BRITISH STANDARD

BS EN
10208-2 : 1997

Steel pipes for pipelines for combustible fluids — Technical delivery conditions

Part 2. Pipes of requirement class B

The European Standard EN 10208-2 : 1996 has the status of a British Standard

ICS 23.040.10

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by Technical Committee PSE/17, Materials and equipment for petroleum and natural gas industries, to Subcommittee PSE/17/1, Linepipe, upon which the following bodies were represented:

Association of Wellhead Equipment Manufacturers
British Iron and Steel Producers Association
Energy Industries Council
Engineering Equipment and Materials Users Association
Pipeline Industries Guild
Co-opted members

This British Standard, having been prepared under the direction of the Engineering Sector Board, was published under the authority of the Standards Board and comes into effect on
15 June 1997

Amendments issued since publication

Amd. No.	Date	Text affected

The following BSI references relate to the work on this standard:
Committee reference PSE/17/1
Draft for comment 93/707819 DC

ISBN 0 580 26737 7

Contents

National foreword

This British Standard has been prepared by Subcommittee PSE/17/1 and is the English language version of EN 10208-2 : 1996 — *Steel pipes for pipelines for combustible fluids — Technical delivery conditions — Part 2. Pipes of requirements class B* published by the European Committee for Standardization (CEN).

EN 10208-2 : 1996 was produced as a result of international discussions in which the United Kingdom took an active part. It has the same scope as the International Standard ISO 3183-2, and the principal differences in content are summarized in the foreword to EN 10208-2 : 1996.

Cross-references

Publication referred to	Corresponding British Standard
CR 10260	DD 214 : 1993 *Designation system for steel: additional symbols for steel names (ECISS Information Circular 10 : 1992)*
EN 473	BS EN 473 : 1993 *General principles for qualification and certification of NDT personnel*
	BS EN 10002 *Tensile testing of metallic materials*
EN 10002-1	BS 10002-1 : 1990 *Part 1. Method of test at ambient temperature*
	BS EN 10003 *Metallic materials. Brinell hardness test*
EN 10003-1	BS EN 10003-1 : 1995 *Part 1. Test method*
EN 10020	BS EN 10020 : 1991 *Definition and classification of grades of steel*
EN 10021	BS EN 10021 : 1993 *General technical delivery requirements for steel and iron products*
	BS EN 10027 *Designation systems for steel*
EN 10027-1	BS EN 10027-1 : 1992 *Part 1. Steel names, principal symbols*
EN 10027-2	BS EN 10027-2 : 1992 *Part 2. Steel numbers*
	BS EN 10045 *Charpy impact test on metallic materials*
EN 10045-1	BS EN 10045-1 : 1990 *Part 1. Test method (V- and U-notches)*
EN 10052	BS EN 10052 : 1994 *Vocabulary of heat treatment terms for ferrous products*
EN 10079	BS EN 10079 : 1993 *Definition of steel products*
	BS EN 10109 *Metallic materials. Hardness test*
EN 10109-1	BS EN 10109-1 : 1996 *Part 1. Rockwell test (scales A, B, C, D, E, F, G, H, K) and Rockwell superficial test (scales 15 N, 30 N, 45 N, 15 T, 30 T and 45 T)*
EN 10204	BS EN 10204 : 1991 *Metallic products. Types of inspection documents*
EN 10233	BS EN 10233 : 1994 *Metallic materials. Tube. Flattening test*
EN ISO 9000	BS EN ISO 9000 *Quality management and quality assurance standards*
EN ISO 9001	BS EN 9001 : 1994 *Quality systems. Model for quality assurance in design, development, production, installation and servicing*
EN ISO 9002	BS EN ISO 9002 : 1994 *Quality systems. Model for quality assurance in production, installation and servicing*
ENV 10220	DD ENV 10220 : 1994 *Seamless and welded steel tubes. Dimensions and masses per unit length*
EN 910	BS EN 910 : 1996 *Destructive tests on welds in metallic materials — Bend test*

Publication referred to	Corresponding British Standard
	BS EN 10246 *Non-destructive testing of steel tubes*
EN 10246-7	BS EN 10246-7 : 1996 *Part 7. Automatic full peripheral ultrasonic testing of seamless and welded (except submerged arc welded) steel tubes for the detection of longitudinal imperfections*

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, the EN title page, pages 2 to 36, an inside back cover and a back cover.

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EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN 10208-2

June 1996

ICS 23.040.10

Descriptors: Steel tubes, pressure pipes, fluid pipelines, fuels, classifications, designation, delivery, manufacturing, chemical composition, mechanical properties, dimensions, dimensional tolerances, tests, acceptance, marking

English version

Steel pipes for pipelines for combustible fluids — Technical delivery conditions — Part 2. Pipes of requirement class B

Tubes en acier pour conduites de fluides combustibles — Conditions techniques de livraison — Partie 2. Tubes de la classe de prescription B

Stahlrohre für Rohrleitungen für brennbare Medien — Technische Lieferbedingungen — Teil 2. Rohre der Anforderungsklasse B

This European Standard was approved by CEN on 1996-02-23. CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

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CEN

European Committee for Standardization
Comité Européen de Normalisation
Europäisches Komitee für Normung

Central Secretariat: rue de Stassart 36, B-1050 Brussels

Ref. No. EN 10208-2 : 1996 E

Foreword

This European Standard 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 December 1996, and conflicting national standards shall be withdrawn at the latest by December 1996.

The differences between EN 10208-2 and ISO 3183-2 [1] are mainly restricted to the following:

– normative references (see clause **2**);

– this European Standard uses steel numbers in accordance with EN 10027-2 (see table 1);

– basis of the calculation of hydrostatic test pressure (minimum wall thickness; ISO 3183- 2 offers the use of the specified wall thickness by agreement);

– this European Standard uses the standardized code numbers and terms of EURONORM 168 for the structure and the content of inspection documents.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

Contents

Introduction

In the preparation of this European Standard the competent committee was unanimous in seeking to avoid specifying the quality of line pipe to be used for a particular application. However, the committee recognized that there are several broad quality levels commonly used, and has differentiated between these quality levels as follows.

Firstly, the committee recognized the need to provide a basic quality level broadly similar to that specified in the main part of ANSI/API 5L [2]. This is designated requirement class A and considered in EN 10208 Part 1.

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

Thirdly, there are certain particularly demanding applications where very stringent requirements on quality and testing are imposed. Such requirements are reflected in requirement class C and considered in EN 10208 Part 3.

The Charpy energy requirements for this Part 2 of EN 10208 have been derived from established data to avoid long running shear fracture in pipelines transporting lean, dry natural gas in accordance with EPRG recommendations [3]. 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 enhanced properties.

For pipes of requirement class B, a weld efficiency factor of 1,0 can be used in design calculations, due to the conditions specified for the manufacture of the pipes and for the testing of the welds.

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 standard gives no detailed guidelines. It is the ultimate responsibility of the user to select the appropriate requirement class for the intended application.

NOTE. This European Standard combines a wide range of product types, dimensions and technical restrictions. In some areas of application, the absence of a single European pipeline design standard has resulted in differing national regulations imposing conflicting requirements on the users, thus making technical harmonization difficult.

Consequently, it may be necessary to amend certain requirements of this European Standard to satisfy various national design codes. However, this European Standard shall be the basic reference document. Such amendments should be specified at the time of enquiry and order. (See clause **5** and the note to **8.2.3.3.1**).

1 Scope

1.1 This European Standard EN 10208-2 specifies the technical delivery conditions for unalloyed and alloyed (except stainless) seamless and welded steel pipes. It includes quality and testing requirements higher than those specified in EN 10208 Part 1. EN 10208-2 applies to pipes which are normally used for the transmission of combustible fluids. The maximum allowable operating pressure is given in the corresponding design code.

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

Other parts of this European Standard are:

EN 10208-1	*Steel pipes for pipelines for combustible fluids — Technical delivery conditions — Part 1. Pipes of requirement class A*
EN 10208-3	*Steel pipes for pipelines for combustible fluids — Technical delivery conditions — Part 3. Pipes of requirement class C*

1.2 In addition to the requirements of this European Standard the general technical delivery conditions specified in EN 10021 apply.

2 Normative references

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

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

CR 10260	*Designation systems for steel; Additional symbols for steel names (CEN Report)*
EN 473	*Qualification and certification of NDT personnel — General principles*
EN 10002-1	*Metallic materials — Tensile testing — Part 1. Method of test (at ambient temperature)*
EN 10003-1	*Metallic materials — Hardness test — Brinell — Part 1. Test method*
EN 10020	*Definition and classification of grades of steel*
EN 10021	*General technical delivery conditions for steel and iron products*

EN 10027-1	*Designation systems for steel — Part 1. Steel names, principal symbols*
EN 10027-2	*Designation systems for steel — Part 2. Numerical system*
EN 10045–1	*Metallic materials — Charpy impact tests — Part 1. Test method*
EN 10052	*Vocabulary of heat treatment terms for ferrous products*
EN 10079	*Definition of steel products*
EN 10109-1	*Metallic materials — Hardness test — Rockwell — Part 1. Test method (scales A, B, C, D, E, F, G, H, K, N, T)*
EN 10204	*Metallic products — Types of inspection documents*
EN 10233	*Metallic materials — Tube — Flattening test*
EN ISO 9001	*Quality systems — Model for quality assurance in design/development, production, installation and servicing* (ISO 9001 : 1994)
EN ISO 9002	*Quality systems — Model for quality assurance in production, installation and servicing* (ISO 9002 : 1994)
ENV 10220	*Seamless and welded steel tubes — Dimensions and masses per unit length*
EURONORM 168[1)]	*Iron and steel products — Inspection documents — Contents*
IC 2[2)]	*Weldable fine-grained structural steels; Recommendations for processing, in particular for welding*
ISO 1027	*Radiographic image quality indicators for non-destructive testing — Principles and identification*
ISO 2566-1	*Steel — Conversion of elongation values — Part 1. Carbon and low alloy steels*
ISO/DIS 14284[3)]	*Steel and iron — Sampling and preparation of samples for the determination of chemical composition*
prEN 910[3)]	*Welding — Welded butt joints in metallic materials — Bend test*
prEN 10246-3[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*
prEN 10246-5[3)]	*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*
prEN 10246-7[3)]	*Non-destructive testing of steel tubes — Part 7. Automatic full peripheral ultrasonic testing of seamless and welded (except submerged arc-welded) steel tubes for the detection of longitudinal imperfections*
prEN 10246-8[3)]	*Non-destructive testing of steel tubes — Part 8: Automatic ultrasonic testing of the weld seam of electric resistance and induction welded steel tubes for the detection of longitudinal imperfections*
prEN 10246-9[3)]	*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*
prEN 10246-10[3)]	*Non-destructive testing of steel tubes — Part 10. Radiographic testing of the weld seam of submerged arc-welded steel tubes for the detection of imperfections*
prEN 10246-14[3)]	*Non-destructive testing of steel tubes — Part 14. Automatic ultrasonic testing of seamless and welded (except submerged arc-welded) steel tubes for the detection of laminar imperfections*

[1)] Until this EURONORM is transformed into a European Standard it can either be implemented or the corresponding national standard shall be agreed at the time of enquiry order.

