Welded steel tubes for pressure purposes — Technical delivery conditions —

Part 6: Submerged arc welded non-alloy steel tubes with specified low temperature properties

The European Standard EN 10217-6:2002 has the status of a British Standard

 $\mathrm{ICS}\ 23.040.10;\ 77.140.75$



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National foreword

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The UK participation in its preparation was entrusted by Technical Committee ISE/73, Steels for pressure purposes, to Subcommittee ISE/73/1, Steel tubes for pressure purposes, which has the responsibility to:

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

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

Cross-references

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This British Standard, having been prepared under the direction of the Engineering Sector Policy and Strategy Committee, was published under the authority of the Standards Policy and Strategy Committee on 26 June 2002

Summary of pages

This document comprises a front cover, an inside front cover, the EN title page, pages 2 to 32, an inside back cover and a back cover.

The BSI copyright date displayed in this document indicates when the document was last issued.

Amendments issued since publication

© BSI 26 June 2002

ISBN 0 580 39846 3

EUROPEAN STANDARD NORME EUROPÉENNE EUROPÄISCHE NORM

EN 10217-6

May 2002

ICS 23.040.10; 77.140.75

English version

Welded steel tubes for pressure purposes - Technical delivery conditions - Part 6: Submerged arc welded non-alloy steel tubes with specified low temperature properties

Tubes soudés en acier pour service sous pression -Conditions techniques de livraison - Partie 6: Tubes soudés à l'arc immergé sous flux en poudre en acier non allié avec caractéristiques spécifiées à basse température Geschweißte Stahlrohre für Druckbeanspruchungen -Technische Lieferbedingungen - Teil 6: Unterpulvergeschweißte Rohre aus unlegierten Stählen mit festgelegten Eigenschaften bei tiefen Temperaturen

This European Standard was approved by CEN on 25 April 2002.

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Ref. No. EN 10217-6:2002 E

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Foreword

This document (EN 10217-6:2002) has been prepared by Technical Committee ECISS/TC 29, "Steel tubes and fittings for steel tubes", the secretariat of which is held by UNI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by November 2002, and conflicting national standards shall be withdrawn at the latest by November 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(s).

For relationship with EU Directive(s), see informative annex ZA, which is an integral part of this document.

Other parts of EN 10217 are:

- Part 1: 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: Alloy fine grain steel tubes.
- 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 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 organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

1 Scope

This Part of EN 10217 specifies the technical delivery conditions in two test categories of submerged arc welded tubes of circular cross section, with specified low temperature properties, made of non-alloy steel.

2 Normative references

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

The requirements of this European Standard rule when they differ from those in the standards and documents referred to below:

EN 760, Welding consumables - Fluxes for submerged arc welding – Classification.

EN 895, Destructive tests on welds in metallic materials - Transverse tensile test.

EN 910, Destructive tests on weld in metallic materials -Bend test.

EN 1321, Destructive tests on welds in metallic materials - Macroscopic and microscopic examination of welds.

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

EN 10020, Definitions and classification of grades of steel.

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

- EN 10027-1, Designation systems for steels Part 1 : Steel names, principle symbols.
- EN 10027-2, Designation systems for steels Part 2 : Numerical systems.
- EN 10045-1, Metallic materials Charpy impact test Part 1 : Test method.
- EN 10052, Vocabulary of heat treatment terms for ferrous products.

EN 10204, Metallic products - Types of inspection documents.

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

EN 10246-9, Non-Destructive Testing of steel tubes – Part 9: Automatic ultrasonic testing of the weld seam of submerged arc-welded steel tubes for the detection of longitudinal and/or transverse imperfections.

EN 10246-10, Non-Destructive Testing of steel tubes – Part.10: Radiographic testing of the weld seam of automatic fusion arc-welded steel tubes for the detection of imperfections.

EN 10246-15, Non-Destructive Testing of steel tubes - Part 15: Automatic ultrasonic testing of strip/ plate used in the manufacture of welded steel tubes for the detection of laminar imperfections.

EN 10246-16, Non-Destructive Testing of steel tubes - Part 16: Automatic ultrasonic testing of the area adjacent to the weld seam of welded steel tubes for the detection of laminar imperfections.

EN 10246-17, Non-Destructive Testing of steel tubes - Part 17: Ultrasonic testing of tube ends of seamless and welded steel tubes for the detection of laminar imperfections.

EN 10256, Non-Destructive Testing of steel tubes - Qualification and competence of level 1 and level 2 NDT personnel.

prEN 10168¹⁾, Iron and steel products - Inspection documents - List of information and description.

prEN 10266¹⁾, Steel tubes, fittings and structural hollow sections - Symbols and definition of terms for use in product standards

EN ISO 377, Steel and steel products - Location and preparation of samples and test pieces for mechanical testing (ISO 377:1997).

