

English Version

Seamless steel tubes for pressure purposes - Technical delivery conditions - Part 2: Non-alloy and alloy steel tubes with specified elevated temperature properties

Tubes sans soudure en acier pour service sous pression - Conditions techniques de livraison - Partie 2: Tubes en acier non allié et allié avec caractéristiques spécifiées à température élevée

Nahtlose Stahlrohre für Druckbeanspruchungen - Technische Lieferbedingungen - Teil 2: Rohre aus unlegierten und legierten Stählen mit festgelegten Eigenschaften bei erhöhten Temperaturen

This European Standard was approved by CEN on 17 August 2013 and includes Amendment 1 approved by CEN on 23 September 2019.

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European foreword

This document (EN 10216-2:2013+A1:2019) has been prepared by Technical Committee CEN/TC 459 SC/10 "Steel tubes, and iron and steel fittings", the secretariat of which is held by UNI.

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of an identical text or by endorsement, at the latest by June 2020, and conflicting national standards shall be withdrawn at the latest by June 2020.

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

This document includes Amendment 1 approved by CEN on 23 September 2019.

This document supersedes A1 EN 10216-2:2013 A1.

The start and finish of text introduced or altered by amendment is indicated in the text by tags A1 A1.

For the list of the most significant technical changes that A1 were made in EN 10216-2:2013 A1, see Annex B.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

For relationship with EU Directive(s), see informative Annex ZA, which is an integral part of this document.

This European Standard consists of the following parts, under the general title "*Seamless steel tubes for pressure purposes – Technical delivery conditions*":



- *Part 1: Non-alloy steel tubes with specified room temperature properties*
- *Part 2: Non-alloy and alloy steel tubes with specified elevated temperature properties* (the present document)
- *Part 3: Alloy fine grain steel tubes*
- *Part 4: Non-alloy and alloy steel tubes with specified low temperature properties*
- *Part 5: Stainless steel tubes*

Another European Standard series covering tubes for pressure purposes is:

EN 10217, *Welded steel tubes for pressure purposes – Technical delivery conditions*

According to the CEN-CENELEC Internal Regulations, the national standards organisations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

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1 Scope

This European Standard specifies the technical delivery conditions in two test categories for seamless tubes of circular cross section, with specified elevated temperature properties, made of non-alloy and alloy steel.

This Part of EN 10216 may also be applied for tubes of non-circular cross section; necessary modification should be agreed at the time of enquiry and order.

NOTE Once this standard is published in the Official Journal of the European Union (OJEU) under Directive 2014/68/EU, presumption of conformity to the Essential Safety Requirements (ESR) of Directive 2014/68/EU is limited to technical data of materials in this standard and does not presume adequacy of the material to a specific item of equipment. Consequently, the assessment of the technical data stated in this material standard against the design requirements of this specific item of equipment to verify that the ESRs of the Pressure Equipment Directive are satisfied, needs to be done by the designer or manufacturer of the pressure equipment, taking also into account the subsequent manufacturing processes which may affect properties of the base materials.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 10020:2000 ^{A1}, *Definitions and classification of grades of steel*

EN 10021:2006 ^{A1}, *General technical delivery requirements for steel products*

EN 10027-1, *Designation systems for steels - Part 1: Steel names*

EN 10027-2, *Designation systems for steels - Part 2: Numerical system*

EN 10168:2004, *Steel products - Inspection documents - List of information and description*

EN 10204:2004, *Metallic products - Types of inspection documents*

EN 10220, *Seamless and welded steel tubes - Dimensions and masses per unit length*

EN 10266:2003 ^{A1}, *Steel tubes, fittings and structural hollow sections - Symbols and definitions of terms for use in product standards*

CEN/TR 10261, *Iron and steel - Review of available methods of chemical analysis*

EN ISO 148-1:2010, *Metallic materials - Charpy pendulum impact test - Part 1: Test method (ISO 148-1:2009)*

EN ISO 377:2013, *Steel and steel products - Location and preparation of samples and test pieces for mechanical testing (ISO 377:2013)*

EN ISO 2566-1, *Steel - Conversion of elongation values - Part 1: Carbon and low-alloy steels (ISO 2566-1)*

EN ISO 4885:2018, *Ferrous materials - Heat treatments - Vocabulary (ISO 4885:2018)* ^{A1}

EN ISO 6892-1:2009, *Metallic materials - Tensile testing - Part 1: Method of test at room temperature (ISO 6892-1:2009)*

EN ISO 6892-2:2011, *Metallic materials - Tensile testing - Part 1: Method of test at elevated temperature (ISO 6892-2:2011)*

EN ISO 8492:2013 ^{A1}, *Metallic materials - Tube - Flattening test (ISO 8492)*

EN ISO 8493:2004 ^{A1}, *Metallic materials - Tube - Drift expanding test (ISO 8493)*

EN ISO 8495:2013 ^{A1}, *Metallic materials - Tube - Ring expanding test (ISO 8495)*

EN ISO 8496:2013 ^{A1}, *Metallic materials - Tube - Ring tensile test (ISO 8496)*

EN ISO 10893-1, *Non-destructive testing of steel tubes - Part 1: Automated electromagnetic testing of seamless and welded (except submerged arc-welded) steel tubes for the verification of hydraulic leak-tightness (ISO 10893-1)*

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

EN ISO 10893-8, *Non-destructive testing of steel tubes - Part 8: Automated ultrasonic testing of seamless and welded steel tubes for the detection of laminar imperfections (ISO 10893-8)*

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

EN ISO 14284:2002, *Steel and iron - Sampling and preparation of samples for the determination of chemical composition (ISO 14284:1996)*

ISO 11484:2009, *Steel products - Employer's qualification system for non-destructive testing (NDT) personnel*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 10020, EN 10021, ^{A1} EN ISO 4885 ^{A1} and EN 10266 and the following apply.

3.1

test category

classification that indicates the extent and level of inspection and testing

3.2

employer

organization for which a person works on a regular basis

Note 1 to entry: The employer may be either the tube manufacturer or supplier or a third party organization providing Non-Destructive Testing (NDT) services.

4 Symbols

For the purposes of this document, the symbols given in EN 10266 and the following apply:

- d specified inside diameter
- d_{min} specified minimum inside diameter
- T_{min} specified minimum wall thickness
- D_c calculated outside diameter
- d_c calculated inside diameter
- T_c calculated wall thickness
- TC test category

5 Classification and designation

5.1 Classification

In accordance with the classification system in EN 10020, the steel grades P195GH, P235GH and P265GH are classified as non-alloy quality steels and the other steel grades are classified as alloy special steels.

5.2 Designation

5.2.1 For the tubes covered by this Part of EN 10216, the steel designation consists of:

- the number of this Part of EN 10216;
- plus either:
- the steel name in accordance with EN 10027-1;
- or:
- the steel number allocated in accordance with EN 10027-2.

5.2.2 The steel name of non-alloy steel grades is designated by:

- the capital letter P for pressure purposes;
- the indication of the specified minimum yield strength at room temperature for wall thickness less than or equal to 16 mm, expressed in MPa (see Table 4);
- the symbols GH for elevated temperature.

5.2.3 The steel name of alloy steel grades is designated by the chemical composition (see Table 2) and the symbols for the heat treatment, where specified in column 3 and footnote c of Table 1.

6 Information to be supplied by the purchaser

6.1 Mandatory information

The following information shall be supplied by the purchaser at the time of enquiry and order:

- a) the quantity (mass or total length or number);
- b) the term "tube";
- c) the dimensions (outside diameter D and wall thickness T or a set of dimensions covered by Option 11) (see Table 6);
- d) the designation of the steel grade in accordance with this Part of EN 10216 (see 5.2);
- e) the test category (TC) for non-alloy steel (see 9.3).

6.2 Options

A number of options are specified in this Part of EN 10216 and these are listed below. In the event that the purchaser does not indicate a wish to implement any of these options at the time of enquiry and order, the tubes shall be supplied in accordance with the basic specification (see 6.1).

- 1) Cold finishing (see 7.2.2);
- 2) restriction on copper and tin content (see Table 2);
- 3) product analysis (see 8.2.2);
- 4) verification of impact energy (see Table 4);
- 5) verification of longitudinal impact energy at -10° C for non-alloy steel grades (see Table 4);
- 6) verification of elevated temperature properties (see 8.3.2);
- 7) selection test method for verification of leak-tightness (see 8.4.2.1);
- 8) Non-Destructive Testing for test category 2 tubes for detection of transverse imperfections (see 8.4.2.2);
- 9) Non-Destructive Testing for test category 2 tubes for detection of laminar imperfections (see 8.4.2.2);
- 10) special ends preparation (see 8.6);
- 11) set of dimensions other than D and T (see 8.7.1);
- 12) exact lengths (see 8.7.3);
- 13) the type of inspection certificate 3.2 other than the standard document (see 9.2.1);
- 14) test pressure for hydrostatic leak-tightness test (see 11.8.1);
- 15) wall thickness measurement away from the ends (see 11.9);

16) Non-Destructive Testing method (see 11.11.1);

17) additional marking (see 12.2);

18) protection (see Clause 13).

6.3 Examples of an order

6.3.1 Example 1

100 t of seamless tube with an outside diameter of 168,3 mm, a wall thickness of 4,5 mm, in accordance with EN 10216-2, made of steel grade P265GH, to test category 1 with a 3.2 inspection certificate in accordance with EN 10204:

EXAMPLE 100 t - Tube - 168,3 x 4,5 - EN 10216-2 - P265GH - TC1 - Option 13: 3.2

6.3.2 Example 2

100 m of seamless tube with a minimum inside diameter of 240 mm, a minimum wall thickness of 40 mm in accordance with A_1 EN 10216-2 A_1 , made of steel grade 10CrMo9-10, with a 3.2 inspection certificate in accordance with EN 10204:

EXAMPLE 100 m - Tube - d_{\min} 240 x T_{\min} 40 - EN 10216-2 - 10CrMo9-10 - Option 13: 3.2

7 Manufacturing process

7.1 Steel making process

The steelmaking process is at the discretion of the manufacturer with the exception that the open hearth (Siemens-Martin) process shall not be employed unless in combination with a secondary steelmaking or ladle refining process.

Steels shall be fully killed.

NOTE This excludes the use of rimming, balanced or semi-killed steel.

