

Thermostatic Expansion Valves

Installation, Field Service, and Assembly



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■ Installation

For peak performance, it is important to select a Sporlan Thermostatic Expansion Valve (TEV) with correct capacity, selective charge, external or internal equalizer, etc. See Bulletins 10-9 and 10-10 for complete application information. Equally important is the proper installation, which can determine the success or failure of the entire system.

Valve Location

TEVs may be mounted in any position, but they should be installed as close to the evaporator as possible. If a refrigerant distributor is used with the expansion valve, best performance is obtained if the distributor is mounted directly to the valve outlet. If the distributor cannot be mounted directly to the valve outlet, the distance between the valve outlet and distributor should not exceed 24 inches or refrigerant distribution problems may occur. Also, the tube connecting the valve outlet and distributor can be sized smaller to maintain refrigerant velocity and better distribution. Elbows located between the expansion valve and distributor will hinder proper distribution and therefore, are not recommended.

Best distribution is usually obtained if the expansion valve feeds vertically up or down into the distributor. System manufacturers, however, have successfully applied distributors in other orientations.

See Bulletin 20-10 for application and selection information on refrigerant distributors.

While not always convenient or possible, valve Types BI, F, FB, and O are easier to service if mounted in a vertical and upright position. If mounted in a horizontal position, the internal parts must be carefully reassembled to prevent damage to them. Also, some consideration should be taken in mounting larger sized expansion valves. They must be adequately supported since system vibration and the weight of the valve may cause valve connections to fracture.

If a hand valve is located on the outlet side of the TEV it should have a full sized port. No restrictions should appear between the TEV and the evaporator, except a refrigerant distributor if one is used.

Sporlan TEVs having Selective Charges C, Z, L, or X may be installed and operated in most locations. The amount of thermostatic charge and the bulb size are such that the bulb retains control despite a colder valve body or diaphragm case. The exception is when the element is subjected to sub-zero temperatures for extended periods of time during an off-cycle. In this case, start-up may be prolonged until the bulb and element are warmed sufficiently to open the valve.

To minimize the possibility of charge migration, the Sporlan MOP type charges (CP series, ZP series, and VGA) should be installed so the diaphragm case is warmer than the bulb. Special non-condensable charges without MOP and double diaphragm hydraulic elements with MOP are available for system manufacturers to overcome this potential problem.

Occasionally, TEVs are located in corrosive atmospheric conditions that can damage the valve and/or the element assembly. Due to this possibility, the valve must be protected with appropriate materials to prevent premature failure. Consult specialists in protective coatings.

Precautions:

When the evaporator and TEV are located above the receiver, there is a static pressure loss in the liquid line. This is due to the weight of the column of liquid refrigerant, and this weight may be interpreted in terms of pressure loss in pounds per square inch as shown in Table 3, Bulletin 10-9. If the vertical lift is great enough, vapor or **flash gas** will form in the liquid line causing a serious reduction in the capacity of the TEV.

When an appreciable vertical lift is unavoidable, precautions should be taken to prevent the accompanying pressure loss from producing liquid line vapor. This can be accomplished by providing enough subcooling to the liquid refrigerant, either in the condenser or after the liquid leaves the receiver. Subcooling is determined by subtracting the actual liquid temperature from the condensing temperature (corresponding to the condensing pressure). A subcooling calculation example is provided in the "subcooling" section of Bulletin 10-9.

Liquid subcooling is provided by the following methods:

1. In the condenser
2. Suction – liquid heat exchanger
3. Special devices

Method 1 – will provide sufficient subcooling for the simple short-coupled system that has only moderate liquid line pressure drop.

Method 2 – will usually not provide more than 20°F subcooling on air conditioning systems operating at normal head pressures. The amount of subcooling will depend on the design and size of the heat exchanger and on the operating suction and discharge pressures.

Method 3 – may be used to provide considerable subcooling required for systems with excessive vertical lift. The following special devices are the most commonly used methods:

- Water coils in heat exchange relationship with the liquid line.
- Separate refrigeration system.
- Special heat exchanger which uses a portion of the refrigerant to cool the main body of liquid. See Figure 1.

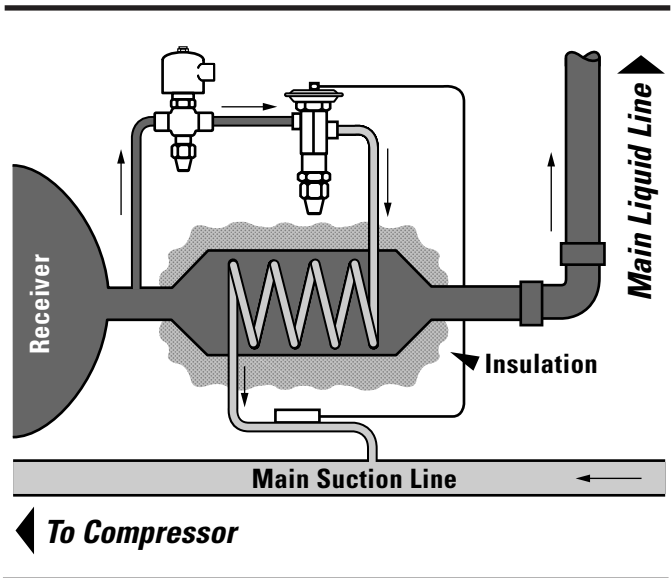


Figure 1

Ordinarily the conventional suction-liquid heat exchanger is installed near the evaporator, where the suction vapor is the coldest, to re-condense any vapor in the liquid line. When the primary purpose of the heat exchanger is to prevent the formation of flash gas – particularly on systems that have a long liquid line or excessive vertical lift – install the heat exchanger near the receiver **before the vertical lift occurs**. (This also applies to the special devices described in Method 3). Because vapor in the liquid line considerably increases friction losses, the total pressure drop available across the expansion device on these types of systems is reduced. Also, the suction line and liquid line should be carefully insulated to minimize heat gain if subcooled below ambient temperature.

Important

Preventing the formation of vapor in liquid lines having high pressure losses does not eliminate the requirement that an adequate pressure drop must be available across the TEV. The capacity tables show valve capacities at pressure drops lower than normal. For TEV application data and capacities at pressure drops below those listed, **consult Sporlan Valve Company**.

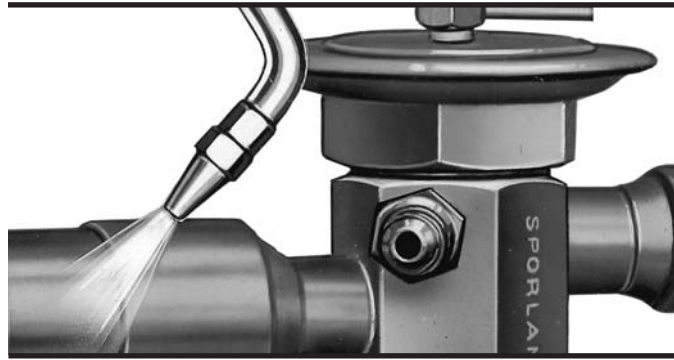


Figure 2

Solder Techniques

It is not necessary to disassemble solder type valves when soldering to the connecting lines. Any of the commonly used types of solders, e.g., 95-5, Sil-Fos, Easy-Flo, Phos-Copper, Stay Brite 8 or equivalents may be used for copper to copper connections. When soldering a brass refrigerant distributor to the valve, appropriate solders for these connections, such as 95-5, Easy-Flo, Stay Brite 8 or equivalents must be used. It is important however, regardless of the solder used, to direct the flame away from the valve body and avoid excessive heat on the diaphragm, Figure 2. As an extra precaution, a wet cloth may be wrapped around the body and element during the soldering operation.

