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Industries du pétrole et du gaz naturel — Tiges de forage en acier

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ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Fax: +41 22 749 09 47
Email: copyright@iso.org
Website: www.iso.org

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 67, *Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries*, Subcommittee SC 5, *Casing, tubing and drill pipe*.

This third edition cancels and replaces the second edition (ISO 11961:2008), which has been technically revised. It also incorporates the Technical Corrigendum ISO 11961:2008/Cor.1:2009.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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Introduction

Users of this document are advised that further or differing requirements might be needed for individual applications. This document is not intended to inhibit a vendor from offering, or the purchaser from accepting, alternative equipment or engineering solutions for the individual application. This may be particularly applicable where there is innovative or developing technology. Where an alternative is offered, the vendor can identify any variations from this document and provide details.

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Petroleum and natural gas industries — Steel drill pipe

1 Scope

This document specifies the technical delivery conditions for steel drill-pipes with upset pipe-body ends and weld-on tool joints for use in drilling and production operations in petroleum and natural gas industries for three product specification levels (PSL-1, PSL-2 and PSL-3). The requirements for PSL-1 form the basis of this document. The requirements that define different levels of standard technical requirements for PSL-2 and PSL-3 are in Annex G.

This document covers the following grades of drill-pipe:

— grade E drill-pipe;

— high-strength grades of drill-pipe, grades X, G and S;

— enhanced H_2S resistance drill pipe, grades D and F.

A typical drill-pipe configuration is given, showing main elements and lengths (see Figure B.1). The main dimensions and masses of the grades of drill-pipe are given in both SI units (see Table A.1) and in USC units (see Table C.1).

This document can also be used for drill-pipe with tool joints not specified by ISO or API standards.

By agreement between purchaser and manufacturer, this document can also be applied to other drill-pipe body and/or tool-joint dimensions. This document lists supplementary requirements that can optionally be agreed between purchaser and manufacturer, for testing, performance verification and non-destructive examination (see Annex E).

This document does not consider performance properties, nor performance degradation of the product when in service.

NOTE 1 In this document, drill-pipe is designated by label 1, label 2, grade of material (E, X, G, S, D and F), upset type and type of rotary shouldered connection. Designations are used for the purpose of identification in ordering.

NOTE 2 Reference can be made to ISO 10424-2 or API Spec 7-2 for the detailed requirements for the threading of drill-pipe tool joints.

NOTE 3 Reference can be made to API RP 7G for the performance properties of the drill-pipe.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 6506-1, *Metallic materials — Brinell hardness test — Part 1: Test method*

ISO 6507-1, *Metallic materials — Vickers hardness test — Part 1: Test method*

ISO 6508-1, *Metallic materials — Rockwell hardness test — Part 1: Test method*

ISO 6892, *Metallic materials — Tensile testing*

ISO 7500-1, *Metallic materials — Calibration and verification of static uniaxial testing machines — Part 1: Tension/compression testing machines — Calibration and verification of the force-measuring system*

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ISO 9513, *Metallic materials — Calibration of extensometer systems used in uniaxial testing*

ISO 10424-2, *Petroleum and natural gas industries — Rotary drilling equipment — Part 2: Threading and gauging of rotary shouldered thread connections*

ISO 10893-2, *Non-destructive testing of steel tubes — Part 2: Automated eddy current testing of seamless and welded (except submerged arc-welded) steel tubes for the detection of imperfections*

ISO 10893-3, *Non-destructive testing of steel tubes — Part 3: Automated full peripheral flux leakage testing of seamless and welded (except submerged arc-welded) ferromagnetic steel tubes for the detection of longitudinal and/or transverse imperfections*

ISO 10893-5, *Non-destructive testing of steel tubes — Part 5: Magnetic particle inspection of seamless and welded ferromagnetic steel tubes for the detection of surface imperfections*

ISO 10893-10, *Non-destructive testing of steel tubes — Part 10: Automated full peripheral ultrasonic testing of seamless and welded (except submerged arc-welded) steel tubes for the detection of longitudinal and/or transverse imperfections*

ISO 11484, *Steel products — Employer's qualification system for non-destructive testing (NDT) personnel*

Spec API 7-2, *Specification for Threading and Gauging of Rotary Shouldered Thread Connections*