7.2 Tube manufacture and delivery conditions

7.2.1 All NDT activities shall be carried out by qualified and competent level 1,2 and/or 3 personnel authorized to operate by the employer.

The qualification shall be in accordance with ISO 11484 or, at least, an equivalent to it.

It is recommended that the level 3 personnel be certified in accordance with EN ISO 9712 or, at least, an equivalent to it.

The operating authorization issued by the employer shall be in accordance with a written procedure.

NDT operations shall be authorized by level 3 NDT individual approved by the employer.

NOTE The definition of level 1, 2 and 3 can be found in appropriate standards, e.g. EN ISO 9712 and ISO 11484.

7.2.2 The tubes shall be manufactured by a seamless process.

Unless option 1 is specified, the tubes may be either hot or cold finished at the discretion of the manufacturer. The terms “ hot finished “ and “ cold finished “ apply to the condition of the tube before it is heat treated in accordance with A_1 7.2.3 A_1 .

Option 1: The tubes shall be cold finished before heat treatment.

7.2.3 The tubes shall be supplied in the relevant heat treatment conditions as specified in Table 1.

Table 1 — Heat treatment conditions

Steel grade		Heat treatment ^a	Austenitizing		Tempering	
Steel name	Steel number		Temperature °C	Cooling Medium	Temperature °C	Cooling medium
P195GH	1.0348	+N ^b	880 to 940	air	-	-
P235GH	1.0345	+N ^b	880 to 940	air	-	-
P265GH	1.0425	+N ^b	880 to 940	air	-	-
20MnNb6	1.0471	+N ^b	900 to 960	air	-	-
16Mo3	1.5415	+N ^b	890 to 950	air	-	-
8MoB5-4	1.5450	+N ^b	920 to 960	air	-	-
14MoV6-3	1.7715	+NT ^{b,c}	930 to 990	air	680 to 730	air
10CrMo5-5	1.7338	+NT ^{b,c}	900 to 960	air	650 to 750	air
13CrMo4-5	1.7335	+NT ^{b,c}	900 to 960	air	660 to 730	air
10CrMo9-10	1.7380	+NT ^{b,c}	900 to 960	air	680 to 750	air
11CrMo9-10	1.7383	+QT	900 to 960	air or liquid	680 to 750	air
25CrMo4	1.7218	+QT	860 to 900	air or liquid	620 to 680	air
20CrMoV13-5-5	1.7779	+QT	980 to 1030	air or liquid	680 to 730	air
15NiCuMoNb5-6-4	1.6368	+NT ^c	880 to 980	air	580 to 680	air
7CrWVMoNb9-6	1.8201	+NT ^d	1 040 to 1 080	air	730 to 780	air
7CrMoVTiB10-10	1.7378	+NT ^d	980 to 1 020	air	730 to 770	air
X11CrMo5+I	1.7362+I	+I	890 to 950	Furnace atmosphere	-	-
X11CrMo5+NT1	1.7362+NT 1	+NT1	930 to 980	Air	730 to 770	air
X11CrMo5+NT2	1.7362+NT 2	+NT2 ^c	930 to 980	air	710 to 750	air
X11CrMo9-1+I	1.7386+I	+I	950 to 980	Furnace atmosphere	-	-
X11CrMo9-1+NT	1.7386+NT	+NT ^c	890 to 950	air	720 to 800	air

Steel grade		Heat treatment ^a	Austenitizing		Tempering	
Steel name	Steel number		Temperature °C	Cooling Medium	Temperature °C	Cooling medium
X10CrMoVNb9-1	1.4903	+NT ^c	1 040 to 1 090	air	730 to 780	air
X10CrWMoVNb9-2	1.4901	+NT ^c	1 040 to 1 090	Air	730 to 780	air
X11CrMoWVNb9-1-1	1.4905	+NT ^c	1 040 to 1 080	Air	740 to 780	air
X20CrMoV11-1	1.4922	+NT ^c	1 020 to 1 080	air	730 to 780	air

^a +N = Normalizing, +NT = Normalizing + Tempering, +QT = Quenching + Tempering (air or liquid), +I = Isothermal Annealing.

^b Normalizing includes Normalizing Forming. Normalized Forming shall be carried out in a temperature range from 880 °C to 1 000 °C.

^c For these steel grades it may be necessary in the case of wall thickness T above 10 mm or $T/D > 0,15$ to apply quenching and tempering in order to achieve the intended structure and material properties. The decision shall be left to the discretion of the manufacturer but shall be stated to the customer at the time of enquiry and order. Steel tubes treated in such a way shall be designated by the steel name supplemented by the symbol "+QT".

^d For these steel grades it may be necessary in case of wall thickness T above 16 mm or $T/D > 0,15$ to apply quenching and tempering in order to achieve the intended structure and material properties. The decision shall be left to the discretion of the manufacturer but shall be stated to the customer at the time of enquiry and order. Steel tubes treated in such a way shall be designated by the steel name supplemented by the symbol "+QT".

8 Requirements

8.1 General

When supplied in a delivery condition indicated in 7.2 and inspected in accordance with Clauses 9, 10 and 11, the tubes shall conform to the requirements of this Part of EN 10216.

In addition, the general technical delivery requirements specified in EN 10021 shall apply.

Tubes shall be suitable for hot and cold bending provided the bending is carried out in an appropriate manner.

When tubes are specified in the order by d , d_{min} or T_{min} the following formulae, with all terms in mm, shall apply for the calculation of outside diameter D_c , inside diameter d_c and wall thickness T_c , instead of D , d and T for the relevant requirements in 8.4.1.4, 10.2.2.2, 11.3, 11.8.1, 11.9, 11.11.4, 12.1 and Table 1, footnote c, Tables 4, 5, 8, 10, 13 and 14:

$$D_c = d + 2T \quad (1)$$

$$D_c = d_{min} + \frac{\text{tolerance} \cdot \text{of} \cdot d_{min}}{2} + 2T \quad (2)$$

$$d_c = d_{min} + \frac{\text{tolerance} \cdot \text{of} \cdot d_{min}}{2} \quad (3)$$

$$T_c = T_{min} + \frac{\text{tolerance} \cdot \text{of} \cdot T_{min}}{2} \quad (4)$$

For tolerances, see Tables 8, 9 and 10.

8.2 Chemical composition

8.2.1 Cast analysis

The cast analysis reported by the steel producer shall apply and conform to the requirements of Table 2.

When welding tubes produced in accordance with this Part of this EN 10216, account should be taken of the fact that the behaviour of the steel during and after welding is dependent not only on the steel, but also on the applied heat treatment and the conditions of preparing for and carrying out the welding.

8.2.2 Product analysis

Option 3: Product analysis for the tubes shall be supplied.

Table 3 specifies the permissible deviations of the product analysis from the specified limits on cast analysis given in Table 2.

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Table 2 — Chemical composition (cast analysis)^a, in % by mass

Steel grade		C	Si	Mn	P max	S max	Cr	Mo	Ni	Al _{tot}	Cu	Nb	Ti max	V	Cr+Cu +Mo+Ni	Others
Steel name	Steel number															
P195GH	1.0348	≤ 0,13	≤ 0,35	≤ 0,70	0,025	0,010	≤ 0,30	≤ 0,08	≤ 0,30	≥ 0,020 ^b	≤ 0,30 ^c	≤ 0,010 ^d	0,040 ^d	≤ 0,02 ^d	≤ 0,70	-
P235GH	1.0345	≤ 0,16	≤ 0,35	≤ 1,20	0,025	0,010	≤ 0,30	≤ 0,08	≤ 0,30	≥ 0,020 ^b	≤ 0,30 ^c	≤ 0,020 ^d	0,040 ^d	≤ 0,02 ^d	≤ 0,70	-
P265GH	1.0425	≤ 0,20	≤ 0,40	≤ 1,40	0,025	0,010	≤ 0,30	≤ 0,08	≤ 0,30	≥ 0,020 ^b	≤ 0,30 ^c	≤ 0,020 ^d	0,040 ^d	≤ 0,02 ^d	≤ 0,70	-
20MnNb6	1.0471	≤ 0,22	0,15 to 0,35	1,00 to 1,50	0,025	0,010	-	-	-	≤ 0,060	≤ 0,30 ^c	0,015 to 0,10	-	-	-	-
16Mo3	1.5415	0,12 to 0,20 ^e	≤ 0,35	0,40 to 0,90	0,025	0,010	≤ 0,30	0,25 to 0,35	≤ 0,30	≤ 0,040	≤ 0,30 ^c	-	-	-	-	-
8MoB5-4	1.5450	0,06 to 0,10	0,10 to 0,35	0,60 to 0,80	0,025	0,010	≤ 0,20	0,40 to 0,50	-	≤ 0,060	≤ 0,30 ^c	-	0,060	-	-	0,002 to 0,006
14MoV6-3	1.7715	0,10 to 0,15	0,15 to 0,35	0,40 to 0,70	0,025	0,010	0,30 to 0,60	0,50 to 0,70	≤ 0,30	≤ 0,040	≤ 0,30 ^c	-	-	0,22 to 0,28	-	-
10CrMo5-5	1.7338	≤ 0,15	0,50 to 1,00	0,30 to 0,60	0,025	0,010	1,00 to 1,50	0,45 to 0,65	≤ 0,30	≤ 0,040	≤ 0,30 ^c	-	-	-	-	-
13CrMo4-5	1.7335	0,10 to 0,17 ^e	≤ 0,35	0,40 to 0,70	0,025	0,010	0,70 to 1,15	0,40 to 0,60	≤ 0,30	≤ 0,040	≤ 0,30 ^c	-	-	-	-	-
10CrMo9-10	1.7380	0,08 to 0,14	≤ 0,50	0,30 to 0,70	0,020	0,010	2,00 to 2,50	0,90 to 1,10	≤ 0,30	≤ 0,040	≤ 0,30 ^c	-	-	-	-	-
11CrMo9-10	1.7383	0,08 to 0,15	≤ 0,50	0,40 to 0,80	0,025	0,010	2,00 to 2,50	0,90 to 1,10	≤ 0,30	≤ 0,040	≤ 0,30 ^c	-	-	-	-	-

Table 2 (continued)

