# ENGINEERING STANDARD

# FOR

# PROCESS DESIGN OF PRESSURE RELIEVING

# SYSTEMS INCLUSIVE SAFETY RELIEF VALVES

**ORIGINAL EDITION**

**DEC. 1997**

**This standard specification is reviewed and updated by the relevant technical committee on May. 2005. The approved modifications are included in the present issue of IPS.**

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APPENDICES

## 0. INTRODUCTION.

"Process Design of Safeguarding Systems for OGP Processes" are broad and contain variable subjects of paramount importance. Therefore, a group of Engineering Standards are prepared to cover the subject.

This group includes the following Standards:

| STANDARD CODE | STANDARD TITLE |
|---|---|
| IPS-E-PR-450 | "Process Design of Pressure Relieving Systems Inclusive Safety Relief Valves" |
| IPS-E-PR-460 | "Process Design of Flare & Blowdown Systems" |
| IPS-E-PR-470 | "Process Design of Emergency Measures" |

This Engineering Standard Specification covers:

**"PROCESS DESIGN OF PRESSURE RELIEVING SYSTEMS INCLUSIVE SAFETY RELIEF VALVES"**

## 1. SCOPE

This Engineering Standard Specification covers minimum requirements for process design and engineering of pressure relieving devices in OGP Industries excluding cryogenic services.

Reference shall be made to IPS-G-ME-250, "Pressure and Vacuum Relief Systems" for mechanical design, material, fabrication, inspection and shop test of pressure and vacuum safety relief devices.

For the rating and adjustment of safety valves on power boilers refer to the ASME Boiler and Pressure Vessel Code, Section I, "Power Boilers".

**Note:**

**This standard specification is reviewed and updated by the relevant technical committee on May. 2005. The approved modifications by T.C. were sent to IPS users as amendment No. 1 by circular No. 270 on May. 2005. These modifications are included in the present issue of IPS.**

## 2. REFERENCES

Throughout this Standard the following dated and undated standards/codes are referred to. These referenced documents shall, to the extent specified herein, form a part of this standard. For dated references, the edition cited applies. The applicability of changes in dated references that occur after the cited date shall be mutually agreed upon by the Company and the Vendor. For undated references, the latest edition of the referenced documents (including any supplements and amendments) applies.

**API (AMERICAN PETROLEUM INSTITUTE)**

| | |
|---|---|
| RP 520 part 1 | “Sizing, selection and installation of pressure Reliving divices in Refineries” |
| RP 520 part II | “Sizing, selection and installation of pressure Reliving divices in Refineries” |
| PR 521 | “Guide for pressure – Relieving and Depressuring systems” |
| Standard 526 | “Flanged steel pressure Relief Valves” |
| Standard 2000 | “Venting Atmospheric and Low-pressure storage tanks Nonrefrigerted and Refrigerated” |

**ASME (AMERICAN SOCIETY OF MECHANICAL ENGINEERS)**

| | |
|---|---|
| ASME B 31.3 | “Process piping” |

**ASME Boiler and Pressure Vessel Code**

| | |
|---|---|
| **Section I:** | "Power Boilers" |
| **Section VIII:** | "Pressure Vessels" |
| **Section VIII:** | "UG 134" |

**Crane Technical Paper No. 410 Section 3.4, Ed., 1976.**

**NEC (NATIONAL ELECTRICAL CODE)**

| | |
|---|---|
| Division 2 | "Electrical Classification Areas" |

**IPS (IRANIAN PETROLEUM STANDARDS)**

| | |
|---|---|
| IPS-E-GN-100 | "Units" |
| IPS-G-ME-250(1) | "Pressure and Vacuum Relief Systems" |
| IPS-E-PR-460 | "Process Design of Flare & Blowdown Systems" |

## 3. DEFINITIONS AND TERMINOLOGY

### 3.1 Accumulation

Pressure increase over the maximum allowable working pressure of the vessel during discharge through the pressurerelief valve (expressed as a percent of that pressure) is called accumulation.

### 3.2 Back Pressure

Pressure on the discharge side of safety-relief valves is back pressure.

#### 3.2.1 Built-Up back pressure

Built-up back pressure is the pressure in the discharge header which develops as a result of flow after that the safetyrelief valve opens.

#### 3.2.2 Superimposed back pressure

Superimposed back pressure is the pressure in the discharge header before the safety-relief valve opens.

### 3.3 Blowdown

Difference between set pressure and reseating pressure of a safety valve expressed in percent of the set pressure or in bar or kPa.

### 3.4 Design Pressure

The pressure used or designated in the design of equipment for the purpose of determining the minimum permissible thickness of the pressure parts at a designated temperature,exclusive of any thickness allowances added for corrosion and for loadings other than pressure.

### 3.5 Lift

The rise of the disk in a pressure-relief valve is called lift.

### 3.6 Maximum Allowable Working Pressure

As defined in the construction codes for pressure vessels, the maximum allowable working pressure depends on the type of material, its thickness and the service conditions set as the basis for design. The vessel may not be operated above this pressure or its equivalent at any metal temperature other than that used in its design. Consequently, for that metal temperature, it is the highest pressure at which the primary pressure-relief valve is set to open.

### 3.7 Overpressure

Pressure increase over the set pressure of the relieving device is overpressure. It is the same as accumulation when the relieving device is set at the maximum allowable working pressure of the vessel and may be greater than the allowable accumulation if the valve is set lower than the vessel MAWP.

**3.8 Relief Valve**

A relief valve is an automatic pressure-relieving device actuated by the static pressure upstream of the valve. The valve opens in proportion to the increase in pressure over the opening pressure. It is used primarily for liquid service.

**3.9 Reseating Pressure of a Safety Valve**

The values of inlet static pressure at which the disc re-establishes contact with the seat or at which lift becomes zero.

**3.10 Rupture Disk**

A rupture disk consists of a thin metal diaphragm held between flanges and bursts when a predetermined pressure is reached below the disk, so preventing a predetermined safe pressure being exceeded in the vessel to be protected.

**3.11 Safety-Relief Valve**

A safety-relief valve is an automatic pressure-relieving device suitable for use as either a safety or relief valve, depending on application. It is used in either gas and vapor or liquid services.

**3.11.1 Direct loaded safety-relief valve**

A safety-relief valve in which the loading due to the fluid pressure underneath the valve disk is opposed only by direct mechanical loading such as a mass, a lever and mass, or a spring.

**3.11.2 Pilot operated safety-relief valve (indirect loaded safety-relief valve)**

A safety-relief valve, the operation of which is initiated and controlled by the fluid discharged from a pilot valve which is itself a direct loaded safety-relief valve subject to the requirements of this Standard.

**3.11.3 Balanced bellows safety-relief valve**

A valve incorporating a bellows which has an effective area equal to that of the valve seat to eliminate the effect of back pressure on the set pressure of the valve and which effectively prevents the discharging fluid entering the bonnet space.

**3.11.4 Conventional safety-relief valve**

A valve of the direct loaded type, the set pressure of which will be affected by changes in the superimposed back pressure.

**3.12 Safety Valve**

A safety valve is an automatic pressure-relieving device actuated by the static pressure upstream of the valve and characterized by rapid full opening or pop action. It is used for gas or vapor services.

### 3.13 Set Pressure

Inlet pressure to which a safety valve is adjusted, in a test stand or other source of pressure, to open with an atmospheric discharge or atmospheric back pressure.

### 3.14 Vacuum Relief Valves

Vacuum Relief Valves are usually installed on storage tanks and shall normally be of the mass loaded or pilot operated type. For full description and determination of size of vacuum relief valves reference shall be made to API 2000 "Venting Atmospheric and Low Pressure Storage Tanks (Non-Refrigerated and Refrigerated)".

## 4. SYMBOLS AND ABBREVIATIONS

| | |
|---|---|
| **Con.** | Contractor. |
| **DN** | Diameter Nominal, in (mm). |
| **DP** | Design Pressure. |
| **F** | Environment Factor. |
| **L** | Liquid. |
| **LSAP** | Limiting System Allowable Pressure. |
| **MAWP** | Maximum Allowable Working Pressure. |
| **MRP** | Maximum Relief (Relieving) Pressure. |
| **NEC** | National Electrical Code. |
| **OGP** | Oil, Gas and Petrochemical. |
| **P & ID** | Piping & Instrumentation Diagram. |
| **RF** | Raise Face. |
| **SP** | Set Pressure. |
| **TRC** | Temperature Recorder Controller. |
| **V** | Vapor. |

## 5. UNITS

This Standard is based on International System of Units (SI) as per IPS-E-GN-100, except where otherwise specified.

## 6. DESIGN REQUIREMENTS

### 6.1 General

**6.1.1** Safety relief valves shall be provided to protect all equipment subject to overpressure and under certain other conditions as specified herein.

**6.1.2** For applicable design codes and standards, reference shall be made to IPS-G-ME-250(1), unless otherwise specified in this Standard.

**6.1.3** For material specification of safety relief valves, reference should be made to IPS-G-ME-250(1).

**6.1.4** Pressure/vacuum relief requirement and relief load capacity for atmospheric and low pressure storage tanks shall be evaluated based on API-Standard 2000.

**6.1.5** Snuffing steam shall be provided for safety valves discharging to atmosphere in the following services:

**a)** Material above its auto-ignition point.

**b)** Light hydrocarbon service at locations listed in the job specification where hazard of exposure to lightning is prevalent due to high rate of electrical storms.

When snuffing steam is required, provide a DN 25 (one inch) snuffing steam connection approximately 300 mm from outlet end of the discharge piping. The steam line to this connection shall be run to grade, provided with a double valve and bleeder at grade and a steam condensate trap upstream of the double valves.

### 6.2 Provisions of Pressure Safety Relief Valves

Pressure safety or relief valve shall be provided for all cases as specified herein below.

#### 6.2.1 Vessels

**6.2.1.1** When designed in accordance with Section VIII, ASME Unfired Pressure Vessel Code and the overpressure exceed the Design Pressure.

Special attention shall be made to the cases, where process conditions are changed during the engineering stage or after initial start-up of the plant and require increased operating pressure.

