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Petroleum and natural gas industries — Steel pipes for use as casing or tubing for wells

Industries du pétrole et du gaz naturel — Tubes d'acier utilisés comme cuvelage ou tubes de production dans les puits

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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*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 12, *Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This sixth edition cancels and replaces the fifth edition (ISO 11960:2014), which has been technically revised. The main changes compared to the previous edition are as follows:

— deletion of Groups;

— deletion of Product Specifications Levels (PSL) and re-integration of the main requirements into the body of the text or into Annex A as a supplementary requirement;

— addition of Annex H on high collapse requirements;

— modification of NDT requirements for sour service grades.

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 can 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 can be particularly applicable where there is innovative or developing technology. Where an alternative is offered, it is advisable that the vendor identify any variations from this document and provide details.

This document includes statements of various nature. These are identified by the use of certain verbal forms:

— "Shall" is used to indicate that a provision is mandatory;

— "Should" is used to indicate that a provision is not mandatory but recommended as good practice;

— "May" is used to indicate that a provision is optional.

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Petroleum and natural gas industries — Steel pipes for use as casing or tubing for wells

1 Scope

This document specifies the technical delivery conditions for steel pipes (casing, tubing and pup joints), coupling stock, coupling material and accessory material.

By agreement between the purchaser and manufacturer, this document can also be applied to other plain-end pipe sizes and wall thicknesses.

This document is applicable to the following connections:

— short round thread casing (SC);

— long round thread casing (LC);

— buttress thread casing (BC);

— non-upset tubing (NU);

— external upset tubing (EU);

— integral-joint tubing (IJ).

NOTE 1 For further information, see API Spec 5B.

For such connections, this document specifies the technical delivery conditions for couplings and thread protection.

NOTE 2 Supplementary requirements that can optionally be agreed for enhanced leak resistance connections (LC) are given in A.9 SR22.

This document can also be applied to tubulars with connections not covered by ISO or API standards.

This document is applicable to products including the following grades of pipe: H40, J55, K55, N80, L80, C90, R95, T95, P110, C110 and Q125.

This document is not applicable to threading requirements.

NOTE 3 Dimensional requirements on threads and thread gauges, stipulations on gauging practice, gauge specifications, as well as, instruments and methods for inspection of threads are given in API Spec 5B.

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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 80000-1, *Quantities and units — Part 1: General*

ISO 643, *Steels — Micrographic determination of the apparent grain size*

ISO 6506-1:2004, *Metallic materials — Brinell hardness test — Part 1: Test method*

ISO 6506-2, *Metallic materials — Brinell hardness test — Part 2: Verification and calibration of testing machines*

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ISO 6508-1:2006, *Metallic materials — Rockwell hardness test — Part 1: Test method*

ISO 6508-2, *Metallic materials — Rockwell hardness test — Part 2: Verification and calibration of testing machines and indenters*

ISO 6892-1, *Metallic materials — Tensile testing — Part 1: Method of test at room temperature*

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 8501-1, *Preparation of steel substrates before application of paints and related products — Visual assessment of surface cleanliness — Part 1: Rust grades and preparation grades of uncoated steel substrates and of steel substrates after overall removal of previous coatings*

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

ISO 9712, *Non-destructive testing — Qualification and certification of NDT personnel*

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 10893-11, *Non-destructive testing of steel tubes — Part 11: Automated ultrasonic testing of the weld seam of 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*

ISO 13678, *Petroleum and natural gas industries — Evaluation and testing of thread compounds for use with casing, tubing, line pipe and drill stem elements*

ANSI/NACE TM0177-2016, *Laboratory Testing of Metals for Resistance to Sulfide Stress Cracking and Stress Corrosion Cracking in H_2S Environments*

API RP 5A3, *Recommended Practice on Thread Compounds for Casing, Tubing, Line Pipe, and Drill Stem Elements*

API TR 5C3, *Technical Report on Equations and Calculations for Casing, Tubing, and Line Pipe Used as Casing or Tubing; and Performance Properties Tables for Casing and Tubing*

SPEC API 5B, *Specification for Threading, Gauging and Thread Inspection of Casing, Tubing, and Line Pipe Threads*

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, *Standard Terminology Relating to Steel, Stainless Steel, Related Alloys and Ferroalloys*

ASTM B117, *Standard Practice for Operating Salt Spray (Fog) Apparatus*

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

ASTM E10-18, *Standard Test Method for Brinell Hardness of Metallic Materials*

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ASTM E18-19, *Standard Test Methods for Rockwell Hardness of Metallic Materials*

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

ASTM E29, *Standard Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications*

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

ASTM E112, *Standard Test Methods for Determining Average Grain Size*

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

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

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

ASTM E543, *Standard Specification for Agencies Performing Nondestructive Testing*

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

ASTM E709, *Standard Guide for Magnetic Particle Testing*

ASNT-SNT-TC-1A, Personnel Qualification and Certification in Nondestructive Testing

IADC/SPE 11396, *B.A. Dale, M.C. Moyer, T.W. Sampson, A Test Program for the Evaluation of Oilfield Thread Protectors, IADC/SPE Drilling Conference, New Orleans, LA, 20-23 February 1983*

MIL-STD-810c, Military Standard: Environmental Test Methods, 10 March 1975

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 https://www.iso.org/obp

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

3.1.1
accessory material
seamless *casing* (3.1.5) or tubing, or seamless thick-walled tubes or mechanical tubes, or bar stock or hot forgings used for the manufacture of accessories

3.1.2
API threads
threads as specified in API Spec 5B

3.1.3
arc burn
localized point of surface melting caused by arcing between an electrode or ground (earth) and the product surface

Note 1 to entry: Contact marks, which are intermittent marks adjacent to the weld line of EW pipe resulting from electrical contact between the electrodes supplying the welding current and the pipe surface, or contact marks resulting from the use of a spectrometer for the detection of steel chemical composition, are not arc burns.

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3.1.4
carload
quantity of product loaded on a railway car for shipment from the product-making facilities

3.1.5
casing
pipe run from the surface and intended to line the walls of a drilled well

3.1.6
connection
threaded assembly of tubular components

3.1.7
controlled cooling
cooling from an elevated temperature in a pre-determined manner to avoid hardening, cracking or internal damage, or to produce a desired microstructure or mechanical properties

3.1.8
coupling
internally threaded cylinder for joining two lengths of threaded pipe

3.1.9
coupling blank
unthreaded material used to produce an individual *coupling* (3.1.8)

3.1.10
coupling material
thick-walled seamless tube used to manufacture *coupling blanks* (3.1.9)

Note 1 to entry: The main difference between coupling material and coupling stock is that coupling material has no mandatory NDE inspection requirements (see 10.15). See Clause 9 for mandatory NDE requirements for finished couplings.

3.1.11
coupling stock
coupling material that meets the coupling stock requirements

3.1.12
defect
imperfection of sufficient magnitude to warrant rejection of the product based on criteria defined document

3.1.13
electric-welded pipe
pipe having one longitudinal seam formed by electric-resistance or electric-induction welding, without the addition of filler metal, wherein the edges to be welded are mechanically pressed together and the heat for welding is generated by the resistance to flow of electric current

3.1.14
full-body
complete cross-section of the product

3.1.15
full-length
complete length of the product (end-to-end)

3.1.16
heat
metal produced by a single cycle of a batch melting process

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3.1.17
heat analysis
chemical analysis representative of a heat as reported by the metal producer

3.1.18
imperfection
discontinuity in the product wall or on the product surface that can be detected by a specific NDE method

Note 1 to entry: See NDE method included in Table C.42 or Table E.42.

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

3.1.20
inspection lot
lot
definite quantity of product manufactured under conditions that are considered uniform for the attribute to be inspected

3.1.21
inspection lot sample
one or more units of product selected from an *inspection lot* (3.1.20) to represent that inspection lot

3.1.22
lot size
inspection lot size
number of units of product in an *inspection lot* (3.1.20)

3.1.23
interrupted quenching
quenching in which the product being quenched is removed from the quenching medium while the product is at a temperature substantially higher than that of the quenching medium

3.1.24
label 1
dimensionless designation for the size or specified outside diameter that can be used when ordering pipe

3.1.25
label 2
dimensionless designation for the mass per unit length that can be used when ordering pipe

3.1.26
length
piece of pipe that can be plain-end, threaded, or threaded and coupled, that is in accordance with specific length requirements

Note 1 to entry: See requirements in 8.6, Table C.27 or Table E.27.

3.1.27
linear imperfection
imperfection which includes, but is not limited to, seams, laps, cracks, plug scores, cuts and gouges

Note 1 to entry: See API Std 5T1.

3.1.28
manufacturer
one or more of the following, depending on the context: pipe mill; processor; threader; coupling manufacturer, pup-joint manufacturer; accessory manufacturer

Note 1 to entry: See Clause 14.

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3.1.29
non-linear imperfection
imperfection which includes, but is not limited to, pits and round-bottom die stamping

Note 1 to entry: See API Std 5T1.

3.1.30
pipe
casing (3.1.5), tubing and pup joints as a group

3.1.31
pipe mill
firm, company or corporation that operates pipe-making facilities

3.1.32
plain-end pipe
pipe, either upset or non-upset, furnished without threads

3.1.33
processor
firm, company or corporation that operates facilities capable of heat-treating products made by a pipe mill

3.1.34
product
pipe, *coupling* (3.1.8), coupling stock, coupling material, *coupling blank* (3.1.9) or *accessory material* (3.1.1), either individually or collectively as applicable

3.1.35
product test block
test block removed from the product, the tensile test specimen or through-wall hardness test ring

3.1.36
pup joint
casing (3.1.5) or tubing of length shorter than Range 1

Note 1 to entry: Range 1 is specified in Table C.27 or Table E.27.

3.1.37
purchaser
party responsible for both the definition of requirements for a product order and for payment for that order

3.1.38
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.

3.1.39
seamless pipe
wrought steel tubular product made without a weld seam

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

3.1.40
skelp
hot-rolled steel strip used for manufacturing EW pipe

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3.1.41
special end-finish
threads with specific thread form and features, manufacturing specifications, dimensions, *connection* (3.1.6) make-up and performance properties

Note 1 to entry: The specificities of such threads are beyond the scope of this document.

3.1.42
standardized test block
test block, certified to a mean hardness number, used for the verification of the performance of hardness testing machines

3.1.43
thread protector
cap or insert used to protect threads and seals during handling, transportation and storage

3.1.44
tubing
pipe placed in a well to produce or inject fluids

3.1.45
upper critical temperature
Ar_3
temperature at which austenite begins to transform to ferrite during cooling

3.2 Symbols and abbreviated terms

BC	API Spec 5B buttress thread casing connection
B_f	maximum bearing face diameter
CS	coupling stock
C_V	Charpy V-notch impact test minimum absorbed energy
CVN	Charpy V-notch
D	specified outside diameter for pipe
d	calculated inside diameter
EMI	electromagnetic inspection
EU	API Spec 5B external upset tubing connection
EW	electric-welded process
HBW	Brinell hardness, when testing with a tungsten carbide ball
HRC	Rockwell hardness C-scale
ID	inside diameter
IJ	API Spec 5B integral tubing connection
k	a constant used in the calculation of elongation
LC	API Spec 5B long round thread casing connection
max.	maximum

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min.	minimum
N	heat-treat process full-body, full-length normalized
N&T	normalized and tempered
NDE	non-destructive examination
NU	API Spec 5B non-upset tubing connection
OD	outside diameter
PE	unthreaded pipe either upset or non-upset
Q	quenched and tempered
RC	regular coupling
S	seamless process (when not referencing the chemical element sulfur)
Sc	minimum acceptable result of the ANSI/NACE=TM0177- Method B test
SCC	special clearance coupling
SSC	sulfide stress cracking
SC	API Spec 5B short round thread casing connection
SR	supplementary requirement
SF	special end finishing
t	specified wall thickness
T&C	threaded and coupled
USC	United States customary (units)
UT	ultrasonic testing
W	specified outside diameter for regular couplings with API threads
W_c	specified outside diameter of special clearance couplings with API threads
YS_{max}	specified maximum yield strength
YS_{min}	specified minimum yield strength

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4 Conformance

4.1 Dual referencing of normative references

In the interests of world-wide application of this document, ISO/TC 67 has decided, after detailed technical analysis, that certain normative documents listed in Clause 3 and prepared by ISO/TC 67 or other 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) or 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

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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. 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, conformance with the requirements of this document as expressed in one system provides conformance with requirements expressed in the other system.

For data expressed in the SI, 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 parentheses.

Separate tables for data expressed in SI units and USC units are given in Annex C and Annex E respectively.

Figures are contained in Annex D and express data in both SI and USC units.

Annex F provides the applied procedures to convert the USC units into SI units

5 Information to be supplied by the purchaser

5.1 Grades C90, T95 and C110

The purchaser should refer to ISO 15156-2 and/or ANSI/NACE MR0175 for guidance on the usage of Grades C90, T95 and C110. Particular attention should be given to the application of Grade C110 in ISO 15156-2 or ANSI/ MR0175/ISO 15156-2 SSC Regions 2 or 3, as this material is not suitable for all sour (hydrogen sulfide-containing) service applications.

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 Casing

5.2.1 When enquiring or placing orders for pipe manufactured in accordance with this document, the purchaser shall specify the following according to Table 1.

Table 1 — Purchaser supplied information (Casing)

Requirement	Reference
International Standard	This document, i.e. ISO 11960
Quantity	
Type of pipe or couplings	
Casing:	
Threaded or plain-end	8.12.1, Table C.1 or Table E.1
Type of connection: SC, LC or BC or other connection	8.12.2, 8.12.5, Table C.1 or Table E.1
With or without couplings	8.12.2, Table C.1 or Table E.1

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Table 1 *(continued)*

Requirement	Reference
Special clearance couplings – BC	9.6, Tables C.1 and C.33 or Tables E.1 and E.33
Special clearance couplings with special bevel – BC	9.6
Label 1 or specified outside diameter	Table C.1 or Table E.1
Label 2 or specified mass or wall thickness	Table C.1 or Table E.1
Grade and type where applicable	Tables C.1 and C.4 or Tables E.1 and E.4
Length	8.6, Table C.27 or Table E.27
Seamless or electric-welded	6.2, Table C.3 or Table E.3
Critical thickness for special end-finish couplings, stock or blanks	7.6.6
Delivery date and shipping instructions	
Inspection by purchaser	Annex B

5.2.2 The purchaser shall also state on the purchase agreement the requirements, where applicable, concerning the following stipulations, which are at the purchaser's option according to Table 2.

Table 2 — Purchaser supplied agreement optional requirements (Casing)

Requirement	Reference
International Standard	This document, i.e. ISO 11960
Heat treatment	6.3, Table C.3 or Table E.3
Lower alternative impact test temperature	7.3.7
Impact testing for Grades H40, J55, K55	7.5.1, A.8 SR16
Impact testing for Grades N80 all types, L80 all types, C90, R95, T95 and P110	7.5.2, A.8 SR16
Sulfide stress cracking test method(s) – Grades C90 and T95	7.14, 10.10
Sulfide stress cracking test method(s) and test solution(s) – Grade C110	7.14, 10.10, A.11 SR39
Casing jointers – SC and LC	8.7
Alternative drifting requirements	8.10
Casing with couplings detached	8.14
Coupling make-up (other than power-tight)	8.14
Coupling grade	9.2
Seal ring couplings	9.9, A.7 SR13
Heat and supplementary analyses	10.3
Additional markings	Clause 11
Pipe coatings	12.1
Alternative grades or heat treatments of coupling	9.2
Combination couplings	9.7

5.2.3 The following may be agreed between purchaser and manufacturer according to Table 3.

Table 3 — Purchaser/Manufacturer agreement (Casing)

Requirement	Reference
International Standard	This document, i.e. ISO 11960
Length other than specified in Table C.27 or Table E.27	8.6
Upset – Grade C110	6.2

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Table 3 *(continued)*

Requirement	Reference
Cold rotary straightening - Grade Q125	6.3.5
Statistical tensile testing	7.2.4, A.10 SR38
Statistical impact testing	7.3.8, A.6 SR12
Impact testing for non-heat-treated pipe – Grades H40, J55 and K55	7.5.1, A.8 SR16
Alternative hardenability requirement for products with a wall thickness of 30 mm (0.181 in) or larger	7.10.2
Thread and storage compound	8.14
Waiving NDE of couplings in Grades H40, J55 and K55	9.11.3
Coupling thread surface treatment - Grade Q125 only	9.15
Reduced section tensile specimens – Grade Q125	10.4.6
Additional hardness testing	10.6.2
Alternative hydrostatic test pressures	10.12.3
Plain-end Grade Q125 casing hydrostatic testing	10.12.2
Non-destructive examination	10.15, A.2 SR2, A.4 SR10 and A.5 SR11
Marking requirements	Clause 11
Thread protectors	12.2
Coupling blanks – Grade Q125 only	9.4.2, A.3 SR9
Upset casing – Grade Q125 only	A.4 SR10
Electric-weld casing and pup joints – all Grades except Grades P110 and Q125	A12 SR40
Electric-weld casing and pup joints – Grades P110 and Q125	6.2, A.5 SR11
Alternative *F* factor for statistical impact testing	A.6.2 SR12.2
Special size and wall thickness – plain-end pipe	8.2
Enhanced leak resistance LC connections	A.9 SR22
High collapse resistance	A.19 SR47

5.3 Tubing

5.3.1 When enquiring or placing orders for pipe manufactured in accordance with this document, the purchaser shall specify the following according to Table 4.

Table 4 — Purchaser supplied information (Tubing)

Requirement	Reference
International Standard	This document, i.e. ISO 11960
Quantity	
Type of pipe or couplings	
Tubing:	
Non-upset, external-upset or integral joint	Table C.2 or Table E.2
Threaded, plain-end, or other connection	8.12
With or without couplings	8.12
Regular couplings with special bevel – NU, EU	9.10, Tables C.24, C.34 and C.35 or Tables E.24, E.34 and E.35
Special clearance couplings – EU	9.6, Tables C.24 and C.35 or Tables E.24 and E.35
Label 1 or specified outside diameter	Table C.2 or Table E.2

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Table 4 *(continued)*

Requirement	Reference
Label 2 or specified mass or wall thickness	Table C.2 or Table E.2
Grade and type, where applicable	Table C.2 or Table E.2, Table C.4 or Table E.4
Length	8.6, Table C.27 or Table E.27
Seamless or electric-welded	6.2, Table C.3 or Table E.3
Critical thickness for special end-finish couplings	7.6.6
Delivery date and shipping instructions	
Inspection by purchaser	Annex B

5.3.2 The purchaser shall also state on the purchase agreement the requirements, where applicable, concerning the following stipulations, which are at the purchaser's option according to Table 5.

Table 5 — Purchaser supplied agreement optional requirements (Tubing)

Requirement	Reference
International Standard	This document, i.e. ISO 11960
Heat treatment	6.3, Table C.3 or Table E.3
Lower alternative impact test temperature	7.3.7
Impact testing for Grades H40 and J55	7.5.1, A.8 SR16
Impact testing for Grades N80 all types, L80 all types, C90, R95, T95 and P110	7.5.2, A.8 SR16
Sulfide stress cracking test method(s) – Grades C90 and T95	7.14, 10.10
Alternative drift requirements	8.10
Extended length upset	8.11.6
Rounded nose for EU	8.12.3
Coupling make-up (other than power-tight)	8.14
Tubing with couplings detached	8.14
Coupling grade	9.2
Alternative grades or heat treatments of coupling	9.2
Combination couplings	9.7
Seal ring couplings	9.9, A.7 SR13
Heat and supplementary analyses	10.3
Additional hardness testing	10.6.2
Additional markings	Clause 11
Pipe coatings	12.1

5.3.3 The following may be agreed between purchaser and manufacturer according to Table 6.

Table 6 — Purchaser/Manufacturer agreement (Tubing)

Requirement	Reference
International Standard	This document, i.e. ISO 11960
Length other than specified in Table C.27 or Table E.27	8.6
Statistical tensile test	7.2.4, A.10 SR38
Statistical impact testing	7.3.8, A.6 SR12
Impact testing of non heat treated pipe – Grades H40, J55 and K55	7.5.1, A.8 SR16

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Table 6 *(continued)*

Requirement	Reference
Alternative hardenability requirement for products with a wall thickness of 30 mm (1.181 in) or larger – C110	7.10.2
Thread and storage compound	8.14
Waiving NDE of couplings in Grades H40, J55 and K55	9.11.3
Additional hardness testing	10.6.2
Alternative hydrostatic test pressures	10.12.3
Non-destructive examination	10.15, A.2 SR2, A.4 SR10 and A.5 SR11
Marking requirements	Clause 11
Thread protectors	12.2
Electric-weld tubing and pup joints – All Grades except Grade P110	A.12 SR40
Electric-weld tubing and pup joints — Grade P110	A.5 SR11
Special size and wall thickness	8.2
Casing used for tubing	8.2, Table C.27 or Table E.27

5.4 Coupling stock, coupling material and accessory material

5.4.1 When enquiring or placing orders for coupling stock, coupling material or accessory material manufactured in accordance with this document, the purchaser shall specify the following according to Table 7.

Table 7 — Purchaser supplied information (Coupling stock and material and accessory material)

Requirement	Reference
International Standard	This document, i.e. ISO 11960
Quantity	
Kind of product: coupling stock, coupling material or accessory material	
Sulfide stress cracking test method(s) – Grades C90 and T95	7.14, 10.10
Sulfide stress cracking test method(s) and test solution(s) – Grade C110	7.14, 10.10, A.11 SR39
Outside diameter and tolerances	8.2
Wall thickness and tolerances	8.2
Straightness tolerance	8.9.2
Length	8.6
Grade and type, where applicable	Tables C.3 and C.4 or Tables E.3 and E.4
Impact requirements or critical thickness	7.4
Inspection by purchaser	Annex B
Critical thickness for special end-finish accessory material	7.6.6
Wall thickness verification of special end-finish accessory material	10.13.4
Delivery date and shipping instructions	

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5.4.2 The purchaser shall also state on the purchase agreement the requirements, where applicable, concerning the following stipulations, which are at the purchaser's option according to Table 8.

Table 8 — Purchaser supplied agreement optional requirements (Coupling stock and material, and accessory material)

Requirement	Reference
International Standard	This document, i.e. ISO 11960
Heat treatment	6.3, Table C.3 or Table E.3
Statistical tensile testing	7.2.4, A.10 SR38
Statistical impact testing	7.3.8, A.6 SR12
Impact testing Alternative hardenability requirement for products with a wall thickness of 30 mm or larger	7.4, 7.6, A.8 SR16 7.10.2
Heat and supplementary analyses	10.3
Additional markings	Clause 11

6 Process of manufacture

6.1 General

The product furnished in accordance with this document shall be made to a fine-grain practice. Steel made to a fine-grain practice contains one or more grain-refining elements, such as aluminium, niobium (columbium), vanadium or titanium in amounts intended to result in the steel having a fine austenitic grain size.

Pipe furnished in accordance with this document shall be made by the seamless or electric-weld process as shown in Table C.3 or Table E.3 and as specified on the purchase agreement. Pup joints shall be made from the materials listed in 3.1.36. Material for couplings, coupling stock and coupling material shall be manufactured by the seamless process. Cold-drawn tubular products without appropriate heat treatment are not acceptable.

Accessory material for casing and tubing shall be seamless unless otherwise specified on the purchase agreement.

Electric-welded Grade P110 pipe and Grade Q125 casing shall be provided only when the supplementary requirement in A.5 SR11 is specified on the purchase agreement.

Grade C110 product shall not be upset unless agreed between the purchaser and manufacturer.

Grade Q125 upset casing shall be provided only when the supplementary requirement in A.4 SR10 is specified on the purchase agreement.

6.2 Heat treatment

6.2.1 General

Product shall be heat-treated in accordance with a documented procedure as stipulated in Table C.3 or Table E.3 for the particular grade and type specified on the purchase agreement. Product requiring heat treatment shall be heat-treated full-body, full-length. When heat-treated upset product shall be heat-treated full-body, full-length after upsetting. Individually heat-treated coupling blanks are acceptable. All pipe processed through a hot-stretch mill (i.e. stretch-reduced) shall be considered normalized, provided the exit temperature is above the upper critical temperature (Ar_3) for the steel being processed and the pipe is air-cooled.

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The weld seam of electric-welded pipe shall be heat-treated after welding to a minimum temperature of 540 °C (1 000 °F) or processed in such a manner that no untempered martensite remains.

6.2.2 Grades J55, K55, N80 all types and R95

For Grades J55 and K55 product heat treatment is not mandatory. A heat-treatment, consistent with Table C.3 footnote b or Table E.3 footnote b, shall be applied if specified on the purchase agreement or may be applied at the manufacturer's option.

Grade N80 Type 1 product shall be normalized or, at the manufacturer's option, shall be normalized and tempered. Grade N80Q product shall be quenched and tempered.

Grade R95 shall be quenched and tempered.

6.2.3 Grades L80 all types, C90, T95 and C110

When requested by the purchaser, the manufacturer shall produce evidence to show that the tempering practice will result in the pipe attaining the minimum tempering temperature.

Grade L80 13Cr may be subject to embrittlement when tempered below 620 °C (1 150 °F). When all product meets the requirements in 7.3, 7.4.4, 7.5.2 and 10.7, no further precautions are necessary.

NOTE In this document, when the symbol L80 is used alone, it covers Grades L80 Type 1 and L80 13Cr.

6.3 Straightening

6.3.1 Grades H40, J55, K55, N80 all types

No specific methods are required.

6.3.2 Grades R95 and P110

Grades R95 product shall be subjected to no tensile or expansion cold-working, except that which is incidental to normal straightening operations, and to no more than 3 % compressive cold-working, after the final tempering operation.

Gag press straightening or hot rotary straightening at 400 °C (750 °F) minimum at the end of rotary straightening (unless a higher minimum temperature is specified on the purchase agreement) is acceptable. If hot rotary straightening is not possible, the pipe may be cold rotary straightened provided it is then stress-relieved at 510 °C (950 °F) or higher.

6.3.3 Grade L80

Grade L80 shall not be subjected to cold working after the final heat treatment, except for that which is incidental to normal straightening operations. Grade L80 product rotary-straightened at temperatures less than 480 °C (900 °F) shall not contain roll marks that exceed the maximum hardness specified in Table C.5 or Table E.5; however:

— roll marks that are not detectable by feel and have no measurable surface deformation are acceptable without further evaluation;

— roll marks that are not more severe than those previously evaluated and verified by the manufacturer in a documented procedure not to exceed the maximum hardness specified in Table C.5 or Table E.5 are acceptable without further evaluation;

— product with severe roll marks shall be either rejected or stress-relieved at 480 °C (900 °F) minimum.

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6.3.4 Grades C90, T95 and C110

Product, when necessary, shall be either cold rotary straightened followed by stress relief at 30 °C to 55 °C (50 °F to 100 °F) below the final specified tempering temperature, or hot rotary straightened with an exit temperature not more than 165 °C (300 °F) below the final specified tempering temperature. When necessary, light gag straightening shall be permitted.

Stress relief after cold rotary straightening may be performed for Grades C90 and T95 to temperatures below the specified range when based on a documented procedure and agreed to between purchaser and manufacturer.

6.3.5 Grade Q125

Gag-press straightening or hot rotary-straightening at 400 °C (750 °F) minimum at the end of rotary-straightening is acceptable (unless a higher minimum temperature is specified on the purchase agreement). If hot rotary-straightening is not possible, the product may be cold rotary-straightened provided it is then stress-relieved at 510 °C (950 °F) or higher. Product may be cold rotary-straightened without subsequent stress-relieving only by agreement between purchaser and manufacturer.

6.4 Traceability

6.4.1 General

The manufacturer shall establish and follow procedures for maintaining heat and/or lot identity until all required heat and/or lot tests are performed and conformance with specification requirements has been shown.

6.4.2 Serialization of Grades C90, T95, C110 and Q125

The serial number shall be marked on products as specified below. It is the responsibility of the manufacturer to maintain the identification of material until it is received by the purchaser.

Each length of pipe shall be uniquely numbered so that test data can be related to individual lengths. In addition, when supplementary requirement A.6 SR12 is specified, the number shall identify the sequence in which the lengths were tempered in order to allow retest in accordance with A.6.3 SR12.3.

Each length of coupling stock, coupling material, coupling blank, pup joint or accessory material shall be uniquely numbered so that test data can be related to individual lengths. When cut from material that has been heat-treated full-body, full-length, the pieces shall be marked with the serial number of the full-length piece. When heat-treated in coupling blank or individual lengths, each heat-treat lot (see 10.2.3) shall be uniquely numbered. Additionally, when coupling blanks, or pup joints or accessory material in individual lengths, are heat-treated as a unit in a continuous process-run, the pieces within the lot shall be sequentially numbered in the order in which they are heat-treated.

6.5 Processes requiring validation

Final operations performed during product manufacturing that affect attribute conformance as required in this document (except chemical composition and dimensions) shall have their processes validated.

Those processes requiring validation are:

— for seamless, as-rolled product: final reheating practice and hot sizing or stretch-reducing. If applicable, upsetting, cold-working;

— for seamless, heat-treated product: heat treatment;

— for electric-welded, as-rolled product: sizing and seam welding. If applicable, seam heat treatment and upsetting;

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— for electric-welded, heat-treated product: seam welding and full-body, full-length heat treatment.

7 Material requirements

7.1 Chemical composition

Product shall conform to the requirements specified in Table C.4 or Table E.4 for the grade and type specified.

For Grades C90, T95 and C110 the manufacturer shall inform the purchaser at the time of inquiry of the minimum and maximum concentrations for all elements intentionally added to each heat, regardless of the purpose of the addition.

7.2 Tensile properties

7.2.1 General

Product shall conform to the tensile requirements specified in Table C.5 or Table E.5.

The tensile properties of upset casing and tubing, except elongation of the upset ends, shall conform to the requirements given for the pipe body. In case of dispute, the properties (except elongation) of the upset shall be determined from a tensile test specimen cut from the upset. A record of such tests shall be available to the purchaser.

7.2.2 Elongation

The minimum elongation, e, expressed in percent, is calculated as given by Formula (1):

$$e = k \times \frac{A^{0,2}}{U^{0,9}} \tag{1}$$

where

e is the minimum gauge length extension in 50,8 mm (2.0 in), expressed in percent, rounded to the nearest 0,5 % below 10 % and to the nearest unit percent for 10 % and larger;

k is a constant: 1 942,57 (625 000);

A is the cross-sectional area of the tensile test specimen, expressed in square millimetres (square inches), based on specified outside diameter or nominal specimen width and specified wall thickness, rounded to the nearest 10 mm^2 (0.01 in^2), or 490 mm^2 (0.75 in^2) whichever is smaller;

U is the minimum specified tensile strength, in megapascals (pounds per square inch).

The minimum elongation for both round-bar tensile specimens [8,9 mm (0.350 in) diameter with 35,6 mm (1.40 in) gauge length and 12,7 mm (0.500 in) diameter with 50,8 mm (2.0 in) gauge length] shall be determined using an area A of 130 mm^2 (0.20 in^2).

Table C.6 or Table E.6 gives minimum elongation values for various sizes of tensile specimens and for various grades.

7.2.3 Yield strength

The yield strength shall be the tensile stress required to produce the elongation under load specified in Table C.5 or Table E.5 as determined by an extensometer.

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7.2.4 Statistical tensile testing — Grades C90, T95 and C110

By agreement between purchaser and manufacturer the supplementary requirements for statistical tensile testing of Grades C90, T95 and C110 in A.10 (SR38) shall apply.

7.3 Charpy V-notch test — General requirements

7.3.1 Evaluation of test results

A test shall consist of a set of three specimens taken from one location from a single tubular product length. The average value of the three impact specimens shall equal or exceed the absorbed energy requirement specified in 7.4, 7.5 and 7.6. In addition, not more than one impact specimen shall exhibit an absorbed energy below the absorbed energy requirement, and in no case shall an individual impact specimen exhibit an absorbed energy below two-thirds of the absorbed energy requirement.

For Grade C110 either:

a) the minimum shear area shall be 75 %, in accordance with ASTM E23 or

b) the manufacturer may use a documented procedure (taking into account, as a minimum, variations in chemical composition, diameter and wall thickness) together with the impact test results to demonstrate that the upper shelf behaviour is achieved.

If the minimum shear area is less than 75 % or if the requirements of b) are not met, then either the material shall be rejected or a transition curve shall be made to demonstrate that the product is on the upper shelf at the specified test temperature (either the standard test temperature or a reduced test temperature specified by the purchaser).

7.3.2 Critical thickness

The absorbed energy requirements are based on the critical thickness. The critical thickness for couplings with API threads is the thickness at the root of the thread at the middle of the coupling, based on the specified coupling diameter and the specified thread dimensions. The critical thickness for all couplings with API threads is provided in Table C.7 or Table E.7. For pipe, the critical thickness is the specified wall thickness. For other applications, the critical thickness shall be determined as specified in 7.6.6.

For coupling stock, coupling materials and accessory materials where the critical thickness is not specified in the purchaser agreement, the critical thickness shall be the specified wall thickness.

7.3.3 Specimen size and orientation

When the use of full-size (10 mm × 10 mm) transverse test specimens is not possible, the largest possible sub-size transverse test specimen listed in Table C.8 or Table E.8 shall be used. When it is not possible (or allowed in accordance with 7.3.6) to test using any of these transverse test specimens, the largest possible longitudinal test specimen listed in Table C.8 or Table E.8 shall be used.

When testing EW pipe using a transverse test specimen, the weld line shall be positioned at the notch in the Charpy test specimen.

When the outside diameter or wall thickness precludes the machining of longitudinal impact test specimens ½-size or larger, the product need not be tested; however, the manufacturer shall use a chemical composition and processing that is documented and demonstrated to result in impact-energy absorption which meets or exceeds the minimum specified requirement.

7.3.4 Hierarchy of test specimens

The hierarchy of test specimen orientation and size is specified in Table C.9 or Table E.9.

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7.3.5 Alternative size impact test specimens

At the manufacturer's option, impact test specimens of an alternative size, listed in Table C.8 or Table E.8, may be used instead of the minimum size specified in Tables C.10 to C.15, C.20, C.21 and Tables E.10 to E.15, E.20 and E.21. However, the alternative test specimen selected shall be higher on the hierarchy table (Table C.9 or Table E.9) than the specified size, and the absorbed energy requirement shall be adjusted consistent with the orientation and size of the impact specimen.

7.3.6 Sub-size test specimens

The minimum CVN absorbed energy requirement for sub-size test specimens shall be that specified for a full-size test specimen multiplied by the reduction factor in Table C.8 or Table E.8; however, in no event shall a sub-size test specimen be used if the reduced absorbed-energy requirement is less than 11 J (8 ft·lb).

7.3.7 Test temperature

The test temperature shall be 0 °C (32 °F) for all Grades except Grades J55 and K55. Grades J55 and K55 shall be tested at 21 °C (70 °F). An alternative lower test temperature may be specified on the purchase agreement or selected by the manufacturer for any grade. The tolerance on the test temperature shall be ±3 °C (± 5 °F).

A reduction in test temperature may be required for Grades J55 and K55 when sub-size specimens are used. The amount of test-temperature reduction depends on the critical thickness of the connection and the size of the impact test specimen. The test-temperature reduction specified in Table C.10 or Table E.10 shall be used when applicable.

7.3.8 Statistical impact testing

By agreement between purchaser and manufacturer, the supplementary requirements for statistical impact testing in A.6 SR12 shall apply.

7.3.9 Reference information

ISO/TR 10400 or API TR 5C3 includes reference information on fracture mechanics and equations and tables used in preparing impact requirements.

7.4 Charpy V-notch — Absorbed energy requirements for coupling stock, coupling material, coupling blanks and couplings

7.4.1 General

Coupling stock, coupling material and coupling blanks suitable for more than one type of connection may be qualified by a test to demonstrate conformance to the most stringent requirements. The test specimen orientation and size shall be the highest possible listed on the hierarchy in Table C.9 or Table E.9 and the absorbed energy requirement shall equal or exceed the applicable requirements.

7.4.2 Grade H40

There is no mandatory CVN impact energy requirement.

NOTE See A.8 SR16 for optional CVN requirements.

7.4.3 Grades J55 and K55 for API threads

The minimum full-size transverse absorbed energy requirement C_V is 20 J (15 ft-lb). The minimum full-size longitudinal absorbed energy requirement C_V is 27 J (20 ft-lb). The impact specimen orientation, minimum size, minimum absorbed energy requirement (that is, adjusted for the size of specimen

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indicated), and test temperature reduction (as applicable) for couplings are provided in Table C.10 or Table E.10.

7.4.4 Grades N80 all Types, R95, L80 all Types, C90, T95, P110 and Q125 for API threads

The impact specimen orientation, minimum size and minimum absorbed energy requirement C_V (i.e. adjusted for the specimen size indicated) for couplings are provided in Tables C.11 to C.15 or Tables E.11 to E.15.

The minimum absorbed energy requirements, C_V, for full-size test specimens are calculated based on the formulae in Table 9:

where

YS_{max} is the specified maximum yield strength for the grade evaluated, in megapascals (thousand pounds per square inch);

t is the critical wall thickness, in millimetres (inches), based on the specified dimensions for couplings.

Table 9 — Full-size test specimen minimum absorbed energy requirements (couplings for grades N80 [all types], R95, L80 [all types], C90, T95, P110, and Q125)

Unit system	Transverse requirement C_V	Longitudinal requirement C_V
SI units, joules	$YS_{max} \cdot (0{,}001\ 18 \cdot t + 0{,}012\ 59)$ or 20 J, whichever is greater (Table C.16)	$YS_{max} \cdot (0{,}002\ 36 \cdot t + 0{,}025\ 18)$ or 41 J, whichever is greater (Table C.17)
USC units, foot-pounds	$YS_{max} \cdot (0.152 \cdot t + 0.064)$ or 15 ft-lb whichever is greater (Table E.16)	$YS_{max} \cdot (0.304 \cdot t + 0.128)$ or 30 ft-lb, whichever is greater (Table E.17)

NOTE Tables for requirements for Grade C110 couplings with API threads are not included since these threads are not standardized for this grade.

7.4.5 Special end-finish

The critical thickness shall be as specified in 7.6.6. The absorbed energy requirements in 7.4.1 to 7.4.4 shall apply.

7.5 Charpy V-notch — Absorbed energy requirements for pipe

7.5.1 Grades H40, J55 and K55

There is no mandatory CVN impact requirement.

NOTE See A.8 SR16 for optional CVN impact energy requirements.

7.5.2 Grades N80 all Types, R95, L80, C90, T95 and P110

The minimum absorbed energy requirement, C_V, for full-size test specimens is provided in Tables C.18 and C.19 or Tables E.18 and E.19.

The requirements are calculated based on the formulae in Table 10:

where

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YS_{min} is the specified minimum yield strength, in megapascals (thousand pounds per square inch);

t is the specified wall thickness, in millimetres (inches).

Table 10 — Full-size test specimen minimum absorbed energy requirements (pipe for grades N80 [all types], R95, L80, C90, T95, and P110)

Unit system and grade	Transverse requirement C_V	Longitudinal requirement C_V
SI units, joules Grades N80Q, R95, L80, C90, T95	$YS_{min} \cdot (0{,}001\,18 \cdot t + 0{,}012\,59)$ or 14 J, whichever is greater (Table C.18)	$YS_{min} \cdot (0{,}002\,36 \cdot t + 0{,}025\,18)$ or 27 J, whichever is greater (Table C.19)
SI units, joules Grade P110	$YS_{min} \cdot (0{,}001\,18 \cdot t + 0{,}012\,59)$ or 20 J, whichever is greater (Table C.18)	$YS_{min} \cdot (0{,}002\,36 \cdot t + 0{,}025\,18)$ or 41 J, whichever is greater (Table C.19)
USC units, foot pounds Grades N80Q, R95, L80, C90, T95	$YS_{min} \cdot (0.152 \cdot t + 0.064)$ or 10 ft-lb, whichever is greater (Table E.18)	$YS_{min} \cdot (0.304 \cdot t + 0.128)$ or 20 ft-lb, whichever is greater (Table E.19)
USC units, foot pounds Grade P110	$YS_{min} \cdot (0.152 \cdot t + 0.064)$ or 15 ft-lb, whichever is greater (Table E.18)	$YS_{min} \cdot (0.304 \cdot t + 0.128)$ or 30 ft-lb, whichever is greater (Table E.19)

7.5.3 Grades C110 and Q125

The minimum absorbed energy requirement for full-size test specimens is provided in Tables C.18 and C.19 or Tables E.18 and E.19.

The requirements are calculated based on the formulae in Table 11:

where

YS_{max} is the specified maximum yield strength, in megapascals (thousand pounds per square inch);

t is the specified wall thickness, in millimetres (inches).

Table 11 — Full-size test specimen minimum absorbed energy requirements (pipe for grades C110 and Q125)

Unit system and Grade	Transverse requirement C_V	Longitudinal requirement C_V
SI units, joules Grades C110 and Q125	$YS_{max} \cdot (0{,}001\,18 \cdot t + 0{,}012\,59)$ or 20 J whichever is greater (Table C.18)	$YS_{max} \cdot (0{,}002\,36 \cdot t + 0{,}025\,18)$ or 41 J whichever is greater (Table C.19)
USC units, foot pounds Grades C110 and Q125	$YS_{max} \cdot (0.152 \cdot t + 0.064)$ or 15 ft-lb whichever is greater (Table E.18)	$YS_{max} \cdot (0.304 \cdot t + 0.128)$ or 30 ft-lb, whichever is greater (Table E.19)

7.5.4 Test specimen

Table C.20 or Table E.20 for transverse specimens and Table C.21 or Table E.21 for longitudinal specimens provide the calculated wall thickness required to machine full-size, ¾-size, and ½-size impact test specimens. The impact test specimen size that shall be selected from these tables is the largest impact test specimen having a calculated wall thickness that is less than the specified wall thickness for the pipe tested.

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7.5.5 Testing conditions

For Grades N80 all types, L80 all types, R95, C90, T95, P110, C110 and Q125 pipe, impact testing is mandatory. For Grades N80 all types, L80 Type 1, R95 and P110, conformance with the requirements of 7.5.2 may be qualified by a documented procedure instead of testing, when agreed by the purchaser and manufacturer, unless A.8 SR16 is specified on the purchase agreement, in which case testing is mandatory as specified in 10.7. Pipe qualified by a documented procedure that fails to show conformance to the specified impact energy requirements after shipment shall be rejected.

Grades H40, J55 and K55 have no impact requirements for pipe.

7.6 Charpy V-notch — Absorbed energy requirements for accessory material

7.6.1 Accessory material — General

If the accessory has an API internally threaded connection, the minimum impact energy requirement for the accessory material shall not be less than the requirement for that particular connection.

7.6.2 Accessory material for accessories with internal API threads except integral tubing connections

The requirements in 7.4.1 to 7.4.4 apply.

7.6.3 Accessory material for accessories with internal special end-finish tapered interference-type threads

The requirements in 7.4.5 apply.

7.6.4 Accessory material for accessories with external threads

The requirements in 7.4 apply.

7.6.5 Accessory material for accessories with either integral tubing connections or internal special end-finish connections that do not have thread interference

By agreement between the manufacturer and purchaser, the provisions of A.8 SR16 shall apply.

7.6.6 Critical thickness for accessory material and special end-finish material

If not specified on the purchase agreement,

a) the critical thickness for determining the impact energy requirements shall be based on the thickness of the cross-section of the accessory that has the lowest t/D ratio, where D is the specified outside diameter and t is the calculated wall thickness at that section;

b) for an accessory with API internal threads, the critical thickness for these API threads is shown in Table C.7 or Table E.7, and D is the specified outside diameter of the connection as specified in 9.4 and 9.6;

c) for special end-finish connections, the critical thickness for externally threaded members is the specified pipe body thickness, while for internally threaded members it is the calculated thickness of the internally threaded member at the plane of the small end of the pin (when the connection is made up power-tight).

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7.7 Maximum hardness

7.7.1 Grades L80 all types, C90, T95 and C110

a) Grades L80 all types, C90, T95 and C110 – Through-wall hardness

The mean hardness numbers obtained shall conform with the requirements in Table C.5 or Table E.5.

In addition, the following apply.

— For L80 all types, any mean hardness number not exceeding 23,0 HRC is acceptable. If any hardness number from a single indentation exceeds 24,0 HRC, the length or piece shall be rejected.

— For Grades C90 and T95, any mean hardness number not exceeding 25,4 HRC is acceptable. If any hardness number from a single indentation exceeds 27,0 HRC, the length or piece shall be rejected. Products with mean hardness numbers between 25,4 HRC and 27,0 HRC shall be retested.

— For Grade C110, any mean hardness number not exceeding 30,0 HRC is acceptable. If any hardness number from a single indentation exceeds 32,0 HRC the length or piece shall be rejected. Products with mean hardness numbers between 30,0 HRC and 32,0 HRC shall be retested.

b) Grades C90, T95 and C110 — Surface hardness (only if required in accordance with 10.6)

For Grades C90 and T95, if the Brinell or Rockwell C-scale hardness number does not exceed 255 HBW or 25,4 HRC respectively, then the length or piece is acceptable. If any of the hardness numbers are over 255 HBW or 25,4 HRC two additional indentations may be made in the immediate area. If either of the second test hardness numbers exceeds 255 HBW or 25,4 HRC the length or piece shall be rejected.

For Grade C110, if the Brinell or Rockwell C-scale hardness number does not exceed 286 HBW or 30 HRC respectively, then the length or piece is acceptable. If any of the hardness numbers are over 286 HBW or 30 HRC two additional indentations may be made in the immediate area. If either of the second test hardness numbers exceeds 286 HBW or 30 HRC the piece shall be rejected.

c) Grades C90 and T95 — Alternative maximum hardness requirements

By agreement between the purchaser and manufacturer, the maximum mean hardness numbers may be altered from those stated above, based on sulfide stress corrosion cracking tests specified in 7.14.

7.7.2 Grade Q125 — All products

No hardness limits are specified but the maximum variation is restricted as a manufacturing control in accordance with 7.8 and 7.9.

7.8 Hardness variation — Grades C90, T95, C110 and Q125

Material shall conform to the hardness variation requirements of Table C.5 or Table E.5. Hardness variation is defined as the difference between any two mean hardness numbers within one quadrant. This criterion shall not apply between specimens.

7.9 Process control — Grades C90, T95, C110 and Q125

All individually heat-treated coupling blanks, pup joints or accessory material shall be surface hardness tested to verify process control. For Grades C90, T95 and C110, the surface hardness test results shall be used in the selection of the pieces for through-wall hardness testing. The process-control hardness

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test results need not be provided by the manufacturer or processor unless specified on the purchase agreement.

7.10 Hardenability — Minimum percentage martensite for quenched and tempered products

7.10.1 Grade L80 Type 1

For each size, mass, chemical composition and austenitize-and-quench combination, a through-wall hardness test shall be made on products after quenching and prior to tempering for each production run to characterize the hardening response. These tests shall be made on the body of products or, in the case of upset products or accessory material, shall be made in the upset or design area of greatest wall thickness. Mean hardness numbers shall equal or exceed the hardness corresponding to a minimum of 50 % martensite, as determined by Formula (2):

$$HRC_{min} = 52 \times (\%carbon) + 21 \quad (2)$$

NOTE The above formula was derived from data in Reference [2]. Based on these data, Formula (2) is valid from 0,15 % carbon to 0,50 % carbon.

7.10.2 Grades C90 and T95

For each size, mass, chemical composition and austenitize-and-quench combination, a through-wall hardness test shall be made on products after quenching and prior to tempering for each production run to characterize the hardening response. These tests shall be made on the body of products or, in the case of upset products or accessory material, these shall be made in the upset or design area of greatest wall thickness. Mean hardness numbers shall equal or exceed the hardness corresponding to a minimum of 90 % martensite, as determined by Formula (3):

$$HRC_{min} = 58 \times (\%carbon) + 27 \quad (3)$$

NOTE The above formula was derived from data in Reference [2]. Based on these data, Formula (3) is valid from 0,15 % carbon to 0,50 % carbon.

7.10.3 Grade C110

For each size, mass, chemical composition and austenitize-and-quench combination, a through-wall hardness test shall be made after quenching and prior to tempering for each production run. These tests shall be made on the body of products or, in the case of accessory material, these shall be made in the design area of greatest wall thickness. Mean hardness numbers shall equal or exceed the hardness corresponding to 95 % minimum martensite as determined by Formula (4):

$$HRC_{min} = 59 \times (\%carbon) + 29 \quad (4)$$

NOTE The above formula was derived from data in Reference [2]. Based on these data, Formula (4) is valid from 0,15 % carbon to 0,50 % carbon.

For pipe, coupling blanks, coupling material and coupling stock with a wall thickness of 30 mm (1.181 in) or larger, an alternative requirement may be used by agreement between manufacturer and purchaser.

7.10.4 All grades except Grades L80, C90, T95 and C110

For each size, mass, chemical composition and austenitize-and-quench combination, a through-wall hardness test shall be made after quenching and prior to tempering as part of a documented procedure to confirm sufficient hardening. These tests shall be made on the body of products or, in the case of upset products or accessory material, these shall be made in the upset or design area of greatest wall

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thickness. Mean hardness numbers shall equal or exceed the hardness corresponding to a minimum of 50 % martensite, as determined by Formula (5):

$$HRC_{min} = 52 \times (\%carbon) + 21 \quad (5)$$

7.11 Grain size — Grades C90, T95 and C110

Prior austenitic grain size shall be ASTM 5 or finer for Grades C90 and T95 and ASTM 6 or finer for Grade C110 (determined in accordance with ISO 643 or ASTM E112).

7.12 Surface condition — Grade L80 13Cr

The internal surface of the pipe shall be free from scale after the final heat treatment.

For Grade L80 13Cr, the pipe inside surface properties shall meet the requirements for Sa 2½ in ISO 8501-1. During surface preparation, any blasting media that might cause surface iron contamination shall not be used.

7.13 Flattening — Electric-welded pipe

All products that are produced by the electric-weld process of manufacture shall conform with the flattening requirements shown in Table C.22 or Table E.22.

7.14 Sulfide stress cracking test — Grades C90, T95 and C110

7.14.1 General guidance

The purchaser should refer to ISO 15156-2 and/or ANSI/NACE MR0175 for guidance on the usage of Grades C90, T95 and C110. Particular attention should be given to the application of Grade C110 in ISO 15156-2 and/or ANSI/NACE MR0175 SSC Regions 2 or 3, as this material is not suitable for all sour (hydrogen sulfide-containing) service applications.

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.

7.14.2 Test and retest requirements and recommendations

a) Grades C90 and T95: for each lot, as specified by 10.2, manufacturers shall demonstrate that the product meets or exceeds the minimum SSC requirement using the purchaser specified test method(s) given in 7.14.5. If the purchaser requires an SSC requirement higher than the minimum, agreement shall be reached between purchaser and manufacturer.

b) Grade C110: for each lot, as defined in 10.2, manufacturers shall demonstrate that the product meets or exceeds the minimum SSC requirement using the purchaser specified test method(s) given in 7.14.5. If the purchaser requires an SSC requirement higher than the minimum, agreement shall be reached between the purchaser and manufacturer.

   If Method A is specified for the SSC test in accordance with ANSI/NACE TM0177-2016, manufacturers shall, for each lot as defined in 10.2, demonstrate that the product meets or exceeds the 85 % YS_{min} requirement for three specimens, one each from the ends of three different products selected from sub-lots composed of the front one-third, middle one-third and back one-third of the lot. The selection criteria in 7.14.3 shall apply to each of the sub-lots, including the random selection by agreement.

c) For Method A full size tensile test specimens shall be used except where sub-size tensile specimens are required because of product size constraints.

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d) For Method D, a full size DCB specimen shall be used except where sub-size DCB specimens are required because of product size constraints. When Method D sub-size or alternative specimens are required, acceptance criteria shall be agreed between the purchaser and manufacturer.

e) When not specified in this document, the details of the manufacturer's qualification, frequency of sulfide stress-cracking testing, retest procedures and testing practices should be addressed by the purchaser and manufacturer prior to placing or accepting a purchase agreement.

For Grade C110 a retest may be carried out if only one of the initial specimens fail. If more than one of the initial specimens fails, the lot shall be rejected. A retest may be performed on two further test specimens taken from an area of the product adjacent to where the initial failed test specimen was taken. If either of the retest specimens fail, the lot shall be rejected. Rejected lots may be re-heat treated and tested as new lots.

By agreement between the purchaser and the manufacturer, the number of specimens per lot required may be reduced to no less than one with a process control that is sufficient to ensure that the product meets or exceeds the 85 % YS_{min} threshold.

7.14.3 Test sample selection and location

Where possible, based on product size and type of test specimen required, the SSC test specimens shall be taken from a length, end and location (outside-wall, midwall, inside-wall based on through wall hardness tests, see Figure D.10) selected using one of the following criteria:

a) for all test methods, for Grades C90 and T95 a mean hardness of 24,4 HRC or higher or for Grade C110 a mean hardness of 29 HRC or higher, or

b) for all test methods, the highest mean hardness number based on preliminary hardness testing with a minimum of five lengths per lot and a frequency of not less than one length per 20 spaced uniformly in the sequence of the lot, or

NOTE Preliminary hardness testing is intended to capture 5 % of the required hardness tests in order to expedite SSC testing. These lengths are part of the pipe required to be tested in 7.7.1.

c) for all test methods, specimens shall be taken from product representing the highest mean hardness for a particular lot, or

d) for all test methods, when agreed by the purchaser, the manufacturer may use randomly selected test specimens provided prior documented validation test results or previous qualification of the manufacturing procedure (according to ISO 15156-2 and/or ANSI/NACE MR0175) confirm that the manufacturing procedure results in products that meet the SSC requirements of this document.

Hardness data obtained on the SSC test specimens shall be for information only.

7.14.4 Test solution

For the purposes of this document, ANSI/NACE TM0177:2016 Test Solution A shall be used.

Where ANSI/NACE TM0177-2016 requires documented validation of test solution saturation, then analysis shall be done using the iodometric titration procedure in ANSI/NACE TM0177-2016, Appendix C or other validated and documented method.

See A.11 SR39 for use of an alternative test solution in an additional informative test.

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7.14.5 Minimum SSC requirements

a) ANSI/NACE TM0177-2016 Method A, Smooth tensile

Full-size (6,35 mm [0.250 in] diameter) specimen	80 % of YS_{min}	496 MPa (72 000 psi) for C90
		524 MPa (76 000 psi) for T95
	85 % of YS_{min}	644 MPa (93 500 psi) for C110
Sub-size (3,81 mm [0.150 in] diameter) specimen	72 % of YS_{min}	447 MPa (64 800 psi) for C90
		472 MPa (68 400 psi) for T95
	76 % of YS_{min}	576 MPa (83 600 psi) for C110
b) ANSI/NACE TM0177-2016 Method B, Bent beam		Sc (12.0) for C90
		Sc (12.6) for T95

NOTE The requirement for Method B is only stated in USC units, based on current industry convention. There is no Method B requirement for Grade C110.

c) ANSI/NACE TM0177-2016 Method D, DCB

A mean value of 33,0 MPa·m$^{1/2}$ (30.0 ksi·in$^{1/2}$) with a minimum of at least three valid test specimens for Grades C90 and T95 or a mean value of 26,3 MPa·m$^{1/2}$ (24.0 ksi·in$^{1/2}$) with a minimum of at least three valid test specimens for Grade C110.

All valid test results shall be included when calculating the mean value.

No valid test specimen shall have a value less than

— 30,0 MPa·m$^{1/2}$ (27.0 ksi·in$^{1/2}$) for Grades C90 and T95, or

— 23,1 MPa·m$^{1/2}$ (21.0 ksi·in$^{1/2}$) for Grade C110.

A standard test specimen thickness of 9,53 mm (0.375 in) shall be used except as allowed by 7.14.2 d).

Either non-pre-cracked or fatigue pre-cracked specimens may be used. If fatigue pre-cracking of specimens is employed, the maximum stress intensity factor during pre-cracking shall not exceed

— 30,0 MPa·m$^{1/2}$ (27.0 ksi·in$^{1/2}$) for Grades C90 and T95, or

— 20,7 MPa·m$^{1/2}$ (18.6 ksi·in$^{1/2}$) for Grade C110.

For Grade C90 the arm displacement shall be 0,76 mm +0,03 mm, −0,05 mm (0.030 in +0.001 in, −0.002 in).

For Grade T95 the arm displacement shall be 0,71 mm +0,03 mm, −0,05 mm (0.028 in +0.001 in, −0.002 in).

For Grade C110 the arm displacement shall be 0,51 mm +0,03 mm, −0,05 mm (0.020 in +0.001 in, −0.002 in).

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7.14.6 Invalidation of tests

An SSC test shall be deemed invalid and a replacement test performed only when an assignable cause is identified and not simply because it fails to exhibit the minimum SSC requirement. Assignable causes include but are not limited to:

a) test specimen machining defects;

b) testing errors.

7.14.7 Additional testing provisions for ANSI/NACE TM0177-2016 Method D

All measurements for arm displacement shall be made along the load line. Pins shall not be inserted for making these measurements.

The initial measurement for arm displacement shall be made before wedge insertion and may be made on the outer or inner surface of the loading holes or on the outer surfaces of the DCB specimen.

The final measurement for arm displacement shall be made on the assembled specimen at the same location as the initial measurement.

The arm displacement shall be the difference between the initial and final measurements.

Before the SSC test, Rockwell C hardness tests (minimum of three indentations) shall be made as shown in Figure D.29. Hardness data obtained on the DCB test specimens shall be for information only.

As specified in ANSI/NACE TM0177-2016, particular attention shall be given to the identification and evaluation of edge cracks.

8 Dimensions, masses, tolerances, product ends and defects

8.1 Labels and sizes

In the dimensional tables in this document, pipe is designated by labels and by size (outside diameter). The outside diameter size of external-upset pipe is the outside diameter of the body of the pipe, not the upset portion.

8.2 Dimensions and masses

Pipe shall be furnished in the sizes, wall thicknesses and masses (as shown in Tables C.23 to C.26 inclusive or Tables E.23 to E.26 inclusive) as specified on the purchase agreement. Other plain-end pipe sizes and wall thicknesses may be furnished by agreement between purchaser and manufacturer. Coupling stock, coupling material and accessory material shall be furnished in dimensions specified on the purchase agreement or, in the case of coupling material, the dimensions shall be specified in the manufacturer's internal requirements. Coupling stock and coupling material outside diameter and wall thickness combinations shall exclude those in Tables C.1 and C.2 or Tables E.1 and E.2. 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.

Casing sizes larger than Label 1: 4-1/2 but smaller than Label 1: 10-3/4 may be specified by the purchaser to be used in tubing service, see Tables C.1, C.23, C.27 and C.28 or Tables E.1, E.23, E.27 and E.28.

The accuracy of all measuring equipment used for acceptance or rejection, except ring-and-plug thread gauges and weighing devices, shall be verified at least every operating shift.

Verifying the accuracy of measuring devices such as snap gauges and drift mandrels shall consist of inspection for wear and conformance to specified dimensions. Verifying the accuracy of rules, length-measuring tapes and other non-adjustable measuring devices shall consist of a visual check for the

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legibility of markings and general wear of fixed reference points. The manufacturer shall document the measuring devices utilized as “adjustable” or “non-adjustable”.

The verification procedure for working ring-and-plug thread gauges shall be documented. The accuracy of all weighing devices shall be verified at periods not to exceed those required by the manufacturer’s documented procedure in accordance with known and internationally or nationally accepted procedures.

NOTE See for instance standards from the National Institute of Standards and Technology (NIST).

If measuring equipment whose calibration or verification is required under the provisions of this document is subjected to unusual or severe conditions sufficient to make its accuracy questionable, re-calibration or re-verification shall be performed before further use of the equipment.

8.3 Diameter

8.3.1 Measurement and design

a) Using SI units

For measurement of diameter, an accuracy of one decimal place shall be used for sizes larger than Label 1: 6-5/8. In this document two decimal places are used for design purposes to ensure interchangeability.

b) Using USC units

The diameter shall be rounded to three decimal places.

8.3.2 Requirements

The outside diameter of pipe shall be within the tolerances specified in 8.11.1. For pipe furnished non-upset and plain-end and which is specified on the purchase agreement for the manufacture of pup joints, the non-upset plain-end tolerances shall apply to the full length.

For coupling stock, coupling material and accessory material outside diameter tolerances shall be specified on the purchase agreement or, in the case of coupling material and accessory material, the outside diameter tolerances shall be specified in the manufacturer's internal requirements.

For threaded pipe, the outside diameter at the threaded ends shall be such that the total thread length, L_4, (excluding BC) and the full-crest thread length, L_c, shall be within the dimensions and tolerances specified in API Spec 5B.

8.4 Wall thickness

For pipe, the wall thickness at any place shall not be less than the specified thickness, t, minus the permissible under-tolerance specified in 8.11.2.

For coupling stock, coupling material and accessory material the wall thickness tolerance shall be specified on the purchase agreement or, in the case of coupling material and accessory material, the wall thickness shall be specified in the manufacturer's internal requirements.

8.5 Mass

The masses determined as described in 10.13.7 shall conform to the calculated masses as specified herein (or adjusted calculated masses for martensitic chromium grade L80 Type 13Cr) for the end-finish

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specified on the purchase agreement, within the tolerances stipulated in 8.11.3. Calculated masses shall be determined in accordance with Formula (6):

$$W_L = w_{pe} \cdot L_{ef} + k_m \cdot e_m \quad (6)$$

where (according to ISO/TR 10400 or API TR 5C3, 11.4),

W_L is the calculated mass of a piece of pipe of length L, in kilograms (pounds);

w_{pe} is the plain-end mass in kilograms per metre (pounds per foot);

L_{ef} is the length of pipe, including end-finish, in metres (feet), as defined in 8.6;

k_m is the mass correction factor: 1,000 for carbon steels; 0,989 for martensitic chromium steels;

e_m is the mass gain due to end-finishing, in kilograms (pounds).

8.6 Length

Unless otherwise agreed between the purchaser and the manufacturer, casing, tubing and pup joints shall be furnished in lengths conforming to Table C.27 or Table E.27. The length of API couplings shall be as specified in Tables C.32 to C.35 or Tables E.32 to E.35 as applicable. The length of coupling stock, coupling material and accessory material shall be as specified on the purchase agreement or, in the case of coupling material and accessory material, the length shall be specified in the manufacturer's internal requirements. The length of each finished product shall be determined for conformance to length requirements. Length determination shall be in metres and hundredths of a metre (feet and tenths of a foot).

The accuracy of length-measuring devices for lengths of product less than 30 m (100 ft) shall be ±0,03 m (±0.1 ft).

8.7 Casing jointers

If so specified on the purchase agreement, for round thread casing only, jointers (two pieces coupled to make a standard length) may be furnished to a maximum of 5 % of the order; but no length used in making a jointer shall be less than 1,52 m (5.0 ft).

8.8 Height and trim of electric-weld flash

8.8.1 Trimming electric-weld flash

The outside flash of electric-welded pipe shall be trimmed to an essentially flush condition.

It shall be the aim of the manufacturer to provide an inside surface at the weld of electric-weld pipe that is

a) reasonably close to flush after trimming, and

b) contains no jagged edges from the original weld flash.

It might be desirable for the manufacturer to provide an inside surface at the trimmed weld with a slight groove in order to meet this aim. The inside flash of electric-welded pipe shall be trimmed as given in 8.8.2 and 8.8.3.

8.8.2 Grades H40, J55, K55, N80 all types, R95; and L80 Type 1

The height of the inside weld flash shall not exceed 1,14 mm (0.045 in) for casing or casing pup joints or 0,38 mm (0.015 in) for tubing or tubing pup joints, measured from the inside surface adjacent to the flash.

The depth of groove resulting from removal of the inside flash shall not be greater than the amount listed in Table 12 for the various wall thicknesses. Depth of groove is the difference between the

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wall thickness measured approximately 25 mm (1 in) from the weld line and the remaining wall under the groove.

Table 12 — Electric-weld flash height and trim (all grades except P110 and Q125)

Wall thickness	Maximum depth of trim
3,84 mm to 7,64 mm (0.151 in to 0.301 in)	0,38 mm (0.015 in)
≥7,64 mm (≥0.301 in)	$0{,}05 \cdot t$

8.8.3 Grades P110 and Q125

No inside flash height shall be permitted. The groove on the inside weld surface shall not exceed a depth of 0,38 mm (0.015 in) and shall not contain sharp corners that would interfere with ultrasonic inspection. Depth of groove is the difference between the wall thickness measured approximately 25 mm (1 in) from the weld line and the remaining wall under the groove.

8.8.4 Disposition

Pipe with weld flash exceeding the limits specified in 8.8.2 or 8.8.3, as applicable, shall be either rejected or repaired by grinding.

