

## SECTION FOUR

# Refrigerants and the Refrigeration System

## UNIT 25

### Accessing Sealed Refrigeration Systems

#### OBJECTIVES

After completing this unit you will be able to:

- describe the different types of refrigeration service valves.
- explain the operation of gauge manifold valves.
- explain how to properly install and remove a gauge manifold set on manual service valves.
- explain the operation of split system installation valves.
- explain how to properly install and remove a gauge manifold set on Schrader valves.
- describe how to gain access to systems without service valves.

determine the pressures. Knowing the temperature difference across the coils, the amperage, and the airflow all give the technician vital information; but sometimes without the system operating pressures a final determination of a problem cannot be accurately made.

It is important to attach and remove a gauge manifold set properly. Understanding how to properly manipulate system access valves and install gauge manifolds is vital to the personal safety of the service technician. Improper technique can damage the system or injure the technician. Proper techniques should always be practiced so that they become a habit performed the same way each time.

#### 25.1 INTRODUCTION

One of the last things a service technician should do when troubleshooting a system is attach a set of gauges to the system. Each time a sealed system is accessed there is a chance that some contaminants can be introduced to the system, or refrigerant can be lost. However, there are times when a refrigeration system's operating conditions cannot be accurately assessed without accessing the system's refrigerant piping to

#### SAFETY TIP

The proper personal protective equipment, PPE, for installing refrigeration gauges and manipulating valves includes safety glasses and gloves. When liquid refrigerant escapes into the atmosphere it boils at extremely cold temperatures. Liquid refrigerant sprayed in the eyes can cause blindness, sprayed on the skin can cause frostbite.

## 25.2 FACTORY INSTALLED SERVICE VALVES

With the implementation of the Clean Air Act, all manufacturers are required to install factory-installed service valves on Type II and Type III equipment. Type I equipment is only required to have a process stub. Commercial refrigeration and air conditioning systems have had factory-installed service valves for years.

### SERVICE TIP

You must put service valve caps back on all access ports. This is an EPA refrigerant management requirement. Failure to do so is a violation of EPA rules and regulations. Many service access valve caps have O-rings to seal the system. Be sure these O-rings are in place before installing the cap to ensure a proper seal. Caps that have a metal-to-metal seal must be tightened one-eighth turn with a wrench after they have been finger tightened.

Factory installed service valves may be a manually operated stem shut-off valve, as in Figure 25-1, or a Schrader type valve. Schrader valves are spring-loaded valves similar to the valves used on car tires. They have a core that threads down into them, Figure 25-2. Refrigerant is allowed to flow into and out of the valve when the core is depressed. To prevent leaks, Schrader valves should always have their valve caps on when not in use, Figure 25-3.

Residential split system equipment service valves are usually located on the suction line and liquid line, Figure 25-4. The valve on the suction line is used to read the low side system pressure and the valve on the liquid line is used to read the high side system pressure. Most air conditioning systems use front-seating split system shut-off valves, as shown in

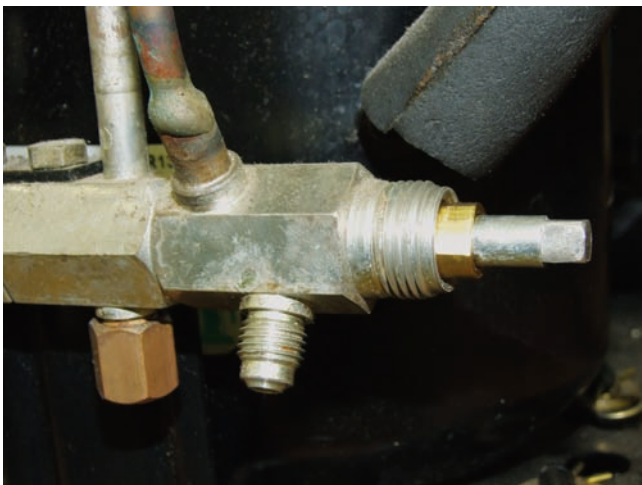


Figure 25-1 Manual two-way service valve



Figure 25-2 Schrader valve and core



Figure 25-3 Schrader valves should always have their cap on when not in use

Figure 25-5(b). These valves are used to hold the system refrigerant in during shipping. The gauges connect to the Schrader valve that is built into them. These valves are normally opened when the unit is installed, and then seldom used after that. It is not necessary to turn them to read pressure because the Schrader valve in them reads line pressure regardless of the valve position.

### SAFETY TIP

A few residential split systems use manual stem valves as shown in Figure 25-3(a). The gauge connection on these valves is not a Schrader valve. These valves must be opened to read pressure. More importantly, they must be closed before removing the gauges.



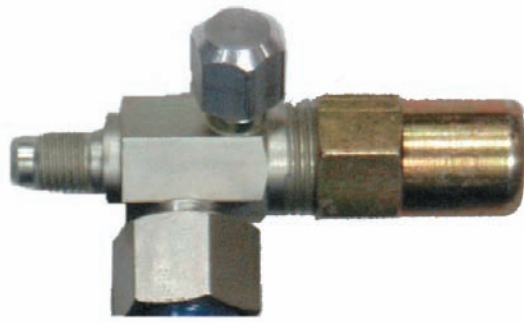
**Figure 25-4** Residential split system installation valves

On heat pump systems, both lines are on the high side during the heating cycle. To allow technicians to read low side pressures in heat, heat pump systems use a third valve which is always connected to the low side of the system regardless of the cycle, Figure 25-6. Residential packaged units typically have a low side and high side Schrader valve mounted on the outside of the equipment, Figure 25-7.

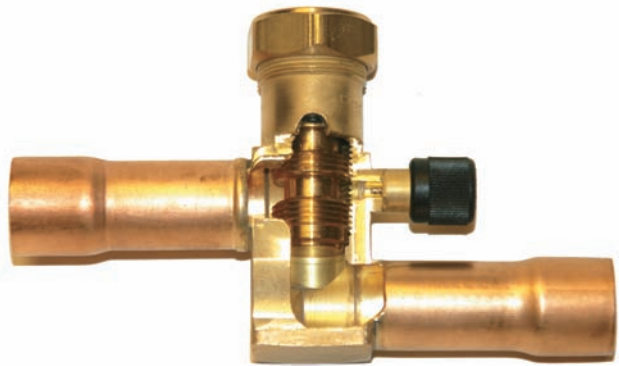
Commercial refrigeration systems typically have three manual stem service valves. A suction service valve and a discharge service valve are located on the compressor. A service valve called the king valve is mounted on the outlet of the receiver. These service valves are equipped with a gauge service port. Operating refrigerant pressures may be observed on the service gauge manifold when hoses are connected to these ports and the valves are cracked open.

### 25.3 MANUAL STEM SERVICE VALVES

Manual service valves have three ports and two seats. The three ports include a middle port which connects to the compressor or system, a line port which connects to the refriger-



(a)



(b)

**Figure 25-5** Service valves  
(b Courtesy Rheem Manufacturing)

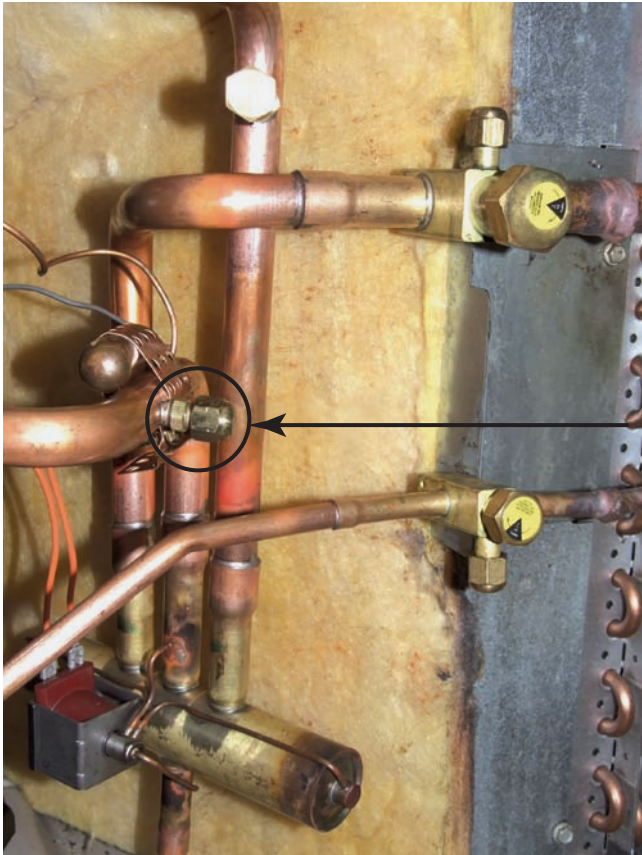
ant line, and a service port which is used for servicing the system, Figure 25-8. The refrigerant has two paths it can take through the valve. It can flow between the middle port to the line port, the middle port to the service port, or between all ports. There is not a closed position on these valves because one of the two exit ports will always be open. Instead, the terms back seated and front seated are used to describe the valve positions.

The valve is back seated when the stem is turned all the way out counterclockwise. This position is called back seated because the valve is seated on the back port of the valve. In this position the service port is closed but the middle port is open to the line port, Figure 25-9. Service valves should always be placed in the back seated position before installing or removing gauges.

The valve is front seated when the stem is turned all the way in clockwise. This position is called front seated because the valve is seated on the front port of the valve. In this position the line port is closed but the middle port is open to the service port, Figure 25-10. The front seat position can be used to isolate refrigeration system components.



