BRITISH STANDARD

BS EN 10305-2:2002

Incorporating Corrigendum No. 1

Steel tubes for precision applications — Technical delivery conditions —

Part 2: Welded cold drawn tubes

The European Standard EN 10305-2:2002 has the status of a British Standard

ICS 77.140.75

BSI British Standards

National foreword

This British Standard is the official English language version of EN 10305-2:2002. Together with BS EN 10305-3 and BS EN 10305-6, it supersedes BS 6323-6:1982 which will be withdrawn upon publication of BS EN 10305-6. Together with BS EN 10305-1, BS EN 10305-3, BS EN 10305-4, BS EN 10305-5 and BS EN 10305-6, BS EN 10296-1 and BS EN 10296-2 and BS EN 10297-1, it also supersedes BS 6323-1:1982, which will be withdrawn upon publication of all the standards in the series.

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.

Cross-references

The British Standards which implement international or European publications referred to in this document may be found in the BSI Catalogue under the section entitled "International Standards Correspondence Index", or by using the "Search" facility of the *BSI Electronic Catalogue* or of British Standards Online.

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Summary of pages

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EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 10305-2

November 2002

ICS 77.140.75

English version

Steel tubes for precision applications - Technical delivery conditions - Part 2: Welded cold drawn tubes

Tubes de précision en acier - Conditions techniques de livraison - Partie 2: Tubes soudés étirés à froid

Präzisionsstahlrohre - Technische Lieferbedingungen - Teil 2: Geschweißte kaltgezogene Rohre

This European Standard was approved by CEN on 2 October 2002.

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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 Management Centre has the same status as the official versions.

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Contents

Foreword

This document EN 10305-2:2002 has been prepared by Technical Committee ECISS /TC 29, "Steel tubes and fittings for steel tubes" 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 May 2003, and conflicting national standards shall be withdrawn at the latest by May 2003.

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 cold sized square and rectangular tubes.*

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

In this European Standard the annex A is informative.

This document includes a Bibliography.

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

1 Scope

This Part of EN 10305 specifies the technical delivery conditions for welded cold drawn steel tubes of circular cross section for precision application.

NOTE This Part of EN 10305 may also be applicable to other types of cross section.

Tubes according to this Part of EN 10305 are characterized by having precisely defined tolerances on dimensions and a specified surface roughness. Typical fields of application are in the vehicle, furniture and general engineering industries.

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 these 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 steel — 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 10204, *Metallic products — Types of inspection documents.*

EN 10233, *Metallic materials — Tube — Flattening test.*

EN 10234, *Metallic materials — Tube — Drift expanding test.*

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 10246-3, *Non-destructive testing of steel tubes — Part 3 : Automatic eddy current testing of seamless and welded (except submerged arc-welded) steel tubes for the detection of imperfections.*

EN 10246-5, *Non-destructive testing of steel tubes — Part 5 : Automatic full peripheral magnetic transducer/flux leakage testing of seamless and welded (except submerged arc-welded) ferromagnetic steel tubes for the detection of longitudinal imperfections.*

EN 10246-7, *Non-destructive testing of steel tubes — Part 7 : Automatic full peripheral ultrasonic testing of seamless and welded (except submerged arc-welded) steel tubes for the detection of longitudinal imperfections.*

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

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).*

prEN 10168[1)], *Iron and steel products — Inspection documents — List of information and description.*

ENV 10220, *Seamless and welded steel tubes — Dimensions and masses per unit length.*

prEN 10266[1)], *Steel tubes, fittings and structural hollow sections — Definitions and symbols for use in product standards.*

EN ISO 4287, *Geometrical product specifications (GPS) - Surface texture: Profile method - Terms, definitions and surface texture parameters (ISO 4287:1997).*

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, prEN 10266 and the following apply.

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

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

4 Symbols

See prEN 10266.

NOTE In this Part of EN 10305 "T" is the specified or the calculated wall thickness.

5 Classification and designation

5.1 Classification

In accordance with the classification system in EN 10020 the steel grades given in Table 2 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; EN 10305-2;

plus either:

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

— the steel number in accordance with EN 10027-2.

