Engineering Standard

SAES-J-600 20 February 2013

Pressure Relief Devices

Document Responsibility: Instrumentation Standards Committee

Saudi Aramco DeskTop Standards

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Revised paragraphs are indicated in the right margin

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1 Scope

This Standard defines the minimum mandatory requirements governing the design, installation, and maintenance of safety and relief devices except for residential and commercial water heating equipment under 100 gallons. For simplicity, all pressure relief valves in this standard are called "PZV."

This Standard may not be attached to nor made a part of purchase orders.

2 Conflicts and Deviations

2.1 Any conflicts between this standard and other applicable Saudi Aramco Engineering Standards (SAESs), Materials System Specifications (SAMSSs), Standard Drawings (SASDs), or Industry Standards, Codes, and Forms shall be resolved by the Company or Buyer Representative through the Manager, Process & Control Systems Department of Saudi Aramco, Dhahran.

2.2 Direct all requests to deviate from this standard in writing to the Company or Buyer Representative, who shall follow internal company procedure SAEP-302 and forward such requests to the Manager, Process & Control Systems Department of Saudi Aramco, Dhahran.

2.3 The designation "Commentary" is used to label a sub-paragraph that contains comments that are explanatory or advisory. These comments are not mandatory, except to the extent that they explain mandatory requirements contained in this SAES.

3 References

The selection of material and equipment, and the design, construction, maintenance, and repair of equipment and facilities covered by this standard shall comply with the latest edition of the references listed below, unless otherwise noted.

3.1 Saudi Aramco References

Saudi Aramco Engineering Procedures

SAEP-302	*Instructions for Obtaining a Waiver of a Mandatory Saudi Aramco Engineering Requirement*
SAEP-318	*Pressure Relief Valve Program Authorization for Installation, Deletion and Changes*
SAEP-319	*Pressure Relief Devices - Testing and Inspection Requirements*

SAEP-1027	*Use of Form 8020-611-ENG, Instrumentation Specification Sheet, Pressure Relief Valve Conventional and Balanced Types*
SAEP-1131	*Pressure Relief Device Authorization through SAP Workflow*

Saudi Aramco Engineering Standards

SAES-B-054	*Access, Egress, and Materials Handling for Plant Facilities*
SAES-J-605	*Surge Relief Protection Systems*
SAES-L-140	*Thermal Expansion Relief in Piping*
SAES-L-310	*Design of Plant Piping*
SAES-S-020	*Oily Water Drainage Systems*

Saudi Aramco Materials System Specifications

34-SAMSS-611	*Safety Relief Valves, Conventional and Balanced Types*
34-SAMSS-612	*Safety Relief Valves, Pilot Operated Types*

Saudi Aramco Inspection Requirements

Form 175-341900	*Safety Relief Valves, Conventional and Balanced Types*
Form 175-342000	*Safety Relief Valves Pilot Operated Types*

Saudi Aramco Forms and Data Sheets

3099A-ENG	*Relief Valve Authorization*
8020-611-ENG	*Instrument Specification Sheet, Safety Relief Valves, Conventional & Balanced Types*
8020-612-ENG	*Instrument Specification Sheet, Safety Relief Valves Pilot Operated*
8020-613-ENG	*Instrument Specification Sheet, Pressure-Vacuum Relief Valves*

3.2 Industry Codes and Standards

American Petroleum Institute

API STD 520	*Sizing, Selection and Installation of Pressure - Relieving Devices in Refineries*

API STD 520	*Part I - Sizing and Selection*
API RP 520	*Part II - Installation*
API STD 521	*Pressure Relieving and Depressuring Systems*
API STD 526	*Flanged Steel Safety - Relief Valves*
API STD 620	*Recommended Rules for Design and Construction of Large, Welded, Low-Pressure Storage Tanks*
API STD 650	*Welded Steel Tanks for Oil Storage*
API STD 2000	*Venting Atmospheric and Low-Pressure Storage Tanks*

American Society of Mechanical Engineers

ASME SEC I	*Rules for Construction of Power Boilers*
ASME SEC VIII D1	*Rules for Construction of Pressure Vessels*
ASME SEC VIII D2	*Alternative Rules*
ASME B16.5	*Pipe Flanges and Flanged Fittings*
ASME B31.3	*Process Piping*
ASME B31.4	*Pipeline Transportation Systems for Liquid Hydrocarbons and other Liquids*
ASME B31.8	*Gas Transmission and Distribution Piping Systems*

American Society for Testing and Materials

ASTM A216	*Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service*
ASTM A351	*Standard Specification for Castings, for Pressure-Containing Parts*
ASTM A352	*Standard Specification for Steel Castings, Ferritic and Martensitic, for Pressure-Containing Parts, Suitable for Low-Temperature Service*
ASTM A743	*Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application*
ASTM B61	*Standard Specification for Steam or Valve Bronze Castings*
ASTM B62	*Standard Specification for Composition Bronze or Ounce Metal Castings*

ASTM B148 *Standard Specification for Aluminum-Bronze Sand Castings*

National Association of Corrosion Engineers

NACE MR0175/ISO 15156 *Petroleum and Natural Gas Industries – Materials for Use in H_2S Containing Environments in Oil and Gas Production*

National Fire Protection Association

NFPA 59A *Standard for the Production, Storage and Handling of Liquefied Natural Gas (LNG)*

4 Design

4.1 General

4.1.1 Certification

4.1.1.1 PZVs for vessels and piping with operating pressure exceeding 100 kPa (15 psig), shall meet the relevant requirements of ASME SEC VIII and they shall carry the ASME code stamp "UV."

