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

Part 6:
Subsea production control systems

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

Partie 6: Commandes pour équipements immergés

[Revision of second edition (ISO 13628-6:2006)]

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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.

Contents

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 13628-6 was prepared by Technical Committee ISO/TC 67, *Materials, equipment and offshore structures for petroleum and natural gas industries*, Subcommittee SC 4, *Drilling and production equipment*.

This second edition cancels and replaces the first edition (ISO 13628-6:2000) 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 Tools (ROT) intervention systems*
- *Part 10: Specification for bonded flexible pipe*
- *Part 11: Flexible pipe systems for subsea and marine applications*
- *Part 12:Dynamic production risers (in preparation)*
- *Part 13:Remotely operated tools and interfaces on subsea production systems (in preparation)*
- *Part 14: High integrity pressure protection system (HIPPS) (in preparation)*

— *Part 15: Subsea structures and manifolds*

— *Part 16: Specifications for flexible pipes ancillary equipment (in preparation)*

— *Part 17: Recommended practice for flexible pipes ancillary equipment (in preparation)*

Introduction

Description of hardware is included in this part of ISO 13628 to illustrate functional requirements. This part of ISO 13628 should not be interpreted in a way which would limit new solutions with documented improved life-cycle benefits.

This part of ISO 13628 establishes design standards for systems, subsystems, components and operating fluids in order to provide for the safe and functional control of subsea production equipment.

This part of ISO 13628 contains various types of information related to subsea production control systems.

They are

— informative data that provide an overview of the architecture and general functionality of control systems for the purpose of introduction and information,
— basic prescriptive data that apply to by all types of control system,
— selective prescriptive data that are control-system-type sensitive and apply only where relevant,
— optional data or requirements that need be adopted only when considered necessary either by the purchaser or the vendor.

In view of the diverse nature of the data provided, control system purchasers and specifiers are advised to select from this part of ISO 13628 only the provisions needed for the application at hand. Failure to adopt a selective approach to the provisions contained herein can lead to the subsea control system being over specified and higher purchase costs.

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

Part 6:
Subsea production control systems

1 Scope

This part of ISO 13628 is applicable to design, fabrication, testing, installation and operation of subsea production control systems.

This part of ISO 13628 covers surface control system equipment, subsea-installed control system equipment and control fluids. This equipment is utilized for control of subsea production of oil and gas and for subsea water and gas injection services. Where applicable, this part of ISO 13628 can be used for equipment on multiple-well applications.

Rework and repair of used equipment are beyond the scope of this part of ISO 13628.

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 3722, *Hydraulic fluid power — Fluid sample containers —Qualifying and controlling cleaning methods*

ISO 4406:1999, *Hydraulic fluid power — Fluids — Method for coding the level of contamination by solid particles*

ISO 4407, *Hydraulic fluid power — Fluid contamination – Determination of particulate contamination by the counting method using an optical microscope*

ISO 7498 (all parts), *Information processing systems — Open Systems Interconnection — Basic Reference Model*

ISO/IEC 8802-3, *Information technology — Telecommunications and information exchange between systems — Local and metropolitan area networks — Specific requirements — Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications*

ISO 9606-1, *Approval testing of welders — Fusion welding — Part 1: Steels*

ISO 9606-2, *Qualification test of welders — Fusion welding — Part 2: Aluminium and aluminium alloys*

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

ISO 10945, Hydraulic fluid power — Gas-loaded accumulators — Dimensions of gas ports

ISO/TR 10949, *Hydraulic fluid power — Component cleanliness — Guidelines for achieving and controlling cleanliness of components from manufacture to installation*

ISO 11500, *Hydraulic fluid power -- Determination of the particulate contamination level of a liquid sample by automatic particle counting using the light-extinction principle*

ISO 11898-3, *Road Vehicles – Controller Area Network (CAN) – Part 3: Low-Speed, Fault-Tolerant, Medium-Dependent Interface*

ISO 15607, *Specification and qualification of welding procedures for metallic materials — General rules*

ISO 15609-2, *Specification and qualification of welding procedures for metallic materials —Welding procedure specification — Part 2: Gas welding*

ISO 15610, *Specification and qualification of welding procedures for metallic materials — Qualification based on tested welding consumables*

ISO 15611, *Specification and qualification of welding procedures for metallic materials — Qualification based on previous welding experience*

ISO 15612, *Specification and qualification of welding procedures for metallic materials — Qualification by adoption of a standard welding procedure*