8.9 Straightness

8.9.1 Pipe

Deviation from straight, or chord height, shall not exceed the following:

a) 0,2 % of the total length of the pipe measured from one end of the pipe to the other end, for pipes Label 1: 4-1/2 and larger;

b) 3,18 mm (1/8 in) maximum drop in the 1,5 m (5.0 ft) length at each end.

See Figures D.13 and D.14.

8.9.2 Coupling stock, coupling material and accessory material

Straightness requirements shall be as agreed between the purchaser and manufacturer or, in the case of coupling material and accessory material, the straightness shall be specified in the manufacturer's internal requirements

8.10 Drift requirements

Each length of pipe either threaded or plain-end shall be drift-tested throughout its entire length. Pipe threaded by an entity other than the pipe manufacturer shall also be drift-tested for a distance of 0,6 m (24 in) from the coupled end on casing and 1,1 m (42 in) from the coupled end on tubing. Drift dimensions (length and diameter) shall conform with Table C.28 or Table E.28.

When specified by the purchaser as "alternate drift pipe":

— pipe in sizes and masses in Table C.29 or Table E.29 shall be tested with the alternate drift mandrels as shown, unless another size is specified on the purchase agreement;

— pipe in sizes and masses not in Tables C.29 or Table E.29 shall be tested with the alternate drift mandrels as specified on the purchase agreement.

Pipe which is drift tested with the alternate drift mandrels shall be marked, as described in Clause 11.

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8.11 Tolerances on dimensions and masses

8.11.1 Outside diameter

The tolerances in Table 13 apply to the outside diameter, D, of pipe.

Table 13 — Dimension Tolerances (pipe OD)

Label 1	Tolerance on outside diameter, D
<4-1/2	±0,79 mm (±0.031 in)
≥4-1/2	$^{+1}_{-0,5}$ %D

For upset integral tubing connection, the tolerances in Table 14 apply to the outside diameter of the pipe body immediately behind the upset for a distance of approximately 127 mm (5.0 in) for sizes Label 1: 5-1/2 and smaller, and a distance approximately equal to the outside diameter for sizes larger than Label 1: 5-1/2. Measurements shall be made with callipers or snap gauges.

Table 14 — Dimension tolerances (upset integral tubing)

Label 1	Tolerances behind m_{eu} or L_0
≤3-1/2	$^{+2,38}_{-0,79}$ mm$\left(^{+3/32}_{-1/32}\text{ in}\right)$
>3-1/2 to ≤5	+2,78 mm to –0,75 % D (+7/64 in to –0.75 % D)
>5 to ≤8-5/8	+3,18 mm to –0,75 % D (+1/8 in to –0.75 % D)
>8-5/8	+3,97 mm to –0,75 % D (+5/32 in to –0.75 % D)

For Label 1: 2-3/8 and larger external-upset tubing, the tolerances in Table 15 shall apply to the outside diameter at distance L_a (see Figure D.5) from the end of the pipe.

Changes in diameter between L_a and L_b shall be smooth and gradual. Pipe body, outside diameter tolerances do not apply for a distance of L_b from the end of the pipe.

Table 15 — Dimension tolerances (external upset tubing)

Label 1	Tolerances
≥2-3/8 to ≤3-1/2	$^{+2,38}_{-0,79}$ mm$\left(^{+3/32}_{-1/32}\text{ in}\right)$
>3-1/2 to ≤4	+2,78 to –0,79 mm (+7/64 to –1.32 in)
>4	+ 2,78 mm to –0,75 % D (+7/64 in to –0.75 % D)

8.11.2 Wall thickness

Tolerance for pipe –12,5 %

8.11.3 Mass

Table 16 identifies requirements for standard mass tolerances. When the specified minimum wall thickness is equal to or greater than 90 % of the specified wall thickness, the single length positive mass tolerance shall increase to +10 %.

Table 16 — Standard mass tolerances

Amount	Tolerance
Single lengths	$^{+6,5}_{-3,5}$%

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Table 16 *(continued)*

Amount	Tolerance
Carload 18 144 kg (40 000 lb) or more	–1,75 %
Carload less than 18 144 kg (40 000 lb)	–3,5 %
Order items 18 144 kg (40 000 lb) or more	–1,75 %
Order items less than 18 144 kg (40 000 lb)	–3,5 %

8.11.4 Inside diameter

Inside diameter, *d*, is governed by the outside diameter and mass tolerances.

8.11.5 Upset dimensions

Tolerances on upset dimensions are given in Tables C.25 and C.26 or Tables E.25 and E.26.

8.11.6 Extended length upsets

External upset tubing may be ordered with extended length upsets (L_{el}) as agreed between purchaser and manufacturer. A minimum of 95 % of the number of lengths (both ends) shall meet the L_{el} with the remaining balance meeting L_{eu} requirements, unless otherwise agreed between purchaser and manufacturer.

8.12 Product ends

8.12.1 Plain-end pipe

Plain-end pipe is pipe furnished unthreaded, either upset or non-upset, but in conformance with all requirements of this document for a particular grade, and shall be marked as specified in 11.5.2.

8.12.2 Product with API threads

Product shall be furnished with one of the end finishes specified in Tables C.1 and C.2 or Tables E.1 and E.2 as specified on the purchase agreement.

Additionally, seal ring configuration in accordance with A.7 SR13 may be ordered.

Some items of Grades H40, J55 or K55 casing are available in either short or long thread forms (see Table C.1 or Table E.1). If long thread is desired on these items, the purchaser shall so specify on the purchase agreement. Otherwise short-thread casing in accordance with Table C.23 or Table E.23 shall be furnished.

8.12.3 Rounded nose

In lieu of the conventional corner breaks on the threaded ends of external upset tubing, the “round” or “bullet-nose” end may be supplied at the manufacturer’s option or may be specified by the purchaser. The modified end shall be rounded to provide for coatable service, and the radius transition shall be smooth with no sharp corners, burrs, or slivers on the inside-wall or outside-wall chamfer surfaces. See Figure D.6 for an illustration and dimensions. It is recognized that the dimensions in Figure D.6 are recommended values but are not subject to measurement to determine acceptance or rejection of the product.

8.12.4 Threading

Product threads, gauging practice and thread inspection shall conform to the requirements of API Spec 5B. Product ends shall not be rounded out by hammering but may be slightly shaped to secure

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conformance with threading requirements. For grade C90 and higher strength grades this shaping shall only be carried out if agreed with the purchaser.

8.12.5 Special end finish

Pipe with end-finish not specified in this document may be furnished if so specified in the purchase agreement. This pipe shall have the body of the pipe manufactured in accordance with the requirements of this document. When threaded by the pipe mill or processor, the pipe shall be marked as specified in 11.5.2.

Couplings and accessories with end-finish not specified in this document may be furnished if so specified in the purchase agreement. These items shall be manufactured in accordance with the requirements of this document, except for end-finish and dimensions, and shall be marked as specified in 11.5.2.

8.13 Defects

8.13.1 Pipe and accessory made from pipe

All pipe and accessory made from pipe shall be free from defects as listed hereafter:

a) any quench crack;

b) any arc burn;

c) any surface-breaking imperfection which is proven to reduce the net effective wall thickness below 87,5 % of the specified wall thickness;

d) when NDE (except visual) is specified by this document (see 10.15 and A.2 SR2) or specified on the purchase agreement, any non-surface-breaking imperfection detected that, when outlined on the outside surface, has an area greater than 260 mm^2 (0.40 in^2);

e) any non-surface-breaking weld seam imperfection within 1,6 mm (1/16 in) of either side of the weld line that is proven to reduce the net effective wall thickness below 87,5 % of the specified wall thickness;

f) any linear imperfection on the outside or inside surface, of any orientation, with a depth greater than tabulated in Table C.30 or Table E.30;

g) any surface-breaking pipe upset imperfection, of any orientation, with a depth greater than tabulated in Table C.31 or Table E.31;

h) on the internal upset configuration on all upset products, any sharp corner or drastic change of section that would cause a 90° hook-type tool to hang up (see Figure D.24);

i) any non-linear inside surface breaking imperfection located in the external thread section of the pipe body with a depth greater than 10 % of the specified wall thickness.

8.13.2 Accessory material not made from pipe, coupling stock and coupling material

All accessory material not made from pipe, coupling stock and coupling material shall be free from any quench crack or arc burn.

All coupling stock and coupling material shall be free from, or have clearly marked, any outside surface-breaking imperfection which has a depth greater than 5 % of the manufactured wall thickness or which is proven to reduce the outside diameter or wall thickness below specified tolerances. Also, the requirement of 8.13.1 c) shall apply.

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8.13.3 Process control plan

The manufacturer, based on knowledge of the production process and the requirements of Clause 10, shall apply a process control plan that will ensure that the above requirements are fulfilled.

8.14 Coupling make-up and thread protection

8.14.1 All Grades except Q125

All casing couplings and regular tubing couplings shall be screwed onto the pipe power-tight, except that they shall be screwed on handling-tight (see Note 1 below) or shipped separately if so specified on the purchase agreement. Special-clearance tubing couplings shall be screwed onto the pipe handling-tight, except that they shall be shipped separately if so specified on the purchase agreement.

A thread compound shall be applied to cover the full surface on the engaged thread of either the coupling or pipe before making up the connection. Application on both coupling and pipe may be agreed between purchaser and manufacturer. Unless otherwise specified by the purchaser, the thread compound shall conform to ISO 13678 or API RP 5A3. When pipe is furnished threaded and coupled, the field end and the coupling shall be provided with thread protectors. When pipe is furnished threaded, but without couplings attached, each end shall be provided with a thread protector. Thread protectors shall conform to the requirements of 12.2. All exposed threads shall be coated with thread compound. A storage compound of distinct colour may be substituted for this thread compound on all exposed threads. The compound shall be applied to a surface that is clean and reasonably free of moisture and cutting fluids.

NOTE 1 The purpose of making up couplings handling-tight is to facilitate the removal of the couplings for cleaning and inspecting threads and applying fresh thread compound before using the pipe. This procedure has been found to result in less chance for thread leakage, because mill-applied couplings made up power-tight, although leak-proof at the time of make-up, might not always remain so after transportation, handling and use.

NOTE 2 Martensitic chromium steels are sensitive to galling. Special precautions can be necessary for thread surface treatment and/or lubrication to minimize galling during hydrostatic testing (plug application and removal).

To enhance protection from rust, connection surfaces can be prepared by applying a de-watering fluid/corrosion inhibitor, after blowing with air to remove metal and dirt particles and immediately prior to compound application. Excess de-watering fluid/corrosion inhibitor on threaded surfaces should be removed.

8.14.2 Grade Q125

The requirements for Grade Q125 are the same as that shown in 8.14.1, except that couplings with API threads shall be shipped separately unless power-tight make-up is specified on the purchase agreement.

9 Couplings

9.1 General requirements

Couplings shall be seamless and of the same grade and type or higher, as the pipe and shall be given the same heat treatment as the pipe, except as provided in 9.2.

Couplings shall be machined from coupling blanks made from coupling stock, coupling material or hot forgings except Grades C110 and Q125 couplings which shall not be made from hot forgings.

For Grade C110 coupling blanks heat treated individually, only method 10.2.3 c) shall be used.

See A.3 SR9 for optional requirements for Grades C110 and Q125 coupling blanks.

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When couplings are electroplated, the electroplating process should be controlled to minimize hydrogen absorption.

9.2 Alternative grades or heat treatments

9.2.1 When heat treatment is not stipulated on the purchase agreement, Grade H40 pipe shall be furnished with Grade H40, J55 or K55 couplings which are either as-rolled, normalized, normalized and tempered, or quenched and tempered.

9.2.2 When heat treatment is not stipulated on the purchase agreement, Grade J55 pipe shall be furnished with Grade J55 or K55 couplings which are either as-rolled, normalized, normalized and tempered, or quenched and tempered.

9.2.3 When heat treatment is not stipulated on the purchase agreement, Grade K55 pipe shall be furnished with Grade K55 couplings which are either as-rolled, normalized, normalized and tempered, or quenched and tempered.

9.2.4 Grade J55 EU tubing shall be furnished with Grade L80 Type 1 special clearance couplings when specified on the purchase agreement.

9.2.5 Grades J55 and K55 buttress casing shall be furnished with Grade L80 Type 1 couplings when specified on the purchase agreement.

9.2.6 Normalized Grade N80 Type 1 pipe shall be furnished with either Grade N80 Type 1 or N80Q couplings.

9.2.7 Normalized and tempered Grade N80 Type 1 pipe shall be furnished with either normalized and tempered Grade N80 Type 1 or N80Q couplings.

9.2.8 Grades N80 Type 1 and N80Q EU tubing shall be furnished with Grade P110 special clearance couplings when specified on the purchase agreement.

9.2.9 Grades N80 Type 1 and N80Q buttress casing shall be furnished with Grade P110 couplings when specified on the purchase agreement.

9.2.10 Grade P110 buttress casing shall be furnished with Grade Q125 couplings when specified on the purchase agreement.

9.3 Mechanical properties

Couplings shall conform to the mechanical requirements specified in Clauses 7 and 10, including the frequency of testing, retest provision, etc. A record of these tests shall be open to inspection by the purchaser.

9.4 Dimensions and tolerances

9.4.1 All Grades except Q125

Couplings shall conform to the dimensions and tolerances shown in Tables C.32 to C.35 or Tables E.32 to E.35. Unless otherwise specified on the purchase agreement, threaded and coupled casing and tubing shall be furnished with regular couplings.

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9.4.2 Grade Q125

Couplings may be machined on the complete outside surface in addition to the inside surface. Dimensions shall be as specified on the purchase agreement unless couplings with standard API threads are ordered, in which case the dimensions shall be as shown in Tables C.32 and C.33 or Tables E.32 and E.33.

9.5 Regular couplings

Regular couplings have diameters (W) as shown in Tables C.32 to C.35 or Tables E.32 to E.35. The inside and outside edges of the bearing face shall be rounded or broken, but shall not materially reduce the width of the bearing face (dimension b) so that enough thickness is left to safely support the mass of the pipe on the elevator. The ends of couplings shall be faced true at right angles to the axis.

9.6 Special-clearance couplings — All Grades except Q125

When specified in the purchase agreement, special-clearance (reduced outside diameter W_c) couplings for buttress casing and external upset tubing shall be furnished. Unless otherwise specified, special-clearance external upset tubing couplings shall have a special bevel on both ends as specified in 9.10 and shown on Figure D.5.

When specified in the purchase agreement, special-clearance buttress thread casing couplings shall have a special bevel on both ends as shown on Figure D.3. The inside and outside edges of the bearing face shall be rounded or broken as shown on Figures D.3 and D.5.

The ends (or root face when bevelled) of couplings shall be faced at right angles to the axis. Special-clearance couplings shall conform to the dimensions (except b) and tolerances given in Tables C.33 and C.35 or Tables E.33 and E.35 and as shown on Figures D.3 and D.5.

See Clause 11 for marking and colour identification.

9.7 Combination couplings

Combination couplings with different types of thread of the same specified size shall be furnished when specified on the purchase agreement. The minimum length and minimum outside diameter of combination couplings shall be sufficient to accommodate the specified size and type of threads.

9.8 Seal-ring couplings

Seal-ring couplings conforming to the requirements of A.7 SR13 shall be furnished when specified on the purchase agreement.

Seal-ring grooves shall be machined in the same set-up used to machine the box threads. The seal-ring groove eccentricity shall be no greater than 0,13 mm (0.005 in) and shall be verified for each machine set-up. Seal-ring groove eccentricity is the maximum difference between the values of the distance from the root of the seal-ring groove to the minor cone of the coupling threads in a plane at any location around the circumference.

9.9 Special-bevel tubing regular couplings — All Grades

When specified in the purchase agreement, special-bevel tubing regular couplings conforming to the requirements of Tables C.34 and C.35 or Tables E.34 and E.35 shall be furnished for non-upset and external-upset tubing. Unless otherwise specified, special bevel tubing regular couplings shall be bevelled on both ends as shown on Figures D.4 and D.5. The inside and outside edges of the bearing face shall be rounded or broken as shown on Figures D.4 and D.5. The root faces of the couplings shall be faced at right angles to the axis.

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9.10 Threading — Couplings

Casing couplings shall be furnished with one of the end finishes specified in Tables C.1 and C.2 or Tables E.1 and E.2 as specified on the purchase agreement.

Tubing couplings shall be furnished with one of the end-finishes specified in Table C.2 or Table E.2 as specified on the purchase agreement.

9.11 Surface inspection

9.11.1 All finished couplings shall be free from all imperfections that break the continuity of the thread.

9.11.2 All couplings shall be inspected on the outside and inside surfaces after finish machining and before any inside or outside surface plating, using the wet fluorescent magnetic particle method in accordance with ISO 10893-5 or ASTM E709 with a circumferentially oriented magnetic field for the detection of longitudinal surface imperfections, or by other non-destructive method of equal sensitivity as demonstrated to the purchaser. Records shall be maintained in accordance with 10.15.4.

9.11.3 By agreement between purchaser and manufacturer, NDE of Grades H40, J55 and K55 couplings may be waived. However, in this case, the couplings shall be inspected visually on the outside and inside surfaces after finish machining and before plating, and shall be free from all visible seams, cracks and porosity. See Table C.48 or Table E.48 for marking requirements.

NOTE Visible seams or cracks are those that can be seen without the aid of magnetic particle inspection, dye penetrant or other non-destructive methods of inspection.

9.11.4 To ensure adequate plating or coating, the threaded surfaces of all couplings shall be visually inspected after plating or coating.

9.11.5 All imperfections of any depth, revealed during inspection at the manufacturing facility, except as allowed in Table C.36 or Table E.36, shall be removed.

9.11.6 Except as stated in 9.11.7, finished couplings re-inspected outside the manufacturer's facility in accordance with 9.11.2 or 9.11.3 shall be free from imperfections with the exception of those external imperfections given in Table C.36 or Table E.36.

9.11.7 For Grades J55 and K55, material that is impact-tested at or below 0 °C (32 °F), that demonstrates a shear area greater than 80 % and that exceeds the minimum absorbed energy requirements, and for Grades N80 all types, L80 all types, C90, T95, C110, P110 and Q125 material, couplings shall not be rejected for imperfections less than 5 % of the critical wall thickness detected on subsequent re-inspection outside the manufacturer's facility.

The critical thickness is defined in 7.3.2.

9.11.8 Couplings shall be free from any arc burn.

9.12 Measurement of imperfections

The depth of an imperfection shall be measured from the normal surface or contour of the coupling extended over the imperfection. The outside diameter of the finished coupling shall be measured across the finished surface or contour of the coupling (that is, the initial surface or grind contour resulting from the removal of an imperfection or defect). The outside diameter shall not be measured at the base of an acceptable pit.

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9.13 Repair and removal of imperfections and defects

Repair welding is not permitted.

Grinding or machining of quench cracks and arc burns is not permitted.

Non-permissible imperfections defined in 9.11.5 shall be completely removed.

Permissible imperfections, see Table C.36 or Table E.36, may be removed or reduced by machining or grinding on the outer surface.

The area affected by grinding or machining shall be blended smoothly into the contour of the coupling. The outside diameter of the finished coupling shall be within the specified tolerances.

After removal of the defect, the affected zone shall be re-inspected by the same inspection method at the same sensitivity used to perform the initial inspection or by a different inspection method of equal or greater sensitivity.

9.14 Thread surface treatment — Grade Q125

Thread surface treatment shall be as specified on the purchase agreement.

9.15 Couplings and coupling blank protection — Grades C90, T95, C110 and Q125

All loose couplings and all coupling blanks that have been machined to their final outside diameter shall be boxed to prevent contact with one another during shipment. All other coupling blanks shall be boxed to prevent nicks and gouges that will not be removed by subsequent machining. Boxes shall be manufactured from suitable materials that prevent damage to the material surfaces during transportation and shall be designed to be easily handled by forklift.

10 Inspection and testing

10.1 Test equipment

The manufacturer shall determine and document the appropriate calibration and verification frequency in order to be able to certify that all products conform to the requirements of this document.

If test or measuring equipment, whose calibration or verification is required under the provisions of this document, is subjected to unusual or severe conditions which make its accuracy questionable, re-calibration or re-verification shall be performed before further use of the equipment.

10.2 Lot definition for testing of mechanical properties

10.2.1 Grades H40, J55, K55, N80 all types, L80 Type 1, R95 and P110 — Coupling stock, coupling material and pipe (except pup joints heat-treated after cutting to blank or individual length)

A lot is defined as all those lengths with the same specified dimensions and grade which are either as-rolled or heat-treated as part of a continuous operation (or as an individual batch), and are from a single heat of steel, or from different heats that are grouped according to a documented procedure which will ensure that the appropriate requirements of this document are met.

10.2.2 Grades L80 13Cr, C90, T95, C110 and Q125 — Coupling stock, coupling material and pipe (except pup joints heat-treated after cutting to blank or individual length)

A lot is defined as all those lengths with the same specified dimensions and grade, from the same heat of steel which are heat-treated as part of a continuous operation (or as an individual batch).

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10.2.3 Coupling blanks, pup joints or accessory material heat-treated after cutting to blank or individual length

A lot is defined as that group of pieces with the same specified dimensions and grade, from the same heat of steel which has been

a) batch heat-treated concurrently in the same heat treatment line or equipment, or

b) heat-treated in sequential loads using the same process parameters without interruption in the same heat treatment line or equipment equipped with a recording controller to provide documentation of heat-treating control through the run, or

c) individually heat-treated using the same process parameters without interruption in a continuous production run of 8 h or less in the same heat treatment line or equipment equipped with a recording controller to provide documentation of heat treating control through the run.

In addition, for Grades C90, T95, C110 and Q125, a lot shall not exceed 30 coupling blanks, pup joints or accessory material for Label 1: 9-5/8 and larger casing, or 50 coupling blanks, pup joints or accessory material for smaller sizes of individually heat-treated pieces.

10.3 Testing of chemical composition

10.3.1 Heat analyses

For Grades H40, J55, K55, N80 all types, R95, L80 all types, C90, T95 and P110 the manufacturer shall furnish a report giving the heat analysis of each heat of steel used in the manufacture of product specified on the purchase agreement. In addition, the purchaser, upon request, shall be furnished the results of quantitative analyses for other elements used by the manufacturer to control mechanical properties.

For Grades C110 and Q125, the manufacturer shall furnish a report giving the heat analysis of each heat of steel used in the manufacture of product specified on the purchase agreement. The report shall include quantitative analyses for other elements used by the manufacturer to control mechanical properties.

10.3.2 Product analyses

Two tubular products from each heat used shall be analyzed for product analyses. Product analyses shall be made by the manufacturer on the finished tubular product before or after heat-treatment. For electric-welded products, the chemical analysis may be determined on samples of skelp.

Product analyses shall include the results of quantitative determinations of all elements listed in Table C.4 or Table E.4 plus any other elements used by the manufacturer to control mechanical properties.

For Grades H40, J55, K55, N80 all types, R95, L80 all types, C90, T95 and P110 the product analyses shall be available to the purchaser on request.

NOTE For couplings, pup joints and accessory material, the analyses requested can be furnished by the steel manufacturer or processor and can be taken from material in tubular or bar form.

10.3.3 Test method

Chemical composition shall be determined by any of the procedures commonly used for determining chemical composition, such as emission spectroscopy, X-ray emission, atomic absorption, combustion techniques or wet analytical procedures. The calibration methods used shall be traceable to established standards. In case of conflict, chemical analyses shall be made in accordance with ASTM A751. Also see ISO/TR 9769.

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10.3.4 Recheck of product analyses — All Grades

If the product analyses of both lengths of tubular product representing the heat fail to conform to the specified requirements, at the manufacturer's option either the heat shall stand rejected or all the remaining lengths in the heat shall be tested individually for conformance to the specified requirements. If only one of two samples fails, at the manufacturer's option either the heat shall stand rejected or two recheck product analyses shall be made on two additional lengths from the same heat. If both recheck product analyses conform to the requirements, the heat shall be accepted except for the length represented by the initial analysis which failed. If one or both of the recheck product analyses fail, at the manufacturer's option the entire heat shall be rejected or each of the remaining lengths shall be tested individually. In the individual testing of the remaining lengths in any heat, analyses for only the rejecting element or elements need be determined. Samples for recheck product analyses shall be taken in the same manner as specified for product analysis samples. The results of all recheck product analyses shall be provided to the purchaser when specified on the purchase agreement.

10.4 Tensile tests

10.4.1 Stress-relief temperature — All grades

For the purpose of tensile test frequency, stress-relief of tempered products shall not be considered "heat treatment" provided the stress-relief temperature is at least 55 °C (100 °F) below the final tempering temperature.

For Grades C90, T95 and Grade C110 the stress relief of tempered products shall not be considered "heat treatment" provided the stress relief temperature is at least 30 °C (50 °F) below the final tempering temperature.

10.4.2 Heat-control tensile tests — All Grades except Q125

One tensile test shall be made as a control on each heat of steel used by the manufacturer for the production of product in accordance with this document. For electric-welded product, these tensile tests shall be made on either the skelp or the finished product, at the option of the manufacturer.

A heat-control test made on a length of product may also be considered as a product test for the lot being tested.

10.4.3 Frequency of testing and location of test specimen — Casing and tubing

The frequency of testing for casing and tubing of all grades is defined in Table C.37 or Table E.37.

The lengths for testing shall be selected at random and, when more than one test is required, the selection procedures shall provide samples representing the start and end of the heat-treat cycle (as applicable) and front and back ends of the tubes. When more than one test is required, the test specimens shall be from different lengths, except for upset pipe the test specimens may be taken from both ends of one length.

10.4.4 Frequency of testing and test specimen location — Coupling stock, coupling material, coupling blanks, pup joints and accessory material

The frequency of testing is defined for coupling stock, coupling material and coupling blanks in Table C.38 or Table E.38 and for pup joints and accessory material in Table C.39 or Table E.39. When more than one test is required, the test specimens shall be from different lengths.

For Grades H40, K55, N80 all types, R95, L80 all types and P110 for accessory material, the test specimens from bar stock shall be taken from a location corresponding to the mid-wall of the finished accessory.

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For Grades C90, T95, C110 and Q125, tensile test specimens for coupling stock, coupling material, coupling blanks, pup-joint or accessory material heat-treated in tube length shall be removed from locations shown in Figure D.9.

No test is required for pup joints or accessory material manufactured from a length of casing, tubing, coupling stock, coupling blank or coupling material, provided that it has been previously tested and conforms to requirements and there is no subsequent heat treatment.

A heat-control test may also be considered as a product test for the lot being tested.

10.4.5 Test specimens — General

Product-body tensile test specimens shall be either full-section specimens, strip specimens or round bar specimens, as shown in Figure D.8, at the option of the manufacturer. Strip specimens from seamless product shall be taken from any location about the product circumference at the option of the manufacturer. Round bar specimens shall be taken from the mid-wall. Strip specimens and round bar specimens from welded pipe shall be taken approximately 90° from the weld, or, at the option of the manufacturer, from the skelp parallel to the direction of rolling and approximately midway between the edge and the centre. Tensile test specimens for heat-treated product shall be removed from the product subsequent to final heat treatment on the production line.

All strip specimens shall be approximately 38 mm (1.500 in) wide in the gauge length if suitable curved-face testing grips are used, or if the ends of the specimen are machined or cold-flattened to reduce the curvature in the grip area; otherwise they shall be approximately 19 mm (0.750 in) wide for product smaller than Label 1: 4, approximately 25 mm (1.000 in) wide for product from Label 1: 4 up to and including Label 1: 7-5/8, and approximately 38 mm (1.500 in) wide for product larger than Label 1: 7-5/8.

All product-body tensile specimens shall represent the full wall thickness of the product from which the specimen was cut, except for round bar tensile specimens, and shall be tested without flattening. Round bar specimens shall be 12,7 mm (0.500 in) in diameter when the product size allows, and 8,9 mm (0.350 in) in diameter for other sizes. For product sizes too small to allow a 8,9 mm (0.350 in) diameter specimen, round bar tensile specimens are not permitted. When elongation is recorded or reported, the record or report shall show the nominal width of the test specimen when strip specimens are used, the diameter and gauge length when round bar specimens are used, or shall state when full-section specimens are used.

When tensile testing of the upset is required, the purchaser and manufacturer shall agree upon the most representative type and size of test specimen to be used for the test.

10.4.6 Test specimens — Additional requirements for coupling blanks, coupling stock coupling material and pup joint and accessory materials — Grades C110 and Q125

In addition to the requirements in 10.4.5, longitudinal tensile test specimens shall be removed from coupling blanks, coupling stock, coupling material and pup-joint and accessory materials and individually heat-treated coupling blanks, pup joints or accessory material subsequent to final heat treatment. Tensile test specimens shall be either strip specimens or, if the wall thickness of the tubular is over 19,1 mm (0.750 in), a round specimen 12,7 mm (0.500 in) in diameter may be used as shown in Figure D.8.

Tensile test specimens for coupling blanks and pup joint or accessory material heat-treated in coupling blank or individual lengths shall be removed from the piece as illustrated in Figure D.9. Reduced-section strip specimens may be used by agreement between purchaser and manufacturer.

10.4.7 Test method

Tensile properties shall be determined by tests on longitudinal specimens conforming to the requirements of 10.4.5, ISO 6892-1 or ASTM A370, and 10.4.6 for the Grades C110 and Q125 products

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covered therein. Tensile tests shall be made with the specimens at room temperature. The strain rate during tensile testing shall be in accordance with the requirements of ISO 6892-1 or ASTM A370.

Tensile test machines shall have been calibrated within the 15 months preceding any test in accordance with the procedures of ISO 7500-1 or ASTM E4. Extensometers shall be calibrated within 15 months preceding any test in accordance with the procedures of ISO 9513 or ASTM E83. Records retention shall be in accordance with 13.4.

10.4.8 Invalidation of tests

Any test specimen that shows defective preparation or material imperfections unrelated to the intent of the test, whether observed before or after testing, may be discarded and be replaced by another specimen from the same length of product.

10.4.9 Retests — All products (except coupling blanks, coupling stock, coupling material, pup joints or accessory material) — Grades C90, T95, C110 and Q125

If a tensile test representing a lot fails to conform to the specified requirements, the manufacturer may elect to make retests on three additional lengths from the same lot.

If all of the retests conform to the requirements, the lot shall be accepted, excepting the failed length.

If more than one of the original test specimens fails or if one or more of the retest specimens fails to conform to the specified requirements, the manufacturer may elect to test each of the remaining lengths in the lot. Specimens for retests shall be taken in the same manner as specified in 10.4.5 and 10.4.6. For Grades L80 and R95 the tensile retest specimens shall be taken from the same end as the original test specimen.

Rejected lots may be re-heat-treated and tested as new lots.

10.4.10 Retests — Coupling blanks, coupling stock, coupling material, pup joints or accessory material in Grades C90, T95, C110 and Q125

For material heat-treated in tube lengths, if a tensile specimen fails to conform to the specified requirements, the manufacturer shall either make tests on both ends of the tube in question or reject the length. No other additional testing shall be allowed to qualify a length of coupling stock, coupling material, pup joint or accessory material. Both test results shall conform to the specified requirements or the length shall be rejected. Rejected lengths may be re-heat-treated and tested as new lots.

For material heat-treated in coupling blank or individual product lengths, if a tensile specimen fails to conform to the specified requirements the manufacturer shall either reject the lot or make three additional tests from the lot. If one or more of the additional tests fail, the lot shall be rejected. Rejected lots may be re-heat-treated and tested as new lots.

10.5 Flattening test

10.5.1 General requirement for testing

Flattening tests shall be made for all welded pipe with D/t ratios as shown in Table C.22 or Table E.22.

In 10.5.2 to 10.5.7, the 0° position shall have the weld contacting the parallel plate (defined as 12 o'clock or 6 o'clock). The 90° position shall have the weld positioned at 3 o'clock or 9 o'clock.

10.5.2 Frequency of testing

The frequency of testing shall be in accordance with Table C.41 or Table E.41.

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10.5.3 Test specimens

Test specimens shall be rings or crop ends not less than 63,5 mm (2½ in) long.

On pipe cut from multiple lengths of a coil, the test on one end of one piece shall represent a test on the adjacent end of the next piece of pipe. If the pipe is intended to be upset, the test specimen shall be taken from the tube prior to upsetting.

The test specimens may be cut before heat treating and given the same type heat treatment as the pipe represented. If lot testing is used, precaution shall be taken so that the test specimens can be identified with respect to the length of pipe from which they are cut. Each heat in each lot shall be subjected to a flattening test.

For electric-welded pipe that is full-body, full-length normalized, including pipe that is processed through a hot-stretch mill in accordance with the requirements in 6.4.1, flattening test specimens shall be obtained either prior to or after such treatment at the option of the manufacturer.

10.5.4 Test method for Grades H40, J55, K55, N80 all types, R95, and L80 Type 1

Test specimens shall be flattened between parallel plates. From each pair of flattening test specimens, one shall be flattened with the weld located in the 90° position and the other with the weld located in the 0° position. Test specimens shall be flattened until opposite walls of the pipe meet. No cracks or breaks shall occur anywhere in the specimen until the distance between the plates is less than that specified in Table C.22 or Table E.22; nor shall evidence of poor texture, incomplete fusion in the weld, laminations, burnt metal or extruded metal develop during the entire flattening process.

10.5.5 Test method for Grade P110 pipe and Grade Q125 casing

The requirements in A.5 SR11 shall apply when EW pipe and A.5 SR11 are specified on the purchase agreement (see 6.2).

10.5.6 Invalidation of tests

Any test specimen that shows defective preparation or material imperfections unrelated to the intent of the test, whether observed before or after testing, may be discarded and be replaced by another specimen from the same length of product.

10.5.7 Retests

If either test specimen representing a single length of pipe fails to meet the requirements specified, the manufacturer may elect to make additional tests on specimens cut from the same end of the same length of pipe, until the requirements are met, except that the finished pipe shall not be shorter than 80 % of its length after the initial cropping. If any test specimen from a length of pipe representing a lot fails to conform to the requirements specified, the manufacturer may elect to repeat the tests on specimens cut from two additional lengths of pipe from the same lot. If such specimens conform to the specified requirements, all the lengths in the lot shall be accepted except the length initially selected for the test. If any of the retest specimens fails to pass the specified requirements, the manufacturer may elect to test specimens cut from the individual lengths remaining in the lot. Specimens for retests shall be taken in the same manner as specified in 10.5.3. At the option of the manufacturer, any lot of pipe may be re-heat-treated and tested as a new lot.

10.6 Hardness test

10.6.1 Frequency of testing — General

The frequency of hardness testing for all products is specified in Table C.40 or Table E.40. When more than one test is required, the test specimens shall be from different lengths.

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Additional hardness testing on the outside surface and through-wall hardness testing of pipe and upsets may be carried out as agreed between purchaser and manufacturer. Test procedures for this additional testing shall be agreed between purchaser and manufacturer.

No test is required for pup joints, coupling blanks or accessory material manufactured from a length of Grades L80, C90, T95, C110 or Q125 pipe, coupling stock, coupling material or accessory material previously tested, provided there is no subsequent heat treatment.

10.6.2 Frequency of testing — Heat-control tests — Grade L80

A product test block from each heat-control tensile test specimen shall be through-wall hardness-tested to verify conformance with hardness requirements.

A heat-control hardness test made on a product may also be considered as a product test for the lot being tested.

10.6.3 Frequency of testing — Grade L80

On pipe, coupling stock, coupling blanks, coupling material and accessory material, hardness testing shall be carried out at the same frequency as tensile testing for each of these products.

10.6.4 Frequency of testing and test specimen location — Non-upset pipe — Grades C90, T95 and C110

a) For Grades C90 and T95, one through-wall hardness test in one quadrant shall be made on each length from one end of each pipe. Approximately 50 % of these test rings shall be cut from the front ends and approximately 50 % from the back ends of the pipe.

b) For Grade C110, one through-wall hardness test in one quadrant shall be made on each length from both ends of each pipe. If the manufacturer applies a process control plan which has been demonstrated to the satisfaction of the purchaser to be sufficient to ensure that the entire length of the pipe has homogeneous hardness properties, the testing frequency may be reduced to the frequency applicable for Grades C90 and T95 in a).

10.6.5 Frequency of testing and test specimen location — Upset pipe — Grades C90 and T95

The pipe body of each length tensile-tested as required by 10.4.3 shall also be through-wall hardness-tested in all four quadrants to verify conformance to the requirements. The test frequency of the upset shall be one in every 20 lengths within each lot. One through-wall hardness test in four quadrants shall be made on one upset from that length in the section of that upset with the maximum wall thickness.

In addition to the through-wall hardness tests, an external-surface Brinell or Rockwell C-scale test shall be made on the pipe body and one upset of each length.

10.6.6 Frequency of testing and test specimen location — Coupling blanks, coupling stock, coupling material, pup joints and accessory material — Grades C90, T95 and C110

For thick-wall tube used for making more than one coupling blank, pup joint or accessory, through-wall hardness tests shall be made on each of two test rings, one from each end.

For coupling blanks, pup joints and accessory material heat-treated in individual lengths, the piece having the highest surface hardness in the lot shall be selected for through-wall testing.

For individually heat-treated coupling blanks, the hardness test ring shall be removed from the piece as shown in Figure D.9. For individually heat-treated pup joints and accessory material, the hardness test ring shall be removed from either the mid-length, as shown in Figure D.9, or from a prolongation.

Through-wall hardness tests shall be made in four quadrants.

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10.6.7 Frequency of testing — Grade Q125

For casing, through-wall hardness tests shall be made on three lengths per lot. The lengths for testing shall be selected at random, provided the selection procedure provides samples representing the start and end of the heat-treat cycle and front and back ends of the tubes.

For coupling stock, coupling material, pup-joint or accessory material heat-treated in tube length, one end of each length shall be through-wall hardness tested (approximately 50 % each end).

For coupling blanks, pup joints or accessory material heat-treated in coupling blank or individual length, one piece from each lot shall be through-wall hardness tested.

Through-wall hardness tests shall be made in one quadrant.

10.6.8 Test specimens

Test specimens for hardness testing shall be removed from products according to locations shown in Figure D.9, or removed from the end of the length or from a prolongation as specified in this document. For all grades, through-wall hardness tests shall be made on either rings or product test blocks.

Through-wall hardness tests for one quadrant shall be made on a product test block or a ring. Through-wall hardness tests for four quadrants shall be made on a ring or on product test blocks cut from a ring. Through-wall hardness test rings shall be prepared as specified in Figure D.10 in either one or four quadrants.

Hardness test surfaces shall be ground parallel and smooth, and shall be free from oxide scale, foreign matter and lubricants.

10.6.9 Test method

Hardness tests shall be made in accordance with ISO 6506-1 or ASTM E10 for Brinell hardness tests and ISO 6508-1 or ASTM E18 for Rockwell hardness tests.

Two types of hardness test are used in these standards:

a) external surface tests involving a single indentation;

b) through-wall hardness tests involving multiple indentations.

External surface tests may be made using either the Rockwell or the Brinell method and may be used for product acceptance and process control as specified in this document.

Through-wall hardness tests shall be made by the Rockwell method and used for product acceptance for maximum hardness and allowable hardness variation and for as-quenched hardenability. Through-wall hardness tests shall be made transverse to the axis of the product. When the hardness ring is removed from the end of the length, the hardness tests shall be made on the side of the specimen farthest from the end of the length (that is, away from the quenched end surface). The first indentation on each product test block or ring quadrant shall be performed mid-wall and shall be disregarded in order to reduce the possibility of errors.

For Grades L80, C90, T95 and C110 the through-wall hardness test shall only be made using hardness testers with digital readout (one or more decimal places).

When the specified wall thickness of a product is less than 7,62 mm (0.30 in), three indentations in the mid-wall of the specimen in each quadrant are acceptable for through-wall hardness tests. For all other products, in each quadrant three indentations shall be made in each of three locations. The hardness numbers from three indentations in each location, i.e. outside-wall, mid-wall and inside-wall, shall be combined to give a mean hardness number for each location. A through-wall hardness test comprises mean hardness numbers for each location in a quadrant, in either one or four quadrants as specified in this document.

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Indentations at the outside-wall and inside-wall locations shall be made between 2,54 mm (0.10 in) and 3,81 mm (0.15 in) from the applicable outer or inner surface, but not closer than 2½ indentation diameters from the centre of an indentation to the edge of the surface. Indentations shall be no closer than 3 indentation diameters from another indentation, measured centre to centre. Alternate spacing of rows of indentations is permitted for thin-wall product.

The surfaces of the product test block or ring that contact the anvil and the indenter shall be parallel within 0,5°. When product test blocks or rings are prepared using a magnetic platen surface grinder, or other consistent machining processes that ensure this requirement is met, verification of parallelism is not required. When other methods are used to prepare the product test blocks or rings, the parallelism shall be verified on each product test block or ring.

The surface of the product test block or ring that contacts the anvil shall have a finish not rougher than that produced by dry grinding with 240 (P240) grit paper.

The surfaces of the product test block or ring that contact the anvil and the test machine components (e.g. indenter, indenter-holder, anvil and anvil seat) shall be visually inspected and shall be free of visible foreign matter, lubricants, rust and burrs.

Overhang of product test blocks or rings beyond the anvil support of less than or equal to 40 % of the surface area of the product test block or ring is acceptable. The overhang may exceed 40 % of the surface area of the product test block or ring when the testing equipment is designed and validated to yield consistently accurate results for such use. External support is not permitted.

The anvil and anvil seat shall not have protrusions or indentations that adversely affect the hardness result.

When standardized test blocks are used for the verification of a hardness machine, the same anvil shall be used for the verification as will be used for acceptance testing following the verification.

Only indenters that have been calibrated (verified) for use with the specific test machine to be used, such as during an indirect verification, shall be used. When other indenters are used, they shall be verified using an indirect verification with respect to a more accurate indenter (e.g. reference indenter with less error). The polished portion of the HRC indenter shall be visually inspected periodically for damage (e.g. cracks, chips, pits, etc.) with the aid of adequate magnification (e.g. 20X or higher).

If two or more hardness indentations at a location (same outside-wall, mid-wall or inside-wall in a quadrant) are greater than 20 HRC, and if the difference between the highest and lowest indentations at that location is greater than 2,5 HRC, then three additional indentations in the same location shall be taken. In such case, the mean hardness number shall be based on the three additional indentations. The test report shall indicate that additional indentations were made and the original test data shall be available upon request. Additional indentations are not allowed if any Rockwell hardness number is over 27,0 HRC for Grades C90 or T95 or over 32,0 HRC for Grade C110.

The through-wall hardness test is usually made using the Rockwell C-scale. It is acceptable to use the Rockwell C-scale on materials having a hardness below 20 HRC. Care should be exercised when evaluating hardness below 20 HRC because of a potential lack of precision, but nevertheless these results may be used to determine hardness. The use of the Rockwell B-scale on materials having a hardness below 20 HRC is at the manufacturer's option or as specified on the purchase agreement. Rockwell hardness numbers and mean hardness numbers shall be reported in Rockwell C, from actual or converted numbers, to the first or second decimal place.

Hardness conversions shall be made in accordance with an appropriate conversion table selected by the manufacturer, unless otherwise specified on the purchase agreement.

Brinell hardness numbers shall be rounded to three significant digits and the test conditions reported if test forces other than 29,42 kN (3 000 kgf), ball diameters other than 10 mm and test force application duration other than 10 s to 15 s are used.

Laboratory Rockwell C scale shall be used as a referee method in cases of disagreement.

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10.6.10 Invalidation of tests

Any test specimen that shows defective preparation or material imperfections unrelated to the intent of the test, whether observed before or after testing, may be discarded and be replaced by another specimen from the same length of product.

10.6.11 Periodic checks of hardness-testing machines

Periodic checks of testing machines shall be made using the procedures in ISO 6506-1:2004, Annex A or ASTM E10-18, Annex A1 for Brinell hardness test machines, or ISO 6508-1:2006, Annex E or ASTM E18-19, Annex A1 for Rockwell hardness test machines.

For through-wall hardness testing of Grades L80, C90, T95, and C110, the standardized test block shall have a maximum non-uniformity of 0.4 HRC. For all other Grades and hardenability tests, the standardized test block shall have a maximum non-uniformity of 1.0 HRC. The non-uniformity of the standardized test block shall be determined by the difference between the highest and lowest indentation number stated in the standardized test block certificate.

At least two preliminary indentations on each standardized test block should be disregarded in order to reduce the possibility of errors. After the preliminary indentations, at least three hardness indentations shall be made on the standardized test block. For through-wall hardness testing of Grades L80, C90, T95 and C110 the error shall not exceed ±0,5 HRC. For all other grades and hardenability tests, the error shall not exceed ±1,0 HRC. The error shall be determined by the certified mean hardness number of the standardized test block minus the mean hardness number determined during the periodic check.

The testing machine shall be checked at the beginning and end of a continuous run of testing and whenever it is required to assure the operator of the equipment and the purchaser (or his representative) that the machine is satisfactory. In any event, checks should be made at least every 8 h of a continuous run of testing. Checks shall be made on standardized test blocks within the following hardness ranges:

a) Grades L80 all types, C90 and T95: 20 HRC to 27 HRC;

b) Grade C110: 24 HRC to 32 HRC;

c) Grade Q125: 24 HRC to 35 HRC;

d) All hardenability tests: 35 HRC to 55 HRC.

If the checks indicate that the testing machine results are unsatisfactory, the machine shall be verified by indirect verification using standardized test blocks according to the procedures in ISO 6506-2 or ASTM E10 for Brinell hardness test machines, or ISO 6508-2 or ASTM E18 for Rockwell hardness test machines.

In cases of disagreement, for Grades C90, T95 and C110 one standardized test block shall be within 20 HRC to 26 HRC and another standardized test block shall be within 30 HRC to 46 HRC to confirm accuracy and linearity using a two-block verification. The standardized test blocks shall have a maximum non-uniformity of 0,4 HRC (difference between the highest and lowest indentation number stated in the standardized test block certificate). The error shall not exceed ±0,5 HRC (determined by the certified mean hardness number of the standardized test block minus the mean hardness number determined during the periodic check).

The results obtained from the periodic checks shall be recorded and should be analyzed using accepted Statistical Process Control techniques, such as, but not limited to, X-bar (measurement averages) and R-charts (measurement ranges) and histograms.

10.6.12 Verification of hardness-testing machines and indenters

Indirect verification of hardness testing machines shall be performed at least once every year and after a direct verification has been performed, in accordance with the procedures in ISO 6506-2 or ASTM E10 for Brinell hardness test machines, or ISO 6508-2 or ASTM E18 for Rockwell hardness test machines.

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The HRC standardized test blocks shall be within 20 to 55 HRC to confirm accuracy and linearity using a two-block verification. The standardized test blocks used shall bracket the HRC range for acceptance testing. The standardized test blocks shall have a maximum non-uniformity of 0,4 HRC (difference between the highest and lowest indentation number stated in the standardized test block certificate). The error shall not exceed ±0,5 HRC (determined by the certified mean hardness number of the standardized test block minus the mean hardness number determined during the indirect verification).

The indenter should be directly verified at least every 2 years. HRC indenters shall be certified by the manufacturer for performance error (deviation) with respect to a more accurate indenter (e.g. reference indenter with less error) and standardized test blocks in the range being tested. HRC indenters shall have a maximum performance error of ±0,4 HRC.

A calibration certificate (verification report) for the hardness tester shall be issued by an independent certifying agency. The calibration agency that is used to conduct verifications of hardness testing machines and HRC indenters should meet the requirements of ISO/IEC 17025. As a minimum, the calibration certificate shall identify:

a) the reference standard (ISO 6506-2 and/or ASTM E10, or ISO 6508-2 and/or ASTM E18);

b) method of verification (direct and/or indirect);

c) means of verification (reference blocks, elastic proving devices, etc.);

d) temperature;

e) hardness scale(s) verified;

f) date of the verification;

g) standardized test blocks (mean hardness number, scale, serial number, manufacturer and non-uniformity);

h) results obtained;

i) identification of the hardness test machine (manufacturer, model number and serial number);

j) serial number of indenter;

k) certifying agency; and

l) name of their representative performing the verification.

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10.6.13 Retests — Grade L80

For Grade L80 products, if a through-wall hardness test specimen representing a lot fails to conform to the specified requirements, the manufacturer may elect to make retests on two additional lengths from the same lot from the same end as the original test specimen. If all the retests conform to the requirements, the lot shall be accepted except the failed length. If one or more of the retest specimens fails to conform to the specified requirements, the manufacturer may elect to test each of the remaining lengths in the lot or reject the lot.

10.6.14 Retests — Grades C90, T95 and C110 products except for coupling blanks, pup joints or accessory material heat-treated after cutting to individual lengths

For Grades C90 and T95, if any mean hardness number falls between 25,4 HRC and 27,0 HRC inclusive, three additional indentations shall be made in the immediate area to determine a new mean hardness number. If the new mean hardness number does not exceed 25,4 HRC, the piece shall be accepted. If the new mean hardness number exceeds 25,4 HRC, the piece shall be rejected.

For Grade C110, if any mean hardness number falls between 30,0 HRC and 32,0 HRC inclusive, three additional indentations shall be made in the immediate area to determine a new mean hardness

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number. If the new mean hardness number does not exceed 30,0 HRC the piece shall be accepted. If the new mean hardness number exceeds 30,0 HRC the piece shall be rejected.

10.6.15 Retests — Grades C90, T95 and C110 coupling blanks, pup joints or accessory material heat-treated after cutting to individual lengths

For coupling blanks, pup joints or accessory material heat-treated after cutting to blank or individual lengths, if the hardness test specimen representing a lot fails to conform to the specified requirement, the piece or length shall be rejected. The manufacturer shall either re-heat-treat the lot or make three additional tests from the lot using the same selection criteria for the pieces selected in the original test. If any of these three retests fail, the entire heat-treat lot shall be rejected.

10.6.16 Retests — Grade Q125 — General

If the allowable hardness variation as specified in Table C.5 or Table E.5 is exceeded on a specimen, the surface in that quadrant may (at the option of the manufacturer) be re-ground below the initial hardness impressions and retested. Only one re-grind and retest is allowed for each specimen. After retest, product that fails to conform with the specified requirements shall be rejected.

10.6.17 Retests — Grade Q125 — Casing, coupling stock and coupling material

If more than one of the initial three lengths required to qualify a lot of casing is rejected, then the manufacturer may elect to test each of the remaining lengths in the lot. Retests of these lengths shall only be allowed as specified in 10.6.17.

If only one of the initial three lengths required to qualify a lot of casing is rejected, then an additional three lengths may be tested to attempt to qualify the lot of casing. Retests of the additional lengths shall only be allowed as specified in 10.6.17. If any of the additional three lengths required to qualify a lot of casing is rejected, then the manufacturer may elect to test each of the remaining lengths in the lot or reprocess the lot (that is, five of the six lengths tested shall meet the requirements of 7.8 and Table C.5 or Table E.5 to qualify the casing on a lot basis).

10.6.18 Retests — Grade Q125 — Coupling blanks, pup joints and accessory material

In the case of coupling blanks, pup joints or accessory material heat-treated as individual pieces, if the hardness variation as specified in 7.8 and Table C.5 or Table E.5 is exceeded, the manufacturer may carry out through-wall hardness testing of three more pieces from the lot in question. If a specimen from any one of the three pieces exceeds the allowable hardness variation, the lot shall be rejected.

10.6.19 Rejected lots — Grades L80 all types, C90, T95, C110 and Q125

For all products, rejected lots may be reprocessed (that is, heat-treated again) and hardness-tested again as new lots.

10.7 Impact test

10.7.1 Sampling —Grades J55 and K55

For accessory material, when required in 7.6, and for coupling stock, coupling material and coupling blanks, one set of test specimens shall be taken from each lot.

10.7.2 Sampling — Grades N80 all types, R95, L80, C90, T95, C110 and P110

For pipe, one set of test specimens shall be taken from each lot unless conformance with the requirements is qualified by a documented procedure, see 7.5.5. If A.8 SR16 is specified in the purchase agreement, testing is mandatory.

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For accessory material, when required in 7.6, and for coupling stock, coupling material and coupling blanks, one set of test specimens shall be taken from each lot.

10.7.3 Sampling and test specimen location — Grade Q125

For casing, three lengths per lot shall be tested. The lengths for testing shall be selected at random, provided the selection procedures give samples representing the start and end of the heat-treat cycle and the front and back ends, as processed, of the casing.

For coupling stock, coupling material, pup-joint or accessory material heat-treated in tube length, one piece from an end of each length shall be tested. Front and back ends, as processed, shall be tested on an approximately 50 % basis.

For coupling blanks, pup joints or accessory material heat-treated as individual pieces, one piece from each lot shall be tested.

10.7.4 Test specimens

For orientation of longitudinal and transverse specimens, see Figure D.11.

Impact test specimens shall not be machined from flattened tubulars.

When testing EW pipe using a transverse test specimen, the weld line shall be positioned at the notch in the CVN test specimen.

The surface of the finish-machined transverse test specimen may contain the outside diameter curvature of the original tubular product, provided that the requirements of Figure D.12 are met. These specimens shall be used only to permit the use of a transverse specimen of maximum possible thickness consistent with Table C.8 or Table E.8.

10.7.5 Test method

CVN impact tests shall be conducted as specified in ASTM A370 and ASTM E23.

The shear area shall be measured and, for Grade C110 product be reported.

For the purpose of determining conformance with these requirements, the observed result of a test shall be rounded to the nearest whole number. The impact energy value for a set of test specimens (i.e. average of three tests) shall be expressed as a whole number, rounded if necessary. Rounding shall be in accordance with the rounding method of ISO 80000-1 or ASTM E29.

10.7.6 Invalidation of tests

Any test specimen that shows defective preparation or material imperfections unrelated to the intent of the test, whether observed before or after testing, may be discarded and be replaced by another specimen from the same length of product. Specimens shall not be judged defective simply because they failed to exhibit the minimum absorbed energy requirement (see 10.7.7 to 10.7.9).

10.7.7 Retest of a length — All Grades

If the results of more than one specimen are below the specified minimum absorbed energy requirement, or if the result of one specimen is below two-thirds of the minimum specified absorbed energy requirement, a retest of three additional specimens shall be made from the same length. The impact energy of each of the retest specimens shall equal or exceed the specified minimum absorbed energy requirement or the length shall be rejected.

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10.7.8 Replacement of a reject length — All Grades

If the results of a test do not meet the requirements of 7.4 to 7.6, as applicable, and do not qualify for retesting in accordance with 10.7.7, then an additional three test specimens shall be removed from each of three additional lengths from the lot. If all the additional lengths tested conform to the requirements, then the lot shall be qualified except for the length that was initially rejected. If one or more of the additional lengths tested fail to conform to the specified requirements, the manufacturer may elect to test individually the remaining lengths in the lot or re-heat-treat and test the lot as a new lot.

10.7.9 Multiple length rejection — Grade Q125

If more than one of the initial three lengths required to qualify a lot of casing is rejected, retesting to qualify the lot is not permitted. The manufacturer may elect to test each of the remaining pieces in the lot, or to re-heat-treat and test the lot as a new lot.

10.8 Grain size determination — Grades C90, T95 and C110

10.8.1 Sampling

Grain size determination shall be made on each as-quenched hardenability test sample.

10.8.2 Test method

Grain size shall be determined by metallurgical evaluations such as the McQuaid-Ehn Test or other methods as specified in ISO 643 or ASTM E112.

10.9 Hardenability — Grades C90, T95 and C110

Hardenability shall be determined on one sample per production run or heat-treatment practice. Through-wall hardness tests in four quadrants shall be made at the beginning of each order and thereafter whenever a size change occurs or the austenitization and quenching process conditions change significantly.

10.10 Sulfide stress-cracking test — Grades C90, T95 and C110

ANSI/NACE TM0177-2016 shall be used in conjunction with the requirements in 7.14 to determine the room temperature sulfide stress-cracking resistance of Grades C90, T95 and C110 products.

For Grades C90 and T95, the level of resistance to sulfide stress cracking shall be evaluated with the requirements in 7.14 using one or more of the following specified by the purchaser:

a) tensile method (Method A);

b) bent-beam method (Method B);

c) DCB method (Method D).

For Grade C110, the level of resistance to sulfide stress cracking shall be evaluated with the requirements in 7.14 using one or both of the following as specified by the purchaser:

— tensile method (Method A);

— DCB method (Method D).

10.11 Metallographic evaluation — All EW Grades

A metallographic evaluation of the electric-weld zone shall be performed at the beginning of the welding process for each size of tubular, again at least each 4 h during the welding and after any substantial interruption of the welding process. The samples shall be obtained prior to heat treatment.

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The manufacturer shall have objective criteria to evaluate the acceptability of the electric-welded zone.

10.12 Hydrostatic tests

10.12.1 Hydrostatic test procedures

Each length of pipe shall be tested full-length subsequent to upsetting (if applicable) and subsequent to final heat treatment (as applicable) to at least the hydrostatic pressure specified in 10.12.2 without leakage. The test conditions shall be held for not less than 5 s at full pressure. For electric-weld pipe, the pipe seam shall be inspected for leaks and sweats while under full test pressure. The entity performing the threading shall perform a hydrostatic test (or arrange for such a test) on the full length of pipe unless previously tested full-length to at least the pressure required for the final end condition. The test shall be performed in one of the following conditions:

a) plain-end non-upset provided no upsetting or further heat treatment will be performed;

b) plain-end non-upset after heat treatment;

c) plain-end after upsetting, provided no further heat treatment will be performed;

   If such pipe has been tested full-length to the threaded-and-coupled test pressure in the plain-end condition prior to upsetting, the test of the upset portion may be made after upsetting through the use of an end tester which seals behind the portion of the pipe which was heated for upsetting.

d) plain-end upset after heat treatment;

e) threaded without couplings applied;

f) threaded and coupled with couplings applied power-tight.

For pipe requiring heat treatment, the test shall take place after the final heat treatment. The test pressure shall be at least the threaded-and-coupled test pressure for all pipe with threaded ends.

Pup joints, after machining to the final plain-end dimensions and after any heat treatment, shall be tested either plain-end or threaded.

The tester shall be equipped with devices for assuring that the specified test pressure and time interval requirements are met. The test pressure-measuring device shall be calibrated by means of a deadweight tester, or equivalent, within four months prior to each use. Calibration and verification records retention shall be as given in 13.4.

No hydrostatic test is required for pup-joints manufactured from a length of tubing or casing previously hydrostatic tested, provided there is no subsequent heat treatment.

NOTE 1 Martensitic chromium steels are sensitive to galling. Special precautions can be necessary for thread surface treatment and/or lubrication to minimize galling during hydrostatic testing (plug application and removal).

NOTE 2 Various types of hydro-test systems are available. The entity performing the hydro-test is responsible for establishing a test procedure which minimizes the potential for damage to the pipe and threads of both the pipe and coupling.

10.12.2 Hydrostatic test requirements

Pipe shall conform with the test requirements for the size, grade and end-finish.

For threaded pipe, the hydrostatic test pressures shall be standard pressures calculated as described in 10.12.3, or a higher pressure as agreed upon between the purchaser and the entity performing the threading.

For plain-end pipe except Grade Q125, the hydrostatic test pressures shall be the pressures calculated as described in 10.12.3, or a higher pressure as agreed upon between purchaser and manufacturer.

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This does not preclude conducting subsequent hydrostatic tests at a fibre stress not exceeding 80 % of specified minimum yield strength, in accordance with the formula listed below. Failure to pass this hydrostatic test without leakage is basis for rejection.

Plain-end Grade Q125 pipe shall be tested as agreed upon between purchaser and manufacturer.

Testing is not required on coupling stock, coupling material, accessory material or Grade Q125 pup joints, except by agreement between purchaser and manufacturer.

NOTE 1 The hydrostatic test pressures specified herein are inspection test pressures. They are not intended as a basis for design and do not necessarily have any direct relationship to working pressures.

NOTE 2 Couplings having API threads with special clearance or standard outside diameters can leak at a pressure less than the alternative test pressure for the plain-end or threaded-and-coupled tube, due to inadequate bearing pressure between the coupling and pin.

10.12.3 Test pressure calculation

The standard hydrostatic test pressures shall be calculated using Formula (7), rounded to the nearest 0,5 MPa (100 psi) and limited to a maximum of 69,0 MPa (10 000 psi):

$$p=\left(2\cdot f\cdot YS_{\min}\cdot t\right)/D \tag{7}$$

where

p is the hydrostatic test pressure, in megapascals (pounds per square inch);

f is a factor: 0,6 (0.6) for Grades H40, J55 and K55 larger than Label 1: 9-5/8 or 0,8 (0.8) for all other grades and sizes;

$YS_{\min}$ is the specified minimum yield strength for the pipe body, in megapascals (pounds per square inch);

D is the specified outside diameter, in millimetres (inches);

t is the specified wall thickness, in millimetres (inches).

NOTE The above formula for hydrostatic test pressure is applicable to both SI and USC units.

Lower test pressures may be allowed only due to physical limitations of the test equipment. The manufacturer shall have a documented design basis to establish the physical limitations of the hydrostatic test equipment. If the calculated test pressure (based on the outside diameter, thickness and grade) is greater than the physical capability of the hydrostatic test equipment, the manufacturer, upon agreement with the purchaser, shall use a test pressure equal to the physical capability of the test equipment. However, the hydrostatic test capability may be less than 20,5 MPa (3 000 psi) only for those products where the calculated test pressure is less than 20,5 MPa (3 000 psi).

Alternative test pressures for Grades H40, J55 and K55 in sizes larger than Label 1: 9-5/8 are calculated using a factor f of 0,8. For Grades C110, P110 and Q125, when the calculated test pressure exceeds 69,0 MPa (10 000 psi), the standard test pressure is limited to 69,0 MPa (10 000 psi) and the alternative test pressure is as calculated. Alternative test pressures shall be used when specified on the purchase agreement and when agreed by the purchaser and manufacturer.

The hydrostatic test pressures for threaded and coupled pipe are calculated from the above formula, except where a lower pressure is required to avoid leakage due to insufficient coupling strength or interface pressure between pipe and coupling threads. The lower pressures shall be calculated for threaded and coupled pipe as specified in API TR 5C3.

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10.13 Dimensional testing

10.13.1 General

Diameter or wall thickness shall be reported to the number of decimal places shown in the relevant tables, that is Tables in Annex C for SI units or Tables in Annex E for USC units, except that for sizes in SI units larger than Label 1: 6-5/8 in Table C.1, the diameter shall be reported to one decimal place.

NOTE In this document, the specified pipe outside diameter, expressed in SI units, always uses two decimal places for design purposes to ensure interchangeability of actual product regardless of whether it was produced using dimensions in SI or USC units.

10.13.2 Diameter measurement

For pipe, coupling stock, coupling material and accessory material, the manufacturer shall demonstrate conformance to the requirements of 8.3.2 in a single diametric plane at a minimum frequency of one length of pipe, coupling stock, coupling material or accessory material per one hundred lengths.

For non-upset pipe, coupling stock, coupling material and accessory material, the measurements shall be made with pi-tapes (wrap tapes), micrometres, callipers or snap gauges. For upset casing and Label 1: 2-3/8 and larger external upset tubing, the measurements shall be made with micrometres, callipers or snap gauges.

The manufacturer shall measure the diameter of both ends of pipe ordered as plain-end, coupling stock or coupling material at a minimum frequency of one per one hundred.

If any product fails to meet the requirements, the provisions of 10.13.3 shall apply.

In case of dispute of the minimum diameter requirements, micrometre measurements shall govern. In case of dispute of the maximum diameter requirements, pi-tape (wrap tape) measurements shall govern. When using a micrometre, three measurements shall be made in the non-conforming area and averaged. The average of the three readings shall be used to determine the conformance of the diameter.

10.13.3 Diameter retests

If any pipe, coupling stock, coupling material or accessory material fails to meet the specified diameter requirements when measured with callipers, micrometres or snap gauges, the manufacturer may elect to make measurements on three additional lengths from the same lot. If any pipe, coupling stock, coupling material or accessory material fails to meet the specified diameter requirements when measured with a pi-tape, and unless the manufacturer can show evidence of a specific problem affecting only that pipe, coupling stock, coupling material or accessory material, each pipe, coupling stock, coupling material or accessory material from the same lot shall be measured for conformance.

If all retest measurements conform to the specified diameter requirements, all lengths in the lot shall be accepted except the length initially selected for measurement. If any of the retest measurements fails to meet the specified requirements, the manufacturer may elect to measure the individual lengths remaining in the lot. Individual lengths which fail to pass the specified requirements may be cut back and measured again for conformance.

At the option of the manufacturer, any lot of pipe, coupling stock, coupling material or accessory material may be reprocessed and measured as a new lot.

Once the pipe, coupling stock, coupling material or accessory material has proceeded past its last manufacturing quality control point for diameter, some deviations in the maximum and minimum diameters can occur due to handling and storage and should not be cause for rejection, provided the average diameter as measured by a pi-tape is within the diameter tolerances.