**6.2.1.2** When designed in accordance with Section I, ASME Power Boiler Code and the overpressure exceeds the Maximum Allowable Working Pressure as defined in that code.

#### 6.2.2 Pumps

**6.2.2.1** On discharge of positive displacement pumps.

**6.2.2.2** On discharge of centrifugal pumps to protect downstream equipment from overpressure based on pump shutoff pressure. Where the downstream equipment are not designed for pump shut-off pressure.

**6.2.2.3** On pump suction lines from a "bottled in" system where overpressure can be imposed on suction piping by backflow through the pump or through a control valve bypassing from pump discharge to suction.

#### 6.2.3 Compressors

**6.2.3.1** Where each stage of reciprocating compressors to protect interstage, intercooler, compressor frame or cylinder.

**6.2.3.2** On suction lines where overpressure may occur on suction lines or frame, or overload electric motor driver before interstage or discharge safety valve opens. Also for conditions specified in Clause 6.2.2.4 above.

#### 6.2.4 Compressor & pump couplings

**6.2.4.1** On discharge where under blocked discharge the design torque of the driver coupling or keyway may be exceeded due to an oversized motor or turbine.

### 6.2.5 Steam boilers & superheaters

**6.2.5.1** The following equipment falling under the jurisdiction of Section I, ASME Power Boiler Code when the overpressure exceeds the Maximum Allowable Working Pressure as defined by that Code:

**a)** Steam drums.

**b)** Superheater outlet.

**c)** Externally fired superheater coils installed in a process heater.

### 6.2.6 Fired process heaters

**6.2.6.1** To prevent overpressure due to heat input resulting from an action blocking the lines at downstream of the heater, where check valves or other valves upstream of the heater are closed by the same action blocking the upstream line(s), except for the condition covered under (a) below. The safety valve may be located anywhere between the upstream and downstream blocking valves:

**a)** A safety valve will not be required to protect the heater if the only block valve(s) between a fired heater and a tower are operable manually and intended to be used to prevent backflow from the tower to the heater in case of heater tube failure.

### 6.2.7 Turbines & surface condensers

**6.2.7.1** Condensing or non-condensing steam turbine cases where the exhaust outlet may be blocked, thus preventing the turbine from discharging to atmosphere, a low pressure steam header or a surface condenser.

**6.2.7.2** Gas turbine cases, where exhaust outlet is blocked, thus preventing the turbine from exhausting to atmosphere, or to waste heat generators, etc.

**6.2.7.3** Exhaust outlet where the design pressure of an expansion joint is less than the turbine casing design pressure.

**6.2.7.4** Surface condensers for condensing turbines.

### 6.2.8 Piping & connected equipment

**6.2.8.1** For protection of piping, heat exchangers and other equipment served by the piping against overpressure under the following conditions:

**a)** Downstream of steam reducing valves (including protection to steam engine and turbine drivers in this case).

**b)** On the exhaust steam header leaving a Unit regardless of overpressure considerations. Use a chain operated multiport relief valve located on the Unit side of the block valve where the header connects into the plant exhaust steam system.

**c)** Downstream of restriction orifices or manually operated valves in steam make-up or other services where closing a valve would result in overpressure.

**d)** Fuel inlet to gas engine drivers.

**e)** Pressure line to pressure balanced valves used to control fuel supply where the steam breaking point, diaphragm bursting point or diaphragm case breaking point may be exceeded.

**f)** Downstream of steam control or regulating valves.

**g)** Downstream or upstream of all control valves when the piping or equipment would be subjected to overpressure assuming that the control valve will fail in the open or closed position.

**h)** On pedestal or gland water systems to pumps and turbines where overpressure is caused by water pump shutoff pressure. One safety valve may be provided on the supply line to a group of pumps, turbine glands or pedestals in lieu of a safety valve on the line to each equipment.

**i)** Overpressure resulting from any of the conditions outlined in Clauses 6.2.1 through 6.2.7.

### 6.2.9 Cold side blockage & tube failure in exchangers

**6.2.9.1** To prevent overpressure due to heat input resulting from an action blocking the line(s) downstream of the cold side of the exchanger, where check valves or other valves upstream of the exchanger are closed by the same action blocking the upstream line(s). A safety valve is required where heating the cold fluid within the exchanger when the hot side inlet temperature will raise the pressure of the fluid contained between the upstream and downstream blockages to more than 1.5 times of the design pressure of any item of equipment (excluding piping) in the contained system.

### 6.2.10 Pressure safety relief valves not required

Pressure safety relief valves shall not be provided on the following systems:

**a)** Interconnected vessels (excluding those falling under the requirements of Section I ASME Power Boiler Code), if they meet the following conditions:

**a.1)** The vessel which is the source of pressure shall be equipped with a safety valve sized to protect all of the interconnected vessels or requirement and the interconnected piping (including heat exchanger equipment) shall be sized or checked for pressure drop to insure that the design pressure on the downstream vessel or vessels is not exceeded by more than the percentage accumulations allowed in Clause 8.2.1.

**a.2)** At least one interconnecting piping system between the protected vessel and any other vessel must be free of:

- Any equipment which may fail or stop in a closed position.
- Any block valves, control or check valves.
- Any orifices, or similar restrictions to flow.

**b)** Where a lower pressure piping system such as pumpout is routed to an offsite slop or emergency tank with overshot connections (connections entering the top of the tank without block valves).

**c)** Depressuring systems routed to a flare, if all valves at the Unit limit, cooling boxes, or downstream depressuring valves are locked open.

## 6.3 Provisions of Temperature Safety Valves

Temperature safety valve shall be provided for all cases as required herein below:

### 6.3.1 Heat exchangers

Temperature safety valves shall be provided on the cold side of heat exchange equipment, including compressor jackets operating full of liquid and subject to being blocked off, where heat may be applied internally or externally and other forms of pressure relief valves are not provided.

**6.3.2 Piping**

Provide temperature safety valves for the following:

**a) Steam traced lines**

For sections of pipe which are steam traced and contain liquid and may be blocked in.

**b) Lines containing cold solvent or refrigerant**

For blocked in sections of pipe which contain cold liquid and may develop excessive pressure under ambient temperature.

**c) Exposed liquid-filled lines**

For blocked in sections of pipe which may be subjected to excessive pressure due to rays of sun when exposed length of line is 30 meters or greater.

**6.3.3 Temperature safety valves not required**

On pedestal or gland water piping to pumps, turbines, compressors, blowers, etc. when the improbability that blocking off both the inlet and outlet valves and heating of the glands would occur simultaneously temperature safety valve is not required.

**6.4 Provisions of Vacuum Safety Valves**

**6.4.1 Pressure vessels**

**6.4.1.1** Vessels in the following services shall be provided with vacuum breaking device, if they cannot withstand full vacuum:

**a)** Vessels where stripping steam is used and overhead condensing systems are provided.

**b)** Vessels operating under partial vacuum.

**c)** Vessels operating full of liquid having a vapor pressure less than atmospheric pressure at the operating temperature.

**d)** Vessels on suction to compressors.

**e)** Vessels such as hot process softeners, deaerating heaters, hot water storages where cold water is heated bydirect contact with steam and the vessel is not open to atmosphere.

**6.4.1.2** Before vacuum safety valves are provided for vessels where explosive mixtures may occur due to bleeding air into the vessel through a vacuum safety valve and if the set pressure of the vacuum relief valve is so low that special consideration is needed to hold leakage to a minimum, consideration should be given to the alternate method of bleeding gas into the vessel by means of a regulator or control valve using the bleed gas as the operating medium instead of instrument air.

**6.4.1.3** Vacuum relief valves allowing air to enter a hydrocarbon system shall not be used without prior approval of the Company. The Contractor shall provide adequate back up documents to support the design applied to the system.

**6.4.2 Spheres & spheroids**

**6.4.2.1** The necessity for vacuum relief valves on spheres and spheroids shall be investigated for each case, depending on the vapor pressure and corrosivity of the fluid handled and design of such equipment in regard to vacuum.

**6.4.2.2** When required the precautions specified under Clauses 6.4.1.2 and 6.4.1.3 above shall be observed.

## 6.5 Provisions of Rupture Disks

### 6.5.1 Rupture disk alone

A rupture disk alone shall not be used to protect vessels or equipment but it may be used in combination with safety valves as a second relief device.

### 6.5.2 Rupture disk on inlet to safety valve

A rupture disk shall be provided at the inlet to a safety valve in the following instances:

**a)** Where it is difficult to keep safety valves from leaking either due to high pressure involved or to combination of high pressure and fluctuating pressure such as high pressure reciprocating compressors.

**b)** Where toxic material is being handled and contamination of the atmosphere is to be avoided due to possible leakage.

**c)** Where the fluid handled is expensive and possibility of safety valve leakage is to be avoided.

**d)** Where material which will make the safety valve inoperative is to be kept out of the safety valve.

**e)** Where corrosive material is handled and a safety valve can not be obtained of satisfactory material to resist corrosion.

**f)** Where corrosive material is handled and cost of safety valve to resist corrosion is prohibitive.

### 6.5.3 Rupture disk on outlet of safety valve

Rupture disks shall be provided on outlet of safety valves in the following instances:

**a)** To keep corrosive product out of a safety valve connected into a vent system.

**b)** Where it is necessary to confine safety valve leakage and there is insufficient space available on safety valve inlet.

### 6.5.4 Rupture disks used in conjunction with safety valves

Rupture disks shall be provided in parallel with safety valves which discharge to the atmosphere or to a vent system under the following conditions:

**a)** Where exothermic reactions may develop abnormally high and uncontrollable pressure conditions.

## 6.6 Spare Safety Valves

**6.6.1** The necessity for provision of spare safety valves shall be based upon the following considerations:

**a)** On process Units where the required time interval between safety valve inspection periods is less than the time interval between designated inspection and test periods of the Unit, or is less than the normally anticipated frequency of Unit shut-downs for other reasons such as clean up or catalyst change, and the vessel or item of equipment can not be taken out of service without shutting down the Unit.

