BS EN 10305-6:2016

BSI Standards Publication

Steel tubes for precision applications — Technical delivery conditions

Part 6: Welded cold drawn tubes for hydraulic and pneumatic power systems

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National foreword

This British Standard is the UK implementation of EN 10305-6:2016. It supersedes BS EN 10305-6:2005 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee ISE/110, Steel Tubes, and Iron and Steel Fittings.

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This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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European foreword

This document (EN 10305-6:2016) has been prepared by Technical Committee ECISS/TC 110 "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of an identical text or by endorsement, at the latest by September 2016 and conflicting national standards shall be withdrawn at the latest by September 2016.

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

This document supersedes EN 10305-6:2005.

In comparison with the previous edition, the following technical changes have been made:

a) References were adapted;

b) The options were renumbered in such a way that now throughout all parts the number of options are the same;

c) Precision tubes will now be preferably ordered according to outer diameter and wall thickness;

d) The drift expanding test is now beside the tensile test the second test for the verification of the mechanical properties;

e) Editorial updates.

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 Directive 2014/68/EU.

For relationship with Directive 2014/68/EU, see informative Annex ZA, which is an integral part of this document.

EN 10305, *Steel tubes for precision applications - Technical delivery conditions* consists of the following parts:

— *Part 1: Seamless cold drawn tubes*

— *Part 2: Welded cold drawn tubes*

— *Part 3: Welded cold sized tubes*

— *Part 4: Seamless cold drawn tubes for hydraulic and pneumatic power systems*

— *Part 5: Welded cold sized square and rectangular tubes*

— *Part 6: Welded cold drawn tubes for hydraulic and pneumatic power systems*

According to the CEN-CENELEC Internal Regulations, the national standards organizations 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, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

1 Scope

This European Standard specifies the technical delivery conditions for welded cold drawn tubes of circular cross section for use in hydraulic and pneumatic power systems.

Tubes according to this part of EN 10305 are characterized by having precisely defined tolerances on dimensions and a specified surface roughness.

The allowed pressure rates and upper temperatures are the responsibility of the customer in accordance with the state of the art and in application of the safety coefficients specified in the applicable regulations, codes or standards. Concerning the lower temperature range applicability the impact energy requirements are given at 0 °C.

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 (ESRs) 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.

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, *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 10052:1993, *Vocabulary of heat treatment terms for ferrous products*

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

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

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

EN ISO 377, *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 4287, *Geometrical product specifications (GPS) - Surface texture: Profile method - Terms, definitions and surface texture parameters (ISO 4287)*

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

EN ISO 8492, *Metallic materials - Tube - Flattening test (ISO 8492)*

EN ISO 8493, *Metallic materials - Tube - Drift-expanding test (ISO 8493)*

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 leaktightness (ISO 10893-1)*

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

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 10893-10, *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)*

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 10020:2000, EN 10021:2006, EN 10052:1993, EN 10266:2003 and the following apply.

3.1
employer
organization for which a person works on a regular basis

Note 1 to entry: The employer can be either the tube manufacturer or a third party organization providing services, such as non-destructive testing (NDT).

3.2
manufacturer
party to produce and to deliver tubes in accordance with this document

Note 1 to entry: Where tubes are delivered by an intermediary, see EN 10021:2006, Clause 6.

3.3
imperfection
discontinuity in the wall or on the pipe surfaces detectable by methods described in this document

Note 1 to entry: Imperfections with a size complying with the acceptance criteria specified in this document are considered to have no practical implication on the intended use of the product.

3.4
defect
imperfection of a size not complying with the acceptance criteria specified in this document

Note 1 to entry: Defects are considered to adversely affect or limit the intended use of the product.

4 Symbols

For the purposes of this part of EN 10305, the symbols given in EN 10266:2003 and the following apply.

C1, C2 category conformity indicators (see 7.2.2 and 7.2.3)

5 Classification and designation

5.1 Classification

In accordance with the classification system in EN 10020, the steel grades given in Table 1 are non-alloy quality steels.