Exception:

Pressure Relief Valves without ASME certification or code stamps may be allowed with the written approval of the Supervisor, Instrumentation Unit after careful review of the application and only for certain select installations (i.e., small tube fitting type relief valves used for analyzer feed gases, pallet type air relief valves, small air compressor ball and spring valves, etc.).

4.1.1.2 PZVs for steam boilers in Section I service shall meet the relevant requirements of ASME SEC I and be ASME code stamped "V."

4.1.1.3 PZVs installed on vessels designed for operation at pressures from vacuum through 100 kPa (15 psig), shall adhere to the design requirements of API STD 2000. These PZVs do not carry an ASME code stamp.

4.1.1.4 Design of steel flanged-ASME code stamped PZVs shall further be in compliance with API STD 526.

Exceptions:

Orifice Areas smaller than the smallest API STD 526 effective orifice area ("D"- 0.110 in²) may be selected for high set pressure applications typically above 6.89 MPa (1000 psig)].

Orifice Areas larger than the largest API STD 526 effective orifice area ("T"- 26.00 in²) may be selected for high capacity pilot operated PZVs subject to Instrumentation Unit approval.

4.1.1.5 Rupture Disks and Buckling Pin Devices shall meet the relevant requirements of ASME SEC VIII and be ASME Code stamped "UD."

4.1.2 Minimum Size

Minimum PZV inlet size shall be ¾ inch threaded or 1 inch flanged.

Exception:

Smaller sizes may be allowed with the written approval of the Supervisor, Instrumentation Unit after careful review of the application and only for certain select installations. (i.e., small tube fitting type relief valves used for analyzer feed gases).

4.1.3 Flange Rating

The minimum rating for inlet flanges shall be ASME B16.5 Class 150 for all PZVs except for PZVs for atmospheric and low pressure tanks. (Typically, B16.5 Class 150 RF or FF for steel, or Class 125 FF for Aluminum)

4.1.4 Specific Design Requirements

4.1.4.1 Specific design requirements and options shall be listed on forms 8020-611-ENG, Instrument Specification Sheet (ISS) for Safety Relief Valve Specification and Calculation or 8020-613-ENG (Pilot-operated). For API STD 2000 tanks, design requirements and options shall be listed on form 8020-613-ENG.

4.1.4.2 SAEP-1027 "Use of Form 8020-611-ENG, Instrumentation Specification Sheet" for Conventional and Balanced type relief valves may be used as an aide to fill in form 8020-611-ENG.

4.1.4.3 SAEP-1131 "Pressure Relief Device Authorization through SAP Workflow" may be used as an aide to fill in form 3099A-ENG.

4.1.4.4 All PZV specifications sheets must show the "Required Relieving Rate" which is the worst-case relieving case. The derivation of the worst-case relieving rate shall be detailed and preferably attached as additional sheets to the relief valve specification sheet. Derivations of other cases considered shall also be documented.

4.1.4.5 For thermal relief of piping due to solar radiation, the required relieving rate may be calculated by using API STD 521. Per SAES-L-140, the heat input "H" may be taken as 950 W/m² (300 Btu/hr-ft²) * the entire surface area (ft²) of the above ground piping.

4.1.5 Vacuum Relief Devices

Relief devices for vacuum services shall comply with the requirements of API STD 620 and API STD 2000.

4.2 Accessories

a) Lifting levers - Refer to ASME SEC I and ASME SEC VIII requirements.

b) Test gags - PZVs for vessels subject to the requirements of the ASME SEC I shall be specified with test gags to permit testing in place. Test gags shall be removed from the valve after testing.

5 Type Selection Criteria

5.1 Conventional PZVs

Conventional PZVs shall be used when all of the following conditions are met.

5.1.1 The sum of the maximum variable superimposed backpressure plus the built-up backpressure is less than 10% of the set pressure.

5.1.2 Fouling or corrosive conditions are not expected.

5.2 Bellows Type PZVs

Bellows-type pressure relief valves shall have the bonnets painted green to indicate that they must have vented bonnets.

Bellows type PZVs shall be used when:

5.2.1 The sum of the variable superimposed backpressure plus built-up backpressure, per paragraph 5.1.1, exceeds 10% of set pressure.

5.2.2 Fouling or corrosive conditions are expected and protection cannot be afforded by using alternative materials or devices.

5.3 Bellows with Auxiliary Balancing Piston Type PZVs

Bellows type PZVs shall be equipped with auxiliary balancing pistons when a bellows failure may cause an unacceptable increase in setpressure or decrease in flowing capacity.

