# Casing and Tubing

API SPECIFICATION 5CT
TENTH EDITION, JUNE 2018

ERRATA 1, DECEMBER 2018
ERRATA 2, MAY 2019
ERRATA 3, JUNE 2020

API MONOGRAM PROGRAM EFFECTIVE DATE: JULY 1, 2019

ADDENDUM 1, JANUARY 2021
(API MONOGRAM PROGRAM EFFECTIVE DATE: AUGUST 1, 2021)

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# Casing and Tubing

## 1 Scope

### 1.1 Coverage

This standard specifies the technical delivery conditions for steel pipes (casing, tubing, and pup joints), coupling stock, coupling material, and accessory material, and establishes requirements for three product specification levels (PSL-1, PSL-2, and PSL-3). The requirements for PSL-1 are the basis of this standard. The requirements that define different levels of standard technical requirements for PSL-2 and PSL-3, for all grades (except H-40, L 80 9Cr, and C110) are provided.

For pipes covered by this standard, the sizes, masses, and wall thicknesses, as well as grades and applicable end-finishes, are provided. API 5L pipe may be ordered as casing in accordance with API 5C6.

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

### 1.2 Applicability—Connections

This standard is applicable to the following connections in accordance with API 5B:

— short round thread casing (SC)

— long round thread casing (LC)

— buttress thread casing (BC)

— non-upset tubing (NU)

— external upset tubing (EU)

— integral tubing (IJ)

For such connections, this standard specifies the technical delivery conditions for couplings and thread protection. Supplementary requirements that can optionally be agreed upon for enhanced leak resistance connections (LC) are provided.

This standard can also be applied to tubulars with connections not covered by API standards.

This standard is not applicable to threading requirements.

NOTE 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 5B.

### 1.3 Applicability—Grades

The products to which this standard is applicable include the following grades: H40, J55, K55, N80 (all types), L80 (all types), C90, R95, T95, P110, C110, and Q125.

### 1.4 Supplementary Requirements

Supplementary requirements that may be specified by the purchaser or agreed between purchaser and manufacturer for non-destructive examination, fully machined coupling blanks, upset casing, electric-welded casing, tubing and pup joints, impact testing, seal-ring couplings, tensile testing, and sulfide stress cracking testing are provided.

### 1.5 Application of the API Monogram

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

## 2 Normative References

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any addenda or errata) applies.

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

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

API Specification Q1, *Quality Management System Requirements for Manufacturing Organizations for the Petroleum and Natural Gas Industry*

API Technical Report 5C3, *Calculating Performance Properties of Pipe Used as Casing or Tubing*

ASNT SNT-TC-1A, *Recommended Practice No. SNT-TC-1A: Non-Destructive Testing*

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

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

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

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

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

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

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

ASTM 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 Practice 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*

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*

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

ISO 6506-1, *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*

ISO 6508-1, *Metallic materials—Rockwell hardness test—Part 1: Test method (scales A, B, C, D, E, F, G, H, K, N, T)*

ISO 6508-2, *Metallic materials—Rockwell hardness test—Part 2: Verification and calibration of testing machines (scales A, B, C, D, E, F, G, H, K, N, T)*

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

ISO 7500-1, *Metallic materials—Verification of static uniaxial testing machines—Part 1: Tension/compression testing machines—Verification and calibration 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 extensometers used in uniaxial testing*

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

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

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

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

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

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

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

ISO 10893-11, *Steel-Non-destructive testing—Part 11: Automatic ultrasonic testing of weld seam of welded steel tubes for the detection of longitudinal and/or transversal imperfections*

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

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

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

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

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

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

# 3 Terms, Definitions, Symbols, and Abbreviations

## 3.1 Terms and Definitions

For the purposes of this document, the following terms and definitions apply.

**3.1.1**
**accessory material**
Seamless casing 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 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 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.

**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.

**3.1.10**
**coupling material**
Thick-walled seamless tube used to manufacture coupling blanks.

NOTE The main difference between coupling material and coupling stock is that coupling material has no mandatory NDE inspection requirements (see 10.15); see Section 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 in this standard.

**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**
**handling tight**
Sufficiently tight so that the coupling cannot be removed except by the use of a wrench.

**3.1.17**
**heat**
Metal produced by a single cycle of a batch melting process.

**3.1.18**
**heat analysis**
Chemical analysis representative of a heat as reported by the metal producer.

**3.1.19**
**imperfection**
Discontinuity in the product wall or on the product surface that can be detected by a NDE method included in this standard.

NOTE See Table C.42 or Table E.42.

**3.1.20**
**inspection**
Process of measuring, examining, testing, gauging or otherwise comparing a unit of product with the applicable requirements.

**3.1.21**
**inspection lot**
**lot**
Definite quantity of product manufactured under conditions that are considered uniform for the attribute to be inspected.

**3.1.22**
**inspection lot sample**
One or more units of product selected from an inspection lot to represent that inspection lot.

**3.1.23**
**inspection lot size**
Number of units of product in an inspection lot.

**3.1.24**
**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.

**3.1.25**
**label 1**
Dimensionless designation for the size or specified outside diameter that may be used when ordering pipe.

**3.1.26**
**label 2**
Dimensionless designation for the mass per unit length that may be used when ordering pipe.

**3.1.27**
**length**
Piece of pipe that may be plain-end, threaded, or threaded and coupled, that is in accordance with the length requirements in this standard.

NOTE See Table C.27 or Table E.27.

**3.1.28**
**linear imperfection**
Imperfection which includes, but is not limited to, seams, laps, cracks, plug scores, cuts and gouges.

NOTE See API 5T1.

**3.1.29**
**manufacturer**

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

NOTE See Section 14.

**3.1.30**
**non-linear imperfection**
Imperfection which includes, but is not limited to, pits and round-bottom die stamping.

NOTE See API 5T1.

**3.1.31**
**pipe**
Casing, tubing and pup joints as a group.

**3.1.32**
**pipe mill**
Firm, company or corporation that operates pipe-making facilities.

**3.1.33**
**plain-end pipe**
Pipe, either upset or non-upset, furnished without threads.

**3.1.34**
**processor**
Firm, company or corporation that operates facilities capable of heat-treating products made by a pipe mill.

**3.1.35**
**product**
Pipe, coupling, coupling stock, coupling material, coupling blank or accessory material, either individually or collectively as applicable.

**3.1.36**
**product test block**
Test block removed from the product, the tensile test specimen or through-wall hardness test ring.

**3.1.37**
**pup joint**
Casing or tubing of length shorter than Range 1.

NOTE See Table C.27 or Table E.27.

**3.1.38**
**Pup joint material**
Casing or tubing, or thick-wall tubes or mechanical tubes, or bar stock used for the manufacture of pup joints.

**3.1.39**
**purchaser**
Party responsible for the definition of requirements for a product order and payment for that order.

**3.1.40**
**quench crack**
Crack in steel resulting from stresses produced during the transformation from austenite to martensite.

NOTE This transformation is accompanied by an increase in volume.

**3.1.41**
**seamless pipe**
Wrought steel tubular product made without a weld seam.

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

**3.1.42**
**skelp**
Hot-rolled steel strip used for manufacturing EW pipe.

**3.1.43**
**special end-finish**
Threads with thread form and features, manufacturing specifications, dimensions, connection make-up and performance properties which are beyond the scope of this standard or types of threaded end-finish not covered by Tables C.1/E.1 and C.2/E.2.

**3.1.44**
**standardized test block**
Test block, certified to a mean hardness number, used for the verification of the performance of hardness testing machines.

**3.1.45**
**thread protector**
Cap or insert used to protect threads and seals during handling, transportation and storage.

**3.1.46**
**tubing**
Pipe placed in a well to produce or inject fluids.

**3.1.47**
**upper critical temperature**
Temperature at which austenite begins to transform to ferrite during cooling.

## 3.2 Symbols

| | |
|---|---|
| $Ar_3$ | upper critical temperature |
| $B_f$ | maximum bearing face diameter |
| $C_v$ | Charpy V-notch impact test minimum absorbed energy |
| $D$ | specified outside diameter for pipe |
| $d$ | calculated inside diameter |
| $k$ | constant used in the calculation of elongation |
| $S_c$ | minimum acceptable result of the NACE TM0177-2016 Method B test |
| $t$ | specified wall thickness |
| $W$ | 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 |

### 3.3 Abbreviations

| | |
|---|---|
| BC | API 5B buttress thread casing connection |
| CS | coupling stock |
| CVN | Charpy V-notch |
| EMI | electromagnetic inspection |
| EU | API 5B external upset tubing connection |
| EW | electric-welded process |
| HBW | Brinell hardness, when testing with a tungsten carbide ball |
| HRC | Rockwell hardness C-scale |
| IJ | API 5B integral tubing connection |
| LC | API 5B long round thread casing connection |
| N | (heat-treat process) full-body, full-length normalized |
| N&T | normalized and tempered |
| NDE | non-destructive examination |
| NU | API 5B non-upset tubing connection |
| PE | unthreaded pipe either upset or non-upset |
| PSL | product specification level |
| Q | quenched and tempered |
| RC | regular coupling |
| S | seamless process (when not referencing the chemical element sulfur) |
| SCC | special clearance coupling |
| SSC | sulfide stress cracking |
| SC | API 5B short round thread casing connection |
| SR | supplementary requirement |
| SF | special end finishing |
| T&C | threaded and coupled |
| UT | ultrasonic testing |

## 4 Conformance

### 4.1 References to Annexes

For additional requirements or information concerning the manufacturing of casing and tubing, as referenced, see the following for:

— inspections by the purchaser, see Annex B (normative);

— product tables in SI units, see Annex C (normative);

— product figures in SI and USC units, see Annex D (normative);

— product tables in USC units, see Annex E (normative);

— API Monogram licensee additional marking information, see Annex F (informative);

— conversion procedures for USC to SI units, see Annex G (informative);

— product specification levels (PSLs), see Annex H (normative);

— requirements for thread protector design validation, see Annex I (normative);

— requirement summary for PSLs, see Annex J (informative);

— product supplementary requirements, see Annex K (normative).

## 4.2 Extended Scope

The following are extensions that are specific to some of the scope provisions.

— The requirements that define different levels of standard technical requirements for PSL-2 and PSL-3, for all grades except H-40, L-80 9Cr, and C110, are contained in Annex H.

— Supplementary requirements that can optionally be agreed upon for enhanced leak resistance connections (LC) are given in K.10 (SR 22).

— For casing sizes larger than Label 1: 4 $^{1}/_{2}$ but smaller than Label 1: 10 $^{3}/_{4}$ can 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.

## 4.3 Dual Referencing

In the interests of worldwide application of this standard, the API Subcommittee on Tubular Goods (SC5) has decided, after detailed technical analysis, that certain documents listed in Section 2 and prepared by API SC5 or other technical committees are interchangeable in the context of the relevant requirement with the relevant document prepared by the International Organization for Standardization (ISO) or the American Society for Testing and Materials (ASTM). These latter documents are cited in the running text following the API reference and preceded by “or,” for example, “API XXXX or ISO YYYY” or “ISO YYYY or ASTM ZZZZ”. Application of an alternative document cited in this manner may lead to technical results different from the use of the preceding API reference. However, both results are acceptable and these documents are thus considered interchangeable in practice.

## 4.4 Units of Measurement

In this standard, 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, compliance with the requirements of this standard as expressed in one system provides compliance with requirements expressed in the other system.

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

# 5 Information to be Supplied by the Purchaser

## 5.1 Grades C90, T95, and C110

The purchaser should refer to NACE MR0175/ISO 15156-1 and ISO 15156-2 for guidance on the usage of Grades C90, T95, and C110. Particular attention should be given to the application of Grade C110 in NACE MR0175/ISO 15156-1 and 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 inquiring or placing orders for pipe manufactured in accordance with this standard, the purchaser shall specify the following according to Table 1:

**Table 1—Purchaser Supplied Information (Casing)**

| Requirement | Reference |
|---|---|
| Standard | API 5CT |
| 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, 8.12.6, Table C.1 or Table E.1 |
| With or without couplings | 8.12.2, Table C.1 or Table E.1 |
| Special clearance couplings—BC | 9.6, Tables C.1, C.33 or Tables E.1, 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, C.4 or Tables E.1, E.4 |
| Length | 8.6, Table C.27 or Table E.27 |
| Seamless or electric-welded | 6.1, 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 in 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 |
|---|---|
| Heat treatment | 6.2, Table C.3 or Table E.3 |
| Lower alternative impact test temperature | 7.3.7 |
| Impact testing for Grades N80 (all types), L80 (all types), R95, C90, T95, P110 | 7.5.3, K.9 (SR 16) |
| Impact testing for Grades H40, J55, K55 | 7.5.1, K.9 (SR 16) |
| 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, K.12 (SR 39) |
| 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 | 9.8, K.8 (SR 13) |
| Heat and supplementary analyses | 10.3 |
| Additional markings | 11 |
| Pipe coatings | 12.1 |
| Product Specification Level (PSL-2 or PSL-3) | Annex H |
| 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 |
|---|---|
| Upset—Grade C110 | 6.1 |
| Cold rotary straightening—Grade Q125 | 6.3.6 |
| Statistical tensile testing | 7.2.4, K.11 (SR 38) |
| Statistical impact testing | 7.3.8, K.7 (SR 12) |
| Impact of non-heat-treated product | 7.5.1, K.9 (SR 16) |
| Alternative hardenability requirement for products with a wall thickness of 30 mm (1.181 in.) or larger | 7.10.2 |
| Sulfide stress cracking test Method D requirement for Grade C110 product over 50.8 mm (2.0 in.) wall thickness | 7.14.5 |
| Length other than specified in Table C.27 or Table E.27 | 8.6 |
| Thread and storage compound | 8.14 |
| Waiving NDE of Grades H40, J55, K55 couplings | 9.11.3 |
| Coupling thread surface treatment Grade Q125 only | 9.14 |
| 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, K.2 (SR 1), K.3 (SR 2), K.5 (SR 10), K.6 (SR 11) |
| Marking requirements | 11 |
| Thread protectors | 12.2 |
| Include coupling certification with pipe certification | 13.3 s) |
| Special wall thickness with S, L, and B end-finish | Tables C.1/E.1, footnote e; see API 5B for acceptable wall thickness ranges |
| Coupling blanks Grade Q125 only | 9.4.2, K.4 (SR 9) |
| Upset casing Grade Q125 only | K.5 (SR 10) |
| Electric-weld casing and pup joints Grades H40, J55, K55, N80 (all types), L80 Type 1, R95 | K.13 (SR 40) |
| Electric-weld casing and pup joints Grades P110 and Q125 | 6.1, K.6 (SR 11) |
| Alternative F factor for statistical impact testing | K.7.2 (SR 12.2) |
| Special size and wall thickness plain-end pipe | 8.2 |
| Enhanced leak resistance LC connections | K.10 (SR 22) |
| Supplemental inspection when hydrostatic test pressure is limited to 69.0 MPa (10,000 psi) | K.14.1 (SR 41.1), K.14.2 (SR 41.2) |

## 5.3 Tubing

**5.3.1** When inquiring or placing orders for pipe manufactured in accordance with this standard, the purchaser shall specify the following according to Table 4:

**Table 4—Purchaser Supplied Information (Tubing)**

| Requirement | Reference |
|---|---|
| Standard | API 5CT |
| 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 | 9.9, 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, C.35 or Tables E.24 and E.35 |
| Label 1 or specified outside diameter | Table C.2 or Table E.2 |
| 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 | 6.1, Table C.3 or Table E.3 |
| Critical thickness for special end-finish couplings | 7.4.6 |
| Delivery date and shipping instructions | |
| Inspection by purchaser | Annex B |

**5.3.2** The purchaser shall also state in 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 |
|---|---|
| Heat treatment | 6.2, Table C.3 or Table E.3 |
| Lower alternative impact test temperature | 7.3.7 |
| Impact testing for Grades N80 (all types), L80 (all types), R95, C90, T95, P110 | 7.5.2, K.9 (SR 16) |
| Impact testing for Grades H40, J55 | 7.5.1, K.9 (SR 16) |
| 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 | 9.8, K.8 (SR 13) |
| Heat and supplementary analyses | 10.3 |
| Additional hardness testing | 10.6.2 |
| Additional markings | 11 |
| Pipe coatings | 12.1 |
| Product Specification Level (PSL-2 or PSL-3) | Annex H |

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

**Table 6—Purchaser/Manufacturer Agreement (Tubing)**

| Requirement | Reference |
|---|---|
| Statistical tensile test | 7.2.4, K.11 (SR 38) |
| Statistical impact testing | 7.3.8, K.7 (SR 12) |
| Impact testing of non-heat-treated product | 7.5.1, K.9 (SR 16) |
| Length other than specified in Table C.27 or Table E.27 | 8.6 |
| Thread and storage compound | 8.14 |
| Waiving NDE of Grades H40, J55, K55 couplings | 9.11.3 |
| Additional hardness testing | 10.6.2 |
| Alternative hydrostatic test pressures | 10.12.3 |
| Non-destructive examination | 10.15, K.2 (SR 1), K.3 (SR 2), K.5 (SR 10), and K.6 (SR 11) |
| Marking requirements | 11 |
| Thread protectors | 12.2 |
| Include coupling certification with pipe certification | 13.3 s) |
| Electric-weld tubing and pup joints—Grades H40, J55, K55, N80 (all types), L80 Type 1, R95 | K.13 (SR 40) |
| Supplemental inspection when hydrostatic test pressure is limited to 69.0 MPa (10,000 psi) | K.14.1 (SR 41.1), K.14.2 (SR 41.2) |
| Electric-weld tubing and pup joints—Grade P110 | K.6 (SR 11) |
| 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 inquiring or placing orders for coupling stock, coupling material or accessory material manufactured in accordance with this standard, the purchaser shall specify the following according to Table 7.

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

**5.4.3** The following may be agreed between purchaser and manufacturer regarding coupling stock and material, and accessory material:

— sulfide stress cracking test Method D requirement for Grade C110 product over 50.8 mm (2.0 in.) wall thickness according to 7.14.5.

**Table 7—Purchaser Supplied Information (Coupling Stock and Material and Accessory Material)**

| Requirement | Reference |
|---|---|
| Standard | API 5CT |
| 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, K.12 (SR 39) |
| 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, C.4 or Tables E.3, 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 | |

**Table 8—Purchaser Supplied Agreement Optional Requirements (Coupling Stock and Material, and Accessory Material)**

| Requirement | Reference |
|---|---|
| Heat treatment | 6.2, Table C.3 or Table E.3 |
| Statistical tensile testing | 7.2.4, K.11 (SR 38) |
| Statistical impact testing | 7.3.8, K.7 (SR 12) |
| Impact testing | 7.4, 7.6, K.9 (SR 16) |
| Alternative hardenability requirement for products with a wall thickness of 30 mm (1.181 in.) or larger | 7.10.2 |
| Heat and supplementary analyses | 10.3 |
| Additional markings | 11 |
| Product Specification Level (PSL-2 or PSL-3) | Annex H |

# 6 Process of Manufacture

## 6.1 General

The product furnished to this standard 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 to this standard shall be made by the seamless or electric-weld process as shown in Table C.3 or Table E.3 and as specified in the purchase agreement. Pup joints shall be made from the materials listed in 3.1.38. 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 in the purchase agreement.

Electric-welded Grade P110 pipe and Grade Q125 casing shall be provided only when the supplementary requirement in K.6 (SR 11) is specified in the purchase agreement.

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

Grade Q125 upset casing shall be provided only when the supplementary requirement in K.5 (SR 10) is specified in 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 in 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.

The weld seam of electric-welded pipe shall be heat-treated after welding to a minimum temperature of 540 °C (1000 °F) or processed in such a manner that no untempered martensite remains.

For the purposes of this standard, in addition to the terms and definitions given in Section 3, the terms and definitions given in ASTM A941 for heat treatment operations also apply.

### 6.2.2 Grades J55, K55, N80 (All Types), and R95

For grades J55 and K55 products, 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 in 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.

Additional requirements for PSL-2 and PSL-3 products are specified in Annex H.

### 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 (1150 °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 standard, when the symbol L80 is used alone, it covers Grades L80 Type 1, L80 9Cr, and L80 13Cr.

## 6.3 Straightening

### 6.3.1 Grades H40, J55, K55, N80 (All Types), and P110

No specific methods are required.

Additional requirements for PSL-2 and PSL-3 products are specified in Annex H.

### 6.3.2 Grade R95

Grade 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.

Additional requirements for PSL-2 and PSL-3 products are specified in Annex H.

### 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:

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

b) 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;

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

### 6.3.4 Grades C90 and T95

Grades C90 and T95 product may be subjected to cold rotary-straightening if, subsequent to the cold rotary-straightening operation, the pipe is heated to a minimum temperature of 480 °C (900 °F) for stress-relieving. When necessary, light gag-straightening for Grades C90 and T95 shall be permitted.

Additional requirements for PSL-2 and PSL-3 products are specified in Annex H.

### 6.3.5 Grade 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.

#### 6.3.6 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 in 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 or lot identity, or both, until all required heat or lot tests, or both, are performed and conformance with specification requirements has been shown.

For C110, Q125, and PSL-2 products, the procedures shall provide a means of tracing the product to the proper heat and lot, and to all applicable chemical and mechanical test results.

#### 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 K.7 (SR 12) is specified, the number shall identify the sequence in which the lengths were tempered in order to allow retest in accordance with K.7.3 (SR 12.3).

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 compliance as required in this standard (except chemical composition and dimensions) shall have their processes validated.

Those processes requiring validation are:

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

b) for seamless, heat-treated product: heat treatment;

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

d) 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 Grade 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.

Additional requirements for PSL-2 and PSL-3 products are specified in Annex H.

## 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 comply with 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, shall be calculated as given by Equation (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: 1942.57 (625,000);

$A$ is the cross-sectional area of the tensile test specimen, expressed in square millimeters (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 mm2 (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.

Additional requirements for PSL-3 products are specified in Annex H.

### 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 K.11 (SR 38) 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 behavior 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).

Additional requirements for PSL-2 and PSL-3 products are specified in Annex H.

### 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 $\times$ 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 $^1/_2$-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.

### 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 in lieu of the minimum size specified in Tables C.10 to C.15, C.20, and 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 in 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 K.7 (SR 12) shall apply.

### 7.3.9 Reference Information

API 5C3 or ISO 10400 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 K.9 (SR 16) 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 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 equations 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 millimeters (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 | $YS_{max} \times (0.00118t + 0.01259)$ or 20 J, whichever is greater (Table C.16) | $YS_{max} \times (0.00236t + 0.02518)$ or 41 J, whichever is greater (Table C.17) |
| USC units, foot–pounds | $YS_{max} \times (0.152t + 0.064)$ or 15 ft·lb whichever is greater (Table E.16) | $YS_{max} \times (0.304t + 0.128)$ or 30 ft·lb, whichever is greater (Table E.17) |

NOTE Tables with 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.

Additional requirements for PSL-2 and PSL-3 products are specified in Annex H.

NOTE See K.9 (SR 16) 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.

Additional requirements for PSL-2 and PSL-3 products are specified in Annex H.

The requirements are calculated based on the equations given in Table 10,

where

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

$t$ is the specified wall thickness, in millimeters (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<br>Grades N80 (all types), R95, L80, C90, T95 | $YS_{min} \times (0.00118t + 0.01259)$<br>or 14 J, whichever is greater<br>(Table C.18) | $YS_{min} \times (0.00236t + 0.02518)$<br>or 27 J, whichever is greater<br>(Table C.19) |
| SI units, joules<br>Grade P110 | $YS_{min} \times (0.00118t + 0.01259)$<br>or 20 J, whichever is greater<br>(Table C.18) | $YS_{min} \times (0.00236t + 0.02518)$<br>or 41 J, whichever is greater<br>(Table C.19) |
| USC units, foot–pounds<br>Grades N80 (all types), R95, L80, C90, T95 | $YS_{min} \times (0.152t + 0.064)$<br>or 10 ft·lb, whichever is greater<br>(Table E.18) | $YS_{min} \times (0.304t + 0.128)$<br>or 20 ft·lb, whichever is greater<br>(Table E.19) |
| USC units, foot–pounds<br>Grade P110 | $YS_{min} \times (0.152t + 0.064)$<br>or 15 ft·lb, whichever is greater<br>(Table E.18) | $YS_{min} \times (0.304t + 0.128)$<br>or 30 ft·lb, whichever is greater<br>(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.

Additional requirements for PSL-2 and PSL-3 products are specified in Annex H.

The requirements are calculated based on the equations given 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 millimeters (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<br>Grades C110 and Q125 | $YS_{max} \times (0.00118t + 0.01259)$<br>or 20 J whichever is greater<br>(Table C.18) | $YS_{max} \times (0.00236t + 0.02518)$<br>or 41 J whichever is greater<br>(Table C.19) |
| USC units, foot–pounds<br>Grades C110 and Q125 | $YS_{max} \times (0.152t + 0.064)$<br>or 15 ft·lb whichever is greater<br>(Table E.18) | $YS_{max} \times (0.304t + 0.128)$<br>or 30 ft·lb, whichever is greater<br>(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, $^3/_4$-size, and $^1/_2$-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.

### 7.5.5 Testing Conditions

For Grades C110 and Q125 pipe, impact testing in accordance with 10.7 is mandatory. For other grades, except Grades H40, J55, and K55 (which have no mandatory impact requirements for pipe), compliance with the requirements of 7.5.2 may be qualified by a documented procedure in lieu of testing, at the manufacturer's option, unless K.9 (SR 16) is specified in 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.

## 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 through 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 7.5 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 K.9 (SR 16) shall apply.

### 7.6.6 Critical Thickness for Accessory Material and Special End-finish Material

Unless otherwise specified in 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).

## 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 comply with the requirements in Table C.5 or Table E.5. In addition, the following shall apply.

1) 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.

2) 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.

3) For Grade C110, any mean hardness number not exceeding 29.0 HRC is acceptable. If any hardness number from a single indentation exceeds 31.0 HRC the length or piece shall be rejected. Products with mean hardness numbers between 29.0 HRC and 31.0 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 279 HBW or 29.0 HRC respectively, then the length or piece is acceptable. If any of the hardness numbers are over 279 HBW or 29.0 HRC two additional indentations may be made in the immediate area. If either of the second test hardness numbers exceeds 279 HBW or 29.0 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 test results need not be provided by the manufacturer or processor unless specified in the purchase agreement.

## 7.10 Hardenability—Minimum Percentage Martensite for Quenched and Tempered Products

### 7.10.1 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, 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 Equation (2):

$$HRC_{min} = [58 \times (\%\ \text{carbon})] + 27 \tag{2}$$

NOTE Equation (2) was derived from data in reference [2]. Based on these data, Equation (2) is valid from 0.15 % carbon to 0.50 % carbon.

Additional requirements for PSL-3 products are specified in Annex H.

### 7.10.2 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, 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 Equation (3):

$$HRC_{min} = [59 \times (\%\ \text{carbon})] + 29 \tag{3}$$

NOTE Equation (3) was derived from data in reference [2]. Based on these data, Equation (3) 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.

### 7.10.3 All Grades Except Grades 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, 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 Equation (4):

$$HRC_{min} = [52 \times (\%\ \text{carbon})] + 21 \quad (4)$$

Additional requirements for PSL-2 and PSL-3 products are specified in Annex H.

## 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—Grades L80 9Cr and L80 13Cr

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

Additional requirements for PSL-2 and PSL-3 products are specified in Annex H.

## 7.13 Flattening—Electric-welded Pipe

All products that are produced by the electric-weld process of manufacture shall comply 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 NACE MR0175/ISO 15156-1 and ISO 15156-2 for guidance on the usage of Grades C90, T95, and C110. Particular attention should be given to the application of Grade C110 in NACE MR0175/ISO 15156-2 and 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.

### 7.14.2 Test and Retest Requirements

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 NACE TM0177-2016 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.

   Additional requirements for PSL-3 products are specified in Annex H.

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 NACE TM0177-2016 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 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.

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 standard, 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 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 reheat-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 28.0 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 NACE MR0175/ISO 15156-1 and ISO 15156-2) confirm that the manufacturing procedure results in products that meet the SSC requirements of this standard.

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

### 7.14.4 Test Solution

For the purposes of this standard, NACE TM0177-2016 Test Solution A shall be used. Where NACE TM0177-2016 requires documented validation of test solution saturation, then analysis shall be done using the iodometric titration procedure in NACE TM0177-2016 Appendix C or other validated and documented method.

See K.12 (SR 39) for use of an alternative test solution in an additional informative test.

### 7.14.5 Minimum SSC Requirements

a) 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) NACE TM0177-2016 Method B, Bent Beam

Sc (12.0) for C90
Sc (12.6) for T95

NOTE 1 The requirement for Method B is only stated in USC units, based on industry convention.

NOTE 2 There is no Method B requirement for Grade C110.

c) NACE TM0177-2016 Method D, DCB

1) 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 26.4 MPa m1/2 (24.0 ksi·$in.^{1/2}$) with a minimum of at least three valid test specimens for Grade C110.

   For wall thickness greater than 50.8 mm (2.0 in.) for Grade C110, the mean value of at least three valid test specimens is 26.4 MPa-$m^{1/2}$ (24.0 ksi-$in.^{1/2}$) unless otherwise agreed between the purchaser and manufacturer.

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

3) No valid test specimen shall have a value less than:

   i) 29.7 MPa $m^{1/2}$ (27.0 ksi·$in.^{1/2}$) for Grades C90 and T95, or

   ii) 23.1 MPa $m^{1/2}$ (21.0 ksi·$in.^{1/2}$) for Grade C110.

   For wall thickness greater than 50.8 mm (2.0 in.) for Grade C110, the minimum individual valid specimen value is 23.1 MPa-$m^{1/2}$ (21.0 ksi-$in.^{1/2}$) unless otherwise agreed between the purchaser and manufacturer.

4) A standard test specimen thickness of 9.53 mm (0.375 in.) shall be used except as allowed by 7.14.2 d).

5) 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:

i) 29.7 MPa $m^{1/2}$ (27.0 ksi·$in.^{1/2}$) for Grades C90 and T95, or

ii) 20.4 MPa $m^{1/2}$ (18.6 ksi·$in.^{1/2}$) for Grade C110.

6) 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.).

7) 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.).

8) 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.).

#### 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, and

b) testing errors.

#### 7.14.7 Additional Testing Provisions for NACE TM0177-2016 Method D

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

As specified in 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 standard, 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 in the purchase agreement. Other plain-end pipe sizes and wall thicknesses may be furnished by agreement between purchaser and manufacturer. By agreement between purchaser and manufacturer, casing with S, L, or B end-finishes may be furnished with intermediate wall thicknesses

within the particular S, L, or B series of wall thicknesses and grade for the applicable Label 1 size specified in Table C.1 or Table E.1. See API 5B for acceptable pipe wall thickness ranges.

Coupling stock, coupling material, and accessory material shall be furnished in dimensions specified in 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. 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 once each 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 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 National Institute of Standards and Technology (NIST) standards or equivalent regulations in the country of manufacture of products made to this standard.

If measuring equipment whose calibration or verification is required under the provisions of this standard is subjected to unusual or severe conditions sufficient to make its accuracy questionable, recalibration or reverification 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 standard 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 for pipe shall be within the tolerances specified in 8.11.1. For pipe furnished non-upset and plain-end and which is specified in 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 in 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 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 in 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 grades L80 Type 9Cr or L80 Type 13Cr) for the end-finish specified in the purchase agreement, within the tolerances stipulated in 8.11.3. Calculated masses shall be determined in accordance with Equation (5):

$$W_L = [(w_{pe})(L_{ef}) + (e_m)](k_m) \tag{5}$$

where (according to API 5C3 or ISO 10400)

$W_L$ 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 meter (pounds per foot);

$L_{ef}$ is the length of pipe, including end-finish, in meters (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 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 in 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 meters and hundredths of a meter (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 specified in 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 may 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 All Grades Except P110 and Q125

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 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 $t$ |

#### 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 shall be drift-tested throughout its entire length. Drift testing may be done plain end or in threaded condition. For API threaded products and SF products with couplings, if pipe has been drift-tested full-length before coupling installation, it shall also be drift-tested for a minimum 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 after coupling power-tight make-up and include any area potentially affected by the make-up equipment. Drift dimensions (length and diameter) shall comply with Table C.28 or Table E.28.

When specified by the purchaser as “alternate drift pipe”:

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

b) pipe in sizes and masses not in Tables C.29 or E.29 shall be tested with the alternative drift mandrels as specified in the purchase agreement.

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

## 8.11 Tolerances on Dimensions and Masses

### 8.11.1 Outside Diameter

The following tolerances in Table 13 shall 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 following tolerances in Table 14 shall 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 ( $^{+3/32}_{-1/32}$ in.) |
| > 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 following 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 ( $^{+3/32}_{-1/32}$ in.) |
| > 3 1/2 to ≤ 4 | $^{+2.78}_{-0.79}$ mm ( $^{+7/64}_{-1/32}$ in.) |
| > 4 | +2.78 mm to –0.75 % D (+7/64 in. to –0.75 % D) |

### 8.11.2 Wall Thickness

Tolerance for pipe is –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 | $^{+6.5}_{-3.5}$ % |
| 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 compliance with all requirements of this standard 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 in the purchase agreement.

Additionally, seal-ring configuration in accordance with K.8 (SR 13) 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 in 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 5B. Product ends shall not be rounded out by hammering but may be slightly shaped only so as to secure 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 Workmanship of Ends

The inside and outside edges of the ends of all product shall be free of burrs. The threads of martensitic chromium alloys have shown a tendency toward adhesive wear, or galling, during make-up and breakout. Their galling resistance may be improved by surface preparations which are beyond the scope of this standard.

Additional requirements for PSL-2 and PSL-3 products are specified in Annex H.

For Grade C110, the pin and box threads shall be abrasive-blasted, unless processed by any appropriate technique, including the threading process, which has been agreed between the purchaser and manufacturer to be sufficient to avoid the presence of material susceptible to detaching or causing galling during connection make-up.

#### 8.12.6 Special End-finish

Pipe with end-finish not specified in this standard may be furnished if specified in the purchase agreement. This pipe shall have the body of the pipe manufactured in accordance with the requirements of this standard. 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 standard may be furnished if specified in the purchase agreement. These items shall be manufactured in accordance with the requirements of this standard, except for end-finish and dimensions, and shall be marked as specified in 11.5.2.

When applying API 5B-compliant thread to products not listed in Tables C.1/E.1 and C.2/E.2, the product shall be marked as specified in 11.5.2.

### 8.13 Defects

#### 8.13.1 Pipe and Accessory Made from Pipe

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

a) quench crack,

b) arc burn,

c) 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 standard [see 10.15, K.2 (SR 1) and K.3 (SR 2)] or specified in 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) 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) linear imperfection on the outside or inside surface, of any orientation, with a depth greater than those tabulated in Table C.30 or Table E.30,

g) surface-breaking pipe upset imperfection, of any orientation, with a depth greater than those 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.25), and

i) 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

Accessory material not made from pipe, coupling stock, and coupling material shall be free from quench cracks or arc burns.

Coupling stock and coupling material shall be free from, or have clearly marked, outside surface-breaking imperfections 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.

#### 8.13.3 Process Control Plan

The manufacturer, based on knowledge of the production process and the requirements of Section 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) or shipped separately if specified in the purchase agreement. Special-clearance tubing couplings shall be screwed onto the pipe handling-tight, except that they shall be shipped separately if specified in 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 API 5A3 or ISO 13678. 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 color 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 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 of thread leakage because mill-applied couplings made up power-tight, although leak-proof at the time of make-up, may 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 or lubrication, or both, to minimize galling during hydrostatic testing (plug application and removal).

#### 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 in the purchase agreement.

## 9 Couplings

### 9.1 General Requirements

Couplings shall be seamless, be of the same grade and type and the same PSL, or higher, as the pipe and 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 K.4 (SR 9) for optional requirements for Grades C110 and Q125 coupling blanks.

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 in 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 in 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 in 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 in the purchase agreement.

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

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

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

## 9.3 Mechanical Properties

Couplings shall conform to the mechanical requirements specified in Sections 7 and 10, including the frequency of testing, retest provision, and so forth. 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 in the purchase agreement, threaded and coupled casing and tubing shall be furnished with regular couplings.

### 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 in 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 9.9 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 Section 11 for marking and color identification.

## 9.7 Combination Couplings

Combination couplings with different types of thread of the same specified size shall be furnished when specified in 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 K.8 (SR 13) shall be furnished when specified in the purchase agreement. Additional requirements for PSL-2 and PSL-3 products are specified in Annex H.

## 9.9 Special-bevel Tubing Regular Couplings—All Grades Except C110 and Q125

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 in Figures D.4 and D.5. The inside and outside edges of the bearing face shall be rounded or broken as shown in Figures D.4 and D.5. The root faces of the couplings shall be faced at right angles to the axis.

## 9.10 Threading

### 9.10.1 General Requirements

Coupling threads, gauging practice and thread inspection shall conform to the requirements of API 5B. Couplings shall not be expanded to provide the required taper for threads for couplings with API threads.

Additional requirements for PSL-2 and PSL-3 products are specified in Annex H.

NOTE Couplings with API threads may not have a leak resistance as high as the internal yield pressure of the pipe body due to inadequate bearing pressure between the coupling and pin.

### 9.10.2 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 in 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 in the purchase agreement.

## 9.11 Surface Inspection

**9.11.1** Finished couplings shall be free from all imperfections that break the continuity of the thread.

**9.11.2** Couplings shall be inspected on the outside and inside surfaces after finish machining and before inside or outside surface plating, using the wet fluorescent magnetic particle method in accordance with ISO 13665 or ASTM E709 with a circumferentially oriented magnetic field for the detection of longitudinal surface imperfections, or by another 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** Imperfections 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 reinspected 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** Couplings shall not be rejected for imperfections less than 5 % of the critical wall thickness detected on subsequent reinspection outside the manufacturer's facility based on the following.

a) 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

b) Grades N80 (all types), R95, L80 (all types), C90, T95, C110, P110, and Q125 material.

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.

## 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 reinspected 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 in the purchase agreement.

### 9.15 Couplings and Coupling Blank Protection—Grades C90, T95, C110, and Q125

Loose couplings and coupling blanks that have been machined to its final outside diameter shall be boxed to prevent contact with one another during shipment. 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 a 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 standard. When the calibration or verification frequency is based on a month, the maximum interval shall be up to and including the last day in the month in which the calibration is due.

If test or measuring equipment, whose calibration or verification is required under the provisions of this standard, is subjected to unusual or severe conditions which make its accuracy questionable, recalibration or reverification 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, L80 Type 1, N80 (All Types), R95, and P110—Coupling Stock, Coupling Material, Accessory Material, and Pipe (except coupling blanks, pup joints, or accessory material 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 standard are met.

When different heats are grouped according to a documented procedure, at a minimum, the procedure shall ensure the following requirements are met.

a) The identification of the grouped heats shall be unique and different from the heats grouped.

b) Product from each heat that is grouped shall have been previously processed and demonstrated to meet this specification.

c) Each heat that is grouped shall have a chemistry that meets the documented chemistry limits of the previously established process validation.

d) Traceability to each of the original heats grouped shall be documented.

e) A grouped set of heats shall not be grouped with another grouped set of heats.

f) Grouped heats involving grades that do not require heat treatment in accordance with Table C.3/E.3 and are grouped prior to manufacture shall be produced using the same control parameters previously used for product from every heat within the group.

g) Grouped heats that will be further heat treated shall be processed with the same validated heat treatment parameters previously used for product from every heat within the group.

#### 10.2.2 Grades L80 9Cr, L80 13Cr, C90, T95, C110, and Q125—Coupling Stock, Coupling Material, Accessory Material, and Pipe (except coupling blanks, pup joints, or accessory material 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).

#### 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,

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 hr 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 in 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 in 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 including elements used by the manufacturer to control mechanical properties.

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 ISO 9769 or ASTM A751.

#### 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, then at the manufacturer's option, either the heat shall stand rejected or the remaining lengths in the heat shall be tested individually for conformance to the specified requirements. If only one of two samples fails, then 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, then 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 to 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 in 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 and T95, PSL-2 and PSL-3, 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 Grade Q125

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

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.

Additional requirements for PSL-2 and PSL-3 products are specified in Annex H.

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 or a single piece lot where 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, except for a single piece lot where the test specimens may be taken from both ends of one length.

For Grades H40, J55, 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.

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 manufacturer's option. 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 center. 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, Pup Joints, 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 Grades C110 and Q125 products 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 test's intent, observed before or after testing, may be discarded and 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, except the failed length.

If more than one of the original test specimens fails or 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 reheat-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 reheat-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 reheat-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.

### 10.5.3 Test Specimens

Test specimens shall be rings or crop ends not less than 63.5 mm (2 $^{1}/_{2}$ 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 6.2.1, 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 K.6 (SR 11) shall apply when EW pipe and K.6 (SR 11) are specified in the purchase agreement (see 6.1).

### 10.5.6 Invalidation of Tests

A 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 reheat-treated and tested as a new lot.

## 10.6 Hardness Test

### 10.6.1 PSL Requirements

Additional requirements for PSL-3 products are given in Annex H for Grades N80Q, R95, and P110.

### 10.6.2 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, except for a single piece lot where the test specimens may be taken from both ends of one length.

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.

### 10.6.3 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.

### 10.6.4 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. Additional requirements for PSL-3 products are specified in Annex H.

### 10.6.5 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).

Additional requirements for PSL-3 products are given in Annex H.

### 10.6.6 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.

### 10.6.7 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. The hardness test ring shall be removed at mid-length position of individually heat-treated coupling blanks. 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.

### 10.6.8 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.

Additional requirements for PSL-3 products are given in Annex H.

### 10.6.9 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 standard. 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.

### 10.6.10 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:

— external surface tests involving a single indentation, and

— 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 standard.

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 standard.

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 $2\ ^{1}/_{2}$ indentation diameters from the center of an indentation to the edge of the surface. Indentations shall be no closer than three indentation diameters from another indentation, measured center to center. 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, and so forth) 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 31.0 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 option of the manufacturer or as specified in 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 in 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 (3000 kgf), ball diameters other than 10 mm (0.394 in.) 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.

### 10.6.11 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.

### 10.6.12 Periodic Checks of Hardness-testing Machines

Periodic checks of testing machines shall be made using the procedures in ISO 6506-1 or ASTM E10 for Brinell hardness test machines, or ISO 6508-1 or ASTM E18 for Rockwell hardness test machines.