5.2 Designation

For the tubes covered by this document, the steel designation consists of the number of this document (EN 10305-6) plus either:

a) the steel name in accordance with EN 10027-1; or

b) the steel number in accordance with EN 10027-2.

6 Information to be supplied by the purchaser

6.1 Mandatory information

The following information shall be obtained by the manufacturer at the time of enquiry and order:

a) quantity (mass or total length or number);

b) term “tube”;

c) dimensions, preferably by outside diameter D and wall thickness T (or other pair of dimensions), (see 8.5.1.1 and Table 4);

d) steel designation (see 5.2);

e) type of tube length (see 8.5.2);

f) type of inspection certificate (see 9.1).

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 his 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).

- Option 7: Reduced internal roughness of ≤ 2 µm (see 8.4.3);
- Option 8: Measurement of surface roughness (see 8.4.4);
- Option 12: Non-destructive testing for the detection of longitudinal imperfections (see 8.4.7);
- Option 21: another specified length and/or tolerance (see 8.5.2);
- Option 22: Reduced maximum deviation from straightness (see 8.5.3);

- Option 24: higher test pressure for hydrostatic test (see 11.6.2);
- Option 28: alternative marking (see Clause 12);
- Option 31: protection by phosphatization (see 13.1);
- Option 32: protection by electrolytical zinc coating (see 13.1);
- Option 37: protection of tube ends (see 13.1);
- Option 38: unbundled tubes or specific method of packaging (see 13.2).

6.3 Example of an order

1 000 tubes with an outside diameter of D = 20 mm and a specified wall thickness of T = 2,5 mm in accordance with this document, made of steel grade E235, delivered in standard lengths with an inspection certificate 3.1 in accordance with EN 10204:2004:

1 000 tubes – D 20 x T 2,5 – EN 10305-6 – E235 – standard length – inspection certificate 3.1

7 Manufacturing process

7.1 Steelmaking process

The steel making 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 The tubes shall be manufactured from electric welded tubes by cold drawing. Other suitable methods of cold working are permitted.

The tubes shall be delivered in the delivery condition +N, which means that after final cold drawing (or other processing) the tubes are normalized in a controlled atmosphere.

7.2.2 Welding shall be carried out by suitably qualified personnel according to suitable operating procedures.

For tube to be used for pressure equipment in categories II, III, and IV (of Directive 2014/68/EU), the operating procedures and the personnel shall be approved by a competent third-party. Tubes not processed according to this requirement shall be marked “C 1”.

7.2.3 All non-destructive testing (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 11484:2009 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 a level 3 NDT individual approved by the employer.

NOTE The definition of level 1, 2 and 3 can be found in the appropriate standards, e.g. EN ISO 9712 and ISO 11484:2009.

For tubes to be used for pressure equipment in categories III and IV (of Directive 2014/68/EU) the NDT personnel shall be approved by a recognized third-party organization. Tubes not processed according to this requirement shall be marked "C 2", unless a requirement to mark "C 1" (see 7.2.2) applies.

8 Requirements

8.1 General

The tubes, when inspected in accordance with Clauses 9, 10 and 11, shall comply with the requirements of this part of EN 10305.

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

8.2 Chemical composition

The cast analysis reported by the steel producer shall apply and comply with the requirements of Table 1.

NOTE When subsequently welding tubes produced in accordance with this document, it is important to take account of the fact that the behaviour of the steel during and after welding is dependent not only on the steel composition and the delivery condition but also on the conditions of preparing for and carrying out the welding.

