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

**Part 5:
Subsea umbilicals**

iTeh STANDARD PREVIEW

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

Partie 5: Faisceaux de câbles immergés

ISO 13628-5:2002

[https://standards.itih.ai/catalog/standards/sist/8e5772b3-fefb-4066-972d-
ca9795428072/iso-13628-5-2002](https://standards.itih.ai/catalog/standards/sist/8e5772b3-fefb-4066-972d-ca9795428072/iso-13628-5-2002)



PDF disclaimer

This PDF file may contain embedded typefaces. In accordance with Adobe's licensing policy, this file may be printed or viewed but shall not be edited unless the typefaces which are embedded are licensed to and installed on the computer performing the editing. In downloading this file, parties accept therein the responsibility of not infringing Adobe's licensing policy. The ISO Central Secretariat accepts no liability in this area.

Adobe is a trademark of Adobe Systems Incorporated.

Details of the software products used to create this PDF file can be found in the General Info relative to the file; the PDF-creation parameters were optimized for printing. Every care has been taken to ensure that the file is suitable for use by ISO member bodies. In the unlikely event that a problem relating to it is found, please inform the Central Secretariat at the address given below.

iTeh STANDARD PREVIEW
(standards.iteh.ai)

[ISO 13628-5:2002](https://standards.iteh.ai/catalog/standards/sist/8e5772b3-fefb-4066-972d-ca9795428072/iso-13628-5-2002)

<https://standards.iteh.ai/catalog/standards/sist/8e5772b3-fefb-4066-972d-ca9795428072/iso-13628-5-2002>

© ISO 2002

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.ch
Web www.iso.ch

Printed in Switzerland

Contents

	Page
Foreword	vi
Introduction.....	vii
1 Scope	1
2 Normative references	1
3 Terms, definitions and abbreviated terms	2
3.1 Terms and definitions	2
3.2 Abbreviated terms	7
4 Functional requirements	7
4.1 General requirements	7
4.2 Project-specific requirements	8
5 Quality assurance	8
6 Design requirements	8
6.1 General	8
6.2 Design methodology	9
6.3 Analysis	9
7 Component design, manufacture and test	13
7.1 General	13
7.2 Electric cable	13
7.3 Performance requirements — Electric cable	16
7.4 Structural analysis — Electric cable	16
7.5 Manufacture — Electric cable	17
7.6 Verification tests	18
7.7 Component acceptance tests — Electric cable	20
7.8 Optical fibre cable	22
7.9 Hoses	24
7.10 Metallic tubes	35
8 Terminations and ancillary equipment design	48
8.1 General	48
8.2 Terminations	49
8.3 Ancillary equipment	50
9 Umbilical design	51
9.1 Temperature range	51
9.2 Maximum working load	51
9.3 Minimum breaking load	51
9.4 Minimum bend radius	52
9.5 Dynamic service life	52
9.6 Seabed stability	52
9.7 Service environment	52
9.8 Cross-sectional arrangement	52
9.9 Lay-up	53
9.10 Sub-bundles	53
9.11 Inner sheath	53
9.12 Armouring	53
9.13 Outer sheath	54
9.14 Length marking	54
10 Umbilical manufacture and test	54
10.1 Umbilical manufacture	54

