Figure 64-1: The heater core is mounted inside a heater plenum chamber where air passes over it to absorb heat from the warmed engine coolant.

TECH TIP: Water on the Carpet? Check the Evaporator Water Drain

If the evaporator water drip tube becomes clogged with mud, leaves, or debris, water will build up inside the evaporator housing and spill out onto the carpet on the passenger side. Customers often think that the windshield or door seals are leaking. Most evaporator water drains are not visible unless the vehicle is hoisted.
A common problem involves airflow from the defroster ducts even though the selector lever is in another position. The default position is used because it is safer than using the defrost position. Heat is also supplied to the passenger compartments not only through the defrost ducts but also through the heater vents at floor level. If the airflow is mostly directed to the windshield, check under the hood for a broken, disconnected, or missing vacuum hose. Check the vacuum reserve container for cracks or rust (if metal) that could prevent the container from holding vacuum. Check all vacuum hose connections at the intake manifold and trace each carefully, inspecting for cracks, splits, or softened areas that may indicate a problem.

**Figure 64-2** A cable-controlled heater control valve. This valve is normally open, allowing engine coolant to flow through the heater core. When the air conditioning is switched to maximum cooling, the valve shuts off the flow of coolant to the heater.

**TECH TIP: The Hand Test**
To check a radiator or condenser for possible clogged or restricted areas, simply touch the outside of the unit with your hand. Any cool spots indicate that the radiator or condenser is clogged in that cool area.
FREQUENTLY ASKED QUESTION: How Can You Easily Burp Air from the Cooling System?

The first step in being certain there is no air in the cooling system is to try to avoid getting air into the system in the first place during cooling system service. If the engine is equipped with bleeder valves near the high spots of the cooling system, these valves should be open when refilling the radiator. - SEE FIGURE 64–3. Any trapped air will always travel to the highest portion of the cooling system and escape out of these bleeder openings. Close the valves as soon as coolant is observed coming out of the valve opening.

Figure 64-3 Many engines are equipped with a bleeder valve to permit a technician to bleed any trapped air from the cooling system. The valve is loosened as coolant is poured into the system. Because air is lighter than coolant, the air tends to float toward the highest part of the cooling system.

TECH TIP: Hot/Cold/Hot/Cold Heater Diagnosis

A common customer complaint is a lack of heat from the heater but only while driving, even though there seems to be plenty of heat when the engine is at idle speed and the vehicle is stopped. This is a classic symptom of low coolant level. The lower than normal coolant level in the radiator prevents enough flow to supply the heater core. When the engine speed is reduced, the water pump turns slower and coolant can more easily flow through the heater core resulting in heat from the heater. As the engine speed increases, the water pump speed also increases. Because there is less than the proper amount of coolant in the system, the water pump will only be able to supply coolant through the engine (a path of lower resistance).
Many older CFC-12 systems are equipped with a sight glass either on or near the receiver-drier. A fully charged (or completely empty) system is indicated by a clear sight glass. Bubbles or foam indicate that the system is not fully charged. An empty system may have oil streaks on the sight glass being moved by the vapor remaining in the system.

A typical refrigerant identification machine. The readout indicates what kind of refrigerant is in the system. If a blend or some other contaminated refrigerant is discovered, it should be recovered and stored in a separate container to keep it from contaminating fresh refrigerant.

Both high-pressure (red) and low-pressure (blue) hoses have been attached to the vehicle.
Figure 64-6 (b) High-side pressure can be compared to the temperature of the outlet from the compressor. Here a service technician is using an infrared pyrometer to measure the temperature.

Figure 64-7 Hot refrigerant condenses in the condenser when it loses its heat to the outside air. Note how the level of the liquid line changes when undercharged or overcharged.

FREQUENTLY ASKED QUESTION: What's Wrong When the A/C Compressor Clutch Cycles On and Off Rapidly? This is a common occurrence on a vehicle equipped with a cycling clutch orifice tube (CCOT) system that is low on refrigerant charge. With a normal charge, the low-side pressure should be 15 to 35 PSI and the clutch should be on for 45 to 90 seconds and be off for only about 15 to 30 seconds.
HEATING AND AIR-CONDITIONING SYSTEM DIAGNOSIS

Figure 64-8  The average R-134a pressure-temperature readings during a performance test. The high-side pressure of R-12 systems will be lower at higher temperatures.

<table>
<thead>
<tr>
<th>AMBIENT AIR TEMPERATURE (°F)</th>
<th>HUMIDITY</th>
<th>LOW-SIDE PRESSURE (PSI)</th>
<th>HIGH-SIDE PRESSURE (PSI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>70</td>
<td>Low</td>
<td>29 to 30</td>
<td>140 to 157</td>
</tr>
<tr>
<td>80</td>
<td>Low</td>
<td>30 to 35</td>
<td>150 to 165</td>
</tr>
<tr>
<td>90</td>
<td>Low</td>
<td>31 to 37</td>
<td>160 to 180</td>
</tr>
<tr>
<td>100</td>
<td>Low</td>
<td>32 to 41</td>
<td>170 to 200</td>
</tr>
<tr>
<td>110</td>
<td>Low</td>
<td>33 to 44</td>
<td>180 to 220</td>
</tr>
<tr>
<td>120</td>
<td>Low</td>
<td>34 to 44</td>
<td>190 to 250</td>
</tr>
<tr>
<td>130</td>
<td>Low</td>
<td>35 to 44</td>
<td>200 to 280</td>
</tr>
</tbody>
</table>

LOW-SIDE PRESSURE TEMPERATURE CHART

Figure 64-9  When both low- and high-side pressures are low, the system is undercharged with refrigerant.