ANSI/NACE TM0177, *Laboratory testing of metals for Resistance to Sulfide Stress Cracking and Stress Corrosion Cracking in H_2S Environments*

ASME. *Boiler and Pressure Vessel Code, Section IX*

ASNT SNT-TC-1A, *Recommended Practice, Personnel Qualification and Certification in Non-Destructive Testing*

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

ASTM A751, *Standard Test Methods, Practices and Terminology for Chemical Analysis of Steel Products*

ASTM A941, *Terminology Relating to Steel, Stainless Steel, Related Alloys, and Ferroalloys*

ASTM E4, *Standard Practices for Force Verification of Testing Machines*

ASTM E10, *Standard Test Method for Brinell Hardness of Metallic Materials*

ASTM E18, *Standard Test Methods for Rockwell Hardness of Metallic Materials*

ASTM E23, *Standard Test Methods for Notched Bar Impact Testing of Metallic Materials*

ASTM E83, *Standard Practice for Verification and Classification of Extensometer Systems*

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

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

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

ASTM E570, *Standard Practice for Flux Leakage Examination of Ferromagnetic Steel Tubular Products*

ASTM E709, *Standard Guide for Magnetic Particle Testing*

3 Terms, definitions, symbols and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in ASTM A941 and the following apply.

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ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at http://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1.1
bevel diameter
outer diameter of the sealing shoulder of a rotary shouldered connection

3.1.2
defect
imperfection of sufficient magnitude to warrant rejection of the product based on criteria defined in this document

[SOURCE: ISO 11960:2014, definition 4.1.12]

3.1.3
drill-pipe
drill-pipe body with weld-on tool joints

3.1.4
drill-pipe body
seamless pipe with upset ends

Note 1 to entry: See Figure B.1.

3.1.5
drill-pipe-body manufacturer
firm, company or corporation that operates facilities for making drill-pipe bodies and is responsible for compliance with the requirements of this document applicable to the drill-pipe body

Note 1 to entry: See 7.21.

3.1.6
drill-pipe manufacturer
firm, company or corporation responsible for compliance with all the applicable requirements of this document

Note 1 to entry: See 6.16.

3.1.7
drill-pipe torsion-strength ratio
torsion strength of the tool-joint connection divided by the drill-pipe-body torsion strength

3.1.8
drill-pipe weld neck
machined part of the drill-pipe comprising the tool-joint weld neck, the weld and the drill-pipe-body upset

Note 1 to entry: See Figure B.1.

3.1.9
elephant hide
wrinkled outside diameter surfaces of the drill-pipe body caused by the upsetting process

3.1.10
enhanced H_2S resistance
classification of drill pipe that includes Sulfide Stress Cracking testing as part of its qualification and quality control

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3.1.11
essential variable
variable parameter in which a change affects the mechanical properties of the weld joint

3.1.12
gouge
elongated groove or cavity caused by mechanical removal of metal

3.1.13
hard banding
application of material onto tool joints to reduce external wear of the tool joint

Note 1 to entry: This is also known as hard facing.

3.1.14
hardness number
result from a single hardness impression

3.1.15
heat
heat of steel
metal produced by a single cycle of a batch-melting process

3.1.16
heat analysis
chemical analysis representative of a heat as reported by the metal producer

[SOURCE: ISO 11960:2014, definition 4.1.18]

3.1.17
imperfection
discontinuity in the product wall or on the product surface that can be detected by an NDE method included in this document

[SOURCE: ISO 11960:2014, definition 4.1.19, modified]

3.1.18
indication
evidence of a discontinuity that requires interpretation to determine its significance

3.1.19
inspection
process of measuring, examining, testing, gauging or otherwise comparing the product with the applicable requirements

3.1.20
label 1
dimensionless designation for the drill-pipe-body size that may be used when ordering

3.1.21
label 2
dimensionless designation for the drill-pipe-body mass per unit length that may be used when ordering

3.1.22
linear imperfection
imperfection that includes, but is not limited to, seams, laps, cracks, plug scores, cuts, gouges and elephant hide

Note 1 to entry: See API 5T1.

