

DIN EN ISO 11961

ICS 75.180.10; 77.140.75

Ersatz für
DIN EN ISO 11961:2009-09**Erdöl- und Erdgasindustrie –
Stahl-Bohrrohre (ISO 11961:2018);
Englische Fassung EN ISO 11961:2018, nur auf CD-ROM**

Petroleum and natural gas industries –
Steel drill pipe (ISO 11961:2018);
English version EN ISO 11961:2018, only on CD-ROM

Industries du pétrole et du gaz naturel –
Tiges de forage en acier (ISO 11961:2018);
Version anglaise EN ISO 11961:2018, seulement en CD-ROM

Gesamtumfang 130 Seiten

DIN-Normenausschuss Erdöl- und Erdgasgewinnung (NÖG)

Nationales Vorwort

Dieses Dokument (EN ISO 11961:2018) wurde vom Technischen Komitee ISO/TC 67 „Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries“, Unterkomitee SC5 „Casing, tubing and drill pipe“ in Zusammenarbeit mit dem Technischen Komitee CEN/TC 12 „Materialien, Ausrüstungen und Offshore-Bauwerke für die Erdöl-, petrochemische und Erdgasindustrie“ (Sekretariat NEN, Niederlande) erarbeitet.

Für Deutschland hat hieran der Arbeitskreis NA 109-00-01-05 AK „Futter-, Steig- und Bohrrohre - Spiegelausschuss zu ISO/TC 67/SC 5“ im DIN-Normenausschuss Erdöl- und Erdgasgewinnung (NÖG) mitgearbeitet.

Diese Europäische Norm enthält unter Berücksichtigung des DIN-Präsidialbeschlusses 1/2004 nur die englische Originalfassung der ISO-Norm.

Diese Norm enthält neben den gesetzlichen Einheiten auch die Einheiten „°F“, „ft“, „in (inch)“, „ksi“, „lb (pound)“ und „psi (psig)“, die in Deutschland nicht zugelassen sind. Es wird ausdrücklich darauf hingewiesen, dass die Anwendung dieser Einheiten im nationalen amtlichen und geschäftlichen Verkehr aufgrund des Gesetzes über Einheiten im Messwesen nicht zulässig ist. Die Angabe dieser Einheiten dient lediglich als Hilfe im amtlichen und geschäftlichen Verkehr (z. B. bei Einfuhr und Ausfuhr) mit solchen Staaten, die diese Einheiten anwenden.

Umrechnung:

Nicht-SI-Einheit	SI-Einheit	Umrechnung	
°F	°C	°C	$= (5/9) (°F - 32)$
ft	m	1 ft	$= 0,304 8 \text{ m}$
in (inch)	mm	1 inch	$= 25,4 \text{ mm}$
ksi	MPa	1 ksi	$= 6,894 757 \text{ MPa}$
lb (pound)	kg	1 lb	$= 0,453 592 37 \text{ kg}$
psi (psig)	kPa	1 psi	$= 6,894 757 \text{ kPa}$

Für die in diesem Dokument zitierten internationalen Dokumente wird im Folgenden auf die entsprechenden deutschen Dokumente hingewiesen:

ISO 6506-1	siehe	DIN EN ISO 6506-1
ISO 6507-1	siehe	DIN EN ISO 6507-1
ISO 6508-1	siehe	DIN EN ISO 6508-1
ISO 7500-1	siehe	DIN EN ISO 7500-1
ISO 9513	siehe	DIN EN ISO 9513
ISO/TR 10400	siehe	DIN CEN ISO/TR 10400, DIN SPEC 91040
ISO 10424-2	siehe	DIN EN ISO 10424-2
ISO 11960	siehe	DIN EN ISO 11960
ISO 15156-2	siehe	DIN EN ISO 15156-2

Änderungen

Gegenüber DIN EN ISO 11961:2009-09 wurden folgende Änderungen vorgenommen:

- a) Normative Verweisungen überarbeitet und ergänzt;
- b) inhaltliche Ergänzung um Aspekte zu verbesserter H₂S-Beständigkeit;
- c) 5.1 „Grades D95 and F105“ hinzugefügt;
- d) 6.3.7 „Sulfide stress cracking test - Grades D and F“ hinzugefügt;
- e) 7.3.6 „Surface hardness requirements“ hinzugefügt;
- f) 8.9 „Hardness tests“ um Angaben zu Graden D und F ergänzt;
- g) Tabellen in Anhang A und Anhang C inhaltlich überarbeitet;
- h) Bilder in Anhang B überarbeitet;
- i) Anhang H gestrichen.

Frühere Ausgaben

DIN EN ISO 11961: 1997-03, 2009-03, 2009-09

Nationaler Anhang NA (informativ)

Begriffe, Symbole und Abkürzungen

Die Benummerung der folgenden Begriffe, Symbole und Abkürzungen sind identisch mit der Benummerung in der englischen Fassung.

3 Begriffe, Symbole und Abkürzungen

3.1 Begriffe

Für die Anwendung dieses Dokuments gelten die Begriffe nach ASTM A941 für Wärmebehandlungen und die folgenden Begriffe.

