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# EN 10217-2

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English Version

# Welded steel tubes for pressure purposes - Technical delivery conditions - Part 2: Electric welded non-alloy and alloy steel tubes with specified elevated temperature properties

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

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

This European Standard was approved by CEN on 25 February 2019.

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 CEN-CENELEC Management Centre 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 CEN-CENELEC Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and United Kingdom.



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

**CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels**



Ref. No. EN 10217-2:2019 E

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## European foreword

This document (EN 10217-2:2019) has been prepared by Technical Committee CEN/TC 459 "ECISS - European Committee for Iron and Steel Standardization"[1], 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 October 2019, and conflicting national standards shall be withdrawn at the latest by October 2019.

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 supersedes EN 10217-2:2002.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports the essential requirements of EU Directive 2014/68/EU.

For relationship with EU Directive 2014/68/EU (formerly 97/23/EC), see informative Annex ZA, which is an integral part of this document.

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

— *Part 1: Electric welded and submerged arc welded non-alloy steel tubes with specified room temperature properties*

— *Part 2: Electric welded non-alloy and alloy steel tubes with specified elevated temperature properties*

— *Part 3: Electric welded and submerged arc welded alloy fine grain steel tubes with specified room, elevated and low temperature properties*

— *Part 4: Electric welded non-alloy steel tubes with specified low temperature properties*

— *Part 5: Submerged arc welded non-alloy and alloy steel tubes with specified elevated temperature properties*

— *Part 6: Submerged arc welded non-alloy steel tubes with specified low temperature properties*

— *Part 7: Stainless steel tubes*

Another European Standard series covering tubes for pressure purposes is:

EN 10216, *Seamless steel tubes for pressure purposes.*

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, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

[1] Through its subcommittee SC 10 "Steel tubes, and iron and steel fittings" (secretariat: UNI)

# 1 Scope

This document specifies the technical delivery conditions for two test categories of electric welded tubes of circular cross section, with specified elevated temperature properties, made from non-alloy quality steel or alloy special steel.

NOTE 1 These tube grades are intended to support the essential requirements of EU Directive 2014/68/EU in respect of pressure equipment with specified elevated temperature properties, covered under all relevant Categories as set out in Article 13 of that Directive.

NOTE 2 Once this standard is published in the Official Journal of the European Union (OJEU), presumption of conformity to the Essential Safety Requirements (ESR) of Directive 2014/68/EU is limited to the technical data for the materials in this standard and does not presume adequacy of the material for a specific item of pressure equipment. Consequently, the assessment of the technical data stated in this material standard against the design requirements of a 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 any subsequent processing procedures which may affect properties of the base materials.

# 2 Normative references

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

EN 10020, *Definition and classification of grades of steel*

EN 10021:2006, *General technical delivery conditions 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*

CEN/TR 10261, *Iron and steel — European standards for the determination of chemical composition*

EN 10266, *Steel tubes, fittings and structural hollow sections — Symbols and definitions of terms for use in product standards*

EN ISO 148-1:2016, *Metallic materials — Charpy pendulum impact test — Part 1: Test method (ISO 148-1:2016)*

EN ISO 377:2017, *Steel and steel products - Location and preparation of samples and test pieces for mechanical testing (ISO 377:2017)*

EN ISO 2566-1:1999, *Steel — Conversion of elongation values — Part 1: Carbon and low alloy steels (ISO 2566-1:1984)*

EN ISO 4885, *Ferrous materials — Heat treatments — Vocabulary (ISO 4885)*

EN ISO 6892-1:2016, *Metallic materials — Tensile testing — Part 1: Method of test at room temperature (ISO 6892-1:2016)*

EN ISO 6892-2:2018, *Metallic materials — Tensile testing — Part 2: Method of test at elevated temperature (ISO 6892-2:2018)*

EN ISO 8492:2013, *Metallic materials — Tube — Flattening test (ISO 8492:2013)*

EN ISO 8493:2004, *Metallic materials — Tube — Drift-expanding test (ISO 8493:1998)*

EN ISO 8495:2013, *Metallic materials — Tube — Ring-expanding test (ISO 8495:2013)*

EN ISO 8496:2013, *Metallic materials — Tube — Ring tensile test (ISO 8496:2013)*

EN ISO 10893-1:2011, *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 leaktightness (ISO 10893-1:2011)*

EN ISO 10893-2:2011, *Non-destructive testing of steel tubes — Part 2: Automated eddy current testing of seamless and welded (except submerged arc-welded) steel tubes for the detection of imperfections (ISO 10893-2:2011)*

EN ISO 10893-3:2011, *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 10893-3:2011)*

EN ISO 10893-8:2011, *Non-destructive testing of steel tubes — Part 8: Automated ultrasonic testing of seamless and welded steel tubes for the detection of laminar imperfections (ISO 10893-8:2011)*

EN ISO 10893-10:2011, *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 10893-10:2011)*

EN ISO 10893-11:2011, *Non-destructive testing of steel tubes — Part 11: Automated ultrasonic testing of the weld seam of welded steel tubes for the detection of longitudinal and/or transverse imperfections (ISO 10893-11:2011)*

EN ISO 14284, *Steel and iron — Sampling and preparation of samples for the determination of chemical composition (ISO 14284)*

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, EN 10266, EN ISO 4885 and the following apply.

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

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

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

**3.1**
**test category**
classification that indicates the extent and level of inspection and testing

**3.2**
**employer**
organisation for which a person works on a regular basis

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

**3.3**
**EW**
**electric welded tube**
tubular product having one longitudinal seam weld produced by electric (resistance) welding where the strip edges to be welded are mechanically pressed together and the heat for the welding process is generated by the resistance to flow of low or high frequency electric current applied by either a conduction or induction process

**3.4**
**HFW**
**high frequency welded tube**
EW tube produced specifically using a welding current frequency equal to or greater than 100 kHz

# 4 Symbols

For the purposes of this document, the symbols given in EN 10266 apply.