10.2	Verification tests.....	56
11	Umbilical factory acceptance tests (FATs).....	58
11.1	General	58
11.2	Visual and dimensional inspection	59
11.3	Electric cable	59
11.4	Optical fibre cables	59
11.5	Hoses.....	59
11.6	Tubes	60
12	Storage	60
12.1	General	60
12.2	Protection of umbilical services	61
12.3	Spare length.....	61
12.4	Repair kits	61
12.5	Handling for integration tests	61
13	Pre-installation activity	62
13.1	Umbilical information.....	62
13.2	Route information.....	62
13.3	Terminations and ancillary equipment information.....	63
13.4	Host facility information	63
13.5	Subsea structure information	63
13.6	Host facility visit.....	64
14	Load-out	64
14.1	General	64
14.2	Technical audit of load-out facilities	64
14.3	Load-out procedure.....	65
14.4	Pre-load-out meetings	65
14.5	Pre-load-out tests	65
14.6	Load-out operation.....	66
14.7	Stopping and starting the load-out.....	67
14.8	Handling of the umbilical	67
14.9	Load-out monitoring	68
14.10	Load-out on a reel or carousel.....	68
14.11	Post-load-out tests	69
15	Installation operations	69
15.1	General	69
15.2	Requirements for installation vessel and equipment.....	69
15.3	Pre-installation survey.....	70
15.4	I- or J-tube pull-in operations.....	71
15.5	Lay-down of subsea termination (first end)	74
15.6	Lay route	74
15.7	Handling requirements for the main lay.....	74
15.8	Vessel positioning to achieve required touch-down.....	75
15.9	Control and monitoring of length laid.....	75
15.10	Integrity monitoring during lay	76
15.11	Burial operations	76
15.12	Approach to subsea termination position (second end).....	77
15.13	Lay-down of subsea termination	78
15.14	Pull-in of subsea termination	78
15.15	Pipeline crossings.....	78
15.16	Arming of weak link.....	79
15.17	Post-lay survey	79
15.18	Post-burial survey	79
15.19	Post-pull-in test	79
15.20	Post-hook-up test.....	80
15.21	Retrieval of installation aids.....	80
15.22	Contingencies.....	80
15.23	Repairs	81

ITC STANDARD PREVIEW
 (standards.itech.ai)
 ISO 13628-5:2002
<https://standards.itech.ai/catalog/standards/sist/8e5772b3-fefb-4066-972d-ca9795428072/iso-13628-5-2002>

15.24 Post-installation survey	81
Annex A (informative) Information to be provided in a purchaser's functional specification	82
Annex B (informative) Umbilical testing	86
Annex C (informative) Hose and tube preferred sizes	90
Annex D (normative) Characterization tests for hoses and umbilicals	92
Annex E (informative) Fatigue testing	96
Bibliography	103

iTeh STANDARD PREVIEW
(standards.iteh.ai)

[ISO 13628-5:2002](https://standards.iteh.ai/catalog/standards/sist/8e5772b3-fefb-4066-972d-ca9795428072/iso-13628-5-2002)

<https://standards.iteh.ai/catalog/standards/sist/8e5772b3-fefb-4066-972d-ca9795428072/iso-13628-5-2002>

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 3.

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 part of ISO 13628 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 13628-5 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*.

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 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*

Annex D forms a normative part of this part of ISO 13628. Annexes A, B, C and E are for information only.

Introduction

This part of ISO 13628 is based on API Spec 17E, second edition, September 1998, and API RP 17I, first edition August 1996.

Users of this part of ISO 13628 should be aware that further or differing requirements may 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 engineering solutions for the individual application. This may be particularly applicable if there is innovative or developing technology. If an alternative is offered, the vendor should identify any variations from this part of ISO 13628 and provide details.

In this part of ISO 13628, where practical, US Customary units are included in parentheses for information.

iTeh STANDARD PREVIEW (standards.iteh.ai)

[ISO 13628-5:2002](https://standards.iteh.ai/catalog/standards/sist/8e5772b3-fefb-4066-972d-ca9795428072/iso-13628-5-2002)

<https://standards.iteh.ai/catalog/standards/sist/8e5772b3-fefb-4066-972d-ca9795428072/iso-13628-5-2002>

iTeh STANDARD PREVIEW
(standards.iteh.ai)

ISO 13628-5:2002

<https://standards.iteh.ai/catalog/standards/sist/8e5772b3-fefb-4066-972d-ca9795428072/iso-13628-5-2002>

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

Part 5: Subsea umbilicals

1 Scope

This part of ISO 13628 specifies requirements and gives recommendations for the design, material selection, manufacture, design verification, testing, installation and operation of subsea control systems, chemical injection, gas lift, utility and service umbilicals and associated ancillary equipment for the petroleum and natural gas industries.

This part of ISO 13628 applies to umbilicals containing electrical conductors, optical fibres, thermoplastic hoses and metallic tubes, either alone or in combination.

This part of ISO 13628 applies to umbilicals that are for static or dynamic service, and with routings of surface-surface, surface-subsea and subsea-subsea.

