BRITISH STANDARD

BS EN ISO 13628-5:2009

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

Part 5: Subsea umbilicals (ISO 13628-5:2009)

ICS 75.180.10

NO COPYING WITHOUT BSI PERMISSION EXCEPT AS PERMITTED BY COPYRIGHT LAW

British Standards Documents Document Sharing Hub

Full document details: BS EN ISO 13628-5:2009

National foreword

This British Standard is the UK implementation of EN ISO 13628-5:2009. It supersedes BS ISO 13628-5:2002 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee PSE/17/-/4, Drilling and production equipment for petroleum and natural gas industries.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 31 January 2010

© BSI 2010

ISBN 978 0 580 54921 2

Amendments/corrigenda issued since publication

Date	Comments

Documents
Document Sharing Hub

Full document details: BS EN ISO 13628-5:2009

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN ISO 13628-5

December 2009

ICS 75.180.10

English Version

Petroleum and natural gas industries - Design and operation of subsea production systems - Part 5: Subsea umbilicals (ISO 13628-5:2009)

Industries du pétrole et du gaz naturel - Conception et exploitation des systèmes de production immergés - Partie 5: Faisceaux de câbles immergés (ISO 13628-5:2009)

Erdöl- und Erdgasindustrie - Konstruktion und Betrieb von Unterwasser-Produktionssystemen - Teil 5: Unterwasser-Versorgungskabel (ISO 13628-5:2009)

This European Standard was approved by CEN on 18 November 2009.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

Management Centre: Avenue Marnix 17, B-1000 Brussels

© 2009 CEN All rights of exploitation in any form and by any means reserved worldwide for CEN national Members.

Ref. No. EN ISO 13628-5:2009: E

Documents
Document Sharing Hub

Full document details: BS EN ISO 13628-5:2009

Foreword

This document (EN ISO 13628-5:2009) has been prepared by Technical Committee ISO/TC 67 “Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries” in collaboration with Technical Committee CEN/TC 12 “Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries” the secretariat of which is held by AFNOR.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by June 2010, and conflicting national standards shall be withdrawn at the latest by June 2010.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

Endorsement notice

The text of ISO 13628-5:2009 has been approved by CEN as a EN ISO 13628-5:2009 without any modification.

Documents
Document Sharing Hub

Full document details: BS EN ISO 13628-5:2009

Contents

Page

Foreword vi

Introduction vii

1 Scope 1

2 Normative references 1

3 Terms, abbreviated terms and definitions 3
3.1 Terms and definitions 3
3.2 Abbreviated terms 10

4 Functional requirements 11
4.1 General requirements 11
4.2 Project-specific requirements 12

5 Safety, design and testing philosophy 12
5.1 Application 12
5.2 Safety objective 12
5.3 Systematic review 12
5.4 Fundamental requirements 12
5.5 Design philosophy 13
5.6 Testing 14

6 Design requirements 16
6.1 General 16
6.2 Loads 16
6.3 Load effect analysis 20
6.4 Installation analysis 26
6.5 Fatigue life 27

7 Component design, manufacture and test 27
7.1 General 27
7.2 Electric cables 28
7.3 Hoses 38
7.4 Optical-fibre cable 49
7.5 Metallic tubes 54

8 Terminations and ancillary equipment design 71
8.1 Design principles 71
8.2 Design process 71
8.3 Armour terminations 71
8.4 Tube and hose terminations 72
8.5 Cable terminations 72
8.6 Pull-in head 73
8.7 Topside hang-off 73
8.8 Subsea termination interface 74
8.9 Subsea umbilical termination 74
8.10 Bend restrictors 74
8.11 Bend stiffeners 75
8.12 Ancillary equipment 75

9 Umbilical design 78
9.1 Temperature range 78
9.2 Maximum tensile load 78
9.3 Ultimate tensile load 78
9.4 Minimum bend radius 78

Documents
Document Sharing Hub

© ISO 2009 – All rights reserved

Full document details: BS EN ISO 13628-5:2009

9.5 Cross-sectional arrangement 78
9.6 Lay-up 79
9.7 Sub-bundles 79
9.8 Inner sheath 79
9.9 Armouring 79
9.10 Outer sheath 80
9.11 Length marking 80

10 Umbilical manufacture and test 80
10.1 Umbilical manufacture 80
10.2 Qualification and verification tests 83

11 Factory acceptance tests 84
11.1 General 84
11.2 Visual and dimensional inspection 84
11.3 Electrical continuity at the termination 84
11.4 Trial termination fit-up 84
11.5 Electric cable 84
11.6 Optical fibre cables 85
11.7 Hoses 85
11.8 Tubes 86
11.9 Terminations 86
11.10 Continuity check 86

12 Storage 86
12.1 General 86
12.2 Protection of unterminated umbilical components 86
12.3 Spare length 87
12.4 Repair kits 87
12.5 Handling for integration tests 87

13 Pre-installation activity 87
13.1 Umbilical information 87
13.2 Route information 88
13.3 Terminations and ancillary equipment information 88
13.4 Host facility information 89
13.5 Subsea structure information 89
13.6 Host facility visit 89

14 Load-out 90
14.1 General 90
14.2 Technical audit of load-out facilities 90
14.3 Load-out procedure 91
14.4 Pre-load-out meetings 91
14.5 Pre-load-out tests 91
14.6 Load-out operation 92
14.7 Stopping and starting the load-out 93
14.8 Handling of the umbilical 93
14.9 Load-out monitoring 94
14.10 Load-out on a reel or carousel 94
14.11 Post-load-out tests 95

15 Installation operations 95
15.1 General 95
15.2 Requirements for installation vessel and equipment 95
15.3 Pre-installation survey 96
15.4 I-tube or J-tube pull-in operations 97
15.5 Lay-down of subsea termination (first end) 100
15.6 Lay route 100
15.7 Handling requirements for the main lay 100
15.8 Vessel positioning to achieve required touch-down 101
15.9 Control and monitoring of length laid 101
15.10 Integrity monitoring during lay 102

Documents
Document Sharing Hub

© ISO 2009 – All rights reserved

Full document details: BS EN ISO 13628-5:2009

15.11 Burial operations **103**
15.12 Approach to subsea termination position (second end) **104**
15.13 Lay-down of subsea termination **104**
15.14 Pull-in of subsea termination **105**
15.15 Pipeline crossings **105**
15.16 Buoyancy attachments **106**
15.17 Arming of the weak link **106**
15.18 Post-lay survey **106**
15.19 Post-burial survey **106**
15.20 Post-pull-in test **107**
15.21 Post-hook-up test **107**
15.22 Retrieval of installation aids **108**
15.23 Contingencies **108**
15.24 Repairs **108**
15.25 Post-installation survey **108**

Annex A (informative) **Information that should be provided in a purchaser's functional specification** **109**

Annex B (informative) **Umbilical testing** **116**

Annex C (informative) **Hose and tube preferred sizes** **120**

Annex D (normative) **Characterization tests for hoses and umbilicals** **121**

Annex E (informative) **Fatigue testing** **125**

Annex F (informative) **Load-effect analysis** **127**

Annex G (informative) **Umbilical full-scale tests** **139**

Annex H (informative) **Tube material matrix** **145**

Annex I (informative) **Tube-wall thickness example calculation** **157**

Annex J (informative) **Buckling of metallic tubes** **164**

Bibliography **167**

© ISO 2009 – All rights reserved

Documents
Document Sharing Hub
Full document details: BS EN ISO 13628-5:2009

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 13628-5 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 13628-5:2002), 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 Tool (ROT) intervention systems*

— *Part 10: Specification for bonded flexible pipe*

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

A Part 12, dealing with dynamic production risers, a Part 13, dealing with remotely operated tool and interfaces on subsea production systems, a Part 15, dealing with subsea structures and manifolds, a Part 16, dealing with specification for flexible pipe ancillary equipment, and a Part 17, dealing with recommended practice for flexible pipe ancillary equipment, are under development.

© ISO 2009 – All rights reserved
Documents
Document Sharing Hub
Full document details: BS EN ISO 13628-5:2009

Introduction

This part of ISO 13628 is based on the first edition of ISO 13628-5, which was based on API Spec 17E, second edition and API RP 17I, first edition. The first edition of ISO 13628-5 was adopted by API as API Spec 17E, third edition. It is intended that API Spec 17E, fourth edition, will be identical to this International Standard.

It is important that users of this part of ISO 13628 be aware that further or differing requirements can 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 can be particularly applicable if there is innovative or developing technology. If an alternative is offered, it is the responsibility of the vendor to identify any variations from this part of ISO 13628 and provide details.

In this part of ISO 13628, where practical, US Customary (USC) and other units are included in parentheses for information.

© ISO 2009 – All rights reserved

Documents
Document Sharing Hub
Full document details: BS EN ISO 13628-5:2009

Documents
Document Sharing Hub

Full document details: BS EN ISO 13628-5:2009

INTERNATIONAL STANDARD ISO 13628-5:2009(E)

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 umbilicals and associated ancillary equipment for the petroleum and natural gas industries. Ancillary equipment does not include topside hardware. Topside hardware refers to any hardware that is not permanently attached to the umbilical, above the topside hang-off termination.

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

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

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.

This part of ISO 13628 applies only to tubes with the following dimensions: wall thickness, $t < 6$ mm, internal diameter, ID < 50,8 mm (2 in). Tubular products greater than these dimensions can be regarded as pipe/linepipe and it is expected that they be designed and manufactured according to a recognised pipeline/linepipe standard.

This part of ISO 13628 does not apply to a tube or hose rated lower than 7 MPa (1 015 psi).

This part of ISO 13628 does not apply to electric cable voltage ratings above standard rated voltages $U_0 / U(U_m) = 3{,}6/6(7{,}2)$ kV rms, where U_0, U and U_m are as defined in IEC 60502-1 and IEC 60502-2.

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 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*

Documents
Document Sharing Hub

© ISO 2009 – All rights reserved

Full document details: BS EN ISO 13628-5:2009

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

ISO 6803:2008, *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 13628-8, *Petroleum and natural gas industries — Design and operation of subsea production systems — Part 8: Remotely Operated Vehicle (ROV) interfaces on subsea production systems*

ISO 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 1-1: Measurement methods and test procedures — General and guidance*

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

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*

EN 10204:2004, *Metallic products — Types of inspection documents*

ASTM A240, *Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications*

ASTM A370, *Standard Test Methods and Definitions for Mechanical Testing of Steel Products*

ASTM A480, *Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip*

ASTM A789/A789M, *Standard Specification for Seamless and Welded Ferritic/Austenitic Stainless Steel Tubing for General Service*

ASTM A1016/A1016M-04A, *Standard Specification for General Requirements for Ferritic Alloy Steel, Austenitic Alloy Steel and Stainless Steel Tubes*

ASTM E8/E8M, *Standard Test Methods for Tension Testing of Metallic Materials*

ASTM E92, *Standard Test Method for Vickers Hardness of Metallic Materials*

ASTM E213, *Standard Practice for Ultrasonic Examination of Metal Pipe And Tubing*

ASTM E273, *Standard Practice for Ultrasonic Examination of the Weld Zone of Welded Pipe and Tubing*

ASTM E309, *Standard Practice for Eddy-Current Examination of Steel Tubular Products Using Magnetic Saturation*

Documents
Document Sharing Hub
© ISO 2009 – All rights reserved
Full document details: BS EN ISO 13628-5:2009

ASTM E384, *Standard Test Method for Microindentation Hardness of Materials*

ASTM E426, *Standard Practice for Electromagnetic (Eddy-Current) Examination of Seamless and Welded Tubular Products, Austenitic Stainless Steel and Similar Alloys*

ASTM E562, *Standard Test Method for Determining Volume Fraction by Systematic Manual Point Count*

ASTM E1001, *Standard Practice for Detection and Evaluation of Discontinuities by the Immersed Pulse-Echo Ultrasonic Method Using Longitudinal Waves*

ASTM E1245, *Standard Practice for Determining the Inclusion or Second-Phase Constituent Content of Metals by Automatic Image Analysis*

ASTM G48-03, *Standard Test Methods for Pitting And Crevice Corrosion Resistance of Stainless Steels and Related Alloys by Use of Ferritic Chloride Solution*

BS 5099, *Electric cables. Voltage levels for spark testing*

ITU-T G.976, *Test methods applicable to optical fibre submarine cable systems*

3 Terms, abbreviated terms and definitions

3.1 Terms and definitions

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

3.1.1
allowable bend radius
minimum radius to which an umbilical, at a given tension, may be bent to without infringing design criteria or suffering loss of performance

See Figure 1.