This precaution will prevent overheating the valve body which could damage the superheat spring and result in flood back problems. In addition, the Type O, EBF/SBF, and EBS valve contain synthetic parts which can be damaged due to overheating, resulting in poor valve performance.

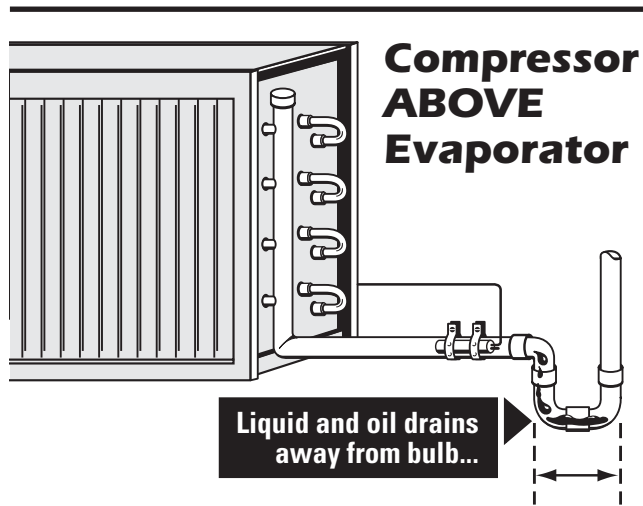
Bulb Location and Installation

The location and installation of the bulb is extremely important to the proper performance of the system and care should be taken with its final location.

Accepted principles of good suction line piping should be followed to provide a bulb location that will give the best possible valve control. When system manufacturers have piping recommendations that differ from the general industry recommendations and Sporlan’s suggestions shown in this section, those recommendations should be used. When specific recommendations are not available, the suggestions below should be used.

The bulb should be attached to a horizontal suction line at the evaporator outlet (See Figures 3, 4, and 5) If the bulb cannot be located in that manner, it may be located on a **descending** vertical line only (as shown in Figure 5 for “pumpdown control”). The bulb should never be located in a trap or downstream of a trap in the suction line. Liquid refrigerant or mixture of liquid refrigerant and oil boiling out of the trap will falsely influence the temperature of the bulb and result in poor valve control.

On suction lines 7/8” OD and larger, the surface temperature may vary slightly around the circumference of the line. On these lines, it is generally recommended that the bulb be installed at 4 or 8 o’clock on the side of the horizontal line, and parallel with respect to the direction of flow. On smaller lines the bulb may be mounted at any point around the circumference, however locating the bulb on the bottom of the line is not recommended as an oil-refrigerant mixture is generally present at that point. Certain conditions peculiar to a particular system may require a different bulb location than normally



Short as possible to minimize amount of oil.

Figure 3

recommended. In these cases the proper bulb location may be determined by trial.

For satisfactory expansion valve control, **good thermal contact** between the bulb and suction line is essential. The bulb should be securely fastened with two bulb straps, supplied with each expansion valve, to a clean straight section of the suction line.

Recommended suction line piping usually includes a horizontal line leaving the evaporator to which the TEV bulb is attached. This line is pitched slightly downward, and when a vertical riser follows, a short trap is placed immediately ahead of the vertical line, see Figure 3. The trap will collect any liquid refrigerant or oil passing through the suction line and prevent it from influencing the bulb temperature.

On multiple evaporator installations the piping should be arranged so that the flow from any valve cannot affect the bulb of another. Approved piping practices including the proper use of traps

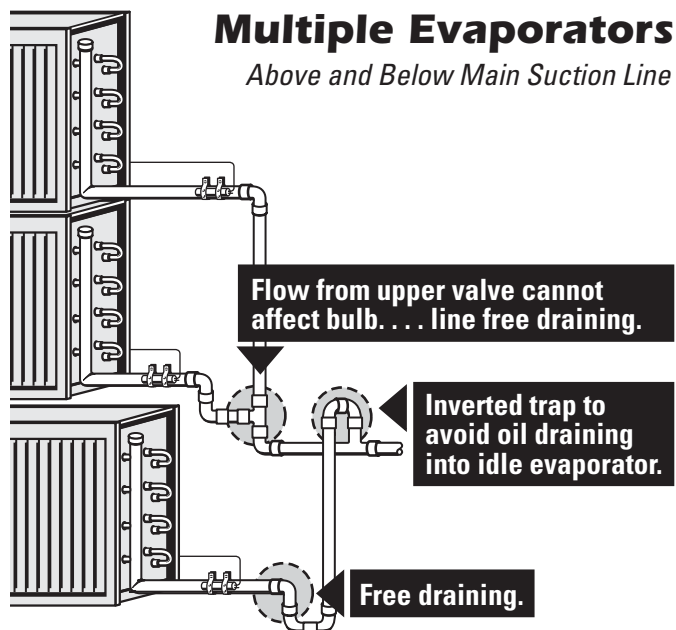


Figure 4

insures individual control for each valve without the influence of refrigerant and oil flow from other evaporators.

For recommended suction line piping when the compressor is located below the evaporator see Figure 5. The vertical riser extending to the height of the evaporator prevents refrigerant from draining by gravity into the compressor during the off-cycle. When a pumpdown control is used the suction line may turn immediately down without a trap.

On commercial and low temperature applications requiring Sporlan Selective Charges C, Z, or X the bulb should be clamped on the suction line at a point where the bulb temperature will be the same as the evaporator temperature during the off-cycle. This will insure tight closing of the valve when the compressor stops. If bulb insulation is used on lines operating below 32°F, use non-water absorbing insulation to prevent water from freezing around the bulb.

On brine tanks and water coolers, the bulb should be below the liquid surface where it will be at the same temperature as the evaporator during the off-cycle. When locating the bulb in a brine tank, paint it and the capillary tubing with pitch or other corrosion resistant paint.

If, for practical reasons, the bulb must be located where its temperature will be higher than the evaporator during the off-cycle, a solenoid valve must be used ahead of the TEV.

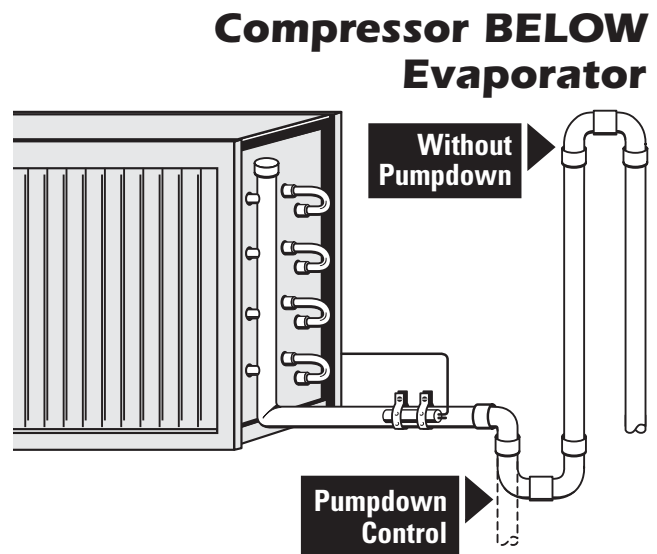


Figure 5

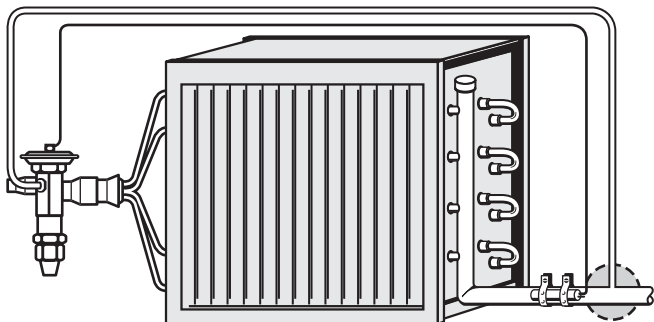
On air conditioning applications having TEVs equipped with VCP100 or VGA elements, the bulb may be located inside or outside the cooled space or duct. The valve body should not be located in the air stream leaving the evaporator. Avoid locating the bulb in the return air stream unless it is well insulated.

