# SAFETY RELIEF VALVES GENERAL REQUIREMENTS

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**CONSORTIUM:** Petro Karan Shafagh Kish (P.K.S.K.)

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|---|---|---|---|---|---|---|---|---|
| 4 | 23.Jun.2008 | ISSUED FOR APPROVAL | T.Arabi | A.Mirzamohammadi | M.Ebrahimi | A.Karimzadeh | S.H. Habibi | |
| Detail Engineering | | | | | | | | |
| 3 | | ISSUED FOR DESIGN | B.Omidi | A.Mirzamohammadi | M.Ebrahimi | A.Karimzadeh | H. Firouzi | |
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## 1. SCOPE

This Specification covers the minimum requirements for the Safety Relief Valves (Pressure safety relief valve and thermal relief valves) for the SOUTH PARS FIELD DEVELOPMENT PHASES 15 & 16 ONSHORE FACILITIES PROJECT.

## 2. REFERENCE DOCUMENTS

This document must be read in conjunction with the following specifications.

| | |
|---|---|
| RP 1516 999 1300 001: | Piping Material Classes |
| RP 1516 999 6600 001: | Painting |
| DB 1516 999 P 332 204: | Basic Engineering Design Data for Onshore Facilities |

## 3. CODES AND STANDARDS

Safety relief valves design and material shall comply with latest editions of codes, standard and recommended practices listed below:

- API RP 520: Recommended practice for the design and installation of pressure relieving systems
- API RP 521: Guide for pressure relief and depressurizing systems
- API STD 526 : Flanged steel safety relief valves(sections 1 to 4)
- API STD 527 : Commercial seat tightness of safety relief valves with metal to metal seat
- API STD 2000 : Tank venting
- NACE MR 01-75 : Material specification and heat treatments required for sour gas service in presence of hydrogen sulfide
- ASME : Boiler and pressure vessel code – Section VIII.
- ANSI B16.5: Steel pipe flange, flanged valve & fittings
- ISO 15156-1 to 3: Petroleum and natural industries-Materials for use in $H_2S$-containing environments in oil and gas production.

## 4. TECHNICAL REQUIREMENTS

### 4.1 GENERAL

The safety relief valves shall meet the requirements of API STD 526.
They shall generally be, except for tank venting or thermal relief, of the direct acting, angle pattern, spring-loaded, full nozzle entry, adjustable blow-down, high-capacity type.
Safety/relief valves shall be set no higher than the Vessel design pressures except as permitted by the vessel codes.
Conventional relief valves shall be used where there is no back pressure or where the backpressure is constant.

Balanced bellows relief valves shall be considered when:

- The back pressure may exceed 10% of the set pressure or is not constant
- The fluid is corrosive or toxic (particularly, bellows will be used on safety relief valves discharging to sour gas flare).

For conventional valves, the spring shall be set at the differential pressure between set pressure and constant back pressure.
For balanced valves, the spring shall be set at the set pressure.
Weight loaded safety valves shall be used only for low-pressure safety valves (API 2000).
Pilot operated pressure safety valves shall be considered when:

- high accuracy of set pressure is required
- quick opening and closing is required

Pilot operated valves shall be used on services such as very high capacities, clean gas in pulsating service.
Pilot operated, balanced bellows or assisted valves may be considered when trying to optimize flare header size and piping.

## 4.2 SIZING REQUIREMENTS

Vendor shall provide a calculation sheet (using API RP 520 formulae) for each Safety Relief Valve in accordance with process values required on P.K.S.K. individual technical datasheets.
The valve size shall be based on size calculations for the worst of all cases that might cause the valve to blow.
Relieving capacity, due to fire exposure, shall be determined as per API RP 520, latest edition for the process area pressure vessels, and taking into account possible equipment insulation.
Sizes shall be identified in accordance with API RP 526 showing inlet size - orifice area – outlet size (e.g. 1D2, 2H3, etc.).
The initial valve size selection shall be based upon the valve's suitability for the given case.
Concurrently, the selected orifice (area) will be the next larger standard area as defined in APISTD 526.
Valves accumulation shall be in accordance with the design codes used. These accumulations are generally the following:

- 10 % for vessels containing liquid, except for pumps discharge and thermal expansion where it will be 25%
- 10 % for gas service
- 3 % for steam generators
- 10 % for steam service except steam generators

- 21 % for fire exposure (liquid and gas).

