INTERNATIONAL STANDARD

**ISO 3183**

Fourth edition
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# Petroleum and natural gas industries — Steel pipe for pipeline transportation systems

*Industries du pétrole et du gaz naturel — Tubes en acier pour les systèmes de transport par conduites*

Reference number
ISO 3183:2019(E)



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# Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

The committee responsible for this document is Technical Committee ISO/TC 67, *Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries*, Subcommittee SC 2, *Pipeline transportation systems*.

This fourth edition cancels and replaces the third edition (ISO 3183:2012), which has been technically revised. It also incorporates the Amendment (ISO 3183:2012/Amd.1:2017).

This document supplements API Spec 5L, 46$^{th}$ edition (2018).

The technical requirements of this document and API Spec 5L used to be identical (except for the inclusion of Annex M in the ISO publication). In the meantime API Spec 5L has been technically revised as API Spec 5L, 46$^{th}$ edition (2018). The purpose of this document is to bring it up to date, by referencing the current edition of API Spec 5L and including supplementary content.

The main changes compared to the previous edition are as follows:

— Technical changes now incorporated by normative reference to API Spec 5L have been made in the API Spec 5L subclauses addressing

  — weld seams (API Spec 5L, 8.8.2 clarifies heat treatment),

  — tolerances for straightness (API Spec 5L, 9.11.3.4b and J.6.4 pipe end tolerances tightened),

  — end squareness (API Spec 5L, 9.12.6 defined in detail),

  — impact test pieces (API Spec 5L, Table 22 test piece size table corrected),

  — location of hardness tests (API Spec 5L, Figures H.1 and J.1 weld centre line for HFW detailed),

  — welded jointers (API Spec 5L, Annex M fit up and geometry, marking & NDT addressed),

  — a new annex N has been added for PSL 2 pipe ordered for applications requiring longitudinal plastic strain capacity, and

 

— changes on order of annexes.

— Annex M of the previous edition of this document, i.e. ISO 3183:2012/Amd 1:2017, for PSL 2 pipe ordered for European onshore natural gas transmission pipelines, is now provided as Annex A.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

# Introduction

This document was originally developed by harmonizing the requirements of API Spec 5L, 44th edition (2007) and the second edition of this document, i.e. ISO 3183:2007. This continued to be the case for the third edition of this document, i.e. ISO 3183:2012 and API Spec 5L, 45th edition (2012), in which clarification and additional technical requirements were added.

# Petroleum and natural gas industries — Steel pipe for pipeline transportation systems

## 1 Scope

This document specifies requirements for the manufacture of two product specification levels (PSL 1 and PSL 2) of seamless and welded steel pipes for use in pipeline transportation systems in the petroleum and natural gas industries.

This document supplements API Spec 5L, 46th edition (2018), the requirements of which are applicable with the exceptions specified in this document.

This document is not applicable to cast pipe.

## 2 Normative references

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

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

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

ISO 5173, *Destructive tests on welds in metallic materials — Bend tests*

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

ISO 9712, *Non-destructive testing — Qualification and certification of NDT personnel*

ISO 10893-2:2011, *Non-destructive testing of steel tubes — Part 2: Automated eddy current testing of seamless and welded (except submerged arc-welded) steel tubes for the detection of imperfections*

ISO 10893-3:2011, *Non-destructive testing of steel tubes — Part 3: Automated full peripheral flux leakage testing of seamless and welded (except submerged arc-welded) ferromagnetic steel tubes for the detection of longitudinal and/or transverse imperfections*

ISO 10893-6:2019, *Non-destructive testing of steel tubes — Part 6: Radiographic testing of the weld seam of welded steel tubes for the detection of imperfections*

ISO 10893-7:2019, *Non-destructive testing of steel tubes — Part 7: Digital radiographic testing of the weld seam of welded steel tubes for the detection of imperfections*

ISO 10893-8:2011, *Non-destructive testing of steel tubes — Part 8: Automated ultrasonic testing of seamless and welded steel tubes for the detection of laminar imperfections*

ISO 10893-9:2011, *Non-destructive testing of steel tubes — Part 9: Automated ultrasonic testing for the detection of laminar imperfections in strip/plate used for the manufacture of welded steel tubes*

ISO 10893-10:2011, *Non-destructive testing of steel tubes — Part 10: Automated full peripheral ultrasonic testing of seamless and welded (except submerged arc-welded) steel tubes for the detection of longitudinal and/or transverse imperfections*

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

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

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

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

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

API Spec 5L, 46th edition (2018), *Specification for Line Pipe*

## 3 Terms and definitions

For the purposes of this document, the terms and definitions given in API Spec 5L, 46th edition (2018) apply.

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

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

## 4 Supplements to API Spec 5L, 46th edition (2018)

### 4.1 General requirements

The requirements specified in API Spec 5L, 46th edition (2018) shall apply, with the supplements and exceptions specified in 4.2 to 4.4.

Pipe manufactured in accordance with this document can be named "ISO 3183 pipe" and may be marked in accordance with 4.4.2. If no exceptions to API Spec 5L are taken and the pipe therefore conforms to both standards, the pipe can be named "API 5L pipe" and may be marked in accordance with 4.4.3.

### 4.2 PSL 2 pipe for European onshore natural gas transmission pipelines

Annex A shall be applied for PSL 2 pipe ordered for European onshore natural gas transmission pipelines.

### 4.3 Information to be supplied by the purchaser

In addition to the requirements of API Spec 5L, 46th edition (2018), Clause 7, the purchase order for pipe manufactured according to this document shall also include the following information:

a) confirmation if Annex A of this document, i.e. ISO 3183:2019, is applicable;

b) marking requirements according to 4.4.

### 4.4 Marking

#### 4.4.1 General

The requirements specified in API Spec 5L, 46th edition (2018) shall apply together with the exceptions specified in 4.4.2 to 4.4.3.

This document describes two marking options (see 4.4.2 and 4.4.3). Additional markings, as desired by the manufacturer or as specified in the purchase order, may be applied, provided that they do not interrupt the sequence of the required markings per 4.4.2 or 4.4.3. If additional markings are used, these markings shall be located after the end of the required marking sequence or as a separate marking at some other location on the pipe.

### 4.4.2 Pipe marked as ISO 3183

Pipe markings for "ISO 3183 pipe" shall include the following information, as applicable:

a) Name or mark of the manufacturer of the pipe (X).

b) "ISO 3183" shall be marked if the product is in conformance with this document. Products in conformance with multiple compatible standards may be marked with the name of each standard. If Annex A is applicable and certification to API Spec 5L is required, then it is advised to review the requirements of the body of Annex A with the body of API Spec 5L to ensure that all requirements are met.

c) Specified outside diameter.

d) Specified wall thickness.

e) Steel grade (steel name) as detailed in API Spec 5L, 46th edition (2018), Tables 1, H.1, J.1 or N.1, and Table A.1 of this document, whichever is applicable. If agreed, both corresponding SI and USC steel grades may be marked on the pipe with the corresponding steel grade marked immediately after the order item steel grade. Where Annex A is specified, the steel grade includes the suffix E, as shown in Tables A.1 and A.2.

f) Product specification level designation followed by the letter G, if API Spec 5L, 46th edition (2018), Annex G is applicable (see API Spec 5L, 46th edition (2018), G.5.1 and see Examples 7 and 8 below).

g) Type of pipe [see API Spec 5L, 46th edition (2018), Table 2].

h) Mark of the purchaser's inspection representative (Y), if applicable.

i) An identification number (Z), which permits the correlation of the product or delivery unit (e.g. bundled pipe) with the related inspection document, if applicable.

j) If the specified hydrostatic test pressure is higher than the test pressure specified in API Spec 5L, 46th edition (2018), Table 24 or Table 25 as applicable, or if it exceeds the pressures stated in API Spec 5L, 46th edition (2018), notes a, b, or c in Table 26 if applicable, the word TESTED shall be marked at the end of the marking immediately followed by the specified test pressure MPa if ordered to SI units or in psi if ordered to USC units.