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**Figure 25-6** The arrow points to the port that is always on the low side of the system regardless of the operating cycle



**Figure 25-7** High side and low side Schrader valves on a packaged unit

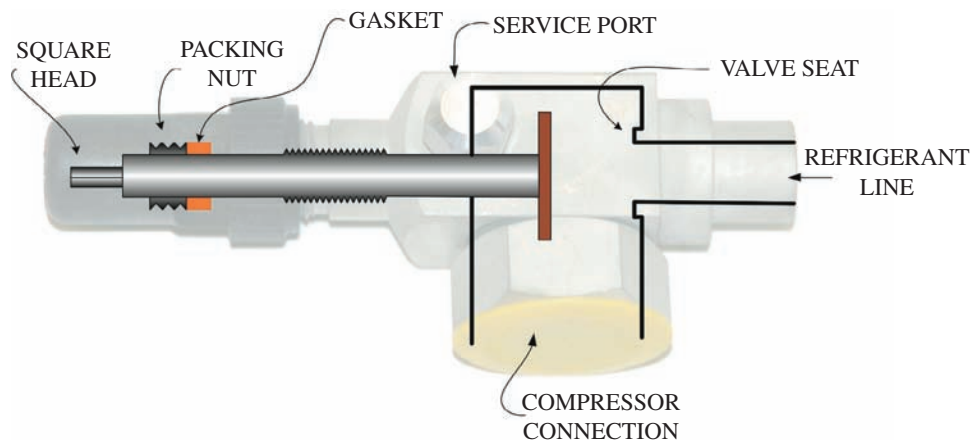
### SAFETY TIP

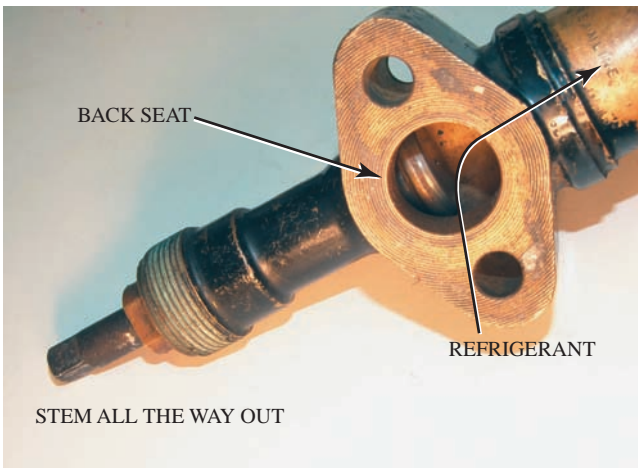
Be sure that internal pressure in the compressor is relieved by recovery and vacuum procedures before attempting to remove an isolated compressor from the system. Pressure remains in the compressor even after the service valves are front seated.

If the stem is positioned anywhere in between the back seat and front seat positions, all three ports will be open. Turning the valve one-half turn off of a fully seated position is called cracking the valve. When checking pressures, the valves are usually in the back seat cracked position, Figure 25-11.

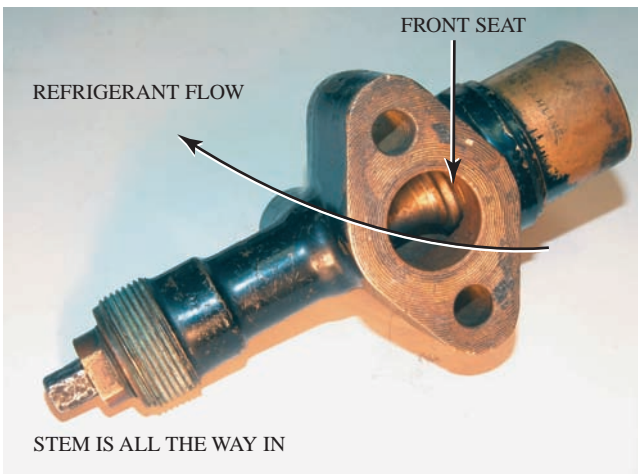
The stems on manual service valves should only be turned with a valve stem wrench, Figure 25-12. The corners

**Figure 25-8** Two-way system service valve

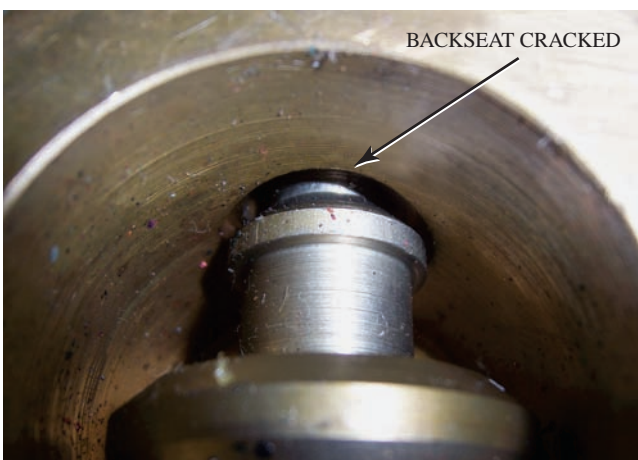




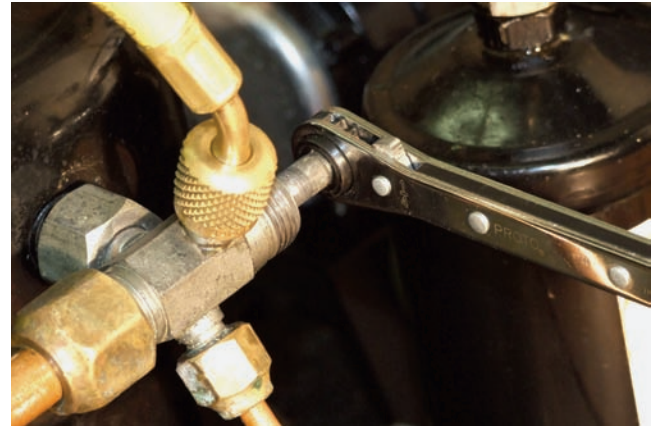
**Figure 25-9** Two-way service valve in the back-seated position



**Figure 25-10** Two-way service valve in the front-seated position



**Figure 25-11** When a two-way service valve is cracked, the valve is just off of the seat, creating a small opening, or crack



**Figure 25-12** Square stem service valve and valve wrench



**Figure 25-13** This valve stem has been ruined by a careless technician using the wrong tool

of the valve stems round off easily when they are turned with adjustable wrenches or pliers. Once a stem is rounded it cannot be turned with the correct wrench, Figure 25-13. The cap for the valve stem and the cap for the service port should always be replaced after using manual service valves.

## 25.4 SCHRADER VALVES

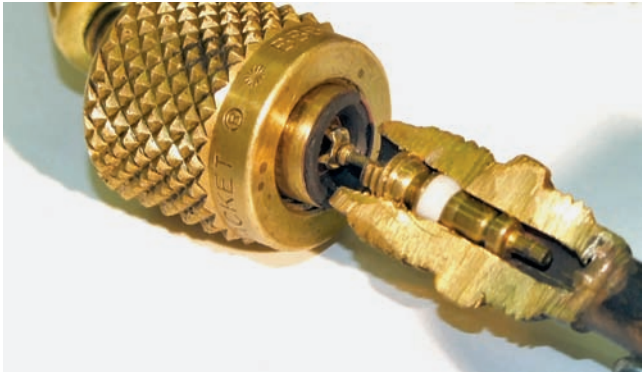
Schrader valves provide a convenient method of checking system pressures or servicing the system where it is not economical or convenient to use manual stem service valves. The Schrader valve core, shown in Figure 25-14, is a spring loaded device for positive seating. The valve is like those used on automobile tires, but the cores used in refrigeration valves are



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**Figure 25-14** Schrader valve core

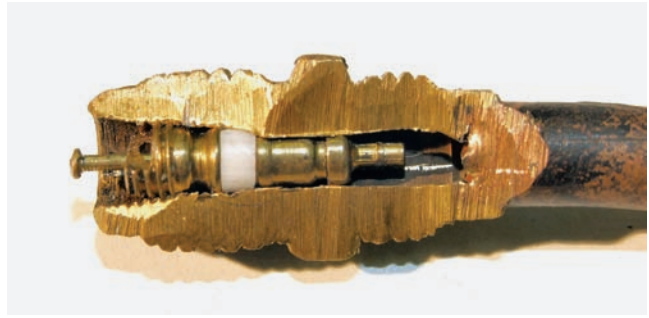


**Figure 25-15** The core depressor on the refrigerant hose pushes in the Schrader valve core when the hose is connected

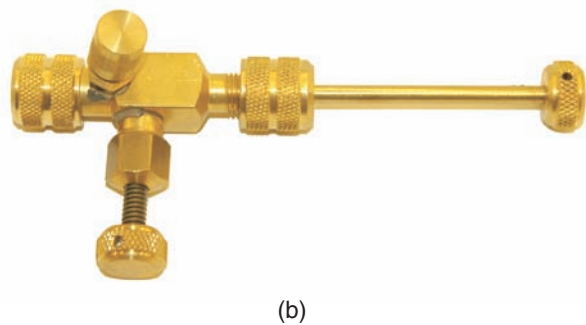
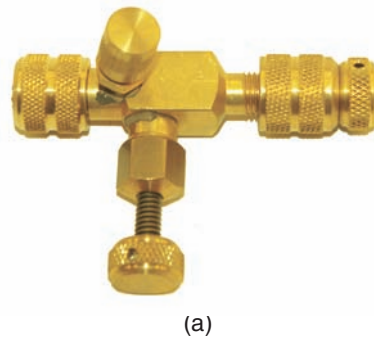
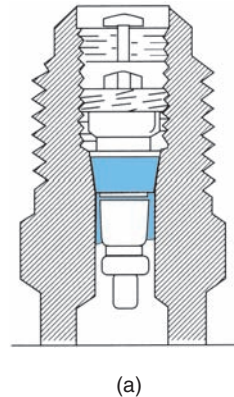
not the same as the cores used in car tires. The rubber used in tire valves is not compatible with refrigerants and would dissolve if used on a refrigeration system.

The stem must be depressed to force the valve seat open against spring pressure. Refrigerant hoses with built in core depressors must be used with Schrader valves. When a hose with a core depressor is connected to a Schrader valve, the valve core is pushed in and the valve opens, Figure 25-15. Ideally, the seal in the gauge hose will seat just as the depressor is pushed in and very little refrigerant will escape. Flow through a Schrader valve is limited because the core takes up most of the space in the center of the valve. This leaves only a small passage for refrigerant to go through, Figure 25-16.