5.4 Backpressure Limitations on Bellows Type PZVs

Total backpressure equals superimposed plus built-up.

5.4.1 Relieving Capacity Restriction

Total backpressure shall not reduce differential pressure across the PZV to a value that would limit PZV relieving capacity to less than design capacity. For gas services this corresponds to a total backpressure of approximately 50% of set pressure.

5.4.2 Bellows Mechanical Strength

The bellows mechanical strength shall exceed the highest total backpressure expected in the discharge system. Vendor's recommendation shall be followed.

5.5 Pilot-operated PZVs

5.5.1 Pilot-operated PZVs are recommended when maximum set point accuracy is required. Pilot-operated PZVs shall have nonflowing pilots.

5.5.2 Pilot-operated PZVs shall generally be limited to clean gas service. Their application in dirty service shall require prior written approval from the Saudi Aramco Supervisor, Instrumentation Unit/Process Automation Systems Division/Process & Control Systems Department, Dhahran.

5.5.3 Pilot-operated PZVs in sour service shall comply with NACE MR0175 / ISO 15156.

5.5.4 In dirty, corrosive or sour services a sweet, noncorrosive, clean gas purge shall be provided on the pilot line whenever such a purge medium is available.

In such services, when no suitable purge medium is available, the pilot line shall be oversized, i.e., ¾ inch or larger (up to the PZV pilot filter connection). Integral pilot connections are not allowed when oversized

pilot lines are required since the PZV valve body connection is generally too small.

Other requirements may be imposed as each proposed case may warrant.

See Section 8.11 for additional pilot-operated PZV application requirements.

5.5.5 All Pilot-operated PZVs shall be provided with a Pilot filter.

5.6 Rupture Disks and Buckling Pin Devices

5.6.1 Rupture Discs may be considered in special cases as a substitute for PZVs or to isolate PZVs from materials that can cause damage or interfere with PZV operation. For design, installation, and application see paragraph UG-127 and UG-137 of ASME SEC VIII D1.

5.6.2 Buckling Pin Devices may be considered in special cases as a substitute for PZVs or as an alternative to rupture disks.

5.6.3 Use of rupture discs as substitutes for PZVs and the use of buckling pin devices shall require prior written approval from the Saudi Aramco Supervisor, Instrumentation Unit/Process Automation Systems Division/Process & Control Systems Department, Dhahran.

5.6.4 Reverse Buckling rupture disks that rely on knife blades to open, shall not be used.

5.7 Vacuum Relief Devices - For application of vacuum relief devices refer to API STD 620 and API STD 2000.

6 Materials

6.1 Materials shall be in accordance with API STD 526, with the following restrictions and exceptions:

6.1.1 Valve bodies for hydrocarbon service at temperatures above 0°C shall be ASTM A216, except in the case of API storage tanks where aluminum bodies may be used if piping and vessel specifications permit. Cast Iron bodies shall not be used.

6.1.2 Valve bodies for non-sour water service shall be of any of the following bronzes:

9% aluminum bronze - ASTM B148 Alloy C95200

7% aluminum bronze - ASTM B148 Alloy C95600

85-5-5-5 Ounce metal - ASTM B62 Alloy C83600

Steam or valve bronze - ASTM B61 Alloy C92200

Nickel aluminum bronze - ASTM B148 Alloy C95800

Exception:

Flanged bodies of ASTM A216 grade WCB with wetted parts (nozzle and disc) fabricated from corrosion resistant alloys may be specified for valve sizes greater than 2 inches.

6.1.3 Valve bodies for service at temperatures from 0 to -46°C shall be ASTM A352 grade LC2 or grade LC3.

6.1.4 Valve bodies for service at temperatures below -46°C shall be ASTM A351 or ASTM A743 cast austenitic stainless steel, grade CF-8.

6.2 Springs for sour service shall either be protected from direct exposure to hydrogen sulfide by means of balanced bellows, an upstream rupture disc or be made of a sulfide stress - corrosion cracking resistant alloy material in accordance with NACE MR0175/ISO 15156.

6.3 Bellows for sour service or water with more than 200 ppm chloride shall be fabricated from Inconel Alloy 625 (UNS NO6625) or Hastelloy Alloy C-276 (UNS N10276).

6.4 For very corrosive services, the responsible specialist in the Engineering Services Organization shall be consulted.

7 Sizing

7.1 Basis

The basis for PZV sizing shall be selected as shown in Table 1.

Table 1 – Basis for PZV Sizing

Conditions	Basis
Vessels and equipment designed for a maximum working pressure of more than 100 kPa (15 psig) and containing primarily gas, vapor or steam.	API STD 520 Part 1
Vessels and equipment designed for a maximum working pressure of more than 100 kPa (15 psig), and containing liquid.	API STD 520 Part 1
Liquid Petroleum Tanks designed for operation at 100 kPa (15 psig), or less (refrigerated and non-refrigerated).	API STD 2000

Conditions	Basis
Vessels and equipment designed for a maximum working pressure of 100 kPa (15 psig) or less	API STD 2000
Vessels storing liquefied hydrocarbon with a boiling point of 20°C or less:	
Capacity 160 m^3 or less (refrigerated or non-refrigerated).	NFPA 59A
Capacity greater than 160 m^3 non-refrigerated.	API STD 520 Part 1
Capacity greater than 160 m^3 refrigerated.	API STD 2000

Notes:

1. In all cases an analysis of relieving requirements due to operational reasons, per API STD 521, Table 2, shall be made as part of the sizing calculation. See paragraph 4.1.4.4 for documentation requirements.
2. The requirement for relieving due to external fire shall be made where required per the referenced codes in all cases.
3. The final specification of all PZVs shall be based upon the manufacturer's data specific to the chosen valve.

