

# **Steel tubes for precision applications — Technical delivery conditions —**

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

The European Standard EN 10305-6:2005 has the status of a  
British Standard

ICS 77.140.75

# National foreword

This British Standard is the official English language version of EN 10305-6:2005. It supersedes BS 6323-6:1982 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee ISE/8, Steel Pipes, which has the responsibility to:

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

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

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## Foreword

This document (EN 10305-6:2005) has been prepared by Technical Committee ECISS/TC 29 “Steel tubes and fittings for steel tubes”, the secretariat of which is held by UNI/UNSIDER.

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of an identical text or by endorsement, at the latest by November 2005, and conflicting national standards shall be withdrawn at the latest by November 2005.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive (97/23/EC).

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

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

This document includes a bibliography.

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

- 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 and sized square and rectangular tubes
- Part 6: Welded cold drawn tubes for hydraulic and pneumatic power systems

## 1 Scope

This Part of EN 10305 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 temperatures are the responsibility of the customer in accordance with the state of the art and in the application of the safety coefficients specified in the applicable regulations, codes or standards.

## 2 Normative references

This European Standard incorporates, by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text, and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of those publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

EN 10002-1, *Metallic materials – Tensile testing – Part 1: Method of test at ambient temperature.*

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

EN 10021, *General technical delivery requirements for steel and iron products.*

EN 10027-1, *Designation systems for steels – Part 1: Steel names, principal symbols.*

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

EN 10052, *Vocabulary of heat treatment terms for ferrous products.*

EN 10168, *Steel products – Inspection documents – List of information and description.*

EN 10204, *Metallic products – Types of inspection documents.*

EN 10246-1, *Non-destructive testing of steel tubes – Part 1: Automatic electromagnetic testing of seamless and welded (except submerged arc-welded) ferromagnetic steel tubes for verification of hydraulic leak-tightness.*

EN 10256, *Non-destructive testing of steel tubes – Qualification and competence of level 1 and 2 non-destructive testing personnel.*

EN 10266, *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 377:1997).*

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

EN ISO 8492, *Metallic materials - Tube - Flattening test (ISO 8492:1998)*

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

CR 10260, *Designation systems for steel - Additional symbols.*

## 3 Terms and definitions

For the purposes of this European Standard, the terms and definitions given in EN 10020, EN 10021, EN 10052, EN 10266 and the following apply.

**3.1****employer**

organisation for which a person works on a regular basis

NOTE The employer may be either the tube manufacturer or a third party organisation providing non-destructive testing (NDT) services.

**4 Symbols**

For the purposes of this Part of EN 10305 the symbols given in EN 10266 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 Part of EN 10305 the steel designation consists of:

— the number of this Part of EN 10305

plus either :

— the steel name in accordance with EN 10027-1 and CR 10260; or

— 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 supplied by the purchaser at the time of enquiry and order:

- a) quantity (mass or total length or number of pieces);
- b) term “tube”;
- c) dimensions [outside diameter and wall thickness] (see 8.5.1.1 and Table 4);
- d) designation of the steel grade in accordance with this Part of EN 10305 (see 5.2);
- e) type of tube length (see 8.5.2);
- f) type of inspection (see 9.1).

**6.2 Options**

A number of options are specified in this Part of EN 10305 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).

- 1) Reduced internal roughness of  $\leq 2 \mu\text{m}$  (see 8.4.2.5);
- 2) leak tightness test method (see 8.4.3);
- 3) supply to inside diameter and wall thickness or outside diameter and inside diameter (see 8.5.1.1);
- 4) lengths other than 6 m ( see 8.5.2);
- 5) Enhanced straightness (see 8.5.3);
- 6) higher test pressure for hydrostatic test (see 11.4.1);
- 7) alternative marking (see clause 12);
- 8) protection by phosphatization (see 13.1);
- 9) protection by electrolytical zinc coating (see 13.1);
- 10) protection of tube ends (see 13.1);
- 11) specified method of packaging (see 13.2).

### 6.3 Example of an order

1 000 tubes with an outside diameter of 20 mm and a specified wall thickness of 2,5 mm in accordance with this Part of EN 10305, made of steel grade E235, delivered in standard lengths:

1 000 tubes – 20 x 2,5 – EN 10305-6 – E235 – standard length

## 7 Manufacturing process

### 7.1 Steelmaking process

The steelmaking process is at the discretion of the manufacturer.