If a valve core leaks, it can be replaced by using a core-removal tool to unscrew it. Some tools, such as the one in Figure 25-17, allow this to be done while the system is under pressure. All Schrader valves should have a leak-proof cap on them when not in use. The cap can prevent refrigerant loss even if the valve core does leak.



**Figure 25-16** This cutaway shows how a Schrader valve works



**Figure 25-17** This tool can be used to change the core in a Schrader valve without losing the refrigerant in the system



**Figure 25-18** The condensing unit is shipped with the valve closed to hold in the system refrigerant

## 25.5 SPLIT SYSTEM INSTALLATION VALVES

Most new residential split systems come equipped with unit installation valves, as shown previously in Figure 25-4. These valves are used to hold the refrigerant charge in the outdoor unit while it is shipped. These valves have three ports: the port to the unit, the line port, and the Schrader valve service port. Even though they have three ports, they do not behave like standard manual service valves. No ports are closed in the back seat position; the Schrader valve service port is always open to the line port regardless of the position of the valve.

These valves are used primarily for holding the system charge during shipping. The systems are shipped with the valve run all the way down clockwise, Figure 25-18. After connecting the refrigerant lines and indoor coil, the system is evacuated through the service port. The valve is turned counterclockwise to open it and allow the trapped refrigerant to flow throughout the system. Typically the valve is never used again because it does not control refrigerant flow to the service port.

### SAFETY TIP

Be careful when opening split system installation valves. The only thing that keeps the plug in the valve is a small lock-ring at the top of the valve. Stop turning when the valve plug approaches the lock-ring. The valve does not need to be tightened in the counterclockwise, or up position. Overtightening the valve can cause the lock-ring to pop out and the plug will fly out under system pressure, with all the system refrigerant behind it.

## 25.6 GAUGE MANIFOLD SET

Technicians use the gauge manifold to diagnose trouble in refrigeration systems. Gauges allow the operator to watch both gauges simultaneously during evacuation or charging opera-

tions, and save time on almost any work that must be done on the system. The most common gauge manifold test sets contains two shut-off valves, three external connections, and two pressure gauges. The gauges and the flexible hoses that connect to the manifold to connect it to the system are color coded; blue is the low side of the system, red is the high side. The left-hand gauge is called a compound or suction pressure gauge. The right-hand gauge is called the high pressure or discharge pressure gauge. The hoses have  $\frac{1}{4}$ -inch diameter and are designed to seal on a  $\frac{1}{4}$ -inch male flare end. Typically one end is straight and connects to the manifold and the other end is angled to allow easier connection to service valves.

More advanced gauge manifolds are available that have four hose connections and four shut-off valves, Figure 25-19. Besides the low side and high side connections, there are two center connections, each with its own shut-off valve. Typically one of the middle connections allows the use of a  $\frac{3}{8}$ -inch hose for faster evacuation.



**Figure 25-19** Four valve manifold gauge set  
(Courtesy Imperial)



**Figure 25-20** Digital manifold gauge set  
(Courtesy of Ritchie Engineering Company, Inc.—Yellow Jacket® Products)

The most advanced gauge manifolds use digital gauges rather than analog bourdon tube gauges, Figure 25-20. These provide more accurate pressure measurement, built in saturation temperature charts for several refrigerants, and system analysis.

All gauge manifold sets are test instruments and should be handled carefully.

- Never drop or abuse the gauge manifold.
- Keep ports or charging lines capped when not in use.
- Never use any fluid other than clean oil and refrigerant.

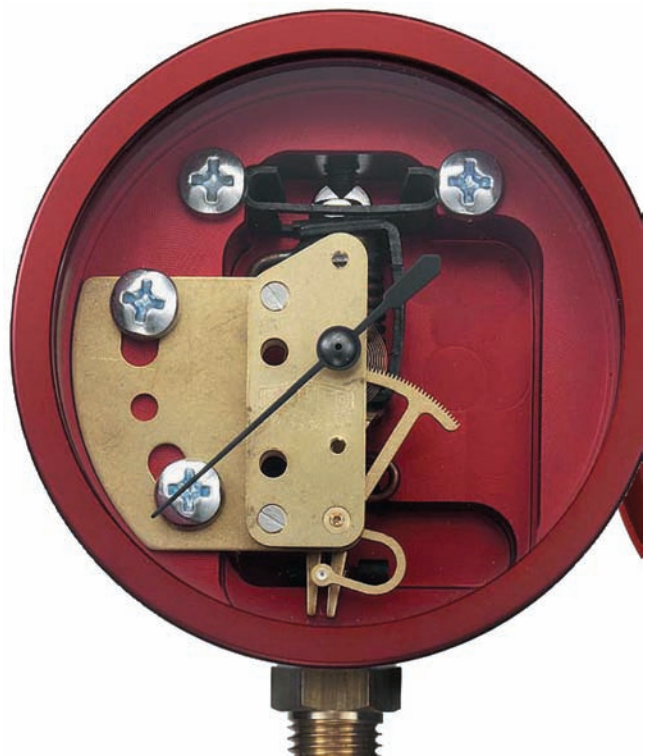
### SAFETY TIP

There are two major groupings of gauge manifold sets. One group is designed to be used with R-12, R-22, R-134A, R-408, R-407, and R-404. The other groups of gauge manifold sets are designed to be used with R-410A only. Do not use gauges designed for the lower pressured refrigerants on the very high pressure R-410A system.

## 25.7 REFRIGERATION GAUGES

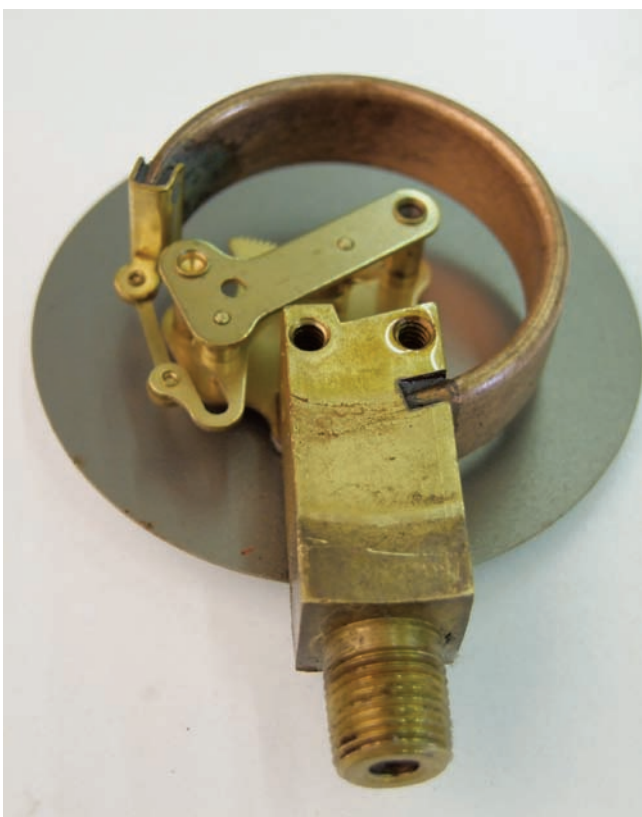
Mechanical gauges require a physical device to translate pressure changes into movement that can be used to move a dial. Three types of devices are used in mechanical gauges: diaphragm, bellows, and Bourdon tube. Diaphragm gauges are generally used for lower pressures within a limited range and are usually not used in refrigeration. Bellows gauges are used in refrigeration gauges, but they are not as common as Bourdon tube gauges. The bellows expand with an increase in pressure and contract with a decrease in pressure. Figure 25-21 shows a bellows gauge used in refrigeration.

Most refrigeration gauges use a Bourdon tube as the operating element. The Bourdon tube is a flattened metal tube which is sealed at one end, curved and soldered to the gauge fitting at the other end, Figure 25-22. Figure 25-23 illustrates how a Bourdon tube operates. The blue shaded section shows the tube at rest at atmospheric pressure. A rise in pressure inside the tube tends to make the Bourdon tube mechanism straighten. The position the Bourdon tube will move to when pressure is applied is shown in Figure 25-23 in the dotted outline. This movement will pull on the link, which will turn

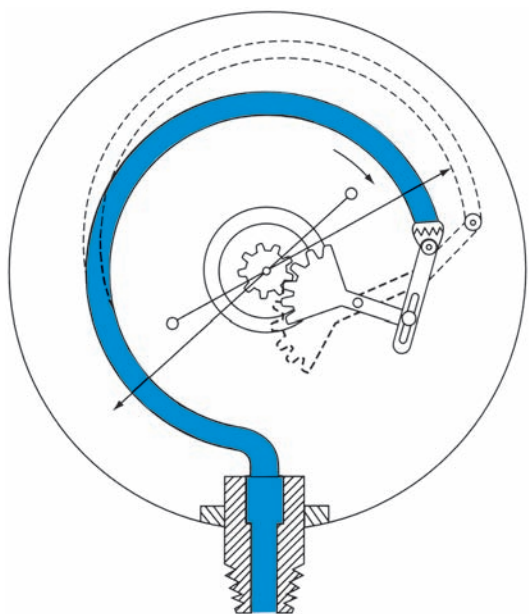


**Figure 25-21** Example of a bellows style refrigeration gauge  
(Courtesy of REFCO Manufacturing Ltd.)





**Figure 25-22** Bourdon tube



**Figure 25-23** The dashed line shows how the Bourdon tube responds to a pressure increase



**Figure 25-24** High side pressure gauge for most common refrigerants except R-410a

(Courtesy of Yellow Jacket Division, Ritchie Engineering Company)

the gear sector counterclockwise. The pointer shaft will move clockwise to move the needle. On a decrease in pressure, the Bourdon tube moves clockwise toward its original position and the pointer moves counterclockwise to indicate a decrease in pressure.

