

SECTION 22: HEATING AND AIR CONDITIONING

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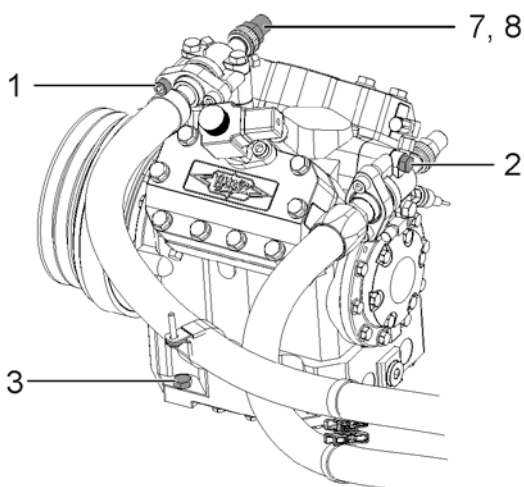
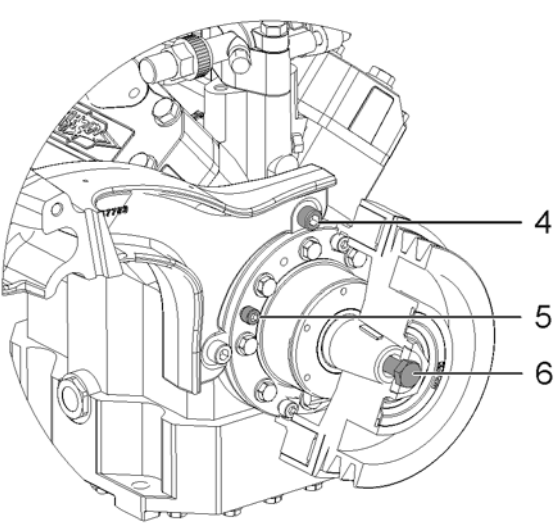
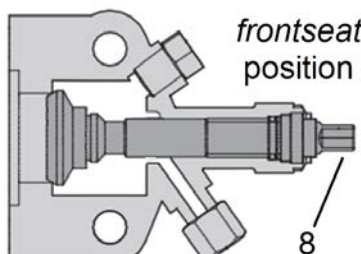
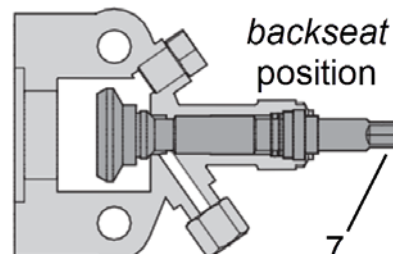
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SECTION CHANGE LOG

DESCRIPTION		DATE
1	Added low pressure switch on High capacity A/C compressor. From J-7446 (X series US), J-6245 (X series CAN), J-3997 (H series).	Nov. 2017
2		
3		
4		
5		
6		

1. TORQUE TABLES

1.1 HIGH CAPACITY COMPRESSOR (CENTRAL HVAC SYSTEM)

 <p>22378_1</p>	 <p>22379</p>	
 <p>frontseat position</p> <p>22406</p>	 <p>backseat position</p> <p>22407</p>	
HIGH CAPACITY COMPRESSOR (CENTRAL HVAC SYSTEM)		
No	DESCRIPTION	TORQUE
1	Compressor flange connection screws	31-35 lb-ft (42-47 Nm)
2	Compressor discharge & suction port screws	38-42 lb-ft (52-57 Nm)
3	Compressor mounting bolts	74 lb-ft (100 Nm)
4	Support arm to compressor screws	38-42 lb-ft (52-57 Nm)
5	Clutch to compressor screws	20-24 lb-ft (27-33 Nm)
6	Clutch pulley to compressor shaft screw	58-62 lb-ft (79-84 Nm)
7	A/C service valve <i>backseat</i> position	Max 12 lb-ft (16 Nm)
8	A/C service valve <i>frontseat</i> position	Max 21 lb-ft (28 Nm)

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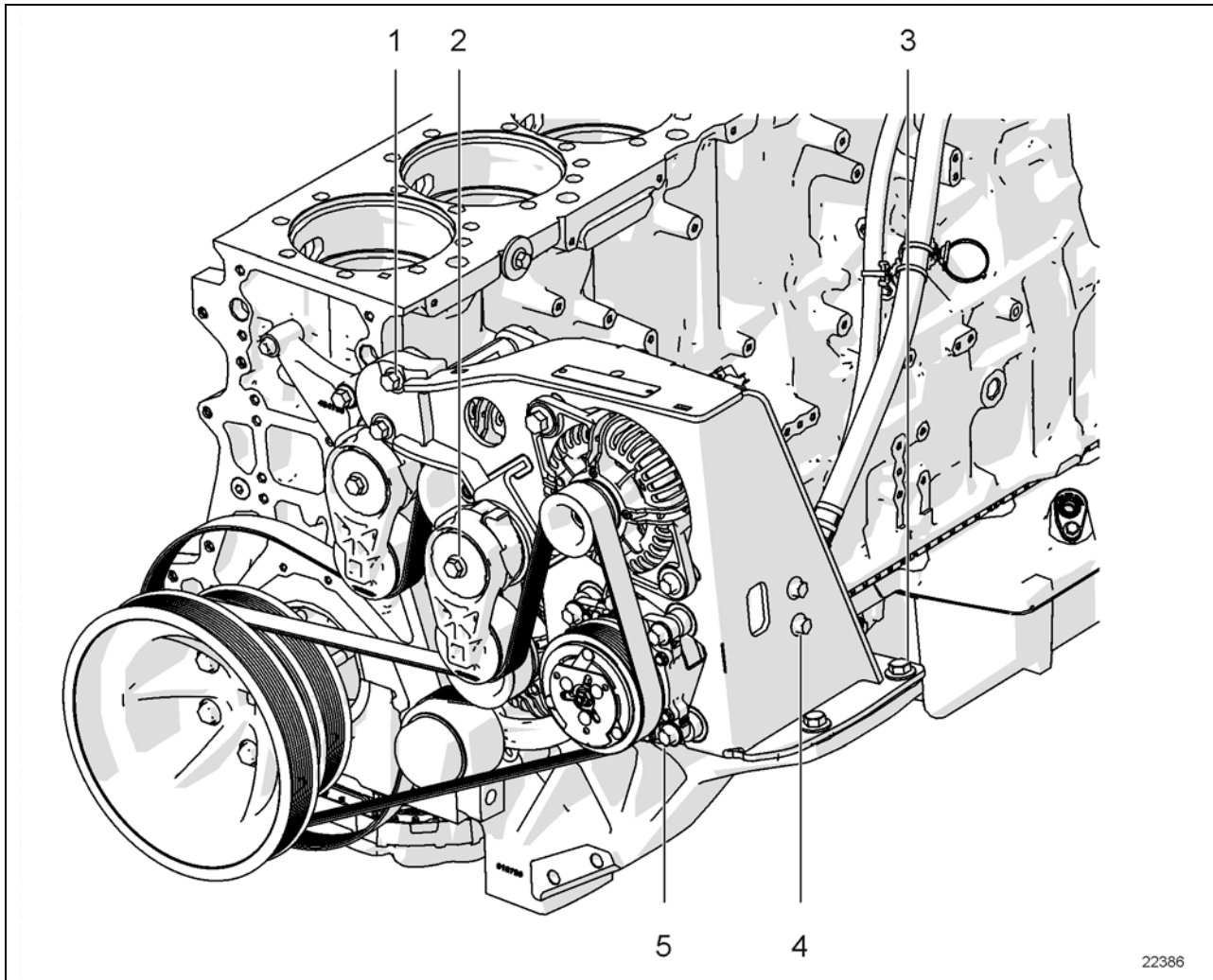
1.2 HIGH/LOW PRESSURE SERVICE AND RECEIVER TANK VALVES

SERVICE AND RECEIVER TANK VALVE		
No	DESCRIPTION	TORQUE
1	High pressure service valve (both positions)	43 lb-ft (58 Nm)
2	Low pressure service valve (both positions)	21 lb-ft (28 Nm)
3	Receiver tank valve (both positions)	21 lb-ft (28 Nm)

1.3 IDLERS & TENSIONERS

IDLERS & TENSIONERS		
No	DESCRIPTION	TORQUE
1	Central A/C tensioner lock bolt	43 lb-ft (58 Nm)
2	Central A/C tensioner idler shaft bolt (M12 shoulder bolt)	31.5-38.5 lb-ft (43-52 Nm)
	Central A/C tensioner idler shaft bolt (M12 x 1.75 std bolt)	59 lb-ft (80 Nm)
3	Idler support bolt	21 lb-ft (28 Nm)
4	Idler support bolts	43 lb-ft (58 Nm)
5	Small A/C idler shaft bolt	135-165 lb-ft (183-224 Nm)
6	Small A/C / alternator transfer pulley shaft nut	135-165 lb-ft (183-224 Nm)
7	Air spring connection fitting nut	15-20 lb-ft (20-27 Nm)
8	Air spring mounting screw	15-20 lb-ft (20-27 Nm)

1.4 SMALL A/C SYSTEM X3-45 VIP



SMALL A/C SYSTEM X3-45 VIP

No	DESCRIPTION	TORQUE
1	Upper mounting screws	48 lb-ft (65 Nm)
2	Belt Tensioner	48 lb-ft (65 Nm)
3	Lower mounting screws	82 lb-ft (111 Nm)
4	Compressor mounting fore bracket screws	35 lb-ft (47 Nm)
5	Compressor mounting screws	35 lb-ft (47 Nm)

2. HVAC SYSTEM OVERVIEW

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

- Small HVAC System
- Driver's unit only
 - Driver's unit with auxiliary system (H3 VIP only)

- Central HVAC System
- Driver's unit and passengers' unit with optional overhead compartment A/C system and optional upper windshield defrost unit

If the vehicle is equipped with a Central HVAC System; air flow and controls divide the vehicle in two areas: driver's area and passengers' area. Each section has its own fresh air, returning air and discharge air ducting. Each section has its own evaporator coil and heater core but both sections share the same condenser

The exhaust is mainly done through the lavatory 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 :

Heating or cooling; Dehumidification; Ventilation; Filtering;

2.1 CENTRAL HVAC SYSTEM EVAPORATOR COMPARTMENT ARRANGEMENT

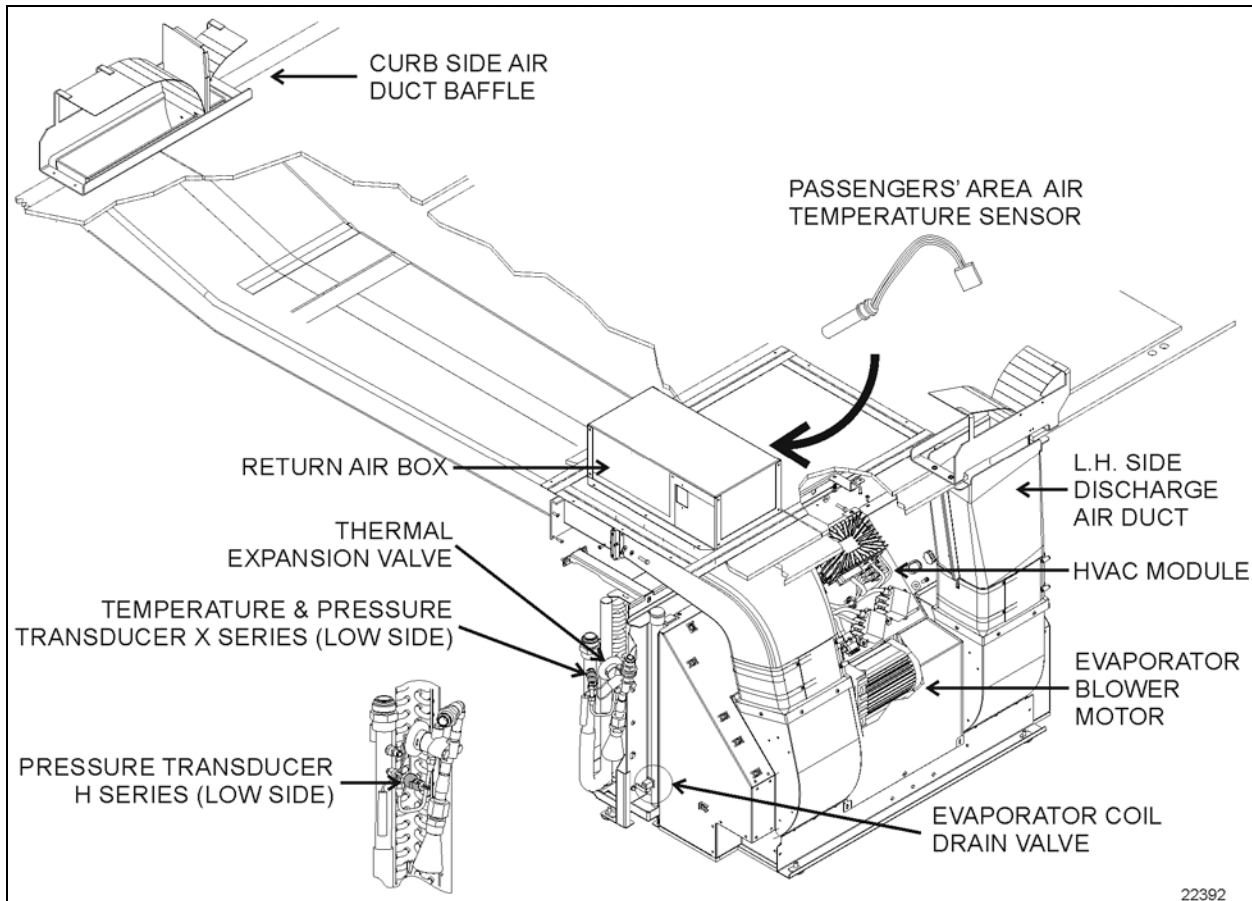


FIGURE 1: EVAPORATOR COMPARTMENT AND DISCHARGE DUCTING ARRANGEMENT

2.2 CENTRAL HVAC SYSTEM – H SERIES

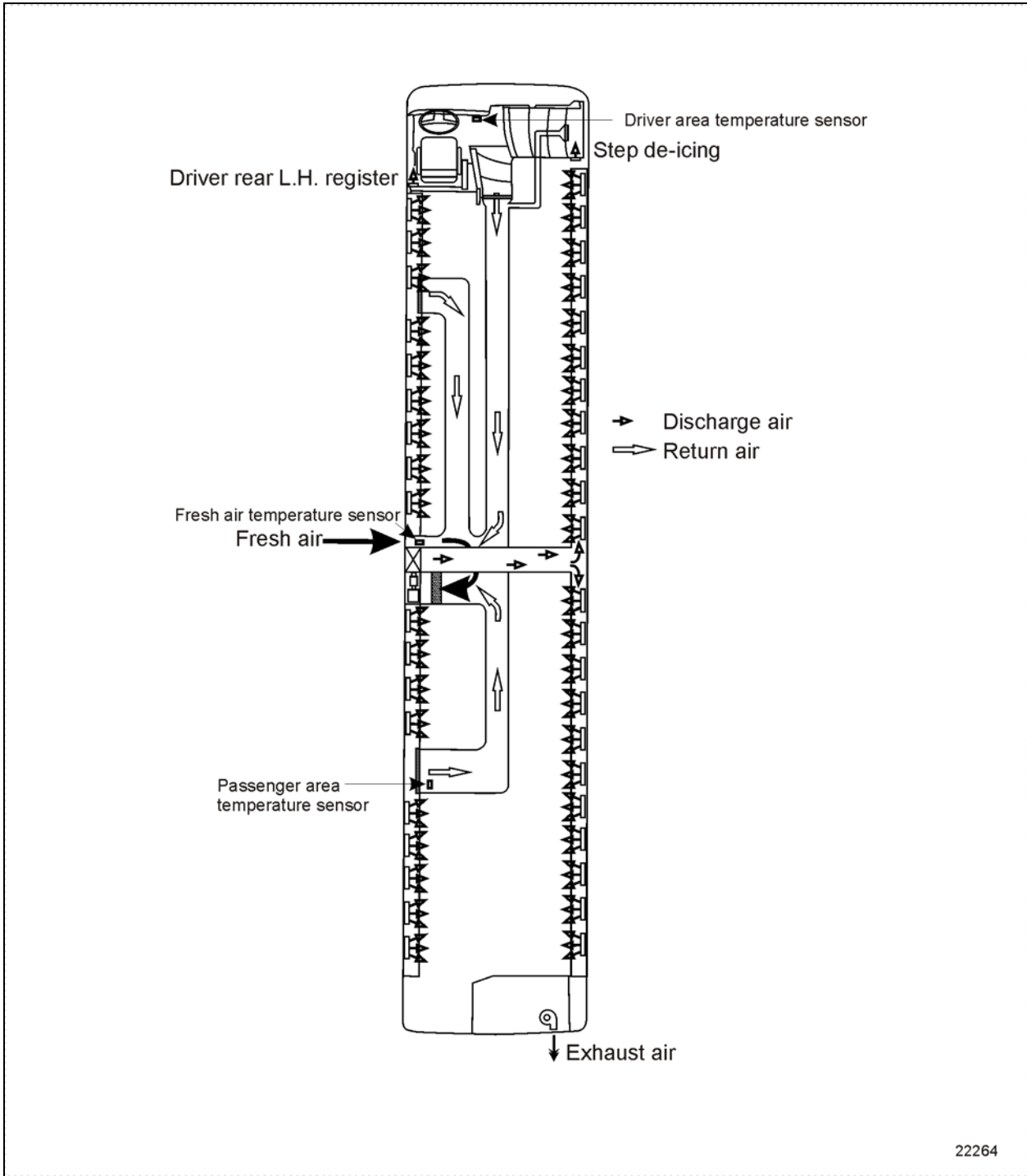


FIGURE 2: H3 COACHES CENTRAL HVAC SYSTEM – PASSENGER'S UNIT AIR CIRCULATION

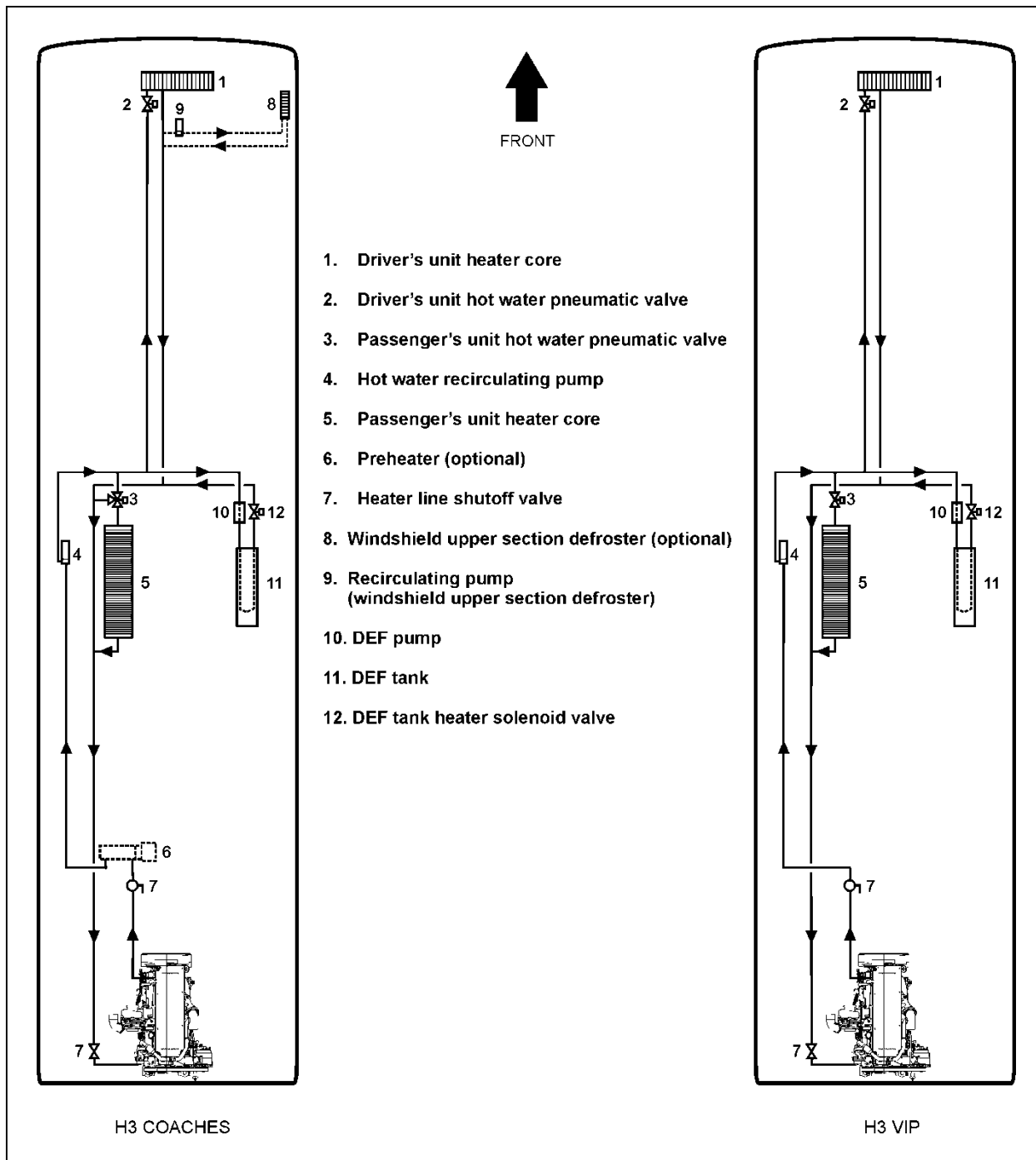
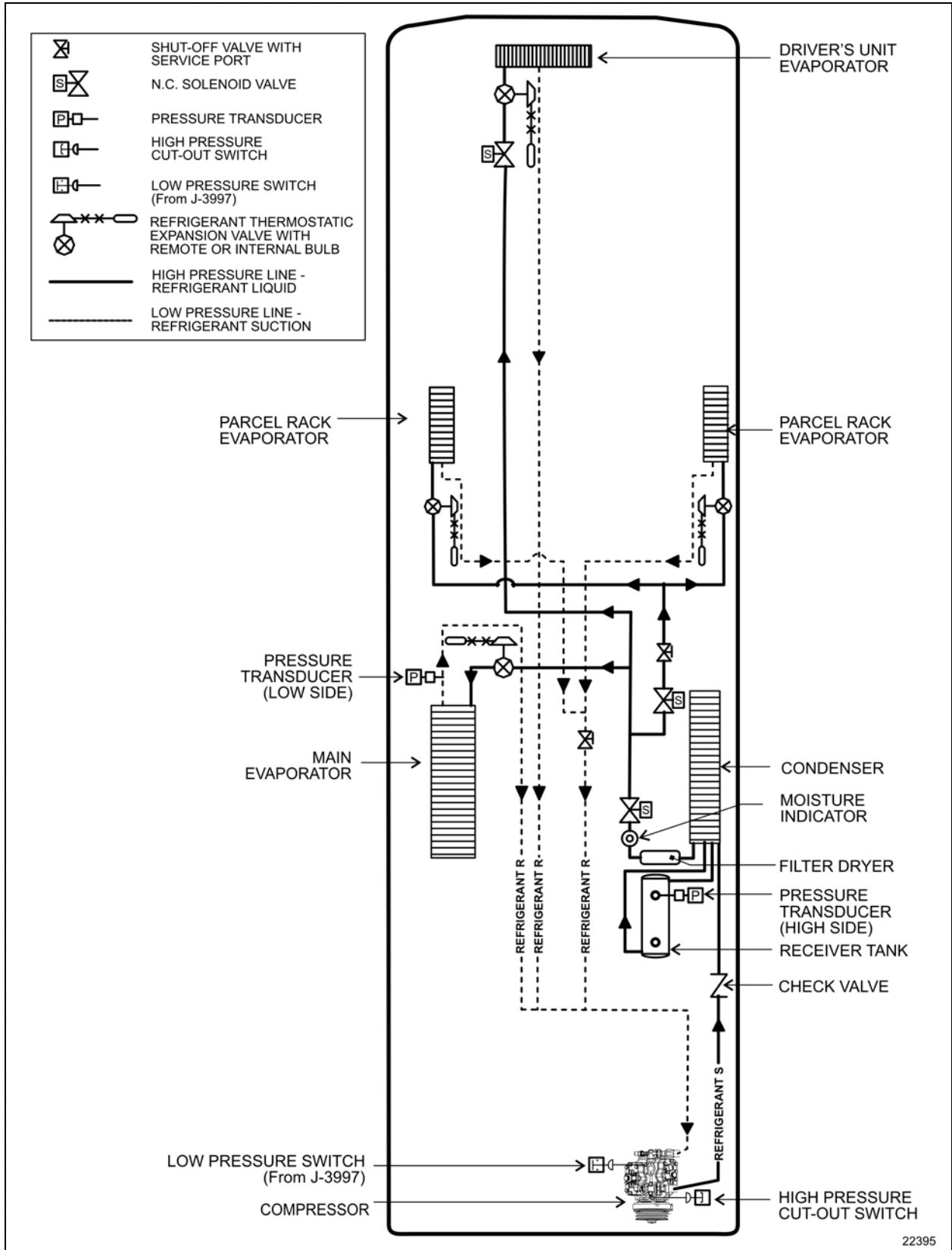