7.2 Acoustically Induced Vibration Evaluation (Design Limit on Tail Pipe Velocity and Sound Power Level)

For PZVs in gas services the effects of acoustically induced vibration on relief system piping shall be considered. A screening process shall be performed on high capacity large diameter gas discharge lines relieving to a closed system. The configuration of the discharge piping and the velocity of the discharge gas in the piping have a direct effect on whether acoustic vibrations may cause fatigue failure of the discharge piping.

No calculations are necessary if:

1. The PZV does not discharge to a closed system; or,
2. The PZV is for liquid relief; or,
3. The Screening Process indicates obviously safe sound power levels.

Screening Process

Perform Test I, II or III depending on the PZV downstream piping configuration.

If the selected test result is True, then further downstream piping sound power level calculations are necessary. The Downstream Process Engineering Division may be consulted for help with the detailed sound power level calculations.

Test I - PZV Downstream line size 16 in. and greater:

Screening Test: The Mass Flow Rate is greater than 91,000 kg/hr (200,000 lb/hr) **OR** the pressure ratio is greater than 3? (True/False)

Test II - PZV Downstream line sizes 8 in. to 14 in.

Screening Test: The downstream line velocity is greater than 50% sonic (0.5 Mach) **AND** the pressure ratio is greater than 3. (True/False)

Test III - PZV Downstream line size less than 8 in. **AND** is swaged up **OR** "Teed" to an 8 in. or larger line size.

Screening Test: The downstream line velocity is greater than 50% sonic (0.5 Mach) **AND** the pressure ratio is greater than 3. (True/False)

Definitions:

$$\text{Pressure Ratio} = \frac{[\text{Built - up Pressure} + \text{Normal Flare Header Pressure (Absolute)}]}{\text{Normal Flare Header Pressure (Absolute)}}$$

Built-up Backpressure = The pressure on the discharge side of a relief valve developed as a result of flow due to the valve in question relieving into the discharge header system. Where multiple valves relieve under a single contingency, the backpressure increase in the discharge system as a result of all involved valves relieving, determines the built up backpressure.

8 Application Requirements

Generally, PZV setting(s) shall be at least 10% or 100 kPa (15 psi), whichever is greater, above the maximum operating pressure. Where unstable process conditions exist, this differential shall be at least 175 kPa (25 psi) or 10% above the maximum operating pressure, whichever is greater.

8.1 Pressure Vessels

Relieving devices shall be furnished, installed and set in accordance with the requirements of the ASME SEC VIII D1 - Pressure Vessels, paragraphs UG-125 thru UG-137 or ASME SEC VIII D2 - Alternative Rules, Article R-1.

The number of PZVs required for an installation shall be determined based on capacity requirement calculations, economics and specific installation requirements.

If the vessel is one of a series interconnected by piping, block valves in the interconnecting piping are permitted. These block valves in the relieving path must meet the requirements of paragraphs 9.4.1-3 and 9.4.5. Swing check

valves that open in the direction of flow for pressure relief are permitted in the interconnecting piping. [Ref. UG-133(c)].

8.2 Power Boilers, Spare Superheaters and Reheaters

Relieving devices shall be furnished, installed and set in accordance with the requirements of the ASME SEC I, Power Boilers.

8.3 Shell and Tube Equipment

PZV(s) shall be installed to protect either side (shell or tube) of the equipment where the pressure can exceed the Maximum Allowable Working Pressure (MAWP) on that side.

The low pressure side shall be protected by a PZV if the MAWP on the high side is more than the Hydrotest Pressure of the low side, and piping on the low side cannot handle the discharge from a split tube without exceeding the allowable accumulation over the low pressure side MAWP.

The PZV(s) shall be sized for the difference between total discharge from the split tube and that portion which can be handled by the piping on the low pressure (LP) side (in addition to normal flow on LP side) without exceeding LP side Hydrotest Pressure.

Calculation of the capacity of the low pressure piping should allow for vaporization (if any) of the high pressure liquid. The opening created by the split is assumed to be equal to twice the tube cross sectional area of a single tube.

Where pressure relief is required to protect against possible heat exchanger tube rupture, rupture disc assemblies shall be considered for the LP side if;

(1) The MAWP on the high pressure side is equal to or greater than 7 MPa (ga) (1000 psig) and the MAWP of the high side is more than the Hydrotest Pressure of the low side, or

(2) The differential between high pressure and low pressure MAWP equals or exceeds 7 MPa.

