

Steel tubes for precision applications — Technical delivery conditions —

Part 3: Welded cold sized tubes

The European Standard EN 10305-3:2002 has the status of a
British Standard

ICS 77.140.75

National foreword

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 Together with BS EN 10305-5 and BS EN 10296-1, it will supersede BS 6323-5:1982 which will be withdrawn upon publication of all three BS EN standards. Together with BS EN 10305-2:2002, it supersedes BS 6323-6:1982 which will be withdrawn upon the publication of both standards.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and BS EN 10305-6, BS EN 10296-1 and BS EN 10296-2 and BS EN 10297-1, it also supersedes BS 6323-1:1982, which will be withdrawn upon publication of all the standards in the series.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

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Cross-references

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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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Foreword

This document EN 10305-3:2002 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of an identical text or by endorsement, at the latest by May 2003, and conflicting national standards shall be withdrawn at the latest by May 2003.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 sized steel tubes of circular cross section for precision applications.

NOTE This Part of EN 10305 may also be applicable to non-circular (excluding square and rectangular) cross sections.

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 10246-8, *Non-destructive testing of steel tubes — Part 8 : Automatic ultrasonic testing of the weld seam of electric 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 10305-3:2002 (E)

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

prEN 10168¹⁾, *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 10266¹⁾, *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.

3.2

parent coil

coil originating from the hot rolling process prior to any subsequent operation (pickling, slitting, cold rolling or coating)

4 Symbols

See prEN 10266.

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 10305-3;

plus either:

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

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.

- 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) the quantity (mass or total length or number);
- b) the term “tube”;
- c) the dimensions (see 8.5.1);
- 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 length and the type of tube 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 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) 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) removal of internal weld bead (see 8.4.1.5);
- 4) measurement of surface roughness (see 8.4.1.6);
- 5) lower surface roughness (see 8.4.1.6);
- 6) non-destructive testing of the weld seam for the detection of longitudinal imperfections (see 8.4.2);
- 7) non-destructive testing of the full tube circumference for the detection of longitudinal;
- 8) non-destructive testing for verification of leak-tightness (see 8.4.2);
- 9) specification of an agreed testing procedure of transverse welds for the detection of imperfections (see 8.4.2);
- 10) specification of a cross-section other than circular (see 8.5.1.1);
- 11) reduced diameter tolerances (see 8.5.1.2);
- 12) diameter tolerance unilateral (see 8.5.1.2);
- 13) reduced wall thickness tolerance (see 8.5.1.3);
- 14) wall thickness tolerance unilateral (see 8.5.1.3);
- 15) another specified length and/or tolerance (see 8.5.2);
- 16) agreement on a tolerance for exact lengths ≤ 500 mm or $> 8\ 000$ mm (see 8.5.2);

- 17) special end finishing (see 8.5.4);
- 18) specific inspection (see 9.1);
- 19) inspection certificates 3.1.A or 3.1.C (see 9.2.1);
- 20) flattening or drift expanding test (see Table 9);
- 21) test unit with tubes from one cast only (see 10.1);
- 22) more restrictive requirement on flattening test (see 11.2);
- 23) alternative marking (see clause 12);
- 24) delivery without corrosion protection (see clause 13);
- 25) specified corrosion protection (see clause 13);
- 26) specified method of packaging (see clause 13).

6.3 Example of an order

12 000 m tube with an outside diameter of 40 mm and a wall thickness of 1,5 mm in accordance with this Part of EN 10305, made of steel grade E235 in the normalized condition, pickled, to be delivered in standard lengths of 6 m with an 3.1.B inspection certificate in accordance with EN 10204.

12 000 m tubes – 40 x 1,5 - EN 10305-3 - E235 +N, S2 - 6 m standard length - Option 18

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 steel strip by electric welding. The tubes shall not include welds used for joining lengths of flat rolled strip prior to forming the tube, except for coiled tubes which may be supplied in the delivery conditions +A and +N (for testing see 8.4.2).

