

Changes shown by

SCOPE

- I 1.1 This practice covers the design, and installation of pressure-relieving systems comprising pressure relief devices and associated flare pipe headers.
- I 1.2 **An asterisk (*)** indicates that additional information is required. If a job is contracted, this additional information is furnished in the Job Specification.

SUMMARY OF ADDITIONAL REQUIREMENTS

- I 2.1 **Table 1** lists the practices, codes, publications, and standards which shall be used with this practice.

TABLE 1

PRACTICES	
IP 3-15-1	Pressure Relief Valves
IP 3-18-1	Piping Fabrication Shop or Field
CODES, PUBLICATIONS, AND STANDARDS	
ACGIH	American Conference of Governmental Industrial Hygienist - Threshold Limits Values (except in U.K.)
British Health and Safety Executive (HSE)	Guidance Note for Threshold Limit Values (in UK)
API Standards and Recommended Practices (RP)	
RP 520 Part I	Design of Pressure-Relieving Systems in Refineries
RP 520 Part II	Installation of Pressure-Relieving Systems in Refineries
RP 521	Guide for Pressure Relief and Depressuring Systems
2000	Venting Atmospheric and Low-Pressure Storage Tanks
ASME Codes	
Section I	Power Boilers
Section VIII	Pressure Vessels, Division 1 and Division 2
ASTM Standard	
E84	Surface Burning Characteristics of Building Materials
ANSI Standards	
B31.3	Chemical Plant and Petroleum Refinery Piping
Z35.1	Industrial Accident Prevention Signs
EBSI	Exxon Occupational Exposure Limits for Chemical Contaminants

DESIGN

- I 3.1 Designs shall follow practices recommended in **API RP 520** and **RP 521** with exceptions and additions noted here.
- I 3.2 Pressure relief (PR) valve requirements for fired steam boilers furnished to **ASME Code Section I** shall be per that code.
- I 3.3 Waste heat boilers PR systems, shall be in accordance with the provisions of **ASME Code Section VIII**, unless prohibited by local law or government regulations.
- I 3.4 PR requirements for all other systems shall be per **ASME Code Section VIII**.

PRESSURE RELIEF (PR) DEVICE SELECTION AND INSTALLATION

TYPES OF DEVICES

- S * 4.1 **Acceptable types** of PR valves are: conventional, balanced bellows, or pilot-operated. The use of pilot-operated valves shall be approved by the Owner's Engineer. Balanced-bellows PR valves shall also be approved by the Owner's Engineer.

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- S * **4.2 Rupture discs (RD)** may be used in conjunction with or as a substitute for PR valves only with the approval of the Owner's Engineer. Acceptable types of RD's are: pre-scored tension loaded conventional (forward acting) for both liquid and gas/two-phase service; pre-scored (cross-scored) reverse buckling for gas/two-phase only service; pre-scored (semi-circular) reverse buckling for gas/two-phase or liquid service. Pre-scored (semi-circular) may not be used under PRV's due to possible fragmentation unless a special holder is used. The manufacturing range for all RD's shall be the lowest available from the manufacturer, preferably zero. The full amount of the manufacturing range shall be applied below the design pressure of the equipment. Use of other types of RD's with larger manufacturing ranges shall be approved by the Owner's Engineer.
- S * **4.3 Buckling pin valves (BPV)** may be used in conjunction with, or as a substitute for, PR valves only with the approval of the Owner's Engineer. Conventional or balanced BPV's are acceptable. If the BPV contains an internal check valve, it shall be used in clean service only. BPV are recognized by **ASME Code Case 2091**.

VALVE SIZING

- O * **4.4 The minimum size of PR valves** shall be as follows:
- 1 in. NPS (25 mm) inlet size with flanged inlet and outlet connections.
 - 3/4 in. NPS (20 mm) when used only for protection against liquid thermal expansion. This size may be used with threaded inlet and outlet connections.
- C **4.5** Smaller sizes should be approved by Owner's Engineer. Vessels fabricated from pipe, less than 24 in. NPS (600 mm) which are not ASME code stamped, do not require PR devices for protection against fire.

