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English Version

Steel tubes for precision applications - Technical delivery conditions - Part 1: Seamless cold drawn tubes

Tubes de précision en acier - Conditions techniques de livraison - Partie 1: Tubes sans soudure étirés à froid

Präzisionsstahlrohre - Technische Lieferbedingungen - Teil 1: Nahtlose kaltgezogene Rohre

This European Standard was approved by CEN on 18 January 2016.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
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European foreword

This document (EN 10305-1:2016) has been prepared by Technical Committee ECISS/TC 110 "Steel tubes and iron and steel fittings", the secretariat of which is held by UNI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by September 2016 and conflicting national standards shall be withdrawn at the latest by September 2016.

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

This document supersedes EN 10305-1:2010.

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

a) References were adapted;

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

c) Editorial updates.

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

— *Part 1: Seamless cold drawn tubes*

— *Part 2: Welded cold drawn tubes*

— *Part 3: Welded cold sized tubes*

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

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

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

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

1 Scope

This European Standard specifies the technical delivery conditions for seamless cold drawn steel tubes of circular cross section for precision applications with specified outside diameter $D \leq 380$ mm.

This document may also be applied to other types of cross sections.

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

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 10020:2000, *Definition and classification of grades of steel*

EN 10021:2006, *General technical delivery conditions for steel products*

EN 10027-1, *Designation systems for steels - Part 1: Steel names*

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

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

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

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

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

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

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

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

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

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

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

EN ISO 10893-1, *Non-destructive testing of steel tubes - Part 1: Automated electromagnetic testing of seamless and welded (except submerged arc-welded) steel tubes for the verification of hydraulic leaktightness (ISO 10893-1)*

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

EN ISO 10893-3, *Non-destructive testing of steel tubes - Part 3: Automated full peripheral flux leakage testing of seamless and welded (except submerged arc-welded) ferromagnetic steel tubes for the detection of longitudinal and/or transverse imperfections (ISO 10893-3)*

EN ISO 10893-10, *Non-destructive testing of steel tubes - Part 10: Automated full peripheral ultrasonic testing of seamless and welded (except submerged arc-welded) steel tubes for the detection of longitudinal and/or transverse imperfections (ISO 10893-10)*

ISO 11484, *Steel products - Employer's qualification system for non-destructive testing (NDT) personnel*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 10020:2000, EN 10021:2006, EN 10052:1993, EN 10266:2003 and the following apply.

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

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

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

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

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

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

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

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

3.5
mother tube
length of tube produced in the final cold drawing process

4 Symbols

For the purposes of this document, the symbols in EN 10266:2003 apply.

NOTE For tubes specified by the outside diameter and by the inside diameter, "*T*" is the specified or the calculated wall thickness in this document.

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.

The steel grades given in Table A.1 are classified as follows:

a) non-alloy quality steels (E255, E410, 26Mn5, 10S10, 15S10, 18S10 and 37S10);

b) non-alloy special steels (C35E and C45E); and

c) alloy special steels (26Mo2, 25CrMo4 and 42CrMo4).

5.2 Designation

For the tubes covered by this document, the steel designation consists of the number of this document (EN 10305-1) plus either:

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

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

6 Information to be supplied by the purchaser

6.1 Mandatory information

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

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

b) term “tube”;

c) dimensions (see 8.5);

d) steel designation (see 5.2);

e) delivery condition (see 7.2.2);

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

g) type of inspection document (see 9.1).

6.2 Options

A number of options are specified in this document and these are listed below. In the event that the purchaser does not indicate 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).

- Option 1: specification of a steel grade not specified in this document (see 8.2);
- Option 2: specification of a sulphur range to support machinability (see 8.2);
- Option 3: suitability for hot-dip galvanizing (see 8.2);

