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EN 10246-6

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English version

Non-destructive testing of steel tubes - Part 6: Automatic full peripheral ultrasonic testing of seamless steel tubes for the detection of transverse imperfections

Essais non destructifs des tubes en acier - Partie 6: Contrôle automatique par ultrasons sur toute la circonférence des tubes pour la détection des imperfections transversales des tubes en acier sans soudure

Zerstörungsfreie Prüfung von Stahlrohren - Teil 6: Automatische Ultraschallprüfung nahtloser Stahlrohre über den gesamten Rohrumfang zum Nachweis von Querfehlern

This European Standard was approved by CEN on 6 October 1999.

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

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

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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of an identical text or by endorsement, at the latest by May 2000, and conflicting national standards shall be withdrawn at the latest by May 2000.

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association. This European Standard is considered to be a supporting standard to those application and product standards which in themselves support an essential safety requirement of a New Approach Directive and which make reference to this European Standard.

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

1 Scope

This Part of EN 10246 specifies the requirements for automatic ultrasonic shear wave testing of seamless steel tubes for the detection of transverse imperfections. The standard specifies acceptance levels and calibration procedures.

This Part of EN 10246 is applicable to the inspection of tubes with an outside diameter equal to or greater than 10 mm.

European Standard EN 10246 "Non-destructive testing of steel tubes" comprises the Parts shown in annex A.

2 General requirements

2.1 The ultrasonic inspection covered by this Part of EN 10246 is usually carried out on tubes after completion of all the primary production process operations.

2.2 The tubes to be tested shall be sufficiently straight and free from foreign matter as to ensure the validity of the test.

3 Method of test

3.1 The tubes shall be tested using an ultrasonic shear wave technique for the detection of predominantly transverse imperfections.

3.2 During testing the tube and the transducer assembly shall be moved relative to each other so that the whole of the tube surface is scanned.

It is recognized that there may be a short length at both tube ends which cannot be tested. Any untested ends shall be dealt with in accordance with the requirements of the appropriate product standards (see also annex B).

The relative speed during testing shall not vary by more than +10 %.

3.3 During testing, the tubes shall be scanned in two opposite longitudinal directions of beam travel, unless otherwise agreed between purchase and manufacturer.

3.4 The ultrasonic test frequency applied shall be in the range of 1 MHz to 15 MHz dependant upon the thickness and surface finish of the tubes to be tested.

3.5 The maximum width of each individual transducer, measured at right angles to the major axis of tube, shall be 25 mm.

3.6 The equipment shall be capable of classifying tubes as either acceptable or suspect tubes by means of an automatic trigger/alarm level combined with a marking and/or sorting system.

3.7 Where manual ultrasonic testing of untested tube ends and/or local suspect areas is required, this shall be carried out in accordance with annex B.

4 Reference standards

4.1 General

4.1.1 The reference standards defined in this Part of EN 10246 are convenient standards for calibration of non-destructive testing equipment. The dimensions of these standards should not be construed as the minimum size of imperfections detectable by such equipment.

4.1.2 The ultrasonic equipment shall be calibrated using a transverse reference notch on the outside surface of a tubular test piece. By agreement between purchaser and manufacturer and for internal diameter greater than 20 mm, both external and internal notches may be used.

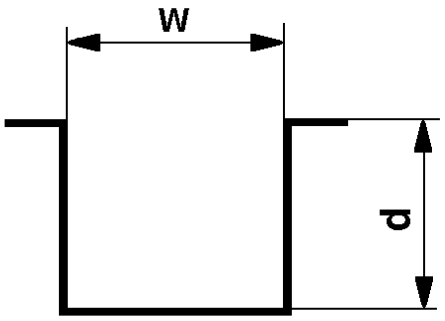
NOTE: The internal surface of the test piece may be dressed or machined prior to the preparation of the internal notch.

4.1.3 The test piece shall be of the same specified diameter, thickness, surface finish and heat treatment conditions as the tube to be tested and shall have similar acoustic properties (for example velocity, attenuation coefficient).

4.1.4 The external notch (and the internal notch when used) shall be sufficiently separated from the ends of the test piece and from each other (when both are used), so that clearly distinguishable signal indications are obtained.