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10.13.4 Wall thickness measurement

Each length of pipe, coupling stock, coupling material or accessory material shall be measured to verify conformance with wall thickness requirements. Wall thickness measurements shall be made with a mechanical calliper, a go/no-go gauge or with a properly calibrated NDE device of appropriate accuracy.

In case of dispute, the measurement determined by use of the mechanical calliper shall govern. The mechanical calliper shall be fitted with contact pins having circular cross-sections of 6,4 mm (¼ in) diameter. The end of the pin contacting the inside surface of the product shall be rounded to a maximum radius of 38,1 mm (1½ in) for product sizes Label 1: 6-5/8, and larger, a maximum radius of $d/4$ for product less than Label 1: 6-5/8, with a minimum radius of 3,2 mm (1/8 in). The end of the pin contacting the outside surface of the product shall be either flat or rounded to a radius of not less than 38,1 mm (1½ in).

For Grades L80 13Cr, C90, T95, C110 and Q125 the wall thickness shall be measured over the full length, with a minimum coverage of 100 % of the surface area covered by the automatic system. The minimum measured wall thickness for each pipe shall be recorded. Traceability and/or reporting of each pipe is only required when specified on the purchase agreement.

To ensure conformance to wall thickness requirements, all seamless pipe and coupling stock requiring electromagnetic or ultrasonic inspection as specified in Table C.42 or Table E.42 shall have the wall thickness verified in a helical or longitudinal path over the full length of the pipe or coupling stock, excluding end areas not covered by automated systems, in accordance with a documented procedure. The location of the wall-thickness verification equipment shall be at the discretion of the manufacturer.

Accessory material shall have the wall thickness verified if so specified in the purchase agreement.

10.13.5 Drift test

All drift testing shall be performed with a drift mandrel containing a cylindrical portion conforming to the requirements shown in Tables C.28 and C.29 or Tables E.28 and E.29 as applicable. See 8.10 for requirements for casing used as tubing. The ends of the drift mandrel extending beyond the specified cylindrical portion shall be shaped to permit easy entry into the pipe. The drift mandrel shall pass freely through pipe by the use of a manual or power drift procedure. In case of dispute, the manual drift procedure shall be used. Pipe shall not be rejected until it has been drift-tested when it is free of all foreign matter and properly supported to prevent sagging.

10.13.6 Length measurement

For plain-end pipe, and for other products if specified on the purchase agreement, the length shall be measured from end to end.

For threaded and coupled pipe:

— when measured with the coupling installed, the length shall be measured from the end of the pin to the outer face of the coupling;

— when measured without coupling, the length shall be measured from pin end to pin end and proper allowance for the length of the coupling shall be added.

For integral-joint tubing, the length shall be measured from the pin end to the outer face of the box end.

For pup joints and accessories, the length shall be measured from end to end.

10.13.7 Mass (weight) determination

Each length of casing and each length of tubing in sizes Label 1: 1.660 and larger shall be weighed separately. Lengths of tubing in sizes smaller than Label 1: 1.660 shall be weighed either individually or in convenient bundles.

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The pipe manufacturer applying the markings to the pipe body (see Clause 11) shall be responsible for weighing the pipe to determine conformance with mass tolerance. The pipe may be weighed plain-end, upset, non-upset, threaded, or threaded and coupled. Threaded-and-coupled pipe may be weighed with the couplings screwed on or without couplings, provided proper allowance is made for the mass of the couplings. Threaded-and-coupled pipe, integral-connection pipe and threaded pipe shipped without couplings shall be weighed with or without thread protectors if proper allowances are made for the mass of the thread protectors. Weighing of a pipe by a threader is not mandatory.

10.13.8 Straightness evaluation

All pipe, coupling stock, coupling material and accessory material shall be visually examined. The straightness of questionably bent lengths or crooked extremities shall be measured as follows:

a) for Label 1: 4-1/2 and larger, using a straightedge or taut string (wire) from one end of the length to the other end;

b) using a straightedge with a minimum length of 1,8 m (6 ft) of which at least 0,3 m (1 ft) shall contact the surface beyond the extent of the hooked extremity or an equivalent method. In the case of dispute, the straightedge measurement shall govern.

The taut string and straightedge shall be positioned to highlight the maximum deviation.

Deviation from the straight, or chord height, shall not exceed the requirements in 8.9. See Figures D.13 and D.14.

Measurement of the deviation shall not be made in the plane of the upset, the upset fade-away or the coupling.

10.13.9 Internal upset inspection

Inspection of the internal upset configuration shall be made with a 90° hook-type tool. The contact pin shall have a circular cross-section of 4,8 mm (3/16 in) diameter that is visually determined to be attached perpendicular to the handle. The end of the pin contacting the inside surface of the pipe shall be rounded to a height (between the radius tangent point and the vertical surface of the contact point shaft) that shall not exceed 0,30 mm (0.012 in). The contact point radius shall not exceed the inside radius of the pipe being inspected. Sharp edges on the contact point shall be removed. See Figure D.24. The 90° hook-type tool contact point should be maintained perpendicular to the longitudinal axis of the pipe while the contact point is passed axially throughout the inside upset transition length. Pressure on the contact point shall be no greater than the pressure created by the mass of the 90° hook-type tool.

10.14 Visual inspection

10.14.1 General

All visual inspection shall be carried out by trained personnel with satisfactory visual acuity to detect surface imperfections. Documented lighting standards for visual inspection shall be established by the manufacturer. The minimum illumination level at the inspection surface shall be 500 lux (50 foot-candles).

All visual inspection may be at any appropriate point in the manufacturing process, except that end-area inspection, when required, shall be after the final heat treatment.

If another method is applied with demonstrated capability of detecting defects as defined in 8.13, visual inspection is not required.

If end cropping is performed to remove defects, the end of the pipe revealed after cropping shall be subjected to a repeat internal surface inspection as previously performed.

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10.14.2 Pipe body, coupling stock and coupling material (excluding pipe ends)

Each length of pipe, coupling stock and coupling material shall be visually inspected over the entire outside surface for the detection of imperfections. For Grade L80 roll marks, see 6.3.3.

10.14.3 Pipe ends

Pipe ends shall be visually inspected on the outside surface for a minimum distance of 450 mm (18 in).

For non-upset products, pipe ends shall be visually inspected on the inside surface for a minimum distance of 2,5 *D* or 450 mm (18 in), whichever is the lesser.

For upset products, pipe ends shall be visually inspected on the inside surface for a minimum distance of the length of upset including the run-out interval.

10.14.4 Disposition

Surface imperfections disclosed by visual inspection shall be treated in accordance with 10.15.16, 10.15.17 and 10.15.18.

10.15 Non-destructive examination (NDE)

10.15.1 General

Subclause 10.15 specifies the NDE requirements and inspection levels for seamless and electric-welded pipe and for coupling stock. For NDE of couplings see 9.11. A summary of the required NDE operations for seamless pipe, coupling stock and the body of welded pipe is given in Table C.42 or Table E.42. All pipe, accessory material and coupling stock that require NDE (except visual inspection) shall be inspected full-body, full-length for defects.

The NDE tube standards referenced in this clause are based on traditional proven NDE methods and techniques practised and adopted world-wide for the inspection of tubular products. However, other NDE methods/techniques, that have demonstrated capability in detecting defects as defined in 8.13, can be used. Records in accordance with 10.15.4 shall be maintained.

For all grades except C90, T95 and C110, at the discretion of the manufacturer, the notches in addition to those in Table C.43 or Table E.43 may be oriented at an angle such that detection of defects typical of the manufacturing process is optimised. The technical justification for modification of the orientation shall be documented.

For grades C90, T95 and C110, in addition to longitudinal and transverse notches, internal and external obliques notches shall be utilized in accordance with 10.15.9. The angle of the notches shall be validated and documented by the manufacturer according to the defect of their typical manufacturing process.

If the provisions for purchaser inspection of pipe and/or witnessing of NDE operations are stated on the purchase agreement, they shall be in accordance with Annex B.

The inspections performed in accordance with 10.15, with the equipment calibrated to the reference indicators in Table C.44 or Table E.44, should not be construed as assuring that the material requirements in 8.13 have been met.

NDE equipment calibration shall be performed in accordance with ASTM E543.

For full-body, full-length NDE, the inspection equipment shall provide 100 % coverage for imperfections other than wall thickness. For untested pipe ends, see 10.15.14.

When performing wet magnetic particle inspection, wet particle concentration shall be checked every 8 h or every shift change whichever is more frequent. When performing fluorescent magnetic particle inspection the minimum black light intensity at the examination surface shall not be less than 1 000 $\mu W \cdot cm^{-2}$ (10 $W \cdot m^{-2}$).

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10.15.2 NDE personnel

10.15.2.1 ISO 9712, ISO 11484, ASNT-SNT-TC-1A, or equivalent recognized industry standard shall be the basis for the qualification of non-destructive inspection personnel (excluding visual inspection). Such personnel shall be qualified for any method previously qualified, if they have to perform non-destructive inspection in that method for a period exceeding 12 months. The manufacturer or inspection company shall have a training program to qualify and/or certify the NDE personnel for the method, technique, and equipment that are used for the inspection(s) specified in this document.

10.15.2.2 Non-destructive inspection shall be conducted by level 1, 2 or 3 personnel, using a procedure approved by a level-3 personnel.

10.15.2.3 Evaluation of indications shall be performed by level 2 or 3 personnel, or by level 1 personnel under the supervision of level 2 or 3 personnel.

10.15.3 Reference standards

For seamless pipe, coupling stock and the pipe body of electric welded pipe, ultrasonic and electromagnetic inspection systems for verification, other than wall thickness verification, shall use reference standards containing notches or holes as described in Tables C.43 and C.44 or Tables E.43 and E.44 to verify equipment response from artificial reference indicators.

When ultrasonic inspection systems are used for verification of the weld seam, reference standards containing notches or holes as described in Tables C.43 and C.44 or Tables E.43 and E.44 shall be used to verify equipment response from artificial reference indicators. When holes are used to establish the reject threshold, the manufacturer shall use a documented procedure to ensure the correct transducer alignment with the weld line.

The manufacturer may use any documented procedure to establish the reject threshold for ultrasonic or electromagnetic inspection provided the artificial reference indicators described in Tables C.43 and C.44 or Tables E.43 and E.44 are detected dynamically at or above the reject threshold under normal operating conditions. Such detection capability shall be demonstrated dynamically. At the option of the manufacturer this may be performed either online or offline.

Tables C.43 and C.44 or Tables E.43 and E.44 list the acceptance (inspection) levels and associated artificial reference indicators that manufacturers shall use in establishing thresholds for sorting pipe that may contain defects as defined in 8.13. The reference indicators, used during automated ultrasonic or electromagnetic inspection, are not to be construed as being the defect sizes defined in 8.13, or be used by those other than the manufacturer as the only basis for pipe rejection.

When standardising EMI equipment using drilled holes, the inspection system shall be capable of producing signals from both outside-wall and inside-wall notches that are equal to or greater than the reject threshold established using the drilled hole. Records in accordance with 10.15.4 shall be maintained.

10.15.4 NDE system capability records

The manufacturer shall maintain NDE system records verifying the system(s) capabilities in detecting the reference indicators used to establish the equipment test sensitivity.

The verification shall cover, as a minimum, the following criteria:

a) coverage calculation (i.e. scan plan), including wall thickness verification;

b) capability for the intended wall thickness;

c) repeatability;

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d) transducer orientation that provides detection of defects typical of the manufacturing process (see 10.15.1);

e) documentation demonstrating that defects typical of the manufacturing process are detected using the NDE methods in Table C.42 or Table E.42;

f) threshold-setting parameters.

In addition, the manufacturer shall maintain documentation relating to the following:

g) NDE system operating procedures;

h) NDE equipment description;

i) NDE personnel qualification information;

j) dynamic test data demonstrating the NDE system/operation capabilities under production test conditions.

10.15.5 Pipe body or coupling stock inspection — General

Unless otherwise agreed, all required NDE operations (except visual inspection, but including the final end-area inspection in accordance with 10.15.13) for pipe and coupling stock shall be carried out after final heat treatment and rotary straightening operations, with the following exceptions:

a) certain types of pup joint (see 10.15.11);

b) when more than one pipe-body NDE method is applied, one of these (other than ultrasonic inspection) may take place prior to heat treatment/rotary straightening.

10.15.6 Full-body, full-length NDE of casing and tubing — Grades H40, J55, K55, N80 all types, L80 and R95

All pipe shall be inspected for the detection of longitudinal imperfections on the outside and inside surfaces to acceptance level U4/F4/E4/L4 by one or more of the following methods:

a) ultrasonic testing in accordance with ISO 10893-10 or ASTM E213;

b) flux leakage testing in accordance with ISO 10893-3 or ASTM E570;

c) eddy current concentric coil testing in accordance with ISO 10893-2 or ASTM E309;

d) for pipe outside surface, magnetic particle inspection in accordance with ISO 10893-5 or ASTM E709.

10.15.7 Full-body, full-length NDE of casing and tubing — Grade P110 to A.8 SR16

All pipe shall be inspected for the detection of both longitudinal and transverse imperfections on the outside and inside surfaces to acceptance level U4/F4/E/4/L4 by one or more of the following methods:

a) ultrasonic testing in accordance with ISO 10893-10 or ASTM E213 (longitudinal and transverse);

b) flux leakage testing in accordance with ISO 10893-3 or ASTM E570 (longitudinal and transverse);

c) eddy current concentric coil testing in accordance with ISO 10893-2 or ASTM E309.

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10.15.8 Full-body, full-length NDE of casing and tubing — Grade P110 and Grade P110 to A.8 SR16 and A.2 SR2

All pipe shall be inspected for the detection of both longitudinal and transverse imperfections on the outside and inside surfaces to acceptance level U2/F2/E2/L2 by one or more of the following methods:

a) ultrasonic testing in accordance with ISO 10893-10 or ASTM E213 (longitudinal and transverse);

b) flux leakage testing in accordance with ISO 10893-3 or ASTM E570 (longitudinal and transverse);

c) eddy current concentric coil testing in accordance with ISO 10893-2 or ASTM E309.

10.15.9 Full-body, full-length NDE of casing and tubing — Grades L80 13Cr, C90, T95, C110 and Q125

All pipe shall be ultrasonically inspected for the detection of both longitudinal and transverse imperfections on the outside and inside surfaces to acceptance level L2 in accordance with ISO 10893-10 or ASTM E213 (longitudinal and transverse).

For grades C90, T95 and C110, internal and external oblique notches shall be ultrasonically inspected for detection to acceptance level L2 in addition to longitudinal and transverse imperfections. The angle of the notches shall be validated and documented by the manufacturer according to the imperfection orientation of their typical manufacturing process.

In addition, all pipes shall be inspected for the detection of imperfections on the outside surface by one of the following methods:

a) flux leakage testing to acceptance level F2/L2 in accordance with ISO 10893-3 or ASTM E570 (longitudinal and transverse);

b) eddy current testing to acceptance level E2/L2 in accordance with ISO 10893-2 or ASTM E309;

c) magnetic particle inspection in accordance with ISO 10893-5 or ASTM E709.

10.15.10 NDE of the weld seam of welded pipe

Unless otherwise agreed, the timing of the weld seam inspection of welded pipe shall be at the manufacturer's discretion, with the exception that for quenched and tempered welded pipe, the weld seam inspection shall take place after final heat treatment and rotary straightening operations.

NDE of the weld seam of electric-welded pipe shall be carried out using inspection equipment capable of full volumetric inspection over a 3 mm (1/8 in) wide zone centred on the fusion line.

If the NDE of the weld seam is performed simultaneously with the full-body, full-length NDE, then the reference standard shall contain all of the required artificial reference indicators (for pipe body and weld seam) as described in Table C.44 or Table E.44.

NOTE As described in Table C.43 or Table E.43, the acceptance level for the pipe body and the weld seam can be different.

For Grades H40, J55, K55, N80 all types, R95, L80 all types, the weld seam shall be inspected for the detection of longitudinal imperfections by one or more of the following methods:

a) ultrasonic testing to acceptance level U3/L3 in accordance with ISO 10893-11 or ASTM E273;

b) flux leakage testing to acceptance level F3/L3 in accordance with ISO 10893-3 or ASTM E570;

c) eddy current testing to acceptance level E3/L3 in accordance with ISO 10893-2 or ASTM E309.

For Grades P110 and Q125, the requirements of A.5.5 SR11.5 shall apply.

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When A.12 SR40 is specified on the purchase agreement for all Grades except Grades P110 and Q125 products, the additional requirements of A.12 SR40 apply.

10.15.11 NDE of coupling stock, accessory material (except Grades L80 13Cr, C90, T95, C110 and Q125) and pup joints

When NDE is required for coupling stock and accessory material according to Table C.42 or Table E.42, the inspection shall be for the detection of longitudinal and transverse imperfections on the outside surface to acceptance level U3/F3/E3/L2 by one or more of the following methods:

— ultrasonic testing in accordance with ISO 10893-10 or ASTM E213;

— flux leakage testing in accordance with ISO 10893-3 or ASTM E570;

— eddy current concentric coil testing in accordance with ISO 10893-2 or ASTM E309;

— magnetic particle inspection in accordance with ISO 10893-5 or ASTM E709.

The reference indicators used by the manufacturer to calibrate the compression and shear wave ultrasonic equipment may be retained in the coupling stock. If the reference indicators are retained in the reference standard, the outside-wall surface area adjacent to the reference indicators shall be stencilled with the letters "RI". The reference indicators shall be considered defects and marked in accordance with 10.15.18 b).

Coupling stock for couplings that will be fully machined may have imperfections on the unmachined surfaces, however the final machined surfaces shall meet the specified dimensions and the surface inspection criteria of 9.12.

Pup joints shall be inspected and meet the same requirements as casing and tubing.

a) For pup joints made from full-length casing and tubing, the required inspection for inside and outside defects shall take place either before or after cutting into final length, provided there is no subsequent upsetting or heat treatment.

b) For pup joints machined from pipe or bar stock, the required inspection shall take place either before or after machining to final product dimensions; however, the outside surface shall be visually inspected subsequent to being machined to final product dimensions.

c) For all other pup joints, except for those round thread pup joints in d), the required inspection shall be performed according to a) above.

d) For API round thread pup joints in size designations listed in Table C.2 or Table E.2 for Grades H40, J55, K55, N80 all types, R95, L80 all types and P110, the required inspections, unless otherwise agreed upon between purchaser and manufacturer, are as specified in e).

e) For outside surface and end areas, the required inspection shall be performed following any upset process and final heat treatment. For Grade P110 pup joints magnetic particle inspection for the detection of longitudinal and transverse defects may be substituted for the required outside surface inspection.

10.15.12 NDE of coupling stock and accessory material – Grades L80 13Cr, C90, T95, C110 and Q125

All coupling stock and accessory material shall be inspected for the detection of longitudinal and transverse imperfections on the outside surface to acceptance level U2/F2/E2/L2 by one or more of the following methods:

— ultrasonic testing in accordance with ISO 10893-10 or ASTM E213;

— flux leakage in accordance with ISO 10893-3 or ASTM E570;

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— eddy current concentric coil testing in accordance with ISO 10893-2 or ASTM E309;

— magnetic particle inspection in accordance with ISO 10893-5 or ASTM E709;

a) Permitted imperfections before machining

Coupling stock for couplings and accessory material that will be fully machined may have imperfections on the unmachined surfaces. However, the final machined surfaces shall meet the specified dimensions and the surface inspection criteria of 9.12 (A.3.3 SR9.3).

b) Further evaluation

Coupling stock and accessory material containing defects may be given further evaluation in accordance with 10.15.15, except the maximum size of the non-surface-breaking imperfection specified in 8.13.1 d) shall be reduced to 32 mm^2 (0.05 in^2). Coupling stock and accessory material containing defects shall either be given a disposition in accordance with 10.15.18, or the section of coupling stock containing the defect shall be cut off within the limits of the requirements on length specified on the coupling stock purchase agreement.

c) Ultrasonic testing — Through-wall

Coupling stock and accessory material shall be inspected full-body, full-length from the outside surface using ultrasonic compression-wave techniques to detect and identify imperfections. The reference indicator shall be a 6,4 mm (1/4 in) flat bottomed round hole from the inside surface as shown in Figure D.16 d. The minimum coverage shall be 100 % of the inspected surface, see 10.15.4 a).

d) Ultrasonic testing — Inside surface

Coupling stock and accessory material from casing, tubing, thick-walled pipe, mechanical pipe or hot forgings shall be inspected for longitudinal and transverse imperfections on the inside surface using ultrasonic shear-wave techniques to acceptance level L3 with a maximum notch length of 25 mm (1 in). By agreement between the purchaser and manufacturer, alternative NDE methods which demonstrate the capability to detect the reference indicators may be used.

Accessory material from bar stock (i.e. without a hollow section) has to be inspected to the NDT requirements per 10.15.12 c).

10.15.13 NDE of coupling stock and accessory material — Grades C90 and T95

All coupling stock and accessory material shall be inspected for the detection of longitudinal transverse and oblique imperfections on the outside surface to acceptance level U2/F2/E2/L2 by one or more of the following methods:

— ultrasonic testing in accordance with ISO 10893-10 or ASTM E213;

— flux leakage in accordance with ISO 10893-3 or ASTM E570;

— eddy current concentric coil testing in accordance with ISO 10893-2 or ASTM E309;

— magnetic particle inspection in accordance with ISO 10893-5 or ASTM E709.

a) Permitted imperfections before machining

Coupling stock for couplings and accessory material that will be fully machined may have imperfections on the unmachined surfaces. However, the final machined surfaces shall meet the specified dimensions and the surface inspection criteria of 9.12 (A.3.3 SR9.3).

b) Further evaluation

Coupling stock and accessory material containing defects may be given further evaluation in accordance with 10.15.15, except the maximum size of the non-surface-breaking imperfection

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specified in 8.13.1 d) shall be reduced to 32 mm^2 (0.05 in^2). Coupling stock and accessory material containing defects shall either be given a disposition in accordance with 10.15.18, or the section of coupling stock containing the defect shall be cut off within the limits of the requirements on length specified on the coupling stock purchase agreement.

c) Ultrasonic testing — Through-wall

Coupling stock and accessory material shall be inspected full-body, full-length from the outside surface using ultrasonic compression-wave techniques to detect and identify imperfections. The reference indicator shall be a 6,4 mm (1/4 in) flat bottomed round hole from the inside surface as shown in Figure D.16 d. The minimum coverage shall be 100 % of the inspected surface, see 10.15.4 a).

d) Ultrasonic testing — Inside surface

Coupling stock and accessory material from casing, tubing, thick-walled pipe, mechanical pipe or hot forgings shall be inspected for longitudinal and transverse imperfections on the inside surface using ultrasonic shear-wave techniques to acceptance level L3 with a maximum notch length of 25 mm (1 in). By agreement between the purchaser and manufacturer, alternative NDE methods which demonstrate the capability to detect the reference indicators may be used.

Accessory material from bar stock (i.e. without a hollow section) has to be inspected to the NDT requirements per 10.15.12 c.

10.15.14 Untested pipe ends, coupling stock ends and accessory material ends

The end-area inspections shall be subsequent to all heat treatment.

It is emphasized that in many of the automatic NDE operations specified in this document, there may be a short length at each end which cannot be tested. In such cases, the untested ends shall be either

a) cropped off, or

b) subjected to magnetic particle inspection of the outside and inside surfaces around the full periphery and over the length of the untested ends, or

c) subjected to a manual/semi-automatic test which achieves, as a minimum, the same degree of inspection as the automatic NDE.

Records in accordance with 10.15.4 shall be maintained.

10.15.15 Pipe upsets

Forged upsets (including the upset run-out interval) on all grades, except Grades H40, J55 and K55, shall be subjected, after all heat-treatment operations, to NDE for the detection of transverse defects on the outside and inside surfaces of the upset, using the criteria given in 8.13. For all grades manufactured by the quench-and-temper process, the end-area inspection shall include inspection for longitudinal defects.

Records in accordance with 10.15.4 shall be maintained.

10.15.16 Pipe, coupling stock and accessory material requiring further evaluation

In all cases, indications producing a threshold alarm condition as a result of the specified NDE operation(s) shall have the indications evaluated in accordance with 10.15.16, unless it can be demonstrated that the imperfection causing the indication is not a defect as described in 8.13.

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10.15.17 Evaluation of indications (prove-up)

For an indication which is greater than or equal to the reject threshold, the manufacturer shall either evaluate it in accordance with this subclause or dispose of the indication as a defect in accordance with 10.15.17. Evaluation of indications shall be performed by NDE Level I certified inspectors under the supervision of NDE Level II or III certified inspectors, or by NDE Level II or III certified inspectors. Evaluation of indications shall be performed in accordance with documented procedures.

When no imperfection is found in the area of the original indication and there is no explanation for the indication, then the product shall be rejected or, at the manufacturer's option, re-inspected full-body, full-length either using the same inspection method or using ultrasonic inspection methods. At the manufacturer's option, the inspection equipment shall be adjusted either to the same sensitivity level as that used to perform the original inspection or to a reduced sensitivity that meets the specified requirements.

All magnetic particle indications that are produced by leakage fields originating from imperfections shall be evaluated in accordance with 10.15.16 a).

For the evaluation of an indicated imperfection, the depth shall be measured by one of the following methods:

a) using a mechanical measuring device (for example, pit gauge, callipers, etc.). Removal of material by grinding or other means to facilitate measurement shall not, for pipe, reduce the remaining wall thickness below 87,5 % of the specified wall thickness or, for coupling stock, reduce the remaining outside diameter or wall thickness below the minimum specified on the purchase agreement. Abrupt changes in wall thickness caused by material removal during prove-up shall be removed;

b) using an ultrasonic technique(s) (time- and/or amplitude-based), or other comparable techniques. Verification of the ultrasonic technique(s) shall be documented and shall show capability to differentiate imperfection sizes larger and smaller than the appropriate defect size stated in 8.13.

If the purchaser and manufacturer do not agree on the evaluation test results, either party may require destructive evaluation of the material, after which disposition shall be as described in B.4.

Imperfections that have been evaluated and found to be defects shall be given a disposition in accordance with 10.15.17.

10.15.18 Disposition of pipe containing defects

Imperfections that satisfy the material requirements and are less than the defect size stated in 8.13 are allowed to remain in the pipe. Repair welding is not permitted.

Pipe containing cracks and or quench cracks within a distance of twice the diameter from the end may be cut back, once only, to remove the cracks. After cutting the pipe shall be re-inspected full-body, full-length. Where cracks and / or quench cracks are detected at a distance more than twice the diameter from the ends, the pipe shall be rejected.

Pipe containing defects shall be given one of the following dispositions.

a) Grinding or machining

Grinding or machining of quench cracks or arc burns is not permitted. Defects shall be completely removed by grinding or machining, provided the remaining wall thickness is within specified limits. The area affected by grinding or machining shall be blended smoothly into the contour of the tube. Where the depth of the removal exceeds 10 % of the specified wall thickness, the remaining wall thickness shall be verified in accordance with 10.13.4. When the defect is located on the inside surface in the external thread section of the pipe body, the depth of the removal shall not exceed 10 % of the specified wall thickness as measured using a dial depth gauge or other suitable device, and the length of the removal shall be limited to that which allows for accurate depth measurement. After removal of the defect, the affected area shall be re-inspected to verify that the defect was completely removed. The re-inspection shall be either

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1) by the same inspection unit at the same sensitivity that performed the initial inspection, or

2) by another NDE method, or combination of methods, that demonstrate equal or greater sensitivity than the original NDE.

When method 2) above is used, the NDE method (or combination of methods) shall be documented and shall demonstrate equal or greater sensitivity than the original NDE. In addition, method 2) shall address the possibility that there may be other coincident defects in the affected area.

b) Cut-off

The section of pipe containing the defect shall be cut off within the limits of requirements on length of the intended product.

c) Rejection

The pipe shall be rejected.

10.15.19 Disposition of coupling stock and accessory material containing defects

Imperfections that satisfy the material requirements and that are less than the defect size stated in 8.13 are allowed to remain in the coupling stock and accessory material. Repair welding is not permitted.

Coupling stock and accessory material containing cracks and or quench cracks within a distance of twice the diameter from the end may be cut back, once only, to remove the cracks. After cutting, the piece shall be reinspected full-body, full-length. Where cracks and/or quench cracks are detected at a distance more than twice the diameter from the ends, the piece shall be rejected.

Coupling stock and accessory material containing defects shall be given one of the following dispositions.

a) Grinding or machining

Grinding or machining of quench cracks or arc burns is not permitted.

Defects shall be completely removed by grinding or machining, provided the remaining wall thickness is within specified limits. The area affected by grinding or machining shall be blended smoothly into the contour of the tube. Where the depth of the removal exceeds 10 % of the specified wall thickness, the remaining wall thickness shall be verified in accordance with 10.13.4 and the resultant outside diameter at the site of imperfection removal shall be verified to ensure conformance with specified outside diameter requirements. After removal of the defect, the affected area shall be re-inspected to verify that the defect was completely removed. The re-inspection shall be either

1) by the same inspection unit at the same sensitivity that performed the initial inspection, or

2) by another NDE method, or combination of methods, that demonstrate equal or greater sensitivity than the original NDE.

When method 2) above is used, the NDE method (or combination of methods) shall be documented and shall demonstrate equal or greater sensitivity than the original NDE. In addition, method 2) shall address the possibility that there may be other coincident defects in the affected area.

b) Marking the area of defect

If a defect is not removed from coupling stock and accessory material within acceptable limits, then the area shall be marked to indicate the presence of a defect. The marking shall consist of a paint band encircling the tube body that covers the entire defect area if this area is equal to or less than 50 mm (2 in) in axial length, or bands in a cross-hatched pattern if this area is greater than 50 mm (2 in) in length. The band colour shall be as agreed between the purchaser and manufacturer.

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c) Cut off

The section of coupling stock or accessory material containing the defect shall be cut off within the limits of requirements on length of the intended product.

d) Rejection

The coupling stock or accessory material shall be rejected.

11 Marking

11.1 General

11.1.1 Products manufactured in conformance with this document shall be marked by the manufacturer as specified herein.

11.1.2 For all manufacturers except threaders, the marking instructions in Clause 11, except those in 11.6, are applicable. For threaders, the marking instructions in 11.5 and 11.6 and Table C.48 or Table E.48 are applicable. Processors shall remove any identity that is not indicative of the new condition of the product as a result of heat treatment (for example, prior grade identity and original pipe manufacturer's name or logo).

11.1.3 Products shall be colour-coded as specified in 11.4.

11.1.4 Products shall be marked by stencilling, or a combination of stencilling and stamping, at the option of the manufacturer, as stipulated, with two exceptions:

— by agreement between purchaser and manufacturer, stamping can be required, in which case a combination of stamping and stencil marking shall be used;

— at the option of the manufacturer, hot-rolled or hot-stamped markings on pipe and couplings may be substituted for die-stamped markings and are permitted at intervals along the length.

11.1.5 Requirements for optional stamp markings are specified in 11.2, and stencil markings shall be as specified in 11.3. Marking instructions and sequence of markings are specified in Table C.48 or Table E.48, which includes only those items that are stamped or stencilled for product identification. If die stamp marking is selected, it is not required to also stencil mark the information. Examples of markings are shown in Figure D.15. Marking shall not overlap and shall be applied in such a manner as not to injure the product.

11.1.6 Additional markings for compatible standards shall be listed after "ISO 11960".

11.1.7 In a circumstance where it is necessary to re-mark product with the original marking information, the accuracy and traceability of the transferred markings shall be the responsibility of the entity re-marking the product. The transferred markings shall include the words "transferred by « »", with the name of the entity responsible for transferring the markings shown between the « ».

11.1.8 The date of manufacture is defined for marking purposes as either

a) a two-digit number, consisting of the last digit of the year followed by the calendar quarter in which the markings of Clause 11 are completed, or

b) a three-digit number, consisting of the last digit of the year followed by a two-digit number indicating the month in which the markings of Clause 11 are completed.

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11.1.9 Other additional markings are allowed and may be applied as desired by the manufacturer or as requested by the purchaser but shall be applied after the markings specified in Table C.48 or Table E.48.

11.1.10 Marking for coupling material and accessory material shall be specified on the purchase agreement or, in the case of coupling material, in the manufacturer's internal marking requirements but shall be traceable to, as a minimum, this document, the manufacturer, the date of manufacture and the grade. When the purchase agreement specifies marking with colour bands these bands shall be consistent with Table C.46 or Table E.46.

11.2 Stamp marking requirements

11.2.1 Methods

Permitted methods of stamp marking are shown in Table 17.

Table 17 — Stamp Marking

Number	Method
1	Hot-rolled or hot-stamped markings
2	Cold die stamping with standard dies
3	Cold die stamping with interrupted dot-face dies
4	Cold die stamping with rounded-face dies
5	Vibratory

After stamp marking, Grade R95, L80 all types, C90, T95, C110 and Q125 products might require subsequent heat treatment as specified in 11.2.5. Such heat treatment shall be in accordance with 6.4. The sequence of stamp markings shall be as shown in Table C.48 or Table E.48.

11.2.2 Size

Sizes of stamp markings shall be as shown in Table C.45 or Table E.45.

11.2.3 Location

Placements of these markings on casing and tubing sizes Label 1: 1.660 and larger shall be on the outside surface of each length within approximately 0,3 m (1 ft) from the coupling or box, either end of plain-end pipe or either end of pin-by-pin threaded pipe. The optional stamp marking on sizes smaller than Label 1: 1.660 may be on a metal tag affixed to each length or, for bundled tubing, stamped on a metal tag affixed to each bundle.

11.2.4 Grades H40, J55, K55, N80 all types and P110

When specified on the purchase agreement, products shall be stamped by one or more of the methods in 11.2.1 at the option of the manufacturer.

11.2.5 Grades R95, L80 all types, C90, T95, C110 and Q125

When specified on the purchase agreement, products shall be stamped by one or more of the methods in 11.2.1 at the option of the manufacturer. In addition, the following apply:

a) Grade R95 and L80 all types products shall be heat-treated subsequent to using method 2 in 11.2.1.

b) Grades C90, T95, C110 and Q125 products shall be heat-treated subsequent to using methods 2 and 4 in 11.2.1, with the following exceptions:

   — stamping of the make-up triangle;

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— when the stamp markings are removed by cropping or by grinding, machining, threading to a depth not less than twice the depth of the stamping;

— by agreement between purchaser and manufacturer, the stamp marks may be left in the product.

11.2.6 Make-up triangle marking

For buttress casing in all sizes and grades and for round thread casing in sizes Label 1: 16 and larger in Grades H40, J55 and K55, the make-up triangle shall be stamped on the outside of each length on both ends. By agreement between purchaser and manufacturer, the make-up triangle may be replaced with a transverse white paint band 10 mm (3/8 in) wide by 76 mm (3 in) long. To assist in locating the triangle or transverse white paint band on buttress casing, a 25 mm (1 in) wide by 610 mm (24 in) long longitudinal white paint stripe shall be placed adjacent to the triangle or transverse paint band on the field end; additionally, a 25 mm (1 in) wide by 100 mm (4 in) long longitudinal white paint stripe shall be placed adjacent to the triangle or transverse paint band on the mill end.

For Grades H40, J55, K55, N80 all types and P110, the triangle shall be stamped by method 2, 4 or 5 only.

For Grades C90 and T95, the triangle shall be stamped by method 3 only.

For Grades R95, L80 all types, C110 and Q125, the triangle shall be stamped by method 3 or 4 only.

11.3 Stencil marking requirements

Stencil markings shall be placed on the outside surface of each length of pipe, beginning at least 0,6 m (2 ft) from the coupling or box or from either end of plain-end pipe, pin-by-pin threaded pipe or coupling stock. For accessory material and pup joints less than 1,8 m (6 ft) in length, the required stencil markings may be placed on a decal attached to the outside surface within 0,3 m (1 ft) of the end. These markings shall be separated by a dash or shall be adequately spaced.

The sequence of stencil markings shall be as specified in Table C.48 or Table E.48, except the thread marking shall be at a location convenient to the manufacturer.

11.4 Colour identification

11.4.1 Colour coding

Each product shall be colour-coded as specified in 11.4.2 to 11.4.6, unless otherwise specified on the purchase agreement.

11.4.2 Product 1,8 m (6 ft) and longer

The following methods shall be used, as applicable.

a) For threaded pipe, pup joints and accessory material paint a band encircling the product at a distance not greater than 0,6 m (24 in) from the coupling or internally threaded end.

b) For plain-end or pin-by-pin threaded product: paint a band encircling the product at a distance not greater than 0,6 m (24 in) from either end.

c) Couplings: for all grades except Grade L80 13Cr, paint the entire outside surface of the coupling, including the appropriate coupling colour bands.

d) Couplings: for Grade L80 13Cr, apply only the appropriate colour bands with a band width of 12,7 mm (½ in) to the outside surface of the coupling.

e) If the pipe is furnished with special-clearance couplings or if the pipe and couplings are of a different grade (except Grades H40, J55 and K55 applied in accordance with 9.2.1), paint both the pipe and couplings as specified in items a), b) and c) above.

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11.4.3 Loose couplings

For all grades except Grade L80 13Cr, paint the entire outside surface of the coupling, including the appropriate colour bands.

For Grade L80 13Cr, apply only the appropriate colour bands with a band width of 12,7 mm (½ in) to the outside surface of the coupling.

11.4.4 Special-clearance couplings

For all grades except for Grade L80 13Cr, paint the coupling using the appropriate colours and also paint a black band around the centre.

For Grade L80 13Cr, apply only the appropriate colour bands and a black band around the centre with a band width of 12,7 mm (½ in).

11.4.5 Pup joints shorter than 1,8 m (6 ft) in length

For all grades except for Grade L80 13Cr, paint the entire outside surface except the threads including the appropriate colour bands.

For Grade L80 13Cr, apply only the appropriate colour bands with a band of 12,7 mm (½ in) to the outside surface.

11.4.6 Grade colour-codes

The colour and number of bands for each grade shall be as shown in Table C.46 or Table E.46.

11.5 Thread and end-finish marking

11.5.1 API thread marking

For manufacturers, thread identification shall be stencilled on casing with round or buttress threads. For threaders, thread identification is required on casing and tubing. Thread identification shall be as shown in Table C.47 or Table E.47.

11.5.2 Plain-end and special end-finish markings

Marking requirements for

a) plain-end pipe furnished either upset or non-upset, or

b) pipe with special end-finish not specified herein but having the body of the pipe manufactured in accordance with the requirements specified herein, or

c) couplings and accessories furnished with special end-finish not specified herein but which meet all the other requirements specified herein for these products except dimensions.

shall be as shown in Table C.48 or Table E.48.

11.6 Pipe-threader marking requirements

Pipe threaded by a facility other than the original pipe manufacturer shall be identified, by a stamp or stencil consistent with 11.1, 11.2 and 11.3 adjacent to the threads, with the name or mark of the threader, the specification mark, and size and type of thread as listed in 11.5 and Table C.47 or Table E.47.

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The threader shall mark on the body of the pipe the actual hydrostatic test pressure, unless the pipe has been previously tested to the pressure required for the thread and marked as specified in Table C.48 or Table E.48.

EXAMPLE For Label 1: 7, Label 2: 29.00, R95, long thread coupling:

Case 1): If the pipe manufacturer produced plain-end pipe and hydrostatic pressure-tested to 34,5 MPa (5 000 psi) based on the documented design basis of the tester for 177,8 mm (7 in) pipe (see 10.12.3), and marked P34,5 (P5000), then the threader shall pressure-test the pipe to 60,5 MPa (8 800 psi) and mark the pipe in accordance with Figure D.15.

Case 2): If the pipe manufacturer produced plain-end pipe and hydrostatic pressure-tested to 61,0 MPa (8 900 psi) and marked the pipe P61,0 (P8900), then the threader is not required to pressure-test the pipe or mark the test pressure.

The markings applied to the body of the pipe by the original pipe manufacturer shall not be removed or altered.

12 Coating and protection

12.1 Coatings

12.1.1 Coatings for protection during transit

Unless otherwise specified on the purchase agreement, pipe and couplings shall be given an external coating for protection from rust while in transit. An attempt should be made to make these coatings smooth, hard to the touch and with minimum sags. The coating shall be rated to protect the pipe for at least three months.

Unless otherwise specified on the purchase agreement, coupling stock, coupling material and accessory material shall be supplied without external coating (bare), except for a protective coating that may be applied over the stencil.

The purchase agreement shall specify when bare pipe or specially coated pipe is required. For special coatings, the purchase agreement shall further specify whether the coating shall be applied to the full length or whether a certain specific distance from the end shall be left un-coated. Unless otherwise specified, such bare ends are commonly given a coating with oil for protection in transit.

NOTE 13 % Cr tubulars have shown a tendency toward localized pitting corrosion when stored in moist environments. Special precautions during coating, shipping and storage are worthwhile.

12.1.2 Coatings for long-term storage

By agreement between purchaser and manufacturer, protective coatings, internal and external, may be required for pipe for long-term storage to protect against corrosion, especially when stored in a marine environment.

The following points shall apply.

a) The protection shall be effective against corrosion in a marine environment during the long-term storage period defined by the purchaser and manufacturer; minor surface discolouration shall be acceptable.

b) There shall be no need for removal of the protective coating before the running of the tubulars.

c) Correct application of the coating is essential and the following parameters shall be assessed:

— dryness of the pipe;

— cleanliness of the pipe;

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— temperature at application;

— thickness of the coating film.

12.2 Thread protectors

12.2.1 General

The entity performing the threading shall apply external and internal thread protectors that meet the requirements of Annex G unless otherwise specified on the purchase agreement. External thread protectors total pipe thread length of the internal thread. Thread protectors shall be of such design, material and mechanical strength to protect the thread and end of the pipe from damage under normal handling and transportation and to inhibit infiltration of dust and water to the threads during transportation and normal storage period. Normal storage period shall be considered as approximately one year. The thread forms in protectors shall be such that the product threads are not damaged by the protectors. Thread protectors are not required for pup joints and accessories provided they are packaged in a manner that protects the threads.

NOTE Damage is an injury resulting from impact that causes an out-of-specification condition to the threads and/or pipe end.

12.2.2 Grade L80 13Cr

Bare steel thread protectors shall not be used on Grade L80 13Cr tubulars.

12.2.3 Driftable thread protectors

By agreement between purchaser and manufacturer, open-ended, driftable protectors may be supplied. Thread compound shall cover the entire thread and seal surfaces of the connection.

13 Documents

13.1 Electronic media

A material test report, certificate of conformance or similar document printed from or used in electronic form from an electronic data interchange (EDI) transmission shall be regarded as having the same validity as a counterpart printed in the certifier's facility. The content of the EDI-transmitted document shall meet the requirements of this document and conform to any existing EDI agreement between purchaser and manufacturer.

13.2 Certification requirements

A certification shall be provided by the manufacturer for all delivered products. In addition to the data listed here after, the certificate shall include a statement that the product has been manufactured, sampled, tested and/or inspected in accordance with this document and has been found to meet the requirements.

13.3 Content of the certificate

The certificate shall, as applicable to each item, contain at least the following information:

— Reference to this document, i.e. ISO 11960:2020;

— Applicable supplementary requirements;

— Heat and/or lot traceability identification to which the product was produced;

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— Specified diameter, wall thickness, grade, process of manufacture, type of heat treatment and end-finish (including with or without power-tight couplings) and product serialization;

— The minimum tempering temperature allowed by the documented procedure for each lot of quenched and tempered or normalized and tempered casing and tubing (except coupling stock and coupling material);

— The chemical analyses for heat, product, control and eventual recheck, showing the mass fraction, expressed as a percent, of all elements whose limits or reporting requirements are set in this document;

— The tensile tests results, including yield strength, tensile strength and elongation. The type, size and orientation of the specimens shall be reported;

— Where impact testing is required by this document, impact test results including:

  1) The acceptance criteria;

  2) The size, location and orientation of the test specimens;

  3) The nominal test temperature (i.e. actual test temperature, including the sub-size temperature reduction if applicable);

  4) The absorbed energy measured for each test specimen, and

  5) The average absorbed energy for each test.

  The percent shear area shall be reported for Grades N80 all types, L80 Type 1, C90, R95, T95, P110 and Q125 (see A.14, SR 42) and Grade C110 (see 7.3.1).

— Where harness testing is required, hardness test results (including Rockwell hardness numbers and mean hardness numbers, test type and criterion, and specimen location and orientation);

— The grain size and the test method used for the determination;

— For SSC testing of Grade C110 a statement specifying if the SSC testing was performed in Solution A or, when performed in the solution described in A.11.3 (SR 39.3), the actual percent H2S;

— The information specified in the ANSI/NACE TM0177-2016, Table 7 “NACE Uniform Material Testing Report Form (Part 2): testing in accordance with ANSI/NACE TM0177 Method D – NACE Standard DCB Test” shall be provided;

— The minimum hydrostatic test pressure and duration;

— For welded pipe for which NDE of the weld seam is required by this document, the method of NDE employed (UT, ET or MT) and the type of reference standard;

— For seamless products for which NDE is specified (either in the body of the standard, in the Supplementary requirements or in the purchase order), the method of NDE employed (UT, ET or MT), the acceptance criteria, the location and orientation of the reference indicator used, and the type and size of the reference standard used;

— For electric-welded pipe, the minimum temperature for heat treatment of the weld seam. If such treatment is not performed, “no seam heat treatment” shall be stated in the certificate;

— For High Collapse pipe (see H.4) all collapse test results and the minimum collapse value shall be stated;

— The results of any supplemental testing required by the purchaser.

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13.4 Retention of records

Tests and inspections requiring retention of records in this document are shown in Table C.49 or Table E.49. Such records shall be retained by the manufacturer for a minimum of five years or as required by customer and other applicable requirements, whichever is longer after the date of purchase from the manufacturer.

14 Minimum facility requirements for various categories of manufacturer

14.1 Pipe mill

A pipe mill shall operate one or more pipe-making facilities capable of producing products as described in Clause 6. A pipe mill shall also have suitable equipment for, and be responsible for, weighing pipe and marking pipe, coupling stock, coupling material or accessory material.

A pipe mill shall also have facilities for conducting all required tests and inspections. Alternatively, and at the option of the pipe mill, any of these tests or inspections may be provided by a subcontractor and may be located off-site. In the event that a subcontractor performs any of these services, the conduct of such inspections and tests shall be controlled and monitored by the pipe mill in accordance with a documented procedure to ensure conformance with the relevant requirements of this document.

14.2 Processor

A processor shall operate heat-treating facilities capable of heat-treating full-lengths of pipe, coupling stock, coupling material or accessory material. A processor shall also have suitable equipment for, and be responsible for, weighing pipe and marking pipe, coupling stock, coupling material or accessory material.

A processor shall also have facilities for conducting all required tests and inspections. Alternatively, and at the option of the processor, any of these tests or inspections may be provided by a subcontractor and may be located off site. In the event that a subcontractor performs any of these services, the conduct of such inspections and tests shall be controlled and monitored by the processor in accordance with a documented procedure to ensure conformance with the relevant requirements of this document.

14.3 Pipe threader

A pipe threader shall operate one or more threading machines capable of threading pipe ends to the dimensions and tolerances specified in API Spec 5B. A threader shall also have suitable equipment for, and be responsible for, markings. A threader shall also have access to master plug and ring gauges, as well as the required working gauges, for each size and type of thread.

A threader shall either have or have access to facilities for

a) applying couplings to specified make-up,

b) hydrostatic testing the entire length to the pressure required for finished pipe,

c) drift-testing the ends after threading and coupling in accordance with specification requirements, and

d) measuring length.

In the event that a subcontractor performs any of items a), b), c) or d), such services shall be carried out in accordance with documented procedures and shall be controlled and monitored by the threader to ensure conformance with the relevant requirements of this document.

A threader (or a subcontractor) shall not change or alter the markings on the pipe body or certify that the pipe body conforms with any ISO/API specification. When subcontract work is performed for the

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threader, it shall be the responsibility of the threader to ensure that such work conforms with the requirements of this document.

14.4 Coupling, pup-joint or accessory manufacturer

A coupling, pup-joint or accessory manufacturer shall operate equipment capable of machining and threading products in accordance with the dimensions and tolerances provided in the applicable specifications. The manufacturer shall also have access to master plug and ring gauges, as well as the required working gauges, for each size and type of thread produced on products marked by the manufacturer in accordance with Clause 11.

A coupling, pup-joint or accessory manufacturer shall have access to facilities for conducting all other aspects of the manufacturing process for the products (e.g. heat treatment). In the event that subcontractors perform these services, the conduct of inspections and tests shall be controlled and monitored by the coupling, pup-joint or accessory manufacturer in accordance with documented procedures to ensure conformance with the relevant requirements of this document.

Pup-joint manufacturers shall either have or have access to facilities for

a) hydrostatic testing, and

b) drift-testing finished products

in accordance with the requirements of this document.

In the event that a subcontractor performs any of items a) or b) above, such services shall be carried out in accordance with documented procedures and shall be controlled and monitored by the manufacturer to ensure conformance with the relevant requirements of this document.

Coupling manufacturers shall be capable of inspecting couplings by the magnetic particle inspection or other adequate non-destructive testing method.

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Annex A
(normative)

Supplementary requirements

A.1 General

This annex describes supplementary requirements that may be specified by the purchaser or agreed between purchaser and manufacturer. These requirements apply only when stated on the purchase agreement.

A.2 SR2 Supplementary non-destructive examination for Grades H40, J55, K55, N80 all types, L80, R95 and P110 to A.8 SR16

The specified casing and tubing shall be inspected for imperfections that are greater than 5 % of the specified wall thickness or which reduce the net effective wall thickness below 87,5 % of the specified wall thickness. These imperfections shall be considered defects and shall be given a disposition in accordance with 10.15.17. The inspection(s), including forged upsets, shall be performed to the minimum requirements stated in 10.15 for Grade P110 including full-body, full-length wall thickness verification according to 10.13.4.

A.3 SR9 Coupling blanks — Grades C110 and Q125

A.3.1 SR9.1 Coupling blank size

Coupling blank dimensions shall be adequate to yield a fully machined cylinder with uniform wall thickness with an outside diameter, inside diameter and length as specified on the purchase agreement. The coupling blanks shall be provided fully machined by the manufacturer only when specified on the purchase agreement.

A.3.2 SR9.2 Dimensional tolerances

For fully machined coupling blanks, the tolerance on outside diameter shall be $^{+2,38}_{0}$ mm $\left(^{+3/32}_{0}\text{ in}\right)$ and the tolerance on the inside diameter shall be $^{0}_{-2,38}$ mm $\left(^{0}_{-3/32}\text{ in}\right)$, unless otherwise agreed upon between purchaser and manufacturer.

Coupling blanks ordered with as-rolled outside diameter surface shall have an outside diameter tolerance of ±1 %, but not greater than $^{+3,18}_{-1,59}$ mm $\left(^{+1/8}_{-1/16}\text{ in}\right)$.

A.3.3 SR9.3 Imperfections

Coupling blanks that will not be fully machined by either the manufacturer or the purchaser shall be inspected and meet the same requirements as finished couplings. Coupling blanks that will be fully machined by either the manufacturer or the purchaser may have imperfections on the as-rolled surface; however, the machined surface shall meet the surface inspection criteria of 9.12 and be to the specified dimensions.

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A.3.4 SR9.4 Marking

All coupling blanks meeting the requirements of A.3 SR9 shall be marked as specified in Table C.48 or E.48.

A.4 SR10 Upset casing — Grade Q125 only

A.4.1 SR10.1 Dimensions

Grade Q125 casing shall be provided with upset end(s). Dimensions of the upset shall be specified on the purchase agreement.

A.4.2 SR10.2 Material properties

Tensile, impact and hardness properties of the pipe and upset shall conform with the requirements of Clause 7. The allowable hardness variation of the upset shall be based on the nominal wall thickness of the upset specified on the purchase agreement. The tensile test specimens for the upset shall be the largest round specimen feasible. The size to be used shall be agreed by the purchaser and manufacturer prior to testing.

A.4.3 SR10.3 Heat treatment

Upset pipe shall be heat-treated full-body, full-length after upsetting.

A.4.4 SR10.4 Other testing considerations

The frequency of testing, retest provisions, identification, etc., for both the pipe body and the upset material shall be as specified in Clause 10.

A.4.5 SR10.5 End area inspection

The outside and inside surfaces of the ends of upset pipe shall be inspected after final heat treatment and before threading for transverse and longitudinal defects by the magnetic particle method.

A.5 SR11 Electric-welded Grades P110 and Q125 pipe

A.5.1 SR11.1 General

Casing (Grades P110 and Q125) and tubing (Grade P110) may be produced by the electric-weld process only when detailed quality control provisions are jointly agreed by purchaser and manufacturer prior to the manufacture of the pipe. Tensile, impact and hardness testing shall be performed as frequently as required for seamless pipe.

A.5.2 SR11.2 Flattening test frequency

A.5.2.1 SR11.2.1 — Grade P110

The flattening test frequency shall be as specified in 10.5.2.

A.5.2.2 SR11.2.2 — Grade Q125

Flattening tests shall be performed on each end of each length of pipe. On one end, flattening tests shall be made with weld at 6 o'clock and on the other end with weld at 3 o'clock. All inspection shall be performed and imperfections removed (cut-backs made) prior to removal of flattening test specimens.

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A.5.3 SR11.3 Flattening test procedures

A.5.3.1 SR11.3.1 — Grade P110

The test specimens shall be flattened as specified in 10.5.3, 10.5.5 and 10.5.7.

A.5.3.2 SR11.3.2 — Grade Q125

Test specimens shall be rings or crop ends not less than 63,5 mm (2½ in) long, cut from each end of each length of pipe. Precautions shall be taken so that the test specimens can be identified with respect to the lengths of pipe from which they are cut. Flattening tests shall be conducted with the weld line located at the 6 o'clock or 3 o'clock position. Minimum acceptable flattening without cracking at any location shall be as shown in Table C.50 (SR11.1) or Table E.50 (SR11.1) or 0,85*D*, whichever requires the greater flattening.

No cracks or breaks shall occur anywhere in the specimen until the distance between the plates is less than that specified above; nor shall evidence of poor texture, incomplete fusion in the weld or laminations develop during the entire flattening process.

A.5.4 SR11.4 Other material properties

Electric-welded pipe shall meet the same tensile, impact and hardness requirements as seamless pipe. The impact test specimen shall be machined with the notch at the weld line. The requirements of Clause 10 (for seamless pipe) shall also apply to electric-welded pipe.

A.5.5 SR11.5 Inspection and rejection

A.5.5.1 SR11.5.2 Non-weld area inspection

The pipe body shall be inspected in the same manner as the seamless product as specified in Clause 10.

A.5.5.2 SR11.5.3 Non-destructive examination of weld seam

The weld seam of pipe (except upset ends) furnished in accordance with this document shall be inspected non-destructively full-length (100 %) by ultrasonic methods. The inspection shall be performed after all heat treatment and any subsequent rotary straightening operation. Pipe upsets shall be inspected as specified in 10.15.14.

A.5.5.3 SR11.5.4 Equipment

Any equipment utilizing the ultrasonic principles capable of continuous and uninterrupted inspection of the weld seam shall be used. The equipment shall be checked with an applicable reference standard as described in A.5.5.4 SR11.5.5 at least once every working shift to demonstrate the effectiveness of the inspection equipment and procedures. The equipment shall be adjusted to produce well-defined indications when the reference standard is scanned by the inspection unit in a manner simulating the inspection of the product, and shall be capable of inspecting 1,6 mm (1/16 in) on either side of the weld line for the entire wall thickness.

A.5.5.4 SR11.5.5 Reference standards

A reference standard having the same specified diameter and thickness as the product being inspected shall be used to demonstrate the effectiveness of the inspection equipment and procedures at least once every working shift. The reference standard may be of any convenient length as determined by the manufacturer. It shall be scanned by the inspection unit in a manner simulating the inspection of the product. For ultrasonic inspection, the reference standard, with similar acoustic properties to the product being inspected, shall contain two notches, one on the outer and one on the inner surface as specified in Figure D.16. The 1,6 mm (1/16 in) diameter hole shall be drilled radially through the wall of the reference standard. The inspection equipment shall be adjusted to produce a well-defined indication

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from each reference indicator when the reference standard is scanned by the inspection system(s). Responses from the notches and hole shall meet the required system(s) sensitivity level. Outside-wall and inside-wall notches of reduced length may be used by agreement between the purchaser and manufacturer.

A.5.5.5 SR11.5.6 Rejection limits

Any imperfection that produces a signal greater than or equal to the signal received from the reference standard shall be considered a defect unless it can be demonstrated by the manufacturer that the imperfection does not exceed the provisions of A.5.5.6 SR11.5.7.

A.5.5.6 SR11.5.7 Disposition

Imperfections revealed by magnetic particle inspection and determined to be greater in depth than 5 % but not greater than 12,5 % of the specified wall thickness shall be removed by grinding or machining, or the pipe shall be rejected. All imperfections classified as defects by the ultrasonic or electromagnetic equipment which do not exceed 12,5 % of the specified wall thickness in depth shall be removed by grinding or machining, or the pipe shall be rejected.

Pipe with defects whose removal requires grinding or machining to a depth in excess of 12,5 % of the specified wall thickness shall be given a disposition in accordance with 10.15.17. Where grinding or machining is done, generous radii shall be used to prevent abrupt changes in wall thickness, and such areas shall be re-inspected by one of the non-destructive inspection methods specified herein to verify complete removal of the defect.

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A.6 SR12 Statistical impact testing

A.6.1 SR12.1 General

This supplementary requirement specifies a statistical approach to testing. It is applicable only to those items that are accepted or rejected on a lot basis. The frequency of testing is based on standard statistical techniques for properties that have a normal distribution and where the standard deviation for a particular manufacturer, size, chemistry, etc., is not well established. The statistical acceptance and rejection procedures are required only for impact properties; however, the tensile and hardness properties shall be measured on all product where impact samples are taken. Tensile, impact and hardness requirements are as required in Clause 7. The basis of the testing procedure is explained in Note 1 in A.6.5 SR12.5.

A.6.2 SR12.2 Frequency of testing

Every length of product shall be uniquely numbered. This number shall be used for all subsequent identification. Tensile, impact and hardness test specimens for product shall be taken at the same frequency from locations shown in Figure D.9. The sample size for each lot of product shall be selected by the manufacturer from Table C.51 (SR12.1) or Table E.51 (SR12.1).

The factor *F* shown for the sample size selected shall be used in A.6.4 SR12.4 to determine acceptance or rejection of a lot based on the applicable transverse or longitudinal impact requirements. The number of samples is not dependent on the size of the lot. The lengths for testing shall be selected at random, provided the selection procedure provides samples representing at least the start and end of the heat treat cycle and both ends of the tubes (approximately 50 % each end).

By agreement between purchaser and manufacturer, a factor *F* of 3,090 may be used in lieu of the values given in Table C.51 (SR12.1) or Table E.51 (SR12.1) provided the standard deviation of the new lot of material is consistent with past experience.

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A.6.3 SR12.3 Retest

If a tensile test specimen fails to conform to the specified requirements, the manufacturer shall make additional tests on each end of the tubular. If an impact test specimen fails to conform to the specified requirements, the manufacturer shall follow the retest provisions of 10.7.7, 10.7.8 and 10.7.9 and (as applicable). If a hardness test specimen fails to conform to the specified requirements, the manufacturer shall follow the retest provisions of 10.6.14 to 10.6.19 inclusive (as applicable).

If any product is rejected from a lot due to failure to demonstrate acceptable tensile, impact or hardness requirements, then the product tempered immediately before and after the length rejected shall be tested on the same end as the product that was rejected. If one or both of the additional test lengths fail to conform to the specified requirements, the manufacturer may elect to test individually all remaining lengths in the lot, in which case determinations are required only for the particular requirement with which the specimens failed to conform in the preceding tests (i.e. a lot which meets the hardness and impact criteria but which has been rejected due to low elongation shall be retested to verify tensile properties). Specimens for all retests shall be taken in the same manner as the initial test specimen. Tubulars that fail to meet the requirements of Clause 7 shall be rejected.

A.6.4 SR12.4 Acceptable impact energy for any lot of product

Subsequent to impact testing, the mean and standard deviation shall be calculated for the average impact energy values. This calculation shall be made including the data for all lengths rejected due to low impact energy. The lot minimum impact energy S_{min} shall then be estimated (based on the sample data) using Formula (A.1):

$$S_{min} = \bar{S} - F \cdot \sigma_{lot} \tag{A.1}$$

where

S_{min} is the minimum impact energy in joules (foot-pounds);

$\bar{S}$ is the test lot mean impact energy in joules (foot-pounds);

F is the factor determined from Table C.51 (SR12.1) or Table E.51 (SR12.1);

σ_{lot} is the lot standard deviation.

A.6.5 SR12.5 Lot acceptance/rejection

The lot shall be accepted provided S_{min} is greater than or equal to C_V determined in 7.4, 7.5 or 7.6 (as applicable). If S_{min} is less than C_V, then additional random lengths may be selected for testing. The $\bar{S}$, σ_{lot}, and S_{min} shall be determined as above based on all the data and the new F value. The new S_{min} shall exceed C_V determined in 7.4, 7.5 or 7.6, otherwise the lot shall be rejected. Additional random samples may be taken from additional product as many times as necessary, considering that the probability that the string includes one or more lengths whose impact properties do not meet the desired minimum. If the product is rejected as a lot, then each length may be tested to demonstrate that it meets the minimum impact energy requirements of 7.4, 7.5 or 7.6 (as applicable).

Table C.52 (SR12.2) or Table E.52 (SR12.2) gives the probability of a product string of 100 lengths including one or more unacceptable lengths. If the probability of any length being unacceptable is 1 in 1 000 then there is a 10 % chance that the product string will include one or more unacceptable lengths. If the probability of any length being unacceptable is 1 in 10 000, then there is a 1 % chance that the product string will include one or more unacceptable lengths. The statistical model used for the examination frequency is designed to yield an individual tube reliability of 99,9 %. A typical confidence limit of 95 % is used with a tolerance interval approach, since the standard deviation is neither well established nor expected to be consistent for all manufacturers, product sizes, heat treatments, chemistries, etc.

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The tolerance interval approach assumes that the standard deviation is not well known. The factor *F* is large because it includes variations that can be expected in the standard deviation. For example, if the impact requirement is 27 J (20 ft-lb), 5 lengths are sampled and the standard deviation is determined to be 4,1 then the factor *F* is 7,501 (7.501). For the lot to be acceptable, the average transverse impact value shall exceed 27 + (7,501 × 4,1) or 58 J [20 + (7.501 × 3.0) or 43 ft-lb]. If 10 lengths had been sampled and the standard deviation was still 4,1, then the average impact value shall exceed 27 + (5,203 × 4,1) or 48 J [20 + (5.203 × 3.0) or 36 ft-lb]. If the standard deviation from a mill is well known, then the factor *F* is taken for an infinite number of samples of *F* = 3,090 (3.090). Assuming the standard deviation for an infinite number of samples from a given size tubular and one mill is 4,1, then the average impact value shall exceed 27 + (3,090 × 4,1) or 40 J [20 + (3.090 × 3.0) or 29 ft-lb]. The method is applicable to both SI and USC units.

NOTE The procedure in A.6 SR12 is taken from Reference [5]. Table C.51 (SR12.1) or Table E.51 (SR12.1) is taken from Table A-7 in Reference [5]. The procedure to calculate the mean and standard deviation for the average transverse impact energy for the lot can also be found in Reference [5], Chapter 1, Clauses 1 to 6.

A.7 SR13 Seal-ring couplings

A.7.1 SR13.1 Seal-ring groove

Seal-ring couplings shall be grooved in accordance with dimensions and tolerance specified in Figures D.17 (SR13.1) to Figure D.20 (SR13.4). Seal-ring grooves shall be machined in the same set-up used to machine the box threads. Grooves and threads shall be free of fins, wickers and ribbons that are loose or can become loose and fold into the thread form. Couplings shall be inspected after final machining of the groove. The inspection shall be by the wet fluorescent magnetic particle method, using a circumferentially oriented magnetic field, or by another non-destructive method of equal sensitivity as demonstrated to the purchaser. The inspection shall encompass both the inside and outside surfaces. The inspection shall exclude the dry magnetic particle method.

The seal-ring groove dimensions are not the same as those used historically and may not be interchangeable with them.

A.7.2 SR13.2 Non-metallic ring

Dimensions and tolerances of non-metallic rings for seal-ring couplings shall be as specified in Figures D.17 (SR13.1) to Figure D.20 (SR13.4). Rings shall be made from virgin polytetrafluoroethylene (PTFE) with 25 % fibreglass filler. The starting PTFE shall be free of filler.

The seal-ring dimensions are not the same as those used historically and may not be interchangeable with them.