# 5 Classification and designation

## 5.1 Classification

In accordance with the classification system in EN 10020, the steel grades P195GH, P235GH and P265GH in this standard are classified as non-alloy quality steels and the steel grade 16Mo3 is classified as an alloy special steel.

## 5.2 Designation

**5.2.1** For the tubes covered by this document, the steel designation consists of:

— the number of this European Standard, e.g. EN 10217-2;

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 thickness *T* 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 grade 16Mo3 is designated by the chemical composition (see Table 2).

# 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, total length or number of tubes of set length);

b) the term ‘tube’ and tube type, HFW;

c) the dimensions (outside diameter $D$ and wall thickness $T$) (see Table 6);

d) the random length range (see 8.7.3).

e) for tubes with a $D/T > 100$, out of roundness limits (see 8.7.4.4).

f) the designation of the steel grade in accordance with this document (see 5.2);

g) the test category for non-alloy steel (see 9.3).

## 6.2 Options

A number of options are specified in this document 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) Tube manufacturing route (see 7.2.1);

2) Restriction on copper and tin content (see Table 2);

3) Product analysis (see 8.2.2);

4) Verification of tube body impact energy (see 8.3);

5) Additional longitudinal impact test at −10°C for non-alloy steel grades (see Table 4);

6) Verification of proof strength $R_{p0,2}$ at elevated temperature (see 8.3);

7) Selection of method for verification of leak-tightness test (see 8.4.3.1);

8) Non-Destructive Testing of test category 2 tubes for the detection of transverse imperfections (see 8.4.3.2);

9) Non-Destructive Testing of test category 2 tubes for the detection of laminar imperfections (see 8.4.3.2);

10) Special end preparation (see 8.6);

11) Exact lengths (see 8.7.3);

12) Inspection document 3.2 in place of the standard 3.1 inspection certificate (see 9.2.1);

13) Verification of tensile strength of the weld in the transverse direction for tubes of outside diameter $D > 219{,}1$ mm (see Table 10);

14) Agreement of a different test pressure for hydrostatic leak-tightness test (see 11.9.1);

15) Wall thickness measurement away from the ends (see 11.10);

16) Selection of the Non-Destructive Testing method for the inspection of the weld seam of test category 1 tubes (see 11.12.1);

17) Selection of the Non-Destructive Testing method for the full peripheral inspection of test category 2 tubes (see 11.12.2);

18) Additional marking (see 12.2);

19) Protection (see Clause 13).

### 6.3 Example of an order

500 m of HFW tube with an outside diameter of 168,3 mm, a wall thickness of 4,5 mm in accordance with EN 10217-2, made of steel grade P265GH, test category 1, in 6 m random lengths, with a 3.2 inspection certificate in accordance with EN 10204:

500 m – HFW Tube - 168,3 × 4,5 - EN 10217–2 — P265GH - TC 1 - 6m - Option 12: 3.2

## 7 Manufacturing process

### 7.1 Steelmaking process

The steelmaking process is at the discretion of the steel or tube manufacturer with the exception that steel produced by 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 and contain nitrogen binding elements, details of which shall be reported.

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

### 7.2 Tube manufacture and delivery conditions

**7.2.1** The tubes shall be manufactured by an electric welding process employing high frequency welding (HFW), of minimum frequency 100 kHz in accordance with one of the manufacturing routes specified in Table 1.

Unless Option 1 is specified the manufacturing route is at the discretion of the manufacturer.

***Option 1:*** *The manufacturing route from Table 1 is specified by the purchaser.*

The finished tubes shall not include the welds used to join together the lengths of strip prior to forming.

**7.2.2** Tube production welding shall be carried out by qualified personnel in accordance with documented procedures. For tubes to be used in pressure equipment under European legislation, manufacturers shall employ an established procedure for the approval of welding operatives.

The production (welding) process shall be qualified and approved under the tube manufacturer's own QA system. Only HFW tubes (see 3.4) shall be supplied for pressure equipment under European legislation.

**7.2.3** The delivery conditions of tubes covered by this document are shown in Table 1.

**Table 1 — Tube manufacturing route and delivery condition**

| Route N° (according to Part 1) | Manufacturing routes | | Acceptable delivery condition a |
|---|---|---|---|
| | Starting material | Forming operation | |
| 1c | As (hot) rolled strip | Cold formed and welded | NP |
| 1d | | | NR |
| 2b | Normalized rolled strip | | NW |
| 2c | | | NP |
| 2d | | | NR |

a NP = tube full body normalized; NW = normalized weld zone; NR = normalized rolled or hot (stretch) reduced within the normalizing temperature range.

### 7.3 Non Destructive Testing Personnel Requirements

**7.3.1** All NDT activities shall be carried out by qualified and competent level 1, 2 and/or 3 personnel, authorized to carry out this work by the employer.

**7.3.2** The qualification for levels 1 and 2 personnel shall be in accordance with ISO 11484 or, at least, an equivalent to it.

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

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

**7.3.5** All NDT operations shall be authorised by a level 3 NDT technician approved by the employer.

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

## 8 Requirements

### 8.1 General

The tubes shall conform to the requirements of this document when supplied in a delivery condition in accordance with Table 1 and inspected in accordance with the specified requirements in Table 10.

Tubes shall be suitable for hot and cold bending.