NOTE 1 The bend radius is measured to the centreline of the umbilical.

NOTE 2 Allowable bend radius increases with increasing tensile load and varies depending on internal pressure and condition, i.e. safety level.

3.1.2
allowable tensile load
maximum tensile load that an umbilical, at a given bend radius, can be loaded to without infringing design criteria or suffering loss of performance

See Figure 1.

NOTE Allowable tensile load decreases with decreasing bend radius and will vary depending on internal pressure and condition, i.e. safety level.

3.1.3
ancillary equipment
accessory to the umbilical system that does not form part of the main functional purpose

EXAMPLES Weak link, buoyancy attachments, I-tube or J-tube seals, VIV strakes, centralizers, anchors external clamps.

© ISO 2009 – All rights reserved

Documents
Document Sharing Hub
Full document details: BS EN ISO 13628-5:2009

3.1.4
bend restrictor
device for limiting the bend radius of the umbilical by mechanical means

NOTE A bend restrictor typically is comprised of a series of interlocking metallic or moulded rings, applied over the umbilical. It is sometimes referred to as a bend strain reliever (BSR).

3.1.5
bend stiffener
device for providing a localized increase in bending stiffness, preserving the minimum bend radius of the umbilical under defined bending moment conditions

NOTE The stiffener is usually a moulded device, sometimes reinforced, depending on the required duty, applied over the umbilical. It is sometimes referred to as a bend strain reliever (BSR).

3.1.6
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)

3.1.7
bundle
laid-up functional components and associated fillers in the umbilical prior to further processing

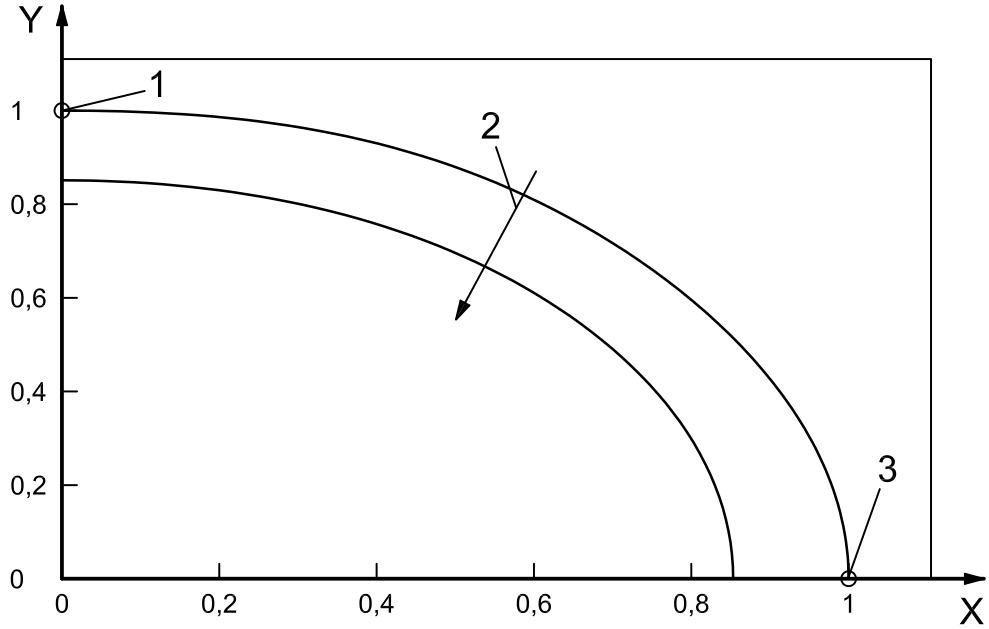
NOTE Typical functional components in a bundle include hoses, tubes, electric cables, optical fibre cables.

3.1.8
capacity curve
curve that defines the relationship between the allowable bend radius and allowable tension for an internal pressure condition

See Figure 1.

NOTE Curves can, therefore, differ for storage, testing, installation and operation scenarios.

© ISO 2009 – All rights reserved
Documents
Document Sharing Hub
Full document details: BS EN ISO 13628-5:2009



Key

X inverse of the normalized bend radius, MBR per radius

Y normalized allowable tensile load, tension per MTL

1 maximum tensile load (MTL) with no bending

2 increasing pressure and/or increasing safety level

3 inverse of minimum bend radius (MBR) with no tension

NOTE 1 Increasing the level of safety generally increases the allowable bend radius and decreases the allowable tensile load, i.e. moves the capacity curves towards origin.

NOTE 2 Increasing the internal pressure generally increases the allowable bend radius and decreases the allowable tensile load, i.e. moves the capacity curves towards origin.

Figure 1 — Capacity curves

3.1.9
carousel
storage container that can be rotated by a drive about a vertical axis

3.1.10
caterpillar
device that holds the umbilical between belts or pads and which transfers axial linear motive power to the umbilical

NOTE A caterpillar is also known as an in-line cable engine, or haul off, or tensioner.

3.1.11
characterization data
data relating to a component or an umbilical giving an indication of performance but not giving specific acceptance/rejection criteria

3.1.12
chinese finger
type of gripper used to hold the umbilical via its outer diameter, comprised of a number of spirally interwoven wires or synthetic rope attached to a built-in anchorage arrangement

© ISO 2009 – All rights reserved

Documents
Document Sharing Hub
Full document details: BS EN ISO 13628-5:2009

3.1.13
core
generic term used to describe an individual electrically insulated conductor

3.1.14
crab lay
installation deployment activity whereby the installation vessel moves sideways along, or at the end of, the installation route

3.1.15
crushing load
load that acts in the radial direction that might not be evenly distributed along the circumference and that is limited in length along the umbilical

NOTE A crushing load is typically induced during installation.

3.1.16
deep water
water depth generally ranging from 610 m (2 000 ft) to 1 830 m (6 000 ft)

3.1.17
design life
service life multiplied by an appropriate factor that is equal to, or greater than, one

3.1.18
design working pressure
DWP
maximum working pressure at which a hose or tube is rated for continuous operation

3.1.19
design tensile load
maximum tensile load multiplied by an appropriate factor that is equal to, or less than, one

3.1.20
end termination
mechanical fitting that is attached to the end of an umbilical and that 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

3.1.21
factory acceptance test
series of tests carried out on the completed umbilical component or complete umbilical to demonstrate the integrity of the item under test

3.1.22
filler
item wholly or partially filling the voids between the **functional components** (3.1.23) with the purpose(s) of maintaining the relative location of the components, maintaining the shape of the cross-section, influencing the weight-to-diameter ratio, separating components for wear considerations, or providing a certain radial stiffness

3.1.23
functional component
hoses, tubes, electric/optical fibre cables included within an umbilical which are required to fulfil the operational service needs

© ISO 2009 – All rights reserved
Documents
Document Sharing Hub
Full document details: BS EN ISO 13628-5:2009

3.1.24
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

3.1.25
host facility
fixed or floating facility to which the umbilical is mechanically and functionally connected and that provides the functions and services transmitted through the umbilical

EXAMPLES Platform, buoy, floating production system.

3.1.26
hydrogen scavenger
gel material applied inside the tube (metal or polymer) holding the optical fibre to absorb hydrogen ions that prevent fibre from “darkening” and from reducing transmission capabilities

3.1.27
independent verification agent
party or group independent from the manufacturer and the purchaser

3.1.28
lay-up
operation of helically assembling (SZ where appropriate) electrical cores or optical fibres into a cable, or hoses, tubes, electric cables, optical fibre cables into a bundle or sub-bundle

NOTE Sometimes referred to as “cabling”.

3.1.29
lay angle
angle between the axis of a spiral-wound element (e.g. armour wires) and a line parallel to the longitudinal axis of the umbilical

3.1.30
load-out
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

3.1.31
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 be comprised of a multiplicity of documents (design plan, inspection and test plan, test procedures, etc.).

3.1.32
maximum tensile load
maximum tensile load that an umbilical, with zero curvature, can withstand without infringing the stress criterion or suffering loss of performance

See Figure 1, and 3.1.8.

3.1.33
messenger wire
device installed or pre-fitted into an I-tube or J-tube for transferring the primary pulling device, usually a wire rope, into the tube to provide means of pulling an umbilical through the tube

© ISO 2009 – All rights reserved

Documents
Document Sharing Hub
Full document details: BS EN ISO 13628-5:2009

3.1.34
minimum bend radius
minimum radius to which an umbilical, at zero tensile load, can be bent to without infringing the stress criterion or suffering loss of performance

See Figure 1 and 3.1.8.

3.1.35
multi-coupler
multi-way connector arrangement comprised of two mating 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, that mate simultaneously with corresponding coupler halves on the other sub-assembly when the two sub-assemblies are brought together

3.1.36
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

NOTE In some designs, the terminated armours can be used to anchor the umbilical at the top of the I-tube or J-tube. It normally is comprised of 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.

3.1.37
reel
device for storing, transporting, or installing umbilicals or components comprised of two flanges, separated by a barrel, with the barrel axis normally being horizontal

NOTE Reels are designed for the intended use.

3.1.38
service life
specified time during which the umbilical system shall be capable of meeting the functional requirements

3.1.39
S-N data
data obtained by plotting cyclic stress level versus number of cycles to failure

3.1.40
splice
join together component lengths or sub-components to achieve the required production length

3.1.41
static application
application for which the load effect(s) due to dynamic loads (e.g. wave action, induced vibrations, etc.) when installed can be neglected

NOTE Free spans, in an otherwise static umbilical, should be considered as a dynamic application.

3.1.42
subsea termination interface
mechanism that forms the transition between the umbilical and the subsea termination

NOTE The interface is comprised typically of an umbilical armour termination and/or a mechanical anchoring device for the tubes, bend stiffener/limiter, and tube or hose-end fittings. If the umbilical contains electric cables/fibre optics, then penetrator(s) and/or connectors may also be incorporated.

Documents
Document Sharing Hub
© ISO 2009 – All rights reserved
Full document details: BS EN ISO 13628-5:2009

3.1.43
subsea umbilical termination
mechanism for mechanically, electrically, optically and/or hydraulically connecting an umbilical or jumper bundle to a subsea system

3.1.44
tensile armour
structural layer consisting of e.g. steel wires, fibre reinforced plastic rods, etc. that is used to sustain tensile loads in the umbilical

NOTE For some applications, the tensile armour may also have the additional function of providing additional weight and/or impact protection.

3.1.45
ultimate tensile load
load at which the weakest component of the umbilical bundle fails when the load is applied with the umbilical in a straight condition

3.1.46
ultra-deep water
term used to imply depths exceeding 1 830 m (6 000 ft), which can necessitate the consideration of design and/or technology alternatives

3.1.47
umbilical
group of functional components, such as electric cables, optical fibre cables, hoses, and tubes, laid up or bundled together or in combination with each other, that generally provides hydraulics, fluid injection, power and/or communication services

NOTE Other elements or armouring may be included for strength, protection, or weight considerations.

3.1.48
umbilical joint
means of joining together two lengths of umbilical to effect a repair or to achieve the required production length

3.1.49
umbilical system
umbilical, complete with end terminations and other ancillary equipment

3.1.50
unaged representative sample
non-degraded sample of umbilical, or component that has not previously been subjected to operational or installation loadings, stresses, elevated temperature, and/or other conditions that can degrade the sample

EXAMPLES Electric cables, hoses, tubes and optical fibres.