EXAMPLE 1 For SI units: X ISO 3183 508 12,7 L360M PSL 2 SAWL Y Z.

EXAMPLE 2 For USC units: X ISO 3183 20 0.500 X52M PSL 2 SAWL Y Z.

EXAMPLE 3 If pipe also meets the requirements of compatible standard ABC (inserted as agreed), for SI units: X ISO 3183/ABC 508 12,7 L360M PSL 2 SAWL Y Z.

EXAMPLE 4 If pipe also meets the requirements of compatible standard ABC (inserted as agreed), for USC units: X ISO 3183/ABC 20 0.500 X52M PSL 2 SAWL Y Z.

EXAMPLE 5 If hydrotest pressure differs from the standard pressure, for SI units tested to 17,5 MPa: X ISO 3183 508 12,7 L360M PSL 2 SAWL Y Z TESTED 17,5.

EXAMPLE 6 If hydrotest pressure differs from the standard pressure, for USC units tested to 2 540 psi: X ISO 3183 20 0.500 X52M PSL 2 SAWL Y Z TESTED 2540.

EXAMPLE 7 For SI units with both corresponding steel grades marked and application of API Spec 5L, 46th edition (2018), Annex G indicated: X ISO 3183 508 12,7 L360M X52M PSL2G SAWL Y Z.

EXAMPLE 8 For USC units with both corresponding steel grades marked and application of API Spec 5L), Annex G indicated: X ISO 3183 20 0.500 X52M L360M PSL2G SAWL Y Z.

EXAMPLE 9 If pipe meets the requirements of Annex A and also compatible standard ABC (inserted as agreed), for SI units: X ISO 3183/ABC 508 12,7 L360ME PSL 2 SAWL Y Z.

EXAMPLE 10 If pipe meets the requirements of Annex A and also compatible standard ABC (inserted as agreed), for USC units: X ISO 3183/ABC 20 0.500 X52ME PSL 2 SAWL Y Z.

NOTE For specified outside diameter markings in USC units, it is not necessary to include the ending zero digits to the right of the decimal sign.

### 4.4.3 Pipe marked as API 5L (with monogram option) and the additional marking of "ISO 3183"

The additional marking of "ISO 3183" to API 5L marking shall be in accordance with API Spec 5L, 46th edition (2018), 11.2 and 11.1.4. This marking shall be as illustrated in Examples 1 to 4 below.

If dual certification with Annex A is required, pipe shall meet the requirements of both standards. It is advised to review the requirements of Annex A with the requirements of API Spec 5L to ensure that all requirements are met.

EXAMPLE 1 For SI units where Annex A is not specified: X API Spec 5L-#### (API) (MO-YR)/ISO 3183 508 12.7 L360M PSL 2 SAWL Y Z.

EXAMPLE 2 For USC units where Annex A is not specified: X API Spec 5L-#### (API) (MO-YR)/ISO 3183 20 0.500 X52M PSL 2 SAWL Y Z.

EXAMPLE 3 For SI units, where Annex A is specified: X API Spec 5L-#### (API) (MO-YR) 508 12.7 L360M PSL2 SAWL Y Z ISO 3183 L360ME

EXAMPLE 4 For USC units, where Annex A is specified: X API Spec 5L-#### (API) (MO-YR) 20 0.500 X52M PSL2 SAWL Y Z ISO 3183 X52ME

# Annex A
(normative)

# PSL 2 pipe ordered for European onshore natural gas transmission pipelines

## A.1 General

This annex specifies additional provisions that apply for API 5L PSL 2 pipe for European onshore natural gas transmission pipelines. The chemical elements of the composition could be outside the limits of API Spec 5L and therefore ISO 3183 pipe in accordance with this annex conforms to ISO 3183 only. The steel grade designation concludes with the letter "E".

NOTE The chemistry limits in this annex could be different than those in API Spec 5L. Users of this document are cautioned that pipe manufactured with chemistry not in accordance with API Spec 5L, cannot be certified as conforming with API Spec 5L.

## A.2 Additional information to be supplied by the purchaser

In addition to specifying API Spec 5L, 46$^{th}$ edition (2018), 7.1 items a) to g) and 7.2 items a) to c), the purchaser shall specify in the purchase order which of the following provisions apply for the specific order item:

a) items that are subject to mandatory agreement, if applicable:

   1) chemical composition for pipe with $t$ > 25,0 mm (0.984 in) (see A.4.1.2);

   2) carbon equivalent limit for Grades L415NE (X60NE) and L555QE (X80QE) (see Table A.1);

   3) tensile properties for pipe with $t$ > 25,0 mm (0.984 in) (see A.4.2.1);

   4) minimum average CVN energy (see A.4.4.1);

   5) diameter and out-of-roundness tolerances for the ends of SMLS pipe with $t$ > 25,0 mm (0.984 in) (see Table A.3, footnote b);

   6) diameter and out-of-roundness tolerances for pipe with $D$ > 1 422 mm (56.000 in) (see Table A.3);

   7) type of inspection certificate (see A.7.1.1);

   8) party issuing the inspection certificate (see A.7.1.1);

b) items that apply as prescribed, unless otherwise agreed:

   1) steel casting method for coil or plate used for the manufacture of welded pipe (see A.3.3.2.1);

   2) application of diameter tolerance to the outside diameter for pipe with $D$ ≥ 610 mm (24.000 in) (see Table A.3, footnote d);

   3) timing of NDT of HFW weld seam with outside diameter $D$ < 219,1 mm (8.625 in) (see A.7.5.3);

4) timing of NDT of full body seamless pipe (see A.7.5.3);

c) items that apply, if agreed:

1) approval of the quality system (see A.3.1);

2) manufacturing procedure qualification [see A.3.1 and API Spec 5L), Annex B];

3) another steelmaking process (see A.3.2);

4) supply of helical seam pipe containing coil/plate end welds (see A.3.3.2.3);

5) chemical composition limits (see Table A.1, footnotes a, f and j);

6) temperature for the CVN impact test for the pipe body (see A.4.4.1);

7) temperature for the CVN impact test for the pipe weld and heat affected zone (see A.4.4.2);

8) use of inside diameter to determine diameter and out-of-roundness tolerances for pipe with $D \geq 219{,}1$ mm (8.625 in) (see Table A.3, footnote c);

9) pipe body DWT testing frequency (see A.7.2 and Table A.7);

10) hardness testing frequency (see A.7.2 and Table A.7);

11) orientation of tensile test piece (see Table A.8, footnote c);

12) ultrasonic inspection for laminar imperfections of pipe body and ends (see Table A.10, numbers 2, 5, 6, 8, 9);

13) flux leakage testing for longitudinal imperfections in seamless pipe (see Table A.10);

14) flux leakage, or eddy current testing for longitudinal imperfections in HFW pipe (see Table A.10);

15) alternate acceptance level for ultrasonic (U2) or flux leakage (F2) testing of longitudinal imperfections (see Table A.10);

16) use of fixed-depth notches for equipment standardization [see API Spec 5L, 46$^{th}$ edition (2018), K.5.1.1 c)];

17) radiographic inspection of the pipe ends (non-inspected pipe ends) and repaired areas on longitudinal imperfections [see Table A.10 and API Spec 5L, 46$^{th}$ edition (2018), K.5.3 a)];

18) use of hole penetrameter instead of ISO wire penetrameter (see A.7.5.6.2);

19) use of digital radiographic inspection (see A.7.5.6.3).