Table 1 — Chemical composition (cast analysis)

Steel grade		**% by mass**					
Steel name	**Steel number**	C max.	Si max.	Mn max.	P max.	S max.	Al_{total} [a] min.
E155	1.0033	0,11	0,35	0,70	0,025	0,015	0,015
E195	1.0034	0,15	0,35	0,70	0,025	0,015	0,015
E235	1.0308	0,17	0,35	1,20	0,025	0,015	0,015
E275	1.0225	0,21	0,35	1,40	0,025	0,015	0,015
E355	1.0580	0,22	0,55	1,60	0,025	0,015	0,020
Elements not quoted in this table (but see footnote a)) shall not be intentionally added to the steel without the agreement of the purchaser, except for elements which may be added for the purposes of deoxidation and/or nitrogen binding. All appropriate measures shall be taken to prevent the addition of undesirable elements from scrap or other materials used in the steel making process.							
a This requirement is not applicable provided the steel contains a sufficient amount of other nitrogen binding elements, such as Ti, Nb or V. If added, the content of these elements shall be reported in the inspection document. When using titanium, the manufacturer shall verify that (Al + Ti/2) ≥ 0,020.							

Table 2 specifies the permissible deviations of the product analysis from the specified limits on cast analysis given in Table 1.

Table 2 — Permissible deviations of the product analysis from the specified limits on the cast analysis given in Table 1

Element	**Specified limit of the cast analysis** % by mass	**Permissible deviation of the product analysis** % by mass
C	≤ 0,22	+ 0,02
Si	≤ 0,55	+ 0,05
Mn	≤ 1,60	+ 0,10
P	≤ 0,025	+ 0,005
S	≤ 0,015	+ 0,003
Al	≥ 0,015	- 0,005

8.3 Mechanical properties

The mechanical properties of the tubes shall comply with the requirements of Table 3 and 11.2.

Table 3 — Mechanical properties at room temperature

Steel grade		**Yield strength** [a]	**Tensile strength**	**Elongation**
Steel name	**Steel number**	R_{eH} MPa [b] min	R_m MPa	A **%** min
E155	1.0033	155	270 to 410	28
E195	1.0034	195	300 to 440	28
E235	1.0308	235	340 to 480	25
E275	1.0225	275	410 to 550	21
E355	1.0580	355	490 to 630	22
The steel grades defined in this document have an intrinsic minimum transverse impact energy of 27 J at 0 °C.				
[a] For tubes with outside diameter ≤ 30 mm and wall thickness ≤ 3 mm, the minimum permitted values of R_{eH} are 10 MPa lower than given in this table.				

8.4 Appearance and soundness

8.4.1 The weld area shall be free from cracks and lack of fusion (cold weld).

8.4.2 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. Any surface imperfections, which in accordance with the manufacturer's experience might be considered defects as specified in 8.4.5, shall be dressed in accordance with 8.4.6, or the tube or part of tube shall be rejected.

8.4.3 The tubes shall have smooth outer and inner surfaces with a roughness R_a ≤ 4 µm, unless option 7 is specified.

NOTE In the case of the inner surface, this requirement applies to inner diameters ≥ 15 mm.

Option 7 *A specified reduced roughness of $R_a \leq 2$ µm applies for the inner and/or outer surface of the tube.*

8.4.4 Verification of surface roughness and/or improved levels of roughness may be specified (see option 8).

Option 8: *The surface roughness shall be measured in accordance with 11.4 and reported.*

8.4.5 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 document.

8.4.6 It shall be permissible to dress, only by grinding or machining, surface imperfections provided that, after doing so, the dimensions are within the specified tolerances. All dressed areas shall blend smoothly into the contour of the tube.

8.4.7 Non-destructive testing for the detection of longitudinal imperfections may be specified (see option 12).

Option 12: *Non-destructive testing for the detection of longitudinal imperfections in accordance with 11.6.1 is specified.*

8.4.8 For verification of leak-tightness, the tubes shall pass a non-destructive test in accordance with 11.6.2.

8.5 Dimensions and tolerances

8.5.1 Outside diameter, inside diameter, wall thickness and eccentricity

8.5.1.1 The tubes shall be supplied preferably by outside diameter *D* and wall thickness *T* (or by outside diameter *D* and inside diameter *d* or inside diameter *d* and wall thickness *T*).