8.4 Pumps

8.4.1 Centrifugal pumps shall have PZV(s) installed in the discharge when the discharge pressure of the pumps when operating between minimum stable flow and zero flow exceeds the MAWP of discharge piping, downstream equipment or pump casing. The minimum required PZV capacity shall equal the capacity of the pump at which the MAWP of the casing, discharge piping or downstream equipment would be exceeded.

In these applications PZV discharge shall recycle to the pumped system, but not directly into the pump suction piping. Location of the recycle return shall be selected to provide sufficient cooling of recycle stream.

Exception:

High pressure Water Injection Pumps connected to ASME B31.4 designed discharge piping may alternatively use protective devices other than PZVs. The alternate system of protective devices used (i.e., redundant pressure transmitters, overspeed mechanical trip protection and/or control circuits) shall be approved in advance by Supervisor, Instrumentation Unit, Process Automation Systems Division, Process & Control Systems Department.

8.4.2 Reciprocating, gear pumps and other types of positive displacement pumps shall have a PZV upstream of the discharge isolation valve, relieving to the suction tank. Pressure regulators or other means of overprotection devices that are integral or internal to the positive displacement pumps do not qualify as a PZV.

Exception:

When it can be calculated or shown that PZV recycle from positive displacement pumps will not cause damaging heat build-up, the PZV may discharge to the suction side of the pump instead of the tank.

Commentary Note:

Internal pressure regulating devices do not qualify as PZVs for the following reasons:

1) The quality and reliability of these devices is unknown,

2) In-place testing is necessary (difficult to achieve) and

3) These devices cannot be entered into the relief valve authorization format of Form 3099A-ENG since spring range, orifice size and materials of construction are typically unknown.

8.5 Process Furnaces

PZV(s) shall be installed on the outlet when the outlet piping includes a control valve or other backpressure device, or could otherwise be overpressured, e.g., by a closed block valve. Furnaces which operate at high pressure maintained by a restriction in the outlet line shall be protected since the restriction may become fouled. Furnaces having outlet block valves which are car-sealed open do not require PZVs. A check valve shall be installed in the outlet line when there is a possibility of introducing overpressure into the furnace as a result of downstream equipment failure.

Multipass furnaces shall have provisions to guarantee that no pass is isolated from the PZV in any way. The normal location for a PZV is on the furnace outlet, upstream of the block valve. This is a particularly important consideration when the feed to the furnace is 100% vapor and the furnace tubes, if "dead-ended", could fail thermally at or below normal operating pressure.

Basis for PZV sizing shall be that burners shut down on low process flow, and that valves on furnace discharge shall relieve 10% of design process flow.

PZV installation at furnace inlet shall be allowed only when:

a) Feed consists wholly or partly of liquid; and

b) There is a possibility of coking PZV inlet if it was located at the furnace outlet, and no steam or other purge is available to keep PZV inlet clean.

8.6 Condensing Turbines

PZV(s) shall be provided to protect condensers and the exhaust end of condensing turbine casings against full steam supply pressure which could result from loss of cooling water or other operating failure.

8.7 Noncondensing Turbines

PZV(s) shall be provided to protect the casing against high backpressure resulting from exhaust valve closure and backpressure fluctuations. The PZV(s) shall be sized for normal steam flow and exhaust to atmosphere. The set pressure shall exceed the normal exhaust pressure by 10% or 175 kPa (25 psi) (ga), whichever is greater, but it shall never exceed the design pressure of the turbine casing.

8.8 Compressors

PZV(s) shall be provided for all centrifugal and positive displacement compressors, where pressure during surge or at closed discharge can exceed safe limits. For positive displacement compressors, interstage PZV as well as discharge PZV shall be provided. The set pressure shall exceed the rated discharge pressure by 10% or 175 kPa (25 psi)(ga) whichever is greater. In case of reciprocating compressors a greater differential than 10% may be required due to pressure surges. Interstage PZVs shall be set at or above the compressor settling-out pressure, to avoid lifting at shutdown.

The PZV capacity shall equal compressor capacity. For centrifugal compressors, the combination of set point and capacity shall be selected to avoid surge conditions during emergency.

The PZV shall not discharge to the compressor suction.

8.9 Thermal Relief of Piping

Thermal relief valves shall be provided to protect sections of blocked-in liquid piping against overpressure due to thermal expansion of the liquid. PZVs shall be installed as required by SAES-L-140. Disposal of relieved liquid shall be as follows:

8.9.1 In-plant Thermal Reliefs

a) Thermal Reliefs serving lines containing liquids with vapor pressure greater than 100 kPa (absolute) (14.7 PSIA) at 55°C shall discharge to a closed system.

b) Thermal Reliefs serving lines containing other liquids shall have discharge piping that terminates per SAES-S-020, paragraph 4.8.

8.9.2 Pipeline Thermal Reliefs shall discharge at grade.

8.9.3 Per SAES-L-140, the set pressure of a thermal relief valve shall not exceed 110% of the maximum allowable operating pressure for the maximum temperature during shut in, considering pipe hoop stress, combined stress, flange rating and any other weakest component in the system.