Steel grade		C	Si	Mn	P max	S max	Cr	Mo	Ni	Al _{tot}	Cu	Nb	Ti	V	Cr+Cu +Mo+Ni	Others
Steel Grade	Steel Number															
25CrMo4	1.7218	0,22 to 0,29	≤ 0,40	0,60 to 0,90	0,025	0,010	0,90 to 1,20	0,15 to 0,30	≤ 0,3	≤ 0,040	≤ 0,30 ^c	-	-	-	-	-
20CrMoV13-5-5	1.7779	0,17 to 0,23	0,15 to 0,35	0,30 to 0,50	0,025	0,010	3,00 to 3,30	0,50 to 0,60	≤ 0,3	≤ 0,040	≤ 0,30 ^c	-	-	0,45 to 0,55	-	-
15NiCuMoNb5-6-4	1.6368	≤ 0,17	0,25 to 0,50	0,80 to 1,20	0,025	0,010	≤ 0,30	0,25 to 0,50	1,00 to 1,30	≤ 0,050	0,50 to 0,80	0,015 to 0,045	-	-	-	-
7CrWVMoNb9-6	1.8201	0,04 to 0,10	≤ 0,50	0,10 to 0,60	0,030	0,010	1,90 to 2,60	0,05 to 0,30	-	≤ 0,030	-	0,02 to 0,08	0,005 to 0,060	0,20 to 0,30	-	N ≤ 0,015 B = 0,0010 to 0,006 W = 1,45 to 1,75 Ti/N ≥ 3,5 ^g
7CrMoVTiB10-10	1.7378	0,05 to 0,10	0,15 to 0,45	0,30 to 0,70	0,020	0,010	2,20 to 2,60	0,90 to 1,10	-	≤ 0,020	-	-	0,05 to 0,10	0,20 to 0,30	-	N ≤ 0,010 B = 0,0015 to 0,0070
X11CrMo5+I X11CrMo5+NT1 X11CrMo5+NT2	1.7362+I 1.7362+NT1 1.7362+NT2	0,08 to 0,15	0,15 to 0,50	0,30 to 0,60	0,025	0,010	4,0 to 6,0	0,45 to 0,65	-	≤ 0,040	≤ 0,30 ^c	-	-	-	-	-
X11CrMo9-1+I X11CrMo9-1+NT	1.7386+I 1.7386+NT	0,08 to 0,15	0,25 to 1,00	0,30 to 0,60	0,025	0,010	8,0 to 10,0	0,90 to 1,10	-	≤ 0,040	≤ 0,30 ^c	-	-	-	-	-
X10CrMoVNb9-1	1.4903	0,08 to 0,12	0,20 to 0,50	0,30 to 0,60	0,020	0,005	8,0 to 9,5	0,85 to 1,05	≤ 0,40	≤ 0,02	≤ 0,30 ^c	0,06 to 0,10	0,01 max	0,18 to 0,25	-	N = 0,030 to 0,070 Zr = 0,01 max

Table 2 (concluded)

Steel grade		C	Si	Mn	P max	S max	Cr	Mo	Ni	Al _{tot}	Cu	Nb	Ti	V	Cr+Cu +Mo+Ni	Others
Steel name	Steel number															
X10CrWMoVNB9-2	1.4901	0,07 to 0,13	≤ 0,50	0,30 to 0,60	0,020	0,010	8,5 to 9,5	0,30 to 0,60	≤ 0,40	≤ 0,02	-	0,04 to 0,09	0,01 max	0,15 to 0,25	-	N = 0,030 to 0,070 B = 0,001 to 0,006 W = 1,50 to 2,00 Zr = 0,01 max
X11CrMoWVNB9-1-1	1.4905	0,09 to 0,13	0,10 to 0,50	0,30 to 0,60	0,020	0,010	8,5 to 9,5	0,90 to 1,10	0,10 to 0,40	≤ 0,02	-	0,06 to 0,10	0,01 max	0,18 to 0,25	-	N = 0,050 to 0,090 B = 0,0005 to 0,0005 W = 0,90 to 1,10 Zr = 0,01 max
X20CrMoV11-1	1.4922	0,17 to 0,23 ^f	0,15 to 0,50	≤ 1,00	0,025	0,010	10,0 to 12,5	0,80 to 1,20	0,30 to 0,80	≤ 0,040	≤ 0,30 _c	-	-	0,25 to 0,35	-	-

^a Elements not included in this table shall not be intentionally added to the steel without the agreement of the purchaser, except for elements which may be added for finishing the cast. All appropriate measures shall be taken to prevent the addition of undesirable elements from scrap or other materials used in the steel making process.

^b This requirement is not applicable provided the steel contains a sufficient amount of other nitrogen binding elements which shall be reported. When using titanium, the producer shall verify that $(Al+Ti)/2 \geq 0,020\%$.

^c **Option 2:** In order to facilitate subsequent forming operations, an agreed maximum copper content lower than indicated and an agreed specified maximum tin content shall apply.

^d The content of these elements need not to be reported unless intentionally added to the cast.

e For wall thickness $T \geq 30$ mm the carbon content may be increased by 0,02 % for cast and product analysis.

f The upper carbon value of 0,23 % shall not be exceeded for product analysis.

g Alternatively, in lieu of the minimum ratio the material shall have a minimum hardness of 275 HV in the hardened condition, defined as after austenitizing and cooling to room temperature, but before tempering. Hardness testing shall be performed at mid thickness of the product. The testing frequency shall be two samples of product per heat treatment lot and the hardness testing results shall be reported.

Table 3 — Permissible deviations of the product analysis from specified limits on cast analysis given in Table 2

Element	Limiting value for the cast analysis in accordance with Table 2 % by mass	Permissible deviation of the product analysis % by mass
C	≤ 0,29	± 0,02
Si	≤ 0,40	± 0,05
	> 0,40 to ≤ 1,00	± 0,06
Mn	≤ 1,00	± 0,05
	> 1,00 to ≤ 1,50	± 0,10
P	≤ 0,030	+ 0,005
S	≤ 0,010	+ 0,003
	> 0,010 to ≤ 0,020	+ 0,005
Al	≤ 0,060	± 0,005
B	≤ 0,007	+ 0,000 5
Cr	≤ 1,00	± 0,05
	> 1,00 to ≤ 10,0	± 0,10
	> 10,0 to ≤ 12,5	± 0,15
Cu	≤ 0,80	± 0,05
Mo	≤ 0,35	± 0,03
	> 0,35 to ≤ 1,20	± 0,04
N	≤ 0,070	± 0,01
Nb	≤ 0,10	± 0,005
Ni	≤ 0,35	± 0,05
	> 0,35 to ≤ 1,30	± 0,07
Ti	≤ 0,060	+ 0,010
V	≤ 0,10	+ 0,01
	> 0,10 to ≤ 0,55	± 0,03
W	≤ 2,00	± 0,10

8.3 Mechanical properties

8.3.1 Mechanical properties at and below room temperature

The mechanical properties at and below room temperature of the tubes shall conform to the requirements in Table 4 and in 11.3, 11.4, 11.5 and 11.6 irrespective of whether they are verified or not (see Table 13).

8.3.2 Proof strength at elevated temperature

The minimum proof strength $R_{p0,2}$ values at elevated temperature are given in Table 5.

Option 6: Proof strength $R_{p0,2}$ shall be verified. The test temperature shall be specified at the time of enquiry and order.

8.3.3 Creep rupture strength

The creep rupture strength values are given in Annex A for information.

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Table 4 — Mechanical properties

Steel grade		Tensile properties at room temperature						Elongation			Impact properties ^{a,b}			
Steel name	Steel number	Upper yield strength or proof strength R_{eH} or $R_{p0.2}$ for wall thickness T min.						Tensile strength R_m	A min. % ^{a,h}	Minimum average absorbed energy KV_2^h J at a temperature of °C				
		$T \leq 16$	$16 < T \leq 40$	$40 < T \leq 60$	$60 < T \leq 100$									
		MPa ^g	MPa ^g	MPa ^g	MPa ^g	MPa ^g	MPa ^g	l	t	20	0	-10	20	0
P195GH	1.0348	195	-	-	-	-	320 to 440	27	25	-	40 ^c	28 ^d	-	27 ^c
P235GH	1.0345	235	225	215	-	-	360 to 500	25	23	-	40 ^c	28 ^d	-	27 ^c
P265GH	1.0425	265	255	245	-	-	410 to 570	23	21	-	40 ^c	28 ^d	-	27 ^c
20MnNb6	1.0471	355	345	335	-	-	500 to 650	22	20	-	40 ^c	-	-	27 ^c
16Mo3	1.5415	280	270	260	-	-	450 to 600	22	20	40 ^c	-	-	27 ^c	-
8MoB5-4	1.5450	400	-	-	-	-	540 to 690	19	17	40 ^c	-	-	27 ^c	-
14MoV6-3	1.7715	320	320	310	-	-	460 to 610	20	18	40 ^{cf}	-	-	27 ^{cf}	-
10CrMo5-5	1.7338	275	275	265	-	-	410 to 560	22	20	40 ^c	-	-	27 ^c	-
13CrMo4-5	1.7335	290	290	280	-	-	440 to 590	22	20	40 ^c	-	-	27 ^c	-
10CrMo9-10	1.7380	280	280	270	-	-	480 to 630	22	20	40 ^c	-	-	27 ^c	-
11CrMo9-10	1.7383	355	355	355	-	-	540 to 680	20	18	40 ^c	-	-	27 ^c	-
25CrMo4	1.7218	345	345	345	-	-	540 to 690	18	15	40 ^{cf}	-	-	27 ^{cf}	-
20CrMoV13-5-5	1.7779	590	590	590	-	-	740 to 880	16	14	40 ^{cf}	-	-	27 ^{cf}	-
15NiCuMoNb5-6-4	1.6368	440	440	440	440 ^e	-	610 to 780	19	17	40 ^{cf}	-	-	27 ^{cf}	-
7CrWVMoNb9-6	1.8201	400	400	400	-	-	510 to 740	20	18	40 ^{cf}	-	-	27 ^{cf}	-

Table 4 — (concluded)