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

### 8.2 Chemical composition

#### 8.2.1 Cast analysis

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

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

**Table 2 — Chemical composition (cast analysis) [a] in % by mass**

| Steel grade | | C | Si | Mn | P | S | Cr | Mo | Ni | Al tot | Cu [b] | Nb [d] | Ti [d] | V [d] | Cr+Cu+Mo+Ni |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Steel name | Steel number | | max. | | max. | max. | max. | | max. | | max. | max. | max. | max. | max. |
| P195GH | 1.0348 | ≤ 0,13 | 0,35 | ≤ 0,70 | 0,025 | 0,020 | 0,30 | ≤ 0,08 | 0,30 | ≥ 0,020 [c] | 0,30 | 0,010 | 0,03 | 0,02 | 0,70 |
| P235GH | 1.0345 | ≤ 0,16 | 0,35 | ≤ 1,20 | 0,025 | 0,020 | 0,30 | ≤ 0,08 | 0,30 | ≥ 0,020 [c] | 0,30 | 0,010 | 0,03 | 0,02 | 0,70 |
| P265GH | 1.0425 | ≤ 0,20 | 0,40 | ≤ 1,40 | 0,025 | 0,020 | 0,30 | ≤ 0,08 | 0,30 | ≥ 0,020 [c] | 0,30 | 0,010 | 0,03 | 0,02 | 0,70 |
| 16Mo3 | 1.5415 | 0,12 to 0,20 | 0,35 | 0,40 to 0,90 | 0,025 | 0,020 | 0,30 | 0,25 to 0,35 | 0,30 | ≤ 0,040 | 0,30 | - | - | - | - |

[a] Elements not quoted 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, which would have a negative impact on the mechanical properties, ageing and the suitability of the material.

[b] ***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;*

[c] For Al/N ratios ≥ 2, if nitrogen is fixed by niobium, titanium or vanadium, details of which shall be reported, this requirement does not apply except that when using titanium, the steel producer shall verify that (Al+Ti/2) ≥ 0,020%;

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

### 8.2.2 Product analysis

Unless Option 3 is specified, only the cast analysis shall be reported.

***Option 3:*** *A 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.

**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<br>% by mass | Permissible deviation of the product analysis<br>% by mass |
|---|---|---|
| C | ≤ 0,20 | + 0,02 |
| Si | ≤ 0,40 | + 0,05 |
| Mn | ≤ 1,00 | + 0,05 |
| | > 1,00 to ≤ 1,40 | ± 0,10 |
| P | ≤ 0,025 | + 0,005 |
| S | ≤ 0,020 | + 0,005 |
| Cr | ≤ 0,30 | + 0,05 |
| Mo | ≤ 0,35 | + 0,03 |
| Ni | ≤ 0,30 | + 0,05 |
| Al | ≤ 0,040 | + 0,005 |
| Cu | ≤ 0,30 | + 0,05 |
| Nb | ≤ 0,010 | + 0,005 |
| Ti | ≤ 0,030 | + 0,010 |
| V | ≤ 0,02 | + 0,01 |
| Cr + Cu + Mo + Ni | ≤ 0,70 | + 0, 05 |



## 8.3 Mechanical properties

The mechanical properties of the tubes, in a specified delivery condition from Table 1, shall conform to the requirements of Table 4 and the relevant additional tests specified in 11.3 to 11.7, irrespective of whether the test results are actually verified or not (see Table 10 for a summary of the inspection and verification testing required).

Unless Option 4 is specified, the impact properties need not be verified.

***Option 4:*** *The tube body impact properties shall be verified (see 10.2.2.5 and 11.8).*

**Table 4 — Mechanical properties for wall thickness $T \leq 16$ mm**

| Steel grade | | Tensile properties at room temperature | | | | Impact properties [b] | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Steel name | Steel number | Upper yield strength or proof strength $R_{eH}$ or $R_{p0,2}$ [a] min. MPa | Tensile strength $R_m$ MPa | Elongation [a c] $A$ min. % | | Minimum average absorbed energy [c] $KV_2$ [d] J at a temperature of °C | | | | |
| | | | | | | l | | | t | |
| | | | | l | t | 20 | 0 | −10 | 20 | 0 |
| P195GH | 1.0348 | 195 | 320 – 440 | 27 | 25 | - | 40 | 28 [e] | - | 27 |
| P235GH | 1.0345 | 235 | 360 – 500 | 25 | 23 | - | 40 | 28 [e] | - | 27 |
| P265GH | 1.0425 | 265 | 410 – 570 | 23 | 21 | - | 40 | 28 [e] | - | 27 |
| 16Mo3 | 1.5415 | 280 | 450 – 600 | 22 | 20 | 40 | - | - | 27 | - |

[a] See 11.2.1

[b] To be verified only when Options 4 and/or 5 are specified

[c] l = longitudinal t = transverse

[d] $KV_2$ = impact values obtained using a 2 mm radius striker in accordance with EN ISO 148-1

[e] ***Option 5:*** *In addition to the specified impact test at 0 °C, an additional longitudinal impact test shall be performed at −10 °C.*

The minimum proof strength $R_{p0,2}$ values of the tube grades at elevated temperature are given in Table 5. These need not be verified, unless Option 6 is specified.

***Option 6:*** *Proof strength $R_{p0,2}$ at elevated temperature shall be verified. The test temperature from Table 5 shall be agreed at the time of enquiry and order.*

The manufacturer shall have data available to demonstrate that their products are capable of achieving the minimum elevated temperature properties shown.

**Table 5 — Minimum 0,2% proof strength ($R_{p0,2}$) at elevated temperature for wall thickness $T \leq 16$ mm**

| Steel grade | | $R_{p0,2}$ min. MPa at a temperature of °C | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Steel name | Steel number | 100 | 150 | 200 | 250 | 300 | 350 | 400 |
| P195GH | 1.0348 | 175 | 165 | 150 | 130 | 113 | 102 | 94 |
| P235GH | 1.0345 | 198 | 187 | 170 | 150 | 132 | 120 | 112 |
| P265GH | 1.0425 | 226 | 213 | 192 | 171 | 154 | 141 | 134 |
| 16Mo3 | 1.5415 | 243 | 237 | 224 | 205 | 173 | 159 | 156 |

## 8.4 Appearance and internal soundness

### 8.4.1 Weld seam

The weld area shall be free from cracks and lack of fusion. Repairs to the weld seam of HFW tubes are not permitted.