FIGURE 3: H3 SERIES CENTRAL HVAC SYSTEM – HEATING CIRCUIT

22262



22395

FIGURE 4: H3 SERIES CENTRAL SYSTEM – REFRIGERANT CIRCUIT WITH OVERHEAD COMPARTMENT EVAPORATOR

2.3 CENTRAL HVAC SYSTEM – X SERIES

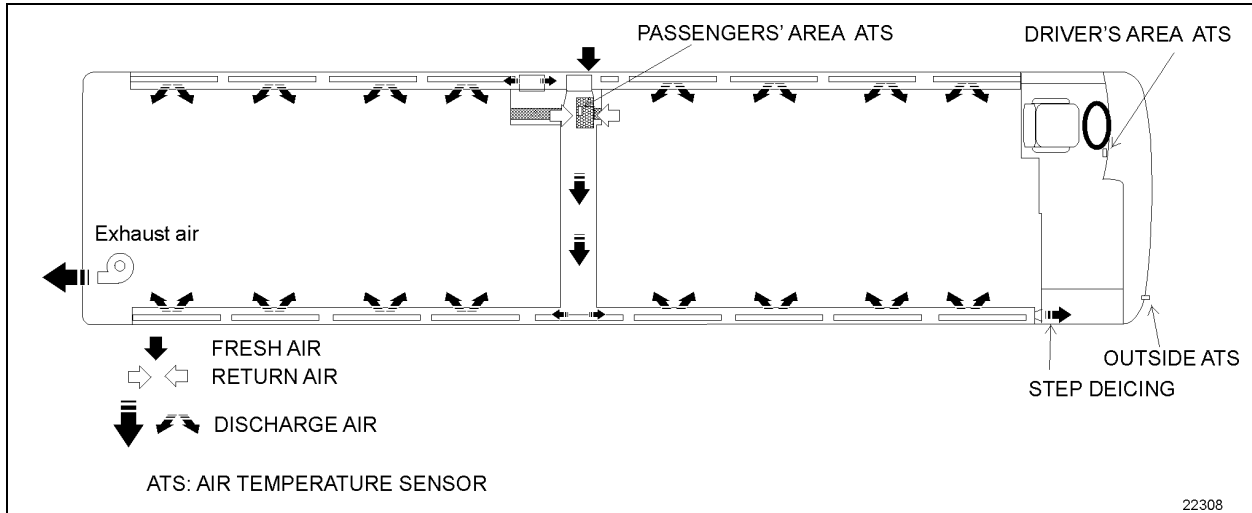


FIGURE 5: X3 COACHES CENTRAL HVAC SYSTEM - PASSENGER'S UNIT AIR CIRCULATION

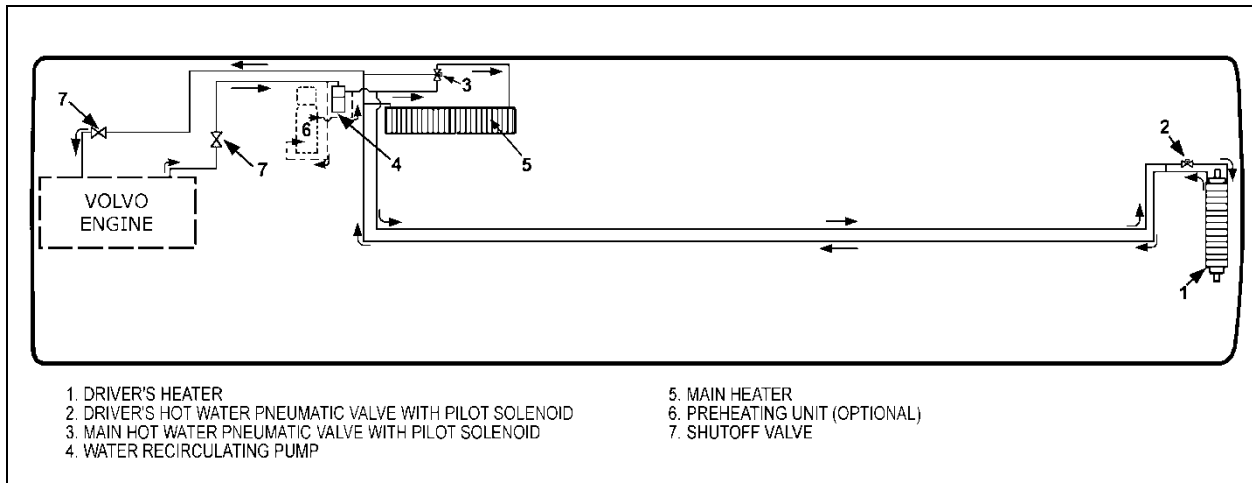
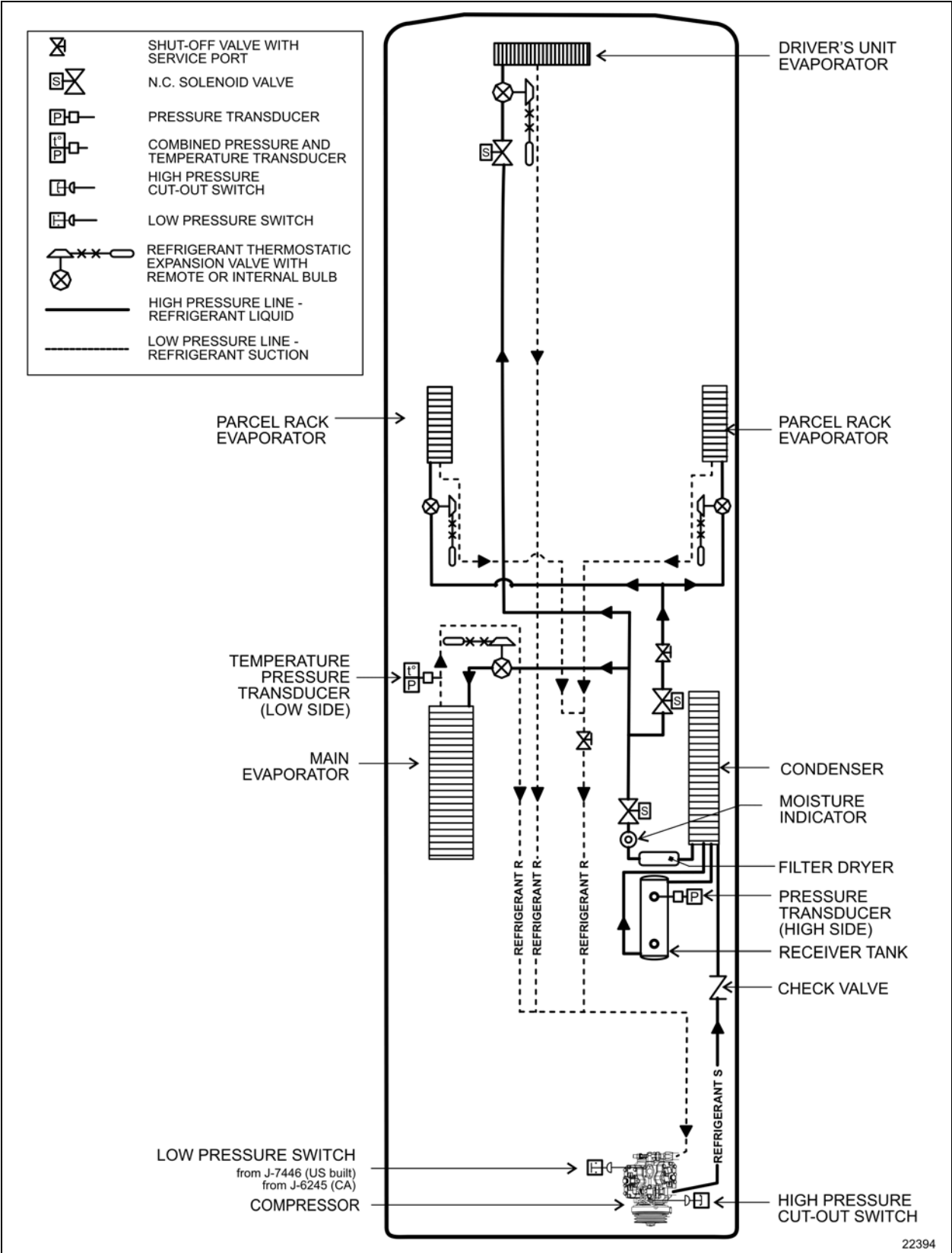


FIGURE 6: X3 SERIES CENTRAL HVAC SYSTEM – HEATING CIRCUIT



22394

FIGURE 7: X3 SERIES CENTRAL HVAC SYSTEM –CIRCUIT W/ OVERHEAD COMPARTMENT EVAPORATORS

2.4 SMALL HVAC SYSTEM – H SERIES

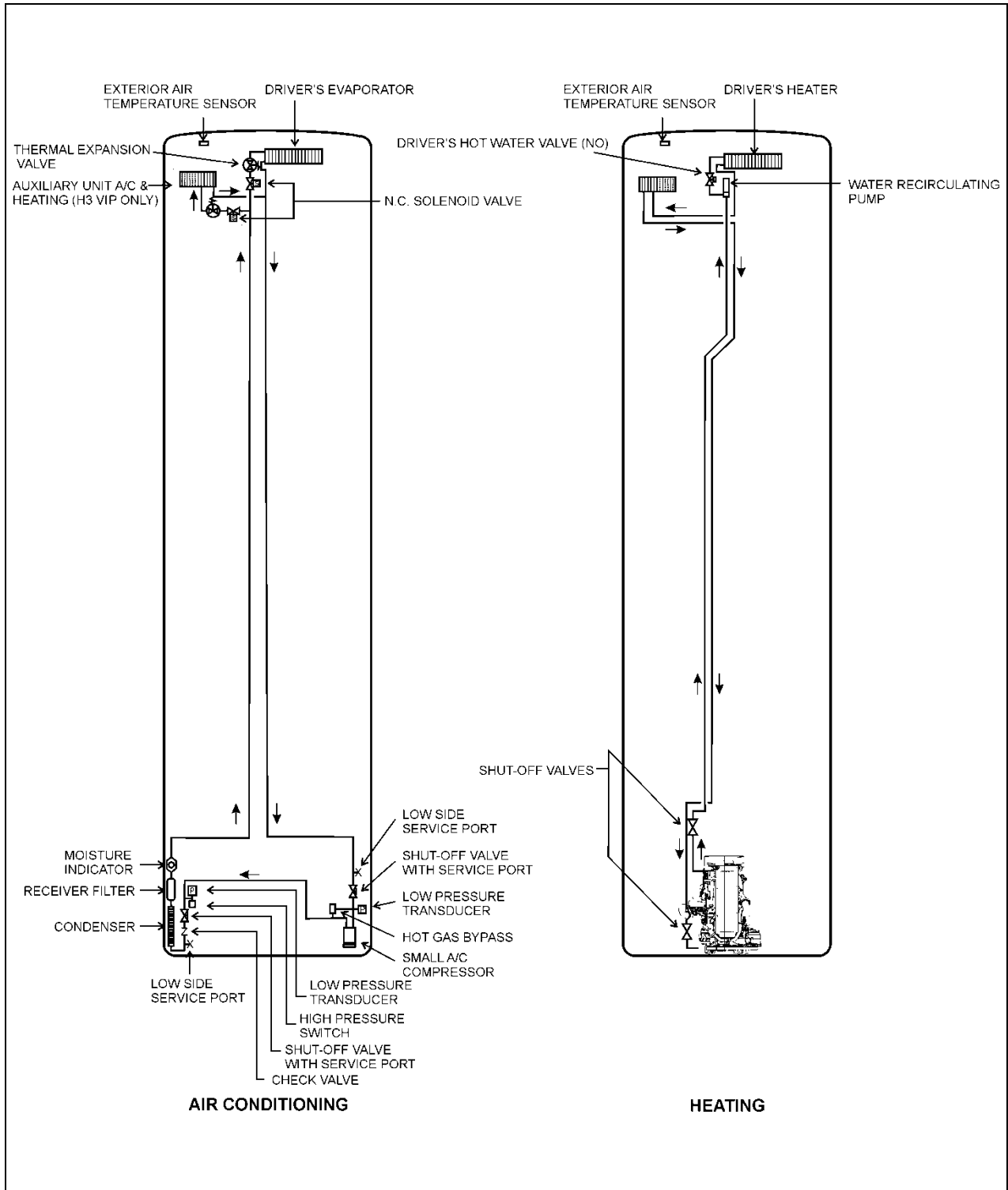


FIGURE 8: H SERIES SMALL HVAC SYSTEM – HEATING AND AIR CONDITIONING

22345

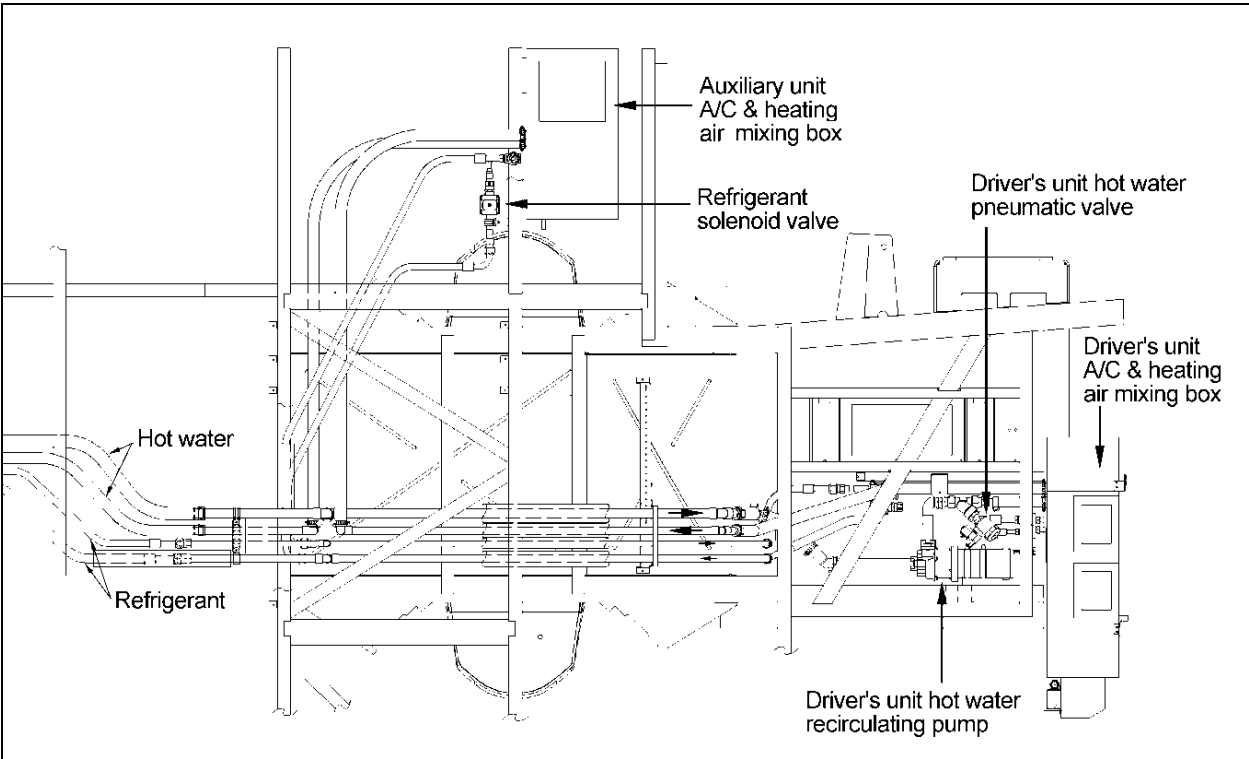


FIGURE 9: SMALL HVAC SYSTEM - DRIVER'S AND AUXILIARY UNIT (H3 VIP ONLY)