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

ISO 14284, Iron and steel products - Sampling and preparation of samples for the determination of the chemical composition.

CR 10260, Designation systems for steel - Additional symbols.

CR 10261, ECISS Information Circular IC 11 - Iron and steel - Review of available methods of chemical analysis.

3 Terms and definitions

For the purpose of this Part of EN 10217 the definitions given in EN 10020, EN 10021, EN 10052, prEN 10266 and the followings apply:

3.1

Test Category

Classification that indicates the extent and level of inspection and testing.

3.2

employer

Organisation for which a person works on a regular basis.

NOTE The employer may be either the tube manufacturer or supplier or a third party organisation providing Non-Destructive Testing (NDT) services.

3.3

qualification of welding procedure

Testing and inspection of the welding procedure in accordance with annex A by the manufacturer.

3.4

approval of welding procedure

Testing and inspection of the welding procedure witnessed and approved in accordance with annex A by an authorised body.

4 Symbols

For the purposes of this part of EN 10217. The symbols given in prEN 10266 and the following apply:

- C1, C2 is the category conformity indicators (see 7.3.1 and 7.3.3.)
- TC test category.

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

Classification and designation 5

5.1 Classification

In accordance with the classification system in EN 10020, the steel grade given in Tables 2 and 4 the 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 Part of EN 10217;

plus either:

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

or:

- the steel number allocated in accordance with EN 10027-2.
- The steel name is designated by 5.2.2
- the capital letter P for pressure purposes;
- the indication of the specified minimum yield strength expressed in MPa, (see Table 4);
- the symbol of the delivery condition for the steel grade concerned (see Table 1);
- the symbol L for low temperature.

Information to be supplied by the purchaser 6

6.1 Mandatory information

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

- the quantity (mass or total length or number); a)
- b) the term "tube";
- the dimensions [outside diameter D, wall thickness T (see Table 6). C)
- the designation of the steel grade in accordance with this Part of EN 10217 (see 5.2); d)
- the test category (see 9.3). e)

6.2 Options

A number of options are specified in this Part of this EN 10217 and these are listed below. In the event that the purchaser does not indicate his wish to implement any of these options at the time of enquiry and order, the tubes shall be supplied in accordance with the basic specification (see 6.1).

- Tube manufacturing route (see 7.3.2). 1)
- 2) Restriction on copper and tin content (see Table 2).
- 3) Product analysis (see 8.2.2).
- 4) Special end preparation (see 8.6). Copyright British Standards Institution Reproduced by IHS under license with BSI Uncontrolled Copy

- 5) Exact lengths (see 8.7.3).
- 6) Type of inspection document other than the standard document (see 9.2.1).
- 7) Transverse weld tensile test (see Table 11).
- 8) Test pressure for hydrostatic leak-tightness test (see 11.6).
- 9) Wall thickness measurement away from the ends (see 11.7).
- 10) Non Destructive Testing method for the inspection of weld seam (see 11.9.1).
- 11) Image quality class R1 of EN 10246-10 for the non-destructive radiographic inspection of the weld seam (see 11.9.1).
- 12) Additional marking (see 12.2).
- 13) Protection (see 13).

6.3 Example of an order

500 m of submerged arc welded tube with an outside diameter of 508 mm, a wall thickness of 4,5 mm in accordance with EN 10217-6, made of steel grade P265NL, test category 1, with a 3.1.C inspection certificate in accordance with EN 10204:

500 m - Tube - 508 x 4,5 - EN 10217-6 - P265NL - TC 1 - Option 6: 3.1.C

7 Manufacturing process

7.1 Steelmaking process

The steelmaking process is at the discretion of the manufacturer.

7.2 Deoxidation process

Steels shall be fully killed.

7.3 Tube manufacture and delivery conditions

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

The qualification shall be in accordance with EN 10256 or, at least, an equivalent to it.

It is recommended that the level 3 personnel be certified in accordance with EN 473 or, at least, an equivalent to it.

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

NDT operations shall be authorised by a level 3 NDT individual approved by the employer.

NOTE The definition of level 1,2 and 3 can be found in appropriate Standards, e.g. EN 473 and EN 10256.

For pressure equipment in categories III and IV (of Directive 97/23-EC) the personnel shall be approved by a recognised third-party organisation. Tubes not conforming to this requirement shall be marked "C 2", unless a requirement to mark "C1" (see 7.3.3) applies

7.3.2 The tubes shall be manufactured by a submerged arc welding (SAW) process and in accordance with one of the routes as specified in Table 1.

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

Option 1: The manufacturing route is specified by the purchaser.

Tubes shall be submerged arc welded 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 the helically submerged arc welded (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 welds used for joining together lengths of the hot or cold rolled strip or plate prior to forming except that for helically welded.

