BRITISH STANDARD

BS EN
10208-1:2009

Steel pipes for pipelines for combustible fluids — Technical delivery conditions

Part 1: Pipes of requirement class A

ICS 23.040.10

BSI
British Standards

National foreword

This British Standard is the UK implementation of EN 10208-1:2008. It supersedes BS EN 10208-1:1998 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee PSE/17/2, Transmission pipelines.

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

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Foreword

This document (EN 10208-1:2009) has been prepared by Technical Committee ECISS/TC 29 “Steel tubes and fittings for steels 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of an identical text or by endorsement, at the latest by September 2009, and conflicting national standards shall be withdrawn at the latest by September 2009.

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

This document supersedes EN 10208-1:1997

This European Standard consists of the following parts, under the general title *Steel pipes for pipelines for combustible fluids — Technical delivery conditions:*

— *Part 1: Pipes of requirement class A*

— *Part 2: Pipes of requirement class B*

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

Introduction

It was the intention, when preparing this document, to avoid specifying the quality of line pipe to be used for a particular application. However, it was recognized that there are several quality levels commonly used, and it was decided to reflect these in the standard by the differentiation between two quality levels.

Firstly, the need was recognized to provide a basic quality level. This is designated requirement class A and considered in EN 10208-1.

Secondly, many purchasers impose requirements additional to the basic standard, for instance concerning toughness and non-destructive inspection. This approach is common, for example, for transmission pipelines. Such enhanced requirements are addressed in requirement class B and considered in EN 10208-2.

For offshore applications and other applications outside the scope of EN 10208-1 and EN 10208-2, other standards may be applicable, e.g. ISO 3183 [1].

In this Part 1 of EN 10208, no Charpy impact energy requirements are specified. The corresponding requirements in EN 10208-2 have been derived from established data in accordance with EPRG recommendations [2], and are intended to prevent the occurrence of long running shear fracture in pipelines transporting lean, dry natural gas. It is the responsibility of the designer to decide whether these energy requirements suffice for the intended application. For example, rich gas or two-phase fluids may require additional testing to be carried out.

The selection of the requirement class depends on many factors: the properties of the fluid to be conveyed, the service conditions, design code and any statutory requirements should all be taken into consideration. Therefore this document gives no detailed guidelines. It is the ultimate responsibility of the user to select the appropriate requirement class for the intended application.

NOTE This document combines a wide range of product types, dimensions and technical restrictions in accordance with the functional requirements for gas supply systems referred to in EN 1594 [3].

1 Scope

This European Standard specifies the technical delivery conditions for seamless and welded steel pipes for the on land transport of combustible fluids primarily in gas supply systems but excluding pipeline applications in the petroleum and natural gas industries. It includes less stringent quality and testing requirements than those in EN 10208-2.

NOTE 1 Steel pipes for pipeline transportation systems within the petroleum and natural gas industries are covered by ISO 3183 [1]. This standard specifies products with the same (and additional) strength levels and partly similar (but not identical) requirements as EN 10208-1 and EN 10208-2 and is with two additional annexes specifying deviating or additional requirements also published as API Spec 5L [4].

NOTE 2 This European Standard does not apply to cast steel pipe.

2 Normative references

The following referenced documents are indispensable for the application 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 287-1, *Qualification test of welders — Fusion welding — Part 1: Steels*

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

EN 910, *Destructive tests on welds in metallic materials — Bend tests*

EN 1011-1, *Welding — Recommendations for welding of metallic materials — Part 1: General guidance for arc welding*

EN 1011-2, *Welding — Recommendations for welding of metallic materials — Part 2: Arc welding of ferritic steels*

EN 10002-1, *Metallic materials — Tensile testing — Part 1: Method of test at ambient temperature*

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

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

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

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

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

EN 10079:2007, *Definition of steel products*

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

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

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

EN 10246-1, *Non-destructive testing of steel tubes — Part 1: Automatic electromagnetic testing of seamless and welded (except submerged arc welded) ferromagnetic steel tubes for verification of hydraulic leak tightness*

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

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

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

EN 10246-8, *Non-destructive testing of steel tubes — Part 8: Automatic ultrasonic testing of the weld seam of electric welded steel tubes for the detection of longitudinal imperfections*

EN 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 weld seam of automatic fusion arc welded steel tubes for the detection of 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 2 non-destructive testing personnel*

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

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

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

EN ISO 6506-1, *Metallic materials — Brinell hardness test — Part 1: Test method* (ISO 6506-1:2005)

EN ISO 6508-1, *Metallic materials — Rockwell hardness test — Part 1: Test method (scales A, B, C, D, E, F, G, H, K, N, T) (ISO 6508-1:2005)*

EN ISO 8492, *Metallic materials — Tube — Flattening test (ISO 8492:1998)*

EN ISO 14284, *Steel and iron — Sampling and preparation of samples for the determination of the chemical composition (ISO 14284:1996)*

EN ISO 15607, *Specification and qualification of welding procedures for metallic materials — General rules (ISO 15607:2003)*

EN ISO 15609-1, *Specification and qualification of welding procedures for metallic materials — Welding procedure specification — Part 1: Arc welding (*ISO 15609-1:2004)

ISO 19232-1, *Non-destructive testing — Image quality of radiographs — Part 1: Image quality indicators (wire type) — Determination of image quality value*

CEN/TR 10261, *Iron and steel — Review of available methods of chemical analysis*

3 Terms and definitions

For the purposes of this document the following terms and definitions apply in addition to or deviating from those given in EN 10020:2000, EN 10052:1993, EN 10079:2007 and EN 10266:2003.

3.1
normalizing forming
[deviating from EN 10052:1993]
forming process in which the final deformation is carried out in a certain temperature range leading to a material condition equivalent to that obtained after normalizing so that the specified values of the mechanical properties are retained even after normalizing

NOTE The abbreviated form of this delivery condition is N.

3.2
thermomechanical forming
[as in EN 10052:1992, but supplemented]
forming process in which the final deformation is carried out in a certain temperature range leading to a material condition with certain properties which cannot be achieved or repeated by heat treatment alone

NOTE 1 Subsequent heating above 580 °C may lower the strength values.

NOTE 2 The abbreviated form of this delivery condition is M (in this document for special marking).

NOTE 3 Thermomechanical forming leading to the delivery condition M may include processes of increased cooling rates without or with tempering including self-tempering but excluding definitively direct quenching and quenching and tempering.

NOTE 4 As a consequence of lower carbon content and carbon equivalent values, material in the delivery condition M has improved weldability properties.

3.3
quenching and tempering
heat treatment comprising of quench hardening followed by tempering, where quench hardening implies austenitization followed by cooling, under conditions such that austenite transforms more or less completely into martensite and possibly into bainite

NOTE 1 By tempering to specific temperature ($< Ac_1$) one or more times or holding at these temperatures, followed by cooling at an appropriate rate, the properties are brought to the required level.

NOTE 2 The abbreviated form of this delivery condition is Q (in this document for special marking).

3.4
cold forming
(in this context) the process by which a flat product is formed into a pipe without heating of the plate or strip

3.5
cold finishing
cold working operation (normally cold drawing) with a permanent strain greater than the maximum strain of 1,5 % which differentiates it from sizing operations specified in 7.5

3.6
pipe body
for seamless pipe, the entire pipe; for welded pipes, the entire pipe excluding weld(s) and heat affected zone (HAZ)

3.7
imperfection
irregularity in the wall or on the pipe surfaces detectable by methods described in this document

NOTE Imperfections with a size and/or population density complying with the acceptance criteria specified in this document are considered to have no practical implication on the intended use of the product.

3.8
defect
imperfection of a size and/or population density not complying with the acceptance criteria specified in this document

NOTE Defects are considered to adversely affect or limit the intended use of the product.

3.9
jointer
two lengths of pipe coupled or welded together by the manufacturer

3.10
by agreement/agreed
[as in EN 10266]
agreement between manufacturer and purchaser at the time of enquiry and order

4 Symbols and abbreviations

For symbols and abbreviations, see EN 10266:2003.

NOTE 1 EN 10266 includes definitions of types of pipe and their abbreviations.

NOTE 2 Symbols from EN 10266:2003 most frequently used in this document are:

D specified outside diameter;

D_{min} (specified) minimum outside diameter;

T specified wall thickness;

T_{min} (specified) minimum wall thickness.

5 Classification and designation

5.1 Classification

The steel grades specified in this document are non-alloy quality steels in accordance with EN 10020.

5.2 Designation

The specified steel grades are designated with steel names in accordance with EN 10027-1. The corresponding steel numbers have been allocated in accordance with EN 10027-2.

6 Information to be supplied by the purchaser

6.1 Mandatory information

The purchaser shall state in his enquiry and order the following minimum information:

a) quantity ordered (e.g. total tonnage or total length of pipe);

b) type of pipe (seamless (S) or welded (W));

c) product form (i.e. pipe);

d) pipe outside diameter and wall thickness in millimetres (see 8.6.1.2);

e) random length group or, if a fixed length is required, the length in millimetres (see 8.6.3.3 and Table 8);

f) number of this European Standard (EN 10208-1);

g) steel name or number (see Table 2 or 4);

h) type of inspection document required (see 9.1.1).