8.5.1.2 Preferred outside diameters with tolerances, inside diameters with tolerances and wall thicknesses with tolerances are given in Table 4.

Depending on the ordered pair of dimensions (see 8.5.1.1) either the tolerances on specified outside diameter and specified wall thickness or on specified outside diameter and specified inside diameter or on specified inside diameter and specified wall thickness apply.

Dimensions which are different from those in Table 4 may be agreed at the time of enquiry and order. In this case, the tolerances and surface roughness shall also be agreed.

The diameter tolerances of tubes specified by outside and inside diameter shall be within the tolerance limits given in Table 4. When the T/D ratio is < 0,05 the tolerances are increased by a factor 1,5.

The diameter tolerances include the out-of-roundness. For a maximum distance of 100 mm, the ends may, due to the cutting method, have diameters outside the tolerances.

8.5.1.3 For tubes specified by the outside and the inside diameter, the eccentricity shall fulfil the following requirement:

$$\frac{T_{\max} - T_{\min}}{T_{\max} + T_{\min}} \times 100 \leq 7{,}5\ \% \qquad (1)$$

where

$T_{\max}$ and $T_{\min}$ are measured in the same cross section.

8.5.2 Lengths

The type of tube lengths shall be specified at the time of enquiry and order by either:

— a standard length of 6 m $^{+50}_{0}$ mm, or

— an exact length of 6 m $^{+10}_{0}$ mm

unless option 21 is specified.

5 % of shorter lengths may be supplied provided they are not shorter than 4 m and bundled separately.

Option 21: *Another length and/or tolerance is specified.*

Table 4 — Sizes and tolerances

Dimensions in millimetres

Specified outside diameter *D* with tolerance [a]		**Specified wall thickness *T* with tolerance** [a]		**Specified inside diameter *d* with tolerance** [a]	
4	±0,08	0,5	±0,05	3	±0,15
		1	±0,08	2	
5	±0,08	0,75	±0,06	3,5	±0,15
		1	±0,08	3	
6	±0,08	1	±0,08	4	±0,12
		1,5	±0,11	3	±0,15
		2	±0,15	2	
8	±0,08	1	±0,08	6	±0,10
		1,5	±0,11	5	
		2	±0,15	4	±0,15
		2,5	±0,19	3	
10	±0,08	1	±0,08	8	±0,08
		1,5	±0,11	7	±0,12
		2	±0,15	6	±0,15
		2,5	±0,19	5	
12	±0,08	1	±0,08	10	±0,08
		1,5	±0,11	9	±0,10
		2	±0,15	8	±0,12
		2,5	±0,19	7	±0,15
		3	±0,23	6	
14	±0,08	1	±0,08	12	±0,08
		1,5	±0,11	11	
		2	±0,15	10	±0,10
		2,5	±0,19	9	±0,12
		3	±0,23	8	±0,15
15	±0,08	1	±0,08	13	±0,08
		1,5	±0,11	12	
		2	±0,15	11	±010
		2,5	±0,19	10	±0,12
		3	±0,23	9	±0,15

Specified outside diameter *D* with tolerance [a]		**Specified wall thickness *T* with tolerance** [a]		**Specified inside diameter *d* with tolerance** [a]	
16	±0,08	1	±0,08	14	±0,08
		1,5	±0,11	13	
		2	±0,15	12	
		2,5	±0,19	11	±0,15
		3	±0,23	10	
18	±0,08	1	±0,08	16	±0,08
		1,5	±0,11	15	
		2	±0,15	14	
		2,5	±0,19	13	±0,15
		3	±0,23	12	
20	±0,08	1,5	±0,11	17	±0,08
		2	±0,15	16	
		2,5	±0,19	15	±0,15
		3	±0,23	14	
		3,5	±0,26	13	
		4	±0,30	12	
22	±0,08	1	±0,08	20	±0,08
		1,5	±0,11	19	
		2	±0,15	18	
		2,5	±0,19	17	
		3	±0,23	16	±0,15
		3,5	±0,26	15	
		4	±0,30	14	
25	±0,08	1,5	±0,11	22	±0,08
		2	±0,15	21	
		2,5	±0,19	20	
		3	±0,23	19	±0,15
		4	±0,30	17	
		4,5	±0,34	16	
28	±0,08	1,5	±0,11	25	±0,08
		2	±0,15	24	
		2,5	±0,19	23	
		3	±0,23	22	±0,15
		4	±0,30	20	
30	±0,08	2	±0,15	26	±0,08
		2,5	±0,19	25	
		3	±0,23	24	±0,15
		4	±0,30	22	