For helycally welded submerged arc welded (SAWH) tubes, when the weld joining lengths of strip are part of the delivered tube, they shall have the welding procedure qualified in accordance with annex A and the weld shall be subjected to the same inspection and testing as the helical weld.

7.3.3 Welding shall be carried out by suitably qualified personnel in accordance with suitable operating procedures.

For pressure equipment in categories II, III, and IV, (of Directive 97/23-EC) the operating procedures and the personnel shall be approved by a competent third-party. Tubes not conforming to this requirement shall be marked "C 1".

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

7.3.5 The delivery condition of tubes covered by this Part of EN 10217 are shown in Table 1

Route	Manufacturing	process	Manufacturing	Delivery			
N°	Process	Symbols	Starting material	Forming operation	condition		
1			As (hot) rolled plate or strip	Cold formed	Normalized (entire tube)		
2a	Submerged arc welded	(SAW)	Normalising rolled plate or strip	Cold formed	Without subsequent		
2b	-longitudinal seam	- (SAWL)	Normalised plate or strip		heat treatment ^a		
······································	-helical seam	- (SAWH)	As (hot) rolled or Normalising or Normalising Normalising Without subs normalising rolled plate or formed ^b heat treatm		Without subsequent heat treatment ^a		
^a Stress relieving treatment on the weld is permissible							
^b Only a	Only applicable to SAWL tubes						

Table 1 — Tube manufacturing process, route and delivery condition

8 Requirements

8.1 General

The tubes, when supplied in a delivery condition indicated in clause 7.3 and inspected in accordance with clauses 9, 10 and 11, shall conform to with the requirements of this Part EN 10217.

Tubes shall be suitable for hot and cold bending provided the bending is carried out in an appropriate manner.

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.

NOTE When welding tubes produced in accordance with this part of EN 10217, account should be taken of the fact that the behaviour of the steel during and after welding is dependent not only on the steel, but also on the applied heat treatment and the conditions of preparing for and carrying out the welding.

8.2.2 Product analysis

Option 3: A product analysis for the tube shall be supplied.

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

ć

Steel	grade	С	Si	Mn	Р	S	Cr	Мо	Ni	AI total b	Cu ^c	Nb	Ti	V
Steel name	Steel number	max	max		max	max	max	max	max	min	max	max	max	max
P215NL	1.0451	0,15	0,35	0,40 to 1,20	0,025	0,020	0,30	0,08	0,30	0,020	0,30	0,010	0,03	0,02
P265NL	1.0453	0,20	0,40	0,60 to 1,40	0,025	0,020	0,30	0,08	0,30	0,020	0,30	0,010	0,03	0,02
P265NL	1.0453	0,20	0,40	0,60 to 1,40	0,025	0,020	0,30	0,08	0,30	0,020	0,30	0,010	0,03	

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

^a Elements not included 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 steel making process.

^b This requirement is not applicable provided the steel contains a sufficient amount of other nitrogen binding elements which shall be reported. When using titanium, the producer shall verify that $(AI+Ti/2) \ge 0.020\%$.

Option 2: In order to facilitate subsequent forming operation, an agreed maximum copper content lower than indicated and an agreed specified maximum tin content shall apply.

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

Element	Limiting value for the cast analysis in accordance with Table 3 % by mass	Permissible deviation of the product analysis % by mass
С	≤ 0,20	+ 0,02
Si	≤ 0,40	+ 0,05
Mn	≤ 1,40	+ 0,10 - 0,05
Р	≤ 0,025	+ 0,005
S	≤ 0,020	+ 0,005
AI	≥0,020	- 0,005
Cr	≤ 0,30	+ 0,05
Cu	≤ 0,30	+ 0,05
Мо	≤ 0,08	+ 0,02
Nb	≤ 0,010	+ 0,005
Ni	≤ 0,30	+ 0,05
Ti	≤ 0,03	+ 0,01
V	≤ 0,02	+ 0,01

8.3 Mechanical properties

The mechanical properties of the tubes shall conform to the requirements in Tables 4 and 5 and in clause 11.4.

Steel	grade	Tensile properties				
Steel name	Steel Number	Upper yield strength or proof strength R_{eH} or $R_{p0,2}$ min.	Tensile strength R _m	Elong A	ation ^a min. %	
		MPa *	MPa *	Ι	t	
P215NL ^b 1.0451		215	360 to 480	25	23	
P265NL 1.0453		265	410 to 570	24	22	
a I = longitudir	^a I = longitudinal t = transverse					
^b For wall thic	^b For wall thickness T \leq 10 mm					
* 1 MPa = 1 N/mm ²						

Table 4 — Mechanical properties at room temperature for wall thickness up to and including 25 mm

Table 5 — Im	nact prop	erties for wal	I thickness T	up to and	including	25 mm
	ρασι ρι ορ	erties for war		up to and	monuumy	23 11111

Steel grade		Orientation of test pieces with respect to tube axis	Minimum a	verage absor KV J emperature	bed energy	
Steel name	Steel number		-40	-20	+20	
P215NL ^a	1.0451	Longitudinal	40	45	55	
DOGENI	1 0452	Longitudinal	40	45	50	
P200NL 1.0405		Transverse	27	30	35	
a For wall thick	^a For wall thickness T \leq 10 mm					

8.4 Appearance and internal soundness

8.4.1 General

The weld area shall be free from cracks, lack of fusion and lack of penetration.