This part of ISO 13628 does not apply to the associated component connectors, unless they affect the performance of the umbilical or that of its ancillary equipment.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 13628. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO 13628 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 527 (all parts), *Plastics — Determination of tensile properties*

ISO 1402, *Rubber and plastics hoses and hose assemblies — Hydrostatic testing*

ISO 4080, *Rubber and plastics hoses and hose assemblies — Determination of permeability to gas*

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

ISO 4672:1997, *Rubber and plastics hoses — Sub-ambient temperature flexibility tests*

ISO 6801, *Rubber or plastics hoses — Determination of volumetric expansion*

ISO 6803, *Rubber or plastics hoses and hose assemblies — Hydraulic-pressure impulse test without flexing*

ISO 7751, *Rubber and plastics hoses and hose assemblies — Ratios of proof and burst pressure to design working pressure*

ISO 13628-5:2002(E)

ISO 8308, *Rubber and plastics hoses and tubing — Determination of transmission of liquids through hose and tubing walls*

IEC 60228, *Conductors of insulated cables*

IEC 60502-1, *Power cables with extruded insulation and their accessories for rated voltages from 1 kV ($U_m = 1,2$ kV) up to 30 kV ($U_m = 36$ kV), — Part 1: Cables for rated voltages of 1 kV ($U_m = 1,2$ kV) and 3 kV ($U_m = 3,6$ kV)*

IEC 60502-2 *Power cables with extruded insulation and their accessories for rated voltages from 1 kV ($U_m = 1,2$ kV) up to 30 kV ($U_m = 36$ kV), — Part 2: Cables for rated voltages from 6 kV ($U_m = 7,2$ kV) up to 30 kV ($U_m = 36$ kV)*

IEC 60793-1-1, *Optical fibres — Part 1: Generic specification — General*

IEC 60793-2, *Optical fibres — Part 2: Product specifications*

IEC 60794-1-1, *Optical fibre cables — Part 1-1: Generic specification — General*

IEC 60794-1-2, *Optical fibre cables — Part 1-2: Generic specification — Basic optical cable test procedures*

ASTM A 370, *Standard test methods and definitions for mechanical testing of steel products*

ASTM A 450/A 450M, *Standard specification for general requirements for carbon, ferritic alloy and austenitic alloy steel tubes*

ASTM E 562, *Standard test method for determining volume fraction by systematic manual point count*

ASTM G 48, *Standard test methods for pitting and crevice corrosion resistance of stainless steels and related alloys by the use of ferritic chloride solution*

BS 5099, *Specification for spark testing of electric cables*

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this part of ISO 13628, the following terms and definitions apply:

3.1.1

ancillary equipment

accessory to the umbilical system which does not form part of the main functional purpose

EXAMPLES Weak link, buoyancy collar and I-tube or J-tube seals.

3.1.2

bend limiter

device for limiting the bend radius of the umbilical by mechanical means

NOTE It typically comprises a series of interlocking metallic or moulded rings, applied over the umbilical.

3.1.3

bend stiffener

device for limiting the bend radius of the umbilical by providing a localized increase in bending stiffness

NOTE The stiffener is usually a moulded device, sometimes reinforced, depending on the required duty, applied over the umbilical.

3.1.4**bird-caging**

phenomenon whereby armour wires locally rearrange with an increase and/or decrease in pitch circle diameter as a result of accumulated axial and radial stresses in the armour layer(s)

3.1.5**bundle**

laid-up functional components and associated fillers in the umbilical prior to sheathing

NOTE Typical functional components in a bundle include hoses, tubes, electric cables, optical fibre cables.

3.1.6**carousel**

storage container which can be rotated by a drive about a vertical axis

NOTE It incorporates an inner core structure and an outer peripheral structure, both of which support the umbilical. The umbilical is stored at nominally zero tension. Carousels which do not have a structure on their outer periphery to support the umbilical are often known as turntables.