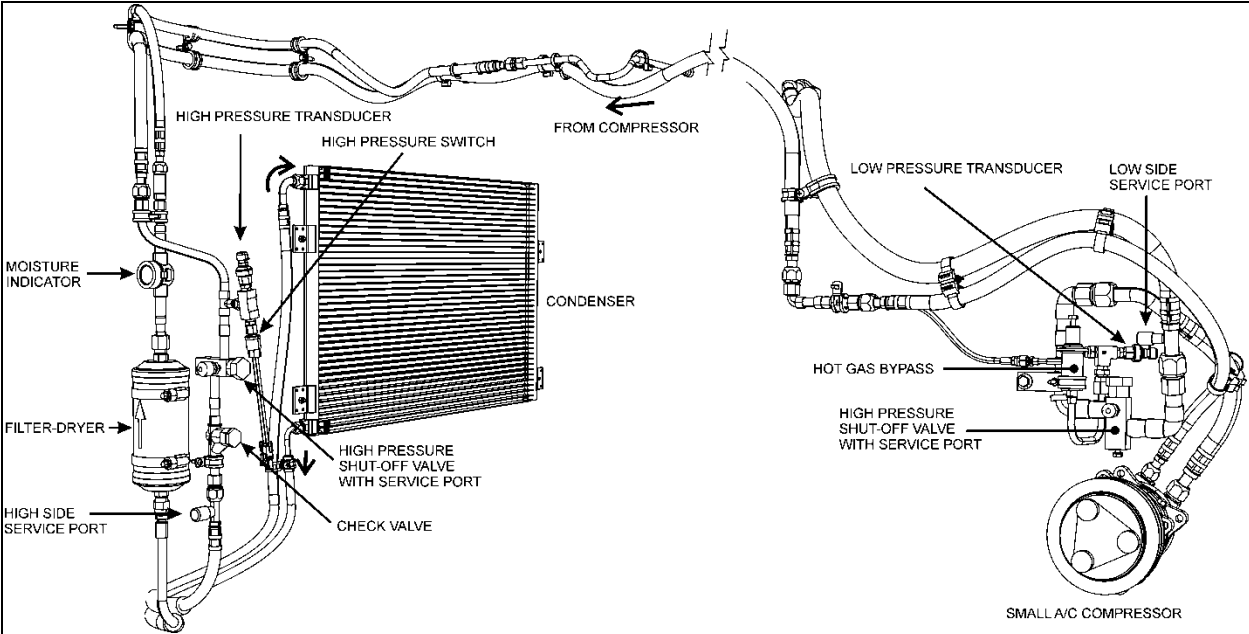
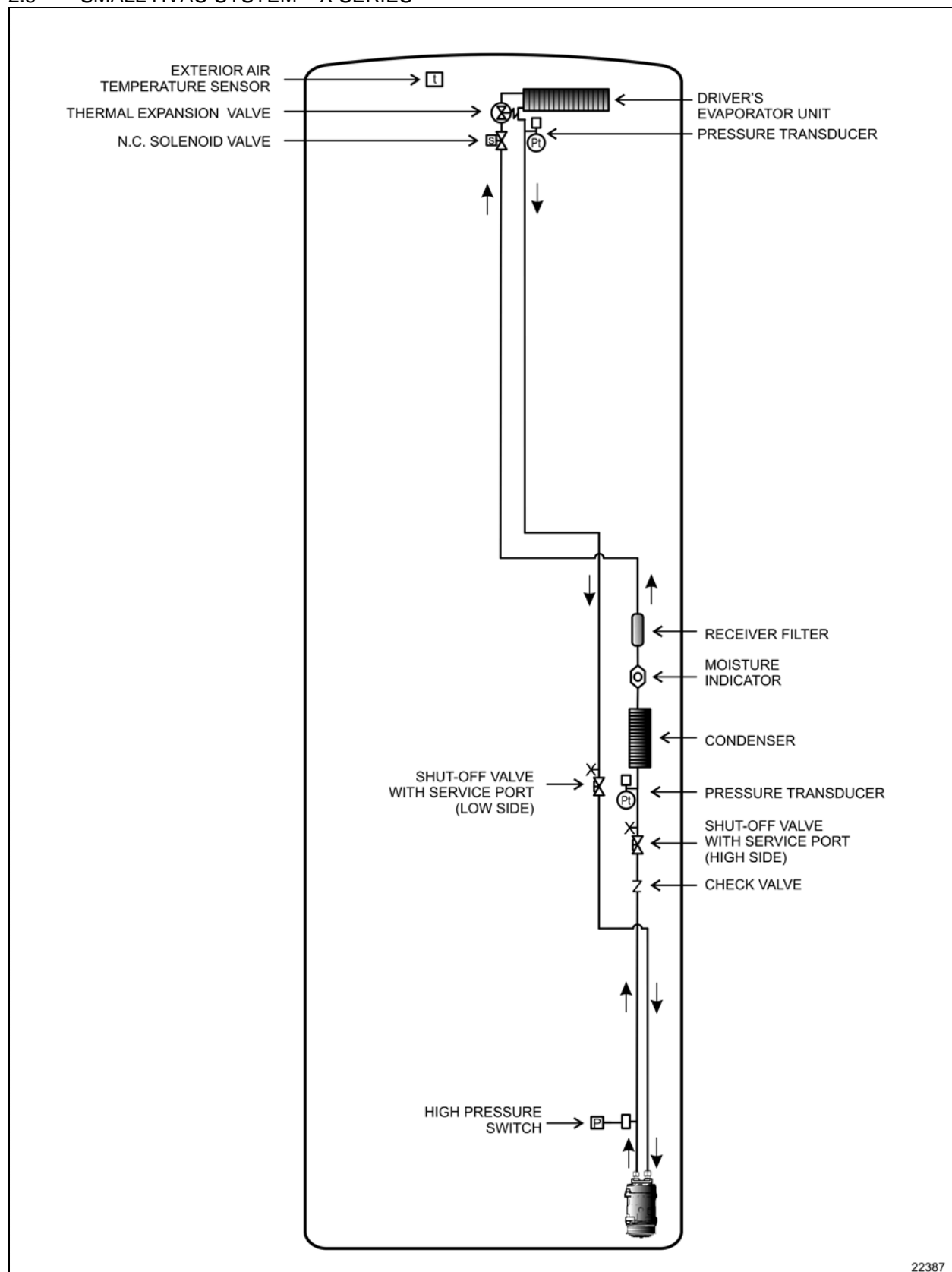


FIGURE 10: H SERIES SMALL HVAC SYSTEM – AIR CONDITIONING

22377

2.5 SMALL HVAC SYSTEM – X SERIES



22387

FIGURE 11: X3 SERIES SMALL HVAC SYSTEM - REFRIGERANT CIRCUIT

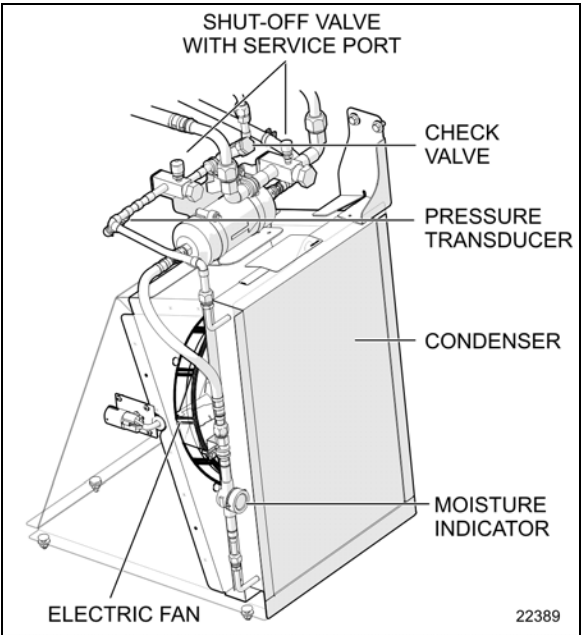


FIGURE 12: X-SERIES CONDENSER ARRANGEMENT

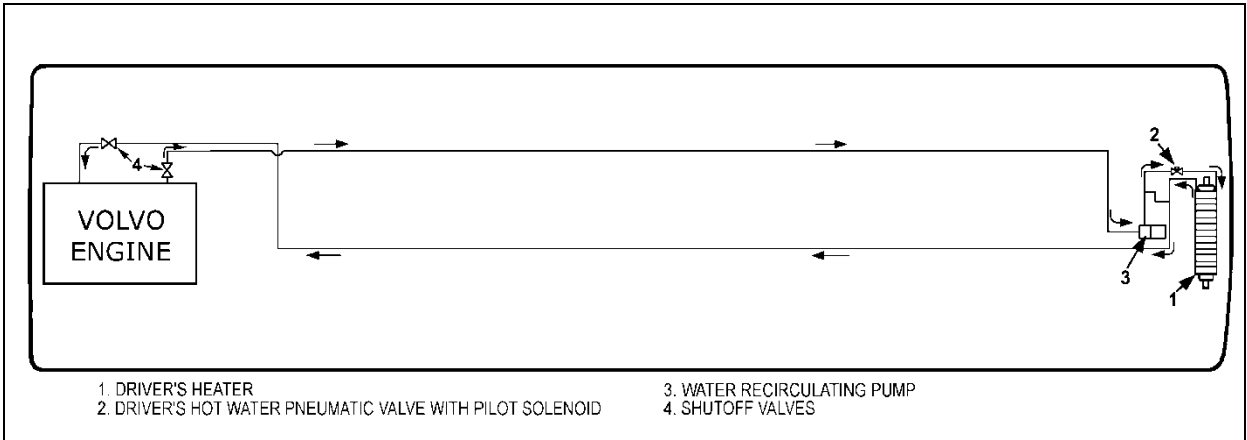



FIGURE 13: X-SERIES SMALL HVAC SYSTEM - HEATING CIRCUIT

3. HVAC SYSTEM BASIC MAINTENANCE

Basic maintenance required on the passenger's 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.

3.1 COIL CLEANING

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

3.1.1 Driver's Unit



MAINTENANCE

Once a year, gain access to the driver's unit, remove the coil access panel (Figure 14) and clean the **driver's** unit evaporator and heater coils with low pressure air jet, taking care not to damage fins. Clean the bottom of the defrost plenum.

For the optional windshield upper section defogger/defroster, remove the bottom access panel, remove the six bolts fixing the blower motor assembly. Use low air pressure to clean the coil.

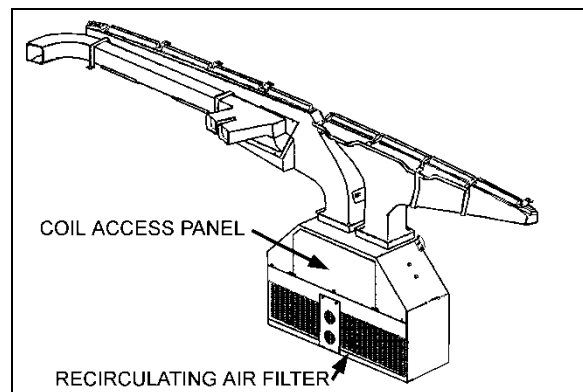



FIGURE 14: DRIVER'S UNIT AIR FILTERS 22171


3.1.2 Passenger's Unit



MAINTENANCE

With the air filters previously removed, clean the **passenger's** unit evaporator and heater coils with low air pressure or a stream low-pressure water **once a year**. Do not use a pressure washer as this will damage the fins. Remove the air filter and brush the evaporator coil from behind.

Once a year, clean the condenser with low-pressure air jet or a stream of low-pressure water, taking care not to damage fins (Figure 16).



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.

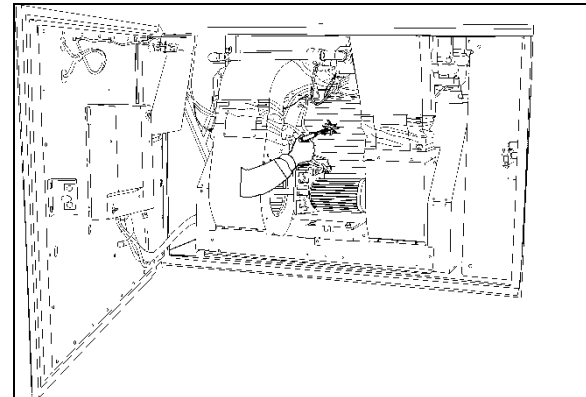


FIGURE 15: EVAPORATOR COIL CLEANING WITH LOW-PRESSURE AIR JET 22373

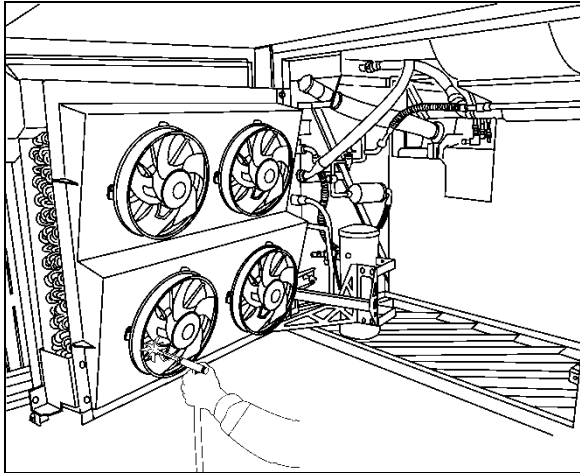


FIGURE 16: CLEANING PASSENGER'S UNIT CONDENSER COIL WITH LOW-PRESSURE AIR JET 22362

3.2 DRIVER'S UNIT AIR FILTER

The driver's unit is located behind the R.H. console panel. To gain access to the air filter, unscrew the R.H. console's grill located in the entrance stepwell. Remove the plastic cover and slide out the recirculating air filter (FIGURE 18).

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 17). Unscrew the plastic cover and slide out the recirculating air filter (FIGURE 18). Doing so will give you access to the fresh air filter (see item 18, Figure 71).

assembly. Clean the steel wire screen as required.

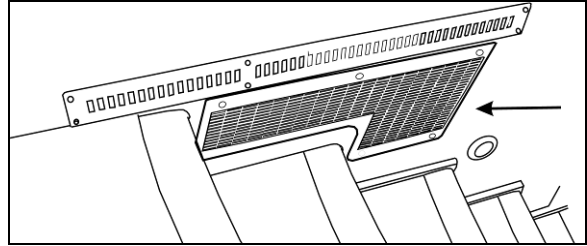


FIGURE 17: R.H CONSOLE AIR FILTER ACCESS GRILL (COACHES) 18505

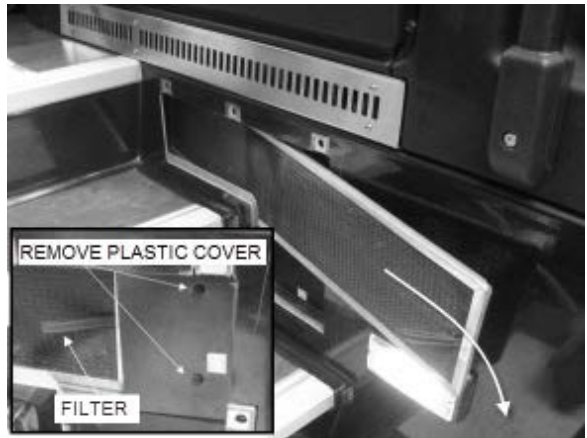


FIGURE 18: REMOVING DRIVER'S SECTION AIR FILTERS

3.3 PASSENGER'S UNIT AIR FILTER – H3 SERIES

The passenger's unit 2-part air filter is located in the evaporator compartment. To access the filter, locate the access panel in the baggage compartment at the left of the evaporator compartment. Open panels by turning the three screws of either panel 1/4 of a turn (Figure 20), unsnap both fasteners on top of filter, and slide out filter (Figure 21).

MAINTENANCE

Driver's unit return air filter

Clean or replace return air filter at the intervals specified by the Lubrication And Servicing Schedule in Section 24: LUBRICATION & SERVICING.

To clean filter, back flush with water or soapy water, then dry with air.

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.

On H3 series vehicles, a fresh air intake filter is located behind the R.H. side headlights

MAINTENANCE

Passenger's unit air filter

Clean or replace filter at the intervals specified by the Lubrication And Servicing Schedule in Section 24: LUBRICATION & SERVICING.

To clean filter, back flush with water or soapy water, then dry with air.

CAUTION

Be sure not to reverse filter upon installation.

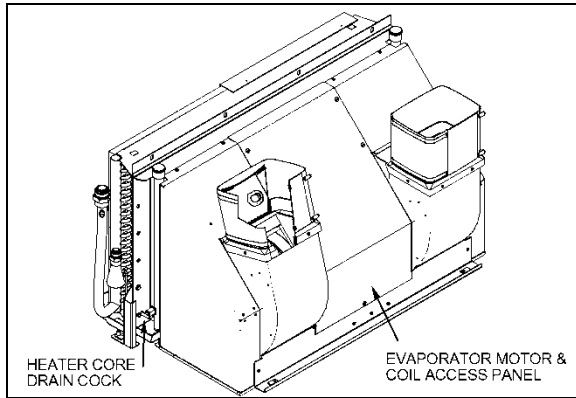


FIGURE 19: PASSENGER'S UNIT EVAPORATOR COIL
22332

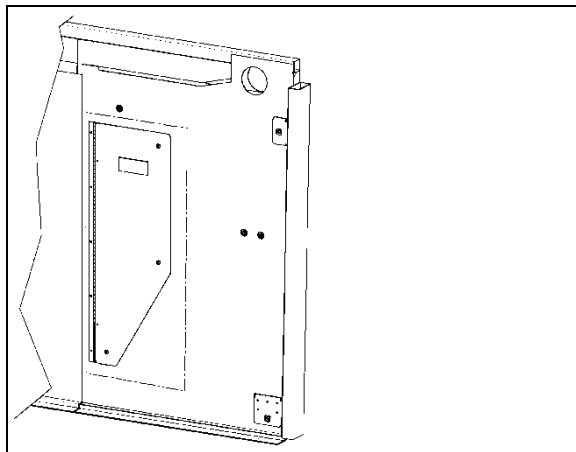


FIGURE 20: PASSENGER'S UNIT 2-PART AIR FILTER
ACCESS PANEL H-SERIES

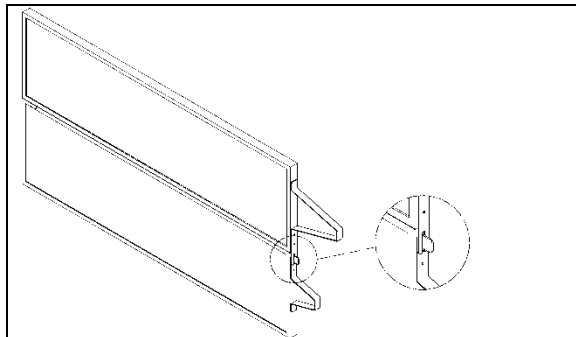


FIGURE 21: PASSENGER'S UNIT 2-PART AIR FILTER
H SERIES

3.4 PASSENGER'S UNIT AIR FILTER – X3 SERIES

The cabin or passengers' section air filter is located in the evaporator compartment above the evaporator coil and fans (Figure 22).



MAINTENANCE

Passenger's unit air filter

Clean or replace filter at the intervals specified by the Lubrication And Servicing Schedule in Section 24: LUBRICATION & SERVICING.

To clean filter, back flush with water or soapy water, then dry with air

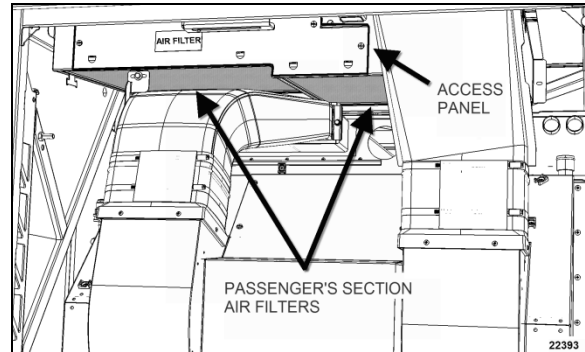


FIGURE 22: PASSENGERS' SECTION AIR FILTER



CAUTION

Be sure not to reverse filter upon installation.

3.5 OVERHEAD COMPARTMENT FAN AIR FILTER

Air conditioning evaporator coils may be installed in both overhead compartment air systems. Only the air filters are serviceable. The air filters are accessible from inside the overhead compartments (Figure 23).



MAINTENANCE

At the intervals specified by the Lubrication And Servicing Schedule in Section 24: LUBRICATION & SERVICING, slide out the filters, then back flush with water, dry with air and reinstall.

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



FIGURE 23: OVERHEAD COMPARTMENT FAN AIR FILTER

22201

3.6 COMPRESSOR BELTS

3.6.1 Belt Replacement – Central System



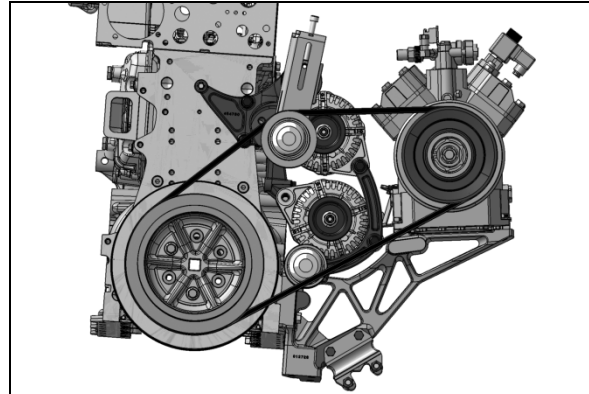
DANGER

Set the main battery disconnect switch to the OFF position. For greater safety, set the engine rear starter selector switch in engine compartment to the OFF position.

1. Open engine compartment rear door and locate A/C compressor drive belt tensioner. Loosen tensioner screw to release belt tension.
2. For vehicles equipped with a 3rd alternator, belt tensioning is also applied through air bellows (Figure 25). Turn the belt tensioner two-way control valve counterclockwise to release bellows pressure (Figure 27).
3. Remove the radiator fan drive belt (refer to Section 05 COOLING).
4. Slip the old compressor belts off and the new ones on.

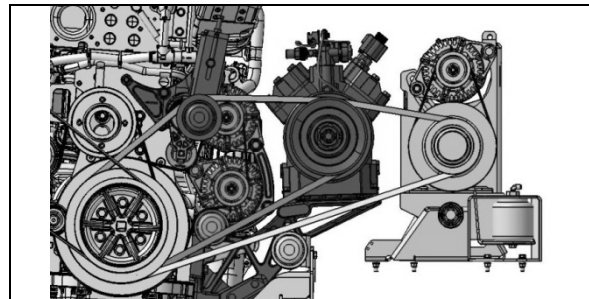
NOTE

Both belts must always be replaced simultaneously to ensure an equal distribution of load on each of them.



Twin BX71 belt proper tension
New: 90-100 lbs
Used: 75-85 lbs
Belt tension Tool:7770002

FIGURE 24: STANDARD BELT LAYOUT WITH CENTRAL HVAC SYSTEM



Single 5VX740 belt proper tension
New: 150-160 lbs
Used: 120-130 lbs
Belt tension Tool:7770002
Single 5VX940 belt to 3rd alternator proper tension
Automatic with pneumatic bellows

FIGURE 25: H SERIES BELT LAYOUT W/ 3RD ALT.

NOTE

Belts specifications may vary. For proper belt selection, always consult your vehicle Coach Final Record.



MAINTENANCE

A/C compressor drive belt

Clean belt tension, inspect for cracks or frayed material at the intervals specified by the Lubrication And Servicing Schedule in Section 24: LUBRICATION & SERVICING.

