ENGINEERING SERVICE BULLETIN

ESB-31
Page 1 of 6
Effective: 12-16-10
Supersedes: 5-27-85

To: **MASTER CATALOG HOLDERS**

SUBJECT: **VIKING PRESSURE RELIEF VALVES**

This Engineering Service Bulletin deals with the terminology and some typical questions asked with regards to the performance of Viking pressure relief valves. In general, the terminology and answers given apply to the following types of valves shown below:

Figure 1 – Pump Mounted Internal Pressure Relief Valve

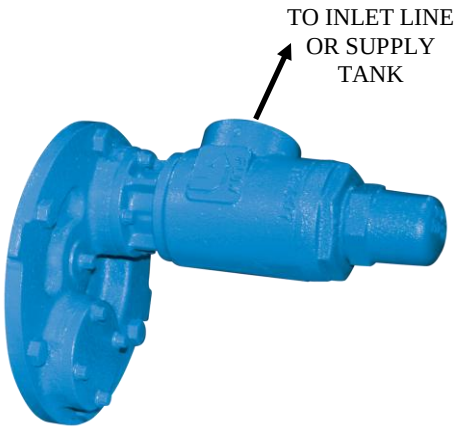


Figure 2 – Pump Mounted Return-To-Tank Pressure Relief Valve

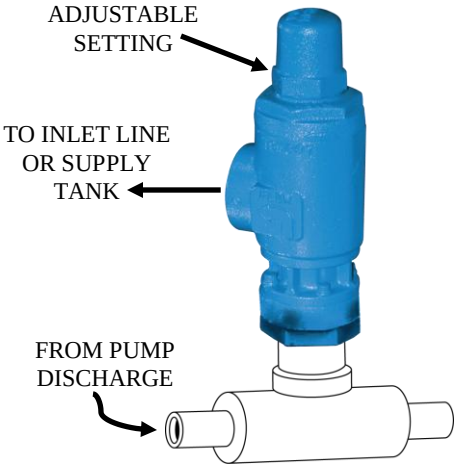


Figure 3 – In-Line Pressure Relief Valve Mounted in Discharge Line

TERMINOLOGY OF VIKING PRESSURE RELIEF VALVES

1. **Cracking Pressure:** The cracking pressure (refer to Figure 4) is the pressure at which the valve begins to open and bypass liquid. The cracking pressure is not affected by pump size, pump capacity, or liquid viscosity. The pump will deliver full capacity (except for slippage loss) at the cracking pressure.
   Most commercial relief valves use the cracking pressure as their valve setting. The relief valve size is selected by the amount of over pressure desired (pressure between cracking and complete bypass). This over pressure is determined by the capacity and liquid viscosity.

2. **Complete Bypass Pressure:** The complete bypass pressure (refer to Figure 4) is the pressure at which the entire capacity of the pump is bypassing through the relief valve. No liquid is going through the discharge line. At Viking, this pressure is referred to as the "valve setting." This pressure is stamped on a small boss on the valve body when shipped from Viking. Viking relief valves are normally set in 25 psi increments.