External Equalizer Connection

For a complete explanation of when an externally equalized valve should be used, refer to "equalization method," Bulletin 10-9. Valves supplied with an external equalizer **will not operate** unless this connection is made.

The equalizer connection should be made at a point that will most accurately reflect the pressure existing in the suction line at the bulb location. See Figure 6. Generally, the connection is immediately downstream of the bulb. However, equipment manufacturers sometimes locate them in return bends or suction headers that are

External Equalizer Connection



***It must be connected - NEVER CAPPED!
Must be free of crimps, solder, etc.***

Figure 6

compatible with their specific design requirements. The difference between the pressure at the equalizer connection and the suction pressure at the bulb location should not exceed reasonable pressure drop values. The values shown in Table 1 of Bulletin 10-9 can be used as a guide in determining the value.

If any evaporator pressure or temperature control valves are located in the suction line at or near the evaporator outlet, the equalizer must be connected on the evaporator side of these valves.

Driers, Strainers, and Accessories

Most Sporlan TEVs are equipped with built-in screens of varying mesh sizes depending on the valve size and type. These strainers are effective only in removing particles of scale, solder, etc. which could obstruct the closure of the pin and seat.

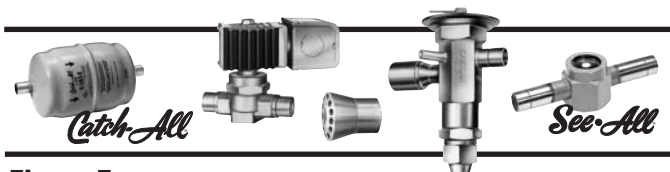


Figure 7

Moisture and smaller particles of foreign materials are equally harmful to the system and must be removed for peak system performance. Field experience has proven that, without a doubt, most expansion valve failures are due to the presence of dirt, sludge, and moisture in the system. Furthermore, the performance and life of other system components are also seriously affected by these foreign materials. The Sporlan **Catch-All Filter-Drier®** removes dirt, moisture, acids, and sludge, and insures the circulation of clean, dry refrigerant through the system at all times.

For all refrigeration and air conditioning applications we recommend that a Sporlan Catch-All Filter-Drier be installed in the liquid line ahead of the TEV. See Bulletin 40-10 for complete Catch-All Filter-Drier specifications.

Further system protection is easily and inexpensively provided with the installation of a Sporlan **See-All®**. The See-All is a combination liquid and moisture indicator that visually indicates if there is a shortage of refrigerant in the liquid line, or if the moisture content of the refrigerant is at a dangerous level. See Bulletin 70-10 for complete See-All specifications.

Test Pressures and Dehydration Temperatures

Inert dry gases such as nitrogen, helium or CO₂ are often used for leak detection.

CAUTION: Inert gases must be added to the system carefully through a pressure regulator. Unregulated gas pressure can seriously damage the system and endanger human life. Never use oxygen or explosive gases.

Excessive test pressures can shorten the life of the TEV diaphragm. Table 1 lists the maximum pressure that can safely be applied with the expansion valve connected to the evaporator. These maximum pressures are well above the minimum field leak test pressures for low sides, listed by the ANSI/ASHRAE Standard 15-2001 or latest revision.

The external equalizer line should be disconnected if there is any possibility of exceeding the recommended maximum pressures listed below.

If elevated temperatures are used to assist in dehydrating the system, the TEV should not be exposed to temperatures exceeding those shown in Table 2.

Table 2 refers to the maximum dehydration temperatures when the bulb and valve body are subjected to the same temperature. On L, C, Z, and X charges, 250°F maximum valve body temperature is permissible **if the bulb temperature** does not exceed those shown in the table.

**Table 1
Maximum Low Side Test Pressures**

Valve Type	psig
(B)I, X, NI, F, FB, (E)BF/SBF, RI, G, EG, C, S, EBS, Small O	450
D, P, H, Large O	425
A, M, V, W	400

**Table 2
Maximum Dehydration Temperatures – Degrees F**

Refrigerant	Thermostatic Charge					
	L	C	Z	X	VGA	P Type, ZP Series
12, 134a	190	190	250		---	250
22	160	160	185	210	250	
404A, 502, 507	150	150	170		---	
717 (Ammonia)	150	190	235	---	---	---

Expansion Valve Adjustment

Each Sporlan TEV is thoroughly tested and set at the factory before shipment. This factory superheat setting will be correct and no further adjustment is required for the majority of applications. However, there are many factors which can affect the performance of a TEV. These factors are independently variable and all of them cannot be compensated for in the design of a valve. When the application or operating conditions require a different valve setting due to one or more of the factors listed below, the valve may be adjusted to obtain the required operating superheat. Therefore, an adjusting stem is provided on all standard valves. The valve should be set with the system as near as possible to design conditions.

Factors which affect valve performance and may make it necessary to adjust the valve are:

1. Low temperature difference (TDs) between the refrigerant and the air
2. TEV bulb location
3. Balance between compressor and evaporator
4. Ratio of load to TEV capacity
5. Condenser capacity
6. Operation of several fixtures on multiple installation
7. Seasonal variation in head pressure caused by extreme changes in ambient air temperature.

Note: Valve Types F, (E)BF/SBF, Q, A, M, V, K, and W have non-adjusting stems and a change in adjustment does not change the stem position.

When setting valves on multi-evaporator refrigeration systems with pressure or temperature sensitive evaporator control valves, the following procedure is recommended:

1. Evaporator Pressure Regulating Valve (ORI Type): the ORI valve is set first at the minimum load condition. Then, if necessary, the expansion valve is adjusted to the desired superheat setting while under the normal operating load condition.
2. Temperature Sensitive Evaporator Regulating Valves (CDS Type): The CDS valve is forced into a fully open position first. Then the expansion valve is adjusted to the desired superheat setting at full load condition. Finally, the controller for the CDS is set to the desired temperature. Contact Sporlan Valve Company, or the case manufacturer, for additional details on setting the CDS controller.

When the adjustment is completed on the TEV, always tighten the adjusting stem packing nut and replace the seal cap tightly.

Many expansion valves are made **non-adjustable** for use on Original Equipment Manufacturer's units, particularly those valves used on residential air conditioning and heat pump systems. These valves are set at a superheat predetermined by the manufacturer's laboratory tests and cannot be adjusted in the field.

Some **non-adjustable** models are modifications of standard adjustable type valves. This is done by using a solid bottom cap instead of one equipped with an adjusting stem and seal cap. These valves can be identified by an **N** preceding the standard valve designation. Adjustable bottom cap assemblies are available for converting most non-adjustable valves to the adjustable type. However, this is rarely required. If symptoms indicate that a valve adjustment is needed, carefully check the other possible causes of incorrect superheat, pages 6 through 10, before attempting an adjustment.

How to Determine Superheat Correctly

1. Measure the temperature of the suction line at the bulb location.
2. Obtain the suction pressure that exists in the suction line at the bulb location by **either** of the following methods:
 - a. If the valve is externally equalized, a gauge in the external equalizer line will indicate the desired pressure directly and accurately.
 - b. Read the gauge pressure at the suction valve of the compressor. To the pressure add the estimated pressure drop through the suction line between bulb location and compressor suction valve. The sum of the gauge reading and

the estimated pressure drop will equal the approximate suction line pressure at the bulb.