3.6.2 Belt Tension Adjustment – Central System

On the mechanical tensioner (Figure 26), slightly slack lock bolt (A). Adjust tension by turning

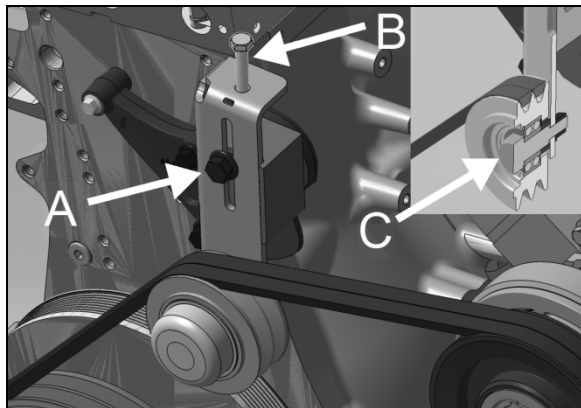
adjustment screw (B). Tighten the lock bolt (A) to preserve adjustment.

TORQUE: 43 lb-ft (58 Nm)

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

TORQUE: 31.5-38.5 lb-ft (43-52 Nm)
(M12 shoulder bolt)

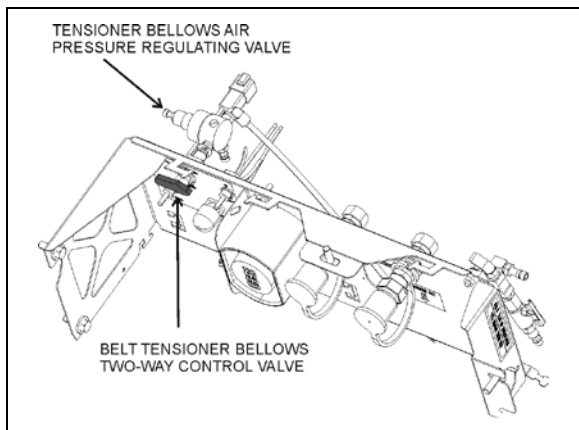
TORQUE: 59 lb-ft (80 Nm)
(M12 x 1.75 std bolt)



22381

FIGURE 26: TENSIONER ON CENTRAL A/C

For H Series vehicles equipped with a 3rd alternator, (Figure 25) belt tensioning is also applied through air bellows which is adjusted by an air pressure regulating valve pressure (Figure 27). The correct pressure of 45 psi is set at the factory. Periodically verify the pressure using a pressure gauge and correct if required.



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FIGURE 27: BELT TENSIONER CONTROL VALVE - H SERIES

3.6.3 Belt Tension Adjustment – Small HVAC System H-SERIES

Belt tensioning is applied through air bellows which are adjusted by an air pressure regulating valve (Figure 27). The correct pressure of 45 psi is set at the factory. Periodically verify the pressure at the regulating valve using a pressure gauge and correct if necessary.

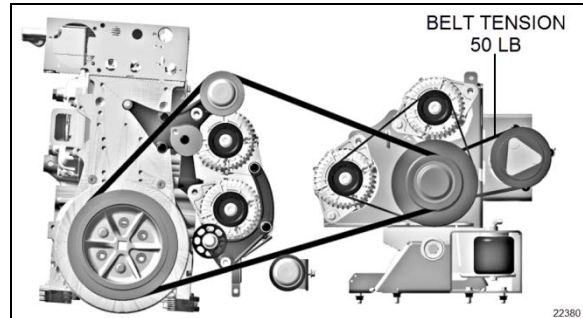
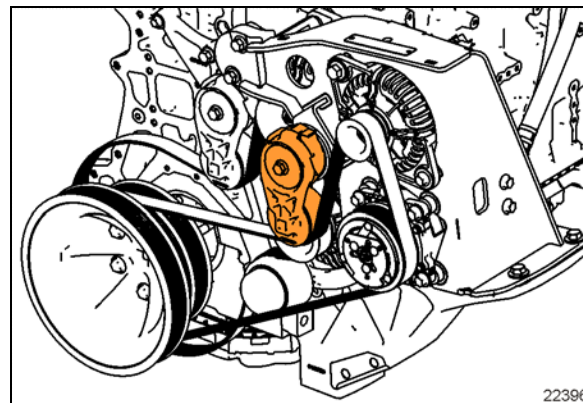


FIGURE 28: BELT LAYOUT WITH SMALL A/C COMPRESSOR H-SERIES

3.6.4 Belt Tension - Small HVAC System X-SERIES

Belt tension is achieved by an automatic belt tensioner. No adjustment is required.



22396

FIGURE 29: BELT LAYOUT WITH SMALL A/C COMPRESSOR X-SERIES

3.7 TORCH BRAZING

Use electrode containing 35% silver.

NOTE

A 3.5% silver low temperature brazing electrode can be used on low side pressure and liquid high side.



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.

3.8 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 [3,1 mm]). After completing repairs, test for leaks.

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

4. HVAC SYSTEM COMPONENTS

4.1 COMPRESSOR – CENTRAL A/C SYSTEM

The central system is equipped with a **Bitzer 4-cylinder model 4NFCY** compressor. Refer to paragraph 9 “Specifications” at the end of this section.

4.1.1 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 hose flange by hand in 2 sequences.
3. Apply a final torque on cap screws.

TORQUE: 31-35 lb-ft (42-47 Nm)

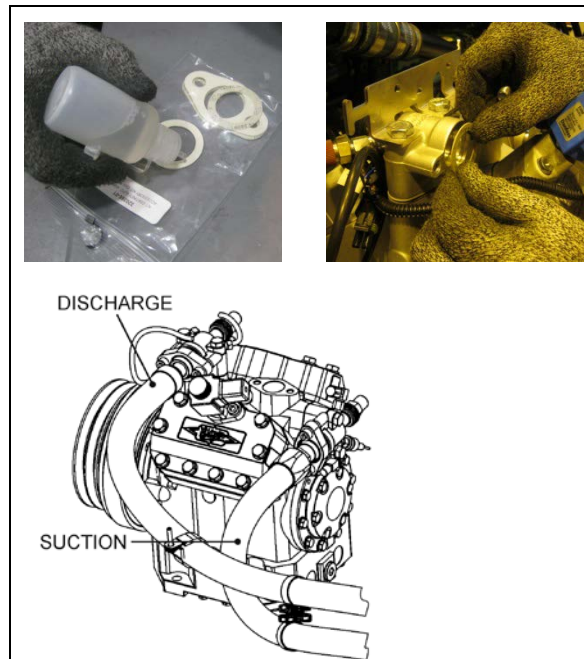


FIGURE 30: SUCTION AND DISCHARGE HOSE

4.1.2 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.

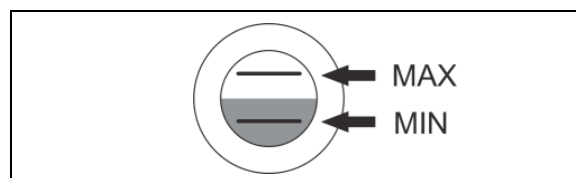
- Bitzer kb-540-3 Operating Instructions
- Bitzer ke-540-7 Spare Parts List
- Bitzer kw-541-2 Exchanging Shaft Seal
- Bitzer kt-510-5 Tech Info oils
- Bitzer kw-555-3 Tightening Torques
- Bitzer kt-100-3 Capacity Control (unloader)
- Bitzer kw-540-1 Maintenance Instruction

4.1.3 Oil Level Check and Oil Change

Oil level should be between $\frac{1}{4}$ and $\frac{3}{4}$ of sight glass height.

Oil Type: Polyolester ISO68.

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





MAINTENANCE

A/C compressor oil

Check compressor oil level at the intervals specified by the Lubrication And Servicing Schedule in Section 24: LUBRICATION & SERVICING.



MAINTENANCE

The shaft seal oil tube collects oil seeping through the felt shaft seal. Empty the shaft seal oil collecting tube at the intervals specified by the Lubrication And Servicing Schedule in Section 24: LUBRICATION & SERVICING.

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

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.



MAINTENANCE

Compressor oil

Change the oil, clean the compressor oil filter and the magnetic plug at the intervals specified by the Lubrication And Servicing Schedule in Section 24: LUBRICATION & SERVICING.



FIGURE 31: SHAFT SEAL OIL COLLECTING TUBE

4.1.4 Troubleshooting Guide

A preliminary check may be made by simply feeling the cylinder heads with the unit in operation at ambient temperatures of 35°F (2°C) and over. The cylinder heads are internally divided into suction and discharge 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 service valve frontseated.

Cause:

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

Unloader Valve Stuck Open

Symptom:

- Loss of unit capacity at all temperatures.
- Higher than normal suction pressure.
- Even cylinder head temperature.

Cause:


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

4.1.5 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.

4.2 COMPRESSOR – SMALL HVAC SYSTEM

Consult Ice Compressor Service Manual, found on your Technical Publications USB flash drive.

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

4.2.1 Removal - When the Compressor Is Operational

Perform the “OIL RETURN OPERATION” (Refer to paragraph 7.9).

<p>NOTE</p> <p><i>Belts specifications may vary. For proper belt selection, always consult your vehicle Coach Final Record.</i></p>
--

4.2.2 Removal - When the Compressor Is Inoperable

- Perform the “Refrigerant Recovery” operation (paragraph 7.5).
- Remove any tension on the belts

Slacken bolts fixing small compressor. (FIGURE 32 and Figure 33)

- Remove the compressor.
- Reinstall following system clean-out recommendations (Paragraph 7.6)

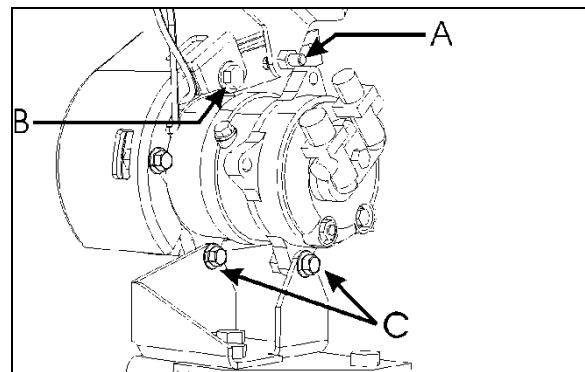


FIGURE 32: COMPRESSOR MOUNTING H-SERIES

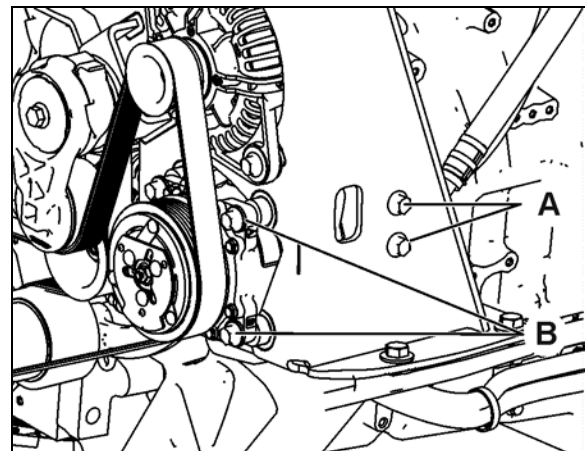


FIGURE 33: COMPRESSOR MOUNTING X-SERIES

4.3 BRUSHLESS EVAPORATOR MOTOR

The brushless evaporator motor is installed in the evaporator compartment (Figure 34). It is a 27.5 volt, 2HP (1,5 kW) motor which activates a double blower fan unit.

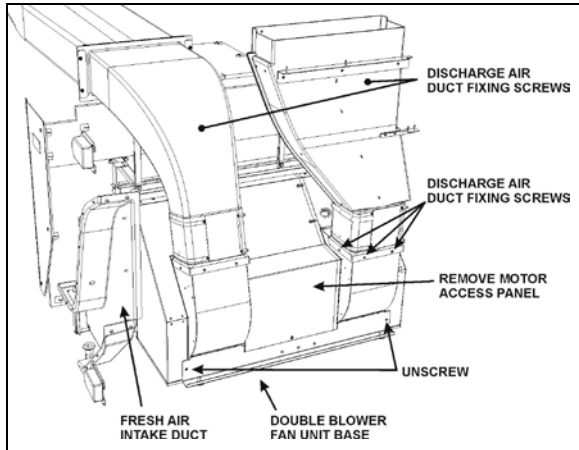


FIGURE 34: H3 SERIES EVAPORATOR COMPARTMENT

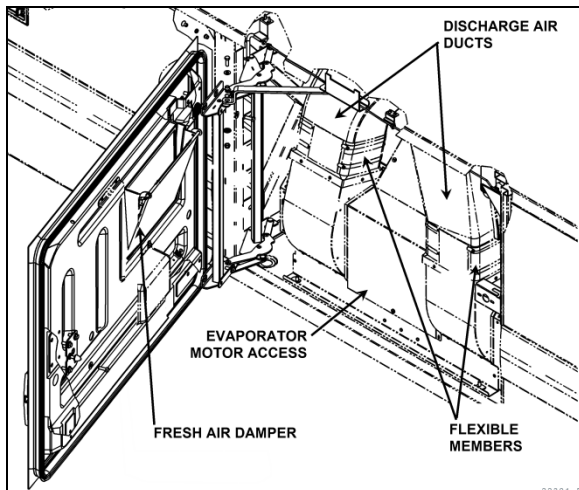


FIGURE 35: X3 SERIES EVAPORATOR COMPARTMENT

4.3.1 Removal

1. Set the battery master switch to the OFF position and trip circuit breaker CB3 (CB6 on X3 VIP).
2. Open the evaporator compartment door.
3. On the HVAC module. Disconnect circuit 90H1 from evaporator relay R12.
4. Identify the discharge ducts inside compartment and remove the Phillips head screws fixing the air duct to blower fan unit.
5. Remove the motor access panel.

6. Disconnect electrical motor speed control wire (white wire, circuit 2F), power cable and ground cable from motor terminals.
7. From under the vehicle, remove the eight bolts fixing the double blower fan unit base. Remove the complete unit from the evaporator compartment (Figure 36).



CAUTION

Never support evaporator motor assembly by its output shafts while moving it. Always use double blower fan unit base.

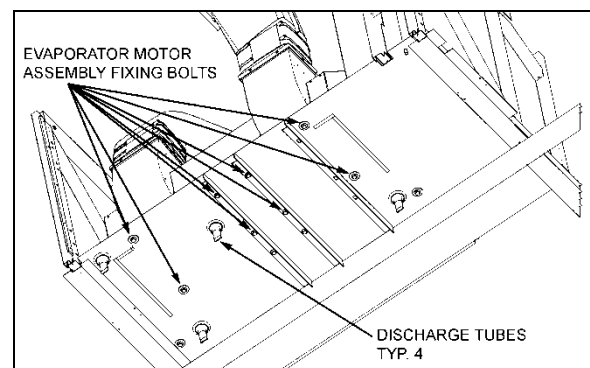


FIGURE 36: EVAPORATOR MOTOR BOLTS

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8. Install the complete unit on a work bench, unfasten the fan square head set screws, the Phillips head screws retaining cages to base and slide out the assemblies from the evaporator motor output shaft.
9. Remove motor from double blower fan unit base.

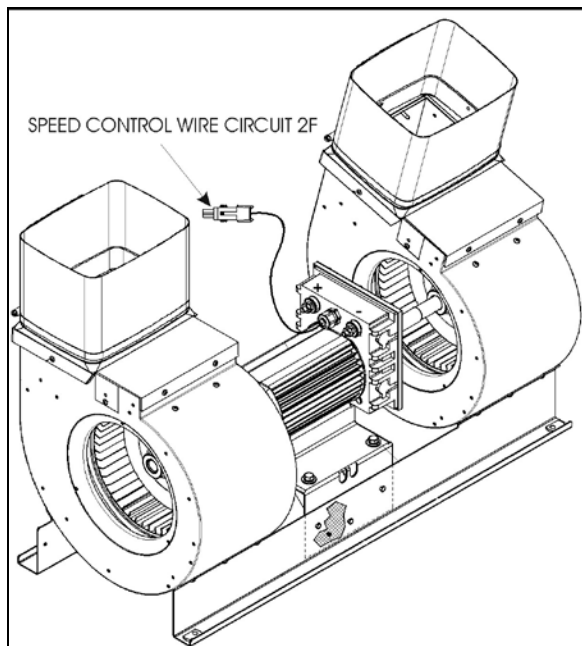


FIGURE 37: EVAPORATOR MOTOR ASSEMBLY

4.3.2 Installation

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

4.4 CONDENSER (CENTRAL A/C)

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

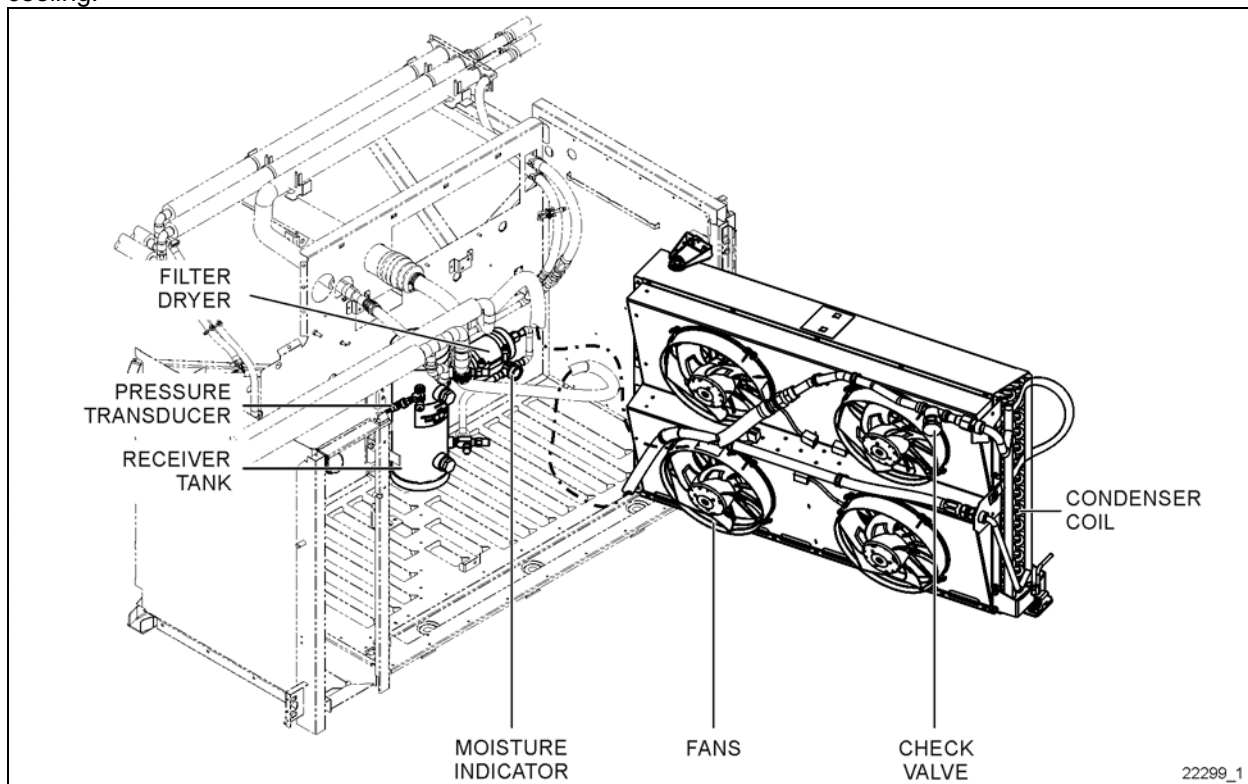


FIGURE 38: CENTRAL A/C CONDENSER

4.4.1 Condenser Fan Control

Four brushless motors fan are installed in condenser compartment on R.H. side of vehicle in order to ventilate the condenser coil. The fans pull outside air through the condenser coil and discharge it through an opening at bottom of compartment.

Fan speed is controlled by the multiplex program and varies according to high side pressure. A Pulse Width Modulation (PWM) signal is used to control fan speed.

You will notice fan speed ramp up to full speed between 100 psi and 200 psi, and a ramp down from 200 psi to 100psi. Below 100psi, the fans are not running. Refer to Figure 39 below.

NOTE

During normal conditions, fan function according to the following specifications:

Full speed: 6200cfm, 37A at 28 VDC

Fan motor speed: 2950 rpm at full speed

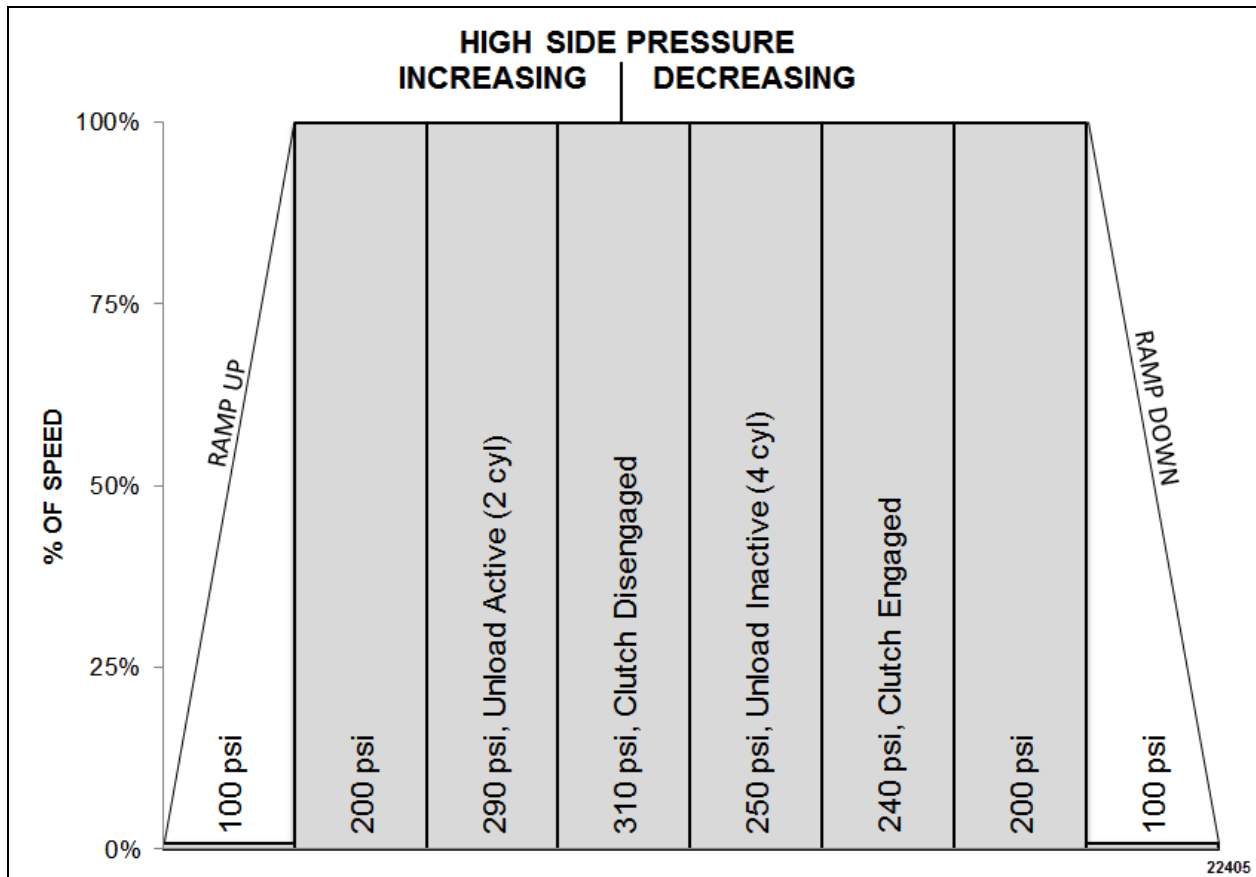


FIGURE 39: CONDENSER FAN SPEED AND COMPRESSOR EVENTS IN RELATION WITH HIGH SIDE PRESSURE

4.4.2 Condenser Fan Removal

1. Set the battery master switch to the OFF position.
2. Unplug the fan harness connector (Figure 40).
3. Remove the four hexagonal head cap screws retaining the fan assembly to the shroud.
4. Remove the motor.