- Option 4: surface condition for further processing (see 8.4.1);
- Option 8: measurement of surface roughness (see 8.4.3);
- Option 9: specific surface roughness (see 8.4.3);
- Option 10: tube surfaces free from not easily removable substances (see 8.4.6);
- Option 12: non-destructive testing for the detection of longitudinal imperfections (see 8.4.7);
- Option 13: non-destructive testing for verification of leak-tightness (see 8.4.7);
- Option 15: specification of a cross section other than circular (see 8.5.1.1);
- Option 16: reduced diameter tolerances (see 8.5.1.2);
- Option 17: unilateral diameter tolerances (see 8.5.1.2);
- Option 18: reduced eccentricity (see 8.5.1.3);
- Option 19: reduced wall thickness tolerance (see 8.5.1.4);
- Option 20: unilateral wall thickness tolerance (see 8.5.1.4);
- Option 22: reduced maximum deviation from straightness (see 8.5.3);
- Option 23: specified end finishing (see 8.5.4);
- Option 25: flattening or drift expanding test for delivery condition +A or +N (see Table 8);
- Option 26: test unit with tubes from one cast only (see 10.1);
- Option 28: alternative marking (see Clause 12);
- Option 29: delivery without corrosion protection (see Clause 13);
- Option 30: specified corrosion protection (see Clause 13);
- Option 38: unbundled tubes or specific method of packaging (see Clause 13).

6.3 Example of an order

12 000 m tube with an outside diameter of $D = 60$ mm and an inside diameter of $d = 56$ mm in accordance with this document, made of steel grade E235 in the normalized condition, delivered in random lengths, with a 3.1 inspection certificate in accordance with EN 10204:

12 000 m tube – *D* 60 x *d* 56 – EN 10305-1 – E235+N – random length – inspection certificate 3.1

7 Manufacturing process

7.1 Steelmaking process

The steelmaking process is at the discretion of the manufacturer with the exception that the open hearth (Siemens-Martin) process shall not be employed unless in combination with a secondary steelmaking or ladle refining process.

Steels shall be fully killed.

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

7.2 Tube manufacture and delivery conditions

7.2.1 The tubes shall be manufactured from hot finished seamless hollows by cold drawing.

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 ISO 11484 or, at least, an equivalent to it.

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

The operating authorization issued by the employer shall be in accordance with a written procedure. NDT operations shall be authorized by a level 3 NDT individual approved by the employer.

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

Table 1 — Delivery conditions

Designation	Symbol[a]	Description
Cold drawn / hard	+C	No final heat treatment after final cold drawing.
Cold drawn / soft	+LC	Final heat treatment is followed by a suitable drawing pass (limited reduction of area).
Cold drawn and stress relieved	+SR	After final cold drawing the tubes are stress relieved in a controlled atmosphere.
Soft annealed	+A	After final cold drawing the tubes are soft annealed in a controlled atmosphere.
Normalized	+N	After final cold drawing the tubes are normalized in a controlled atmosphere.
[a] In accordance with EN 10027–1.		

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 document.

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

8.2 Chemical composition

The cast analysis reported by the steel producer shall apply and comply with the requirements of Table 2 (but see options 1 to 3) or Table A.1.

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

Option 1: *A steel grade not specified in this document, with a maximum total content of alloying elements of 5 % and agreed chemical composition, mechanical properties and delivery condition, is specified.*

Table 2 — Chemical composition (cast analysis)

Steel grade		% by mass					
Steel name	**Steel number**	C max.	Si max.	Mn max.	P max.	S[a] max.	Al_{total}[b] min.
E215	1.0212	0,10	0,05	0,70	0,025	0,025	0,025
E235	1.0308	0,17	0,35	1,20	0,025	0,025	0,015
E355	1.0580	0,22	0,55	1,60	0,025	0,025	0,020
Elements not quoted 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 the purposes of deoxidation and/or nitrogen binding. All appropriate measures shall be taken to prevent the addition of undesirable elements from scrap or other materials used in the steel making process.							
[a] See option 2. [b] This requirement is not applicable provided the steel contains a sufficient amount of other nitrogen binding elements, such as Ti, Nb or V. If added, the content of these elements shall be reported in the inspection document. When using titanium, the manufacturer shall verify that (Al + Ti/2) ≥ 0,020.							

Option 2: *For the steel grades E235 and E355 a controlled sulphur content of 0,015 % to 0,040 % is specified to support machinability. It shall be obtained by resulphurizing the steel after maximum desulphurization or alternatively by using a low oxygen process.*

Option 3: *The chemical composition of the specified steel grade shall be such that it is suitable for hot-dip galvanizing (see e.g.* EN ISO 1461 *or* EN ISO 14713-2 *for guidance).*

Table 3 and Table A.2 specify the permissible deviation of product analysis from the specified limits on cast analysis given in Table 2 and Table A.1.