**6.6.2** When a spare safety valve is required, the size of the safety valves shall be such as to provide the least number of safety valves which will have a total capacity equal or greater than the calculated required relieving capacity.

**6.6.3** A spare relief valve is not required when two or more pressure or safety relief valves are required for the calculated relieving capacity on spheres or spheroids. However, where only one valve is needed for the required capacity, a spare valve shall be provided for spheres or spheroids.

When a vacuum relief valve or valves are required on spheres or spheroids, no spare relief valve is required.

**6.6.4** Spare temperature safety valves are not required.

### 6.7 Emergency Vapor Depressuring Requirements

**6.7.1** In addition to (not in lieu of) the pressure relief facilities described in this Section, a depressuring system shall be provided for reducing the pressure under fire conditions. To this end all process equipment, except as mentioned below, containing more than 2 metric tonnes of liquid C4 or more volatile liquid under normal operating conditions, shall be provided with remotely operated vapor depressuring valves discharging into a closed system, preferably the relief system, leading away from the probable fire areas.

**6.7.2** Platformate separators in platforming Units and high pressure separators in hydrotreating and hydrocracking Units shall always be provided with depressuring facilities.

**6.7.3** Facilities for remote operation of the depressuring valves shall be located in the control room.

### 6.8 Provisions of Fire Relief Valves

Fire relief valves shall be considered for liquid containing equipment, (e.g.,vessels, columns and settlers) if all of the following circumstances apply:

**a)** If the equipment is located in an area where a sizable fire may occur.

**b)** If the equipment under consideration can be blocked in, while the Unit remains in operation.

## 7. SELECTION OF TYPE

### 7.1 Conventional (Unbalanced) Safety Relief Valves

**7.1.1** Use the conventional safety relief valve where the service is:

**a)** Clean and non-corrosive.

**b)** Corrosive, with provision of corrosion resistant materials.

**7.1.2** Do not use this valve where service is:

**a)** Corrosive and corrosive materials may damage the guide and disk, or guide and spindle or spring and bonnet.

**b)** Such that the variable back pressure is greater than 10% where 10% accumulation is allowed or greater than 20% where 20% accumulation is allowed under fire conditions.

**c)** Such that the differential pressure when the valve is relieving compared to the normal differential pressure across the protected equipment is less than 10%. This particularly applies when starting up a Unit where the initial back pressure on a valve is zero and the differential pressure across the valve may be below the intended operating pressure or closer than 10% above the normal operating pressure.

**d)** Such that the material relieved may contain coke in suspension or slurries containing particles which may clog the guiding surfaces.

### 7.2 Balanced Bellows Safety Relief Valves

**7.2.1** Use the balanced bellows safety relief valve where:

**a)** The relieving pressure is to be independent of the back pressure.

**b)** The bellows is used to prevent clogging of the guiding surfaces with coke or other particles in suspension.

**c)** The bellows is used to prevent corrosive products from damaging the guiding surfaces, spring or associated pieces.

**d)** Back pressure as specified in 7.1.2(b) and 7.1.2(c) above exists and either liquid or vapor relief is to be handled.

**e)** Savings in discharge piping and size of flare header may be realized through use of higher back pressure in the flare header.

**7.2.2** Where the balanced bellows safety valve is used in closed flare system and the variable back pressure is above 30 percent of the relieving pressure, check with the manufacturer on the decrease in the capacity of the particular valve when sizing. Do not use this type of safety valve where the liquid being discharged could accumulate and set up in the convolutions or bellows and make safety valve inoperative.

**7.2.3** Superimposed back pressure due to operation of emergency depressuring valves shall be disregarded when evaluating the necessity of balanced type valves, since simultaneous operation of relief and depressuring valves should not normally occur. As variable back pressure the highest pressure shall be taken that can be generated in the outlet of a valve by the valve itself, and possibly other valves at the same time of blowing.

**7.2.4** Bellows balanced valves shall not be used for services involving materials with their pour point at or above lowest ambient temperature (e.g., materials containing wax) or where coking may be expected. Balanced valves with a piston only shall be used in such cases.

### 7.3 Balanced Bellows Plus Balanced Piston Safety Valves

The balanced piston added to a balanced bellows safety valve is to be provided where it is important that the valve operate properly in case of bellows failure. This type of valve is to be used only on approval of the Company.

### 7.4 Multiport Relief Valves

**7.4.1** Use the multiport relief valve on exhaust steam systems where it is desired to open the valve manually to dump the exhaust steam to the atmosphere, or to provide protection for process Unit exhaust steam headers.

**7.4.2** Multiport relief valves may also be used in vacuum service to protect surface condensers, etc. Such valves are to be water sealed.

**7.5 Pilot Operated Safety Relief Valves**

**7.5.1** Types of pilot operated pressure safety valves:

**a) With integral pilots**

**a.1)** External Pressure Sensing-Pilot Exhaust Atmosphere.

**a.2)** Integral Pressure Sensing-Pilot Exhaust Atmosphere.

**a.3)** Integral Pressure Sensing-Pilot Exhaust to Relief Valve Outlet.

**b) With external pilot**

**b.1)** External Pressure Sensing-Pilot Exhaust Atmosphere.

**7.5.2** Pilot operated safety valves are used in the following cases:

**a)** On spheres, spheroids and other low pressure storage vessels.

**b)** In clean, non-corrosive services.

**c)** Where premium tightness is desired. These valves are tight to set pressure wherever conventional valves are tight to 90-95% of set pressure. Therefore, for equipment that operates between 90 and 95% of the set pressure, utilization of pilot operated valves shall be considered.

**d)** Where maximum capacity with least overpressure is desired.

**e)** Where the built-up back pressure and variable superimposed back pressure does not exceed 50% of the set pressure.

**f)** When the pressure drop to the inlet of the safety relief valve is greater than 3% of the set pressure (in this case, the remote pressure pickup type should be used).

**g)** Where the valve size is so large that a direct loaded safety relief valve would be unsuitable.

**7.5.3** Pilot operated safety relief valves are not to be used in the following cases:

**a)** In corrosive service.

**b)** In coking or slurry service.

**c)** In closed flare systems unless back pressure effects have been investigated and envisaged.

**7.6 Open Spring Type Valves**

**7.6.1** Open spring type valves are permitted in the following services:

**a)** Steam service such as boilers, waste heat boilers, etc. where ASME Power Boiler Code applies.

**b)** Steam service such as turbine cases, etc. which are located inside shelters or buildings.

**7.6.2** Open spring type valves located outdoor shall have a specially constructed metal hood over the spring to prevent water seepage into the relief valve interior or accumulation of foreign particles such as catalyst dust.

### 7.7 Closed Spring Type Valves

**7.7.1** Closed spring type valves are required in the following services:

**a)** Steam service, such as turbine cases exposed to the weather, where ASME Power Boiler Code does not apply.

**b)** Hydrocarbon service.

**c)** Chemical service.

**d)** Air service.

**e)** Multiport relief valves.

**7.7.2** A DN 20 (¾ inch) minimum size vent connection shall be provided in the closed bonnet of all safety valves to vent the spring housing to the atmosphere. This is especially needed on bellows type safety valves to prevent build up of back pressure.

### 7.8 Safety Valves with Lifting Devices

**7.8.1 Lifting levers shall be furnished for the following valves:**

**a)** Steam safety valves where ASME Section I Power Boiler Code applies.

**b)** Safety valves for air receivers.

**c)** Open spring safety valves where the lifting lever is standard construction.

**d)** Other safety valves when specified for special applications.

**7.8.2** When lifting levers are required, standard lifting levers shall be furnished except as follows:

**a)** Packed lifting levers shall be provided on safety valves with closed bonnets when specified in the job specifications where no leakage of vapor at the lifting lever can be tolerated.

### 7.9 Temperature Safety Relief Valves

**7.9.1 Water service**

Use top guided standard relief valve or puppet type spring load check valve with resilient seats.

**7.9.2 Hydrocarbon or chemical service**

Top guided standard relief valves with size and type connection required by the applicable piping material service specification shall be provided where valve discharges to a drain or sewer, unless otherwise accepted by the Company.

### 7.10 Safety Valve Caps

All closed bonnet safety valves shall be furnished with screwed or bolted caps.

### 7.11 Safety Valve Drains

Drain connections shall be provided on all safety valves used in condensable vapor service (see also Article 11.4 hereinafter).

### 7.12 Rupture Disc Types

The following types shall be used for all applications:

**a)** Insert type rupture disc preassemblies for installation inside bolt circle of two flanges.

**b)** Multiple component discs with plastic or metallic seal and vacuum or back pressure support.

### 7.13 Safety Valve Bonnet

**7.13.1** Conventional safety relief valves for closed relief systems shall have a closed bonnet.

**7.13.2** Safety relief valves of the balanced type shall have a vented bonnet which shall be vented to atmosphere in such a manner as to prevent the ingress of rain and dirt. Personnel hazard should be avoided whilst on the other hand ready observation of any flow from a vent line should remain possible.

## 8. SET PRESSURE

### 8.1 General

**8.1.1** Unless otherwise specified in this Section, safety relief valves shall be set to relieve initially at the design pressure of the equipment, within the limitations of the allowable blowdown and accumulation specified in this Section.

**8.1.2** Unless otherwise specified in this Section, the stated set pressure is the initial relieving pressure.

**8.1.3** In general, Set Pressures (SP) and Maximum Relief Pressures (MRP) of safety/relief valves, expressed in relation to the Design Pressure (DP) of the protected equipment, all expressed in gage pressure, shall not exceed the values given in the Table 1 below.

