

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

The European Standard EN ISO 11960 : 1998 has the status of a
British Standard

ICS 23.040.10; 75.180.10; 77.140.70

National foreword

This British Standard is the English language version of EN ISO 11960 : 1998. It is identical with ISO 11960 : 1996.

The UK participation in its preparation was entrusted by Technical Committee PSE/17, Materials and equipment for the petroleum and natural gas industries, to Subcommittee PSE/17/5, Casing, tubing and drill pipe, which has the responsibility to:

- aid enquirers to understand the text;
- present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;
- monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this subcommittee can be obtained on request to its secretary.

Cross-references

Attention is drawn to the fact that CEN and CENELEC standards normally include an annex which lists normative references to international publications with their corresponding European publications. The British Standards which implement international or European publications referred to in this document may be found in the BSI Standards Catalogue under the section entitled 'International Standards Correspondence Index', or by using the 'Find' facility of the BSI Standards Electronic Catalogue.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, the EN ISO title page, the EN ISO foreword page, the ISO title page, pages ii to vi, pages 1 to 87 and a back cover.

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English version

**Petroleum and natural gas industries - Steel pipes for use as
casing or tubing for wells (ISO 11960:1996)**

Industries du pétrole et du gaz naturel - Tubes en acier
utilisés comme tubes de cuvelage ou tubes de production
dans les puits (ISO 11960:1996)

Erdöl- und Erdgasindustrien - Stahlrohre zur Verwendung
als Futter- oder Steigrohre für Bohrungen (ISO
11960:1996)

This European Standard was approved by CEN on 23 November 1997.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.



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

Central Secretariat: rue de Stassart, 36 B-1050 Brussels

Foreword

The text of the International Standard from Technical Committee ISO/TC 67 "Materials, equipment and offshore structures for petroleum and natural gas industries" of the International Organization for Standardization (ISO) has been taken over as an European Standard by Technical Committee CEN/TC 12 "Materials, equipment and offshore structures for petroleum and natural gas industries", the secretariat of which is held by AFNOR.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by July 1998, and conflicting national standards shall be withdrawn at the latest by July 1998.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

Endorsement notice

The text of the International Standard ISO 11960:1996 has been approved by CEN as a European Standard without any modification.

INTERNATIONAL STANDARD

**ISO
11960**

First edition
1996-07-01

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

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



Reference number
ISO 11960:1996(E)

AVA Documents
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Descriptors: petroleum industry, oil wells, pipes (tubes), steel tubes, casing pipes, pipe joints, couplings, specifications, dimensions, materials specifications, mechanical properties, chemical composition, delivery condition, tests, dimensional measurements, mechanical tests, hydrostatic tests, chemical analysis, designation, marking, colour marking.

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Foreword

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

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.

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 first edition cancels and replaces ISO 2645:1975, which has been technically revised.

Annexes A, B and C form an integral part of this International Standard. Annex D is for information only.

Introduction

This International Standard includes requirements of various nature. These are identified by the use of certain words or phrases.

- **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.

In addition, in certain cases, this International Standard offers **Alternative requirements**. These offer different options, either:

- **At purchaser's discretion** in which case such option shall be mentioned on the purchase order. These cases are recognized by the use of the words or phrases such as **alternative** or **at purchaser's discretion**.
- **At manufacturer's discretion** in which case such option shall be notified to the purchaser. Such cases are identified by the use of the phrase **at manufacturer's discretion**.
- **By agreement between purchaser and manufacturer**. Such cases are recognized by the use of the phrase **by agreement between interested parties**.

This International Standard, when this phrase is used, intends to

either

waive the application of a requirement (either mandatory or recommended) and leave it to both purchaser and manufacturer to use the requirement or not;

or

offer one (or several) alternative requirement(s), the selection of which is left to both purchaser and manufacturer.

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 and liners), pup-joints and connectors.

This International Standard is applicable to the following connections in accordance with ISO 10422:

- short, round-thread casing;
- long, round-thread casing;
- buttress-thread casing;
- extreme-line casing;
- non-upset tubing;
- external-upset tubing;
- integral-joint tubing.

The applicable types of end finishing for each size are described in annex A (tables A.1 to A.3).

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

Threading requirements are not considered in this International Standard. 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.

This International Standard may also be used for tubulars with connections not covered by ISO standards.

1.2 The products described by this International Standard are gathered in four groups as follows.

- Group 1: all casing and tubing in grades H, J, K and N.
- Group 2: all casing and tubing in restricted yield strength grades C, L and T.
- Group 3: all seamless casing and tubing and 139,70 mm and larger electric-welded (EW) casing in high strength grade P.
- Group 4: all special service casing in grade Q.

1.3 Supplementary requirements, that may be agreed between interested parties, for non-destructive inspection, coupling blanks, upset casing, electric-welded casing, impact testing, seal-ring couplings and certificates are specified in annex B.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers currently valid International Standards.

ISO 31-0:1992, *Quantities and units — Part 0: General principles*.

ISO 643:1983, *Steels — Micrographic determination of the ferritic or austenitic grain size*.

ISO 6506:1981, *Metallic materials — Hardness test — Brinell test*.

ISO 6508:1986, *Metallic materials — Hardness test — Rockwell test (scales A - B - C - D - E - F - G - H - K)*.

ISO 6892:1984, *Metallic materials — Tensile testing*.

ISO 7500-1:1986, *Metallic materials — Verification of static uniaxial testing machines — Part 1: Tensile testing machines*.

ISO 10422:1993, *Petroleum and natural gas industries — Threading, gauging, and thread inspection of casing, tubing and line pipe threads — Specification*.

ISO/TR 9769:1991, *Steel and iron — Review of available methods of analysis*.

API Bul 5A2:1988, *Bulletin on Thread Compounds for Casing, Tubing and Line Pipe*.

API Bul 5C2:1987, *Bulletin on Performance Properties of Casing, Tubing and Drill Pipe*.

ASTM A370-92, *Test Methods and Definitions for Mechanical Testing of Steel Products*.

ASTM A919-84 (1993), *Terminology relating to Heat Treatment of Metals*.

ASTM E23-94a, *Test Methods for Notched Bar Impact Testing of Metallic Materials*.

ASTM E83-94, *Practice for Verification and Classification of Extensometers*.

ASTM E165-94, *Practice for Liquid Penetrant Inspection*.

ASTM E213-93, *Practice for Ultrasonic Inspection of Metal Pipe and Tubing*.

ASTM E273-93, *Practice for Ultrasonic Examination of Longitudinal Welded Pipe and Tubing*.

ASTM E309-93a, *Practice for Eddy-Current Examination of Steel Tubular Products Using Magnetic Saturation*.

ASTM E570-91, *Practice for Flux Leakage Examination of Ferromagnetic Steel Tubular Products*.

ASTM E709-95, *Practice for Magnetic Particle Examination*.

