INTERNATIONAL STANDARD

ISO 13703

First edition
2000-12-15

Petroleum and natural gas industries — Design and installation of piping systems on offshore production platforms

Industries du pétrole et du gaz naturel — Conception et installation de systèmes de tuyauterie sur les plates-formes de production en mer

Reference number
ISO 13703:2000(E)

Contents

Page

Foreword v
Introduction vi
1 Scope 1
2 Normative references 1
3 Terms, definitions, symbols and abbreviated terms 2
3.1 Terms and definitions 2
3.2 Symbols and abbreviated terms 4
4 General considerations 6
4.1 Materials 6
4.2 Code of pressure piping 7
4.3 Demarcation between systems with different pressure ratings 7
4.4 Corrosion considerations 9
5 Piping design 10
5.1 Pipe material grades 10
5.2 Sizing criteria — General 12
5.3 Sizing methods for liquid lines 12
5.4 Sizing criteria for single-phase gas lines 19
5.5 Sizing criteria for gas/liquid two-phase lines 23
5.6 Pipe wall thicknesses 26
5.7 Joint connections 30
5.8 Expansion and flexibility 31
5.9 Start-up provisions 32
6 Selection of valves 32
6.1 General 32
6.2 Types of valves 33
6.3 Fire resistance of valves 35
6.4 Valve sizing 35
6.5 Valve pressure and temperature ratings 36
6.6 Valve materials 37
7 Fittings and flanges 37
7.1 General 37
7.2 Welded fittings 38
7.3 Screwed fittings 38
7.4 Branch connections 38
7.5 Flanges 39
7.6 Proprietary connectors 41
7.7 Special requirements for sulfide stress-cracking service 41
7.8 Erosion prevention 41
8 Design considerations for particular piping systems 41
8.1 General 41
8.2 Wellhead accessory items 41
8.3 Flowline and flowline accessories 42
8.4 Production manifolds 45
8.5 Process vessel piping 45
8.6 Utility systems 47
8.7 Heating fluid and glycol systems 48
8.8 Pressure relief and disposal systems 48
8.9 Drain systems 50

8.10 Bridge piping between platforms 50
8.11 Risers 50
8.12 Sampling valves 51

9 Considerations of related items 51
9.1 General 51
9.2 Layout 51
9.3 Elevations 51
9.4 Piping supports 51
9.5 Other corrosion considerations 51
9.6 Thermal insulation 54
9.7 Noise 56
9.8 Pipe, valves and fittings tables 56
9.9 Inspection, maintenance, repair and modification 56

10 Installation and quality control 56
10.1 General 56
10.2 Welding 56
10.3 Pressure testing 57
10.4 Test record 58

Annex A (informative) Example problems 59

Annex B (informative) Examples of pipe, valves and fittings tables 71

Annex C (informative) Acceptable butt-welded joint design for unequal wall thicknesses 74

Bibliography 76

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 13703 was prepared by Technical Committee ISO/TC 67, *Materials, equipment and offshore structures for petroleum and natural gas industries*, Subcommittee SC 6, *Processing equipment and systems*.

Annexes A, B and C of this International Standard are for information only.

Introduction

This International Standard is based on API RP 14E, 5th edition, October 1991.

Petroleum and natural gas industries — Design and installation of piping systems on offshore production platforms

1 Scope

This International Standard specifies minimum requirements and gives guidance for the design and installation of new piping systems on production platforms located offshore for the petroleum and natural gas industries. It covers piping systems up to 69 000 kPa (ga) maximum, within temperature range limits for the materials meeting the requirements of ASME B31.3.

NOTE For applications outside these pressure and temperature ranges, this International Standard may be used but special consideration should be given to material properties.

Annex A gives some worked examples for solving piping design problems.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 13623, *Petroleum and natural gas industries — Pipeline transportation systems.*

API RP 520-2[1)], *Recommended practice for design and installation of pressure-relieving systems in refineries — Part 2.*

ASME[2)], *Boiler and pressure vessel code: Section VIII: Pressure vessels, Division 1.*

ASME B 31.3, *Process piping.*

NACE MR0175[3)], *Sulfide stress cracking resistant metallic materials for oil field equipment.*

NACE TM0177, *Laboratory testing of metals for resistance to specific forms of environmental cracking in H_2S environments.*

NACE TM0284, *Evaluation of pipeline and pressure vessel steels for resistance to hydrogen-induced cracking.*

---

1) American Petroleum Institute, 1220 L Street, N.W., Washington, DC 20005-4070, U.S.A.

