Specification for Casing and Tubing

API Specification 5CT, Seventh Edition
October 1, 2001

ISO 11960:2001, Petroleum and Natural Gas Industries—Steel Pipes for Use as Casing and Tubing for Wells

EFFECTIVE DATE: APRIL 1, 2002

PROPOSED NATIONAL ADOPTION

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API Foreword

This standard is under the jurisdiction of the API Standards Subcommittee on Tubular Goods (API C1/SC5). This API standard is identical with the English version of ISO 11960:2001. ISO 11960 was prepared by Technical Committee ISO/TC 67, Materials, equipment and offshore structures for petroleum and natural gas industries, SC 5, Casing, Tubing, and Drilling Pipe.

This standard shall become effective on the date printed on the cover but may be used voluntarily from the date of publication.

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Suggested revisions are invited and should be submitted to the Upstream Segment, API, 1220 L Street, NW, Washington, DC 20005.

Date of Issue: April 1, 2002
Affected Publication: API Specification 5CT, Specification for Casing and Tubing, Seventh Edition

ERRATA

API has agreed to issue the 7th edition of API Spec 5CT as an identical adoption of the 2nd edition of ISO 11960. After the issuance of ISO 11960, several editorial corrections were discovered. In order to keep the ISO and API standards aligned and identical, it was decided not to incorporate the changes into the 7th edition of API Spec 5CT, but to publish an identical document and this Errata as a separate document at the same time as the 7th edition of 5CT. It is anticipated that ISO will publish an identical Errata (Corrigendum) soon after the publication of this Errata.

Please note that other editorial items of less significance were also identified but determined not appropriate for inclusion in this errata. A listing of the items identified will be maintained on the API web site for reference to those that help maintain the document.

1.1 Revise the next to the last paragraph to read "For pipes covered by this International Standard, the sizes, masses, wall thicknesses, grades, and applicable end finish are listed in Tables C.1 to C.3 and E.1 to E.3.

6.1 Change "C.1 to C.4" and "E.1 to E.4".

8.12.2, 2nd line Delete "and casing accessories"

8.12.3, 2nd line Delete "and tubing accessories"

10.12.2, 2nd paragraph Change to "For threaded pipe, the hydrostatic test pressure...."

A.2 Title Change to "**SR22 Supplementary.....and P110 to A.9 (SR16)**

A.9.6.1 Delete "ISO 6892 or"

Table C.39, Column 2, < 6-5/8 is for casing, not tubing

Table C.62, Column 1 Combine cells for C90 and T96-Q125 and list as: C90, T95, Q125

Table C67, Box 3, Column 2 Shift all text lines down one line so have alignment with "UF" and "SF", etc., see Table E.67 for correct format

Table C.67, Box 8, Column 2 In 3rd line after M65 add "Quenched and tempered"

Table C.79, Box 8, Column 2 In 3rd line after M65 add "Quenched and tempered"

Figure D.3 Move text "On special clearance...." To below top figure

Figure D.8 Add footnote c to Label 7

Figure D.9 Change to b)Strip specimen[a]
Remove superscript "a" from "R" in Figure b)

Figure D.16, Example 5, Stamp Marking Delete 2.15.9 and revise "DA" to "DA[d]" and add new footnote d. as follows:

"[d]Express alternate drift diameter in mm for pipe manufactured in SI units and in inches for pipe manufactured in USC units."

Figure D.23 Make the same changes as for Figure D.16

Table E.27, Column 4

For 2nd 1.050 Change 1.20 to 1.54
For 2nd 1.315 Change 1.80 to 2.24
For 2nd 1.660 Change 2.40 to 3.07
For 2nd 1.990 Change 2.90 to 3.73

Should be the same values as in column 2

Table E.35 Change the tolerance on Outside diameter to +1/8 in Group 4

Table E.39 Make same changes as done for Table C.39

Table E.62 Make same changes as done for Table C.62

Table E.67, Box 8, Column 2 In 3rd line after M65 add "Quenched and tempered"

Table E.79 Box 3, Make same changes as done for Table C.67
Box 8, Change to be like that in Table C.79
Box 16, Change couplings to H40, J55 and K55

Contents **Page**

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75% of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 11960 was prepared by Technical Committee ISO/TC 67, *Materials, equipment and offshore structures for petroleum and natural gas industries*, Subcommittee SC 5, *Casing, tubing and drill pipe*.

This second edition replaces the first edition (ISO 11960:1996) which has been technically revised. It is the intent of TC 67 that the first and second editions of ISO 11960 both be applicable, at the user's option, for a period of six months after the date of publication of this second edition, after which the first edition will no longer be applicable.

Annexes A to E form a normative part of this International Standard. Annexes F and G are for information only.

Introduction

This International Standard is based on API 5CT (Specification for Casing and Tubing).

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

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

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

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

— MAY is used to indicate that a provision is OPTIONAL.

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

1 Scope

1.1 This International Standard specifies the technical delivery conditions for steel pipes (casing, tubing, plain end casing liners and pup-joints) and accessories. This International Standard is applicable to the following connections in accordance with ISO 10422 or API Spec 5B:

— short round thread casing (STC);
— long round thread casing (LC);
— buttress thread casing (BC);
— extreme-line casing (XC);
— non-upset tubing (NU);
— external upset tubing (EU);
— integral joint tubing (IJ).

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

For pipes covered by this International Standard, the sizes, masses, wall thicknesses, grades and applicable end finishes are defined.

This International Standard may also be applied to tubulars with connections not covered by ISO/API standards.

1.2 The four groups of products to which this International Standard is applicable include the following grades of pipe:

— Group 1: All casing and tubing in Grades H, J, K and N;
— Group 2: All casing and tubing in Grades C, L, M and T;
— Group 3: All casing and tubing in Grade P;
— Group 4: All casing in Grade Q.

1.3 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.24, C.30 and C.31 or Tables E.1, E.24, E.30 and E.31.

1.4 Supplementary requirements that may optionally be agreed between purchaser and manufacturer, for non-destructive examination, coupling blanks, upset casing, electric-welded casing, impact testing, seal ring couplings and certificates are given in annex A.

1.5 This International Standard is not applicable to threading requirements.

NOTE Dimensional requirements on threads and thread gauges, stipulations on gauging practice, gauge specifications, as well as instruments and methods for inspection of threads are given in ISO 10422 or API Spec 5B. Connections machined to either of these specifications are the same for practical purposes and are totally interchangeable.

2 Conformance

2.1 Normative references

In the interests of worldwide application of this International Standard, ISO/TC 67 has decided, after detailed technical analysis, that certain of the normative documents listed in clause 3 and prepared by ISO/TC 67 or 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 lead to the same results as the use of the preceding ISO reference. These documents are thus considered interchangeable in practice.

2.2 Units of measurement

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

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

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

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

2.3 Tables and figures

Separate tables for data expressed in SI units and USC units are given in annex C and annex E respectively. For a specific order item, only one unit system shall be used.

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

3 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 31-0, *Quantities and units—Part 0: General principles*

ISO 643, *Steels—Micrographic determination of the ferritic or austenitic grain size*

ISO 6506-1, Metallic materials—Brinell Hardness test—Part 1:Test method

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

ISO 6892, *Metallic materials—Tensile testing at ambient temperature*

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

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

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

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

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

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

ISO 9764, *Electric resistance and induction welded steel tubes for pressure purposes—Ultrasonic testing of the weld seam for the detection of longitudinal imperfections*

ISO 10400, *Petroleum and natural gas industries—Formulae and calculation for casing, tubing, drill pipe and line pipe properties*

ISO 10422, *Petroleum and natural gas industries—Threading, gauging and thread inspection of casing, tubing and line pipe threads—Specification*

ISO 10474, *Steel and steel products—Inspection documents*

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

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

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

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

ANSI-ASNT SNT-TC-1A:1984, *Personnel qualifications and certification in non.destructive testing*

ANSI-NACE TM0177:1996, *Laboratory testing of metals for resistance to sulfide stress cracking at ambient temperature in* H_2S *environment*

API Bul 5C2, *Bulletin on performance properties of casing, tubing and drill pipe*

API Bul 5C3, *Bulletin on formulas and calculations for casing, tubing, drill pipe and line pipe properties* (plus Supplement 1)

API RP 5A3, *Bulletin on thread compounds for casing, tubing and line pipe*

API Spec 5B, *Specification for threading, gauging and thread inspection of casing, tubing and line pipe threads*

API Std 5T1, *Imperfection technology*

ASTM A370, *Standard test methods and definitions for mechanical testing of steel products*

ASTM A751, *Methods, practices and definitions for chemical analysis of steel products*

ASTM A941, *Terminology relating to steel, stainless steel, related alloys and ferro-alloys*

ASTM E4, *Practices for load verification of testing machines*

ASTM E10, *Standard method of test for Brinell hardness of metallic materials*

ASTM E18, *Standard methods of test for Rockwell hardness and Rockwell superficial hardness of metallic materials*

ASTM E23, *Standard test methods for notched bar impact testing of metallic materials*

ASTM E29, *Practice for using significant digits in test data to determine conformance with specifications*

ASTM E83, *Standard practice for verification and classification of extensometers*

ASTM E112, *Methods for determining average grain size*

ASTM E213, *Standard practice for ultrasonic examination of metal pipe and tubing*

ASTM E273, *Standard practice for ultrasonic examination of longitudinal welded pipe and tubing*

ASTM E309, *Standard practice for eddy-current examination of steel tubular products using magnetic saturation*

ASTM E570, *Standard practice for flux leakage examination of ferro-magnetic steel tubular products*

ASTM E709, *Standard practice for magnetic particle examination*

4 Terms, definitions, symbols and abbreviated terms

4.1 Terms and definitions

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

4.1.1
carload
quantity of pipe loaded on a railway car for shipment from the pipe-making facilities

4.1.2
casing
pipe run from the surface and intended to line the walls of a drilled well

4.1.3
casing and tubing accessory
one-piece tubular section used in a pipe string to provide mechanical and pressure integrity within the pipe string and facilitate the performance of some other function required of that pipe string

NOTE Examples of accessories are: crossover connectors, swages, nipples, flow couplings, blast joints, etc. Accessories exclude the other tubular products specifically defined in this International Standard or products included in other ISO (API) specifications.

4.1.4
connection
threaded assembly of tubular components

4.1.5
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

4.1.6
coupling
internally threaded cylinder for joining two lengths of threaded pipe

4.1.7
coupling blank
unthreaded material used to produce an individual coupling

4.1.8
coupling stock
tubular used for the manufacture of coupling blanks

4.1.8
defect
imperfection of sufficient magnitude to warrant rejection of the product based on criteria defined in this International Standard

4.1.9
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

4.1.10
handling tight
sufficiently tight that the coupling cannot be removed except by the use of a wrench

4.1.11
heat
metal produced by a single cycle of a batch melting process

4.1.12
heat analysis
chemical analysis representative of a heat as reported by the metal producer

4.1.13
imperfection
discontinuity in the product wall or on the product surface that can be detected by a NDE method included in Table C.61 or Table E.61 of this International Standard

4.1.14
inspection
process of measuring, examining, testing, gauging or otherwise comparing a unit of product with the applicable requirements

4.1.15
inspection lot
definite quantity of product manufactured under conditions that are considered uniform for the attribute to be inspected

4.1.16
inspection lot sample
one or more units of product selected from an inspection lot to represent that inspection lot

4.1.17
inspection lot size
number of units of product in an inspection lot

4.1.18
interrupted quenching
quenching in which the pipe being quenched is removed from the quenching medium while the pipe is at a temperature substantially higher than that of the quenching medium

4.1.19
ISO/API threads
threads as specified in ISO 10422 or API Spec 5B

4.1.20
label 1
dimensionless designation for the size or specified outside diameter that may be used when ordering pipe

4.1.21
label 2
dimensionless designation for the mass per unit length or wall thickness that may be used when ordering pipe

4.1.22
length
piece of pipe that may be plain-end, threaded, or threaded and coupled, that is in accordance with the range requirements in Table C.30 or Table E.30 of this International Standard

4.1.23
linear imperfection
imperfection which includes, but is not limited to, seams, laps, cracks, plug scores, cuts and gouges

NOTE See API Std 5T1.

4.1.24
manufacturer
one or more of the following, depending on the context: pipe mill; processor; threader; coupling manufacturer, pup-joint manufacturer; accessory manufacturer

NOTE See clause 14.

4.1.25
non-linear imperfection
imperfection which includes, but is not limited to, pits and round bottom die stamping

NOTE See API Std 5T1.

4.1.26
pipe
casing, tubing, plain-end casing liners and pup-joints as a group

4.1.27
pipe mill
firm, company or corporation that operates pipe-making facilities

4.1.28
plain-end casing liner
casing provided unthreaded and with a wall thickness often greater than that specified for J55

4.1.29
processor
firm, company or corporation that operates facilities capable of heat-treating pipe made by a pipe mill

4.1.30
product
pipe, coupling, accessory, coupling stock or coupling blank, either individually or collectively as applicable

4.1.31
pup-joint
casing, tubing or plain-end casing liner of length shorter than Range 1

4.1.32
purchaser
party responsible for both the definition of requirements for a product order and for payment for that order

4.1.33
quench crack
crack in steel resulting from stresses produced during the transformation from austenite to martensite

NOTE This transformation is accompanied by an increase in volume.

4.1.34
seamless pipe
wrought steel tubular product made without a weld seam

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

4.1.35
special end finish
threads with thread form and features, manufacturing specifications, dimensions, connection make-up and performance properties which are beyond the scope of this International Standard

4.1.36
special processes
final operations which are performed during pipe manufacturing that affect the attributes of product, except its chemistry and dimensions

NOTE These special processes are:

Manufacturing conditions	Special processes
Seamless, as-rolled	— Final re-heating practice and hot sizing or stretch-reducing. — If applicable, upsetting, coldfinishing. — Non-destructive examination
Seamless, heat-treated	— Heat treatment — Non-destructive examination
Electric-weld, as-rolled	— Sizing and seam welding — If applicable, seam heat treatment and upsetting — Non-destructive examination
Electric-weld, heat-treated	— Seam welding and full-body heat treatment — Non-destructive examination

4.1.37
thread protector
cap or insert used to protect threads and seals during handling, transportation and storage

4.1.38
tubing
pipe placed within a well and serving to produce well fluids or to inject fluids

4.1.39
upper critical temperature
Ar_3
temperature at which austenite begins to transform to ferrite during cooling

4.2 Symbols and abbreviated terms

BC	buttress thread casing connection
C_V	Charpy V-notch impact test minimum absorbed energy
D	specified outside diameter for pipe
d	calculated inside diameter
EMI	electromagnetic inspection
EU	external upset tubing connection
EW	electric-welded process
HBW	Brinell hardness, when testing with a tungsten carbide ball
HBS	Brinell hardness, when testing with a steel ball
HRC	Rockwell hardness C-scale
ID	inside diameter
IJ	integral joint tubing connection
k	a constant used in the calculation of elongation
LC	long round thread casing connection
N	⟨heat-treat process⟩ full-length normalized
N&T	normalized and tempered
NDE	non-destructive examination
NU	non-upset tubing connection
OD	outside diameter
Q	quenched and tempered
S	seamless process
Sc	minimum acceptable result of the ANSI-NACE TM0177:1996 Method B test
SCC	special clearance coupling
SSCC	sulfide stress corrosion cracking

STC	short round thread casing connection
t	specified wall thickness
T&C	threaded and coupled
USC	United States customary (units)
UT	ultrasonic testing
W	specified outside diameter for ISO/API thread couplings other than special clearance couplings
W_c	specified outside diameter of special clearance couplings
XC	extreme line casing connection
YS_{min}	specified minimum yield strength

5 Information to be supplied by the purchaser

5.1 Casing

5.1.1 When enquiring or placing orders for pipe to be manufactured in accordance with this International Standard, the purchaser shall specify the following:

Requirement	**Reference**
Standard	ISO 11960 or API 5CT
Quantity	
Type of pipe or couplings	
Casing:	
Threaded or plain-end	8.12
Type of connection: round (short or long), buttress, extreme-line threads, or other connection	8.12, Table C.1 or Table E.1
With or without couplings	8.12
Special clearance couplings	9.8, Tables C.1, C.36 or Tables E.1, E.36
Liners:	8.12.1, Table C.2 or Table E.2
Label 1 or specified outside diameter	Tables C.1, C.2 or Tables E.1, E.2
Label 2 or specified mass or wall thickness	Tables C.1, C.2 or Tables E.1, E.2
Grade and type where applicable	Tables C.1, C.2, C.5 or Tables E.1, E.2, E.5
Range length	8.6, Table C.30 or Table E.30
Seamless or electric-welded	6.1, Table C.4 or Table E.4
Critical thickness for special end-finish couplings, stock or blanks	7.6.6
Critical thickness for special end-finish accessories	7.6.6
Wall thickness verification of special end-finish accessories	10.13.4
Delivery date and shipping instructions	
Inspection by purchaser	Annex B

5.1.2 The purchaser should also state on the purchase agreement his requirements concerning the following stipulations, which are at the purchaser's option:

Requirement	**Reference**
Heat treatment	6.2
Lower alternative impact test temperature	7.3.7
Casing jointers	8.7

Alternative drifting requirements	8.10
Casing with couplings detached	8.14
Coupling make-up (other than power-tight)	8.14
Coupling blanks	9.2, A.3 (SR9)
Seal ring couplings	9.11, A.7 (SR13)
Heat and supplementary analyses	10.3
Additional markings	11
Pipe coatings	12.1
Material certification	13.2, A.8 (SR15)

5.1.3 The following may be agreed between purchaser and manufacturer:

Requirement	**Reference**
Cold rotary straightening - Q125 Grade	6.3
Statistical impact testing	7.3.8, A.6 (SR12)
Impact of Group 1 non-heat-treated pipe	7.5.1, A.9 (SR16)
Sulfide stress cracking test - C90 and T95 Grade	7.14
Length of accessories	8.6
Thread and storage compound	8.14
Waiving NDE of Group 1 couplings in Grades H40, J55 and K55	9.14.3
Coupling thread plating - Q125 Grade only	9.17
Additional hardness testing - Grades M65 and L80	10.6.2
Additional hardness testing - C90 and T95 Grade	10.6.4
Reduced section tensile specimens - Q125 Grade	10.4.6
Hydrostatic pressure test for handling-tight make-up, accessories and	10.12.2
Alternative hydrostatic test pressures	10.12.3
Plain-end Q125 casing hydrostatic testing	10.12.2
Non-destructive examination	10.15, A.1 (SR1), A.2 (SR2), A.4 (SR10) and A.5 (SR11)
Marking requirements	11.1
Thread protectors	12.2
Coupling blanks - Q125 Grade only	A.3 (SR9)
Upset casing - Q125 Grade only	A.4 (SR10)
Electric-weld casing - P110 and Q125 Grade	A.5 (SR11)
Alternative F factor in SR 12 - Q125 Grade	A.6 (SR12.2)
Special end-finish for casing, couplings, pup-joints or accessories	8.12.8, 9.13.2
Quality assurance requirements	
Special wall thickness for Grades C90, T95 and Q125	8.2

5.2 Tubing

5.2.1 When enquiring or placing orders for pipe to be manufactured in accordance with this International Standard, the purchaser shall specify the following:

Requirement	**Reference**
Standard	ISO 11960 or API 5CT
Quantity	
Type of pipe or couplings	
Tubing:	
Non-upset, external-upset or integral joint	Table C.3 or Table E.3
Threaded, plain-end, or other connection	8.12
With or without couplings	8.12
Special bevel couplings	9.12, Tables C.3, C.37 and C.38 or Tables E.3, E.37 and E.38

Special clearance couplings	9.8, Tables C.3, C.38 or Tables E.3 and E.38
Label 1 or specified outside diameter	Table C.3 or Table E.3
Label 2 or specified mass or wall thickness	Table C.3 or Table E.3
Grade and type, where applicable	Table C.3 or Table E.3, Table C.5 or Table E.5
Range length	8.6, Table C.30 or Table E.30
Seamless or electric-welded	6.1, Table C.4 or Table E.4
Critical thickness for special end-finish couplings, stock or blanks	7.4.6
Critical thickness for accessory material	7.6.6
Wall thickness verification of special end-finish accessories	10.13.4
Delivery date and shipping instructions	
Inspection by purchaser	Annex B

5.2.2 The purchaser should also state on the purchase agreement his requirements concerning the following stipulations, which are at the purchaser's option:

Requirement	**Reference**
Heat treatment	6.2
Upset length—Standard or extended	8.11.6
Rounded nose	8.12.4
Coupling make-up (other than power-tight)	8.14
Tubing with couplings detached	8.14
Seal ring couplings	9.11, A.7 (SR13)
Heat and supplementary analyses	10.3
Additional markings	11
Pipe coatings	12.1
Material certification	13.2, A.8 (SR15)

5.2.3 The following may be agreed between purchaser and manufacturer:

Requirement	**Reference**
Statistical impact testing	7.3.8, A.6 (SR12)
Impact testing of Group 1 pipe	7.5.1, A.9 (SR16)
Sulfide stress cracking test—C90 and T95 Grade	7.14
Length of accessories	8.6
Thread and storage compound	8.14
Special end-finish for tubing, couplings or accessories	8.12.8, 9.13.3
Waiving NDE of Group1 couplings in Grades H40, J55 and K55	9.14.3
Additional hardness testing—Grades M65 and L80	10.6.2
Additional hardness testing—C90 and T95 Grade	10.6.4
Hydrostatic pressure test for handling-tight make-up and pup-joints	10.12.2
Alternative hydrostatic test pressures	10.12.3
Non-destructive examination	10.15, A.1 (SR1), A.2 (SR2), A.4 (SR10) and A.5 (SR11)
Marking requirements	11.1
Thread protectors	12.2
Electric-weld tubing—Grade P110	A.5 (SR11)
Special end-finish tubing, couplings, pup-joints and accessories	8.12.8, 9.13.3
Quality assurance requirements	
Special wall thickness for Grades C90 and T95	8.2
Casing used for tubing	8.2, Table C.30 or Table E.30

6 Process of manufacture

6.1 General

The various grades and groups of pipe furnished to this International Standard shall be made to a fine-grain practice. Steel made to a fine-grain practice contains one or more grain-refining elements, such as aluminium, niobium (columbium), vanadium or titanium in amounts intended to result in the steel having a fine austenitic grain size.

Pipe furnished to this International Standard shall be made by the seamless or electric-weld process as shown in Table C.1 or Table E.1 and as specified on the purchase agreement. Pup-joints shall be made from standard casing or tubing or by machining thick-wall casing, tubing or bar stock. Couplings shall be manufactured by one of the processes listed in 9.3 or 9.4. Cold-drawn tubular products without appropriate heat treatment are not acceptable.

Casing and tubing accessories shall be seamless and made from standard casing or tubing, or by machining thick-wall casing, tubing or mechanical tubes, or bar stock or hot forgings.

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 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.4 or Table E.4 for the particular grade and type specified on the purchase agreement. Heat-treated upset pipe shall be heat-treated full length after upsetting. Product requiring heat treatment shall be heat-treated the full length. Individually heat-treated coupling blanks are acceptable. All pipe processed through a hot-stretch mill (i.e. stretch-reduced) shall be considered normalized, provided the exit temperature is above the upper critical temperature (Ar_3) for the steel being processed, and the pipe is air-cooled.

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

6.2.2 Group 1

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 (including the interrupted quenching followed by controlled cooling method) full length. Grade J55 and K55 casing and Grade J55 tubing shall be heat-treated if so specified on the purchase agreement.

6.2.3 Group 2

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, 7.4.5, 7.5.3 and 10.7, no further precautions are necessary.

NOTE In this International Standard when the symbol L80 is used alone it covers Grades L80 Type 1, L80 9Cr and L80 13Cr.

6.2.4 Groups 3 and 4

Product furnished to this International Standard shall be quenched and tempered.

6.3 Straightening

6.3.1 Groups 1 and 3

No specific methods are required.

6.3.2 Grades M65 and L80

Grades M65 and L80 shall not be subjected to cold working after the final heat treatment, except for that which is incidental to normal straightening operations. Grades M65 and L80 pipe rotary-straightened at temperatures less than 480°C (900°F) shall not contain roll marks that exceed the maximum hardness specified in Table C.6 or Table E.6; 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.6 or Table E.6 are acceptable without further evaluation.

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

6.3.3 Grade C95

Grade C95 pipe 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.

6.3.4 Grades C90 and T95

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

6.3.5 Grade Q125

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. Pipe 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 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 re-test in accordance with A.6.3 (SR12.3).

Each tube length of coupling, 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 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, pup-joint or accessory material in coupling blank or individual lengths is 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.

7 Material requirements

7.1 Chemical composition

Product shall conform to the requirements specified in Table C.5 or Table E.5 for the grade and type specified.

7.2 Tensile properties

7.2.1 General

Product shall conform to the tensile requirements specified in Table C.6 or Table E.6.

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

7.2.2 Elongation—All groups

The minimum elongation shall be that determined by the following equation:

$$e = k \cdot \frac{A^{0,2}}{U^{0,9}}$$

where

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

k is a constant: 1 944 (625 000);

A is the cross-sectional area of the tensile test specimen 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 with an area A of 130 mm^2 (0.20 in^2)

Table C.7 or Table E.7 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.6 or Table E.6 as determined by an extensometer.

7.3 Charpy V-notch test properties—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.

7.3.2 Critical thickness

The absorbed energy requirements are based on the critical thickness. The critical thickness for couplings with ISO/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 ISO/API threads is provided in Table C.8 or Table E.8. 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.

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.9 or Table E.9 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.9 or Table E.9 shall be used.

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

When the outside diameter or wall thickness precludes the machining of longitudinal impact test specimens 1/2-size or larger, the pipe need not be tested; however, the manufacturer shall use a chemical composition and processing that is documented and demonstrated to result in impact-energy absorption meeting or exceeding the minimum specified requirement.

7.3.4 Hierarchy of test specimens

The hierarchy of test specimen orientation and size is specified in Table C.10 or Table E.10.

7.3.5 Alternative size impact test specimens

At the manufacturer's option, impact test specimens of an alternative size, listed in Table C.9 or Table E.9, may be used in lieu of the minimum size specified in Tables C.11 through C.16, C.21, C.22 and Tables E.11 through E.16, E.21 and E.22. However, the alternative test specimen selected shall be higher on the hierarchy table (Table C.10 or Table E.10) 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 Charpy V-notch 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.9 or Table E.9; 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 groups except Group 1, 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.11 or Table E.11 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 (SR 12) shall apply.

7.3.9 Reference information

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

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

7.4.1 General

Coupling stock 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.10 or Table E.10 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.9 (SR16) for optional CVN requirements.

7.4.3 Grades J55 and K55 for ISO/API threads

The minimum full-size transverse absorbed energy requirement C_V is 20 J (15 ft·lb). The minimum full-size longitudinal absorbed energy requirement C_V is 27 J (20 ft·lb). The impact specimen orientation, minimum size, minimum absorbed energy requirement (that is, adjusted for the size of specimen indicated), and test temperature reduction (as applicable) for couplings are provided in Table C.11 or Table E.11.

7.4.4 Grade M65 for ISO/API threads

There are no Grade M65 couplings. Grade L80 Type 1 couplings shall be used on Grade M65 pipe.

7.4.5 Grades N80 Type 1 and N80Q, Groups 2 (except M65), 3 and 4 for ISO/API threads

7.4.5.1 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.12 to C.16 or Tables E.12 to E.16.

7.4.5.2 **For SI units**, the minimum absorbed energy requirements C_V for full-size test specimens are calculated based on the equations given in a) and b) below, where:

YS_{max} is the specified maximum yield strength, in megapascals, for the grade evaluated;

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

a) Transverse requirement

The minimum full-size transverse absorbed energy requirement, C_V, in joules, shall be as specified in Table C.17 for various critical wall thicknesses based on the following:

$C_V = YS_{max} \cdot (0{,}001\,18\ t + 0{,}012\,59)$ or 20 J, whichever is greater.

b) Longitudinal requirement

The minimum full-size absorbed energy requirement, C_V, in joules, shall be as specified in Table C.18 for various critical wall thicknesses based on the following:

$C_V = YS_{max} \cdot (0{,}002\,36\ t + 0{,}025\,18)$ or 41 J, whichever is greater.

7.4.5.3 For USC units, the minimum absorbed energy requirements, C_V, for full-size test specimens are calculated based on the equations given in a) and b) below, where:

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

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

c) Transverse requirement

The minimum full-size transverse C_V absorbed energy requirement, in foot-pounds, shall be as specified in Table E.17 for various critical wall thicknesses based on the following:

C_V (foot-pounds) = $YS_{max} \cdot (0.152\ t + 0.064)$ or 15 ft·lb, whichever is greater.

d) Longitudinal requirement

The minimum full-size absorbed energy requirement, C_V, in foot-pounds, shall be as specified in Table E.18 for various critical wall thicknesses based on the following:

C_V (foot-pounds) = $YS_{max} \cdot (0.304\ t + 0.128)$ or 30 ft.lb, whichever is greater.

7.4.6 Special end-finish

The critical thickness shall be as specified in 7.6.6. The absorbed energy requirements in 7.4.1 to 7.4.5 shall apply.

7.5 Charpy V-notch—Absorbed energy requirements for pipe

7.5.1 Grades H40, J55, K55 and N80 Type 1

There is no mandatory CVN impact requirement.

NOTE See A.9 (SR16) for optional CVN impact energy requirements.

7.5.2 Grade M65

The minimum full-size transverse absorbed energy requirement shall be 20 J (15 ft·lb). The minimum full-size longitudinal absorbed energy requirement shall be 41 J (30 ft·lb).

7.5.3 Grades N80Q, L80, C90, C95, T95 and P110

7.5.3.1 The minimum absorbed energy requirement for full-size test specimens for pipe is provided in Tables C.19 and C.20 or Tables E.19 and E.20.

7.5.3.2 **For SI units,** the requirements are calculated based on the equations given in a) and b) below, where:

YS_{min} is the specified minimum yield strength, in megapascals;

t is the specified wall thickness, in millimetres.

a) Transverse requirement:

C_V (joules) = $YS_{min} \cdot (0{,}001\ 18\ t + 0{,}012\ 59)$ or 20 J, whichever is greater, for Grade P110
or 14 J, whichever is greater, for other grades

b) Longitudinal requirement:

C_V (joules) = $YS_{min} \cdot (0{,}002\ 36\ t + 0{,}025\ 18)$ or 41 J, whichever is greater, for Grade P110
or 27 J, whichever is greater, for other grades

7.5.3.3 **For USC units** the requirements are calculated based on the equations given in a) and b) below, where:

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

t is the specified wall thickness, in inches

a) Transverse requirement:

C_V (foot-pounds) = $YS_{min} \cdot (0.152\ t + 0.064)$ or 15 ft·lb, whichever is greater, for Grade P110
or 10 ft·lb, whichever is greater, for other grades

b) Longitudinal requirement:

C_V (foot-pounds) = $YS_{min} \cdot (0.304\ t + 0.128)$ or 30 ft·lb, whichever is greater, for Grade P110
or 20 ft·lb, whichever is greater, for other grades

7.5.4 Grade Q125

7.5.4.1 The minimum absorbed energy requirement for full-size test specimens for pipe is provided in Tables C.19 and C.20 or Tables E.19 and E.20.

7.5.4.2 **For SI units,** the requirements are calculated based on the equations given in a) and b) below, where:

YS_{max} is the specified maximum yield strength, in megapascals (1 034 MPa);

t is the specified wall thickness, in millimetres.

a) Transverse requirement:

$C_V = YS_{max} \cdot (0{,}001\ 18\ t + 0{,}012\ 59)$ or 20 J whichever is greater

b) Longitudinal requirement:
$C_V = YS_{max} \cdot 0{,}002\,36\ t + 0{,}025\,18)$ or 41 J whichever is greater

7.5.4.3 For USC units, the requirements are calculated in based on the equations given in a) and b) below, where:

YS_{max} is the specified maximum yield strength, in thousand pounds per square inch (125 ksi);

t is the specified wall thickness, in inches.

a) Transverse requirement:
C_V (foot-pounds) $= YS_{max} \cdot (0.152\ t + 0.064)$ or 15 ft·lb, whichever is greater

b) Longitudinal requirement:
C_V (foot-pounds) $= YS_{max} \cdot (0.304\ t + 0.128)$ or 30 ft·lb, whichever is greater

7.5.5 Test specimen

Table C.21 or Table E.21 for transverse specimens and Table C.22 or Table E.22 for longitudinal specimens provide the calculated wall thickness required to machine full-size, 3/4-size, and 1/2-size impact test specimens. The impact test specimen size that shall be selected from these tables is the largest impact test specimen having a calculated wall thickness that is less than the specified wall thickness for the pipe tested.

7.5.6 Testing conditions

For Grade M65 and Grade Q125 pipe, impact testing in accordance with 10.7 is mandatory. For all other grades except Grades H40, J55, K55 and N80 Type 1 (which have no mandatory impact requirements for pipe) compliance with the requirements of 7.5.3 may be qualified by a documented procedure in lieu of testing, at the manufacturer's option, unless A.9 (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.

7.6 Charpy V-notch test—Absorbed energy requirements for casing and tubing accessories

7.6.1 Accessories—General

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

7.6.2 Accessories with internal ISO/API threads except integral joint tubing connections and extreme-line casing connections

The requirements in 7.4.1 to 7.4.5 apply.