3.1.51
verification test
test performed to qualify the design and manufacture of the item for its use in service as well as to provide characterization data

3.1.52
weak link
device that is used to ensure that the umbilical parts or severs at a specified load and location

© ISO 2009 – All rights reserved

Documents
Document Sharing Hub
Full document details: BS EN ISO 13628-5:2009

3.2 Abbreviated terms

AC alternating current

AVE apparent volumetric expansion

CP corrosion protection

DC direct current

DWP design working pressure (mathematical symbol: p_{DW})

FAT factory acceptance test

FD frequency domain

FE finite element

FEM finite element modelling

ID inside diameter (mathematical symbol: d)

LTD linearized time domain

MBR minimum bending radius at zero tensile load

MTL maximum tensile load

NDE non-destructive examination

NTD nonlinear time domain

OD outside diameter (mathematical symbol: D)

OTDR optical time-domain reflectometer

PMI portable metal identification

PRE pitting resistance equivalent

RAO response amplitude operator

ROV remotely operated vehicle

SF safety factor

SMYS specified minimum yield strength (mathematical symbol: σ_{SMY})

TDR time-domain reflectometry

TVE true volumetric expansion

UT ultrasonic testing

UV ultra-violet

VIV vortex-induced vibration

WT wall thickness (mathematical symbol: t)

© ISO 2009 – All rights reserved
Documents
Document Sharing Hub
Full document details: BS EN ISO 13628-5:2009

4 Functional requirements

4.1 General requirements

4.1.1 Umbilical

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

a) be capable of withstanding specified design loads and load combinations and perform its function for the specified design life;

b) be capable of storage and operation at the specified temperatures during the design life;

c) be composed of materials compatible with the environment to which they are exposed, including permeating fluids, and in conformance with the corrosion control and compatibility requirements;

d) have electric cables capable of transmitting power and signals with the required characteristics;

e) have optical fibres capable of transmitting signals at the required wavelengths within the attenuation specified;

f) have hoses and/or tubes capable of conveying fluids at the required flow rate, pressure, temperature and cleanliness levels;

g) be capable of venting, in a controlled manner, if permeation through components can occur;

h) be capable of being installed, recovered and reinstalled as defined in the manufacturer's written specification.

4.1.2 End terminations and ancillary equipment

End-termination interfaces with the umbilical components are a critical area and should be addressed during the design review stage.

End terminations and ancillary equipment shall, as a minimum, meet the same functional requirements as the umbilical. If applicable, the following shall be demonstrated.

a) The end termination shall provide a structural interface between the umbilical and the support structure.

b) The end termination can provide a structural interface between the umbilical and bend restrictor/bend stiffener device.

c) The end termination shall not downgrade the service life of the umbilical or the system performance below the functional requirements.

d) CP shall meet the design life requirement.

e) Contingency or planned recovery of the end termination to the surface during installation shall not downgrade the service life or system performance of the umbilical.

f) The materials in the end terminations shall be compatible with any specified fluids with which they come into contact (including potential permeation).

© ISO 2009 – All rights reserved

Documents
Document Sharing Hub
Full document details: BS EN ISO 13628-5:2009

4.2 Project-specific requirements

The purchaser shall specify the functional requirements for the umbilical.

Functional requirements neither specifically required nor specified by the purchaser but which can affect the design, materials, manufacturing, testing, installation and operation of the umbilical shall be specified by the manufacturer. If the purchaser does not specify a requirement and its absence does not affect any of these activities, the manufacturer may assume there is no requirement.

NOTE Annex A provides a basis for such specifications.

5 Safety, design and testing philosophy

5.1 Application

Clause 5 applies to umbilical systems, including umbilicals, terminations and auxiliary equipment that are built in accordance with this part of ISO 13628.

5.2 Safety objective

An overall safety objective shall be established, planned and implemented covering all phases from conceptual development until retrieval or abandonment.

All companies have policy regarding human aspects and environment issues. These are typically on an overall level, but more detailed objectives and requirements in specific areas can follow them. These policies should be used as a basis for defining the safety objective for a specified umbilical system.

5.3 Systematic review

A systematic review or analysis shall be carried out for all phases (e.g. manufacture, load-out, installation and operation) in order to identify and evaluate the consequences of single failures and series of failures in the umbilical, such that necessary remedial measures can be taken. The consequences include consequences of such events for people, for the environment and for the entire subsea system and financial interests.

The operator shall determine the extent of risk assessments and the risk assessment methods, and it should be the operator's responsibility to perform the systematic review.

5.4 Fundamental requirements

5.4.1 General

The following fundamental requirements apply.

— The materials and products shall be used as specified in this part of ISO 13628 or in the relevant material or product specification.

— Adequate supervision and quality control shall be provided during manufacture and fabrication.

— Manufacture, fabrication, handling, transportation and operation shall be carried out by personnel having the appropriate skill and experience. Reference is made to recognized standards for personnel qualifications.

— The umbilical shall be adequately maintained including inspection and preservation when applicable.

— The umbilical shall be operated in accordance with the design basis and the installation and operating manuals.

© ISO 2009 – All rights reserved
Documents
Document Sharing Hub
Full document details: BS EN ISO 13628-5:2009

— Design reviews shall be carried out where all contributing and affected disciplines (professional sectors) are included to identify and solve any problems.

— Verification shall be performed to check compliance with provisions contained herein in addition to purchaser requirements and national and international regulations. The extent of the verification and the verification method in the various phases, including design and fabrication, shall be agreed with the purchaser. As a minimum, the manufacturer shall issue an inspection and test plan with planned surveillance and QC and shall issue this to the purchaser. The inspection and test plan shall include plans for sub-supplier and sub-contractor activities when applicable.

— Relevant information between personnel involved in the design, manufacture, fabrication, installation and operation shall be communicated in a clear manner to avoid misunderstandings.

5.4.2 Quality assurance

Equipment manufactured in accordance with this part of ISO 13628 shall conform to a certified quality assurance program. The manufacturer shall develop written specifications that describe how the quality assurance program will be implemented.

5.5 Design philosophy

5.5.1 Design principles

The umbilical system shall be designed according to the following basic principles.

— The umbilical system shall satisfy functional and operational requirements as given in the design basis.

— The umbilical system shall be designed such that an unintended event does not escalate into an accident of significantly greater extent than the original event.

— The umbilical system shall permit simple and reliable installation, retrieval and be robust with respect to use.

— The umbilical system shall provide adequate access for replacement and repair.

— Design of structural details and selection of materials shall address the effects of corrosion, ageing, erosion and wear.

— A conservative design approach shall be applied for the umbilical mechanical components. Redundancy may be considered for essential components.

5.5.2 Design basis

A design basis document shall be established in the initial stages of the design process. The design basis should contain or reference all relevant information required for design of the umbilical system. The design basis normally includes

— specifications supplied by the purchaser as specified in Annex A (e.g. functional requirements, field data, host data);

— procedures for load-effect analyses for the umbilical and associated components; see Annex F; and

— load-case matrices, as specified in Annex A (e.g. temporary conditions, installation, extreme conditions, fatigue conditions).

© ISO 2009 – All rights reserved

Documents
Document Sharing Hub
Full document details: BS EN ISO 13628-5:2009

5.5.3 Design methodology

5.5.3.1 General

The design methodology shall include, as a minimum, the following.

a) A description of the theoretical basis, including calculation procedures and methods for evaluating the umbilical design parameters and the criteria that it is necessary to satisfy in order to meet the functional requirements shall be included.

b) Documentation of the fatigue life and extreme stress assessment methodology shall be provided.

c) Verification shall be provided of the theoretical basis via verification or qualification tests on component samples and on samples of the complete umbilical as specified in 5.6 and Annex B. The testing or documentation shall include the capacity of all umbilical structural components.

d) Simplified conservative analysis methods for checking of non-critical components, such as anti-wear layers, shall be acceptable if the method does not influence the reliability of the calculation of stresses in the other components.

e) The documented basis for the effect of internal friction on stresses and the basis for stress concentration factors to account for the geometry of metallic structural components, including stress concentrations at and within the end-termination interface, clamped accessories, contact with rigid surfaces, manufacturing tolerances, and load-induced gaps shall be documented.

f) Manufacturing and design tolerances, manufacturing-induced stresses, internal friction, welds and other effects that influence structural capacity shall be provided.

g) The design methodology shall clearly state the range and application limits to which it applies.

The design methodology shall account for the effects of wear, corrosion, fretting, manufacturing processes, installation loads, dimensional changes, creep and ageing (due to mechanical, chemical and thermal degradation) in all layers, unless the umbilical design is documented to not suffer from such effects.

If the umbilical design is outside the envelope of previously qualified designs, then the manufacturer shall perform qualification tests to test the design methodology for this new design. The qualification tests shall validate fitness-for-purpose for those design parameters that are outside the previously validated envelope. the requirements on when qualification testing shall be performed are stated in 5.6.

For steel structural parts of the end termination, recognized standards, such as BS 5950, EN 10027 and EN 10025, or equivalent shall apply.

5.5.3.2 Independent agent verification

If required by purchaser, an independent verification party should review, evaluate, and report on the design methodology to establish the range of applications for which it is suitable.

5.6 Testing

5.6.1 General

All tests specified in this part of ISO 13628 can be sorted into three categories: qualification, verification and acceptance testing. The selection of test methodology shall be agreed between the purchaser and manufacturer and shall account for the risks involved in the intended application and the practicality of the test programme in relation to the project schedule.

Guidance on the responsibility of identifying the need for qualification testing is given in A.2.9.

© ISO 2009 – All rights reserved
Documents
Document Sharing Hub
Full document details: BS EN ISO 13628-5:2009

5.6.2 Qualification testing

Qualification testing are tests performed on a prototype component or prototype umbilical to prove that it can withstand the environment and/or loads for which it is designed and that it has the properties that it is predicted to have. It is not necessarily performed only on new designs or components, but a testing philosophy is chosen based on the purchaser's risk profile and the manufacturer's design/testing statistics. Choosing this testing philosophy reflects high project risk or low purchaser risk willingness. See also A.2.9.

For umbilicals and/or components which represent new technology or high risk, qualification testing should be performed according to a structured methodology as defined in the manufacturer's written specification, DNV RP-A203 or equivalent.

NOTE DNV RP-A203 (September 2001) defines proven and new technology as follows. Proven technology (definition): in the field, proven technology has a documented track record for a defined environment. Such documentation shall provide confidence in the technology from practical operations, with respect to the ability of the technology to meet the specified requirements. New technology (definition): new technology is technology that is not proven. This implies that the application of proven technology in a new environment or an unproven technology in a known environment, are both new technology. The degree of new technology can be classified in categories to be used as input to risk assessments (see DNV RP-A203).

It is the responsibility of the manufacturer to document the track record for, and to identify the need for, qualification testing. The evaluation of existing data and the extent of qualification testing shall be approved by the purchaser.

The above implies that qualification testing should be carried out in cases where no relevant track record or test data exist for the umbilical design, component and/or environment in question.

Whenever a new component is used and the properties of this component affect the global properties of the umbilical, qualification testing of the umbilical, and not only the individual component, shall be carried out.

Analysis may be used to compare umbilical and component designs and to judge the relevance of data from previous testing and operation experience. Such analysis shall be carried out according to the requirements of this part of ISO 13628; see Clause 6.

Unless otherwise agreed, all qualification testing shall be performed prior to manufacture of the umbilical.

Qualification testing should also be considered for the end terminations and midline connectors and ancillary equipment, if applicable.

5.6.3 Verification testing

Verification tests performed on an umbilical component, or a production length of umbilical, are designed to determine conformance with specified design requirements, or predicted properties.

Verification tests shall include end terminations and midline connectors and ancillary equipment.

5.6.4 Acceptance testing

Acceptance testing is testing performed to ensure that the umbilical or components meet the design values/criteria specified by the purchaser and stated in the design basis, i.e. to ensure that the sample subjected to verification testing is representative for the manufactured components. Acceptance testing includes testing performed on the actual delivery component or umbilical, e.g. tests that are performed to document that a welded tube string can withstand the test pressure over a defined time period, or to verify that an electrical/optical signal element has the characteristics it is designed to have. These tests are normally performed several times per product. Required acceptance tests for common components are outlined in Annex B.

