Sizing, Selection, and Installation Of Pressure-Relieving Devices in Refineries

Part II—Installation

API RECOMMENDED PRACTICE 520
FOURTH EDITION, DECEMBER 1994

American Petroleum Institute
1220 L Street, Northwest
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Manufacturing, Distribution and Marketing Department

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FOREWORD

This recommended practice is intended to cover methods of installation for pressure relief devices for equipment that has a maximum allowable working pressure of 15 pounds per square inch gauge (1.03 bar g) or greater.

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Suggested revisions are invited and should be submitted to the director of the Manufacturing, Distribution and Marketing Department, American Petroleum Institute, 1220 L Street, N.W., Washington, D.C. 20005.

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SECTION 1—GENERAL

1.1 Scope

This recommended practice is intended to cover methods of installation for pressure relief devices for equipment that has a maximum allowable working pressure (MAWP) of 15 pounds per square inch gauge (psig) (1.03 bar g) or greater. Pressure relief valves or rupture disks may be used independently or in combination with each other to provide the required protection against excessive pressure accumulation. As used in this recommended practice, the term *pressure relief valve* includes safety relief valves used in either compressible or incompressible fluid service, and relief valves used in incompressible fluid service. This recommended practice covers gas, vapor, steam, and incompressible fluid service; it does not cover special applications that require unusual installation considerations.

1.2 Definition of Terms

The terminology for pressure relief devices that is used in this recommended practice is in general agreement with the definitions given in ASME PTC 25.

1.3 Referenced Publications

The current editions of the following standards, codes, and specifications are cited in this recommended practice:

API

RP 521 *Guide for Pressure-Relieving and Depressuring Systems*

RP 576 *Inspection of Pressure Relieving Devices*

ASME[1]

PTC 25 *Performance Test Code—Safety and Relief Valves*

B31.3 *Chemical Plant and Petroleum Refinery Piping*

Boiler and Pressure Vessel Code, Section VIII, "Pressure Vessels"

SECTION 2—INLET PIPING TO PRESSURE RELIEF DEVICES

2.1 General Requirements

For general requirements for inlet piping, see Figures 1 and 2.

2.1.1 FLOW AND STRESS CONSIDERATIONS

Inlet piping to the pressure relief device should provide for proper system performance. This requires design consideration of the flow-induced pressure drop in the inlet piping. Excessive pressure losses in the piping system between the protected vessel and a pressure relief device will adversely affect the system-relieving capacity and can cause valve instability. In addition, the effect of stresses derived from both pressure relief device operation and externally applied loads must be considered. For more complete piping design guidelines, see ASME B31.3.

2.1.2 VIBRATION CONSIDERATIONS

Most vibrations that occur in inlet piping systems are random and complex. These vibrations may cause leakage at the seat of a pressure relief valve, premature opening, or premature fatigue failure of certain valve parts, inlet and outlet piping, or both. Vibration in inlet piping to a rupture disk may adversely affect the burst pressure and life of the rupture disk.

Detrimental effects of vibrations on the pressure relief device can be reduced by minimizing the cause of vibrations, by additional piping support, by use of either pilot-operated relief valves or soft-seated pressure relief valves, or by providing greater pressure differentials between the operating pressure and the set pressure.

2.2 Pressure-Drop Limitations and Piping Configurations

For pressure-drop limitations and piping configurations, see Figures 1 through 4.

[1]American Society of Mechanical Engineers, 345 East 47th Street, New York, New York 10017.

2.2.1 PRESSURE LOSS AT THE PRESSURE RELIEF VALVE INLET

Excessive pressure loss at the inlet of a pressure relief valve can cause rapid opening and closing of the valve, or chattering. Chattering will result in lowered capacity and damage to the seating surfaces. The pressure loss that affects valve performance is caused by non-recoverable entrance losses (turbulent dissipation) and by friction within the inlet piping to the pressure relief valve.

Chattering has sometimes occurred due to acceleration of liquids in long inlet lines.

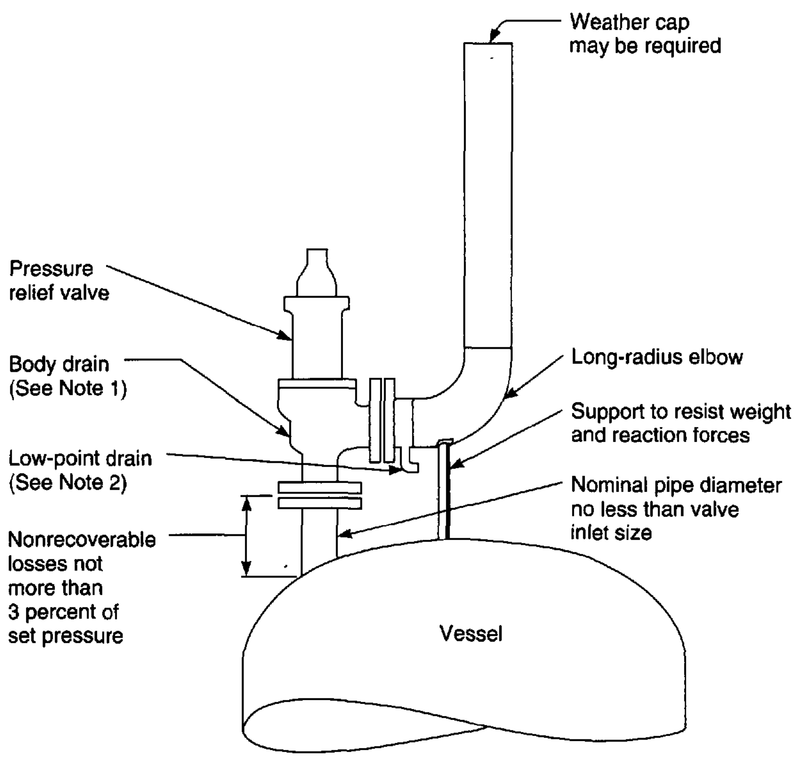
2.2.2 SIZE AND LENGTH OF INLET PIPING TO PRESSURE RELIEF VALVES

When a pressure relief valve is installed on a line directly connected to a vessel, the total non-recoverable pressure loss between the protected equipment and the pressure relief valve should not exceed 3 percent of the set pressure of the valve except as permitted in 2.2.3.1 for pilot-operated pressure relief valves. When a pressure relief valve is installed on a process line, the 3 percent limit should be applied to the sum of the loss in the normally non-flowing pressure relief valve inlet pipe and the incremental pressure loss in the process line caused by the flow through the pressure relief valve. The pressure loss should be calculated using the rated capacity of the pressure relief valve. Pressure losses can be reduced materially by rounding the entrance to the inlet piping, by reducing the inlet line length, or by enlarging the inlet piping. Keeping the pressure loss below 3 percent becomes progressively more difficult as the orifice size of a pressure relief valve increases.

The nominal size of the inlet piping must be the same as or larger than the nominal size of the pressure relief valve inlet flange connection as shown in Figure 2.

An engineering analysis of the valve performance at higher inlet losses may permit increasing the allowable pressure loss above 3 percent.

When a rupture disk device is used in combination with a pressure relief valve, the pressure-drop calculation must include the additional pressure drop developed by the disk (See 2.6 for additional information on rupture disk devices).



Notes:
1. See Section 6.
2. Orient low-point drain—or weep hole—away from relief valve, structural steel, and operating area.

Figure 1—Typical Pressure Relief Valve Installation: Atmospheric (Open) Discharge