7.6.3 Accessories with internal special end finish tapered interference-type threads

The requirements in 7.4.6 apply.

7.6.4 Accessories with external threads

The requirements in 7.5 apply.

7.6.5 Accessories with both integral joint tubing connections and extreme line casing connections, and also internal special end finish connections that do not have thread interference

By agreement between the manufacturer and purchaser, the provisions of A.9 (SR16) shall apply.

7.6.6 Critical thickness for accessory material

If not specified on the purchase agreement, 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.

For an accessory with ISO/API internal threads, the critical thickness for these ISO/API threads is shown in Table C.8 or Table E.8, and D is the specified outside diameter of the connection as specified in 9.6 and 9.8.

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

7.7 Hardness maxima

7.7.1 Group 2—Casing, tubing, couplings, pup-joints and accessories

a) Grades M65 and L80 all types

For each tensile specimen required, a hardness specimen (ring or block) shall be removed from the product from the location shown in Figure D.10 and described in the notes of the figure. The hardness survey specimen shall be prepared and tested in accordance with the requirements of 10.6. The hardness values obtained shall comply with the requirements given in Table C.6 or Table E.6.

b) Grades C90 and T95

Any hardness value (see Figure D.11) not exceeding 25,4 HRC is acceptable. If any hardness reading exceeds 27,0 HRC, the piece shall be rejected. Hardness values falling between these limits require re-test. Hardness tests shall be taken on each ring or blocks in accordance with Figure D.11 to provide three hardness values in one quadrant for non-upset pipe and in each of four quadrants for upset pipe.

7.7.2 Grade Q125—Casing, couplings, pup-joints and accessories

There are no upper or lower hardness limits for these products.

7.8 Hardness variation—Grades C90, T95 and Q125

Material shall conform to the hardness variation requirements of Table C.6 or Table E.6, where hardness variation is defined as the difference between any two hardness values within one quadrant. This criterion shall not apply between specimens.

7.9 Process control—Grades C90, T95 and Q125

All individually heat-treated coupling blanks, pup-joints or accessories shall be surface hardness-tested to verify process control. For grades C90 and T95, the hardness test results shall be used in the selection of the pieces for through-wall hardness testing (see 10.6.5). The hardness 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 Grades C90 and T95

A full body as-quenched sample shall be taken to characterize the hardening response for a particular size, mass, chemistry and austenitize-and-quench combination. Hardness values shall equal or exceed the hardness corresponding to 90% minimum martensite as determined by the following equation:

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

NOTE The above equation was derived from data in [2]. Based on these data, the above equation is valid from 0,15% carbon to 0,50% carbon.

7.10.2 All grades except Grades C90 and T95

A full body as-quenched sample shall be taken as part of a documented procedure to confirm sufficient hardening for each size, mass, chemistry and austenitize-and-quench combination. To be in compliance with this International Standard, hardness values (see 10.6.8) taken during the documentation procedure shall equal or exceed the hardness corresponding to 50% minimum martensite as determined by the following equation:

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

7.11 Grain size—Grades C90 and T95

Prior austenitic grain size shall be ASTM 5 or finer (determined in accordance with ISO 643 or ASTM E112).

7.12 Surface condition—Grades L80 9Cr and L80 13Cr

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

7.13 Flattening—Electric-welded pipe

All products that are produced by the electric-weld process of manufacture shall comply with the flattening requirements shown in Table C.23 or Table E.23.

7.14 Sulfide stress corrosion cracking (SSCC) test—Grades C90 and T95

7.14.1 Test and re-test requirements

For each heat, manufacturers shall demonstrate that the product meets or exceeds the minimum SSCC threshold using one of the ANSI-NACE TM0177-96 test methods given below. If the purchaser requires an SSCC threshold higher than the minimum, or requires a specific test method from the list below, agreement shall be reached between purchaser and manufacturer. For Methods A and D, sub-size or alternative specimens shall only be used following agreement with the purchaser. When Method D sub-size or alternative specimens are required, acceptance criteria shall be agreed between the purchaser and manufacturer.

The details of a manufacturer's qualification, frequency of sulfide stress cracking testing, re-test procedures and testing practices should be addressed by the purchaser and the manufacturer prior to placing or accepting a purchase order.

7.14.2 Minimum SSCC threshold values

a) ANSI-NACE TM0177-96 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
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

b) ANSI-NACE TM0177-96 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.

c) ANSI-NACE TM0177-96 Method D, DCB

Mean value of 33,0 MPa·m$^{1/2}$ (30.0 ksi$\sqrt{in}$) with a minimum of at least three valid test specimens for Grades C 90 and T95. All valid test results shall be included when calculating the mean value.

A standard test specimen thickness of 9,53 mm (0.375 in) shall be used.

No valid test specimen shall have a value less than 30,0 MPa·m$^{1/2}$ (27.0 ksi$\sqrt{in}$).

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$\sqrt{in}$).

The arm displacement shall be 0,70 mm to 0,80 mm (0.028 in to 0.032 in).

7.14.3 Test temperature

The test solution shall be maintained at 24°C ± 3°C (75°F ± 5°F).

7.14.4 Test solution

For the purposes of this International Standard, ANSI-NACE TM0177-96 Test Solution A shall be used. To prevent conflict arising from future revisions, the properties of the test solution shall be:

a) for Test Methods A and D:

— The test solution shall have a pH in the range 2,6 to 2,8 before contacting the test specimen.

— The test solution shall have 5,0% mass fraction sodium chloride and 0,5% mass fraction glacial acetic acid dissolved in distilled or de-ionized water.

— The test solution shall be saturated with hydrogen sulfide (H_2S) as described in ANSI-NACE TM0177-96.

b) for Test Method B:

— The test solution shall have a pH in the range 2,6 to 2,8 before contacting the test specimen.

— The test solution shall have 0,5% mass fraction glacial acetic acid dissolved in distilled or de-ionized water.

— The test solution shall be saturated with H_2S as described in ANSI-NACE TM0177-96.

8 Dimensions, masses, tolerances, pipe ends and defects

8.1 Labels and sizes

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

8.2 Dimensions and masses

Pipe shall be furnished in the sizes, wall thicknesses and masses (as shown in Tables C.24 to C.29 inclusive or Tables E.24 to E.29 inclusive) as specified on the purchase agreement except Grades C90, T95 and Q125 which may be furnished in other sizes, masses and wall thickness as agreed between purchaser and manufacturer. 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.24, C.30 and C.31 or Tables E.1, E.24, E.30 and E.31.

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 legibility of markings and general wear of fixed reference points. The adjustable and non-adjustable designations of measuring devices utilized by the manufacturer shall be documented.

The verification procedure for working ring-and-plug thread gauges shall be documented. The accuracy of all weighing devices shall be verified at periods not to exceed those required by the manufacturer's documented procedure in accordance with National Institute of Standards and Technology (NIST) standards or equivalent regulations in the country of manufacture of products made to this International Standard.

If measuring equipment whose calibration or verification is required under the provisions of this International Standard 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 International Standard two decimal places are used for design purposes to ensure interchangeability.

b) Using USC units

The diameter shall be rounded to three decimal places.

8.3.2 Requirements

The outside diameter shall be within the tolerances specified in 8.11.1. For threaded pipe, the outside diameter at the threaded ends shall be such that the thread length, L_4, and the full-crest thread length, L_C, are within the tolerances and dimensions specified in ISO 10422 or API Spec 5B. 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.

8.4 Wall thickness

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

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 the end finish specified on the purchase agreement, within the tolerances stipulated in 8.11.3. Calculated masses shall be determined in accordance with the following formula:

$$m_L = (m_{\text{pe}} \cdot L) + e_m$$

where

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

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

L is the length of pipe, including end-finish in metres (feet), as defined in 8.6;

e_m is the mass gain or loss due to end-finishing, in kilograms (pounds). For plain-end non-upset pipe, $e_m = 0$.

NOTE The densities of martensitic chromium steels (L80 Types 9Cr and 13Cr) are less than those of carbon steels. The masses shown are therefore not accurate for martensitic chromium steels. A mass correction factor of 0,989 may be used.

8.6 Length

Casing, tubing, plain end liners, and pup-joints shall be furnished in lengths conforming to Table C.30 or Table E.30. The length of accessories, except couplings, shall be as agreed between purchaser and manufacturer.

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

8.8.2 Groups 1 and 2

The height of the inside weld flash shall not exceed 1,14 mm (0.045 in) for casing or 0,38 mm (0.015 in) for tubing, 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 below for the various wall thicknesses. Depth of groove is the difference between the wall thickness measured approximately 25 mm (1 in) from the weld line and the remaining wall under the groove.

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)	0,05t

8.8.3 Groups 3 and 4

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.

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

Deviation from straight, or chord height, shall not exceed either of 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 1,83 m (6.0 ft) length at each end. See Figures D.14 and D.15.

8.10 Drift requirements

Each length of casing and tubing either finished or unfinished shall be drift tested throughout its entire length (see Table C.31 or Table E.31). Casing and tubing 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.

Casing sizes larger than Label 1: 4-1/2 but smaller than Label 1: 10-3/4 specified by the purchaser to be used in tubing service shall be drift tested with drift mandrels as indicated hereafter and marked as specified in clause 11.

NOTE See ISO 10400 or API Bul 5C3 for the joint strength of casing used in tubing service.

Label 1	Mandrel length	Mandrel diameter
> 4-1/2 to ≤ 8-5/8	1 067 mm (42.0 in)	d – 3,18 mm (d – 1/8 in)
> 8-5/8 to < 10-3/4	1 067 mm (42.0 in)	d – 3,97 mm (d – 5/32 in)

When specified by the purchaser as "alternative drift casing", casing in the sizes and masses in Table C.32 or Table E.32 shall be tested with the alternative drift mandrels as shown. Pipe which is drifted with the alternative drift mandrels shall be marked as described in clause 11.

8.11 Tolerances on dimensions and masses

8.11.1 Outside diameter, D

The following tolerances apply to the outside diameter, D, of pipe:

Label 1	Tolerance on outside diameter, D
< 4-1/2	± 0,79 mm (± 0.031 in)
≥ 4-1/2	+ 1% D to – 0,5% D

For upset pipe, the following tolerances 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.

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

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

The measurements shall be made with snap gauges or callipers. Changes in diameter between L_a and L_b shall be smooth and gradual. Pipe body OD tolerances do not apply for a distance of L_b from the end of the pipe.

Label 1	Tolerances
≥ 2-3/8 to ≤ 3-1/2	+ 2,38 mm to – 0,79 mm (+ 3/32 in to – 1/32 in)
> 3-1/2 to ≤ 4	+ 2,78 mm to – 0,79 mm (+ 7/64 in to – 1/32 in)
> 4	+ 2,78 mm to – 0,75% D (+ 7/64 in to – 0.75% D)

8.11.2 Wall thickness, t

Tolerance – 12,5%

8.11.3 Mass

Amount	Tolerance
Single lengths	+ 6,5% to – 3,5%
Carload 18 144 kg (40 000 lb) or more	– 1,75%
Carload less than 18 144 kg (40 000 lb)	– 3,5%
Order items 18 144 kg (40 000 lb) or more	– 1,75%
Order items less than 18 144 kg (40 000 lb)	– 3,5%

8.11.4 Inside diameter, d

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.26, C.27 and C.28 or Tables E.26, E.27 and E.28.

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 joints (both ends) shall meet the L_{el} with the remaining balance meeting L_{eu} requirements, unless otherwise agreed between purchaser and manufacturer.

8.12 Pipe ends

8.12.1 Unfinished pipe

Unfinished pipe is pipe furnished unthreaded, either upset or non-upset, but in compliance with all requirements of this International Standard for a particular grade, and shall be identified by the UF symbol in addition to the other marking requirements. See 11.5.2.

8.12.2 Casing with ISO/API threads

Unless otherwise stated on the purchase agreement, casing shall be furnished threaded and coupled, 8-round long or short thread as applicable. If specified on the purchase agreement, casing and casing accessories shall be furnished with one of the following end finishes:

— 8-round thread without coupling;

— Buttress thread with coupling;

— Buttress thread without coupling;

— Extreme-line thread.

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

If long-thread Grade H40, J55 or K55 casing in accordance with Table C.24 or Table E.24 is desired, the purchaser shall so specify on the purchase agreement. Otherwise short-thread casing in accordance with Table C.24 or Table E.24 shall be furnished.

Liners shall be furnished with square-cut plain ends, with all burrs removed from both inside and outside edges.

8.12.3 Tubing with ISO/API threads

Unless otherwise stated on the purchase agreement, tubing shall be threaded and coupled. If specified on the purchase agreement, tubing and tubing accessories shall be furnished with any of the following end finishes:

— threaded ends without coupling;

— integral joint.

Additionally, seal ring configuration according to A.7 (SR13) may be ordered.

8.12.4 Rounded nose

In lieu of the conventional corner breaks on the threaded ends of 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 ID or OD 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.

8.12.5 Pup-joints and accessories

Pup-joints and accessories shall be furnished with threaded ends without couplings unless otherwise specified.

8.12.6 Threading

Pipe threads, gauging practice and thread inspection shall conform to the requirements of ISO 10422 or API Spec 5B. Pipe ends shall not be rounded out by hammering to secure conformance with threading requirements.

8.12.7 Workmanship of ends

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

8.12.8 Special end finish

Pipe with end finish not specified in this International Standard 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 International Standard and shall be marked with the symbol "SF" as specified in 11.5.2.

Completed couplings and completed accessories with end finish not specified in this International Standard may be furnished if so specified in the purchase agreement. These items shall be manufactured in accordance with the requirements of this International Standard, except for end finish and dimensions, and shall be marked with the symbol "SF" as specified in 11.5.2.

8.13 Defects

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

a) any quench crack;

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

c) when NDE (except visual) is specified by this International Standard [see 10.15, A.1 (SR1) and clause 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);

d) 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;

e) any linear imperfection on the outside or inside surface, of any orientation, with a depth greater than tabulated in Table C.33 or Table E.33;

f) any surface breaking pipe upset imperfection, of any orientation, with a depth greater than tabulated in Table C.34 or Table E.34;

g) 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.

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 Groups 1, 2 and 3

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 joint. 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 color may be substituted for this thread compound on all exposed threads. The compound shall be applied to a surface that is clean and reasonably free of moisture and cutting fluids.

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

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

8.14.2 Group 4

All requirements for Group 4 are the same as that shown in 8.14.1, except that ISO 10422 or API Spec 5B casing couplings shall be shipped separately unless power-tight make-up is specified on the purchase agreement.

9 Couplings

9.1 General requirements

Couplings for pipe conforming to this International Standard shall be seamless, be of the same grade and type as the pipe and be given the same heat treatment as the pipe except as provided in 9.2 and 9.3.

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 EUE tubing shall be furnished with L80 Type 1 special clearance couplings when specified on the purchase agreement.

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

9.2.6 Grade M65 products shall be furnished with L80 couplings.

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

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

9.2.9 Grade N80 EUE tubing shall be furnished with P110 special clearance couplings when specified on the purchase agreement.

9.2.10 Grade N80 buttress casing shall be furnished with P110 couplings when specified on the purchase agreement.

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

9.3 Process of manufacture—Groups 1, 2 and 3

9.3.1 Seamless pipe and hot forging

Couplings made from seamless pipe as defined in 4.1 or hot forgings shall be heat-treated as required in 6.2.

9.3.2 Sub-critical forging

Grade J55 and K55 couplings made by sub-critical forging shall be stress-relieved or, at the option of the manufacturer, normalized or normalized and tempered. Grade N80 Type 1 couplings shall be normalized and tempered or, at the option of the manufacturer, quenched and tempered. For Groups 2 and 3 couplings shall be heat-treated as specified in 6.2 for the particular grade and type.

9.3.3 Centrifugal casting

Couplings made by centrifugal casting shall be cast in a rotating mould, shall be given a homogenizing heat treatment (as specified in ASTM A941) prior to the final treatment, and shall be fully machined on all surfaces. All grades of centrifugal cast couplings shall be either normalized and tempered or quenched and tempered at the option of the manufacturer.

9.4 Process of manufacture—Grade Q125

Grade Q125 couplings shall be made from seamless coupling stock using the same requirements and quality control provisions as Grade Q125 casing manufactured to this International Standard (see clauses 6 and 7). Couplings and coupling blanks shall be cut from coupling stock. See A.3 (SR9) for optional requirements for coupling blanks.

9.5 Mechanical properties

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

9.6 Dimensions and tolerances

9.6.1 Groups 1, 2 and 3

Couplings shall conform to the dimensions and tolerances shown in Tables C.35 to C.38 or Tables E.35 to E.38. Unless otherwise specified on the purchase agreement, threaded and coupled casing and tubing shall be furnished with regular couplings.

9.6.2 Group 4

Couplings may be machined on the complete outside surface in addition to the inside surface. Dimensions shall be as specified on the purchase agreement unless standard ISO/API couplings are ordered, in which case the dimension shall be as shown in Tables C.35 and C.36 or Tables E.35 and E.36.

The purchaser should recognize that ISO/API threaded couplings with the regular outside diameter may not have a leak resistance as high as the internal yield pressure rating of the pipe body, due to inadequate bearing pressure between the coupling and pin.

9.7 Regular couplings

Regular couplings have diameters (W) as shown in Tables C.35 to C.38 or Tables E.35 to E.38. The inside and outside edges of the bearing face shall be rounded or broken, but shall not materially reduce the width of the bearing face (dimension b) so that enough thickness is left to safely support the mass of the pipe on the elevator. The ends of couplings shall be faced true at right angles to the axis.

9.8 Special-clearance couplings—Groups 1, 2 and 3

Special clearance (reduced outside diameter W_c) couplings for buttress casing and external upset tubing shall be furnished when specified in the purchase agreement. Special-clearance couplings shall conform to the dimensions (except b) and tolerances given in Tables C.36 and C.38 or Tables E.36 and E.38. See clause 11 for marking and color identification. Unless otherwise specified, special-clearance tubing couplings shall be bevelled on both ends.

9.9 Combination couplings

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

9.10 Reducing couplings

9.10.1 Groups 1, 2 and 3

Reducing couplings are used to connect two pipes of different diameter with the same or different types of thread on the two ends, and shall be furnished when specified on the purchase agreement. The minimum length and minimum diameter of reducing coupling shall be sufficient to accommodate the specified size and type of threads.

9.10.2 Grade Q125

Reducing couplings are not allowed.

9.11 Seal-ring couplings

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

9.12 Special-bevel couplings—Groups 1, 2 and 3

Special-bevel couplings conforming to the requirements of Tables C.37 and C.38 or Table E.37 and E.38 shall be furnished for non-upset and external-upset tubing when specified on the purchase agreement. Unless otherwise specified, special-bevel couplings shall be bevelled 20° on both ends.

9.13 Threading

9.13.1 General requirements

Coupling threads, gauging practice, and thread inspection shall conform to the requirements of ISO 10422 or API Spec 5B. Couplings shall not be expanded to provide the required taper for threads for couplings with ISO/API threads.

9.13.2 Casing couplings—All groups

Casing couplings shall be furnished with one of the following end finishes, as specified on the purchase agreement:

a) long or short 8-round thread;

b) buttress—regular, special bevel or special clearance;

c) seal ring configuration A.7 (SR13);

d) special end-finish.

9.13.3 Tubing couplings—Groups 1, 2, and 3

Tubing couplings shall be furnished with one of the following end finishes as specified on the purchase agreement:

a) 8- or 10-round thread for upset tubing—regular, special bevel, or special clearance;

b) 8- or 10-round thread for non-upset tubing—regular or special bevel;

c) seal ring configuration A.7 (SR13);

d) special end finish.

9.14 Surface inspection

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

9.14.2 All couplings shall be inspected on the outside and inside surfaces after finish machining and before any inside or outside surface plating, using the wet fluorescent magnetic particle method in accordance with ISO 13665 or ASTM E709 with a circumferentially oriented magnetic field for the detection of longitudinal surface imperfections, or by other non-destructive method of equal sensitivity as demonstrated to the purchaser. Records according to 10.15.4 shall be maintained.

9.14.3 By agreement between purchaser and manufacturer, NDE of Grades H40, J55 and K55 couplings may be waived. However, in this case, the couplings shall be inspected visually on the outside and inside surfaces after finish machining and before plating and shall be free from all visible seams, cracks and porosity. See Table C.67 or Table E.67 for marking requirements.

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

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

9.14.5 All finished couplings shall be free of imperfections, with the exception of those external imperfections given in Table C.39 or Table E.39 which are disclosed by inspection in accordance with 9.14.2 or 9.14.3.

9.14.6 All imperfections of any depth, revealed during inspection at the manufacturing facility, except as allowed in Table C.39 or Table E.39, shall be removed. For Grades J55 and K55 coupling material that is impact-tested at or below 0°C (32°F) that demonstrates a shear area greater than 80% and exceeds the minimum absorbed energy requirements, and Grade N80 and Groups 2, 3 and 4 coupling material shall not be rejected for imperfections less than 5% of the critical wall thickness if detected on subsequent re-inspection outside the manufacturer's facility. The critical thickness is defined in 7.3.2.

9.15 Measurement of imperfections

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

9.16 Repair and removal of imperfections and defects

Repair welding is not permitted. Non-permissible imperfections defined in 9.14.5 shall be removed. Permissible imperfections, see Table C.39 or Table E.39, may be removed or reduced by machining or grinding on the outer surface, provided the outside diameter of the finished coupling is within the tolerances when measured at the point from where the defect was removed, or the coupling shall be rejected. The machining or grinding shall be approximately blended into the outer contour of the coupling.

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

9.17 Thread surface treatment—Grade Q125

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

9.18 Couplings and coupling blank protection—Grade Q125

All loose couplings and all coupling blanks that have been machined to their final outside diameter shall be boxed to prevent contact with one another during shipment. All other coupling blanks shall be boxed to prevent nicks and gouges that will not be removed by subsequent machining. Boxes shall be manufactured from wood and designed to be easily handled by forklift. Boxes shall be limited to 1,22 m (4.0 ft) in width to facilitate truck transport.

10 Inspection and testing

10.1 Test equipment

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

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

10.2 Lot definition for testing of mechanical properties

10.2.1 Groups 1, 2 (Grades M65, L80 Type 1, and C95 only) and 3—Pipe except pup-joints heat-treated after cutting to blank or individual length

For the purposes of testing the mechanical properties of the above pipe, a lot is defined as all those lengths of pipe with the same specified dimension and grade which are either as rolled or heat-treated as part of the continuous operation (or batch), and are from a single heat of steel; or from different heats that are grouped according to a documented procedure which will ensure that the appropriate requirements of this International Standard are met.

10.2.2 Grades L80 9Cr, L80 13Cr, C90, T95 and Q125—Pipe except pup-joints heat-treated after cutting to blank or individual length

For the purposes of testing the mechanical properties of the above pipe, a lot is defined as all those lengths of pipe with the same specified dimensions and grade from the same heat of steel which are heat-treated as part of a continuous operation (or batch).

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

For the purposes of testing the mechanical properties, a lot of coupling blanks, pup-joints or accessories heat-treated after cutting to blank or individual lengths is defined as that group of pieces with the same specified dimensions and grade from the same heat of steel which has been

a) batch heat-treated concurrently in the same heat treating furnace unit or

b) heat-treated in sequential loads to the same cycle without interruption in an integral quench furnace unit equipped with a recording controller to provide documentation of heat treating control through the run or

c) individually heat-treated as a unit in a continuous process run within eight hours or less of continuous operation.

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

10.3 Testing of chemical composition

10.3.1 Couplings, pup-joints and accessories

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

10.3.2 Heat analyses

For Groups 1, 2 and 3, when requested by the purchaser, the manufacturer shall furnish a report giving the heat analysis of each heat of steel used in the manufacture of pipe and couplings furnished on the purchase agreement. In addition the purchaser, upon request, shall be furnished the results of quantitative analyses of other elements used by the manufacturer to control mechanical properties.

For Grade Q125, the manufacturer shall furnish a report giving the heat analysis of each heat of steel used in the manufacture of pipe and couplings furnished on the purchase agreement. The report shall include quantitative analyses of other elements used by the manufacturer to control mechanical properties.

10.3.3 Product analyses

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

Product analyses shall include the results of quantitative determinations of all elements listed in Table C.5 or Table E.5 plus any other elements used by the manufacturer to control mechanical properties.

For Groups 1, 2 and 3, the product analyses shall be available to the purchaser on request.

For Group 4, the product analyses shall be provided to the purchaser.

10.3.4 Test method

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

10.3.5 Re-check of product analyses—All groups

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

10.4 Tensile tests

10.4.1 Stress-relief temperature

For the purpose of tensile test frequency, stress-relief of tempered products shall not be considered "heat treatment" provided the stress-relief temperature is at least 56°C (100°F) below the final tempering temperature.

10.4.2 Heat-control tensile tests—Groups 1, 2 and 3

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

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

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

The frequency of testing for casing and tubing of all groups is defined in Table C.40 or Table E.40.

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

10.4.4 Frequency of testing and test specimen location—Couplings, pup-joints and accessories

The frequency of testing is defined for couplings in Table C.41 or Table E.41 and for pup-joints and accessories in Table C.42 or Table E.42.

For Group 1, Group 2 (except Grades C90 and T95) and Group 3, the test specimens from bar stock shall be taken from a location corresponding to the mid-wall of the finished products for accessories.

For Group 2 (Grades C90 and T95) and Group 4, tensile test specimens for coupling, pup-joint or accessory material heat-treated in tube length shall be removed from locations shown in Figure D.10.

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

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

10.4.5 Test specimens—General

Pipe-body tensile test specimens shall be either full-section specimens, strip specimens or round bar specimens, as shown in Figure D.9, at the option of the manufacturer. Strip specimens from seamless pipe shall be taken from any location about the pipe circumference at the option of the manufacturer. Round bar specimens shall be taken from the mid-wall. Strip specimens and round bar specimens from welded pipe shall be taken approximately 90° from the weld, or, at the option of the manufacturer, from the skelp parallel to the direction of rolling and approximately midway between the edge and the centre. Tensile test specimens for heat-treated pipe shall be removed from pipe subsequent to final heat treatment on the production line.

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

All pipe-body tensile specimens shall represent the full wall thickness of the pipe from which the specimen was cut, except for round bar tensile specimens, and shall be tested without flattening. When round bar specimens are used, the 12,7 mm (0.500 in) diameter round bar specimens shall be used when the pipe size allows, and the 8,9 mm (0.350 in) diameter round bar specimen shall be used for other sizes. For pipe sizes too small to allow a 8,9 mm (0.350 in) specimen, round bar tensile specimens are not permitted.

When elongation is recorded or reported, the record or report shall show the nominal width of the test specimen when strip specimens are used, the diameter and gauge length when round bar specimens are used or shall state when full section specimens are used.

10.4.6 Test specimens—Additional requirements for couplings, pup-joints and accessories—Grade Q125

In addition to the requirements in 10.4.5, longitudinal tensile test specimens shall be removed from coupling, pup-joint or accessory material and individually heat-treated coupling blanks, pup-joints or accessories subsequent to final heat treatment. Tensile test specimens shall be either strip specimens or, if the wall thickness of the tubular is over 19,1 mm (0.750 in), a round specimen 12,7 mm (0.500 in) in diameter may be used as shown in Figure D.9.

Round specimens may be used for coupling stock at the option of the manufacturer. Tensile test specimens for coupling, pup-joint or accessory material heat-treated in coupling blank or individual lengths shall be removed from the piece as illustrated in Figure D.10. Reduced-section strip specimens may be used by agreement between purchaser and manufacturer.

10.4.7 Test method

Tensile properties shall be determined by tests on longitudinal specimens conforming to the requirements of 10.4.5, ISO 6892 or ASTM A370, and 10.4.6 for the Q125 products covered therein. Tensile tests shall be made with the specimens at room temperature. The strain rate during tensile testing shall be in accordance with the requirements of ISO 6892 or ASTM A370.

Tensile test machines shall have been calibrated within the 15 months preceding any test in accordance with the procedures of ISO 7500-1 or ASTM E4. Extensometers shall be calibrated within 15 months preceding any test in accordance with the procedures of ASTM E83. Records retention shall be in accordance with 13.5.

10.4.8 Invalidation of tests

If any tensile specimen shows defective machining or develops flaws, it may be discarded and another specimen substituted. When the elongation of any tensile specimen is less than that specified, if any part of the fracture is outside the middle third of the gauge length as indicated by scribe scratches on the specimen before testing, a re-test shall be allowed.

10.4.9 Re-tests—All products except couplings, coupling stock, pup-joints or accessory materials in Grades C90, T95 and Q125

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

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

If more than one of the original test specimens fails or one or more of the re-test specimens fails to conform to the specified requirements, the manufacturer may elect to test each of the remaining lengths in the lot. Specimens for re-tests shall be taken in the same manner as specified in 10.4.5 and 10.4.6. For Grades M65, L80 and C95 the tensile re-test specimens shall be taken from the same end as the original test specimen.

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

10.4.10 Re-tests—Couplings, coupling stock, pup-joints or accessory materials in Grades C90, T95 and Q125

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

For material heat-treated in coupling blank or individual product lengths, if a tensile specimen fails to conform to the specified requirements, the manufacturer shall either re-heat treat that lot in question or make three additional tests from the lot in question. If one or more of them fails, the lot shall be rejected. The manufacturer may elect to re-heat treat and re-test the lot.

10.5 Flattening test

10.5.1 General requirement for testing

Flattening tests shall be made for all welded pipe with D/t ratios as shown in Table C.23 or Table E.23.

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

10.5.2 Frequency of testing

The frequency of testing shall be in accordance with Table C.43 or Table E.43.

10.5.3 Test specimens

Test specimens shall be rings or crop ends not less than 63,5 mm (2-1/2 in) long.

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

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

For electric-welded pipe that is full-body normalized, including pipe that is processed through a hot-stretch mill in accordance with the requirements in 6.2.1, flattening test specimens shall be obtained either prior to or after such treatment at the option of the manufacturer.

10.5.4 Test method for Group 1—Non-full-body heat-treated pipe

Test specimens shall be flattened between parallel plates. From each pair of flattening test specimens, one shall be flattened with the weld located in the 90° position and the other with the weld located in the 0° position. Test specimens shall be flattened until opposite walls of the pipe meet. No cracks or breaks shall occur anywhere in the specimen until the distance between the plates is less than that specified in Table C.23 or Table E.23; nor shall evidence of poor texture, incomplete fusion in the weld, laminations, burnt metal or extruded metal develop during the entire flattening process.

10.5.5 Test method for Groups 1 and 2—Full-body heat-treated pipe

Test specimens shall be flattened between parallel plates with the weld at the point of maximum bending; and, at the discretion of the inspector, separate flattening tests shall also be made with the weld located 90° from the point of maximum bending. Test specimens shall be flattened until opposite walls of the pipe meet. No cracks or breaks shall occur anywhere in the specimen until the distance between the plates is less than that specified in Table C.23 or Table E.23; nor shall evidence of poor texture, incomplete fusion in the weld, laminations, burnt metal or extruded metal develop during the entire flattening process.

10.5.6 Test method for Grade P110 pipe and Grade Q125 casing

The supplementary requirements in A.5 (SR11) shall apply.

10.5.7 Re-tests

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

10.6 Hardness test

10.6.1 Sampling—Heat control tests —Grades M65 and L80

Each heat control tensile test specimen shall be hardness-tested to verify conformance to hardness requirements.

10.6.2 Sampling and test specimen location—Grades M65 and L80

On pipe, coupling stock and accessory material, hardness testing shall be carried out at the same frequency as tensile testing for each of these products. Additional hardness testing of the outside surface and through-wall hardness testing of upsets may be carried out as agreed between purchaser and manufacturer. Test procedures for this additional testing shall be as agreed between purchaser and manufacturer.

10.6.3 Sampling and test specimen location—Non-upset pipe—Grades C90 and T95

A test ring shall be cut from one end of each pipe. Approximately 50% of these test rings shall be cut from the front end and approximately 50% from the back end of the pipe. HRC impressions shall be made in one quadrant of each ring as shown in Figure D.11.

10.6.4 Sampling and test specimen location—Upset pipe—Grades C90 and T95

The pipe body of each length tensile-tested as required by 10.4.3 shall also be hardness-tested in all four quadrants to verify conformance to the requirements.

The test frequency of the upset shall be one in every 20 lengths within each lot. One ring shall be cut from the section of the upset with the maximum wall thickness. Hardness impressions shall be taken on each ring in accordance with Figure D.11 to provide three hardness values per quadrant in each of four quadrants.

In addition to the through-wall (transverse) hardness tests, an external-surface Brinell or Rockwell C-scale test shall be made on the pipe body and the upset of each length. If the Brinell or Rockwell C-scale reading does not exceed 255 HBW (HBS) or 25,4 HRC respectively, the length is acceptable. If any of the readings are over 255 HBW (HBS) or 25,4 HRC, two additional tests may be made in the immediate area. If either of the second tests exceeds 255 HBW (HBS) or 25,4 HRC, the length shall be rejected.

By agreement between purchaser and manufacturer, hardness test frequencies greater than those required above may be specified.

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

10.6.5 Sampling—Couplings, pup-joints and accessories—Grades C90 and T95

For thick-wall pipe used for making more than one coupling, pup-joint or accessory, two test rings, one from each end, shall be taken from each length.