NACE TM-01-77:1986, *Testing of Metals for Resistance to Sulfide Stress Cracking at Ambient Temperature*.

ASNT-TC-1A:1984, *Recommended Practice for Certification of NDT Personnel*.

3 Definitions

For all terms related to heat treatment operations, the definitions in ASTM A919 apply.

For the purposes of this International Standard, the following definitions apply.

3.1 product: Pipe, coupling, connector, coupling stock and coupling blank, either individually or collectively as applicable.

3.2 connection: Threaded assembly of tubular components.

3.3 pipe: Casing, tubing, plain-end casing liners, pup-joints and connectors, individually or as a group, as applicable.

3.4 coupling: Internally threaded cylinder for joining two lengths of threaded pipe.

3.5 connector: One-piece tubular section not including pipe or couplings, used for the purpose of joining or changing from one size, mass or type of thread connection to the same or another size, mass or type of threaded connection.

3.6 coupling stock: Tubular component used for the manufacture of coupling blanks.

3.7 coupling blank: Material used to produce an individual coupling.

NOTE 1 Coupling blanks may be obtained from coupling stock, forgings or centrifugal castings.

3.8 casing: A pipe run from the surface and intended to line the walls of a drilled well.

3.9 tubing: A pipe placed within a well to produce well fluids or to inject fluids.

3.10 plain-end casing liner: Casing provided unthreaded with a wall thickness often greater than that specified for J55.

3.11 pup-joint: Length of casing, tubing or plain-end casing liner shorter than Range 1.

3.12 seamless pipe: A wrought steel tubular product made without a welded seam, manufactured by hot working steel and, if necessary, by subsequently cold finishing the hot-worked tubular product to produce the desired shape, dimensions and properties.

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

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

3.15 special processes: Final operations which are performed during pipe manufacturing that affect product attributes, except chemistry and dimensions.

NOTE 2 The special processes are:

Manufacturing condition	Special processes
Seamless: as-rolled	Final reheating practice and hot sizing or stretch reducing. If applicable, upsetting, cold finishing.
heat treated	Heat treatment
Electric welded: as-rolled	Sizing and seam welding. If applicable, seam heat treatment and upsetting.
heat treated	Seam welding and full body heat treatment

3.16 interested parties: The manufacturer and the purchaser of the products.

4 Information to be supplied by the purchaser

4.1 Casing

4.1.1 In placing orders for pipe to be manufactured in accordance with this International Standard, the purchaser shall specify the following on the purchase order.

Stipulation	Section
International Standard ISO 11960	—
Quantity	—
Type of pipe or couplings:	
Casing	
Threaded or plain-end	7.11
Type of connection — round (short or long), buttress, extreme-line threads, or other connection	table A.1, 7.11
With or without couplings	7.11
Special clearance couplings	tables 27, 28, A.1, 8.7
Liners	table A.2, 7.11
Size designation or outside diameter	tables A.1, A.2
Nominal mass or wall thickness	tables A.1, A.2
Grade and type where applicable	tables A.1, A.2
Length range	7.5, table 24
Seamless or electric welded	5.1, table 1
Material certification	12.1, SR15
Delivery date and shipping instructions	—
Inspection by purchaser	annex C

4.1.2 The purchaser should also state on the purchase order his requirements concerning the following stipulations, which are optional with the purchaser.

Stipulation	Section
Heat treatment	5.2
Heat and supplementary analyses	9.2
Casing jointers	7.6
Casing with couplings detached	7.12
Alternate drifting requirements	7.9
Coupling make-up (other than power-tight)	7.12
Pipe coatings	11.1
Seal-ring couplings	8.10, SR13.1, SR13.2
Coupling blanks	8.1, SR9
Statistical impact testing — Q125 grade	6.2.3.6, SR12
Additional markings	clause 10

4.1.3 The following stipulations are subject to agreement between interested parties.

Stipulation	Section
Hydrostatic pressure test for handling-tight make-up, connectors and group 4 pup-joints	9.4
Alternate hydrostatic test pressures	9.4
Thread and storage compound	7.12
Thread protectors	11.2
Marking requirements	10.1
Non-destructive inspection	9.7, SR1, SR2 and SR11
Alternate chemical analysis procedures — Q125 grade	9.2
Reduced section tensile specimens — Q125 grade	9.3.3
Alternate F factor in SR12 — Q125 grade	SR12.2
Cold rotary straightening — Q125 grade	5.3

Coupling blanks — Q125 grade only	SR9
Upset casing — Q125 grade only	SR10
Electric-welded casing — P110 and Q125 grade	SR11
Supplementary Coupling thread plating — Q125 grade only Sulfide stress cracking test — C90 and T95 grade Additional hardness testing — C90 and T95 grade	8.16 6.2.13 9.3.2.3
Quality assurance requirements (e.g. one of the ISO 9000 series)	—

4.2 Tubing

4.2.1 In placing orders for pipe to be manufactured in accordance with this International Standard, the purchaser shall specify the following on the purchase order.

Stipulation	Section
International Standard ISO 11960	—
Quantity	—
Type of pipe or couplings:	
Tubing	
Non-upset, external-upset or integral-joint	table A.3
Threaded, plain-end, or special end	7.11
With or without couplings	7.11
Special bevel couplings	tables A.3 and 30, 8.11
Special clearance couplings	tables A.3, 29, 30, 8.7
Size designation or outside diameter	table A.3
Nominal mass or wall thickness	table A.3
Grade	table A.3
Length range	7.5, table 24
Seamless or electric welded	5.1, table 1
Material certification	12.1, SR15
Delivery date and shipping instructions	—
Inspection by purchaser	annex C

4.2.2 The purchaser should also state on the purchase order his requirements concerning the following stipulations, which are optional with the purchaser.

Stipulation	Section
Heat treatment	5.2
Heat and supplementary analyses	9.2
Coupling make-up (other than power-tight)	7.12
Pipe coatings	11.1
Seal-ring couplings	8.10, SR13.1, SR13.2
Tubing with couplings detached	7.12
Additional markings	clause 10

4.2.3 The following stipulations are subject to agreement between interested parties.

Stipulation	Section
Hydrostatic pressure test for handling-tight make-up and pup-joints	9.4
Alternate hydrostatic test pressures	9.4
Thread and storage compound	7.12
Thread protectors	11.2
Marking requirements	10.1
Non-destructive inspection	9.7, SR1, SR2 and SR11
Supplementary Sulfide stress cracking test — C90 and T95 grade Additional hardness testing — C90 and T95 grade	6.2.13 9.3.2.3
Quality assurance requirements (e.g. one of the ISO 9000 series)	—

5 Process of manufacture

5.1 General

The various grades and groups of pipe furnished according 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, vanadium or titanium in amounts intended to result in the steel having a fine austenitic grain size.