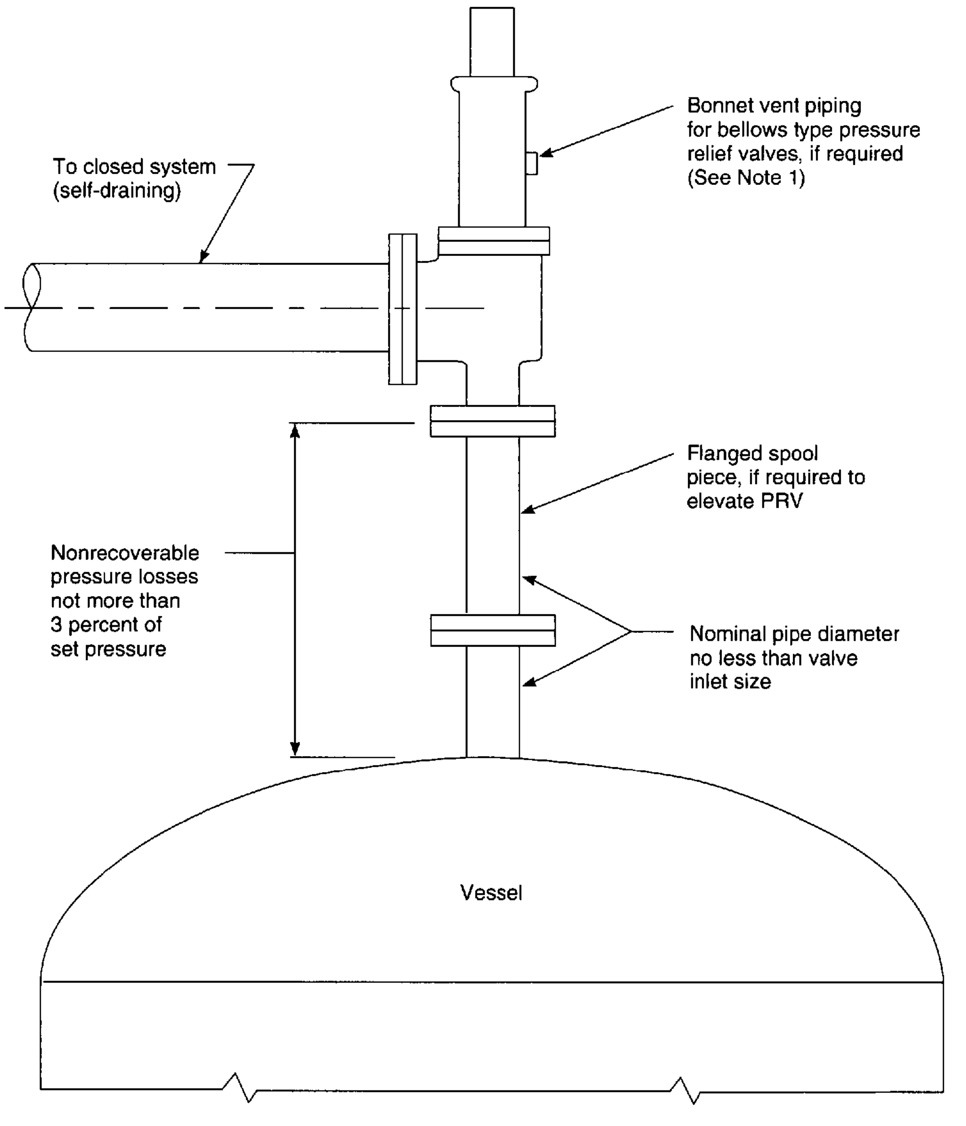
2.2.3 REMOTE SENSING FOR PILOT-OPERATED PRESSURE RELIEF VALVES

Remote sensing for pilot-operated pressure relief valves can be utilized when there is excessive inlet pipe pressure loss or when the main valve must be located at a pressure source different from the pilot sensing point because of service limitations of the main valve (see Figure 5).

2.2.3.1 Inlet Pipe Loss

Remote sensing permits the pilot to sense the true system pressure upstream of the piping loss. Remote sensing may eliminate uncontrolled valve cycling or chattering for a pop action pressure relief valve and will permit a modulating action pressure relief valve to achieve full lift at the required overpressure. However, high inlet pressure losses may induce pressure pulsations in the inlet piping that can cause uncontrolled main valve cycling. Some valves incorporate design features to prevent uncontrolled cycling.

Although remote sensing may eliminate valve chatter or permit a modulating valve to achieve full lift at the required overpressure, the relieving capacity will be reduced by any pressure drop in the inlet pipe.



Note:
1. See Section 5.

Figure 2—Typical Pressure Relief Valve Installation: Closed System Discharge

2.2.3.2 Installation Guidelines

Remote sensing lines should measure static pressure where the velocity is low. Otherwise, the pilot will sense an artificially low pressure due to the effect of velocity.

Ensure that the pilot sensing point is within the system protected by the main valve.

For flowing pilots, remote sensing lines shall be sized to limit the pressure loss to 3 percent of the set pressure based on the maximum flow rate of the pilot at 110 percent of set pressure. Consult the manufacturer for recommendations.

For non-flowing pilots, remote sensing lines with a flow area of 0.070 square inches (45 square millimeters) is sufficient since no system medium flows through this type of pilot when the main valve is open and relieving.

Consider using pipe for remote sensing lines to ensure mechanical integrity.

If a block valve is installed in the remote sensing line, the guidelines in Section 4 should be followed. A closed block valve in a remote sense line renders the pressure relief valve inoperative.

2.2.4 CONFIGURATION OF INLET PIPING FOR PRESSURE RELIEF VALVES

Avoid the installation of a pressure relief valve at the end of a long horizontal inlet pipe through which there is normally no flow. Foreign matter may accumulate, or liquid may be trapped, creating interference with the valve's operation or requiring more frequent valve maintenance.

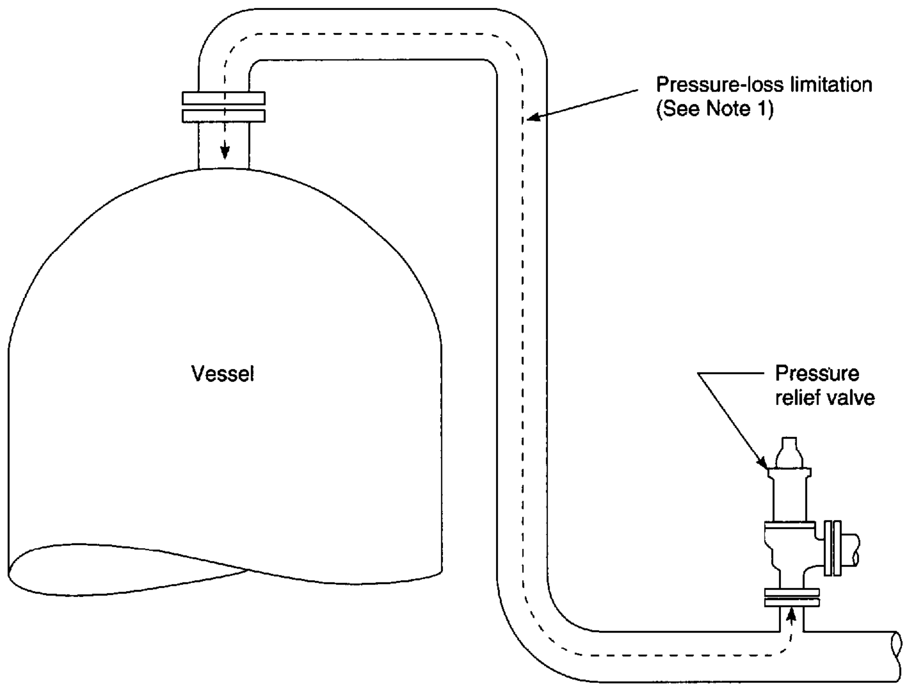
The inlet piping system to relief valves should be free-draining from the pressure relief device to prevent accumulation of liquid or foreign matter in the piping.

2.3 Inlet Stresses that Originate from Static Loads in the Discharge Piping

Improper design or construction of the discharge piping from a pressure relief device can set up stresses that will be transferred to the pressure relief device and its inlet piping. These stresses may cause a pressure relief valve to leak or malfunction or may change the burst pressure of a rupture disk. The pressure relief device manufacturer should be consulted about permissible loads and moments.

2.3.1 THERMAL STRESSES

Fluid flowing from the discharge of a pressure relief device may cause a change in the temperature of the discharge piping. A change in temperature may also be caused by prolonged exposure to the sun or to heat radiated from nearby equipment. Any change in the temperature of the discharge piping will cause a change in the length of the



Note:
1. See 2.2.2 for pressure-loss limitation.

Figure 3—Typical Pressure Relief Valve Mounted on Process Line

piping and may cause stresses that will be transmitted to the pressure relief device and its inlet piping. The pressure relief device should be isolated from piping stresses through proper support, anchoring, or flexibility of the discharge piping.

2.3.2 MECHANICAL STRESSES

Discharge piping should be independently supported and carefully aligned. Discharge piping that is supported by only the pressure relief device will induce stresses in the pressure relief device and the inlet piping. Forced alignment of the discharge piping will also induce such stresses.