2) American Society of Mechanical Engineers, 345 East 47th Street, New York, N.Y. 10017, U.S.A.

3) National Association of Corrosion Engineers, P.O. Box 218340, Houston, Texas 77218-8340, U.S.A.

3 Terms, definitions, symbols and abbreviated terms

For the purposes of this International Standard, the following terms, definitions, symbols and abbreviated terms apply.

3.1 Terms and definitions

3.1.1
chloride stress-corrosion cracking service
service in which the process stream contains water and chlorides in a sufficient concentration, and at a high enough temperature, to induce stress-corrosion cracking of susceptible materials

NOTE Other constituents present, such as oxygen (O_2), may contribute to such chloride stress-corrosion cracking.

3.1.2
choke
device specifically intended to restrict the flow rate of fluids

3.1.3
corrosion-erosion
eroding away of a protective film of corrosion product by the action of the process stream, exposing fresh metal which then corrodes

NOTE Extremely high metal mass loss can occur under these conditions.

3.1.4
corrosive gas
gas which, when dissolved in water or other liquid, causes corrosion of metal

NOTE Corrosive gases usually contain hydrogen sulfide (H_2S), carbon dioxide (CO_2) and/or oxygen (O_2).

3.1.5
corrosive hydrocarbon service
service in which the process stream contains water or brine and carbon dioxide (CO_2), hydrogen sulfide (H_2S), oxygen (O_2) or other corrosive agents under conditions which cause corrosion of metal

3.1.6
expansion bellows
corrugated piping device designed to absorb expansion and contraction

3.1.7
expansion bend
piping configuration designed to absorb expansion and contraction

3.1.8
flowline
piping that carries well fluid from wellhead to manifold or first process vessel

3.1.9
flow regime
flow condition of a multi-phase process stream

EXAMPLES Slug flow, mist flow or stratified flow.

3.1.10
fluid
gas, vapour, liquid or combinations thereof

3.1.11
header
part of a manifold that directs fluid to a specific process system

See Figures 5 and 6.

3.1.12
hydrocarbon wettability
ability of the process stream to form a protective hydrocarbon film on metal surfaces

3.1.13
manifold
assembly of pipe, valves and fittings by which fluid from one or more sources is selectively directed to various process systems

3.1.14
nipple
section of threaded or socket-welded pipe, shorter than 300 mm, used as an appurtenance

3.1.15
nominal pipe size
nominal size
NPS
DN
designation of size in inches which is common to all components in a piping system other than those components designated by outside diameter

NOTE Nominal pipe size is designated by the letters NPS (when relating to inches) or DN (when relating to millimetres) followed by a number; it is a convenient number for reference purposes and it is normally only loosely related to manufacturing dimensions.

3.1.16
non-corrosive hydrocarbon service
service in which the process stream conditions do not cause significant metal mass loss, selective attack, chloride stress-corrosion cracking or sulfide stress-cracking

3.1.17
normal conditions
absolute pressure of 101,325 kPa and temperature of 0 °C

3.1.18
platform piping
any piping intended to contain or transport fluid on a platform

3.1.19
pressure rating
number relating to the pressure for which a system is suitable

NOTE The number may relate directly to the rated working pressure (e.g. ISO 10423 [1] pressure rating 13,8 MPa and API pressure rating 2 000 psi) or may have a more indirect correlation (e.g. ASME class 300).

3.1.20
pressure sensor
device designed to detect a predetermined pressure

3.1.21
process component
single functional piece of production equipment and associated piping

EXAMPLES Pressure vessel, heater, pump, etc.

3.1.22
riser
vertical portion of a pipeline (including the bottom bend) arriving on or departing from a platform

3.1.23
shutdown valve
automatically-operated valve used for isolating a process component or process system

3.1.24
sulfide stress-cracking service
service in which the process stream contains water or brine and contains a sufficient concentration of hydrogen sulfide (H_2S) to induce sulfide stress-cracking of susceptible materials

3.1.25
wellhead pressure
maximum shut-in surface pressure that may exist in a well

3.2 Symbols and abbreviated terms

3.2.1 Symbols

A minimum pipe cross-sectional flow area required per unit volume flowrate, expressed in square millimetres per cubic metre per hour ($mm^2/m^3/h$)

B mean coefficient of thermal expansion at operating temperatures normally encountered, expressed in millimetres per kelvin (mm/K)

C empirical constant, dimensionless

C_e sum of corrosion, mechanical strength and thread allowance, expressed in millimetres (mm)

C_v valve coefficient, dimensionless

NOTE 1 This value is equal to the water flowrate in US gpm at 60 °F required to generate a pressure drop of 1 psi (US Customary units only are used in this instance to maintain alignment with other published data).