Steels shall be fully killed.

### 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 97/23/EC), 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 EN 10256 or, at least, an equivalent to it.

It is recommended that the level 3 personnel be certified in accordance with EN 473 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 473 and EN 10256.

For tube to be used for pressure equipment in categories III and IV (of Directive 97/23/EC) the NDT personnel shall be approved by a recognised third-party organisation. 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 welding tubes produced in accordance with this Part of EN 10305, account should be taken of the fact that the behaviour of the steel during and after welding is dependent not only on the steel, but also on the conditions of preparing for and carrying out the welding.

**Table 1 — Chemical composition (cast analysis) <sup>a</sup>**

Steel grade		in % by mass				
Steel name	Steel number	C max	Si max	Mn max	P max	S max
E155	1.0033	0,11	0,35	0,70	0,025	0,015
E195	1.0034	0,15	0,35	0,70	0,025	0,015
E235	1.0308	0,17	0,35	1,20	0,025	0,015
E275	1.0225	0,21	0,35	1,40	0,025	0,015
E355 <sup>b</sup>	1.0580	0,22	0,55	1,60	0,025	0,015
<p><sup>a</sup> Elements not included in this Table (but see footnote <sup>b</sup>) 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.</p> <p><sup>b</sup> Additions of Nb, Ti and V are permitted at the discretion of the manufacturer. If added, the content of these elements shall be reported.</p>						

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 cast analysis given in Table 1**

Element	Limiting value for cast analysis in accordance with Table 2 in % by mass	Permissible deviation of the product analysis in % 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

### 8.3 Mechanical properties

The mechanical properties of the tubes shall comply with the requirements of Table 3 and 11.2 or 11.3.

**Table 3 — Mechanical properties at room temperature**

Steel grade		Yield strength <sup>a</sup> $R_{eH}$ MPa <sup>b</sup> min	Tensile strength $R_m$ MPa <sup>b</sup>	Elongation $A$ % min
Steel name	Steel number			
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
NOTE The steel grades defined in this Part of EN 10305 have an intrinsic minimum transverse impact energy KV of 27 J at 0 °C.				
<sup>a</sup> 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.				
<sup>b</sup> 1 MPa = 1 N/mm <sup>2</sup>				

### 8.4 Appearance and internal soundness

#### 8.4.1 General

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

#### 8.4.2 Appearance

**8.4.2.1** The internal and external surface finish of the tubes shall be typical of the manufacturing process and the heat treatment, and it shall be such that any surface imperfections such as ridges, dents or shallow grooves requiring dressing can be identified.

**8.4.2.2** Any surface imperfections, whose depth cannot be clearly identified (i.e. scales, overlaps) shall be either dressed in accordance with 8.4.2.3 or treated in accordance with 8.4.2.4.

**8.4.2.3** 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.

**8.4.2.4** Surface imperfections which encroach on the specified minimum wall thickness shall be considered defects and tubes containing these shall be deemed not to conform to this Part of EN 10305.

**8.4.2.5** The tubes shall have smooth outer and inner surfaces with a roughness  $R_a \leq 4 \mu\text{m}$ , unless option 1 is specified.

NOTE In the case of the inner surface this requirement applies to inner diameters  $\geq 15 \text{ mm}$ .

**Option 1** A specified reduced roughness of  $R_a \leq 2 \mu\text{m}$  applies for the inner and/or outer surface of the tube.

### 8.4.3 Internal soundness

The tubes shall pass a test for verification of leak-tightness in accordance with 11.4.1 (Hydrostatic test) or 11.4.2 (Electromagnetic test).

The choice of the test method shall be at the discretion of the manufacturer, unless option 2 is specified.

**Option 2** The test method for verification of leak-tightness according to 11.4.1 or 11.4.2 is specified by the purchaser.

## 8.5 Dimensions and tolerances

### 8.5.1 Outside diameter, inside diameter and wall thickness

**8.5.1.1** The tubes shall be supplied by outside diameter and wall thickness, unless option 3 is specified. Preferred outside diameters, wall thicknesses and inside diameters are given in Table 4.

**Option 3** Tubes shall be supplied to inside diameter and wall thickness or outside diameter and inside diameter as specified by the purchaser.

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

**8.5.1.2** The diameter tolerances of tubes specified by outside and inside diameter shall be within the tolerance limits given in Table 4. When the D/T ratio is  $\geq 20$  the tolerances are increased by a factor 1,5.

