

Best Under Pressure

Direct-Spring to Pilot-Operated PRV Upgrade

Direct-Spring PRV Costly Misapplications

Direct-Spring Pressure Relief Valves (PRVs) are a perfect fit for many overpressure protection applications across the oil & gas, power, and chemical industries. However, when they are misapplied, Direct-Spring PRVs can present risky & costly consequences leading to safety hazards, frequent & costly repairs, inefficient operation and unwanted fugitive emissions. Common failure modes include:

- **Bellows Failure** – Rapid cycling or excessive backpressure can lead to bellows failure, creating a safety concern by rendering the valve susceptible to the negative effects of backpressure and requiring the costly replacement of the bellows.
- **Seat Damage** – Seat damage from process debris or a damaged seat is a common failure mode in PRVs. This seat damage will create an expanding leak path for process to leak during normal operation.
- **Valve Chatter** – In applications with >3% inlet line loss or where a valve is significantly oversized, the valve may experience a violent rapid cycling known as valve chatter. This dangerous event can damage the valve as well as the surrounding system, leading to immediate costly maintenance, repair parts and in some cases, an entire replacement valve.
- **Process Loss & Fugitive Emissions** – Whether it be from a ruptured bellows causing backpressure to leak out of the valve bonnet, metal to metal seat damage causing seat leakage, or a violent event like valve chatter creating major leak paths for process fluid, this unwanted leakage leads to costly loss of process and unwanted fugitive emissions into our environment (see Figure 1).

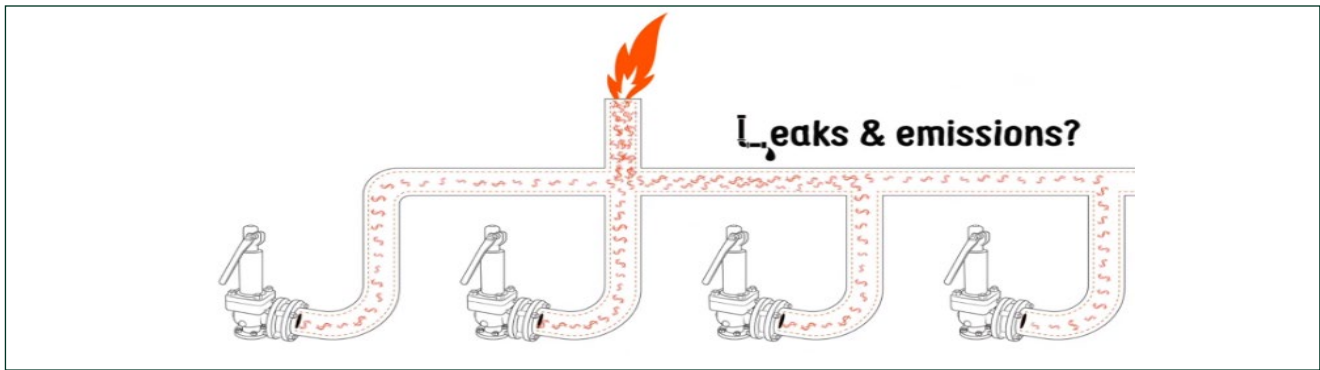


Figure 1 – Direct-Spring PRV leakage

Three Solutions: Good, Better, and Best!

These issues are generally not new to our industry. For decades, end users have been developing patches and band aids to delay or reduce their impact and, in some cases, have even become relatively efficient at doing so, but is this the best way? In this section, I will lay out 2 historically common responses to these issues (the Good and Better options) along with a revolutionary simple & economical solution in the Generation II 2900 Series upgrade to attack and solve the root cause failure modes.