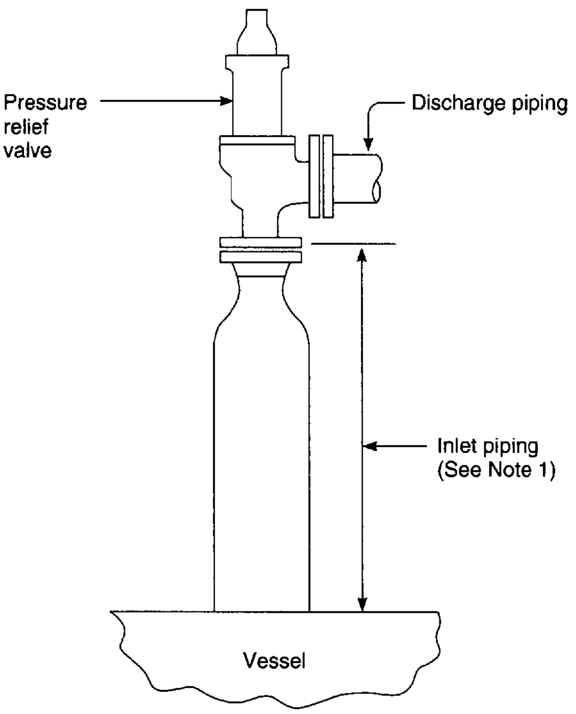
2.4 Inlet Stresses that Originate from Discharge Reaction Forces

The discharge of a pressure relief device will impose a reaction force as a result of the flowing fluid (see Figure 6). This force will be transmitted into the pressure relief device and also into the mounting nozzle and adjacent supporting vessel shell unless designed otherwise. The precise magnitude of the loading and resulting stresses will depend on the reaction force and the configuration of the piping system. The designer is responsible for analyzing the discharge system to determine if the reaction forces and the associated bending moments will cause excessive stresses on any of the components in the system.

The magnitude of the reaction force will differ substantially depending on whether the installation is open or closed discharge. When an elbow is installed in the discharge system to direct the fluid up into a vent pipe, the location of the elbow and any supports is an important consideration in the analysis of the bending moments.

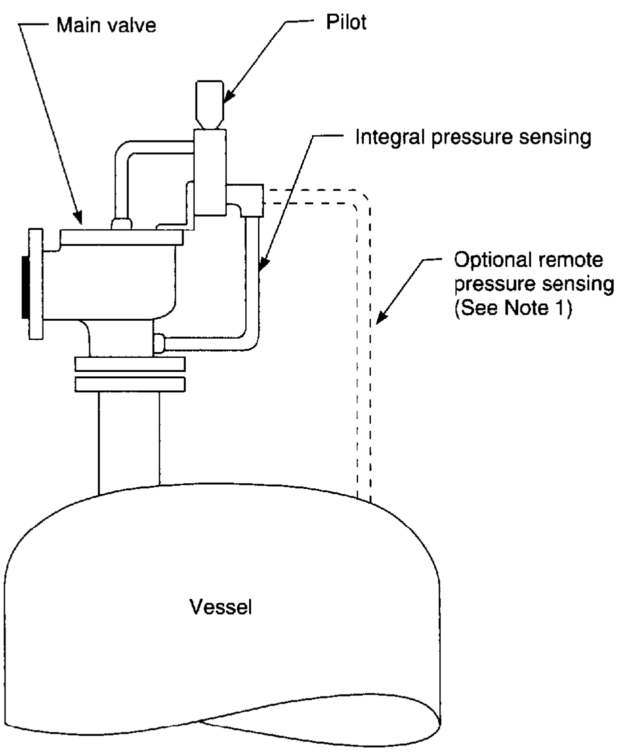
2.4.1 DETERMINING REACTION FORCES IN AN OPEN DISCHARGE SYSTEM

The following formula is based on a condition of critical steady-state flow of a compressible fluid that discharges to the atmosphere through an elbow and a vertical discharge pipe.



Note:
1. Inlet piping sized so that nonrecoverable pressure losses from vessel to pressure relief valve inlet flange do not exceed 3 percent of valve set pressure.

Figure 4—Typical Pressure Relief Valve Mounted on Long Inlet Pipe



Note:
1. See 2.2.3.

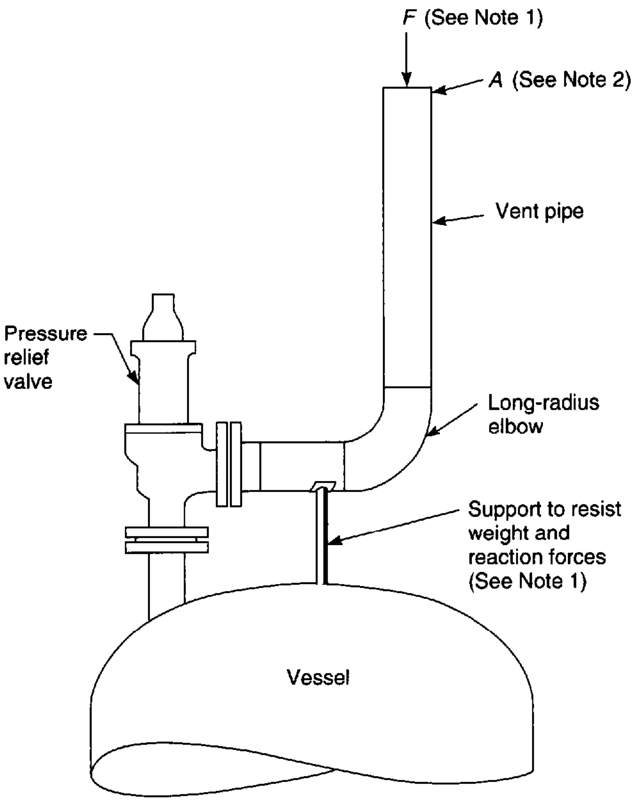
Figure 5—Typical Pilot-Operated Pressure Relief Valve Installation

The reaction force (F) includes the effects of both momentum and static pressure; thus, for any gas, vapor, or steam,

$$F = \frac{W}{366}\sqrt{\frac{kT}{(k+1)M}} + (AP)$$

Where:

F = reaction force at the point of discharge to the atmosphere, in pounds.
W = flow of any gas or vapor, in pounds per hour.
k = ratio of specific heats (C_p/C_v).
C_p = specific heat at constant pressure.
C_v = specific heat at constant volume.
T = temperature at inlet, in degrees Rankine.
M = molecular weight of the process fluid.
A = area of the outlet at the point of discharge, in square inches.
P = static pressure within the outlet at the point of discharge, in pounds per square inch gauge.



Notes:
1. The support should be located as close as possible to the centerline of the vent pipe.
2. F = reaction force; A = cross-sectional area.

Figure 6—Typical Pressure Relief Valve Installation with Vent Pipe

In metric units,

$$F = 129\, W\sqrt{\frac{kT}{(k+1)M}} + 0.1\,(AP)$$

Where:

F = reaction force at the point of discharge to the atmosphere, in newtons.
W = flow of any gas or vapor, in kilograms per second.
k = ratio of specific heats (C_p/C_v).
C_p = specific heat at constant pressure.
C_v = specific heat at constant volume.
T = temperature at inlet, in degrees Kelvin.
M = molecular weight of the process fluid.
A = area of the outlet at the point of discharge, in square millimeters.
P = static pressure within the outlet at the point of discharge, in bars gauge.

2.4.2 DETERMINING REACTION FORCES IN A CLOSED DISCHARGE SYSTEM

Pressure relief devices that relieve under steady-state flow conditions into a closed system usually do not create large forces and bending moments on the exhaust system. Only at points of sudden expansion will there be any significant reaction forces to be calculated. Closed discharge systems, however, do not lend themselves to simplified analytical techniques. A complex time history analysis of the piping system may be required to obtain the true values of the reaction forces and associated moments.

2.5 Isolation Valves in Inlet Piping

Isolation valves located in the inlet piping to pressure relief devices shall be in accordance with the guidelines in Section 4.

2.6 Rupture Disk Devices in Combination with Pressure Relief Valves

A rupture disk device may be used as the sole pressure relief device, or it may be installed between a pressure relief valve and the vessel or on the downstream side of a pressure relief valve (see Figure 7).

For ASME Boiler and Pressure Vessel Code applications, the capacity of a pressure relief valve used in combination with a rupture disk mounted as shown in Figure 7 must be derated by 10 percent unless that particular combination has a capacity factor derived from testing as listed in the National Board of Boiler and Pressure Vessel Inspectors' publication, *Pressure Relief Device Certifications.*

When a rupture disk device is used between the pressure relief valve and the protected vessel, a pressure indicator, bleed valve, free vent, or suitable telltale indicator should be provided to permit detection of disk rupture or leakage. The user is cautioned that any pressure buildup between the rupture disk and the pressure relief valve will increase the vessel pressure at which the rupture disk will burst.

Only non-fragmenting rupture disk devices may be used beneath a pressure relief valve.

Rupture disks are not available in all sizes at lower pressures; therefore, for these low-pressure applications the available rupture disk may have to be larger than the nominal size of the inlet piping and pressure relief valve.

