BS EN ISO 11960:2021

BSI Standards Publication

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

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National foreword

This British Standard is the UK implementation of EN ISO 11960:2021. It is identical to ISO 11960:2020. It supersedes BS EN ISO 11960:2014, which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee PSE/17/-/5, Casing, tubing and drill pipe.

A list of organizations represented on this committee can be obtained on request to its committee manager.

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Petroleum and natural gas industries - Steel pipes for use as casing or tubing for wells (ISO 11960:2020)

Industries du pétrole et du gaz naturel - Tubes d'acier utilisés comme cuvelage ou tubes de production dans les puits (ISO 11960:2020)

Erdöl- und Erdgasindustrie - Stahlrohre zur Verwendung als Futter - oder Steigrohre für Bohrungen (ISO 11960:2020)

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Full document details: BS EN ISO 11960:2021

Contents

Page

Foreword ... **x**

Introduction ... **xi**

1 Scope ... **1**

2 Normative references ... **1**

3 Terms, definitions, symbols and abbreviated terms ... **3**
3.1 Terms and definitions ... 3
3.2 Symbols and abbreviated terms ... 7

4 Conformance ... **8**
4.1 Dual referencing of normative references ... 8
4.2 Units of measurement ... 9

5 Information to be supplied by the purchaser ... **9**
5.1 Grades C90, T95 and C110 ... 9
5.2 Casing ... 9
5.3 Tubing ... 11
5.4 Coupling stock, coupling material and accessory material ... 13

6 Process of manufacture ... **14**
6.1 General ... 14
6.2 Heat treatment ... 14
6.2.1 General ... 14
6.2.2 Grades J55, K55, N80 all types and R95 ... 15
6.2.3 Grades L80 all types, C90, T95 and C110 ... 15
6.3 Straightening ... 15
6.3.1 Grades H40, J55, K55, N80 all types ... 15
6.3.2 Grades R95 and P110 ... 15
6.3.3 Grade L80 ... 15
6.3.4 Grades C90, T95 and C110 ... 16
6.3.5 Grade Q125 ... 16
6.4 Traceability ... 16
6.4.1 General ... 16
6.4.2 Serialization of Grades C90, T95, C110 and Q125 ... 16
6.5 Processes requiring validation ... 16

7 Material requirements ... **17**
7.1 Chemical composition ... 17
7.2 Tensile properties ... 17
7.2.1 General ... 17
7.2.2 Elongation ... 17
7.2.3 Yield strength ... 17
7.2.4 Statistical tensile testing — Grades C90, T95 and C110 ... 18
7.3 Charpy V-notch test — General requirements ... 18
7.3.1 Evaluation of test results ... 18
7.3.2 Critical thickness ... 18
7.3.3 Specimen size and orientation ... 18
7.3.4 Hierarchy of test specimens ... 18
7.3.5 Alternative size impact test specimens ... 19
7.3.6 Sub-size test specimens ... 19
7.3.7 Test temperature ... 19
7.3.8 Statistical impact testing ... 19
7.3.9 Reference information ... 19
7.4 Charpy V-notch — Absorbed energy requirements for coupling stock, coupling material, coupling blanks and couplings ... 19
7.4.1 General ... 19
7.4.2 Grade H40 ... 19

AVA Documents
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Full document details: BS EN ISO 11960:2021