ISO und IEC stellen terminologische Datenbanken für die Verwendung in der Normung unter den folgenden Adressen bereit:

— ISO Online Browsing Platform: verfügbar unter <http://www.iso.org/obp>

— IEC Electropedia: verfügbar unter <http://www.electropedia.org/>

3.1.1

Kegeldurchmesser

Außendurchmesser der Dichtschulter einer drehenden Schulteransatz-Gewindeverbindung

3.1.2

Fehler

Mangel, der so ausgeprägt ist, dass eine Rückweisung des Produkts auf der Grundlage der in dieser Internationalen Norm festgelegten Kriterien gerechtfertigt ist

[QUELLE: ISO 11960:2014, 4.1.12]

3.1.3

Bohrrohr

Bohrrohrkörper mit Anschweiß-Werkzeugverbindungen

3.1.4

Bohrrohrkörper

nahtloses Rohr mit gestauchten Enden

Anmerkung 1 zum Begriff: Siehe Bild B.1.

3.1.5

Bohrrohrkörper-Hersteller

Firma, Unternehmen oder Gesellschaft, welche(s) Anlagen zur Herstellung von Bohrohrkörpern betreibt und verantwortlich ist für die Übereinstimmung mit den auf den Bohrohrkörper anwendbaren Anforderungen dieser Internationalen Norm

Anmerkung 1 zum Begriff: Siehe 7.21.

3.1.6**Bohrrohr-Hersteller**

Firma, Unternehmen oder Gesellschaft, welche(s) verantwortlich ist für die Übereinstimmung mit allen anwendbaren Anforderungen dieser Internationalen Norm

Anmerkung 1 zum Begriff: Siehe 6.16.

3.1.7**Torsionsfestigkeitsverhältnis des Bohrrohres**

Torsionsfestigkeit der Werkzeugverbindung dividiert durch die Torsionsfestigkeit des Bohrrohrkörpers

3.1.8**Bohrrohr-Vorschweißbund**

bearbeiteter Teil des Bohrrohres, der den Vorschweißbund der Werkzeugverbindung, die Schweißnaht und die Stauchung des Bohrrohrkörpers umfasst

Anmerkung 1 zum Begriff: Siehe Bild B.1.

3.1.9**Elefantenhaut**

gefurchte Außenflächen des Bohrrohrkörpers aufgrund des Stauchvorgangs

3.1.10**erhöhte H₂S-Beständigkeit**

Bohrrohr-Klassifizierung, welche die Prüfung auf Schwefelwasserstoff-Spannungsrisskorrosion als Teil der Qualifizierung und Qualitätslenkung einschließt

3.1.11**wesentliche Einflussgröße**

variabler Parameter, dessen Änderung die mechanischen Eigenschaften der Schweißverbindung beeinflusst

3.1.12**Einkerbung**

längliche Nut oder Vertiefung, verursacht durch mechanisches Abtragen von Metall

3.1.13**Ringpanzerung**

Auftragen von Werkstoff auf Werkzeugverbindungen, um deren äußeren Verschleiß zu verringern

Anmerkung 1 zum Begriff: Auch als Panzerung bezeichnet.

3.1.14**Härtezahl**

Ergebnis eines einzelnen Härteeindrucks

3.1.15**Schmelze****Stahlschmelze**

Schmelzvorgang einer Charge eines Metalls, bei dem die flüssige Phase dieses Metalls durch einen einzigen Schmelzzyklus erzeugt wird

3.1.16**Schmelzenanalyse**

vom Hersteller des Metalls angegebene repräsentative chemische Zusammensetzung einer Schmelze

[QUELLE: ISO 11960:2014, 4.1.18]

3.1.17

Mangel

Unstetigkeit in der Wand oder auf der Oberfläche des Produkts, die mit einem in dieser Internationalen Norm festgelegten zerstörungsfreien Prüfverfahren nachgewiesen werden kann

[QUELLE: ISO 11960:2014, 4.1.19, modifiziert]

3.1.18

Anzeige

Nachweis einer Unregelmäßigkeit, die der Auswertung bedarf, um ihre Bedeutung zu bestimmen

3.1.19

Prüfung

Vorgang des Messens, Untersuchens, Prüfens, Lehrens oder eines anderen Vergleichs des Produkts mit den zutreffenden Anforderungen

3.1.20

Label 1

dimensionslose Bezeichnung für die Bohrrohrkörperweite, die bei der Bestellung angewendet werden darf

3.1.21

Label 2

dimensionslose Bezeichnung für die längenbezogene Masse des Bohrrohrkörpers, die bei der Bestellung angewendet werden darf

3.1.22

linienförmiger Mangel

Mangel, unter anderem Überwalzungen, Überlappungen, Risse, Auskolkungen, Schnitte, Einkerbungen und Elefantenhaut

Anmerkung 1 zum Begriff: Siehe API 5T1.

[QUELLE: ISO 11960:2004^{*)}, 4.1.28, modifiziert]

3.1.23

Los

bestimmte Menge eines Produkts, die unter für das zu untersuchende Merkmal als einheitlich anzusehenden Bedingungen hergestellt wird

3.1.24

Umfang des Loses

Anzahl der Produkteinheiten in einem Los

3.1.25

Hersteller

Bohrrohr-Hersteller, Bohrrohrkörper-Hersteller oder Hersteller von Werkzeugverbindungen

Anmerkung 1 zum Begriff: Der Hersteller kann der Hersteller von einem oder mehreren Bauteilen sein, in Abhängigkeit vom Kontext

^{*)} Quelle ist die ISO 11960:2014.

