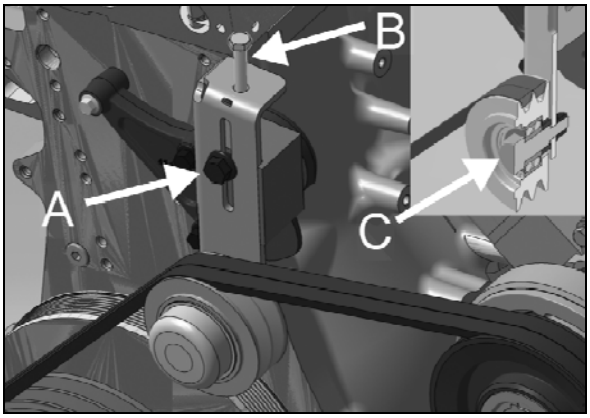


FIGURE 24: COMPRESSOR BELT TENSIONER

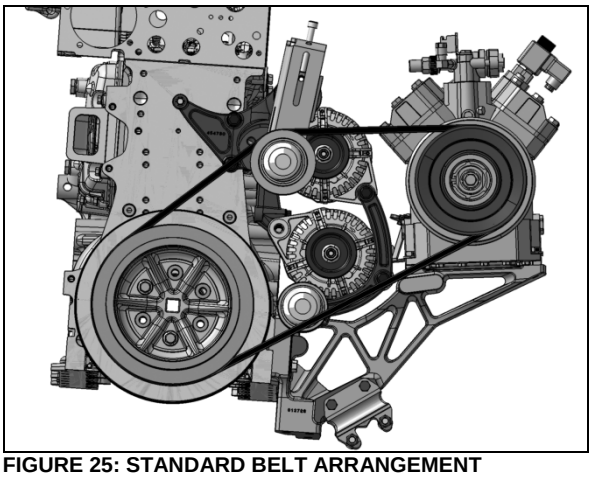


FIGURE 25: STANDARD BELT ARRANGEMENT

Belt tensions should be within the following values:

BX71 Double Belt

90 - 100 lbs. – new

75 - 85 lbs. – used

7.1.3 Suction and Discharge Hose Connection

1. Before connecting suction and discharge refrigerant hoses to the compressor, apply POE compressor oil on new gaskets, **do not dip in oil**.
2. Tighten flanged hose by hand in 2 sequences.
3. Apply a final torque of 33 lbf-ft on cap screws.

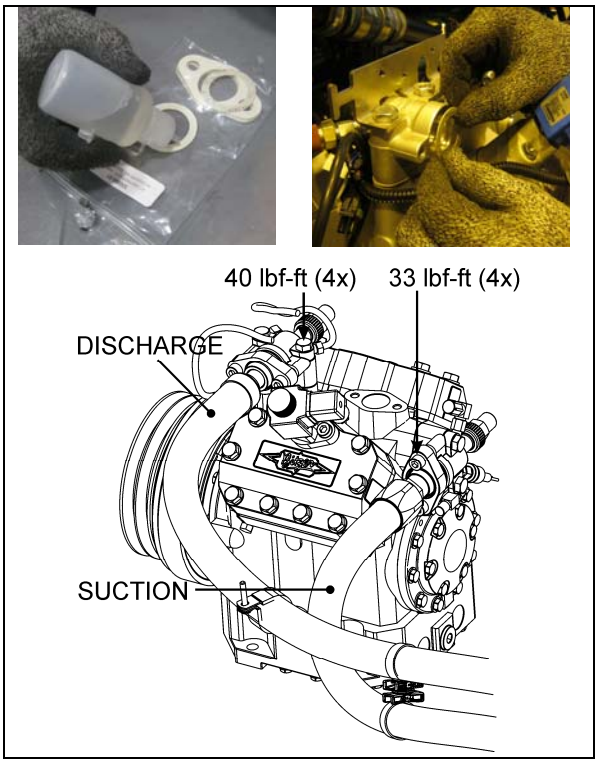


FIGURE 26: TORQUES

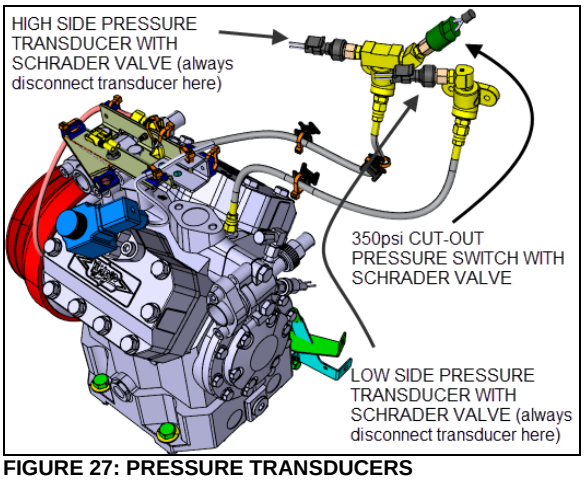


FIGURE 27: PRESSURE TRANSDUCERS

7.1.4 Compressor Maintenance

For complete information on Bitzer A/C compressor maintenance, installation, torque chart, approved oils, refer to the following Bitzer manuals included with the technical publications in PDF format.

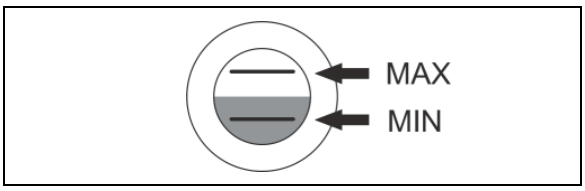
- Bitzer kb-540-3 Operating Instructions
- Bitzer ke-540-7 Spare Parts List
- Bitzer kw-541-2 Exchanging Shaft Seal
- Bitzer kt-510-5 Tech Info oils
- Bitzer kw-555-3 Tightening Torques
- Bitzer kt-100-3 Capacity Control (unloader)
- Bitzer kw-540-1 Maintenance Instruction

7.1.5 Oil Level Check and Oil Change

Oil level should be at ¼ to ¾ of sight glass height.

Oil Type: Polyoester ISO68.

- Bitzer BSE55 (POE)
- Castrol Icematic SW 68
- Mobil EAL Arctic 68
- Shell S4 FR-F 68, Clavus R68



Changing the compressor oil is not necessarily required for A/C systems which are operated in a normal fashion. Only impurities from the system components or operation outside the application ranges can lead to deposits in the lubrication oil and darken its color. Change the oil in this case. At the same time, clean the oil filter and magnetic plug as well. Determine and eliminate the cause for operation outside the application ranges.

However, compressor oil does wear down; therefore, it is strongly recommended to change the oil approximately every 4 years (10000-12000 operating hours). Clean the oil filter and the magnetic plug with every oil change.

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

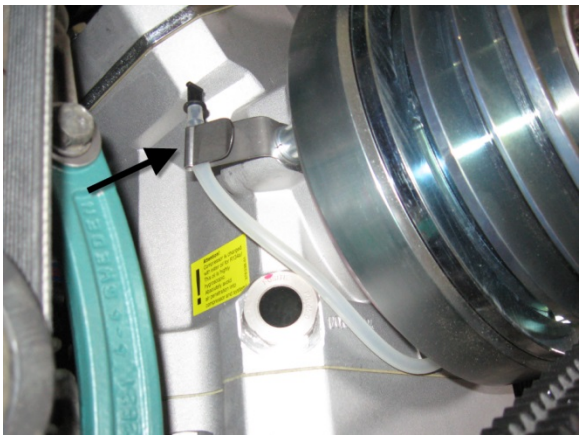


FIGURE 28: SHAFT SEAL OIL COLLECTING TUBE

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

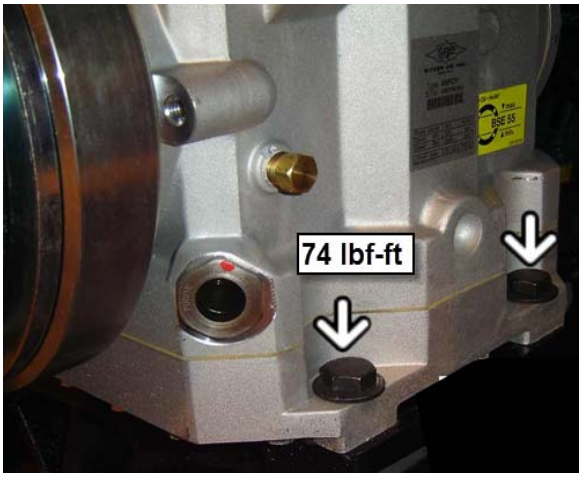


FIGURE 29: MOUNTING BOLTS TORQUE – 4 BOLTS

7.1.6 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 areas. The upper central section of the cylinder is the suction side and it should be relatively cool to the touch, as opposed to the hot discharge area which is the lower perimeter area of the cylinder head. 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 shut-off 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.
* Even cylinder head temperature.

