

GENERAL SPECIFICATION

SAFETY

GS EP SAF 262

Pressure protection relief and hydrocarbon disposal systems

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1. Scope

1.1 Purpose of the specification

The purpose of this general specification is to define safety requirements for the design of the pressure protection and relief and the hydrocarbon disposal systems suitable for production, processing, transportation and storage installations in the oil and gas industry.

Hydrocarbon disposal systems are here defined as the systems to dispose of vapours or liquid hydrocarbon by burning or venting to the atmosphere during normal operation (fatal flow) including maintenance or inspection, abnormal operation such as process upsets (excess flow, off-specification products) and emergencies (pressure relief and emergency depressurisation).

The usual hydrocarbon disposal methods are to discharge vapours to atmosphere, non-volatile liquids to a catch pit and volatile liquids to other equipment operating at a lower pressure. However Company's policy is to **reduce its overall emissions and waste generation** wherever technically and/or economically feasible. Therefore alternate solutions to disposal e.g. vapour recovery system, gas re-injection, fully rated mechanical design; instrumented protection systems should be assessed.

The following basic principles should be applied (refer to **GS EP ENV 001**):

- **Minimising flaring operations**, with a “no flaring” target, by implementing all practical alternatives to burning associated gas.
- **Avoiding, as far as reasonably practically, the continuous process cold venting practice.**

These principles do not apply to emergency situations and special operations (blow-down, shutdown, trips and start-up, etc.).

Other factors that may impact the design of hydrocarbon disposal system should be considered, in particular:

- Applicable local or international regulations governing air and water quality control.
- Meteorological conditions.
- Properties of hydrocarbon released (toxicity, volatility, flammability, etc.).
- Other specifics, as applicable.

1.2 Applicability

This specification is not retroactive. It shall apply to new installations and to major modifications or extensions of existing installations. This specification applies to on-shore and offshore installations including FPSO and their cargo blanketing systems, refrigerated LPG/NGL storages and cryogenic LNG storages (see **GS EP SAF 341** section 5.1.1). Specific requirements for FPSO vent systems are also covered in **GS EP STR 651** section 5.8.

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This specification is limited to highlight HSE related matters (refer to [GS EP ENV 001](#) & [GS EP SAF 221](#)) and does not cover, in particular:

- Shutdown and emergency depressurisation systems (refer to [GS EP SAF 261](#)).
- Detailed design of disposal systems, such as flares, vents, pits, etc. (refer to [GS EP ECP 103](#)).

2. Reference documents

The reference documents listed below form an integral part of this General Specification.

External Documents

Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and supplements, is the latest revision published at the effective date of this document.

Reference	Title
API RP 14C	Recommended Practice for Analysis, Design, Installation, and Testing of Basic Surface Safety Systems for Offshore Production Platforms
API RP 520 PT II	Sizing, Selection, and Installation of Pressure-relieving Devices in Refineries Part II - Installation
API STD 520 PT I	Sizing, Selection, and Installation of Pressure-relieving Devices in Refineries Part I - Sizing and Selection
ISO 23251 / API STD 521	Petroleum, petrochemical and natural gas industries - Pressure-relieving and depressuring systems
NF EN 12874	Flame arresters - Performance requirements, test methods and limits for use

Total General Specifications

Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and supplements, is the latest revision published in the applicable yearly collection.

Reference	Title
GS EP ECP 103	Process sizing criteria
GS EP ENV 001	Environmental Requirements for Projects Design and E&P activities
GS EP EXP 407	Identification of Safety Critical Elements
GS EP SAF 021	Layout
GS EP SAF 216	Area classification
GS EP SAF 221	Safety rules for buildings
GS EP SAF 228	Liquid drainage
GS EP SAF 253	Impacted area, restricted area and fire zones
GS EP SAF 260	Design of High Integrity Protection Systems (HIPS)
GS EP SAF 261	Emergency Shutdown and Emergency De-Pressurisation (ESD & EDP)
GS EP SAF 337	Passive fire protection: Basis of design
GS EP SAF 341	Location and protection of onshore hydrocarbon storage
GS EP SAF 380	Safety engineering requirements for an F(P)SO
GS EP STR 651	General principles for a F(P)SO design

3. Terminology and definitions

There are five types of statement in this specification, the “shall”, “should”, “may”, “can” and “must” statements. They are to be understood as follows:

