BRITISH STANDARD

BS EN
10246-16:2000

Non-destructive testing of steel tubes —

Part 16: Automatic ultrasonic testing of the area adjacent to the weld seam of welded steel tubes for the detection of laminar imperfections

The European Standard EN 10246-16:2000 has the status of a British Standard

ICS 23.040.10; 25.160.40; 77.040.20

National foreword

This British Standard is the official English language version of EN 10246-16:2000.

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 When all relevant parts have been published BS 3889-1:1983 will be withdrawn.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, Steels 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.

Cross-references

The British Standards which implement international or European publications referred to in this document may be found in the BSI Standards Catalogue under the section entitled "International Standards Correspondence Index", or by using the "Find" facility of the BSI Standards Electronic Catalogue.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

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

Summary of pages

This document comprises a front cover, an inside front cover, the EN title page, pages 2 to 12, an inside back cover and a back cover.

The BSI copyright notice displayed in this document indicates when the document was last issued.

This British Standard, having been prepared under the direction of the Engineering Sector Committee, was published under the authority of the Standards Committee and comes into effect on 15 June 2000

ISBN 0 580 34174 7

Amendments issued since publication

Amd. No.	Date	Comments

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 10246-16

February 2000

ICS 23.040.10; 25.160.40; 77.040.20

English version

Non-destructive testing of steel tubes – Part 16: Automatic ultrasonic testing of the area adjacent to the weld seam of welded steel tubes for the detection of laminar imperfections

Essais non destructifs sur des tubes en acier – Partie 16: Contrôle automatique par ultrasons pour la détection des dédoublures dans la zone soudée des tubes en acier soudés

Zerstörungsfreie Prüfung von Stahlrohren – Teil 16: Automatische Ultraschallprüfung des an die Schweißnaht angrenzenden Bereiches geschweißter Stahlrohre zum Nachweis von Dopplungen

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

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CEN member.

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

CEN members are the national standards bodies of Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

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

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

Ref. No. EN 10246-16:2000 E

CONTENTS

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.

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 requirements for the ultrasonic testing of the area adjacent to the weld of welded steel tubes for the detection of laminar imperfections. The standard specifies acceptance levels and calibration procedures.

NOTE: This inspection may alternatively, in accordance with EN 10246-15, be carried out on longitudinal edges of strip/plate (used in the manufacture of welded tubes) in the flat form prior to seam welding. Electric welded tubes may alternatively be inspected in accordance with EN 10246-14 assuming that the scanning coverage used is sufficient to detect the minimum imperfection length given in table 1.

This part of EN 10246 is applicable to the inspection of welded tubes with an outside diameter greater than 30 mm. No lower limit of wall thickness is specified but see note in 4.1.

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

2 NORMATIVE REFERENCES

This part of EN 10246 incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of those publications apply to this part of EN 10246 only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

EN 10246-10 Non-destructive testing of steel tubes - Part 10: Radiographic testing of the weld seam of automatic fusion arc welded steel tubes for the detection of imperfections

3 GENERAL REQUIREMENTS

3.1 The ultrasonic inspection covered by this part of EN 10246 may be performed at any stage in the production process after seam welding.

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

4 METHOD OF TEST

4.1 The area adjacent to the weld seam of the welded tube shall be tested using the ultrasonic pulse echo technique for the detection of laminar imperfections. The ultrasound shall be transmitted in the direction normal to the tube surface.

NOTE: For wall thicknesses less than 5 mm, where difficulties may occur in detecting and sizing laminar imperfections using this method of test, an alternative method of test may be agreed between manufacturer and purchaser.

4.2 During testing, the tubes and the transducer assembly shall be moved relative to each other so that at least a 15 mm wide band on either side of the weld as close as possible to the parent metal/weld interface is 100 % ultrasonically inspected for the detection of laminar imperfections in order to detect the relevant minimum imperfection length L_{min} (parallel to the weld) as given in table 1.

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.

Table 1: Acceptance level designation and minimum laminar imperfection length (L_{min}) to be detected (trigger/alarm condition)

Acceptance level	Minimum laminar imperfection length L_{min} mm
U1	10
U2	20
U3	30

4.3 The maximum width of each individual transducer, measured at right angles to the direction of scanning, shall be 30 mm. The ultrasonic transducer test frequency shall be 2 to 10 MHz.

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

5 REFERENCE STANDARDS

5.1 General

5.1.1 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.

5.1.2 The ultrasonic equipment shall be calibrated either electronically using a tubular test piece (see 6.1.a)) or with a reference standard comprising flat bottomed circular or rectangular recess (see 6.1.b)) machined into the inner surface or on the external surface of a tubular test piece. For the external surface, the reference standard may be blocked off by means of a piece of steel of corresponding dimension and fixed by welding.

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

5.1.3 The test piece shall be of the same nominal diameter, thickness and surface finish as the tube to be tested and shall have similar acoustic properties (e.g. velocity, attenuation coefficient).

5.2 Dimensions of reference standards

5.2.1 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.

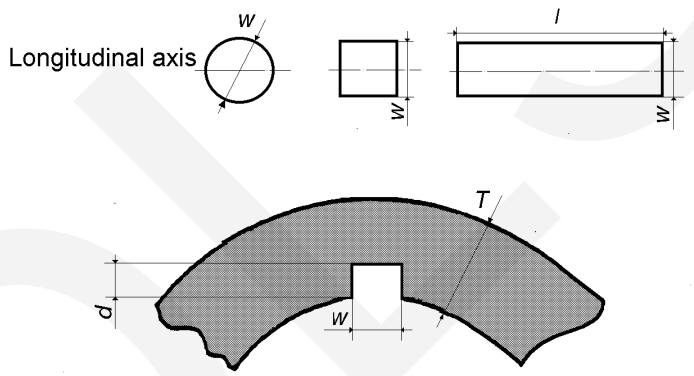
5.2.2 The dimensions of the circular and square recess reference standards (see figure 1 shall) be as follows:

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

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

5.3 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)

6 EQUIPMENT CALIBRATION AND CHECKING

6.1 The equipment shall be calibrated statically either without reference standard in accordance with 6.1.a) or using a reference standard in accordance with 6.1.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 can 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 circular recess reference standard as given in 5.1.2 and figure 1. If this is not the case, the necessary adjustment in sensitivity shall be made prior to the testing of production tubes.