Pipe furnished according to this International Standard shall be made by the seamless or electric weld process as shown in table 1 and as specified on the purchase order. Pup-joints and connectors may be made from standard casing or tubing or by machining heavy wall casing, tubing or bar stock. Couplings shall be manufactured by one of the processes listed in 8.2. Cold-drawn tubular products without appropriate heat treatment are not acceptable.

5.2 Heat treatment

5.2.1 General

Product shall be heat treated in accordance with a documented procedure as stipulated in table 1 for the particular grade and type specified on the purchase order. Heat-treated upset pipe shall be heat treated the full length after upsetting. Pipe and coupling stock 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 be above the upper critical temperature (A_{r3}) for the steel being processed, and the pipe be air cooled.

The weld seam of electric-welded pipe shall be heat treated after welding to a minimum temperature of 538 °C or processed in such a manner that no untempered martensite remains.

NOTE 3 A_{r3} refers to the critical temperature for the austenite-to-ferrite transformation on cooling.

5.2.2 Group 1

Grade N80 pipe and coupling stock shall be normalized or, at the manufacturer's discretion, shall be normalized and tempered. Grade N80Q pipe and coupling stock shall be quenched and tempered (including the interrupted quenching followed by controlled cooling method) the full length. Grade J55 and K55 casing and grade J55 tubing shall be heat treated if so specified on the purchase order.

NOTES

4 Interrupted quenching is 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.

5 Controlled cooling is cooling from an elevated temperature in a predetermined manner to avoid hardening, cracking or internal damage to produce a desired microstructure or mechanical properties.

Table 1 — Process of manufacture and heat treatment

Group	Grade	Type	Manufacturing process ¹⁾	Heat treatment	Tempering temperature min. °C
1	H40	—	S or EW	none	—
	J55	—	S or EW	none ²⁾	—
	K55	—	S or EW	none ²⁾	—
	N80	—	S or EW	3)	—
	N80	Q	S or EW	Q and T	—
2	L80 ⁴⁾	1	S or EW	Q and T	566
	L80	9Cr	S	Q and T ⁵⁾	593
	L80	13Cr	S	Q and T ⁵⁾	593
	C90	1	S	Q and T	621
	C90	2	S	Q and T	621
	C95	—	S or EW	Q and T	538
	T95	1	S	Q and T	649
	T95	2	S	Q and T	649
3	P110	—	S or EW ^{6, 7)}	Q and T	—
4	Q125	1	S or EW ⁷⁾	Q and T	—
	Q125	2	S or EW ⁷⁾	Q and T	—
	Q125	3	S or EW ⁷⁾	Q and T	—
	Q125	4	S or EW ⁷⁾	Q and T	—

1) S = seamless process; EW = electric welded process.
2) Full-length normalized, normalized and tempered (N and T), or quenched and tempered (Q and T), at the manufacturer's discretion or if so specified on the purchaser order.
3) Full-length normalized or normalized and tempered at the manufacturer's discretion.
4) The manufacturer shall use a process that is documented to yield not less than 50 % martensite.
5) Type 9Cr and 13Cr may be air quenched.
6) Special chemical requirements for electric-welded P110 casing are specified in table 2.
7) Special requirements unique to electric-welded P110 and Q125 casing are specified in annex B (SR11). When electric-welded P110 and Q125 casing is furnished, the provisions of SR11 are automatically in effect.

5.2.3 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.

5.2.4 Groups 3 and 4

Pipe and couplings furnished to this International Standard shall be quenched and tempered.

5.3 Straightening

5.3.1 Groups 1 and 3

No specific methods are required.

5.3.2 Group 2

Grade L80 shall not be subjected to cold working after the final tempering treatment, except for that which is incidental to normal straightening operations. Grade 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 482 °C for stress relieving. When necessary, light gag straightening for grade C90 and T95 shall be permitted. Grade C95 pipe shall be subjected to no tensile or expansion cold working, except for that which is incidental to normal straightening operations, and to no more than 3 % compressive cold working, after the final tempering operation.

5.3.3 Group 4

Gag press straightening or hot rotary straightening (417 °C minimum at end of rotary straightening unless otherwise specified on purchase order) 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 or higher. Pipe may be cold rotary straightened without subsequent stress relieving only by agreement between interested parties.

5.4 Traceability

5.4.1 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.

5.4.2 Serialization of group 2 (grades C90 and T95) and group 4

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.

5.4.2.1 Pipe — Group 2 (grades C90 and T95 only) and group 4

Each length of pipe shall be uniquely numbered so that test data may be related to individual lengths.

5.4.2.2 Pipe — Group 4 manufactured to SR12

In addition to the requirements in 5.4.2.1, when SR12 is specified, the number shall identify the sequence in which the lengths were tempered in order to allow retest per SR12.3.

5.4.2.3 Coupling, pup-joint and connector material

Each tube length of coupling, pup-joint or connector material shall be uniquely numbered so that test data may be related to individual lengths. When couplings, coupling blanks, or pup-joint and connector material are cut from material that has been treated full length, the pieces shall be marked with the serial number of the full length piece. When coupling, pup-joint, or connector material is heat treated in coupling blank or individual lengths, each heat treat lot (see 9.3.1.2.2) shall be uniquely numbered. Additionally, when coupling, pup-joint or connector material in coupling blank or individual lengths is heat treated on a unit in a continuous process run, the pieces within the lot shall be sequentially numbered in the order in which they are heat treated.

6 Material requirements

6.1 Chemical requirements

Pipe and couplings shall conform to the chemical requirements specified in table 2 for the grade and type specified.

6.2 Mechanical properties requirements

6.2.1 Tensile properties

6.2.1.1 Pipe and couplings shall conform to the tensile requirements specified in table 3.

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 state when full section specimens are used.

The tensile properties, except elongation of the upset ends of upset casing and tubing, 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 made available to the purchaser.

6.2.1.2 The minimum elongation, for all groups, over 50,8 mm (gauge length of the tensile specimen) shall be that determined by the following formula:

$$e = 1\,944 \frac{A^{0,2}}{U^{0,9}}$$

where

- e* is the minimum elongation over 50,8 mm, in percent rounded to the nearest 0,5 %;
- A* is the cross-sectional area of the tensile test specimen, in square millimetres, based on specified outside diameter or nominal specimen width and specified wall thickness rounded to the nearest 10 mm², or 490 mm², whichever is smaller;
- U* is the specified tensile strength, in newtons per square millimetre.

The minimum elongations for both round bar tensile specimens (the 8,9 mm diameter with 35,6 mm gauge length, and the 12,7 mm diameter with

50,8 mm length) shall be determined with an area *A* of 130 mm².

6.2.2 Yield strength

The yield strength shall be the tensile stress required to produce the following extension under load as determined by an extensometer.