6.2 Options

A number of options are specified in this document and these are listed below. If the purchaser does not indicate a wish to implement any of these options at the time of enquiry and order, the pipe shall be supplied in accordance with the basic specification (see 6.1).

a) Mandatory agreement – options which shall be agreed when applicable:

1) diameter tolerances for seamless pipe with wall thickness T > 25 mm (see Table 6, footnote b);

2) diameter and out-of-roundness tolerances for pipe with outside diameter D > 1 430 mm (see Table 6, columns 2 and 3);

3) party to issue the inspection document 3.2 (see 9.1.1).

b) Unless otherwise agreed –left to the discretion of the manufacturer:

1) process of manufacture for welded pipe (see 7.3);

2) choice of the heat treatment condition (see 7.4);

3) choice of the welding process for jointers (see A.1);

4) radiographic inspection for the detection of longitudinal imperfections (see C.4.2 a).

c) Optional agreement – options which may be agreed:

1) approval of the quality system (see 7.1);

2) manufacture of SAWL pipe with two seams (see 7.3);

3) delivery of jointers (see 7.7);

4) application of the diameter tolerance to the inside diameter (see Table 6, footnote c);

5) application of the diameter tolerance to the outside diameter (see Table 6, footnote d);

6) special bevel configuration (see 8.6.4.2);

7) threaded ends or belled ends (see 8.6.4.3);

8) offset of strip end welds (see Table 10, footnote a);

9) test piece direction (see Table 13, footnote b);

10) use of circular test pieces (see 9.3.2.2, second paragraph);

11) use of flattened and heat treated test coupons (see 9.3.2.2, last paragraph)

12) non-destructive leak-tightness test instead of hydrostatic test (see 9.4.6.4);

13) use of special devices for measuring the pipe diameter (see 9.4.8.1);

14) use of (cold) die stamping (see 10.1.3);

15) special marking (see 10.2);

16) coating and lining (see Clause 11);

17) degree of staggering of pipe weld seams in jointers (see A.1);

18) verification of quality requirement for laminar imperfections (see C.2.3);

19) use of fixed depth notches for equipment calibration (see C.4.1.1 d);

20) use of hole penetrameter instead of ISO wire penetrameter (see C.4.3.1 a);

21) use of fluoroscopic inspection (C.4.3.1 b).

6.3 Example of ordering

Orders shall be preferably presented as given in the example.

EXAMPLE 1 000 m welded pipe with an outside diameter of 219,1 mm, a wall thickness of 6,3 mm in a length according to random length group r2 (see Table 8), made of steel grade L235GA, with test report 2.2 in accordance with EN 10204:

1 000 m W pipe – 219,1 x 6,3 x r2 – EN 10208-2 – L235GA –
test report EN 10204 – 2.2

7 Manufacturing

7.1 General

The pipe manufacturer and the stockist, where products are supplied through a stockist, shall operate a quality system. An approval of the quality system may be agreed.

7.2 Steelmaking

The steel making process is left to the discretion of the manufacturer.

7.3 Pipe manufacture

Acceptable types of pipe are listed together with acceptable manufacturing routes in Table 1. Unless otherwise agreed, the process of manufacture (type of pipe) for welded pipe is left to the discretion of the manufacturer. For all types of pipe, the choice of the process route in accordance with Table 1 is left to the discretion of the manufacturer.

SAWH pipe shall be manufactured using strip with a width not less than 0,8 or more than 3,0 times the pipe outside diameter.

SAWL pipe may be manufactured with two seams by agreement.

7.4 Heat treatment condition

The pipes shall be delivered in one of the forming and heat treatment conditions given in Table 1. Unless otherwise agreed, the choice of the heat treatment condition is left to the discretion of the manufacturer.

Table 1 — Type of piping and manufacturing route (starting material, pipe forming and heat treatment conditions)

<table>
<tr><th>Type of pipe</th><th>Starting material</th><th>Pipe forming [a]</th><th>Heat treatment condition</th></tr>
<tr><td rowspan="5">Seamless (S)</td><td rowspan="5">Ingot or billet</td><td rowspan="3">Hot rolling</td><td>— (as rolled)</td></tr>
<tr><td>Normalizing or normalizing formed</td></tr>
<tr><td>Quenched and tempered</td></tr>
<tr><td rowspan="2">Hot rolling and cold finishing</td><td>Normalized</td></tr>
<tr><td>Quenched and tempered</td></tr>
<tr><td rowspan="6">Electric welded (EW)</td><td rowspan="4">Normalizing rolled strip</td><td rowspan="3">Cold forming</td><td>— [b]</td></tr>
<tr><td>Stress relieved (weld area)[b]</td></tr>
<tr><td>Normalized (weld area)</td></tr>
<tr><td>Cold forming and cold finishing</td><td>Normalized (entire pipe)</td></tr>
<tr><td>Thermomechanically rolled strip</td><td>Cold forming</td><td>Heat treated (weld area)</td></tr>
<tr><td rowspan="2">Hot rolled or normalizing rolled strip</td><td>Cold forming</td><td>Normalized (entire pipe)</td></tr>
<tr><td>Cold forming and hot stretch reducing under controlled temperature resulting in a normalized condition</td><td>—</td></tr>
<tr><td rowspan="5">Submerged arc-welded (SAW)
– longitudinal seam (SAWL)
– helical seam (SAWH),
Combination welded (COW)
– longitudinal seam COWL)
– helical seam (COWH)</td><td>Normalized or normalizing rolled plate or strip</td><td rowspan="2">Cold forming</td><td rowspan="2">—</td></tr>
<tr><td>Thermomechanically rolled plate or strip</td></tr>
<tr><td>As rolled plate or strip</td><td rowspan="2">Normalizing forming</td><td rowspan="2">—</td></tr>
<tr><td>Normalized or normalizing rolled plate or strip</td></tr>
<tr><td>As rolled plate or strip</td><td>Cold forming</td><td>— [d]</td></tr>
<tr><td>Continuous welded (BW)[c]</td><td>Hot rolled or normalizing rolled strip</td><td>Hot forming</td><td>—
(as welded; normalized if necessary)</td></tr>
</table>

a See 3.4 and 3.5.

b Steel grades L210GA, L235GA, L245GA and L290GA only.

c Steel grades L210GA and L235GA and $D \leq 114{,}3$ mm for distribution pipelines only.

d Steel grades L210GA, L235GA and L245GA only.

7.5 Sizing

The pipes may be sized to their final dimensions by expanding or reducing. This shall not produce excessive permanent strain. Where no further heat treatment or only a heat treatment of the weld area is carried out, the sizing ratio s_r achieved by this cold working shall not exceed 0,015. It shall be calculated according to the formula:

$$s_r = \frac{\left|D_a - D_b\right|}{D} \quad (1)$$

where

D_a is the outside diameter after sizing;

D_b is the outside diameter before sizing;

D is the specified outside diameter.

7.6 Strip end welds

7.6.1 For helical seam welded pipe, the strip end weld shall be located at least 200 mm from the pipe end.

7.6.2 For welded pipe with a longitudinal seam, strip end welds are not permitted in the pipe.

7.7 Jointers

The delivery of jointers is permitted by agreement provided the lengths of pipe used have fulfilled the requirements of this document and the special requirements in Annex A are complied with.

7.8 General requirements for non-destructive testing

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

The qualification shall be in accordance with EN 10256 or, at least, an equivalent to it. It is recommended that the level 3 personnel be certified in accordance to EN 473 or, at least an equivalent to it.

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

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

8 Requirements

8.1 General

The requirements specified in this document apply on condition that the relevant specifications for test piece selection, test piece preparation and test methods given in 9.3 and 9.4 are complied with.

NOTE Table 12 gives a survey on the tables and clauses containing requirements and specifications for testing.

8.2 Chemical composition

8.2.1 Cast analysis

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

Table 2 — Chemical composition [a] of the cast analysis

Steel grade		Maximum content, % by mass					
Steel name	Steel number	C	Si	Mn	P	S	Others
L210GA	1.0319	0,21	0,40	0,90	0,030	0,030	[b]
L235GA	1.0458	0,16	0,40	1,20	0,030	0,030	
L245GA	1.0459	0,20	0,40	1,15	0,030	0,030	
L290GA	1.0483	0,20	0,40	1,40	0,030	0,030	[c]
L360GA	1.0499	0,22	0,55	1,45	0,030	0,030	

[a] The steels shall be fully killed with 0,015 % ≤ Al_{total} < 0,060 %.

[b] Other elements shall not be added intentionally.

[c] V, Nb, Ti and combinations thereof may be added at the discretion of the manufacturer. The sum of these elements shall not exceed 0,15 %.

8.2.2 Product analysis

The product analysis shall not deviate from the limiting values for the cast analysis as specified in Table 2 by more than the values given in Table 3.

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 according to Table 2 % by mass	Permissible deviation of the product analysis % by mass
C	≤ 0,22	+ 0,02
Si	≤ 0,55	+ 0,05
Mn	≤ 1,45	+ 0,10
P	≤ 0,030	+ 0,005
S	≤ 0,030	+ 0,005
Al	≥ 0,015 < 0,060	± 0,005
V + Nb + Ti	≤ 0,15	+ 0,02

8.3 Mechanical properties

The pipe shall, as applicable (see Table 12, column 2), comply with the requirements given in Table 4.