**Note:**

**For the pressure setting of the safety/relief valve instead of the Design Pressure (DP), the Maximum Allowable Working Pressure**

**(MAWP) is also used.**

**TABLE 1 - SET PRESSURE AND MAXIMUM RELIEVING PRESSURE**

| DESCRIPTION | SET PRESSURE (SP) | | MAXIMUM RELIEVING PRESSURE (MRP) | |
|---|---|---|---|---|
| | Non-fire Conditions | Fire conditions | Non-fire conditions | Fire Conditions |
| Single valve | 100% of DP | 100% of DP | 110% of DP | 121% of DP |
| Multiple valves | One valve 100% of DP the others at 105% of DP** | 110% of DP* | 110% of DP | 121% of DP |

*** Relief valves for fire protection may only be set at 110% of DP if they are installed in addition to adequate relief protection of the process equipment against non-fire situations.**

**** For set pressures below 1000 kPa (10 bar), staggering of set pressure becomes impracticable because of the difference between the set pressure tolerance of 3% (according**

**to ASME VIII UG 134) and the value of 5% of the DP becomes too small.**

The above shall also apply to safety/relief valves discharging liquid and flashing liquid.

**Note:**

**For safety valves protecting vessels or other equipment falling under the jurisdiction of ASME Section 1 Power Boiler Code see Article 8.2.4.**

### 8.2 Pressure Safety or Relief Valve Set Pressure

**8.2.1** Maximum pressure accumulations above the set pressure (initial relieving pressure) of safety or relief valves shall be limited as shown for the following services and equipment.

**a)** 3% for:

Steam boilers and steam systems governed by Section I, ASME Power Boiler Code.

**b)** 10% for:

**b.1)** Air receivers.

**b.2)** Compressors.

**b.3)** Pumps.

**b.4)** Turbine cases.

**b.5)** Piping.

**b.6)** Heat exchanger units.

**b.7)** Vessels and fired heaters other than those governed by Section I, ASME Power Boiler Code.

**c)** 20% covers fire conditions for:

**c.1)** Air receivers.

**c.2)** Piping.

**c.3)** Heat exchanger units.

**c.4)** Vessels other than those governed by Section I ASME Power Boiler Code.

**8.2.2 The following allowable blowdown shall be specified for pressure safety relief valves:**

**a)** 3% Blowdown - for all steam service.

**b)** 4% Blowdown - for all vapor and gas service other than steam.

#### 8.2.3 Equipment and piping safety relief valve set pressure

#### 8.2.3.1 Vessels

**a)** ASME, Section VIII Code Vessels : Set at Design Pressure.

**b)** ASME, Section VIII Code Vessels (special conditions only): For special cases when the overpressure exceeds the Design Pressure, the set pressure shall be the Maximum Allowable Working Pressure as defined in applicable Code.

**c)** ASME, Section I Code Vessels: Set at Maximum Allowable Working Pressure as defined in Section I, ASME Code.

**8.2.3.2 Pumps & compressors**

On discharge where under blocked discharge, the horse-power rating (in kilowatts) of the electric motor drive may be exceeded, set at a pressure plus the over pressure which does not exceed the pressure developed at the maximum safe horse-power rating (in kilowatts) recommended by the pump or compressor manufacturer.

**8.2.3.3 Steam boiler systems**

Set at a minimum of 10% or 100 kPa (ga), (whichever is greater) above the normal operating pressure, but not to exceed the set pressure of any safety valve protecting other lower pressure boilers feeding into the system.

**8.2.3.4 Compressor & pump couplings**

To protect against overpressure on discharge under conditions defined in 6.2.4, set at manufacturer's recommendation.

**8.2.3.5 Turbines**

**a)** When turbines exhaust into a separate steam system, set turbine case safety valve at a minimum of 70 kPa (ga) above the normal operating pressure of the system into which the turbines exhaust but not to exceed turbine case design pressure.

**b)** For safety valves to protect gas turbine cases, set at turbine manufacturer's recommendation.

**8.2.3.6** Cold side blockage and tube failure in exchangers set at 1.5 times Lowest Design Pressure for any item of equipment (excluding piping) in the system contained between the blockages.

**8.2.3.7 Piping & connected equipment**

**8.2.3.7.1** For safety valves required to protect piping and connected equipment (including fired heater tubes), set at the lower of the following:

**a)** Design pressure of equipment or fired heater tubes.

**b)** The short time pressure of the piping as determined by the classification and limits of short time conditions defined in the relevant ASME B.31.3.

**8.2.3.7.2** For safety valves required to protect piping only (no connected equipment involved), set at pressure specified in 8.2.3.7.1 (b) above.

**8.2.3.7.3** For safety valves required to protect piping and connected equipment in pulsating service, verify that the design pressure of the piping or equipment has been established on the basis of the maximum pressure anticipated under pulsation.

**8.2.3.7.4** For steam service, the following additional requirements shall be noted:

**a)** For safety valves used to protect piping or equipment downstream of a steam pressure reducing valve, set at a minimum of 70 kPa (ga) above the normal operating pressure of the system on the low pressure side but not to exceed settings of any turbine safety valves exhausting into the same system or the design pressure of other equipment to be protected.

**b)** For safety valves provided to protect piping and equipment in steam service, set at a pressure consistent with the setting of safety valves protecting any turbine exhausting into the same system.

#### 8.2.4 Multiple safety valves

Safety valve settings for multiple safety valves shall conform to the following:

**a)** For safety valves protecting vessels or other equipment falling under the jurisdiction of ASME Section I Power Boiler Code, the first valve shall be set at or below the Maximum Allowable Working Pressure as defined by that code. The other safety valve(s) may be set at a pressure not to exceed the Maximum Allowable Working Pressure by 3%. The range of settings between the first and other safety valves shall not be more than 10% of the setting of the highest set valve.

**b)** For safety valves protecting vessels falling under the jurisdiction of ASME Section VIII Unfired Pressure Vessel Code, the first valve may be set at or below the Design Pressure. The other safety valve(s) may be set at pressures which do not exceed the Design Pressure by more than 5%. For fire conditions set pressure of all valves shall not exceed 110% of Design Pressure.

### 8.3 Temperature Safety Valve Set Pressure

#### 8.3.1 Valves discharging to atmosphere:

**a)** Heat exchangers and equipment excluding piping: Set at Design Pressure.

**b)** Piping only: Set at the Maximum Allowable Short Time Pressure, permitted under the applicable class of short time conditions defined in the relevant ASME B.31.3, for the anticipated blocked in temperature.

**c)** Where piping and other equipment are involved in a common system to be protected: Set at Design Pressure of governing equipment or at pressure defined in "b" above whichever is lower.

#### 8.3.2 Valves discharging to a closed system:

In a consecutive system of piping (including other equipment) containing block valves, check valves, pumps or other closed devices, it may be desirable to install a series of temperature safety valves so that each valve relieves to the section of pipe protected by the next valve, with the last safety valve in series relieving pressure to the destination of the low pressure end of the system. In such a consecutive system, the set pressure shall be determined as follows:

**a)** Determine the Limiting System Allowable Pressure (LSAP), e.g., design pressure of equipment in the system or Short Time Pressure of the piping, whichever is smaller.

**b)** The set pressure of each safety valve must be checked to insure that the summation of the set pressures of all the safety valves in series in the system does not exceed the LSAP defined in "a" above. If the summation of the set pressures exceeds the LSAP, each safety valve set pressure shall be reduced to bring the summation within the prescribed limits.

### 8.4 Rupture Disc Set Pressure

#### 8.4.1 General

The set pressure for rupture disc is determined the same as for pressure safety valves but the differential between the normal operating pressure and the set pressure of the rupture disc depends on whether a single component rupture disc alone is used, whether a multiple component disc with plastic or metallic seal is used and whether the normal operating pressure is constant or pulsating.

#### 8.4.2 Rupture disc (single component)

Where the pressure is fluctuating or pulsating, the burst pressure of the single component rupture disc shall not be closer than 33% above the normal operating pressure for a metallic disc and 25% for a non-metallic disc.

**8.4.3 Multiple component rupture discs**

**a)** Multiple component rupture discs with plastic pressure seal and vacuum or back pressure support shall be used where the pressure is constant or fluctuating. The burst pressure of the disc shall be no closer than 20% above the normal operating pressure.

**b)** A similar rupture disc with metallic pressure seal and vacuum or back pressure support shall have a bursting pressure not closer than 10% above the normal operating pressure.

**8.5 Vacuum Relief Valve Set Pressure**

**8.5.1** Vacuum relief valves are set as close to atmospheric pressure as possible and still not be affected by normal upsets. This is to allow as much accumulation as possible to keep the valve size to a minimum.

**8.5.2** Vacuum relief valves are allowed to accumulate to the maximum external design pressure.

## 9. SIZING

### 9.1 Pressure Safety Relief Valves

#### 9.1.1 General

**9.1.1.1** Safety relief valve capacity formulas used for calculation of the required orifice area shall be in accordance with API Recommended Practice 520 Part I, Section 4 "Procedures for Sizing".

**9.1.1.2** The standard effective orifice areas and the corresponding letter designations shall be according to API Standard 526.

**9.1.1.3** The thermal expansion valves shall be DN 25 × DN 25 (1 inch × 1 inch) with flange orifice area of $38.7 \times 10^{-6}$ or $71.0 \times 10^{-6}$ square meters as required.

**9.1.1.4** All safety relief valves shall have flanged inlet and outlet connections of 300 # RF and 150 # RF respectively, unless the service requires a higher rating or a different type of facing.

**9.1.1.5** When estimating the normal fluid mass inflow to the system at blocked outlet conditions, credit shall be given that, the vessel under emergency is at relieving conditions (i.e.,at pressure higher than the normal operating one). When evaluating relieving requirements, it is assumed that any automatic control valve, which is not the cause of upset, will remain in the normal position. Credit may therefore be taken for the normal capacity of these valves, corrected for relieving conditions, limited to the flow rates that downstream equipment can safely handle.

**9.1.1.6** A load summary table including the following information and data shall be provided for each safety relief valve (a typical arrangement of pressure safety relief valve load summary table is demonstrated in Appendix A):

**a)** Item number.

**b)** P & ID number.

**c)** Protected equipment.

**d)** Size and type.

**e)** Set pressure [bar (ga) or kPa (ga)].

**f)** Discharge to..............

**g)** Emergency Failure (see Paragraph 9.1.2 for the emergency failure cases, all applicable emergency causes shall be tabulated). For each applicable emergency cause, the following information/data shall be specified:

- MW for vapor and kg/m³ at flowing conditions for liquid.
- kg/h for vapor and m³/h at flowing conditions for liquid.
- °C.
- V. or L.
- Area (only for fire case).