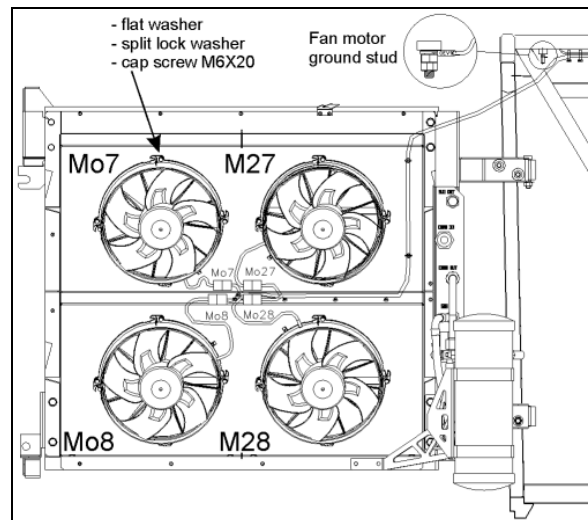


FIGURE 40: CONDENSER FANS

4.5 CONDENSER (SMALL A/C)

On H3-series vehicles, the condenser is installed over the radiator and benefits from the existing airflow in this location.

On X3-series vehicles the condenser is installed in the 4th baggage compartment and has its own MUX controlled electrical fan.

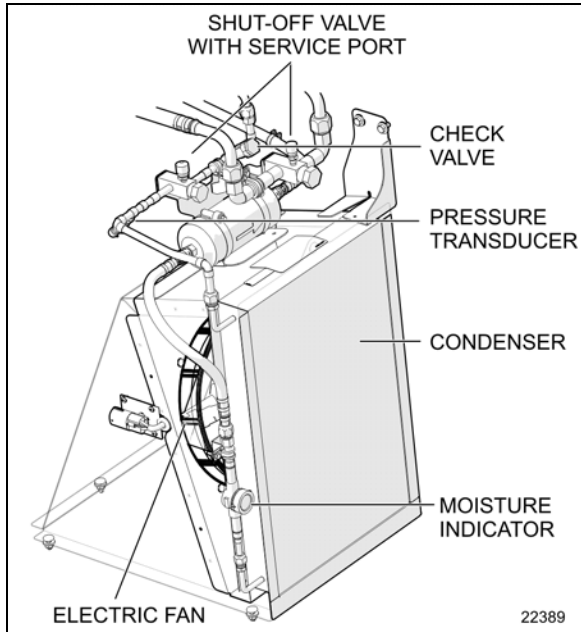


FIGURE 41 X SERIES SMALL A/C CONDENSER ASSEMBLY.

4.6 RECEIVER TANK

The receiver tank is located in the condenser compartment (Figure 42). 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.



MAINTENANCE

Check refrigerant level and add if necessary, at the intervals specified by the Lubrication And Servicing Schedule in Section 24: LUBRICATION & SERVICING.

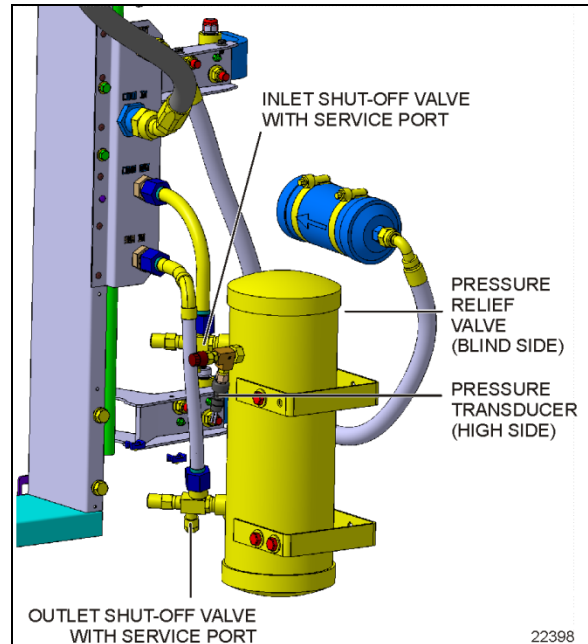


FIGURE 42: RECEIVER TANK (H SERIES)

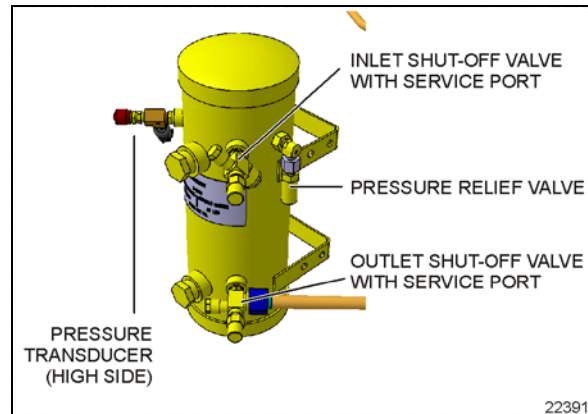


FIGURE 43 RECEIVER TANK X SERIES

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.

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.

4.7 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.

4.7.1 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.

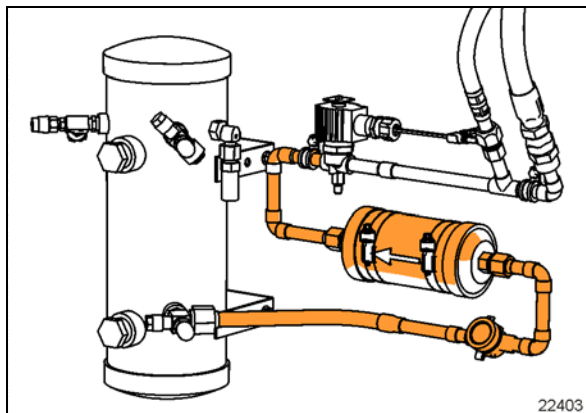


FIGURE 44: ISOLATED SECTION X SERIES

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 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.

4.8 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 at the intervals specified by the Lubrication And Servicing Schedule in Section 24: LUBRICATION & SERVICING.

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 sub cooling 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.

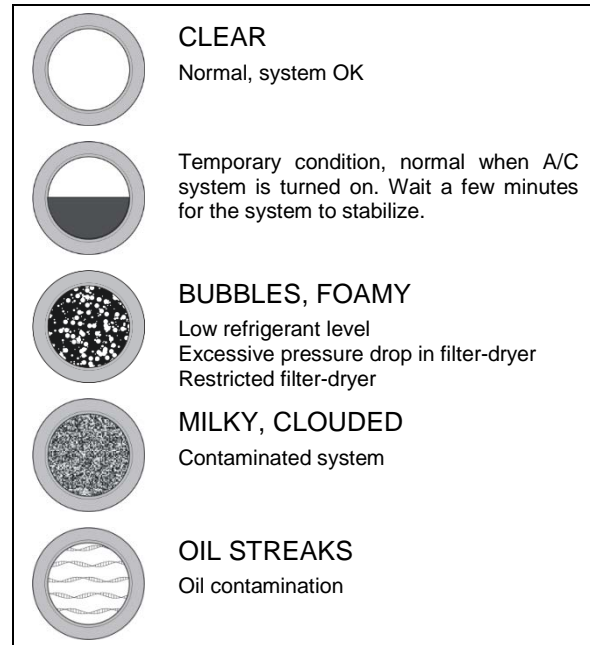


FIGURE 45: CONDITIONS THAT MAY BE OBSERVED IN THE MOISTURE INDICATOR SIGHT GLASS

4.9 SHUT-OFF VALVE WITH SERVICE PORT

This shut-off valve (FIGURE 46) 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.

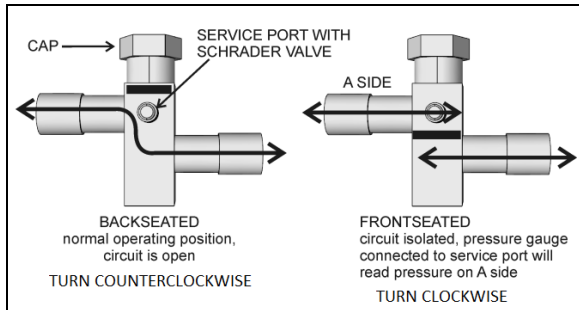


FIGURE 46: REFRIGERANT CIRCUIT SHUT-OFF VALVE

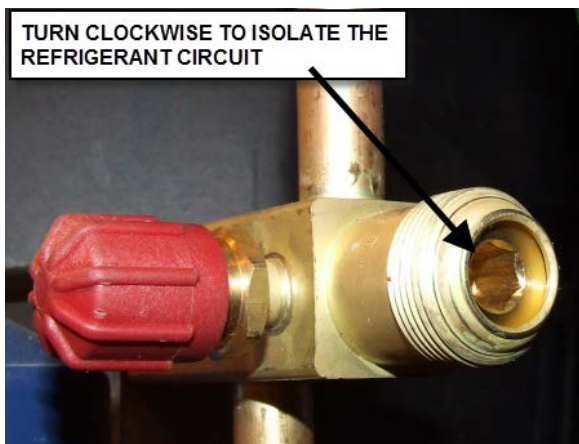


FIGURE 47: REFRIGERANT CIRCUIT SHUT-OFF VALVE

4.10 LIQUID REFRIGERANT SOLENOID VALVE

The flow of liquid refrigerant to the driver's unit evaporator, passengers' unit evaporator (main evaporator) and overhead compartments 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 48) and is accessible through the reclining bumper.

Two identical NC (normally closed) refrigerant solenoid valves are found in the condenser compartment (FIGURE 49). One is used to control flow of refrigerant to the overhead compartments evaporator while the other is used to control flow to the driver's and passenger's main evaporators.

On H3 VIP, one identical refrigerant solenoid valve is used on the small HVAC system auxiliary unit (Figure 9).

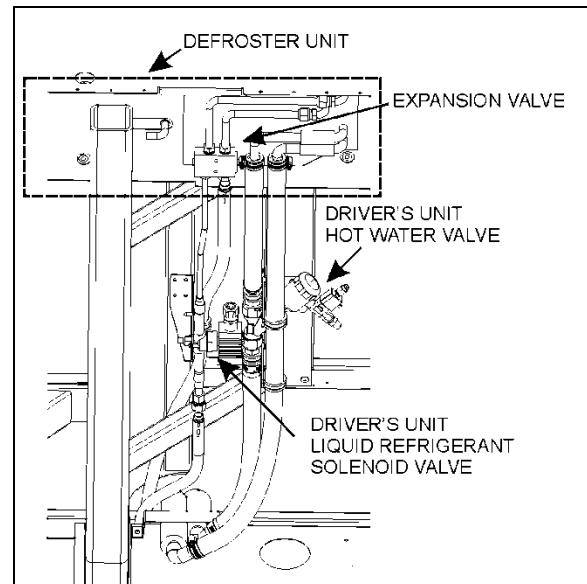


FIGURE 48: DRIVER'S UNIT LIQUID SOLENOID VALVE

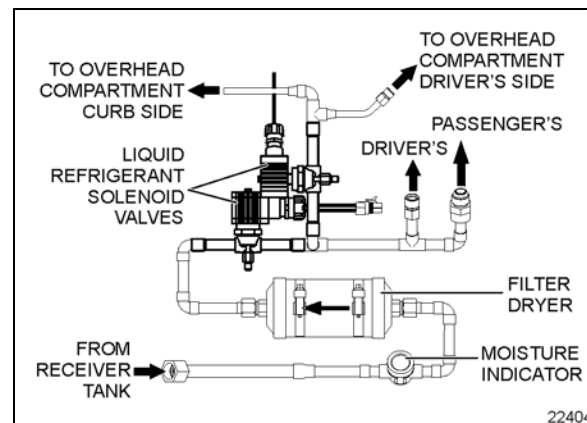


FIGURE 49: LIQUID REFRIGERANT SOLENOID VALVES IN CONDENSER COMPARTMENT (X-SERIES)

4.10.1 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 USB flash drive.

4.10.2 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 overhead compartment 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 overhead compartment liquid solenoid valves open, and result in battery draining if the bus remains unused for several days.

4.10.3 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.

4.10.4 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.

4.10.5 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. Do not over tighten.

TORQUE: 20-40 lb-ft (27-54 Nm)

6. Put back manual lift stem. Tighten lift stem assembly and seal cap.

TORQUE: 11 lb-ft (15 Nm)

7. Place the coil assembly.

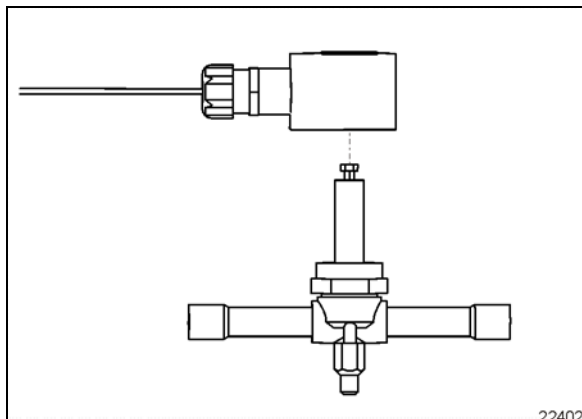


FIGURE 50: TYPICAL REFRIGERANT SOLENOID VALVE

**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.

4.11 THERMOSTATIC EXPANSION VALVE

4.11.1 Central System

The expansion valve for the main system is a thermo-sensitive valve with a remote control bulb head attached to the evaporator outlet line and is accessible by the evaporator filter access door. The valve regulates the flow of refrigerant liquid into the evaporator coils and is controlled by the suction gas temperature leaving the evaporator. The bulb head senses the refrigerant gas temperature as it leaves the evaporator. High temperature will cause expansion and pressure on the power head and spring. Such action causes the assembly valve to open, allowing a flow of refrigerant liquid into the evaporator.

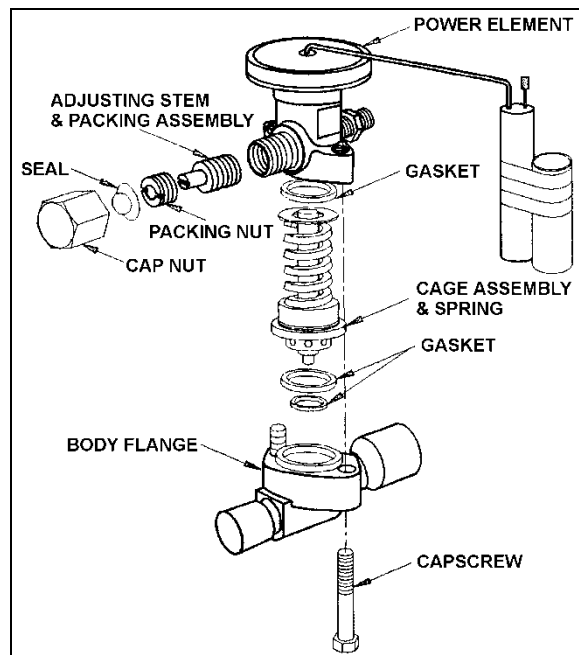


FIGURE 51: EXPANSION VALVE

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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 under side of the diaphragm and acting in the closing direction, is the force exerted by the superheat spring. As the temperature of the refrigerant gas at the evaporator outlet increases above the saturation temperature corresponding to the evaporator pressure, it becomes superheated. The pressure thus generated in the remote bulb and power assembly surpasses the combined pressures of the evaporator pressure and the superheat spring, causing the valve pin to move in the opening direction.

Conversely, as the temperature of the **refrigerant** gas leaving the evaporator decreases, the pressure in the remote bulb and power assembly also decreases and the combined evaporator and spring pressures cause the valve pin to move in the closing position.

As the operating superheat is raised, the evaporator capacity decreases, since more of the evaporator surface is required to produce the superheat necessary to open the valve. It is obvious, then, that it is most important to adjust the operating superheat correctly and that a minimum change in superheat to move the valve

pin to full open position, is of vital importance because it provides savings in both initial evaporator cost of operation.

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

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

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

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

4.11.2 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.

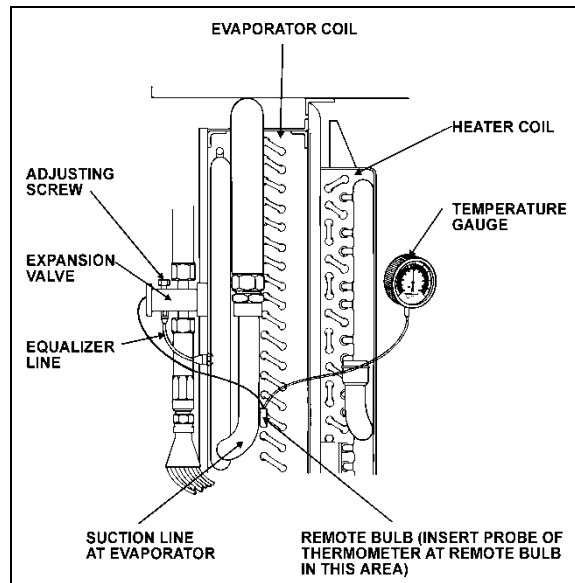


FIGURE 52: SUPERHEAT ADJUST. INSTALLATION 22046

2. In the DID "Gages" Menu note the indicated "LoS" (Low side) pressure.
3. Use a remote reading thermometer or thermocouple / multimeter to measure temperature at the evaporator outlet line near the existing remote bulb (Figure 52).
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.
6. Check approximately 5 readings of pressure at 2-minute intervals and convert to temperature using the vapor-pressure table. Likewise check the temperature reading at the remote bulb at the same 2-minute intervals and record the low and high swing readings of the needle (Figure 53).

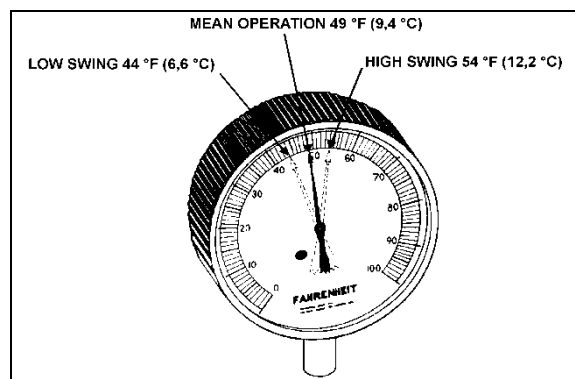


FIGURE 53: HIGH & LOW SWING TEMPERATURE AT REMOTE BULB 22047

Example of readings taken:

A/C pressure gauge at compressor suction converted to temperature with chart	40°F
Temperature on remote bulb	Low swing 44°F
	High swing 54°F
Average of low and high swing	49°F
Formula for superheat $T^\circ \text{ at bulb} - T^\circ \text{ suction} = T^\circ \text{ superheat}$ $49^\circ\text{F} - 40^\circ\text{F} = 9^\circ\text{F}$	

NOTE
The low swing of the superheat should be a minimum of 4°F (2,2°C) higher at the remote bulb and have an average of 12 to 16°F (4 to 6°C) 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, increase refrigerant flow by turning adjusting screw counterclockwise on expansion valve. To increase superheat, flow of refrigerant is reduced by turning adjustment screw of clockwise.

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

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



CAUTION

Before proceeding with 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.

4.11.3 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.

4.11.4 Driver's Unit

The function and operation of the driver's unit expansion valve are similar to the central system, but no superheat adjustment is required (FIGURE 48).

4.12 HOT WATER PNEUMATIC VALVE

No maintenance is needed unless a malfunction occurs. Refer to Prevost parts manual for available service kits. Valve is normally closed.