For couplings, pup-joints and accessories heat-treated using method a) or b), as specified in 10.2.3, the piece having the highest surface hardness based on the process control tests required in 7.9 shall be selected for testing. For couplings, the hardness-test ring shall be removed from either the mid-length as shown in Figure D.10 or from one end.

For couplings, pup-joints or accessories heat-treated using method c), as specified in 10.2.3, the pieces selected for testing shall be from near the start and approximately every 30th piece in the production run for pipe Label 1: 9-5/8 and larger, or every 50th piece in the run for smaller sizes. The piece selected for testing shall be the piece having the highest hardness in that interval of the run, based on the process control tests required in 7.9. For couplings, the hardness-test ring shall be removed from the mid-length as shown in Figure D.10. For pup-joints and accessories, the hardness-test ring may be removed from either the mid-length, as shown in Figure D.10, or from a prolongation.

Hardness tests shall be made on each ring in accordance with Figure D.11 and shall include three locations in each of four quadrants.

No test is required for pup-joints or accessories manufactured from a length of Grade C90 or T95 pipe or coupling stock previously tested, provided there is no subsequent heat treatment.

10.6.6 Sampling—Grade Q125

For casing, the hardness test specimens shall be taken at the frequency of three lengths per lot. The lengths for testing shall be selected at random, provided the selection procedure provides samples representing the start and end of the heat-treat cycle and alternative ends of the tubes.

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

For couplings, pup-joints or accessories heat-treated in coupling blank or individual length, one piece from each lot shall be tested to verify conformance to hardness requirements.

Hardness tests shall be made on each ring in accordance with Figure D.11 and shall include three locations in one quadrant.

No test is required for pup-joints or accessories manufactured from a length of Grade Q125 casing or coupling stock previously tested, provided there is no subsequent heat treatment.

10.6.7 Test specimens

Hardness test specimens (blocks or rings) shall be taken as shown in Figure D.10, or removed from the end of the length as specified in this International Standard, and tested as shown in Figure D.11. When the ring is removed from the end of the length, the hardness tests shall be taken on the side of the ring farthest from the end of the piece (that is, away from the quenched end surface).

Hardness test surfaces shall be ground parallel and smooth.

10.6.8 Test method

Hardness tests shall be made in accordance with ISO 6508-1 or ASTM E18 and ISO 6506-1 or ASTM E10, as appropriate.

Conversions shall be made in accordance with ASTM A370. The use of the Rockwell B-scale is permissible at hardness levels below 20 HRC. Although hardness readings below 20 HRC may not be precise, they may be used for the calculation of hardness values. Care should be exercised when evaluating those hardness readings and values below 20 HRC. The laboratory Rockwell C-scale hardness test shall be used as a referee method in cases of disagreement.

Calibration shall be checked at the beginning and end of a continuous run, and at such times during the run as required to assure the operator and the purchaser or his representative that the testing machine is in calibration. In any event, calibration shall be checked at least once every 8 h.

Calibration shall be made on a certified test block in a range of 25 HRC to 35 HRC for Grade Q125, and a range of 20 HRC to 25 HRC for Group 2 products. Rockwell hardness readings and values shall be reported to the first decimal place, to minimize conflict as to the hardness and acceptance or rejection of the material.

OD and ID readings shall be taken between 2,54 mm (0.10 in) and 3,81 mm (0.15 in) from the applicable surface. Hardness impressions shall not be made closer to the outside or inside surface than specified in Figure D.11. When the specified wall thickness is less than 7,62 mm (0.30 in), one hardness value (three impressions) made at the mid-wall shall be acceptable. Hardness surveys performed on ring specimens shall be made on either one or four quadrants of each ring as applicable. The three hardness readings taken at each position (OD, mid-wall and ID) shall be averaged to give one hardness value for each position.

Hardness values shall be reported (actual or converted) as Rockwell C-scale values.

All hardness impressions shall be at least three impression diameters apart, as specified in Figure D.11. The first impression on each hardness block or ring quadrant may be disregarded in order to reduce the probability of errors.

10.6.9 Invalidation of tests

If any hardness specimen shows defective machining or develops flaws, it may be discarded and another specimen substituted.

10.6.10 Re-tests—Group 2

For Grades M65 and L80, re-test in accordance with 10.6.2.

For Grades C90 and T95, if any hardness value falls between 25,4 HRC and 27,0 HRC inclusive, one more hardness value shall be taken in the immediate area (three readings required). If the new hardness value does not exceed 25,4 HRC, the new hardness value shall be accepted. If the new hardness value exceeds 25,4 HRC, the piece shall be rejected.

10.6.11 Re-tests—Grade Q125—General

If the maximum hardness variation as specified in Table C.6 or Table E.6 is exceeded on a specimen, the surface in that quadrant may (at the option of the manufacturer) be reground below the initial hardness impressions and re-tested. Only one regrind and re-test is allowed for each specimen. After re-test, product that fails to comply with Table C.6 or Table E.6 shall be rejected.

10.6.12 Re-tests—Grade Q125—Casing

If more than one of the initial three lengths required to qualify a lot of casing is rejected, then the manufacturer may elect to test each of the remaining lengths in the lot as specified in 10.6.6, 10.6.7 and 10.6.8 or reprocess the lot. Re-tests of these lengths shall only be allowed as specified in 10.6.11.

If only one of the initial three lengths required to qualify a lot of casing is rejected as specified, then an additional three lengths may be tested as specified in 10.6.6, 10.6.7 and 10.6.8 to attempt to qualify the lot of casing. Re-tests of the additional lengths shall only be allowed as specified in 10.6.11. If any of the additional three lengths required to qualify a lot of casing is rejected, then the manufacturer may elect to test each of the remaining lengths in the lot or reprocess the lot (that is, five of the six lengths tested shall meet the requirements of 7.8 and Table C.6 or Table E.6 to qualify the casing on a lot basis).

10.6.13 Re-tests—Grade Q125—Couplings, pup-joints, accessories

In the case of couplings, pup-joints or accessories heat-treated as coupling blank or individual pieces, if the maximum hardness variation as specified in 7.8 and Table C.6 or Table E.6 is exceeded, the manufacturer shall either sample three more pieces from the lot in question or re-heat-treat the lot. If a specimen from any one of the three pieces fails to meet the maximum hardness variations, the lot shall be rejected. The manufacturer may elect to re-heat treat and re-test the lot.

10.7 Impact test

10.7.1 Sampling—Grade M65 pipe

One set of test specimens shall be taken from each lot.

10.7.2 Sampling—Grades N80Q, L80, C90, C95, T95 and P110

For pipe, one set of test specimens shall be taken from each lot unless compliance with the requirements is qualified by a documented procedure, see 7.5.6. If A.9 (SR16) is specified in the purchase agreement, testing is mandatory.

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

10.7.3 Sampling and test specimen location—Grade Q125

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

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

For couplings, pup-joints, or accessories heat-treated in coupling blank or individual length, one piece from each lot shall be tested.

10.7.4 Test specimens

For orientation of longitudinal and transverse specimens, see Figure D.12.

Impact test specimens shall not be machined from flattened tubulars.

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

The surface of the finish machined transverse test specimen may contain the outside diameter curvature of the original tubular product, provided that the requirements of Figure D.13 are met. These specimens shall be used only to permit the use of a transverse specimen of maximum possible thickness consistent with Table C.9 or Table E.9.

10.7.5 Test method

Charpy V-notch impact tests shall be conducted as specified in ASTM A370 and ASTM E23.

For the purpose of determining conformance with these requirements, the observed result of a test shall be rounded to the nearest whole number. The impact energy value for a set of test specimens (i.e. average of three tests) shall be expressed as a whole number, rounded if necessary. Rounding shall be in accordance with the rounding method of ISO 31-0 or ASTM E29.

10.7.6 Invalidation of tests

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

10.7.7 Re-test of a length—All groups

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

10.7.8 Replacement of a reject length—All groups

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

10.7.9 Multiple length rejection—Grade Q125

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

10.8 Grain size determination—Grades C90 and T95

10.8.1 Sampling

The frequency of testing for grain size shall be a minimum of once per heat-treatment run. The grain size determination shall be made on the as-quenched hardenability test sample.

10.8.2 Test method

Grain size shall be determined by metallurgical evaluations such as the McQuaid-Ehn Test or other methods as specified in ISO 643 or ASTM E112. The method used to determine the grain size shall be reported.

10.9 Hardenability—Grades C90 and T95

The sample ring shall be tested with nine Rockwell C impressions in each of four quadrants as shown in Figure D.11. The minimum frequency of this test shall be one per production run or heat-treatment practice. Samples shall be taken at the beginning of each order and thereafter whenever a size change occurs or the austenitization and quenching process conditions change significantly. The average of three readings on an arc constitutes a hardness value.

10.10 Sulfide stress cracking test—Grades C90 and T95

ANSI-NACE Test Method TM0177-96 shall be used in conjunction with the requirements of 7.14 to determine the room temperature sulfide stress cracking resistance of Grades C90 and T95 products. The level of resistance to sulfide stress cracking shall be measured using either Method A: Tensile, Method B: Bent Beam, or Method D: DCB, test method. For Method A, full-size smooth tensile test specimens shall be used except where sub-size smooth tensile test specimens are required because of pipe geometry constraints.

10.11 Metallographic evaluation—EW Grades P110 and Q125

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

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

10.12 Hydrostatic test

10.12.1 Hydrostatic test procedures

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

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

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

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

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

d) plain-end upset after heat treatment;

e) threaded without couplings applied;

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

g) pup-joints, after finish machining and any heat treatment, shall be tested either plain-end or threaded.

For pipe requiring heat treatment, the test shall take place after the final heat treatment. The test pressure shall be at least the threaded and coupled test pressure for all pipe with threaded ends. Pipe furnished with extreme-line end finish shall have been hydro-tested to at least the extreme-line test pressure in one of the above conditions.

The tester shall be equipped with devices for assuring that the specified test pressure and time interval requirements are met. The test pressure-measuring device shall be calibrated by means of a deadweight tester, or equivalent, within four months prior to each use. Calibration and verification records retention shall be as given in 13.5.

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

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

10.12.2 Hydrostatic test requirements

Pipe shall comply with the test requirements for the size, grade and end finish detailed in Tables C.44 to C.60 inclusive or Tables E.44 to E.60 inclusive.

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

For plain-end pipe except Grade Q125, the hydrostatic test pressures shall be the pressures calculated as described in 10.12.3, or a higher pressure as agreed upon between purchaser and manufacturer. This does not preclude conducting subsequent hydrostatic tests at a fibre stress not exceeding 80% of specified minimum yield strength in accordance with the formula listed below. Failure to pass this hydrostatic test without leakage is basis for rejection.

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

Testing is not required on accessories or Grade Q125 pup-joints except by agreement between purchaser and manufacturer.

NOTE 1 Hydrostatic test requirements for ISO/API plain-end casing liners are included in Table C.45 or Table E.45.

NOTE 2 The hydrostatic test pressures specified herein are inspection test pressures, are not intended as a basis for design, and do not necessarily have any direct relationship to working pressures.

NOTE 3 The user should be aware that ISO/API couplings with special clearance or standard outside diameters may leak at a pressure less than the ISO/API alternative test pressure for the plain-end or threaded and coupled tube due to inadequate bearing pressure between the coupling and pin.

10.12.3 Test pressure calculation

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

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

where

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

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

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

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

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

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

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

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

The hydrostatic test pressures for threaded and coupled pipe are calculated from the above formula, except where a lower pressure is required to avoid leakage due to insufficient coupling strength or interface pressure between pipe and coupling threads. The lower pressures shall be calculated for threaded and coupled pipe as specified in ISO 10400 or API Bul 5C3.

10.13 Dimensional testing

10.13.1 Diameter—Accuracy of measurement

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

10.13.2 Diameter measurement

The manufacturer shall demonstrate conformance to the requirements of 8.11.1 in a single diametric plane at a minimum frequency of one pipe per one hundred.

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

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

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

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

10.13.3 Diameter re-tests

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

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

At the option of the manufacturer, any lot of pipe may be reprocessed and measured as a new lot.

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

10.13.4 Wall thickness

Each length of pipe shall be measured for conformance to wall thickness requirements. Wall thickness measurements shall be made with a mechanical calliper, a go/no-go gauge or with a properly calibrated non-destructive examination device of appropriate accuracy.

In case of dispute, the measurement determined by use of the mechanical calliper shall govern. The mechanical calliper shall be fitted with contact pins having circular cross-sections of 6,35 mm (1/4 in) diameter. The end of the pin contacting the inside surface of the pipe shall be rounded to a maximum radius of 38,10 mm (1/2 in) for pipe sizes Label 1: 6-5/8 and larger, a maximum radius of $d/4$ for pipe less than Label 1: 6-5/8 with a minimum radius of 3,18 mm (1/8 in). The end of the pin contacting the outside surface of the pipe shall be either flat or rounded to a radius of not less than 38,10 mm (1/2 in).

To ensure conformance to wall thickness requirements, all seamless pipe requiring electromagnetic or ultrasonic inspection as specified in Table C.61 or Table E.61 shall have the wall thickness verified in a helical or longitudinal path over the length of the pipe, excluding end areas not covered by automated systems in accordance with a documented procedure. The location of the wall-thickness verification equipment shall be at the discretion of the manufacturer.

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

10.13.5 Drift test

All drift testing shall be performed with a drift mandrel containing a cylindrical portion conforming to the requirements shown in Tables C.31 and C.32 or Tables E.31 and E.32 as applicable. See 8.10 for requirements for casing used as tubing. The ends of the drift mandrel extending beyond the specified cylindrical portion shall be shaped to permit easy entry into the pipe. The drift mandrel shall pass freely through pipe by the use of a manual or power drift procedure. In case of dispute, the manual drift procedure shall be used. Pipe shall not be rejected until it has been drift-tested when it is free of all foreign matter and properly supported to prevent sagging.

10.13.6 Length

When pipe is furnished with threads and couplings, the length shall be measured to the outer face of the coupling or, if measured without couplings, proper allowance shall be made to include the length of coupling. For extreme-line casing and integral-joint tubing, the length shall be measured to the outer face of the box end. For pup-joints and accessories, the length shall be measured from end to end.

10.13.7 Mass (weight) determination

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

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

NOTE The densities of martensitic chromium steels (L80 Types 9Cr and 13Cr) are different from carbon steels. The masses shown are therefore not accurate for martensitic chromium steels. A mass correction factor of 0,989 may be used.

10.13.8 Straightness

All pipe shall be visually examined. The straightness of questionably bent pipes or crooked extremities shall be measured:

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

b) using a minimum 1,83 m (6.0 ft) straightedge shouldered on the pipe surface beyond the extent of the hooked extremity.

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

Deviation from straight, or chord height, shall not exceed the requirements in 8.9. See Figures D.14 and D.15.

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

10.14 Visual inspection

10.14.1 General

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

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

10.14.2 Pipe body (excluding pipe ends)

Each pipe shall be visually inspected over the entire outside surface for the detection of imperfections. For roll marks see 6.3.2.

10.14.3 Pipe ends

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

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

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

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

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

10.14.4 Disposition

Surface imperfections disclosed by visual inspection shall be treated in accordance with 10.15.16.

10.15 Non-destructive examination (NDE)

10.15.1 General

Clause 10.15 specifies the NDE requirements and inspection levels for seamless and electric-welded pipe and accessories. A summary of the required NDE operations for seamless pipe and the body of welded pipe is given in Table C.61 or Table E.61 and Table C.62 or Table E.62. All pipe and accessories that require NDE (except visual inspection) shall be inspected full length (end to end) for defects.

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

At the discretion of the manufacturer, the notches referenced in Table C.63 or Table E.63 may be oriented at an angle such that detection of defects typical of the manufacturing process is optimized. The technical justification for modification of the orientation shall be documented.

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

The inspections performed in accordance with 10.15, with the equipment calibrated to the reference indicators in Table C.63 or Table E.63, should not be construed as assuring that the material requirements in 8.13 have been met.

10.15.2 NDE personnel

All NDE operations (except visual inspection) referred to in this International Standard shall be conducted by NDE personnel qualified and certified in accordance with ISO 11484 or ANSI-ASNT SNT-TC-1A:1984.

10.15.3 Reference standards

Ultrasonic and electromagnetic inspection systems for other than wall thickness verification shall use reference standards containing notches or holes as shown in Tables C.62 and C.63 or Tables E.62 and E.63 to verify equipment response from artificial reference indicators.

The manufacturer may use any documented procedures to establish the reject threshold for ultrasonic or electromagnetic inspection, provided the artificial reference indicators described in Table C.63 or Table E.63 can be detected dynamically under normal operating conditions. Such detection capability shall be demonstrated dynamically. At the option of the manufacturer, this may be performed either on line or off line.

Tables C.62 and C.63 or Tables E.62 and E.63 list the acceptance (Inspection) levels and associated artificial reference indicators that manufacturers shall use in establishing thresholds for sorting pipe that may contain defects as defined in 8.13. The reference indicators, used during automated ultrasonic or electromagnetic inspection, are not to be construed as being the defect sizes defined in 8.13, or be used by those other than the manufacturer as the only basis for pipe rejection.

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

10.15.4 NDE system capability records

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

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

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

b) capability for the intended wall thickness;

c) repeatability;

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

e) documentation demonstrating that defects typical of the manufacturing process are detected using the NDE methods in Table C.61 or Table E.61;

f) threshold-setting parameters.

In addition, the manufacturer shall maintain documentation relating to:

g) NDE system operating procedures;

h) NDE equipment description;

i) NDE personnel qualification information;

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

10.15.5 Pipe body inspection—General

Unless otherwise agreed, all required NDE operations (except visual inspection but including the final end-area inspection in accordance with 10.15.12) for pipe shall be carried out after final heat treatment and rotary straightening operations, with the following exceptions:

a) certain types of pup-joints (see 10.15.11)

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

10.15.6 Full-body NDE of casing and tubing—Grades N80Q, M65, L80 and C95

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

a) ultrasonic testing in accordance with ISO 9303 or ASTM E213;

b) flux leakage testing in accordance with ISO 9402 or ASTM E570;

c) eddy current concentric coil testing in accordance with ISO 9304 or ASTM E309;

d) for pipe outside surface, magnetic particle inspection in accordance with ISO 13665 or ASTM E709.

10.15.7 Full-body NDE of casing and tubing—Grade P110 to A.9 (SR16)

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

a) ultrasonic testing in accordance with ISO 9303 or ASTM E213 (longitudinal) and ISO 9305 or ASTM E213 (transverse);

b) flux leakage testing in accordance with ISO 9402 or ASTM E570 (longitudinal) and ISO 9598 or ASTM E570 (transverse);

c) eddy current concentric coil testing in accordance with ISO 9304 or ASTM E309.

10.15.8 Full-body NDE of casing and tubing—Grade P110 and Grade P110 to A.9 (SR16) and A.2 (SR2)

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

a) ultrasonic testing in accordance with ISO 9303 or ASTM E213 (longitudinal) and ISO 9305 or ASTM E213 (transverse);

b) flux leakage testing in accordance with ISO 9402 or ASTM E570 (longitudinal) and ISO 9598 or ASTM E570 (transverse);

c) eddy current concentric coil testing in accordance with ISO 9304 or ASTM E309.

10.15.9 Full-body NDE of casing and tubing—Grades C90, T95 and Q125

All pipe shall be ultrasonically inspected for the detection of both longitudinal and transverse imperfections on the outside and inside surfaces to acceptance level L2 in accordance with ISO 9303 or ASTM E213 (longitudinal) and ISO 9305 or ASTM E213 (transverse)

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

a) flux leakage testing to acceptance level L2 in accordance with ISO 9402 or ASTM E570 (longitudinal) and ISO 9598 or ASTM E570 (transverse);

b) eddy current testing to acceptance level L2 in accordance with ISO 9304 or ASTM E309;

c) magnetic particle inspection in accordance with ISO 13665 or ASTM E709.

10.15.10 NDE of the weld seam of welded pipes

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

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

For all grades of Groups 1 and 2, the weld seam shall be inspected for the detection of longitudinal imperfections by one or more of the following methods:

a) ultrasonic testing to acceptance level L3 in accordance with ISO 9764 or ASTM E273 or ISO 9303 or ASTM E213;

b) flux leakage testing to acceptance level L3 in accordance with ISO 9402 or ASTM E570;

c) eddy current testing to acceptance level L3 in accordance with ISO 9304 or ASTM E309 .

For Grades P110 and Q125, the requirements of A.5.4 (SR11.5) shall apply.

10.15.11 Pup-joints and accessories

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

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

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

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

d) For ISO/API round thread pup-joints and accessories in size designations listed in Table C.3 or Table E.3 in Group 1, Group 2 Grades L80 and C95 and Group 3, the required inspections, unless otherwise agreed upon between purchaser and manufacturer, are as specified in e) and f):

e) For pipe body outside surface and end areas, the required inspection shall be performed following any upset process and final heat treatment. For Group 3 pup-joints and accessories, magnetic particle inspection for the detection of longitudinal and transverse defects may be substituted for the required outside surface inspection.

f) For inside surfaces, the required pipe body inside inspection may take place before or after cutting to individual lengths, any upset process, or final heat treatment.

10.15.12 Untested pipe ends

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

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

a) cropped off, or

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

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

Records in accordance with 10.15.4 shall be maintained.

10.15.13 Pipe upsets

Forged upsets (including the upset run-out interval) on all grades, except Grades H40, J55 and K55, shall be subjected after all heat treatment operations to NDE as outlined in this International Standard for the detection of transverse imperfections on the outside and inside surfaces of the upset, using the acceptance criteria given in 8.13. For all grades manufactured by the quench-and-temper process, the end area inspection shall include inspection for longitudinal imperfections. Records in accordance with 10.15.4 shall be maintained.

10.15.14 Pipe and accessories requiring further evaluation

In all cases, pipe giving rise to indications producing a trigger alarm condition as a result of the specified NDE operation(s) shall have the indications evaluated in accordance with 10.15.15, unless it can be demonstrated that the imperfection causing the indication is not a defect as described in 8.13.

10.15.15 Evaluation of indications (Prove-up)

For an indication which is equal to or greater than the reject threshold, the manufacturer shall either evaluate it in accordance with this subclause or dispose of the indication as a defect in accordance with 10.15.16. Evaluation of indications shall be performed by NDE Level I certified inspectors under the supervision of NDE Level II or III certified inspectors or by NDE Level II or III certified inspectors. Evaluation of indications shall be performed in accordance with documented procedures.

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

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

a) using a mechanical measuring device (for example, pit gauge, callipers, etc.). Removal of material by grinding or other means to facilitate measurement shall not reduce the remaining wall below 87,5% of the specified wall thickness. Abrupt changes in wall thickness caused by proof grinding shall be removed.

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

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

Imperfections that have been evaluated and found to be defects shall be given a disposition in accordance with 10.15.16.

10.15.16 Disposition of pipe containing defects

Imperfections that satisfy the material requirements and are less than the defect size stated in 8.13 are allowed to remain in the pipe. Repair welding is not permitted. Pipe containing defects shall be given one of the following dispositions:

a) grinding or machining

Defects shall be completely removed by grinding or machining, provided the remaining wall thickness is within specified limits. Grinding shall be carried out in such a way that the dressed area blends smoothly into the contour of the tube. Where the depth of the grind exceeds 10% of the specified wall thickness, the remaining wall thickness shall be verified in accordance with 10.13.4. After removal of the defect, the affected area shall be re-inspected to verify that the defect was completely removed. The re-inspection shall be either

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

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

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

b) cut-off

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

c) rejected

The pipe shall be rejected.

11 Marking

11.1 General

11.1.1 Products manufactured in conformance with this International Standard shall be marked by the manufacturer as specified herein.

11.1.2 For all manufacturers except threaders, the marking instructions in clause 11, except those in 11.6, are applicable. For threaders, the marking instructions in 11.5 and 11.6 and Tables C.67 or Table E.67 are applicable. Processors shall remove any identity that is not indicative of the new condition of the product as a result of heat treating (for example, prior grade identity and original pipe manufacturer's name or logo).

11.1.3 Products shall be color-coded as specified in 11.4.

11.1.4 Products shall be marked by stencilling, or a combination of stencilling and stamping, at the option of the manufacturer, as stipulated, with two exceptions:

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

— at the option of the manufacturer, hot-rolled or hot-stamped markings on pipe and couplings may be substituted for die-stamped markings and are permitted at intervals along the length.

11.1.5 Requirements for optional stamp markings are specified in 11.2, and stencil markings shall be as specified in 11.3. Marking instructions and sequence of markings are specified in Table C.67 or Table E.67, which includes only those items that are stamped or stencilled for product identification. If die stamp marking is selected, it is not required to also stencil mark the information. Examples of markings are shown in Figure D.16. Marking shall not overlap and shall be applied in such a manner as not to injure the pipe.

11.1.6 Additional markings for compatible standards shall be listed after "ISO 11960". Other additional markings are allowed and may be applied as desired by the manufacturer or as requested by the purchaser, but shall be applied after the markings specified in Table C.67 or Table E.67.

11.1.7 In a circumstance where it is necessary to re-mark pipe with the original marking information, the accuracy and traceability of the transferred markings shall be the responsibility of the entity re-marking the pipe. The transferred markings shall include the words "transferred by".

11.1.8 The date of manufacture is defined for marking purposes as a minimum of a two-digit number representing the last digit of the year followed by the calendar quarter in which the markings of clause 11 are completed.

11.1.9 Products manfactured in accordance with this second edition of ISO 11960 during the period of overlap of application (see Foreword) with the first edition may be identified either by using "0" as the overlap period designation, rather than the quarter, or by other appropriate markings using the provisions of 11.1.6. The overlap period designation "0" applies to the pipe body characteristics and does not apply to changes in ISO 10422 or API Spec 5B.

11.2 Stamp marking requirements

11.2.1 Methods

Permitted methods of stamp marking are as follows:

Number	Method
1	Hot-rolled or hot-stamped markings
2	Cold die stamping with standard dies
3	Cold die stamping with interrupted dot-face dies
4	Cold die stamping with rounded-face dies
5	Vibratory

After stamp marking, Group 2 and Group 4 products may require subsequent heat treatment as specified in 11.2.5. Such heat treatment shall be in accordance with 6.2. The sequence of stamp markings shall be as shown in Table C.67 or Table E.67.

11.2.2 Size

Sizes of stamp markings shall be as shown in Table C.64 or Table E.64.

11.2.3 Location

Placements of these markings on casing, liners and tubing sizes Label 1: 1.660 and larger shall be on the outside surface of each length within 300 mm (12 in) from the coupling or box, either end of plain-end pipe or either end of pin-by-pin threaded pipe. The optional stamp marking on sizes smaller than Label 1: 1.660 may be on a metal tag affixed to each length, or for bundled tubing, stamped on a metal tag affixed to each bundle.

11.2.4 Groups 1 and 3

When specified on the purchase agreement, products shall be stamped by one or more of the methods in 11.2.1 at the option of the manufacturer.

11.2.5 Groups 2 and 4

When specified on the purchase agreement, products shall be stamped by one or more of the methods in 11.2.1 at the option of the manufacturer. In addition, the following apply:

— Group 2 (except Grades C90 and T95) shall be heat-treated subsequent to using method 2 in 11.2.1.

— Group 2 (Grades C90 and T95 only) and Group 4 products shall be heat-treated subsequent to using methods 2 and 4 in 11.2.1, with the following exceptions:

  — stamping of the make-up triangle;

  — when the stamp markings are removed by cropping or by grinding, machining, threading to a depth not less than twice the depth of the stamping;

  — by agreement between purchaser and manufacturer, the stamp marks may be left in the product.

11.2.6 Make-up triangle marking

For buttress casing in all sizes and grades and for round thread casing in sizes Label 1: 16 and larger in Grades H40, J55, K55 and M65, the make-up triangle shall be stamped on the outside of each length on both ends. By agreement between purchaser and manufacturer, the make-up triangle may be replaced with a transverse white paint band 10 mm (3/8 in) wide by 76 mm (3 in) long. To assist in locating the triangle or transverse white paint band on buttress casing, a 25 mm (1 in) wide by 610 mm (24 in) long longitudinal white paint stripe shall be placed adjacent to the triangle or transverse paint band on the field end; additionally, a 25 mm (1 in) wide by 100 mm (4 in) long longitudinal white paint stripe shall be placed adjacent to the triangle or transverse paint band on the mill end.

For Groups 1 and 3, the triangle shall be stamped by method 2 or 4 only.

For Group 2 (Grades C90 and T95 only), the triangle shall be stamped by method 3 only.

For Group 2 (except Grades C90 and T95) and Group 4, the triangle shall be stamped by method 3 or 4 only.

11.3 Stencil marking requirements

Stencilled markings shall be placed on the outside surface of each length of pipe, starting not less than 0,6 m (24 in) from the coupling or box or from either end of plain-end pipe or either end of pin-by-pin threaded pipe. For accessories and pup-joints less than 1,8 m (6 ft) in length, the required stencil markings may be placed on a decal attached to the outside surface within 0,3 m (12 in) of the end. These markings shall be separated by a dash or shall be adequately spaced.

The sequence of stencil markings shall be as specified in Table C.67 or Table E.67, except the thread marking shall be at a location convenient to the manufacturer.

11.4 Colour identification

11.4.1 Colour coding

Each product shall be colour-coded as specified in 11.4.2 to 11.4.6, unless otherwise specified on the purchase agreement.

11.4.2 Pipe and pup-joints 1,8 m (6 ft) and longer

One or more of the following methods shall be used.

a) Paint a band encircling the pipe at a distance not greater than 0,6 m (24 in) from the coupling or box or either end of plain-end or pin-by-pin threaded pipe.

b) Paint the entire outside surface of the coupling, including the appropriate coupling color bands.

c) If the pipe is furnished with special clearance couplings or if the pipe and couplings are of a different grade (except Grades H40, J55 and K55 applied in accordance with 9.2.1), paint both the pipe and couplings as specified in items a) and b) above.

11.4.3 Loose couplings

Paint the entire surface of the coupling, including the appropriate color bands.

11.4.4 Pup-joints and accessories shorter than 1,8 m (6 ft) in length

Paint the entire surface except the threads, including the appropriate color bands.

11.4.5 Special clearance couplings

Paint the coupling using the colours indicative of the steel grade from which the coupling is manufactured, and also paint a black band around the centre.

11.4.6 Grade color-codes

The colour and number of bands for each grade shall be as shown in Table C.65 or Table E.65.

11.5 Thread and end-finish marking—All groups

11.5.1 ISO/API thread marking

For manufacturers, thread identification shall be stencilled on casing with round, buttress or extreme-line threads. For threaders, thread identification is required on casing and tubing. This thread identification shall be as shown in Table C.66 or Table E.66.

11.5.2 Unfinished and special end-finish markings

Different marking is required for

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

b) pipe with special end-finish not specified herein but having the body of the pipe manufactured in accordance with the requirements specified herein, or

c) completed couplings and completed accessories furnished with special end-finish not specified herein but which meet all the other requirements specified herein for these products except dimensions.

This marking shall be as shown in Table C.67 or Table E.67.

11.6 Pipe-threader marking requirements—All groups

Pipe threaded by a facility other than the original pipe manufacturer shall be identified, by a stamp or stencil consistent with 11.1, 11.2 and 11.3 adjacent to the threads, with the name or mark of the threader, the specification mark, and size and type of thread as listed in 11.5 and Table C.66 or Table E.66.

The threader shall mark on the body of the pipe the actual hydrostatic test pressure, unless the pipe has been previously tested to the pressure required for the thread as shown in Tables C.44 to C.60 or Tables E.44 to E.60 and marked as specified in Table C.67 or Table E.67.

EXAMPLE For Label 1: 7, Label 2: 29.00, C95, long thread coupling

Case 1) If the pipe manufacturer produced UF pipe and hydrostatic pressure-tested to 34,5 MPa (5 000 psi) based on the documented design basis of the tester for 177,8 mm (7 in) pipe (see 10.12.3), and marked P34,5 (P5000), then the threader shall pressure-test the pipe to 60,5 MPa (8 800 psi) and mark the pipe in accordance with Figure D.16.

Case 2) If the pipe manufacturer produced UF pipe and hydrostatic pressure-tested to 61,0 MPa (8 900 psi) and marked the pipe P61,0 (P8900) then the threader is not required to pressure-test or mark the test pressure.

The markings applied to the body of the pipe by the original pipe manufacturer shall not be removed or altered.

Use of the letters "ISO" or "API" to identify or certify that threads on tubular goods comply with ISO 10422 or API Spec 5B is not permitted.

12 Coating and protection

12.1 Coatings—All groups

12.1.1 Coatings for protection during transit

Unless otherwise specified in the purchase agreement, pipe and couplings shall be given an external coating for protection from rust while in transit. An attempt should be made to make these coatings smooth, hard to the touch, and with minimum sags. The coating shall be rated to protect the pipe for at least three months.

If bare pipe or specially coated pipe is desired, the purchase agreement should so state. For special coatings, the purchase agreement should state further whether the coating is to be applied to the full length or whether a certain specific distance from the end is to be left uncoated. Unless otherwise specified, such bare ends are commonly given a coating with oil for protection in transit.

