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SCOPE

This Project Standard and Specification provides requirements for the following aspects of topside process piping and equipment design on offshore production facilities:

- design pressure and temperature;
- safety instrumented secondary pressure protection systems;
- line sizing;
- system and equipment isolation;
- insulation and heat tracing.

These criteria are applicable for all processes, process support and utility systems.

REFERENCES

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

1. API (American Petroleum Institute)

API RP 14 C	Analysis, Design, Installation and Testing of Basic Surface Safety Systems on Offshore Production Platforms
API RP 520	Sizing, Selection and Installation of Pressure-Relieving Systems in Refineries
API RP 521	Guide for Pressure-Relieving and Depressuring SystemsBS MA-18, Salt water piping systems in ships
API Std 2000	Venting Atmospheric and Low-Pressure Storage Tanks

2. IEC (International Electro Technical Commission)

IEC 61508	Functional safety of electrical/electronic/programmable electronic safety related systems
IEC 61511	Functional safety – Safety instrumented systems for the process industry sector
OLF GL 070	Recommended guidelines for the application of IEC 61508 and IEC 61511

3. ISO (International Organization for Standardization)

ISO 10418	Petroleum and Natural Gas Industries – Offshore Production Installations – Basic Surface Process Safety Systems
ISO 13703	Petroleum and natural gas industries – Design and installation of piping system on offshore production platforms

DEFINITIONS AND TERMINOLOGY

Design pressure - pressure, together with the design temperature, used to determine the minimum permissible thickness or physical characteristic of each component as determined by the design rules of the pressure design code.
Note: The design pressure is selected by the user to provide a suitable margin above the most severe pressure expected during normal operation at coincident temperature.

Maximum operating pressure - maximum pressure including plant operation at unstable conditions.
Note: Unstable conditions include start-up/shutdown, control requirements and process upsets.

Maximum operating temperature - maximum temperature including plant operation at unstable conditions.
Note: Unstable conditions include start-up/shutdown, control requirements and process upsets.

Minimum operating temperature - minimum temperature including plant operation at unstable conditions.
Note: Unstable conditions include start-up, shutdown and depressurizing.

Operating pressure - pressure during normal operation, including normal variations.

Operating temperature - temperature during normal operation, including normal variations.

Settle out pressure - pressure equilibrium after a compressor shutdown.

Shut-in pressure - pressure for pumps and compressors determined by the curves for a “no flow” situation, i.e. blocked outlet.

SYMBOLS AND ABBREVIATIONS

SYMBOL/ABBREVIATION	DESCRIPTION
CS	carbon steel
FB	full bore
GRP	glass fibre reinforced polyester
ID	internal diameter
LO	locked open
NPSH	net positive suction head
PSV	pressure safety valve
SS	stainless steel

DESIGN PRESSURE AND TEMPERATURE

General

Where pressure relief devices are used, set points for these shall be in accordance with the design code applied for the components in the system.

Design Pressure

1. Maximum design pressure

   For systems protected by a PSV, the criteria in Table 1 shall be applied unless the PSV manufacturer guarantees that use of other margins is acceptable. The minimum margin is defined to avoid unintentional PSV opening. The relation between high trip pressure and maximum operating pressure is given in Figure 1.

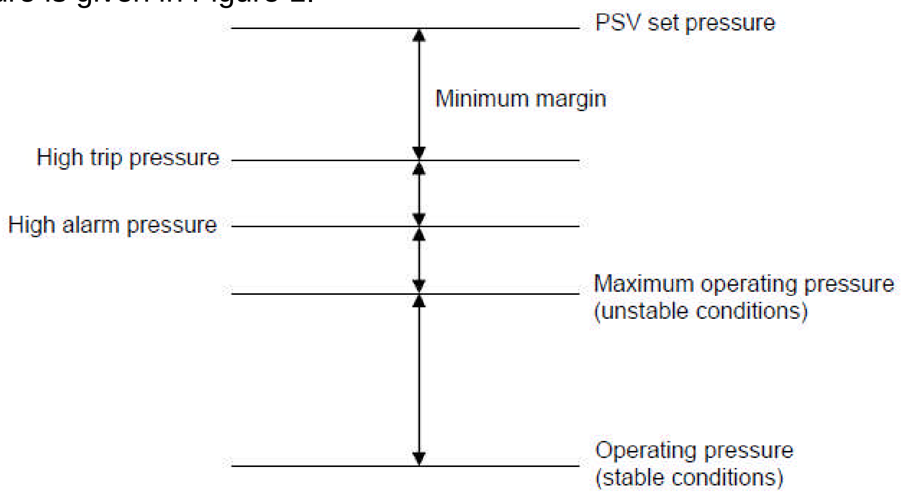

Figure 1 - Pressure relations

Table 1 - Design pressure criteria for pressurised systems

High trip pressure 1),2) barg	Minimum margin between high trip pressure 1),2) and PSV set pressure bar
0 to 35	3,5
over 35	10 % of PSV set pressure

Note:

1) For systems without a high pressure trip, the minimum margin shall be applied between the maximum operating pressure and the PSV set pressure.
2) Maximum operating pressure for compressor suction scrubbers and coolers shall be the maximum settle-out pressure, calculated from coincident high trip pressures on both suction and discharge sides of the compressor, and the minimum margin shall be applied between the maximum operating pressure and the PSV set pressure.