Cause:

* Unloader body stem bent.
* Foreign material binding unloader plunger.

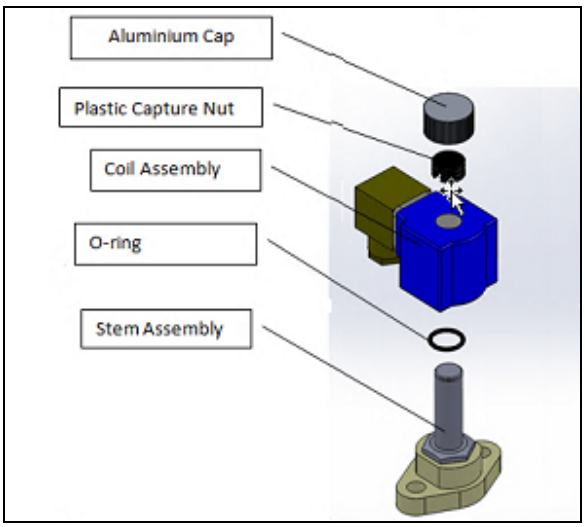


FIGURE 30: UNLOADER COIL ASSEMBLY

7.2 ELECTRO-MAGNETIC CLUTCH

Refer to ***Lang Electromagnetic clutch mounting-dismounting*** and ***Bitzer Maintenance Instruction kw-540-1*** provided with the technical publications in PDF format for further details on electro-magnetic clutch removal and installation.

7.3 EVAPORATOR MOTOR

The evaporator motor is installed in the evaporator compartment (L.H. side of vehicle) (Figure 31). It is a 27.5 volt, 2 HP (1.5 kW) motor which activates a double blower fan unit.

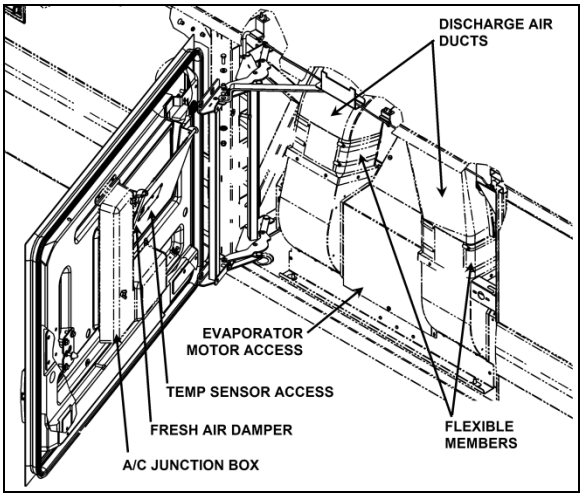


FIGURE 31: EVAPORATOR COMPARTMENT 22301_B

7.3.1 Removal

- Set the battery master switch (Kissling switch) to the OFF position.

- Open the evaporator compartment door.
- On the HVAC module (FIGURE 11). Disconnect circuit 90H1 from evaporator relay R12.
- 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 32).

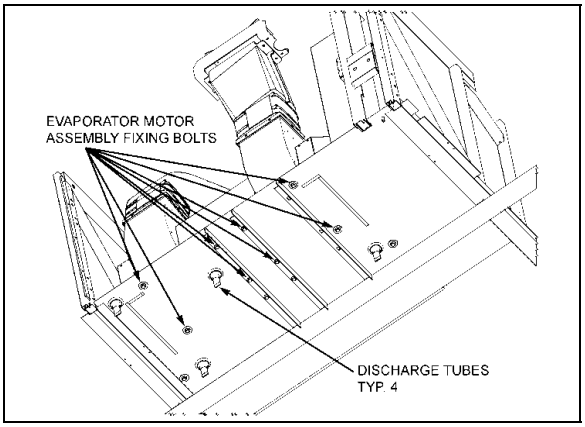


FIGURE 32: EVAPORATOR MOTOR ASSY FIXING BOLTS 22315

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.

7.3.2 Installation

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

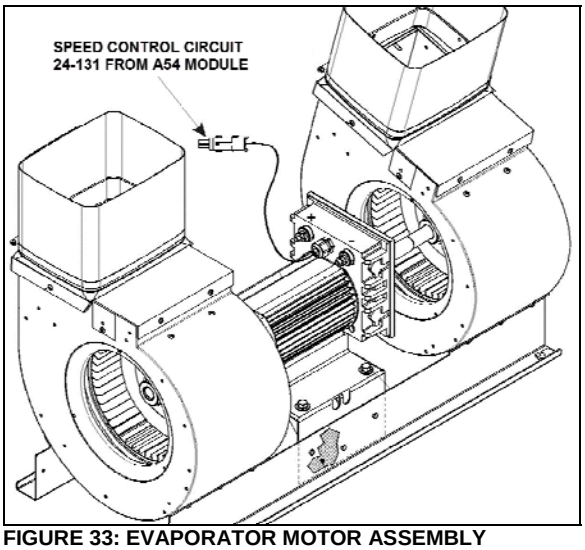


FIGURE 33: EVAPORATOR MOTOR ASSEMBLY

7.4 CONDENSER

The A/C system condenser coil is hinge mounted on the R.H. side of the vehicle on the A/C condenser door. 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.

7.4.1 Condenser Fan Motors

Four 2-speed brushless fan motors (Figure 35), 28.5 V - (0.6 HP - 0.42 kW) are mounted on the condenser coil and swing out with it. The fans draw 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. Consequently, when pressure drops to 175 psi, the motors will run at low 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 low speed. If the pressure rises to 205 psi, the motors will switch to high speed.

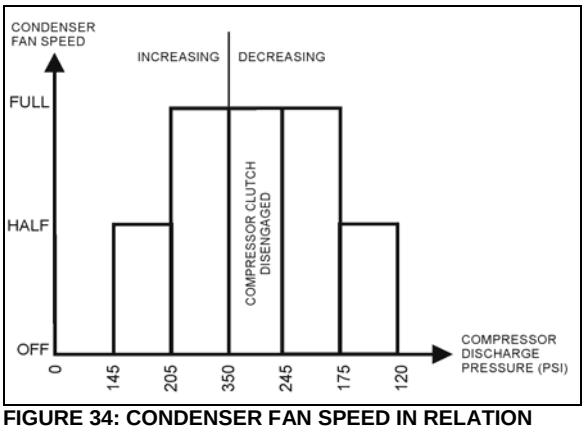


FIGURE 34: CONDENSER FAN SPEED IN RELATION WITH HIGH SIDE PRESSURE

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

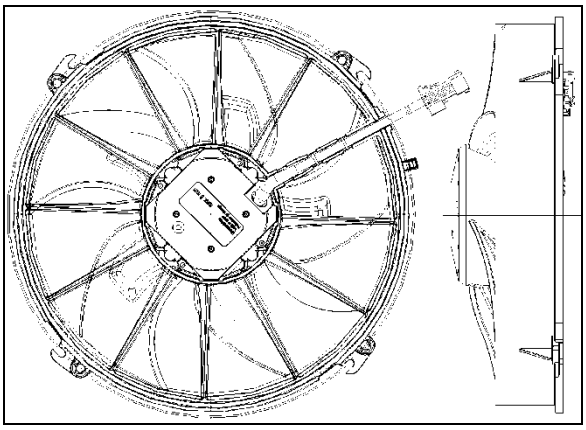


FIGURE 35: CONDENSER FAN MOTOR 22322

7.4.2 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.