3.1.7**caterpillar**

cable engine in which the umbilical is held between belts which transfer motive power to the umbilical

3.1.8**characterization data**

data relating to a component or an umbilical giving an indication of performance but not giving specific acceptance/rejection criteria

3.1.9**chinese finger**

type of gripper or stopper used to hold the umbilical via its outer diameter, comprising a number of spirally interwoven wires attached to a built-in anchorage arrangement

3.1.10**core**

generic term used to describe an individual electrically insulated conductor

3.1.11**crab lay**

installation deployment activity whereby the installation vessel moves sideways along, or at the end of, the installation route

3.1.12**design life**

service life multiplied by an appropriate safety factor

3.1.13**design working pressure****DWP**

maximum working pressure at which a hose or tube is rated for continuous operation

3.1.14**design working load**

maximum working load multiplied by an appropriate safety factor

3.1.15**end termination**

mechanical fitting attached to the end of an umbilical which provides a means of transferring installation and operating loads, fluid and electrical services to a mating assembly mounted on the subsea facility or surface facility

3.1.16
factory acceptance test
FAT

series of tests carried out on the complete umbilical system after manufacture is complete, to verify the integrity of the umbilical

3.1.17
functional components

components included within an umbilical which are required to fulfil the operational service needs

EXAMPLES Hoses, tubes, electric/optical fibre cables.

3.1.18
functional specification

document that specifies the totality of needs expressed by features, characteristics, process conditions, boundaries and exclusions defining the performance of a product or service including quality assurance requirements

3.1.19
host facility

fixed or floating facility to which the umbilical is mechanically and functionally connected and which provides the functions and services to be transmitted through the umbilical

EXAMPLES Platform, buoy, floating production system.

3.1.20
hydrogen getter

medium, within an optical fibre system, that chemically neutralizes hydrogen

3.1.21
lay-up
cabling

operation of assembling electrical cores or optical fibres into a cable, or hoses, tubes, electric cables, optical fibre cables into a bundle, or sub-bundle

3.1.22
loadout

transfer of an umbilical or umbilical system from a storage facility onto an installation/shipping vessel either by transfer spooling or by lifting the product stored on its installation/shipping reel

3.1.23
manufacturer's written specification

specification for the umbilical, the umbilical components and their manufacture, generated by the manufacturer in compliance with requirements specified by the purchaser and this part of ISO 13628

NOTE The specification may comprise a multiplicity of documents (design plan, inspection and test plan, test procedures, etc.).

3.1.24
maximum working load

maximum working tensile load that the umbilical can continuously withstand during handling and/or in the installed configuration without suffering damage or loss of performance

NOTE As the bending radius of the umbilical decreases, the maximum working load decreases.

3.1.25
messenger wire

device installed or pre-fitted into an I-tube or J-tube for transferring the primary pulling device, usually a rope, into the tube to provide means of pulling an umbilical through the tube

3.1.26**minimum bend radius**

radius to which a functional component may be bent during processing, reeling and unreeling, storage and installation, service and recovery without damage

NOTE 1 Typical functional components which may be bent include electrical/optical fibre cable, hose, tube, umbilical, etc.

NOTE 2 Minimum bend radius is measured from the centre of the bend to the functional component outer diameter on the inside of its bend, which may vary with the load applied to the component or umbilical.

3.1.27**minimum breaking load**

minimum tensile load that the umbilical can sustain before mechanical failure occurs when the load is applied with the umbilical in a straight condition

3.1.28**moonpool**

open access between a vessel deck and the sea, through which equipment and/or product is deployed

3.1.29**multi-coupler**

multiway connector arrangement comprising two stabplate sub-assemblies, one of which is made of a number of hydraulic and/or electric and/or optical coupler halves, each carrying a separate service, which mate simultaneously with corresponding coupler halves on the other sub-assembly when the two sub-assemblies are brought together

3.1.30**pull-in head**

device used for terminating the end of an 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

[ISO 13628-5:2002](https://standards.iteh.ai/catalog/standards/iso/805772b3-6fb-40c6-973d-us19517607b1c-3608152013)

NOTE In some designs the terminated armours may be used to anchor the umbilical at the top of the I-tube or J-tube. It normally comprises a streamlined cylindrical housing into which the umbilical armouring is terminated and within which the ends of the functional components are contained. It is usually capable of rapid disassembly to access the components for post-pull-in tests and monitoring. A form of pull-in head may also be used at the subsea end of the umbilical.