3. Convert the pressure obtained in **2a** or **2b** above to saturated evaporator temperature by using a temperature-pressure chart.
4. Subtract the two temperatures obtained in **1** and **3** – the difference is superheat.

Figure 8 illustrates a typical example of superheat measurement on an air conditioning system using Refrigerant 22. The temperature of the suction line at the bulb location is read at 52°F. The suction pressure at the compressor is 66 psig and the estimated suction line pressure drop is 2 psi ... 66 psig + 2 psig = 68 psig at the bulb, which is equivalent to a 40°F saturation temperature. (Use dew point temperature for refrigerant blends.) 40°F subtracted from 52°F = 12°F superheat.

Note: Refrigerated case manufacturers frequently use a “temperature difference” method to approximate superheat. This procedure consists of measuring the temperature of a location on the evaporator which is representative of saturated vapor temperature; and, then subtracting that temperature from the outlet evaporator temperature which is measured at the bulb location.

While this method of reading “superheat” is acceptable on those manufacturer's cases where the pressure drop through the evaporator is low, Sporlan does not recommend the “temperature difference” method for other types of systems.

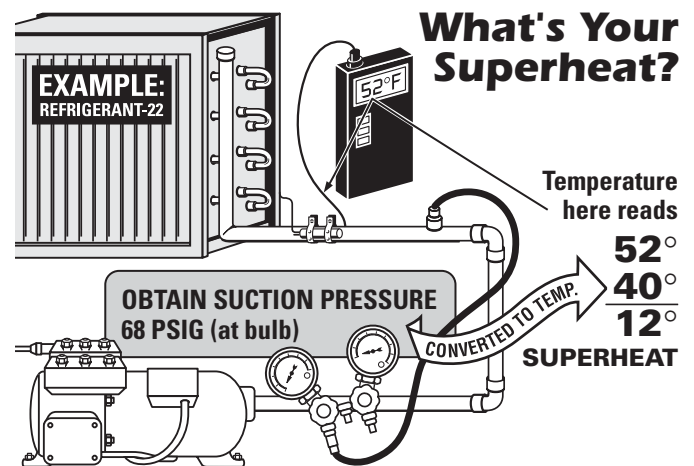


Figure 8

How to Change the Superheat Setting

Note: There are some valve bodies (G, EG, C, S, EBS and EMC) that have a packing nut around the adjustment stem. It may be necessary to loosen the packing nut slightly to turn the adjusting stem. Do not forget to retighten the nut after the superheat is set.

To reduce the superheat, turn the adjusting stem **counter-clockwise**. To increase the superheat, turn the adjusting stem **clockwise**. When adjusting the valve, make no more than one turn of the stem at a time and observe the change in superheat closely to prevent **over-shooting** the desired setting. As much as 30 minutes may be required for the new balance to take place after an adjustment is made.

If in doubt about the correct superheat setting for a particular system, consult the equipment manufacturer. As a general rule, the proper superheat setting will depend on the amount of temperature difference (TD) between refrigerant temperature and the temperature of the air or other substance being cooled. Where high TD's exist, such as on air conditioning applications, the superheat setting can be made as high as 15°F without noticeable loss in evaporator capacity. Where low TD's exist, such as in low temperature blower coil applications, a superheat setting of 10°F or below is usually recommended for maximum evaporator capacity. It is these applications that the TEV will more than likely need to be adjusted.

For the correct valve setting on factory built equipment, manufacturers' recommendations should be followed. Some manufacturers specify the superheat directly; others may recommend valve adjustment to a given suction pressure at certain operating conditions, or until a certain frost line is observed. Such recommendations, however they are stated, represent the results of extensive laboratory testing to determine the best possible operation.

■ Field Servicing

The TEV is erroneously considered by some to be a mysterious and complex device. As a result, many valves are needlessly replaced when the cause of the system malfunction is not immediately recognized.

Actually the TEV performs only one very simple function – **it keeps the evaporator supplied with enough refrigerant to satisfy all load conditions.** It is not a temperature control, suction pressure control, a control to vary the compressor's running time, or a humidity control.

How effective the valve performs is easily determined by measuring the superheat as outlined in Figure 8. Observing the frost on the suction line, or considering only the suction pressure may be misleading. **Checking the superheat is the first step in a simple and systematic analysis of TEV performance.**

- **If not enough refrigerant is being fed to the evaporator – the superheat will be high.**
- **If too much refrigerant is being fed to the evaporator – the superheat will be low.**

Although these symptoms may be attributed to improper TEV control, more frequently the origin of the trouble lies elsewhere.

Note: TEVs with permanent bleed ports (BP) or Rapid Pressure Balancer (RPB) construction are applied on many air conditioning and refrigeration systems by original equipment manufacturers. Each application is tested and approved by the manufacturer. The primary function of these devices is to equalize high-to-low side pressures during the off cycle on systems equipped with low starting torque compressors.

However, some BP type valves are applied to allow small amounts of liquid refrigerant to pass for compressor motor cooling. The specific function of the feature on a given unit must be determined from the system manufacturer. Once that is determined, it is easier to troubleshoot the system.

The primary cause of difficulty with either the BP or RPB feature is dirt and other foreign materials that restrict or plug them. And if the system purpose intended for either feature is not being satisfied, the valve probably needs cleaning or replacing.

As stated in Bulletin 10-9, the RPB type valve is not to be applied on systems using high starting torque compressors or "hard-start" electrical components, on outdoor coils of heat pumps, or on any refrigeration system, and it should **not** be used to replace BP type valves that are applied on those types of systems. On systems other than those described above, the RPB type valve can replace the BP type valve when necessary. Usually it is advisable to replace a valve with one of the same specification unless advised differently. Consult with the system manufacturer for assistance.

Complaint "A"

"Valve does not feed enough refrigerant."

SYMPTOMS:

- **Load temperature (air or water leaving evaporator) too high.**
- **Superheat too high.**
- **Suction pressure lower than normal with compressor unloaders locked out or hot gas bypass shut off.***

THE CAUSE MAY BE:

1. **Moisture** — Water or a mixture of water and oil frozen in the valve port or working parts of the valve will prevent proper operation. This is a common source of trouble on expansion valves. Since the valve is the first cold spot in the system, moisture will freeze and block the valve open, closed, or any position in between. If the valve is frozen in the intermediate position so that flow is restricted, the superheat will be high.

Remedy — Install a Sporlan Catch-All Filter-Drier in the liquid line for removal of moisture from the refrigerant and oil. See Bulletin 40-10.

To determine a safe level of moisture in the system, install a Sporlan See•All Moisture and Liquid Indicator. See Bulletin 70-10.

Excessive moisture has a damaging effect on all system components regardless of the evaporating temperature. Moisture must be removed for trouble-free performance.

2. **Dirt or foreign material** — Contaminants such as copper oxide scale, metal chips, oil breakdown sludge, etc. will restrict the flow of refrigerant when it collects in strainers or other liquid line accessories. This produces a shortage of refrigerant at the TEV port. Conventional strainers frequently allow the material to pass through the screen and obstruct the flow at the valve port. If a See•All is installed downstream of the restriction, bubbles will be visible. This should not be confused, however, with a refrigerant shortage or excessive liquid line pressure loss which are also indicated by bubbles in the See•All.

Remedy — Locate and remove the foreign material creating the restriction. Install a Sporlan Catch-All Filter-Drier to provide effective filtration of the refrigerant. See Bulletin 40-10.