7.5 RECEIVER TANK

The receiver tank is located in the condenser compartment (Figure 36). 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.

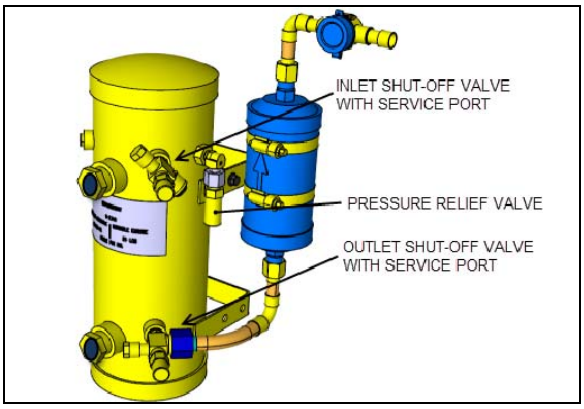


FIGURE 36: RECEIVER TANK

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

MAINTENANCE

Check refrigerant level and add if necessary, every 12 000 miles or twice a year, whichever comes first.

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.

During **normal operation**, inlet and outlet shut-off valves are in backseated position (stem out). When connecting a gauge to the service port, make sure the shut-off valve is in backseated position because the service port is not fitted with a Schrader valve.

7.6 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-dryer should be replaced after a severe system failure, after a prolonged exposure and most important, when the moisture indicator sight glass turns to pink.

7.6.1 Replacement of the Filter-Dryer After Pumping Down

The filter-dryer 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. Perform the pumping down procedure to isolate refrigerant in the receiver tank.
2. Disconnect C24 to isolate the section of the system located between the receiver tank outlet shut-off valve and the passengers' unit liquid solenoid valve.
3. Change the filter-dryer.

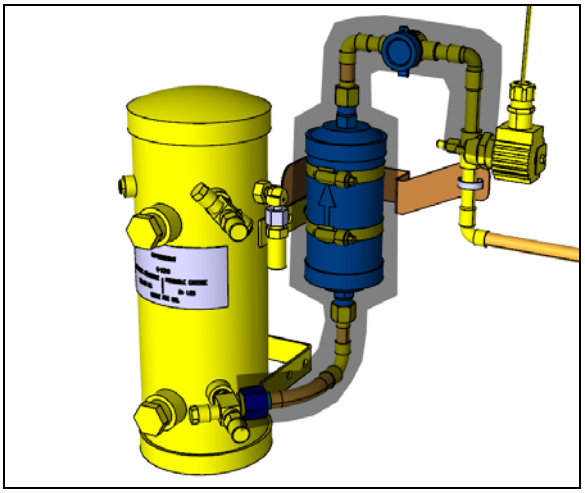


FIGURE 37: ISOLATED SECTION

4. Once the filter-dryer has been replaced, it is necessary to evacuate the opened section of the refrigerant circuit. Evacuate the isolated section of the system using a vacuum pump connected to the service port of the receiver outlet shut-off valve.
5. Evacuate the section of the refrigerant piping as needed and in accordance with best practices, using a micron gauge to monitor the depth of vacuum. Evacuate to a system pressure less than 1000 microns.
6. Turn off the vacuum pump.
7. Backseat the outlet shut-off valve and then disconnect the vacuum pump hose.

CAUTION

Do not use carbon tetrachloride or similar solvents to clean parts. Do not use a steam gun. 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.

7.7 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: high levels of moisture detected.
- PURPLE (caution): low levels of moisture detected.
- BLUE: dry, optimal operating conditions.

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.

MAINTENANCE

Check refrigerant moisture indicator every 50 000 miles or twice a year, whichever comes first. Replace filter-dryer unit according to moisture indicator

COLOR INDICATOR			
TEMPERATURE	BLUE (ppm)	LIGHT VIOLET (ppm)	PINK (ppm)
75°F (24°C)	20	35	130
100°F (38°C)	35	55	160
125°F (52°C)	60	65	190
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 or flash gas indicates an insufficient system charge, low

head pressure, insufficient liquid subcooling or some form of restriction in the liquid 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.

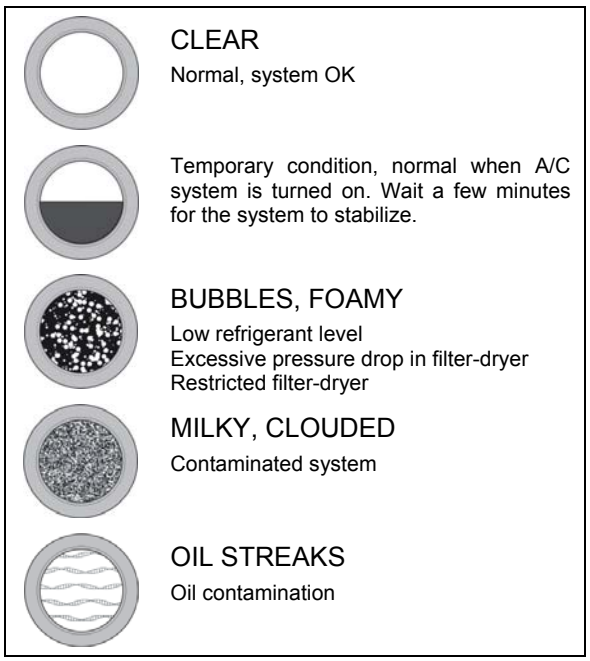


FIGURE 38: CONDITIONS THAT MAY BE OBSERVED IN THE MOISTURE INDICATOR SIGHT GLASS

7.8 SHUT-OFF VALVE WITH SERVICE PORT

This shut-off valve (FIGURE 39) is located in the condenser compartment. It is used to isolate one section of the refrigerant circuit. The service port is equipped with a Schrader valve.

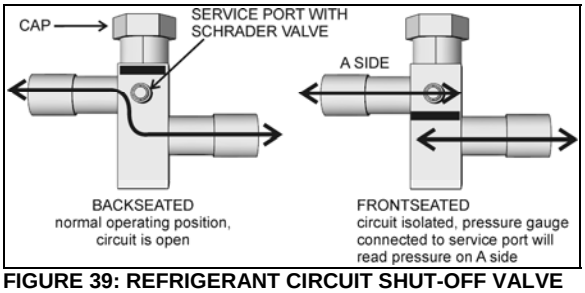


FIGURE 39: REFRIGERANT CIRCUIT SHUT-OFF VALVE

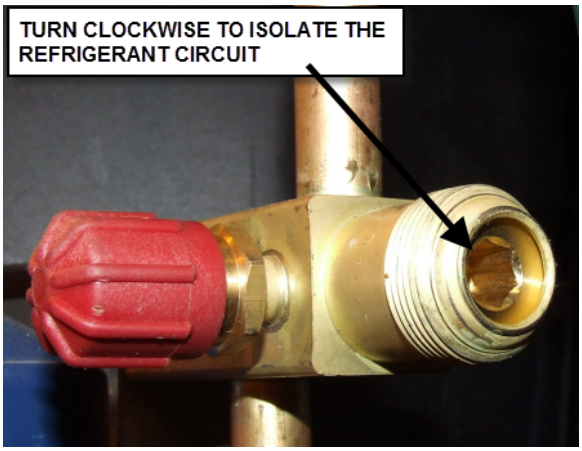


FIGURE 40: REFRIGERANT CIRCUIT SHUT-OFF VALVE

7.9 LIQUID REFRIGERANT SOLENOID VALVE

The flow of liquid refrigerant to the driver's unit evaporator, passengers' unit evaporator (main evaporator) and parcel racks evaporator is controlled by one NC (normally closed) solenoid valve on each circuit, for a total of three solenoid valves.