**h)** Remarks.

**9.1.2 Relief load requirements**

**9.1.2.1 Double jeopardy:**

**a)** Safety valves shall be sized on the basis of a single involuntary occurrence.

**b)** The sizing shall not be on the basis of double or multiple occurrences which are completely independent of one another, except where one of the occurrences happens frequently. Where multiple occurrences are dependent on one another and the probability of the occurrences are likely, the condition shall be considered for sizing.

**9.1.2.2** For each safety relief valve the maximum of the relief conditions shall be determined for each of the applicable causes cited in Table 1 of API-RP 520, Part I "Bases for Relief Capacities Under Selected Conditions", with the following modifications/reservations:

**a)** For new designs no corrections shall be made for the difference between operating and relieving pressure, except and subject to the Company’s approval where there is an appreciable difference between maximum operating pressure and maximum allowable working pressure [e.g., a vacuum column or a near atmospheric column with a MAWP of 600 to 800 kPa (ga)].

**b)** For new designs the cooling effect of an air cooling heat exchanger resulting from natural drought in case of fan failure shall not be taken into account.

**c)** In case of lean oil failure to an absorber the quantity to be released shall be taken as the total incoming vapor, plus the quantity generated therein under normal conditions.

**9.1.2.3** In addition to 9.1.2.2 above, the quantities to be discharged in the event of each emergency case as specified in this Section shall be determined for each valve. The conditions resulting in a maximum relief quantity found under the all possible emergency cases shall be evaluated. The size of the relief valve and of its outlet pipe up to the relief header shall be determined on the basis of the largest of the relief quantities.

The following emergency cases should be evaluated for each system. Each system shall be considered as an equipment or a group of equipment that may be isolated by control valves or other valves, but without any other isolation in between.

**- Utilities failures:**

- Power failure.
- Cooling water failure (main system).
- Cooling water failure (within process Unit limits).
- Cooling water plus power failure (simultaneous failure).
- Instrument air failure.
- Steam failure.
- Fuel oil/fuel gas failure.

- Air fan coolers failure.

**- Operating failures:**

- Blocked outlet.
- Control valve failure.
- Reflux failure.
- Side stream failure/pump around failure.
- Loss of fractionator or column or liquid gas separator drum condensing duty.
- Simultaneous failure of reflux and condensing duty.

**- Mechanical failures:**

- External fire.
- Heat exchanger tube failure.
- Hydraulic expansion.
- Other failures.

#### 9.1.2.4 Utilities failures

Impact of utility failures shall be evaluated based on API RP 521 Section 2 Clause 2.3.5 and the criteria set forth herein below. The utilities failures can be plant-wide or local.

#### 9.1.2.4.1 Power failure

Power failure effects on Unit operation and safety valve sizing shall be considered and shall include the following:

**a)** Complete Unit-wide loss of low and medium volt supply while high volt supply power source, steam drivers, gas engine drivers, etc. are still operable.

**b)** Complete Unit-wide loss of all types of electricity while steam drivers (if any used), gas engine drivers (if any used), etc. are still operable.

**c)** Consideration must be given to any automatic shut-down of drivers caused by power failure affecting controls.

#### 9.1.2.4.2 Cooling water failure (main system)

**a)** Complete Unit-wide or partial cooling water loss shall be considered if the cooling water pumps are motor driven with zero to partial steam turbine spare drivers that automatically are started upon power failure.

**b)** Each service requiring cooling water shall be considered as losing the same percentage of cooling water where there is only a partial failure.

**c)** Complete loss of cooling water due to a break in the main cooling water header or due to main cooling water header block valve being closed shall not be considered.

#### 9.1.2.4.3 Cooling water failure within process Unit limits

Every condenser or cooler employing cooling water shall be investigated for the following:

**a)** 100% of cooling water in any given riser taken off from the main cooling water supply line. All condensers and coolers being fed from a single riser shall be considered to lose water simultaneously due to a possible break in the riser above grade or the block valve in the riser being inadvertently closed:

**a.1)** If there is a single riser from or to the main cooling water headers above grade then all branches must be considered as having failed.

**a.2)** It is permissible to use parallel risers that are distinctly separate, feeding parallel condensers or coolers to prevent 100 percent cooling duty loss.

**b)** Credit for cooling from air fan exchangers may be taken if employed prior to a cooling water condenser or cooler when cooling water is lost and the air fan is still under normal operation.

**c)** Cooling or condensing duty shall be calculated in the same manner as set forth in Paragraphs 9.1.2.5.5 or 9.1.2.5.6 below.

**9.1.2.4.4 Cooling water plus power failure (simultaneous failure)**

This emergency case is associated with steam failure when the electrical power generators are linked to the situation caused by steam failure. In case of steam failure, the cooling water pumps will also be failed if the pumps drivers are steam or electrical driven.

Relief load for each system shall be evaluated based on possible overpressure source when no steam is available. No credit shall be taken for running of steam turbines or heat generation by steam in the reboilers and steam heaters.

**9.1.2.4.5 Instrument air failure**

The relief load corresponding to this emergency shall be calculated based on the consequence of this failure such as:

**a)** Blocking the vapor or liquid outlet, when fail close type control valve is applied on vapor or liquid outlet.

**b)** Cutting out the heat input to the system (e.g.,when fail close type control valve on steam to reboiler has been utilized).

**c)** Others.

**9.1.2.4.6 Steam failure**

Plant-wide steam failure is also related to the simultaneous failure of cooling water and electric power. Local failure shall also be considered based on the consequence of steam loss.

**9.1.2.4.7 Fuel oil/fuel gas failure**

The impact of this contingency on the Unit and the associated equipment shall be investigated in the light of the equipment affected. For example, the loss of fuel gas/oil may lead to loss of heater duty.

**9.1.2.4.8 Air fan coolers failure**

**a)** Air fan condensers and coolers shall be considered as completely losing their duty if the air fans fail (See Sub-Clause 9.1.2.2(b) above).

**b)** Where cooling water exchangers follow air fan exchangers, cooling duty credit can be taken to the extent of cooling water available per Sub-Clause 9.1.2.4.2 above:

**b.1)** This cooling or condensing duty shall be calculated on the basis of entering pressure and temperature at relieving conditions and a constant water rate that will not exceed normal design rates if available.

**b.2)** The design heat transfer coefficient based on normal conditions can be assumed but should be recalculated if obviously different at relieving conditions, e.g., a liquid subcooler transformed to condensing service relieving conditions.

**9.1.2.5 Operating failures**

The potential operating contingencies shall be considered for evaluating overpressure in the system. The most possible cases are as follows:

**9.1.2.5.1 Blocked outlet**

**a)** The protected system shall be included in this study, i.e., tower plus overhead condensing system and accumulator, provided there is no control valve or other restrictions between the tower and accumulator.

**b)** No credit shall be allowed for operation of any control valve in overhead, bottom or feed system.

**c)** Only those sources of fluid having sufficient pressure to open the safety valve shall be considered:

**c.1)** Where the design pressure of the vessel is greater than the stalling pressure of the positive displacement pump, the safety valve on the pump provides the protection from this source of pressure.

**c.2)** Where the discharge pressure of a centrifugal pump is above the design pressure of the vessel, the flow quantity is the pumped quantity at the accumulated relieving pressure.

**d)** Liquid flow:

**d.1)** The flow quantity shall be the quantity available at the accumulated pressure.

**d.2)** The liquid flow quantity and relative density (specific gravity) shall be determined at the temperature existing at the accumulated pressure.

**d.3)** Circulating streams pumped from a vessel and back into the same vessel shall be excluded when determining the flow quantity.

**d.4)** Reflux flow quantities shall be excluded except when these flows are furnished from tankage outside the Unit or where there is a control valve or other restriction in the overhead line before the reflux drum.

**e)** Vapor flow:

**e.1)** Only the vapor input needs to be considered if the vessel has a high level alarm plus at least 10 minutes liquid residence time after the alarm.

**e.2)** Large vessels that have over 30 minutes liquid residence time above high liquid level need not have a high level alarm and vapor input only is considered .

**e.3)** Where only vapor input is considered the flow quantity shall be the vapor generated at the controlled temperature at a pressure equal to the safety valve accumulated relieving pressure.

**9.1.2.5.2 Control valve failure**

This contingency should include control valve failure either in the open or closed position. Special attention shall be given to the inadvertent opening of a control valve on the high pressure source such as steam which may lead to overpressure in the system.

**9.1.2.5.3 Reflux failure**

**a)** In towers where the source of heat is in the charge to the tower, special attention shall be given to the location of safety valve and charge flowrate at the relieving conditions:

**a.1)** A flash curve shall be calculated to determine the vapor quantity at relieving conditions using heat input if feed is pressured into the tower.

**a.2)** The available feed rate should be investigated using the pump characteristics at the relieving conditions.

**a.3)** Stripping steam if used in the tower should be added to the hydrocarbon vapor if the stripping steam pressure is above the safety valve relieving pressure.

**b)** For towers where reboilers, heaters or feed preheaters are used, the heat input is calculated as follows:

**b.1)** Heat input via fired heaters:

- The heater outlet shall be on TRC control with the fuel gas or fuel oil rate being adjusted by the outlet temperature.
- Simultaneous failure of the TRC and failure of reflux shall not be considered.
- Special consideration shall be given for a multi-service heater where the entire heat input to a stream is in the convection section.

**b.2)** Heat input via exchangers:

- The charge rate shall be the normal design rate unless the rate is limited by the charge pump flow characteristics or flow from a higher pressure vessel at the relieving pressure.
- The heating medium fluid throughput shall be the design rate, even if on TRC control, unless the relieving conditions affect the normal design rate.
- After determining the new hot and cold fluid rates, the heat exchange shall be calculated using inlet and outlet temperatures at the relieving conditions. The heat transfer coefficient used can be the design heat transfer coefficient, unless it is obviously different at the relieving conditions.