* When system has some form of capacity reduction — cylinder unloaders or hot gas bypass, a low suction pressure will not exist. Therefore, when checking TEV performance, a better analysis is possible when these devices are locked out or shut off so the suction pressure will respond to variations in load or valve feed.

- 3. Wax** — Certain systems are contaminated with small amounts of wax which will precipitate at low temperatures in systems with Refrigerants 22 or 502. Since the TEV represents the first cold point in the refrigeration cycle, wax is most likely to form at the valve port.

It is sometimes difficult to observe the wax in a valve because it may exist in solid form only at very low temperatures. By the time the valve has been taken apart, the temperature has increased enough to cause the wax to melt and thus become difficult to detect. When wax is suspected, it can usually be detected on the pin and seat by packing the valve in dry ice while disassembling.

Remedy — Clean the valve with solvent before reassembling the valve. The Sporlan HH style Catch-All Filter-Driers have a special activated charcoal desiccant that is designed to remove wax in the liquid line before it causes trouble. Therefore, to prevent wax problems, use these HH style driers (e.g., C-415-S-HH) on all low temperature systems using Refrigerants 22 or 502.

- 4. Refrigerant shortage** — See All or sight glass in the liquid line will show bubbles when the system is short of refrigerant charge. Before adding more refrigerant however, be sure the bubbles are not produced by other causes (See Paragraphs A-2 and A-5).

A lack of refrigerant charge may also be detected by a hissing sound at the TEV. Some systems not equipped with a liquid line sight glass will have test cocks or other devices for checking the refrigerant level in the receiver.

Remedy — Add enough refrigerant to obtain desired result.

- 5. Gas in the liquid line** — As explained in Paragraphs A-2 and A-4, liquid line vapor can be produced by a partially plugged strainer or drier and by a shortage of refrigerant charge. In addition, gas in the liquid line can be caused by air or other non-condensable gases in the system or by excessive pressure losses in the liquid line as a result of:

- Long or undersized line.
- Liquid line vertical lift.

Remedy — Verify the correct liquid line size for the equivalent length and system tonnage. Consult liquid line sizing data published in many manufacturers' catalogs and in textbooks. If undersized, repipe with the correct size.

Determine amount of vertical lift, and obtain the resulting pressure loss from Table 3, Bulletin 10-9. Using the subcooling calculation example provided in the "subcooling" section of Bulletin 10-9, find required subcooling necessary to prevent gasification with the existing pressure losses. Provide the necessary subcooling by using one of the methods described on Page 1.

- 6. Misapplication of internally equalized valve or incorrect location of external equalizer** — If the pressure drop through the evaporator exceeds the predetermined values shown in Table 1, Bulletin 10-9, an externally equalized valve must be used. When an externally equalized valve is used, the equalizer connection should be made at a point in the suction line that will reflect the pressure existing in the line at the bulb location.

Remedy — Replace internally equalized valve with one having an external equalizer.

If external equalizer is installed incorrectly, change to correct location. See Page 3.

- 7. Insufficient pressure drop across valve** — One of the factors that influence expansion valve capacity is the pressure drop that exists between the inlet and outlet. Anything contributing to a reduction in this pressure drop will reduce valve capacity. Abnormally low condensing pressures, excessive liquid line pressure losses (even with adequate subcooling), undersized distributor nozzle or distributor tubes may also be responsible for a very low net pressure drop across the valve port.

Remedy — Remove source of pressure loss, or install valve with adequate capacity at the reduced pressure drop. If inlet pressure to valve is low due to low condensing pressure, raise pressure.

If the refrigerant distributor nozzle is undersized replace with correct size. See Bulletin 20-10.

- 8. Dead thermostatic element or wrong thermostatic charge** — If the element has partially or completely lost its thermostatic charge, the valve will be unable to feed sufficient refrigerant or will remain closed. A wrong charge may cause insufficient feed also.

Remedy — Replace the element if it is dead. If charge is incorrect, replace with proper selective charge. See Bulletin 10-9.

- 9. Charge migration (CP series, ZP series, and VGA charges only)** — In order for valves with these charges to maintain control at the bulb, the bulb must be kept at a lower temperature than the element (diaphragm case). If the thermostatic charge does migrate to the element because of a lower element temperature, the valve will throttle.

Detection — Warm the element with a cloth saturated with hot water. If this produces more refrigerant feed and reduces the superheat to normal, charge migration is responsible for the starved evaporator.

Causes —

- Insufficient pressure drop between the valve outlet and bulb location, possibly due to an oversized distributor nozzle or no nozzle at all.
- Excessive pushrod leakage, which allows the leaking refrigerant to cool the diaphragm case before passing into the equalizer line. This is a rare occurrence and should be carefully checked before arriving at this conclusion.
- Cold location of TEV, or condensate drippage on the diaphragm case.

Remedies —

- Install distributor nozzle correctly sized in accordance with nozzle sizing procedure given in Sporlan Bulletin 20-10.
- On valves with packed pushrod construction, remove element and tighten the pushrod packing nuts.
- Relocate the TEV away from cold outlet air, or condensate drippage.

10. Undersized valve

Remedy — Install valve sized in accordance with procedure given in Bulletin 10-9, or Bulletin 10-10.

11. High Superheat adjustment

Remedy — Turn the adjusting stem counter clockwise until the correct superheat is indicated.

- 12. Feed-back from another valve** — Review instructions for Bulb Location and Installation, Page 2.

Remedy — Check the bulb temperature and calculate the superheat. If superheat is normal but too little refrigerant is

flowing through the evaporator, check the piping for possible refrigerant flow from another evaporator affecting the bulb. Re-pipe if necessary. See Figure 4.

13. High pressure drop through evaporator

Remedy — Check the pressure at the evaporator inlet and outlet with gauges. If pressure difference is greater than the values shown in Table 1, Bulletin 10-9, use an externally equalized valve.

14. Restricted, plugged, or capped external equalizer —

If the pressure under the diaphragm builds up due to pushrod leakage and cannot escape through the external equalizer line, the valve will remain closed.

Remedy — Check the external equalizer line to be sure it is open or not capped.

Complaint "B"

"Valve feeds too much refrigerant."

SYMPTOMS:

- **Liquid returns to compressor.**
- **Superheat is low.**
- **Suction pressure is normal or higher than normal.**

THE CAUSE MAY BE:

1. Moisture — Water or a mixture of water and oil frozen in the valve port or working parts of the valve will prevent proper operation. This is the most common source of trouble on TEVs. Since the valve is the first cold spot in the system, moisture will freeze and block the valve open, closed, or any position in between. If the valve is held in the open position by ice, liquid flood-back will occur.

Remedy — Install a Sporlan Catch-All Filter-Drier in the liquid line for removal of moisture from the refrigerant and oil. See Bulletin 40-10.

For additional protection, install a Sporlan See•All Moisture and Liquid Indicator for a positive indication of when a safe moisture level is reached. See Bulletin 70-10.

2. Dirt or foreign material — Contaminants such as copper oxide scale, metal chips, oil breakdown sludge, etc. may pass through ordinary strainers and lodge at the TEV port and prevent the valve from closing.

Remedy — Disassemble the valve and remove all foreign material from the internal parts. Install a Sporlan Catch-All Filter-Drier in the liquid line. The Catch-All filters out the smallest particles of foreign material that might interfere with the operation of any system component.

3. Expansion valve seat leak — When the valve port does not seat tightly, refrigerant will pass through during the off-cycle and fill the evaporator with refrigerant. If the seat leak is severe, the valve will feed too much refrigerant during the operating cycle as well. (Not applicable to valves with permanent bleed ports or RPB feature.)

