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Petroleum and natural gas industries — Design and operation of subsea production systems

Part 4: Subsea wellhead and tree equipment

Industries du pétrole et du gaz naturel — Conception et exploitation des systèmes de production immergés

Partie 4: Équipements immergés de tête de puits et tête de production

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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 2.

The main task of technical committees is to prepare International Standards. 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 document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 13628-4 was prepared by Technical Committee ISO/TC 67, *Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries*, Subcommittee SC 4, *Drilling and production equipment*.

This second edition cancels and replaces the first edition (ISO 13628-4:1999), which has been technically revised.

ISO 13628 consists of the following parts, under the general title *Petroleum and natural gas industries — Design and operation of subsea production systems*:

— *Part 1: General requirements and recommendations*

— *Part 2: Unbonded flexible pipe systems for subsea and marine applications*

— *Part 3: Through flowline (TFL) systems*

— *Part 4: Subsea wellhead and tree equipment*

— *Part 5: Subsea umbilicals*

— *Part 6: Subsea production control systems*

— *Part 7: Completion/workover riser systems*

— *Part 8: Remotely Operated Vehicle (ROV) interfaces on subsea production systems*

— *Part 9: Remotely Operated Tool (ROT) intervention systems*

— *Part 10: Specification for bonded flexible pipe*

— *Part 11: Flexible pipe systems for subsea and marine applications*

A part 12, dealing with dynamic production risers, a part 14, dealing with High Integrity Pressure Protections Systems (HIPPS), a part 15, dealing with subsea structures and manifolds, a part 16, dealing with specifications for flexible pipe ancillary equipment, and a part 17, dealing with recommended practice for flexible pipe ancillary equipment, are under development.

Introduction

This second edition of ISO 13628-4 has been updated by users and manufacturers of subsea wellheads and trees. Particular attention was paid to making it an auditable standard. It is intended for worldwide application in the petroleum industry. It is not intended to replace sound engineering judgement. It is necessary that users of this part of ISO 13628 be aware that additional or different requirements can better suit the demands of a particular service environment, the regulations of a jurisdictional authority or other scenarios not specifically addressed.

A major effort in developing this second edition was a study of the risks and benefits of penetrations in subsea wellheads. All previous editions of both this part of ISO 13628 and its parallel API document *Specification for Subsea Wellhead and Christmas Tree Equipment* (Specification 17D) prohibited wellhead penetrations. However, that prohibition was axiomatic. In developing this second edition, the workgroup used qualitative risk analysis techniques and found that the original insight was correct: subsea wellheads with penetrations are more than twice as likely to develop leaks over their life as those without penetrations.

The catalyst for examining this portion of the original editions of the API and ISO standards was the phenomenon of casing pressure and its monitoring in subsea wells. The report generated by the aforementioned risk analysis has become API 17 TR3 and API RP 90. The workgroup encourages the use of these documents when developing designs and operating practices for subsea wells.

Care has also been taken to address the evolving issue of using external hydrostatic pressure in design. The original versions of both API 17D and ISO 13628-4 were adopted at a time when the effects of that parameter were relatively small. The industry's move into greater water depths has prompted a consideration of that aspect in this version of this part of ISO 13628. The high-level view is that it is not appropriate to use external hydrostatic pressure to augment the applications for which a component can be used. For example, this part of ISO 13628 does not allow the use of a subsea tree rated for 69 MPa (10 000 psi) installed in 2 438 m (8 000 ft) of water on a well that has a shut-in tubing pressure greater than 69 MPa (10 000 psi). See 5.1.2.1.1 for further guidance.

The design considerations involved in using external hydrostatic pressure are only currently becoming fully understood. If a user or fabricator desires to explore these possibilities, it is recommended that a thorough review of the forthcoming American Petroleum Institute technical bulletin on the topic be carefully studied.

The overall objective of this part of ISO 13628 is to define clear and unambiguous requirements that facilitate international standardization in order to enable safe and economic development of offshore oil and gas fields by the use of subsea wellhead and tree equipment. It is written in a manner that allows the use of a wide variety of technology, from well established to state-of-the-art. The contributors to this update do not wish to restrict or deter the development of new technology. However, the user of this part of ISO 13628 is encouraged to closely examine standard interfaces and the reuse of intervention systems and tools in the interests of minimizing life-cycle costs and increasing reliability through the use of proven interfaces.