NOTE Both relevant ISO texts are entitled “Procedure for Periodic Checks of the Testing Machines by the User” and both ASTM paragraphs are entitled “Daily Verification”.

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 at such times as are required to assure the operator of the equipment and the purchaser (or representative) that the machine is satisfactory. In any event, checks should be made at least once every 8 hr 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.

### 10.6.13 Verification of Hardness—testing Machines and Indenters

Indirect verification of hardness testing machines shall be performed at least once every 12 months 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.

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 24 months. 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 be accredited to the requirements of ISO 17025 (or an equivalent) by a recognized accrediting body that operates to the requirements of ISO/IEC 17011. As a minimum, the calibration certificate shall identify:

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

b) method of verification (direct or indirect, or both)

c) means of verification (reference blocks, elastic proving devices, and so forth)

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

#### 10.6.14 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.

#### 10.6.15 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 29.0 HRC and 31.0 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 29.0 HRC, the piece shall be accepted. If the new mean hardness number exceeds 29.0 HRC, the piece shall be rejected.

#### 10.6.16 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 reheat-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.

#### 10.6.17 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 reground below the initial hardness impressions and retested. Only one re-grind and retest is allowed for each specimen. After retest, product that fails to comply with the specified requirements shall be rejected.

#### 10.6.18 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).

#### 10.6.19 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.

#### 10.6.20 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 compliance with the requirements is qualified by a documented procedure, see 7.5.5. If K.9 (SR 16) is specified in the purchase agreement, testing is mandatory.

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 approximate 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 and PSL-2 and PSL-3 products (see 13.2), shall 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.

### 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 reheat-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 reheat-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 are not within the validated process conditions for the product.

## 10.10 Sulfide Stress-cracking Test-Grades C90, T95, and C110

**10.10.1** 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.

**10.10.2** 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 as specified by the purchaser:

a) Tensile Method (Method A)

b) Bent-beam Method (Method B)

c) DCB method (Method D)

**10.10.3** 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:

a) Tensile Method (Method A)

b) DCB Method (Method D)

**10.10.4** For Method A, full-size smooth tensile test specimens shall be used except where sub-size smooth tensile test specimens are required because of product size constraints.

## 10.11 Metallographic Evaluation—EW Grades P110 and Q125

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 hr during the welding and after any substantial interruption of the welding process. The samples shall be obtained prior to heat treatment. The manufacturer shall have objective criteria to evaluate the acceptability of the electric-welded zone. Additional requirements for PSL-2 and PSL-3 products are given in Annex H.

## 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;

NOTE 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. For mechanical pressure devices (e.g. Bourdon tube and dial readout), the maximum calibration interval shall be six months. For electronic pressure devices (i.e. pressure transducers), the maximum calibration interval shall be 12 months. 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 or lubrication, or both, 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 comply with the test requirements for the size, grade and end-finish.

Additional requirements for PSL-2 and PSL-3 products are given in Annex H.

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. This does not preclude conducting subsequent hydrostatic tests at a fiber stress not exceeding 80 % of specified minimum yield strength, in accordance with the formula listed in Equation (6). 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, are not intended as a basis for design and do not necessarily have any direct relationship to working pressures.

NOTE 2 The user should be aware that 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 Equation (6), rounded to the nearest 0.5 MPa (100 psi) and limited to a maximum of 69.0 MPa (10,000 psi):

$$p = (2 \times f \times YS_{min} \times t)/D \tag{6}$$

where

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

$f$ is a factor:

— 0.6 for Grades H40, J55, and K55 larger than Label 1: 9 $^5/_8$

— 0.8 for Grades H40, J55, and K55 less than or equal to Label 1: 9 $^5/_8$

— 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 millimeters (inches);

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

NOTE The formula (Equation [6]) for hydrostatic test pressure is applicable to both SI and USC units.

a) By agreement between purchaser and manufacturer, an alternative test pressure may be used.

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.

b) A test pressure lower than the calculated value is allowed under the following conditions.

1) The calculated test pressure value exceeds 69.0 MPa (10,000 psi).

i) In this situation, the test pressure shall be at least 69.0 MPa (10,000 psi).

ii) By agreement between purchaser and manufacturer, an alternative test pressure greater than 69.0 MPa (10,000 psi) shall apply or the provisions of K.14 (SR 41.1 or SR 41.2) shall apply.

2) The test equipment is physically limited.

i) 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 Equation 6) 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.

ii) The hydrostatic test equipment capability may be less than 20.5 MPa (3000 psi) only for those products where the calculated test pressure is less than 20.5 MPa (3000 psi).

3) The pipe is threaded and coupled, and a lower pressure is required to avoid leakage due to insufficient coupling strength or interface pressure between pipe and coupling threads:

The lower pressure shall be calculated for threaded and coupled pipe, as specified in API 5C3 and ISO 10400.

NOTE If the calculated hydrostatic test pressure would exceed the contact pressure of the connector, hydrostatic test may be performed in plain end condition or without the coupling installed.

## 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 C for SI units or Tables 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 standard, 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), micrometers, callipers or snap gauges. For upset casing and Label 1: 2 $^{3}/_{8}$ and larger external upset tubing, the measurements shall be made with micrometers, 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, micrometer measurements shall govern. In case of dispute of the maximum diameter requirements, pi-tape (wrap tape) measurements shall govern. When using a micrometer, 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, micrometers 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.

NOTE 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.

### 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.

Additional requirements for PSL-2 and PSL-3 products are given in Annex H.

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 ($^{1}/_{4}$ 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 (1 $^{1}/_{2}$ in.) for product sizes Label 1: 6 $^{5}/_{8}$, and larger, a maximum radius of $d/4$ for products 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 (1 $^{1}/_{2}$ in.).

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.

For Grade C110, 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 reported. Traceability by pipe is only required when specified in the purchase agreement.

Accessory material shall have the wall thickness verified if 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 in the purchase agreement, the length shall be measured from end-to-end.

For threaded and coupled pipe:

a) when measured with the coupling installed the length shall be measured from the end of the pin to the outer face of the coupling, and

b) 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.

The pipe manufacturer applying the markings to the pipe body (see Section 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; and

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.25. 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.

### 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 2.5D 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

Herein (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 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 section are based on traditional proven NDE methods and techniques practiced 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 shall be maintained in accordance with 10.15.4.

At the discretion of the manufacturer, the notches referenced 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 optimized. The technical justification for modification of the orientation shall be documented.

If the provisions for purchaser inspection of pipe or witnessing of NDE operations, or both, are stated in 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 10.15.13.

When performing wet magnetic particle inspection, wet particle concentration shall be checked every 8 hr 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 1000 $\mu W \bullet cm^{-2}$ (10 $W \bullet m^{-2}$).

#### 10.15.2 NDE Personnel

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 requalified for any method previously qualified, if they have not performed non-destructive inspection in that method for a period exceeding 12 months. The manufacturer or inspection company shall have a training program to qualify or certify, or both, the NDE personnel for the method, technique, and equipment that are used for the inspection(s) specified in this standard.

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

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 to be used by those other than the manufacturer as the only basis for pipe rejection.

When standardizing 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

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

**10.15.4.2** 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,

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, and

f) threshold-setting parameters.

**10.15.4.3** In addition, the manufacturer shall maintain documentation relating to:

a) NDE system operating procedures,

b) NDE equipment description,

c) NDE personnel qualification information, and

d) 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), and

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.

Additional requirements for PSL-2 and PSL-3 products are given in Annex H.

### 10.15.6 Full-body, Full-length NDE of Casing and Tubing—Grades N80 (All Types), L80, and R95

All pipe shall be inspected for the detection of imperfections on the outside and inside surfaces by one or more of the following methods:

a) ultrasonic testing to acceptance level as specified in Table C.43 or Table E.43 in accordance with ISO 10893-10 or ASTM E213;

b) flux leakage testing to acceptance level as specified in Table C.43 or Table E.43 in accordance with ISO 10893-3 or ASTM E570;

c) eddy current concentric coil testing to acceptance level as specified in Table C.43 or Table E.43 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.

Additional requirements for PSL-2 and PSL-3 products are given in Annex H.

### 10.15.7 Full-body, Full-length NDE of Casing and Tubing—Grade P110 to K.9 (SR 16)

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

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

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

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

Additional requirements for PSL-3 products are given in Annex H.

### 10.15.8 Full-body, Full-length NDE of Casing and Tubing-grade P110 and Grade P110 to K.9 (SR 16) and K.3 (SR 2)

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

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

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

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

Additional requirements for PSL-3 products are given in Annex H.

### 10.15.9 Full-body, Full-length NDE of Casing and Tubing-grades 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 ISO 10893-10 or ASTM E213 (transverse).

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 ISO 10893-3 or ASTM E570 (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 of 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 centered 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, and 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 or ISO 10893-10 or ASTM E213;

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 K.6.5 (SR 11.5) shall apply.

Additional requirements for PSL-2 and PSL-3 products are given in Annex H. When K.13 (SR 40) is specified in the purchase agreement for all Grades except P110 and Q125, the additional requirements of K.13 (SR 40) apply.

### 10.15.11 NDE of Coupling Stock (Except Grade C110), Accessory Material (Except Grade C110) and Pup Joints (All Grades)

**10.15.11.1** When NDE is required for coupling stock or accessory material, except Grade C110, according to Table C.42 or Table E.42, the inspection shall be for the detection of imperfections on the outside surface by one or more of the following methods:

a) ultrasonic testing to acceptance level as specified in Table C.43 or Table E.43 in accordance with ISO 10893-10 or ASTM E213;

b) flux leakage testing to acceptance level as specified in Table C.43 or Table E.43 in accordance with ISO 10893-3 or ASTM E570;

c) eddy current concentric coil testing to acceptance level as specified in Table C.43 or Table E.43 in accordance with ISO 10893-2 or ASTM E309;

d) 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).

**10.15.11.2** 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.

Additional requirements for PSL-2 and PSL-3 products are given in Annex H.

### 10.15.12 NDE of Coupling Stock and Accessory Material—Grade C110

#### 10.15.12.1 General

All coupling stock and accessory material shall be inspected for the detection of imperfections on the outside and inside surfaces by one or more of the following methods:

a) ultrasonic testing to acceptance level as specified in Table C.43 or Table E.43 in accordance with ISO 10893-10 or ASTM E213;

b) flux leakage testing to acceptance level as specified in Table C.43 or Table E.43 in accordance with ISO 10893-3 or ASTM E570;

c) eddy current concentric coil testing to acceptance level as specified in Table C.43 or Table E.43 in accordance with ISO 10893-2 or ASTM E309;

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

#### 10.15.12.2 Permitted Imperfections Before Machining

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 9.11 [K.4.3 (SR 9.3)].

#### 10.15.12.3 Further Evaluation

Coupling stock containing imperfections 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 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.

#### 10.15.12.4 Ultrasonic Testing—Through-wall

Coupling stock 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 10.15.4.2 a).

#### 10.15.12.5 Ultrasonic Testing—Inside Surface

Coupling stock 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.

### 10.15.13 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 standard, 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,

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.

Grade C110 pipe, with the ends treated in accordance with 10.15.13 b), shall be inspected after end finishing (and before coupling installation on threaded and coupled tubulars) using the wet magnetic particle method, or a method agreed between the purchaser and manufacturer.

Records shall be maintained in accordance with 10.15.4

Additional requirements for PSL-3 products are given in Annex H.

### 10.15.14 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 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.

### 10.15.15 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.

### 10.15.16 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 the requirements herein (10.15.16) 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 option of the manufacturer, reinspected full-body, full-length, as required by Tables C.42/E.42 and 10.15.10 and applicable supplementary requirements, 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, and so forth). 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 in 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- or amplitude-based, or both), 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.

### 10.15.17 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 or quench cracks, or both, within a distance of twice the diameter from the end, may be cut back only once to remove the cracks. After cutting the pipe, it shall be reinspected full-body, full-length. Where cracks or quench cracks, or both, 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 reinspected to verify that the defect was completely removed. The reinspection 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) 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.

### 10.15.18 Disposition of Coupling Stock and Accessory Material 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 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 or quench cracks, or both, 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 compliance with specified outside diameter requirements. After removal of the defect, the affected area shall be reinspected to verify that the defect was completely removed. The reinspection 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 color shall be as agreed between the purchaser and manufacturer.

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 standard shall be marked by the manufacturer as specified herein, and also in accordance with Annex F.

**11.1.2** For all manufacturers except threaders, the marking instructions in Section 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 color-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 three exceptions:

a) by agreement between purchaser and manufacturer, stamping can be required, in which case a combination of stamping and stencil marking shall be used,

b) 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, and

c) Alternative systems to stenciling may be used. The system shall mark all the information required for a paint stencil in Table C.48 or Table E.48. If the alternative system has the potential to modify the mechanical or corrosion properties of the material on the applied surfaces, process control parameters shall be validated through a documented procedure ensuring that on the underlying surface, the cracking resistance for sour service and the surface hardness (as in 7.7) are maintained and defects (as in 8.13) were not created.

**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 Figures D.15 and D.22. 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 “API 5CT”.

**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 << >>.

NOTE An alternative marking agreement is required for API Monogram licensees (see Annex A).

**11.1.8** The date of manufacture is defined for marking purposes as the first two digits representing the month and the last two digits representing the year with a hyphen (dash) or slash in between (e.g., 05-12 or 05/12 for May 2012).

**11.1.9** Products manufactured in accordance with this edition of API 5CT during the period of overlap of application with the previous edition shall be identified by including the edition number after the manufacture date separated by a hyphen (dash) or slash (e.g., $10^{th}$ Edition during $9^{th}$ Edition applicability, 05-19-10ED or 05/19/10ED for $10^{th}$ Edition). Once the new edition is effective, marking of the edition is at the manufacturer’s discretion. The edition marking applies to the pipe body characteristics and does not apply to changes in API 5B.

**11.1.10** 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.

**11.1.11** Marking for coupling material and accessory material shall be specified in 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 standard, the manufacturer, the date of manufacture and the grade. When the purchase agreement specifies marking with color 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, Grades R95, L80 (all types), C90, T95, C110, and Q125 products may require subsequent heat treatment as specified in 11.2.5. Such heat treatment shall be in accordance with 6.2. 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 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 in 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 in 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) Products for Grades R95 and L80 (all types) shall be heat-treated subsequent to using method 2 in 11.2.1.

b) Products for Grades C90, T95, C110, and Q125 shall be heat-treated subsequent to using methods 2 and 4 in 11.2.1, with the following exceptions:

1) 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, and

2) 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, 3, 4, or 5 only.

For Grades C90, T95, and Q125, the triangle shall be stamped by method 3 only.

For Grades R95 and L80 (all types), 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 Color Identification

#### 11.4.1 Color Coding

Each product shall be color-coded as specified in 11.4.2 through 11.4.6, unless otherwise specified in 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 Grades L80 9Cr and L80 13Cr, paint the entire outside surface of the coupling, including the appropriate coupling color bands.

d) Couplings: for Grades L80 9Cr and L80 13Cr, apply only the appropriate color bands with a band width of 12.7 mm ($^1/_2$ 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.

#### 11.4.3 Loose Couplings

For all grades except Grades L80 9Cr and L80 13Cr, paint the entire outside surface of the coupling, including the appropriate color bands.

For Grades L80 9Cr and L80 13Cr, apply only the appropriate color bands with a band width of 12.7 mm ($^1/_2$ in.) to the outside surface of the coupling.

#### 11.4.4 Special Clearance Couplings

For all grades, except for Grades L80 9Cr and L80 13Cr, paint the coupling using the appropriate colors and also paint a black band around the center.

For Grades L80 9Cr and L80 13Cr, apply only the appropriate color bands and a black band around the center with a band width of 12.7 mm ($^1/_2$ in.).

#### 11.4.5 Pup Joints Shorter than 1.8 m (6 ft) in Length

For all grades, except for Grades L80 9Cr and L80 13Cr, paint the entire outside surface, except the threads, including the appropriate color bands.

For Grades L80 9Cr and L80 13Cr, apply only the appropriate color bands with a band width of 12.7 mm ($^1/_2$ in.) to the outside surface.

#### 11.4.6 Grade Color—Codes

The color 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 the following shall be as shown in Table C.48 or Table E.48:

a) plain-end pipe furnished either upset or non-upset,

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.

When applying API 5B-compliant thread to products not listed in Tables C.1/E.1 and C.2/E.2, the product shall be marked as “SF” and the API thread designator (as shown in Table C.47/E.47) placed after the API marking sequence specified in Tables C.48/E.48 or C.61/E.61 (see also 11.1.10).

### 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.

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 (5000 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 (8900 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.

Use of the letters “API” to identify or certify that threads on tubular goods comply with API 5B is not permitted.

## 12 Coating and Protection

### 12.1 Coatings

#### 12.1.1 Coatings for Protection during Transit

Unless otherwise specified in 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 in 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 uncoated. 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 discoloration 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:

   1) dryness of the pipe,

   2) cleanliness of the pipe,

   3) temperature at application, and

   4) 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 I unless otherwise specified in the purchase agreement. External thread protectors shall cover the full length of the thread on the pipe and internal thread protectors shall cover the equivalent 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 or pipe end, or both.

### 12.2.2 Grade L80 Types 9Cr and 13Cr

Bare steel thread protectors shall not be used on Grade L80 Types 9Cr and 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 compliance 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 standard 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 in 13.3, the certificate shall include a statement that the product has been manufactured, sampled, tested or inspected, or both, in accordance with this standard and has been found to meet the requirements.

## 13.3 Certification Content

The certificate shall, as applicable to each item, contain at least the following information.

a) Reference to this standard, the edition and the revision date thereof;

b) Applicable Product Specification Level;

c) Applicable supplementary requirements;

d) Heat or lot traceability identification according to 6.4.1;

e) Specified diameter, wall thickness, grade, process of manufacture, type of heat treatment;

f) 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);

g) 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 standard;

h) The tensile tests results, including yield strength, tensile strength and elongation. The type, size, and orientation of the specimens shall be reported. The 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 it shall state when full-section specimens are used;

i) Where impact testing is required by this standard, impact test results include:

   1) acceptance test criteria,

   2) size, location, and orientation of the test specimens,

   3) nominal test temperature (i.e. actual test temperature, including the sub-size temperature reduction if applicable),

   4) absorbed energy measured for each test specimen, and

   5) average absorbed energy for each test;

   The percent shear area shall be reported for Grade C110 (see 7.3.1) and PSL-2 or PSL-3 products (see H.6.1);

j) Where hardness testing is required, hardness test results (including Rockwell hardness numbers and mean hardness numbers, test type and criterion, and specimen location and orientation);

k) Where grain size determination is required, the size and test method used for the determination;

l) 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 K.12.3 (SR 39.3), the actual percent $H_2S$;

m) The information specified in the NACE TM0177-2016, “NACE Uniform Material Testing Report Form (Part 2): Testing in accordance with NACE TM0177 Method A—NACE Standard Tensile Test” shall be provided;

n) The information specified in the NACE TM0177-2016, “NACE Uniform Material Testing Report Form (Part 2): Testing in accordance with NACE TM0177 Method D—NACE Standard DCB Test” shall be provided;

o) The minimum hydrostatic test pressure and duration;

p) For welded pipe for which NDE of the weld seam is required by this standard, the method of NDE employed (UT, EMI, or MT) and the type and size of the artificial reference indicators used;

q) 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, EMI or MT), the acceptance criteria, the location and orientation of the reference indicator used, and the type and size of the artificial reference indicators used;

r) 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;

s) When agreed between the manufacturer and purchaser, certification of couplings (e.g. made-up power-tight) with the material test results, inspection results, statement of conformance to the connection requirements and traceability identification;

t) The results of any supplemental testing required by the purchaser.

### 13.4 Retention of Records

Tests and inspections requiring retention of records in this standard are shown in Table C.49 or Table E.49. Such records shall be retained by the manufacturer and shall be available to the purchaser on request for a period of three years 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 Section 6 of this standard. A pipe mill shall also have suitable equipment 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 offsite. 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 compliance with the relevant requirements of this standard.

### 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 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 offsite. 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 compliance with the relevant requirements of this standard.

## 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 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 compliance with the relevant requirements of this standard.

A threader (or a subcontractor) shall not change or alter the markings on the pipe body or certify that the pipe body complies with any API/ISO specification. When subcontract work is performed for the threader, it shall be the responsibility of the threader to ensure that such work complies with the requirements of this standard.

## 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 Section 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 compliance with the relevant requirements of this standard.

In accordance with the requirements of this standard, pup joint manufacturers shall either have or have access to facilities for:

a) hydrostatic testing, and

b) drift-testing finished products.

In the event that a subcontractor performs any of items a) or b), such services shall be carried out in accordance with documented procedures and shall be controlled and monitored by the manufacturer to ensure compliance with the relevant requirements of this standard.

Coupling manufacturers shall be capable of inspecting couplings by the magnetic particle inspection or other adequate non-destructive testing method.

# Annex A
(informative)

# API Monogram Program
# Use of the API Monogram by Licensees

## A.1 Scope

### A.1.1 Applicability

This annex is normative (mandatory) for products supplied bearing the API Monogram and manufactured at a facility licensed by API; for all other instances it is not applicable.

### A.1.2 General

The API Monogram® is a registered certification mark owned by the American Petroleum Institute (API) and authorized for licensing by the API Board of Directors. Through the API Monogram Program, API licenses product manufacturers to apply the API Monogram to products which comply with product specifications and have been manufactured under a quality management system that meets the requirements of API Q1. API maintains a complete, searchable list of all Monogram licensees on the API Composite List website (www.api.org/compositelist).

The application of the API Monogram and license number on products constitutes a representation and warranty by the licensee to API and to purchasers of the products that, as of the date indicated, the products were manufactured under a quality management system conforming to the requirements of API Q1 and that the product conforms in every detail with the applicable standard(s) or product specification(s). API Monogram program licenses are issued only after an on-site audit has verified that an organization has implemented and continually maintained a quality management system that meets the requirements of API Q1 and that the resulting products satisfy the requirements of the applicable API product specification(s) and/or standard(s). Although any manufacturer may claim that its products meet API product requirements without monogramming them, only manufacturers with a license from API can apply the API Monogram to their products.

Together with the requirements of the API Monogram license agreement, this annex establishes the requirements for those organizations who wish to voluntarily obtain an API license to provide API monogrammed products that satisfy the requirements of the applicable API product specification(s) and/or standard(s) and API Monogram Program requirements.

For information on becoming an API Monogram Licensee, please contact API, Certification Programs, 1220 L Street, N. W., Washington, DC 20005 or call 202-682-8145 or by email at certification@api.org.

## A.2 Normative References

In addition to the referenced standards listed in Section 2, this annex references the following standard:

API Specification Q1, Specification for Quality Management System Requirements for Manufacturing Organizations for the Petroleum and Natural Gas Industry

For Licensees under the Monogram Program, the latest version of this document shall be used. The requirements identified therein are mandatory.

## A.3 API Monogram Program: Licensee Responsibilities

### A.3.1 Monogram Program Requirements

For all organizations desiring to acquire and maintain a license to use the API Monogram, conformance with the following shall be required at all times:

a) the quality management system requirements of API Q1;

b) the API Monogram Program requirements of API Q1, Annex A;

c) the requirements contained in the API product specification(s) to which the organization is licensed; and

d) the requirements contained in the API Monogram Program License Agreement.

### A.3.2 Control of the Application and Removal of the API Monogram

Each licensee shall control the application and removal of the API Monogram in accordance with the following:

a) products that do not conform to API specified requirements shall not bear the API Monogram;

b) each licensee shall develop and maintain an API Monogram marking procedure that documents the marking/ monogramming requirements specified by this annex and any applicable API product specification(s) and/or standard(s). The marking procedure shall:

   1) define the authority responsible for application and removal of the API Monogram and license number;

   2) define the method(s) used to apply the Monogram and license number;

   3) identify the location on the product where the API Monogram and license number are to be applied;

   4) require the application of the date of manufacture of the product in conjunction with the use of the API Monogram and license number;

   5) require that the date of manufacture, at a minimum, be two digits representing the month and two digits representing the year (e.g. 05-12 for May 2012) unless otherwise stipulated in the applicable API product specification(s) or standard(s); and

   6) define the application of all other required API product specification(s) and/or standard(s) marking requirements.

c) only an API licensee shall apply the API Monogram and its designated license number to API monogrammable products;

d) the API Monogram and license number, when issued, are site-specific and subsequently the API Monogram shall only be applied at that site specific licensed facility location; and

e) the API Monogram may be applied at any time appropriate during the production process but shall be removed in accordance with the licensee's API Monogram marking procedure if the product is subsequently found to be out of conformance with any of the requirements of the applicable API product specification(s) and/or standard(s) and API Monogram Program.

f) For certain manufacturing processes or types of products, alternative API Monogram marking procedures may be acceptable. Requirements for alternative API Monogram marking are detailed in the, API Monogram Program

Alternative Marking of Products License Agreement, available on the API Monogram Program website at http://www.api.org/alternative-marking

### A.3.3 Design and Design Documentation

Each licensee and/or applicant for licensing shall maintain current design documentation as identified in API Q1 for all of the applicable products that fall under the scope of each Monogram license. The design document information shall provide objective evidence that the product design meets the requirements of the applicable and most current API product specification(s) and/or standard(s). The design documentation shall be made available during API audits of the facility.

In specific instances, the exclusion of design activities is allowed under the Monogram Program, as detailed in Advisory #6, available on API Monogram Program website at http://www.api.org/products-and-services/api-monogram-and-apiqr/advisories-updates.

### A.3.4 Manufacturing Capability

The API Monogram Program is designed to identify facilities that have demonstrated the ability to manufacture equipment that conforms to API specifications and/or standards. API may refuse initial licensing or suspend current licensing based on a facility's level of manufacturing capability. If API determines that an additional review is warranted, API may perform additional audits (at the organization's expense) of any subcontractors to ensure their conformance with the requirements of the applicable API product specification(s) and/or standard(s).

### A.3.5 Use of the API Monogram in Advertising

An API Monogram licensee shall not use the API Monogram and/or license number on letterheads, buildings or other structures, websites or in any advertising without an express statement of fact describing the scope of Licensee's authorization (license number and product specification). The Licensee should contact API for guidance on the use of the API Monogram other than on products.

## A.4 Product Marking Requirements

### A.4.1 General

These marking requirements shall apply only to those API Licensees wishing to mark applicable products in conjunction with the requirements of the API Monogram Program.

### A.4.2 Product Specification Identification

Manufacturers shall mark products as specified by the applicable API specifications or standards. Marking shall include reference to the applicable API specification and/or standard. Unless otherwise specified, reference to the API specifications and/or standards shall be, as a minimum, “API [Document Number]” (e.g., API 6A, or API 600). Unless otherwise specified, when space allows, the marking may include use of “Spec” or “Std”, as applicable (e.g. API Spec 6A or API Std 600).

### A.4.3 Units

Products shall be marked with units as specified in the API specification and/or standard. If not specified, equipment shall be marked with U.S. customary (USC) units. Use of dual units [USC units and metric (SI) units] may be acceptable, if such units are allowed by the applicable product specification and/or standard.

### A.4.4 Nameplates

Nameplates, when applicable, shall be made of a corrosion-resistant material unless otherwise specified by the API specification and/or standard. Nameplates shall be located as specified by the API specification and/or standard. If the location is not specified, then the licensee shall develop and maintain a procedure detailing the location to which the nameplate shall be applied. Nameplates may be attached at any time during the manufacturing process.

The API Monogram and license number shall be marked on the nameplate, in addition to the other product marking requirements specified by the applicable product specification and/or standard.

### A.4.5 License Number

The API Monogram license number shall not be used unless it is marked in conjunction with the API Monogram. The license number shall be used in close proximity to the API Monogram.

## A.5 API Monogram Program: Nonconformance Reporting

API solicits information on products that are found to be nonconforming with API specified requirements, as well as field failures (or malfunctions), which are judged to be caused by either specification and/or standard deficiencies or nonconformities against API specified requirements. Customers are requested to report to API all problems with API monogrammed products. A nonconformance may be reported using the API Nonconformance Reporting System available at http://compositelist.api.org/ncr.aspx.

# 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

All inspections should be made prior to shipment at the place of manufacture or processing, unless otherwise specified in the purchase agreement, and shall be so conducted as not to interfere unnecessarily with the operation of the works.

## B.3 Compliance

The manufacturer is responsible for complying with all of the provisions of this standard. The purchaser may conduct an investigation to ensure compliance by the manufacturer and may reject any product that does not comply with this standard.

## 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 standard shall be rejected. Disposition of rejected product shall be a matter of agreement between purchaser and manufacturer.

# Annex C
(normative)

# Tables in SI Units

**Table C.1—API Casing List (sizes, masses, wall thickness, grade, and applicable end-finish)**

| Labels [a] | | Outside Diameter | Nominal Linear Mass [b,c] T&C | Wall Thick-ness | Type of End-finish [d] | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | *D* mm | kg/m | *t* mm | H40 | J55 K55 | L80 R95 | N80 Type 1, Q | 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 |
| 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 | — | — |

**Table C.1—API Casing List (sizes, masses, wall thickness, grade, and applicable end-finish) (Continued)**

| Labels | | Outside Diameter | Nominal Linear Mass [b,c] T&C | Wall Thick-ness | Type of End-finish [d, e] | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | *D* mm | kg/m | *t* mm | H40 | J55 K55 | L80 R95 | N80 Type 1, Q | 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 | — | — |
| 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 |

**Table C.1—API Casing List (sizes, masses, wall thickness, grade, and applicable end-finish) (Continued)**

| Labels | | Outside Diameter | Nominal Linear Mass [b,c] T&C | Wall Thick-ness | Type of End-finish [d] | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | D mm | kg/m | t mm | H40 | J55 K55 | L80 R95 | N80 Type 1, Q | C90 T95 | C110 | P110 | Q125 |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| 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 | — | — | — | — | — | — |

NOTE 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 (Column 4) are shown for information only.

[c] The densities of martensitic chromium steels (L80 Types 9Cr and 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.

[d] Buttress casing is available with regular, special clearance couplings or special clearance couplings with special bevel.

[e] For casing with S, L, B connections, intermediate wall thicknesses are allowed in accordance with 5.2.3 and 8.2 and API 5B.

## Table C.2—API Tubing List (sizes, masses, wall thickness, grade, and applicable end-finish)

| Labels | | | | Outside Diameter | Nominal Linear Masses [a, b] | | | Wall Thickness | Type of End Finish | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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 Type 1, Q | 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 | 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 | 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 | — |
| 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 | — |

NOTE P = Plain-end, N = Non-upset threaded and coupled, U = External upset threaded and coupled, I = Integral joint.

[a] Nominal linear masses (Columns 6, 7, and 8) are shown for information only.

[b] The densities of martensitic chromium steels (L80 types 9Cr and 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.

## Table C.3—Process of Manufacture and Heat Treatment

| Grade | Type | Manufacturing Process [a] | Heat Treatment [e] | Tempering Temperature °C min |
|---|---|---|---|---|
| *1* | *2* | *3* | *4* | *5* |
| H40 | — | S or EW | — | — |
| J55 [i] | — | S or EW | — [b] | — |
| K55 | — | S or EW | — [b] | — |
| N80 | 1 [i] | S or EW | [c] | — |
| N80 | Q | S or EW | Q [d] | — |
| R95 [i] | — | S or EW | Q | 538 |
| L80 | 1 | S or EW | Q | 566 |
| L80 | 9Cr [i] | S | Q [f] | 593 |
| L80 | 13Cr | S | Q [f] | 593 |
| C90 | 1 | S | Q | 621 |
| T95 | 1 | S | Q | 649 |
| C110 | — | S | Q | 649 |
| P110 | — | S or EW [g, h] | Q | — |
| Q125 | 1 | S or EW [h] | Q | — |

[a] S = seamless process; EW = electric-welded process.

[b] Full-body, full-length normalized, normalized and tempered or quenched and tempered at the manufacturer's option or as specified in the purchase agreement (see 6.2.2).

[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] Q = quenched and tempered.

[f] Type 9Cr and 13Cr may be air-quenched.

[g] Special chemical requirements for electric-welded P110 pipe are specified in Table C.4.

[h] Products shall be heat-treated full-body, full-length; Special requirements unique to electric-welded P110 and Q125 are specified in K.6 (SR 11).

[i] Quenched and tempered product in large $D/t$ ratio combinations and non-quenched and tempered product may exhibit ductile rupture values lower than internal yield values; See API 5C3/ISO 10400 calculated performance values in Columns 15 and 18 in Table K.1 and Table L.1.

**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 |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| 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 | 9Cr | — | 0.15 | 0.30 | 0.60 | 0.90 | 1.10 | 8.00 | 10.0 | 0.50 | 0.25 | 0.020 | 0.010 | 1.00 |
| 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 | 1 | — | 0.35 | — | 1.20 | 0.25 [b] | 0.85 | — | 1.50 | 0.99 | — | 0.020 | 0.010 | — |
| T95 | 1 | — | 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 | 1 | — | 0.35 | | 1.35 | — | 0.85 | — | 1.50 | — | — | 0.020 | 0.010 | — |

NOTE 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.

## Table C.5—Tensile and Hardness Requirements

| Grade | Type | Total Elongation Under Load % | Yield Strength MPa | | Tensile Strength min MPa | Hardness [a,c] max | | Specified Wall Thickness | Allowable Hardness Variation [b] |
|---|---|---|---|---|---|---|---|---|---|
| | | | min | max | | HRC | HBW | mm | HRC |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 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 | 9Cr | 0.5 | 552 | 655 | 655 | 23.0 | 241 | — | — |
| L80 | 13Cr | 0.5 | 552 | 655 | 655 | 23.0 | 241 | — | — |
| C90 | 1 | 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 | 1 | 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 | 29.0 | 279 | ≤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 | 1 | 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.

[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.

## 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 $mm^2$ | 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* | *7* | *8* | *9* | *10* | *11* | *12* |
| 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 |
| 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 |

## Table C.6—Elongation Table (Continued)

| Tensile Test Specimen | | | | Minimum Elongation in 50.8 mm % | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Grade | | | | | | | |
| | | | | H40 | J55 | K55 L80 | N80 C90 | R95 T95 | C110 | P110 | Q125 |
| Specimen Area $mm^2$ | 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* | *7* | *8* | *9* | *10* | *11* | *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.

## Table C.7—Critical Thickness for Couplings with API Threads

Dimensions in millimeters

| 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 those 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 |
| 3/4-size | 10.0 × 7.5 | 0.80 |
| 1/2-size | 10.0 × 5.0 | 0.55 |

**Table C.9—Hierarchy of Test Specimen Orientation and Size**

| Choice | Orientation | Size |
|---|---|---|
| 1st | Transverse | Full-size |
| 2nd | Transverse | 3/4-size |
| 3rd | Transverse | 1/2-size |
| 4th | Longitudinal | Full-size |
| 5th | Longitudinal | 3/4-size |
| 6th | Longitudinal | 1/2-size |

**Table C.10—Charpy Impact Test Specimen Requirements for Couplings, Coupling Stock, Coupling Material, Coupling Blanks, and Accessory Material for 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 |

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.

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 = 3/4-size (i.e. 10 mm × 7.5 mm)

5 = 1/2-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

[a] Not thick enough to test.

[b] The information in this table assumes that special clearance couplings are machined from regular coupling blanks.

**Table C.11—Charpy Impact Test Specimen Requirements for Couplings, Coupling Stock, Coupling Material, Coupling Blanks, and Accessory Material for 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 |

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.

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 = 3/4-size (i.e. 10 mm × 7.5 mm)

5 = 1/2-size (i.e. 10 mm × 5 mm)

[a] Not thick enough to test.

[b] The information in this table assumes that special clearance couplings are machined from regular coupling blanks.

**Table C.12—Charpy Impact Test Specimen Requirements for Couplings, Coupling Stock, Coupling Material, Coupling Blanks, and Accessory Material for 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 | — | — | — | — | — | — | — |

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.

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 = 3/4-size (i.e. 10 mm × 7.5 mm)

5 = 1/2-size (i.e. 10 mm × 5 mm)

[a] Not thick enough to test.

[b] The information in this table assumes that special clearance couplings are machined from regular coupling blanks.

**Table C.13—Charpy Impact Test Specimen Requirements for Couplings, Coupling Stock, Coupling Material, Coupling Blanks, and Accessory Material for 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 | — | — | — | — | — | — | — |

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.

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 = 3/4-size (i.e. 10 mm × 7.5 mm)

5 = 1/2-size (i.e. 10 mm × 5 mm)

[a] Not thick enough to test.

[b] The information in this table assumes that special clearance couplings are machined from regular coupling blanks.

**Table C.14—Charpy Impact Test Specimen Requirements for Couplings, Coupling Stock, Coupling Material, Coupling Blanks, and Accessory Material for 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 | — | — | — | — | — | — | — |

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.

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 = 3/4-size (i.e. 10 mm × 7.5 mm)

5 = 1/2-size (i.e. 10 mm × 5 mm)

[a] Not thick enough to test.

[b] The information in this table assumes that special clearance couplings are machined from regular coupling blanks.

**Table C.15—Charpy Impact Test Specimen Requirements for Couplings, Coupling Stock, Coupling Material, Coupling Blanks, and Accessory Material for 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 | — | — | — | — |

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.

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 = 3/4-size (i.e. 10 mm × 7.5 mm)

5 = 1/2-size (i.e. 10 mm × 5 mm)

[a] The information in this table assumes that special clearance couplings are machined from regular coupling blanks.

**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 [a] 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 |

NOTE Critical thicknesses greater than the measurements shown in Table C.7 are not applicable for couplings with API threads and are shown in this table for special applications.

[a] For critical thickness greater than those shown above, the requirements shall be according to the equations for the wall thickness and grade.

**Table C.17—Longitudinal Charpy Absorbed Energy Requirements for Couplings, Coupling Stock, Coupling Material, Coupling Blanks, and Accessory Material**

| Maximum Critical Thickness [a] 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 |

NOTE Critical thicknesses greater than the measurements shown in Table C.7 are not applicable for couplings with API threads and are shown in this table for special application.

[a] For critical thickness greater than those shown above, the requirements shall be according to the equations for the wall thickness and grade.

**Table C.18—Transverse Charpy Absorbed Energy Requirements for Pipe**

| Maximum Specified Wall Thickness [a] 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 |

NOTE Wall thicknesses greater than those of standard API pipe are shown in this table for special applications.

[a] For wall thickness greater than those shown above, the requirements shall be according to the equations for the wall thickness and grade.

**Table C.19—Longitudinal Charpy Absorbed Energy Requirements for Pipe**

| Maximum Specified Wall Thickness [a] 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 |
| — | — | — | 21.82 | 24.82 | 15.35 | 63 |
| — | — | — | 22.33 | 25.38 | 15.76 | 64 |
| — | — | — | 22.85 | 25.94 | 16.17 | 65 |

**Table C.19—Longitudinal Charpy Absorbed Energy Requirements for Pipe (Continued)**

| Maximum Specified Wall Thickness [a] mm | | | | | | Minimum Longitudinal Absorbed Energy J |
|---|---|---|---|---|---|---|
| N80, L80 | C90 | R95, T95 | C110 | P110 | Q125 | |
| *1* | *2* | *3* | *4* | *5* | *6* | *7* |
| — | — | — | 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 |

NOTE Wall thicknesses greater than those of standard API pipe are shown in this table for special applications.

[a] For wall thicknesses greater than those shown above, the requirements shall be according to the equations for the wall thickness and grade.

**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 | 3/4-size | 1/2-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 API pipe are for information only; The information in this table provides a 0.50 mm inside-wall and a 0.50 mm outside-wall machining allowance.

**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 | 3/4-size | 1/2-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 API pipe are for information only; The measurements in this table provide a 0.50 mm inside-wall and a 0.50 mm outside-wall machining allowance.

**Table C.22—Distance between Plates for Electric-weld Flattening Tests**

| Grade | *D/t* ratio | Distance between Plates mm |
|---|---|---|
| H40 | ≥ 16 | $0.5 \times D$ |
| | < 16 | $D \times (0.830 - 0.0206\ D/t)$ |
| J55 and K55 | ≥ 16 | $0.65 \times D$ |
| | 3.93 to 16 | $D \times (0.980 - 0.0206\ D/t)$ |
| | < 3.93 | $D \times (1.104 - 0.0518\ D/t)$ |
| N80 (all types) [a] | 9 to 28 | $D \times (1.074 - 0.0194\ D/t)$ |
| L80 Type 1 | 9 to 28 | $D \times (1.074 - 0.0194\ D/t)$ |
| R95 [a] | 9 to 28 | $D \times (1.080 - 0.0178\ D/t)$ |
| P110 [b] | All | $D \times (1.086 - 0.0163\ D/t)$ |
| Q125 [b] | All | $D \times (1.092 - 0.0140\ D/t)$ |

NOTE

$D$ is the specified outside diameter of pipe, in millimeters.

$t$ is the specified wall thickness of the pipe, in millimeters.

[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 K.6 (SR 11); Flattening shall be conducted until this distance or until $0.85 \times D$, whichever is less, without cracking at any location.

**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 Thick-ness | 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 | |
| | | $D$ 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* |
| 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 | — | — | — | — |
| 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 |

**Table C.23—Dimensions and Masses for Standard Casing and for Casing Threaded with API Round Thread and Buttress Thread (Continued)**

| Labels [a] | | Outside Diameter | Nominal Linear Mass T& C [b,c] | Wall Thick-ness | 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 | |
| | | $D$ 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 | 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 | — | — | — | — |
| 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 | — | 7.91 | 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 | — | — | — | — |

**Table C.23—Dimensions and Masses for Standard Casing and for Casing Threaded with API Round Thread and Buttress Thread (Continued)**

| Labels [a] | | Outside Diameter | Nominal Linear Mass T& C [b,c] | Wall Thick-ness | 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 | |
| | | $D$ 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* |
| 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 | — | 8.88 | 8.85 | –1.21 |
| 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 | 222.40 | 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 | 222.50 | 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 | 79.62 | 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 | — | — | — | — |

**Table C.23—Dimensions and Masses for Standard Casing and for Casing Threaded with API Round Thread and Buttress Thread (Continued)**

| Labels [a] | | Outside Diameter | Nominal Linear Mass T& C [b,c] | Wall Thick-ness | 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 | |
| | | $D$ 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 | — | 12.25 | –0.09 |
| 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 | — | 12.25 | –0.09 |
| 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 | — | 11.07 | — |
| 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 | — | 9.98 | — |
| 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 | — | — | — | — |
| 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 [e] | 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 | — | — | — | — |

**Table C.23—Dimensions and Masses for Standard Casing and for Casing Threaded with API Round Thread and Buttress Thread (Continued)**

| Labels [a] | | Outside Diameter | Nominal Linear Mass T& C [b,c] | Wall Thick-ness | 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 | |
| | | $D$ 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* |
| 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 | 10.98 | — | 14.33 | — |
| 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 | 10.98 | — | 14.33 | — |
| 13 3/8 | 72.00 | 339.72 | 107.15 | 13.06 | 313.60 | 309.63 | 105.21 | 10.91 [e] | — | 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 | 33.60 | — | 39.25 | — |
| 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] | 24.78 | — |
| 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 | — |

NOTE 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 (Column 4) are shown for information only.