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 % by mass	Permissible deviation of the product analysis % by mass
C	≤ 0,22	+ 0,02
Si	≤ 0,55	+ 0,05
Mn	≤ 1,60	+ 0,10
P	≤ 0,025	+ 0,005
S	≤ 0,040	±0,005
Al	≥ 0,015	- 0,005

8.3 Mechanical properties

The mechanical properties of the tubes shall conform to the requirements of Table 4, Table A.3 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]											
		+C[b]		+LC[b]		+SR			+A[c]		+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}[d] MPa	A %
E215	1.0212	430	8	380	12	380	280	16	280	30	290 to 430	215	30
E235	1.0308	480	6	420	10	420	350	16	315	25	340 to 480	235	25
E355	1.0580	640	4	580	7	580	450[e]	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] 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 relationships are recommended:
— for delivery condition +C: $R_{eH} \geq 0{,}8\ R_m$;
— for delivery condition +LC: $R_{eH} \geq 0{,}7\ R_m$.

[c] For calculation purposes the following relationship is recommended: $R_{eH} \geq 0{,}5\ R_m$.

[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.

[e] For tubes with outside diameter > 160 mm: $R_{eH} \geq 420$ MPa.

8.4 Appearance and internal soundness

8.4.1 The internal and external surface finish of the tubes shall be typical of the manufacturing process and, where applicable, the heat treatment employed.

***Option 4**: A surface condition suitable for special further processing is specified by the purchaser.*

Normally, the finish and surface condition shall be such that any surface imperfections requiring dressing can be identified. Any surface imperfections, which in accordance with the manufacturer's experience might be considered defects as specified in 8.4.4, shall be dressed in accordance with 8.4.5, or the tube or part of tube shall be rejected.

8.4.2 The tubes shall have smooth outer and inner surfaces.

The following maximum values apply for the roughness *Ra*:

a) For tubes of outside diameter $D \leq 260$ mm:

— ≤ 4 µm on the outer surface of tubes in the delivery conditions +SR, +A and +N;

— ≤ 4 µm on the outer and inner surface of tubes in the delivery conditions +C and +LC, where the requirement for the inner surface applies for specified or calculated inside diameters ≥ 15 mm;

b) For tubes of outside diameter $D > 260$ mm: ≤ 6 µm on the outer and inner surface.

8.4.3 Verification of surface roughness and/or improved levels of roughness may be specified (see options 8 and 9).

Option 8: *The surface roughness shall be measured in accordance with 11.5 and reported.*

Option 9: *A specific surface roughness of agreed type and limiting value is specified. The roughness shall be measured and reported.*

8.4.4 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 document.

8.4.5 It shall be permissible to dress, only by grinding or machining, surface imperfections provided that, after doing so, the wall thickness in the dressed area is not less than the specified minimum wall thickness. All dressed areas shall blend smoothly into the contour of the tube.

8.4.6 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.

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.

Option 10: *The tube surfaces shall only bear residual substances which can be easily removed during processing of the tube. Specific requirements shall be agreed at the time of enquiry and order.*

8.4.7 Verification of internal soundness by non-destructive testing may be specified by the purchaser (see options 12 and 13).

Option 12: *Non-destructive testing of the full tube circumference for the detection of longitudinal imperfections in accordance with 11.7.1 is specified.*

Option 13: *Non-destructive testing for verification of leak tightness in accordance with 11.7.2 is specified.*

8.5 Dimensions and tolerances

8.5.1 Outside diameter, inside diameter, wall thickness and eccentricity

8.5.1.1 Circular tubes shall be specified by the outside and the inside diameters or by outside diameter and wall thickness or by inside diameter and wall thickness, as appropriate.

Cross-sections other than circular may be specified (see option 15).

Option 15: *A cross section other than circular is specified.*

8.5.1.2 Preferred diameters and wall thicknesses, 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. For a maximum distance of 100 mm, the ends may, due to the cutting method, have diameters outside the tolerances.

The diameter tolerances given in Table 5 apply for tubes in delivery condition +C or +LC. Depending on the ratio of wall thickness and outside diameter the corresponding 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 16 and 17).