## Pressure Gauges

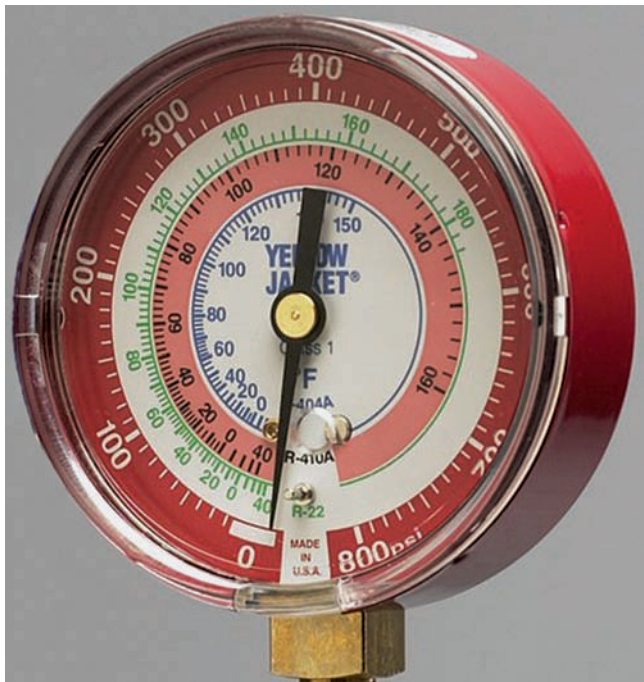
The high pressure gauge has a single continuous scale. Gauge sets made for refrigerants such as R-134a and R-22 are usually calibrated (marked off) to read 0 to 500 psi. Figure 25-24 shows a high pressure gauge. The scale is usually marked in 5 lb increments. The black scale is the pressure scale and the colored scales indicate the saturation temperature of different refrigerants at the indicated pressure. For example, if the gauge pointer indicated 200 psi pressure for R-22, the saturation temperature of the refrigerant would be approximately 101°F.

Pressure gauges made for R-410a have a higher pressure range because of the higher pressures of R-410 systems. R-410a pressure gauges can typically read pressures up to 800 psig. On an R-410a pressure gauge, each mark on the pressure scale represents 10 psig pressure. Figure 25-25 shows a high pressure gauge for R410a systems.

## Compound Gauges

The low side gauge is a compound gauge that measures both pressure and vacuum, Figure 25-26. Gauge sets made for refrigerants such as R-134a and R-22 are usually calibrated from 0 to 30 in of mercury vacuum and from 0 to 120 psig

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**Figure 25-25** High side pressure gauge for R-410a  
(Courtesy of Ritchie Engineering Company, Inc.—Yellow Jacket® Products)

pressure. On a typical compound gauge each mark on the vacuum scale represents 2 in Hg vacuum and each mark on the pressure scale represents 1 psig pressure.

It is common for the standing pressure on the low side of a system to exceed the normal range of the compound gauge.



**Figure 25-26** Compound gauge for most common refrigerants except R-410a  
(Courtesy of Yellow Jacket Division, Ritchie Engineering Company)

The retard range protects the gauges from damage when a pressure above their normal range of operation is connected to them. Gauges for R-134a and R-22 typically have a retard range of up to 350 psig.

Compound gauges made for R-410a have a higher pressure range because of the higher operating pressures of R-410a systems. R-410a gauges can typically read pressures up to 350 psig and have a retard range up to 500 psig. On an R-410a compound gauge, each mark on the pressure scale represents 5 psig pressure. Each mark on the vacuum scale represents 5 in Hg vacuum.

Like the high pressure gauge, the compound gauge also has scales calibrated to read saturation temperatures of various refrigerants such as R-134a, R-22, and R-410A. With these scales it is not necessary to refer to pressure-temperature tables or curves to calculate pressure-temperature relationships. Figure 25-27 shows a compound gauge for an R-410A system.

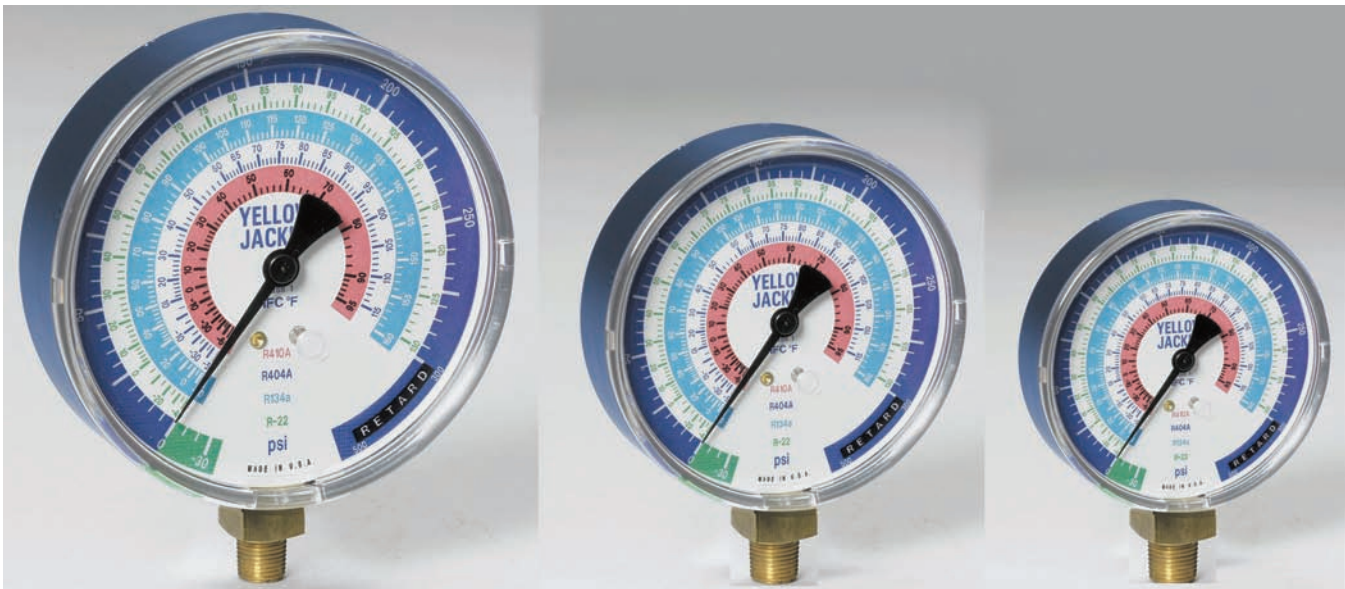
### Gauge Accuracy

Gauges are classified by their percentage accuracy. Class 1 gauges are accurate to  $\pm 1\%$  of the reading throughout their range. This means that 100 psig can read anywhere between 99 and 101. Class 1 gauges are the most accurate mechanical



**Figure 25-27** Compound gauge for R-410a  
(Courtesy of Ritchie Engineering Company, Inc.—Yellow Jacket® Products)





**Figure 25-28** Comparison of 2½ in, 3⅛ in, and 4 in mechanical gauges  
(Courtesy of Ritchie Engineering Company, Inc.—Yellow Jacket® Products)

gauges used in refrigeration. Class 1.6 and class 2 gauges are accurate to 1.6% and 2%, respectively. Class 2-3-2 gauges are accurate to 2% for the first third of their scale, 3% for the middle third, and 2% for the final third of their scale. Class 3-2-3 gauges are the least accurate gauges used in refrigeration.

### Gauge Size

Gauges are available in different sizes. The most common sizes are 2½", 3⅛", and 4" in diameter. Figure 25-28 shows all three common sizes of gauges. Larger gauges are easier to read than smaller gauges. Their larger circumference allows for more accurate increments making them more accurate as well. This is especially important for gauges that are used over a wider range of pressure, like gauges designed for use with R-410a.

### SERVICE TIP

Refrigeration gauges have a small adjustment screw that allows the gauge to be zeroed. The gauge is adjusted to zero with the hoses open to atmospheric pressure. However, it is possible for a gauge to zero out but not read other pressures accurately. From time to time the technician should attach the gauges to a new cylinder of refrigerant at a known temperature and compare the pressure reading to the temperature-pressure chart so that the gauge can be checked for accuracy. Gauges that are zeroed and are still inaccurate should be replaced.

## 25.8 GAUGE MANIFOLD VALVES

The valves on a gauge manifold are used to control the flow of refrigerant from either side of the manifold to the center. Figure 25-29 shows a cutaway view of a gauge manifold. It is not necessary to open the valves on the gauge set to read pressure. The parts above and below each valve are interconnected so the gauges will read pressure at all times when connected to the system. The valves open or close the path from each side to the middle port. When both valves are closed (front seated) the center or utility port is isolated, Figure 25-30(a).

Slightly opening a valve is called cracking the valve. Cracking open the low side valve connects the low side and center hoses, Figure 25-30(b). Some refrigerant can now flow from the center hose to the system. Fully opening the low side valve opens the low side port to the center port for full flow or refrigerant or for evacuating the system, Figure 25-30(c).