3.1.26**mittlere Härtezahl**

Ergebnis der Mittelwertbildung aus den Härtezahlen für den einzelnen zu bewertenden Prüfling oder Ort

3.1.27**unwesentliche Einflussgröße**

variabler Parameter, der in der Schweißanweisung (WPS) ohne erneute Qualifizierung geändert werden darf

3.1.28**nicht linienförmiger Mangel**

Mangel, u. a. lochartige Vertiefungen

Anmerkung 1 zum Begriff: Siehe API Std 5T1.

3.1.29**Rohrkörper**

nahtloses Rohr, ausgenommen gestauchte und dadurch beeinflusste Bereiche

Anmerkung 1 zum Begriff: Siehe Bild B.1.

3.1.30**Dokumentation der Verfahrensprüfung****PQR**

(en: procedure qualification record)

schriftliche Dokumentation, die eine Beurteilung der Übereinstimmung der mit einer bestimmten WPS hergestellten Schweißnähte mit den Anforderungen dieser Internationalen Norm enthält

3.1.31**Produkt**

Bohrrohr, Bohrrohrkörper oder Werkzeugverbindung

3.1.32**Kunde**

Partei, die für die Festlegung der Anforderungen an ein Produkt bei seiner Bestellung und für die Bezahlung dieser Bestellung verantwortlich ist

[QUELLE: ISO 11960:2014, 4.1.39]

3.1.33**Härteriss**

Riss im Stahl, der auf Spannungen zurückzuführen ist, die bei der Umwandlung von Austenit in Martensit erzeugt werden

Anmerkung 1 zum Begriff: Mit dieser Umwandlung ist eine Volumenzunahme verbunden.

[QUELLE: ISO 11960:2014, 4.1.40]

3.1.34**drehende Schulteransatz-Gewindeverbindung**

bei Bohrgestängeteilen verwendete Verbindung mit Kegelgewinden und Dichtschultern (Dichtkanten)

3.1.35**Rotationsreibschweißen**

Schweißen im festen Zustand von zusammengepressten Werkstücken in zueinander relativer Drehbewegung entlang einer gemeinsamen Achse für Temperaturerhöhung und plastischen Werkstoffabtrag von den Verbindungsflächen

Anmerkung 1 zum Begriff: Zulässig ist entweder Schweißen mit direktem Antrieb oder Reibschweißen mit Schwungradantrieb.

3.1.36

Probe

aus einem Los ausgewählte Produkteinheit(en), die das Los repräsentieren

3.1.37

nahtloses Rohr

aus warm verformtem Stahl hergestelltes rohrförmiges Produkt ohne Schweißnaht

Anmerkung 1 zum Begriff: Es wird aus Stahl durch Warmverformung und gegebenenfalls durch eine anschließende Kaltnachbearbeitung oder/und Wärmebehandlung so hergestellt, dass die gewünschten Formen, Maße und Eigenschaften erreicht werden.

[QUELLE: ISO 11960:2014, 4.1.41, modifiziert]

3.1.38

Werkzeugverbindung

Bauteil aus Schmiede- oder Walzstahl für Bohrohre, das für das Anschweißen an den Bohrohrkörper vorgesehen und mit einer drehenden Schulteransatz-Gewindeverbindung versehen ist

3.1.39

Muffenstück der Werkzeugverbindung

Gewindeanschluss an Werkzeugverbindungen mit Innengewinden

3.1.40

Hersteller der Werkzeugverbindung

Firma, Unternehmen oder Gesellschaft, welche(s) Anlagen für die Herstellung von Werkzeugverbindungen betreibt und verantwortlich ist für die Übereinstimmung mit den auf die Werkzeugverbindung anwendbaren Anforderungen dieser Internationalen Norm

Anmerkung 1 zum Begriff: Siehe 8.14.

3.1.41

Zapfenstück der Werkzeugverbindung

Gewindeanschluss an Werkzeugverbindungen mit Außengewinden

3.1.42

Ovalität der Stauchung

Differenz zwischen dem größten und dem kleinsten Durchmesser in einer Ebene senkrecht zur Stauchungsachse

3.1.43

Schweißzone

Zone, welche die Schweißnaht und die Wärmeeinflusszonen zu beiden Seiten der Schweißnaht, verursacht durch Reibschweißen und anschließende Wärmebehandlungsprozesse, einschließt

3.1.44

Leistungsbeurteilung von Schweißmaschinen und Bedienern von Schweißeinrichtungen

WPQ

(en: welding machine and welding operator performance qualification)

schriftlich niedergelegtes Verfahren zum Nachweis, dass mit einer Kombination aus einer Schweißmaschine und einem Bediener von Schweißeinrichtungen unter Anwendung der WPS eine Schweißnaht hergestellt werden kann, die den Anforderungen dieser Internationalen Norm entspricht

Anmerkung 1 zum Begriff: Darin eingeschlossen sind Aufzeichnungen der Qualifizierungsprüfungen.