The Good: Reactive PRV Maintenance

The traditional approach to managing these issues is a “good enough” strategy through reactive PRV maintenance. While this approach may serve to stop the bleeding, it doesn’t go so far as to attack the root cause failure modes. With reactive maintenance, most PRVs will be placed on a regular service interval ranging from 6 months to 3 years. Unfortunately, this approach has 2 primary drawbacks due to the unpredictable nature of PRVs and their applications:



Unplanned Outages

No one can predict with certainty if or when a PRV is going to open, how long it will open, and most importantly how stable it will perform under the actual overpressure conditions it is experiencing. For this reason, unplanned outages can occur, putting operators in a major bind and causing the entire supply chain to scramble in an attempt to provide critical service, parts, and/or replacement PRVs to get the process back up and running as quickly as possible.

And by the way, this is NOT a cheap exercise for anyone involved when you consider air freight, expedite fees, overtime hours, etc. It would benefit all parties involved to re-deploy these resources into more proactive and value-add activities if there were a solution to solve the root cause failure modes.



Maintenance Guesswork

PRV maintenance can be next to impossible to accurately predict. If you ask a manufacturer “How often should I service my PRV?” the answer is resoundingly the same: “It depends...” In their defense, they are not dodging the question, because it truly does depend!

Factors to consider when developing a PRV service interval plan include criticality of the service, how often the PRV is expected to cycle, the amount of debris and particulates in the line, the stability of the PRV during the overpressure event, and countless other variables! As a result, end users tend to err on the side of caution, and service their PRVs more often than required, throwing away precious money to service PRVs that in some cases did not require service at that time. Better safe than sorry though, right? Yes, but there is a **Better** way.

The Better: Pilot-Operated PRV Replacement

Pilot-Operated PRV technology offers many solutions to some of the most challenging applications in overpressure protection.

Here are just a few ways that upgrading to Pilot-Operated PRV technology can counter the challenges that arise from a misapplied Direct-Spring PRV:



Figure 2 - Damaged bellows from excessive back-pressure and valve chatter

Failure Mode: Bellows Failure

Countermeasure: Balanced Without a Bellows

“Bellows are the most fragile component in a spring-operated SRV and also the most expensive to replace.” (The Safety Relief Valve Handbook, 2010).

Pilot valves are balanced against backpressure without needing a bellows and are not susceptible to backpressure due to bellows failure. No need to constantly replace expensive bellows.

Failure Mode: Metal Seat Damage

Countermeasure: Soft Seat with Metal Seat Backup

When a metal seat becomes damaged, even in the slightest, the PRV will begin to leak even under normal operating conditions. Pilot valves come with a soft seat and metal seat backup, which is more forgiving than traditional direct-spring metal seats due to their elasticity. They are also far cheaper to replace than metal components such as nozzles & discs and don't require labor intensive lapping.