8.4.2 Appearance

8.4.2.1 The tubes shall be free from external and internal surface defects that can be detected by visual examination.

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.

This requirement does not apply to surface imperfection with a depth equal or less 0,3 mm.

8.4.2.5 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 with this Part of EN 10217.

8.4.2.6 Repairs to the weld seam are permitted in accordance with an established and agreed procedure.

8.4.3 Internal soundness

8.4.4 Leak Tightness

The tubes shall pass a hydrostatic test (see 11.6) for leak-tightness.

8.4.4.1 Non-Destructive Testing

The full length of weld seam of tubes of test category 1 and test category 2 shall be subjected to a Non-Destructive Testing for the detection of imperfections in accordance with clauses 11.9.1.

Additionally the edges of plate or strip and the ends of tubes of test category 2 shall be subjected to a Non-Destructive Testing for the detection of laminar imperfections in accordance with clauses 11.9.2.

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

Tubes shall be delivered with square cut ends. The ends shall be free from excessive burrs.

Option 4: The tubes shall be delivered with bevelled ends (see figure 1). The bevel shall have an angle α of 30° $_{0^{\circ}}^{+5^{\circ}}$ with a root face C of 1,6 mm \pm 0,8 mm, except that for wall thicknesses T greater than 20 mm, an agreed alternative bevel may be specified



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.

Preferred outside diameters D and wall thicknesses T have been selected from ENV 10220 and are given in Table 6.

NOTE Dimensions which are different from those in Table 6 may be agreed.

8.7.2 Mass

For the mass per unit length the provision of ENV 10220 applies.

8.7.3 Lengths

Unless option 5 is specified, the tubes shall be delivered in random length. The delivery range shall be agreed at the time of enquiry and order.

Option 5: The tubes shall be delivered in exact lengths, the length to be specified at the time of enquiry and order. For tolerances see 8.7.4.5.

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.

																dim	ensio	ons in	mm
Outsid	de dian Series	neter D a								Wall	thickn	iess T							
1	2	3	4	4,5	5	5,6	6,3	7,1	8	8,8	10	11	12,5	14,2	16	17,5	20	22,2	25
406,4																			
457																			
508					0		þ						-						
		559																	
610																			
		660																	
711																			
	762																		
813																			
		864																	
914																			
1016																			
1067																			
1118																			
	1166																		
1219																			
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1829																			
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2032																			
	2134																		
2235																			
	2337																		
	2438																		
2540																			
^a se standa se	ries 1 Irdized ries 2 : ries 3 :	= diar : = diame = diame	mete	sters for which all the accessories needed for the construction of piping system are rs for which not all the accessories are standardized; rs for special application for which very few standardized accessories exist															

Table 6 — Preferred dimensions

.

		dimensions in mm			
Tolerance on	Tolerance on T ^a				
D	$T \leq 5$	5< T ≤ 40			
± 0,75 % or ± 6 mm± 10 % or ± 0,3 mm± 8 % or ± 2 mmwhichever is the lowerwhichever is the greaterwhichever is the lower					
³ The plus tolerance excludes the weld area (see 8.7.4.2)					

Table 7 — Tolerances on outside diameter and on wall thickness

8.7.4.2 Height of the weld seam

The height of the external and internal weld seam shall be within the limits indicated in Table 8.

Table 8 — Maximum height of the weld seam

dimensions in mm

Wall thickness T	Maximum height of the outside and inside weld seam
T ≤ 12,5	3
T > 12,5	4

8.7.4.3 Radial offset of plate or strip edges at the weld

The radial offset of the abutting plate or strip edges shall within the limits indicated in Table 9.

Table 9 — Maximum radial offset of the abutting plate or strip edges

	dimension in mm
Thickness T	Maximum radial offset
T ≤ 12,5	1,6
T > 12,5	0,125 T with a max. of 3,2

8.7.4.4 Misalignment of the weld seam

Misalignment of the weld seam shall be acceptable provided complete penetration and complete fusion are achieved.