A.7.3 SR13.3 Marking

All couplings that meet the requirements of A.7 SR13 shall be marked "S13" and have a blue band painted around the coupling, see Figure D.28. If the coupling size does not permit separation of markings as shown in Figure D.28, stencil marking may cross over the paint bands. When this occurs, the stencil shall be on top of the band and be of a contrasting colour.

A.8 SR16 Impact testing (Charpy V-notch)

A.8.1 SR16.1 Testing requirements

When A.8 SR16 is specified on the purchase agreement for Grades N80 all types, R95, L80 all types, C90, T95, C110 and P110, the testing provisions of 10.7, which are optional for the manufacturer in accordance with 7.5.5, become mandatory. When A.8 SR16 is specified on the purchase agreement for Grades H40, J55 and K55, the requirements in A.8.2 are mandatory.

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A.8.2 SR16.2 Charpy V-notch test — General requirements

A.8.2.1 SR16.2.1 General

A test shall consist of three specimens from a pipe, taken from each lot in accordance with 10.2. The average result from the three impact specimens shall equal or exceed the absorbed energy requirement specified in A.8.3 SR16.3. In addition, not more than one impact specimen shall exhibit an absorbed energy below the absorbed energy requirement, and in no case shall an individual impact specimen exhibit an absorbed energy below two-thirds of the absorbed energy requirement.

A.8.2.2 SR16.2.2 All grades except Grade Q125 (7.5.3)

Impact testing shall be carried out in accordance with A.8 SR16. The test temperature shall be 21 °C (70 °F) for Grades J55 and K55 and 0°C (32 °F) for all other grades, or a lower temperature by agreement between purchaser and manufacturer.

A.8.2.3 SR16.2.3 Specimen size

Table C.53 (SR16.1) or Table E.53 (SR16.1) provides the calculated wall thickness required to machine full-size, ¾-size, and ½-size transverse impact test specimens. Table C.54 (SR16.2) or Table E.54 (SR16.2) provides the same information for longitudinal impact test specimens. The impact test specimen size that shall be selected from Table C.53 (SR16.1) or Table C.54 (SR16.2) or Table E.53 (SR16.1) or Table E.54 (SR16.2) is the largest impact test specimen having a calculated wall thickness that is less than the specified wall thickness for the pipe tested.

When the use of full-size (10 mm × 10 mm) transverse test specimens is not possible, the largest possible sub-size transverse test specimen listed in Table C.55 (SR16.3) or Table E.55 (SR16.3) shall be used. When it is not possible [or allowed in accordance with A.8.2.4 SR16.2.4] to test using any of these transverse test specimens, the largest possible longitudinal test specimen listed in Table C.55 (SR16.3) or Table E.55 (SR16.3) shall be used.

When the outside diameter or wall thickness precludes machining longitudinal impact test specimens ½-size or larger, the pipe need not be tested; however, the manufacturer shall use a chemical composition and processing that is documented and demonstrated to result in impact energy absorption in excess of the minimum specified requirement.

A.8.2.4 SR16.2.4 Specimen allowance for outside diameter curvature

The surface of the finish-machined transverse test specimens may contain the outside diameter curvature of the original tubular product provided that the requirements of Figure D.21 (SR16.1) are met. These specimens shall be used only to permit the use of a transverse specimen of maximum thickness.

A.8.2.5 SR16.2.5 Hierarchy of test specimens

The hierarchy of test specimen orientation and size is as specified in Table C.56 (SR16.4) or Table E.56 (SR16.4).

A.8.2.6 SR16.2.6 Alternative-size impact test specimens

At the manufacturer's option, alternative-size impact test specimens, listed in Table C.55 (SR16.3) or Table E.55 (SR16.3), may be used in lieu of the minimum size specified in the tables referenced in A.8.2.2 (SR16.2.2). However, the alternative test specimen size shall be higher on the hierarchy table [Table C.56 (SR16.4) or Table E.56 (SR16.4)] than the specified size, and the absorbed energy requirement shall be adjusted consistent with the impact specimen orientation and size selected.

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A.8.2.7 SR16.2.7 Absorbed energy requirement for sub-size specimens

The minimum CVN absorbed energy requirement, C_V, for sub-size test specimens shall be that specified for a full-size test specimen multiplied by the reduction factor in Table C.55 (SR16.3) or Table E.55 (SR16.3); however, in no event shall a sub-size test specimen be used if the reduced absorbed energy requirement is less than 11 J (8 ft-lb).

A.8.3 SR16.3 Charpy V-notch test — Impact requirements for pipe and for accessory material for externally threaded accessories

A.8.3.1 SR16.3.1 Grade H40 only

The minimum full-size transverse CVN absorbed energy requirement, $C_{V,}$ is 16 J (12 ft-lb) for all wall thicknesses.

The minimum full-size longitudinal CVN absorbed energy requirement, $C_{V,}$ is 20 J (15 ft-lb) for all wall thicknesses.

A.8.3.2 SR16.3.2 Grades J55 and K55 only

The minimum full-size transverse CVN absorbed energy requirement, $C_{V,}$ is 20 J (15 ft-lb) for all wall thicknesses.

The minimum full-size longitudinal CVN absorbed energy requirement, $C_{V,}$ is 27 J (20 ft-lb) for all wall thicknesses.

A.8.4 SR16.4 Accessory material for accessories with integral joint API tubing connections

The requirements in 7.4 shall apply. The critical thickness shall be as specified in 7.3.2 and 7.6.6.

A.8.5 SR16.5 Accessory material for accessories with internal special end-finish connections that do not have thread interference

The requirements in A.8.3 SR16.3 apply. The critical thickness shall be as specified in 7.3.2 and 7.6.6.

A.8.6 SR16.6 Impact test procedures

A.8.6.1 SR16.6.1 General procedures

CVN Type A impact tests shall be conducted as specified in ASTM A370 and ASTM E23. When transverse impact test specimens are used for EW pipe, the test specimen shall be machined with the notch at the weld line. When longitudinal impact test specimens are used for EW pipe, the test specimens shall be taken from a location approximately 90° from the weld. Impact test specimens shall not be machined from flattened tubulars.

A.8.6.2 SR16.6.2 Specimen orientation

Specimen orientation shall be in accordance with Figure D.11.

A.8.6.3 SR16.6.3 Test temperature

The test temperature for full-size test specimens shall be specified by the purchaser as

a) +21 °C (+70 °F), or

b) 0 °C (+32 °F), or

c) –10 °C (+14 °F), or

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d) other temperature as specified on the purchase agreement.

The tolerance on the test temperature for full-size test specimens shall be ±3 °C (±5 °F).

The test temperature shall be reduced as specified in A.8.6.5 SR16.6.5 for Grades H40, J55 and K55 when sub-size test specimens are required.

NOTE The Grades H40, J55 and K55 are low strength steels considered to be loading-rate sensitive. Increasing the loading rate from that generally occurring in the use of the product to the loading rate occurring in the impact testing of the Charpy specimens results in shifting the fracture transition to higher temperatures. Thus, the fracture transition behaviour of the product would be expected to occur at temperatures lower than those obtained with Charpy testing. In most applications, testing Grades H40, J55 and K55 at +21 °C (+70 °F) and higher strength grades at 0 °C (+32 °F) can be adequate. If the pipe will be handled at temperatures below –18 °C (0 °F), a lower impact test temperature can be appropriate.

A.8.6.4 SR16.6.4 Defective specimens

Any test specimen that shows defective preparation or material imperfections unrelated to the intent of the test, whether observed before or after testing, may be discarded and be replaced by another specimen from the same length of pipe. Specimens shall not be judged defective simply because they failed to exhibit the minimum absorbed energy requirement.

A.8.6.5 SR16.6.5 Sub-size test temperature reduction — Grades H40, J55 and K55 only

A test temperature reduction may be required when sub-size test specimens are used. The test temperature reduction depends on the thickness of the pipe and the size of the impact test specimen.

The test temperature reduction specified in Table C.57 (SR16.7) or Table E.57 (SR16.7) shall be used when applicable.

A.8.6.6 SR16.6.6 Frequency of testing

One test shall be made on one pipe from each lot.

A.8.6.7 SR16.6.7 Retest of a pipe or accessory material

If the results from more than one specimen are below the specified minimum absorbed energy requirement or if one value is below two-thirds of the specified minimum absorbed energy requirement, a retest shall be carried out on three additional specimens from the same product. The impact energy of each of the retest specimens shall equal or exceed the specified minimum absorbed energy requirement or the product shall be rejected.

A.8.6.8 SR16.6.8 Replacement of a reject pipe or accessory material

If the results of a test do not meet the requirements of A.8.3 SR16.3, A.8.4 SR16.4 or A.8.5 SR16.5 as applicable and do not qualify for retesting accordance with A.8.6.7 SR16.6.7, then an additional three test specimens shall be removed from each of three additional products from the lot. If all the additional products tested conform to the requirements, then the lot shall be qualified except for the product that was initially rejected. If one or more of the additional test products fail to conform to the specified requirements, the manufacturer may elect to test individually the remaining product in the lot or re-heat-treat and test the lot as a new lot.

A.8.6.9 SR16.6.9 Rounding procedures

For purposes of determining conformance with these requirements, an observed value shall be rounded to the nearest whole number in accordance with the rounding method of ISO 80000-1 or ASTM E29. Further, limiting values as specified or calculated shall be expressed as whole numbers, rounded if necessary.

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A.8.7 SR16.7 Reporting

The size and orientation of the test specimen (i.e. full-size, ¾-size or ½-size), the actual test temperature (i.e. specified temperature less the test temperature reduction that may be applicable for Grades H40, J55, and K55), the results of the individual specimens (i.e. the impact energy absorption and the percentage shear), and the average absorbed energy shall be reported to the purchaser.

A.8.8 SR16.8 Marking

Product tested in accordance with this supplementary requirement shall be marked to indicate A.8 SR16, the minimum full-size energy absorption requirement, and the specified test temperature (i.e. not including the test temperature reduction that may be applicable for Grades H40, J55 and K55) preceded by a positive or negative sign. This marking shall be paint-stencilled after the grade designation.

Example for SI units: S16-20-10C

Example for USC units: S16-15+14F

A.9 SR22 Enhanced leak resistance, LC

A.9.1 General

By agreement between purchaser and manufacturer, the supplementary requirements for enhanced leak resistance LC in SR22 shall apply. It should be noted that the SR22 product is fully interchangeable with standard API LC connections. However, the SR22 design criteria concerning leak resistance shall not apply for such mixed product.

NOTE 1 Other provisions for the implementation of SR22 are found in API Spec 5B, API RP 5B1 and API RP 5C1.

Liquid metal embrittlement may result if thread compound containing lead is used with tin-plated couplings at elevated temperatures for some materials. Use of thread compounds containing lead in applications involving temperatures in excess of 135 °C (275 °F) is cautioned.

NOTE 2 The application of API connections or pipe at elevated temperature or in sour service conditions is beyond the scope of this document.

A.9.2 SR22 Enhanced leak resistance

A.9.2.1 SR22.1

Casings and couplings shall be furnished with enhanced leak resistance connections (LC) in accordance with the requirements specified in API Spec 5B SR22 for dimensions, inspection and coupling thread coatings.

A.9.2.2 SR22.2.a Die stamp-marking the end of the pipe

An equilateral triangle die stamp 6,35 mm (¼ in) high shall be placed at a distance of L_9 from each end of each pipe using Method 3, 4 or 5 of 11.2.1. See Figure D.22 SR22-1.

A.9.2.3 SR22.2.b Paint-marking the end of the pipe

High-visibility green paint marks shall be applied on the field end of each pipe. See Figure D.22 SR22-1.

A.9.2.4 SR22.2.c Die stamp-marking the couplings

All couplings shall be marked “S22” using Method 3 or 5 of 11.2.1.

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A.9.2.5 SR22.2.d Colour-banding the couplings

Couplings shall be colour-banded with the colour(s) indicative of the steel grade from which the couplings are manufactured and shall also be painted with a high-visibility green band around the outside surface near one end of the coupling.

A.9.2.6 SR22.3 Optional tapered bore requirement for casing with special drift requirements

For casing ordered with a drift mandrel of diameter larger than standard (see 8.10), the manufacturer may drift or bore along the inside diameter of the ends of the pipe. This option requires either of the following treatments for both ends of the pipe:

a) to be drifted with a special end drift with a minimum diameter in accordance with the "special end drift diameter" column of Option 1 in Figure D.23 (SR22.2). The drift shall be inserted a distance equal to or greater than L_9. Pipe ends that are too small to accept the special end drift shall be bored along the inside diameter in accordance with b) below;

b) to be finished with a tapered bore along the inside diameter with a taper between 2° and 15°, the maximum diameter of the machined surface at the end of the pipe "(chamfer diameter d_0)", and the angle of the tapered bore shall be in accordance with Option 2 in Figure D.23 (SR22.2). The tapered bore machined surface need not run continuously around the inside circumference. The bore shall run smoothly to the pipe inside diameter. If bored, the inside diameter of every pin end shall meet the requirements of Option 2 "d_0".

A.9.2.7 SR22.4.1 Application of thread compound

ISO 13678 or API RP 5A3 thread compound shall be applied in one of the three following locations:

— to the pin end only;

— to the coupling thread only;

— to the pin in a band approximately 25 mm (1 in) wide at the large end of the thread and to the entire coupling thread.

In all cases, the full thread-form outline shall be clearly discernible after applying thread compound evenly over the surface.

It should be recognized by the user that conformance with ISO 13678 or API RP 5A3 does not ensure adequate thread compound system performance in field service. The user has the responsibility of evaluating the results obtained from the procedures and test protocols and determining if the thread compound system in question meets the anticipated requirements of that particular field service application.

A.9.2.8 SR22.4.2 Coupling make-up

SR22 requires make-up based on power turns and position, not torque. Torque is not a basis for acceptance or rejection, but is an indicator of process control. Make-up shall be rejected when the coupling does not achieve the position criteria with minimum power-turns.

A.9.2.9 SR22.4.3 Coupling make-up speed

Power make-up speed shall not exceed 10 r/min.

A.9.2.10 SR22.4.4 Coupling make-up acceptance criteria

Options are allowed for SR22 connection make-up. Make-up shall be rejected when the coupling does not make the position criteria with minimum power-turns. Any connection in which the face of the

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coupling advances beyond the apex of the triangle shall be rejected. The coupling make-up shall be verified by one of the following methods:

a) by power turns: the number of power turns shall equal or exceed the minimum number of power turns specified in Table C.57 (SR22.1) or Table E.57 (SR22.1). Counting power turns should start at a reference start torque specified in Table C.57 (SR22.1) or Table E.57 (SR22.1). Ensure proper alignment in make-up equipment and identity, and minimize abnormal sources of torque oscillation;

b) by position: make up the face of the coupling within the triangle mark. Verify that the number of power turns equals or exceeds the number of power turns specified in Table C.57 (SR22.1) or Table E.57 (SR22.1) during operations.

A.9.2.11 SR22.4.5 Coupling break-out and make-up

If a connection is broken out, subsequent make-up shall be in accordance with A.9.2.10 SR22.4.4.

A.10 SR38 Statistical tensile testing — Grades C90, T95 and C110

A.10.1 SR38.1 General

This method shall be used when specified on the purchase agreement or at the option of the manufacturer to either

— test all lengths in the lot, or

— determine the acceptance of the minimum yield strength for the lot, as defined in 10.2 on a statistical basis.

NOTE A.10 SR38 is intended to be used when the specified yield strength range is less than 103 MPa (15 ksi).

A.10.2 SR 38.2 Frequency of testing

The tensile test frequency shall not be less than one per 20 pipes. If the lot size is less than 20 pipes each pipe shall be tested. The selection of the pipes for testing shall be at random but shall include samples over the full lot. The lot may contain any number of lengths provided the requirements of 10.2.2 are met.

A.10.3 SR38.3 Yield strength determination

The yield strength of each pipe shall be determined as specified in 10.4. The acceptance or rejection of the yield strength for a lot shall be determined based on the mean and standard deviation for the lot. The mean and standard deviation shall be determined using standard statistical methods.

When determining the mean and standard deviation for the lot, all valid (see 10.4.8) test data on pipe from the lot shall be included. This includes data for all tests for mill control and any pipes that are determined not to conform to the yield strength requirements. The lot is acceptable if the mean yield strength for the lot minus 1,74 times the standard deviation for the lot is greater than or equal to the specified minimum yield strength in Table C.5 or Table E.5.

NOTE The factor of 1,74 above is based on an Acceptable Quality Limit (AQL) of 0,01, a Rejectable Quality Limit (RQL) of 0,10, an Alpha of 0,05 and a Beta of 0,10.

A.10.4 SR38.4 Additional testing to qualify a lot

The manufacturer may elect to tensile test additional pipes (i.e. in excess of the minimum of 20 pipes per lot specified in A.10.2 SR38.2). The additional pipes shall be selected at random. The data from the original tests and the additional tests shall be used to determine acceptance as specified in A.10.3 SR 38.3.

The manufacturer may elect to test as many additional pipes as necessary to attempt to improve the mean yield strength or to lower the standard deviation to meet the acceptance criteria in A.10.3 SR38.3.

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A.10.5 SR38.5 Retests to qualify a pipe

If the original tensile specimen from a pipe fails to conform to the specified requirements, the manufacturer shall either reject the pipe or make additional tensile tests (as specified in 10.4) on both ends of the pipe in question. The results of both of the retests shall meet the requirements of Table C.5 or Table E.5. In addition, the average of the initial test data and the two retests shall meet the requirements of Table C.5 or Table E.5 or the pipe shall be rejected. The average yield strength for the pipe (i.e. based on the original test and the two retests) shall replace the original test data and be used to determine the mean and standard deviation for the qualification of the lot as specified in A.10.3 SR 38.3.

No other additional testing shall be allowed to qualify a pipe.

Rejected lots may be re-heat treated and tested as new lots.

A.11 SR39 Alternative ANSI/NACE TM0177-2016 Method D Sulfide stress cracking (SSC) tests — Grade C110

A.11.1 SR39.1 Test requirements

For each lot, as defined in 10.2, manufacturers shall carry out an ANSI/NACE TM0177:2016 Method D test with the test solution specified in A.11.3 SR39.3. The test results shall not be used to determine conformance of the product to this document.

A.11.2 SR39.2 Test sample selection and location

Test sample selection and location shall be in accordance with 7.14.3.

A.11.3 SR39.3 Alternative test solution

ANSI/NACE TM0177-2016 Test Solution D shall be used.

The test gas shall be premixed and certified by the provider of the test gas.

The ANSI/NACE TM0177-2016, 11.5.6 requirement for documented validation of test solution saturation shall include analysis using the iodometric titration procedure in ANSI/NACE TM0177-2016 Appendix C or other validated and documented method.

A.11.4 SR39.4 Test conditions

All test results shall be included when calculating the mean value.

A standard test specimen thickness of 9,53 mm (0.375 in) shall be used except as allowed by 7.14.2, d).

Either non-pre-cracked or fatigue pre-cracked specimens may be used. If fatigue pre-cracking of specimens is employed, the maximum stress intensity factor during pre-cracking shall not exceed 20,7 MPa$\sqrt{m}$ (18.6 ksi$\sqrt{in}$).

The arm displacement shall be 0,89 mm +0,03 mm, –0,05 mm (0.035 in +0.001 in, –0.002 in).

A.11.5 SR39.5 Invalidation of tests

Invalidation of tests shall be in accordance with 7.14.6.

A.11.6 SR39.6 Additional testing provisions

Additional test provisions shall be in accordance with 7.14.7.

The length of the dry cracking, if any, shall be reported for information only.

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A.12 SR40 Electric-welded casing, tubing and pup joints, Grades H40, J55, K55, N80 all types and L80 Type 1

A.12.1 SR40.1 Height and trim of electric-weld flash

No inside flash height shall be permitted. The groove on the inside weld surface shall not exceed a depth of 0,38 mm (0.015 in) and shall not contain any geometry that would interfere with ultrasonic inspection.

Pipe with weld flash exceeding these limits shall be either rejected or repaired by grinding.

A.12.2 SR40.2 Non-destructive examination of weld seam

For the weld seam of welded pipe, ultrasonic inspection systems for verification, other than wall thickness verification, shall use reference standards containing notches and holes as described in Tables C.43 and C.44 or Tables E.43 and E.44 to verify equipment response from artificial reference indicators.

The inspection equipment shall be adjusted to produce a well-defined indication from each reference indicator when the reference standard is scanned by the inspection system(s). Responses from the notches and hole shall meet the required system(s) sensitivity level. Outside-wall and inside-wall notches of reduced length may be used by agreement between the purchaser and manufacturer.

A.13 SR41 Yield Strength — Grade Q125

The maximum yield strength shall be 965 MPa (140 ksi).

A.13.1 Marking

All products meeting the requirements of A.13 SR41 shall be marked as specified in Table C.48 or E.48.

A.14 SR42 Charpy V-notch test properties — Grades N80 all types, L80 Type 1, C90, R95, T95, P110 and Q125

Either

a) The minimum shear area shall be 75%, in accordance with ASTM E23, or

b) The manufacturer may use a documented procedure (taking into account, as a minimum, variations in chemistry, diameter and wall thickness) together with the impact test results to demonstrate that the upper shelf behaviour is achieved

If the minimum shear area is less than 75% or if the requirements of b) are not met, then either the material shall be rejected or a transition curve shall be made to demonstrate that the product is on the upper shelf at the specified test temperature (either the standard test temperature or a reduced test temperature specified by the purchaser).

A.15 SR43 NDE of pipe ends — Grades L80 13Cr, C90, T95 and Q125

The pipe ends shall be either treated in accordance with 10.15.14 a) or c), or inspected after end finishing (and before coupling installation on threaded and coupled tubular) using the wet magnetic-particle method, or a method agreed between purchaser and manufacturer.

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A.16 SR44 Hardenability — Minimum percentage martensite required for quenched and tempered products

A.16.1 SR44.1 Grade L80 Type 1

A full-body as-quenched sample shall be taken in accordance with a documented procedure to confirm sufficient hardening for each size, mass, chemical composition, and austenitise and quench combination. To be in conformance with this document, the mean hardness numbers (see 10.6.10) obtained during the documented procedure shall equal or exceed the hardness corresponding to 90 % minimum martensite, as determined by Formula (A.2):

$$\mathrm{HRC}_{\min} = 58 \times (\%\mathrm{carbon}) + 27 \tag{A.2}$$

A.16.2 SR44.2 Grades C90 and T95

The mean hardness numbers obtained as specified in 7.10.1 shall equal or exceed the hardness corresponding to a minimum of 95 % martensite as determined by Formula (A.3):

$$\mathrm{HRC}_{\min} = 59 \times (\%\mathrm{carbon}) + 29 \tag{A.3}$$

For product with a wall thickness of 30 mm (1.181 in) or larger, an alternative requirement may be used by agreement between manufacturer and purchaser.

A.17 SR45 Sulfide stress-cracking (SSC) test — Grades L80 Type 1, C90 and T95

If Method A is specified for the SSC test (in accordance with ANSI/NACE TM0177-2016), manufacturers shall, for each lot as defined in 10.2, demonstrate that the product meets or exceeds the 90 % $YS_{\min}$ requirement for three specimens, one each from the ends of three different products selected from sub-lots composed of the front one-third, middle one-third and back one-third of the lot. The selection criteria in 7.14.3 shall apply to each of the sub-lots, including the random selection by agreement.

A retest may be carried out if only one of the initial specimens fails. If more than one of the initial specimens fails, the lot shall be rejected. A retest may be performed on two further test specimens taken from an area of the product adjacent to where the initial failed test specimen was taken. If either of the retest specimens fails, the lot shall be rejected. Rejected lots may be re-heat treated and tested as new lots.

By agreement between the purchaser and manufacturer, the number of specimens per lot required may be reduced to no less than one with a process control plan that is sufficient to ensure that the product meets or exceeds the 90 % $YS_{\min}$ threshold.

A.18 SR 46 Hardness testing — Non-upset pipe, Grades C90 and T95 (10.6.5)

A test ring shall be cut from both ends of each pipe.

A.19 SR 47 High Collapse Resistance (Annex H)

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Annex B
(normative)

Purchaser inspection

B.1 Inspection notice

If the inspector representing the purchaser desires to inspect the product or witness a test, reasonable notice shall be given of the time at which the run is intended to be made.

B.2 Plant access

The inspector representing the purchaser shall have unrestricted access, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which will concern the manufacturer of the products ordered. The manufacturer shall afford the inspector all reasonable facilities to satisfy the inspector that the product is being manufactured in accordance with this document. All inspections should be made prior to shipment at the place of manufacture or processing, unless otherwise specified on the purchase agreement, and shall be so conducted as not to interfere unnecessarily with the operation of the works.

B.3 Conformance

The manufacturer is responsible for conforming with all of the provisions of this document. The purchaser may make any investigation necessary to ensure conformance by the manufacturer and may reject any product that does not comform with this document.

B.4 Rejection

Unless otherwise provided, material which shows defects on inspection or subsequent to acceptance at manufacturer's works, or which proves defective when properly applied in service, may be rejected, and the manufacturer so notified. If tests that require the destruction of material are made, any product which is proven not to meet the requirements of this document shall be rejected. Disposition of rejected product shall be a matter of agreement between purchaser and manufacturer.

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Annex C
(normative)

Tables in SI units

NOTE The numbers in italics in the table headers indicate column numbers.

Table C.1 — ISO/API casing list — Sizes, masses, wall thickness, grade and applicable end-finish

Labels[a]		Outside diameter	Nominal linear mass[b,c] T&C	Wall thickness	Type of end-finish[d]							
1	2	*D* mm	kg/m	*t* mm	H40	J55 K55	L80 R95	N80	C90 T95	C110	P110	Q125
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*
4-1/2	9.50	114,30	14,38	5,21	PS	PS	—	—	—	—	—	—
4-1/2	10.50	114,30	15,73	5,69	—	PSB	—	—	—	—	—	—
4-1/2	11.60	114,30	17,38	6,35	—	PSLB	PLB	PLB	PLB	P	PLB	—
4-1/2	13.50	114,30	19,87	7,37	—	—	PLB	PLB	PLB	P	PLB	—
4-1/2	15.10	114,30	22,69	8,56	—	—	—	—	—	—	PLB	PLB
5	11.50	127,00	17,19	5,59	—	PS	—	—	—	—	—	—
5	13.00	127,00	19,69	6,43	—	PSLB	—	—	—	—	—	—
5	15.00	127,00	22,69	7,52	—	PSLB	PLB	PLB	PLB	P	PLB	—
5	18.00	127,00	27,19	9,19	—	—	PLB	PLB	PLB	P	PLB	PLB
5	21.40	127,00	32,13	11,10	—	—	PLB	PLB	PLB	P	PLB	PLB
5	23.20	127,00	34,76	12,14	—	—	PLB	PLB	PLB	P	PLB	PLB
5	24.10	127,00	36,15	12,70	—	—	PLB	PLB	PLB	P	PLB	PLB

Key

P: Plain-end

S: Short round thread

L: Long round thread

B: Buttress thread

[a] Labels are for information and assistance in ordering.

[b] Nominal linear masses (col. 4) are shown for information only.

[c] The density of martensitic chromium steel (L80 Type 13Cr) is different from carbon steels. The masses shown are therefore not accurate for martensitic chromium steels. A mass correction factor of 0,989 may be used.

[d] Buttress casing is available with regular, special clearance couplings or special clearance couplings with special bevel.

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Table C.1 *(continued)*

Labels[a]		Outside diameter	Nominal linear mass[b,c] T&C	Wall thickness	Type of end-finish[d]							
1	2	*D* mm	kg/m	*t* mm	H40	J55 K55	L80 R95	N80	C90 T95	C110	P110	Q125
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*
5-1/2	14.00	139,70	20,91	6,20	PS	PS	—	—	—	—	—	—
5-1/2	15.50	139,70	23,48	6,98	—	PSLB	—	—	—	—	—	—
5-1/2	17.00	139,70	25,72	7,72	—	PSLB	PLB	PLB	PLB	P	PLB	—
5-1/2	20.00	139,70	30,05	9,17	—	—	PLB	PLB	PLB	P	PLB	—
5-1/2	23.00	139,70	34,05	10,54	—	—	PLB	PLB	PLB	P	PLB	PLB
5-1/2	26.80	139,70	40,15	12,70	—	—	—	—	P	P	—	—
5-1/2	29.70	139,70	44,47	14,27	—	—	—	—	P	P	—	—
5-1/2	32.60	139,70	48,74	15,88	—	—	—	—	P	P	—	—
5-1/2	35.30	139,70	52,80	17,45	—	—	—	—	P	P	—	—
5-1/2	38.00	139,70	56,82	19,05	—	—	—	—	P	P	—	—
5-1/2	40.50	139,70	60,64	20,62	—	—	—	—	P	P	—	—
5-1/2	43.10	139,70	64,41	22,22	—	—	—	—	P	P	—	—
6-5/8	20.00	168,28	29,76	7,32	PS	PSLB	—	—	—	—	—	—
6-5/8	24.00	168,28	35,72	8,94	—	PSLB	PLB	PLB	PLB	P	PLB	—
6-5/8	28.00	168,28	41,67	10,59	—	—	PLB	PLB	PLB	P	PLB	—
6-5/8	32.00	168,28	47,62	12,06	—	—	PLB	PLB	PLB	P	PLB	PLB
7	17.00	177,80	25,60	5,87	PS	—	—	—	—	—	—	—
7	20.00	177,80	29,91	6,91	PS	PS	—	—	—	—	—	—
7	23.00	177,80	34,67	8,05	—	PSLB	PLB	PLB	PLB	P	—	—
7	26.00	177,80	39,14	9,19	—	PSLB	PLB	PLB	PLB	P	PLB	—
7	29.00	177,80	43,60	10,36	—	—	PLB	PLB	PLB	P	PLB	—
7	32.00	177,80	47,92	11,51	—	—	PLB	PLB	PLB	P	PLB	—
7	35.00	177,80	52,09	12,65	—	—	PLB	PLB	PLB	P	PLB	PLB
7	38.00	177,80	56,10	13,72	—	—	PLB	PLB	PLB	P	PLB	PLB
7	42.70	177,80	63,84	15,88	—	—	—	—	P	P	—	—
7	46.40	177,80	69,35	17,45	—	—	—	—	P	P	—	—
7	50.10	177,80	74,85	19,05	—	—	—	—	P	P	—	—
7	53.60	177,80	80,21	20,62	—	—	—	—	P	P	—	—
7	57.10	177,80	85,42	22,22	—	—	—	—	P	P	—	—

Key

P: Plain-end

S: Short round thread

L: Long round thread

B: Buttress thread

[a] Labels are for information and assistance in ordering.

[b] Nominal linear masses (col. 4) are shown for information only.

[c] The density of martensitic chromium steel (L80 Type 13Cr) is different from carbon steels. The masses shown are therefore not accurate for martensitic chromium steels. A mass correction factor of 0,989 may be used.

[d] Buttress casing is available with regular, special clearance couplings or special clearance couplings with special bevel.

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Table C.1 *(continued)*

Labels[a]		Outside diameter	Nominal linear mass[b,c] T&C	Wall thickness	Type of end-finish[d]							
1	2	*D* mm	kg/m	*t* mm	H40	J55 K55	L80 R95	N80	C90 T95	C110	P110	Q125
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*
7-5/8	24.00	193,68	35,72	7,62	PS	—	—	—	—	—	—	—
7-5/8	26.40	193,68	39,29	8,33	—	PSLB	PLB	PLB	PLB	P	—	—
7-5/8	29.70	193,68	44,20	9,52	—	—	PLB	PLB	PLB	P	PLB	—
7-5/8	33.70	193,68	50,15	10,92	—	—	PLB	PLB	PLB	P	PLB	—
7-5/8	39.00	193,68	58,04	12,70	—	—	PLB	PLB	PLB	P	PLB	PLB
7-5/8	42.80	193,68	63,69	14,27	—	—	PLB	PLB	PLB	P	PLB	PLB
7-5/8	45.30	193,68	67,41	15,11	—	—	PLB	PLB	PLB	P	PLB	PLB
7-5/8	47.10	193,68	70,09	15,88	—	—	PLB	PLB	PLB	P	PLB	PLB
7-5/8	51.20	193,68	76,19	17,45	—	—	—	—	P	P	—	—
7-5/8	55.30	193,68	82,30	19,05	—	—	—	—	P	P	—	—
7-3/4	46.10	196,85	68,60	15,11	—	—	P	P	P	P	P	P
8-5/8	24.00	219,08	35,72	6,71	—	PS	—	—	—	—	—	—
8-5/8	28.00	219,08	41,67	7,72	PS	—	—	—	—	—	—	—
8-5/8	32.00	219,08	47,62	8,94	PS	PSLB	—	—	—	—	—	—
8-5/8	36.00	219,08	53,57	10,16	—	PSLB	PLB	PLB	PLB	P	—	—
8-5/8	40.00	219,08	59,53	11,43	—	—	PLB	PLB	PLB	P	PLB	—
8-5/8	44.00	219,08	65,48	12,70	—	—	PLB	PLB	PLB	P	PLB	—
8-5/8	49.00	219,08	72,92	14,15	—	—	PLB	PLB	PLB	P	PLB	PLB
9-5/8	32.30	244,48	48,07	7,92	PS	—	—	—	—	—	—	—
9-5/8	36.00	244,48	53,57	8,94	PS	PSLB	—	—	—	—	—	—
9-5/8	40.00	244,48	59,53	10,03	—	PSLB	PLB	PLB	PLB	P	—	—
9-5/8	43.50	244,48	64,73	11,05	—	—	PLB	PLB	PLB	P	PLB	—
9-5/8	47.00	244,48	69,94	11,99	—	—	PLB	PLB	PLB	P	PLB	PLB
9-5/8	53.50	244,48	79,62	13,84	—	—	PLB	PLB	PLB	P	PLB	PLB
9-5/8	58.40	244,48	86,91	15,11	—	—	PLB	PLB	PLB	P	PLB	PLB
9-5/8	59.40	244,48	88,40	15,47	—	—	—	—	P	P	—	—
9-5/8	64.90	244,48	96,58	17,07	—	—	—	—	P	P	—	—
9-5/8	70.30	244,48	104,62	18,64	—	—	—	—	P	P	—	—
9-5/8	75.60	244,48	112,50	20,24	—	—	—	—	P	P	—	—

Key

P: Plain-end

S: Short round thread

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B: Buttress thread

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[b] Nominal linear masses (col. 4) are shown for information only.

[c] The density of martensitic chromium steel (L80 Type 13Cr) is different from carbon steels. The masses shown are therefore not accurate for martensitic chromium steels. A mass correction factor of 0,989 may be used.

[d] Buttress casing is available with regular, special clearance couplings or special clearance couplings with special bevel.

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Table C.1 *(continued)*

Labels[a]		Outside diameter	Nominal linear mass[b,c] T&C	Wall thickness	Type of end-finish[d]							
1	2	*D* mm	kg/m	*t* mm	H40	J55 K55	L80 R95	N80	C90 T95	C110	P110	Q125
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*
10-3/4	32.75	273,05	48,74	7,09	PS	—	—	—	—	—	—	—
10-3/4	40.50	273,05	60,27	8,89	PS	PSB	—	—	—	—	—	—
10-3/4	45.50	273,05	67,71	10,16	—	PSB	—	—	—	—	—	—
10-3/4	51.00	273,05	75,90	11,43	—	PSB	PSB	PSB	PSB	P	PSB	—
10-3/4	55.50	273,05	82,59	12,57	—	—	PSB	PSB	PSB	P	PSB	—
10-3/4	60.70	273,05	90,33	13,84	—	—	—	—	PSB	P	PSB	PSB
10-3/4	65.70	273,05	97,77	15,11	—	—	—	—	PSB	P	PSB	PSB
10-3/4	73.20	273,05	108,93	17,07	—	—	—	—	P	P	—	—
10-3/4	79.20	273,05	117,86	18,64	—	—	—	—	P	P	—	—
10-3/4	85.30	273,05	126,94	20,24	—	—	—	—	P	P	—	—
11-3/4	42.00	298,45	62,50	8,46	PS	—	—	—	—	—	—	—
11-3/4	47.00	298,45	69,94	9,53	—	PSB	—	—	—	—	—	—
11-3/4	54.00	298,45	80,36	11,05	—	PSB	—	—	—	—	—	—
11-3/4	60.00	298,45	89,29	12,42	—	PSB	PSB	PSB	PSB	P	PSB	PSB
11-3/4	65.00	298,45	96,73	13,56	—	—	P	P	P	P	P	P
11-3/4	71.00	298,45	105,66	14,78	—	—	P	P	P	P	P	P
13-3/8	48.00	339,72	71,43	8,38	PS	—	—	—	—	—	—	—
13-3/8	54.50	339,72	81,10	9,65	—	PSB	—	—	—	—	—	—
13-3/8	61.00	339,72	90,78	10,92	—	PSB	—	—	—	—	—	—
13-3/8	68.00	339,72	101,19	12,19	—	PSB	PSB	PSB	PSB	P	PSB	—
13-3/8	72.00	339,72	107,15	13,06	—	—	PSB	PSB	PSB	P	PSB	PSB
16	65.00	406,40	96,73	9,53	PS	—	—	—	—	—	—	—
16	75.00	406,40	111,61	11,13	—	PSB	—	—	—	—	—	—
16	84.00	406,40	125,01	12,57	—	PSB	—	—	—	—	—	—
16	109.00	406,40	162,21	16,66	—	P	P	P	—	—	P	P
18-5/8	87.50	473,08	130,21	11,05	PS	PSB	—	—	—	—	—	—
20	94.00	508,00	139,89	11,13	PSL	PSLB	—	—	—	—	—	—
20	106.50	508,00	158,49	12,70	—	PSLB	—	—	—	—	—	—
20	133.00	508,00	197,93	16,13	—	PSLB	—	—	—	—	—	—

Key

P: Plain-end

S: Short round thread

L: Long round thread

B: Buttress thread

[a] Labels are for information and assistance in ordering.

[b] Nominal linear masses (col. 4) are shown for information only.

[c] The density of martensitic chromium steel (L80 Type 13Cr) is different from carbon steels. The masses shown are therefore not accurate for martensitic chromium steels. A mass correction factor of 0,989 may be used.

[d] Buttress casing is available with regular, special clearance couplings or special clearance couplings with special bevel.

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Table C.2 — ISO/API tubing list — Sizes, masses, wall thickness, grade and applicable end-finish

Labels				Out-side diam-eter	Nominal linear masses[a,b]			Wall thick-ness	Type of end finish I I						
1	2				Non-upset T&C	Ext. upset T&C	Integ. joint								
	NU T&C	EU T&C	IJ	*D* mm	kg/m	kg/m	kg/m	*t* mm	H40	J55	L80 R95	N80	C90	T95	P110
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*
1.050	1.14	1.20	—	26,67	1,70	1,79	—	2,87	PNU	PNU	PNU	PNU	PNU	PNU	—
1.050	1.48	1.54	—	26,67	2,20	2,29	—	3,91	PU	PU	PU	PU	PU	PU	PU
1.315	1.70	1.80	1.72	33,40	2,53	2,68	2,56	3,38	PNUI	PNUI	PNUI	PNUI	PNUI	PNUI	—
1.315	2.19	2.24	—	33,40	3,26	3,33	—	4,55	PU	PU	PU	PU	PU	PU	PU
1.660	2.09	—	2.10	42,16	—	—	3,13	3,18	PI	PI	—	—	—	—	—
1.660	2.30	2.40	2.33	42,16	3,42	3,57	3,47	3,56	PNUI	PNUI	PNUI	PNUI	PNUI	PNUI	—
1.660	3.03	3.07	—	42,16	4,51	4,57	—	4,85	PU	PU	PU	PU	PU	PU	PU
1.900	2.40	—	2.40	48,26	—	—	3,57	3,18	PI	PI	—	—	—	—	—
1.900	2.75	2.90	2.76	48,26	4,09	4,32	4,11	3,68	PNUI	PNUI	PNUI	PNUI	PNUI	PNUI	—
1.900	3.65	3.73	—	48,26	5,43	5,55	—	5,08	PU	PU	PU	PU	PU	PU	PU
1.900	4.42	—	—	48,26	6,58	—	—	6,35	—	—	P	—	P	P	—
1.900	5.15	—	—	48,26	7,66	—	—	7,62	—	—	P	—	P	P	—
2.063	3.24	—	3.25	52,40	—	—	4,84	3,96	PI	PI	PI	PI	PI	PI	—
2.063	4.50	—	—	52,40	—	—	—	5,72	P	P	P	P	P	P	P
2-3/8	4.00	—	—	60,32	5,95	—	—	4,24	PN	PN	PN	PN	PN	PN	—
2-3/8	4.60	4.70	—	60,32	6,85	6,99	—	4,83	PNU	PNU	PNU	PNU	PNU	PNU	PNU
2-3/8	5.80	5.95	—	60,32	8,63	8,85	—	6,45	—	—	PNU	PNU	PNU	PNU	PNU
2-3/8	6.60	—	—	60,32	9,82	—	—	7,49	—	—	P	—	P	P	—
2-3/8	7.35	7.45	—	60,32	10,94	11,09	—	8,53	—	—	PU	—	PU	PU	—
2-7/8	6.40	6.50	—	73,02	9,52	9,67	—	5,51	PNU	PNU	PNU	PNU	PNU	PNU	PNU
2-7/8	7.80	7.90	—	73,02	11,61	11,76	—	7,01	—	—	PNU	PNU	PNU	PNU	PNU
2-7/8	8.60	8.70	—	73,02	12,80	12,95	—	7,82	—	—	PNU	PNU	PNU	PNU	PNU
2-7/8	9.35	9.45	—	73,02	13,91	14,06	—	8,64	—	—	PU	—	PU	PU	—
2-7/8	10.50	—	—	73,02	15,63	—	—	9,96	—	—	P	—	P	P	—
2-7/8	11.50	—	—	73,02	17,11	—	—	11,18	—	—	P	—	P	P	—

Key

P: Plain-end

N: Non-upset threaded and coupled

U: External upset threaded and coupled

I: Integral joint

[a] Nominal linear masses (col. 6, 7, 8) are shown for information only.

[b] The density of martensitic chromium steel (L80 type 13Cr) is different from carbon steels. The masses shown are therefore not accurate for martensitic chromium steels. A mass correction factor of 0,989 may be used.

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Table C.2 *(continued)*

Labels				Outside diameter	Nominal linear masses[a,b]			Wall thickness	Type of end finish I I						
1	2				Non-upset T&C	Ext. upset T&C	Integ. joint								
	NU T&C	EU T&C	IJ	*D* mm	kg/m	kg/m	kg/m	*t* mm	H40	J55	L80 R95	N80	C90	T95	P110
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*
3-1/2	7.70	—	—	88,90	11,46	—	—	5,49	PN	PN	PN	PN	PN	PN	—
3-1/2	9.20	9.30	—	88,90	13,69	13,84	—	6,45	PNU	PNU	PNU	PNU	PNU	PNU	PNU
3-1/2	10.20	—	—	88,90	15,18	—	—	7,34	PN	PN	PN	PN	PN	PN	—
3-1/2	12.70	12.95	—	88,90	18,90	19,27	—	9,52	—	—	PNU	PNU	PNU	PNU	PNU
3-1/2	14.30	—	—	88,90	21,28	—	—	10,92	—	—	P	—	P	P	—
3-1/2	15.50	—	—	88,90	23,07	—	—	12,09	—	—	P	—	P	P	—
3-1/2	17.00	—	—	88,90	25,30	—	—	13,46	—	—	P	—	P	P	—
4	9.50	—	—	101,60	14,14	—	—	5,74	PN	PN	PN	PN	PN	PN	—
4	10.70	11.00	—	101,60	—	16,37	—	6,65	PU	PU	PU	PU	PU	PU	—
4	13.20	—	—	101,60	19,64	—	—	8,38	—	—	P	—	P	P	—
4	16.10	—	—	101,60	23,96	—	—	10,54	—	—	P	—	P	P	—
4	18.90	—	—	101,60	28,13	—	—	12,70	—	—	P	—	P	P	—
4	22.20	—	—	101,60	33,04	—	—	15,49	—	—	P	—	P	P	—
4-1/2	12.60	12.75	—	114,30	18,75	18,97	—	6,88	PNU	PNU	PNU	PNU	PNU	PNU	—
4-1/2	15.20	—	—	114,30	22,62	—	—	8,56	—	—	P	—	P	P	—
4-1/2	17.00	—	—	114,30	25,30	—	—	9,65	—	—	P	—	P	P	—
4-1/2	18.90	—	—	114,30	28,13	—	—	10,92	—	—	P	—	P	P	—
4-1/2	21.50	—	—	114,30	32,00	—	—	12,70	—	—	P	—	P	P	—
4-1/2	23.70	—	—	114,30	35,27	—	—	14,22	—	—	P	—	P	P	—
4-1/2	26.10	—	—	114,30	38,84	—	—	16,00	—	—	P	—	P	P	—

Key

P: Plain-end

N: Non-upset threaded and coupled

U: External upset threaded and coupled

I: Integral joint

[a] Nominal linear masses (col. 6, 7, 8) are shown for information only.

[b] The density of martensitic chromium steel (L80 type 13Cr) is different from carbon steels. The masses shown are therefore not accurate for martensitic chromium steels. A mass correction factor of 0,989 may be used.

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Table C.3 — Process of manufacture and heat treatment

	Grade	Type	Manufacturing process	Heat treatment	Tempering temperature °C min
	2	*3*	*4*	*5*	*6*
	H40	—	S or EW	—	—
	J55	—	S or EW	—[b]	—
	K55	—	S or EW	—[b]	—
	N80	1[a]	S or EW	[c]	—
	N80	Q	S or EW	Q[d]	—
	R95	—	S or EW	Q	538
	L80	1	S or EW	Q	566
	L80	13Cr	S	Q[f]	593
	C90		S	Q	621
	T95		S	Q	649
	C110	—	S	Q	649
	P110	—	S or EW[e, g]	Q	—
	Q125		S or EW[e]	Q	—

Key

S: seamless process

EW: electric-welded process

[a] N80 Type 1 products may exhibit ductile rupture values lower than internal yield values. See API TR5C3:2018 and/or ISO TR10400 calculated performance values in columns 15 and 18 in Table K1 and Table L1

[b] Full-body, full-length normalized, normalized and tempered or quenched and tempered at the manufacturer's option or as specified on the purchase agreement (see 6.3.2).

[c] Full-body, full-length heat treatment is mandatory. At the manufacturer's option either normalized or normalized and tempered.

[d] Includes the method of interrupted quenching followed by controlled cooling.

[e] Products shall be heat-treated full-body, full-length. Special requirements unique to electric-welded P110 and Q125 are specified in A.5 SR11.

[f] Type 13Cr may be air-quenched.

[g] Special chemical requirements for electric-welded P110 pipe are specified in Table C.4.

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Table C.4 — Chemical composition, mass fraction (%)

	Grade	Type	C		Mn		Mo		Cr		Ni	Cu	P	S	Si
			min.	max.	min.	max.	min.	max.	min.	max.	max.	max.	max.	max.	max.
	2	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*
	H40	—	—	—	—	—	—	—	—	—	—	—	0,030	0,030	—
	J55	—	—	—	—	—	—	—	—	—	—	—	0,030	0,030	—
	K55	—	—	—	—	—	—	—	—	—	—	—	0,030	0,030	—
	N80	1	—	—	—	—	—	—	—	—	—	—	0,030	0,030	—
	N80	Q	—	—	—	—	—	—	—	—	—	—	0,030	0,030	—
	R95	—	—	0,45[c]	—	1,90	—	—	—	—	—	—	0,030	0,030	0,45
	L80	1	—	0,43[a]	—	1,90	—	—	—	—	0,25	0,35	0,030	0,030	0,45
	L80	13Cr	0,15	0,22	0,25	1,00	—	—	12,0	14,0	0,50	0,25	0,020	0,010	1,00
	C90		—	0,35	—	1,20	0,25[b]	0,85	—	1,50	0,99	—	0,020	0,010	—
	T95		—	0,35	—	1,20	0,25[d]	0,85	0,40	1,50	0,99	—	0,020	0,010	—
	C110	—	—	0,35	—	1,20	0,25	1,00	0,40	1,50	0,99	—	0,020	0,005	—
	P110	e	—	—	—	—	—	—	—	—	—	—	0,030[e]	0,030[e]	—
	Q125		—	0,35		1,35	—	0,85	—	1,50	0,99	—	0,020	0,010	—

Key

NL: no limit

Elements shown shall be reported in product analysis.

[a] The carbon content for L80 may be increased up to 0,50 % maximum if the product is oil-quenched or polymer-quenched.

[b] The molybdenum content for Grade C90 Type 1 has no minimum tolerance if the wall thickness is less than 17,78 mm.

[c] The carbon content for R95 may be increased up to 0,55 % maximum if the product is oil-quenched.

[d] The molybdenum content for T95 Type 1 may be decreased to 0,15 % minimum if the wall thickness is less than 17,78 mm.

[e] For EW Grade P110, the phosphorus content shall be 0,020 % maximum and the sulfur content 0,010 % maximum.

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Table C.5 — Tensile and hardness requirements

Grade	Type	Total elongation under load	Yield strength MPa		Tensile strength min.	Hardness[a] max.		Specified wall thickness	Allowable hardness variation[b]
		%	min.	max.	MPa	HRC	HBW	mm	HRC
2	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*
H40	—	0,5	276	552	414	—	—	—	—
J55	—	0,5	379	552	517	—	—	—	—
K55	—	0,5	379	552	655	—	—	—	—
N80	1	0,5	552	758	689	—	—	—	—
N80	Q	0,5	552	758	689	—	—	—	—
R95	—	0,5	655	758	724	—	—	—	—
L80	1	0,5	552	655	655	23,0	241	—	—
L80	13Cr	0,5	552	655	655	23,0	241	—	—
C90		0,5	621	724	689	25,4	255	—	—
								≤12,70	3,0
								12,71 to 19,04	4,0
								19,05 to 25,39	5,0
								≥25,40	6,0
T95		0,5	655	758	724	25,4	255	≤12,70	3,0
								12,71 to 19,04	4,0
								19,05 to 25,39	5,0
								≥25,40	6,0
C110	—	0,7	758	828	793	30,0	286	≤12,70	3,0
								12,71 to 19,04	4,0
								19,05 to 25,39	5,0
								≥25,40	6,0
P110	—	0,6	758	965	862	—	—	—	—
Q125		0,65	862	1034	931	[b]	—	≤12,70	3,0
								12,71 to 19,04	4,0
								≥19,05	5,0

[a] In case of dispute, laboratory Rockwell C hardness testing shall be used as the referee method.

[b] No hardness limits are specified, but the maximum variation is restricted as a manufacturing control in accordance with 7.8 and 7.9.

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Table C.6 — Elongation table

Tensile test specimen				Minimum elongation in 50,8 mm %								
				Grade								
				H40	J55		K55 L80	N80 C90	R95 T95	C110	P110	Q125
Specimen area mm²	Specified wall thickness mm			Specified minimum tensile strength MPa								
	Specimen width 19 mm	Specimen width 25 mm	Specimen width 38 mm	414	517		655	689	724	793	862	931
1	*2*	*3*	*4*	*5*	*6*		*8*	*9*	*10*	*11*	*12*	*13*
490	≥25,53	≥19,41	≥12,77	30	24		20	19	18	16	15	14
480	25,00-25,52	19,00-19,40	12,51-12,76	29	24		19	19	18	16	15	14
470	24,48-24,99	18,61-18,99	12,24-12,50	29	24		19	19	18	16	15	14
460	23,95-24,47	18,20-18,60	11,98-12,23	29	24		19	18	18	16	15	14
450	23,43-23,94	17,81-18,19	11,72-11,97	29	24		19	18	18	16	15	14
440	22,90-23,42	17,40-17,80	11,45-11,71	29	24		19	18	18	16	15	14
430	22,37-22,89	17,01-17,39	11,19-11,44	29	24		19	18	17	16	15	14
420	21,85-22,36	16,60-17,00	10,93-11,18	29	23		19	18	17	16	15	14
410	21,32-21,84	16,21-16,59	10,66-10,92	29	23		19	18	17	16	15	14
400	20,79-21,31	15,80-16,20	10,40-10,65	28	23		19	18	17	16	15	14
390	20,27-20,78	15,41-15,79	10,14-10,39	28	23		19	18	17	16	15	14
380	19,74-20,26	15,00-15,40	9,87-10,13	28	23		19	18	17	16	15	14
370	19,22-19,73	14,61-14,99	9,61-9,86	28	23		19	18	17	16	14	13
360	18,69-19,21	14,20-14,60	9,35-9,60	28	23		18	18	17	16	14	13
350	18,16-18,68	13,81-14,19	9,08-9,34	28	23		18	17	17	15	14	13
340	17,64-18,15	13,40-13,80	8,82-9,07	28	23		18	17	17	15	14	13
330	17,11-17,63	13,01-13,39	8,56-8,81	27	22		18	17	17	15	14	13
320	16,58-17,10	12,60-13,00	8,29-8,55	27	22		18	17	16	15	14	13
310	16,06-16,57	12,21-12,59	8,03-8,28	27	22		18	17	16	15	14	13
300	15,53-16,05	11,80-12,20	7,77-8,02	27	22		18	17	16	15	14	13

NOTE The calculations of the elongation requirements are based on the cross-sectional area in column 1, which is shown rounded to two significant figures. The applicable wall thickness ranges shown in columns 2, 3, and 4 were calculated based on the specified specimen width (shown above the column numbers 2, 3, and 4) taking into account the rounding rules for the specimen area (i.e. to two significant figures) but with the wall thickness rounded down to two significant figures for SI units. When making these wall thickness ranges for USC units 3 significant figures are used.

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Table C.6 *(continued)*

Tensile test specimen				Minimum elongation in 50,8 mm %								
				Grade								
				H40	J55		K55 L80	N80 C90	R95 T95	C110	P110	Q125
Specimen area mm²	Specified wall thickness mm			Specified minimum tensile strength MPa								
	Specimen width 19 mm	Specimen width 25 mm	Specimen width 38 mm	414	517		655	689	724	793	862	931
1	*2*	*3*	*4*	*5*	*6*		*8*	*9*	*10*	*11*	*12*	*13*
290	15,01-15,52	11,41-11,79	7,51-7,76	27	22		18	17	16	15	14	13
280	14,48-15,00	11,00-11,40	7,24-7,50	26	22		18	17	16	15	14	13
270	13,95-14,47	10,61-10,99	6,98-7,23	26	22		17	17	16	15	14	13
260	13,43-13,94	10,20-10,60	6,72-6,97	26	21		17	16	16	15	13	13
250	12,90-13,42	9,81-10,19	6,45-6,71	26	21		17	16	16	14	13	12
240	12,37-12,89	9,40-9,80	6,19-6,44	26	21		17	16	16	14	13	12
230	11,85-12,36	9,01-9,39	5,93-6,18	25	21		17	16	15	14	13	12
220	11,32-11,84	8,60-9,00	5,66-5,92	25	21		17	16	15	14	13	12
210	10,79-11,31	8,21-8,59	5,40-5,65	25	20		17	16	15	14	13	12
200	10,27-10,78	7,80-8,20	5,14-5,39	25	20		16	16	15	14	13	12
190	9,74-10,26	7,41-7,79	4,87-5,13	24	20		16	15	15	14	13	12
180	9,22-9,73	7,00-7,40	4,61-4,86	24	20		16	15	15	13	13	12
170	8,69-9,21	6,61-6,99	4,35-4,60	24	20		16	15	14	13	12	12
160	8,16-8,68	6,20-6,60	4,08-4,34	24	19		16	15	14	13	12	11
150	7,64-8,15	5,81-6,19	3,82-4,07	23	19		15	15	14	13	12	11
140	7,11-7,63	5,40-5,80	3,56-3,81	23	19		15	15	14	13	12	11
130	6,58-7,10	5,01-5,39	3,29-3,55	23	19		15	14	14	13	12	11
120	6,06-6,57	4,60-5,00	3,03-3,28	22	18		15	14	14	12	12	11
110	5,53-6,05	4,21-4,59	2,77-3,02	22	18		15	14	13	12	11	11
100	5,01-5,52	3,80-4,20	2,51-2,76	22	18		14	14	13	12	11	10
90	4,48-5,00	3,41-3,79	2,24-2,50	21	17		14	13	13	12	11	10
80	3,95-4,47	3,00-3,40	1,98-2,23	21	17		14	13	12	11	11	10
70	3,43-3,94	2,61-2,99	1,72-1,97	20	16		13	13	12	11	10	9,5
60	2,90-3,42	2,20-2,60	1,45-1,71	19	16		13	12	12	11	10	9,5
50	2,37-2,89	1,81-2,19	1,19-1,44	19	15		12	12	11	10	9,5	9

NOTE The calculations of the elongation requirements are based on the cross-sectional area in column 1, which is shown rounded to two significant figures. The applicable wall thickness ranges shown in columns 2, 3, and 4 were calculated based on the specified specimen width (shown above the column numbers 2, 3, and 4) taking into account the rounding rules for the specimen area (i.e. to two significant figures) but with the wall thickness rounded down to two significant figures for SI units. When making these wall thickness ranges for USC units 3 significant figures are used.

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Table C.7 — Critical thickness for couplings with API threads

Dimensions in millimetres

Label 1	Critical thickness for couplings						
	NU	EU	Special clearance		BC	LC	SC
			EU	BC			
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
1.050	4,29	5,36	—	—	—	—	—
1.315	5,36	6,55	—	—	—	—	—
1.660	6,07	6,10	—	—	—	—	—
1.900	4,98	6,38	—	—	—	—	—
2-3/8	7,72	7,62	5,69	—	—	—	—
2-7/8	9,65	9,09	6,45	—	—	—	—
3-1/2	11,46	11,53	7,47	—	—	—	—
4	11,53	11,63	—	—	—	—	—
4-1/2	11,05	12,52	—	6,58	11,35	12,04	11,74
5	—	—	—	6,76	12,17	12,98	12,47
5-1/2	—	—	—	6,81	12,28	13,06	12,57
6-5/8	—	—	—	6,96	11,91	12,90	12,32
7	—	—	—	7,11	13,46	14,43	13,72
7-5/8	—	—	—	8,84	13,61	14,55	13,87
8-5/8	—	—	—	8,94	15,29	16,43	15,54
9-5/8	—	—	—	8,94	15,29	16,69	15,60
10-3/4	—	—	—	8,94	15,29	—	15,70
11-3/4	—	—	—	—	15,29	—	15,70
13-3/8	—	—	—	—	15,29	—	15,70
16	—	—	—	—	16,94	—	16,05
18-5/8	—	—	—	—	21,69	—	20,80
20	—	—	—	—	16,94	17,09	16,10

NOTE The coupling blank thickness is greater than indicated above, due to thread height and manufacturing allowance to avoid black crest threads.

Table C.8 — Acceptable size impact specimens and absorbed energy reduction factor

Test specimen size	Specimen dimensions mm	Reduction factor
Full-size	10,0 × 10,0	1,00
¾-size	10,0 × 7,5	0,80
½-size	10,0 × 5,0	0,55

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Table C.9 — Hierarchy of test specimen orientation and size

Choice	Orientation	Size
1st	Transverse	Full-size
2nd	Transverse	¾-size
3rd	Transverse	½-size
4th	Longitudinal	Full-size
5th	Longitudinal	¾-size
6th	Longitudinal	½-size

Table C.10 — Charpy impact test specimen requirements for couplings, coupling stock, coupling material, coupling blanks and accessory material Grades J55 and K55

Label 1	API connection type and CVN specimen orientation, size, energy and temperature reduction						
	NU	EU	Special clearance[b]		BC	LC	SC
			EU	BC			
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
1.050	[a]	L-5-15-A	—	—	—	—	—
1.315	L-5-15-A	L-7-22-A	—	—	—	—	—
1.660	L-5-15-B	L-5-15-B	—	—	—	—	—
1.900	L-5-15-A	L-7-22-B	—	—	—	—	—
2-3/8	L-7-22-A	L-7-22-A	L-7-22-A	—	—	—	—
2-7/8	L-10-27-A	L-10-27-A	L-10-27-A	—	—	—	—
3-1/2	T-5-11-E	T-5-11-E	T-5-11-D	—	—	—	—
4	T-7-16-B	T-7-16-B	—	—	—	—	—
4-1/2	T-7-16-B	T-7-16-B	—	L-7-22-A	T-7-16-A	T-7-16-A	T-7-16-A
5	—	—	—	T-5-11-C	T-7-16-A	T-10-20-A	T-7-16-A
5-1/2	—	—	—	T-5-11-C	T-7-16-A	T-10-20-A	T-10-20-A
6-5/8	—	—	—	T-10-20-A	T-10-20-A	T-10-20-A	T-10-20-A
7	—	—	—	T-7-16-A	T-10-20-A	T-10-20-A	T-10-20-A
7-5/8	—	—	—	T-10-20-A	T-10-20-A	T-10-20-A	T-10-20-A
8-5/8	—	—	—	T-10-20-A	T-10-20-A	T-10-20-A	T-10-20-A
9-5/8	—	—	—	T-10-20-A	T-10-20-A	T-10-20-A	T-10-20-A
10-3/4	—	—	—	T-10-20-A	T-10-20-A	—	T-10-20-A
11-3/4	—	—	—	—	T-10-20-A	—	T-10-20-A
13-3/8	—	—	—	—	T-10-20-A	—	T-10-20-A
16	—	—	—	—	T-10-20-A	—	T-10-20-A
18-5/8	—	—	—	—	T-10-20-A	—	T-10-20-A
20	—	—	—	—	T-10-20-A	T-10-20-A	T-10-20-A

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Table C.10 *(continued)*

Label 1	API connection type and CVN specimen orientation, size, energy and temperature reduction						
	NU	EU	Special clearance[b]		BC	LC	SC
			EU	BC			
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*

Key

10: full-size (i.e. 10 mm × 10 mm)

7: ¾-size (i.e. 10 mm × 7,5 mm)

5: ½-size (i.e. 10 mm × 5 mm)

A: no temperature reduction

B: 3 °C reduction

C: 6 °C reduction

D: 8 °C reduction

E: 11 °C reduction

T is the transverse specimen orientation (see Figure D.11)

L is the longitudinal specimen orientation (see Figure D.11)

[a] Not thick enough to test.

[b] The above assumes that special-clearance couplings are machined from regular coupling blanks.

NOTE In this table, the specimen orientation (T or L) is followed by the minimum specimen size (10, 7 or 5) which is followed by the minimum absorbed energy requirement (joules) and the temperature reduction (A, B, C, D or E), according to the following code. Both the absorbed energy requirement and the test temperature reduction requirement are adjusted for the test specimen size indicated. Orientation and specimen size is calculated on coupling material/stock wall and not coupling critical thickness.

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Table C.11 — Charpy impact test specimen requirements for couplings, coupling stock, coupling material, coupling blanks and accessory material Grade L80 all types

Label 1	API connection type and CVN specimen orientation, size and energy						
	NU	EU	Special clearance[b]		BC	LC	SC
			EU	BC			
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
1.050	[a]	L-5-22	—	—	—	—	—
1.315	L-5-22	L-7-32	—	—	—	—	—
1.660	L-5-22	L-5-22	—	—	—	—	—
1.900	L-5-22	L-7-32	—	—	—	—	—
2-3/8	L-7-32	L-7-32	L-7-32	—	—	—	—
2-7/8	L-10-40	L-10-40	L-10-40	—	—	—	—
3-1/2	T-5-11	T-5-11	T-5-11	—	—	—	—
4	T-7-16	T-7-16	—	—	—	—	—
4-1/2	T-7-16	T-7-16	—	L-7-32	T-7-16	T-7-16	—
5	—	—	—	T-5-11	T- 7-16	T- 10-20	—
5-1/2	—	—	—	T-5-11	T-7-16	T- 10-20	—
6-5/8	—	—	—	T-10-20	T-10-20	T-10-20	—
7	—	—	—	T-7-16	T-10-16	T-10-20	—
7-5/8	—	—	—	T-10-20	T-10-20	T-10-20	—
8-5/8	—	—	—	T-10-20	T-10-20	T-10-21	—
9-5/8	—	—	—	T-10-20	T-10-20	T-10-21	—
10-3/4	—	—	—	T-10-20	T-10-20	—	T-10-20
11-3/4	—	—	—	—	T-10-20	—	T-10-20
13-3/8	—	—	—	—	T-10-20	—	T-10-20
16	—	—	—	—	T-10-21	—	T-10-21
18-5/8	—	—	—	—	T-10-25	—	T-10-24
20	—	—	—	—	T-10-21	T-10-21	T-10-21

Key

10: full-size (i.e. 10 mm × 10 mm)

7: ¾-size (i.e. 10 mm × 7,5 mm)

5: ½-size (i.e. 10 mm × 5 mm)

T is the transverse specimen orientation (see Figure D.11)

L is the longitudinal specimen orientation (see Figure D.11)

[a] Not thick enough to test.