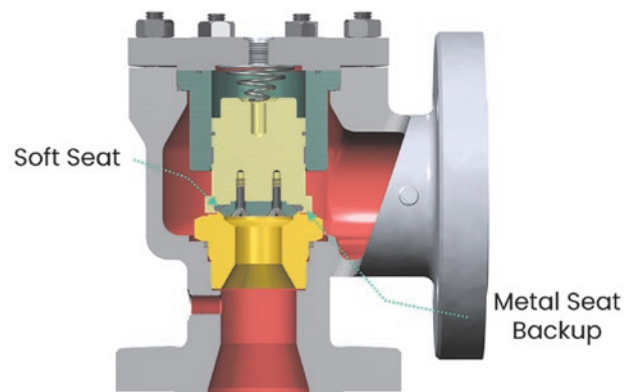


Figure 3 - Pilot-main valve cutaway

Remote Sense Eliminates Valve Chatter

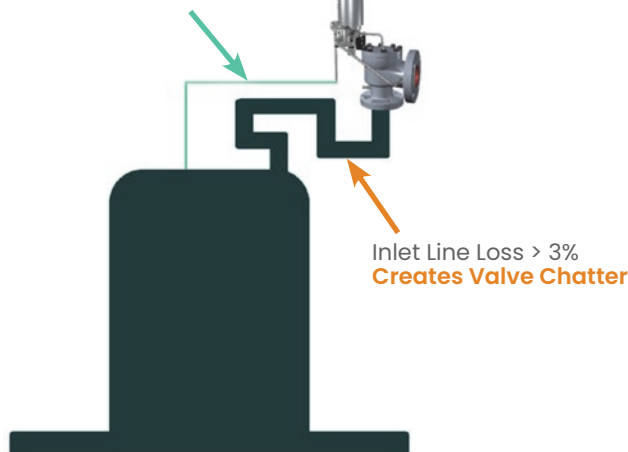


Figure 4 - Pilot valve remote sense option

Failure Mode: Valve Chatter

Countermeasure: Remote Sense & Modulation

Pilot Valves are able to overcome the failure mode of valve chatter due to high inlet line loss or oversized valves with the options of remote pressure sense and modulating action.

Remote sensing pilots allows the pilot to sense the pressure directly from the source, eliminating valve chatter caused by inlet line loss. Modulating action ensures the main valve opens proportional to the overpressure, thus only relieving the required capacity and mitigating valve chatter.

Failure Mode: Process Loss & Fugitive Emissions

Countermeasure: Enhanced Seat Tightness

Direct-Spring PRVs have a decreasing seating force as system pressure increases. When system pressure reaches 90% of set pressure, the valve is allowed to leak up to 100 bubbles/min according to API 527, and often at a much higher rate in real operating conditions.

By contrast, Pilot-Operated PRVs have an increasing seating force as system pressure increases. This advanced design allows most pilot valves' main valve seats to remain leak tight up to 98% of set pressure.

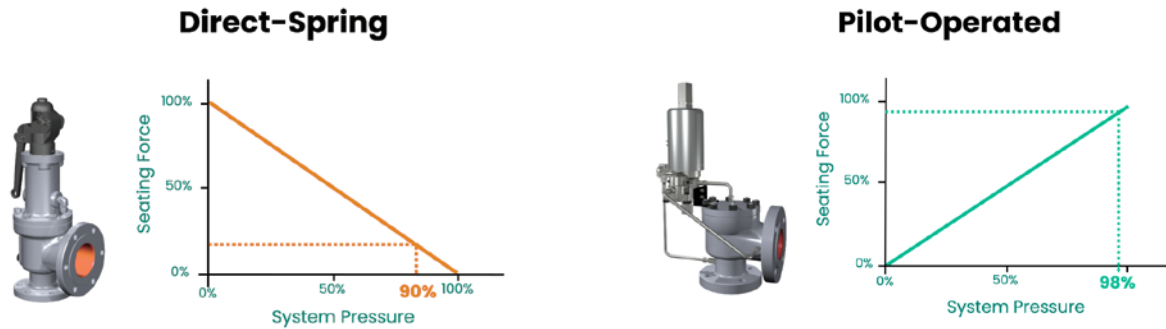


Figure 5 - Seating force vs. system pressure

Clearly, Pilot-Operated PRV technology can solve many of the root cause failure modes in misapplied Direct-Spring PRV applications, but is this the best possible solution? Unfortunately, there are many hidden costs when it comes to upgrading an existing Direct-Spring PRV to a traditional Pilot-Operated PRV. Most traditional Pilot-Operated PRVs see main valve leakage starting as early as 95% of set pressure, thus negating some of the main valve seat tightness advantages. Hidden costs primarily stem from inlet/outlet piping modifications due to Center-to-Face (CTF) dimensional differences and associated Management of Change (MOC) activities.

The Best: Consolidated 2900 Series Upgrade with the 'True Zero Leakage' Modulating Pilot

This brings us to a new and revolutionary solution that delivers the full benefits of a Pilot-Operated PRV, adds the benefit of the *Consolidated™* 'True Zero Leakage' Modulating Pilot (more on that in a moment), and completely eliminates hidden costs associated with piping modifications due to CTF dimensional differences. But first, a bit of background.