NOTE 13% Cr tubulars have shown a tendency toward localized pitting corrosion when stored in moist environments. Special precautions during coating, shipping and storage are worthwhile.

12.1.2 Coatings for long-term storage

By agreement between purchaser and manufacturer, protective coatings, internal and external, may be required for pipe for long-term storage to protect against corrosion, especially when stored in a marine environment.

The following points shall apply.

a) The protection shall be effective against corrosion in a marine environment during the long-term storage period defined by the purchaser and manufacturer; minor surface discoloration shall be acceptable.

b) There shall be no need for removal of the protective coating before the running of the tubulars.

c) Correct application of the coating is essential and the following parameters shall be assessed:

- dryness of the pipe;
- cleanliness of the pipe;
- temperature at application;
- thickness of the coating film.

12.2 Thread protectors

12.2.1 General

The entity performing the threading shall apply external and internal thread protectors of such design, material and mechanical strength to protect the thread and end of the pipe from damage under normal handling and transportation. External thread protectors shall cover the full length of the thread on the pipe, and internal thread protectors shall cover the equivalent total pipe thread length of the internal thread. Thread protectors shall be of such design and material to inhibit infiltration of dust and water to the threads during transportation and normal storage period. Normal storage period shall be considered as approximately one year. The thread forms in protectors shall be such that the product threads are not damaged by the protectors. Thread protectors are not required for pup-joints and accessories provided they are packaged in a manner that protects the threads.

12.2.2 Material

Protector material shall contain no compounds capable of causing corrosion or promoting adherence of the protectors to the threads and shall be suitable for service temperatures from –46°C to +66°C (–50 °F to +150°F).

12.2.3 Grade L80 Types 9Cr and 13Cr

Bare steel thread protectors shall not be used on Grade L80 Types 9Cr and 13Cr tubulars.

12.2.4 Driftable thread protectors

By agreement between purchaser and manufacturer, open-ended, driftable protectors may be supplied. Thread compound shall cover the entire thread and seal surfaces of the connection.

13 Documents

13.1 Electronic media—All groups

A material test report, certificate of compliance or similar document printed from or used in electronic form from an electronic data interchange (EDI) transmission shall be regarded as having the same validity as a counterpart printed in the certifier's facility. The content of the EDI-transmitted document shall meet the requirements of this International Standard and conform to any existing EDI agreement between purchaser and manufacturer.

13.2 Certification—Groups 1, 2 and 3

A record of heat control tests shall be available to the purchaser.

The manufacturer shall, upon request by the purchaser, furnish to the purchaser a certificate of compliance stating that the material has been manufactured, sampled, tested and inspected in accordance with this International Standard and has been found to meet the requirements.

Where additional information is required, including the results of mechanical testing, the supplementary requirement in A.8 (SR15) shall be specified in the purchase agreement.

13.3 Certification requirements—Grade Q125

A certification shall be provided by the manufacturer for all pipe shipped meeting Group 4 requirements. The requirements in A.8 (SR15) shall apply.

13.4 Retention of records

Tests and inspections requiring retention of records in this International Standard are shown in Table C.68 or Table E.68. Such records shall be retained by the manufacturer and shall be available to the purchaser on request for a period of three years after the date of purchase from the manufacturer.

14 Minimum facility requirements for various categories of manufacturer

14.1 Pipe mill

A pipe mill shall operate one or more pipe-making facilities capable of producing products as described in clause 6 of this International Standard.

A pipe mill shall also have facilities for conducting all required tests and inspections. Alternatively, and at the option of the pipe mill, any of these tests or inspections may be provided by a third party and may be located off-site. In the event that a third party performs any of these services, the conduct of such inspections and tests shall be controlled and monitored by the pipe mill in accordance with a documented procedure. The pipe mill shall possess suitable equipment for, and be responsible for, weighing and marking pipe.

14.2 Processor

A processor shall operate heat-treating facilities capable of heat-treating full lengths of pipe. A processor shall also have facilities for conducting all required tests and inspections. Alternatively, and at the option of the processor, any of these tests or inspections may be provided by a third party and may be located off site. In the event that a third party performs any of these services, the conduct of such inspections and tests shall be controlled and monitored by the processor in accordance with a documented procedure. The processor shall possess suitable equipment for, and be responsible for, weighing and marking pipe.

14.3 Threader

A pipe threader shall operate one or more threading machines capable of threading pipe ends to the dimensions and tolerances specified in ISO 10422 or API Spec 5B. He shall also have access to master plug and ring gauges, as well as the required working gauges, for each size and type of thread.

A threader shall also have facilities for

a) applying couplings to specified make-up,

b) hydrostatic testing the entire length to the pressure required for finished pipe,

c) drift-testing the ends after threading and coupling in accordance with specification requirements, and

d) measuring length.

A threader shall not change or alter the markings on the pipe body or certify that the pipe body complies with any ISO/API specification. When third-party work is performed for the threader, it shall be the responsibility of the threader to see that such work complies with the requirements of the specification.

14.4 Coupling, pup-joint, and accessory manufacturer

A coupling, pup-joint, or accessory manufacturer shall operate equipment capable of machining and threading products in accordance with the dimensions and tolerances provided in the applicable specifications. He shall also have access to master plug and ring gauges, as well as the required working gauges, for each size and type of thread produced on products marked by him in accordance with clause 11.

Pup-joint manufacturers shall also have facilities for

a) hydrostatic testing and

b) drift testing finished products,

in accordance with the requirements of this International Standard.

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

Annex A
(normative)

Supplementary requirements

NOTE This annex describes supplementary requirements that may be specified by the purchaser or agreed between purchaser and manufacturer. These requirements apply only when stated on the purchase agreement.

A.1 SR1 Supplementary non-destructive examination for Grades H40, J55, K55 and N80 Type 1

The specified casing and tubing shall be inspected for imperfections that are greater than 12,5 % of the specified wall thickness or which reduce the net effective wall thickness below 87,5 % of the specified wall thickness.

These imperfections shall be considered defects and shall be given a disposition in accordance with 10.15.16. The inspection(s) including forged upsets shall be performed to minimum requirements stated in 10.15 for Grades N80Q, L80 and C95.

A.2 SR2 Supplementary non-destructive examination for Grades H40, J55, K55, N80, L80, C95 and P110

The specified casing and tubing shall be inspected for imperfections that are greater than 5 % of the specified wall thickness or which reduce the net effective wall thickness below 87,5 % of the specified wall thickness. These imperfections shall be considered defects and shall be given a disposition in accordance with 10.15.16. The inspection(s), including forged upsets, shall be performed to the minimum requirements stated in 10.15 as for Grade P110.

A.3 SR9 Coupling blanks—Grade Q125 only

A.3.1 SR9.1 Coupling blank size

Coupling blank dimensions shall be adequate to yield a fully machined cylinder with uniform wall thickness with an outside diameter and inside diameter and length as specified on the purchase agreement. The coupling blanks shall be provided fully machined by the manufacturer only when specified on the purchase agreement.

A.3.2 SR9.2 Dimensional limitation

For fully machined coupling blanks, the tolerance on outside diameter shall be $^{-2,38}_{0}$ ($^{+3/32}_{0}$) and the tolerance on the inside diameter shall be $^{0}_{-2,38}$ mm ($^{0}_{-3/32}$ in.), unless otherwise agreed upon between purchaser and manufacturer.

Coupling blanks ordered with as-rolled outside diameter surface shall have an outside diameter tolerance of ± 1 %, but not greater than $^{+3,18}_{-1,59}$ mm ($^{+1/8}_{-1/16}$ in.).

A.3.3 SR9.3 Imperfections

Coupling blanks that will not be fully machined by either the manufacturer or the purchaser shall be inspected and meet the same requirements as finished couplings. Coupling blanks that will be fully machined by either the

manufacturer or the purchaser may have imperfections on the as-rolled surface; however, the machined surface shall meet the surface inspection criteria of 9.14 and be to the specified dimensions.

A.3.4 SR9.4 Marking

All coupling blanks meeting the requirements of A.3 (SR9) for Q125 Type 1 shall be marked "S9 Q1".

A.4 SR10 Upset casing—Grade Q125 only

A.4.1 SR10.1 Dimensions

Grade Q125 casing shall be provided with upset end(s). Dimensions of the upset, if other than extreme-line (including tolerances), shall be specified on the purchase agreement.

A.4.2 SR10.2 Material properties

Tensile, impact and hardness properties of the pipe and upset shall comply with the requirements of clause 7. The allowable hardness variation of the upset shall be based on the nominal wall thickness of the upset specified on the purchase agreement. The tensile test specimens for the upset shall be the largest round specimen feasible. The size to be used shall be agreed by the purchaser and manufacturer prior to testing.

A.4.3 SR10.3 Heat treatment

Upset pipe shall be heat-treated full length after upsetting.

A.4.4 SR10.4 Other testing considerations

The frequency of testing, re-test provisions, identification, etc., for both the pipe body and the upset material shall be as specified in clause 10.

A.4.5 SR10.5 End area inspection

The outside and inside surfaces of the ends of upset pipe shall be inspected before threading for transverse and longitudinal defects by the magnetic particle method after final heat treatment.

A.4.6 SR10.6 Machined surface inspection of extreme-line casing

A.4.6.1 SR10.6.1 Requirements for inspection

The machined surface of extreme-line casing shall be visually examined for imperfections. The maximum permissible depth of imperfection measured from the surface shall be as follows:

A.4.6.2 SR10.6.2 Pin end

Location of imperfection	Permissible depth
External surface:	12,5 % of specified pipe body wall thickness
Internal surface:	
From end of pipe to plane of external shoulder (bored):	0,38 mm (0.015 in)
From plane of external shoulder to upset run-out:	12,5 % of specified pipe body wall thickness

A.4.6.3 SR10.6.3 Box end

Location of imperfection	Permissible depth
External surface:	
From the end of the pipe to a plane 120,60 mm (4-3/4 in) from the end of pipe Label 1: 7-5/8 and smaller, and 165,10 mm (6-1/2 in) from the end of pipe Label 1: 8-5/8 and larger:	0,25 mm (0.010 in)
From a plane 120,60 mm (4-3/4 in) from the end for pipe Label 1: 7-5/8 and smaller and 165,10 mm (6-1/2 in) from the end for pipe Label 1: 8-5/8 and larger, to the upset run-out:	12,5 % of specified pipe body wall thickness
Internal surface:	12,5 % of specified pipe body wall thickness

A.4.6.4 SR10.6.4

All machined surfaces of the box shall be free of seams and cracks. All threads and seals shall be free of any imperfections which break the continuity.

A.4.6.5 SR10.6.5

The minimum wall thickness in the upset run-out interval, see Figure D.8, shall not be less than 87,5 % of the specified pipe body wall thickness.

A.4.6.6 SR10.7 Dimensions and masses

Dimensions and masses for extreme-line casing are shown in Tables C.24 and C.26 or Tables E.24 and E.26.

A.5 SR11 Electric-welded casing, tubing and pup-joints, Grade P110 and electric-welded casing and pup-joints, Grade Q125

A.5.1 SR11.1 General

Casing (Grades P110 and Q125) and tubing (Grade P110) may be produced by the electric weld process only when detailed quality control provisions are jointly agreed by purchaser and manufacturer prior to the manufacture of the pipe. Tensile, impact and hardness testing shall be performed as frequently as required for seamless casing.

A.5.2 SR11.2 Flattening test frequency

A.5.2.1 SR11.2.1—Grade P110

The flattening test frequency shall be as specified in 10.5.2.

A.5.2.2 SR11.2.2—Grade Q125

Flattening tests shall be performed on each end of each length of pipe. On one end, flattening tests shall be made with weld at 6 o'clock and on the other end with weld at 3 o'clock. All inspection shall be performed and imperfections removed (cut-backs made) prior to removal of flattening test specimens.

A.5.3 SR11.3 Flattening test procedures

A.5.3.1 SR11.3.1—Grade P110

The test specimens shall be flattened as specified in 10.5.3, 10.5.5 and 10.5.7.

A.5.3.2 SR11.3.2—Grade Q125

Test specimens shall be rings or crop ends not less than 63,5 mm (2-1/2 in) long cut from each end of each length of pipe. Precaution shall be taken so that the test specimens can be identified with respect to the lengths of pipe from which they are cut. Flattening tests shall be conducted with the weld line located at the 6 o'clock or 3 o'clock position. Minimum acceptable flattening without cracking at any location shall be as shown in Table C.69 (SR11.1) or Table E.69 (SR11.1) or 0,85D, whichever requires the greater flattening.

No cracks or breaks shall occur anywhere in the specimen until the distance between the plates is less than that specified above; nor shall evidence of poor texture, incomplete fusion in the weld or laminations develop during the entire flattening process.

A.5.4 SR11.4 Other material properties

Electric-welded pipe shall meet the same tensile, impact, and hardness requirements as seamless pipe. The impact test specimen shall be machined with the notch at the weld line. The requirements of clause 10 (for seamless pipe) shall also apply to electric-welded pipe.

A.5.5 SR11.5 Inspection and rejection

A.5.5.1 SR11.5.1 Non-weld area inspection

The pipe body shall be inspected in the same manner as the seamless product as specified in clause 10.

A.5.5.2 SR11.5.2 Non-destructive examination of weld seam

The weld seam of pipe (except upset ends) furnished to this International Standard shall be inspected non-destructively full length (100 %) by ultrasonic methods. The inspection shall be performed after all heat treatment and any subsequent rotary straightening operation. Pipe upsets shall be inspected as specified in 10.15.13.

A.5.5.3 SR11.5.3 Equipment

Any equipment utilizing the ultrasonic principles capable of continuous and uninterrupted inspection of the weld seam shall be used. The equipment shall be checked with an applicable reference standard as described in A.5.5.4 (SR11.5.4) at least once every working shift to demonstrate the effectiveness of the inspection equipment and procedures. The equipment shall be adjusted to produce well-defined indications when the reference standard is scanned by the inspection unit in a manner simulating the inspection of the product, and shall be capable of inspecting 1,6 mm (1/16 in) on either side of the weld line for the entire wall thickness.

A.5.5.4 SR11.5.4 Reference standards

A reference standard having the same specified diameter and thickness as the product being inspected shall be used to demonstrate the effectiveness of the inspection equipment and procedures at least once every working shift. The reference standard may be of any convenient length as determined by the manufacturer. It shall be scanned by the inspection unit in a manner simulating the inspection of the product. For ultrasonic inspection, the reference standard shall contain two notches, one on the outer and one on the inner surface as specified in Figure D.17 (SR 11.1). The 1,6 mm (1/16 in) diameter hole shall be drilled radially through the wall of the reference standard. The inspection equipment shall be adjusted to produce a well-defined indication when the reference standard is scanned by the inspection unit.

A.5.5.5 SR11.5.5 Rejection limits

Any imperfection that produces a signal as great as the signal received from the reference standard shall be considered a defect unless it can be demonstrated by the manufacturer that the imperfection does not exceed the provisions of A.5.5.6 (SR11.5.6).

A.5.5.6 SR11.5.6 Disposition

Imperfections revealed by magnetic particle inspection and determined to be greater in depth than 5 % but not greater than 12,5 % of the specified wall thickness shall be removed by grinding or machining, or the pipe shall be rejected. All imperfections classified as defects by the ultrasonic or electromagnetic equipment which do not exceed 12,5 % of the specified wall thickness in depth shall be removed by grinding or machining or the pipe shall be rejected.

Pipe with defects whose removal requires grinding or machining to a depth in excess of 12,5 % of the specified wall thickness shall be disposed of in accordance with 10.15.16. Where grinding or machining is done, generous radii shall be used to prevent abrupt changes in wall thickness and such areas shall be re-inspected by one of the non-destructive inspection methods specified herein to verify complete removal of the defect.

A.6 SR12 Statistical impact testing

A.6.1 SR12.1 General

This supplementary requirement specifies a statistical approach to testing. It is applicable only to those items that are accepted or rejected on a lot basis. The frequency of testing is based on standard statistical techniques for properties that have a normal distribution and where the standard deviation for a particular manufacturer, size, chemistry, etc., are not well established. The statistical acceptance and rejection procedures are required only for impact properties; however, the tensile and hardness properties shall be measured on all tubulars where impact samples are taken. Tensile, impact and hardness requirements are as required in clause 7. The basis of the testing procedure is explained in note 1 in A.6.5 (SR12.5).

A.6.2 SR12.2 Frequency of testing

Every length of casing shall be uniquely numbered. This number shall be used for all subsequent identification. Tensile, impact and hardness test specimens for casing shall be taken at the same frequency from locations shown in Figure D.10. The sample size for each lot of casing shall be selected by the manufacturer from Table C.70 (SR12.1) or Table E.70 (SR12.1).

The F factor shown for the sample size selected shall be used in A.6.4 (SR12.4) to determine acceptance or rejection of a lot based on the applicable transverse or longitudinal impact requirements. The number of samples is not dependent on the size of the lot. The lengths for testing shall be selected at random provided the selection procedure provides samples representing at least the start and end of the heat treat cycle and both ends of the tubes (approximately 50 % each end).

By agreement between purchaser and manufacturer an F factor of 3,090 may be used in lieu of the values given in Table C.70 (SR12.1) or Table E.70 (SR12.1) provided the standard deviation of the new lot of material is consistent with past experience.

A.6.3 SR12.3 Re-test

If a tensile test specimen fails to conform to the specified requirements, the manufacturer shall make additional tests on each end of the tubular. If impact test specimens fail to conform to the specified requirements, the manufacturer shall follow the re-test provision of 10.7.7, 10.7.8 and 10.7.9 (as applicable). If a hardness test specimen fails to conform to the specified requirements, the manufacturer shall follow the re-test provisions of 10.6.10, 10.6.11, 10.6.12 and 10.6.13 (as applicable).

If any pipe is rejected from a lot due to failure to demonstrate acceptable tensile, impact or hardness requirements, then the pipe tempered immediately before and after the length rejected shall be tested on the same end as the pipe that was rejected. If one or both of the additional test lengths fail to conform to the specified requirements, the manufacturer may elect to test individually all remaining lengths in the lot, in which case determinations are required only for the particular requirement with which the specimens failed to comply in the preceding tests (i.e. a lot which meets the hardness and impact criteria but which has been rejected due to low elongation shall be re-tested to verify tensile properties). Specimens for all re-tests shall be taken in the same manner as the initial test specimen. Tubulars that fail to meet the requirements of clause 7 shall be rejected.

A.6.4 SR12.4 Acceptable impact strength for any lot of casing

Subsequent to impact testing, the mean and standard deviation shall be calculated for the average transverse impact values. This calculation shall be made including the data for all lengths rejected due to low impact strength. The lot minimum impact strength shall be estimated (based on the sample data) as follows:

Impact Test Lot Minimum = (Lot Mean) – F × (Lot Standard Deviation)

where F is determined in Table C.70 (SR12.1) or Table E.70 (SR12.1).

A.6.5 SR12.5 Lot acceptance/rejection

The lot shall be accepted provided the Impact Test Lot Minimum is greater than or equal to C_V determined in 7.4, 7.5 or 7.6 (as applicable). If the Impact Test Lot Minimum is less than C_V, then additional random joints may be selected for testing. The Lot Mean, Lot Standard Deviation, and Impact Test Lot Minimum shall be determined as above based on all the data and the new F value. The new Impact Test Lot Minimum shall exceed C_V determined in 7.4, 7.5 or 7.6 or the lot shall be rejected. Additional random samples may be taken from additional pipes as many times as necessary. If the casing is rejected as a lot, then each length may be tested to demonstrate that it meets the minimum impact requirements of 7.4, 7.5 or 7.6 (as applicable).

NOTE 1 Explanation of testing frequency [see A.6.2 (SR12.2)]: Since a string of casing consists of more than one length of pipe, analysis should consider the probability that the string includes one or more lengths whose impact properties do not meet the desired minimum.

Table C.71 (SR12.2) or Table E.71 (SR12.2) gives the probability of a pipe string of 100 lengths including one or more unacceptable lengths. If the probability of any length being unacceptable is 1 in 1 000 then there is a 10 % chance that the pipe string will include one or more unacceptable lengths. If the probability of any length being unacceptable is 1 in 10 000, then there is a 1 % chance that the pipe string will include one or more unacceptable lengths. The statistical model used for the examination frequency is designed to yield an individual tube reliability of 99,9 %. A typical confidence limit of 95 % is used with a tolerance interval approach, since the standard deviation is neither well established nor expected to be consistent for all manufacturers, product sizes, heat treatments, chemistries, etc.

The tolerance interval approach assumes that the standard deviation is not well known. The F factor is large because it includes variations that can be expected in the standard deviation. For example, if the impact requirement is 27 J (20 ft·lb), 5 lengths are sampled and the standard deviation is determined to be 4,1 then the F factor is 7,501 (7.501). For the lot to be acceptable, the average transverse impact value shall exceed 27 + (7,501 × 4,1) or 58 J [20 + (7.501 × 3.0) or 43 ft·lb]. If 10 lengths had been sampled and the standard deviation was still 4,1, then the average impact value shall exceed 27 + (5,203 × 4,1) or 48 J [20 + (5.203 × 3.0) or 36 ft·lb]. If the standard deviation from a mill is well known, then the F factor is taken for an infinite number of samples of F = 3,090 (3.090). Assuming the standard deviation for an infinite number of samples from a given size tubular and one mill is 4,1, then the average impact value shall exceed 27 + (3,090 × 4,1) or 40 J [20 + (3.090 × 3.0) or 29 ft·lb]. The method is applicable to both SI and USC units.

NOTE 2 The procedure of A.6 (SR 12) is taken from the National Bureau of Standards, Handbook 91, U.S. Department of Commerce, Experimental Statistics. Table C.70 (SR12.1) or Table E.70 (SR12.1) comes from Table A-7 in the above. The procedure to calculate the mean and standard deviation for the average transverse impact strength for the lot comes from the above, Chapter 1, Basic Statistical Concepts and Preliminary Considerations, clause 1-6.

A.7 SR13 Seal-ring couplings

A.7.1 SR13.1 Seal-ring groove

Seal-ring couplings shall be grooved in accordance with dimensions and tolerance specified in Figures D.18 (SR13.1) to D.21 (SR13.4). Grooves may be cut before or after threading at manufacturer's option. Grooves and threads shall be free of fins, wickers and ribbons that are loose or can become loose and fold into the thread form. Couplings shall be inspected after final machining of the groove. The inspection shall be by the wet fluorescent magnetic particle method, using a circumferentially oriented magnetic field, or by another non-destructive method of equal sensitivity as demonstrated to the purchaser. The inspection shall encompass both the inside and outside surfaces. The inspection shall exclude the dry magnetic particle method.

A.7.2 SR13.2 Non-metallic ring

Dimensions and tolerances of non-metallic rings for seal-ring couplings shall be as specified in Figures D.18 (SR13.1) to D.21 (SR13.4). Rings shall be made from virgin polytetrafluoroethylene (PTFE) with 25 % fibreglass filler. The starting PTFE shall be free of filler.

A.7.3 SR13.3

All couplings that meet the requirements of A.7 (SR13) shall be marked "S13".

NOTE The seal-ring and groove dimensions are not the same as those used historically, and may not be interchangeable with them.

A.8 SR15 Test certificates

A.8.1 SR15.1

The manufacturer shall provide the following data, as applicable, for each item for which this Supplementary Requirement is specified on the purchase agreement. The manufacturer's certificate shall cite this International Standard, and revision date thereof, to which pipe was manufactured.

a) SR15.1.1

Specified diameter, wall thickness, grade, process of manufacture, and type of heat treatment.

b) SR15.1.2

Chemical analyses (heat, product, control, and re-check) showing the mass fraction, expressed as a percent, of all elements whose limits or reporting requirements are set in this International Standard.

c) SR15.1.3

Test data for all tensile tests required by this International Standard, including yield strength, ultimate tensile strength, elongation. The type, size and orientation of specimens shall be shown.

When elongation is recorded or reported, the record or report shall show the nominal width of the test specimen when strip specimens are used, the diameter and gauge length when round-bar specimens are used, or it shall state when full-section specimens are used.

d) SR15.1.4

Impact test results [including the test criteria, and the size, location and orientation of the test specimen, the nominal test temperature (i.e. the actual test temperature, including the sub-size temperature reduction if

applicable) the absorbed energy measured for each test specimen, the percent shear area, and the average absorbed energy for each test] where such testing is required by this International Standard.

e) SR15.1.5

Hardness test results (including test type and criterion, and specimen location and orientation), where such testing is required.

f) SR15.1.6

Minimum hydrostatic test pressure and duration.

g) SR15.1.7

For welded pipe for which non-destructive examination of the weld seam is required by this International Standard, the method of NDE employed (ultrasonic, electromagnetic, and/or magnetic particle), and the type of reference standard.

h) SR15.1.8

For seamless pipe for which NDE is specified by the purchaser (either in the body of this International Standard, Supplementary Requirements, or in the purchase agreement), the method of inspection employed (ultrasonic, electromagnetic, or magnetic particle), and the type and size of the reference standard used.

i) SR15.1.9

For electric-welded pipe, the minimum temperature for heat treatment of the weld seam. Where such heat treatment is not performed, "No Seam Heat Treatment" shall be stated on the certificate.

j) SR15.1.10

Results of any supplemental testing required by the purchaser.

A.8.2 SR15.2

The manufacturer shall establish and follow procedures for maintaining heat and lot identity of all pipe covered by this Supplementary Requirement. The procedures shall provide means for tracing any length of pipe or coupling to the proper heat and lot, and to all applicable chemical and mechanical test results.

A.9 SR 16 Impact testing (Charpy V-notch) for pipe

A.9.1 SR16.1 Testing requirements

When A.9 (SR16) is specified on the purchase agreement for Group 1 Grade N80Q, Group 2 (except M65), and Group 3, the testing provisions of 10.7, which are optional for the manufacturer in accordance with 7.5.6, become mandatory. When A.9 (SR16) is specified on the purchase agreement for Group 1 grades H40, J55, K55 and N80 Type 1, the requirements in A.9.2 are mandatory.

A.9.2 SR16.2 Charpy V-notch test—General requirements

A.9.2.1 General

A test shall consist of three specimens from a pipe, taken from each lot in accordance with 10.2. The average result from the three impact specimens shall equal or exceed the absorbed energy requirement specified in A.9.3 (SR16.3). In addition, not more than one impact specimen shall exhibit an absorbed energy below the absorbed energy requirement, and in no case shall an individual impact specimen exhibit an absorbed energy below two-thirds of the absorbed energy requirement.

A.9.2.2 SR16.2.1 Specimen size

Table C.72 (SR16.1) or Table E.72 (SR16.1) provides the calculated wall thickness required to machine full-size, 3/4-size, and 1/2-size transverse impact test specimens. Table C.73 (SR16.2) or Table E.73 (SR16.2) provides the same information for longitudinal impact test specimens. The impact test specimen size that shall be selected from Tables C.72 (SR16.1) or C.73 (SR16.2) or Table E.72 (SR16.1) or Table E.73 (SR16.2) is the largest impact test specimen having a calculated wall thickness that is less than the specified wall thickness for the pipe tested.

When the use of full-size (10 mm × 10 mm) transverse test specimens is not possible, the largest possible sub-size transverse test specimen listed in Table C.74 (SR16.3) or Table E.74 (SR16.3) shall be used. When it is not possible (or allowed in accordance with A.9.2.4 [SR16.2.4]) to test using any of these transverse test specimens, the largest possible longitudinal test specimen listed in Table C.74 (SR16.3) or Table E.74 (SR16.3) shall be used.

When the outside diameter or wall thickness precludes machining longitudinal impact test specimens 1/2-size or larger, the pipe need not be tested; however, the manufacturer shall use a chemical composition and processing that is documented and demonstrated to result in impact energy absorption in excess of the minimum specified requirement.

A.9.2.3 SR16.2.2 Specimen allowance for outside diameter curvature

The surface of the finish machined transverse test specimens may contain the outside diameter curvature of the original tubular product provided that the requirements of Figure D.22 (SR16.1) are met. These specimens shall be used only to permit the use of a transverse specimen of maximum thickness.

A.9.2.4 SR16.2.3 Hierarchy of test specimens

The hierarchy of test specimen orientation and size is as specified in Table C.75 (SR16.4) or Table E.75 (SR16.4).

A.9.2.5 SR16.2.4 Alternative-size impact test specimens

At the manufacturer's option, alternative-size impact test specimens, listed in Table C.74 (SR16.3) or Table E.74 (SR16.3), may be used in lieu of the minimum size specified in the tables referenced in A.9.2.1 (SR16.2.1). However, the alternative test specimen size shall be higher on the hierarchy table [Table C.75 (SR16.4) or Table E.75 (SR16.4)] than the specified size, and the absorbed energy requirement shall be adjusted consistent with the impact specimen orientation and size selected.

A.9.2.6 SR16.2.5 Absorbed energy requirement for sub-size specimens

The minimum Charpy V-notch (CVN) absorbed energy requirement, C_V, for sub-size test specimens shall be that specified for a full-size test specimen multiplied by the reduction factor in Table C.74 (SR16.3) or Table E.74 (SR16.3); however, in no event shall a sub-size test specimen be used if the reduced absorbed energy requirement is less than 11 J (8 ft·lb).

A.9.3 SR16.3 Charpy V-notch—Impact requirements for pipe and for externally threaded accessory material

A.9.3.1 SR16.3.1 Grade H40 only

The minimum full-size transverse CVN absorbed energy requirement is C_V = 16 J (12 ft·lb) for all wall thicknesses.

The minimum full-size longitudinal CVN absorbed energy requirement is C_V = 20 J (15 ft·lb) for all wall thicknesses.

A.9.3.2 SR16.3.2 Grades J55 and K55 only

The minimum full-size transverse CVN absorbed energy requirement is C_V = 20 J (15 ft·lb) for all wall thicknesses.

The minimum full-size longitudinal CVN absorbed energy requirement is C_V = 27 J (20 ft·lb) for all wall thicknesses.

A.9.3.3 SR16.3.3 Grade N80 Type 1

A.9.3.3.1 The minimum CVN absorbed energy requirement for full-size test specimens for pipe is provided in Table C.76 (SR16.5) or Table C.77 (SR16.6), or Table E.76 (SR16.5) or Table E.77 (SR16.6).

A.9.3.3.2 **For SI units** the requirements are calculated based on the equations given in a) and b) below, where

YS_{min} is the minimum specified yield strength, in megapascals (552 MPa), and

t is the specified wall thickness, in millimetres.

a) Transverse requirement

C_V (joules) = YS_{min} (0,001 18 t + 0,012 59) or 14 J whichever is greater.

b) Longitudinal requirement

C_V (joules) = YS_{min} (0,002 36 t + 0,025 18) or 27 J whichever is greater.

A.9.3.3.3 **For USC units** the requirements are calculated based on the equations given in c) and d) below, where

YS_{min} is the minimum specified yield strength, in thousands of pounds per square inch (80 ksi), and

t is the specified wall thickness, in inches.

a) Transverse requirement

C_V (foot pounds) = YS_{min} (0.152 t + 0.064) or 10 ft·lb whichever is greater.

b) Longitudinal requirement

C_V (foot pounds) = YS_{min} (0.304 t + 0.128) or 20 ft·lb whichever is greater.

A.9.4 SR16.4 Accessories with integral joint ISO/API tubing connections and extreme line casing connections

The requirements in 7.4 shall apply. The critical thickness shall be as specified in 7.3.2 and 7.6.6.

A.9.5 SR16.5 Accessories with internal special end finish connections that do not have thread interference

The requirements in A.9.3 (SR16.3) apply. The critical thickness shall be as specified in 7.3.2 and 7.6.6.

A.9.6 SR16.6 Impact test procedures

A.9.6.1 SR16.6.1 General procedures

CVN Type A impact tests shall be conducted as specified in ISO 6892 or ASTM A370 and ASTM E23. When transverse impact test specimens are used for EW pipe, the test specimen shall be machined with the notch at the weld line. When longitudinal impact test specimens are used for EW pipe, the test specimens shall be taken from a location approximately 90° from the weld. Impact test specimens shall not be machined from flattened tubulars.

A.9.6.2 SR16.6.2 Specimen orientation

Specimen orientation shall be in accordance with Figure D.12.

A.9.6.3 SR16.6.3 Test temperature

The test temperature for full-size test specimens shall be specified by the purchaser as:

a) + 21 °C (+ 70 °F), or

b) 0 °C (+ 32 °F), or

c) – 10 °C (+ 14 °F), or

d) other temperature as specified on the purchase agreement.

The tolerance on the test temperature for full-size test specimens shall be ± 3 °C (± 5 °F).

The test temperature shall be reduced as specified in A.9.6.5 (SR16.5.5) for Grades H40, J55 and K55 when sub-size test specimens are required.

NOTE The Grades H40, J55 and K55 are low strength steels considered to be loading rate sensitive. Increasing the loading rate from that generally occurring in the use of the product to the loading rate occurring in the impact testing of the Charpy specimens results in shifting the fracture transition to higher temperatures. Thus, the fracture transition behaviour of the product would be expected to occur at temperatures less than those obtained with Charpy testing. In most applications, testing Grades H40, J55 and K55 at + 21 °C (+ 70 °F) and higher strength grades at 0 °C (+ 32 °F) should be adequate. When the pipe will be handled at temperatures below – 18 °C (0 °F), a lower impact test temperature may be appropriate.