7.4.3 Grades J55 and K55 for API threads 19
7.4.4 Grades N80 all Types, R95, L80 all Types, C90, T95, P110 and Q125 for API threads 20
7.4.5 Special end-finish 20
7.5 Charpy V-notch — Absorbed energy requirements for pipe 20
7.5.1 Grades H40, J55 and K55 20
7.5.2 Grades N80 all Types, R95, L80, C90, T95 and P110 20
7.5.3 Grades C110 and Q125 21
7.5.4 Test specimen 21
7.5.5 Testing conditions 22
7.6 Charpy V-notch — Absorbed energy requirements for accessory material 22
7.6.1 Accessory material — General 22
7.6.2 Accessory material for accessories with internal API threads except integral tubing connections 22
7.6.3 Accessory material for accessories with internal special end-finish tapered interference-type threads 22
7.6.4 Accessory material for accessories with external threads 22
7.6.5 Accessory material for accessories with either integral tubing connections or internal special end-finish connections that do not have thread interference 22
7.6.6 Critical thickness for accessory material and special end-finish material 22
7.7 Maximum hardness 23
7.7.1 Grades L80 all types, C90, T95 and C110 23
7.7.2 Grade Q125 — All products 23
7.8 Hardness variation — Grades C90, T95, C110 and Q125 23
7.9 Process control — Grades C90, T95, C110 and Q125 23
7.10 Hardenability — Minimum percentage martensite for quenched and tempered products 24
7.10.1 Grade L80 Type 1 24
7.10.2 Grades C90 and T95 24
7.10.3 Grade C110 24
7.10.4 All grades except Grades L80, C90, T95 and C110 24
7.11 Grain size — Grades C90, T95 and C110 25
7.12 Surface condition — Grade L80 13Cr 25
7.13 Flattening — Electric-welded pipe 25
7.14 Sulfide stress cracking test — Grades C90, T95 and C110 25
7.14.1 General guidance 25
7.14.2 Test and retest requirements and recommendations 25
7.14.3 Test sample selection and location 26
7.14.4 Test solution 26
7.14.5 Minimum SSC requirements 27
7.14.6 Invalidation of tests 28
7.14.7 Additional testing provisions for ANSI/NACE TM0177-2016 Method D 28

8 Dimensions, masses, tolerances, product ends and defects 28
8.1 Labels and sizes 28
8.2 Dimensions and masses 28
8.3 Diameter 29
8.3.1 Measurement and design 29
8.3.2 Requirements 29
8.4 Wall thickness 29
8.5 Mass 29
8.6 Length 30
8.7 Casing jointers 30
8.8 Height and trim of electric-weld flash 30
8.8.1 Trimming electric-weld flash 30
8.8.2 Grades H40, J55, K55, N80 all types, R95; and L80 Type 1 30
8.8.3 Grades P110 and Q125 31
8.8.4 Disposition 31
8.9 Straightness 31

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AVA Documents Document Sharing Hub
Full document details: BS EN ISO 11960:2021

8.9.1 Pipe ... 31
8.9.2 Coupling stock, coupling material and accessory material ... 31
8.10 Drift requirements ... 31
8.11 Tolerances on dimensions and masses ... 32
8.11.1 Outside diameter ... 32
8.11.2 Wall thickness ... 32
8.11.3 Mass ... 32
8.11.4 Inside diameter ... 33
8.11.5 Upset dimensions ... 33
8.11.6 Extended length upsets ... 33
8.12 Product ends ... 33
8.12.1 Plain-end pipe ... 33
8.12.2 Product with API threads ... 33
8.12.3 Rounded nose ... 33
8.12.4 Threading ... 33
8.12.5 Special end finish ... 34
8.13 Defects ... 34
8.13.1 Pipe and accessory made from pipe ... 34
8.13.2 Accessory material not made from pipe, coupling stock and coupling material ... 34
8.13.3 Process control plan ... 35
8.14 Coupling make-up and thread protection ... 35
8.14.1 All Grades except Q125 ... 35
8.14.2 Grade Q125 ... 35

9 Couplings ... 35
9.1 General requirements ... 35
9.2 Alternative grades or heat treatments ... 36
9.3 Mechanical properties ... 36
9.4 Dimensions and tolerances ... 36
9.4.1 All Grades except Q125 ... 36
9.4.2 Grade Q125 ... 37
9.5 Regular couplings ... 37
9.6 Special-clearance couplings — All Grades except Q125 ... 37
9.7 Combination couplings ... 37
9.8 Seal-ring couplings ... 37
9.9 Special-bevel tubing regular couplings — All Grades ... 37
9.10 Threading — Couplings ... 38
9.11 Surface inspection ... 38
9.12 Measurement of imperfections ... 38
9.13 Repair and removal of imperfections and defects ... 39
9.14 Thread surface treatment — Grade Q125 ... 39
9.15 Couplings and coupling blank protection — Grades C90, T95, C110 and Q125 ... 39