Total extension under load of gauge length:

Grade	
H40	0,5 %
J55	0,5 %
K55	0,5 %
L80	0,5 %
N80	0,5 %
C90	0,5 %
C95, T95	0,5 %
P110	0,6 %
Q125	0,65 %

Table 2 — Chemical requirements % (m/m)

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	H40	—	—	—	—	—	—	—	—	—	—	—	0,030	0,030	—
	J55	—	—	—	—	—	—	—	—	—	—	—	0,030	0,030	—
	K55	—	—	—	—	—	—	—	—	—	—	—	0,030	0,030	—
	N80	—	—	—	—	—	—	—	—	—	—	—	0,030	0,030	—
	N80	Q	—	—	—	—	—	—	—	—	—	—	0,030	0,030	—
2	L80	1	—	0,43 ¹⁾	—	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	10,00	0,50	0,25	0,020	0,010	1,00
	L80	13Cr	0,15	0,22	0,25	1,00	—	—	12,00	14,00	0,50	0,25	0,020	0,010	1,00
	C90	1	—	0,35	—	1,00	0,25 ²⁾	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 ³⁾	—	1,90	—	—	—	—	—	—	0,030	0,030	0,45
	T95	1	—	0,35	—	1,20	0,25 ⁴⁾	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	S	—	—	—	—	—	—	—	—	—	—	0,030	0,030	—
	P110	EW	—	—	—	—	—	—	—	—	—	—	0,020	0,010	—
4	Q125	1	—	0,35	—	1,00	—	0,75	—	1,20	0,99	—	0,020	0,010	—
	Q125	2	—	0,35	—	1,00	—	N.L.	—	N.L.	0,99	—	0,020	0,020	—
	Q125	3	—	0,50	—	1,90	—	N.L.	—	N.L.	0,99	—	0,030	0,010	—
	Q125	4	—	0,50	—	1,90	—	N.L.	—	N.L.	0,99	—	0,030	0,020	—

NOTE — N.L. = No limit — elements shown shall be reported in product analysis.

- 1) The carbon content for L80 type 1 may be increased to 0,50 % maximum if the product is oil quenched.
- 2) The molybdenum content for grade C90 type 1 has no minimum tolerance if the wall thickness is less than 17,78 mm.
- 3) The carbon content for C95 may be increased to 0,55 % maximum if the product is oil quenched.
- 4) The molybdenum content for grade T95 type 1 may be decreased to 0,15 % minimum if the wall thickness is less than 17,78 mm.

Table 3 — Tensile and hardness requirements

Group	Grade	Type	Yield strength		Tensile strength	Hardness ¹⁾		Specified wall thickness	Allowable hardness variation
			min. N/mm ²	max. N/mm ²	min. N/mm ²	max. HRC	HBS	mm	HRC
1	H40	—	276	552	414	—	—	—	—
	J55	—	379	552	517	—	—	—	—
	K55	—	379	552	655	—	—	—	—
	N80	—	552	758	689	—	—	—	—
	N80	Q	552	758	689	—	—	—	—
2	L80	1	552	655	655	23	241	—	—
	L80	9Cr	552	655	655	23	241	—	—
	L80	13Cr	552	655	655	23	241	—	—
	C90	1,2	621	724	689	25,4	255	12,70 or less	3,0
	C90	1,2	621	724	689	25,4	255	12,71 to 19,04	4,0
	C90	1,2	621	724	689	25,4	255	19,05 to 25,39	5,0
	C90	1,2	621	724	689	25,4	255	25,40 and above	6,0
	C95	—	655	758	724	—	—	—	—
	T95	1,2	655	758	724	25,4	255	12,70 or less	3,0
	T95	1,2	655	758	724	25,4	255	12,71 to 19,04	4,0
	T95	1,2	655	758	724	25,4	255	19,05 to 25,39	5,0
	T95	1,2	655	758	724	25,4	255	25,40 and above	6,0
3	P110	—	758	965	862	—	—	—	—
4	Q125	—	862	1 034	931	—	—	12,70 or less	3,0
	Q125	—	862	1 034	931	—	—	12,71 to 19,04	4,0
	Q125	—	862	1 034	931	—	—	19,05 and above	5,0

1) In case of dispute, laboratory Rockwell C hardness tests shall be used as the referee method.

6.2.3 Charpy V notch — General requirements (all groups)

A test shall consist of three specimens from a single tubular product length. The average value of the three impact specimens shall equal or exceed the absorbed energy requirement specified in 6.2.4 and 6.2.5. 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.

6.2.3.1 Critical thickness

The absorbed energy requirements are based on the critical thickness. The critical thickness for ISO couplings is defined as 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 is provided in table 4. For pipe, the critical thickness is

the specified wall thickness. For other applications, the critical thickness and absorbed energy requirements shall be specified on the purchase order.

6.2.3.2 Specimen size

When full size (10 mm × 10 mm) transverse test specimens are not possible, the largest possible sub-size transverse test specimen listed in table 5 shall be used. When it is not possible (or allowed as in 6.2.3.5) to test using any of these transverse test specimens, the largest possible longitudinal test specimen listed in table 5 shall be used.

When 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.

Table 4 — Critical thickness for couplings

Dimensions in millimetres

Pipe diameter, <i>D</i>	Critical thickness for couplings						
	NUE	EUE	EUE ¹⁾	BTC ¹⁾	BTC	LTC	STC
26,67	4,29	5,36	—	—	—	—	—
33,40	5,36	6,55	—	—	—	—	—
42,16	6,08	6,10	—	—	—	—	—
48,26	4,98	6,38	—	—	—	—	—
60,33	7,72	7,62	5,68	—	—	—	—
73,03	9,66	9,10	6,46	—	—	—	—
88,90	11,44	11,53	7,47	—	—	—	—
101,60	11,53	11,63	—	—	—	—	—
114,30	11,05	12,53	—	6,59	8,17	8,85	8,56
127,00	—	—	—	6,76	9,15	9,95	9,46
139,70	—	—	—	6,81	9,04	9,89	9,39
168,28	—	—	—	6,96	11,92	12,91	12,32
177,80	—	—	—	7,11	10,67	11,63	10,93
193,70	—	—	—	8,85	13,61	14,56	13,86
219,10	—	—	—	8,95	15,30	16,44	15,55
244,50	—	—	—	8,95	15,30	16,69	15,60
273,10	—	—	—	8,95	15,30	—	15,70
298,50	—	—	—	—	15,30	—	15,70
339,70	—	—	—	—	15,30	—	15,70
406,40	—	—	—	—	16,93	—	16,05
473,10	—	—	—	—	21,70	—	20,81
508,00	—	—	—	—	16,93	17,09	16,10

NOTE — The coupling blank thickness is greater than indicated above, due to thread height and manufacturing allowance to avoid black crested threads.

1) Special clearance.