Steel grade		Tensile properties at room temperature					Impact properties ^{a,b}						
Steel name	Steel number	Upper yield strength or proof strength R _{eH} or R _{p0.2} for wall thickness T min.					Tensile strength R _m	Elongation A min. % ^{a,h}	Minimum average absorbed energy KV _{2h} J at a temperature of °C				
		R _{eH} or R _{p0.2} for wall thickness T min.							Minimum average absorbed energy KV _{2h} J at a temperature of °C				
		T ≤ 16	16 < T ≤ 40	40 < T ≤ 60	60 < T ≤ 100	MPa ^g			l	t	20	0	-10
7CrMoVTiB10-10	1.7378	450	430	430	-	565 to 840	17	15	40 ^{cf}	-	-	27 ^{cf}	-
X11CrMo5+I	1.7362+I	175	175	175	175	430 to 580	22	20	40 ^c	-	-	27 ^c	-
X11CrMo5+NT1	1.7362+NT 1	280	280	280	280	480 to 640	20	18	40 ^c	-	-	27 ^c	-
X11CrMo5+NT2	1.7362+NT 2	390	390	390	390	570 to 740	18	16	40 ^c	-	-	27 ^c	-
X11CrMo9-1+I	1.7386+I	210	210	210	-	460 to 640	20	18	40 ^c	-	-	27 ^c	-
X11CrMo9-1+NT	1.7386+NT	390	390	390	-	590 to 740	18	16	40 ^c	-	-	27 ^c	-
X10CrMoVNb9-1	1.4903	450	450	450	450	630 to 830	19	17	40 ^{cf}	-	-	27 ^{cf}	-
X10CrWMoVNb9-2	1.4901	440	440	440	440	620 to 850	19	17	40 ^{cf}	-	-	27 ^{cf}	-
X11CrMoWVNb9-1-1	1.4905	450	450	450	450	620 to 850	19	17	40 ^{cf}	-	-	27 ^{cf}	-
X20CrMoV11-1	1.4922	490	490	490	490	690 to 840	17	14	40 ^{cf}	-	-	27 ^{cf}	-

^a l = longitudinal; t = transverse.^b [A] To be verified when Option 4 or Option 5 or both is/are specified, unless footnote ^f applies. [A]

^c **Ⓐ** **Option 4:** Impact energy shall be verified for Group B (see Table 13; for specimen direction see 10.2.2.4). **Ⓐ**

^d **Option 5:** Longitudinal impact energy shall be verified **Ⓐ** at $-10\text{ }^{\circ}\text{C}$. **Ⓐ**

^e For wall thickness $60\text{ mm} < T \leq 80\text{ mm}$.

^f Impact test verification (longitudinal or transversal) is mandatory for wall thickness $T \geq 16\text{ mm}$.

^g $1\text{ MPa} = 1\text{ N/mm}^2$.

^h Observe that the A_{\min} value 14 % and the minimum average KV value 27 J is exactly on the design requirements levels according to **Ⓐ** European Legislation for Pressure Equipment **Ⓐ**.

Table 5 — Minimum proof strength $R_{p0,2}$ at elevated temperature

Steel grade		Wall thickness mm	Minimum proof strength $R_{p0,2}$ MPa ^a at a temperature of °C												
Steel name	Steel number		100	150	200	250	300	350	400	450	500	550	600		
P195GH	1.0348	≤16	175	165	150	130	113	102	94	-	-	-	-		
P235GH	1.0345	≤60	198	187	170	150	132	120	112	108	-	-	-		
P265GH	1.0425	≤60	226	213	192	171	154	141	134	128	-	-	-		
20MnNb6	1.0471	≤60	312	292	264	241	219	200	186	174	-	-	-		
16Mo3	1.5415	≤60	243	237	224	205	173	159	156	150	146	-	-		
8MoB5-4	1.5450	≤16	368	368	368	368	368	368	368	-	-	-	-		
14MoV6-3	1.7715	≤60	282	276	267	241	225	216	209	203	200	197	-		
10CrMo5-5	1.7338	≤60	240	228	219	208	165	156	148	144	143	-	-		
13CrMo4-5	1.7335	≤60	264	253	245	236	192	182	174	168	166	-	-		
10CrMo9-10	1.7380	≤60	249	241	234	224	219	212	207	193	180	-	-		
11CrMo9-10	1.7383	≤60	323	312	304	296	289	280	275	257	239	-	-		
25CrMo4	1.7218	≤60	-	315	305	295	285	265	225	185	-	-	-		
20CrMoV13-5-5	1.7779	≤60	-	575	570	560	550	510	470	420	370	-	-		
15NiCuMoNb5-6-4	1.6368	≤80	422	412	402	392	382	373	343	304	-	-	-		
7CrWVMoNb9-6	1.8201	≤60	379	370	363	361	359	351	345	338	330	299	266		
7CrMoVTiB10-10	1.7378	$A_1 \leq 60$ (A1)	397	383	373	366	359	352	345	336	324	301	248		
X11CrMo5+I	1.7362+I	≤100	156	150	148	147	145	142	137	129	116	-	-		
X11CrMo5+NT1	1.7362+NT1	≤100	245	237	230	223	216	206	196	181	167	-	-		
X11CrMo5+NT2	1.7362+NT2	≤100	366	350	334	332	309	299	289	280	265	-	-		

Table 5 — (concluded)

Steel grade		Wall thickness mm	Minimum proof strength $R_{p0,2}$ MPa ^a at temperature of °C											
Steel name	Steel number		100	150	200	250	300	350	400	450	500	550	600	
X11CrMo9-1+I	1.7386+I	≤ 60	187	186	178	177	175	171	164	153	142	120	-	
X11CrMo9-1+NT	1.7386+NT	≤ 60	363	348	334	330	326	322	316	311	290	235	-	
X10CrMoVNb9-1	1.4903	≤ 100	410	395	380	370	360	350	340	320	300	270	215	
X10CrWMoVNb9-2	1.4901	≤ 100	420	412	405	400	392	382	372	360	340	300	248	
X11CrMoWVNb9-1-1	1.4905	≤ 100	412	401	390	383	376	367	356	342	319	287	231	
X20CrMoV11-1	1.4922	≤ 100	-	-	430	415	390	380	360	330	290	250	-	

^a 1 MPa = 1 N/mm².

8.4 Appearance and internal soundness

8.4.1 Appearance

8.4.1.1 The tubes shall be free from external and internal surface defects that can be detected by visual examination.

8.4.1.2 The internal and external surface finish of the tubes shall be typical of the manufacturing process and, where applicable, the heat treatment employed. Normally the finish and surface condition shall be such that any surface imperfections requiring dressing can be identified.

8.4.1.3 It shall be permissible to dress, only by grinding or machining, surface imperfections provided that, after doing so, the wall thickness in the dressed area is not less than the specified minimum wall thickness. All dressed areas shall blend smoothly into the contour of the tube.

8.4.1.4 Any surface imperfection, which is demonstrated to be deeper than 5 % of the wall thickness T or 3 mm, whichever is the smaller, shall be dressed.

This requirement does not apply to surface imperfection with a depth equal or less 0,3 mm

8.4.1.5 Surface imperfections which encroach on the specified minimum wall thickness shall be considered defects and tubes containing these shall be deemed not to conform to this Part of EN 10216.

8.4.2 Internal soundness

8.4.2.1 Leak Tightness

The tubes shall pass a hydrostatic test (see 11.8.1) or electromagnetic test (see 11.8.2) for leak-tightness. Unless option 7 is specified, the choice of the test method is at the discretion of the manufacturer.

Option 7: *The test method for verification of leak-tightness in accordance with 11.8.1 or 11.8.2 is specified by the purchaser.*

8.4.2.2 Non-Destructive Testing

The tubes of test category 2 shall be subjected to a non-destructive testing for the detection of longitudinal imperfections, in accordance with 11.11.1.

Option 8: *The tubes of test category 2 shall be subjected to a non-destructive testing for the detection of transverse imperfections in accordance with 11.11.2.*

Option 9: *The tubes of test category 2 shall be subjected to a non-destructive testing for the detection of the laminar imperfections in accordance with 11.11.3.*

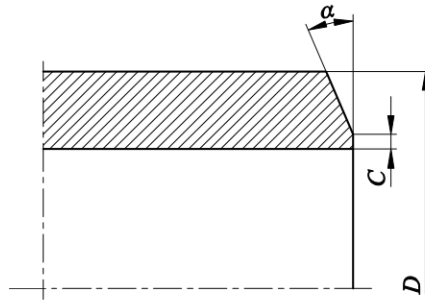
8.5 Straightness

The deviation from straightness of any tube length L shall not exceed $0,0015 L$. Deviations from straightness over any one metre length shall not exceed 3 mm.

8.6 Preparation of ends

Tubes with wall thickness $\geq 3,2$ mm shall be delivered with square cut ends. The ends shall be free from excessive burrs.

Option 10: *The tubes shall be delivered with bevelled ends (see Figure 1). The bevel shall have an angle α of 30° $^{+5^\circ}$ $_0^\circ$ with a root face C of $1,6 \text{ mm} \pm 0,8 \text{ mm}$, except that for wall thickness T greater than 20 mm, an agreed alternative bevel may be specified.*

**Key**

- D outside diameter
 α bevel angle
 C root face of bevelled end

Figure 1 — Tube end bevel**8.7 Dimensions, masses and tolerances****8.7.1 Diameter and wall thickness**

Unless option 11 is specified, tubes shall be delivered by outside diameter D and wall thickness T .

Preferred outside diameters D and wall thicknesses T have been selected from EN 10220 and are given in Table 6.

Dimensions which are different from those in Table 6 may be agreed.

Option 11: The tubes shall be delivered in accordance with one of the following sets of dimensions as specified at the time of enquiry and order:

- outside diameter D and minimum wall thickness T_{min} ;
- inside diameter d and wall thickness T for $d \geq 220$ mm;
- inside diameter d and minimum wall thickness T_{min} for $d \geq 220$ mm;
- minimum inside diameter d_{min} and wall thickness T for $d_{min} \geq 220$ mm;
- minimum inside diameter d_{min} and minimum wall thickness T_{min} for $d_{min} \geq 220$ mm.