[2)] Information Circular of the European Committee for Iron and Steel Standardization (ECISS), published by the members of CEN.

[3)] In preparation; until this document is published as European Standard the corresponding national standard should be agreed at the time of enquiry and order.

prEN 10246-15[3)]	*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*
prEN 10246-16[3)]	*Non-destructive testing of steel tubes — Part 16. Automatic ultrasonic testing of the areas adjacent to the weld seam of welded steel tubes for the detection of laminar imperfections*
prEN 10246-17[3)]	*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*
prEN 10256[3)]	*Non-destructive testing of steel tubes — Qualification and competence of level 1 and level 2 NDT personnel*
prEN 10274	*Metallic materials — Drop weight tear test*
prEN ISO 377[3)]	*Steel and steel products — Location of samples and test pieces for mechanical testing*

3 Definitions

3.1 General

For the purpose of this European Standard the definitions in **3.2** to **3.4** shall apply when additional to or differing from those given for the

– classification of steels in EN 10020;
– definition of steel products in EN 10079;
– heat treatment in EN 10052 and
– for types of sampling procedures, inspection and inspection documents in prEN ISO 377, EN 10021 and EN 10204.

3.2 Types of pipes and welds

3.2.1 *Seamless (S) pipe*

The tubular product is manufactured in a hot forming process which may be followed by sizing (see **6.5**) or cold finishing (see **3.3.4**) to produce the desired dimensions.

3.2.2 *High frequency welded (HFW) pipe*

The tubular product is manufactured by forming from strip and welding the abutting edges without addition of filler metal. The longitudinal seam is generated by high frequency current applied by induction or conduction.

NOTE. High frequency implies in this European Standard a frequency of at least 100 kHz.

3.2.3 *Submerged arc-welded (SAW) pipe*

The tubular product is manufactured by forming from strip or plate and welding the abutting edges by addition of filler metal. The pipe having a longitudinal (SAWL) or helical (SAWH) seam is produced by the automatic submerged arc process (but see also **6.3**). At least one pass is made on the inside and at least one pass on the outside of the pipe. An intermittent or continuous single pass tack weld made by the gas metal arc-welding process is permitted.

3.2.4 *Combination gas metal arc and submerged arc-welded (COW) pipe*

The tubular product is manufactured by forming from strip or plate and welding the abutting edges by addition of filler metal. The pipe having one longitudinal (COWL) or one helical (COWH) seam is produced by a combination of gas metal arc welding and submerged arc-welding. The gas metal arc-welding process is continuous and first, followed by the automatic submerged arc-welding process with at least one pass on the inside and at least one pass on the outside of the pipe.

3.2.5 *Strip end weld*

A weld that joins strip ends together.

3.2.6 *Jointer*

Two pieces of pipe joined together by a circumferential weld.

3.2.7 *Pipe body*

For welded pipe the entire pipe excluding the weld(s) and heat affected zone(s); for seamless pipe the entire pipe.

3.3 Treatment condition

3.3.1 *Normalizing forming*

A forming process in which the final deformation is carried out within 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.

The abbreviated form of this delivery condition is N.

3.3.2 Thermomechanical forming

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

The abbreviated form of this delivery condition is M.

NOTE 1. 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 2. As a consequence of lower carbon content and carbon equivalent values material in the delivery condition M has improved weldability properties.

[3)] See page 4.

3.3.3 *Quenching and tempering*

A heat treatment consisting of quench hardening followed by tempering. Quench hardening implies austenitization followed by cooling, under conditions such that austenite transforms more or less completely into martensite and possibly into bainite. Tempering implies heating to a specific temperature ($< Ac_1$) one or more times or holding at this temperature, followed by cooling at an appropriate rate so that the structure is modified and the specified properties are achieved.

The abbreviated form of this delivery condition is Q.

3.3.4 *Cold forming and cold finishing*

In this context cold forming is a process by which a flat product is formed to a pipe without heating. Cold finishing is a cold working operation (normally cold drawing) with a permanent strain greater than 1,5 %, which differentiates it from sizing operations specified in **6.5**.

3.4 Imperfections and defects

3.4.1 Imperfections are irregularities in the wall or on the pipe surfaces detectable by methods described in this European Standard. Imperfections with a size and/or population density that are within the acceptance criteria defined in this European Standard are considered to have no practical implication on the intended use of the product.

3.4.2 Defects are imperfections with a size and/or population density that are greater than the acceptance criteria defined in this European Standard. Defects are considered to adversely affect or limit the intended use of the product.

3.5 Agreement

Unless otherwise indicated 'by agreement' means 'by agreement between manufacturer and purchaser at the time of enquiry and order'.

3.6 Margin symbols

The following symbols are used in the margin of pages or tables for indicating optional delivery conditions:

M Mandatory agreement (see **5.2**a);

U Unless otherwise agreed left to the discretion of the manufacturer (see **5.2**b);

O Optional agreement (see **5.2**c).

4 Classification and designation

4.1 Classification

The steels specified in this European Standard are non-alloy quality or alloy special steels. Their classification in accordance with EN 10020 is indicated in table 1.

4.2 Designation

The steels specified in this European Standard are designated with steel names and steel numbers. Their designation in accordance with EN 10027-1, EN 10027-2 and CR 10260 is given in table 1.

NOTE. A comparison of the basic steel names with those specified in ANSI/API 5L [2] using the basis of minimum yield strength values, is given in annex A.

Table 1. Classification and designation of the steels

Heat treatment condition	Steel class in accordance with EN 10020	Steel name	Steel number
Normalized or normalizing formed	Non-alloy quality steel	L245NB L290NB L360NB	1.0457 1.0484 1.0582
	Alloy special steel	L415NB	1.8972
Quenched and tempered	Alloy special steel	L360QB L415QB L450QB L485QB L555QB	1.8948 1.8947 1.8952 1.8955 1.8957
Thermomechanically rolled	Non-alloy quality steel	L245MB L290MB L360MB	1.0418 1.0429 1.0578
	Alloy special steel	L415MB L450MB L485MB L555MB	1.8973 1.8975 1.8977 1.8978

5 Information to be supplied by the purchaser

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

c) type of pipe (see table 2, column 1);

d) number of this part of this European Standard;

e) steel name or number (see table 1);

f) pipe outside diameter and wall thickness in millimetres (see **7.6.1.2**);

g) random length group or, if a fixed length is required, the length in millimetres (see **7.6.3.3** and table 11);

h) which impact requirements, table 6 or table 7, shall apply;

i) type of inspection document (see **8.1.1**).

5.2 Other information

This European Standard offers to the purchaser and manufacturer the possibility to agree additional information (see note 1 to **7.3**) or in addition to the normally applicable delivery conditions other conditions, in accordance with items a) to c) as follows. The need for additional information or the options required shall be clearly indicated at the enquiry stage and stated in the order and in the confirmation of the order.

a) Mandatory agreement - option which shall be agreed when applicable (indicated in the margin by M):

1) chemical composition of pipe with wall thickness > 25 mm (see table 3, footnote 2);

2) mechanical properties of pipe with wall thickness > 25 mm (see table 5, footnote 1);

3) impact and DWT test requirements for pipe with outside diameter > 1 430 mm and/or wall thickness > 25 mm (see tables 6 and 7, footnote 2);

4) diameter tolerances for seamless pipe with wall thickness > 25 mm (see table 9, footnote 2);

5) diameter tolerances for pipe with outside diameter > 1 430 mm (see table 9, columns 2/3);

6) party to issue the inspection document 3.2 (see **8.1.1,** note 2**).**

b) Unless otherwise agreed left to the discretion of the manufacturer (indicated in the margin by U)

1) method of verification of dimensional and geometrical requirements (see **8.2.3.10.4**);

2) timing of NDT of seamless and HFW pipe (see **D.2.2**);

3) radiographic inspection for the detection of longitudinal imperfections (see **D.5.4**a).

c) Optional agreement - option which may be agreed (indicated in the margin by O)

1) approval of the quality system or verification of the manufacturing procedure (see **6.1** and annex B);

2) steelmaking process (see **6.2.1**);

3) manufacture of SAWL pipes with two seams (see **6.3**);

4) acceptance of strip end welds in SAWH/COWH pipe (see **6.6.1**);

5) Mo content (see table 3, footnote 7);

6) lower CEV (see table 3, footnote 4);

7) DWT test (see tables 6 and 7, footnote 4);

8) weldability data or weld tests (see **7.4.2**);

9) application of the diameter tolerance to the inside diameter (see table 9, footnote 3);

10) application of the diameter tolerance to the outside diameter (see table 9, footnote 4);

11) special bevel configuration (see **7.6.4.2**);

12) offset of strip end welds (see table 13, footnote 1);

13) impact test for the heat affected zone (see **8.2.1.2**);

14) test piece direction (see table 18, footnote 2);

15) use of round test pieces (see **8.2.2.2.2**);

16) use of flattened and heat treated test coupons (see **8.2.2.2.2**);

17) impact and DWT test temperatures other than 0 °C (see **8.2.3.3.1** and **8.2.3.4**);

18) substitution of the macrographic examination of the weld by alternative test methods (see **8.2.3.7.1**);

19) hardness test during production for seam heat treated HFW pipe (see **8.2.3.7.2**);

20) hydrostatic test pressures greater than 250 or 500 bar and up to 100 % of specified minimum yield strength respectively (see **8.2.3.8.1**);

21) use of special devices for measuring the pipe diameter (see **8.2.3.10.1**);

22) use of (cold) die stamping (see **9.1.3**);

23) special marking (see **9.2**);

24) coating and lining (see clause **10**);

25) acceptance level U2/C or F2, respectively for NDT of seamless pipe (see **D.3.1**, **D.3.2**);

26) use of the flux leakage test (for seamless and HFW pipe) or the eddy current test (for HFW pipe) (see **D.3.2** and **D.4.1.2**);

27) acceptance level U2/C (U2) for NDT of HFW pipe (see **D.4.1.1**);

28) acceptance level F2 for NDT of HFW pipe (see **D.4.1.2**a)

29) verification of quality requirement for laminar imperfections (see **D.2.4**, **D.4.2** and **D.4.3**, **D.5.2** and **D.5.3**);

30) use of fixed depth notches for equipment calibration (see **5.1.1**d);

31) use of hole penetrameters instead of ISO Wire Penetrameter (see **D.5.5.1**a);

32) use of fluoroscopic inspection (**D.5.5.1**b).

5.3 Example for ordering

The information should preferably be given in the way indicated in the following example of ordering:

10 000 m pipe SAWL EN 10208-2-L415MB- 61X12,5-r2, impact properties in accordance with table 7, with DWT- test, inspection document EN 10204-3.1.C.

6 Manufacturing

6.1 General

6.1.1 The pipe manufacturer and the stockist, where products are supplied through a stockist, shall operate a quality system in accordance with EN ISO 9002[4].

O Approval of the quality system by one of the following parties may be agreed:

– the purchaser;

– the purchaser's representative;

– an independent third party;

– or a regulatory authority.

NOTE. In special cases the verification of the manufacturing

O procedure either by available data or in accordance with annex B may also be agreed.