NOTE In case of hot forming and/or subsequent field heat treatment of pipes delivered in the quenched and tempered or thermomechanically rolled condition, an adverse change of mechanical properties can occur (see for example 3.2). Where appropriate, the purchaser should contact the manufacturer for more detailed information.

Table 4 — Requirements for the result of tensile and bend test and for the hydrostatic test

Steel grade		Pipe body (seamless and welded pipes)			Weld seam (pipe)		Entire pipe
					EW, BW, SAW, COW	SAW, COW	
Steel name	Steel number	Yield strength $R_{t0,5}$ MPa	Tensile strength R_m MPa min.	Elongation [a] A % min.	Tensile strength R_m MPa min.	Diameter of the mandrel for bend test [b] (see 9.4.3)	Hydrostatic test (see 9.4.6)
L210GA	1.0319	210	335 to 475	25	The same values as for the pipe body apply.	2 T	Each length of pipe shall withstand the test without showing leakage or visible deformation
L235GA	1.0458	235	370 to 510	23			
L245GA	1.0459	245	415 to 555	22		3 T	
L290GA	1.0483	290	415 to 555	21			
L360GA	1.0499	360	460 to 620	20		4 T	

[a] These values apply to transverse specimens taken from the pipe body. When longitudinal specimens are tested (see Table 13), the values of elongation shall be 2 units higher.

[b] T specified wall thickness of the pipe.

8.4 Weldability

In view of the processes for the manufacture of pipes and of pipe lines, the requirements for the chemical composition of the steels have been selected to insure that the steels delivered in accordance with this document are weldable.

However, 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 welding consumables used and on the conditions of preparing for and carrying out the welding.

8.5 Appearance and soundness

8.5.1 The pipes shall be free from defects in the finished condition.

8.5.2 The internal and external surface finish of the pipes shall be typical of the manufacturing process and the heat treatment employed. The surface condition shall be such that any surface imperfections requiring dressing can be identified.

8.5.3 Surface imperfections disclosed by visual inspection shall be investigated, classified and treated as follows:

a) imperfections with a depth equal to or less than 12,5 % of the specified wall thickness, and which do not encroach on the specified minimum wall thickness, shall be classified as acceptable imperfections and treated in accordance with B.1;

b) imperfections with a depth greater than 12,5 % of the specified wall thickness, but which do not encroach on the specified minimum wall thickness, shall be classified as defects and shall either be dressed-out by grinding in accordance with B.2 or treated in accordance with B.3 as appropriate;

c) imperfections which encroach the specified minimum wall thickness shall be classified as defects and treated in accordance with B.3.

8.5.4 Geometric deviations for the normal cylindrical contour of the pipe which occur as a result of the pipe forming process or manufacturing operations (e.g. dents, flat spots, peaks) shall not exceed the following values:

a) 3 mm (flat spots, peaks and cold formed dents with sharp bottom gouges);

b) 6 mm (other dents).

These limits refer to the gap between the extreme point of the deviation and the prolongation of the normal contour of the pipe.

For the measurement of flat spots and peaks, see 9.4.8.3. For dents, the length in any direction shall not exceed one half of the pipe outside diameter.

8.5.5 For undercuts disclosed by visual inspection of SAW and COW pipes, the acceptance criteria given in C.4.3.2 d) to C.4.3.2 f) apply.

8.5.6 Surface imperfections may be removed, but only by grinding or machining. The tube thickness in the dressed area shall not be less than the specified minimum wall thickness. All dressed areas shall blend smoothly into the contour of the tube.

8.5.7 Any hard spot exceeding 50 mm in any direction shall have a hardness value less than 35 HRC (327 HB) (see 9.4.7).

8.5.8 The acceptance criteria for imperfections detected by non-destructive testing, as required by 9.4.10, are specified in Annex C.

8.6 Dimensions, masses and tolerances

8.6.1 Dimensions

8.6.1.1 The pipes shall be delivered to the dimensions specified in the enquiry and order, within the tolerances given in 8.6.3 to 8.6.6.

8.6.1.2 Where appropriate, the preferred outside diameters D and wall thicknesses T given in Table 5 and selected from those in EN 10220 should be ordered.

8.6.1.3 For the length of pipes, see 8.6.3.3, and for the execution of the pipe ends, see 8.6.4.

8.6.2 Masses

The mass per unit length may be calculated by the formula

$$M = (D - T) \times T \times 0{,}0246615 \text{ kg/m} \qquad (2)$$

where

M is the mass per unit length,

D is the specified outside diameter in mm,

T is the specified wall thickness in mm.

The formula is based on density equal to 7,85 kg/dm^3.

Table 5 — Preferred outsides diameters and wall thickness
(indicated by the shadowed field)

Dimensions in mm

Qutside diameter D	Wall thickness T																										
	2,3	2,6	2,9	3,2	3,6	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	28	30	32	36	40
33,7	■	■	■	■	■	■	■	■	■	■	■	■	■	■													
42,4	■	■	■	■	■	■	■	■	■	■	■	■	■	■													
48,3	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■											
60,3	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■										
88,9	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■							
114,3	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■							
168,3			■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
219,1				■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
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													■	■	■	■	■	■	■	■	■	■	■	■	■	■	

8.6.3 Tolerances on the pipe

8.6.3.1 Diameter and out-of-roundness

The outside diameters and the out-of-roundness of the pipes as defined in 9.4.8.2 shall be within the tolerance limits given in Table 6.

Table 6 — Tolerance on diameter and out-of-roundness

<table>
<tr><td rowspan="3">Outside diameter
D
mm</td><td colspan="4">Diameter tolerance [a]</td><td colspan="2">Out-of-roundness [a]</td></tr>
<tr><td colspan="2">Pipe except the end</td><td colspan="2">Pipe end [b]</td><td rowspan="2">Pipe except the end</td><td rowspan="2">Pipe end [b,e]</td></tr>
<tr><td>Seamless pipe</td><td>Welded pipe</td><td>Seamless pipe</td><td>Welded pipe</td></tr>
<tr><td>$D \leq 60$</td><td rowspan="2">± 0,5 mm or ± 0,75 % D (whichever is the greater)</td><td rowspan="2">± 0,5 mm or ± 0,75 % D (whichever is the greater), but max. ± 3 mm</td><td colspan="2" rowspan="2">± 0,5 mm or ± 0,5 % D [c] (whichever is the greater), but max. ± 1,6 mm</td><td colspan="2">(included in the diameter tolerance)</td></tr>
<tr><td>$60 < D \leq 610$</td><td>2,0 %</td><td>1,5 %</td></tr>
<tr><td>$610 < D \leq 1\,430$</td><td>± 1 % D</td><td>± 0,5 % D but max. ± 4 mm</td><td>± 2,0 mm [d]</td><td>± 1,6 mm [d]</td><td>1,5 % (but max. 15 mm) for $\frac{D}{T} \leq 75$;
2,0 % for $\frac{D}{T} > 75$</td><td>1,0 % for $\frac{D}{T} \leq 75$;
1,5 % for $\frac{D}{T} > 75$</td></tr>
<tr><td>$D > 1\,430$</td><td colspan="2">as agreed</td><td colspan="2">as agreed [d]</td><td></td><td>as agreed [d]</td></tr>
</table>

a The pipe end shall be considered to include a length of 100 mm at the pipe extremities.

b For seamless pipe, the values apply for wall thicknesses $T \leq 25$ mm; for greater thicknesses by agreement.

c Subject to agreement, the tolerance may be applied to the inside diameter for outside diameters $D > 210$ mm.

d Unless otherwise agreed, the diameter tolerance applies to the inside diameter.

e When the diameter tolerance is applied to the inside diameter, the inside diameter shall also be the basis for the out-of-roundness requirements.

8.6.3.2 Wall thickness

The wall thickness shall be within the tolerances given in Table 7.

Table 7 — Tolerances on wall thickness

Wall thickness T mm	Permissible tolerance
Seamless pipe [a]	
$T \leq 4$	+ 0,6 mm / – 0,5 mm
$4 < T < 25$	+ 15 % / – 12,5 %
$T \geq 25$	+ 3,75 mm/ – 3,0 mm or ± 10 % (whichever is the greater)
Welded pipe	
$T \leq 10$	+ 1,0 mm / – 0,5 mm
$10 < T < 20$	+ 10 % / – 5 %
$T \geq 20$	+ 2,0 mm / – 1,0 mm

a For outside diameters $D \geq 355{,}6$ mm, it is permitted to exceed the upper wall thickness locally by further 5 % of the specified wall thickness. However, the mass tolerance in 8.6.6 applies.

8.6.3.3 Length

8.6.3.3.1 Depending on the order the pipes are to be delivered in random lengths or in fixed lengths.

8.6.3.3.2 Random lengths shall be delivered in accordance with the requirements of the specified length groups (see Table 8).

