RELIEF VALVES IN PARALLEL

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Why use a Relief Valve (PRV)

- It is Required by Code
- Protect our Personnel
- Prevent loss of Capital Investment
- Conserve the Product
- Minimize Downtime
- Protect the Environment
PRV Defined (official version)

A pressure relief device designed to actuate on inlet static pressure and reclose after normal conditions have been restored.

- relief valve: characterized by gradual opening that is generally proportional to the increase in pressure. It is normally used for incompressible fluids.

- safety relief valve: characterized by rapid opening or by gradual opening that is generally proportional to the increase in pressure. It can be used for compressible or incompressible fluids.

- safety valve: characterized by rapid opening and normally used to relieve compressible fluids.

ASME PTC-25
A PRV is nothing more than a self-contained back pressure regulator. A PRV is highly reliable but poorly designed Control Valve.

Like a regulator, a PRV can be direct acting or pilot type.

PRV trim characteristic is “quick opening”.

PRV trim is not as robust (or accurate) as CV trim. A CV is designed to open and a PRV is designed to stay closed (open infrequently).

Remember – an open PRV maintains a pressure over MAWP. It does not reduce pressure.
Pressure Terminology

- Operating Pressure
- MAWP
- Design Pressure
- Set Pressure
- Back Pressure
- Re-seat Pressure
- Over Pressure
- Blowdown
Code & Standards

ASME for Boilers & Pressure Vessels

- UG-125(c)(1) allows for 16% (or 4 psi) over MAWP when using multiple devices.
- UG-134(a) Single device cannot be set over MAWP. When required capacity is provided in more than one device, only one need be set at or below MAWP. 2nd device cannot be higher than 105% of MAWP.
Chatter is Bad

- Chatter is the rapid opening and closing of a PRV. It can happen in any service with any PRV valve type.

- Chatter damages the PRV and can damage the connecting Pipe.

- **Chatter reduces the PRV’s capacity!**

- Chatter can be violent enough to cause catastrophic failure releasing process fluid to the atmosphere.
Chatter - The Cause

Chatter is caused by varying differential pressure across the PRV resulting from:

- Excessive pressure drop at the inlet
- Changes in the back pressure (built-up or from another valve or related source)
- Any combination of the above
- Operational Resonance

An oversized PRV is a primary culprit.
The basis must be determined
Inlet and outlet piping must be considered
Inlet piping pressure drop and backpressure must be estimated/calculated
A relief valve type is selected
A sizing calculation is made
Relief and flare headers must be evaluated if applicable
Piping reactions must be considered and proper support provided
Consideration must be given to noise both with regard to personnel protection and to the potential for piping damage
Project Issues

- PRV sizing and selection should be an iterative process.
- Cost and Schedule considerations often leave PRVs oversized.
PRV Sizing

The basis must be determined.

- Are there multiple cases with widely varying flow rates?
- What is the design effect on the relief header?
- What is the relief header effect on the PRV?
- Calculate
- Select PRV orifice with “no safety factor” applied
- Confirm relief load and reactions are still within acceptable limits.
Sizing Rules of Thumb

Maximum Selection based on Required Orifice

- 140% absolute maximum
- 125% ideal max for vapor service
- 110% ideal max for liquid service

Minimum

- 25-30% Relief flow against Capacity for spring operated devices. (if there is a case <30%, the installation is a candidate for dual valves per UG-125 & 134)
Piping & Instrumentation Diagrams

- Base Line document for a Facility
- Defines the Facility more succinctly than any other document
- P&ID must always represent the Facility
- Management of Change is required
- P&ID’s rule – full stop.
The Problem at Hand

When there is an installation that provides for a spare relief valve that is supposed to be normally closed to the process and that spare valve is then opened to the process along with the primary valve, facility safety is compromised. There are a number of reasons why this is true.
This misapplication of relief valves gives new definition to the term “Chatter”. We can now add valve Interaction to the previous definition.

It should be readily apparent what the additional interactions can do to a pair of fully sized relief valves open to the process.
2 - Relief System Piping Design

- Transient increase in relief load translates to increased moment in the pipe works
- Transient increase Sound Pressure Level (SPL)
- Transient increase in fluid velocity
3 - Flare Loading

- Flare system and Flare Tip design can be exceeded.

- Spurious opening of a pilot operated valve. A pilot operated PRV is a “Fail Open” device. By opening both PRVs to the process, the MTBF is cut in half.
4 - Safety Issues & Assumptions

- Fundamental assumption is incorrect: it is not safer!

- Layer of Protection Analysis: Apparently LOPA credit is given for opening the 2\textsuperscript{nd} PRV to the process. This is bad practice and gives a false legitimacy to the practice.

- If set points are staggered and one valve comes out of service for maintenance, it could leave the valve set at 105\% in service – an unacceptable practice.
Summary

Potential Issues

- The facility line-up at the time of an accident or event does not match the authority approved P&ID.
- Relief valve pairs may chatter on and off thus decreasing capacity possibly below the amount required to maintain MAWP.
- Relief valve damage.
- Damage to piping and/or pipe supports. Note that the phenomenon of stress is cumulative.
- Flare or relief system overload with resultant overpressure.
- Relief into the process area due to damaged headers or venting at unexpected locations.
Recommendations

- If a pair of relief valves is to remain open to the process, ensure the installation is applied correctly per Code, and ensure the provided capacity does not exceed 140% of the required capacity.
- Make engineering design contractors aware of the desired practice at the start of a facility design so engineering is done correctly and work does not have to be repeated.
- Ensure operations personnel understand the sanctity of the P&ID, the procedures required to make revisions, and management of change.
- If a set-point is changed, the valve nameplate and data sheet must be changed accordingly.
- If a facility has been operating not in accordance with approved design and there have been incidents of dual PSV lift, inspect the relief system piping and supports for damage.

Never provide parallel valves open to the process when both are fully rated for the maximum load.