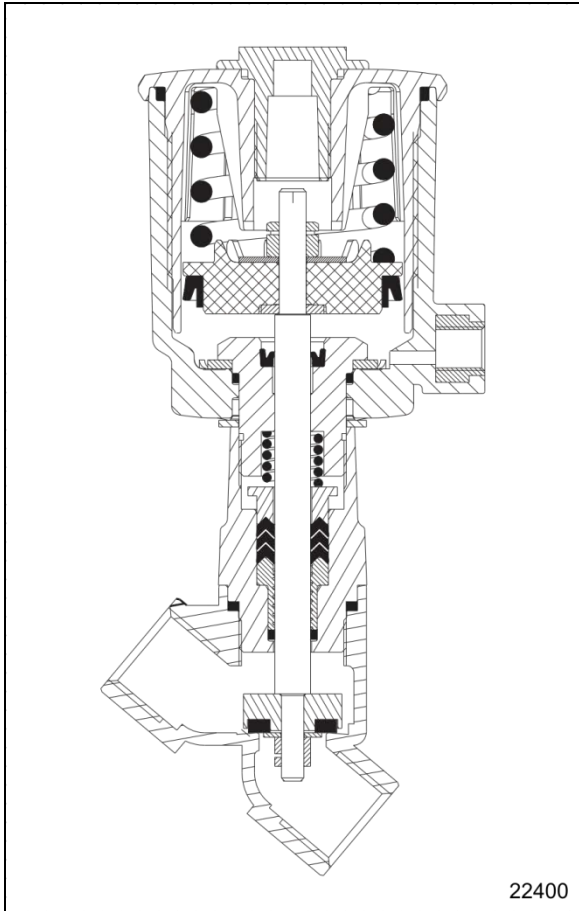


FIGURE 54: PASSENGER'S UNIT PNEUMATIC HOT WATER VALVE – TYPICAL CUT-OUT VIEW

4.12.1 Valve Troubleshooting

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

4.13 HOT WATER CIRCULATING PUMP

4.13.1 Central HVAC system

The vehicle is provided with a seal-less/brushless water circulating pump which is located in:

- H3 Series - evaporator compartment
- X3 Series - coolant preheater compartment (Figure 56)
- Additional circulating pump in the first curbside baggage compartment with optional upper windshield defrost unit

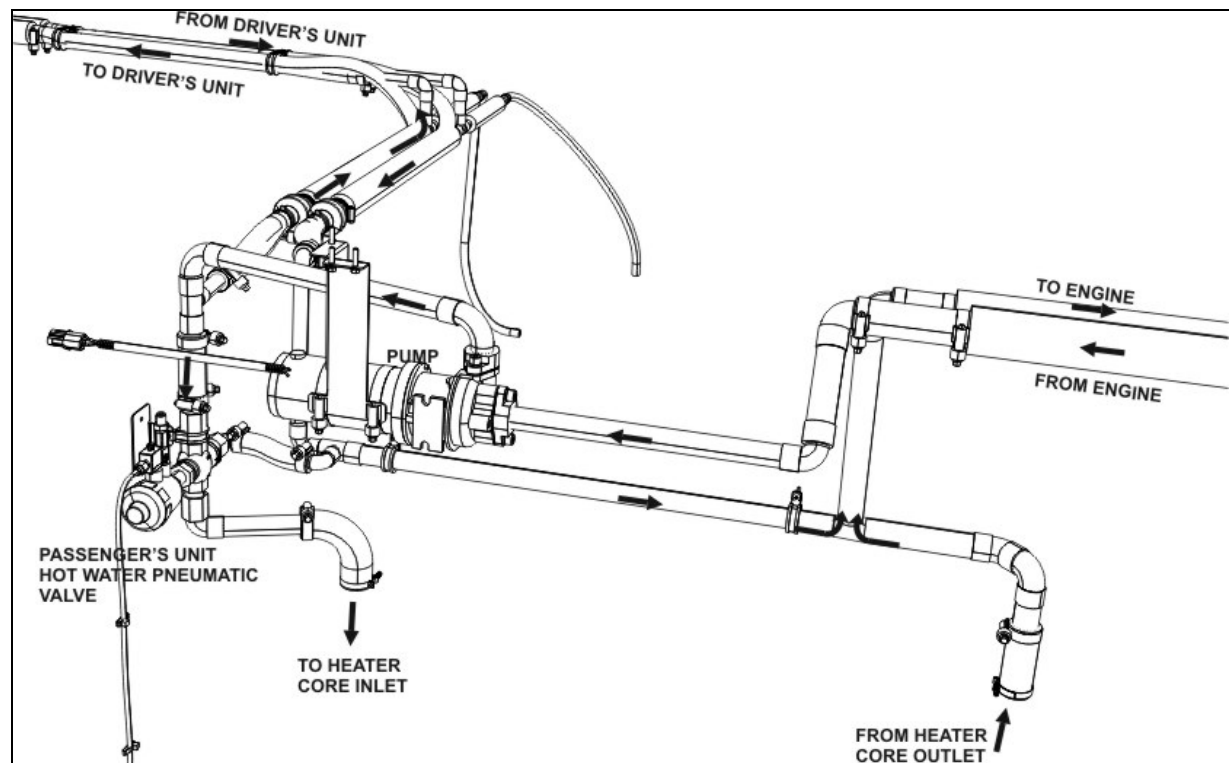
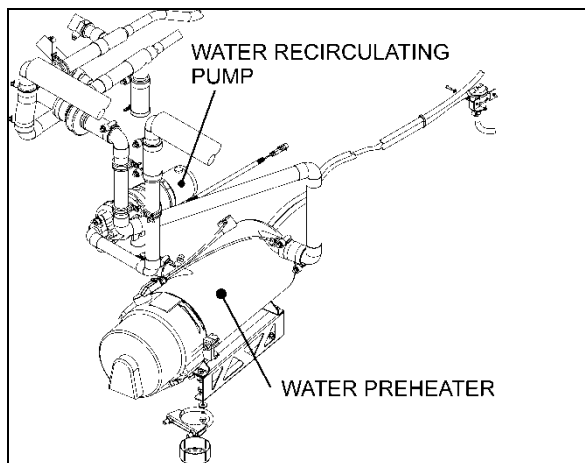
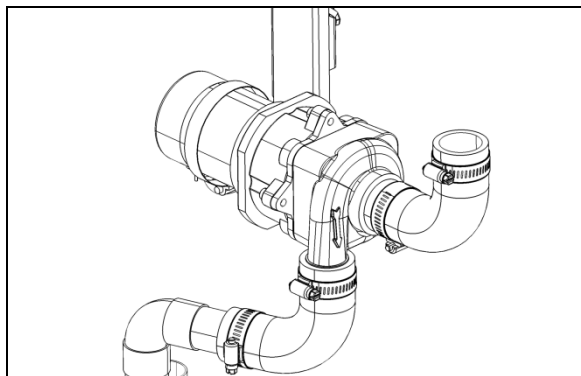


FIGURE 55: HOT WATER CIRCULATING PUMP INSTALLATION (H3 SERIES CENTRAL HVAC SYSTEM)



**FIGURE 56: PUMP LOCATION – X3 SERIES
(CENTRAL A/C)** 22331



**FIGURE 57: WATER CIRCULATING PUMP (CENTRAL
A/C)**

4.13.2 Small HVAC system

Water circulating pump which is located on the ceiling of the spare wheel compartment (Figure 58)

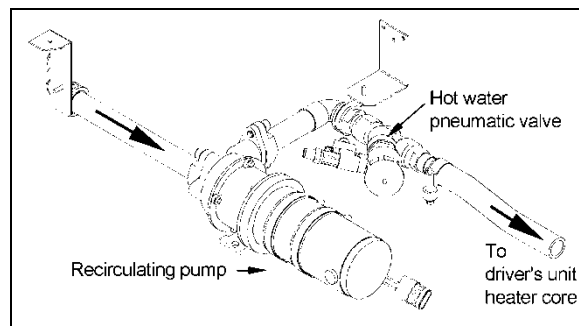
The water circulating pump consists of a centrifugal pump and an electric motor which are mounted in a compact assembly.

The seal-less/brushless pump requires no periodic maintenance. The pump motor is not repairable but can be separated from the impeller housing. In case of pump impeller failure, refer to Ametek 18 GPM Seal-Less ECDC Water Circulating Pump manual for repair. Inspection of the pump, to determine if the pump is working properly, should be made while the pump is in operation.

If there is evidence that the pump is not operating as per specifications, the unit must be disassembled for repair (impeller assembly only).

NOTE

For complete information on seal-less water circulating pump, refer to Ametek 18 GPM Seal-Less ECDC Water Circulating Pump manual. Take note that the motor described in this manual is different from the one installed on your circulating pump which is not repairable.



**FIGURE 58: HOT WATER CIRCULATING PUMP
INSTALLATION (SMALL HVAC SYSTEM)**

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4.13.3 Removal

1. Stop engine and allow engine coolant to cool.
2. Close shutoff valves on the heater line. Refer to Figure 72 ou Figure 73 in this section to gain access to the heater line shutoff valve.
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 the pump at the fittings.
5. Remove the two clamps holding the pump motor to its mounting bracket. Remove the pump with the motor as an assembly.

4.13.4 Installation

1. Connect water lines to the pump. Position the pump and motor assembly on the mounting bracket. Position the mounting clamps over the motor and secure with mounting bolts.
2. Connect electrical wiring to the pump motor.

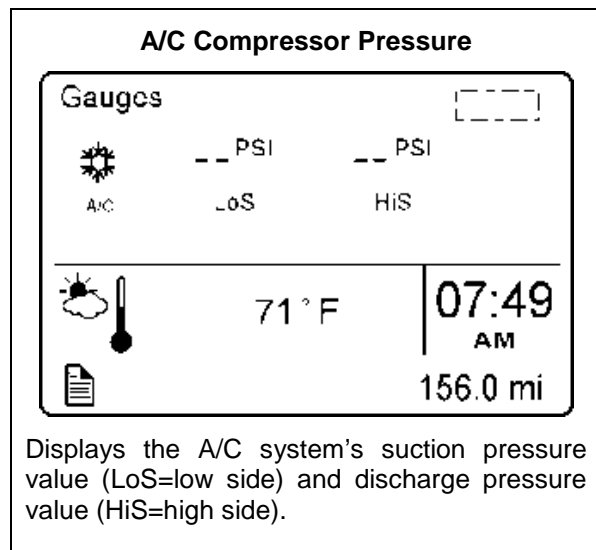
3. Open both shutoff valves.
4. Fill the cooling system as previously instructed in this section under 6.4.4 Filling Heating System and then bleed the system as previously instructed in this section.

5. HVAC SYSTEM 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 SYSTEM 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.

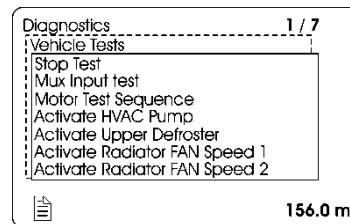


Displays the A/C system's suction pressure value (LoS=low side) and discharge pressure value (HiS=high side).

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 TEMPERATURE SENSORS

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

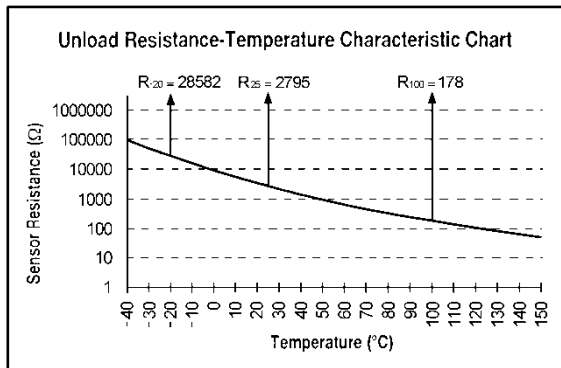
- 1) Driver area temperature sensor (SE21);
- 2) Passenger area temperature sensor (SE25);
- 3) Outside air temperature sensor (SE20).

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

NOTE
VIP vehicles equipped with Small HVAC System have two air temperature sensors; the driver's area temperature sensor (same place as coaches) and the exterior temperature sensor located behind the reclining bumper.

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

If the temperature sensor resistance value is measured at the multiplex module inputs, the measured value includes a parallel 33 kohms resistor.



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

5.4 TEST MODE FOR SWITCHES AND SENSORS

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

vehicle is traveling to check the A/C compressor pressure values.

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

When performing an A/C cooling test and having the water pump shut off in switch/sensor test mode is required, just set the passenger set point temperature to the minimum 64°F (18°C) to shut off the pump.

5.5 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, overhead compartment 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.

5.6 MODES OF OPERATION

<p>COOLING DEMAND Conditions for engaging the 2nd speed on the evaporator motor</p>	<p>- 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.</p>
<p>HEATING DEMAND Conditions for hot water circulating pump activation</p>	<p>- 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.</p>
<p>The compressor unloader operation is based on pressure and on the difference between the passengers' area temperature and set point.</p>	<p>right compressor cylinders</p> <p>- 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 290 psi, or if compressor suction pressure is below 23 psi.</p> <p>- Restart if: The Passengers' area temperature is 1.3°F or more above the set point and compressor discharge pressure is less than 250 psi and compressor suction pressure is above 32 psi.</p>
<p>A/C compressor deactivation pressure</p>	<p>- 310 psi</p> <p>- In case of high pressure, the high pressure transducer connected to the multiplex module deactivates the compressor</p> <p>- There is also a 350 psi pressure switch that acts to stop the compressor in the instance that the multiplex module fails.</p>
<p>Compressor turns on automatically if (2 required conditions)</p>	<p>outside temperature is above 32°F and return air temperature in passengers' area is 61°F or above (ΔT=7° with set point)</p>

Problem/Symptom	Probable Causes	Actions
HVAC condenser fans not functioning in <u>speed 1</u>	Module A49 (A54 on H3 VIP & X3 VIP) is not powered or is faulty	<ol style="list-style-type: none"> 1. Check the Diagnostics menu of Driver Information Display (DID). Select Fault Diagnostics and Electrical System. The message “No Response ModA49, 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 except: X3 VIP check CB7 3. Check fuse F65 except : H3 VIP check F67+F68 X3 VIP check F67 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 (CB5 on X3 VIP) tripped Seized bearing Bad wiring	<ol style="list-style-type: none"> 1. Check / reset circuit breaker CB7 2. See <i>HVAC condenser fans not functioning & HVAC condenser fans not functioning in <u>speed 1</u></i> above.
Defroster fan is functioning but no heat or cooling available in the driver's area	Module A46 is not powered or is faulty Bad wiring	<ol style="list-style-type: none"> 1. Check the Diagnostics menu of Driver Information Display (DID). Select Fault 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(CB7 on X3 VIP) 3. Check fuse F12V & F13 except X3 VIP 4. X3 VIP check fuse F65 5. 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	<ol style="list-style-type: none"> 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 fuse F65 4. Probe gray connector on module to see if it is powered.

SECTION 22: HEATING AND AIR CONDITIONING

Problem/Symptom	Probable Causes	Actions
Evaporator fan not functioning	<p>Circuit breaker CB3 (CB6 on X3 VIP) tripped</p> <p>Module A54 is not powered or is faulty</p>	<ol style="list-style-type: none"> 1. Check / reset circuit breaker CB3 (CB6 on X3 VIP) 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 except: X3 VIP check CB7 4. Check fuse F67 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).

5.7.1 Air Conditioning

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 And High superheat	<p>Loss of contact between the expansion valve bulb and the suction line or sticking of the expansion valve.</p> <p>Improper insulation.</p> <p>Check for corrosion and clean, repair or replace the valve.</p>
Noisy or knocking compressor.	Check for broken internal parts. Overhaul if required.
Compressor vibrates excessively.	Check and tighten compressor mounting bolts and belt tension.
Low refrigerant level	Check for refrigerant leaks and add refrigerant as required.
Suction pressure rises fast after shutdown.	Check compressor valve for breakage or damage.
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.

TROUBLE	CAUSE
Superheat too high.	Reset superheat adjustment. Check for clogged external equalizer line, or filter-dryer.
Reduced air flow: a. Dirty or clogged air filter; b. Evaporator motor inoperative; or c. Plugged return air ducts.	Dirty or iced evaporator coil. Clean air filter screen. Check return ducts for obstructions. Check blower motor.
Frequent starting and stopping on low pressure control switch.	Lack of refrigerant. Check for leaks. Recharge.
Compressor intermittently starts and stops.	Intermittent contact in electrical control circuit. Compressor valves not in operating position.
Non-condensable in the refrigeration system.	<p>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.)</p> <p>An evaporator just does a proper cooling job without sufficient air. Shortage of air can be caused by the following:</p> <ul style="list-style-type: none"> ○ Dirty filters; or ○ Dirty coils.
<p>Testing condenser pressure. <i>NOTE: R-134A pressure varies according to temperature.</i></p> <p>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 "5.8 Temperature & Pressure". Note the corresponding pressure for a temperature of 130°F, 199.8 psi. Read the condenser pressure, example 171.9 psi. 171.9 psi & 199.8 psi, the pressure in the condenser is inferior to the pressure corresponding to the exterior temperature, in this case the condenser pressure may be too low. Check for refrigerant leaks and add refrigerant if necessary. If the pressure corresponding to the condenser temperature is superior to the pressure corresponding to the exterior temperature, then the air cooled condenser pressure may be too high. Most frequent causes are:</p> <p>Reduced air quantity. This may be due to:</p> <ul style="list-style-type: none"> * Non-condensable in system; * Dirt on the coil; * Restricted air inlet or outlet; * Dirty fan blades; * Incorrect rotation of fan; * Fan speed too low; * Fan motor going out on overload; or * Prevailing winds. * Too much refrigerant in system. Remove refrigerant if necessary. 	

5.7.2 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 filter-dryer.
Superheat adjustment too high.	Adjust superheat as outlined under "Superheat Adjustment".
Power assembly failure or partial loss of charge.	Replace expansion valve.
Air filter screen clogged.	Clean or replace air filter screen.
Plugged / kinked / chaffed 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	
Internally leaking compressor	Locate leak. Repair/ replace.
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.	Recover to proper charge.
Condenser dirty.	Clean condenser.

5.8 TEMPERATURES & PRESSURES
CHART

R134a VAPOR-PRESSURE			
TEMPERATURE		PRESSURE	
°F	°C	psi	kPa
-100	-73.3	27.8	191.7
-90	-67.8	26.9	185.5
-80	-62.2	25.6	176.5
-70	-56.7	23.8	164.1
-60	-51.1	21.5	148.2
-50	-45.6	18.5	127.6
-40	-40.0	14.7	101.4
-30	-34.4	9.8	67.6
-20	-29	3.8	26.2
-10	-23	1.8	12.4
0	-18	6.3	43.4
10	-12	11.6	80
20	-7	18.0	124.1
30	-1	25.6	176.5
40	4	34.5	237.9
50	10	44.9	309.6
60	16	56.9	392.3
70	21.1	70.7	487.5
80	27	86.4	595.7
90	32.2	104.2	718.5
100	38	124.3	857.0
110	43.3	146.8	1012.2
120	49	171.9	1185.3
130	54.4	199.8	1377.6
140	60	230.5	1589.3
150	65.6	264.4	1823.0
160	71	301.5	2078.8
170	76.7	342.0	2358.1
180	82.2	385.9	2660.8
190	87.8	433.6	2989.7
200	93.3	485.0	3344.1
210	98.9	540.3	3725.4

5.9 LEAK TESTING

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



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

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

The procedure for testing is:

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

NOTE

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

6. CENTRAL HVAC SYSTEM

The passenger's unit evaporator fan, located in the evaporator compartment on the L.H. side of vehicle is protected by circuit breaker CB3 (CB6 on X3 VIP), 90 amp with manual-reset mounted

SECTION 22: HEATING AND AIR CONDITIONING

in the main power compartment/junction panel (Figure 60 & Figure 61).

The passenger's unit condenser coil mounted on the opposite side of the evaporator is ventilated by four brushless axial fans. The fan motors are protected by circuit breaker CB7 (CB5 on X3 VIP), 70 amp with manual-reset mounted in the main power compartment/junction panel.

Furthermore, the following relays, diodes and multiplex module are located in the evaporator compartment. They are mounted on top of the fan housing.

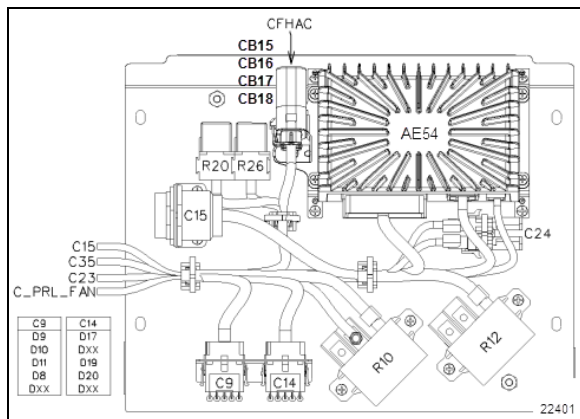


FIGURE 59: HVAC MODULE

A/C Junction Box	
Multiplex Module	
AE54	I/O-B
Relays	
R10	Condenser fan power
R12	Evaporator fan power
R20	Water circulating pump relay
R26	Water Preheater Relay
Diodes	
D8	Overhead compartment Liq. Sol. Valve
D9	Water circulating pump
D10	Water circulating pump
D11	Pass. Liq. Sol. Valve
D17	3 rd Baggage Compartment Lights
D19	2 nd Baggage Compartment Lights
D20	1 st Baggage Compartment 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

Multiplex Module (evaporator compartment)	
A54	I/O-B
Relays (evaporator compartment)	
R10	24V Condenser fans
R12	24V Evaporator fan
R20	Water pump
R26	Pre-heating

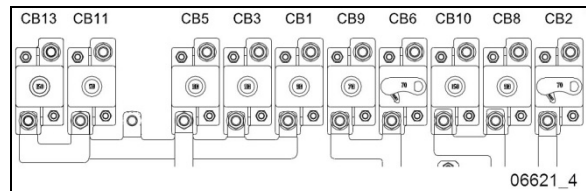


FIGURE 60: X3 SERIES REAR ELECTRICAL JUNCTION PANEL WITH CIRCUIT BREAKERS

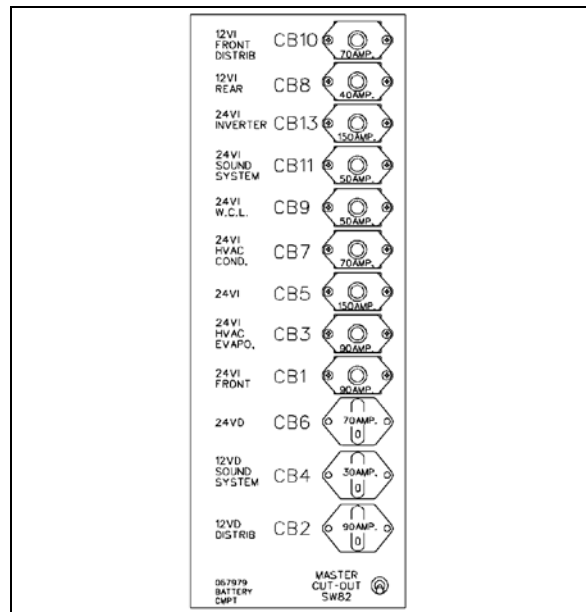


FIGURE 61: H3 SERIES MAIN CIRCUIT BREAKERS
06582A

6.1 AIR CIRCULATION IN DRIVER'S AREA

Fresh air is taken from behind the R.H. side headlights assembly (H3 series) or from a plenum underneath the front service compartment (X3 Series) and enters the mixing box through a ON/OFF damper. Return air is taken through the right console into the mixing box (Figure 69). 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 62 and Owner's or Operator's manual).