Possible surface conditions are:

- S1 (black);
- S2 (pickled);
- S3 (cold rolled);
- S4 (coated to an agreed condition).

NOTE The surface conditions S1 and S3 apply for the strip. The surface condition S2 and S4 may apply for the strip or the tube; the purchaser should, where necessary, indicate the required condition at the time of enquiry and order.

7.2.2 Tubes made of the steel grades E155, E195, E235, E275 and E355 shall be supplied in the delivery condition +CR1 or +A or +N (see Table 1). Tubes made of the grades E190, E220, E260, E320, E370 and E420 shall be supplied in the delivery condition +CR2.

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 levels 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
Welded and cold sized	+CR1 ^b	Normally not heat treated, but suitable for final annealing.
	+CR2 ^c	Not intended for heat treatment after the welding and sizing process
Annealed	+A	After the welding and sizing process the tubes are annealed in a controlled atmosphere.
Normalized	+N	After the welding and sizing process the tubes are normalized in a controlled atmosphere. This delivery condition can be reached via direct processing.
<p>^a Former frequently used corresponding heat treatment symbols are given in Table A.1.</p> <p>^b NOTE 1 After annealing or normalizing, the mechanical properties given in Table 4 for the delivery condition +A or +N, respectively are normally obtained.</p> <p>^c NOTE 2 If further heat treatment is applied, the resulting mechanical properties may be outside the specified requirements.</p>		

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 shall be 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		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	0,025
E190	1.0031	0,10				
E195	1.0034	0,15	0,35	0,70	0,025	0,025
E220	1.0215	0,14				
E235	1.0308	0,17	0,35	1,20	0,025	0,025
E260	1.0220	0,16				
E275	1.0225	0,21	0,35	1,40	0,025	0,025
E320	1.0237	0,20				
E355 ^b	1.0580	0,22	0,55	1,60	0,025	0,025
E370 ^b	1.0261	0,21				
E420 ^b	1.0575	0,16	0,50	1,70	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 permissible 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	≤ 1,70	+ 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 Tables 4 and 5 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 for the delivery conditions +CR1, +A and +N

Steel grade		Minimum values for the delivery condition ^a						
		+CR1 ^{b, c}		+A ^c		+N		
Steel name	Steel number	R_m MPa	A %	R_m MPa	A %	R_m MPa	R_{eH} ^d MPa	A %
E155	1.0033	290	15	260	28	270 to 410	155	28
E195	1.0034	330	8	290	28	300 to 440	195	28
E235	1.0308	390	7	315	25	340 to 480	235	25
E275	1.0225	440	6	390	21	410 to 550	275	21
E355	1.0580	540	5	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 Depending on the degree of cold forming the strip material and sizing the as welded tube, the yield strength may nearly be as high as the tensile strength. For calculation purposes yield strength values of $R_{eH} \geq 0,7 R_m$ are recommended in the +CR1 condition.

^c NOTE The mechanical properties and technological properties of the weld zone may, in the case of the delivery conditions +CR1 and +A, differ from those of the base material.

^d 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.

Table 5 — Mechanical properties (minimum values) at room temperature for the delivery condition +CR2 ^a

Steel grade		Tensile strength	Yield strength	Elongation after fracture
Steel name	Steel number	R_m MPa	R_{eH} MPa	A %
E190	1.0031	270	190	26
E220	1.0215	310	220	23
E260	1.0220	340	260	21
E320	1.0237	410	320	19
E370	1.0261	450	370	15
E420	1.0575	490	420	12

NOTE The mechanical and technological properties of the weld zone may differ from those of the base material.

^a For the symbol for the delivery condition see Table 1.

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 condition 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 external weld bead shall be removed flush with the surface. The internal weld bead shall not be removed, unless Option 3 is specified.

Option 3: The internal weld bead shall be limited to a specified height or be removed.

The wall thickness in the weld area shall not be lower than the specified minimum wall thickness.

8.4.1.6 The tubes shall have smooth outer surfaces with a roughness $R_a \leq 4 \mu\text{m}$. Verification of surface roughness and/or lower roughness values may be specified (see Options 4 and 5).