[c] The densities of martensitic chromium steels (L80 Types 9Cr and 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 in the purchase agreement and marked on the pipe; See 8.10 for drift requirements.

[f] Based on 758 MPa minimum yield strength or greater.

[g] Based on 379 MPa minimum yield strength.

## 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 | | | |
| | 2 | | | | Non-upset T&C | External Upset T&C | Integral Joint | | | | | External Upset [e] | | |
| 1 | NU T&C | EU T&C | IJ | $D$ mm | kg/m | kg/m | kg/m | $t$ mm | $d$ mm | $w_{pe}$ kg/m | Non-upset | Regular | Special Clearance | Integral Joint |
| *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 | — | — |
| 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 | — | — | — | — |

**Table C.24—Dimensions and Masses for Standard Tubing and for Tubing Threaded with API Non-upset, External Upset, and Integral Tubing Connections (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 | | | |
| | 2 | | | | Non-upset T&C | External Upset T&C | Integral Joint | | | | | External Upset [e] | | |
| 1 | NU T&C | EU T&C | IJ | $D$ mm | kg/m | kg/m | kg/m | $t$ mm | $d$ mm | $w_{pe}$ kg/m | Non-upset | Regular | Special Clearance | Integral Joint |
| *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* | *12* | *13* | *14* | *15* |
| $2\ ^{7}/_{8}$ | 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 | 57.78 | 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 | — | — | 7302 | 15.67 | — | — | 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 | 27.07 | — | — | 12.09 | 64.72 | 22.90 | — | — | — | — |
| $3\ ^{1}/_{2}$ | 17.00 | — | — | 88.90 | 25.70 | — | — | 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 | — | — | — | — |

**Table C.24—Dimensions and Masses for Standard Tubing and for Tubing Threaded with API Non-upset, External Upset, and Integral Tubing Connections (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 | | | |
| | 2 | | | | Non-upset T&C | External Upset T&C | Integral Joint | | | | | External Upset [e] | | |
| 1 | NU T&C | EU T&C | IJ | $D$ mm | kg/m | kg/m | kg/m | $t$ mm | $d$ mm | $w_{pe}$ kg/m | Non-upset | Regular | Special Clearance | Integral Joint |
| *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 | — | — | — | — |

NOTE See also Figures D.4, D.5, and D.7.

[a] Labels are for information and assistance in ordering.

[b] Nominal linear masses (Columns 6, 7, and 8) are shown for information only.

[c] The densities of martensitic chromium (L80 Types 9Cr and 13Cr) are 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.

**Table C.25—External Upset Tubing Dimensions for API Connections for Grades H40, J55, L80 (All Types), R95, N80 (All Types), C90, T95, and P110**

| 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 [e] $L_b$ |
| | | | | mm | mm | mm | mm |
| | | | | +1.59 | +0 | | max |
| 1 | 2 | mm | kg/m | 0 | –25.4 | | |
| *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 |

NOTE 1 See also Figures D.5 and D.6.

NOTE 2 Nominal linear masses are shown for information only.

[a] Labels are for information and assistance in ordering.

[b] The densities of martensitic chromium steels (L80 9Cr and 13Cr) 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 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.

**Table C.26—Integral Tubing Connection Dimensions for API Connections for Grades H40, J55, L80 (All Types), R95, N80 (All Types), C90, and T95**

| Labels | | Outside Diameter $D$ | Nominal Linear Mass [a] | 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 | 38.89 | 6.35 | 53.59 | 50.80 | 25.40 | 49.86 | 0.79 |
| 1.900 | 2.76 | 48.26 | 4.11 | — | 38.89 | 38.89 | 6.35 | 53.59 | 50.80 | 25.40 | 49.86 | 0.79 |
| 2.063 | 3.25 | 52.40 | 4.84 | 53.19 | 42.47 | 42.47 | 6.35 | 59.06 | 53.98 | 25.40 | 54.76 | 0.79 |

NOTE 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 5B.

[c] The minimum diameter $d_{iu}$ is limited by the drift test.

## Table C.27—Range Lengths

Dimensions in meters

| | Range 1 [b] | Range 2 [b] | Range 3 [b] |
|---|---|---|---|
| **CASING (PE/T and C/SF)** | | | |
| Total range length, inclusive | 4.88 to 7.62 | 7.62 to 10.36 | 10.36 to 14.63 |
| Permissible variation, max [a] | 1.83 | 1.52 | 1.83 |
| **TUBING AND CASING USED AS TUBING (PE/T and C/SF)** | | | |
| Total range length, inclusive | 6.10 to 7.32 | 8.53 to 9.75 | 11.58 to 12.80 |
| Permissible variation, max [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 |
| Permissible variation, max [a] | 0.61 | 0.61 | 0.61 |
| **PUP JOINTS [b]** | Lengths: 0.61; 0.91; 1.22; 1.83; 2.44; 3.05 and 3.66<br>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] Lengths other than those listed may be furnished by agreement between purchaser and manufacturer.

## Table C.28—Standard Drift Size

Dimensions in millimeters

| 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 | 1067 | d – 2.38 |
| > 2 7/8 to ≤ 8 5/8 | 1067 | d – 3.18 |
| > 8 5/8 to < 10 3/4 | 1067 | 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 1067 mm in length and $d_{iu}$ – 0.38 mm in diameter (see Table C.26, Column 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 Section 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 |

**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 K.9 (SR 16) | 12.5 % | 12.5 % |
| N80 Type 1 | 10 % | 10 % |
| C90 – T95 – C110 – P110 – Q125 | 5 % | 5 % |
| P110 to K.9 (SR 16) and K.3 (SR 2) | 5 % | 5 % |

**Table C.31—Upset Products—Maximum Permissible Depth of Imperfections**

| | Surface | Depth | Measurement Notes |
|---|---|---|---|
| **A Integral Joint and External Upset Tubing (see Figure D.5 and Figure D.7)** | | | |
| A.1 | All surfaces of upset and upset run-out interval, except as stated below | 12.5 % $t$ | Percentage of specified pipe body wall thickness $t$; for non-linear imperfections; for all grades of pipe. |
| | | 12.5 % $t$ | Percentage of specified pipe body wall thickness $t$; for linear imperfections; for Grades H40, J55, K55, L80 (all types), N80 (all types), and R95. |
| | | 5 % $t$ | Percentage of specified pipe body wall thickness $t$; for linear imperfections; for Grades C90, T95, and P110 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 | Box end and external surface | 0.25 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. |
| B.2 | Pin end internal surface | 0.38 mm | 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.<br><br>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. | | | |

**Table C.32—API Round-thread Casing Coupling—Dimensions, Tolerances, and Masses**

| Label 1 | Size [a] | Outside Diameter $W$ [b, c] | Minimum Length mm | | Diameter of Recess $Q$ [d] | Width of Bearing Face $b$ | Mass kg | |
|---|---|---|---|---|---|---|---|---|
| | Outside Diameter $D$ mm | mm | Short $N_L$ | Long $N_L$ | mm | 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 |

NOTE See also Figure D.1 and Figure 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.

## Table C.33—API Buttress Thread Casing Coupling—Dimensions, Tolerances, and Masses

| Label 1 | Size [a] | Outside Diameter | | Minimum Length $N_L$ | Diameter of Counterbore $Q$ | Width of Bearing Face $b$ | Mass kg | |
|---|---|---|---|---|---|---|---|---|
| | Outside Diameter $D$ | Regular $W$ [b, c] | Special Clearance [d] $W_c$ | | | | Regular | Special Clearance |
| | mm | mm | mm | mm | mm | mm | | |
| *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 | — |

NOTE 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.

**Table C.34—API Non-upset Tubing Coupling—Dimensions, Tolerances, and Masses**

| Label 1 | Size [a] | Outside Diameter $W$ [b] | Minimum Length $N_L$ | Diameter of Recess $Q$ | Width of Bearing Face $b$ | Maximum Bearing Face Diameter, Special Bevel $B_f$ | Mass |
|---|---|---|---|---|---|---|---|
| | Outside Diameter $D$ | | | | | | |
| | 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 |

NOTE 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 | — |

NOTE 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.

## 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 |
| | | mm | mm | mm |
| *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 [e] | 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 9Cr, 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 9Cr, 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] | 1 | 1 |
| Q125 | All sizes | — [d] | 3 [c] | — |

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, except for a single piece lot where the test specimens may be taken from both ends of one length.

[d] See 10.2.2.

[e] 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.

**Table C.38—Frequency of Tensile Tests—Coupling Stock, Coupling Material, and Coupling Blanks**

| Grade | Material | Condition when Heat-treated | 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), 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 9Cr and 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]<br>Label 1: ≥ 9 5/8: 30 [c] | 1 | — |
| | Hot forging | Coupling blank | Label 1: < 9 5/8: 50 [c]<br>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]<br>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, except for a single piece lot where the test specimens may be taken from both ends of one length.

## Table C.39—Frequency of Tensile Testing—Pup Joints and Accessory Material

| Grade | Material and Heat Treatment Conditions [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<br>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<br>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<br>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<br>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<br>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 9Cr, L80 13Cr | Full-length standard tubing or casing from one or more heats | | Label 1: ≤ 4 1/2: 200<br>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<br>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<br>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]<br>Label 1: ≥ 9 5/8: 30 [c] | 1 | — |
| | | Heat-treated in sequential loads or continuous heat treatment | Label 1: < 9 5/8: 50 [c]<br>Label 1: ≥ 9 5/8: 30 [c] | 1 | — |
| 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]<br>Label 1: ≥ 9 5/8: 30 [c] | 1 | — |
| | | Heat-treated in sequential loads or continuous heat treatment | Label 1: < 9 5/8: 50 [c]<br>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, except for a single piece lot where the test specimens may be taken from both ends of one length.

[c] Each lot shall be from the same heat of steel for Grades L80 9Cr, 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* |
| 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 |
| 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 | Approximately 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<br>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 [a] | 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]<br>Label 1: ≥ 9 5/8: 30 [c] | Through-wall, 4 quadrants | From a piece with the highest surface hardness number in the lot |

**Table C.40—Frequency of Hardness Testing (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* |
| 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 [a] | 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]<br>Label 1: ≥ 9 $^{5}/_{8}$: 30 [c] | Through-wall, 4 quadrants | From a piece with the highest surface hardness number in the lot |
| Q125 | Casing | | 3 [a] | 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 | Approximately 50 % from each end |
| | | Individual heat treatment | 1 | Each piece | Surface—HRC or HBW | Each piece |
| | | | 1 | Label 1: < 9 $^{5}/_{8}$: 50 [c]<br>Label 1: ≥ 9 $^{5}/_{8}$: 30 [c] | Through-wall, 1 quadrant | Randomly selected piece |

[a] When more than one test is required, the test specimens shall be from different lengths, except for a single piece lot where the test specimens may be taken from both ends of one length.

[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 9Cr, L80 13Cr, C90, T95, and Q125.

[d] One upset approximately 50 % from each end if both ends are upset.

## 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 K.6 (SR 11)] | | |
| **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.

**Table C.42—Summary of NDE Methods for Seamless Pipe, Coupling Stock, 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 and accessory material | H40, J55, K55 | R | N | N | N | N | N |
| | 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 | 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 |

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.

**Table C.43—Acceptance (Inspection) Levels**

| Material | Grade | | External Imperfections | | Internal Imperfections | |
|---|---|---|---|---|---|---|
| | | | Longitudinal | Transverse | Longitudinal | Transverse |
| *1* | *2* | | *3* | *4* | *5* | *6* |
| Pipe body [a] | N80 Type 1 | | L3 | — | L3 | — |
| | N80Q, L80, R95 | | L4 | — | L4 | — |
| | P110 to K.9 (SR 16) | | L4 | L4 | L4 | L4 |
| | P110 | | L2 | L2 | L2 | L2 |
| | P110 to K.9 (SR 16) and K.3 (SR 2) | | L2 | L2 | L2 | L2 |
| | C90, T95, C110, Q125 | UT | L2 | L2 | L2 | L2 |
| | | Second method | L2 | L2 | — | — |
| Coupling stock | All grades except C110 | | L2 | L2 | N | N |
| | C110 | | L2 | L2 | L3 | L3 |
| Weld seam | P110, Q125 | | L2 | N | L2 | N |
| | All other grades | | L3 | N | L3 | N |
| | All other grades to K.3 (SR 2) | | L2 | N | L2 | N |

NOTE N = Not required; $L_x$ = Acceptance (inspection) level.

[a] Accessory material shall be treated as pipe body.

**Table C.44—Artificial Reference Indicators**

| Acceptance (Inspection) Level | Notch Depth [a] Maximum % | Notch Length Maximum at Full Depth mm | Notch Width Maximum mm | Radially Drilled Hole Diameter [b] mm |
|---|---|---|---|---|
| *1* | *2* | *3* | *4* | *5* |
| L2 | 5 | 50 | 1 | 1.6 |
| L3 | 10 | 50 | 1 | 3.2 |
| 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 |
| | $\geq 4\ ^1/_2$ | 6.4 |
| Coupling | For pipe sizes $< 4\ ^1/_2$ | 6.4 |
| | For pipe sizes $\geq 4\ ^1/_2$ to $< 7\ ^5/_8$ | 9.5 |
| | For pipe sizes $\geq 7\ ^5/_8$ | 12.7 |

## Table C.46—Grade Color Codes

| Grade | Grade Type | Number and Color of Bands for Product [a] with Length ≥ 1.8 m | Color(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 | 9Cr | One red, one brown, two yellow | None | Two yellow |
| L80 | 13Cr | One red, one brown, one yellow | None | One yellow |
| C90 | 1 | One purple | Purple | None |
| T95 | 1 | One silver | Silver | None |
| C110 | — | One white, two brown | White | Two brown |
| P110 | — | One white | White | None |
| Q125 | 1 | One orange | Orange | None |

[a] In the case of coupling material, unless otherwise specified in 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 Materials |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 1 | Manufacturer's name or mark | «....» | D or P | D or P | P | P | P |
| 2 | API Spec 5CT | 5CT [c] | D or P | D or P | P | P | P |
| | Date of manufacture as in 11.1.8 or 11.1.9. | «....» | D or P | D or P | P | P | P |
| | Manufacturer's option (applicable to API Monogram licensees):<br>— API license number<br>— API Monogram<br>— Date of manufacture as in 11.1.8 or 11.1.9 | «....» | D or P | D or P | D or P | P | P |
| 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) | «....» | P | | P | | |
| | Specified diameter for coupling stock and other products with no mass designation | | | | | | P |
| 5 | Mass designation (fill in Label 2 designation from Table C.1 or C.2) | «....» | D or P | | P | | |
| | Specified wall thickness for coupling stock and other products with no mass designation | | | | | | P |
| 6 | Grade of product:<br>— H40<br>— J55<br>— K55 | <br>H<br>J<br>K | | | | | |

**Table C.48—Marking Requirements and Sequence (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 Materials |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 6 | — N80 Type 1 | N1 | | | | | |
| | — N80Q | NQ | | | | | |
| | — R95 | R | | | | | |
| | — L80 Type 1 | L | | | | | |
| | — L80 Type 9Cr | L9 | | | | | |
| | — L80 Type 13Cr | L13 | | | | | |
| | — C90 Type 1 | C90-1 | | | | | |
| | — T95 Type 1 | T95-1 | | | | | |
| | — C110 | C110 | | | | | |
| | — P110 | P | | | | | |
| | — Q125 Type 1 | Q1 | | | | | |
| | All grade designations | | D or P | D or P | P | P | P |
| 7 | Sulfide cracking test [f] | | | | | | |
| | — C90 Type 1 | A, B, or D | | | | | |
| | — T95 Type 1 | A, B, or D | | | | | |
| | — C110 | A, D, or DA [g] | | | | | |
| | All test method designations | | | | P | P | P |
| 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 | |
| 9 | Heat treatment, if applicable: | | | | | | |
| | — J55 or K55 normalised | Z | P | P | | | P |
| | — J55 or K55 normalised and tempered | N&T | P | P | | | P |
| 10 | Process of manufacture: | | | | | | |
| | — Seamless | S | | | | | |
| | — Electric-welded | E | | | | | |
| | All designations | | D or P | | P | | |

**Table C.48—Marking Requirements and Sequence (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 Materials |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 11 | Supplementary requirements, if applicable: | | | | | | |
| | — K.2 (SR 1) | S1 | P | | P | | |
| | — K.3 (SR 2) | S2 | P | | P | | |
| | — K.4 (SR 9) (fill in type) | S9Q«....» | | | | P | |
| | — K.8 (SR 13) | S13 | | D or P | | P | |
| | — K.9 (SR 16) (fill in minimum full-size energy absorption requirement, in joules, and test temperature including ± symbol and °C) | S16«....»C | P | | P | | |
| | — K.10 (SR 22) | S22 | P | D | P | D | |
| | — K.14 (SR 41) | S41.1 | P | | P | | |
| | | S41.2 | P | | P | | |
| | — Annex H (PSL) | L2 or L3 | P | P | P | P | P |
| 12 | Hydrostatic test pressure [e] (fill in the actual test pressure, in MPa) | | | | | | |
| | All designations | P«....» | P | | P | | |
| 13 | Type of thread, if applicable | «....» [h] | P | P | P | P | |

**Table C.48—Marking Requirements and Sequence (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 Materials |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 14 | Full-length drift test, if applicable: | | | | | | |
| | — Standard (casing or tubing) | D | | | | | |
| | — Alternative (casing or tubing) where «  » is the size of the alternative drift | DA«....» | | | | | |
| | — For casing specified for tubing service and drift-tested in accordance with 8.10 | DT42 | | | | | |
| | All designations | | P | | P | | |
| 15 | Serialization of Grades C90, T95, C110, and Q125 | | | | D [d] or P | D [d] 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 color code requirements.

[a] D = optional (die) stamping (for location see 11.2.3); P = requirement for (paint) stencilling (for location see 11.3); Additional marking is permitted as specified in 11.1.10.

[b] A blank space, «....», indicates information to be filled in.

[c] The manufacturer may include “API” before “5CT”.

[d] Stamp marking shall conform to the requirements of 11.2.

[e] 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 1000 (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.

[f] “A” when tested using Method A (smooth tensile), “B” when tested using Method B (bent beam), “D” when tested using Method D (DCB).

[g] For Grade C110 only, “DA” when tested using a test solution other than NACE TM0177-2016 Test Solution A.

[h] See Table C.47 for thread type markings.

**Table C.49—Retention of Records**

| Requirement | Sub-section Reference |
|---|---|
| **Chemical Properties** | |
| Heat analysis | 10.3.1 |
| Product analysis | 10.3.2 |
| **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, 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 |
| Supplemental inspection when hydrostatic test pressure is limited, if applicable | K.14.1 (SR 41.1), K.14.2 (SR 41.2) |
| **Manufacturer Certification** | |
| Results of all required tests | 13.3 |
| Sulfide stress-cracking test (Grades C90, T95, and C110) | 7.14, 10.10 |
| Calibration | Various |

**Table C.50—SR 11.1—Distance between Plates for Flattening Tests**

| Grade | $D/t$ ratio | Distance between Plates max mm |
|---|---|---|
| P110 | All ratios | $D \times (1.086 - 0.0163\ D/t)$ |
| Q125 | All ratios | $D \times (1.092 - 0.0140\ D/t)$ |

NOTE

$D$ is the specified outside diameter of pipe, in millimeters.

$t$ is the specified wall thickness of the pipe, in millimeters.

**Table C.51—SR 12.1—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 |

**Table C.52—SR 12.2—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 | 0.99997 (or 100 %) |
| 1/100 | 0.634 (or 63 %) |
| 1/1000 | 0.095 (or 10 %) |
| 1/10,000 | 0.00995 (or 1 %) |

**Table C.53—SR 16.1—Transverse Impact Specimen Size Required**

| Label 1 | Calculated Wall Thickness Required to Machine Transverse Charpy Impact Specimens mm | | |
|---|---|---|---|
| | Full-size | 3/4-size | 1/2-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 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.

**Table C.54—SR 16.2—Longitudinal Impact Specimen Size Required**

| Label 1 | Calculated Wall Thickness Required to Machine Longitudinal Charpy Impact Specimens mm | | |
|---|---|---|---|
| | Full-size | 3/4-size | 1/2-size |
| 1 | 2 | 3 | 4 |
| 1.050 | 11.97 | 9.47 | 6.97 |
| 1.315 | 11.77 | 9.27 | 6.77 |
| 1.6660 | 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 API pipe are for information only; The measurements in this table provide a 0.50 mm inside-wall and a 0.50 mm outside-wall machining allowance.

**Table C.55—SR 16.3—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 |
| $^{3}/_{4}$-size | 10.0 × 7.5 | 0.80 |
| $^{1}/_{2}$-size | 10.0 × 5.0 | 0.55 |

**Table C.56—SR 16.4—Hierarchy of Test Specimen Orientation and Size**

| Choice | Orientation | Size |
|---|---|---|
| 1st | Transverse | Full-size |
| 2nd | Transverse | $^{3}/_{4}$-size |
| 3rd | Transverse | $^{1}/_{2}$-size |
| 4th | Longitudinal | Full-size |
| 5th | Longitudinal | $^{3}/_{4}$-size |
| 6th | Longitudinal | $^{1}/_{2}$-size |

**Table C.57—SR 16.7—Test Temperature Reduction for Sub-size Specimens for Grades H40, J55, and K55 Only**

| Specimen Size | Specified Pipe Wall Thickness | Temperature Reduction |
|---|---|---|
| mm | mm | °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 SR 22.1

| 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 |
| 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 | 92.08 | 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 |

**Table C.58—Enhanced Leak Resistance SR 22.1 (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* |
| 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 | 104.78 | 721 | — | 30 |
| 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 |

**Table C.58—Enhanced Leak Resistance SR 22.1 (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 | 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 |
| 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 |

**Table C.58—Enhanced Leak Resistance SR 22.1 (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* |
| 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 | 220.45 | 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 |
| 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 Type 1 and N80Q.

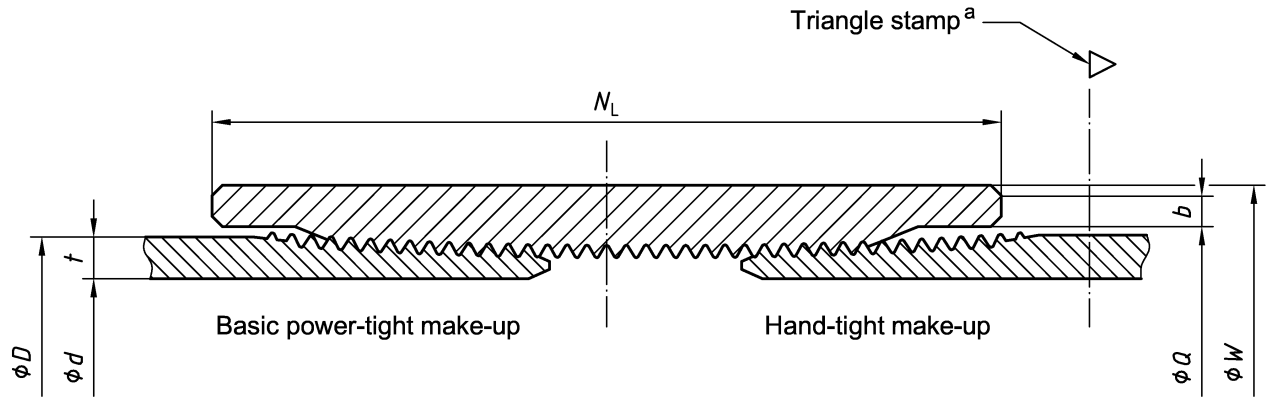
[b] End of pipe to apex of triangle.

[c] The recommended mass of thread compound shown in this table is for a compound containing metals, including lead (i.e. former API Bulletin 5A2) which has a specific gravity of approximately 2; Use of compounds such as described in API 5A3 or ISO 13678 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.

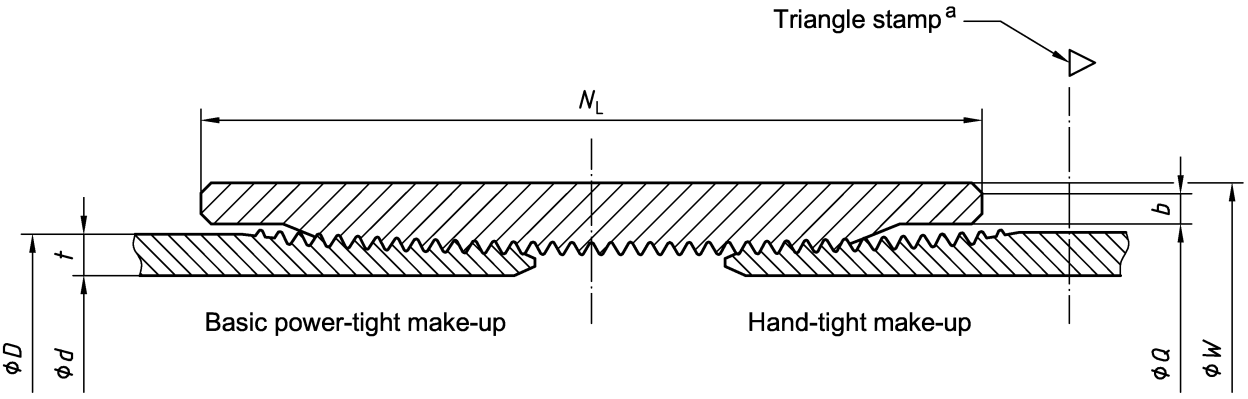
# Annex D
(normative)

# 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 5B for $L_4$.

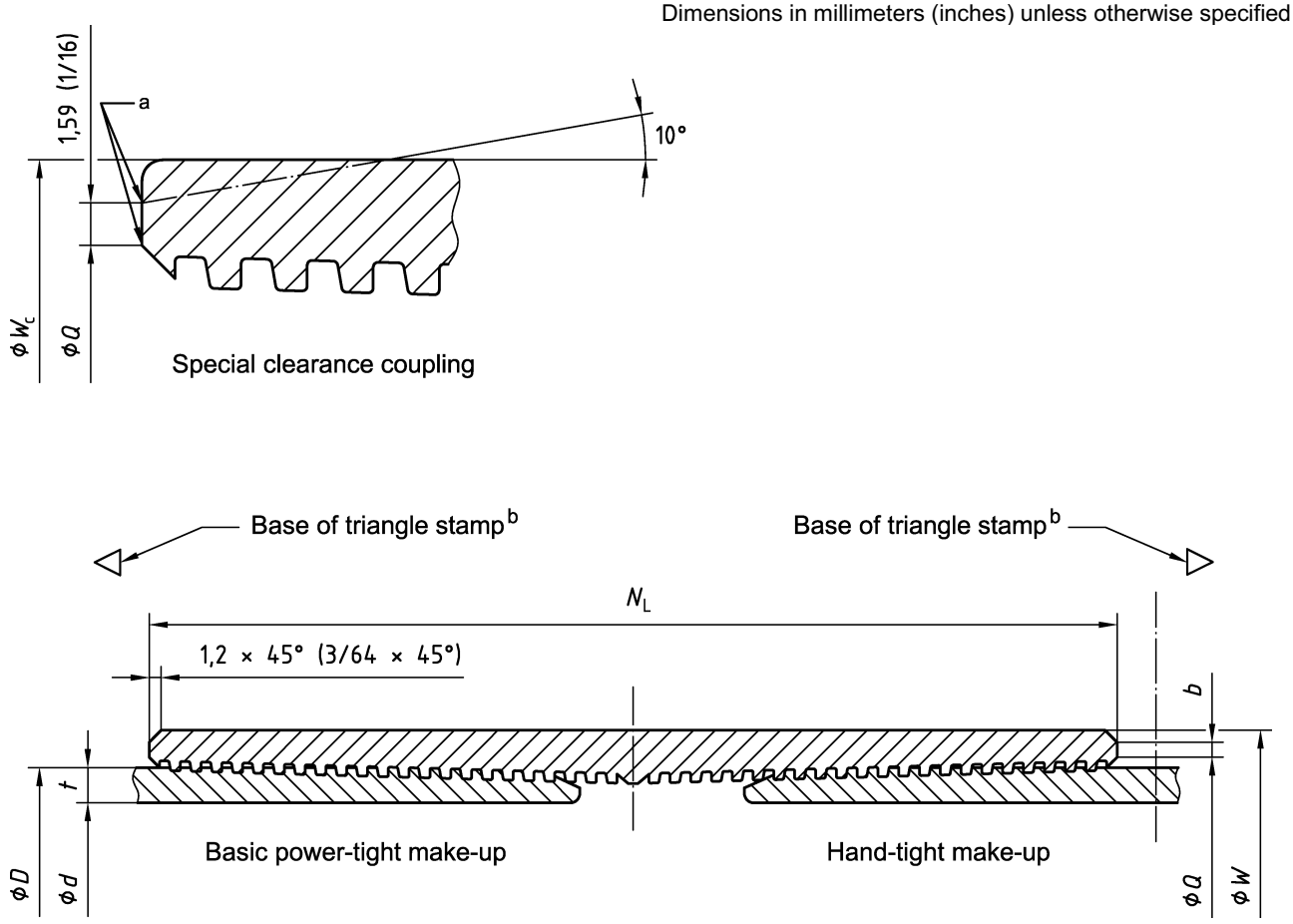
**Figure D.1—Short Round-thread Casing and Coupling**




[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 5B for $L_4$.

**Figure D.2—Long Round-thread Casing and Coupling**

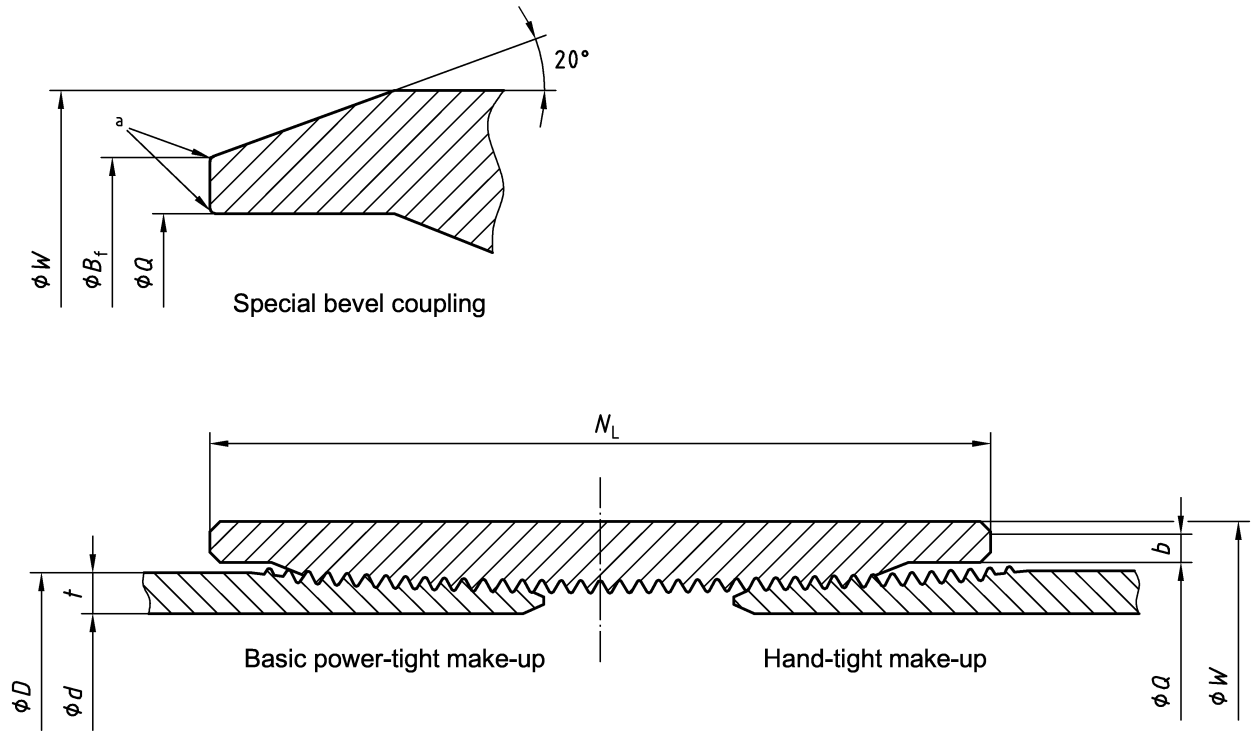
Dimensions in millimeters (inches) unless otherwise specified




[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 5B for A1.

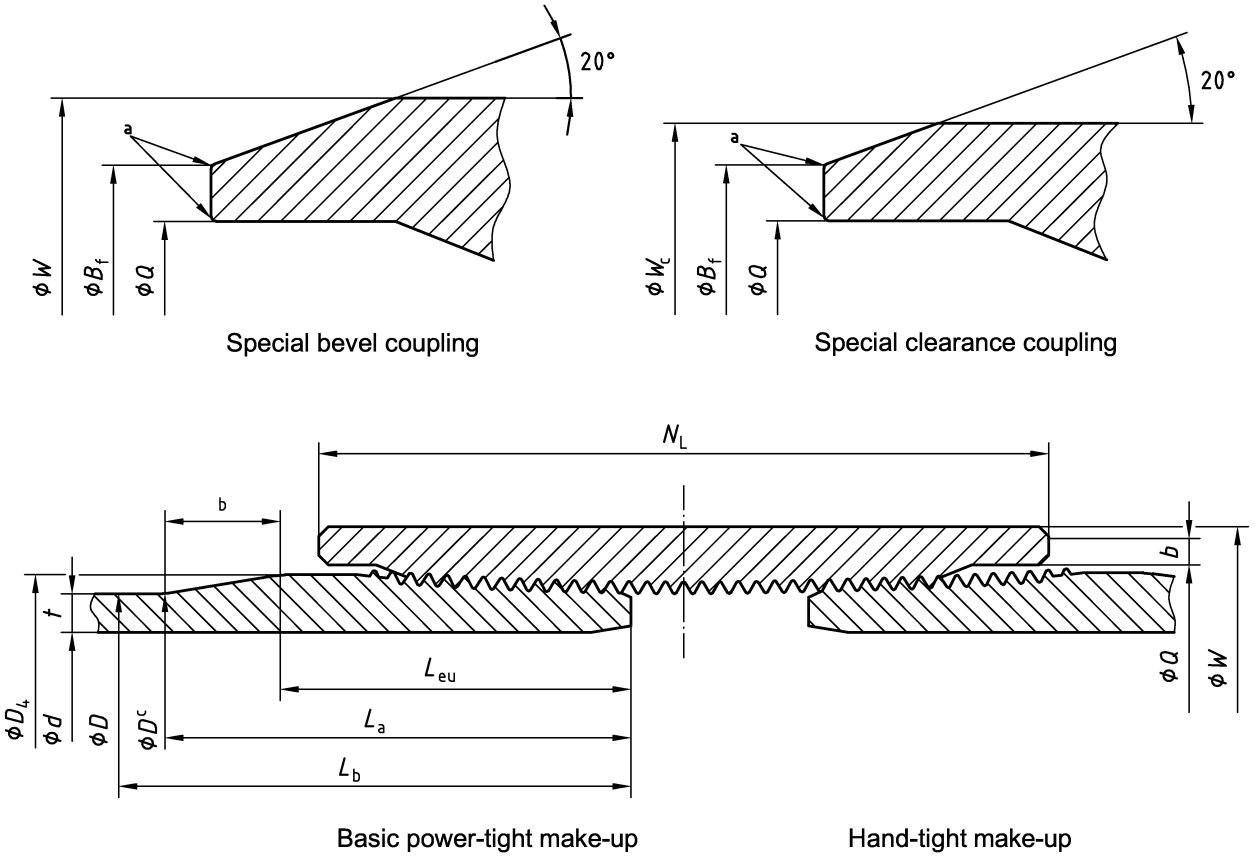
**Figure D.3—Buttress-thread Casing and Coupling**




NOTE See Table C.24 or Table E.24 for pipe dimensions, Table C.34 or Table E.34 for coupling dimensions, and API 5B for thread details.

[a] On special bevel couplings, the inside and outside edges of the bearing face shall be broken or rounded.

**Figure D.4—Non-upset Tubing and Coupling**



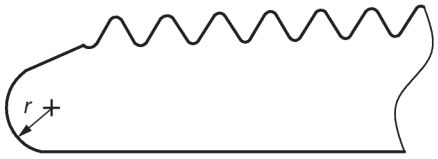

NOTE See Tables C.24 and C.25 or Tables E.24 and E.25 for pipe dimensions, Table C.35 or Table E.35 for coupling dimensions, and API 5B for thread details.

[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.

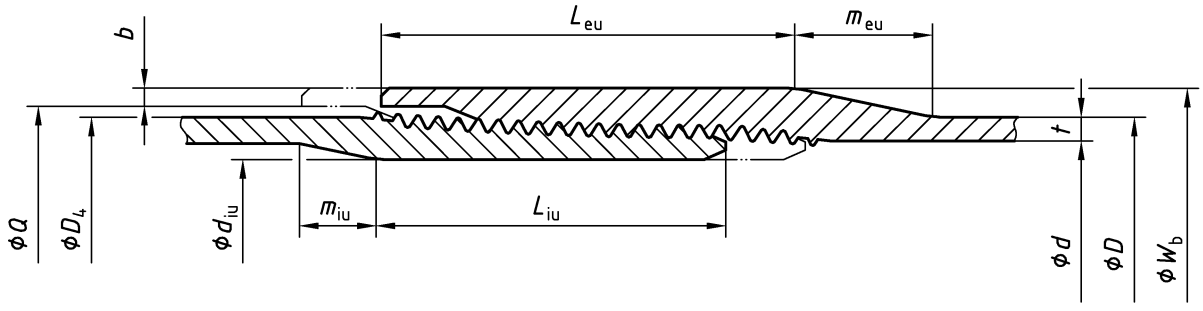
[c] See 8.11.1 for tolerance on outside diameter at a distance $L_a$ from end of pipe.

**Figure D.5—External-upset Tubing and Coupling**



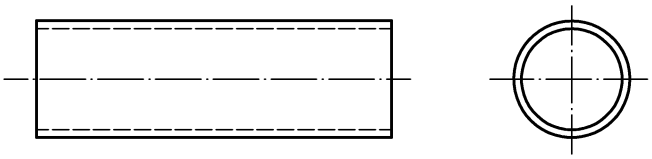

| Label 1 | Radius [a] r mm (in.) |
|---|---|
| *1* | *2* |
| 2 3/8 | 2.4 (3/32) |
| 2 7/8 | 2.4 (3/32) |
| 3 1/2 | 3.2 (1/8) |
| 4 1/2 | 3.2 (1/8) |
| NOTE See API 5B for product acceptance. | |
| [a] These dimensions are for reference only and are not subject to measurement for determining product acceptance. | |

**Figure D.6—Rounded Nose for External-upset Tubing**

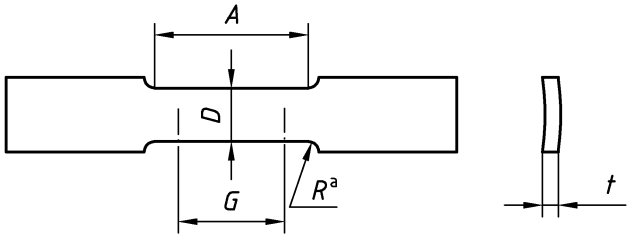



NOTE 1 Dashed lines indicate power-tight make-up.
NOTE 2 See Tables C.24 and C.26 or Tables E.24 and E.26 for pipe dimensions, and API 5B for thread details.

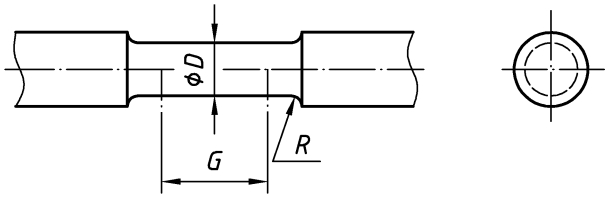
**Figure D.7—Integral-joint Tubing**



**a) Full-section specimen**




**b) Strip specimen** [a]

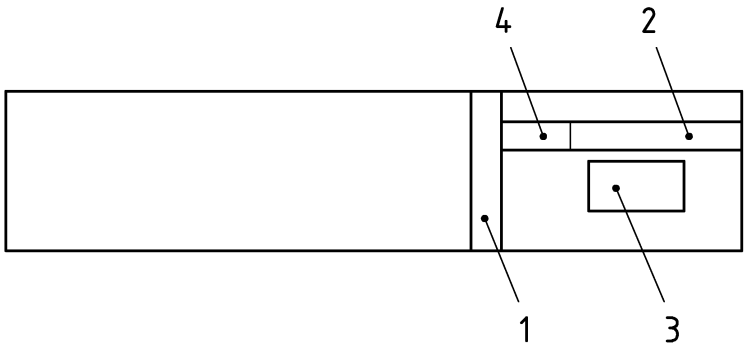



**c) Round bar specimen**

| 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) approximately | 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**




**Key**

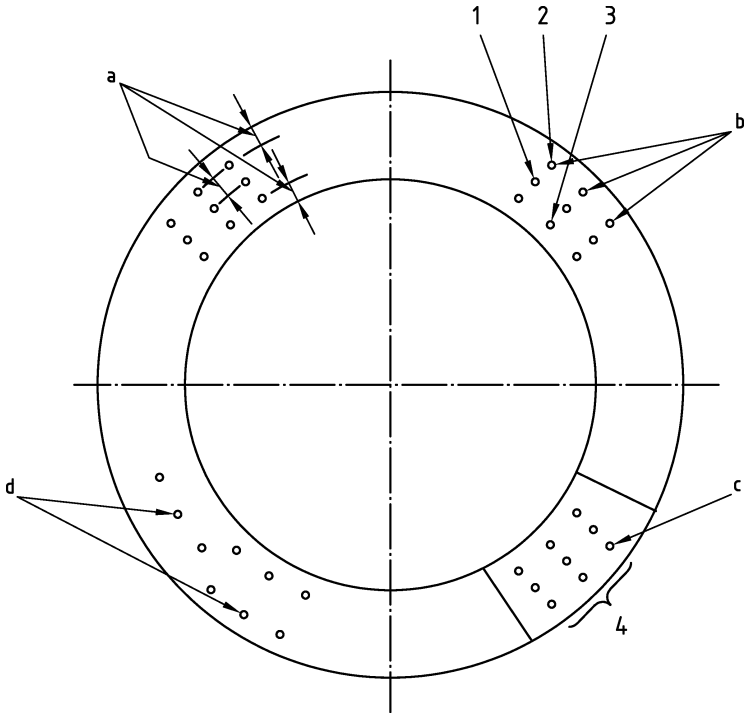
1 Hardness test ring [see Figure D.10 for detail, 6.4 mm (0.25 in.) minimum thickness].