API 526 Direct-Spring PRV



Typical Pilot-Operated PRV



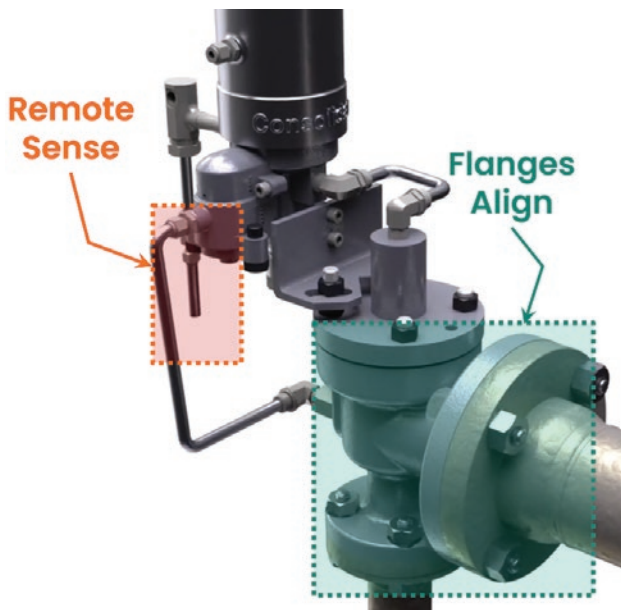
Consolidated 2900 Series



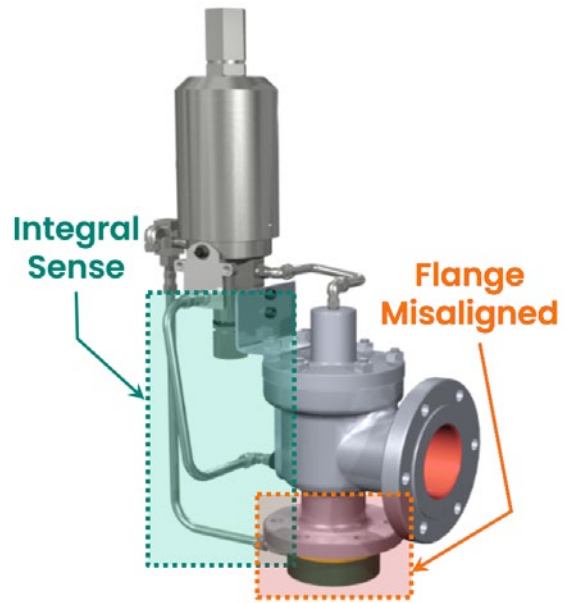
Figure 6 - PRV center-to-face dimensional comparison

As depicted in Figure 6 on page 4, you can see that when replacing an API 526 Direct-Spring PRV with a typical Pilot-Operated PRV, the CTF dimensions of the inlet and outlet flanges will not align to the existing piping. This creates high levels of Management of Change (MOC) activities and costly piping modifications that can range from \$5K - \$15K per installation. This additional cost & complexity diminishes the benefits that a typical pilot valve provides. With the Consolidated 2900 Series, the CTF dimensions match exactly to the API 526 Direct-Spring PRV without the need for any costly piping modifications. However, there is one catch with this design.

