

English Version

**Welded steel tubes for pressure purposes - Technical
delivery conditions - Part 1: Electric welded and
submerged arc welded non-alloy steel tubes with specified
room temperature properties**

Tubes soudés en acier pour service sous pression -
Conditions techniques de livraison - Partie 1 : Tubes en
acier non allié, soudés électriquement et soudés à l'arc
immergé, avec caractéristiques spécifiées à
température ambiante

Geschweißte Stahlrohre für Druckbeanspruchungen -
Technische Lieferbedingungen - Teil 1: Elektrisch
geschweißte und unterpulvergeschweißte Rohre aus
unlegierten Stählen mit festgelegten Eigenschaften bei
Raumtemperatur

This European Standard was approved by CEN on 25 February 2019.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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European foreword

This document (EN 10217-1:2019) has been prepared by Technical Committee CEN/TC 459 “ECISS - European Committee for Iron and Steel Standardization”¹, the secretariat of which is held by AFNOR.

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of an identical text or by endorsement, at the latest by October 2019, and conflicting national standards shall be withdrawn at the latest by October 2019.

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

This document supersedes EN 10217-1:2002.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive 2014/68/EU.

For relationship with EU Directive 2014/68/EU (formerly 97/23/EC), see informative Annex ZA, which is an integral part of this document.

This European Standard consists of the following parts, under the general title *Welded steel tubes for pressure purposes – Technical delivery conditions*:

- *Part 1: Electric welded and submerged arc welded non-alloy steel tubes with specified room temperature properties;*
- *Part 2: Electric welded non-alloy and alloy steel tubes with specified elevated temperature properties;*
- *Part 3: Electric welded and submerged arc welded alloy fine grain steel tubes with specified room, elevated and low temperature properties;*
- *Part 4: Electric welded non-alloy steel tubes with specified low temperature properties;*
- *Part 5: Submerged arc welded non-alloy and alloy steel tubes with specified elevated temperature properties;*
- *Part 6: Submerged arc welded non-alloy steel tubes with specified low temperature properties;*
- *Part 7: Stainless steel tubes.*

Another European Standard series covering tubes for pressure purposes is:

EN 10216, *Seamless steel tubes for pressure purposes*.

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

¹ Through its subcommittee SC 10 “Steel tubes, and iron and steel fittings” (secretariat: UNI)

1 Scope

This document specifies the technical delivery conditions for qualities TR1 and TR2 of electric welded and submerged arc welded tubes of circular cross section, with specified room temperature properties, made from non-alloy quality steel.

NOTE 1 Quality TR2 is intended to support the essential requirements of EU Directive 2014/68/EU in respect of pressure equipment with specified room temperature properties (see Table 5).

NOTE 2 Once this standard is published in the Official Journal of the European Union (OJEU), presumption of conformity to the Essential Safety Requirements (ESR) of Directive 2014/68/EU is limited to the technical data for the materials in this standard and does not presume adequacy of the material for a specific item of pressure equipment. Consequently, the assessment of the technical data stated in this material standard against the design requirements of a specific item of equipment to verify that the ESRs of the Pressure Equipment Directive are satisfied, needs to be done by the designer or manufacturer of the pressure equipment, taking also into account any subsequent processing procedures which may affect properties of the base materials.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 10020, *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 10168:2004, *Steel products — Inspection documents — List of information and description*

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

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

CEN/TR 10261, *Iron and steel — European standards for the determination of chemical composition*

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

EN ISO 148-1:2016, *Metallic materials — Charpy pendulum impact test — Part 1: Test method (ISO 148-1:2016)*

EN ISO 377:2017, *Steel and steel products — Location and preparation of samples and test pieces for mechanical testing (ISO 377:2017)*

EN ISO 2566-1:1999, *Steel — Conversion of elongation values — Part 1: Carbon and low alloy steels (ISO 2566-1:1984)*

EN ISO 4885, *Ferrous materials — Heat treatments — Vocabulary (ISO 4885)*

EN ISO 5173:2010, *Destructive tests on welds in metallic materials — Bend tests (ISO 5173:2009)*

EN ISO 6892-1:2016, *Metallic materials — Tensile testing — Part 1: Method of test at room temperature (ISO 6892-1:2016)*

EN ISO 8492:2013, *Metallic materials — Tube — Flattening test (ISO 8492:2013)*

EN ISO 8493:2004, *Metallic materials — Tube — Drift-expanding test (ISO 8493:1998)*

EN ISO 10893-1:2011, *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 10893-1:2011)*

EN ISO 10893-2:2011, *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 10893-2:2011)*

EN ISO 10893-3:2011, *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 10893-3:2011)*

EN ISO 10893-6:2011, *Non-destructive testing of steel tubes — Part 6: Radiographic testing of the weld seam of welded steel tubes for the detection of imperfections (ISO 10893-6:2011)*

EN ISO 10893-7:2011, *Non-destructive testing of steel tubes — Part 7: Digital radiographic testing of the weld seam of welded steel tubes for the detection of imperfections (ISO 10893-7:2011)*

EN ISO 10893-10:2011, *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 10893-10:2011)*

EN ISO 10893-11:2011, *Non-destructive testing of steel tubes — Part 11: Automated ultrasonic testing of the weld seam of welded steel tubes for the detection of longitudinal and/or transverse imperfections (ISO 10893-11:2011)*

EN ISO 14174:2012, *Welding consumables — Fluxes for submerged arc welding and electroslag welding - Classification (ISO 14174:2012)*

EN ISO 14284, *Steel and iron — Sampling and preparation of samples for the determination of chemical composition (ISO 14284)*

EN ISO 17639:2013, *Destructive tests on welds in metallic materials — Macroscopic and microscopic examination of welds (ISO 17639:2003)*

ISO 11484:2009, *Steel products — Employer's qualification system for non-destructive testing (NDT) personnel*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 10020, EN 10021, EN 10266, EN ISO 4885 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

3.1

employer

organisation for which a person works on a regular basis

Note 1 to entry: The employer may be either the tube manufacturer or a third party organization providing services, such as Non-Destructive Testing (NDT).

3.2

EW

electric welded tube

tubular product having one longitudinal seam weld produced by electric (resistance) welding where the strip edges to be welded are mechanically pressed together and the heat for the welding process is generated by the resistance to flow of low or high frequency electric current applied by either a conduction or induction process

3.3

HFW

high frequency welded tube

EW tube produced specifically using a welding current frequency equal to or greater than 100 kHz

3.4

SAW

submerged-arc welded tube

tubular product having one or two longitudinal seams, or one helical seam, produced using the submerged-arc welding process

3.5

SAWH

submerged-arc helical welded tube

tubular product having one helical weld seam produced using the submerged-arc welding process

3.6

SAWL

submerged-arc longitudinal welded tube

tubular product having one or two longitudinal weld seams produced using the submerged-arc welding process

4 Symbols

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

5 Classification and designation

5.1 Classification

In accordance with the classification system in EN 10020, the steel grades in this standard are classified as non-alloy quality steels.

5.2 Designation

5.2.1 For the tubes covered by this Part of EN 10217 the steel designation consists of:

— the number of this European Standard, e.g. EN 10217-1;

plus either:

— the steel name in accordance with EN 10027-1;

or:

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

5.2.2 The steel name is designated by:

— the capital letter P for pressure purposes;

- the indication of the specified minimum yield strength for thickness T less than or equal to 16 mm, expressed in MPa (see Tables 4 and 5);

plus either:

- the alphanumeric TR1 for qualities without specified aluminium content and specified impact properties and with non-specific inspection requirements (see 9.1);

or:

- the alphanumeric TR2 for qualities with specified aluminium content, specified impact properties and either non-specific or specific inspection requirements (see 9.1);

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, total length or number of tubes of set length);
- b) the term 'tube' and tube type, EW / HFW, SAWL or SAWH;
- c) the dimensions (outside diameter D and wall thickness T) (see Table 6);
- d) the random length range (see 8.7.3);
- e) for tubes with a $D/T > 100$, out of roundness limits (see 8.7.4.6).
- f) the designation of the steel grade in accordance with this document (see 5.2);

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):

- 1) Tube manufacturing process and/or route (see 7.2.1);
- 2) Selection of the delivery condition (see 7.2.5);
- 3) Restriction on copper and tin content for quality TR2 (see Table 2);
- 4) Product analysis for tubes of quality TR2 (see 8.2.2);
- 5) Additional longitudinal impact test at -10°C for quality TR2 (see Table 5);
- 6) Selection of method for verification of leak-tightness (see 8.4.3.1);
- 7) Special end preparation (see 8.6);
- 8) Exact lengths (see 8.7.3);
- 9) Specific inspection for quality TR2 (see 9.1);
- 10) Verification of tensile strength of the weld in the transverse direction for tubes with $219,1 < D \leq 508$ mm (see Table 12 and Table 13);
- 11) Wall thickness measurement away from the ends (see Table 12, Table 13 and 11.9);

- 12) Test unit restriction for tubes with $D \leq 76,1$ mm of quality TR2 with specific inspection (see 10.1.1);
- 13) Selection of the Non-Destructive Testing method (see 11.11.1);
- 14) Additional marking (see 12.2);
- 15) Protection (see Clause 13).

