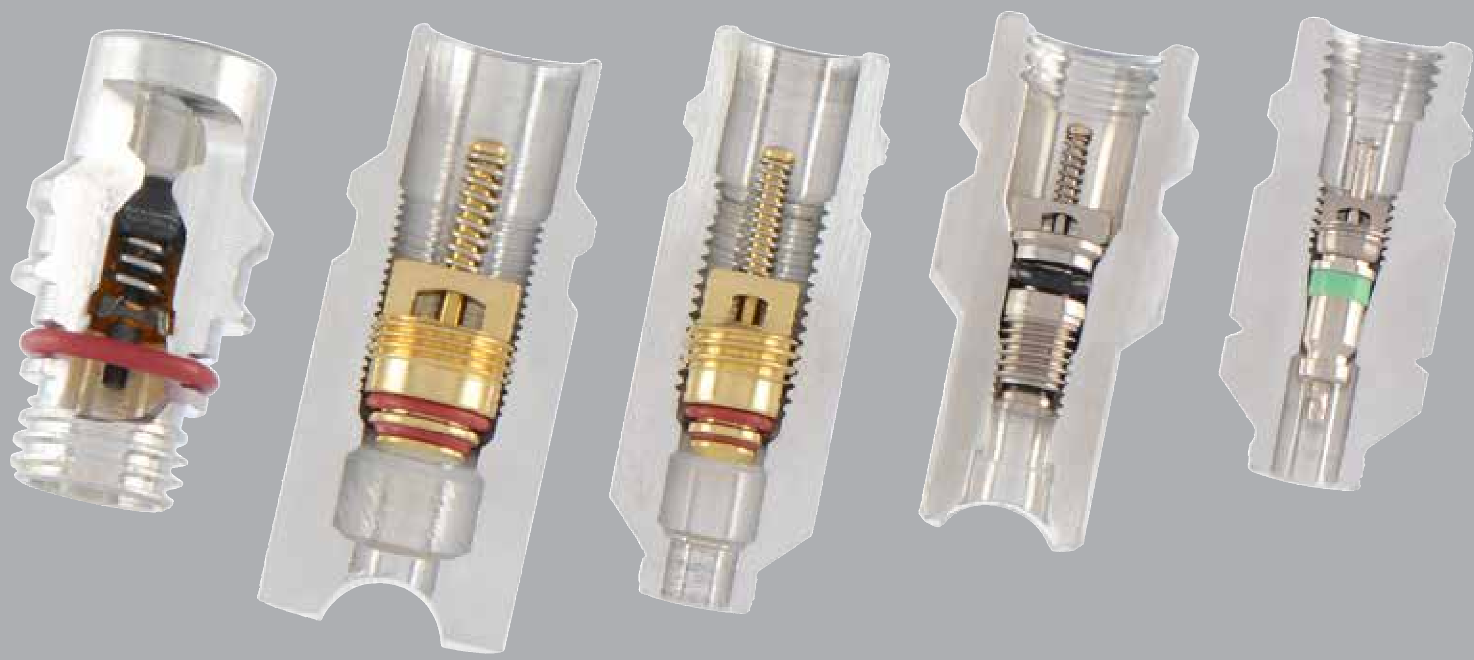
A/C Valve Application and Installation Manual

Mobile A/C Systems



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Scope

This engineering guide contains application and installation recommendations for refrigeration valves and cores used in mobile AC systems.

Specifications

The principal Technical Specification that governs the application of service and access ports for mobile AC applications is Society of Automotive Engineers (SAE) J-639. Other specifications that apply to particular valve designs described in this standard are governed by International Standards Organization (ISO), Tire & Rim Association (TRA), Japan Refrigerant Association (JRA), and American Refrigeration Institute (ARI).

Applications

The AC system has several access ports that are used to monitor and service the A/C system. These ports consist of a valve element inside a port that is usually brazed to the A/C line. The valve usually consists of a self-sealing rubber element activated by a depressor pin that opens and closes the A/C valve element.

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Table of Contents

Due to the variety of operating conditions or applications, the customer is responsible to perform their own testing to insure performance, safety and warning requirements for the intended application.

Section A
AC VALVE APPLICATION

A1 AC System ports
There are three distinct valve applications: high side service, low side service and access (both high and low side). The exterior configuration of the service ports are defined by SAE J639.

