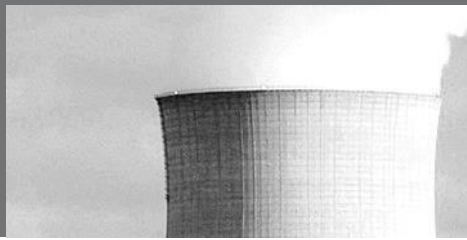
Farris Engineering

Codes & Standards



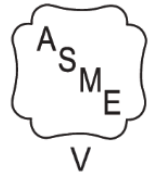
The aim of this presentation is to discuss the Codes & Standards which apply to pressure relief valves.

American Society of Mechanical Engineers

- The ASME establishes rules of safety governing the design, the fabrication and the inspection during construction of boilers and unfired pressure vessels, and interprets these rules when questions arise regarding their intent.
- Different Sections of ASME Code deal with the manufacture of safety valves:
  - ASME Code Section I
  - ASME Code Section II
  - ASME Code Section III
  - ASME Code Section VIII

ASME Section I

- **This is a construction code covering power, electric and miniature boilers and high temperature boilers used in stationary service above 15 psig.**
  - **3% maximum overpressure at rated capacity.**
  - **Blowdown requirements:**
    - P_{set} < 67 psi — 4 psi
    - P_{set} ≥ 67 and ≤ 250 psi — 6% of set pressure
    - P_{set} > 250 and ≤ 375 psi — 15 psi
    - P_{set} > 375 psi — 4% of set pressure
  - **Set pressure tolerance:**
    - $P_{set} \leq 70$ psig — +/- 2 psi
    - 70 psi < $P_{set} \leq 300$ psi — +/- 3 psi
    - 300 psi < P_{set} < 10 — +/- 10 psi
    - $P_{set} \geq 1000$ psi — +/- 1%
  - **Must have lifting lever and nameplate showing rated capacity in lb/hr steam**



ASME Section II

- **This is a construction code listing materials suitable for the construction of safety valves according to ASME Code.**
  - **Part A:** Ferrous Materials Specifications
  - **Part B:** Nonferrous Materials Specification
  - **Part C:** Specifications for Welding Rods, Electrodes & Filler Materials
  - **Part D:** Properties (Customary or Metric)
- **In order for a part to be used in the construction of a safety valve, the material must appear in ASME Code Section II*.**

* Materials found in ASME Code Cases are allowable to the limits specified in the code case.

ASME Section VIII

- **This is a construction code covering the basic rules for the construction, design, fabrication, inspection and certification of unfired pressure vessels above 15 psig.**
  - **Maximum accumulation at rated capacity:**
    - 10% (or 3 psi) single valve
    - 16% (or 4 psi) multiple valves (non-fire)
    - 21% overpressure due to fire
  - **No mandatory blowdown; however, adjustable blowdown valves must meet 7% during test for certification**
  - **Set pressure tolerance:**
    - Pset $\leq$ 70 psi +/- 2 psi
    - Pset > 70 psi +/- 3%
  - **Lifting lever for water (>140ºF [60ºC]), air or steam service**
  - **Nameplate showing rated capacity in SCFM air, US-GPM water or lb/hr steam**

National Board of Boiler & Pressure Vessel Inspectors (NB)

- The NB represents the enforcement agency who assures adherence to provisions of the ASME boiler and pressure vessel codes.
- The NB:
  - Sets inspection standards
  - Qualifies inspectors
  - Works for owners, insurers
  - Maintains records (Red Book – NB-18)
  - Looks into violations
  - Covers repair (VR Stamp)

American Petroleum Institute (API)

- API publishes several standards dealing with safety valves:
  - API 520 Part 1 – Sizing & Selection of Pressure Relief Devices
  - API 520 Part 2 – Installation of Pressure Relief Devices
  - API 521 – Guide for Pressure-Relieving & Depressurizing Systems
  - API 526 – Flanged Steel Safety Relief Valves
  - API 527 – Seat Tightness of Pressure Relief Valves

API 520

API 520 Part 1

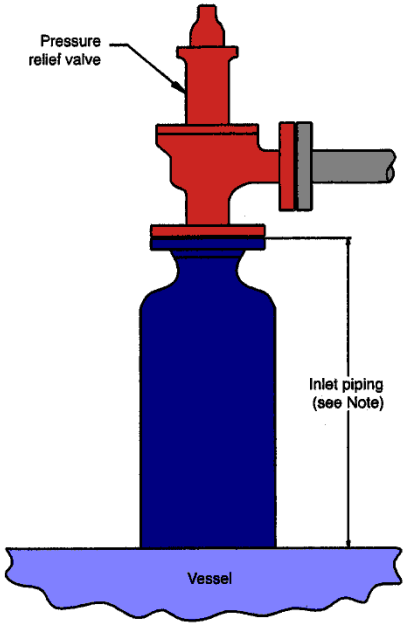
- Applies to the sizing and selection of pressure relief devices for equipment with an MAWP of 15 psig or greater.
  - Protection of unfired vessels
  - Basic definitions
  - Operational characteristics of pressure relief devices
  - Sizing procedures, equations and methods

API 520 Part 2

- Covers methods of installation for pressure relief devices on equipment with an MAWP of 15 psig or greater.

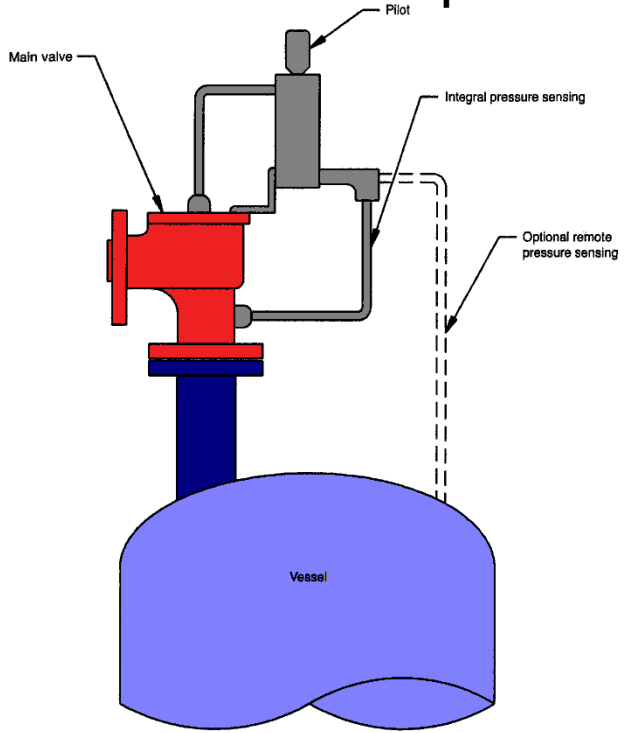
API 520 Part 2

- **According to API 520 Part 2, inlet piping must be sized so that non-recoverable pressure losses from vessel to pressure relief valve inlet flange do not exceed 3% of set pressure.**