## A.3 Manufacturing

### A.3.1 Manufacturing procedure

The pipe manufacturer and the stockist, where products are supplied through a stockist, shall operate a quality system. If agreed, the quality system shall be approved by the purchaser.

NOTE The term “stockist” is equivalent to, and interchangeable with, the term “distributor”.

If agreed, the manufacturing procedure shall be qualified in accordance with API Spec 5L, 46$^{th}$ edition (2018), Annex B.

### A.3.2 Steel making

The steel shall be made to a clean steel practice, using either the basic oxygen steel-making process or the electric-arc furnace steel-making process, and shall be fully killed and be made according to fine grain practice.

Other steelmaking processes may be used by agreement.

### A.3.3 Pipe manufacturing

#### A.3.3.1 SMLS pipe

SMLS pipe shall be manufactured from continuously (strand) cast or ingot steel. If the process of cold finishing followed by normalizing (N) or quench and tempering (Q) is used, this shall be stated in the inspection document. The as-rolled (R) pipe forming processes as described in API Spec 5L, 46$^{th}$ edition (2018), Table 3, shall not be used.

#### A.3.3.2 Welded pipe

**A.3.3.2.1** Unless otherwise agreed, coil and plate used for the manufacture of welded pipe shall be rolled from continuously (strand) cast or pressure cast slabs. The pipe shall be SAWH, SAWL, COWH, COWL, or HFW in the N or M delivery conditions only as described in API Spec 5L, 46$^{th}$ edition (2018), Table 3.

For HFW pipe from hot-rolled coil, the pipe forming process 'cold forming followed by thermomechanical forming' as described in API Spec 5L, 46$^{th}$ edition (2018), Table 3, shall not be used.

**A.3.3.2.2** For HFW pipe, the abutting edges of the coil or plate shall be sheared, milled or machined before welding such that the edges are clean and free of damage.

**A.3.3.2.3** If agreed, for helical seam pipe made from coil or plate, pipe containing coil/plate end welds may be delivered, provided that such welds are located at least 300 mm (11.8 in) from the pipe end and such welds have been subjected to the same non-destructive testing that is required in A.7.5 for coil/plate edges and welds.

## A.4 Acceptance criteria

### A.4.1 Chemical composition

**A.4.1.1** For pipe with $t \leq 25{,}0$ mm (0.984 in), the chemical composition for standard grades shall be as given in Table A.1. Intermediate grades are not allowed. The steel name shall be as given in Table A.1 and consists of an alphanumeric designation that identifies the strength level, followed by a suffix that consists of a letter (N, Q or M) that identifies the delivery condition and a second letter (E) that identifies the pipe as manufactured to the requirements of this annex.

**A.4.1.2** For pipe with $t$ > 25,0 mm (0.984 in), the chemical composition shall be as agreed, with the requirements given in Table A.1 being amended as appropriate.

**Table A.1 — Chemical composition for pipe with $t \leq 25{,}0$ mm (0.984 in)**

| Steel grade | Mass fraction, based upon heat and product analyses[a] % maximum | | | | | | | | | Carbon equivalent[c] % max | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | C[b] | Si | Mn[b] | P | S | V | Nb | Ti | Other | $CE_{IIW}$ | $CE_{Pcm}$ |
| **Seamless and welded pipe** | | | | | | | | | | | |
| L245NE or BNE | 0,18 | 0,40 | 1,20 | 0,025 | 0,015 | — | — | — | d | 0,42 | 0,25 |
| L290NE or X42NE | 0,19 | 0,40 | 1,20 | 0,025 | 0,015 | 0,06 | 0,05 | 0,04 | d | 0,42 | 0,25 |
| L360NE or X52NE | 0,22 | 0,45 | 1,40 | 0,025 | 0,015 | 0,10 | 0,05 | 0,04 | d,e | 0,43 | 0,25 |
| L415NE or X60NE | 0,23 | 0,45[j] | 1,40[j] | 0,025 | 0,015 | 0,10[j] | 0,05[j] | 0,04[j] | d,e,f | As agreed | As agreed |
| **Seamless pipe** | | | | | | | | | | | |
| L360QE or X52QE | 0,18 | 0,45 | 1,50 | 0,025 | 0,015 | 0,05 | 0,05 | 0,04 | d | 0,42 | 0,25 |
| L415QE or X60QE | 0,18 | 0,45 | 1,70 | 0,025 | 0,015 | 0,09 | 0,06 | 0,05 | d,e,f | 0,43 | 0,25 |
| L450QE or X65QE | 0,18 | 0,45 | 1,70 | 0,025 | 0,015 | 0,10 | 0,06 | 0,07 | d,e,f | 0,43 | 0,25 |
| L485QE or X70QE | 0,18 | 0,45 | 1,80 | 0,025 | 0,015 | 0,11 | 0,06 | 0,07 | d,e,f | 0,43 | 0,25 |
| L555QE or X80QE | 0,18 | 0,45 | 1,90 | 0,025 | 0,015 | 0,11 | 0,07 | 0,07 | e,g | As agreed | As agreed |
| **Welded pipe** | | | | | | | | | | | |
| L245ME or BME | 0,18 | 0,45 | 1,20 | 0,025 | 0,015 | 0,05 | 0,05 | – | d | 0,40 | 0,25 |
| L290ME or X42ME | 0,18 | 0,45 | 1,30 | 0,025 | 0,015 | 0,05 | 0,05 | – | d | 0,40 | 0,25 |
| L360ME or X52ME | 0,18 | 0,45 | 1,40 | 0,025 | 0,015 | 0,06 | 0,06 | 0,05 | d | 0,41 | 0,25 |
| L415ME or X60ME | 0,12[j] | 0,45 | 1,60 | 0,025 | 0,015 | 0,09 | 0,08[i] | 0,07 | e,h | 0,42 | 0,25 |
| L450ME or X65ME | 0,12[j] | 0,45 | 1,60 | 0,025 | 0,015 | 0,09 | 0,08[i] | 0,07 | e,h | 0,43 | 0,25 |
| L485ME or X70ME | 0,12[j] | 0,45 | 1,70 | 0,025 | 0,015 | 0,11 | 0,08[i] | 0,07 | e,h | 0,43 | 0,25 |
| L555ME or X80ME | 0,12[j] | 0,45 | 1,80 | 0,025 | 0,015 | 0,11 | 0,08[i] | 0,07 | e,h | 0,43[j] | 0,25[j] |

[a] Elements not mentioned in this table shall not be added intentionally without purchaser's approval except for elements that may be added for deoxidation and finishing of the heat.

