Specification for Subsea Umbilicals

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This is the Fifth Edition.

API Subcommittee 17 documents consist of the following:

— Recommended Practice 17A, *Design and Operation of Subsea Production Systems—General Requirements and Recommendations*

— Recommended Practice 17B, *Recommended Practice for Flexible Pipe*

— Specification 17D, *Specification for Subsea Wellhead and Christmas Tree Equipment*

— Specification 17E, *Specification for Subsea Umbilicals*

— Standard 17F, *Specification for Subsea Production Control Systems*

— Recommended Practice 17G, *Recommended Practice for Completion/Workover Riser Systems*

— Recommended Practice 17H, *Remotely Operated Tools and Interfaces on Subsea Production Systems*

— Specification 17J, *Specification for Unbonded Flexible Pipe*

— Specification 17K, *Specification for Bonded Flexible Pipe*

— Specification 17L1, *Specification for Flexible Pipe Ancillary Equipment*

— Recommended Practice 17L2, *Recommended Practice for Flexible Pipe Ancillary Equipment*

— Recommended Practice 17N, *Recommended Practice for Subsea Production System Reliability and Technical Risk Management*

— Standard 17O, *Standard for Subsea High Integrity Pressure Protection Systems (HIPPS)*

— Recommended Practice 17P, *Design and Operation of Subsea Production Systems—Subsea Structures and Manifolds*

— Recommended Practice 17Q, *Recommended Practice for Subsea Equipment Qualification—Standardized Process for Documentation*

— Recommended Practice 17R, *Recommended Practice for Flowline Connectors and Jumpers*

— Recommended Practice 17S, *Recommended Practice for Design, Testing and Operation of Subsea Multiphase Flow Meters*

— Recommended Practice 17U, *Recommended Practice for Wet and Dry Thermal Insulation of Subsea Flowlines and Equipment*

— Recommended Practice 17V, *Recommended Practice for Subsea Safety*

— Recommended Practice 17W, *Recommended Practice for Subsea Capping Stacks*

— TR 17TR1, *Evaluation Standard for Internal Pressure Sheath Polymers for High Temperature Flexible Pipes*

— TR 17TR2, *The Ageing of PA-11 in Flexible Pipes*

— TR 17TR3, *An Evaluation of the Risks and Benefits of Penetrations in Subsea Wellheads Below the BOP Stack*

— TR 17TR4, *Subsea Equipment Pressure Ratings*

— TR 17TR5, *Avoidance of Blockages in Subsea Production Control and Chemical Injection Systems*

— TR 17TR6, *Attributes of Production Chemicals in Subsea Production Systems*

— TR 17TR8, *High-pressure High-temperature Design Guidelines*

— TR 17TR10, *Subsea Umbilical Termination (SUT) Design Recommendations*

— TR 17TR11, *Pressure Effects on Subsea Hardware during Flowline Pressure Testing in Deep Water*

— TR 17TR12, *Consideration of External Pressure in the Design and Pressure Rating of Subsea Equipment*

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Suggested revisions are invited and should be submitted to the Standards Department, API, 1220 L Street, NW, Washington, DC 20005, standards

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Introduction

This document is based on API Specification 17E, Fourth Edition, which superseded previous versions of API 17E and API RP 17I, First Edition.

It is important that users of this document be aware that further or differing requirements can be needed for individual applications. This document 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 document and provide details.

Within this document, "shall" is used to state that a provision is mandatory; "should" is used to state that a provision is not mandatory, but is recommended as good practice; and "may" is used to state that a provision is optional.

Système International (SI) units are identified first when cited in the document. United States Customary (USC) units may be given in parentheses after the SI units.

Specification for Subsea Umbilicals

1 Scope

This document 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 document applies to umbilicals containing components, such as electrical cables, optical fibers, thermoplastic hoses, and metallic tubes, either alone or in combination.

This document applies to umbilicals for static or dynamic service, with surface–surface, surface–subsea, and subsea–subsea routings.

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

This document applies only to tubes with the following dimensions:

— wall thickness, $t < 6$ mm (0.2 in.);

— internal diameter, ID < 50.8 mm (2 in.).

NOTE Tubular products with dimensions greater than these can be regarded as pipeline/line pipe, and therefore designed and manufactured according to a recognized pipeline/line pipe standard.