Out-of-roundness is included in the tolerances on diameter.

### 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  $6 \text{ m } {}^{+50}_{0} \text{ mm}$ ; or

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

unless option 4 is specified.

Up to 5% of an order for standard lengths may be supplied shorter than 6m, provided that the tubes are not less than 4 m long and that they are bundled separately.

**Option 4** The tubes shall be delivered in a length other than 6 m. The length and the tolerances shall be agreed at the time of enquiry and order.

Table 4 — Sizes and tolerances

Dimensions in mm

Specified outside diameter with tolerance <sup>a</sup>		Specified wall thickness with tolerance <sup>a</sup>		Specified inside diameter with tolerance <sup>a</sup>	
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	± 0,10
		2,5	± 0,19	10	± 0,12
		3	± 0,23	9	± 0,15

To be continued

Table 4 (continued)

Dimensions in mm

Specified outside diameter with tolerance <sup>a</sup>		Specified wall thickness with tolerance <sup>a</sup>		Specified inside diameter with tolerance <sup>a</sup>	
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	

To be continued

Table 4 (continued)

Dimensions in mm

Specified outside diameter with tolerance <sup>a</sup>		Specified wall thickness with tolerance <sup>a</sup>		Specified inside diameter with tolerance <sup>a</sup>	
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	
35	± 0,15	2	± 0,15	31	± 0,15
		2,5	± 0,19	30	
		3	± 0,23	29	
		4	± 0,30	27	
		5	± 0,35	25	
		6	± 0,35	23	
38	± 0,15	2	± 0,15	34	± 0,15
		2,5	± 0,19	33	
		3	± 0,23	32	
		4	± 0,30	30	
		5	± 0,35	28	
		6	± 0,35	26	
		7	± 0,35	24	
		8	± 0,35	22	
42	± 0,20	2	± 0,15	38	± 0,20
		3	± 0,23	36	
		4	± 0,30	34	
		5	± 0,35	32	
		8	± 0,35	26	

To be continued

Table 4 (end)

Dimensions in mm					
Specified outside diameter with tolerance <sup>a</sup>		Specified wall thickness with tolerance <sup>a</sup>		Specified inside diameter with tolerance <sup>a</sup>	
50	± 0,20	4	± 0,30	42	± 0,20
		5	± 0,35	40	
		6	± 0,35	38	
		8	± 0,35	34	
55	± 0,25	4	± 0,30	47	± 0,25
		6	± 0,35	43	
		8	± 0,35	39	
60	± 0,25	5	± 0,35	50	± 0,25
		8	± 0,35	44	
70	± 0,30	5	± 0,35	60	± 0,30
		8	± 0,35	54	
80	± 0,35	6	± 0,35	68	± 0,35
		8	± 0,35	64	
		10	± 0,35	60	
<sup>a</sup> 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 inside diameter and specified wall thickness or on specified outside diameter and specified inside diameter apply.					

### 8.5.3 Straightness

The deviation from straightness of any tube length  $L$  shall not exceed  $0,0015 L$ , unless option 5 is specified. Deviations from straightness over any one metre length shall not exceed 3 mm.

**Option 5** Tubes shall be supplied with a maximum deviation from straightness of  $0,0005 L$ .

### 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

The compliance with the requirements of the order shall be checked by non-specific or specific inspection. The type of inspection shall be specified at the time of enquiry and order.

When an inspection document 3.1 is specified, the manufacturer shall state in the confirmation of the order whether he is operating according to a "quality-assurance-system", certified by a competent Body established within the Community, and, if tube is required for pressure equipment in categories II, III, or IV according to the Directive 97/23/EC, confirm that the supplier of the welded tube feedstock (hollows) has undergone a specific assessment for materials and processes relevant to manufacture of welded tubes, including welding procedure approvals, welder/weld operator approval and NDT operator approval.

NOTE See Directive 97/23/EC Annex I section 4.3 third paragraph

## 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 shall be issued.

When specific inspection is requested an inspection certificate 3.1 in accordance with EN 10204 shall be issued.

### 9.2.2 Content of inspection documents

#### 9.2.2.1 General

The content of the inspection document shall be in accordance with EN 10168 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 document 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-D99 leak tightness test;
- Z validation.