10 Inspection and testing ... 39
10.1 Test equipment ... 39
10.2 Lot definition for testing of mechanical properties ... 39
10.2.1 Grades H40, J55, K55, N80 all types, L80 Type 1, R95 and P110 — Coupling stock, coupling material and pipe (except pup joints heat-treated after cutting to blank or individual length) ... 39
10.2.2 Grades L80 13Cr, C90, T95, C110 and Q125 — Coupling stock, coupling material and pipe (except pup joints heat-treated after cutting to blank or individual length) ... 39
10.2.3 Coupling blanks, pup joints or accessory material heat-treated after cutting to blank or individual length ... 40
10.3 Testing of chemical composition ... 40
10.3.1 Heat analyses ... 40
10.3.2 Product analyses ... 40
10.3.3 Test method ... 40
10.3.4 Recheck of product analyses — All Grades ... 41

AVA Documents
Document Sharing Hub

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Full document details: BS EN ISO 11960:2021

10.4 Tensile tests ... 41
10.4.1 Stress-relief temperature — All grades ... 41
10.4.2 Heat-control tensile tests — All Grades except Q125 ... 41
10.4.3 Frequency of testing and location of test specimen — Casing and tubing ... 41
10.4.4 Frequency of testing and test specimen location — Coupling stock, coupling material, coupling blanks, pup joints and accessory material ... 41
10.4.5 Test specimens — General ... 42
10.4.6 Test specimens — Additional requirements for coupling blanks, coupling stock coupling material and pup joint and accessory materials — Grades C110 and Q125 ... 42
10.4.7 Test method ... 42
10.4.8 Invalidation of tests ... 43
10.4.9 Retests — All products (except coupling blanks, coupling stock, coupling material, pup joints or accessory material) — Grades C90, T95, C110 and Q125 ... 43
10.4.10 Retests — Coupling blanks, coupling stock, coupling material, pup joints or accessory material in Grades C90, T95, C110 and Q125 ... 43
10.5 Flattening test ... 43
10.5.1 General requirement for testing ... 43
10.5.2 Frequency of testing ... 43
10.5.3 Test specimens ... 44
10.5.4 Test method for Grades H40, J55, K55, N80 all types, R95, and L80 Type 1 ... 44
10.5.5 Test method for Grade P110 pipe and Grade Q125 casing ... 44
10.5.6 Invalidation of tests ... 44
10.5.7 Retests ... 44
10.6 Hardness test ... 44
10.6.1 Frequency of testing — General ... 44
10.6.2 Frequency of testing — Heat-control tests — Grade L80 ... 45
10.6.3 Frequency of testing — Grade L80 ... 45
10.6.4 Frequency of testing and test specimen location — Non-upset pipe — Grades C90, T95 and C110 ... 45
10.6.5 Frequency of testing and test specimen location — Upset pipe — Grades C90 and T95 ... 45
10.6.6 Frequency of testing and test specimen location — Coupling blanks, coupling stock, coupling material, pup joints and accessory material — Grades C90, T95 and C110 ... 45
10.6.7 Frequency of testing — Grade Q125 ... 46
10.6.8 Test specimens ... 46
10.6.9 Test method ... 46
10.6.10 Invalidation of tests ... 48
10.6.11 Periodic checks of hardness-testing machines ... 48
10.6.12 Verification of hardness-testing machines and indenters ... 48
10.6.13 Retests — Grade L80 ... 49
10.6.14 Retests — Grades C90, T95 and C110 products except for coupling blanks, pup joints or accessory material heat-treated after cutting to individual lengths ... 49
10.6.15 Retests — Grades C90, T95 and C110 coupling blanks, pup joints or accessory material heat-treated after cutting to individual lengths ... 50
10.6.16 Retests — Grade Q125 — General ... 50
10.6.17 Retests — Grade Q125 — Casing, coupling stock and coupling material ... 50
10.6.18 Retests — Grade Q125 — Coupling blanks, pup joints and accessory material ... 50
10.6.19 Rejected lots — Grades L80 all types, C90, T95, C110 and Q125 ... 50
10.7 Impact test ... 50
10.7.1 Sampling —Grades J55 and K55 ... 50
10.7.2 Sampling — Grades N80 all types, R95, L80, C90, T95, C110 and P110 ... 50
10.7.3 Sampling and test specimen location — Grade Q125 ... 51
10.7.4 Test specimens ... 51
10.7.5 Test method ... 51