3.1.45

Schweißanweisung

WPS

(en: welding procedure specification)

schriftlich niedergelegtes Verfahren, das Anweisungen für den Bediener von Schweißeinrichtungen zur Herstellung von Produktionsschweißnähten entsprechend den Anforderungen dieser Internationalen Norm enthält

Anmerkung 1 zum Begriff: Darin eingeschlossen sind alle wesentlichen und unwesentlichen Variablen für das Reibschweißen von Werkzeugverbindungen an Bohrrohrkörper. Eine WPS gilt für sämtliche Schweißnähte, bei denen alle Elemente dieselbe(n) Maße und chemische Zusammensetzung aufweisen und die nach einem dokumentierten Verfahren angeordnet sind, welches eine vorhersagbare Reaktion auf die Behandlung der Schweißzone für eine bestimmte Werkstoffklasse sicherstellt.

3.2 Symbole und Abkürzungen

A_{dp}	Querschnittsfläche des Bohrrohrkörpers auf Grundlage der festgelegten Maße des Rohrkörpers
A	Querschnittsfläche des Probekörpers für den Zugversuch, in Quadratmillimeter (Quadrat-inch)
A	Länge des verkleinerten Abschnitts, in Millimeter
A_w	kleinste Querschnittsfläche der Schweißzone
D	Außendurchmesser der Werkzeugverbindung (Zapfen und Muffe)
C_m	Standard-Charpy-Schlagenergie, in Joule
C	Standard-Charpy-Schlagenergie, in foot-pound
D_{dp}	Außendurchmesser des Rohrkörpers
D_f	Kegeldurchmesser (Zapfen und Muffe)
D_j	Außendurchmesser an der Werkzeugverbindungsschulter, wird zu D_{te} nach Schweißen und Endbearbeitung
D	Rundstabdurchmesser
D_{te}	Außendurchmesser der Bohrrohr-Schweißverbindung nach Bearbeitung
D_{0u}	Außendurchmesser der Stauchung des Bohrrohrkörpers
d_{dp}	Innendurchmesser des Rohrkörpers
d_j	Innendurchmesser an der Werkzeugverbindungsschulter, wird zu d_{te} nach Schweißen und Endbearbeitung
d_p	Innendurchmesser des Zapfenstücks der Werkzeugverbindung
d_{te}	Innendurchmesser der Bohrrohr-Schweißverbindung nach Bearbeitung

d_{0u}	Innendurchmesser der Stauchung des Bohrrohrkörpers
EU	äußere Stauchung (en: external upset)
e	kleinste Dehnung in einer Messlänge von 50,8 mm (2.0 in)
e_m	kleinste Längsdehnung
e_w	Zu- oder Abnahme der Bohrrohrkörpermasse aufgrund von Endbearbeitung; bei ungestauchten Rohren mit glatten Enden gilt $e_w = 0$
G	Messlänge
ID	Innendurchmesser (en: inside diameter)
IEU	innere und äußere Stauchung (en: internal-external upset)
IU	innere Stauchung (en: internal upset)
L	Länge des Bohrrohrs mit Anschweiß-Werkzeugverbindung (von Schulter zu Schulter)
L_b	Länge des Außendurchmessers der Muffen-Werkzeugverbindung, einschließlich Verbindungskegel und Ringpanzerung, siehe Bild B.1 und Bild B.12
L_{eu}	Länge der äußeren Stauchung des Bohrrohrkörpers
L_{iu}	Länge der inneren Stauchung des Bohrrohrkörpers
L_{pb}	Länge des Außendurchmessers der Zapfen-Werkzeugverbindung, einschließlich Verbindungskegel, siehe Bild B.1 und Bild B.12
L_{pe}	Länge des Bohrrohrkörpers (ohne Werkzeugverbindung)
m_{eu}	Kegellänge der äußeren Stauchung des Bohrrohrkörpers
m_{iu}	Kegellänge der inneren Stauchung des Bohrrohrkörpers
N	Bruch oder Dezimalzahl
NDE	zerstörungsfreie Prüfung (en: non-destructive examination)
OD	Außendurchmesser (en: outside diameter)
PQR	Dokumentation der Schweißverfahrensprüfung (en: procedure qualification record)
PSL	Herstellungsstufen (en: product specification level)
R	Mindestradius der Kehlnaht
RSC	drehende Schulteransatz-Gewindeverbindung (en: rotary shouldered connection)
SSC	Schwefelwasserstoff-Spannungsrissskorrosion (en: Sulfide Stress Cracking)
T_S	Zugfestigkeit

t	Wanddicke des Rohrkörpers
U	Stauchungsmaß
U_{dp}	festgelegte Mindestzugfestigkeit
UT	Ultraschallprüfung (en: ultrasonic testing)
W	Breite
W_L	annähernde berechnete Masse eines Bohrrohrkörperabschnitts der Länge L_{pe}
WPQ	Leistungsbeurteilung von Schweißern (en: welder performance qualification)
WPS	Schweißanweisung (en: welding procedure specification)
w_{dp}	annähernde lineare Masse des Bohrrohres
w_{pe}	Masse des Rohrkörpers mit glatten Enden (ohne Stauchungen)
Y_{min}	festgelegte Mindeststreckgrenze, siehe Tabelle A.5 oder Tabelle C.5
Y_w	Streckgrenze der Schweißzone

Nationaler Anhang NB (informativ)

Literaturhinweise

DIN EN ISO 6506-1, *Metallische Werkstoffe — Härteprüfung nach Brinell — Teil 1: Prüfverfahren*