6.1.2 All non-destructive testing (NDT) activities shall be carried out by qualified and competent Level 1 and/or Level 2 NDT personnel approved by the employer[5]. At the discretion of the manufacturer these personnel may be qualified in accordance with prEN 10256 or certificated in accordance with EN 473. All Level 1 and 2 NDT personnel and NDT operations shall be authorized by a Level 3 NDT individual, approved by the employer and certificated in accordance with EN 473 (see **8.2.3.12** and annex D).

6.2 Steelmaking

6.2.1 The steels covered by this European Standard shall be made using the basic oxygen process or the electric furnace process.

O Other equivalent steelmaking processes may be used by agreement.

6.2.2 The steels shall be fully killed and shall be made according to fine grain practice.

6.3 Pipe manufacturing

Acceptable types of pipe are described in **3.2** and listed together with acceptable manufacturing routes in table 2. The type of pipe and the type of heat treatment as given in the steel name shall be specified by the purchaser.

SAWL pipe may be manufactured with two seams by agreement. O

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.

6.4 Heat treatment condition

The pipes shall be delivered in one of the forming and heat treatment conditions given in table 2.

6.5 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:

$$s_r = \frac{|D_a - D_b|}{D}$$

where

D_a = outside diameter after sizing;

D_b = outside diameter before sizing;

D = specified outside diameter.

6.6 Strip end welds

6.6.1 For helical seam welded pipe, the strip end weld may be retained in the pipe, by agreement. Where accepted, the strip end weld shall be located at least 200 mm from the pipe end. O

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

6.7 Jointers

The delivery of jointers is not permitted.

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[4] This requirement is also fulfilled by a quality system in accordance with EN ISO 9001.

[5] Employer - is the organization for which the person works on a regular basis. The employer may be either the tube manufactuer or a third party organization providing NDT services.

Table 2. Type of pipe and manufacturing route (starting material, pipe forming and heat treatment conditions)

Type of pipe	Starting material	Pipe forming[1)]	Heat treatment condition	Symbol for the heat treatment
Seamless (S)	Ingot or billet	Hot rolling	Normalized or normalizing formed	N
			Quenched and tempered	Q
		Hot rolling and cold finishing	Normalized	N
			Quenched and tempered	Q
High frequency welded (HFW)	Normalizing rolled strip	Cold forming	Normalized weld area	N
	Thermomechanically rolled strip		Heat treated welded area	M
	Hot rolled or normalizing rolled strip		Normalized (entire pipe)	N
		Cold forming and hot stretch reducing under controlled temperature resulting in a normalized condition	—	N
Submerged arc-welded (SAW)	Normalized or normalizing rolled plate or strip	Cold forming	—	N
— longitudinal seam (SAWL)	Thermomechanically rolled plate or strip			M
— helical seam (SAWH)				
Combination welded (COW)	As rolled plate or strip	Normalizing forming	—	N
— longitudinal seam (COWL)	Normalized or normalizing rolled plate or strip			
— helical seam (COWH)				

[1)] see **3.3.4**.

7 Requirements

7.1 General

The requirements specified in this European Standard apply on condition that the relevant specifications for test piece selection, test piece preparation and test methods given in **8.2.2** and **8.2.3** are complied with.

NOTE. Table 17 gives a survey of the tables and clauses containing requirements and specifications for testing.

7.2 Chemical composition

7.2.1 *Cast analysis*

The cast analysis of the steel shall comply with the requirements in table 3.

Table 3. Chemical composition[1] of the cast analysis for wall thickness ≤ 25 mm[2]

Steel designation		Maximum content, %									CEV[4] maximum
name	number	C[3]	Si	Mn[3]	P	S	V	Nb	Ti	other	
Steels for seamless and welded pipes											
L245NB	1.0457	0,16	0,40	1,1	0,025	0,020	—	—	—	5)	0,42
L290NB	1.0484	0,17	0,40	1,2	0,025	0,020	0,05	0,05	0,04	5)	0,42
L360NB	1.0582	0,20	0,45	1,6	0,025	0,020	0,10	0,05	0,04	5) 6)	0,45
L415NB	1.8972	0,21	0,45	1,6	0,025	0,020	0,15	0,05	0,04	5) 6) 7)	by agreement
Steels for seamless pipes											
L360QB	1.8948	0,16	0,45	1,4	0,025	0,020	0,05	0,05	0,04	5)	0,42
L415QB	1.8947	0,16	0,45	1,6	0,025	0,020	0,08	0,05	0,04	5) 6) 7)	0,43
L450QB	1.8952	0,16	0,45	1,6	0,025	0,020	0,09	0,05	0,06	5) 6) 7)	0,45
L485QB	1.8955	0,16	0,45	1,7	0,025	0,020	0,10	0,05	0,06	5) 6) 7)	0,45
L555QB	1,8957	0,16	0,45	1,8	0,025	0,020	0,10	0,06	0,06	6) 8)	by agreement
Steels for welded pipes											
L245MB	1.0418	0,16	0,45	1,5	0,025	0,020	0,04	0,04	—	5)	0,40
L290MB	1.0429	0,16	0,45	1,5	0,025	0,020	0,04	0,04	—	5)	0,40
L360MB	1.0578	0,16	0,45	1,6	0,025	0,020	0,05	0,05	0,04	5)	0,41
L415MB	1.8973	0,16	0,45	1,6	0,025	0,020	0,08	0,05	0,06	5) 6) 7)	0,42
L450MB	1.8975	0,16	0,45	1,6	0,025	0,020	0,10	0,05	0,06	5) 6) 7)	0,43
L485MB	1.8977	0,16	0,45	1,7	0,025	0,020	0,10	0,06	0,06	5) 6) 7)	0,43
L555MB	1,8978	0,16	0,45	1,8	0,025	0,020	0,10	0,06	0,06	5) 6) 7)	by agreement

[1] Elements not mentioned in this table shall not be added intentionally without purchaser's approval except for elements which may be added for deoxidation and finishing of the heat (see footnote 5).

M [2] Chemical composition for larger wall thicknesses up to 40 mm is to be agreed.

[3] For each reduction of 0,01 % below the max. carbon content an increase of 0,05 % manganese above the specified maximum value is permitted with a max. increase of 0,2 %.

[4] $CEV = C + \frac{Mn}{6} + \frac{Cr + Mo + V}{5} + \frac{Cu + Ni}{15}$; the CEV is only specified for the product analysis.

O For grades with values higher than 0,43 a max. CEV of 0,43 may be agreed.

[5] $0{,}015 \leq Al_{tot} < 0{,}060$; $N \leq 0{,}0012$; $\frac{Al}{N} \geq \frac{2}{1}$; $Cu \leq 0{,}25$; $Ni \leq 0{,}30$; $Cr \leq 0{,}30$; $Mo \leq 0{,}10$.

[6] The sum of V, Nb, Ti shall not exceed 0,15 %.

O [7] For these steel grades a molybdenum content up to 0,35 % may be agreed.

[8] Al, N, Al/N and Cu see footnote[5]; $Ni \leq 0{,}60$; $Cr \leq 0{,}50$; $Mo \leq 0{,}35$.

7.2.2 *Product analysis*

The permissible deviations from the specified chemical composition of the cast analysis given in table 3 shall be as given in table 4.

Table 4. Permissible deviations on product analysis from the specified chemical composition limits given in table 3

Element	Permissible deviation
C	+ 0,02
Si	+ 0,05
Mn	+ 0,10
P	+ 0,005
S	+ 0,005
V	+ 0,01
Nb	+ 0,01
Ti	+ 0,01
V + Nb + Ti	+ 0,02
Cr	+ 0,05
Ni	+ 0,05
Mo	+ 0,03
Cu	+ 0,05
Al	+ 0,005
N	+ 0,002

7.3 Mechanical and technological properties

The pipe shall, as far as applicable (see table 17, column 2), conform with the requirements given in table 5 and tables 6 or 7. The purchaser shall state at the time of enquiry and order which impact requirements, depending on the safety factor to be used, shall apply.

NOTE 1. In the case of hot forming and/or subsequent field heat treatment of pipes delivered in the quenched and tempered or thermomechanically rolled condition adverse change of mechanical properties can occur (see for example **3.3.2**). Where appropriate the purchaser should contact the manufacturer for more detailed information.

NOTE 2. The impact requirements in tables 6 and 7 have been determined using among other parameters a safety factor. The safety factors 1,4 and 1,6 have been chosen as typical examples in the range of commonly used safety factors.

Table 5. Requirements for the results of tensile and bent test for wall thickness ≤ 25 mm[1], and for the hydrostatic test

Steel designation		Pipe body (seamless and welded pipes)				Weld seam		Entire pipe
						HFW, SAW, COW	SAW, COW	
		Yield strength $R_{t0,5}$	Tensile strength R_m	$R_{t0,5}/R_m$[2]	Elongation[3] ($L_o = 5{,}65\sqrt{S_0}$) A	Tensile strength R_m	Diameter of the mandrel for bend test[4] (see 8.2.3.5)	Hydrostatic test (see 8.2.3.8)
name	number	N/mm²	N/mm² min.	max.	% min.	N/mm² min.		
L245NB	1.0457	245 to 440	415	0,80	22	The same values as for the pipe body apply	3*T*	Each length of pipe shall withstand the test without showing leakage or visible deformation
L245MB	1.0418			0,85				
L290NB	1.0484	290 to 440	415	0,85	21		3*T*	
L290MB	1.0429			0,85				
L360NB	1.0582			0,85				
L360QB	1.8948	360 to 510	460	0,88	20		4*T*	
L360MB	1.0578			0,85				
L415NB	1.8972			0,85				
L415QB	1.8947	415 to 565	520	0,88	18		5*T*	
L415MB	1.8973			0,85				
L450QB	1.8952	450 to 570	535	0,90	18		6*T*	
L450MB	1.8975			0,87				
L485QB	1.8955	485 to 605	570	0,90	18		6*T*	
L485MB	1.8977			0,90				
L555QB	1.8957	555 to 675	625	0,90	18		6*T*	
L555MB	1.8978			0,90				

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[1] Mechanical properties of pipes with greater wall thickness up to 40 mm are to be agreed.
[2] The values for the yeild strength radio apply to the product 'pipe'. They cannot be required for the starting material.
[3] These values apply to transverse specimens taken from the pipe body. When longitudinal specimens are tested (see table 18), the values of elongation shall be 2 units higher.
[4] *T* = specified wall thickness of the pipe.