[b] For each reduction of 0,01 % below the specified maximum for C, an increase of 0,05 % above the specified maximum for Mn is permissible, up to a maximum increase of 0,20 %.

[c] Based upon product analysis [see API Spec 5L, 46th edition (2018)], 9.2.4 and 9.2.5). The $CE_{IIW}$ limits apply if C > 0,12 % and the $CE_{Pcm}$ limits apply if C ≤ 0,12 %.

[d] 0,015 % ≤ $Al_{total}$ ≤ 0,060 %; N ≤ 0,012 %; Al/N ≥ 2:1, Cu ≤ 0,25 %; Ni ≤ 0,30 %; Cr ≤ 0,30 %; Mo ≤ 0,10 %.

[e] V + Nb + Ti ≤ 0,15 %.

[f] If agreed, Mo ≤ 0,35 %.

[g] 0,015 % ≤ $Al_{total}$ ≤ 0,060 %; N ≤ 0,012 %; Al/N ≥ 2:1, Cu ≤ 0,25 %; Ni ≤ 0,60 %; Cr ≤ 0,50 %; Mo ≤ 0,50 %.

[h] 0,015 % ≤ $Al_{total}$ ≤ 0,060 %; N ≤ 0,012 %; Al/N ≥ 2:1, Cu ≤ 0,50 %; Ni ≤ 0,50 %; Cr ≤ 0,30 %; Mo ≤ 0,35 %.

[i] Use of higher Nb levels shall meet the following formula: Nb + C ≤ 0,20 %.

[j] Unless otherwise agreed.

### A.4.2 Tensile properties

**A.4.2.1** The tensile properties shall be as given in Table A.2. For pipe with $t$ > 25,0 mm (0.984 in) up to 40 mm (1.575 in), the tensile properties shall be as agreed, with the requirements given in Table A.2 being amended as appropriate.

**Table A.2 — Requirements for the results of tensile test $t \leq 25{,}0$ mm (0.984 in)**

| Steel grade | Pipe body of SMLS and welded pipes | | | | | | Weld seam of HFW, SAW and COW pipes |
|---|---|---|---|---|---|---|---|
| | Yield strength $R_{t0,5}$ MPa (psi) | | Tensile strength $R_m$ MPa (psi) | | Ratio $R_{t0,5}/R_m$ | Elongation[a] $A_f$ % | Tensile strength $R_m$ MPa (psi) |
| | min | max | min | max | max | min | min |
| L245NE or BNE | 245 (35 500) | 440 (63 800) | 415 (60 200) | 655 (95 000) | 0,80 | 22 | 415 (60 200) |
| L245ME or BME | 245 (35 500) | 440 (63 800) | 415 (60 200) | 655 (95 000) | 0,85 | 22 | 415 (60 200) |
| L290NE or X42NE<br>L290ME or X42ME | 290 (42 100) | 440 (63 800) | 415 (60 200) | 655 (95 000) | 0,85 | 21 | 415 (60 200) |
| L360NE or X52NE<br>L360ME or X52ME | 360 (52 200) | 510 (74 000) | 460 (66 700) | 760 (110 200) | 0,85 | 20 | 460 (66 700) |
| L360QE or X52QE | 360 (52 200) | 510 (74 000) | 460 (66 700) | 760 (110 200) | 0,88 | 20 | 460 (66 700) |
| L415NE or X60NE<br>L415ME or X60ME | 415 (60 200) | 565 (81 900) | 520 (75 400) | 760 (110 200) | 0,85 | 18 | 520 (75 400) |
| L415QE or X60QE | 415 (60 200) | 565 (81 900) | 520 (75 400) | 760 (110 200) | 0,88 | 18 | 520 (75 400) |
| L450QE or X65QE | 450 (65 300) | 570 (82 700) | 535 (77 600) | 760 (110 200) | 0,90 | 18 | 535 (77 600) |
| L450ME or X65ME | 450 (65 300) | 570 (82 700) | 535 (77 600) | 760 (110 200) | 0,87 | 18 | 535 (77 600) |
| L485QE or X70QE<br>L485ME or X70ME | 485 (70 300) | 605 (92 100) | 570 (82 700) | 760 (110 200) | 0,90 | 18 | 570 (82 700) |
| L555QE or X80QE<br>L555ME or X80ME | 555 (79 800) | 675 (97 900) | 625 (90 600) | 825 (110 200) | 0,90 | 18 | 625 (90 600) |

[a] These values apply to transverse test pieces taken from the pipe body. When longitudinal test pieces are tested [see API Spec 5L, 46th edition (2018), Table 20], the values of elongation shall be 2 units higher.

### A.4.3 Hydrostatic test

Each length of pipe shall withstand the test without showing leakage or visible deformation.

### A.4.4 CVN impact test

#### A.4.4.1 Pipe body

The minimum average (set of three test pieces) CVN energy for the pipe body shall be in accordance with API Spec 5L, 46th edition (2018), Table G.1 or Table G.2 as specified by the purchaser. Single values of the CVN energy shall be at minimum 75 % of the minimum specified mean value. The test temperature shall be 0 °C (32 °F), or if agreed a lower test temperature.

If no transverse test pieces can be obtained, see A.7.3.3, longitudinal test pieces shall be tested. The required absorbed energy for longitudinal test pieces shall be 50 % higher than the specified energy for transverse test pieces.

### A.4.4.2 Pipe weld and heat affected zone

The minimum average (set of three test pieces) absorbed energy for pipe weld and heat affected zone, based upon full-size test pieces and a test temperature of 0 °C (32 °F), or if agreed a lower test temperature, shall be 40 J (30 ft·lbf).

## A.5 Tolerances for diameter, wall thickness, length, and straightness

**A.5.1** Except as allowed by API Spec 5L, 46th edition (2018), C.2.3, the diameter and out-of-roundness shall be within the tolerances given in in Table A.3.

**Table A.3 — Tolerances for diameter and out-of-roundness**

| **Specified outside diameter** *D* mm (in) | **Diameter tolerances**[a] mm (in) | | | | **Out-of-roundness tolerances**[a,e] mm (in) | |
|---|---|---|---|---|---|---|
| | **Pipe except the end** | | **Pipe end** | | **Pipe except the end** | **Pipe end**[b,c] |
| | **SMLS pipe** | **Welded pipe** | **SMLS pipe**[b] | **Welded pipe** | | |
| <60,3 (2.375) | ±0,5 (0.020) or ±0,007 5 *D*, whichever is the greater | ±0,5 (0.020) or ±0,007 5 *D*, whichever is the greater, but maximum of ±3,0 (0.125) | ±0,5 (0.020) or ±0,005 *D*[c] (whichever is the greater) but maximum of ±1,6 (0.063) | | Included in diameter tolerance | |
| ≥60,3 (2.375) to 610 (24.000) | | | | | 0,02 *D* | 0,015 *D* |
| >610 (24.000) to 1 422 (56.000) | ±0,01 *D* | ±0,005 *D*, but maximum of ±4,0 (0.160) | ±2,0 (0.079)[d] | ±1,6 (0.063)[d] | 0,015 *D*, but maximum of 15 (0.6), for $D/t \leq 75$ | 0,01 *D*, but maximum of 13 (0.5), for $D/t \leq 75$ |
| | | | | | 0,02 *D* for $D/t > 75$ | 0,015 *D* for $D/t > 75$ |
| >1 422 (56.000) | As agreed | | As agreed[d] | | As agreed[d] | |

[a] The pipe end includes a length of 100 mm (4.0 in) at each of the pipe extremities.