Acceptance tests shall also be carried out for the end terminations and midline connectors and ancillary equipment.

© ISO 2009 – All rights reserved

Documents
Document Sharing Hub
Full document details: BS EN ISO 13628-5:2009

6 Design requirements

6.1 General

The umbilical and its constituent components shall be designed to meet the functional and technical requirements of this part of ISO 13628. The requirement for analysis shall result from a risk evaluation for the umbilical. The factors that shall be considered are, amongst others, the environmental and service conditions for the umbilical and the consequences of non-performance.

Fatigue analyses shall include fatigue at operating temperature, a prediction of load cycles and translation of load cycles into nominal stress or strain cycles. The load cycles shall include reeling, handling, construction, installation, unplanned events such as partial recovery and reinstallation, as stated in the design basis.

The effect of mean stresses, internal (service) and external (environmental) plastic pre-strain and rate of cyclic loading shall be considered when determining fatigue resistance.

Assessment of fatigue resistance may be based on either S-N data obtained on representative components or a fracture mechanics fatigue-life assessment. The selection of safety factors shall take into account the inherent sensitivity in fatigue-resistance predictions for such designs.

Account shall be taken of the effect of the strain accumulated during manufacturing, handling and installation on the umbilical fatigue performance.

Guidance on fatigue testing is given in Annex E.

6.2 Loads

6.2.1 Load classification

Loads are classified as functional, environmental (external) or accidental, and defined as follows.

a) Functional loads are all loads acting on the umbilical during manufacture, installation and operation, including those loads that can act on the umbilical in still water, with the exception of wind, wave or current loads.

b) Environmental loads are those loads induced by external forces caused directly or indirectly by all environmental parameters acting on the umbilical, including those induced by waves, currents and vessel motion.

c) Accidental loads are those loads caused directly or indirectly by unplanned activities. Accidental loads shall be understood as loads to which the umbilical can be subjected in case of abnormal conditions, incorrect operation or technical failure as defined by purchaser.

6.2.2 Functional loads

The functional loads of relevance for the actual umbilical system shall be identified. Examples of functional loads are

a) loads due to weight and buoyancy of the umbilical, its contents and attachments, both temporary and permanent;

b) marine growth based on information for the actual geographical location;

c) pressure within hoses and tubes;

d) thermal loads resulting from radiant heat, hot injected gas/fluids, or from adjacent hot riser(s);

e) external hydrostatic pressure;

© ISO 2009 – All rights reserved
Documents
Document Sharing Hub
Full document details: BS EN ISO 13628-5:2009

f) testing pressures, including installation, commissioning and storage pressures;

g) external soil or rock reaction forces for trenched, buried or rock-dumped umbilicals;

h) static reaction and deformation loads from supports and protection structures;

i) temporary installation or recovery loads, including applied tension and crushing loads, impact loads and guidance induced loads;

j) displacements due to pressure- and tension-induced rotation;

k) interaction effects of clamping the umbilical;

l) loads due to rigid or flexible pipe crossings, or spans;

m) loads due to positioning tolerances during installation;

n) loads from inspection and maintenance tools.

6.2.3 Environmental loads

The environmental loads of relevance for the actual geographical location shall be identified. Examples of environmental loads are

a) waves;

b) current;

c) wave-frequency host motions;

d) low-frequency host motions due to wave drift and wind loading and station-keeping system characteristics;

e) vortex-induced host motions due to current loading;

f) host offset from nominal position due to environmental loading;

g) ice;

h) earthquake;

i) subsea landslides.

6.2.4 Accidental loads

The accidental-load scenarios of relevance for the actual umbilical system shall be identified. Examples of accidental loads are

a) dropped objects;

b) trawl-board impact;

c) anchor-line failure;

d) fire and explosion;

e) compartment damage or unintended flooding of support vessel or other buoyancy device (e.g. subsea arch structure);

© ISO 2009 – All rights reserved

Documents
Document Sharing Hub
Full document details: BS EN ISO 13628-5:2009

f) loss of buoyancy modules in lazy-wave umbilical configuration;

g) failure of thrusters;

h) dynamic-positioning failure

i) net external pressure (due to flooding, crushing, incorrect installation rate, etc.);

j) net internal pressure;

k) failure of turret drive system.

6.2.5 Load combinations and conditions

6.2.5.1 General

The umbilical shall be designed to withstand the most onerous load combinations of functional, environmental and accidental loads selected from the extreme design and fatigue environment specified by the purchaser. The load combination selection shall cover all relevant loading conditions that can be applied to the umbilical during factory-acceptance testing, installation, operation and any temporary condition specified by the purchaser as defined in Annex A. Variation of the loads with respect to time shall be addressed.

6.2.5.2 Extreme load combinations

The extreme load combinations shall reflect the most probable extreme combined load effect over a specified design time period. Extreme load combinations shall be defined for permanent as well as temporary design conditions as follows.

a) Normal operation: This applies to the permanent operational state of the umbilical, considering functional and environmental loads. Design conditions with a 10^{-2} annual exceedence probability (i.e. 100 year return period) shall be applied.

b) Abnormal operation: This applies to the permanent operational state of the umbilical considering functional, environmental and accidental loads. Combined design conditions with an annual exceedence probability between 10^{-2} and 10^{-4} shall be considered.

c) Temporary conditions: This applies to temporary conditions, such as installation, retrieval, pressure testing and other intermediate conditions prior to permanent operation, e.g. temporary in-field configurations prior to platform tie-in of umbilicals in dynamic service or burial of static umbilicals. The applicable return period for the design conditions depends on the seasonal timing and duration of the temporary period. The return periods shall be defined such that the probability of exceedence in the temporary state is no greater than that of the permanent normal operational state.

Accidental loads in terms of frequency of occurrence and magnitude should be determined based on risk analyses and relevant accumulated experiences. Account shall be taken of other loads that can reasonably be present at the time of the accidental event. Further, accidental loads shall be determined with due account of the factors of influence. Such factors may be personnel qualifications, operational procedures, the arrangement of the installation, equipment, safety systems and control procedures. Combined design conditions with an annual exceedence probability higher than 10^{-2} should be considered as normal operation. Load combinations with an annual exceedence probability lower than 10^{-4} may normally be ignored.

Recommended load combinations for assessment of the extreme-load effect are summarized in Table 1.

© ISO 2009 – All rights reserved
Documents
Document Sharing Hub
Full document details: BS EN ISO 13628-5:2009

Table 1 — Load combinations

Load type	Temporary conditions	Normal operation	Abnormal operation
Functional	Expected, specified or extreme	Expected, specified or extreme	Expected, specified or extreme
Environmental	Probability of exceedence according to season and duration of the temporary period. If more information is not available, the following return period values may be applied for temporary conditions: a 100 year return period if duration in excess of 6 months; a 10 year return period for the actual seasonal environmental condition if duration is in excess of 3 days but less than 6 months. For temporary conditions with a duration less than 3 days or operations that can be terminated within a 3 day window, an extreme load condition may be specified and start-up /shut down of the operation is then based on reliable weather forecasts.	Annual exceedence probability of 10^{-2}	Annual exceedence probability of 10^{-2} to 10^{-4} If combined with accidental loads, the environmental load may be established so that the combined annual exceedence probability is 10^{-4}.
Accidental	As appropriate to the actual temporary condition	Not applicable	Individual considerations. Annual exceedence probability $\geqslant 10^{-4}$.

6.2.5.3 Fatigue load conditions

Fatigue damage shall be calculated considering all relevant cyclic loading imposed on the umbilical over its design life covering fabrication, temporary conditions including installation as well as in-place operation. Consideration shall be given to the long-term probabilistic nature of the fatigue loading. The following principal sources of fatigue damage shall be evaluated:

a) wave-frequency response of the umbilical due to direct wave loading as well as wave induced (first-order) host motions;

b) slow drift (second-order) host motions including variation of mean position;

c) VIV response of the umbilical under steady current conditions;

d) possible VIV motions of the host hull where applicable (typically spar platforms);

e) cyclic loading during fabrication and installation, e.g. reeling/unreeling;

f) cyclic loading due to operation of the umbilical, e.g. variation in temperature and pressure.

The interfaces to the supporting rigid structures are normally the most critical locations for fatigue loading on in-place dynamic umbilicals operated from a floating host. The fatigue performance of the umbilical is in most situations governed by the bend limiting devices installed at the rigid supports, e.g. bend stiffener or bellmouth.

Consideration shall be given to the long-term operation/performance of the host/station-keeping system, e.g. variation of loading conditions/draft, change in mooring pretension, change in restoring due to additional riser tie-ins, re-location, connected/disconnected operational mode for loading systems, etc. Conservative assumptions shall be made in case of lack of precise information.

© ISO 2009 – All rights reserved

Documents
Document Sharing Hub
Full document details: BS EN ISO 13628-5:2009

Average values may be applied for functional loading unless more precise information is available regarding the long-term variation of functional loading.

Calculation of fatigue stresses shall address wear/corrosion.

Calculation of fatigue stresses should, unless more precise information is available, be based on nominal component dimensions minus half the corrosion/wear allowance. In a uniform thickness degradation environment, this corresponds to the average wall thickness over the umbilical service life.

6.3 Load effect analysis

6.3.1 General

The manufacturer shall, as part of the design evaluations, consider the results of any installation, dynamic service and structural analysis that might have been carried out in relation to the umbilical design. The output of the analyses shall be used to demonstrate that the umbilical is suitable for installation and will remain fit for service during its design life.

The analysis results shall be verified either during qualification or verification testing. In lieu of physical testing of the components/umbilical, representative historical data may be offered by the manufacturer to verify the models or calculations used; see Clause 5.

All load-effect analyses shall be based on accepted physical/numerical principles for modelling of the umbilical response in all relevant static- and dynamic-loading scenarios. All of the software tools used for the umbilical global and local analysis should be

— verified against closed-form analytical solutions;

— verified by a range of simulations or by an independent verification agent that the generic model/software tool is internally consistent and that it does not contain detectable flaws; and

— calibrated against full-scale tests by means of manipulating the independent variables of the software model to obtain a match between the observed and simulated distributions of the dependent variables.

The validity range of the calibration shall be documented.

The accuracy/validity range of the software should be specified based on a correlation to observed values from the physical testing (full scale/model tests).

The manufacturer shall demonstrate to the purchaser supporting verification, validation and confirmation documentation for all global and local analysis tools, including those developed in-house, used for the umbilical analysis and design.

The main types of load-effect analyses in Table 2 may be required, depending on the actual concept.