A1.1 High side service
The high side service port is a quick connect fitting that provides access to the high pressure side of the AC system. Most AC systems are evacuated and filled from the high side service port in the assembly plant. Accordingly, the high side service port should include a high flow capacity valve element to assure that the system can be evacuated to an appropriate vacuum level in the least time.

Valves usually utilized for the high side service port are the Primary Seal Integrated Valve (two-piece valve) and the 10 mm Valve core (one-piece valve). Smaller valves may be used in this application if the assembly plant processing allows sufficient time for the appropriate vacuum level to be achieved in the system with the lower flow rates cores. The high side service fitting exterior has a design which allows a quick connection to the A/C charging head. The quick connect design is specified by SAE J639, and there are different connection designs for each refrigerant to assure that there is no cross contamination of refrigerant.

A1.2 Low side service
The low side service port is a quick connect fitting that provides access to the low pressure side of the AC system. This port is used to evacuate and fill the AC system in service conditions, although sometimes the AC system is evacuated and/or filled from the low side service port in the assembly plant.

When used for assembly plant evacuation, the low side port usually utilized is the low side version of the Primary Seal Integrated Valve (two-piece valve) or the 8 mm Valve core (one-piece valve). Smaller valves such as the JRA core or standard core may be used in this application if this fitting is not used for assembly plant evacuation. The port exterior has a design which allows a quick connection to the A/C charging unit. The quick connect design is specified by SAE J639, and there are different connection designs for each refrigerant to assure that there is no cross contamination of refrigerant.

A1.3 Switch port
Access ports are provided on both the high and low side lines in AC systems for pressure and temperature sensing. These access ports often include a standard valve core between the sensing element and the refrigerant. The standard core is normally utilized in switch ports.

A1.4 Coupler Mating
The external configuration, and internal functional dimensions, of the high and low side service ports must meet the requirements of SAE J639. The ports may use any of the various valve cores described in this guide, which are chosen to meet specific vehicle and system requirements, and vehicle charging needs. Ports are designed specifically for each core so that the requirements of SAE J639 are respected.

A2 AC valves
Schrader-Pacific supplies two types of AC valves: valve cores within a separate port (referred to as a one-piece valve), and integrated valve/port (referred to as a two-piece valve). Drawings of the various valves and cores are shown in the following sections.

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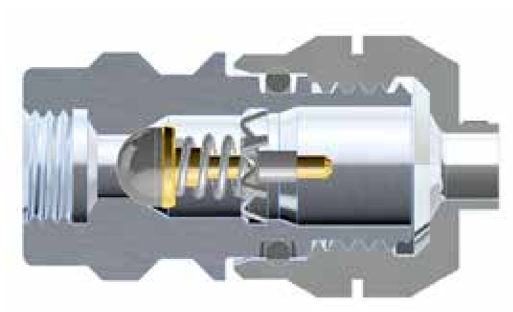
A.2.1 Integrated valves

Integrated Valves consist of a port with a sealing poppet permanently assembled within the port. The integrated valve is attached to a threaded adapter that is brazed to the AC line. A robust o-ring is used to seal the valve to the adapter. Integrated valves are available for both high and low side charge port applications.

A2.1.1 Primary seal

Both the high and low side Primary Seal valves are excellent choices for ports used for evacuation and fill. The Primary Seal charge valve has the valve element permanently assembled into the port, which provides a pre-tested and quality verified valve to the line manufacturer. This high flow valve is normally used for high side charge port applications that function to evacuate and charge the vehicle. The internal seal is a hemispherical rubber poppet that fits into a conical sealing surface assuring robust sealing. The coupler depressor pin contacts the rubber poppet directly for valve actuation. The SAE port dimensions are produced on the valve body, and the required seal location dimensions are machined into the body yielding robust dimensions that are not affected by core assembly variability. The primary seal charge valve is available for both high side and low side charge valve applications, in several different refrigeration styles. The primary seal charge valves are available with different rubber compounds for various applications. The primary seal charge valve attaches to an adapter which is normally brazed into the AC line, the attachment between the charge valve and adapter utilizes an o-ring connection.