8.7.4.5 Tolerances on exact length

The tolerances for exact lengths shall be as given in Table 10.

	dimensions in mm
Length L	Tolerance
L ≤ 6000	+ 25 0
6000 < L ≤ 12000	+ 50 0
L > 12000	+ By agreement 0

Table 10 — Tolerances on exact length

8.7.4.6 Out of roundness

The out-of-roundness (O) shall be calculated using the following equation:

$$O = \frac{D_{\text{max}} - D_{\text{min}}}{D} 100 \tag{1}$$

where:

0	=	out-of-roundness	in %
D	=	specified outside diameter	in mm
D max, D min.	=	maximum and minimum outside	diameter measured in the same plane in mm

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

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

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

9 Inspection

9.1 Types of inspection

Conformity to the requirements of the order, for tubes in accordance with this Part of EN 10217, shall be checked by specific inspection.

9.2 Inspection documents

9.2.1 Types of inspection documents

Unless option 6 is specified, an inspection certificate 3.1.B, in accordance with EN 10204, shall be issued.

Option 6: One of the inspection documents 3.1.A, 3.1.C or 3. in accordance with EN 10204 shall be issued

If an inspection document 3.1.A, 3.1.C or 3.2 is specified, the purchaser shall notify the manufacturer of the name and address of the organisation or person who is to carry out the inspection and produce the inspection document in the case of the inspection report 3.2 it shall be agreed which party shall issue the certificate.

9.2.2 Content of inspection documents

The content of the inspection document shall be in accordance with prEN 10168.

The inspection certificate or inspection 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-C03 location of the samples and direction of the test pieces and testing temperature;
- C10-C13 tensile test;
- C40-C43 impact test;
- C60-C69 other tests (e.g. weld bend test);
- C71-C92 chemical composition on cast analysis (product analysis if applicable);
- D01 marking and identification, surface appearance, shape and dimensional properties;
- D02-D99 leak-tightness test, NDT;
- Z validation.

9.3 Summary of inspection and testing

The tubes shall be inspected and tested in accordance with test category 1 or test category 2 as specified at the time of enquiry and order (see 6.1).

Inspection and testing to be carried out are summarised in Table 11

	Type of inspection and test	Frequency Refer to		Test category	
		of testing		1	2
	Cast analysis	one per cast	8.2.1 and 11.1	Х	Х
	Tensile test on the base material at room temperature	one per sample tube	8.3 and 11.2.1	Х	х
	Tensile test on the weld at room temperature for tubes with D $>$ 508 mm ^a		8.3 and 11.3	х	Х
	Weld bend test		8.3 and 11.4	Х	Х
Impact test on the base material at low temperature			8.3 and 11.5	Х	х
tests	Impact test on the weld at low temperature			Х	Х
	Leak tightness test	each tube	each tube 8.4.3.1 and 11.6		Х
	Dimensional inspection		8.7, 8.5 and 11.7		
	Visual examination		Х	Х	
	NDT of the weld		8.4.3.2, 11.9.1 and 11.9.3	Х	Х
	NDT of base material for laminations	acab tuba	8.4.3.2 and 11.9.2.1		Х
	NDT of tube ends for laminations		8.4.3.2 and 11.9.2.2		Х
NDT of plate/strip edges for laminations			8.4.3.2 and 11.9.2.3		Х
Ontional	Product analysis (option 3)	one per cast	8.2.2 and 11.1	Х	Х
tests	Wall thickness measurement away from tube end (option 9)	8.7.1 and 11.7			Х

Table 11 — Summary of inspection and testing

^a **Option 7:** For tubes of outside diameter D less than or equal to 508 mm a transverse tensile test on the weld shall be carried out.

10 Sampling

10.1 Frequency of tests

10.1.1 Test unit

For tubes delivered without subsequent heat treatment (see Table 1) 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.

For tubes which are furnace heat treated 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, subjected to the same finishing treatment in a continuous furnace o heat treated in the same furnace charge in a batch type furnace.

The maximum number of tubes per test unit shall be 50.

10.1.2 Number of sample tubes per test unit

The following number of sample tubes shall be selected from each test unit :

-test category 1: one sample tube ;

-test category 2: two samples tubes; when the total number of tubes is less than 20, only one sample tube.

10.2 Preparation of samples and test pieces

10.2.1 Selection and preparation of samples for product analysis

Samples for product analysis shall be taken from the test pieces or samples for mechanical testing or from the whole wall thickness of the tube at the same location as for the mechanical test samples, in accordance with ISO 14284.

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 of base material

The test piece for the tensile test on base material shall be prepared in accordance with the requirements of EN 10002-1.

At the manufacturer's discretion the test piece shall either a machined test piece with circular cross section from an unflattened sample or a strip section and be taken in a direction either longitudinal or transverse to the axis of the tube.

The test piece shall be taken diametrically opposite the weld; for helically submerged arc-welded tubes (SAWH) the test piece shall be taken at 1/4 of the distance between the welds.

10.2.2.3 Test pieces for tensile tests on the weld

The test piece 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 thickness of the tube; the weld bead may be removed.

