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

Part 1: General requirements and recommendations

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

Partie 1: Exigences générales et recommandations

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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 13628-1 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 13628-1:1999), 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: Flexible pipe systems for subsea and marine applications* [1)]

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

— *Part 4: Subsea wellhead and tree equipment*

— *Part 5: Subsea umbilicals*

— *Part 6: Subsea production control systems*

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

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

The following parts are under preparation:

— *Part 7: Completion/workover riser systems*

— *Part 10: Specification for bonded flexible pipe*

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

1) Under revision.

Introduction

This part of ISO 13628 has been prepared to provide general requirements, recommendations and overall guidance for the user to the various areas requiring consideration during development of a subsea production system for the petroleum and natural gas industries. The functional requirements defined in this part of ISO 13628 will allow alternatives in order to suit specific field requirements. The intention is to facilitate and complement the decision process rather than to replace individual engineering judgement and, where requirements are non-mandatory, to provide positive guidance for the selection of an optimum solution.

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

Part 1:
General requirements and recommendations

1 Scope

This part of ISO 13628 provides general requirements and overall recommendations for development of complete subsea production systems, from the design phase to decommissioning and abandonment. This part of ISO 13628 is intended as an umbrella document to govern other parts of ISO 13628 dealing with more detailed requirements for the subsystems which typically form part of a subsea production system. However, in some areas (e.g. system design, structures, manifolds, lifting devices, and colour and marking) more detailed requirements are included herein, as these subjects are not covered in a subsystem standard.

The complete subsea production system comprises several subsystems necessary to produce hydrocarbons from one or more subsea wells and transfer them to a given processing facility located offshore (fixed, floating or subsea) or onshore, or to inject water/gas through subsea wells. This part of ISO 13628 and its related subsystem standards apply as far as the interface limits described in Clause 4.

Specialized equipment, such as split trees and trees and manifolds in atmospheric chambers, are not specifically discussed because of their limited use. However, the information presented is applicable to those types of equipment.

If requirements as stated in this part of ISO 13628 are in conflict with, or are inconsistent with, requirements as stated in the relevant complementary parts of ISO 13628, then the specific requirements in the complementary parts take precedence.

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 3506-1, *Mechanical properties of corrosion-resistant stainless-steel fasteners — Part 1: Bolts, screws and studs*

ISO 3506-2, *Mechanical properties of corrosion-resistant stainless-steel fasteners — Part 2: Nuts*

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

ISO 13535, *Petroleum and natural gas industries — Drilling and production equipment — Hoisting equipment*

ISO 13628-4, *Petroleum and natural gas industries — Design and operation of subsea production systems — Part 4: Subsea wellhead and tree equipment*

ISO 13628-5, *Petroleum and natural gas industries — Design and operation of subsea production systems — Part 5: Subsea umbilicals*

ISO 13628-6, *Petroleum and natural gas industries — Design and operation of subsea production systems — Part 6: Subsea production control systems*

ISO 13628-7: —[2], *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*

API RP 2A, *Recommended Practice for Planning, Designing and Constructing Fixed Offshore Platforms — Working Stress Design* Twenty-First Edition

DNV2.7-1, *Offshore freight containers*

3 Terms, definitions and abbreviations

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

3.1 Terms and definitions

3.1.1
barrier
element forming part of a pressure-containing envelope which is designed to prevent unintentional flow of produced/injected fluids, particularly to the external environment

3.1.2
deep water
water depth generally ranging from 610 m (2 000 ft) to 1 830 m (6 000 ft)

NOTE Since the physical circumstances of any situtation will change as a function of water depth, use of the term “deep water” implies that it may be necessary to consider design and/or technology alternatives.

3.1.3
first-end connection
connection made at the initiation point of the flowline or umbilical installation process

3.1.4
flowline
production/injection line, service line or pipeline through which fluid flows

NOTE In this part of ISO 13628, the term is used to describe solutions or circumstances of general nature related to a flowline.

3.1.5
flying lead
unarmoured umbilical jumper with a termination plate at either end (incorporating connectors for the various lines) used to connect subsea facilities together

NOTE 1 A flying lead is commonly used to connect e.g. a subsea control module on a subsea tree to a subsea umbilical distribution unit.