Table 6. Requirements for the results of the Charpy V-notch impact test for a safety factor of 1,6[1] and for the drop weight tear (DWT) test at 0 °C

Steel designation		Charpy V-notch impact test Minimum impact energy in J for outside diameters ≤ 1 430 mm and wall thicknesses ≤ 25 mm[2]									DWT test[4] Shear fracture area in %
		Pipe body (pipe outside diameter D, in mm)								Weld seam	Pipe body (D in mm)
		≤ 510	> 510 ≤ 610	> 610 ≤ 720	> 720 ≤ 820	> 820 ≤ 920	> 920 ≤ 1020	> 1 020 ≤ 1 120	> 1 120 ≤ 1 220	> 1 220 ≤ 1 430	$D \leq 1\,430$ transverse to the seam	500 < $D \leq 1\,430$
name	number	transverse to the pipe axis (longitudinal to the pipe axis in angular brackets)[3]										
L245NB	1.0457	40 (30)			40 (30)					40 (30)	40 (30)	not applicable
L245MB	1.0418	[60 (45)]										
L290NB	1.0484									42 (32)		
L290MB	1.0429											
L360NB	1.0582											
L360QB	1.8948											
L360MB	1.0578											
L415NB	1.8972											85[5]
L415QB	1.8947											
L415MB	1.8973											
L450QB	1.8952				40 (30)			42 (32)	43 (32)	47 (35)		
L450MB	1.8975											
L485QB	1.8955	40 (30)	41 (31)	45 (34)	48 (36)	51 (38)	53 (40)	56 (42)	58 (44)	63 (47)		
L485MB	1.8977	[60 (45)]	[62 (47)]	[68 (51)]								
L555QB	1.8957	48 (36)	55 (41)	61 (46)	66 (50)	72 (54)	77 (58)	82 (62)	87 (65)	96 (72)		
L555MB	1.8978	[72 (54)]	[83 (62)]	[92 (69)]								

[1] See NOTE 2 in **7.3**.
[2] The values apply for standard test pieces. For subsize test pieces see **8.2.3.3.2**. The specified values without brackets are the minimum average values for three tests; minimum individual values (75 % of the average values) are indicated in round brackets. The impact requirements do not apply for the heat affected zone (HAZ). For outside diameters > 1 430 mm and/or wall thicknesses > 25 mm values shall be agreed.
[3] The test pieces shall be taken transverse to the pipe axis as long as minimum subsize test pieces with a width of ≥ 5 mm are still obtainable without flattening.
[4] To be carried out by agreement for pipes with an outside diameter > 500 mm, a wall thickness > 8 mm and a specified yield strength > 360 N/mm2.
[5] Avearge value of two tests.

Table 7. Requirements for the results of the Charpy V-notch impact test for a safety factor of 1,4[1] and requirements for the drop weight tear (DWT) test at 0 °C

Steel designation		Charpy V-notch impact test Minimum impact energy in J for outside diameters ≤ 1 430 mm and wall thicknesses ≤ 25 mm[2]									DWT test[4] Shear fracture area in %
		Pipe body (pipe outside diameter D, in mm)								Weld seam	Pipe body (D in mm)
		≤ 510	> 510 ≤ 610	> 610 ≤ 720	> 720 ≤ 820	> 820 ≤ 920	> 920 ≤ 1020	> 1 020 ≤ 1 120	> 1 120 ≤ 1 220	> 1 220 ≤ 1 430	$D \leq 1\,430$ transverse to the seam	500 < $D \leq 1\,430$
name	number	transverse to the pipe axis (longitudinal to the pipe axis in angular brackets)[3]										
L245NB	1.0457	40 (30)			40 (30)					40 (30)	40 (30)	not applicable
L245MB	1.0418	[60 (45)]										
L290NB	1.0484									42 (32)		
L290MB	1.0429											
L360NB	1.0582											
L360QB	1.8948											
L360MB	1.0578											
L415NB	1.8972				40 (30)	41 (31)	44 (33)	46 (35)	48 (36)	51 (38)		85[5]
L415QB	1.8947											
L415MB	1.8973											
L450QB	1.8952	40 (30)		41 (31)	43 (32)	46 (35)	48 (36)	51 (38)	53 (40)	57 (43)		
L450MB	1.8975	[60 (45)]		[62 (47)]								
L485QB	1.8955	46 (35)	50 (38)	55 (41)	58 (44)	62 (47)	65 (49)	68 (51)	71 (53)	77 (58)		
L485MB	1.8977	[69 (52)]	[75 (56)]	[83 (62)]								
L555QB	1.8957	61 (46)	68 (51)	76 (57)	83 (62)	90 (68)	96 (72)	102 (77)	108 (81)	120 (90)		
L555MB	1.8978	[92 (69)]	[102 (77)]	[114 (86)]								

[1] See NOTE 2 in **7.3**.
[2] The values apply for standard test pieces. For subsize test pieces see **8.2.3.3.2**. The specified values without brackets are the minimum average values for three tests; minimum individual values (75 % of the average values) are indicated in round brackets. The impact requirements do not apply for the heat affected zone (HAZ). For outside diameters > 1 430 mm and/or wall thicknesses > 25 mm values shall be agreed.
[3] The test pieces shall be taken transverse to the pipe axis as long as minimum subsize test pieces with a width of ≥ 5 mm are still obtainable without flattening.
[4] To be carried out by agreement for pipes with an outside diameter > 500 mm, a wall thickness > 8 mm and a specified yield strength > 360 N/mm^2.
[5] Average value of two tests.

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7.4 Weldability

7.4.1 In view of the processes of manufacture of pipes and of pipelines the requirements for the chemical composition of the steels, and in particular the limiting values for the carbon equivalent CEV (see table 3), have been selected to ensure that the steels delivered in accordance with this European Standard 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.

O **7.4.2** If so agreed, the manufacturer shall supply for the type of steel concerned weldability data or perform weld tests. In the case of weld tests, the details for carrying out the tests and the acceptance criteria are also to be agreed.

7.5 Surface condition, imperfections and defects

7.5.1 The manufacturer shall take adequate precautions to minimize the presence of pipe damage and imperfections.

7.5.2 The surface finish produced by the manufacturing process shall allow the detection of surface imperfections that can be disclosed by visual inspection.

7.5.3 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 **C.1**.

b) Imperfections with a depth greater than 12,5 % of the specified wall thickness, and 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 **C.2** or treated in accordance with **C.3** as appropriate.

c) Imperfections which encroach on the specified minimum wall thickness shall be classified as defects and treated in accordance with **C.3**.

7.5.4 For undercuts disclosed by visual inspection of SAW and COW pipes the acceptance criteria given in **D.5.5.2**d to **D.5.5.2**f shall apply.

7.5.5 The acceptance criteria for imperfections detected by non-destructive testing, as required by **8.2.3.12**, are specified in annex D.

7.5.6 All pipes shall be free from defects (see **3.4.2**).

7.5.7 Geometric deviations from 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 limits:

– 3 mm for flat spots, peaks and cold formed dents with sharp bottom gouges;

– 6 mm for 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 **8.2.3.10.3**. For dents, the length in any direction shall not exceed one half of the pipe outside diameter.

7.5.8 Any hard spot exceeding 50 mm in any direction shall have a hardness value less than 35 HRC (327 HB)(see **8.2.3.9**).

7.6 Dimensions, masses and tolerances

7.6.1 *Dimensions*

7.6.1.1 The pipes shall be delivered to the dimensions specified in the enquiry and order, within the tolerances given in **7.6.3** to **7.6.6**.

7.6.1.2 The outside diameters and wall thicknesses given in table 8 are selected from ENV 10220 and should preferably be ordered. Other dimensions may be chosen.

7.6.1.3 For the length of the pipes see **7.6.3.3**. and for the finish of the pipe ends see **7.6.4**.

7.6.2 *Masses*

The mass per unit length shall be calculated using the following formula:

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

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 a density equal to 7,85 kg/dm^3.

7.6.3 *Tolerances on the pipe*

7.6.3.1 *Diameter and out-of-roundness*

The outside diameter and the out-of-roundness as defined in **8.2.3.10.2**, shall be within the tolerances given in table 9.

7.6.3.2 *Wall thickness*

The wall thickness shall be within the tolerances given in table 10.

Table 8.Preferred outside diameters and wall thicknesses
(indicated by the enframed field including the frame itself)

Outside diameter mm	**Wall thickness** mm																									
	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																										
1016																										
1067																										
1118																										
1168																										
1219																										
1321																										
1422																										
1524																										
1626																										

Table 9. Tolerance on diameter and out-of-roundness

Outside diameter D	**Diameter tolerance**				**Out-of-roundness**	
	Pipe except the end[1)]		**Pipe end**[1)2)]			
mm	**Seamless pipe**	**Welded pipe**	**Seamless pipe**	**Welded pipe**	**Pipe except the end**[1)]	**Pipe end**[1)2)]
$D \leq 60$	± 0,5 mm or ± 0,75 % D (whichever is the greater)	± 0,5 mm or ± 0,75 % D (whichever is the greater) but max. ± 3 mm	± 0,5 mm or ± 0,5 % D[3)] (whichever is the greater), but max. ± 1,6 mm		(included in the diameter tolerance)	
$60 < D \leq 610$					2,0 %	1,5 %
$60 < D \leq 1\,430$	± 1 % D	± 0,5 % D but max. ± 4 mm	± 2,0 mm[4)]	± 1,6 mm[4)]	1,5 % (but max. 15 mm) for $\frac{D}{T} \leq 75$, 2,0 %	1,0 % for $\frac{D}{T} \leq 75$ 1,5 % for $\frac{D}{T} > 75$
M $D > 1\,430$	by agreement		by agreement[4)]		for $\frac{D}{T} > 75$	by agreement[4)]

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[1)] The pipe end shall be considered to include a length of 100 mm at the pipe extremities.
[2)] For seamless pipe the values apply for wall thicknesses ≤ 25 mm; for greater thicknesses by agreement.
[3)] Subject to agreement the tolerance may be applied to the inside diameter for outside diameters > 210 mm.
[4)] Unless otherwise agreed the diameter tolerance applies to the inside diameter.
[5)] When the diameter tolerance is applied to the inside diameter, the inside diameter shall also be the basis for the out-of-roundness requirements.

Table 10. Tolerances on wall thickness	
Wall thickness T mm	**Tolerance**
Seamless pipe[1)]	
$T \leq 4$	+ 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
[1)] For outside diameters ≥ 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 **7.6.6** applies.	

7.6.3.3 *Length*

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

7.6.3.3.2 Random lengths shall be delivered in accordance with the requirements of the specified length groups (see table 11).

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

Table 11. Requirements for random length groups			
Length group	**Length range for 90 % of order item**[1)] m	**Minimum average length of order item** m	**Shortest length of order item** m
r1	6 to 11	8	4
r2	9 to 14	11	6
r3	10 to 16	13	7
r4	11 to 18	15	8
[1)] The upper limit is the maximum value for the length of each individual pipe.			

7.6.3.4 *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.

7.6.4 ***Finish of pipe ends***

7.6.4.1 All pipe ends shall be cut square and be free from harmful burrs.

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

– 1 mm for outside diameters less than or equal to 220 mm; and

– 0,005D, but max. 1,6 mm, for outside diameters greater than 220 mm.

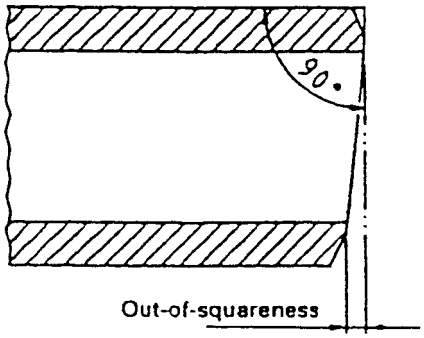


Figure 1. Out-of-squareness

7.6.4.2 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. O

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

– as given in table 12 (for seamless pipe);

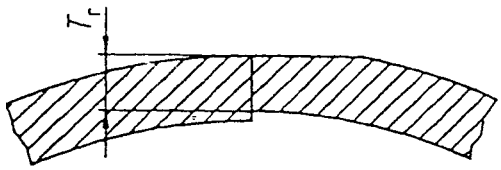
– 7° (for welded pipe, greater than 114,3 mm outside diameter).

