International Standard

ISO 13628-1

Third edition
2025-01

Oil and gas industries including low carbon energy — Design and operation of subsea production systems —

Part 1: General requirements and recommendations

Industries du pétrole et du gaz, y compris les énergies à faible teneur en carbone — Conception et exploitation des systèmes de production immergés —

Partie 1: Exigences générales et recommandations

Reference number
ISO 13628-1:2025(en)

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Published in Switzerland

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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This document was prepared by Technical Committee ISO/TC 67, *Oil and gas industries including lower carbon energy*, Subcommittee SC 4, *Drilling, production and injection equipment*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 12, *Oil and gas industries including lower carbon energy,* in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This third edition cancels and replaces the second edition (ISO 13628-1:2005), which has been technically revised. It also incorporates the Amendment ISO 13628-1:2005/Amd 1:2010.

The main changes are as follows:

— ISO 13628-1 has been fully re-written compared to the 2005 edition of the document;

— ISO 13628-1 has been aligned with API RP 17A and is now a technically equivalent document.

A list of all parts in the ISO 13628 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user’s national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

This document has been prepared to provide general requirements and recommendations for the user to the various areas requiring consideration during development of a subsea production system for the petroleum and natural gas industries. The requirements and guidance in this document are intended to complement engineering judgement and facilitate the decision process.

Oil and gas industries including low carbon energy — Design and operation of subsea production systems —

Part 1:
General requirements and recommendations

1 Scope

This document provides general requirements and recommendations for the development and operation of subsea production/injection systems, from the concept development phase to decommissioning and abandonment.

Flexible pipe standards form part of the API 17-series of documents (see 4.3.3); however, this document (technically equivalent to API RP 17A 6th edition) does not generally cover flowlines/pipelines or production/injection risers (associated with flowlines/pipelines). These components form part of a complete subsea production system (SPS), as shown in Figure 1.

2 Normative references

There are no normative references in this document.

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

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

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

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

3.1.2
factory acceptance test
FAT
test conducted to verify that the specified requirements for a product have been fulfilled

3.1.3
first article
first of a product produced using the "normal processes" as will be used to make multiple numbers of the same product

EXAMPLE The first of a new design of SCM manufactured on a production line and intended for use in the field.

Note 1 to entry: As distinct from a prototype, a first article should accurately represent all aspects and functionality of the production-model product.

The "normal processes" typically includes the standard design, procurement, manufacture, QA/QC, and testing processes, as would be used in the production of a production model/production product.

Such a product is suitable for normal use.

First article products are often subjected to comprehensive *verification testing* (3.1.9) and *validation testing* (3.1.8), as well as subsequent strip-down and inspection for evidence of component deterioration and/or loss of functionality.

3.1.4
high-pressure high-temperature
HPHT
any environment above 103,5 MPa (15 000 psi) working pressure and/or operating above 177 °C (350 °F)

3.1.5
interchangeability test
ICT
test conducted to verify that the interchangeability requirements of "identical" products [including products of like design, with respect to the relevant interface(s)], which may be interfaced with other mating products at the installation site, have been fulfilled

3.1.6
life cycle
series of identifiable stages through which an item goes, from its conception to disposal

3.1.7
pilot
first of a product used for an extended period in the intended service in order to validate a concept or process, prior to the manufacture and deployment of additional similar products

EXAMPLE The Troll Pilot subsea separation system.

Note 1 to entry: Similar to a prototype, a pilot is usually a "one-off" and therefore is often not produced using the exact same processes as will be used to make the actual production model of a product (of which multiple numbers are typically produced).

However, unlike a prototype, a pilot should accurately represent all aspects and functionality of the intended production model product in order to ensure a valid test and to be suitable for use in the field.

Based on the results gained from the extended field testing of a pilot, it is not uncommon for the actual production model to be different from the pilot in some aspects.

3.1.8
validation testing
test conducted to confirm that the requirements for a specific intended use or application of a product have been fulfilled

3.1.9
verification testing
test conducted to confirm that the specified requirements for a product have been fulfilled

3.1.10
qualification
process to demonstrate the ability to fulfil specified requirements

EXAMPLE Auditor qualification process, material qualification process.

Note 1 to entry: The term "qualified" is used to designate the corresponding status.

Note 2 to entry: Qualification can concern persons, products, processes or systems.

3.1.11
validation
confirmation, through the provision of objective evidence, that the requirements for a specific intended use or application have been fulfilled

Note 1 to entry: The term "validated" is used to designate the corresponding status.

Note 2 to entry: The use conditions for validation can be real or simulated.

3.1.12
verification
confirmation, through the provision of objective evidence, that specified requirements have been fulfilled

Note 1 to entry: The term "verified" is used to designate the corresponding status.

Note 2 to entry: Confirmation can comprise activities such as:

— performing alternative calculations;

— comparing a new design specification with a similar proven design specification;

— undertaking tests and demonstrations;

— reviewing documents prior to issue.