NOTE For strip alignment (radial offset) and tolerances in the weld region, see 8.7.4.2.

### 8.4.2 Tube surface

**8.4.2.1** The tubes shall be free from external and internal surface defects that can be detected by visual examination of the surfaces that are accessible without the use of special equipment.

**8.4.2.2** 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.

**8.4.2.3** 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.

**8.4.2.4** 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.

**8.4.2.5** Surface imperfections which extend below the specified minimum wall thickness shall be considered defects and tubes containing these shall be deemed not to conform with this document and shall be rejected.

### 8.4.3 Internal soundness

#### 8.4.3.1 Leak-tightness

The tubes shall be assessed for leak tightness by either a hydrostatic test (see 11.9.1) or an electromagnetic test (see 11.9.2).

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 11.9.1 or 11.9.2 is specified by the purchaser.*

#### 8.4.3.2 Non-Destructive Testing

The full length of the weld seam of tubes of test category 1 shall be subjected to Non-Destructive Testing for the detection of imperfections in accordance with 11.12.1.

The full length of the weld seam and the body of tubes of test category 2 shall be subjected to Non-Destructive Testing for the detection of longitudinal imperfections, in accordance with 11.12.2.

For test category 2 tubes, if Options 8 or 9 are specified, the following additional NDT testing shall also be applied.

***Option 8:*** *The tubes of test category 2 shall be subjected to Non-Destructive Testing for the detection of transverse imperfections in accordance with 11.12.3.*

***Option 9:*** *The tubes of test category 2 shall be subjected to Non-Destructive Testing for the detection of laminar imperfections in accordance with 11.12.4.*

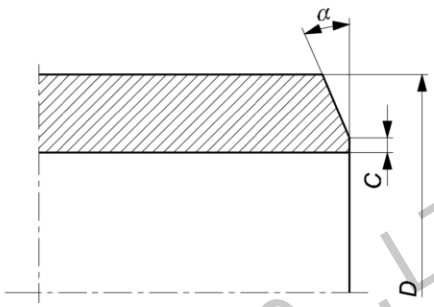
## 8.5 Straightness

The deviation from straightness of any tube length *L* shall not exceed 0,001 5 *L*. Deviations from straightness over any one metre length shall not exceed 3 mm.

## 8.6 Preparation of ends

Unless Option 10 is specified, tubes shall be delivered with square cut ends 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° $^{+5°}_{0°}$ with a root face C of 1,6 mm ± 0,8 mm. Bevelling is applicable for specified wall thicknesses ≥ 3,2 mm, except that for wall thickness T ≥ than 20 mm, an agreed alternative bevel may be specified.*




**Key**

$D$ outside diameter

$\alpha$ 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

Tubes shall be delivered by outside diameter $D$ and wall thickness $T$.

The preferred outside diameters $D$ and wall thicknesses $T$ have mainly been selected from EN 10220 and are given in Table 6.

NOTE Dimensions other than those in Table 6 may be agreed.

## Table 6 — Preferred dimensions

Dimensions in millimetres

| Outside diameter *D* Series [a] | | | Wall thicknesses, *T* | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 1,4 | 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 | 16 |
| 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 | | | | | | | | | | | | | | | | | | | | | | | |

| Outside diameter *D* Series [a] | | | Wall thicknesses, *T* | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 1,4 | 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 | 16 |
| 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 | | | | | | | | | | | | | | | | | | | | | | |
| | 165,1 | | | | | | | | | | | | | | | | | | | | | | | |
| 168,3 | | | | | | | | | | | | | | | | | | | | | | | | |
| | | 177,8 | | | | | | | | | | | | | | | | | | | | | | |

| Outside diameter *D* Series [a] | | | Wall thicknesses, *T* | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 1,4 | 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 | 16 |
| | | 193,7 | | | | | | | | | | | | | | | | | | | | | | |
| 219,1 | | | | | | | | | | | | | | | | | | | | | | | | |
| | | 244,5 | | | | | | | | | | | | | | | | | | | | | | |
| 273 | | | | | | | | | | | | | | | | | | | | | | | | |
| 323,9 | | | | | | | | | | | | | | | | | | | | | | | | |
| 355,6 | | | | | | | | | | | | | | | | | | | | | | | | |
| 406,4 | | | | | | | | | | | | | | | | | | | | | | | | |
| 457 | | | | | | | | | | | | | | | | | | | | | | | | |
| 508 | | | | | | | | | | | | | | | | | | | | | | | | |
| 610 | | | | | | | | | | | | | | | | | | | | | | | | |

[a] series 1 = diameters for which all the accessories needed for the construction of piping systems are standardised;
series 2 = diameters for which not all the accessories are standardised;
series 3 = diameters for special applications for which very few standardised accessories exist.

### 8.7.2 Mass

For the mass per unit length the provisions of EN 10220 apply.

### 8.7.3 Lengths

Unless Option 11 is specified, the tubes shall be delivered in random lengths. The delivery range shall be agreed at the time of enquiry and order.

***Option 11:*** *The tubes shall be delivered in exact lengths, the length to be specified at the time of enquiry and order. For tolerances on exact lengths see 8.7.4.3.*

### 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 tolerance limits given in Table 7.

**Table 7 — Tolerances on outside diameter and wall thickness**

Dimensions in millimetres

| Outside diameter *D* | Tolerance on outside diameter | Tolerance on wall thickness [a] | |
|---|---|---|---|
| | | $T \leq 5$ | $5 < T \leq 16$ |
| ≤ 219,1 | ± 1 % or ± 0,5 whichever is the greater | ± 10 % or ± 0,3 whichever is the greater | ± 8 % |
| > 219,1 | ± 0,75 % | | |

[a] The plus tolerance excludes the weld area (see 8.7.4.2).