The driver's unit solenoid valve is located on the ceiling of the spare wheel compartment (FIGURE 41) and is accessible through the reclining bumper.

Two identical NC (normally closed) refrigerant solenoid valves are found in the condenser compartment (FIGURE 42). One is used to control flow of refrigerant to the parcel racks evaporator while the other is used to control flow to the main evaporator.

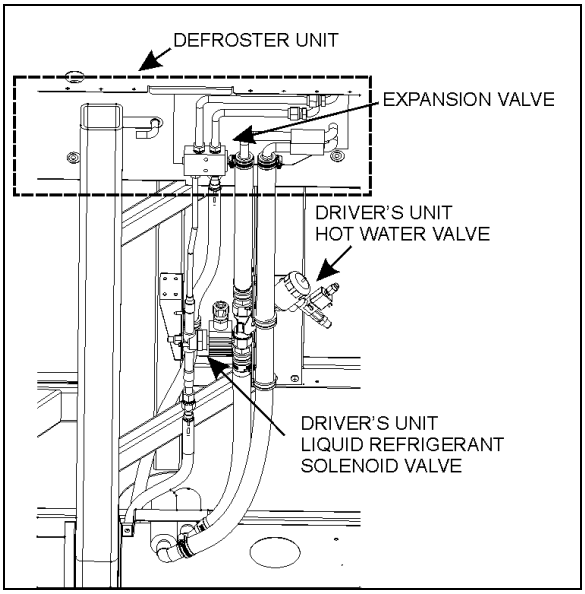


FIGURE 41: DRIVER'S UNIT LIQUID SOLENOID VALVE

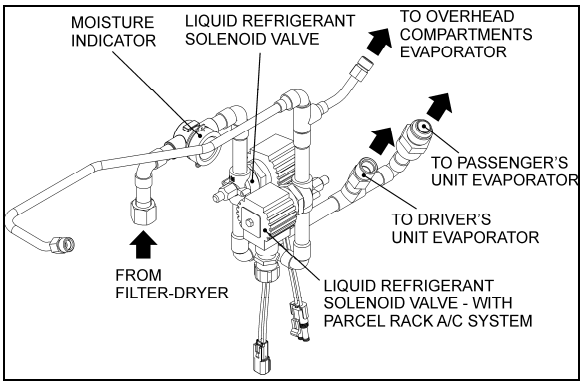


FIGURE 42: LIQUID REFRIGERANT SOLENOID VALVES INSIDE CONDENSER COMPARTMENT

7.9.1 Typical malfunctions

Faulty control circuit: Check the electric system by energizing the solenoid with 24-V DC. A metallic clicking noise indicates that the solenoid is operating. Absence of clicking indicates a loss of power or a defective solenoid. Check for open breaker, open-circuited or grounded coil, broken lead wires.

Burned-out coil: Check for open-circuited coil. Replace coil if necessary.

Low voltage: Check voltage across the coil leads. Voltage must be at least 85% of nameplate rating.

Excessive leakage: Disassemble valve and clean all parts. Replace worn or damaged parts with a complete repair kit for best results.

There are only three main possible malfunctions:

1. Coil burnout.
2. Failure to open.
3. Failure to close.

Each is discussed in *Sporlan Parker Hannifin Solenoid Valve Installation and Servicing* bulletin included on your Technical Publications CD.

7.9.2 Electrical Bypass/On Demand Opening of liquid refrigerant solenoid valves

To ease purging, pumping down and refilling of refrigerant, it is possible to open the liquid solenoid valves (normally closed NC). To do so, uncap and connect plug and socket housings of connector **C24 together for the passengers' unit and parcel rack units liquid solenoid valves** (located on the HVAC module in evaporator compartment) or **C44 for the driver's unit liquid solenoid valve** (located on the ceiling of the spare wheel compartment).

During normal use, both plug and socket housings of connector C24 or C44 are to be kept unplugged and capped.

CAUTION

Connectors C24 & C44 must be disconnected and their caps reinstalled after this procedure. Leaving them connected will keep the driver's, passengers' and parcel rack liquid solenoid valves open, and result in battery draining if the bus remains unused for several days.

7.9.3 Coil Replacement

1. Unplug 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 on the enclosing tube. Lay data identification plate in place.
4. Insert the coil retaining screw, rotate coil housing to proper position and tighten screw securely.
5. Plug coil connector.

7.9.4 Valve Disassembly

1. Because of possible damage to valve components due to the high temperature of soldering and brazing, it is necessary to completely disassemble the **A & B series** valves before any heat is applied to the valve body. For **E series** (extended copper connections), braze into the line without disassembly because the valve contains extended connections. Use caution by placing a wet cloth or chill block on the extensions at the body to prevent excessive overheating.
2. Remove the coil as stated previously.
3. Pump down the system as stated in this section.
4. Remove the enclosing tube and locknut, all internal parts, and manual lift stem assembly.

NOTE

The previous 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.

7.9.5 Valve Reassembly

1. Place the seat disc into the valve body with the smaller diameter end facing up.
2. Place the enclosing tube gasket onto the valve body above the threads.
3. Hold the plunger with one hand so that the pointed end is resting in the pilot port of the disk. Make sure the small spring is in place on the top of the plunger.
4. With the other hand, place the enclosing tube over the plunger, making sure the enclosing tube gasket is in position.
5. Put back the enclosing tube locknut and tighten **20-40 lbf-ft**. Do not over tighten.
6. Put back manual lift stem. Tighten lift stem assembly and seal cap to **11 lbf-ft**.
7. Place the coil assembly.

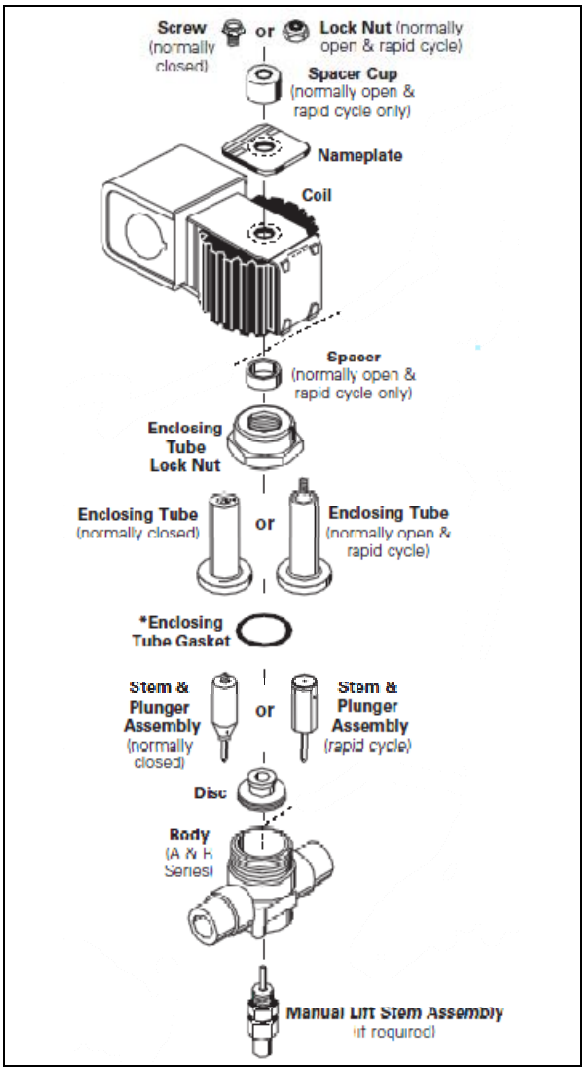


FIGURE 43: TYPICAL REFRIGERANT SOLENOID VALVE 22044

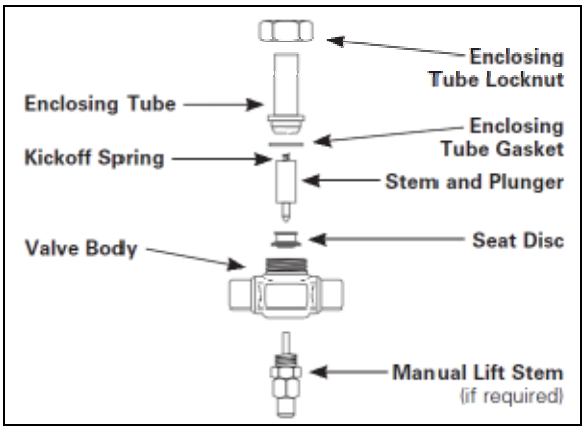


FIGURE 44: REFRIGERANT SOLENOID VALVE 22044

CAUTION

The filter-dryer must be replaced after a severe system failure or if a line in the system has been opened over a prolonged period of time. The line will then have to be properly evacuated.