3.2 Abbreviated terms

BOP	blowout preventer
CRA	corrosion-resistant alloy
C/WO	completion/workover
EDP	emergency disconnect package
FMEA	failure modes and effects analysis
FMECA	failure mode, effects, and criticality analysis
HAZOP	hazard and operability study
HIPPS	high integrity pressure protection system
HSE	health, safety and environment
IWOCS	installation workover control system
LMRP	lower marine riser package
LRFD	load and resistance factored design
MODU	mobile offshore drilling unit
MPFM	multiphase flow meter
OEM	original equipment manufacturer
OREDA	offshore and onshore reliability data
PLEM	pipeline end manifold
QRA	quantitative risk assessment

ROT	remotely operated tool
ROV	remotely operated vehicle
SCM	subsea control module
SUT	subsea umbilical termination
USV	underwater safety valve
VIV	vortex induced vibration
WSD	working stress design

4 Subsea production system

4.1 General

A complete subsea production/injection system comprises several subsystems necessary to produce hydrocarbons from one or more subsea wells and transfer them to a processing/host facility located offshore (fixed, floating, or subsea) or onshore, or to inject water/gas via subsea facilities and/or wells (as shown in Figure 1).

NOTE The term "subsea production system" is used generically throughout this document to describe both production and injection systems.

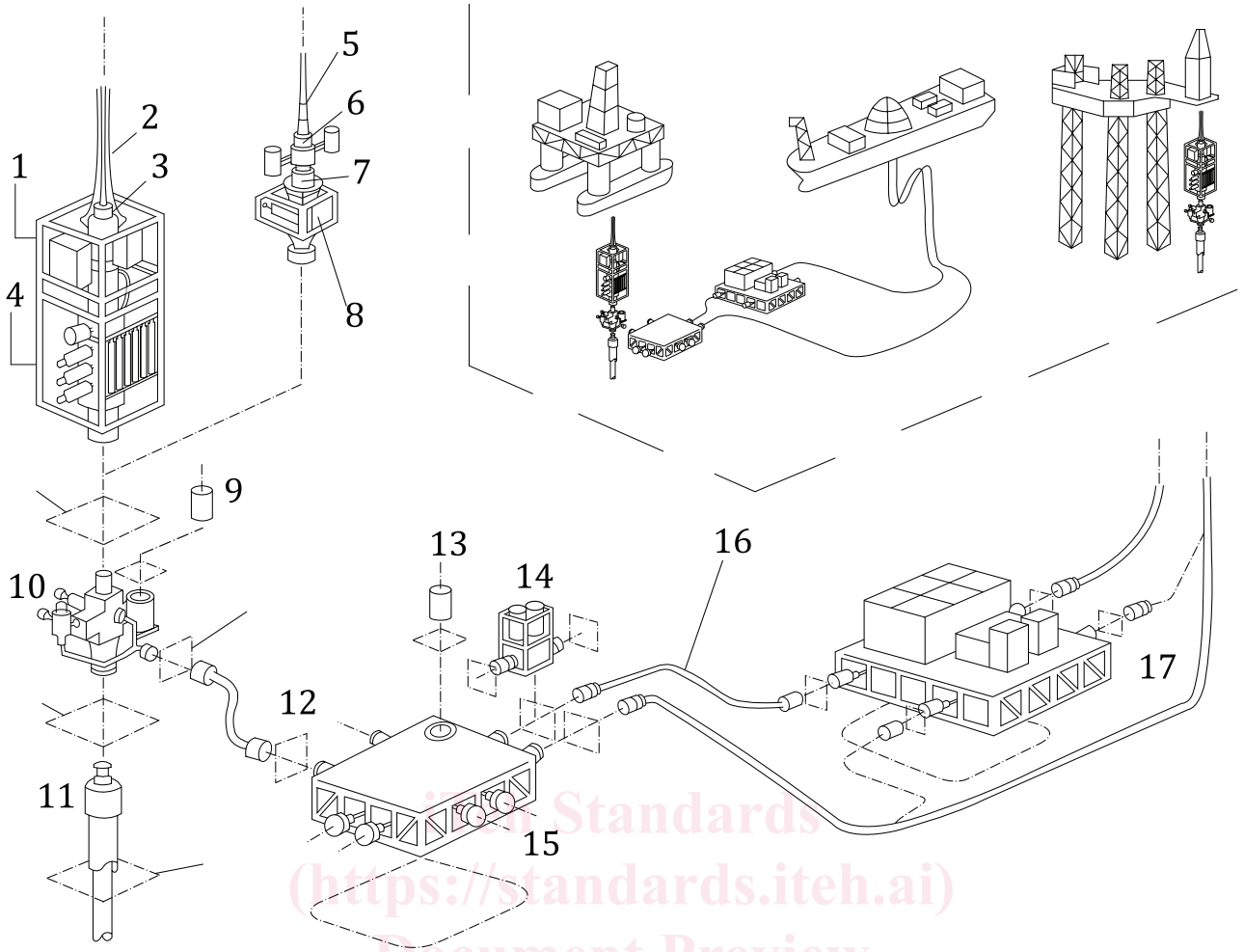
Subsea production systems range in complexity from a single satellite well linked to an offshore or onshore installation to several wells comingled in a subsea manifold producing to a fixed, floating, or onshore facility.