**b.3)** Total heat input:

- Total heat input shall generally be the input via fired heaters, plus exchangers plus heat inherently in the feed or side-cut streams.
- Sensible heat can normally be deducted from the total heat input where the feed enters the vessel below its bubble point at relieving conditions, i.e., sensible heat from feed inlet temperature to its bubble point at relieving conditions.
- Sensible heat represented by the net tower bottoms and/or sidecut streams at their relieving temperature can also be deducted from the total heat input.
- Credit for condensing duty shall not be taken unless the accumulator drum has a high liquid level alarm plus at least 20 minutes residence time at the relieving condensing rate after the alarm is actuated and there is no build up of vapor into accumulator to prevent flow through the condensers at the relieving conditions.

**9.1.2.5.4 Side stream reflux/pumparound failure**

The relief load for this contingency shall be calculated according to API RP 521 Section 3 Clauses 3.6.7 and 3.6.8.

**9.1.2.5.5 Loss of fractionator column or liquid gas separator drum condensing duty:**

**a)** Maximum loss of condensing duty shall be determined by Paragraph 9.1.2.4.8 above.

**b)** Heat input can be considered as vaporizing liquid of the same composition as residing in the top tray:

**b.1)** Latent heat shall be at the top tray temperature at the relieving pressure.

**b.2)** Feed vapors calculated at the relieving conditions shall be added to the vapor calculated at the top section.

**b.3)** Stripping steam, if available at the relieving conditions, shall also be added if not condensed at the relieving conditions.

**c)** A portion of the vapors generated at the relieving condition may be considered as condensing as set forth in Paragraph 9.1.2.4.8 above. However, no partial condensing credit may be taken if vapor build up in the accumulator or separator can prevent flow through the condensers.

**9.1.2.5.6 Simultaneous failure of reflux and condensing duty:**

**a)** This emergency case shall be considered if caused by power failure which affects both reflux and condensing duty.

**b)** In most cases relieving capacity is the same as for reflux failure.

**9.1.2.6 Mechanical failure**

Failure of electrical or mechanical equipment such as fans, pumps, compressors, etc., shall be evaluated as an emergency case. Occurrence of such mechanical failures can be evaluated as part of operating failures or a partial utility failure.

**9.1.2.7 External fire**

The external fire shall be evaluated based on API RP 520 Appendix D, unless otherwise specified in this Section and the following criteria.

**9.1.2.7.1 General**

**a)** The surface area effective in generating vapor when exposed to fire is limited to areas wetted by internal liquid contents.

**b)** No credit shall be taken for insulation (i.e., F=1.0).

**c)** For establishing the fire areas, each Unit shall be divided into probable fire areas of approximately 460 $m^2$.

**d)** Air coolers shall be assumed under fire even if installed above 8 meters. Wetted surface area of air fin cooler shall be based on API 521, Paragraph 3.15.4.1, depending on services.

**9.1.2.7.2 Vertical distance covered by fire**

**a)** The total wetted surface included within a height of 8 m above grade shall be used.

**b)** Where the vessel is on a platform or flat roof, the roof or platform shall be considered grade level if it can sustain a fire.

**c)** For spheres or spheroids the vertical distance covered by fire is the elevation of the maximum horizontal diameter or a height of 8 m, whichever is the greater.

**9.1.2.7.3 Area covered by fire**

**a)** For horizontal accumulators the fire covers the area in the two heads plus the horizontal wetted surface within the height limitation above grade. The horizontal wetted surfaces depends on the internal arrangement of the vessel and the maximum liquid level covered by the level control instrument.

**b)** For vertical accumulators the fire covers the area in the bottom head plus the vertical wetted surface up to the height limitation. The maximum liquid level covered by the level instrument governs the vertical wetted surface.

**c)** In settlers operating full of liquid the total surface area up to the height limitation shall be used as the wetted surface.

**d)** In charge drums or surge drums the total surface area up to the height limitation shall be used as the wetted surface since it is assumed these vessels may be operated full.

**e)** For vessels in pits the fire is assumed to cover the entire surface area.

**f)** For fractionators, strippers and absorbers, the area of the bottom head exposed to fire plus the vertical area within height limitation shall be considered as wetted surface.

**g)** For spheres and spheroids only the vessel surface above grade level and to the equator of the vessel shall be considered as wetted surface.

**h)** The area covered by a fire is considered to be a circle 24 m in diameter around a given tower. The presence of firewalls to contain liquid shall be considered also.

**i)** Storage vessels are assumed to contain their maximum working volume.

**9.1.2.7.4 Heat input due to fire**

**a)** Heat input shall be calculated according to the procedure established in API RP 520 and the criteria set forth in this Section.

**9.1.2.7.5 Quantity to be released from liquid storage**

**a)** Heat input due to fire is assumed to be going into vaporizing the stored products at the relieving pressure.

**b)** The relieving temperature shall correspond to the boiling point of the material corrected to the absolute relieving pressure.

**c)** Where material is vaporizing from a constant boiling mixture, the temperature shall be the boiling point of the mixture at the absolute relieving pressure.

**d)** Where water, caustic or amine solution or other liquids exist in the presence of another liquid, the temperature shall correspond to the temperature at which the partial pressure of the different components add up to the relieving pressure.

**9.1.2.8 Heat exchanger tube failure**

**a)** Heat exchanger tube failure shall be evaluated based on API RP 521, Section 2 Clause 2.3.13 and Section 3 Clause 3.18 for relief load estimation.

**b)** Flow through the ruptured tube shall be determined according to CRANE Technical Paper No. 410 Section 3.4.

**9.1.2.9 Hydraulic expansion**

**a)** The hydraulic expansion shall be considered as per API RP 521 Section 3 Clause 3.14. Requirement of thermal relief valve for the process piping shall be evaluated based on pipe length and diameter.

**9.1.3 Equipment safety relief valve capacity**

**9.1.3.1 Reciprocating compressors**

Compressor safety valves shall be sized for the maximum capacity of each stage at recommended speed.

**9.1.3.2 Positive displacement pumps:**

**a)** Safety valves on positive displacement pumps shall be sized for the maximum pumping capacity at recommended speed.

**b)** Where the pump and equipment pumped into are designed for the stalling pressure of the pump under normal conditions, the safety valve shall be sized for 25 percent of the pump rated capacity under continuous operating conditions.

**9.1.3.3 Sizing for protection of electric motors on positive displacement pumps:**

**a)** Safety valves for protecting electric motors shall be sized for the quantity which can be pumped at the relief valve setting without exceeding the horsepower rating (in kilowatts) recommended by the motor manufacturer. Particular consideration shall be given to effects of viscosity on horsepower (in kilowatts) requirements.

**9.1.3.4 Sizing for protection of gas turbines:**

**a)** Safety valves to protect the casing of gas turbines or expansion joints on turbines shall be sized for the quantity of effluent gases developed by the turbine at the safety valve relieving pressure. The quantity shall be checked with the equipment manufacturer. Consideration shall be given to pressure drop in effluent gas header before safety valve.

**9.1.3.5 Sizing for protection of shell and tube heat exchangers:**

**a)** Safety valves shall be sized to protect shell and tube equipment for the pump capacity at the relieving pressure.

**b)** Safety valves shall be sized for the wide open capacity of the control valve at its normal inlet pressure and control valve outlet pressure shall be equal to the relieving pressure of safety valve.

**c)** Cold side blockage safety valves shall be sized based on the assumed heat input equal to the design exchanger duty. The temperature and composition of the relieving fluid and the required safety valve capacity will depend upon the location of the safety valve relative to the exchanger, e.g., a safety valve located on the exchanger will be relieving heated vapors; a safety valve in the piping 15 meters upstream of the exchanger will be relieving cold fluid. Each situation must be individually examined.

**d)** For tube rupture cases, see Clause 9.1.2.8 above.

**9.1.3.6 Fired heaters**

Safety valves on fired heaters (if required) shall be sized on the basis that no less than 50 percent of the normal heat input shall be used due to residual heat input from the hot firebox. However, as cracking will often occur, each situation will require careful evaluation of the individual system conditions to determine the required relieving rate.

**9.1.3.7 Vessels/towers**

Safety valves for towers and other types of pressure vessels shall be checked by each of the following method and sized for the most severe condition:

**a)** Vessel blocked outlet (see 9.1.2.5.1 above).

**b)** Failure of condensing duty (see 9.1.2.5.5 above).

**c)** Failure of reflux (see 9.1.2.5.3 above).

**d)** Simultaneous failure of reflux and condensing duty (see 9.1.2.5.6 above).

**e)** Fire (see 9.1.2.7 above).

**f)** Electrical or electrical plus cooling water failure (this case may be covered through the above b,c and d).

**9.1.4 Steam safety valve sizing**

**9.1.4.1 Safety valves on steam boilers:**

Refer to Section I, ASME Power Boiler Code for sizing of these valves.

**9.1.4.2 Safety valves on process Unit steam superheater coils:**

Refer to Section I, ASME Power Boiler Code for sizing of these valves.

**9.1.4.3 Safety valves downstream from pressure reducing and automatic control valves:**

The wide open capacity of the pressure reducing valve, make up valve or automatic control valve, with normal operating pressure at the inlet of the valve and outlet pressure equal to the safety valve relieving pressure, is to be used for sizing safety valve downstream of automatic control valves.

**9.1.4.4 Safety valves for protect: ion of turbine cases:**

**a) Non-condensing turbines**

The flowrate shall be based on the capacity of the turbine steam nozzles. Data from turbine manufacturer shall be obtained.

**b) Condensing steam turbines**

The flowrate shall be based on the water rate at a back pressure equal to the relieving pressure. (Water rate rises with increase of back pressure).

**c) Vent exhaust steam header safety valves**

When a safety valve is placed on the common exhaust steam header from all turbine cases, the steam consumption of all operating turbines and other operating steam driven equipment exhausting into the header shall be used to size this valve.

**9.2 Vacuum Relief Valve Sizing**

**9.2.1** Vessels operating full of liquid shall be sized to provide protection against loss of liquid input depending on rate of withdrawal.