Typical Pressure-Relief Valve Mounted on Long Inlet Pipe

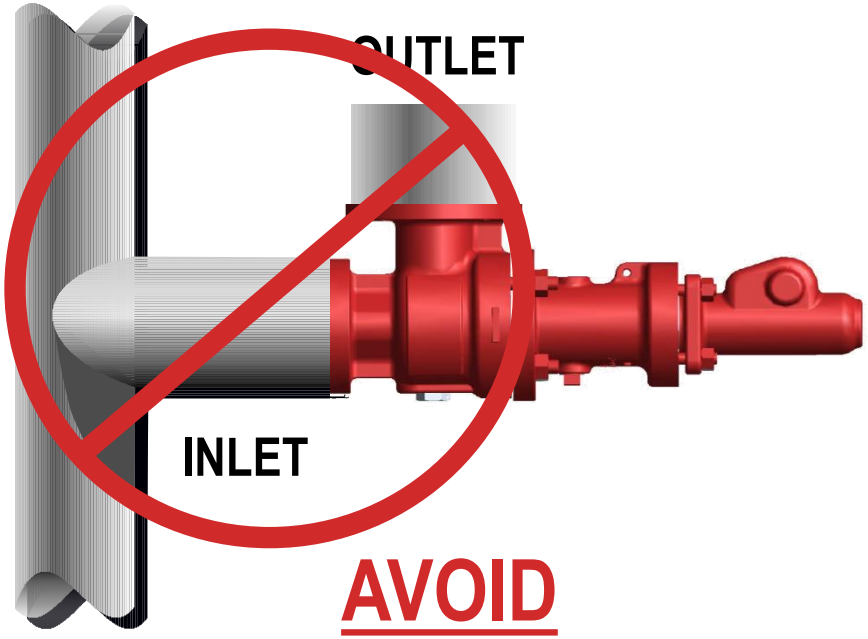
Pressure Drop ≤ 3% of P_{set}



Typical Pilot-Operated Pressure-Relief Valve Installation

API 520 Part 2

- **Install the PRV in an upright, vertical position**

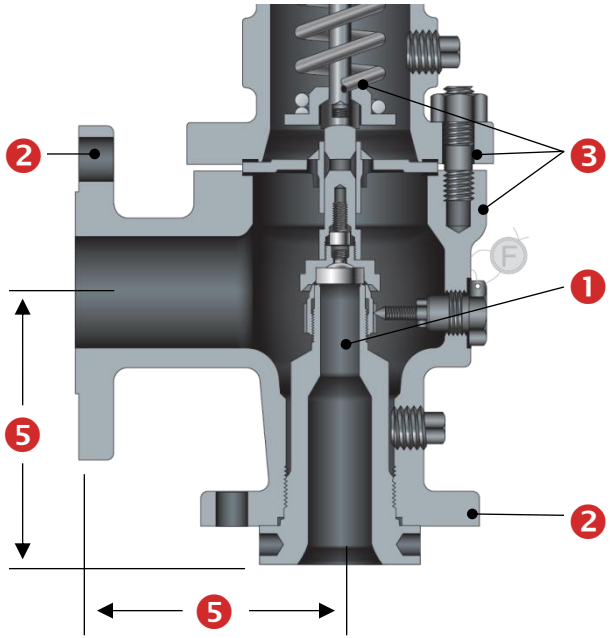


API 521

- **API 521 is designed to aid in the selection of the system that is most appropriate for the risks and circumstances involved in various installations.**
- **This standard provides guidelines for:**
  - **Examining the principal causes of overpressure**
  - **Determining individual relieving rates**
    - Including fire vapor generation and fire gas expansion
  - **Selecting and designing disposal systems**

API 526

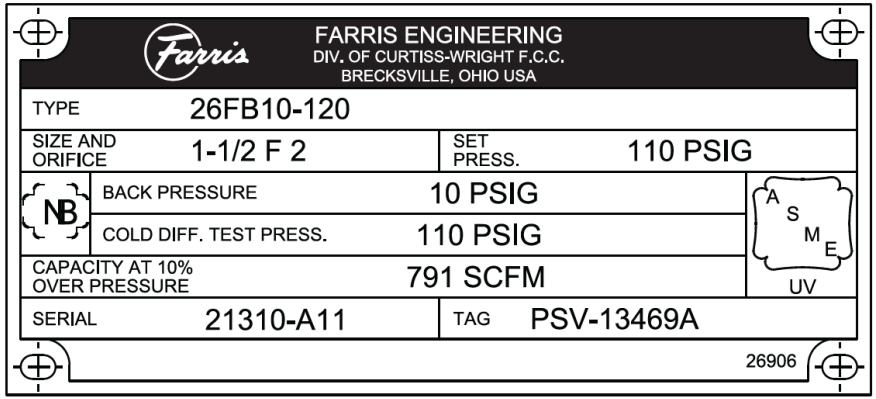
- API 526 is a purchasing specification for flanged steel pressure relief valves. Requirements are given for spring loaded pressure relief valves and pilot-operated relief valves.
- API 526 has standardized the following items:
  1. Orifice designation and area
  2. Valve size and pressure rating, inlet and outlet
  3. Materials
  4. Pressure-temperature limits
  5. Center-to-face dimensions, inlet and outlet
  - Inspection and shop tests
  - Identification and preparation for shipment



API 527

- API 527 describes tests to determine the seat tightness of metal and soft-seated pressure relief valves. Valves of conventional, bellows, and pilot-operated designs are covered. Acceptable leakage rates are defined.
- It contains criteria for:
  - Testing with air
  - Testing with steam
  - Testing with water
  - Testing with air – another method

Required Nameplate Data



Nomenclature	Description
Manufacturer's Name	Identification of Manufacturer
Size	Nominal pipe size, inlet x outlet
Type, style or model	Manufacturer's designation
Capacity	lb/hr of saturated steam, SCFM or air at 60°F and 14.7 psia or U.S.GPM of water at 70°F
Serial Number	Manufacturer's identification
Set Pressure	Valve inlet pressure at which the valve is adjusted to open
Back Pressure	Constant and/or Variable
Cold Differential Test Pressure	Pressure at which the valve is adjusted to open on the test stand
Tag Number	Valve tag number

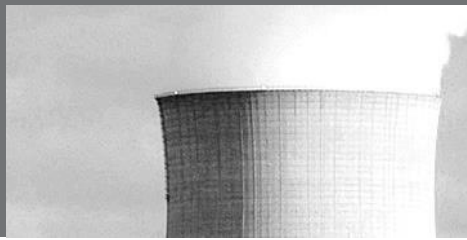
Worldwide Approvals

The following is a list of Farris approvals currently on record:

- ASME “V”, “UV” and “NV”
- National Board “NB” approval
- ISO 9001-2008
- US Coast Guard
- PED 97/23/EC (European Pressure Equipment Directive)
- ATEX 94/9/EC (European Potentially Explosive Atmospheres)
- B51 CRN (Canadian Registration)
- China Safety Quality License
- Russian GOSH-R and GGNT (Russian Certification and Permits)
- First Point Assesment Limited
- Nuclear – 10 CFR 50 Appendix B, NCA-4000, NQA-1, N285.0