4.2 Types of references notches

4.2.1 The reference notch shall be of the "N" type (see figure 1) and shall be transverse to the major axis of the tube. The sides shall be nominally parallel and the bottom shall be nominally square to the sides.



w = width *d* = depth

Figure 1: "N" type notch

4.2.2 The reference notch shall be formed by machining, spark erosion or other methods.

NOTE: It is recognized that the bottom or the bottom corners of the notch may be rounded.

4.2.3 The reference notch used shall be one of the form shown in figures 2 at the discretion of the manufacturer.

4.3 Dimensions of reference notch

4.3.1 The width, *w* (see figure 1), of the reference notch shall not be greater than 1,0 mm.

4.3.2 The reference notch depth (see figure 1) shall be as given in table 1 with the following limitations:

- the minimum notch depth is related to the type of tube used for a particular application and is denoted by a sub-category as given in table 2, unless otherwise agreed between purchaser and manufacturer;

- the maximum notch depth for all acceptance levels and sub-categories shall be 1,5 mm, with the exception that in the case of tubes with a thickness greater than 50 mm, the maximum notch depth shall be agreed between purchase and manufacturer.

4.3.3 The tolerance on notch depth shall be ± 15 % of the reference notch depth or ± 0,05 mm whichever is the larger at the deepest point, with the exception that when the notch depth is less than 0,2 mm, the tolerance on the depth shall be ± 0,03 mm.

4.3.4 The length of the reference notch, as far as it is not specified by the type of notch (chord notch, arc notch - see figures 2c to 2e), shall be at least 25 mm.

4.4 Verification of reference notch

The reference notch dimensions and shape shall be verified by a suitable technique.

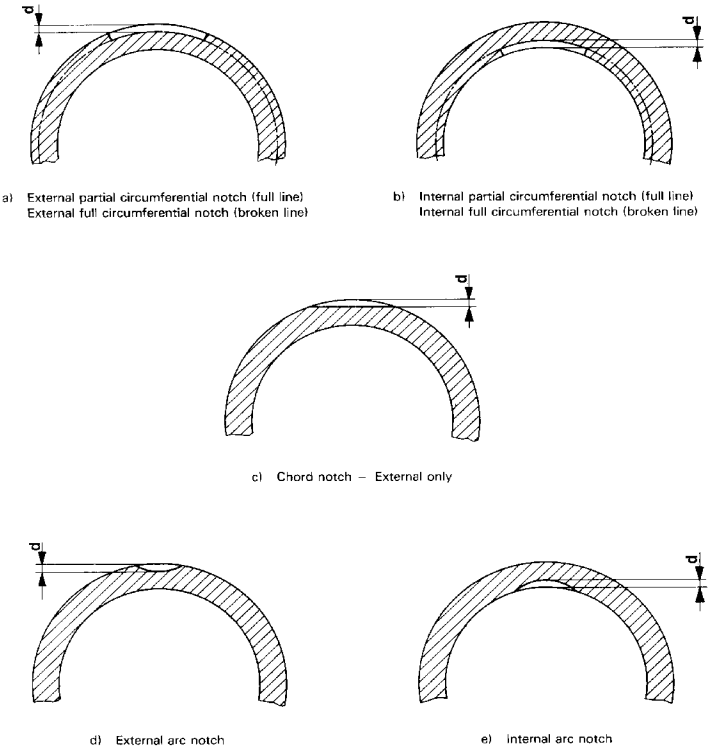


Figure 2: Transverse notch forms

Table 1: Acceptance level designation and corresponding reference notch depth

Acceptance level	Notch depth in % of the specified thickness (see note)
U1	3
U2	5
U3	10
U4	12,5
U5	15
U6	20

Note. The values of notch depth specified in this table are the same for the corresponding categories, in all European Standards concerning non-destructive testing of steel tubes where reference is made to different acceptance levels. It should, however, be kept in mind that although the reference standards are identical, the various test methods involved can give different test results. Accordingly the acceptance level designation prefix U (ultrasonic) has been adopted to avoid any inferred direct equivalence with other test methods.

Table 2: Minimum notch depth categories

Sub-category	Minimum notch depth (mm)	Typical tube condition
A	0,1	Cold
B	0,2	finished tubes
C	0,3	All other
D	0,5	condition
Note: The minimum notch depth that can be used for ultrasonic equipment calibration in order to achieve an acceptable signal/noise ratio is related to specific tube manufacturing methods where the surface finish plays a dominant role.		