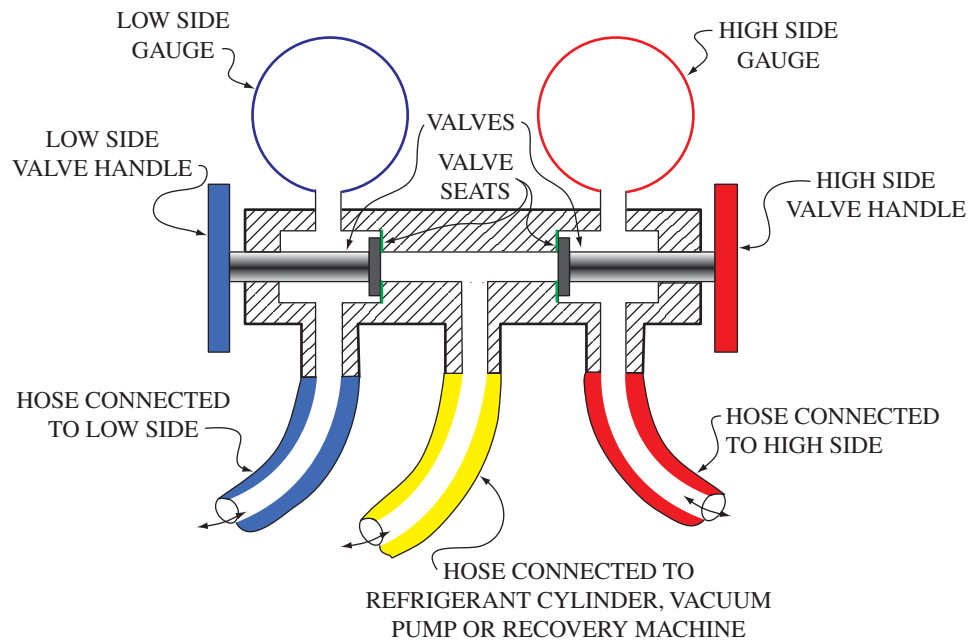
With the low side valve closed, cracking open the high side valve will allow some refrigerant to flow from the high side to the center hose, Figure 25-30(d). Fully opening the high side valve opens the high side port to the center port to remove refrigerant from the system or for system evacuation, Figure 25-30(e).

Opening both the low and high side valves opens both the low and high side ports to the center port. This valve position is used for system evacuation, Figure 25-30(f).

## 25.9 REFRIGERATION HOSES

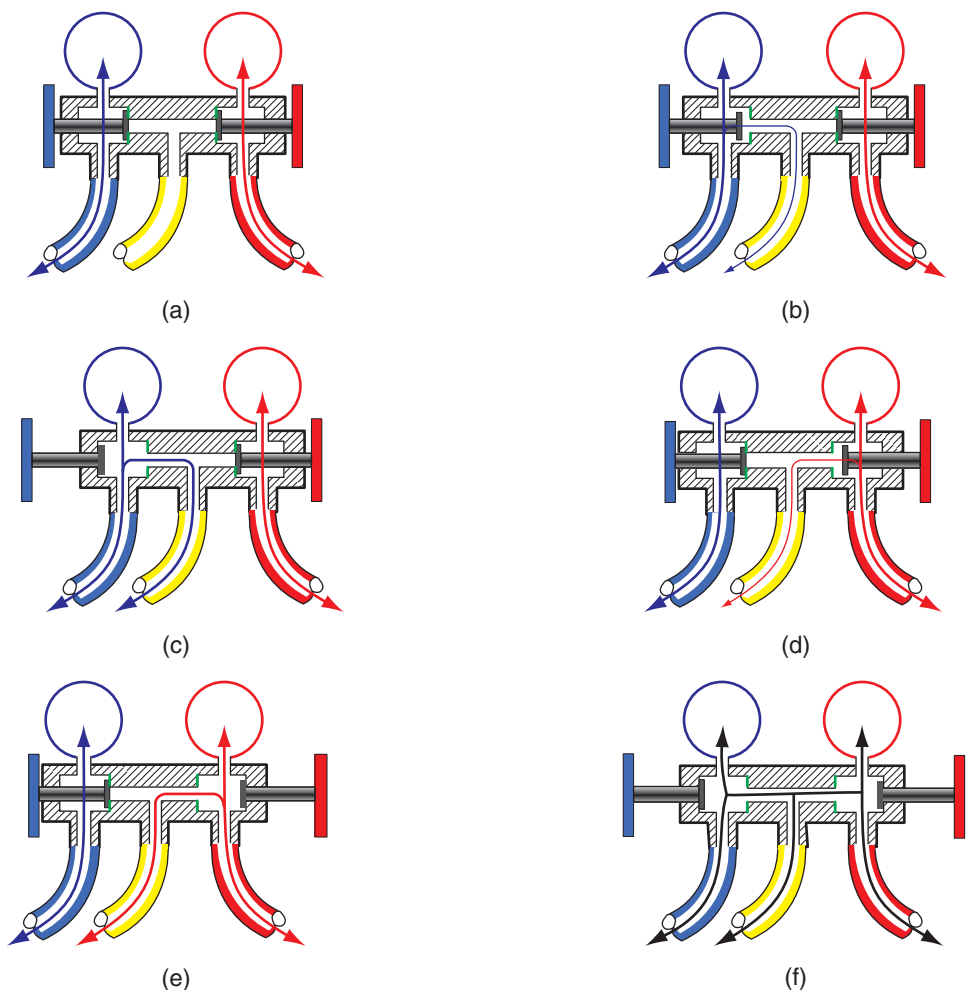
The refrigeration hoses are an important part of a gauge manifold set. They are what actually connects the gauges to the system. Charging and vacuum hoses are available in sizes

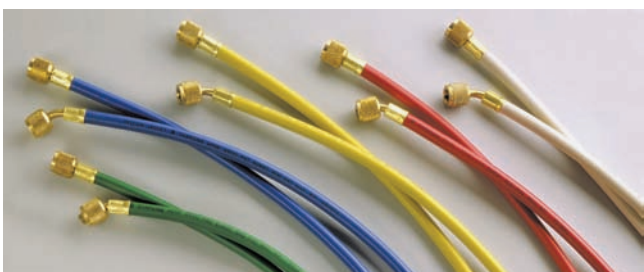


**Figure 25-29** Cutaway of a gauge manifold

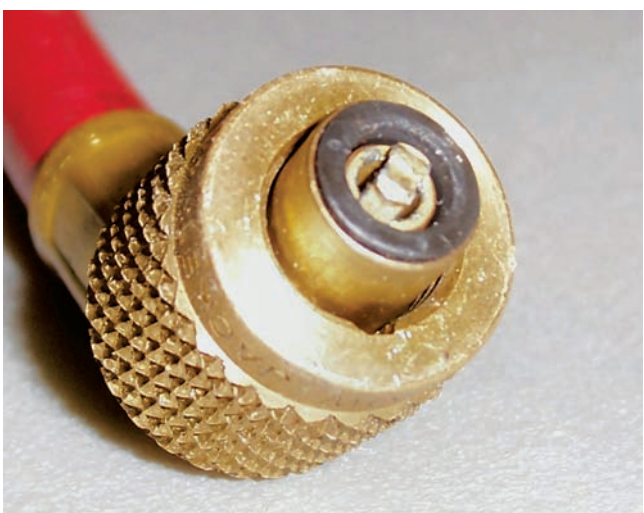
of  $\frac{1}{4}$ ",  $\frac{3}{8}$ ",  $\frac{1}{2}$ ", and  $\frac{5}{8}$ " inside diameter. The most common size is  $\frac{1}{4}$ ". Refrigeration hoses are available in many colors, Figure 25-31. Many gauge sets use hoses that are color coded to the gauges: red for the high side, blue for the low side, and

yellow for the center hose. Many four-port gauge manifolds have a  $\frac{3}{8}$ " port for vacuum and come equipped with a  $\frac{3}{8}$ " hose. Typical charging hoses have a straight end that connects to the manifold and an angled end that connects to the

**Figure 25-30** Gauge manifold valve positions



**Figure 25-31** Refrigeration hoses are available in many colors  
(Courtesy of Ritchie Engineering Company, Inc.—Yellow Jacket® Products)

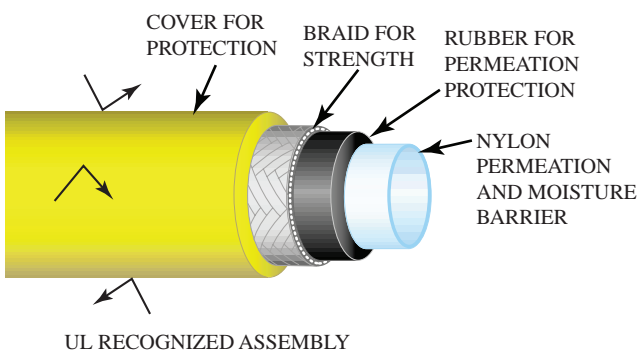


**Figure 25-32** The angled end contains a core depressor for Schrader valves

system. The angled end contains the core depressor for Schrader valves, Figure 25-32.

Refrigeration hoses are not simply a single tube; they are built in layers. Figure 25-33 illustrates the construction of a refrigeration hose. The rubber seen on the outside simply provides physical protection for the inner layers. The woven fabric layer just under the outer rubber layer provides strength. Some refrigeration hoses have two more inner layers, while others have only a single inner layer. The innermost layer actually contains the refrigerant. Hoses with two inner layers have extra permeation protection.

Hoses designed for use with refrigerants which operate at lower pressures than R-410a typically have a working pressure of 500 psig and a minimum burst pressure of 2,500 psig. Hoses designed for use with R-410a typically have a working pressure of 800 psig and a minimum burst pressure of 4,000 psig.



**Figure 25-33** Diagram of refrigeration hose construction  
(Courtesy of Ritchie Engineering Company, Inc.—Yellow Jacket® Products)

## 25.10 CONNECTING A GAUGE MANIFOLD SET ON MANUAL SERVICE VALVES

Locate the suction service valve. It is usually located on the compressor where the suction line attaches. Check to make sure the service valve stem is back seated. This will ensure that no pressure is currently applied to the gauge port of the service valve. Remove the gauge port flare cap and attach the hose connected to the compound side of your gauges to the gauge port. Locate the discharge service valve. It is also located on the compressor, but it is the valve connected to the smaller discharge line leaving the compressor. Check to be sure the valve stem is back seated. Remove the gauge port cap and attach the hose connected to the high side of the manifold to the gauge access port on the discharge service valve.

The gauge manifolds and connecting lines should be purged to avoid system contamination from air and moisture. To purge a unit that does not operate in a vacuum, crack both the suction and discharge service valves. Open the gauge manifold valves one at a time and bleed refrigerant out the middle line until all the air is out. This usually just takes a few seconds. This will purge the gauge manifold and the connecting lines. Many technicians simply loosen the hoses at the manifold connections and purge each hose. However, this does not purge the manifold or middle line.

### SAFETY TIP

Contact with the gases being purged should be avoided. Oil and liquid refrigerant will sometimes escape during the purging process. Liquid refrigerant can cause frostbite.

