Cost Effective Solutions for Pressure Relief Valve Deficiencies

By Sean Croxford, Business Unit Manager, Farris Engineering Services, Stan Zalar P.E., Engineering Manager & Cynthia Andersen, Marketing Manager, Farris Engineering

When a pressure relief valve (PRV) shows chronic maintenance issues such as leakage, galling, bellows integrity failure or even catastrophic failure, often it is assumed that the PRV is the issue. Chronic maintenance issues can be an indication that there are deficiencies in the relief system itself, attributable to the sizing, specification, installation, overall system design, disregard of best practices and code, or some combination of these. This situation can be further complicated if the deficiency is incorrectly identified and the mitigation implemented causes issues with other equipment or systems.

Deficiencies must be corrected to ensure the safety integrity of any pressure relief system. Safety relief valve instability, ranging from minor fluctuation to severe chattering, can prevent valves from functioning as designed. These deficiencies increase maintenance expenditures and, in worst case scenarios, can cause catastrophic failure of a protected system during a relief event. Proper analysis of a relief system requires evaluation of all applicable overpressure scenarios, including piping hydraulic calculations. Engineering analysis performed during a plant or system-wide audit of the safety relief system offers an ideal time to investigate deficiencies. A well-executed engineering audit will ensure that the ultimate causes of deficiencies are fully understood.

Following the deficiency assessment process, a safe and cost-effective mitigation strategy should be defined. Mitigation solutions have a vast range of cost implications, from the relatively low cost of changing piping or installing a High Integrity Pressure Protection System (HIPPS). Decision makers should take time to understand the cost implications of the various mitigation strategies available to them.

In some cases the engineering quick-fix, such as making piping modifications, can be the most costly to implement. Outlined below are common deficiencies and guidelines that can be used to help understand economical options from a hardware standpoint.

1. Inlet Pressure Drop – According to API recommendations, the inlet piping between the protected equipment and the inlet flange of the PRV should be designed so that the total pressure drop does not exceed 3% of the valve’s set pressure. This limit is intended to ensure high inlet losses do not cause excessively high accumulated pressures in protected equipment as well as to ensure the spring loaded PRV is intended to ensure high inlet pressure drop due to the stream state. If a smaller PRV is not an option, consider installing a remote sensed pilot operated valve. Remote sensing of a pilot valve ensures that the equipment is protected and that the valve functions properly.

2. Inlet Pressure Relief Valve Sizing – A PRV having an orifice which is “oversized” can introduce valve instability issues. These issues can result in increased maintenance costs and/or potential catastrophic failures during relief events. A PRV having an orifice that is “undersized” requires immediate attention as the integrity of the protected equipment is in jeopardy. PRVs, in general, have pressure limitations based on model config-

Overpressure risk never goes away. That’s why we offer total pressure relief solutions.

Real value behind every valve. That’s the FAST Center guarantee.

Farris Total Pressure Relief Solutions Include:
- Engineering Services
- Factory Acceptance Testing
- Asset Management Services
- Training

It’s simple. Safety relief valves and services to support your facility’s safety and reliability needs. Contact Farris today. Contact Farris today. Contact Farris today.

Farris is a nationwide team of pressure relief and safety experts. Farris Engineering in the Americas, a Curtiss-Wright Company. Curtiss-Wright is a global industrial company that provides custom-engineered solutions for a wide variety of industries worldwide. Curtiss-Wright provides advanced engineering, research, design, and product development services to meet your needs. Our way was designed to ensure your success.

To locate your local FAST Center, visit http://fast-center.com or 1-877-FAST-459.
3. Backpressure Issues – The pressure existing at the outlet of a PRV due to pressure in a discharge system is defined as backpressure. Since back pressure can have serious effects on the performance of a safety relief valve, it must be reviewed and properly addressed. Backpressure can be categorized two ways: superimposed or built-up. Superimposed is static pressure that exists at the outlet of a relief valve at the time the valve is required to operate. It can be either constant or variable. Built-up backpressure is variable existing at the outlet of a pressure relief valve due to the flow through the particular device into the discharge system. Limits on built-up back pressure for conventional valves are based on the set pressure and the sum of all back pressure, and should be less than or equal to the accumulation pressure -10% for a single valve, 16% for multiple valve or 21% for flow. When back-pressure is not correctly identified, several deficiencies can result:

a. Conventional spring loaded valve experiencing built-up or variable superimposed back-pressure above the limits will cause PRV instability which may result in a reduction of capacity. The recommended options are to convert the PRV to a bellows construction or to replace it with a pilot operated relief valve, where process conditions permit.

