INTERNATIONAL STANDARD

ISO 11961

Second edition
2008-11-01

Petroleum and natural gas industries — Steel drill pipe

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

Reference number
ISO 11961:2008(E)

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Published in Switzerland

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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.

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 11961 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 second edition cancels and replaces the first edition (ISO 11961:1996), which has been extensively technically revised.

It is the intention of ISO/TC 67 that either this edition or the previous edition of ISO 11961 be applicable, at the option of the purchaser (as defined in 4.1.31), for a period of six months from the first day of the calendar quarter immediately following the date of publication of this edition, after which period the previous edition will no longer be applicable.

Introduction

This International Standard is based on API Spec 5D and API Spec 7.

Users of this International Standard should be aware that further or differing requirements may be needed for individual applications. This International Standard 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 should identify any variations from this International Standard and provide details.

This International Standard includes provisions of various natures. These are identified by the use of certain verbal forms:

a) SHALL is used to indicate that a provision is MANDATORY;

b) SHOULD is used to indicate that a provision is not mandatory, but RECOMMENDED as good practice;

c) MAY is used to indicate that a provision is OPTIONAL.

Petroleum and natural gas industries — Steel drill pipe

1 Scope

This International Standard 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 International Standard. The requirements that define different levels of standard technical requirements for PSL-2 and PSL-3 are in Annex G.

This International Standard covers the following grades of drill-pipe:

— grade E drill-pipe;

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

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

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

This International Standard does not consider performance properties.

NOTE 1 In this International Standard, drill-pipe is designated by label 1, label 2, grade of material (E, X, G and S), 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 Conformance

2.1 Dual citing of normative references

In the interests of world-wide application of this International Standard, Technical Committee ISO/TC 67 has decided, after detailed technical analysis, that certain of the normative documents listed in Clause 3 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.

2.2 Units of measurement

In this International Standard, 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 International Standard 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 informative Annex F.

3 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 amendment) 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 (scales A, B, C, D, E, F, G, H, K, N, T)*

ISO 6892, *Metallic materials — Tensile testing*

ISO 7500-1, *Metallic materials — Verification of static uni-axial testing machines — Part 1: Tension/compression testing machines — Verification and calibration of the force-measuring system*

ISO 9303, *Seamless and welded (except submerged arc-welded) steel tubes for pressure purposes — Full peripheral ultrasonic testing for the detection of longitudinal imperfections*

ISO 9304, *Seamless and welded (except submerged arc-welded) steel tubes for pressure purposes — Eddy current testing for the detection of imperfections*

ISO 9305, *Seamless steel tubes for pressure purposes — Full peripheral ultrasonic testing for the detection of transverse imperfections*

ISO 9402, *Seamless and welded (except submerged arc-welded) steel tubes for pressure purposes — Full peripheral magnetic transducer/flux leakage testing of ferromagnetic steel tubes for the detection of longitudinal imperfections*

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

ISO 9598, *Seamless steel tubes for pressure purposes — Full peripheral magnetic transducer/flux leakage testing of ferromagnetic steel tubes for the detection of transverse imperfections*

ISO/TR 9769, *Steel and iron — Review of available methods of analysis*

ISO/TR 10400, *Petroleum and natural gas industries — Equations and calculations for the properties of casing, tubing, drill-pipe and line pipe used as casing or tubing*

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

ISO 11484, *Steel tubes for pressure purposes — Qualification and certification of non-destructive (NDT) personnel*

ISO 13665, *Seamless and welded steel tubes for pressure purposes — Magnetic particle inspection of the tube body for the detection of surface imperfections*

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

API RP 7G, *Recommended Practice for Drill Stem Design and Operating Limits*

ANSI/API 5C3, *Bulletin on Formulas and Calculations for Casing, Tubing, Drill-pipe, and Line Pipe Properties* (including Supplement 1)

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*

4 Terms, definitions, symbols and abbreviated terms

4.1 Terms and definitions

For the purposes of this document, the terms and definitions in ASTM A941 for heat treatment operations and the following apply.

4.1.1
bevel diameter
outer diameter of the sealing shoulder of a rotary shouldered connection

4.1.2
defect
imperfection of sufficient magnitude to warrant rejection of the product based on criteria defined in this International Standard

[ISO 11960:2004, definition 4.1.11]

4.1.3
drill-pipe
drill-pipe body with weld-on tool joints

4.1.4
drill-pipe body
seamless pipe with upset ends

See Figure B.1.