The high side is used to purge both sides of the manifold on systems whose low side is likely to be in a vacuum. To purge from the high side only, connect the lines as before, but crack only the high side service valve. Open the low side and high side manifold valves at the same time and loosen the hose

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connection at the low side service valve. This will purge everything but the middle hose. It can then be purged separately by loosening the middle hose at the plug connection. This procedure will work on any system with manual service valves, but is only necessary when the low side is likely to be in a vacuum.

Some technicians purge the hoses and gauges from a separate refrigerant tank. This has the advantage of not losing any of the system charge. It has the disadvantage of requiring a drum of refrigerant even if you are just checking the pressures. To use this method, connect your gauges as before; except, connect the middle leg to the refrigerant drum. Do not open the service valves. Crack the tank valve and open both manifold valves. Loosen the refrigerant hoses at both the suction and discharge service valves and purge each individually. After both hoses are purged, close the valve on the refrigerant cylinder and close the manifold valves.

### 25.11 REMOVING A GAUGE MANIFOLD SET FROM MANUAL SERVICE VALVES

The simplest way to remove the gauge set is to back seat both the service valves. This should prevent any further escape of refrigerant into the gauges. There is still a considerable amount of refrigerant in the gauges and hoses that needs to be carefully released. Generally it is easier to release the refrigerant through the middle leg. Disconnect the middle hose at the plug connection and direct it into an empty can or other safe area. Slowly open each manifold valve, one at a time, until all the refrigerant has been released from the gauges.

There is a way to remove the gauges and avoid losing quite as much refrigerant. Leave the unit running. Instead of back seating both service valves, back seat only the discharge service valve. Crack open both manifold valves. This will allow the high pressure gas in the discharge side of the manifold to pass into the low side of the refrigeration system. The pressure on the gauges will then be equal to the low side operating pressure. This is the lowest pressure any part of the system will ever have on it. After the pressures in the gauge manifold have come down to the operating low side pressure, back seat the suction service valve. The pressure trapped in the gauges can now be bled off through the middle hose; except now, the trapped pressure is significantly lower.

#### SAFETY TIP

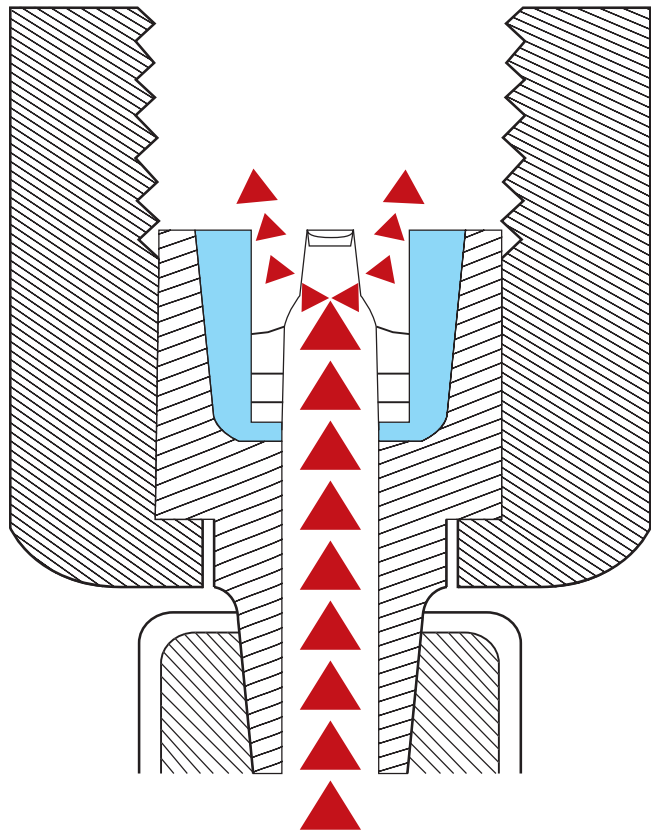
If an error or equipment failure causes an unexpected release of refrigerant, keep your hands and body out of the refrigerant spray. Do not try to replace a hose or valve cap on a valve that has refrigerant escaping. Liquid R-410a is approximately  $-70^{\circ}\text{F}$  at atmospheric pressure. It does not take long to get a nasty frostbite burn at that temperature.

### 25.12 CONNECTING A GAUGE MANIFOLD SET TO SCHRADER VALVES

Schrader valves automatically open when a hose with a core depressor is connected to them. The service technician normally does not have control over when the valve opens and closes. When hoses are connected the valve opens; when hoses are removed the valve closes. Frequently the valve will open before the seal is made and release refrigerant. If the Schrader valve is on the liquid line, the liquid that comes out will be extremely cold as it flashes off at atmospheric pressure. Occasionally the hose will seat before the core is depressed, and no pressure will be read. Some manufacturers' hoses have adjustable core depressors that can help either of these situations, Figure 25-34.

One way of minimizing the risk to the technician is to install the gauges on the Schrader valves with the system off. This reduces the pressures available at the high side valve when the hose is connected and reduces the chance of liquid refrigerant escaping. Connecting with the system off also makes purging the gauges easier. The gauges may be purged by opening the valves one at a time and releasing the air through the center hose.

Tools are available that give the technician more control over the valve. With control over when the valves open and



**Figure 25-34** Adjustable core depressor  
(Courtesy of Ritchie Engineering Company, Inc.—Yellow Jacket® Products)





**Figure 25-35** Thumbscrew core depressor valve  
(Courtesy of Ritchie Engineering Company, Inc.—Yellow Jacket® Products)

close, gauges may be safely connected to Schrader valves with the unit in operation. A valve core removal tool like the one shown in Figure 25-17 allows gauges to be connected before opening the valve. Then the tool is used to remove the core, opening the system to the gauges. This also has the advantage of improving flow through the valve. This type of core removal tool can be used to change a Schrader valve core without recovering the system refrigerant.

A simpler tool, the thumbscrew core depressor, also allows the connection of gauges before the valve is opened, Figure 25-35. Turning in the thumbscrew depresses the valve core and opens the valve. This process is reversed to remove the gauges. The thumbscrew is turned out, allowing the valve to close. After the valve is closed, the gauges are removed.

### 25.13 REMOVING A GAUGE MANIFOLD SET FROM SCHRADER VALVES

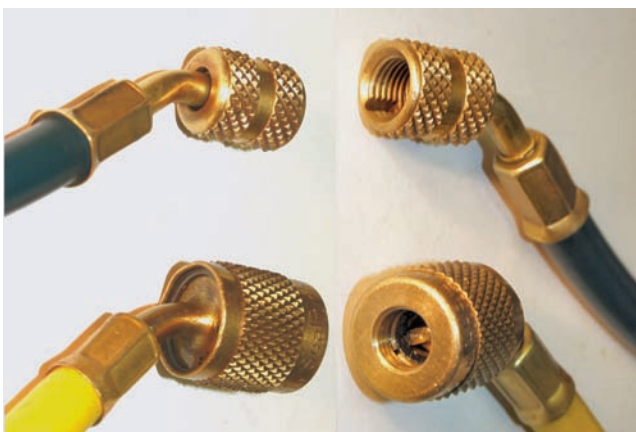
When a hose is disconnected from a Schrader valve, the refrigerant that is trapped in the hose and gauges comes back out. This can be a surprising amount of refrigerant when the high side is connected to the liquid line. Positive shut-off hoses can drastically reduce the amount of refrigerant released when the gauges are disconnected. Positive shut-off devices include check valves on the end of refrigerant hoses, manually operated ball valves on the ends of hoses, and adapters that can be used with standard hoses. Available adapters include check valves, mechanisms like the quick couplings used on air hoses, and ball valves, Figure 25-36.

The check valves built into the end of a hose keep refrigerant from flowing backward out of the hose, Figure 25-37. Refrigerant will be trapped in the hoses after the gauges have been disconnected using a positive shut-off valve. Most of the trapped refrigerant can be put back in the system if the proper removal procedure is followed.

Using a positive shut-off hose, disconnect the high side with the unit still operating. Now crack both the gauge mani-



**Figure 25-36** Positive shut-off adapters make connecting to Schrader valves easier



**Figure 25-37** The hoses at the top of the picture have a standard Schrader core depressors. The hoses on the bottom of the picture have automatic check valves built in that keep the refrigerant in the hose from coming back out when the hose is removed.

fold valves to allow the trapped high pressure refrigerant into the low side. Last, disconnect the low side with the unit still operating. The remaining amount of refrigerant in the hoses can be safely and legally vented. Note that the gauges must be purged when they are connected, or part of what is going back into the system will be air and contaminants.

Three simple steps will reduce your exposure to refrigerant spray if positive shut-off hoses or adapters are not used. First, wear gloves and safety glasses. It is always a good idea to wear gloves and safety glasses when handling refrigerant, but it is especially important when using Schrader valves. Disconnect the low side with the system operating because the low side pressure is lower with the unit on. Turn the system off and let the system sit for several minutes before disconnecting the high side, because the high side pressure is lower with the unit off.