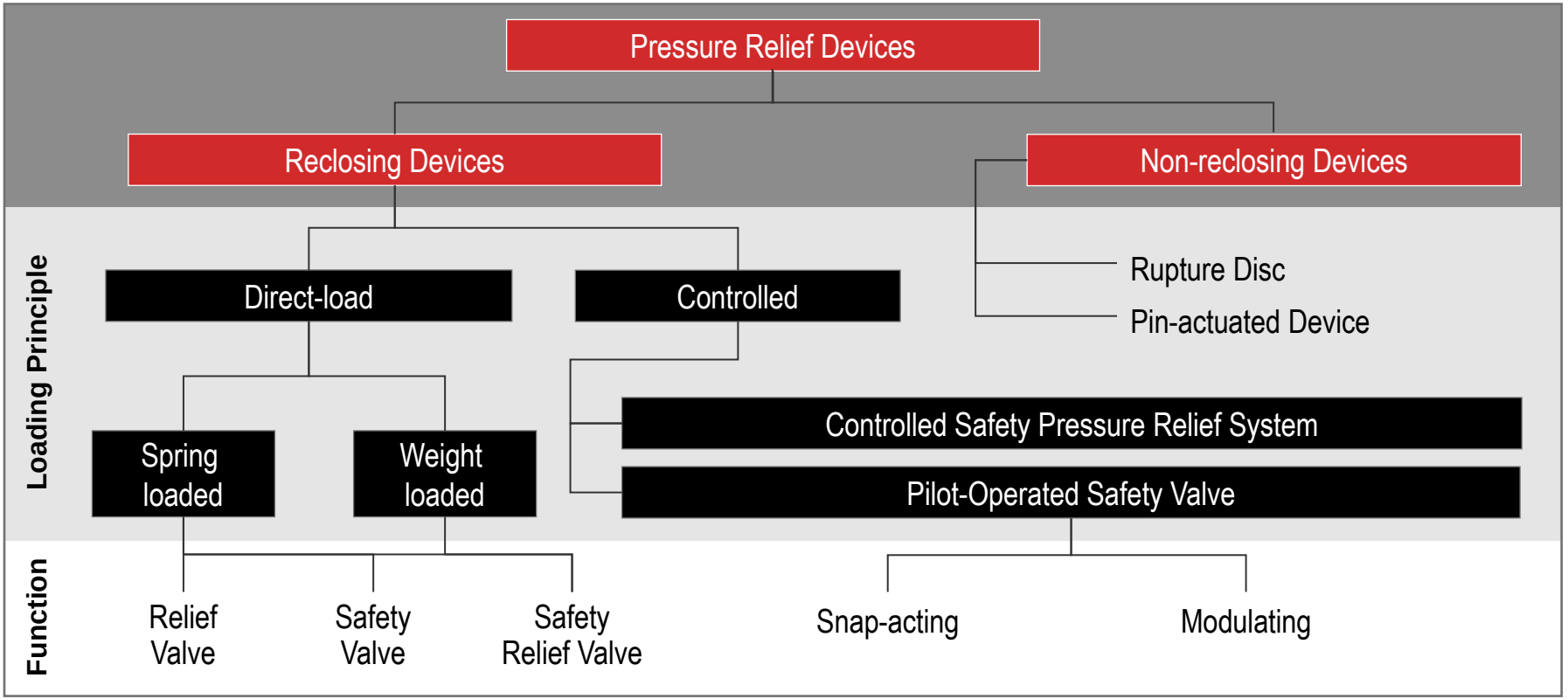
Farris Engineering

Terminology



The aim of this presentation is to provide an overview of pressure relief terminology.

Safety Device Classification

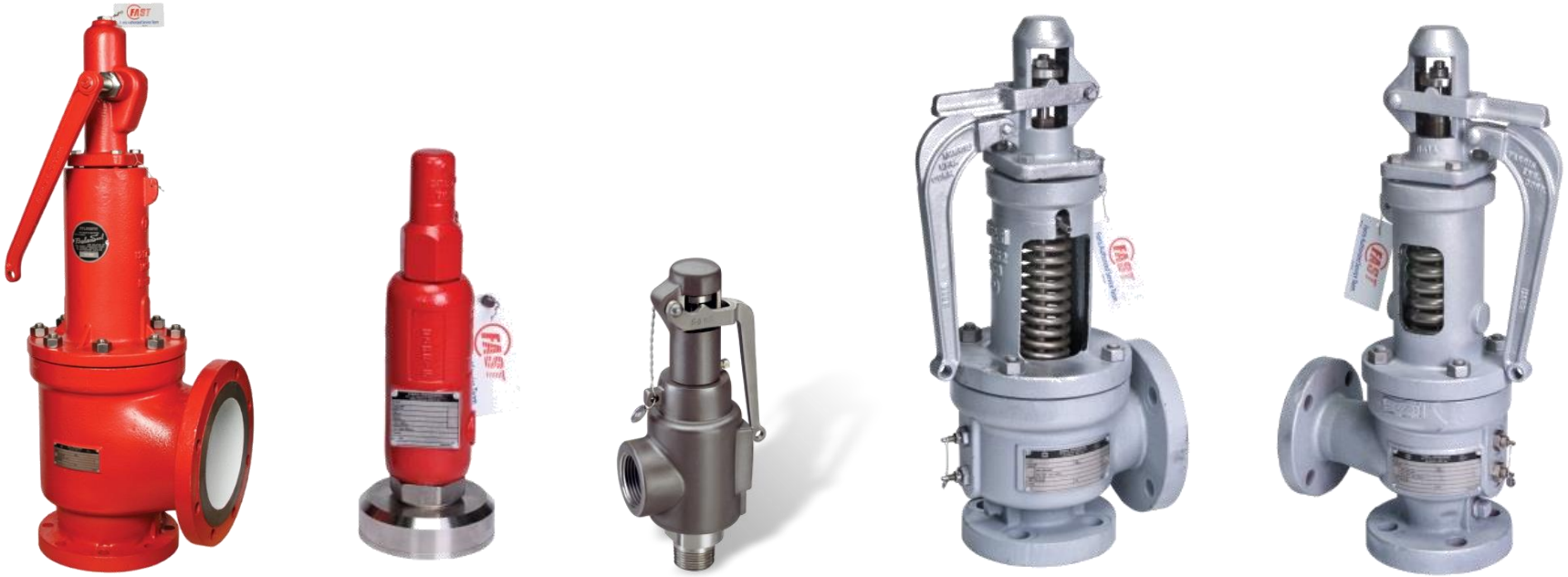


Pressure Relief Valve

- **A pressure relief device, either direct loaded or controlled, designed to open and relieve excess pressure and to re-close and prevent the further flow of fluid after normal conditions have been restored.**

Loading Principle: Spring Loaded

- A pressure relief valve in which the opening and closing of the valve is controlled by a spring.