Best practice would be to replace the filter-dryer each time a line is opened.

CAUTION

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

7.10 THERMOSTATIC EXPANSION VALVE

7.10.1 Passengers' Section HVAC Unit

The expansion valve for the passengers' section HVAC unit 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 (Figure 45). 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 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 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.

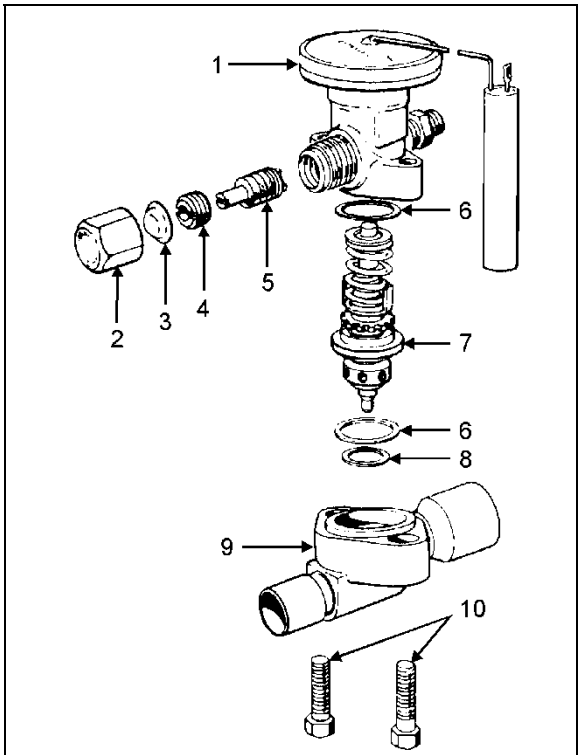


FIGURE 45: EXPANSION VALVE 22045

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 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 should be adjusted to give 12°F to 16°F 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

Expansion valves are factory preset for optimum superheat settings. This setting should be modified only if absolutely necessary. The readjustment should be at the lowest expected evaporating temperature.

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 4 cylinders, full charge.
2. Install the pressure gauge at compressor suction, but then add 3 PSI to reading.

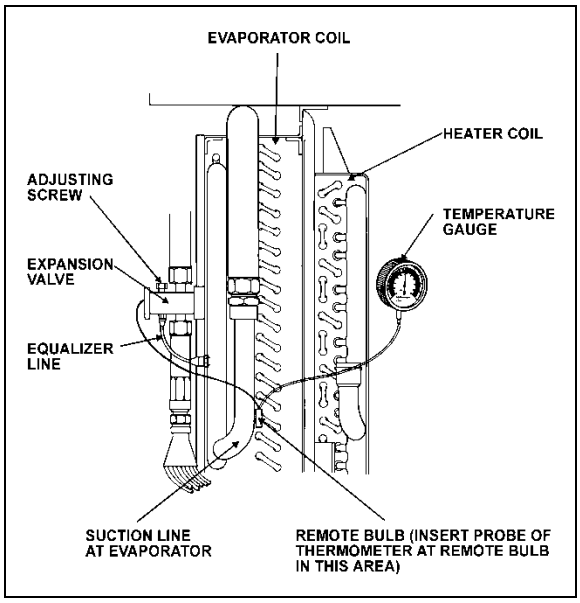


FIGURE 46: SUPERHEAT ADJUSTMENT INSTALLATION
22046

3. Install a remote reading thermometer to the evaporator outlet line near the existing remote bulb (Figure 46).
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.

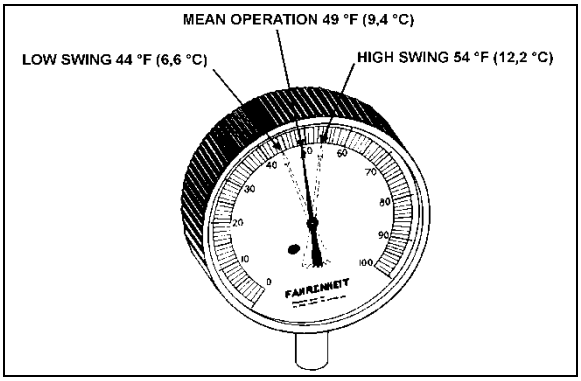


FIGURE 47: HIGH & LOW SWING TEMPERATURE AT REMOTE BULB
22047

6. Check approximately 5 readings of suction pressure at 2-minute intervals and convert to temperature using the temperatures & pressures table (paragraph 7.13). 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 47).

Example of readings taken:

A/C	pressure	gauge	at	40°F

compressor suction converted to temperature with chart	
Temperature on remote bulb	Low swing 44°F
	High swing 54°F
Average of low and high swing	49°F

Formula for superheat

T° at bulb – T° suction = T° superheat

49°F – 40°F = 9°F

NOTE

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

NOTE

The thermal expansion valve has a MOP (maximum operating pressure) of 55 psi. At this setting, the valve is completely opened.

If the temperature at the bulb is greater than 50°F, do not try to adjust superheat as the valve is almost completely opened.

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.

6. 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 converted to 32°F on chart. If temperature reading is 40°F, subtract 32°F and the result will be **8°F 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

1. Pump down the system as previously indicated in this section.
2. Disconnect the external equalizer line from the underside of the power head, and unclamp the remote control bulb from the evaporator coil outlet line.
3. Remove the two cap screws holding the power assembly to the valve body flange. Lift off the power assembly and remove the cage assembly.
4. 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.
5. Check for leaks.

Safety Instructions

1. Make sure the valve is installed with the flow arrow on the valve body corresponding to the flow direction through the piping system.
2. 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.

7.10.2 Driver's HVAC Unit

The function and operation of the expansion valve for the driver's HVAC unit are similar to the passengers' HVAC unit but no superheat adjustment is required (see **FIGURE 3** and **FIGURE 41**).

7.11 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.

7.12 TROUBLESHOOTING

7.12.1 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.
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.
Condenser dirty.	Clean condenser.

7.12.2 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 or replace air filter. 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. (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.)

TROUBLE	CAUSE
	An evaporator just does a proper cooling job without sufficient air. Shortage of air can be caused by the following: * Dirty filters; or * Dirty coils.

Testing condenser pressure.

NOTE: R-134A pressure is function of the temperature variation.

Example, for an exterior temperature of 100°F.
Exterior temperature (100°F) + 30°F = 130°F.
Take note: 30°F is added to ambient temperature by definition.
Refer to paragraph "7.13 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:

Reduced air quantity. This may be due to:
* 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.

7.13 TEMPERATURES & PRESSURES CHART

VAPOR-PRESSURE R134A			
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
190	87.8	433.6	2989.7
200	93.3	485.0	3344.1
210	98.9	540.3	3725.4

7.14 LEAK TESTING

Some methods such as nitrogen pressure, soap and electronic sniffer can be used for leak testing.