#### 8.7.4.2 Height of the weld seam

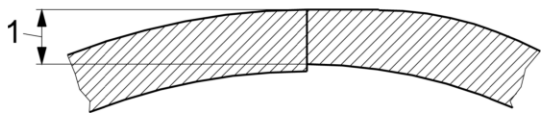
The height of the external and internal weld beads shall be within the limits indicated in Table 8.

**Table 8 — Maximum height of the weld bead**

Dimensions in millimetres

| Outside | Inside |
|---|---|
| Trimmed Flush | Trimmed or 0,5 + 0,05 *T* |

The radial offset of the strip edges after trimming, see Figure 2, shall not cause the remaining wall thickness to be less than the minimum set out in Table 7.




**Key**

1 remaining wall thickness at the weld

**Figure 2 — Radial offset of the strip edges (HFW tube)**

#### 8.7.4.3 Tolerances on exact length

The tolerances for exact lengths shall be as given in Table 9.

**Table 9 — Tolerances on exact length**

Dimensions in millimetres

| Length range *L* | Tolerance for outside diameter (*D*) | |
|---|---|---|
| | < 406,4 | ≥ 406,4 |
| $L \leq 6\,000$ | + 10<br>0 | + 25<br>0 |
| $6\,000 < L \leq 12\,000$ | + 15<br>0 | + 50<br>0 |
| $L > 12\,000$ | + by agreement<br>0 | |

#### 8.7.4.4 Out-of-roundness

The out-of-roundness $O$ shall be calculated using the following Formula (1):

$$O = \frac{D_{\max} - D_{\min}}{D} \times 100 \quad (1)$$

where

$O$ is the out-of-roundness in %;

$D$ is the specified outside diameter in mm;

$D_{\max}$, $D_{\min}$ is the maximum and minimum outside diameter measured in the same plane in mm.

For tubes of $D \leq 406{,}4$ mm, out-of-roundness shall be included in the limits of the diameter tolerances.

For tubes of $D > 406{,}4$ mm and with $D/T \leq 100$, out-of-roundness shall not exceed 2 %.

For tubes with a $D/T$ ratio > 100 the values for out-of-roundness shall be agreed at the time of enquiry and order.

## 9 Inspection

### 9.1 Type of inspection

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

### 9.2 Inspection documents

#### 9.2.1 Types of inspection documents

Unless Option 12 is specified an inspection certificate 3.1 in accordance with EN 10204 shall be issued. The tube manufacturer shall confirm in this whether they are operating according to a "quality assurance system", certified by a competent body established within the community, and have undergone a specific assessment for materials and processes relevant to the manufacture of welded tubes (see 7.2.2 and NOTE below).

***Option 12****: An inspection certificate 3.2 in accordance with* EN 10204 *shall be issued.*

When an inspection certificate 3.2 is specified, this shall be prepared by the manufacturer's authorized representative(s). The purchaser shall notify the manufacturer of the name and address of the organization or person that will carry out the inspection and confirm who will validate and issue the inspection document.

### 9.2.2 Content of inspection documents

**9.2.2.1** The content of the inspection document shall be in accordance with EN 10168 as shown in 9.2.2.2. The inspection documents shall include a statement confirming the conformity of the products to the requirements of this specification and to the order.

**9.2.2.2** 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;
- C01-C03 location of the samples, direction of the test pieces and testing temperature;
- C10-C13 tensile test(s);
- C40-C43 impact test results if verified;
- C50-C69 other mechanical tests (e.g. flattening, ring tensile, drift or ring expanding);
- C71-C92 cast analysis reported by the steel producer and product analysis, if applicable;
- D01 statement that marking and identification, surface appearance, shape and dimensional properties are satisfactory;
- D02-D99 statement confirming that leak tightness test and applicable NDT testing has been carried out, and the test results are satisfactory;
- Z validation.

- Reference to specific assessment under pressure equipment European legislation for materials and processes relevant to manufacture of welded tubes;
- Reference to welding process approval, where applicable;
- Reference to non-destructive testing operators approval, where applicable;
- In addition, where applicable, the manufacturer shall make reference to any certification of his "quality assurance system" by a competent body established within the community, see 9.2.1.

## 9.3 Summary of inspection and testing

Inspection and testing shall be carried out as stated in Table 10.

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 enquiry and order (see 6.1).

Tubes of steel grade 16Mo3 shall be inspected and tested in accordance with test category 2.