© ISO 2009 – All rights reserved
Documents
Document Sharing Hub
Full document details: BS EN ISO 13628-5:2009

Table 2 — Load-effect analysis

Type of analysis	Description	Main application
Global analysis	Static- and dynamic-load effect analysis due to static and dynamic environmental loading (current, waves and host offset/motions)	Extreme-load analyses of umbilicals in dynamic service Fatigue-load analyses of umbilicals in dynamic service Analyses of installation scenarios to establish limiting criteria for the operations
On-bottom stability analyses	Analyses to assess the displacement of on-bottom umbilicals exposed to functional and environmental loading	Stability analysis of umbilicals in static service Stability analysis of laying operations Stability analysis of on-bottom part of umbilicals in dynamic service
VIV analyses	Analysis of VIV in steady current	Fatigue analyses of umbilicals in dynamic service Fatigue analyses of umbilicals during installation operations Assessment of requirement for VIV suppression devices Considered as a sensitivity assessment of the effect on drag coefficients for application to global analyses and interference analyses where these analyses are critical
Interference analyses	Analysis to determine minimum distance or contact loads/forces between adjacent structures exposed to static and dynamic environmental loading	Assessment of minimum distance to neighbouring risers, umbilicals and mooring lines; applies to in-place analyses of umbilicals in dynamic service as well as installation scenarios
Free-spanning analyses	Analysis of VIV of free spans in steady current and establish product curvature	Fatigue analyses of free spans of umbilicals in static service
Pull-in analyses	Analysis of pull-in installation operations	Analysis of I/J tube pull-in operations of umbilicals in dynamic/static service
Installation analysis	Analyses to establish the lay limits of installation operations and to assess and compare the variables for all planned and contingency operations	Assessment of allowable environmental criteria for first-end initiation, initial lay, normal lay, curve lay, second-end approach, second-end installation; either end may be a subsea termination, an I/J tube pull-in operation or a landfall approach Assessment that planned handling routes and loads are within manufacturer's recommendations or limitations (combinations of bend radius, contact force, tension, squeeze load from caterpillar, internal pressure) Analysis of the installation scenario and comparison with assumptions used for the calculation of fatigue damage
Structural analyses	Establish loads and/or load sharing between the components of the umbilical cross-section	Establish combined tension/curvature capacity for the umbilical cross-section (basis for global capacity checks) Establish stress/strain in individual components of the umbilical cross-section for a given tension/curvature combination (basis for, e.g., fatigue analyses) Establish cross-sectional stiffness (bending, axial, torsional) for application to global analyses Analyses of installation scenarios to establish limiting criteria for the operations (e.g., assessment of load effects due to crushing loads from caterpillars)

© ISO 2009 – All rights reserved

Documents
Document Sharing Hub
Full document details: BS EN ISO 13628-5:2009

6.3.2 Global load-effect analysis

The purpose of global load-effect analyses is to describe the overall static and dynamic structural response of the umbilical. The global analyses shall be based on accepted principles of static and dynamics analysis, with the use of discrete modelling, strength of materials, environmental loading and soil mechanics to determine reliable load effects on the umbilical system. Global load-effect analyses should be based on numerical simulations by means of FE, or similar, analyses with due regard to the following issues.

— The global response model shall include the complete umbilical system considering accurate modelling of stiffness, mass, damping and hydrodynamic load effects along the umbilical in addition to top and bottom boundary conditions.

— Appropriate drag and inertia coefficients for the selected method shall be applied. Effects of marine growth shall be considered. Recognized principles shall be applied to assess possible drag magnification due to VIV.

— The global cross-sectional properties shall be representative of the stiffness and damping properties of the actual umbilical cross-section.

— The umbilical shall be modelled with a sufficient number of elements to represent environmental loading and structural response and to resolve load effects in all critical areas. Time and/or frequency discretization shall be verified to ensure that the desired accuracy is obtained. The principles for model validation as outlined in Annex F, Appendix F of DNV OS-F201, or equivalent may be applied.

— Sensitivity studies should be considered to investigate the influence of uncertain system parameters (e.g. soil data, hydrodynamic coefficients, marine growth, structural damping and stiffness, host draft, current modelling in fatigue analysis, etc.). The main purpose is to quantify model uncertainties, support rational conservative assumptions and identify areas where a more thorough investigation is needed.

— Any use of simplified modelling and/or analysis techniques shall be verified by more advanced modelling and/or analyses for representative (critical) load cases.

For further details, reference can be made to Annex F.

6.3.3 On bottom stability analysis

The umbilical shall be designed to be sufficiently stable, when laid on the seabed, to meet the requirements of Clause 4. The need for additional ballast and impact on other installation activities shall be evaluated, if required.

DNV RP-F109 is an example of a standard suitable for assessing the lateral stability of umbilicals exposed to current and wave loading.

6.3.4 Pull-out analysis

Routing of the umbilicals on the seabed often requires that static service umbilicals are arranged in a predefined, curved configuration. Pull-out analyses shall be performed to document that the geometry of curved on-bottom sections of the umbilical remains stable for the maximum apparent effective tension in the umbilical. It shall be documented that the axial and sideways soil resistance is sufficient to support the tension in a curved, on-bottom configuration. Static analyses using analytical expressions for the holding capacity of straight and curved umbilical sections as given in DNV RP-F109 should be applied. Sensitivity studies shall be performed to support rational, conservative assumptions for the governing parameters (e.g. soil friction coefficients and submerged weight).

Pull-out analyses shall be performed to assess the capacity of the seabed portion of an in-place dynamic service umbilical system, in terms of its ability to absorb the bottom tension generated by the dynamic part of the umbilical system. Pull-out analyses shall also be conducted to document the stability of curved sections during lay installations.

© ISO 2009 – All rights reserved
Documents
Document Sharing Hub
Full document details: BS EN ISO 13628-5:2009

6.3.5 Vortex-induced vibration analysis

The effect of vortex-induced vibration (VIV) shall be considered for all umbilicals exposed to current and/or waves. For cases where VIV is likely to represent a design problem, refined assessment according to the methods outlined in this subclause is required. The requirement for qualification testing shall be assessed in accordance with 5.6.

In most cases the focus of this assessment is to evaluate whether the fatigue capacity is sufficient. Accordingly, a simplified conservative VIV analysis suffices if the resulting fatigue damage is within the tolerated limit. If the simplified analysis indicates insufficient fatigue capacity, more sophisticated methods should be chosen. The method should be chosen according to the specific case investigated.

Important parameters for VIV response are cross-sectional diameter, mass, damping, bending stiffness and effective tension. Mass ratio, reduced damping and number of natural frequencies within the bandwidth of the vortex shedding frequency can be important for a determination of lock-in behaviour and VIV amplitude.

Methodology for the prediction of fatigue damage due to VIV on other slender elements such as pipelines and risers may be applied with special attention to umbilical-specific properties. In particular, cross-sectional stiffness and damping properties shall be selected to represent the umbilical VIV (typically small amplitude) response. VIV analyses are in most cases carried out using a modal approach. The eigenmodes/ eigenfrequencies applied in such analyses shall reflect the physical umbilical configuration (i.e. geometrical configuration, tension, boundary conditions, etc.). The number of modes shall be sufficient to determine the umbilical response at the highest VIV frequency. For further guidance on VIV analysis methodology, reference can be made to ANSI/API RP 2RD, DNV RP-F204, or other recognized industry standards.

The increase in the drag coefficient due to cross-flow VIV for application in global response analyses may be estimated in accordance with DNV RP-F203.

If vortex-suppression devices are used for the mitigation of VIV, their efficiency shall be qualified. In most cases, vortex-suppression devices increase the in-line drag of the umbilical. This shall be accounted for in other design analyses, such as global load-effect analyses.

6.3.6 Interference analysis

The system design shall include a check of possible interference with other adjacent structures (e.g. host hull, mooring lines, risers, umbilicals or any other obstacles). Critical loading conditions are normally governed by extreme current events. The interference assessment shall include relevant installation scenarios. Normal operation as well as accidental scenarios shall be considered for the in-place condition.

Interference analysis requires information on the entire host/umbilical/riser/mooring system and it is the purchaser's responsibility to provide the required information; the responsibility to carry out the analysis is defined in Annex A; see Table A.2.

The basic design strategy should be that no impact with other structures is allowed. In this case, interference analyses shall document sufficient spacing between the umbilical and adjacent structures for all critical-load cases. Due regard shall be given to hydrodynamic interaction in terms of wake effects on the downstream configuration (i.e. reduced drag force and non-zero lift force as function of distance from upstream configuration). Effects from possible VIV on the drag coefficients for the upstream and downstream configurations shall be evaluated and implemented in a conservative way supported by sensitivity studies.

The minimum clearance between two adjacent slender structures should be greater than $D_1 + D_2$, where D_1 and D_2 are the outer diameters of the slender structures.

Umbilicals in dynamic service operated from hosts are normally placed close to other dynamic structures such as risers. The static and dynamic response characteristics of the adjacent slender structures should be as similar as possible to avoid interference. This may be accomplished, to some extent, by assigning a common target value for the weight-diameter ratio for the adjacent slender structures. The weight-diameter ratio is defined as $\gamma = W/D$, where W is the submerged weight per unit length and D is the outer diameter. It should be noted that the weight-diameter ratio can be significantly influenced by variable functional loading due to, for

© ISO 2009 – All rights reserved

Documents
Document Sharing Hub
Full document details: BS EN ISO 13628-5:2009

example, marine growth and the internal fluid content of risers. Sensitivity studies shall be performed to support assumptions regarding functional loading for application in interference analyses.

Account shall be taken of installation tolerances and length manufacturing tolerances.

The same basis for selection of drag coefficients shall be applied for umbilicals and neighbouring risers that can interfere with each other. It is the responsibility of the purchaser to ensure that there is sufficient distance in instances where neighbouring risers are delivered by different manufacturers.

The interference analyses are essentially global load-effect analyses with due regard to the modelling of hydrodynamic interaction. Industry standards, such as outlined in DNV RP-F203 or equivalent should be adhered to. Hydrodynamic interaction models for new applications (e.g. different diameters of the adjacent structures, VIV-suppression devices, etc.) shall be validated on the basis of physical testing.

An alternative design strategy that may be applied is to allow for structural impact in the most extreme load conditions. In this case, it shall be documented that the structural integrity is not endangered due to impact loads. Wear fatigue and extreme impact load shall be considered.

The engineering efforts required to qualify an umbilical system for structural impact is hence substantially more demanding compared to that for a no-impact design criterion. Load-effect models to account for structural impact should be validated with basis in physical testing.

Structural impact should be avoided in the buoyancy section of wave-type configurations.

6.3.7 Free spanning analysis

As-laid umbilicals on the seabed can suffer VIV in a steady bottom current under span-length and tension combinations. For umbilicals at the seabed, reference is made to DNV RP F-105 or equivalent. Due consideration shall be made to the specific properties of the umbilical. In particular, empirical equations for natural frequencies and unit amplitude stress levels are not directly applicable to umbilicals. FE analysis should be applied for determination of eigen modes with due regard to boundary conditions and multi-span scenarios.

Umbilicals are normally more tension-dominated than pipelines due to the low bending stiffness. Effective as-laid tension is, hence, important for the prediction of participating modes. The uncertainty in the tension can be large, causing large uncertainties in the VIV fatigue-damage prediction. Sensitivity studies shall be performed to support rational, conservative assumptions.

6.3.8 Pull-in analyses

The purpose of a pull-in analysis is to provide an estimate of the required pulling force for the installation of the umbilical in I- and J-tubes or other supporting structures. The pull-in analysis should in general be comprised of

— an estimation of the friction force due to the weight of the umbilical;

— an estimation of the friction force due to the bends around corners, if relevant;

— an estimation of the required pulling force due to bending of the umbilical, if relevant;

— an estimation of reverse pull-in analysis for contingency scenarios or for future removal and/or abandonment.

Pull-in analyses may be conducted by means of conservative analytical formulas or by FE-based computer analyses.

© ISO 2009 – All rights reserved
Documents
Document Sharing Hub
Full document details: BS EN ISO 13628-5:2009

Analytical expressions can be found in literature for the friction force due to weight, due to pulling around corners and due to bending (e.g. the equation for bending around corners is given in DNV RP-E305). The contributions from friction forces and bending of the umbilical should be added together in a conservative manner.

Computer analyses by use of general purpose FE code should be applied in the case of complex pull-in scenarios. Such analyses should be performed as non-linear static analyses. The load application shall represent the actual pull-in scenario. Due regard shall be given to the modelling of constraints and contact forces from the supporting structure (e.g. bend geometry with appropriate friction-force modelling). A contact formulation is required in order to estimate the friction force and, accordingly, the required pulling force.

6.3.9 Structural analysis

6.3.9.1 General

The purpose of the structural analysis is to establish a design for the umbilical and its constituent components that shall be capable of withstanding the design loads and conditions envisaged during manufacture, load-out, recovery, repair, installation and also for the operational conditions throughout the design life.

Details relating to structural analyses of umbilical components are provided within 7.2 to 7.5 for individual component design.

The structural analysis includes a description of the load-sharing between components in the cross-section to determine the stresses and strains in each component and to establish the stiffness parameters required for global analyses. The results from structural analyses can be grouped into the following main categories:

— capacity curves in terms of tension versus curvature at a specific pressure, if applicable;

— assessment of maximum allowable crushing loads;

— stresses and strains used for fatigue calculations;

— cross-sectional stiffness parameters for application as input to global load effect analyses.