R-134a High Side Primary Seal integrated valve

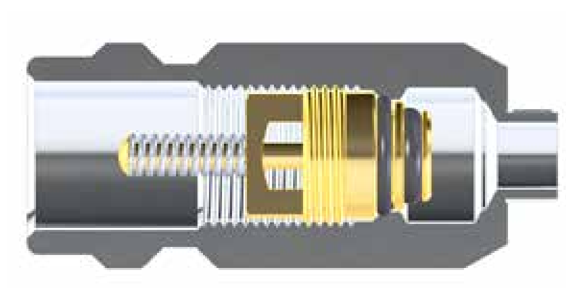
A2.2 Valve cores

Valve cores consist of machined brass bodies with rubber seals that are screwed into a separate valve port. The core seal is attached to a pin which is actuated when contacted by the coupler depressor. The core is screwed into a port which is generally fabricated of aluminum that is brazed or welded onto the lines. An external seal on the core, made of rubber or Teflon®, provides leak-free attachment between the core and port.

There are several styles of valve core available with different performance parameters, these are described in the following paragraphs. Valve selection should be based on system application needs and valve core performance parameters. Information below will assist in the correct selection.

A2.2.1 The 10 mm core

This high flow core is used only in high side charge port applications where the high flow capability of this core can be of great value. Both the internal and external seals are robust o-rings, which are available with different rubber compounds for various applications.

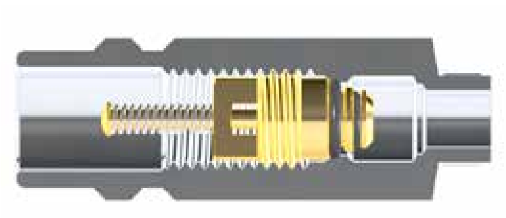


10 mm Core in a high side R-134a port

Due to the variety of operating conditions or applications, the customer is responsible to perform their own testing to insure performance, safety and warning requirements for the intended application.

A2.2.2 The 8 mm core

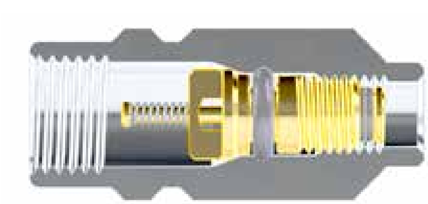
This medium flow core can be used on either the high side or low side charge port applications, although it is normally used on the low side of systems that utilize the 10mm core on the high side. This core is a good choice for low side charge valve ports if these ports will be used for assembly plant evacuation or charge. Both the internal and external seals are robust o-rings, which are available with different rubber compounds for various applications.



8 mm Core in a low side R-134a port

A2.2.3 The JRA core

This low flow core may be used on either the high side or low side charge port, but only in applications where high flow is not required. This valve core provides low permeation, although the small pin and light spring have lower robustness to coupler variability. The internal seals are a special molded section; the external seal is an o-ring. This core is available only in HNBR.

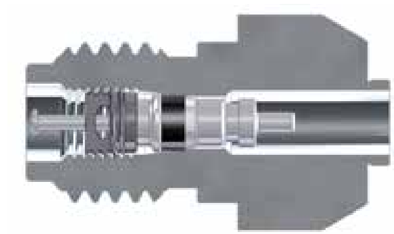


JRA Core in a low side R-134a port

A2.2.4 The Standard core

This core has been used extensively in switch port applications since the introduction of AC systems in mobile applications. The standard core offers great value for non-critical applications where low flow is not a sacrifice to system performance, and where dynamic service conditions do not exist.

This core has historically been utilized in both high side and low side charge ports, although the other cores and integrated valves are now recommended for these applications. Standard cores are available with different rubber compounds for various applications. Great care should be exercised when installing standard core in their mating ports due to the lower robustness of these cores to torque and assembly contamination.



Standard Core in a switch port

A3 Performance parameters

The key to successful AC valve specification is mating the requirements of the port performance to the capability of the selected valve or core. Following are two tables and a chart that provide parameters to assist in that determination.

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A3.1 Core selection

Table 1 is a summary of the key performance parameters for various AC valves. These parameters should be considered together with the relative valve capability shown in table 2 below when considering the selection of an AC valve for each system application.

Among the most critical requirements for the charge port is supporting fast evacuation of the AC system. A low residual pressure in the vehicle system assures that residual moisture has been removed. The evacuation port must allow a sufficient flow rate to evacuate the AC system to the required low pressure, within the allocated plant process cycle time. Chart 1 is a summary of test data of evacuation trials conducted on a typical mobile AC system using an assembly plant evacuation system. The evacuation pressure was monitored within the AC system; time to achieve 20 mm Hg was recorded for various Schrader-Pacific valves and cores.