It is important that users of this part of ISO 13628 be aware that further or differing requirements can be needed for individual applications. This part of ISO 13628 is not intended to inhibit a vendor from offering, or the purchaser from accepting, alternative equipment or engineering solutions for the individual application. This can be particularly applicable where there is innovative or developing technology. Where an alternative is offered, it is the responsibility of the vendor to identify any variations from this part of ISO 13628 and provide details.

Petroleum and natural gas industries — Design and operation of subsea production systems

Part 4: Subsea wellhead and tree equipment

1 Scope

This part of ISO 13628 provides specifications for subsea wellheads, mudline wellheads, drill-through mudline wellheads and both vertical and horizontal subsea trees. It specifies the associated tooling necessary to handle, test and install the equipment. It also specifies the areas of design, material, welding, quality control (including factory acceptance testing), marking, storing and shipping for both individual sub-assemblies (used to build complete subsea tree assemblies) and complete subsea tree assemblies.

The user is responsible for ensuring subsea equipment meets any additional requirements of governmental regulations for the country in which it is installed. This is outside the scope of this part of ISO 13628.

Where applicable, this part of ISO 13628 can also be used for equipment on satellite, cluster arrangements and multiple well template applications.

Equipment that is within the scope of this part of ISO 13628 is listed as follows:

a) subsea trees:

- tree connectors and tubing hangers,
- valves, valve blocks, and valve actuators,
- chokes and choke actuators,
- bleed, test and isolation valves,
- TFL wye spool,
- re-entry interface,
- tree cap,
- tree piping,
- tree guide frames,
- tree running tools,
- tree cap running tools,
- tree mounted flowline/umbilical connector,
- tubing heads and tubing head connectors,

— flowline bases and running/retrieval tools,

— tree mounted controls interfaces (instrumentation, sensors, hydraulic tubing/piping and fittings, electrical controls cable and fittings);

b) subsea wellheads:

— conductor housings,

— wellhead housings,

— casing hangers,

— seal assemblies,

— guidebases,

— bore protectors and wear bushings,

— corrosion caps;

c) mudline suspension systems:

— wellheads,

— running tools,

— casing hangers,

— casing hanger running tool,

— tieback tools for subsea completion,

— subsea completion adaptors for mudline wellheads,

— tubing heads,

— corrosion caps;

d) drill through mudline suspension systems:

— conductor housings,

— surface casing hangers,

— wellhead housings,

— casing hangers,

— annulus seal assemblies,

— bore protectors and wear bushings,

— abandonment caps;

e) tubing hanger systems:

— tubing hangers,

— running tools;

f) miscellaneous equipment:

— flanged end and outlet connections,

— clamp hub-type connections,

— threaded end and outlet connections,

— other end connections,

— studs and nuts,

— ring joint gaskets,

— guideline establishment equipment.

This part of ISO 13628 includes equipment definitions, an explanation of equipment use and function, an explanation of service conditions and product specification levels, and a description of critical components, i.e. those parts having requirements specified in this part of ISO 13628.

The following equipment is outside the scope of this part of ISO 13628:

— subsea wireline/coiled tubing BOPs;

— installation, workover, and production risers;

— subsea test trees (landing strings);

— control systems and control pods;

— platform tiebacks;

— primary protective structures;

— subsea process equipment;

— subsea manifolding and jumpers;

— subsea wellhead tools;

— repair and rework;

— multiple well template structures;

— mudline suspension high pressure risers;

— template piping;

— template interfaces.

This part of ISO 13628 is not applicable to the rework and repair of used equipment.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 8501-1, *Preparation of steel substrates before application of paints and related products — Visual assessment of surface cleanliness — Part 1: Rust grades and preparation grades of uncoated steel substrates and of steel substrates after overall removal of previous coatings*

ISO 10423, *Petroleum and natural gas industries — Drilling and production equipment — Wellhead and christmas tree equipment*

ISO 10424-1, *Petroleum and natural gas industries — Rotary drilling equipment — Part 1: Rotary drill stem elements*

ISO 11960, *Petroleum and natural gas industries — Steel pipes for use as casing or tubing for wells*

ISO 13625, *Petroleum and natural gas industries — Drilling and production equipment — Marine drilling riser couplings*

ISO 13628-1, *Petroleum and natural gas industries — Design and operation of subsea production systems — Part 1: General requirements and recommendations*

ISO 13628-3, *Petroleum and natural gas industries — Design and operation of subsea production systems — Part 3: Through flowline (TFL) systems*

ISO 13628-7, *Petroleum and natural gas industries — Design and operation of subsea production systems — Part 7: Completion/workover riser systems*

ISO 13628-8, *Petroleum and natural gas industries — Design and operation of subsea production systems — Part 8: Remotely Operated Vehicle (ROV) interfaces on subsea production systems*