DIN EN ISO 6507-1, *Metallische Werkstoffe — Härteprüfung nach Vickers — Teil 1: Prüfverfahren*

DIN EN ISO 6508-1, *Metallische Werkstoffe — Härteprüfung nach Rockwell — Teil 1: Prüfverfahren*

DIN EN ISO 7500-1, *Metallische Werkstoffe — Kalibrierung und Überprüfung von statischen einachsigen Prüfmaschinen — Teil 1: Zug- und Druckprüfmaschinen — Kalibrierung und Überprüfung der Kraftmesseinrichtung*

DIN EN ISO 9513, *Metallische Werkstoffe — Kalibrierung von Längenänderungs-Messeinrichtungen für die Prüfung mit einachsiger Beanspruchung*

DIN CEN ISO/TR 10400 (DIN SPEC 91040), *Erdöl- und Erdgasindustrie — Formeln und Berechnungen der Eigenschaften von Futterrohren, Steigrohren, Bohrgestängen und Leitungsrohren*

DIN EN ISO 10424-2, *Erdöl- und Erdgasindustrie — Bohr- und Förderanlagen — Teil 2: Verschraubungen, Kalibrierung und Prüfung von drehenden Schulteransatz-Gewindeverbindungen*

ISO 11960 *Erdöl- und Erdgasindustrie — Stahlrohre zur Verwendung als Futter- oder Steigrohre für Bohrungen (ISO 11960:2014)*

DIN EN ISO 15156-2, *Erdöl- und Erdgasindustrie — Werkstoffe für den Einsatz in H₂S-haltiger Umgebung bei der Öl- und Gasgewinnung — Teil 2: Gegen Rissbildung beständige unlegierte und niedriglegierte Stähle und Gusseisen*

English Version

Petroleum and natural gas industries —
Steel drill pipe
(ISO 11961:2018)

Industries du pétrole et du gaz naturel —
Tiges de forage en acier
(ISO 11961:2018)

Erdöl- und Erdgasindustrie —
Stahl-Bohrrohre
(ISO 11961:2018)

This European Standard was approved by CEN on 3 October 2018.

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

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European foreword

This document (EN ISO 11961:2018) 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 NEN.

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 May 2019, and conflicting national standards shall be withdrawn at the latest by May 2019.

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Endorsement notice

The text of ISO 11961:2018 has been approved by CEN as EN ISO 11961:2018 without any modification.

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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).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

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.

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 H₂S 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*

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 H₂S 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

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 H₂S resistance

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

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]

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]

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.

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

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

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;

- consider one or more of the following procedures:
 - maintain pH of water phase at 10 or higher to neutralize H₂S in the drilled formation and alkalinity of 1 or higher to maintain the pH;
 - use chemical sulfide scavengers
 - use a drilling fluid in which oil is the continuous phase.

NOTE The SSC test is for quality control purposes only and does not qualify the material for any specific sour service application. It is the product user's responsibility to ensure that the product is suitable for the intended application.

5.2 General information

When placing orders for drill-pipe to be manufactured in accordance with this document, the purchaser shall specify the following on the purchase agreement.

Requirements	Reference
Document number(s)	ISO 11961
Quantity	
Label 1	Table A.1 or Table C.1
Label 2	Table A.1 or Table C.1
Grade	Table A.1 or Table C.1
Upset type (internal, external or internal-external upset)	Table A.1 or Table C.1
RSC type or other special connection by agreement between purchaser and manufacturer	Table A.1 or Table C.1, or 6.2.2
Range or special length and tolerance by agreement between purchaser and manufacturer	Table A.3 or Table C.3
Delivery date and shipping instructions	
Inspection by purchaser	Annex D
Documentation	6.17

5.3 Additional information

The purchaser shall also specify in the purchase agreement his requirements concerning the following stipulations, which are optional with the purchaser.

Requirements	Reference
Tool-joint outside diameter	6.2.2
Tool-joint inside diameter of the pin end	6.2.2
Length of pin-tool-joint outside diameter	6.2.6
Length of box-tool-joint outside diameter	6.2.6
Under-thickness tolerance if less than 12,5 %	7.2.6

Type of heat treatment for drill-pipe body: grade E only	7.4.3
SSC test method and solution for grades D and F	6.3.7
Hard banding: type, location, dimensions and acceptance criteria	8.4.7
NOTE Hard banding reduces the length of the tool-joint outside diameter available for tong placement.	
Pipe coatings: internal and/or external	6.4.5, 6.4.6 and 7.4.4
Special threads on tool joints	8.2.5
Specific thread or storage compound	6.4.7
Thread-protector type	6.4.7 and 8.4.8
Marking requirements	6.15, 7.20 and 8.13
Individual drill-pipe traceability	6.5

Supplementary requirements

Non-destructive examination for grades E, X, G, D and F	Clause E.2, SR2
Test certificates	Clause E.3, SR15
Charpy V-notch (CVN) impact toughness testing of grade E pipe body	Clause E.4, SR19
Alternative low-temperature Charpy V-notch impact testing	Clause E.5, SR20
Weld-zone testing frequency	Clause E.6, SR23
Charpy V-notch: increased weld-zone requirements	Clause E.7, SR24
For PSL-2 or PSL-3	Annex G

6 Requirements for drill-pipe

6.1 General

The drill-pipe shall be made from drill-pipe body manufactured in accordance with Clause 7 and tool joints manufactured in accordance with Clause 8. Areas of the drill-pipe body and tool joint affected by the welding and finishing processes are addressed in Clause 6.