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.

**Figure D.9—Example 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

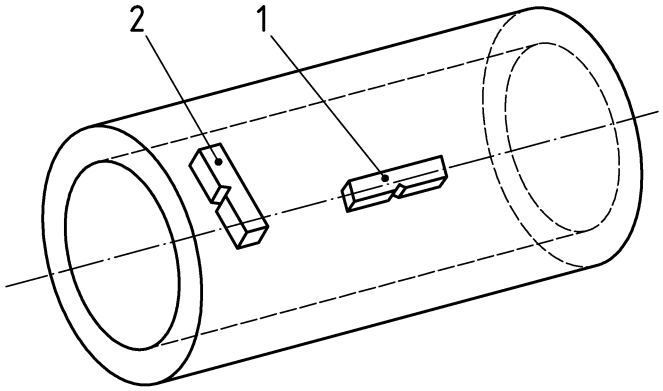
[a] The outside-wall and inside-wall tests shall be taken between 2.54 mm (0.10 in.) and 3.81 mm (0.15 in.) from the applicable surface; An error may result if an indentation is spaced closer than 2 $^{1}/_{2}$ diameters from its center to the edge of the specimen or three diameters from another indentation measured center-to-center.

[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**



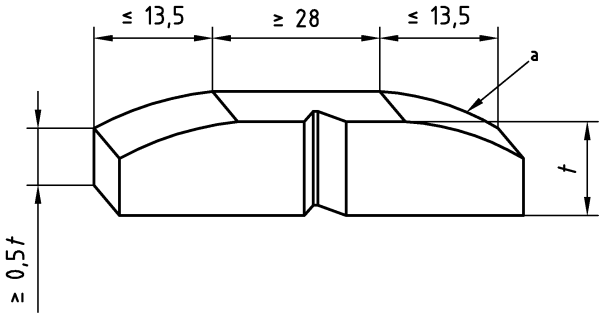

**Key**

1 Longitudinal specimen
2 Transverse specimen

[a] All impact test specimens shall be 10 mm × 10 mm (0.394 in. × 0.394 in.) if possible.
[b] The notch shall be oriented perpendicular to the axis of the tube (normal to the tube surface).

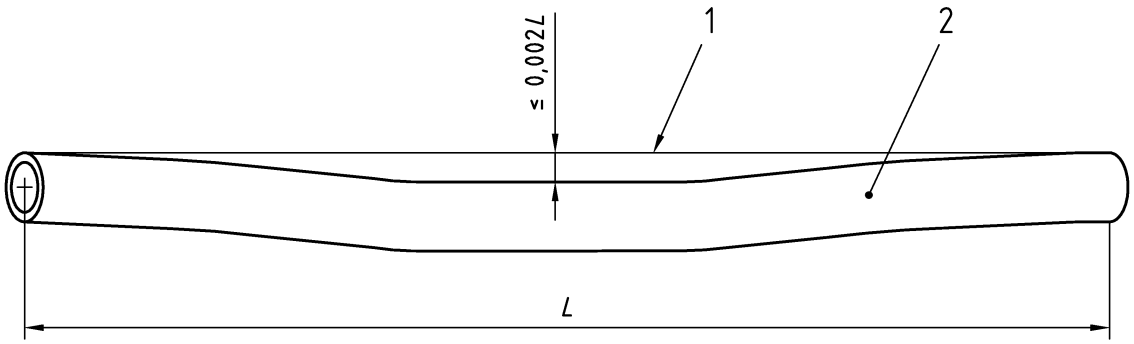
**Figure D.11—Impact Test Specimen Orientation [a, b]**

Dimensions in millimeters




[a] Outside diameter curvature.

**Figure D.12—Charpy Specimen Dimensions**



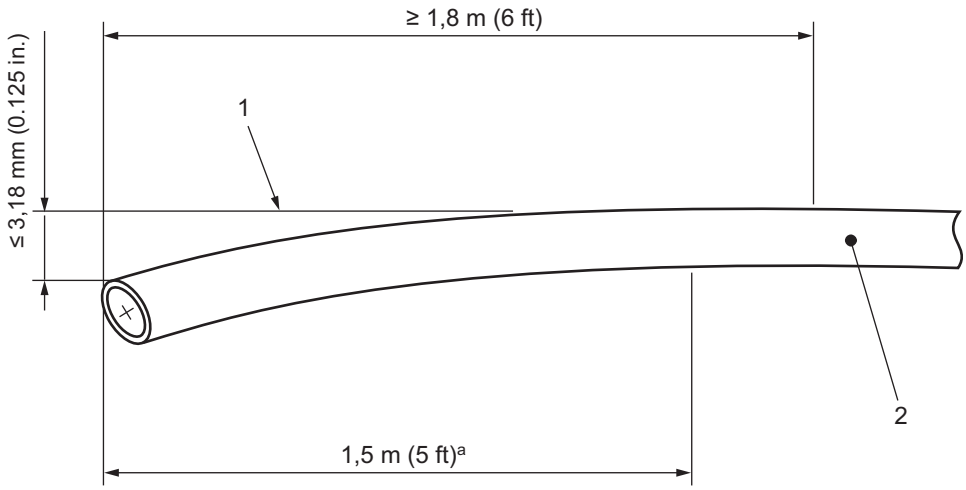

**Key**

1 Taut string or wire

2 Pipe

**Figure D.13—Measuring Full-length Straightness**

Dimensions in millimeters (inches) unless otherwise specified



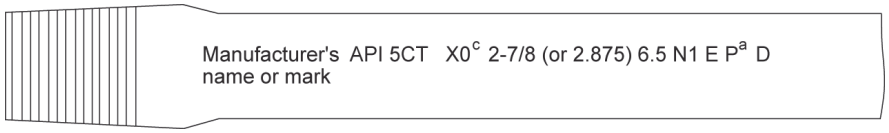

**Key**

1 Straight line

2 Pipe

[a] Hooked end.

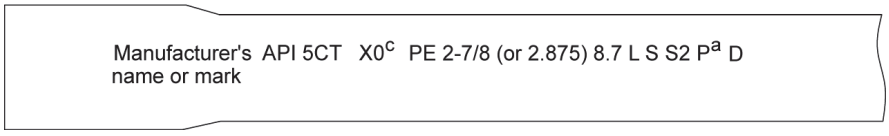
**Figure D.14—Measuring End Straightness**




**Stencil Marking** [beginning at least 0.6 m (2 ft) from either externally threaded end]

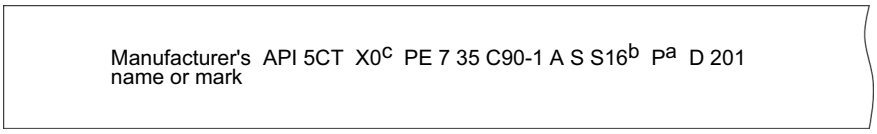
**Stamp Marking—Optional** [within approximately 0.3 m (1 ft) of either externally threaded end]

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 SR 2.

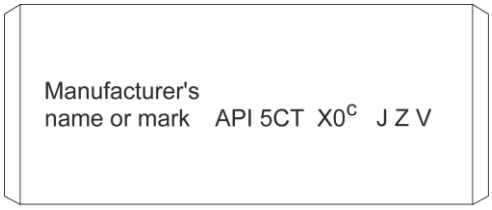



**Stencil Marking** [beginning at least 0.6 m (2 ft) from either end]

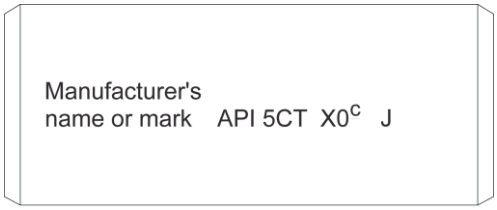
**Stamp Marking—Optional** [within approximately 0.3 m (1 ft) from either end]

c) **EXAMPLE 3**—Casing Label 1: 7, Label 2: 35, Grade C90 Type 1, seamless, plain-end, serial number 201. Supplementary requirement 16 (SR 16) for test at −10 °C (+14 °F). The pipe was pressuretested to 69 MPa (10,000 psi).

**Figure D.15—Examples of Marking Requirements and Sequence for Manufacturers and Threaders Using Section 11 and Table C.48 or E.48**

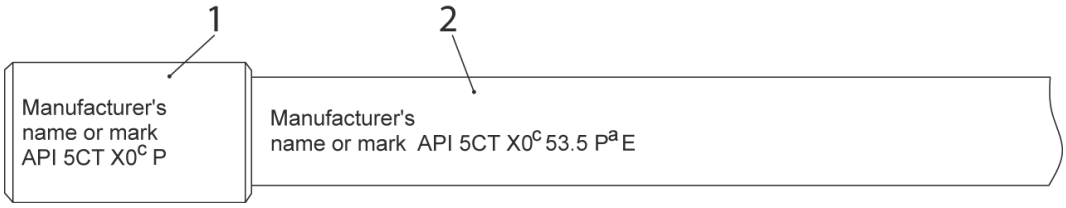



**Stencil Marking**

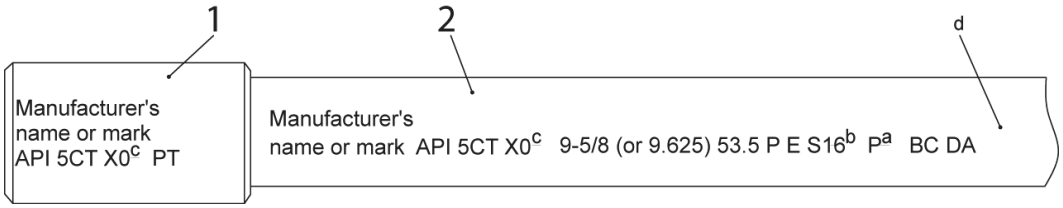



**Stamp Marking—Optional**

d) **EXAMPLE 4** [e]—Tubing coupling for Label 1; 2 7/8, Grade J55, normalized upset (or non-upset) tubing, only visual inspection required.



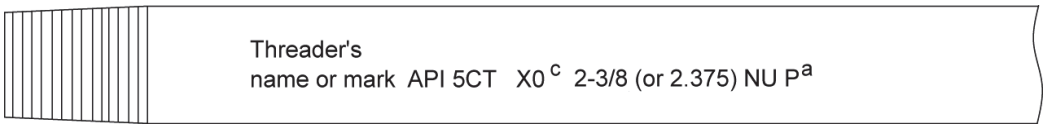

**Stamp Marking—Optional** [within approximately 0.3 m (1 ft) from the coupling]




**Stencil Marking** [beginning not less than 0.6 m (2 ft) from the coupling]

**e) EXAMPLE 5** [e] —Buttress casing with coupling: Label 1: 9-5/8, Label 2: 53.5, Grade P110, electric weld; supplementary requirements are SR 11 and SR 16 for test at −18 °C (0 °F) and 215.9 mm (8.500 in.) drift test. Coupling is tin-plated.

**Figure D.15—Examples of Marking Requirements and Sequence for Manufacturers and Threaders Using Section 11 and Table C.48 or E.48 (Continued)**




**Stencil Marking (adjacent to the threads)**

**f) EXAMPLE 6** [f]—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 (6300 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.

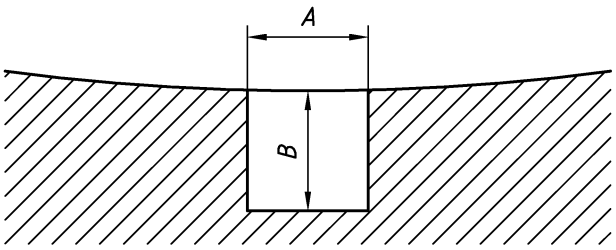
[c] Date of manufacture: This example is for product manufactured in accordance with the current edition of API 5CT during the period of overlap with application (see 11.1.9) of the previous edition; Note that "X" is used for the last digit of the year of manufacture so that it is a generic example, and will not change with subsequent editions of this standard; For examples of other dates of manufacture, see Figure D.22.

[d] Express alternative drift diameter in millimeters for pipe manufactured to SI units and in inches for pipe manufactured to USC units.

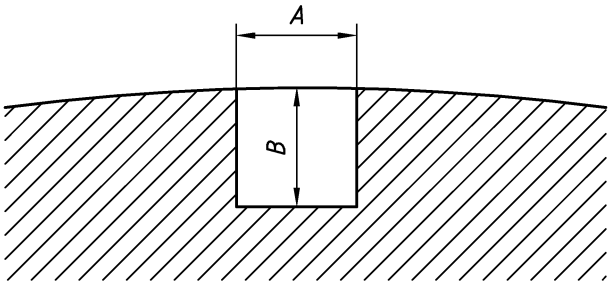
[e] Marking in the center of the coupling may be in either the longitudinal or transverse direction.

[f] Threader stencil marking shall be placed adjacent to the threads and is in addition to marking applied by other pipe manufacturers.

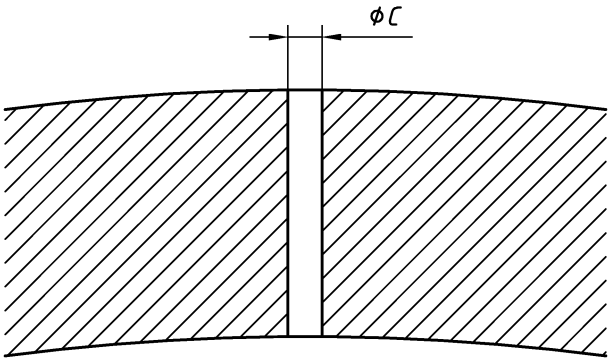
**Figure D.15—Examples of Marking Requirements and Sequence for Manufacturers and Threaders Using Section 11 and Table C.48 or E.48 (Continued)**




**a) Notch—Inner Surface** [a]

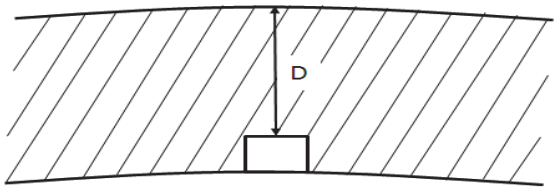



**b) Notch—Outer Surface** [a]




**c) Drilled Hole**

**Figure D.16—Reference Indicators**




**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:

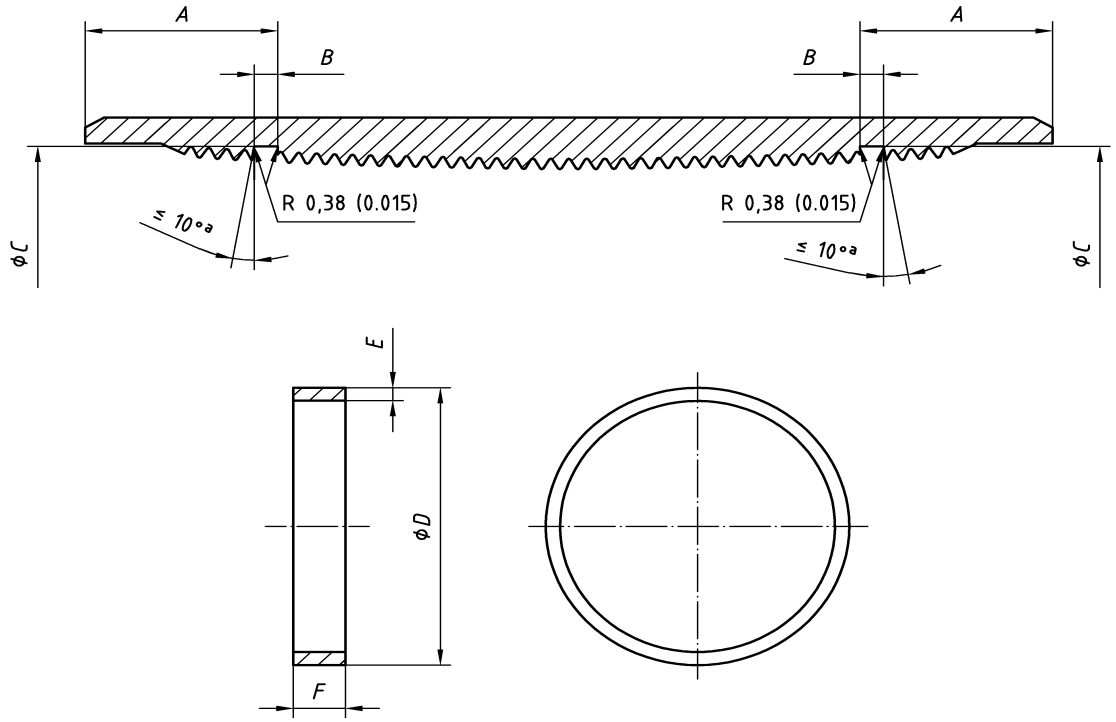
— For eddy current, 38.10 mm (1.5 in.) maximum total length;

— 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 (Continued)**

Dimensions in millimeters (inches)

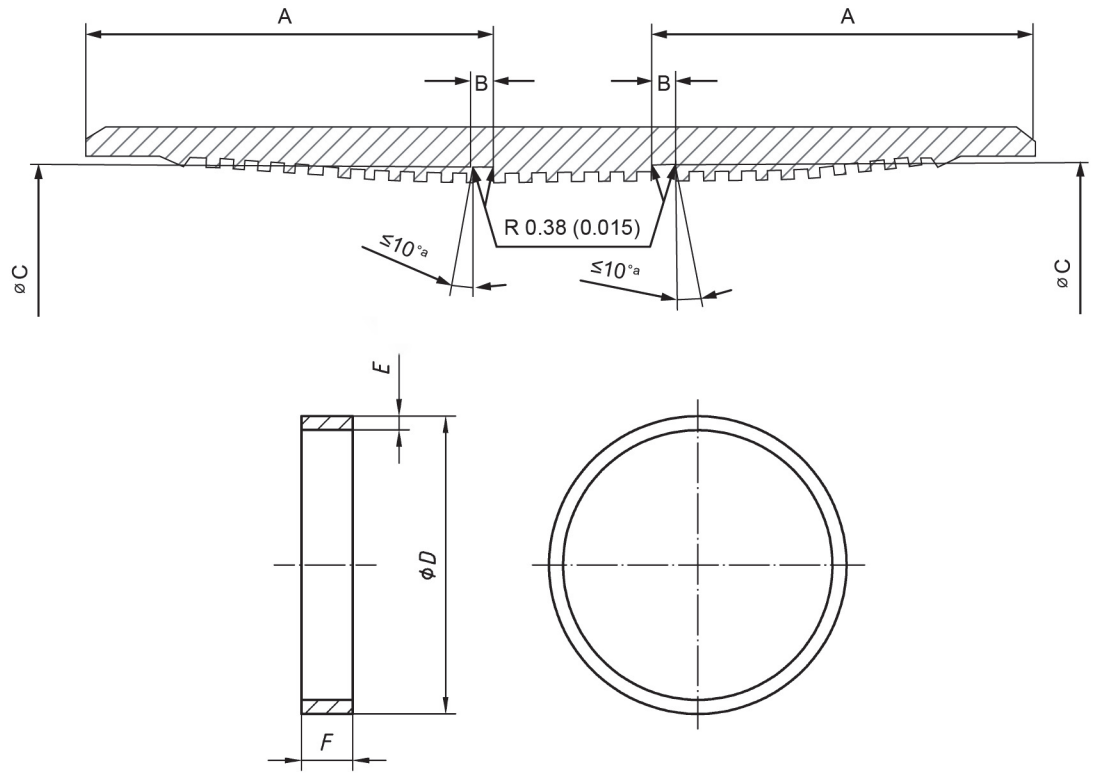



[a] Angle optional; Seal-ring groove and thread pitch diameter shall be concentric within 0.51 mm (0.020 in.) of indicated thread run-out.

| 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) |

**Figure D.17—SR 13.1 Seal-ring Coupling and Non-metallic Ring for Round-thread Casing**

Dimensions in millimeters (inches)



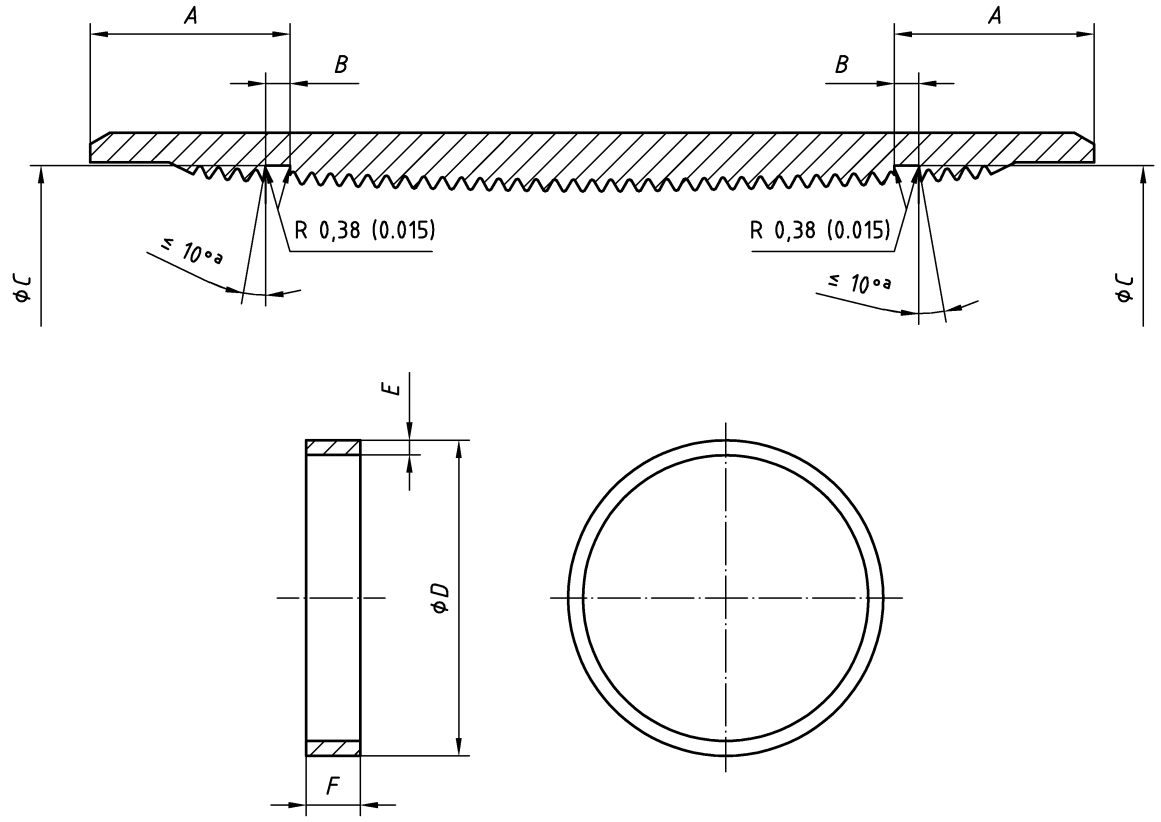

[a] Angle optional.

[b] Seal-ring groove and thread pitch diameter shall be concentric within 0.51 mm (0.020 in.) of indicated thread run-out.

| Buttress Casing Label 1 | Outside Diameter | Coupling Dimensions [b] 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) |

**Figure D.18—SR 13.2 Seal-ring Coupling and Non-metallic Ring for Buttress-thread Casing**

Dimensions in millimeters (inches)



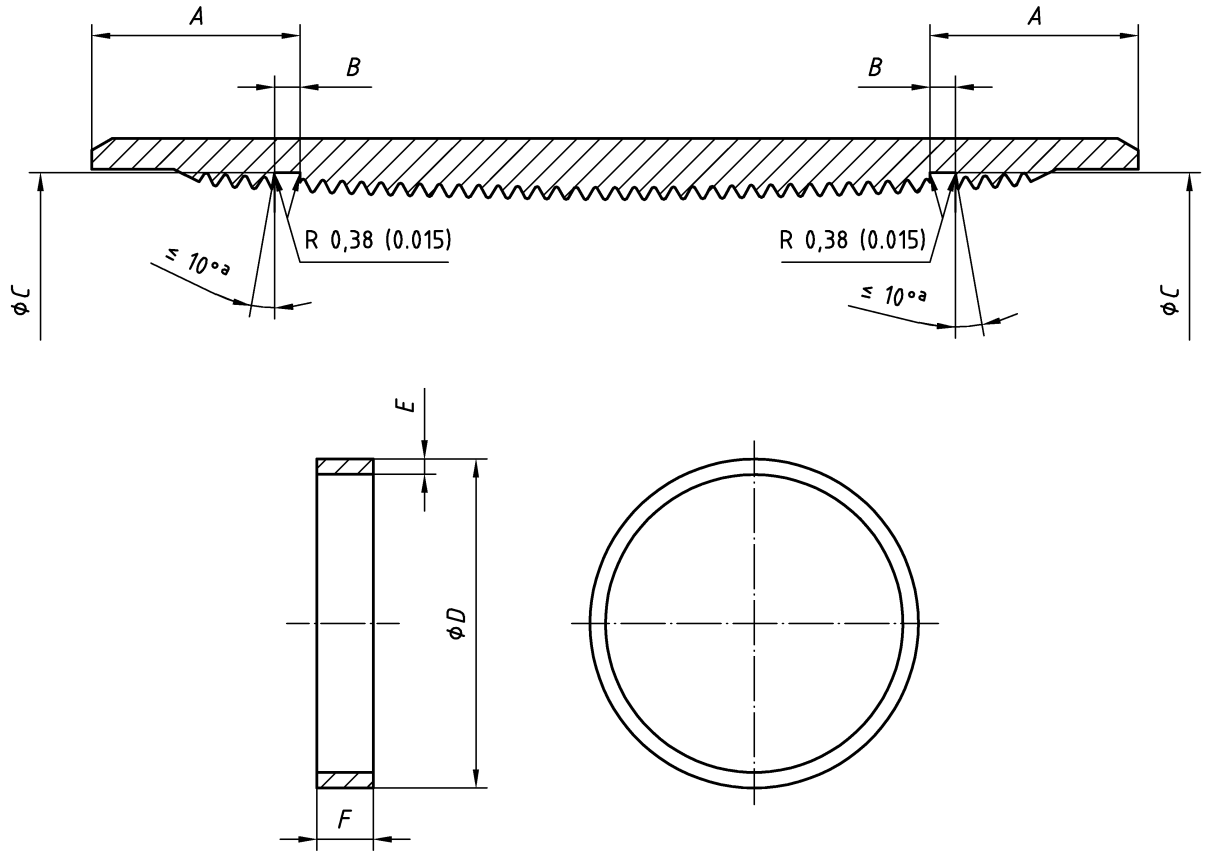

[a] Angle optional.

[b] Seal-ring groove and thread pitch diameter shall be concentric within 0.51 mm (0.020 in.) of indicated thread runout.

| Non-upset Tubing Size Label 1 | Outside Diameter | Coupling Dimensions [b] 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* $^{+0.13}_{0}$ $\left(^{+0.005}_{0}\right)$ | *F* $^{+0.38}_{0}$ $\left(^{+0.015}_{0}\right)$ |
| *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) |

**Figure D.19—SR 13.3 Seal-ring Coupling and Non-metallic Ring for Non-upset Tubing**

Dimensions in millimeters (inches)



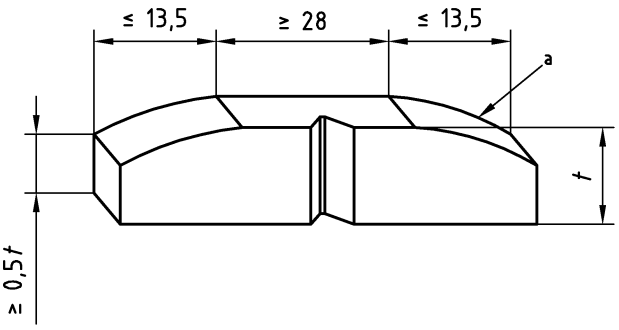

[a] Angle optional.

[b] Seal-ring groove and thread pitch diameter shall be concentric within 0.51 mm (0.020 in.) of indicated thread run-out.

| EU Tubing Size Label 1 | Outside Diameter | Coupling Dimensions [b] 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* $^{+0.13}_{0}$ $\left(^{+0.005}_{0}\right)$ | *F* $^{+0.38}_{0}$ $\left(^{+0.015}_{0}\right)$ |
| *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) |

**Figure D.20—SR 13.4-Seal-ring Coupling and Non-metallic Ring for Upset Tubing**

Dimensions in millimeters



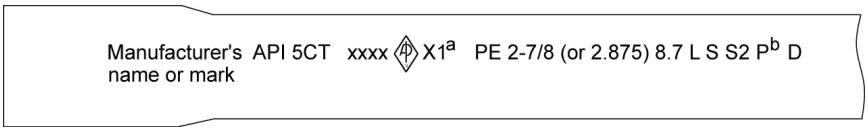

[1] Outside diameter curvature.

**Figure D.21—SR 16.1**

**Stencil Marking** [beginning at least 0.6 m (2 ft) from either externally threaded end]

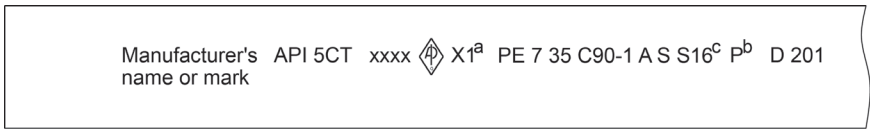
**Stamp Marking—Optional** [within approximately 0.3 m (1 ft) of either externally threaded end]

**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. January 20XX.




**Stencil Marking** [beginning at least 0.6 m (2 ft) from either end]

**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 SR 2. January 20XX.




**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]

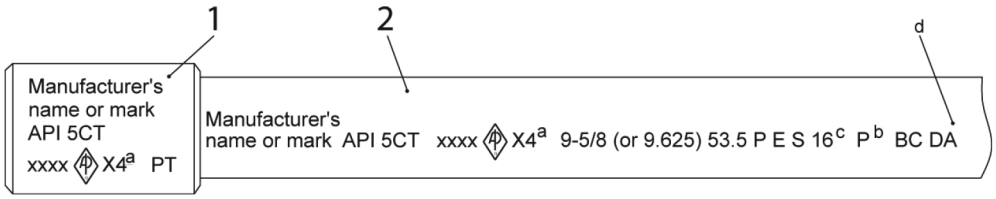
**EXAMPLE 3**—Casing Label 1: 7, Label 2: 35, Grade C90 Type 1, seamless, plain-end, serial number 201. Supplementary requirement 16 (SR 16) for test at −10 °C (+14 °F). The pipe was pressure tested to 69 MPa (10,000 psi). February 20XX.

**Figure D.22—Examples of Marking Requirements and Sequence for Manufacturers and Threaders using the API Monogram (Annexes A and F), Section 11, and Table C.48 or E.48**

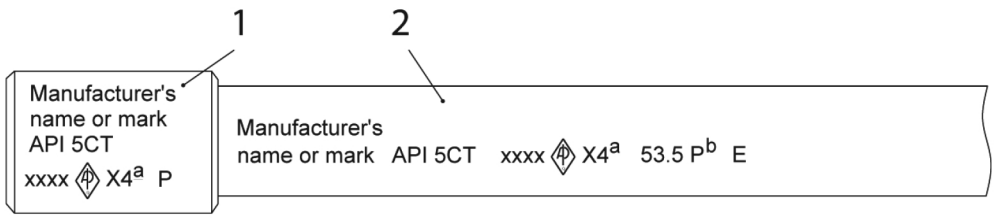
**Stencil Marking**

**Stamp Marking—Optional**

**d) EXAMPLE 4** [e] —Tubing coupling for Label 2 7/8, Grade J55, normalized upset (or non-upset) tubing, only visual inspection required. April 20XX.




**Stencil Marking** [beginning not less than 0.6 m (2 ft) from the coupling]




**Stamp Marking—Optional** [within approximately 0.3 m (1 ft) from the coupling]

**e) EXAMPLE 5** [e]—Buttress casing with coupling: Label 1: 9 5/8, Label 2: 53.5, Grade P110, electric weld; supplementary requirements are SR 11 and SR 16 for test at −18 °C (0 °F) and 215.9 mm (8.500 in.) drift test. Coupling is tin-plated. December 20XX.

**Figure D.22—Examples of Marking Requirements and Sequence for Manufacturers and Threaders using the API Monogram (Annexes A and F), Section 11, and Table C.48 or E.48 (Continued)**

**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 $^{7}/_{8}$, Label 2: 4, Grade J55 non-upset thread, and hydrostatically tested to alternative test pressure of 43.5 MPa (6300 psi). July 20XX.

**Key**

1 coupling

2 pipe

[a] API license number, API monogram, date of manufacture (see Section 11); 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 standard.

[b] Express pressure in megapascals for pipe manufactured to SI units, and in pounds per square inch for pipe manufactured to USC units.

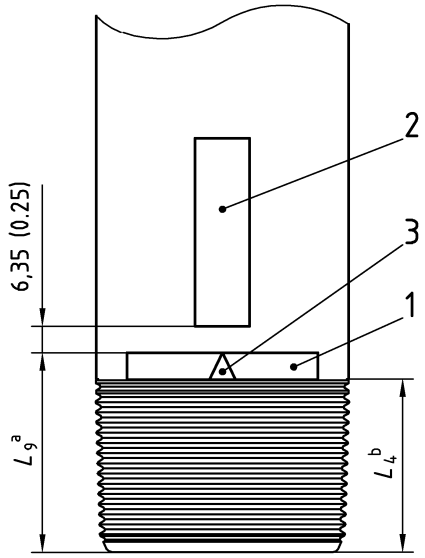
[c] Express the CVN requirements in joules and the temperature in degrees Celsius for pipe manufactured to SI units, and in foot–pounds and degrees Fahrenheit for pipe manufactured to USC units.

[d] Express alternative drift diameter in millimeters for pipe manufactured to SI units, and in inches for pipe manufactured to USC units.

[e] Marking in the center of the coupling may be in either the longitudinal or transverse direction.

**Figure D.22—Examples of Marking Requirements and Sequence for Manufacturers and Threaders using the API Monogram (Annexes A and F), Section 11, and Table C.48 or E.48 (Continued)**

Dimensions in millimeters (inches)




**Key**

1 Paint mark, of high visibility green color.

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.

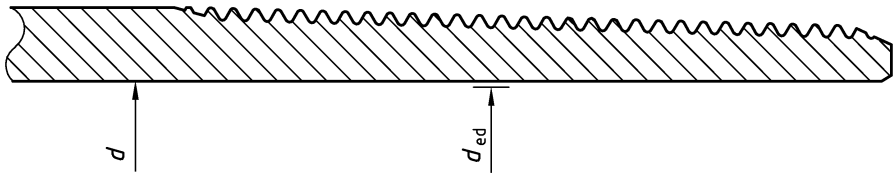
[a] Maximum make-up length: end of pipe to triangle apex.

[b] Total length: end of pipe to vanish point.

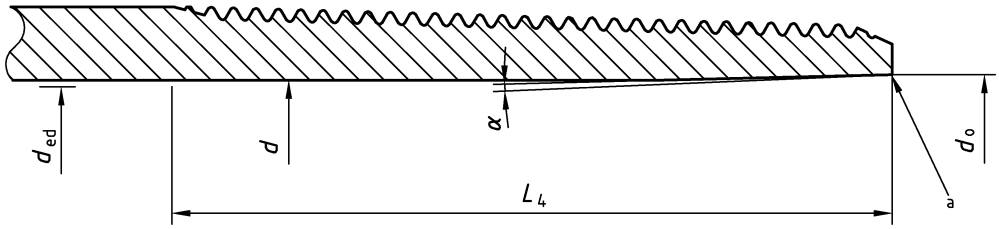
| Triangle Stamp Location | | |
|---|---|---|
| **Label 1** | $L_4$ | $L_9$ $^{0}_{-1.59}$ mm ($^{0}_{-1/16}$ in.) |
| *1* | *2* | *3* |
| 4 1/2 | 76.20 (3.000) | 82.55 (3.250) |
| 5 | 85.73 (3.375) | 92.11 (3.625) |
| 5 1/2 | 88.90 (3.500) | 95.25 (3.750) |
| 6 5/8 | 98.43 (3.875) | 104.78 (4.125) |
| 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) |
| 9 5/8 | 120.65 (4.750) | 127.00 (5.000) |

**Figure D.23—SR 22.1 Field-end Paint Mark and Triangle Stamp (Stamp on Mill and Field Ends)**

Dimensions in millimeters (inches)




**a) Option 1**




**b) Option 2**

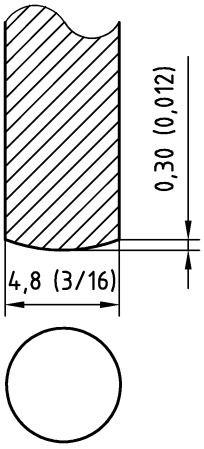
[a] Break edge.

| 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) |

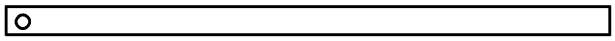
| Option 2—Bored | | | | | | |
|---|---|---|---|---|---|---|
| **Label 1** | **Label 2** | **Special End Drift Diameter** $d_{ed}$ ±0.13 (±0.005) | **Inside Diameter** $d$ | **Bore Length** $L_4$ max | **Bore Diameter** $d_0$ ±0.38 (±0.015) | **Bore Angle** α |
| *1* | *2* | *3* | *4* | *5* | *6* | *7* |
| 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° |

**Figure D.24—SR 22.2 Optional Tapered Bore along Inside Diameter Specifications**

Dimensions in millimeters (inches)




**a) Rounded Contact Point**

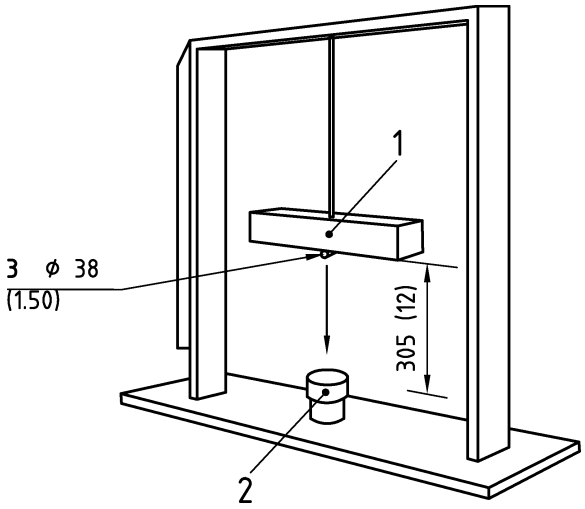


**b) Top View**

**c) Side View**

**Figure D.25—Example of a 90° Hook-type Tool**

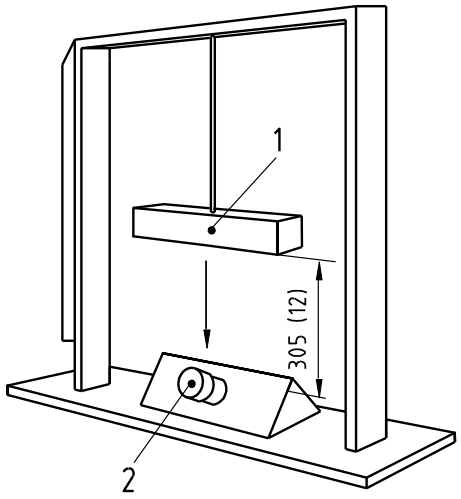
Dimensions in millimeters (inches)




**Key**
1 Flat steel plate
2 Test-piece set
3 Round steel bar

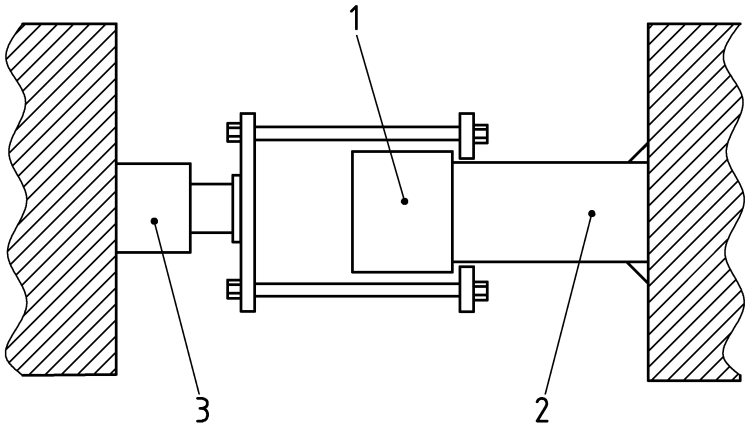
**Figure D.26—Axial Impact Test Apparatus**

Dimensions in millimeters (inches)




**Key**
1 Flat steel plate
2 Test-piece set

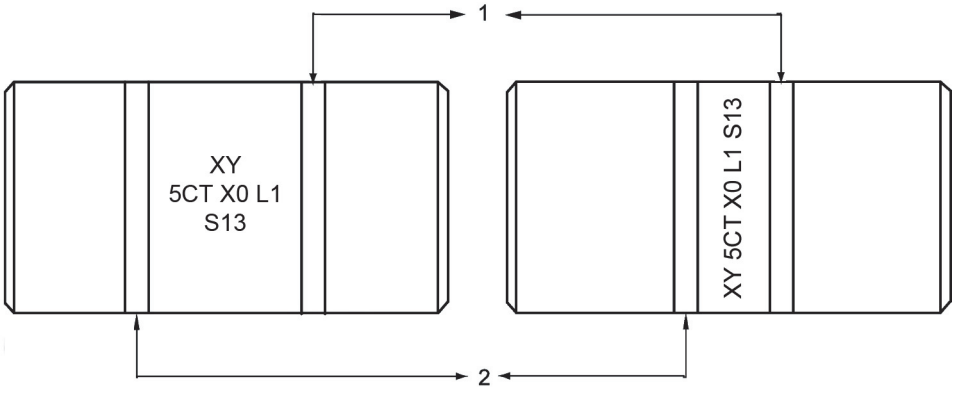
**Figure D.27—45º Impact Test Apparatus**




**Key**

1 Thread protector
2 Pipe section
3 Hydraulic cylinder

**Figure D.28—Stripping Test Apparatus**




**Key**

1 Blue seal-ring paint band
2 Grade or other paint band(s)

**Figure D.29—Seal-ring Paint Band Example**

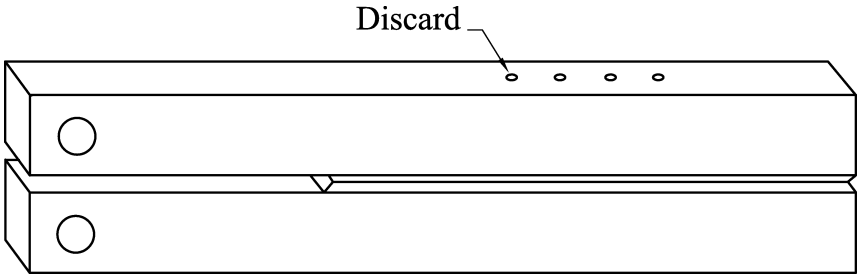



**Figure D.30—Location of Hardness Impressions on DCB Specimen**

# Annex E
(normative)

# Tables in USC Units

**Table E.1—API Casing List (sizes, masses, wall thickness, grade, and applicable end-finish)**

| Labels [a] | | Outside Diameter | Nominal Linear Mass [b,c] T&C | Wall Thick-ness | Type of End-finish [d, e] | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | *D* in. | lb/ft | *t* in. | H40 | J55 K55 | L80 R95 | N80 Type 1, Q | 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 |
| 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 | — | — |

**Table E.1—API Casing List (sizes, masses, wall thickness, grade, and applicable end-finish) (Continued)**

| Labels [a] | | Outside Diameter | Nominal Linear Mass [b,c] T&C | Wall Thick-ness | Type of End-finish [d, e] | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | *D* in. | lb/ft | *t* in. | H40 | J55 K55 | L80 R95 | N80 Type 1, Q | 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 | 26.40 | 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 | — | — |
| 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 |

**Table E.1—API Casing List (sizes, masses, wall thickness, grade, and applicable end-finish) (Continued)**

| Labels [a] | | Outside Diameter | Nominal Linear Mass [b,c] T&C | Wall Thick-ness | Type of End-finish [d, e] | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | *D* in. | lb/ft | *t* in. | H40 | J55 K55 | L80 R95 | N80 Type 1, Q | C90 T95 | C110 | P110 | Q125 |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| 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 | — | — | — | — | — | — |

NOTE 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 (Column 4) are shown for information only.