**Table 10 — Summary of inspection and verification testing**

| Type of inspection and test | | Frequency of testing | Refer to | Test category | |
|---|---|---|---|---|---|
| | | | | 1 | 2 |
| Mandatory Tests | Cast analysis (reported by steel producer) | One per cast | 8.2.1 and 11.1 | X | X |
| | Tensile test on tube body at room temperature | One test per sample tube | 8.3, 10.2.2.2 and 11.2.1 | X | X |
| | Flattening test for ***D*** < 600 mm and *T/D* ratio ≤ 0,15 but *T* ≤ 40 mm<br>or [b]<br>Ring tensile test for ***D*** > 150 mm and *T* ≤40 mm | Two tests per sample tube [a]<br>or<br>One test per sample tube | 8.3, 10.2.2.4, 11.4 and 11.5 | X | X |
| | Drift expanding test for ***D*** ≤ 150 mm and *T* ≤ 10 mm<br>or [b]<br>Ring expanding test for ***D*** ≤ 114,3 mm and *T* ≤ 12,5 mm | One test per sample tube | 8.3, 10.2.2.4, 11.6 and 11.7 | X | X |
| | Leak tightness test [c] (see ***Options 7 and 14***) | Each tube | 8.4.3.1 and 11.9 | X | X |
| | Dimensional inspection | | 11.10 | X | X |
| | Visual examination | | 11.11 | X | X |
| | NDT on the weld for the detection of longitudinal imperfections | | 8.4.3.2 and 11.12.1 | X | - |
| | NDT on the tube body and on the weld for the detection of longitudinal imperfections | | 8.4.3.2 and 11.12.2 | - | X |
| | Material identification check for steel grade 16Mo3 | One tube per test unit | 11.13 | - | X |
| Optional Tests | Product analysis ***(Option 3)*** | One per cast | 8.2.2, 10.2.1 and 11.1 | X | X |
| | Verification of impact properties ***(Option 4)*** | One set of tests per sample tube | 8.3, 10.2.2.5 and 11.8 | X | X |
| | Additional longitudinal impact test at −10°C for non- alloy steels ***(Option 5)*** | | 8.3, Table 4, 10.2.2.5 and 11.8 | X | X |
| | Verification of proof stress at elevated temperature ***(Option 6)*** | One test per sample tube | 8.3 and 11.2.2 | X | X |
| | NDT for the detection of transverse imperfections ***(Option 8)*** | Each tube | 8.4.3.2 and 11.12.3 | - | X |
| | NDT for the detection of laminar imperfections ***(Option 9)*** | | 8.4.3.2 and 11.12.4 | - | X |

| Type of inspection and test | | Frequency of testing | Refer to | Test category | |
|---|---|---|---|---|---|
| | | | | 1 | 2 |
| | Transverse tensile test on the weld at room temperature for tubes with outside diameter ***D*** > 219,1 mm OD ***(Option 13)*** | One test per sample tube | 11.3 | X | X |
| | Alternative hydrostatic test pressure for leak tightness assessment [c] ***(Option 14)*** | Each tube | 11.9.1 | X | X |
| | Wall thickness measurement away from tube end ***(Option 15)*** | Each tube | 11.10 | X | X |

[a] For the flattening test, two tests shall be carried out, one with the weld positioned at 0° and one with the weld at 90°.

[b] The choice of flattening test or ring tensile test and of drift expanding test or ring expanding test, where applicable, is at the discretion of the manufacturer.

[c] Where the manufacturer normally uses an electromagnetic test to assess leak tightness, Option 14 will only apply if the purchaser has specified hydrostatic testing in conjunction with Option 7.

# 10 Sampling

## 10.1 Frequency of tests

### 10.1.1 Test unit

For tubes delivered in conditions NR or NW (see Table 1) 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 delivered in condition NP (see Table 1) 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 maximum number of tubes per test unit shall conform to Table 11:

**Table 11 — Test unit details**

| 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 shall be taken.

## 10.2 Preparation of samples and test pieces

### 10.2.1 Selection and preparation of samples for product analysis

When Option 3 is specified, one product analysis sample per cast shall be taken in accordance with EN ISO 14284. The product analysis can be carried out either on the sample tube, at the same location as for the mechanical test samples, or on the test pieces or samples after mechanical testing.

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

#### 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 on the tube body

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

The test piece for the proof stress test at elevated temperature shall be prepared in accordance with the requirements of EN ISO 6892-2.

At the manufacturer's discretion:

— for tubes with an outside diameter $D < 219{,}1$ 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 $D \geq 219{,}1$ mm the test piece shall either a machined test piece with circular cross section from an un-flattened sample or a strip section and shall be taken in a direction either longitudinal or transverse to the axis of the tube.

Except when a full tube section is used the test piece shall be taken diametrically opposite the weld.

#### 10.2.2.3 Test pieces for tensile tests on the weld

Samples shall be taken transverse to the weld with the weld at the centre of the test piece. The test piece shall be a strip section with the full wall thickness of the tube; any remnant of the internal weld bead may be removed.

#### 10.2.2.4 Test pieces for flattening test, ring tensile test, drift expanding test, ring expanding test

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

#### 10.2.2.5 Test pieces for impact tests on the tube body

Three standard Charpy V-notch test pieces shall be prepared in accordance with EN ISO 148-1. Unless otherwise specified (see Option 5, Table 4), the test pieces shall be taken transverse to the tube axis.

The test pieces shall be taken diametrically opposite the weld.

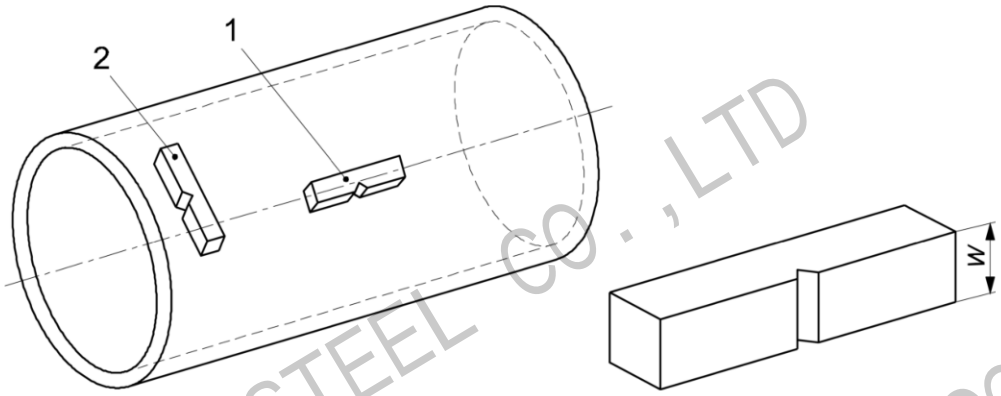
If the tube specified wall thickness is such that standard width test pieces cannot be produced without flattening of the section, then test pieces of standard width less than 10 mm, but not less than 5 mm shall be prepared; the largest obtainable standard width, either 7,5 mm or 5 mm, shall be used.