**9.2.2** Protection against loss of stripping steam is determined by whether the vessel is bare or insulated and the maximum possible condensation which may occur in a rain or snow storm.

**9.2.3** Where a column or vessel during start-up, abnormal operating conditions, heating medium failure, etc., may possibly be subjected to vacuum, it should normally be designed to withstand vacuum conditions. Only when this is very costly or impractical, means for introducing fuel gas or inert gas at a sufficient rate may be considered upon approval of the Company. Steaming-out shall not be considered in this context.

### 9.3 Temperature Safety Valve Sizing

**9.3.1** Temperature safety valves are not sized. They are generally selected on the basis of the minimum size connection permitted on piping for the particular service. For cases where expansion relief is required around check valves, block valves or pumps, sizes down to DN 15 (½ inch) may be acceptable provided that, the applicable piping material service specification permits screwed connections for small sizes and approved by the Company.

### 9.4 Rupture Disc Sizing

**9.4.1** Rupture discs shall be sized using the manufacturer's charts.

**9.4.2** Orifice formula may be used for sizing rupture discs using a coefficient discharge of 0.6 and picking pipe size with internal area equal to or greater than calculated area.

### 9.5 Emergency Vapor Depressuring Systems

**9.5.1** Sizing of depressuring systems shall be based on the assumption that during the fire all input and output streams to and from the system have been ceased, whilst all internal heat sources have been shut off.

**9.5.2** The pressure of the equipment shall be reduced to 700 kPa(ga) or 50% of the MAWP, whichever is lower, within 15 minutes while vapor is being generated at a rate corresponding to the following:

> **a)** Vapor generated from liquid by heat input from the fire, plus.
>
> **b)** Density change of the vapor in the equipment during pressure reduction, plus.
>
> **c)** Liquid flashing during pressure reduction.

**9.5.3** Vessels and columns need not be provided with emergency vapor depressuring facilities, if as the result of a fire, the pressure in the equipment will not rise to 700 kPa (ga) or 50% of the MAWP within 30 minutes.

**9.5.4** For the purpose of sizing depressuring systems, each Unit area shall be divided into probable fire areas as outlined in 9.1.2.7.1 (c) above. It shall be assumed that, the fire is present throughout the depressuring period.

**9.5.5** To determine the vapor quantities contributed by the factors mentioned above, it is necessary to establish the liquid inventory and vapor volume of the system. This shall include all facilities located in the fire area and all liquid and vapor in facilities outside the fire area which, under normal operating conditions, are in open condition with the facilities located in the fire area.

**9.5.6** Subject to corrections made necessary by the final plant design, following assumptions may be made for estimating purposes:

> **a)** The liquid inventory of fractionating columns can be estimated as the normal column bottom and draw off tray capacity plus normal tray liquid hold-up (total tray liquid hold-up shall be based on the pressure drop over the column).
>
> **b)** The liquid inventory of accumulators, flash drums, knock-out vessels and the like may be based on normal operating levels.
>
> **c)** For shell and tube heat exchangers it may be assumed that 1/3 of the total shell volume is occupied by the tube bundle.

**9.5.7** Depressuring valves shall be located near the vessel or vapor lines to be protected.

**9.5.8** The valves shall be spring-loaded, pneumatic diaphragm operated, tight shut-off, spring to open, except valves for ethylene-producing Units, platformate, separators and high pressure separators (see 6.7 above), which shall be spring to close.

**9.5.9** The minimum size of the valves shall be DN 25 (1 inch).

**9.5.10** Block valves shall be provided to isolate the depressuring valves.

**9.5.11** Air for depressuring valves shall be supplied from the instrument air system. They shall not be provided with a handwheel.

## 10. ARRANGEMENT OF SAFETY RELIEF VALVES

### 10.1 General

**10.1.1** Safety devices shall be so arranged that their proper functioning is not hampered by the nature of the vessel's contents. If necessary, the use of protecting devices such as rupture discs, swan-neck seals or purge arrangements is permissible, but these shall not interfere with the proper functioning of the safety device.

If a rupture disc is used in combination with a safety relief valve a pressure gage preceded by a block valve shall be provided between rupture disc and safety relief valve.

**10.1.2** The pressure drop in the connection between equipment and safety relief valve should not exceed 3% of the valve set pressure.

**10.1.3** Safety relief valves discharging to atmosphere shall in general be located at maximum practical elevation to economize on discharge piping, considering also ease of maintenance.

**10.1.4** Safety relief valves connected to a closed relief system shall be located slightly above the relief header, if possible. For instance, valves protecting tall columns shall be put in a suitable position on the overhead vapor line.

**10.1.5** If the valves must be below the header, the outlet lines leading to the header shall be steam traced from the safety relief valve to their highest point. However, agreement by the Company shall be made for lowering the valve in such a way. Branches should be connected to the headers so that the latter can not drain back into them, even with the header full of liquid.

**10.1.6** Notwithstanding with the above requirements, arrangement of safety valves shall be in accordance with API 520 part II.

### 10.2 Location on Vessels

**10.2.1** Where a safety valve is provided for a vessel, the connection for the safety valve shall be provided on the vessel and not on the vapor line or discharge line from the vessel except as follows:

> **a)** When access to the safety valve or discharge piping arrangement can be improved by locating the safety valve on vessel piping, such location is permissible providing the maximum pressure drop permitted between the vessel and safety valve inlet is not exceeded the allowable figure per 10.1.2 above and provided the safety valve can be properly supported with full consideration to the reaction forces.

**10.2.2** Safety valve nozzles shall be vertical when placed in the top head of vessels, except as follows:

> **a)** In those cases where the vessel diameter is small enough to prohibit vertical nozzles, the safety valve nozzle should be attached at a 45 degree angle from the top head with a 45° ell so that the flange face is horizontal and above the nozzle.

**10.2.3** If a safety valve inlet nozzle can not be located in the top head of vessel as outlined in 10.2.2 above, due to constructions or limited working space, then the safety valve nozzle should be attached at a 45 degree angle from the vessel shell, with a 45° ell so that the flange face to be horizontal and above the nozzle.

### 10.3 Location of Safety Valve Nozzles to Minimize Turbulence

**10.3.1** Where safety valves are installed to protect piping and are located downstream of control valves, pressure reducing stations, orifice plates, flow nozzles or pipe fittings, such as elbows, which may cause turbulence, the safety valve shall be located at a sufficient distance downstream of these devices to avoid improper operation of the safety valves caused by whatever turbulence may be present.

**10.3.2** The minimum number of straight pipe diameters which must be provided between the source of turbulence and the safety valve shall be according to API RP 520 - Part II.

### 10.4 Location of Safety Valve Nozzles to Minimize Pulsation

Where there are pressure fluctuations at the pressure source (discharge of reciprocating pumps or compressors) which peak close to the set pressure of the safety valve, it is beneficial to locate the safety valves farther from the pressure source in a more stable pressure region.

### 10.5 Inlet Piping of Safety Relief Valves

**10.5.1** The piping from the vessel to the safety valve inlet shall be as a minimum the same size as the safety valve inlet connection with a pressure drop, including that in any block valve or fittings, of 3% of the set pressure or less.

**a)** Where this requirement can not be met, means must be found to reduce the pressure drop by rounding the entrance connection, using block valves (when required) with full area ports or enlarging the inlet piping.

**10.5.2** The inlet piping or nozzle to safety valves on vessels shall be kept as short and direct as possible, preferably with a single nozzle for each valve. Where more than one safety valve is involved, avoid mounting them on a common header tee type nozzle to prevent turbulence and excessive pressure drop.

### 10.6 Discharge Piping of Safety Relief Valves

#### 10.6.1 General

**10.6.1.1** In the design of the outlet piping, the effect of superimposed or build-up back pressure on the particular type of valve and its service shall be considered.

**10.6.1.2** In addition to any specific requirements set forth in this Standard, the determination of discharging pressure and safety valves to atmosphere or to a closed system shall be governed by the philosophy covered in API RP 520 – Part I and IPS-E-PR-460.

#### 10.6.2 Permissible pressure drop in closed flare system

**a)** The permissible pressure drop from the outlet of a safety valve to a flare system shall be as given for the standard safety valve or balanced bellows safety valve stated in 10.6.1.2 above.

**b)** The pressure drop permissible shall be limited to a great extent by the lowest set safety valve in the system since this determines the pressure permissible at the point where this safety valve ties into the flare header.

**c)** Further, from the permissible pressure drop, the pressure drop in any emergency cooler and the pressure required at the Unit flare knock-out drum must be subtracted.

A minimum of 35 kPa(ga) shall be used for the pressure in the Unit flare knock-out drum. The type of safety valve used on the lowest set safety valve shall be such that permits this back pressure to exist.

### 10.6.3 Closed header design considerations

**a)** A single maximum discharge occurrence for one safety valve or manual depressuring valve shall be used to determine the header size.

**b)** The header shall be sized based on the maximum relief load as outlined in 9.1 above.

**c)** Consideration shall be given to utilizing balanced bellows safety valves where pressures available are limiting.

**d)** Unless further restricted by job specifications, hot streams which flow into the closed above ground header shall be limited to 232°C maximum temperature downstream of the safety valve. An emergency cooler shall be provided to cool to 232°C all relief streams that exceed this maximum temperature, except:

**d.1)** Relief stream where a temperature higher than 232°C will be reached under fire conditions, and where the safety valve size is not set by fire conditions, need not have an emergency cooler unless it is required for other reasons. However, a cooler is required for such streams when the safety valve size is set by fire conditions.

**d.2)** Under the conditions permitted in "d.1" above preceding, the piping and flare appurtenances shall be designed for the temperatures involved.

### 10.6.4 Vapor safety valve piping

#### 10.6.4.1 Sizing

Sizing of discharge piping for vapor safety valves depends on whether the valve is relieving to the atmosphere, or into a closed relieving system, and whether a standard or bellows type safety valve is used.

#### 10.6.4.2 Permissible pressure drop

**a) Conventional (standard) safety valve**

The permissible pressure drop in discharge piping from the safety valve in vapor service is 10% of the set pressure under normal relief where 10% accumulation is used and 20% of the set pressure under emergency fire condition where 20% accumulation is used.