CREDIT FOR THERMAL INSULATION

- C **4.6** Credit factors for insulation in determining the minimum PR device sizes for fire exposure shall be per **API RP 521** and subject to the following:
- Credit may be taken for the following insulation systems on steel vessels and vessels constructed of low melting point material, such as aluminum when the insulation is held in place by systems that will withstand a fire, for example, a galvanized steel or stainless steel jacket.
Cellular glass, mineral fiber (Class II), expanded perlite, calcium silicate (Types I and II), lightweight or dense cementitious. Jacketing is not required for cementitious.
 - Credit is allowed for plastic foam, e.g., polyurethane and similar types of materials, which melt or decompose under fire exposure conditions if covered with materials such as in a.) and protected with a galvanized or aluminum coated steel, or stainless steel jacket. Plastic foam shall have a flame spread classification of 25 or less per **ASTM E84**. The covering shall prevent the plastic foam from decomposing or melting when the insulation system is exposed to a temperature of 1660°F (900°C) for two hours. Credit may also be taken for the insulation property of the covering material.
- S **4.7 Venting requirements** for pressurized storage vessel installations may include the need for vacuum relief valves to prevent the vessel from collapsing. The Owner's Engineer will determine which conditions to consider.

PR DEVICE LOCATION AND INSTALLATION

- S **4.8 Bellows type PR valve installation** shall be per the following:
- Bonnet plug removed.
 - * Any piping connected to the bonnet vent must be relatively short with no obstructions to prevent any appreciable back pressure. Piping shall allow access to check for leakage. The discharge location for toxic materials must be approved by the Owner's Engineer.
 - * One of the bonnet venting systems in **Figures 1.1** through **1.4** shall be used whenever bellows type PR valves are to be installed. The Owner's Engineer shall approve the system selected.
- S **4.9 Inlet piping** to PR devices shall be installed to continuously slope away from the PR device.
- O **4.10** RD's shall be installed as shown in **Figure 2** if installed upstream of a PR valve.
- S * **4.11 All flange nuts on the inlet and outlet of PR valves in liquid service** and their block valves shall be designed to prevent loosening by vibration. The use of elastic stop nuts, safety wiring, double lock nuts, or spring washers, e.g., Belleville Springs may be selected based on local practice. This requirement can be deleted when the PR valve is modulating pilot-operated.



- S **4.12** For **PR devices in plugging service**, special consideration shall be given to inlet or outlet piping subject to plugging with materials such as coke, fluid catalyst, polymer, or viscous materials. Gas or steam blowback, a special heater, heat tracing, or other provisions shall be made to prevent plugging. Where stagnant inlet lines may result in condensation of corrosive water vapor or freezing of water, inlet lines shall be heat traced. Possible backflow from other PR valves must be considered on the design of discharge laterals of PR valves discharging into common headers.

PRESSURE DROP

- S **4.13** The **nominal cross-sectional area of the inlet line**, or the inlet manifold for multiple valves, must be at least equal to that of the PR valve inlet flange(s).
- S **4.14** The nominal **cross-sectional area of the outlet line**, or manifold for multiple valves, should be at least equal to that of the PR valve outlet flange(s). Smaller cross-sectional areas are permitted for retrofits provided the backpressure requirements of **Par. 4.21** are met, and the change is approved by the Owner's Engineer.
- S **4.15** When relieving at rated capacity, the total frictional (fluid acceleration effects not included) pressure drop between the vessel and PR valve shall not exceed 3% of the set pressure (gauge) for both conventional and balanced bellows type PR valves, for set pressures 50 psig (345 kPag) or higher; or 5% of set pressures below 50 psig (345 kPag).

BACK PRESSURE

- S **4.16** For **single or multiple PR valve releases** discharging under a single-risk contingency:
- The built-up back pressure for operating contingencies shall be limited to 10% of the set pressure for non-balanced PR valves such as conventional type PR valves.
 - The built-up back pressure for fire contingencies shall be limited to the code allowable for fire for non-balanced PR valves such as conventional type PR valves, 21% for ASME Code.
 - * The total back pressure (built-up plus superimposed) shall be limited to 50% of the set pressure for balanced bellows type PR valves for either operating or fire contingencies, in new designs. In retrofits, the maximum backpressure published by the valve manufacturer for correction factors, K_b may be allowed with approval by the Owner's Engineer.
- Note:** The built up back pressure should be calculated based on the frictional plus kinetic pressure changes.
- S **4.17** Superimposed back pressure on the non-discharging PR valves in the system during a maximum system release (from either single or multiple device releases under a single contingency) shall not exceed:
- 25% of the lowest set pressure or burst pressure for a conventional type PR valve or a rupture disk respectively, or
 - 75% of the lowest set pressure for balanced-area bellows type PR valves in the system.
- S **4.18** The **mechanical design of the PR valve**, including outlet flange, bonnet and bellows, shall take into account any limitations imposed by the back pressure.