For guidance, transverse test pieces shall be taken unless $D_{min}$, as calculated by the following equation, is greater than the specified tube outside diameter, in which cases longitudinal test pieces shall be used.

$$D_{min.} = (T - 5) + [756{,}25 / (T - 5)] \quad (2)$$

Where the dimensions of the tube is such that 5mm wide longitudinal test pieces cannot be obtained, the tubes shall not be subjected to impact testing.

The test pieces shall be prepared such that the axis of the notch is through thickness, perpendicular to the surface of the tube, see Figure 3.




**Key**

1 longitudinal test piece

2 transverse test piece

*W* specimen width

**Figure 3 — Impact test piece orientation**

# 11 Verification of 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 the chemical analytical method for the analysis shall be at the discretion of the steel, strip or tube manufacturer. If further clarification is required, relevant test methods in accordance with CEN/TR 10261 shall be agreed between the manufacturer and purchaser

## 11.2 Tensile test on the tube body

### 11.2.1 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 ($L_o$) of $5{,}65\cdot\sqrt{S_o}$ ; if a non-proportional test piece is used, the percentage elongation value shall be converted to the value for a gauge length of $5{,}65\cdot\sqrt{S_o}$ using the conversion tables in EN ISO 2566-1.

### 11.2.2 At elevated temperature

The test shall be carried out in accordance with EN ISO 6892-2, at one temperature from Table 5 agreed at the time of enquiry and order (see 6.2), and the proof strength ($R_{p0,2}$) shall be determined.

### 11.3 Transverse tensile test on the weld

This is applicable to tubes of $D$ > 219,1 mm, if Option 13 applies (see Table 10). The test shall be carried out in accordance with EN ISO 6892-1 except that only the tensile strength ($R_m$) shall be determined. The tube weld will pass the test if the result obtained exceeds the minimum $R_m$ value specified in Table 4. The maximum $R_m$ value does not apply in this case.

### 11.4 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 (3):

$$H = \frac{(1+C)}{C+(T/D)} \times T \qquad (3)$$

where

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

$D$ is the specified outside diameter, in mm;

$T$ is the specified wall thickness, in mm;

$C$ is the deformation factor, the value of which is:

0,09 for P195GH and P235GH;

0,07 for P265GH and 16Mo3.

Two samples shall be tested, one with the weld at 0° and the other with the weld at 90°. After testing, the test piece shall be free from cracks or breaks. However, slight incipient cracks at the edges shall not be regarded as justification for rejection.

### 11.5 Ring tensile test

The test is applicable to tubes having an outside diameter > 150 mm and a wall thickness ≤ 40 mm.

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 display any cracks visible without the use of magnifying aids, excluding the fracture point.

### 11.6 Drift expanding test

This test is applicable to HFW tubes of outside diameter ≤ 150 mm and wall thickness ≤ 10 mm.

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 12 is reached.

**Table 12 — Drift expanding test requirements**

| Steel grade | Steel number | % increase in outside diameter for $d/D$ [a] | | |
|---|---|---|---|---|
| | | ≤ 0,6 | > 0,6 ≤ 0,8 | > 0,8 |
| P195GH | 1.0348 | 12 | 15 | 19 |
| P235GH | 1.0345 | 10 | 12 | 17 |
| P265GH | 1.0425 | 8 | 10 | 15 |
| 16Mo3 | 1.5415 | 8 | 10 | 15 |

[a] $d = D - 2T$

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

## 11.7 Ring expanding test

This test is applicable to tubes of outside diameter 18 mm < $D$ ≤ 150 mm and wall thickness 2 mm < $T$ ≤ 16 mm.

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 the edges shall not be regarded as justification for rejection.

## 11.8 Impact test

**11.8.1** Testing shall be carried out in accordance with EN ISO 148-1, using a 2 mm radius striker, at the test temperature given in Table 4.

**11.8.2** The mean value of each set of three test pieces shall meet the $KV_2$ requirement given in Table 4. One individual test result may be below the specified requirement, provided that it is not less than 70 % of that value.

**11.8.3** If the width ($W$) of the test piece is less than 10 mm, the measured impact energy values ($KV_p$) shall be converted to equivalent calculated impact energy values ($KV_c$) using the following Formula (4):

$$KV_c = \frac{10 \times KV_p}{W} \quad (4)$$

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 mm.

The mean calculated impact energy values $KV_c$ shall conform to the requirements given in 11.8.2.

**11.8.4** If the requirements of 11.8.2 are not met, then an additional set of three test pieces may be taken at the discretion of the manufacturer from the same sample tube and tested. To consider the test unit as conforming after testing the second set, the following conditions shall be satisfied simultaneously:

— the average of the six test results shall be equal to or greater than the specified minimum average value;

— not more than two of the six individual test results may be lower than the specified minimum average value;

— not more than one of the six individual test results may be lower than 70 % of the specified minimum average value.

**11.8.5** The dimensions in millimetres of the test pieces, the actual impact test results and the resulting average value shall be reported in the inspection certificate.

## 11.9 Leak tightness test

### 11.9.1 Hydrostatic test

Unless Option 14 is specified, the hydrostatic test shall be carried out at a test pressure of 70 bar[2)] or at a test pressure $P$ calculated using the following equation, whichever is lower:

$$P = 20 \times \frac{S \times T}{D} \quad (5)$$

where

$P$ is the test pressure, in bar;

$D$ is the specified outside diameter, in mm;

$T$ is the specified wall thickness, in mm;

$S$ 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 $D \leq 457$ mm and for not less than 10 s for tubes with an outside diameter $D > 457$ mm.

The tubes shall withstand the test without showing leakage.