Table 6 — Preferred dimensions

Dimensions in millimetres

Outside diameter <i>D</i>			Wall thickness <i>T</i>																				
Series ^a			1,6	1,8	2	2,3	2,6	2,9	3,2	3,6	4	4,5	5	5,6	6,3	7,1	8	8,8	10	11	12,5	14,2	
10,2																							
	12																						
	12,7																						
13,5																							
		14																					
	16																						
17,2																							
		18																					
	19																						
	20																						
21,3																							
		22																					
	25																						
		25,4																					
26,9																							
		30																					
	31,8																						
	32																						
33,7																							
		35																					
	38																						
	40																						
42,4																							
		44,5																					
48,3																							
	51																						
		54																					
	57																						
60,3																							
	63,5																						
	70																						
		73																					
76,1																							
		82,5																					
88,9																							
	101,6																						
		108																					
114,3																							
	127																						
	133																						
139,7																							
		141,3																					
		152,4																					
		159																					
168,3																							
		177,8																					
		193,7																					
219,1																							
		244,5																					
273																							
323,9																							
355,6																							
406,4																							
457																							
508																							
		559																					

Outside diameter <i>D</i> Series ^a			Wall thickness <i>T</i>																				
1	2	3	1,6	1,8	2	2,3	2,6	2,9	3,2	3,6	4	4,5	5	5,6	6,3	7,1	8	8,8	10	11	12,5	14,2	
610																							
		660																					
711																							

Table 6 (concluded)

Dimensions in millimetres

Outside diameter <i>D</i> series ^a			Wall thickness <i>T</i>																			
1	2	3	16	17,5	20	22,2	25	28	30	32	36	40	45	50	55	60	65	70	80	90	100	
10,2																						
	12																					
	12,7																					
13,5																						
		14																				
	16																					
17,2																						
		18																				
	19																					
	20																					
21,3																						
		22																				
	25																					
	25,4																					
26,9																						
	30																					
	31,8																					
	32																					
33,7																						
		35																				
	38																					
	40																					
42,4																						
		44,5																				
48,3																						
	51																					
	54																					
	57																					
60,3																						
	63,5																					
	70																					
		73																				
76,1																						
		82,5																				
88,9																						
	101,6																					
		108																				
114,3																						
	127																					
	133																					
139,7																						
		141,3																				
		152,4																				
		159																				
168,3																						
		177,8																				
		193,7																				

Outside diameter D			Wall thickness T																		
series ^a			16	17,5	20	22,2	25	28	30	32	36	40	45	50	55	60	65	70	80	90	100
219																					
		244,5																			
273																					
323,9																					
355,6																					
406,4																					
457																					
508																					
		559																			
610																					
		660																			
711																					

^a series 1 = diameter for which all the accessories needed for the construction of piping system are standardized;
series 2 = diameter for which not all the accessories are standardized;
series 3 = diameter for special application for which very few standardized accessories exist.

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8.7.2 Mass

For the mass per unit length, the provisions of EN 10220 apply except that for the steel grade X11CrMo9-1+I, X11CrMo9-1+NT, X10CrMoVNb9-1 and X20CrMoV11-1 a density of 7,77 kg/dm³ shall be used.

8.7.3 Lengths

Unless option 12 is specified, the tubes shall be delivered in random length. The delivery length range shall be agreed at the time of enquiry and order.

Option 12: The tubes shall be delivered in exact lengths and the length shall be specified at the time of enquiry and order. For the tolerances see 8.7.4.2.

8.7.4 Tolerances

8.7.4.1 Tolerances on diameter and thickness

The diameter and the wall thickness of the tubes shall be within the relevant tolerance limits given in Tables 7, 8, 9, 10 or 11.

Out of roundness is included in the tolerances on diameter and eccentricity is included in the tolerances on wall thickness.

Table 7 — Tolerances on outside diameter and wall thickness

Outside Diameter D mm	Tolerances on D	Tolerances on T for a T/D ratio			
		$\leq 0,025$	$> 0,025$ $\leq 0,050$	$> 0,050$ $\leq 0,10$	$> 0,10$
$D \leq 219,1$	$\pm 1\%$ or $\pm 0,5$ mm	$\pm 12,5\%$ or $\pm 0,4$ mm whichever is the greater			
$D > 219,1$	whichever is the greater	$\pm 20\%$	$\pm 15\%$	$\pm 12,5\%$	$\pm 10\%$ ^a

^a For outside diameters $D \geq 355,6$ mm it is permitted to exceed the upper wall thickness locally by a further 5 % of the wall thickness T .

Table 8 — Tolerances on inside diameter and wall thickness

Tolerances on inside diameter		Tolerances on T for a T/d ratio			
d	d_{min}	$\leq 0,03$	$> 0,03$ $\leq 0,06$	$> 0,06$ $\leq 0,12$	$> 0,12$
$\pm 1\%$ or ± 2 mm	$+ 4$ mm				
whichever is the greater	or	$\pm 20\%$	$\pm 15\%$	$\pm 12,5\%$	$\pm 10\%$ ^a
	0				
	0				

^a For outside diameters $D \geq 355,6$ mm it is permitted to exceed the upper wall thickness locally by a further 5 % of the wall thickness T .

Table 9 — Tolerances on outside diameter and minimum wall thickness

Outside diameter D mm	Tolerances on D	Tolerances on T_{min} for a T_{min}/D ratio			
		$\leq 0,02$	$> 0,02$ $\leq 0,04$	$> 0,04$ $\leq 0,09$	$> 0,09$
$D \leq 219,1$	$\pm 1\%$ or $\pm 0,5$ mm	+ 28 % 0	or + 0,8 mm 0	whichever is the greater	
$D > 219,1$	whichever is the greater	+ 50 % 0	+ 35 % 0	+ 28 % 0	+ 22 % ^a 0

^a For outside diameters $D \geq 355,6$ mm it is permitted to exceed the upper wall thickness locally by a further 5 % of the wall thickness T .

Table 10 — Tolerances on inside diameter and minimum wall thickness

d	Tolerances on inside diameter		Tolerances on T_{min} for a T_{min}/d ratio		
	d	d_{min}	$\leq 0,05$	$> 0,05$ $\leq 0,1$	$> 0,1$
$\pm 1\%$ or ± 2 mm whichever is the greater	+ 2 % 0	or + 4 mm 0	whichever is the greater	+ 28 % 0	+ 22 % ^a 0

^a For outside diameters $D \geq 355,6$ mm it is permitted to exceed the upper wall thickness locally by a further 5 % of the wall thickness T .

Table 11 — Tolerances on outside diameter and wall thickness for tube ordered cold finished

Tolerance on D	Tolerance on T
$\pm 0,5\%$ or $\pm 0,3$ mm whichever is the greater	$\pm 10\%$ or $\pm 0,2$ mm whichever is the greater

8.7.4.2 Tolerances on exact lengths

The tolerances for exact lengths shall be as given in Table 12.

Table 12 — Tolerances on exact lengths

Dimensions in mm

Length L	Tolerance on exact length
$L \leq 6\,000$	+10 0
$6\,000 < L \leq 12\,000$	+15 0
$L > 12\,000$	+ by agreement 0

9 Inspection

9.1 Types of inspection

Conformity to the requirements of the order, for tubes in accordance with this Part of EN 10216, shall be verified by specific inspection.

When an inspection document 3.1 is specified, the material manufacturer shall state in the confirmation of the order whether he is operating according to a “quality-assurance system”, certified by a competent Body established within the Community and having undergone a specific assessment for materials.

NOTE See the ^{A1} Directive 2014/68/EU ^{A1}, Annex I, section 4.3 third paragraph and for further information the Guidelines of the EU Commission and the Member States for its interpretation (see e.g. Guidelines ^{A1} G-02 and G-16 ^{A1}).

9.2 Inspection documents

9.2.1 Types of inspection documents

Unless option 13 is specified, an inspection certificate 3.1, in accordance with EN 10204, shall be issued.

Option 13: *The inspection certificate 3.2 in accordance with EN 10204 shall be issued.*

If an inspection certificate 3.2 is specified, the purchaser shall notify the manufacturer of the name and address of the organization or person who is to carry out the inspection and produce the inspection document.

In the case of the inspection certificate 3.2, it shall be agreed which party shall issue the certificate.

Document 3.1 and 3.2 are to be validated by the manufacturer's authorized representative.

9.2.2 Content of inspection documents

The content of the inspection document shall be in accordance with EN 10168.

In all types of inspection documents, a statement on the conformity of the products delivered with the requirements of this specification and the order shall be included.

The inspection certificate shall contain the following codes and information:

- A commercial transactions and parties involved;
- B description of products to which the inspection document applies;
- C02-C03 direction of the test pieces and testing temperature;
- C10-C13 tensile test;
- C40-C43 impact test, if applicable;
- C60-C69 other tests;
- C71-C92 chemical composition on cast analysis (product analysis, if applicable);
- D01 marking and identification, surface appearance, shape and dimensional properties;
- D02-D99 leak-tightness test; NDT, material identification, if applicable;
- Z validation.

In addition, for inspection certificate 3.1, the manufacturer shall state the references to the certificate (see 9.1) of the appropriate “quality-assurance system”, if applicable.

9.3 Summary of inspection and verification testing

Non-alloy steel tubes shall be inspected and tested in accordance with test category 1 or test category 2 as specified at the time of inquiry and order (see 6.1).

Alloy steel tubes shall be inspected and tested in accordance with test category 2 (see Table 13).

Inspection and testing to be carried out are summarized in Table 13.

Table 13 — Summary of inspection and verification testing

Type of inspection and test		Frequency of Testing	Refer to	Test category (TC)	
				1	2
Mandatory tests	Cast analysis	One per cast	8.2.1 - 11.1	X	X
	Tensile test at room temperature	One per sample tube	8.3.1 - 11.2.1	X	X
	Flattening test for $D < 600$ mm and T/D ratio $\leq 0,15$ but $T \leq 40$ mm or ^{a b} Ring tensile test for $D > 150$ mm and $T \leq 40$ mm		8.3 - 11.3 - 11.4	X	X
	Drift expanding test for $D \leq 150$ mm and $T \leq 10$ mm or ^{a b} Ring expanding test for $D \leq 114,3$ mm and $T \leq 12,5$ mm		8.3 - 11.5 - 11.6	X	X
	Impact test at 20° C for Group A ^c		8.3 - 11.7	X	X
	Leak tightness test		Each tube	8.4.2.1 - 11.8	X
	Dimensional inspection	8.7.1 - 11.9		X	X
	Visual examination	11.10		X	X
	NDT for the detection of longitudinal imperfections	Each	8.4.2.2 - 11.11.1	--	X
	Material identification of alloy steels	tube	11.12	X	X
Optional tests	Product analysis (Option 3)	One per cast	8.2.2 - 11.1	X	X
	Tensile test at elevated temperature (Option 6)	One per cast and same heat treatment condition	8.3.2 - 11.2.2	X	X
	Impact test for Group B ^c (Option 4)	One per	8.3 - 11.7	X	X
	Longitudinal impact test at -10°C for non-alloy steel grades (Option 5)	sample tube	8.3 - 11.7	X	X
	Wall thickness measurement away from tube ends (Option 15)	8.7.1 - 11.9		X	X
	NDT for the detection of transverse imperfections (Option 8)	Each	8.4.2.2 - 11.11.2	--	X
NDT for the detection of laminar imperfections (Option 9)	tube	8.4.2.2 - 11.11.3	--	X	

^a The choice of flattening or ring tensile test and of drift expanding test or ring expanding test is at the manufacturer's discretion.