6.3 Example of an order

100 t of HFW steel tube with an outside diameter of 168,3 mm, a wall thickness of 4,5 mm in accordance with EN 10217-1, made of steel grade P235TR2 in 6 m random lengths, with a 3.2 inspection certificate in accordance with EN 10204:

100 t – HFW - Tube – 168,3 × 4,5 – EN 10217-1 – P235TR2 – 6m - Option 9: 3.2

7 Manufacturing process

7.1 Steelmaking process

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

Steel for quality TR2 shall be fully killed and contain nitrogen binding elements, details of which shall be reported.

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

7.2 Tube manufacture and delivery conditions

7.2.1 Tube manufacturing shall be as specified in Table 1.

Unless Option 1 is specified, the manufacturing process and route is at the discretion of the manufacturer.

Option 1: *The manufacturing process and/or route from Table 1 is specified by the purchaser.*

The submerged arc weld of SAW tubes shall be made using at least one weld run on the inside and one weld run on the outside of the tube.

The strip used for the manufacture of SAWH tubes shall have a width of not less than 0,8 times or more than 3,0 times the outside diameter of the tube.

The finished tubes shall not include the welds used to join together the strip or plate prior to forming, except for SAWH tubes where this is permitted only when the welding procedure for the weld joining the strip or plate has been qualified in accordance with Annex A and has also been subjected to the same inspection and testing regime as the helical pipe welds (see 11.11.4).

7.2.2 Tube production welding shall be carried out by qualified personnel in accordance with documented procedures. For tubes to be used in pressure equipment under European legislation, manufacturers shall employ an established procedure for the approval of welding operatives.

7.2.3 The welding procedure for SAW tubes shall be qualified in accordance with Annex A.

7.2.4 The production (welding) process for EW and HFW tubes shall be qualified and approved under the tube manufacturer's own QA system. Only HFW tubes (see 3.3) shall be supplied for pressure equipment under European legislation.

7.2.5 The delivery conditions for tubes covered by this document are shown in Table 1.

Unless Option 2 is specified at the time of enquiry and order the choice of the delivery condition is at the discretion of the manufacturer.

Option 2: The delivery condition is chosen by the purchaser.

Table 1 — Tube production processes, manufacturing routes and permitted delivery conditions

Route Nº	Tube production process		Manufacturing route		Acceptable delivery condition ^a	Applicable for Quality	
	Process	Symbol	Starting material	Forming operation		TR1	TR2
1a	Electric Welded ^b	EW HFW	Hot rolled strip	Cold formed and welded	As welded	Yes	No
1b					NW	Yes	No
1c					NP	Yes	Yes
1d					NR	Yes	Yes
2a			Normalized rolled strip		As welded	Yes	No
2b					NW	Yes	Yes
2c					NP	Yes	Yes
2d					NR	Yes	Yes
3c			Cold rolled and stress relieved strip		NP	Yes	Yes
3d					NR	Yes	Yes
4a	Submerge d arc welded Longitudi nal seam or Helical seam	SAW: — SAWL — SAWH	Hot rolled plate or strip		As welded ^d	Yes	No
4b					NP	Yes	Yes
5a			Normalized rolled plate or strip		As welded ^d	Yes	Yes
5b					NP	Yes	Yes
6a			Full body normalized plate or strip		As welded ^d	Yes	Yes
7a			Hot rolled plate or strip	Normalized formed and welded ^c	As welded ^d	Yes	Yes
7b					NP	Yes	Yes
8a			Normalized rolled plate or strip		As welded ^d	Yes	Yes
8b					NP	Yes	Yes
9a			Full body normalized plate or strip		As welded ^d	Yes	Yes

^a As welded = as formed with no subsequent heat treatment; NP = tube full body normalized; NW = normalized weld zone; NR = normalized rolled or hot (stretch) reduced within the normalizing temperature range;

^b See definition of EW and HFW in 3.2 and 3.3. For tubes of quality TR2, only HFW tubes, minimum welding frequency 100kHz, (symbol = HFW) are permitted;

^c Only applicable to SAWL tubes;

^d Stress relieving treatment on the weld is permissible.

7.3 Non Destructive Testing Personnel Requirements

7.3.1 All NDT activities shall be carried out by qualified and competent level 1, 2 and/or 3 personnel, authorized to carry out this work by the employer.

7.3.2 The qualification for levels 1 and 2 personnel shall be in accordance with ISO 11484 or, at least, an equivalent to it.

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

7.3.4 The operating authorization issued by the employer shall be in accordance with a written procedure.

7.3.5 All NDT operations shall be authorised by a level 3 NDT technician approved by the employer.

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

8 Requirements

8.1 General

The tubes shall conform to the requirements of document when supplied in a delivery condition in accordance with Table 1 and inspected in accordance with the specified requirements in Table 12 or Table 13, as applicable.

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

8.2 Chemical composition

8.2.1 Cast analysis

The cast analysis reported by the steel producer shall apply and conform to the requirements of Table 2.

When welding tubes produced in accordance with this document, account should be taken of the fact that the behaviour of the steel during and after welding is dependent not only on the steel analysis, but also on the welding process, including heat input, any applied heat treatment and the conditions of preparing for and carrying out the welding.

Table 2 — Chemical composition (cast analysis) ^a in % by mass

Steel grade		C	Si	Mn	P	S	Cr ^b	Mo ^b	Ni ^b	Al tot min.	Cu ^b	Nb ^b	Ti ^b	V ^b	Cr+Cu+Mo+Ni ^b max.
Steel name	Steel number	max.	max.	max.	Max.	max.	max.	max.	max.		max.	max.	max.	max.	
P195TR1	1.0107	0,13	0,35	0,70	0,025	0,020	0,30	0,08	0,30	-	0,30	0,010	0,04	0,02	0,70
P195TR2	1.0108	0,13	0,35	0,70	0,025	0,015	0,30	0,08	0,30	0,02 ^d	0,30 ^c	0,010	0,04	0,02	0,70
P235TR1	1.0254	0,16	0,35	1,20	0,025	0,020	0,30	0,08	0,30	-	0,30	0,010	0,04	0,02	0,70
P235TR2	1.0255	0,16	0,35	1,20	0,025	0,015	0,30	0,08	0,30	0,02 ^d	0,30 ^c	0,010	0,04	0,02	0,70
P265TR1	1.0258	0,20	0,40	1,40	0,025	0,020	0,30	0,08	0,30	-	0,30	0,010	0,04	0,02	0,70
P265TR2	1.0259	0,20	0,40	1,40	0,025	0,015	0,30	0,08	0,30	0,02 ^d	0,30 ^c	0,010	0,04	0,02	0,70

^a Elements not quoted in this table 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 steelmaking process, which would have a negative impact on the mechanical properties, ageing and the suitability of the material;

^b For qualities TR1 and TR2 supplied with non-specific inspection, the content of these elements need not be reported unless intentionally added to the cast;

^c **Option 3:** In order to facilitate subsequent forming operations, an agreed maximum copper content lower than indicated and an agreed specified maximum tin content shall apply. In such cases a 3.1 Test Certificate shall be supplied for steel quality TR2 (see Option 9);

^d For Al/N ratios ≥ 2 , if nitrogen is fixed by niobium, titanium or vanadium, details of which shall be reported, this requirement does not apply except that when using titanium, the steel producer shall verify that $(Al+Ti/2) \geq 0,020$ %.

8.2.2 Product analysis

Unless Option 4 is specified, only the cast analysis shall be reported.