ISO 13628-9, *Petroleum and natural gas industries — Design and operation of subsea production systems — Part 9: Remotely Operated Tool (ROT) intervention systems*

ISO 13533, *Petroleum and natural gas industries — Drilling and production equipment — Drill-through equipment*

ISO 15156 (all parts), *Petroleum and natural gas industries — Materials for use in H_2S-containing environments in oil and gas production*

ANSI/ASME B16.11, *Forged Fittings, Socket-Welding and Threaded*

ANSI/ASME B31.3, *Process Piping*

ANSI/ASME B31.4, *Pipeline Transportation Systems for Liquid Hydrocarbons and Other Liquids*

ANSI/ASME B31.8, *Gas Transmission and Distribution Piping Systems*

ANSI/ISA 75.02, *Control Valve Capacity Test Procedure*

ANSI/SAE J517, *Hydraulic Hose Fittings*

ANSI/SAE J343, *Test and Test Procedures for SAE 100R Series Hydraulic Hose and Hose Assemblies*

API Spec 5B, *Specification for Threading, Gauging, and Thread Inspection of Casing, Tubing, and Line Pipe Threads (US Customary Units)*

ASTM D1414, *Standard Test Methods for Rubber O-Rings*

DNV RP B401, *Cathodic Protection Design*

ISA 75.01.01, *Flow Equations for Sizing Control Valves*

NACE No. 2/SSPC-SP 10, *Joint Surface Preparation Standard: Near-White Metal Blast Cleaning*

NACE SP0176, *Corrosion Control of Submerged Areas of Permanently Installed Steel Offshore Structures Associated With Petroleum Production*

SAE/AS 4059, *Aerospace Fluid Power — Cleanliness Classification for Hydraulic Fluids*

3 Terms, definitions, abbreviated terms and symbols

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1.1
annulus seal assembly
mechanism that provides pressure isolation between each casing hanger and the wellhead housing

3.1.2
backdriving
⟨general⟩ an unplanned movement in the reverse direction of an operation

3.1.3
backdriving
⟨linear actuator⟩ condition where the valve drifts from the set position

3.1.4
backdriving
⟨manual/ROV operated choke⟩ condition where the valve changes position after the operator is disengaged

3.1.5
backdriving
⟨rotary actuator⟩ condition where the valve continues to change position subsequent to the completion of a positional movement

3.1.6
backdriving
⟨stepping-actuated choke⟩ condition where the valve changes position after the operator is disengaged

3.1.7
bore protector
device that protects internal bore surfaces during drilling or workover operations

3.1.8
check valve
device designed to prevent flow in one direction

3.1.9
choke
equipment used to restrict and control the flow of fluids and gas

3.1.10
completion/workover riser
extension of the production and/or annulus bore(s) of a subsea well to a surface vessel

See ISO 13628-7.

3.1.11
conductor housing
top of the first casing string, which forms the basic foundation of the subsea wellhead and provides attachments for guidance structures

3.1.12
corrosion cap
cap placed over the wellhead to protect it from contamination by debris, marine growth or corrosion during temporary abandonment of the well

3.1.13
corrosion-resistant alloy
CRA
non-ferrous alloy for which any one or the sum of the specified amount of the following alloy elements exceeds 50 %: titanium, nickel, cobalt, chromium and molybdenum

NOTE This term refers to corrosion-resistant alloys and not cracking-resistant alloys as mentioned in ISO 15156 (all parts).

3.1.14
corrosion-resistant material
CRM
ferrous or non-ferrous alloy that is more corrosion resistant than low-alloy steels

NOTE This term includes: CRAs, duplex, and stainless steels.

3.1.15
depth rating
maximum rated working depth for a piece of equipment at a given set of operating conditions

3.1.16
downstream
direction of movement away from the reservoir

3.1.17
equipment
any item or assembly to which ISO 13628-4 is applicable

3.1.18
extension sub
sealing tubular member that provides tree-bore continuity between adjacent tree components

3.1.19
fail-closed valve
actuated valve designed to fail to the closed position

3.1.20
fail-open valve
actuated valve designed to fail to the open position

3.1.21
flowline
any pipeline connecting to the subsea tree assembly outboard the flowline connector or hub

3.1.22
flowline connector support frame
structural frame which receives and supports the flowline connector and transfers flowline loads back into the wellhead or seabed anchored structure

3.1.23
flowline connector system
equipment used to attach subsea pipelines and/or control umbilicals to a subsea tree

EXAMPLE Tree-mounted connection systems used to connect a subsea flowline directly to a subsea tree, connect a flowline end termination to the subsea tree through a jumper, connect a subsea tree to a manifold through a jumper, etc.