[b] The above assumes that special clearance couplings are machined from regular coupling blanks.

NOTE In this table, the specimen orientation (T or L) is followed by the minimum specimen size (10, 7 or 5) which is followed by the minimum absorbed energy requirement (joules) according to the following code. The absorbed energy requirement is adjusted for the test specimen size indicated. Orientation and specimen size is calculated on coupling material/stock wall and not coupling critical thickness.

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Table C.12 — Charpy impact test specimen requirements for couplings, coupling stock, coupling material, coupling blanks and accessory material Grade C90

Label 1	API connection type and CVN specimen orientation, size and energy						
	NU	EU	Special clearance[b]		BC	LC	SC
			EU	BC			
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
1.050	[a]	L-5-22	—	—	—	—	—
1.315	L-5-22	L-7-32	—	—	—	—	—
1.660	L-5-22	L-5-22	—	—	—	—	—
1.900	L-5-22	L-7-32	—	—	—	—	—
2-3/8	L-7-32	L-7-32	L-7-32	—	—	—	—
2-7/8	L-10-40	L-10-40	L-10-40	—	—	—	—
3-1/2	T-5-11	T-5-11	T-5-11	—	—	—	—
4	T-7-16	T-7-16	—	—	—	—	—
4-1/2	T-7-16	T-7-16	—	L-7-32	T-7-16	T-7-16	—
5	—	—	—	T-5-11	T- 7-16	T- 10-20	—
5-1/2	—	—	—	T-5-11	T- 7-16	T- 10-20	—
6-5/8	—	—	—	T-10-20	T-10-20	T-10-20	—
7	—	—	—	T-7-16	T- 10-20	T-10-20	—
7-5/8	—	—	—	T-10-20	T-10-21	T-10-22	—
8-5/8	—	—	—	T-10-20	T-10-22	T-10-23	—
9-5/8	—	—	—	T-10-20	T-10-22	T-10-23	—
10-3/4	—	—	—	T-10-20	T-10-22	—	T-10-23
11-3/4	—	—	—	—	T-10-22	—	T-10-23
13-3/8	—	—	—	—	T-10-22	—	T-10-23
16	—	—	—	—	—	—	—
18-5/8	—	—	—	—	—	—	—
20	—	—	—	—	—	—	—

Key

10: full-size (i.e. 10 mm × 10 mm)

7: ¾-size (i.e. 10 mm × 7,5 mm)

5: ½-size (i.e. 10 mm × 5 mm)

T is the transverse specimen orientation (see Figure D.11)

L is the longitudinal specimen orientation (see Figure D.11)

[a] Not thick enough to test.

[b] The above assumes that special-clearance couplings are machined from regular coupling blanks.

NOTE In this table, the specimen orientation (T or L) is followed by the minimum specimen size (10, 7 or 5) which is followed by the minimum absorbed energy requirement (joules) according to the following code. The absorbed energy requirement is adjusted for the test specimen size indicated. Orientation and specimen size is calculated on coupling material/stock wall and not coupling critical thickness.

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Table C.13 — Charpy impact test specimen requirements for couplings, coupling stock, coupling material, coupling blanks and accessory material Grades N80 all types, R95 and T95

Label 1	API connection type and CVN specimen orientation, size and energy						
	NU	EU	Special clearance[b]		BC	LC	SC
			EU	BC			
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
1.050	[a]	L-5-22	—	—	—	—	—
1.315	L-5-22	L-7-32	—	—	—	—	—
1.660	L-5-22	L-5-22	—	—	—	—	—
1.900	L-5-22	L-7-32	—	—	—	—	—
2-3/8	L-7-32	L-7-32	L-7-32	—	—	—	—
2-7/8	L-10-40	L-10-40	L-10-40	—	—	—	—
3-1/2	T-5-11	T-5-11	T-5-11	—	—	—	—
4	T-7-16	T-7-16	—	—	—	—	—
4-1/2	T-7-16	T-7-21	—	L-7-32	T-7-16	T-7-16	—
5	—	—	—	T-5-11	T-10-20	T-10-20	—
5-1/2	—	—	—	T-5-11	T-10-20	T-10-20	—
6-5/8	—	—	—	T-10-20	T-10-20	T-10-21	—
7	—	—	—	T-7-16	T-10-21	T-10-21	—
7-5/8	—	—	—	T-10-20	T-10-22	T-10-23	—
8-5/8	—	—	—	T-10-20	T-10-23	T-10-24	—
9-5/8	—	—	—	T-10-20	T-10-23	T-10-24	—
10-3/4	—	—	—	T-10-20	T-10-23	—	T-10-24
11-3/4	—	—	—	—	T-10-23	—	T-10-24
13-3/8	—	—	—	—	T-10-23	—	T-10-24
16	—	—	—	—	—	—	—
18-5/8	—	—	—	—	—	—	—
20	—	—	—	—	—	—	—

Key

10: full-size (i.e. 10 mm × 10 mm)

7: ¾-size (i.e. 10 mm × 7,5 mm)

5: ½-size (i.e. 10 mm × 5 mm)

T is the transverse specimen orientation (see Figure D.11)

L is the longitudinal specimen orientation (see Figure D.11)

[a] Not thick enough to test.

[b] The information in this table assumes that special clearance couplings are machined from regular coupling blanks.

NOTE In this table, the specimen orientation (T or L) is followed by the minimum specimen size (10, 7 or 5) which is followed by the minimum absorbed energy requirement (joules) according to the following code. The absorbed energy requirement is adjusted for the test specimen size indicated. Orientation and specimen size is calculated on coupling material/stock wall and not coupling critical thickness.

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Table C.14 — Charpy impact test specimen requirements for couplings, coupling stock, coupling material, coupling blanks and accessory material Grade P110

Label 1	API connection type and CVN specimen orientation, size and energy						
	NU	EU	Special clearance[b]		BC	LC	SC
			EU	BC			
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
1.050	[a]	L-5-22	—	—	—	—	—
1.315	L-5-22	L-7-32	—	—	—	—	—
1.660	L-5-22	L-5-22	—	—	—	—	—
1.900	L-5-22	L-7-32	—	—	—	—	—
2-3/8	L-7-34	L-7-33	L-7-32	—	—	—	—
2-7/8	L-10-46	L-10-45	L-10-40	—	—	—	—
3-1/2	T-5-14	T-5-14	T-5-11	—	—	—	—
4	T-7-20	T-7-20	—	—	—	—	—
4-1/2	T-7-20	T-7-21	—	L-7-32	T-7-19	T-7-20	—
5	—	—	—	T-5-11	T-10-25	T-10-26	—
5-1/2	—	—	—	T-5-11	T-10-25	T-10-26	—
6-5/8	—	—	—	T-10-20	T-10-26	T-10-26	—
7	—	—	—	T-7-16	T-10-26	T-10-28	—
7-5/8	—	—	—	T-10-22	T-10-28	T-10-29	—
8-5/8	—	—	—	T-10-22	T-10-30	T-10-31	—
9-5/8	—	—	—	T-10-22	T-10-30	T-10-31	T-10-30
10-3/4	—	—	—	T-10-22	T-10-30	—	T-10-30
11-3/4	—	—	—	—	T-10-30	—	T-10-30
13-3/8	—	—	—	—	T-10-30	—	—
16	—	—	—	—	—	—	—
18-5/8	—	—	—	—	—	—	—
20	—	—	—	—	—	—	—

Key

10: full-size (i.e. 10 mm × 10 mm)

7: ¾-size (i.e. 10 mm × 7,5 mm)

5: ½-size (i.e. 10 mm × 5 mm)

T is the transverse specimen orientation (see Figure D.11)

L is the longitudinal specimen orientation (see Figure D.11)

[a] Not thick enough to test.

[b] The above assumes that special clearance couplings are machined from regular coupling blanks.

NOTE In this table, the specimen orientation (T or L) is followed by the minimum specimen size (10, 7 or 5) which is followed by the minimum absorbed energy requirement (joules) according to the following code. The absorbed energy requirement is adjusted for the test specimen size indicated. Orientation and specimen size is calculated on coupling material/stock wall and not coupling critical thickness.

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Table C.15 — Charpy impact test specimen requirements for couplings, coupling stock, coupling material, coupling blanks and accessory material Grade Q125

Label 1	API connection type and CVN specimen orientation, size and energy			
	Special clearance[a] BC	BC	LC	SC
1	*2*	*3*	*4*	*5*
4-1/2	L-7-34	T-7-21	T-7-22	—
5	T-5-12	T-10-27	T-10-28	—
5-1/2	T-5-12	T-10-27	T-10-28	—
6-5/8	T-10-22	T-10-28	T-10-29	—
7	T-7-17	T-10-28	T-10-30	—
7-5/8	T-10-24	T-10-30	T-10-31	—
8-5/8	T-10-24	T-10-32	T-10-33	—
9-5/8	T-10-24	T-10-32	T-10-33	—
10-3/4	T-10-24	T-10-32	—	T-10-32
11-3/4	—	T-10-32	—	T-10-32
13-3/8	—	T-10-32	—	T-10-32
16	—	—	—	—
18-5/8	—	—	—	—
20	—	—	—	—

Key

10: full-size (i.e. 10 mm × 10 mm)

7: ¾-size (i.e. 10 mm × 7,5 mm)

5: ½-size (i.e. 10 mm × 5 mm)

T is the transverse specimen orientation (see Figure D.11)

L is the longitudinal specimen orientation (see Figure D.11)

[a] The above assumes that special-clearance couplings are machined from regular coupling blanks.

NOTE In this table, the specimen orientation (T or L) is followed by the minimum specimen size (10, 7 or 5) which is followed by the minimum absorbed energy requirement (joules) according to the following code. The absorbed energy requirement is adjusted for the test specimen size indicated. Orientation and specimen size is calculated on coupling material/stock wall and not coupling critical thickness.

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Table C.16 — Transverse Charpy absorbed energy requirements for couplings, coupling stock, coupling material, coupling blanks and accessory material

Maximum critical thickness for various grades mm						Minimum transverse absorbed energy J
L80	**C90**	**N80Q, R95, T95**	**C110**	**P110**	**Q125**	
1	*2*	*3*	*4*	*5*	*6*	*7*
15,85	13,32	12,24	10,31	7,33	6,13	20
17,14	14,49	13,36	11,33	8,21	6,95	21
18,44	15,66	14,48	12,35	9,08	7,77	22
19,73	16,83	15,60	13,38	9,96	8,59	23
21,02	18,00	16,72	14,40	10,84	9,41	24
22,32	19,17	17,83	15,42	11,72	10,23	25
23,61	20,34	18,95	16,45	12,60	11,04	26
24,91	21,51	20,07	17,47	13,48	11,86	27
26,20	22,69	21,19	18,50	14,35	12,68	28
	23,86	22,31	19,52	15,23	13,50	29
	25,03	23,43	20,54	16,11	14,32	30
	26,20	24,54	21,57	16,99	15,14	31
		25,66	22,59	17,87	15,96	32
			23,61	18,75	16,78	33
			24,64	19,62	17,60	34
			25,66	20,50	18,42	35
				21,38	19,24	36
				22,96	20,06	37
				23,14	20,88	38
				24,01	21,70	39
				24,89	22,52	40
				25,77	23,34	41
					24,16	42
					24,98	43
					25,80	44

For critical thickness greater than shown above, the requirements shall be according to the formulas for the wall thickness and grade.

NOTE Critical thicknesses greater than shown in Table C.7 are not applicable for couplings with API threads and are shown here for information for special applications.

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Table C.17 — Longitudinal Charpy absorbed energy requirements for couplings, coupling stock, coupling material, coupling blanks and accessory material

Maximum critical thickness mm						Minimum longitudinal absorbed energy J
L80	C90	N80Q, R95, T95	C110	P110	Q125	
1	*2*	*3*	*4*	*5*	*6*	*7*
16,17	13,61	12,52	10,56	7,55	6,33	41
16,82	14,20	13,08	11,07	7,99	6,74	42
17,47	14,78	13,64	11,59	8,43	7,15	43
18,11	15,37	14,20	12,10	8,87	7,56	44
18,76	15,95	14,76	12,61	9,30	7,97	45
19,41	16,54	15,32	13,12	9,74	8,38	46
20,05	17,13	15,88	13,63	10,18	8,79	47
20,70	17,71	16,44	14,15	10,62	9,20	48
21,35	18,30	17,00	14,66	11,06	9,61	49
21,99	18,88	17,56	15,17	11,50	10,02	50
22,64	19,47	18,11	15,68	11,94	10,43	51
23,29	20,05	18,67	16,19	12,38	10,84	52
23,94	20,64	19,23	16,70	12,82	11,25	53
24,58	21,22	19,79	17,22	13,26	11,66	54
25,23	21,81	20,35	17,73	13,70	12,07	55
25,88	22,31	20,91	18,24	14,13	12,48	56
	22,98	21,47	18,75	14,57	12,89	57
	23,56	22,03	19,26	15,01	13,30	58
	24,15	22,59	19,77	15,45	13,71	59
	24,73	23,15	20,29	15,89	14,12	60
	25,32	23,70	20,80	16,33	14,53	61
	25,90	24,26	21,31	16,77	14,94	62
		24,82	21,82	17,21	15,35	63
		25,38	22,33	17,65	15,76	64
		25,94	22,85	18,09	16,17	65
			23,36	18,53	16,58	66
			23,87	18,96	16,99	67
			24,38	19,40	17,40	68
			24,89	19,84	17,81	69
			25,40	20,28	18,22	70

For critical thickness greater than shown above, the requirements shall be according to the formulas for the wall thickness and grade.

NOTE Critical thicknesses greater than shown in C.7 are not applicable for couplings with API threads and are shown here for information for special applications.

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Table C.18 — Transverse Charpy absorbed energy requirements for pipe

Maximum specified wall thickness mm						Minimum transverse absorbed energy J
N80, L80	**C90**	**R95, T95**	**C110**	**P110**	**Q125**	
1	*2*	*3*	*4*	*5*	*6*	*7*
11,59	9,11	8,09	—	—	—	14
13,12	10,48	9,38	—	—	—	15
14,66	11,84	10,67	—	—	—	16
16,19	13,21	11,97	—	—	—	17
17,73	14,57	13,26	—	—	—	18
19,26	15,94	14,56	—	—	—	19
20,80	17,30	15,85	10,31	12,24	6,13	20
22,33	18,67	17,14	11,33	13,36	6,95	21
23,87	20,03	18,44	12,35	14,48	7,77	22
25,40	21,40	19,73	13,38	15,60	8,59	23
	22,76	21,02	14,40	16,72	9,41	24
			15,42	17,83	10,23	25
			16,45	18,95	11,04	26
			17,47	20,07	11,86	27
			18,50	21,19	12,68	28
			19,52	22,31	13,50	29
			20,54	23,43	14,32	30
			21,57	24,54	15,14	31
			22,59	25,66	15,96	32
			23,61		16,78	33
			24,64		17,60	34
			25,66		18,42	35
					19,24	36
					20,06	37
					20,88	38
					21,70	39
					22,52	40
					23,34	41
					24,16	42
					24,98	43
					25,80	44

For wall thickness greater than shown above, the requirements shall be according to the formulas for the wall thickness and grade.

NOTE Wall thicknesses greater than those of standard ISO/API pipe are shown here for information for special applications.

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Table C.19 — Longitudinal Charpy absorbed energy requirements for pipe

Maximum specified wall thickness mm						Minimum longitudinal absorbed energy J
N80, L80	C90	R95, T95	C110	P110	Q125	
1	*2*	*3*	*4*	*5*	*6*	*7*
10,44	8,09	7,12	—	—	—	27
11,20	8,77	7,76	—	—	—	28
11,97	9,45	8,41	—	—	—	29
12,74	10,14	9,06	—	—	—	30
13,51	10,82	9,70	—	—	—	31
14,27	11,50	10,35	—	—	—	32
15,04	12,18	11,00	—	—	—	33
15,81	12,87	11,64	—	—	—	34
16,58	13,55	12,29	—	—	—	35
17,34	14,23	12,94	—	—	—	36
18,11	14,91	13,58	—	—	—	37
18,88	15,60	14,23	—	—	—	38
19,65	16,28	14,88	—	—	—	39
20,41	16,96	15,53	—	—	—	40
21,18	17,64	16,17	10,56	12,52	6,33	41
21,95	18,32	16,82	11,07	13,08	6,74	42
22,72	19,01	17,47	11,59	13,64	7,15	43
23,48	19,69	18,11	12,10	14,20	7,56	44
24,25	20,37	18,76	12,61	14,76	7,97	45
25,02	21,05	19,41	13,12	15,32	8,38	46
25,79	21,74	20,05	13,63	15,88	8,79	47
	22,42	20,70	14,15	16,44	9,20	48
			14,66	17,00	9,61	49
			15,17	17,56	10,02	50
			15,68	18,11	10,43	51
			16,19	18,67	10,84	52
			16,70	19,23	11,25	53
			17,22	19,79	11,66	54
			17,73	20,35	12,07	55
			18,24	20,91	12,48	56
			18,75	21,47	12,89	57
			19,26	22,03	13,30	58
			19,77	22,59	13,71	59
			20,29	23,15	14,12	60
			20,80	23,70	14,53	61
			21,31	24,26	14,94	62

For wall thicknesses greater than shown above, the requirements shall be according to the formulas for the wall thickness and grade.

NOTE Wall thicknesses greater than those of standard ISO/API pipe are shown here for information for special applications.

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Table C.19 *(continued)*

Maximum specified wall thickness mm						Minimum longitudinal absorbed energy J
N80, L80	**C90**	**R95, T95**	**C110**	**P110**	**Q125**	
1	*2*	*3*	*4*	*5*	*6*	*7*
			21,82	24,82	15,35	63
			22,33	25,38	15,76	64
			22,85	25,94	16,17	65
			23,36		16,58	66
			23,87		16,99	67
			24,38		17,40	68
			24,89		17,81	69
			25,40		18,22	70
					18,63	71
					19,04	72
For wall thicknesses greater than shown above, the requirements shall be according to the formulas for the wall thickness and grade.						
NOTE Wall thicknesses greater than those of standard ISO/API pipe are shown here for information for special applications.						

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Table C.20 — Transverse impact specimen size required for quenched and tempered product

Label 1	Calculated wall thickness required to machine transverse Charpy impact specimens mm		
	Full-size	¾-size	½-size
1	*2*	*3*	*4*
3-1/2	20,53	18,03	15,53
4	19,09	16,59	14,09
4-1/2	18,05	15,55	13,05
5	17,26	14,76	12,26
5-1/2	16,64	14,14	11,64
6-5/8	15,62	13,12	10,62
7	15,36	12,86	10,36
7-5/8	14,99	12,49	9,99
7-3/4	14,92	12,42	9,92
8-5/8	14,51	12,01	9,51
9-5/8	14,13	11,63	9,13
10-3/4	13,80	11,30	8,80
11-3/4	13,56	11,06	8,56
13-3/8	13,24	10,74	8,24
16	12,87	10,37	7,87
18-5/8	12,60	10,10	7,60
20	12,49	9,99	7,49

NOTE The wall thicknesses in columns 2, 3 and 4 that are in excess of the maximum wall thicknesses for ISO/API pipe are for information only. The above provides a 0,50 mm inside-wall and a 0,50 mm outside-wall machining allowance.

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Table C.21 — Longitudinal impact specimen size required for quenched and tempered product

Label 1	Calculated wall thickness required to machine longitudinal Charpy impact specimens mm		
	Full-size	¾-size	½-size
1	*2*	*3*	*4*
1.050	11,97	9,47	6,97
1.315	11,77	9,27	6,77
1.660	11,60	9,10	6,60
1.900	11,52	9,02	6,52
2.063	11,48	8,98	6,48
2-3/8	11,42	8,92	6,42
2-7/8	11,34	8,84	6,34
3-1/2	11,28	8,78	6,28
4	11,25	8,75	6,25
4-1/2	11,22	8,72	6,22
5	11,20	8,70	6,20
5-1/2	11,18	8,68	6,18
6-5/8	11,15	8,65	6,15
7	11,14	8,64	6,14
7-5/8	11,13	8,63	6,13
7-3/4	11,13	8,63	6,13
8-5/8	11,11	8,61	6,11
9-5/8	11,10	8,60	6,10
10-3/4	11,09	8,59	6,09
11-3/4	11,08	8,58	6,08
13-3/8	11,07	8,57	6,07
16	11,06	8,56	6,06
18-5/8	11,05	8,55	6,05
20	11,05	8,55	6,05

NOTE The wall thicknesses in columns 2, 3 and 4 that are in excess of the maximum wall thicknesses for ISO/API pipe are for information only. The above provides a 0,50 mm inside-wall and a 0,50 mm outside-wall machining allowance.

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Table C.22 — Distance between plates for electric-weld flattening tests

Grade	D/t ratio	Distance between plates mm
H40	≥16	0,5 × D
	<16	D × (0,830 - 0,020 6 D/t)
J55 & K55	≥16	0,65 × D
	3,93 to 16	D × (0,980 - 0,020 6 D/t)
	<3,93	D × (1,104 - 0,051 8 D/t)
N80 Type 1, N80Q[a]	9 to 28	D × (1,074 - 0,019 4 D/t)
L80 Type 1	9 to 28	D × (1,074 - 0,019 4 D/t)
R95[a]	9 to 28	D × (1,080 - 0,017 8 D/t)
P110[b]	All	D × (1,086 - 0,016 3 D/t)
Q125[b]	All	D × (1,092 - 0,014 0 D/t)

D is the specified outside diameter of pipe, in millimetres.

t is the specified wall thickness of the pipe, in millimetres.

[a] If the flattening test fails at 12 o'clock or 6 o'clock, the flattening shall continue until the remaining portion of the specimen fails at the 3 o'clock or 9 o'clock position. Premature failure at 12 o'clock or 6 o'clock shall not be considered basis for rejection.

[b] See A.5 SR11. Flattening shall be conducted until this distance or until 0,85 × D, whichever is less, without cracking at any location.

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Table C.23 — Dimensions and masses for standard casing and for casing threaded with API round thread and buttress thread

Labels[a]		Outside diameter	Nominal linear mass T&C[b,c]	Wall thickness	Inside diameter	Drift diameter	Calculated mass[c]				
							Plain-end	e_m, mass gain or loss due to end finishing[d] kg			
								Round thread		Buttress thread	
1	2	D mm	kg/m	t mm	d mm	mm	w_{pe} kg/m	Short	Long	BC	SCC
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*
4-1/2	9.50	114,30	14,38	5,21	103,88	100,70	14,02	3,64	—	—	—
4-1/2	10.50	114,30	15,73	5,69	102,92	99,74	15,24	3,33	—	4,53	1,12
4-1/2	11.60	114,30	17,38	6,35	101,60	98,42	16,91	3,18	3,61	4,32	0,91
4-1/2	13.50	114,30	19,87	7,37	99,56	96,38	19,44	—	3,35	4,07	0,60
4-1/2	15.10	114,30	22,69	8,56	97,18	94,00	22,32	—	3,53	3,64	0,24
5	11.50	127,00	17,19	5,59	115,82	112,64	16,74	4,32	—	—	—
5	13.00	127,00	19,69	6,43	114,14	110,96	19,12	4,00	4,85	5,38	1,24
5	15.00	127,00	22,69	7,52	111,96	108,78	22,16	3,71	4,51	4,99	0,61
5	18.00	127,00	27,19	9,19	108,62	105,44	26,70	—	4,52	4,40	0,22
5	21.40	127,00	32,13	11,10	104,80	101,62	31,73	—	3,45	3,76	-0,62
5	23.20	127,00	34,76	12,14	102,72	99,54	34,39	—	3,15	3,42	-0,96
5	24.10	127,00	36,15	12,70	101,60	98,42	35,80	—	2,99	3,23	-1,14
5-1/2	14.00	139,70	20,91	6,20	127,30	124,12	20,41	4,60	—	—	—
5-1/2	15.50	139,70	23,48	6,98	125,74	122,56	22,85	4,36	5,26	5,71	0,87
5-1/2	17.00	139,70	25,72	7,72	124,26	121,08	25,13	4,14	5,31	5,41	0,58
5-1/2	20.00	139,70	30,05	9,17	121,36	118,18	29,52	—	4,50	4,84	0,45
5-1/2	23.00	139,70	34,05	10,54	118,62	115,44	33,57	—	4,37	4,31	-0,52
5-1/2	26.80	139,70	40,15	12,70	114,30	111,12	39,78	—	—	—	—
5-1/2	29.70	139,70	44,47	14,27	111,16	107,98	44,14	—	—	—	—
5-1/2	32.60	139,70	48,74	15,88	107,94	104,76	48,49	—	—	—	—
5-1/2	35.30	139,70	52,80	17,45	104,80	101,62	52,61	—	—	—	—
5-1/2	38.00	139,70	56,82	19,05	101,60	98,42	56,68	—	—	—	—
5-1/2	40.50	139,70	60,64	20,62	98,46	95,28	60,55	—	—	—	—
5-1/2	43.10	139,70	64,41	22,22	95,26	92,08	64,38	—	—	—	—

See also Figures D.1, D.2 and D.3.

[a] Labels are for information and assistance in ordering.

[b] Nominal linear masses, threaded and coupled (Col. 4) are shown for information only.

[c] The density of martensitic chromium steel (L80 Type 13Cr) is less than those of carbon steels. The masses shown are therefore not accurate for martensitic chromium steels. A mass correction factor of 0,989 shall be used.

[d] Mass gain or loss due to end finishing. See 8.5.

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Table C.23 *(continued)*

Labels[a]		Outside diameter	Nominal linear mass T&C[b,c]	Wall thickness	Inside diameter	Drift diameter	Calculated mass[c]				
							Plain-end	e_m, mass gain or loss due to end finishing[d] kg			
								Round thread		Buttress thread	
1	2	D mm	kg/m	t mm	d mm	mm	w_{pe} kg/m	Short	Long	RC	SCC
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*
6-5/8	20.00	168,28	29,76	7,32	153,64	150,46	29,06	5,58	6,23	6,35	0,89
6-5/8	24.00	168,28	35,72	8,94	150,40	147,22	35,13	4,42	5,48	5,52	0,68
6-5/8	28.00	168,28	41,67	10,59	147,10	143,92	41,18	—	4,73	4,71	-0,75
6-5/8	32.00	168,28	47,62	12,06	144,16	140,98	46,46	—	4,73	4,00	-1,46
7	17.00	177,80	25,60	5,87	166,06	162,88	24,89	7,61	—	—	—
7	20.00	177,80	29,91	6,91	163,98	160,80	29,12	6,74	—	—	—
7	23.00	177,80	34,67	8,05	161,70	158,75[e]	33,70	6,26	7,94	8,28	0,58
7	23.00	177,80	34,67	8,05	161,70	158,52	33,70	6,26	7,94	8,28	0,58
7	26.00	177,80	39,14	9,19	159,42	156,24	38,21	5,79	7,37	7,65	-0,54
7	29.00	177,80	43,60	10,36	157,08	153,90	42,78	—	6,79	7,13	-0,69
7	32.00	177,80	47,92	11,51	154,78	152,40[e]	47,20	—	6,23	6,40	-1,31
7	32.00	177,80	47,92	11,51	154,78	151,60	47,20	—	6,23	6,40	-1,31
7	35.00	177,80	52,09	12,65	152,50	149,32	51,52	—	5,68	5,79	-1,91
7	38.00	177,80	56,10	13,72	150,36	147,18	55,52	—	5,18	5,24	-2,47
7	42.70	177,80	63,84	15,88	146,04	142,86	63,41	—	—	—	—
7	46.40	177,80	69,35	17,45	142,90	139,72	69,01	—	—	—	—
7	50.10	177,80	74,85	19,05	139,70	136,52	74,58	—	—	—	—
7	53.60	177,80	80,21	20,62	136,56	133,38	79,93	—	—	—	—
7	57.10	177,80	85,42	22,22	133,36	130,18	85,25	—	—	—	—

See also Figures D.1, D.2 and D.3.

[a] Labels are for information and assistance in ordering.

[b] Nominal linear masses, threaded and coupled (Col. 4) are shown for information only.

[c] The density of martensitic chromium steel (L80 Type 13Cr) is less than those of carbon steels. The masses shown are therefore not accurate for martensitic chromium steels. A mass correction factor of 0,989 shall be used.

[d] Mass gain or loss due to end finishing. See 8.5.

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Table C.23 *(continued)*

Labels[a]		Outside diameter	Nominal linear mass T&C[b,c]	Wall thickness	Inside diameter	Drift diameter	Calculated mass[c]				
							Plain-end	e_m, mass gain or loss due to end finishing[d] kg			
								Round thread		Buttress thread	
1	2	D mm	kg/m	t mm	d mm	mm	w_{pe} kg/m	Short	Long	RC	SCC
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*
7-5/8	24.00	193,68	35,72	7,62	178,44	175,26	34,96	7,11	—	—	—
7-5/8	26.40	193,68	39,29	8,33	177,02	173,84	38,08	6,78	8,58	9,12	2,59
7-5/8	29.70	193,68	44,20	9,52	174,64	171,46	43,24	—	7,90	8,38	1,84
7-5/8	33.70	193,68	50,15	10,92	171,84	168,66	49,22	—	7,13	7,51	0,98
7-5/8	39.00	193,68	58,04	12,70	168,28	165,10	56,68	—	6,16	6,44	-0,10
7-5/8	42.80	193,68	63,69	14,27	165,14	161,96	63,14	—	5,32	5,50	-1,03
7-5/8	45.30	193,68	67,41	15,11	163,46	160,28	66,54	—	4,87	5,01	-1,52
7-5/8	47.10	193,68	70,09	15,88	161,92	158,74	69,63	—	4,48	4,57	-1,96
7-5/8	51.20	193,68	76,19	17,45	158,78	155,60	75,84	—	—	—	—
7-5/8	55.30	193,68	82,30	19,05	155,58	152,40	82,04	—	—	—	—
7-3/4	46.10	196,85	68,60	15,11	166,63	165,10[e]	67,72	—	—	—	—
7-3/4	46.10	196,85	68,60	15,11	166,63	163,45	67,72	—	—	—	—
8-5/8	24.00	219,08	35,72	6,71	205,66	202,48	35,14	10,93	—	—	—
8-5/8	28.00	219,08	41,67	7,72	203,64	200,46	40,24	10,07	—	—	—
8-5/8	32.00	219,08	47,62	8,94	201,20	200,02[e]	46,33	9,39	12,44	12,57	2,51
8-5/8	32.00	219,08	47,62	8,94	201,20	198,02	46,33	9,39	12,44	12,57	2,51
8-5/8	36.00	219,08	53,57	10,16	198,76	195,58	52,35	8,72	11,60	11,68	1,62
8-5/8	40.00	219,08	59,53	11,43	196,22	193,68[e]	58,53	—	10,73	10,77	0,71
8-5/8	40.00	219,08	59,53	11,43	196,22	193,04	58,53	—	10,73	10,77	0,71
8-5/8	44.00	219,08	65,48	12,70	193,68	190,50	64,64	—	9,88	9,87	-0,20
8-5/8	49.00	219,08	72,92	14,15	190,78	187,60	71,51	—	8,92	8,85	-1,21

See also Figures D.1, D.2 and D.3.

[a] Labels are for information and assistance in ordering.

[b] Nominal linear masses, threaded and coupled (Col. 4) are shown for information only.

[c] The density of martensitic chromium steel (L80 Type 13Cr) is less than those of carbon steels. The masses shown are therefore not accurate for martensitic chromium steels. A mass correction factor of 0,989 shall be used.

[d] Mass gain or loss due to end finishing. See 8.5.

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Table C.23 *(continued)*

Labels[a]		Outside diameter	Nominal linear mass T&C[b,c]	Wall thickness	Inside diameter	Drift diameter	Calculated mass[c]				
							Plain-end	e_m, mass gain or loss due to end finishing[d] kg			
								Round thread		Buttress thread	
1	2	D mm	kg/m	t mm	d mm	mm	w_{pe} kg/m	Short	Long	RC	SCC
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*
9-5/8	32.30	244,48	48,07	7,92	228,60	224,66	46,20	11,00	—	—	—
9-5/8	36.00	244,48	53,57	8,94	226,60	222,63	51,93	10,36	14,48	13,87	2,74
9-5/8	40.00	244,48	59,53	10,03	224,40	222,25[e]	57,99	9,69	13,59	12,97	1,84
9-5/8	40.00	244,48	59,53	10,03	224,40	220,45	57,99	9,69	13,59	12,97	1,84
9-5/8	43.50	244,48	64,74	11,05	222,40	218,41	63,61	—	12,78	12,15	1,01
9-5/8	43.50	244,48	64.74	11,05	220,40	218,41	63,61	—	12,84[f]	12,15	1,01
9-5/8	47.00	244,48	69,94	11,99	220,50	216,54	68,75	—	12,03	11,39	0,25
9-5/8	47.00	244,48	69,94	11,99	220,50	216,54	68,75	—	12,09[f]	11,39	0,25
9-5/8	53.50	244,48	79,62	13,84	216,80	215,90[e]	78,72	—	10,57	9,92	-1,22
9-5/8	53.50	244,48	79,62	13,84	216,80	215,90[e]	78,72	—	10,63[f]	9,92	-1,22
9-5/8	53.50	244,48	79,62	13,84	216,80	212,83	78,72	—	10,57	9,92	-1,22
9-5/8	53.50	244,48	76,62	13,84	216,80	212,83	78,72	—	10,63[f]	9,92	-1,22
9-5/8	58.40	244,48	86,91	15,11	214,25	212,72[e]	85,47	—	9,58	8,92	-2,22
9-5/8	58.40	244,48	86,91	15,11	214,25	212,72[e]	85,47	—	9,65[f]	8,92	-2,22
9-5/8	58.40	244,48	86.91	15,11	214,25	210,29	85,47	—	9,58	8,92	-2,22
9-5/8	58.40	244,48	86,91	15,11	214,25	210,29	85,47	—	9,65[f]	8,92	-2,22
9-5/8	59.40	244,48	88,40	15,47	213,50	209,58	87,37	—	—	—	—
9-5/8	64.90	244,48	96,58	17,07	210,30	206,38	95,73	—	—	—	—
9-5/8	70.30	244,48	104,62	18,64	207,20	203,23	103,82	—	—	—	—
9-5/8	75.60	244,48	112,51	20,24	204,00	200,02	111,93	—	—	—	—

See also Figures D.1, D.2 and D.3.

[a] Labels are for information and assistance in ordering.

[b] Nominal linear masses, threaded and coupled (Col. 4) are shown for information only.

[c] The density of martensitic chromium steel (L80 Type 13Cr) is less than those of carbon steels. The masses shown are therefore not accurate for martensitic chromium steels. A mass correction factor of 0,989 shall be used.

[d] Mass gain or loss due to end finishing. See 8.5.

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Table C.23 *(continued)*

Labels[a]		Outside diameter	Nominal linear mass T&C[b,c]	Wall thickness	Inside diameter	Drift diameter	Calculated mass[c]				
							Plain-end	e_m, mass gain or loss due to end finishing[d] kg			
								Round thread		Buttress thread	
1	2	D mm	kg/m	t mm	d mm	mm	w_{pe} kg/m	Short	Long	RC	SCC
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*
10-3/4	32.75	273,05	48,74	7,09	258,90	254,91	46,50	13,94	—	—	—
10-3/4	40.50	273,05	60,27	8,89	255,30	251,31	57,91	11,91	—	15,38	3,03
10-3/4	45.50	273,05	67,71	10,16	252,70	250,82[e]	65,87	11,00	—	14,21	1,86
10-3/4	45.50	273,05	67,71	10,16	252,70	248,77	65,87	11,00	—	14,21	1,86
10-3/4	51.00	273,05	75,90	11,43	250,20	246,23	73,75	10,11	—	13,05	0,70
10-3/4	51.00	273,05	75,90	11,43	250,20	246,33	73,75	10,16[f]	—	13,05	0,70
10-3/4	55.50	273,05	82,59	12,57	247,90	244,48[e]	80,75	9,30	—	12,01	-0,34
10-3/4	55.50	273,05	82,59	12,57	247,90	244,48[e]	80,75	9,35[f]	—	12,01	-0,34
10-3/4	55.50	273,05	82,59	12,57	247,90	243,94	80,75	9,30	—	12,01	-0,34
10-3/4	55.50	273,05	82,59	12,57	247,90	243,94	80,75	9,35[f]	—	12,01	-0,34
10-3/4	60.70	273,05	90,33	13,84	245,40	241,40	88,47	8,42	—	10,87	—
10-3/4	60.70	273,05	90,33	13,84	245,40	241,40	88,47	8,47[f]	—	10,87	—
10-3/4	65.70	273,05	97,77	15,11	242,80	238,86	96,12	7,54	—	9,74	—
10-3/4	65.70	273,05	97,77	15,11	242,80	238,86	96,12	7,60[f]	—	9,74	—
10-3/4	73.20	273,05	108,93	17,07	238,90	234,95	107,76	—	—	—	—
10-3/4	79.20	273,05	117,86	18,64	235,80	231,80	116,95	—	—	—	—
10-3/4	85.30	273,05	126,94	20,24	232,60	228,60	126,19	—	—	—	—

See also Figures D.1, D.2 and D.3.

[a] Labels are for information and assistance in ordering.

[b] Nominal linear masses, threaded and coupled (Col. 4) are shown for information only.

[c] The density of martensitic chromium steel (L80 Type 13Cr) is less than those of carbon steels. The masses shown are therefore not accurate for martensitic chromium steels. A mass correction factor of 0,989 shall be used.

[d] Mass gain or loss due to end finishing. See 8.5.

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Table C.23 *(continued)*

Labels[a]		Outside diameter	Nominal linear mass T&C[b,c]	Wall thickness	Inside diameter	Drift diameter	Calculated mass[c]				
							Plain-end	e_m, mass gain or loss due to end finishing[d] kg			
								Round thread		Buttress thread	
1	2	D mm	kg/m	t mm	d mm	mm	w_{pe} kg/m	Short	Long	RC	SCC
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*
11-3/4	42.00	298,45	62,50	8,46	281,50	279,40[e]	62,56	13,27	—	—	—
11-3/4	42.00	298,45	62,50	8,46	281,50	277,50	62,56	13,27	—	—	—
11-3/4	47.00	298,45	69,94	9,52	279,41	275,44	67,83	12,42	—	16,04	—
11-3/4	54.00	298,45	80,36	11,05	276,40	272,39	78,32	11,23	—	14,50	—
11-3/4	60.00	298,45	89,29	12,42	273,60	269,88[e]	87,61	10,17	—	13,12	—
11-3/4	60.00	298,45	89,29	12,42	273,60	269,88[e]	87,61	9,77[f]	—	13,12	—
11-3/4	60.00	298,45	89,29	12,42	273,60	269,65	87,61	10,17	—	13,12	—
11-3/4	60.00	298,45	89,29	12,42	273,60	269,65	87,61	9,77[f]	—	13,12	—
11-3/4	65.00	298,45	96,73	13,56	271,30	269,88[e]	95,27	—	—	—	—
11-3/4	65.00	298,45	96,73	13,56	271,30	267,36	95,27	—	—	—	—
11-3/4	71.00	298,45	105,66	14,78	268,90	264,92	103,40	—	—	—	—
13-3/8	48.00	339,72	71,43	8,38	322,96	318,99	68,48	15,04	—	—	—
13-3/8	54.50	339,72	81,10	9,65	320,42	316,45	78,55	13,88	—	17,91	—
13-3/8	61.00	339,72	90,78	10,92	317,88	313,91	88,55	12,74	—	16,44	—
13-3/8	68.00	339,72	101,19	12,19	315,34	311,37	98,46	11,61	—	14,97	—
13-3/8	68.00	339,72	101,19	12,19	315,34	311,37	98,46	11,67[f]	—	14,97	—
13-3/8	72.00	339,72	107,15	13,06	313,60	311,15[e]	105,21	10,85	—	13,98	—
13-3/8	72.00	339,72	107,15	13,06	313,60	311,15[e]	105,21	10,91[f]	—	13,98	—
13-3/8	72.00	339,72	107,15	13,06	313,60	309,63	105,21	10,85	—	13,98	—
13-3/8	72.00	339,72	107,15	13,06	313,60	309,63	105,21	10,91[f]	—	13,98	—
16	65.00	406,40	96,73	9,53	387,40	382,57	96,73	18,59	—	—	—
16	75.00	406,40	111,61	11,13	384,10	379,37	108,49	16,66	—	20,13	—
16	84.00	406,40	125,01	12,57	381,30	376,48	122,09	14,92	—	18,11	—
16	109.00	406,40	162,21	16,66	373,10	368,30	160,13	—	—	—	—
18-5/8	87.50	473,08	130,21	11,05	450,98	446,22	125,91	32,80	—	39,25	—

See also Figures D.1, D.2 and D.3.

[a] Labels are for information and assistance in ordering.

[b] Nominal linear masses, threaded and coupled (Col. 4) are shown for information only.

[c] The density of martensitic chromium steel (L80 Type 13Cr) is less than those of carbon steels. The masses shown are therefore not accurate for martensitic chromium steels. A mass correction factor of 0,989 shall be used.

[d] Mass gain or loss due to end finishing. See 8.5.

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Table C.23 *(continued)*

Labels[a]		Outside diameter	Nominal linear mass T&C[b,c]	Wall thickness	Inside diameter	Drift diameter	Calculated mass[c]				
							Plain-end	e_m, mass gain or loss due to end finishing[d] kg			
								Round thread		Buttress thread	
1	2	D mm	kg/m	t mm	d mm	mm	w_{pe} kg/m	Short	Long	RC	SCC
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*
20	94.00	508,00	139,89	11,13	485,70	480,97	136,38	20,50	27,11	24,78	—
20	94.00	508,00	139,89	11,13	485,70	480,97	136,38	20,61	27,26[g]	27,78	—
20	106.50	508,00	158,49	12,70	482,60	477,82	155,13	18,22	24,27	22,00	—
20	133.00	508,00	197,93	16,13	475,70	470,97	195,66	13,03	17,84	16,02	—

See also Figures D.1, D.2 and D.3.

[a] Labels are for information and assistance in ordering.

[b] Nominal linear masses, threaded and coupled (Col. 4) are shown for information only.

[c] The density of martensitic chromium steel (L80 Type 13Cr) is less than those of carbon steels. The masses shown are therefore not accurate for martensitic chromium steels. A mass correction factor of 0,989 shall be used.

[d] Mass gain or loss due to end finishing. See 8.5.

Table C.24 — Dimensions and masses for standard tubing and for tubing threaded with API non-upset, external upset and integral tubing connections

Labels[a]				Outside diameter	Nominal linear masses[b,c]			Wall thickness	Inside diameter	Calculated mass[c]				
										Plain-end	e_m, mass gain or loss due to end finishing[d] kg			
1	2										Non-upset	External upset[e]		Integral joint
	NU T&C	EU T&C	IJ	D mm	Non-upset T&C kg/m	Ext upset T&C kg/m	Integral joint kg/m	t mm	d mm	w_{pe} kg/m		Regular	Special clear	
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
1.050	1.14	1.20	—	26,67	1,70	1,79	—	2,87	20,93	1,68	0,09	0,64	—	—
1.050	1.48	1.54	—	26,67	2,20	2,29	—	3,91	18,85	2,19	—	0,60	—	—
1.315	1.70	1.80	1.72	33,40	2,53	2,68	2,56	3,38	26,64	2,50	0,18	0,64	0,09	0,09
1.315	2.19	2.24	—	33,40	3,26	3,33	—	4,55	24,30	3,24	—	0,61	—	—
1.660	2.09	—	2.10	42,16	—	—	3,13	3,18	35,80	3,06	—	—	—	0,09
1.660	2.30	2.40	2.33	42,16	3,42	3,57	3,47	3,56	35,04	3,39	0,36	0,73	—	0,09
1.660	3.03	3.07	—	42,16	4,51	4,57	—	4,85	32,46	4,46	—	0,68	0,09	—

See also Figures D.4, D.5 and D.7.

[a] Labels are for information and assistance in ordering.

[b] Nominal linear masses (Col. 6,7 and 8) are shown for information only.

[c] The density of martensitic chromium steel (L80 Type13Cr) is different from carbon steels. The masses shown are therefore not accurate for martensitic chromium steels. A mass correction factor of 0,989 shall be used.

[d] Mass gain or loss due to end finishing. See 8.5.

[e] The length of the upset may alter the mass gain or loss due to end finishing.

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Table C.24 *(continued)*

Labels[a]				Outside diameter	Nominal linear masses[b,c]			Wall thickness	Inside diameter	Calculated mass[c]				
										Plain-end	e_m, mass gain or loss due to end finishing[d] kg			
1	2				Non-upset T&C	Ext upset T&C	Integral joint				Non-upset	External upset[e]		Integral joint
	NU T&C	EU T&C	IJ	D mm	kg/m	kg/m	kg/m	t mm	d mm	w_{pe} kg/m		Regular	Special clear	
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
1.900	2.40	—	2.40	48,26	—	—	3,57	3,18	41,90	3,54,	—	—	—	0,09
1.900	2.75	2.90	2.76	48,26	4,09	4,32	4,11	3,68	40,90	4,05	0,27	0,91	—	0,09
1.900	3.65	3.73	—	48,26	5,43	5,55	—	5,08	38,10	5,41	—	0,92	—	—
1.900	4.42	—	—	48,26	6,58	—	—	6,35	35,56	6,56	—	—	—	—
1.900	5.15	—	—	48,26	7,66	—	—	7,62	33,02	7,64	—	—	—	—
2.063	3.24	—	3.25	52,40	—	—	4,84	3,96	44,48	4,73	—	—	—	0,09
2.063	4.50	—	—	52,40	—	—	—	5,72	40,96	6,58	—	—	—	—
2-3/8	4.00	—	—	60,32	5,95	—	—	4,24	51,84	5,86	0,73	—	—	—
2-3/8	4.60	4.70	—	60,32	6,85	6,99	—	4,83	50,66	6,61	0,73	1,81	1,34	—
2-3/8	5.80	5.95	—	60,32	8,63	8,85	—	6,45	47,42	8,57	0,64	1,63	1,16	—
2-3/8	6.60	—	—	60,32	9,82	—	—	7,49	45,34	9,76	—	—	—	—
2-3/8	7.35	7.45	—	60,32	10,94	11,09	—	8,53	43,26	10,89	—	—	—	—
2-7/8	6.40	6.50	—	73,02	9,52	9,67	—	5,51	62,00	9,17	1,45	2,54	1,71	—
2-7/8	7.80	7.90	—	73,02	11,61	11,76	—	7,01	59,00	11,41	1,27	2,63	1,78	—
2-7/8	8.60	8.70	—	73,02	12,80	12,95	—	7,82	57,38	12,57	1,18	2,27	1,43	—
2-7/8	9.35	9.45	—	73,02	13,91	14,06	—	8,64	54,74	13,72	—	—	—	—
2-7/8	10.50	—	—	73,02	15,63	—	—	9,96	53,10	15,49	—	—	—	—
2-7/8	11.50	—	—	73,02	17,11	—	—	11,18	50,66	17,05	—	—	—	—
3-1/2	7.70	—	—	88,90	11,46	—	—	5,49	77,92	11,29	2,45	—	—	—
3-1/2	9.20	9.30	—	88,90	13,69	13,84	—	6,45	76,00	13,12	2,27	4,17	2,45	—
3-1/2	10.20	—	—	88,90	15,18	—	—	7,34	74,22	14,76	2,18	—	—	—
3-1/2	12.70	12.95	—	88,90	18,90	19,27	—	9,52	69,86	18,64	1,81	3,72	2,00	—
3-1/2	14.30	—	—	88,90	21,28	—	—	10,92	67,06	21,00	—	—	—	—
3-1/2	15.50	—	—	88,90	23,07	—	—	12,09	64,72	22,90	—	—	—	—
3-1/2	17.00	—	—	88,90	25,30	—	—	13,46	61,98	25,04	—	—	—	—
4	9.50	—	—	101,60	14,14	—	—	5,74	90,12	13,57	2,81	—	—	—
4	10.70	11.00	—	101,60	—	16,37	—	6,65	88,30	15,57	—	4,81	—	—
4	13.20	—	—	101,60	19,64	—	—	8,38	84,84	19,27	—	—	—	—
4	16.10	—	—	101,60	23,96	—	—	10,54	80,52	23,67	—	—	—	—
4	18.90	—	—	101,60	28,13	—	—	12,70	76,20	27,84	—	—	—	—
4	22.20	—	—	101,60	33,04	—	—	15,49	70,62	32,89	—	—	—	—

See also Figures D.4, D.5 and D.7.

[a] Labels are for information and assistance in ordering.

[b] Nominal linear masses (Col. 6,7 and 8) are shown for information only.

[c] The density of martensitic chromium steel (L80 Type13Cr) is different from carbon steels. The masses shown are therefore not accurate for martensitic chromium steels. A mass correction factor of 0,989 shall be used.

[d] Mass gain or loss due to end finishing. See 8.5.

[e] The length of the upset may alter the mass gain or loss due to end finishing.

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Table C.24 *(continued)*

Labels[a]				Outside diameter	Nominal linear masses[b,c]			Wall thickness	Inside diameter	Calculated mass[c]				
										Plain-end	e_m, mass gain or loss due to end finishing[d] kg			
1	2				Non-upset T&C	Ext upset T&C	Integral joint				Non-upset	External upset[e]		Integral joint
	NU T&C	EU T&C	IJ	D mm	kg/m	kg/m	kg/m	t mm	d mm	w_{pe} kg/m		Regular	Special clear	
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
4-1/2	12.60	12.75	—	114,30	18,75	18,97	—	6,88	100,54	18,23	2,72	5,99	—	—
4-1/2	15.20	—	—	114,30	22,62	—	—	8,56	97,18	22,32	—	—	—	—
4-1/2	17.00	—	—	114,30	25,30	—	—	9,65	95,00	24,90	—	—	—	—
4-1/2	18.90	—	—	114,30	28,13	—	—	10,92	92,46	27,84	—	—	—	—
4-1/2	21.50	—	—	114,30	32,00	—	—	12,70	88,90	31,82	—	—	—	—
4-1/2	23.70	—	—	114,30	35,27	—	—	14,22	85,86	35,10	—	—	—	—
4-1/2	26.10	—	—	114,30	38,84	—	—	16,00	82,30	38,79	—	—	—	—

See also Figures D.4, D.5 and D.7.

[a] Labels are for information and assistance in ordering.

[b] Nominal linear masses (Col. 6,7 and 8) are shown for information only.

[c] The density of martensitic chromium steel (L80 Type13Cr) is different from carbon steels. The masses shown are therefore not accurate for martensitic chromium steels. A mass correction factor of 0,989 shall be used.

[d] Mass gain or loss due to end finishing. See 8.5.

[e] The length of the upset may alter the mass gain or loss due to end finishing.

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Table C.25 — External upset tubing dimensions for API connections, all Grades except Grades C110 and Q125

Labels[a]		Outside diameter D	Nominal linear mass threaded and coupled[b]	Upset			
				Outside diameter[c] D_4	Length from end of pipe to start of taper[d, e] L_{eu}	Length from end of pipe to end of taper[e] L_a	Length from end of pipe to start of pipe body L_b
1	2	mm	kg/m	mm +1,59 0	mm +0 −25,4	mm	mm max.
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
1.050	1.20	26,67	1,79	33,40	60,32	—	—
1.050	1.54	26,67	2,29	33,40	60,32	—	—
1.315	1.80	33,40	2,68	37,31	63,50	—	—
1.315	2.24	33,40	3,33	37,31	63,50	—	—
1.660	2.40	42,16	3,57	46,02	66,68	—	—
1.660	3.07	42,16	4,57	46,02	66,68	—	—
1.900	2.90	48,26	4,32	53,19	68,26	—	—
1.900	3.73	48,26	5,55	53,19	68,26	—	—
2-3/8	4.70	60,32	6,99	65,89	101,60	152,40	254,00
2-3/8	5.95	60,32	8,85	65,89	101,60	152,40	254,00
2-3/8	7.45	60,32	11,09	65,89	101,60	152,40	254,00
2-7/8	6.50	73,02	9,67	78,59	107,95	158,75	260,35
2-7/8	7.90	73,02	11,76	78,59	107,95	158,75	260,35
2-7/8	8.70	73,02	12,95	78,59	107,95	158,75	260,35
2-7/8	9.45	73,02	14,06	78,59	107,95	158,75	260,35
3-1/2	9.30	88,90	13,84	95,25	114,30	165,10	266,70
3-1/2	12.95	88,90	19,27	95,25	114,30	165,10	266,70
4	11.00	101,60	16,37	107,95	114,30	165,10	266,70
4-1/2	12.75	114,30	18,97	120,65	120,65	171,45	273,05

See also Figures D.5 and D.6.

NOTE Nominal linear masses are shown for information only.

[a] Labels are for information and assistance in ordering.

[b] The densities of martensitic chromium steels (L8013Cr) are different from carbon steels. The masses shown are therefore not accurate for chromium steels. A mass correction factor of 0,989 shall be used.

[c] The minimum outside diameter of upset D_4 is limited by the minimum length of full-crest threads. See API Spec 5B.

[d] For pup joints only, the length tolerance on L_{eu} is +101,6 mm to –25,4 mm. The length on L_b may be 101,6 mm longer than specified.

[e] For extended-length upsets on external upset tubing, add 25,4 mm to the dimensions in columns 6, 7 and 8.

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Table C.26 — Integral tubing connection dimensions for API connections, all Grades except Grades C110 and Q125

Labels		Outside diameter D	Nominal linear mass[a] I I	Upset dimensions								
				Pin				Box				
1	2	mm	kg/m	Outside diameter[b] D_4 mm +1,59 0	Inside diameter[c] d_{iu} mm +0,38 0	Length L_{iu} mm min.	Length of taper m_{iu} mm min.	Outside diameter W_b mm +0,13 −0,64	Length L_{eu} mm min.	Length of taper m_{eu} mm	Diameter of recess Q mm	Width of face b mm min.
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*
1.315	1.72	33,40	2,56	—	24,64	34,92	6,35	39,37	44,45	25,40	35,00	0,79
1.660	2.10	42,16	3,13	—	33,05	38,10	6,35	47,75	47,62	25,40	43,76	0,79
1.660	2.33	42,16	3,47	—	33,05	38,10	6,35	47,75	47,62	25,40	43,76	0,79
1.900	2.40	48,26	3,57	—	38,89	41,28	6,35	53,59	50,80	25,40	49,86	0,79
1.900	2.76	48,26	4,11	—	38,89	41,28	6,35	53,59	50,80	25,40	49,86	0,79
2.063	3.25	52,40	4,84	53,19	42,47	42,86	6,35	59,06	53,98	25,40	54,76	0,79

See also Figure D.7.

[a] Nominal linear masses, upset and threaded, are shown for information only.

[b] The minimum outside diameter D_4 is limited by the minimum length of full-crest threads. See API Spec 5B.

[c] The minimum diameter d_{iu} is limited by the drift test.

Table C.27 — Range lengths

Dimensions in metres

	Range 1[b]	Range 2[b]	Range 3[b]
CASING (PE/T&C/SF)			
Total range length, inclusive	4,88 to 7,62	7,62 to 10,36	10,36 to 14,63
Maximum length variation within a load[a]	1,83	1,52	1,83
tubing AND CASING USED AS TUBING(PE/T&C/SF)			
Total range length, inclusive	6,10 to 7,32	8,53 to 9,75	11,58 to 12,80
Maximum length variation within a load[a]	0,61	0,61	0,61
INTEGRAL TUBING CONNECTIONS (including IJ/PE and IJ/SF)			
Total range length, inclusive	6,10 to 7.92	8,53 to 10,36	11,58 to 13,72
Maximum length variation within a load	0,61	0,61	0,61
PUP JOINTS	Lengths 0,61; 0,91; 1,22; 1,83; 2,44; 3,05 and 3,66 Tolerance ±0,076		

[a] Length variation applies to rail car shipment to the point of use and does not apply to order items of less than 18 144 kg of pipe.

[b] Length other than those listed may be furnished by agreement between purchaser and manufacturer.

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Table C.28 — Standard drift size

Dimensions in millimetres

Product and Label 1	Standard drift mandrel size min.	
	Length	Diameter
Casing		
<9-5/8	152	d – 3,18
≥9-5/8 to ≤13-3/8	305	d – 3,97
>13-3/8	305	d – 4,76
Tubing[a, b]		
≤2-7/8	1 067	d – 2,38
>2-7/8 to ≤8-5/8	1 067	d – 3,18
>8-5/8 to <10-3/4	1 067	d – 3,97

[a] Integral-joint tubing shall be tested before upsetting with a drift mandrel as shown, and shall also be drift tested at the pin end, after upsetting, with a cylindrical drift mandrel 1 067 mm in length and d_{iu} – 0,38 mm in diameter (see Table C. 26, Col. 6 for d_{iu}).

[b] Casing sizes larger than Label 1: 4-1/2 but smaller than Label 1: 10-3/4 specified by the purchaser to be used in tubing service shall be marked as specified in Clause 11.

Table C.29 — Alternative drift size

Labels		Pipe outside diameter D	Nominal linear mass T&C	Alternative drift mandrel size mm min.	
1	2	mm	kg/m	Length	Diameter
1	*2*	*3*	*4*	*5*	*6*
7	23.00	177,80	34,67	152	158,75
7	32.00	177,80	47.92	152	152,40
7-3/4	46.10	196,85	68,60	152	165,10
8-5/8	32.00	219,08	47,62	152	200,02
8-5/8	40.00	219,08	59,53	152	193,68
9-5/8	40.00	244,48	59,53	305	222,25
9-5/8	53.50	244,48	79,62	305	215,90
9-5/8	58.40	244,48	86,91	305	212,72
10-3/4	45.50	273,05	67,71	305	250,82
10-3/4	55.50	273,05	82,59	305	244,48
11-3/4	42.00	298,45	62,50	305	279,40
11-3/4	60.00	298,45	89,29	305	269,88
11-3/4	65.00	298,45	96,73	305	269,88
13-3/8	72.00	339,72	107,15	305	311,15

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Table C.30 — Maximum permissible depth of linear imperfections

Grade	Depth as % of specified wall thickness	
	External imperfections	Internal imperfections
H40 – J55 – K55 - N80Q L80 – R95 – P110 to A.8 SR16	12,5 %	12,5 %
C90 – T95 – C110 – P110 – Q125	5 %	5 %
N80 Type 1	10 %	10 %
P110 to A.8 SR16 and A.2 SR2	5 %	5 %

Table C.31 — Upset products — Maximum permissible depth of imperfections

	Surface	Depth	Measurement notes
A Integral joint and external upset tubing (see Figures D.5 and D.7)			
A.1	All surfaces of upset and upset run-out interval, except as stated below	12,5 % t 12,5 % t 5 % t	Percentage of specified pipe body wall thickness t; for non-linear imperfections; for all pipe Percentage of specified pipe body wall thickness t; for linear imperfections; for all Grades except Grades C90, T95, C110 and Q125 pipe Percentage of specified pipe body wall thickness t; for linear imperfections; for Grades C90, T95, P110 and Q125 pipe
A.2 The minimum wall thickness in the upset run-out interval, and the maximum combined effect of coincident internal and external imperfections in all areas, shall not total less than 87,5 % of the specified wall thickness.			
B Integral tubing connections (see Figure D.7)			
B.1 B.2	Box end external surface Pin end internal surface	0,25 mm 0,38 mm	From end of pipe to a plane at a distance equal to the specified minimum dimension L_{eu} (Figure D.7) from end of pipe. From end of pipe to a plane at a distance equal to the specified minimum dimension L_{iu} (Figure D.7) from end of pipe. For Grades C90 and T95, the maximum permissible depth for linear imperfections shall be 5 % of the specified pipe body wall thickness.
B.3 Upset underfill in the upset run-out intervals shall not be considered a defect unless the remaining wall thickness (at the upset underfill) is less than 87,5 % of the specified pipe body wall thickness.			

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Table C.32 — API round-thread casing coupling — Dimensions, tolerances and masses

Label 1	Size[a]	Outside diameter	Minimum length mm		Diameter of recess	Width of bearing face	Mass kg	
	Outside diameter D mm	$W^{b,c}$ mm	Short N_L	Long N_L	Q^d mm	b mm	Short	Long
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
4-1/2	114,30	133,35	158,75	177,80	116,68	7,14	5,24	5,96
5	127,00	147,32	165,10	196,85	129,38	7,14	6,43	7,86
5-1/2	139,70	160,02	171,45	203,20	142,08	6,35	7,34	8,92
6-5/8	168,28	187,71	184,15	222,25	170,66	6,35	9,12	11,34
7	177,80	200,03	184,15	228,60	180,18	7,94	10,88	13,92
7-5/8	193,70	215,90	190,50	234,95	197,64	5,56	12,16	15,63
8-5/8	219,08	244,48	196,85	254,00	223,04	6,35	15,62	21,67
9-5/8	244,48	269,88	196,85	266,70	248,44	6,35	17,85	25,45
10-3/4	273,05	298,45	203,20	—	277,02	6,35	20,58	—
11-3/4	298,45	323,85	203,20	—	302,42	6,35	22,43	—
13-3/8	339,72	365,12	203,20	—	343,69	5,56	25,42	—
16	406,40	431,80	228,60	—	411,96	5,56	34,33	—
18-5/8	473,08	508,00	228,60	—	478,63	5,56	53,33	—
20	508,00	533,40	228,60	292,10	513,56	5,56	42,81	56,98

See also Figures D.1 and D.2.

[a] The size designation for the coupling is the same as the size designation for the pipe on which the coupling is used.

[b] All Grades except Grade Q125 — Tolerance on outside diameter W: ±1 % but not greater than ± 3,18 mm.

[c] Grade Q125 — Tolerance on outside diameter W: ±1 % but not greater than $^{+3,18}_{-1,59}$ mm.

[d] Tolerance on diameter of recess, Q, for all Grades : $^{+0,79}_{0}$ mm.

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Table C.33 — API buttress thread casing coupling — Dimensions, tolerances and masses

Label 1	Size[a]	Outside diameter		Minimum length	Diameter of counterbore	Width of bearing face	Mass kg	
	Outside diameter D mm	Regular $W^{b,c}$ mm	Special clearance[d] W_c mm	N_L mm	Q mm	b mm	Regular	Special clearance
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
4-1/2	114,30	133,35	123,82	225,42	117,86	6,35	6,89	3,48
5	127,00	147,32	136,52	231,78	130,56	7,14	8,38	4,00
5-1/2	139,70	160,02	149,22	234,95	143,26	7,14	9,30	4,47
6-5/8	168,28	187,71	177,80	244,48	171,83	6,35	11,01	5,65
7	177,80	200,03	187,32	254,00	181,36	7,94	13.98	6,28
7-5/8	193,68	215,90	206,38	263,52	197,23	7,94	15,82	9,29
8-5/8	219,08	244,48	231,78	269,88	222,63	9,52	20,86	10,80
9-5/8	244,48	269,88	257,18	269,88	248,03	9,52	23,16	12,02
10-3/4	273,05	298,45	285,75	269,88	276,61	9,52	25,74	13,39
11-3/4	298,45	323,85	—	269,88	302,01	9,52	28,03	—
13-3/8	339,72	365,12	—	269,88	343,28	9,52	31,77	—
16	406,40	431,80	—	269,88	410,31	9,52	40,28	—
18-5/8	473,08	508,00	—	269,88	476,99	9,52	62,68	—
20	508,00	533,40	—	269,88	511,91	9,52	50,10	—

See also Figure D.3.

[a] The size designation for the coupling is the same as the size designation for the pipe on which the coupling is used.

[b] All Grades except Grade Q125 : Tolerance on outside diameter W: ±1 % but not greater than ±3,18 mm.

[c] Grade Q125 : Tolerance on outside diameter W: ± 1 % but not greater than $^{+3,18}_{-1,59}$ mm.

[d] All Grades except Grade Q125 : — Tolerance on outside diameter W_c: $^{+0,79}_{-0,40}$ mm.

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Table C.34 — API non-upset tubing coupling — Dimensions, tolerances and masses

Label 1	Size[a]	Outside diameter	Minimum length	Diameter of recess	Width of bearing face	Maximum bearing face diameter, special bevel	Mass
	Outside diameter						
	D	W^b	N_L	Q	b	B_f	
	mm	mm	mm	mm	mm	mm	kg
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
1.050	26,67	33,35	80,96	28,27	1,59	30,00	0,23
1.315	33,40	42,16	82,55	35,00	2,38	37,80	0,38
1.660	42,16	52,17	88,90	43,76	3,18	47,17	0,59
1.900	48,26	55,88	95,25	49,86	1,59	52,07	0,56
2-3/8	60,32	73,02	107,95	61,93	4,76	66,68	1,28
2-7/8	73,02	88,90	130,18	74,63	4,76	80,98	2,34
3-1/2	88,90	107,95	142,88	90,50	4,76	98,42	3,71
4	101,60	120,65	146,05	103,20	4,76	111,12	4,35
4-1/2	114,30	132,08	155,58	115,90	4,76	123,19	4,89

See also Figure D.4.