[b] For SMLS pipe, the tolerances apply for $t \leq 25{,}0$ mm (0.984 in) and the tolerances for heavier wall pipe shall be as agreed.

[c] Subject to agreement, the diameter tolerance may be applied to the inside diameter for $D \geq 219{,}1$ mm (8.625 in).

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

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

**A.5.2** The wall thickness shall be within the tolerances given in Table A.4.

**Table A.4 — Tolerances for wall thickness**

| **Wall thickness** *t* mm (in) | **Tolerances**[a] mm (in) |
|---|---|
| **SMLS pipe**[b] | |
| ≤4,0 (0.157) | 0,6 (0.024)<br>−0,5 (0.020) |
| >4,0 (0.157) to <25,0 (0.984) | +0,150 *t*<br>−0,125 *t* |
| ≥25,0 (0.984) | +3,7 (0.146) or +0,1 *t*, whichever is the greater<br>−3,0 (0.120) or −0,1 *t*, whichever is the greater |
| **Welded pipe**[c,d] | |
| ≤10,0 (0.394) | ±0,5 (0.020) |
| >10,0 (0.394) to <15,0 (0.591) | +0,1 *t*<br>−0,05 t |
| ≥15,0 (0.591) to <20,0 (0.787) | +1,5 (0.060)<br>−0,05 t |
| ≥20,0 (0.787) | +1,5 (0.060)<br>−1,0 (0.039) |

[a] If the purchase order specifies a minus tolerance for wall thickness smaller than the applicable value given in this table, the plus tolerance for wall thickness shall be increased by an amount sufficient to maintain the applicable tolerance range.

[b] For pipe with $D \geq 355{,}6$ mm (14.000 in) and $t \geq 25{,}0$ mm (0.984 in), the wall-thickness tolerance locally may exceed the plus tolerance for wall thickness by an additional 0,05 *t*, provided that the plus tolerance for mass [see API Spec 5L, 46th edition (2018), 9.14] is not exceeded.

[c] The plus tolerance for wall thickness does not apply to the weld area.

[d] See API Spec 5L, 46th edition (2018), 9.13.2 for additional restrictions.

**A.5.3** The out-of-squareness, measured as shown in API Spec 5L, 46th edition (2018), Figure 3, shall not exceed

a) 1,0 mm (0.040 in) for outside diameters $D \leq 219{,}1$ mm (8.625 in), or

b) 0,005 *D* but a maximum of 1,6 mm (0.063 in) for outside diameters $D > 219{,}1$ mm (8.625 in).

## A.6 Tolerances for the weld seam

### A.6.1 Radial offset of coil/plate edges

For SAW and COW pipe, the inside and outside radial offsets of the coil/plate edges [see API Spec 5L, 46th edition (2018), Figure 4 b) or Figure 4 c)] shall not exceed the applicable value given in Table A.5.

**Table A.5 — Maximum permissible radial offset for SAW and COW pipe**

| Specified wall thickness<br>*t*<br>mm (in) | Maximum permissible radial offset[a]<br>mm (in) |
|---|---|
| ≤10,0 (0.394) | 1,0 (0.039) |
| >10,0 (0.394) to 20,0 (0.787) | 0,1 *t* |
| >20,0 (0.787) | 2,0 (0.079) |

[a] These limits apply also to coil/plate end welds.

### A.6.2 Weld flash of HFW pipe

The inside flash shall not extend above the contour of the pipe by more than 0,3 mm (0.012 in) + 0,05 *t* to a maximum of 1,5 mm (0.060 in).

### A.6.3 Maximum height of the weld beads

Height of the weld beads of SAW and COW pipe shall not exceed the applicable value given in Table A.6.

**Table A.6 — Maximum permissible weld bead height for SAW and COW pipe (except at pipe ends)**

| Specified wall thickness<br>*t*<br>mm (in) | Weld bead height<br>mm (in)<br>max | |
|---|---|---|
| | inside | outside |
| ≤15 (0.590) | 3,0 (0.120) | 3,0 (0.120) |
| >15 (0.590) | 3,0 (0.120) | 4,0 (0.157) |

## A.7 Inspection

### A.7.1 Inspection certificate

**A.7.1.1** Conformance to the requirements of the purchase order shall be checked for products in accordance with this annex by specific inspection.

The purchaser shall specify the required type of inspection certificate (3.1 or 3.2) in accordance with EN 10204 [see API Spec 5L, 46th edition (2018), 10.1].

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

**A.7.1.2** The inspection certificate shall include, in accordance with EN 10168, the following codes and information:

— A commercial transactions and parties involved;

— B description of products to which the inspection certificate applies;

— C01 to C02 location of sample, direction of the test piece and, if applicable, testing temperature;

— C10 to C29 tensile test;

— C40 to C43 impact test and, if applicable, DWT test;

— C50 to C69 bend or flattening test;

— C71 to C92 cast analysis and product analysis;

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

— D02 to D99 non-destructive testing and hydrostatic test;

— Z validation.

### A.7.2 Specific inspection

The frequency of inspection shall be as given in API Spec 5L, 46th edition (2018), Table 18, except as specifically modified in Table A.7.

**Table A.7 — Inspection frequency**

| No | Type of inspection | Type of pipe | Frequency of inspection |
|---|---|---|---|
| 1 | Tensile testing of the pipe body of pipe with $D < 508$ mm (20.000 in) | SMLS, HFW, SAW, or COW | Once per test unit of not more than 100 lengths of pipe from the same heat of steel and with the same cold-expansion percentage[a] |
| 2 | Tensile testing of the pipe body of pipe with $D \geq 508$ mm (20.000 in) | SMLS, HFW, SAW, or COW | Once per test unit of not more than 50 lengths of pipe from the same heat of steel and with the same cold-expansion percentage[a] |
| 3 | Tensile testing of the longitudinal or helical seam weld of welded pipe with 219,1 mm (8.625 in) $\leq D <$ 508 mm (20.000 in) | HFW, SAW, or COW | Once per test unit of not more than 100 lengths of pipe from the same heat of steel and with the same cold-expansion percentage[a,b] |
| 4 | Tensile testing of the longitudinal or helical seam weld of welded pipe with $D \geq 508$ mm (20.000 in) | HFW, SAW, or COW | Once per test unit of not more than 50 lengths of pipe from the same heat of steel and with the same cold-expansion percentage[a,b,c] |
| 5 | Tensile testing of the coil/plate end weld of SAW pipe with $D \geq 219{,}1$ mm (8.625 in) | SAWH or COWH | Once per 50 coil/plate end welds from pipe with the same cold-expansion percentage[a,b,d] |
| 6 | CVN impact testing of the pipe body of pipe with $D <$ 508 mm (20.000 in) and specified wall thickness as given in API Spec 5L, 46th edition (2018), Table 22 (transverse test piece or either longitudinal test piece) | SMLS, HFW, SAW, or COW | Once per test unit of not more than 100 lengths of pipe from the same heat of steel and with the same cold-expansion percentage[a] |
| 7 | CVN impact testing of the pipe body of pipe with $D \geq 508$ mm (20.000 in) and specified wall thickness as given in API Spec 5L, 46th edition (2018), Table 22 | SMLS, HFW, SAW, or COW | Once per test unit of not more than 50 lengths of pipe from the same heat of steel and with the same cold-expansion percentage[a] |
| 8 | CVN impact testing of the longitudinal or helical seam weld of welded pipe with 114,3 mm (4.500 in) $\leq D <$ 508 mm (20.000 in) and specified wall thickness as given in API Spec 5L, 46th edition (2018), Table 22 | HFW, SAW, or COW | Once per test unit of not more than 100 lengths of pipe from the same heat of steel and with the same cold-expansion percentage[a,b] |

[a] The cold-expansion ratio is designated by the manufacturer, and is derived using the designated before-expansion outside diameter or circumference and the after-expansion outside diameter or circumference. An increase or decrease in the cold-expansion ratio of more than 0,002 requires the creation of a new test unit.