In general, more than one valve will be applied when after calculation an area equal to or greater than that of a "T" orifice as defined in API RP 526 would be required.
The total area of all combined valves will be at least equal to the calculated area. The valves selected for that purpose will preferably be of the same size. When including installed spare valves care shall be taken that the total area of the valves on duty will be at least equal to the calculated required area.
Orifice area will be expressed in mm².
For general safety relief purposes the following standard sizes will be used:

| Inlet orifice outlet | Area mm² |
|---|---|
| 1 D 2 | 71 |
| 1 E 2 | 126 |
| 1 ½ F 2 | 198 |
| 2 H 3 | 506 |
| 3 K 4 | 1186 |
| 4 L 6 | 1841 |
| 4 P 6 | 4116 |
| 6 Q 8 | 7129 |
| 6 R 8 | 10322 |
| 6 R 10 | 10322 |
| 8 T 10 | 16774 |

Except for special service, on process requirement, other sizes that those mentioned will not be used.
Thermal safety valves for liquid expansion will be minimum 3/4" x 1" with an area of minimum 38 mm².

## 4.3 BODY

Valve bodies material and connections shall be in accordance with Piping Class specifications.
Safety relief valve body shall be flanged (As a rule, inlet minimum 300lb, ANSI B16.34) except small capacity liquid thermal relief valves.

## 4.4 NOZZLE, DISCS AND SPRING

Spring material is carbon steel up to 230°C and tungsten steel for higher temperatures.
All flanged valves shall have full nozzle with one-piece disc construction. Screwed valves have inlet type nozzles with manufacturer's standard disc. The disc is a piston type held against process pressure by a spring.

Disc, nozzle, guide, and ring are manufacturer's standard stainless steel except where the line classification dictates a better material.
The spring is adjustable for popping pressures within Code allowances above and below initial set pressure.
Semi-nozzle is acceptable for pilot operated relief valves.

### 4.5 ACCESSORIES

- Bonnet and Cap: Bolted closed bonnets for all conventional valves except where the code requires open bonnets shall be used (refer also to §9).Balanced valves shall have vented bonnets. Bonnet and cap material is carbon steel, unless process fluid entering bonnet or balanced safety valves requires alloy construction. Cap is usually screwed but may be bolted for pressure tightness. The cap and bonnet shall be provided with lugs for wire seal after setting the valve.
- O" ring soft seated type valves shall furnished for "hard to hold" fluids. "O" ring shall be compatible with fluid to be relieved.
- All safety relief valves shall be fitted with a blow-down adjustment ring set at 5% by manufacturer unless otherwise specified (see ASME Boiler Code).
- Plain lifting levers are provided on all pressure safety valves used on steam and air service. When required, packed levers shall be used on closed bonnet valves.
- Test gag: A gag shall be provided when specified on the data sheets.

### 4.6 CONNECTIONS

All pressure safety relief valves shall be flanged according to piping class specification as required in individual technical datasheet.
Minimum inlet connections for flanged valves are 1".
Flanges facing shall be in accordance with the relevant piping material class.
3/4"x1" screwed connections may be used for thermal relief valves.

## 5. VALVE TYPE SELECTION CRITERIA

### 5.1 GENERAL

Specific operating conditions and requirements shall determine the selection of a certain valve (type) for a given service.
Such operating conditions/requirements may be created by one or more of (but not necessarily be limited to) the below-mentioned circumstances:

- applicable relief case(s)
- media, blow-off to atmosphere/relief system – flare
- Pressure/temperature rating.

Selection of a valve for a particular service shall always be subject to sound engineering practices and be in line with the basic principles and requirements of this specification and follow the safety protection philosophies thereof.

## 5.2 CONVENTIONAL VALVES

For conventional relief valves, the back pressure will not exceed 10% of the set pressure.