Shall	Is to be understood as mandatory. Deviating from a “shall” statement requires derogation approved by Company.
Should	Is to be understood as strongly recommended to comply with the requirements of the specification. Alternatives shall provide the same level of protection or performance and this shall be documented.
May	Is to be understood as permission.
Can	Is to be understood as a physical possibility.
Must	Expresses a regulatory obligation

For the purpose of this specification, the following definitions shall apply:

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Abnormal (operating condition)	Condition which occurs in a process component when an operating variable ranges outside of its normal operating limits (API).
Blow-Down (of a plant or equipment)	Depressurisation of a plant or part of a plant, or equipment.
Blow-Down (PSV device)	Difference between the set pressure and the closing pressure of a pressure relieving device (API + Company).
Bursting Disc “burst pressure”	The burst pressure of a rupture disc at the specified temperature is the value of the upstream static pressure minus the value of the downstream static pressure just prior to when the disc bursts. When the downstream pressure is atmospheric, the burst pressure is the upstream static gauge pressure (API RP 520).
Bursting Disc “rated or marked burst pressure”	The marked burst pressure, or rated burst pressure of a rupture disc, is the burst pressure established by tests for the specified temperature and marked on the disc tag by the manufacturer. The marked burst pressure may be any pressure within the manufacturing range unless otherwise specified by the customer. The marked burst pressure is applied to all of the rupture discs of the same lot (API RP 520).
Flaring, emergency	Flaring a peak flow of combustible gas in emergency conditions for periods of time generally less than 15 minutes (Company).
Flaring, maximum continuous	Flaring the largest allowable steady flow of combustible gas in abnormal or upset operating conditions, for periods of time that may exceed 15 minutes (Company).
Fuel source	Same as ISO definition of "source of release" (API).
Ignition source	Source of temperature and energy sufficient to initiate combustion (API).
Impacted area	Area that extends beyond the boundaries of the installation but which is nevertheless affected either permanently by normal operation of the facility (noise, radiation, etc.) or exceptionally by the consequences of an emergency situation caused by a major failure (Company).
Latent failure	Latent failures should normally be considered as an existing condition and not as a cause of overpressure when assessing whether a scenario is single or double jeopardy (ISO 23251 / API STD 521).
Major failure	A conceivable incident that can possibly occur on the facility. Used for the definition of the facility restricted area and impacted +area (Company).
Pressure Protection and Relief device (PRV or PSV)	Device, generally Pressure Safety Valve (PSV) or bursting disk, releasing hydrocarbon contained inside process equipment in order to ensure that the prevailing pressure shall not exceed the design pressure (Company).

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Pressure Relief device “back pressure”	Back Pressure is the pressure that exists at the outlet of a relief device as the result of the pressure of the discharge system. It is the sum of the superimposed and built-up back pressure (API RP 520).
Pressure Relief device “set pressure”	The set pressure is the inlet gauge pressure at which the pressure relief device is set to open under service conditions (API RP 520).
Public	Human beings, fauna, flora, installations or organisations who are outside the installation restricted area and who are not commissioned by Company to conduct a work approved by them (Company).
Restricted area	Area within the boundaries of the installation and hence under the control of Company, affected permanently by normal operation of the facility or exceptionally by the consequences of an emergency situation caused by a major failure (Company).
Source of release	Point from which flammable gas, liquid or a combination of both can be released into the atmosphere (ISO).
Thermal Expansion Relief Valve (TERV or TSV)	Device releasing hydrocarbon trapped inside a capacity (usually a pipeline section) submitted to heat input in order to maintain pressure below design pressure. The acronym "TSV" is used in the present specification.

4. Pressure protection and relief

4.1 Requirements for pressure protection and relief

4.1.1 Causes of over-pressurisation

The abnormal events listed below can lead to an over-pressurisation; they shall therefore be taken into account for the design of Pressure Protection and Relief systems:

- Blocked outlet.
- Inadvertent inlet valve opening.
- Check-valve failure.
- Utilities failure (Electricity, Cooling, Instrument Air, Steam, Fuel, Inert Gas, etc.).
- Mechanical failure.
- Heat exchanger tube failure.
- Transient pressure surge (water hammer etc., slugging regime).
- Plant fires.
- Process changes, chemical reactions:
- Gas blow-by
- Subsea production line or pipeline depacking

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Process facilities shall be designed to minimise the occurrence of these causes. The rules and principles contained in this document are focused on the mitigation devices to minimise the effects of an over-pressurisation.