[c] The densities of martensitic chromium steels (L80 Types 9Cr and 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.

[d] Buttress casing is available with regular, special clearance couplings or special clearance couplings with special bevel.

[e] For casing with S, L, and B connections, intermediate wall thicknesses are allowed in accordance with 5.2.3 and 8.2 and API 5B.

## Table E.2—API Tubing List (sizes, masses, wall thickness, grade, and applicable end-finish)

| Labels | | | | Outside Diameter | Nominal Linear Masses [a, b] | | | Wall Thickness | Type of End-finish | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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 Type 1, Q | 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 | PNUI | 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 | — |
| 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 | — |

NOTE P = Plain-end, N = Non-upset threaded and coupled, U = External upset threaded and coupled, I = Integral joint.

[a] Nominal linear masses (Columns 6, 7, and 8) are shown for information only.

[b] The densities of martensitic chromium steels (L80 types 9Cr and 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.

**Table E.3—Process of Manufacture and Heat Treatment**

| Grade | Type | Manufacturing Process [a] | Heat Treatment [e] | Tempering Temperature °F min |
|---|---|---|---|---|
| *1* | *2* | *3* | *4* | *5* |
| H40 | — | S or EW | — | — |
| J55 [i] | — | S or EW | — [b] | — |
| K55 | — | S or EW | — [b] | — |
| N80 | 1 [i] | S or EW | [c] | — |
| N80 | Q | S or EW | Q [d] | — |
| R95 [i] | — | S or EW | Q | 1000 |
| L80 | 1 | S or EW | Q | 1050 |
| L80 | 9Cr [i] | S | Q [f] | 1100 |
| L80 | 13Cr | S | Q [f] | 1100 |
| C90 | 1 | S | Q | 1150 |
| T95 | 1 | S | Q | 1200 |
| C110 | — | S | Q | 1200 |
| P110 | — | S or EW [g, h] | Q | — |
| Q125 | 1 | S or EW [h] | Q | — |

[a] S = seamless process; EW = electric-welded process.

[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 6.2.2).

[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] Q = quenched and tempered.

[f] Types 9Cr and 13Cr may be air-quenched.

[g] Special chemical requirements for electric-welded P110 pipe are specified in Table E.4.

[h] Products shall be heat-treated full-body, full-length. Special requirements unique to electric-welded P110 and Q125 are specified in K.6 (SR 11).

[i] Quenched and tempered product in large $D/t$ ratio combinations and non-quenched and tempered product may exhibit ductile rupture values lower than internal yield values. See API 5C3/ISO 10400 calculated performance values in Columns 15 and 18 in Table K.1 and Table L.1.

## 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 |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| 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 | 9Cr | — | 0.15 | 0.30 | 0.60 | 0.90 | 1.10 | 8.00 | 10.0 | 0.50 | 0.25 | 0.020 | 0.010 | 1.00 |
| 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 | 1 | — | 0.35 | — | 1.20 | 0.25 [b] | 0.85 | — | 1.50 | 0.99 | — | 0.020 | 0.010 | — |
| T95 | 1 | — | 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 | 1 | — | 0.35 | | 1.35 | — | 0.85 | — | 1.50 | — | — | 0.020 | 0.010 | — |

NOTE 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.

## Table E.5—Tensile and Hardness Requirements

| Grade | Type | Total Elongation Under Load % | Yield Strength ksi | | Tensile Strength min ksi | Hardness [a,c] max | | Specified Wall Thickness | Allowable Hardness Variation [b] |
|---|---|---|---|---|---|---|---|---|---|
| | | | min | max | | HRC | HBW | in. | HRC |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 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 | 9Cr | 0.5 | 80 | 95 | 95 | 23.0 | 241 | — | — |
| L80 | 13Cr | 0.5 | 80 | 95 | 95 | 23.0 | 241 | — | — |
| C90 | 1 | 0.5 | 90 | 105 | 100 | 25.4 | 255 | ≤ 0.500 | 3.0 |
| | | | | | | | | 0.501 to 0.749 | 4.0 |
| | | | | | | | | 0.750 to 0.999 | 5.0 |
| | | | | | | | | ≥ 1.000 | 6.0 |
| T95 | 1 | 0.5 | 95 | 110 | 105 | 25.4 | 255 | ≤ 0.500 | 3.0 |
| | | | | | | | | 0.501 to 0.749 | 4.0 |
| | | | | | | | | 0.750 to 0.999 | 5.0 |
| | | | | | | | | ≥ 1.000 | 6.0 |
| C110 | — | 0.7 | 110 | 120 | 115 | 29.0 | 279 | ≤ 0.500 | 3.0 |
| | | | | | | | | 0.501 to 0.749 | 4.0 |
| | | | | | | | | 0.750 to 0.999 | 5.0 |
| | | | | | | | | ≥ 1.000 | 6.0 |
| P110 | — | 0.6 | 110 | 140 | 125 | — | — | — | — |
| Q125 | 1 | 0.65 | 125 | 150 | 135 | [b] | — | ≤ 0.500 | 3.0 |
| | | | | | | | | 0.501 to 0.749 | 4.0 |
| | | | | | | | | ≥ 0.750 | 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.

[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.

## 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 $^3/_4$ in. | Specimen Width 1 in. | Specimen Width $1\ ^1/_2$ in. | 60 | 75 | 95 | 100 | 105 | 115 | 125 | 135 |
| *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* | *12* |
| 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 | 0.861–0.873 | 0.646–0.654 | 0.431–0.436 | 29 | 24 | 19 | 18 | 17 | 16 | 15 | 14 |
| 0.650 | 0.847–0.860 | 0.635–0.645 | 0.424–0.430 | 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 |
| 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 |

## Table E.6—Elongation Table (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 $^3/_4$ in. | Specimen Width 1 in. | Specimen Width $1\ ^1/_2$ in. | 60 | 75 | 95 | 100 | 105 | 115 | 125 | 135 |
| *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* | *12* |
| 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 |
| 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 | 0.420–0.433 | 0.315–0.325 | 0.210–0.216 | 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 |
| 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 |

## Table E.6—Elongation Table (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 $^3/_4$ in. | Specimen Width 1 in. | Specimen Width 1 $^1/_2$ in. | 60 | 75 | 95 | 100 | 105 | 115 | 125 | 135 |
| *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* | *12* |
| 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 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.

**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 those 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 |
| 3/4-size | 10.0 × 7.5 | 0.80 |
| 1/2-size | 10.0 × 5.0 | 0.55 |

**Table E.9—Hierarchy of Test Specimen Orientation and Size**

| Choice | Orientation | Size |
|---|---|---|
| 1st | Transverse | Full-size |
| 2nd | Transverse | 3/4-size |
| 3rd | Transverse | 1/2-size |
| 4th | Longitudinal | Full-size |
| 5th | Longitudinal | 3/4-size |
| 6th | Longitudinal | 1/2-size |

**Table E.10—Charpy Impact Test Specimen Requirements for Couplings, Coupling Stock, Coupling Material, Coupling Blanks, and Accessory Material for 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 | — | — | — | — | — |
| 4 1/2 | T-7-12-B | T-7-12-B | — | L-7-16-A | 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-5-8-C | T-7-12-D | T-10-15-D | T-10-15-D |
| 6 5/8 | — | — | — | T-10-15-A | T-10-15-A | T-10-15-A | T-10-15-A |
| 7 | — | — | — | T-7-12-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 | — | 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 |

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.

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 = 3/4-size (i.e. 10 mm × 7.5 mm)

5 = 1/2-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

[a] Not thick enough to test.

[b] The information in this table assumes that special clearance couplings are machined from regular coupling blanks.

**Table E.11—Charpy Impact Test Specimen Requirements for Couplings, Coupling Stock, Coupling Material, Coupling Blanks, and Accessory Material for 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 |

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 = 3/4-size (i.e. 10 mm × 7.5 mm)

5 = 1/2-size (i.e. 10 mm × 5 mm)

[a] Not thick enough to test.

[b] The information in this table assumes that special clearance couplings are machined from regular coupling blanks.

**Table E.12—Charpy Impact Test Specimen Requirements for Couplings, Coupling Stock, Coupling Material, Coupling Blanks, and Accessory Material for 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 | — | — | — | — | — | — | — |

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 = 3/4-size (i.e. 10 mm × 7.5 mm)

5 = 1/2-size (i.e. 10 mm × 5 mm)

[a] Not thick enough to test.

[b] The information in this table assumes that special clearance couplings are machined from regular coupling blanks.

**Table E.13—Charpy Impact Test Specimen Requirements for Couplings, Coupling Stock, Coupling Material, Coupling Blanks, and Accessory Material for Grades N80 Type 1, N80Q, 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 | — | — | — | — | — | — | — |

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 = 3/4-size (i.e. 10 mm × 7.5 mm)

5 = 1/2-size (i.e. 10 mm × 5 mm)

[a] Not thick enough to test.

[b] The information in this table assumes that special clearance couplings are machined from regular coupling blanks.

**Table E.14—Charpy Impact Test Specimen Requirements for Couplings, Coupling Stock, Coupling Material, Coupling Blanks, and Accessory Material for 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 | T-10-22 |
| 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 | — | — |
| 16 | — | — | — | — | | — | — |
| 18 5/8 | — | — | — | — | — | — | — |
| 20 | — | — | — | — | — | — | — |
| | | | | | — | — | |

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 = 3/4-size (i.e. 10 mm × 7.5 mm)

5 = 1/2-size (i.e. 10 mm × 5 mm)

[a] Not thick enough to test.

[b] The information in this table assumes that special clearance couplings are machined from regular coupling blanks.

**Table E.15—Charpy Impact Test Specimen Requirements for Couplings, Coupling Stock, Coupling Material, Coupling Blanks, and Accessory Material for Grade Q125**

| Label 1 | API Connection Type and CVN Specimen Orientation, Size, and Energy | | | |
|---|---|---|---|---|
| | Special Clearance [a] | BC | LC | SC |
| | BC | | | |
| *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 | — | — | — | — |

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 = 3/4-size (i.e. 10 mm × 7.5 mm)

5 = 1/2-size (i.e. 10 mm × 5 mm)

[a] The information in this table assumes that special clearance couplings are machined from regular coupling blanks.

**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 [a] 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 |

NOTE Critical thicknesses greater than the measurements shown in Table E.7 are not applicable for couplings with API threads and are shown in this table for special applications.

[a] For critical thickness greater than those shown above, the requirements shall be according to the equations for the wall thickness and grade.

**Table E.17—Longitudinal Charpy Absorbed Energy Requirements for Couplings, Coupling Stock, Coupling Material, Coupling Blanks, and Accessory Material**

| Maximum Critical Thickness [a] 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 |
| 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 |

NOTE Critical thicknesses greater than the measurements shown in Table E.7 are not applicable for couplings with API threads and are shown in this table for special application.

[a] For critical thickness greater than those shown above, the requirements shall be according to the equations for the wall thickness and grade.

**Table E.18—Transverse Charpy Absorbed Energy Requirements for Pipe**

| Maximum Specified Wall Thickness [a] in. | | | | | | 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 |
| — | 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 |

NOTE Wall thicknesses greater than those of standard API pipe are shown in this table for special applications.

[a] For wall thickness greater than those shown above, the requirements shall be according to the equations for the wall thickness and grade.

**Table E.19—Longitudinal Charpy Absorbed Energy Requirements for Pipe**

| Maximum Specified Wall Thickness [a] 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 |
| 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 |

NOTE Wall thicknesses greater than those of standard API pipe are shown in this table for special applications.

[a] For wall thicknesses greater than those shown above, the requirements shall be according to the equations for the wall thickness and grade.

**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 | 3/4-size | 1/2-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 API pipe are for information only; The information in this table provides a 0.020 in. inside-wall and a 0.020 in. outside-wall machining allowance.

**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 | 3/4-size | 1/2-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 API pipe are for information only; The above provides a 0.020 in. inside-wall and a 0.020 in. outside-wall machining allowance.

**Table E.22—Distance between Plates for Electric-weld Flattening Tests**

| Grade | *D/t* ratio | Distance between Plates in. |
|---|---|---|
| H40 | ≥ 16 | $0.5 \times D$ |
| | < 16 | $D \times (0.830 - 0.0206\ D/t)$ |
| J55 and K55 | ≥ 16 | $0.65 \times D$ |
| | 3.93 to 16 | $D \times (0.980 - 0.0206\ D/t)$ |
| | < 3.93 | $D \times (1.104 - 0.0518\ D/t)$ |
| N80 (all types) [a] | 9 to 28 | $D \times (1.074 - 0.0194\ D/t)$ |
| L80 Type 1 | 9 to 28 | $D \times (1.074 - 0.0194\ D/t)$ |
| R95 [a] | 9 to 28 | $D \times (1.080 - 0.0178\ D/t)$ |
| P110 [b] | All | $D \times (1.086 - 0.0163\ D/t)$ |
| Q125 [b] | All | $D \times (1.092 - 0.0140\ D/t)$ |

NOTE

$D$ 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 K.6 (SR 11); Flattening shall be conducted until this distance or until $0.85 \times D$, whichever is less, without cracking at any location.

**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 Thick-ness | 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 | |
| | | $D$ 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 | 11.30 | 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 | 10.67 | 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 | 0.625 | 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 | — | — | — | — |
| 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 |

**Table E.23—Dimensions and Masses for Standard Casing and for Casing Threaded with API Round Thread and Buttress Thread (Continued)**

| Labels [a] | | Outside Diameter | Nominal Linear Mass T& C [b,c] | Wall Thick-ness | 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 | |
| | | $D$ 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 | 17.00 | 7.00 | 17.20 | 0.231 | 6.538 | 6.413 | 16.72 | 16.77 | — | — | — |
| 7 | 20.00 | 7.00 | 20.10 | 0.272 | 6.456 | 6.331 | 19.56 | 14.68 | — | — | — |
| 7 | 23.00 | 7.00 | 23.30 | 0.317 | 6.366 | 6.250 [e] | 22.65 | 13.80 | 17.51 | 18.26 | 1.27 |
| 7 | 23.00 | 7.00 | 23.30 | 0.317 | 6.366 | 6.241 | 22.65 | 13.80 | 17.51 | 18.26 | 1.27 |
| 7 | 26.00 | 7.00 | 26.30 | 0.362 | 6.276 | 6.151 | 25.69 | 12.76 | 16.25 | 16.86 | –0.12 |
| 7 | 29.00 | 7.00 | 29.30 | 0.408 | 6.184 | 6.059 | 28.75 | — | 14.97 | 15.46 | –1.52 |
| 7 | 32.00 | 7.00 | 32.20 | 0.453 | 6.094 | 6.000 [e] | 31.70 | — | 13.74 | 14.11 | –2.88 |
| 7 | 32.00 | 7.00 | 32.20 | 0.453 | 6.094 | 5.969 | 31.70 | — | 13.74 | 14.11 | –2.88 |
| 7 | 35.00 | 7.00 | 35.00 | 0.498 | 6.004 | 5.879 | 34.61 | — | 12.53 | 12.77 | –4.21 |
| 7 | 38.00 | 7.00 | 37.70 | 0.540 | 5.920 | 5.795 | 37.29 | — | 11.41 | 11.55 | –5.44 |
| 7 | 42.70 | 7.00 | 42.90 | 0.625 | 5.750 | 5.625 | 42.59 | — | — | — | — |
| 7 | 46.40 | 7.00 | 46.60 | 0.687 | 5.626 | 5.501 | 46.36 | — | — | — | — |
| 7 | 50.10 | 7.00 | 50.30 | 0.750 | 5.500 | 5.375 | 50.11 | — | — | — | — |
| 7 | 53.60 | 7.00 | 53.90 | 0.812 | 5.376 | 5.251 | 53.71 | — | — | — | — |
| 7 | 57.10 | 7.00 | 57.40 | 0.875 | 5.250 | 5.125 | 57.29 | — | — | — | — |
| 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 | — | — | — | — |

**Table E.23—Dimensions and Masses for Standard Casing and for Casing Threaded with API Round Thread and Buttress Thread (Continued)**

| Labels [a] | | Outside Diameter | Nominal Linear Mass T& C [b,c] | Wall Thick-ness | 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 | |
| | | $D$ 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* |
| 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 | 7.386 | 48.04 | — | 19.67 | 19.52 | –2.66 |
| 9 5/8 | 32.30 | 9.625 | 32.30 | 0.312 | 9.001 | 8.845 | 31.06 | 24.25 | — | — | — |
| 9 5/8 | 36.00 | 9.625 | 36.00 | 0.352 | 8.921 | 8.765 | 34.89 | 22.85 | 31.93 | 30.58 | 6.03 |
| 9 5/8 | 40.00 | 9.625 | 40.00 | 0.395 | 8.835 | 8.750 [e] | 38.97 | 21.37 | 29.97 | 28.60 | 4.05 |
| 9 5/8 | 40.00 | 9.625 | 40.00 | 0.395 | 8.835 | 8.679 | 38.97 | 21.37 | 29.97 | 28.60 | 4.05 |
| 9 5/8 | 43.50 | 9.625 | 43.50 | 0.435 | 8.755 | 8.599 | 42.73 | — | 28.17 | 26.78 | 2.23 |
| 9 5/8 | 43.50 | 9.625 | 43.50 | 0.435 | 8.755 | 8.599 | 42.73 | — | 28.31 [f] | 26.78 | 2.23 |
| 9 5/8 | 47.00 | 9.625 | 47.00 | 0.472 | 8.681 | 8.525 | 46.18 | — | 26.52 | 25.11 | 0.56 |
| 9 5/8 | 47.00 | 9.625 | 47.00 | 0.472 | 8.681 | 8.525 | 46.18 | — | 26.66 [f] | 25.11 | 0.56 |
| 9 5/8 | 53.50 | 9.625 | 53.50 | 0.545 | 8.535 | 8.500 [e] | 52.90 | — | 23.30 | 21.86 | –2.70 |
| 9 5/8 | 53.50 | 9.625 | 53.50 | 0.545 | 8.535 | 8.500 [e] | 52.90 | — | 23.44 [f] | 21.86 | –2.70 |
| 9 5/8 | 53.50 | 9.625 | 53.50 | 0.545 | 8.535 | 8.379 | 52.90 | — | 23.30 | 21.86 | –2.70 |
| 9 5/8 | 53.50 | 9.625 | 53.50 | 0.545 | 8.535 | 8.379 | 52.90 | — | 23.44 [f] | 21.86 | –2.70 |
| 9 5/8 | 58.40 | 9.625 | 58.40 | 0.595 | 8.435 | 8.375 [e] | 57.44 | — | 21.13 | 19.66 | –4.89 |
| 9 5/8 | 58.40 | 9.625 | 58.40 | 0.595 | 8.435 | 8.375 [e] | 57.44 | — | 21.27 [f] | 19.66 | –4.89 |
| 9 5/8 | 58.40 | 9.625 | 58.40 | 0.595 | 8.435 | 8.279 | 57.44 | — | 21.13 | 19.66 | –4.89 |
| 9 5/8 | 58.40 | 9.625 | 58.40 | 0.595 | 8.435 | 8.279 | 57.44 | — | 21.27 [f] | 19.66 | –4.89 |
| 9 5/8 | 59.40 | 9.625 | 59.40 | 0.609 | 8.407 | 8.251 | 58.70 | — | — | — | — |
| 9 5/8 | 64.90 | 9.625 | 64.90 | 0.672 | 8.281 | 8.125 | 64.32 | — | — | — | — |
| 9 5/8 | 70.30 | 9.625 | 70.30 | 0.734 | 8.157 | 8.001 | 69.76 | — | — | — | — |
| 9 5/8 | 75.60 | 9.625 | 75.60 | 0.797 | 8.031 | 7.875 | 75.21 | — | — | — | — |

**Table E.23—Dimensions and Masses for Standard Casing and for Casing Threaded with API Round Thread and Buttress Thread (Continued)**

| Labels [a] | | Outside Diameter | Nominal Linear Mass T& C [b,c] | Wall Thick-ness | 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 | |
| | | $D$ 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* |
| 10 3/4 | 32.75 | 10.750 | 32.75 | 0.279 | 10.192 | 10.036 | 31.23 | 30.74 | — | — | — |
| 10 3/4 | 40.50 | 10.750 | 40.50 | 0.350 | 10.050 | 9.894 | 38.91 | 26.26 | — | 33.91 | 6.69 |
| 10 3/4 | 45.50 | 10.750 | 45.50 | 0.400 | 9.950 | 9.875 [e] | 44.26 | 24.26 | — | 31.32 | 4.10 |
| 10 3/4 | 45.50 | 10.750 | 45.50 | 0.400 | 9.950 | 9.794 | 44.26 | 24.26 | — | 31.32 | 4.10 |
| 10 3/4 | 51.00 | 10.750 | 51.00 | 0.450 | 9.850 | 9.694 | 49.55 | 22.28 | — | 28.76 | 1.54 |
| 10 3/4 | 51.00 | 10.750 | 51.00 | 0.450 | 9.850 | 9.684 | 49.55 | 22.39 [f] | — | 28.76 | 1.54 |
| 10 3/4 | 55.50 | 10.750 | 55.50 | 0.495 | 9.760 | 9.625 [e] | 54.26 | 20.51 | — | 26.47 | –0.74 |
| 10 3/4 | 55.50 | 10.750 | 55.50 | 0.495 | 9.760 | 9.625 [e] | 54.26 | 20.62 [f] | — | 26.47 | –0.74 |
| 10 3/4 | 55.50 | 10.750 | 55.50 | 0.495 | 9.760 | 9.604 | 54.26 | 20.51 | — | 26.47 | –0.74 |
| 10 3/4 | 55.50 | 10.750 | 55.50 | 0.495 | 9.760 | 9.604 | 54.26 | 20.62 [f] | — | 26.47 | –0.74 |
| 10 3/4 | 60.70 | 10.750 | 60.70 | 0.545 | 9.660 | 9.504 | 59.45 | 18.56 | — | 23.96 | — |
| 10 3/4 | 60.70 | 10.750 | 60.70 | 0.545 | 9.660 | 9.504 | 59.45 | 18.67 [f] | — | 23.96 | — |
| 10 3/4 | 65.70 | 10.750 | 65.70 | 0.595 | 9.560 | 9.404 | 64.59 | 16.63 | — | 21.47 | — |
| 10 3/4 | 65.70 | 10.750 | 65.70 | 0.595 | 9.560 | 9.404 | 64.59 | 16.75 [f] | — | 21.47 | — |
| 10 3/4 | 73.20 | 10.750 | 73.20 | 0.672 | 9.406 | 9.250 | 72.40 | — | — | — | — |
| 10 3/4 | 79.20 | 10.750 | 79.20 | 0.734 | 9.282 | 9.126 | 78.59 | — | — | — | — |
| 10 3/4 | 85.30 | 10.750 | 85.30 | 0.797 | 9.156 | 9.000 | 84.80 | — | — | — | — |
| 11 3/4 | 42.00 | 11.750 | 42.00 | 0.333 | 11.084 | 11.000 [e] | 40.64 | 29.25 | — | — | — |
| 11 3/4 | 42.00 | 11.750 | 42.00 | 0.333 | 11.084 | 10.928 | 40.64 | 29.25 | — | — | — |
| 11 3/4 | 47.00 | 11.750 | 47.00 | 0.375 | 11.000 | 10.844 | 45.60 | 27.39 | — | 35.36 | — |
| 11 3/4 | 54.00 | 11.750 | 54.00 | 0.435 | 10.880 | 10.724 | 52.62 | 24.76 | — | 31.96 | — |
| 11 3/4 | 60.00 | 11.750 | 60.00 | 0.489 | 10.772 | 10.625 [e] | 58.87 | 22.42 | — | 28.93 | — |
| 11 3/4 | 60.00 | 11.750 | 60.00 | 0.489 | 10.772 | 10.625 [e] | 58.87 | 21.54 [f] | — | 28.93 | — |
| 11 3/4 | 60.00 | 11.750 | 60.00 | 0.489 | 10.772 | 10.616 | 58.87 | 22.42 | — | 28.93 | — |
| 11 3/4 | 60.00 | 11.750 | 60.00 | 0.489 | 10.772 | 10.616 | 58.87 | 21.54 [f] | — | 28.93 | — |
| 11 3/4 | 65.00 | 11.750 | 65.00 | 0.534 | 10.682 | 10.625 [e] | 64.03 | — | — | — | — |
| 11 3/4 | 65.00 | 11.750 | 65.00 | 0.534 | 10.682 | 10.526 | 64.03 | — | — | — | — |
| 11 3/4 | 71.00 | 11.750 | 71.00 | 0.582 | 10.586 | 10.430 | 69.48 | — | — | — | — |

**Table E.23—Dimensions and Masses for Standard Casing and for Casing Threaded with API Round Thread and Buttress Thread (Continued)**

| Labels [a] | | Outside Diameter | Nominal Linear Mass T& C [b,c] | Wall Thick-ness | 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 | |
| | | $D$ 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* |
| 13 3/8 | 48.00 | 13.375 | 48.00 | 0.330 | 12.715 | 12.559 | 46.02 | 33.15 | — | — | — |
| 13 3/8 | 54.50 | 13.375 | 54.50 | 0.380 | 12.615 | 12.459 | 52.79 | 30.61 | — | 39.49 | — |
| 13 3/8 | 61.00 | 13.375 | 61.00 | 0.430 | 12.515 | 12.359 | 59.50 | 28.09 | — | 36.24 | — |
| 13 3/8 | 68.00 | 13.375 | 68.00 | 0.480 | 12.415 | 12.259 | 66.17 | 25.59 | — | 33.01 | — |
| 13 3/8 | 68.00 | 13.375 | 68.00 | 0.480 | 12.415 | 12.259 | 66.17 | 25.73 [f] | — | 33.01 | — |
| 13 3/8 | 72.00 | 13.375 | 72.00 | 0.514 | 12.347 | 12.250 [e] | 70.67 | 23.91 | — | 30.83 | — |
| 13 3/8 | 72.00 | 13.375 | 72.00 | 0.514 | 12.347 | 12.250 [e] | 70.67 | 24.05 [f] | — | 30.83 | — |
| 13 3/8 | 72.00 | 13.375 | 72.00 | 0.514 | 12.347 | 12.191 | 70.67 | 23.91 | — | 30.83 | — |
| 13 3/8 | 72.00 | 13.375 | 72.00 | 0.514 | 12.347 | 12.191 | 70.67 | 24.05 [f] | — | 30.83 | — |
| 16 | 65.00 | 16.000 | 65.00 | 0.375 | 15.250 | 15.062 | 62.64 | 40.98 | — | — | — |
| 16 | 75.00 | 16.000 | 75.00 | 0.438 | 15.124 | 14.936 | 72.86 | 36.72 | — | 44.37 | — |
| 16 | 84.00 | 16.000 | 84.00 | 0.495 | 15.010 | 14.822 | 82.05 | 32.89 | — | 39.92 | — |
| 16 | 109.00 | 16.000 | 109.00 | 0.656 | 14.688 | 14.500 | 107.60 | — | — | — | — |
| 18 5/8 | 87.50 | 18.625 | 87.50 | 0.435 | 17.755 | 17.567 | 84.59 | 72.31 | — | 86.54 | — |
| 20 | 94.00 | 20.000 | 94.00 | 0.438 | 19.124 | 18.936 | 91.59 | 45.20 | 59.77 | 54.62 | — |
| 20 | 94.00 | 20.000 | 94.00 | 0.438 | 19.124 | 18.936 | 91.59 | 45.44 | 60.09 [g] | 54.62 | — |
| 20 | 106.50 | 20.000 | 106.50 | 0.500 | 19.000 | 18.812 | 104.23 | 40.17 | 53.51 | 48.50 | — |
| 20 | 133.00 | 20.000 | 133.00 | 0.635 | 18.730 | 18.542 | 131.45 | 28.83 | 39.33 | 35.32 | — |

NOTE 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 (Column 4) are shown for information only.

[c] The densities of martensitic chromium steels (L80 Types 9Cr and 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.

## Table E.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] lb | | | |
| | 2 | | | | Non-upset T&C | External Upset T&C | Integral Joint | | | | | External Upset [e] | | |
| 1 | NU T&C | EU T&C | IJ | $D$ in. | lb/ft | lb/ft | lb/ft | $t$ in. | $d$ in. | $w_{pe}$ lb/ft | Non-upset | Regular | Special Clearance | Integral Joint |
| *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* | *12* | *13* | *14* | *15* |
| 1.050 | 1.14 | 1.20 | — | 1.050 | 1.14 | 1.20 | — | 0.113 | 0.824 | 1.13 | 0.20 | 1.40 | — | — |
| 1.050 | 1.48 | 1.54 | — | 1.050 | 1.48 | 1.54 | — | 0.154 | 0.742 | 1.48 | — | 1.32 | — | — |
| 1.315 | 1.70 | 1.80 | 1.72 | 1.315 | 1.70 | 1.80 | 1.72 | 0.133 | 1.049 | 1.68 | 0.40 | 1.40 | — | 0.20 |
| 1.315 | 2.19 | 2.24 | — | 1.315 | 2.19 | 2.24 | — | 0.179 | 0.957 | 2.17 | — | 1.35 | — | — |
| 1.660 | 2.09 | — | 2.10 | 1.660 | — | — | 2.10 | 0.125 | 1.410 | 2.05 | — | — | — | 0.20 |
| 1.660 | 2.30 | 2.40 | 2.33 | 1.660 | 2.30 | 2.40 | 2.33 | 0.140 | 1.380 | 2.27 | 0.80 | 1.60 | — | 0.20 |
| 1.660 | 3.03 | 3.07 | — | 1.660 | 3.03 | 3.07 | — | 0.191 | 1.278 | 3.00 | — | 1.50 | 0.20 | — |
| 1.900 | 2.40 | — | 2.40 | 1.900 | — | — | 2.40 | 0.125 | 1.650 | 2.37 | — | — | — | 0.20 |
| 1.900 | 2.75 | 2.90 | 2.76 | 1.900 | 2.75 | 2.90 | 2.76 | 0.145 | 1.610 | 2.72 | 0.60 | 2.00 | — | 0.20 |
| 1.900 | 3.65 | 3.73 | — | 1.900 | 3.65 | 3.73 | — | 0.200 | 1.500 | 3.63 | — | 2.03 | — | — |
| 1.900 | 4.42 | — | — | 1.900 | 4.42 | — | — | 0.250 | 1.400 | 4.41 | — | — | — | — |
| 1.900 | 5.15 | — | — | 1.900 | 5.15 | — | — | 0.300 | 1.300 | 5.13 | — | — | — | — |
| 2.063 | 3.24 | — | 3.25 | 2.063 | — | — | 3.25 | 0.156 | 1.751 | 3.18 | — | — | — | 0.20 |
| 2.063 | 4.50 | — | — | 2.063 | — | — | — | 0.225 | 1.613 | 4.42 | — | — | — | — |
| 2 3/8 | 4.00 | — | — | 2.375 | 4.00 | — | — | 0.167 | 2.041 | 3.94 | 1.60 | — | — | — |
| 2 3/8 | 4.60 | 4.70 | — | 2.375 | 4.60 | 4.70 | — | 0.190 | 1.995 | 4.44 | 1.60 | 4.00 | 2.96 | — |
| 2 3/8 | 5.80 | 5.95 | — | 2.375 | 5.80 | 5.95 | — | 0.254 | 1.867 | 5.76 | 1.40 | 3.60 | 2.56 | — |
| 2 3/8 | 6.60 | — | — | 2.375 | 6.60 | — | — | 0.295 | 1.785 | 6.56 | — | — | — | — |
| 2 3/8 | 7.35 | 7.45 | — | 2.375 | 7.35 | 7.45 | — | 0.336 | 1.703 | 7.32 | — | — | — | — |

## Table E.24—Dimensions and Masses for Standard Tubing and for Tubing Threaded with API Non-upset, External Upset, and Integral Tubing Connections (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] lb | | | |
| | 2 | | | | Non-upset T&C | External Upset T&C | Integral Joint | | | | | External Upset [e] | | |
| 1 | NU T&C | EU T&C | IJ | $D$ in. | lb/ft | lb/ft | lb/ft | $t$ in. | $d$ in. | $w_{pe}$ lb/ft | Non-upset | Regular | Special Clearance | Integral Joint |
| *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* | *12* | *13* | *14* | *15* |
| 2 7/8 | 6.40 | 6.50 | — | 2.875 | 6.40 | 6.50 | — | 0.217 | 2.441 | 6.17 | 3.20 | 5.60 | 3.76 | — |
| 2 7/8 | 7.80 | 7.90 | — | 2.875 | 7.80 | 7.90 | — | 0.276 | 2.323 | 7.67 | 2.80 | 5.80 | 3.92 | — |
| 2 7/8 | 8.60 | 8.70 | — | 2.875 | 8.60 | 8.70 | — | 0.308 | 2.259 | 8.45 | 2.60 | 5.00 | 3.16 | — |
| 2 7/8 | 9.35 | 9.45 | — | 2.875 | 9.35 | 9.45 | — | 0.340 | 2.195 | 9.21 | — | — | — | — |
| 2 7/8 | 10.50 | — | — | 2.875 | 10.50 | — | — | 0.392 | 2.091 | 10.40 | — | — | — | — |
| 2 7/8 | 11.50 | — | — | 2.875 | 11.50 | — | — | 0.440 | 1.995 | 11.45 | — | — | — | — |
| 3 1/2 | 7.70 | — | — | 3.500 | 7.70 | — | — | 0.216 | 3.068 | 7.58 | 5.40 | — | — | — |
| 3 1/2 | 9.20 | 9.30 | — | 3.500 | 9.20 | 9.30 | — | 0.254 | 2.992 | 8.81 | 5.00 | 9.20 | 5.40 | — |
| 3 1/2 | 10.20 | — | — | 3.500 | 10.20 | — | — | 0.289 | 2.922 | 9.92 | 4.80 | — | — | — |
| 3 1/2 | 12.70 | 12.95 | — | 3.500 | 12.70 | 12.95 | — | 0.375 | 2.750 | 12.53 | 4.00 | 8.20 | 4.40 | — |
| 3 1/2 | 14.30 | — | — | 3.500 | 14.30 | — | — | 0.430 | 2.640 | 14.11 | — | — | — | — |
| 3 1/2 | 15.50 | — | — | 3.500 | 15.50 | — | — | 0.476 | 2.548 | 15.39 | — | — | — | — |
| 3 1/2 | 17.00 | — | — | 3.500 | 17.00 | — | — | 0.530 | 2.440 | 16.83 | — | — | — | — |
| 4 | 9.50 | — | — | 4.000 | 9.50 | — | — | 0.226 | 3.548 | 9.12 | 6.20 | — | — | — |
| 4 | 10.70 | 11.00 | — | 4.000 | — | 11.00 | — | 0.262 | 3.476 | 10.47 | — | 10.60 | — | — |
| 4 | 13.20 | — | — | 4.000 | 13.20 | — | — | 0.330 | 3.340 | 12.95 | — | — | — | — |
| 4 | 16.10 | — | — | 4.000 | 16.10 | — | — | 0.415 | 3.170 | 15.90 | — | — | — | — |
| 4 | 18.90 | — | — | 4.000 | 18.90 | — | — | 0.500 | 3.000 | 18.71 | — | — | — | — |
| 4 | 22.20 | — | — | 4.000 | 22.20 | — | — | 0.610 | 2.780 | 22.11 | — | — | — | — |

**Table E.24—Dimensions and Masses for Standard Tubing and for Tubing Threaded with API Non-upset, External Upset, and Integral Tubing Connections (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] lb | | | |
| | 2 | | | | Non-upset T&C | External Upset T&C | Integral Joint | | | | | External Upset [e] | | |
| 1 | NU T&C | EU T&C | IJ | $D$ in. | lb/ft | lb/ft | lb/ft | $t$ in. | $d$ in. | $w_{pe}$ lb/ft | Non-upset | Regular | Special Clearance | Integral Joint |
| *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* | *12* | *13* | *14* | *15* |
| 4 1/2 | 12.60 | 12.75 | — | 4.500 | 12.60 | 12.75 | — | 0.271 | 3.958 | 12.25 | 6.00 | 13.20 | — | — |
| 4 1/2 | 15.20 | — | — | 4.500 | 15.20 | — | — | 0.337 | 3.826 | 15.00 | — | — | — | — |
| 4 1/2 | 17.00 | — | — | 4.500 | 17.00 | — | — | 0.380 | 3.740 | 16.77 | — | — | — | — |
| 4 1/2 | 18.90 | — | — | 4.500 | 18.90 | — | — | 0.430 | 3.640 | 18.71 | — | — | — | — |
| 4 1/2 | 21.50 | — | — | 4.500 | 21.50 | — | — | 0.500 | 3.500 | 21.38 | — | — | — | — |
| 4 1/2 | 23.70 | — | — | 4.500 | 23.70 | — | — | 0.560 | 3.380 | 23.59 | — | — | — | — |
| 4 1/2 | 26.10 | — | — | 4.500 | 26.10 | — | — | 0.630 | 3.240 | 26.06 | — | — | — | — |

NOTE See also Figures D.4, D.5, and D.7.

[a] Labels are for information and assistance in ordering.

[b] Nominal linear masses (Columns 6, 7, and 8) are shown for information only.

[c] The densities of martensitic chromium (L80 Types 9Cr and 13Cr) are 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.

**Table E.25—External Upset Tubing Dimensions for API Connections for Grades H40, J55, L80 (All Types), R95, N80 (All Types), C90, T95, and P110**

| Labels [a] | | Size 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 [e] $L_b$ |
| | | | | in. | in. | | |
| | | | | +0.0625<br>0 | 0<br>–1 | | |
| 1 | 2 | in. | lb/ft | | | in. | in. max |
| *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* |
| 1.050 | 1.20 | 1.050 | 1.20 | 1.315 | 2 3/8 | — | — |
| 1.050 | 1.54 | 1.050 | 1.54 | 1.315 | 2 3/8 | — | — |
| 1.315 | 1.80 | 1.315 | 1.80 | 1.469 | 2 1/2 | — | — |
| 1.315 | 2.24 | 1.315 | 2.24 | 1.469 | 2 1/2 | — | — |
| 1.660 | 2.40 | 1.660 | 2.40 | 1.812 | 2 5/8 | — | — |
| 1.660 | 3.07 | 1.660 | 3.07 | 1.812 | 2 5/8 | — | — |
| 1.900 | 2.90 | 1.900 | 2.90 | 2.094 | 2 11/16 | — | — |
| 1.900 | 3.73 | 1.900 | 3.73 | 2.094 | 2 11/16 | — | — |
| 2 3/8 | 4.70 | 2.375 | 4.70 | 2.594 | 4.00 | 6.00 | 10.00 |
| 2 3/8 | 5.95 | 2.375 | 5.95 | 2.594 | 4.00 | 6.00 | 10.00 |
| 2 3/8 | 7.45 | 2.375 | 7.45 | 2.594 | 4.00 | 6.00 | 10.00 |
| 2 7/8 | 6.50 | 2.875 | 6.50 | 3.094 | 4 1/4 | 6 1/4 | 10 1/4 |
| 2 7/8 | 7.90 | 2.875 | 7.90 | 3.094 | 4 1/4 | 6 1/4 | 10 1/4 |
| 2 7/8 | 8.70 | 2.875 | 8.70 | 3.094 | 4 1/4 | 6 1/4 | 10 1/4 |
| 2 7/8 | 9.45 | 2.875 | 9.45 | 3.094 | 4 1/4 | 6 1/4 | 10 1/4 |
| 3 1/2 | 9.30 | 3.500 | 9.30 | 3.750 | 4 1/2 | 6 1/2 | 10 1/2 |
| 3 1/2 | 12.95 | 3.500 | 12.95 | 3.750 | 4 1/2 | 6 1/2 | 10 1/2 |
| 4 | 11.00 | 4.000 | 11.00 | 4.250 | 4 1/2 | 6 1/2 | 10 1/2 |
| 4 1/2 | 12.75 | 4.500 | 12.75 | 4.750 | 4 3/4 | 6 3/4 | 10 3/4 |

NOTE 1 See also Figures D.5 and D.6.