[a] The size designation for the coupling is the same as the size designation for the pipe on which the coupling is used.

[b] Tolerance on outside diameter W: ±1 %.

Table C.35 — API external-upset tubing coupling — Dimensions, tolerances and masses

Label 1	Size[a]	Outside diameter		Minimum length	Diameter of recess	Width of bearing face, regular	Maximum bearing face diameter B_f		Mass kg	
	Outside diameter	Regular	Special clearance				Regular with special bevel	Special clearance	Regular	Special clearance
	D	W^b	W_c^c	N_L	Q	b				
	mm	mm	mm	mm	mm	mm	mm	mm		
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*
1.050	26,67	42,16	—	82,55	35,00	2,38	37,80	—	0,38	—
1.315	33,40	48,26	—	88,90	38,89	2,38	42,77	—	0,57	—
1.660	42,16	55,88	—	95,25	47,63	3,18	50,95	—	0,68	—
1.900	48,26	63,50	—	98,42	54,76	3,18	58,34	—	0,84	—
2-3/8	60,32	77,80	73,91	123,82	67,46	3,97	71,83	69,90	1,55	1,07
2-7/8	73,02	93,17	87,88	133,35	80,16	5,56	85,88	83,24	2,40	1,55
3-1/2	88,90	114,30	106,17	146,05	96,85	6,35	104,78	100,71	4,10	2,38
4	101,60	127,00	—	152,40	109,55	6,35	117,48	—	4,82	—
4-1/2	114,30	141,30	—	158,75	122,25	6,35	130,96	—	6,05	—

See also Figure D.5.

[a] The size designation for the coupling is the same as the size designation for the pipe on which the coupling is used.

[b] Tolerance on outside diameter W: ±1 %.

[c] Tolerance on outside diameter W_c: ±0,38 mm.

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Table C.36 — Permissible depth of external imperfections on coupling

Coupling for Label 1		Grades H40, J55, K55, N80 all types, R95, L80 all types and P110		Grades C90, T95, C110 and Q125
		Pits and round-bottom gouges	Grip marks and sharp-bottom gouges	Pits, round-bottom gouges, sharp-bottom gouges, grip marks
1	*2*	*3*	*4*	*5*
Tubing	<3-1/2	0,76	0,64	0,76
	≥3-1/2 to ≤ 4-1/2	1,14	0,76	0,89
Casing[a]	<6-5/8	0,89	0,76	0,76
	≥6-5/8 to ≤ 7-5/8	1,14	1,02	0,89
	>7-5/8	1,52	1,02	0,89

[a] Includes casing used as tubing.

Table C.37 — Frequency of tensile tests — Casing and tubing

Grade	Label 1	Maximum number of pieces in a lot	Number of tests	
			per lot	per heat
1	*2*	*3*	*4*	*5*
H40, K55, J55, N80 all types	<6-5/8	400[a, b]	1	1
	≥6-5/8	200[a, b]	1	1
R95	≤4-1/2	200[a, b]	2[c]	1
	>4-1/2	100[a, b]	2[c]	1
L80 Type 1	≤4-1/2	200[a, b]	2[c]	1
L80 13Cr	≤4-1/2	200[b, d]	2[c]	—
C90, T95	≤4-1/2	200[b, d]	1	—
L80 Type 1	>4-1/2	100[a, b]	2[c]	1
L80 13Cr	>4-1/2	100[b, d]	2[c]	—
C90, T95	>4-1/2	100[b, d]	1	—
C110	All sizes	100[b, d]	1	—
P110	<6-5/8	200[a, b]	1	1
	≥6-5/8	100[a, b]		
Q125	All sizes	[d]	3[c]	

For all Grades except Grade Q125 multiple-length seamless pipe, a length shall be considered as all of the sections cut from a particular multiple length, provided the pipe receives no additional heat treatment after being cut into individual lengths.

NOTE Table includes casing used as tubing.

[a] See 10.2.1.

[b] See 10.4.2.

[c] See 10.4.3. When more than one test is required, the test specimens shall be from different lengths.

[d] See 10.2.2.

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Table C.38 — Frequency of tensile tests — Coupling stock, coupling material and coupling blanks

Grade	I I		Maximum number of pieces in a lot	Number of tests	
	Material	Condition when heat-treated		per lot	per heat
1	*2*	*3*	*4*	*5*	*6*
H40, J55, K55, N80 all types and P110	Coupling stock and coupling material	Coupling stock and coupling material for pipe ≤ Label 1: 4-1/2	200[a]	1	1[b]
		Coupling stock and coupling material for pipe > Label 1: 4-1/2	100[a]	1	1[b]
		Coupling blank	400[c]	1	—
	Hot forging	Coupling blank	400[c]	1	—
R95, L80 Type 1	Coupling stock and coupling material	Coupling stock and coupling material for pipe ≤ Label 1: 4-1/2	200[a]	2[d,e]	2[d,e]
		Coupling stock and coupling material for pipe > Label 1: 4-1/2	100[a]	2[d,e]	2[d,e]
		Coupling blank	400[c]	2[e]	—
	Hot forging	Coupling blank	400[c]	2[e]	—
L80 13Cr	Coupling stock and coupling material	Coupling stock and coupling material for pipe ≤ Label 1: 4-1/2	200[d]	2[d,e]	—
		Coupling stock and coupling material for pipe > Label 1: 4-1/2	100[d]	2[d,e]	—
		Coupling blank	400[c]	2[e]	—
	Hot forging	Coupling blank	400[c]	2[e]	—
C90 and T95	Coupling stock and coupling material	Coupling stock and coupling material for pipe Label 1: All sizes	1[b]	1	—
		Coupling blank	Label 1: < 9-5/8: 50[c] Label 1: ≥ 9-5/8: 30[c]	1	—
	Hot forging	Coupling blank	Label 1: < 9-5/8: 50[c] Label 1: ≥ 9-5/8: 30[c]	1	—
C110 and Q125	Coupling stock and coupling material	Coupling stock and coupling material for pipe Label 1: All sizes	1[b]	1	—
		Coupling blank	Label 1: < 9-5/8: 50[c] Label 1: ≥ 9-5/8: 30[c]	1	—

[a] See 10.2.1.

[b] Approximately 50 % from each end.

[c] See 10.2.3.

[d] See 10.2.2.

[e] When more than one test is required, the test specimens shall be from different lengths.

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Table C.39 — Frequency of tensile testing — Pup joints and accessory material

Grade	Material and heat treatment condition[a]		Maximum number of pieces in a lot	Number of tests	
				per lot	per heat
1	*2*	*3*	*4*	*5*	*6*
H40, J55, K55, N80 all types	: Full-length standard tubing or casing from one or more heats		Label 1: < 6-5/8: 400 Label 1: ≥ 6-5/8: 200	1	1
P110	: Full-length standard tubing or casing from one or more heats		Label 1: < 6-5/8: 200 Label 1: ≥ 6-5/8: 100	1	1
H40, J55, K55, N80 all types, P110	Thick-wall mechanical tube or bar stock from a single heat		Label 1: ≤ 4-1/2: 200 Label 1: > 4-1/2: 100	1	1
	Heat-treated in individual lengths or hot forgings	Batch heat treatment	100 pup joints or 400 accessory material	1	—
		Heat-treated in sequential loads or continuous heat treatment	In accordance with 10.2.3	1	—
R95, L80 Type 1	Full-length standard tubing or casing from one or more heats		Label 1: ≤ 4-1/2: 200 Label 1: > 4-1/2: 100	2[a,b]	2[a,b]
	Thick-wall mechanical tube or bar stock from a single heat		Label 1: ≤ 4-1/2: 200 Label 1: > 4-1/2: 100	2[a,b]	2[a,b]
	Heat-treated in individual lengths or hot forgings	Batch heat treatment	100 pup joints or 400 accessory material	2[b]	—
		Heat-treated in sequential loads or continuous heat treatment	In accordance with 10.2.3	2[b]	—
L80 13Cr	Full-length standard tubing or casing from one or more heats		Label 1: ≤ 4-1/2: 200 Label 1: > 4-1/2: 100	2[a,b]	—
	Thick-wall mechanical tube or bar stock from a single heat		Label 1: ≤ 4-1/2: 200 Label 1: > 4-1/2: 100	2[a,b]	—
	Heat-treated in individual lengths or hot forgings	Batch heat treatment	100 pup joints or 400 accessory material	2[b]	—
		Heat-treated in sequential loads or continuous heat treatment	In accordance with 10.2.3	2[b]	—
C90 and T95	Full-length standard tubing or casing from one or more heats		Label 1: ≤ 4-1/2: 200 Label 1: > 4-1/2: 100	1	—
	Thick-wall mechanical tube or bar stock from a single heat		1	1[a]	—
	Heat-treated in individual lengths or hot forgings	Batch heat treatment	Label 1: < 9-5/8: 50[c] Label 1: ≥ 9-5/8: 30[c]	1	—
		Heat-treated in sequential loads or continuous heat treatment	Label 1: < 9-5/8: 50[c] Label 1: ≥ 9-5/8: 30[c]	1	—

[a] Approximately 50 % from each end.

[b] When more than one test is required, the test specimens shall be from different lengths.

[c] Each lot shall be from the same heat of steel for Grades , L80 13Cr, C90, T95, C110 and Q125. See 10.2.3.

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Table C.39 *(continued)*

Grade	Material and heat treatment condition[a]		Maximum number of pieces in a lot	Number of tests	
				per lot	per heat
1	*2*	*3*	*4*	*5*	*6*
C110 and Q125	Full-length standard tubing or casing from one or more heats		In accordance with 10.2.3	3[a,b]	—
	Thick-wall mechanical tube or bar stock from a single heat		1	1[a]	—
	Heat-treated in individual lengths or hot forgings	Batch heat treatment	Label 1: < 9-5/8: 50[c] Label 1: ≥ 9-5/8: 30[c]	1	—
		Heat-treated in sequential loads or continuous heat treatment	Label 1: < 9-5/8: 50[c] Label 1: ≥ 9-5/8: 30[c]	1	—

[a] Approximately 50 % from each end.

[b] When more than one test is required, the test specimens shall be from different lengths.

[c] Each lot shall be from the same heat of steel for Grades , L80 13Cr, C90, T95, C110 and Q125. See 10.2.3.

Table C.40 — Frequency of hardness testing

Grade	Material		Number of tests per lot	Maximum number of pieces in a lot	Type of test	Location
1	*2*		*3*	*4*	*5*	*6*
Grade, L80	Pipe, coupling stock, coupling material	Label 1: ≤ 4-1/2	2[a]	200[b,c]	Through-wall, 1 quadrant	Body tensile test
		Label 1: > 4-1/2	2[a]	100[b,c]	Through-wall, 1 quadrant	Body tensile test
	Coupling blanks or hot forgings		2[a]	Heat-treat lot or 400 coupling blanks[b, c]	Through-wall, 1 quadrant	Coupling blank tensile test
	Pup joints and accessory material (heat-treated in individual lengths)	Batch heat treatment (method a, 10.2.3)	2[a]	100 pup joints or 400 accessory material[b,c]	Through-wall, 1 quadrant	Pup joint or accessory tensile test
		Heat-treated in sequential loads (method b, 10.2.3)	2[a]	Lot (see 10.2)[b,c]	Through-wall, 1 quadrant	Pup joint or accessory tensile test
		Continuous heat treatment (method c, 10.2.3)	2[a]	Lot (see 10.2)[b,c]	Through-wall, 1 quadrant	Pup joint or accessory tensile test

[a] Lots which include more than one heat shall have two hardness tests from each heat. When more than one test is required, the test specimens shall be from different lengths.

[b] The lengths tested shall be selected randomly and represent the start and end of the heat treatment cycle.

[c] Each lot shall be from the same heat of steel for Grades, L80 13Cr, C90, T95 and Q125.

[d] One upset approximately 50 % from each end if both ends are upset.

[e] When more than one test is required, the test specimens shall be from different lengths.

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Table C.40 *(continued)*

Grade	Material		Number of tests per lot	Maximum number of pieces in a lot	Type of test	Location
1	*2*		*3*	*4*	*5*	*6*
Grades C90, T95	As-quenched product		1	Each production run or heat treatment practice	Through-wall, 4 quadrants	Design area of greatest thickness
	Non-upset pipe		1	Each length	Through-wall, 1 quadrant	Approx. 50 % from each end
	Upset pipe		1	Each length	Surface – HRC or HBW	Pipe body and one upset[d]
			1	20[c]	Through-wall, 4 quadrants	One upset
			1	Label 1: ≤ 4-1/2: 200 Label 1: > 4-1/2: 100	Through-wall, 4 quadrants	Pipe body tensile test
	Coupling blanks, coupling stock, coupling material, pup joints and accessory material	Tube-length heat treatment	2[e]	Each length	Through-wall, 4 quadrants	One from each end
		Individual heat treatment	1	Each piece	Surface – HRC or HBW	Each piece
			1	Label 1: < 9-5/8: 50[c] Label 1: ≥ 9-5/8: 30[c]	Through-wall, 4 quadrants	From a piece with the highest surface hardness number in the lot

[a] Lots which include more than one heat shall have two hardness tests from each heat. When more than one test is required, the test specimens shall be from different lengths.

[b] The lengths tested shall be selected randomly and represent the start and end of the heat treatment cycle.

[c] Each lot shall be from the same heat of steel for Grades, L80 13Cr, C90, T95 and Q125.

[d] One upset approximately 50 % from each end if both ends are upset.

[e] When more than one test is required, the test specimens shall be from different lengths.

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Table C.40 *(continued)*

Grade	Material		Number of tests per lot	Maximum number of pieces in a lot	Type of test	Location
1	*2*		*3*	*4*	*5*	*6*
Grade C110	As-quenched product		1	Each production run or heat treatment practice	Through wall, 4 quadrants	Design area of greatest thickness
	Non-upset pipe		2	One from each end	Through wall, 1 quadrant	Each end of each piece
	Coupling blanks, coupling stock, coupling material, pup joints and accessory material	Tube length heat treatment	2[e]	Each length	Through wall, 4 quadrants	One from each end
		Individual heat treatment	1	Each piece	Surface: HRC or HBW	Each piece
			1	Label 1: < 9-5/8: 50[c] Label 1: ≥9-5/8: 30[c]	Through-wall, 4 quadrants	From a piece with the highest surface hardness number in the lot
Grade Q125	Casing		3[e]	Lot (see 10.2)[b,c]	Through-wall, 1 quadrant	Pipe body
	Coupling blanks, coupling stock, coupling material, pup joints and accessory material	Tube-length heat treatment	1	Each length	Through-wall, 1 quadrant	Approx. 50 % from each end
		Individual heat treatment	1	Each piece	Surface – HRC or HBW	Each piece
			1	Label 1: < 9-5/8: 50[c] Label 1: ≥ 9-5/8: 30[c]	Through-wall, 1 quadrant	Randomly selected piece

[a] Lots which include more than one heat shall have two hardness tests from each heat. When more than one test is required, the test specimens shall be from different lengths.

[b] The lengths tested shall be selected randomly and represent the start and end of the heat treatment cycle.

[c] Each lot shall be from the same heat of steel for Grades, L80 13Cr, C90, T95 and Q125.

[d] One upset approximately 50 % from each end if both ends are upset.

[e] When more than one test is required, the test specimens shall be from different lengths.

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Table C.41 — Frequency of flattening tests

Casing and tubing			
Grade	**Type of heat treatment**		**Number of tests**
1	*2*	*3*	*4*
H40, J55, K55, N80 all types, L80 Type 1, R95, P110	Non-full-body		As described in footnote a
	Full-body, full-length	≤ Label 1: 4-1/2	Same as non-full-body heat-treated or 1 per lot of 100 lengths or less
		> Label 1: 4-1/2 [b]	Same as non-full-body heat-treated or 1 per lot of 20 lengths or less
Q125	All		1 on each end of each length of pipe [see A.5 SR11]

[a] The leading end of the first pipe of each coil shall have two test specimens flattened: one in the 90° position and one in the 0° position.

Two test specimens shall be flattened from an intermediate pipe of each coil: one in the 90° position and one in the 0° position.

The trailing end of the last pipe of each coil shall have two test specimens flattened: one in the 90° position and one in the 0° position.

When a weld stop condition occurs during production of a multiple length, flattening tests with the weld at the 90° position and 0° position shall be made from the crop end resulting from each side of the weld stop, and may be substituted for the intermediate flattening tests.

90° position: the weld is positioned at 3 o'clock or at 9 o'clock. 0° position: the weld is positioned at 6 o'clock or at 12 o'clock.

[b] Includes casing used as tubing.

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Table C.41 *(continued)*

Casing and tubing					
Pup joints					
Grade	**Type of heat treatment**		**Maximum number of pieces in a lot**	**Number of tests**	
				per lot	per heat
1	*2*	*3*	*4*	*5*	*6*
H40, J55, K55, N80 all types, L80 Type 1, R95, P110	Treated after cutting to length	Batch heat-treated	100 pup joints	1	1
		Continuously heat-treated	—		
	Treated before cutting to length	≤ Label 1: 4-1/2	200 lengths		
		> Label 1: 4-1/2 [b]	100 lengths		
Q125	All			1 on each end of each length of pipe	

[a] The leading end of the first pipe of each coil shall have two test specimens flattened: one in the 90° position and one in the 0° position.

Two test specimens shall be flattened from an intermediate pipe of each coil: one in the 90° position and one in the 0° position.

The trailing end of the last pipe of each coil shall have two test specimens flattened: one in the 90° position and one in the 0° position.

When a weld stop condition occurs during production of a multiple length, flattening tests with the weld at the 90° position and 0° position shall be made from the crop end resulting from each side of the weld stop, and may be substituted for the intermediate flattening tests.

90° position: the weld is positioned at 3 o'clock or at 9 o'clock. 0° position: the weld is positioned at 6 o'clock or at 12 o'clock.

[b] Includes casing used as tubing.

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Table C.42 — Summary of NDE methods for seamless pipe, coupling stock, the body of welded pipe and accessory material (in accordance with 10.15.11)

Product	Grade	Visual inspection (see 10.14)	Wall thickness verification	Ultrasonic inspection	Flux leakage inspection	Eddy current inspection	Magnetic particle inspection[a]
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Pipe	H40, J55, K55	R	N	A	A	A	A
	N80 all types, L80, R95	R	R	A	A	A	A
	P110	R	R	A	A	A	NA
	C90, T95, C110, Q125	R	R	C	B	B	B
Coupling stock and accessory material	H40, J55, K55,	R	NA	N	N	N	N
	N80 all types, L80, R95, P110, C90, T95, C110, Q125	R	R	A	A	A	A

Key

N: not required

R: required

A: one method or any combination of methods shall be used

B: at least one method shall be used in addition to ultrasonic inspection to inspect the outside surface

C: ultrasonic inspection shall be used to inspect the outside and inside surface

NA: not applicable

[a] MPI is permitted for end-area inspection. MPI is permitted for pipe-body outside-surface inspection in combination with other methods of pipe body inspection. MPI is permitted for coupling stock outside surface inspection. Coupling stock receiving full-length MPI does not require full-length wall thickness verification, however, mechanical wall thickness measurement of each end is required.

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Table C.43 — Acceptance (inspection) levels

Material	Grade		External imperfections			Internal imperfections		
			Longitudinal	Transverse	Oblique	Longitudinal	Transverse	Oblique
1	*2*		*3*	*4*	*5*	*6*	*7*	*8*
Pipe body	N80 Type 1		U3/F3/E3/L3	—	—	U3/F3/E3/L3	—	—
	H40, J55, K55, N80Q, L80, R95		U4/F4/E4/L4	—	—	U4/F4/E4/L4	—	—
	P110 to A.8 SR16		U4/F4/E4/L4	U4/F4/E4/L4	—	U4/F4/E4/L4	U4/F4/E4/L4	—
	P110		U2/F2/E2/L2	U2/F2/E2/L2	—	U2/F2/E2/L2	U2/F2/E2/L2	—
	P110 to A.8 SR16 and A.2 SR2		U2/F2/E2/L2	U2/F2/E2/L2	—	U2/F2/E2/L2	U2/F2/E2/L2	—
	Q125	UT	U2/F2/E2/L2	U2/F2/E2/L2	—	U2/F2/E2/L2	U2/F2/E2/L2	—
		2nd method	U2/F2/E2/L2	U2/F2/E2/L2	—			—
	C90, T95, C110,	UT	U2/F2/E2/L2	U2/F2/E2/L2	U2/F2/E2/L2	U2/F2/E2/L2	U2/F2/E2/L2	U2/F2/E2/L2
		2nd method	U2/F2/E2/L2	U2/F2/E2/L2	—	—	—	—
Coupling stock and accessory material	All grades except C110		U2/F2/E2/L2	U2/F2/E2/L2	—	N	N	—
	C90, T95, C110		U2/F2/E2/L2	U2/F2/E2/L2	—	U3/F3/E3/L3	U3/F3/E3/L3	—
Weld seam	P110, Q125		U2/F2/E2/L2	N	—	U2/F2/E2/L2	N	—
	All other grades		U3/F3/E3/L3	N	—	U3/F3/E3/L3	N	—
	All other grades to A.2 (SR2)		U2/F2/E2/L2	N	—	U2/F2/E2/L2	N	—

N: not required

U*x*/F*x*/E*x*/L*x* correspond to the acceptance (inspection) level.

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Table C.44 — Artificial reference indicators

Acceptance (inspection) level	Notch depth[a] max. %	Notch length max. at full depth mm	Notch width max. mm	Radially drilled hole diameter[b] mm
1	*2*	*3*	*4*	*5*
U2/F2/E2/L2	5	50	1	1,6
U3/F3/E3/L3	10	50	1	3,2
U4/F4/E4/L4	12,5	50	1	3,2

NOTE See Figure D.16.

[a] Depth as a percent of specified wall thickness. The depth tolerance shall be ±15 % of the calculated notch depth with a minimum notch depth of 0,3 mm ± 0,05 mm.

[b] Drilled hole diameter (through the pipe wall) shall be based on the drill bit size.

Table C.45 — Size of stamp markings

Product	Label 1	Marking height mm
Pipe	<4-1/2	4,8
	≥4-1/2	6,4
Coupling	For pipe sizes <4-1/2	6,4
	For pipe sizes ≥4-1/2 to <7-5/8	9,5
	For pipe sizes ≥7-5/8	12,7

Table C.46 — Grade colour codes

Grade	Grade type	Number and colour of bands for product[a] with length ≥1,8 m	Colour(s) for couplings	
			Entire coupling	Band(s)[b,c]
1	*2*	*3*	*4*	*5*
H40		None or black band at the manufacturer's option	None	Same as for pipe
J55 tubing		One bright green	Bright green	None
J55 casing		One bright green	Bright green	One white
K55		Two bright green	Bright green	None
N80	1	One red	Red	None
N80	Q	One red, one bright green	Red	Green
R95		One brown	Brown	None
L80	1	One red, one brown	Red	One brown
L80	13Cr	One red, one brown, one yellow	None	One yellow
C90		One purple	Purple	None
T95		One silver	Silver	None

[a] In the case of coupling material, unless otherwise specified on the purchase agreement, the manufacturer's internal requirements shall govern.

[b] Special-clearance couplings shall also have a black band.

[c] Seal-ring couplings shall also have a blue band.

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Table C.46 *(continued)*

Grade	Grade type	Number and colour of bands for product[a] with length ≥1,8 m	Colour(s) for couplings	
			Entire coupling	Band(s)[b,c]
1	*2*	*3*	*4*	*5*
C110		One white, two brown	White	Two brown
P110		One white	White	None
Q125		One orange	Orange	None

[a] In the case of coupling material, unless otherwise specified on the purchase agreement, the manufacturer's internal requirements shall govern.

[b] Special-clearance couplings shall also have a black band.

[c] Seal-ring couplings shall also have a blue band.

Table C.47 — Thread type markings

Thread type	Marked symbol
Short round	SC
Long round	LC
Buttress	BC
Non-upset	NU
External upset	EU
Integral joint	IJ

Table C.48 — Marking requirements and sequence

Marking sequence		Mark or symbol[b]	Stencil and/or stamp marking requirements[a]				
			Grades H40, J55, K55, N80 all types, R95 and P110		Grades L80 all types, C90, T95, C110 and Q125		All Grades
			Pipe	Couplings and accessories	Pipe	Couplings and accessories	Coupling stock and accessory material
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
1	Manufacturer's name or mark	« ..... »	D or P	D or P	P	P	P
2	ISO 11960	ISO 11960	D or P	D or P	P	P	P
	Date of manufacture as in 11.1.8.	« ..... »	D or P	D or P	P	P	P

NOTE See 11.4 for mandatory colour code requirements.

[a] D indicates optional (die) stamping (for location see 11.2.3); P indicates a requirement for (paint) stencilling (for location see 11.3). Additional marking is permitted as specified in 11.1.9.

[b] A blank space, « ..... », indicates information to be filled in.

[c] Stamp marking shall conform to the requirements of 11.2.5.

[d] Pipe can be identified as manufactured to SI units by the marked hydro-test pressure which will be less than 100 (MPa), while the pressure marked for pipe manufactured to USC units will be over 1 000 (psi). This information is used to clearly identify the units used for CVN markings, which shall be in the same unit system as the pressure markings.

[e] "A" when tested using Method A (smooth tensile), "B" when tested using Method B (bent beam), "D" when tested using Method D (DCB).

[f] For Grade C110 only, "DA" when tested using a test solution other than ANSI/NACE TM0177-2016 Test Solution A.

[g] See Table C.47 for thread type markings.

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Table C.48 *(continued)*

Marking sequence		Mark or symbol[b]	Stencil and/or stamp marking requirements[a]				
			Grades H40, J55, K55, N80 all types, R95 and P110		Grades L80 all types, C90, T95, C110 and Q125		All Grades
			Pipe	Couplings and accessories	Pipe	Couplings and accessories	Coupling stock and accessory material
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
3	Unthreaded pipe or special end-finish, if applicable (place symbol after specification marking):						
	— Unthreaded pipe either upset or non-upset;	PE	D or P		P		
	— Pipe with special end-finish threaded by the pipe mill or processor;	SF	D or P		P		
	— Couplings threaded with special end-finish;	SF		D or P		P	
	— Coupling stock.	CS					P
4	Size designation (fill in Label 1 designation from column 1 of Table C.1 or C.2) Specified diameter for coupling stock and other products with no mass designation	« ..... »	P		P		P
5	Mass designation (fill in Label 2 designation from Table C.1 or C.2) Specified wall thickness for coupling stock and other products with no mass designation	« ..... »	D or P		P		P

NOTE See 11.4 for mandatory colour code requirements.

[a] D indicates optional (die) stamping (for location see 11.2.3); P indicates a requirement for (paint) stencilling (for location see 11.3). Additional marking is permitted as specified in 11.1.9.

[b] A blank space, « ..... », indicates information to be filled in.

[c] Stamp marking shall conform to the requirements of 11.2.5.

[d] Pipe can be identified as manufactured to SI units by the marked hydro-test pressure which will be less than 100 (MPa), while the pressure marked for pipe manufactured to USC units will be over 1 000 (psi). This information is used to clearly identify the units used for CVN markings, which shall be in the same unit system as the pressure markings.

[e] "A" when tested using Method A (smooth tensile), "B" when tested using Method B (bent beam), "D" when tested using Method D (DCB).

[f] For Grade C110 only, "DA" when tested using a test solution other than ANSI/NACE TM0177-2016 Test Solution A.

[g] See Table C.47 for thread type markings.

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Table C.48 *(continued)*

Marking sequence		Mark or symbol[b]	Stencil and/or stamp marking requirements[a]				
			Grades H40, J55, K55, N80 all types, R95 and P110		Grades L80 all types, C90, T95, C110 and Q125		All Grades
			Pipe	Couplings and accessories	Pipe	Couplings and accessories	Coupling stock and accessory material
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
6	Grade of product:						
	— H40	H					
	— J55	J					
	— K55	K					
	— N80 Type 1	N1					
	— N80Q	NQ					
	— R95	R					
	— L80 Type 1	L					
	— L80 Type 13Cr	L13					
	— C90 Type 1	C90					
	— T95 Type 1	T95					
	— C110	C110					
	— P110	P					
	— Q125 Type 1	Q					
	All grade designations		D or P	D or P	P	P	P
7	Sulfide cracking test [e]						
	— C90 Type 1	A, B or D					
	— T95 Type 1	A, B or D			P	P	P
	— C110	A, D or DA[f]					
	All test method designations						
8	Reduced alternative impact test temperature, if applicable. Fill in specified test temperature for full-size specimens, including ± symbol and °C	« ... »C	P	P	P	P	

NOTE See 11.4 for mandatory colour code requirements.

[a] D indicates optional (die) stamping (for location see 11.2.3); P indicates a requirement for (paint) stencilling (for location see 11.3). Additional marking is permitted as specified in 11.1.9.

[b] A blank space, « ..... », indicates information to be filled in.

[c] Stamp marking shall conform to the requirements of 11.2.5.

[d] Pipe can be identified as manufactured to SI units by the marked hydro-test pressure which will be less than 100 (MPa), while the pressure marked for pipe manufactured to USC units will be over 1 000 (psi). This information is used to clearly identify the units used for CVN markings, which shall be in the same unit system as the pressure markings.

[e] "A" when tested using Method A (smooth tensile), "B" when tested using Method B (bent beam), "D" when tested using Method D (DCB).

[f] For Grade C110 only, "DA" when tested using a test solution other than ANSI/NACE TM0177-2016 Test Solution A.

[g] See Table C.47 for thread type markings.

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Table C.48 *(continued)*

Marking sequence		Mark or symbol[b]	Stencil and/or stamp marking requirements[a]				
			Grades H40, J55, K55, N80 all types, R95 and P110		Grades L80 all types, C90, T95, C110 and Q125		All Grades
			Pipe	Couplings and accessories	Pipe	Couplings and accessories	Coupling stock and accessory material
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
9	Heat treatment, if applicable:						
	— J55 or K55 normalized	Z	P	P			P
	— J55 or K55 normalized & tempered	N&T	P	P			P
10	Process of manufacture:						
	— Seamless						
	— Electric-welded	S					
	All designations	E	D or P		P		
11	Supplementary requirements, if applicable:						
	— A.2 SR2	S2	P		P		
	— A.3 SR9 (fill in type)	S9Q« .. »				P	
	— A.7 SR13	S13		D or P		P	
	— A.8 SR16 (fill in minimum full-size energy absorption requirement, in joules, and test temperature including ± symbol and °C)	S16« ... »C	P		P		
	— A.9 SR22	S22	P	D	P	D	
	— A.13 SR41	S41	P	P	P	P	P
	— A.19 SR47	AH	P		P		
12	Hydrostatic test pressure[d]						
	(fill in the actual test pressure, in MPa)						
	All designations	P« ..... »	P		P		
13	Type of thread, if applicable	« ..... »[g]	P	P	P	P	

NOTE See 11.4 for mandatory colour code requirements.

[a] D indicates optional (die) stamping (for location see 11.2.3); P indicates a requirement for (paint) stencilling (for location see 11.3). Additional marking is permitted as specified in 11.1.9.

[b] A blank space, « ..... », indicates information to be filled in.

[c] Stamp marking shall conform to the requirements of 11.2.5.

[d] Pipe can be identified as manufactured to SI units by the marked hydro-test pressure which will be less than 100 (MPa), while the pressure marked for pipe manufactured to USC units will be over 1 000 (psi). This information is used to clearly identify the units used for CVN markings, which shall be in the same unit system as the pressure markings.

[e] "A" when tested using Method A (smooth tensile), "B" when tested using Method B (bent beam), "D" when tested using Method D (DCB).

[f] For Grade C110 only, "DA" when tested using a test solution other than ANSI/NACE TM0177-2016 Test Solution A.

[g] See Table C.47 for thread type markings.

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Table C.48 *(continued)*

Marking sequence		Mark or symbol[b]	Stencil and/or stamp marking requirements[a]				
			Grades H40, J55, K55, N80 all types, R95 and P110		Grades L80 all types, C90, T95, C110 and Q125		All Grades
			Pipe	Couplings and accessories	Pipe	Couplings and accessories	Coupling stock and accessory material
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
14	Full-length drift test, if applicable: — Standard (casing or tubing) — Alternative (casing or tubing) where « » is the size of the alternative drift — For casing specified for tubing service and drift-tested in accordance with 8.10 All designations	 D DA« ..... » DT42	 P	 	 P	 	
15	Serialization of Grades C90, T95, C110 and Q125				D[c] or P	D[c] or P	P
16	Tin plating of couplings, if applicable	T		P		P	
17	Couplings H40, J55 and K55 only visually inspected	V		P			

NOTE See 11.4 for mandatory colour code requirements.

[a] D indicates optional (die) stamping (for location see 11.2.3); P indicates a requirement for (paint) stencilling (for location see 11.3). Additional marking is permitted as specified in 11.1.9.

[b] A blank space, « ..... », indicates information to be filled in.

[c] Stamp marking shall conform to the requirements of 11.2.5.

[d] Pipe can be identified as manufactured to SI units by the marked hydro-test pressure which will be less than 100 (MPa), while the pressure marked for pipe manufactured to USC units will be over 1 000 (psi). This information is used to clearly identify the units used for CVN markings, which shall be in the same unit system as the pressure markings.

[e] "A" when tested using Method A (smooth tensile), "B" when tested using Method B (bent beam), "D" when tested using Method D (DCB).

[f] For Grade C110 only, "DA" when tested using a test solution other than ANSI/NACE TM0177-2016 Test Solution A.

[g] See Table C.47 for thread type markings.

Table C.49 — Retention of records

Requirement	Subclause reference
Chemical properties	
Heat analysis	10.3.1
Product analysis	10.3.2

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Table C.49 *(continued)*

Requirement	Subclause reference
Mechanical properties	
Heat control tensile tests	10.4.2
Tensile tests on products	7.2, 10.4.7
Impact tests on products	7.4, 7.5, 7.6, 10.7
Hardness tests	7.7, 7.8, 7.9 and 10.6
Hardenability tests	7.10, 10.9
Grain size (Grades C90, T95 and C110)	7.11, 10.8
Coupling tests	9.3
Hydrostatic tests	
Tester recorder charts	10.12.1
Testing	10.12.1
Manufacturer certification	
Results of all required tests (Grade Q125)	13.3
Sulfide stress-cracking test (Grades C90, T95 and C110)	7.14, 10.10
Calibration	Various

Table C.50 — SR11.1 Distance between plates for flattening tests

Grade	D/t ratio	Distance between plates max. mm
P110	All ratios	$D \times (1{,}086 - 0{,}016\ 3\ D/t)$
Q125	All ratios	$D \times (1{,}092 - 0{,}014\ 0\ D/t)$
D is the specified outside diameter of pipe, in millimetres.		
t is the specified wall thickness of the pipe, in millimetres.		

Table C.51 — SR12.1 Inspection lot sample sizes vs. *F* factor

Sample size	*F*	Sample size	*F*
1	*2*	*3*	*4*
3	13,857	16	4,534
4	9,215	18	4,415
5	7,501	20	4,319
6	6,612	25	4,143
7	6,061	30	4,022
8	5,686	35	3,937
9	5,414	40	3,866
10	5,203	45	3,811
12	4,900	50	3,766
14	4,690	∞	3,090

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Table C.52 — SR12.2 Probability of defective product

Probability of one length being defective	Probability that one or more defective lengths is included in a string of 100 products
1/10	0,999 97 (or 100 %)
1/100	0,634 (or 63 %)
1/1 000	0,095 (or 10 %)
1/10 000	0,009 95 (or 1 %)

Table C.53 — SR16.1 Transverse impact specimen size required

Label 1	Calculated wall thickness required to machine transverse Charpy impact specimens mm		
	Full-size	¾-size	½-size
1	*2*	*3*	*4*
3-1/2	20,53	18,03	15,53
4	19,09	16,59	14,09
4-1/2	18,05	15,55	13,05
5	17,26	14,76	12,26
5-1/2	16,64	14,14	11,64
6-5/8	15,62	13,12	10,62
7	15,36	12,86	10,36
7-5/8	14,99	12,49	9,99
7-3/4	14,92	12,42	9,92
8-5/8	14,51	12,01	9,51
9-5/8	14,13	11,63	9,13
10-3/4	13,80	11,30	8,80
11-3/4	13,56	11,06	8,56
13-3/8	13,24	10,74	8,24
16	12,87	10,37	7,87
18-5/8	12,60	10,10	7,60
20	12,49	9,99	7,49

NOTE The wall thicknesses in columns 2, 3 and 4 that are in excess of the maximum wall thicknesses for ISO/API pipe are for information only. The calculated values in this table provide a 0,50 mm inside-wall and a 0,50 mm outside-wall machining allowance.

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Table C.54 — SR16.2 Longitudinal impact specimen size required

Label 1	Calculated wall thickness required to machine longitudinal Charpy impact specimens mm		
	Full-size	¾-size	½-size
1	*2*	*3*	*4*
1.050	11,97	9,47	6,97
1.315	11,77	9,27	6,77
1.660	11,60	9,10	6,60
1.900	11,52	9,02	6,52
2.063	11,48	8,98	6,48
2-3/8	11,42	8,92	6,42
2-7/8	11,34	8,84	6,34
3-1/2	11,28	8,78	6,28
4	11,25	8,75	6,25
4-1/2	11,22	8,72	6,22
5	11,20	8,70	6,20
5-1/2	11,18	8,68	6,18
6-5/8	11,15	8,65	6,15
7	11,14	8,64	6,14
7-5/8	11,13	8,63	6,13
7-3/4	11,13	8,63	6,13
8-5/8	11,11	8,61	6,11
9-5/8	11,10	8,60	6,10
10-3/4	11,09	8,59	6,09
11-3/4	11,08	8,58	6,08
13-3/8	11,07	8,57	6,07
16	11,06	8,56	6,06
18-5/8	11,05	8,55	6,05
20	11,05	8,55	6,05

NOTE The wall thicknesses in columns 2, 3 and 4 that are in excess of the maximum wall thicknesses for ISO/API pipe are for information only. The above provides a 0,50 mm inside-wall and a 0,50 mm outside-wall machining allowance.

Table C.55 — SR16.3 Acceptable size impact specimens and absorbed energy reduction factor

Test specimen size	Specimen dimensions mm	Reduction factor
Full-size	10,0 × 10,0	1,00
¾-size	10,0 × 7,5	0,80
½-size	10,0 × 5,0	0,55

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Table C.56 — SR16.4 Hierarchy of test specimen orientation and size

Choice	Orientation	Size
1st	Transverse	Full-size
2nd	Transverse	¾-size
3rd	Transverse	½-size
4th	Longitudinal	Full-size
5th	Longitudinal	¾-size
6th	Longitudinal	½-size

Table C.57 — SR16.7 Test temperature reduction for sub-size specimens — Grades H40, J55 and K55 only

Specimen size mm	Specified pipe wall thickness mm	Temperature reduction °C
10,0 × 7,5	>10,0	3
10,0 × 5,0	>10,0	11
10,0 × 5,0	7,5 to 10,0	8
10,0 × 5,0	6,7 to 7,4	6
10,0 × 5,0	6,0 to 6,6	3

Table C.58 — Enhanced leak resistance SR22.1

Label 1	Label 2	Grade[a]	Outside diameter *D*	Drift diameter	Coupling OD regular *W*	Power turns min.	Length[b] L_9	Approximate start torque		Recommended thread compound mass[c]
								Tin	Phosphate	
			mm	mm	mm	N	mm	N·m	N·m	g
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*
4-1/2	11.60	J55, K55	114,30	98,42	133,35	3	82,55	176	294	15
4-1/2	11.60	L80, N80	114,30	98,42	133,35	3	82,55	168	279	15
4-1/2	13.50	L80, N80	114,30	96,38	133,35	3	82,55	184	308	15
4-1/2	11.60	C90	114,30	98,42	133,35	3	82,55	172	—	15
4-1/2	13.50	C90	114,30	96,38	133,35	3	82,55	194	—	15
4-1/2	11.60	R95, T95	114,30	98,42	133,35	3	82,55	176	—	15
4-1/2	13.50	R95, T95	114,30	96,38	133,35	3	82,55	198	—	15
4-1/2	11.60	P110	114,30	98,42	133,35	3	82,55	176	—	15
4-1/2	13.50	P110	114,30	96,38	133,35	3	82,55	201	—	15
5	13.00	J55, K55	127,00	110,96	147,32	3	92,08	157	262	20
5	15.00	J55, K55	127,00	108,78	147,32	3	92,08	169	282	20

[a] L/N80 implies L80 Type 1, N80 Type1 and N80Q.

[b] End of pipe to apex of triangle.

[c] The recommended mass of thread compound shown in this table is for a compound containing metals, including lead (i.e. former API Bull 5A2) which has a specific gravity of approximately 2. Use of compounds such as described in ISO 13678 or API RP 5A3 requires less mass to achieve an equivalent volume of thread compound. Use of excessive thread compound may be detrimental to leak resistance.

[d] The alternative size drift (see Table C.29) is shown.

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Table C.58 *(continued)*

Label 1	Label 2	Grade[a]	Outside diameter D	Drift diameter	Coupling OD regular W	Power turns min.	Length[b] L_9	Approximate start torque		Recommended thread compound mass[c]
								Tin	Phosphate	
			mm	mm	mm	N	mm	N·m	N·m	g
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*
5	15.00	L80, N80	127,00	108,78	147,32	3,5	92,08	222	370	20
5	18.00	L80, N80	127,00	105,44	147,32	3,5	92,08	298	498	20
5	15.00	C90	127,00	108,78	147,32	3	92,08	268	—	20
5	18.00	C90	127,00	105,44	147,32	3	92,08	323	—	20
5	15.00	R95, T95	127,00	108,78	147,32	3,5	92,08	274	—	20
5	18.00	R95, T95	127,00	105,44	147,32	3,5	9208	329	—	20
5	15.00	P110	127,00	108,78	147,32	3,5	92,08	282	—	20
5	18.00	P110	127,00	105,44	147,32	3,5	92,08	336	—	20
5-1/2	15.50	J55, K55	139,70	122,56	160,02	3	95,25	220	366	25
5-1/2	17.00	J55, K55	139,70	121,08	160,02	3	95,25	260	434	25
5-1/2	17.00	L80, N80	139,70	121,08	160,02	4	95,25	325	542	25
5-1/2	20.00	L80, N80	139,70	118,18	160,02	4	95,25	370	618	25
5-1/2	17.00	C90	139,70	121,08	160,02	3	95,25	244	—	25
5-1/2	20.00	C90	139,70	118,18	160,02	3	95,25	278	—	25
5-1/2	17.00	R95, T95	139,70	121,08	160,02	3,5	95,25	301	—	25
5-1/2	20.00	R95, T95	139,70	118,18	160,02	3,5	95,25	340	—	25
5-1/2	17.00	P110	139,70	121,08	160,02	4	95,25	366	—	25
5-1/2	20.00	P110	139,70	118,18	160,02	4	95,25	408	—	25
6-5/8	20.00	J55, K55	168,28	150,46	187,71	3	104,78	220	365	30
6-5/8	24.00	J55, K55	168,28	147,22	187,71	3	104,78	274	457	30
6-5/8	24.00	L80, N80	168,28	147,22	187,71	4	104,78	450	751	30
6-5/8	28.00	L80, N80	168,28	143,92	187,71	4	104,78	525	876	30
6-5/8	32.00	L80, N80	168,28	140,98	187,71	4	104,78	579	965	30
6-5/8	24.00	C90	168,28	147,22	187,71	4	104,78	476	—	30
6-5/8	28.00	C90	168,28	143,92	187,71	4	104,78	553	—	30
6-5/8	32.00	C90	168,28	140,98	187,71	4	104,78	611	—	30
6-5/8	24.00	R95, T95	168,28	147,22	187,71	4	104,78	483	—	30
6-5/8	28.00	R95, T95	168,28	143,92	187,71	4	104,78	557	—	30
6-5/8	32.00	R95, T95	168,28	140,98	187,71	4	104,78	614	—	30
6-5/8	24.00	P110	168,28	147,22	187,71	4,5	104,78	565	—	30
6-5/8	28.00	P110	168,28	143,92	187,71	4,5	104,78	655	—	30
6-5/8	32.00	P110	168,28	140,98	187,71	4,5	10478	721	—	30

[a] L/N80 implies L80 Type 1, N80 Type1 and N80Q.

[b] End of pipe to apex of triangle.

[c] The recommended mass of thread compound shown in this table is for a compound containing metals, including lead (i.e. former API Bull 5A2) which has a specific gravity of approximately 2. Use of compounds such as described in ISO 13678 or API RP 5A3 requires less mass to achieve an equivalent volume of thread compound. Use of excessive thread compound may be detrimental to leak resistance.

[d] The alternative size drift (see Table C.29) is shown.

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Table C.58 *(continued)*

Label 1	Label 2	Grade[a]	Outside diameter D	Drift diameter	Coupling OD regular W	Power turns min.	Length[b] L_9	Approximate start torque		Recommended thread compound mass[c]
								Tin	Phosphate	
			mm	mm	mm	N	mm	N·m	N·m	g
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*
7	23.00	J55, K55	177,80	158,52	200,03	4	107,95	321	536	35
7	26.00	J55, K55	177,80	156,24	200,03	4	107,95	370	617	35
7	23.00	L80, N80	177,80	158,52	200,03	5,5	107,95	561	936	35
7	26.00	L80, N80	177,80	156,24	200,03	5,5	107,95	659	1098	35
7	29.00	L80, N80	177,80	153,90	200,03	5,5	107,95	736	1226	35
7	32.00	L80, N80	177,80	151,61	200,03	5,5	107,95	793	1322	35
7	23.00	C90	177,80	158,52	200,03	4,5	107,95	480	—	35
7	26.00	C90	177,80	156,24	200,03	4,5	107,95	548	—	35
7	29.00	C90	177,80	153,90	200,03	4,5	107,95	609	—	35
7	32.00	C90	177,80	151,61	200,03	4,5	107,95	663	—	35
7	23.00	R95, T95	177,80	158,52	200,03	4,5	107,95	489	—	35
7	26.00	R95, T95	177,80	156,24	200,03	4,5	107,95	556	—	35
7	29.00	R95, T95	177,80	153,90	200,03	4,5	107,95	617	—	35
7	32.00	R95, T95	177,80	151,61	200,03	4,5	107,95	670	—	35
7	26.00	P110	177,80	156,24	200,03	5	107,95	643	—	35
7	29.00	P110	177,80	153,90	200,03	5	107,95	712	—	35
7	32.00	P110	177,80	151,61	200,03	5	107,95	769	—	35
7-5/8	26.40	J55, K55	193,68	173,84	215,90	3,5	111,12	331	550	40
7-5/8	26.40	L80, N80	193,68	173,84	215,90	5	111,12	654	1090	40
7-5/8	29.70	L80, N80	193,68	171,46	215,90	5	111,12	767	1279	40
7-5/8	33.70	L80, N80	193,68	168,66	215,90	5	111,12	880	1466	40
7-5/8	39.00	L80, N80	193,68	165,10	215,90	5	111,12	999	1665	40
7-5/8	26.40	C90	193,68	173,84	215,90	4,5	111,12	555	—	40
7-5/8	29.70	C90	193,68	171,46	215,90	4,5	111,12	637	—	40
7-5/8	33.70	C90	193,68	168,66	215,90	4,5	111,12	721	—	40
7-5/8	39.00	C90	193,68	165,10	215,90	4,5	111,12	813	—	40
7-5/8	26.40	R95, T95	193,68	173,84	215,90	4,5	111,12	565	—	40
7-5/8	29.70	R95, T95	193,68	171,46	215,90	4,5	111,12	645	—	40
7-5/8	33.70	R95, T95	193,68	168,66	215,90	4,5	111,12	728	—	40
7-5/8	39.00	R95, T95	193,68	165,10	215,90	4,5	111,12	818	—	40
7-5/8	29.70	P110	193,68	171,46	215,90	5	111,12	747	—	40
7-5/8	33.70	P110	193,68	168,66	215,90	5	111,12	841	—	40

[a] L/N80 implies L80 Type 1, N80 Type1 and N80Q.

[b] End of pipe to apex of triangle.

[c] The recommended mass of thread compound shown in this table is for a compound containing metals, including lead (i.e. former API Bull 5A2) which has a specific gravity of approximately 2. Use of compounds such as described in ISO 13678 or API RP 5A3 requires less mass to achieve an equivalent volume of thread compound. Use of excessive thread compound may be detrimental to leak resistance.

[d] The alternative size drift (see Table C.29) is shown.

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Table C.58 *(continued)*

Label 1	Label 2	Grade[a]	Outside diameter D	Drift diameter	Coupling OD regular W	Power turns min.	Length[b] L_9	Approximate start torque		Recommended thread compound mass[c]
								Tin	Phosphate	
			mm	mm	mm	N	mm	N·m	N·m	g
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*
7-5/8	39.00	P110	193,68	165,10	215,90	5	111,12	942	—	40
8-5/8	32.00	J55, K55	219,08	198,02	244,48	3,5	120,65	415	691	50
8-5/8	36.00	J55, K55	219,08	195,58	244,48	3,5	120,65	483	804	50
8-5/8	36.00	L80, N80	219,08	195,58	244,48	5,5	120,65	832	1388	50
8-5/8	40.00	L80, N80	219,08	193,04	244,48	5,5	120,65	891	1485	50
8-5/8	44.00	L80, N80	219,08	190,50	244,48	5,5	120,65	999	1666	50
8-5/8	49.00	L80, N80	219,08	187,60	244,48	5,5	120,65	1079	1798	50
8-5/8	36.00	C90	219,08	195,58	244,48	4,5	120,65	881	—	50
8-5/8	40.00	C90	219,08	193,04	244,48	4,5	120,65	980	—	50
8-5/8	44.00	C90	219,08	190,50	244,48	4,5	120,65	1070	—	50
8-5/8	49.00	C90	219,08	187,60	244,48	4,5	120,65	1162	—	50
8-5/8	36.00	R95, T95	219,08	195,58	244,48	5	120,65	936	—	50
8-5/8	40.00	R95, T95	219,08	193,04	244,48	5	120,65	1047	—	50
8-5/8	44.00	R95, T95	219,08	190,50	244,48	5	120,65	1143	—	50
8-5/8	49.00	R95, T95	219,08	187,60	244,48	5	120,65	1239	—	50
8-5/8	40.00	P110	219,08	193,04	244,48	5,5	120,65	1083	—	50
8-5/8	44.00	P110	219,08	190,50	244,48	5,5	120,65	1222	—	50
8-5/8	49.00	P110	219,08	187,60	244,48	5,5	120,65	1322	—	50
9-5/8	36.00	J55, K55	244,48	222,63	269,88	3,5	127,00	533	687	55
9-5/8	40.00	J55, K55	244,48	220,45	269,88	3,5	127,00	595	776	55
9-5/8	40.00	L80, N80	244,48	220,45	269,88	5,5	127,00	912	1520	55
9-5/8	43.50	L80, N80	244,48	218,41	269,88	5,5	127,00	1040	1733	55
9-5/8	47.00	L80, N80	244,48	216,54	269,88	5,5	127,00	1116	1859	55
9-5/8	53.50	L80, N80	244,48	215,90[d]	269,88	5,5	127,00	1251	2087	55
9-5/8	40.00	C90	244,48	220,45	269,88	5	127,00	915	—	55
9-5/8	43.50	C90	244,48	218,41	269,88	5	127,00	999	—	55
9-5/8	47.00	C90	244,48	216,54	269,88	5	127,00	1071	—	55
9-5/8	53.50	C90	244,48	215,90[d]	269,88	5	127,00	1340	—	55
9-5/8	40.00	R95, T95	244,48	220,45	269,88	5,5	127,00	1033	—	55
9-5/8	43.50	R95, T95	244,48	218,41	269,88	5,5	127,00	1129	—	55
9-5/8	47.00	R95, T95	244,48	216,54	269,88	5,5	127,00	1211	—	55
9-5/8	53.50	R95, T95	244,48	215,90[d]	269,88	5,5	127,00	1318	—	55

[a] L/N80 implies L80 Type 1, N80 Type1 and N80Q.

[b] End of pipe to apex of triangle.

[c] The recommended mass of thread compound shown in this table is for a compound containing metals, including lead (i.e. former API Bull 5A2) which has a specific gravity of approximately 2. Use of compounds such as described in ISO 13678 or API RP 5A3 requires less mass to achieve an equivalent volume of thread compound. Use of excessive thread compound may be detrimental to leak resistance.

[d] The alternative size drift (see Table C.29) is shown.

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Table C.58 *(continued)*

Label 1	Label 2	Grade[a]	Outside diameter D	Drift diameter	Coupling OD regular W	Power turns min.	Length[b] L_9	Approximate start torque		Recommended thread compound mass[c]
								Tin	Phosphate	
			mm	mm	mm	N	mm	N·m	N·m	g
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*
9-5/8	43.50	P110	244,48	218,41	269,88	6	127,00	1239	—	55
9-5/8	47.00	P110	244,48	216,54	269,88	6	127,00	1326	—	55
9-5/8	53.50	P110	244,48	215,90[d]	269,88	6	127,00	1481	—	55

[a] L/N80 implies L80 Type 1, N80 Type1 and N80Q.

[b] End of pipe to apex of triangle.

[c] The recommended mass of thread compound shown in this table is for a compound containing metals, including lead (i.e. former API Bull 5A2) which has a specific gravity of approximately 2. Use of compounds such as described in ISO 13678 or API RP 5A3 requires less mass to achieve an equivalent volume of thread compound. Use of excessive thread compound may be detrimental to leak resistance.

[d] The alternative size drift (see Table C.29) is shown.

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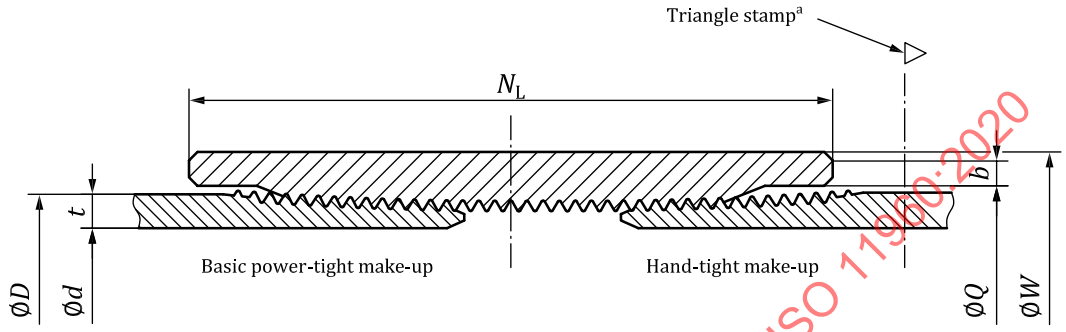
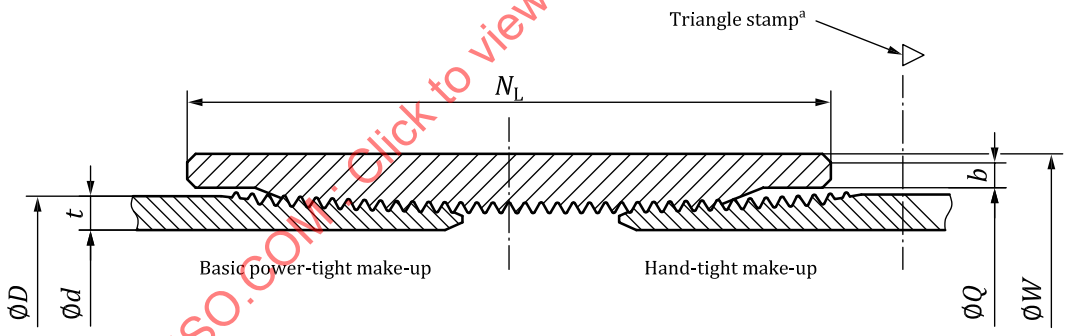
Annex D
(normative)

Figures in SI (USC) units



[a] A 9,52 mm (3/8 in) high equilateral triangle die stamp shall be placed at a distance of L_4 + 1,59 mm (+1/16 in) from each end of Label 1: 16, 18-5/8 and 20 short round-thread casing in Grades H40, J55 and K55. See Table C.23 or Table E.23 for pipe dimensions, Table C.32 or Table E.32 for coupling dimensions and API Spec 5B for L_4.

Figure D.1 — Short round-thread casing and coupling



[a] A 9,52 mm (3/8 in) high equilateral triangle die stamp shall be placed at a distance of L_4 + 1,59 mm (1/16 in) from each end of Label 1: 20 long round-thread casing in Grades H40, J55 and K55. See Table C.23 or Table E.23 for pipe dimensions, Table C.32 or Table E.32 for coupling dimensions and API Spec 5B for L_4.

Figure D.2 — Long round-thread casing and coupling

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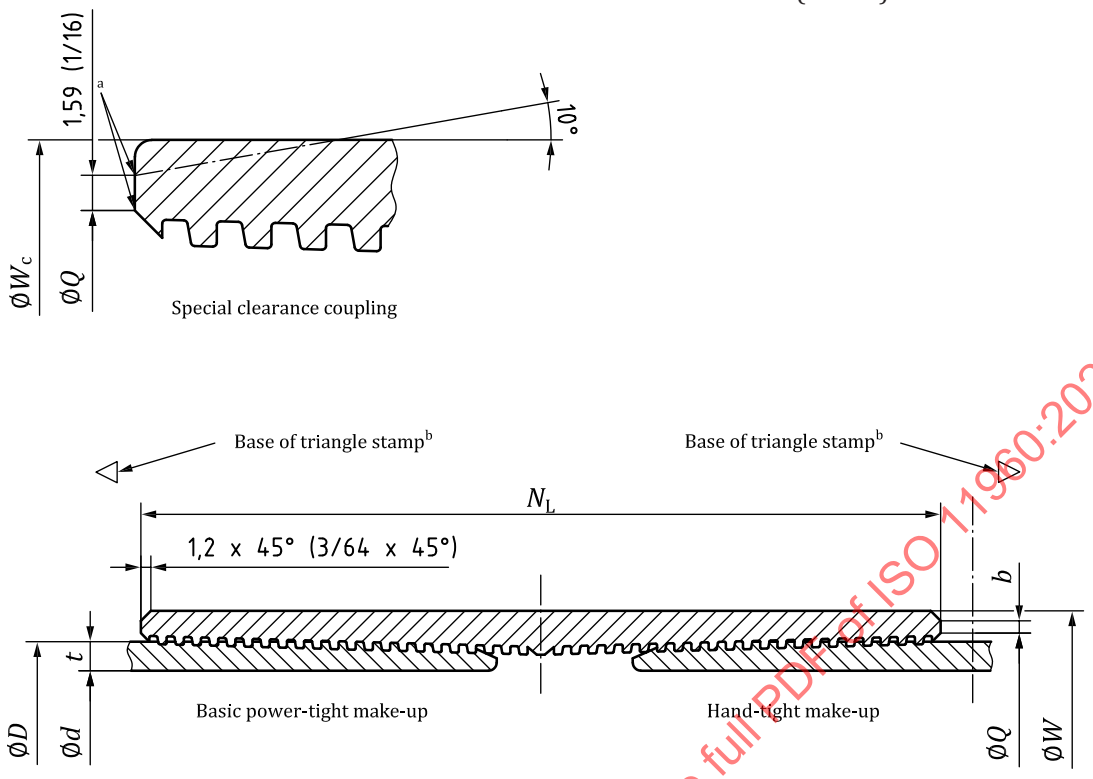
Dimensions in millimetres (inches) unless otherwise specified



a On special-clearance couplings, the inside and outside edges of the bearing face shall be broken or rounded. A 10° bevel (both ends) shall be furnished only when specified on the purchase order.

b A 9,52 mm (3/8 in) high equilateral triangle die-stamp or paint band shall be placed at a distance of A1 from each end of buttress casing. See Table C.23 or Table E.23 for pipe dimensions, Table C.33 or Table E.33 for coupling dimensions and API Spec 5B for A1.

Figure D.3 — Buttress-thread casing and coupling

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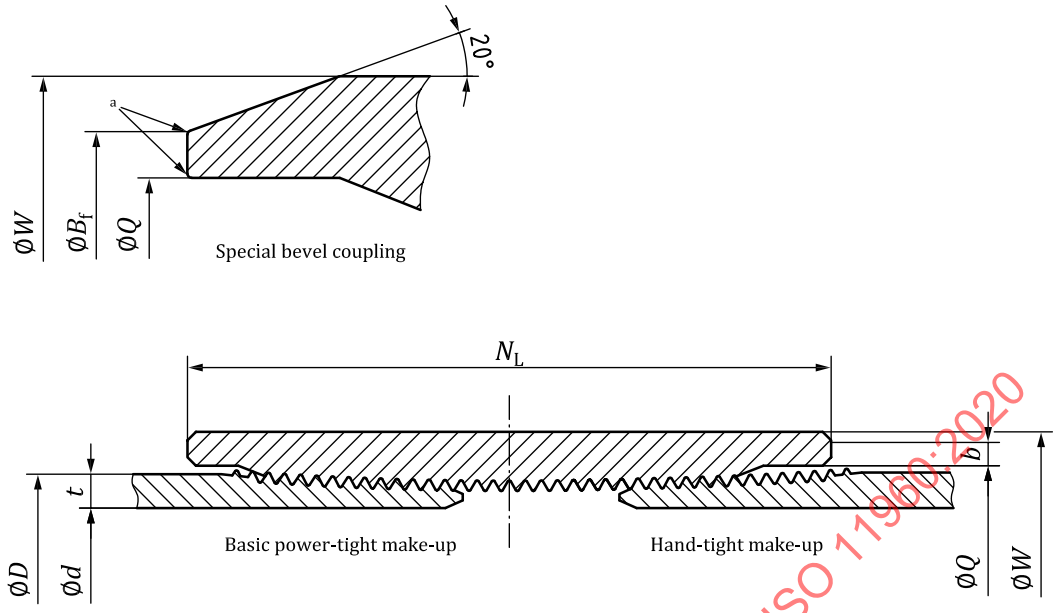

[a] On special bevel couplings, the inside and outside edges of the bearing face shall be broken or rounded.

NOTE See Table C.24 or Table E.24 for pipe dimensions, Table C.34 or Table E.34 for coupling dimensions and API Spec 5B for thread details.

Figure D.4 — Non-upset tubing and coupling

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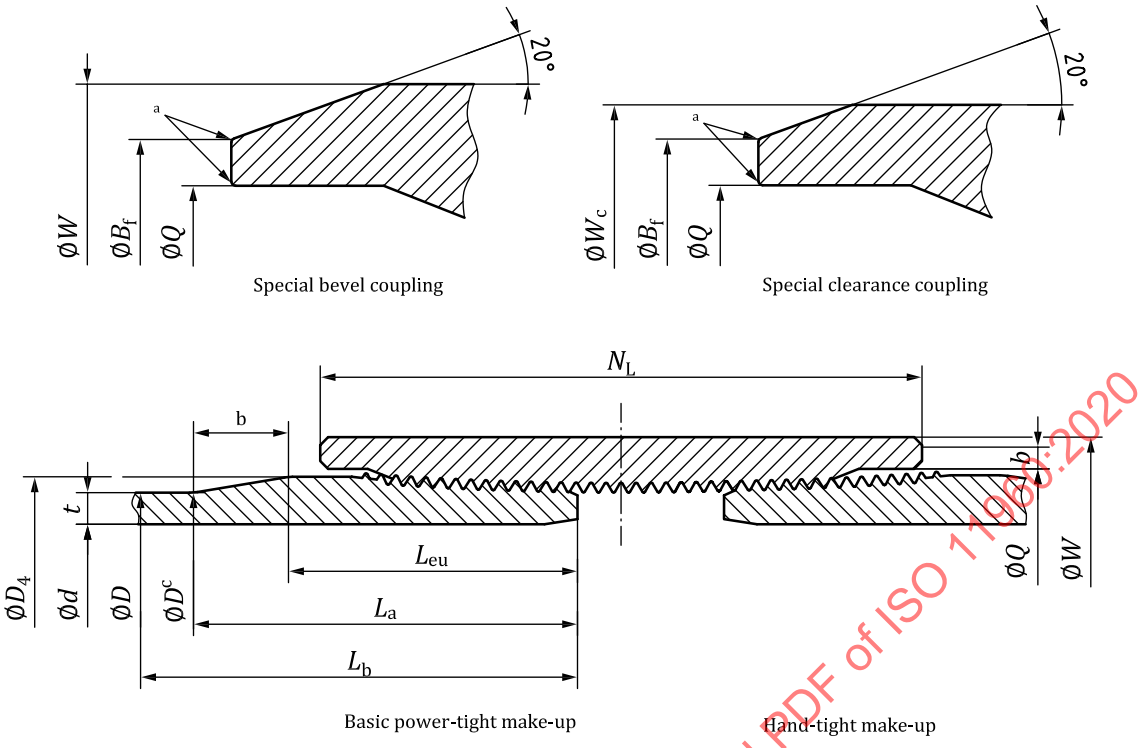


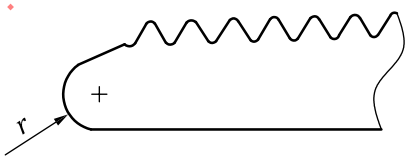
a On special bevel couplings and special clearance couplings, the inside and outside edges of the bearing face shall be broken or rounded.

b Upset run-out interval, not to be confused with *b* on the right-hand side of the figure which indicates the coupling bearing face dimension.

c See 8.11.1 for tolerance on outside diameter at a distance L_a from end of pipe.