Figure 64-10  Both low- and high-side pressures higher than normal indicate that the system is overcharged with refrigerant.
Figure 64-11  Lack of proper airflow across the condenser is usually the cause of this condition.

Figure 64-12  A clogged orifice tube.

TECH TIP: High-Side Pressure Tip
A quick and easy way to determine the correct high-side pressure is to add 100 to the ambient air temperature in Fahrenheit.

For example: 85°F outside air temperature

+100

185 PSI = typical normal high-side pressure
TECH TIP: Clogged Orifice Tube

A clogged orifice tube is a common air-conditioning system failure. When the orifice tube becomes clogged, it blocks the flow of refrigerant through the evaporator, which causes a reduced cooling of the passenger compartment. To check for a possible restriction in the system, follow these easy steps:

STEP 1: Connect the A/C pressure gauge to both low- and high-side pressure fittings.

STEP 2: Operate the A/C system for 5 to 10 minutes.

STEP 3: Shut off the A/C system and watch the pressure gauges. If the pressures do not equalize quickly, then there is a restriction in the system. - SEE FIGURES 64–12 AND 64–13.

NOTE: To locate a restriction anywhere in the system, feel along the system lines. The restriction exists at the point of greatest temperature difference. Frosting is a good indication of a restriction.

Figure 64-13: Assortment of orifice tubes. Note that each is color coded and identified on the lid of the assortment. Even though some technicians have purposely installed an orifice tube with a larger opening in an attempt to increase cooling, it is always safe to use the exact orifice tube specified for the vehicle being serviced.

TECH TIP: The Fire Extinguisher Test

To test the expansion valve, start the engine and allow the A/C system to function with the control set to "recirculate." Using a CO2 fire extinguisher, blast the expansion valve with CO2. The valve should close and the low-side pressure should go into a vacuum. If the low-side pressure does not go into a vacuum, the expansion valve is faulty and should be replaced. - SEE FIGURE 64–14.
A CO₂ fire extinguisher equipped with the fittings necessary to test the operation of an expansion valve.

The size of the opening at the end of the hose determines how much CO₂ is released to cool the expansion valve temperature sensor bulb.

REAL WORLD FIX

The owner of an older Buick complained that the blower motor was defective because the air no longer flowed from the air-conditioning vents as it should. A check of the blower motor circuit revealed that the blower motor was working. To confirm the operation of the blower, the resistor pack was removed and air flowed out of the opening. Then the technician discovered the cause of the lack of airflow—the evaporator was covered with oily dirt. The technician recovered the refrigerant and removed the evaporator. Apparently, the evaporator had a small refrigerant leak that allowed the refrigerant oil to coat the fins of the evaporator. Any dirt in the air stuck to the evaporator until the dirt almost completely blocked the airflow. Replacing the evaporator and recharging the system fixed the blower motor problem. —SEE FIGURE 64–15.
Figure 64-15 A partially clogged evaporator.

**TECH TIP: The Touch, Feel Test**

A quick-and-easy test to check the state of charge of an orifice tube system is to use one hand and touch the evaporator side of the orifice tube. Touch your other hand to the inlet to the accumulator. The following conditions can be determined by noticing the temperature of these two locations. **SEE FIGURE 64–16.**

- **Normal operation** — both temperatures about the same
- **Undercharged condition** — accumulator temperature higher (warmer) than the orifice tube temperature

Just remember: High pressure means that the temperature of the component or line will also be high (hot). Low pressure means that the temperature of the component or line will also be low (cold). For example, the inlet to the compressor (low pressure) should always be cool whereas the outlet of the compressor (high pressure) should always be hot.

Figure 64-16 If the system is fully charged, the outlet temperature of the line leaving the evaporator should be about the same as the temperature of the line entering the expansion after the expansion valve. The low-pressure cycling switch usually has to be disconnected and a jumper wire used to connect the two electrical terminals allowing the compressor to run if the system is low on charge.
**TECH TIP: The Smell Test**

Many air-conditioning systems form mildew inside the evaporator housing due to the moist condition that exists in this area. If a "wet" smell is noticed, the mold and mildew may be the cause and a biocide will need to be used to correct the problem.

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**TECH TIP: Leak-Testing the Evaporator**

A quick-and-easy test to check whether the evaporator is leaking refrigerant is to remove the blower motor resistor pack. The blower motor resistor pack is almost always located directly “downstream” and near the blower motor. Removing the blower motor resistor pack gives access to the area near the evaporator. Inserting the probe of a leak detector into this open area allows the detector to test the air close to the evaporator. If the vehicle does not use a blower motor resistor or if it is difficult to access, hoist the vehicle and insert the sniffer probe in the condensate tube.

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**Figure 64-17** Typical electronic refrigerant leak detector. Many are capable of detecting either CFC-12 or HFC-134a.
Figure 64-18 A black light being used to look for refrigerant leaks after a fluorescent dye was injected in the system.