[b] Pipe produced by each welding machine shall be tested at least once per week.

[c] For double seam pipe, both longitudinal weld seams in the pipe selected to represent the test unit shall be tested.

[d] Applies only to finished helical seam pipe containing coil/plate end welds.

**Table A.7** *(continued)*

| No | Type of inspection | Type of pipe | Frequency of inspection |
|---|---|---|---|
| 9 | CVN impact testing of the longitudinal or helical seam weld of welded pipe with $D \geq 508$ mm (20.000 in) and specified wall thickness as given in API Spec 5L, 46th edition (2018), Table 22 | HFW, SAW, or COW | Once per test unit of not more than 50 lengths of pipe from the same heat of steel and with the same cold-expansion percentage[a,b,c] |
| 10 | CVN impact testing of the coil/plate end weld of welded pipe with $D \geq 114{,}3$ mm (4.500 in) and specified wall thickness as given in API Spec 5L, 46th edition (2018), Table 22 | SAWH, COWH | Once per 50 coil/plate end welds from pipe with the same cold-expansion percentage[a,b,d] |
| 11 | If agreed, DWT testing of the pipe body ($D \geq 508$ mm (20.000 in) and $t > 8$ mm (0.315 in), $R_{t0,5} > 360$ MPa) | SMLS, HFW, SAW, or COW | Once per test unit of not more than 50 lengths of pipe from the same heat of steel and with the same cold-expansion percentage[a] |
| 12 | If agreed, hardness testing of pipe body and of the longitudinal or helical seam weld and HAZ of welded pipe | HFW, SAW, or COW | Same frequency as macro- or metallographic examination |
| 13 | Pipe diameter and out-of-roundness on pipe ends | SMLS, HFW, SAW, or COW | Each pipe |
| 14 | Non-destructive inspection | SMLS, HFW, SAW, or COW | See Table A.10 |

[a] The cold-expansion ratio is designated by the manufacturer, and is derived using the designated before-expansion outside diameter or circumference and the after-expansion outside diameter or circumference. An increase or decrease in the cold-expansion ratio of more than 0,002 requires the creation of a new test unit.

[b] Pipe produced by each welding machine shall be tested at least once per week.

[c] For double seam pipe, both longitudinal weld seams in the pipe selected to represent the test unit shall be tested.

[d] Applies only to finished helical seam pipe containing coil/plate end welds.

## A.7.3 Samples and test pieces for mechanical and technological tests

### A.7.3.1 General

For tensile tests, CVN impact tests, guided-bend tests, flattening tests, and DWT test, the samples shall be taken and the corresponding test pieces shall be prepared in accordance with the applicable reference standard.

Samples and test pieces for the various test types shall be taken from locations as shown in API Spec 5L, 46th edition (2018), Figures 5 and 6, and as given in Table A.8, taking into account the supplementary details in API Spec 5L, 46th edition (2018), 10.2.3.2 to 10.2.3.7 and 10.2.4.

**Table A.8 — Number, orientation, and location of test pieces per sample for mechanical tests**

| Type of pipe | Sample location | Type of test | Number, orientation and location of test pieces per sample[a] | | |
|---|---|---|---|---|---|
| | | | Specified outside diameter *D* mm (in) | | |
| | | | <219,1 (8.625) | ≥219,1 (8.625) to <508 (20.000) | ≥508 (20.000) |
| SMLS, not cold-expanded [see API Spec 5L, 46th edition (2018), Figure 5 a)] | Pipe body | Tensile | 1L[b] | 1L[c] | 1L[c] |
| | | CVN | 3T | 3T | 3T |
| | | Drop weight tear | — | — | 2T |
| SMLS, cold-expanded [see API Spec 5L, 46th edition (2018), Figure 5 a)] | Pipe body | Tensile | 1L[b] | 1T | 1T |
| | | CVN | 3T | 3T | 3T |
| | | Drop weight tear | — | — | 2T |
| HFW [see API Spec 5L), 46th edition (2018), Figure 5 b)] | Pipe body | Tensile | 1L90[b] | 1T180 | 1T180 |
| | | CVN | 3T90 | 3T90 | 3T90 |
| | | Drop weight tear | — | — | 2T90 |
| | Seam weld | Tensile | — | 1W | 1W |
| | | CVN | 3W | 3W | 3W |
| | Pipe body and weld | Flattening | As shown in API Spec 5L, 46th edition (2018), Figure 6 | | |
| SAWL, COWL [see API Spec 5L, 46th edition (2018), Figure 5 b)] | Pipe body | Tensile | 1L90[b] | 1T180 | 1T180 |
| | | CVN | 3T90 | 3T90 | 3T90 |
| | | Drop weight tear | — | — | 2T90 |
| | Seam weld | Tensile | — | 1W | 1W[d] |
| | | CVN | 3W and 3HAZ | 3W and 3HAZ | 3W and 3HAZ[d] |
| | | Guided-bend | 2W | 2W | 2W[d] |
| SAWH, COWH [see API Spec 5L, 46th edition (2018), Figure 5 c)] | Pipe body | Tensile | 1L[b] | 1T | 1T |
| | | CVN | 3T | 3T | 3T |
| | | Drop weight tear | — | — | 2T |
| | Seam weld | Tensile | — | 1W | 1W |
| | | CVN | 3W and 3HAZ | 3W and 3HAZ | 3W and 3HAZ |
| | | Guided-bend | 2W | 2W | 2W |
| | Coil/plate end weld | Tensile | — | 1WS | 1WS |
| | | CVN | 3WS and 3HAZ | 3WS and 3HAZ | 3WS and 3HAZ |
| | | Guided-bend | 2WS | 2WS | 2WS |

[a] See API Spec 5L), 46th edition (2018), Figure 5 for an explanation of the symbols used to designate orientation and location.

[b] Full-section longitudinal test pieces may be used at the option of the manufacturer.

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

[d] For double-seam pipe, both longitudinal weld seams in the pipe selected to represent the test unit shall be tested.

### A.7.3.2 Tensile test pieces

Rectangular test pieces, representing the full wall thickness of the pipe, shall be taken in accordance with ISO 6892-1 and API Spec 5L, 46th edition (2018), Figure 5.