NOTE 2 This type of umbilical jumper is lightweight and hence can be picked up from a deployment basket on the seabed and manoeuvred into position using a free-flying ROV.

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2) To be published.

3.1.6
jumper
short segment of flexible pipe with a connector half at either end

NOTE A jumper is commonly used to connect flowlines and/or subsea facilities together, e.g. a subsea flowline to a hard pipe riser installed on a production platform.

3.1.7
process valve
any valve located downstream of the tree wing valves in the production flow path

3.1.8
pull-in head
device used for terminating the end of a flowline or umbilical so that it can be loaded/offloaded from a vessel and pulled along the seabed and/or through an I-tube or J-tube

3.1.9
second-end connection
connection made at the termination point of the flowline or umbilical installation process

3.1.10
spool
short segment of rigid pipe with a connector half at either end

NOTE A spool is commonly used to connect flowlines and/or subsea facilities together, e.g. a subsea tree to a subsea manifold.

3.1.11
ultra-deep water
water depth exceeding 1 830 m (6 000 ft)

NOTE 1 Since the physical circumstances of any situtation will change as a function of water depth, use of the term “ultra-deep water” implies that it may be necessary to consider design and/or technology alternatives.

NOTE 2 For description of pressure and temperature ratings, the definition given in the applicable subsystem International Standard and other relevant standards and design codes is used.

3.1.12
umbilical jumper
short segment of umbilical with a termination plate at either end (incorporating connectors for the various lines) used to connect subsea facilities together

NOTE An umbilical jumper is commonly used to connect e.g. a subsea umbilical termination to a subsea umbilical distribution unit.

3.2 Abbreviated terms

AAV annulus access valve

AC alternating current

ADS atmospheric diving system

AIV annulus isolation valve

AMV annulus master valve

API American Petroleum Institute

ASV annulus swab valve

AUV	autonomous underwater vehicle
AWS	American Welding Society
BOP	blow-out preventer
CRA	corrosion-resistant alloy
C/WO	completion/workover
DC	direct current
DFI	design, fabrication, installation
DHPTT	downhole pressure temperature transmitter
DNV	Det Norske Veritas
EDP	emergency disconnect package
ESD	emergency shutdown
ESP	electrical submersible pump
FAT	factory acceptance test
FMEA	failure mode and effects analysis
FPS	floating production system
FPU	floating production unit
GOR	gas-oil ratio
GVF	gas volume fraction
HAZOP	hazards in operation analysis
HBW	Brinell hardness
HIPPS	high-integrity pressure protection system
HPU	hydraulic power unit
HV	Vickers hardness
HXT	horizontal tree
ID	internal diameter
IPU	integrated pipeline umbilical
LMRP	lower marine riser package (for drilling)
LPMV	lower production master valve
LRFD	load and resistance factored design
LRP	lower riser package (for workover)

LWI	light well intervention
MEG	monoethylene glycol
MIV	methanol injection valve
MODU	mobile offshore drilling unit
MPFM	multiphase flowmeter
MPP	multiphase pump
NACE	National Association of Corrosion Engineers
OTDR	optical time domain reflectometry
PCS	production control system
PGB	permanent guide base
PIV	production isolation valve
PLEM	pipeline end manifold
PLET	pipeline end termination
PLS	plastic limit state
PMV	production master valve
PRE	pitting-resistance equivalent
PSD	production shut-down
PSW	production swab valve
PWV	production wing valve
QRA	quantitative risk analysis
RAL	“Reichsausschuss für Lieferbedingungen”, a Colour system used by German paint manufacturers
ROT	remotely operated tool
ROV	remotely operated vehicle
SAS	safety and automation system
SCM	subsea control module
SCSSV	surface-controlled subsurface safety valve
SEM	subsea electronic module
SIL	safety integrity level
SITHP	shut-in tubing head pressure
SSIV	subsea isolation valve