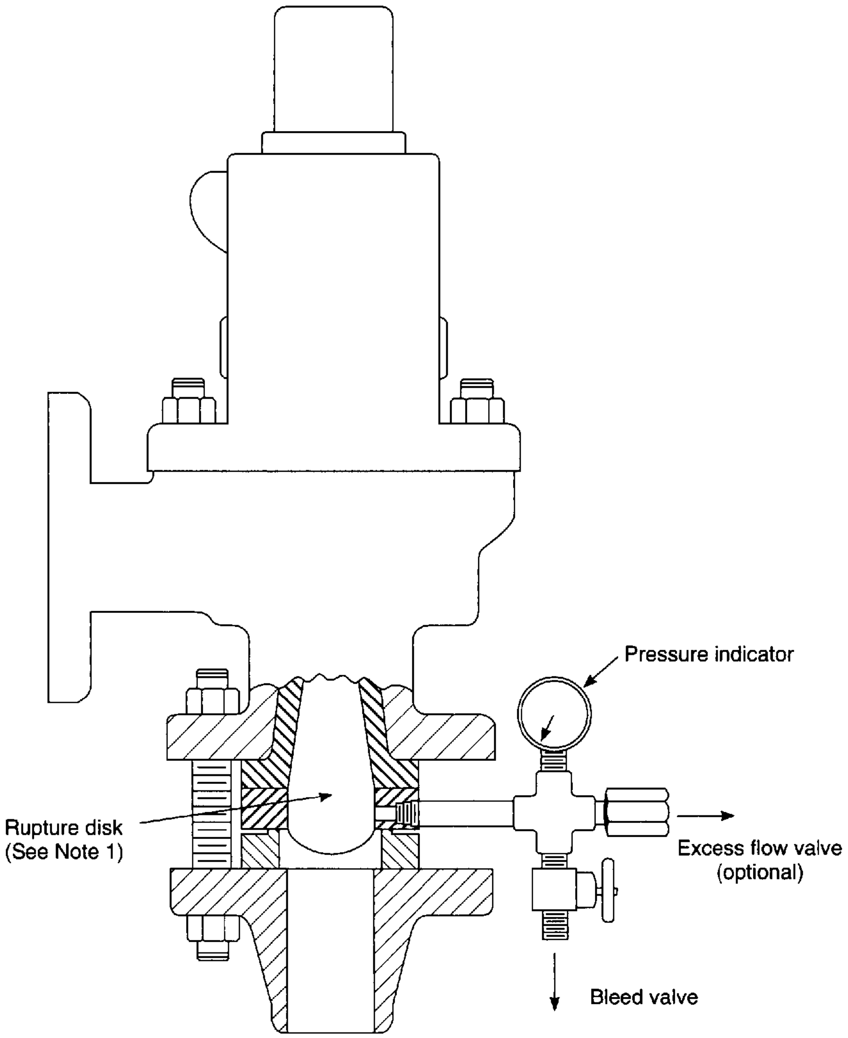
Refer to API Recommended Practice 520, Part I, paragraphs 2.5 (Rupture Disks-General) and 2.6 (Rupture Disks in Combination with Pressure Relief Valves) for additional information.

2.7 Process Laterals Connected to Inlet Piping of Pressure Relief Valves

Process laterals should generally not be connected to the inlet piping of pressure relief valves (see Figure 8). Exceptions should be analyzed carefully to ensure that the allowable pressure drop at the inlet of the pressure relief valve is not exceeded under simultaneous conditions of rated flow through the pressure relief valve and maximum possible flow through the process lateral.

2.8 Turbulence in Pressure Relief Device Inlets

See 7.3 for information regarding the effects of turbulence on pressure relief valves.



Note:
1. Rupture disk can be either non-fragmenting forward or reverse acting rupture disk (reverse acting shown).

Figure 7—Typical Rupture Disk Assembly Installed in Combination with a Pressure Relief Valve

SECTION 3—DISCHARGE PIPING FROM PRESSURE RELIEF DEVICES

3.1 General Requirements

For general requirements for discharge piping, see Figures 1, 2, 6, and 9.

The discharge piping installation must provide for proper pressure relief device performance and adequate drainage (free-draining systems are preferred—see Section 6). Consideration should be given to the type of discharge system used, the back pressure on the pressure relief device, and the set-pressure relationship of the pressure relief devices in the system.

Auto-refrigeration during discharge can cool the outlet of the pressure relief device and the discharge piping to the point that brittle fracture can occur. Materials must be selected which are compatible with the expected temperature.

3.2 Safe Disposal of Relieving Fluids

For a comprehensive source of information about the safe disposal of various relieving fluids, see API Recommended Practice 521.

3.3 Back Pressure Limitations and Sizing of Pipe

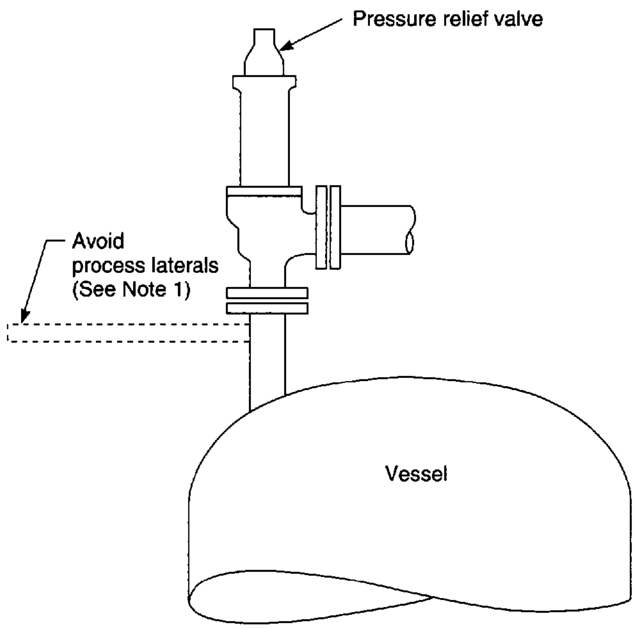
When discharge piping for pressure relief valves is designed, consider the combined effect of superimposed and built-up back pressure on the operating characteristics of the pressure relief valves. The discharge piping system should be designed so that the back pressure does not exceed an acceptable value for any pressure relief valve in the system.

When rupture disks are used as the sole relieving device and discharge into a closed system, the effect of the superimposed back-pressure on the bursting pressure for the disk must be considered.

The rated capacity of the pressure relief valve shall be used to size the discharge line from the pressure relief valve to the relief header. Additional information on sizing of discharge piping systems for vapor or gas service is covered in API Recommended Practice 521.

3.4 Considerations for Pilot-Operated Pressure Relief Valves

Superimposed back pressure that exceeds the inlet pressure of a pilot-operated pressure relief valve can cause the main valve to open, allowing reverse flow through the main valve. For example, backflow can occur if several pressure relief valves have their outlets manifolded into a common discharge header, and one or more of these valves is discharging while another is connected to a system with a lower inlet pressure. An accessory should be specified that will prevent such backflow.



Note:
1. See 2.7.

Figure 8—Installation Avoiding Process Laterals Connected to Pressure Relief Valve Inlet Piping

3.5 Stresses that Originate from Discharge Piping

The effects of stresses that originate from discharge piping are discussed in 2.3.1 and 2.3.2.

3.6 Isolation Valves in the Discharge Piping

Isolation valves located in the discharge piping system shall be in accordance with the guidelines in Section 4.

SECTION 4—ISOLATION (STOP) VALVES IN PRESSURE RELIEF PIPING

4.1 General

Block valves may be used to isolate a pressure relief device from the equipment it protects or from its downstream disposal system. Since improper use of a block valve may render a pressure relief device inoperative, the design, installation, and management of these isolation block valves should be carefully evaluated to ensure that plant safety is not compromised.

4.2 Application

If a pressure relief device has a service history of leakage, plugging, or other severe problems which affect its performance, isolation and sparing of the relief device may be provided. This design strategy permits the pressure relief device to be inspected, maintained, or repaired without shutting down the process unit. However, there are potential hazards associated with the use of isolation valves. The ASME Boiler and Pressure Vessel Code, Section VIII, Appendix M, discusses proper application of these valves and the administrative controls which must be in place when isolation block valves are used. Local jurisdictions may have other requirements.

Additional examples of isolation valve installations are given in 4.4.

4.3 Isolation Valve Requirements

In addition to previously noted inlet and outlet pressure drop restrictions, all isolation valves located in relief system piping shall meet the following requirements:

a. Valves shall be full bore.
b. Valves shall be suitable for the line service classification.
c. Valves shall have the capability of being locked or car-sealed open.
d. When gate valves are used, they should be installed with stems oriented horizontally or, if this is not feasible, the stem could be oriented downward to a maximum of 45° from the horizontal to keep the gate from falling off and blocking the flow.

Consider painting the isolation valves a special color or providing other identification.

When isolation valves are installed in pressure relief valve discharge piping, a means to prevent pressure buildup between the pressure relief valve and the isolation valve should be provided (for example, a bleeder valve). Also, the installation of bleed valves should be considered to enable the system to be depressured prior to performing maintenance on the system as shown in Figures 9 through 12.

Typical installations of isolation valves under pressure relief valves are shown in Figures 9 through 11.