SYSTEM APPLICATION	Low Permeation	High Flow	Robustness	Location
Evacuation & Charge	✔	✔	✔	HS, LS, Both
Service Access	✔		✔	LS
Switch Port	✔			Both HS & LS

Table 1. Valve Application Parameters

	Integrity		Flow
Valve	**Permeation**	**Robustness**	**Evacuation**
Primary Seal	+	++++	+++
10 mm Core	B	++	+++
8mm Core	++	++	++
JRA Core	++	+	+
Standard Core	++	B	B

B Denotes baseline values for relative strength

Table 2. Valve Performance Parameters

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SCHRADER PACIFIC
Advanced Valves

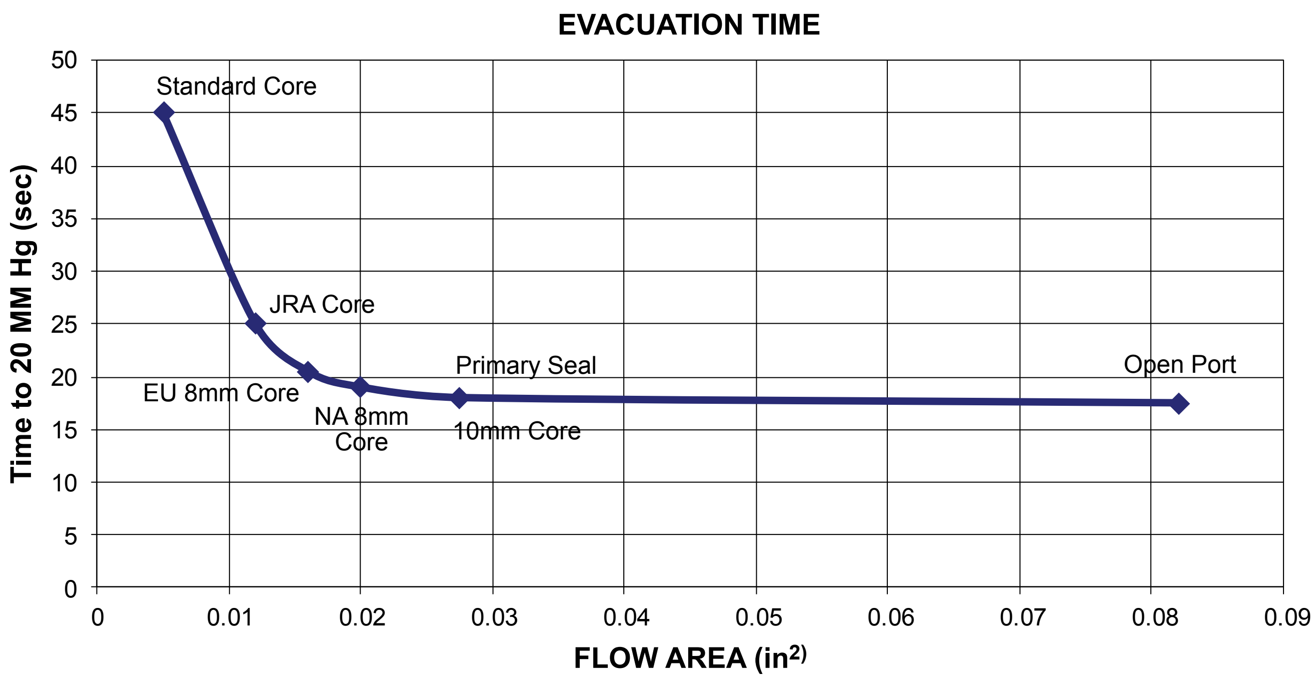

Chart 1. Evacuation time for various Schrader-Pacific valves

A4 Seal material

Schrader-Pacific valves and cores are available in a variety of seal materials for various applications. In general we recommend HNBR to provide the greatest robustness in the widest variety of applications, but other choices are available for specific system assignment. Some of the material choices available:

a. Chloroprene: This compound, commonly referred to as Neoprene is a traditional AC seal material with good compatibility to all mobile refrigerants and both mineral and PAG oil. This seal material is not recommended for use at temperatures above 120°C, All Schrader-Pacific valves except the JRA valve are available in chloroprene.

b. HNBR: The most broadly capable of the various compound choices, HNBR is recommended for system operating temperature up to 150°C. This rubber compound is compatible with all mobile refrigerants and mineral oil, PAG and POE. The low temperature range of older versions of HNBR is limited, the newer compound varieties are capable of good performance to -40°C. All Schrader-Pacific valves are available in HNBR.

c. EPDM: This compound provides the broadest operating temperature range of any compound, and may be used up to 180°C in extreme situations. EPDM is compatible with all mobile refrigerants with PAG oil. This compound cannot be used with mineral oil, and has shown compatibility issues with some POE oils. All Schrader-Pacific valves except the JRA valve are available in EPDM.