Table 5 — Sizes and tolerances

Dimensions in millimetres

Specified outside diameter *D* and tolerances		Wall thickness *T*																											
		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	12	14	16	18	20	22	25
		Specified inside diameter *d* and tolerances																											
4	±0,08	3 ± 0,15	2,4 ± 0,15	2 ± 0,15	1,6 ± 0,15																								
5		4 ± 0,15	3,4 ± 0,15	3 ± 0,15	2,6 ± 0,15																								
6		5 ± 0,15	4,4 ± 0,15	4 ± 0,15	3,6 ± 0,15	3 ± 0,15	2,4 ± 0,15	2 ± 0,15																					
7		6 ± 0,15	5,4 ± 0,15	5 ± 0,15	4,6 ± 0,15	4 ± 0,15	3,4 ± 0,15	3 ± 0,15																					
8		7 ± 0,15	6,4 ± 0,15	6 ± 0,15	5,6 ± 0,15	5 ± 0,15	4,4 ± 0,15	4 ± 0,15	3,6 ± 0,15	3 ± 0,25																			
9		8 ± 0,15	7,4 ± 0,15	7 ± 0,15	6,6 ± 0,15	6 ± 0,15	5,4 ± 0,15	5 ± 0,15	4,6 ± 0,15	4 ± 0,25	3,4 ± 0,25																			
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	5,6 ± 0,15	5 ± 0,15	4,4 ± 0,25	4 ± 0,25																		
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	7,6 ± 0,15	7 ± 0,15	6,4 ± 0,15	6 ± 0,25	5 ± 0,25	4 ± 0,25																
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	8,4 ± 0,15	8 ± 0,15	7 ± 0,15	6 ± 0,25	5 ± 0,25															
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	9,4 ± 0,15	9 ± 0,15	8 ± 0,15	7 ± 0,15	6 ± 0,25	5 ± 0,25														
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	10,4± 0,15	10 ± 0,15	9 ± 0,15	8 ± 0,15	7 ± 0,15	6 ± 0,25	5 ± 0,25	4 ± 0,25												
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	10± 0,15	9 ± 0,15	8 ± 0,15	7 ± 0,25	6 ± 0,25												
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	11± 0,15	10 ± 0,15	9 ± 0,15	8 ± 0,25	6 ± 0,25											
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	13± 0,15	12 ± 0,15	11 ± 0,15	10± 0,15	8 ± 0,25											
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	15 ± 0,15	14 ± 0,15	13± 0,15	11± 0,15	9 ± 0,25										
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	16 ± 0,15	15 ± 0,15	14 ± 0,15	12 ± 0,15	10 ± 0,25										
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	18 ± 0,15	17 ± 0,15	16± 0,15	14 ± 0,15	12 ± 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	19 ± 0,15	18± 0,15	16 ± 0,15	14 ± 0,15	12 ± 0,15	10 ± 0,25								

Specified outside diameter *D* and tolerances		Wall thickness *T*																								
		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	12	14	16	18	20	22	25
		Specified inside diameter *d* and tolerances																										
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	21 ± 0,15	20± 0,15	18 ± 0,15	16 ± 0,15	14 ± 0,15	12 ± 0,25						
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	24 ± 0,15	23± 0,15	21 ± 0,15	19 ± 0,15	17 ± 0,15	15 ± 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	26± 0,15	24 ± 0,15	22 ± 0,15	20 ± 0,15	18 ± 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	28± 0,15	26 ± 0,15	24 ± 0,15	22 ± 0,15	20 ± 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	30± 0,20	28 ± 0,20	26 ± 0,20	24 ± 0,20	22 ± 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	31 ± 0,20	29 ± 0,20	27 ± 0,20	25 ± 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	34 ± 0,20	32 ± 0,20	30 ± 0,20	28 ± 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	36 ± 0,20	34 ± 0,20	32 ± 0,20	30 ± 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	39 ± 0,25	37 ± 0,25	35 ± 0,25	31 ± 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	44 ± 0,25	42 ± 0,25	40 ± 0,25	36 ± 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	49 ± 0,30	47 ± 0,30	45 ± 0,30	41 ± 0,30	37 ± 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	54 ± 0,30	52 ± 0,30	50 ± 0,30	46 ± 0,30	42 ± 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	57 ± 0,35	55 ± 0,35	51 ± 0,35	47 ± 0,35	43 ± 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	62 ± 0,35	60 ± 0,35	56 ± 0,35	52 ± 0,35	48 ± 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	67 ± 0,40	65 ± 0,40	61 ± 0,40	57 ± 0,40	53 ± 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	72 ± 0,40	70 ± 0,40	66 ± 0,40	62 ± 0,40	58 ± 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	77 ± 0,45	75 ± 0,45	71 ± 0,45	67 ± 0,45	63 ± 0,45	59 ± 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	76 ± 0,45	72 ± 0,45	68 ± 0,45	64 ± 0,45			
110	±0,50				106 ± 0,50	105,6±0,50	105±0,50	104±0,50	103±0,50	102±0,5 0	101±0,5 0	100±0,5 0	99± 0,50	98± 0,50	96 ± 0,50	94 ± 0,50	92 ± 0,50	90 ± 0,50	86 ± 0,50	82 ± 0,50	78 ± 0,50	74 ± 0,50				
120					116 ± 0,50	115,6±0,50	115±0,50	114±0,50	113±0,50	112±0,5 0	111±0,5 0	110±0,5 0	109±0,5 0	108±0,5 0	106±0,5 0	104±0,5 0	102±0,5 0	100±0,5 0	96 ± 0,50	92 ± 0,50	88 ± 0,50	84 ± 0,50				