3.1.24
flow loop
piping that connects the outlet(s) of the subsea tree to the subsea flowline connection and/or to other tree piping connections (crossover piping, etc.)

3.1.25
guide funnel
tapered enlargement at the end of a guidance member to provide primary guidance over another guidance member

3.1.26
guideline
taut line from the seafloor to the surface for the purpose of guiding equipment to the seafloor structure

3.1.27
high-pressure riser
tubular member which extends the wellbore from the mudline wellhead or tubing head to a surface BOP

3.1.28
horizontal tree
tree that does not have a production master valve in the vertical bore but in the horizontal outlets to the side

3.1.29
hydraulic rated working pressure
maximum internal pressure that the hydraulic equipment is designed to contain and/or control

NOTE Hydraulic pressure should not be confused with hydraulic test pressure.

3.1.30
hydrostatic pressure
maximum external pressure of ambient ocean environment (maximum water depth) that equipment is designed to contain and/or control

3.1.31
intervention fixture
device or feature permanently fitted to subsea well equipment to facilitate subsea intervention tasks including, but not limited to,

— grasping intervention fixtures;

— docking intervention fixtures;

— landing intervention fixtures;

— linear actuator intervention fixtures;

— rotary actuator intervention fixtures;

— fluid coupling intervention fixtures

3.1.32
intervention system
means to deploy or convey intervention tools to subsea well equipment to carry out intervention tasks, including

— ROV;

— ROT;

— ADS;

— Diver

3.1.33
intervention tool
device or ROT deployed by an intervention system to mate or interface with an intervention fixture

3.1.34
lifting pad eye
pad eye, intended for lifting and suspending a designed load or packaged assembly

3.1.35
lower workover riser package
LWRP
unitized assembly that interfaces with the tree upper connection and allows sealing of the tree vertical bore(s)

3.1.36
mudline suspension system
drilling system consisting of a series of housings used to support casing strings at the mudline, installed from a bottom-supported rig using a surface BOP

3.1.37
orienting bushings
non-pressure-containing parts that are used to orient equipment or tools with respect to the wellhead

3.1.38
outboard tree piping
subsea tree piping that is downstream of the last tree valve (including choke assemblies) and upstream of flowline connection

See **flow loop** (3.1.24).

3.1.39
permanent guidebase
structure that sets alignment and orientation relative to the wellhead system and provides entry guidance for running equipment on or into the wellhead assembly

3.1.40
pressure-containing part
part whose failure to function as intended results in a release of wellbore fluid to the environment

EXAMPLES Bodies, bonnets, stems.

3.1.41
pressure-controlling part
part intended to control or regulate the movement of pressurized fluids

EXAMPLE Valve-bore sealing mechanisms, choke trim and hangers.

3.1.42
rated working pressure
RWP
maximum internal pressure that equipment is designed to contain and/or control

NOTE Rated working pressure should not be confused with test pressure.

3.1.43
re-entry spool
tree upper connection profile, which allows remote connection of a tree running tool, LWRP or tree cap

3.1.44
reverse differential pressure
condition during which differential pressure is applied to a choke valve in a direction opposite to the specified operating direction

NOTE This can be in the operating or closed-choke position.

3.1.45
running tool
tool used to run, retrieve, position or connect subsea equipment remotely from the surface

EXAMPLES Tree running tools, tree cap running tools, flowline connector running tools, etc.

3.1.46
subsea BOP
blowout preventer designed for use on subsea wellheads, tubing heads or trees

3.1.47
subsea casing hanger
device that supports a casing string in the wellhead at the mudline

3.1.48
subsea completion equipment
specialized tree and wellhead equipment used to complete a well below the surface of a body of water

3.1.49
subsea wellhead housing
pressure-containing housing that provides a means for suspending and sealing the well casing strings

3.1.50
subsea wireline/coiled tubing BOP
subsea BOP that attaches to the top of a subsea tree to facilitate wireline or coiled tubing intervention

3.1.51
surface BOP
blowout preventer designed for use on a surface facility such as a fixed platform, jackup or floating drilling on intervention unit

3.1.52
swivel flange
flange assembly consisting of a central hub and a separate flange rim that is free to rotate about the hub

NOTE Type 17SV swivel flanges can mate with standard ISO type 17SS and 6BX flanges of the same size and pressure rating.

3.1.53
tieback adapter
device used to provide the interface between mudline suspension equipment and subsea completion equipment