

PETRONAS TECHNICAL STANDARD
DESIGN AND ENGINEERING PRACTICE

TECHNICAL SPECIFICATION

**RELIEF VALVES - SELECTION, SIZING AND
SPECIFICATION**

PTS 80.36.00.30

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PREFACE

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The objective is to set the recommended standard for good technical practice to be applied by PETRONAS' OPU in oil and gas production facilities, refineries, gas processing plants, chemical plants, marketing facilities or any other such facility, and thereby to achieve maximum technical and economic benefit from standardisation.

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1. INTRODUCTION

1.1 SCOPE

This PTS specifies requirements and gives recommendations for the selection, sizing, and specification of relief devices.

The selection, sizing, and specification of relief devices shall be in accordance with the following standards, as clarified, amended or supplemented by this PTS:

- ASME VIII, Division 1 or 2;
- API RP 520, Part I and Part II;
- ISO 23251;
- API Std 526;
- ISO 28300.

NOTES: 1. API Std 521, 5th edition is identical to ISO 23251:2006.
2. API 2000, 6th edition will be identical to ISO 28300:2008.

Refer to PTS 80.45.10.10 to determine the hydraulics and other requirements of the relief and flare system.

This PTS is a revision of the PTS of the same number dated May 2004; see (1.5) regarding the changes.

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

Unless otherwise authorised by PETRONAS, the distribution of this PTS is confined to companies forming part of PETRONAS or managed by a Group company, and to Contractors and Manufacturers/Suppliers nominated by them.

This PTS is intended for use in petrochemical facilities, such as oil refineries, chemical plants, gas plants, exploration and production facilities and supply/distribution installations.

When PTS are applied, a Management of Change (MOC) process should be implemented; this is of particular importance when existing facilities are to be modified.

If national and/or local regulations exist in which some of the requirements may be more stringent than in this PTS, the Contractor shall determine by careful scrutiny which of the requirements are the more stringent and which combination of requirements will be acceptable with regard to the safety, environmental, economic and legal aspects. In all cases the Contractor shall inform the Principal of any deviation from the requirements of this PTS which is considered to be necessary in order to comply with national and/or local regulations. The Principal may then negotiate with the Authorities concerned, the objective being to obtain agreement to follow this PTS as closely as possible.

1.3 DEFINITIONS

1.3.1 General definitions

The **Contractor** is the party which carries out all or part of the design, engineering, procurement, construction, commissioning or management of a project or operation of a facility. The Principal may undertake all or part of the duties of the Contractor.

The **Manufacturer/Supplier** is the party which manufactures or supplies equipment and services to perform the duties specified by the Contractor.

The **Principal** is the party which initiates the project work and ultimately pays for its design and construction. The Principal will generally specify the technical requirements. The Principal may also include an agent or consultant, authorized to act for the Principal.

The word **shall** indicates a requirement.

The word **should** indicates a recommendation.

1.3.2 Specific definitions

For pressure relief valve (PRV) terminology and related terms, refer to API RP 520 and PTS 80.45.10.10.

1.4 CROSS-REFERENCES

Where cross-references to other parts of this PTS are made, the referenced section number is shown in brackets. Other documents referenced in this PTS are listed in (10).

1.5 CHANGES SINCE PREVIOUS EDITION

The previous edition of this PTS was dated May 2004. The changes have been too extensive to summarise here.

2. RELIEF DEVICE SELECTION

2.1 GENERAL CRITERIA

Pressure relief valves (PRVs) shall be selected from the standard sizes listed in API 526. For standardisation purposes, and to reduce the quantity of spares, the Principal may require the number of standard sizes at the site to be restricted; the Contractor shall submit the proposed valve sizes for the approval of the Principal.

Inlet and outlet flanges shall form an integral part of the body unless otherwise approved by the Principal.

Flanges shall be in accordance with ASME B16.5.

Flange ratings (ASME Class) shall be as summarized in Table 1.

Table 1 Inlet Flange Ratings

System rating	Inlet Flange Rating ⁽¹⁾
150	150 or 300 ^(2,3)
300	300 ⁽³⁾
600	600
900	900
1500	1500
2500	2500
NOTES: 1. For orifices types "P" and larger with inlet flanges ASME Class 300 and higher, the maximum available set pressure limit in API 526 is not suitable for the full ASME rating. Therefore, for these sizes the next higher rated inlet flange shall be selected if so dictated by the design pressure of the system. 2. Generally, an ASME Class 300 flange should be selected as it allows use in higher pressure applications and is consistent with the efforts of some sites to standardize inlet flange classes. 3. For valves with ASME Class 300 inlet flanges, the valve with the highest pressure limit available in API 526 shall be selected.	

Outlet flange ratings for PRVs that relieve to a flare system or atmosphere shall be in accordance with API 526 unless the Manufacturer's standard is a higher rating. For PRVs that relieve to a pressurised system, the outlet flange shall be rated accordingly.