b. Backpressure, whether superimposed, built-up, or a combination of the two, exceeds the design pressure of the bellows, deformation of the bellows can occur. This will render the bellows inoperable and is the damage is severe enough, it may cause leakage to atmosphere. Options for mitigation include replacement of the bellows with a higher design pressure, replacement of the PRV with a pilot operated relief valve or installation of a rupture disc.

c. For fire scenarios where 21% overpressure is utilized, there may be issues with excessive built-up back pressure. Consider evaluating fire cases at 10% overpressure to determine if equipment can be protected and not cause back pressure issues. This has added benefit of reducing loading on collection/fibre systems during relief events.

4. Set Pressure Too High - A PRV's set pressure is too high due to the MAWP of the code protected relief valve. Mitigation requires lowering of the PRV set pressure. A proper engineering analysis requires recalculation of all relief scenarios and subsequent piping loss calculations based on the new lower set pressure.

5. Operating Too Close to Set Pressure – If a PRV's set pressure is too close to the system's maximum operating pressure, the valve may simmer or leak, making it susceptible to premature wear and damage to the seat. Product loss is also associated with this leakage. Consider the following:

a. Lower the system operating pressure to increase the pressure differential.

b. Consider installing a pilot operated PRV.

6. PRV Not Certified for Installed Service – PRV’s are ASME code certified for either vapor or liquid applications. Often, cases have been found where the PRV's certification, either vapor or liquid, does not match the actual service of the valve. For example, a PRV certified in vapor service but put into a liquid service application will not be sized correctly and will have performance issues. In this case, the PRV will likely need to be replaced. However, a pressure relief system engineering analysis should be done prior to valve selection as it is very important to ensure all overpressure scenarios are calculated using the correct formula, methodology and the certified IV parameters.

b. PRV’s with special trim design can be certified on both vapor and liquid service and can be used in both applications, thus allowing sizing for liquid, vapor or 2-phase flow scenarios.

7. General Maintenance Issues – Like all operating equipment in a plant, PRV’s require routine preventative maintenance at regular intervals. When a PRV’s maintenance frequencies surpass the expected regular intervals, this indicates the issues may reside at the protected system level rather than at the PRV level. Chronic maintenance issues that may be indicators of this problem include bellows integrity failures, galling, internal part failures, and overall erosion/corrosion issues.

a. The entire protected system should be re-evaluated including its piping pressure loss calculations.

b. Examination of damaged PRV parts may reveal the causal defect. For example, severe gall ing of internal parts bellows fatigue failures and nozzle/disc damage typically indicate valve chattering. Chattering is symptomatic of a broader system issue similar to those we have described in this article.

Summary

Pressure relieving systems are installed in process and power plants to protect process equipment and their surroundings from the effects of an overpressure situation. Pressure relief systems are extremely critical safety elements as they are the final line of protection against equipment failure and catastrophic overpressure events. Protected systems that may have relief valve deficiencies jeopardize the integrity of these critical safety elements and all efforts to mitigate these efficiencies must be addressed.

About the authors

Sean Croxford is currently the Business Unit Manager for Farris Engineering. Farris is currently the business unit of Curtis-Wright Flow Control Company. FES provides industrial plants with pressure relief system design and analysis services. Sean received his degree in electrical engineer ing and instrumentation from Lamont College. Sean has 16 years in the valve industry with experience in safety, engineering analysis, operations and business management.

Stan Zalar is the Engineering Manager with Farris Engineering. Stan earned his bachelor’s degree in Mechanical Engineering from Cleveland State University, and returned to attain an MBA that concentrated in marketing and finance. He is a member of the American Society of Mechanical Engineers, and a registered Professional Engineer in the state of Ohio. He has been with Farris Engineering for over 16 years and has served in various roles, including Applications Engineer, Field Engineer, Product Manager and now Engineering Manager.

TRIPLERAIL THREE RAIL PRESSURE RELIEF VALVE

Valve World Americas • December 2012 • www.valve-world-americas.net