BRITISH STANDARD

BS EN
10246-15:2000

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

The European Standard EN 10246-15:2000 has the status of a British Standard

ICS 23.040.10; 77.040.20: 77.140.50

National foreword

This British Standard is the official English language version of EN 10246-15:2000.

This British Standard contains elements of BS 3889-1, *Non-destructive testing of pipes and tubes — Part 1: Methods of ultrasonic testing for the detection of imperfections in wrought steel tubes*. A complete list of the parts of EN 10246 is given in annex A of this standard. When all relevant parts have been published BS 3889-1:1983 will be withdrawn.

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

— aid enquirers to understand the text;

— present to the responsible European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;

— monitor related international and European developments and promulgate them in the UK.

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

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Summary of pages

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EUROPEAN STANDARD

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EN 10246-15

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English version

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

Essais non destructifs des tubes en acier – Partie 15: Contrôle automatique par ultrasons pour la détection des dédoublures dans les bandes/plaques utilisées pour la fabrication des tubes en acier soudés

Zerstörungsfreie Prüfung von Stahlrohren – Teil 15: Automatische Ultraschallprüfung von Band/Bech, das für die Herstellung geschweißter Stahlrohre eingesetzt wird, zum Nachweis von Dopplungen

This European Standard was approved by CEN on 25 December 1999.

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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 August 2000, and conflicting national standards shall be withdrawn at the latest by August 2000.

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1 SCOPE

This part of EN 10246 specifies requirements for the ultrasonic testing of strip/plate used in the manufacture of welded tubes for the detection of laminar imperfections. The standard specifies acceptance levels and calibration procedures.

NOTE 1: In the case of welded tube, an alternative ultrasonic testing specification for the detection of laminar imperfections is available which may be applied at the manufacturer's option by ultrasonic testing of the tube subsequent to seam welding in accordance with EN 10246-14.

NOTE 2: At the discretion of the manufacturer, the requirements of this part of EN 10246 may be applied to finished submerged arc welded (SAW) tubes.

This part of EN 10246 is applicable to the inspection of strip/plate with a thickness greater than or equal to 4,0 mm.

European Standard EN 10246, Non-destructive testing of steel tubes, comprises the parts shown in Annex A.

2 GENERAL REQUIREMENTS

2.1 This ultrasonic inspection of strip/plate shall be carried out before or during pipe production in the flat form.

2.2 The strip/plate to be tested shall be sufficiently free from surface irregularities and foreign matter so as to ensure the validity of the test.

3 METHOD OF TEST

3.1 The strip/plate shall be tested using an ultrasonic pulse echo technique for the detection of laminar imperfections with ultrasound transmitted in the direction normal to the strip/plate surface or using the ultrasonic through-transmission technique at the discretion of the manufacturer.

3.2 During testing, the strip/plate and the transducer assembly shall be moved relative to each other so that the strip/plate surface is scanned along equidistant scan lines parallel or transverse to the principal rolling direction of the strip/plate, with a minimum coverage and maximum allowable gap between adjacent scanning tracks as given in table 1. For the oscillating technique, the minimum coverage shall be half the values given in table 1.

Table 1: Acceptance level designation and minimum coverage of the strip/plate (C_{min}) and maximum gap between adjacent scanning tracks

Acceptance level	Coverage C_{min} %	Maximum gap between adjacent scanning tracks mm
U1	20	100
U2	10	150
U3	5	200

3.3 The longitudinal strip/plate edges shall be 100 % ultrasonically inspected for the detection of laminar imperfections over a width of at least 15 mm plus, if appropriate, the total width of the edge material which will be removed from each original strip/plate edge prior to seam welding in order to detect the relevant minimum imperfection length L_{min} as given in table 2.

NOTE: The longitudinal edges are defined as those parallel to the principle rolling direction.

Table 2: Acceptance level designation and minimum laminar imperfection length (L_{min}) on the strip/plate edges to be detected (trigger/alarm condition)

Acceptance level	Minimum length of laminar imperfections L_{min} mm
S 1	10
S 2	20
S 3	30

3.4 The maximum dimension of each individual transducer measured at right angles to the scanning direction shall be 30 mm.