1) In preparation, until this document is published as a European Standard a corresponding national standard should be agreed at the time of enquiry and order.

6 Information to be supplied by the purchaser

6.1 Mandatory information

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

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

b) the term "tube";

c) the dimensions (see 8.5);

d) the designation of the steel grade in accordance with this Part of EN 10305 (see 5.2);

e) the delivery condition including the surface condition (see 7.2.1 and 7.2.2);

f) the type of tube length and, where applicable, the length (see 8.5.2).

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 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) specification of a steel grade not specified in this Part of EN 10305 (see 8.2);

2) surface condition for further processing (see 8.4.1.1);

3) measurement of surface roughness (see 8.4.1.5);

4) lower surface roughness (see 8.4.1.5);

5) defined removable substances on surface (see 8.4.1.6);

6) non-destructive testing for the detection of longitudinal imperfections (see 8.4.2);

7) non-destructive testing for verification of leak tightness (see 8.4.2);

8) tubes specified by outside or inside diameter and wall thickness (see 8.5.1.1);

9) agreement on a cross section other than circular (see 8.5.1.1);

10) reduced diameter tolerances (see 8.5.1.2);

11) diameter tolerances unilateral (see 8.5.1.2);

12) reduced wall thickness tolerance (see 8.5.1.3);

13) wall thickness tolerances unilateral (see 8.5.1.3);

14) agreement on a tolerance for exact lengths ≤ 500 mm or > 8000 mm (see Table 7);

15) special end finishing (see 8.5.4);

16) specific inspection (see 9.1);

17) inspection certificates 3.1.A or 3.1.C (see 9.2.1);

18) flattening or drift expanding test (see Table 8);

19) test unit with tubes from one cast only (see 10.1);

20) alternative marking (see clause 12);

21) delivery without corrosion protection (see clause 13);

22) specified corrosion protection (see clause 13);

23) specified method of packaging (see clause 13).

6.3 Example of an order

12 000 m tube with an outside diameter of 60 mm and an inside diameter of 56 mm in accordance with this Part of EN 10305, made of steel grade E235 in the normalized condition, delivered in random lengths, with a 3.1.B inspection certificate in accordance with EN 10204 :

12 000 m tube - 60 x ID 56 - EN 10305-2 - E235 +N - random length – Option 16

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 condition

7.2.1 The tubes shall be manufactured from electric welded pre-tubes by cold drawing or other suitable processes. The tubes shall not include welds used for joining lengths of flat rolled strip prior to forming the pre-tube.

7.2.2 The tubes shall be supplied in one of the delivery conditions given in Table 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 appropriate standards, e.g. EN 473 and EN 10256.

Table 1 — Delivery conditions

Designation	Symbol[a]	Description
Cold drawn / hard	+C	No heat treatment after the final cold drawing process.
Cold drawn / soft	+LC	After the final heat treatment there is a suitable drawing pass.
Cold drawn and stress relieved	+SR	After the final cold drawing process there is a stress relieve heat treatment in a controlled atmosphere.
Annealed	+A	After the final cold drawing process the tubes are annealed in a controlled atmosphere.
Normalized	+N	After the final cold drawing operation the tubes are normalized in a controlled atmosphere.

[a] Former frequently used corresponding heat treatment symbols are given in Table A.1.

8 Requirements

8.1 General

The tubes, when supplied in a delivery condition indicated in Table 1 and 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 2. A steel grade not specified in this Part of EN 10305 may be specified (see Option 1).

***Option 1**:* A steel grade not specified in this Part of EN 10305 with a maximum total content of alloying elements of 5 % is specified. Chemical composition, mechanical properties and delivery condition are specified by the purchaser.

NOTE When subsequently welding tubes are 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 and the delivery condition, but also on the conditions of preparing for and carrying out the welding.