ISO 15613, *Specification and qualification of welding procedures for metallic materials — Qualification based on pre-production welding test*

ISO 15614-1, *Specification and qualification of welding procedures for metallic materials —Welding procedure test — Part 1: Arc and gas welding of steels and arc welding of nickel and nickel alloys*

ISO 16889, *Hydraulic fluid power — Filters — Multi-pass method for evaluating filtration performance of a filter element*

ISO 21018,*Hydraulic fluid power —Monitoring the level of particulate contamination of the fluid — Part 1: General principles*

ANSI/ASME B31.3, *Process Piping*

ANSI/TIA/EIA-568-B, *Commercial Building Telecommunications Cabling Standard*

AS 4059, *Aerospace fluid power — Cleanliness classification for hydraulic fluids*

ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, *Rules for the Construction of Pressure Vessels*

ASME Boiler and Pressure Vessel Code, Section IX, *Welding and Brazing Qualifications*

ASME Boiler and Pressure Vessel Code, Section V,*Non-destructive Examination*

ASTM D97, *Standard Method for Pour Point of Petroleum Products*

ASTM D445, *Standard Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and the Calculation of Dynamic Viscosity)*

ASTM D1141, *Standard Practice for the Preparation of Substitute Ocean Water*

ASTM D1401,*Water Separability of Petroleum Oils and Synthetic Fluids*

ASTM D3233, *Standard Test Methods for Measurement of Extreme Pressure Properties of Fluid Lubricants (Falex Pin and Vee Block Methods)*

ASTM G1:2003, *Standard Practice for Preparing, Cleaning, and Evaluating Corrosion Test Specimens*

BS 7201-1, *Hydraulic fluid power — Gas loaded accumulators — Specification for seamless steel accumulator bodies above 0,5 l water capacity*

CiA 309-1, *Interfacing CANopen with TCP/IP – Part 1: General Principles and Services*

CiA 309-3, *Interfacing CANopen with TCP/IP – Part 3: ASCII Mapping*

CiA 443, *CANopen Profile for SIIS Level-2 Devices*

DIN 41612-2, *Special contacts for multi two-part connectors; concentric contacts (type C)*

IEEE 802.3, *CSMA/CD Ethernet*

Internet RFC 791, *Internet Protocol,* http://www.faqs.org/rfcs/rfc791.html

Internet RFC 793, *The Transmission Control Protocol (TCP),* http://www.faqs.org/rfcs/rfc793.html

Internet RFC 1332, *The PPP Internet Protocol Control Protocol (IPCP),* http://www.ietf.org/rfc/rfc1332.txt

Internet RFC 1661, *The Point-to-Point Protocol (PPP),* http://www.faqs.org/rfcs/rfc1661.html

Internet RFC 768, *User Datagram Protocol*

3 Terms and definitions

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

3.1
boost
pressure maintained on the spring-return side of a subsea actuator for the purposes of improving closing-time response

3.2
closed hydraulic circuit
hydraulic circuit (system) where the used control fluid is returned to the HPU through an umbilical return line

3.3
commanded closure
closure of the underwater safety valve and possibly other valves depending on the control system design

NOTE Such commands can originate manually, automatically or as part of an ESD.

3.4
communication distribution unit
CDU
communicates with the host facility and distributes communication within the subsea network in an electrohydraulic or electric system

3.5
control path
total distance that a control signal (e.g. electrical, optical, hydraulic) travels from the topside control system to the subsea control module or valve actuator

3.6
design life
specified operational life of system after pre-delivery test

3.7
design pressure
maximum pressure for which the system or component was designed for continuous usage

3.8
diagnostic data
data provided to monitor the condition of the equipment

NOTE Can include the ability to make (engineering) adjustments.

3.9
direct hydraulic control
control method wherein hydraulic pressure is applied through an umbilical line to act directly on a subsea valve actuator

NOTE Upon venting of the pressure at the surface, the control fluid is returned through the umbilical to the surface due to the action of the restoring spring in the valve actuator. Subsea functions may be ganged together to reduce the number of umbilical lines.

3.10
downstream
away from a component in the direction of flow

3.11
electrohydraulic control
control method wherein communication signals are conducted to the subsea system and used to open or close electrically-controlled hydraulic control valves. See Annex A.

3.12
electric control
control method wherein communication signals and power are conducted to the subsea system and use motors to open or close Subsea valves. See Annex A.