Option 4: *A product analysis shall be supplied for tubes of Quality TR2; for tubes with outside diameter equal or less than 76,1 mm this option applies only in combination with Option 12.*

Table 3 specifies the permissible deviations of the 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 the cast analysis in accordance with Table 2 % by mass	Permissible deviation of the product analysis % by mass
C	$\leq 0,20$	+ 0,02
Si	$\leq 0,40$	+ 0,05
Mn	$\leq 1,40$	+ 0,10
P	$\leq 0,025$	+ 0,005
S	$\leq 0,020$	+ 0,005
Cr	$\leq 0,30$	+ 0,05
Mo	$\leq 0,08$	+ 0,02
Ni	$\leq 0,30$	+ 0,05
Al	$\geq 0,020$	– 0,005
Cu	$\leq 0,30$	+ 0,05
Nb	$\leq 0,010$	+ 0,005
Ti	$\leq 0,04$	+ 0,01
V	$\leq 0,02$	+ 0,01
Cr + Cu + Mo + Ni	$\leq 0,70$	+ 0,05

8.3 Mechanical properties

The mechanical properties of the tubes, in a specified delivery condition from Table 1, shall conform to the requirements of Tables 4 or 5, as applicable, and the relevant additional tests specified in 11.3 to 11.6, irrespective of whether the test results are actually verified or not (see Tables 12 and 13 for a summary of the inspection and verification testing required).

Table 4 — Mechanical properties for quality TR1

Steel grade		Tensile properties at room temperature				
Steel name	Steel number	Upper yield strength R_{eH}^a min, for wall thickness T mm		Tensile strength R_m	Elongation A min. % ^{a b}	
		$T \leq 16$	$16 < T \leq 40$			
		MPa	MPa	MPa	l	t
P195TR1	1.0107	195	185	320 - 440	27	25
P235TR1	1.0254	235	225	360 - 500	25	23
P265TR1	1.0258	265	255	410 - 570	21	19
NOTE Tube grades in quality TR1 do not support the essential requirements of EU Directive 2014/68/EU in respect of pressure equipment.						
a See 11.2.						
b l = longitudinal; t = transverse						

Table 5 — Mechanical properties for quality TR2

Steel grade		Tensile properties at room temperature					Impact properties		
Steel name	Steel number	Upper yield strength R_{eH}^a min. for specified wall thickness T mm		Tensile strength R_m	Elongation ^{a b} A min. %		Minimum average absorbed energy ^b KV_2^c J at temperature of °C		
		$T \leq 16$	$16 < T \leq 40$		l	t			
		MPa	MPa	MPa	l	t	0	-10	0
P195TR2	1.0108	195	185	320 - 440	27	25	40	28 ^d	27
P235TR2	1.0255	235	225	360 - 500	25	23	40	28 ^d	27
P265TR2	1.0259	265	255	410 - 570	21	19	40	28 ^d	27
NOTE Tube grades in quality TR2 are intended to support the essential requirements of EU Directive 2014/68/EU in respect of pressure equipment with specified room temperature properties. For use in pressure equipment in accordance with PED Categories II, III and IV, TR2 grades with specific inspection are necessary (see Table 13).									
a See 11.2.									
b l = longitudinal; t = transverse									
c KV_2 = impact values obtained using a 2 mm radius striker in accordance with EN ISO 148-1									
d Option 5: In addition to the specified impact test at 0°C, the longitudinal impact properties at -10 °C shall be verified and reported.									

8.4 Appearance and internal soundness

8.4.1 Weld seam

The weld area shall be free from cracks, lack of fusion and lack of penetration. Repairs to the weld seam of EW and HFW tubes are not permitted. Repairs to the weld seam of SAW tubes shall be permitted if done in accordance with an agreed documented procedure.

NOTE For strip and plate alignment (radial offset) and tolerances in the weld region, see 8.7.4.2 for EW and HFW tubes and 8.7.4.3 / 8.7.4.4. for SAW tubes.

8.4.2 Tube surface

8.4.2.1 The tubes shall be free from external and internal surface defects that can be detected by visual examination of the surfaces that are accessible without the use of special equipment.

8.4.2.2 The internal and external surface finish of the tubes shall be typical of the manufacturing process and, where applicable, the heat treatment employed. Normally the finish and surface condition shall be such that any surface imperfections requiring dressing can be identified

8.4.2.3 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.

8.4.2.4 Any surface imperfection, which is demonstrated to be deeper than 5 % of the wall thickness T or 3 mm, whichever is the smaller, shall be dressed.

8.4.2.5 Surface imperfections which extend below the specified minimum wall thickness shall be considered defects and tubes containing these shall be deemed not to conform with this document and shall be rejected.

8.4.3 Internal soundness

8.4.3.1 Leak-tightness

The tubes shall be assessed for leak tightness by either a hydrostatic test (see 11.8.1) or an electromagnetic test (see 11.8.2).

Unless Option 6 is specified the choice of the test method is at the discretion of the manufacturer.

Option 6: *The test method for verification of leak-tightness in accordance with 11.8.1 or 11.8.2 is specified by the purchaser.*

NOTE SAW tubes cannot be tested in accordance with 11.8.2.

8.4.3.2 Non-Destructive Testing

Tubes shall be Non-Destructively-Tested in accordance with 11.11.

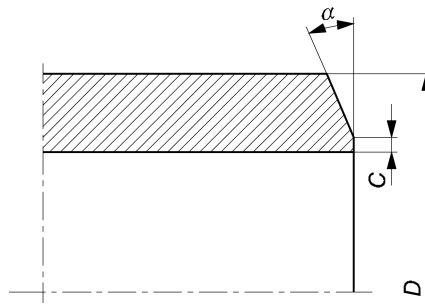
8.5 Straightness

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

8.6 Preparation of ends

Unless Option 7 is specified, tubes shall be delivered with square cut ends free from excessive burrs.

Option 7: *The tubes shall be delivered with bevelled ends (see Figure 1). The bevel shall have an angle α of $30^\circ \substack{+5^\circ \\ 0^\circ}$ with a root face C of $1,6 \text{ mm} \pm 0,8 \text{ mm}$. Beveling is applicable for specified wall thicknesses $\geq 3,2 \text{ mm}$, except that for wall thickness $T \geq$ than 20 mm, an agreed alternative bevel may be specified.*

**Key** D outside diameter α bevel angle C root face of bevelled end**Figure 1 — Tube end bevel****8.7 Dimensions, masses and tolerances****8.7.1 Diameter and wall thickness**

Tubes shall be delivered by outside diameter D and wall thickness T .

The preferred outside diameters D and wall thicknesses T have mainly been selected from EN 10220 and are given in Table 6.

NOTE Dimensions other than those in Table 6 may be agreed.

8.7.2 Mass

For the mass per unit length the provisions of EN 10220 apply.

8.7.3 Lengths

Unless the Option 8 is specified the tubes shall be delivered in random lengths. The delivery range shall be agreed at the time of enquiry and order.

Option 8: *The tubes shall be delivered in exact lengths, the length to be specified at the time of enquiry and order. For tolerances on exact lengths see 8.7.4.5.*

Table 6a — Preferred dimensions for wall thickness T between 0,5 and 5,6

Dimensions in millimetres

Outside diameter D series ^a			Wall thickness T																	
1	2	3	0,5	0,6	0,8	1	1,2	1,4	1,6	1,8	2	2,3	2,6	2,9	3,2	3,6	4	4,5	5	5,6
10,2																				
	12																			
	12,7																			
13,5																				
		14																		
	16																			
17,2																				
		18																		
	19																			
	20																			
21,3																				
		22																		
	25																			
		25,4																		
26,9																				
		30																		
	31,8																			
	32																			
33,7																				
		35																		
	38																			
	40																			
42,4																				
		44,5																		
48,3																				
	51																			
		54																		
	57																			
60,3																				
	63,5																			
	70																			
		73																		
76,1																				
		82,5																		
88,9																				

	101,6																		
		108																	
114,3																			
	127																		
	133																		
139,7																			
		141,3																	
		152,4																	
		159																	
	165,1																		
168,3																			
		177,8																	
		193,7																	
219,1																			
		244,5																	
273																			
323,9																			
355,6																			
406,4																			
457																			
508																			
		559																	
610																			
		660																	
711																			
	762																		
813																			
		864																	
914																			
1 016																			
1 067																			
1 118																			
	1 168																		
1 219																			
	1.321																		
1.422																			

^a series 1 = diameters for which all the accessories needed for the construction of piping systems are standardized;
series 2 = diameters for which not all the accessories are standardized;
series 3 = diameters for special applications for which very few standardized accessories exist.