2900 Series - Remote Sense



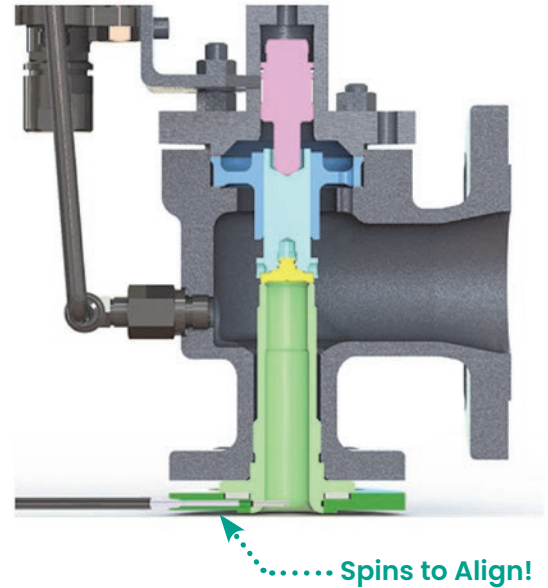
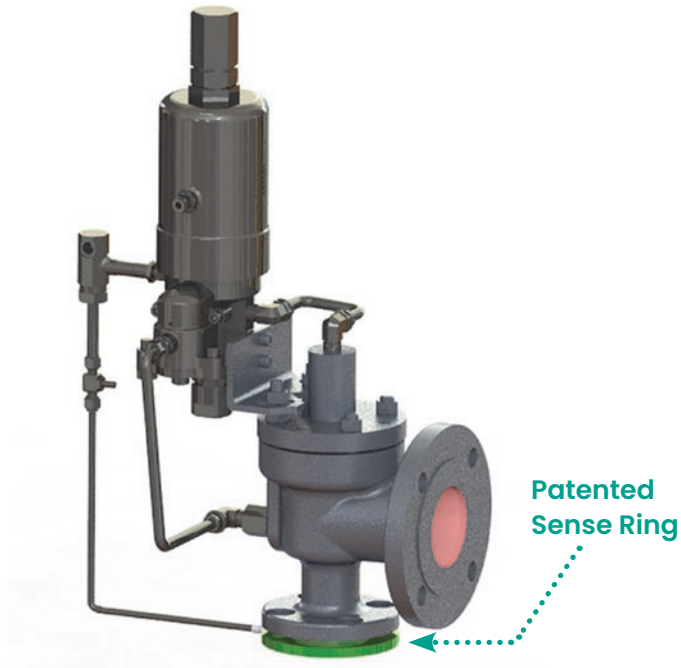
2900 Series - Integral Sense



In the previous design of the 2900 Series Pilot-Operated PRV, the end user had to choose between two options, each with potential pros and cons:

1. If the end user prefers to hold the CTF dimensions the same as their existing API 526 Direct-Spring PRV, they must select the Remote Sense option. This requires them to run the pressure sensing tube to an alternate location and tap into the vessel in order to sense the pressure, requiring additional installation cost and Management of Change (MOC) activities.
2. If the end user prefers the Integral Sense option to avoid the complexity and cost of Remote Sense, the CTF dimension of the outlet flange is altered due to the addition of an inlet sensing ring which is added under the full-nozzle, thus diminishing part of the operational cost savings that the 2900 Series Pilot-Operated PRV provides.

INTRODUCING: The Consolidated Generation II 2900 Series Pilot-Operated PRV



Remote and Integral Sense with Same CTF Dimensions

Whether your application calls for remote sense due to inlet line loss, or you prefer integral sense to avoid additional installation costs & MOC activities, the **Generation II 2900 Series** will always match your existing API 526 Direct-Spring PRV CTF dimensions and therefore will never require piping modifications. Read the **case study** to learn more about the savings.



Sensing Ring Always Aligns to Tubing After Service

The 2900 Series is a full-nozzle PRV design with a threaded nozzle at the inlet of the main valve body, which can potentially become misaligned after service. The Generation II 2900 Series has a **patented sensing ring** that allows the sensing tube to always connect in the same location and sense the pressure without perfect alignment.



Available with the "True Zero Leakage" Modulation Pilot

The Generation II 2900 Series is available with the Consolidated **'True Zero Leakage'** Modulating Pilot, which features advanced bolt-on modulation technology to keep the main valve **and** the pilot valve leak tight all the way up to set pressure, keeping your process efficient and dramatically reducing your unwanted fugitive emissions. Watch the **animation** and read the **article** to learn more.

This unique and patented design offers the ultimate API 526 Direct-Spring to Pilot-Operated PRV upgrade opportunity by allowing the end user to select either Remote Sense or Integral Sense (depending on their application needs), and hold the same CTF dimensions as the existing API 526 Direct-Spring PRV. Now for Integral Sense applications, it is truly as simple as taking out the existing API 526 Direct-Spring PRV and dropping in the **Generation II 2900 Series Pilot-Operated PRV** and **start running your operation cleaner and more efficient.**

Consolidated

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