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Steam Safety Relief Valves

Introduction

The NIH uses steam for a variety of purposes, including domestic and hydronic water heating, humidification, cage washing, and sterilizing. Pressure for steam systems and associated equipment is regulated by pressure reducing valve (PRV) stations and control elements that monitor pressure, return condensate from steam lines to boilers at the NIH Central Utility Plant, and segregate steam and steam condensate of differing pressures. The pressure in steam piping and pressure vessels can rise above rated design pressures for many reasons, including control instrumentation failure and pressure surges. Excessive pressures risk damage, unpredictable steam supply through system components to end user equipment, and catastrophic failure.

The NIH *Design Requirements Manual* (*DRM*) requires Safety Relief Valves (SRVs) to be installed at appropriate locations in steam systems to vent steam above design pressure to the atmosphere. This article describes the components of SRVs, sizing and location considerations, and applicable codes and industry practices.

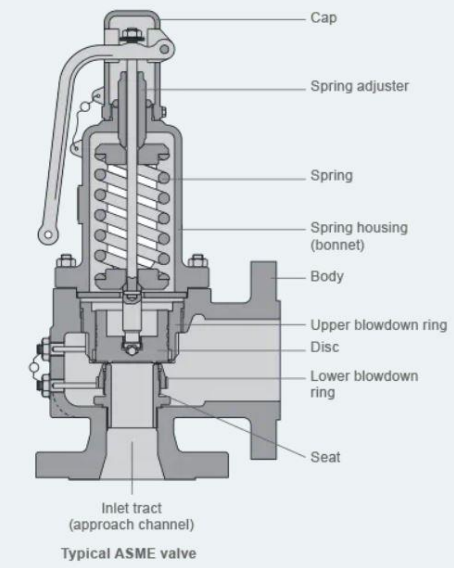
Safety Relief Valve Components and Basic Operation

Basic components of spring-loaded "conventional" SRVs include a vertical steam inlet, a horizontal discharge, and an inner valve disc held closed by a spring housed in a bonnet. Steam escapes through the discharge when the valve disc is lifted off its seat by steam entering the valve inlet above a set steam pressure, which the system designer selects by adjusting the spring. Set pressures are higher than the system's normal working pressure to avoid unnecessary discharge, but they must never exceed the system's maximum allowable working pressure. The valve relieves steam through outlet piping attached to the discharge with a flanged or threaded connection. Outlet piping is bent at an elbow where steam escapes into a vent piped to the roof. The elbow is fitted with a drip pan to ensure condensate from the valve or steam vent is piped to the nearest sanitary floor drain. The valve lifting action caused by the inlet steam then compresses the valve spring, creating a reaction force that closes the valve disc against its seat when the inlet steam can no longer sustain the set pressure.

Installation Practices and Code & *DRM* Requirements

Designers must comply with ASME B31.1, the ASME Boiler Pressure Vessel Code (BVPC), and manufacturers' detailed installation requirements. Generally, valves must be installed vertically upright, above the steam pipe or equipment served, at any location where steam system components (PRVs, flash tanks, boilers, etc.) could be subjected to pressure above their ASME rating. Designers must minimize pressure drop at the valve inlet by maintaining or increasing the inlet pipe size, rounding any corners at the inlet tee, and installing SRVs at least 8-10 pipe diameters away from fittings.

When an SRV is located downstream of PRVs, the steam flow capacity of the SRV at set point must exceed the PRV's maximum flow capacity so that the SRV can handle the flow if the PRV were to fail open. Multiple SRVs may be used in places where a single SRV is not feasible due to capacity or physical limitations. All SRVs must have identical set points and capacities, and vent pipes must be sized to handle all the SRVs opening simultaneously.



Typical ASME valve diagram (from Spirax Sarco, Inc.)

Designers must provide sufficient structural support for the SRV and pipe to resist reaction forces in the system caused by steam discharge. Inadequately supported systems may suffer catastrophic failure due to bending moments caused by reaction forces. ASME B31.1's "Nonmandatory Appendix II: Rules for the Design of Safety Valve Installations" provides guidance for calculating these forces.

Per *DRM* 6.3.7.4.K, steam valves and specialties shall meet industrial high-performance standards and utilize stainless steel seats and discs. *DRM* 6.3.7.4.L requires that SRVs be vented separately from each other and other steam vents. When locating vent pipes, designers must ensure discharge is not entrained in air system outdoor intakes and occurs no less than seven feet above the roof and away from any location posing a risk to maintenance personnel. All SRVs shall meet ASME requirements, which include being stamped per BPVC, certified by the National Board of Boiler and Pressure Vessel Inspectors, and sealed to prevent tampering.

Maintenance personnel shall follow ASME BPVC, Section I and VIII requirements for testing SRVs to certify normal operation. Testing frequency depends on the risk a faulty valve poses to facilities operation and the safety of maintenance personnel or end users.

Additional Reading

1. Safety Valves, Spirax Sarco Inc., https://www.spiraxsarco.com/learn-about-steam
2. Pressure Relief Valve Engineering Handbook, Emerson https://www.emerson.com/documents/automation/pressure-relief-valve-engineering-handbook-en-gb-4244934.pdf