**9.2.2.3** For tubes supplied with specific inspection the inspection certificate 3.1 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-C13 tensile test;
- C60-C69 other tests;
- C71-C92 chemical composition;
- D01 marking, surface appearance, shape and dimensional properties;
- D02-D99 leak tightness test;

- Reference to welding procedure approval;
- Reference to welder and/or welding operator approval;
- Reference to non-destructive testing operators approval;



— Z validation

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

### 9.3 Summary of inspection and testing

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

**Table 5 — Summary of inspection and testing**

Type of inspection or test	Frequency of testing <sup>a</sup>		Reference
	Non-specific inspection	Specific inspection	
Chemical analysis	M	M	8.2
Tensile test	M	One per test unit	8.3, 11.1
Flattening test or Drift expanding test <sup>b</sup>	M	2 per test unit	11.2
			11.3
Verification of leak tightness	Individual	Individual	8.4.3, 11.4
Dimensional inspection	M	M	8.5, 11.5
Visual inspection	M	M	11.6
<sup>a</sup> M: According to manufacturer's procedure.			
<sup>b</sup> The test method is at the discretion of the manufacturer.			

## 10 Sampling

### 10.1 Test unit

A test unit is defined as a quantity of tubes of the same steel grade and dimensions manufactured by the same process and in the same delivery condition, heat treated in the same batch and the same heat treatment facility<sup>1)</sup>.

A test unit shall comprise not more than 500 mill lengths (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 piece for the tensile test

The test piece shall be prepared in accordance with EN 10002-1.

#### 10.2.3 Test piece for the flattening and drift expanding test

The test piece shall consist of a full tube section, in accordance with EN ISO 8492 or EN ISO 8493 respectively.

1) In the case of a continuous furnace a batch is the lot heat treated without intermission with the same process parameters.

## 11 Test methods

### 11.1 Tensile test

The test shall be carried out at room temperature in accordance with EN 10002-1, 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 after fracture with a reference to a gauge length  $L_0$  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  $L_0 = 5,65 \sqrt{S_0}$  using the conversion tables given in EN ISO 2566-1.

### 11.2 Flattening test

The test shall be carried out in accordance with EN ISO 8492 with the weld placed at 90° to the direction of flattening, provided the wall thickness is less than 15 % of the outside diameter. The tube section shall be flattened in a press until the distance  $H$  between the platens reaches the value calculated by the following formula:

$$H = \frac{(1+C)}{C+T/D} x T$$

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 a constant, the value of which is:

0,10 for steel grade E155,

0,09 for steel grades E195 and E235,

0,07 for steel grades E275 and E355.

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

### 11.3 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  $D$  shown in Table 6 is reached.

**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

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

## 11.4 Leak tightness test

### 11.4.1 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 6 is specified:

$$P = 20 \frac{S \times T}{D}$$

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 6** A test pressure corresponding to a strength level of  $\leq 95$  % 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.

### 11.4.2 Electromagnetic test

The test shall be carried out in accordance with EN 10246-1.

## 11.5 Dimensional inspection

Specified dimensions shall be verified.

## 11.6 Visual examination

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

### 11.7 Retests, sorting and reprocessing

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

## 12 Marking

The following marking shall, unless option 7 is specified, 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 8 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 7** *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 8 or 9 is specified. The manufacturer shall take appropriate measures to prevent ingress of foreign matter into the tube.

**Option 8** *The tubes shall be phosphatized before temporary protection.*

**Option 9** *The external surface of the tubes shall be electrolytically zinc coated and given a treatment to minimise "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 10** *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  $\geq 12$  mm outside diameter, unless option 11 is specified.

**Option 11** *The method of packaging shall be as specified by the purchaser.*

Care shall be taken in handling and transportation to avoid surface and straightness damage.

## Annex ZA (informative)

### Relationship between this European Standard and the Essential Requirements of 97/23/EC

This European standard 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 97/23/EC.

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 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 Directive 97/23/EC**

<b>Clauses/sub-clauses of this EN</b>	<b>Pressure Equipment Directive 97/23/EC Annex I</b>	<b>Content</b>
7.2.2	3.1.2	Welding
7.2.3	3.1.3	NDT personnel
8.3	4.1a	Appropriate material properties
7.2 and 8.4	4.1d	Suitable for the processing procedures
9 and 10	4.3	Documentation

**WARNING:** Other requirements and other EC Directives may be applicable to the product(s) falling within the scope of this standard.

## Bibliography

- [1] EN 473, *Non-destructive testing – Qualification and certification of NDT personnel – General principles*.



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