NOTE: In the case of twin crystal probes with different sizes of transducer within the transducer assembly, the dimension of the smallest transducer shall be used to calculate the coverage.

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

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 imperfection detectable by such equipment.

4.1.2 The ultrasonic equipment shall be calibrated either electronically using a test piece (see 5.1.a)) or with a reference standard comprising flat bottomed circular, square or rectangular recess (see figure 1) machined into the surface of a flat test piece (see 5.1.b)).

The flat bottomed circular reference standard shall be used as the primary means of establishing the test sensitivity. When using one of the other types of reference standards, the test sensitivity shall be adjusted such that it is equivalent to that obtained when using the flat bottomed circular recess.

For the through-transmission technique, either the recess shall be filled with a suitable attenuating material or a suitable attenuating material of the same dimensions as the reference standard shall be attached to the surface of the test piece.

4.1.3 The test piece shall have a similar surface finish and similar acoustic properties (e.g. velocity, attenuation coefficient) as the strip/plate to be tested. The test piece selected by the manufacturer for calibration purposes shall be of convenient length and width.

4.2 Dimensions of reference standards

4.2.1 The dimensions of the rectangular recess reference standards (see figure 1) shall be as follows:

a) width, w : 6 mm, $^{+10\ \%}_{0}$;

b) length, l : 6 mm min;

c) depth, d : $T/4 < d < T/2$, with a maximum of 10 mm.

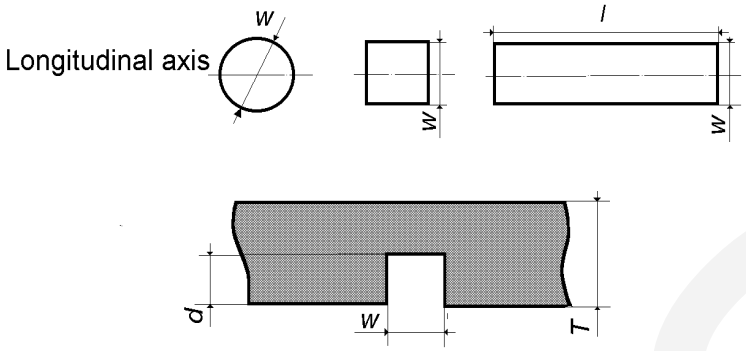
4.2.2 The dimensions of the circular and square recess reference standards (see figure 1) shall be as follows:

a) width or diameter, w : 6 mm, $^{+10\ \%}_{0}$;

b) depth, d : $T/4 < d < T/2$, with a maximum of 10 mm.

4.3 Verification of reference standards

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



l = length of rectangular recess *w* = width or diameter of recess

d = depth of recess *T* = specified wall thickness

Figure 1 - Reference recess forms (reference standards)

5 EQUIPMENT CALIBRATION AND CHECKING

5.1 The equipment shall be calibrated statically either without reference standard in accordance with 5.1.a) or using a reference standard in accordance with 5.1.b).

a) Calibration without reference standard:

With the transducer assembly positioned on the test piece, the full amplitude of the first back-wall echo minus 6 dB shall be used to set the trigger/alarm level of the equipment.

The test sensitivity may also be established with DAC[1)] curves as supplied by the transducer manufacturer or with DAC curves as prepared by the tube manufacturer using, in both cases, the 6 mm flat bottom hole curve.

At the commencement of the production test run, the manufacturer shall demonstrate that at the set sensitivity, the equipment will detect under static conditions the reference standard as given in 4.1.2 and figure 1. If this is not the case, the necessary adjustment in sensitivity shall be made prior to the production test run.

b) Calibration using a reference standard:

Under static conditions, with the transducer or each transducer of a transducer assembly centrally located over the reference standard, the full signal amplitude of the signal obtained from the reference standard shall be used to set the trigger/alarm level of the equipment.