10.2.2.4 Test piece for weld bend test

The test piece for the weld bend test at the root and face shall be taken and prepared in accordance with EN 910.

10.2.2.5 Test pieces for the impact test on base material

Three standard Charpy V-notch test pieces shall be prepared in accordance with EN 10045-1. If the wall thickness is such that standard test pieces cannot be produced without flattening of the section, then test pieces of width less than 10 mm, but not less than 5 mm shall be prepared; the largest obtainable width shall be used.

Where test pieces at least 5 mm width cannot be obtained, the tubes shall not be subjected to impact testing.

The test pieces shall be taken transverse to the tube axis unless D_{min} , as calculated by the following equation, is greater than the specified outside diameter, in which case longitudinal test pieces shall be used:

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

The test pieces shall be taken diametrically opposite the weld; for helically submerged arc-welded tubes (SAWH) the test piece shall be taken at 1/4 of the distance between the welds.

The test pieces shall be prepared such that the axis of the notch is perpendicular to the surface of the tube see figure 2.

Key:

1 Longitudinal test piece

2 Transverse test piece



Figure 2 — Impact test piece orientation

10.2.2.6 Test piece for the impact test on the weld

Three sets of three standard Charpy V-notch test pieces in accordance with EN 10045-1 shall be prepared. If the wall thickness is such that standard test pieces cannot be produced without flattening of the section, then test pieces of width less than 10 mm, but not less than 5 mm shall be prepared; the largest obtainable width shall be used.

Where 5 mm width minimum test pieces cannot be obtained, these weld shall not be subject to impact testing.

The test pieces shall be taken transverse to the weld.

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 as follows:

- in the middle of weld for one set;
- at both side of the weld corresponding to the heat-effected zone for the other two sets.

11 Test methods

11.1 Chemical analysis

The elements to be determined and reported shall be specified those in Table 2. The choice of a suitable physical or the chemical analytical method for the analysis shall be at the discretion of the manufacturer. In case of dispute the method used shall be agreed between manufacturer and purchaser taking into account CR 10261.

11.2 Tensile test on the base material

The test shall be carried out in accordance with EN 10002-1 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 $5,65 \cdot \sqrt{So}$; if a nonproportional test piece is used, the percentage elongation value shall be converted to the value for a gauge length $Lo = 5,65 \cdot \sqrt{So}$ using the conversion tables in EN ISO 2566-1.

11.3 Tranverse tensile test on the weld

The test shall be carried out in accordance with EN 10002-1 and the tensile strength (R_m) shall be determined.

11.4 Weld bend test

The test shall be carried out in accordance with EN 910 using a mandrel of a diameter of 3T.

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

11.5 Impact test

11.5.1 The test shall be carried out in accordance with EN 10045-1 at -40° C.

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

11.5.3 If the width (W) of the test piece is less than 10 mm, the measured impact energy (KV_p) shall be converted to impact energy (KV_c) using the following equation:

$$KVc = \frac{10xKVp}{W}$$
(3)

where:

- KV_c is the calculated impact energy, in J;
- KV_p is the measured impact energy, in J;
- W is the width of the test piece, in mm.

The calculated impact energy KV_c shall conform to the requirements given in 11.5.2.

11.5.4 If the requirements of 11.5.2 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 value of the six tests shall be equal to or greater than the specified minimum average value;
- not more than two of the six individual values may be lower than the specified minimum average value;
- not more than one of the six individual values may be lower than 70 % of the specified minimum average value.

11.5.5 The dimensions in millimetres of the test pieces, the measured impact energy values and the resulting average value shall be reported.

11.6 Hydrostatic leak tightness test

The hydrostatic leak-tightness test shall be carried out at a test pressure of 70 bar²) or at a test P pressure calculated using the following equation, whichever is lower:

$$P = 20(SxT) / D \tag{4}$$

where :

- P is the test pressure, in bar;
- D is the specified outside diameter, in mm;
- T is the specified wall thickness, in mm;
- S is the stress, in MPa, corresponding to 70 % of the specified minimum yield strength (see Table 4) for the steel grade concerned.

The test pressure shall be held for not less than 5 s for tubes with an outside diameter D less than or equal to 457 mm and for not less than 10 s for tubes with an outside diameter D greater than 457 mm.

The tube shall withstand the test without showing leakage or visible deformation.

Option 8: A test pressure different from that specified in 11.6 6 and corresponding to stress below 90% of the specified minimum yield strength (see Table 4) for the steel grades concerned is specified..

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

11.7 Dimensional inspection

Specified dimensions, including straightness shall be verified.

The outside diameter shall be measured across the diameter or using a circumference tape at the tube ends.

Unless option 9 is specified the wall thickness shall be measured at both tube ends.