A5 Caps

All ports include thread features to attach a closure cap. Security of this cap is essential to the leak integrity of the port. Accordingly these caps include a rubber seal around the port mouth. SAE J639 requires that caps be used for charge ports, and suggest that these caps be tethered to prevent loss.

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Section B
AC VALVE INSTALLATION

B1 Valve installation

Appropriate procedures must be employed for effective assembly of AC cores and valves. Installation torque, lubrication and cleanliness are three areas of particular interest that should be addressed in procedure development. These procedures will differ for the various valves so it is important to have verified procedures for each valve and core type.

It is strongly recommended that valve cores be "started" by hand to minimize cross-threading. The small thread size and fine pitch of valve cores makes these threads susceptible to cross-threading. See section B1.5 for critical quality evaluations that are recommended following installation.

B1.1 Installation torque

Each valve core will have a different installation torque recommendation because the thread size is unique for each core. Torque of the integrated valve to its adapter will be different for the high and low side version.

Std. Core: 0.36 – 0.67 Nm / 3 – 6 in-lbs
JRA: 0.56 – 1.13 Nm / 5 – 10 in-lbs
8mm: 1.13 – 2.26 Nm / 10 – 20 in-lbs
10mm: 1.70 – 3.40 Nm / 15 – 30 in-lbs
Primary Seal (HS): 9.5 – 13.6 Nm / 7 – 10 ft-lbs
Primary Seal (LS): 6.8 – 9.5 Nm / 5 – 7 ft-lbs

All torque recommendations are for dry threads. If lubricants are used the installer should develop dry vs. lubricated correlation.

It is important that the torque be monitored during the installation process if possible, and that assessment of installation torque be taken in the "installed" direction. Breakaway torque is not an accurate way to verify the installation torque due to variability in material, surface friction, and surface conditions.

Note that the installation torque recommended above for the standard core differs from that specified in the TRA & ISO specifications. These industry specifications recommend an installation torque of 2 – 5 in. lbs. [0.23 – 0.56 Nm]; this recommendation does not allow for the greater robustness offered by the Schrader-Pacific "positive stop" core which allows for greater torque.

B1.1.1 Torque driver:

The proper tooling must be utilized in installing valve cores into their ports. The recommended torque for valve cores is very low for most automated drivers; damaged cores or inconsistent installation torque is a common processing issue. It is important that appropriate driver equipment be selected and properly adjusted, and that capability assessment of installed torque be made to assure that cores are being installed effectively. Schrader-Pacific has found that equipment such as the Deprag Minimat and Mountz® E-Driv® BF series drivers have provided capable torque control for the low torque required when used in accordance with recommended practices. It is recommended that core driver speed be carefully controlled as the small size and low torque required for core driving are very difficult to control if the driver operates at high speed.

Selection of torque driver for the integrated valves is less of a problem because the recommended installation torque is greater, and there are a greater variety of capable commercial drive systems available.

B1.1.2 Driver tip

Utilization of a proper valve core driver tip is essential to minimize damage to the valve core during the installation process. The design of the driver bit tip should have a radius on the edges which contact the core, and if the driver bit is introduced onto the core while spinning, a radius leading surface to allow seating on the core.

The driver bit must have a central bore with sufficient clearance to assure the bit does not contact the external spring on the 8mm, 10mm, and JRA cores. This is particularly critical for the JRA core which has a light spring that is vulnerable to damage from the driver bit.