Table 2 — Chemical composition (cast analysis) [a]

Steel grade		% 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	0,025
E195	1.0034	0,15	0,35	0,70	0,025	0,025
E235	1.0308	0,17	0,35	1,20	0,025	0,025
E275	1.0225	0,21	0,35	1,40	0,025	0,025
E355 [b]	1.0580	0,22	0,55	1,60	0,025	0,025

[a] Elements not included in this Table (but see footnote b) shall not be intentionally added to the steel without the agreement of the purchaser, except for elements which may be added for finishing the cast. All appropriate measures shall be taken to prevent the addition of undesirable elements from scrap or other materials used in the steel making process.

[b] Additions of Nb, Ti and V are permitted at the discretion of the manufacturer. The content of these elements shall be reported.

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

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

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	≤ 0,025	+ 0,005

8.3 Mechanical properties

The mechanical properties of the tubes shall conform to the requirements of Table 4 and, if applicable, 11.2 or 11.3.

NOTE Subsequent processing (cold or hot) may change the mechanical properties.

Table 4 — Mechanical properties at room temperature

Steel grade		Minimum values for the delivery condition [a] [b]											
		+C [c]		+LC [c]		+SR			+A [d]		+N		
Steel name	Steel number	R_m MPa	A %	R_m MPa	A %	R_m MPa	R_{eH} MPa	A %	R_m MPa	A %	R_m MPa	R_{eH} [e] MPa	A %
E155	1.0033	400	6	350	10	350	245	18	260	28	270 to 410	155	28
E195	1.0034	420	6	370	10	370	260	18	290	28	300 to 440	195	28
E235	1.0308	490	6	440	10	440	325	14	315	25	340 to 480	235	25
E275	1.0225	560	5	510	8	510	375	12	390	21	410 to 550	275	21
E355	1.0580	640	4	590	6	590	435	10	450	22	490 to 630	355	22

[a] R_m : tensile strength ; R_{eH} : upper yield strength (but see 11.1) ; A : elongation after fracture. For symbols for the delivery condition see Table 1.

[b] 1 MPa = 1 N/mm$^{2.}$

[c] Depending on the degree of cold work in the finishing pass the yield strength may nearly be as high as the tensile strength. For calculation purposes the following relations are recommended:

- for delivery condition +C : $R_{eH} \geq 0{,}8\ R_m$
- for delivery condition +LC : $R_{eH} \geq 0{,}7\ R_m$

[d] For calculation purposes the following relation is recommended : $R_{eH} \geq 0{,}5\ R_{m.}$

[e] For tubes with outside diameter ≤ 30 mm and wall thickness ≤ 3 mm the R_{eH} minimum values are 10 MPa lower than the values given in this Table.

8.4 Appearance and internal soundness

8.4.1 Appearance

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

Option 2: A surface conditions suitable for special further processing is specified by the purchaser.

8.4.1.2 Any surface imperfections, whose depth cannot be clearly identified (i.e. scales, overlaps) shall be either dressed in accordance with 8.4.1.3 or treated in accordance with 8.4.1.4.

8.4.1.3 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.

8.4.1.4 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.

8.4.1.5 The tubes shall have smooth outer and inner surfaces with a roughness $R_a \leq 4$ µm. Verification of surface roughness and/or lower roughness values may be specified (see Options 3 and 4).

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

Option 3: The surface roughness shall be measured and reported.

Option 4: The tubes shall have a specified surface roughness. Type and limiting value of roughness shall be agreed at the time of enquiry and order. The roughness shall be measured and reported.

8.4.1.6 Tubes in the delivery condition +C or +LC normally have thin layers of lubricant and lubricant carrier as a result of the cold finishing process.

Option 5: The tube surface shall only bear residual substances which can be easily removed during processing of the tube. Specific requirements shall be agreed.

Tubes in the delivery condition +SR may have thin layers of lubricant and lubricant carrier partially transformed during stress relieve annealing. Tubes in the delivery condition +SR, +A or +N shall be free of loose scale but may show discoloration.

8.4.2 Internal soundness

Verification of internal soundness by non-destructive testing may be specified by the purchaser (see Options 6 and 7).