SSP subsea processing

SUDU subsea umbilical distribution unit

SUT subsea umbilical termination

SXT surface tree

TFL through-flowline system

TGB temporary guidebase

TH tubing hanger

THRT tubing hanger running tool

TRT tree running tool

ULS ultimate limit state

UNS unified numbering system

UPMV upper production master valve

UPS uninterruptable power supply

VXT vertical tree

WAT wax appearance temperature

WHP wellhead pressure

WOCS workover control system

WOR workover riser

XOV cross-over valve

XT tree

4 Systems and interface descriptions

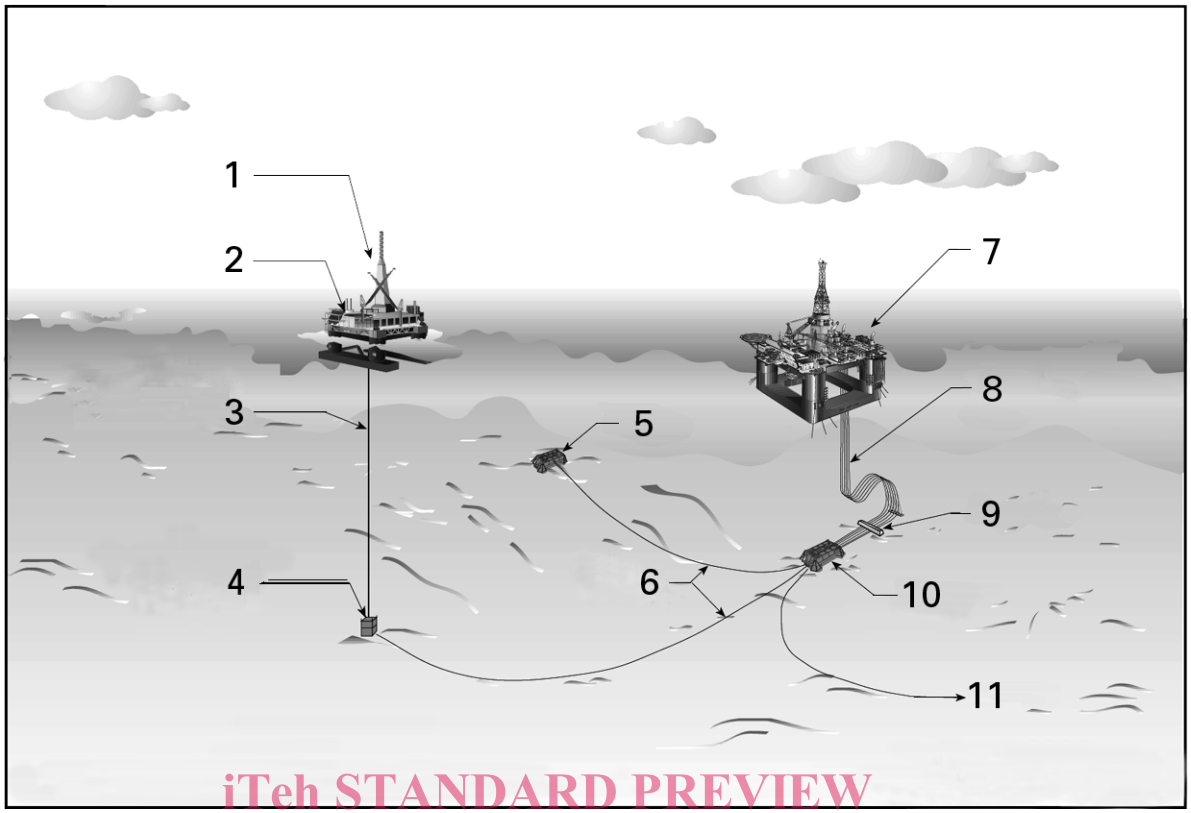
4.1 General

4.1.1 This clause describes subsea systems and main components in general and defines subsystem interfaces and corresponding specification break points.

4.1.2 Subsea production systems can range in complexity from a single satellite well with a flowline linked to a fixed platform or an onshore installation, to several wells on a template or clustered around a manifold producing via subsea processing/commingling facilities and transferring to a fixed or floating facility, or directly to an onshore installation.

4.1.3 The major components of a typical subsea production system are shown in Figure 1. The various elements are further described in detail in Annex A.

4.1.4 Detailed requirements are given in the following clauses and in subsystem standards of this part of ISO 13628. Some specific requirements are covered by this part of ISO 13628 only. They apply to overall system design, materials, structures, manifold piping, colour and marking, and lifting devices.