All cores have different size driver features, and the

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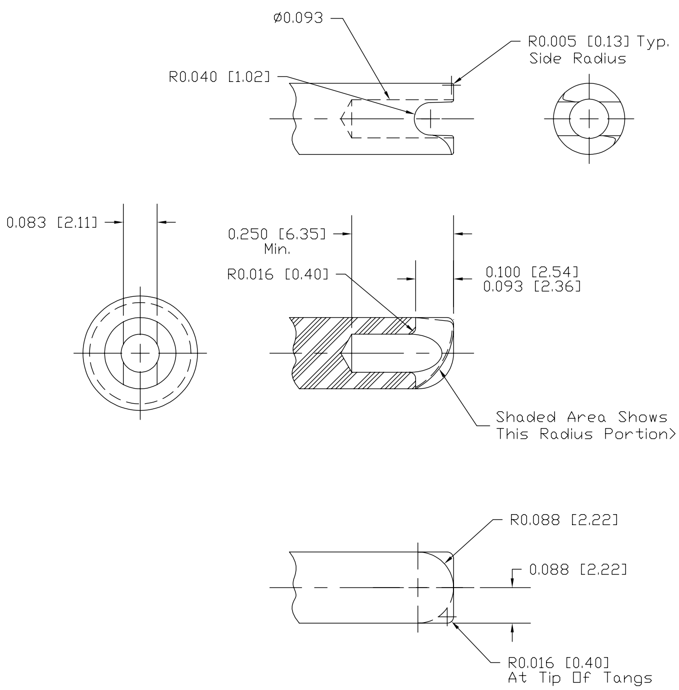
correct driver must be utilized for each core. Do not attempt to utilize a common driver for several core sizes.



Above is a suggested driver tip design for standard cores, similar features should be used for other core types.

For integrated valves, the exterior configuration is octagonal, and requires special bits which are commercially available. Do not use pliers or other tooling that is not designed for these valves.

B1.2 Lubrication

It is important to lubricate the external seal of valve cores, or of integrated valves, to prevent damage to the seal during installation. Excess lubrication, however, is to be avoided for two reasons:

a. The oil film on the external seal will confound leak test of the assembly by providing a second sealing element; excessive oil on the core may migrate to the internal seal and confound leak test of that seal as well. When this occurs the leak test is rendered ineffective.

b. Lubricant applied, or migrating to, the threads may reduce the coefficient of friction at the threads. This will increase the amount of torque transferred to the core body, and may cause core failure within the recommended torque value.

It is recommended that the lubricant used is the same as the refrigerant oil used in the system, so that chemical compatibility between the lubricant and the seal is assured.

B1.3 Cleanliness

Contamination is the greatest enemy of AC system durability, and of AC valve robustness. All surfaces of the AC port must be carefully cleaned to assure a leak tight assembly. Machining debris and braze flux contamination are common causes of surface contamination that have caused defective assembly performance, these must be removed from the ports prior to core assembly. Use of the Primary Seal integrated valve reduces the potential for thread and braze flux contamination.

B1.4 Port machining

The importance of properly machined housings cannot be over-stressed. Of particular importance are the location and dimension of the "positive stop" feature that locates and supports the core within the port, and the dimension and surface finish of the mating diameter to the external o-ring. For standard cores the location and angle of the mating surface is also important. The use of the Primary Seal integrated valve reduces the potential for adapter issues causing valve leakage since the critical internal seal mating features are produced in the factory by Schrader-Pacific.

The surface quality of the internal threads in the port is also critical to the cleanliness of the final assembly, as some amount of metallic debris in the threads of aluminum housings is unavoidable. This is particularly important when the internal thread in the port that accepts the core is extended for the cap mounting, and the core is threaded a greater distance. In these cases there will be a potential for increased debris generated in the threading process.

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B1.5 Assembly quality

Following assembly of the core into the port, or attachment of the integrated valve onto its adapter, the assembly should checked to assure that the assembly was completed correctly. There are two checks that should be used: pin height check, and leak integrity.

Valve cores should be tested for pin height to assure the core is properly installed within the port, and for leakage to assure the external seal is properly seated. Primary Seal integrated valves have the pin height set at the factory, and therefore will not require a pin height test. Schrader-Pacific does not recommend that any other checks, such as pin travel or function, be attempted.

B1.5.1 Pin height

Each AC port has a correct depth for the top of the valve pin from the top of the port. For high side and low side charge ports that dimension is specified by SAE J639; adherence to that specification will assure that the service couplers will interface with the port correctly. Each different refrigerant has a different pin height specification. For R-134a the core pin height should be between 6.1 mm and 7.1 mm below the mouth of the port. For R-1234yf the core pin height should be between 8.3 mm and 9.3 mm below the mouth of the port for both the high side and low side ports.

Switch port cores should have a pin height between 6.1 mm and 7.2 mm below the mouth of the valve.