8.6.3.3.3 Fixed lengths shall be delivered with a tolerance of ± 500 mm.

Table 8 — Requirements for random length groups

Dimensions in metres

Length group	Length range for 90 % of order item [a]	Minimum average length of order item	Shortest length of order item
r1	6 to 11	8	4
r2	9 to 14	11	6
r3	10 to 16	13	7
r4	11 to 18	15	8

[a] The upper limit applies as an absolute maximum value for the length of each individual pipe.

8.6.3.4 Straightness

The total deviation from a straight line shall be ≤ 0,2 % of the whole pipe length. Any local deviation in straightness shall be < 4 mm/m.

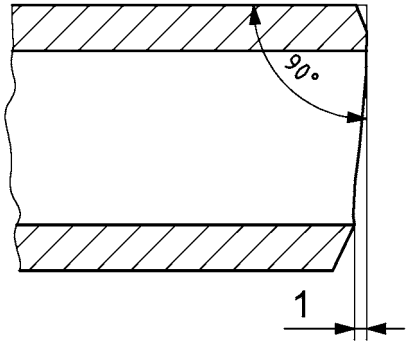
8.6.4 Finish of pipe ends

8.6.4.1 Unless otherwise agreed (see 8.6.4.3), the pipe shall be delivered with plain ends. All pipe ends shall be cut square and be free from harmful burrs.

The out-of-squareness (see Figure 1) shall not exceed:

a) 1 mm for outside diameters $D \leq 220$ mm;

b) 0,005 D, but max. 1,6 mm, for outside diameters $D > 220$ mm.



Key
1 out-of-squareness

Figure 1 — Out-of-squareness

8.6.4.2 The end faces of pipes with a wall thickness greater than 3,2 mm shall be bevelled for welding. The angle of the bevel measured from a line drawn perpendicular to the axis of the pipe shall be 30° with a tolerance of $^{+5}_{0}$ °. The width of the root face of the bevel shall be 1,6 mm with a tolerance of ± 0,8 mm.

Other bevel preparations may be agreed.

Where internal machining or grinding is carried out, the angle of the internal taper, measured from the longitudinal axis, shall be not greater than:

a) as given in Table 9 (for seamless pipe);

b) 7° (for welded pipe, outside diameter D > 114,3 mm).

Table 9 — Maximum angle of internal taper for seamless pipe

Specified wall thickness T mm	Maximum angle of taper degrees
T < 10,5	7
10,5 ≤ T < 14	9,5
14 ≤ T < 17	11
T ≥ 17	14

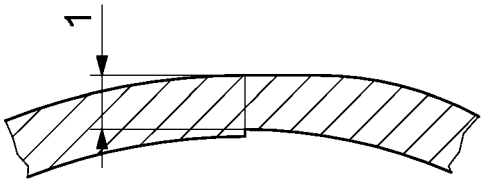
8.6.4.3 By agreement, the pipe may be delivered with threaded ends or with belled ends.

NOTE Threaded and belled end pipes are in general only applicable for distribution pipelines and/or under less critical service conditions.

8.6.5 Tolerances of the weld seam

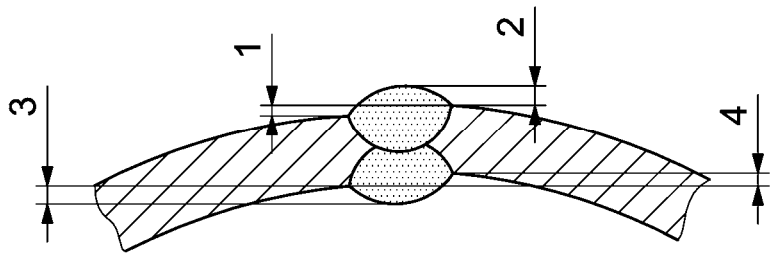
8.6.5.1 Radial offset of plate or strip edges

8.6.5.1.1 In the case of EW pipe, the radial offset of strip edges shall not cause the remaining wall thickness at the weld to be less than the specified minimum wall thickness (see Figure 2a).



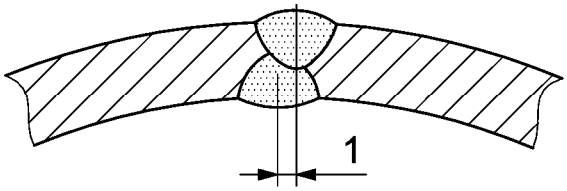
Key
1 remaining wall thickness at the weld

a) Radial offset of strip edges (EW pipe)



Key
1, 4 outside/inside radial offset
2, 3 outside/inside height of the weld bead

b) Radial offset and height of the weld beads of plate/strip edges (SAW and COW pipe)



Key
1 misalignment

c) Misalignment of the weld beads (SAW and COW pipe)

Figure 2 — Possible dimensional deviations of the weld seam

8.6.5.1.2 In the case of SAW and COW pipes the maximum radial offset (see Figure 2b) of the strip/plate edges shall be as given in Table 10.

Table 10 — Maximum permissible offset of SAW and COW pipes

Dimensions in mm

Specified wall thickness T	Maximum permissible radial offset [a]
$T \leq 10$	1,0
$10 < T \leq 20$	0,1 T
$T > 20$	2,0
[a] For strip and welds other requirements may be agreed.	

8.6.5.2 Height of the flash or weld bead/weld reinforcement

8.6.5.2.1 The outside flash of EW pipe shall be trimmed to an essentially flush condition. The inside flash of EW and BW pipe shall not extend above the contour of the pipe by more than 0,5 mm + 0,05 T. When trimming EW pipe, the wall thickness shall not be reduced below the minimum specified.

8.6.5.2.2 The inside weld bead of SAW and COW pipe (see Figure 2b) shall be ground flush with a tolerance of $^{+0,5}_{0}$ mm for a distance of 100 mm from each pipe end.

The height of the weld bead of the remainder of the pipe shall not exceed the applicable value given in Table 11.

Table 11 — Maximum permissible weld bead of SAW and COW pipes

Dimensions in mm

Specified wall thickness T	Maximum height of the weld bead
$T \leq 12,7$	3
$T > 12,7$	4,8

8.6.5.2.3 The weld beads shall blend in smoothly with the parent metal and shall for SAW and COW pipe not come below the contour of the pipe, except that dressing out of undercuts is permitted (see C.4.3.2 d).

8.6.5.3 Misalignment of the weld beads

Any misalignment of the weld beads of SAW and COW pipes (see Figure 2c) shall not be cause for rejection provided complete penetration and complete fusion have been achieved (see C.4.3.2 a).

8.6.6 Mass tolerance

The mass of any individual pipe shall not deviate from the nominal mass determined in accordance with 8.6.2 by more than + 10 % or – 3,5 %.

9 Inspection

9.1 Types of inspection and inspection documents

9.1.1 The compliance with the requirements of the order shall be checked for products in accordance with this document either by non-specific or by specific inspection.

The purchaser shall specify the required type of inspection and the inspection document in accordance with EN 10204.

In the case of non-specific inspection, a test report 2.2 shall be issued. In the case of specific inspection, an inspection certificate (3.1 or 3.2) shall be issued.

If an inspection certificate 3.2 is specified, the purchaser shall notify the manufacturer of the name and address of the organization or person who is to carry out the inspection and produce the inspection document. It shall also be agreed which party shall issue the certificate.

9.1.2 The inspection document shall include, in accordance with EN 10168, the following codes and information:

A commercial transactions and parties involved;

B description of products to which the inspection certificate applies;

C01 to C02 location of sample and direction of the test piece;

C10 to C13 tensile test;

C50 to C69 bend or flattening test;

C71 to C92 cast analysis and – in the case of specific inspection – product analysis;

D01 marking and dimensional checking and verification of the surface appearance;

D02 to D99 non-destructive testing and hydrostatic test;

Z validation.

9.2 Summary of inspection and testing

The tests to be carried out and the frequency of testing are given in 9.3.2.2 Table 13:

a) for non-specific inspection and testing, in columns 2, 3 and 4; and

b) for specific inspection and testing, in columns 2, 3 and 5.

9.3 Selection and preparation of samples and test pieces

9.3.1 Samples and test pieces for the product analysis

The samples and test pieces shall be taken and prepared in accordance with EN ISO 14284. At the discretion of the pipe manufacturer, they shall be taken either from plate/strip or pipe.