[1)] DAC = Distance amplitude correction

5.2 During production testing of the strip/plate, the relative translational speeds and pulse repetition frequency shall be chosen so that the minimum coverage values and maximum separation values between adjacent scanning tracks given in table 1 are obtained.

5.3 The calibration of the equipment shall be checked at regular intervals during the production testing of strip/plate of the same specified thickness and grade.

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

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

If agreed between manufacturer and purchaser, this recalibration is not required in the case of automatic equipment with self-calibration.

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 strip/plate tested since the previous check shall be retested after the equipment has been recalibrated.

6 ACCEPTANCE

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

6.2 Any strip/plate 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 strip/plate shall be deemed to have passed this test.

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

NOTE: If applicable, the evaluation may be based on DAC curves.

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

a) The suspect area shall be explored by a manual ultrasonic compression wave method in accordance with Annex B to establish the extent of the laminar imperfections. The product shall be deemed to have passed this test if the size and frequency of the laminar imperfections do not exceed the values given in table 3 and 4. If the width of the laminar imperfections exceed the minimum width to be considered (see also the note of table 3), an area of 500 mm x 500 mm with the indication in the centre shall be explored 100 % to establish the presence of other laminar imperfections exceeding B_{max} and to determine if the population density of laminar imperfections > B_{min} and < B_{max} exceeds the permissible values in table 3. In the event of further laminar imperfections exceeding the minimum width to be considered being detected, the exploration shall be extended for a further area of 500 mm x 500 mm with the new indication at the centre.

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

c) The strip/plate shall be deemed not to have passed this test.

Table 3: Acceptance limits on strip/plate body[1)]

Acceptance level	Width of lamination to be considered min. mm	Individual lamination area		Maximum cumulative area of laminations > B_{min} to < B_{max}[2)]	
		Minimum area to be considered B_{min}[2)] mm²	Maximum acceptable area B_{max}[2)] mm²	Local population density per m strip/plate length. mm² max	Mean value per m of total strip/plate length mm² max.
U1	12	165 + *w*/4	165 + *w* with a max. of 2500 mm²	0,01 *w* x 1000	0,005 *w* x 1000
U2	15	165 + *w*/2	165 + 2 *w* with a max. of 5000 mm²	0,02 *w* x 1000	0,01 *w* x 1000
U3	20	165 + *w*	165 + 4 *w* with a max. of 10000 m²	0,04 *w* x 1000	0,02 *w* x 1000

1) B_{min} and B_{max} shall, when calculated as the product of length and width of lamination, be rounded up to the next 10 mm².

2) *w* = strip/plate width

NOTE: For determining the extent of the laminated suspect area, adjacent suspect areas separated by less than the smaller of the two minor axes of the laminations shall be considered as one lamination

Table 4: Acceptance limits strip/plate edges

Acceptance level	Maximum individual laminar imperfections [1)]		Maximum number of laminar imperfections[1)] per m of edge length where:
	Length L_{max} mm	Size (product of length and width) E_{max} mm²	L_{min}[2)] < *L* < L_{max} and *E* < E_{max}
U 1	20	250	3
U 2	40	500	4
U 3	60	1000	5

1) Only laminar imperfections exceeding 6 mm in width are to be considered.

2) See table 2 for $L_{min.}$

NOTE: For determining the extent of the laminated suspect area, adjacent suspect areas separated by less than the smaller of the two minor axes of the laminations shall be considered as one lamination

7 TEST REPORTING

When specified, the manufacturer shall submit to the purchaser a test report including at least the following information:

a) reference to this part of EN 10246;

b) date of test report;

c) acceptance level;

d) statement of conformity;

e) product designation by grade and size;

f) type and details of inspection technique;

g) description of the reference standard, if used;

h) equipment calibration method used.

ANNEX A
(informative)

Table A.1: 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)

Procedure for the determination of the size of laminar imperfections by manual ultrasonic testing

B.1 GENERAL

This annex describes the procedure for manual ultrasonic pulse echo scanning of strip/plate for the determination of the extent of laminated suspect areas found by automatic/semi-automatic testing of strip/plate for the detection of laminar imperfections.