A.9.6.4 SR16.6.4 Defective specimens

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

A.9.6.5 SR16.6.5 Sub-size test temperature reduction—Grades H40, J55 and K55 only

A test temperature reduction may be required when sub-size test specimens are used. The test temperature reduction depends on the thickness of the pipe and the size of the impact test specimen.

The test temperature reduction specified in Table C.78 (SR16.7) or Table E.78 (SR 16.7) shall be used when applicable.

A.9.6.6 SR16.6.6 Frequency of testing

One test shall be taken from one pipe from each lot.

A.9.6.7 SR16.6.7 Reject of a pipe or accessory

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

A.9.6.8 SR16.6.8 Replacement of a reject pipe or accessory

If the results of a test do not meet the requirements of A.9.3 (SR16.3), A.9.4 (SR16.4) or A.9.5 (SR16.5) as applicable and do not qualify for re-testing accordance with A.9.6.7 (SR16.6.7), then an additional three test specimens shall be removed from each of three additional pipes from the lot. If all the additional pipes tested conform to the requirements, then the lot shall be qualified except for the pipe that was initially rejected. If one or more of the additional test pipes fail to conform to the specified requirements, the manufacturer may elect to test individually the remaining pipe in the lot or re-heat treat and re-test the lot.

A.9.6.9 SR16.6.9 Rounding procedures

For purposes of determining conformance with these requirements, an observed value shall be rounded to the nearest whole number in accordance with the rounding method of ISO 31-0 or ASTM E29. Further, limiting values as specified or calculated shall be expressed as whole numbers, rounded if necessary.

A.9.7 SR16.7 Reporting

The size and orientation of the test specimen (i.e. full-size, 3/4-size, or 1/2-size), the actual test temperature (i.e. specified temperature less the test temperature reduction that may be applicable for Grades H40, J55, and K55), the results of the individual specimens (i.e. the impact energy absorption, in joules, and the percentage shear), and the average absorbed energy shall be reported to the purchaser.

A.9.8 SR16.8 Marking

Pipe tested in accordance with this supplementary requirement shall be marked to indicate clause A.9 (SR16), the minimum full-size energy absorption requirement, and the specified test temperature (i.e. not including the test temperature reduction that may be applicable for Grades H40, J55 and K55) preceded by a positive or negative sign. This marking shall be paint-stencilled after the grade designation.

Example for SI units: S16-20-10C

Example for USC units: S16-15+14F

Annex B
(normative)

Purchaser inspection

B.1 Inspection notice

Where the inspector representing the purchaser desires to inspect the pipe or witness a test, reasonable notice shall be given of the time at which the run is to be made.

B.2 Plant access

The inspector representing the purchaser shall have unrestricted access at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which will concern the manufacturer of the pipe or couplings ordered. The manufacturer shall afford the inspector all reasonable facilities to satisfy him that the pipe is being manufactured in accordance with this International Standard. All inspections should be made at the place of manufacture or processing prior to shipment, unless otherwise specified on the purchase agreement, and shall be so conducted as not to interfere unnecessarily with the operation of the works.

B.3 Compliance

The manufacturer is responsible for complying with all of the provisions of this International Standard. The purchaser may make any investigation necessary to satisfy himself of compliance by the manufacturer and may reject any material that does not comply with this International Standard.

B.4 Rejection

Unless otherwise provided, material which shows defects on inspection or subsequent to acceptance at manufacturer's works, or which proves defective when properly applied in service, may be rejected, and the manufacturer so notified. If tests that require the destruction of material are made, any product which is proven to have not met the requirements of this International Standard shall be rejected. Disposition of rejected product shall be a matter of agreement between purchaser and manufacturer.

Annex C
(normative)

Tables in SI units

Table C.1—ISO/API casing list

Sizes, masses, wall thickness, grade and applicable end-finish

Labels[a]		Outside diameter	Nominal linear mass[b,c] T&C	Wall thickness	Type of end-finish							
1	2	*D* mm	kg/m	*t* mm	H40	J55 K55	M65	L80 C95	N80 Type 1,Q	C90[d] T95[d]	P110	Q125[d]
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*
4-1/2	9.50	114,30	14,14	5,21	PS	PS	PS	—	—	—	—	—
4-1/2	10.50	114,30	15,63	5,69	—	PSB	PSB	—	—	—	—	—
4-1/2	11.60	114,30	17,26	6,35	—	PSLB	PLB	PLB	PLB	PLB	PLB	—
4-1/2	13.50	114,30	20,09	7,37	—	—	PLB	PLB	PLB	PLB	PLB	—
4-1/2	15.10	114,30	22,47	8,56	—	—	—	—	—	—	PLB	PLB
5	11.50	127,00	17,11	5,59	—	PS	PS	—	—	—	—	—
5	13.00	127,00	19,35	6,43	—	PSLB	PSLB	—	—	—	—	—
5	15.00	127,00	22,32	7,52	—	PSLBE	PLB	PLBE	PLBE	PLBE	PLBE	—
5	18.00	127,00	26,79	9,19	—	—	PLB	PLBE	PLBE	PLBE	PLBE	PLBE
5	21.40	127,00	31,85	11,10	—	—	PLB	PLB	PLB	PLB	PLB	PLB
5	23.20	127,00	34,53	12,14	—	—	—	PLB	PLB	PLB	PLB	PLB
5	24.10	127,00	35,86	12,70	—	—	—	PLB	PLB	PLB	PLB	PLB
5-1/2	14.00	139,70	20,83	6,20	PS	PS	PS	—	—	—	—	—
5-1/2	15.50	139,70	23,07	6,98	—	PSLBE	PSLB	—	—	—	—	—
5-1/2	17.00	139,70	25,30	7,72	—	PSLBE	PLB	PLBE	PLBE	PLBE	PLBE	—
5-1/2	20.00	139,70	29,76	9,17	—	—	PLB	PLBE	PLBE	PLBE	PLBE	—
5-1/2	23.00	139,70	34,23	10,54	—	—	PLB	PLBE	PLBE	PLBE	PLBE	PLBE
5-1/2	26.80	139,70	39,88	12,70	—	—	—	—	—	P	—	—
5-1/2	29.70	139,70	44,20	14,27	—	—	—	—	—	P	—	—
5-1/2	32.60	139,70	48,51	15,88	—	—	—	—	—	P	—	—
5-1/2	35.30	139,70	52,53	17,45	—	—	—	—	—	P	—	—
5-1/2	38.00	139,70	56,55	19,05	—	—	—	—	—	P	—	—
5-1/2	40.50	139,70	60,27	20,62	—	—	—	—	—	P	—	—
5-1/2	43.10	139,70	64,14	22,22	—	—	—	—	—	P	—	
6-5/8	20.00	168,28	29,76	7,32	PS	PSLB	PSLB	—	—	—	—	—
6-5/8	24.00	168,28	35,72	8,94	—	PSLBE	PLB	PLBE	PLBE	PLBE	PLBE	—
6-5/8	28.00	168,28	41,67	10,59	—	—	PLB	PLBE	PLBE	PLBE	PLBE	—
6-5/8	32.00	168,28	47,62	12,06	—	—	—	PLBE	PLBE	PLBE	PLBE	PLBE
7	17.00	177,80	25,30	5,87	PS	—	—	—	—	—	—	—
7	20.00	177,80	29,76	6,91	PS	PS	PS	—	—	—	—	—
7	23.00	177,80	34,23	8,05	—	PSLBE	PLB	PLBE	PLBE	PLBE	—	—
7	26.00	177,80	38,69	9,19	—	PSLBE	PLB	PLBE	PLBE	PLBE	PLBE	—
7	29.00	177,80	43,16	10,36	—	—	PLB	PLBE	PLBE	PLBE	PLBE	—
7	32.00	177,80	47,62	11,51	—	—	PLB	PLBE	PLBE	PLBE	PLBE	—
7	35.00	177,80	52,09	12,65	—	—	—	PLBE	PLBE	PLBE	PLBE	PLBE
7	38.00	177,80	56,55	13,72	—	—	—	PLBE	PLBE	PLBE	PLBE	PLBE
7	42.70	177,80	63,54	15,88	—	—	—	—	—	P	—	—
7	46.40	177,80	69,05	17,45	—	—	—	—	—	P	—	—
7	50.10	177,80	74,56	19,05	—	—	—	—	—	P	—	—
7	53.60	177,80	79,77	20,62	—	—	—	—	—	P	—	—
7	57.10	177,80	84,97	22,22	—	—	—	—	—	P	—	—

See notes at end of table.

Table C.1 (*continued*)

Labels[a]		Outside diameter	Nominal linear mass[b,c] T&C	Wall thickness	Type of end-finish							
1	2	*D* mm	kg/m	*t* mm	H40	J55 K55	M65	L80 C95	N80 Type 1,Q	C90[d] T95[d]	P110	Q125[d]
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*
7-5/8	24.00	193,68	35,72	7,62	PS	—	—	—	—	—	—	—
7-5/8	26.40	193,68	39,29	8,33	—	PSLBE	PSLB	PLBE	PLBE	PLBE	—	—
7-5/8	29.70	193,68	44,20	9,52	—	—	PLB	PLBE	PLBE	PLBE	PLBE	—
7-5/8	33.70	193,68	50,15	10,92	—	—	PLB	PLBE	PLBE	PLBE	PLBE	—
7-5/8	39.00	193,68	58,04	12,70	—	—	—	PLBE	PLBE	PLBE	PLBE	PLBE
7-5/8	42.80	193,68	63,69	14,27	—	—	—	PLB	PLB	PLB	PLB	PLB
7-5/8	45.30	193,68	67,41	15,11	—	—	—	PLB	PLB	PLB	PLB	PLB
7-5/8	47.10	193,68	70,09	15,88	—	—	—	PLB	PLB	PLB	PLB	PLB
7-5/8	51.20	193,68	76,19	17,45	—	—	—	—	—	P	—	—
7-5/8	55.30	193,68	82,30	19,05	—	—	—	—	—	P	—	—
7-3/4	46.10	196,85	68,60	15,11	—	—	—	P	P	P	P	P
8-5/8	24.00	219,08	35,72	6,71	—	PS	PS	—	—	—	—	—
8-5/8	28.00	219,08	41,67	7,72	PS	—	PS	—	—	—	—	—
8-5/8	32.00	219,08	47,62	8,94	PS	PSLBE	PSLB	—	—	—	—	—
8-5/8	36.00	219,08	53,57	10,16	—	PSLBE	PSLB	PLBE	PLBE	PLBE	—	—
8-5/8	40.00	219,08	59,53	11,43	—	—	PLB	PLBE	PLBE	PLBE	PLBE	—
8-5/8	44.00	219,08	65,48	12,70	—	—	—	PLBE	PLBE	PLBE	PLBE	—
8-5/8	49.00	219,08	72,92	14,15	—	—	—	PLBE	PLBE	PLBE	PLBE	PLBE
9-5/8	32.30	244,48	48,07	7,92	PS	—	—	—	—	—	—	—
9-5/8	36.00	244,48	53,57	8,94	PS	PSLB	PSLB	—	—	—	—	—
9-5/8	40.00	244,48	59,53	10,03	—	PSLBE	PSLB	PLBE	PLBE	PLBE	—	—
9-5/8	43.50	244,48	64,73	11,05	—	—	PLB	PLBE	PLBE	PLBE	PLBE	—
9-5/8	47.00	244,48	69,94	11,99	—	—	PLB	PLBE	PLBE	PLBE	PLBE	PLBE
9-5/8	53.50	244,48	79,62	13,84	—	—	—	PLBE	PLBE	PLBE	PLBE	PLBE
9-5/8	58.40	244,48	86,91	15,11	—	—	—	PLB	PLB	PLB	PLB	PLB
9-5/8	59.40	244,48	88,40	15,47	—	—	—	—	—	P	—	—
9-5/8	64.90	244,48	96,58	17,07	—	—	—	—	—	P	—	—
9-5/8	70.30	244,48	104,62	18,64	—	—	—	—	—	P	—	—
9-5/8	75.60	244,48	112,50	20,24	—	—	—	—	—	P	—	—
10-3/4	32.75	273,05	48,74	7,09	PS	—	—	—	—	—	—	—
10-3/4	40.50	273,05	60,27	8,89	PS	PSB	PSB	—	—	—	—	—
10-3/4	45.50	273,05	67,71	10,16	—	PSBE	PSB	—	—	—	—	—
10-3/4	51.00	273,05	75,90	11,43	—	PSBE	PSB	PSBE	PSBE	PSBE	PSBE	—
10-3/4	55.50	273,05	82,59	12,57	—	—	PSB	PSBE	PSBE	PSBE	PSBE	—
10-3/4	60.70	273,05	90,33	13,84	—	—	—	—	—	PSBE	PSBE	PSBE
10-3/4	65.70	273,05	97,77	15,11	—	—	—	—	—	PSB	PSB	PSB
10-3/4	73.20	273,05	108,93	17,07	—	—	—	—	—	P	—	—
10-3/4	79.20	273,05	117,86	18,64	—	—	—	—	—	P	—	—
10-3/4	85.30	273,05	126,94	20,24	—	—	—	—	—	P	—	—
11-3/4	42.00	298,45	62,50	8,46	PS	—	—	—	—	—	—	—
11-3/4	47.00	298,45	69,94	9,53	—	PSB	PSB	—	—	—	—	—
11-3/4	54.00	298,45	80,36	11,05	—	PSB	PSB	—	—	—	—	—
11-3/4	60.00	298,45	89,29	12,42	—	PSB	PSB	PSB	PSB	PSB	PSB	PSB
11-3/4	65.00	298,45	96,73	13,56	—	—	—	P	P	P	P	P
11-3/4	71.00	298,45	105,66	14,78	—	—	—	P	P	P	P	P
13-3/8	48.00	339,72	71,43	8,38	PS	—	—	—	—	—	—	—
13-3/8	54.50	339,72	81,10	9,65	—	PSB	PSB	—	—	—	—	—
13-3/8	61.00	339,72	90,78	10,92	—	PSB	PSB	—	—	—	—	—
13-3/8	68.00	339,72	101,19	12,19	—	PSB	PSB	PSB	PSB	PSB	PSB	—
13-3/8	72.00	339,72	107,15	13,06	—	—	—	PSB	PSB	PSB	PSB	PSB

See notes at end of table.

Table C.1 (*continued*)

Labels[a]		Outside diameter	Nominal linear mass[b,c] T&C	Wall thickness	Type of end-finish							
1	2	*D* mm	kg/m	*t* mm	H40	J55 K55	M65	L80 C95	N80 Type 1,Q	C90[d] T95[d]	P110	Q125[d]
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*
16	65.00	406,40	96,73	9,53	PS	—	—	—	—	—	—	—
16	75.00	406,40	111,61	11,13	—	PSB	PSB	—	—	—	—	—
16	84.00	406,40	125,01	12,57	—	PSB	PSB	—	—	—	—	—
16	109.00	406,40	162,21	16,66	—	P	—	P	P	—	P	P
18-5/8	87.50	473,08	130,21	11,05	PS	PSB	PSB	—	—	—	—	—
20	94.00	508,00	139,89	11,13	PSL	PSLB	PSLB	—	—	—	—	—
20	106.50	508,00	158,49	12,70	—	PSLB	PSLB	—	—	—	—	—
20	133.00	508,00	197,93	16,13	—	PSLB	—	—	—	—	—	—

P = Plain end, S = Short round thread, L = Long round thread, B = Buttress thread, E = Extreme-line.

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

[b] Nominal linear masses, threaded and coupled (col. 2) are shown for information only.

[c] The densities of martensitic chromium steels (L80 types 9Cr and 13Cr) are different from carbon steels. The masses shown are therefore not accurate for martensitic chromium steels. A mass correction factor of 0,989 may be used.

[d] Grade C90, T95 and Q125 casing shall be furnished in sizes, masses and wall thicknesses listed above or as shown on the purchase agreement.

Table C.2—ISO/API plain-end casing liner list—Grade J55

Labels		Outside diameter *D*	Plain-end linear mass	Wall thickness *t*
1	2	mm	kg/m	mm
3-1/2	9.92	88,90	14,76	7,34
4	11.35	101,60	16,89	7,26
4-1/2	13.05	114,30	19,42	7,37
5	17.95	127,00	26,71	9,19
5-1/2	19.83	139,70	29,51	9,17
6-5/8	27.66	168,28	41,18	10,59

Table C.3—ISO/API tubing list

Sizes, masses, wall thickness, grade and applicable end-finish

Labels				Outside diameter	Nominal linear masses[a,b]			Wall thick'ss	Type of end finish[c]						
1	2				Non-upset T&C	Ext. upset T&C	Integ. joint		H40	J55	L80	N80	C90 [d]	T95 [d]	P110
	NU T&C	EU T&C	IJ	*D*				*t*				Type 1,Q			
				mm	kg/m	kg/m	kg/m	mm							
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*
1.050	1.14	1.20	—	26,67	1,70	1,79	—	2,87	PNU	PNU	PNU	PNU	PNU	PNU	—
1.050	1.48	1.54	—	26,67	2,20	2,29	—	3,91	PU	PU	PU	PU	PU	PU	PU
1.315	1.70	1.80	1.72	33,40	2,53	2,68	2,56	3,38	PNUI	PNUI	PNUI	PNUI	PNUI	PNUI	—
1.315	2.19	2.24	—	33,40	3,26	3,33	—	4,55	PU	PU	PU	PU	PU	PU	PU
1.660	2.09	—	2.10	42,16	—	—	3,13	3,18	PI	PI	—	—	—	—	—
1.660	2.30	2.40	2.33	42,16	3,42	3,57	3,47	3,56	PNUI	PNUI	PNUI	PNUI	PNUI	PNUI	—
1.660	3.03	3.07	—	42,16	4,51	4,57	—	4,85	PU	PU	PU	PU	PU	PU	PU
1.900	2.40	—	2.40	48,26	—	—	3,57	3,18	PI	PI	—	—	—	—	—
1.900	2.75	2.90	2.76	48,26	4,09	4,32	4,11	3,68	PNUI	PNUI	PNUI	PNUI	PNUI	PNUI	—
1.900	3.65	3.73	—	48,26	5,43	5,55	—	5,08	PU	PU	PU	PU	PU	PU	PU
1.900	4.42	—	—	48,26	6,58	—	—	6,35	—	—	P	—	P	P	—
1.900	5.15	—	—	48,26	7,66	—	—	7,62	—	—	P	—	P	P	—
2.063	3.24	—	3.25	52,40	—	—	4,84	3,96	PI	PI	PI	PI	PI	PI	—
2.063	4.50	—	—	52,40	—	—	—	5,72	P	P	P	P	P	P	P
2-3/8	4.00	—	—	60,32	5,95	—	—	4,24	PN	PN	PN	PN	PN	PN	—
2-3/8	4.60	4.70	—	60,32	6,85	6,99	—	4,83	PNU	PNU	PNU	PNU	PNU	PNU	PNU
2-3/8	5.80	5.95	—	60,32	8,63	8,85	—	6,45	—	—	PNU	PNU	PNU	PNU	PNU
2-3/8	6.60	—	—	60,32	9,82	—	—	7,49	—	—	P	—	P	P	—
2-3/8	7.35	7.45	—	60,32	10,94	11,09	—	8,53	—	—	PU	—	PU	PU	—
2-7/8	6.40	6.50	—	73,02	9,52	9,67	—	5,51	PNU	PNU	PNU	PNU	PNU	PNU	PNU
2-7/8	7.80	7.90	—	73,02	11,61	11,76	—	7,01	—	—	PNU	PNU	PNU	PNU	PNU
2-7/8	8.60	8.70	—	73,02	12,80	12,95	—	7,82	—	—	PNU	PNU	PNU	PNU	PNU
2-7/8	9.35	9.45	—	73,02	13,91	14,06	—	8,64	—	—	PU	—	PU	PU	—
2-7/8	10.50	—	—	73,02	15,63	—	—	9,96	—	—	P	—	P	P	—
2-7/8	11.50	—	—	73,02	17,11	—	—	11,18	—	—	P	—	P	P	—
3-1/2	7.70	—	—	88,90	11,46	—	—	5,49	PN	PN	PN	PN	PN	PN	—
3-1/2	9.20	9.30	—	88,90	13,69	13,84	—	6,45	PNU	PNU	PNU	PNU	PNU	PNU	PNU
3-1/2	10.20	—	—	88,90	15,18	—	—	7,34	PN	PN	PN	PN	PN	PN	—
3-1/2	12.70	12.95	—	88,90	18,90	19,27	—	9,52	—	—	PNU	PNU	PNU	PNU	PNU
3-1/2	14.30	—	—	88,90	21,28	—	—	10,92	—	—	P	—	P	P	—
3-1/2	15.50	—	—	88,90	23,07	—	—	12,09	—	—	P	—	P	P	—
3-1/2	17.00	—	—	88,90	25,30	—	—	13,46	—	—	P	—	P	P	—
4	9.50	—	—	101,60	14,14	—	—	5,74	PN	PN	PN	PN	PN	PN	—
4	10.70	11.00	—	101,60	—	16,37	—	6,65	PU	PU	PU	PU	PU	PU	—
4	13.20	—	—	101,60	19,64	—	—	8,38	—	—	P	—	P	P	—
4	16.10	—	—	101,60	23,96	—	—	10,54	—	—	P	—	P	P	—
4	18.90	—	—	101,60	28,13	—	—	12,70	—	—	P	—	P	P	—
4	22.20	—	—	101,60	33,04	—	—	15,49	—	—	P	—	P	P	—
4-1/2	12.60	12.75	—	114,30	18,75	18,97	—	6,88	PNU	PNU	PNU	PNU	PNU	PNU	—
4-1/2	15.20	—	—	114,30	22,62	—	—	8,56	—	—	P	—	P	P	—
4-1/2	17.00	—	—	114,30	25,30	—	—	9,65	—	—	P	—	P	P	—
4-1/2	18.90	—	—	114,30	28,13	—	—	10,92	—	—	P	—	P	P	—
4-1/2	21.50	—	—	114,30	32,00	—	—	12,70	—	—	P	—	P	P	—
4-1/2	23.70	—	—	114,30	35,27	—	—	14,22	—	—	P	—	P	P	—
4-1/2	26.10	—	—	114,30	38,84	—	—	16,00	—	—	P	—	P	P	—

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

[a] Nominal linear masses, threads and coupling (col. 2, 3, 4) are shown for information only.

[b] The densities of martensitic chromium steels (L80 types 9Cr and 13Cr) are different from carbon steels. The masses shown are therefore not accurate for martensitic chromium steels. A mass correction factor of 0,989 may be used.

[c] Non-upset tubing is available with regular couplings or special bevel couplings. External-upset tubing is available with regular, special-bevel, or special clearance couplings.

[d] Grade C90 and T95 tubing shall be furnished in sizes, masses, and wall thicknesses as listed above, or as shown on the purchase agreement.

Table C.4—Process of manufacture and heat treatment

Group	Grade	Type	Manufacturing process [a]	Heat treatment	Tempering temperature min. °C
1	*2*	*3*	*4*	*5*	*6*
1	H40	—	S or EW	None	—
	J55	—	S or EW	None [b]	—
	K55	—	S or EW	None [b]	—
	N80	1	S or EW	[c]	—
	N80	Q	S or EW	Q&T	—
2	M65	—	S or EW	[d]	—
	L80	1	S or EW	Q&T	566
	L80	9Cr	S	Q&T [e]	593
	L80	13Cr	S	Q&T [e]	593
	C90	1	S	Q&T	621
	C90	2	S	Q&T	621
	C95	—	S or EW	Q&T	538
	T95	1	S	Q&T	649
	T95	2	S	Q&T	649
3	P110	—	S or EW [f, g]	Q&T	—
4	Q125	1	S or EW [g]	Q&T	—
	Q125	2	S or EW [g]	Q&T	—
	Q125	3	S or EW [g]	Q&T	—
	Q125	4	S or EW [g]	Q&T	—

[a] S = seamless process; EW = electric-welded process.
[b] Full length normalized (N), normalized and tempered (N&T), or quenched and tempered (Q&T), at the manufacturer's option or as specified on the purchase agreement.
[c] Full length normalized or normalized and tempered at the manufacturer's option.
[d] All pipe shall be full body heat-treated. Full length normalized (N), normalized and tempered (N&T), or quenched and tempered (Q&T), at the manufacturer's option or as specified on the purchase agreement.
[e] Type 9Cr and 13Cr may be air-quenched.
[f] Special chemical requirements for electric-welded P110 casing are specified in Table C.5.
[g] Special requirements unique to electric-welded P110 and Q125 are specified in A.5 (SR11).

Table C.5—Chemical composition, mass fraction (%)

Group	Grade	Type	C		Mn		Mo		Cr		Ni	Cu	P	S	Si
			min.	max.	min.	max.	min.	max.	min.	max.	max.	max.	max.	max.	max.
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*
1	H40	—	—	—	—	—	—	—	—	—	—	—	0,030	0,030	—
	J55	—	—	—	—	—	—	—	—	—	—	—	0,030	0,030	—
	K55	—	—	—	—	—	—	—	—	—	—	—	0,030	0,030	—
	N80	1	—	—	—	—	—	—	—	—	—	—	0,030	0,030	—
	N80	Q	—	—	—	—	—	—	—	—	—	—	0,030	0,030	—
2	M65	—	—	—	—	—	—	—	—	—	—	—	0,030	0,030	—
	L80	1	—	0,43 [a]	—	1,90	—	—	—	—	0,25	0,35	0,030	0,030	0,45
	L80	9Cr	—	0,15	0,30	0,60	0,90	1,10	8,00	10,0	0,50	0,25	0,020	0,010	1,00
	L80	13Cr	0,15	0,22	0,25	1,00	—	—	12,0	14,0	0,50	0,25	0,020	0,010	1,00
	C90	1	—	0,35	—	1,00	0,25 [b]	0,75	—	1,20	0,99	—	0,020	0,010	—
	C90	2	—	0,50	—	1,90	—	NL	—	NL	0,99	—	0,030	0,010	—
	C95	—	—	0,45 [c]	—	1,90	—	—	—	—	—	—	0,030	0,030	0,45
	T95	1	—	0,35	—	1,20	0,25 [d]	0,85	0,40	1,50	0,99	—	0,020	0,010	—
	T95	2	—	0,50	—	1,90	—	—	—	—	0,99	—	0,030	0,010	—
3	P110	[e]	—	—	—	—	—	—	—	—	—	—	0,030 [e]	0,030 [e]	—
4	Q125	1	—	0,35		1,00	—	0,75	—	1,20	0,99	—	0,020	0,010	—
	Q125	2	—	0,35	—	1,00	—	NL	—	NL	0,99	—	0,020	0,020	—
	Q125	3	—	0,50	—	1,90	—	NL	—	NL	0,99	—	0,030	0,010	—
	Q125	4	—	0,50	—	1,90	—	NL	—	NL	0,99	—	0,030	0,020	—

[a] The carbon content for L80 may be increased up to 0,50 % maximum if the product is oil-quenched.
[b] The molybdenum content for Grade C90 Type 1 has no minimum tolerance if the wall thickness is less than 17,78 mm.
[c] The carbon content for C95 may be increased up to 0,55 % maximum if the product is oil-quenched.
[d] The molybdenum content for T95 Type 1 may be decreased to 0,15 % minimum if the wall thickness is less than 17,78 mm.
[e] For EW Grade P110 the phosphorus content shall be 0,020 % maximum and the sulfur content 0,010 % maximum.
NL = no limit. Elements shown shall be reported in product analysis.

Table C.6—Tensile and hardness requirements

Group	Grade	Type	Total elongation under load %	Yield strength MPa		Tensile strength min. MPa	Hardness [a] max.		Specified wall thickness mm	Allowable hardness variation [b] HRC
				min.	max.		HRC	HBW/HBS		
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*
1	H40	—	0,5	276	552	414	—	—	—	—
	J55	—	0,5	379	552	517	—	—	—	—
	K55	—	0,5	379	552	655	—	—	—	—
	N80	1	0,5	552	758	689	—	—	—	—
	N80	Q	0,5	552	758	689	—	—	—	—
2	M65	—	0,5	448	586	586	22	235	—	—
	L80	1	0,5	552	655	655	23	241	—	—
	L80	9Cr	0,5	552	655	655	23	241	—	—
	L80	13Cr	0,5	552	655	655	23	241	—	—
	C90	1 & 2	0,5	621	724	689	25,4	255	≤ 12,70	3,0
	C90	1 & 2	0,5	621	724	689	25,4	255	12,71 to 19,04	4,0
	C90	1 & 2	0,5	621	724	689	25,4	255	19,05 to 25,39	5,0
	C90	1 & 2	0,5	621	724	689	25,4	255	≥ 25,40	6,0
	C95	—	0,5	655	758	724	—	—	—	—
	T95	1 & 2	0,5	655	758	724	25,4	255	≤ 12,70	3,0
	T95	1 & 2	0,5	655	758	724	25,4	255	12,71 to 19,04	4,0
	T95	1 & 2	0,5	655	758	724	25,4	255	19,05 to 25,39	5,0
	T95	1 & 2	0,5	655	758	724	25,4	255	≥ 25,40	6,0
3	P110	—	0,6	758	965	862	—	—	—	—
4	Q125	All	0,65	862	1034	931	2)	—	≤ 12,70	3,0
	Q125	All	0,65	862	1034	931	2)	—	12,71 to 19,04	4,0
	Q125	All	0,65	862	1034	931	2)	—	≥ 19,05	5,0

[a] In case of dispute, laboratory Rockwell C hardness tests shall be used as the referee method.

[b] No hardness limits are prescribed, but the maximum variation is restricted as a manufacturing control in accordance with 7.8 and 7.9.

Table C.7—Elongation table

Tensile test specimen				Minimum elongation in 50,8 mm %							
				Grade							
				H40	J55	M65	K55 L80	N80 Type 1 N80Q C90	C95 T95	P110	Q125
Specimen area mm²	Specified wall thickness mm			Specified minimum tensile strength, MPa							
	Specimen width 19 mm	Specimen width 25 mm	Specimen width 38 mm	414	517	586	655	689	724	862	931
1	2	3	4	5	6	7	8	9	10	11	12
490	≥ 25,53	≥ 19,41	≥ 12,77	30	24	22	20	19	18	15	14
480	25,00-25,52	19,00-19,40	12.51-12,76	29	24	22	20	19	18	15	14
470	24,48-24,99	18,61-18,99	12,24-12,50	29	24	21	19	19	18	15	14
460	23,95-24,47	18,20-18,60	11,98-12,23	29	24	21	19	18	18	15	14
450	23,43-23,94	17,81-18,19	11,72-11,97	29	24	21	19	18	18	15	14
440	22,90-23,42	17,40-17,80	11,45-11,71	29	24	21	19	18	18	15	14
430	22,37-22,89	17,01-17,39	11,19-11,44	29	24	21	19	18	17	15	14
420	21,85-22,36	16,60-17,00	10,93-11,18	29	24	21	19	18	17	15	14
410	21,32-21,84	16,21-16,59	10,66-10,92	29	23	21	19	18	17	15	14
400	20,79-21,31	15,80-16,20	10,40-10,65	28	23	21	19	18	17	15	14
390	20,27-20,78	15,41-15,79	10,14-10,39	28	23	21	19	18	17	15	14
380	19,74-20,26	15,00-15,40	9,87-10,13	28	23	21	19	18	17	15	14
370	19,22-19,73	14,61-14,99	9,61-9,86	28	23	20	19	18	17	14	13
360	18,69-19,21	14,20-14,60	9,35-9,60	28	23	20	18	18	17	14	13
350	18,16-18,68	13,81-14,19	9,08-9,34	28	23	20	18	18	17	14	13
340	17,64-18,15	13,40-13,80	8,82-9,07	28	23	20	18	17	17	14	13
330	17,11-17,63	13,01-13,39	8,56-8,81	27	22	20	18	17	17	14	13
320	16,58-17,10	12,60-13,00	8,29-8,55	27	22	20	18	17	16	14	13
310	16,06-16,57	12,21-12,59	8,03-8,28	27	22	20	18	17	16	14	13
300	15,53-16,05	11,80-12,20	7,77-8,02	27	22	20	18	17	16	14	13
290	15,01-15,52	11,41-11,79	7,51-7,76	27	22	20	18	17	16	14	13
280	14,48-15,00	11,00-11,40	7,24-7,50	26	22	19	18	17	16	14	13
270	13,95-14,47	10,61-10,99	6,98-7,23	26	22	19	17	17	16	14	13
260	13,43-13,94	10,20-10,60	6,72-6,97	26	21	19	17	16	16	13	13
250	12,90-13,42	9,81-10,19	6,45-6,71	26	21	19	17	16	16	13	12
240	12,37-12,89	9,40-9,80	6,19-6,44	26	21	19	17	16	16	13	12
230	11,85-12,36	9,01-9,39	5,93-6,18	25	21	19	17	16	15	13	12
220	11,32-11,84	8,60-9,00	5,66-5,92	25	21	18	17	16	15	13	12
210	10,79-11,31	8,21-8,59	5,40-5,65	25	20	18	17	16	15	13	12
200	10,27-10,78	7,80-8,20	5,14-5,39	25	20	18	16	16	15	13	12
190	9,74-10,26	7,41-7,79	4,87-5,13	24	20	18	16	15	15	13	12
180	9,22-9,73	7,00-7,40	4,61-4,86	24	20	18	16	15	15	13	12
170	8,69-9,21	6,61-6,99	4,35-4,60	24	20	18	16	15	14	12	12
160	8,16-8,68	6,20-6,60	4,08-4,34	24	19	17	16	15	14	12	11
150	7,64-8,15	5,81-6,19	3,82-4,07	23	19	17	15	15	14	12	11
140	7,11-7,63	5,40-5,80	3,56-3,81	23	19	17	15	15	14	12	11
130	6,58-7,10	5,01-5,39	3,29-3,55	23	19	17	15	14	14	12	11
120	6,06-6,57	4,60-5,00	3,03-3,28	22	18	16	15	14	14	12	11
110	5,53-6,05	4,21-4,59	2,77-3,02	22	18	16	15	14	13	11	11
100	5,01-5,52	3,80-4,20	2,51-2,76	22	18	16	14	14	13	11	10
90	4,48-5,00	3,41-3,79	2,24-2,50	21	17	15	14	13	13	11	10
80	3,95-4,47	3,00-3,40	1,98-2,23	21	17	15	14	13	12	11	10
70	3,43-3,94	2,61-2,99	1,72-1,97	20	16	15	13	13	12	10	10
60	2,90-3,42	2,20-2,60	1,45-1,71	19	16	14	13	12	12	10	9,5
50	2,37-2,89	1,81-2,19	1,19-1,44	19	15	14	12	12	11	9,5	9
40	1,85-2,36	1,40-1,80	0,93-1,18	18	15	13	12	11	11	9,5	8,5
30	1,32-1,84	1,01-1,39	0,66-0,92	17	14	12	11	11	10	9	8

Table C.8—Critical thickness for couplings with ISO/API threads

Dimensions in millimetres

Label 1	Critical thickness for couplings						
			Special clearance				
	NU	EU	EU	BC	BC	LC	STC
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
1.050	4,29	5,36	—	—	—	—	—
1.315	5,36	6,55	—	—	—	—	—
1.660	6,07	6,10	—	—	—	—	—
1.900	4,98	6,38	—	—	—	—	—
2-3/8	7,72	7,62	5,69	—	—	—	—
2-7/8	9,65	9,09	6,45	—	—	—	—
3-1/2	11,46	11,53	7,47	—	—	—	—
4	11,53	11,63	—	—	—	—	—
4-1/2	11,05	12,52	—	6,58	8,18	8,86	8,56
5	—	—	—	6,76	9,14	9,96	9,45
5-1/2	—	—	—	6,81	9,04	9,88	9,40
6-5/8	—	—	—	6,96	11,91	12,90	12,32
7	—	—	—	7,11	10,67	11,63	10,92
7-5/8	—	—	—	8,84	13,61	14,55	13,87
8-5/8	—	—	—	8,94	15,29	16,43	15,54
9-5/8	—	—	—	8,94	15,29	16,69	15,60
10-3/4	—	—	—	8,94	15,29	—	15,70
11-3/4	—	—	—	—	15,29	—	15,70
13-3/8	—	—	—	—	15,29	—	15,70
16	—	—	—	—	16,94	—	16,05
18-5/8	—	—	—	—	21,69	—	20,80
20	—	—	—	—	16,94	17,09	16,10

NOTE The coupling blank thickness is greater than indicated above, due to thread height and manufacturing allowance to avoid black crest threads.