Table 6b — Preferred dimensions for wall thickness T between 6,3 and 40

Dimensions in millimetres

Outside diameter D series ^a			Wall thickness T																	
1	2	3	6,3	7,1	8	8,8	10	11	12,5	14,2	16	17,5	20	22,2	25	28	30	32	36	40
		30																		
	31,8																			
	32																			
33,7																				
		35																		
	38																			
	40																			
42,4																				
		44,5																		
48,3																				
	51																			
		54																		
	57																			
60,3																				
	63,5																			
	70																			
		73																		
76,1																				
		82,5																		
88,9																				
	101,6																			
		108																		
114,3																				
	127																			
	133																			
139,7																				
		141,3																		
		152,4																		
		159																		
	165,1																			
168,3																				
		177,8																		
		193,7																		
219,1																				
		244,5																		
273																				
323,9																				

355,6																		
406,4																		
457																		
508																		
		559																
610																		
		660																
711																		
	762																	
813																		
		864																
914																		
1 016																		
1 067																		
1 118																		
	1 168																	
1 219																		
	1 321																	
1 422																		
	1 524																	
1 626																		
	1 727																	
1 829																		
	1 930																	
2 032																		
	2 134																	
2 235																		
	2 337																	
	2 438																	
2.540																		

^a series 1 = diameters for which all the accessories needed for the construction of piping systems are standardized;
series 2 = diameters for which not all the accessories are standardized;
series 3 = diameters for special applications for which very few standardized accessories exist.

8.7.4 Tolerances

8.7.4.1 Tolerances on diameter and thickness

The diameter and the wall thickness of the tubes shall be within the tolerance limits given in Table 7.

Table 7 — Tolerances on outside diameter and wall thickness

Dimensions in millimetres

Outside diameter D	Manufacturing process	Tolerance on outside diameter	Tolerance on wall thickness ^a		
			$T \leq 5$	$5 < T \leq 10$	$10 < T \leq 40$
$\leq 219,1$	EW and HFW	$\pm 1 \%$ or $\pm 0,5$ whichever is the greater	$\pm 10 \%$ or $\pm 0,3$ whichever is the greater	$\pm 8 \%$ or ± 2 whichever is the smaller	
$> 219,1$	EW and HFW	$\pm 0,75 \%$ or ± 6 whichever is the smaller			
ALL	SAW	$\pm 0,75 \%$ or ± 6 whichever is the smaller	$\pm 10 \%$ or $\pm 0,3$ whichever is the greater		$\pm 8 \%$ or ± 2 whichever is the smaller

^a The plus tolerance excludes the weld area (see 8.7.4.2).

8.7.4.2 Height of the weld seam

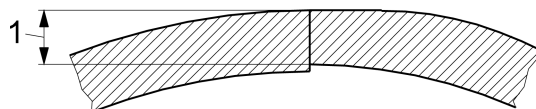
The height of the external and internal weld seams shall be within the limits indicated in Table 8 (for EW and HFW tubes) and Table 9 (for SAW tubes).

Table 8 — Maximum height of the weld bead for EW and HFW tubes

Dimensions in millimetres

Manufacturing Process	Quality TR1		Quality TR2	
	Outside	Inside	Outside	Inside
EW and HFW	Trimmed flush	1,5	Trimmed flush	Trimmed or $0,5 + 0,05T$

For EW and HFW tubes, radial offset of the strip edges after weld trimming, see Figure 2, shall not cause the remaining wall thickness to be less than the minimum set out in Table 7.



Key

1 remaining wall thickness at the weld

Figure 2 — Radial offset of the strip edges (EW and HFW tube)

Table 9 — Maximum height of the weld seam for SAW tubes

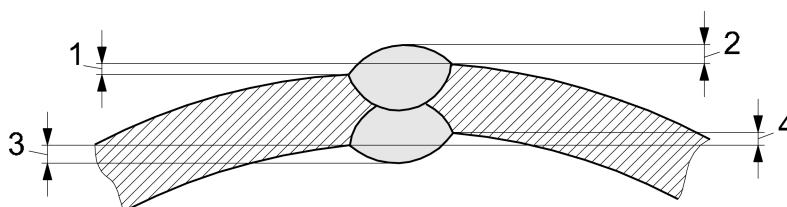
Dimensions in millimetres

Wall thickness T	Maximum height of the weld seam	
	Inside	Outside
$T \leq 12,5$	3,5	3,5
$T > 12,5$	4,8	4,8

For plate or strip alignment in SAW tubes see 8.7.4.3 and 8.7.4.4.

8.7.4.3 Radial offset of plate or strip edges at the weld for SAW tubes

The radial offset of the abutting plate or strip edges, see Figure 3, shall be within the limits indicated in Table 10.



Key

- 1, 4 outside/inside diameter radial offset
2, 3 outside/inside height of the weld seam

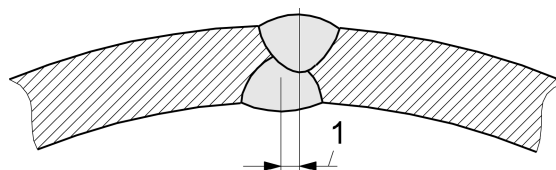
Figure 3 — Radial offset of the abutting plate or strip edges**Table 10 — Maximum radial offset of the abutting plate or strip**

Dimensions in millimetres

Wall Thickness T	Maximum radial offset
$T \leq 12,5$	1,6
$T > 12,5$	$0,125 T$ with a max. of 3,2

8.7.4.4 Misalignment of the weld seams of SAW tubes

Misalignment of the weld seams, see Figure 4, shall be acceptable provided complete penetration and complete fusion are achieved.



Key

- 1 misalignment

Figure 4 — Example showing the possible misalignment of the weld seams

8.7.4.5 Tolerances on exact length

The tolerances for exact lengths shall be as given in Table 11.

Table 11 — Tolerances on exact length

Dimensions in millimetres

Length range L	Tolerance for outside diameter D	
	$< 406,4$	$\geq 406,4$
$L \leq 6\,000$	+ 10 0	+ 25 0
$6\,000 < L \leq 12\,000$	+ 15 0	+ 50 0
$L > 12\,000$	+ by agreement 0	

8.7.4.6 Out-of-roundness

The out-of-roundness O shall be calculated using Formula (1):

$$O = \frac{D_{\max} - D_{\min}}{D} \times 100 \quad (1)$$

where

O is the out-of-roundness in %;

D is the specified outside diameter in mm;

$D_{\max}, D_{\min}$ is the maximum and minimum outside diameter measured in the same plane in mm.

For tubes of $D \leq 406,4$ mm, out-of-roundness shall be included in the limits of the diameter tolerances.

For tubes of $D > 406,4$ mm and with $D/T \leq 100$, out-of-roundness shall not exceed 2 %.

For tubes with a D/T ratio > 100 the values for out-of-roundness shall be agreed at the time of enquiry and order.

9 Inspection

9.1 Types of Inspection and inspection documents

Conformity to the requirements of the order, for tubes in accordance with this document, shall be verified by inspection procedures and documents according to EN 10204 as follows:

- non-specific inspection with a test report 2.2 for quality TR1;
- either non-specific inspection with a test report 2.2 or specific inspection with an inspection certificate 3.1 for quality TR2. When Option 9 is specified, specific inspection shall be applied;

Option 9: *Quality TR2 shall be subject to specific inspection. An inspection certificate 3.1 shall be provided unless the purchaser specifies an inspection certificate 3.2.*

TR2 tube grades are intended to support the essential requirements of the European legislation on pressure equipment. For pressure equipment in Categories II, III and IV, specific inspection shall be applied (see Table 13).

When an inspection certificate 3.1 or 3.2 is specified, the tube manufacturer shall confirm whether they are operating according to a “quality assurance system”, certified by a competent body

established within the community, and have undergone a specific assessment for materials and processes relevant to the manufacture of welded tubes (see 7.2.3 and 7.2.4).

When an inspection certificate 3.2 is specified, this shall be prepared by the manufacturer's authorized representative(s). The purchaser shall notify the manufacturer of the name and address of the organization or person that will carry out the inspection and confirm who will validate and issue the inspection document.

9.2 Content of inspection documents

9.2.1 The content of the inspection document shall be in accordance with EN 10168 as shown in 9.2.2 and 9.2.3. The inspection documents shall include a statement confirming the conformity of the products to the requirements of this specification and to the order.