Option 6: Non-destructive testing for the detection of longitudinal imperfections shall be carried out according to 11.7.1.

Option 7: Non-destructive testing for verification of leak tightness shall be carried out in accordance with 11.7.2.

8.5 Dimensions and tolerances

8.5.1 Outside diameter, inside diameter and wall thickness

8.5.1.1 Circular tubes (but see Option 8) shall be specified by the outside and the inside diameter, unless option 9 is specified.

Option 8: An agreed cross section other than circular is specified.

Option 9: The tubes shall be specified by outside diameter and wall thickness or by inside diameter and wall thickness.

8.5.1.2 Diameters and wall thicknesses based with minor modifications on sizes in ENV 10220, as well as diameter tolerances, are given in Table 5.

For intermediate sizes the tolerances of the next greater size apply.

The diameter tolerances include the out-of-roundness.

The diameter tolerances given in Table 5 apply for tubes in delivery condition +C or +LC. Depending on the ratio of wall thickness and diameter the diameter tolerances of heat treated tubes in delivery condition +SR, +A and +N are given by consideration of the corrective factors in Table 6. Other diameter tolerances may be specified (see Options 10 and 11).

Table 5 — Sizes and tolerances

Specified outside diameter *D* with tolerance ranges		Wall thickness																				
		0,5	0,8	1	1,2	1,5	1.8	2	2,2	2,5	2,8	3	3,5	4	4,5	5	5,5	6	7	8	9	10
		Specified inside diameter and tolerances																				
4	±0,08	3±0,15	2,4±0,15	2±0,15																		
5		4±0,15	3,4±0,15	3±0,15																		
6		5±0,15	4,4±0,15	4±0,15																		
7		6±0,15	5,4±0,15	5±0,15	4,6±0,15	4±0,15																
8		7±0,15	6,4±0,15	6±0,15	5,6±0,15	5±0,15																
9		8±0,15	7,4±0,15	7±0,15	6,6±0,15	6±0,15																
10		9±0,15	8,4±0,15	8±0,15	7,6±0,15	7±0,15	6,4±0,15	6±0,15														
12		11±0,15	10,4±0,15	10±0,15	9,6±0,15	9±0,15	8,4±0,15	8±0,15														
14		13±0,08	12.4±0,08	12±0,08	11,6±0,15	11±0,15	10,4±0,15	10±0,15	9,6±0,15	9±0,15												
15		14±0,08	13,4±0,08	13±0,08	12,6±0,08	12±0,15	11,4±0,15	11±0,15	10,6±0,15	10±0,15												
16		15±0,08	14,4±0,08	14±0,08	13,6±0,08	13±0,08	12,4±0,15	12±0,15	11,6±0,15	11±0,15												
18		17±0,08	16,4±0,08	16±0,08	15,6±0,08	15±0,08	14,4±0,08	14±0,08	13,6±0,15	13±0,15	12,4±0,15	12±0,15	11±0,15									
20		19±0,08	18,4±0,08	18±0,08	17,6±0,08	17±0,08	16,4±0,08	16±0,08	15,6±0,15	15±0,15	14,4±0,15	14±0,15	13±0,15	12±0,15								
22		21±0,08	20,4±0,08	20±0,08	19,6±0,08	19±0,08	18,4±0,08	18±0,08	17,6±0,08	17±0,15	16,4±0,15	16±0,15	15±0,15	14±0,15								
25		24±0,08	23,4±0,08	23±0,08	22,6±0,08	22±0,08	21,4±0,08	21±0,08	20,6±0,08	20±0,08	19,4±0,15	19±0,15	18±0,15	17±0,15	16±0,15							
26		25±0,08	24,4±0,08	24±0,08	23,6±0,08	23±0,08	22,4±0,08	22±0,08	21,6±0,08	21±0,08	20,4±0,15	20±0,15	19±0,15	18±0,15	17±0,15							
28		27±0,08	26,4±0,08	26±0,08	25,6±0,08	25±0,08	24,4±0,08	24±0,08	23,6±0,08	23±0,08	22,4±0,08	22±0,15	21±0,15	20±0,15	19±0,15							
30		29±0,08	28,4±0,08	28±0,08	27,6±0,08	27±0,08	26,4±0,08	26±0,08	25,6±0,08	25±0,08	24,4±0,08	24±0,15	23±0,15	22±0,15	21±0,15	20±0,15						