**b) Balanced bellows safety valve**

The permissible pressure drop in discharge piping for balanced bellows safety valves in vapor service is 25 to 45 percent of the valve set pressure. For particular valve, the manufacturer’s curve shall be used.

### 10.6.5 Liquid relief valve piping

**a)** Since the pressure drop in the outlet piping affects the set pressure of a conventional safety relief valve and also affects the capacity of both a conventional and a bellows relief valve, these impacts shall be evaluated when determining the size of the outlet piping.

**b)** Most liquid relief valves have short discharge lines, such as relieving into suction of pump, where the discharge line relieves back to tankage or a tower that considerable pressure drop may be developed, its effect must be considered.

**c)** The discharge piping from safety valves in liquid service shall be no smaller than the outlet connection on the safety valve and shall be increased where pressure drop significantly affects the set pressure or capacity of the relief valve.

### 10.7 Block Valves

#### 10.7.1 General

**a)** When spare safety valves are required in accordance with Article 6.6 of this Standard, block valves shall be provided as follows to permit removal of all of the valves being spared and the spare safety valve:

**a.1)** Block valves shall be provided only on the inlet of the safety valve where each safety valve discharges independently to the atmosphere.

**a.2)** Block valves shall be provided on the inlet and outlet of a safety valve which discharges into a system operating under pressure or into a common discharge header.

**a.3)** Block valves in accordance with the applicable piping material service specification shall be provided in the pressure sensing piping to the pilot valves and in the inlet piping to the controlled relief valves when spare safety valves are required as per Article 6.6.

**b)** Although, it is not permitted except as noted in (a) above, provision of block valves and by-pass line may be requested in the job specification for all safety relief valves provided for protection of the vessel(s) in order to make possible removal of safety relief valve for maintenance purpose while the Unit/system is under normal operation. In such cases, due considerations shall be made to the requirements of safety features around the subject equipment/system. The inlet and outlet block valves shall be locked open in any case.

#### 10.7.2 Block valves on inlet of safety valves

**a)** Block valves in accordance with the applicable inlet piping material service specifications shall be used.

**b)** Block valves for the inlet of safety valves shall be as a minimum the same size as the safety valve inlet. They shall be increased in size where necessary to reduce the pressure drop in the inlet piping to that essential for proper operation of the safety valve.

#### 10.7.3 Block valves on outlet of safety valves

**a)** Block valves in accordance with the Piping Material Service Specification for the service involved at the discharge may be used.

**b)** Block valves for the inlet of safety valves shall be as a minimum the same size as the outlet of the safety valve. They shall be increased in size as necessary to reduce the pressure drop in the outlet piping to that essential for proper operation at the capacity required.

#### 10.7.4 Locking methods

**a)** Suitable devices shall be provided on all block valves at the inlet or the outlet of safety valves which will allow locking of the valves by authorized persons in an open or closed position. The job specification will specify whether the devices are to be suitable for a padlock and chain or a car seal, depending on plant preference.

**b)** A list of all safety valves with block valves which must be locked shall be furnished by the

Contractor.

### 10.8 Discharge Piping Support

**a)** If guided laterally, a maximum of 3 meters of piping may be supported by the welding neck flange and long radius elbow on safety valve outlet. If move than 3 meters of piping is used or if high pressures are involved, mass and reaction forces should be supported as close to valve discharge as possible using a free support.

**b)** Long piping should be anchored to the equipment as close to the valve discharge as possible, providing the expansion between the connection and anchor is taken care of and guided from that point up a tower, steel structure or into the closed header piping.

**c)** Stops and guides shall be provided to support piping independent of the safety valve when safety valve is removed.

**d)** Discharge piping shall be designed to prevent undesirable temperature and mechanical stresses being placed on the valve body and inlet connection.

**e)** Supports shall be provided for discharge piping to compensate for the reaction force or load caused by discharging of the valve.

### 10.9 Position

**a)** All safety relief valves, except expansion relief valves, shall be mounted with the stem in a vertical position.

**b)** Temperature safety valves shall be mounted in either the vertical or horizontal position to permit installation of discharge piping without pocketing.

### 10.10 Discharge Piping of Temperature Safety Valves

#### 10.10.1 Water service

Temperature safety valves in water service may discharge to grade or to a sewer.

#### 10.10.2 Hydrocarbon service

**a)** Temperature safety valves in hydrocarbon service on process Units shall be piped to the nearest safe location such as drain or sewer hub, with end of discharge pipe visible.

**b)** Temperature safety valves located in National Electrical Code, Division 2 electrical classification areas shall have discharge piped to an open drain or sewer, with end visible, outside the Division 2 area.

**c)** Temperature safety valves in storage or product loading areas shall not discharge to atmosphere but shall have discharge piped, using a spring loaded popped type check valve around block valves, check valves, pumps, etc., back to storage.

#### 10.10.3 Chemical service

**a)** The procedure for handling discharge from temperature safety valves in chemical service shall be specified in the job specification.

## 11. VENTING AND DRAINING PHILOSOPHY

Type of hydrocarbons to be vented to atmosphere or closed drain flare system shall be according to the criteria set forth in IPS-E-PR-460 and API RP 520 - Part I. Venting to a safe zone shall be in accordance with the specifications outlined herein below:

### 11.1 Vapor Venting

#### 11.1.1 Venting to atmosphere

**a)** To determine safe zones for venting hydrocarbon vapor safety valves to atmosphere, the following requirements shall be proceeded:

**a.1)** Establish truncated cones on the highest platform of each vessel.

**a.2)** The top horizontal plane of the truncated portion shall be a minimum of 3.2 meters above the platform. The lines forming the sides of the cone shall start at the circumference of a circle circumscribing the periphery of the platform and extend downward at an angle of 30° from the horizontal until it forms a base of the cone at a point 15 meters above grade.

**b)** Hydrocarbon vapor safety valves may be vented to atmosphere anywhere outside of the space encompassed by a single truncated cone or any similar intersecting truncated cones from other platforms, but not less than 15 meters above grade.

**c)** All flooring of platforms or walkways shall be a minimum of 3.2 meters vertically below the top or sides of any one of the established truncated cones.

**d)** 6 mm drip hole shall be provided at safety valve discharge for drainage of liquids unless otherwise prohibited by the operating personnel safety aspects (see 11.4.1(b) below).

#### 11.1.2 Venting compressor safety valves

**a)** Safety valves for compressors shall discharge back to the suction except where back pressure limitation of the valve prevents its use.

#### 11.1.3 Venting steam safety valves

**a)** Steam safety valves may be vented to the atmosphere but the discharge must be run to a spot where there is no hazard to operating personnel.

**b)** Discharge piping for steam safety valves in buildings shall be run outside building and directed away from operating passageways or platforms.

### 11.2 Liquid Venting

#### 11.2.1 Pump relief valve

**a)** Relief valves on displacement type pumps shall discharge into the suction of the pump except where back pressure limitations of the valve prevent their application.

**b)** Where the pump safety valve can not be piped back to the suction line, the subject material shall be routed to the pump suction vessel or tank.

#### 11.2.2 Venting acid or corrosive liquid

Special consideration shall be given to location of safety valves discharging acid or corrosive liquids and also destination of discharge.

### 11.3 Safety Valve Bonnet Venting

#### 11.3.1 Conventional safety valves

In conventional safety valves the bonnet shall be vented internally into the outlet line.

#### 11.3.2 Balanced bellows valves

**a)** In balanced bellows safety valves the bonnet shall be vented to the atmosphere or to a closed system.

**b)** When it is not permissible to vent the bonnet to the atmosphere, the bonnet should be vented through an independent piping system to a safe location taking care not to impose a back pressure on the safety valve bonnet as a result of pressure drop in the bonnet vent line.

**11.3.3 Pilot operated valves**

**a)** The pilot may be vented to the atmosphere if the slight discharge during operation is acceptable. The quantity normally vented shall be checked with the manufacturer.

**b)** When the pilot discharge to atmosphere is not permissible, the pilot should be vented through an independent piping system to a safe location taking care not to impose back pressure in the pilot.

**11.3.4 Sizing bonnet vent lines**

The nominal size of the bonnet vent piping shall be as large or larger than the nominal size of the bonnet vent connection.

**11.4 Safety Valve Draining**

**11.4.1** Drain provision shall be made for draining the low point of the safety valve outlet piping according to the following quirements for all condensable vapor services:

**a)** All safety valves discharging to the atmosphere shall be provided with a 6 mm drain hole in the bottom of the discharge line.

**b)** In addition to the drain hole as required in "a" above, one DN 15 (one inch) drain connection with bleeder shall be provided for all safety valves discharging to the atmosphere.

**c)** Such drain holes and drain connections shall be piped where necessary to direct the drainage away from the operating platforms or operating areas and avoid draining on the vessel insulation.

## APPENDICES

### APPENDIX A

### TYPICAL PRESSURE SAFETY RELIEF VALVES LOAD SUMMARY TABLE

| | | |
|---|---|---|
| CONTRACTOR NAME | N I O C<br>ARAK REFINERY PROJECT | PRESSURE RELI<br>LOAD SUM |
| | UNIT NAME<br>CRUDENACUME UNIT | |

| ITEM | PAI NUMBER | PROTECTED EQUIPMENT | SIZE AND TYPE DN (INCH) | SET BAR | DISCHARGE TO | COOLING WATER FAILLRE | | | FIRE | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | MW | Kg/h | ◦C | V | MW | Kg/h | ◦C |
| | | | | | | | | | L | $Kg/m^3$ at com | $M^3/h$ | ◦C |
| Psv-1010 | D-01-107 | V-121 | 20+65 ($1.5^{a}$+25) | 5.5 | FLARE | - | - | - | V | 27.2 | 2.786 | 105.8 |

| | | | | | |
|---|---|---|---|---|---|
| NOTES: | 2 | | | | |
| | 1 | | | | |
| | 4 | | | | |
| | REV | DESCRIPTION | DATE | BY | APPR |