Table C.9—Acceptable size impact specimens and absorbed energy reduction factor

Test specimen size	Specimen dimensions mm	Reduction factor
Full-size	10,0 × 10,0	1,00
3/4-size	10,0 × 7,5	0,80
1/2-size	10,0 × 5,0	0,55

Table C.10—Hierarchy of test specimen orientation and size

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

Table C.11—Charpy impact test specimen requirements for couplings Grades J55 and K55

Label 1	Orientation, size, energy and temperature reduction (see Note)						
			Special clearance [b]				
	NU	EU	EU	BC	BC	LC	STC
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
1.050	[a]	L-5-15-A	—	—	—	—	—
1.315	L-5-15-A	L-7-22-A	—	—	—	—	—
1.660	L-5-15-B	L-5-15-B	—	—	—	—	—
1.900	L-5-15-A	L-7-22-B	—	—	—	—	—
2-3/8	L-7-22-A	L-7-22-A	L-7-22-A	—	—	—	—
2-7/8	L-10-27-A	L-10-27-A	L-10-27-A	—	—	—	—
3-1/2	T-5-11-E	T-5-11-E	T-5-11-D	—	—	—	—
4	T-7-16-B	T-7-16-B	—	—	—	—	—
4-1/2	T-7-16-B	T-7-16-B	—	L-7-22-A	L-7-22-A	L-10-27-A	L-10-27-A
5	—	—	—	T-5-11-C	T-5-11-D	T-5-11-D	T-5-11-D
5-1/2	—	—	—	T-5-11-C	T-5-11-D	T-5-11-D	T-5-11-D
6-5/8	—	—	—	T-10-20-A	T-10-20-A	T-10-20-A	T-10-20-A
7	—	—	—	T-7-16-A	T-7-16-A	T-10-20-A	T-7-16-B
7-5/8	—	—	—	T-10-20-A	T-10-20-A	T-10-20-A	T-10-20-A
8-5/8	—	—	—	T-10-20-A	T-10-20-A	T-10-20-A	T-10-20-A
9-5/8	—	—	—	T-10-20-A	T-10-20-A	T-10-20-A	T-10-20-A
10-3/4	—	—	—	T-10-20-A	T-10-20-A	—	T-10-20-A
11-3/4	—	—	—	—	T-10-20-A	—	T-10-20-A
13-3/8	—	—	—	—	T-10-20-A	—	T-10-20-A
16	—	—	—	—	T-10-20-A	—	T-10-20-A
18-5/8	—	—	—	—	T-10-20-A	—	T-10-20-A
20	—	—	—	—	T-10-20-A	T-10-20-A	T-10-20-A

NOTE In this table, the specimen orientation (T or L) is followed by the minimum specimen size (10, 7 or 5) which is followed by the minimum absorbed energy requirement (joules) and the temperature reduction (A, B, C, D or E), according to the following code. Both the absorbed energy requirement and the test temperature reduction requirement are adjusted for the test specimen size indicated.

T is the transverse specimen orientation (reference Figure D.12)

L is the longitudinal specimen orientation (reference Figure D.12)

10 = full-size (i.e. 10 mm × 10 mm)

7 = 3/4 size (i.e. 10 mm × 7,5 mm)

5 = 1/2-size (i.e. 10 mm × 5 mm)

A = no temperature reduction

B = 3 °C reduction

C = 6 °C reduction

D = 8 °C reduction

E = 11 °C reduction

[a] Not thick enough to test.

[b] The above assumes that special-clearance couplings are machined from standard couplings.

Table C.12—Charpy impact test specimen requirements for couplings Grade L80 all types

Label 1	Orientation, size, energy (see Note)						
			Special clearance[b]				
	NU	EU	EU	BC	BC	LC	STC
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
1.050	[a]	L-5-22	—	—	—	—	—
1.315	L-5-22	L-7-32	—	—	—	—	—
1.660	L-5-22	L-5-22	—	—	—	—	—
1.900	L-5-22	L-7-32	—	—	—	—	—
2-3/8	L-7-32	L-7-32	L-7-32	—	—	—	—
2-7/8	L-10-40	L-10-40	L-10-40	—	—	—	—
3-1/2	T-5-11	T-5-11	T-5-11	—	—	—	—
4	T-7-16	T-7-16	—	—	---	—	—
4-1/2	T-7-16	T-7-16	—	L-7-32	L-7-32	L-10-40	—
5	—	—	—	T-5-11	T-5-11	T-5-11	—
5-1/2	—	—	—	T-5-11	T-5-11	T-5-11	—
6-5/8	—	—	—	T-10-20	T-10-20	T-10-20	—
7	—	—	—	T-7-16	T-7-16	T-10-20	—
7-5/8	—	—	—	T-10-20	T-10-20	T-10-20	—
8-5/8	—	—	—	T-10-20	T-10-20	T-10-21	—
9-5/8	—	—	—	T-10-20	T-10-20	T-10-21	—
10-3/4	—	—	—	T-10-20	T-10-20	—	T-10-20
11-3/4	—	—	—	—	T-10-20	—	T-10-20
13-3/8	—	—	—	—	T-10-20	—	T-10-20
16	—	—	—	—	T-10-21	—	T-10-21
18-5/8	—	—	—	—	T-10-25	—	T-10-24
20	—	—	—	—	T-10-21	T-10-21	T-10-21

NOTE In this table, the specimen orientation (T or L) is followed by the minimum specimen size (10, 7 or 5) which is followed by the minimum absorbed energy requirement (joules) according to the following code. The absorbed energy requirement is adjusted for the test specimen size indicated.

T is the transverse specimen orientation (reference Figure D.12)

L is the longitudinal specimen orientation (reference Figure D.12)

10 = full-size (i.e. 10 mm × 10 mm)

7 = 3/4-size (i.e. 10 mm × 7,5 mm)

5 = 1/2-size (i.e. 10 mm × 5 mm)

[a] Not thick enough to test.

[b] The above assumes that special clearance couplings are machined from standard couplings.

Table C.13—Charpy impact test specimen requirements for couplings Grade C90

Label 1	Orientation, size and energy (see Note)						
			Special clearance[b]				
	NU	EU	EU	BC	BC	LC	STC
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
1.050	[a]	L-5-22	—	—	—	—	—
1.315	L-5-22	L-7-32	—	—	—	—	—
1.660	L-5-22	L-5-22	—	—	—	—	—
1.900	L-5-22	L-7-32	—	—	—	—	—
2-3/8	L-7-32	L-7-32	L-7-32	—	—	—	—
2-7/8	L-10-40	L-10-40	L-10-40	—	—	—	—
3-1/2	T-5-11	T-5-11	T-5-11	—	—	—	—
4	T-7-16	T-7-16	—	—	—	—	—
4-1/2	T-7-16	T-7-16	—	L-7-32	L-7-32	L-10-40	—
5	—	—	—	T-5-11	T-5-11	T-5-11	—
5-1/2	—	—	—	T-5-11	T-5-11	T-5-11	—
6-5/8	—	—	—	T-10-20	T-10-20	T-10-20	—
7	—	—	—	T-7-16	T-7-16	T-10-20	—
7-5/8	—	—	—	T-10-20	T-10-21	T-10-22	—
8-5/8	—	—	—	T-10-20	T-10-22	T-10-23	—
9-5/8	—	—	—	T-10-20	T-10-22	T-10-23	—
10-3/4	—	—	—	T-10-20	T-10-22	—	T-10-23
11-3/4	—	—	—	—	T-10-22	—	T-10-23
13-3/8	—	—	—	—	T-10-22	—	T-10-23
16	—	—	—	—	—	—	—
18-5/8	—	—	—	—	—	—	—
20	—	—	—	—	—	—	—

NOTE In this table, the specimen orientation (T or L) is followed by the minimum specimen size (10, 7 or 5) which is followed by the minimum absorbed energy requirement (joules) according to the following code. The absorbed energy requirement is adjusted for the test specimen size indicated.

T is the transverse specimen orientation (reference Figure D.12)

L is the longitudinal specimen orientation (reference Figure D.12)

10 = full-size (i.e. 10 mm × 10 mm)

7 = 3/4-size (i.e. 10 mm × 7,5 mm)

5 = 1/2-size (i.e. 10 mm × 5 mm)

[a] Not thick enough to test.

[b] The above assumes that special-clearance couplings are machined from standard couplings.

Table C.14—Charpy impact test specimen requirements for couplings— Grades N80 Type 1, N80Q, C95 and T95

Label 1	Orientation, size and energy (see Note)						
			Special clearance[b]				
	NU	EU	EU	BC	BC	LC	STC
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
1.050	[a]	L-5-22	—	—	—	—	—
1.315	L-5-22	L-7-32	—	—	—	—	—
1.660	L-5-22	L-5-22	—	—	—	—	—
1.900	L-5-22	L-7-32	—	—	—	—	—
2-3/8	L-7-32	L-7-32	L-7-32	—	—	—	—
2-7/8	L-10-40	L-10-40	L-10-40	—	—	—	—
3-1/2	T-5-11	T-5-11	T-5-11	—	—	—	—
4	T-7-16	T-7-16	—	—	—	—	—
4-1/2	T-7-16	T-7-21	—	L-7-32	L-7-32	L-10-40	—
5	—	—	—	T-5-11	T-5-11	T-5-11	—
5-1/2	—	—	—	T-5-11	T-5-11	T-5-11	—
6-5/8	—	—	—	T-10-20	T-10-20	T-10-21	—
7	—	—	—	T-7-16	T-7-16	T-10-20	—
7-5/8	—	—	—	T-10-20	T-10-22	T-10-23	—
8-5/8	—	—	—	T-10-20	T-10-23	T-10-24	—
9-5/8	—	—	—	T-10-20	T-10-23	T-10-24	—
10-3/4	—	—	—	T-10-20	T-10-23	—	T-10-24
11-3/4	—	—	—	—	T-10-23	—	T-10-24
13-3/8	—	—	—	—	T-10-23	—	T-10-24
16	—	—	—	—	—	—	—
18-5/8	—	—	—	—	—	—	—
20	—	—	—	—	—	—	—

NOTE In this table, the specimen orientation (T or L) is followed by the minimum specimen size (10, 7 or 5) which is followed by the minimum absorbed energy requirement (joules) according to the following code. The absorbed energy requirement is adjusted for the test specimen size indicated.

T is the transverse specimen orientation (reference Figure D.12)

L is the longitudinal specimen orientation (reference Figure D.12)

10 = full-size (i.e. 10 mm × 10 mm)

7 = 3/4-size (i.e. 10 mm × 7,5 mm)

5 = 1/2-size (i.e. 10 mm × 5 mm)

[a] Not thick enough to test.

[b] The above assumes that special clearance couplings are machined from standard couplings.

Table C.15—Charpy impact test specimen requirements for couplings Grade P110

Label 1	Orientation, size and energy (see Note)						
			Special clearance[b]				
	NU	EU	EU	BC	BC	LC	STC
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
1.050	a	L-5-22	—	—	—	—	—
1.315	L-5-22	L-7-32	—	—	—	—	—
1.660	L-5-22	L-5-22	—	—	—	—	—
1.900	L-5-22	L-7-32	—	—	—	—	—
2-3/8	L-7-34	L-7-33	L-7-32	—	—	—	—
2-7/8	L-10-46	L-10-45	L-10-40	—	—	—	—
3-1/2	T-5-14	T-5-14	T-5-11	—	—	—	—
4	T-7-20	T-7-20	—	—	—	—	—
4-1/2	T-7-20	T-7-21	—	L-7-32	L-7-34	L-10-44	—
5	—	—	—	T-5-11	T-5-12	T-5-13	—
5-1/2	—	—	—	T-5-11	T-5-12	T-5-13	—
6-5/8	—	—	—	T-10-20	T-10-26	T-10-26	—
7	—	—	—	T-7-16	T-7-19	T-10-25	—
7-5/8	—	—	—	T-10-22	T-10-28	T-10-29	—
8-5/8	—	—	—	T-10-22	T-10-30	T-10-31	—
9-5/8	—	—	—	T-10-22	T-10-30	T-10-31	T-10-30
10-3/4	—	—	—	T-10-22	T-10-30	—	T-10-30
11-3/4	—	—	—	—	T-10-30	—	T-10-30
13-3/8	—	—	—	—	T-10-30	—	—
16	—	—	—	—	—	—	—
18-5/8	—	—	—	—	—	—	—
20	—	—	—	—	—	—	—

NOTE In this table, the specimen orientation (T or L) is followed by the minimum specimen size (10, 7 or 5) which is followed by the minimum absorbed energy requirement (joules) according to the following code. The absorbed energy requirement is adjusted for the test specimen size indicated.

T is the transverse specimen orientation (reference Figure D.12)

L is the longitudinal specimen orientation (reference Figure D.12)

10 = full-size (i.e. 10 mm × 10 mm)

7 = 3/4-size (i.e. 10 mm × 7,5 mm)

5 = 1/2-size (i.e. 10 mm × 5 mm)

a Not thick enough to test.

b The above assumes that special-clearance couplings are machined from standard couplings.

Table C.16—Charpy impact test specimen requirements for ISO/API couplings Grade Q125

Label 1	Orientation, size and energy (see Note)			
	Special clearance [a] BC	BC	LC	STC
1	*2*	*3*	*4*	*5*
4-1/2	L-7-34	L-7-34	L-10-48	—
5	T-5-12	T-5-13	T-5-14	—
5-1/2	T-5-12	T-5-13	T-5-14	—
6-5/8	T-10-22	T-10-28	T-10-29	—
7	T-7-17	T-7-21	T-10-27	—
7-5/8	T-10-24	T-10-30	T-10-31	—
8-5/8	T-10-24	T-10-32	T-10-33	—
9-5/8	T-10-24	T-10-32	T-10-33	—
10-3/4	T-10-24	T-10-32	—	T-10-32
11-3/4	—	T-10-32	—	T-10-32
13-3/8	—	T-10-32	—	T-10-32
16	—	—	—	—
18-5/8	—	—	—	—
20	—	—	—	—

NOTE In this table, the specimen orientation (T or L) is followed by the minimum specimen size (10, 7 or 5) which is followed by the minimum absorbed energy requirement (joules) according to the following code. The absorbed energy requirement is adjusted for the test specimen size indicated.

T is the transverse specimen orientation (reference Figure D.12)

L is the longitudinal specimen orientation (reference Figure D.12)

10 = full-size (i.e. 10 mm × 10 mm)

7 = 3/4-size (i.e. 10 mm × 7,5 mm)

5 = 1/2-size (i.e. 10 mm × 5 mm)

[a] The above assumes that special-clearance couplings are machined from standard couplings.

Table C.17—Transverse Charpy absorbed energy requirements for ISO/API couplings

Maximum critical thickness for various grades mm					Minimum transverse absorbed energy J
L80	C90	N80Q, C95, T95	P110	Q125	
1	*2*	*3*	*4*	*5*	*6*
15,85	13,32	12,24	7,33	6,13	20
17,14	14,49	13,36	8,21	6,95	21
18,44	15,66	14,48	9,08	7,77	22
19,73	16,83	15,60	9,96	8,59	23
21,02	18,00	16,72	10,84	9,41	24
22,32	19,17	17,83	11,72	10,23	25
23,61	20,34	18,95	12,60	11,04	26
24,91	21,51	20,07	13,48	11,86	27
26,20	22,69	21,19	14,35	12,68	28
	23,86	22,31	15,23	13,50	29
	25,03	23,43	16,11	14,32	30
	26,20	24,54	16,99	15,14	31
		25,66	17,87	15,96	32
			18,75	16,78	33
			19,62	17,60	34
			20,50	18,42	35
			21,38	19,24	36
			22,26	20,06	37
			23,14	20,88	38
			24,01	21,70	39
			24,89	22,52	40
			25,77	23,34	41
				24,16	42
				24,98	43
				25,80	44

NOTE 1 Critical thicknesses greater than shown in Table C.8 are not applicable for ISO/API couplings and are shown here for information for special applications. For wall thickness greater than shown above, the requirements shall be according to the equations for the wall thickness and grade.

NOTE 2 Grade M65 is not mentioned in this table, because it is furnished with L80 couplings.

Table C.18—Longitudinal Charpy absorbed energy requirements for ISO/API couplings

Maximum critical thickness mm					Minimum longitudinal absorbed energy J
L80	C90	N80Q, C95, T95	P110	Q125	
1	*2*	*3*	*4*	*5*	*6*
16,17	13,61	12,52	7,55	6,33	41
16,82	14,20	13,08	7,99	6,74	42
17,47	14,78	13,64	8,43	7,15	43
18,11	15,37	14,20	8,87	7,56	44
18,76	15,95	14,76	9,30	7,97	45
19,41	16,54	15,32	9,74	8,38	46
20,05	17,13	15,88	10,18	8,79	47
20,70	17,71	16,44	10,62	9,20	48
21,35	18,30	17,00	11,06	9,61	49
21,99	18,88	17,56	11,50	10,02	50
22,64	19,47	18,11	11,94	10,43	51
23,29	20,05	18,67	12,38	10,84	52
23,94	20,64	19,23	12,82	11,25	53
24,58	21,22	19,79	13,26	11,66	54
25,23	21,81	20,35	13,70	12,07	55
25,88	22,39	20,91	14,13	12,48	56
	22,98	21,47	14,57	12,89	57
	23,56	22,03	15,01	13,30	58
	24,15	22,59	15,45	13,71	59
	24,73	23,15	15,89	14,12	60
	25,32	23,70	16,33	14,53	61
	25,90	24,26	16,77	14,94	62
		24,82	17,21	15,35	63
		25,38	17,65	15,76	64
		25,94	18,09	16,17	65
			18,53	16,58	66
			18,96	16,99	67
			19,40	17,40	68
			19,84	17,81	69
			20,28	18,22	70

NOTE 1 Critical thicknesses greater than shown in Table C.8 are not applicable for ISO/API couplings and are shown here for information for special applications. For wall thickness greater than shown above, the requirements shall be according to the equations for the wall thickness and grade.

NOTE 2 Grade M65 is not mentioned in this table, because it is furnished with L80 couplings.

Table C.19—Transverse Charpy absorbed energy requirements for pipe

Maximum specified wall thickness mm					Minimum transverse absorbed energy J
N80Q, L80	C90	C95, T95	P110	Q125	
1	*2*	*3*	*4*	*5*	*6*
11,59	9,11	8,09			14
13,12	10,48	9,38			15
14,66	11,84	10,67			16
16,19	13,21	11,97			17
17,73	14,57	13,26			18
19,26	15,94	14,56			19
20,80	17,30	15,85	12,24	6,13	20
22,33	18,67	17,14	13,36	6,95	21
23,87	20,03	18,44	14,48	7,77	22
25,40	21,40	19,73	15,60	8,59	23
	22,76	21,02	16,72	9,41	24
	24,12	22,32	17,83	10,23	25
	25,49	23,61	18,95	11,04	26
		24,91	20,07	11,86	27
			21,19	12,68	28
			22,31	13,50	29
			23,43	14,32	30
			24,54	15,14	31
			25,66	15,96	32
				16,78	33
				17,60	34
				18,42	35
				19,24	36
				20,06	37
				20,88	38
				21,70	39
				22,52	40
				23,34	41
				24,16	42
				24,98	43
				25,80	44

NOTE Wall thickness greater than standard ISO/API pipe are shown here for information for special applications. For wall thickness greater than shown above, the requirements shall be according to the equations for the wall thickness and grade.

Table C.20—Longitudinal Charpy absorbed energy requirements for pipe

Maximum specified wall thickness mm					Minimum longitudinal absorbed energy J
N80Q, L80	C90	C95, T95	P110	Q125	
1	*2*	*3*	*4*	*5*	*6*
10,44	8,09	7,12			27
11,20	8,77	7,76			28
11,97	9,45	8,41			29
12,74	10,14	9,06			30
13,51	10,82	9,70			31
14,27	11,50	10,35			32
15,04	12,18	11,00			33
15,81	12,87	11,64			34
16,58	13,55	12,29			35
17,34	14,23	12,94			36
18,11	14,91	13,58			37
18,88	15,60	14,23			38
19,65	16,28	14,88			39
20,41	16,96	15,53			40
21,18	17,64	16,17	12,52	6,33	41
21,95	18,32	16,82	13,08	6,74	42
22,72	19,01	17,47	13,64	7,15	43
23,48	19,69	18,11	14,20	7,56	44
24,25	20,37	18,76	14,76	7,97	45
25,02	21,05	19,41	15,32	8,38	46
25,79	21,74	20,05	15,88	8,79	47
	22,42	20,70	16,44	9,20	48
	23,10	21,35	17,00	9,61	49
	23,78	21,99	17,56	10,02	50
	24,47	22,64	18,11	10,43	51
	25,15	23,29	18,67	10,84	52
	25,83	23,94	19,23	11,25	53
		24,58	19,79	11,66	54
		25,23	20,35	12,07	55
		25,88	20,91	12,48	56
			21,47	12,89	57
			22,03	13,30	58
			22,59	13,71	59
			23,15	14,12	60
			23,70	14,53	61
			24,26	14,94	62
			24,82	15,35	63
			25,38	15,76	64
			25,94	16,17	65
				16,58	66
				16,99	67
				17,40	68
				17,81	69
				18,22	70
				18,63	71
				19,04	72

NOTE Wall thickness greater than standard ISO/API pipe are shown here for information for special applications. For wall thickness greater than shown above, the requirements shall be according to the equations for the wall thickness and grade.

Table C.21—Transverse impact specimen size required for pipe in quenched and tempered grades

Label 1	Calculated wall thickness required to machine transverse Charpy impact specimens mm		
	Full-size	3/4-size	1/2-size
1	*2*	*3*	*4*
3-1/2	20,53	18,03	15,53
4	19,09	16,59	14,09
4-1/2	18,05	15,55	13,05
5	17,26	14,76	12,26
5-1/2	16,64	14,14	11,64
6-5/8	15,62	13,12	10,62
7	15,36	12,86	10,36
7-5/8	14,99	12,49	9,99
7-3/4	14,92	12,42	9,92
8-5/8	14,51	12,01	9,51
9-5/8	14,13	11,63	9,13
10-3/4	13,80	11,30	8,80
11-3/4	13,56	11,06	8,56
13-3/8	13,24	10,74	8,24
16	12,87	10,37	7,87
18-5/8	12,60	10,10	7,60
20	12,49	9,99	7,49

NOTE The wall thicknesses in columns 2, 3 and 4 that are in excess of the maximum ISO wall thicknesses are for information only. The above provides a 0,50 mm ID and a 0,50 mm OD machining allowance.

Table C.22—Longitudinal impact specimen size required for pipe in quenched and tempered grades

Label 1	Calculated wall thickness required to machine longitudinal Charpy impact specimens mm		
	Full-size	3/4-size	1/2-size
1	*2*	*3*	*4*
1.050	11,97	9,47	6,97
1.315	11,77	9,27	6,77
1.660	11,60	9,10	6,60
1.900	11,52	9,02	6,52
2.063	11,48	8,98	6,48
2-3/8	11,42	8,92	6,42
2-7/8	11,34	8,84	6,34
3-1/2	11,28	8,78	6,28
4	11,25	8,75	6,25
4-1/2	11,22	8,72	6,22
5	11,20	8,70	6,20
5-1/2	11,18	8,68	6,18
6-5/8	11,15	8,65	6,15
7	11,14	8,64	6,14
7-5/8	11,13	8,63	6,13
7-3/4	11,13	8,63	6,13
8-5/8	11,11	8,61	6,11
9-5/8	11,10	8,60	6,10
10-3/4	11,09	8,59	6,09
11-3/4	11,08	8,58	6,08
13-3/8	11,07	8,57	6,07
16	11,06	8,56	6,06
18-5/8	11,05	8,55	6,05
20	11,05	8,55	6,05

NOTE The wall thicknesses in columns 2, 3 and 4 that are in excess of the maximum ISO wall thicknesses are for information only. The above provides a 0,50 mm ID and a 0,50 mm OD machining allowance.

Table C.23—Distance between plates for electric-weld flattening tests

Grade	D/t ratio	Maximum distance between plates mm
H40	≥ 16	0,5 D
	< 16	$D \times (0{,}830 - 0{,}020\,6\ D/t)$
J55	≥ 16	0,65 D
&	3,93 to 16	$D \times (0{,}980 - 0{,}020\,6\ D/t)$
K55	< 3,93	$D \times (1{,}104 - 0{,}051\,8\ D/t)$
M65	All	$D \times (1{,}074 - 0{,}019\,4\ D/t)$
N80 [a]	9 to 28	$D \times (1{,}074 - 0{,}019\,4\ D/t)$
L80	9 to 28	$D \times (1{,}074 - 0{,}019\,4\ D/t)$
C95 [a]	9 to 28	$D \times (1{,}080 - 0{,}017\,8\ D/t)$
P110 [b]	All	$D \times (1{,}086 - 0{,}016\,3\ D/t)$
Q125 [b]	All	$D \times (1{,}092 - 0{,}014\,0\ D/t)$

D is the specified outside diameter of pipe, in millimetres.

t is the specified wall thickness of the pipe, in millimetres.

[a] If the flattening test fails at 12 o'clock or 6 o'clock, the flattening shall continue until the remaining portion of the specimen fails at the 3 o'clock or 9 o'clock position. Premature failure at 12 o'clock or 6 o'clock shall not be considered basis for rejection.

[b] See A.5 (SR11). Flattening shall be at least 0,85 D.

Table C.24—Dimensions and masses for round thread, buttress thread and extreme-line casing

Labels [a]		Outside diameter	Nominal linear mass T&C [b, c]	Wall thickness	Inside diamet'r	Drift diamet'r	Calculated mass [c]						
							Plain end	e_u, mass gain or loss due to end finishing [d] kg					
								Round thread		Buttress thread		Extreme-line	
1	2	D mm	kg/m	t mm	d mm	mm	W_{pe} kg/m	Short	Long	Reg. OD	SCC	Stand'd	Optional
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*
4-1/2	9.50	114,30	14,14	5,21	103,88	100,70	14,02	1,91	—	—	—	—	—
4-1/2	10.50	114,30	15,63	5,69	102,92	99,74	15,24	1,72	—	2,27	1,16	—	—
4-1/2	11.60	114,30	17,26	6,35	101,60	98,42	16,91	1,54	1,72	2,09	0,98	—	—
4-1/2	13.50	114,30	20,09	7,37	99,56	96,38	19,44	—	1,45	1,81	0,71	—	—
4-1/2	15.10	114,30	22,47	8,56	97,18	94,00	22,32	—	1,27	1,45	0,34	—	
5	11.50	127,00	17,11	5,59	115,82	112,64	16,74	2,45	—	—	—	—	—
5	13.00	127,00	19,35	6,43	114,14	110,96	19,12	2,18	2,63	2,99	1,10	—	—
5	15.00	127,00	22,32	7,52	111,96	108,78	22,16	1,91	2,36	2,63	0,73	2,09	—
5	18.00	127,00	26,79	9,19	108,61	105,44	26,70	—	1,91	2,00	0,,10	0,64	—
5	21.40	127,00	31,85	11,10	104,80	101,62	31,73	—	1,34	1,12	–0,78	—	—
5	23.20	127,00	34,53	12,14	102,72	99,54	34,39	—	1,04	0,93	–0,95	—	—
5	24.10	127,00	35,86	12,70	101,60	98,42	35,80	—	0,88	0,56	–1,33	—	—
5-1/2	14.00	139,70	20,83	6,20	127,30	124,12	20,41	2,45	—	—	—	—	—
5-1/2	15.50	139,70	23,07	6,98	125,74	122,56	22,85	2,18	2,63	2,90	0,95	2,63	1,91
5-1/2	17.00	139,70	25,30	7,72	124,26	121,08	25,13	2,00	2,45	2,63	0,68	2,18	1,45
5-1/2	20.00	139,70	29,76	9,17	121,36	118,18	29,52	—	2,00	2,09	0,14	0,64	–0,09
5-1/2	23.00	139,70	34,23	10,54	118,62	115,44	33,57	—	1,45	1,54	–0,41	0,00	–0,73
5-1/2	26.80	139,70	39,88	12,70	114,30	111,12	39,78	—	—	—	—	—	—
5-1/2	29.70	139,70	44,20	14,27	111,16	107,98	44,14	—	—	—	—	—	—
5-1/2	32.60	139,70	48,51	15,88	107,94	104,76	48,49	—	—	—	—	—	—
5-1/2	35.30	139,70	52,53	17,45	104,80	101,62	52,61	—	—	—	—	—	—
5-1/2	38.00	139,70	56,55	19,05	101,60	98,42	56,68	—	—	—	—	—	—
5-1/2	40.50	139,70	60,27	20,62	98,46	95,28	60,55	—	—	—	—	—	—
5-1/2	43.10	139,70	64,14	22,22	95,25	92,08	64,38	—	—	—	—	—	—
6-5/8	20.00	168,28	29,76	7,32	153,64	150,46	29,06	4,99	6,17	6,53	1,08	—	—
6-5/8	24.00	168,28	35,72	8,94	150,40	147,22	35,13	4,35	5,44	5,72	0,26	1,54	0,82
6-5/8	28.00	168,28	41,67	10,59	147,10	143,92	41,18	—	4,63	4,81	–0,64	0,09	–0,64
6-5/8	32.00	168,28	47,62	12,06	144,16	140,98	46,46	—	3,99	4,08	–1,37	–0,64	–1,36
7	17.00	177,80	25,30	5,87	166,06	162,88	24,89	4,54	—	—	—	—	—
7	20.00	177,80	29,76	6,91	163,98	160,80	29,12	4,26	—	—	—	—	—
7	23.00	177,80	34,23	8,05	161,70	158,75 e	33,70	3,63	4,72	4,99	0,73	2,72	1,91
7	23.00	177,80	34,23	8,05	161,70	158,52	33,70	3,63	4,72	4,99	0,73	2,72	1,91
7	26.00	177,80	38,69	9,19	159,42	156,24	38,21	3,27	4,26	4,35	0,09	1,27	0,45
7	29.00	177,80	43,16	10,36	157,08	153,90	42,78	—	3,63	3,72	–0,54	0,27	–0,54
7	32.00	177,80	47,62	11,51	154,78	152,40 e	47,20	—	2,99	3,08	–1,18	–0,27	–1,09
7	32.00	177,80	47,62	11,51	154,78	151,60	47,20	—	2,99	3,08	–1,18	–0,27	–1,09
7	35.00	177,80	52,09	12,65	152,50	149,32	51,52	—	2,54	2,54	–1,72	0,45	–0,82
7	38.00	177,80	56,55	13,72	150,36	147,18	55,52	—	2,00	1,91	–2,36	–0,09	–1,36
7	42.70	177,80	63,54	15,88	146,04	142,86	63,41	—	—	—	—	—	—
7	46.40	177,80	69,05	17,45	142,90	139,72	69,01	—	—	—	—	—	—
7	50.10	177,80	74,56	19,05	169,70	136,52	74,58	—	—	—	—	—	—
7	53.60	177,80	79,77	20,62	136,56	133,38	79,93	—	—	—	—	—	—
7	57.10	177,80	84,97	22,22	133,36	130,18	85,25	—	—	—	—	—	—
7-5/8	24.00	193,68	35,72	7,62	178,44	175,26	34,96	7,17	—	—	—	—	—
7-5/8	26.40	193,68	39,29	8,33	177,02	173,84	38,08	6,89	8,62	9,34	2,82	2,90	1,81
7-5/8	29.70	193,68	44,20	9,52	174,64	171,46	43,24	—	7,89	8,53	2,00	1,18	0,09
7-5/8	33.70	193,68	50,15	10,92	171,84	168,66	49,22	—	7,17	7,71	1,18	0,00	–1,09
7-5/8	39.00	193,68	58,04	12,70	168,28	165,10	56,68	—	6,17	6,62	0,10	–1,00	–2,09
7-5/8	42.80	193,68	63,69	14,27	165,14	161,96	63,14	—	5,45	5,17	–1,37	—	—
7-5/8	45.30	193,68	67,41	15,11	163,46	160,28	66,54	—	5,01	5,01	–1,52	—	—
7-5/8	47.10	193,68	70,09	15,88	161,92	158,74	69,63	—	4,61	4,19	–2,35	—	—
7-5/8	51.20	193,68	76,19	17,45	158,78	155,60	75,84	—	—	—	—	—	—
7-5/8	55.30	193,68	82,30	19,05	155,58	152,40	82,04	—	—	—	—	—	—
7-3/4	46.10	196,85	68,60	15,11	166,63	165,10	67,72	—	—	—	—	—	—
7-3/4	46.10	196,85	68,60	15,11	166,63	163,45	67,72	—	—	—	—	—	—
8-5/8	24.00	219,08	35,72	6,71	205,66	202,48	35,14	10,70	—	—	—	—	—
8-5/8	28.00	219,08	41,67	7,72	203,64	200,46	40,24	10,07	—	—	—	—	—
8-5/8	32.00	219,08	47,62	8,94	201,20	198,02	46,33	9,43	12,52	12,79	2,74	5,99	3,99
8-5/8	32.00	219,08	47,62	8,94	201,20	200,02	46,33	9,43	12,52	12,79	2,74	5,99	3,99
8-5/8	36.00	219,08	53,57	10,16	198,76	195,58	52,35	8,80	11,61	11,88	1,83	3,45	1,91
8-5/8	40.00	219,08	59,53	11,43	196,22	193,68	58,53	—	10,80	10,98	0,92	1,81	0,27
8-5/8	40.00	219,08	59,53	11,43	196,22	193,04	58,53	—	10,80	10,98	0,92	1,81	0,27
8-5/8	44.00	219,08	65,48	12,70	193,68	190,50	64,64	—	9,89	10,07	0,01	0,73	–0,82
8-5/8	49.00	219,08	72,92	14,15	190,78	187,60	71,51	—	8,89	8,98	–1,08	–0,36	–1,91

See notes at end of table.