Flange face finish shall be in accordance with the piping class of the connected piping.

PRVs for steam service discharging to atmosphere shall be of the exposed-spring type if operating above 250 °C (480 °F).

Manual lifting devices shall be avoided. Typical design codes only require lifting devices on PRVs in air, hot water (over 60 °C or 140 °F), or steam service.

NOTE: ASME VIII, Division 1, paragraph UG-136(a)(3) requires a lifting device on a PRV in air, hot water, or steam service. Code Case 2203 allows omission of the lifting device under certain provisions. These provisions are: (1) there is a documented inspection and maintenance program (2) the omission is documented on the data sheet, and (3) the omission is approved by the authority having jurisdiction (if applicable).

Where the application of Code Case 2203 is permitted by local regulations, a lifting device shall not be provided. If local regulations do not permit application of Code Case 2203, then a lifting device shall be provided only for the fluids specified in the relevant pressure vessel design Code.

Test rods (gags) are seldom justified and shall only be provided with the approval of the Principal.

An example of where the installation of test rods could be approved is for PRVs installed on a steam drum, to prevent them from lifting during in-situ testing of the PRVs installed on the superheater.

NOTE: Test rods prevent the stem moving and are sometimes used to block the PRV during hydrotesting the equipment or are used when transporting the PRV.

2.2 MECHANICAL DESIGN

1. For new installations, the inlet and outlet shall be flanged except where the piping specification approved by the Principal permits use of threaded piping. PRVs with threaded inlet nozzles shall not have threaded nozzle/body connections (e.g. inlet bushing).

NOTE: On PRVs with inlet bushings the valve is liable to come apart during removal if the pipe wrench is applied to the PRV body (instead of the PRV inlet bushing). PRVs with inlet bushings also require additional inspection/maintenance of the threaded connection).

2. Threaded inlet/outlet connections shall not be used except as noted in item 1 above and for bronze valves in water service. Seal welding of threaded connections is not allowed.
3. Slip-on flanges shall not be used.
4. If PRV fabrication requires welding, the welding procedures shall be submitted for approval prior to start of fabrication.
5. Pressure relief device design temperature

The PRV design temperature shall be determined by the inlet and outlet temperatures that result from extreme operating and relieving conditions. The temperature reduction resulting from possible valve leakage (e.g., flashing of liquid) shall be included in the determination of the design temperature. Elevated temperature arising from an external fire, however, is not a basis for the PRV design temperature and is not a selection criterion for PRV material.

To determine the minimum temperature, an isentropic flash to the choking pressure followed by an isenthalpic flash to the calculated back pressure shall be carried out – this is described in more detail in (3.1.7). If this results in a minimum temperature that is only slightly below the threshold at which low-temperature (fine grain) material is required, more detailed calculations should be carried out.

Design temperatures for other types of pressure relief devices shall be evaluated on a case-by-case basis.

2.3 SPECIFIC SELECTION CRITERIA

2.3.1 General

PRVs shall normally be of the spring-loaded type. For special applications, pilot-operated PRVs, rupture pin valves, and where permitted by local regulations, air-assisted PRVs may be employed.

For a description of the various types of PRVs, reference is made to API RP 520 Part I.

Capacities to be used for selecting the PRVs shall be those established and guaranteed by the PRV Manufacturer for the applicable service conditions.

The criteria given below for the selection of a PRV shall be followed.

2.3.2 Non-balanced spring-loaded pressure relief valves

If the built-up back pressure plus the variable superimposed back pressure [see (3.1.7.1) for definitions] does not exceed the allowable overpressure, PRVs shall be conventional safety relief valves unless other considerations justify the use of a balanced PRV (e.g., corrosion or fouling of PRV valve stem).

The allowable overpressure, as defined in API RP 520 Part I, is the pressure at the PRV inlet ("relieving pressure") minus the set pressure.

NOTE: Local regulations might not accept non-balanced PRVs set at equipment design pressure if the actual opening pressure could at times be higher as a result of the back pressure generated by other PRVs blowing at the same time. In that case, the use of balanced valves, or a slightly lower setting of the non-balanced valves, should be considered for those valves which may blow as the result of a common relief contingency.

Spring-loaded PRVs connected to a closed discharge system shall always have a closed bonnet.

2.3.3 Balanced type pressure relief valves

This type of valve shall be used when the built-up back pressure plus the variable superimposed back pressure is higher than that allowed for a non-balanced valve. Nevertheless, the back pressure shall not exceed the maximum specified by the Vendor, with account being taken of the flow capacity reduction and the bellows pressure rating. The maximum back pressure provided by the Manufacturer for the bellows shall not be exceeded.

PRVs of the balanced type shall have a continuously vented bonnet. See PTS 80.45.10.10 regarding the need to route to a safe area.