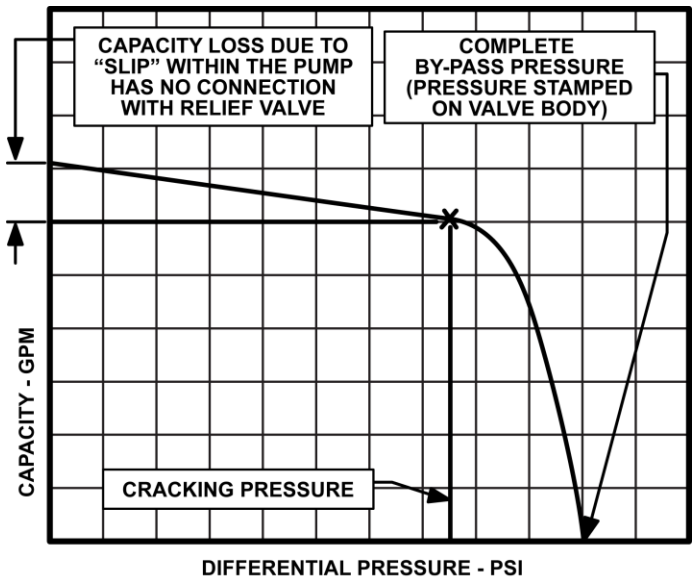


Figure 4

3. **Complete Bypass Pressure Range:** Several springs or spring combinations are used in Viking's relief valves. With these springs and the use of the relief valve adjusting screw, various complete bypass pressures can be obtained. Each spring in a particular relief valve will produce a pressure range which is determined by the adjusting screw. The **Minimum Complete Bypass Pressure** is when the adjusting screw is backed out until loose, which allows the relief valve spring to be fully extended within the valve body. With the adjusting screw turned in completely, the **Maximum Complete Bypass Pressure** is obtained. The **Complete Bypass Pressure Range** is the pressure from the **Minimum Complete Bypass Pressure** to the **Maximum Complete Bypass Pressure**.
   The **Pressure Range PSI** column on the Parts List (Catalog Section R620) represents the **Complete Bypass Pressure Range**. Because of the overlap of the springs, each spring may go below and above the range indicated in the Parts List.

FREQUENTLY ASKED QUESTIONS

Listed below are some typical questions asked about the performance of the Viking Pressure Relief Valves:

Q) What is the relationship between cracking pressure and complete bypass pressure?

A) The cracking pressure is always less than the complete bypass pressure as shown in Figure 4. The charts on page 5 and 6 show the actual relationship for valves mounted on pumps. The higher the capacity, the greater difference between cracking and complete bypass pressure. Doubling the capacity will nearly double the difference between cracking and full bypass. Higher viscosity liquids will increase the difference because of higher resistance of the more viscous liquids. Higher pressure settings will also increase the difference because of higher spring rates required for the high pressure settings.

Q) Why does the pressure range for a given spring increase as the pump size increases as shown in the Parts List?

A) As the volume of the liquid through the relief valve increases, the poppet in the valve must rise higher to allow the liquid to bypass. This requires additional compression of the spring, which requires higher pressure.

Q) Can the Viking Return-To-Tank Pressure Relief and In-Line Pressure Relief Valves (Figures 2 and 3) be used as a capacity regulating device?

A) In cases where the system to which the pump is delivering liquid has a variable resistance to fluid flow, the Return-To-Tank Pressure Relief and In-Line Pressure Relief Valves can serve as a capacity regulating device. Examples of this would be multiple LPG bottle or tank filling systems. For instance when only one bottle on a manifold is being filled at a time, the valve will open and bypass the quantity of liquid that cannot be forced through the system. Refer to Figure 5.

Note: The pump mounted Internal Pressure Relief Valve (Figure 1) is <u>not</u> recommended for use as a capacity regulating device.

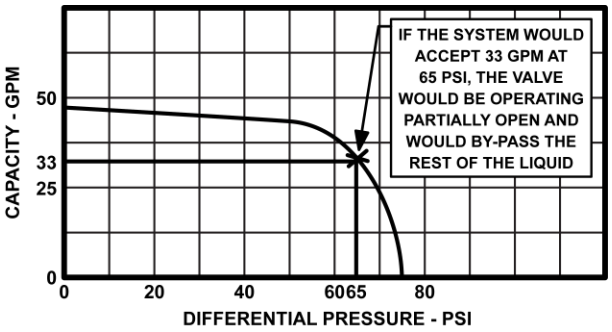


Figure 5

Several points should be considered when the Viking Return-To-Tank Pressure Relief and In-Line Pressure Relief Valves are being considered for use as a capacity regulating device:

1. The pump will of necessity be handling considerably more liquid than is going through the system. This means the pump must be larger than required for the system, the motor will be larger than necessary, and it will cost more to operate.

2. When operating at pressures higher than the cracking pressure, a slight change in pressure results in a large change in capacity. This makes it difficult to accurately predict the capacity at pressures above the cracking pressure.

3. Viking does not recommend the use of Viking Return-To-Tank Pressure Relief and In-Line Pressure Relief Valves in place of the more conventional regulating devices.

Q) Should the motor horsepower for a unit be determined by the horsepower required at the complete bypass pressure or at the cracking pressure of the valve?

A) The relief valve curves on pages 5 and 6 give the relationship between cracking pressure and the complete bypass pressure. The motor size determination should be made based on the application. In many cases, the motor horsepower increments will cover both the cracking (operating) pressure and the complete bypass pressure. When this is not the case, then:

1. If the application calls for frequent full opening of the relief valve, the motor should be sized to cover or nearly cover the complete bypass setting.

2. If the relief valve is to serve strictly as an over pressure relief device with no additional use except under an unusual set of circumstances, then the motor size can be selected based on operating pressure. This assumes proper motor protection has been installed and delay to reset the motor can be tolerated.