Option 4: The surface roughness shall be measured and reported.

Option 5: The tubes shall have a lower specified surface roughness. Type and limiting value shall be agreed at the time of enquiry and order. The roughness shall be measured and reported.

Roughness requirements shall not apply to the welded zone.

8.4.1.7 Tubes in the delivery condition +A or +N shall be free of loose scale but may show discoloration.

8.4.2 Internal soundness

Verification of soundness by non-destructive testing may be specified by the purchaser (see Options 6 to 8).

Option 6: Non-destructive testing of the weld seam for the detection of longitudinal imperfections shall be carried out in accordance with 11.7.1.

Option 7: Non-destructive testing of the full tube circumference for the detection of longitudinal imperfections shall be carried out in accordance with 11.7.1.

Option 8: Non-destructive testing for verification of leak tightness shall be carried out in accordance with 11.7.2.

Transverse welds on coiled tubes shall be subjected to an additional testing. The testing method is left to the discretion of the manufacturer, unless Option 9 is specified.

Option 9: An agreed testing procedure for the detection of imperfections in transverse welds is specified.

8.5 Dimensions and tolerances

8.5.1 Outside diameter and wall thickness

8.5.1.1 The tubes shall be specified by outside diameter and wall thickness, unless Option 10 is specified.

Option 10: An agreed cross-section other than circular (but see the note to clause 1) is specified.

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 6.

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 6 apply for tubes in delivery conditions +CR1 and +CR2. Depending on the ratio of wall thickness and diameter the diameter tolerances of heat treated tubes in delivery condition +A and +N

are given by consideration of the corrective factors in Table 7. Other diameter tolerances may be specified (see Options 11 and 12).

Table 6 — Sizes and diameter tolerances

Dimensions in millimetres

Specified outside diameter D with tolerance limits		Wall thickness T																
		0,6	0,8	1	1,2	1,5	1,8	2	2,2	2,5	3	3,5	4	4,5	5	5,5	6	
6	± 0,12																	
8																		
10																		
12																		
15																		
16																		
18																		
19																		
20		± 0,15																
22																		
25																		
28																		
30																		
32	± 0,20																	
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44	± 0,25																	
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48,3																		
50																		
51																		
55	± 0,30																	
57																		
60																		
63,5																		
70	± 0,35																	
76																		
80	± 0,40																	
89																		
90																		
100	± 0,50																	
101,6																		
108	± 0,60																	
114																		
120																		
127	± 0,8																	
133																		
139,7																		
159	± 1,0																	
168																		
193,7																		

Table 7 — Diameter tolerances for heat treated tubes

<i>T/D</i> -ratio	Tolerance of Table 6 to be multiplied by
$\geq 0,05$	1
$0,05 > T/D \geq 0,025$	1,5
$< 0,025$	2

Option 11: An agreed reduced diameter tolerance is specified.

Option 12: The diameter tolerances shall be unilateral, with the corresponding tolerance range specified in Table 6.

8.5.1.3 Depending on the wall thickness *T* the following tolerances are specified:

- $T \leq 1,5$ mm: $\pm 0,15$ mm ;
- $T > 1,5$ mm: $\pm 0,1 T$ or $\pm 0,35$ mm whichever is the smaller.

The plus tolerance does not apply to the weld area. Other wall thickness tolerances may be specified (see Options 13 and 14).

Option 13: A reduced wall thickness tolerance shall be applied. The value shall be agreed at the time of enquiry and order.

Option 14: 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:

- standard length; or
- exact length (but see Option 15).

They are defined as follows:

- a) standard length: a length of 6 m or 6,4 m; the tolerance shall be + 100/0 mm ;
- b) exact length: specified lengths with tolerances as given in Table 8. For lengths ≤ 500 mm or $> 8\ 000$ mm, tolerances shall be agreed (see Option 16).