B1.5.2 Leak test

Each completed connection should be leak tested to assure the assembly was accomplished properly. Schrader-Pacific recommends that this test be done with the system charged with refrigerant using a halogen leak detector calibrated for the refrigerant used. Schrader-Pacific recommends an acceptance leak rate of 1.0 x 10-5 cc/sec for this test. Appropriate test methods must be developed because this acceptance level is very low and subject to corruption from external influences. If this test is conducted on a valve that had been under a cap for any period of time the volume in the valve mouth must be well vented to remove residual build-up of refrigerant under the cap.

While leak tests with other fluids are sometimes used, results of these tests may not be valid. For example, while test results with helium can be corrected to account for the lower density of helium, there is no correction for molecule size, so helium tests will generally indicate higher leak rates than the valve will exhibit with refrigerant.

Pressure is another leak test parameter that must be carefully chosen. It is conventional wisdom to conduct leak tests with as high a pressure as practical, this is appropriate for leak testing metal systems because the higher pressure will improve test sensitivity. But with rubber sealed systems that procedure may be counter-productive. Higher pressures will increase the load on the seal and will tend to minimize seal inconsistencies. Therefore Schrader-Pacific recommends conducting a dual stage leak test, first at 300 psi (2 MPa) to check metal joints and secondly at 25 psi (0.18 MPa) at the elastomeric seals so that the process can detect the smallest possible system imperfections.

B2 Temperature

It is not recommended to subject a Valve Core assembled into a Valve Body to temperatures above the normal operating temperatures. Transient seen during brazing and oven curing for paints and other coating processes are to be avoided. Permanent damage to the seals and loosening of the core may occur resulting in leaks or reduced durability.

B3 Serviceability

Valve Cores are not to be reused under any circumstances after removal from the Valve Body. The external sealing element of the core will take a "compression set", conforming to the mating port surface after installation. This is a common phenomenon for rubber, and contributes to the robustness of rubber seals. But after the core has been removed and reinstalled the seal may experience difficulty sealing to another position with different surface conditions. Therefore it is recommended that service personnel always install a new core when servicing the system.

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B4 Assembly plant

The charge ports used for evacuation and charge in the assembly plants are subject to significant stress and potential abuse. The principal issues are driven by the coupler interface, evacuation and charging pressure, and contamination.

B4.1 Coupler interface

The coupler must seal to the charge port, otherwise there will be a sealing fault noted which will result in rejection of the charge. The coupling should be designed for sealing on the outer diameter of uppermost diameter of the charge port to assure a leak-free connection to the valve port as required in SAE J639. The o-ring that seals the coupler to the charge port is part of the coupler, it must be maintained appropriately to maintain its condition for capable sealing. Replacement of this o-ring on a periodic basis, as frequently as once per shift is highly recommended. It is also recommended that the coupler be supported in a manner so that it is placed over the charge port with proper alignment. The steel coupler body can, if not properly aligned during the connection process, damage the charge valve or scratch the soft aluminum port causing a vacuum leak and resultant rejection of charge.

Assembly plant charge heads are generally pneumatically actuated, locking onto the quick connect features of the port, and driving a depressor pin onto the valve core. The coupler pin travel should be periodically checked, and should not exceed 8.3 mm for R-134a ports (10.5 mm for R-1234yf ports). Pin travel beyond these values may cause permanent damage to the charge valve.

The coupler pin diameter should be no larger than 3.2mm in diameter where the pin enters the mouth of the Primary Seal integrated valve. Larger diameter pins will restrict the flow area of the valve, reducing the flow capacity resulting in sub-optimal vehicle evacuation in the assembly plant.

B4.2 Charge pressure

Charge pressure should not exceed 600 psi. Pressure beyond 600 psi may cause damage to the charge valve.

B4.3 Contamination

Contamination is the greatest enemy of AC valve integrity, and may be introduced at every stage in its life cycle.

Ports for cores should be checked for retained machining chips that can become trapped in the interior port features. During line assembly processing contamination may be introduced to the valve port in the brazing operation. Braze migration, splatter, and flux may extend into the sealing area. This is especially critical with cores that have their external sealing element lower on the core.

Metallic debris is generated during the installation of the core in its port, as the core threads slide across the port threads. Ports with deep cores using the same threads for the cap have longer thread travel and present a correspondingly greater risk.

The evacuation process will cause any loose material, metal chips and shavings in the AC system to be carried to the evacuation port. This debris may become lodged in the valve causing a leak. There is no valve preventative action that may be taken to reduce the potential for this to occur.