Specified outside diameter *D* with tolerance [a]		Specified wall thickness *T* with tolerance [a]		Specified inside diameter *d* with tolerance [a]	
35	±0,08	2	±0,15	31	±0,15
		2,5	±0,19	30	
		3	±0,23	29	
		4	±0,30	27	
		5	±0,38	25	
		6	±0,45	23	
38	±0,08	2	±0,15	34	±0,15
		2,5	±0,19	33	
		3	±0,23	32	
		4	±0,30	30	
		5	±0,38	28	
		6	±0,45	26	
		7	±0,53	24	
		8	±0,60	22	
42	±0,08	2	±0,15	38	±0,20
		3	±0,23	36	
		4	±0,30	34	
		5	±0,38	32	
		8	±0,60	26	
50	±0,20	4	±0,30	42	±0,20
		5	±0,38	40	
		6	±0,45	38	
		8	±0,60	34	
55	±0,25	4	±0,30	47	±0,25
		6	±0,45	43	
		8	±0,60	39	
60	±0,25	5	±0,38	50	±0,25
		8	±0,60	44	
70	±0,30	5	±0,38	60	±0,30
		8	±0,60	54	
80	±0,35	6	±0,45	68	±0,35
		8	±0,60	64	
		10	±0,75	60	

[a] Dimensions and tolerances only apply for the ordered pair of dimensions (see 8.5.1.1 and 8.5.1.2).

8.5.3 Straightness

For tubes with an outside diameter $D > 15$ mm supplied in lengths greater than 1 000 mm, 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, unless option 22 is specified.

Option 22 *A reduced maximum deviation from straightness is specified.*

8.5.4 Preparation of ends

The tubes shall be delivered with square cut ends. The ends shall be free from excessive burrs.

9 Inspection

9.1 Type of inspection

Products complying with this document shall be ordered and delivered with one of the inspection documents as specified in EN 10204. The type of document shall be agreed upon at the time of enquiry and order. If the order does not contain any specification of this type, inspection certificate 3.1 shall be issued.

9.2 Inspection documents

9.2.1 Type of inspection documents

In the case of non-specific inspection a test report 2.2 in accordance with EN 10204:2004 shall be issued.

When specific inspection is requested, an inspection certificate 3.1 or 3.2 in accordance with EN 10204:2004 shall be issued. If an inspection certificate 3.2 is ordered the purchaser shall additionally 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. It shall also be agreed which party shall issue the certificate.

9.2.2 Content of inspection documents

9.2.2.1 The content of the inspection document shall be in accordance with EN 10168:2004 as shown in 9.2.2.2 and 9.2.2.3.

9.2.2.2 For tubes supplied with non-specific inspection, the test report 2.2 shall contain the following codes and information:

A	commercial transactions and parties involved;
B	description of products to which the inspection applies;
C10 to C13	tensile test;
C60 to C69	other tests;
C71 to C92	chemical composition;
D01	marking, surface appearance, shape and dimensional properties;
D02 to D99	leak tightness test;
Z	validation.

9.2.2.3 For tubes supplied with specific inspection the inspection certificate 3.1 or 3.2 shall contain the following codes and information:

A	commercial transactions and parties involved;
B	description of products to which the inspection document applies;
C01-C02	directions of test pieces;
C10 to C13	tensile test;
C60 to C69	other tests;

C71 to C92 chemical composition (cast analysis);

D01 marking, surface appearance, shape and dimensional properties;

D02 to D99 leak tightness test and other (optional) tests (e.g.: roughness measurement, NDT on longitudinal imperfections);

Z validation.