Loading Principle: Weight Loaded

- **A pressure relief valve in which the opening and closing of the valve is controlled by a weight.**

Loading Principle: Pilot Operated

- **A pressure relief valve in which the main valve is combined with and controlled by an auxiliary pressure relief valve (pilot-controlled).**

Loading Principle: Controlled PRV

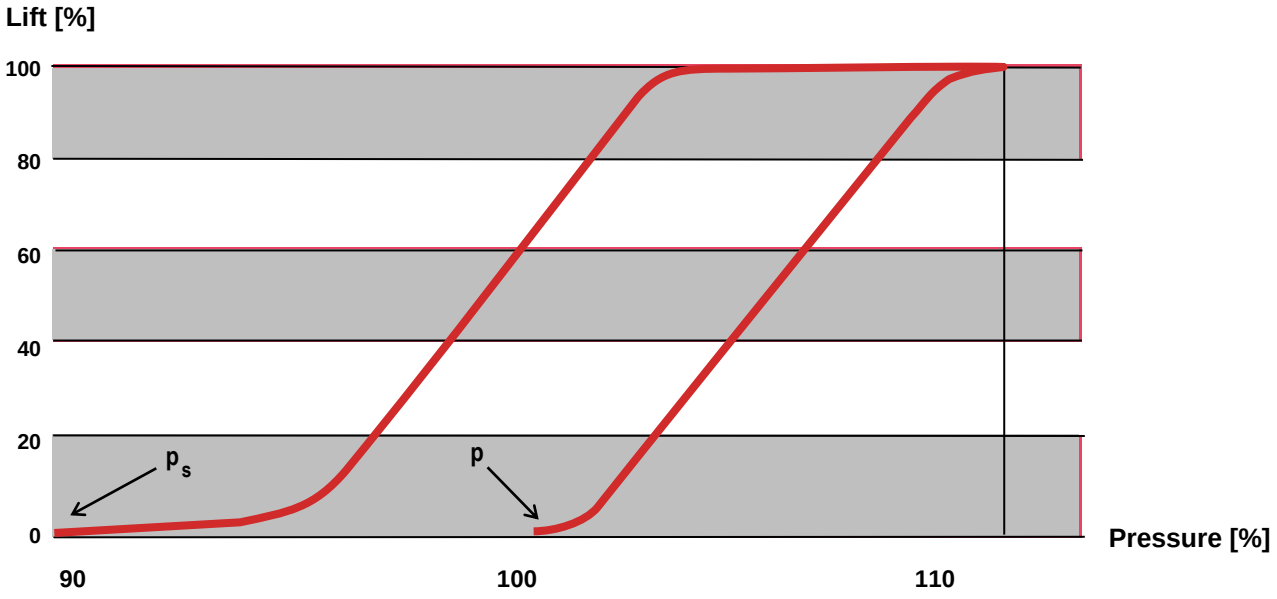
- **A system consisting of a main valve in combination with control units. The closing force is applied by a control device which will typically control an actuator on a direct load pressure relief valve.**

Pressure Relief Valve / Rupture Disk Combination

- **A system consisting of a pressure relief valve in combination with a rupture disk.**

Relief Valve

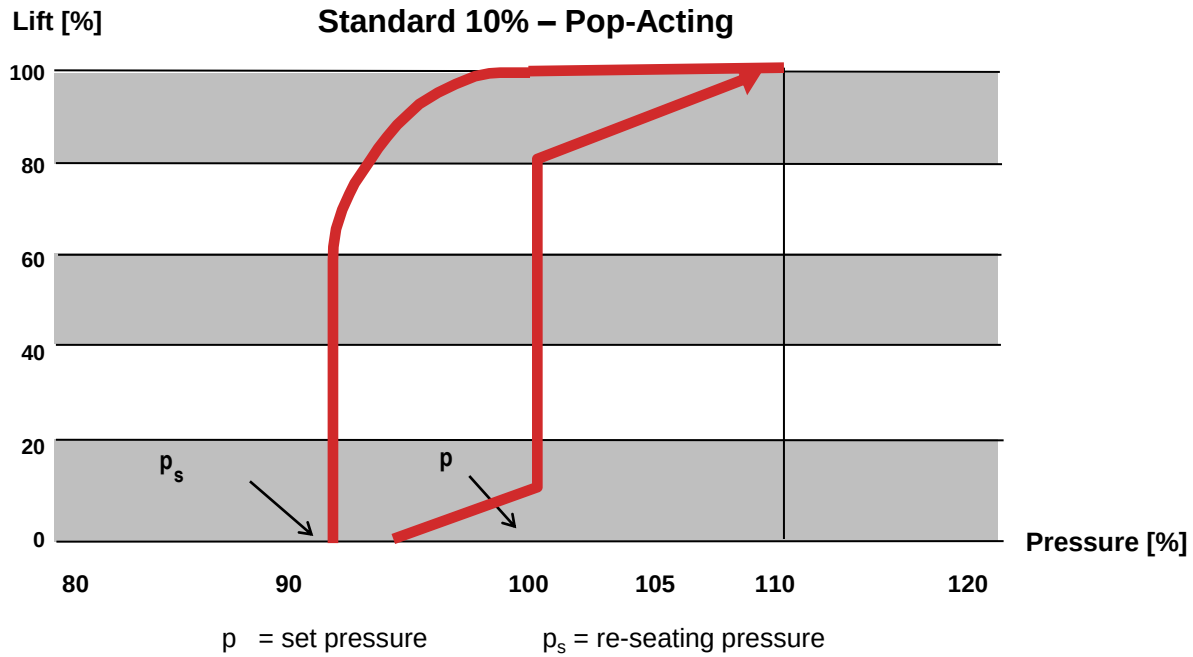
- A spring loaded pressure relief valve which opens in proportion to the pressure increase over the opening pressure. Used for liquid (non-compressible) service.



p = set pressure p_s = re-seat pressure

Relief Valve

- A spring loaded pressure relief valve characterized by rapid opening or pop-action. Used for <u>compressible</u> (gas / vapor / steam) service.

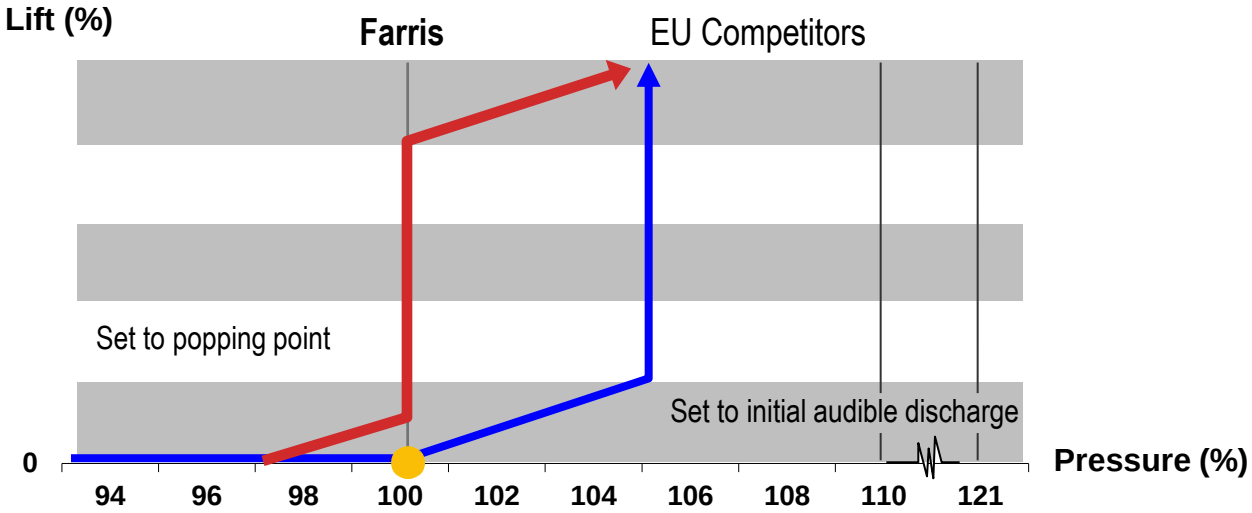


Pressure Relief Valve

- **A spring loaded pressure relief valve that may be used as either a safety or relief valve depending on the application.**