Almost all Viking pumps are catalogued and priced with relief valves. A standard relief valve setting has been established for each of the catalogued pump series except our external gear pump series. Since there is no standard setting for external gear pumps, the relief valve setting must be listed on the order. For all other pump series, orders on which there is no valve setting or application data given, a standard setting will be furnished. This standard setting is shown in document ES-19 and on the price sheet for each of the catalogued pump series, e.g. Price Page P630.1 covering Heavy Duty Universal Series 124A/4124A pumps has the following note:

"All pumps will be furnished with a relief valve set at 100 lbs. unless otherwise ordered."

Q) What effect does viscosity have on the performance of a valve?

A) As the viscosity of the liquid increases and if the valve setting and volume of liquid through the valve remain the same, the complete bypass pressure will increase. The reason is, as for any flow system, the pressure drop across the poppet will increase as the viscosity increases, assuming all other factors remain the same.

Tests in the Product Engineering Laboratory have been conducted to determine the relief valve characteristics as the viscosity increases. These results have shown increased differential between cracking and complete bypass at the higher viscosities but is lowered by the reduced speed (capacity) rating for pumps at these higher viscosities. The overall result is a slight increase in the difference for the higher viscosity.

Very low viscosity liquids (LPG, ammonia, refrigerants, etc.) do not change the normal operation of the valves. Frequently these low viscosity or "thin" liquids are quite volatile. For applications handling these liquids, the Return-To-Tank Pressure Relief and In-Line Pressure Relief Valves are recommended. The Internal Pressure Relief Valve is not recommended because the liquid being circulated through the Internal Pressure Relief Valve starts to heat up as soon as the valve begins to open. The heating causes vapor to form on the inlet side of the pump. As the pump continues to operate with the Internal Pressure Relief Valve open, the inlet side of the pump becomes vapor bound. Under this condition the pump will cavitate, be noisy, vibrate, and rapid wear can occur. The Return-To-Tank Pressure Relief and In-Line Pressure Relief Valve eliminate this condition by returning the liquid to the supply tank.

Q) What is the maximum complete bypass pressure setting for Viking valves?

A) The maximum complete bypass pressure can be obtained from the curves at the end of this ESB bulletin. The maximum pressure recommended for the pump may be lower than the pressure capability of the valve. Consult a Viking catalog or representative for the maximum operating pressure of the pump.

Q) What are the temperature limitations on springs used in Viking valves?

A) The maximum recommended operating temperature for springs made of oil tempered spring steel (plated steel) is 350^{o}F. For stainless steel springs, the maximum is 550^{o}F.

Q) What is the maximum viscosity limitation for Viking valves?

A) The maximum recommended viscosity for Viking valves is 250,000 SSU.

Q) What effect do vacuum conditions have on the performance of a valve?

A) On an application involving low discharge pressure and high vacuum, the relief valve setting must take into account the differential pressure across the pump and not just the discharge pressure. In this type of application, the vacuum accounts for a good portion of the differential. If the vacuum is neglected,

the relief valve may be set too low and will operate partially open causing low pump capacity.

Q) Are there applications for which Viking pressure relief valves are not recommended?

A) Yes, some examples of these applications are:

1. The handling of shear sensitive liquids. The small volume of the valve and the large flow of liquid from the full capacity of the pump through the valve results in a rapid break-down of a shear sensitive liquid when it is recirculated through a pressure relief valve.

2. Liquids containing solids which settle out. Solids such as filteraid will frequently settle out of liquids in quiet areas of the system such as in a relief valve. Solids may accumulate to a point where the valve will become inoperative.

For additional information on Viking Pressure Relief Valves on each series of pumps, refer to the Technical Service Manual (TSM630, TSM420, etc) for that particular pump series.

CAUTION

THE INTERNAL PRESSURE RELIEF VALVE MUST ALWAYS BE MOUNTED WITH THE CAP OR BONNET POINTED TOWARDS THE SUCTION SIDE OF THE PUMP. THE RETURN-TO-TANK PRESSURE RELIEF VALVE MUST ALWAYS BE MOUNTED ON THE DISCHARGE SIDE OF THE PUMP. IF PUMP ROTATION IS PERMANENTLY REVERSED, CHANGE THE RELIEF VALVE TO THE CORRECT MOUNTING POSITION. TURN THE INTERNAL PRESSURE RELIEF VALVE END FOR END; MOVE THE RETURN-TO-TANK PRESSURE RELIEF VALVE TO THE OTHER PORT.