## 5.3 BALANCED VALVES

Where a back pressure in excess of 10% of the required set pressure is specified, a balanced valve shall be used. The maximum back pressure will not exceed 50% of the set pressure (gauge pressure).
In case of variable back pressure the highest pressure that can occur shall be taken. This pressure may be generated by other valves blowing simultaneously in the same discharge system (superimposed back pressure) and by the subject valve itself (built up back pressure).
Superimposed back pressure generated by depressurizing valves in the discharge system shall not be taken into consideration when determining the need for a balanced valve if operation of depressurizing valves and relief valves does not take place at the same time.
The preferred means of balanced design shall be by balanced bellows. The use of balanced piston arrangements in conjunction with bellows will only be considered in cases where cocking may occur.
Balanced-type relief valves shall have a vented bonnet. The vent shall be protected against rain and dirt. Venting shall be such as to cause no hazard of any kind.

## 5.4 PILOT-OPERATED VALVES

Pilot operated valves may be used in clean process fluid service (they shall not be used in desiccant, catalyst of entrained solids service).
Pilot operated valves may be used when the set point is less than 10% above the operating pressure or when quick opening or closing is required, i.e. less than 10 % overpressure for liquids and 5 % for gas.
Pilot operated valves may be equipped with integral pilots or have provision for external pickups. A screwed cap with a sealing device shall protect adjusting spring screw.
Where used, pilot-operated valves shall have facilities for on stream testing, local depressurizing and back flow prevention.
Pilot operated valves shall be provided with cartridge filters suitable for service conditions.
Modulating pilot shall be provided as required on process data sheet.

### 5.5 LIQUID EXPANSION VALVES

Special relief valves shall be applied to cope with the thermal expansion of liquids.
The discharge of liquid expansion valves shall be hooked up so as to lead to a safe location.
Drain shall be led to the dedicated system for the medium.

## 6. RUPTURE DISCS

Rupture discs may be applied to protect safety/relief valve systems against corrosion, jamming and reduce minor leakage.
A pressure gauge shall always be installed between rupture disc and safety/relief valve by mean of a tee and an excess flow valve.
Installation of a rupture disc for the above-mentioned purpose shall never be of influence on the basic functioning of the associated safety/relief valve system.
Rupture discs shall be designed in accordance with ASME Boiler and Pressure vessel code, Section VIII.
Rupture discs shall be supplied complete with holders to fit between line flanges.
For every rupture disc, two spare discs shall be supplied for commissioning and start-up.
Rupture discs shall be reverse buckling type for vapor and gas services and of the tension type for liquid discharge only. They shall be capable of withstanding vacuum and be non-fragmenting type.
Vendor shall be required to calculate sizing of rupture discs using formula issued by API RP520.
The material of disc and holder shall be specified in the individual data sheet.
Each rupture disc shall have a non-corrodible metal nameplate permanently attached to the disc tab.

## 7. TANK PRESSURE/VACUUM (BREATHER) SYSTEMS

Tank pressure/vacuum valve for storage tanks shall be of the weight-loaded type and designed in accordance with API 2000. All vents shall be suitable for mounting on a vertical stub connection from the tank and shall be furnished with the specified flange. Deviations shall not be considered.
Vacuum break or inlets shall be included vertically upwards and shall be protected by a weatherproof cover and screen.
Pressure relief outlets for local discharge duty shall be protected by a weatherproof cover and screen.
Inlet and outlet flanges where specified on the individual technical P.K.S.K.'s data sheets will be unless otherwise required, in accordance with ANSI B 16.5.
Relieving capacity due to fire exposure storage to tanks containing flammable or combustible liquids shall be determined as per API ST 2000, latest edition.

## 8. CONSTRUCTIONS

Equipment to be hydrostatically tested after valve installation, test gag shall be provided on all safety and relief valves. Test gag shall be removed as soon as hydrostatic testing is completed.
The safety relief valve nozzle shall be capable of being removed from the valve body.
On steam services, open spring bonnets shall be used. In this case spring material shall be resistant to corrosive atmosphere (carbon steel to be avoided).
In all other cases bonnets shall be closed.
Plain closed bonnets shall be specified with tapped and plugged vent for easy conversion to balanced valve.
On sour gas service, NACE MR 01-75 shall be applied for construction and material.
Valve bodies shall be flanged, flanges being an integral part of the body casing and not attached by welding.
An exception to this requirement will be made in the case of small capacity liquid thermal relief valves where threaded connections will be used, size will be 3/4" x 1" NPT carbon steel or better for all liquids in accordance with piping specification.