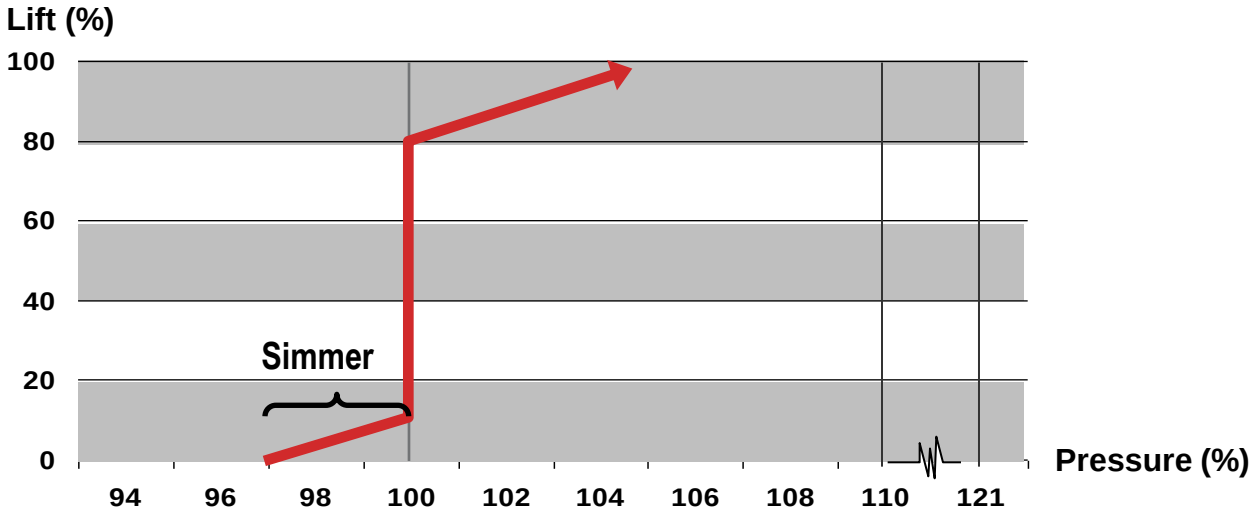
Set Pressure

- The inlet gauge pressure at which the Pressure Relief Valve is set to open.



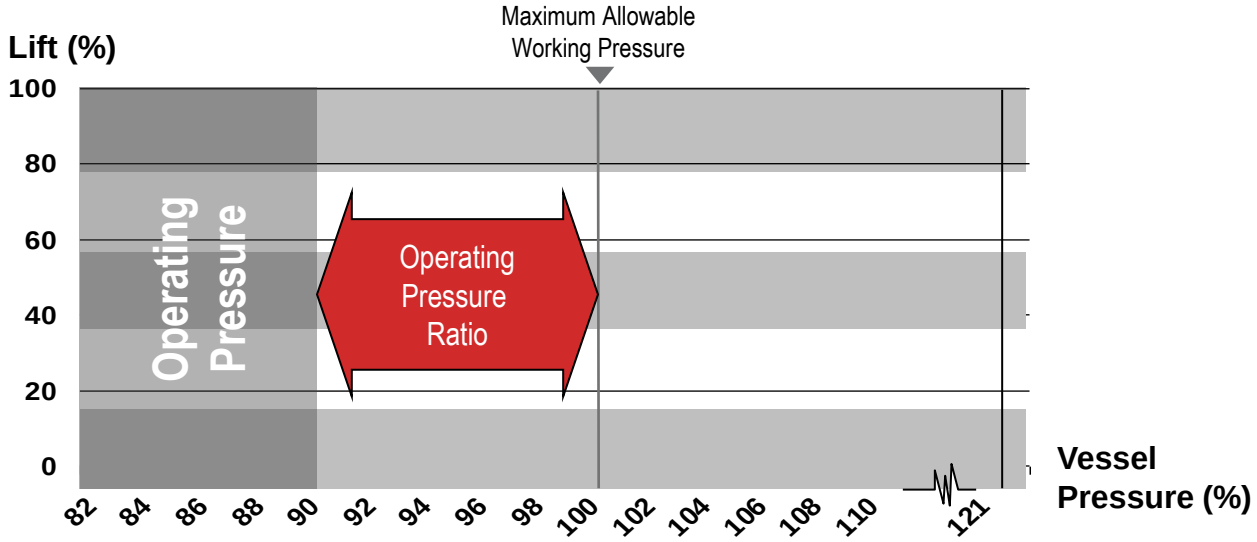
Simmer

- The audible or visible escape of compressible fluid between the seat and disc of the Pressure Relief Valve prior to set pressure



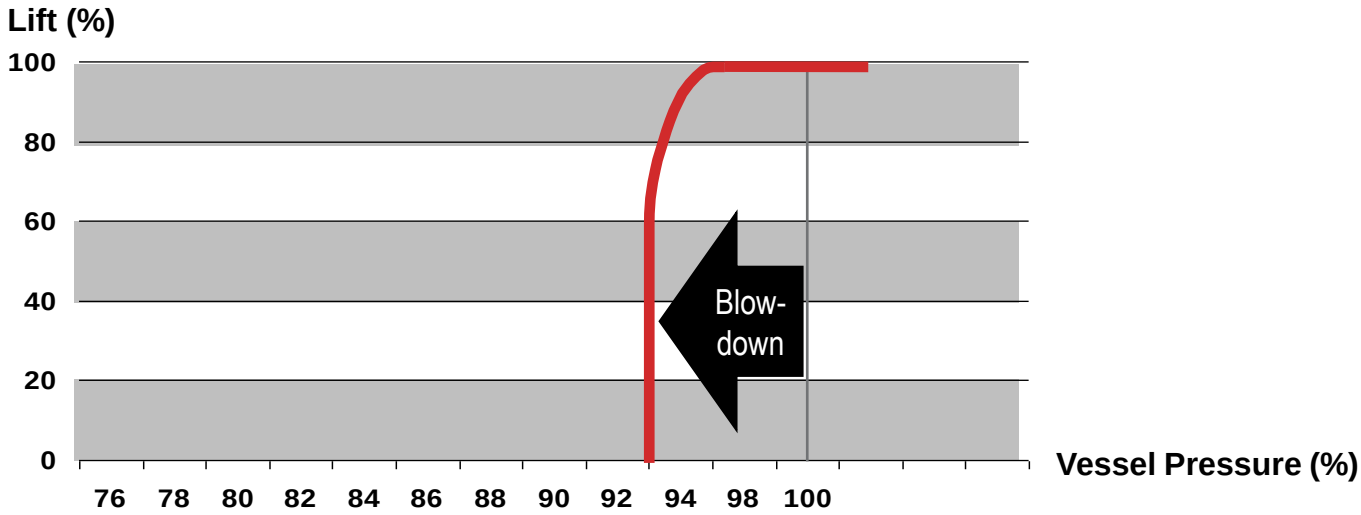
Operating Pressure Ratio

- **The ratio of operating pressure to set pressure. 90% should not be exceeded for spring loaded valves.**