Table 8 — Tolerances for exact lengths

Length <i>L</i> mm	Tolerance mm
≤ 500	a
$500 < L \leq 2\ 000$	+3 0
$2\ 000 < L \leq 5\ 000$	+5 0
$5\ 000 < L \leq 8\ 000$	+10 0
$> 8\ 000$	a
^a See Option 16.	

Option 15: Another specified length and/or tolerance shall be delivered.

Option 16: An agreed unilateral tolerance is specified for the exact length.

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 0,002 L .

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

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

NOTE 2 Short exact length 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.

Option 17: 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 18 is specified.

Option 18 : 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 (but see Option 19).

Option 19: An inspection certificate 3.1.A or 3.1.C shall be issued.

When Option 19 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 dimensional properties;
- 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 9.

Table 9 — 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 20) ^b	M	One per test unit	11.2, 11.3
	Roughness measurement	not applicable	One per test unit	8.4.1.6, 11.5
	NDT of the weld seam for longitudinal imperfections	not applicable	Each individual tube	8.4.2, 11.7.1
	NDT of the full tube circumference for longitudinal imperfections			8.4.2, 11.7.1
	NDT for verification of leak tightness			8.4.2, 11.7.2
	NDT of the transverse weld seam for imperfections			8.4.2, 11.7.3

^a M : According to manufacturer's procedure.

^b **Option 20:** 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 or the parent coil for non-heat treated tubes, whichever is the greater mass. Residual quantities of less than 50 tubes may be added to test units evenly.

Option 21: 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 is 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.

10.2.2 Test piece for roughness measurement

The test piece should be taken from the same location as for the mechanical tests. At the manufacturer's discretion the test piece shall be either a full tube section or be taken in a direction longitudinal to the axis of a full section at random.

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 with a reference to a gauge length L_0 of $5,65 \sqrt{S_0}$:

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

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 10, unless Option 22 is specified.

Table 10 — 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

Option 22: A higher value of constant C is specified.

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 to EN 10234 with a 60° conical mandrel. The tube section shall be expanded until the percentage increase in outside diameter shown in Table 11 is reached.

Table 11 — 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 straightness, shall be verified. 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 outside the weld bead.

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 of the weld seam or of the full tube circumference for the detection of longitudinal imperfections shall be carried out at the discretion of the manufacturer, either prior or after sizing, 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;
- ultrasonic testing: EN 10246-8, 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.

11.7.3 Testing of transverse welds for imperfections

See 8.4.2 and Option 9.

11.8 Retests, sorting and reprocessing

For retests, sorting and reprocessing EN 10021 applies.

12 Marking

The following marking shall, unless option 23 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 21 applies;
- the delivery condition including the surface condition (symbol);
- 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 23: Alternative marking is specified.

13 Protection and packaging

The tubes shall be delivered with a temporary corrosion protection. The type of protection shall be at the discretion of the manufacturer, unless Options 24 or 25 is specified.

Option 24: The tubes shall be delivered without corrosion protection.

Option 25: 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 26: 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
+CR1	BKM
+CR2	
+A	GBK
+N	NBK

Table A.2 — List of corresponding former steel designations

Steel name in accordance with this Part of EN 10305	Former	
	steel name	national standard
E155	CEW1	BS 6323-6:1982(1990)
E195	CEW2	BS 6323-6:1982 (1990)
	RSt 34-2	DIN 2394:1994
	ES185	NF A 49-646:1997
E220	ES200	NF A 49-646:1997
E235	CEW4	BS 6323-6:1982(1990)
	RSt 37-2	DIN 2394
	ES235	NF A 49-646:1997
E260	ES250	NF A 49-646:1997
E275	CEW4	BS 6323-6:1982(1990)
	St 44-2	DIN 2394:1994
	ES275	NF A 49-646:1997
E320	ES320	NF A 49-646:1997
E355	CEW5	BS 6323-6:1982 (1990)
	St52-3	DIN 2394:1994
	ES355	NF A 49-646:1997
E370	ES380	NF A 49646:1997
E420	ED420	NF A 49-646:1997

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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