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

- A commercial transactions and parties involved;
- B description of products to which the inspection document applies;
- C01-C02 location of the samples and direction of test pieces;
- C10-C13 tensile test(s);
- C40-C43 impact test for quality TR2;
- C50-C59 weld bend test, if applicable;
- C60-C69 other tests (e.g. flattening, drift expanding);
- C71-C92 cast analysis reported by the steel producer;
- D01 statement that marking and identification, surface appearance, shape and dimensional properties are satisfactory;
- D02-D99 statement confirming that leak tightness test and NDT of the weld seam has been carried out, and the test results are satisfactory;
- Z validation.

9.2.3 For tubes supplied with specific inspection the inspection certificate shall contain the following codes and information:

- A commercial transactions and parties involved;
- B description of products to which the inspection document applies;
- C01-C03 the location of the samples and direction of test pieces and testing temperature;
- C10-C13 tensile test;
- C40-C43 impact test results;
- C50-C59 weld bend test, if applicable;
- C60-C69 other mechanical tests (e.g. flattening, drift expanding);
- C71-C92 cast analysis reported by the steel producer and product analysis, if applicable;
- D01 statement that marking and identification, surface appearance, shape and dimensional properties are satisfactory;
- D02-D99 statement confirming that leak tightness test and NDT of the weld seam has been carried out, and the test results are satisfactory;

- Z validation;
- Reference to specific assessment under pressure equipment European legislation for materials and processes relevant to manufacture of welded tubes;
- Reference to welding process approval, where applicable;
- Reference to welder and or welding operator approval, where applicable;
- Reference to non-destructive testing operators approval, where applicable;
- In addition, where applicable, the manufacturer shall make reference to any certification of his “quality assurance system” by a competent body established within the community, see 9.1.

9.3 Summary of inspection and testing

Inspection and testing shall be carried out as stated in Table 12 for tubes of quality TR1 and Table 13 for tubes of quality TR2.

Table 12 — Summary of inspection and verification testing for quality TR1

Type of inspection and test		Frequency of testing	Refer to
		Non-specific inspection	
Mandatory tests	Cast analysis (reported by steel producer)	One representative result per delivery item	8.2.1 and 11.1
	Tensile test on the base material at room temperature		8.3, 10.2.2.2 and 11.2
	Transverse tensile test on the weld for tubes with outside diameter $D > 508$ mm		8.3, 10.2.2.3 and 11.3
	Flattening test for $D < 600$ mm and T/D ratio $\leq 0,15$ but $T \leq 40$ mm or ^b	Manufacturer's procedure ^a	8.3, 10.2.2.4 and 11.4
	drift expanding test for $D \leq 150$ mm and $T \leq 10$ mm (EW and HFW tubes)		8.3, 10.2.2.4 and 11.5
	Weld bend test for SAW tubes		8.3, 10.2.2.5 and 11.6
	Leak-tightness test	Each tube	8.4.3.1 and 11.8
	Dimensional inspection		11.9
	Visual examination		11.10
	NDT of the weld		8.4.3.2 and 11.11
Optional tests	Transverse tensile test on weld for tubes with outside diameter (D) $219,1 < D \leq 508$ mm (Option 10)	One representative result per delivery item	11.3
	Wall thickness measurement away from tube ends (Option 11)	Each tube	11.9
^a For the flattening test the two tests shall be carried out, one with the weld positioned at 0° and one at 90°.			
^b The test method used is at the discretion of the manufacturer for outside diameters ≤ 150 mm.			

Table 13 — Summary of inspection and verification testing for quality TR2

Type of inspection and test		Frequency of testing		Refer to
		Non-specific inspection	Specific inspection	
Mandatory tests	Cast analysis (reported by steel producer)	One representative result per delivery item	One per cast	8.2.1 and 11.1
	Tensile test on tube body at room temperature	One representative result per delivery item	One test per test unit	8.3, 10.2.2.2 and 11.2
	Transverse tensile test on weld for tubes with outside diameter (<i>D</i>) > 508 mm			8.3, 10.2.2.3 and 11.3
	Flattening test for <i>D</i> < 600 mm and <i>T</i> / <i>D</i> ratio ≤ 0,15 but <i>T</i> ≤ 40 mm or ^b drift expanding test for <i>D</i> ≤ 150 mm and <i>T</i> ≤ 10 mm (EW and HFW tubes)	Manufacturer's procedure ^a	Two tests per test unit ^a	8.3, 10.2.2.4 and 11.4
	Weld bend test for SAW tubes		One test per test unit	8.3, 10.2.2.4 and 11.5 8.3, 10.2.2.5 and 11.6
	Impact test on the tube body	One representative result per delivery item	One set of tests per test unit	8.3, 10.2.2.6 and 11.7
	Leak-tightness test	Each tube		8.4.3.1 and 11.8
	Dimensional inspection			11.9
	Visual examination			11.10
	NDT of the weld			8.4.3.2 and 11.11
	NDT of plate / strip end welds for SAWH tubes	Each end weld		7.2.1, 8.4.3.2 and 11.11.4
	Optional tests	Product analysis (Option 4)	Not applicable	One per cast
Additional longitudinal Impact test at – 10°C (Option 5)		One set of tests per test unit		8.3, Table 5 and 11.7
Transverse tensile test on weld for tubes with outside diameter (<i>D</i>) 219,1 < <i>D</i> ≤ 508 mm (Option 10)		One representative result per delivery item	One test per test unit	11.3
Wall thickness measurement away from tube ends (Option 11)		Each tube		11.9
^a For the flattening test, two tests shall be carried out, one with the weld positioned at 0° and one with the weld at 90°.				
^b The test method chosen is at the discretion of the manufacturer for outside diameters ≤ 150 mm.				

10 Sampling

10.1 Frequency of tests

10.1.1 Test unit

In case of specific inspection for quality TR2, a test unit shall comprise:

- Tubes of the same specified diameter and wall thickness, the same steel grade, the same cast, the same manufacturing process and, if applicable, the same normalizing treatment in a continuous furnace or heat treated in the same furnace charge in a batch-type furnace. Tubes with specified diameter $D \leq 76,1$ mm need not be separated by cast unless Option 12 is specified.

Option 12: Tubes with specified outside diameter less than or equal to 76,1 mm shall be separated by cast for quality TR2.

The maximum number of tubes per test unit shall conform to Table 14.

Table 14 — Test unit details

Outside diameter (mm)	Maximum number of tubes per test unit
D	Quality TR2
$D \leq 114,3$	400
$114,3 < D \leq 323,9$	200
$323,9 < D \leq 660$	100
$D > 660$	50

10.1.2 Number of sample tubes per test unit

One sample tube shall be taken from each test unit.

10.2 Preparation of samples and test pieces

10.2.1 Selection and preparation of samples for product analysis

When Option 4 is specified for quality TR2, see 8.2.2, one product analysis sample per cast shall be taken in accordance with EN ISO 14284. The product analysis can be carried out either on the sample tube, at the same location as for the mechanical test samples, or on the test pieces or samples after mechanical testing.

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

10.2.2.1 General

Samples and test pieces shall be taken at the tube ends and in accordance with the requirements of EN ISO 377.

10.2.2.2 Test pieces for tensile tests on the tube body

The test pieces shall be taken in accordance with the requirements of EN ISO 6892-1.

At the manufacturer's discretion:

- for tubes with an outside diameter $D < 219,1$ mm the test piece shall be either a full tube section or a strip section and shall be taken in a direction longitudinal to the axis of the tube;

- for tubes with an outside diameter $D \geq 219,1$ mm the test piece shall either a machined test piece with circular cross section from an un-flattened sample or a strip section and shall be taken in a direction either longitudinal or transverse to the axis of the tube.

The test pieces for HFW and SAWL tubes shall be taken diametrically opposite the weld except when a full tube section is used; for SAWH tubes, the test pieces shall be taken at 1/4 of the distance between the welds.

10.2.2.3 Test pieces for tensile tests on the weld

Samples shall be taken transverse to the weld with the weld at the centre of the test piece. The test piece shall be a strip section with the full wall thickness of the tube; for HFW tubes the internal weld bead may be removed and for SAW tubes the internal and external weld seam reinforcement can be removed.

10.2.2.4 Test pieces for flattening or drift expanding test

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

10.2.2.5 Test pieces for weld bend tests (SAW tubes)

The test pieces for the weld bend test at the root and face shall be taken and prepared in accordance with EN ISO 5173.

10.2.2.6 Test pieces for impact tests on the tube body

Three standard Charpy V-notch test pieces shall be prepared in accordance with EN ISO 148-1. The test pieces shall be taken transverse to the tube axis unless otherwise specified (see below or if Option 5 applies).