32	±0,15	31±0,15	30,4±0,15	30±0,15	29,6±0,15	29±0,15	28,4±0,15	28±0,15	27,6±0,15	27±0,15	26,4±0,15	26±0,15	25±0,15	24±0,15	23±0,15	22±0,15						
35		34±0,15	33,4±0,15	33±0,15	32,6±0,15	32±0,15	31,4±0,15	31±0,15	30,6±0,15	30±0,15	29,4±0,15	29±0,15	28±0,15	27±0,15	26±0,15	25±0,15						
38		37±0,15	36,4±0,15	36±0,15	35,6±0,15	35±0,15	34,4±0,15	34±0,15	33,6±0,15	33±0,15	32,4±0,15	32±0,15	31±0,15	30±0,15	29±0,15	28±0,15	27±0,15					
40		39±0,15	38,4±0,15	38±0,15	37,6±0,15	37±0,15	36,4±0,15	36±0,15	35,6±0,15	35±0,15	34,4±0,15	34±0,15	33±0,15	32±0,15	31±0,15	30±0,15	29±0,15					
42	±0,20			40±0,20	39,6±0,20	39±0,20	38,4±0,20	38±0,20	37,6±0,20	37±0,20	36,4±0,20	36±0,20	35±0,20	34±0,20	33±0,20	32±0,20	31±0,20					
45				43±0,20	42,6±0,20	42±0,20	41,4±0,20	41±0,20	40,6±0,20	40±0,20	39,4±0,20	39±0,20	38±0,20	37±0,20	36±0,20	35±0,20	34±0,20	33±0,20				
48				46±0,20	45,6±0,20	45±0,20	44,4±0,20	44±0,20	43,6±0,20	43±0,20	42,4±0,20	42±0,20	41±0,20	40±0,20	39±0,20	38±0,20	37±0,20	36±0,20				
50				48±0,20	47,6±0,20	47±0,20	46,4±0,20	46±0,20	45,6±0,20	45±0,20	44,4±0,20	44±0,20	43±0,20	42±0,20	41±0,20	40±0,20	39±0,20	38±0,20				
55	±0,25			53±0,25	52,6±0,25	52±0,25	51,4±0,25	51±0,25	50,6±0,25	50±0,25	49,4±0,25	49±0,25	48±0,25	47±0,25	46±0,25	45±0,25	44±0,25	43±0,25	41±0,25			
60				58±0,25	57,6±0,25	57±0,25	56,4±0,25	56±0,25	55,6±0,25	55±0,25	54,4±0,25	54±0,25	53±0,25	52±0,25	51±0,25	50±0,25	49±0,25	48±0,25	46±0,25			
65	±0,30			63±0,30	62,6±0,30	62±0,30	61,4±0,30	61±0,30	60,6±0,30	60±0,30	59,4±0,30	59±0,30	58±0,30	57±0,30	56±0,30	55±0,30	54±0,30	53±0,30	51±0,30			
70				68±0,30	67,6±0,30	67±0,30	66,4±0,30	66±0,30	65,6±0,30	65±0,30	64,4±0,30	64±0,30	63±0,30	62±0,30	61±0,30	60±0,30	59±0,30	58±0,30	56±0,30			
75	±0,35			73±0,35	72,6±0,35	72±0,35	71,4±0,35	71±0,35	70,6±0,35	70±0,35	69,4±0,35	69±0,35	68±0,35	67±0,35	66±0,35	65±0,35	64±0,35	63±0,35	61±0,35	59±0,35		
80				78±0,35	77,6±0,35	77±0,35	76,4±0,35	76±0,35	75,6±0,35	75±0,35	74,4±0,35	74±0,35	73±0,35	72±0,35	71±0,35	70±0,35	69±0,35	68±0,35	66±0,35	64±0, 35		
85	±0,40					82±0,40	81,4±0,40	81±0,40	80,6±0,40	80±0,40	79,4±0,40	79±0,40	78±0,40	77±0,40	76±0,40	75±0,40	74±0,40	73±0,40	71±0,40	69±0,40		
90						87±0,40	86,4±0,40	86±0,40	85,6±0,40	85±0,40	84,4±0,40	84±0,40	83±0,40	82±0,40	81±0,40	80±0,40	79±0,40	78±0,40	76±0,40	74±0,40		
95	±0,45							91±0,45	90,6±0,45	90±0,45	89,4±0,45	89±0,45	88±0,45	87±0,45	86±0,45	85±0,45	84±0,45	83±0,45	81±0,45	79±0,45		
100								96±0,45	95,6±0,45	95±0,45	94,4±0,45	94±0,45	93±0,45	92±0,45	91±0,45	90±0,45	89±0,45	88±0,45	86±0,45	84±0,45	82±0,45	80±0,45
110	±0,50							106±0,50	105,6±0,50	105±0,50	104,4±0,50	104±0,50	103±0,50	102±0,50	101±0,50	100±0,50	99±0,50	98±0,50	96±0,50	94±0,50	92±0,50	90±0,50
120								116±0,50	115,6±0,50	115±0,50	114,4±0,50	114±0,50	113±0,50	112±0,50	111±0,50	110±0,50	109±0,50	108±0,50	106±0,50	104±0,50	102±0,50	100±0,50
130	±0,70									125±0,70	124,4±0,70	124±0,70	123±0,70	122±0,70	121±0,70	120±0,70	119±0,70	118±0,70	116±0,70	114±0,70	112±0,70	110±0,70
140										135±0,70	134,4±0,70	134±0,70	133±0,70	132±0,70	131±0,70	130±0,70	129±0,70	128±0,70	126±0,70	124±0,70	122±0,70	120±0,70
150	±0,80											144±0,80	143±0,80	142±0,80	141±0,80	140±0,80	139±0,80	138±0,80	136±0,80	134±0,80	132±0,80	130±0,80
														↑=0,025*D*						↑ *T*=0,05*D*		