Table 12. Maximum angle of internal taper for seamless pipe	
Specified wall thickness (T) mm	**Maximum angle of taper** degrees
$T < 10,5$	7
$10,5 \leq T < 14$	9,5
$14 \leq T < 17$	11
$T \geq 17$	14

7.6.5 ***Tolerances of the weld seam***

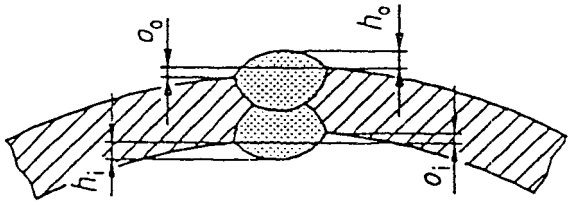
7.6.5.1 *Radial offset of plate or strip edges*

7.6.5.1.1 In the case of HFW pipe the radial offset of strip edges shall not cause the remaining wall thickness T_r at the weld to be less than the specified minimum wall thickness (see figure 2a).



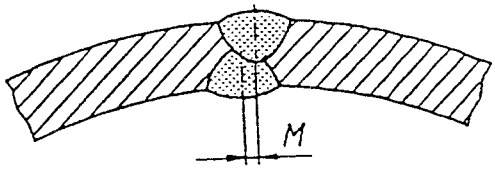
T_r - remaining wall thickness caused by radial offset

a) Radial offset of strip edges (HFW pipe)



o_o, o_i - outside/inside radial offset
h_o, h_i - outside/inside height of the weld beads

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



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

Figure 2. Possible dimensional deviations of the weld seam

7.6.5.1.2 In the case of SAW and COW pipes the maximum radial offset (see o_0 and o_i in figure 2b) of the plate/strip edges shall be as given in table 13.

Table 13. Maximum radial offset of SAW and COW pipes

Specified wall thickness (T) mm	**Maximum radial offset**[1] mm
$T \leq 10$	1,0
$10 < T \leq 20$	0,1 T
$T > 20$	2,0

[1] For strip end welds other requirements may be agreed.

7.6.5.2 *Height of the flash or weld bead (weld reinforcement)*

7.6.5.2.1 The outside flash of HFW pipe shall be trimmed to an essentially flush condition. The inside flash shall not extend above the contour of the pipe by more than 0,3 mm + 0,05T, where T is the specified wall thickness. When trimming, the wall thickness shall not be reduced below the minimum specified.

The depth of groove resulting from trimming the internal flash of HFW pipe shall not undercut the contour of the pipe by more than that given in table 14.

Table 14. Maximum depth of groove of HFW pipe

Specified wall thickness (T) mm	**Maximum depth of groove** mm
$T \leq 4,0$	0,1 T
$4,0 < T \leq 8$	0,4
$T > 8$	0,05 T

7.6.5.2.2 The inside weld bead of SAW and COW pipes shall be ground flush with a tolerance of + 0,5/ 0 mm for a distance of 100 mm from each pipe end (see h_i in figure 2b).

The height of the weld bead of the remainder of the pipe shall not exceed the values given in table 15.

Table 15. Maximum height of the weld beads of SAW and COW pipes

Specified wall thicknesses (T) mm	**Maximum height of the weld beads**	
	inside h_i mm	**outside** h_o mm
$T \leq 15$	3	3
$T > 15$	3	4

7.6.5.2.3 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 **D.5.5.2**d).

7.6.5.3 *Misalignment of the weld beads*

Any misalignment of the weld beads of SAW and COW pipe (see figure 2c) shall not exceed the values given in table 16.

Table 16. Maximum misalignment of the weld beads of SAW and COW pipes

Specified wall thicknesses (T) mm	**Maximum misalignment of the weld beads** mm
$T \leq 10$	3
$T > 10$	4

7.6.6 ***Mass tolerance***

The mass of any individual pipe shall not deviate from the nominal mass determined in accordance with **7.6.2** by more than + 10 % or − 3,5 %.

8 Inspection

8.1 Types of inspection and inspection documents

8.1.1 The compliance with the requirements of the order shall be checked for products manufactured in accordance with this European Standard by specific inspection and testing.

The purchaser shall, taking into account the notes below, state which of the following types of inspection document is required:

– EN 10204-3.1.A
– EN 10204-3.1.B
– EN 10204-3.1.C
– EN 10204-3.2

NOTE 1. When making his choice the purchaser should, where necessary, take into account the relevant requirements of standards or legal regulations for pipelines.

NOTE 2. If an inspection document 3.1.A, 3.1.C or 3.2 is ordered the purchaser should also indicate in his order the address of the organization or person nominated by him to carry out the inspection and to issue and validate the inspection document. In the case of the document 3.2 it shall be agreed which party shall issue the document.

M

8.1.2 The inspection document shall cover the following in accordance with EURONORM 168:

a) the necessary information on:

A – commercial transactions and parties involved;

B – description of products to which the inspection document applies (traceability shall be possible; see also **9.1**).

b) the data on test pieces, test conditions and test results required under:

CO1CO2	location of sample and direction of the test piece;
C10-C13	tensile test;
C40-C43	Charpy V-notch impact test and if applicable (see table 17, footnote 6) the drop weight tear test;
C50-C69	bend or flattening test;
C71-C92	cast analysis and product analysis;
D01	marking and verification of the surface appearance and dimensional properties;
D02-D99	non-destructive inspection and hydrostatic test.

c) Z – authentication of the inspection document.

8.2 Specific inspection and testing

8.2.1 ***Type and frequency of tests***

8.2.1.1 The tests to be carried out on the various types of pipe are given in table 17, columns 2, 3 and 4. The frequency of testing is given in table 17, column 5.

8.2.1.2 In addition to the tests specified in table 17 impact tests on the heat affected zone of welded pipes may, where appropriate be agreed (see for example **B.0**). In such cases the details of the requirements and the testing conditions shall also be agreed.

O

Table 17. Survey of tests and requirements

1	2				3	4	5	6	7	8
	Specification in column 3 to 8 apply for[1]				**Type of test or requirement**	**Test status**[2]	**Frequency of testing**	**Sampling conditions see**	**Test method see**	**Requirements see**
	S	**HFW**	**SAW, COW**							
			lgt.	**hel.**						
	pipes		**pipes**							
a1	x	x	x	x	Cast analysis	m	1 analysis/cast	Left to the discretion of the manufacturer		table 3
a2	x	x	x	x	Product analysis	m	1 analysis/cast	**8.2.2.1**	**8.2.3.1**	table 4
b1	x	x	x	x	Tensile test[3] – on the pipe body	m	Except for strip end weld testing the test units shall consist only of pipes of – the same cast – the same treatment condition – the same dimension and a) in the case of outside diameters < 508 mm not more than 100 pipes b) otherwise not more than 50 pipes. 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	**8.2.2.2.1** and table 18	table 5
b2		x	x	x	– on the weld seam ($D \geq 210$ mm)	m		1		
b3				x	– on the strip end weld seam ($D \geq 210$ mm)	m		1		
					Charpy V-notch impact test (for $T \geq 5$ mm)[4]			3	**8.2.3.3**	table 6 and table 7
c1	x	x	x	x	– on the pipe body	m				
c2		x	x	x	– on the weld seam[5]	m		3		
c3				x	– on the strip end weld seam[5]	m		3		
d	x	x	x	x	Drop weight tear test on the pipe body[6]	o		2	**8.2.3.4**	
e1			x	x	Bend test – on the weld seam	m		2	**8.2.3.5**	figure 6, table 5 and **8.2.3.5.2**
e2				x	– on the strip end weld seam	m		2		

Table 17. Survey of tests and requirements (*concluded*)

1	2				3	4	5	6	7	8
	Specification in column 3 to 8 apply for[1]				**Type of test or requirement**	**Test status**[2]	**Frequency of testing**	**Sampling conditions see**	**Test method see**	**Requirements see**
	S	**HFW**	**SAW, COW**							
			lgt.	**hel.**						
	pipes		**pipes**							
f		x			Flattening test	m	4 tests per coil; plus 2 tests in the case of a weld stop.	figure.4 and **8.2.2.2.6**	**8.2.3.6**	figure 4, table 5 and **8.2.3.6.2**
gl			x	x	Macro- and metallographic examination – Macrography	m	Once per shift or when pipe size is changed	**8.2.2.3**	**8.2.3.7.1**	**7.6.5.3**
g2		x			– Metallography	m	Once per shift or when size or steel grade of the pipe is changed		**8.2.3.7.2**	**8.2.3.7.2**
h1		x	x	x	Hardness test	m	In cold formed pipe any hard spot exceeding 50 mm in any direction shall be tested	—	**8.2.3.9**	**7.5.8**
h2		x				o	To be carried out by agreement for seam heat treated HFW pipes.	—	—	[7]
i	x	x	x	x	Hydrostatic testing	m	Each pipe shall be tested.	—	**8.2.3.8**	**8.2.3.8** and table 5
j	x	x	x	x	Visual examination	m	Each pipe shall be examined.		**8.2.3.9**	**7.5**
kl	x	x	x	x	Dimensional testing – outside or inside diameter and out-of-roundness of pipe ends	m	Dimensions of each pipe shall be verified	—	**8.2.3.10.1**, **8.2.3.10.2**	**7.6.3.1** and table 9
k2	x	x	x	x	– wall thickness of pipe ends				**8.2.3.10.4**	**7.6.3.2** and table 10
k3	x	x	x	x	– other dimensional characteristics excluding the seam	m	At random testing. The details are left to the discretion of the inspecotor.		**8.2.3.10.3, 8.2.3.10.4**	**7.6.3.3, 7.6.3.4, 7.6.4**
k4		x	x	x	– weld seam	m				**7.6.5**
l	x	x	x	x	Weighing	m	Each pipe or lot shall be weighed.		**8.2.3.11**	**7.6.6**
m	x	x	x	x	Non-destructive testing	See table D.1				

[1] S = seamless; HFW = High frequency welded; SAW = Sumerged arc welded; COW = Combination welded; lgt. = longitudinal seam; hel. = helical seam
[2] m = mandatory; o = optional;
[3] D = outside diameter;
[4] T = wall thickness;
[5] As far as test pieces transverse to the weld seam with a width of ≥ 5 mm are obtainable without straightening.
[6] To be carried out by agreement for pipes with an ouside diameter > 500 mm, a wall thickness > 8 mm and a minimum yield strength greater than 360 N/mm^2.
[7] The hardness values shall be agreed.

8.2.2 ***Selection and preparation of samples and test pieces***

8.2.2.1 *Samples and test pieces for the product analysis*

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

8.2.2.2 *Samples and test pieces for the mechanical tests*

8.2.2.2.1 *General*

The samples for the:

– tensile test;

– Charpy V-notch impact test;

– drop weight tear test;

– bend test; and

– flattening test;

shall be taken and the corresponding test pieces prepared in accordance with the general conditions of prEN ISO 377, as far as applicable.