Balanced-bellows valves, with a bonnet vent open to atmosphere, shall not be used with fluids which may cause the valve to freeze if there is a leak. If this happens, the bonnet and balancing bellows may fill up with ice due to condensation and subsequent freezing of the moisture in the air, making the valve inoperative. Instead of balanced-bellows PRVs, the use of an auxiliary balancing piston should be considered. In clean service, pilot-operated PRVs, of which the pilot stays relatively warm, may be selected.

Balanced-bellows valves should not be used on reciprocating compressor discharges, because the pulsation can cause fatigue cracking of the bellows.

Balanced-bellows valves should not be used in coking or fouling services because the bellows can become fouled and may not operate properly.

A suitable corrosion-resistant material shall be specified for the bellows since, in the event of a bellows failure, fluid could enter the bonnet space and escape through the bonnet vent. Bellows shall be made of Alloy 625 LCF unless otherwise specified in the materials selection report. If no suitable corrosion-resistant material can be selected or if the chance of leakage is present, the use of an auxiliary balancing piston should be considered.

2.3.4 Pilot-operated pressure relief valves

Use of pilot-operated PRVs requires approval by the Principal. Where required, permission for use of pilot-operated PRVs shall be obtained from local authorities.

For proper operation, pilot-operated PRVs shall only be selected for clean gas or liquid service so that the pilot valve or sensing line cannot be blocked with hydrates, ice, wax, solids or dirt. The pilot valve shall be of the non-flowing type. With this type, the flow through the pilot lines and pilot valve ceases immediately when the main valve opens, thus minimising the likelihood of foreign matter being drawn into the small sections of the pilot valve. Heat tracing or purging shall be installed where cooling of process fluids to temperatures as low as the Lowest One-Day Mean Ambient Temperature (LODMAT) can cause plugging in the pilot, sensing line, pilot-operated valve (POV) inlet, or dome. Where tracing and/or purging are installed, alarms shall also be installed to alert operators of any problem with these systems. The sensing line shall also be as short as practical while still limiting the effect of high inlet pressure drop on the pilot-operated PRV.

Situations in which pilot-operated PRVs may be suitable are:

- where the pressure loss between the protected equipment and the inlet flange of the PRV exceeds 3 % of the set pressure of the PRV; in such situations the pilot sensor tapping shall be located close to the protected equipment. The pilot line shall be installed with no low points in the sensing line or its take-off so that liquid/debris cannot collect between the pilot valve and the main PRV;

- where seat leakage may be a problem with spring loaded relief devices, since pilot operated relief devices have superior sealing qualities;
- where high back pressures limit even the applicability of balanced valves;
- in large capacity and high set-pressure service due to their smaller size and weight and where, especially for the larger sizes, a higher operating pressure is allowed;
- if the margin between the maximum operating pressure (MOP) of the protected system and the PRV set pressure is less than 10 % of the PRV set pressure, since the process pressure provides a higher seating force than if a spring were used.

If pilot-operated PRVs are used, the options in Table 2 shall be considered.

Table 2 Options for pilot-operated pressure relief valves

Option	Provided	Comments
Modulating pilot	Normally	Less disruptive to process
Field test connections	No ⁽¹⁾	If required, special installation precautions are required to assure that the test connection is not plugged.
Pilot filters and/or purge	Yes	Unless the service is absolutely clean. ⁽²⁾
Pressure spike snubbers	Yes	Cyclic services (e.g., positive displacement compressors)
Backflow preventors	Yes	Whenever discharging into a closed system, where the closed system pressure might exceed the design pressure of the protected equipment. ⁽³⁾
NOTES: 1. Where in-situ pop-testing is required, field test connections shall be provided. 2. Pilot filters require periodic maintenance in order to control the risk of blockage. Where a spare filter is used, the switching valve shall be carefully designed, installed, and flow tested to ensure proper line-ups. Operating procedures for switching filters shall be developed to avoid inadvertent closure of the pilot sensing line. 3. Malfunction of backflow preventors could cause the PRV not to reseal.		

3. If pilot-operated PRVs are used, the following issues shall be considered:

- Minimum process pressure required to seat the main valve to accommodate the elasticity of the seat.

NOTE: Can cause commissioning problems while air-freeing equipment

- Pilot-operated valves are more complex than spring-loaded valves. This can result in lower reliability and more opportunities for error during repair.
- The selection of the soft goods for main valve and pilot shall consider compatibility with the process composition, temperature (relieving and heat tracing temperatures, if applicable), and pressure. Soft goods can be affected by substances in the process at low concentration. Some materials are susceptible to explosive decompression in certain process environments.

NOTE: Where a high pressure gas is present, the gas can permeate into an o-ring. If rapid depressurization occurs, and if the gas cannot escape quickly enough, the o-ring can be physically damaged (known as "explosive decompression"). This should be addressed by appropriate o-ring material selection and/or o-ring gland design, in consultation with the Manufacturer.

- Low temperature service can cause brittle failure or loss of elasticity of the soft goods.