NOTE 2 Nominal linear masses are shown for information only.

[a] Labels are for information and assistance in ordering.

[b] The densities of martensitic chromium steels (L80 9Cr and 13Cr) 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 5B.

[d] For pup joints only, the length tolerance on $L_{eu}$ is $^{+4}_{-1}$ in.; The length on $L_b$ may be 4 in. longer than specified.

[e] For extended-length upsets on external upset tubing, add 1 in. to the dimensions in Columns 6, 7, and 8.

**Table E.26—Integral Tubing Connection Dimensions for API Connections for Grades H40, J55, L80 (All Types), R95, N80 (All Types), C90, and T95**

| Labels | | | | Upset Dimensions | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Pin | | | | Box | | | | |
| 1 | 2 | Outside Diameter $D$ in. | Nominal Linear Mass [a] lb/ft | Outside Diameter [b] $D_4$ +0.0625 0 | Inside Diameter [c] $d_{iu}$ +0.015 0 | Length $L_{iu}$ min | Length of Taper $m_{iu}$ min | Outside Diameter $W_b$ +0.005 –0.025 | Length $L_{eu}$ min | Length of Taper $m_{eu}$ | Diameter of Recess $Q$ | Width of Face $b$ min |
| *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* | *12* | *13* |
| 1.315 | 1.72 | 1.315 | 1.72 | — | 0.970 | 1 3/8 | 1/4 | 1.550 | 1.750 | 1 | 1.378 | 1/32 |
| 1.660 | 2.10 | 1.660 | 2.10 | — | 1.301 | 1 1/2 | 1/4 | 1.880 | 1.875 | 1 | 1.723 | 1/32 |
| 1.660 | 2.33 | 1.660 | 2.33 | — | 1.301 | 1 1/2 | 1/4 | 1.880 | 1.875 | | 1.723 | 1/32 |
| 1.900 | 2.40 | 1.900 | 2.40 | — | 1.531 | 1 5/8 | 1/4 | 2.110 | 2.000 | 1 | 1.963 | 1/32 |
| 1.900 | 2.76 | 1.900 | 2.76 | — | 1.531 | 1 5/8 | 1/4 | 2.110 | 2.000 | | 1.963 | 1/32 |
| 2.063 | 3.25 | 2.063 | 3.25 | 2.094 | 1.672 | 1 11/16 | 1/4 | 2.325 | 2.125 | 1 | 2.156 | 1/32 |

NOTE 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 5B.

[c] The minimum diameter $d_{iu}$ is limited by the drift test.

## Table E.27—Range Lengths

Dimensions in feet

| | Range 1 [b] | Range 2 [b] | Range 3 [b] |
|---|---|---|---|
| **CASING (PE/T and C/SF)** | | | |
| Total range length, inclusive | 16.0 to 25.0 | 25.0 to 34.0 | 34.0 to 48.0 |
| Permissible variation, max [a] | 6.0 | 5.0 | 6.0 |
| **TUBING AND CASING USED AS TUBING (PE/T and C/SF)** | | | |
| Total range length, inclusive | 20.0 to 24.0 | 28.0 to 32.0 | 38.0 to 42.0 |
| Permissible variation, max [a] | 2.0 | 2.0 | 2.0 |
| **INTEGRAL TUBING CONNECTIONS (including IJ/PE and IJ/SF)** | | | |
| Total range length, inclusive | 20.0 to 26.0 | 28.0 to 34.0 | 38.0 to 45.0 |
| Permissible variation, max [a] | 2.0 | 2.0 | 2.0 |
| **PUP JOINTS [b]** | Lengths: 2; 3; 4; 6; 8; 10; and 12<br>Tolerance: ±3 in. | | |

[a] Length variation applies to rail car shipment to the point of use and does not apply to order items less than 40,000 lb of pipe.

[b] Lengths other than those listed may be furnished by agreement between purchaser and manufacturer.

## Table E.28—Standard Drift Size

Dimensions in inches

| Product and Label 1 | Standard Drift Mandrel Size min | |
|---|---|---|
| | Length | Diameter |
| Casing | | |
| < 9 5/8 | 6 | d – 1/8 |
| ≥ 9 5/8 to ≤ 13 3/8 | 12 | d – 5/32 |
| > 13 3/8 | 12 | d – 3/16 |
| Tubing [a, b] | | |
| ≤ 2 7/8 | 42 | d – 3/32 |
| > 2 7/8 to ≤ 8 5/8 | 42 | d – 1/8 |
| > 8 5/8 to < 10 3/4 | 42 | d – 5/32 |

[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 42 in. in length and $d_{iu}$ – 0.015 in diameter (see Table E.26, Column 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 Section 11.

**Table E.29—Alternative Drift Size**

| Labels | | Pipe Outside Diameter *D* | Nominal Linear Mass, T&C | Alternative Drift Mandrel Size in. min | |
|---|---|---|---|---|---|
| 1 | 2 | in. | lb/ft | Length | Diameter |
| *1* | *2* | *3* | *4* | *5* | *6* |
| 7 | 23.00 | 7.000 | 23.3 | 6 | 6.250 |
| 7 | 32.00 | 7.000 | 32.2 | 6 | 6.000 |
| 7 3/4 | 46.10 | 7.750 | 46.1 | 6 | 6.500 |
| 8 5/8 | 32.00 | 8.625 | 32.0 | 6 | 7.875 |
| 8 5/8 | 40.00 | 8.625 | 40.0 | 6 | 7.625 |
| 9 5/8 | 40.00 | 9.625 | 40.0 | 12 | 8.750 |
| 9 5/8 | 53.50 | 9.625 | 53.5 | 12 | 8.500 |
| 9 5/8 | 58.40 | 9.625 | 58.4 | 12 | 8.375 |
| 10 3/4 | 45.50 | 10.750 | 45.5 | 12 | 9.875 |
| 10 3/4 | 55.50 | 10.750 | 55.5 | 12 | 9.625 |
| 11 3/4 | 42.00 | 11.750 | 42.0 | 12 | 11.000 |
| 11 3/4 | 60.00 | 11.750 | 60.0 | 12 | 10.625 |
| 11 3/4 | 65.00 | 11.750 | 65.0 | 12 | 10.625 |
| 13 3/8 | 72.00 | 13.375 | 72.0 | 12 | 12.250 |

**Table E.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 K.9 (SR 16) | 12.5 % | 12.5 % |
| N80 Type 1 | 10 % | 10 % |
| C90 – T95 – C110 – P110 – Q125 | 5 % | 5 % |
| P110 to K.9 (SR 16) and K.3 (SR 2) | 5 % | 5 % |

**Table E.31—Upset Products—Maximum Permissible Depth of Imperfections**

| | Surface | Depth | Measurement Notes |
|---|---|---|---|
| **A Integral Joint and External Upset Tubing (see Figure D.5 and Figure D.7)** | | | |
| A.1 | All surfaces of upset and upset run-out interval, except as stated below | 12.5 % $t$ | Percentage of specified pipe body wall thickness $t$; for non-linear imperfections; for all grades of pipe. |
| | | 12.5 % $t$ | Percentage of specified pipe body wall thickness $t$; for linear imperfections; for Grades H40, J55, K55, L80 (all types), N80 (all types), and R95. |
| | | 5 % $t$ | Percentage of specified pipe body wall thickness $t$; for linear imperfections; for Grades C90, T95, and P110 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 | Box end and external surface | 0.010 in. | 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. |
| B.2 | Pin end internal surface | 0.015 in. | 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.<br><br>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. | | | |

**Table E.32—API Round-thread Casing Coupling—Dimensions, Tolerances, and Masses**

| Label 1 | Size [a] | Outside Diameter $W$ [b, c] | Minimum Length in. | | Diameter of Recess $Q$ [d] | Width of Bearing Face $B$ | Mass lb | |
|---|---|---|---|---|---|---|---|---|
| | Outside Diameter $D$ in. | in. | Short $N_L$ | Long $N_L$ | in. | in. | Short | Long |
| *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* |
| 4 1/2 | 4.500 | 5.250 | 6 1/4 | 7 | 4 19/32 | 9/32 | 11.55 | 13.15 |
| 5 | 5.000 | 5.800 | 6 1/2 | 7 3/4 | 5 3/32 | 9/32 | 14.17 | 17.32 |
| 5 1/2 | 5.500 | 6.300 | 6 3/4 | 8 | 5 19/32 | 1/4 | 16.18 | 19.66 |
| 6 5/8 | 6.625 | 7.390 | 7 1/4 | 8 3/4 | 6 23/32 | 1/4 | 20.11 | 25.00 |
| 7 | 7.000 | 7.875 | 7 1/4 | 9 | 7 3/32 | 5/16 | 23.98 | 30.69 |
| 7 5/8 | 7.625 | 8.500 | 7 1/2 | 9 1/4 | 7 25/32 | 7/32 | 26.80 | 34.15 |
| 8 5/8 | 8.625 | 9.625 | 7 3/4 | 10 | 8 25/32 | 1/4 | 34.44 | 47.42 |
| 9 5/8 | 9.625 | 10.625 | 7 3/4 | 10 1/2 | 9 25/32 | 1/4 | 39.36 | 55.72 |
| 10 3/4 | 10.750 | 11.750 | 8 | — | 10 25/32 | 1/4 | 45.38 | — |
| 11 3/4 | 11.750 | 12.750 | 8 | — | 11 29/32 | 1/4 | 49.44 | — |
| 13 3/8 | 13.375 | 14.375 | 8 | — | 13 17/32 | 7/32 | 56.04 | — |
| 16 | 16.000 | 17.000 | 9 | — | 16 7/32 | 7/32 | 75.69 | — |
| 18 5/8 | 18.625 | 20.000 | 9 | — | 18 27/32 | 7/32 | 117.58 | — |
| 20 | 20.000 | 21.000 | 9 | 11 1/2 | 20 7/32 | 7/32 | 94.38 | 125.61 |

NOTE See also Figure D.1 and Figure 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 ±1/8 in.

[c] Grade Q125: Tolerance on outside diameter $W$: ±1 % but not greater than $^{+1/8}_{-1/16}$ in.

[d] Tolerance on diameter of recess, $Q$, for all grades: $^{+0.031}_{0}$ in.

**Table E.33—API Buttress Thread Casing Coupling—Dimensions, Tolerances, and Masses**

| Label 1 | Size [a] | Outside Diameter | | Minimum Length $N_L$ | Diameter of Counterbore $Q$ | Width of Bearing Face $b$ | Mass lb | |
|---|---|---|---|---|---|---|---|---|
| | Outside Diameter $D$ | Regular $W$ [b, c] | Special Clearance [d] $W_c$ | | | | Regular | Special Clearance |
| | in. | in. | in. | in. | in. | in. | | |
| *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* |
| 4 1/2 | 4.500 | 5.250 | 4.875 | 8 7/8 | 4.640 | 1/4 | 15.19 | 7.68 |
| 5 | 5.000 | 5.800 | 5.375 | 9 1/8 | 5.140 | 9/32 | 18.46 | 8.82 |
| 5 1/2 | 5.500 | 6.300 | 5.875 | 9 1/4 | 5.640 | 9/32 | 20.50 | 9.85 |
| 6 5/8 | 6.625 | 7.390 | 7.000 | 9 5/8 | 6.765 | 1/4 | 24.49 | 12.46 |
| 7 | 7.000 | 7.875 | 7.375 | 10 | 7.140 | 5/16 | 30.82 | 13.84 |
| 7 5/8 | 7.625 | 8.500 | 8.125 | 10 3/8 | 7.765 | 5/16 | 34.88 | 20.47 |
| 8 5/8 | 8.625 | 9.625 | 9.125 | 10 5/8 | 8.765 | 3/8 | 45.99 | 23.80 |
| 9 5/8 | 9.625 | 10.625 | 10.125 | 10 5/8 | 9.765 | 3/8 | 51.05 | 26.49 |
| 10 3/4 | 10.750 | 11.750 | 11.250 | 10 5/8 | 10.890 | 3/8 | 56.74 | 29.52 |
| 11 3/4 | 11.750 | 12.750 | — | 10 5/8 | 11.890 | 3/8 | 61.80 | — |
| 13 3/8 | 13.375 | 14.375 | — | 10 5/8 | 13.515 | 3/8 | 70.03 | — |
| 16 | 16.000 | 17.000 | — | 10 5/8 | 16.154 | 3/8 | 88.81 | — |
| 18 5/8 | 18.625 | 20.000 | — | 10 5/8 | 18.779 | 3/8 | 138.18 | — |
| 20 | 20.000 | 21.000 | — | 10 5/8 | 20.154 | 3/8 | 110.45 | — |

NOTE 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 ±1/8 in.

[c] Grade Q125: Tolerance on outside diameter $W$: ±1 % but not greater than $^{+1/8}_{-1/16}$ in.

[d] All Grades except Grade Q125: Tolerance on outside diameter $W_c$: $^{-1/64}_{+1/32}$ in.

**Table E.34—API Non-upset Tubing Coupling—Dimensions, Tolerances, and Masses**

| Label 1 | Size [a] | Outside Diameter $W$ [b] | Minimum Length $N_L$ | Diameter of Recess $Q$ | Width of Bearing Face $b$ | Maximum Bearing Face Diameter, Special Bevel $B_f$ | Mass |
|---|---|---|---|---|---|---|---|
| | Outside Diameter $D$ | | | | | | |
| | in. | in. | in. | in. | in. | in. | lb |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 1.050 | 1.050 | 1.313 | 3 3/16 | 1.113 | 1/16 | 1.181 | 0.51 |
| 1.315 | 1.315 | 1.660 | 3 1/4 | 1.378 | 3/32 | 1.488 | 0.84 |
| 1.660 | 1.660 | 2.054 | 3 1/2 | 1.723 | 1/8 | 1.857 | 1.29 |
| 1.900 | 1.900 | 2.200 | 3 3/4 | 1.963 | 1/16 | 2.050 | 1.23 |
| 2 3/8 | 2.375 | 2.875 | 4 1/4 | 2.438 | 3/16 | 2.625 | 2.82 |
| 2 7/8 | 2.875 | 3.500 | 5 1/8 | 2.938 | 3/16 | 3.188 | 5.15 |
| 3 1/2 | 3.500 | 4.250 | 5 5/8 | 3.563 | 3/16 | 3.875 | 8.17 |
| 4 | 4.000 | 4.750 | 5 3/4 | 4.063 | 3/16 | 4.375 | 9.58 |
| 4 1/2 | 4.500 | 5.200 | 6 1/8 | 4.563 | 3/16 | 4.850 | 10.77 |

NOTE 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 E.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 lb | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Outside Diameter | Regular | Special Clearance | | | | Regular with Special Bevel | Special clearance | Regular | Special Clearance |
| | $D$ | $W$ [b] | $W_c$ [c] | $N_L$ | $Q$ | $b$ | | | | |
| | in. | in. | in. | in. | in. | in. | in. | in. | | |
| *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* |
| 1.050 | 1.050 | 1.660 | — | 3 1/4 | 1.378 | 3/32 | 1.488 | — | 0.84 | — |
| 1.315 | 1.315 | 1.900 | — | 3 1/2 | 1.531 | 3/32 | 1.684 | — | 1.26 | — |
| 1.660 | 1.660 | 2.200 | — | 3 3/4 | 1.875 | 1/8 | 2.006 | — | 1.49 | — |
| 1.900 | 1.900 | 2.500 | — | 3 7/8 | 2.156 | 1/8 | 2.297 | — | 1.85 | — |
| 2 3/8 | 2.375 | 3.063 | 2.910 | 4 7/8 | 2.656 | 5/32 | 2.828 | 2.752 | 3.43 | 2.35 |
| 2 7/8 | 2.875 | 3.668 | 3.460 | 5 1/4 | 3.156 | 7/32 | 3.381 | 3.277 | 5.30 | 3.42 |
| 3 1/2 | 3.500 | 4.500 | 4.180 | 5 3/4 | 3.813 | 1/4 | 4.125 | 3.965 | 9.03 | 5.24 |
| 4 | 4.000 | 5.000 | — | 6 | 4.313 | 1/4 | 4.625 | — | 10.63 | — |
| 4 1/2 | 4.500 | 5.563 | — | 6 1/4 | 4.813 | 1/4 | 5.156 | — | 13.33 | — |

NOTE 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 $W_c$: ±0.015 in.

**Table E.36—Permissible Depth of External Imperfections on Coupling (Dimensions in Inches)**

| 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 | 0.030 | 0.025 | 0.030 |
| | ≥ 3 1/2 to ≤ 4 1/2 | 0.045 | 0.030 | 0.035 |
| Casing [a] | < 6 5/8 | 0.035 | 0.030 | 0.030 |
| | ≥ 6 5/8 to ≤ 7 5/8 | 0.045 | 0.040 | 0.035 |
| | > 7 5/8 | 0.060 | 0.040 | 0.035 |

[a] Includes casing used as tubing.

**Table E.37—Frequency of Tensile Tests—Casing and Tubing**

| Grade [e] | 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 9Cr, 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 9Cr, 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] | 1 | 1 |
| Q125 | All sizes | — [d] | 3 [c] | — |

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, except for a single piece lot where the test specimens may be taken from both ends of one length.

[d] See 10.2.2.

[e] 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.

**Table E.38—Frequency of Tensile Tests—Coupling Stock, Coupling Material, and Coupling Blanks**

| Grade | Material | Condition when Heat-treated | 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), 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 9Cr and 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]<br>Label 1: ≥ 9 5/8: 30 [c] | 1 | — |
| | Hot forging | Coupling blank | Label 1: < 9 5/8: 50 [c]<br>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]<br>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. except for a single piece lot where the test specimens may be taken from both ends of the length.

**Table E.39—Frequency of Tensile Testing—Pup Joints and Accessory Material**

| Grade | Material and Heat Treatment Conditions [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<br>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<br>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<br>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<br>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<br>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 9Cr, L80 13Cr | Full-length standard tubing or casing from one or more heats | | Label 1: ≤ 4 1/2: 200<br>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<br>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<br>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]<br>Label 1: ≥ 9 5/8: 30 [c] | 1 | — |
| | | Heat-treated in sequential loads or continuous heat treatment | Label 1: < 9 5/8: 50 [c]<br>Label 1: ≥ 9 5/8: 30 [c] | 1 | — |
| 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]<br>Label 1: ≥ 9 5/8: 30 [c] | 1 | — |
| | | Heat-treated in sequential loads or continuous heat treatment | Label 1: < 9 5/8: 50 [c]<br>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, except for a single piece lot where the test specimens may be taken from both ends of one length.

[c] Each lot shall be from the same heat of steel for Grades L80 9Cr, L80 13Cr, C90, T95, C110, and Q125; See 10.2.3.

**Table E.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* |
| 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 |
| 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 | Approximately 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<br>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 [a] | 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]<br>Label 1: ≥ 9 5/8: 30 [c] | Through-wall, 4 quadrants | From a piece with the highest surface hardness number in the lot |

**Table E.40—Frequency of Hardness Testing (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* |
| 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 [a] | 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]<br>Label 1: ≥ 9 $^{5}/_{8}$ 30 [c] | Through-wall, 4 quadrants | From a piece with the highest surface hardness number in the lot |
| Q125 | Casing | | 3 [a] | 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 | Approximately 50 % from each end |
| | | Individual heat treatment | 1 | Each piece | Surface—HRC or HBW | Each piece |
| | | | 1 | Label 1: < 9 $^{5}/_{8}$: 50 [c]<br>Label 1: ≥ 9 $^{5}/_{8}$: 30 [c] | Through-wall, 1 quadrant | Randomly selected piece |

[a] When more than one test is required, the test specimens shall be from different lengths, except for a single piece lot where the test specimens may be taken from both ends of one length.

[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 9Cr, L80 13Cr, C90, T95, and Q125.

[d] One upset approximately 50 % from each end if both ends are upset.

## Table E.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 K.6 (SR 11)] | | |
| **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.

**Table E.42—Summary of NDE Methods for Seamless Pipe, Coupling Stock, 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 and accessory material | H40, J55, K55 | R | N | N | N | N | N |
| | 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 | 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 |

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.

**Table E.43—Acceptance (Inspection) Levels**

| Material | Grade | | External Imperfections | | Internal Imperfections | |
|---|---|---|---|---|---|---|
| | | | Longitudinal | Transverse | Longitudinal | Transverse |
| *1* | *2* | | *3* | *4* | *5* | *6* |
| Pipe body [a] | N80 Type 1 | | L3 | — | L3 | — |
| | N80Q, L80, R95 | | L4 | — | L4 | — |
| | P110 to K.9 (SR 16) | | L4 | L4 | L4 | L4 |
| | P110 | | L2 | L2 | L2 | L2 |
| | P110 to K.9 (SR 16) and K.3 (SR 2) | | L2 | L2 | L2 | L2 |
| | C90, T95, C110, Q125 | UT | L2 | L2 | L2 | L2 |
| | | Second method | L2 | L2 | — | — |
| Coupling stock | All grades except C110 | | L2 | L2 | N | N |
| | C110 | | L2 | L2 | L3 | L3 |
| Weld seam | P110, Q125 | | L2 | N | L2 | N |
| | All other grades | | L3 | N | L3 | N |
| | All other grades to K.3 (SR 2) | | L2 | N | L2 | N |

NOTE N = Not required; $L_x$ = Acceptance (inspection) level.

[a] Accessory material shall be treated as pipe body.

**Table E.44—Artificial Reference Indicators**

| Acceptance (Inspection) Level | Notch Depth [a] Maximum % | Notch Length Maximum at Full Depth in. | Notch Width Maximum in. | Radially Drilled Hole Diameter [b] in. |
|---|---|---|---|---|
| *1* | *2* | *3* | *4* | *5* |
| L2 | 5 | 2.0 | 0.040 | $^{1}/_{16}$ |
| L3 | 10 | 2.0 | 0.040 | $^{1}/_{8}$ |
| L4 | 12.5 | 2.0 | 0.040 | $^{1}/_{8}$ |

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 0.012 in. ± 0.002 in.

[b] Drilled hole diameter (through the pipe wall) shall be based on the drill bit size.

**Table E.45—Size of Stamp Markings**

| Product | Label 1 | Marking Height in. |
|---|---|---|
| Pipe | < 4 $^{1}/_{2}$ | $^{3}/_{16}$ |
| | ≥ 4 $^{1}/_{2}$ | $^{1}/_{4}$ |
| Coupling | For pipe sizes < 4 $^{1}/_{2}$ | $^{1}/_{4}$ |
| | For pipe sizes ≥ 4 $^{1}/_{2}$ to < 7 $^{5}/_{8}$ | $^{3}/_{8}$ |
| | For pipe sizes ≥ 7 $^{5}/_{8}$ | $^{1}/_{2}$ |

## Table E.46—Grade Color Codes

| Grade | Grade Type | Number and Color of Bands for Product [a] with Length ≥ 6.0 ft | Color(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 | 9Cr | One red, one brown, two yellow | None | Two yellow |
| L80 | 13Cr | One red, one brown, one yellow | None | One yellow |
| C90 | 1 | One purple | Purple | None |
| T95 | 1 | One silver | Silver | None |
| C110 | — | One white, two brown | White | Two brown |
| P110 | — | One white | White | None |
| Q125 | 1 | One orange | Orange | None |

[a] In the case of coupling material, unless otherwise specified in 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 E.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 E.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 Materials |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 1 | Manufacturer's name or mark | «....» | D or P | D or P | P | P | P |
| 2 | API Spec 5CT | 5CT [c] | D or P | D or P | P | P | P |
| | Date of manufacture as in 11.1.8 or 11.1.9. | «....» | D or P | D or P | P | P | P |
| | Manufacturer's option (applicable to API Monogram licensees):<br>— API license number<br>— API Monogram<br>— Date of manufacture as in 11.1.8 or 11.1.9 | «....» | D or P | D or P | P | P | P |
| 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 E.1 or E.2) | «....» | P | | P | | |
| | Specified diameter for coupling stock and other products with no mass designation | | | | | | P |
| 5 | Mass designation (fill in Label 2 designation from Table E.1 or E.2) | «....» | D or P | | P | | |
| | Specified wall thickness for coupling stock and other products with no mass designation | | | | | | P |
| 6 | Grade of product: | | | | | | |
| | — H40 | H | | | | | |
| | — J55 | J | | | | | |

**Table E.48—Marking Requirements and Sequence (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 Materials |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 6 | — K55 | K | | | | | |
| | — N80 Type 1 | N1 | | | | | |
| | — N80Q | NQ | | | | | |
| | — R95 | R | | | | | |
| | — L80 Type 1 | L | | | | | |
| | — L80 Type 9Cr | L9 | | | | | |
| | — L80 Type 13Cr | L13 | | | | | |
| | — C90 Type 1 | C90-1 | | | | | |
| | — T95 Type 1 | T95-1 | | | | | |
| | — C110 | C110 | | | | | |
| | — P110 | P | | | | | |
| | — Q125 Type 1 | Q1 | | | | | |
| | All grade designations | | D or P | D or P | P | P | P |
| 7 | Sulfide cracking test [f] | | | | | | |
| | — C90 Type 1 | A, B, or D | | | | | |
| | — T95 Type 1 | A, B, or D | | | | | |
| | — C110 | A, D, or DA [g] | | | | | |
| | All test method designations | | | | P | P | P |
| 8 | Reduced alternative impact test temperature, if applicable. Fill in specified test temperature for full-size specimens, including ± symbol and °F | «....»F | P | P | P | P | |
| 9 | Heat treatment, if applicable: | | | | | | |
| | — J55 or K55 normalised | Z | P | P | | | P |
| | — J55 or K55 normalised and tempered | N&T | P | P | | | P |
| 10 | Process of manufacture: | | | | | | |
| | — Seamless | S | | | | | |
| | — Electric-welded | E | | | | | |
| | All designations | | D or P | | P | | |

**Table E.48—Marking Requirements and Sequence (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 Materials |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 11 | Supplementary requirements, if applicable: | | | | | | |
| | — K.2 (SR 1) | S1 | P | | P | | |
| | — K.3 (SR 2) | S2 | P | | P | | |
| | — K.4 (SR 9) (fill in type) | S9Q«....» | | | | P | |
| | — K.8 (SR 13) | S13 | | D or P | | P | |
| | — K.9 (SR 16) (fill in minimum full-size energy absorption requirement, in ft-lb, and test temperature including ± symbol and °F) | S16«....»F | P | | P | | |
| | — K.10 (SR 22) | S22 | P | D | P | D | |
| | — K.14 (SR 41) | S41.1<br>S41.2 | P<br>P | | P<br>P | | |
| | — Annex H (PSL) | L2 or L3 | P | P | P | P | P |
| 12 | Hydrostatic test pressure [e]<br>(fill in the actual test pressure, in psi) | | | | | | |
| | All designations | P«....» | P | | P | | |
| 13 | Type of thread, if applicable | «....» [h] | P | P | P | P | |

**Table E.48—Marking Requirements and Sequence (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 Materials |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 14 | Full-length drift test, if applicable: | | | | | | |
| | — Standard (casing or tubing) | D | | | | | |
| | — Alternative (casing or tubing) where «  » is the size of the alternative drift | DA«....» | | | | | |
| | — For casing specified for tubing service and drift-tested in accordance with 8.10 | DT42 | | | | | |
| | All designations | | P | | P | | |
| 15 | Serialization of Grades C90, T95, C110, and Q125 | | | | D [d] or P | D [d] 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 color code requirements.

[a] D indicates for optional (die) stamping; P indicates a requirement for (paint) stencilling. Optional marking is permitted as specified in 11.1 and 11.2.

[b] A blank space, «....», indicates information to be filled in.

[c] The manufacturer may include “API” before “5CT”.

[d] Stamp marking shall conform to the requirements of 11.2.

[e] 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 1000 (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.

[f] ”A” when tested using Method A (smooth tensile), “B” when tested using Method B, (bent beam), “D” when tested using Method D (DCB).

[g] For Grade C110 only, “DA” when tested using a test solution other than NACE TM0177-2016 Test Solution A.

[h] See Table E.47 for thread type markings.

**Table E.49—Retention of Records**

| Requirement | Sub-section Reference |
|---|---|
| **Chemical Properties** | |
| Heat analysis | 10.3.1 |
| Product analysis | 10.3.2 |
| **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, 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 |
| Supplemental inspection when hydrostatic test pressure is limited, if applicable | K.14.1 (SR 41.1), K.14.2 (SR 41.2) |
| **Manufacturer Certification** | |
| Results of all required tests | 13.3 |
| Sulfide stress-cracking test (Grades C90, T95, and C110) | 7.14, 10.10 |
| Calibration | Various |

**Table E.50—SR 11.1—Distance between Plates for Flattening Tests**

| Grade | $D/t$ ratio | Distance between Plates max in. |
|---|---|---|
| P110 | All ratios | $D \times (1.086 - 0.0163\ D/t)$ |
| Q125 | All ratios | $D \times (1.092 - 0.0140\ D/t)$ |

NOTE

$D$ is the specified outside diameter of pipe, in inches.

$t$ is the specified wall thickness of the pipe, in inches.

**Table E.51—SR 12.1—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 |

**Table E.52—SR 12.2—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 | 0.99997 (or 100 %) |
| 1/100 | 0.634 (or 63 %) |
| 1/1000 | 0.095 (or 10 %) |
| 1/10,000 | 0.00995 (or 1 %) |

**Table E.53—SR 16.1—Transverse Impact Specimen Size Required**

| Label 1 | Calculated Wall Thickness Required to Machine Transverse Charpy Impact Specimens in. | | |
|---|---|---|---|
| | Full-size | 3/4-size | 1/2-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 API pipe are for information only; the calculated values in this table provide a 0.020 in. inside-wall and a 0.020 in. outside-wall machining allowance.

**Table E.54—SR 16.2—Longitudinal Impact Specimen Size Required**

| Label 1 | Calculated Wall Thickness Required to Machine Longitudinal Charpy Impact Specimens in. | | |
|---|---|---|---|
| | Full-size | 3/4-size | 1/2-size |
| 1 | 2 | 3 | 4 |
| 1.050 | 0.472 | 0.374 | 0.275 |
| 1.315 | 0.464 | 0.366 | 0.267 |
| 1.6660 | 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 API pipe are for information only; The above provides a 0.020 in. inside-wall and a 0.020 in. outside-wall machining allowance.

**Table E.55—SR 16.3—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 |
| 3/4-size | 10.0 × 7.5 | 0.80 |
| 1/2-size | 10.0 × 5.0 | 0.55 |

**Table E.56—SR 16.4—Hierarchy of Test Specimen Orientation and Size**

| Choice | Orientation | Size |
|---|---|---|
| 1st | Transverse | Full-size |
| 2nd | Transverse | 3/4-size |
| 3rd | Transverse | 1/2-size |
| 4th | Longitudinal | Full-size |
| 5th | Longitudinal | 3/4-size |
| 6th | Longitudinal | 1/2-size |

**Table E.57—SR 16.7—Test Temperature Reduction for Sub-size Specimens for Grades H40, J55, and K55 Only**

| Specimen Size | Specified Pipe Wall Thickness | Temperature Reduction |
|---|---|---|
| mm | in. | °F |
| 10.0 × 7.5 | > 0.394 | 5 |
| 10.0 × 5.0 | > 0.394 | 20 |
| 10.0 × 5.0 | 0.295 to 0.394 | 15 |
| 10.0 × 5.0 | 0.264 to 0.291 | 10 |
| 10.0 × 5.0 | 0.236 to 0.260 | 5 |

## Table E.58—Enhanced Leak Resistance SR 22.1

| 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 | |
| | | | in. | in. | in. | N | in. | ft·lb | ft·lb | g |
| *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* |
| 4 1/2 | 11.60 | J55, K55 | 4.500 | 3.875 | 5.250 | 3 | 3.250 | 130 | 217 | 15 |
| 4 1/2 | 11.60 | L80, N80 | 4.500 | 3.875 | 5.250 | 3 | 3.250 | 124 | 206 | 15 |
| 4 1/2 | 13.50 | L80, N80 | 4.500 | 3.795 | 5.250 | 3 | 3.250 | 136 | 227 | 15 |
| 4 1/2 | 11.60 | C90 | 4.500 | 3.875 | 5.250 | 3 | 3.250 | 127 | — | 15 |
| 4 1/2 | 13.50 | C90 | 4.500 | 3.795 | 5.250 | 3 | 3.250 | 143 | — | 15 |
| 4 1/2 | 11.60 | R95, T95 | 4.500 | 3.875 | 5.250 | 3 | 3.250 | 130 | — | 15 |
| 4 1/2 | 13.50 | R95, T95 | 4.500 | 3.795 | 5.250 | 3 | 3.250 | 146 | — | 15 |
| 4 1/2 | 11.60 | P110 | 4.500 | 3.875 | 5.250 | 3 | 3.250 | 130 | — | 15 |
| 4 1/2 | 13.50 | P110 | 4.500 | 3.795 | 5.250 | 3 | 3.250 | 148 | — | 15 |
| 5 | 13.00 | J55, K55 | 5.000 | 4.369 | 5.800 | 3 | 3.625 | 116 | 193 | 20 |
| 5 | 15.00 | J55, K55 | 5.000 | 4.283 | 5.800 | 3 | 3.625 | 125 | 208 | 20 |
| 5 | 15.00 | L80, N80 | 5.000 | 4.283 | 5.800 | 3.5 | 3.625 | 164 | 273 | 20 |
| 5 | 18.00 | L80, N80 | 5.000 | 4.151 | 5.800 | 3.5 | 3.625 | 220 | 367 | 20 |
| 5 | 15.00 | C90 | 5.000 | 4.283 | 5.800 | 3 | 3.625 | 198 | — | 20 |
| 5 | 18.00 | C90 | 5.000 | 4.151 | 5.800 | 3 | 3.625 | 238 | — | 20 |
| 5 | 15.00 | R95, T95 | 5.000 | 4.283 | 5.800 | 3.5 | 3.625 | 202 | — | 20 |
| 5 | 18.00 | R95, T95 | 5.000 | 4.151 | 5.800 | 3.5 | 3.625 | 243 | — | 20 |
| 5 | 15.00 | P110 | 5.000 | 4.283 | 5.800 | 3.5 | 3.625 | 208 | — | 20 |
| 5 | 18.00 | P110 | 5.000 | 4.151 | 5.800 | 3.5 | 3.625 | 248 | — | 20 |
| 5 1/2 | 15.50 | J55, K55 | 5.000 | 4.825 | 6.300 | 3 | 3.750 | 162 | 270 | 25 |
| 5 1/2 | 17.00 | J55, K55 | 5.000 | 4.767 | 6.300 | 3 | 3.750 | 192 | 320 | 25 |
| 5 1/2 | 17.00 | L80, N80 | 5.000 | 4.767 | 6.300 | 4 | 3.750 | 240 | 400 | 25 |
| 5 1/2 | 20.00 | L80, N80 | 5.000 | 4.653 | 6.300 | 4 | 3.750 | 273 | 456 | 25 |
| 5 1/2 | 17.00 | C90 | 5.000 | 4.767 | 6.300 | 3 | 3.750 | 180 | — | 25 |
| 5 1/2 | 20.00 | C90 | 5.000 | 4.653 | 6.300 | 3 | 3.750 | 205 | — | 25 |
| 5 1/2 | 17.00 | R95, T95 | 5.000 | 4.767 | 6.300 | 3.5 | 3.750 | 222 | — | 25 |
| 5 1/2 | 20.00 | R95, T95 | 5.000 | 4.653 | 6.300 | 3.5 | 3.750 | 251 | — | 25 |
| 5 1/2 | 17.00 | P110 | 5.000 | 4.767 | 6.300 | 4 | 3.750 | 270 | — | 25 |
| 5 1/2 | 20.00 | P110 | 5.000 | 4.653 | 6.300 | 4 | 3.750 | 301 | — | 25 |

**Table E.58—Enhanced Leak Resistance SR 22.1 (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 | |
| | | | in. | in. | in. | N | in. | ft·lb | ft·lb | g |
| *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* |
| 6 5/8 | 20.00 | J55, K55 | 6.625 | 5.924 | 7.390 | 3 | 4.125 | 162 | 269 | 30 |
| 6 5/8 | 24.00 | J55, K55 | 6.625 | 5.796 | 7.390 | 3 | 4.125 | 202 | 337 | 30 |
| 6 5/8 | 24.00 | L80, N80 | 6.625 | 5.796 | 7.390 | 4 | 4.125 | 332 | 554 | 30 |
| 6 5/8 | 28.00 | L80, N80 | 6.625 | 5.666 | 7.390 | 4 | 4.125 | 387 | 646 | 30 |
| 6 5/8 | 32.00 | L80, N80 | 6.625 | 5.550 | 7.390 | 4 | 4.125 | 427 | 712 | 30 |
| 6 5/8 | 24.00 | C90 | 6.625 | 5.796 | 7.390 | 4 | 4.125 | 351 | — | 30 |
| 6 5/8 | 28.00 | C90 | 6.625 | 5.666 | 7.390 | 4 | 4.125 | 408 | — | 30 |
| 6 5/8 | 32.00 | C90 | 6.625 | 5.550 | 7.390 | 4 | 4.125 | 451 | — | 30 |
| 6 5/8 | 24.00 | R95, T95 | 6.625 | 5.796 | 7.390 | 4 | 4.125 | 356 | — | 30 |
| 6 5/8 | 28.00 | R95, T95 | 6.625 | 5.666 | 7.390 | 4 | 4.125 | 411 | — | 30 |
| 6 5/8 | 32.00 | R95, T95 | 6.625 | 5.550 | 7.390 | 4 | 4.125 | 453 | — | 30 |
| 6 5/8 | 24.00 | P110 | 6.625 | 5.796 | 7.390 | 4.5 | 4.125 | 417 | — | 30 |
| 6 5/8 | 28.00 | P110 | 6.625 | 5.666 | 7.390 | 4.5 | 4.125 | 483 | — | 30 |
| 6 5/8 | 32.00 | P110 | 6.625 | 5.550 | 7.390 | 4.5 | 4.125 | 532 | — | 30 |
| 7 | 23.00 | J55, K55 | 7.000 | 6.241 | 7.875 | 4 | 4.250 | 237 | 395 | 35 |
| 7 | 26.00 | J55, K55 | 7.000 | 6.151 | 7.875 | 4 | 4.250 | 273 | 455 | 35 |
| 7 | 23.00 | L80, N80 | 7.000 | 6.241 | 7.875 | 5.5 | 4.250 | 414 | 690 | 35 |
| 7 | 26.00 | L80, N80 | 7.000 | 6.151 | 7.875 | 5.5 | 4.250 | 486 | 810 | 35 |
| 7 | 29.00 | L80, N80 | 7.000 | 6.059 | 7.875 | 5.5 | 4.250 | 543 | 904 | 35 |
| 7 | 32.00 | L80, N80 | 7.000 | 5.969 | 7.875 | 5.5 | 4.250 | 585 | 975 | 35 |
| 7 | 23.00 | C90 | 7.000 | 6.241 | 7.875 | 4.5 | 4.250 | 354 | — | 35 |
| 7 | 26.00 | C90 | 7.000 | 6.151 | 7.875 | 4.5 | 4.250 | 404 | — | 35 |
| 7 | 29.00 | C90 | 7.000 | 6.059 | 7.875 | 4.5 | 4.250 | 449 | — | 35 |
| 7 | 32.00 | C90 | 7.000 | 5.969 | 7.875 | 4.5 | 4.250 | 489 | — | 35 |
| 7 | 23.00 | R95, T95 | 7.000 | 6.241 | 7.875 | 4.5 | 4.250 | 361 | — | 35 |
| 7 | 26.00 | R95, T95 | 7.000 | 6.151 | 7.875 | 4.5 | 4.250 | 410 | — | 35 |
| 7 | 29.00 | R95, T95 | 7.000 | 6.059 | 7.875 | 4.5 | 4.250 | 455 | — | 35 |
| 7 | 32.00 | R95, T95 | 7.000 | 5.969 | 7.875 | 4.5 | 4.250 | 494 | — | 35 |
| 7 | 26.00 | P110 | 7.000 | 6.151 | 7.875 | 5 | 4.250 | 474 | — | 35 |
| 7 | 29.00 | P110 | 7.000 | 6.059 | 7.875 | 5 | 4.250 | 525 | — | 35 |
| 7 | 32.00 | P110 | 7.000 | 5.969 | 7.875 | 5 | 4.250 | 567 | — | 35 |