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Documents
Document Sharing Hub
Full document details: BS EN ISO 11960:2021

10.7.6 Invalidation of tests ... 51
10.7.7 Retest of a length — All Grades ... 51
10.7.8 Replacement of a reject length — All Grades ... 52
10.7.9 Multiple length rejection — Grade Q125 ... 52
10.8 Grain size determination — Grades C90, T95 and C110 ... 52
10.8.1 Sampling ... 52
10.8.2 Test method ... 52
10.9 Hardenability — Grades C90, T95 and C110 ... 52
10.10 Sulfide stress-cracking test — Grades C90, T95 and C110 ... 52
10.11 Metallographic evaluation — All EW Grades ... 52
10.12 Hydrostatic tests ... 53
10.12.1 Hydrostatic test procedures ... 53
10.12.2 Hydrostatic test requirements ... 53
10.12.3 Test pressure calculation ... 54
10.13 Dimensional testing ... 55
10.13.1 General ... 55
10.13.2 Diameter measurement ... 55
10.13.3 Diameter retests ... 55
10.13.4 Wall thickness measurement ... 56
10.13.5 Drift test ... 56
10.13.6 Length measurement ... 56
10.13.7 Mass (weight) determination ... 56
10.13.8 Straightness evaluation ... 57
10.13.9 Internal upset inspection ... 57
10.14 Visual inspection ... 57
10.14.1 General ... 57
10.14.2 Pipe body, coupling stock and coupling material (excluding pipe ends) ... 58
10.14.3 Pipe ends ... 58
10.14.4 Disposition ... 58
10.15 Non-destructive examination (NDE) ... 58
10.15.1 General ... 58
10.15.2 NDE personnel ... 59
10.15.3 Reference standards ... 59
10.15.4 NDE system capability records ... 59
10.15.5 Pipe body or coupling stock inspection — General ... 60
10.15.6 Full-body, full-length NDE of casing and tubing — Grades H40, J55, K55, N80 all types, L80 and R95 ... 60
10.15.7 Full-body, full-length NDE of casing and tubing — Grade P110 to A.8 SR16 ... 60
10.15.8 Full-body, full-length NDE of casing and tubing — Grade P110 and Grade P110 to A.8 SR16 and A.2 SR2 ... 61
10.15.9 Full-body, full-length NDE of casing and tubing — Grades L80 13Cr, C90, T95, C110 and Q125 ... 61
10.15.10 NDE of the weld seam of welded pipe ... 61
10.15.11 NDE of coupling stock, accessory material (except Grades L80 13Cr, C90, T95, C110 and Q125) and pup joints ... 62
10.15.12 NDE of coupling stock and accessory material – Grades L80 13Cr, C90, T95, C110 and Q125 ... 62
10.15.13 NDE of coupling stock and accessory material — Grades C90 and T95 ... 63
10.15.14 Untested pipe ends, coupling stock ends and accessory material ends ... 64
10.15.15 Pipe upsets ... 64
10.15.16 Pipe, coupling stock and accessory material requiring further evaluation ... 64

AVA Documents
Document Sharing Hub

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Full document details: BS EN ISO 11960:2021

10.15.17 ..... Evaluation of indications (prove-up) 65
10.15.18 ..... Disposition of pipe containing defects 65
10.15.19 ..... Disposition of coupling stock and accessory material containing defects 66