**Figure 25-38** This gauge is reading 150 psig with a saturation temperature of 45°F for R-410a

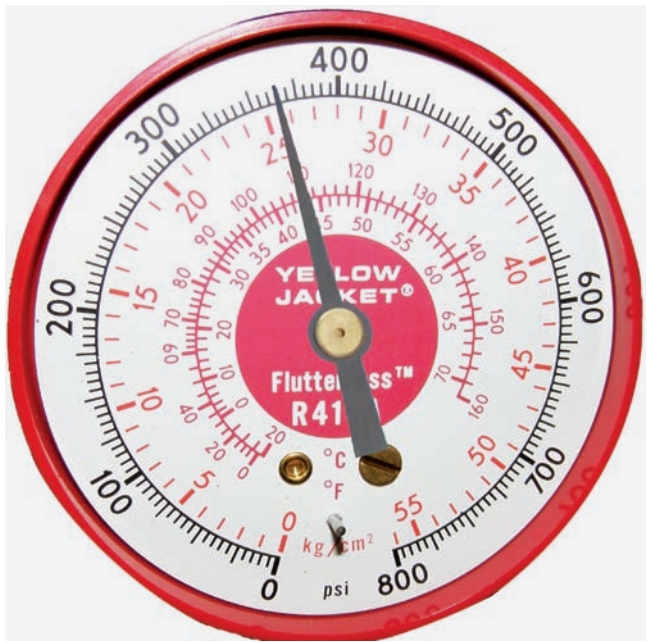
## 25.14 READING REFRIGERANT SATURATION TEMPERATURES

Refrigeration gauges not only read system pressure, they also show the refrigerant saturation temperature of common refrigerants. The saturation temperature of a refrigerant may be determined by observing the colored scale for that particular refrigerant. The gauge in Figure 25-38 is showing 150 psig for an R-410A system. The needle also points toward its corresponding saturation temperature, 45°F. The high pressure gauge shown in Figure 25-39 indicates a pressure of 365 psig and a corresponding temperature for R-410A of 110°F.

## 25.15 ACCESSING SEALED SYSTEMS

Most small appliances like refrigerators or window units do not have any valves installed at the factory. Instead, the systems are evacuated and charged at the factory through process tubes. A process tube, or process stub, is a copper tube connected to the system for the sole purpose of evacuating and charging the unit at the factory. The process tubes can be on the compressor or on one of the system lines, Figure 25-40. After the system is evacuated and charged at the factory, the process tube is pinched off and brazed shut.

The only way to gain access to these refrigeration systems is to use a valve that pierces a hole in the tubing. It is better to avoid entering a sealed system unless it is absolutely necessary because poking a hole in a sealed system can create problems. The technician could literally be installing a leak.



**Figure 25-39** This gauge is reading 365 psig with a saturation temperature of 110°F for R-410a

Small systems sometimes only hold a few ounces and putting gauges on them can remove enough refrigerant to make the system undercharged. It is definitely not a good idea to install piercing valves on small sealed systems just to perform a routine check. However, when the refrigeration system must be accessed a piercing valve or piercing pliers are required.



**Figure 25-40** Process tube on hermetic compressor



**SAFETY TIP**

You must wear eye protection and gloves any time you access a refrigeration system. Liquid refrigerant accidentally released from a pressurized system can be at an extremely low temperature which can cause blindness and skin burns. Never position your face or head in a direct line with an access port as you are attaching or removing hoses.

**25.16 PIERCING VALVES**

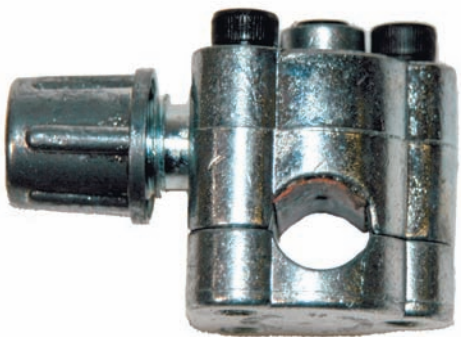
One of the easiest devices available for sealed system access is the saddle piercing valve, or tap-a-line. These piercing valves are clamped to the tubing, sealed by a bushing gasket, and then they pierce the tube with a tapered needle. Most contain some sort of shut-off control. The technician should keep in mind that these valves should be used to gain temporary access to a hermetically sealed system for checking system operating pressures or for pressurizing for leak testing. The piercing valve shown in Figure 25-41 allows quick access to system pressures to immediately start diagnosing the refrigeration problem.

**SAFETY TIP**

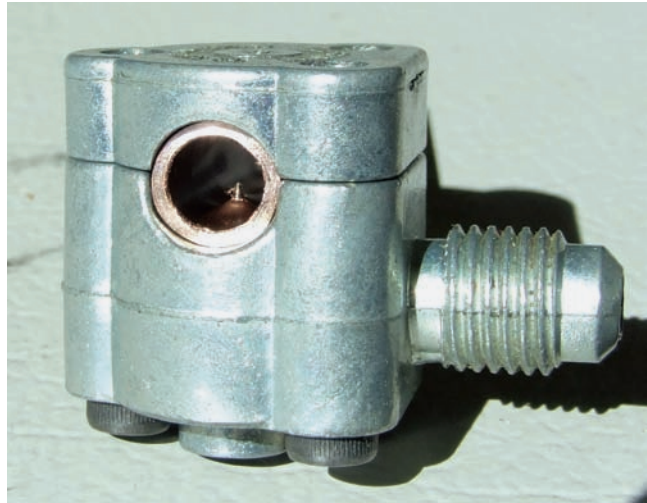
Before brazing a Schrader valve onto an existing refrigerant line, all of the refrigerant in the system must be recovered. Any refrigerant that is allowed to enter the torch flame will produce a noxious gas. Breathing this gas can be dangerous, and could even cause lung damage. Remove the Schrader core before brazing to keep it from becoming damaged.

Bolt on piercing valves are bolted on the line, then the piercing needle is run down to pierce the copper tubing, Figure 25-42. Refrigerant flows through the hole pierced by the needle to the service port on the valve.

Bolt on piercing valves should be removed once the source of the sealed system malfunction has been located. The only way to do this is to recover the refrigerant from the system through the piercing valve. After the refrigerant has been recovered, a permanent valve may be brazed on. One way to do this

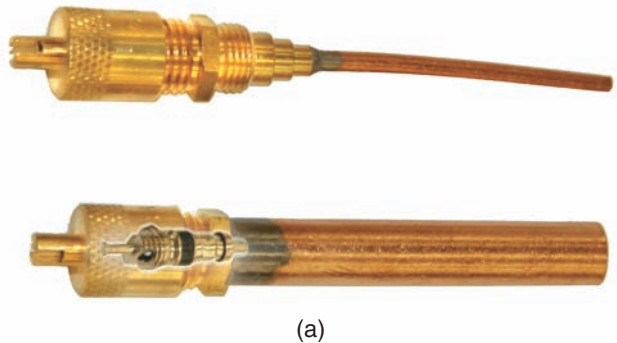


**Figure 25-41** Bolt on piercing valve

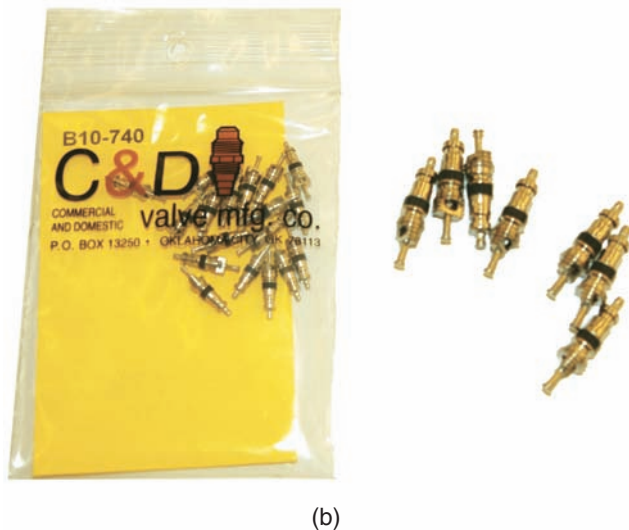


**Figure 25-42** The needle pierces the copper tubing to gain access to the refrigeration system

is to install the piercing valve on a process tube. After the refrigerant is recovered, the process tube can be cut and a permanent valve brazed onto the process tube. Figure 25-43 shows Schrader valves made for field application.



(a)

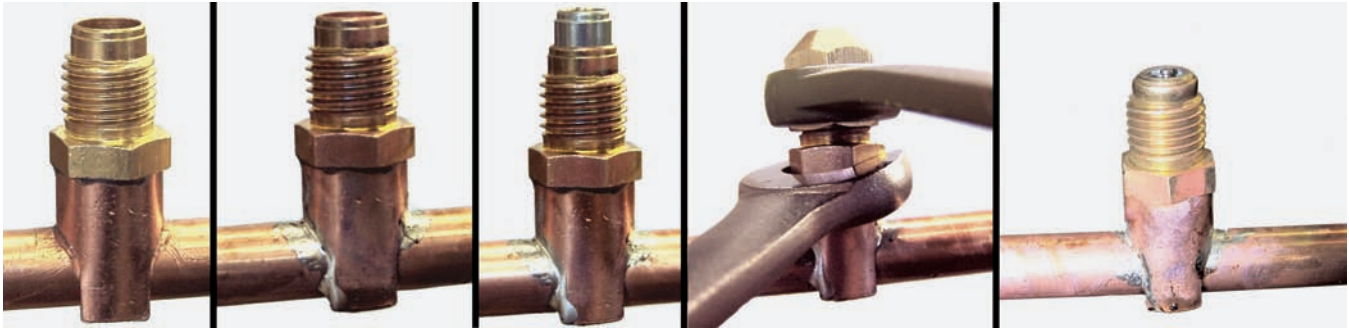


(b)