When rupture disks are applied, sufficient margin shall be included to

- prevent unintentional disk ruptures, i.e. margin between the disk set pressure and the operating pressure,
- ensure system pressure protection, i.e. margin between the disk set pressure and the maximum accumulated overpressure.

Reference is made to relevant pressure relieving design codes for further guidance.

When accurate information is unavailable, the shut-in pressure for centrifugal compressors should be determined as the maximum operating suction pressure +1,3 times the normal differential pressure developed by the compressor, to include for pressure rise at surge condition and maximum speed. The maximum operating suction pressure for a compressor shall in this case be determined by the high trip pressure from upstream separators or compressors.

When accurate information is unavailable, the maximum operating pressure (shut-in pressure) for centrifugal pumps should be determined as the suction pressure at relieving conditions +1,25 times the normal differential pressure developed by the pump.

Care should be taken not to define higher design pressure than required when it affects the selection of material and pressure class rating.

To minimise the requirements for process relief (full flow) the design pressure should be kept identical for systems with almost identical operating pressures.

For piping, occasional variations in the pressure above the design pressure is permissible in some design codes. This shall be subject to due consideration of all aspects in the relevant piping design code. If such variations are permitted by the project owner, the duration and extent of overpressure that the piping is subjected to, shall be logged. Logging is not considered required when it is evident that overpressure will not occur more frequently than allowed by the piping code.

Atmospheric tanks shall as a minimum be designed to be liquid filled to the highest point of the overflow line, and with an overpressure of 0,07 bar. If the overflow line can be blocked or have reversed flow (e.g. during loading) the atmospheric tank shall be designed for a liquid filled vent line up to the goose neck. Reference is made to API Std 2000 for further guidance.

For flare knock out drums, it is acceptable that the design pressure is equal to the maximum operating pressure. A safety margin shall be added to the maximum operating pressure in the design phase to account for increase due to uncertainties in the calculations. When accurate information is unavailable, Table 1 shall be used to set the safety margin.

2. Minimum design pressure

   For equipment where cooling or condensing vapours (e.g. after steam-out of vessels), drainage or pump out may lead to less than atmospheric pressure, the equipment shall be designed for full vacuum or protected by vacuum relief. Reference is made to API RP 521 for further guidance.

Design Temperature

1. Maximum design temperature

   a. General

      Where the maximum operating temperature can be determined accurately, this temperature should be used as maximum design temperature, without adding a safety margin. As an example, this can apply to the use of reservoir temperature as maximum design temperature for platform inlet facilities.

      Where the maximum operating temperature can not be calculated accurately, the maximum design temperature should be determined by adding 30 °C to the operating temperature. For equipment operating at ambient conditions, the maximum design temperature should be 50 °C for the North Sea.

      A high temperature shut down function, in accordance with ISO 10418 or API RP 14C, can limit the maximum operating temperature. A margin should be included to determine the design temperature.

      Care should be taken not to define higher design temperature than required when it affects the selection of material and pressure class rating.

      Vessels and instruments subject to steam-out shall be designed for temperature during steam-out operation.

b. Sea water systems

For sea water supply systems a maximum design temperature less than 50 °C can be accepted if documented by calculations.
For seawater return systems the maximum operating temperature shall be calculated at the minimum seawater flow. Minimum seawater flow is calculated at lowest seawater supply temperature and heat exchanger without fouling.

c. Compressor systems

The maximum operating temperature on a compressor discharge shall be determined as follows:

- when a compressor curve is not available: as 15 °C above the predicted design point temperature to allow for lower efficiency and higher pressure ratio at compressor surge conditions;
- when compressor curves are available: as the temperature at surge conditions and maximum compressor speed for normal and start up cases.

The following shall be used to determine the maximum design temperature:

- add 15 °C to the maximum operating temperature to allow for margins in the compressor curves, and for wear and tear giving lower efficiency over time;
- add 10 °C as an additional margin.

d. Compressor suction scrubber

Compressor suction scrubber maximum design temperatures shall be the higher of the following:

- maximum operating temperature at the compressor suction in the event of cooling medium failure, the maximum operating temperature can be limited by a high temperature shutdown function on the compressor suction or discharge;
- maximum recycle temperature (maximum discharge (temperature trip) minus temperature drop across anti-surge valve) in the event of cooling medium failure;
- maximum temperature due to settle out conditions;
- operating temperature plus a margin as defined above

e. Heat exchangers

For all heat exchangers, both sides shall have the same maximum design temperature determined by the hottest of the fluids on either side. For upset conditions, overpressure of connected piping at resulting upset temperature may be acceptable if permitted by relevant piping design code.