^b For steel grades X10CrMoVNb9-1, X10CrWMoVNb9-2, X11CrMoWVNb9-1-1 and X20CrMoV11-1 tubes, the flattening or ring tensile test and the drift expanding test or ring expanding test shall be carried out at one end of 20 % of the tubes of each test unit.

^c **A)** Group A: tubes having wall thickness $T \geq 16$ mm manufactured from steel grades 14MoV6-3, 25CrMo4, 20CrMoV13-5-5, 15NiCuMoNb5-6-4, X10CrMoVNb9-1, 7CrWVMoNb9-6, 7CrMoVTiB10-10, X10CrWMoVNb9-2, X11CrMoWVNb9-1-1 and X20CrMoV11-1.

Group B: tubes having wall thickness $T < 16$ mm manufactured from steel grades 14MoV6-3, 25CrMo4, 20CrMoV13-5-5, 15NiCuMoNb5-6-4, X10CrMoVNb9-1, 7CrWVMoNb9-6, 7CrMoVTiB10-10, X10CrWMoVNb9-2, X11CrMoWVNb9-1-1 and X20CrMoV11-1 and all wall thicknesses manufactured from steel grades P195GH, P235GH, P265GH, 20MnNb6, 16Mo3, 8MoB5-4, 10CrMo5-5, 13CrMo4-5, 10CrMo9-10, 11CrMo9-10, X11CrMo5+I, X11CrMo5+NT1, X11CrMo5+NT2, X11CrMo9-1+I, X11CrMo9-1+NT. **A1**.

10 Sampling

10.1 Frequency of tests

10.1.1 Test unit

For normalized formed tubes, a test unit shall comprise tubes of the same specified diameter and wall thickness, the same steel grade, the same cast, the same manufacturing process.

For tubes which are furnace heat treated, a test unit shall comprise tubes of the same specified diameter and wall thickness, the same steel grade, the same cast, the same manufacturing process, subjected to the same finishing treatment in a continuous furnace or heat treated in the same furnace charge in a batch-type furnace.

The number of tubes per test unit shall conform to Table 14.

The manufacturing length (e.g. the rolled length after the normalizing forming process) may differ from the delivery length providing there is no additional HT after cutting the manufacturing lengths into individual lengths.

Table 14 — Number of tubes per test unit

Outside diameter D mm	Maximum number of tubes per test unit
$D \leq 114,3$	200
$114,3 < D \leq 323,9$	100
$D > 323,9$	50

10.1.2 Number of sample tubes per test unit

The following number of sample tubes shall be selected from each test unit:

- test category 1: one sample tube;
- test category 2: two sample tubes; when the total number of tubes is less than 20, only one sample tube.

10.2 Preparation of samples and test pieces

10.2.1 Selection and preparation of samples for product analysis

Samples for product analysis shall be taken from the test pieces or samples for mechanical testing or from the whole thickness of the tube at the same location as the mechanical test samples, in accordance with EN ISO 14284.

10.2.2 Location, orientation and preparation of samples and test pieces for mechanical test

10.2.2.1 General

Samples and test pieces shall be taken at the tube ends and in accordance with the requirements of EN ISO 377.

10.2.2.2 Test pieces for tensile tests

The test pieces for the tensile tests at room temperature shall be prepared in accordance with EN ISO 6892-1.

The test piece for the tensile tests at elevated temperature shall be prepared in accordance with EN ISO 6892-2.

At the manufacturer's discretion:

- for tubes with an outside diameter $D \leq 219,1$ mm, the test piece shall be either a full tube section or a strip section and shall be taken in a direction longitudinal to the axis of the tube;
- for tubes with an outside diameter $D > 219,1$ mm, the test piece shall either a machined test piece with circular cross section from an unflattened sample or a strip section and be taken in a direction either longitudinal or transverse to the axis of the tube.

10.2.2.3 Test pieces for flattening test, ring tensile test, drift expanding test and ring expanding test

The test pieces for the flattening test, ring tensile test, drift expanding test and the ring expanding test shall consist of a full tube section in accordance with EN ISO 8492, EN ISO 8496, EN ISO 8493 or EN ISO 8495 respectively.

10.2.2.4 Test pieces for impact test

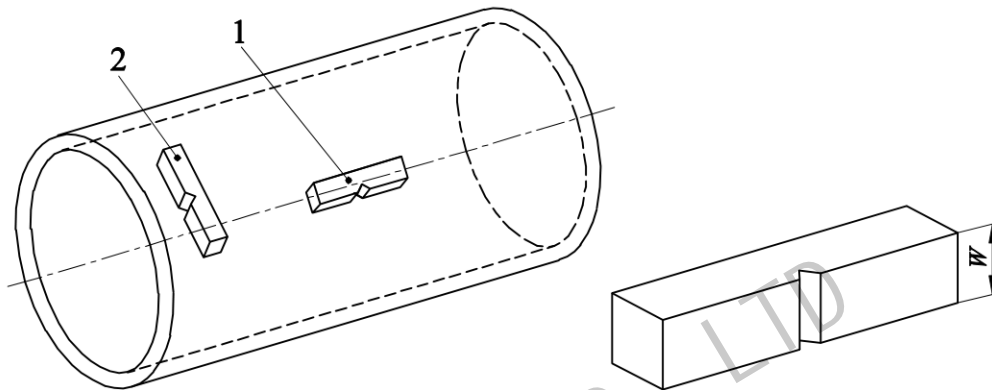
Three standard Charpy V-notch test pieces shall be prepared in accordance with EN ISO 148-1. If the wall thickness is such that standard test pieces cannot be produced without flattening of the section, then test pieces of width less than 10 mm, but not less than 5 mm shall be prepared; the largest obtainable width shall be used.

Where test pieces of least 5 mm width cannot be obtained, the tubes shall not be subjected to impact testing.

Unless otherwise specified (see Option 5), the test pieces shall be taken transverse to the tube axis unless D_{min} , as calculated by the following formula, is greater than the specified outside diameter, in which case longitudinal test pieces shall be used:

$$D_{min} = (T-5) + [756,25 / (T-5)] \quad (5)$$

The test pieces shall be prepared such that the axis of the notch is perpendicular to the surface of the tube; see Figure 2.



Key

- 1 longitudinal test piece
- 2 transverse test piece
- W width of test piece

Figure 1 — Impact test piece orientation

11 Verification test methods

11.1 Chemical analysis

The elements to be determined and reported shall be those specified in Table 2. The choice of a suitable physical or chemical analytical method for the analysis shall be at the discretion of the manufacturer. In case of dispute the method used shall be agreed between manufacturer and purchaser taking into account CEN/TR 10261.

11.2 Tensile test

11.2.1 Tensile test at room temperature

The test shall be carried out at room temperature in accordance with EN ISO 6892-1, and the following determined:

- the tensile strength (R_m);
- the upper yield strength (R_{eH}) or if a yield phenomenon is not present the 0,2 % proof strength ($R_{p0,2}$);
- the percentage elongation after fracture with a reference to a gauge length (L_0) of $5,65 \cdot \sqrt{S_0}$; if a non-proportional test piece is used, the percentage elongation value shall be converted to the value for a gauge length $L_0 = 5,65 \cdot \sqrt{S_0}$ using the conversion tables in EN ISO 2566-1.

11.2.2 Tensile test at elevated temperature

The test shall be carried out in accordance with EN ISO 6892-2 at the temperature agreed at the time of enquiry and order (see 6.2) and the proof strength ($R_{p0,2}$) shall be determined.

11.3 Flattening test

The test shall be carried out in accordance with EN ISO 8492.

The tube section shall be flattened in a press until the distance H between the platens reaches the value given by the following formula:

$$H = \frac{(1+C)}{C+(T/D)} \times T \quad (6)$$

where

H is the distance between platens, in millimetres, to be measured under load;

D is the specified outside diameter, in millimetres;

T is the specified wall thickness, in millimetres;

C is the constant factor of deformation (given in Table 15).

Table 15 — Flattening test - Constant factor of deformation C

Steel grade			Steel grade		
Steel name	Steel number	C	Steel name	Steel number	C
P195GH	1.0348	0,09	20CrMoV13-5-5	1.7779	0,05
P235GH	1.0345	0,09	15NiCuMoNb5-6-4	1.6368	0,05
P265GH	1.0425	0,07	7CrWVMoNb9-6	1.8201	0,05
20MnNb6	1.0471	0,07	7CrMoVTiB10-10	1.7378	0,05
16Mo3	1.5415	0,07	X11CrMo5+I	1.7362+I	0,05
8MoB5-4	1.5450	0,05	X11CrMo5+NT1	1.7362+NT1	0,05
14MoV63	1.7715	0,05	X11CrMo5+NT2	1.7362+NT2	0,05
10CrMo5-5	1.7338	0,08	X11CrMo9-1+I	1.7386+I	0,05
13CrMo4-5	1.7335	0,07	X11CrMo9-1+NT	1.7386+NT	0,05
10CrMo9-10	1.7380	0,07	X10CrMoVNb9-1	1.4903	0,05
11CrMo9-10	1.7383	0,07	X10CrWMoVNb9-2	1.4901	0,05
25CrMo4	1.7218	0,06	X11CrMoWVNb9-1-1	1.4905	0,05
			X20CrMoV11-1	1.4922	0,05

After testing, the test piece shall be free from cracks or breaks. However, slight incipient cracks at its edges shall not be regarded as justification for rejection.