**Figure 25-43** (a) Pigtail-type Schrader valve; (b) Schrader valve replacement cores



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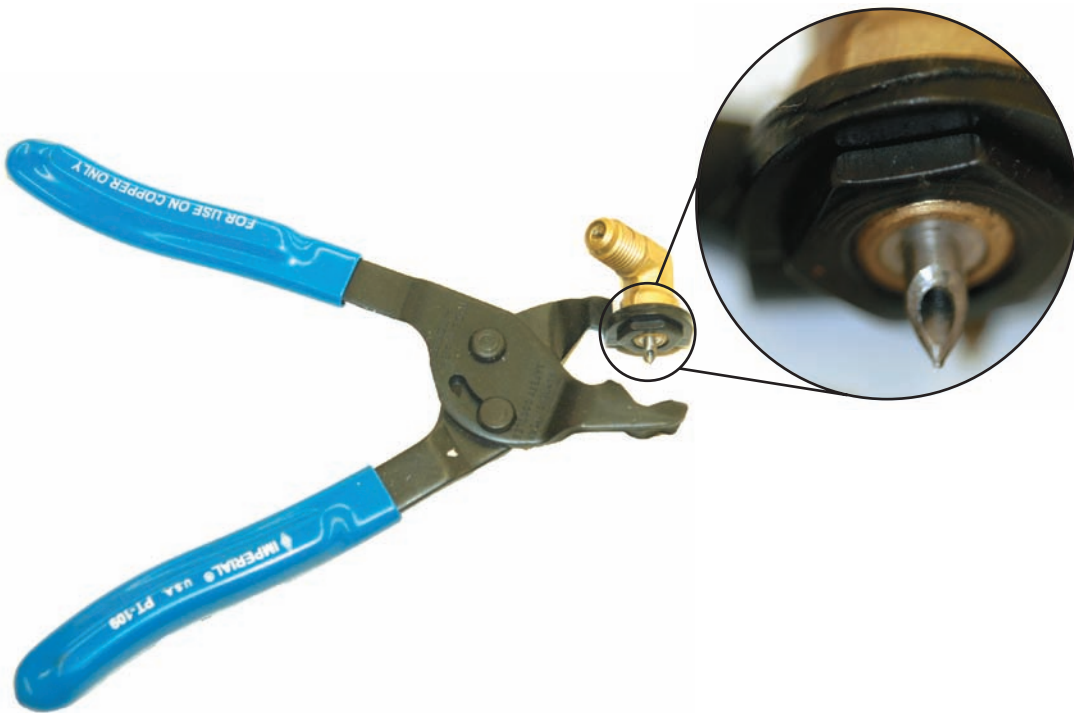


**Figure 25-44** Steps in installing a braze-on piercing valve. Braze-on piercing valves can be used as both a means of gaining access to a sealed system as well as a permanent valve.

Braze-on piercing valves are available, such as the one in Figure 25-44. They function like a Schrader valve after the tubing is pierced. Braze-on piercing valves can be used for initial access and left on the system. One safety concern with braze-on piercing valves is that they are brazed on while the system is still under pressure. Brazing on a system with pressure still in it is generally considered unsafe. If the tubing is overheated, it can rupture, allowing refrigerant and oil under pressure to blast out unexpectedly. The oil spray can ignite and create a flame thrower effect.

Another tool for accessing sealed systems is a set of piercing pliers, Figure 25-45. These can pierce the tubing and allow temporary access for system diagnosis and refrigerant recovery. Since the pliers obviously must be removed, they can only be used if the technician plans to recover the system refrigerant.

After piercing the system and recovering the refrigerant, a Schrader valve can be installed. Schrader valves are available for field installation in a variety of forms as seen in Figure 25-43. The core should be removed from the valve before brazing to avoid melting the plastic seals.



**Figure 25-45** These piercing pliers can be used to gain access to sealed systems

## UNIT 25—SUMMARY

Service valves are used to gain access to the refrigeration system. Type II and Type III systems all have service valves installed at the factory, Type I systems have process tubes. Commercial refrigeration systems typically use manual stem service valves on the suction and discharge sides of the compressor and on the liquid receiver. The normal operating position of a manual stem service valve is back seated. In the back seated position the service port is closed. System pressures can be read in the back seat cracked position. In the back seat cracked position, the valve is turned one-half turn off of the back seated position. Schrader valves are similar to the valves on car tires. They are found on most residential air conditioning systems. Schrader valves automatically open when a hose with a core depressor is connected and close when the hose is removed.

Type I systems must be accessed using piercing valves. Bolt-on piercing valves should be used for system diagnosis and refrigerant recovery, but should not be left on the system. Braze-on piercing valves can be used for access and may be left on the system. Care should be taken when installing a braze-on piercing valve because of the inherent danger of brazing on a system under pressure.

Gauge manifolds are used to read system pressure. They consist of a compound gauge to read low side pressures, a high pressure gauge to read high side pressure, a manifold and valves to control refrigerant flow through the gauges, and hoses to connect to the system. Gauges are available in a high pressure range suitable for R-410a, and in a lower pressure range suitable for everything else. Positive shut-off hoses or adapters help technicians control the flow of refrigerant in and out of the gauges, especially when using Schrader valves. The saturation temperature of common refrigerants can be read on the gauges by looking at the colored scales.

## WORK ORDERS

### Service Ticket 2501

**Customer Complaint:** Air Conditioner Freezes Up

**Equipment:** Packaged Terminal Air Conditioner (PTAC) Using R-22 Refrigerant

A service technician for the Rest Easy Motel chain is asked to look at a PTAC in one of the rooms because it cools poorly and freezes over. Like most PTACs, this one has no service valves of any kind. The technician knows that the two most common causes of air conditioning evapora-

tors freezing over are poor airflow and refrigerant undercharge. The technician decides to check the airflow first. The air filter is missing and the evaporator is very dirty. This is most likely causing reduced airflow over the evaporator. After cleaning the coil, the unit airflow is noticeably improved and the evaporator no longer freezes. The technician elects not to install a piercing valve and keep the system sealed. Instead, the system operation is checked by checking the system amp draw, airflow, and temperature drop across the evaporator coil.

### Service Ticket 2502

**Customer Complaint:** Unit Operates But Does Not Cool

**Equipment:** Packaged Terminal Air Conditioner (PTAC) Using R-22 Refrigerant

A service technician for the Rest Easy Motel chain is asked to look at a PTAC in one of the rooms because it operates but does not cool. Like most PTACs, this one has no service valves of any kind. The system operation is checked by checking the system amp draw, airflow, and temperature drop across the evaporator coil. The amp draw of the compressor is less than half of the normal RLA rating. The coil appears clean, the airflow is normal, but the supply air is the same temperature as the return air; no cooling is taking place. The technician decides to install a bolt-on piercing valve on the low side process tube. The reading on the low side with the compressor operating is 150 psig. The technician believes the compressor is bad, but decides to install a piercing valve on the high side process tube to be certain. The pressure on the high side with the compressor operating is also 150 psig. The compressor is condemned, the system refrigerant is recovered, the bolt on piercing valves are removed, Schrader valves are brazed in, a new compressor and liquid line filter are installed, the system is evacuated to 500 microns, and a charge is weighed in.

### Service Ticket 2503

**Customer Complaint:** Unit Does Not Cool Adequately

**Equipment:** Commercial Refrigeration Unit on Walk in Cooler with R-134a

A technician is called to look at a walk in cooler whose capacity has noticeably declined. A check of the system pressures at the suction and discharge service valves reveals that the suction pressure is very low and the high side pressure is just slightly low. Both the system superheat and subcooling are high. The technician looks for system restrictions and finds a sweating liquid line filter drier. The technician determines that the filter drier is restricted and decides to change the filter drier, but does not want to recover all of the refrigerant. Instead, the king valve is front seated and the system is operated until the

filter drier no longer sweats and the pressure on the line leaving the king valve is 0 psig. The technician turns off the unit and waits to make sure the pressure does not go above 0 psig. The old filter drier is replaced with a new filter drier, the system is evacuated from the suction service and king valves to 500 microns, the king valve is back seated, and the system is returned to service.

#### Service Ticket 2504

##### **Job: Check Oil for Acidity on Semi-Hermetic Compressor**

##### **Equipment: Commercial Refrigeration System with Semi-Hermetic Compressor**

A-1 Refrigeration changed the compressor in a commercial refrigeration system last week. A technician is sent to collect a small oil sample and perform an oil acid test on the oil to see if the oil is contaminated. The technician does not want to recover all the system refrigerant, but knows that the refrigerant pressure must be taken off of the compressor before opening the oil plug, so the technician decides to isolate the compressor using the suction and discharge service valves. First the system is operated long enough to warm up the crankcase and boil out any residual refrigerant from the oil. The system is turned off and locked out. Then gauges are installed on the compressor and both the service valves are front seated. The compressor is now isolated from the rest of the system. A recovery system is used to recover the small amount of refrigerant in the compressor. The crankcase plug is removed, a small oil sample taken, the plug replaced, and the oil is tested. The oil is clean, so the technician pulls a 500 micron vacuum on the compressor through the suction and discharge service valves. The service valves are back seated and the system is put back in operation.

## UNIT 25—REVIEW QUESTIONS

1. What do technicians use the gauge manifold for?
2. What are the colors used on a gauge manifold set and what do they indicate?
3. What is the term for slightly opening a valve?
4. List three cautions when handling a gauge manifold set.
5. Why is the low side gauge called a compound gauge?
6. How does a Bourdon tube work in a gauge?
7. What must always be put on a Schrader valve port when not in use?
8. Why is it not always a good idea to install a gauge set and check system pressure?
9. What type of units are required to have service valves?
10. What type of units are only required to have process stubs?
11. Explain the difference between the back seated position and the front seated position on manual stem service valves.
12. When using manual stem service valves, describe how to position both the service valves and the gauge manifold valves when reading system pressures.
13. Why are positive shut-off hoses helpful when using Schrader valves?
14. What is the purpose of the saddle or piercing valve?
15. How can refrigeration gauges show the saturation temperature of the refrigerant in the system?
16. What is the retard range on compound gauges for?
17. What is the normal pressure range for the compound and high pressure gauges made for use on R-410a systems?
18. What is the normal pressure range for the compound and high pressure gauges made for use on R-134a and R-22 systems?
19. What personal protective equipment (PPE) should be worn when using gauge manifolds?
20. What can be done to reduce the risk of exposure to liquid refrigerant spray?
21. What is the difference between the two ends of a refrigeration hose?
22. What service valves are normally found on a commercial refrigeration system?
23. Why do split system heat pumps have three service valves?
24. Describe how to remove a gauge manifold set from a system and put most of the trapped refrigerant back into the system.
25. Describe how to purge a gauge manifold set using only the high side service valve.
26. Describe how to purge a gauge manifold set when connecting to Schrader valves.
27. What tool is used to turn the stems on manual stem service valves?
28. Describe how split system installation valves are used.
29. Why are bolt-on piercing valves not supposed to remain on systems permanently?
30. What is a process tube?