Remedy — If the valve seat is leaking, a gurgling or hissing sound can usually be heard during the off-cycle. Also, a sight glass or See•All in the liquid line may indicate continued refrigerant flow for a long period after the compressor has stopped. Make certain however, that the bubbles are not the result of **back-flow** through a vertical liquid line.

Disassemble the valve to be certain that dirt or foreign material is not responsible (see **B-2**). If the pin and seat are worn or damaged and an internal parts kit is available, replace the parts. When parts are not available, the valve must be replaced.

4. Oversized valve — Check valve ratings considering all the factors which affect its capacity. See Page 16, Bulletin 10-9, or Page 3, Bulletin 10-10.

Remedy — Install correctly sized valve.

5. Incorrect bulb installation — The bulb should be securely fastened to a straight, clean, section of the suction line using two bulb straps for good thermal contact. Also, the temperature of the bulb should not be influenced by ambient temperature — an external heat source such as a steam pipe or heating coil.

Remedy — Install bulb correctly. See Bulb Location and Installation, Page 2.

6. Low superheat adjustment

Remedy — Turn the adjusting stem clockwise until the correct superheat is indicated. See Page 4.

7. Incorrect thermostatic charge

Remedy — Select and install the correct selective charge. See Bulletin 10-9.

8. Incorrectly located external equalizer

Remedy — Relocate external equalizer or the connection between evaporator and any other temperature or pressure sensitive evaporator control valve near bulb location. See Page 3 for recommendations.

9. Inefficient compressor — If the compressor is inefficient or for some other reason lacks capacity, the suction pressure will operate higher than normal. This may or may not be accompanied by low superheats.

Remedy — Consult with compressor manufacturer.

Complaint "C"

"Valve feeds too much refrigerant at start-up only."

SYMPTOMS:

- **Liquid returns to compressor.**
- **No superheat.**
- **Suction pressure higher than normal.**

THE CAUSE MAY BE:

1. Refrigerant drainage — Drainage of refrigerant from the evaporator (during the off-cycle) when installed at a higher level than the compressor.

Remedy — Install a trap-riser to top of evaporator or use pump-down control. See Figure 5.

2. Compressor or suction line in cold location — During the period when the system is not in operation, liquid refrigerant will condense at the coldest point in the system. Liquid will condense in the compressor or suction line, if they are located in an ambient temperature below that of the evaporator during the off-cycle. Upon re-starting, this liquid will slug the compressor.

Remedy — Keep compressor or suction line warm during the off-cycle. Some compressors are equipped with crankcase heaters

for this purpose. Another corrective measure is to install a suction line solenoid valve that is de-energized during the off-cycle.

3. Restricted or plugged external equalizer — A momentary flood can occur when the load increases suddenly, such as at start-up because the higher suction pressure cannot reach the underside of the diaphragm and help close the valve. If the pressure under the diaphragm increases due to any pressure leakage around the pushrods, the valve will eventually throttle.

Remedy — Remove the restriction or plugged portion of the external equalizer.

4. Liquid line solenoid valve seat leak or interrupted pumpdown — Liquid refrigerant can continue to feed the TEV and/or remain in evaporator upon shut-down causing flood-back to the compressor upon start-up.

Remedy — Disassemble and clean solenoid valve and/or replace damaged internal parts if seat leakage is the problem. If the pumpdown cycle isn't completed before the compressor cycles off, or the thermostat calls for cooling and reopens the liquid line solenoid before the evaporator has been properly evacuated, check the low pressure cut-off setting or the electrical controls for possible causes.

Complaint "D"

"Valve doesn't feed properly."

SYMPTOMS:

- **Poor system performance.**
- **Superheat normal or lower than normal.**
- **Suction pressure lower than normal with compressor unloaders locked out or hot gas bypass shut off.***

THE CAUSE MAY BE:

1. Unequal circuit loading (Multi-circuit evaporators and parallel evaporators connected to a single refrigerant distributor) — When each circuit is not subjected to the same heat load, the lightly loaded circuits will allow unevaporated refrigerant or low temperature vapor to enter the suction line and throttle the valve. This will cause normally loaded circuits to be deprived of their share of refrigerant. The net result is a loss of refrigerated evaporator surface.

Remedy — Make necessary modifications which will allow each evaporator circuit to receive the same percentage of the total load. See Bulletin 20-10 for application information on multi-circuit evaporators using a refrigerant distributor.

2. Poor refrigerant distribution (Multi-circuit evaporators and parallel evaporators connected to a single refrigerant distributor) — If the refrigerant distribution is faulty, the circuits receiving the largest portion of refrigerant will have the controlling influence on the TEV. The result is the same as in paragraph 1 above.

Remedy — Correct refrigerant distribution. See Bulletin 20-10 for complete information on Refrigerant Distributors.

3. Low load— Low evaporator load may be caused by insufficient air over the coil as a result of an undersized blower, dirty air filters, or an obstruction in the air stream. In addition, frost formation on the coil or low entering air temperatures will reduce the evaporator load.

Remedy — Correct the condition responsible.

4. Flow from one coil affecting TEV bulb of another (Multiple evaporator systems only) — The temperature of the bulb may be falsely influenced by flow from another evaporator usually because of incorrect piping.

Remedy — Correct the piping. See Figure 4, Page 3.

5. Improper compressor-evaporator balance — If the compressor is too large for the load and evaporator capacity, the low suction pressure which results will cause poor system performance.

Remedy — Consult with the manufacturer or consulting engineer, or the ASHRAE Handbook on component balancing. If necessary, change or correct the improperly sized component. Hot gas bypass may be used to balance properly.

6. Evaporator oil-logged — Poor heat transfer occurs and unpredictable performance takes place. If erratic performance is observed over a period of time, and other causes are omitted from consideration, review the amount of oil in the system. Turbulent compressor oil level with little or no return to the compressor sump indicates oil problems.

Remedy — Remove excessive oil from evaporator and connecting piping. Many times the evaporator temperature will be too low for the oil to be removed. Therefore, the system must be allowed to warm sufficiently to get cold oil to drain. Analyze system components for possible causes of oil problem before restarting the system. Consult with the compressor manufacturer for specific details on their compressor.

Complaint "E"

"System hunts or cycles."

SYMPTOMS:

- **Suction pressure fluctuates***
- **Superheat fluctuates.**
- **Valve does not feed enough, and then too much refrigerant.**

THE CAUSE MAY BE:

1. System characteristics — Certain design characteristics of the system may have an effect on the system's tendency to hunt or cycle. As an example, after the valve admits refrigerant to the evaporator inlet, there is a time delay before the bulb senses the effect at the evaporator outlet. This time delay is dependent on evaporator length, tube size, and load. Generally, there is more likelihood for hunting to occur when this time interval is long. Other influencing factors are circuit arrangement, load per circuit, and temperature difference.

Remedy — When hunting is moderate particularly with no floodback, the effect on the system is insignificant and correc-

* When system has some form of capacity reduction — cylinder unloaders or hot gas bypass, a low suction pressure will not exist. Therefore, when checking TEV performance, a better analysis is possible when these devices are locked out or shut off so the suction pressure will respond to variations in load or valve feed.

tions are not necessary. If hunting is severe with floodback to the compressor, check the possible remedies shown in paragraphs below.

2. Valve size — An over-sized valve usually aggravates hunting. Carefully check the valve rating considering all the factors affecting its capacity. See Bulletin 10-9, or Bulletin 10-10.

Remedy — Replace valve with one correctly sized. On multiple circuit evaporators using a refrigerant distributor, the capacity of the valve can be reduced, within certain limits, by installing a smaller distributor nozzle. See Bulletin 20-10.

3. Bulb location — If the bulb is located in a suction line trap, its temperature will be affected by liquid oil and refrigerant alternately collecting and evaporating at this point. This condition frequently results in severe hunting.