Consider the installation of an additional relief device, so that 100 percent design relieving capacity is available while any relief device is out of service. Examples of this type of installation are shown in Figures 10 and 11. Consider storing the spare valve until needed to preserve its integrity and allow bench testing just prior to installation.

When spare relief devices are provided, a mechanical interlock or interlocking procedure shall be provided which manages proper opening and closing sequences of the isolation valves to ensure that overpressure protection of the vessel or equipment is not compromised. Typically the inlet isolation valves for spare relief valves are closed.

Three-way isolation valves are acceptable provided the installation meets the size and inlet pressure drop requirements.

4.4 Examples of Isolation Valve Installations

An isolation valve downstream of a pressure relief device may be installed at battery limits of process units. This is illustrated in Figure 12. The purpose of battery limit isolation valves is to allow process units to be removed from service for maintenance while other process units discharging into the main plant flare header remain in service.

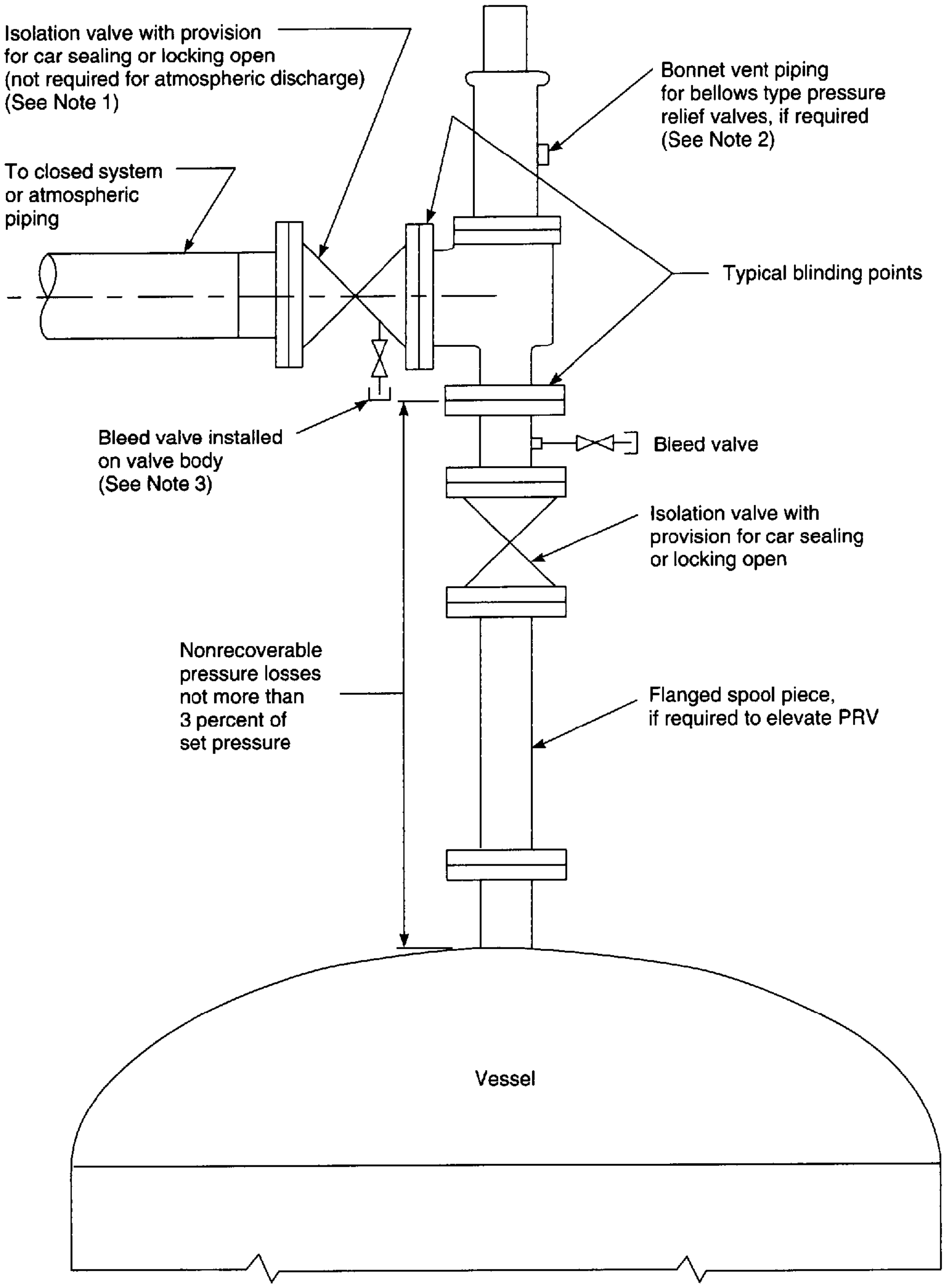
Similarly, relief system isolation valves may be used for equipment such as compressors, salt dryers, or coalescers, which are spared and need to be shut down for maintenance while spare equipment remains online (see Figure 13).

4.5 Management Procedures Related to Isolation Valves

Strict management procedures should be in place that will prohibit the inadvertent closing of isolation valves in relief piping. These procedures should require that the opening and closing of the valves be done by an authorized person.

An updated list should be kept of all isolation valves located in relief piping which could isolate relief valves. Documentation of the required position and reason for the lock or seal should be provided.

Periodic inspections of isolation valves located in relief piping should be made which verify the position of valves and the condition of the locking or sealing device.



Notes:
1. See Section 4.
2. See Section 5.
3. Alternatively, a pipe spool with bleed may be installed.