Specified outside diameter *D* and tolerances		Wall thickness *T*																												
		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	12	14	16	18	20	22	25
		Specified inside diameter *d* and tolerances																												
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	106±0,70	102±0,70	98 ± 0,70	94 ± 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	116±0,70	112±0,70	108± ,70	104±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	126±0,80	122±0,80	118±0,80	114±0,80	110±0,80		
160												154±0,80	153±0,80	152±0,80	151±0,80	150±0,80	149±0,80	148±0,80	146±0,80	144±0,80	142±0,80	140±0,80	136±0,80	132±0,80	128±0,80	124±0,80	120±0,80		
170	±0,90											164±0,90	163±0,90	162±0,90	161±0,90	160±0,90	159±0,90	158±0,90	156±0,90	154±0,90	152±0,90	150±0,90	146±0,90	142±0,90	138±0,90	134±0,90	130±0,90		
180													173±0,90	172±0,90	171±0,90	170±0,90	169±0,90	168±0,90	166±0,90	164±0,90	162±0,90	160±0,90	156±0,90	152±0,90	148±0,90	144±0,90	140±0,90		
190	±1,00												183± 1,0	182 ± 1,0	181± 1,0	180± 1,0	179± 1,0	178±1,0	176±1,0	174 ± 1,0	172±1,0	170 ±1,0	166 ± 1,0	162± 1,0	158± 1,0	154±1,0	150 ± 1,0	146 ± 1,0	
200													193± 1,0	192 ± 1,0	191± 1,0	190± 1,0	89± 1,0	188±1,0	186±1,0	184 ± 1,0	182±1,0	180 ±1,0	176 ± 1,0	172± 1,0	168± 1,0	164±1,0	160 ± 1,0	156 ± 1,0	
220	±1,10														211± 1,1	210± 1,1	209± 1,1	208±1,1	206±1,1	204 ± 1,1	202±1,1	200±1,1	196 ± 1,1	192± 1,1	188± 1,1	184±1,1	180 ± 1,1	176 ± 1,1	170±1,1
240	±1,20														231± 1,2	230± 1,2	229± 1,2	228±1,2	226±1,2	224 ± 1,2	222±1,2	220±1,2	216 ± 1,2	212± 1,2	208± 1,2	204±1,2	200 ± 1,2	196 ± 1,2	190±1,2
260	±1,30															250± 1,3	249± 1,3	248±1,3	246±1,3	244 ± 1,3	242±1,3	240±1,3	236 ± 1,3	232± 1,3	228± 1,3	224±1,3	220 ± 1,3	216 ± 1,3	210±1,3
280	±1,40																269± 1,4	268±1,4	266±1,4	264 ± 1,4	262±1,4	260±1,4	256 ± 1,4	252± 1,4	248± 1,4	244±1,4	240 ± 1,4	236 ± 1,4	230±1,4
300	±1,50																	288±1,5	286±1,5	284 ± 1,5	282±1,5	280±1,5	276 ± 1,5	272± 1,5	268± 1,5	264±1,5	260 ± 1,5	256 ± 1,5	250±1,5
320	±1,60																	308±1,6	306±1,6	304 ± 1,6	302±1,6	300±1,6	296 ± 1,6	292± 1,6	288± 1,6	284±1,6	280 ± 1,6	276 ± 1,6	270±1,6
340	±1,70																			324 ± 1,7	322±1,7	320±1,7	316 ± 1,7	312± 1,7	308± 1,7	304±1,7	300 ± 1,7	296 ± 1,7	290±1,7
360	±1,80																			344 ± 1,8	342±1,8	340±1,8	336 ± 1,8	332± 1,8	328± 1,8	324±1,8	320 ± 1,8	316 ± 1,8	310±1,8
380	±1,90																			364 ± 1,9	362±1,9	360±1,9	356 ± 1,9	352± 1,9	348± 1,9	344±1,9	340 ± 1,9	336 ± 1,9	330±1,9