For HFW and SAWL tubes, the test pieces shall be taken diametrically opposite the weld; for SAWH tubes the test pieces shall be taken at 1/4 of the distance between the welds.

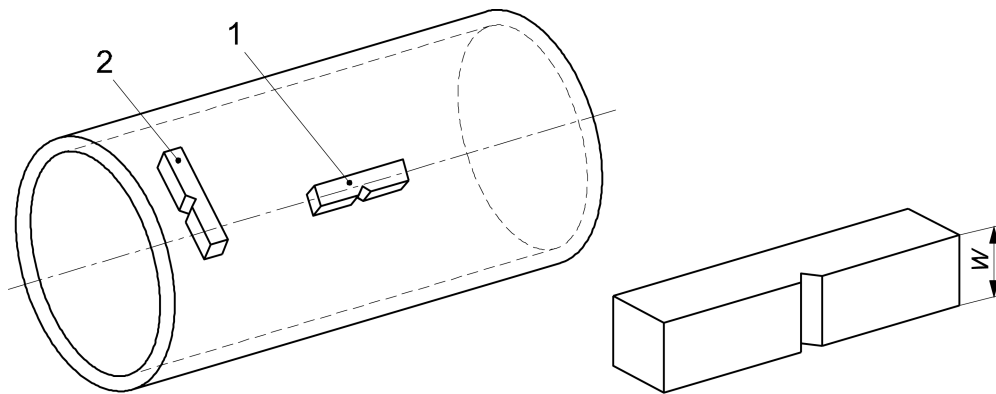
If the tube specified wall thickness is such that standard width test pieces cannot be produced without flattening of the section, then test pieces of standard width less than 10 mm, but not less than 5 mm shall be prepared; the largest obtainable standard width, either 7,5 mm or 5 mm, shall be used.

For guidance, transverse test pieces shall be taken unless $D_{\min}$, as calculated by Formula (2), is greater than the specified tube outside diameter, in which cases longitudinal test pieces shall be used.

$$D_{\min.} = (T - 5) + [756,25 / (T - 5)] \quad (2)$$

Where the dimensions of the tube is such that 5mm wide longitudinal test pieces cannot be obtained, the tubes shall not be subjected to impact testing.

The test pieces shall be prepared such that the axis of the notch is through thickness, perpendicular to the surface of the tube, see Figure 5.

**Key**

- 1 longitudinal test piece
- 2 transverse test piece
- W specimen width

Figure 5 — Impact test piece orientation**11 Verification of test methods****11.1 Chemical analysis**

The elements to be determined and reported shall be those specified in Table 2. The choice of a suitable physical or the chemical analytical method for the analysis shall be at the discretion of the steel, plate, strip or tube manufacturer. If further clarification is required, relevant methods in accordance with CEN/TR 10261 shall be agreed between the manufacturer and purchaser.

11.2 Tensile test on the tube body

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

- the tensile strength (R_m);
- the upper yield strength (R_{eH}) or if a yield phenomenon is not present the 0,2 % proof strength ($R_{p0,2}$);
- the percentage elongation after fracture with a reference to a gauge length (L_0) of $5,65 \cdot \sqrt{S_0}$; if a non-proportional test piece is used, the percentage elongation value shall be converted to the value for a gauge length (L_0) = $5,65 \cdot \sqrt{S_0}$ using the conversion tables in EN ISO 2566-1.

11.3 Transverse tensile test on the weld

This is applicable to tubes of $D > 508$ mm and to tubes with outside diameter $219,1 \text{ mm} < D \leq 508$ mm if Option 10 applies (see Table 12 and Table 13). The test shall be carried out in accordance with EN ISO 6892-1 except that only the tensile strength (R_m) shall be determined. The tube weld will pass the test if the result obtained exceeds the minimum R_m value specified in Table 4 or Table 5 as applicable. The maximum R_m value does not apply in this case.

11.4 Flattening test

The test is applicable to EW and HFW tubes. It shall be carried out in accordance with EN ISO 8492. The tube section shall be flattened in a press until the distance H between the platens reaches the value calculated by Formula (3):

$$H = \frac{(1+C)}{C+(T/D)} \times T \quad (3)$$

where

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

D is the specified outside diameter, in mm;

T is the specified wall thickness, in mm;

C is the deformation factor, the value of which is:

0,09 for steel grades of all P195 and P235 qualities;

0,07 for steel grades of all P265 qualities.

Two samples shall be tested, one with the weld at 0° and the other with the weld at 90°. After testing, the test piece shall be free from cracks or breaks. However, slight incipient cracks at the edges shall not be regarded as justification for rejection.

11.5 Drift expanding test

This test is applicable to EW and HFW tubes of outside diameter ≤ 150 mm and wall thickness ≤ 10 mm.

The test shall be carried out in accordance with EN ISO 8493. The tube section shall be expanded with a 60° conical tool, until the percentage increase in outside diameter shown in Table 15 is reached.

Table 15 — Drift expanding test requirements

Steel grade	qualities	% increase in outside diameter for d/D ^a	
		$\leq 0,8$	$> 0,8$
P195	all	10	12
P235	all	10	12
P265	all	8	10
^a $d = D - 2T$			

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

11.6 Weld bend test

This test is applicable only to SAW (SAWL and SAWH) tubes. It shall be carried out in accordance with EN ISO 5173 using a former of diameter $3T$, where T is the specified wall thickness in millimetres.

After testing, the test pieces shall show no cracks or flaws, but slight premature failure at the edges shall not be regarded as a justification for rejection.

11.7 Impact test

11.7.1 Testing shall be carried out in accordance with EN ISO 148-1, using a 2 mm radius striker, at the following test temperatures:

— TR2: 0 °C and, if Option 5 is specified, also at –10 °C.

11.7.2 The mean value of each set of three test pieces shall meet the KV_2 requirements given in Table 5. One individual test result may be below the specified requirement, provided that it is not less than 70 % of that value.

11.7.3 If the width (W) of the test piece is less than 10 mm, the measured impact energy values (KV_p) shall be converted to equivalent calculated impact energy values (KV_c) using the following Formula (4):

$$KV_c = \frac{10 \times KV_p}{W} \quad (4)$$

where

KV_c is the calculated impact energy, in Joules;

KV_p is the measured impact energy, in Joules;

W is the width of the test piece, in mm.

The mean calculated impact energy values (KV_c) shall conform to the requirements given in 11.7.2.

11.7.4 If the requirements of 11.7.2 are not met, then an additional set of three test pieces may be taken at the discretion of the manufacturer from the same sample and tested. To consider the test unit as conforming after testing the second set, the following conditions shall be satisfied simultaneously:

- the average of the six test results shall be equal to or greater than the specified minimum average value;
- not more than two of the six individual test results may be lower than the specified minimum average value;
- not more than one of the six individual test results may be lower than 70 % of the specified minimum average value.

11.7.5 The dimensions in millimetres of the test pieces, the actual impact test results and the resulting average value shall be stated in the test report or inspection certificate.

11.8 Leak tightness test

11.8.1 Hydrostatic test

The hydrostatic test shall be carried out at a test pressure of 70 bar²⁾ or at a test pressure P calculated using the following Formula (5), whichever is lower:

$$P = 20 \times \frac{S \times T}{D} \quad (5)$$

where

P is the test pressure, in bar;

D is the specified outside diameter, in mm;

T is the specified wall thickness, in mm;

2) 1 bar = 100 kPa

S is the stress, in MPa, corresponding to 70 % of the specified minimum yield strength (see Table 4 or 5) for the steel grade concerned.

The test pressure shall be held for not less than 5 s for tubes with an outside diameter $D \leq 457$ mm and for not less than 10 s for tubes with an outside diameter $D > 457$ mm.

The tubes shall withstand the test without showing leakage

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

11.8.2 Electromagnetic test

The test shall be carried out in accordance with EN ISO 10893-1.

11.9 Dimensional inspection

Specified dimensions, including straightness shall be verified.

The outside diameter shall be measured at the tube ends. For tubes with outside diameter $D \geq 406,4$ mm, the diameter may be measured using a circumference tape.

Unless Option 11 is specified the wall thickness shall also be measured at the tube ends.

Option 11: *The wall thickness shall be measured away from the tube ends in accordance with an agreed procedure.*

11.10 Visual examination

Tubes shall be visually examined to ensure conformity to the requirements of 8.4.1 and 8.4.2.1.

11.11 Non-Destructive Testing

11.11.1 General

For EW and HFW and SAW tubes, the full length of the weld seam shall be non-destructively tested in accordance with 11.11.2 or 11.11.3, as applicable.