Table C.24 (*continued*)

Labels [a]		Outside diameter	Nominal linear mass T&C[b, c]	Wall thick-ness	Inside diamet'r	Drift diamet'r	Calculated mass [c]						
							Plain end	e_{ws} mass gain or loss due to end finishing [d] kg					
								Round thread		Buttress thread		Extreme-line	
1	2	D mm	kg/m	t mm	d mm	mm	W_{pe} kg/m	Short	Long	Reg. OD	SCC	Stand'd	Optional
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*
9-5/8	32.30	244,48	48,07	7,92	228,60	224,66	46,20	11,07	—	—	—	—	—
9-5/8	36.00	244,48	53,57	8,94	226,60	222,63	51,93	10,43	14,51	14,06	2,94	—	—
9-5/8	40.00	244,48	59,53	10,03	224,40	222,25 [e]	57,99	9,71	13,61	13,15	2,03	4,81	3,27
9-5/8	40.00	244,48	59,53	10,03	224,40	220,45	57,99	9,71	13,61	13,15	2,03	4,81	3,27
9-5/8	43.50	244,48	64,74	11,05	222,40	218,41	63,61	—	12,79	12,34	1,22	2,45	0,91
9-5/8	47.00	244,48	69,94	11,99	220,50	216,54	68,75	—	12,07	11,61	0,49	1,00	–0,54
9-5/8	53.50	244,48	79,62	13,84	216,80	215,90 [e]	78,72	—	10,61	10,16	–0,96	–0,54	–2,09
9-5/8	53.50	244,48	79,62	13,84	216,80	212,83	78,72	—	10,61	10,16	–0,96	–0,54	–2,09
9-5/8	58.40	244,48	86,91	15,11	214,25	212,72 [e]	85,47	—	9,75	9,13	–2,00	—	—
9-5/8	58.40	244,48	86.91	15,11	214,25	210,29	85,47	—	9,75	9,13	–2,00	—	—
9-5/8	59.40	244,48	88,40	15,47	213,50	209,58	87,37	—	—	—	—	—	—
9-5/8	64.90	244,48	96,58	17,07	210,30	206,38	95,73	—	—	—	—	—	—
9-5/8	70.30	244,48	104,62	18,64	207,20	203,23	103,82	—	—	—	—	—	—
9-5/8	75.60	244,48	112,51	20,24	204,00	200,02	111,93	—	—	—	—	—	—
10-3/4	32.75	273,05	48,74	7,09	258,90	254,91	46,50	13,15	—	—	—	—	—
10-3/4	40.50	273,05	60,27	8,89	255,30	251,31	57,91	11,97	—	15,60	3,27	—	—
10-3/4	45.50	273,05	67,71	10,16	252,70	250,82	65,87	11,07	—	14,42	2,09	9,62	—
10-3/4	45.50	273,05	67,71	10,16	252,70	248,77	65,87	11,07	—	14,42	2,09	9,62	—
10-3/4	51.00	273,05	75,90	11,43	250,20	246,23	73,75	10,25	—	13,34	1,00	8,35	—
10-3/4	55.50	273,05	82,59	12,57	247,90	244,48	80,75	9,43	—	12,25	–0,09	7,17	—
10-3/4	55.50	273,05	82,59	12,57	247,90	243,94	80,75	9,43	—	12,25	–0,09	7,17	—
10-3/4	60.70	273,05	90,33	13,84	245,40	241,40	88,47	8,53	—	11,07	—	5,90	—
10-3/4	65.70	273,05	97,77	15,11	242,80	238,86	96,12	7,62	—	9,98	—	—	—
10-3/4	73.20	273,05	108,93	17,07	238,90	234,95	107,76	—	—	—	—	—	—
10-3/4	79.20	273,05	117,86	18,64	235,80	231,80	116,95	—	—	—	—	—	—
10-3/4	85.30	273,05	126,94	20,24	232,60	228,60	126,19	—	—	—	—	—	—
11-3/4	42.00	298,45	62,50	8,46	281,50	279,40	62,56	13,43	—	—	—	—	—
11-3/4	42.00	298,45	62,50	8,46	281,50	277,50	62,56	13,43	—	—	—	—	—
11-3/4	47.00	298,45	69,94	9,53	279,40	275,44	69,94	12,52	—	16,24	—	—	—
11-3/4	54.00	298,45	80,36	11,05	276,40	272,39	78,32	11,34	—	14,70	—	—	—
11-3/4	60.00	298,45	89,29	12,42	273,60	269,88	87,61	10,25	—	13,43	—	—	—
11-3/4	60.00	298,45	89,29	12,42	273,60	269,65	87,61	10,25	—	13,43	—	—	—
11-3/4	65.00	298,45	96,73	13,56	271,30	269,88	95,27	—	—	—	—	—	—
11-3/4	65.00	298,45	96,73	13,56	271,30	267,36	95,27	—	—	—	—	—	—
11-3/4	71.00	298,45	105,66	14,78	268,90	264,92	103,40	—	—	—	—	—	—
13-3/8	48.00	339,73	71,43	8,38	323,00	319,00	68,48	15,06	—	—	—	—	—
13-3/8	54.50	339,73	81,10	9,65	320,40	316,46	78,55	13,97	—	18,23	—	—	—
13-3/8	61.00	339,73	90,78	10,92	317,90	313,92	88,55	12,88	—	16,69	—	—	—
13-3/8	68.00	339,73	101,19	12,19	315,30	311,38	98,46	11,70	—	15,24	—	—	—
13-3/8	72.00	339,73	107,15	13,06	313,60	311,15	105,21	10,98	—	14,33	—	—	—
13-3/8	72.00	339,73	107,15	13,06	313,60	309,65	105,21	10,98	—	14,33	—	—	—
16	65.00	406,40	96,73	9,53	387,40	382,57	96,73	19,32	—	—	—	—	—
16	75.00	406,40	111,61	11,13	384,10	379,37	108,49	17,33	—	20,68	—	—	—
16	84.00	406,40	125,01	12,57	381,30	376,48	122,09	15,51	—	17,96	—	—	—
16	109.00	406,40	162,21	16,66	373,10	368,30	160,13	—	—	—	—	—	—
18-5/8	87.50	473,10	130,21	11,05	451,00	446,20	125,91	33,38	—	39,19	—	—	—
20	94.00	508,00	139,89	11,13	485,70	480,97	136,38	21,32	27,76	24,86	—	—	—
20	106.50	508,00	158,49	12,70	482,60	477,82	155,13	18,87	24,86	21,95	—	—	—
20	133.00	508,00	197,93	16,13	475,70	470,97	195,66	13,61	18,42	15,97	—	—	—

See also Figures D.1, D.2, D.3 and D.8.

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

[b] Nominal linear masses, threaded and coupled (Col. 4) are shown for information only.

[c] The densities of martensitic chromium steels (L80 Types 9Cr and 13Cr) are less than those of carbon steels. The masses shown are therefore not accurate for martensitic chromium steels. A mass correction factor of 0,989 may be used.

[d] Mass gain or loss due to end finishing. See 8.5.

[e] Drift diameter for most common bit size. This drift diameter shall be specified on the purchase agreement and marked on the pipe. See 8.10 for drift requirements.

Table C.25—Dimensions and masses for non-upset, external upset and integral joint tubing

Labels [a]				Outside dia.	Nominal linear masses [b, c]			Wall thickness	Inside dia.	Calculated mass [c]				
					Non-upset T&C	Ext upset T&C	Integral joint			Plain end	e_w, mass gain or loss due to end finishing [d], kg			
1	2										Non-upset	External upset [e]		Integral joint
	NU T&C	EU T&C	IJ	D mm	kg/m	kg/m	kg/m	t mm	d mm	W_{pe} kg/m		Regular	Special clear	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1.050	1.14	1.20	—	26,67	1,70	1,79	—	2,87	20,93	1,68	0,09	0,64	—	—
1.050	1.48	1.54	—	26,67	2,20	2,29	—	3,91	18,85	2,19	—	0,60	—	—
1.315	1.70	1.80	1.72	33,40	2,53	2,68	2,56	3,38	26,64	2,50	0,18	0,64	—	0,09
1.315	2.19	2.24	—	33,40	3,26	3,33	—	4,55	24,30	3,24	—	0,61	—	—
1.660	2.09	—	2.10	42,16	—	—	3,13	3,18	35,81	3,06	—	—	—	0,09
1.660	2.30	2.40	2.33	42,16	3,42	3,57	3,47	3,56	35,04	3,39	0,36	0,73	—	0,09
1.660	3.03	3.07	—	42,16	4,51	4,57	—	4,85	32,46	4,46	—	0,68	—	—
1.900	2.40	—	2.40	48,26	—	—	3,57	3,18	41,90	3,54,	—	—	—	0,09
1.900	2.75	2.90	2.76	48,26	4,09	4,32	4,11	3,68	40,90	4,05	0,27	0,91	—	0,09
1.900	3.65	3.73	—	48,26	5,43	5,55	—	5,08	38,10	5,41	—	0,92	—	—
1.900	4.42	—	—	48,26	6,58	—	—	6,35	35,56	6,56	—	—	—	—
1.900	5.15	—	—	48,26	7,66	—	—	7,62	33,02	7,64	—	—	—	—
2.063	3.24	—	3.25	52,40	—	—	4,84	3,96	44,48	4,73	—	—	—	0,09
2.063	4.50	—	—	52,40	—	—	—	5,72	40,96	6,58	—	—	—	—
2-3/8	4.00	—	—	60,32	5,95	—	—	4,24	51,84	5,87	0,73	—	—	—
2-3/8	4.60	4.70	—	60,32	6,85	6,99	—	4,83	50,66	6,61	0,73	1,81	1,34	—
2-3/8	5.80	5.95	—	60,32	8,63	8,85	—	6,45	47,42	8,57	0,64	1,63	1,16	—
2-3/8	6.60	—	—	60,32	9,82	—	—	7,49	45,34	9,76	—	—	—	—
2-3/8	7.35	7.45	—	60,32	10,94	11,09	—	8,53	43,26	10,89	—	—	—	—
2-7/8	6.40	6.50	—	73,02	9,52	9,67	—	5,51	62,00	9,17	1,45	2,54	1,71	—
2-7/8	7.80	7.90	—	73,02	11,61	11,76	—	7,01	59,00	11,41	1,27	2,63	1,78	—
2-7/8	8.60	8.70	—	73,02	12,80	12,95	—	7,82	57,38	12,57	1,18	2,27	1,43	—
2-7/8	9.35	9.45	—	73,02	13,91	14,06	—	8,64	55,75	13,72	—	—	—	—
2-7/8	10.50	—	—	73,02	15,63	—	—	9,96	53,10	15,49	—	—	—	—
2-7/8	11.50	—	—	73,02	17,11	—	—	11,18	50,66	17,05	—	—	—	—
3-1/2	7.70	—	—	88,90	11,46	—	—	5,49	77,92	11,29	2,45	—	—	—
3-1/2	9.20	9.30	—	88,90	13,69	13,84	—	6,45	76,00	13,12	2,27	4,17	2,45	—
3-1/2	10.20	—	—	88,90	15,18	—	—	7,34	74,22	14,76	2,18	—	—	—
3-1/2	12.70	12.95	—	88,90	18,90	19,27	—	9,52	69,86	18,64	1,81	3,72	2,00	—
3-1/2	14.30	—	—	88,90	21,28	—	—	10,92	67,06	21,00	—	—	—	—
3-1/2	15.50	—	—	88,90	23,07	—	—	12,09	64,72	22,90	—	—	—	—
3-1/2	17.00	—	—	88,90	25,30	—	—	13,46	61,98	25,04	—	—	—	—
4	9.50	—	—	101,60	14,14	—	—	5,74	90,12	13,57	2,81	—	—	—
4	10.70	11.00	—	101,60	—	16,37	—	6,65	88,30	15,57	—	4,81	—	—
4	13.20	—	—	101,60	19,64	—	—	8,38	84,84	19,27	—	—	—	—
4	16.10	—	—	101,60	23,96	—	—	10,54	80,52	23,67	—	—	—	—
4	18.90	—	—	101,60	28,13	—	—	12,70	76,20	27,84	—	—	—	—
4	22.20	—	—	101,60	33,04	—	—	15,49	70,62	32,89	—	—	—	—
4-1/2	12.60	12.75	—	114,30	18,75	18,97	—	6,88	100,54	18,23	2,72	—	—	—
4-1/2	15.20	—	—	114,30	22,62	—	—	8,56	97,18	22,32	—	—	—	—
4-1/2	17.00	—	—	114,30	25,30	—	—	9,65	95,00	24,90	—	—	—	—
4-1/2	18.90	—	—	114,30	28,13	—	—	10,92	92,46	27,84	—	—	—	—
4-1/2	21.50	—	—	114,30	32,00	—	—	12,70	88,90	31,82	—	—	—	—
4-1/2	23.70	—	—	114,30	35,27	—	—	14,22	85,86	35,10	—	—	—	—
4-1/2	26.10	—	—	114,30	38,84	—	—	16,00	82,30	38,79	—	—	—	—

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

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

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

[c] The densities of martensitic chromium (L80 Types 9Cr and 13Cr) are different from carbon steels. The masses shown are therefore not accurate for martensitic chromium steels. A mass correction factor of 0,989 may be used.

[d] Mass gain or loss due to end finishing. See 8.5.

[e] The length of the upset may alter the mass gain or loss due to end finishing.

Table C.26—Extreme-line casing upset end dimensions and masses

Labels		Outside diameter	Nominal linear mass upset and threaded	Finished pin-and-box dimensions [a]								
				Pin-and-box outside diameter (turned) +0.5 −0.2		Pin inside diameter (bored) ± 0,38	Box inside diameter (bored) +0.76 0	Pin-and-box made-up (power-tight) b			Drift dia'r for finished upset member	Drift diameter for full length drifting min.
		mm	kg/m	mm		mm	mm	Outside diameter, +0.5 −0.2 mm		Inside diameter, +0.2 −0.1	mm	mm
				Standard	Optional	Standard and optional	Standard and optional				Standard and optional	Standard and optional
1	2	*D*		*M*	*M*	*B*	*D*	Standard [c]	Optional [c]	Standard and optional		
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*
5	15.00	127,00	22,32	136,14	—	106,88	107,57	136,14	—	106,63	106,25	105,44
5	18.00	127,00	26,79	136,14	—	106,88	107,57	136,14	—	106,63	106,25	105,44
5-1/2	15.50	139,70	23,07	148,84	146,81	120,55	121,23	148,84	146,81	120,29	119,91	118,19
5-1/2	17.00	139,70	25,30	148,84	146,81	119,66	120,35	148,84	146,81	119,41	119,02	118,19
5-1/2	20.00	139,70	29,76	148,84	146,81	119,66	120,35	148,84	146,81	119,41	119,02	118,19
5-1/2	23.00	139,70	34,23	148,84	146,81	117,32	118,03	148,84	146,81	117,09	116,71	115,44
6-5/8	24.00	168,28	35,72	177,80	176,02	147,12	147,78	177,80	176,02	146,84	146,46	145,54
6-5/8	28.00	168,28	41,67	177,80	176,02	145,82	146,51	177,80	176,02	145,57	145,19	143,92
6-5/8	32.00	168,28	47,62	177,80	176,02	142,85	143,56	177,80	176,02	142,62	142,24	140,97
7	23.00	177,80	34,23	187,71	185,67	157,02	157,68	187,71	185,67	156,74	156,36	156,24
7	26.00	177,80	38,69	187,71	185,67	157,02	157,68	187,71	185,67	156,74	156,36	156,24
7	29.00	177,80	43,16	187,71	185,67	155,80	156,46	187,71	185,67	155,52	155,14	153,90
7	32.00	177,80	47,62	187,71	185,67	153,47	154,15	187,71	185,67	153,21	152,83	151,61
7	35.00	177,80	52,09	191,26	187,71	151,10	151,82	191,26	187,71	150,88	150,50	149,33
7	38.00	177,80	56,55	191,26	187,71	149,07	149,78	191,26	187,71	148,84	148,46	147,19
7-5/8	26.40	193,68	39,29	203,45	201,17	172,26	172,90	203,45	201,17	171,96	171,58	171,45
7-5/8	29.70	193,68	44,20	203,45	201,17	172,26	172,90	203,45	201,17	171,96	171,58	171,45
7-5/8	33.70	193,68	50,15	203,45	201,17	170,59	171,25	203,45	201,17	170,31	169,93	168,66
7-5/8	39.00	193,68	58,04	203,45	201,17	167,00	167,69	203,45	201,17	166,75	166,37	165,10
8-5/8	32.00	219,08	47,62	231,65	229,36	196,52	197,15	231,65	229,36	196,22	195,83	195,58
8-5/8	36.00	219,08	53,57	231,65	229,36	196,52	197,16	231,65	229,36	196,22	195,83	195,58
8-5/8	40.00	219,08	59,53	231,65	229,36	194,92	195,58	231,65	229,36	194,64	194,26	193,04
8-5/8	44.00	219,08	65,48	231,65	229,36	192,40	193,09	231,65	229,36	192,15	191,77	190,50
8-5/8	49.00	219,08	72,92	231,65	229,36	189,48	190,20	231,65	229,36	189,26	188,87	187,60
9-5/8	40.00	244,48	59,53	256,54	254,51	220,40	221,03	256,54	254,51	220,09	219,71	218,41
9-5/8	43.50	244,48	64,73	256,54	254,51	220,40	221,03	256,54	254,51	220,09	219,71	218,41
9-5/8	47.00	244,48	69,94	256,54	254,51	219,28	219,91	256,54	254,51	218,97	218,59	216,54
9-5/8	53.50	244,48	79,62	256,54	254,51	215,52	216,20	256,54	254,51	215,27	214,88	212,83
10_	45.50	273,05	67,71	291,08	—	249,66	250,29	291,08	—	249,40	249,02	248,77
10_	51.00	273,05	75,90	291,08	—	247,12	247,75	291,08	—	246,86	246,48	246,23
10_	55.50	273,05	82,59	291,08	—	244,83	245,47	291,08	—	244,58	244,20	243,94
10_	60.70	273,05	90,33	291,08	—	242,29	242,93	291,08	—	242,04	241,66	241,40

See also Table C.24 and Figure D.8.

[a] Due to the nature of extreme-line casing, certain dimensional symbols and nomenclature differ from those for similar details for other pipe covered by this International Standard.

[b] Shown for reference.

[c] Made-up joint *D* is the same as the outside diameter dimension *M*.

Table C.27—External-upset tubing—Upset end dimensions and masses for Groups 1, 2 and 3

Labels [a]		Outside diameter	Nominal linear mass threaded and coupled [b]	Upset			
				Outside diameter [c] +1,59 0	Length from end of pipe to start of taper [d, e] +25,4 0	Length from end of pipe to end of taper [e]	Length from end of pipe to start of pipe body [e] max.
1	2	mm D	kg/m	mm D_4	mm L_{eu}	mm L_a	mm L_b
1	2	3	4	5	6	7	8
1.050	1.20	26,67	1,79	33,40	60,32	—	—
1.050	1.54	26,67	2,29	33,40	60,32	—	—
1.315	1.80	33,40	2,68	37,31	63,50	—	—
1.315	2.24	33,40	3,33	37,31	63,50	—	—
1.660	2.40	42,16	3,57	46,02	66,68	—	—
1.660	3.07	42,16	4,57	46,02	66,68	—	—
1.900	2.90	48,26	4,32	53,19	68,26	—	—
1.900	3.73	48,26	5,55	53,19	68,26	—	—
2-3/8	4.70	60,32	6,99	65,89	101,60	152,40	254,00
2-3/8	5.95	60,32	8,85	65,89	101,60	152,40	254,00
2-3/8	7.45	60,32	11,09	65,89	101,60	152,40	254,00
2-7/8	6.50	73,02	9,67	78,59	107,95	158,75	260,35
2-7/8	7.90	73,02	11,76	78,59	107,95	158,75	260,35
2-7/8	8.70	73,02	12,95	78,59	107,95	158,75	260,35
2-7/8	9,45	73,02	14,06	78,59	107,95	158,75	260,35
3-1/2	9.30	88,90	13,84	95,25	114,30	165,10	266,70
3-1/2	12.95	88,90	19,27	95,25	114,30	165,10	266,70
4	11.00	101,60	16,37	107,95	114,30	165,10	266,70
4-1/2	12.75	114,30	18,97	120,65	120,65	171,45	273,05

See also Figures D.5 and D.6.

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

[b] The densities of martensitic chromium steels (L80 9Cr and 13Cr) are different from carbon steels. The masses shown are therefore not accurate for chromium steels. A mass correction factor of 0,989 may be used.

[c] The minimum outside diameter of upset D_4 is limited by the minimum length of full-crest threads. See ISO 10422 or API Spec 5B.

[d] For pup-joints only, the length tolerance on L_{eu} is $^{1016}_{25,4}$ mm. The length on L_b may be 101,6 mm longer than specified.

[e] For extended-length upsets on external upset tubing, add 25,4 mm to the dimensions in columns 5, 6 and 7.

Table C.28—Integral joint tubing—Upset end dimensions and masses for Groups 1, 2

Labels		Outside dia.	Nominal linear mass [a] T&C	Upset dimensions								
				Pin				Box				
				Outside dia. [b] +1,59 0	Inside dia. [c] +0,38 0	Length min.	Length of taper min.	Outside diameter + 0.13 - 0.64	Length min.	Length of taper	Diameter of recess	Width of face min.
1	2	mm D	kg/m	mm D_4	mm d_{iu}	mm L_{iu}	mm m_{iu}	mm W_b	mm L_{eu}	mm m_{eu}	mm Q	mm b
1	2	3	4	5	6	7	8	9	10	11	12	13
1.315	1.72	33,40	2,56	—	24,64	34,92	6,35	39,37	44,45	25,40	35,00	0,79
1.660	2.10	42,16	3,13	—	33,05	38,10	6,35	47,75	47,62	25,40	43,76	0,79
1.660	2.33	42,16	3,47	—	33,05	38,10	6,35	47,75	47,62	25,40	43,76	0,79
1.900	2.40	48,26	3,57	—	38,89	41,28	6,35	53,59	50,80	25,40	49,86	0,79
1.900	2.76	48,26	4,11	—	38,89	41,28	6,35	53,59	50,80	25,40	49,86	0,79
2.063	3.25	52,40	4,84	53,19	42,47	42,86	6,35	59,06	53,98	25,40	54,76	0,79

See also Figure D.7.

[a] Nominal linear masses, upset and threaded, are shown for information only.

[b] The minimum outside diameter D_4 is limited by the minimum length of full-crest threads. See ISO 10422 or API Spec 5B.

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

Table C.29—Plain-end liners—Dimensions and masses for Grade J55

Labels		Outside diameter	Plain-end linear mass	Wall thickness	Inside diameter
		D		*t*	*d*
1	2	mm	kg/m	mm	mm
1	*2*	*3*	*4*	*5*	*6*
3-1/2	9.92	88,90	14,76	7,34	74,22
4	11.35	101,60	16,89	7,26	87,08
4-1/2	13.05	114,30	19,44	7,37	99,56
5	17.95	127,00	26,70	9,19	108,62
5-1/2	19.83	139,70	29,52	9,17	121,36
6-5/8	27.67	168,28	41,18	10,59	147,10

Table C.30—Range lengths

Dimensions in metres

	Range 1	Range 2	Range 3
CASING AND LINERS			
Total range length, inclusive	4,88 to 7,62	7,62 to 10,36	10,36 to 14,63
Range length for 95 % or more of carload: [a]			
Permissible variation, max.	1,83	1,52	1,83
Permissible length, min.	5,49	8,53	10,97
TUBING AND CASING USED AS TUBING			
Total range length, inclusive [b]	6,10 to 7,32	8,53 to 9,75	11,58 to 12,80 [c]
Range length for 100 % of carload: [a]			
Permissible variation, max	0,61	0,61	0,61
PUP-JOINTS	Lengths 0,61; 0,91; 1,22; 1,83 ; 2,44 ; 3,05 and 3,66 [d] Tolerance ± 0,076		

[a] Carload tolerances shall not apply to order items of less than 18 144 kg of pipe. For any carload of 18 144 kg or more of pipe that is shipped to the final destination without transfer or removal from the car, the tolerance shall apply to each car. For any order item consisting of more than 18 144 kg of pipe that is shipped from the manufacturer's facility by rail, but not to the final destination, the carload tolerance shall apply to the overall quantity of pipe shipped on the order item, but not to the individual carloads.

[b] By agreement between purchaser and manufacturer the total range length for Range 1 tubing may be 6,10 m to 8,53 m.

[c] By agreement between manufacturer and purchaser the maximum length may be increased to 13,72 m.

[d] 0,61 m pup-joints may be furnished up to 0,91 m long by agreement between purchaser and manufacturer, and lengths other than those listed may be furnished by agreement between purchaser and manufacturer.

Table C.31—Standard drift size

Dimensions in millimetres

Product and Label 1	Standard drift mandrel size min.	
	Length	Diameter
Casing [a] and liners		
< 9-5/8	152	$d - 3{,}18$
≥ 9-5/8 to ≤ 13-3/8	305	$d - 3{,}97$
> 13-3/8	305	$d - 4{,}76$
Tubing [b]		
≤ 2-7/8	1 067	$d - 2{,}38$
> 2-7/8	1 067	$d - 3{,}18$

[a] The minimum diameter of the drift mandrel for extreme-line casing shall be as shown in col.12 and 13, Table C.26.

[b] Integral-joint tubing shall be tested before upsetting with a drift mandrel as shown, and shall also be drift tested at the pin end, after upsetting, with a cylindrical drift mandrel 1 067 mm in length and $d_{iu} - 0{,}38$ mm in diameter (see Table C.28, Col. 6 for d_{iu}).

Table C.32—Alternative drift size

Labels		Outside diameter D	Product linear mass	Alternative drift mandrel size min. mm	
1	2	mm	kg/m	Length	Diameter
1	*2*	*3*	*4*	*5*	*6*
7	23.00	177,80	34,23	152	158,75
7	32.00	177,80	47,62	152	152,40
7-3/4	46.10	196,85	68,60	152	165,10
8-5/8	32.00	219,08	47,62	152	200,03
8-5/8	40.00	219,08	59,53	152	193,68
9-5/8	40.00	244,48	59,53	305	222,25
9-5/8	53.50	244,48	79,62	305	215,90
9-5/8	58.40	244,48	86,91	305	212,72
10-3/4	45.50	273,05	67,71	305	250,82
10-3/4	55.50	273,05	82,59	305	244,48
11-3/4	42.00	298,45	62,50	305	279,40
11-3/4	60.00	298,45	89,29	305	269,88
11-3/4	65.00	298,45	96,73	305	269,88
13-3/8	72.00	339,72	107,15	305	311,15

Table C.33—Maximum permissible depth of linear imperfections

Grade	Depth as % of specified wall thickness	
	External	Internal
H40 – J55 – K55 – M65 – N80 – N80Q L80 – C95 – P110 to A.9 (SR16)	12,5 %	12,5 %
C90 – T95 – P110 – Q125	5 %	5 %
P110 to A.9 (SR16) and A.2 (SR2)	5 %	5 %

Table C.34—Upset products—Maximum permissible depth of imperfections

	Surface	Depth	Measurement notes
1	*2*	*3*	*4*
A. Extreme-line casing, integral joint and external upset tubing (see Figures D.5, D.7 and D.8)			
A.1	All surfaces of upset and upset run-out interval, except as stated below	12,5 % t	Percentage of specified pipe body wall thickness t; for non-linear imperfections; for all groups of pipe
		12,5 % t	Percentage of specified pipe body wall thickness t; for linear imperfections; for Group 1 and Group 2 (except C90 and T95) pipe
		5 % t	Percentage of specified pipe body wall thickness t; for linear imperfections; for Group 3, Group 4 and Grades C90 and T95 pipe
A.2 The minimum wall thickness in the upset run-out interval, and the maximum combined effect of coincident internal and external imperfections in all areas, shall not total less than 87,5 % of the specified wall thickness.			
B. Extreme-line casing (see Figure D.8)			
B.1.	Box end external surface	0,25 mm	For Label-1: 7-5/8 and smaller sizes. From end of pipe to a plane 120,6 mm from the end.
		0,25 mm	For Label-1: Larger than 7-5/8. From end of pipe to a plane 165,1 mm from the end.
B.2	Pin end internal surface	0,38 mm	From end of pipe to plane of external shoulder (bored)
B.3 All machined surfaces of the box shall be free of seams, laps and cracks. The pin-and-box shall be free of any imperfections which break the continuity of the threads or seals.			
C. Integral joint tubing (see Figure D.7)			
C.1	Box end external surface	0,25 mm	From end of pipe to a plane at a distance equal to the specified minimum dimension L_{eu} (Figure D.7) from end of pipe.
C.2	Pin end internal surface	0,38 mm	From end of pipe to a plane at a distance equal to the specified minimum dimension L_{iu} (Figure D.7) from end of pipe.
			For Grades C90 and T95, the maximum permissible depth for linear imperfections shall be 5 % of the specified pipe body wall thickness.
C.3 Upset underfills in the upset run-out intervals shall not be considered a defect unless the remaining wall thickness (at the upset underfill) is less than 87,5 % of the specified pipe body wall thickness.			