8. CENTRAL HEATING SYSTEM

As seen earlier in this section, the vehicle interior is pressurized by its Heating, Ventilation and Air Conditioning (HVAC) system. The vehicle interior should always be slightly pressurized to prevent cold and moisture from entering. Air flow and controls divide the vehicle into two areas: driver's area and passengers' area.

The schematic of Figure 2 shows the heating system with its components.

8.1 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 hot water pneumatic valve on the ceiling of the spare wheel compartment (Figure 48), disconnect its wiring connector, and then connect a 24-volt external power source, using jumper cables, to close valve.
3. Close the hot water lines shut-off valves located next the engine on street side (see Figure 2 & Figure 52).

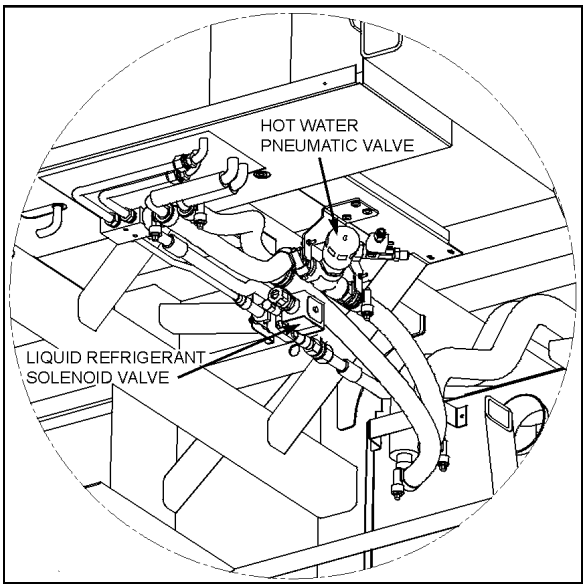


FIGURE 48: CEILING OF THE SPARE WHEEL COMPARTMENT

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 hot 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 driver's HVAC unit, on the driver's side (Figure 49) to ensure an efficient draining.

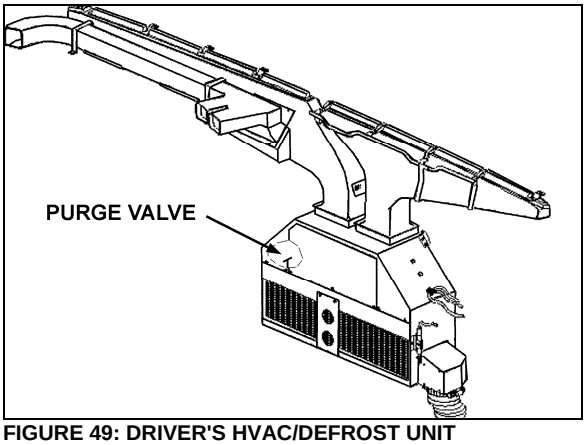


FIGURE 49: DRIVER'S HVAC/DEFROST UNIT

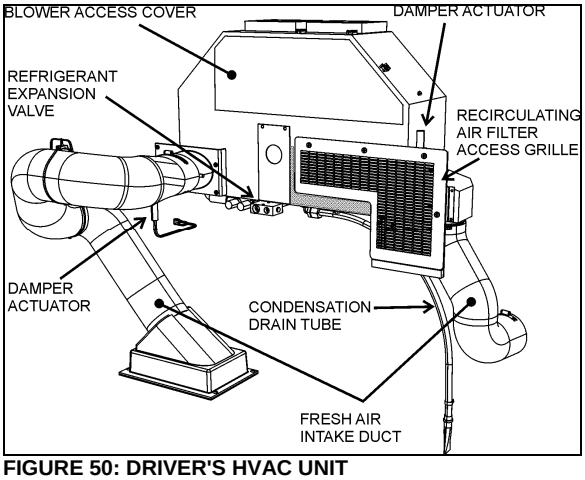


FIGURE 50: DRIVER'S HVAC UNIT

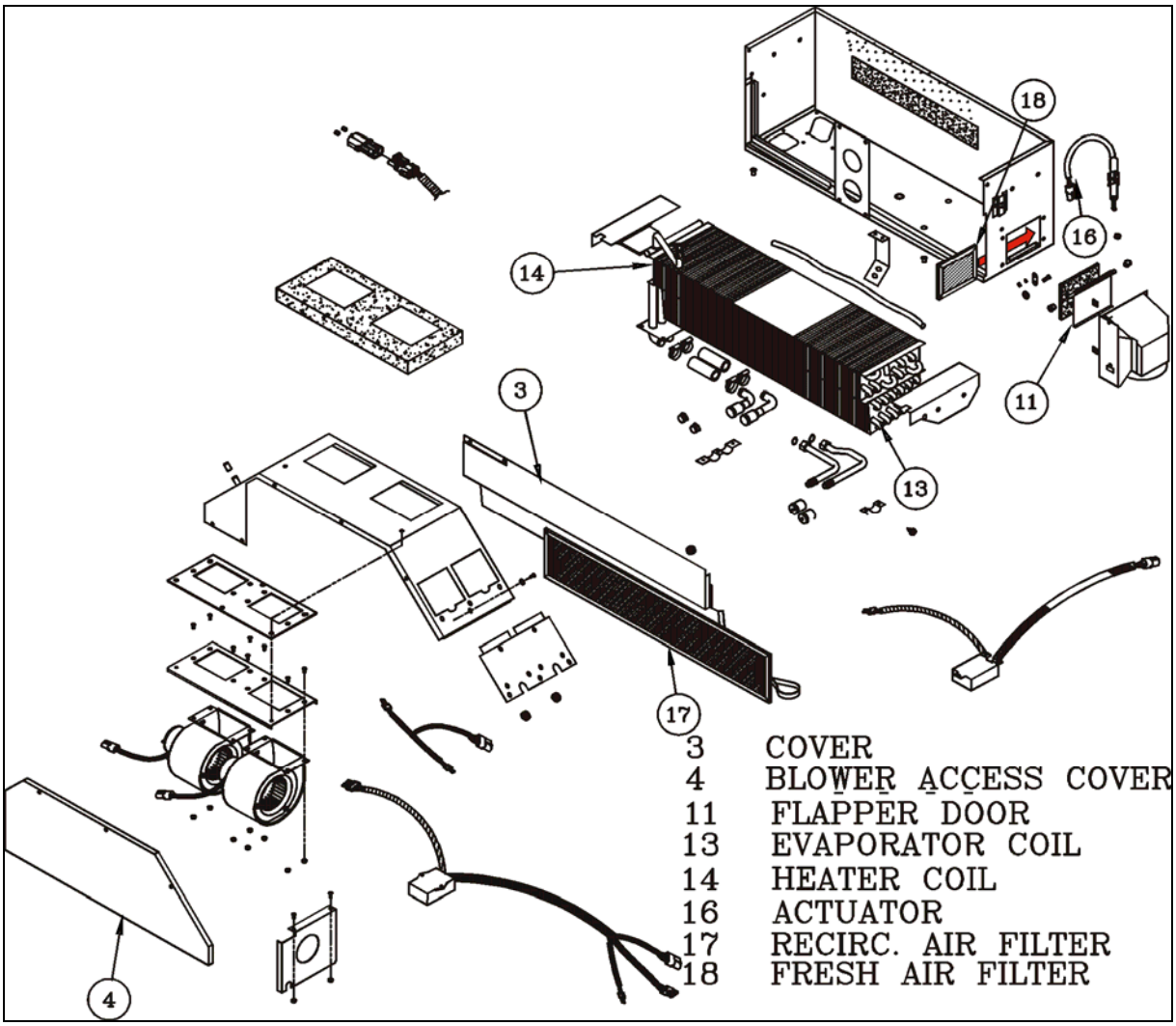


FIGURE 51: DRIVER'S HVAC UNIT

- **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 52).