Unless Option 13 is specified the selection of test method from 11.11.2 (for EW and HFW tubes), or 11.11.3 (for SAW tubes), is at the discretion of the manufacturer.

Option 13: *The test method, from 11.11.2 or 11.11.3 as applicable, is specified by the purchaser.*

11.11.2 EW and HFW tubes

The weld seam of EW and HFW tubes shall be tested in accordance with one of the following:

- EN ISO 10893-2 to acceptance level E3 or E3H;
- EN ISO 10893-3 to acceptance level F3;
- EN ISO 10893-10 to acceptance level U3 sub category C;
- EN ISO 10893-11 to acceptance level U3.

Where the testing procedure is not capable of assessing the weld seam at the tube ends, then this area shall either be subjected to manual / semi-automatic ultrasonic testing in accordance with EN ISO 10893-11:2011, Annex A, or equivalent, or shall be cropped off.

11.11.3 SAW tubes

The weld seams of SAWL and SAWH tubes shall be tested in accordance with one of the following:

- EN ISO 10893-6 to image quality class A;

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- EN ISO 10893-7 to image quality class A;
- EN ISO 10893-11 to acceptance level U3 or U3H.

Where the testing procedure is not capable of assessing the weld seam at the tube ends, then this area shall be subjected to either manual / semi-automatic ultrasonic testing in accordance with EN ISO 10893-11:2011, Annex A, or equivalent, radiography in accordance with EN ISO 10893-6, digital radiography in accordance with EN ISO 10893-7 or shall be cropped off.

11.11.4 Strip end welds in SAWH tubes

SAWH tubes containing strip end welds shall only be supplied when the strip welds have also been tested in accordance with 11.11.3.

11.12 Retest, sorting and reprocessing

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

12 Marking

12.1 Marking to be applied

At least one end of each tube shall be indelibly marked by a suitable and durable method, such as an automated ink or paint marking process, paint stencil or hard stamping (using low stress or pin stamps) or a combination of these.

The marking shall include the following information:

- the manufacturer's name or trade mark or product brand;
- the type of tube (EW, HFW, SAWL or SAWH - symbol in accordance with Table 1);
- the number of this document (EN 10217-1);
- the steel name or steel number (see 5.2.1);

In case of specific inspection:

- the cast number and/or an identification number (e.g. an order or item number or manufacturing reference code) which permits correlation of the product or delivery unit to the related documentation;
- the mark of the inspection representative, if applicable.

For tubes with outside diameter $D \leq 51$ mm the marking on the tubes may be replaced by marking on a label or tag, which shall be securely attached to the bundle or box. Additionally, the label or tag shall identify the tube diameter, wall thickness and length range.

NOTE Example of marking:

X – SAWL – EN 10217-1 – P265TR2 – Y-Z

where

- | | |
|------|---|
| X | is the manufacturer's mark; |
| SAWL | is the type of tube; |
| Y | is the cast number or identification number or a code number; |
| Z | is the mark of the inspection representative, if applicable. |

12.2 Additional marking

Unless Option 14 is specified, no additional marking other than that specified in 12.1 need be applied.

Option 14: *Additional marking, as agreed upon at the time of the enquiry and order, shall be applied.*

13 Protection

Unless Option 15 is specified, the tubes shall be delivered without any protective coating.

Option 15: *A temporary protective coating or a durable coating and/or lining shall be applied.*

Annex A **(normative)**

Qualification of welding procedure for quality TR2 SAW tube production

A.1 General

SAW tube of quality TR2, produced to this document, shall be welded in accordance with set procedures which have been specified, qualified and/or approved in accordance with this Annex.

This Annex does not invalidate previous welding procedures qualified and/or approved to meet national standards or specification, providing the content of the requirements is satisfied and the previous procedure qualifications and/or approvals are relevant to the applications and production work on which they are to be employed.

This Annex covers the requirements for the qualification and/or approval of weld procedures for the production of SAW tube including inspection and testing and also for other fusion welding processes used in SAW tube production.

A.2 Welding procedure specification

A.2.1 General

The qualification for the welding procedure shall be carried out in accordance with a welding procedure specification (WPS). The specification shall include the following information as a minimum requirement.

A.2.2 Parent metal

A.2.2.1 Steel name or number

The steel grade shall be identified in accordance with the requirements of this document.

NOTE A welding procedure specification may cover a group of materials (see A.8.1).

A.2.2.2 Tube dimensions

Tube dimensions shall be supplied for the following:

- outside diameter D ;
- wall thickness T .

A.2.3 Weld preparation

Details of the strip/plate edge profile prior to welding shall be given. This may be in the form of a dimensional sketch. Details of the methods of preparation and tack welding shall be included.

A.2.4 Filler wires and fluxes

A.2.4.1 The standard number and grade shall be referenced.

A.2.4.2 The number, dimensions and position of filler wire or wires and details of any additional filler metal shall be supplied. When specifying the position, any angular variation shall be included, if applicable.

A.2.4.3 If carried out, the flux recycling procedure shall be referenced.

A.2.5 Electrical parameters

Details of the electrical parameters shall include as a minimum:

- type of current (a.c. and/or d.c.) and polarity;
- nominal current, the range to be expressed as a plus and minus percentage;
- nominal arc voltage, the range to be expressed as a plus and minus percentage.

A.2.6 Mechanical parameters

Details of mechanical parameters shall include as a minimum:

- nominal travel speed, the range to be expressed as a plus and minus percentage;
- number and order of inside and outside weld runs.

A.2.7 Heat input (kJ/mm)

If required the maximum value achieved during the qualification/approval test shall be recorded.

A.2.8 Preheat temperature

If required the minimum preheat temperature shall be specified.

A.2.9 Interpass temperature

The maximum permissive interpass temperature shall be specified where applicable.

A.2.10 Postweld heat treatment

The delivery condition after welding shall be in accordance with Table 1 for the steel grade concerned.

Details of the heat treatment, where applicable, shall be included on the qualification documentation.

A.2.11 Example of welding procedure specification form

A typical weld procedure specification is shown in Table A.1, for information.

Table A.1 — Example of typical welding procedure specification form

Welding procedure specification										
Ref. N. WPS:			Prepared by:			Checked by:			Date:	
Parent metal:						Thickness/diameter:				
Weld preparation:						Pass location:				
Preparation method Machined/plasma or flame cut										
Pass n.	Wire n.	Welding position	Wire					Nominal current	Nominal arc voltage	Nominal travel speed
			Size mm	Code n.	Designation	Polarity	Flux	A	V	mm/s
Heat input ^a								Preheat		°C min
Heat treatment			Stress relieving		Normalizing			Interpass temperature		°C max
Heating rate								NDT		
Soaking temperature										
Soaking time										
Cooling rate										
Withdraw temperature										
Notes										
^a If required.										

A.3 Preparation of sample tube and sample assessment

A.3.1 Sample tube

When required, preparation and welding of a sample tube shall be carried out in accordance with the WPS and under the general conditions of production welding which they shall represent. The sample tube shall be in the relevant delivery condition specified in Table 1.

Where an approved procedure is required, the name and address of the authorized body shall also be supplied.

A.3.2 Sample assessment

Inspection and testing of the weld shall be in accordance with A.4. A test sample sufficiently long to carry out the tests specified in A.5 shall be taken from the end of the sample tube.

A.4 Inspection and testing of the weld

The test sample shall be subjected to the inspection or testing of Table A.2.

Table A.2 — Inspection and testing of the weld

Type of inspection or test	Extent or number of test pieces
Visual examination of the weld ^a	100 % of the sample
Radiographic examination of the weld	100 % of the sample
Weld bend test	2 root and 2 face test pieces ^b
Macro-examination of weld cross section	1 specimen
Transverse weld tensile test	2 test pieces
Weld impact test ^c	1 set of three test pieces
^a Magnetic particle inspection or penetrant inspection may be used at the discretion of the manufacturer. ^b These tests may be replaced by 4 side bend tests for wall thickness greater than 12,5 mm, at the manufacturer's discretion. ^c This test is applicable only for group 2 steels (see Table A.4).	

A.5 Weld test pieces

A.5.1 Weld bend test pieces

The bend test pieces shall be prepared in accordance with 10.2.2.5.

A.5.2 Macro-examination

The sample shall be prepared in accordance with EN ISO 17639.

A.5.3 Transverse weld tensile test

The transverse tensile test piece shall be prepared in accordance with 10.2.2.3.