Table 6 — Diameter tolerances for heat treated tubes

T/D-ratio	Tolerance limits of Table 5 to be multiplied by
≥ 0,05	1
0,05 > *T/D* ≥ 0,025	1,5
< 0,025	2

Option 10: The tolerances of the outside and the inside diameter shall be in accordance with Table 5 divided by 2, with a minimum of ± 0,05 mm.

Option 11: The diameter tolerances shall be unilateral, with the corresponding tolerance ranges specified in Table 5.

8.5.1.3 Tubes specified by outside diameter and wall thickness or by inside diameter and wall thickness shall have a wall thickness tolerance of ± 7,5 %, limited however to a maximum of ± 0,35 mm and a minimum ± 0,05 mm, unless Options 12 or 13 is specified.

Option 12: A reduced wall thickness tolerance shall be applied. The value shall be agreed at the time of enquiry and order.

Option 13: The wall thickness tolerance shall be unilateral, with the tolerance range specified in 8.5.1.3.

8.5.2 Lengths

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

— random length; or

— approximate length; or

— exact length.

They are defined as follows:

a) random length : length with a minimum of 3 m and a maximum of 8 m. The maximum range shall be 2 m per order item;

The purchaser shall be informed of the delivery range at the time of enquiry and order.

b) approximate length: specified length with a tolerance of ± 500 mm;

Up to 10 % of the quantity ordered may have lengths other than specified but not shorter than 2 m. Those quantities shall be bundled separately.

c) exact length: specified length with tolerances as given in Table 7. For lengths ≤ 500 mm or > 8 000 m, tolerances shall be agreed (see Option 14).

Option 14: An agreed unilateral tolerance is specified for the exact length.