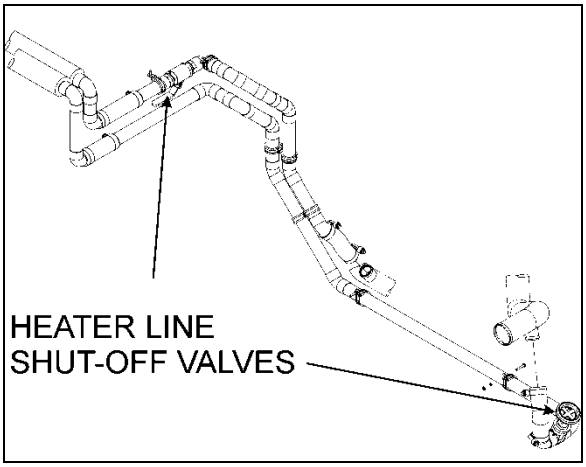


FIGURE 52: HEATER LINE SHUT-OFF VALVES

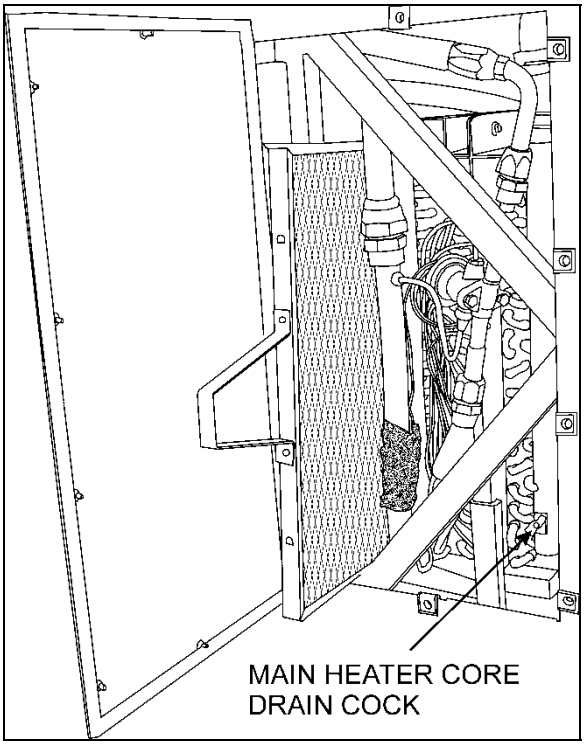


FIGURE 53: EVAPORATOR COMPARTMENT

3. The main heater core drain cock is located in the evaporator compartment. To access the valve on X3-45 coaches, open baggage compartment door located in front of the evaporator compartment (L.H. side). Open access panel by turning the three screws of panel ¼ of a turn.

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 53) in order to allow air to enter while draining.

8.2 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 circulating 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 passengers' sections, and set temperature to the maximum position 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.

8.3 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 49 , and open momentarily until no air escapes from the line.

8.4 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.

8.5 DRIVER'S HOT WATER PNEUMATIC VALVE ASSEMBLY

- **Description**

The flow of hot water to the driver's heater core is controlled by a normally open (N.O.) pneumatic 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 without electrical supply 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.

Air pressure at port + 24-V signal at coil = valve closed

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.

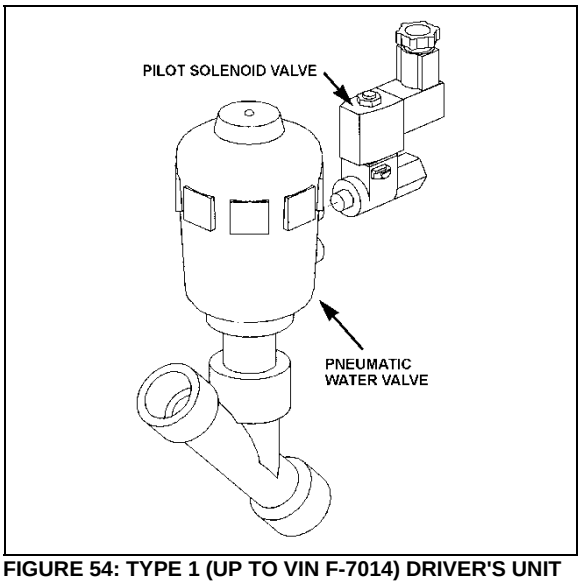


FIGURE 54: TYPE 1 (UP TO VIN F-7014) DRIVER'S UNIT HOT WATER PNEUMATIC VALVE ASSEMBLY

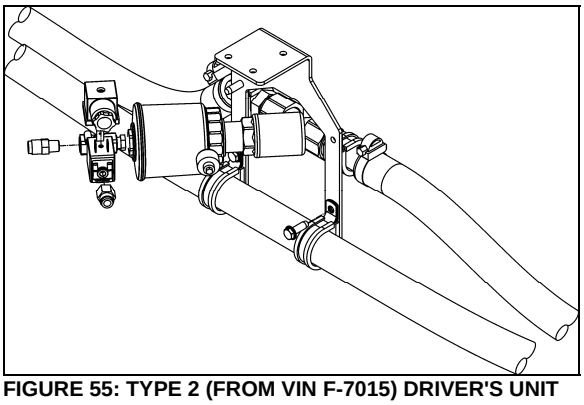


FIGURE 55: TYPE 2 (FROM VIN F-7015) DRIVER'S UNIT HOT WATER PNEUMATIC VALVE ASSEMBLY

8.5.1 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 56).
3. Remove the snap ring using a pair of pliers.
4. You can now access all seals for replacement. See your vehicle Parts Manual for replacement parts availability.

8.5.2 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 56. Fasten pilot solenoid vale to the pneumatic water valve. Reconnect air supply pressure and electrical current to the pilot solenoid valve.
3. Check for proper operation.

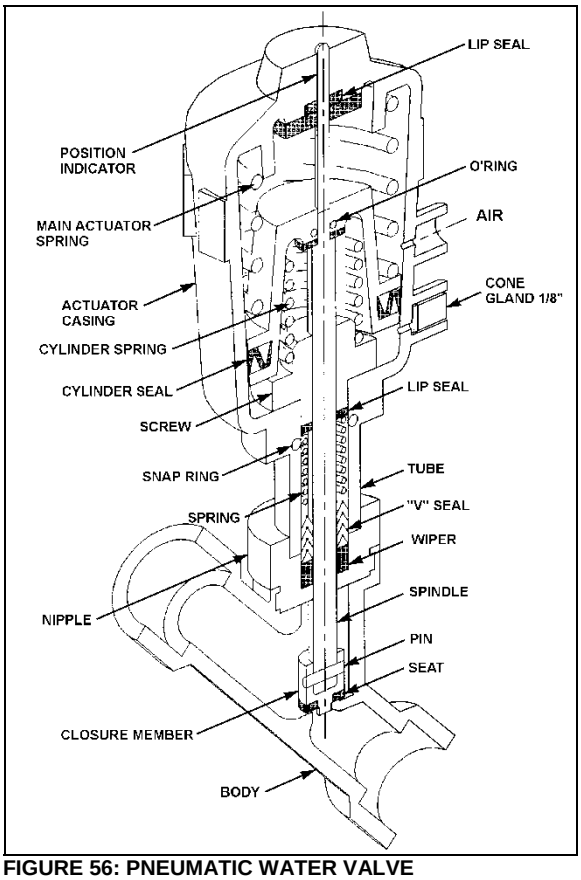


FIGURE 56: PNEUMATIC WATER VALVE

8.5.3 Pilot Solenoid Valve

1. No maintenance is needed unless a malfunction occurs.
2. A pilot solenoid valve replacement seal kit is available. See your vehicle Parts Manual for replacement parts.

8.6 CENTRAL HOT WATER PNEUMATIC VALVE ASSEMBLY

8.6.1 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.

8.6.2 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 58).
3. Remove the snap ring using a pair of pliers.