The structural analysis should be based on accepted principles of structural mechanics and strength of materials and may be based on empirical, analytical or numerical (FE) methods that are qualified by structural testing. See Clause F.3 for an overview of the fatigue-analysis strategies.

Maximum allowable stress/strain and usage factor for each component (tube, electric cable, strength member, sheath, etc.) in the installation, in the in-place pressure test and in the operation phase shall be clearly indicated and justified by the manufacturer.

6.3.9.2 Modelling and analysis requirements

The analysis shall demonstrate and justify that the structural and functional materials used within the umbilical system are designed to satisfy the application requirements of the material throughout the umbilical design life. This shall be performed using recognized standards and applicable factors of safety if they are available.

The following shall be considered:

a) deterioration of material properties and degradation as a result of ageing throughout the service life;

b) materials selection, including corrosion of metallic elements, cathodic attack and delamination of bonded elements;

c) fatigue of structural and functional components (e.g. metallic tubes, armour wires, copper conductor, fillers, bend stiffeners, polymers);

© ISO 2009 – All rights reserved

Documents
Document Sharing Hub
Full document details: BS EN ISO 13628-5:2009

d) contact pressure and friction among different umbilical components;

e) effects of environmental conditions, (for example UV radiation, temperature, ozone and long-term exposure to seawater and permeated fluids);

f) cumulative effects of strain of copper conductors, armour wires, metallic tubes and fibres throughout the manufacturing processes, handling, and installation operations;

g) strain of optical fibres;

h) assessment of lateral deformations and stress/strain of the individual components due to crushing loads during storage and installation.

The load effects in the umbilical cross-section may be documented by qualification or verification testing. Numerical methods may also be used to predict local stresses. If numerical analysis is used, the analysis results may be qualified as described in Clause 5 and F.3.

Design formulas are related to the specific umbilical design and may be validated for those specific designs by strain-gauge results from prototype tests. Justification for extrapolation of results shall be documented. When considering the use of analytical methods, the actual load situation in the umbilical shall be considered, especially with regard to combined loading.

Models for structural analysis should be capable of describing the load sharing between each component of the cross-section based on evaluating the stiffness contribution from each component.

The load-sharing analysis shall be based on nominal dimensions. It is necessary to take dimensional tolerances, including effects from corrosion and wear, into account in the stress and fatigue analysis.

Tolerances shall be considered in wall-thickness sizing of steel tubes.

The internal frictional resistance resulting from internal contact forces shall be applied to calculate the friction stresses that are added to the elastic axial and bending stresses in fatigue and extreme stress calculations. Sensitivity studies should be conducted on the internal friction factor as part of the fatigue analysis.

NOTE 1 Friction can influence the global damping and stiffness behaviour and it is, therefore, necessary to consider it in global dynamic analyses.

In cases where fretting and wear due to a combination of internal contact forces, metal-to-metal contact and relative deformations can occur, it is necessary to take this into account as part of the fatigue calculation.

It is necessary to give special attention to the terminations of dynamic umbilicals in operation. Due to high bending gradients, end effects can occur due to the helically layered umbilical structure. It is necessary to evaluate or document by testing (qualification or verification testing according to Clause 5) the stress amplification due to this effect. This governs for both extreme stress and fatigue evaluations.

NOTE 2 For standard service-life tests of dynamic umbilicals, the umbilical components are normally terminated by end fittings providing axial fixation. Provided that the length of the specimen is shorter than the real length from the dynamically curved section to the end termination, such tests are normally conservative with respect to end effects. To avoid such conservatism, validated 3D structural analysis models can be used to adjust the test program to simulate the real loading conditions.

6.4 Installation analysis

All transport, load transfer, lifting, subsea operations shall be performed according to company requirements, DNV Rules for Planning and Execution of Marine Operations or other equivalent standard.

Installation analysis shall demonstrate that suitable installation equipment (tensioners, pads, chutes, etc.) and procedures will be used to install the umbilical without risk of damage. In particular, load transfer, friction between umbilical components, crushing resistance and friction between umbilical and pads shall be evaluated and accounted for in the installation analysis.

Documents
Document Sharing Hub
© ISO 2009 – All rights reserved
Full document details: BS EN ISO 13628-5:2009

In addition, a recovery analysis shall be performed. Conditions of recovery shall be identified. The analysis shall be conducted in the same way as for the installation analysis. The utilization factors identical to those for the installation case shall be taken.

6.5 Fatigue life

The umbilical shall be designed with fatigue life that is equal to, or greater than 10 times the service life. The service life is determined on a project-specific basis.

Qualification or verification testing can be considered necessary to confirm that the manufacturer's design methodology, analysis methodologies and software tools are mature and accurate for the prediction of fatigue damage and fatigue life.

7 Component design, manufacture and test

7.1 General

7.1.1 Design verification

The umbilical components shall be designed and manufactured to meet the umbilical functional and technical requirements. Conformance shall be demonstrated by verification and acceptance testing.

For new component designs that are similar to previously verified designs and whose performance can be predicted with a high level of confidence, design verification tests may be included with some or all of the component FATs. For unusual designs or designs significantly different from previously verified designs, design verification testing shall be undertaken as a separate program.

If the component design is similar to a previously validated design and the umbilical is being installed under similar environmental and service conditions, design verification may be substituted by previous historical design verification data.

The performance of verification and acceptance tests shall also be considered for the end terminations and midline connectors and ancillary equipment, if applicable.

NOTE Verification and acceptance tests that it is necessary to perform during and on completion of component manufacture specified in this subclause are summarized in Annex B.

7.1.2 Quality plan

Before production commences, the manufacturer shall prepare a quality plan. The quality plan shall demonstrate how the specified properties can be achieved and verified through the proposed manufacturing route. The quality plan shall address all factors that influence the quality and reliability of production. All main manufacturing steps from control of received raw material to shipment of the finished product, including all examination and check points, should be covered in detail. References to the procedures established for the execution of all steps shall be included. The quality plan shall be approved by the purchaser and shall, as a minimum, contain the following information:

— plan(s) and process flow description/diagram;

— project-specific quality plan;

— manufacturing process;

— manufacturer(s) of functional components and any supplier quality plans;

— handling, loading and shipping procedures.

© ISO 2009 – All rights reserved

Documents
Document Sharing Hub
Full document details: BS EN ISO 13628-5:2009

7.1.3 Materials selection

The choice of the materials shall be made with a consideration of the following:

a) installed environment;

b) installed duty;

c) processability;

d) in-service repair;

e) degradation related to the seawater environment and service fluids.

NOTE The EEMUA publication No. 194 includes guidance on materials selection for umbilicals and subsea equipment.

7.2 Electric cables

7.2.1 General

Electric cables shall be capable of continuous operation with the insulated conductors operating in a fully flooded seawater environment.

The design of the electric cables shall recognize that the cables may be terminated in some form of water blocking arrangement(s), which shall function throughout the design life.

7.2.2 Operating voltages

The following definitions shall be used.

a) U_0 is the rated power-frequency voltage between conductor and earth or metallic screen, for which the cable is designed;

b) U is the rated power-frequency voltage between conductors, for which the cable is designed;

c) U_m is the maximum value of the “highest system voltage” for which the equipment may be used; see IEC 60038.

The standard voltage ratings shall be as described in IEC 60502-1 and IEC 60502-2, such as 0,6/1 (1,2) kV, 1,8/3 (3,6) kV and 3,6/6 (7,2) kV.

Whether a cable is intended for a power or signal application shall be defined in the purchaser's functional specification.

This definition shall be used to identify which type of tests and conditions normally apply as described.

In the event cables are used for “Signal on Power”, then both sets of conditions apply.

7.2.3 Power cables

Power-cable voltage ratings shall be selected up to the standard rated voltages $U_0 / U(U_m) = 3{,}6/6\ (7{,}2)$ KV rms, where U_0, U and U_m are as defined in IEC 60502-1 and IEC 60502-2.

© ISO 2009 – All rights reserved
Documents
Document Sharing Hub
Full document details: BS EN ISO 13628-5:2009

7.2.4 Signal cables

Signal cables shall be designed to transmit electrical control and communication signals in the voltage range 0 V rms to $U_0/U(U_m) = 0{,}6/1\,(1{,}2)$ kV rms, where U_0, U and U_m are as defined in IEC 60502-1 and IEC 60502-2.

7.2.5 Construction

7.2.5.1 General

Various cable constructions are acceptable for use in a subsea umbilical, however the chosen design shall be verified according to requirements defined in Clause 4.

Cables shall be manufactured in accordance with the manufacturer's written specification.

Some cables may include screening and/or armouring depending on intended service or for other reasons.

Electric cores and cables should be manufactured as continuous lengths.

If splices are necessary to achieve the final length requirements, these shall be carried out in accordance with the qualified procedures by qualified personnel specified in the manufacturer's written specification. Splices shall also be subject to the same qualification and acceptance criteria as the insulated conductors and cables.

In a multi-core cable, the construction shall ensure that the cores can be readily separated for termination purposes and do not adhere or do not bond to the sheath, fillers, binder tape or adjacent cores.

As cable cores are, in many cases, sealed by boot-seal methods, the surface of the insulation shall be round, smooth and free from marks, indentations and surface defects that can affect sealing.

On a design-specific basis, consideration shall be given to conductor-strain relief due to compressive and tensile forces and the potential for damaging crushing forces that can arise in the laid-up components, particularly for deepwater service.

Designs shall take into consideration the effects and mitigation of gas migration in electric cables.

7.2.5.2 Construction material

Electric-cable construction materials (such as insulation, fillers, sheathing, etc.) shall be oil/dielectric-fluid-resistant in order to avoid deterioration of their electrical and physical properties if terminations/connectors are of the pressure-compensated type that normally uses electrical or hydraulic oil/dielectric fluid as an equalizing fluid.

7.2.5.3 Conductor

The conductors shall be fabricated from high-conductivity copper wire and shall comply with the relevant conductivity and material requirements of IEC 60228. The conductors shall be manufactured from annealed circular copper wire.

If stranded, each conductor shall be comprised of a minimum of seven strands. The minimum nominal cross-sectional area shall be 2,5 mm^2 (0,004 in^2). The nominal cross-sectional area for the conductor shall meet the functional requirements of Clause 4. The relationship between conductor size, strand count and stiffness should be considered.

© ISO 2009 – All rights reserved

Documents
Document Sharing Hub
Full document details: BS EN ISO 13628-5:2009

7.2.5.4 Insulation

The insulation material shall be suitable for immersion in seawater.

The chosen insulation material shall be of virgin stock applied as a continuous seamless circular single/multiple extrusion and shall meet the requirements of IEC 60502-1 and IEC 60502-2.

Materials that have been used successfully, e.g. thermoplastic polyethylene and various grades of ethylene propylene rubber, may be used. These materials shall keep their insulating properties for the full service life and be proven to keep the required mechanical properties under the actual temperature and pressure conditions. During the material selection process, consideration shall be given to the operating temperature.

The minimum allowable insulation thickness shall be stated in the manufacturer's written specification.

Depending on voltage rating, insulation material and thickness, non-metallic conductor and insulation screening may be required, as specified in IEC 60502-1 and IEC 60502-2.

7.2.5.5 Insulation coding

The insulated conductors shall be identified either by colour or by numbers. If numbers are employed, these shall be printed at regular intervals not exceeding 100 mm (4,0 in) along the length of each core. The numbers and/or colours employed shall be cited in the manufacturer's written specification.

Coding shall be stable under heat ageing and shall not cause a failure to satisfy the requirements of Clause 4.

Embossed printing is not permitted.

7.2.5.6 Core lay-up

The process of twisting individual cores shall be qualified for the specific application.

If an alternative lay-up technique is used, then it shall be qualified for the service.

For an intermediate lay-up operation, the cabled cores may be bound with a helically applied overlapping tape to ensure bundle stability and a circular cross-section.

The lay-up operation shall minimize compressive forces between the cores to minimize the extent of deformation of the insulation.