Table 7 — Tolerances for exact lengths

Length *L* mm	Tolerance mm
≤ 500	[a]
500 < *L* ≤ 2 000	+ 3 0
2 000 < *L* ≤ 5 000	+ 5 0
5 000 < *L* ≤ 8 000	+ 10 0
> 8 000	[a]
[a] See Option 14.	

8.5.3 Straightness

For tubes with an outside diameter greater than 15 mm the deviation from straightness of any tube length *L* shall not exceed:

— 0,0015 *L* for $R_{eH} \leq 500$ MPa ;

— 0,002 *L* for $R_{eH} > 500$ MPa.

Deviations from straightness over one metre length shall not exceed 3 mm.

NOTE 1 For tubes with an outside diameter of ≤ 15 mm a deviation from specified straightness and the inspection method to be used may be agreed at the time of enquiry and order.

NOTE 2 Short exact lengths below 1 000 mm may have a deviation from specified straightness of 0,003 *L*.

8.5.4 Preparation of ends

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

NOTE Due to the cutting method the ends of random lengths and approximate lengths can have diameters outside the tolerance limits given in 8.5.1.2.

Option 15: A specified end finishing shall be carried out.

9 Inspection

9.1 Types of inspection

The compliance with the requirements of the order shall be checked by non-specific inspection, unless Option 16 is specified.

Option 16: Tubes shall be subjected to specific inspection.

9.2 Inspection documents

9.2.1 Types of inspection documents

Unless otherwise specified a test report 2.2 in accordance with EN 10204 shall be issued.

When specific inspection is requested an inspection certificate 3.1.B in accordance with EN 10204 shall be issued, unless Option 17 is specified.

Option 17: An inspection certificate 3.1.A or 3.1.C shall be issued.

When option 17 is specified the purchaser shall supply to the manufacturer the name and address of the organization or person nominated to carry out the inspection and to issue and validate 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 prEN 10168 as shown in 9.2.2.1 and 9.2.2.2.

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 and identification, surface appearance, shape and dimensional properties;

Z validation.

9.2.2.3 For tubes supplied with specific inspection the inspection certificate 3.1.A, 3.1.B or 3.1.C 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 tests;

C60 to C69 other tests;

C71 to C92 chemical composition (cast analysis);

D01 marking and identification, surface appearance, shape and dimensions;

D02 to D99 other (optional) tests (e.g. roughness measurement, NDT for defects);

Z validation.

9.3 Summary of inspection and testing

Inspection and testing shall be carried out as stated in Table 8 and 10.1.

Table 8 — 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
	Dimensional inspection	M	M	8.5, 11.4
	Visual examination	M	M	11.6
Optional	Flattening test or drift expanding test (Option 18) [b]	M	One per test unit	11.2, 11.3
	Roughness measurement	not applicable	One per test unit	8.4.1.5, 11.5
	NDT for longitudinal imperfections	not applicable	Individual	8.4.2, 11.7.1
	NDT for verification of leak-tightness			8.4.2, 11.7.2

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

[b] ***Option 18:*** A flattening or a drift expanding test shall be carried out, the test method is at the discretion of the manufacturer. This option only applies for tubes supplied in the annealed or normalized delivery condition.

10 Sampling

10.1 Test unit

A test unit is defined as a quantity of tubes of the same steel grade and dimensions continuously manufactured by the same process and in the same delivery condition heat treated, where applicable, in the same batch and the same heat treatment facility [2)].

A test unit shall comprise not more than 3 000 m or 500 tubes whichever is the greater mass. Residual quantities of less than 50 tubes may be added to test units evenly.

Option 19: The test unit shall only contain tubes from one cast.

10.2 Preparation of samples and test pieces

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

10.2.1.1 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.

10.2.1.2 Test piece for the tensile test

The test piece shall be prepared in accordance with EN 10002-1. At the manufacturer's discretion the test piece shall be either a full tube section or a strip section taken in a direction longitudinal to the axis of the tube.

10.2.1.3 Test piece for the flattening or drift expanding test

The test piece shall consist of a full tube section, in accordance with EN 10233 or EN 10234 respectively.