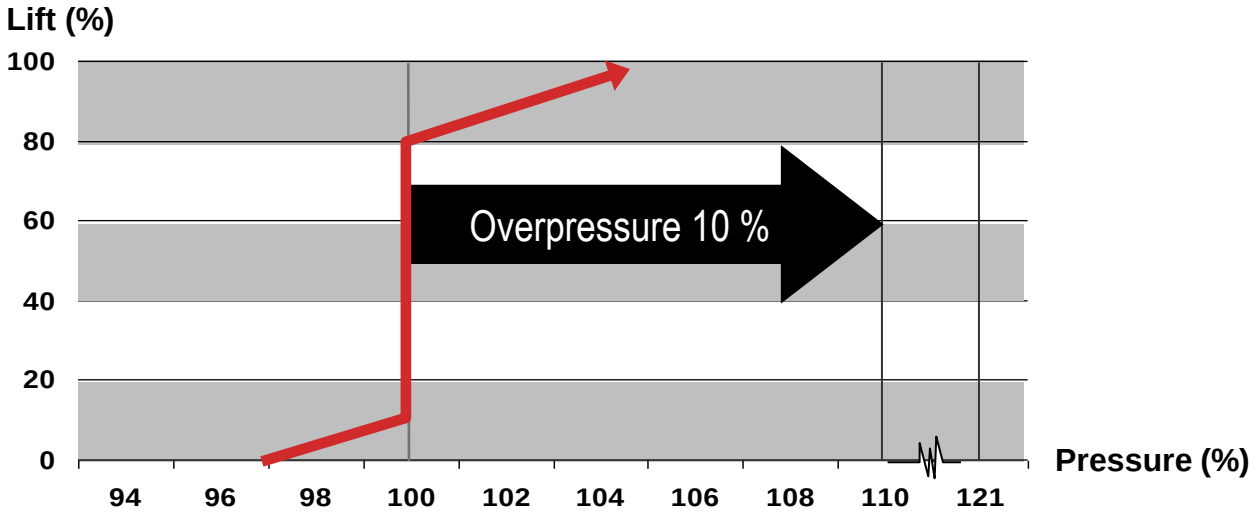
Blowdown

- The difference between the set pressure and the closing pressure of a Pressure Relief Valve (expressed as a percentage of set pressure).



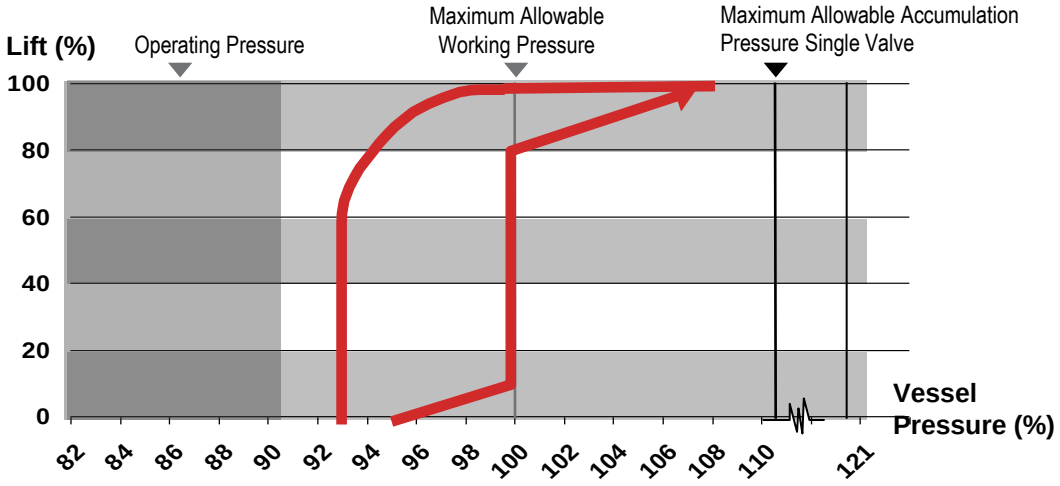
Overpressure

- **The pressure increase over the set pressure of the pressure relief valve allowed to achieve rated flow.**



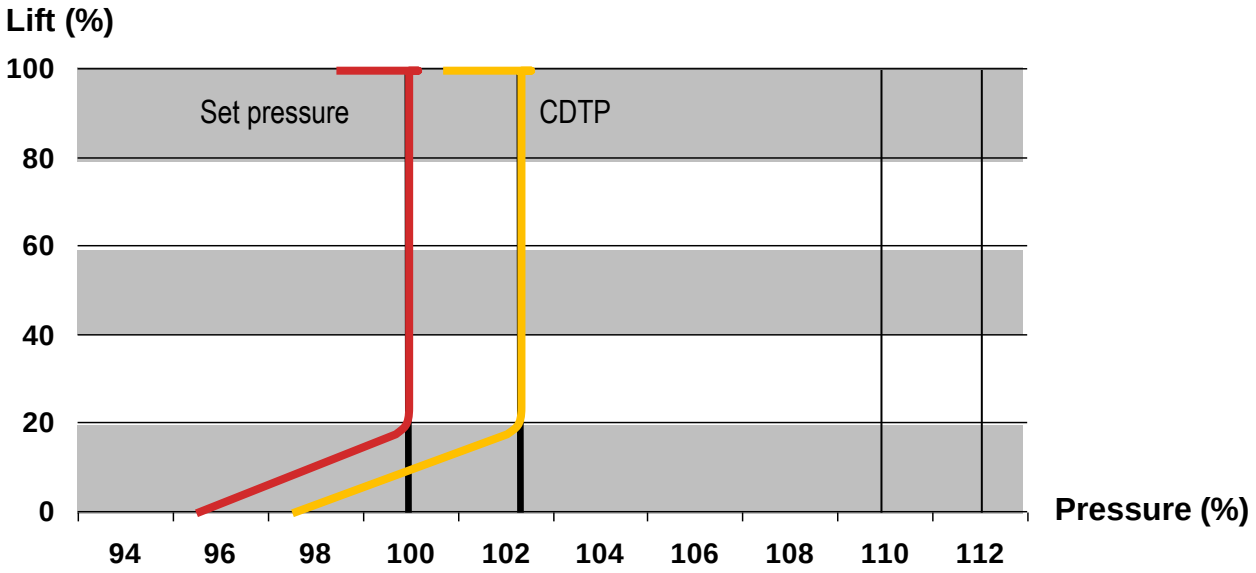
Terminology

- **Maximum Allowable Working Pressure (MAWP).** The maximum gauge pressure allowed at the top of a completed vessel. Design pressure may be used instead of MAWP in all cases where the MAWP has not been established. Design pressure is equal to or less than MAWP.
- **Accumulation.** The pressure increase over the MAWP of the vessel allowed during discharge through the Pressure Relief Valve (governed by applicable codes).
- **Maximum Allowable Accumulated Pressure:** The sum of the MAWP and the accumulation.