5 Equipment calibration and checking

5.1 The equipment shall be calibrated to produce consistently, (e.g. from three consecutive passes of the test piece through the equipment), clearly identifiable signals from the reference standard(s) (see 4.1.2). The full amplitude of these signals shall be used to set the trigger/alarm level(s) of the equipment as follows.

When using the external reference notch only with:

a) a single trigger/alarm level, and the gated period encompasses half-skip (internal) and first-skip (external) echoes, the full first-skip amplitude from the external notch shall be used to set the trigger/alarm level of the equipment; when the gated time-period encompasses first-skip (external) and one-and-a-half skip (internal) echoes, the full second-skip signal amplitude from the external notch shall used to set the trigger/alarm level of the equipment;

or

b) separate trigger/alarm levels from segregation of internal and external echoes, the full amplitude from the external notch (usually the first full-skip) occurring within the external gated time-period shall be used to set the external trigger/alarm level; while the full signal amplitude of the full-skip external notch (usually either the first or second full-skip) signal occurring immediately after the internal gated time-period shall be used to set the internal trigger/alarm level.

When using both internal and external reference notches with:

a) a single trigger/alarm level, the full signal amplitude of the lesser of the two signals from the internal and external notches shall be used to set the trigger/alarm level of the equipment;

or

b) separate trigger/alarm levels from segregation of internal and external notch echoes, the full amplitude from each notch shall be used to set the relevant trigger/alarm level of the equipment.

5.2 During calibration check, the relative speed of movement between the test piece and the transducer assembly shall be the same as that to be used during the production test. Semi-dynamic calibration checking may be used.

5.3 The calibration of the equipment shall be checked at regular intervals during the production testing of tubes of the same specified diameter, thickness and grade by passing the test piece through the test equipment.

The frequency of checking the calibration shall be at least every four hours but also whenever there is an equipment operator team changeover and at the start and end of production.

5.4 The equipment shall be recalibrated if any of the parameters which were used during the initial calibration are changed.

5.5 If on checking during production testing the calibration requirements are not satisfied, even after increasing the test sensitivity by 3 dB to allow for system drift, then all tubes tested since the previous equipment check shall be retested after the equipment has been recalibrated.

6 Acceptance

6.1 Any tube producing signals lower than the trigger/alarm level shall be deemed to have passed this test.

6.2 Any tube producing signals equal to or greater than the trigger/alarm level shall be designated suspect or, at the manufacturer's option, may be retested.

6.3 If on retesting no signal is obtained equal to or greater than the trigger/alarm level, the tube shall be deemed to have passed this test.

Tubes giving signals equal to or greater than the trigger/alarm level shall be designated suspect.

6.4 For suspect tubes, one or more of the following actions shall be taken, subject to the requirements of the product standard:

a) The suspect area shall be dressed or explored by a suitable method. After checking that the remaining thickness is within tolerance, the tube shall be tested as previously specified. If no signals are obtained equal to or greater than the trigger/alarm level, the tube shall be deemed to have passed this test.

   The suspect area may be retested by other non-destructive techniques and test methods, by agreement between purchaser and manufacturer to agreed acceptance levels.

b) The suspect area shall be cropped off. The manufacturer shall ensure that all the suspect area has been removed.

c) The tube shall be deemed not to have passed the test.

7 Test reporting

When specified, the manufacturer shall provide the purchaser with, at least, the following information:

a) reference to this Part of EN 10246;

b) date of test report;

c) acceptance level and sub-category;

d) statement of conformity;

e) product designation by grade and size;

f) type and details of inspection technique;

g) description of the reference standard.