11 Marking 67
11.1 General 67
11.2 Stamp marking requirements 68
11.2.1 Methods 68
11.2.2 Size 68
11.2.3 Location 68
11.2.4 Grades H40, J55, K55, N80 all types and P110 68
11.2.5 Grades R95, L80 all types, C90, T95, C110 and Q125 68
11.2.6 Make-up triangle marking 69
11.3 Stencil marking requirements 69
11.4 Colour identification 69
11.4.1 Colour coding 69
11.4.2 Product 1,8 m (6 ft) and longer 69
11.4.3 Loose couplings 70
11.4.4 Special-clearance couplings 70
11.4.5 Pup joints shorter than 1,8 m (6 ft) in length 70
11.4.6 Grade colour-codes 70
11.5 Thread and end-finish marking 70
11.5.1 API thread marking 70
11.5.2 Plain-end and special end-finish markings 70
11.6 Pipe-threader marking requirements 70

12 Coating and protection 71
12.1 Coatings 71
12.1.1 Coatings for protection during transit 71
12.1.2 Coatings for long-term storage 71
12.2 Thread protectors 72
12.2.1 General 72
12.2.2 Grade L80 13Cr 72
12.2.3 Driftable thread protectors 72

13 Documents 72
13.1 Electronic media 72
13.2 Certification requirements 72
13.3 Content of the certificate 72
13.4 Retention of records 74

14 Minimum facility requirements for various categories of manufacturer 74
14.1 Pipe mill 74
14.2 Processor 74
14.3 Pipe threader 74
14.4 Coupling, pup-joint or accessory manufacturer 75

Annex A (normative) **Supplementary requirements 76**

Annex B (normative) **Purchaser inspection 91**

Annex C (normative) **Tables in SI units 92**

Annex D (normative) **Figures in SI (USC) units 159**

Annex E (normative) **Tables in USC units 182**

Annex F (informative) **Procedures used to convert from USC units to SI units 248**

Annex G (normative) **Requirements for thread protector design validation 260**

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Annex H (normative) **High collapse requirements** **265**
Bibliography **267**

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Foreword

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

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This document was prepared by Technical Committee ISO/TC 67, *Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries*, Subcommittee SC 5, *Casing, tubing and drill pipe*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 12, *Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

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

— deletion of Groups;

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

— addition of Annex H on high collapse requirements;

— modification of NDT requirements for sour service grades.

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

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Introduction

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

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

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

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

1 Scope

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

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

This document is applicable to the following connections:

— short round thread casing (SC);

— long round thread casing (LC);

— buttress thread casing (BC);

— non-upset tubing (NU);

— external upset tubing (EU);

— integral-joint tubing (IJ).

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

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

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

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

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

This document is not applicable to threading requirements.

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

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

ASTM E709, *Standard Guide for Magnetic Particle Testing*

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

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

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

3 Terms, definitions, symbols and abbreviated terms

3.1 Terms and definitions

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

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

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

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

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

3.1.2
API threads
threads as specified in API Spec 5B

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

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

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

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

3.1.6
connection
threaded assembly of tubular components

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

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

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

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

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

3.1.11
coupling stock
coupling material that meets the coupling stock requirements

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

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

3.1.14
full-body
complete cross-section of the product

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Note 1 to entry: See API Std 5T1.

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

Note 1 to entry: See Clause 14.

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

Note 1 to entry: See API Std 5T1.

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

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

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

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

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

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

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

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

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

3.1.38
quench crack
crack in steel resulting from stresses produced during the transformation from austenite to martensite

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

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

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

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

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

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

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

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

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

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

3.2 Symbols and abbreviated terms

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

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

4 Conformance

4.1 Dual referencing of normative references

In the interests of world-wide application of this document, ISO/TC 67 has decided, after detailed technical analysis, that certain normative documents listed in Clause 3 and prepared by ISO/TC 67 or other ISO Technical Committee are interchangeable in the context of the relevant requirement with the relevant document prepared by the American Petroleum Institute (API), the American Society for Testing and Materials (ASTM) or the American National Standards Institute (ANSI). These latter documents are cited in the running text following the ISO reference and preceded by “or”, for example “ISO XXXX or API YYYY”. Application of an alternative normative document cited in this manner will

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lead to technical results different from the use of the preceding ISO reference. However, both results are acceptable and these documents are thus considered interchangeable in practice.