Samples for the various types of tests shall be taken from pipe ends in accordance with figures 3 and 4 and table 18 taking into account the supplementary details specified in **8.2.2.2.2** to **8.2.2.2.6**.

8.2.2.2.2 *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.

O Round 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 $D \leq 210$ 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.

O 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.

8.2.2.2.3 *Charpy V-notch impact test pieces*

The test pieces shall be prepared in accordance with EN 10045-1 (see also figure 5a) without flattening. The axis of the notch shall be perpendicular to the pipe surface. In case of test pieces taken on the weld, the axis of the notch shall be placed in the middle of the weld.

The orientation and size of the test piece shall be as follows:

– The greatest possible transverse width between 10 and 5 mm (see figure 5b) shall be machined. The minimum outside diameter D_{min} of the pipe necessary to obtain transverse test pieces is given by

$$D_{min} = (T - 5) + \frac{756{,}25}{T - 5}$$

where T is the wall thickness.

– If the smallest permitted transverse test piece is not obtainable, the greatest possible longitudinal width between 10 and 5 mm shall be used.

8.2.2.2.4 *Test pieces for the drop weight tear (DWT) test*

The test pieces shall be taken and prepared in accordance with prEN 10274.

8.2.2.2.5 *Test pieces for the bend test*

The test pieces shall be taken in accordance with prEN 910 and figure 6. For pipes with a wall thickness > 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 wall thickness ≤ 20 mm.

The weld reinforcement shall be removed from both faces.

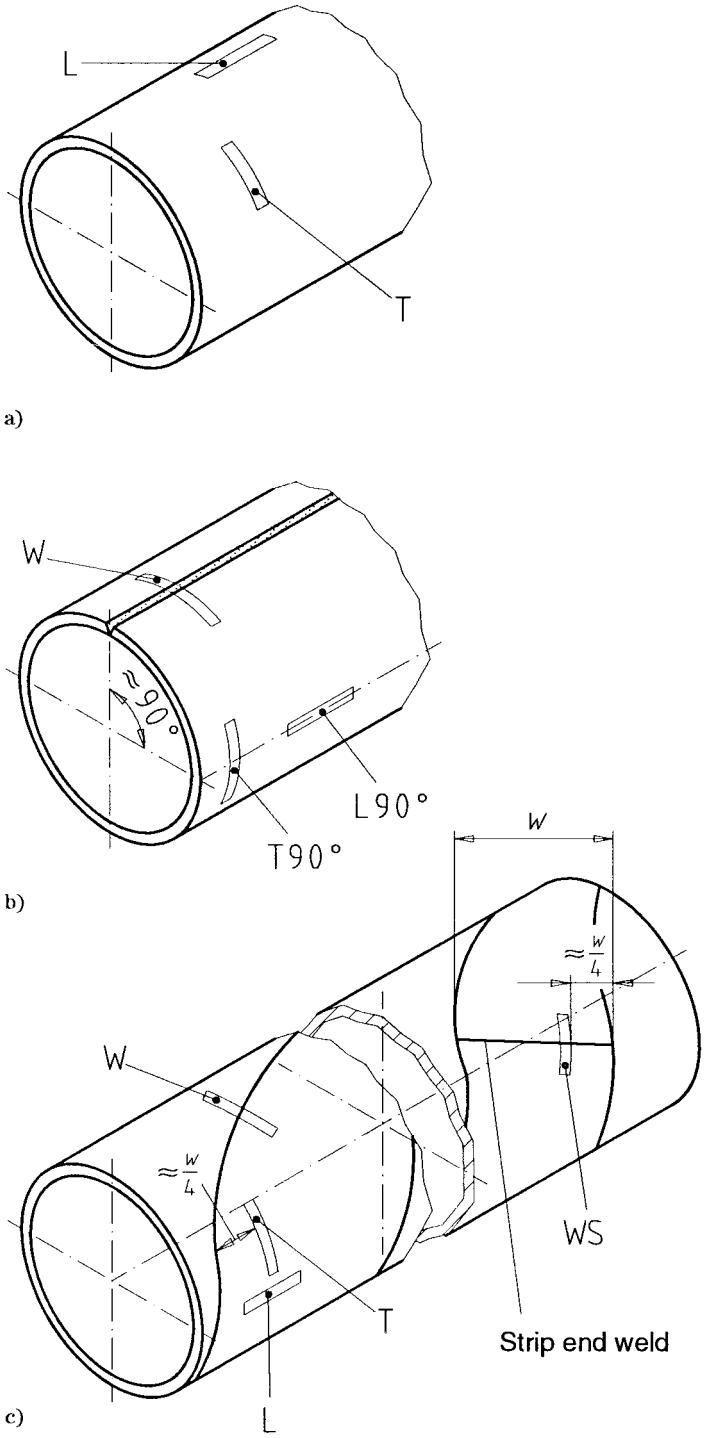
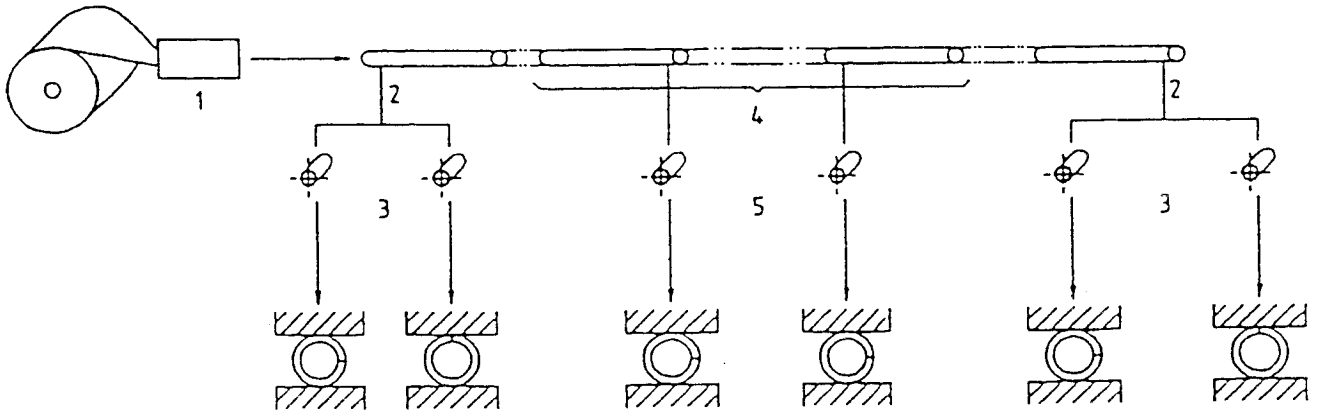


Figure 3. Sample position and explanation of the symbols applied in table 18 for specifying the test piece direction and position



Key

1 Welding

2 End of coil

3 Crop end, two samples

4 Weld stop

5 Two samples, one from each side of a weld stop

Figure 4. Flattening test — Sampling and testing (schematically) (See further details in **8.2.3.6.1**).

Table 18. Number, direction and location of the test pieces to be taken per sample for the mechanical tests

Type of pipe[1]		Test	Test pieces to be taken from	Outside diameter in mm			For further information see
				< 210	≥ 210 < 500	≥ 500	
				Number, direction and location of the test pieces (see explanation of the symbols in figure 3)			
Seamless (see figure 3a)		Tensile	pipe body	1L	1L[2]	1L[2]	**8.2.2.2.2**
		Charpy V-notch		3T	3T	3T	**8.2.2.2.3**
		Drop weight tear[3]		—	—	2T	**8.2.2.2.4**
Longitudinal seam (see figure 3b)	HFW, SAW and COW	Tensile	pipe body	1L90	1T90	1T90	**8.2.2.2.2**
		Charpy V-notch		3T90	3T90	3T90	**8.2.2.2.3**
		Drop weight[3]		—	—	2T90	**8.2.2.2.4**
		Tensile	seam[4]	—	1W	1W	**8.2.2.2.2**
		Charpy V-notch		3W	3W	3W	**8.2.2.2.3**
	SAW, COW	Bend	seam[4]	2W	2W	2W	**8.2.2.2.5**
	HFW	Flattening	See figure 4				**8.2.2.2.6**
Helical seam (see figure 3c)	SAW, COW	Tensile	pipe body	1L, *w*/4	1T, *w*/4	1T, *w*/4	**8.2.2.2.2**
		Charpy V-notch		3T, *w*/4	3T, *w*/4	3T, *w*/4	**8.2.2.2.3**
		Drop weight tear[3]		—	—	2T, *w*/4	**8.2.2.2.4**
		Tensile	seam	—	1W	1W	**8.2.2.2.2**
		Charpy V-notch		3W	3W	3W	**8.2.2.2.3**
		Bend		2W	2W	2W	**8.2.2.2.5**
		Tensile	strip end weld	—	1WS	1WS	**8.2.2.2.2**
		Charpy V-notch		3WS	3WS	3WS	**8.2.2.2.3**
		Bend		2WS	2WS	2WS	**8.2.2.2.5**

[1] HFW = High frequency welded; SAW = Submerged arc welded; COW = Combination welded.
[2] By agreement 1T instead of 1L.
[3] see table 6 and 7, footnote 4.
[4] If, by agreement (see **6.3**) pipes with two seams are delivered, both seams are to be subjected to the tests.

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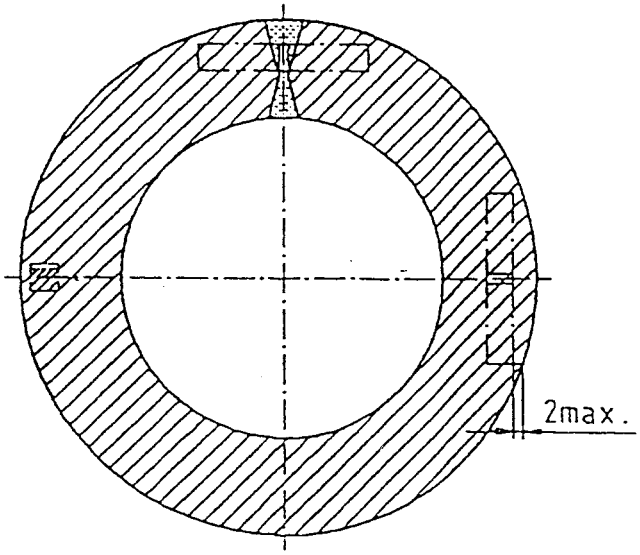
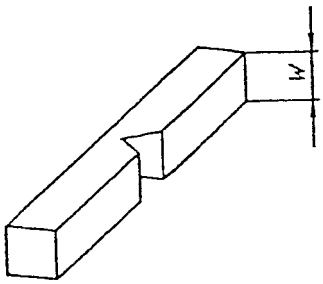


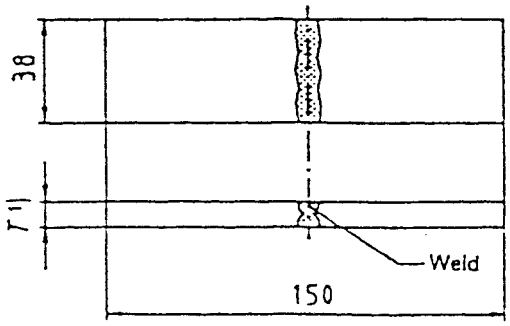
a) Position of test pieces (longitudinal, transverse, transverse to the weld)



b) Width of the test piece (including subsize test pieces) [5 mm $\leq w \leq$ 10 mm]

Dimensions in millimetres

Figure 5. Position and width of impact test pieces



Dimensions in millimetres

[1)] Unless machined test pieces (see explanation in **8.2.2.2.5**) are used.