6.2 Dimensions, masses and connections

6.2.1 Standard configuration

The configuration of drill-pipe shall correspond to Figure B.1. Drill-pipe shall be furnished with dimensions and tolerances as in Tables A.1 and A.2 or Tables C.1 and C.2 and/or in the purchase agreement. All dimensions shown without tolerances are related to the basis for design and are not subject to measurement to determine acceptance or rejection of product. Drill-pipe dimensions that are not in this document or in the purchase agreement are at the manufacturer's discretion.

Rotary shouldered connections shall conform to the dimensions, together with the tolerances, in ISO 10424-2 or API Spec 7-2. Right-hand thread connections shall be considered standard.

6.2.2 Alternative configurations

When specified in the purchase agreement, drill-pipe shall be furnished in dimensional configurations not defined in this document. In this case, dimensions, tolerances and markings shall be agreed between the purchaser and manufacturer. The drill-pipe body and tool joint shall be modified in accordance with this agreement but the drill-pipe shall otherwise be manufactured in accordance with the requirements of this document.

The outside diameter of the box tool joint, D , and inside diameter of the pin tool joint, d_p , dimensions in Table A.1 or Table C.1, result in a drill-pipe torsion-strength ratio 0,8 or greater. Changes in the OD and ID of the tool joints can result in a lower drill-pipe torsion-strength ratio, which should be determined by the purchaser to be suitable for the intended application.

6.2.3 Drill-pipe weld neck diameters

The drill-pipe weld diameters, D_{te} and d_{te} , as shown in Figure B.1, apply to the finished product after the tool joint is welded to the drill-pipe body and machined and/or ground. The outside diameter, D_{te} , shall meet the requirements of Table A.1 or Table C.1, and 6.3.2. The inside diameter, d_{te} , shall meet the requirements of 6.3.2 and may be different on the pin and box weld zones.

6.2.4 Tool-joint inside diameters

The tool-joint-pin inside diameter, d_p , shall meet the requirements in Table A.1 or Table C.1. The tool-joint-box inside diameter is at the manufacturer's discretion but shall not be less than the tool-joint-pin internal diameter, d_p .

6.2.5 Length

Drill-pipe shall be furnished in length ranges conforming to Table A.3 or Table C.3 or other lengths and tolerances as specified in the purchase agreement.

The drill-pipe manufacturer shall specify the lengths and tolerances of the drill-pipe body and tool joints such that the required length of each drill-pipe is achieved.

6.2.6 Length of tool-joint outside diameter

The length of pin-tool-joint outside diameter, L_{pb} , and the length of box-tool-joint outside diameter, L_b , in Table A.1 or Table C.1, may be increased by agreement between purchaser and manufacturer.

6.2.7 End-drift

Each drill-pipe shall be end-drift tested throughout the length of the tool joints and upsets with a cylindrical mandrel having a minimum diameter of 3,2 mm (0.125 in) smaller than the specified inside diameter of the pin end, d_p . The drift mandrel shall be at least 100 mm (4 in) long.

NOTE Drift testing of the full length of the drill-pipe is not required.

6.2.8 Drill-pipe body and tool-joint alignment

The maximum misalignment between the longitudinal axis of the drill-pipe body and the longitudinal axis of the welded-on tool joint shall not exceed the following:

- for parallel misalignment: 4 mm (0,157 in) total indicator reading;
- for angular misalignment: 8 mm/m (0,008 in/in) for label 1: 4-1/2 and larger;
10 mm/m (0,010 in/in) for smaller than label 1: 4-1/2.

The axis of the tool joint shall be determined on the surface of the outside diameter, D , that is unaffected by markings or hard banding. The axis of the drill-pipe body shall be determined over a minimum length of 400 mm (15 in) on the outside surface of the pipe body.

6.2.9 Weld-zone profile

The weld zone shall have no sharp corners or drastic changes of section. The internal weld-zone profile shall not cause a 90° hook-type tool to hang up.

6.3 Material requirements

6.3.1 General

The material properties of the drill-pipe body and the tool joint shall be as in Tables A.4 to A.8 or Tables C.4 to C.8 inclusive.

6.3.2 Weld-zone yield strength

The yield load of the weld zone in tension shall be greater than the yield load of the drill-pipe body as given by Formula (1):

$$(Y_w \times A_w) > (Y_{\min} \times A_{dp}) \quad (1)$$

where

- A_{dp} is the cross-sectional area of the drill-pipe body based on the specified dimensions of the pipe body;
- A_w is the minimum cross-sectional area of the weld zone;
- $Y_{\min}$ is the specified minimum yield strength of the drill-pipe body;
- Y_w is the weld zone minimum yield strength (determined by the manufacturer based on the design).

The method for calculating the minimum cross-sectional area, A_w , of the weld zone shall be as given in Formula (2):

$$A_w = 0,7854 \times (D_{te,\min}^2 - d_{te,\max}^2) \quad (2)$$

where

- $d_{te,\max}$ is the maximum allowable inside diameter specified by the drill-pipe manufacturer;
- $D_{te,\min}$ is the minimum allowable outside diameter specified by the drill-pipe manufacturer.