4.1.5
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 International Standard applicable to the drill-pipe body

See 7.21.

4.1.6
drill-pipe manufacturer
firm, company or corporation responsible for compliance with all the applicable requirements of this International Standard

See 6.16.

4.1.7
drill-pipe torsion-strength ratio
torsion strength of the tool-joint connection divided by the drill-pipe-body torsion strength

4.1.8
drill-pipe weld neck
machined part of the drill-pipe comprising the tool-joint weld neck, the weld and the drill-pipe-body upset

See Figure B.1.

4.1.9
elephant hide
wrinkled outside diameter surfaces of the drill-pipe body caused by the upsetting process

4.1.10
essential variable
variable parameter in which a change affects the mechanical properties of the weld joint

4.1.11
gouge
elongated groove or cavity caused by mechanical removal of metal

4.1.12
hard banding
application of material onto tool joints to reduce external wear of the tool joint

NOTE Also known as hard facing.

4.1.13
hardness number
result from a single hardness impression

4.1.14
heat
heat of steel
metal produced by a single cycle of a batch-melting process

4.1.15
heat analysis
chemical analysis representative of a heat as reported by the metal producer

[ISO 11960:2004, definition 4.1.15]

4.1.16
imperfection
discontinuity in the product wall or on the product surface that can be detected by an NDE method included in this International Standard

[ISO 11960:2004, definition 4.1.16]

4.1.17
indication
evidence of a discontinuity that requires interpretation to determine its significance

4.1.18
inspection
process of measuring, examining, testing, gauging or otherwise comparing the product with the applicable requirements

4.1.19
label 1
dimensionless designation for the drill-pipe-body size that may be used when ordering

4.1.20
label 2
dimensionless designation for the drill-pipe-body mass per unit length that may be used when ordering

4.1.21
linear imperfection
imperfection that includes, but is not limited to, seams, laps, cracks, plug scores, cuts, gouges and elephant hide

NOTE See API 5T1.

[ISO 11960:2004, definition 4.1.25]

4.1.22
lot
definite quantity of product manufactured under conditions that are considered uniform for the attribute being inspected

4.1.23
lot size
number of units in a lot

4.1.24
manufacturer
one or more of the following, depending on the context: the maker of drill-pipe, the maker of drill-pipe body or the maker of tool joints

4.1.25
mean hardness number
result of averaging the hardness numbers for the single specimen or location being evaluated

4.1.26
non-essential variable
variable parameter in which a change may be made in the WPS without re-qualification

4.1.27
non-linear imperfection
imperfection that includes, but is not limited to, pits

See API Std 5T1.

4.1.28
pipe body
seamless pipe excluding upset and upset-affected areas

See Figure B.1.

4.1.29
procedure qualification record
PQR
written documentation stating an assessment that a specific WPS produces welds in accordance with the requirements of this International Standard.

4.1.30
product
drill-pipe, drill-pipe body or tool joint

4.1.31
purchaser
party responsible for both the definition of requirements for a product order and for payment for that order

[ISO 11960:2004, definition 4.1.35]

4.1.32
quench crack
crack in steel resulting from stresses produced during the transformation from austenite to martensite

NOTE This transformation is accompanied by an increase in volume.

[ISO 11960:2004, definition 4.1.36]

4.1.33
rotary shouldered connection
connection used on drill string elements which has tapered threads and sealing shoulders

4.1.34
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 Either direct drive or inertia friction welding is acceptable.

4.1.35
sample
one or more units of product selected from a lot to represent that lot

4.1.36
seamless pipe
wrought steel tubular product made without a weld seam

NOTE 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.

[ISO 11960:2004, definition 4.1.37]

4.1.37
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

4.1.38
tool-joint box
threaded connection on tool joints that has internal threads

4.1.39
tool-joint manufacturer
firm, company or corporation that operates facilities for making tool joints and is responsible for compliance with the requirements of this International Standard applicable to the tool joint

See 8.14.

4.1.40
tool-joint pin
threaded connection on tool joints that has external threads

4.1.41
upset ovality
difference between the largest and smallest diameter in a plane perpendicular to the axis of the upset

4.1.42
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

4.1.43
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 International Standard

NOTE It includes records from the qualification tests.

4.1.44
welding procedure specification
WPS
written procedure that provides instructions to the welding operator for making production welds in accordance with the requirements of this International Standard

NOTE 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.

4.2 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
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
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
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