Figure 6. Test piece for the bend test

8.2.2.2.6 *Test pieces for the flattening test*

The test pieces shall be taken in accordance with EN 10233. Minor surface imperfections may be removed by grinding.

8.2.2.3 *Samples for macrographic and metallographic tests*

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

8.2.3 ***Test methods***

8.2.3.1 *Chemical analysis (product analysis)*

The elements shall be determined in accordance with the methods considered in the corresponding European Standards. Spectrographic analysis is permitted.

In cases of dispute, the method to be used for product analysis shall be agreed.

8.2.3.2 *Tensile test*

8.2.3.2.1 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 $5{,}65\sqrt{S_o}$ where S_o is the initial cross sectional area of the gauge length. If other gauge lengths are used, the elongation referred to a gauge length of $5{,}65\sqrt{S_o}$ shall be determined in accordance with 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.

8.2.3.2.2 In the tensile test transverse to the weld only the tensile strength (R_m) shall be determined.

8.2.3.3 *Impact test*

8.2.3.3.1 The impact test shall be carried out at 0 °C in accordance with EN 10045-1.

NOTE. As long as existing national design codes specify testing temperatures for the impact and drop weight tear (DWT) tests different from those specified in this European Standard, the necessary deviations from this European Standard may be agreed (see the NOTE to the clause Introduction. However, the requirements of this European Standard are based on the principal that the impact and DWT tests are performed at the same temperature.

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8.2.3.3.2 Where test pieces with a width < 10 mm are used, in accordance with **8.2.2.2.3**, the measured impact energy (KV_p) and the cross sectional area of the test piece (S_p) in mm^2 measured under the notch shall be reported. For comparison with the requirements in tables 6 and 7 the measured energy shall be converted to the impact energy (KV) in joules (J) using the formula:

$$KV = \frac{8 \times 10 \times KV_p}{S_p}$$

8.2.3.4 *Drop weight tear (DWT) test*

The DWT test shall be carried out in accordance with prEN 10274. The test temperature shall be 0 °C. (However, see the note to **8.2.3.3.1**).

8.2.3.5 *Bend test*

8.2.3.5.1 The bend test shall be carried out in accordance with prEN 910. The mandrel dimension shall be as indicated in table 5 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.

8.2.3.5.2 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.

8.2.3.6 *Flattening test*

8.2.3.6.1 The flattening test shall be carried out in accordance with EN 10233. As indicated in figure 4 one of the two test pieces taken from both end-of-coil locations shall be tested with the weld at the 12 o'clock position whilst the remaining two test pieces shall be tested at the 3 o'clock position. Test pieces taken in the case of the weld stop shall be tested at 3 o'clock position only.

8.2.3.6.2 The flattening test shall be carried out in three steps with following acceptance criteria.

– Flatten to 2/3 of the original outside diameter; no weld opening shall occur.

– Flatten to 1/3 of the original outside diameter; no crack or break shall occur other than in the weld.

– Flatten until opposite walls of the pipe meet.

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

8.2.3.7 *Macrographic and metallographic examination*

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

Alternative methods, such as ultrasonic inspection, may be used by agreement. The ability of such equipment to detect misalignment shall be demonstrated. Where alternative methods are used, macrographic inspection shall be carried out at the beginning of the production of each pipe size (diameter and/or wall thickness).

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8.2.3.7.2 For HFW pipe with seam heat treatment it shall be verified by metallographic examination that the entire heat affected zone has been heat treated over the full wall thickness. In addition, a hardness test may be agreed. O

8.2.3.8 *Hydrostatic test*

8.2.3.8.1 The hydrostatic test pressure shall be calculated in accordance with **8.2.3.8.2** so that, referred to the specified minimum wall thickness of the pipe, a hoop stress of 95 % of the specified minimum yield strength for the appropriate steel grade (see table 5) is reached. Unless otherwise agreed, the hydrostatic test pressure shall in no case be greater than O

– 500 bar for outside diameter ≤ 406,4 mm;

– 250 bar for outside diameter > 406,4 mm.

NOTE. A higher hoop stress up to 100 % of the specified minimum yield strength may be agreed. However, plastic deformations may occur in such cases. O

8.2.3.8.2 The method of calculation for determining the hydrostatic test pressure necessary to reach a hoop stress of 95 % of the specified minimum yield strength depends on the equipment.

Consequently the manufacturer shall state in the inspection document which of the following methods (A or B) has been used.

Method A. In cases where the seal is made on the outside or inside diameter of the pipe the following formula shall apply:

$$p = \frac{20 \times S \times T_{min}}{D}$$

where:

p is the hydrostatic test pressure in bar;

D is the specified outside diameter in mm;

S is the stress in N/mm^2, equal to 95 % of the minimum yield strength specified for the steel grade concerned (see also the note in **8.2.3.8.1**);

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

Method B. In the case of sealing against the end face of the pipe by means of a ram a compressive longitudinal stress is produced. To take this into account the following formula shall apply:

$$p_1 = \frac{10\,S - \dfrac{P_R \times A_R}{A_p}}{\dfrac{D}{2T_{min}} - \dfrac{A_1}{A_p}}$$

where

p_1 is the hydrostatic test pressure in bar;

A_1 is the internal cross-sectional area of pipe in mm^2;

A_p is the cross-sectional area of pipe wall in mm^2;

A_R is the cross-sectional area of ram in mm^2;

D is the specified outside diameter in mm;

P_R is the internal pressure on end sealing ram in bar;

S is the stress in N/mm^2 equal to 95 % of the specified minimum yield strength for the steel grade concerned (see also the note in **8.2.3.8.1**);

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

8.2.3.8.3 The test pressure shall be held for not less than 10 seconds, and the pressure versus time shall be recorded in the case of pipes with diameters equal to or greater than 114,3 mm. This record shall be available for examination by the inspection representative.

8.2.3.9 *Visual examination*

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

– from each end for pipe outside diameters less than 610 mm

– over the entire internal surface for pipe outside diameters equal to or greater than 610 mm.

The examination shall be carried out under sufficient lighting conditions[6)] by trained personnel with satisfactory visual acuity to verify the conformity of the pipes with the requirements of **7.5**.

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 **7.5.8**), the hardness in this area shall be determined in accordance with EN 10003-1 or EN 10109-1. The choice of the test method is left to the discretion of the manufacturer. If dimensions and hardness exceed the acceptance criteria given in **7.5.8**, the hard spot shall be removed.

8.2.3.10 *Dimensional testing*

8.2.3.10.1 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. O

[6)] The light level should be of the order of 300 Lux.

8.2.3.10.2 The out-of-roundness (*0)* in percent shall be calculated by the formula:

$$0 = 100 \times \frac{D_{max} - D_{min}}{D}$$

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 9 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.

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

– in the case of longitudinally welded pipe with a template located transverse to the pipe axis :

– 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.

8.2.3.10.4 For the verification of other dimensional and geometrical requirements specified in **7.6** suitable methods shall be used. The methods to be used are
U left to the discretion of the manufacturer, unless otherwise agreed.

8.2.3.11 *Weighing*

Each length of pipe with outside diameter equal to or greater than 141,3 mm shall be weighed separately. Lengths of pipe with outside diameters smaller than 141,3 mm shall be weighed either individually or in convenient lots at the discretion of the manufacturer.

8.2.3.12 *Nondestructive testing*

For non-destructive testing see annex D.

8.2.4 ***Retests, sorting and reprocessing***

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

9 Marking of the pipes

9.1 General marking

9.1.1 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;

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

e) the mark of the inspection representative (Y);

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

Example:

X EN 10208-2 L360MB S Y Z

9.1.2 Unless die stamping is agreed (see **9.1.3**) the mandatory markings which shall be applied indelibly shall be as follows.

a) For pipe outside diameters less than or equal to 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 smaller than 406,4 mm outside diameter: paint stencilled on the outside surface starting at a point between 450 and 750 mm from one end of the pipe.

c) For welded pipe equal to or greater than 406,4 mm outside diameter: paint stencilled on the inside surface starting at a point no less than 150 mm from one end of the pipe.

9.1.3 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 O
than 100 °C) of plate/strip or pipe not subsequently heat treated is only permitted if especially agreed and, in this case, shall be done with rounded or blunt dies.

9.1.4 If a protective coating is applied, marking shall be readable after coating.

9.2 Special marking

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

10 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 O
required this shall be agreed at the time of enquiry and order.

Annex A (informative)
Correspondence with API steel grades

The table below gives the correspondence between the grades defined by this European Standard and similar grades in specification ANSI/API 5L (41st Edition) [2] based on a comparison of the yield strength. However, the grades shown as comparable may differ in other respects.

Seel grade in accordance with EN 10208-2	Steel grade in accordance with ANSI/API 5L
L245..	B
L290..	X 42
L360..	X 52
L415..	X 60
L450..	X 65
L485..	X 70
L555..	X 80

Annex B (normative)
Manufacturing procedure qualification

B.0 Introductory note

In special cases (e.g. first supply or new grades) the purchaser may, when ordering large quantities, ask for data demonstrating that the requirements specified in this European Standard can be met through the proposed manufacturing route. Where acceptable data from previous production is not available, e.g. in the case of new grades or new processing routes, the purchaser and manufacturer may agree qualification in accordance with **B.1** and/or **B.2**.

B.1 Characteristics of the manufacturing procedure

Before production commences the manufacturer shall supply the purchaser with information on the main characteristics of the manufacturing procedure. This specification shall include the following:

a) for all pipe:

– steelmaker;

– steel making and casting techniques;

– target chemistry;

– hydrostatic test procedure;

– non-destructive testing procedures for the pipe.

b) for welded pipe:

– plate or strip manufacturing method including heat treatment method;

– non-destructive testing procedures for the plate or strip;

– pipe forming procedures, including preparation of edges, control of alignment and shape;

– specification of the seam welding including repair welding procedure to be used together with previous qualification records for this procedure. This shall include sufficient information of the following kind:

for HFW pipe:

- mechanical test results from seam heat treated pipes made from thermomechanically rolled strip (including hardness tests on the heat affected zone);
- metallography;

and

for SAW and COW pipe:

- mechanical test results (including hardness test results on the heat affected zone);
- deposited weld metal analysis.

– Pipe heat treatment procedure where applicable including in-line heat treatment of the weld seam.

c) for seamless pipe:

– Pipe forming process;

– Pipe heat treatment procedure.

B.2 Manufacturing procedure qualification tests

For the qualification of the manufacturing procedure the tests specified in clause 8 shall be carried out at the beginning of the production. The frequency of testing is to be agreed. The purchaser may ask for characteristic data on other properties (e.g. weldability) of the product.