**Table E.58—Enhanced Leak Resistance SR 22.1 (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 | |
| | | | in. | in. | in. | N | in. | ft·lb | ft·lb | g |
| *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* |
| 7 5/8 | 26.40 | J55, K55 | 7.625 | 6.844 | 8.500 | 3.5 | 4.375 | 244 | 406 | 40 |
| 7 5/8 | 26.40 | L80, N80 | 7.625 | 6.844 | 8.500 | 5 | 4.375 | 482 | 804 | 40 |
| 7 5/8 | 29.70 | L80, N80 | 7.625 | 6.750 | 8.500 | 5 | 4.375 | 566 | 943 | 40 |
| 7 5/8 | 33.70 | L80, N80 | 7.625 | 6.640 | 8.500 | 5 | 4.375 | 649 | 1081 | 40 |
| 7 5/8 | 39.00 | L80, N80 | 7.625 | 6.500 | 8.500 | 5 | 4.375 | 737 | 1228 | 40 |
| 7 5/8 | 26.40 | C90 | 7.625 | 6.844 | 8.500 | 4.5 | 4.375 | 409 | — | 40 |
| 7 5/8 | 29.70 | C90 | 7.625 | 6.750 | 8.500 | 4.5 | 4.375 | 470 | — | 40 |
| 7 5/8 | 33.70 | C90 | 7.625 | 6.640 | 8.500 | 4.5 | 4.375 | 532 | — | 40 |
| 7 5/8 | 39.00 | C90 | 7.625 | 6.500 | 8.500 | 4.5 | 4.375 | 600 | — | 40 |
| 7 5/8 | 26.40 | R95, T95 | 7.625 | 6.844 | 8.500 | 4.5 | 4.375 | 417 | — | 40 |
| 7 5/8 | 29.70 | R95, T95 | 7.625 | 6.750 | 8.500 | 4.5 | 4.375 | 476 | — | 40 |
| 7 5/8 | 33.70 | R95, T95 | 7.625 | 6.640 | 8.500 | 4.5 | 4.375 | 537 | — | 40 |
| 7 5/8 | 39.00 | R95, T95 | 7.625 | 6.500 | 8.500 | 4.5 | 4.375 | 603 | — | 40 |
| 7 5/8 | 29.70 | P110 | 7.625 | 6.750 | 8.500 | 5 | 4.375 | 551 | — | 40 |
| 7 5/8 | 33.70 | P110 | 7.625 | 6.640 | 8.500 | 5 | 4.375 | 620 | — | 40 |
| 7 5/8 | 39.00 | P110 | 7.625 | 6.500 | 8.500 | 5 | 4.375 | 695 | — | 40 |
| 8 5/8 | 32.00 | J55, K55 | 8.625 | 7.796 | 9.625 | 3.5 | 4.750 | 306 | 510 | 50 |
| 8 5/8 | 36.00 | J55, K55 | 8.625 | 7.700 | 9.625 | 3.5 | 4.750 | 356 | 593 | 50 |
| 8 5/8 | 36.00 | L80, N80 | 8.625 | 7.700 | 9.625 | 5.5 | 4.750 | 614 | 1024 | 50 |
| 8 5/8 | 40.00 | L80, N80 | 8.625 | 7.600 | 9.625 | 5.5 | 4.750 | 657 | 1095 | 50 |
| 8 5/8 | 44.00 | L80, N80 | 8.625 | 7.500 | 9.625 | 5.5 | 4.750 | 737 | 1229 | 50 |
| 8 5/8 | 49.00 | L80, N80 | 8.625 | 7.386 | 9.625 | 5.5 | 4.750 | 796 | 1326 | 50 |
| 8 5/8 | 36.00 | C90 | 8.625 | 7.700 | 9.625 | 4.5 | 4.750 | 650 | — | 50 |
| 8 5/8 | 40.00 | C90 | 8.625 | 7.600 | 9.625 | 4.5 | 4.750 | 723 | — | 50 |
| 8 5/8 | 44.00 | C90 | 8.625 | 7.500 | 9.625 | 4.5 | 4.750 | 789 | — | 50 |

**Table E.58—Enhanced Leak Resistance SR 22.1 (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 | |
| | | | in. | in. | in. | N | in. | ft·lb | ft·lb | g |
| *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* |
| 8 5/8 | 49.00 | C90 | 8.625 | 7.386 | 9.625 | 4.5 | 4.750 | 857 | — | 50 |
| 8 5/8 | 36.00 | R95, T95 | 8.625 | 7.700 | 9.625 | 5 | 4.750 | 690 | — | 50 |
| 8 5/8 | 40.00 | R95, T95 | 8.625 | 7.600 | 9.625 | 5 | 4.750 | 772 | — | 50 |
| 8 5/8 | 44.00 | R95, T95 | 8.625 | 7.500 | 9.625 | 5 | 4.750 | 843 | — | 50 |
| 8 5/8 | 49.00 | R95, T95 | 8.625 | 7.386 | 9.625 | 5 | 4.750 | 914 | — | 50 |
| 8 5/8 | 40.00 | P110 | 8.625 | 7.600 | 9.625 | 5.5 | 4.750 | 799 | — | 50 |
| 8 5/8 | 44.00 | P110 | 8.625 | 7.500 | 9.625 | 5.5 | 4.750 | 901 | — | 50 |
| 8 5/8 | 49.00 | P110 | 8.625 | 7.386 | 9.625 | 5.5 | 4.750 | 975 | — | 50 |
| 9 5/8 | 36.00 | J55, K55 | 9.625 | 8.765 | 10.625 | 3.5 | 5.000 | 393 | 507 | 55 |
| 9 5/8 | 40.00 | J55, K55 | 9.625 | 8.679 | 10.625 | 3.5 | 5.000 | 439 | 572 | 55 |
| 9 5/8 | 40.00 | L80, N80 | 9.625 | 8.679 | 10.625 | 5.5 | 5.000 | 673 | 1121 | 55 |
| 9 5/8 | 43.50 | L80, N80 | 9.625 | 8.599 | 10.625 | 5.5 | 5.000 | 767 | 1278 | 55 |
| 9 5/8 | 47.00 | L80, N80 | 9.625 | 8.525 | 10.625 | 5.5 | 5.000 | 823 | 1371 | 55 |
| 9 5/8 | 53.50 | L80, N80 | 9.625 | 8.500 [d] | 10.625 | 5.5 | 5.000 | 923 | 1539 | 55 |
| 9 5/8 | 40.00 | C90 | 9.625 | 8.679 | 10.625 | 5 | 5.000 | 675 | — | 55 |
| 9 5/8 | 43.50 | C90 | 9.625 | 8.599 | 10.625 | 5 | 5.000 | 737 | — | 55 |
| 9 5/8 | 47.00 | C90 | 9.625 | 8.525 | 10.625 | 5 | 5.000 | 790 | — | 55 |
| 9 5/8 | 53.50 | C90 | 9.625 | 8.500 [d] | 10.625 | 5 | 5.000 | 988 | — | 55 |
| 9 5/8 | 40.00 | R95, T95 | 9.625 | 8.679 | 10.625 | 5.5 | 5.000 | 762 | — | 55 |
| 9 5/8 | 43.50 | R95, T95 | 9.625 | 8.599 | 10.625 | 5.5 | 5.000 | 833 | — | 55 |
| 9 5/8 | 47.00 | R95, T95 | 9.625 | 8.525 | 10.625 | 5.5 | 5.000 | 893 | — | 55 |
| 9 5/8 | 53.50 | R95, T95 | 9.625 | 8.500 [d] | 10.625 | 5.5 | 5.000 | 972 | — | 55 |
| 9 5/8 | 43.50 | P110 | 9.625 | 8.599 | 10.625 | 6 | 5.000 | 914 | — | 55 |
| 9 5/8 | 47.00 | P110 | 9.625 | 8.525 | 10.625 | 6 | 5.000 | 978 | — | 55 |
| 9 5/8 | 53.50 | P110 | 9.625 | 8.500 [d] | 10.625 | 6 | 5.000 | 1092 | — | 55 |

[a] L/N80 implies L80 Type 1, N80 Type 1 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 Bulletin 5A2) which has a specific gravity of approximately 2; Use of compounds such as described in API 5A3 or ISO 13678 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 E.29) is shown.

# Annex F
(informative)

# Additional Information for API Monogram Licensees

## F.1 Other Marking Requirements for Products

Products manufactured in conformance with this standard may be marked by the API Licensee as specified in Section 11 and this annex. Products to which the API Monogram is applied shall be marked according to Section 11 and this annex along with the requirements of Annex A, API Monogram licensing agreement, and any alternative marking agreement.

It is allowable to place additional markings for other compatible standards following the required marking sequence. Such markings are at the option of the manufacturer or as requested by the purchaser.

The complete monogram consists of the following: “Spec 5CT”, license number of the plant doing the manufacturing, the API Monogram and the date of manufacture.

# Annex G
(informative)

# Procedures Used to Convert from USC Units to SI Units

## G.1 Background

The following procedures were adopted in this standard for converting units from the United States Customary (USC) system into the International System (SI).

## G.2 General

### G.2.1 Rounding

The last retained digit in a number was unchanged when the next digit was less than 5 or raised when it was greater than 5.

When the digit following the last retained digit was exactly 5 followed by zeros, the last retained digit was unchanged if it was even, or was raised if it was odd.

### G.2.2 Fractions

Fractions or numbers with fractions in USC units were converted to the full decimal equivalents in USC units without rounding. The full decimal equivalents in USC units were then converted to SI values using Equation (G.1):

$$N_m = 25.4 \times N \tag{G.1}$$

where

$N_m$ is the SI equivalent, expressed in millimeters, of a USC fraction or USC number with fractions (in inches);

$N$ is the full decimal equivalent, expressed in inches, of a USC fraction or number with fractions which has not been rounded.

The converted SI values, in millimeters, for the equivalent of USC fractions or numbers with fractions were rounded to the appropriate number of places for the application.

### G.2.3 Tolerances

Equation (G.1) was used. The USC values for tolerances, except angular misalignment, were converted to SI values based on the appropriate conversion factor.

The converted SI values for the tolerances, except angular misalignment, were rounded to the same number of decimal places as the SI value to which they were applicable.

## G.3 Pipe Dimensions

### G.3.1 Outside Diameter

The USC values for outside diameters of pipe and couplings were converted to SI values using Equation (G.2):

$$D_m = 25.4 \times D \tag{G.2}$$

where

$D_m$ is the outside diameter, expressed in millimeters;

$D$ is the outside diameter, expressed in inches.

The converted SI values for the outside diameters of pipe and couplings were rounded to the nearest 0.01 mm.

### G.3.2 Wall Thickness

The USC values for wall thickness were converted to SI values using Equation (G.3):

$$t_m = 25.4 \times t \tag{G.3}$$

where

$t_m$ is the wall thickness, expressed in millimeters;

$t$ is the wall thickness, expressed in inches.

The converted SI values for wall thickness were rounded to the nearest 0.01 mm.

### G.3.3 Inside Diameter

The SI values for the inside diameters of pipe were calculated (not converted) using Equation (G.4):

$$d_m = D_m - (2 \times t_m) \tag{G.4}$$

where

$d_m$ is the inside diameter, expressed in millimeters;

$D_m$ is the outside diameter, expressed in millimeters;

$t_m$ is the wall thickness, expressed in millimeters.

The calculated SI values for inside diameters of pipe were rounded to the nearest 0.01 mm.

### G.3.4 Diameters and Lengths of Upsets

The USC values for the diameters and lengths of upsets were converted to SI values using Equation (G.5):

$$U_m = 25.4 \times U \tag{G.5}$$

where

$U_m$ is the upset dimension, expressed in millimeters;

$U$ is the upset dimension, expressed in inches.

The converted SI values for the diameters and lengths of upsets were rounded to the nearest 0.01 mm.

## G.4 Drift Diameters

### G.4.1 Drift Diameter, Standard Drift Size, Table C.28

The SI values for standard drift diameters of pipe were calculated (not converted) using Equation (G.6):

$$dd_m = d_m - dc_m \tag{G.6}$$

where

$dd_m$ is the drift diameter, expressed in millimeters;

$d_m$ is the inside diameter, expressed in millimeters;

$dc_m$ is the drift constant, expressed in millimeters.

The drift constants used are given in Table G.1.

**Table G.1—Drift Constants**

| Product | Label 1 | $dc_m$ mm |
|---|---|---|
| Casing | < 9 5/8 | 3.18 |
| | 9 5/8 to 13 3/8 | 3.97 |
| | > 13 3/8 | 4.76 |
| Tubing | ≤ 2 7/8 | 2.38 |
| | > 2 7/8 | 3.18 |
| Casing specified by the purchaser to be used in tubing service where Label 1 is larger than 4 1/2 but smaller than 10 3/4 | > 4 1/2 to 8 5/8 | 3.18 |
| | > 8 5/8 to 10 3/4 | 3.97 |

The calculated SI values for standard drift diameters were rounded to the nearest 0.01 mm.

### G.4.2 Drift Diameter, Alternative Drift Size, Table C.29

The USC values for alternative drift diameters were converted to SI values using Equation (G.7):

$$dd_{a,m} = 25.4 \times dd_a \tag{G.7}$$

where

$dd_{a,m}$ is the alternative drift diameter, expressed in millimeters;

$dd_a$ is the alternative drift diameter, expressed in inches.

The converted SI values for alternative drift diameters were rounded to the nearest 0.01 mm.

## G.5 Coupling Dimensions

### G.5.1 Length of Couplings

The USC values for the lengths of couplings in inches and fractions of inches were converted to decimal equivalents in USC units without rounding. The full decimal equivalent of the lengths of the couplings in USC units were then converted to SI units using Equation (G.8):

$$N_{L,m} = 25.4 \times N_L \tag{G.8}$$

where

$N_{L,m}$ is the length of couplings, expressed in millimeters;

$N_L$ is the length of couplings, expressed in inches, without rounding.

The converted SI values for the lengths of couplings were rounded to the nearest 0.01 mm.

### G.5.2 Diameter of Coupling Recess

The USC values for diameters of the coupling recess were converted to SI values using Equation (G.9):

$$Q_m = 25.4 \times Q \tag{G.9}$$

where

$Q_m$ is the diameter of the coupling recess, expressed in millimeters;

$Q$ is the diameter of the coupling recess, expressed in inches.

The converted SI values for the diameters of the coupling recess were rounded to the nearest 0.01 mm.

### G.5.3 Width of the Coupling Bearing Face

The USC values for the widths of the bearing face of couplings were converted to SI values using Equation (G.10):

$$b_m = 25.4 \times b \tag{G.10}$$

where

$b_m$ is the width of the coupling bearing face, expressed in millimeters;

$b$ is the width of the coupling bearing face, expressed in inches.

The converted SI values for the widths of the coupling bearing faces were rounded to the nearest 0.01 mm.

### G.5.4 Diameter at the Root of the Coupling Thread at the End of the Pipe in the Power-tight Position

The USC values for the diameter at the root of the coupling thread at the end of the pipe in the power-tight position were calculated without rounding and were then converted to SI values using Equation (G.11):

$$D_{1m} = 25.4 \times d_1 \tag{G.11}$$

where

$D_{1m}$ is the diameter, expressed in millimeters, at the root of the coupling thread at the end of the pipe in the power-tight position;

$d_1$ is the unrounded diameter, expressed in inches, at the root of the coupling thread at the end of the pipe in the power-tight position.

The converted SI values for the diameter at the root of the coupling thread at the end of the pipe in the power-tight position were rounded to the nearest 0.01 mm.

## G.6 Linear Mass

### G.6.1 Nominal Threaded and Coupled Linear Mass

The USC values for nominal threaded and coupled linear mass were converted to SI units using Equation (G.12):

$$w_m = 1.48816 \times w \tag{G.12}$$

where

$w_m$ is the linear mass, expressed in kilograms per meter;

$w$ is the linear mass, expressed in pounds per foot.

The converted SI values for nominal threaded and coupled linear mass were rounded to the nearest 0.01 kg/m.

### G.6.2 Plain-end Linear Mass

The plain-end linear masses expressed in SI units were calculated (not converted) using Equation (G.13):

$$w_{pe,m} = 0.0246615 \times (D_m - t_m) \times t_m \tag{G.13}$$

where

$w_{pe,m}$ is the plain-end linear mass, expressed in kilograms per meter;

$D_m$ is the outside diameter, expressed in millimeters;

$t_m$ is the wall thickness, expressed in millimeters.

The calculated SI values for plain-end linear masses were rounded to the nearest 0.01 kg/m.

### G.6.3 Coupling Masses

The USC values for the calculated masses of couplings were converted to SI values using Equation (G.14):

$$w_{c,m} = 0.453592 \times w_c \tag{G.14}$$

where

$w_{c,m}$ is the mass of the coupling, expressed in kilograms;

$w_c$ is the mass of the coupling, expressed in pounds.

The converted SI values for calculated masses of couplings were rounded to the nearest 0.01 kg.

### G.6.4 Mass Gain or Loss due to End Finish

The USC values for mass gain or loss due to end finish were converted to SI units using Equation (G.15):

$$e_{e,m} = 0.453592 \times e_e \tag{G.15}$$

where

$e_{e,m}$ is the mass gain or loss due to end finish, expressed in kilograms;

$e_e$ is the mass gain or loss due to end finish, expressed in pounds.

The converted SI values for mass gain or loss due to end finish were rounded to the nearest 0.01 kg.

## G.7 Tensile and Flattening Tests

### G.7.1 Yield Strength

The USC values for yield strength were converted to SI values using Equation (G.16):

$$YS_m = 0.00689476 \times YS \tag{G.16}$$

where

$YS_m$ is the yield strength, expressed in megapascals;

$YS$ is the yield strength, expressed in pounds per square inch.

The converted SI values for strengths were rounded to the nearest megapascal.

### G.7.2 Tensile Strength

The USC values for tensile strength were converted to SI values using Equation (G.17):

$$TS_m = 0.00689476 \times TS \tag{G.17}$$

where

$TS_m$ is the tensile strength, expressed in megapascals;

$TS$ is the tensile strength, expressed in pounds per square inch.

The converted SI values for strengths were rounded to the nearest megapascal.

### G.7.3 Elongation

The values for elongation, in SI units, were calculated (not converted) using Equation (G.18):

$$e_m = 1944 \times [A_m{}^{0.2} / U_m{}^{0.9}] \quad \text{(G.18)}$$

where

$e_m$ is the minimum elongation, expressed as a percentage;

$A_m$ is the cross-sectional area of the tensile specimen, expressed in square millimeters;

$U_m$ is the specified minimum tensile strength, expressed in megapascals.

The calculated SI values for elongation were rounded to the nearest 1.0 % for values of 10.0 % and larger, and to the nearest 0.5 % for values less than 10.0 %.

### G.7.4 Flattening Test Formula

The equation used to determine the maximum distance between the plates during a flattening test was Equation (G.19):

$$D_f = D \times [Z_1 - (Z_2 \times D / t)] \quad \text{(G.19)}$$

where

$D_f$ is the maximum distance between the plates during a flattening test, expressed in inches or millimeters depending on the units of $D$ and $t$;

$Z_1$ is a constant;

$Z_2$ is a constant;

$D$ is the specified outside diameter of the pipe, expressed in inches or millimeters;

$t$ is the specified wall thickness of the pipe, expressed in inches or millimeters.

The same values for the constants $Z_1$ and $Z_2$ were used regardless of whether the units for $D$ and $t$ were inches or millimeters, provided the units for both $D$ and $t$ were the same.

## G.8 Charpy Impact Energy Requirements

### G.8.1 Critical Thickness for Couplings with API Threads, Table C.7

The USC values for the critical thickness for couplings with API threads were converted to SI values using Equation (G.20):

$$t_{c,m} = 25.4 \times t_c \quad \text{(G.20)}$$

where

$t_{c,m}$ is the critical thickness, expressed in millimeters;

$t_c$ is the critical thickness, expressed in inches.

The calculated SI values were rounded to the nearest 0.01 mm.

### G.8.2 Charpy Impact Energy

The USC values for standard CVN impact energy requirements that are not determined by an equation (for example, as used in Table C.10 and other minimum requirements) were converted to SI values using Equation (G.21):

$$C_m = 1.35582 \times C \tag{G.21}$$

where

$C_m$ is the standard Charpy impact energy, expressed in joules;

$C$ is the standard Charpy impact energy, expressed in foot–pounds (e.g. 8, 15, 20, 30 ft–lb).

The converted SI values for standard CVN impact energy were rounded to the nearest joule.

### G.8.3 Minimum Absorbed Energy Requirements for Couplings, Tables C.11 to C.17

The SI values for the minimum absorbed energy requirements for couplings with API threads were calculated using Equations (G.22) and (G.23):

For Grades N80 (all types), L80, C90, R95, T95, P110, and Q125

Transverse Charpy absorbed energy requirements for couplings:

$$C_{ctm} = f_c \times YS_{max} \times [(0.00118 \times t_c) + 0.01259] \tag{G.22}$$

Longitudinal Charpy absorbed energy requirements for couplings

$$C_{clm} = f_c \times YS_{max} \times [(0.00236 \times t_c) + 0.02518] \tag{G.23}$$

where

$C_{ctm}$ is the minimum transverse Charpy impact energy for couplings, expressed in joules;

$C_{clm}$ is the minimum longitudinal Charpy impact energy for couplings, expressed in joules;

$YS_{max}$ is the specified maximum yield strength of the coupling, expressed in megapascals;

$t_c$ is the critical thickness shown in Table C.7 for couplings with API threads, expressed in millimeters;

$f_c$ is a factor depending on the size of the Charpy impact specimen:

1.00 for full-size specimens (10 mm $\times$ 10 mm);

0.80 for $^3/_4$-size specimens (10 mm $\times$ 7.5 mm);

0.55 for $^1/_2$-size specimens (10 mm × 5 mm).

The calculated SI values were rounded to the nearest joule.

NOTE 1 The maximum-size fully machined transverse and longitudinal Charpy impact specimens for couplings for API threads can be found in API 5C3; These sizes are included in Tables C.11 to C.15 and used in the calculation of the Charpy requirements shown in those tables.

NOTE 2 The absorbed energy requirements in Tables C.16 and C.17 are for full-size test specimens where the factor f is set to 1.00.

### G.8.4 Absorbed Energy Requirements for Pipe

The SI values for the maximum specified wall thickness for various grades of pipe for minimum absorbed energy values from full-size test specimens were calculated using Equations (G.24) to (G.27).

The rounding procedures of ISO 80000-1 or ASTM E29 shall be followed. For example, when calculating the requirements for 27 J, 27.49999999 should be used for $C_{pt,m}$ or $C_{pl,m}$ (since it rounds to 27). Similarly, when calculating the requirements for 28 J, 28.50000000 should be used for $C_{pt,m}$ or $C_{pl,m}$ (since it rounds to 28). The wall thickness that results from the calculation shall be rounded down to two decimal places.

a) Grades N80Q, L-80, C90, R95, T95, and P110

Transverse Charpy absorbed energy requirements for pipe, Table C.18:

$$t = [(C_{pt,m}/YS_{min}) - 0.01259]/0.00118 \quad \text{(G.24)}$$

Longitudinal Charpy absorbed energy requirements for pipe, Table C.19:

$$t = [(C_{pl,m}/YS_{min}) - 0.02518]/0.00236 \quad \text{(G.25)}$$

b) Grades C110 and Q125

Transverse Charpy absorbed energy requirements for pipe, Table C.18:

$$t = [(C_{pt,m}/YS_{max}) - 0.01259]/0.00118 \quad \text{(G.26)}$$

Longitudinal Charpy absorbed energy requirements for pipe, Table C.19:

$$t = [(C_{pl,m}/YS_{max}) - 0.02518]/0.00236 \quad \text{(G.27)}$$

where

$C_{pt,m}$ is the minimum transverse Charpy impact energy for pipe, expressed in joules;

$C_{pl,m}$ is the minimum longitudinal Charpy impact energy for pipe, expressed in joules;

$YS_{max}$ is the specified maximum yield strength of the pipe, expressed in megapascals;

$YS_{min}$ is the specified minimum yield strength of the pipe, expressed in megapascals.

### G.8.5 Calculated Wall Thickness Required to Machine Transverse and Longitudinal Charpy Impact Specimens from Pipe and Couplings, Tables C.20 and C.21

The SI values for the wall thicknesses required to machine transverse and longitudinal Charpy impact test specimens from pipe and couplings were calculated using Equations (G.28) and (G.29):

Transverse Charpy impact specimens, Table C.20:

$$t = (D_m/2) - [(D_m/2)^2 - 756.25]^{0.5} + 1.00 + w_{Cs} \quad \text{(G.28)}$$

Longitudinal Charpy impact specimens, Table C.21:

$$t = (D_m/2) - [(D_m/2)^2 - 25]^{0.5} + 1.00 + w_{Cs} \quad \text{(G.29)}$$

where

$t_t$ is the calculated value for the wall thickness, expressed in millimeters, required to machine transverse Charpy impact test specimens from pipe and couplings;

$t_l$ is the calculated value for the wall thickness, expressed in millimeters, required to machine longitudinal Charpy impact test specimens from pipe and couplings;

$D_m$ is the specified outside diameter of the pipe or coupling, expressed in millimeters;

$w_{Cs}$ is the width of the Charpy impact test specimen, expressed in millimeters:

- 10.0 mm for full-size specimens;
- 7.5 mm for $^3/_4$-size specimens;
- 5.0 mm for $^1/_2$-size specimens.

In the above formulas, a machining allowance of 1.00 mm is included (USC formula allowed 0.020 in. on the inside pipe surface and 0.020 in. on the outside surface or 1.00 mm total for the purposes of this calculation).

The calculated SI values for the wall thicknesses required to machine transverse and longitudinal Charpy impact test specimens from pipe and couplings were rounded to the nearest 0.01 mm.

## G.9 Hydrostatic Testing

### G.9.1 Hydrostatic Test Pressure for Plain-end Pipe

The SI values for hydrostatic test pressures for plain-end pipe were calculated (not converted) using the SI outside diameter, wall thickness and yield strengths and using Equation (G.30):

$$p_m = 2 \times f \times YS_m \times t_m/D_m \quad \text{(G.30)}$$

where

$p_m$ is the hydrostatic test pressure, expressed in megapascals;

$D_m$ is the outside diameter, expressed in millimeters;

$YS_m$ is the yield strength, expressed in megapascals;

$t_m$ is the wall thickness, expressed in millimeters;

$f$ is a factor, based on the size and grade of the pipe as found in Table G.2:

**Table G.2—Plain-end Pipe Hydrostatic Test Factors by Grade and Size**

| Grades | Label 1 | Standard Test | | Alternative Test | |
|---|---|---|---|---|---|
| | | $f$ | Maximum Pressure MPa | $f$ | Maximum Pressure MPa |
| *1* | *2* | *3* | *4* | *5* | *6* |
| H40, J55, K55 | < 10 3/4 | 0.8 | 69.0 | — | — |
| | ≥ 10 3/4 | 0.6 | 69.0 | 0.8 | 69.0 |
| N80 (all types), R95, L80, T95 | All sizes | 0.8 | 69.0 | — | — |
| C110, P110, Q125 | All sizes | 0.8 | 69.0 | 0.8 | No max |

The calculated SI values for hydrostatic test pressures for plain-end pipe were rounded to the nearest 0.5 MPa up to a maximum of 69.0 MPa.

## G.9.2 Hydrostatic Test Pressure for Couplings

The SI values for the maximum hydrostatic test pressures for couplings were calculated (not converted) using Equation (G.31) (taken from API 5C3):

$$p_m = 0.8 \times YS_m \times (W_m - d_{1m}) W_m \quad \text{(G.31)}$$

where

$pm$ is the hydrostatic test pressure, expressed in megapascals;

$W_m$ is the outside diameter of the coupling, expressed in millimeters;

$YS_m$ is the yield strength, expressed in megapascals;

$d_{1m}$ is the diameter, expressed in millimeters, at the root of the coupling thread at the plane of the end of the pipe in the power-tight position.

The calculated SI values for the maximum hydrostatic test pressures for couplings were rounded to the nearest 0.5 MPa.

### G.9.3 Internal Pressure Leak-resistance at $E_1$ or $E_7$ Plane

The SI values for internal pressure leak-resistance at the $E_1$ plane of round thread connections and at the $E_7$ plane of buttress thread casing were calculated (not converted) using Equation (G.32) (taken from API 5C3):

$$P_{LR_m} = E \times \tau \times N \times P \times [W_{m^2} - E_s{}^2] / [2 \times E_s \times W_m{}^2] \quad \text{(G.32)}$$

where

$P_{LR_m}$ is the internal pressure leak-resistance at the $E_1$ or $E_7$ plane, expressed in megapascals;

$W_m$ is the outside diameter of the coupling, expressed in millimeters;

$E$ is the modulus of elasticity, 207,000 MPa;

$E_s$ is the pitch diameter at the seal, expressed in millimeters:

$E_1$ for round threads;

$E_7$ for buttress threads;

$N$ is the number of power turns;

$P$ is the thread pitch, expressed in inches per thread;

$\tau$ is the thread taper, expressed in inches per inch.

The calculated SI values for internal pressure leak resistance limits were rounded to the nearest 0.5 MPa.

### G.9.4 Hydrostatic Test Pressure for Threaded and Coupled Pipe

The hydrostatic test pressure for threaded and coupled pipe is the lowest pressure of:

— the hydrostatic test pressure for plain-end pipe,

— the maximum hydrostatic test pressure for couplings, or

— the internal pressure leak-resistance.

## G.10 Other

### G.10.1 Temperature

The temperatures in degrees Fahrenheit (USC) were converted to temperatures in degrees Celsius (SI) using Equation (G.33):

$$°C = (°F - 32) \times 5/9 \quad \text{(G.33)}$$

where

°C is the temperature, expressed in degrees Celsius;

°F is the temperature, expressed in degrees Fahrenheit.

The converted SI values for temperatures were rounded to the nearest degree.

When the temperature being converted was over 600 °F, the number was rounded to the most rational value rounded to the nearest 5 °C. For example, 750 °F converts to 399 °C but the rational conversion is 400 °C.

### G.10.2 Torque

The USC values for make-up torque may be converted to SI values using Equation (G.34):

$$T_m = 1.35582 \times T \tag{G.34}$$

where

$T_m$ is the torque, expressed in newton-meters;

$T$ is the torque, expressed in foot–pounds.

The converted SI values for make-up torque may be rounded to the nearest newton meter.

NOTE This standard does not include requirements for torque; however, as this standard is the primary casing and tubing standard, a conversion procedure for torque is included for convenience of the user.

### G.10.3 Critical Stress Intensity Factor ($K_{Issc}$) for SSC Requirements

The critical stress intensity factor $K_{Issc}$ expressed in USC may be converted to SI values using Equation (G.35):

$$K_{Isscm} = 1.099 \times K_{Issc} \tag{G.35}$$

where

$K_{Isscm}$ is the critical stress intensity factor for SSC, expressed in megapascals–square root of meters (MPa·√m);

$K_{Issc}$ is the critical stress intensity factor for SSC, expressed in kilopounds–square root of inches (ksi·√in.).

The converted SI values for critical stress intensity factor $K_{Isscm}$ for SSC may be rounded to the nearest 0.1 megapascals–square root of meters (MPa·√m).

The converted USC values for critical stress intensity factor $K_{Issc}$ for SSC may be rounded to the nearest 0.1 kilopounds–square root of inches (ksi·√in.).

# Annex H
(normative)

# Product Specification Levels

## H.1 General

This annex describes Product Specification Level (PSL) requirements for PSL-2 and PSL-3, for all grades except H-40, L-80 9Cr, and C110, that may be specified by the purchaser. Higher PSL requirements may be furnished at the option of the manufacturer. The requirements for PSL-2 and PSL-3 are in addition to those for PSL-1, which are the basis of this standard. All requirements for PSL-3 are in addition to requirements for PSL-2, except as otherwise indicated by PSL-3 requirements. Accordingly, in the body of this standard, sections and sub-sections that give additional PSL-3 requirements are identified as only PSL-3. Those sections and sub-sections that give PSL-2 requirements are identified as both PSL-2 and PSL-3.

Table H.1, at the end of this annex, is a reference table for PSL-2 and PSL-3 requirements.

NOTE The numbers in parentheses following titles to sections and sub-sections in this annex are the paragraph numbers in the body of this standard which are amended by the requirements of the PSL.

## H.2 Heat Treatment

### H.2.1 Grade J55 and K55, PSL-2 (6.2.2)

Product shall be full-body, full-length normalized, normalized and tempered or quenched and tempered. Upset product shall be full-body, full-length normalized, normalized and tempered or quenched and tempered after upsetting.

Product processed through a hot-stretch mill (that is, stretch reduced product) shall be considered normalized, provided: 1) the exit temperature is above the upper critical temperature ($Ar_3$) for the steel being processed, and 2) the product is air cooled.

### H.2.2 Grade N80Q, PSL-3 (6.2.2)

Only Grade N80Q shall be furnished for PSL-3.

## H.3 Straightening, PSL-2

### H.3.1 Grades C90 and T95 (6.3.4)

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 temper temperature, or hot rotary straightened with an exit temperature not more than 165 °C (300 °F) below the final specified temper temperature. When necessary, light gag straightening shall be permitted.

### H.3.2 Grades R95 and P110 (6.3.1, 6.3.3)

Gag press straightening or hot rotary straightening [400 °C (750 °F)] minimum at end of rotary straightening unless a higher minimum temperature is specified in 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.

## H.4 Chemical Composition Grades C90 and T95, PSL-3 (7.1)

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.

## H.5 Yield Strength—Grade Q125, PSL-3 (7.2.3)

The maximum yield strength shall be 965 MPa (140 ksi).

## H.6 Charpy V-notch Tests

### H.6.1 Charpy V-notch Test Properties—General Requirements, Grades N80 (All Types), L80 Type 1, C90, R95, T95, P110, and Q125, PSL-2 (7.3.1)

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 behavior 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).

### H.6.2 Charpy V-notch—Absorbed Energy Requirements for Pipe, PSL-2

#### H.6.2.1 All Grades Except Q125 (7.5.1 and 7.5.3)

Impact testing shall be carried out in accordance with K.9 (SR 16). 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.

#### H.6.2.2 Grade Q125 (7.5.4)

Statistical impact testing is required in accordance with K.7 (SR 12).

## H.7 Hardenability—Minimum Percentage Martensite Required for Quenched and Tempered Products

### H.7.1 Grade L80 Type 1, PSL-2 (7.10.3)

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 austenitize and quench combination. To be in compliance with this standard, 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 Equation (H.1):

$$HRC_{min} = [58 \times (\%\ \text{carbon})] + 27 \tag{H.1}$$

### H.7.2 Grades C90 and T95, PSL-3 (7.10.1)

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 Equation (H.2):

$$HRC_{min} = [59 \times (\%\ \text{carbon})] + 29 \tag{H.2}$$

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.

## H.8 Inside Surface Preparation—Grade L80 13Cr, PSL-2 (7.12)

All pipe shall be delivered with the internal surface grit blasted or pickled to meet the requirements for $S_a$ 2 $^1/_2$ in. ISO 8501-1. Grit blasting shall be carried out using stainless steel, aluminum oxide grit, or other blasting media that does not cause surface iron contamination.

## H.9 Sulfide Stress-cracking (SSC) Test—PSL-3

### H.9.1 Grades C90 and T95 (7.14)

If Method A is specified for the SSC test (in accordance with 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 reheat- 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.

### H.9.2 Grade L80 13Cr

If requested by the purchaser, the manufacturer shall for each heat demonstrate that the product meets or exceeds the 80 % SMYS threshold using test Method A in accordance with NACE TM0177-2016. The test solution shall have a pH of 3.5 and a partial pressure of $H_2S$ of 10 kPa (1.5 psi).

## H.10 Processing of Pin Ends—All Grades, PSL-2 (8.12.5)

Pin threads shall be abrasive-blasted, unless processed by any appropriate technique, including the threading process, which has been agreed between the purchaser and manufacturer to be sufficient to avoid the presence of material susceptible to detaching or causing galling during make-up.

## H.11 Seal-ring Couplings—All Grades, PSL-2 (9.8)

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.

## H.12 Processing of Box Ends—All Grades, PSL-2 (9.10.1)

Box threads shall be abrasive-blasted, unless processed by any appropriate technique, including the threading process, which has been agreed between the purchaser and manufacturer to be sufficient to avoid the presence of material susceptible to detaching or causing galling during make-up.

## H.13 Frequency of Tensile Testing—Casing and Tubing, Grades N80 (All Types), PSL-2 (10.4.3)

The frequency of testing shall be the same as for Grade L80 Type 1.

## H.14 Hardness Testing, PSL-3

### H.14.1 Hardness Test-Grades N80Q, L80 Type 1, R95, P110, and Q125 (10.6.1, 10.6.4, and 10.6.8)

The manufacturer shall apply a process control plan which has been demonstrated to the satisfaction of the purchaser as sufficient to ensure that each pipe body, each upset and each coupling has mechanical properties conforming to the requirements of this standard. If this condition is not fulfilled, each pipe body, each upset and each coupling shall be surface hardness tested. Hardness minimum and maximum values, when not specified in this standard, shall be in accordance with the manufacturer's specifications or by agreement between the purchaser and the manufacturer.

### H.14.2 Sampling and Test Specimen Location—Non-upset Pipe, Grades C90 and T95 (10.6.5)

A test ring shall be cut from both ends of each pipe.

## H.15 Metallographic Evaluation for EW Pipe—Grades J55, K55, N80 (All Types), L80 Type 1, and R95, PSL-2 (10.11)

A metallographic evaluation shall be performed at the beginning of the welding process for each size of tubular, at least once every four hours during the welding, and after any substantial interruption of the welding process. The samples shall be obtained prior to heat treatment.

## H.16 Hydrostatic Test—Grades J55 and K55, PSL-2 (10.12.2)

Alternative test pressures shall be used for sizes above Label 1: 9 $^{5}/_{8}$.

## H.17 Wall Thickness (10.13.4)

### H.17.1 All Grades, PSL-2

Wall thickness shall be measured and recorded over the full length to confirm conformance to the thickness criteria of this standard. For the surface area covered by the automated system the minimum coverage shall be 25 %.

### H.17.2 All Grades, PSL-3

Wall thickness shall be measured and recorded over the full length, For the surface area covered by the automated system the minimum coverage shall be 100 %. The minimum measured wall thickness for each pipe shall be reported. Traceability per pipe is only required when specified in the purchase agreement.

## H.18 Non-destructive Examination (NDE)

### H.18.1 Full-body, Full-length NDE—Casing and Tubing

#### H.18.1.1 Grades J55 and K55, PSL-2 (10.15.5)

All pipe shall be inspected for the detection of longitudinal imperfections on the outside and inside surfaces to acceptance level L4 by one or more of the methods specified in 10.15.5.

#### H.18.1.2 Grade N80 (All Types), PSL-2 (10.15.5 and 10.15.6)

All pipe shall be inspected for the detection of longitudinal and transverse imperfections on the outside and inside surfaces to acceptance level L3 by ultrasonic or EMI testing in accordance with K.2 (SR 1).

#### H.18.1.3 Grades L80 Type 1, L80 13CR, and R95, PSL-2 (10.15.6)

All pipe shall be inspected for the detection of both longitudinal and transverse imperfections on the outside and inside surfaces to acceptance level L2 by one or more of the methods specified in 10.15.8. Magnetic particle testing is only allowed as a second full-length inspection.

#### H.18.1.4 Grades J55 and K55, PSL-3 (10.15.5 and 10.15.6)

All pipe shall be inspected for the detection of both longitudinal and transverse imperfections on the outside and inside surfaces to acceptance level L2 by one or more of the methods specified in 10.15.6 a), b), or c). Magnetic particle testing is only allowed as a second full-length inspection.

#### H.18.1.5 Grades N80Q, R95, L80 Type 1, L80 13CR, and P110, and P110 K.9 (SR 16), PSL-3 (10.15.6, 10.15.7, and 10.15.8)

All pipe shall be 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 ISO 10893-10 or ASTM E213 (transverse).

In addition, all pipe shall be inspected for the detection of imperfections on the outside surface by one of the methods in 10.15.9.

### H.18.2 NDE of the Weld Seam of Welded Pipe-Grades K55, PSL-2 (10.15.10)

The weld seam inspection required by this standard shall be performed after the hydrostatic test using ultrasonic test methods.

### H.18.3 NDE of Pipe Ends-All Grades, PSL-3 (10.15.13)

The pipe ends shall be either treated in accordance with 10.15.13 a) or c), or inspected after end finishing (and before coupling installation on threaded and coupled tubulars) using the wet magnetic-particle method, or a method agreed between purchaser and manufacturer.

### H.18.4 NDE of Coupling Stock—Grades R95, L80 (All Types), C90, T95, P110, and Q125, PSL-2 (10.15.11)

#### H.18.4.1 Permitted Imperfections before Machining

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 9.11.

#### H.18.4.2 Further Evaluation

Coupling stock containing imperfections 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 containing defects shall either be given 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.

#### H.18.4.3 Ultrasonic Testing—Through-wall

Coupling stock 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 25 % of the inspected surface, see 10.15.4.2 a).

#### H.18.4.4 Ultrasonic Testing—Inside Surface

Coupling stock shall be inspected for longitudinal and transverse imperfections on the inside surface using ultrasonic shear-wave techniques to acceptance level L4. By agreement between the purchaser and manufacturer, alternative NDE methods which demonstrate the capability to detect the reference indicators may be used.

### H.18.5 NDE of Coupling Stock—Grades R95, L80 (All Types), C90, T95, P110, and Q125, PSL-3 (10.15.11)

#### H.18.5.1 Minimum Coverage

Coupling stock shall be inspected in accordance with H.18.4.3, except the minimum coverage shall be 100 %.

#### H.18.5.2 Acceptance Level

Coupling stock shall be inspected in accordance with H.18.4.4, except the acceptance level shall be L3 with a maximum notch length of 25 mm (1 in.).

## H.19 Non-metallic Seal-ring—All Grades, PSL-2 [K.8.2 (SR 13.2)]

Unless otherwise specified in the purchase agreement, seal-rings for field-end box threads shall be shipped separately in a sealed package labelled with the quantity, connection description, connection manufacturer, date inspected, and date packaged.