D_i pipe inside diameter, expressed in metres (m)

D_o pipe outside diameter, expressed in millimetres (mm)

d_i pipe inside diameter, expressed in millimetres (mm)

d_g gas relative density (air = 1), dimensionless

d_L liquid relative density (water = 1), dimensionless

E longitudinal weld joint factor, dimensionless

E_m modulus of elasticity of piping material in the cold condition, expressed in newtons per square millimetre (N/mm^2)

f Moody friction factor, dimensionless

g gravitational constant, expressed in metres per second per second (m/s^2)

h_a acceleration head, expressed in metres (m) of liquid

h_f friction head, expressed in metres (m) of liquid

h_p absolute pressure head, expressed in metres (m) of liquid

h_{st} static head, expressed in metres (m) of liquid

h_{vh} velocity head, expressed in metres (m) of liquid

h_{vpa} absolute vapour pressure, expressed in metres (m) of liquid

h_W pressure loss, expressed in kilopascals (kPa)

K acceleration factor, dimensionless

L developed pipe length, expressed in metres (m)

L_m pipe length, expressed in kilometres (km)

m manufacturing wall thickness tolerance, expressed as a percentage (%)

$NPSH_a$ available net positive suction head, expressed in metres (m) of liquid

p operating pressure, expressed in kilopascals [kPa (abs)]

NOTE 2 Also denoted in text as “flowing pressure”.

p_i internal design pressure, expressed in kilopascals [kPa (ga)]

q_g gas flow rate, expressed in cubic metres per hour (m^3/h) at normal conditions

q_L liquid flow rate, expressed in cubic metres per hour (m^3/h)

q_m total liquid plus vapour mass flowrate, expressed in kilograms per hour (kg/h)

R gas/liquid volume ratio, dimensionless

Re Reynolds number, dimensionless

R_p pump speed, expressed in revolutions per minute (r/min)

S allowable stress, expressed in newtons per square millimetre (N/mm^2)

T operating temperature, expressed in kelvin (K)

NOTE 3 Also denoted in text as “flowing temperature”.

t pressure design thickness, expressed in millimetres (mm)

t_{nom} minimum nominal pipe wall thickness, expressed in millimetres (mm)

U anchor distance (straight line distance between anchors), expressed in metres (m)

v_e fluid erosional velocity, expressed in metres per second (m/s)

v_g average gas velocity, expressed in metres per second (m/s)

NOTE 4 Also denoted in text as “gas velocity”

v_L average liquid velocity, expressed in metres per second (m/s)

y resultant of total displacement strains, expressed in millimetres (mm)

Y temperature factor, dimensionless

Z gas compressibility factor, dimensionless

ΔL expansion to be absorbed by pipe, expressed in millimetres (mm)

Δp pressure drop, expressed in kilopascals (kPa)

ρ_g gas density at operating pressure and temperature, expressed in kilograms per cubic metre (kg/m^3)

ρ_L liquid density at operating temperature, expressed in kilogram per cubic metre (kg/m^3)

ρ_m gas/liquid mixture density at operating pressure and temperature, expressed in kilograms per cubic metre (kg/m^3)

ΔT temperature change, expressed in kelvin (K)

μ_g gas viscosity at flowing pressure and temperature, expressed in pascal seconds (Pa·s)

μ_L liquid viscosity, expressed in pascal seconds (Pa·s)

3.2.2 Abbreviated terms

ERW Electric Resistance Weld

PWHT Post-Weld Heat Treatment

RF Raised Face

RTJ Ring Type Joint

SAW Submerged Arc Weld

SMYS Specified Minimum Yield Strength

4 General considerations

4.1 Materials

Carbon steel materials are suitable for many of the piping systems on production platforms, although stainless steels and other materials are also widely used. The following should be considered when selecting piping materials:

a) type of service;

b) compatibility with other materials;

c) mechanical strength, ductility, elasticity and toughness;

d) need for special welding procedures, or other jointing techniques;

e) need for special inspections, tests, or quality control;

f) possible misapplication in the field;

g) corrosion and erosion caused by internal fluids and/or marine environments;

h) need for performance in a fire situation.