IF IT IS THE INTENT TO REVERSE THE PUMP ROTATION FREQUENTLY, THEN OVER PRESSURE PROTECTION MUST BE PROVIDED ON BOTH SIDES OF THE PUMP OR FOR BOTH ROTATIONS. AN EXAMPLE IS USING ONE PUMP TO FILL A TANK AND THEN BY REVERSING ROTATION TO PERMIT THE SAME PUMP TO MOVE THE LIQUID FROM THE TANK TO LOAD OUT. USE AN INTERNAL PRESSURE RELIEF VALVE TO PORTECT ONE SIDE AND AN IN-LINE PRESSURE RELIEF VALVE ON THE OTHER SIDE OF THE PUMP OR USE SOME MEANS OF LIMITING TORQUE THAT IS FUCTIONAL IN BOTH DIRECTIONS OF ROTATION.

HOW TO USE RELIEF VALVE PERFORMANCE CHARTS

The following charts show the performance of Viking Pressure Relief Valves. These charts show the relationship between the capacity, cracking pressure, and full bypass pressure. Please see the example below on how to use the relief valve charts.

Example:
An H124A is to operate at 1200 RPM on 100 SSU liquid with a differential pressure of 110 PSIG. What setting should be specified for the relief valve?

1. From the performance curves for an H124A at 1200 RPM, 100 SSU, and 110 PSIG, the capacity of an H124A is 10.2 GPM.

2. On the relief valve chart for G-HL size pumps, draw a horizontal line at 10.2 GPM. See the G-HL Relief Valve Chart on page 5.

3. Draw a vertical line at 110 PSIG.

4. Through the point of intersection of these two lines, draw a line parallel to the nearest diagonal relief valve line directly to the right of your point.

5. Read the full bypass relief valve setting at the intersection with the horizontal axis. For this example, the full bypass pressure would be 130 PSIG.

6. Viking recommends a relief valve setting which is 10% greater than what is shown in the charts to account for any variations in the spring rate of the spring. Relief valve settings are usually rounded up to the nearest 25 psi increment. For this example, the relief valve setting would be 150 PSIG. (130 + 13 = 143; rounded up to the nearest 25 psi increment = 150)

Notes:

1. If significant vacuum is encountered on the suction side, it should be added to the discharge pressure to obtain the differential pressure. (1 in. Hg = 0.49 psi)

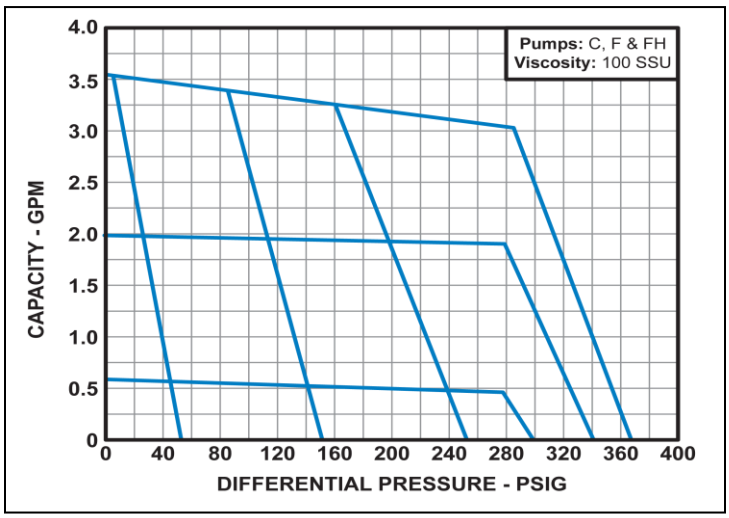
2. The relief valve charts are plotted for a viscosity of 100 SSU but are reasonably accurate for any viscosity between 38 to 750 SSU. For viscosities between 750 and 25,000 SSU, add 5 PSIG to the differential pressure between cracking and full bypass (135 PSIG in step 5 of example above). For viscosities between 25,000 and 250,000 SSU, add 10 PSIG (140 PSIG in step 5 of example above).