When low D/T ratio tubular products are tested, because the strain imposed due to geometry is unreasonably high on the inside surface at the six and twelve o'clock locations, cracks at these locations shall not be cause for rejection if the D/T ratio is less than 10.

11.4 Ring tensile test

The test shall be carried out in accordance with EN ISO 8496.

The tube section shall be subjected to strain in the circumferential direction until fracture occurs.

After fracture the test pieces shall not show any visible cracks without the use of magnifying aids (excluding the fracture point).

11.5 Drift expanding test

The test shall be carried out in accordance with EN ISO 8493.

The tube section shall be expanded with a 60° conical tool until the percentage increase in outside diameter shown in Table 16 is reached.

Table 16 — Drift expanding test requirements

Steel grade		% increase in outside diameter for d/D ^a		
Steel name	Steel number	≤ 0,6	> 0,6 to ≤ 0,8	> 0,8
P195GH	1.0348	12	15	19
P235GH	1.0345	10	12	17
P265GH	1.0425	8	10	15
20MnNb6	1.0471	8	10	15
16Mo3	1.5415	8	10	15
8MoB5-4	1.5450	8	10	15
14MoV63	1.7715	8	10	15
10CrMo5-5	1.7338	8	10	15
13CrMo4-5	1.7335	8	10	15
10CrMo9-10	1.7380	8	10	15
11CrMo9-10	1.7383	8	10	15
25CrMo4	1.7218	6	8	12
20CrMoV13-5-5	1.7779	6	8	12
15NiCuMoNb5-6-4	1.6368	8	10	15
7CrWVMoNb9-6	1.8201	8	10	15
7CrMoVTiB10-10	1.7378	8	10	15
X11CrMo5+I	1.7362+I	8	10	15
X11CrMo5+NT1	1.7362+NT1	8	10	15
X11CrMo5+NT2	1.7362+NT2	8	10	15
X11CrMo9-1+I	1.7386+I	8	10	15
X11CrMo9-1+NT	1.7386+NT	8	10	15
X10CrMoVNb9-1	1.4903	8	10	15
X10CrWVMoNb9-2	1.4901	8	10	15
X11CrMoWVNb9-1-1	1.4905	8	10	15
X20CrMoV11-1	1.4922	6	8	12

^a $d = D - 2T$.

After testing, the test piece shall be free from cracks or breaks. However, slight incipient cracks at its edges shall not be regarded as justification for rejection.

11.6 Ring expanding test

The test shall be carried out in accordance with EN ISO 8495.

The tube section shall be expanded with a conical tool until it breaks. The surface outside the fracture zone shall be free from cracks or breaks. However, slight incipient cracks at its edges shall not be regarded as justification for rejection.

11.7 Impact test

11.7.1 The test shall be carried out (but see 10.2.2.4) in accordance with EN ISO 148-1 at the temperature given in Table 4.

11.7.2 The mean value of the three test pieces shall meet the requirements given in Table 4. One individual value may be below the specified value, provided that it is not less than 70 % of that value.

11.7.3 If the width (w) of the test piece is less than 10 mm, the measured impact energy (KV_p) shall be converted to the calculated impact energy (KV_c) using the following formula:

$$KV_c = \frac{10 \times KV_p}{w} \quad (7)$$

where

KV_c is the calculated impact energy, in joules;

KV_p is the measured impact energy, in joules;

w is the width of the test piece, in millimetres.

The calculated impact energy KV_c shall conform to the requirements given in 11.7.2.

11.7.4 If the requirements of 11.7.2 are not met, then an additional set of three test pieces may be taken at the discretion of the manufacturer from the same sample and tested. To consider the test unit as conforming, after testing the second set, the following conditions shall be satisfied simultaneously:

- the average value of the six tests shall be equal to or greater than the specified minimum average value;
- not more than two of the six individual values may be lower than the specified minimum average value;
- not more than one of the six individual values may be lower than 70 % of the specified minimum average value.

11.7.5 The dimensions in millimetres of the test pieces, the measured impact energy values and the resulting average value shall be reported.

11.8 Leak tightness test

11.8.1 Hydrostatic test

The hydrostatic test shall be carried out at a test pressure of 70 bar¹⁾ or at a test pressure P calculated using the following formula, whichever is lower:

$$P = 20 \frac{S \times T}{D} \quad (8)$$

where

P is the test pressure, in bar;

D is the specified outside diameter, in millimetres;

T is the specified wall thickness, in millimetres;

S is the stress, in MPa, corresponding to 70 % of the specified minimum yield strength (see Table 4) for the steel grade concerned.

The test pressure shall be held for not less than 5 s for tubes with an outside diameter D less than or equal to 457 mm and for not less than 10 s for tubes with an outside diameter D greater than 457 mm.

The tube shall withstand the test without showing leakage.

NOTE This hydrostatic leak-tightness test is not a strength test.

Option 14: A test pressure different from that specified in 11.8.1.

11.8.2 Electromagnetic test

The test shall be carried out in accordance with EN ISO 10893-1.

11.9 Dimensional inspection

Specified dimensions, including straightness, shall be verified.

The outside diameter shall be measured at tube ends. For tubes with outside diameter $D \geq 406,4$ mm, the diameter may be measured using a circumference tape.

Unless option 15 is specified, the wall thickness shall be measured at both tube ends.

Option 15: The wall thickness shall be measured away from the tube ends in accordance with an agreed procedure.

11.10 Visual examination

Tubes shall be visually examined to ensure conformity to the requirements of 8.4.1.

11.11 Non-destructive testing

11.11.1 Tubes of test category 2 shall be subjected to a Non-Destructive Testing for the detection of longitudinal imperfections, in accordance with EN ISO 10893-10, to acceptance level U2, sub-category C or EN ISO 10893-3 acceptance level F2.

Unless option 16 is specified, the selection of the test method is at the discretion of the manufacturer.

¹⁾ 1 bar = 100 kPa.

Option 16: *The test method is specified by the purchaser.*

Regions at the tube ends not automatically tested shall either be subjected to manual/semi-automatic ultrasonic testing in accordance with EN ISO 10893-10 to acceptance level U2, sub-category C or be cropped off.

11.11.2 If option 8 is specified (see 8.4.2.2), the tubes shall be subjected to ultrasonic testing for the detection of transverse imperfections in accordance with EN ISO 10893-10 to acceptance level U2, sub-category C.

11.11.3 If option 9 is specified (see 8.4.2.2), the tubes shall be subjected to ultrasonic testing for the detection of the laminar imperfections in accordance with EN ISO 10893-8 to acceptance level U2.

11.11.4 For tubes ordered by minimum wall thickness T_{\min} (see option 11), the acceptance level shall apply to the calculated wall thickness T_c as determined in accordance with the formula stated in 8.1.

11.12 Material identification

Each tube made from alloy steel (see 5.1) shall be tested by an appropriate method to ensure that the correct grade is being supplied.

11.13 Retests, sorting and reprocessing

For retest, sorting and reprocessing the requirements of EN 10021 shall apply.

12 Marking

12.1 Marking to be applied

The marking shall be indelibly marked on each tube at least at one end. For tubes with outside diameter $D \leq 51$ mm, the marking on tubes may be replaced by the marking on a label attached to the bundle or box.

The marking shall include the following information:

- the manufacturer's name or trade mark;
- the number of this European Standard and the steel name (see 5.2);
- the test category in case of non-alloy steel grades;
- the cast number or a code number;
- the mark of the inspection representative;
- an identification number (e.g. order or item number) which permits the correlation of the product or delivery unit to the related document.

Example of marking:

EXAMPLE X - EN 10216-2 - P265GH - TC1 - Y - Z₁ - Z₂

where

- X is the manufacturer's mark;
- TC1 is the designation of the test category 1;
- Y is the cast number or a code number;
- Z₁ is the mark of the inspection representative;

Z₂ is the identification number.

12.2 Additional marking

Option 17: Additional marking, as agreed upon at the time of enquiry and order, shall be applied.

13 Protection

The tubes shall be delivered without a temporary protective coating.

Option 18: A temporary protective coating or durable coating and/or lining shall be applied.

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Annex A
(informative)

Creep rupture strength values

The creep rupture strength values of steel grades covered by this Part of EN 10216 are given in Table A1.

Table A.1 — Creep rupture strength values (1 of 6)

Steel grade		Temperature °C	Creep rupture strength values for (MPa) ^{a b c d}			
Steel name	Steel number		10 000 h	100 000 h	200 000 h	250 000 h
P235GH P265GH	1.0345 1.0425	400	182	141	128	122
		410	166	128	115	109
		420	151	114	102	97
		430	138	100	89	86
		440	125	88	77	74
		450	112	77	66	64
		460	100	66	56	54
		470	88	56	46	44
		480	77	47	33	30
		490	67	39	26	--
		500	58	32	24	--
20MnNb6	1.0471	400	243	179	157*	150*
		410	221	157	135*	128*
		420	200	136	115*	108*
		430	180	117	97*	91*
		440	161	100	82*	77*
		450	143	85	70*	66*
		460	126	73	60*	56*
		470	110	63	52*	48*
		480	96	55	44*	41*
		490	84	47	37*	32*
		500	74	41	--	--
16Mo3	1.5415	450	298	236	218	210
		460	273	205	188	179
		470	247	176	158	148
		480	221	149	129	122
		490	196	124	105	98
		500	171	102	84	78
		510	148	83	67	63
		520	125	65	53	50
		530	104	51	42	38
		540	84	40	34	--
		550	64	32	25	--
14MoV6-3	1.7715	450	377	305	282	275
		460	349	276	255	247
		470	324	249	226	220
		480	298	224	202	195
		490	274	200	179	171
		500	249	177	158	150
		510	225	155	136	129
		520	203	135	117	110
		530	181	117	101	95
		540	162	102	86	82
		550	143	87	74	70
		560	126	75	63	59
		570	112	65	54	50
		580	97	58	47	43
590	85	48	40	37		
600	74	41	34	32		

Table A.1 (2 of 6)