4.2 Units of measurement

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

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

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

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

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

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

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

5 Information to be supplied by the purchaser

5.1 Grades C90, T95 and C110

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

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

5.2 Casing

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

Table 1 — Purchaser supplied information (Casing)

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

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Table 1 *(continued)*

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

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

Table 2 — Purchaser supplied agreement optional requirements (Casing)

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

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

Table 3 — Purchaser/Manufacturer agreement (Casing)

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

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Table 3 *(continued)*

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

5.3 Tubing

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

Table 4 — Purchaser supplied information (Tubing)

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

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Table 4 *(continued)*

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

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

Table 5 — Purchaser supplied agreement optional requirements (Tubing)

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

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

Table 6 — Purchaser/Manufacturer agreement (Tubing)

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

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Table 6 *(continued)*

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

5.4 Coupling stock, coupling material and accessory material

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

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

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

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

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

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

6 Process of manufacture

6.1 General

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

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

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

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

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

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

6.2 Heat treatment

6.2.1 General

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

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

6.2.2 Grades J55, K55, N80 all types and R95

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

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

Grade R95 shall be quenched and tempered.

6.2.3 Grades L80 all types, C90, T95 and C110

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

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

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

6.3 Straightening

6.3.1 Grades H40, J55, K55, N80 all types

No specific methods are required.

6.3.2 Grades R95 and P110

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

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

6.3.3 Grade L80

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

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

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

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

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6.3.4 Grades C90, T95 and C110

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

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

6.3.5 Grade Q125

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

6.4 Traceability

6.4.1 General

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

6.4.2 Serialization of Grades C90, T95, C110 and Q125

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

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

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

6.5 Processes requiring validation

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

Those processes requiring validation are:

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

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

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

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

7 Material requirements

7.1 Chemical composition

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

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

7.2 Tensile properties

7.2.1 General

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

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

7.2.2 Elongation

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

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

where

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

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

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

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

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

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

7.2.3 Yield strength

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

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7.2.4 Statistical tensile testing — Grades C90, T95 and C110

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

7.3 Charpy V-notch test — General requirements

7.3.1 Evaluation of test results

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

For Grade C110 either:

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

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

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

7.3.2 Critical thickness

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

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

7.3.3 Specimen size and orientation

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

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

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

7.3.4 Hierarchy of test specimens

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

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7.3.5 Alternative size impact test specimens

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

7.3.6 Sub-size test specimens

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

7.3.7 Test temperature

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

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

7.3.8 Statistical impact testing

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

7.3.9 Reference information

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

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

7.4.1 General

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

7.4.2 Grade H40

There is no mandatory CVN impact energy requirement.

NOTE See A.8 SR16 for optional CVN requirements.

7.4.3 Grades J55 and K55 for API threads

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

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

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

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

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

where

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

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

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

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

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

7.4.5 Special end-finish

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

7.5 Charpy V-notch — Absorbed energy requirements for pipe

7.5.1 Grades H40, J55 and K55

There is no mandatory CVN impact requirement.

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

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

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

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

where

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

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

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

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

7.5.3 Grades C110 and Q125

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

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

where

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

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

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

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

7.5.4 Test specimen

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

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7.5.5 Testing conditions

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

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

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

7.6.1 Accessory material — General

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

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

The requirements in 7.4.1 to 7.4.4 apply.

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

The requirements in 7.4.5 apply.

7.6.4 Accessory material for accessories with external threads

The requirements in 7.4 apply.

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

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

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

If not specified on the purchase agreement,

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

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

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

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7.7 Maximum hardness

7.7.1 Grades L80 all types, C90, T95 and C110

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

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

In addition, the following apply.

