Instructions to Voters/Comments on API 520 Part I Ballot – "Minimum Operating Pressure for POPRVs"

- This ballot covers Action Item 2023-13 and modifies paragraph 4.2.2 on Pilot-Operated Pressure-relief Valves.
- Your comments should be limited to the **red-lined portions of the ballot only.**
- If you are voting negative, please indicate which of your comment or comments are the reason for your negative vote. API's Balloting system will categorize all of your comments as Negative.

Thanks to Jason Knudson and his team for working on this item.

Phil Henry
API 520 Task Force Chair

BALLOT FOR ACTION ITEM AI-2023-13 – "Minimum Operating Pressures for POPRVs"

4 Pressure-relief Devices

4.1 General

4.2 Pressure-relief Valves

4.2.1 Spring-loaded Pressure-relief Valves

4.2.2 Pilot-operated Pressure-relief Valves

4.2.2.1 General

4.2.2.1.1 A pilot-operated PRV consists of the main valve, which normally encloses a floating unbalanced piston assembly, and an external pilot (see Figure 10 through Figure 14). The piston is designed to have a larger area on the top than on the bottom. Up to the set pressure, the top and bottom areas are exposed to the same inlet operating pressure. Because of the larger area on the top of the piston, the net force holds the piston tightly against the main valve nozzle. As the operating pressure increases, the net seating force increases and tends to make the valve tighter. This feature allows most pilot-operated valves to be used where the maximum expected operating pressure is higher than the percentage shown in Figure 15. At the set pressure, the pilot vents the pressure from the top of the piston; the resulting net force is now upward causing the piston to lift, and process flow is established through the main valve. After the overpressure incident, the pilot will close the vent from the top of the piston, thereby re-establishing pressure, and the net force will cause the piston to reseat.

4.2.2.1.2 The main valve of the pilot-operated PRV can use a diaphragm in lieu of a piston to provide the unbalanced moving component of the valve. A disc, which normally closes the main valve inlet, is integral with a flexible diaphragm (see Figure 14). The external pilot serves the same function to sense process pressure, vent the top of the diaphragm at set pressure, and reload the diaphragm once the process pressure is reduced. As with the piston valve, the seating force increases proportionally with the operating pressure because of the differential exposed area of the diaphragm.

4.2.2.1.3 The lift of the main valve piston or diaphragm, unlike a conventional or balanced spring-loaded valve, is not affected by built-up backpressure. This allows for even higher pressures in the relief discharge manifolds.

4.2.2.1.4 The pilot vent can be either directly exhausted to atmosphere or to the main valve outlet depending upon the pilot's design and user's requirement. Only a balanced type of pilot, where set pressure is unaffected by backpressure, should be installed with its exhaust connected to a location with varying pressure (such as to the main valve outlet). Slight variations in backpressure may be acceptable for unbalanced pilots.

4.2.2.2 Backflow Prevention

A backflow preventer shall be installed when the possibility exists of developing a pressure on the discharge side of a valve that exceeds the inlet pressure of the valve. The higher discharge pressure can cause sufficient upward force on the diaphragm or piston to open the valve and cause flow reversal. The backflow preventer allows the discharge pressure to provide a net downward force on the diaphragm or piston to keep the valve closed (see Figure 11). The proper operation of the backflow preventer is critical to further ensuring no flow reversal occurs in the valve. The selection of the material and seals in the backflow preventer should be consistent with the pilot-operated PRV. Some examples where the protected system pressure can be less than the discharge pressure are:

— the protected equipment can be depressured and isolated (e.g. to prepare for maintenance) while lined up to an active flare header;

- a vacuum may be present at the inlet connection due to unusual operating conditions or during start-up;
- the valve is connected to a downstream pressure vessel where pressure may vary in excess of the pressure in the upstream system;
- the discharge of multiple PRVs is combined into a single manifold or vent system, creating superimposed backpressure in excess of the current upstream system pressure.

4.2.2.3 Pilot Types

4.2.2.3.1 The pilot that operates the main valve can be either a pop-action or modulating action pilot. The pop-action pilot, as shown in Figure 16, causes the main valve to lift fully at set pressure without overpressure. This immediate release of pressure provides extremely high opening and closing forces on the main valve seat. This opening action is typically not recommended for liquid services to avoid valve instability.

4.2.2.3.2 The modulating pilot, as shown in Figure 17, opens the main valve only enough to satisfy the required relieving capacity and can be used in gas, liquid, or two-phase flow applications. A modulating pilot-operated valve, in contrast to a pop-action valve, limits the amount of relieving fluid to only the amount required to prevent the pressure from exceeding the allowable accumulation. Since a modulating pilot only releases the required relieving rate, the calculation of built-up backpressure may be based on the required relieving rate instead of the rated capacity of the valve corrected for the actual overpressure. The modulating pilot valve also can reduce interaction with other pressure control equipment in the system during an upset condition, reduce unwanted atmospheric emissions, and reduce the noise level associated with discharge to the atmosphere.

4.2.2.3.3 The pilots may be either a flowing or nonflowing type. The flowing type allows process fluid to continuously flow through the pilot when the main valve is open; the nonflowing type does not. The nonflowing pilot type is generally recommended for most services to reduce the possibility of hydrate formation (icing) or solids in the lading fluid affecting the pilot's performance.

4.2.2.4 Application and Limitations of Pilot-operated Pressure-relief Valves

4.2.2.4.1 Pilot-operated PRVs are available for use in liquid and vapor services. Operating characteristics of some pilot-operated PRVs are unaffected by the state of fluid (liquid or gas), and these types are recommended for two-phase flow applications.