Figure 9—Typical Pressure Relief Valve Installation with an Isolation Valve

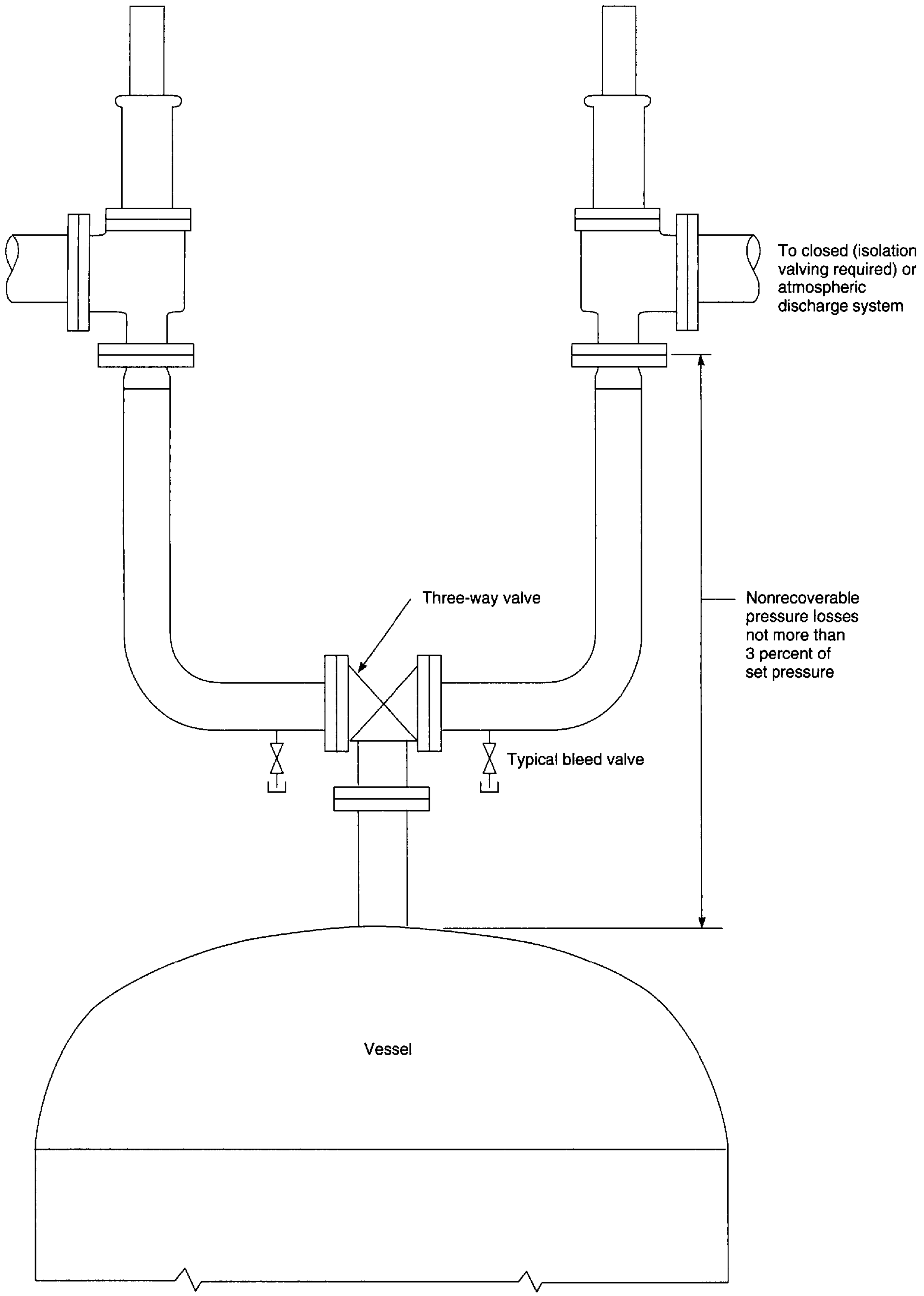
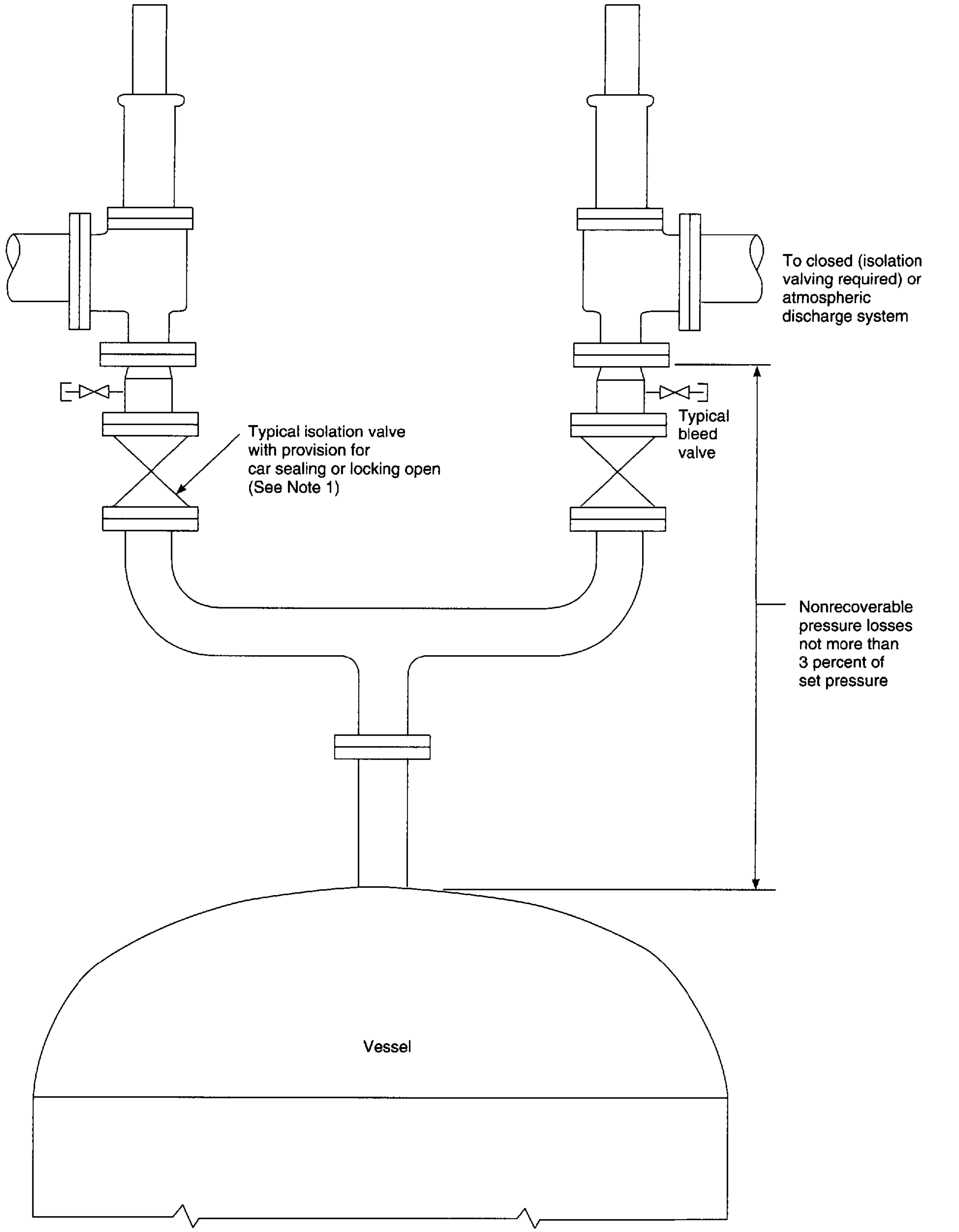


Figure 10—Typical Pressure Relief Valve Installation Arrangement for 100 Percent Spare Relieving Capacity



Note:
1. See Section 4.

Figure 11—Alternate Pressure Relief Valve Installation Arrangement for 100 Percent Spare Relieving Capacity

SECTION 5—BONNET OR PILOT VENT PIPING

5.1 Conventional Valves

The two types of conventional valves are:

a. Open spring, often used in steam service.
b. Closed spring, where the bonnet enclosing the spring is vented internally to the pressure relief valve discharge. The bonnet normally has a tapped vent that is closed off with a threaded plug.

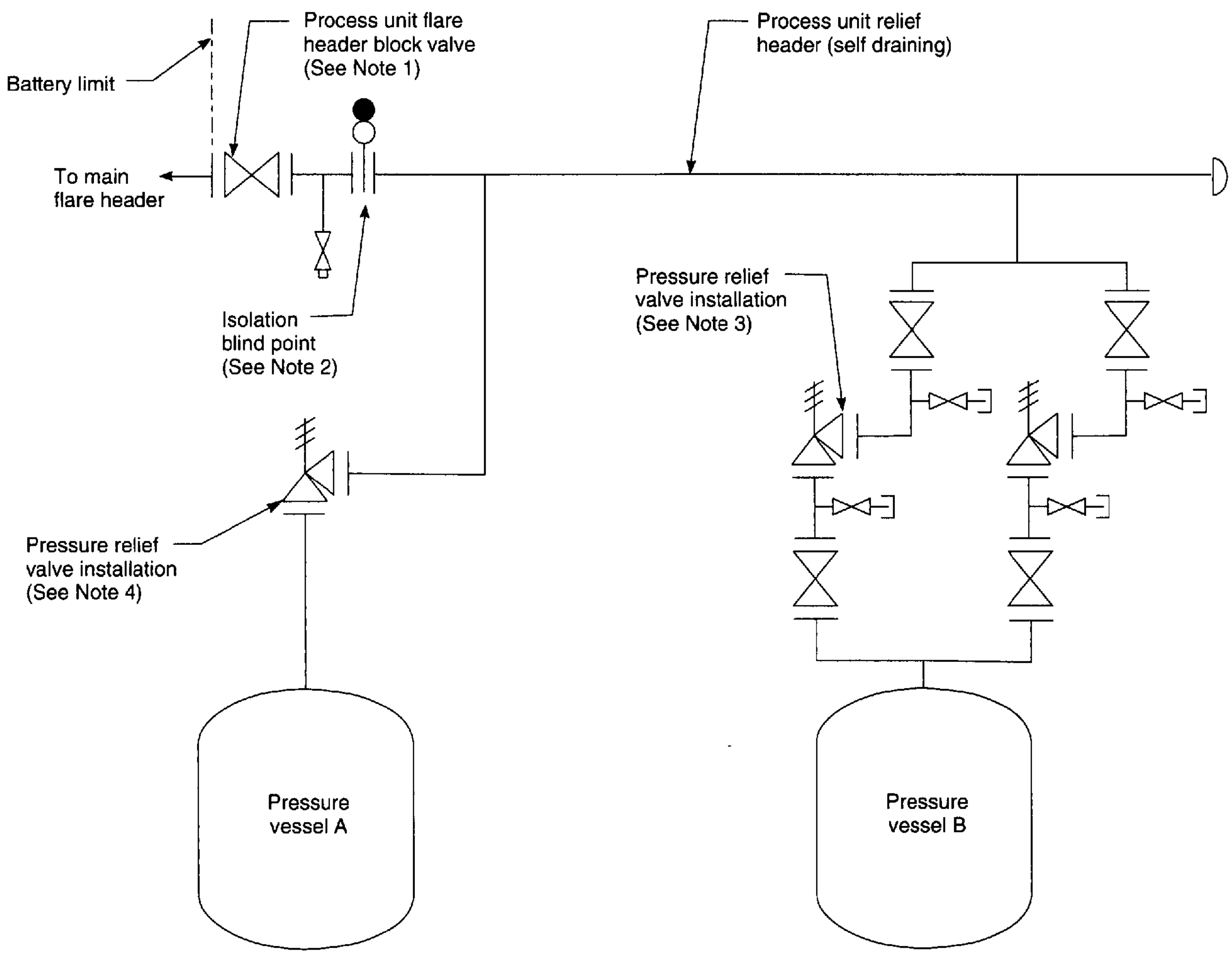
5.2 Balanced Bellows Valves

Balanced bellows valves are utilized in applications where it is necessary to minimize the effect of back pressure on the set pressure and relieving capacity. This is done by balancing the effect of the back pressure on the top and bottom sides of the disk. This requires the spring to operate at atmospheric pressure.