↑ T = 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 16: *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 17: *The diameter tolerances shall be unilateral, with the corresponding tolerance range specified in Table 5.*

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

$$\frac{T_{max} - T_{min}}{T_{max} + T_{min}} \times 100 \leq 10\ \% \quad (1)$$

where T_{max} and T_{min} are measured in the same cross section (but see option 18).

Option 18*: A reduced eccentricity is specified.*

8.5.1.4 Tubes specified by outside diameter and wall thickness or by inside diameter and wall thickness shall have a wall thickness tolerance of ± 10 % or ± 0,1 mm, whichever is the greater, unless option 19 or 20 is specified.

Option 19: *A reduced wall thickness tolerance is specified.*

Option 20: *A unilateral wall thickness tolerance with the tolerance range specified in 8.5.1.4, first paragraph, is specified.*

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. The length difference between the tubes shall not exceed 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 be supplied in short lengths ≥ 2 m. Short lengths shall be bundled separately.

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

Table 7 — Tolerances for exact lengths

Length L mm	Tolerance mm
≤ 500	+ by agreement 0
500 < L ≤ 2 000	+ 3 0
2 000 < L ≤ 5 000	+ 5 0
5 000 < L ≤ 8 000	+ 10 0
> 8 000	+ by agreement 0

8.5.3 Straightness

For tubes with an outside diameter D > 15 mm supplied in lengths greater than 1 000 mm, the deviation from straightness of any tube length L shall not exceed:

a) Tubes with outside diameter D ≤ 260 mm:

1) 0,001 5 L for R_{eH} ≤ 500 MPa;

2) 0,002 L for R_{eH} > 500 MPa.

b) Tubes with outside diameter D > 260 mm:

1) 0,002 5 L for R_{eH} ≤ 500 MPa;

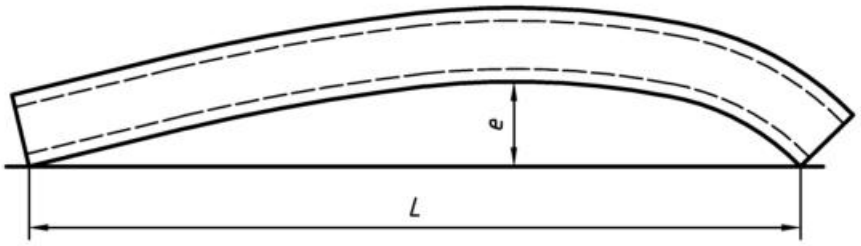
2) 0,003 0 L for R_{eH} > 500 MPa.

In both cases, the deviation from straightness over 1 m length shall not exceed 3 mm, unless option 22 is specified.

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

For exact lengths less than 1 000 mm with an outside diameter D > 15 mm, the deviation from straightness of any tube length L shall not exceed 0,003 L. The deviation from straightness shall be measured in accordance with Figure 1.

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



Key

L tube length

e deviation from straightness

Figure 1 — Measurement of deviation from straightness e

8.5.4 Preparation of ends

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

***Option 23**: A specified end finishing shall be carried out.*

9 Inspection

9.1 Types of inspection

Products complying with this document shall be ordered and delivered with one of the inspection documents as specified in EN 10204. The type of document shall be agreed upon at the time of enquiry and order. If the order does not contain any specification of this type, a test report 2.2 shall be issued.

9.2 Inspection documents

9.2.1 Types 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 or 3.2 in accordance with EN 10204 shall be issued. If an inspection certificate 3.2 is ordered, the purchaser shall additionally supply to the manufacturer the name and address of the organization or person nominated to carry out the inspection. It shall be agreed which party shall issue the certificate.