7.2.5.7 Fillers

To achieve a circular consolidated arrangement, fillers or extruded filling shall be included in the interstices. Any filler and binder tape materials shall be compatible with other materials in the cable. In particular, the effect on electrical insulation shall be considered. The materials shall be as stated in the manufacturer's written specification. The binder tape can be longitudinally applied or helically applied depending on whether or not a screen is applied.

7.2.5.8 Screening

If required, the cable shall be screened with a suitable metallic tape, or a two-component tape comprised of a thin metallic film, bonded to a polymer-based substrate. The thickness and number of layers shall be as stated in the manufacturer's written specification. The screen shall be electrically continuous throughout the cable length, and should be applied in such a manner that its electrical continuity shall not be broken throughout its design life.

Plain metal tape screens, for electric cables or individual power cores, shall provide 100 % coverage of the enclosed electrical cores. They shall be applied helically with an overlap. The screen shall not be applied directly over the twisted cores without due consideration for the cores beneath.

© ISO 2009 – All rights reserved
Documents
Document Sharing Hub
Full document details: BS EN ISO 13628-5:2009

If present, a drain wire shall have a minimum of three strands and the total cross-sectional area shall not be less than 0,35 mm^2 (0,000 5 in^2). It shall be incorporated in such a way that the drain wire remains in contact with the metallic part of the screen.

7.2.5.9 Sheathing

The electric cable sheath shall be of a polymeric material incorporating protection against UV radiation and oxidation, and shall be as stated in the manufacturer's written specification. The chosen material shall be continuously and concentrically extruded over the laid-up cores to produce a uniform cross-section. The material shall be compatible with sea-water and the specified service fluids throughout manufacture, installation and service, and shall not degrade the quality of other materials with which it can be in contact in the lay-up.

The coefficient of friction between the sheath and the sheaths of other electric cables and/or other components shall be minimized.

As cable sheaths are, in many cases, sealed by boot-seal methods, the surface of the insulation shall be round, smooth and free from marks, indentations and surface defects that can affect the sealing.

7.2.5.10 Armour/reinforcement

In some cases, cables may incorporate additional layers for strength or mechanical protection. These are, typically, metallic armour, tapes or alternatively a non-metallic reinforcement.

Details of any required layers are included in the manufacturer's written specification.

7.2.5.11 Cable identification

The cables shall be marked along the complete length at regular intervals not exceeding 1 m (3,28 ft). As a minimum the marking shall include

a) the manufacturer;

b) a unique component reference, e.g. “Cable 3”;

c) the batch number;

d) the voltage rating.

7.2.6 Performance requirements

7.2.6.1 DC conductor resistance

The DC resistance for each conductor shall not exceed the value defined in IEC 60228.

7.2.6.2 Insulation resistance

The DC insulation resistivity for each electrical core shall not be less than the value defined in the manufacturer's written specification, which shall not be less than 500 MΩ km at 500 V DC.

7.2.6.3 Screen layer resistivity

For power cable incorporating non-metallic (semi-conducting) screening layers, the resistivities shall not exceed the following values:

a) conductor screen: 1 000 Ω m;

b) core screen: 500 Ω m.

© ISO 2009 – All rights reserved

Documents
Document Sharing Hub
Full document details: BS EN ISO 13628-5:2009

7.2.6.4 Power-cable requirements

The power-cable design shall consider

a) the voltage rating,

b) the current rating,

c) the number of phases,

d) the maximum ambient temperature, and

e) the maximum voltage drop.

7.2.6.5 Signal-cable requirements

The following characteristics for each signal-conductor pair shall be defined between upper and lower limits at frequencies within the operating bandwidth of the proposed system:

a) attenuation;

b) characteristic impedance;

c) inductance;

d) capacitance;

e) resistance, if requested by subsea system supplier;

f) conductance, if requested by subsea system supplier.

These transmission characteristics and cross-talk limits between pairs of conductors shall be as stated in the manufacturer's written specification.

7.2.7 Structural analysis

Structural analysis, taking account of the data generated from the umbilical structural analysis specified in 6.3, shall be undertaken to verify the acceptability of the electric cable design for tensile, compressive and fatigue loadings upon the conductors.

7.2.8 Manufacturing

7.2.8.1 Conductor stranding

The stranding process shall ensure that individual strands and the stranded conductor shall not be subject to compressive and tensile loadings that can introduce kinks or a reduction in the conductor or strand cross-sectional area. This does not exclude the use of compacted conductors as defined in IEC 60228.

The tension applied to the strands during the stranding operation shall be uniformly controlled during the manufacturing process and checked at regular intervals in accordance with the manufacturer's written specification.

Multi-stranded conductors shall be of the concentric lay construction and planetary lay-up in a continuous helix. Other constructions shall not be employed. During the stranding operation, the stranded conductor shall show no propensity to corkscrew or exhibit any other out-of-balance effects.

Blocking compounds in stranded conductors may be incorporated to minimize/eliminate water/gas migration.

© ISO 2009 – All rights reserved
Documents
Document Sharing Hub
Full document details: BS EN ISO 13628-5:2009

7.2.8.2 Insulation extrusion

During extrusion, the following process parameters shall be continuously measured and recorded:

a) extruder barrel/head temperatures;

b) melt pressure/temperature;

c) screw speed/power requirements;

d) haul-off speed.

The insulation shall be extruded as one continuous length without defects, and shall be subject to inspection and continuous spark-testing during the extrusion process, in accordance with the manufacturer's written specification. Repairs to the insulation shall not be permitted.

The insulation thickness shall be measured and the outside diameter (OD) shall be measured continuously at two positions 90° apart, and continuously recorded.

After extrusion, the insulated conductors shall be stored in a dedicated area under cover and protected against direct sunlight, dust and other potential contaminants.

7.2.8.3 Core lay-up

During the cabling operation, the conductors shall not be subject to tensile and compressive loadings that introduce kinks or reduction in conductor or strand cross-sectional area.

If necessary, filler material shall be incorporated to form a compact and reasonably circular bundle. These fillers may be included in the external interstices of the laid-up cores or, alternatively, remaining voids inside functional elements shall be filled with a compound to minimize water ingress.

During lay-up, the twisted cores shall be subject to continuous visual inspection to ensure consistent cabling of the cores and fillers.

If a binder tape is incorporated in the construction, it shall be applied at a uniform tension level that shall not prevent relative movement between individual cores when the cable is flexed.

On completion of lay-up, the cabled cores and/or cabled electric-cable elements shall be stored in a dedicated area under cover and protected against direct sunlight, dust and other potential contaminants.

7.2.8.4 Sheath extrusion

There shall be no discontinuities or holes observed or detected in the extruded sheath. Repairs to a sheath are permissible and shall be performed and documented in accordance with the manufacturer's written specification.

The sheath OD shall be measured continuously, at a minimum of two positions 90° apart. Eccentricity and wall thickness shall be measured from samples taken from each end of the extrusion.

7.2.8.5 Armouring/reinforcement

Where present, this shall be uniformly applied in accordance with the manufacturer's written specification.

© ISO 2009 – All rights reserved

Documents
Document Sharing Hub
Full document details: BS EN ISO 13628-5:2009

7.2.9 Verification/qualification testing

7.2.9.1 General

Verification tests are performed on samples of the particular cable, and are intended to qualify the design as being fit for purpose, considering the characteristics and properties described in 7.2.9.2 to 7.2.9.14.

If a splice is being provided in the cable, then this shall also be subjected to the same qualification testing.

7.2.9.2 Visual and dimensional

Electrical cores shall be 100 % visually examined on samples of cores and shall be free from damage, conductor kinks or faults. This shall include examination of materials for possible contamination, verification of dimensions and construction. Conductors shall be examined in accordance with IEC 60228.

7.2.9.3 DC conductor resistance

A DC conductor resistance test shall be performed on two samples of each insulated conductor, each sample being at least 1 m (3,28 ft) long. One sample shall be taken from each end of a completed electric cable. The measured DC conductor resistance of each conductor, corrected to 20 °C (68 °F), shall not exceed the value specified in IEC 60228 by more than 2 % when corrected for lay-loss, i.e. assembly angle or twist.

7.2.9.4 DC insulation resistance

A DC insulation resistance test shall be performed on two samples of insulated conductors, each sample being at least 1 m (3,28 ft) long. One sample shall be taken from each end of a completed electric cable.

The individual insulated conductors shall be fully immersed in a tank filled with potable water. Insulation resistance shall be measured. The specimens shall then be subjected to a minimum hydrostatic pressure of 3,5 MPa (500 psi), or maximum hydrostatic pressure at service water depth, whichever is greater, for a minimum period of 22 h, and then insulation-resistance tested while still under pressure. The value of the insulation resistance shall not be less than the value defined in 7.2.6.2.

If an insulated conductor incorporates a metal screen over its entire length, this test may be undertaken by carrying it out under ambient conditions, without immersion in water.

7.2.9.5 High-voltage DC

A high-voltage DC test shall be performed on two samples of insulated conductor, each sample being at least 1 m (3,28 ft) long. One sample shall be taken from each end of a completed electric cable.

This test may be combined with the insulation-resistance test specified in 7.2.9.4, using the same samples, provided the insulation resistance test is performed first.

The individual insulated conductors shall be fully immersed in a tank filled with potable water. An initial insulation resistance test, shall be made. The specimens shall then be subjected to a minimum hydrostatic pressure of 3,5 MPa (500 psi), or maximum hydrostatic pressure at service water depth, whichever is greater, for a minimum period of 22 h and then high voltage tested while still under pressure.

Each insulated conductor shall withstand the DC voltage between conductor and water at each of the pressure levels, for a period of not less than 5 min, without breakdown. At the end of each period, the leakage current shall be measured and shall not exceed the value stated in the manufacturer's written specification.

The DC test voltage for conductors designated as “signal” and for conductors designated as “power” shall be 5 kV or three times U_0, whichever is greater.

If an insulated conductor incorporates a metal screen over its entire length (such as a single power core), this test may be undertaken by carrying it out under ambient conditions, without immersion in water.

© ISO 2009 – All rights reserved
Documents
Document Sharing Hub
Full document details: BS EN ISO 13628-5:2009

7.2.9.6 High-voltage AC

On completion of the high-voltage DC test specified in 7.2.9.5, a high-voltage AC test shall be performed on the insulated conductors while subjected to the same hydrostatic pressure.

The test shall be performed with an alternating voltage of sine waveform having a frequency in the range 40 Hz to 62 Hz, unless otherwise stated in the manufacturer's written specification. The value of the applied test voltage shall be as shown in Table 3. The voltage shall be applied between conductor and water. It shall be increased at the rate defined in 7.2.9.10, and maintained at the full value for 5 min without breakdown of the insulation.

If an insulated conductor incorporates a metal screen over its entire length (such as a single power core), this test may be undertaken by carrying it out under ambient conditions, without immersion in water.

Table 3 — AC test voltages

Voltage designation of cable		Test voltage V (rms)
Signal cables	$U_0/U(U_m) =$ 0,6/1,0 (1,2) kV[a]	1 500
Power cables $U_0 < 600$ V	$\leqslant$ 6 mm^2 (0,009 3 in^2)	1 500
	$>$ 6 mm^2 (0,009 3 in^2)	3 000
Power cables $U_0 \geqslant 600$ V	$U_0/U(U_m) =$ 3,6/6 (7,2) kV	7 500

[a] See IEC 60502-1 and IEC 60502-2 for definition of U_0, U and U_m.

7.2.9.7 Complete breakdown

On completion of the high-voltage tests, four further samples at least 1 m (3,28 ft) in length shall be subjected to a complete DC breakdown test. Two samples shall be taken from each end of a completed electric cable.

Each of the samples shall be tested in a manner identical to that in 7.2.9.5, with two samples being tested at ambient hydrostatic pressure and two being tested at the higher pressure used in the test defined in 7.2.9.5. The DC voltage shall be increased at a rate of 0,1 kV/s until breakdown occurs. The test results shall be recorded for each sample. If no voltage breakdown occurs before application of $10 \times U_0$ the insulated conductor shall be considered suitable.

7.2.9.8 Partial discharge

For cables rated above $U_0/U(U_m) = 1{,}8/3(3{,}6)$ kV, a partial discharge test in accordance with IEC 60502-2 shall be performed. The discharge magnitude shall not exceed 10 pC.