This document does not apply to a tube or hose rated lower than 7 MPa (1015 psi).

This document applies to electrical cables for rated voltages from 1kV (Um = 1.2kV) up to 30kV (Um = 36kV).

If a product is supplied bearing the API Monogram and manufactured at a facility licensed by API, the requirements of Annex A apply.

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.

API RP 17H, *Remotely Operated Tools and Interfaces on Subsea Production Systems*

ASTM A240/A240M, *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/A480M, *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 and Knoop Hardness of Metallic Materials*

ASTM E213, *Standard Practice for Ultrasonic Testing of Metal Pipe and Tubing*

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

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

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 G48-11, *Standard Test Methods for Pitting And Crevice Corrosion Resistance of Stainless Steels and Related Alloys by Use of Ferritic Chloride Solution*

DNV-OS-H205, *Lifting Operations (VMO Standard—Part 2–5)*

DNV-RP-B401, *Cathodic Protection Design*

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

ICEA S-97-682, *Standard for Utility Shielded Power Cables Rated 5 Through 46 kV*

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

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

IEC 60794-1-21, Optical fiber cables - Part 1-21: Generic specification — Basic optical cable test procedures — Mechanical test methods

IEC 62230, *Electric cables — Spark-test method*

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

ISO 10619-2:2011, *Rubber and plastics hoses and tubing — Measurement of flexibility and stiffness — Part 2: Bending tests at sub-ambient temperatures*

ITU-T G.652, *Characteristics of a single-mode optical fibre cable*

ITU-T G.654, *Characteristics of a cut-off shifted single-mode optical fibre cable*

ITU-T G.976, *Test methods applicable to optical fiber 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
accidental load
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

3.1.2
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

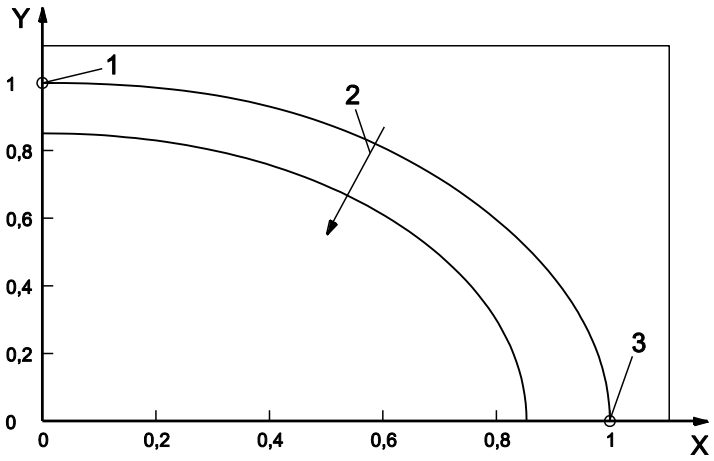
See Figure 1.

NOTE 1 The bend radius is measured to the centerline 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.

NOTE 3 Increasing the level of safety generally increases the allowable bend radius and decreases the allowable tensile load, i.e. moves the capacity curves toward origin.

NOTE 4 Increasing the internal pressure generally increases the allowable bend radius and decreases the allowable tensile load, i.e. moves the capacity curves toward origin.



Key

X inverse of the normalized bend radius, MBR per radius
Y normalized allowable tensile load, tension
1 maximum tensile load, with no bending
2 increasing pressure and/or increasing safety level
3 inverse of minimum bend radius (MBR) with no tension

Figure 1—Capacity Curves

3.1.3
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 varies depending on internal pressure and condition, i.e. safety level.

3.1.4
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.

3.1.5
bend restrictor
Device for limiting the bend radius of the umbilical by mechanical means.

NOTE 1 A bend restrictor typically is comprised of a series of interlocking metallic or molded rings, applied over the umbilical.

NOTE 2 It is sometimes referred to as a bend limiter.

3.1.6
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 molded device, sometimes reinforced, depending on the required duty, applied over the umbilical. It is sometimes referred to as a bend strain reliever (BSR).

3.1.7
bird-caging
Phenomenon whereby armor wires locally rearrange with an increase and/or decrease in pitch-circle diameter as a result of accumulated axial and radial stresses in the armor layer(s).