NOTE See Tables C.24 and C.25 or Tables E.24 and E.25 for pipe dimensions, Table C.35 or Table E.35 for coupling dimensions and API Spec 5B for thread details.

Figure D.5 — External-upset tubing and coupling



Label 1	Radius[a] *r* mm (in)
1	*2*
2-3/8	2,4 (3/32)
2-7/8	2,4 (3/32)
3-1/2	3,2 (1/8)
4-1/2	3,2 (1/8)

a These dimensions are for reference only and are not subject to measurement for determining product acceptance.

NOTE See API Spec 5B for product acceptance.

Figure D.6 — Rounded nose for external-upset tubing

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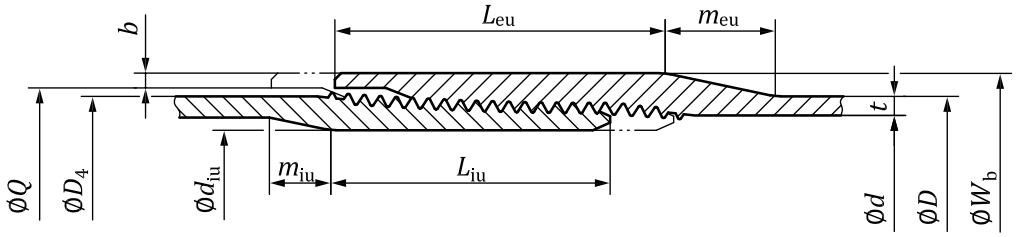

NOTE 1 Dashed lines indicate power-tight make-up.

NOTE 2 See Tables C.24 and C.26 or Tables E.24 and E.26 for pipe dimensions and API Spec 5B for thread details.

Figure D.7 — Integral-joint tubing

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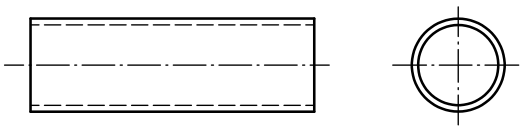
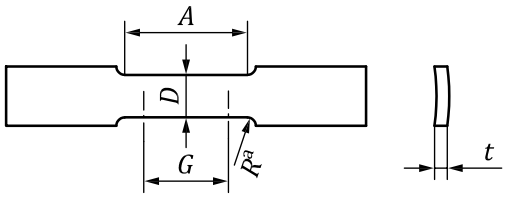
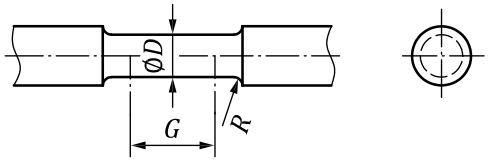


a) Full-section specimen



b) Strip specimen a



c) Round bar specimen

Dimension	Strip specimen mm (in)	Round bar specimen mm (in)	
		D = 12,7 (0.500)	D = 8,9 (0.350)
Gauge length, G	50,8 ± 0,13 (2.000 ± 0.005)	50,8 ± 0,13 (2.000 ± 0.005)	35,6 ± 0,13 (1.400 ± 0.005)
Diameter or width, D	38,1 (1.500) approx.	12,7 ± 0,25 (0.500 ± 0.010)	8,9 ± 0,18 (0.350 ± 0.007)
Radius of fillet, min., R	25,4 (1.000)	9,5 (0.375)	6,4 (0.250)
Length of reduced section, min., A	57,2 (2.250)	57,2 (2.250)	44,5 (1.750)

[a] See 10.4.5 for testing without use of suitable curved-face testing grips.

Figure D.8 — Tensile test specimens

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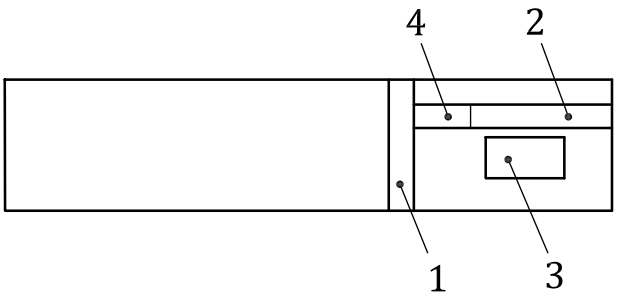


Key

1 hardness test ring [see Figure D.10 for detail, 6,4 mm (0.25 in) minimum thickness]

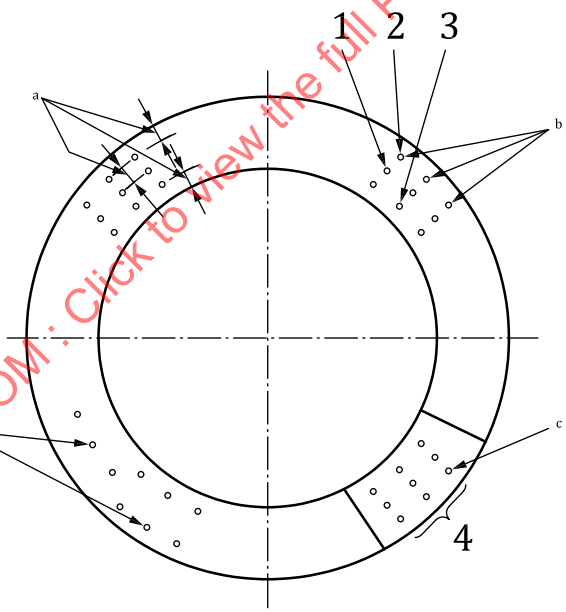
2 tensile test specimen

3 impact test samples (See Figure D.11 for detail)

4 hardness test sample [6,4 mm (0.25 in) minimum thickness], to be removed from tensile test sample prior to tensile test piece preparation

The hardness test ring shall be removed at mid-length position of individually heat-treated coupling blanks.

Figure D.9 — Typical location of test samples removed from product



Key

1 indentation at mid-wall location

2 indentation at outside-wall location

3 indentation at inside-wall location

4 product test block

a The outside-wall and inside-wall tests shall be taken between 2,54 mm (0.10 in) and 3,81 mm (0.15 in) from the applicable surface. An error may result if an indentation is spaced closer than 2½ diameters from its centre to the edge of the specimen or 3 diameters from another indentation measured centre-to-centre.

b The mean hardness number is the average of three Rockwell hardness numbers in the same location.

c Rockwell hardness indentation data are called Rockwell hardness numbers.

d Alternate spacing of rows permitted for thin-wall product.

Figure D.10 — Through-wall hardness test

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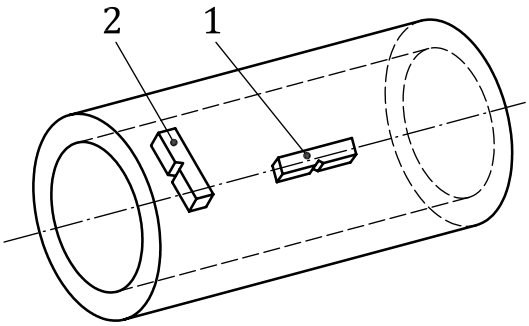


Key

1 longitudinal specimen

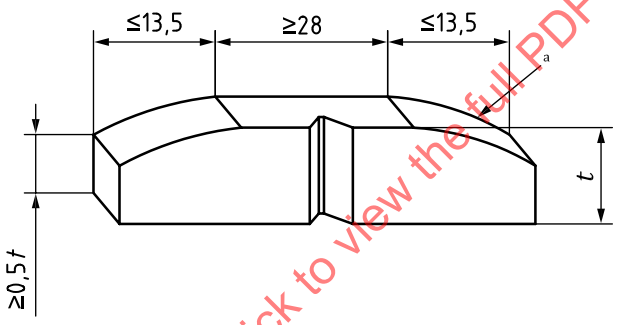
2 transverse specimen

All impact test specimens shall be 10 mm × 10 mm if possible.

The notch shall be oriented perpendicular to the axis of the tube (normal to the tube surface).

Figure D.11 — Impact test specimen orientation

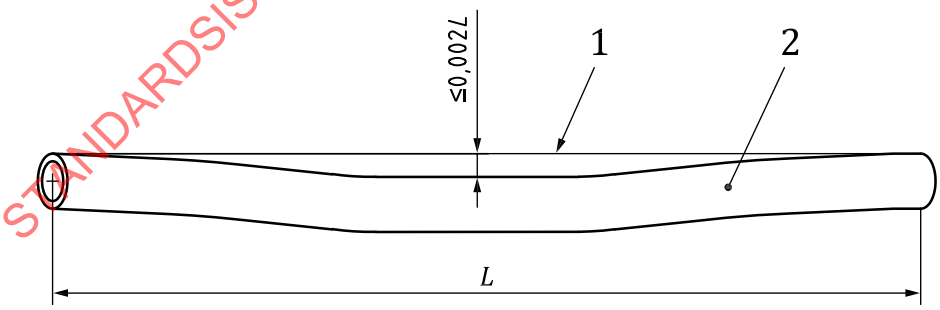
Dimensions in millimetres



Key

a Outside diameter curvature.

Figure D.12 — Charpy specimen dimensions



Key

1 taut string or wire

2 pipe

Figure D.13 — Measuring full-length straightness

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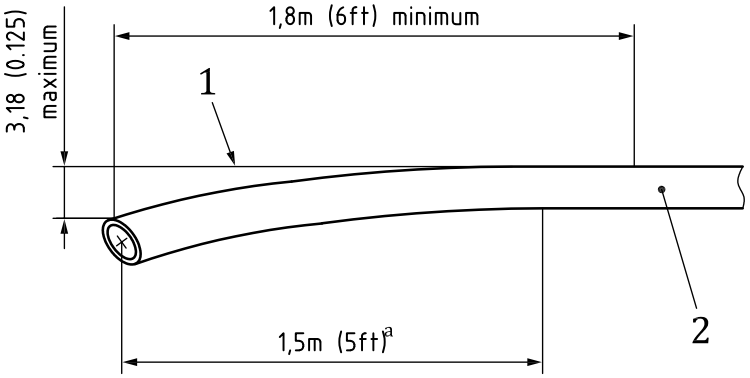
Dimensions in millimetres (inches) unless otherwise specified



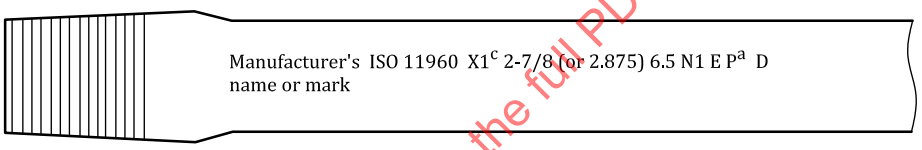
Key

1 straight line

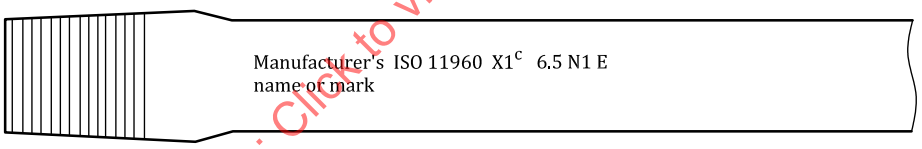
2 pipe

[a] Hooked end.

Figure D.14 — Measuring end straightness

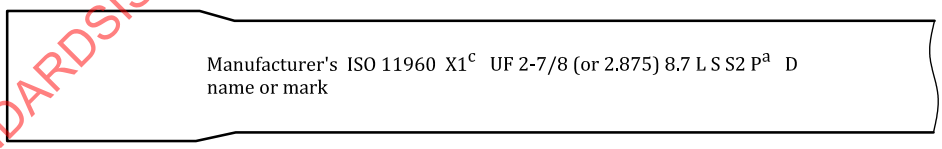


Stencil marking [beginning at least 0,6 m (2 ft) from either externally threaded end]



Stamp marking — Optional [within approximately 0,3 m (1 ft) of either externally threaded end]

a) EXAMPLE 1 — Tubing Label 1: 2-7/8, Label 2: 6.5, Grade N80 Type 1, electric weld, external upset, threaded (by the manufacturer) pin-by-pin without couplings



Stencil marking [beginning at least 0,6 m (2 ft) from either end]

b) EXAMPLE 2 — Tubing Label 1: 2-7/8, Label 2: 8.7, Grade L80 Type 1, seamless, external upset, plain-end.

Additional requirements include hydrostatic testing to 94,5 MPa (13 700 psi) and inspection to SR2

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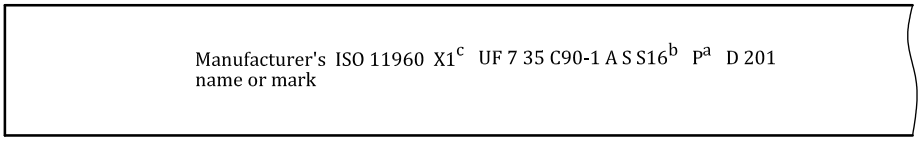
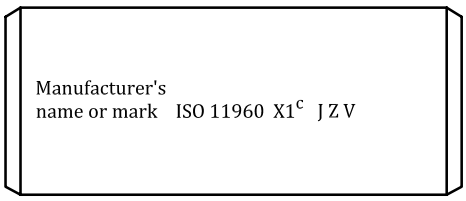


Stencil marking [beginning at least 0,6 m (2 ft) from either end]

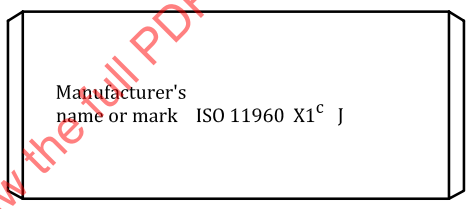
Stamp marking — Optional [within approximately 0,3 m (1 ft) from either end]

c) EXAMPLE 3 — Casing Label 1: 7, Label 2: 35, Grade C90 Type 1, seamless, plain-end, serial number 201.

Supplementary requirement 16 (SR16) for test at -10 °C (+14 °F). The pipe was pressure-tested to 69 MPa (10 000 psi)



Stencil marking



Stamp marking — Optional

Marking in the centre of the coupling may be stamped in either the longitudinal or transverse direction.

d) EXAMPLE 4 — Tubing coupling for Label 1; 2-7/8, Grade J55, normalized upset (or non-upset) tubing, only visual inspection required

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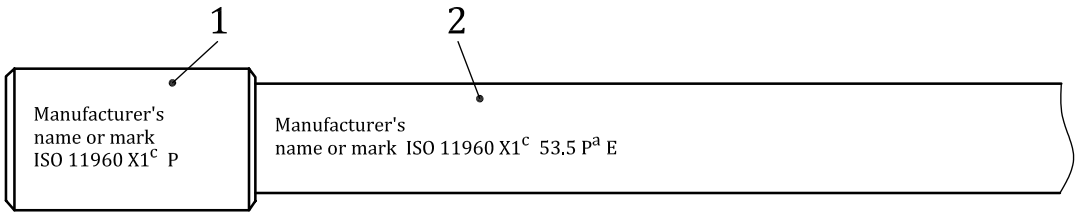
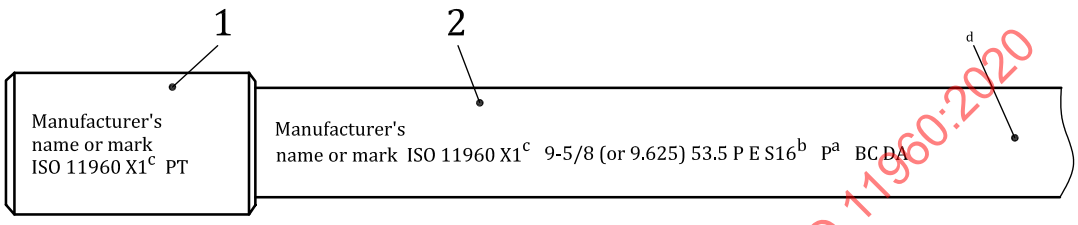


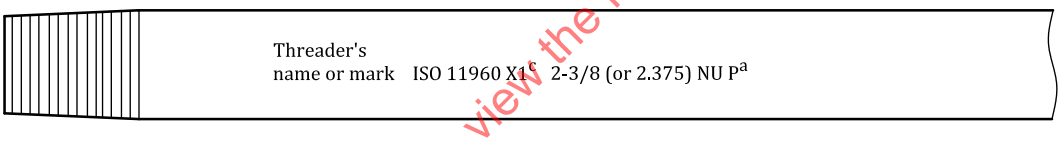
Stamp marking [beginning not less than 0,6 m (2 ft) from the coupling]



Stencil marking — Optional [within approximately 0,3 m (1 ft) from the coupling]

Marking in the centre of the coupling may be in either the longitudinal or transverse direction.

e) EXAMPLE 5 — Buttress casing with coupling: Label 1: 9-5/8, Label 2: 53.5, Grade P110, electric weld; supplementary requirements are SR11 and SR16 for test at -18 °C (0 °F) and 215,9 mm (8.500 in) drift test. Coupling is tin-plated



Stencil marking (adjacent to the threads)

Threader stencil marking shall be placed adjacent to the threads and is in addition to marking applied by other pipe manufacturers.

f) EXAMPLE 6 — Threader: Label 1: 2-3/8, Label 2: 4, Grade J55 non-upset thread, and hydrostatically tested to alternative test pressure of 43,5 MPa (6 300 psi)

Key

1 coupling

2 pipe

a Express pressure in megapascals for pipe manufactured to SI units and in pounds per square inch for pipe manufactured to USC units.

b Express the CVN requirements in joules and the temperature in degrees Celsius for pipe manufactured to SI units, and in foot-pounds and degrees Fahrenheit for pipe manufactured to USC units.

c Date of manufacture: Note that "X" is used for the last digit of the year of manufacture so that it is a generic example and will not change with subsequent editions of this International Standard document. "1" is used for the first calendar quarter in which the markings of Clause 11 are completed.

d Express alternative drift diameter in millimetres for pipe manufactured to SI units and in inches for pipe manufactured to USC units.

Figure D.15 — Examples of marking requirements and sequence for manufacturers and threaders using Clause 11 and Table C.48 or E.48

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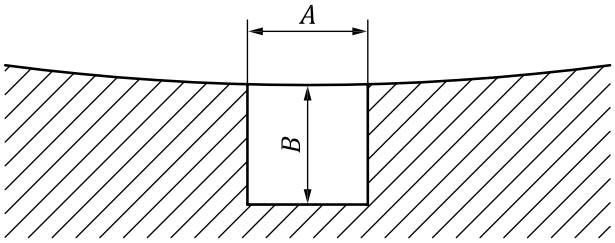
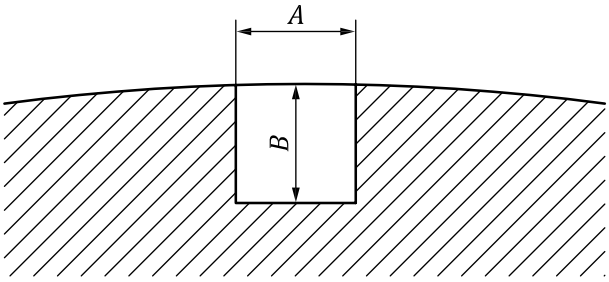
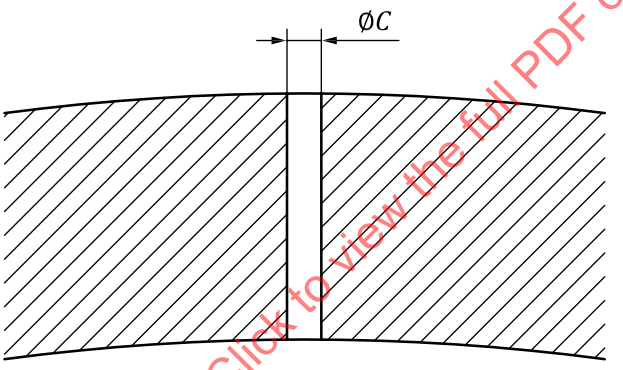


a) Notch — Inner surface a



b) Notch — Outer surface a



c) Drilled hole

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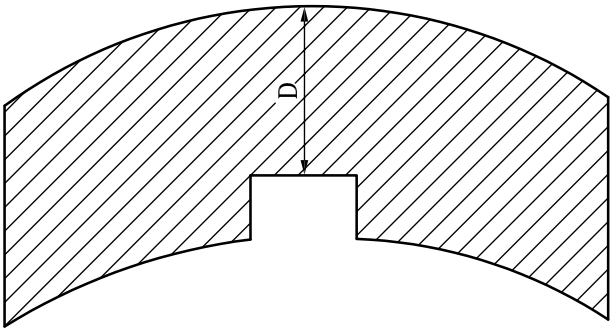

d) Flat bottomed hole

Key

A notch width

B notch depth

C hole diameter

D 90 % ± 1,5 % of the specified minimum wall thickness

[a] Notch length:

— for eddy current, 38,10 mm (1.5 in) maximum total length;

— for ultrasonic, 50,80 mm (2 in) maximum at full depth;

— for diverted flux, the length of notch shall be as required by the equipment design to provide a reproducible signal when the reference standard is passed through the equipment at the inspection-line speed for the pipe being inspected. Three passes through the equipment shall be carried out to ensure reproducibility.

Figure D.16 — Reference indicators

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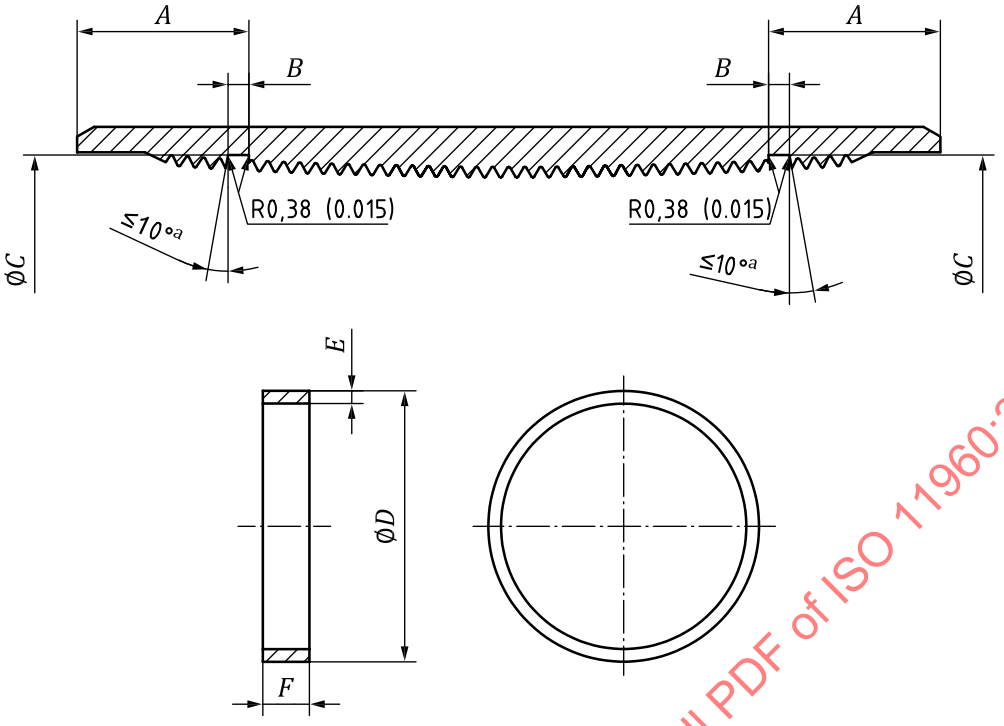
Dimensions in millimetres (inches)



8 Round casing Label 1	Outside diameter	Coupling dimensions mm (in)			Ring dimensions mm (in)		
		A ±3,2 (±0.125)	*B* ±0,13 (±0.005)	*C* ±0,25 (±0.010)	*D* ±0,38 (±0.015)	*E* $^{+0,25}_{0}$ $\left(^{+0,010}_{0}\right)$	*F* $^{+0,38}_{0}$ $\left(^{+0,015}_{0}\right)$
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
4-1/2	114,30	34,9 (1.375)	4,78 (0.188)	114,63 (4.513)	115,27 (4.538)	2,54 (0.100)	3,96 (0.156)
5	127,00	38,1 (1.500)	4,78 (0.188)	127,13 (5.005)	127,76 (5.030)	2,54 (0.100)	3,96 (0.156)
5-1/2	139,70	38,1 (1.500)	4,78 (0.188)	139,83 (5.505)	140,46 (5.530)	2,54 (0.100)	3,96 (0.156)
6-5/8	168,28	44,5 (1.750)	4,78 (0.188)	168,00 (6.614)	168,63 (6.639)	2,54 (0.100)	3,96 (0.156)
7	177,80	44,5 (1.750)	4,78 (0.188)	177,52 (6.989)	178,16 (7.014)	2,54 (0.100)	3,96 (0.156)
7-5/8	193,68	44,5 (1.750)	4,78 (0.188)	193,29 (7.610)	193,93 (7.635)	2,54 (0.100)	3,96 (0.156)
8-5/8	219,09	47,6 (1.875)	4,78 (0.188)	218,52 (8.603)	219,15 (8.628)	2,54 (0.100)	3,96 (0.156)
9-5/8	244,48	47,6 (1.875)	4,78 (0.188)	243,92 (9.603)	244,55 (9.628)	2,54 (0.100)	3,96 (0.156)
10-3/4	273,05	44,5 (1.750)	4,78 (0.188)	272,67 (10.735)	273,30 (10.760)	2,54 (0.100)	3,96 (0.156)
11-3/4	298,45	47,6 (1.875)	4,78 (0.188)	297,89 (11.728)	298,53 (11.753)	2,54 (0.100)	3,96 (0.156)
13-3/8	339,72	57,2 (2.250)	4,78 (0.188)	338,56 (13.329)	339,19 (13.354)	2,54 (0.100)	3,96 (0.156)
16	406,40	69,9 (2.750)	4,78 (0.188)	404,44 (15.923)	405,08 (15.948)	2,54 (0.100)	3,96 (0.156)
18-5/8	473,08	69,9 (2.750)	4,78 (0.188)	471,12 (18.548)	471,75 (18.573)	2,54 (0.100)	3,96 (0.156)
20	508,00	69,9 (2.750)	4,78 (0.188)	506,04 (19.923)	506,68 (19.948)	2,54 (0.100)	3,96 (0.156)

[a] Angle optional. Seal ring groove and thread pitch diameter shall be concentric within 0,51 mm (0.020 in) of indicated thread run-out.

Figure D.17 — SR13.1 Seal-ring coupling and non-metallic ring for round-thread casing

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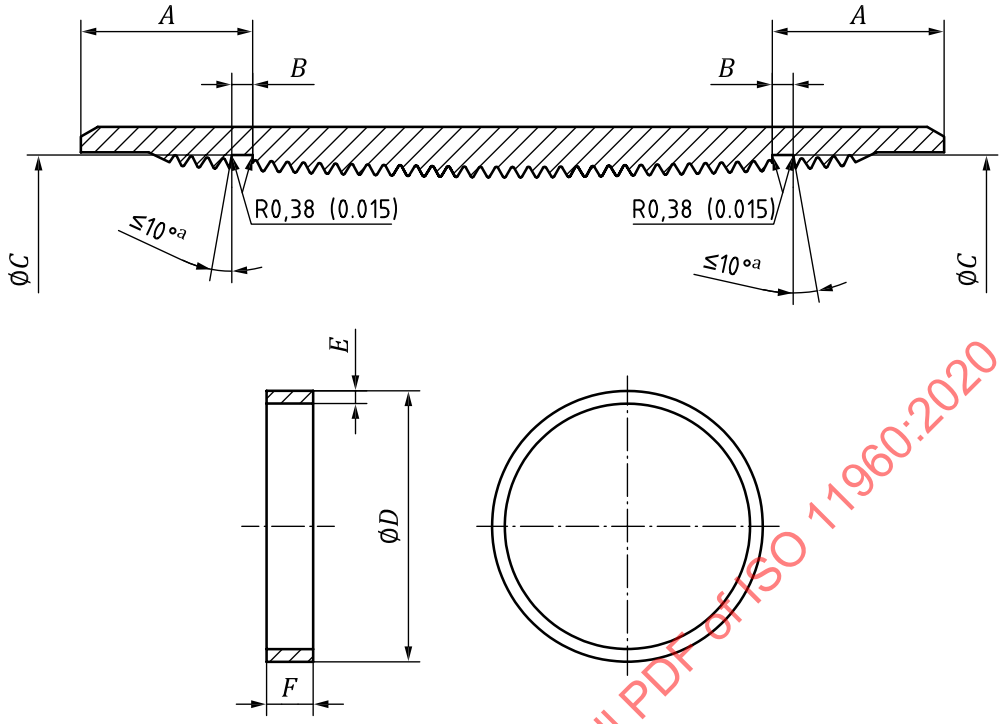
Dimensions in millimetres (inches)



Buttress casing Label 1	Outside diameter	Coupling dimensions mm (in)			Ring dimensions mm (in)		
		A ±3,2 (±0.125)	*B* ±0,13 (±0.005)	*C* ±0,25 (±0.010)	*D* ±0,38 (±0.015)	*E* $^{+0,25}_{0}$ $\left(^{+0,010}_{0}\right)$	*F* $^{+0,38}_{0}$ $\left(^{+0,015}_{0}\right)$
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
4-1/2	114,30	76,2 (3.000)	4,78 (0.188)	115,21 (4.536)	115,85 (4.561)	2,54 (0.100)	3,96 (0.156)
5	127,00	81,0 (3.188)	4,78 (0.188)	127,46 (5.018)	128,09 (5.043)	2,54 (0.100)	3,96 (0.156)
5-1/2	139,70	81,0 (3.188)	4,78 (0.188)	140,16 (5.518)	140,79 (5.543)	2,54 (0.100)	3,96 (0.156)
6-5/8	168,28	81,0 (3.188)	4,78 (0.188)	168,73 (6.643)	169,37 (6.668)	2,54 (0.100)	3,96 (0.156)
7	177,80	82,6 (3.250)	4,78 (0.188)	178,16 (7.014)	178,79 (7.039)	2,54 (0.100)	3,96 (0.156)
7-5/8	193,68	85,7 (3.375)	4,78 (0.188)	193,85 (7.632)	194,49 (7.657)	2,54 (0.100)	3,96 (0.156)
8-5/8	219,09	85,7 (3.375)	4,78 (0.188)	219,25 (8.632)	219,89 (8.657)	2,54 (0.100)	3,96 (0.156)
9-5/8	244,48	85,7 (3.375)	4,78 (0.188)	244,65 (9.632)	245,29 (9.657)	2,54 (0.100)	3,96 (0.156)
10-3/4	273,05	85,7 (3.375)	4,78 (0.188)	273,23 (10.757)	273,86 (10.782)	2,54 (0.100)	3,96 (0.156)
11-3/4	298,45	88,9 (3.500)	4,78 (0.188)	298,42 (11.749)	299,06 (11.774)	2,54 (0.100)	3,96 (0.156)
13-3/8	339,72	95,3 (3.750)	4,78 (0.188)	339,29 (13.358)	339,93 (13.383)	2,54 (0.100)	3,96 (0.156)

Seal ring groove and thread pitch diameter shall be concentric within 0,51 mm (0.020 in) of indicated thread run-out.

[a] Angle optional.

Figure D.18 — SR13.2 Seal-ring coupling and non-metallic ring for buttress-thread casing

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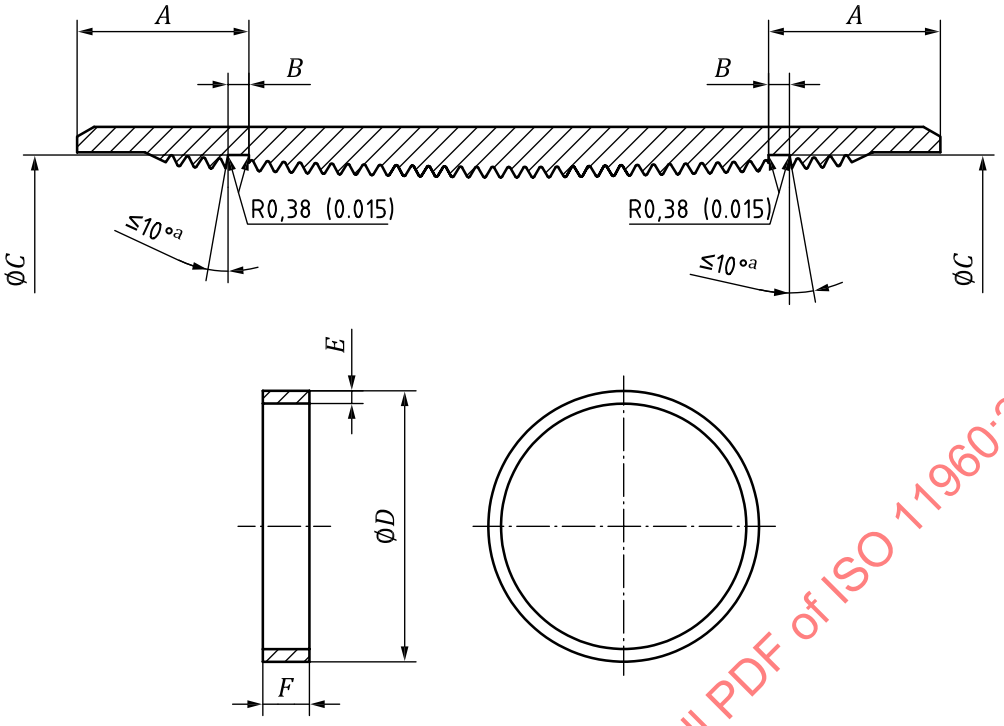
Dimensions in millimetres (inches)



Non-upset tubing size Label 1	Outside diameter	Coupling dimensions mm (in)			Ring dimensions mm (in)		
		A ±3,2 (±0.125)	*B* ±0,13 (±0.005)	*C* ±0,25 (±0.010)	*D* ±0,19 (±0.008)	*E* +0,13 0 (+0,005 0)	*F* +0,38 0 (+0,015 0)
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
1.050	26,67	20,7 (0.813)	3,96 (0.156)	27,46 (1.081)	27,89 (1.098)	2,03 (0.080)	3,18 (0.125)
1.315	33,40	20,7 (0.813)	3,96 (0.156)	34,19 (1.346)	34,62 (1.363)	2,03 (0.080)	3,18 (0.125)
1.660	42,16	20,7 (0.813)	3,96 (0.156)	42,95 (1.691)	43,38 (1.708)	2,03 (0.080)	3,18 (0.125)
1.900	48,26	25,4 (1.000)	4,78 (0.188)	48,74 (1.919)	49,20 (1.937)	2,03 (0.080)	3,96 (0.156)
2-3/8	60,32	25,4 (1.000)	4,78 (0.188)	60,81 (2.394)	61,26 (2.412)	2,03 (0.080)	3,96 (0.156)
2-7/8	73,02	25,4 (1.000)	4,78 (0.188)	73,51 (2.894)	73,96 (2.912)	2,03 (0.080)	3,96 (0.156)
3-1/2	88,90	25,4 (1.000)	4,78 (0.188)	89,38 (3.519)	89,84 (3.537)	2,03 (0.080)	3,96 (0.156)
4	101,60	28,6 (1.125)	4,78 (0.188)	102,31 (4.028)	102,77 (4.046)	2,54 (0.100)	3,96 (0.156)
4-1/2	114,30	28,6 (1.125)	4,78 (0.188)	115,01 (4.528)	115,47 (4.546)	2,54 (0.100)	3,96 (0.156)

Seal ring groove and thread pitch diameter shall be concentric within 0,51 mm (0.020 in) of indicated thread run-out.

[a] Angle optional.

Figure D.19 — SR13.3 Seal-ring coupling and non-metallic ring for non-upset tubing

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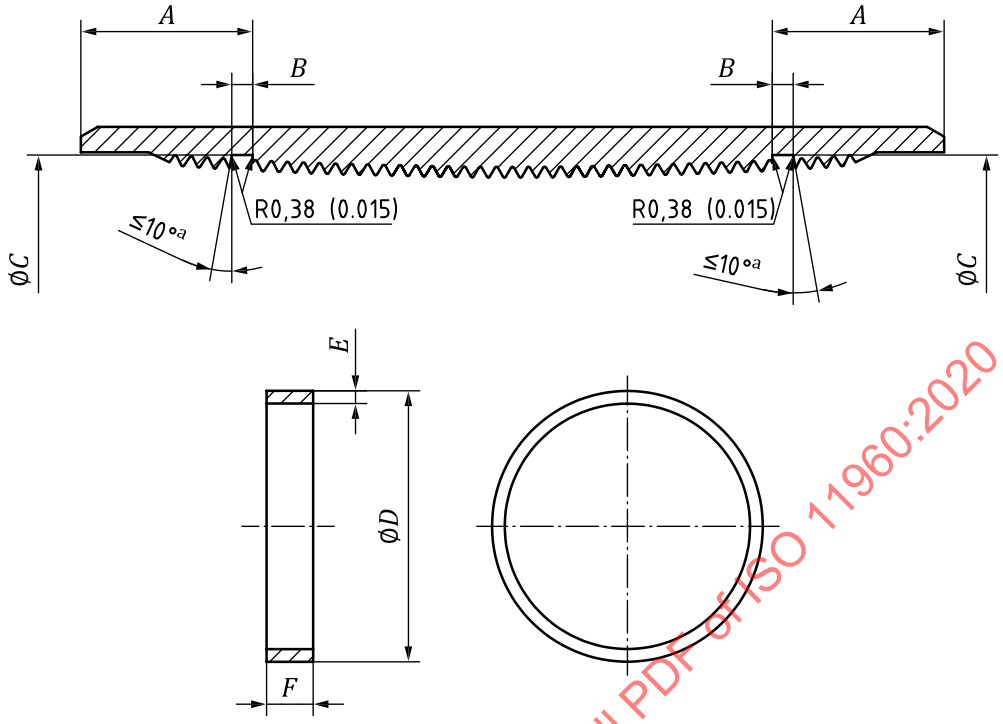
Dimensions in millimetres (inches)



EU tubing size Label 1	Outside diameter	Coupling dimensions mm (in)			Ring dimensions mm (in)		
		A ±3,2 (±0.125)	*B* ±0,13 (±0.005)	*C* ±0,25 (±0.010)	*D* ±0,19 (±0.008)	*E* +0,13 0 (+0,005 0)	*F* +0,38 0 (+0,015 0)
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
1.050	26,67	22,2 (0.875)	3,96 (0.156)	34,09 (1.342)	34,54 (1.360)	2,03 (0.080)	3,18 (0.125)
1.315	33,40	22,2 (0.875)	3,96 (0.156)	38,00 (1.496)	38,43 (1.513)	2,03 (0.080)	3,18 (0.125)
1.660	42,16	22,2 (0.875)	4,78 (0.188)	46,74 (1.840)	47,17 (1.857)	2,03 (0.080)	3,96 (0.156)
1.900	48,26	22,2 (0.875)	4,78 (0.188)	53,87 (2.121)	54,31 (2.138)	2,03 (0.080)	3,96 (0.156)
2-3/8	60,32	28,6 (1.125)	4,78 (0.188)	66,60 (2.622)	67,06 (2.640)	2,54 (0.100)	3,96 (0.156)
2-7/8	73,02	28,6 (1.125)	4,78 (0.188)	79,30 (3.122)	79,76 (3.140)	2,54 (0.100)	3,96 (0.156)
3-1/2	88,90	28,6 (1.125)	4,78 (0.188)	95,96 (3.778)	96,42 (3.796)	2,54 (0.100)	3,96 (0.156)
4	101,60	28,6 (1.125)	4,78 (0.188)	108,66 (4.278)	109,12 (4.296)	2,54 (0.100)	3,96 (0.156)
4-1/2	114,30	28,6 (1.125)	4,78 (0.188)	121,36 (4.778)	121,82 (4.796)	2,54 (0.100)	3,96 (0.156)

Seal ring groove and thread pitch diameter shall be concentric within 0,51 mm (0.020 in) of indicated thread run-out.

[a] Angle optional.

Figure D.20 — SR13.4 Seal-ring coupling and non-metallic ring for upset tubing

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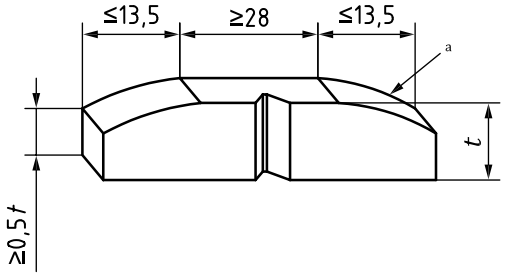
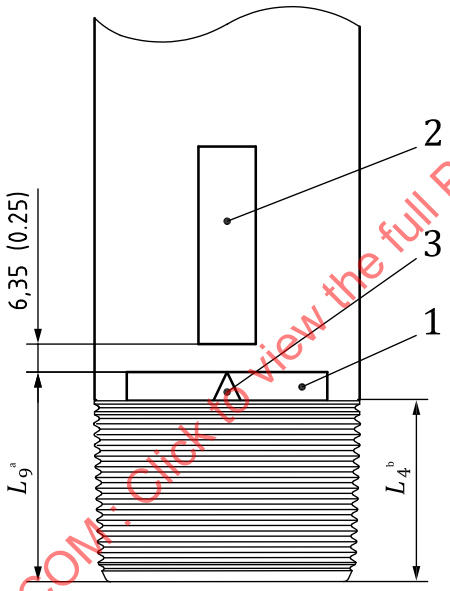
Dimensions in millimetres



a Outside diameter curvature.

Figure D.21 — SR16.1

Dimensions in millimetres (inches)



Triangle stamp location		
Label 1	L_4	L_9 $^{0}_{-1,59}$ mm ($^{0}_{-1/16}$ in)
1	*2*	*3*
4-1/2	76,20 (3.000)	82,55 (3.250)
5	85,73 (3.375)	92,11 (3.625)
5-1/2	88,90 (3.500)	95,25 (3.750)
6-5/8	98,43 (3.875)	104,78 (4.125)
7	101,60 (4.000)	107,95 (4.250)
7-5/8	104,78 (4.125)	111,13 (4.375)
8-5/8	114,30 (4.500)	120,65 (4.750)

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Triangle stamp location		
Label 1	L_4	L_9 $^{0}_{-1,59}$ mm ($^{0}_{-1/16}$ in)
1	*2*	*3*
9-5/8	120,65 (4.750)	127,00 (5.000)

Key

1 paint mark, of high visibility green colour

2 paint stripe, approximately 25 mm (1 in) wide and approximately 0,6 m (2 ft) long for the pin end and not less than 100 mm (4 in) long when a coupling is installed by the manufacturer

3 triangle stamp

[a] Maximum make-up length: end of pipe to triangle apex.

[b] Total length: end of pipe to vanish point.

Figure D.22 — SR22.1 Field-end paint mark and triangle stamp (stamp on mill and field ends)

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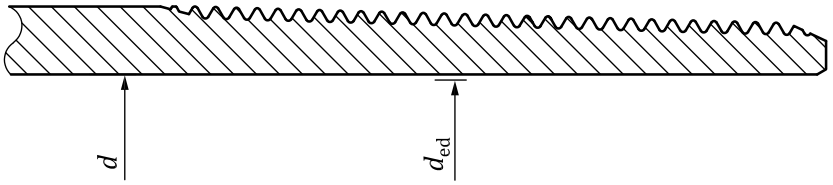
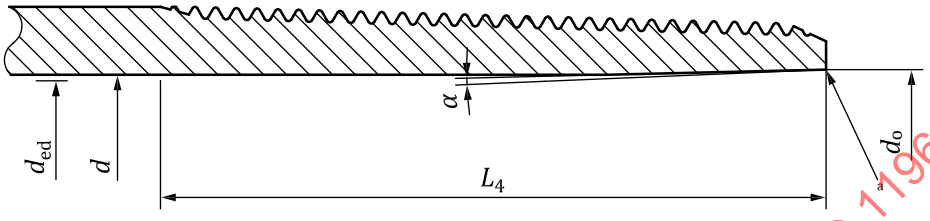
Dimensions in millimetres (inches)



a) Option 1



b) Option 2

Option 1 – non-bored			
Label 1	**Label 2**	**Special end drift diameter** d_{ed} ±0,13 (±0.005)	**Inside diameter** d
1	*2*	*3*	*4*
7	23.00	160,68 (6.326)	161,70 (6.366)
7	32.00	154,18 (6.070)	154,79 (6.094)
8-5/8	32.00	201,96 (7.951)	201,19 (7.921)
8-5/8	40.00	195,61 (7.701)	196,22 (7.725)
9-5/8	40.00	224,18 (8.826)	224,41 (8.835)
9-5/8	47.00	221,01 (8.701)	220,50 (8.681)
9-5/8	53.50	217,83 (8.576)	216,79 (8.535)

Option 2 - bored						
Label 1	**Label 2**	**Special end drift diameter** d_{ed} ±0,13 (±0.005)	**Inside diameter** d	**Bore length** L_4 max.	**Bore diameter** d_0 ±0,38 (±0.015)	**Bore angle** α
1	*2*	*3*	*4*	*5*	*6*	*7*
7	23.00	158,75 (6.250)	161,70 (6.366)	101,60 (4.000)	162,56 (6.400)	2° to 15°
7	32.00	152,40 (6.000)	154,79 (6.094)	101,60 (4.000)	157,48 (6.200)	2°to 15°
8-5/8	32.00	200,02 (7.875)	201,19 (7.921)	114,30 (4.500)	204,47 (8.050)	2° to 15°
8-5/8	40.00	193,68 (7.625)	196,22 (7.725)	114,30 (4.500)	198,12 (7.800)	2° to 15 °
9-5/8	40.00	222,25 (8.750)	224,41 (8.835)	120,65 (4.750)	227,33 (8.950)	2° to 15°
9-5/8	47.00	219,08 (8.625)	220,50 (8.681)	120,65 (4.750)	223,52 (8.800)	2° to 15°
9-5/8	53.50	215,90 (8.500)	216,79 (8.535)	120,65 (4.750)	220,98 (8.700)	2° to 15°

[a] Break edge.

Figure D.23 — SR22.2 Optional tapered bore along inside diameter specifications

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Dimensions in millimetres (inches)

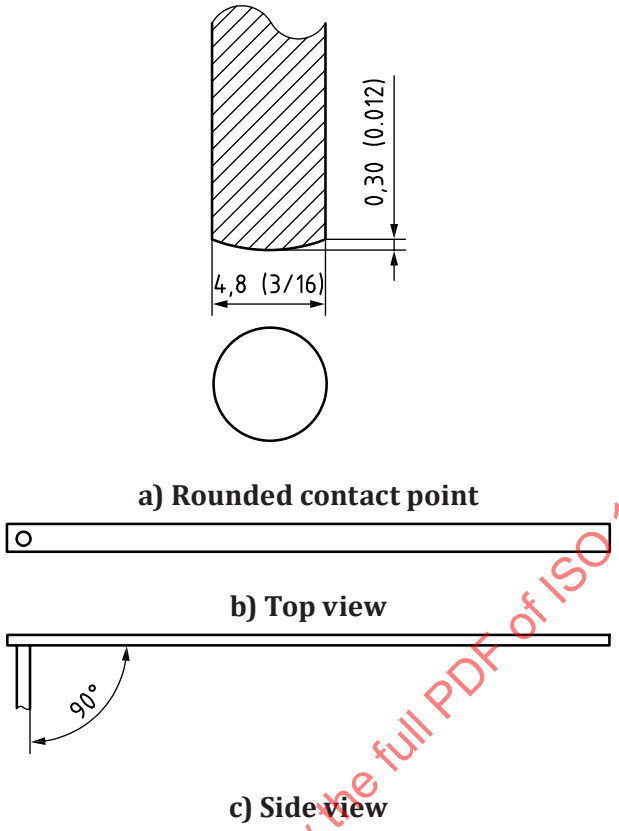
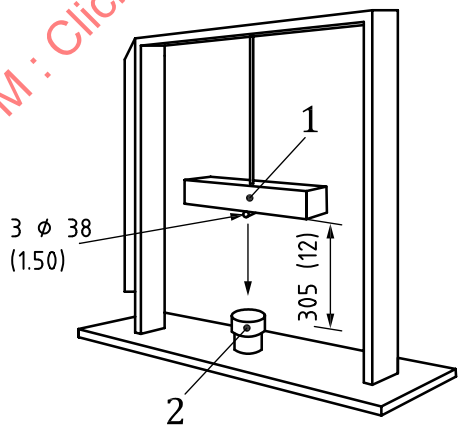


Figure D.24 — Example of a typical 90° hook-type tool

Dimensions in millimetres (inches)



Key

1 flat steel plate
2 test-piece set
3 round steel bar

Figure D.25 — Axial impact test apparatus

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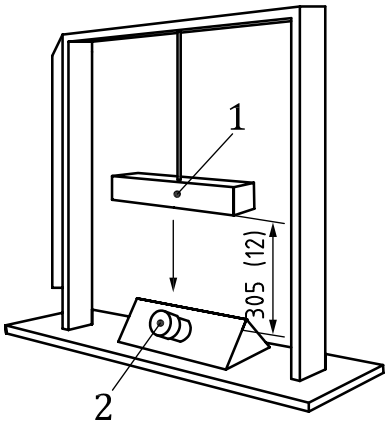
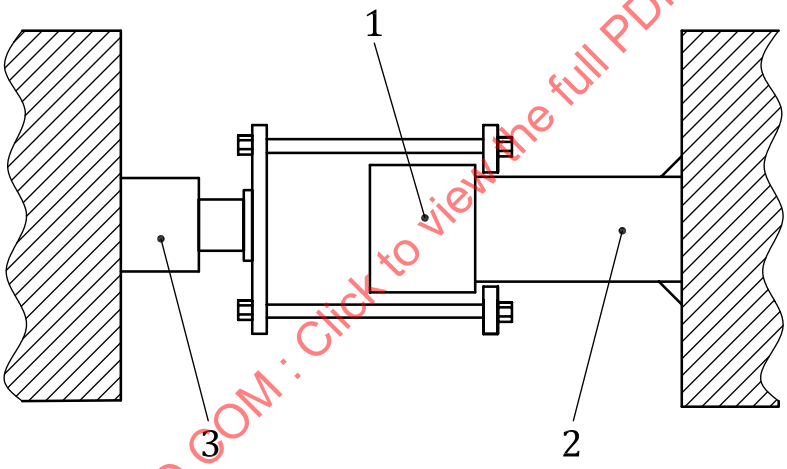
Dimensions in millimetres (inches)



Key

1 flat steel plate
2 test-piece set

Figure D.26 — 45° impact test apparatus



Key

1 thread protector
2 pipe section
3 hydraulic cylinder

Figure D.27 — Stripping test apparatus

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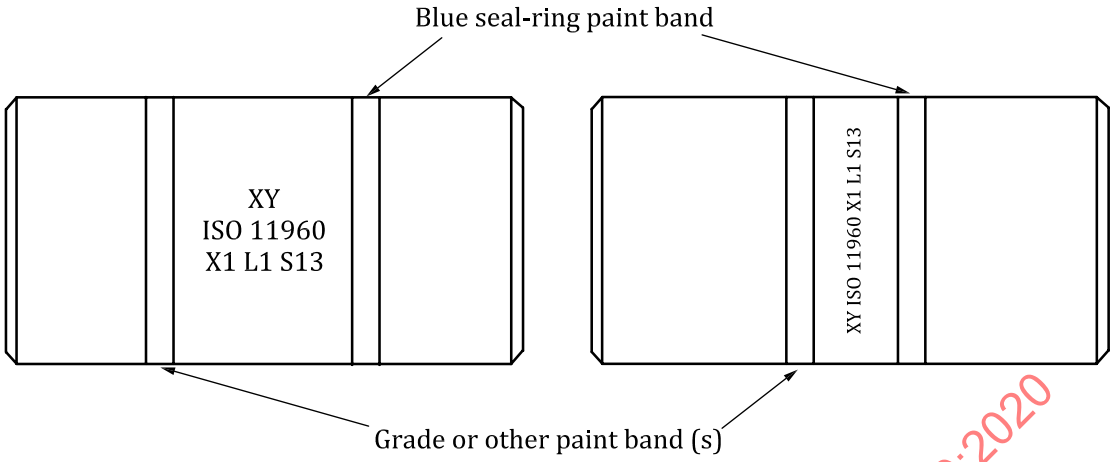

Figure D.28 — Seal ring paint band example

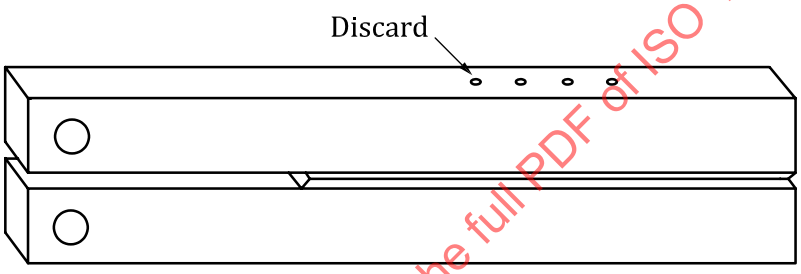

Figure D.29 — Location of hardness impressions on DCB specimen

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Annex E
(normative)

Tables in USC units

NOTE The numbers in italics in the table headers indicate column numbers.

Table E.1 — ISO/API casing list Sizes, masses, wall thickness, grade and applicable end-finish

Labels[a]		Outside diameter	Nominal linear mass[b,c] T&C	Wall thickness	Type of end-finish[d]							
1	2	*D* in	lb/ft	*t* in	H40	J55 K55	L80 R95	N80	C90 T95	C110	P110	Q125
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*
4-1/2	9.50	4.500	9.70	0.205	PS	PS	—	—	—	—	—	—
4-1/2	10.50	4.500	10.60	0.224	—	PSB	—	—	—	—	—	—
4-1/2	11.60	4.500	11.70	0.250	—	PSLB	PLB	PLB	PLB	P	PLB	—
4-1/2	13.50	4.500	13.30	0.290	—	—	PLB	PLB	PLB	P	PLB	—
4-1/2	15.10	4.500	15.30	0.337	—	—	—	—	—	—	PLB	PLB
5	11.50	5.000	11.60	0.220	—	PS	—	—	—	—	—	—
5	13.00	5.000	13.20	0.253	—	PSLB	—	—	—	—	—	—
5	15.00	5.000	15.30	0.296	—	PSLB	PLB	PLB	PLB	P	PLB	—
5	18.00	5.000	18.30	0.362	—	—	PLB	PLB	PLB	P	PLB	PLB
5	21.40	5.000	21.60	0.437	—	—	PLB	PLB	PLB	P	PLB	PLB
5	23.20	5.000	23.40	0.478	—	—	PLB	PLB	PLB	P	PLB	PLB
5	24.10	5.000	24.30	0.500	—	—	PLB	PLB	PLB	P	PLB	PLB

Key

P: Plain-end

S: Short round thread

L: Long round thread

B: Buttress thread

[a] Labels are for information and assistance in ordering.

[b] Nominal linear masses (col. 4) are shown for information only.

[c] The density of martensitic chromium steel (L80 Type 13Cr) is different from carbon steels. The masses shown are therefore not accurate for martensitic chromium steels. A mass correction factor of 0,989 may be used.

[d] Buttress casing is available with regular, special clearance couplings or special clearance couplings with special bevel.

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Table E.1 *(continued)*

Labels[a]		Outside diameter	Nominal linear mass[b,c] T&C	Wall thickness	Type of end-finish[d]							
1	2	*D* in	lb/ft	*t* in	**H40**	**J55 K55**	**L80 R95**	**N80**	**C90 T95**	**C110**	**P110**	**Q125**
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*
5-1/2	14.00	5.500	14.00	0.244	PS	PS	—	—	—	—	—	—
5-1/2	15.50	5.500	15.80	0.275	—	PSLB	—	—	—	—	—	—
5-1/2	17.00	5.500	17.30	0.304	—	PSLB	PLB	PLB	PLB	P	PLB	—
5-1/2	20.00	5.500	20.20	0.361	—	—	PLB	PLB	PLB	P	PLB	—
5-1/2	23.00	5.500	22.90	0.415	—	—	PLB	PLB	PLB	P	PLB	PLB
5-1/2	26.80	5.500	27.00	0.500	—	—	—	—	P	P	—	—
5-1/2	29.70	5.500	29.90	0.562	—	—	—	—	P	P	—	—
5-1/2	32.60	5.500	32.70	0.625	—	—	—	—	P	P	—	—
5-1/2	35.30	5.500	35.50	0.687	—	—	—	—	P	P	—	—
5-1/2	38.00	5.500	38.20	0.750	—	—	—	—	P	P	—	—
5-1/2	40.50	5.500	40.80	0.812	—	—	—	—	P	P	—	—
5-1/2	43.10	5.500	43.30	0.875	—	—	—	—	P	P	—	—
6-5/8	20.00	6.625	20.00	0.288	PS	PSLB	—	—	—	—	—	—
6-5/8	24.00	6.625	24.00	0.352	—	PSLB	PLB	PLB	PLB	P	PLB	—
6-5/8	28.00	6.625	28.00	0.417	—	—	PLB	PLB	PLB	P	PLB	—
6-5/8	32.00	6.625	32.00	0.475	—	—	PLB	PLB	PLB	P	PLB	PLB
7	17.00	7.000	17.20	0.231	PS	—	—	—	—	—	—	—
7	20.00	7.000	20.10	0.272	PS	PS	—	—	—	—	—	—
7	23.00	7.000	23.30	0.317	—	PSLB	PLB	PLB	PLB	P	—	—
7	26.00	7.000	26.30	0.362	—	PSLB	PLB	PLB	PLB	P	PLB	—
7	29.00	7.000	29.30	0.408	—	—	PLB	PLB	PLB	P	PLB	—
7	32.00	7.000	32.20	0.453	—	—	PLB	PLB	PLB	P	PLB	—
7	35.00	7.000	35.00	0.498	—	—	PLB	PLB	PLB	P	PLB	PLB
7	38.00	7.000	37.70	0.540	—	—	PLB	PLB	PLB	P	PLB	PLB
7	42.70	7.000	42.90	0.625	—	—	—	—	P	P	—	—
7	46.40	7.000	46.60	0.687	—	—	—	—	P	P	—	—
7	50.10	7.000	50.30	0.750	—	—	—	—	P	P	—	—
7	53.60	7.000	53.90	0.812	—	—	—	—	P	P	—	—
7	57.10	7.000	57.40	0.875	—	—	—	—	P	P	—	—

Key

P: Plain-end

S: Short round thread

L: Long round thread

B: Buttress thread

[a] Labels are for information and assistance in ordering.

[b] Nominal linear masses (col. 4) are shown for information only.

[c] The density of martensitic chromium steel (L80 Type 13Cr) is different from carbon steels. The masses shown are therefore not accurate for martensitic chromium steels. A mass correction factor of 0,989 may be used.

[d] Buttress casing is available with regular, special clearance couplings or special clearance couplings with special bevel.

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Table E.1 *(continued)*

Labels[a]		Outside diameter	Nominal linear mass[b,c] T&C	Wall thickness	Type of end-finish[d]							
1	2	*D* in	lb/ft	*t* in	H40	J55 K55	L80 R95	N80	C90 T95	C110	P110	Q125
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*
7-5/8	24.00	7.625	24.00	0.300	PS	—	—	—	—	—	—	—
7-5/8	26.20	7.625	26.40	0.328	—	PSLB	PLB	PLB	PLB	P	—	—
7-5/8	29.70	7.625	29.70	0.375	—	—	PLB	PLB	PLB	P	PLB	—
7-5/8	33.70	7.625	33.70	0.430	—	—	PLB	PLB	PLB	P	PLB	—
7-5/8	39.00	7.625	39.00	0.500	—	—	PLB	PLB	PLB	P	PLB	PLB
7-5/8	42.80	7.625	42.80	0.562	—	—	PLB	PLB	PLB	P	PLB	PLB
7-5/8	45.30	7.625	45.30	0.595	—	—	PLB	PLB	PLB	P	PLB	PLB
7-5/8	47.10	7.625	47.10	0.625	—	—	PLB	PLB	PLB	P	PLB	PLB
7-5/8	51.20	7.625	51.20	0.687	—	—	—	—	P	P	—	—
7-5/8	55.30	7.625	55.30	0.750	—	—	—	—	P	P	—	—
7-3/4	46.10	7.750	46.10	0.595	—	—	P	P	P	P	P	P
8-5/8	24.00	8.625	24.00	0.264	—	PS	—	—	—	—	—	—
8-5/8	28.00	8.625	28.00	0.304	PS	—	—	—	—	—	—	—
8-5/8	32.00	8.625	32.00	0.352	PS	PSLB	—	—	—	—	—	—
8-5/8	36.00	8.625	36.00	0.400	—	PSLB	PLB	PLB	PLB	P	—	—
8-5/8	40.00	8.625	40.00	0.450	—	—	PLB	PLB	PLB	P	PLB	—
8-5/8	44.00	8.625	44.00	0.500	—	—	PLB	PLB	PLB	P	PLB	—
8-5/8	49.00	8.625	49.00	0.557	—	—	PLB	PLB	PLB	P	PLB	PLB
9-5/8	32.30	9.625	32.30	0.312	PS	—	—	—	—	—	—	—
9-5/8	36.00	9.625	36.00	0.352	PS	PSLB	—	—	—	—	—	—
9-5/8	40.00	9.625	40.00	0.395	—	PSLB	PLB	PLB	PLB	P	—	—
9-5/8	43.50	9.625	43.50	0.435	—	—	PLB	PLB	PLB	P	PLB	—
9-5/8	47.00	9.625	47.00	0.472	—	—	PLB	PLB	PLB	P	PLB	PLB
9-5/8	53.50	9.625	53.50	0.545	—	—	PLB	PLB	PLB	P	PLB	PLB
9-5/8	58.40	9.625	58.40	0.595	—	—	PLB	PLB	PLB	P	PLB	PLB
9-5/8	59.40	9.625	59.40	0.609	—	—	—	—	P	P	—	—
9-5/8	64.90	9.625	64.90	0.672	—	—	—	—	P	P	—	—
9-5/8	70.30	9.625	70.30	0.734	—	—	—	—	P	P	—	—
9-5/8	75.60	9.625	75.60	0.797	—	—	—	—	P	P	—	—

Key

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L: Long round thread

B: Buttress thread

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[b] Nominal linear masses (col. 4) are shown for information only.

[c] The density of martensitic chromium steel (L80 Type 13Cr) is different from carbon steels. The masses shown are therefore not accurate for martensitic chromium steels. A mass correction factor of 0,989 may be used.

[d] Buttress casing is available with regular, special clearance couplings or special clearance couplings with special bevel.