Table 5 — Acceptable size impact specimens and absorbed energy reduction factor

Test specimen size	Specimen dimensions mm	Reduction factor
Full size	10 × 10	1,00
3/4 size	10 × 7,5	0,80
1/2 size	10 × 5	0,55

6.2.3.3 Hierarchy of test specimens

The hierarchy of test specimen orientation and size is specified in table 6.

6.2.3.4 Alternative size impact test specimens

At the manufacturer's discretion alternative size impact test specimens, listed in table 5, may be used in lieu of the minimum size specified in the tables referenced in 6.2.4 and 6.2.5. However, the alternative test specimen selected shall be higher on the hierarchy table (table 6) than the specified size, and the absorbed energy requirement shall be adjusted consistent with the impact specimen orientation and size.

6.2.3.5 Subsize specimens

The minimum Charpy V notch absorbed energy requirement for subsize test specimens shall be those specified for a full size test specimen multiplied by the reduction factor in table 5; however, in no event shall a subsize test specimen be used if the reduced absorbed energy requirement is less than 11 J.

6.2.3.6 Group 4 statistical impact testing

By agreement between interested parties, the supplemental requirements for group 4 statistical impact testing in annex B (SR12) shall apply.

Table 6 — Hierarchy of test specimen orientation and size

	Choice	Orientation
1st	Transverse	full
2nd	Transverse	3/4
3rd	Transverse	1/2
4th	Longitudinal	full
5th	Longitudinal	3/4
6th	Longitudinal	1/2

6.2.4 Charpy V notch — absorbed energy requirements for coupling stock, coupling blanks, couplings with ISO threads and connectors with internal ISO threads; except integral-joint ISO tubing connections and extreme-line casing connections (all groups)

Coupling stocks 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 in the hierarchy table 6 and the absorbed energy requirement shall equal or exceed the applicable requirements.

6.2.4.1 Group 1, H40 only

There is no requirement for minimum absorbed energy.

6.2.4.2 Group 1, grades J55 and K55 only

The minimum full size transverse absorbed energy requirement, KV, is 20 J. The minimum full size longitudinal absorbed energy requirement is 27 J. The impact specimen orientation, minimum size, minimum absorbed energy requirement, and test temperature reduction (as applicable) for couplings are provided in table 7.

6.2.4.3 Group 1, grade N80 only, groups 2, 3 and 4

The impact specimen orientation, minimum size, and minimum absorbed energy requirement for couplings are provided in tables 8 to 12 based on the following equations.

In these equations, the following is applicable:

- S is the maximum specified yield strength for the grade evaluated, in newtons per square millimetre;
- t_1 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 shall be as specified in table 13 for various critical wall thicknesses based on the following:

$$KV = S(0,00118t_1 + 0,01259) J \text{ or } 20 J, \text{ whichever is greater.}$$

b) **Longitudinal requirement.** The minimum full size absorbed energy requirement shall be as specified in table 14 for various critical wall thicknesses based on the following:

$$KV = S(0,00236t_1 + 0,02518) J \text{ or } 40 J, \text{ whichever is greater.}$$

6.2.5 Charpy V notch — Absorbed energy requirements for casing, pup-joints and externally threaded connector material, group 4

a) **Transverse requirement.** The minimum full size transverse absorbed energy requirement shall be as specified by the equation in 6.2.4.3 (see table 13). Table 15 provides the calculated wall thickness required to machine full size, 3/4 size and 1/2 size transverse impact test specimens. The impact test specimen size that shall be selected from table 15 is the largest impact test specimen having a calculated wall thickness that is less than the specified wall thickness for the pipe tested.

b) **Longitudinal requirement.** The minimum full size longitudinal absorbed energy requirement shall be as specified by the equation in 6.2.4.3 (see table 14). When the wall thickness does not permit machining full size longitudinal test specimens, the largest possible subsize longitudinal specimen specified in table 16 shall be used. Table 16 is construed and used in the same way as table 15.

6.2.6 Charpy V notch — Absorbed energy requirements for pipe, groups 1, 2 and 3

By agreement between interested parties, the provisions of annex B (SR16) shall apply.

Table 7 — Charpy impact test specimen requirements for couplings: Group 1, grades J55 and K55

Pipe diameter, <i>D</i> mm	Charpy specimen orientation — Size — Impact energy — Temperature reduction						
	NUE	EUE	EUE ¹⁾	BTC ¹⁾	BTC	LTC	STC
26,67	2)	L-5-15-A	—	—	—	—	—
33,40	L-5-15-A	L-7-22-A	—	—	—	—	—
42,16	L-5-15-B	L-5-15-B	—	—	—	—	—
48,26	L-5-15-A	L-7-22-B	—	—	—	—	—
60,33	L-7-22-A	L-7-22-A	L-7-22-A	—	—	—	—
73,03	L-10-27-A	L-10-27-A	L-10-27-A	—	—	—	—
88,90	T-5-11-E	T-5-11-E	T-5-11-D	—	—	—	—
101,60	T-7-16-B	T-7-16-B	—	—	—	—	—
114,30	T-7-16-B	T-7-16-B	—	L-7-22-A	L-7-22-A	L-10-27-A	L-10-27-A
127,00	—	—	—	T-5-11-C	T-5-11-D	T-5-11-D	T-5-11-D
139,70	—	—	—	T-5-11-C	T-5-11-D	T-5-11-D	T-5-11-D
168,28	—	—	—	T-10-20-A	T-10-20-A	T-10-20-A	T-10-20-A
177,80	—	—	—	T-7-16-A	T-7-16-A	T-10-20-A	T-7-16-B
193,70	—	—	—	T-10-20-A	T-10-20-A	T-10-20-A	T-10-20-A
219,10	—	—	—	T-10-20-A	T-10-20-A	T-10-20-A	T-10-20-A
244,50	—	—	—	T-10-20-A	T-10-20-A	T-10-20-A	T-10-20-A
273,10	—	—	—	T-10-20-A	T-10-20-A	—	T-10-20-A
298,50	—	—	—	—	T-10-20-A	—	T-10-20-A
339,70	—	—	—	—	T-10-20-A	—	T-10-20-A
406,40	—	—	—	—	T-10-20-A	—	T-10-20-A
473,10	—	—	—	—	T-10-20-A	—	T-10-20-A
508,00	—	—	—	—	T-10-20-A	T-10-20-A	T-10-20-A

NOTE — In the above 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 (J) and the temperature reduction in °C (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 = transverse specimen orientation (reference figure 11)
L = longitudinal specimen orientation (reference figure 11)

10 = full size (i.e. 10 mm × 10 mm)

7 = 3/4 size (i.e. 10 mm × 7,5 mm)

5 = 1/2 size (i.e. 10 mm × 5 mm)

A = no reduction

B = 3 °C

C = 6 °C

D = 8 °C

E = 11 °C

The above assumes that special clearance couplings are machined from standard couplings.

1) Special clearance.

2) Not thick enough to test.