3.1.31**reel**

device for storing umbilicals or components comprising two flanges, separated by a barrel, with the barrel axis normally being horizontal

3.1.32**service life**

specified time during which the umbilical system shall be capable of meeting the functional requirements

3.1.33**S-N data**

data obtained by plotting cyclic stress level versus number of cycles to failure

3.1.34**splice, verb**

join together component lengths or sub-components to achieve the required production length

3.1.35**subsea termination interface**

mechanism which forms the transition between the umbilical and the subsea termination or subsea umbilical distribution unit

NOTE The interface comprises typically an umbilical armour termination, bend stiffener, hose and/or tube end fittings. If the umbilical contains electric cables, then electrical penetrator(s) and/or electrical connectors may also be incorporated.

3.1.36

subsea umbilical distribution unit

mechanism for mechanically, electrically, optically and/or hydraulically connecting an umbilical independently to more than one subsea system

NOTE In this context, hydraulic fluids includes production system service fluids and produced fluid, control fluid and gas lift lines.

3.1.37

subsea umbilical termination

mechanism for mechanically, electrically, optically and/or hydraulically connecting an umbilical or jumper bundle to a subsea system

NOTE In this context, hydraulic fluids include production system service fluids and produced fluid, control fluid, well service fluid and gas lift lines.

3.1.38

umbilical, noun

group of electric cables, optical fibre cables, hoses, tubes, either on their own or in combination with each other, cabled together for flexibility and oversheathed and/or armoured for mechanical strength

3.1.39

umbilical joint

means of joining together two lengths of umbilical to effect a repair or to achieve the required production length

3.1.40

umbilical system

umbilical, complete with end terminations and other ancillary equipment, installed between a fixed platform, a floating production facility or a land-based station, and a fixed platform, a floating production system or a subsea system, providing control, data communication and transportation of production system service fluids and/or utility supplies

iTeh STANDARD PREVIEW

(standards.iteh.ai)

[ISO 13628-5:2002](https://standards.iteh.ai/catalog/standards/sist/8e5772b3-fefb-4066-972d-ca9795428072/iso-13628-5-2002)

<https://standards.iteh.ai/catalog/standards/sist/8e5772b3-fefb-4066-972d-ca9795428072/iso-13628-5-2002>

3.1.41

unaged representative sample

sample of umbilical, or its internal components, which has not previously been subjected to loadings, stresses and/or elevated temperature

EXAMPLES Electric cables, hoses, tubes and optical fibres.

3.1.42

utility umbilical

umbilical for the provision of electric/hydraulic power, process fluids and data communications installed between two fixed platforms, between a fixed platform and a floating facility, or between a fixed platform/floating facility and a land-based station

3.1.43

virgin material

virgin stock

new and unused material as supplied by the material manufacturer

NOTE Virgin material or virgin stock does not comprise or contain regranulated, recycled, reprocessed, reused or other similar material.

3.1.44

weak link

device which is used to ensure that the umbilical parts or severs at a specified load and location

3.2 Abbreviated terms

For the purposes of this part of ISO 13628, the following abbreviations apply:

AC	alternating current
AVE	apparent volumetric expansion
DC	direct current
DWP	design working pressure
FAT	factory acceptance test
FIR	full indicated reading
<i>d</i>	inside diameter
KP	kilometre point
LAT	lowest astronomical tide
NDE	non-destructive examination
<i>D</i>	outside diameter
OTDR	optical time-domain reflectometer
QA	quality assurance
ROV	remotely operated vehicle
σ_y	specified minimum yield stress
TAN	titrated acid number
TVE	true volumetric expansion
UV	ultra-violet
<i>t</i>	wall thickness

ITC STANDARD PREVIEW
(standards.iteh.ai)

[ISO 13628-5:2002](#)

[standards.iteh.ai/catalog/standards/sist/8e5772b3-fefb-4066-972d-ca9795428072/iso-13628-5-2002](#)

4 Functional requirements

4.1 General requirements

4.1.1 Umbilical

The umbilical, and its constituent components, shall have the following characteristics:

- capable of withstanding all design loads and load combinations and perform its function for the specified design life;
- capable of storage and operation at the specified temperatures during the design life;
- materials: compatible with the environment to which they are exposed and in conformance with the corrosion control and compatibility requirements;
- electric cables: capable of transmitting power and signals with the required characteristics;