Annex A
(informative)

Table of Parts of EN 10246 - Non-destructive testing of steel tubes

Purpose of test	Title of part	Part no.	ISO ref.
Leak tightness	Automatic electromagnetic testing of seamless and welded (except submerged arc-welded) ferromagnetic steel tubes for verification of hydraulic leak-tightness.	1	9302
	Automatic eddy current testing of seamless and welded (except submerged arc-welded) austenitic and austenitic-ferritic steel tubes for verification of hydraulic leak-tightness.	2	-
Longitudinal and/or transverse imperfections	Automatic eddy current testing of seamless and welded (except submerged arc-welded) steel tubes for the detection of imperfections	3	9304
	Automatic full peripheral magnetic transducer/flux leakage testing of seamless ferromagnetic steel tubes for the detection of transverse imperfections	4	9598
	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	5	9402
	Automatic full peripheral ultrasonic testing of seamless steel tubes for the detection of transverse imperfections.	6	9305
	Automatic full peripheral ultrasonic testing of seamless and welded (except submerged arc-welded) steel tubes for the detection of longitudinal imperfections.	7	9303
	Automatic ultrasonic testing of the weld seam of electric welded steel tubes for the detection of longitudinal imperfections.	8	9764
	Automatic ultrasonic testing of the weld seam of submerged arc-welded steel tubes for the detection of longitudinal and/or transverse imperfections.	9	9765
	Radiographic testing of the weld seam of automatic fusion arc welded steel tubes for the detection of imperfections	10	12096
Surface imperfections	Liquid penetrant testing of seamless and welded steel tubes for the detection of surface imperfections.	11	12095
	Magnetic particle inspection of seamless and welded ferromagnetic steel tubes for the detection of surface imperfections	12	13665
Thickness	Automatic full peripheral ultrasonic thickness testing of seamless and welded (except submerged arc-welded) steel tubes.	13	10543
Laminar imperfections	Automatic ultrasonic testing of seamless and welded (except submerged arc-welded) steel tubes for the detection of laminar imperfections.	14	10124
	Automatic ultrasonic testing of strip/plate used in the manufacture of welded steel tubes for the detection of laminar imperfections.	15	12094
	Automatic ultrasonic testing of the areas adjacent to the weld seam of welded steel tubes for the detection of laminar imperfections.	16	13663
	Ultrasonic testing of the tube ends of seamless and welded steel tubes for the detection of laminar imperfections	17	11496
	Magnetic particle inspection of the tube ends of seamless and welded ferromagnetic steel tubes for the detection of laminar imperfections.	18	13664

Annex B
(normative)

Manual/semi-automatic ultrasonic testing of untested ends/suspect areas

B.1 Untested tube ends

When specified by the relevant product standard, tube end zones which cannot be tested by the automatic ultrasonic equipment shall be subjected to a manual/semi-automatic ultrasonic test around the full periphery of the tube, from the ultimate tube ends and over the length of the original untested zone plus 10 %.

The manual/semi-automatic ultrasonic test shall be carried out so that the whole surface of the untested end is scanned with a 10 % overlap of adjacent scanning paths, with reference to the ultrasonic transducer width used, measured in the direction at right angles to the major axis of the tube.

The manual/semi-automatic ultrasonic test shall be carried out using the ultrasonic shear wave technique, test sensitivity (reference notch depth) and general test parameters, as used during the original automatic test on the main tube length, with the restrictions given in B.3 below.

B.2 Local suspect areas

Where appropriate, local areas on the tube deemed suspect by the automatic ultrasonic equipment shall be subjected to a manual ultrasonic test using the ultrasonic shear wave technique, test sensitivity (reference notch depth) and general test parameters, as used during the original automatic test, with the restrictions given in B.3 below, so that the whole of the local suspect area is scanned.

B.3 Manual ultrasonic test restrictions

The following restrictions apply to the application of a manual ultrasonic test to untested end zones and/or local suspect areas.

B.3.1 The scanning speed over the tube surface shall not exceed 150 mm/s.

B.3.2 Scanning shall be carried out in two opposite directions of ultrasonic beam travel.

B.3.3 The nominal ultrasonic test frequency of the transducer used in manual testing shall not vary from that used during the original automatic test by more than $\pm$ 1MHz.

B.3.4 The width of the transducer, measured at right angles to the major axis of the tube, used in the manual ultrasonic test shall not exceed that used during the original automatic test.

B.3.5 The ultrasonic angle in steel used during manual ultrasonic testing shall be nominally the same as that used during the original automatic test.

B.3.6 The ultrasonic transducer type to be used during manual ultrasonic testing shall be of the contact, gap-scan or immersion type. Means shall be provided to ensure that the transducer is held at the correct attitude in relation to the tube surface, e.g. for

contact type transducers, the “wear-face” at the front face of the transducer shall be profiled to the radius of curvature of the tube under test.