7.2.9.9 Screen resistivity

In cases where this is required, the resistivity of the non-metallic screening layers (semi-conducting) in the completed power core shall not exceed the values specified in 7.2.6.3.

© ISO 2009 – All rights reserved

Documents
Document Sharing Hub
Full document details: BS EN ISO 13628-5:2009

7.2.9.10 Application of test voltages

Unless otherwise specified for all voltage tests, the rate of increase from the initially applied voltage to the specified test voltage shall be uniform and shall not be more than 100 % in 10 s, nor less than 100 % in 60 s. The initial applied voltage shall not be greater than 500 V.

7.2.9.11 Inductance

A sample of completed electric cable, of 10 m (32,8 ft) minimum length, shall be measured for inductance. The inductance of each conductor pair in the cable shall be measured at fixed frequencies as specified in the manufacturer's written specification. The measured values shall comply with the requirements specified in 7.2.6.5, which shall include limits for deviation between actual and specified values.

7.2.9.12 Capacitance

A sample of completed electric cable, of 10 m (32,8 ft) minimum length, shall be measured for capacitance. The capacitance of each conductor pair in the cable shall be measured at fixed frequencies as stated in the manufacturer's written specification.

The capacitance of each power unit (a single screened power core) shall be measured at the transmission frequency with respect to ground, unless stated otherwise in the manufacturer's written specification. The measured values shall comply with the requirements specified in 7.2.6.5, which shall include limits for deviation between actual and specified values.

7.2.9.13 Attenuation

The test shall be performed on signal cables and on power cables if signals are being superimposed on the power conductors.

A sample of completed electric cable, of 10 m (32,8 ft) minimum length, shall be evaluated for attenuation. The attenuation of each conductor pair shall be measured or derived at the frequencies specified in the manufacturer's written specification and a curve of attenuation versus frequency shall be produced. The measured values shall be in accordance with the requirements specified in 7.2.6.5, which shall include limits for deviation between actual and specified values.

7.2.9.14 Characteristic impedance

A sample of completed electric cable of 10 m (32,8 ft) minimum length shall be used for the determination of characteristic impedance.

Measurements shall be made on each pair, at the frequencies specified in the manufacturer's written specification, and the characteristic impedance derived from the values obtained.

A curve of impedance versus frequency shall be produced. The results shall be in accordance with the requirements specified in 7.2.6.5, which shall include limits for deviation between actual and specified values.

7.2.10 Acceptance testing

7.2.10.1 General

Acceptance tests shall be performed on 100 % of manufactured cable, cores and conductors, prior to their inclusion within an umbilical.

© ISO 2009 – All rights reserved
Documents
Document Sharing Hub
Full document details: BS EN ISO 13628-5:2009

7.2.10.2 Visual and dimensional

Electrical cores shall be visually examined on samples of cores and shall be free from damage, conductor kinks or faults. This shall include examination of materials for possible contamination, verification of dimensions and construction. Conductors shall be examined in accordance with IEC 60228.

7.2.10.3 Spark testing

All cores shall be spark-tested during insulation extrusion and all sheathing extrusions should be tested if the extrudate is applied directly over a screen or metallic armour layer. There shall be no indication of faults during the extrusion process in order to pass this test. During the process of insulation and sheath extrusion, the minimum voltage levels shall be in accordance with BS 5099 for the insulation and sheath thicknesses.

NOTE It is not possible to spark-test cores incorporating non-metallic screening (semi-conducting) layers.

7.2.10.4 DC conductor resistance

This test shall be performed on the complete conductor lengths at the following manufacturing stages, as a minimum:

a) after insulation extrusion;

b) after lay-up of the cores;

c) after completion of the electric cable.

The measured DC conductor resistance of each conductor, corrected to 20 °C (68 °F), shall not exceed the value in IEC 60228 by more than + 2 % when corrected for lay-loss, i.e. assembly angle or twist.

7.2.10.5 Insulation resistance

This test shall be performed on the completed insulated conductor lengths in accordance with the procedure and acceptance value specified in 7.2.9.4 after having been immersed in potable water for a duration of 22 h. For acceptance testing of these insulated conductors, the hydrostatic pressure and duration shall be stated in the manufacturer's written specification. This may be different from the value used for qualification testing.

The test shall also be repeated without the requirement for immersion in town-mains water under pressure after lay-up and on completion of the manufacture of the electric cable.

7.2.10.6 High-voltage DC

This test shall be performed on the completed insulated conductor lengths in accordance with the procedure and acceptance value specified in 7.2.9.5. For acceptance testing of these insulated conductors, the hydrostatic pressure and duration shall be stated in the manufacturer's written specification. This may be different from the value used for qualification testing.

The test shall also be repeated without the requirement for immersion in town-mains water under pressure after lay-up and on completion of the manufacture of the electric cable.

7.2.10.7 Inductance

On completion of cable manufacture, the inductance characteristics shall be measured in accordance with the procedure and acceptance values specified in 7.2.9.11 as follows:

a) on a sample of minimum length 10 m (32,8 ft) removed from the completed length; or

b) on the completed length, provided the overall length does not introduce spurious results.

Documents
Document Sharing Hub

© ISO 2009 – All rights reserved

Full document details: BS EN ISO 13628-5:2009

7.2.10.8 Capacitance

On completion of cable manufacture, the capacitance characteristics shall be measured in accordance with the procedure and acceptance values specified in 7.2.9.12 as follows:

a) on a sample of minimum length 10 m (32,8 ft) removed from the completed length;

b) on the completed length, provided the overall length does not introduce spurious results.

7.2.10.9 Attenuation

On completion of cable manufacture, the attenuation characteristics shall be measured or derived in accordance with the procedure and acceptance values specified in 7.2.9.13 as follows:

a) on a sample of minimum length 10 m (32,8 ft) removed from the completed length;

b) on the completed length, provided the overall length does not introduce spurious results.

7.2.10.10 Characteristic impedance

On completion of cable manufacture, the characteristic impedance shall be established in accordance with the procedure specified in 7.2.9.14 as follows:

a) on a sample of minimum length 10 m (32,8 ft) removed from the completed length;

b) on the completed length, provided the overall length does not introduce spurious results.

7.2.10.11 Cross-talk

For cables containing independent conductor pairs, if it is necessary to minimize cross-talk, the cross-talk between conductor pairs at the specified testing conditions shall be measured on the complete cable length for the appropriate mode.

The measured values shall not exceed the values stated in the manufacturer's written specification.

7.2.10.12 Time-domain reflectometry

A time-domain reflectometry (TDR) trace shall be obtained for each conductor from both ends. The width of the pulse shall be sufficient to allow a scan of the complete conductor length. The graphs produced shall detail all the major points, such as start and finish of the conductor, splices, if present, etc. The results of this test shall be used to characterize a conductor within an electric cable or electric cable element and do not constitute acceptance/rejection criteria.

7.2.10.13 Delivery testing

Should completed cables be transported from the cable manufacturer's facility to the umbilical manufacturer's facility, the following tests shall be performed on all electrical cores following delivery and prior to lay-up:

a) DC conductor resistance as specified in 7.2.10.4;

b) insulation resistance as specified in 7.2.10.5.

7.3 Hoses

7.3.1 General

Hoses shall be capable of continuous operation immersed in a seawater environment.

© ISO 2009 – All rights reserved
Documents
Document Sharing Hub
Full document details: BS EN ISO 13628-5:2009

7.3.2 Hose sizing

All hoses shall be referenced by nominal bore and DWP.

NOTE Preferred hose bore sizes and DWP are tabulated in Annex C.

Tolerances on nominal bore shall not exceed the values given in Table 4, and the IDs and ODs of the hose shall be concentric within the limits in Table 5.

The completed hose OD, D, shall be within ± 4 % of the value specified in the manufacturer's written specification.

Table 4 — Nominal bore and wall thickness tolerances

Nominal bore		Tolerance	Liner wall thickness t	
mm	(in)	%	mm	(in)
6,0 to 10,0	(0,236 to 0,394)	$^{+5,0}_{-3,0}$	± 0,2	(0,008)
10,1 to 20,0	(0,395 to 0,787)	$^{+3,0}_{-2,0}$	± 0,2	(0,008)
20,1 to 38,1	(0,788 to 1,5)	$^{+2,0}_{-1,5}$	± 0,25	(0,010)

If the hose liner is specifically designed to withstand external hydrostatic pressure and this necessitates increasing the thickness of the liner to resist collapse, larger wall thickness and concentricity tolerances are permissible. Such tolerances shall be as stated in the manufacturer's written specification.

Table 5 — Concentricity

Nominal bore		Concentricity (full indicated reading)	
mm	(in)	mm	(in)
⩽ 25,4	(1,0)	1,0	(0,039)
> 25,4	(1,0)	1,5	(0,059)

7.3.3 Hose construction

7.3.3.1 General

The hose shall be comprised of three component parts: the liner, the reinforcement and the sheath. When subject to pressure in an unrestrained state, the hose construction shall show no significant propensity to loop, or rotate about its axis.

The hose, fittings and couplings shall be designed considering exposure to sunlight, UV radiations, temperatures of storage and operation, seawater, air and marine atmosphere according to the expected conditions of storage during manufacturing, storage, packing, handling and lay-up relative to the umbilical's characteristics for the specified service life.

7.3.3.2 Liner

The liner shall be a continuous, seamless, circular and concentric extrusion, manufactured from virgin thermoplastic material, and shall be compatible with the intended service fluids.

Documents
Document Sharing Hub

© ISO 2009 – All rights reserved

Full document details: BS EN ISO 13628-5:2009

Multi-layer liners may be acceptable if application requirements cannot be satisfied by a single-layer construction. For instance in situations where there are high external pressures, then an internal support may be incorporated.

For collapse-resistant hoses, the liner may incorporate an internal structure, such as an interlocking carcass, to provide resistance to external hydrostatic pressure. The interlocked carcass shall be of CR material, compatible with both external environment and inner fluid, e.g. AISI 316L for control fluids.

The material in its extruded form shall not introduce particulate contamination of the hose bore, either by extraction or by reaction with the fluid being transported, to the extent that fluid cleanliness cannot be maintained.

7.3.3.3 Reinforcement

The reinforcement shall be comprised of one or more layers of synthetic fibre, applied around the liner.

7.3.3.4 Sheath

The sheath shall be comprised of a continuous, seamless, circular extrusion, manufactured from thermoplastic material incorporating protection against ozone and UV radiation.

The sheath shall provide for the venting of permeated fluids if the particular fluid/hose liner combination can give rise to permeation. The sheath material shall be compatible with the interstitial filler material and the sheathing material of other services within the umbilical throughout its design life. The sheath shall be designed to protect the reinforcement and liner from abrasion, erosion and mechanical damage.

The coefficient of friction between the sheath and the sheaths of other hoses and/or other components shall be minimized.

7.3.3.5 Identification

At least the following information shall be marked, along the complete length of a hose, on the external sheath at regular intervals not exceeding 1 m (3,28 ft):

a) manufacturer;

b) batch number;

c) nominal bore size;

d) DWP;

e) manufacturer's part number;

f) unique component reference, e.g. “Line 6”.

7.3.3.6 Termination interface

The long-term sealing and retention of couplings and/or end fittings shall not be impeded by the hose materials of construction. All materials used shall be suitable for long-term immersion in seawater and shall be in accordance with the manufacturer's written specification. If fittings are crimped or swaged onto the outer sheath of the hose, special attention should be given to ensuring that permeated fluids from the hose do not soften or otherwise degrade the sheath material, resulting in leakage of the end fitting or its detachment from the hose.

Couplings used to join two hose lengths within an umbilical shall be of the one-piece unthreaded type. Couplings used to join hose lengths within a rigid umbilical joint shall be of the threaded type and/or a one-piece design type eliminating the requirements for mechanical connection between the two abutment halves.

© ISO 2009 – All rights reserved
Documents
Document Sharing Hub
Full document details: BS EN ISO 13628-5:2009