How to Isolate Fluid Systems for Safer Maintenance

When performing fluid system maintenance, safety is paramount. A line with any pressure or flow inside represents a hazard when technicians need to maintain a valve or change a filter. That's why risk managers emphasize the necessity of isolating any line that is being worked on. Swagelok engineers believe the best way to achieve this essential state of zero pressure and zero flow is to place two block valves in sequence. Then, if the first one fails or leaks, the second one can still protect the line under maintenance.

In such a configuration, we typically follow the recommended practice of adding a third valve between the two block valves that vents or bleeds off any pressure or flow that may be leaking from the first block valve. Another viable option is to have the third valve divert flow to a bypass loop around the section of the line that is under maintenance. We'll review both configurations here.

Main Locations for Isolation Configurations in a Plant

For any line in a plant that may require maintenance, technicians need to have some means of safely isolating that line. Some specific locations that require a configuration for isolation include:

1. Any device or component that may require regular maintenance, such as a filter, valve, or transmitter
2. Any system, skid, or line that may need to be reconfigured, repaired, or replaced
3. Any section of the main process pipe that may need to be serviced or maintained
4. Any instrumentation line that comes off the process line (for example, a grab sample station, sampling system, or readings for pressure, temperature, or flow)
5. Calibration fluids in sampling systems, as well as any sampling streams that may be switched on or off

Options for Configuring Isolation

We recommend avoiding a situation in which there is only one block valve or no backup. If the block valve has even a small leak across the seat, pressure can slowly build up in the line under maintenance, creating a safety hazard. Therefore, we encourage following one of two main configurations for achieving isolation in a line:

1. **Double-Block-and-Bleed (DBB)**
   A DBB configuration is the simplest configuration for isolating a system (Figure 1). It is commonly used when transitioning from the process line to an instrumentation line, such as when using a process interface valve, or on a line that leads to an instrument or device, such as a transmitter. The three valves may be configured as a manifold (one unit, as shown in Figure 2) or as three separate components.

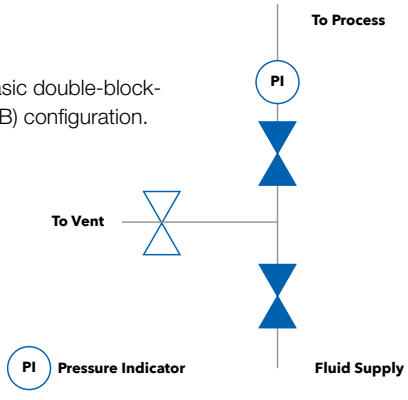

Figure 1. A basic double-block-and-bleed (DBB) configuration.

2. **Bypass Loop**
   A bypass is a slightly more complicated configuration that not only isolates the line under maintenance, but also reroutes the flow so the process can continue to function during maintenance.

Figure 2. A process interface valve consolidates three valves into one valve body – two ball valves used for isolation and one needle valve for a vent.

In Figure 3, the first block valve is a three-way valve diverting flow around the section requiring maintenance. The filter can now be changed out without requiring downtime. Another reason for a bypass is to avoid hydraulic shock or "water hammer" that results when there is a sudden shutoff of the flow (see below for further discussion).

Making the Right Component Choices

The two most common choices for block valves in instrumentation lines are ball valves or needle valves. Be sure maintenance technicians check system specifications for the one that is required for each system.

Ball Valves: Ball valves are good for quick shutoff and high flow. Also, the handles are helpful in indicating directional flow or shutoff. With liquid flow, however, a ball valve can create a hydraulic shock or "water hammer" because of the sudden shutoff that it causes, resulting in damage to pressure indicators, flow meters, and other components upstream of the shutoff. There are a couple of ways to avoid hydraulic shock. One is to incorporate a bypass loop (Figure 3). Before closing the first ball valve, the bypass loop is opened so the flow has a place to go, which avoids the sudden halt to flow and pressure spike that would otherwise result. The second option is to employ needle valves rather than ball valves for the block valves.

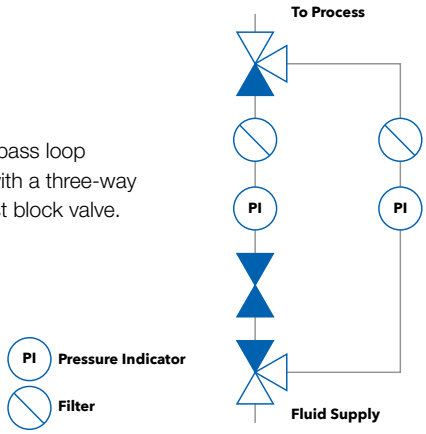

Figure 3. A bypass loop configuration with a three-way valve as the first block valve.

Needle Valves: Needle valves are primarily designed for flow or metering control, but many needle valves are effective at positive shutoff. Further, shutoff with a needle valve is gradual, and therefore they protect against hydraulic shock. If used as a block valve, the needle valve should be designed for that specific purpose, with a rotating tip or a soft stem tip.

Table 1. Types of Fluid Isolation Valves*

Valve Type	Flow Path	Visual Indication	Closing Speed	Shaft Seal	Applications
Gate	Straight	Maybe	Gradual	Packing	Most-used isolation valve on process tap
Ball	Straight	Yes	Rapid	Packing	Many uses; practical and economical
Plug	Straight	Yes	Rapid	Packing	Low-cost valve for utility fluids and vent headers
Needle	Globe	No	Gradual	Packing	For liquid sample shutoff; mitigates water hammer
Diaphragm	Globe	Yes	Rapid	Packless	High purity, fast action, and high cycle life
Bellows	Globe	Maybe	Gradual	Packless	Achieves a complete seal to atmosphere
Solenoid	Globe	No	Fast	N/A	Pilot for air actuator, but not for sample switching

*From *Industrial Sampling Systems*. Tony Waters. Solon, Ohio: Swagelok Company. 2013, p. 510.

Special design considerations may be needed to prevent leakage when using a needle valve in some instances – for example, if the metal V-tip grinds into the metal seat during shutoff, causing scoring.

Other valves that may be used for isolation are identified in Table 1.

In addition, it's a good practice to install a pressure indicator downstream from the second block valve in the isolation configuration, enabling a visual check on pressure at the time of maintenance (see Figures 1 and 3).

Also, beware of inadvertently using the wrong type of component in an isolation configuration. Ball valves and some types of needle valves are made for positive shutoff, but regulators are not – even though it is possible to set regulators such that they will stop most of the flow. If you need a shutoff around the location of a regulator, it would be safer to install a ball valve upstream.

Isolate and Depressurize

The first step when preparing for maintenance on any fluid system is to depressurize the system. When doing so, a best practice is to have two block valves in sequence to guard against pressure buildup in the section of the line under maintenance. A good valve should not leak across the seat, but it could happen. If the line is outside, perhaps the sun is heating up the line and raising pressure beyond the valve's specified rating. Other examples include if the valve has not been properly maintained or if it's the wrong valve choice for a positive shutoff. To guard against these and other possible scenarios, a second block valve is necessary, along with a vent or bleed valve. Alternatively, in cases where downtime is not an option, a bypass loop that duplicates the components in the line under maintenance is an excellent choice.

To learn more about how to safely configure fluid systems in your plant and train your team on best practices, contact your local **Swagelok sales and service center.**