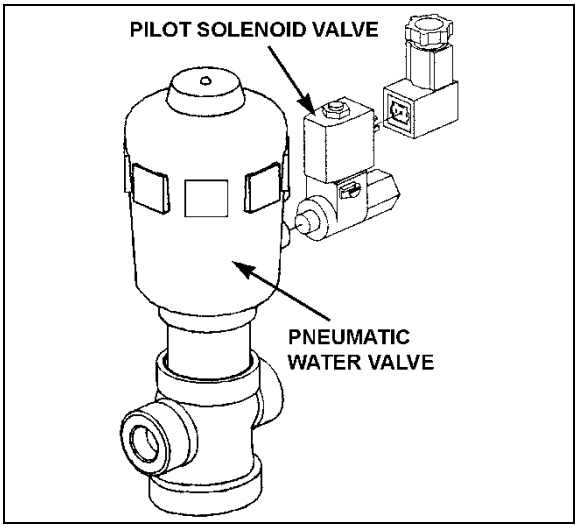


FIGURE 57: CENTRAL HOT WATER PNEUMATIC VALVE ASSEMBLY 22329

5. You can now access all seals for replacement. See your vehicle Parts Manual for replacement parts availability.

8.6.3 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 58. Fasten pilot solenoid vale to the pneumatic water valve. Reconnect air supply pressure and electrical current to the pilot solenoid valve.
3. Check for proper operation.

8.6.4 Pilot Solenoid Valve

1. No maintenance is needed unless a malfunction occurs.
2. A pilot solenoid valve replacement seal kit is available. See your vehicle Parts Manual for replacement parts.

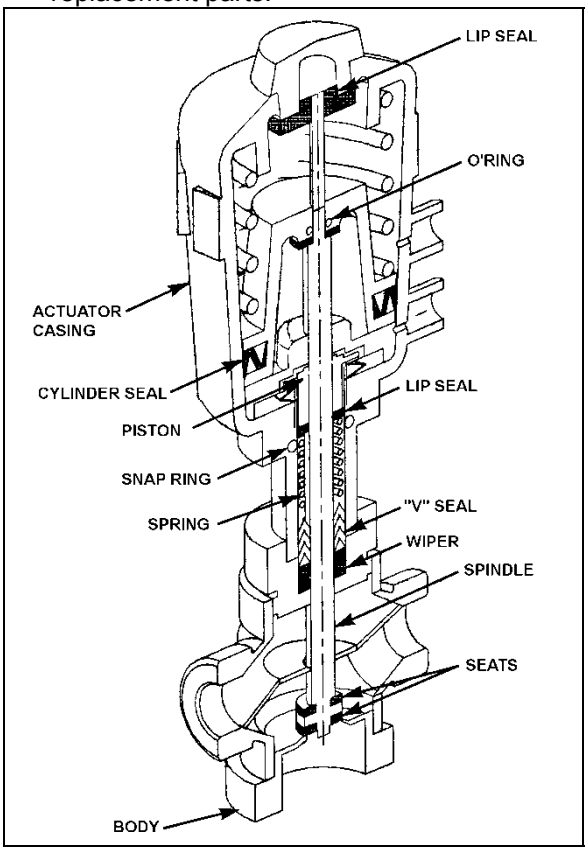


FIGURE 58: PNEUMATIC WATER VALVE 22330

- **Valve Troubleshooting**

PROBLEM	PROCEDURE
Valve fails to close	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.	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.

8.7 HOT WATER CIRCULATING PUMP

This vehicle is provided with a brushless/sealess water circulation pump which is in the compartment located aft of the evaporator compartment (Figure 59). The assembly consists of a centrifugal pump and an electric motor which are mounted in a compact assembly.

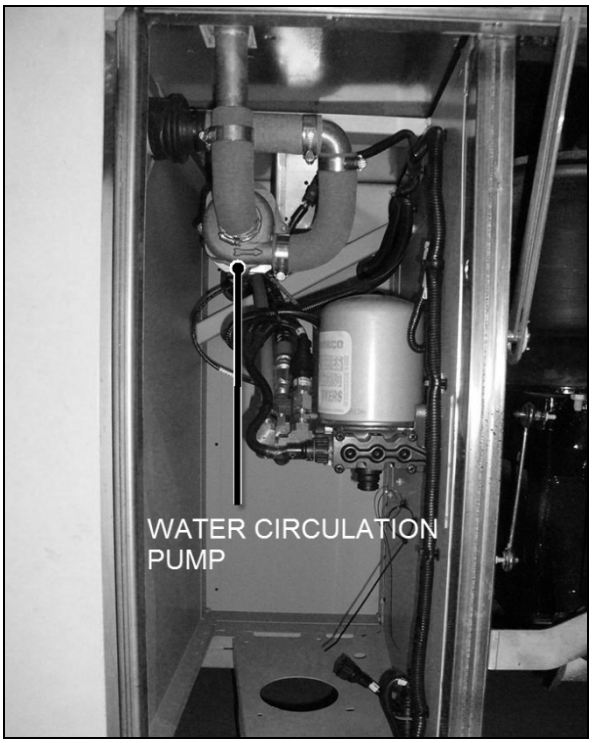


FIGURE 59: PUMP LOCATION

The brushless DC sealess circulating pump requires no periodic maintenance. The sealess design offers leak-proof protection and the capability to resist harsh environmental conditions. The pump magnetically couples to the brushless DC motor without a wet seal to wear or replace, this coupling method also enables easy motor removal without requiring system draining. The pump electronically commutated brushless DC motor provides virtually maintenance-free operation over time by eliminating brush maintenance and associated brush motor failure.

Inspection of the circulating pump, to determine if the pump is working properly, should be made while the pump is in operation.

If there is evidence that the circulating pump is not operating as per specifications, the unit must be disassembled for repair.

Disassembly of the pump will be necessary only in the case of a rotor failure or motor failure.

- **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. Apply gasket cement to the line flanges, put the two gaskets in place, and connect water lines to the pump at the flange connections. 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.
4. Fill the cooling system as previously instructed in this section under *"8.2 Filling Heating System"*, then bleed the system as previously instructed in this section under *"8.3 Bleeding Heating System"*.

9. SPECIFICATIONS

Main evaporator motor

Make..... AMETEK
Type ..... BRUSHLESS DC MICROPROCESSOR CONTROLED
Voltage ..... 27.6 V DC
Current draw ..... 68 amps
Horsepower 2
Revolution ..... 1400 & 1700 rpm
Insulation ..... Class F

Condenser fan motors

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

Driver's unit evaporator motors

Make..... MCC
Voltage ..... 24 V DC
Quantity 1

Hot water circulating pump

Make..... AMETEK
Flow ..... 15 gpm
Inlet/outlet OD ..... 3/8"

Driver's unit evaporator air filters

Make..... MCC
TYPE ..... Recirculating air 6-¼" x 28" Washable

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

Refrigerant

Type R-134a
Quantity (standard) ..... 24 lbs (10.89 Kg)
Quantity (A/C system located in parcel racks) ..... 2 lbs (1.8 Kg)

Compressor

Make..... Bitzer
Displacement ..... 41 CFM
Model, R-134a..... 4NFCY
No. of cylinders 4
Cylinder volume ..... 39 in^3 (647 cm^3)
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 ISO68)

Compressor V belt (Bitzer)
BX71 Set of 2, two Bosch alternators arrangement, Prevost Number 5060134

A/C Compressor Electro-magnetic clutch
Make..... Lang
Type KK73.1
Voltage ..... 24 V DC

Liquid refrigerant solenoid valve
Make..... Sporlan Parker Hannifin
Type ..... Normally closed with manual bypass
Voltage ..... 24 V DC

Driver's unit hot water pneumatic valve (type 1)
Make..... BURKERT
Type ..... Normally open
Voltage ..... 24 V DC

Driver's unit hot water pneumatic valve (type 2)
Make..... Asco
Type ..... Normally open
Voltage ..... 24 V DC

Passengers' unit hot water pneumatic valve
Make..... BURKERT
Type ..... Normally open 3 ways/2 positions
Voltage ..... 24 V DC

10. SECTION CHANGE LOG

	DESCRIPTION	DATE
1		
2		
3		
4		
5		
6		