#### A.7.3.3 CVN impact test pieces

If the smallest permitted transverse test piece is not obtainable, the greatest possible defined standard longitudinal test piece width between 10 mm (0.394 in) and 5 mm (0.197 in) shall be used.

#### A.7.3.4 Test pieces for the guided-bend test

The test pieces shall be prepared in accordance with ISO 5173 and API Spec 5L, 46th edition (2018), Figure 8. For pipes with a wall thickness $t$ > 20 mm (0.787 in), the test pieces may be machined to provide a rectangular cross section having a thickness of 19 mm (0.748 in). Full wall thickness curved section test pieces are mandatory for pipe with wall thickness $t \leq 20$ mm (0.787 in).

The weld reinforcement shall be removed from both faces.

### A.7.4 Test methods

#### A.7.4.1 Tensile test

The tensile test shall be carried out in accordance with ISO 6892-1.

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

The percentage elongation after fracture shall be reported with reference to a proportional gauge length of $5{,}65\sqrt{S_o}$ where $S_o$ is the initial cross-sectional area. If another gauge length is used, the measured value shall be converted to a proportional elongation result in accordance with ISO 2566-1.

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

#### A.7.4.2 CVN impact test

The impact test shall be carried out in accordance with ISO 148-1 and the required striker radius is 2 mm.

#### A.7.4.3 Hydrostatic test

The minimum permissible wall thickness per this Annex A shall be used for determining the required test pressures [see API Spec 5L, 46th edition (2018), 10.2.6.7].

#### A.7.4.4 Guided-bend test

The bend test shall be carried out in accordance with ISO 5173. The mandrel dimension shall be as indicated in Table A.9 for the appropriate steel grade. Both test pieces shall be bent through approximately 180°, one with the root of the weld, and the other with the face of the weld, directly under the mandrel.

**Table A.9 — Requirements for the mandrel diameter in the guided bend test**

| Pipe steel grade | Weld seam of SAW and COW pipes |
|---|---|
| | Diameter<br>$A_{gb}$<br>mm |
| L245NE or BNE<br>L245ME or BME | 3$t$ |
| L290NE or X42NE<br>L290ME or X42ME | |
| L360NE or X52NE<br>L360QE or X52QE<br>L360ME or X52ME | 4$t$ |
| L415NE or X60NE<br>L415QE or X60QE<br>L415ME or X60ME | 5$t$ |
| L450QE or X65QE<br>L450ME or X65ME<br>L485QE or X70QE<br>L485ME or X70ME<br>L555QE or X80QE<br>L555ME or X80ME | 6$t$ |

#### A.7.4.5 Flattening test

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

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

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

c) Flatten until opposite walls of the pipe meet.

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

### A.7.5 Non-destructive testing

#### A.7.5.1 General

The non-destructive test requirements and acceptance levels are defined in Table A.10.

#### A.7.5.2 NDT personnel

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

The qualification for level 1 and level 2 shall be in accordance with ISO 11484 or equivalent standard. Level 3 personnel shall meet the requirements of ISO 9712 or equivalent standard.

Manufacturers shall authorize all NDT personnel in accordance with a documented procedure. All NDT operations shall be authorized by a level 3 NDT individual approved by the manufacturer.

**Table A.10 — Survey of non-destructive tests**

| 1 | 2 | 3 | 4 | | 5 |
|---|---|---|---|---|---|
| **No** | **NDT operation** | **Test** | **Types of test and requirements, acceptance level** | | **Reference API Spec 5L, 46th edition (2018)** |
| **Seamless and welded pipes** | | | | | |
| 1 | Residual magnetism at the pipe ends | M | Hall effect gauss meter or equivalent; 30 Gs max., random testing | | E.7 |
| 2 | Laminar imperfections at the pipe ends | O | Ultrasonic test ISO 10893-8:2011, acceptance limit: 6 mm (0.236 in) max. circumferentially | | E.3.2.3<br>E.3.3.2 |
| **Seamless pipe** | | | | | |
| 3 | Longitudinal imperfections (including the pipe ends, where applicable; see A.7.5.4) | M | | Ultrasonic test ISO 10893-10:2011, acceptance level U3 or, by agreement, U2 | K.3.1 |
| | | | or | [by agreement for $t$ < 10 mm (0.394 in)]<br>Flux leakage test ISO 10893-3:2011, acceptance level F3 or, by agreement, F2 | K.3.4.2 |
| **High frequency welded pipe** | | | | | |
| 4 | Longitudinal imperfections in the weld (including the pipe ends, where applicable; see A.7.5.4) | M | | Ultrasonic test ISO 10893-10:2011 or ISO 10893-11:2011, acceptance level U3 or, by agreement U2 | K.4.1 |
| | | | or | [by agreement for $t$ < 10 mm (0.394 in)]<br>Flux leakage test ISO 10893-3:2011, acceptance level F3 or, by agreement, F2 | K.3.4.2 (also for HFW) |
| | | | or | [by agreement for $D$ < 273,1 mm (10.75 in); $t$ < 6,3 mm (0.248 in); $t/D$ < 0,18]<br>Eddy current test ISO 10893-2:2011, acceptance level E2H (concentric or segment coil technique) | K.3.4.3 (also for HFW) |
| 5 | Laminar imperfections in the pipe body | O | Ultrasonic test ISO 10893-9:2011, acceptance level U2 or ISO 10893-8:2011, acceptance level U2 | | E.8.1 |
| 6 | Laminar imperfections on coil edges/area adjacent to weld seam | O | Ultrasonic test ISO 10893-9:2011 or ISO 10893-8:2011, acceptance level U2 | | E.9 |
| **Submerged arc welded/Combination welded pipe** | | | | | |
| 7 | Longitudinal/ transverse imperfections in the weld | M | Ultrasonic test ISO 10893-11:2011, acceptance level U2/U2H or "two lambda" calibration method (also for the coil end weld of helically welded pipe) | | K.5.1[a] |
| | | | Radiographic inspection ISO 10893-6:2019 or 10893-7:2019, image quality class B, acceptance limits in accordance with A.7.5.6, for T-joints of helically welded pipe | | A.7.5.6 |
| 8 | Laminar imperfections in the pipe body | O | Ultrasonic test ISO 10893-9:2011, acceptance level U2 | | E.8.2 |

**Key**

M: mandatory test

O: optional test for mandatory requirement.

[a] In these subclauses, the reference to API Spec 5L, 46th edition (2018), E.4 (radiographic inspection of the weld seam) shall be replaced by A.7.5.6 for this annex only.

**Table A.10** *(continued)*

| 1 | 2 | 3 | 4 | | 5 |
|---|---|---|---|---|---|
| **No** | **NDT operation** | **Test** | **Types of test and requirements, acceptance level** | | **Reference API Spec 5L, 46th edition (2018)** |
| 9 | Laminar imperfections on coil or plate edges/area adjacent to weld seam | O | Ultrasonic test ISO 10893-9:2011 or ISO 10893-8:2011, acceptance level U2 | | E.9 |
| 10 | NDT of the weld seam at pipe ends (untested ends)/repaired areas | M | | Ultrasonic test ISO 10893-11:2011 to requirements of API 5L K.5.1.1[a] on longitudinal imperfections, acceptance level U2/U2H | K.5.1.1[a] |
| | | | or | (unless otherwise agreed)<br>Radiographic inspection ISO 10893-6:2019 or ISO 10893-7:2019, image quality class B on longitudinal imperfections | A.7.5.6 |
| | | | and | Ultrasonic test ISO 10893-11:2011 or radiographic test<br>Radiographic inspection ISO 10893-6:2019 or ISO 10893-7:2019 on transverse imperfections, acceptance limits in accordance with API 5L K.5.3 b)[a] | K.5.3 b)[a] |

**Key**

M: mandatory test

O: optional test for mandatory requirement.