**Table H.1—Reference Table for PSL-2 and PSL-3 Requirements**

| Annex H | API 5CT | Grade | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | J55 | K55 | N80 Type 1 | N80 Q | R95 | L80 Type 1 | L80 13Cr | C90 | T95 | P110 | Q125 |
| *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* | *12* | *13* |
| H.2.1 | 6.2.2 | 2 | 2 | | | | | | | | | |
| H.2.2 | 6.2.2 | | | | 3 | | | | | | | |
| H.3.1 | 6.3.4 | | | | | | | | 2 | 2 | | |
| H.3.2 | 6.3.1<br>6.3.2 | | | | | 2 | | | | | 2 | |
| H.4 | 7.1 | | | | | | | | 3 | 3 | | |
| H.5 | 7.2.3 | | | | | | | | | | | 3 |
| H.6.1 | 7.3.1 | | | 2 | 2 | 2 | 2 | | 2 | 2 | 2 | 2 |
| H.6.2.1 | 7.5.1<br>7.5.3<br>K.9 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | |
| H.6.2.2 | 7.5.4<br>K.7 | | | | | | | | | | | 2 |
| H.7.1 | 7.10.3 | | | | | | 2 | | | | | |
| H.7.2 | 7.10.1 | | | | | | | | 3 | 3 | | |
| H.8 | 7.12 | | | | | | | 2 | | | | |
| H.9.1 | 7.14.2 | | | | | | | | 3 | 3 | | |
| H.9.2 | 7.14.2 | | | | | | | 3 | | | | |
| H.10 | 8.12.5 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| H.11 | 9.8 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| H.12 | 9.10.1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| H.13 | 10.4.3 | | | 2 | 2 | | | | | | | |
| H.14.1 | 10.6.1<br>10.6.4<br>10.6.8 | | | | 3 | 3 | 3 | | | | 3 | 3 |
| H.14.2 | 10.6.5 | | | | | | | | 3 | 3 | | |
| H.15 | 10.11 | 2 | 2 | 2 | 2 | 2 | 2 | | | | | |
| H.16 | 10.12.2 | 2 | 2 | | | | | | | | | |
| H.17.1 | 10.13.4 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| H.17.2 | 10.13.4 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |

**Table H.1—Reference Table for PSL-2 and PSL-3 Requirements (Continued)**

| Annex H | API 5CT | Grade | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | J55 | K55 | N80 Type 1 | N80 Q | R95 | L80 Type 1 | L80 13Cr | C90 | T95 | P110 | Q125 |
| *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* | *12* | *13* |
| H.18.1.1 | 10.15.5 | 2 | 2 | | | | | | | | | |
| H.18.1.2 | 10.15.5<br>10.15.6 | | | 2 | 2 | | | | | | | |
| H.18.1.3 | 10.15.6 | | | | | 2 | 2 | 2 | | | | |
| H.18.1.4 | 10.15.5<br>10.15.6 | 3 | 3 | | | | | | | | | |
| H.18.1.5 | 10.15.6<br>10.15.7<br>10.15.8 | | | | 3 | 3 | 3 | 3 | | | 3 | |
| H.18.2 | 10.15.10 | | 2 | | | | | | | | | |
| H.18.3 | 10.15.13 | 3 | 3 | | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| H.18.4 | 10.15.11 | | | | | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| H.18.5 | 10.15.11 | | | | | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| H.19 | K.8.2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |

# Annex I
(normative)

# Requirements for Thread Protector Design Validation

## I.1 General

**I.1.1** The design validation requirements in this annex pertain to thread protectors that are required by 12.2 for tubular products with API or SF threaded connections. These protectors are typically composite-type metal-plastic; composite-type plastic, or all-plastic construction; they have a plastic-type thread profile to prevent galling and a reinforced outer shell to resist impact loads. The thread protector shall be designed to meet the design and testing requirements of 12.2 and this annex.

**I.1.2** The thread-protector manufacturer shall document the design criteria, evaluation data and installation procedures to demonstrate compliance with these requirements. This information shall be available upon request to both the protector purchaser or the tubular user, or both.

**I.1.3** The thread-protector manufacturer shall design the protector to be used in conjunction with API or SF thread forms, or both. Thread-protector design shall assist in minimizing corrosion that can result from moisture intrusion or entrapment. The protectors shall be capable of a snug-up fit with the face of the pin or coupling as applicable (no gap). The use of a gasket-type insert in the pin-end protector is acceptable by agreement between the manufacturer and purchaser.

**I.1.4** The protector shall be designed to operate in the temperature range of –46 °C (–50 °F) to 66 °C (150 °F). The tolerance for all test temperatures shall be ±6 °C (±10 °F).

**I.1.5** The thread profile shall be made of a material that will prevent galling of both the pin and box threads. It shall have sufficient thread contact to ensure performance. There shall be no metal-to-metal contact on the connection thread form and no metal-to-metal or plastic-to-metal contact with radial, steel, seal surfaces.

**I.1.6** All plastic shall be either compounded or protected against deterioration from ultraviolet light for not less than one year. This may be accomplished by either chemical additions to the plastic or mechanical methods that limit exposure to this type of radiation.

**I.1.7** The protector shall not be affected by solvents (such as diesel fuel, acetone, varsol, trichloroethylene), storage or assembly-thread compounds.

**I.1.8** Air entrapment in the plastic material during molding shall be minimized. This should be controlled by the manufacturing process. At least 90 % of any one thread shall remain where air entrapment voids do occur, and no continuous line of broken threads shall cross the seal area or perfect-thread area.

**I.1.9** If hookable/liftable thread protectors are specified, the protectors shall be made in such a way to preclude contact between lift hooks and pipe ends or the threaded portion of the box.

## I.2 Validation Procedure

The following validation procedure determines the suitability for service of thread protectors. The protector manufacturer shall test a minimum of two sizes of tubing and two sizes of casing that define the size range offered by the manufacturer for each of the manufacturer's design types. The manufacturer shall provide objective evidence that pipe sizes tested are the worst case for design. Justification for extrapolation to non-tested sizes shall be provided.

## I.3 Sample Identification

Hereafter, the protector/connector sets are referred to as “test-piece sets”. Each protector and connector set shall be identified with a unique identifier (pin and box).

## I.4 Dimensional Stability Tests

**I.4.1** Measure and record the thread diameters and seal diameters (where applicable) on the test-piece sets at 21 °C (70 °F). Test-piece sets that do not meet the manufacturer's design criteria shall be rejected.

**I.4.2** Using appropriate temperature bath(s), soak test-piece sets at -46 °C (–50 °F), 66 °C (150 °F) and 21 °C (70 °F). Remove from the bath and immediately record the thread diameters of the test-piece sets.

**I.4.3** Restabilize the test-piece sets at 21 °C (70 °F). Measure and record the thread diameters and the seal diameters (where applicable) of the protectors and connectors. Changes in thread diameter resulting in thread engagement of less than one-half the specified thread height per side shall be unacceptable throughout the design temperature range.

## I.5 Torque and Vibration Tests

**I.5.1** The pin and box-thread protector shall be self-locking and able to withstand vibrations encountered during transportation. Refer to manufacturer’s procedures for torque requirements to seat and remove protectors.

**I.5.2** Make up test sets (with storage compound or thread compound, or both, applied to machined threaded area of a connection) by applying the protectors to the connections using the protector manufacturer's recommended practice, and record the make-up torque.

**I.5.3** Stabilize made-up test-piece sets at –46 °C (–50 °F), 66 °C (150 °F) and 21 °C (70 °F). Break out the protector from the connection and record the torque. Recorded torque values for the break-out of the protectors are for information only.

**I.5.4** Protectors that are incapable of meeting the manufacturer’s required installation torque (or with stripping, disengaging and not shouldering the threads of the protector) shall not be considered acceptable for service.

**I.5.5** Using test-piece sets made up to manufacturer's installation procedure, vibration testing in accordance with MIL STD 810c shall be performed.

**I.5.6** The protector shall not fall off or out during a one-million-cycle test. The test shall be conducted at a minimum of 900 r/min with a minimum vertical displacement of 8.4 mm (0.33 in.) and a minimum acceleration of four times gravitational acceleration.

## I.6 Axial Impact Tests

**I.6.1** Make up test-piece sets (with appropriate storage compound or thread compound, or both) by applying the protectors to the connectors using the protector manufacturer's recommended practice and record torque.

**I.6.2** Stabilize test-piece sets at –46 °C (–50 °F), 66 °C (150 °F), and 21 °C (70 °F).

**I.6.3** Subject the test-piece sets to the axial impact test (see Figure D.26) at the stabilized temperatures using a steel bar of 38 mm (1.5 in.) diameter and a minimum free fall height of 0.3 m (12 in.). The thread protectors (pin and box) shall be capable of sustaining the axial impact loads in Table I.1 without damage to the machined surfaces of pipe pin or box threads.

**Table I.1—Axial Impact Test Using 38 mm (1.5 in.) Diameter Steel Bar**

| Test Temperature °C (°F) | Minimum Impact Energy joules (foot–pounds) | | |
|---|---|---|---|
| | Label 1: ≤ 3 1/2 | Label 1: > 3 1/2 to 8 3/4 | Label 1: > 8 3/4 |
| 1 | 2 | 3 | 4 |
| 66 (150) | 407 (300) | 1627 (1200) | 2034 (1500) |
| 21 (70) | 407 (300) | 1627 (1200) | 2034 (1500) |
| –46 (–50) | 230 (170) | 814 (600) | 1085 (800) |

## I.7 Angular Impact Test

**I.7.1** Make up test piece sets (with storage compound or thread compound, or both) by applying the protectors to the connections using the protector manufacturer's recommended practice and record make-up torque.

**I.7.2** Stabilize made-up test-piece sets at –46 °C (–50 °F), 66 °C (150 °F), and 21 °C (70 °F).

**I.7.3** Apply a 45° angular impact load (see Figure D.27) to the test-piece sets at the stabilized temperatures using a flat steel plate and a minimum free fall height of 0.3 m (12 in.). The thread protectors (pin and box) shall be capable of sustaining angular impact loads in Table I.2 without damage to the tubular's pin and box machined surfaces.

**Table I.2—Angular (45°) Impact Test Using a Flat Steel Plate**

| Test Temperature °C (°F) | Minimum Impact Energy joules (foot–pounds) | | |
|---|---|---|---|
| | Label 1: ≤ 3 1/2 | Label 1: > 3 1/2 to 8 3/4 | Label 1: > 8 3/4 |
| 1 | 2 | 3 | 4 |
| 66 (150) | 203 (150) | 814 (600) | 1017 (750) |
| 21 (70) | 203 (150) | 814 (600) | 1017 (750) |
| –46 (–50) | 115 (85) | 407 (300) | 542 (400) |

## I.8 Corrosion Test

**I.8.1** The protector shall assist in the prevention of corrosion of the thread and sealing surfaces. Proper sealing, venting and use of corrosion-inhibiting compounds are essential to minimize corrosion. The normal storage period shall be one year, as described in 12.2.1.

**I.8.2** The salt-water spray test shall be in accordance with ASTM B117 to determine corrosion resistance for comparison purposes. The salt-spray test may not duplicate actual field use due to factors other than thread-protector performance.

**I.8.3** Make up test-piece sets (with storage compound or thread compound, or both) by applying protectors to the connection using the protector manufacturer's recommended practice, and record the make-up torque.

**I.8.4** The cut-off end of the connector shall be sealed and vented with a hole to allow chamber atmosphere circulation.

**I.8.5** A salt-spray test shall be conducted in accordance with ASTM B117 for a minimum of 1000 hr at a temperature of 35 °C (95 °F).

**I.8.6** Orient the test-piece sets in the test chamber to simulate pipe rack storage.

**I.8.7** The protectors shall be deemed to have passed the test if there is:

a) no corrosion damage in the seal and the perfect thread area, and

b) less than 10 % corrosion damage of the overall thread surface.

## I.9 Stripping Test (Pin-end Protector Only)

**I.9.1** Make up test-piece sets (with storage compound or thread compound, or both) by applying protectors to the connector using the protector manufacturer's recommended practice, and record the make-up torque.

**I.9.2** Stabilize made-up test-piece sets at –46 °C (–50 °F), 66 °C (150 °F), and 21 °C (70 °F).

**I.9.3** A stripping test shall be conducted in accordance with IADC/SPE 11396 on the pin protector (see Figure D.28) at the required stabilized temperatures and with an axial load equal to or greater than Fax calculated using Equation (I.1) (SI units) or Equation (I.2) (USC units):

$$F_{ax} = 0.18 \times w \tag{I.1}$$

where

$F_{ax}$ is the force, in kilonewtons;

$w$ is the linear mass of the pipe, in kilograms per meter;

or

$$F_{ax} = 60 \times w \tag{I.2}$$

where

$F_{ax}$ is the force, in pounds force;

$w$ is the linear mass of the pipe, in pounds per foot.

**I.9.4** Remove the protectors and inspect for torn threads. Protector threads may show signs of stress but shall not be torn away.

## I.10 Hookability (Liftability) Test

When a hookable (liftable) thread protector is required, the manufacturer shall demonstrate the hookability (liftability) of the design by testing the protector to 150 % of the load based on the plain-end mass for the maximum anticipated wall thickness of a specified diameter pipe. The hookability (liftability) shall be evaluated on the basis of no damage to the pin-end or box-end of the connector. The type of hook used for the test shall be documented.

# Annex J
(informative)

# Summary of Product Specification Level (PSL) Requirements

## J.1 General

This informative annex is provided for the convenience of the user of this standard and identifies the places where additional requirements are detailed when product is ordered to PSL-2 or PSL-3.

Detailed requirements are given in the sub-sections indicated in square brackets [ ] after each item.

The PSL-3 requirements are in addition to the PSL-2 requirements.

There are no PSL-2 or PSL-3 requirements for Grade H40.

## J.2 Grades J55 and K55

### J.2.1 PSL-2

The following requirements shall be satisfied:

a) Full-body, full-length heat treatment (after upsetting if applicable) [H.2.1].

b) Mandatory Charpy V-notch impact testing and requirements (according to K.9 (SR 16)) [H.6.2.1].

c) No product to be susceptible to having material detach during make-up (appropriate processing or abrasive blasting) [H.10 and H.12].

d) Seal-ring groove machining and tolerances [H.11].

e) Metallographic examination of the weld zone [H.15].

f) Alternative test pressures for Label 1 larger than 9 5/8 [H.16].

g) Wall thickness measurement with 25 % coverage [H.17.1].

h) NDE for longitudinal internal and external defects to acceptance level L4 [H.18.1.1].

i) K55 only: Ultrasonic testing of the weld seam after hydrotest [H.18.2].

j) Seal-ring to be shipped separately [H.19].

### J.2.2 PSL-3

The following requirements shall be satisfied:

a) Wall thickness measurement with 100 % coverage, report the minimum wall thickness [H.17.2].

b) NDE for longitudinal and transverse, internal and external defects to acceptance level L2 (no MPI) [H.18.1.4].

c) NDE of pipe ends after end finishing [H.18.3].

## J.3 Grades N80, (All Types)

### J.3.1 PSL-2

The following requirements shall be satisfied:

a) Charpy V-notch impact shear area minimum of 75 % [H.6.1].

b) Mandatory Charpy V-notch impact testing and requirements (according to K.9 (SR 16)) [H.6.2.1].

c) No product to be susceptible to having material detach during make-up (appropriate processing or abrasive blasting) [H.10 and H.12].

d) Seal-ring groove machining and tolerances [H.11].

e) Tensile test frequency as for Grade L80 [H.13].

f) Metallographic examination of the weld zone [H.15].

g) Wall thickness measurement with 25 % coverage [H.17.1].

h) NDE for longitudinal and transverse, internal and external defects to acceptance level L3 (no MPI) [H.18.1.2].

i) Seal-ring to be shipped separately [H.19].

### J.3.2 PSL-3

The following requirements shall be satisfied:

a) Only grade N80Q shall be furnished for PSL-3 [H.2.2].

b) Process control plan or surface hardness test of each pipe body, upset end and coupling [H.14.1].

c) Wall thickness measurement with 100 % coverage, report the minimum wall thickness [H.17.2].

d) NDE: mandatory ultrasonic test plus one other method [H.18.1.5].

e) NDE of pipe ends after end finishing [H.18.3].

## J.4 Grade L80 Type 1

### J.4.1 PSL-2

The following requirements shall be satisfied:

a) Charpy V-notch impact shear area minimum of 75 % [H.6.1].

b) Mandatory Charpy V-notch impact testing and requirements (according to K.9 (SR 16)) [H.6.2.1].

c) Minimum martensite content of 90 % (based on a minimum Rockwell C-scale hardness for an as-quenched sample) [H.7.1].

d) No product to be susceptible to having material detach during make-up (appropriate processing or abrasive blasting) [H.10 and H.12].

e) Seal-ring groove machining and tolerances [H.11].

f) Metallographic examination of the weld zone [H.15].

g) Wall thickness measurement with 25 % coverage [H.17.1].

h) NDE for longitudinal and transverse, internal and external defects to acceptance level L2 [H.18.1.3].

i) NDE of coupling stock sold as coupling stock [H.18.4].

j) Seal-ring to be shipped separately [H.19].

### J.4.2 PSL-3

The following requirements shall be satisfied:

a) Surface hardness test of each pipe body, upset end and coupling [H.14.1].

b) Wall thickness measurement with 100 % coverage, report the minimum wall thickness [H.17.2].

c) NDE: mandatory ultrasonic test plus one other method [H.18.1.5].

d) NDE of pipe ends after end finishing [H.18.3].

e) NDE of coupling stock [H.18.5].

## J.5 Grade L80 13Cr

### J.5.1 PSL-2

The following requirements shall be satisfied:

a) Mandatory Charpy V-notch impact testing and requirements (according to K.9 (SR 16)) [H.6.2.1].

b) Inside surface preparation [H.8].

c) No product to be susceptible to having material detach during make-up (appropriate processing or abrasive blasting) [H.10 and H.12].

d) Seal-ring groove machining and tolerances [H.11].

e) NDE for longitudinal and transverse, internal and external defects to acceptance level L2 [H.18.1.3].

f) NDE of coupling stock sold as coupling stock [H.18.4].

g) Wall thickness measurement with 25 % coverage [H.17.1].

h) Seal-ring to be shipped separately [H.19].

### J.5.2 PSL-3

The following requirements shall be satisfied:

a) SSC test: for NACE TM0177-2016 Method A, demonstrate a threshold stress of 80 % of the specified minimum yield stress in a test solution with pH 3.5 and a hydrogen sulfide partial pressure of 0.1 bar (1.5 psi) [H.9.2].

b) Wall thickness measurement with 100 % coverage, report the minimum wall thickness [H.17.2].

c) NDE: mandatory ultrasonic test plus EMI for the outside surface [H.18.1.5].

d) NDE of pipe ends after end finishing [H.18.3].

e) NDE of coupling stock [H.18.5].

## J.6 Grades C90 and T95

### J.6.1 PSL-2

The following requirements shall be satisfied:

a) Hot straightening requirement with a minimum temperature or cold straightening followed by stress relief [H.3.1].

b) Charpy V-notch impact shear area minimum of 75 % [H.6.1].

c) Mandatory Charpy V-notch impact testing and requirements (according to K.9 (SR 16)) [H.6.2.1].

d) No product to be susceptible to having material detach during make-up (appropriate processing or abrasive blasting) [H.10 and H.12].

e) Seal-ring groove machining and tolerances [H.11].

f) Wall thickness measurement with 25 % coverage [H.17.1].

g) NDE of coupling stock sold as coupling stock [H.18.4].

h) Seal-ring to be shipped separately [H.19].

### J.6.2 PSL-3

The following requirements shall be satisfied:

a) Information on chemical composition [H.4.2].

b) Minimum martensite content of 95 % (based on a minimum Rockwell C-scale hardness for an as-quenched sample) [H.7.2].

c) SSC test: for NACE TM0177-2016 Method A, test three pipes per heat at an applied stress of 90 % of the specified minimum yield stress [H.9.1].

d) Through-wall hardness test of both ends of each pipe [H.14.2].

e) Wall thickness measurement with 100 % coverage, report the minimum wall thickness [H.17.2].

f) NDE of pipe ends after end finishing [H.18.3].

g) NDE of coupling stock [H.18.5].

## J.7 Grade R95

### J.7.1 PSL-2

The following requirements shall be satisfied:

a) Hot straightening requirement with a minimum temperature or cold straightening followed by stress relief [H.3.2].

b) Charpy V-notch impact shear area minimum of 75 % [H.6.1].

c) Mandatory Charpy V-notch impact testing and requirements (according to K.9 (SR 16)) [H.6.2.1].

d) No product to be susceptible to having material detach during make-up (appropriate processing or abrasive blasting) [H.10 and H.12].

e) Seal-ring groove machining and tolerances [H.11].

f) Metallographic examination of the weld zone [H.15].

g) Wall thickness measurement with 25 % coverage [H.17.1].

h) NDE for longitudinal and transverse, internal and external defects to acceptance level L2 [H.18.1.3].

i) NDE of coupling stock sold as coupling stock [H.18.4].

j) Seal-ring to be shipped separately [H.19].

### J.7.2 PSL-3

The following requirements shall be satisfied:

a) Surface hardness test of each pipe body, upset end and coupling [H.14.1].

b) Wall thickness measurement with 100 % coverage, report the minimum wall thickness [H.17.2].

c) NDE: mandatory ultrasonic test plus one other method [H.18.1.5].

d) NDE of pipe ends after end finishing [H.18.3].

e) NDE of coupling stock [H.18.5].

## J.8 Grade P110

### J.8.1 PSL-2

The following requirements shall be satisfied:

a) Hot straightening requirement with a minimum temperature or cold straightening followed by stress relief [H.3.2].

b) Charpy V-notch impact shear area minimum of 75 % [H.6.1].

c) Mandatory Charpy V-notch impact testing and requirements (according to K.9 (SR 16)) [H.6.2.1].

d) No product to be susceptible to having material detach during make-up (appropriate processing or abrasive blasting) [H.10 and H.12].

e) Seal-ring groove machining and tolerances [H.11].

f) Wall thickness measurement with 25 % coverage [H.17.1].

g) NDE of coupling stock sold as coupling stock [H.18.4].

h) Seal-ring to be shipped separately [H.19].

### J.8.2 PSL-3

The following requirements shall be satisfied:

a) Surface hardness test of each pipe body, upset end and coupling [H.14.1].

b) Wall thickness measurement with 100 % coverage, report the minimum wall thickness [H.17.2].

c) NDE: mandatory ultrasonic test plus one other method [H.18.1.5].

d) NDE of pipe ends after end finishing [H.18.3].

e) NDE of coupling stock [H.18.5].

## J.9 Grade Q125

### J.9.1 PSL-2

The following requirements shall be satisfied:

a) Charpy V-notch impact shear area minimum of 75 % [H.6.1].

b) Statistical impact testing according to K.7 (SR 12) [H.6.2.2].

c) No product to be susceptible to having material detach during make-up (appropriate processing or abrasive blasting) [H.10 and H.12].

d) Seal-ring groove machining and tolerances [H.11].

e) Wall thickness measurement with 25 % coverage [H.17.1].

f) NDE of coupling stock sold as coupling stock [H.18.4].

g) Seal-ring to be shipped separately [H.19].

### J.9.2 PSL-3

The following requirements shall be satisfied:

a) Maximum yield strength of 965 MPa (140 ksi) specified [H.5].

b) Surface hardness test of each pipe body, upset and coupling [H.14.1].

c) Wall thickness measurement with 100 % coverage, report the minimum wall thickness [H.17.2].

d) NDE of pipe ends after end finishing [H.18.3].

e) NDE of coupling stock [H.18.5].

# Annex K
(normative)

# Supplementary Requirements

## K.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 in the purchase agreement.

## K.2 SR 1-Supplementary Non-destructive Examination for Grades H40, J55, and K55

The specified casing and tubing shall be inspected for imperfections that are greater than 12.5 % 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 minimum requirements stated in 10.15 for Grades N80Q, L80, and R95 including full-body, full-length wall thickness verification according to 10.13.4.

## K.3 SR 2—Supplementary Non-destructive Examination for Grades H40, J55, K55, N80 (All Types), L80, R95, and P110 to K.9 (SR 16)

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.

## K.4 SR 9—Coupling Blanks—Grades C110 and Q125

### K.4.1 SR 9.1—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 in the purchase agreement. The coupling blanks shall be provided fully machined by the manufacturer only when specified in the purchase agreement.

### K.4.2 SR 9.2—Dimensional Tolerances

For fully machined coupling blanks, the tolerance on outside diameter shall be $^{+2.38}_{0}$ mm ($^{+3/32}_{0}$ in.) and the tolerance on the inside diameter shall be $^{0}_{-2.38}$ mm ($^{0}_{-3/32}$ in.), 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 ($^{+1/8}_{-1/16}$ in.).

### K.4.3 SR 9.3—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 9.11 and be to the specified dimensions.

### K.4.4 SR 9.4—Marking

All coupling blanks meeting the requirements of K.4 (SR 9) shall be marked as specified in Table C.48 or E.48.

## K.5 SR 10—Upset Casing—Grade Q125

### K.5.1 SR 10.1—Dimensions

Grade Q125 casing shall be provided with upset end(s). Dimensions of the upset shall be specified in the purchase agreement.

### K.5.2 SR 10.2—Material Properties

Tensile, impact and hardness properties of the pipe and upset shall comply with the requirements of Section 7. The allowable hardness variation of the upset shall be based on the nominal wall thickness of the upset specified in 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.

### K.5.3 SR 10.3—Heat Treatment

Upset pipe shall be heat-treated full-body, full-length after upsetting.

### K.5.4 SR 10.4—Other testing considerations

The frequency of testing, retest provisions, identification, and so forth, for both the pipe body and the upset material shall be as specified in Section 10.

### K.5.5 SR 10.5—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.

## K.6 SR 11—Electric-welded Grades P110 and Q125 Pipe

### K.6.1 SR 11.1—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.

### K.6.2 SR 11.2—Flattening Test Frequency

#### K.6.2.1 SR 11.2.1—Grade P110

The flattening test frequency shall be as specified in 10.5.2.

#### K.6.2.2 SR 11.2.2—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.

## K.6.3 SR 11.3—Flattening Test Procedures

### K.6.3.1 SR 11.3.1—Grade P110

The test specimens shall be flattened as specified in 10.5.3, 10.5.5, and 10.5.7.

### K.6.3.2 SR 11.3.2—Q125

Test specimens shall be rings or crop ends not less than 63.5 mm (2 $^1/_2$ 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 (SR 11.1) or Table E.50 (SR 11.1) 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.

## K.6.4 SR 11.4—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 Section 10 (for seamless pipe) shall also apply to electric-welded pipe.

## K.6.5 SR 11.5—Inspection and Rejection

### K.6.5.1 SR 11.5.1—Non-weld Area Inspection

The pipe body shall be inspected in the same manner as the seamless product as specified in Section 10.

### K.6.5.2 SR 11.5.2—Non-destructive Examination of Weld Seam

The weld seam of pipe (except upset ends) furnished to this standard 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.

### K.6.5.3 SR 11.5.3—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 K.6.5.4 (SR 11.5.4) 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.

### K.6.5.4 SR 11.5.4—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 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.

#### K.6.5.5 SR 11.5.5—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 K.6.5.6 (SR 11.5.6).

#### K.6.5.6 SR 11.5.6—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 reinspected by one of the non-destructive inspection methods specified herein to verify complete removal of the defect.

## K.7 SR 12—Statistical Impact Testing

### K.7.1 SR 12.1—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, and so forth, 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 Section 7. The basis of the testing procedure is explained in the Note in K.7.5 (SR 12.5).

### K.7.2 SR 12.2—Frequency of Testing

Each 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 (SR 12.1) or Table E.51 (SR 12.1).

The factor $F$ shown for the sample size selected shall be used in K.7.4 (SR 12.4) 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 (SR 12.1) or Table E.51 (SR 12.1) provided the standard deviation of the new lot of material is consistent with past experience.

### K.7.3 SR 12.3—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 10.7.8, 10.7.9, and 10.7.10 (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 (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 the remaining lengths in the lot, in which case determinations are required only for the particular requirement where specimens failed to comply in the preceding tests (i.e. a lot which meets the hardness and impact criteria, but 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 Section 7 shall be rejected.

### K.7.4 SR 12.4—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 Equation (K.1):

$$S_{min} = \bar{S} - (F \times \sigma_{lot}) \tag{K.1}$$

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 (SR 12.1) or Table E.51 (SR 12.1);

$\sigma_{lot}$ is the lot standard deviation.

### K.7.5 SR 12.5—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 $\bar{S}$, $\sigma_{lot}$ 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. 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).

Explanation and commentary of testing frequency [see K.7.2 (SR 12.2)]:

— Since a string of product consists of more than one length of product, analysis should consider the probability that the string includes one or more lengths whose impact properties do not meet the desired minimum.

— Table C.52 (SR 12.2) or Table E.52 (SR 12.2) 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 1000 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, and so forth.

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. For the lot to be acceptable, the average transverse impact value shall exceed 27 + (7.501 $\times$ 4.1) or 58 J [20 + (7.501 $\times$ 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 $\times$ 4.1) or 48 J [20 + (5.203 $\times$ 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. 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 $\times$ 4.1) or 40 J [20 + (3.090 $\times$ 3.0) or 29 ft·lb]. The method is applicable to both SI and USC units.

NOTE The procedure in K.7 (SR 12) is taken from reference [5]; Table C.51 (SR 12.1) or Table E.51 (SR 12.1) 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, Section 1-6.

## K.8 SR 13—Seal-ring Couplings

### K.8.1 SR 13.1—Seal-ring Groove

Seal-ring couplings shall be grooved in accordance with dimensions and tolerance specified in Figures D.17 (SR 13.1) to D.20 (SR 13.4). Grooves may be cut before or after threading at manufacturer's option. 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.

NOTE The seal-ring groove dimensions are not the same as those used historically and may not be interchangeable with them.

### K.8.2 SR 13.2—Non-metallic Ring

Dimensions and tolerances of non-metallic rings for seal-ring couplings shall be as specified in Figures D.17 (SR 13.1) to D.20 (SR 13.4). Rings shall be made from virgin polytetrafluoroethylene (PTFE) with 25 % fiberglass filler. The starting PTFE shall be free of filler.

Additional requirements for PSL-2 and PSL-3 products are given in Annex H.

NOTE The seal-ring dimensions are not the same as those used historically and may not be interchangeable with others.

### K.8.3 SR 13.3—Marking

All couplings that meet the requirements of K.8 (SR 13) shall be marked "S13" and have a blue band painted around the coupling, see Figure D.29. If the coupling size does not permit separation of markings as shown in Figure D.29, 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 color.

## K.9 SR 16—Impact Testing (Charpy V-notch)

### K.9.1 SR 16.1—Testing Requirements

When K.9 (SR 16) is specified in the purchase agreement for Grades N80 (all types), R95, L80, C90, T95, and P110, the testing provisions of 10.7, which are optional for the manufacturer in accordance with 7.5.5, become mandatory. When K.9 (SR 16) is specified in the purchase agreement for Grades H40, J55, and K55, the requirements in K.9.2 are mandatory.

### K.9.2 SR 16.2—Charpy V-notch Test—General Requirements

#### K.9.2.1 SR 16.2.1 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 K.9.3 (SR 16.3). 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.

#### K.9.2.2 SR 16.2.2—Specimen Size

Table C.53 (SR 16.1) or Table E.53 (SR 16.1) provides the calculated wall thickness required to machine full-size, $^{3}/_{4}$-size, and $^{1}/_{2}$-size transverse impact test specimens. Table C.54 (SR 16.2) or Table E.54 (SR 16.2) provides the same information for longitudinal impact test specimens. The impact test specimen size that shall be selected from Table C.53 (SR 16.1) or Table C.54 (SR 16.2) or Table E.53 (SR 16.1) or Table E.54 (SR 16.2) 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 (0.394 in. × 0.394 in.)] transverse test specimens is not possible, the largest possible sub-size transverse test specimen listed in Table C.55 (SR 16.3) or Table E.55 (SR 16.3) shall be used. When it is not possible [or allowed in accordance with K.9.2.4 (SR 16.2.4] to test using any of these transverse test specimens, the largest possible longitudinal test specimen listed in Table C.55 (SR 16.3) or Table E.55 (SR 16.3) shall be used.

When the outside diameter or wall thickness precludes machining longitudinal impact test specimens $^{1}/_{2}$-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.

#### K.9.2.3 SR 16.2.3—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 (SR 16.1) are met. These specimens shall be used only to permit the use of a transverse specimen of maximum thickness.

#### K.9.2.4 SR 16.2.4—Hierarchy of Test Specimens

The hierarchy of test specimen orientation and size is as specified in Table C.56 (SR 16.4) or Table E.56 (SR 16.4).

#### K.9.2.5 SR 16.2.5-Alternative-size Impact Test Specimens

At the manufacturer's option, alternative-size impact test specimens, listed in Table C.55 (SR 16.3) or Table E.55 (SR 16.3), may be used in lieu of the minimum size specified in the tables referenced in K.9.2.2 (SR 16.2.2). However, the alternative test specimen size shall be higher on the hierarchy table [Table C.56 (SR 16.4) or Table E.56 (SR 16.4)]

than the specified size, and the absorbed energy requirement shall be adjusted consistent with the impact specimen orientation and size selected.

#### K.9.2.6 SR 16.2.6—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 (SR 16.3) or Table E.55 (SR 16.3); 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).

### K.9.3 SR16.3—Charpy V-notch Test-Impact Requirements for Pipe and for Accessory Material for Externally Threaded Accessories

#### K.9.3.1 SR 16.3.1—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.

#### K.9.3.2 SR 16.3.2—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.

### K.9.4 SR 16.4—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.

### K.9.5 SR 16.5—Accessory Material for Accessories with Internal Special End-finish Connections that Do Not Have Thread Interference

The requirements in K.9.3 (SR 16.3) apply. The critical thickness shall be as specified in 7.3.2 and 7.6.6.

### K.9.6 SR 16.6—Impact Test Procedures

#### K.9.6.1 SR 16.6.1—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.

#### K.9.6.2 SR 16.6.2-Specimen Orientation

Specimen orientation shall be in accordance with Figure D.11.

#### K.9.6.3 SR 16.6.3—Test Temperature

The test temperature for full-size test specimens shall be specified by the purchaser as:

a) +21 °C (+70 °F),

b) 0 °C (+32 °F),

c) –10 °C (+14 °F), or

d) other temperature as specified in 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 K.9.6.5 (SR 16.6.5) for Grades H40, J55, and K55 when subsize test specimens are required.

Additional requirements for PSL-2 and PSL-3 products are given in Annex H.

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 behavior 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.

#### K.9.6.4 SR 16.6.4—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.

#### K.9.6.5 SR 16.6.5—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 (SR 16.7) or Table E.57 (SR 16.7) shall be used when applicable.

#### K.9.6.6 SR 16.6.6—Frequency of Testing

One test shall be made on one pipe from each lot.

#### K.9.6.7 SR 16.6.7—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.

#### K.9.6.8 SR 16.6.8—Replacement of a Reject Pipe or Accessory Material

If the results of a test do not meet the requirements of K.9.3 (SR 16.3), K.9.4 (SR 16.4), or K.9.5 (SR 16.5) as applicable and do not qualify for retesting accordance with K.9.6.7 (SR 16.7), 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 reheat-treat and test the lot as a new lot.

#### K.9.6.9 SR 16.6.9—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.

### K.9.7 SR 16.7—Reporting

The size and orientation of the test specimen (i.e. full-size, $^{3}/_{4}$-size or $^{1}/_{2}$-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.

### K.9.8 SR16.8—Marking

Product tested in accordance with this supplementary requirement shall be marked to indicate K.9 (SR 16), 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

## K.10 SR 22—Enhanced Leak Resistance, LC

### K.10.1 General

By agreement between purchaser and manufacturer, the supplementary requirements for enhanced leak resistance LC shall apply. It should be noted that the product is fully interchangeable with standard API LC connections. However, the design criteria concerning leak resistance shall not apply for such mixed product.

NOTE 1 Other provisions for the implementation of SR 22 are found in API 5B, API 5B1, and API 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 standard.

### K.10.2 SR 22—Enhanced Leak Resistance

#### K.10.2.1 SR 22.1—Casing and Coupling Threads General Requirements

Casings and couplings shall be furnished with enhanced leak resistance connections (LC) in accordance with the requirements specified in API 5B SR 22 for dimensions, inspection, and coupling thread coatings.

#### K.10.2.2 SR 22.2.a—Die Stamp-marking the End of the Pipe

An equilateral triangle die stamp 6.35 mm ($^{1}/_{4}$ in.) high shall be placed at a distance of $L_9$ from each end of each pipe using the applicable method identified in 11.2.6. See Figure D.23 for SR 22.1.

#### K.10.2.3 SR 22.2.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.23 for SR 22.1.

#### K.10.2.4 SR 22.2.c—Die Stamp-marking the Couplings

All couplings shall be marked “S22” using Method 3 or 5 of 11.2.1.

#### K.10.2.5 SR 22.2.d—Color-banding the Couplings

Couplings shall be color-banded with the color(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.

#### K.10.2.6 SR 22.3—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) 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.24 for SR 22.2.

   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.

   or

b) 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.24 for SR 22.2.

   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 each pin end shall meet the requirements of Option 2 “$d_0$”.

#### K.10.2.7 SR22.4.1—Application of Thread Compound

API 5A3 or ISO 13678 thread compound shall be applied in one of the three following locations:

a) to the pin end only;

b) to the coupling thread only; or

c) 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 compliance with API 5A3 or ISO 13678 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.

#### K.10.2.8 SR 22.4.2—Coupling Make-up

Required make-up is 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.

#### K.10.2.9 SR 22.4.3—Coupling Make-up Speed

Power make-up speed shall not exceed 10 r/min.

#### K.10.2.10 SR 22.4.4—Coupling Make-up Acceptance Criteria

Options are allowed for 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 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) Power turns—the number of power turns shall equal or exceed the minimum number of power turns specified in Table C.58 (SR 22.1) or Table E.58 (SR 22.1). Counting power turns should start at a reference start torque specified in Table C.58 (SR 22.1) or Table E.58 (SR 22.1). Ensure proper alignment in make-up equipment and identity, and minimize abnormal sources of torque oscillation.

b) 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.58 (SR 22.1) or Table E.58 (SR 22.1) during operations.

#### K.10.2.11 SR 22.4.5—Coupling Break-out and Make-up

If a connection is broken out, subsequent make-up shall be in accordance with K.10.2.10 (SR 22.4.4).

## K.11 SR 38—Statistical Tensile Testing—Grades C90, T95, and C110

### K.11.1 SR 38.1—General

This method shall be used when specified in the purchase agreement or at the option of the manufacturer to either:

a) test all lengths in the lot, or

b) determine the acceptance of the minimum yield strength for the lot, as defined in 10.2 on a statistical basis.

NOTE K.11 (SR 38) is intended to be used when the specified yield strength range is less than 103 MPa (15 ksi).

### K.11.2 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.

### K.11.3 SR 38.3—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.

### K.11.4 SR 38.4—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 K.11.2 (SR 38.2)]. 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 K.11.3 (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 K.11.3 (SR 38.3).

### K.11.5 SR 38.5—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 K.11.3 (SR 38.3).

No other additional testing shall be allowed to qualify a pipe.

Rejected lots may be reheat-treated and tested as new lots.

## K.12 SR 39—Alternative NACE TM0177-2016 Method D Sulfide Stress Cracking (SSC) Tests-Grade C110

### K.12.1 SR 39.1—Test Requirements

For each lot, as defined in 10.2, manufacturers shall carry out an NACE TM0177-2016 Method D test with the test solution specified in K.12.3 (SR 39.3). The test results shall not be used to determine conformance of the product to this standard.

### K.12.2 SR 39.2—Test Sample Selection and Location

Test sample selection and location shall be in accordance with 7.14.3.

### K.12.3 SR 39.3—Alternative Test Solution

NACE TM0177-2016 Test Solution D shall be used.

The test gas shall be premixed and certified by the provider of the gas.

The NACE TM0177-2016 Section 11.5.6 requirement for documented validation of test solution saturation shall include analysis using the iodometric titration procedure in NACE TM0177-2016 Appendix C or other validated and documented method.

### K.12.4 SR 39.4—Test Conditions

All valid 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 20.4 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.).

### K.12.5 SR 39.5—Invalidation of Tests

Invalidation of tests shall be in accordance with 7.14.6.

### K.12.6 SR 39.6—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.

## K.13 SR 40—Electric-welded Casing, Tubing, and Pup Joints, Grades H40, J55, K55, N80 (All Types), L80 Type 1, and R95

### K.13.1 SR 40.1—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.

### K.13.2 SR 40.2—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.

## K.14 SR 41—Supplemental Inspection when Hydrostatic Test Pressure is Limited to 69.0 MPa (10,000 psi)

### K.14.1 SR 41.1—Wall Thickness Measuring, Recording, and Reporting

For each length of pipe, the wall thickness shall be measured and recorded 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 minimum measured wall thickness to each unique pipe is only required when specified on the purchase agreement.

### K.14.2 SR 41.2—Non-destructive Examination of Pipe

Additionally, when agreed between purchaser and manufacturer, for each length of pipe a full-body imperfection NDE utilizing oblique OD/ID reference indicators consistent with the defects typical of the manufacturer's manufacturing process as required in 10.15.4.2 e) shall be performed.

# Bibliography


[1] API Bulletin 5A2, *Thread Compounds for Casing, Tubing, and Line Pipe*

[2] API Bulletin 5T1, *Imperfection Terminology*

[3] API Recommended Practice 5B1, *Gauging and Inspection of Casing, Tubing and Line Pipe Threads*

[4] API Recommended Practice 5C1, *Care and Use of Casing and Tubing*

[5] API Recommended Practice 5C6, *Pipe with Welded Connectors*

[6] Failure Analysis and Prevention, *ASM Metals Handbook,* Volume 11, Ninth Edition, 1986

[7] Hodge, J. M. and Orehoski, M. A., *Relationship between hardenability and percentage martensite in some low alloy steels*, Trans. AIME, 167, pp. 627–642, 1946

[8] ASTM A941, *Standard Terminology Relating to Steel, Stainless Steel, Related Alloys and Ferroalloys*

[9] ISO/IEC 17011, *Conformity assessment—General requirements for accreditation bodies accrediting conformity assessment bodies*

[10] ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories*

[11] NACE MR0175/ISO 15156-1, *Petroleum and natural gas industries—Materials for use in $H_2S$-containing environments in oil and gas production—Part 1: General principles for selection of cracking-resistant materials*

[12] NACE MR0175/ISO 15156-2, *Petroleum and natural gas industries—Materials for use in $H_2S$-containing environments in oil and gas production—Part 2: Cracking-resistant carbon and low-alloy steels, and the use of cast irons*

[13] National Bureau of Standards, *Handbook 91*, U.S. Department of Commerce, Experimental Statistics

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