Subsea production systems can be used to produce from shallow-water or deepwater reservoirs. Deepwater conditions can inherently dictate development of a field by means of a subsea production system, since fixed structures such as a steel-piled jacket can be either technically infeasible or uneconomical due to the water depth.

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

4.2 System configuration

The elements of the subsea production or injection system may be configured in numerous ways, as dictated by the specific requirements and the field development strategy. For a description of the various components, assemblies, and subsystems that can be combined to form a complete subsea system, refer to API 17TR13. Figure 1 provides an overview of a basic subsea system.



Key

1	LMRP	10	XT
2	marine riser	11	wellhead
3	flex joint	12	jumper
4	BOP	13	HCM
5	workover riser	14	HIPPS
6	stress joint	15	manifold
7	EDP	16	flowline
8	ERP/well control module	17	process station
9	SCM		

Figure 1 — Basic subsea systems

4.3 Overview of API 17 series documents by categories

4.3.1 System level documents

Subsea documents that address system requirements include the following.

— API RP 17A provides general requirements and recommendations for the development of subsea production systems, from the design phase to decommissioning and abandonment. API 17A also provides guidance to other parts in the API 17 series and related documents.

NOTE API RP 17A is technically equivalent to this document.

— API RP 17N provides recommended practice for subsea production system reliability and technical risk management. Reliability is critical to subsea production system design and operation. API RP 17N provides a comprehensive approach to help ensure that reliability needs are achieved with subsea systems. It is broadly referenced in the deepwater technical community as a foundation document for addressing reliability.

— API RP 17O provides recommended practice for high integrity pressure protection systems (HIPPS). It establishes criteria for HIPPS that are seeing increased utilization in industry as a means to safely provide overall system pressure capability while restricting the section that requires full shut-in pressure rating to a segment that is close to the source.

— API RP 17Q provides recommended practice for subsea equipment qualification. It provides guidance on relevant qualification methods that may be applied to facilitate subsea project execution.

— API RP 17V provides recommended practice for analysis, design, installation, and testing of safety systems for subsea applications. It provides a comprehensive treatment of the requirements for safety systems necessary for a variety of subsea applications.

— API 17TR5 addresses avoidance of blockages in subsea production control and chemical injection systems. It also includes requirements and gives recommendations for the design and operation of subsea production systems with the aim of preventing blockages in control and production chemical fluid conduits and associated connectors/fittings.

— API 17TR6 addresses attributes of production chemicals in subsea production systems. Production chemicals delivered to a subsea production system via a chemical injection system can be complex formulations that have a wide range of chemical and physical properties. In service, the production chemicals can come into contact with other fluids, metallic and polymeric materials, and a range of physical conditions related to temperature and pressure. API 17TR6 was developed with the objective of minimizing the risk of a production chemical not being delivered at the required volumetric rate due to inadequate specification of the production chemical delivery system or formation of restrictions or blockages in that system.

— API 17TR13 provides general overview of subsea production systems. It covers descriptions and basic design guidance on subsea production systems.

4.3.2 Subsea hardware (wellheads, trees, manifolds, structures, connectors, and pumps)

Subsea documents that address assembled equipment include the following.

— API Spec 17D provides specifications for subsea wellheads, mudline wellheads, drill-through mudline wellheads, vertical and horizontal subsea trees, and the associated tooling for handling, testing, and installing this equipment.

— API RP 17P provides recommendations for subsea structures and manifolds used for pressure control in both subsea production of oil and gas and subsea injection ser-vices.

— API RP 17X provides guidance for the design, manufacture, installation, and operation of subsea pumps, including rotary displacement and rotodynamic types for single-phase and multiphase services. It applies to all subsea pump modules placed at or above the mudline.

— API 17TR3 documents the results of a study of the risks and benefits of additional penetrations in subsea wellheads below the blowout preventer (BOP) stack for the purpose of monitoring additional casing annuli for sustained casing pressure. Special attention was paid to the risk and benefits introduced by monitoring annuli other than the “A” annulus (the annulus between the production tubing and the production casing strings).

— API 17TR4 addresses the impact of operation in deepwater on the pressure rating of equipment is a special concern. The objective of API 17TR4 is to foster a better understanding of the effects of simultaneous internal and external pressures on the rated working pressure of equipment covered by the scope of API 17D.