4.1.2 Gas blow-by

Gas blow-by via a liquid outlet can occur in the event of a loss of liquid level in a gas/liquid separator connected to a lower pressure system. Since a much larger volume of gas can pass through a valve than the liquid for which the valve was originally sized, there is a risk of overpressurizing the lower pressure system.

4.1.3 Subsea production line or pipeline depacking

A subsea production line or interfield pipeline constitutes an infinite source of potentially very high pressure fluid (in packed conditions) which feeds into a production system (manifold, separator etc) of finite volume and designed for a lower pressure. The high gas rate resulting from the sudden opening of the isolation valves or control valves (choke, letdown station) at the HP/LP interface may cause 1) overpressure of the lower pressure system 2) exceedance of the flare system design capacity.

4.1.4 Check-valve failure

A check-valve complete failure at HP/LP interface shall be taken into account for assessment of overpressure risk and PSV sizing. With reference to [ISO 23251 / API STD 521](#), a two dissimilar type check-valve arrangement can be implemented to limit the leakage rate if required. If credit is given to a reduction in back-flow rate for PSV sizing, then the non-return valves shall be classified as critical safety elements and shall be tested and maintained accordingly (reference is made to [GS EP EXP 407](#)).

4.1.4.1 Full pressure-rated mechanical design

The system design pressure exceeds any possible pressure, including in the case(s) of process upset, and with due allowance for corrosion being made.

Fully rated pressure mechanical design is the preferred option from a safety point of view.

This type of design is highly recommended downstream of wellheads up to the production manifold, advisable for the first stage production separator when technically realistic to do so and mandatory for closed drain gathering networks up to the closed drain drum inlet nozzle.

Any part of a compression unit shall be able to withstand the equalising pressure ("settle out" pressure) after a shutdown.

Note: A pressure system requiring TSV's cannot be considered as fully-pressure rated. Refer to § 4.1.5.

4.1.4.2 Relief systems

The system design pressure includes a safety margin above the system maximum operating pressure (refer to [GS EP ECP 103](#) for "maximum operating pressure" definition) but, in case of a process upset, the pressure prevailing in the system can nevertheless exceed the design pressure. The system is therefore fitted with relief devices, designed to open at design pressure in case of upset conditions. Refer also to [GS EP ECP 103](#).

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Offshore and in accordance with [API RP 14C](#), a primary protection against over-pressurisation shall be provided by a PSHH (actuating a SDV or an ESDV) and a secondary protection by relief valves.

Although not specifically meant for onshore environment, [API RP 14C](#) approach shall also be applied to onshore facilities for over-pressure protection. Possible derogations may be granted based on SAFE chart analysis e.g. low hazard facilities and/or low sensitivity environment.

4.1.4.3 High Integrity Pressure Protection Systems (HIPPS)

They are instrumented systems (involving high reliability redundant and/or diversified instruments and final elements) used to protect equipment against overpressure and the safety integrity of which is the same as or greater than a proven conventional mechanical relief system (refer to [GS EP SAF 260](#)). HIPPS are not an option given preference by Company. HIPPS shall be selected **only when** full pressure rated designs and conventional relief systems prove impractical, generally because of environmental considerations (to avoid relief to atmosphere through relief valve) and/or constructability or lay-out constraints (size of relief headers and associated downstream systems: vents, flares, etc.). In all cases, an exception dossier including a detailed **reliability study** based on Vendor final documentation shall be submitted to Company for approval.

Note: Thermal expansion relief valves (TSVs) may be necessary on HIPPS protected equipment. Refer to § 4.1.5.

4.1.5 Criteria for installation of relief devices

Pressure relief devices shall be limited to hardware devices with no possibility of common mode of failure e.g. common upstream isolation valves. Pressure relief devices may consist in one, or a combination, of the following: Pressure Safety Valve PSV, PSV fire case, Thermal Safety Valve TSV, bursting discs or other specifics.