Table 8 — Charpy impact test specimen requirements for couplings: Group 2, grade L80 only

Pipe diameter, <i>D</i> mm	Charpy specimen orientation — Size — Impact energy						
	NUE	EUE	EUE ¹⁾	BTC ¹⁾	BTC	LTC	STC
26,67	²⁾	L-5-22	—	—	—	—	—
33,40	L-5-22	L-7-32	—	—	—	—	—
42,16	L-5-22	L-5-22	—	—	—	—	—
48,26	L-5-22	L-7-32	—	—	—	—	—
60,33	L-7-32	L-7-32	L-7-32	—	—	—	—
73,03	L-10-40	L-10-40	L-10-40	—	—	—	—
88,90	T-5-11	T-5-11	T-5-11	—	—	—	—
101,60	T-7-16	T-7-16	—	—	—	—	—
114,30	T-7-16	T-7-16	—	L-7-32	L-7-32	L-10-40	L-10-40
127,00	—	—	—	T-5-11	T-5-11	T-5-11	T-5-11
139,70	—	—	—	T-5-11	T-5-11	T-5-11	T-5-11
168,28	—	—	—	T-10-20	T-10-20	T-10-20	T-10-20
177,80	—	—	—	T-7-16	T-7-16	T-10-20	T-7-16
193,70	—	—	—	T-10-20	T-10-20	T-10-20	T-10-20
219,10	—	—	—	T-10-20	T-10-20	T-10-21	T-10-20
244,50	—	—	—	T-10-20	T-10-20	T-10-21	T-10-20
273,10	—	—	—	T-10-20	T-10-20	—	T-10-20
298,50	—	—	—	—	T-10-20	—	T-10-20
339,70	—	—	—	—	T-10-20	—	T-10-20
406,40	—	—	—	—	T-10-21	—	T-10-21
473,10	—	—	—	—	T-10-25	—	T-10-24
508,00	—	—	—	—	T-10-21	T-10-21	T-10-21

NOTE — In the above 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 (J), consistent with the specimen size indicated, according to the following code:

T = transverse specimen orientation (reference figure 11)
L = longitudinal specimen orientation (reference figure 11)

10 = full size (i.e. 10 mm × 10 mm)
7 = 3/4 size (i.e. 10 mm × 7,5 mm)
5 = 1/2 size (i.e. 10 mm × 5 mm)

The above assumes that special clearance couplings are machined from standard couplings.

1) Special clearance.
2) Not thick enough to test.

Table 9 — Charpy impact test specimen requirements for couplings: Group 2, grade C90 only

Pipe diameter, <i>D</i> mm	Charpy specimen orientation — Size — Impact energy						
	NUE	EUE	EUE ¹⁾	BTC ¹⁾	BTC	LTC	STC
26,67	2)	L-5-22	—	—	—	—	—
33,40	L-5-22	L-7-32	—	—	—	—	—
42,16	L-5-22	L-5-22	—	—	—	—	—
48,26	L-5-22	L-7-32	—	—	—	—	—
60,33	L-7-32	L-7-32	L-7-32	—	—	—	—
73,03	L-10-40	L-10-40	L-10-40	—	—	—	—
88,90	T-5-11	T-5-11	T-5-11	—	—	—	—
101,60	T-7-16	T-7-16	—	—	—	—	—
114,30	T-7-16	T-7-16	—	L-7-32	L-7-32	L-10-40	L-10-40
127,00	—	—	—	T-5-11	T-5-11	T-5-11	T-5-11
139,70	—	—	—	T-5-11	T-5-11	T-5-11	T-5-11
168,28	—	—	—	T-10-20	T-10-20	T-10-20	T-10-20
177,80	—	—	—	T-7-16	T-7-16	T-10-20	T-7-16
193,70	—	—	—	T-10-20	T-10-21	T-10-22	T-10-21
219,10	—	—	—	T-10-20	T-10-22	T-10-23	T-10-22
244,50	—	—	—	T-10-20	T-10-22	T-10-23	T-10-22
273,10	—	—	—	T-10-20	T-10-22	—	T-10-23
298,50	—	—	—	—	T-10-22	—	T-10-23
339,70	—	—	—	—	T-10-22	—	T-10-23
406,40	—	—	—	—	T-10-24	—	T-10-23
473,10	—	—	—	—	T-10-28	—	T-10-27
508,00	—	—	—	—	T-10-24	T-10-24	T-10-23

NOTE — In the above 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 (J), consistent with the specimen size indicated, according to the following code:

T = transverse specimen orientation (reference figure 11)
L = longitudinal specimen orientation (reference figure 11)

10 = full size (i.e. 10 mm × 10 mm)
7 = 3/4 size (i.e. 10 mm × 7,5 mm)
5 = 1/2 size (i.e. 10 mm × 5 mm)

The above assumes that special clearance couplings are machined from standard couplings.

1) Special clearance.
2) Not thick enough to test.

Table 10 — Charpy impact test specimen requirements for couplings: Group 1, grade N80 and group 2, grades C95 and T95

Pipe diameter, <i>D</i> mm	Charpy specimen orientation — Size — Impact energy						
	NUE	EUE	EUE ¹⁾	BTC ¹⁾	BTC	LTC	STC
26,67	2)	L-5-22	—	—	—	—	—
33,40	L-5-22	L-7-32	—	—	—	—	—
42,16	L-5-22	L-5-22	—	—	—	—	—
48,26	L-5-22	L-7-32	—	—	—	—	—
60,33	L-7-32	L-7-32	L-7-32	—	—	—	—
73,03	L-10-40	L-10-40	L-10-40	—	—	—	—
88,90	T-5-11	T-5-11	T-5-11	—	—	—	—
101,60	T-7-16	T-7-16	—	—	—	—	—
114,30	T-7-16	T-10-21	—	L-7-32	L-7-32	L-10-40	L-10-40
127,00	—	—	—	T-5-11	T-5-11	T-5-11	T-5-11
139,70	—	—	—	T-5-11	T-5-11	T-5-11	T-5-11
168,28	—	—	—	T-10-20	T-10-20	T-10-21	T-10-21
177,80	—	—	—	T-7-16	T-7-16	T-10-20	T-7-16
193,70	—	—	—	T-10-20	T-10-22	T-10-23	T-10-22
219,10	—	—	—	T-10-20	T-10-23	T-10-24	T-10-23
244,50	—	—	—	T-10-20	T-10-23	T-10-24	T-10-24
273,10	—	—	—	T-10-20	T-10-23	—	T-10-24
298,50	—	—	—	—	T-10-23	—	T-10-24
339,70	—	—	—	—	T-10-23	—	T-10-24
406,40	—	—	—	—	T-10-25	—	T-10-24
473,10	—	—	—	—	T-10-29	—	T-10-28
508,00	—	—	—	—	T-10-25	T-10-25	T-10-24

NOTE — In the above 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 (J), consistent with the specimen size indicated, according to the following code:

T = transverse specimen orientation (reference figure 11)
L = longitudinal specimen orientation (reference figure 11)

10 = full size (i.e. 10 mm × 10 mm)
7 = 3/4 size (i.e. 10 mm × 7,5 mm)
5 = 1/2 size (i.e. 10 mm × 5 mm)

The above assumes that special clearance couplings are machined from standard couplings.