[SOURCE: ISO 11960:2004, definition 4.1.28, modified]

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3.1.23
lot
definite quantity of product manufactured under conditions that are considered uniform for the attribute being inspected

3.1.24
lot size
number of units in a lot

3.1.25
manufacturer
maker of drill-pipe, drill-pipe body or tool joints

Note 1 to entry: The manufacturer can be the maker of one or more of the specified components, depending on context.

3.1.26
mean hardness number
result of averaging the hardness numbers for the single specimen or location being evaluated

3.1.27
non-essential variable
variable parameter in which a change may be made in the WPS without re-qualification

3.1.28
non-linear imperfection
imperfection that includes, but is not limited to, pits

Note 1 to entry: See API Std 5T1.

3.1.29
pipe body
seamless pipe excluding upset and upset-affected areas

Note 1 to entry: See Figure B.1.

3.1.30
procedure qualification record
PQR
written documentation stating an assessment that a specific WPS produces welds in accordance with the requirements of this document.

3.1.31
product
drill-pipe, drill-pipe body or tool joint

3.1.32
purchaser
party responsible for both the definition of requirements for a product order and for payment for that order

[SOURCE: ISO 11960:2014, definition 4.1.39]

3.1.33
quench crack
crack in steel resulting from stresses produced during the transformation from austenite to martensite

Note 1 to entry: This transformation is accompanied by an increase in volume.

[SOURCE: ISO 11960:2014, definition 4.1.40]

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3.1.34
rotary shouldered connection
connection used on drill string elements which has tapered threads and sealing shoulders

3.1.35
rotary friction welding
solid state welding under compressive-force contact of work-pieces rotating relative to one another along a common axis to increase temperature and plastically displace material from the faying surfaces

Note 1 to entry: Either direct drive or inertia friction welding is acceptable.

3.1.36
sample
one or more units of product selected from a lot to represent that lot

3.1.37
seamless pipe
wrought steel tubular product made without a weld seam

Note 1 to entry: It is manufactured by hot working and, if necessary, by subsequently cold-working or heat-treating, or a combination of these operations, to produce the desired shape, dimensions and properties.

[SOURCE: ISO 11960:2014, definition 4.1.41, modified]

3.1.38
tool joint
forged or rolled steel component for drill-pipe designed to be welded to the drill-pipe body and having a rotary shouldered connection

3.1.39
tool-joint box
threaded connection on tool joints that has internal threads

3.1.40
tool-joint manufacturer
firm, company or corporation that operates facilities for making tool joints and is responsible for compliance with the requirements of this document applicable to the tool joint

Note 1 to entry: See 8.14.

3.1.41
tool-joint pin
threaded connection on tool joints that has external threads

3.1.42
upset ovality
difference between the largest and smallest diameter in a plane perpendicular to the axis of the upset

3.1.43
weld zone
zone comprising the weld line and the heat-affected areas on either side of the weld line caused by the friction welding and subsequent heat-treatment processes

3.1.44
welding machine and welding operator performance qualification
WPQ
written procedure used to demonstrate that a welding machine and welding operator combination has the capability to use the WPS to produce a weld meeting the requirements of this document

Note 1 to entry: It includes records from the qualification tests.

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3.1.45
welding procedure specification
WPS
written procedure that provides instructions to the welding operator for making production welds in accordance with the requirements of this document

Note 1 to entry: It includes all essential variables and non-essential variables for friction welding of tool joints to drill-pipe body. A WPS applies to all those welds, of which each element has the same specified dimensions and chemistry, that are grouped according to a documented procedure that ensures a predictable response to weld-zone treatment for a particular grade.

3.2 Symbols and abbreviated terms

A_{dp}	cross-sectional area of the drill-pipe body based on the specified dimensions of the pipe body
A	cross-sectional area of the tensile specimen, expressed in square millimetres (square inches)
A	length of reduced section, expressed in millimetres
A_w	minimum cross-sectional area of the weld zone
D	tool-joint outside diameter (pin and box)
C_m	standard Charpy impact energy, expressed in Joules
C	standard Charpy impact energy, expressed in foot-pounds
D_{dp}	pipe-body outside diameter
D_f	bevel diameter (pin and box)
D_j	external diameter on the tool-joint neck, which becomes D_{te} after welding and final machining
D	diameter of round bar
D_{te}	outside diameter of the drill-pipe weld after machining
D_{0u}	drill-pipe-body upset outside diameter
d_{dp}	pipe-body inside diameter
d_j	internal diameter of the tool-joint neck, which becomes d_{te} after welding and final machining
d_p	tool-joint-pin inside diameter
d_{te}	inside diameter of the drill-pipe weld after machining
d_{0u}	drill-pipe-body upset inside diameter
EU	external upset
e	minimum extension in a gauge length of 50,8 mm (2.0 in)
e_m	minimum elongation
e_w	drill-pipe-body mass gain or loss due to end finishing. For plain-end non-upset pipe, e_w equals zero
G	gauge length