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Table 1 - Criteria for installation of PSVs and TSVs

	PSV (Process)	PSV (Fire case)	TSV
Piping that cannot be isolated (5): - All fluids	No	No	No
Piping that can be isolated (5) but cannot be exposed to fire: - Flammable gas - Liquefied HC - Liquid HC	Yes (1) Yes (1) Yes (1)	No No No	No Yes (7) (6) Yes (6) (7)
PIPING that can be isolated (5) and can be exposed to fire (8) (9): - Flammable gas - Liquefied HC - Liquid HC	Yes (1) Yes (1) Yes (1)	if > 3 tonnes if > 2 tonnes if > 2 tonnes	No Yes (7) Yes (7)
Vessels that cannot be isolated (5): - All fluids	Yes (1)	No	No
Vessels that can be isolated (5) but cannot be exposed to fire: - All fluids	Yes (1)	No	No
Vessels that can be isolated (5) and can be exposed to fire (8): - All fluids	Yes (1)	Yes	No

Note 1: A process PSV is required unless vessel/piping is protected against maximum possible pressure under upset conditions (full pressure rated design or PSV installed upstream of it).

Note 2, Note 3, Note 4: Deleted.

Note 5: Any type of isolation, automatic or manual valves.

Note 6: A TSV is required if ambient temperature condition and/or sun radiation may lead to prevailing pressure exceeding piping design pressure.

Note 7: A TSV is not required if a PSV (process or fire case) is already installed.

Note 8: Piping or vessels shall be considered as being possibly exposed to fire if part or the whole of it is inside the 3D Fire Scenario Envelope (FSE) defined as a cylinder with a default radius = 12 m and height = 7.5 m or submitted to a jet fire lasting more than 3 minutes. Default values may be adapted to specific hydrocarbons risks.

Note 9: For piping, fire case PSV may not be required for high boiling service in high design pressure system where it is established that the piping will rupture before the relief valve has lifted due to structural weakening (fire duration > 30 mn).

In case of toxic substances, the threshold criteria for the installation of PSV fire case and/or TSV may be made more stringent. This issue shall be assessed on a case by case basis.

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4.2 Relief device setting

The setting points and other characteristics of the relief devices shall be as per [GS EP ECP 103](#) for process equipment, utilities and pressure vessels for storage of liquefied hydrocarbon. [GS EP SAF 341](#) recommendations shall apply for liquid petroleum product tanks.

4.3 Relief system sizing

4.3.1 Failure cases

Individual relief valves shall be sized to relief the overpressure resulting from the combination of any existing steady state condition and any cause of overpressure. The simultaneous occurrence of two or more unrelated causes of overpressure (also known as double or multiple jeopardy) is not a basis for design.

The causes of overpressure are considered unrelated if no process or mechanical or electrical linkages exist among them, or if the length of time that elapses between possible successive occurrences of these causes is sufficient to make their classification unrelated.

Latent failures (e.g. instrumentation, check valves, fire pumps, etc.) should normally be considered as an existing condition and not as a cause of overpressure when assessing whether a scenario is single or double jeopardy.

One example of latent failure is a fire pump not starting upon demand. The scenario of having a single fire event and the pump failing to start is the combination of a single jeopardy and a latent failure, and is not considered as a double jeopardy. The fire heat input to calculate the flare load cannot be reduced by the possible cooling effect of the firewater system.

Operator error is considered as a potential source of overpressure.

Fire is a cause of overpressure. To define the combined relieving loads under fire exposure, the probable maximum extent of a fire should be estimated, as noted in § 4.1.5. A more detailed analysis can show a smaller fire-impact area.

For examples of single and double jeopardy scenarios, refer to [ISO 23251 / API STD 521](#), section 4.2.

This International Standard describes single-jeopardy scenarios that should be considered as a basis for design. The user may choose to go beyond these practices and assess multiple jeopardy scenarios.

4.3.2 Multiple wells system relief

The relief system shall be sized to handle the most demanding overpressure situations likely to occur.

In the absence of general common mode of failure (e.g. logic solver, wellhead control panel, air instrument, power supply, etc.) the default scenario shall be full flow production from all the sources involved (wells, trunklines in the case of a riser platform receiving remote wellhead effluent, etc.) during 90 seconds, followed by 15 minutes of production of the source producing the largest flow rate.

Where relevant, a transient analysis shall be conducted to check that incoming master valve and/or wing valve closing time does not lead to an overpressure situation in the flow-line,

manifold or even trunk-line. If this were the case, then the pressure relieving devices would be sized to avoid this occurrence, unless the piping section likely to become over pressured could be designed to withstand the well shut-in pressure.

4.3.3 Control valves

Sizing of PSVs for protection against overpressure in case of failure of control valves fitted with a by-pass shall be covered by guidance provided within **GS EP ECP 103**.