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 recess, the full signal amplitude of the signal obtained from the reference standard shall be used to set the trigger/alarm level of the equipment.

6.2 During the production testing of the tubes, the relative translational speed and pulse repetition frequency shall be chosen in order to detect the minimum laminar imperfection length L_{min} as given in table 1 by producing a trigger/alarm condition.

6.3 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.

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 the production run.

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

6.5 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 check shall be retested after the equipment has been recalibrated.

7 ACCEPTANCE

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

7.2 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.

[1)] DAC = Distance amplitude correction

7.3 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.

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

7.4 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 explored by a manual ultrasonic compression wave method according to Annex B or by a suitable automatic or semi-automatic system to establish the extent of the laminar imperfections. The tube shall be deemed to have passed this test if the laminar imperfection size (E_{max}, L_{max}) and the maximum population density, as given in table 2, are not exceeded.

Table 2: Acceptance limits

Acceptance level	Maximum individual laminar imperfection [1]		Maximum number of laminar imperfections [1] per m of tube length where
	Length	Size (product of length and width)	
	L_{max} mm	E_{max} mm^2	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 1 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.

b) In the case of spiral and longitudinal submerged arc welded tubes, and by agreement between purchaser and manufacturer, the weld seam in the vicinity of laminar imperfections exceeding the relevant acceptance limits given in table 2 may be subjected to radiographic inspection in accordance with EN 10246-10 to disclose the presence of imperfections in or at the extremities of the weld seam which may has escaped detection during ultrasonic weld seam inspection due to the presence of such laminar imperfections.

c) Crop off the suspect area. The manufacturer shall ensure that all the suspect area has been removed.

d) The tube shall be deemed not to have passed this test.

8 TEST REPORTING

When specified, the manufacturer shall provide the purchaser with a test report that includes, 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 equipment;

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 tubes for the determination of the extent of laminated suspect areas found by automatic/semi-automatic testing of tubes 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 tubes.

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 7.4.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 the equivalent laminar imperfection.

B.3 SURFACE CONDITION

The surface of tubes 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 tube either manually or by mechanical means. The ultrasound shall be transmitted in the direction normal to the tube surface.

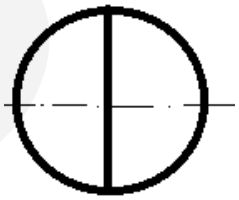
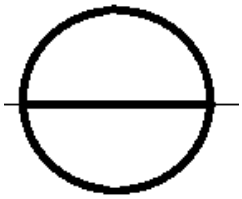
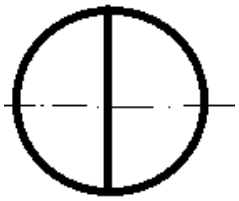
B.4.2 One of the following two types of ultrasonic testing equipment shall be used:

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

Probe-to-lamination distance	Type of twin crystal probe	Plane of acoustic separation
≤ 20 mm	either – Nominal frequency: 4 MHz – Transducer angle: approx. 5° – Transducer size: 8 to 12,5 mm – Focal depth: approx. 10 to 12 mm	At right angles to PRD [1)] 
	or – Nominal frequency: 4 MHz – Transducer angle: approx. 0° – Transducer size: 18 to 20 mm – Focal depth: approx. 10 to 12 mm	Parallel to PRD [1)] 
> 20 mm	– Nominal frequency: 4 MHz – Transducer angle: approx. 0° – Transducer size: 18 to 20 mm – Focal depth: approx. 25 to 60 mm	At right angles to PRD [1)] 
1) PRD = Principal rolling direction		

blank

BSI — British Standards Institution

BSI is the independent national body responsible for preparing British Standards. It presents the UK view on standards in Europe and at the international level. It is incorporated by Royal Charter.

Revisions

British Standards are updated by amendment or revision. Users of British Standards should make sure that they possess the latest amendments or editions.

It is the constant aim of BSI to improve the quality of our products and services. We would be grateful if anyone finding an inaccuracy or ambiguity while using this British Standard would inform the Secretary of the technical committee responsible, the identity of which can be found on the inside front cover. Tel: 020 8996 9000. Fax: 020 8996 7400.

BSI offers members an individual updating service called PLUS which ensures that subscribers automatically receive the latest editions of standards.

Buying standards

Orders for all BSI, international and foreign standards publications should be addressed to Customer Services. Tel: 020 8996 9001. Fax: 020 8996 7001.

In response to orders for international standards, it is BSI policy to supply the BSI implementation of those that have been published as British Standards, unless otherwise requested.

Information on standards

BSI provides a wide range of information on national, European and international standards through its Library and its Technical Help to Exporters Service. Various BSI electronic information services are also available which give details on all its products and services. Contact the Information Centre. Tel: 020 8996 7111. Fax: 020 8996 7048.

Subscribing members of BSI are kept up to date with standards developments and receive substantial discounts on the purchase price of standards. For details of these and other benefits contact Membership Administration. Tel: 020 8996 7002. Fax: 020 8996 7001.

Copyright

BSI
389 Chiswick High Road
London
W4 4AL