Another form of contamination in the AC system is moisture. While moisture will not be a detriment to the valves, the presence of moisture will interfere with system evacuation, resulting in charge rejection. Understanding the effects of moisture on the evacuation process is necessary to effectively resolve assembly plant evacuation and charge issues.

B4.4 Caps

Following charging, caps will be attached over the high side and low side charge ports. These caps should be firmly finger tight. There is no single cap torque recommendation since there are a large variety of caps with different sizes, materials and using different seal materials.

The caps are an integral component of the valve system, and play and key role in assuring system integrity. Not only do the caps serve as a redundant seal to the valve, but the caps assure the valves and port surfaces remain clean while the vehicle is in service.

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Section C

SERVICING AC VALVES

The valve system is comprised of the valve and the cap, both contribute to the service sealing of the port. Initial leak testing to a vehicle thought to have a refrigerant leak should be conducted with the cap in place as it was when the vehicle was in service.

Leak testing of the vehicle should be conducted with an SAE J1627 compliant halogen leak detector, "sniffing" all potential leak sources. If there is no indication of leakage around the cap than the port is not the source of the leak. If a leak is indicated than the next step will be to remove the cap and test the valve. We suggest the following process:

1. After removing the cap, look closely at the condition of the space under the cap. The presence of refrigerant oil of fluorescent dye is an indication that there is leakage past the valve. Look also for the presence of contaminants that may have been introduced at previous re-charging operations.

2. If there was no cap installed clean the external surfaces of the port so that later, when re-charging, the coupler can seal properly to the port.

3. When utilizing a halogen leak detector:

a. First, be sure the leak detector is set to detect the refrigerant used in the system. Many halogen leak detectors are calibrated for several common refrigerants, be sure you are set to detect the correct refrigerant.

b. Next set the leak detection scale. We recommend using a leak scale no less than 10 grams/year (0.35 oz/year). This will allow searching for significant leaks with less possibility of false indications which occur with very low sensitivity settings.

c. It is important when "sniffing" the valve that the space under the cap be evacuated of retained refrigerant. Accordingly blow-out the port opening with compressed air blast, wait two minutes and blow-out the port a second time.

d. After clearing the port of retained refrigerant vapor, slowly pass the "sniffer" probe across, and two inches above, the port opening. If the detector gives a consistent and repeatable indication then there is a leak in the port.

4. If there is a leak within the port, it's important to find and correct, the cause of the leak.

a. Retighten the core to 4 in-lb and recheck for leaks. (Occasionally a core leaks because it has vibrated loose or was misassembled). Remove the core if a leak is detected after retightening.

***CAUTION:* The AC system is pressurized. If the core requires removal evacuate the system with SAE J2788 compliant Recovery and Recycling Unit before removal to prevent injury and the escape of refrigerant into the atmosphere.**

b. Look for contamination on the valve seal, look at the condition of the seals, and the "smoothness" of the internal surfaces of the port. Based on experience some of the more frequent causes of valve leaks are:

i. Contamination. The valve core is the smallest passage through which the AC system is evacuated. Contamination from many sources can become lodged in the valve causing a leak. If the vehicle is operated on the road without a cap, road dust and debris may have been introduced into the valve during an earlier service action. If the leak was caused by contamination than the port must be cleaned as well as possible and the system flushed prior to recharging.

ii. Valve Degradation. There are many valve designs and versions available in the market, not all will work in all systems. Use of valves with the wrong rubber compound may be incompatible with the refrigerant or refrigerant oil used, or be not suitable for the temperatures in the vehicle. If the leak was caused by a degraded valve, the valve must be replaced by the correct version valve. We recommend the Schrader-Pacific "Universal" valve family, this set of valves has been designed for use in the greatest variety of systems.

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iii. Valve Damage. A misadjusted service coupler may damage the valve and cause it to subsequently leak. We recommend that all service couplers be periodically examined to assure the depressor pin is not damaged or misadjusted. Publication SAE J639 gives the proper depressor pin length for the various refrigerants in use.

iv. Defective Port machining. This would be the most difficult defect to find, and correct. Service technician so not have the instruments required to assess valve port quality. If none of the three potential causes listed above seem to be the cause of the leak, and a new valve does not correct the leak, than the cause is most likely a defective port. The corrective action in this case is to remove and replace the entire line, with a new port and valve.

5. In all cases we recommend that if the valve core is removed from the port it should be replaced with a new core. Over time the external rubber seal of the core takes a "set" and may not seal with the same robustness as a new component.

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