8.10 Pressure Reducing Stations

PZV(s) shall be installed on the low pressure side of pressure reducing valves when piping and equipment on the low pressure side are not suitable for the conditions which exist on the high pressure side.

8.11 Atmospheric and Low Pressure Storage Tanks

Tanks designed to API STD 650, and which may also require pressure relief devices, may be protected by pilot-operated relief valves or weighted pallet type relief devices.

Tanks designed to API STD 620 shall be protected by pilot-operated relief valves.

8.12 Air Accumulators

Air accumulators installed for operation of emergency isolation, control valves or shutdown valves have been determined by Saudi Aramco to not require pressure relief valves provided the system maximum air dew point is -15°C and the air accumulators are protected from overpressure from the source. (e.g., the accumulators are protected by PZVs located on the air receivers or on the discharge of the air compressors.)

8.13 Gas/Oil Separators

8.13.1 Intermediate and Low Pressure Vessels

Relief valve capacity and size shall be calculated for the following three emergency conditions. The largest resulting orifice area shall be used. For single stage GOSP refer to 8.13.2.

8.13.1.1 Fire

See procedure outlined in API STD 521.

8.13.1.2 Blocked Discharge, assuming that:

a) The pressure control valve (backpressure control valve) fails in closed position.

b) The inlet level control valve and the outlet control valve stay in their normal operating positions.

c) Gas is generated in accordance with the gas-oil ratio at popping pressure conditions.

8.13.1.3 Blow-By, assuming that:

a) The inlet level control valve is fully open.

b) Blow-by gas enters the intermediate Pressure Production Trap (or the Low Pressure Production Trap). Blow-by gas is the quantity of gas entering the vessel together with the crude oil.

The quantity of blow-by gas for the purpose of this calculation is equal to (inlet control valve capacity at 100% open minus inlet control valve capacity at its normal operating position) at relief valve popping pressure conditions. The normal operating position of the inlet level control valve is as stated in the "Control Valve Calculation and Specification" of this control valve.

c) Gas is generated from the crude oil at normal flow rate and in accordance with the Gas-Oil-Ratio at popping pressure conditions.

d) The pressure control valve (backpressure control valve) stays in its normal operating position. The normal operating position of the backpressure

control valve is as stated in the "Control Valve Calculation and Specification" of this control valve.

8.13.2 Calculation of PZV for Single Stage GOSP

Single stage GOSP PZV shall be calculated in the same manner as the first stage PZV of a multi-stage GOSP by determining the relief gas generated in accordance with the gas-oil ratio at accumulated pressure conditions. Calculate either for fire or for blocked discharge.

8.13.3 Calculation of PZV Orifice Area

The calculation shall comply with Section 7 of this standard.

8.14 Multiple Valve Application

Multiple valve application shall be considered if:

a) The required orifice area exceeds that of the largest single PZV available; or

b) A combination of smaller valves with staggered set points will more closely approximate the required orifice area.

Staggered pressure settings shall be specified to minimize emissions or loss from PZV operation.

8.15 Spares

8.15.1 Single Working Valve Installations

A permanently installed spare relief valve shall be required for all single working valve installations.

Exceptions:

1) Thermal relief of piping;

2) When spare standby equipment complete with PZV(s) is provided;

3) When protected equipment is operated intermittently for brief periods in association with a continuous process (e.g., during start-ups, regeneration, etc.) or may be temporarily removed from service.

4) For power boilers covered by ASME SEC I.

Commentary Note:

When single relief valves are removed for maintenance, the protected equipment or system shall not be left in an unprotected state if the cause for overpressure still exists. (i.e., the equipment must be depressured and vented or otherwise protected.)

8.15.2 Multiple Working Valve Installations

In multiple working valve installations no spare relief valve is required if conditions of paragraph 18.15.1(2) or (3) are met. If not, one spare valve shall be installed with capacity equal to that of the largest capacity working valve. This capacity requirement shall be determined at the pressure equal to the lowest set pressure among the multiple working valves.

8.16 In-Plant Piping

Pressure shall not exceed 20% or 33% above the MAWP of the piping, depending on the duration of the overpressure, in accordance with ASME B31.3, paragraph 302.2.4.

In-plant piping exposed to pressures above and at a longer time than the limits of ASME B31.3 paragraph 302.2.4 shall be protected by pressure relief devices. (Specific cases of centrifugal and positive displacement pumps are detailed in sections 8.4.1 and 8.4.2).

There is no mandatory requirement for surge analysis or surge protection for in-plant piping; however, transient analysis on transfer lines of significant length should be considered on a case by case basis. (Refer to SAES-J-605 for surge relief requirements).

8.17 Liquid Pipelines

Surge calculations shall be made, and adequate controls and protective equipment shall be provided, so that the level of pressure rise due to surges and other variations from normal operations shall not exceed the internal design pressure at any point in the piping system and equipment by more than 10%. (Reference ASME B31.4 paragraph 402.2.4).

Pipeline Surge Control shall adhere to the requirements of SAES-J-605.