2. Minimum design temperature

   The minimum design temperature determines the requirements to the low temperature characteristics of the material, and shall be the more stringent of the following:

   a. minimum operating temperature (obtained during normal operation, start-up, shutdown or process upsets) with a margin of 5 °C;
   b. minimum ambient temperature, the lowest temperature should be based on available weather data, and safety factors should be selected based on the quality of such weather data;
   c. minimum temperature occurring during depressurising with a margin of 5 ºC, the temperature calculations shall as a minimum include heat transfer between fluid and vessel, and the most conservative starting conditions for depressurising shall be used including the following considerations as a minimum:
      - cool down to minimum ambient temperature after shut-in at PSV set pressure and corresponding temperature (including reduction in pressure during cool down);
      - conditions during a start-up operation following a depressurisation;
      - minimum operating temperature and maximum operating pressure.

   The minimum design temperature may be limited by initiating depressurisation at a higher temperature than the minimum ambient temperature. If implemented, this shall be subject to project owner approval, and be addressed in documentation for operation.
   The minimum design temperature may be limited by delaying start-up (to heat the system prior to start-up). If implemented, this shall be subject to project owner approval, and be addressed in documentation for operation.

SAFETY INSTRUMENTED SECONDARY PRESSURE PROTECTION SYSTEMS

General

Mechanically based pressure protection systems (e.g. PSV) shall be the preferred solution for secondary pressure protection.
Use of safety instrumented secondary pressure protection systems shall be based on acceptance criteria for overall system integrity, and shall be limited to the following applications:

- as a replacement for PSVs to protect pipelines against overpressure. The pressure specification break shall be downstream the pipeline riser valve. Where leakage or other flow from upstream system through valves in the safety instrumented system may be crucial to the integrity of the downstream system, a PSV shall be installed to prevent overpressure. The valve leakage rate shall be based on relevant experience and consideration of valve damage scenarios;

- to reduce the relief design rate by avoiding simultaneous flaring from parallel equipment/equipment trains. The safety instrumented system is for pressure protection of the flare system only;
- to reduce the relief design rate for process equipment and piping where multiple feeds (each with instrument loops to protect the equipment by shutting off the feed) enter the same equipment. Overpressure protection of the equipment/piping is then dependent of the safety instrumented system.

The relief design rate shall as a minimum be based on instrument loop failure for the largest feed. However, acceptance criteria for overall system integrity may require more failures to be included. This relief rate shall be accommodated within the flare system design pressure. Similarly, flare radiation for this relief rate shall meet the radiation criteria in API RP 521.

Safety instrumented secondary pressure protection systems shall be designed in accordance with IEC 61508 and IEC 61511. Special consideration shall be given to the design of the safety instrumented system due to the potential for erosion problems, hydrate formation, fluid viscosity, wax content etc. Common mode failures (e.g. loss of heat tracing), shall be considered.

The design pressures shall allow for "water hammering" effects caused by valve closure, in particular for liquid service.

Testing

Safety instrumented secondary pressure protection systems shall be functionally tested to reveal hidden failures to maintain the required safety reliability as defined by IEC 61508 and IEC 61511. The required test frequency shall be established, and the following shall apply:

- a system that requires testing more frequent than every third month to achieve the required reliability, is not considered to be sufficiently robust;
- to ensure that system functionality is maintained, the test frequency shall be equal or higher than once a year.

Where leakage or other flow from upstream system through valves in the safety instrumented system may be crucial to the integrity of the downstream system, the valve leakage rate shall be tested annually.

A high system regularity requirement may dictate the need for parallel systems to enable testing without affecting the plant production.

LINE SIZING CRITERIA

General

When sizing piping, the following constraints shall be addressed:

- required capacity/available driving pressure;
- flow induced forces;
- noise/vibration;
- pressure surges;
- material degradation - erosion, corrosion, cavitation;
- liquid accumulation/slug flow;
- sand accumulation.

Line sizing criteria in the sub clauses below shall be adhered to for design of new installations. For modification of existing installations, additional considerations shall be given to life cycle cost, and increased velocity and/or pressure drop may be accepted if mechanical integrity can be documented, e.g. ρV^2 > 200 000 kg/ms^2 for a line in the flare system.
In general, sizing of lines should be in accordance with ISO 13703.

Permissible pipe sizes

A minimum size of DN 50 (2 in) should in general be used for all process, process support and utility piping to ensure adequate mechanical integrity. Smaller piping can be used where protection and/or support is provided to withstand human activity.
Minimum size for the sewage and open drain header shall be DN 100 (4 in) and sub-headers DN 80 (3 in). Overflow from atmospheric tanks shall as a minimum be equal to the largest inlet pipe.
Tubing may be used for air, hydraulic oil and other non-combustible/non-hazardous fluids.

Pipe roughness

For all calculations of pressure drop, the following pipe roughness values should be used:

Carbon steel (CS) non-corroded:	0,05 mm
Carbon steel (CS) corroded:	0,5 mm
Stainless steel (SS):	0,05 mm
Titanium and Cu-Ni:	0,05 mm
Glassfiber reinforced polyester (GRP):	0,02 mm
Polyethylene, PVC:	0,005 mm
Flexible hose	Vendor to be consulted*)

*)As a rough estimation, ID/20 mm can be used (ID is the internal diameter in inches) for steel carcass and 0,005 mm for plastic coating.