Table 12 — Survey of tests and requirements

1	2				3	4	5		6	7	8
	The specifications in columns 3 to 8 apply for [a]				Type of test or requirement	Frequency of testing			Sampling conditions see	Test method see	Requirements see
	Seam-less pipe	EW, BW	SAW, COW pipe			Non-specific inspection	Specific inspection				
			longitudi-nal seam	helical seam							
a1	x	x	x	x	Cast analysis	x [b]	1 analysis/cast		Left to the discretion of the manufacturer.		Table 2
a2	x	x	x	x	Product analysis	–	1 analysis/cast		9.3.1	9.4.1	Table 3
b1	x	x	x	x	Tensile test – on the pipe body	x [b]	Except for strip end weld testing, the test units shall consist only of pipes of – the same heat treatment condition – the same dimension and of – 400 pipes ($D \leq 141{,}3$ mm) – 200 pipes (141,3 mm < $D \leq 323{,}9$ mm) – 100 pipes ($D > 323{,}9$ mm). For strip end welds, the test unit shall consist of not more than 50 pipes containing strip end welds per order item. One sample shall be taken per test unit.	Test pieces per sample 1	9.3.2.2 and Table 13	9.4.2	Table 4
b2		x	x	x	– on the weld seam ($D \geq$ 210 mm)	x [b]		1			
b3				x	– on the strip end weld seam ($D \geq$ 210 mm)	x [b]		1			
e1			x	x	Bend test – on the weld seam	x [b]		2	9.3.2.3 and Table 13	9.4.3	9.4.5.2, Table 4 and Figure 5
e2				x	– on the strip end weld seam	x [b]		2			
f		x			Flattening test	x [b]	4 tests per coil; plus 2 tests in the case of a weld stop.		9.3.2.4 and Figure 4	9.4.4	9.4.4.2 and Figure 4

Table 12 *(continued)*

1	2				3	4	5	6	7	8
	The specifications in columns 3 to 8 apply for [a]				Type of test or requirement	Frequency of testing		Sampling conditions see	Test method see	Requirements see
	Seamless pipe	EW, BW pipe	SAW, COW pipe							
			longitudinal seam	helical seam		Non-specific inspection	Specific inspection			
g1			x	x	Macro- and metallographic examination – Macrography	Once per shift or when pipe size is changed.		9.3.2.5	9.4.5.1	8.6.5.3
g2		x [c]			– Metallography	Once per shift or when size or steel grade of the pipe is changed.			9.4.5.2	9.4.5.2
h		x	x	x	Hardness test	In cold formed pipe any hard spot exceeding 50 mm in any direction shall be tested.		–	9.4.7	8.5.7
i	x	x	x	x	Hydrostatic testing	Each pipe shall be tested.		—	9.4.6	9.4.6 and Table 4
j	x	x	x	x	Visual examination	Each pipe shall be examined.			9.4.7	8.5
k1	x	x	x	x	Dimensional testing – outside or inside diameter and out-of-roundness of pipe ends	X [b]	Dimensions of each pipe shall be verified.	–	9.4.8	8.6.3.1
k2	x	x	x	x	– wall thickness of pipe ends	Dimensions of each pipe shall be verified.				8.6.3.2 and Table 7
k3	x	x	x	x	– other dimensional characteristics	X [b]	At random testing. In the case of specific testing, the details are left to the discretion of the inspector.			8.6.3.3, 8.6.3.4, 8.6.4
k4		x	x	x	– weld seam					8.6.5
l	x	x	x	x	Weighing	Each pipe or lot shall be weighed.			9.4.9	8.6.6
m	x	x	x	x	Non-destructive testing	See Table C.1				

[a] EW Electric welded; BW Continuous welded; SAW Submerged arc welded; COW Combination welded.

[b] Frequency of testing in accordance with the manufacturer's procedure.

[c] Only applicable for EW pipe with heat treated weld area

Table 13 — Number, direction and location of the test pieces to be taken per sample for the mechanical tests

Type of pipe[a]		Test	Test pieces to be taken from	Outside diameter in mm			For further information
				< 210	≥ 210 < 500	≥ 500	
				Number, direction and location of the test pieces (see explanation of the symbols in Figure 3)			see
Seamless (see Figure 3a)		Tensile	pipe body	1L	1L [b]	1L [b]	9.3.2.2
Longitudinal seam (see Figure 3b)	EW, BW, SAW, COW	Tensile	pipe body	1L90	1T90	1T90	
		Tensile	seam[b]	–	1W	1W	
	SAW, COW	Bend	seam[b]	2W	2W	2W	9.3.2.3
	HFW	Flattening	See Figure 4				9.3.2.4
Helical seam (see Figure 3c)	SAW, COW	Tensile	pipe body	1L, *a*/4 [c]	1T, *a*/4 [c]	1T, *a*/4 [c]	9.3.2.2
			seam[b]	–	1W	1W	9.3.2.2
		Bend	seam[b]	2W	2W	2W	9.3.2.3
		Tensile	strip end weld	–	1WS	1WS	9.3.2.2
		Bend		2WS	2WS	2WS	9.3.2.3

[a] EW Electric welded ; BW Continuous welded; SAW Submerged arc welded; COW Combination welded.

[b] If, by agreement (see 7.2), pipes with two seams are delivered, both seams are to be subjected to the tests.

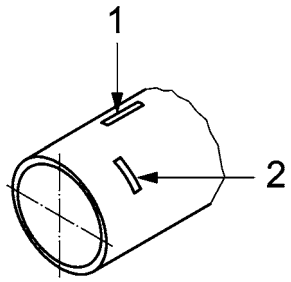
[c] By agreement 1T instead of 1L.

9.3.2 Samples and test pieces for the mechanical tests

9.3.2.1 General

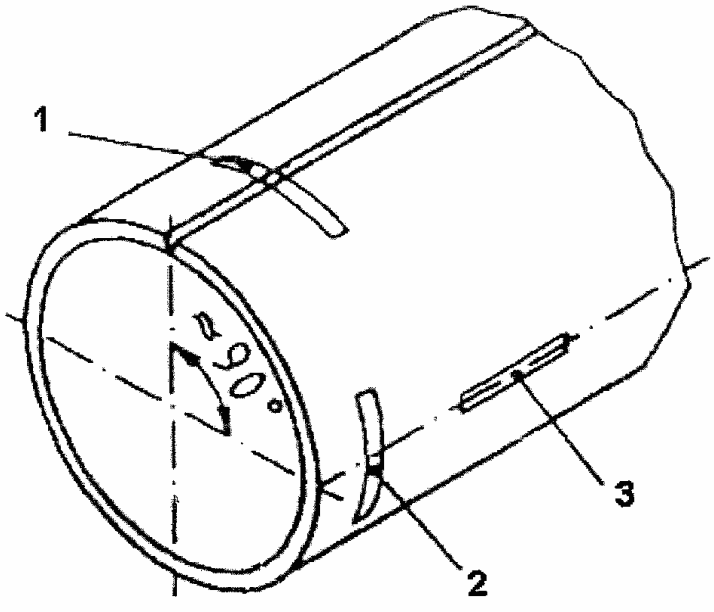
The samples and test pieces for the specified tests shall be taken and the corresponding test pieces prepared in accordance with the general conditions of EN ISO 377, as far as applicable.

Samples for the various types of test shall be taken from pipe ends in accordance with Figures 3 and 4 and Table 13 taking into account the supplementary details specified in 9.3.2.2 to 9.3.2.4.



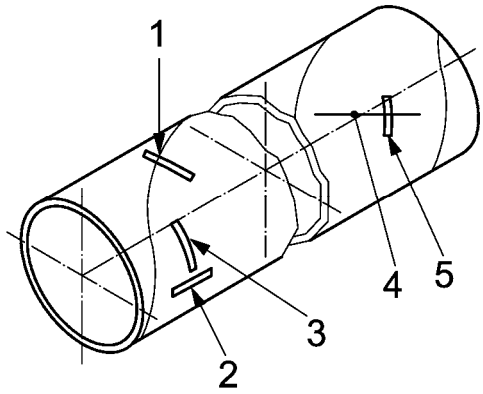
Key
1 L — longitudinal sample
2 T — transverse sample

a) Seamless pipe



Key
1 W — transverse sample, centred on the weld
2 T90 — transverse sample, centred ≈ 90° from the longitudinal weld
3 L90 — longitudinal sample, centred ≈ 90° from the longitudinal weld

b) HFW, SAWL and COWL pipe



Key

1 W — transverse sample, centred on the helical seam weld

2 L — longitudinal sample, centred at least a/4 in the longitudinal direction from the helical seam weld

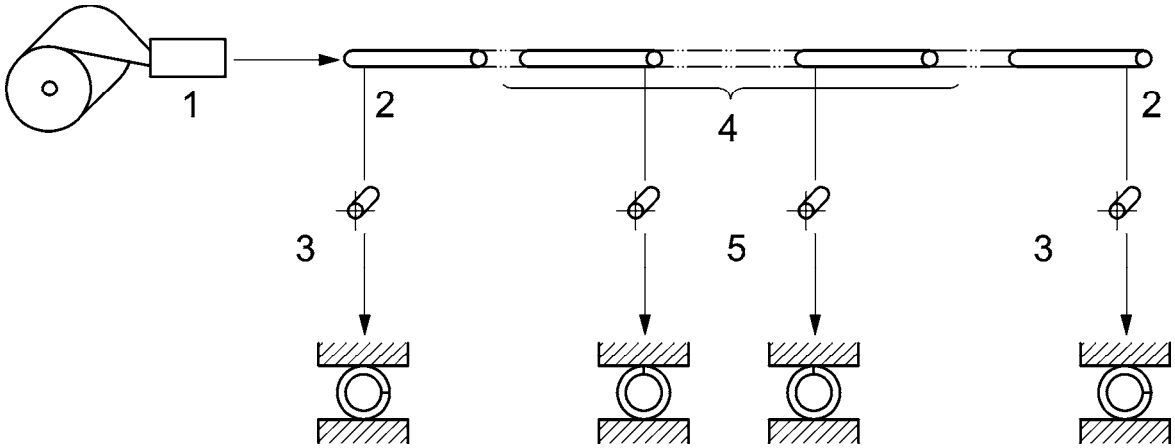
3 T — transverse sample, centred at least a/4 in the longitudinal direction from the helical seam weld

4 strip/plate end weld, with length a

5 WS — transverse sample, centred at least a/4 from the junctions of the helical seam weld and the strip/plate end weld

c) SAWH and COWH pipe

Figure 3 — Sample position and explanation of the symbols applied in Table 13 for specifying the test piece direction and position



Key

1 welding

2 coil end

3 one test piece from each coil end

4 Intermediate position

5 two test pieces, each one from different pipes

Figure 4 — Flattening test – sampling and testing (schematically)
(see further details in 9.4.4.1)

9.3.2.2 Tensile test pieces

Rectangular test pieces representing the full wall thickness of the pipe shall be taken in accordance with EN 10002-1 and Figure 3. Transverse test pieces shall be flattened.