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

10.2.2 Test piece for roughness measurement

The test piece 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 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 ($R_{p0,2}$) or the 0,5 % proof strength (total extension) ($R_{t0,5}$) shall be determined. In case of dispute the 0,2 % proof strength ($R_{p0,2}$) shall apply ;

— the percentage elongation after fracture shall be reported 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 10233 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 given by the following formula:

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

where:

H is the distance between the 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 given in Table 9.

Table 9 — Values of constant C (delivery conditions +A and +N)

Steel grade		*C*
Steel name	**Steel number**	
E155	1.0033	0,10
E195	1.0034	0,09
E235	1.0308	0,09
E275	1.0225	0,07
E355	1.0580	0,07

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 10234 with a 60° conical mandrel. The tube section shall be expanded until the percentage increase in outside diameter shown in Table 10 is reached.

Table 10 — Requirements for the drift expanding test (delivery conditions +A and +N)

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 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.

11.4 Dimensional inspection

Specified dimensions, including straigthness, shall be verified using adequate methods. Where diameter measurements are carried out, they shall be at a distance of ≥ 100 mm off the tube ends.

11.5 Roughness measurement

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

11.6 Visual examination

The tubes shall be visually examined for compliance with the requirements of 8.4.1.

11.7 Non-destructive testing

11.7.1 Testing for 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:

— eddy current testing: EN 10246-3, acceptance level E3 ;

— magnetic transducer/flux leakage testing: EN 10246-5, acceptance level F3 ;

— ultrasonic testing: EN 10246-7, acceptance level U3.

11.7.2 Leak-tightness

Non-destructive testing for verification of leak-tightness shall be carried out in accordance with EN 10246-1.

11.8 Retests, sorting and reprocessing

For retests, sorting and reprocessing EN 10021 applies.

12 Marking

The following marking shall, unless Option 20 is specified, be shown on a label attached to the bundle:

— the manufacturer's name or trade mark;

— the specified dimensions;

— the number of this European Standard;

— the steel name or number;

— the cast number, when Option 19 applies;

— the delivery condition;

— 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 20: Alternative marking is specified.

13 Protection and packaging

The tube shall be delivered with a temporary corrosion protection. The type of protection shall be at the discretion of the manufacturer, unless Options 21 or 22 is specified.

Option 21: The tubes shall be delivered without corrosion protection.

Option 22: The tubes shall be delivered with a specified corrosion protection to be agreed at the time of enquiry and order.

NOTE Unprotected tubes are prone to corrosion at any stage of storage or transportation.

Where appropriate, the tubes shall be delivered in bundles securely banded.

Option 23: 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 A
(informative)

List of corresponding former symbols for delivery conditions and national steel designations

Table A.1 — List of corresponding former frequently used symbols of the delivery condition

Symbol in accordance with this Part of EN 10305 (from CR 10260)	Former symbol
+C	BK
+LC	BKW
+SR [a]	BKS
+A	GBK
+N	NBK
[a] This symbol will be considered in revised EN 10027-1 combining both EN 10027-1 and CR 10260.	

Table A.2 — List of corresponding former designations

Steel name in accordance with this Part of EN 10305	Former	
	Steel name	National standard
E155	CEW 1	BS 6323-6:1982 (1990)
E195	CEW 2	BS 6323-6:1982 (1990)
	RSt34-2	DIN 2393:1994
	TS-30a	NF A 49-341:1975
E235	CEW 4	BS 6323-6:1982 (1990)
	RSt 37-2	DIN 2393:1994
	TS-34a	NF A 49-341:1975
E275	CEW 4	BS 6323-6:1982 (1990)
	St 44-2	DIN 2393:1994
	TS-42a	NF A 49-341:1975
E355	CEW 5	BS 6323-6:1982 (1990)
	St 52-3	DIN 2393:1994
	TS-47a	NF A 49-341:1975
NOTE Corresponding former national steel grades are slightly different from the grades specified in this Part of EN 10305.		

Bibliography

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

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