Table C.35—Round-thread casing coupling dimensions, masses and tolerances

Label-1	Size [a]	Outside diameter	Minimum length mm		Diameter of recess	Width of bearing face	Mass kg	
	Outside diameter		Short	Long			Short	Long
	D mm	W mm	N_L	N_L	Q [b] mm	b mm		
1	2	3	4	5	6	7	8	9
4-1/2	114,30	127,00	158,75	177,80	116,68	3,97	3,62	4,15
5	127,00	141,30	165,10	196,85	129,38	4,76	4,66	5,75
5-1/2	139,70	153,67	171,45	203,20	142,08	3,18	5,23	6,42
6-5/8	168,28	187,71	184,15	222,25	170,66	6,35	9,12	11,34
7	177,80	194,46	184,15	228,60	180,18	4,76	8,39	10,83
7-5/8	193,70	215,90	190,50	234,95	197,64	5,56	12,30	15,63
8-5/8	219,08	244,48	196,85	254,00	223,04	6,35	16,23	21,67
9-5/8	244,48	269,88	196,85	266,70	248,44	6,35	18,03	25,45
10-3/4	273,05	298,45	203,20	—	277,02	6,35	20,78	—
11-3/4	298,45	323,85	203,20	—	302,42	6,35	22,64	—
13-3/8	339,72	365,12	203,20	—	343,69	5,56	25,66	—
16	406,40	431,80	228,60	—	411,96	5,56	34,91	—
18-5/8	473,08	508,00	228,60	—	478,63	5,56	54.01	—
20	508,00	533,40	228,60	292,10	513,56	5,56	43,42	57,04

See also Figures D.1 and D.2.

Tolerance on outside diameter W, ±1 % but not greater than ± 3,18 mm—Groups 1, 2 and 3.

Tolerance on outside diameter W, ±1 % but not greater than $^{+3,18}_{-1,59}$—Group 4.

[a] The size designation for the coupling is the same as the size designation for the pipe on which the coupling is used.

[b] Tolerance on diameter of recess, Q, for all groups is $^{+0,79}_{0}$

Table C.36—Buttress thread casing coupling dimensions, masses and tolerances

Label-1	Size [a]	Outside diameter		Minimum length	Diameter of counterbore	Width of bearing face	Mass kg	
	Outside diameter D mm	Regular W mm	Special clearance W_c mm	N_L mm	Q mm	b mm	Regular	Special clearance
1	2	3	4	5	6	7	8	9
4-1/2	114,30	127,00	123,82	225,42	117,86	3,18	4,55	3,48
5	127,00	141,30	136,52	231,78	130,56	3,97	5,85	4,00
5-1/2	139,70	153,67	149,22	234,95	143,26	3,97	6,36	4,47
6-5/8	168,28	187,71	177,80	244,48	171,83	6,35	11,01	5,65
7	177,80	194,46	187,32	254,00	181,36	5,56	10,54	6,28
7-5/8	193,68	215,90	206,38	263,52	197,23	7,94	15,82	9,29
8-5/8	219,08	244,48	231,78	269,88	222,63	9,52	20,86	10,80
9-5/8	244,48	269,88	257,18	269,88	248,03	9,52	23,16	12,02
10-3/4	273,05	298,45	285,75	269,88	276,61	9,52	25,74	13,39
11-3/4	298,45	323,85	—	269,88	302,01	9,52	28,03	—
13-3/8	339,72	365,12	—	269,88	343,28	9,52	31,77	—
16	406,40	431,80	—	269,88	410,31	9,52	40,28	—
18-5/8	473,08	508,00	—	269,88	476,99	9,52	62,68	—
20	508,00	533,40	—	269,88	511,91	9,52	50,10	—

See also Figure D.3.

Tolerance on outside diameter W, ±1 % but not greater than ± 3,18 mm—Groups 1, 2 and 3.

Tolerance on outside diameter W, ±1 % but not greater than $^{+3,18}_{-1,59}$—Group 4.

[a] The size designation for the coupling is the same as the size designation for the pipe on which the coupling is used.

Table C.37—Non-upset tubing coupling dimensions, masses and tolerances

Label 1	Size [a] Outside diameter D mm	Outside diameter W mm	Minimum length N_L mm	Diameter ofrecess Q mm	Width of bearing face b mm	Maximum bearing face diameter, special bevel Bf mm	Mass kg
1	2	3	4	5	6	7	8
1.050	26,67	33,35	80,96	28,27	1,59	30,00	0,23
1.315	33,40	42,16	82,55	35,00	2,38	37,80	0,38
1.660	42,16	52,17	88,90	43,76	3,18	47,17	0,59
1.900	48,26	55,88	95,25	49,86	1,59	52,07	0,56
2-3/8	60,32	73,02	107,95	61,93	4,76	66,68	1,28
2-7/8	73,02	88,90	130,18	74,63	4,76	80,98	2,34
3-1/2	88,90	107,95	142,88	90,50	4,76	98,42	3,71
4	101,60	120,65	146,05	103,20	4,76	111,12	4,35
4-1/2	114,30	132,08	155,58	115,90	4,76	123,19	4,89

See also Figure D.4.

Tolerance on outside diameter W, ±1 %.

[a] The size designation for the coupling is the same as the size designation for the pipe on which the coupling is used.

Table C.38—External-upset tubing coupling dimensions, masses and tolerances

Label 1	Size [a]	Outside diameter		Minimum length	Diameter of recess	Width of bearing face, regular	Maximum bearing face diameter *Bf*		Mass kg	
	Outside diameter	Regular & special bevel	Special clearance				Special bevel	Special clearance	Regular	Special clearance
	D mm	*W* mm	W_C mm	N_L mm	*Q* mm	mm	mm	mm		
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*
1.050	26,67	42,16	—	82,55	35,00	2,38	37,80	—	0,38	—
1.315	33,40	48,26	—	88,90	38,89	2,38	42,77	—	0,57	—
1.660	42,16	55,88	—	95,25	47,63	3,18	50,95	—	0,68	—
1.900	48,26	63,50	—	98,42	54,76	3,18	58,34	—	0,84	—
2-3/8	60,32	77,80	73,91	123,82	67,46	3,97	71,83	69,90	1,55	1,07
2-7/8	73,02	93,17	87,88	133,35	80,16	5,56	85,88	83,24	2,40	1,55
3-1/2	88,90	114,30	106,17	146,05	96,85	6,35	104,78	100,71	4,10	2,38
4	101,60	127,00	—	152,40	109,55	6,35	117,48	—	4,82	—
4-1/2	114,30	141,30	—	158,75	122,25	6,35	130,96	—	6,05	—

See also Figure D.5.
Tolerance on outside diameter W, ± 1 %.
Tolerance on outside diameter W_C, ± 0,38 mm.

[a] The size designation for the coupling is the same as the size designation for the pipe on which the coupling is used.

Table C.39—Permissible depth of coupling external imperfections

Coupling for pipe size		Group 1 Group 2 (except C90 and T95) Group 3		Group 2 (C90 and T95) Group 4
		Pits and round-bottom gouges	Grip marks and sharp-bottom gouges	Pits, round-bottom gouges, sharp-bottom gouges, grip marks
1	*2*	*3*	*4*	*5*
Tubing	< 3-1/2	0,76	0,64	0,76
	≥ 3-1/2 to ≤ 4-1/2	1,14	0,76	0,89
	< 6-5/8	0,89	0,76	0,76
Casing [a]	≥ 6-5/8 to ≤ 7-5/8	1,14	1,02	0,89
	> 7-5/8	1,52	1,02	0,89

[a] Includes casing used as tubing.

Table C.40—Frequency of tensile tests—Casing and tubing

Group	Label 1	Maximum number of pieces in a lot	Number of tests	
			per lot	per heat
1	*2*	*3*	*4*	*5*
1	< 6-5/8	400	1	1
	≥ 6-5/8	200	1	1
2	≤ 4-1/2 – Grades M65, L80, C95	200	2	1
	≤ 4-1/2 – Grades C90, T95	200	1	—
	> 4-1/2 – Grades M65, L80, C95	100	2	1
	> 4-1/2 – Grades C90, T95	100	1	—
3	< 6 5/8	200	1	1
	≥ 6 5/8	100	1	1
4	All sizes	—	3	—

NOTE Table includes casing used as tubing.

For Groups 1, 2 and 3 multiple-length seamless pipe, a length shall be considered as all of the sections cut from a particular multiple length provided the pipe receives no additional heat-treatment after being cut into individual lengths.

Table C.41—Frequency of tensile tests—Couplings

Group	Source of coupling		Maximum number of pieces in a lot	Number of tests	
	Material	Heat treatment		per lot	per heat
1	*2*	*3*	*4*	*5*	*6*
Groups 1 & 3	Seamless pipe	Coupling stock for pipe Label 1 (≤ 4-1/2)	200	1	1
		Coupling stock for pipe Label 1 (> 4-1/2)	100	1	1
		Coupling blank	Heat-treat lot or 400 couplings, whichever is less	1	1
	Forged or centrifugally cast	—	Heat-treat lot or 400 couplings, whichever is less	1	1
Group 2 Grades L80 and C95	Seamless pipe	Coupling stock for pipe Label 1 (≤ 4-1/2) [a]	200	2	2
		Coupling stock for pipe Label 1 (> 4-1/2) [a]	100	2	2
		Coupling blank	Heat-treat lot or 400 couplings, whichever is less	2	2
	Forged or centrifugally cast	—	Heat-treat lot or 400 couplings, whichever is less	2	2
Group 2 Grades C90 and T95, Group 4	Material heat-treated in tube length		1 tube	1 per tube [a]	
	Material heat-treated as individual coupling blanks		Heat-treat lot in accordance with 10.2	1	—

[a] 50 % each end.

Table C.42—Frequency of tensile tests—Pup-joints and accessories

Group	Source of pup-joints and accessories		Maximum number of pieces in a lot	Number of tests	
	Material	Heat treatment		per lot	per heat
1	*2*	*3*	*4*	*5*	*6*
Groups 1 & 3	Casing [a] or tubing	Heat-treated separately from casing and tubing	—	1	1
		Batch heat treatment	100 pup-joints or 400 accessories	1	1
		Continuous heat treatment	In accordance with 10.2	1	1
	Thick wall tube or bar stock	—	≤ Label 1: 4-1/2: 200 tubes or bars	1	1
			> Label 1: 4-1/2: 100 tubes or bars	1	1
Group 2 Grades L80 & C95	Casing [a] or tubing	Heat-treated separately from casing and tubing	—	2	2
		Batch heat treatment	100 pup-joints or 400 accessories	2	2
		Continuous heat treatment	In accordance with 10.2	2	2
	Thick wall tube or bar stock	—	≤ Label 1: 4-1/2: 200 tubes or bars	2	2
			> Label 1: 4-1/2: 100 tubes or bars	2	2
Group 2 Grades C90 and T95, Group 4	Material heat-treated in tube length		1 tube	1 per tube [b]	
	Material heat-treated in individual length		Heat-treat lot in accordance with 10.2	1	—

[a] Includes casing used as tubing.
[b] 50 % each end.

Table C.43—Frequency of flattening tests

Casing and tubing					
Group	**Type of heat treatment**		**Number of tests**		
1	*2*	*3*	*4*		
1, 2 and 3	Non-full body		As described in Notes 1 to 5		
	Full body	≤ Label 1: 4-1/2	Same as non-full body heat-treated or 1 per lot of 100 lengths or less		
		> Label 1: 4-1/2 [a]	Same as non-full body heat-treated or 1 per lot of 20 lengths or less		
4	All		1 on each end of each length of pipe [see A.5 (SR11)]		
Pup-joints					
Group	**Source of pup-joint**		**Maximum number of pieces in a lot**	**Number of tests**	
				per lot	**per heat**
1	*2*	*3*	*4*	*5*	*6*
1, 2 and 3	Treated separately	Batch heat-treated	100 pup-joints	1	1
		Continuously heat-treated	—		
	Manufactured from EW pipe	≤ Label 1: 4-1/2	200 lengths		
		> Label 1: 4-1/2 [a]	100 lengths		
4	All			1 on each end of each length of pipe	

NOTE 1 The leading end of the first pipe of each coil shall have two test specimens flattened: one in the 90° position and one in the 0° position.

NOTE 2 Two test specimens shall be flattened from an intermediate pipe of each coil: one in the 90° position and one in the 0° position.

NOTE 3 The trailing end of the last pipe of each coil shall have two test specimens flattened: one in the 90° position and one in the 0° position.

NOTE 4 When a weld stop condition occurs during production of a multiple length, flattening tests with the weld at the 90° position and 0° position shall be made from the crop end resulting from each side of the weld stop, and may be substituted for the intermediate flattening tests.

NOTE 5 90° position: the weld is positioned at 3 o'clock or at 9 o'clock. 0° position: the weld is positioned at 6 o'clock or at 12 o'clock.

[a] Includes casing used as tubing.

Table C.44—Hydrostatic test pressure for Grade H40 casing

Labels		Test pressure MPa		
		Plain end	Round thread [a]	
1	2		STC	LC
1	*2*	*3*	*4*	*5*
4-1/2	9.50	20,0	20,0	—
5-1/2	14.00	19,5	19,5	—
6-5/8	20.00	19,0	19,0	—
7	17.00	14,5	14,5	—
7	20.00	17,0	17,0	—
7-5/8	24.00	17,5	17,5	—
8-5/8	28.00	15,5	15,5	—
8-5/8	32.00	18,0	18,0	—
9-5/8	32.30	14,5	14,5	—
9-5/8	36.00	16,0	16,0	—
10-3/4	32.75	8,5 (11,5)	8,5 (11,5)	— —
10-3/4	40.50	11,0 (14,5)	11,0 (14,5)	— —
11-3/4	42.00	9,5 (12,5)	9,5 (12,5)	— —
13-3/8	48.00	8,0 (11,0)	8,0 (11,0)	— —
16	65.00	8,0 (10,5)	8,0 (10,5)	— —
18-5/8	87.50	7,5 (10,5)	7,5 (10,5)	— —
20	94.00	7,5 (9,5)	7,5 (9,5)	7,5 (9,5)

NOTE Alternative test pressures are given in parentheses.

[a] The test pressures shown are for threaded and coupled pipe furnished with H40, J55 or K55 couplings.

Table C.45—Hydrostatic test pressure for Grades J55 and K55 casing

Labels		Test pressure MPa							
			Round thread		Buttress thread				
					Regular coupling		Special-clearance coupling		XC
1	2	Plain end	STC	LC	J55 K55	L80	J55 K55	L80	
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
3-1/2 [a]	9.91	50,0	—	—	—	—	—	—	—
4 [a]	11.34	43,5	—	—	—	—	—	—	—
4-1/2	9.50	27,5	27,5	—	—	—	—	—	—
4-1/2	10.50	30,0	30,0	—	30,0	30,0	30,0	30,0	—
4-1/2	11.60	33,5	33,5	33,5	33,5	33,5	30,5	33,5	—
4-1/2 [a]	13.04	39,0	—	—	—	—	—	—	—
5	11.50	26,5	26,5	—	—	—	—	—	—
5	13.00	30,5	30,5	30,5	30,5	30,5	28,5	30,5	—
5	15.00	36,0	36,0	36,0	36,0	36,0	28,0	36,0	36,0
5 [a]	17.93	44,0	—	—	—	—	—	—	—
5-1/2	14.00	27,0	27,0	—	—	—	—	—	—
5-1/2	15.50	30,5	30,5	30,5	30,5	30,5	26,0	30,5	30,5
5-1/2	17.00	33,5	33,5	33,5	33,5	33,5	26,0	33,5	33,5
5-1/2 [a]	19.81	40,0	—	—	—	—	—	—	—
6-5/8	20.00	26,5	26,5	26,5	26,5	26,5	22,5	26,5	—
6-5/8	24.00	32,0	32,0	32,0	32,0	32,0	22,5	32,0	32,0
6-5/8 [a]	27.65	38,0	—	—	—	—	—	—	—
7	20.00	23,5	23,5	—	—	—	—	—	—
7	23.00	27,5	27,5	27,5	27,5	27,5	21,5	27,5	27,5
7	26.00	31,5	31,5	31,5	31,5	31,5	21,5	31,5	31,5
7-5/8	26.40	26,0	26,0	26,0	26,0	26,0	25,0	26,0	—
8-5/8	24.00	18,5	18,5	—	—	—	—	—	—
8-5/8	32.00	24,5	24,5	24,5	24,5	24,5	22,5	24,5	24,5
8-5/8	36.00	28,0	28,0	28,0	28,0	28,0	22,5	28,0	28,0
9-5/8	36.00	22,0	22,0	22,0	22,0	22,0	20,0	22,0	—
9-5/8	40.00	25,0	25,0	25,0	25,0	25,0	20,0	25,0	25,0
10-3/4	40.50	15,0 (19,5)	15,0 (19,5)	— —	15,0 (19,5)	15,0 (19,5)	15,0 (18,0)	15,0 (19,5)	— —
10-3/4	45.50	17,0 (22,5)	17,0 (22,5)	— —	17,0 (22,5)	17,0 (22,5)	17,0 (18,0)	17,0 (22,5)	17,0 (22,5)
10-3/4	51.00	19,0 (25,5)	19,0 (25,5)	— —	19,0 (25,5)	19,0 (25,5)	18,0 (18,0)	19,0 (25,5)	19,0 (25,5)
11-3/4	47.00	14,5 (19,5)	14,5 (19,5)	— —	14,5 (19,5)	14,5 (19,5)	— —	— —	— —
11-3/4	54.00	17,0 (22,5)	17,0 (22,5)	— —	17,0 (22,5)	17,0 (22,5)	— —	— —	— —
11-3/4	60.00	19,0 (25,0)	19,0 (25,0)	— —	19,0 (25,0)	19,0 (25,0)	— —	— —	— —
13-3/8	54.50	13,0 (17,0)	13,0 (17,0)	— —	13,0 (17,0)	13,0 (17,0)	— —	— —	— —
13-3/8	61.00	14,5 (19,5)	14,5 (19,5)	— —	14,5 (19,5)	14,5 (19,5)	— —	— —	— —
13-3/8	68.00	16,5 (22,0)	16,5 (22,0)	— —	16,5 (22,0)	16,5 (22,0)	— —	— —	— —
16	75.00	12,5 (16,5)	12,5 (16,5)	— —	12,5 (16,5)	12,5 (16,5)	— —	— —	— —
16	84.00	14,0 (19,0)	14,0 (19,0)	— —	14,0 (19,0)	14,0 (19,0)	— —	— —	— —
16	109.00	18,5 (25,0)	— —	— —	— —	— —	— —	— —	— —
18-5/8	87.50	10,5 (14,0)	10,5 (14,0)	— —	10,5 (14,0)	10,5 (14,0)	— —	— —	— —
20	94.00	10,0 (13,5)	10,0 (13,5)	10,0 (13,5)	10,0 (13,5)	10,0 (13,5)	— —	— —	— —
20	106.50	11,5 (15,0)	11,5 (15,0)	11,5 (15,0)	11,5 (15,0)	11,5 (15,0)	— —	— —	— —
20	133.00	14,5 (19,5)	14,5 (16,5)	14,5 (16,5)	14,5 (16,0)	14,5 (16,0)	— —	— —	— —

NOTE Alternative test pressures are given in parentheses.

[a] Used as plain-end casing liner.

Table C.46—Hydrostatic test pressure for Grade M65 casing

Labels		Test pressure MPa				
		Plain end	Round thread		Buttress thread [a]	
1	2		STC	LC	Regular coupling	Special-clearance coupling
1	*2*	*3*	*4*	*5*	*6*	*7*
4-1/2	9.50	32,5	32,5	—	—	—
4-1/2	10.50	35,5	35,5	—	35,5	35,5
4-1/2	11.60	40,0	—	40,0	40,0	40,0
4-1/2	13.50	46,0	—	46,0	46,0	44,0
5	11.50	31,5	31,5	—	—	—
5	13.00	36,5	36,5	36,5	36,5	36,5
5	15.00	42,5	—	42,5	42,5	41,0
5	18.00	52,0	—	52,0	52,0	41,0
5	21.40	62,5	—	59,5	54,5	41,0
5-1/2	14.00	32,0	32,0	—	—	—
5-1/2	15.50	36,0	36,0	36,0	36,0	36,0
5-1/2	17.00	39,5	—	39,5	39,5	38,0
5-1/2	20.00	47,0	—	47,0	47,0	38,0
5-1/2	23.00	54,0	—	54,0	49,5	38,0
6-5/8	20.00	31,0	31,0	31,0	31,0	31,0
6-5/8	24.00	36,0	—	36,0	36,0	32,5
6-5/8	28.00	45,0	—	45,0	45,0	32,5
7	20.00	28,0	28,0	—	—	—
7	23.00	32,5	—	32,5	32,5	31,5
7	26.00	37,0	—	37,0	37,0	31,5
7	29.00	42,0	—	42,0	42,0	31,5
7	32.00	46,5	—	46,5	46,5	31,5
7-5/8	26.40	31,0	31,0	31,0	31,0	31,0
7-5/8	29.70	35,0	—	35,0	35,0	35,0
7-5/8	33.70	40,5	—	40,5	40,5	36,0
8-5/8	24.00	22,0	22,0	—	—	—
8-5/8	28.00	25,5	25,5	—	—	—
8-5/8	32.00	29,5	29,5	29,5	29,5	29,5
8-5/8	36.00	33,0	33,0	33,0	33,0	32,5
8-5/8	40.00	37,5	—	37,5	37,5	32,5
9-5/8	36.00	26,0	26,0	26,0	26,0	26,0
9-5/8	40.00	29,5	29,5	29,5	29,5	29,5
9-5/8	43.50	32,5	—	32,5	32,5	29,5
9-5/8	47.00	35,0	—	35,0	35,0	29,5
10-3/4	40.50	23,5	23,5	—	23,5	23,5
10-3/4	45.50	26,5	26,5	—	26,5	26,5
10-3/4	51.00	30,0	30,0	—	30,0	26,5
10-3/4	55.50	33,0	33,0	—	33,0	26,5
11-3/4	47.00	23,0	23,0	—	23,0	—
11-3/4	54.00	26,5	26,5	—	26,5	—
11-3/4	60.00	30,0	30,0	—	30,0	—
13-3/8	54.50	20,5	20,5	—	20,5	—
13-3/8	61.00	23,0	23,0	—	23,0	—
13-3/8	68.00	25,5	25,5	—	25,5	—
16	75.00	19,5	19,5	—	19,5	—
16	84.00	22,0	22,0	—	22,0	—
18-5/8	87.50	16,5	16,5	—	16,5	—
20	94.00	15,5	14,5	15,5	15,5	—
20	106.50	18,0	14,5	16,5	16,0	—

[a] Threaded and coupled grade M65 casing shall be furnished with grade L80 couplings.

Table C.47—Hydrostatic test pressure for Grade L80 casing

Labels		Test pressure MPa					
		Plain end	Round thread		Buttress thread		XC
1	2		STC	LC	Regular coupling	Special-clearance coupling	
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
4-1/2	11.60	49,0	—	49,0	49,0	44,0	—
4-1/2	13.50	57,0	—	57,0	54,0	44,0	—
5	15.00	52,5	—	52,5	52,5	41,0	52,5
5	18.00	64,0	—	59,5	54,5	41,0	64,0
5	21.40	69,0	—	59,5	54,5	41,0	—
5	23.20	69,0	—	59,5	54,5	41,0	—
5	24.10	69,0	—	59,5	54,5	41,0	—
5-1/2	17.00	49,0	—	49,0	49,0	38,0	49,0
5-1/2	20.00	58,0	—	54,5	49,5	38,0	58,0
5-1/2	23.00	66,5	—	54,5	49,5	38,0	66,5
6-5/8	24.00	47,0	—	47,0	47,0	32,5	47,0
6-5/8	28.00	55,5	—	55,5	54,0	32,5	55,5
6-5/8	32.00	63,5	—	59,0	54,0	32,5	63,5
7	23.00	40,0	—	40,0	40,0	31,5	40,0
7	26.00	45,5	—	45,5	45,5	31,5	45,5
7	29.00	51,5	—	51,0	46,5	31,5	51,5
7	32.00	57,0	—	51,0	46,5	31,5	57,0
7	35.00	63,0	—	51,0	46,5	31,5	63,0
7	38.00	68,0	—	51,0	46,5	31,5	68,0
7-5/8	26.40	38,0	—	38,0	38,0	36,0	38,0
7-5/8	29.70	43,5	—	43,5	43,5	36,0	43,5
7-5/8	33.70	50,0	—	50,0	50,0	36,0	50,0
7-5/8	39.00	58,0	—	58,0	54,0	36,0	58,0
7-5/8	42.80	65,0	—	58,0	54,0	36,0	—
7-5/8	45.30	69,0	—	58,0	54,0	36,0	—
7-5/8	47.10	69,0	—	58,0	54,0	36,0	—
7-3/4	46.10	68,0	—	—	—	—	—
8-5/8	36.00	41,0	—	41,0	41,0	32,5	41,0
8-5/8	40.00	46,0	—	46,0	46,0	32,5	46,0
8-5/8	44.00	51,0	—	51,0	51,0	32,5	51,0
8-5/8	49.00	57,0	—	57,0	54,0	32,5	57,0
9-5/8	40.00	36,0	—	36,0	36,0	29,5	36,0
9-5/8	43.50	40,0	—	40,0	40,0	29,5	40,0
9-5/8	47.00	43,5	—	43,5	43,5	29,5	43,5
9-5/8	53.50	50,0	—	50,0	49,0	29,5	50,0
9-5/8	58.40	54,5	—	53,0	49,0	29,5	—
10-3/4	51.00	37,0	37,0	—	37,0	26,5	37,0
10-3/4	55.50	40,5	40,5	—	40,5	26,5	40,5
11-3/4	60.00	37,0	37,0	—	37,0	—	—
11-3/4	65.00	40,0	—	—	—	—	—
11-3/4	71.00	43,5	—	—	—	—	—
13-3/8	68.00	31,5	31,5	—	31,5	—	—
13-3/8	72.00	34,0	31,5	—	34,0	—	—
16	109.00	36,0	—	—	—	—	—

Table C.48—Hydrostatic test pressure for Grade N80 Type 1 and N80Q casing

Labels		Test pressure MPa							
		Plain end	Round thread		Buttress thread				XC
1	2		STC	LC	Regular coupling		Special-clearance coupling		
					N80	P110	N80	P110	
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
4-1/2	11.60	49,0	—	49,0	49,0	49,0	44,0	49,0	—
4-1/2	13.50	57,0	—	57,0	54,0	57,0	44,0	57,0	—
5	15.00	52,5	—	52,5	52,5	52,5	41,0	52,5	52,5
5	18.00	64,0	—	59,5	54,5	64,0	41,0	56,5	64,0
5	21.40	69,0	—	59,5	54,5	69,0	41,0	56,5	—
5	23.20	69,0	—	59,5	54,5	69,0	41,0	56,5	—
5	24.10	69,0	—	59,5	54,5	69,0	41,0	56,5	—
5-1/2	17.00	49,0	—	49,0	49,0	49,0	38,0	49,0	49,0
5-1/2	20.00	58,0	—	54,5	49,5	58,0	38,0	52,0	58,0
5-1/2	23.00	66,5	—	54,5	49,5	66,5	38,0	52,0	66,5
6-5/8	24.00	47,0	—	47,0	47,0	47,0	32,5	45,0	47,0
6-5/8	28.00	55,5	—	55,5	54,0	55,5	32,5	45,0	55,5
6-5/8	32.00	63,5	—	59,0	54,0	63,5	32,5	45,0	63,5
7	23.00	40,0	—	40,0	40,0	40,0	31,5	40,0	40,0
7	26.00	45,5	—	45,5	45,5	45,5	31,5	43,5	45,5
7	29.00	51,5	—	51,0	46,5	51,5	31,5	43,5	51,5
7	32.00	57,0	—	51,0	46,5	57,0	31,5	43,5	57,0
7	35.00	63,0	—	51,0	46,5	63,0	31,5	43,5	63,0
7	38.00	68,0	—	51,0	46,5	64,0	31,5	43,5	68,0
7-5/8	26.40	38,0	—	38,0	38,0	38,0	36,0	38,0	38,0
7-5/8	29.70	43,5	—	43,5	43,5	43,5	36,0	43,5	43,5
7-5/8	33.70	50,0	—	50,0	50,0	50,0	36,0	49,5	50,0
7-5/8	39.00	58,0	—	58,0	54,0	58,0	36,0	49,5	58,0
7-5/8	42.80	65,0	—	58,0	54,0	65,0	36,0	49,5	—
7-5/8	45.30	69,0	—	58,0	54,0	69,0	36,0	49,5	—
7-5/8	47.10	69,0	—	58,0	54,0	69,0	36,0	49,5	—
7-3/4	46.10	68,0	—	—	—	—	—	—	—
8-5/8	36.00	41,0	—	41,0	41,0	41,0	32,5	41,0	41,0
8-5/8	40.00	46,0	—	46,0	46,0	46,0	32,5	44,0	46,0
8-5/8	44.00	51,0	—	51,0	51,0	51,0	32,5	44,0	51,0
8-5/8	49.00	57,0	—	57,0	54,0	57,0	32,5	44,0	57,0
9-5/8	40.00	36,0	—	36,0	36,0	36,0	29,5	35,5	36,0
9-5/8	43.50	40,0	—	40,0	40,0	40,0	29,5	35,5	40,0
9-5/8	47.00	43,5	—	43,5	43,5	43,5	29,5	35,5	43,5
9-5/8	53.50	50,0	—	50,0	49,0	50,0	29,5	35,5	50,0
9-5/8	58.40	54,5	—	53,0	49,0	54,5	29,5	35,5	—
10-3/4	51.00	37,0	37,0	—	37,0	37,0	26,5	28,5	37,0
10-3/4	55.50	40,5	40,5	—	40,5	40,5	26,5	28,5	40,5
11-3/4	60.00	37,0	37,0	—	37,0	37,0	—	—	—
11-3/4	65.00	40,0	—	—	—	—	—	—	—
11-3/4	71.00	43,5	—	—	—	—	—	—	—
13-3/8	68.00	31,5	31,5	—	31,5	31,5	—	—	—
13-3/8	72.00	34,0	31,5	—	34,0	34,0	—	—	—
16	109.00	36,0	—	—	—	—	—	—	—

Table C.49—Hydrostatic test pressure for Grade C90 casing

Labels		Test pressure MPa					
			Round thread		Buttress thread		
1	2	Plain end	STC	LC	Regular coupling	Special-clearance coupling	XC
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
4-1/2	11.60	55,0	—	55,0	55,0	49,5	—
4-1/2	13.50	64,0	—	64,0	61,0	49,5	—
5	15.00	59,0	—	59,0	59,0	46,5	59,0
5	18.00	69,0	—	67,0	61,5	46,5	69,0
5	21.40	69,0	—	67,0	61,5	46,5	—
5	23.20	69,0	—	67,0	61,5	46,5	—
5	24.10	69,0	—	67,0	61,5	46,5	—
5-1/2	17.00	55,0	—	55,0	55,0	42,5	55,0
5-1/2	20.00	65,0	—	61,5	56,0	42,5	65,0
5-1/2	23.00	69,0	—	61,5	56,0	42,5	69,0
5-1/2	26.80	69,0	—	—	—	—	—
5-1/2	29.70	69,0	—	—	—	—	—
5-1/2	32.60	69,0	—	—	—	—	—
5-1/2	35.30	69,0	—	—	—	—	—
5-1/2	38.00	69,0	—	—	—	—	—
5-1/2	40.50	69,0	—	—	—	—	—
5-1/2	43.10	69,0	—	—	—	—	—
6-5/8	24.00	53,0	—	53,0	53,0	36,5	53,0
6-5/8	28.00	62,5	—	62,5	61,0	36,5	62,5
6-5/8	32.00	69,0	—	66,5	61,0	36,5	69,0
7	23.00	45,0	—	45,0	45,0	35,5	45,0
7	26.00	51,5	—	51,5	51,5	35,5	51,5
7	29.00	58,0	—	57,5	52,5	35,5	58,0
7	32.00	64,5	—	57,5	52,5	35,5	64,5
7	35.00	69,0	—	57,5	52,5	35,5	69,0
7	38.00	69,0	—	57,5	52,5	35,5	69,0
7	42.70	69,0	—	—	—	—	—
7	46.40	69,0	—	—	—	—	—
7	50.10	69,0	—	—	—	—	—
7	53.60	69,0	—	—	—	—	—
7	57.10	69,0	—	—	—	—	—
7-5/8	26.40	42,5	—	42,5	42,5	40,5	42,5
7-5/8	29.70	49,0	—	49,0	49,0	40,5	49,0
7-5/8	33.70	56,0	—	56,0	56,0	40,5	56,0
7-5/8	39.00	65,0	—	65,0	61,0	40,5	65,0
7-5/8	42.80	69,0	—	65,0	61,0	40,5	—
7-5/8	45.30	69,0	—	65,0	61,0	40,5	—
7-5/8	47.10	69,0	—	65,0	61,0	40,5	—
7-5/8	51.20	69,0	—	—	—	—	—
7-5/8	55.30	69,0	—	—	—	—	—
7-3/4	46.10	69,0	—	—	—	—	—
8-5/8	36.00	46,0	—	46,0	46,0	36,5	46,0
8-5/8	40.00	52,0	—	52,0	52,0	36,5	52,0
8-5/8	44.00	57,5	—	57,5	57,5	36,5	57,5
8-5/8	49.00	64,0	—	64,0	60,5	36,5	64,0