9.3 Summary of inspection and testing

Inspection and testing shall be carried out as stated in Table 5 and 10.1.

Table 5 — Summary of inspection and testing

Type of inspection or test		Frequency of testing [a]		Reference
		Non-specific inspection	Specific inspection	
mandatory	Chemical analysis	M	M	8.2
	Tensile test	M	one per test unit	8.3, 11.1
	Drift expanding test [b]	M	2 per test unit	11.2
	Dimensional inspection	M	M	8.5, 11.3
	Visual examination	M	M	11.5
	Verification of leak tightness	Each individual tube	Each individual tube	8.4.8, 11.6.2
optional	Roughness measurement (option 8)	not applicable	one per test unit	8.4.4, 11.4
	NDT on longitudinal imperfections (Option 12)	not applicable	Each individual tube	8.4.7, 11.6.1

[a] M : according to manufacturer's procedure.

[b] For tubes with outside diameters $D > 150$ mm and/or wall thicknesses $T > 10$ mm, instead of the drift expanding test the flattening test may be applied (see Table 6).

10 Sampling

10.1 Test unit

A test unit is defined as a quantity of tubes of the same steel grade and dimensions, the same cast, manufactured by the same process and heat treated in the same batch and the same heat treatment facility.

NOTE In the case of a continuous heat treatment furnace, a batch is the lot heat treated without intermission with the same process parameters.

A test unit shall comprise not more than 500 mother tubes with a maximum of 10 000 m.

10.2 Preparation of samples and test pieces

10.2.1 General

Samples and test pieces shall be taken at the tube ends and in accordance with EN ISO 377 from one sample tube per test unit.

10.2.2 Test pieces for the tensile test

The test pieces shall be prepared in accordance with EN ISO 6892-1.

10.2.3 Test pieces for the drift expanding test

The test pieces for the drift expanding test shall consist of a full tube section, in accordance with EN ISO 8493.

10.2.4 Test pieces for roughness measurement

The test pieces should be taken from the same location as for the mechanical tests.

11 Test methods

11.1 Tensile test

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};

If a yield phenomenon is not present the 0,2 % proof strength $R_{p0,2}$ shall be determined;

— the percentage elongation A after fracture with a reference to a gauge length L_o of $5,65\sqrt{S_0}$;

If a non-proportional test piece is used, the percentage elongation value shall be converted to the value for a gauge length $L_o = 5,65\sqrt{S_0}$ using the conversion tables given in EN ISO 2566-1.

11.2 Drift expanding test

The test shall be carried out in accordance with EN ISO 8493 with a 60° conical mandrel. The tube section shall be expanded until the increase in diameter reaches the applicable values shown in Table 6.

Table 6 — Requirements for the drift expanding test

Steel grade		% increase of the diameter D for	
Steel name	**Steel number**	$T \leq 4$ mm	$T > 4$ mm
E155	1.0033	22	17
E195	1.0034	20	15
E235	1.0308	18	12
E275	1.0225	15	10
E355	1.0580	15	10
For outside diameters above 150 mm and/or wall thicknesses above 10 mm instead of the drift expanding test the flattening test may be applied as described in EN ISO 8492 (see also 11.2, EN 10305–2).			

After testing, the test piece shall be free from cracks or breaks. However, a slight cracking at the edges shall not be considered cause for rejection.

11.3 Dimensional inspection

Specified dimensions, including straightness, shall be verified. Diameter measurements shall be carried out at a distance of ≥ 100 mm from the tube ends (see 8.5.1.2).

11.4 Roughness measurement

Roughness shall be measured in the axial direction in accordance with EN ISO 4287.