Remedy — As a temporary measure relocate the bulb away from the trap, and any turbulent areas created by elbows, tees, etc. Also remove the bulb from the air stream or insulate. Re-pipe if necessary. Sometimes another position around the circumference of the suction line will minimize hunting. Follow the Bulb Location and Installation instructions given on Page 2 for the best TEV control.

4. Refrigerant and load distribution — In addition to the effects of poor distribution explained in paragraphs D-1 and D-2, hunting also frequently results. This is caused by liquid refrigerant from the overfed circuits occasionally reaching the bulb of the valve.

Remedy — Correct the faulty distribution.

5. Superheat adjustment — All Sporlan TEVs are preset at the factory to give the best performance on the average system. A valve should not be adjusted unnecessarily, but occasionally another setting may prove to be better.

Remedy — Turn the adjusting stem clockwise a turn at a time. If the hunting stops or is reduced, turn the adjusting stem counter clockwise a turn at a time to obtain the lowest superheat with stable operation.

6. Moisture — As ice forms in a TEV from excessive moisture, a very erratic hunt may result.

Remedy — Remove the moisture with the installation of a Sporlan Catch-All Filter-Drier. A safe moisture level can be determined by installing a Sporlan See•All.

5. System is hunting or cycling. See Section E on Page 9.

6. The TEV has been physically abused in an effort to make the valve work properly. This is usually the result of a mistaken analysis. It is frequently assumed that if a valve does not feed properly, it is stuck (either opened or closed). Beating the valve body with a hammer will only distort the body and make it impossible for the valve to work once the real cause is determined.

If a valve “sticks,” it is usually due to moisture freezing in the port, dirt and other foreign material restricting or plugging the internal parts, wax forming on the internal parts at low temperatures, or the valve has been physically abused so it **cannot** function.

Remedy — Inspect the valve and its internal parts, including the inlet strainer. If plugged or restricted in any way, clean the parts thoroughly, oil the parts with a good grade of refrigerant oil, and reassemble the parts. Complete details on this subject are found on Pages 10 through 12.

If the valve is beyond normal cleaning processes, or if it is physically damaged in any way, replace the valve with its proper replacement model.

Field Assembly Instructions

Sporlan valves may be opened easily for inspection.

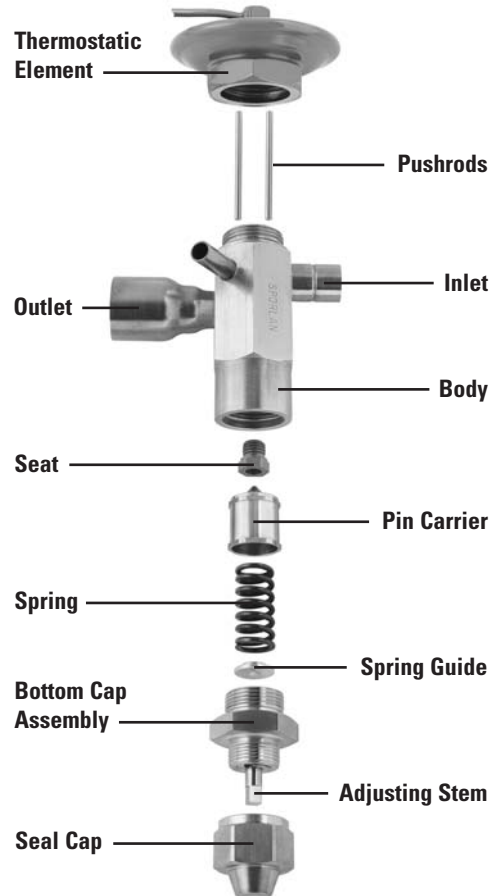


Figure 9

Complaint "F"

"System won't perform properly."

SYMPTOM:

- Cannot get valve to react or regulate at all.

THE CAUSE MAY BE:

- No refrigerant being fed to evaporator.** See Section A on Pages 6 & 7.
- Too much refrigerant being fed to evaporator.** See Section B on Page 8.
- Too much refrigerant being fed to evaporator at start-up only.** See Section C on Page 8.
- Refrigerant control is erratic.** See Section D on Page 9.

Note: These Field Assembly Instructions apply in part to all Sporlan TEVs. See Figure 9 for an “exploded” view of those models that can be completely disassembled. When a TEV is to be disassembled for inspection and cleaning, or for replacement of the thermostatic element or the internal parts, the following information should be reviewed for assistance.

Types F dated approximately C84 or earlier and Types I, BI, NI, RI, FB manufactured prior to 1994 do not have replaceable elements nor internal parts kits, but can be disassembled for inspection and cleaning. Type F dated D84 or later, Type S valves dated B69 or later, Type C valves dated C70 or later, and **ALL** Type G, X, (E)BF/SBF and EBS valves employ packless pushrod construction and internal parts are NOT available for use with them. However, their elements can be replaced and they can be disassembled for inspection and cleaning. Due to the single pushrod construction of the Type (E)BF/SBF and EBS valves, only the bottom cap assembly, pin guide, and superheat spring may be removed for inspection and cleaning.

Early production of the Type F valve with the replaceable element requires a 15/16" **thin jaw**, open end type element wrench such as a Bonney 1230. Subsequent production of the Type F valve and all Types (E)BF/SBF, I, BI, NI, RI, and FB valves require a 1" **thin jaw**, open end type element wrench such as the one available from Sporlan wholesalers. An open end wrench is necessary because of limited space between the body and element of these valves. Precautions must be taken in removing the KT-43 element (F) so the element, body, or connections are not damaged by the wrenches.

While standard open end or adjustable wrenches fit the other element sizes, the **thin jaw** type wrenches are also available for the other element sizes: Bonney 1236 (1-1/8") for KT-53 elements, Bonney 1240 (1-1/4") for KT-83 elements, Bonney 1248 for KT-33 elements, and Bonney 1252 for KT-63 and 7 elements.

Replaceable elements and internal parts kits are available for current valves with **packed** pushrod construction: Types P, H, M, D, and A.

Replaceable elements for Types O, V, W, and U are also available. However, special field assembly instructions are included with their internal parts kits.

Assembling Instructions

The following steps are necessary in properly disassembling, inspecting, cleaning, and reassembling a TEV whether the valve is in or out of the refrigerant piping.

1. Before disassembling the valve, be sure the refrigerant pressure in the system has been reduced to a safe level (**0 psig**).
2. Remove the seal cap and turn the adjustment stem counter-clockwise to relieve the spring force. Count and record the number of turns so adjustment can be returned to its original position.
3. Using appropriate wrenches or a vise to properly support the valve body, remove the element (if a replaceable type), the bottom cap assembly, and the internal parts. (Only remove the bottom cap, pin guide, and superheat spring on Type (E)BF/SBF and EBS valves. **DO NOT** remove the single pushrod from these valves.)

Caution: Regardless of whether the valve is in the system or in a vise, care must be taken to prevent distorting the body by

exerting too much pressure in tightening the element or in clamping the body in the vise. Also, do not use a wrench on the outer welded edge of the element.

4. Inspect parts, element, and body for any foreign materials or physical damage.
5. On valves with replaceable elements and/or internal parts, replace any items that appear damaged.
6. Clean all parts with solvent, preferably by applying and then blowing off with clean dry compressed air.