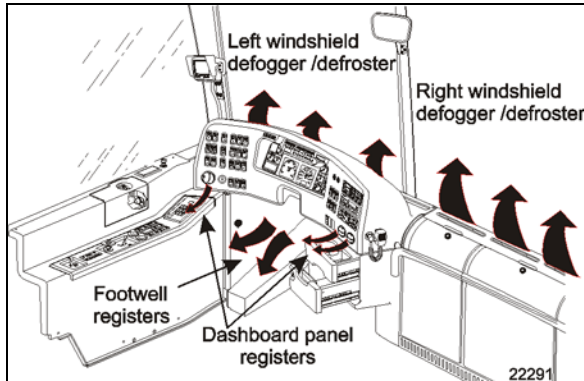


FIGURE 62: DRIVER'S UNIT AIR CIRCULATION

An additional air is located in the stepwell for step de-icing (Figure 2 & Figure 5). This air flow is supplied by the passengers' air ducting system.

X3 coaches are also equipped with a defogger/defroster system in the upper windshield section. Similar system is optional on H3 coaches.

6.2 AIR CIRCULATION IN PASSENGER'S AREA

Fresh air enters from the left side of vehicle through a damper located:

- H3 Series - Inside the air intake duct at the left of the evaporator compartment.
- X3 Series - On the evaporator compartment door (Figure 63).

The damper can be fully opened for normal operation or partially closed for extreme weather or highly polluted areas. The recirculation REC button is located on the HVAC control unit. Press down the button to partially close the fresh air damper (refer to the Owner's or Operator's Manual for more details).

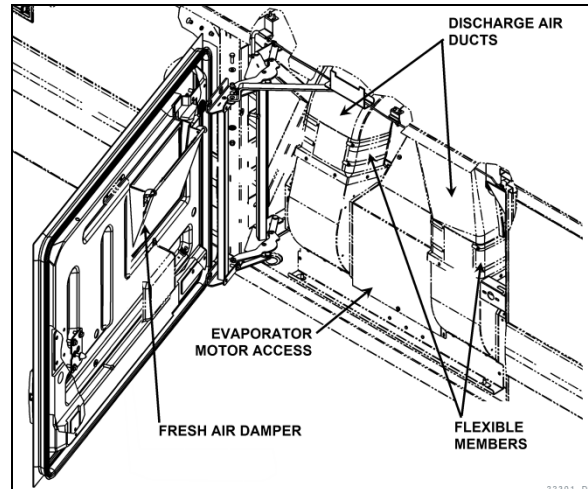


FIGURE 63: X3 SERIES PASSENGERS' AREA FRESH AIR DAMPER

NOTE

Opening the entrance door also partially closes the fresh air damper.

Return air is drawn through:

- H3 coaches - the first entrance step, last entrance step riser and from the lower section of the floor ducts in two locations: one in the rear section of vehicle and the other in the front section of vehicle on the L.H. side (Figure 2).
- X3 coaches - Return air is drawn from inside the vehicle through the register duct located on L.H. side of vehicle (Figure 5).

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 (upper section) along the walls, and finally exhausts it at the bottom of the windows.

The coaches are equipped with an overhead compartment ventilation system equipped with adjustable registers in the passenger's overhead console to control air flow. Return air is drawn just below the middle side windows through an air filter into the overhead compartment fan; discharge air is fed to the rotating registers through the ventilation duct (Figure 64).

The lavatory ventilator found on coaches acts as the main exhaust for the whole vehicle, eliminates odors, and finally heats or cools the lavatory with the vehicle's ambient air.

MAINTENANCE

Passenger's area fresh air intake filter (X3 Series only)

Clean or replace filter at the intervals specified by the Lubrication And Servicing Schedule in Section 24: LUBRICATION & SERVICING.

To clean filter, back flush with water or soapy water, then dry with air.

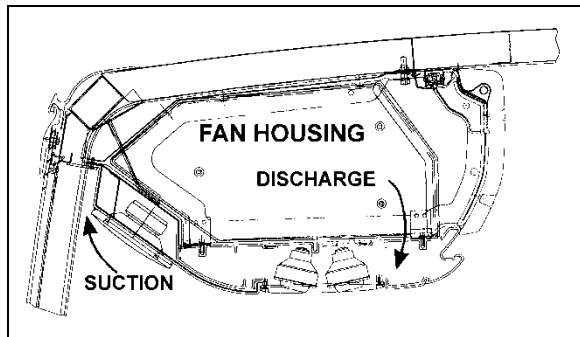


FIGURE 64: OVERHEAD COMPARTMENT VENTILATION SYSTEM 22211

6.3 HVAC SYSTEM OPERATION

To operate the HVAC system when the vehicle is stationary, engine should run at fast idle. During operation of the HVAC 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.

The vehicle is divided into two areas:

- Driver's area (driver's HVAC unit).
- Passengers' area (passengers' HVAC unit).

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° (4°C) of the set point or higher (if set point is 68°F for example, 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 up to a temperature of 15°F (-9°C) to prevent fogging up of the windows.

NOTE

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

6.3.1 Control Unit

The temperature control in the driver's area is provided directly by the DRIVER control on the L.H. side of the HVAC control unit.

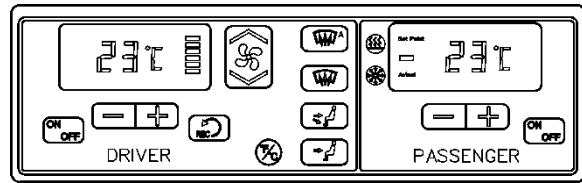


FIGURE 65: CONTROL UNIT - CENTRAL HVAC SYST 22276

The driver's unit piping is paralleled with the passenger's unit piping. Both units use the same refrigerant and coolant, and are linked to the same condenser and compressor, even if they are individually controlled. It requires engagement of the A/C compressor magnetic clutch; consequently, the driver's unit cannot be operated alone in the air conditioning mode.

NOTE

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

The PASSENGER control on the R.H side of the HVAC control unit enables the selection of the temperature in the passenger's section.

Temperature control is provided in conjunction with a thermistor sensor located inside return duct, on L.H. side of vehicle (Figure 2, Figure 5).

The flow of hot water to the passenger's unit heater core is controlled by the solenoid pilot pneumatic hot water valve which varies the cycling rate depending on selected temperature. A red LED indicator, located on the HVAC control unit, illuminates when the heating mode is one. A green LED indicator 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.

6.3.2 Overhead Compartment Unit

Optional A/C evaporator coils may be added to both overhead compartment air systems. This

air conditioning unit permits a wider temperature range in the passenger's area.

6.4 HEATING

The schematic of FIGURE 3 shows the central HVAC system heating arrangement.

On coaches, in addition to the normal heating provided by the engine, an optional preheating system (104,000 Btu/hr) may have been installed above the rear wheelhousing on the L.H. side.

6.4.1 Driver's Unit Hot Water Pneumatic Valve

The flow of hot water to the driver's unit heater core is controlled by a normally-open (NO) pneumatic valve like. The valve, located at the ceiling of the spare wheel compartment (Figure 66), 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 unit hot 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.

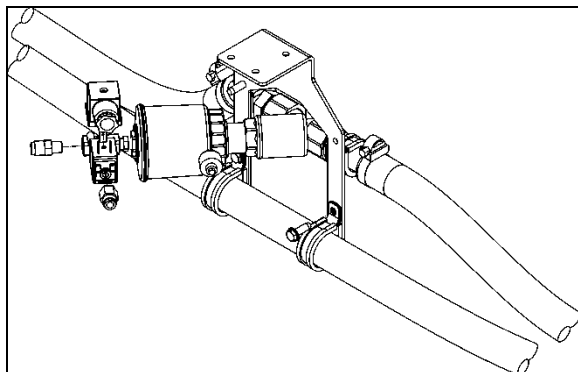


FIGURE 66: DRIVER'S UNIT HOT WATER PNEUMATIC VALVE ASSEMBLY

6.4.2 Passenger's Unit Hot Water Pneumatic Valve

The flow of hot water to the vehicle's central heater core is controlled by a normally-open NO 3-way pneumatic water valve assembly (Figure 67). 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 opening or closing the valve.

When the vehicle is operating without electrical power 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.

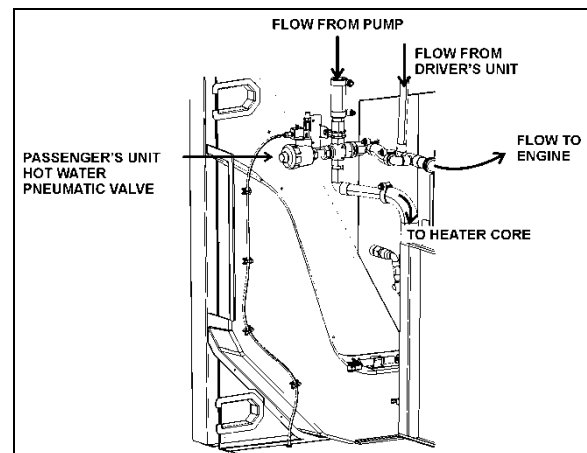


FIGURE 67: PASSENGER'S UNIT PNEUMATIC HOT WATER VALVE ASSEMBLY

22240

6.4.3 Draining Heating System

To drain the entire system, refer to SECTION 05 COOLING SYSTEM. If only the driver's unit heater core or passenger's unit heater core must be drained, refer to the following instructions.

Draining Driver's Unit 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 66), 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 72 or Figure 73).



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 pneumatic 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 purge valve located inside the driver's unit (Figure 69). If present, open the manual vent located inside the HVAC unit, on the driver's side (Figure 68) to ensure an efficient draining.

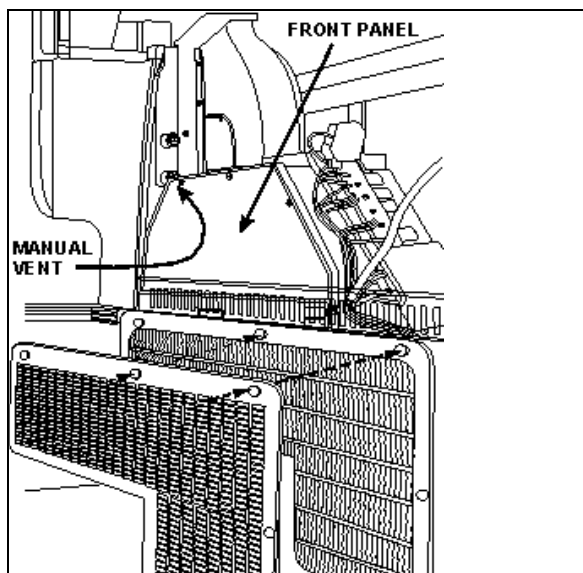


FIGURE 68: DRIVER'S HVAC/DEFROST UNIT

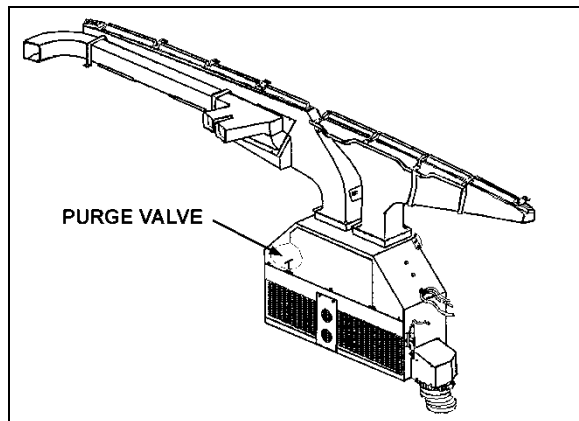


FIGURE 69: DRIVER'S UNIT AIR MIXING BOX 22171PV

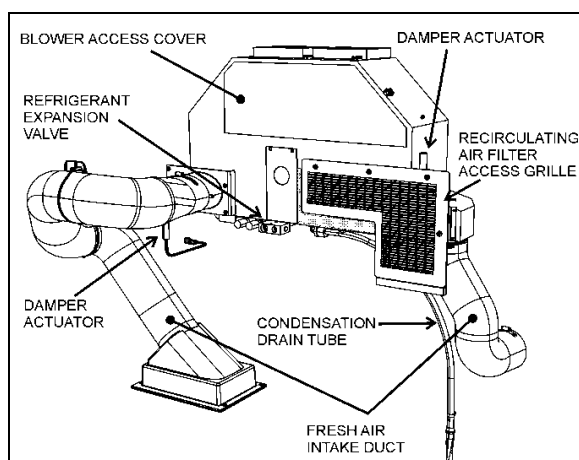


FIGURE 70: DRIVER'S HVAC UNIT

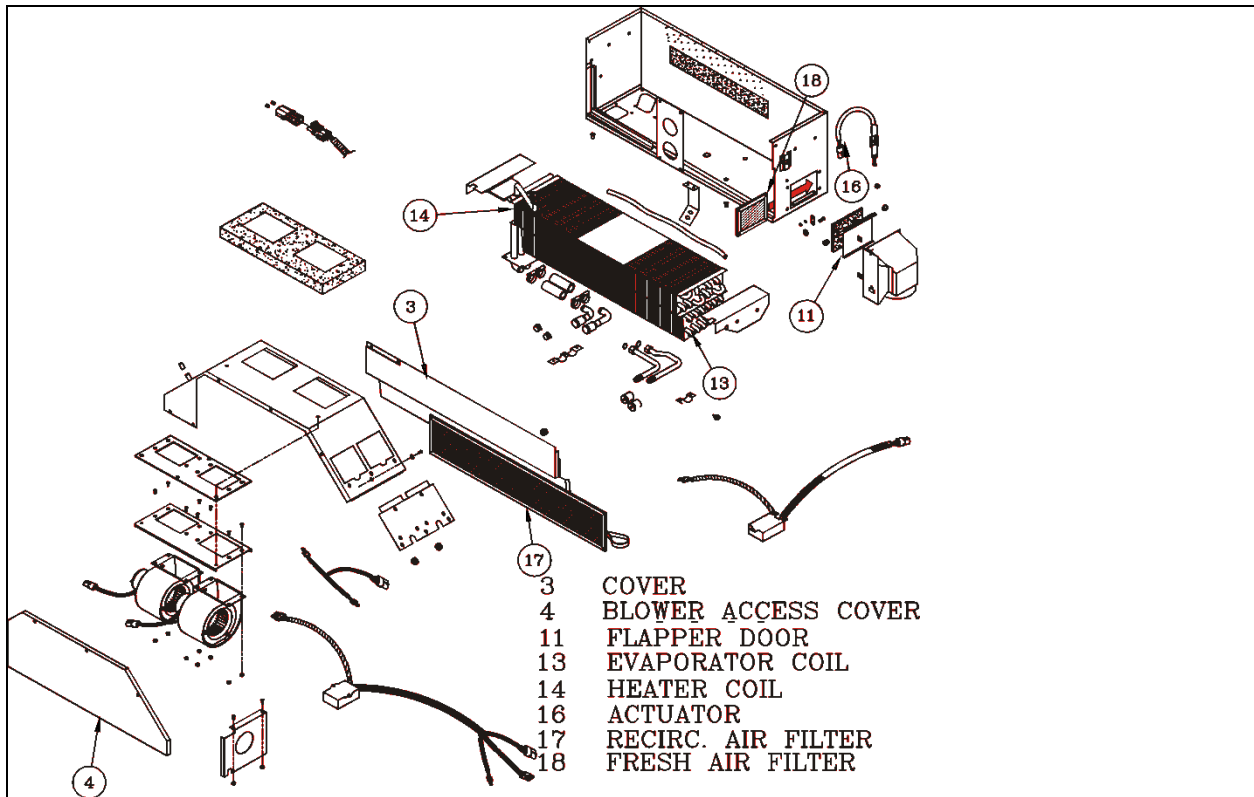


FIGURE 71: DRIVER'S HVAC UNIT

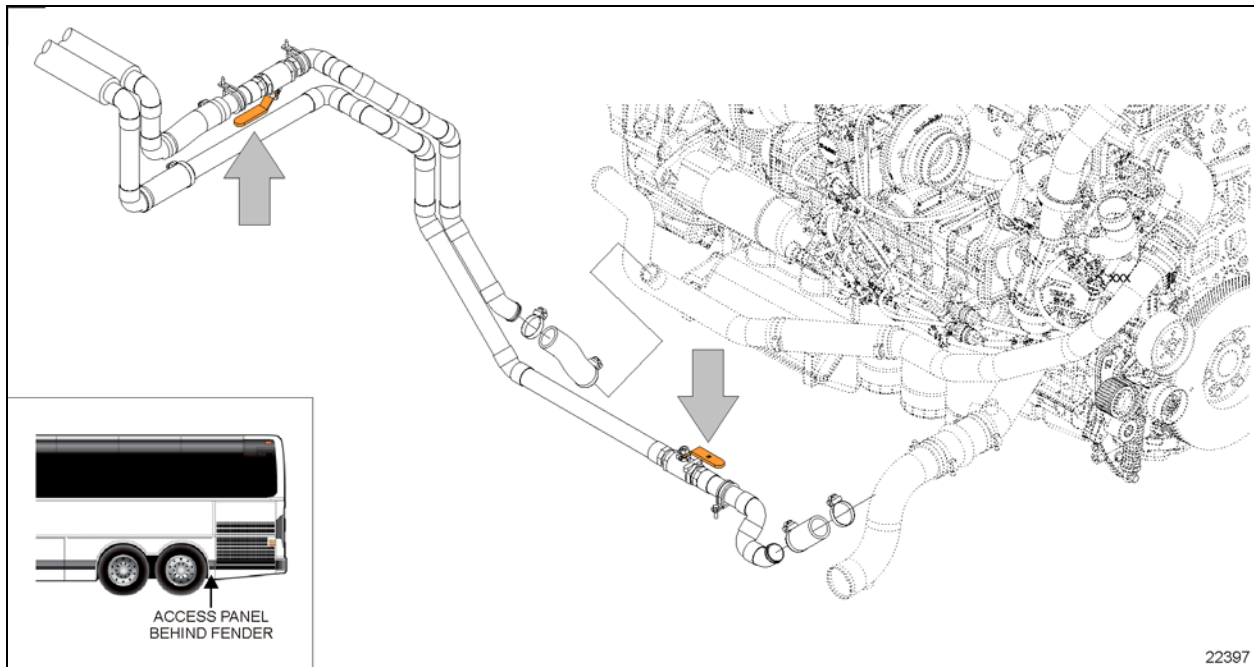


FIGURE 72 X SERIES HEATER LINE SHUT-OFF VALVES- (ALLISON TRANS. PIPING ARRANGEMENT SHOWN)

Draining Passenger's Unit Heater Core

1. Stop engine and allow engine coolant to cool.
2. Close both heater line shutoff valves (Figure 72 or Figure 73). One is located in the engine compartment, lower road side, near the radiator while the other one is located behind the L.H. hinged rear fender near the preheater.
3. Open the evaporator compartment door.

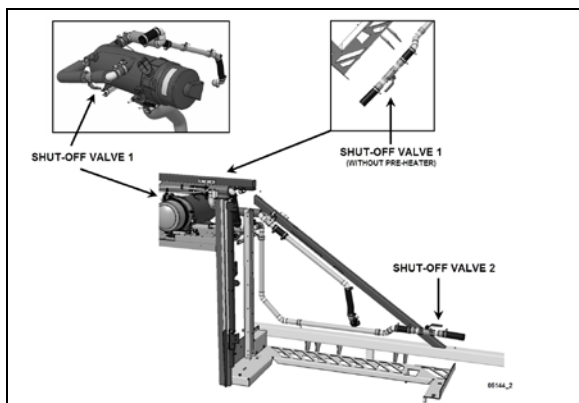


FIGURE 73: H3 SERIES HEATER LINE SHUTOFF VALVES
05144



WARNING

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

4. Open drain cock in bottom of heater core (Figure 74) you can unfasten a hose connection on top of heater core in order to allow air to enter while draining. The main heater core drain cock is located in the evaporator compartment. To access the valve, open baggage compartment door located in front of the evaporator compartment (L.H. side). Open the evaporator compartment access panel.