In cases of dispute, between the manufacturer and the purchaser, or his representative regarding the extent and frequency of detected laminar imperfections, this procedure shall be used. This procedure determines the details of the sizing method to establish the extent and frequency of laminar imperfections in strip/plate.

B.2 TEST PROCEDURE

Laminar imperfections shall be located by comparing the amplitude of the imperfection echo with the amplitude of the echo of a 6 mm flat bottom hole located at the same depth as the imperfection.

Only those imperfections giving an echo at least equivalent in amplitude to that obtained with the 6 mm flat bottom hole shall be considered.

In order to determine the extent of laminar imperfections to be considered, the method of measuring the half-amplitude value shall be used.

This method requires that the ultrasonic probe is passed over the laminated suspect area in two directions, transverse (X) and longitudinal (Y). The suspect location shall be 100 % scanned as described in 6.4.a). During the transverse scan, the positions X1 and X2 shall be determined, where, over the greatest transverse extent, the magnitude of the intermediate reflection equals half the related maximum value (6 dB difference in signal level). If this value is less than the minimum allowable width to be considered, no further explorations shall be done. Similarly, during the longitudinal scan, the positions Y1 and Y2 are determined. The distances between point X1 and X2 and Y1 and Y2 are defined as the maximum width and length dimensions respectively. The product of these dimensions is defined as the area of equivalent laminar imperfection.

B.3 SURFACE CONDITION

The surface of strip/plate shall be sufficiently free from foreign matter as to ensure the validity of the test.

B.4 TEST EQUIPMENT REQUIREMENTS

B.4.1 The ultrasonic probe shall be guided over the strip/plate either manually or by mechanical means. The ultrasound shall be transmitted in the direction normal to the strip/plate surface.

B.4.2 One of the following two types of ultrasonic testing equipment shall be used:

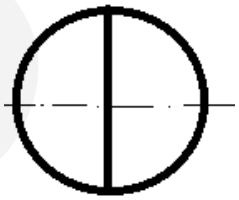
a) Equipment with a screen display and gain control adjustable in 2 dB steps. The gain control shall be adjusted so that the ultrasonic signals from the laminated suspect area to be evaluated are between 20 % and 80 % of the usable height of the screen display.

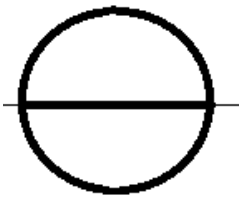
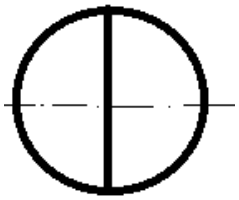
b) Equipment without a screen display where automatic signal amplitude measurement/ assessment facilities are used. The amplitude measuring unit shall be capable of signal amplitude assessment in steps not exceeding 2 dB.

B.4.3 If twin crystal probes are used for manual determination of the size of the laminated suspect area, the details given in table B.1 shall be noted.

Table B.1

<table>
<tr><th>Probe-to-lamination distance</th><th>Type of twin crystal probe</th><th>Plane of acoustic separation</th></tr>
<tr><td rowspan="2">≤ 20 mm</td><td>either

– Nominal frequency: 4 MHz
– Transducer angle: approx. 5°
– Transducer size: 8 to 12,5 mm
– Focal depth: approx. 10 to 12 mm</td><td>At right angles to PRD [1)]
  </td></tr>
<tr><td>or

– Nominal frequency: 4 MHz
– Transducer angle: approx. 0°
– Transducer size: 18 to 20 mm
– Focal depth: approx. 10 to 12 mm</td><td>Parallel to PRD [1)]
  </td></tr>
<tr><td>> 20 mm</td><td>– Nominal frequency: 4 MHz
– Transducer angle: approx. 0°
– Transducer size: 18 to 20 mm
– Focal depth: approx. 25 to 60 mm</td><td>At right angles to PRD [1)]
  </td></tr>
<tr><td colspan="3">1) PRD = Principal rolling direction</td></tr>
</table>

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