8.18 Gas Pipeline Distribution Systems

Every pipeline connected to a pressure source, which might result in a pressure, which would exceed the maximum allowable operating pressure of the pipeline, shall be equipped with suitable pressure relieving or pressure limiting devices. Pressure limiting devices shall adhere to the requirements of ASME B31.8 and if chosen over the use of Pressure Relief valves, must have concurrence by Supervisor, Instrumentation Unit, Process Automation Systems Division, Process & Control Systems Department.

9 Installation

The following requirements are in addition to those of the ASME SEC I, ASME SEC VIII, API RP 520 Part II, and API STD 521:

9.1 Atmospheric Relief

PZVs in combustible non-toxic gas service shall discharge at a minimum distance of 30 m from any source of ignition. When the open end of the PZV discharge is installed at least 15 m above grade, the minimum horizontal distance to any source of ignition shall be 15 m. Discharge shall be 3 m above the nearest equipment or manway (ladder, platform, walkway, etc.) within a 15 m radius.

For combustible fluids that are 100% gas as they enter the PZV, but that may condense to combustible liquids, special provisions such as steam tracing shall be furnished or the PZV shall discharge into a closed system.

For gases above their auto-ignition temperature, provisions for remotely controlled, manually operated introduction of snuffing steam into the discharge piping shall be made.

9.2 Closed System Relief

Discharge of PZVs in the following services shall be to a closed system:

- All liquids, except water.
- Vapor which under some conditions might discharge as liquid.
- Corrosive vapors that are liquids at ambient conditions.

Toxic vapors, unless it can be shown by actual calculation, approved by Saudi Aramco, that ground level concentrations at platforms, walkways, and at ground level will be below the threshold limit value.

Commentary Note:

Noxious vapors may require special handling if so dictated by atmospheric pollution considerations.

9.3 Open Funnel Relief

When bellows failure would release flammable, toxic or corrosive liquids through the vent, a short nipple and elbow shall be used to direct the leakage to an open funnel which is piped to grade and ties into a catch basin or manhole with a sealed inlet connection. If the liquid release could cause a concentration of toxic vapor equal to the threshold limit value at a distance of 1 m from the funnel, the vent shall be tied into a closed low pressure disposal system.

For toxic or flammable gas/vapors, the bellows bonnet needs to be vented to a safe location.

Minimum length venting piping shall be used.

9.4 Block Valves

Block valves shall be installed on the inlet to all PZVs unless they are expressly prohibited by the ASME SEC I. Block valves shall be installed on the outlet of all PZVs that discharge into a closed system, unless they are also prohibited by the ASME code.

9.4.1 Block valves in relieving paths or block valves on remote pilot sense lines shall be readily accessible and shall be painted orange.

9.4.2 Block valves in relieving paths shall be provided with positive, readily identifiable position indication.

9.4.3 When gate valves are used as block valves in relieving paths they shall be installed with the stem horizontal or sloping down away from the relief valve to keep the gate from falling off and blocking the flow.

9.4.4 Block valves on remote pilot sense lines shall be either car-sealed open on operational PZVs or car-sealed closed on spare PZVs.

Commentary Note:

The term "car-sealed" is used within this standard to mean any corrosion, sunlight resistant method of preventing accidental opening or closing of a manual block valve or pilot sense valve. Standard methods include, a.) chain and lock, b.) tamper-proof stainless steel banding or c.) multistrand wire with a lead seal.

9.4.5 All block valves in relieving paths of operational PZVs, shall be car-sealed open.

Exception:

Inlet block valves on spare PZVs shall be car-sealed closed.

Commentary Note:

Discharge block valves on spare relief valves shall remain open to prevent possible overpressure of downstream lower class piping due to upstream block valve and PZV leakage.

9.4.6 Car-sealed valves shall be noted on the P&ID.

9.5 Changeover Valves

9.5.1 Changeover valves shall not be installed on vessels in ASME SEC VIII service or piping systems.

Exceptions:

1) Vessels in ASME SEC VIII unfired boiler steam service.

2) Existing Vessels in ASME SEC VIII service.

9.5.2 Changeover valves shall not be installed on ASME SEC I power boilers.

9.5.3 The changeover valve manufacturer shall be approved for usage by the Chairmen of the Instrumentation Standards Committee and the Valves Standards Committee.

9.5.4 Installations with one changeover valve installed at the inlet and one changeover valve installed at the outlet of two PZVs, shall have the two changeover valves physically linked to operate together.

9.5.5 Where changeover valves are linked together, the discharge piping of the PZV, up to and including the inlet to the changeover valve, shall have a pressure rating at least equal to the inlet piping to prevent leakage from overpressuring the downstream piping on the blocked-in spare PZV.

9.6 Access

Access to PZVs shall be per SAES-B-054.

9.7 Relief Valve Piping

9.7.1 Inlet Piping Length

PZVs shall be installed as close as practicable to the protected equipment. Inlet piping to PZVs shall have no dead or stagnant zones.

For liquid services and for sour and other corrosive services the inlet piping:

a) length shall not exceed three nominal pipe diameters; or

b) shall be self draining; or

c) shall be protected against internal corrosion of dead legs in accordance with SAES-L-310.

