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

Part 14:
Subsea high integrity pressure protection systems (HIPPS)

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

Partie 14: Systèmes immergés de protection contre les pressions à haute intégrité

ICS 75.180.10

ISO/CEN PARALLEL PROCESSING

This draft has been developed within the International Organization for Standardization (ISO), and processed under the **ISO-lead** mode of collaboration as defined in the Vienna Agreement.

This draft is hereby submitted to the ISO member bodies and to the CEN member bodies for a parallel five-month enquiry.

Should this draft be accepted, a final draft, established on the basis of comments received, will be submitted to a parallel two-month approval vote in ISO and formal vote in CEN.

In accordance with the provisions of Council Resolution 15/1993 this document is circulated in the English language only.

Conformément aux dispositions de la Résolution du Conseil 15/1993, ce document est distribué en version anglaise seulement.

To expedite distribution, this document is circulated as received from the committee secretariat. ISO Central Secretariat work of editing and text composition will be undertaken at publication stage.

Pour accélérer la distribution, le présent document est distribué tel qu'il est parvenu du secrétariat du comité. Le travail de rédaction et de composition de texte sera effectué au Secrétariat central de l'ISO au stade de publication.

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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 13628-14 was prepared by Technical Committee ISO/TC 67, *Materials, equipment and offshore structures for the petroleum, petrochemical and natural gas industries*, Subcommittee SC 4, *Drilling and production equipment*.

This is the first edition of ISO 13628-14.

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*

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

— *Part 4: Subsea wellhead and tree equipment*

— *Part 5: Subsea umbilicals*

— *Part 6: Subsea production control sytems*

— *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* (combined into Part 8)

— *Part 10: Specification for bonded flexible pipe*

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

— *Part 12: Dynamic production risers* (under preparation)

— *Part 13:* Vacant

— *Part 14: Subsea high integrity pressure protection systems (HIPPS)*

— *Part 15: Subsea structures and man ifolds (under preparation)*

— *Part 16 Recommended practice for flexib le pipe ancilliary equipment* (under preparation)

— *Part 17: Specification for flexible pipe ancillary equipment* (under preparation)

Introduction

The part of International Standard ISO 13628 has been prepared to provide general recommendations and overall guidance for the designa and operation of remotely operated tools comprising ROT and ROV tooling, used on subsea production systems for the petroleum and natural gas indsutries worldwide.

Specific design requirements are used where a standard design or operating principle has been adopted in the industry for a period of time. Requirements valid for certain geographic areas or environmental conditions, are included where applicable.

The functional recommendations for the tooling systems and interfaces on the subsea production system allow alternative solutions to suite field specific requirements. The intention is to facilitate and complement the decision process rather than replace individual engineering judgement and, where requirements are non-mandatory, to provide positive guidance for hte selection of an optimum solution.

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

Part 14:
Subsea high integrity pressure protection systems (HIPPS)

1 Scope

This part of the International Standard ISO 13628 series addresses the requirements for the use of high integrity pressure protection systems (HIPPS) for subsea applications. ISO 10418, IEC 61508, and IEC 61511 specify the requirements for onshore, topsides, and subsea safety instrumented systems (SIS's) and are applicable to HIPPS, which are designed to autonomously isolate downstream facilities from overpressure situations. This International Standard integrates these requirements to address the specific needs of subsea production. These requirements cover the HIPPS pressure sensors, logic solver, shutdown valves, and ancillary devices including testing, communications, and monitoring subsystems.

2 Normative references

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

ISO 10418, *Petroleum and natural gas industries – Offshore production installations – Basic surface safety systems*

ISO 10423 [1)] , *Petroleum and natural gas industries,*

ISO 13628-1[2)], *Petroleum and natural gas industries, Design and operation of subsea production systems, General requirements and recommendations*

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

ISO 13628-4[4)], *Petroleum and natural gas industries, Design and operation of subsea production systems, Subsea wellhead and Christmas tree equipment*

ISO 13628-6[5)], *Petroleum and natural gas industries, Design and operation of subsea production systems, Subsea Production Control Systems*

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1) API 6A, *Specification Wellhead and Christmas Tree Equipment*, is equivalent to ISO 10423.
2) API 17A, *Design and Operation of Subsea Production Systems—General Requirements and Recommendations, is* equivalent to ISO 13628-1.
3) API 17C, *Recommended Practice on TFL (Through Flowline) Systems*, is equivalent to ISO 13628-3.
4) API 17D, *Recommended Practice on Subsea Wellhead and Christmas Tree Equipment*, is equivalent to ISO 13628-4.
5) API 17F, *Specification for Subsea Production Control Systems*, is equivalent to ISO13628-6.

ISO 13628-8[6] , *Petroleum and natural gas industries, Design and operation of subsea production systems, Remotely operated vehicle (ROV) interfaces.*

NOTE ISO 13628-8 will be withdrawn and r eplaced by ISO 13628-13 when published. In this document, any reference to ISO 13628-8 should be replaced with ISO 13628-13 when published and available.

IEC 61508, Part 1 to Part 4, *Functional safety of electrical/electronic/programmable electronic safety-related systems*

IEC 61511, Part 1, *Functional safety—Safety instrumented systems for the process industry sector*

API Recommended Practice 6HT, *Heat Treatment and Testing of Large Cross Section and Critical Section Components*

ANSI/ASME B31.3, *Process Piping*

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

AWS D1.1, *Structural Welding Code—Steel*

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

ANSI/SAE J517, *Hydraulic Hose*

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

3 Terms, definitions, symbols and abbreviations

3.1 Terms and definitions

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

3.1.1
alternative pressure source
injection fluid used for valve seal test not to exceed the RWP of the HIPPS at its depth rating

NOTE Injection fluid can be any fluid that can be introduced into the system not only for testing but also for flushing or preventing hydrates from forming.