1) Special clearance.
2) Not thick enough to test.

Table 11 — Charpy impact test specimen requirements for couplings: Group 3, grade P110

Pipe diameter, <i>D</i> mm	Charpy specimen orientation — Size — Impact energy						
	NUE	EUE	EUE ¹⁾	BTC ¹⁾	BTC	LTC	STC
26,67	2)	L-5-22	—	—	—	—	—
33,40	L-5-22	L-7-32	—	—	—	—	—
42,16	L-5-22	L-5-22	—	—	—	—	—
48,26	L-5-22	L-7-32	—	—	—	—	—
60,33	L-7-34	L-7-34	L-7-32	—	—	—	—
73,03	L-10-46	L-10-45	L-10-40	—	—	—	—
88,90	T-5-14	T-5-14	T-5-12	—	—	—	—
101,60	T-7-20	T-7-20	—	—	—	—	—
114,30	T-7-20	T-7-21	—	L-7-32	L-7-34	L-10-44	L-10-44
127,00	—	—	—	T-5-11	T-5-13	T-5-13	T-5-13
139,70	—	—	—	T-5-11	T-5-12	T-5-12	T-5-13
168,28	—	—	—	T-10-20	T-10-26	T-10-26	T-10-26
177,80	—	—	—	T-7-16	T-7-19	T-10-25	T-7-20
193,70	—	—	—	T-10-22	T-10-28	T-10-29	T-10-28
219,10	—	—	—	T-10-22	T-10-30	T-10-31	T-10-30
244,50	—	—	—	T-10-22	T-10-30	T-10-31	T-10-30
273,10	—	—	—	T-10-22	T-10-30	—	T-10-30
298,50	—	—	—	—	T-10-30	—	T-10-30
339,70	—	—	—	—	T-10-30	—	T-10-30
406,40	—	—	—	—	T-10-31	—	T-10-30
473,10	—	—	—	—	T-10-37	—	T-10-36
508,00	—	—	—	—	T-10-31	T-10-32	T-10-30

NOTE — In the above 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 (J), consistent with the specimen size indicated, according to the following code:

T = transverse specimen orientation (reference figure 11)
L = longitudinal specimen orientation (reference figure 11)

10 = full size (i.e. 10 mm × 10 mm)
7 = 3/4 size (i.e. 10 mm × 7,5 mm)
5 = 1/2 size (i.e. 10 mm × 5 mm)

The above assumes that special clearance couplings are machined from standard couplings.

1) Special clearance.
2) Not thick enough to test.

Table 12 — Charpy impact test specimen requirements for couplings: Group 4, grade Q125

Pipe diameter, <i>D</i> mm	Charpy specimen orientation — Size — Impact energy			
	BTC ¹⁾	BTC	LTC	STC
114,30	L-7-34	L-7-37	L-10-48	L-10-48
127,00	T-5-12	T-5-13	T-5-14	T-5-14
139,70	T-5-12	T-5-13	T-5-14	T-5-14
168,28	T-10-22	T-10-28	T-10-29	T-10-28
177,80	T-7-18	T-7-21	T-10-27	T-7-21
193,70	T-10-24	T-10-30	T-10-31	T-10-30
219,10	T-10-24	T-10-32	T-10-33	T-10-32
244,50	T-10-24	T-10-32	T-10-33	T-10-32
273,10	T-10-24	T-10-32	—	T-10-32
298,50	—	T-10-32	—	T-10-32
339,70	—	T-10-32	—	T-10-32
406,40	—	T-10-34	—	T-10-33
473,10	—	T-10-40	—	T-10-38
508,00	—	T-10-34	T-10-34	T-10-33

NOTE — In the above 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 (J), consistent with the specimen size indicated, according to the following code:

T = transverse specimen orientation (reference figure 11)
L = longitudinal specimen orientation (reference figure 11)

10 = full size (i.e. 10 mm × 10 mm)
7 = 3/4 size (i.e. 10 mm × 7,5 mm)
5 = 1/2 size (i.e. 10 mm × 5 mm)

The above assumes that special clearance couplings are machined from standard couplings.

1) Special clearance.

Table 13 — Transverse Charpy absorbed energy requirements

Maximum critical thickness for various grades mm					Minimum transverse absorbed energy J
L80	C90	N80 C95 T95	P110	Q125	
15,85	13,32	12,24	7,33	6,11	20
17,14	14,49	13,36	8,20	6,93	21
18,43	15,66	14,48	9,08	7,75	22
19,73	16,83	15,59	9,96	8,56	23
21,02	18,00	16,71	10,84	9,38	24
22,31	19,17	17,83	11,72	10,20	25
23,61	20,34	18,95	12,59	11,02	26
24,90	21,51	20,07	13,47	11,84	27
26,20	22,68	21,19	14,35	12,66	28
	23,85	22,30	15,23	13,48	29
	25,02	23,42	16,11	14,30	30
	26,19	24,54	16,98	15,11	31
		25,66	17,86	15,93	32
			18,74	16,75	33
			19,62	17,57	34
			20,50	18,39	35
			21,38	19,21	36
			22,25	20,03	37
			23,13	20,85	38
			24,01	21,66	39
			24,89	22,48	40
			25,77	23,30	41
				24,12	42
				24,94	43
				25,76	44

NOTE — Critical wall thicknesses greater than 21,69 mm (i.e. 473 mm BTC) are not applicable for ISO couplings and are provided for information only for special applications. The round-off procedures were followed in the preparation of this table.