3.13
expert operation
operating the IWCS with other control commands or other methods than used for normal operation

NOTE Typically used by IWCS supplier or other skilled resource to read IWCS diagnostic data and make (engineering) adjustments to IWCS equipment.

3.14
flying lead
single or multiple composite grouping of hydraulic, chemical, electrical power, electrical signal, and/or optical signal carrying conduits used to interconnect various items of subsea equipment.

NOTE Flying leads may be designed for ROV or ROT assisted deployment.

3.15
hydraulic circuit
arrangement of interconnected components which generates, transmits, controls and converts hydraulic energy

3.16
hydraulic component
individual unit, excluding piping, comprising one or more parts designed to be a functional part of a hydraulic circuit

3.17
hydrostatic test pressure
maximum test pressure at a level greater than the design pressure

3.18
intelligent well
well that employs permanently installed downhole sensors and/or permanently installed downhole control devices that are operable from a surface facility

3.19
intelligent well control system
control system used to operate an intelligent well

3.20
looped hydraulic circuit
hydraulic circuit where the return side of the SCM is connected to the return/boost side of the process valve actuators

NOTE During stroking, used control fluid is expelled to ambient sea for open hydraulic circuits, or into the umbilical return line for closed hydraulic circuits. At the return stroke, control fluid from the actuator function side is looped via the DCV to the actuator return/boost side.

3.21
normal operation
operating the system to perform the intended basic functionality

3.22
offset
horizontal component of control path length

3.23
open hydraulic circuit
hydraulic circuit (system) where the used control fluid is exhausted into the ambient sea at the subsea location.

3.24
response time
sum of the signal time and the shift time

3.25
running tool
tool used to install, operate, retrieve, position or connect subsea equipment remotely from the surface

NOTE An example is the subsea control-module running tool.

3.26
shift time
period of time elapsed between the arrival of a control signal at the subsea location (the completion of the signal time) and the completion of the control function operation

NOTE Of primary interest is the time to fully stroke, on a subsea tree, a master or wing valve that has been designated as the underwater safety valve.

3.27
signal time
period of time elapsed between the remote initiation of a control command and the initiation of a control function operation subsea (the commencement of the shift time)

3.28
subsea production control system
control system operating a subsea production system during production operations

3.29
surface safety valve
safety device that is located in the production bore of the well tubing above the wellhead (platform well), or at the point of subsea well production embarkation onto a platform, and that will automatically close upon loss of hydraulic pressure

3.30
surface controlled subsurface safety valve
safety device that is located in the production bore of the well tubing below the subsea wellhead and that will close on loss of hydraulic pressure

3.31
umbilical
combination of electric cables, hoses or steel tubes, either on their own or in combination (or with fibre optic cables), cabled together for flexibility and over-sheathed and/or armoured for mechanical strength and typically supplying power and hydraulics, communication and chemicals to a subsea system

3.32
underwater safety valve
safety valve assembly that is declared to be the USV and which will automatically close upon loss of power to that actuator

3.33
unlooped hydraulic circuit
hydraulic circuit where the actuator return side and the SCM return side are not interconnected. Control fluid is not looped from either side of the actuator to the other side

3.34
upstream
away from a component against the direction of flow

Pressure definitions

OFFICIAL TERM	WIDELY USED ALTERNATIVE TERMS	3.1.1	DEFINITION	
			COMPONENT BASED	SYSTEM BASED
DESIGN PRESSURE	RATED WORKING PRESSURE	DP	A generic component characteristic. The component is expected to function normally for a given design life and/or a number of cycles at the design pressure in continuous usage.	The maximum pressure for which the system is designed to operate. The system design pressure is limited by the component with the lowest design pressure. This is the maximum set point for the pressure relief valve.
HYDROSTATIC TEST PRESSURE	PROOF PRESSURE; TEST PRESSURE	HTP	Constant pressure, at a defined factor higher than the design pressure applied to a component for a limited duration to demonstrate its integrity without causing destruction or deterioration. The component is not designed to be operated at the hydrostatic test pressure	Constant pressure, at a defined factor higher than the design pressure applied to a system for a limited duration to demonstrate its integrity without causing destruction or deterioration. The system is not designed to be operated at the hydrostatic test pressure
MAXIMUM WORKING PRESSURE	MAXIMUM OPERATING PRESSURE	MAX WP	An operational system characteristic. The highest pressure at which the component is intended to operate in steady state conditions. It shallbe equal or lower than design pressure.	An operational system characteristic. The highest pressure at which the system is intended to operate in steady state conditions.
MINIMUM WORKING PRESSURE	MINIMUM OPERATING PRESSURE	MIN WP	An operational system characteristic. The lowest pressure at which the component is intended to operate in steady state conditions. A safety margin between minimum working pressure, actuator closing pressure and DCV delatching pressure shallbe considered.	An operational system characteristic. The lowest pressure at which the system is intended to operate in steady state conditions. System pressure shallbe equal or above minimum working pressure to avoid unintended change of commanded state of any DCV or actuator.
DCV DELATCHING PRESSURE	DROP-OUT PRESSURE		On falling pressure from normal working pressure towards ambient pressure the pressure at which a DCV moves from the latched open position into the fail-safe close (spring loaded) position.	N/A
DESIGN AMBIENT PRESSURE			A generic component characteristic. The maximum ambient pressure (induced by hydrostatic head) for which the component is designed to operate continuously.	The maximum ambient pressure (induced by hydrostatic head) for which the system is designed to operate continuously. The system design ambient pressure is limited by the component with the lowest design ambient pressure in the system
INTERLOCK PRESSURE			N/A	Pressure at which the MCS locks any further DCV operation to avoid a critical pressure drop below the minimum working pressure.