3.1.2
commissioning
functional validation of equipment and facilities prior to initiating operations

3.1.3
dangerous failure
failure which has potential to put safety-related system in a hazardous or fail-to-function state

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6) API 17H, *Recommended Practice for Remotely Operated Vehicle (ROV) Interfaces on Subsea Production Systems,* is equivalent to ISO 13628-8.

3.1.4
final element
part of a SIS which implements the physical action necessary to achieve a safe state

3.1.5
fortified section
piping and equipment with an intermediate pressure rating somewhere between the SIP (high) and MAWP (low) ratings

3.1.6
hardware fault tolerance
HFT
ability of a functional unit to continue to perform a required function in the presence of faults or errors

NOTE In determining the HFT, no account is taken of other measures that may control the effects of faults such as diagnostics, and where one fault directly leads to the occurrence of one or more subsequent faults, these are considered as a single fault.

3.1.7
high integrity pressure protection system
HIPPS
mechanical and electrical-hydraulic SIS used to protect production assets from high-pressure upsets

3.1.8
maximum allowable operating pressure
MAOP
maximum pressure at which a system is allowed to operate that shall not be exceeded in steady state conditions

3.1.9
maximum operating pressure
maximum pressure predicted including deviations from normal operations, such as start-up/shutdown, process flexibility, control requirements, and process upsets

3.1.10
operating pressure
pressure in the equipment when the plant operates at steady state condition, subject to normal variation in operating parameters

3.1.11
overpressure source
one or a combination of sources which can create a pressure buildup beyond the RWP of hardware downstream

NOTE Examples include the reservoir, pressure or boosting equipment (i.e. pump/compressor) manifolds, or other fluid injection sources.

3.1.12
pipeline
piping, risers, and appurtenances installed for transporting oil, gas, sulfur, and produced waters

3.1.13
process hazard
process upset that could result in loss of life, injury to personnel, pollution, or damage to production assets such as overpressure and the subsequent rupture or failure of the process equipment

3.1.14
rated working pressure
RWP
maximum internal pressure that the equipment is designed to contain and/or control

3.1.15
reliability
likelihood of a given piece of safety-related equipment to remain in operation for the expected duration

3.1.16
risk analysis
determination of the frequency of the event (e.g. overpressure) and the ability of safeguards (e.g. HIPPS) to reduce the frequency or the consequence such that the event becomes tolerable, either by being very rare (unlikely) or lessening the impact

3.1.17
safe failure
failure which does not have the potential to put the safety-related system in a hazardous or fail-to-function state

3.1.18
safe failure fraction
SFF
ratio of the average rate of safe failures plus dangerous detected failures of the subsystem to the total average failure rate of the component, as defined by IEC 61508, Part 2

3.1.19
safety instrumented function
SIF
safety function with a specified SIL which is necessary to achieve functional safety and which can be either a safety instrumented protection function or a safety instrumented control function

3.1.20
safety integrity level
SIL
discrete level (one out of four) for specifying the safety integrity requirements of the SIFs to be allocated to the SIS. SIL 4 has the highest level of safety integrity; SIL 1 has the lowest

3.1.21
shut-in pressure
SIP
full internal product process pressure that shall be contained by the HIPPS at the seabed when the high-pressure source is abruptly isolated to protect lower pressure hardware downstream of the spec break

3.1.22
specification (spec) break
point at which equipment pressure rating changes from one RWP rating to a lower one (or vice versa) downstream

NOTE These locations are defined by the normal operating conditions of a flow stream that allows the use of lower design pressure equipment.

3.1.23
subsea tieback
an offshore field developed with one or more wells completed on the seafloor, using subsea trees

NOTE The wells are connected by flowlines and umbilicals—the pathways for electrical and hydraulic signals—to a production facility in another area.

3.1.24
systems integration test
SIT
a process conducted on land to verify the fit, form, and function between interfaces of all subsea equipment and associated running tools prior to offshore installation

3.1.25
systematic failure
failure related in a deterministic way to a certain cause, which can only be eliminated by a modification of the design or of the manufacturing process, operational procedures, documentation, or other relevant factors

3.2 Symbols and abbreviations

C	number of anticipated HIPPS final element closures per year
L	expected design operating life of the HIPPS final element (years)
$MTBF$	mean time (number of cycles) between failures
PFD_a	average PFD
t	defined as the planned testing interval of the entire HIPPS (sensors, logic solvers, and final elements) while in-service to maintain the demonstrated SIL
λ_{du}	dangerous undetectable failures
λ_{TOT}	total failure rate
BSDV	boarding shutdown valve
DCS	distributed control system
DCV	directional control valve
EPU	electrical power unit
ESD	emergency shutdown
FAT	factory acceptance test
FIV	flowline isolation valve
FMECA	failure mode effects and criticality analysis
GOR	gas-oil-ratio
HFT	hardware fault tolerance
HIPPS	high integrity pressure protection system
HPU	hydraulic power unit
HSCM	HIPPS subsea control module
LOPA	layer of protection analysis
MAOP	maximum allowable operating pressure
MAWP	maximum allowable working pressure
MCS	master control station
MOC	management of change
MTBF	mean time between failures
MTTF	mean time to failure
NDE	normally de-energized
NE	normally energized
PCS	production control system
PE	programmable electronics
PES	programmable electronic system
PFD	probability of failure on demand
PLEM	pipeline end manifold
PLET	pipeline end termination
PR	performance requirement
PSD	production shutdown
PSH	pressure switch high
PSL	product specification level
PST	partial stroke testing
PSV	process safety valve
QRA	quantitative risk analysis
QTC	qualification test coupon