4.2.2.4.2 Similar to soft seated spring-loaded valves, most main valves and their pilots contain nonmetallic components, and process temperature and fluid compatibility can limit their use. In addition, as with all PRDs, fluid characteristics such as susceptibility to polymerization or fouling, viscosity, the presence of solids, and corrosiveness should be considered. The manufacturer should be consulted to ensure that the proposed application is compatible with available valves.

4.2.2.4.3 When the system operating pressure is below normal levels, there is an increased potential for leakage through pilot-operated PRVs. It is important to account for the full range of low operating conditions, not just the maximum operating pressure for pilot-operated PRVs. Several factors can considerably influence the ability of pilot-operated PRVs to maintain a tight, leak-free seal, including the type of seals (material & hardness), process temperature, and valve size. Most manufacturers offer permanent design options to enhance seat tightness in low operating pressure scenarios. Shorter-term cases of low operating pressures (such as startup) may warrant temporary mitigation to keep the pilot-operated PRV seated. Due to the variations in design and available options across manufacturers, it is recommended to consult the manufacturer when system operating pressures are below normal operating conditions.

4.2.2.4.4 During transient conditions when the pressure at the inlet of a pilot-operated PRV builds rapidly (greater than approximately 50 psi/sec), the main valve may open before dome pressure can build on top of the piston. This operational issue can be more prevalent in larger valves due to the significant difference in dome volume from that of smaller valves. Manufacturers should be consulted for options to address this concern.

4.2.2.5 Pilot-operated Pressure-relief Valve Accessories

4.2.2.5.1 General

A variety of accessories and options are available for pilot-operated PRVs to provide additional functions. The following is a list of the more common accessories, some of which may not be available for all valve models.

4.2.2.5.2 Field Test Connection

Pilot-operated PRVs may be readily tested for verification of set pressure during normal system operation with this accessory. This field test is typically done via pressure from an independent source such as a nitrogen bottle, where the source gas is slowly admitted through a metering valve. The pilot and main valve dome are pressurized simulating an increased system pressure. The field test pressure will actuate the pilot and may or may not actuate the main valve. The valve manufacturer can provide details.

4.2.2.5.3 Backflow Preventer

This accessory, sometimes called a "vacuum block," prevents a pilot-operated valve from reverse flow when the pressure at the outlet flange (superimposed backpressure) is greater than the current system pressure. Reverse flow can occur with any standard type or design of pilot-operated PRV when sufficient reverse differential pressure exists. A backflow preventer permits the introduction of outlet pressure into the dome of the main valve, thereby holding the piston firmly on the nozzle, overcoming the effect of a reverse differential pressure.

4.2.2.5.4 Pilot Supply Filter

A pilot supply filter protects the pilot from particulate matter in the flow stream. This accessory, installed in the pilot supply line, has expanded the service applications for pilot-operated PRVs. The user is cautioned that in services prone to plugging, frequent maintenance of the filter may be required to achieve the benefits. For applications with excessive particulate matter, other methods such as the addition of a purge system may be required.

4.2.2.5.5 Pressure Spike Snubber

A pressure spike snubber is recommended for use on compressible or incompressible lading fluid installations where instantaneous pressure spikes or pulsations approach or exceed the simmer or set pressure and may cause inadvertent valve wear and actuation (e.g. downstream of positive displacement rotating equipment). The device dampens these transient pressure rises before they reach the sensing chambers of the pilot without affecting the valve's set pressure.

4.2.2.5.6 Remote Pressure Sense Connection

This optional feature permits the pilot to sense system pressure at a location that most accurately reflects the actual operating pressure of the protected system. It can also be used to eliminate the false system pressure indication that will occur during relieving conditions due to pressure losses in the inlet piping. The addition of a remote pilot sense line allows the pilot to correctly sense system pressure and to keep the valve from rapid cycling or chattering due to high inlet piping pressure losses. Rated relieving capacity corrected for the actual overpressure will be proportionately reduced whenever there is inlet pressure loss to the valve.

4.2.2.5.7 Manual or Remote Unloader

An unloader permits the main valve to be opened either manually or remotely to depressurize the system. Its use has no effect on the sealed pressure settings. Either a manual, pneumatic, or solenoid operated valve is connected to the main valve dome. Opening this valve vents the dome pressure faster than it can be recharged by the pilot supply allowing the piston to lift. When permitted by code, the manual unloader may be substituted for a mechanical lift lever.

4.2.2.5.8 Pilot Lift Lever

This accessory is provided for those applications where the mechanical lifting of the pilot is required for verification of valve operation. Lifting of the pilot spindle will permit the main valve to lift when the system pressure is at least equal to or greater than 75 % of the set pressure. The ASME *Code* requires the use of this device or a manual unloader for air, hot water over 140 °F (60 °C), and steam applications, unless ASME *BPVC* Case 2203 has been used to eliminate the need for a lifting lever.

4.2.2.5.9 Pilot Valve Isolation

There are several designs that use an inert fluid to isolate all or part of the pilot valve portion of the pilot-operated PRV from the service conditions. This may allow the pilot-operated PRV to be considered in applications where plugging and fouling might otherwise be a concern (e.g. where there is a potential for polymerization, high viscosity fluids, presence of solids, or corrosiveness). These isolation systems are designed to provide the inert fluid to protect the critical parts of the pilot valve during normal operating conditions and also when the pilot valve operates during an overpressure event. The user should contact the manufacturer to discuss the various isolation options available with a particular pilot design and what isolation options would be suitable for the specific service condition. The user should advise the manufacturer of any local codes or regulations that affect the application and the suitability of a particular pilot valve isolation system.