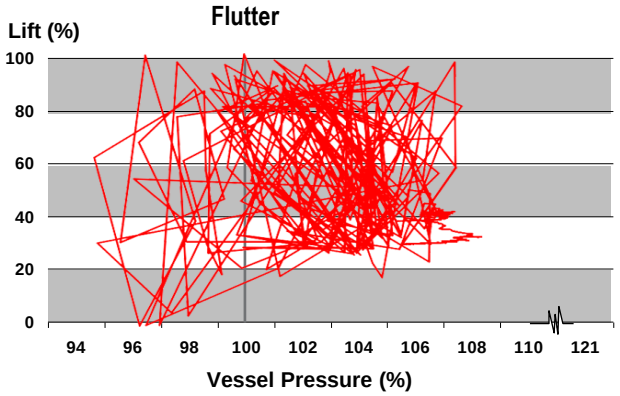
Cold Differential Test Pressure (CDTP)

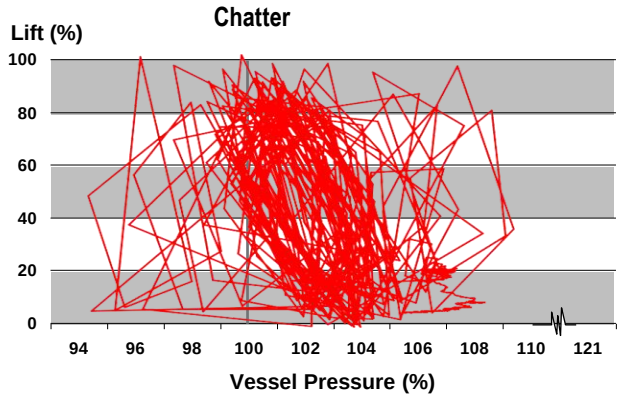
- The pressure at which a Pressure Relief Valve is adjusted to open on the test stand. It includes corrections for constant back pressure or elevated temperature or both.



Abnormal Valve Function

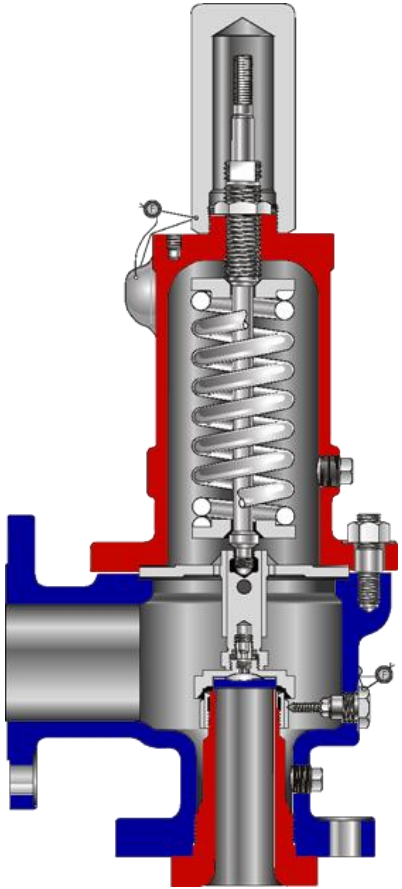
- Flutter - The abnormal, rapid reciprocating motion of the movable parts of a pressure relief valve in which the disc does not contact the nozzle
- Chatter - The abnormal, rapid reciprocating motion of the movable parts of a pressure relief valve in which the disc contacts the nozzle
- Possible causes for the above include:
  - Inlet pressure drop too high
  - Excessive back pressure
  - Oversized valve





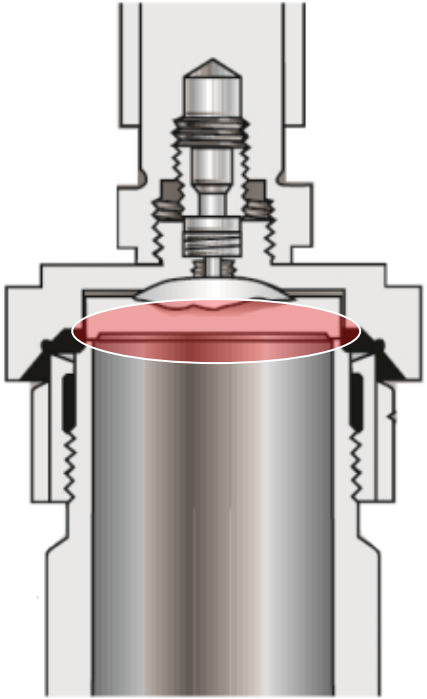
Pressure Retaining Components

- Body
- Bonnet
- Nozzle
- Disc



Valve Seat

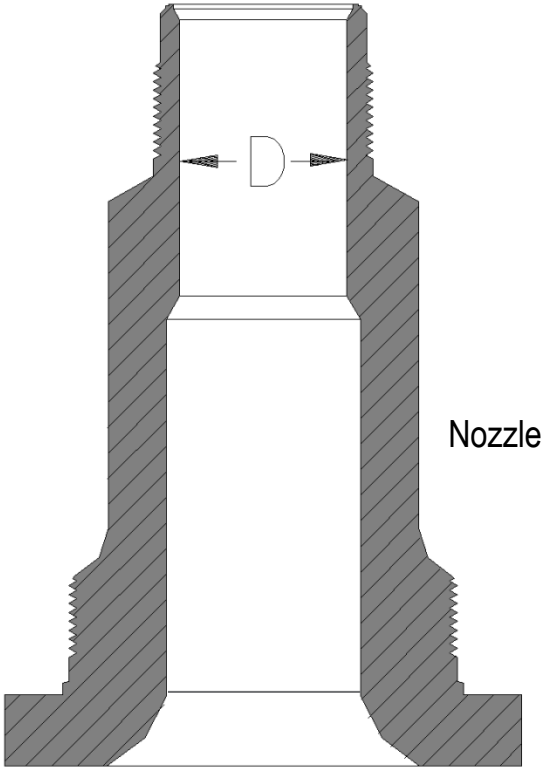
- The area of contact between the valve nozzle and disc.



Actual (ASME) Discharge Area

- **The minimum net area that determines the flow through the valve.**

$$A = \frac{\pi D^2}{4}$$



Coefficient of Discharge

Coefficient of Discharge (K_d)

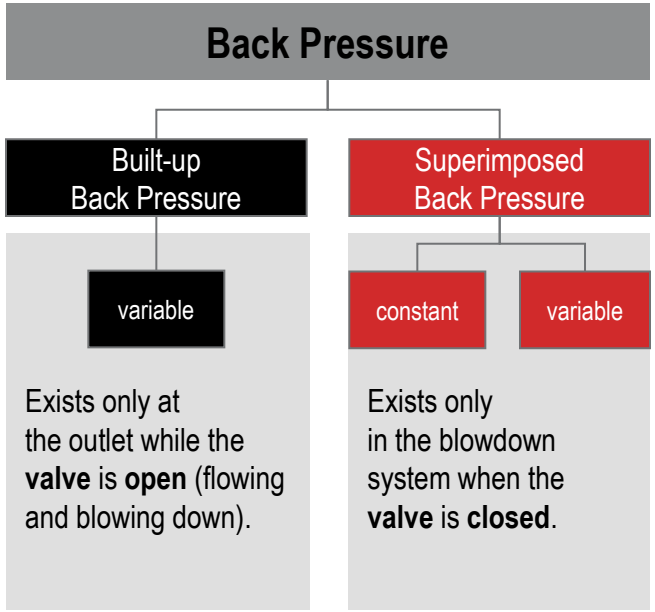
- The ratio of the mass flow rate in a valve to that of an ideal nozzle (used for calculating flow through a Pressure Relief Valve).
  - 9 tests are required for each valve series
  - Average of the 9 tests shall be the coefficient of discharge (as long as each of the tests is ±5 % of the average).
  - Cannot be greater than 0.975.