DISCHARGE PR DEVICES TO ATMOSPHERE AND CLOSED SYSTEMS

GENERAL

- S **5.1** **PR device piping**, including discharge risers and supports, shall be designed to:
- Resist reactive forces from discharge.
 - Prevent excessive vibration during discharge.
 - Permit independent PR device removal including independent support of discharge risers.

DISCHARGE TO ATMOSPHERE (IF PERMITTED BY REGULATIONS AND LOCAL PRACTICE)

- S * **5.2** **PR devices discharging nonflammables** such as air, inert gas, steam, or hot water to atmosphere shall be furnished with outlet piping to direct the flow away from areas where personnel may be present.
- S * **5.3** **PR devices discharging toxic vapors to atmosphere** shall be provided with risers of sufficient height and location so that the toxic vapors at grade and any operating platform are below the short term exposure limits (STEL). When STEL's are not available, use the Exxon occupational exposure limits. The Owner's Engineer should determine whether limits should apply to all platforms or whether access controls can be applied to non-frequently manned platforms.

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- E 5.4 **PR devices discharging toxic or odorous vapors** to the atmosphere shall be provided with risers of sufficient height to keep the concentration beyond the site boundary below limits set by government regulations.
- S,E *5.5 PR devices, including those located on the top of fractionating towers, which discharge 100% vapors during all relieving contingencies can be discharged to the atmosphere providing the **liquid holdup time** above the high level alarm is at least 30 minutes. The holdup volume shall be based on the vessel design liquid inlet rate. The high level alarm must be independent of the level indications.
- S *5.6 **PR devices discharging flammable vapors to the atmosphere** shall be equipped with risers. The riser may serve a single PR device or may be common to two or more devices. The riser shall discharge a minimum of 10 ft (3 m) above platforms and any equipment within a horizontal distance of 50 ft (15 m). Riser discharge velocities at 25% of rated capacity must meet **API 521** requirements for jet dominated flow. If a single riser is used for more than one valve, the API requirements must be met for the single discharge of either valve.
- S *5.7 The **discharge location of the riser** from a PR device relative to adjacent equipment may need to be increased from the requirements of **Par. 5.6** dependent on design considerations such as the following:
- Volume and nature of discharge
 - Prevailing wind direction
 - Height, type, and frequency of occupancy of adjacent structures
 - Heat density based on the ignition of PR valve discharge
 - Noise
- Note:** Radiant Density shall be less than 6000 BTU/hr ft² (19.2 kw/m²) at grade or frequently manned platform. If released material is above 600°F (310°C) or ethane or lighter, the density may be up to 6000 BTU/hr ft² (19.2 kw/m²) only if automatic, instrumentation would normally limit the release to 3000 BTU/hr ft² (9.6 kw/m²). Without instrumentation the limit for these materials shall be 3000 BTU/hr ft² (9.6 kw/m²). On frequently manned platforms, ladders must be available such that the structure provides shielding from radiation during escape.
- S 5.8 A **drain hole**, 3/4 in. (20 mm) size, shall be provided at the lowest point in the PR device riser. If the drain hole is located so that a flame developing from hydrocarbons released during a PR device discharge would impinge on equipment or piping, the drain shall be piped with minimum length nipple and elbow to direct the flames away from the equipment or lines. If the drain connection is at a low elevation in a congested area where gas released may not be readily dissipated, the drain shall be provided with a valve to permit periodic draining. If a valve is installed and freezing is possible, the drain line shall be heat traced.
- O *5.9 **Snuffing steam** is required for PR valves that discharge greater than 50 mole % hydrogen or vapors above their autoignition temperature to the atmosphere. The Owner's Engineer will specify when flammable vapors below their autoignition point require snuffing steam. Snuffing steam shall be installed as follows:
- A NPS 1 in. (25 mm) steam line shall be tied directly to a separate connection on the discharge riser per **Figure 3.1**. The steam isolation valve, normally closed, and a 3/4 in. (20 mm) bleeder, normally open, shall be located adjacent to each other at a safe location (typically grade) accessible to the operator. Or,
 - A NPS 1 in. (25 mm) line with a block valve and hose connection shall be separately connected to the discharge riser, per **Figure 3.2**. The block valve and hose connection shall be located within 20 feet (6.1 m) of a steam utility station.
- The snuffing steam line shall be traced and insulated if vapors leaking from the PR valve contain enough water to condense, freeze, and block off the steam line.
- S 5.10 **Discharge risers for PR devices in hydrogen service** at greater than 50 mole % hydrogen shall be equipped with toroidal rings according to **Figure 4**.
- S 5.11 Piping from **PR devices discharging to the atmosphere** shall have no liquid traps.
- M *5.12 The Owner's Engineer shall specify any local corrosion protection for atmospheric discharge risers e.g., internal galvanizing, rain cap, or none.
- M 5.13 Fugitive emissions from non-relieving PR valves shall conform to any local regulatory requirements.