Circular test pieces machined from an unflattened sample may be used by agreement.

At the manufacturer's discretion, for testing the pipe body of pipes with outside diameter $D \leq 210$ mm, a full pipe test piece may be used.

Weld beads shall be ground flush, local imperfections may be removed, but mill scale should not be removed from the test pieces.

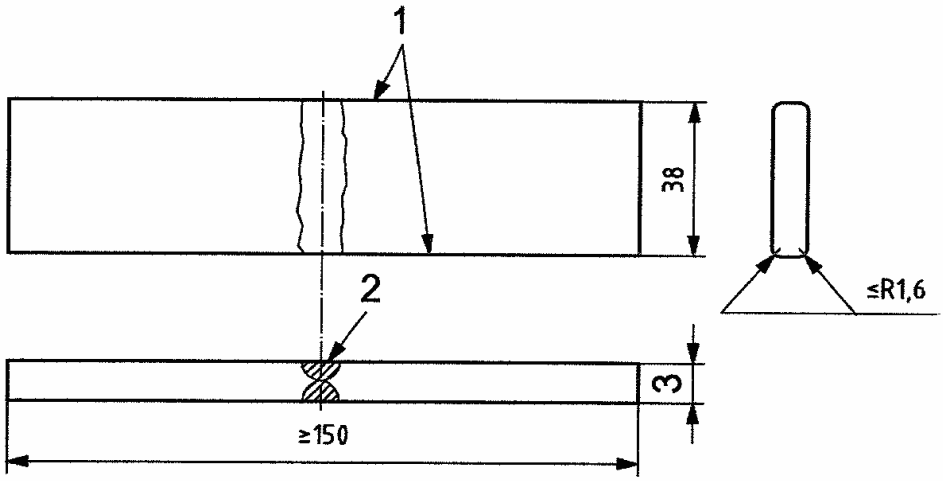
If the pipes are to be heat treated, test coupons may, by agreement, be taken and flattened before the heat treatment. The flattened test coupon shall then undergo the same heat treatment as the pipe.

9.3.2.3 Test pieces for the bend test

The test pieces shall be taken in accordance with EN 910 and Figure 5. For pipes with a wall thickness T> 20 mm the test pieces may be machined to provide a rectangular cross section having a thickness of 19 mm. Full wall thickness curved section test pieces are mandatory for pipe with a wall thickness T≤ 20 mm.

The weld reinforcement shall be removed from both faces.

Dimensions in mm



Key

1 long edges machined or oxygen cut, or both
2 weld
3 wall thickness

Figure 5 — Test piece for the bend test

9.3.2.4 Test pieces for the flattening test

The test pieces shall be taken in accordance with EN ISO 8492.

Minor surface imperfections may be removed by grinding.

9.3.2.5 Samples for macrographic and metallographic tests

The samples including the weld cross-section shall be taken and prepared in accordance with EN ISO 377, as far as applicable.

9.4 Test methods

9.4.1 Chemical analysis (product analysis)

The elements specified in Table 2 shall be determined.

Unless otherwise agreed at the time of enquiry and order, the choice of a suitable physical or chemical analytical method for the product analysis shall be at the discretion of the manufacturer. In cases of dispute, the analysis shall be carried out by a laboratory approved by both parties. In this case, the analysis method to be used shall be agreed taking into account the relevant existing European Standards. The list of available European Standards is given in CEN/TR 10261.

9.4.2 Tensile test

9.4.2.1 The tensile test shall be carried out in accordance with EN 10002-1.

The tensile strength R_m, the yield strength for 0,5 % total elongation $R_{t0,5}$ and the percentage elongation after fracture A shall be determined on the pipe body.

The percentage elongation after fracture shall be reported with reference to a gauge length of 5,65 $\sqrt{S_0}$ where S_0 is the initial cross section of the gauge length. If other gauge lengths are used, the elongation referred to a gauge length of 5,65 $\sqrt{S_0}$ shall be determined in accordance with EN ISO 2566-1.

NOTE The $R_{t0,5}$ value is considered to be approximately equivalent to the R_{eH} or $R_{p0,2}$ value within the normal scatter band of test results.

9.4.2.2 In the tensile test transverse to the weld, only the tensile strength R_m shall be determined.

9.4.3 Bend test

9.4.3.1 The bend test shall be carried out in accordance with EN 910. The mandrel dimension shall be as indicated in Table 4 for the appropriate steel grade. Both test pieces shall be bent through approximately 180°, one with the root of the weld, the other with the face of the weld, directly under the mandrel.

9.4.3.2 The specimens shall not:

a) fracture completely; nor

b) reveal any crack or rupture in the weld metal greater than 3 mm in length regardless of depth; nor

c) reveal any crack or rupture in the parent metal, the heat affected zone or the fusion line longer than 3 mm and deeper than 12,5 % of the specified wall thickness. Cracks that occur at the edges of the specimen and that are less than 6 mm in length shall not be cause for rejection in b) or c) regardless of depth.

If a fracture or crack in a test piece is caused by imperfections, the test piece may be discarded and a new test piece substituted.

9.4.4 Flattening test

9.4.4.1 The flattening test shall be carried out in accordance with EN ISO 8492 and Figure 4.

When a weld stop occurs, flattening tests with the weld in the 3 o'clock position shall be made from crop ends resulting from each side of the weld stop and may be substituted for the intermediate flattening tests.

9.4.4.2 The flattening test shall be carried out in three steps with following acceptance criteria:

a) flatten to 2/3 of the original outside diameter; no weld opening shall occur;

b) flatten to 1/3 of the original outside diameter; no crack or break shall occur other than in the weld;

c) flatten until opposite walls of the pipe meet.

The presence of laminar imperfections or burnt metal shall not become apparent during the entire test.

9.4.5 Macrographic and metallographic examination

9.4.5.1 For SAW and COW pipes, the alignment of internal and external seams (see Figure 2c) shall be verified by macrographic examination.

9.4.5.2 For EW pipe with seam heat treatment (see Table 1), it shall be verified by metallographic examination that the entire heat affected zone has been heat treated over the full wall thickness.

9.4.6 Hydrostatic test

9.4.6.1 The hydrostatic test pressure shall be calculated in accordance with 9.4.6.2.

9.4.6.2 For calculation of the test pressure, the following formula shall apply:

$$p = \frac{20 \times S \times Tmin}{D} \qquad (3)$$

where

p is the hydrostatic test pressure in bar;

D is the specified outside diameter in mm;

S is the stress in MPa, equal to the percentage of the minimum yield strength specified for the steel grade concerned (see Table 14);

T_{min} is the specified minimum wall thickness in mm.

The test pressure shall be limited to a maximum of 207 bar.

Table 14 — Percentage of specified minimum yield strength (SMYS) for calculation of S

Steel grade/specified pipe outside diameter	Percentage of SMYS for calculation of S
L 210GA, L 235GA, L 245GA	60 [a]
L 290GA, L 360GA	
— $D \leq 114{,}3$ mm	60
— 114,3 mm < $D \leq 219{,}1$ mm	75
— 219,1 mm < $D < 508$ mm	85
— $D \geq 508$ mm	90
[a] all pipe sizes	

9.4.6.3 The test pressure shall be held for not less than:

a) 5 s for pipes of outside diameter $D \leq 457$ mm and

b) 10 s for pipes of outside diameter $D > 457$ mm.

In the case of pipes with outside diameters $D \geq 114{,}3$ mm, the test pressure, the test pressure versus time shall be recorded. This record shall be available for examination by the inspection representative.

9.4.6.4 For pipes with outside diameters less than 500 mm, a non-destructive leak-tightness test according to EN 10246-1 may be agreed instead of the hydrostatic testing.

9.4.7 Visual examination

Each pipe shall be visually examined over the entire external surface.

The internal surface shall be visually examined:

a) from each end for pipe outside diameters $D < 610$ mm;

b) over the entire internal surface for pipe outside diameters $D \geq 610$ mm.

The examination shall be carried out under sufficient lighting conditions by trained personnel with satisfactory visual acuity to verify the conformity of the pipes with the requirements of 8.5.

NOTE The light level should be of the order of 300 Lux.