***Option 14:*** *A test pressure different from that specified above and corresponding to a stress < 90% of the specified minimum yield strength (see Table 4) for the steel grade concerned is agreed at the time of enquiry and order.*

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

### 11.9.2 Electromagnetic test

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

## 11.10 Dimensional inspection

Specified dimensions, including straightness, shall be verified.

The outside diameter shall be measured at the 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 also be measured at the tube ends.

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

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2) 1bar = 100 Kpa

## 11.11 Visual examination

Tubes shall be visually examined to ensure conformity to the requirements of 8.4.1 and 8.4.2.1.

## 11.12 Non-Destructive Testing

**11.12.1** The full length of the weld seam of tubes of test category 1 shall be tested in accordance with one of the following:

— EN ISO 10893-2 to acceptance level E3 or E3H;

— EN ISO 10893-3 to acceptance level F3;

— EN ISO 10893-10 to acceptance level U3 sub category C;

— EN ISO 10893-11 to acceptance level U3.

Where the testing procedure is not capable of assessing the weld seam at the tube ends, then this area shall either be subjected to manual/semi-automatic ultrasonic testing in accordance with EN ISO 10893-11:2011, Annex A, or equivalent, or shall be cropped off.

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

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

**11.12.2** Tubes of test category 2 shall be tested in accordance with one of the following:

— EN ISO 10893-3 to acceptance level F2;

— EN ISO 10893-10 for longitudinal imperfections to acceptance level U2 sub-category C.

Regions at the tube ends not automatically tested shall either be subjected to manual/semi-automatic ultrasonic testing in accordance with EN ISO 10893-10:2011, Annex B or shall be cropped off.

Unless Option 17 is specified, the selection of test method is at the discretion of the manufacturer.

***Option 17:*** *The test method is specified by the purchaser.*

**11.12.3** When Option 8 (see 8.4.3.2) is specified, tubes of test category 2 shall also 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.

**11.12.4** When Option 9 (see 8.4.3.2) is specified, tubes of test category 2 shall also be subjected to ultrasonic testing for the detection of laminar imperfections in accordance with EN ISO 10893-8 to acceptance level U2.

## 11.13 Material identification

Tubes made from steel grade 16Mo3 shall be tested to ensure that the correct grade is being supplied (see Table 10).

## 11.14 Retests, sorting and reprocessing

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

# 12 Marking

## 12.1 Marking to be applied

At least one end of each tube shall be indelibly marked by a suitable and durable method, such as an automated ink or paint marking process, paint stencil or hard stamping (using low stress or pin stamps) or a combination of these.

The marking shall include the following information:

— the manufacturer's name or trade mark or product brand;

— the type of tube (HFW);

— the number of this document (EN 10217-2);

— the steel name or steel number (see 5.2.1 and 5.2.2 or 5.2.3);

— the designation of test category in the case of non-alloy steel grades (see 9.3);

— the cast number and/or an identification number (e.g. an order or item number or manufacturing reference code) which permits correlation of the product or delivery unit to the related documentation;

— the mark of the inspection representative, if applicable.

For tubes with outside diameter $D \leq 51$ mm the marking on the tubes may be replaced by marking on a label or tag, which shall be securely attached to the bundle or box. Additionally, the label or tag shall identify the tube diameter, wall thickness and length range.

NOTE Example of marking:

X – HFW - EN 10217–2 — P265GH - TC1 — Y - Z

where

X is the manufacturer's mark;

HFW is the type of tube;

TC1 is the test category;

Y is the cast number or identification number or a code number;

Z is the mark of the inspection representative, if applicable;

## 12.2 Additional marking

Unless Option 18 is specified, no additional marking other than that specified in 12.1 need be applied.

***Option 18****: Additional marking, as agreed upon at the time of enquiry and order, shall be applied.*

# 13 Protection

Unless Option 19 is specified, the tubes shall be delivered without any protective coating.

***Option 19:*** *A temporary protective coating or durable coating and/or lining shall be applied.*

# Annex A
(informative)

# Technical changes from the previous edition

## A.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, users should satisfy themselves that they fully understand 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.

## A.2 Technical changes

— 1 Scope

— 2 Normative references

— 3 Terms and definitions

— 4 Symbols

— 6 Information to be supplied by the purchaser

  — 6.2 Options [ 4), 5), 6), 7), 12), 13), 16) and 17)]

  — 6.3 Example of an order

— 7 Manufacturing process

  — 7.1 Steelmaking process

  — 7.2 Tube manufacture and delivery conditions

  — Table 1

  — 7.3 Non-destructive testing personnel requirements

— 8 Requirements

  — 8.1 General

  — Table 2

  — 8.3 Mechanical properties

  — Table 4

  — Table 5

# Annex ZA
(informative)

## Relationship between this European Standard and the Essential Requirements of 2014/68/EU

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association to provide a means of conforming to Essential Requirements of the New Approach Directive formerly 2014/68/EU.

Once this standard is cited in the Official Journal of the European Union under that Directive and has been implemented as a national standard in at least one Member State, compliance with the 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 the Directive 2014/68/EU**

| Essential Requirements of the Directive 2014/68/EU | Clauses/sub- clauses of this EN | Remarks/Notes |
|---|---|---|
| 3.1.2 | 7.2.2 | Welding<br>For the HFW tubes used for pressure equipment in categories II, III and IV, the operating procedures and the personnel shall be approved by a notified body or a recognized third party organisation. |
| 3.1.3 | 7.3 | NDT personnel requirements<br>For tubes to be used in pressure equipment under Categories III and IV the personnel shall be approved by a recognised third party organisation. |
| 4.1.a | 8.3 | Appropriate material properties |
| 4.1.c | 7.1 and 8.2 | Ageing |
| 4.1.d | 7.2.1, 7.2.3, 8.4 | Suitable for the processing procedures. |
| 4.3 | Clause 9 | 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 products falling within the scope of this standard.

# Bibliography

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