Option 9: The wall thickness shall be measured away from the tube ends in accordance with an agreed procedure.

11.8 Visual examination

Tubes shall be visually examined to ensure conformity to the requirements of 8.4.1 and 8.4.2.

bar = 100 kPa.

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11.9 Non-Destructive Testing

11.9.1 Non-Destructive Testing of the weld seam

The full length of the weld seam of tubes shall be tested in accordance with either EN 10246-9 to acceptance level U3 for test categories 1 and level U2 for test category 2 or to EN 10246-10 to image quality class R2.

Unless option 10 is specified, the selection of the test inspection method is at the discretion of the manufacturer.

Option 10: The test inspection method is specified by the purchaser

Option 11: The image quality class R1 of EN 10246-10 shall be applied for the radiographic inspection of the weld seam.

Weld seam at the tube ends not automatically tested shall either be subjected to manual/semiautomatic ultrasonic testing or to radiographic testing using the same conditions and method as specified above or be cropped off.

11.9.2 Non-Destructive Testing for the detection of laminations for tubes of test category 2

11.9.2.1 The base material shall be tested in accordance with EN 10246-15 with acceptance level U2.

11.9.2.2 The tube ends shall tested in accordance with EN 10246-17. Laminar imperfections greater than 6 mm in the circumferential direction are not permitted within 25 mm at the tube ends.

11.9.2.3 The strip/plate edges adjacent to the weld seam shall be tested in accordance with either EN 10246-15 or EN 10246-16 with acceptance level U2 within a 15 mm zone along the weld seam.

11.9.3 Non-Destructive Testing of strip end welds

Strip end welds for helically welded tubes shall be tested in accordance with 11.9.1 and 11.9.2.

11.10 Retests, sorting and reprocessing

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

12 Marking

12.1 Marking to be applied

The marking shall be marked indelibly on each tube at least at one end.

The marking shall include the following information:

- the manufacturer's name or trade mark;
- the type of the tubes (symbols in accordance with Table 1);
- the number of this European standard and the steel name (see 5.2);
- the test category;
- the category conformity indicator (see 7.3.1 and 7.3.3).
- the cast number or a code number;
- the mark of the inspection representative

an identification number (e.g. order or item number) which permits the correlation of the product or delivery unit to the related document;

Example of marking:

X – SAWH - EN 10217-6 - P265NL - TC1 - C1 - Y - Z₁ - Z₂

where:

- X is the manufacturer's mark;
- SAWH is the type of tube
- TC1 is the designation of the test category 1;
- C1 is the category conformity indicator;
- Y is the cast number or a code number;
- Z₁ is the mark of the inspection representative;
- Z₂ is the identification number.

12.2 Additional marking

Option 12: Additional marking, as agreed upon at the time of enquiry and order, shall be applied.

13 Protection

The tubes shall be delivered without a temporary protective coating.

Option 13: A temporary protective coating or durable coating and/or lining shall be applied.

Annex A (normative)

Qualification of welding procedure

A.1 General

Submerged arc weld tube produced to this Part of EN 10217 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 specifications, 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

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.2.1 Parent metal

A.2.1.1 Steel name or number

The steel grade shall be identified in accordance with the requirements of this Part of EN 10217.

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

A.2.1.2 Tube dimensions

Tube dimensions shall be supplied for the following:

outside diameter D;

wall thickness T.

A.2.2 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.2.3 Filler wires and fluxes

A.2.3.1 The standard number and grade shall be referenced.

A.2.3.2 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.2.3.3 If carried out, the flux recycling procedure shall be referenced.

A.2.4 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.2.5 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.2.6 Heat input (kJ/mm)

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

A.2.7 Preheat temperature

If required the minimum preheat temperature shall be specified.

A.2.8 Interpass temperature

The maximum permissive interpass temperature shall be specified where applicable.

A.2.9 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.2.10 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	specificatio	n								
Ref. N. W	PS:		Prepared by:				Checked by:				Date:
Parent metal:						Thickness/dia	ameter:				
Weld preparation:					Pass location:						
Preparation method Machined/plasma or falme cut											
Pass n. Wire n. Welding position			Wire				Nominal Nominal current arc voltage			Nominal arc voltage	Nominal travel speed
			Size mm	Code n.	Code n. Designatior		Polarity	Flux	А	V	mm/s
Heat imput ^a								Preheat		°C min	
Heat treatment			Stress relieving Nor			orma	lizing		Interpass temperature		°C max
Heating rate								NDT			
Soaking temperature											
Soaking time											
Cooling rate]			
Withdraw temperature											
Notes											
a If re	auired										

A.3 Preparation of sample tube and sample

A.3.1 Sample tube

Preparation and welding of sample tube shall be carried out in accordance with the WPS and under the general conditions of production welding which they shall represent.

When an approved procedure is required the name and address of the authorised body shall be supplied.