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Table E.1 *(continued)*

Labels[a]		Outside diameter	Nominal linear mass[b,c] T&C	Wall thickness	Type of end-finish[d]							
1	2	*D* in	lb/ft	*t* in	H40	J55 K55	L80 R95	N80	C90 T95	C110	P110	Q125
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*
10-3/4	32.75	10.750	32.75	0.279	PS	—	—	—	—	—	—	—
10-3/4	40.50	10.750	40.50	0.350	PS	PSB	—	—	—	—	—	—
10-3/4	45.50	10.750	45.50	0.400	—	PSB	—	—	—	—	—	—
10-3/4	51.00	10.750	51.00	0.450	—	PSB	PSB	PSB	PSB	P	PSB	—
10-3/4	55.50	10.750	55.50	0.495	—	—	PSB	PSB	PSB	P	PSB	—
10-3/4	60.70	10.750	60.70	0.545	—	—	—	—	PSB	P	PSB	PSB
10-3/4	65.70	10.750	65.70	0.595	—	—	—	—	PSB	P	PSB	PSB
10-3/4	73.20	10.750	73.20	0.672	—	—	—	—	P	P	—	—
10-3/4	79.20	10.750	79.20	0.734	—	—	—	—	P	P	—	—
10-3/4	85.30	10.750	85.30	0.797	—	—	—	—	P	P	—	—
11-3/4	42.00	11.750	42.00	0.333	PS	—	—	—	—	—	—	—
11-3/4	47.00	11.750	47.00	0.375	—	PSB	—	—	—	—	—	—
11-3/4	54.00	11.750	54.00	0.435	—	PSB	—	—	—	—	—	—
11-3/4	60.00	11.750	60.00	0.489	—	PSB	PSB	PSB	PSB	P	PSB	PSB
11-3/4	65.00	11.750	65.00	0.534	—	—	P	P	P	P	P	P
11-3/4	71.00	11.750	71.00	0.582	—	—	P	P	P	P	P	P
13-3/8	48.00	13.375	48.00	0.330	PS	—	—	—	—	—	—	—
13-3/8	54.50	13.375	54.50	0.380	—	PSB	—	—	—	—	—	—
13-3/8	61.00	13.375	61.00	0.430	—	PSB	—	—	—	—	—	—
13-3/8	68.00	13.375	68.00	0.480	—	PSB	PSB	PSB	PSB	P	PSB	—
13-3/8	72.00	13.375	72.00	0.514	—	—	PSB	PSB	PSB	P	PSB	PSB
16	65.00	16.000	65.00	0.375	PS	—	—	—	—	—	—	—
16	75.00	16.000	75.00	0.438	—	PSB	—	—	—	—	—	—
16	84.00	16.000	84.00	0.495	—	PSB	—	—	—	—	—	—
16	109.00	16.000	109.00	0.656	—	P	P	P	—	—	P	P
18-5/8	87.50	18.625	87.50	0.435	PS	PSB	—	—	—	—	—	—
20	94.00	20.000	94.00	0.438	PSL	PSLB	—	—	—	—	—	—
20	106.50	20.000	106.50	0.500	—	PSLB	—	—	—	—	—	—
20	133.00	20.000	133.00	0.635	—	PSLB	—	—	—	—	—	—

Key

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Table E.2 — ISO/API tubing list Sizes, masses, wall thickness, grade and applicable end-finish

Labels				Outside diameter	Nominal linear masses[a,b]			Wall thick-ness	Type of end-finish I I						
1	2				Non-up-set T&C	Ext. upset T&C	Integ. joint								
	NU T&C	EU T&C	IJ	*D* in	lb/ft	lb/ft	lb/ft	*t* in	H40	J55	L80 R95	N80	C90	T95	P110
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*
1.050	1.14	1.20	—	1.050	1.14	1.20	—	0.113	PNU	PNU	PNU	PNU	PNU	PNU	—
1.050	1.48	1.54	—	1.050	1.48	1.54	—	0.154	PU	PU	PU	PU	PU	PU	PU
1.315	1.70	1.80	1.72	1.315	1.70	1.80	1.72	0.133	PNUI	PNUI	PNUI	PNUI	PNUI	PNUI	—
1.315	2.19	2.24	—	1.315	2.19	2.24	—	0.179	PU	PU	PU	PU	PU	PU	PU
1.660	2.09	—	2.10	1.660	—	—	2.10	0.125	PI	PI	—	—	—	—	—
1.660	2.30	2.40	2.33	1.660	2.30	2.40	2.33	0.140	PNUI	PNUI	PNUI	PNUI	PNUI	PNUI	—
1.660	3.03	3.07	—	1.660	3.03	3.07	—	0.191	PU	PU	PU	PU	PU	PU	PU
1.900	2.40	—	2.40	1.900	—	—	2.40	0.125	PI	PI	—	—	—	—	—
1.900	2.75	2.90	2.76	1.900	2.75	2.90	2.76	0.145	PNUI	PNUI	PNUI	PNUI	PNU I	PNUI	—
1.900	3.65	3.73	—	1.900	3.65	3.73	—	0.200	PU	PU	PU	PU	PU	PU	PU
1.900	4.42	—	—	1.900	4.42	—	—	0.250	—	—	P	—	P	P	—
1.900	5.15	—		1.900	5.15	—	—	0.300	—	—	P	—	P	P	—
2.063	3.24	—	3.25	2.063	—	—	3.25	0.156	PI	PI	PI	PI	PI	PI	—
2.063	4.50	—	—	2.063	4.50	—	—	0.225	P	P	P	P	P	P	P
2-3/8	4.00	—	—	2.375	4.00	—	—	0.167	PN	PN	PN	PN	PN	PN	—
2-3/8	4.60	4.70	—	2.375	4.60	4.70	—	0.190	PNU	PNU	PNU	PNU	PNU	PNU	PNU
2-3/8	5.80	5.95	—	2.375	5.80	5.95	—	0.254	—	—	PNU	PNU	PNU	PNU	PNU
2-3/8	6.60	—	—	2.375	6.60	—	—	0.295	—	—	P	—	P	P	—
2-3/8	7.35	7.45	—	2.375	7.35	7.45	—	0.336	—	—	PU	—	PU	PU	—
2-7/8	6.40	6.50	—	2.875	6.40	6.50	—	0.217	PNU	PNU	PNU	PNU	PNU	PNU	PNU
2-7/8	7.80	7.90	—	2.875	7.80	7.90	—	0.276	—	—	PNU	PNU	PNU	PNU	PNU
2-7/8	8.60	8.70	—	2.875	8.60	8.70	—	0.308	—	—	PNU	PNU	PNU	PNU	PNU
2-7/8	9.35	9.45	—	2.875	9.35	9.45	—	0.340	—	—	PU	—	PU	PU	—
2-7/8	10.50	—	—	2.875	10.50	—	—	0.392	—	—	P	—	P	P	—
2-7/8	11.50	—	—	2.875	11.50	—	—	0.440	—	—	P	—	P	P	—
3-1/2	7.70	—	—	3.500	7.70	—	—	0.216	PN	PN	PN	PN	PN	PN	—
3-1/2	9.20	9.30	—	3.500	9.20	9.30	—	0.254	PNU	PNU	PNU	PNU	PNU	PNU	PNU
3-1/2	10.20	—	—	3.500	10.20	—	—	0.289	PN	PN	PN	PN	PN	PN	—
3-1/2	12.70	12.95	—	3.500	12.70	12.95	—	0.375	—	—	PNU	PNU	PNU	PNU	PNU
3-1/2	14.30	—	—	3.500	14.30	—	—	0.430	—	—	P	—	P	P	—
3-1/2	15.50	—	—	3.500	15.50	—	—	0.476	—	—	P	—	P	P	—
3-1/2	17.00	—	—	3.500	17.00	—	—	0.530	—	—	P	—	P	P	—
4	9.50	—	—	4.000	9.50	—	—	0.226	PN	PN	PN	PN	PN	PN	—
4	10.70	11.00	—	4.000	—	11.00	—	0.262	PU	PU	PU	PU	PU	PU	—
4	13.20	—	—	4.000	13.20	—	—	0.330	—	—	P	—	P	P	—
4	16.10	—	—	4.000	16.10	—	—	0.415	—	—	P	—	P	P	—
4	18.90	—	—	4.000	18.90	—	—	0.500	—	—	P	—	P	P	—
4	22.20	—	—	4.000	22.20	—	—	0.610	—	—	P	—	P	P	—

Key

P: Plain-end

N: Non-upset threaded and coupled

U: External upset threaded and coupled

I: Integral joint

[a] Nominal linear masses (col. 6, 7 & 8) are shown for information only.

[b] The density of martensitic chromium steel (L80 type 13Cr) are different from carbon steels. The masses shown are therefore not accurate for martensitic chromium steels. A mass correction factor of 0.989 may be used.

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Table E.2 *(continued)*

Labels				Outside diameter	Nominal linear masses[a,b]			Wall thickness	Type of end-finish I I						
1	2				Non-upset T&C	Ext. upset T&C	Integ. joint								
	NU T&C	EU T&C	IJ	*D* in	lb/ft	lb/ft	lb/ft	*t* in	H40	J55	L80 R95	N80	C90	T95	P110
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*
4-1/2	12.60	12.75	—	4.500	12.60	12.75	—	0.271	PNU	PNU	PNU	PNU	PNU	PNU	—
4-1/2	15.20	—	—	4.500	15.20	—	—	0.337	—	—	P	—	P	P	—
4-1/2	17.00	—	—	4.500	17.00	—	—	0.380	—	—	P	—	P	P	—
4-1/2	18.90	—	—	4.500	18.90	—	—	0.430	—	—	P	—	P	P	—
4-1/2	21.50	—	—	4.500	21.50	—	—	0.500	—	—	P	—	P	P	—
4-1/2	23.70	—	—	4.500	23.70	—	—	0.560	—	—	P	—	P	P	—
4-1/2	26.10	—	—	4.500	26.10	—	—	0.630	—	—	P	—	P	P	—

Key

P: Plain-end

N: Non-upset threaded and coupled

U: External upset threaded and coupled

I: Integral joint

[a] Nominal linear masses (col. 6, 7 & 8) are shown for information only.

[b] The density of martensitic chromium steel (L80 type 13Cr) are different from carbon steels. The masses shown are therefore not accurate for martensitic chromium steels. A mass correction factor of 0.989 may be used.

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Table E.3 — Process of manufacture and heat treatment

	Grade	Type	Manufacturing process	Heat treatment	Tempering temperature °F min.
	2	*3*	*4*	*5*	*6*
	H40	—	S or EW	—	—
	J55	—	S or EW	—[b]	—
	K55	—	S or EW	—[b]	—
	N80	1[a]	S or EW	[c]	—
	N80	Q	S or EW	Q[d]	—
	R95	—	S or EW	Q	1 000
	L80	1	S or EW	Q	1 050
	L80	13Cr	S	Q[f]	1 100
	C90		S	Q	1 150
	T95		S	Q	1 200
	C110	—	S	Q	1 200
	P110	—	S or EW[e,g]	Q	—
	Q125		S or EW[e]	Q	—

Key

S: seamless process

EW: electric-welded process

[a] N80 Type 1 products may exhibit ductile rupture values lower than internal yield values. See API TR5C3 and/or ISO TR10400 calculated performance values in columns 15 and 18 in Table K.1 and Table L.1.

[b] Full-body, full-length normalized, normalized and tempered or quenched and tempered at the manufacturer's option or as specified on the purchase agreement (see 6.3.2).

[c] Full-body, full-length heat treatment is mandatory. At the manufacturer's option, normalized or normalized and tempered.

[d] Includes the method of interrupted quenching followed by controlled cooling.

[e] Products shall be heat-treated full-body, full-length. Special requirements unique to electric-welded P110 and Q125 are specified in A.5 SR11.

[f] Type 13Cr may be air-quenched.

[g] Special chemical requirements for electric-welded P110 pipe are specified in Table E.4.

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Table E.4 — Chemical composition, mass fraction (%)

	Grade	Type	C		Mn		Mo		Cr		Ni	Cu	P	S	Si
			min.	max.	min.	max.	min.	max.	min.	max.	max.	max.	max.	max.	max.
	2	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*
	H40	—	—	—	—	—	—	—	—	—	—	—	0.030	0.030	—
	J55	—	—	—	—	—	—	—	—	—	—	—	0.030	0.030	—
	K55	—	—	—	—	—	—	—	—	—	—	—	0.030	0.030	—
	N80	1	—	—	—	—	—	—	—	—	—	—	0.030	0.030	—
	N80	Q	—	—	—	—	—	—	—	—	—	—	0.030	0.030	—
	R95	—	—	0.45[c]	—	1.90	—	—	—	—	—	—	0.030	0.030	0.45
	L80	1	—	0.43[a]	—	1.90	—	—	—	—	0.25	0.35	0.030	0.030	0.45
	L80	13Cr	0.15	0.22	0.25	1.00	—	—	12.0	14.0	0.50	0.25	0.020	0.010	1.00
	C90		—	0.35	—	1.20	0.25[b]	0.85	—	1.50	0.99	—	0.020	0.010	—
	T95		—	0.35	—	1.20	0.25[d]	0.85	0.40	1.50	0.99	—	0.020	0.010	—
	C110	—	—	0.35	—	1.20	0.25	1.00	0.40	1.50	0.99	—	0.020	0.005	—
	P110	[e]	—	—	—	—	—	—	—	—	—	—	0.030[e]	0.030[e]	—
	Q125		—	0.35		1.35	—	0.85	—	1.50	0.99	—	0.020	0.010	—

Key

NL: no limit

Elements shown shall be reported in product analysis.

[a] The carbon content for L80 may be increased up to 0.50 % max. if the product is oil-quenched or polymer-quenched.

[b] The molybdenum content for Grade C90 Type 1 has no minimum tolerance if the wall thickness is less than 0.700 in.

[c] The carbon content for R95 may be increased up to 0.55 % max. if the product is oil-quenched.

[d] The molybdenum content for T95 Type 1 may be decreased to 0.15 % min. if the wall thickness is less than 0.700 in.

[e] For EW Grade P110, the phosphorus content shall be 0.020 % max. and the sulfur content 0.010 % max.

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Table E.5 — Tensile and hardness requirements

	Grade	Type	Total elongation under load	Yield strength ksi		Tensile strength min.	Hardness[a] max.		Specified wall thickness	Allowable hardness variation[b]
			%	min.	max.	ksi	HRC	HBW	in	HRC
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*
	H40	—	0.5	40	80	60	—	—	—	—
	J55	—	0.5	55	80	75	—	—	—	—
	K55	—	0.5	55	80	95	—	—	—	—
	N80	1	0.5	80	110	100	—	—	—	—
	N80	Q	0.5	80	110	100	—	—	—	—
	R95	—	0.5	95	110	105	—	—	—	—
	L80	1	0.5	80	95	95	23,0	241	—	—
	L80	13Cr	0.5	80	95	95	23,0	241	—	—
	C90		0.5	90	105	100	25.4	255	≤0.500	3.0
									0.501 to 0.749	4.0
										5.0
									0.750 to 0.999	6.0
									≥1.000	
	T95		0.5	95	110	105	25.4	255	≤0.500	3.0
									0.501 to 0.749	4.0
										5.0
									0.750 to 0.999	6.0
									≥1.000	
	C110	—	0.7	110	120	115	30,0	286	≤0.500	3.0
									0.501 to 0.749	4.0
										5.0
									0.750 to 0.999	6.0
									≥1.000	
	P110	—	0.6	110	140	125	—	—	—	—
	Q125		0.65	125	150	135	[b]	—	≤0.500	3.0
									0.501 to 0.749	4.0
										5.0
									≥0.750	

[a] In case of dispute, laboratory Rockwell C hardness testing shall be used as the referee method.

[b] No hardness limits are specified, but the maximum variation is restricted as a manufacturing control in accordance with 7.8 and 7.9.

[c] For through-wall hardness tests of Grades L80 all types, C90, T95 and C110, the requirements stated in HRC scale are for maximum mean hardness number.

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Table E.6 — Elongation table

Tensile test specimen				Minimum elongation in 2.0 in %								
				Grade								
				H40	J55		K55 L80	N80 C90	R95 T95	C110	P110	Q125
Specimen area in^2	Specified wall thickness in			Specified minimum tensile strength ksi								
	Specimen width ¾ in	Specimen width 1 in	Specimen width 1½ in	60	75		95	100	105	115	125	135
1	*2*	*3*	*4*	*5*	*6*		*8*	*9*	*10*	*11*	*12*	*13*
0.750	≥0.994	≥0.746	≥0.497	30	24		20	19	18	16	15	14
0.740	0.980-0.993	0.735-0.745	0.490-0.496	29	24		19	19	18	16	15	14
0.730	0.967-0.979	0.726-0.734	0.484-0.489	29	24		19	19	18	16	15	14
0.720	0.954-0.966	0.715-0.725	0.477-0.483	29	24		19	19	18	16	15	14
0.710	0.941-0.953	0.706-0.714	0.471-0.476	29	24		19	18	18	16	15	14
0.700	0.927-0.940	0.695-0.705	0.464-0.470	29	24		19	18	18	16	15	14
0.690	0.914-0.926	0.686-0.694	0.457-0.463	29	24		19	18	18	16	15	14
0.680	0.900-0.913	0.675-0.685	0.450-0.456	29	24		19	18	18	16	15	14
0.670	0.887-0.899	0.666-0.674	0.444-0.449	29	24		19	18	17	16	15	14
0.660	0.874-0.886	0.655-0.665	0.437-0.443	29	24		19	18	17	16	15	14
0.650	0.861-0.873	0.646-0.654	0.431-0.436	29	23		19	18	17	16	15	14
0.640	0.847-0.860	0.635-0.645	0.424-0.430	29	23		19	18	17	16	15	14
0.630	0.834-0.846	0.626-0.634	0.417-0.423	29	23		19	18	17	16	15	14
0.620	0.820-0.833	0.615-0.625	0.410-0.416	28	23		19	18	17	16	15	14
0.610	0.807-0.819	0.606-0.614	0.404-0.409	28	23		19	18	17	16	15	14
0.600	0.794-0.806	0.595-0.605	0.397-0.403	28	23		19	18	17	16	15	14
0.590	0.781-0.793	0.586-0.594	0.391-0.396	28	23		19	18	17	16	15	14
0.580	0.767-0.780	0.575-0.585	0.384-0.390	28	23		19	18	17	16	15	14

NOTE The calculations of the elongation requirements are based on the cross-sectional area in column 1 which is shown rounded to three significant figures. The applicable wall thickness ranges shown in columns 2, 3, and 4 were calculated based on the specified specimen width (shown above the column numbers 2, 3, and 4) taking into account the rounding rules for the specimen area (i.e. to three significant figures) but with the wall thickness rounded down to two significant figures for SI units. When making these wall thickness ranges for USC units 3 significant figures are used.

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Table E.6 *(continued)*

Tensile test specimen				Minimum elongation in 2.0 in %								
				Grade								
				H40	J55		K55 L80	N80 C90	R95 T95	C110	P110	Q125
Specimen area in^2	Specified wall thickness in			Specified minimum tensile strength ksi								
	Specimen width ¾ in	Specimen width 1 in	Specimen width 1½ in	60	75		95	100	105	115	125	135
1	*2*	*3*	*4*	*5*	*6*		*8*	*9*	*10*	*11*	*12*	*13*
0.570	0.754-0.766	0.566-0.574	0.377-0.383	28	23		18	18	17	16	14	13
0.560	0.740-0.753	0.555-0.565	0.370-0.376	28	23		18	18	17	16	14	13
0.550	0.727-0.739	0.546-0.554	0.364-0.369	28	23		18	18	17	15	14	13
0.540	0.714-0.726	0.535-0.545	0.357-0.363	28	23		18	17	17	15	14	13
0.530	0.701-0.713	0.526-0.534	0.351-0.356	28	23		18	17	17	15	14	13
0.520	0.687-0.700	0.515-0.525	0.344-0.350	27	22		18	17	17	15	14	13
0.510	0.674-0.686	0.506-0.514	0.337-0.343	27	22		18	17	17	15	14	13
0.500	0.660-0.673	0.495-0.505	0.330-0.336	27	22		18	17	16	15	14	13
0.490	0.647-0.659	0.486-0.494	0.324-0.329	27	22		18	17	16	15	14	13
0.480	0.634-0.646	0.475-0.485	0.317-0.323	27	22		18	17	16	15	14	13
0.470	0.621-0.633	0.466-0.474	0.311-0.316	27	22		18	17	16	15	14	13
0.460	0.607-0.620	0.455-0.465	0.304-0.310	27	22		18	17	16	15	14	13
0.450	0.594-0.606	0.446-0.454	0.297-0.303	27	22		18	17	16	15	14	13
0.440	0.580-0.593	0.435-0.445	0.290-0.296	27	22		18	17	16	15	14	13
0.430	0.567-0.579	0.426-0.434	0.284-0.289	26	22		17	17	16	15	14	13
0.420	0.554-0.566	0.415-0.425	0.277-0.283	26	22		17	17	16	15	14	13
0.410	0.541-0.553	0.406-0.414	0.271-0.276	26	21		17	17	16	15	14	13

NOTE The calculations of the elongation requirements are based on the cross-sectional area in column 1 which is shown rounded to three significant figures. The applicable wall thickness ranges shown in columns 2, 3, and 4 were calculated based on the specified specimen width (shown above the column numbers 2, 3, and 4) taking into account the rounding rules for the specimen area (i.e. to three significant figures) but with the wall thickness rounded down to two significant figures for SI units. When making these wall thickness ranges for USC units 3 significant figures are used.

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Table E.6 *(continued)*

Tensile test specimen				Minimum elongation in 2.0 in %								
				Grade								
				H40	J55		K55 L80	N80 C90	R95 T95	C110	P110	Q125
Specimen area	Specified wall thickness in			Specified minimum tensile strength ksi								
	Specimen width ¾ in	Specimen width 1 in	Specimen width 1½ in	60	75		95	100	105	115	125	135
1	*2*	*3*	*4*	*5*	*6*		*8*	*9*	*10*	*11*	*12*	*13*
0.400	0.527-0.540	0.395-0.405	0.264-0.270	26	21		17	16	16	15	13	13
0.390	0.514-0.526	0.386-0.394	0.257-0.263	26	21		17	16	16	14	13	12
0.380	0.500-0.513	0.375-0.385	0.250-0.256	26	21		17	16	16	14	13	12
0.370	0.487-0.499	0.366-0.374	0.244-0.249	26	21		17	16	16	14	13	12
0.360	0.474-0.486	0.355-0.365	0.237-0.243	26	21		17	16	15	14	13	12
0.350	0.461-0.473	0.346-0.354	0.231-0.236	25	21		17	16	15	14	13	12
0.340	0.447-0.460	0.335-0.345	0.224-0.230	25	21		17	16	15	14	13	12
0.330	0.434-0.446	0.326-0.334	0.217-0.223	25	21		17	16	15	14	13	12
0.320	0.420-0.433	0.315-0.325	0.210-0.216	25	20		16	16	15	14	13	12
0.310	0.407-0.419	0.306-0.314	0.204-0.209	25	20		16	16	15	14	13	12
0.300	0.394-0.406	0.295-0.305	0.197-0.203	25	20		16	16	15	14	13	12
0.290	0.381-0.393	0.286-0.294	0.191-0.196	24	20		16	15	15	14	13	12
0.280	0.367-0.380	0.275-0.285	0.184-0.190	24	20		16	15	15	14	13	12
0.270	0.354-0.366	0.266-0.274	0.177-0.183	24	20		16	15	15	13	12	12
0.260	0.340-0.353	0.255-0.265	0.170-0.176	24	20		16	15	14	13	12	12
0.250	0.327-0.339	0.246-0.254	0.164-0.169	24	19		16	15	14	13	12	11
0.240	0.314-0.326	0.235-0.245	0.157-0.163	24	19		16	15	14	13	12	11

NOTE The calculations of the elongation requirements are based on the cross-sectional area in column 1 which is shown rounded to three significant figures. The applicable wall thickness ranges shown in columns 2, 3, and 4 were calculated based on the specified specimen width (shown above the column numbers 2, 3, and 4) taking into account the rounding rules for the specimen area (i.e. to three significant figures) but with the wall thickness rounded down to two significant figures for SI units. When making these wall thickness ranges for USC units 3 significant figures are used.

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Table E.6 *(continued)*

Tensile test specimen				Minimum elongation in 2.0 in %								
				Grade								
				H40	J55		K55 L80	N80 C90	R95 T95	C110	P110	Q125
Specimen area	Specified wall thickness in			Specified minimum tensile strength ksi								
in^2	Specimen width ¾ in	Specimen width 1 in	Specimen width 1½ in	60	75		95	100	105	115	125	135
1	*2*	*3*	*4*	*5*	*6*		*8*	*9*	*10*	*11*	*12*	*13*
0.230	0.301-0.313	0.226-0.234	0.151-0.156	23	19		15	15	14	13	12	11
0.220	0.287-0.300	0.215-0.225	0.144-0.150	23	19		15	15	14	13	12	11
0.210	0.274-0.286	0.206-0.214	0.137-0.143	23	19		15	14	14	13	12	11
0.200	0.260-0.273	0.195-0.205	0.130-0.136	23	19		15	14	14	13	12	11
0.190	0.247-0.259	0.186-0.194	0.124-0.129	22	18		15	14	14	13	12	11
0.180	0.234-0.246	0.175-0.185	0.117-0.123	22	18		15	14	13	12	11	11
0.170	0.221-0.233	0.166-0.174	0.111-0.116	22	18		15	14	13	12	11	11
0.160	0.207-0.220	0.155-0.165	0.104-0.110	22	18		14	14	13	12	11	10
0.150	0.194-0.206	0.146-0.154	0.097-0.103	21	18		14	14	13	12	11	10
0.140	0.180-0.193	0.135-0.145	0.090-0.096	21	17		14	13	13	12	11	10
0.130	0.167-0.179	0.126-0.134	0.084-0.089	21	17		14	13	13	12	11	10
0.120	0.154-0.166	0.115-0.125	0.077-0.083	20	17		14	13	12	11	11	10
0.110	0.141-0.153	0.106-0.114	0.071-0.076	20	16		13	13	12	11	10	9.5
0.100	0.127-0.140	0.095-0.105	0.064-0.070	20	16		13	12	12	11	10	9.5
0.090	0.114-0.126	0.086-0.094	0.057-0.063	19	16		13	12	12	11	10	9.5
0.080	0.100-0.113	0.075-0.085	0.050-0.056	19	15		12	12	11	11	10	9

NOTE The calculations of the elongation requirements are based on the cross-sectional area in column 1 which is shown rounded to three significant figures. The applicable wall thickness ranges shown in columns 2, 3, and 4 were calculated based on the specified specimen width (shown above the column numbers 2, 3, and 4) taking into account the rounding rules for the specimen area (i.e. to three significant figures) but with the wall thickness rounded down to two significant figures for SI units. When making these wall thickness ranges for USC units 3 significant figures are used.

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Table E.7 — Critical thickness for couplings with API threads

Dimensions in inches

Label 1	Critical thickness for couplings						
	NU	EU	Special-clearance		BC	LC	SC
			EU	BC			
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
1.050	0.169	0.211	—	—	—	—	—
1.315	0.211	0.258	—	—	—	—	—
1.660	0.239	0.240	—	—	—	—	—
1.900	0.196	0.251	—	—	—	—	—
2-3/8	0.304	0.300	0.224	—	—	—	—
2-7/8	0.380	0.358	0.254	—	—	—	—
3-1/2	0.451	0.454	0.294	—	—	—	—
4	0.454	0.458	—	—	—	—	—
4-1/2	0.435	0.493	—	0.259	0.447	0.474	0.462
5	—	—	—	0.266	0.479	0.511	0.491
5-1/2	—	—	—	0.268	0.481	0.514	0.495
6-5/8	—	—	—	0.274	0.469	0.508	0.485
7	—	—	—	0.280	0.530	0.568	0.540
7-5/8	—	—	—	0.348	0.536	0.573	0.546
8-5/8	—	—	—	0.352	0.602	0.647	0.612
9-5/8	—	—	—	0.352	0.602	0.657	0.614
10-3/4	—	—	—	0.352	0.602	—	0.618
11-3/4	—	—	—	—	0.602	—	0.618
13-3/8	—	—	—	—	0.602	—	0.618
16	—	—	—	—	0.667	—	0.632
18-5/8	—	—	—	—	0.854	—	0.819
20	—	—	—	—	0.667	0.673	0.634

NOTE The coupling blank thickness is greater than indicated above, due to thread height and manufacturing allowance to avoid black crest threads.

Table E.8 — Acceptable size impact specimens and absorbed energy reduction factor

Test specimen size	Specimen dimensions mm	Reduction factor
Full size	10,0 × 10,0	1.00
¾-size	10,0 × 7,5	0.80
½-size	10,0 × 5,0	0.55

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Table E.9 — Hierarchy of test specimen orientation and size

Choice	Orientation	Size
1st	Transverse	Full size
2nd	Transverse	¾-size
3rd	Transverse	½-size
4th	Longitudinal	Full size
5th	Longitudinal	¾-size
6th	Longitudinal	½-size

Table E.10 — Charpy impact test specimen requirements for couplings, coupling stock, coupling material, coupling blanks and accessory material Grades J55 and K55

Label 1	API connection type and CVN specimen orientation, size, energy and temperature reduction						
	NU	EU	Special-clearance[b]		BC	LC	SC
			EU	BC			
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
1.050	[a]	L-5-11-A	—	—	—	—	—
1.315	L-5-11 A	L-7-16-A	—	—	—	—	—
1.660	L-5-11-B	L-5-11-B	—	—	—	—	—
1.900	L-5-11-A	L-7-16-B	—	—	—	—	—
2-3/8	L-7-16-A	L-7-16-A	L-7-16-A	—	—	—	—
2-7/8	L-10-20-A	L-10-20-A	L-10-20-A	—	—	—	—
3-1/2	T-5-8-E	T-5-8-E	T-5-8-D	—	—	—	—
4	T-7-12-B	T-7-12-B	—	L-7-16-A	—	—	—
4-1/2	T-7-12-B	T-7-12-B	—	T-5-8-C	T-7-12-A	T-7-12-A	T-7-12-A
5	—	—	—	T-5-8-C	T-7-12-D	T-10-15-D	T-7-12-D
5-1/2	—	—	—	T-10-15-A	T-7-12-D	T-10-15-D	T-10-15-D
6-5/8	—	—	—	T-7-12-A	T-10-15-A	T-10-15-A	T-10-15-A
7	—	—	—	T-10-15-A	T-10-15-A	T-10-15-A	T-10-15-B
7-5/8	—	—	—	T-10-15-A	T-10-15-A	T-10-15-A	T-10-15-A
8-5/8	—	—	—	T-10-15-A	T-10-15-A	T-10-15-A	T-10-15-A
9-5/8	—	—	—	T-10-15-A	T-10-15-A	T-10-15-A	T-10-15-A
10-3/4	—	—	—	—	T-10-15-A	—	T-10-15-A
11-3/4	—	—	—	—	T-10-15-A	—	T-10-15-A
13-3/8	—	—	—	—	T-10-15-A	—	T-10-15-A
16	—	—	—	—	T-10-15-A	—	T-10-15-A
18-5/8	—	—	—	—	T-10-15-A	—	T-10-15-A
20	—	—	—	—	T-10-15-A	T-10-15-A	T-10-15-A

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Table E.10 *(continued)*

Label 1	API connection type and CVN specimen orientation, size, energy and temperature reduction						
	NU	EU	Special-clearance[b]		BC	LC	SC
			EU	BC			
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*

Key

[a] Not thick enough to test.

[b] The above assumes that special-clearance couplings are machined from regular coupling blanks.

T is the transverse specimen orientation (see Figure D.11)

L is the longitudinal specimen orientation (see Figure D.11)

10: full size (i.e. 10 mm × 10 mm)

7: ¾-size (i.e. 10 mm × 7,5 mm)

5: ½-size (i.e. 10 mm × 5 mm)

A: no temperature reduction

B: 5 °F reduction

C: 10 °F reduction

D: 15 °F reduction

E: 20 °F reduction

NOTE In this table, the specimen orientation (T or L) is followed by the minimum specimen size (10, 7 or 5) which is followed by the minimum absorbed energy requirement (foot pounds) and the temperature reduction (A, B, C, D or E), according to the following code. Both the absorbed energy requirement and the test temperature reduction requirement are adjusted for the test specimen size indicated. Orientation and specimen size is calculated on coupling material/stock wall and not coupling critical thickness.

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Table E.11 — Charpy impact test specimen requirements for couplings, coupling stock, coupling material, coupling blanks and accessory material Grade L80 all types

Label 1	API connection type and CVN specimen orientation, size and energy						
	NU	EU	Special-clearance[b]		BC	LC	SC
			EU	BC			
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
1.050	[a]	L-5-16	—	—	—	—	—
1.315	L-5-16	L-7-24	—	—	—	—	—
1.660	L-5-16	L-5-16	—	—	—	—	—
1.900	L-5-16	L-7-24	—	—	—	—	—
2-3/8	L-7-24	L-7-24	L-7-24	—	—	—	—
2-7/8	L-10-30	L-10-30	L-10-30	—	—	—	—
3-1/2	T-5-8	T-5-8	T-5-8	—	—	—	—
4	T-7-12	T-7-12	—	—	—	—	—
4-1/2	T-7-12	T-7-12	—	L-7-24	T-7-12	T-7-12	—
5	—	—	—	T-5-8	T-7-12	T-10-15	—
5-1/2	—	—	—	T-5-8	T-7-12	T-10-15	—
6-5/8	—	—	—	T-10-15	T-10-15	T-10-15	—
7	—	—	—	T-7-12	T-10-15	T-10-15	—
7-5/8	—	—	—	T-10-15	T-10-15	T-10-15	—
8-5/8	—	—	—	T-10-15	T-10-15	T-10-15	—
9-5/8	—	—	—	T-10-15	T-10-15	T-10-16	—
10-3/4	—	—	—	T-10-15	T-10-15	—	T-10-15
11-3/4	—	—	—	—	T-10-15	—	T-10-15
13-3/8	—	—	—	—	T-10-15	—	T-10-15
16	—	—	—	—	T-10-16	—	T-10-15
18-5/8	—	—	—	—	T-10-18	—	T-10-18
20	—	—	—	—	T-10-16	T-10-16	T-10-15

Key

[a] Not thick enough to test.

[b] The above assumes that special-clearance couplings are machined from regular coupling blanks.

T is the transverse specimen orientation (see Figure D.11)

L is the longitudinal specimen orientation (see Figure D.11)

10: full size (i.e. 10 mm × 10 mm)

7: ¾-size (i.e. 10 mm × 7,5 mm)

5: ½-size (i.e. 10 mm × 5 mm)

NOTE In this table, the specimen orientation (T or L) is followed by the minimum specimen size (10, 7 or 5) which is followed by the minimum absorbed energy requirement (foot pounds) according to the following code. The absorbed energy requirement is adjusted for the test specimen size indicated. Orientation and specimen size is calculated on coupling material/stock wall and not coupling critical thickness.

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Table E.12 — Charpy impact test specimen requirements for couplings, coupling stock, coupling material, coupling blanks and accessory material Grade C90

Label 1	API connection type and CVN specimen orientation, size and energy						
	NU	EU	Special-clearance[b]		BC	LC	SC
			EU	BC			
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
1.050	[a]	L-5-16	—	—	—	—	—
1.315	L-5-16	L-7-24	—	—	—	—	—
1.660	L-5-16	L-5-16	—	—	—	—	—
1.900	L-5-16	L-7-24	—	—	—	—	—
2-3/8	L-7-24	L-7-24	L-7-24	—	—	—	—
2-7/8	L-10-30	L-10-30	L-10-30	—	—	—	—
3-1/2	T-5-8	T-5-8	T-5-8	—	—	—	—
4	T-7-12	T-7-12	—	—	—	—	—
4-1/2	T-7-12	T-7-12	—	L-7-24	T-7-12	T-7-12	—
5	—	—	—	T-5-8	T-7-12	T-10-15	—
5-1/2	—	—	—	T-5-8	T-7-12	T-10-15	—
6-5/8	—	—	—	T-10-15	T-10-15	T-10-15	—
7	—	—	—	T-7-12	T-10-15	T-10-15	—
7-5/8	—	—	—	T-10-15	T-10-15	T-10-16	—
8-5/8	—	—	—	T-10-15	T-10-16	T-10-17	—
9-5/8	—	—	—	T-10-15	T-10-16	T-10-17	—
10-3/4	—	—	—	T-10-15	T-10-16	—	T-10-17
11-3/4	—	—	—	—	T-10-16	—	T-10-17
13-3/8	—	—	—	—	T-10-16	—	T-10-17
16	—	—	—	—	—	—	—
18-5/8	—	—	—	—	—	—	—
20	—	—	—	—	—	—	—

Key

[a] Not thick enough to test.

[b] The above assumes that special-clearance couplings are machined from regular coupling blanks.

T is the transverse specimen orientation (see Figure D.11)

L is the longitudinal specimen orientation (see Figure D.11)

10: full size (i.e. 10 mm × 10 mm)

7: ¾-size (i.e. 10 mm × 7,5 mm)

5: ½-size (i.e. 10 mm × 5 mm)

NOTE In this table, the specimen orientation (T or L) is followed by the minimum specimen size (10, 7 or 5) which is followed by the minimum absorbed energy requirement (foot pounds) according to the following code. The absorbed energy requirement is adjusted for the test specimen size indicated. Orientation and specimen size is calculated on coupling material/stock wall and not coupling critical thickness.

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Table E.13 — Charpy impact test specimen requirements for couplings , coupling stock, coupling material, coupling blanks and accessory material Grades N80 all types, R95 and T95

Label 1	API connection type and CVN specimen orientation, size and energy						
	NU	EU	Special-clearance[b]		BC	LC	SC
			EU	BC			
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
1.050	[a]	L-5-16	—	—	—	—	—
1.315	L-5-16	L-7-24	—	—	—	—	—
1.660	L-5-16	L-5-16	—	—	—	—	—
1.900	L-5-16	L-7-24	—	—	—	—	—
2-3/8	L-7-24	L-7-24	L-7-24	—	—	—	—
2-7/8	L-10-30	L-10-30	L-10-30	—	—	—	—
3-1/2	T-5-8	T-5-8	T-5-8	—	—	—	—
4	T-7-12	T-7-12	—	—	—	—	—
4-1/2	T-7-12	T-10-15	—	L-7-24	T-7-12	T-7-12	—
5	—	—	—	T-5-8	T-7-12	T-10-15	—
5-1/2	—	—	—	T-5-8	T-7-12	T-10-15	—
6-5/8	—	—	—	T-10-15	T-10-15	T-10-16	—
7	—	—	—	T-7-12	T-10-15	T-10-16	—
7-5/8	—	—	—	T-10-15	T-10-16	T-10-17	—
8-5/8	—	—	—	T-10-15	T-10-17	T-10-18	—
9-5/8	—	—	—	T-10-15	T-10-17	T-10-18	—
10-3/4	—	—	—	T-10-15	T-10-17	—	T-10-17
11-3/4	—	—	—	—	T-10-17	—	T-10-17
13-3/8	—	—	—	—	T-10-17	—	T-10-17
16	—	—	—	—	—	—	—
18-5/8	—	—	—	—	—	—	—
20	—	—	—	—	—	—	—

Key

[a] Not thick enough to test.

[b] The above assumes that special-clearance couplings are machined from regular coupling blanks.

NOTE In this table, the specimen orientation (T or L) is followed by the minimum specimen size (10, 7 or 5) which is followed by the minimum absorbed energy requirement (foot pounds) according to the following code. The absorbed energy requirement is adjusted for the test specimen size indicated. Orientation and specimen size is calculated on coupling material/stock wall and not coupling critical thickness.

T is the transverse specimen orientation (see Figure D.11)

L is the longitudinal specimen orientation (see Figure D.11)

10: full size (i.e. 10 mm × 10 mm)

7: ¾-size (i.e. 10 mm × 7,5 mm)

5: ½-size (i.e. 10 mm × 5 mm)

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Table E.14 — Charpy impact test specimen requirements for couplings, coupling stock, coupling material, coupling blanks and accessory material Grade P110

Label 1	API connection type and CVN specimen orientation, size and energy						
	NU	EU	Special-clearance[b]		BC	LC	SC
			EU	BC			
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
1.050	a	L-5-16	—	—	—	-—	—
1.315	L-5-16	L-7-24	—	—	—	—	—
1.660	L-5-16	L-5-16	—	—	—	—	—
1.900	L-5-16	L-7-24	—	—	—	—	—
2-3/8	L-7-25	L-7-25	L-7-24	—	—	—	—
2-7/8	L-10-34	L-10-33	L-10-30	—	—	—	—
3-1/2	T-5-10	T-5-10	T-5-8	—	—	—	—
4	T-7-15	T-7-15	—	—	—	—	—
4-1/2	T-7-14	T-7-15	—	L-7-24	T-7-14	T-7-18	—
5	—	—	—	T-5-8	T-7-14	T-10-19	—
5-1/2	—	—	—	T-5-8	T-7-14	T-10-19	—
6-5/8	—	—	—	T-10-15	T-10-19	T-10-20	—
7	—	—	—	T-7-12	T-10-19	T-10-20	—
7-5/8	—	—	—	T-10-16	T-10-20	T-10-21	—
8-5/8	—	—	—	T-10-16	T-10-22	T-10-23	—
9-5/8	—	—	—	T-10-16	T-10-22	T-10-23	—
10-3/4	—	—	—	T-10-16	T-10-22	—	T-10-22
11-3/4	—	—	—	—	T-10-22	—	T-10-22
13-3/8	—	—	—	—	T-10-22	—	T-10-22
16	—	—	—	—	—	—	—
18-5/8	—	—	—	—	—	—	—
20	—	—	—	—	—	—	—

Key

[a] Not thick enough to test.

[b] The above assumes that special-clearance couplings are machined from regular coupling blanks.

T is the transverse specimen orientation (see Figure D.11)

L is the longitudinal specimen orientation (see Figure D.11)

10: full size (i.e. 10 mm × 10 mm)

7: ¾-size (i.e. 10 mm × 7,5 mm)

5: ½-size (i.e. 10 mm × 5 mm)

NOTE In this table, the specimen orientation (T or L) is followed by the minimum specimen size (10, 7 or 5) which is followed by the minimum absorbed energy requirement (foot pounds) according to the following code. The absorbed energy requirement is adjusted for the test specimen size indicated. Orientation and specimen size is calculated on coupling material/stock wall and not coupling critical thickness.

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Table E.15 — Charpy impact test specimen requirements for couplings, coupling stock, coupling material, coupling blanks and accessory material Grade Q125

Label 1	API connection type and CVN specimen orientation, size and energy			
	Special-clearance[a] BC	BC	LC	SC
1	*2*	*3*	*4*	*5*
4-1/2	L-7-25	T-7-15	T-7-15	—
5	T-5-9	T-7-16	T-10-20	—
5-1/2	T-5-9	T-7-16	T-10-20	—
6-5/8	T-10-16	T-10-20	T-10-21	—
7	T-7-13	T-10-21	T-10-22	—
7-5/8	T-10-18	T-10-22	T-10-23	—
8-5/8	T-10-18	T-10-23	T-10-24	—
9-5/8	T-10-18	T-10-23	T-10-25	—
10-3/4	T-10-18	T-10-23	—	T-10-24
11-3/4	—	T-10-23	—	T-10-24
13-3/8	—	T-10-23	—	T-10-24
16	—	—	—	—
18-5/8	—	—	—	—
20	—	—	—	—

Key

[a] The above assumes that special-clearance couplings are machined from regular coupling blanks.

T is the transverse specimen orientation (see Figure D.11)

L is the longitudinal specimen orientation (see Figure D.11)

10: full size (i.e. 10 mm × 10 mm)

7: ¾-size (i.e. 10 mm × 7,5 mm)

5: ½-size (i.e. 10 mm × 5 mm)

NOTE In this table, the specimen orientation (T or L) is followed by the minimum specimen size (10, 7 or 5) which is followed by the minimum absorbed energy requirement (foot pounds) according to the following code. The absorbed energy requirement is adjusted for the test specimen size indicated. Orientation and specimen size is calculated on coupling material/stock wall and not coupling critical thickness.

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Table E.16 — Transverse Charpy absorbed energy requirements for couplings, coupling stock, coupling material, coupling blanks and accessory material

Maximum critical thickness for various grades in						Minimum transverse absorbed energy ft·lb
L80	C90	N80Q, R95, T95	C110	P110	Q125	
1	*2*	*3*	*4*	*5*	*6*	*7*
0.652	0.550	0.505	0.428	0.307	0.258	15
0.721	0.612	0.565	0.483	0.354	0.302	16
0.790	0.675	0.625	0.538	0.401	0.346	17
0.860	0.738	0.685	0.593	0.448	0.390	18
0.929	0.800	0.745	0.648	0.495	0.434	19
0.998	0.863	0.805	0.702	0.542	0.478	20
1.067	0.926	0.864	0.757	0.589	0.521	21
	0.988	0.924	0.812	0.636	0.565	22
	1.051	0.984	0.867	0.683	0.609	23
		1.044	0.922	0.730	0.653	24
			0.976	0.777	0.697	25
			1.031	0.824	0.741	26
				0.871	0.785	27
				0.918	0.828	28
				0.965	0.872	29
				1.012	0.916	30
					0.960	31
					1.004	32
For critical thickness greater than shown above, the requirements shall be according to the formulas for the wall thickness and grade.						
NOTE Critical thicknesses greater than shown in Table E.7 are not applicable for couplings with API threads and are shown here for information for special applications.						

Table E.17 — Longitudinal Charpy absorbed energy requirements for couplings, coupling stock, coupling material, coupling blanks and accessory material

Maximum critical thickness in						Minimum longitudinal absorbed energy ft·lb
L80	C90	N80Q, R95, T95	C110	P110	Q125	
1	*2*	*3*	*4*	*5*	*6*	*7*
0.635	0.534	0.491	0.415	0.295	0.247	30
0.669	0.565	0.520	0.442	0.319	0.269	31
0.704	0.597	0.550	0.469	0.342	0.291	32
0.738	0.628	0.580	0.497	0.366	0.313	33
For critical thickness greater than shown above, the requirements shall be according to the formulas for the wall thickness and grade.						
NOTE Critical thicknesses greater than shown in Table E.7 are not applicable for couplings with API threads and are shown here for information for special applications.						

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Table E.17 *(continued)*

Maximum critical thickness in						Minimum longitudinal absorbed energy ft·lb
L80	**C90**	**N80Q, R95, T95**	**C110**	**P110**	**Q125**	
1	*2*	*3*	*4*	*5*	*6*	*7*
0.773	0.659	0.610	0.524	0.389	0.335	34
0.808	0.691	0.640	0.552	0.413	0.357	35
0.842	0.722	0.670	0.579	0.436	0.379	36
0.877	0.753	0.700	0.606	0.460	0.401	37
0.912	0.785	0.730	0.634	0.483	0.423	38
0.946	0.816	0.760	0.661	0.507	0.445	39
0.981	0.847	0.790	0.689	0.530	0.467	40
1.015	0.879	0.819	0.716	0.554	0.489	41
	0.910	0.849	0.743	0.577	0.510	42
	0.941	0.879	0.771	0.601	0.532	43
	0.973	0.909	0.798	0.624	0.554	44
	1.004	0.939	0.826	0.648	0.576	45
		0.969	0.853	0.671	0.598	46
		0.999	0.881	0.695	0.620	47
		1.029	0.908	0.718	0.642	48
			0.935	0.742	0.664	49
			0.963	0.765	0.686	50

For critical thickness greater than shown above, the requirements shall be according to the formulas for the wall thickness and grade.

NOTE Critical thicknesses greater than shown in Table E.7 are not applicable for couplings with API threads and are shown here for information for special applications.

Table E.18 — Transverse Charpy absorbed energy requirements for pipe

111						Minimum transverse absorbed energy ft·lb
N80, L80	**C90**	**R95, T95**	**C110**	**P110**	**Q125**	
1	*2*	*3*	*4*	*5*	*6*	*7*
0.442	0.346	0.306				10
0.524	0.419	0.375				11
0.606	0.492	0.444				12
0.689	0.565	0.513				13
0.771	0.638	0.583				14
0.853	0.711	0.652	0.428	0.505	0.258	15
0.935	0.785	0.721	0.483	0.565	0.302	16
1.018	0.858	0.790	0.538	0.625	0.346	17

For wall thickness greater than shown above, the requirements shall be according to the formulas for the wall thickness and grade.

NOTE Wall thicknesses greater than those of standard ISO/API pipe are shown here for information for special applications.

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Table E.18 *(continued)*

111						Minimum transverse absorbed energy ft·lb
N80, L80	**C90**	**R95, T95**	**C110**	**P110**	**Q125**	
1	*2*	*3*	*4*	*5*	*6*	*7*
	0.931	0.860	0.593	0.685	0.390	18
	1.004	0.929	0.648	0.745	0.434	19
		0.998	0.702	0.805	0.478	20
			0.757	0.864	0.521	21
			0.812	0.924	0.565	22
			0.867	0.984	0.609	23
			0.922	1.044	0.653	24
			0.976		0.697	25
			1.031		0.741	26
					0.785	27
					0.828	28
					0.872	29
					0.916	30
					0.960	31
					1.004	32

For wall thickness greater than shown above, the requirements shall be according to the formulas for the wall thickness and grade.

NOTE Wall thicknesses greater than those of standard ISO/API pipe are shown here for information for special applications.

Table E.19 — Longitudinal Charpy absorbed energy requirements for pipe

Maximum specified wall thickness in						Minimum longitudinal absorbed energy ft·lb
N80, L80	**C90**	**R95, T95**	**C110**	**P110**	**Q125**	
1	*2*	*3*	*4*	*5*	*6*	*7*
0.421	0.328	0.288	—	—	—	20
0.462	0.364	0.323	—	—	—	21
0.504	0.401	0.358	—	—	—	22
0.545	0.437	0.392	—	—	—	23
0.586	0.474	0.427	—	—	—	24
0.627	0.510	0.461	—	—	—	25
0.668	0.547	0.496	—	—	—	26
0.709	0.584	0.531	—	—	—	27
0.750	0.620	0.565	—	—	—	28
0.791	0.657	0.600	—	—	—	29

For wall thicknesses greater than shown above, the requirements shall be according to the formulas for the wall thickness and grade.

NOTE Wall thicknesses greater than those of standard ISO/API pipe are shown here for information for special applications.

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Table E.19 *(continued)*

Maximum specified wall thickness in						Minimum longitudinal absorbed energy ft·lb
N80, L80	**C90**	**R95, T95**	**C110**	**P110**	**Q125**	
1	*2*	*3*	*4*	*5*	*6*	*7*
0.833	0.693	0.635	0.415	0.491	0.247	30
0.874	0.730	0.669	0.442	0.520	0.269	31
0.915	0.766	0.704	0.469	0.550	0.291	32
0.956	0.803	0.738	0.497	0.580	0.313	33
0.997	0.839	0.773	0.524	0.610	0.335	34
1.038	0.876	0.808	0.552	0.640	0.357	35
	0.913	0.842	0.579	0.670	0.379	36
	0.949	0.877	0.606	0.700	0.401	37
	0.986	0.912	0.634	0.730	0.423	38
	1.022	0.946	0.661	0.760	0.445	39
		0.981	0.689	0.790	0.467	40
		1.015	0.716	0.819	0.489	41
			0.743	0.849	0.510	42
			0.771	0.879	0.532	43
			0.798	0.909	0.554	44
			0.826	0.939	0.576	45
			0.853	0.969	0.598	46
			0.881	0.999	0.620	47
			0.908	1.029	0.642	48
			0.935		0.664	49
			0.963		0.686	50

For wall thicknesses greater than shown above, the requirements shall be according to the formulas for the wall thickness and grade.

NOTE Wall thicknesses greater than those of standard ISO/API pipe are shown here for information for special applications.

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Table E.20 — Transverse impact specimen size required for quenched and tempered product

Label 1	Calculated wall thickness required to machine transverse Charpy impact specimens in		
	Full size	¾-size	½-size
1	*2*	*3*	*4*
3-1/2	0.809	0.711	0.612
4	0.752	0.654	0.555
4-1/2	0.712	0.614	0.515
5	0.681	0.583	0.484
5-1/2	0.656	0.558	0.459
6-5/8	0.616	0.518	0.419
7	0.606	0.508	0.409
7-5/8	0.591	0.493	0.394
7-3/4	0.588	0.490	0.391
8-5/8	0.572	0.474	0.375
9-5/8	0.557	0.459	0.360
10-3/4	0.544	0.446	0.347
11-3/4	0.535	0.437	0.338
13-3/8	0.522	0.424	0.325
16	0.508	0.410	0.311
18-5/8	0.497	0.399	0.300
20	0.493	0.395	0.296

NOTE The wall thicknesses in columns 2, 3 and 4 that are in excess of the maximum wall thicknesses for ISO/API pipe are for information only. The above provides a 0.020 in inside-wall and a 0.020 in outside-wall machining allowance.

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Table E.21 — Longitudinal impact specimen size required for quenched and tempered product

Label 1	Calculated wall thickness required to machine longitudinal Charpy impact specimens in		
	Full size	¾-size	½-size
1	*2*	*3*	*4*
1.050	0.472	0.374	0.275
1.315	0.464	0.366	0.267
1.660	0.458	0.360	0.261
1.900	0.455	0.357	0.258
2.063	0.453	0.355	0.256
2-3/8	0.450	0.352	0.253
2-7/8	0.448	0.350	0.251
3-1/2	0.445	0.347	0.248
4	0.444	0.346	0.247
4-1/2	0.443	0.345	0.246
5	0.442	0.344	0.245
5-1/2	0.441	0.343	0.244
6-5/8	0.440	0.342	0.243
7	0.440	0.342	0.243
7-5/8	0.439	0.341	0.242
7-3/4	0.439	0.341	0.242
8-5/8	0.439	0.341	0.242
9-5/8	0.438	0.340	0.241
10-3/4	0.438	0.340	0.241
11-3/4	0.437	0.339	0.240
13-3/8	0.437	0.339	0.240
16	0.436	0.338	0.239
18-5/8	0.436	0.338	0.239
20	0.436	0.338	0.239

NOTE The wall thicknesses in columns 2, 3 and 4 that are in excess of the maximum wall thicknesses for ISO/API pipe are for information only. The above provides a 0.020 in inside-wall and a 0.020 in outside-wall machining allowance.

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Table E.22 — Distance between plates for electric weld flattening tests

Grade	D/t ratio	Distance between plates in
1	*2*	*3*
H40	≥16	$0.5 \times D$
	<16	$D \times (0.830 - 0.020\ 6\ D/t)$
J55 & K55	≥16	$0.65 \times D$
	3.93 to 16	$D \times (0.980 - 0.020\ 6\ D/t)$
	<3.93	$D \times (1.104 - 0.051\ 8\ D/t)$
N80 Type 1, N80Q[a]	9 to 28	$D \times (1.074 - 0.019\ 4\ D/t)$
L80 Type 1	9 to 28	$D \times (1.074 - 0.019\ 4\ D/t)$
R95[a]	9 to 28	$D \times (1.080 - 0.017\ 8\ D/t)$
P110[b]	All	$D \times (1.086 - 0.016\ 3\ D/t))$
Q125[b]	All	$D \times (1.092 - 0.014\ 0\ D/t)$

D is the specified outside diameter of pipe, in inches.

t is the specified wall thickness of the pipe, in inches.

[a] If the flattening test fails at 12 o'clock or 6 o'clock, the flattening shall continue until the remaining portion of the specimen fails at the 3 o'clock or 9 o'clock position. Premature failure at 12 o'clock or 6 o'clock shall not be considered basis for rejection.

[b] See A.5 SR11. Flattening shall be conducted until this distance or until 0,85 × D, whichever is less, without cracking at any location.

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Table E.23 — Dimensions and masses for standard casing and for casing threaded with API round thread and buttress thread

Labels[a]		Outside diameter	Nominal linear mass T&C[b,c]	Wall thickness	Inside diameter	Drift diameter	Calculated mass[c]				
							Plain-end	e_m, mass gain or loss due to end finishing[d] lb			
								Round thread		Buttress thread	
1	2	D in	lb/ft	t in	d in	in	w_{pe} lb/ft	Short	Long	RC	SCC
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*
4-1/2	9.50	4.500	9.70	0.205	4.090	3.965	9.41	8.02	—	—	—
4-1/2	10.50	4.500	10.60	0.224	4.052	3.927	10.24	7.34	—	9.98	2.47
4-1/2	11.60	4.500	11.70	0.250	4.000	3.875	11.36	7.00	7.95	9.52	2.01
4-1/2	13.50	4.500	13.30	0.290	3.920	3.795	13.05	—	7.38	8.82	1.32
4-1/2	15.10	4.500	15.30	0.337	3.826	3.701	15.00	—	6.73	8.02	0.52
5	11.50	5.000	11.60	0.220	4.560	4.435	11.24	9.52	—	—	—
5	13.00	5.000	13.20	0.253	4.494	4.369	12.84	8.81	10.69	11.86	2.21
5	15.00	5.000	15.30	0.296	4.408	4.283	14.88	8.17	9.95	11.00	1.35
5	18.00	5.000	18.30	0.362	4.276	4.151	17.95	—	8.83	9.71	0.05
5	21.40	5.000	21.60	0.437	4.126	4.001	21.32	—	7.60	8.28	-1.37
5	23.20	5.000	23.40	0.478	4.044	3.919	23.11	—	6.95	7.53	-2.12
5	24.10	5.000	24.30	0.500	4.000	3.875	24.05	—	6.60	7.13	-2.52
5-1/2	14.00	5.500	14.00	0.244	5.012	4.887	13.71	10.14	—	—	—
5-1/2	15.50	5.500	15.80	0.275	4.950	4.825	15.36	9.61	11.60	12.58	1.92
5-1/2	17.00	5.500	17.30	0.304	4.892	4.767	16.89	9.12	11.03	11.93	1.27
5-1/2	20.00	5.500	20.20	0.361	4.778	4.653	19.83	—	9.92	10.64	0.01
5-1/2	23.00	5.500	22.90	0.415	4.670	4.545	22.56	—	8.90	9.51	-1.15
5-1/2	26.80	5.500	27.00	0.500	4.500	4.375	26.72	—	—	—	—
5-1/2	29.70	5.500	29.90	0.562	4.376	4.251	29.67	—	—	—	—
5-1/2	32.60	5.500	32.70	0625	4.250	4.125	32.57	—	—	—	—
5-1/2	35.30	5.500	35.50	0.687	4.126	4.001	35.35	—	—	—	—
5-1/2	38.00	5.500	38.20	0.750	4.000	3.875	38.08	—	—	—	—
5-1/2	40.50	5.500	40.80	0.812	3.876	3.751	40.69	—	—	—	—
5-1/2	43.10	5.500	43.30	0.875	3.750	3.625	43.26	—	—	—	—

See Figures D.1, D.2 and D.3.

[a] Labels are for information and assistance in ordering.

[b] Nominal linear masses, threaded and coupled (col.4) are shown for information only.

[c] The density of martensitic chromium steel (L80 Type 13Cr) are less than those of carbon steels. The masses shown are therefore not accurate for martensitic chromium steels. A mass correction factor of 0.989 shall be used.

[d] Mass gain or loss due to end finishing. See 8.5.

[e] Drift diameter for most common bit size. This drift diameter shall be specified on the purchase agreement and marked on the pipe. See 8.10 for drift requirements.

[f] Based on 110,000 psi minimum yield strength or greater.

[g] Based on 55,000 psi minimum yield strength

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Table E.23 *(continued)*

Labels[a]		Outside diameter	Nominal linear mass T&C[b,c]	Wall thickness	Inside diameter	Drift diameter	Calculated mass[c]				
							Plain-end	e_m, mass gain or loss due to end finishing[d] lb			
								Round thread		Buttress thread	
1	2	D in	lb/ft	t in	d in	in	w_{pe} lb/ft	Short	Long	RC	SCC
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*
6-5/8	20.00	6.625	20.00	0.288	6.049	5.924	19.51	11.15	13.74	14.00	1.97
6-5/8	24.00	6.625	24.00	0.352	5.921	5.796	23.60	9.74	12.08	12.18	0.15
6-5/8	28.00	6.625	28.00	0.417	5.791	5.666	27.67	—	10.42	10.38	-1.65
6-5/8	32.00	6.625	32.00	0.475	5.675	5.550	31.23	—	8.98	8.81	-3.22
7	17.00	7.000	17.20	0.231	6.538	6.413	16.72	16.77	—	—	—
7	20.00	7.000	20.10	0.272	6.456	6.331	19.56	14.86	—	—	—
7	23.00	7.000	23.30	0.317	6.366	6.250[e]	22.65	13.80	117.51	18.26	1.27
7	23.00	7.000	23.30	0.317	6.366	6.241	22.65	13.80	117.51	18.26	1.27
7	26.00	7.000	26.30	0.362	6.276	6.151	25.69	12.76	16.25	16.86	-0.12
7	29.00	7.000	29.30	0.408	6.184	6.059	28.75	—	14.97	15.46	-1.52
7	32.00	7.000	32.20	0.453	6.094	6.000[e]	31.70	—	13.74	14.11	-2.88
7	32.00	7.000	32.20	0.453	6.094	5.969	31.70	—	13.74	14.11	-2.88
7	35.00	7.000	35.00	0.498	6.004	5.879	34.61	—	12.53	12.77	-4.21
7	38.00	7.000	37.70	0.540	5.920	5.795	37.29	—	11.41	11.55	-5.44
7	42.70	7.000	42.90	0.625	5.750	5.625	42.59	—	—	—	—
7	46.40	7.000	46.60	0.687	5.626	5.001	46.36	—	—	—	—
7	50.10	7.000	50.30	0.750	5.500	5.375	50.11	—	—	—	—
7	53.60	7.000	53.90	0.812	5.376	5.251	53.71	—	—	—	—
7	57.10	7.000	57.40	0.875	5.250	5.125	57.29	—	—	—	—

See Figures D.1, D.2 and D.3.

[a] Labels are for information and assistance in ordering.

[b] Nominal linear masses, threaded and coupled (col.4) are shown for information only.

[c] The density of martensitic chromium steel (L80 Type 13Cr) are less than those of carbon steels. The masses shown are therefore not accurate for martensitic chromium steels. A mass correction factor of 0.989 shall be used.

[d] Mass gain or loss due to end finishing. See 8.5.

[e] Drift diameter for most common bit size. This drift diameter shall be specified on the purchase agreement and marked on the pipe. See 8.10 for drift requirements.

[f] Based on 110,000 psi minimum yield strength or greater.

[g] Based on 55,000 psi minimum yield strength

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Table E.23 *(continued)*

Labels[a]		Outside diameter	Nominal linear mass T&C[b,c]	Wall thickness	Inside diameter	Drift diameter	Calculated mass[c]				
							Plain-end	e_m, mass gain or loss due to end finishing[d] lb			
								Round thread		Buttress thread	
1	2	D in	lb/ft	t in	d in	in	w_{pe} lb/ft	Short	Long	RC	SCC
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*
7-5/8	24.00	7.625	24.00	0.300	7.025	6.900	23.49	15.68	—	—	—
7-5/8	26.40	7.625	26.40	0.328	6.969	6.844	25.59	14.94	18.91	20.11	5.71
7-5/8	29.70	7.625	29.70	0.375	6.875	6.750	29.06	—	17.43	18.47	4.06
7-5/8	33.70	7.625	33.70	0.430	6.765	6.640	33.07	—	15.71	16.56	2.16
7-5/8	39.00	7.625	39.00	0.500	6.625	6.500	38.08	—	13.57	14.19	0.22
7-5/8	42.80	7.625	42.80	0.562	6.501	6.376	42.43	—	11.72	12.13	-2.28
7-5/8	45.30	7.625	45.30	0.595	6.435	6.310	44.71	—	10.74	11.05	-3.36
7-5/8	47.10	7.625	47.10	0.625	6.375	6.250	46.77	—	9.87	10.07	-4.33
7-5/8	51.20	7.625	51.20	0.687	6.251	6.126	50.95	—	—	—	—
7-5/8	55.30	7.625	55.30	0.750	6.125	6.000	55.12	—	—	—	—
7-3/4	46.10	7.750	46.10	0.595	6.560	6.500[e]	45.51	—	—	—	—
7-3/4	46.10	7.750	46.10	0.595	6.560	6.435	45.51	—	—	—	—
8-5/8	24.00	8.625	24.00	0.264	8.097	7.972	23.60	24.10	—	—	—
8-5/8	28.00	8.625	28.00	0.304	8.017	7.892	27.04	22.20	—	—	—
8-5/8	32.00	8.625	32.00	0.352	7.921	7.875[e]	31.13	20.70	27.42	27.71	5.53
8-5/8	32.00	8.625	32.00	0.352	7.921	7.796	31.13	20.70	27.42	27.71	5.53
8-5/8	36.00	8.625	36.00	0.400	7.825	7.700	35.17	19.23	25.57	25.76	3.57
8-5/8	40.00	8.625	40.00	0.450	7.725	7.625[e]	39.33	—	23.66	23.74	1.56
8-5/8	40.00	8.625	40.00	0.450	7.725	7.600	39.33	—	23.66	23.74	1.56
8-5/8	44.00	8.625	44.00	0.500	7.625	7.500	43.43	—	21.78	21.76	0.43
8-5/8	49.00	8.625	49.00	0.557	7.511	7.286	48.04	—	19.67	19.52	-2.66

See Figures D.1, D.2 and D.3.

[a] Labels are for information and assistance in ordering.

[b] Nominal linear masses, threaded and coupled (col.4) are shown for information only.

[c] The density of martensitic chromium steel (L80 Type 13Cr) are less than those of carbon steels. The masses shown are therefore not accurate for martensitic chromium steels. A mass correction factor of 0.989 shall be used.

[d] Mass gain or loss due to end finishing. See 8.5.

[e] Drift diameter for most common bit size. This drift diameter shall be specified on the purchase agreement and marked on the pipe. See 8.10 for drift requirements.

[f] Based on 110,000 psi minimum yield strength or greater.

[g] Based on 55,000 psi minimum yield strength

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