## 9. MATERIALS

Body and trim materials shall conform to the requirements of the Piping Classes and be suitable for the service conditions. Special attention shall be given to inlet and outlet temperatures. Internal components shall be chosen in compliance with the process service.
Particularly, on sour gas service, manufacturer shall have to certify that his supply follows the NACE MR 01-75 in full conformity.
Bolts and nuts material shall be in accordance with PMS and process condition.

## 10. PAINTING

Safety Relief Valves will be painted according to the RP 1516 999 6600 001.
Final color for the body will be defined before Purchase Order.

## 11. NAMEPLATES

Each valve shall be fitted with a permanent stainless steel nameplate carrying the following information:

- Manufacturer's name and/or trademark
- Tag number.
- Valve type and serial number.

- Set pressure (in units specified on engineering data sheet).
- Valve orifice size and flange rating/size.
- Spring type and range.
- Valve spring, disc, disc holder and body material.
- Rated capacity (in units specified on engineering data sheet).
- Design code
- Relieving temperature
- Each rupture disc shall be fitted with nameplate carrying applicable information as safety relief valves.

## 12. INSPECTION AND TESTING

### 12.1 GENERAL

An inspection and test plan shall be submitted for approval including the following testing and controls:

- Hydraulic body test
- Tightness test
- Set pressure test
- Visual testing : general aspect, finish of surfaces, marking
- Dimensional control.

### 12.2 HYDRAULIC BODY TEST

The hydraulic test of the relief valve shall be performed at the nominal pressure of the outlet flange, according to ANSI B16.34 regulation.

### 12.3 TIGHTNESS TEST

The test shall be performed with air at a minimum pressure of 90% of the setting pressure and according to the testing method called "Bubble test".
The testing pressure shall be applied at least 3 minutes. The leakage flow should be in accordance with API 527.

### 12.4 SET PRESSURE TEST

Generally the checking of the safety relief valve setting pressure shall be performed with air. The maximum tolerance will be +/- 0.1 Bar for a setting pressure below 5 Bars, and +/- 3% for higher set pressure in accordance with ASME Section 1 Division 1.
For steam generator the maximum tolerance will be +/- 0.14 Bar for a set pressure below 4.8 Bars, and +/- 3% for higher pressure according to ASME Section 1.

The set pressure correction given by the Vendor for high temperature services shall be applied.
Bursting disc destructive tests shall be considered and tolerance on setting checked.
The screw of set pressure adjustment shall be sealed.

### 12.5 MATERIAL TEST

Material test shall be performed on the valve in accordance with Piping Class Specification.
Furthermore, where Sour Gas Service is specified, tests involved in NACE MR 01-75 shall be fully applied.

### 12.6 FINAL INSPECTION REPORT

The Vendor shall prepare a final report, which shall contain the information requested and the results of the tests specified in the above sections.

### 12.7 PRESERVATION AND PACKING

After testing, valves shall be cleaned, dried, fitted with test gags and prepared for shipment (test gags to be removed on installation). Proper valve stem packing to be installed in any surface protection needed during shipping shall be applied to the machined surfaces.
Openings shall be covered to exclude dirt and other foreign material from the interior of the valves.
Joint faces and/or flanges shall be protected over their entire surfaces with suitable close-fitting protectors securely attached at not less than four points.

## 13. DOCUMENTATION

- Dimensional drawings,
- Schematic diagrams with component lists,
- Calculation sheets,
- Recommended spare parts list (start-up,commissioning,2 years),
- Test procedures/reports,
- Operating manuals incorporating installation, commissioning, operating and maintenance instructions,
- Self-documenting features.
- Calculation sheets shall be generated for each tag with at least data include in rupture disc and pressure safety relief valve specification sheets in appendix A and appendix C of API PR 520 part 1.

## 14. SPARE PARTS AND SPECIAL TOOLS

The Vendor shall list and provide:

- The special tools required for a correct operation and for maintenance,
- The spare parts for commissioning and maintenance.