Definition for 3-phase system according to IEC terminology

TERM	WIDELY USED ALTERNATIVE TERMS	4	DEFINITION	
			COMPONENT BASED	SYSTEM BASED
Voltage AC $_{rms}$	Rated voltage	U_0U (U_m)	A generic cable characteristic. The cable is expected to function normally for a given design life in continuous AC voltage usage.	The maximum voltage for which the cable is designed to operate. The U_0 is the voltage between a line and common reference (ground), U is the line to line voltage and (U_m) is the highest system voltage for which the cable may be used
Voltage DC	Rated voltage	U_0	A generic cable characteristic. The cable is expected to function normally for a given design life in continuous DC usage.	The maximum voltage for which the cable is designed to operate. The U_0 is the voltage between a line and common reference (ground)

4 Symbols and abbreviated terms

β	filtration ratio obtained in ISO 16889 and used to rate the performance of hydraulic filters
ANSI	American National Standards Institute
API	American Petroleum Institute
AS	Aerospace Standard
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
AWS	American Welding Society
CAPEX	capital expenditure
CAT-5	ANSI/TIA/EIA-568-B cables
CAT-6	ANSI/TIA/EIA-568-B.2-1 cables
CiA	CAN in automation
CIU	chemical injection unit
CIV	chemical injection valve
DC	direct current
DCS	distributed control system
DCV	directional control valve
DH	direct hydraulic
EPU	electrical power unit
EM	electromagnetic
EMC	electromagnetic compatibility
ESD	emergency shutdown
ESS	environmental stress screening
ETH	ethernet
EUT	equipment under test
EXT	extended
FAT	factory acceptance test
GND	ground
HIPPS	high integrity pressure protection system
HP	high pressure
HPU	hydraulic power unit
HPHT	high pressure high temp application
ICSS	integrated control and safety system

IEC	International Electrotechnical Commission
I/O	input/output
IP	Internet Protocol
ISD	intelligent seabed device
ISAS	ISD surface application system (system for acquisition and/or control of ISD)
iSEM	intelligent well subsea electronics module
ISO	International Organization for Standardization
IWCS	intelligent well control system
IWE	intelligent well equipment
LP	low pressure
MAC	media access control
MCS	master control station
MIL-STD	military standard
OPC	object linking and embedding (OLE) for process control
OPEX	operational expenditure
OREDA	offshore reliability data
OSI	open system interconnection
PH	piloted hydraulic
PMV	production master valve
PPP	point-to-point protocol
PSD	process shutdown
PTFE	polytetrafluoroethylene
PWV	production wing valve
RET	return
ROT	remotely operated tool
ROV	remotely operated vehicle
RX	radio receiver
SCM	subsea control module
SCSSV	surface-controlled subsurface safety valve
SDU	subsea distribution unit
SPCS	subsea production control system
SPS	subsea production system
TCP	transmission control protocol
TX	radio transmitter
UDP	user datagram protocol
UPS	uninterruptible power supply
USV	underwater safety valve – typically the PMV and/or PWV
VDC	volts direct current

5 System requirements

5.1 General

This clause describes the activities of specifying organisations. Figure 1 depicts the typical subsea control system elements. Reference should be made to Annex A for types and selection of control system, and to Annex B for typical control and monitoring functions.