11.5 Visual examination

Tubes shall be visually examined for compliance with the requirements of 8.4.1, 8.4.2 and 8.5.3.

11.6 Non-destructive testing

11.6.1 Testing on longitudinal imperfections

Non-destructive testing for the detection of longitudinal imperfections shall be carried out, at the discretion of the manufacturer, in accordance with one or more of the following methods:

a) eddy current testing: EN ISO 10893-2, acceptance level E3;

b) magnetic transducer/flux leakage testing: EN ISO 10893-3, acceptance level F3;

c) ultrasonic testing: EN ISO 10893-10, acceptance level U3B.

11.6.2 Leak tightness test

Non-destructive testing for verification of leak-tightness shall be carried out in accordance with EN ISO 10893-1 or with the following hydrostatic test.

The hydrostatic test shall be carried out at a test pressure of 70 bar or *P*, calculated from the following equation, whichever is the lower, unless option 24 is specified:

$$P = 20\,\frac{S\,x\,T}{D}$$

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 3) for the steel grade concerned.

Option 24 *A test pressure corresponding to a strength level of ≤ 95 % of the specified minimum yield strength (see Table 3) is specified.*

The tube shall withstand the test without showing leakage or visible deformation.

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

11.7 Retests, sorting and reprocessing

For retests, sorting and reprocessing EN 10021 applies.

12 Marking

Unless option 28 is specified, the following marking shall be applied indelibly to each tube. The marking shall be repeated continuously along a line parallel to the tube axis, with a maximum interval of 1,5 m between two sequences.

When option 28 is specified, marking may be applied on a label attached to the bundle or the box.

The marking shall include the following information:

— the manufacturer's name or trade mark;

— the specified dimensions;

— the number of this European Standard;

— the steel name;

— the category conformity indicator, if applicable (see Clause 4, 7.2.2 and 7.2.3).

— in the case of specific inspection, an identification number (e.g. order or item number) which permits the correlation of the product or delivery unit to the related document.

Option 28 *An agreed alternative marking is specified.*

13 Protection and packaging

13.1 Protection

The tubes shall be delivered with a temporary protection against corrosion; the type of protection shall be at the discretion of the manufacturer, unless option 31 or 32 is specified. The manufacturer shall take appropriate measures to prevent ingress of foreign matter into the tube.

Option 31 *The tubes shall be phosphatized before temporary protection.*

Option 32 *The external surface of the tubes shall be electrolytically zinc coated and given a treatment to minimize "white rust" before temporary protection is applied. The zinc coating thickness and the type of white rust inhibitor shall be agreed at the time of enquiry and order.*

Option 37 The tube ends shall be protected with plugs or caps.

13.2 Packaging

The tubes shall be delivered in bundles, with polygonal bundles for tubes ≥ 12 mm outside diameter, unless option 38 is specified.

Option 38 *Supply of unbundled tubes or application of a specific packaging method is specified.*

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 the Directive 2014/68/EU	Clauses/sub-clauses of this EN	Remarks/Notes
3.1.2	7.2.2	Welding
3.1.3	7.2.3	NDT personnel
4.1a	8.3	Appropriate material properties
4.1c	8.2	Ageing
4.1d	7.2.1, 8.4	Suitable for the processing procedures
4.3	Clause 9	Inspection documentation NOTE: Details about the materials certification of the various pressure-bearing parts may be found in the PED EC Guideline 7/5. A test report for non specific product control does only comply with main pressure-bearing parts of pressure equipment in category I. An inspection certificate 3.1 or 3.2 for specific product control is required for the main pressure-bearing parts of pressure equipment in categories II, III and IV.

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 (ISO 9712) personnel*

[2] Directive 2014/68/EU of the European Parliament and of the Council of 15 May 2014 on the harmonisation of the laws of the Member States relating to the making available on the market of pressure equipment

[3] PED-guideline 7/5 “Pressure equipment directive 97/23/EC. Commission’s Working Group 'Pressure'. Guideline related to: Annex I Section 4.3”

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