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

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

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

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

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

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

c) Grades C90 and T95 — Alternative maximum hardness requirements

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

7.7.2 Grade Q125 — All products

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

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

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

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

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

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

7.10 Hardenability — Minimum percentage martensite for quenched and tempered products

7.10.1 Grade L80 Type 1

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

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

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

7.10.2 Grades C90 and T95

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

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

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

7.10.3 Grade C110

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

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

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

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

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

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

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

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

7.11 Grain size — Grades C90, T95 and C110

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

7.12 Surface condition — Grade L80 13Cr

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

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

7.13 Flattening — Electric-welded pipe

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

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

7.14.1 General guidance

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

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

7.14.2 Test and retest requirements and recommendations

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

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

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

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

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

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

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

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

7.14.3 Test sample selection and location

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

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

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

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

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

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

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

7.14.4 Test solution

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

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

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

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7.14.5 Minimum SSC requirements

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

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

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

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

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

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

No valid test specimen shall have a value less than

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

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

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

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

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

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

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

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

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

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7.14.6 Invalidation of tests

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

a) test specimen machining defects;

b) testing errors.

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

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

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

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

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

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

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

8 Dimensions, masses, tolerances, product ends and defects

8.1 Labels and sizes

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

8.2 Dimensions and masses

Pipe shall be furnished in the sizes, wall thicknesses and masses (as shown in Tables C.23 to C.26 inclusive or Tables E.23 to E.26 inclusive) as specified on the purchase agreement. Other plain-end pipe sizes and wall thicknesses may be furnished by agreement between purchaser and manufacturer. Coupling stock, coupling material and accessory material shall be furnished in dimensions specified on the purchase agreement or, in the case of coupling material, the dimensions shall be specified in the manufacturer's internal requirements. Coupling stock and coupling material outside diameter and wall thickness combinations shall exclude those in Tables C.1 and C.2 or Tables E.1 and E.2. All dimensions shown without tolerances are related to the basis for design and are not subject to measurement to determine acceptance or rejection of product.

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

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

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

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

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

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

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

8.3 Diameter

8.3.1 Measurement and design

a) Using SI units

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

b) Using USC units

The diameter shall be rounded to three decimal places.

8.3.2 Requirements

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

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

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

8.4 Wall thickness

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

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

8.5 Mass

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

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

$$W_L = w_{pe} \cdot L_{ef} + k_m \cdot e_m \tag{6}$$

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

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

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

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

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

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

8.6 Length

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

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

8.7 Casing jointers

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

8.8 Height and trim of electric-weld flash

8.8.1 Trimming electric-weld flash

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

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

a) reasonably close to flush after trimming, and

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

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

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

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

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

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

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

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

8.8.3 Grades P110 and Q125

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

8.8.4 Disposition

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

8.9 Straightness

8.9.1 Pipe

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

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

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

See Figures D.13 and D.14.

8.9.2 Coupling stock, coupling material and accessory material

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

8.10 Drift requirements

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

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

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

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

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

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8.11 Tolerances on dimensions and masses

8.11.1 Outside diameter

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

Table 13 — Dimension Tolerances (pipe OD)

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

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

Table 14 — Dimension tolerances (upset integral tubing)

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

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

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

Table 15 — Dimension tolerances (external upset tubing)

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

8.11.2 Wall thickness

Tolerance for pipe –12,5 %

8.11.3 Mass

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

Table 16 — Standard mass tolerances

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

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Table 16 *(continued)*

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

8.11.4 Inside diameter

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

8.11.5 Upset dimensions

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

8.11.6 Extended length upsets

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

8.12 Product ends

8.12.1 Plain-end pipe

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

8.12.2 Product with API threads

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

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

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

8.12.3 Rounded nose

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

8.12.4 Threading

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

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

8.12.5 Special end finish

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

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

8.13 Defects

8.13.1 Pipe and accessory made from pipe

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

a) any quench crack;

b) any arc burn;

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

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

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

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

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

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

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

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

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

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

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8.13.3 Process control plan

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

8.14 Coupling make-up and thread protection

8.14.1 All Grades except Q125

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

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

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

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

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

8.14.2 Grade Q125

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

9 Couplings

9.1 General requirements

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

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

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

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

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

9.2 Alternative grades or heat treatments

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

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

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

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

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

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

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

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

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

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

9.3 Mechanical properties

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

9.4 Dimensions and tolerances

9.4.1 All Grades except Q125

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

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