4.2 Code of pressure piping

4.2.1 The design and installation of platform piping shall be in accordance with ASME B31.3, as modified by this International Standard. Risers for which ASME B31.3 is not applicable should be designed and installed in accordance with 4.2.2 to 4.2.6.

4.2.2 Design, construction, inspection and testing of risers shall be in accordance with ISO 13623 and governmental rules and regulations as appropriate to the application, using a design stress no greater than 0,6 times SMYS. Pipeline design codes may be used from pig trap to pig trap, except where precluded by national regulations.

4.2.3 One hundred percent radiography of welding should be performed on riser piping. The non-destructive testing of platform piping complying with ASME B31.3 should as a minimum satisfy Table 10 of this International Standard.

4.2.4 Impact tests shall be performed as specified by ASME B31.3. The design of high-pressure piping systems (i.e. above ASME class 2500) needs special consideration and shall be in accordance with the high-pressure piping requirements of ASME B31.3.

4.2.5 Valves, fittings and flanges should be manufactured in conformance with International and/or National Standards. Pressure/temperature ratings and material compatibility should be verified.

4.2.6 In determining the transition between risers and platform piping to which these practices apply, the first incoming and last outgoing valve that block pipeline flow are the limits of this International Standard's application, except for riser wall thickness calculations and material selection which may be to a pipeline code to permit a constant bore for pigging. Recommended practices included in this International Standard may be utilized for riser design when factors such as water depth, batter of platforms legs, potential bubbling area etc. are considered. National regulations may require the pipeline code to be continued to/from the pig launcher/receiver.

4.2.7 It is also common practice for a pipeline code to apply through the riser up to the pig trap and to include the piping and the first valve on each branch on the riser/pipeline.

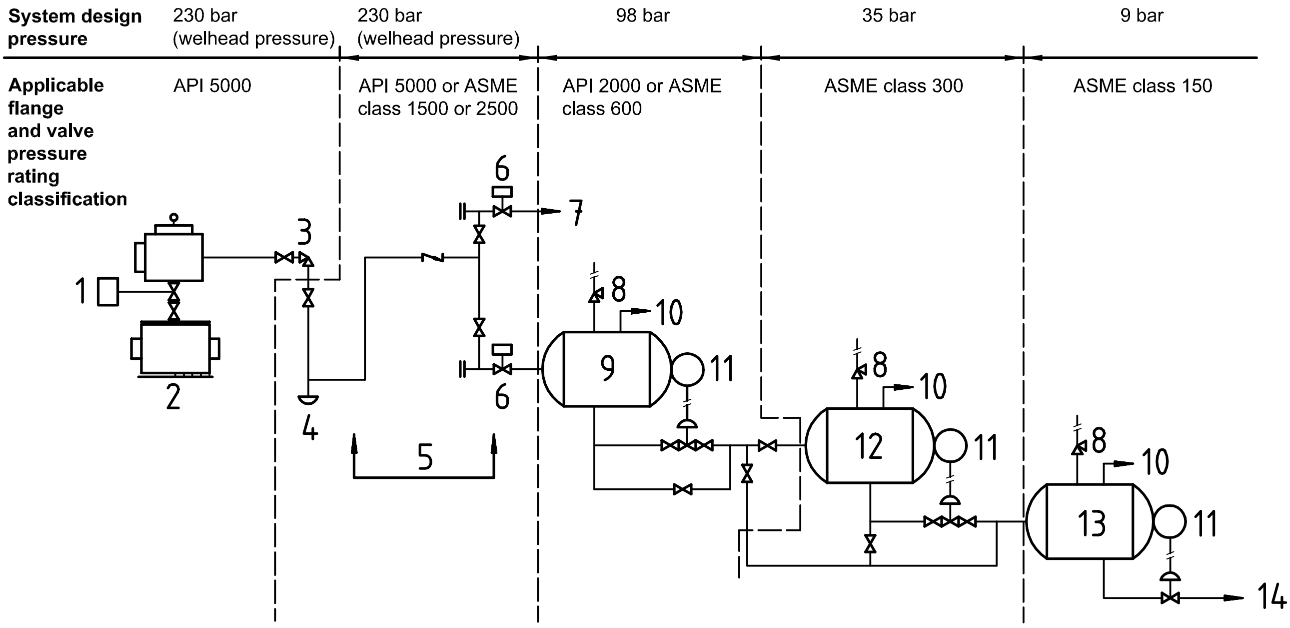
4.3 Demarcation between systems with different pressure ratings

4.3.1 Normally, after the well-stream leaves the wellhead the pressure is reduced in stages.

After the pressure is reduced, process components of lower pressure ratings may be used. A typical example is shown in Figure 1.