The bonnets of bellows valves must always be vented to ensure proper functioning of the valve and to provide a telltale in the event of a bellows failure. The vent must be designed to avoid plugging caused by ice, insects, or other obstructions. When the fluid is flammable, toxic, or corrosive, the bonnet vent may need to be piped to a safe location.

5.3 Balanced Piston Valves

Balanced piston valves are utilized in applications to minimize the effect of back pressure, similar to the balanced



Notes:
1. See 4.4.
2. See Figure 8.
3. See Figures 10 and 11.
4. See Figures 2 and 9.

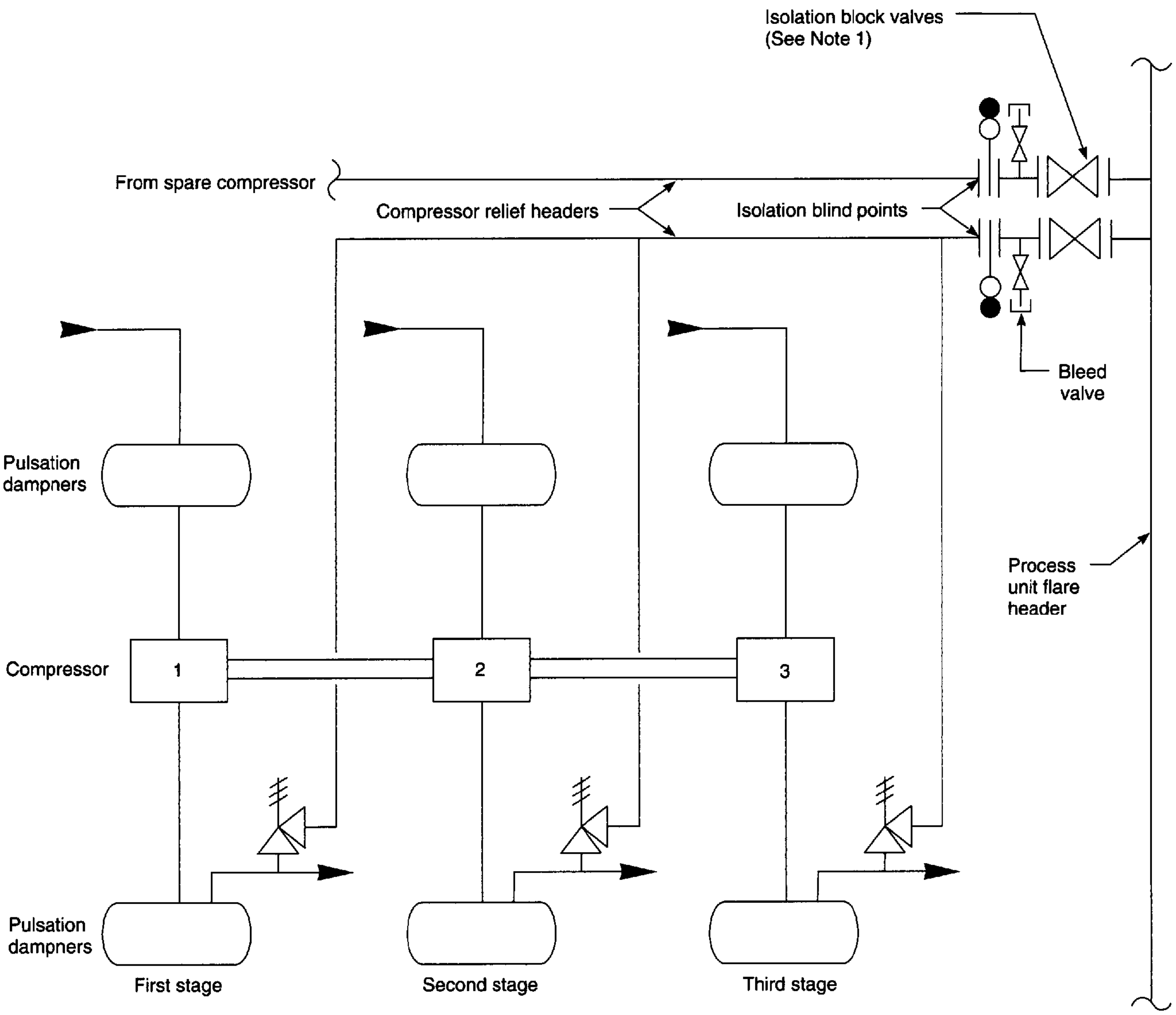
Figure 12—Typical Flare Header Block Valves

bellows valve. Proper operation depends on cancellation of the back pressure effect on opposing faces of the valve disk and balance piston. Since the piston area is equal to the nozzle seat area, the spring must operate at atmospheric pressure.

Because of the flow of system media past the piston, the bonnets of balanced piston valves should always be vented to atmosphere at a safe location. The amount of flow past the piston into the bonnet depends on the pressure differential between the valve outlet and bonnet. In an installation where superimposed back pressure or built-up back pressure is high, the flow past the piston could be substantial. This factor must be considered in the design of the bonnet venting.

5.4 Pilot-Operated Valves

The pilot is often vented to the atmosphere under operating conditions, since the discharge during operation is small. When vent discharge to the atmosphere is not permissible, the pilot should be vented either to the discharge piping or through a supplementary piping system to a safe location. When vent piping is designed, avoid the possibility of back pressure on the pilot unless the pilot is a balanced design.



Note:
1. See 4.4.

Figure 13—Typical Isolation Block Valves for Spare Compressor

SECTION 6—DRAIN PIPING

6.1 Installation Conditions that Require Drain Piping

Drain piping is normally not required on pressure relief valves at the valve body connection provided for this purpose. The outlet piping to closed systems should be self-draining to a liquid disposal point, thereby eliminating the need for a drain from the valve. Drainage must be provided when the discharge is not self-draining and the valve is located where liquids could accumulate at the valve outlet.

6.2 Safe Practice for Installation of Drain Piping

Since drain piping becomes part of the entire venting system, precautions that apply to the discharge system apply similarly to the drain piping. The drain-piping installation must not adversely affect the valve performance, and flammable, toxic, or corrosive fluids must be piped to a safe location.

SECTION 7—PRESSURE RELIEF DEVICE LOCATION AND POSITION

7.1 Inspection and Maintenance

For optimum performance, pressure relief devices must be serviced and maintained regularly. Details for the care and servicing of specific pressure relief devices are provided in the manufacturer's maintenance bulletins and in API Recommended Practice 576. Pressure relief devices should be located for easy access, removal, and replacement so that servicing can be properly handled. Sufficient working space should be provided around the pressure relief device.

7.2 Proximity to Pressure Source

The pressure relief device should normally be placed close to the protected equipment so that the inlet pressure losses to the device are within the allowable limits. For example, where protection of a pressure vessel is involved, mounting the pressure relief device directly on a nozzle on top of the vessel may be necessary. However, on installations that have pressure fluctuations at the pressure source (as with valves on a positive displacement compressor discharge) that peak close to the set pressure of the pressure relief valve or burst pressure of a rupture disk, the pressure relief device should be located farther from the source and in a more stable pressure region. (See Section 2 for information related to this subject.)

7.3 Proximity to Other Equipment

Pressure relief devices should not be located where unstable flow patterns are present (see Figure 14). The branch entrance where the relief device inlet piping joins the main piping run should have a well-rounded, smooth corner that minimizes turbulence and resistance to flow.

When pressure relief branch connections are mounted near equipment that can cause unstable flow patterns, the branch connection should be mounted downstream at a distance sufficient to avoid the unstable flow. Examples of devices that cause unstable flow are discussed in 7.3.1 through 7.3.3.

7.3.1 REDUCING STATIONS

Pressure relief devices are often used to protect piping downstream from pressure reducing valves, where unstable flow usually occurs. Other valves and appurtenances in the system may also disturb the flow. This condition cannot be evaluated readily, but unstable flow at valve inlets tends to generate instability.

7.3.2 ORIFICE PLATES AND FLOW NOZZLES

Proximity to orifice plates and flow nozzles may cause adverse operation of the pressure relief devices.

7.3.3 OTHER VALVES AND FITTINGS

Proximity to other fittings, such as elbows, may create turbulent areas that could result in adverse performance of pressure relief devices.

7.4 Mounting Position

Pressure relief valves should be mounted in a vertical upright position. Installation of a pressure relief valve in other than a vertical upright position may adversely affect its operation. The valve manufacturer should be consulted about any other mounting position, since mounting a pressure relief valve in other positions may cause a shift in the set pressure and a reduction in the degree of seat tightness.