9.2.2 Content of inspection documents

9.2.2.1 The content of the inspection document shall be in accordance with EN 10168 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 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 or 3.2 shall contain the following codes and information:

A	commercial transactions and parties involved;
B	description of products to which the inspection document applies;
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 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 25)[b]	M	One per test unit	11.2, 11.3
	Roughness measurement (Options 8 and 9)	not applicable	One per test unit	8.4.3, 11.5
	NDT on longitudinal imperfections (Option 12)		Each individual tube	8.4.7, 11.7.1
	NDT for verification of leak tightness (Option 13)			8.4.7, 11.7.2

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

[b] ***Option 25:*** *For tubes in the delivery condition soft annealed (+A) or normalized (+N) a flattening test or a drift expanding test shall be carried out. 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 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.

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

A test unit shall comprise not more than 3 000 m or 500 mother tubes whichever is the greater mass. Residual quantities of less than 50 tubes may be combined with one or more test unit(s).

Option 26: *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 pieces for the tensile test

The test pieces shall be prepared in accordance with EN ISO 6892-1, at the manufacturer's discretion either as a full tube section or as a strip section taken in a direction longitudinal to the axis of the tube.

10.2.1.3 Test pieces for the flattening or drift expanding test

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

10.2.2 Test pieces for roughness measurement

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

11 Test methods

11.1 Tensile test

The test shall be carried out at room temperature in accordance with EN ISO 6892-1 and the following determined:

a) the tensile strength R_m;

b) 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.

c) the percentage elongation A 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 A shall be converted to the value for a gauge length $L_o = 5{,}65\sqrt{S_0}$ using the conversion tables given in EN ISO 2566-1.

11.2 Flattening test

The test shall be carried out in accordance with EN ISO 8492 provided the wall thickness T is less than 15 % of the outside diameter D. The tube section shall be flattened in a press until the distance H between the platens reaches the value given by the following formula:

$$H = \frac{(1+C)\times T}{C+\frac{T}{D}} \qquad (2)$$

where

H is the distance between the platens, in millimetres (mm), to be measured under load;

D is the specified outside diameter, in millimetres (mm);

T is the specified wall thickness, in millimetres (mm);

C is a factor, the value of which is given in Table 9.

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

Steel grade		C
Steel name	Steel number	
E215	1.0212	0,09
E235	1.0308	0,09
E355	1.0580	0,07

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

11.3 Drift expanding test

The test shall be carried out in accordance with EN ISO 8493 with a 60° conical mandrel provided the outside diameter is ≤ 150 mm and the wall thickness is ≤ 10 mm. 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 in % for	
Steel name	Steel number	$T \leq 4$ mm	$T > 4$ mm
E215	1.0212	20	15
E235	1.0308	18	12
E355	1.0580	15	10

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

11.4 Dimensional inspection

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

11.5 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:

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

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

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

11.7.2 Leak tightness

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

11.8 Retests, sorting and reprocessing

For retests, sorting and reprocessing EN 10021 applies.

12 Marking

Unless option 28 is specified, the following marking shall be shown on a label attached to the package unit or, where necessary for identification, to the single tube:

a) the manufacturer's name or trade mark;

b) the specified dimensions;

c) the number of this European Standard;

d) the steel name or number;

e) the delivery condition;

f) the cast number, when option 26 is specified;

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

Option 28: *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 option 29 or 30 is specified.

Option 29: *The tubes shall be delivered without corrosion protection.*

Option 30: *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.

The tubes shall be delivered bundled, unless option 38 is specified.

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

Annex A
(informative)

Requirement for additional steel grades

Table A.1 — Chemical composition (cast analysis)