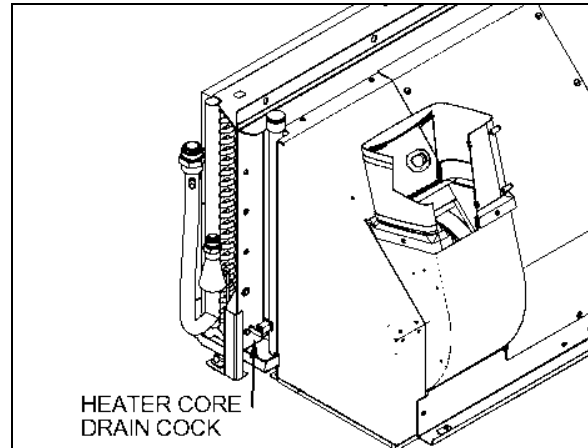


FIGURE 74: HEATER CORE DRAIN COCK LOCATION

6.4.4 Filling Heating System

1. Ensure that the driver's unit heater core purge valve and the passenger's unit heater core drain cock are closed.
2. Open the surge tank filler cap and slowly fill the tank to top of sight glass.
3. After initial filling, the hot water shutoff 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 passenger sections, and set temperature to their maximum positions in order to request the heating mode in each of these sections.
4. When coolant level drops below the surge tank sight glass, slowly fill the tank to top of the sight glass.
5. If vehicle is equipped with a windshield upper section defroster, open front baggage compartment R.H. side door. Locate circulating pump on top of front wheelhousing, momentarily pinch the hose located between the circulating pump suction and the defroster outlet connector to ensure windshield upper section defroster complete filling.
6. Once the level has been stabilized, replace cap

6.4.5 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 purge valve illustrated in Figure 69 & Figure 74, and open them momentarily until no air escapes from the lines. If present, open the manual vent located inside the HVAC unit, on the driver's side (Figure 68).

NOTE

In test mode (see paragraph 5.4 TEST MODE FOR SWITCHES AND SENSORS), with the parking brake applied and the passenger set point set to a value higher than 64°F (18°C), the hot water circulating pump is not set to OFF as it would normally do when the outside temperature gets above 50°F (10°C). This feature is useful when working on the heating system to remove air pockets trapped in the system.

6.5 COOLING

The central system is equipped with 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.

The schematics of FIGURE 4 and FIGURE 7 show the central HVAC system's cooling function arrangement.

6.5.1 Refrigeration 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. The air conditioning system used is the "closed" type using R134a refrigerant.

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 back to the condenser sub-cooler. It leaves the condenser and 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 passenger's and driver's unit evaporator coils which absorb heat from the air passing over the fins and tubes, and changes into gas. In this form, the refrigerant is drawn into the compressor to repeat the air conditioning cycle.
5. The success of the air conditioning system depends on retaining the conditioned air within the vehicle. All windows and intake vents should be closed. An opening of approximately 8 in² (5162 mm²) could easily neutralize the total capacity of the system.
6. Other causes of inadequate cooling are dirty coils or filter. Dirt acts as insulation and is also serves as a restriction to the air flow.
7. The refrigeration load is not constant and varies. It is also affected by outside temperature, relative humidity, passenger load, compressor speed, the number of stops, etc.

The compressor will load depending on operating conditions.

6.5.2 Refrigerant

The A/C system of this vehicle has been designed to use R134a refrigerant as a medium. Regardless of the brand, only R134a must be used in this system. The chemical name for this refrigerant is 1,1,1,2-Tetrafluoroethane.

WARNING

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

Procurement

Refrigerant is shipped and stored in metal cylinders. It is serviced in 30 and 100 pound cylinders.

Approximately 24 lbs are needed in the Central HVAC system plus an additional 2 lbs will be needed for the overhead compartment A/C system if equipped.

For vehicles equipped with the Small HVAC System, approximately 4 lbs of refrigerant are needed.

Refrigerant charge (Approximate)

Central A/C system:	24 lbs
Small A/C system:	4 lbs
Overhead comp. A/C system:	2 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.

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.

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.

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 there happens to be liquid refrigerant 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. In the event that any line is opened to the atmosphere, it 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.

6.5.3 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 cleanout procedures mentioned.

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.

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.

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 prescribed method.
5. Circulate clean R-134a with the reclaimer 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.

6.5.4 Pumping Down

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

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 should be changed each time a line in the system 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" to prevent any injury.

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.

NOTE

On vehicles equipped with small HVAC system, refer to "ICE TM-16HD Compressor Service Manual".

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 and 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 overhead compartment liquid solenoid valves open, and result in battery draining if the vehicle remains unused for several days.

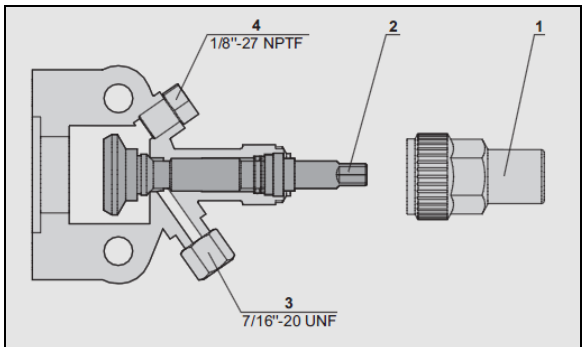
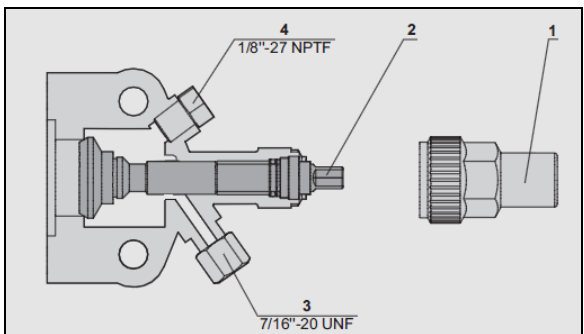


FIGURE 75: COMPRESSOR SHUT-OFF VALVE BACKSEATED POSITION (NORMAL OPERATING POSITION)



- 1 Sealing cap
- 2 Stem
- 3 Service port (shut off when backseated)
- 4 Measurement connection (remote pressure transducer)

FIGURE 76: 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 42 and Figure 76).

MAX TORQUE: 21 lb-ft (28 Nm)

4. Backseat the compressor suction shut-off valve (FIGURE 75).

MAX TORQUE: 12 lb-ft (16 Nm)

5. 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.

6. Disconnect the low pressure transducer. 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.**

7. Run the A/C compressor until suction pressure is pulled down to 0 psig.

8. 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.

9. Stop the compressor.

10. Close (frontseat) the suction shut-off valve on the compressor (Figure 76).

MAX TORQUE: 21 lb-ft (28 Nm)

11. 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.

6.5.5 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.

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 77) 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.

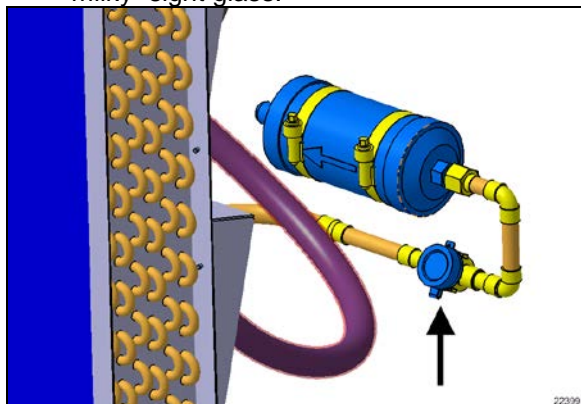


FIGURE 77: MOISTURE INDICATOR SIGHT GLASS

- 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 paragraph 5.8), 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 5.8), 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.

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.
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 100 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 75).

MAX TORQUE: 12 lb-ft (16 Nm)

14. Remove gages and replace caps.
15. Perform a road test for final verification.

6.5.6 Charging System

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

When charging an empty system, weigh the amount of refrigerant put into the system. This will eliminate any possibility of overfilling.

A Central HVAC System nominal charge requires 24 pounds. If the vehicle is equipped with the overhead compartment A/C system, a full charge requires an additional 2 lbs.

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

1. Using connector C24 and C44, energize and open the liquid solenoid valves (driver's unit, passengers' unit and overhead compartment 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 75).

MAX TORQUE: 12 lb-ft (16 Nm)

3. Install A/C pressure gauges at the compressor shut-off valves service ports (item 4, FIGURE 75).
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 42).
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 overhead compartments 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.

**CAUTION**

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

6.6 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.

MAX TORQUE: 12 lb-ft (16 Nm)

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 78).



FIGURE 78: RECOVERY UNIT CONNECTED TO RECEIVER SERVICE PORT

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

6.7 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 in 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. Mid seat 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 overhead compartment 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 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.

7. SMALL HVAC SYSTEM

The small HVAC system is found only on motorhomes and has a much lower heating and air cooling capacity than the central system because it is designed to provide air conditioning to the driver's area only.

7.1 SYSTEM CONFIGURATION H-SERIES

On H3-series vehicles, the compressor is installed away from the engine and uses a pneumatic belt tensioner.

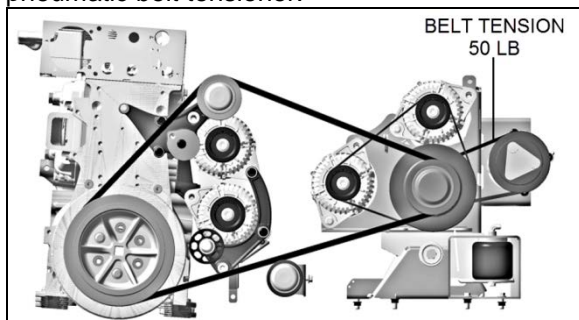


FIGURE 79: BELT LAYOUT WITH SMALL A/C COMPRESSOR h3-45 VIP 22380

In this configuration, the condenser is installed over the radiator and benefits from the existing airflow in this location. All the associated service ports and shut-off valves are close to the compressor.

7.2 SYSTEM CONFIGURATION X SERIES

On X-series vehicles, the compressor is installed on a support attached to the central A/C pedestal on the engine and uses an automatic belt tensioner.

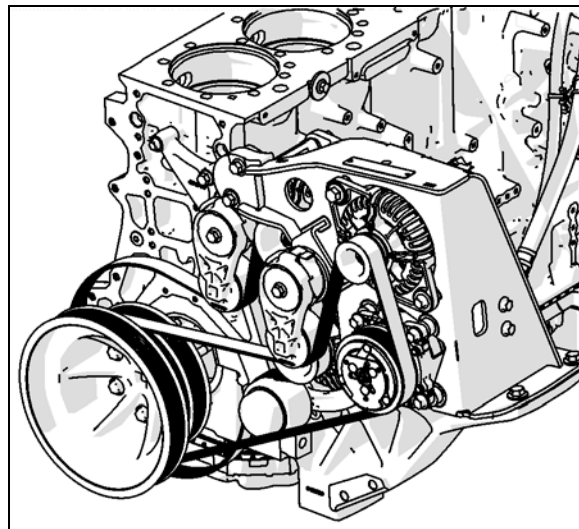


FIGURE 80 X3 SERIES SMALL A/C COMPRESSOR

In this configuration, the condenser is located in the 4th luggage compartment it has its own electric fan to provide the required cooling. All the associated service ports and shut-off valves are on top of the condenser frame.

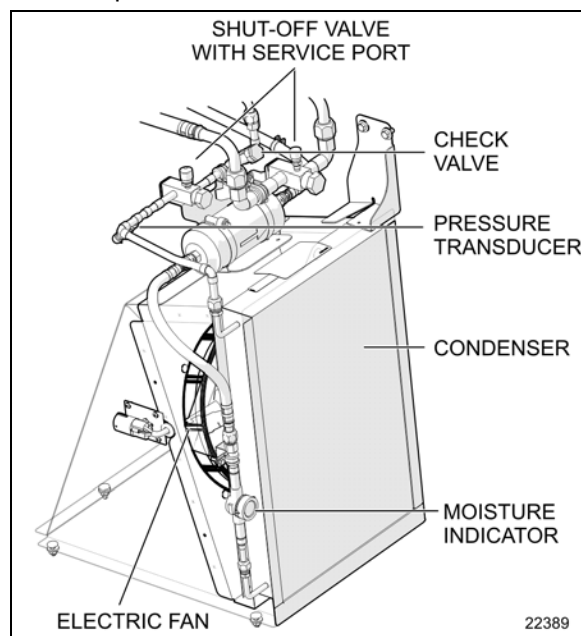


FIGURE 81: CONDENSER CONFIGURATION X3-45 VIP

7.3 AIR CIRCULATION

Fresh air is taken from behind the R.H. side headlights assembly (H3 series) or from a plenum underneath the front service compartment (X3 Series) and enters the mixing box through a damper. Return air is taken through the right console 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 his air flow to the dashboard, from which he can direct vent to his upper body with adjustable HVAC register and to his feet with the appropriate button (see FIGURE 82 and Owner's manual).

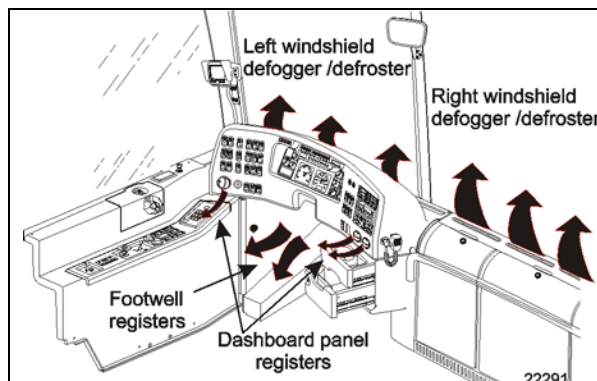


FIGURE 82: DRIVER'S UNIT AIR CIRCULATION

7.3.1 Auxiliary Unit

H3 VIP vehicles equipped with the small HVAC system are equipped with an auxiliary system that provides five additional registers. Three are located behind the driver's seat and the other two are located near the entrance door, at bottom of first lateral window. The auxiliary unit comes with cooling and heating coils, fan and discharge ducts.

7.4 SYSTEM OPERATION

7.4.1 Driver's Unit

The small HVAC system driver's unit is similar to the central HVAC system driver's unit, except that the circulating pump is located on the ceiling of the spare wheel compartment (Figure 9).

On H3 VIP series vehicles, an auxiliary unit is added in series on the return line of the small system, it increases the whole system heating capacity and gives the driver more options.

The temperature control in the driver's area is provided directly by the HVAC control unit mounted on the dashboard R.H. side.

NOTE

X3 Series - The driver's area air temperature sensor is located behind the grill of the R.H. side console.

NOTE

X3 Series - The outside air temperature sensor is located near the RH headlight.

7.4.2 Auxiliary Unit - H3 VIP Vehicles Only

The temperature control is provided by the small system HVAC control unit. The R.H. portion of the HVAC control unit enables to actuate the auxiliary unit and to regulate the fan speed.

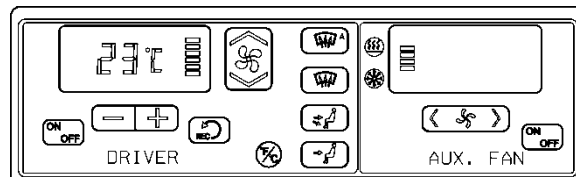


FIGURE 83: CONTROL UNIT - SMALL HVAC SYST. 22286

7.5 REFRIGERANT RECOVERY

The release of refrigerant into the atmosphere must be avoided. Whenever refrigerant is to be released from the air conditioning system, a refrigerant recovery unit must be used to recover the refrigerant. This refrigerant can then be recycled and reused, which is both environmentally safe and economical.

For complete system recovery, any of the High and Low service ports can be used. Energize liquid solenoid valve and measure the quantity of oil recovered. For the compressor only, use the service valve port and close the valves. The service valves open permits full flow of refrigerant to service port. Service valve closed permits flow of refrigerant from compressor to service port.

7.6 EVACUATING SYSTEM PRIOR ADDITION OF REFRIGERANT (DRIVER'S OR AUXILIARY SYSTEM)

When a system has been opened for repairs, change the filter-dryer and evacuate the system. Use the high-pressure service port and low-pressure port. It would be good practice to open the solenoid valve.

1. Connect two hoses equipped with a micron gauge between the high-pressure service port, the low-pressure service port and the vacuum pump.
2. With the unit service valves open and the vacuum pump valves open, start the pump and draw the manifold and hoses into a very deep vacuum (700 microns).
3. Close manifold valve

4. Shut down the vacuum pump.
5. Check to insure that vacuum holds. (If the pressure continues to rise, it indicates a leak or moisture in the system).
6. Charge the system with the proper amount of refrigerant through the service port near the check valve using recommended charging procedures.
7. Remove the hoses.

7.7 OIL ADDITION

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

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

The amount of oil recovered with the refrigerant recovery should be added at the same time.

7.8 COMPRESSOR OIL CONTAMINATION

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

- Dirt in the oil.
- Change to a varnish color.
- Presence of foreign substance, metal shavings, etc. in the oil. When the oil extracted from the compressor is as described above, replace the oil as follows:
 1. Clean the interior of the system with approved method.
 2. Replace the filter-dryer.
 3. Supply with new oil as specified in small Compressor Service Manual included at the end of this section

7.9 OIL RETURN OPERATION

There is a close affinity between oil and refrigerant. During normal operation, part of the oil recirculates with the refrigerant in the system. Therefore, when checking the amount of oil in

the system or replacing any system component, the compressor must be run in advance to ensure return. This procedure is as follows:

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

8. PREHEATING SYSTEM (OPTION)

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

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

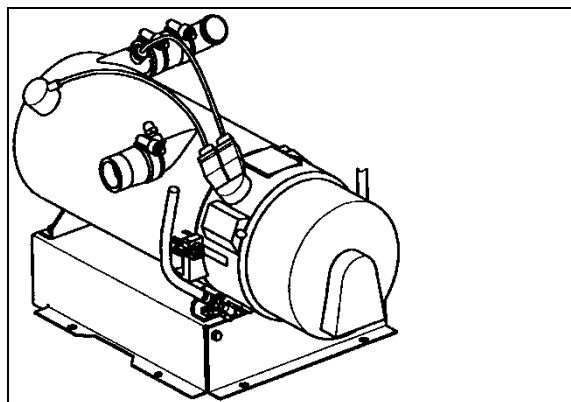


FIGURE 84: PREHEATER (104,000 BTU)

22224

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

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

The hot combustion gases are diverted at the end of the flame pipe, then pass through the indirect heating surfaces of the heat exchanger

and transmit their heat to the water passing through the heat exchanger.

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

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

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

A cutout will take place in case of any failure of the preheater.

8.1 PREHEATER FUEL FILTER

The preheater fuel filter is located beside the preheater above the rear wheelhousing, behind the vehicle's L.H. side rear fender.



MAINTENANCE

Replace preheater fuel filter every 50,000 miles (80 000 km) or once a year, whichever comes first.

8.2 OPERATION

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

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

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

8.3 PREHEATING SYSTEM TIMER

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

In case of failure:

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

8.3.1 Preheater timer instructions

Instructions are shown in the operator’s manual provided with the vehicle or in the Spheros instruction booklet, found on your Technical Publications USB flash drive. These references are also available on the Technical Publications Website.

Operational Failure Symptoms via Fault/Flash code


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


8.4 PREHEATER TROUBLESHOOTING AND MAINTENANCE

Refer to the Spheros manual for more information.

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

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

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

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

SECTION 22: HEATING AND AIR CONDITIONING

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

9. SPECIFICATIONS

Passenger's unit evaporator motor

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

Passenger's unit condenser fan motors

Make..... EBMPAST
 Type 12" AXIAL BRUSHLESS
 Voltage 24 V DC
 Qty..... 4

Driver's unit evaporator motors

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

Driver's unit evaporator air filter

Make..... MCC
 TYPE Washable recirculating air 6-1/4" x 28"
 Make..... MCC
 TYPE Washable fresh air 3-5/8" X 5-1/4"

Refrigerant

Type R-134a
 Quantity (central HVAC system) 24 lbs
 Quantity (central HVAC system with optional overhead compartment A/C system) 26 lbs
 Quantity (small HVAC system) 4 lbs

Compressor (Central HVAC system)

Make..... Bitzer
 Displacement 41 CFM
 Model, R-134a..... 4NFCY
 No. of cylinders 4
 Cylinder volume 39 in³ (647 cm³)
 Operating speed..... 500 to 3500 rpm
 Oil capacity..... 2.8 quarts (2,6 liters)
 Weight 74 lbs (33 kg)
 Oil type Polyolester ISO68

Magnetic clutch

Make..... Lang
 Type KK73.1
 Voltage 24 V DC

A/C Compressor (Small HVAC system)

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

Condenser Fan (Small HVAC system)

Diameter 12 in (30.5 cm)
 Power..... 850W
 Voltage (nominal) 24 Volts
 Voltage (operating range) 16-32 Volts
 Maximum speed 4760 rpm
 Sealing..... SAE J1455 IP67 / IP69K
 Operating temperature range -40 to 138°F (-40 to 59°C)

Receiver tank (with sight glasses)

Make..... Westermeyer
 Maximum pressure..... 450 psig

Filter-dryer assembly

Make..... Emerson-Alco

Moisture indicator

Make..... Emerson-Alco

Liquid refrigerant solenoid valve

Make..... Sporlan Parker Hannifin
 Type Normally closed with manual bypass
 Voltage 24 V DC

Passengers' unit hot water pneumatic valve

Make..... BURKERT
 Type Normally open
 Voltage 24 V DC
 Pressure range..... 0 to 230 psi
 Max. temperature 356°F

Driver's unit hot water pneumatic valve

Make..... Asco
 Type Normally open
 Voltage 24 V DC

Hot water circulating pump

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

Main expansion valve

Make..... Emerson-Alco

Preheating system

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