Steel grade		Temperature °C	Creep rupture strength values for (MPa) ^{a b c d}			
Steel name	Steel number		10 000 h	100 000 h	200 000 h	250 000 h
10CrMo5-5	1.7338	450	377	290	264	257
13CrMo4-5	1.7335	460	347	258	233	225
		470	319	227	203	193
		480	292	198	175	164
		490	264	170	148	138
		500	238	145	123	114
		510	209	121	102	92
		520	181	100	82	73
		530	155	80	66	58
		540	131	65	51	46
		550	109	53	41	37
		560	90	44	35	31
		570	74	38	30	--
		580	60	31	25	--
		590	50	26	--	--
		600	41	20	--	--
10CrMo9-10	1.7380	450	308	229	204	196
		460	284	212	188	180
		470	261	194	172	165
		480	238	177	156	150
		490	216	160	140	134
		500	195	141	124	118
		510	176	124	108	103
		520	158	105	94	88
		530	142	95	80	76
		540	126	81	68	64
		550	111	70	57	54
		560	99	61	49	46
		570	88	53	43	40
		580	78	46	38	34
		590	69	40	33	30
		600	60	35	28	26
11CrMo9-10	1.7383	400	382	313		
		410	355	289		
		420	333	272		
		430	312	255		
		440	294	238		
		450	276	221		
		460	259	204		
		470	242	187		
		480	225	170		
		490	208	153		
		500	191	137		
		510	174	122		
		520	157	107		
20CrMoV13-5-5	1.7779	420	470	420		
		430	440	370		
		440	410	310		
		450	360	260		
		460	310	220		
		470	270	190		
		480	240	165		
		490	210	145		
		500	186	127		
		510	169	114		
		520	152	101		
		530	134	87		
		540	117	74		
		550	98	59		

Table A.1 (3 of 6)

Steel grade		Temperature °C	Creep rupture strength values for (MPa) ^{a b c d}			
Steel name	Steel number		10 000 h	100 000 h	200 000 h	250 000 h
15NiCuMoNb5-6-4	1.6368	400	402	373		
		410	385	349		
		420	368	325		
		430	348	300		
		440	328	273		
		450	304	245		
		460	274	210		
		470	242	175		
		480	212	139		
		490	179	104		
		500	147	69		
7CrWVMoNb9-6	1.8201	450				
		460				
		470				
		480	275	233*		
		490	260	219*		
		500	246	206*		
		510	232	193*		
		520	219	181*		
		530	206	169*		
		540	194	157*		
		550	182	145*		
		560	170	134*		
		570	159	122*		
580	148	110*				
590	137	97*				
600	125	79*				
7CrMoVTiB10-10	1.7378	450		378 ^e		
		460		342 ^e		
		470		311 ^e		
		480		281 ^e		
		490		257 ^e		
		500	278	240		
		510	262	222		
		520	247	205		
		530	231	187		
		540	214	170		
		550	198	152		
		560	181	134		
		570	165	117		
580	148	99				
590	130	82				
600	113	64				
X11CrMo5+I	1.7362+I	450	196	147	130	126
		460	180	133	118	114
		470	166	119	107	102
		480	152	108	96	90
		490	140	98	86	81
		500	128	89	76	72
		510	116	79	67	63
		520	105	69	58	55
		530	95	62	52	49
		540	85	55	46	43
		550	77	49	41	38
		560	69	44	36	34
		570	63	38	31	29
		580	58	34	27	25
		590	50	30	24	--
600	45	26	22	--		
610	41	24	--	--		
620	37	--	--	--		
630	33	--	--	--		

Table A.1 (4 of 6)

Steel grade		Temperature °C	Creep rupture strength values for (MPa) ^{a b c d}			
Steel name	Steel number		10 000 h	100 000 h	200 000 h	250 000 h
X11CrMo5+NT1	1.7362+NT1	450	--	270	237	226
X11CrMo5+NT2	1.7362+NT2	460	--	225	202	189
		470	242	188	170	159
		480	215	157	141	131
		490	188	131	116	108
		500	164	113	96	90
		510	145	96	80	75
		520	128	82	68	64
		530	113	70	58	54
		540	100	60	48	45
		550	88	50	40	37
		560	78	--	--	--
		570	69	--	--	--
		580	60	--	--	--
		590	53	--	--	--
		600	46	--	--	--
X11CrMo9-1+I	1.7386+I	460	275	190		
		470	240	170		
		480	210	150		
		490	190	130		
		500	170	115		
		510	152	102		
		520	134	89		
		530	118	78		
		540	104	67		
		550	90	58		
		560	78	49		
		570	68	42		
		580	60	37		
		590	53	33		
		600	48	30		
X11CrMo9-1+NT	1.7386+NT	450	335	276	259	
		460	308	253	236	
		470	284	231	215	
		480	261	211	196	
		490	239	192	177	
		500	219	174	160	
		510	200	156	142	
		520	182	139	126	
		530	164	123	111	
		540	148	107	95	
		550	132	92	80	
		560	117	78	67	
		570	102	66	55	
		580	89	55	45	
		590	77	45	37	
		600	65	37	32	
		610	55	31	27	
		620	47	27	24	
		630	40	24	--	
		640	34	21	--	
		650	30	--	--	

Table A.1 (5 of 6)

Steel grade		Temperature °C	Creep rupture strength values for (MPa) ^{a b c d}			
Steel name	Steel number		10 000 h	100 000 h	200 000 h	250 000 h
X10CrMoVNb9-1	1.4903	500	289	255	245*	
		510	270	236	225*	
		520	251	217	206*	
		530	234	199	188	
		540	216	182	170	
		550	200	164	153	
		560	183	148	136	
		570	167	132	121	
		580	152	117	106	
		590	137	103	93	
		600	122	90	81	
		610	109	79	71	
		620	97	70	63	
		630	86	62	56*	
		640	76	55	49*	
		650	68	48	43*	
		660	61	42	36*	
670	54	36	---			
X10CrWMoVNb9-2	1.4901	520	272*	235*		
		530	256	218*		
		540	240	202*		
		550	225	187*		
		560	210	172*		
		570	195	157*		
		580	181	142	129*	
		590	167	127	115*	
		600	153	113	101*	
		610	139	100	88*	
		620	126	87	76*	
630	113	75	65*			
640	100	65	56*			
650	88	56	48*			
X11CrMoWVNb9-1-1	1.4905	520	252	220*		
		530	237	204*		
		540	222	188*		
		550	208	173*		
		560	194	157*		
		570	180	142*		
		580	166	126	113*	
		590	152	111	98*	
		600	139	98	86*	
		610	125	85	75*	
		620	111	75	65*	
		630	99	65*	56*	
		640	88	56*		
650	78					

Table A.1 (6 of 6)

Steel grade		Temperature °C	Creep rupture strength values for (MPa) ^{a b c d}			
Steel name	Steel number		10 000 h	100 000 h	200 000 h	250 000 h
X20CrMoV11-1	1.4922	480	348	289	270	
		490	319	263	242	
		500	292	236	218	
		510	269	212	194	
		520	247	188	170	
		530	225	167	149	
		540	205	147	129	
		550	184	128	112	
		560	165	111	96	
		570	147	95	81	
		580	130	81	68	
		590	113	69	58	
		600	97	59	49	
		610	84	51	42	
		620	72	43	36	
		630	61	36	30	
		640	52	31	--	
650	44	26	--			

^a The values listed in the table are values suggested by ECC3 (1) and are average values from scatter range determined from existing data which will be assessed from time to time after test results are available and corrected if necessary. The values for the steel grade X10CrMoVNb9-1 has been obtained by new evaluation. For the remaining steel grades, the values were obtained from creep rupture strength values given in national and international standards.

^b The creep rupture strength values given up to the elevated temperature listed in the table, do not mean that the steels can be used in continuous duty up to the these temperatures. A governing factor is the total stress during operation.

^c For the creep rupture strength values indicated in the table, the extrapolation times are always less than a factor of three unless indicated by an asterisk (*).

^d 1 MPa = 1 N/mm².

^e Italic printed values for grade 7CrMoVTiNb10-10 have been extrapolated graphically in order to determine the intersection with R_{p0,2} values.

Annex B (informative)

Technical changes from the previous edition

B.1 Introduction

This informative annex is intended to guide the user to places where significant technical changes have been introduced into the previous edition of this European Standard. Editorial changes are not included in this annex. References refer to the previous edition.

While this annex is intended to be comprehensive, the user should satisfy himself that he fully understands the changes which have been made. The user is ultimately responsible for recognizing any differences between this edition and the previous edition of the document.

B.2 Technical changes

- 1 Scope
- 2 Normative references
- 6 Information to be supplied by the purchaser
 - 6.2 Options [4), 5), 6), 7) and 13)]
 - 6.3 Example of an order
- 7 manufacturing process
 - 7.1 Steel making process
- 8 Requirements
 - 8.2 Chemical composition (Table 2 and Table 3)
 - 8.3 Mechanical properties (8.3.1 and Table 4)
 - 8.6 Preparation of ends
- 9 Inspections
 - 9.1 Types of inspections
 - 9.2 Inspection documents (9.2.1)
- 10 Sampling
 - 10.1 Frequency of tests (10.1.1)
- 11 Verification test methods
 - 11.8 Leak tightness test (11.8.1)
- Annex A

Annex ZA (informative)

Relationship between this European Standard and the Essential Requirements of Directive 2014/68/EU aimed to be covered


This European Standard has been prepared under a Commission's standardization request "M/071" to provide one voluntary means of conforming to Essential Requirements of Directive 2014/68/EU.

Once this standard is cited in the Official Journal of the European Union under that Directive, compliance with the normative clauses of this standard given in Table ZA.1 confers, within the limits of the scope of this standard, a presumption of conformity with the corresponding essential requirements of that Directive, and associated EFTA regulations.

Table ZA.1 — Correspondence between this European Standard and Annex I of Directive 2014/68/EU

Essential Requirements of Directive 2014/68/EU	Clauses/subclauses of this EN	Remarks/Notes
4.1 a	8.3	Appropriate material properties
4.1 c	7.1	Ageing
4.1 d	7.2 and 8.4	Suitable for the processing procedures
4.3	9 and 10	Inspection Documentation

WARNING 1 — Presumption of conformity stays valid only as long as a reference to this European Standard is maintained in the list published in the Official Journal of the European Union. Users of this standard should consult frequently the latest list published in the Official Journal of the European Union.

WARNING 2 — Other Union legislation may be applicable to the product(s) falling within the scope of this standard. 

Bibliography

- [1] EN ISO 9712, *Non-destructive testing - Qualification and certification of NDT personnel (ISO 9712)*

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