A.5.4 Weld impact test

Three standard Charpy V-notch test pieces taken transverse to the weld shall be prepared in accordance with 10.2.2.6.

The test pieces shall be prepared such that the axis of the notch is perpendicular to the surface of the tube and the notch shall be placed in the middle of the weld.

A.6 Test methods

A.6.1 Visual examination

Visual examination of the test piece shall be carried out.

A.6.2 NDT test

The NDT test shall be carried out in accordance with 11.11.3.

A.6.3 Weld bend test

The weld bend test shall be carried out in accordance with 11.6.

A.6.4 Macro-examination

The macro-examination shall be carried out at a magnification of $\times 5$.

A.6.5 Transverse weld tensile test

The transverse weld tensile test shall be carried out in accordance with 11.3.

A.6.6 Weld impact test

The weld impact test shall be carried out in accordance with 11.7.

A.7 Test acceptance levels

A.7.1 Visual examination

Surface defects, as specified in 8.4.2, shall not be permitted.

A.7.2 NDT test

This shall meet the acceptance requirements of 11.11.3.

A.7.3 Weld bend test

The tested specimen shall be checked for lack of fusion and the results reported.

For acceptance the results shall meet the requirements of 11.6.

A.7.4 Macro-examination

The specimen shall be checked for the following:

- cracks;
- lack of penetration;
- lack of fusion;
- height of internal and external weld beads;
- radial offset of plate edges;
- misalignment of weld seam.

The result shall be recorded.

For acceptance the following apply:

- cracks and lack of penetration and fusion shall not be permitted;
- heights of internal and external weld seams, radial offset of plate and strip edges and misalignment of weld seams shall comply with the requirements of 8.7.4.3, 8.7.4.4 and Tables 9 and 10.

A.7.5 Transverse weld tensile test

The tube weld will pass the test if the result obtained exceeds the minimum R_m value specified in Table 5. The maximum R_m value does not apply in this case. The position of the fracture shall be reported.

A.7.6 Weld impact test

The impact test results shall meet the requirements of 11.7 and Table 5 for the steel grade concerned.

A.7.7 Example of test result document

A typical test results form is shown in A.3, for information.

Table A.3 — Example of typical test results form

Test results						
Manufacturer: Welding procedure Reference no: Visual examination: Pass/fail Penetrant/magnetic particle test Pass/fail				Examiner or examining body: Reference no: Radiographic test ^a : Pass/fail Ultrasonic examination ^a : Temperature: °C		
Tensile tests						
Type /No.	R_m MPa	Fracture location			Remarks	
Requirements						
Bend tests					Macro examination	
Former diameter						
Type /No.	Bend angle	Results				
Impact test ^a						
Type:		Size:		Requirement:		
Notch Location/Direction	Temperature °C	Values J				Remarks
		1	2	3	Average	
Hardness test ^a						
Type/load:						
H. A. Z.:						
Weld Metal:						
Parent metal:						
Other tests:						
Remarks:						
Tests carried out in accordance with the requirements of:						
Examiner or examining body:						
Laboratory report reference no:						
Test results were acceptable/not acceptable (delete as appropriate)						
Test carried out in the presence of:						
Name:		Signature:			Date:	
^a If required.						

A.8 Range of use of qualified procedures

A.8.1 Materials groups

In order to avoid unnecessary qualification of weld procedures all TR2 grades have been grouped together. A qualified welding procedure for any TR2 grade will therefore also cover all other TR2 grades.

A.8.2 Materials thickness

Qualification at a given wall thickness covers a range of wall thicknesses and these are shown in Table A.4.

Table A.4 — Range of qualification based on wall thickness T

Dimensions in millimetres

Wall thickness of tube sample	Range of qualification
$T \leq 12,5$	3 to $2 T$
$T > 12,5$	$0,5 T$ to $2 T$

A.8.3 Filler wire classification

The qualification of a filler wire covers other filler wires provided they meet the following requirements:

- they shall be in the same group of tensile properties with procedures which include impact testing;
- they shall have the same nominal chemical composition.

A.8.4 Welding flux

A change from one welding flux, as defined by EN ISO 14174 to one of a different classification shall require a separate welding procedure qualification.

A.8.5 Other parameters

Changes, singly or collectively, to the number of the welding wires or the type of current (e.g. from a.c. to d.c.) or a changes in the number of weld runs per side from single to multi-pass, or vice versa, shall require one or more separate welding procedure specification(s) and approval(s).

A.9 Qualification record

The manufacturer shall state that each welding procedure has been qualified and the procedure and qualification test results shall be documented and signed by his authorized representative (see Table A.3).

When the testing and inspection have been witnessed and approved by an authorized body the documentation shall contain the name and address of the person or company and be signed by the person approving the procedure.

Annex B

(informative)

Technical changes from the previous edition

B.1 Introduction

This informative annex is intended to guide the user to places where significant technical changes have been introduced into the previous edition of this European Standard. Editorial changes are not included in this annex. References refer to the previous edition.

While this annex is intended to be comprehensive, users should satisfy themselves that they fully understand the changes which have been made. The user is ultimately responsible for recognizing any differences between this edition and the previous edition of the document.

B.2 Technical changes

- 1 Scope
- 2 Normative references
- 3 Terms and definitions
- 4 Symbols
- 5 Classification and designation
- 6 Information to be supplied by the purchaser
 - 6.1 Mandatory information
 - 6.2 Options [1), 2), 3), 4), 5), 6), 9),10),11), 12), 13)]
 - 6.3 Example of order
- 7 Manufacturing process
 - 7.1 Steelmaking process
 - 7.2 Tube manufacture and delivery conditions
 - Table 1
 - 7.3 Non-destructive testing personnel requirements
- 8 Requirements
 - 8.1 General
 - 8.2 Chemical composition (Table 2 and Table 3)
 - 8.3 Mechanical properties (Table 4 and 5)

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- 8.4 Appearance and internal soundness
- 8.6 Preparation of ends
- 8.7 Dimensions, masses and tolerances (Tables 7, 8, 9 and 11)
- 9 Inspections
 - 9.1 Types of inspections
 - 9.2 Inspection documents (9.2.1)
 - 9.3 Summary of inspection and testing (Tables 12 and 13)
- 10 Sampling
 - 10.1 Frequency of tests (Table 14)
 - 10.2 Preparation of samples and test pieces
- 11 Verification test methods
 - 11.1 Chemical analysis
 - 11.3 Transverse tensile test on the weld
 - 11.4 Flattening test
 - 11.5 Drift expanding test
 - 11.6 Weld bend test
 - 11.7 Impact test
 - 11.8 Leak tightness test
 - 11.9 Dimensional inspection
 - 11.10 Visual examination
 - 11.11 Non-destructive testing
- 12 Marking
- Annex A
- Annex ZA

Annex ZA (informative)

Relationship between this European Standard and the Essential Requirements of 2014/68/EU

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association to provide a means of conforming to Essential Requirements of the New Approach Directive 2014/68/EU.

Once this standard is cited in the Official Journal of the European Union under that Directive and has been implemented as a national standard in at least one Member State, compliance with the clauses of this standard given in Table ZA.1 confers, within the limits of the scope of this standard, a presumption of conformity with the corresponding Essential Requirements of that Directive and associated EFTA regulations.

Table ZA.1 — Correspondence between this European Standard and Annex I of the Directive 2014/68/EU

Essential Requirements of the Directive 2014/68/EU	Clauses/sub-clauses of this EN	Remarks/Notes
3.1.2	7.2.2, 7.2.3, 7.2.4, Annex A	Welding For SAW & HFW tubes used for pressure equipment in categories II, III and IV, relevant operating procedures and personnel shall be approved by a notified body or a recognized third party organisation.
3.1.3	7.3	NDT personnel requirements For tubes to be used in pressure equipment under Categories III and IV the personnel shall be approved by a recognised third party organisation.
4.1.a	8.3	Appropriate material properties
4.1.c	7.1 and 8.2	Ageing
4.1.d	7.2.1, 7.2.5, 8.4	Suitable for the processing procedures.
4.3	Clause 9	Inspection documentation.

WARNING 1 — Presumption of conformity stays valid only as long as a reference to this European Standard is maintained in the list published in the Official Journal of the European Union. Users of this standard should consult frequently the latest list published in the Official Journal of the European Union.

WARNING 2 — Other Union legislation may be applicable to the products falling within the scope of this standard.

Bibliography

EN ISO 9712:2012, *Non-destructive testing — Qualification and certification of NDT personnel (ISO 9712:2012)*