When design considerations offer a choice between minimum length of inlet piping versus minimum length of discharge piping, minimum length of inlet piping shall always be chosen.

9.7.2 Inlet Piping Pressure Drop

Relief valve inlet piping shall be sized such that at the combined maximum rated capacity of all operational PZV(s), the pressure drop between the protected equipment and the PZV(s) shall not exceed 3% of the lowest PZV set pressure. The estimated inlet piping pressure drop shall be stated on the relief valve specification sheet.

Exception:

Thermal relief valves with required orifice areas smaller than .110 in² (D orifice).

Commentary Note:

The following items should be considered when designing the overall relieving system in order to minimize PZV inlet pressure losses:

1) Vessel nozzles may be specified with rounded inlets to minimize entrance losses.

2) Piping branch tees may be specified with rounded tees, which will have less entrance loss than hard edged tees. Hot tapping of tee connections should be avoided where entrance losses are significant.

3) For a given orifice size, a larger PZV inlet connection may be specified to reduced friction losses.

9.7.3 Minimum Inlet Piping Size

For inlet piping on which only one PZV is operational, the minimum inlet pipe size shall be the same as the PZV inlet.

For installations in which more than one PZV is operational on a common inlet pipe, the minimum inlet piping cross sectional area shall be equal to the sum of the inlet areas of all operational valves connected to the common inlet pipe.

9.7.4 The installation of multiple PZVs on a tee-type header from a common nozzle on the protected equipment is allowed provided the requirements of paragraphs 9.7.1 and 9.7.2 are met.

9.7.5 Discharge Piping

Discharge piping serving PZVs relieving to atmosphere shall be provided with a ¾-inch low point drain (weep hole) at the low-point. For combustible gas services the discharge from the drain hole shall be directed away from personnel areas, equipment or piping by its orientation, or by use of a minimum length nipple and an elbow.

Discharge piping shall be self-draining toward the discharge end. The horizontal slope is normally specified as 21 millimeters in 10 meters.

Relief valve body and trim and discharge piping material shall meet the lowest temperature requirement. Downstream temperature conditions shall be calculated and specified on the Instrument Specification Sheet (ISS) for all relief valves where the downstream temperature conditions may be reduced to below 0°C due to the Joule-Thompson effect.

9.7.6 Miscellaneous Piping Requirements

a) For PZVs in fouling services, provisions shall be made for steam blowback or other means of heating.

b) Steam tracing shall be used for PZV inlet and outlet lines that may become plugged due to wax deposition or congealing of viscous fluids.

c) When the process fluid is highly viscous, the PZV and its inlet and discharge piping shall be steam jacketed or traced to assure that a maximum viscosity of 400 Centipoise is not exceeded.

d) An Upstream Vent valve shall be provided between the inlet block valve and the PZV inlet. Similarly, a Downstream Vent valve shall be provided between the PZV outlet and the outlet block valve. For relief valves with inlet size less than 1-inch, the vent valves shall be a minimum of the same size as the relief valve inlet size. For all other installations, 1-inch or larger, the vent valves shall be of 1-inch size.

Exceptions:

1) Upstream and Downstream Vent valves are not required for thermal relief valves in clean water service.

2) Upstream Vent valves are not required for thermal relief valves installed on equipment or piping that may be taken out of service and depressured during relief valve maintenance.

3) Upstream Vent valves are not required for thermal relief valves when the normal upstream pressure is below 680 kPa (100 psig), the temperature is below 70°C, the length of pipe between the upstream block valve and the PZV is less than 1 meter and the valves are in liquid service of Crude Oil, Bunkers, Diesel, Kerosene (and Jet Fuels), Naphtha or Gasoline. (Typical bulk plant operations).

4) Downstream Vent valves are not required for thermal relief valves that discharge into a closed system with less than 100 kPa (15 psig) normal pressure.

5) Changeover valves that have integral vent valve connections less than 1-inch in size are acceptable.

10 Documentation

An appropriate Specification Sheet shall be completed for each PZV, buckling pin valve or Rupture Disk. This includes tank breather / vacuum valves.

Documentation shall be provided which details the derivation of the worst-case relieving rate. Other cases considered shall also be detailed in the support material.

Relief valve documentation shall comply with the requirements of SAEP-318.

A Relief Valve Authorization (Form 3099A-ENG) shall be completed for each PZV.

The completed form 3099A-ENG shall be included as a part of the construction design package.

11 Testing and Inspection

11.1 Testing and Inspection of relief valves, for initial installation and maintenance, shall comply with the requirements of SAEP-319.

11.2 Testing and inspection, for the purpose of purchase of Conventional and Bellows Operated Relief Valves, shall adhere to 34-SAMSS-611 and Saudi Aramco Inspection Requirements Form 175-341900.

11.3 Testing and inspection, for the purpose of purchase of pilot-operated relief valves, shall adhere to 34-SAMSS-612 and Saudi Aramco Inspection Requirements Form 175-342000.

Revision Summary

20 February 2013	Revised the "Next Planned Update". Reaffirmed the contents of the document, and reissued with minor changes to correct some references and clarify some requirements.