4.3.2 A pressure-containing process component shall either be designed to withstand the maximum internal pressure which can be exerted on it under any conditions, or shall be protected by a pressure-relieving device. In this case, a pressure-relieving device means a safety relief valve or a rupture disc. In general, when determining if pressure-relieving devices are needed, high-pressure shutdown valves, check valves, control valves or other such devices should not be considered as preventing overpressure of process components.

4.3.3 Pressure-rating boundaries shall be indicated on piping and instrument diagrams. Each system component (vessels, flanges, pipe or accessories) shall be designed to withstand the highest pressure to which it could be subjected under any foreseeable conditions, or it shall be protected by a pressure-relieving device. Abnormal pressure conditions shall be considered, e.g. start-up, shutdown, surge, etc.



NOTE 1 Design temperature is 65 °C throughout.

NOTE 2 Required shutdown sensors are not shown.

NOTE 3 Flowline and manifold are designed for wellhead pressure.

NOTE 4 System design pressures may be limited by factors other than the flange and valve pressure classifications (i.e. pipe wall thickness, separator design pressure, etc.).

NOTE 5 Only where spare relief valves are installed may upstream isolation valves be installed, and then it is essential that all isolation valves are interlocked to ensure that the pressurized system is protected at all times.

Key

1 Upper master gate valve
2 Wellhead
3 Wing choke
4 Flow tee
5 Manifold
6 Shutdown valve
7 To other systems
8 Pressure safety valve
9 High pressure separator
10 Gas outlet
11 Level controller
12 Medium pressure separator
13 Low pressure separator
14 Treating, storage or sales

Figure 1 — Example of a process system, denoting flange and valve pressure-rating changes

4.4 Corrosion considerations

4.4.1 General

Detailed corrosion-control practices for platform piping systems are outside the scope of this International Standard. Such practices should, in general, be developed by corrosion control specialists. Platform piping systems should, however, be designed to accommodate and be compatible with the corrosion control practices described below. Recommendations for corrosion-resistant materials and mitigation practices are given in the appropriate clauses of this International Standard.

The corrosivity of process streams may change over time. The possibility of changing conditions should be considered at the design stage.

4.4.2 Mass loss corrosion

Carbon steel platform piping systems may corrode under some process conditions. Production process streams containing water, brine, carbon dioxide (CO_2), hydrogen sulfide (H_2S) or oxygen (O_2), or combinations of these, may be corrosive to metals used in system components. The type of attack (uniform metal loss, pitting, corrosion-erosion, etc.) as well as the specific corrosion rate can vary in the same system, and can vary over time. The corrosivity of a process stream is a complex function of many variables, including:

a) hydrocarbon, water, salt and corrosive gas content;

b) hydrocarbon wettability;

c) flow velocity, flow regime and piping configuration;

d) temperature, pressure and pH;

e) solids content (sand, mud, bacterial slime and microorganisms, corrosion products, and scale).

Corrosivity predictions are very qualitative and may be unique for each system. Some corrosivity information for corrosive gases found in production streams is shown in Table 1.

Table 1 is intended only as a general guide for corrosion mitigation considerations and not for specific corrosivity predictions. Corrosion inhibition is an effective mitigation procedure when corrosive conditions are predicted or anticipated (see 5.1.2).

Table 1 — Qualitative guideline for mass loss corrosion of steel

Corrosive gas	Solubility[a] ratio $\times 10^{-6}$	Limiting values in brine	
		Non-corrosive ratio $\times 10^{-6}$	Corrosive ratio $\times 10^{-6}$
Oxygen (O_2)	8	< 0,005	> 0,025
Carbon dioxide (CO_2)	1 700	< 600	> 1 200
Hydrogen sulfide (H_2S)	3 900	See Note	See Note

NOTE No limiting values for mass loss corrosion by hydrogen sulfide are shown in this table because the amount of carbon dioxide and/or oxygen greatly influences the metal loss corrosion rate. Hydrogen sulfide alone is usually less corrosive than carbon dioxide due to the formation of an insoluble iron sulfide film which tends to reduce metal mass loss corrosion.

[a] Solubility ratio by volume. Solubility at 20 °C in distilled water at 1 atm partial pressure. Oxygen (O_2) is for 1 atm air pressure. Source: [3].