6.3.3 Weld-zone hardness

6.3.3.1 Grades E, X, G and S

For surface hardness, no hardness number shall exceed 37.0 HRC or equivalent.

For the through-wall hardness test, the mean hardness number of the weld zone shall not exceed 37.0 HRC.

6.3.3.2 Grades D and F

For surface and through-wall hardness, no hardness number shall exceed 30.0 HRC (maximum average), and 32.0 HRC maximum single.

6.3.4 Weld-zone Charpy V-notch absorbed-energy requirements

The minimum absorbed energy requirements shall be as in Table A.8 or Table C.8. In addition, not more than one impact specimen shall exhibit an absorbed energy below the minimum average absorbed-energy requirement, and in no case shall an individual impact specimen exhibit an absorbed energy below the minimum specimen absorbed-energy requirement.

Additional requirements for PSL-3 are in Annex G.

6.3.5 Weld-zone Charpy V-notch absorbed energy — Alternative requirements

When specified in the purchase agreement, the absorbed energy shall meet the SR20 and/or the SR24 requirements in Clause E.5 and/or Clause E.7 respectively (see also Table A.8 or Table C.8).

6.3.6 Weld-zone transverse side bend properties

The guided-bend specimens shall have no open discontinuity in the weld zone exceeding 3 mm (0,125 in) measured in any direction on the convex surface of the specimen after bending. Open discontinuities occurring on the corner of the specimen during testing shall not be considered unless there is definite evidence that they result from lack of fusion, inclusions or other internal discontinuities.

6.3.7 Sulfide stress cracking test — Grades D and F

6.3.7.1 85 % SMYS all parts (default)

All parts (pipe body, tool joint and weld zone) shall have a demonstrated minimum threshold of 85% of the specified minimum yield strength for 720 hours as per NACE TM0177 (latest revision), Method A using Test solution D.

Testing frequency shall be one specimen per heat, per heat treat lot, or every 200 tubes, whichever is the more frequent. If any heat has a failed specimen, two additional specimens from the same heat, heat treat lot are required as a retest. If either fail, the heat is unacceptable.

The SMYS of the weld zone is defined by calculation as described in section 6.3.2.

An additional test shall be performed each time welding parameters change beyond the approved WPS/PQR.

6.3.7.2 Alternative testing (by agreement between purchaser and manufacturer)

The drill pipe tube shall have a demonstrated minimum threshold of 85 % of the specified minimum yield strength for 720 hours per NACE TM0177 (latest revision), Method A using Test solution A. Testing frequency shall be one specimen per heat, per heat treat lot, or every 200 tubes, whichever is the more frequent. If any heat has a failed specimen, two additional specimens from the same heat, heat treat lot are required as a retest. If either fail, the heat is unacceptable.

The drill pipe tool joint shall have a demonstrated minimum threshold of 65 % of the specified minimum yield strength for 720 hours per NACE TM0177 (latest revision), Method A using Test solution A. Testing frequency shall be one set per heat, per heat treat lot or every 200 tool joint box/pin set, whichever is the more frequent. To be acceptable, any heat, heat treat lot with a failed specimen requires two additional specimens with no failures.

The drill pipe weld zone shall have a demonstrated minimum threshold of 60 % of its calculated minimum yield strength (as per section 6.3.2), for 720 hours per NACE TM0177 (latest revision), Method

A using Test solution A. Testing frequency shall be every 200 drill pipe welded. If any heat has a failed specimen, two additional specimens from the same lot are required as a retest. If either fail, the heat is unacceptable. An additional test shall be performed each time the welding parameters are changed.

6.4 Process of manufacture for drill-pipe

6.4.1 Processes requiring validation

Final operations performed during drill-pipe manufacturing that affect compliance as required in this document (except chemical composition and dimensions) shall have their process validated.

Those processes requiring validation are welding and weld heat treatment.

6.4.2 Welding qualification

The manufacturer shall develop, qualify and use a welding procedure, including post-weld heat treatment (WPS and PQR), in accordance with the ASME Boiler and Pressure Vessel Code, Section IX. The procedure shall identify the essential variables and non-essential variables and address the permissible number of re-heat treatments.

The PQR shall include, as a minimum, the data of the specific variables (both essential and non-essential) used to weld a tool joint to a drill-pipe body and the results of all mechanical tests to verify the properties in 6.3 carried out on specimens taken from the test weld.

In addition, the manufacturer shall undertake macrostructural examination of the weld to verify that the weld exhibits complete bonding and freedom from cracks.

The manufacturer shall qualify the welding machines and welding operators to a specific WPQ for each WPS utilized by the operators.

6.4.3 Welding of tool joints to drill-pipe body and post-weld heat treatment

The welding of the tool joint to the drill-pipe body shall be by the rotary friction welding process.

A post-weld heat treatment shall be performed through the entire thickness and from the weld line to beyond where the flow lines of the tool joint and drill-pipe body material change direction as a result of the welding process. The weld shall be austenitized, cooled below the transformation temperature and tempered at a minimum temperature of 593 °C (1 100 °F).

6.4.4 Weld machining

The weld area shall be machined and/or ground, both externally and internally, to produce a flush surface (visually free from gouges or abrupt changes in section).

Tool marks from normal machining operations shall be acceptable.