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ID	inside diameter
IEU	internal-external upset
IU	internal upset
L	length of drill-pipe with weld-on tool joint (from shoulder to shoulder)
L_b	length of box-tool joint outside diameter including connection bevel and hard band; see Figures B.1 and B.12
L_{eu}	drill-pipe-body external upset length
L_{iu}	drill-pipe-body internal upset length
L_{pb}	length of pin-tool-joint outside diameter, including connection bevel; see Figures B.1 and B.12
L_{pe}	length of drill-pipe body (without tool joint)
m_{eu}	drill-pipe-body external upset taper length
m_{iu}	drill-pipe-body internal upset taper length
N	fraction or number with a fraction
NDE	non-destructive examination
OD	outside diameter
PQR	procedure qualification record
PSL	product specification level
R	minimum radius of fillet
RSC	rotary shouldered connection
SSC	Sulfide Stress Cracking
T_S	tensile strength
t	pipe-body wall thickness
U	upset dimension
U_{dp}	minimum specified tensile strength
UT	ultrasonic testing
W	width
W_L	approximate calculated mass of a piece of drill-pipe body of length L_{pe}
WPQ	welder performance qualification
WPS	welding procedure specification
w_{dp}	approximate linear mass of the drill-pipe

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w_{pe} plain-end pipe-body unit mass (without upsets)

Y_{min} specified minimum yield strength, see Table A.5 or Table C.5

Y_w weld zone yield strength

4 Conformance

4.1 Dual citing of normative references

In the interests of world-wide application of this document, Technical Committee ISO/TC 67 has decided, after detailed technical analysis, that some of the normative documents listed in Clause 2 and prepared by ISO/TC 67 or another ISO Technical Committee are interchangeable in the context of the relevant requirement with the relevant document prepared by the American Petroleum Institute (API), the American Society for Testing and Materials (ASTM) and the American National Standards Institute (ANSI). These latter documents are cited in the running text following the ISO reference and preceded by "or", for example "ISO XXXX or API YYYY". Application of an alternative normative document cited in this manner will lead to technical results different from the use of the preceding ISO reference. However, both results are acceptable and these documents are thus considered interchangeable in practice.

4.2 Units of measurement

In this document, data are expressed in both the International System (SI) of units and the United States Customary (USC) system of units. Separate tables for data expressed in SI units and USC units are in Annex A and Annex C, respectively. Figures are in Annex B and express data in both SI and USC units. For a specific order item, it is intended that only one system of units be used, without combining data expressed in the other system.

Products manufactured to specifications expressed in either of these unit systems shall be considered equivalent and totally interchangeable. Consequently, compliance with the requirements of this document as expressed in one system provides compliance with requirements expressed in the other system.

For data expressed in the SI system, a comma is used as the decimal separator and a space as the thousands separator. For data expressed in the USC system, a dot (on the line) is used as the decimal separator and a space as the thousands separator.

In the text, data in SI units are followed by data in USC units in brackets.

NOTE The procedures used to convert from USC units to SI units are given in Annex F.

5 Information to be supplied when placing orders for drill-pipe

5.1 Grades D95 and F105

Particular attention should be given to the application of Grades D95 and F105 in ISO 15156-2 or ANSI-NACE MR0175/SSC Regions 1, 2 or 3, as this material is not suitable for all sour (hydrogen sulfide-containing) service applications.

Given the high strength often needed, drilling equipment may not comply with the requirements of the ISO 15156-2/ANSI-NACE MR0175. In such cases the primary means for avoiding SSC is control of the drilling or well-servicing environment. As service stresses and material hardness increase, drilling fluid control becomes increasingly important. The following precautions are suggested:

— maintain fluid density and integrity of hydrostatic column to minimize inflow of formation fluid;

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