A.3.2 Sample

A test sample sufficiently long to carry out the testing requirements in clause A.5 shall be taken from the end of the tube after welding, in the delivery condition specified in Table 1.

A.4 Inspection and testing of the weld

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

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	3 set of three test pieces						
Magnetic particle inspection or penetrant inspection may be used at the discretion of the manufacturer.							
b These tests were be undered by 4 side band 4							

Table A.2 Inspection and testing of the weld

^b These tests may be replaced by 4 side bend tests for wall thicknesses greater than 12,5 mm, at the manufacturer's discretion.

A.5 Weld test pieces

A.5.1 Bend test pieces

The bend test pieces shall be prepared in accordance with 10.2.2.4.

A.5.2 Macro-examination

The sample shall be prepared in accordance with EN 1321.

A.5.3 Transverse tensile test

The transverse tensile test piece shall be prepared in accordance with EN 895.

A.5.4 Impact test

Three sets of three standard Charpy V-notch test pieces taken transverse to the weld shall be prepared in accordance with 10.2.2.5.

A.6 Test methods

A.6.1 Visual examination

Visual examination of the test piece shall be carried out.

A.6.2 Radiographic test

The radiographic test shall be carried out in accordance with 11.9. 1.

A.6.3 Weld bend test

The weld bend test shall be carried out in accordance with 11.4.

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 11.5.

A.7 Test acceptance levels

A.7.1 Visual examination

Cracks shall not be permitted.

A.7.2 Radiographic test

This shall meet the acceptance requirements of 11.9.1.

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 11.4.

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;
- height of internal and external weld beads, radial offset of plate and strip edges and misalignment of weld seam shall comply with the requirements of Tables 8 and 9 and clause 8.7.4.4 respectively.

A.7.5 Transverse weld tensile test

The value of R_m shall be determined and meet the requirements of 11.3 and of Table 4 for the steel grade concerned. The position of the fracture shall be reported.

A.7.6 Weld impact test

The impact test results shall meet the requirements of 11.5 and Table 4 for the steel grade concerned.

A.7.7 Example of test result document

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

Test results						r				
Manufacturer:						Examiner or examining body:				
Welding procedure						Referen	ce no:			
Reference no:						Radiographic test ^a : Pass/fail				
Visual examination:				Pase	s/fail	Ultrason	ic examinatio	n ^a :		
Penetrant/magnetic p	particle te	est		Pas	s/fail	/fail Temperature: °C				
Tensile tests										
Туре /No.			Rm Fracture			ocation		Remarks	Remarks	
MPa Requirements										
Rend tests							Macro exan	nination		
								mauon		
Former diameter	1						1			
Type /No.	Bend ar	ngle		Resu	lts		-			
Impact test ^a							1			
Туре:					Size: R		equirement:			
Notch		Te	emperatu	ıre	Values J				Remarks	
Location/Direction			°C							
					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	e presenc	ce of:								
Name: Si				Sig	gnature:			Date:		
^a If required.										

Table A.3 Example of typical test results form

A.8 Range of use of qualified procedures

A.8.1 Materials groups

For qualification of weld procedures the material covered by this Part of EN 10217 have been grouped together, see Table A.4.

A procedure qualified for one material covers the other material.

Group	Steel grade					
Gloup	Steel name	Steel number				
1	P215NL P265NL	1.0451 1.0453				

Table A.4 Grouping system for SAW steel tubes

A.8.2 Materials thickness

Qualification at a given wall thickness covers a range of wall thicknesses and these are shown in Table A.5.

Table A.5 Range of qualification based on wall thickness T

	dimension in mm
Wall thickness of sample tube	Range of qualification
T ≤ 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 requirement:

they shall be in the same group of steels as defined in Table A.4;

they shall have the same nominal chemical composition.

A.8.4 Welding flux

A change from one welding flux, as defined by EN 760, to one of a different classification shall require a separate welding procedure qualification.

A.8.5 Other parameters

Changes simply or collectively, to the number of the welding wires or the type of current (e.g. from a.c. to d.c.) or 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 authorised representative (see Table A.3).

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

Annex ZA (informative)

Clauses of this European Standard addressing essential requirements or other provisions of EU Directives

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

Warning: Other requirements and other EU Directives may be applicable to the product(s) falling within the scope of this European Standard.

The clauses of this European Standard are likely to support the essential requirements of section 4 of annex 1, "Essential safety requirements" of the Pressure Equipment Directive 97/23/EC.

Compliance with this European Standard provides one means of conforming with the specific essential requirements of the Directive concerned.

Bibliography

EN 473, Non destructive testing - Qualification and certification of NDT personnel - General principles.

EN 10233, Metallic materials - Tubes - Flattening test.

EN 10234, Metallic materials - Tubes - Drift expanding test.

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