4.4 Relief system configuration

4.4.1 Number of relief valves

The number of relief valves fitted onto an equipment is not driven only by safety related concerns. However the following rules shall apply on top of other (e.g. process) considerations:

- For process pressure safety valves, if n is the number of PSV (or set of PSV) necessary to ensure 100% relief capacity, then $n + 1$ PSV (or set of) shall be installed (generally $2 \times 100\%$, possibly $3 \times 50\%$).
- A spare relief valve is always installed except if the protected equipment can be isolated and de-pressurised/drained without production loss (e.g. test separator, pig trap, etc.).
- Where, for capacity reasons, several pressure relief valves must be provided in parallel, the set pressures should be staggered to avoid chattering during relief. The difference between set points shall be less than 6% of the design pressure.
- A single TSV shall be provided for pipework thermal relief.

4.4.2 Isolation valves

Reference is made to **GS EP ECP 103**.

The following rules shall apply:

- $n + 1$ sets of pressure relief valves shall be associated with car seal procedures for both upstream and downstream isolation valves:
- Interlock devices are acceptable but the use of 'master' keys shall be avoided.
- "Double block and bleed" is an acceptable alternative to positive isolation provided that the workplace is not left unattended during change-out of PSVs.
- In all cases, means shall be provided to allow controlled venting of trapped gas between the upstream isolation valve(s) and the PSV in preparation for a maintenance intervention.
- For single 100% capacity pressure relief valves, the fitting of upstream isolation valve(s) shall be assessed, depending on the Operating Philosophy.
- If feasible, and assuming this does not create interference with other process systems, the relief discharge lines from a process unit should be routed to a common sub-header.
- Upstream and downstream isolation valves should be minimised by careful consideration of operating and maintenance philosophies of the concerned relief device, equipment, or unit.

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- Where downstream isolation valves cannot be avoided, they shall be locked or car sealed open in normal operating conditions. A single valve without positive isolation is generally considered as acceptable, but for toxic services (H_2S partial pressure exceeding 1 bar or an equivalent harmful effect to human life) an auditable risk analysis shall be performed in order to define the downstream isolation.

4.4.3 Relief system piping

Adequate supports shall be provided upstream and downstream the relief devices.

Relief lines shall slope downwards to the relief header, without any low point. The relief headers shall slope continuously towards the vent or flare stack.

Adequate systems shall be installed to separate liquids before the vent or flare tip. Where liquid is expected, a K.O. drum shall be provided. Where practicable, flare KO drum liquids should be re-injected in the main process; however as per **GS EP SAF 228** section 5.1.2 automatic transfer of liquids from a KO flare drum to the closed drain drum may be accepted.

The design of the network and, in particular, of the drain points, shall be such that the ingress of air under vacuum conditions is avoided. The relief piping shall be selected from material suitable for the lowest expected discharge temperatures. If water may be present, the risk of ice or hydrate formation shall be assessed, and methanol or glycol injection or any other suitable mitigation measure such as separate headers to the flare K.O. drum, should be envisaged to avoid blockage.

4.5 Relief devices

Reference is made to **API STD 520 PT I**. The fluid state (gas, liquid or a combination of the two) shall be specified on PSV data sheet. As a general statement, the installed orifice area should not be unnecessarily greater than the required area in order to prevent PSV damage from cyclic lifting/reseating (chattering). Consideration should be given to the installation of (say) two smaller PSVs with staggered set pressures to avoid this phenomenon.

4.5.1 Spring loaded relief valves

4.5.1.1 Conventional spring-loaded relief valves

Conventional spring-loaded PSV shall not be used where back pressure is variable and may exceed 10% of the set pressure.. They are the recommended type for TSVs.

4.5.1.2 Balanced pressure relief valves

Balanced relief valves shall not be used where back pressure may exceed 30% of the set pressure for gases and 20% for liquids. They can be of two main types: balanced piston and balanced bellows. Balanced bellows shall be given preference where the fluid is corrosive or fouling.

4.5.2 Pilot-operated relief valves

Pilot-operated relief valves shall be selected rather than conventional spring-loaded relief valves when any of the requirement listed hereinafter is paramount: low accumulation rates, more accurate settings and thus higher suitability for high pressure service, calibration without removing the valve, handling of large flows, etc. Although the set pressure of a pilot-operated