6.4.5 Internal coating

When specified in the purchase agreement, drill-pipe shall be internally coated over the full length, except the thread. The type of coating shall be specified in the purchase agreement and the application and inspection shall be carried out in accordance with an agreed documented procedure.

6.4.6 External coating

Unless otherwise specified in the purchase agreement, the drill-pipe shall be given an external coating for protection from corrosion during transit. The coating shall be rated to protect the drill-pipe for at least three months and it should be smooth, hard to the touch and with minimum sags.

6.4.7 Thread protection

Threads and shoulders of rotary shouldered connections shall be equipped with thread protectors to protect them from damage during transportation and storage. Unless otherwise specified in the purchase agreement, the type of thread protector is at the manufacturer's discretion.

A thread compound, suitable for rotary shouldered connections, shall be applied over the clean threads and shoulders before protectors are installed. Unless otherwise specified in the purchase agreement, the type of thread compound is at the manufacturer's discretion.

When specified in the purchase agreement, a storage compound shall be applied instead of the thread compound.

6.5 Traceability

The drill-pipe manufacturer shall establish and follow procedures for maintaining traceability to any applicable supplementary requirement and/or PSL requirement, as well as to drill-pipe-body heat and tool-joint heat as in Clauses 7 and 8, respectively.

Lot identity of all welds shall be maintained until all required tests are performed and conformance with specified requirements has been documented. The procedures shall provide means for tracing the welds to the lot and to mechanical and inspection test results.

When additional traceability is required, the details shall be agreed and be specified in the purchase agreement.

6.6 Testing — General

6.6.1 Test equipment calibration

The manufacturer shall determine and document the appropriate calibration frequency and procedures (including occurrences of out-of-calibration and the consequences on products) in order to know whether all products conform to the requirements of this document.

6.6.2 Dimensional inspection

The drill-pipe weld diameters, D_{te} and d_{te} , shall be verified, after final machining and/or grinding according to a documented procedure, to meet the requirements of 6.2.3.

6.6.3 Drill-pipe length

The drill-pipe length, L , (see Figure B.1) shall be measured from shoulder to shoulder unless otherwise specified in the purchase agreement. This length shall be recorded and reported to the purchaser. The accuracy of length-measuring devices shall be $\pm 0,03$ m (± 0.1 ft). Drill-pipe length determination shall be in metres and hundredths of a metre (feet and tenths of a foot).

6.6.4 Straightness

All drill-pipe shall be visually examined for straightness. The straightness of questionably bent pipes or crooked extremities shall be measured in accordance with 7.14.

6.6.5 End-drift test

End-drift testing shall be performed with a drift mandrel conforming to the requirements of 6.2.7. It is permissible for the ends of the drift mandrel, extending beyond the specified cylindrical portion, to be shaped to permit easy entry into the drill-pipe. The drift mandrel shall pass freely through the length of the drill-pipe tool joint and upset by the use of a manual or power drift procedure. In case of dispute, the manual drift procedure shall be used.

6.6.6 Internal profile

Each end of every drill-pipe shall be visually examined for compliance with the requirements of 6.2.9. Questionable ends shall be examined using the following method.

The weld-zone configuration inspection shall be made with a 90° hook-type tool (see Figure B.2). The contact pin shall be visually determined to be attached perpendicular to the handle. The contact-point radius shall not exceed the inside radius of the weld zone being inspected. Sharp edges on the contact point shall be removed (see contact point on Figure B.2). The 90° hook-type-tool contact point should be maintained perpendicular to the longitudinal axis of the weld zone while the contact point is passed axially throughout the weld-zone length. Pressure on the contact point shall be no greater than the pressure created by the weight of the 90° hook-type tool.

6.6.7 Drill-pipe body and tool-joint alignment

Drill-pipe body and tool-joint alignment shall conform to the requirements in 6.2.8 and shall be verified according to a documented procedure.

6.7 Testing of welds

6.7.1 Lot size

A lot shall consist of all those welds that are produced in a single production run (either continuous or interrupted) on the same welding machine (without any modification of the set-up parameters) using the same qualified procedures (WPS and WPQ).

6.7.2 Test specimens

All initial test specimens for the weld zone, where size allows, shall be taken from the same sample.

6.8 Tensile test

6.8.1 Procedures

The tensile test shall be performed at room temperature in accordance with ISO 6892 or ASTM A370.

Tests may be carried out on semi-finished products, that is, before final machining operations but after final heat treatment.

The fracture shall not occur at the weld line.

6.8.2 Test equipment calibration

Tensile test machines shall have been calibrated within a period of 15 months preceding any test, in accordance with the procedures in ISO 7500-1 or ASTM E4. Extensometers shall have been calibrated within a period of 15 months preceding any test, in accordance with the procedures in ISO 9513 or ASTM E83. Retention of records shall be in accordance with 6.17.4 and Table A.9 or Table C.9.

6.8.3 Specimens

A longitudinal section of sufficient length to include the entire weld zone shall be suitably prepared and etched to determine the location of the weld zone relative to the weld line and transverse grain flow. This etched section shall be used to ensure that the tensile specimen includes the full weld zone within the reduced section as shown in Figure B.3.

The largest possible round-bar tensile specimens, in accordance with the requirements of ISO 6892 or ASTM A370, 0,2 % offset method, shall be taken from the longitudinal section location as shown in