Steel grade		% by mass									
Steel name	Steel number	C	Si	Mn	P max.	S	Cr	Mo	V	Others	Cr+Mo+Ni max.
E255	1.0408	≤ 0,21	≤ 0,35	0,40 to 1,10	0,025	≤ 0,025	-	-	-	-	-
E410	1.0509	0,16 to 0,22	0,10 to 0,50	1,30 to 1,70	0,030	≤ 0,035	-	-	0,08 to 0,15[a]	0,010 to 0,060 Al, ≤ 0,07 Nb, ≤ 0,05 Ti	-
26Mn5	1.1161	0,20 to 0,30	≤ 0,40	1,20 to 1,50	0,030	≤ 0,035	-	-	-	-	-
C35E	1.1181	0,32 to 0,39	≤ 0,40	0,50 to 0,80	0,030	≤ 0,035	≤ 0,40	≤ 0,10	-	-	0,63
C45E	1.1191	0,42 to 0,50	≤ 0,40	0,50 to 0,80	0,030	≤ 0,035	≤ 0,40	≤ 0,10	-	-	0,63
26Mo2	1.5417	0,22 to 0,29	≤ 0,40	≤ 1,50	0,025	≤ 0,035	-	0,15 to 0,25	-	≤ 0,40 Ni	-
25CrMo4	1.7218	0,22 to 0,29	≤ 0,40	0,60 to 0,90	0,025	≤ 0,035	0,90 to 1,20	0,15 to 0,30	-	-	-
42CrMo4	1.7225	0,38 to 0,45	≤ 0,40	0,60 to 0,90	0,025	≤ 0,035	0,90 to 1,20	0,15 to 0,30	-	-	-
10S10	1.0711	≤ 0,12	0,10 to 0,35	0,75 to 1,10	0,030	0,08 to 0,13	-	-	-	-	-
15S10	1.0710	0,12 to 0,18	0,10 to 0,35	0,70 to 1,10	0,030	0,07 to 0,13	-	-	-	-	-
18S10	1.0712	0,14 to 0,20	0,10 to 0,35	1,30 to 1,60	0,030	0,08 to 0,13	-	-	-	-	-
37S10	1.0713	0,32 to 0,39	0,10 to 0,35	1,35 to 1,65	0,030	0,07 to 0,13	-	-	-	-	-

[a] Nb+V: max. 0,20 %.

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

Element	Limiting value for cast analysis in accordance with Table A.1 % by mass	Permissible deviation of the product analysis % by mass
C	≤ 0,55	±0,02
Si	≤ 0,50	±0,05
Mn	≤ 1,00	±0,05
	> 1,00	±0,10
P	≤ 0,030	+ 0,005
S	≤ 0,035	+ 0,005
	0,07 to 0,13	±0,01
Cr	≤ 1,20	±0,05
Mo	≤ 0,30	±0,03
Ni	≤ 0,40	+ 0,05
Nb	≤ 0,07	+ 0,010
V	≤ 0,15	±0,02
Cr+Mo+Ni	≤ 0,63	+ 0,05

Table A.3 — Mechanical properties at room temperature[a]

Steel grade		Values for the delivery condition[b]											
		+C		+LC		+SR			+A		+N		
Steel name	Steel number	R_m MPa min.	A % min.	R_m MPa min.	A % min.	R_m MPa min.	R_{eH} MPa min.	A % min.	R_m MPa min.	A % min.	R_m MPa	R_{eH} MPa min.	A % min.
E255	1.0408	580	5	520	8	520	375	12	390	21	440 to 570	255	21
E410	1.0509	750	4	620	8	690	590	12	520	22	550 to 700	410	22
26Mn5	1.1161	700	4	650	7	-	-	-	-	-	-	-	-
C35E	1.1181	590	5	540	7	-	-	-	440	22	≥ 460	280	21
C45E	1.1191	720	4	670	6	-	-	-	510	20	≥ 540	340	18
26Mo2	1.5417	720	4	670	6	-	-	-	-	-	-	-	-
25CrMo4	1.7218	720	4	670	6	-	-	-	-	-	-	-	-
42CrMo4	1.7225	720	4	670	6	-	-	-	-	-	-	-	-
10S10	1.0711	510	8	-	-	440	370	16	-	-	360 to 500	240	25
15S10	1.0710	550	7	-	-	490	415	14	-	-	380 to 540	260	22
18S10	1.0712	650	6	-	-	600	520	12	-	-	520 to 650	360	22
37S10	1.0713	720	4	-	-	700	630	12	-	-	650 to 720	420	16

[a] The parameters for the flattening and the drift expanding test (values of factor C and values of expansion) shall be agreed.

[b] R_m: tensile strength; R_{eH}: upper yield strength (but see 11.1); A: elongation after fracture; for heat treatment symbols see Table 1.

Bibliography

[1] EN ISO 1461, *Hot dip galvanized coatings on fabricated iron and steel articles - Specifications and test methods (ISO 1461)*

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

[3] EN ISO 14713-2, *Zinc coatings. Guidelines and recommendations for the protection against corrosion of iron and steel in structures - Part 2: Hot dip galvanizing*