Key

1 running and retrieving tools
2 installation and workover controls
3 completion/workover riser and workover controls umbilical
4 satellite well
5 template
6 flowlines
7 production controls
8 production riser
9 riser base/SSIV
10 manifold
11 export flowline

Figure 1 — Typical development scenarios

4.2 System description

4.2.1 Subsea production systems can be used to develop reservoirs, or parts of reservoirs, which require drilling of the wells from more than one location. Deep water conditions, or even ultradeep water conditions, can also inherently dictate development of a field by means of a subsea production system, since traditional surface facilities such as on a steel-piled jacket, might be either technically unfeasible or uneconomical due to the water depth.

4.2.2 Subsea equipment may also be used for the injection of water/gas into various formations for disposal and/or to provide pressure maintenance in the reservoir.

4.2.3 The subsystems comprising a subsea production or injection system may include the following:

— a structural foundation/template for positioning and support of various equipment;

— one or more wellhead systems with associated casing strings to provide a basic foundation structure and pressure containment system for the well(s);

— one or more subsea trees incorporating flow and pressure control valves;

— a well entry system, used for initial installation and abandonment, as well as various maintenance activities on the subsea wells which require overhead well entry;

— a PCS for remote monitoring and control of various subsea functions;

— an umbilical which may include electrical power and signal cables, as well as conduits for hydraulic control/service fluids and various chemicals to be injected subsea into the produced fluid streams;

— a manifold system for controlled commingling of various fluid streams;

— multiphase flowmeters, sand detection meters and/or leak detection devices;

— subsea processing equipment, including fluid separation devices and/or pumps/compressors;

— one or more flowlines to convey produced and/or injected fluids between the subsea installations and the host facility;

— HIPPS to protect flowlines not rated for the full shut-in wellhead pressure from being overpressured;

— one or more risers to convey produced and/or injected fluids to/from the various flowlines located on the seafloor to the host processing facilities;

— intervention and inspection, maintenance and repair equipment as defined for all of the above;

— subsea protection structures;

— protection mats;

— pig launcher/receiver;

— pressure- and temperature-monitoring devices;

— power distribution equipment;

— tie-in spools and jumper flowlines;

— flowline and jumper protection devices (mattresses, rock dumping, trenching, dog houses, etc.);

— SSIVs at base of risers.

4.2.4 The subsea production system components are required to functionally and physically interface to each other, as well as to

— the downhole completion equipment, including the SCSSV and any downhole pressure/temperature gauges or chemical injection systems, and to any other interactive components such as remotely operable sliding sleeves and corresponding equipment,

— the host processing facilities, including slug suppression/control devices.

4.3 Subsystem interfaces

4.3.1 Several systems and system elements interface such that determination of e.g. correct design standard in many instances is difficult. In order to avoid inconsistent system design and subsequent contractual disputes, it is recommended to focus on and define these areas and associated standards at an early stage.

4.3.2 Typical system and "code-break" areas which should be addressed are

— tree to flowline/umbilical/manifold,

— tree/TH to well completion system,

— tree to WOR or marine riser,

— tree control system interfaces.

4.3.3 In addition, system-dependent "weak points" should be defined and agreed.

5 Design

5.1 General

5.1.1 When designing a subsea production system, a systems approach should be used which considers equipment and system testing, installation, commissioning, operation, inspection, maintenance, repair, design life and abandonment requirements.

5.1.2 Provision for possible future extensions and operational flexibility to cater for reservoir uncertainty should be planned at an early design stage.

5.1.3 The design of a subsea production system should take into account the above phases of the field development, the requirements to operate the field, and the design data and design loads relevant at the location of the subsea installation. The information should be provided in a design basis document. Typical datasheets included in Annex F may be used for this purpose.

5.1.4 The following subclauses give an overview of typical information required.

5.2 Design criteria

5.2.1 Environmental data

5.2.1.1 General

The following environmental data are typically required for the installation site of the subsea installation, and applicable along flowline routes in the field and along pipeline routes for export.

5.2.1.2 Oceanographic data

Typically data are required for

— *water*: depth, visibility, salinity, temperature, lowest astronomical tide level, highest astronomical tide level, resistivity, oxygen content, pH, mass density, specific heat capacity, swell, surge,

— *currents*: velocity profile, direction, distribution and periodic occurrence through the water column,