Table 14 — Longitudinal Charpy absorbed energy requirements

Maximum critical thickness for various grades mm					Minimum longitudinal absorbed energy J
L80	C90	N80 C95 T95	P110	Q125	
15,52	13,03	11,96	7,11	5,90	40
16,17	13,61	12,52	7,54	6,31	41
16,82	14,20	13,08	7,98	6,72	42
17,46	14,78	13,64	8,42	7,13	43
18,11	15,37	14,20	8,86	7,54	44
18,76	15,95	14,76	9,30	7,95	45
19,40	16,54	15,32	9,74	8,36	46
20,05	17,12	15,87	10,18	8,77	47
20,70	17,71	16,43	10,62	9,18	48
21,34	18,29	16,99	11,06	9,59	49
21,99	18,88	17,55	11,50	10,00	50
22,64	19,46	18,11	11,94	10,41	51
23,29	20,05	18,67	12,37	10,82	52
23,93	20,63	19,23	12,81	11,22	53
24,58	21,22	19,79	13,25	11,63	54
25,23	21,80	20,35	13,69	12,04	55
25,87	22,39	20,91	14,13	12,45	56
	22,97	21,46	14,57	12,86	57
	23,56	22,02	15,01	13,27	58
	24,14	22,58	15,45	13,68	59
	24,73	23,14	15,89	14,09	60
	25,31	23,70	16,33	14,50	61
	25,90	24,26	16,77	14,91	62
		24,82	17,20	15,32	63
		25,38	17,64	15,73	64
		25,94	18,08	16,14	65
			18,52	16,55	66
			18,96	16,96	67
			19,40	17,37	68
			19,84	17,77	69
			20,28	18,18	70

NOTE — Critical wall thicknesses greater than 9,5 mm (i.e. 73 mm EUE) are not applicable for ISO couplings and are provided for information only for special applications. The round-off procedures were followed in the preparation of this table.

Table 15 — Transverse impact specimen size required for grade Q125 casing

Dimensions in millimetres

Pipe outside diameter	Calculated wall thickness required to machine transverse Charpy impact specimens		
	Full size	3/4 size	1/2 size
114,30	18,07	15,57	13,07
127,00	17,28	14,78	12,28
139,70	16,66	14,16	11,66
168,28	15,64	13,14	10,64
177,80	15,38	12,88	10,38
193,70	15,00	12,50	10,00
196,80	14,94	12,44	9,94
219,10	14,52	12,02	9,52
244,50	14,15	11,65	9,15
273,10	13,81	11,31	8,81
298,50	13,57	11,07	8,57
339,70	13,26	10,76	8,26
406,40	12,89	10,39	7,89
473,10	12,62	10,12	7,62
508,00	12,51	10,01	7,51

NOTE — The wall thicknesses that are in excess of the maximum ISO wall thicknesses are for information only. The above provides a 0,5 mm ID and a 0,5 mm OD machining allowance.

Table 16 — Longitudinal impact specimen size required for grade Q125 casing

Dimensions in millimetres

Pipe outside diameter	Calculated wall thickness required to machine longitudinal Charpy impact specimens		
	Full size	3/4 size	1/2 size
114,30	11,24	8,74	6,24
127,00	11,21	8,71	6,21
139,70	11,20	8,70	6,20
168,28	11,16	8,66	6,16
177,80	11,16	8,66	6,16
193,70	11,15	8,65	6,15
196,80	11,14	8,64	6,14
219,10	11,13	8,63	6,13
244,50	11,12	8,62	6,12
273,10	11,11	8,61	6,11
298,50	11,10	8,60	6,10
339,70	11,09	8,59	6,09
406,40	11,08	8,58	6,08
473,10	11,07	8,57	6,07
508,00	11,07	8,57	6,07

NOTE — The wall thicknesses that are in excess of the maximum ISO wall thicknesses are for information only. The above provides a 0,5 mm ID and a 0,5 mm OD machining allowance.

6.2.7 Hardness maxima

6.2.7.1 Group 2 — Casing, tubing, couplings, pup-joints and connectors

a) Grade L80 all types

Each tensile specimen required for all types of grade L80 pipe prepared in accordance with 9.8.2 shall be tested for hardness and shall comply with the requirements given in table 3.

b) Grade C90 and grade T95

Any hardness value (see figure 10) not exceeding 25,4 HRC is acceptable. If any hardness reading exceeds 27 HRC, the piece shall be rejected. Hardness values falling between these limits require retest. Hardness tests shall be taken on each ring in accordance with figure 10 to provide three hardness values in one quadrant for non-upset pipe and in each of four quadrants for upset pipe.

6.2.7.2 Group 4 — Casing, couplings, pup-joints and connectors

There is no upper or lower hardness limit for this material.

6.2.8 Hardness variation — Group 2, grades C90 and T95 and group 4, grade Q125

Material shall conform to the hardness variation requirements given in table 3. Hardness variation is defined as the difference between any two hardness values within one quadrant. This criterion shall not apply between specimens.

6.2.9 Process control — Group 2, grades C90 and T95 and group 4, grade Q125

All individually heat treated coupling blanks, pup-joints or connectors shall be hardness tested to verify process control. Hardness test results need not be provided by manufacturer or processor unless specified on the purchase order.

6.2.10 Hardenability — Group 2, 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/quench combination. Hardness values shall equal or exceed the hardness corresponding to 90 % minimum martensite as determined by the following equation:

$$\text{HRC}_{\min} = 58 \times \% \text{ C} + 27$$

6.2.11 Grain size — Group 2, grades C90 and T95

Prior austenitic grain size shall be ISO grain size 5 or finer.

6.2.12 Flattening — Electric-welded pipe (all groups)

All products that are produced by the electric weld process of manufacture shall comply with the flattening requirements shown in table 17.

Table 17 — Distance between plates for electric weld flattening tests

Grade	D/t ratio	Distance between plates max. mm
H40	≥ 16 < 16	0,5D $D(0,83 - 0,020\ 6D/t)$
J55 and K55	≥ 16 3,93 to 16 $< 3,93$	0,65D $D(0,98 - 0,020\ 6D/t)$ $D(1,104 - 0,051\ 8D/t)$
N80 ¹⁾	9 to 28	$D(1,074 - 0,019\ 4D/t)$
L80	9 to 28	$D(1,074 - 0,019\ 4D/t)$
C95 ¹⁾	9 to 28	$D(1,080 - 0,017\ 8D/t)$
P110 ²⁾	All	$D(1,086 - 0,016\ 3D/t)$
Q125 ²⁾	All	$D(1,092 - 0,014D/t)$

D is the specified outside diameter of pipe, in millimetres.

t is the specified wall thickness of the pipe, in millimetres.

1) 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.

2) See annex B (SR11). Flattening shall be at least 0,85D.

6.2.13 Sulfide stress cracking test — Group 2, grades C90 and T95

It is the responsibility of the purchaser (and/or user) of grade C90 and T95 pipe to determine the level of resistance to sulfide stress cracking (i.e., threshold stress) necessary for the end use of the pipe, and to determine the manufacturers who are capable of manufacturing grade C90 and T95 pipe to meet this resistance level.

The details of a manufacturer's qualification, frequency of sulfide stress cracking testing, retest procedures, and testing practices should be addressed by the purchaser and manufacturer prior to placement or acceptance of a purchase order.

Manufacturers can qualify to make C90 and T95 pipe by complying with the requirements of this International Standard, and in addition for each heat shall demonstrate an absolute minimum threshold stress, as defined in the latest edition of NACE TM-01-77, of 496 N/mm² for C90 and 524 N/mm² for T95 pipe (80 % of the specified minimum yield strength). If the user requires a threshold stress higher than this minimum, agreement shall be reached between interested parties.