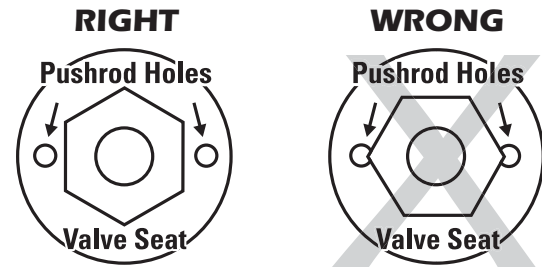


Figure 10

7. To reassemble valves with replaceable seats, screw seat into body with a fairly light pressure since it does not require a heavy pressure to make this small knife-edge joint.

Caution: Be sure hexagon corners of seat do not protrude into pushrod holes (see Figure 10).

For valves that do not have replaceable elements or for Type O valves, place the pushrod(s) into the body now.

8. Next, slip the pin and carrier (which have been pressed together at the factory) into the body and tap the pin into the seat to form a true seating surface. It is generally advisable, before tapping these parts together, to check the concentricity of both the pin and seat by engaging the parts by pressing them lightly together with one finger and noting that there is no tendency to stick together. This should be repeated several times after rotating the pin carrier a quarter of a turn. In assembling valves with port sizes of 1/4" and larger which use the flat disc instead of the tapered pin, **DO NOT TAP THE DISC AGAINST THE SEAT**.
9. Now place the spring guide stamping (when used), and spring, in the pin carrier, place the lower spring guide on the opposite end of the spring and screw the bottom cap in place. (Replace the pin guide, spring, and bottom cap assembly together on Type (E)BF/SBF and EBS valves.) After screwing bottom cap assembly in place, carefully tighten, preferable with two 10" wrenches, to seal the metal-to-metal knife edge joint. The sealing surfaces should be free of any foreign material or nicks that might prevent a leak-tight joint.
10. On valves with replaceable elements (except Types O, (E)BF/SBF and EBS), place the pushrods into the body and open the valve several times by pressing down on the pins with a flat metal surface. This will help seat the pin properly.
11. Check the height of the pushrod(s) above the element sealing surface with the pushrod gauge (see Figure 11). The gauge is supplied with internal parts kits or can be obtained at no charge

Table 3

Valve Type ^①		Gauge Number
Current	Obsolete	
AA(E), LMC-AA(E)	---	1
DA(E), LMC-DA(E)	---	2
PFE or HFE-1 ¹ / ₂ , 3, 4, 5, 8, 12	PFE or HFE-6, 7 ¹ / ₂ , 10, 11	3
PVE or HVE-2 ¹ / ₂ , 5 ¹ / ₂ , 7, 11, 16, 20	PVE or HVE-2, 5, 8, 10, 12, 15, 17, 18	
PDE or HDE-5, 8, 14	PDE or HDE-6, 7 ¹ / ₂ , 9, 12, 13	
PRE or HRE-1 ¹ / ₂ , 4, 6 ¹ / ₂ , 9, 12	PRE or HRE-6, 7 ¹ / ₂ , 11, 13	
---	UFE-12, 17 UVE-22, 30 UDE-15, 21 URE-16, 22	
OFE-23, 32, 40	UFE-23	3A
OVE-40, 55, 70	UVE-40	
ODE-28, 40, 50	UDE-28	
ORE-30, 35, 45	URE-30	
All F Models ^② except FF(E)- ¹ / ₈ , FV(E)- ¹ / ₄ , FD(E)- ¹ / ₈ , FR(E)- ¹ / ₈	---	4
All G Models except GF(E)- ¹ / ₈ , GV(E)- ¹ / ₄ , GR(E)- ¹ / ₈	All small K models	5
All X Models	---	6
MFE-5, 7 ¹ / ₂ , 11, 13, 15, 20	MFE-12, 17	
MVE-8, 12, 18, 21, 26, 34	MVE-30	
MDE-6, 9, 13, 15, 18, 25	MDE-14, 20	
MRE-9, 15, 20, 25	---	
KFE or VFE-45, KVE or VVE-70	---	
KDE or VDE-55, KRE or VRE-50	---	
MFE-25	MFE-22	6A
MVE-42	MVE-40	
MDE-30	MDE-26	
MRE-30	---	
KFE or VFE-35, 55	VFE-50	
KVE or VVE-52, 100	VVE-90	7
KDE or VDE-40, 65	VDE-42, 60	
KRE or VRE-38, 70	---	
WFE-80, 110	WFE-75, 100	
WVE-135, 180	---	
WDE-95, 130	WDE-90, 120	8
WRE-100, 130	---	
CF(E) or SF(E)- ¹ / ₄ , ¹ / ₂ , 1, 1 ¹ / ₂ , 2, 2 ¹ / ₂ , 3	R and T Models with 83 elements	
CV(E) or SV(E)- ¹ / ₂ , 1, 1 ¹ / ₂ , 2, 3, 4, 5		
CD(E) or SD(E)- ¹ / ₄ , ¹ / ₂ , 1, 1 ¹ / ₂ , 2, 2 ¹ / ₂ , 3, 3 ¹ / ₂		
CR(E) or SR(E)- ¹ / ₄ , ¹ / ₂ , 1, 1 ¹ / ₂ , 2, 3, 4		
CFE-5, SFE-5, 6		
CVE-8, SVE-8, 10	---	8A
CDE-6, SDE-6, 7		
CRE-6, SRE-6, 7		
OFE-6, 9, 12		
OVE-10, 15, 20		
ODE-7, 11, 14		
ORE-6, 9, 12		
OFE-16, OVE-30		
ODE-20, ORE-21 ^③		

upon request. (Since the internal parts of the Type (E)BF/SBF and EBS valves cannot be replaced, it is not necessary to check the pushrod height of these valves.)

The appropriate gauge numbers for the various TEV's are given in Table 3.

Caution: If the element-to-body joint utilizes a gasket, the gasket must be removed before checking pushrod height.

If the pushrod(s) are too long, they must be carefully ground off to the proper length. Clean the pushrod(s) of all dirt and grindings and place them into the body.

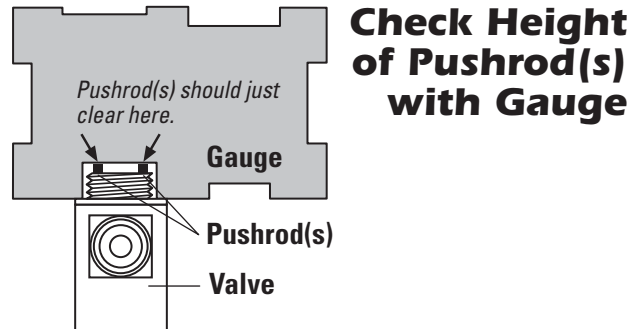


Figure 11

12. Element Replacement — If the element is damaged or has lost its thermostatic charge, replace it with the same type.

To properly replace the element without damaging the element or the valve body on valves which utilize a gasketed joint, be sure only one gasket is used before assembling the element. In assembling gasketed elements held in place by two cap screws, be sure to pull up the cap screws evenly.

On valves which utilize the threaded type of element with metal-to-metal knife edge joints, always use an appropriate wrench (10") on the wrench flats. **DO NOT** use a wrench on the outer welded edge of the element. The sealing surfaces should be free of any foreign materials or nicks that might prevent a leak-tight joint. A few drops of refrigerant oil on the element threads will facilitate easy assembling and removal.

13. Return the superheat spring adjustment to its original position. Replace the seal cap tightly.

- ① Type F (internally and externally equalized) valves dated D84 or later, Type S valves dated B69 or later, Type C valves dated C70 or later, and all Type G (externally equalized only) and X valves have packless pushrod construction and internal parts kits are not available for use with them.
- ② Applies only to Type F valves with a replaceable element.
- ③ Formerly used the KT-33-8 element and gauge number 33-8 (redesignated 8B). The KT-33-8 element has been replaced by the KT-83.