DISCHARGE TO CLOSED SYSTEM

- S,E 5.14 PR devices which may discharge liquid shall be discharged to a closed system.
- S * 5.15 **Discharge piping for PR devices** discharging to a closed system shall be installed to continuously slope downward. The line shall connect into the top of the flare header or into the vapor space of process/collection equipment to prevent liquid from entering the line. If the discharge piping cannot be continuously sloped, a 3/4 in. NPS (20 mm) drain line shall be installed from the lowest point in the discharge piping to a small drain pot equipped with a high level alarm. The drain line and pot shall be winterized when appropriate. A 3/4 in. NPS (20 mm) drain line, with a normally closed block valve, shall be installed from the drain pot to a catch basin or other safe location. Such piping arrangements require approval by the Owner's Engineer.
- S 5.16 All **flare headers** entering or leaving a blowdown drum (or equivalent) shall be sloped 1:480 (1:500 metric) towards the drum. All headers leaving a flare seal drum shall be sloped 1:480 towards the drum.
- S 5.17 For flare headers in plugging, e.g., polymer or viscous service, wet and freezing service, or hydrate or salt deposition service, the need to provide heat tracing or purging similar to **Par. 4.12** shall be reviewed with the Owner's Engineer.

BLOCK AND BLEED VALVES ASSOCIATED WITH PR DEVICES

- M 6.1 A block valve shall be installed between the protected equipment and any PR device that cannot be removed for maintenance without shutting down a unit or part of a unit needed for operation.
- M 6.2 A block valve shall be installed on the discharge side of any PR device which discharges into a manifold, riser, or header serving other pressure relief devices, unless the manifold, riser, or header can be removed for maintenance while the other pressure relief devices are in service.
- S 6.3 **Block valves associated with PR devices and flare headers** shall meet the following requirements:
- Valves shall be car sealed open (CSO).
 - Gate valves shall be installed with stems oriented horizontal or downward.
 - Valves shall be full port, gate, ball or plug type.
 - * Three-way valves are permitted where dual PR devices with interlocks are required, provided all nominal port sizes are equal to or greater than the PRV nominal flange size. A mechanical device or a key system shall be used when interlocks are required. Such installations require approval by the Owner's Engineer.
- S * 6.4 **PR devices and car sealed block valves** shall be painted a distinctive color to aid visual identification after installation. Unless otherwise specified, color identification shall be per the following:
- PR valves: see **IP 3-15-1**
 - Car sealed block valves: yellow
 - Rupture disks holders: yellow
- S 6.5 The use and location of **bleed valves** shall be governed by the following:
- A bleed valve shall be installed between the PR device and the inlet block valve.
 - A bleed valve shall be installed between the PR device and the outlet block valve.
 - A body bleed and drain on the block valve is acceptable.
 - * The use of bleed valves where PR devices are installed for thermal liquid expansion protection shall be consistent with the local site practice.
 - Flangeless drip rings shall not be used to install bleed valves.
- S * 6.6 The bleed valves in **Par. 6.5** shall be reinforced per **IP 3-18-1**.