Annex C (normative)
Treatment of imperfections and defects disclosed by visual examination

C.1 Treatment of surface imperfections (see **7.5.3**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.

C.2 Treatment of dressable surface defects (see **7.5.3**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 **7.6.3.2**.

C.3 Treatment of non-dressable surface defects (see **7.5.3**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 **C.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.

C.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 IC 2.

After weld repair, the total area of the repair shall be ultrasonically inspected in accordance with **D.5.1.1** or radiographically inspected in accordance with **D.5.5**.

In addition after repair, each repaired pipe length shall be hydrostatically tested in accordance with **8.2.3.8**.

Annex D (normative)
Non-destructive testing

D.1 Scope

This annex specifies non-destructive testing (NDT) requirements and acceptance levels. A survey of the tests is given in table D.1.

D.2 General NDT requirements and acceptance criteria

D.2.1 *NDT personnel*

For NDT personnel see **6.1.2**.

D.2.2 *Timing of NDT operations*

Unless otherwise agreed, NDT of the weld seam of HFW pipe less than 200 mm outside diameter, and full body NDT of seamless pipe shall be carried out before or after the hydrostatic test. NDT of the weld seam of SAW and COW pipe, and HFW pipe equal to or greater than 200 mm outside diameter, shall be carried out after the hydrostatic test. U

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

D.2.3 *Residual magnetism at the pipe ends*

The residual magnetism at the ends of each pipe, in the direction parallel to the pipe axis, shall not exceed 30 G (3mT), see note below. Measurements for checking compliance with this requirement, prior to pipe despatch, shall be made at random within the manufacturer's plant on the end face/bevel of the pipe using a calibrated Hall effect gauss meter or equivalent equipment.

NOTE. This measurement may also be taken in Oersteds, where 30 G = 30 Oe (in air), due to equivalence between flux density and field strength in this case.

D.2.4 *Laminar imperfections at the pipe ends*

Laminar imperfections greater than 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 prEN 10246-17 shall be used. O

Table D.1 Survey on non-destructive tests

1	2	3	4		5
No.	**NDT operation**	**Test status[1)]**	**Type of test and requirement, acceptance level**		**Reference**
Seamless and welded pipe					
1	Residual magnetism at the pipe ends	m	Hall effects gauss meter or equivalent; 30 Gauss/Oersteds max,. random testing		**D.2.3**
2	Laminar imperfections at the pipe ends	o	Ultrasonic test prEN 10246-17, acceptance limit; 6 mm max. circumferentially		**D.2.4**
Seamless pipe					
3	Longitudinal imperfections (including the pipe ends, where applicable - see **D.2.5**)	m		Ultrasonic test prEN 10246-7, acceptance level U3/C or, by agreement, U2/C	**D.3.1**
			or	(by agreement for T < 10 mm) Flux leakage test pr EN 10246-5, acceptance level F3 or, by agreement, F2	**D.3.2**
High frequency welded pipe					
4	Longitudinal imperfections in the weld (including the pipe ends, where applicable - see **D.2.5**)	m		Ultrasonic test prEN 10246-7 or 10246-8, acceptance level U3/C or, by agreement, U2/C	**D.4.1.1**
			or	(by agreement for T < 10 mm) Flux leakage test prEN 10246-5, acceptance level F3 or, by agreement, F2	**D.4.1.2**a
			or	(by agreement for D < 250 mm; T < 6 mm; $\frac{T}{D} < 0{,}18$) Eddy current test prEN 10246-3, acceptance level E2	**D.4.1.2**b
5	Laminar imperfections in the pipe body	o		Ultrasonic test prEN 10246-15, acceptance level U2 or prEN 10246-14, acceptance level U2	**D.4.2**
6	Laminar imperfections on strip edges/area adjacent to weld seam	o		Ultrasonic test prEN 10246-15 or prEN 10246-16, acceptance level U2	**D.4.3**
Submerged arc welded/Combination welded pipe					
7	Longitudinal/transverse imperfections in the weld	m		Ultrasonic test prEN 10246-9, acceptance level U2/U2H or 'two lambda' calibration method (also for the strip end weld of helically welded pipe)	**D.5.1**
				Radiographic inspection prEN 10246-10, image quality class R1, acceptance limits as per **D.5.5**, for T–joints of helically welded pipe	**D.5.1.2**
8	Laminar imperfections in the pipe body	o		Ultrasonic test prEN 10246-15, acceptance level U2	**D.5.2**
9	Laminar imperfections on strip or plate edges/area adjacent to the weld seam	o		Ultrasonic test prEN 10246-15 or prEN 10246-16, acceptance level U2	**D.5.3**
10	NDT of the weld seam at pipe ends (untested ends)/repaired areas	m		Ultrasonic test prEN 10246-9 to requirements of **D.5.1.1** on longitudinal imperfections, acceptance level U2/U2H	**D.5.4, D.5.5**
			or	(unless otherwise agreed) Radiographic inspection prEN 10246-10, image quality class R1 (see **D.5.5**) on longitudinal imperfections	
			and	Ultrasonic test prEN 10246-9 or radiographic test prEN 10246-10 on transverse imperfections, acceptance limits as per **D.5.4**.	

[1)] m = mandatory, o = optional test for mandatory requirement.

D.2.5 ***Untested pipe ends***

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

a) the untested ends shall be cropped off; or

b) in the case of seamless or HFW 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 part of EN 10208. 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 **D.5.4** shall apply.

D.2.6 ***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 European Standard. Repair by welding is permitted only on the weld of non-cold-expanded SAW and COW pipe, provided that the provisions of C.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.

D.3 NDT of seamless pipe

D.3.1 Seamless pipes shall be ultrasonically inspected for the detection of longitudinal imperfections in accordance with prEN 10246-7 to acceptance level U3/C or, by agreement, U2/C. O

O **D.3.2** Alternatively, by agreement, seamless pipes, with a specified wall thickness less than 10 mm, shall be inspected using the flux leakage method in accordance with prEN 10246-5 to acceptance level F3 or, by agreement, F2. O

D.4 NDT of HFW pipe

D.4.1 ***Non-destructive testing of the weld seam***

D.4.1.1 The full length of the weld seam of high frequency welded pipes shall be ultrasonically inspected for the detection of longitudinal imperfections, at the discretion of the manufacturer, in accordance with prEN 10246-7 or prEN 10246-8 to acceptance level U3/C or U3, respectively. By agreement, acceptance level U2/C or U2 respectively may be used. O

D.4.1.2 Alternatively, by agreement, the full length of the weld seam shall be inspected using one of the following methods: O

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

The flux leakage method in accordance with prEN 10246-5 to acceptance level F3 or, by agreement, F2.

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

The eddy current method (concentric or segment coil technique) in accordance with prEN 10246-3 to acceptance level E2.

D.4.2 ***Laminar imperfections in the pipe body***

Individual laminations or a lamination population density exceeding the acceptance limit U2 in prEN 10246-15 or U2 in prEN 10246-14 are not permitted within the pipe body.

The verification of compliance with this requirement shall only be carried out by agreement. In such a case an ultrasonic test conducted in the pipe mill, at the discretion of the manufacturer either in the flat form prior to welding in accordance with prEN 10246-15 to acceptance limit U2 or in the as- welded pipe form in accordance with prEN 10246-14 to acceptance level U2, shall be used. O

D.4.3 ***Laminar imperfections on the strip edges/areas adjacent to the weld seam***

Individual laminations or a lamination population density exceeding the U2 acceptance limits in prEN 10246-15 and prEN 10246-16 are not permitted within a 15 mm wide zone along both longitudinal strip edges/areas adjacent to the weld seam.

The verification of compliance with this requirement by means of an ultrasonic test conducted in the pipe mill, at the discretion of the manufacturer either prior to welding of the strip edges in accordance with prEN 10246-15 to acceptance limit U2 or after welding on the area adjacent to the weld seam in accordance with prEN 10246-16 to acceptance limit U2 shall only be carried out by agreement. O

D.5 NDT of SAW and COW pipe

D.5.1 ***Ultrasonic testing for longitudinal and transverse imperfections in the weld seam***

D.5.1.1 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 prEN 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, O 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:

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

(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 **D.5.4** to retest suspect areas.

D.5.1.2 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 **D.5.1.1**.

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 **D.5.5** and the acceptance limits given there.

D.5.2 ***Laminar imperfections in the pipe body***

Individual laminations or a lamination population density exceeding the U2 acceptance limits given in prEN 10246-15 are not permitted within the pipe body.

The verification of compliance with this requirement O shall only be carried out by agreement. In such a case an ultrasonic test conducted in either the plate mill or the pipe mill and in the latter case, at the discretion of the manufacturer, in either the flat form or the pipe form, in accordance with prEN 10246-15 to acceptance level U2 shall be used.

D.5.3 ***Laminar imperfections on the strip or plate edges/area adjacent to the weld seam***

Individual laminations or a lamination population density exceeding the U2 acceptance limits given in prEN 10246-15 and prEN 10246-16 are not permitted within a 15 mm wide zone along both longitudinal strip edges/areas adjacent to the weld seam, and, in the case of helically welded pipe, the transverse strip edges/areas adjacent to the butt weld.

The verification of compliance with this requirement O shall only be carried out by agreement. In such a case an ultrasonic test conducted, at the discretion of the manufacturer, either in the plate mill or the pipe mill prior to welding of the strip/plate edges in accordance with prEN 10246-15 to acceptance limit U2 or in the pipe mill after welding on the areas adjacent to the weld seam in accordance with prEN 10246-16 to acceptance limit U2 shall be used.

D.5.4 ***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 **C.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 **D.5.1.1** or, unless otherwise agreed, radiographic U inspection in accordance with **D.5.5**;

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 **D.5.1.1** or radiographic inspection in accordance with **D.5.5**.

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

D.5.5 ***Radiographic inspection of the weld seam***

D.5.5.1 Where applicable, radiographic inspection of the weld seam shall be conducted in accordance with prEN 10246-10 to image quality class R1, with the conditions given in a) to c) below.

a) The sensitivity requirements, given in table D.2 established on the base material shall be verified by use of the ISO Wire Penetrameter according to ISO 1027 or, if so agreed, by use of an O 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 O 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 D.2. Sensitivity requirements for the radiographic inspection, image quality class R1, in accordance with prEN 10246-10

Wall thickness		Visibility required	
above	up to	of the hole with a diameter	of the wire with a diameter
mm		mm	mm
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

D.5.5.2 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 **C.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.

Annex E (informative)

Bibliography

[1] ISO/DIS 3183-2: *Petroleum and natural gas industries — Steel pipe for pipelines — Technical delivery conditions. Part 2: Pipes of requirement class B*

[2] American National Standard ANSI/API Spec 5L: *Specification for line pipe;* 41st edition, April 1, 1995

[3] Demofonti, G.; Jones, D. G.; Pistone, G.; Re, G.; Vogt, G.: *EPRG recommendation for crack arrest toughness for high strength line pipe steels.*

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[To be ordered from: American Gas Association, Order and Billing Department, 1515 Wilson Boulevard, Arlington, Virginia 22209 USA]

List of references

See national foreword.

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