The surface of cold formed welded pipe shall be examined to detect geometric deviations in the contour of the pipe. When this examination fails to disclose mechanical damage as the cause of the irregular surface, but indicates that the irregular surface may be attributed to a hard spot, the dimensions of the area and, if necessary (see 8.5.7), the hardness in this area shall be determined in accordance with EN ISO 6506-1 or EN ISO 6508-1. The choice of the test method is left to the discretion of the manufac-

turer. If dimensions and hardness exceed the acceptance criteria given in 8.5.7, the hard spot shall be removed.

9.4.8 Dimensional testing

9.4.8.1 The diameter of pipes shall be measured. At the discretion of the manufacturer, a circumferential tape or a caliper gauge may be used. By agreement, other approved measuring devices may be used.

9.4.8.2 The out-of-roundness O in percent shall be calculated by the formula

$$O = \frac{D_{max} - D_{min}}{D} 100 \quad (4)$$

where

D_{max} is the greatest outside (or inside) diameter;

D_{min} is the smallest outside (or inside) diameter;

D is the specified outside diameter (or inside diameter calculated from the specified outside diameter and wall thickness).

To calculate the out-of-roundness of the pipe body, the greatest and smallest outside or inside diameter depending on the requirements of Table 6 shall be measured in the same cross-sectional plane. The determination of out-of-roundness of pipe ends shall be based on corresponding measurements of the inside or outside diameters depending on the manufacturing process.

9.4.8.3 The greatest deviation of flat spots or peaks from the normal contour of the pipe shall be measured:

a) in the case of longitudinally welded pipe with a template located transverse to the pipe axis;

b) in the case of helically welded pipe with a template parallel to the pipe axis.

The templates shall have a length of a quarter of the specified outside diameter but max. 200 mm.

9.4.8.4 For the verification of other dimensional and geometrical requirements specified in 8.6 suitable methods shall be used. The methods to be used are left to the discretion of the manufacturer, unless otherwise agreed.

9.4.9 Weighing

Each length of pipe with outside diameter $D \geq 141{,}3$ mm shall be weighed separately. Lengths of pipe with outside diameters $D < 141{,}3$ mm shall be weighed either individually or in convenient lots, at the discretion of the manufacturer.

9.4.10 Non-destructive testing

For non-destructive testing, see Annex C.

9.5 Retests, sorting and reprocessing

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

10 Marking of the pipes

10.1 General marking

10.1.1 Pipe marking shall include the following minimum information:

a) the name or mark of the manufacturer of the pipe (X);

b) the number of this part of this European Standard;

c) the steel name (see also 10.2);

d) the type of pipe (S or W);

e) if an inspection certificate 3.1 or 3.2 in accordance with EN 10204 shall be issued

   i. the mark of the inspection representative (Y);

   ii. an identification number which permits the correlation of the product or delivery unit with the related inspection document (Z).

EXAMPLE X EN 10208-1 L360GA S Y Z

10.1.2 Unless die stamping is agreed (see 10.1.3), the mandatory markings which shall be applied indelibly shall be as follows.

a) For pipe with outside diameter $D \leq 48{,}3$ mm:
marked on a tag fixed to the bundle or painted on the straps or banding clips used to tie the bundle. Alternatively, at the discretion of the manufacturer, each pipe may be paint stencilled on one end.

b) For seamless pipe in all other sizes and welded pipe with outside diameter $D < 406{,}4$ mm:
paint stencilled on the outside surface starting at a point between 450 mm and 750 mm from one end of the pipe.

c) For welded pipe with outside diameter $D \geq 406{,}4$ mm:
paint stencilled on the inside surface starting at a point no less than 150 mm from one end of the pipe.

10.1.3 Die stamping may be used by agreement within 150 mm of the pipe end and at least 25 mm from the weld.

Cold die stamping (at temperatures lower than 100 °C) of plate/strip or pipe not subsequently heat treated is only permitted if especially agreed and shall, in this case, be done with rounded or blunt dies.

10.1.4 If a protective coating is applied, marking shall be legible after coating.

10.2 Special marking

For pipes delivered in the quenched and tempered (Q) or thermomechanically treated (M) condition a letter „Q” or „M” respectively shall be added to the steel name (e.g. L360GA + Q or L360GA + M).

Any requirements for additional marking or for special locations or methods of marking are subject to agreement.

11 Coating for temporary protection

Unless otherwise ordered, the pipe shall be delivered with an external coating to protect it from rusting in transit.

If unprotected pipe or special coating and/or lining is required, this shall be agreed upon at the time of enquiry and order.

Annex A
(normative)

Specification of welded jointers

A.1 Welding

Pieces of pipe used in making a jointer shall have a minimum length of 1,5 m. Pipe weld seams shall be staggered by between 50 mm and 200 mm unless otherwise agreed. The pipe lengths shall be welded by the manufacturer.

Welding shall be performed by approved and qualified welders (see EN 287-1) and in accordance with approved and qualified welding procedures (see EN ISO 15607 and EN ISO 15609-1).

Unless otherwise agreed, the choice of the welding process shall be at the discretion of the manufacturer.

The completed jointers shall be straight within the limits of 8.6.3.4.

A.2 Testing

A.2.1 Jointers shall be tested with a frequency of one out of a maximum of 50 jointers as specified for the strip end weld in Table 12 and Table 13.

A.2.2 Each jointer shall be submitted to a hydrostatic test in accordance with 9.4.6.

A.2.3 The circumferential weld of jointers shall be completely radiographically inspected in accordance with EN 10246-10 to image quality class R1. Welds failing to pass this test may be repaired in accordance with an approved and qualified weld repair procedure and re-radiographed as above.

A.3 Marking

Each jointer shall in addition to the requirements in Clause 10 be marked using paint stencil to identify the welder.

Annex B
(normative)

Treatment of imperfections and defects disclosed by visual examination

B.1 Treatment of surface imperfections (see 8.5.3 a)

At the manufacturer's discretion, such imperfections not classified as defects are permitted to remain in the pipe without repair. Cosmetic grinding, however, is permitted.

B.2 Treatment of dressable surface defects (see 8.5.3 b)

All dressable surface defects shall be dressed-out by grinding. Grinding shall be carried out in such a way that the dressed area blends in smoothly with the contour of the pipe. Complete removal of defects shall be verified by local visual inspection, aided where necessary by suitable NDT methods. After grinding, the remaining wall thickness in the dressed area shall be checked for compliance with 8.6.3.2.

B.3 Treatment of non-dressable surface defects (see 8.5.3 c)

Pipe containing non-dressable surface defects shall be given one of the following dispositions:

a) weld defects in SAW and COW pipes in the non-cold expanded condition shall be repaired by welding in accordance with B.4;

b) the section of the pipe containing the surface defect shall be cut off, within the limits of the requirement on minimum pipe length;

c) the entire pipe length shall be rejected.

B.4 Repair of defects by welding

Repair by welding is only permitted for the weld of SAW and COW pipes. In the case of cold expanded SAW and COW pipes, repair subsequent to the cold expansion operation is not permitted. The total length of repaired zones on each pipe weld is limited to 5 % of the total weld length. Weld defects separated by less than 100 mm shall be repaired as a continuous single weld repair. Each single repair shall be carried out with a minimum of two layers/passes over a minimum length of 50 mm.

The weld repair work shall be performed using an approved and qualified procedure which, in the case of normalized or quenched and tempered steels, may be based on the recommendations given in EN 1011-1 and EN 1011-2.

After weld repair, the total area of the repair shall be ultrasonically inspected in accordance with C.4.1.1 or radiographically inspected in accordance with C.4.3.

In addition after repair, each repaired pipe length shall be hydrostatically tested in accordance with 9.4.6.

Annex C
(normative)

Non-destructive testing

C.1 Scope

This annex specifies non-destructive testing (NDT) requirements and acceptance levels. A survey on the tests is given in Table C.1.

Table C.1 — Survey of non-destructive tests

1	2	3	4		5
No.	NDT operation	Test status [a]	Types of test and requirements, acceptance level		Reference
Seamless and welded pipe					
1	Laminar imperfections at the pipe ends	o	Ultrasonic test EN 10246-17, acceptance limit: 6 mm max. circumferentially		C.2.3
Electric and continuous welded (EW and BW) pipe					
2	Longitudinal imperfections in the weld (including the pipe ends, where applicable – see C.2.4)	m	or	Ultrasonic test EN 10246-7 or EN 10246-8, acceptance level U3/C (U3)	C.3.1
3			or	(at the manufacturer's discretion for T < 10 mm) Flux leakage test EN 10246-5, acceptance level F3	C.3.2 a)
4				(at the manufacturer's discretion for D < 250 mm; T < 6 mm; $\frac{T}{D}$ < 0,18) Eddy current test EN 10246-3, acceptance level E3	C.3.2 b)
Submerged arc and combination welded (SAW and COW) pipe					
5	Longitudinal/transverse imperfections in the weld	m		Ultrasonic test EN 10246-9, acceptance level U2/U2H or „two lambda“ calibration method (also for the strip end weld of helically welded pipe)	C.4.1
6				Radiographic inspection EN 10246-10, image quality class R1, acceptance limits as per C.4.3, for T-joints of helically welded pipe	C.4.1.2
7	NDT of the weld seam at pipe ends (untested ends)/repaired areas	m	or	Ultrasonic test EN 10246-9 to requirements of C.4.1.1 on longitudinal imperfections, acceptance level U2/U2H	C.4.2, C.4.3
8			or	(unless otherwise agreed) Radiographic inspection EN 10246-10, image quality class R1 (see C.4.3) on longitudinal imperfections	
9			and	Ultrasonic test EN 10246-9 or radiographic test EN 10246-10 on transverse imperfections, acceptance limits as per C.4.3	
[a] m mandatory, o optional test for mandatory requirement					

C.2 General NDT requirements and acceptance criteria

C.2.1 NDT personnel

For NDT personnel, see 7.8.