Additionally, another position may permit liquids to collect in the spring bonnet. Solidification of these liquids around the spring may interfere with the valve operation.

7.5 Test or Lifting Levers

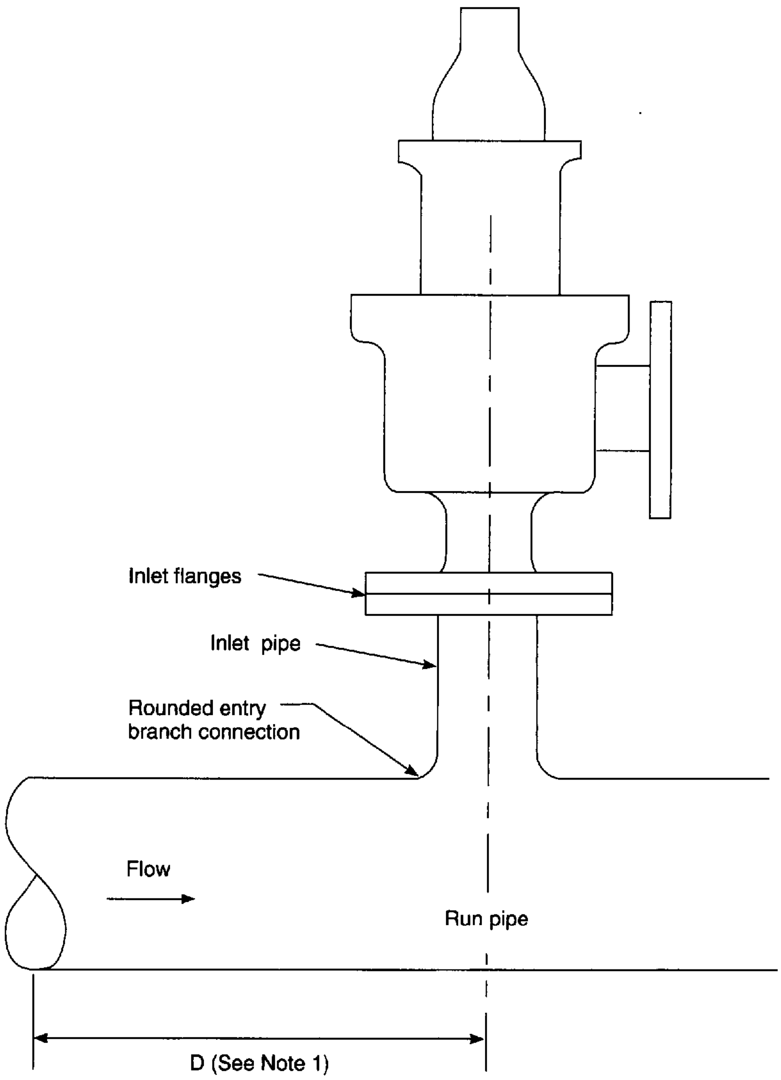
Test or lifting levers should be provided on pressure relief valves as required by the applicable code. Where simple levers are provided, they should hang downward, and the lifting fork must not contact the lifting nuts on the valve spindle. Uploads caused by the lifting-mechanism bearing on the spindle will cause the valve to open below the set pressure. The lifting mechanism should be checked to ensure that it does not bind on the valve spindle.

Where it is necessary to have the test lever in other than a vertical position, or where the test lever is arranged for remote manual operation, the lever should be counterbalanced so that the lifting mechanism, unless actuated, does not exert any force on the valve spindle lifting nut.

In lieu of lifting levers for pilot-operated pressure relief valves, means may be specified for connecting and applying adequate pressure to the pilot to verify that the moving parts critical to proper operation are free to move.

7.6 Heat Tracing and Insulation

For materials which are highly viscous, could result in corrosion upon cooling, or could potentially solidify in pressure relief valves, adequate heat tracing or insulation should be provided for both inlet and outlet piping. Ensure that the valve nameplate and any discharge or vent port are not covered when the valve is insulated.



Note:
1. D is typically not less than 10 pipe diameters from any device that causes unstable flow.

Figure 14—Typical Installation Avoiding Unstable Flow Patterns at Pressure Relief Valve Inlet

SECTION 8—BOLTING AND GASKETING

8.1 Care in Installation

Before a pressure relief device is installed, the flanges on the pressure relief valve or rupture disk holder and the mounting nozzle should be thoroughly cleaned to remove any foreign material that may cause leakage. Where pressure relief devices are too heavy to be readily lifted by hand, the use of proper handling devices will avoid damage to the flange gasket facing. Ring joint and tongue-and-groove joint facings should be handled with extreme care so that the mating sections are not damaged.

8.2 Proper Gasketing and Bolting for Service Requirements

The gaskets used must be dimensionally correct for the specific flanges; they must fully clear the pressure relief device inlet and outlet openings.

Gaskets, flange facings, and bolting should meet the service requirements for the pressure and temperature involved. This information can be obtained by referring to other national standards and to manufacturers' technical catalogs.

When a rupture disk device is installed in the pressure relief system, the flange gasket material and bolting loads may be critical. The disk manufacturer's instructions should be followed for proper performance.

SECTION 9—MULTIPLE PRESSURE RELIEF VALVES WITH STAGGERED SETTINGS

Normal practice is to size a single pressure relief valve to handle the maximum relief from a piece of equipment. However, for some systems, only a fraction of that amount must be relieved through the pressure relief valve during mild upsets. If the fluid volume under a pressure relief valve is insufficient to sustain the flow, the valve operation will be cyclic and will result in poor performance. The valve's ability to reseat tightly may be affected.

When capacity variations are frequently encountered in normal operation, one alternate is the use of multiple, smaller pressure relief valves with staggered settings. With this arrangement, the pressure relief valve with the lowest setting will be capable of handling minor upsets, and additional pressure relief valves will be put in operation as the capacity requirement increases.

For inlet piping to multiple relief valves, the piping which is common to multiple valves must have a flow area which is at least equal to the combined inlet areas of the multiple pressure relief valves connected to it.

Refer to API Recommended Practice 520, Part I, to determine set pressure of the pressure relief valves based on maximum allowable pressure accumulation for multiple valve installations.

An alternate to the use of multiple pressure relief valves with staggered settings is the use of a modulating pilot-operated relief valve.

SECTION 10—PRE-INSTALLATION HANDLING AND INSPECTION

10.1 Storage and Handling of Pressure Relief Devices

Because cleanliness is essential to the satisfactory operation and tightness of a pressure relief valve, take precautions to keep out all foreign materials. Valves should be closed off properly at both inlet and outlet flanges. Take particular care to keep the valve inlet absolutely clean. Pressure relief valves should, when possible, be stored indoors on pallets away from dirt and other forms of contamination.

Pressure relief devices should be handled carefully and should not be subjected to shocks, which can result in considerable internal damage or misalignment. For valves, seat tightness may be adversely affected.

Rupture disks should be stored in the original shipping container.

10.2 Inspection and Testing of Pressure Relief Valves

The condition of all pressure relief valves should be visually inspected before installation. Consult the manufacturer's instruction manuals for details relating to the specific valve. Ensure that all protective material on the valve flanges and any extraneous materials inside the valve body and nozzle are completely removed. Bonnet shipping plugs must be removed from balanced pressure relief valves. The inlet surface must be cleaned, since foreign materials clinging to the inside of the nozzle will be blown across the seats when the valve is operated. Some of these materials may damage the seats or get trapped between the seats in such a way that they cause leakage. Valves should be tested before installation to confirm their set pressure.

10.3 Inspection of Rupture Disk Devices

All rupture disk devices should be thoroughly inspected before installation, according to the manufacturer's instruction manuals. The seating surfaces of the rupture disk holder must be clean, smooth, and undamaged.

Rupture disks should be checked for physical damage to the seating surfaces or the prebulged disk area. Damaged or dented disks should not be used. Apply the proper installation and torquing procedure as recommended by the rupture disk device manufacturer.

On reverse-buckling disks that have knife-blade assemblies, the knife blades must be checked for physical damage and sharpness. Nicked or dull blades must not be used. Damaged rupture disk holders must be replaced.

10.4 Inspection and Cleaning of Systems Before Installation

Because foreign materials that pass into and through pressure relief valves can damage the valve, the systems on which the valves are tested and finally installed must also be inspected and cleaned. New systems in particular are prone to contain welding beads, pipe scale, and other foreign objects that inadvertently get trapped during construction and will destroy the seating surface when the valve opens. The system should be thoroughly cleaned before the pressure relief valve is installed.

Pressure relief devices should be removed or isolated before hydrotesting or pneumatic pressure testing of the system, either by blanking or closing an isolation valve. If an isolation valve is used, the flange at the pressure relief device should be wedged open or a bleed valve provided so that inadvertent leaking through the isolation valve does not damage the pressure relief device.

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