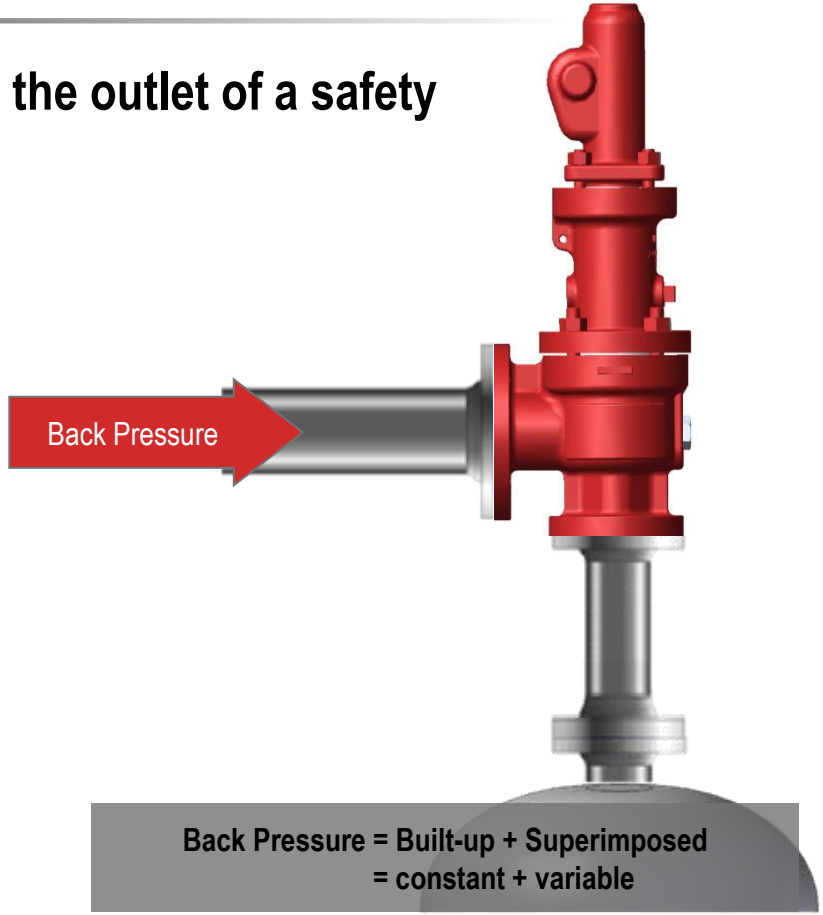
De-rated Coefficient of Discharge (K)

- The product of the coefficient of discharge (Kd) and 0.9 (a 10 % de-rating factor mandated by the ASME).
  - The de-rated coefficient of discharge shall be used in all sizing calculations and capacity calculations.

Back Pressure

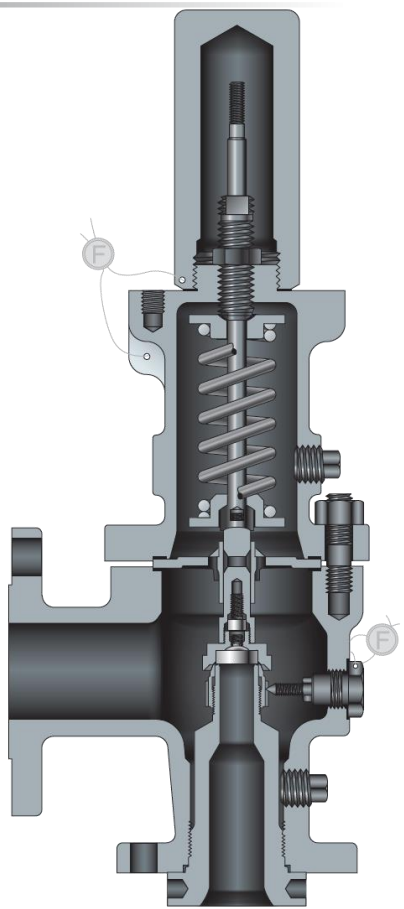
- **Back pressure is the pressure that exists at the outlet of a safety valve.**





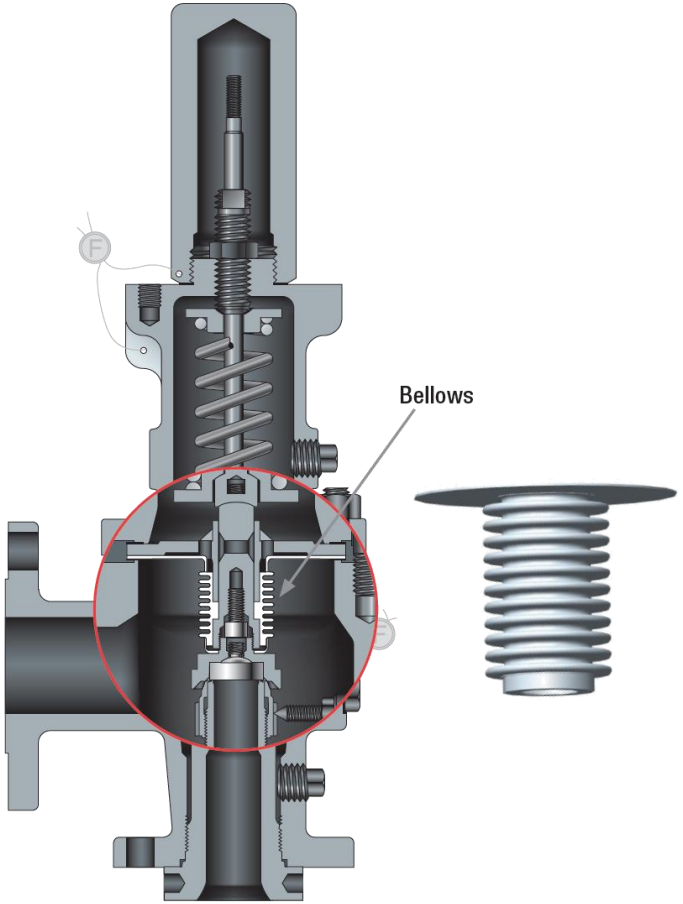
Conventional Valve Construction

- A spring loaded pressure relief valve whose operational characteristics are directly affected by changes in the back pressure on the valve.
- Can be net-set to account for constant back pressure only.



Balanced Bellows Valve Construction

- A spring loaded pressure relief valve that incorporates a bellows or other means to minimize the effect of back pressure on the operational characteristics of the valve.
- Should be used when:
  - The built-up back pressure to set pressure ratio exceeds the allowable accumulation (or 10% as an industry rule).
  - For isolating the bonnet chamber of the valve in corrosive/hazardous service.



Thank You

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