C.2.2 Timing of NDT operations

The sequence of all specified NDT operations shall be at the discretion of the manufacturer, as appropriate.

C.2.3 Laminar imperfections at the pipe ends

Laminar imperfections ≥ 6 mm in the circumferential direction are not permitted within 25 mm of each end of the pipe.

The verification of compliance with this requirement shall only be carried out by agreement. In such a case, an ultrasonic test in accordance with EN 10246-17 shall be used.

C.2.4 Untested pipe ends

It is emphasized that in many of the automatic NDT operations specified in this document, there may be a short length at both pipe ends which cannot be tested. In such cases, either:

a) the untested ends shall be cropped off; or

b) in the case of seamless or EW or BW pipe, the untested ends shall be subjected to a manual/semi-automatic test using the same technique, test sensitivity, test parameters, etc. as specified in the relevant clause of this document, where for manual testing, the scanning speed shall not exceed 150 mm/s; or

c) in the case of SAW and COW pipe, the provisions of C.4.2 shall apply.

C.2.5 Suspect pipe

In all cases, pipes giving rise to indications producing a trigger/alarm condition as a result of the specified NDT operation(s) shall be deemed suspect.

Suspect pipe shall be dealt with in accordance with the clause ‘Acceptance’ as given in the relevant European Standard for NDT of pipe, except where otherwise stated in this document. Repair by welding is only permitted on the weld of SAW and COW pipe, provided that the provisions of B.4 are fulfilled.

Where dressing is carried out, it shall be verified by any appropriate NDT method that the imperfections have been completely removed.

Any manual NDT applied to local suspect areas (dressed or not) shall use the same test sensitivity, test parameters and acceptance level (reference notch depth) as used during the test which originally deemed the pipe suspect. For manual ultrasonic testing, the scanning speed shall not exceed 150 mm/s.

C.3 Non-destructive testing of the weld seam of EW and BW pipe

C.3.1 The full length of the weld seam of EW and BW pipe shall be ultrasonically inspected for the detection of longitudinal imperfections or, at the discretion of the manufacturer, in accordance with EN 10246-7 or EN 10246-8 to acceptance level U3/C or U3 respectively.

C.3.2 Alternatively, at the discretion of the manufacturer, the full length of the weld seam shall be inspected using one of the following methods.

a) For pipes with a specified wall thickness T < 10 mm:

the flux leakage method in accordance with EN 10246-5 to acceptance level F3.

b) For pipes with an outside diameter D < 250 mm, a wall thickness T < 6 mm and a ratio T/D < 0,18:

the eddy current method (concentric or segment coil technique) in accordance with EN 10246-3 to acceptance level E3H.

C.4 NDT of SAW and COW pipe

C.4.1 Ultrasonic testing for longitudinal and transverse imperfections in the weld seam

C.4.1.1 The full length of the weld seam of SAW and COW pipe shall be ultrasonically inspected for the detection of longitudinal and transverse imperfections in accordance with EN 10246-9 to acceptance level U2/U2H, with the modifications given in a) to e) below.

a) The maximum notch depth shall be 2,0 mm.

b) The use of internal and external longitudinal notches located on the centre of the weld seam for equipment calibration purposes is not permitted.

c) As an alternative to the use of the reference hole for equipment calibration for the detection of transverse imperfections, it is permitted to use acceptance level U2 internal and external notches, lying at right-angles to and centred over the weld seam. In this case, both internal and external weld reinforcements shall be ground flush to match the parent pipe contour in the immediate area and on both sides of the reference notches. The notches shall be sufficiently separated from each other in the longitudinal direction and from any remaining reinforcement, to give clearly identifiable separate ultrasonic signal responses. The full signal amplitude from each of these notches shall be used to set the trigger/alarm level of the equipment.

d) As an alternative to the use of acceptance level U2 notches for equipment calibration, it is permitted, by agreement, to use a fixed depth internal and external notch and increase the test sensitivity by electronic means (i.e. increase in dB). In this case (known as the "two lambda" method), the depth of the notches shall be twice the wavelength at the ultrasonic frequency in use, given by:

$$Wavelength = \frac{Ultrasonic\ velocity(tr)}{Ultrasonic\ \ frequency}$$

(for example: at 4 MHz test frequency, wavelength = 0,8 mm, i. e.notch depth = 1,6 mm)

The required increase in test sensitivity shall be based on pipe thickness and the manufacturer shall demonstrate to the satisfaction of the purchaser that the test sensitivity achieved is essentially equivalent to that when using acceptance level U2 notches.

e) The manufacturer may use one of the methods described in C.4.2 to re-test suspect areas.

C.4.1.2 For helically welded pipe, the full length of the strip end weld shall be subjected to an ultrasonic test using the same ultrasonic test sensitivity and the same ultrasonic parameters as used on the primary helical weld seam in accordance with C.4.1.1.

In addition, the T-joints where the extremities of the strip end weld meet the primary weld seam, shall be subjected to radiographic inspection in accordance with C.4.3 and the acceptance limits given there.

C.4.2 NDT of the weld seam at the pipe ends/repaired areas

The length of the weld seam at the pipe ends which cannot be inspected by the automatic ultrasonic equipment and repaired areas of the weld seam (see B.4), shall be subjected to the following:

a) for the detection of longitudinal imperfections, a manual or semi-automatic ultrasonic test using the same test parameters and test sensitivity as specified in C.4.1.1 or, unless otherwise agreed, radiographic inspection in accordance with C.4.3;

b) for the detection of transverse imperfections, at the discretion of the manufacturer, either a manual/semi-automatic ultrasonic test using the same test parameters and test sensitivity as specified in C.4.1.1 or radiographic inspection or C.4.3.

When manual ultrasonic testing is carried out, the scanning speed shall not exceed 150 mm/s.

C.4.3 Radiographic inspection of the weld seam

C.4.3.1 Where applicable, radiographic inspection of the weld seam shall be conducted in accordance with EN 10246-10 to image quality class R1, with the conditions given in a) to c) below:

a) the sensitivity requirements, given in Table C.2 established on the base material shall be verified by use of the ISO Wire Penetrameter according to ISO 19232-1 or, if so agreed, by use of an equivalent hole penetrameter;

b) only X-ray radiation, using fine-grain, high-contrast direct film with lead screen, shall be used. By agreement, fluoroscopic methods are permitted, but only when the manufacturer can demonstrate equivalence to the X-ray film technique;

c) the density of the radiograph shall not be less than 2,0 and shall be chosen so that the density through the thickest portion of the weld seam is not less than 1,5 and that maximum contrast for the type of film used is achieved.

Table C.2 — Sensitivity requirements for the radiographic inspection, image quality class R1, in accordance with EN 10246-10

Dimensions in mm

Wall thickness		Visibility required	
above	up to	of the hole with a diameter	of the wire with a diameter
4,5	10	0,40	0,16
10	16	0,50	0,20
16	25	0,63	0,25
25	32	0,80	0,32
32	40	1,00	0,40

C.4.3.2 The acceptance limits for radiographic inspection of the weld seam shall be as given in a) to f) below.

a) Cracks, incomplete penetration and lack of fusion are not acceptable.

b) Individual circular slag inclusions and gas pockets up to 3,0 mm or $T/3$ in diameter (T = specified wall thickness), whichever is the smaller, are acceptable.

The sum of the diameters of all such permitted individual imperfections in any 150 mm or 12 T of weld length, whichever is the smaller, shall not exceed 6,0 mm or 0,5 T whichever is the smaller, where the separation between individual inclusions is less than 4 T.

c) Individual elongated slag inclusions up to 12,0 mm or 1 T in length, whichever is the smaller, or up to 1,6 mm in width are acceptable.

The maximum accumulated length of such permitted individual imperfections in any 150 mm or 12 T of weld length, whichever is the smaller, shall not exceed 12,0 mm, where the separation between individual inclusions is less than 4 T.

d) Individual undercuts of any length having a maximum depth of 0,4 mm are acceptable.

Individual undercuts of a maximum length of $T/2$ having a maximum depth of 0,8 mm and not exceeding 10 % of the specified wall thickness are acceptable provided that there are not more than two such undercuts in any 300 mm of the weld length, and all such undercuts are dressed out.

e) Any undercuts exceeding the above limits shall be repaired (see B.4) or the suspect area shall be cropped off or the pipe shall be rejected.

f) Any undercuts on the inside and outside weld of any length and depth which are coincident in the longitudinal direction on the same side of the weld are not acceptable.

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