[a] In these subclauses, the reference to API Spec 5L, 46th edition (2018), E.4 (radiographic inspection of the weld seam) shall be replaced by A.7.5.6 for this annex only.

### A.7.5.3 Timing of NDT operations

Unless otherwise agreed, NDT of the weld seam of HFW pipe with outside diameter $D < 219{,}1$ mm (8.625 in) and full body NDT of seamless pipe shall be carried out, at the discretion of the manufacturer, before or after the hydrostatic test. NDT of the weld seam of SAW and COW pipe, and HFW with $D \geq 219{,}1$ mm (8.625 in), shall be carried out after the hydrostatic test.

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

### A.7.5.4 Untested pipe ends

In many of the automatic NDT operations specified in this annex, there can be a short length at both pipe ends that cannot be tested. In such cases one of the following applies:

a) the untested ends shall be cropped off;

b) in the case of seamless or HFW pipe, the untested ends shall be subjected to a manual/semiautomatic test using the same technique, test sensitivity, test parameters, etc. as specified in the relevant subclause of this annex where, for manual testing, the scanning speed shall not exceed 150 mm/s (6.0 in/s);

c) in the case of SAW and COW pipe, the provisions of API Spec 5L, 46th edition (2018), K.5.3 shall apply.

#### A.7.5.5 Suspect pipe

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

Suspect pipe shall be dealt with in accordance with the provisions for "Acceptance" as given in the relevant standard for NDT of pipe (see the parts of the ISO 10893 series referenced in Clause 2), except where otherwise stated in this annex. 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 that originally deemed the pipe suspect. For manual ultrasonic testing, the scanning speed shall not exceed 150 mm/s (6.0 in/s).

#### A.7.5.6 Radiographic inspection of the weld seam

##### A.7.5.6.1 Radiographic techniques

Where applicable, radiographic inspection of the weld seam shall be conducted in accordance with ISO 10893-6:2019 to image quality class B for film radiography or ISO 10893-7:2019 for digital radiography, with the conditions given in A.7.5.6.4 a) to c).

##### A.7.5.6.2 Film radiography

The sensitivity requirements, based on Table A.11, established on the base material shall be verified by use of an ISO wire penetrameter in accordance with ISO 19232-1 or, if so agreed, by use of an equivalent hole penetrameter.

Only X-ray radiation, using fine-grain, high-contrast direct film with lead screen, shall be used.

The density of the radiograph shall be in accordance with API Spec 5L, 46$^{th}$ edition (2018), E.4.2.3.

##### A.7.5.6.3 Digital radiography

The sensitivity requirements, based on Table A.11, established on the base material shall be verified by use of an ISO wire penetrameter in accordance with ISO 19232-1 or, if so agreed, by use of an equivalent hole penetrameter.

The density of the radiograph shall be in accordance with API Spec 5L, 46$^{th}$ edition (2018), E.4.2.3.

Digital radiographic inspection systems and processes shall be in accordance with API Spec 5L, 46$^{th}$ edition (2018), E.4.4.3.

**Table A.11 — Sensitivity requirements for the radiographic inspection image quality class B, in accordance with ISO 10893-6:2019**

| Wall thickness<br>$t$<br>mm (in) | Visibility required | |
|---|---|---|
| | Of the hole with a diameter<br>mm (in) | Of the wire with a diameter<br>mm (in) |
| $4{,}5 \le t < 10$ ($0.177 \le t < 0.394$) | 0,40 (0.016) | 0,16 (0.006) |
| $10 \le t < 16$ ($0.394 \le t < 0.630$) | 0,50 (0.020) | 0,20 (0.008) |
| $16 \le t < 25$ ($0.630 \le t < 0.984$) | 0,63 (0.025) | 0,25 (0.010) |
| $25 \le t < 32$ ($0.984 \le t < 1.260$) | 0,80 (0.031) | 0,32 (0.013) |
| $32 \le t \le 40$ ($1.260 \le t \le 1.575$) | 1,00 (0.039) | 0,40 (0.016) |

#### A.7.5.6.4 Acceptance limits

The acceptance limits for radiographic inspection of the weld seam shall be as given as follows:

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

   Individual circular slag inclusions and gas pockets up to 3,0 mm (0.118 in) or $t/3$ in diameter whichever is the smaller, are acceptable.

   The sum of the diameters of all such permitted individual imperfections in any 150 mm (6.0 in) or 12 $t$ of weld length, whichever is the smaller, shall not exceed 6,0 mm (0.236 in) or 0,5 $t$ whichever is the smaller, where the separation between individual inclusions is less than 4 $t$.

b) Individual elongated slag inclusions up to 12,0 mm (0.472 in) or 1 $t$ in length, whichever is the smaller, or up to 1,6 mm (0.063 in) width are acceptable. The maximum accumulated length of such permitted individual imperfections in any 150 mm (6.0 in) or 12 $t$ of weld length, whichever is the smaller, shall not exceed 12,0 mm (0.472 in), where the separation between individual inclusions is less than 4 $t$.

c) Individual undercuts of any length having a maximum depth of 0,4 mm (0.016 in) are acceptable.

d) Individual undercuts of a maximum length of $t/2$ having a maximum depth of 0,8 mm (0.032 in) 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 (11.8 in) of the weld length, and all such undercuts are dressed out.

e) Any undercuts exceeding the above limits shall be repaired [see API Spec 5L, 46$^{th}$ edition (2018), 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.

## A.8 Pipe markings

In addition to the pipe markings required in 4.4, the pipe markings shall include an identification number that permits the correlation of the product or delivery unit with the related inspection certificate.

## A.9 Steel designations

Table A.12 gives guidance on steel designations (steel numbers) that are used in Europe additionally to the steel name.

**Table A.12 — Corresponding additional steel designations (steel numbers) for use in Europe**

| Steel grades for pipe for service in Tables A.1 and A.2 | |
|---|---|
| **Steel name in accordance with ISO 3183** | **Steel number in accordance with EN 10027-2** |
| L245NE | 1.0457 |
| L290NE | 1.0484 |
| L360NE | 1.0582 |
| L415NE | 1.8972 |
| L360QE | 1.8948 |
| L415QE | 1.8947 |
| L450QE | 1.8952 |
| L485QE | 1.8955 |
| L555QE | 1.8957 |
| L245ME | 1.0418 |
| L290ME | 1.0429 |
| L360ME | 1.0578 |
| L415ME | 1.8973 |
| L450ME | 1.8975 |
| L485ME | 1.8977 |
| L555ME | 1.8978 |

# Bibliography

[1] Spec API 5L, 43rd edition (March 2004), *Specification for Line Pipe*

[2] Spec API 5L, 44th edition (October 2007), *Specification for Line Pipe*

[3] Spec API 5L, 45th edition (December 2012), *Specification for Line Pipe*

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

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