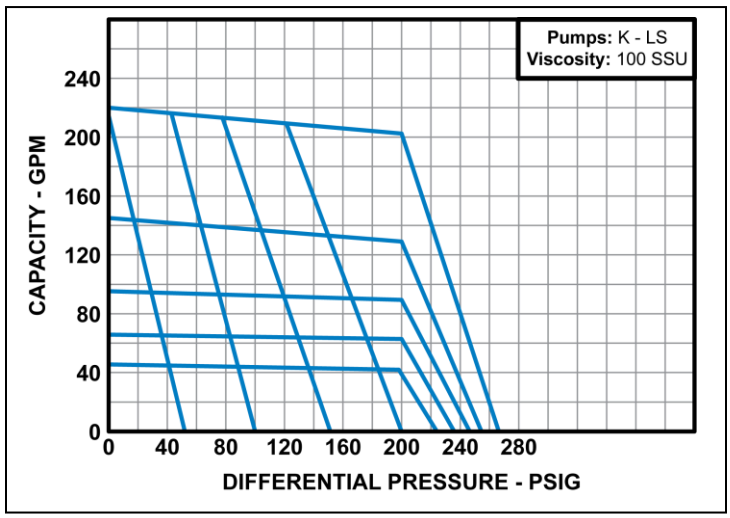
3. When ordering pumps with relief valves, the relief valve pressure setting requested is assumed to be the full bypass pressure of the valve.

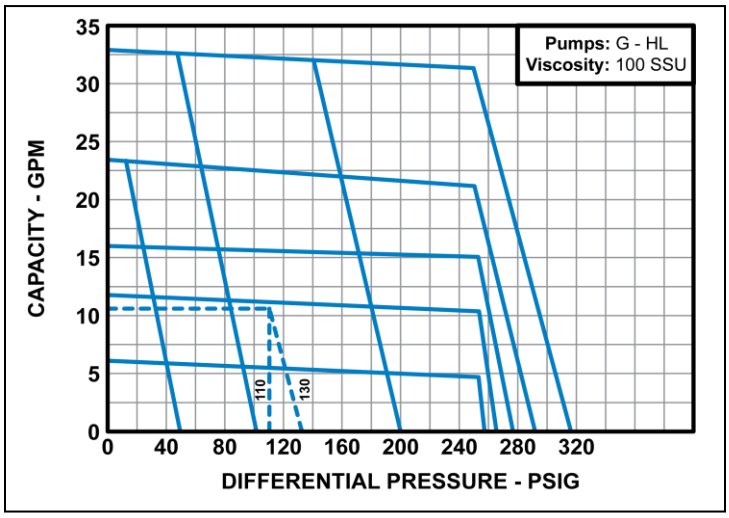
4. Please refer to Engineering Standard 37 (ES-37) for charts on the adjustment screw measurement and spring combination for setting the full bypass pressure of Viking relief valves. SG-04, SG-05, SG-07, and C-FH relief valves are not set by a specific adjustment screw measurement. The relief valves for these pump sizes are set by using a test bench.
5. The relief valve charts show the general performance of the relief valves only. Refer to the Viking catalog and pump performance curves for the maximum pressure recommended for each pump.

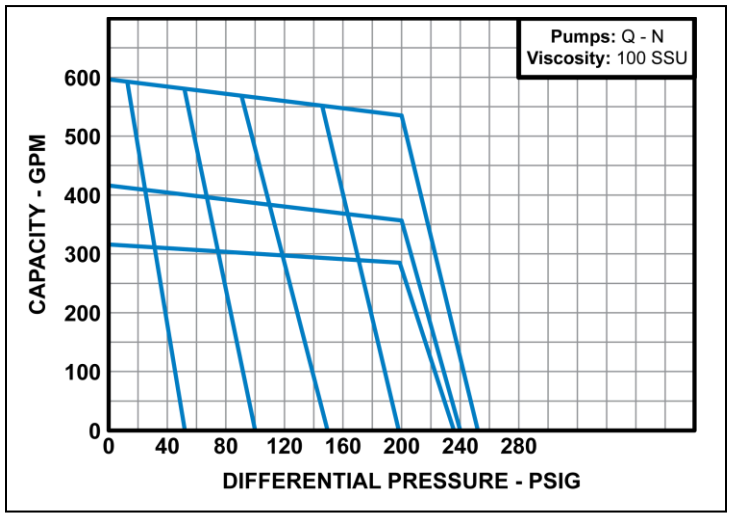
PRESSURE RELIEF VALVE PERFROMANCE CHARTS

These charts show the relationship between cracking pressure and complete bypass pressure with various pump capacities, using 100 SSU product as standard.









PRESSURE RELIEF VALVE
PERFROMANCE CHARTS CONTINUED